Instructions for Use

English

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Ingenia/Ingenia S

PHILIPS

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1 Introduction

Publication Details

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About these Instructions for Use

These Instructions for Use assist Users and operators in the safe and effective operation of their Philips MRI system.

The ‘User’ is considered to be the body with authority over the system; ‘operators’ are those persons who actually handle the system.

Before you operate the system:

- Read, note and strictly observe all danger notices and safety markings on and around the MRI system.
- Read these Instructions for Use thoroughly. Pay particular attention to all warnings, cautions and notes. Pay special attention to all the information and procedures described in chapter “Safety” on page 27.

Safe operation of the MR equipment, as installed and maintained according to Philips’ instructions, requires adherence to all warnings in this IFU. When adhered to, the residual safety risk of the use of Philips MR equipment is evaluated by the manufacturer to be acceptable.

The Instructions for Use of any applied equipment, other than the MR scanner, shall be considered as integral part of the safety and operational requirements, beyond those described in the Instruction for Use of the Philips MR system.

WARNING

Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazard with a low level or risk which, if not avoided, could result in minor or moderate injury.

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NOTICE

Used to highlight information that is considered important but that is not hazard related, such as unusual points or hints for efficiency.

These Instructions for Use, describe the most extensive configuration of the system, including all options and accessories. Not every function described in the Instructions for Use may be available on your system.

Contact your Philips representative to discuss available options.

Contact your local Philips representative for an overview of available options, accessories and other supporting materials.

Other Instructions

Technical Description

The Technical Description provides additional data essential for safe operation, and measures or conditions necessary for installing the MR system. A PDF of the Technical Description is located in the User Documentation folder on the console. The Technical Description is also included in the online Help menu.

Help system

The Help system contains the Instructions for Use, the Technical Description, and gives basic and advanced scanning information. To access the Help system, do one of the following:

- On the menu bar, click **Help**, then **Help Topics**.
- Press the **F1** key.

Context sensitive help

The MR system software includes a context-sensitive Help functionality. This functionality leads you directly from the user interface to the related topic in the Help system. To use the context-sensitive Help:

► Hover over the user interface element your want more information about.

► Press the **F1** key.

⇨ The Help system opens on the relevant page. If context-sensitivity is not available, the home page of the Help system will open.

About function

A summary of relevant hardware and software information is available in the About function. To access the About function:

► On the menu bar, click **Help**, then **About**.

Addendum

With these Instructions for Use a separate addendum may be available. This addendum contains latest information about your system, which is not included in these Instructions for Use. It is important to read and familiarize yourself with the content of the addendum, when available. To access the addendum:

- ► On the menu bar, click **Help**, then **User Documentation**.
- ► Select **Addendum**.
- ⇨ A PDF of the addendum opens.

PDF documents

To access PDF documents of the Instructions for Use, Addendum, Technical Description, DICOM Conformance statement, and IHE Integration statement, on the menu bar, click **Help**, then **User Documentation**. Links will be provided to the PDF documents in the user interface language.

If you require PDF documents of any of these documents in another language than the user interface language:

- ► Press the **Windows** key.
- ► Select **All programs**, then **MR Applications**, then **User Documentation**.
- ► Select the required language.
- ► Select the required document.

Info text for ExamCards and protocols

An editable info text window is available for each scan protocol and ExamCard. See chapter “Info ” on page 401

MR-RT and MR-OR systems

When your Philips MRI system is used in combination with the Philips MR-RT oncology configuration, refer to the MR-RT Instructions for Use for additional information.
When your Philips MRI system is used in combination with the Philips MR-OR solution, refer to the MR-OR Instructions for Use for additional information.

Additional equipment

Additional equipment that is used with the MRI system may have their own Instructions for Use. Always consult the Instructions for Use of the manufacturer of the additional equipment. Only use MR Safe or MR Conditional equipment near your MRI system (also see chapter “Auxiliary Medical equipment” on page 75)

About the system

General and Principle of operation

Philips Ingenia systems are digital broadband Magnetic Resonance Imaging systems.

The operation of Magnetic Resonance Imaging systems is based on the principle that certain atomic nuclei present in the human body will emit a weak relaxation signal when placed in a strong magnetic field and excited by a radio signal at the precession frequency.
The emitted relaxation signals are analyzed by the system and a computed image reconstruction is displayed on a video screen.

Indications for Use

Philips Magnetic Resonance (MR) systems are Medical Electrical Systems indicated for use as a diagnostic device.
This MR system enables trained physicians to obtain cross-sectional images, spectroscopic images and/or spectra of the internal structure of the head, body or extremities, in any orientation, representing the spatial distribution of protons or other nuclei with spin.

Image appearance is determined by many different physical properties of the tissue and the anatomy, the MR scan technique applied, and presence of contrast agents.
The use of contrast agents for diagnostic imaging applications should be performed consistent with the approved labeling for the contrast agent.
The trained clinical user can adjust the MR scan parameters to customize image appearance, accelerate image acquisition, and synchronize with the patient’s breathing or cardiac cycle.
The systems can use combinations of images to produce physical parameters, and related derived images. Images, spectra, and measurements of physical parameters, when interpreted by a trained physician, provide information that may assist diagnosis and therapy planning. The accuracy of determined physical parameters depends on system and scan parameters, and must be controlled and validated by the clinical user.

In addition the Philips MR systems provide imaging capabilities, such as MR fluoroscopy, to guide and evaluate interventional and minimally invasive procedures in the head, body and extremities. MR Interventional procedures, performed inside or adjacent to the Philips MR system, must be performed with MR Conditional or MR Safe instrumentation as selected and evaluated by the clinical user for use with the specific MR system configuration in the hospital. The appropriateness and use of information from a Philips MR system for a specific interventional procedure and specific MR system configuration must be validated by the clinical user.

Compatibility

Do not use your Philips MRI system in combination with other equipment or components, unless the equipment or components are expressly labelled as MR Safe or MR Conditional (see chapter “Auxiliary Medical equipment” on page 75).

Changes and/or additions to the system should only be carried out by a Philips service engineer, or by third parties expressly authorized by Philips. Such changes and/or additions must comply with all applicable laws and regulations that have the force of law within the jurisdiction(s) concerned, and with best engineering practice.

Changes and/or additions to the system that are carried out by persons without the appropriate training and/or using unapproved spare parts may lead to the Philips warranty being voided. As with all complex technical systems, maintenance by persons not appropriately qualified

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and/or using spare parts that do not meet Philips' specifications carries serious risks of damage to the system and of personal injury. Please be aware that Philips does not validate the use of non-Philips provided parts with this system. Validation is done to ensure product performance will meet its specification and Instructions for Use. System performance issues arising from parts not meeting the above requirements will be the responsibility of the User as its use is not validated by Philips.

Technical information to facilitate testing of compatibility of auxiliary equipment, is provided in the Technical Description.

The MRI is intended for use in a professional healthcare facility environment.

NOTICE

The EMISSIONS characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A). If it is used in a residential environment (for which CISPR 11 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services. The user might need to take mitigation measures, such as relocating or re-orienting the equipment.

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Compliance

Philips MRI systems comply with relevant international and national standards and laws. Information on compliance will be supplied on request by your local Philips Healthcare representative.

In particular, the MR system is designed in compliance with IEC60601-2-33 (Basic Safety and Essential Performance of MR Systems), which includes IEC60601-1 (Basic Safety and Essential Performance of Medical Electrical Equipment and Systems) and its collaterals.

IEC-60601-2-33 is the MR Safety standard published by the International Electrotechnical Commission.

Philips MRI systems comply with relevant international and national law and standards on EMC (electromagnetic compatibility) for this type of equipment when used as intended. Such laws and standards define both the permissible electromagnetic emission levels from equipment, and its required immunity to electromagnetic interference from external sources.

Use and operation of this system is subject to the law in the jurisdiction(s) in which the system is being used. Both users and operators must only use and operate the system in such ways as do not conflict with applicable laws or regulations which have the force of law. Both users and operators must be trained appropriately and have taken notice especially of the safety paragraphs in these Instructions for Use.

CAUTION

In the United States, Federal law restricts this device to sale by or on the order of a physician.

Training

Before you attempt to operate the Philips MRI system described in these Instructions for Use, you must have received adequate training on its safe and effective use. Training requirements for this type of device will vary from country to country. Training must be adequate and in accordance with local laws or regulations which have the force of law.

Training for the following emergency procedures must be included:

- Medical emergency
- Fire
- Using the Emergency Magnet Off button
- Actions in case of a quench
- (Unauthorized) access to the Controlled Access Area

Philips provides application training for safe and effective use of general system functions and for dedicated application packages. If you require further information about training, contact your Philips application specialist.

Installation, Maintenance and Repair

Installation, maintenance and repair instructions for the system described are supplied by Philips Healthcare in separate documentation.
Installation, maintenance and repair must be performed by appropriately trained personnel.

The user is responsible to (at least weekly) check the integrity of system and coil covers, coil cables, and accessories. Contact Philips Healthcare for information on the system maintenance program.

Philips Healthcare can only accept responsibility for basic safety, reliability and (essential) performance, if:

- qualified personnel carry out assembly operations, extensions, readjustments or repairs,
- the electrical installation of the technical room complies with the appropriate requirements, and
- the system is used in accordance with the Instructions for Use.

WARNING

The MR equipment/system must emit electromagnetic energy in order to perform its intended function. When installed according to Philips guidelines, electromagnetic emission will be compliant to IEC60601-1-2. The Responsible Organization is advised to evaluate any nearby electronic equipment for the need of additional shielding or repositioning to ensure proper operation. Guidance for such evaluations may be found in e.g. AAMI TIR18:2010.

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Equipment classification

EQUIPMENT CLASSIFICATION	
Classification according to IEC-60601-1	
According to the type of protection against electrical shock:	Class I equipment.
According to the degree of protection against electric shock:	Type B and type BF applied parts.
According to the degree of protection against harmful ingress of water:	Ordinary equipment (enclosed equipment without protection against ingress of water, IPX0).
According to the methods of sterilization or disinfection:	Non sterilizable. Use of Liquid surface disinfectants only.
According to the mode of operation:	Continuous operation.

The following (electrical component containing or weight bearing) parts of the system are considered suitable for direct contact with the patient in normal use conditions, i.e. are considered Applied Parts per IEC60601-1:

- Tabletops.
- VCG sensors and module.
- PPU sensors and module.
- All cord-connected RF coils.

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2 Safety

This Safety chapter covers general MRI Safety. Make sure you read, understand and know all safety information in this chapter before you use the MRI system.

Safety instructions for specific workflows or MRI components are presented in the relevant chapters of these Instructions for Use.

The User is responsible to ensure adequate training and oversight over all safety matters related to the MRI system. Local regulations may apply.

NOTICE

Any serious incident that has occurred in relation to the device should be reported to the manufacturer.

In the European Economic Area (EEA), the incident should also be reported to the Competent Authority that the Member State, in which the user and/or patient is established, has designated responsible for the implementation of Regulation (EU) 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices.

In the United States of America, the Medical Device Reporting regulation contains mandatory requirements for manufacturers, importers, and device user facilities to report certain device-related adverse events and product problems to the FDA.

Follow the applicable laws or regulations on reporting device-related incidents or adverse events in the jurisdiction(s) in which the system is being used.

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Safety before scanning

Prescreening

The User must ensure that all patients and MRI personnel are adequately screened before they are allowed near MRI equipment. Prescreening is essential to prevent injury which may result from exposure to the MRI equipment or an MRI examination.

This specifically applies to patients and MRI personnel who could be at risk of injury due to:

- Their present medical condition.
- Their past medical history.
- Their past or current occupation.

See chapter “Risk factors for MRI-related adverse events” on page 33.

When prescreening patients, exercise particular caution for those patients with:

- A contraindication for MRI examination (see chapter “Contraindications” on page 28).
- An MR Conditional implant (see chapter “MR Conditional implants” on page 31).

- A higher than normal likelihood of requiring emergency medical treatment due to their present medical condition (see chapter “Risk factors for MRI-related adverse events” on page 33).
- A higher than normal likelihood of requiring emergency medical treatment as a result of strong electromagnetic fields when the system operates in first level controlled operating mode, such as anesthetized patients or patients with restricted thermoregulatory capacity (see chapter “Operating modes” on page 38).

If patient eligibility for an MRI scan is unclear, do not scan the patient. Consult the responsible physicians. A qualified physician must evaluate the risk:benefit ratio of the MRI examination for every patient before scanning.

Contraindications

In general, an MRI examination is contraindicated for patients with one or more of the following:

- An active implant (for example a cardiac pacemaker) unless the implant is explicitly marked as MR Safe.
- A metallic or ferromagnetic implant (for example an intracranial aneurysm clip) unless the implant is explicitly marked as MR Safe.
- A body core temperature greater than 39.5 °C.

  Local regulations may specify additional contraindications. See chapter “MR implant labeling” on page 29 for more information about implant labels.

For implants that are labeled MR Safe or MR Conditional, make sure that both these conditions are met before scanning:

- The responsible physician approved the patient for MR scanning.
- The conditions specified by the implant manufacturer are strictly adhered to.

  See chapter “MR implant labeling” on page 29 and chapter “MR Conditional implants” on page 31 for more information.

WARNING

The MRI system may cause implant malfunction or displacement.

Risk of serious patient injury or death.

- **Do not allow persons with implants to enter the Controlled Access Area unless they have specific approval to do so.**

MR scanning or the MRI system itself can:

- Cause the dislodgement of metallic implants through strong attraction or torque.

- Interfere with the operation of electronically, magnetically or mechanically activated implants.
- Cause excessive (local) heating of implants.

  These effects can cause tissue damage, loss of physiologic function, serious injury, or death.

Presence of implants may also cause significant MR image artifacts due to magnetic field distortion. All these effects may also apply to patients and personnel who rely on electrically, magnetically or mechanically activated external life support systems.
Also see chapter “Auxiliary Medical equipment” on page 75 for more information.

MR implant labeling

According to current FDA definitions (21CFR812.3 revised April 1, 2014), an implant is defined as “a device that is placed into a surgically or naturally formed cavity of the human body if it is intended to remain there for a period of 30 days or more. FDA may, in order to protect public health, determine that devices placed in subjects for shorter periods are also ‘implants’ for purposes of this part.”

It is the responsibility of the implant manufacturer to declare an implant MR Safe, MR Conditional, or MR Unsafe. Refer to the table for definitions of the MR implant labels. Implants without adequate labeling are considered MR Unsafe. For MR Conditional implants, the general contraindications regarding implants as listed in chapter “Contraindications” on page 28, may not be applicable in their entirety.

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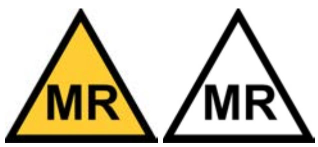
Warning label	Source	Definition*
	IEC 62570 1st edition 2014	MR Safe An item that poses no known hazards resulting from exposure to any MRI environment. MR Safe items are composed of materials that are electrically nonconductive, nonmetallic, and nonmagnetic.
	IEC 62570 1st edition 2014	MR Conditional An item with demonstrated safety in the MRI environment within defined conditions. At a minimum, address the conditions of the static magnetic field, the switched gradient magnetic field and the radiofrequency fields. Additional conditions, including specific configurations of the item, may be required. Also see chapter “MR Conditional implants” on page 31.
	IEC 62570 1st edition 2014	MR Unsafe An item which poses unacceptable risks to the patient, medical staff, or other persons within the MRI environment.

Tab. 1: Icons used to label medical devices and other items, to ensure safe use in the MRI environment. * As defined by: ASTM F2503-13. Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment. ASTM International (2013) and by IEC62570 1st edition 2014.

More about MR Safe and MR Conditional Implants

Implantable medical devices labeled MR Safe or MR Conditional have been cleared, approved and/or licensed by the Competent Governmental Authorities and/or labeled by the manufacturer. For such devices, the general contraindications may not be applicable in its entirety.
It is the responsibility of the implant manufacturer to declare an implant MR Safe or MR Conditional and to define the conditions (restrictions) that allow for safe MR scanning. It is the obligation of the MR operator to be aware of these conditions and to assure that they are strictly adhered to.
Refer to the user documentation of the implant or contact the implant manufacturer to obtain these specific conditions. The system provides options to restrict whole body and head SAR and dB/dt, and to review other system characteristics, as specified in the Technical Description.
Philips does not assume responsibility or liability for the operation of their MRI system with any implantable medical device.

MR Conditional implants

It is the responsibility of the implant manufacturer to define the conditions that allow for safe MR scanning of an MR Conditional implant. It is the obligation of the MRI operator to be aware of these conditions and to ensure that these conditions are strictly adhered to.

Refer to the user documentation of the implant or contact the implant manufacturer to obtain the implant specific conditions.

Your Philips MRI system provides options through ScanWise Implant, to restrict whole body or head SAR or B1+rms, in addition to options to restrict dB/dt, and gradient slew rate, and to review other system characteristics, as specified in the Technical Description. See chapter “Patient conditions” on page 414. Philips does not assume responsibility or liability for the operation of their MRI system with any implant other than restricting the system to such implant-specific values entered.

WARNING

Most implants have only been tested for field strengths up to 1.5T

Risk of patient injury

- **Make sure that implant documentation states that scanning is allowed at the field strength of your system.**

Refer to the table for parameters typically specified for MR Conditional implants and their possible risks.

Conditional parameter (unit)	What is it?	Possible implant-related risk
Main field strength (T)	Strength of the magnetic field at isocenter.	Dislodgement of the implant due to torque.
Spatial field gradient Also called static field gradient, MSG, SFG, SGF (G/cm or T/m)	Measure of how quickly the fringe field of the magnet changes over a given distance. The fringe field of the magnet varies with spatial location inside and around the magnet. 1 T/m = 100 G/cm Note: The spatial field gradient is always present, even when not scanning, because it is related to the magnet, not the gradient coils.	Dislodgement of the implant due to attraction.
SAR value (W/kg) Whole body SAR or head SAR (W/kg, for 15 min)	The RF power absorbed by the patient per unit mass. Note: This value is only valid at the main field strength specified on the implant label.	Excessive (local) heating.

Conditional parameter (unit)	What is it?	Possible implant-related risk
B1+rms (µT)	Average RF deposition in the patient	Excessive (local) heating.
dB/dt (T/s)	The rate of change of the magnetic field generated by the switching gradients used for imaging. The value is specified at a radial distance of 20 cm about the central axis of the magnet bore. Note: this value varies spatially, but the 20-cm nominal value is used for implant labeling.	Malfunction of active implants.
Gradient slew rate (T/m/s)	Measure of the rate of ascent or descent of a gradient from zero to the maximum amplitude.	Malfunction of active implants.

Tab. 2: Typical MR Conditional parameters for implants

The implant manufacturer may specify other conditions, including, but not limited to:

- Use of a specific coil.
- Configuration of the implant itself.
- Special patient preparation (such as no sedation, good communication, etc.).

NOTICE

The maximum dB/dt on the info page does not take the maximum dB/dt for automatically inserted prescans into account. However, if a maximum dB/dt has been specified in ScanWise Implant, all scans, including prescans, will be restricted to the dB/dt value specified. For more information, refer to the paragraph ‘Gradients’ in the Technical Description.

WARNING

Patient has bilateral MR Conditional orthopedic implants.

Risk of skin or internal burns

- **If scanning of bilateral orthopedic implants is approved by the implant manufacturer, use positioning aids to ensure adequate distance between body parts.**

WARNING

Unless otherwise stated by the manufacturer, MR conditions for 3.0T systems are only valid for quadrature excitation.

Risk of skin or internal burns

- **When scanning an MR Conditional implant at 3.0T, never apply patient adaptive RF shimming.**

Risk factors for MRI-related adverse events

Certain patient conditions are not a contraindication, but could increase the risk of an adverse event during an MRI examination.

Therefore, exercise particular caution for patients:

- With MR Conditional implants.
- With microscopic pieces of metallic materials in the body (such as shrapnel or metallic splinters) (see below).
- With cardiovascular impairment of any sort.
- Who are or may be pregnant (see below).
- With extensive dark tattoos, including permanent make-up tattoos (see below).
- Susceptible to seizures or claustrophobic reactions.
- Unable to sense or communicate adverse events (such as unconscious, sedated, anesthetized, paralyzed, pediatric, or confused patients) (see below).
- With fever.
- Who are thermally insulated (for example due to a plaster or fiberglass cast).
- With impaired thermoregulation (see below), which can occur in:
  - Neonates or low birth-weight infants
  - Elderly patients
  - Sedated or anesthetized patients
  - Obese patients
  - Hypertensive patients
  - Patients with diabetes
  - Patients with impaired ability to perspire
  - Patients with a type of cancer that impairs thermoregulation
  - Patients on certain drug regimes, such as diuretics, tranquillizers, vasodilators

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Microscopic pieces of metal

Patients engaged in certain occupations or activities, such as metal welding or military activities, may have embedded metal fragments. These fragments may move and cause damage or patient discomfort (for example in the eye). In addition, these fragments may cause image artifacts.

If there is a suspicion of accidentally embedded metallic fragments, always check with an X-ray before the MRI examination.

If metal fragments are present, a qualified physician must evaluate whether the benefit of the MRI scan outweighs the potential risk.

Pregnancy

No documented adverse fetal effects of MRI examination have been reported. However,

- The fetus is especially thermally vulnerable during the first trimester.
- Scanning is not recommended in the first trimester or if pregnancy status is unknown.
- When scanning a pregnant patient, it is recommended to limit Whole Body SAR level to 2W/kg (normal operating mode). See chapter “Specific Absorption Rate (SAR)” on page 45.
- Local regulations may consider the fetus as a member of the general public and strict exposure limits may apply.

Tattoos & permanent make-up

⚠

WARNING

Tattoos, permanent eye-liner, and facial make-up may contain metallic particles.

Risk of burns

- **Warn patients that scanning may cause heating of the tattooed tissue, resulting in a burning sensation or skin irritation.**
- **Place a cold compress or ice pack on the tattoo to decrease the potential for RF heating, as recommended by the ACR (Kanal E, Barkovich AJ, Bell C, et al. ACR guidance document on MR safe practices: 2013. J Magn Reson Imaging. 2013; 37(3): 501–530).**

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Inability to sense or communicate adverse events

WARNING

Patient is unable to sense adverse events or is unable to notify the operator of an adverse event during scanning.

Risk of patient burns, severe PNS or hearing damage

- **Make sure optimal hearing protection is in place.**
- **Examine patient between individual scans to detect potential burns before they progress.**

Impaired thermoregulation

The risk of RF energy-related injuries is higher in patients with impaired thermoregulation. To prevent injuries, do the following in addition to medical supervision:

- Make sure that airflow in the bore is not obstructed.
- Remove any added insulation such as blankets or warm clothing. Insulation interferes with the ability to dissipate heat.
- Monitor physiological signs.
- Avoid scanning in first level controlled mode.
- Limit the whole body SAR to maximum 1 W/kg whenever possible.
- Avoid SED >3.0 kJ/kg, preferably keep SED <2.0 kJ/kg.
- Examine the patient between individual scans to detect potential burns before they progress.

Clothing and other removable risk factors

WARNING

Clothing or other objects on the patient can lead to local excessive heating.

Risk of burns

- **Remove all metallic and other risk-enhancing items from the patient.**

Objects on the patient:

- Can increase the risk of local excessive heating due to RF energy.
- Influence the homogeneity of the magnetic field.
- Lead to artifacts.

Remove metallic and other risk enhancing items from the patient. These items include:

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- All clothing containing metallic thread or components such as zips, metal buttons, hooks, underwire (bras).
- Clothing made of microfibers that may contain undetectable conductive fibers.
- All other metallic objects, such as:
  - Spectacles, dentures, prostheses, hearing aids, insoles
  - Watches, jewelry, medallions, piercings
  - Hairpins, safety pins
  - Buckles, belts
  - Wigs, hairpieces.
- Transdermal patches for medicine delivery

  Transdermal patches for medicine delivery (for example, nitroglycerin transdermal delivery patch) may contain metallic foil and cause burns to the underlying skin during scanning. Consult the prescribing physician whether the patch can be removed during the examination.
- Damp clothing

  Damp clothing (for example due to perspiration) may facilitate formation of current loops and consequent excessive local heating. Make sure patient clothing is dry before scanning is started.
- Clothing made of synthetic fibers which trap heat. Examples are polyester, polyamide or polypropylene.

Advise patients to wear light, 100% cotton, or linen clothing during the MRI examination or provide MRI compatible garments.

Controlled Access Area

The Controlled Access Area is the area around the magnet wherein the magnetic fringe field exceeds 0.5 mT (5 gauss).

The magnetic fringe field can:

- Cause injury to certain people (see chapter “Contraindications” on page 28).
- Attract objects made of iron or other magnetic material (see chapter “Static magnetic field” on page 44).

The Controlled Access Area must therefore be protected by both administrative and physical barriers.

The perimeters of the Controlled Access Area usually coincide with the walls of the RF room shield. Inside this shield:

- Elevated RF levels or the magnetic fringe field may disturb electronic equipment other than equipment tested by Philips.
- The presence of such equipment may interfere with the operation of the MR system.

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WARNING

The magnet attracts objects made of iron or other magnetic materials.

Risk of injury or death.

- **Do not bring objects made of iron or other magnetic materials into the Controlled Access Area.**

Examples of iron or other magnetic materials include, but are not limited to:

- Scissors, pocket knives, lighters, keys, coins, hair pins
- Vacuum cleaners, floor polishers
- Mobile phones, pagers, tablets
- Magnetic wheel chairs, patient trolleys, iron stretchers
- MR Unsafe fire extinguishers
- Life supporting devices, vital sign monitoring, or emergency equipment

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WARNING

Unauthorized or unintentional access to the Controlled Access Area.

Risk of injury or death, in particular for patients with a pacemaker.

- **The User must ensure that:**
  - **All points of entry into the Controlled Access Area are marked with a Safety Marking Plate or appropriate safety symbols.**
  - **Adequate rules for controlling access to the Controlled Access Area are established.**
  - **Local statutory requirements concerning access to the Controlled Access Area are followed.**

It is advised to ensure that the operator always has visual oversight of the entrance (Kanal E, Barkovich AJ, Bell C, et al. ACR guidance document on MR safe practices: 2013. J Magn Reson Imaging. 2013; 37(3): 501–530).

The distances from the magnet in which 0.5 mT is exceeded, are shown in the table and diagram.

Field Strength	X direction	Y direction	Z direction
1.5T	2.4 m	2.4 m	3.8 m
3.0T	3.1 m	3.1 m	4.9 m

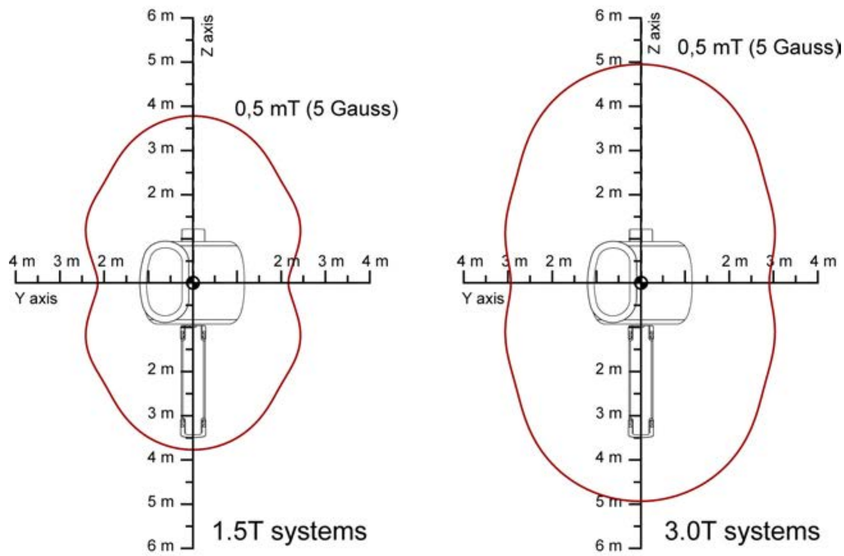

Fig. 1: Top view with 0.5 mT (5 gauss) lines for 1.5T (left) and 3.0T (right).

Philips MRI systems comply with the requirements of applicable electromagnetic compatibility (EMC) standards. Other electronic equipment exceeding the limits defined in these EMC standards could, under unusual circumstance, affect the operation of the system.

The operation of electronic equipment (such as mobile phones) or auxiliary devices (such as vital sign monitoring, life supporting devices, and emergency care equipment) which are not labeled MR Safe or MR Conditional can be affected by MR scanning or the MRI system itself. These devices can also affect the proper functioning of the MRI equipment and cause hazardous situations and artifacts. Only use and permit devices labeled as MR Safe or MR Conditional within the Controlled Access Area. See chapter “Auxiliary Medical equipment” on page 75 for more information.

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Operating modes

All Philips MRI systems comply with the IEC 60601-2-33 standard, which defines separate operating modes.

Operating mode	Explanation
Normal	No physiological stress factors are expected. Routine patient observation is required during scanning.
First level controlled	MRI scanning may cause physiological stress. Medical supervision during scanning is required.
Second level controlled	This operating mode is not accessible.

The type of scanner (static magnetic field) and the scan protocol (gradient output and SAR levels) determine the operating mode. The levels of exposure for the normal operating mode and the first level controlled operating mode are specified in IEC 60601-2-33 and are based on current scientific literature related to safety.

Alerts before entering first level controlled mode

Before an examination enters first level controlled mode for the first time, the operator:

1. Is alerted by the system.
2. Is instructed to ensure medical supervision is in place.
3. Must actively accept this mode of system operation.

For more information, see chapter “Guidance for Specific Absorption Rate (SAR)” on page 48.

Patient observation and medical supervision

It is the responsibility of the User to establish a program to ensure that appropriate patient observation and medical supervision of patients is available when required.

Routine patient observation	Verbal contact with or visual observation of the patient in the MRI examination room. Includes the ability of the patient to attract the attention of the operator using the nurse call.
Medical supervision	Adequate medical management under responsibility of a qualified physician, to ensure safety of patients who can be at risk from exposure to the MRI system either because of their medical condition, the levels of exposure, or a combination of both. MR Safe or MR Conditional auxiliary devices* may be used to monitor various physiological states (such as heart rate, ECG trace, pulse oximetry), in addition to routine patient observation.

*See chapter “Auxiliary Medical equipment” on page 75 for more information about the use of auxiliary devices.

Medical supervision is always indicated when a patient:

- Is exposed to a first level controlled scan. See chapter “Operating modes” on page 38.
- Is at an increased risk of MRI-related adverse events. See chapter “Risk factors for MRI-related adverse events” on page 33.

A qualified physician must evaluate the risk:benefit ratio of the MRI examination for every patient before scanning. The physician must include the need for medical supervision in this evaluation.

Emergency procedures

The User is required to establish emergency procedures for the following situations:

- A medical emergency
- A fire
- An emergency that requires immediate removal of the magnetic field
- The release of helium gas into the examination room

Philips MRI systems have an Emergency Table Stop button in case there is an emergency during tabletop movement.

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Medical emergency

It is the responsibility of the User to make sure that precautions and appropriate procedures are established for medical emergencies during scanning. Especially for patients:

- At risk of cardiac arrest.
- Predisposed to seizures or claustrophobic reactions.
- Who are very sick, sedated, confused, or unconscious.
- Incapable of reliable communication.

A procedure must be in place to remove a patient rapidly from the MRI examination room. Safe and effective use of electronic or other metallic emergency equipment may be impossible near the magnet. Only bring emergency equipment that is MR Safe or MR Conditional into an MRI examination room. If necessary, use the Emergency Magnet Off button (see chapter “Emergency Magnet Off button” on page 41).

A procedure must be in place in case an unexpected implant is found during scanning. In principle, all patients must be adequately screened for implants before they are allowed near MRI equipment (see chapter “Prescreening” on page 27 and chapter “Contraindications” on page 28).

⚠ **WARNING**

When the MR system is used for interventional procedures, the hospital must establish procedures to complete the intervention or adequately stabilize the patient in case of MR system failures.

NOTICE

The system is not designed to withstand cardiac defibrillation procedures. If cardiac defibrillation is required, remove the patient from the table and outside the 5 gauss line. If an MRI system part or coil has been exposed to a defibrillation pulse, do not use the system. A Philips service engineer must replace the affected part.

Fire

It is the responsibility of the User to:

- Establish fire precautions and fire emergency procedures.
- Discuss all fire precautions with the local fire department.
- Comply with all applicable fire regulations.

All operators must be fully aware of and trained in:

- The use of fire extinguishers and other fire-fighting equipment.
- All fire precautions and fire emergency procedures.

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Policy for fire extinguishers

When selecting fire extinguishers, make sure you:

- Provide extinguishers for both electrical and chemical fires.
- Choose extinguishers that suit your site.
- Use MR Safe extinguishers.
- Cannot mix-up the MR Safe extinguishers with MR Unsafe extinguishers.

WARNING

Flammable gases or vapors (such as certain anesthetics) near the MRI system can lead to fire or explosion.

Risk of burns or serious injury

- **It is not allowed to use flammable anesthetic mixtures with air, oxygen or nitrous oxide near the MRI system.**
- **Philips MRI systems are not AP (Anesthetic-Proof) or APG (Anesthetic-Proof-Category G) tested.**
- **Consult an anesthetist if you are not sure whether a certain anesthetic is allowed near the MRI system.**

WARNING

Oxygen rich environment can lead to fire or explosion

Risk of burns or serious injury

- **If ventilation or anesthesia equipment detects an error condition, immediately stop the scan and remove the patient from the MRI system.**

Immediate removal of the magnetic field

Emergency Magnet Off button

Your MRI system has two Emergency Magnet Off buttons:

- Inside the examination room.
- Outside the examination room.

The Emergency Magnet Off button can be used to quench the magnet and remove the static magnetic field within 20 seconds.

Only use the Emergency Magnet Off button when:

- A person is trapped by an object that is attracted by the magnet.

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- Fire or another event occurs, that demands immediate entry of emergency personnel or equipment into the examination room.
- Any other emergency occurs that requires immediate removal of the magnetic field.

For normal and controlled ramp-down, call the number in the **Otherwise** box on the label or contact your Philips service engineer. This is applicable when:

- Material is attracted and stuck to the magnet and needs to be removed.
- Other situations occur where non-urgent removal of the static magnetic field is required.

To quench the magnet:

1. Lift the front cover of the protective cap.
2. Press the red Emergency Magnet Off button fully.

Fig. 2: Emergency Magnet Off button and label.

NOTICE

After a quench, a Philips service engineer must perform a system restart. This restart is expensive and takes two to three days.

Quench

NOTICE

Not applicable to BlueSeal systems

During a quench, a large amount of helium evaporates and is vented outside the building through a venting system. This causes immediate removal of the static magnetic field. A quench can occur spontaneously or can be induced if there is an emergency.

To induce a quench, press the Emergency Magnet Off button (see chapter “Emergency Magnet Off button” on page 41)

During a quench, the system makes a loud noise. This noise is caused by the rapid relief of cold helium gas through the helium vent pipe. When the magnet quenches, the static magnet field falls below 10 mT within 20 seconds.

If there is a quench:

- Stay calm.
- Evacuate the patient.
- Call your Philips service engineer to recover system operation.

After a quench, all MRI scans fail. The following notification appears at the bottom of the user interface: "The MR resonance frequency cannot be found".

To confirm that the magnet is off-field and that no attractive force is present, carefully bring a securely held ferromagnetic coin or key close to the magnet.

Release of helium gas in the examination room

NOTICE

Not applicable to BlueSeal systems

If helium gas is not vented properly after the Magnet Emergency Off button is used or during a quench (for example if the helium vent pipe is blocked) a high concentration of helium gas may build up in the examination room. This gas forms clouds of cold mist.

Helium gas dilutes the oxygen in the air. High concentrations of helium gas can lead to suffocation.

If helium enters the examination room:

- Immediately remove all persons from the examination room.
- Do not switch off air circulation and ventilation in the examination room.
- Do not reenter the examination room until it is confirmed that the air oxygen content is at a safe level.

For more information about helium gas, see chapter “Helium gas” on page 80.

Emergency Table Stop

Your MRI system has an **Emergency Table Stop** button on each side of the magnet bore:

On the UIM

Fig. 3: Emergency Table stop button (1) and the Resume button (2).

Depending on the configuration of your system, the patient-operator intercom in the control room may also have an **Emergency Table Stop** button.

To stop tabletop movement and the current scan immediately:

► Press the **Emergency Stop** button.

⇨ The tabletop is released.

⇨ Manual tabletop movement in and out of the bore is possible.

⇨ The red light on the Emergency Stop button switches on.

► To reset the tabletop and re-enable normal operation, press the **Resume** button.

NOTICE

To stop tabletop movement controlled by software during scanning, press the **F12 key** or press the **Emergency Table Stop** button on the patient-operator intercom.

Safety during scanning

Exposure to EMF

Static magnetic field

The magnetic field strength of the system and the applicable IEC standard are stated in the About function. To access the About function, on the menu bar, click **Help**, then **About**.

Information about the spatial field gradient can be found in the Technical Description.

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Philips 3.0T systems that comply with IEC60601-2-33 second edition are considered to always operate in first level controlled mode for static magnetic field. Medical supervision is therefore recommended when scanning with these systems.

When inside or close to a 3.0T magnet, patients and operators can experience transient effects of:

- Dizziness
- Nausea
- Vertigo
- Metallic taste in the mouth

These effects can occur particularly during rapid head movement. Effects can vary between individuals. To avoid these effects, move slowly within the magnetic fringe field and remain motionless where possible.

In addition, patients should be instructed to avoid moving their heads during the examination.

WARNING

Working near or inside the magnet bore (e.g. interventional procedures) may affect task performance of medical staff.

Reduced attention can be the effect of movement in the magnetic field or peripheral nerve stimulation. It is recommended that medical staff will evaluate their sensitivity to such effects, prior to performing the medical procedure.

Specific Absorption Rate (SAR)

The scan procedures always involve the emission of radio frequency (RF) energy. This RF energy can heat the patient, and hence, is of concern. The Specific Absorption Rate (SAR) is the RF power absorbed by the patient per unit mass expressed in Watts per kg (W/kg).

NOTICE

Personnel working inside or very close to the magnet during scanning may experience heating due to RF exposure. Relative SAR levels for occupational exposure can be derived from the spatial distribution provided in the Technical Description. Exposure can be reduced by keeping distance from the magnet or by selecting Normal Operating Mode.

There are different SAR types each with its own limit:

Whole body SAR	the SAR averaged over the total mass of the patient.
Head SAR	the SAR averaged over the mass of the patient's head.

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Local torso SAR	the SAR averaged over any 10g of tissue of the patient.
Local extremities SAR	the SAR averaged over any 10g of extremity tissue of the patient.

The system determines the limiting SAR type of a scan (whole body, head, local torso, or local extremity) based on the applied coil, table position, and patient orientation. This SAR type is the first to reach its maximum allowed value and thus poses the strongest restriction on the scan.

All limiting SAR types can produce:

- Local warming sensations.
- Core temperature increases.

  The severity of these effects depends on the SAR value, patient positioning, and the condition of the patient. To ensure proper patient care, consider both effects.

The predicted SAR is calculated for each scan and is a conservative estimate. Information on the limiting SAR type and expected SAR values for the scan is displayed on the Scan Dashboard and on the info page:

• SAR / limiting SAR type:	x %
• Whole body / level:	y W/kg / n

Limiting SAR type = whole body, head, local torso or local extremities.
x % = The predicted SAR expressed as a percentage of the maximum for the limiting SAR type.
y W/kg = The predicted whole body SAR.
n = Operating mode (normal or first level)

SAR correlates with the average RF deposition in the patient, also denoted as B1+rms. SAR and B1+rms can be found on the scan information page. Labeling of MR Conditional implants may specify an upper limit for SAR or B1+rms to control the MR exposure conditions. B1+rms is a more direct measure of RF-related heating induced in implants than SAR. See chapter ScanWise Implant for more information about scanning patients with MR Conditional implants and the ScanWise implant wizard.

The maximum value for B1+rms can be limited through ScanWise Implant, see ScanWise Implant.

Operating modes for SAR

The system recognizes three operating modes, see chapter “Operating modes” on page 38

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IEC Operating mode	SAR limits for Volume Transmit Coils	SAR limits for Transmit Surface Coils	Safety measures
Level 0 (Normal)	• Whole body SAR < 2 W/kg • Head SAR < 3.2 W/kg	• Local torso SAR < 10 W/kg* • Local extremities SAR < 20 W/kg*	• Patient observation.
Level I (First level controlled)	• Whole body SAR ≥ 2 W/kg and < 4 W/kg • Head SAR < 3.2 W/kg	• Local torso SAR < 20 W/kg* • Local extremities SAR < 40 W/kg*	• Patient monitoring with medical expertise. • Particular caution for patients at risk.
Level II (Second level controlled)	• Whole body SAR ≥ 4 W/kg • Head SAR ≥ 3.2 W/kg	• Local torso SAR ≥ 20 W/kg* • Local extremities SAR ≥ 40 W/kg*	The system is limited. Level II cannot be reached.

* Note: These are the limits for IEC-60601-2-33 3rd edition. Local regulations may require compliance with IEC-60601-2-33 2nd edition.
Systems operating under 2nd edition always apply Level 0 limits for Transmit Surface Coils.

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More information about level 1

The SAR limitations for Level 0 and Level 1 are based on current scientific knowledge that relate RF power deposition (SAR) to increase of core temperature and local temperature. The system is designed to limit SAR values such that core temperature increase does not exceed 0.5^0C in Level 0, and 1.0^0C in Level 1.
Core temperature limit values are 39^0C for Level 0 and 40^0C for Level 1.

When SAR levels corresponding to Level 1 will be used, a warning message is given and medical supervision of the patient is required.
If the patient's condition cannot be monitored, or the risk is too high (for example due to elevated baseline core temperature or reduced thermoregulatory capabilities of the patient, anesthesia, or unconsciousness), the scan parameters must be changed to give a SAR in Level 0 range (e.g. use SAR mode "low").

When SAR Level 1 is reached, a warning message is given and medical supervision of the patient is required.

- If the patient's condition cannot be monitored, or the risk is too high (for example due to elevated baseline core temperature or reduced thermo-regulatory capabilities of the patient, anesthesia, or unconsciousness), the scan parameters must be changed to lower the SAR to normal operating mode.
- If the risk is acceptable, start the scan.

NOTICE

The patient's temperature rise depends on the total RF energy delivered during the examination (SED). Information on the total (delivered + scheduled) SED is available at the user interface to support evaluation of the patient's warming.

WARNING

Room temperature too high

Risk of excessive patient heating

- **Scan in normal mode if the examination room temperature exceeds 22 °C (72 °F).**
- **Monitor room temperature using MR Safe or MR Conditional equipment.**
- **Reassess medical benefit of the scan versus potential risk to the patient.**

The system is specified for use with examination room temperatures 18–22 °C (64–72 °F). Exceeding the upper limit must be a medical judgment as to the patient's benefit versus potential risk. High examination room temperature may lead to excessive patient heating, especially in combination with high RF exposure.

Check the examination room temperature twice a day. If it exceeds 22 °C (72 °F):

- Take action to reduce the examination room temperature.
- Reevaluate the medical judgement of the benefit of scanning versus the potential risk to the patient.
- Restrict scan SAR values to normal operating mode (whole body SAR < 2W/kg).
- Apply patient ventilation.

NOTICE

The consequence of SAR-induced increase of the patient's core temperature is that scanning a patient with an initial core temperature >39.5 °C is contra-indicated, while a patient with an initial core temperature >39 °C can only be scanned in Normal Mode. Scan duration shall be limited, and monitoring of the core temperature is recommended.

Guidance for Specific Absorption Rate (SAR)

Restricting all scan protocols of an examination to normal operating mode for SAR

► To restrict all scan protocols of an examination to Normal Operating Mode for SAR, set **Allowed SAR Mode** to **Normal** in the **New Examination** window.

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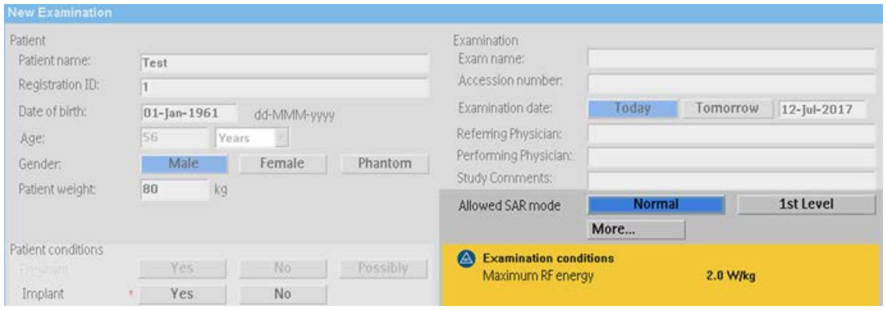


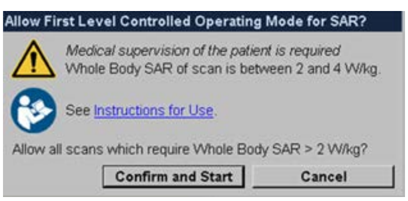
Alerts before entering first level controlled mode

When the Allowed SAR mode or PNS mode is not restricted to the normal operating mode and when the examination enters the first level operating mode, the operator:

1. Is alerted by the system prior to the start of the first scan that exceeds the SAR limit or the gradient output limit for Normal Operating Mode.
2. Is instructed to ensure medical supervision is in place.
3. Must actively accept First Level Operating Mode for the rest of the examination, separately for SAR and for gradient output.

These alerts are given once per examination.

Pop-ups requesting the operator to actively accept first level controlled mode



Allow First Level Controlled Operating Mode for SAR? Medical supervision of the patient is required. Whole Body SAR of scan is between 2 and 4 W/kg. See Instructions for Use. Allow all scans which require Whole Body SAR > 2 W/kg? • Confirm and Start • Cancel	Medical supervision of the patient is required. Whole Body SAR of scan is between 2 and 4 W/kg. This message is displayed when the scan exceeds SAR limits of the Normal Operating Mode. The system enters the First Level Controlled Operating Mode and the following safety measures apply: • Patients need to be monitored with medical expertise. • Particular caution for patients at risk. Press 'cancel' to lower SAR by modifying the scan(s) and operate within Normal Operating Mode. Press 'Confirm & Start' to continue the examination in First Level Controlled Operating Mode. For more information about SAR please refer to section “Specific Absorption Rate (SAR)”.

In Italy, the following message is shown on the UI:

<table>
<tr>
<td>
</td>
<td>Allow First Level Controlled Operating Mode for SAR?

Whole Body SAR of scan is between 2 and 4 W/kg.
SAR level exceeds the limits set by Italian regulation (D.M 3-8-93)

Medical supervision of the patient is required for this and following high SAR scans. SAR can be reduced by lowering the SAR mode.

See Instructions for Use.

Allow all scans which require Whole Body SAR > 2 W/kg?

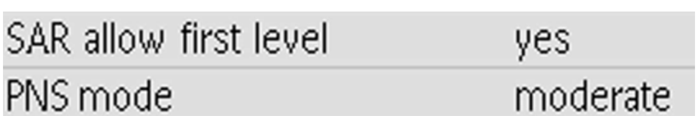
• Confirm and Start
• Cancel</td>
<td>Medical supervision of the patient is required. Whole Body SAR of scan is between 2 and 4 W/kg.

This message is displayed when the scan exceeds SAR limits of the Normal Operating Mode. The system enters the First Level Controlled Operating Mode and the following safety measures apply:

• Patients need to be monitored with medical expertise.
• Particular caution for patients at risk. Press 'cancel' to lower SAR by modifying the scan(s) and operate within Normal Operating Mode. Press 'Confirm & Start' to continue the examination in First Level Controlled Operating Mode. For more information about SAR please refer to section “Specific Absorption Rate (SAR)”.</td>
</tr>
</table>

If you decide to cancel, scanning is interrupted to allow you to restrict operation to Normal Operating Mode. This can be done for each scan:

- Set the imaging parameter **SAR allow first level** on the Contrast tab to **No**.
- Set the imaging parameter **PNS mode** on the Contrast tab to **Moderate** or **Low**.



If you intend to restrict all scans to Normal Operating Mode for SAR, re-registration of the patient allows to select the checkbox for Normal Operating Mode in the New Examination window.

Warning icon during planning

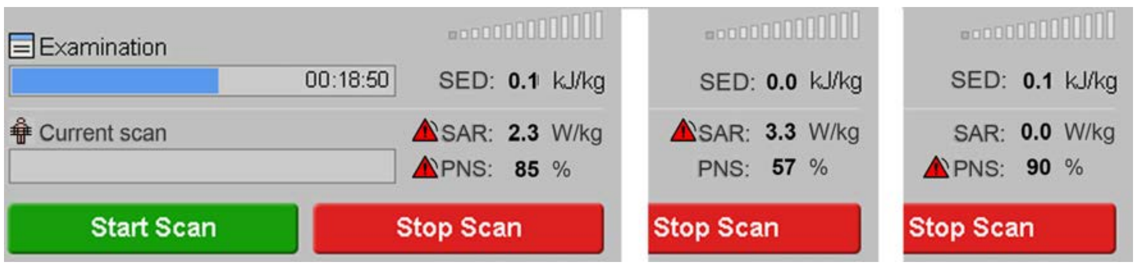
When a planned scan protocol requires operation in First Level Controlled Operating Mode, the warning icon is shown on the user interface, so that you can prepare medical supervision. Hovering over the warning icon shows the SAR, SED and PNS values for the planned scan.

Yellow warning sign to indicate that the system will be operating in First Level Controlled Operating Mode.

A tooltip is available to review the planned SED, SAR and PNS levels.

Alerts during scanning

When the scan is active, the numerical values for SAR and gradient output are displayed together with the warning sign if the output is in First Level Controlled Operating Mode, independently for SAR or gradient output.



Patient Status Area with SAR and PNS values for the running scan.
The alarm icon is displayed if the value corresponds to First Level Controlled Mode, to remind of the need of medical supervision.

Interventional procedures

NOTICE

It is advised to scan in normal mode when scanning without patient ventilation during an interventional procedure.

WARNING

Patient temperature must constantly be monitored during interventional procedures using MR Conditional equipment.

Clothing and environmental conditions

Increased examination room temperature and humidity hinder the body’s ability to dissipate excess heat. Likewise, thick clothing and clothing made of synthetic fibers hinders heat dissipation.

Examination room:

- Room temperature must be kept to 18 - 22°C (64 - 72°F).
  Recommended room temperature is 21°C (70°F) .
- Relative humidity must be kept to 40 - 70%.

WARNING

Take appropriate action to prevent severe perspiration of the patient.

Severe perspiration of the patient may result in the formation of unintended RF circuits between body parts and ultimately in burn injuries.

WARNING

Remove any added insulation (such as blankets).

Added insulation prevents satisfactory dissipation of body heat.

WARNING

Verify that the patient ventilation system is working. Pads and accessories must never obstruct patient airflow in the bore.

Patient core temperature rise can be minimized by adequate ventilation of the patient space.

NOTICE

Avoid direct contact of the patient with the magnet bore covers or Transmit-Receive Coils.

This may cause local heating of the patient.

High SAR scanning

It is advised to use high whole-body SAR levels only if absolutely necessary. For patient comfort lower SAR levels are preferred. Scanning in high SAR mode may result in perspiration and discomfort of the patient.

WARNING

For High SAR scanning it is required to use the patient ventilation system.

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WARNING

Patients who are exposed to high SAR values must be dressed in light clothing (e.g. light pajamas, nightshirt or T-shirt).

WARNING

For scanning a baby in an incubator it is advised to only scan in normal operating mode.

This will avoid a too high SAR value for the baby in the warm and humid incubator environment.

NOTICE

For high SAR scanning it is advised to plan breaks between the scans for the patient to cool down.

Breaks can be created by planning low SAR scans between the high SAR scans.

WARNING

Medical supervision is required for all scans in first level controlled mode.

Special attention is required for young, pregnant and elderly patients to prevent increase of body core temperature. Select low SAR sequences whenever possible.

Specific Energy Dose (SED)

During an MRI examination, RF energy is transferred to the body, potentially resulting in warming sensations. The patient temperature rise is proportional to the total energy delivered to the patient (SED, expressed as kJ/kg). It is determined by the SAR and scan duration. SAR is the rate of delivered energy expressed in Watts/kg, represented as W/kg. Limiting the amount of RF energy (SED) delivered to the patient, limits the temperature rise in the patient.

Specific Energy Dose is a comfort measure and provides feedback on the RF energy delivered to the patient. In general, a delivered SED value > 3.5 kJ/kg may be uncomfortable for some patients. The Philips recommended maximum for SED is 7.0 kJ/kg. Patient comfort during scanning is affected by the condition of the patient and must be taken into account. A rise in body temperature can be a hazard to a patient with impaired thermoregulation. Recommended maximum SED for this group is 3 kJ/kg although preferably SED is kept below 2 kJ/kg. Serious discomfort is reported by healthy volunteers at values greater than 7.0 - 8.5 kJ/kg.

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NOTICE

Adequate patient cooling (for example by using in-bore patient ventilation and making sure examination room temperature is within the specified range) is necessary in order to keep patient comfort within desired limits. Also see chapter “Clothing and environmental conditions” on page 51.

Display of SED on the console

The SED is visible in the Patient Status Area above the **Stop Scan** button (see figures below). The SED bar has a scale of 0.0 to 7.0 kJ/kg. The bar shows the scheduled SED in light grey and the delivered SED in dark grey. Once the delivered SED exceeds 3.5 kJ/kg the color changes to yellow.

Information about SED is also available during planning. The SED of each scan is available on the info page.

Delivered SED	The SED of the completed scans including the SED of the currently running scan.
Scheduled SED	The SED of the scans that are scheduled for the examination.
Total SED	The total amount of the delivered and scheduled SED.

Fig. 4: 1. SED display in Patient Status Area. SED not yet applicable since no scans are selected. 2. Light grey: total scheduled SED for this examination, dark grey: delivered SED of 1.0 kJ/kg. 3. Delivered SED exceeds 3.5 kJ/kg, bar color changes to yellow. 4. SED bar with alarm symbol and black arrow at the right side to indicate that the delivered SED exceeds 7.0 kJ/kg.

Once the total SED exceeds 7.0 kJ/kg, a pop-up appears:

High total SED (High total SED)

Total (delivered + scheduled) SED exceeds the recommended maximum of 7.0 kJ/kg.

See Instructions for Use

Lower the scan time or the SAR of the remaining scans to reduce the SED.

Continue without modification (Continue without modification)

Modify examination (Modify examination)

► Click **Continue without modification (Continue without modification)** to start the examination as scheduled.

► Click **Modify examination (Modify examination)** to lower the scan time or the SAR of the scheduled scans before continuing the examination so that total SED is lower for the patient.

Once delivered SED exceeds 7.0 kJ/kg:

- A pop-up informs you that recommended SED maximum value will be exceeded with the next scan.
- An arrow appears at the end of the SED bar.
- An alarm symbol appears in front of the SED value in the Patient Status Area.

Recommended SED exceeded (Recommended SED exceeded)

Total (delivered + scheduled) SED exceeds the recommended maximum of 7.0 kJ/kg in the next scan.

See Instruction for Use.

If clinical benefit exceeds the risk of high SED:

- Make sure medical supervision is in place.

Accept high SED, continue scanning (Accept high SED, continue scanning)

Stop scanning (Stop scanning)

► Click **Accept high SED, continue scanning (Accept high SED, continue scanning)**to continue with the scheduled scans and a SED above the recommended level.

► Click **Stop scanning (Stop scanning)**to stop.

Gradient system

Gradient field strength (gradient output)

The use of fast switching and high gradients may lead to peripheral nerve stimulation (PNS) during the scan. The location and nature of the PNS differs for each individual. PNS can cause a tingling sensation or superficial twitching. Some patients may report such sensations as pain, when scanning in first level controlled operating mode.

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NOTICE

Very high gradient output could even cause cardiac nerve stimulation.

Literature indicates that threshold levels for cardiac stimulation are much higher than for peripheral nerve stimulation. Peripheral nerve stimulation is possible. Cardiac stimulation is never induced by the exposures from the gradient switching.

Gradient output

During the scan definition, the gradient output is calculated for this scan (PNS) and compared with mean threshold level. This mean threshold PNS is defined as the onset of sensation, and refers to the level at which 50% of the people start to experience PNS.

During the scan definition, the gradient output is calculated for this scan (PNS) and compared with mean threshold level. This mean threshold PNS is defined as the onset of sensation, and refers to the level at which 50% of the people start to experience PNS.

The expected PNS level is displayed on the info page and expressed as a percentage of the mean threshold level for PNS as calculated by the system for the sequence prepared for the patient.

PNS/level	x % / n

x % = The predicted PNS value is expressed as a percentage of the mean threshold level for PNS.
n = Operating mode ('Normal' or 'Level I')

PNS levels

This MR system employs a Whole Body Gradient System, and the Gradient Output related to potential peripheral nerve stimulation is defined in a cylinder of 20 cm radius around the magnet bore's center line.

The system recognizes three PNS levels, corresponding to chapter "Operating modes" on page 38:

IEC Operating mode	Gradient output	Safety measures
Level 0 (Normal)	Gradient output ≤ 80% of the mean threshold level	• Routine patient observation
Level I (First level controlled)	80% of the mean threshold level < Gradient output ≤ 100% of the mean threshold level	• Patient monitoring with medical expertise • Particular caution for patients at risk
Level II (Second level controlled)	Gradient > 100% of the mean threshold level	The system is limited to a maximum gradient output of 100% of the mean threshold level. Level II cannot be reached

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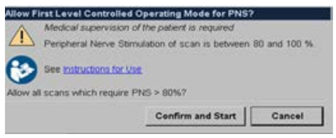
More information about Level 0

In Level 0 the probability of PNS is very low.

More information about Level I

When Level I is reached (predicted gradient output exceeds 80% of the mean threshold level) a warning message is displayed:

	**Allow First Level Controlled Operating Mode for PNS?** Medical supervision of the patient is required. Peripheral Nerve Stimulation of scan is between 80 and 100 %. See Instructions for Use. Allow all scans which require PNS > 80%? • Confirm and Start • Cancel	Medical supervision of the patient is required. Peripheral Nerve Stimulation of scan is between 80 and 100 %. This message is displayed when the scan exceeds PNS limits of the Normal Operating Mode. The system enters the First level controlled operating mode and the following safety measures apply: • Patients need to be monitored with medical expertise. • Particular caution for patients at risk. Press 'cancel' to lower PNS by modifying the scan(s) and operate within Normal Operating Mode. Press 'Confirm & Start' to continue the examination in First Level Controlled Operating Mode. For more information about PNS please refer to section “PNS levels”.

The operator has to decide whether to accept the parameter settings for execution of the scan or to cancel. If cancelled the parameter settings can be modified to decrease the gradient output below the PNS limit.

Safety Measures

For scans which may produce peripheral nerve stimulation attention must be paid to the following:

- Inform the patient that peripheral nerve stimulation may occur and describe the nature of the sensation.
- Maintain permanent contact with the patient during the scan either directly or via an observation monitor and intercom.
- Terminate the scan when the patient calls for attention via the nurse call.
- Patients should be positioned with the arms alongside the body to reduce the likelihood of Peripheral Nerve Stimulation.

NOTICE

Personnel working inside or very close to the magnet during scanning may experience Peripheral Nerve Stimulation. Occupational exposure can be derived from the spatial distribution of the Gradient Output (dB/dt) provided in the Technical Description.

Exposure can be reduced by keeping distance from the magnet or by scanning in Normal Operating Mode.

Defining a scan

The potential for peripheral nerve stimulation depends on the maximum gradient strength, slew rate and timing of the scan. When defining a scan, the parameter ‘PNS mode’ is used to control the maximum allowed gradient output. The actual gradient output is displayed on the Scan Dashboard and on the Info page and is dependent on other parameters.

Three levels are available:

- "low": the maximum allowed gradient output will be limited to 60% of the mean threshold level, i.e. the system will always operate in normal operating mode and the probability of PNS is very low.
- "moderate": the maximum allowed gradient output will be limited to 80% of the mean threshold level, i.e. the system will always operate in normal operating mode. The probability of PNS is low and if experienced it is mostly not painful.
- "high": the maximum allowed gradient output will be limited to 100% of the mean threshold level, i.e. the system may operate in the first level controlled operating mode. The probability of PNS is about 50% and may be experienced as painful. However, the patient may have more tolerance for PNS when properly informed and motivated.

Acoustic noise protection

Basic hearing protection must be worn by the patient during scanning. Such hearing protection is provided by appropriately fitted earplugs with sufficient damping (>30 dB). Additional use of the Philips headset at all times is recommended.

NOTICE

Typical damping characteristic of the Philips' headset is 20 dB in the 1 kHz range.

WARNING

Always apply hearing protection to the patient and anyone else present in the examination room before start scanning.

Without hearing protection, noise levels may be high enough to cause discomfort or result in temporary or even permanent loss of hearing.

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WARNING

Hearing protection shall be used for the safety of the Patient. This hearing protection shall be sufficient to reduce the A-weighted r.m.s. sound pressure level below 99 dB(A); Pay special attention to the correct placement of the earplugs. Positioning of the headset is also critical for additional acoustic damping.

For scanning of patients to whom the earplugs or headset cannot be applied adequately (e.g. neonates and babies), special attention is required to use other means to obtain maximum hearing protection for these patients.

WARNING

Special training for the operator is required for fitting earplugs for optimal hearing protection.

Follow the fitting instructions of the earplug manufacturer to assure maximum noise protection.

WARNING

It is MANDATORY to use earplugs which provide acoustic damping of 30 dB, or better.

WARNING

Always apply hearing protection to the patient and anyone else present in the examination room before start scanning.

WARNING

Always apply hearing protection to anesthetized patients.

Anesthetized patients are more sensitive to high sound pressure, so that hearing protection for these patients must not be omitted.

WARNING

It is MANDATORY to use earplugs when scanning with the gradient mode set to maximum.

For maximum patient comfort it is recommended to use both earplugs and headset.

WARNING

The sound level in the control area must comply with local regulations concerning exposure to noise at work.

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WARNING

Personnel must wear hearing protection when present in the MR examination room during scanning.

WARNING

Due to increased anxiety, accepted sound level may still be of concern to pregnant women, to neonates, infants and young children and to elderly patients.

NOTICE

Enable SofTone to reduce acoustic noise.
Always use hearing protection, even when SofTone is enabled.

Message on the screen

The following message is displayed when the predicted sound level exceeds the maximum level for pediatric patients (age < 3 years).

Verify that appropriate hearing protection is applied to the patient.
The predicted sound pressure level of this scan is xx dB higher than recommended for pediatric patients (99 dB).

---

xx = the calculated sound pressure level for current scan - 99dB

Click:

- Cancel to modify the scan.
- Confirm & start to accept the higher sound level and to start the scan.

Acoustic noise burden is characterized by the measurement method from NEMA MS 4:2010, to establish A-weighted RMS sound pressure levels, LAeq. Representative measurements for maximum acoustic noise are performed on an MR system installed according to specifications. Resulting acoustic noise levels comply with regulations from IEC 60601-2-33.

Sound level meter settings:

- Detector: r.m.s.
- Time weighting: fast or slow.
- Frequency weighting: A-weighting.
- Measurement duration: >20s.

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Occupational exposure to EMF

NOTICE

All personnel that need to enter the MR examination room must be screened and instructed concerning the risk factors associated with working in the MR environment. Specific risk factors include magnetic materials, pacemakers, pregnancy and sensitivity to movement in high magnetic fields.

Similarly, keeping distance when possible will limit exposure to the main magnetic field.

Workers shall be informed that occupational exposure to RF and gradient fields is limited to those present in the examination room when the system is scanning.

Current scientific evidence does not indicate harm related to occupational exposure, but exposure can be limited by keeping distance from the MR system.

NOTICE

In some countries legislation may exist covering occupational limits for exposure to EMF (Electro Magnetic Fields).
These regulations may be stricter than those adopted by the IEC (International Electrical Committee) and used to design the MR systems.

Refer to the Technical Description for applicable EMF exposure values in and around the MR system.

Further information related to exposure and Directive 2013/35/EU can be found in the Technical Description.

Pregnant MRI workers

Whereas no epidemiological evidence exists to date concerning adverse health effects on the fetus, it is prudent for pregnant workers to minimize exposure to the magnetic fields.

NOTICE

Local regulations may consider the fetus as member of the general public, and strict exposure limits may prohibit pregnant workers to approach the MR System.

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Coil and cable positioning

Risk factors

The MR system dissipates energy from various sources. This can lead to a temperature rise of components surrounding the patient such as cables and RF coils. Usually the end temperature of these components do not exceed body temperature. In these situations there is no concern regarding patient safety.

The most important source of energy is the RF energy emitted by the transmit coil. Safety issues on the direct deposition of RF energy into the patient are described in chapter "Specific Absorption Rate (SAR)" on page 45.

When electrical cables are close to the patient (e.g. RF coil cables) or connected to the patient by electrodes (e.g. ECG cables), care must be taken to avoid situations of components heating up to high end temperatures.

WARNING

Never position heavy objects or let patients sit on the posterior coil cover of the patient support.

Heavy weight load can damage the coil, which may result in excessive heating and patient burns when scanning. The posterior coil cover is visible when the tabletop is removed or moved into the magnet bore.

WARNING

Avoid placing cable loops and twisted cables (RF coil cables and ECG leads) inside the body coil (RF area).

Loops can cause excessive heating of the cables which may result in burns upon contact to patient's skin. The cables must be routed parallel to the axis of the bore.

WARNING

Avoid routing of the RF coil cable assembly in proximity to the RF transmit coil. Avoid direct contact of the patient's skin with the RF coil cable assembly.

Failing to do so may result in excessive local heating and ultimately in skin burns. Positioning of the RF coil cable assembly must be done with care. Keep a distance to the patient's skin of at least 2 cm. Use the special spacer or pads of the standard accessory set where the cable assembly may touch the skin.

WARNING

The combined use of RF coils, high SAR levels and direct skin contact of the coils cables may cause local cable heating and can lead to skin burns.

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WARNING

Leave a 2 cm distance between the patient's skin and the RF cables and interface boxes. Use pads from the accessory set.

WARNING

Ensure sufficient distance (> 2 cm at all positions) between coil cables when routed in parallel at the same side of the patient.

WARNING

Never attempt to bend or force the coil into an abnormal shape.

WARNING

Do not place the coil perpendicular to the main magnetic field.

WARNING

Always run the cable directly away from the region of interest.

WARNING

Position and secure the cable in the grooves of the tabletop.

WARNING

Unconnected coils on the tabletop while scanning.

Risk of patient injury and damage to unconnected coils.

- **Connect all coils on the tabletop to the system before scanning, even if the coils are not used for scanning.**

NOTICE

Combination of receive coils is restricted by the software.

In case of combination of RF receive coils, cable handling is even more critical to avoid excessive local heating.

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WARNING

Always position the cables of the coils parallel to the direction in which the table moves. A minimum of 2 centimeters clearance must be secured between the cable and the bore covers (as well as between the cable and the patient).

NOTICE

Always use dedicated pads and mattresses provided with the coils.

Tabletop movement

Mechanical safety

WARNING

Special care must be taken that no objects or body parts (e.g. patient in a wheelchair) are present near the patient support while lowering the patient support.

Objects can get trapped between patient support and floor which may lead to damage or personal injury.

WARNING

Do not remove the covers from the patient support as it contains moving parts.

Removing the covers could lead to serious or fatal injury.

Emergency Stop button

Your MRI system has Emergency Table Stop buttons. See chapter “Emergency Table Stop” on page 43.

Tabletop movement in the event of an electrical power failure

In the event of an electrical power failure, the tabletop is automatically released. The tabletop can be moved manually out of the magnet.

When electric power is re-established the tabletop is engaged again.

Please note that there might be events where table movement is not possible even in manual mode, refer to chapter “Moving the patient into the magnet bore” on page 65.

Horizontal tabletop movement

If horizontal tabletop movement is not functioning properly the patient support switches automatically into 'manual mode': The Manual mode button on the UIM flashes.

Move the tabletop manually out of the system into its end position. The patient support is reset and the button stops flashing.
Press the ‘Manual mode’ to switch to motorized movement again: horizontal movement of the tabletop is re-enabled.

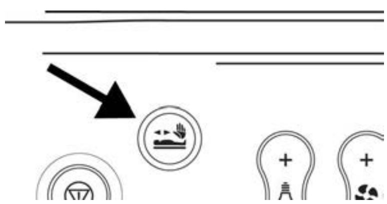

Fig. 5: Manual mode

Manual override switch

If the control electronics break down, it will still be possible to move the patient support to the highest position and continue scanning. The ‘Manual override’ switch is located at the magnet end under the patient support.

If the switch is activated the patient support will move up and stop at its highest position.

Fig. 6: Manual override switch.

Moving the patient into the magnet bore

NOTICE

The operator must be aware that the patient may have claustrophobic reactions when moved into the magnet.

A panicking patient may hurt itself or damage equipment.

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WARNING

In manual mode move the table slowly into the magnet bore.

Fast movement can cause mispositioning and may result in misdiagnoses.

WARNING

Before starting a scan which initiates tabletop movement, always check that nothing can get caught or hit during tabletop movement.

Check patient, patient extremities, clothing, equipment and positioning aids. Guide cables and intravenous lines.

WARNING

Verify if an urine bag is present at the patient. Empty the urine bag before starting an examination.

Spilled urine can form a conductive path possibly resulting in an electric shock.

WARNING

Verify that no blankets, sheets, pillows or clothing hang over the front and end side of the tabletop or are wrapped around it.

These objects may get caught between tabletop and patient support during table movement. This can block tabletop movement even when in manual mode.

WARNING

Avoid contact of the patient's body or extremities with the RF transmit coil or system body coil surface.

This may result in excessive local heating.

WARNING

Due care must be taken to verify that no part of the patient's body, hair, clothing, cables or infusion lines can get trapped or injured by any part of the equipment.

Messages on the screen

The following message is displayed before table movement is initiated.

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Verify that the tabletop can move without harm to the patient. This scan can only start if the table is moved.
Verify that nothing can get trapped or caught when starting table movement: Infusion lines, leads, extremities, hair, blankets etc.

Click:

- Cancel to modify the patient preparation.
- Select one of the two options:
  – Allow the tabletop to move for this scan only.
  – Allow the tabletop to move with normal speed for all scans.
- Followed by clicking Confirm & Start to initiate table movement and to start the examination. Depending the previous selection the:
  – Examination is paused after the first scan, the message is displayed again for the next scan.
  – Examination is started with automatic table movement for all scans.

NOTICE

If you allow automatic tabletop movement for all scans, you still have to confirm tabletop movement in some special cases.

The permission for automatic tabletop movement is withdrawn:

- when a local movement (manual table movement or toggle-switch controlled, or finger pinching) is performed or occurs at the magnet, or
- when a scan or movement is stopped from the operator console.

The next automatic movement must be confirmed again.

The following message is displayed before table movement is initiated.

Careful positioning of the patient is required.
This scan can also start without table movement. However, for optimal image quality table movement is advised.
Verify that nothing can get trapped or caught when starting table movement: Infusion lines, leads, extremities, hair, blankets etc.

- Cancel to modify the patient preparation.
- Select one of the three options:
  – Allow the tabletop to move for this scan only.
  – Allow the tabletop to move with normal speed for all scans.
  – Do not allow tabletop movement.
- Followed by clicking Confirm & Start to initiate table movement and to start the examination. Depending the previous selection the:
  – Examination is paused after the first scan, the message is displayed again for the next scan.

– Examination is started with automatic table movement for all scans.

The following message is displayed before table movement is initiated.

Verify that the tabletop can move fast without harm to the patient. Be aware that the tabletop can make long strokes.
Verify that nothing can get trapped or caught when starting table movement: Infusion lines, leads, extremities, hair, blankets etc.

Click:

- Cancel to modify the patient preparation.
- Confirm & Start to initiate table movement and to start the current scan.

The following message is displayed while the tabletop is moving.

The tabletop is moving automatically.

Click: Stop movement to immediately stop tabletop movement in case something unexpected occurs.

Laser radiation safety (Light visor)

Philips MR systems have a laser type Light visor system.
The laser light visors is in compliance with laser standards *IEC60825-1: 2007* and *21 CFR 1040:10* .

The Light visor should only be used under supervision of medical trained personnel, who are acquainted with hazards implied by the use of laser light.

It is the user’s responsibility to meet local safety regulations.

WARNING

Avoid laser light shining in the patient's eyes. The laser is a Class II (FDA) / Class 2 (IEC) laser.

Instruct the patient not to look into the laser beam. Direct laser light may cause irreversible damage to the eyes.

WARNING

Use the Light visor for its intended use only, avoid unnecessary exposure to laser radiation.

WARNING

For non-responsive patients (babies, anesthetized patients) provide adequate protection to avoid direct laser light in the eyes.

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WARNING

Use of controls, adjustments or procedures other than those specified in this manual may result in hazardous radiation exposure.

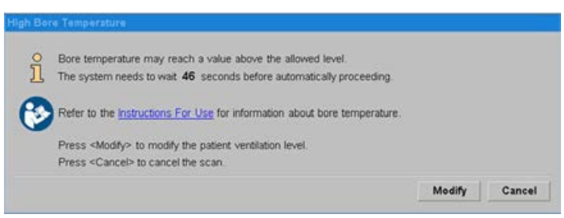
Labeling

The following warning labels are put on the system:

Outside front cover	
	*Caution label* Laser radiation Do not stare into beam Class 2 Laser product Max output< 0.35 mW Emitted wavelength 635 nm IEC 60825-1: 2007
At the laser aperture (outside front cover)	
	*Laser warning symbol*

High Bore Temperature

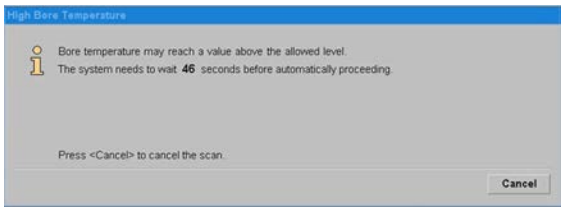
The system calculates the possible bore surface temperature for each scan.
The following messages appear when the calculated temperature of the bore surface may exceed the maximum allowed level.

	**High Bore Temperature (High Bore Temperature)** Bore temperature may reach a value above the allowed level. The system needs to wait <x> seconds before automatically proceeding. Refer to the Instructions for Use for information about bore temperature. Press **<Modify>** (Modify) to modify the patient ventilation level. Press **<Cancel>** (Cancel) to cancel the Scan. **Modify** (Modify), **Cancel** (Cancel)

When this message is displayed, the scan is delayed and started automatically after the indicated time.

Options

- Modify patient ventilation level
  - Click **<Modify>** (Modify), the patient ventilation control window is displayed.
  - Modify the patient ventilation level and click **Proceed** (Proceed).
  - Restart the scan.
- Cancel scan



High Bore Temperature (High Bore Temperature)

Bore temperature may reach a value above the allowed level.
The system needs to wait <x> seconds before automatically proceeding.

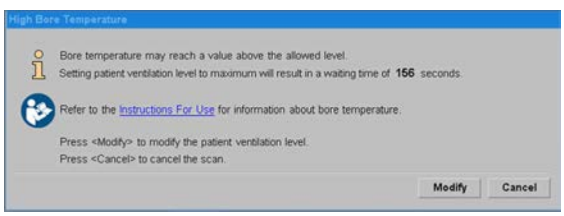
Press **<Cancel>** (Cancel) to cancel the Scan.

Cancel (Cancel)

When this message is displayed, the scan is delayed and started automatically after the indicated time.

Option

- Cancel scan



High Bore Temperature (High Bore Temperature)

Bore temperature may reach a value above the allowed level.
Setting patient ventilation level to maximum will result in a waiting time of <x> seconds.

Refer to the Instructions for Use for information about bore temperature.

Press **<Modify>** (Modify) to modify the patient ventilation level.
Press **<Cancel>** (Cancel) to cancel the Scan.

Modify (Modify), **Cancel** (Cancel)

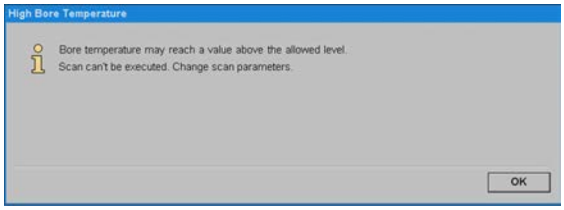
This message is displayed when the operator is **required to set the patient ventilation to maximum** before the scan can be started. After restarting the scan, the scan is executed after the indicated delay time.

Action

- Modify patient ventilation level
  - Click **<Modify>** (Modify), the patient ventilation control window is displayed.
  - Set the patient ventilation to maximum and click **Proceed** (Proceed).
  - Restart the scan.

Option

- Cancel scan



High Bore Temperature (High Bore Temperature)

Bore temperature may reach a value above the allowed level.
Scan can't be executed. Change scan parameters.

OK (OK)

This message is displayed when the scan cannot be executed:

- Click **OK** (OK) to modify the scan parameters and restart the scan.

Other MRI safety

Patient support and tabletop

The safe working load for FlexTrak and Patient support is 250 kg.

NOTICE

The safe working load as labelled on patient support and trolley is based on the sum of the maximum allowable patient weight and the mass of accessories and coils. The weights mentioned above are equal to the safe working load.

- The maximum weight load allowed for horizontal and vertical movement of the tabletop on the patient support is 250 kg.
- The maximum allowed weight load of the tabletop on the FlexTrak is 250 kg.

WARNING

Verify that the hand of the patient are on the tabletop before moving the tabletop into the magnet, to avoid finger pinching.

Fingers can get pinched between the tabletop and the system covers.

- **The special arm supports (see Positioning Aids) can be used to avoid finger pinching. The arm supports prevent the patient from grabbing around the table sides, avoiding finger pinching during tabletop movement.**

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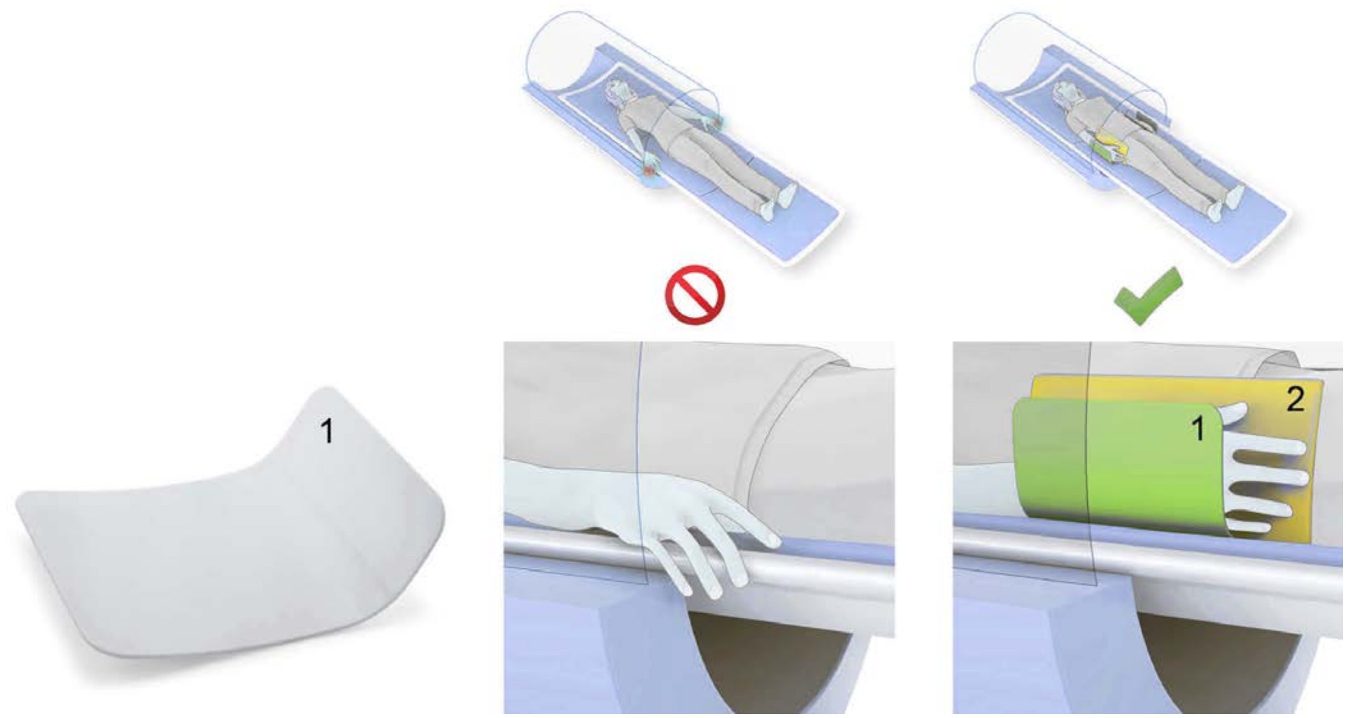

Fig. 7: Left: Arm support. Middle: Incorrect patient positioning. Right: Advised patient positioning with arm support (1) and padding (2).

WARNING

In prone position support the lower legs in such a way that the patient's toes are positioned higher than the tabletop surface.

If the patient's feet are positioned over the end of the tabletop, verify that the feet cannot be caught between tabletop and system parts when moving into the magnet.

WARNING

Take special precautions for anxious patients and patients in panic.

Use the accessories to immobilize a patient.

Communication: nurse call & intercom

WARNING

The 'Nurse call pinch ball' must be given and demonstrated to every patient.

This allows for communication between the patient and the operator at all times. Check correct functioning of the 'Nurse call system' before each examination.

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Pressing the ‘Nurse call pinch ball’ activates a buzzer that can be heard as long as the ball is squeezed. When the pinch ball is pressed more than once within 4 seconds or for more than 1.5 seconds, a flashing yellow light will also be activated in the control room to draw the personnel’s attention.

It is advised to communicate when the system gradients are off.

WARNING

Instruct the patient on using non-verbal communication signs.

Because of acoustic noise levels in the examination room verbal communication with the patient may be impaired.

Image quality

The resulting appearance of anatomical structures on images may be dislocated or distorted. Also non-uniform intensities or contrasts can occur. These image deviations may lead to misinterpretation. More information on typical MR artifacts, including examples, is provided in the MR Help system.

WARNING

MR images may demonstrate structures that are not present in the patient (artifacts), which may lead to misinterpretation.

These structures may occur as a result of technological and physiological factors or can be introduced by metallic or magnetic objects in the patient.
Technological factors can be spurious signal generated by system components or other source in the immediate area of the system.

Intrinsic artifacts

MR technical capabilities and patient physiology may result in artifacts which appear in the image.
These artifacts may be caused by e.g.:

- Magnet homogeneity.
- Gradient non-linearity.
- RF inhomogeneity.
- Truncation.
- Aliasing.
- Motion.
- Flow.
- Chemical shift.

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- Susceptibilities.

Extrinsic artifacts

Magnetic objects or non-magnetic metallic objects such as jewelry, hairpins, buttons, prosthetics will disturb the RF signal or will influence the homogeneity of the magnet field and will interfere with the imaging capabilities of the system. This may lead to clinical misdiagnoses.

WARNING

Do not allow magnetic objects or non-magnetic metallic objects to be brought into the magnet, unless this is needed for the specific study and properly controlled (e.g. biopsy needles).

Imaging Techniques

General

WARNING

Applying imaging techniques must always be done with great care to avoid any unwanted effects like artifacts.

Correct parameter optimization is essential for optimal image quality.

SENSE

The SENSE/CLEAR parallel imaging technique must be applied carefully to avoid unexpected and possibly unidentified image artifacts. The technique can be used successfully to speed up the scan technique, get a ideal homogeneity correction or optimize the protocol in a number of other ways (SAR reduction, acoustic noise reduction, resolution improvement, etc.).

A number of specific warnings and notes are given in the following.

WARNING

With CLEAR and SENSE significant artifacts may occur in case of gross patient motion between the reference scan and the CLEAR or SENSE scans.

The patient must to be instructed not to move head or limbs between scans.

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Geometry compensation

WARNING

For comparing images the same type of geometry compensation must be used.

Erroneous distance, area and volume measurements may lead to misinterpretations. Stereotaxy guidance can be distorted which may lead to personal injury.

k-t BLAST and k-t SENSE

WARNING

The k-t BLAST and k-t SENSE acquisition techniques assumes repeated cyclic behavior of the moving tissue in time. Changes in this behavior can result in incorrect interpretation of details.

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Auxiliary Medical equipment

Only use Philips-approved Multiple Socket Outlet (MSO) to power auxiliary equipment, as approved for connection through MSO by Philips.

WARNING

Assessment of compatibility and use of auxiliary devices for physiological monitoring or sensing inside the MR Examination room is the responsibility of the User. Always follow the guidance of the manufacturer of the auxiliary equipment.

WARNING

All accessories used with the MR system must be labeled MR Safe or MR Conditional Safe, see table below for labeling.

Third parties claims about MR compatibility of accessories must be interpreted with care: Philips does not verify these claims.

WARNING

After an upgrade of the system, e.g. to higher gradients, do not use auxiliary medical equipment approved for use with the system configuration before the upgrade, unless recognized as tested for use with this configuration after the upgrade.

WARNING

Changes and/or additions to the MR system that are carried out using untested auxiliary medical equipment may lead to the Philips Healthcare warranty being voided. Do not use unapproved auxiliary medical equipment.

This equipment carries serious risks to cause damage to the system or personal injury.

WARNING

Third party RF coils cannot be used in combination with Philips RF coils nor with SENSE and CLEAR.

WARNING

The physiology sensing devices of the MR scanner are only intended for sequence triggering purposes.

Patient monitoring of physiological signals and application of sensing devices is subject to requirements and specifications of the monitoring equipment manufacturer.
It is the responsibility of the hospital and the operator to implement necessary safety provisions and to understand potential interferences with monitoring reliability introduced by the MR scanner.

WARNING

Patient ventilator error.

Risk of serious injury or death.

- **When a patient is supported by a ventilator or under anesthesia , any error condition detected by the auxiliary device shall immediately be followed by stopping the MR scan, and moving the patient outside the MR system until the error condition is removed.**

WARNING

The use of auxiliary equipment, such as physiological monitoring and gating equipment and radio frequency coils, which have not been specifically tested and approved for use with Philips MR systems may result in burns or other injuries to the patient.

WARNING

Auxiliary devices labeled as MR Conditional may cause injury if the manufacturer's instructions, especially with respect to electrically conducting lead positioning, are not followed.

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WARNING

Auxiliary devices labeled as MR Conditional may only be used in combination with Philips MR systems when the conditions specified in the manufacturer's instructions for use are fulfilled.

WARNING

Auxiliary devices not labeled as compatible with MR equipment may be affected by electromagnetic interference (EMI).

This may influence the proper functioning of the Auxiliary device.

CAUTION

Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm to any part of the MRI system, including cables specified by the manufacturer. Otherwise, degradation of the performance of this equipment could result in decreased electromagnetic immunity of this equipment and result in improper operation.

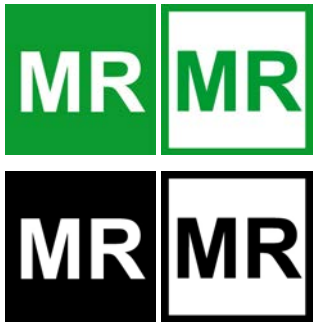
NOTICE

For description and further Instructions for Use on compatibility test protocols, see the Technical Description of the system.

MR compatibility labels on third party equipment

The compatibility of third party equipment in combination with the MRI systems is regulated via special warning labels (see below). These warning signs indicate whether the third party equipment is MR Safe, MR Unsafe or MR Conditional.

When the equipment is marked as MR Conditional these conditions must be described in the instructions for use of this equipment.

Warning label	Category
	MR Safe
	MR Conditional
	MR Unsafe

WARNING

Do not start an examination with the system when the examination-room door is open.

Operation of the system with the examination-room door open can cause malfunction of other (medical) devices outside the examination room and consequently may lead to personal injury.
Other (medical) devices could also interfere with the MR system, possibly resulting in image artifacts.

NOTICE

Compatibility of tools and devices will depend on the magnetic field strength of the MR system.

Contact the supplier when using tools or devices at different systems than specified.

NOTICE

It is advised to carefully secure monitoring equipment to the wall of the examination room, using a chain and/or other anchorage device of sufficient strength.

This will prevent the equipment to be pulled into the system.

Mobile telephones & similar products

Philips MRI systems comply with the requirements of applicable electromagnetic compatibility (EMC) standards. Other electronic equipment exceeding the limits defined in these EMC standards could, under unusual circumstance, affect the operation of the system.

CAUTION

Do not allow radio frequency transmitting devices (such as mobile telephones) into the examination room. Even when switched off.

These devices could exceed EMC radiation standards and, under unusual conditions, interfere with the proper functioning of the system. This could lead to clinical misdiagnoses.

Safety with Helium

NOTICE

Not applicable to BlueSeal systems

Liquid helium

WARNING

Under no circumstances should a liquid helium container be brought into the magnet area unless it is known to be made of non-magnetic material or the magnet is not energized.

It is extremely dangerous for patients, personnel and equipment to bring any magnetic or ferrous metal objects into the examination room. Special non-magnetic containers are available from liquid helium suppliers and must always be specified and appropriately labeled.

WARNING

Under no circumstances should liquid helium be transferred into the magnet prior to installation of the helium venting system.

Filling with liquid helium

WARNING

Filling with liquid helium should be carried out by trained and authorized persons. See chapter “Topping up liquid helium” on page 921.

WARNING

Always use protective gloves, skin covering clothing, and preferably goggles.
Liquid helium is extremely cold and can freeze human tissue.

Injuries caused by freezing must be washed with water and treated as burns.

WARNING

Always verify that the examination room and the storage room for liquid gases are well ventilated.

There is danger of suffocation as the evaporating helium will dilute or displace the oxygen in the air.

WARNING

If liquid helium is accidentally released in the examination room, accumulation of liquid oxygen may occur, resulting in a potential fire hazard.

Helium gas

Properties of helium gas:

- Odorless
- Non-flammable
- Non-poisonous
- On evaporation of liquid helium a cold mist is formed. Helium gas rises in air.

Normal operating conditions

MR systems that are equipped with a zero helium boil-off cooling system have no helium boil-off under normal operating conditions.

For the event that helium is boiling off, Philips MR systems are equipped with a helium venting system, which vents the helium gas from the magnet to the outside of the building. Helium boil-off occurs during a quench and after the Emergency Magnet Off button is pressed.

See chapter “Release of helium gas in the examination room” on page 43 when helium gas is not vented properly and clouds of cold mist form in the examination room.

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A large amount of helium gas is evaporated when the Emergency Magnet Off button is used for immediate removal of the magnetic field, or during a spontaneous quench of the magnet.

An oxygen detector with audible alarm may be used as a warning device.

Magnet monitoring messages

Magnet helium level

Helium is used to keep the magnet in a pre-defined temperature range. When magnet helium levels are too low, the magnet cannot be kept in optimal conditions and the MR system may be disabled for scanning.

Helium refill message

The helium refill level is defined in Field Service Framework (and may vary per geographic region). The following UI message is displayed at the start of a new examination, once the actual helium level is below the helium refill level. You are asked to confirm that your helium supply organization is notified.

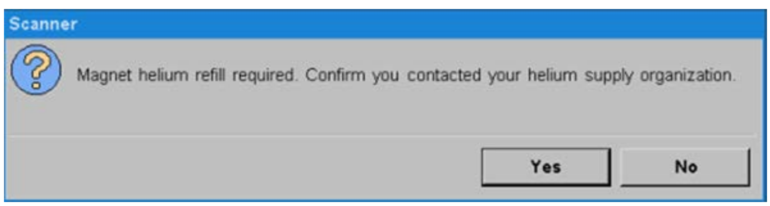

Fig. 8: Magnet helium refill required. Confirm you contacted your helium supply organization.

You can do the following:

- Keep the message on screen until the helium supply organization has been contacted.
- Select **no** to confirm that the helium supply organization has not been contacted yet. The pop-up is closed and will be displayed again at the start of a new examination.
- Select **yes** to confirm that the helium supply organization has been contacted. The pop-up is closed and will not be displayed again. An alert message is displayed on the info status line at the start of each new examination until the helium level is above the refill level again "Magnet helium refill required. PHILIPS Service is already notified.
  The user selection (**no** or **yes**) is logged in the system's log file.

Helium low level message

In case the helium level drops below the critical level, warning messages will be shown at the start of each examination for 3 consecutive days. To prevent magnet damage, scanning will be blocked on the fourth day. A helium refill is then required.

The following warning messages will be displayed.

Message on first day of low helium level:

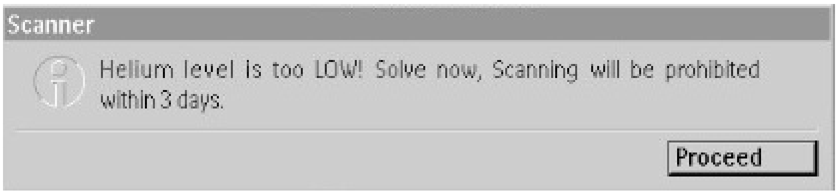

Fig. 9: Helium level is too LOW! Solve now, Scanning will be prohibited within 3 days.

Message on second day of low helium level:

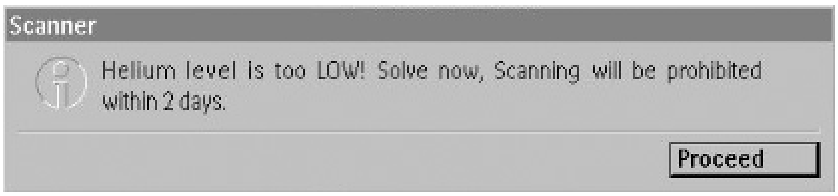

Fig. 10: Helium level is too LOW! Solve now, Scanning will be prohibited within 2 days.

Message on third day of low helium level:

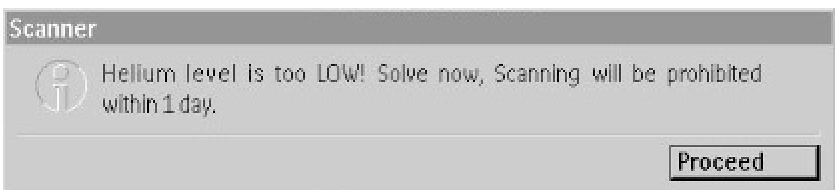

Fig. 11: Helium level is too LOW! Solve now, Scanning will be prohibited within 1 days.

Message after third day of low helium level:

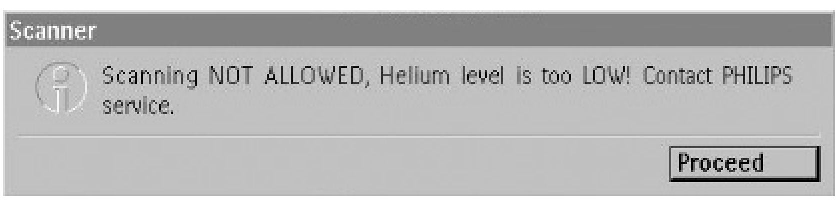

Fig. 12: Scanning NOT ALLOWED, Helium level is too LOW! Contact PHILIPS service.

Cryo compressor messages

Cryo compressor malfunctions may be solved by the user or local hospital engineer. In all other situations please contact your Philips service representative.

The following warning messages, depending on the system type, may be displayed at the start of a new examination. An action from the user is required.

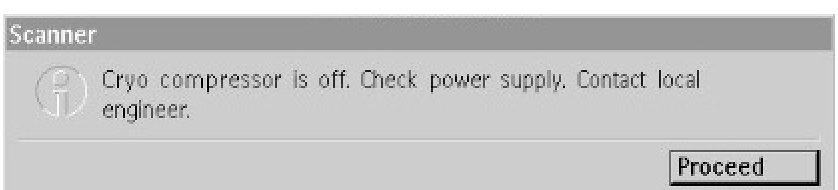

Fig. 13: Cryo compressor is off. Check power supply. Contact local engineer.

Cryo compressor power-off is detected for more than 30 minutes.
Check the power supply. If required, contact your local service representative.

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Fig. 14: Cryo compressor temperature alarm. Check water cooling. Contact local engineer.

Cryo compressor temperature alarm is detected for more than 1.5 hours.
Check the water cooling. If required, contact your local service representative.

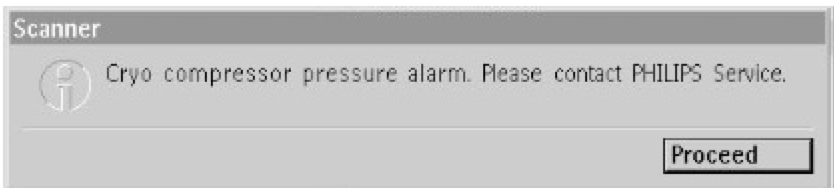

Fig. 15: Cry compressor pressure alarm. Please contact PHILIPS Service.

Cryo compressor pressure alarm is detected for more than 3 hours.
Contact your local service representative.

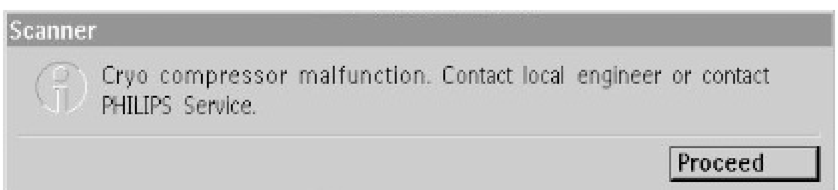

Fig. 16: Cryo compressor malfunction. Contact local engineer or contact PHILIPS Service.

Cryo compressor malfunction is detected for more than 30 minutes.
Check the power supply and water cooling circuit. If required, contact your local service representative.

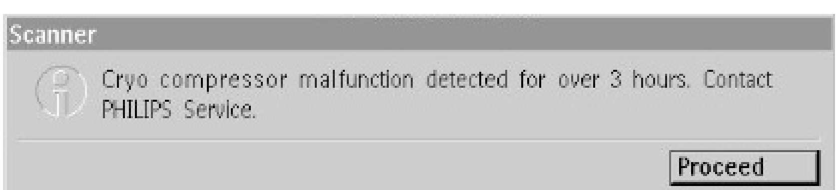

Fig. 17: Cryo compressor malfunction detected for over 3 hours. Contact PHILIPS Service.

Cryo compressor malfunction is detected for over 3 hours.
Contact your local service representative.

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Magnet helium pressure alarm

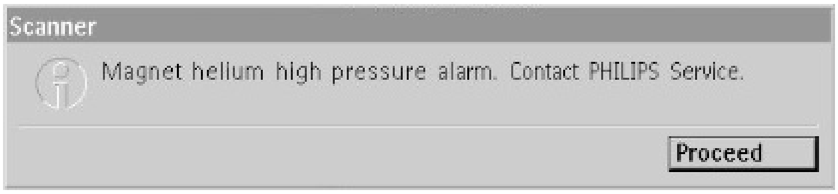

Fig. 18: Magnet helium high pressure alarm.

This message is displayed when the average magnet pressure exceeds the defined level during the last three hours.

Spectroscopy

NOTICE

The system supports export to a proprietary file format. However, since this is not a published standard, Philips makes no claims about the correctness of this file.

CAUTION

Do not use the coils in an unloaded situation.

When the load (normally the patient) is removed from the coil, or vice versa, the voltages may damage the capacitors of the spectroscopy coils.

WARNING

In 3.0T applications, distortions in spatial shift of the CSI PRESS box may lead to misdiagnoses.

Analogous to the fat-water slice shift in imaging, the voxel volume localized using STEAM or PRESS for one metabolite is displaced relative to that for a different metabolite with a different chemical shift. The relative size of this spatial displacement is greater at higher field strengths, because chemical shift differences in Hz scale with the main magnetic field. In chemical shift imaging (CSI), the displacement of localization volumes will give rise to distorted relative intensities and incorrect peak area ratios in spectra from voxels at the edges of the region of interest, where the volumes do not overlap.

The PlanScan Metabolite and Shifted Metabolite boxes displayed during scan set-up, can be used to determine which voxels lie in the overlap region for two metabolites of interest, both in-plane (for 2D and 3D CSI) and in the slice direction for 3D CSI. Choosing higher bandwidth RF pulses (such as the "sharp" excitation pulse) can help to minimize the mismatch.

An alternate for 2D CSI is to use spin-echo slice localization (plus multiple REST slabs if necessary) instead of PRESS or STEAM volume localization, this method eliminates in-plane chemical shift displacement and associated peak ratio distortions.

Spin-echo slice localization is recommended for 3.0T.

Another approach for 3.0T is "overprescription", using a set of high bandwidth REST pulses (power level 3 or 4) applied with negative gap values to saturate signal from non-overlapping regions, effectively redefining the actual localized volume. Whatever the technique, it should be noted that SpectroView does not apply any correction factors for chemical shift displacement.

On Planscan and Review planscan

Since the actual contents of “processed data” in multi voxel experiments can be changed by the order of processing and the actual commands used, the following must be taken into account:

Double volume

The planscan and review planscan show the correct volume numbers only after postprocessing with the available postprocessing batch DOUBLE.scom.

Electrical safety

Philips MR systems may be operated on a permanent 24-hour basis without adversely affecting its safety or performance.

WARNING

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

WARNING

Do NOT open cabinets. Do NOT remove system covers.

The system and all subsystems remain powered. Danger of an electric shock.

WARNING

Covers or cables should only be removed by a qualified and authorized service engineer.

WARNING

Do not allow water or other liquids to enter the equipment as they may cause short-circuits or corrosion.

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Only use the MR system in rooms or areas that comply with all applicable law (or regulations having the force of law) concerning electrical safety for this type of equipment.

Applied Parts

The following electrical or weight bearing parts of the MR system are designed for patient contact during normal use (known as Applied Parts):

- Tabletop.
- VCG.
- PPU.
- All RF coils and their coil parts, see their respective instructions for further details.

Liquids in phantoms

Description of used phantoms.

WARNING

Handle all phantoms with care to prevent damage, and spilling of the liquid contents.

If the phantoms are not used, the phantoms must be placed in the phantom box and closed appropriately.
Note that the contents of the phantoms may irritate the skin. Washing with water after contact with the human skin is sufficient.

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Phantoms for 1.5T systems

Liquid in Body 530 mm, Body 400 mm and Head 200 mm phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• 99.6 - 99.96% water • 0.02 - 0.37% sulfuric acid • 0.03 - 0.08% copper(II)sulphate
Toxicity	• LD-50: 300 mg/kg (ORL-RAT, copper (II) sulfate) • LD-50: 2.14 mg/kg (ORL-RAT, sulfuric acid)
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in Bottle phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• 99.717% water • 0.005% sulfuric acid • 0.077% copper(II)sulphate • 0.2% sodium chloride • 0.001% dialkyl-1-dimethyl ammonium chloride
Toxicity	• LD-50: 300 mg/kg (ORL-RAT, copper (II) sulfate). • LD-50: 2.14 mg/kg (ORL-RAT, sulfuric acid). • LD-50: 3 g/kg (ORL-RAT, sodium chloride).
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in AC-PC Bottle phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• >99.0% water • >0.25<1.0% Nickel Chloride-6-Water
Toxicity	• LD-50: 175 mg/kg (ORL-RAT, Nickel Chloride-6-Water).
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: immediately remove contaminated clothes. Immediately remove residue substance (e.g. rinse with plenty of water). In case of serious exposure call a doctor. • Ingestion: Let victim drink 1 or 2 glasses of water. In case of general disorder call a doctor. • Inhalation: Bring victim immediately into fresh air, let rest and if necessary call a doctor. • Eyes: Rinse for a long time with plenty of water. In case of eye-sight disturbance consult a doctor.

Phantoms for 3.0T systems

Liquid in Head 200 mm phantom	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• 99.6 - 99.96% water • 0.02 - 0.37% sulfuric acid • 0.03 - 0.08% copper(II)sulphate
Toxicity	• LD-50: 300 mg/kg (ORL-RAT, copper (II) sulfate) • LD-50: 2.14 mg/kg (ORL-RAT, sulfuric acid)
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in Body 400 mm phantom and Bottle phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• 100% Spectrasyn 4 (ExxonMobil Chemical: http://www.exxonmobilchemical.com)
Toxicity	• Oral: LD50: > 15 g/kg Practically non-toxic. • Dermal: LD50: > 5 g/kg Practically non-toxic. • Inhalation: LD50: > 5 mg/l Practically non-toxic. • Eye irritation: Practically non-irritating. • Skin irritation: Practically non-irritating.
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot. • Clothing: Remove contaminated clothing. Launder contaminated clothing before re-use.
First aid	• Skin contact: Wash with soap and water. • Eyes: Rinse for a long time with plenty of water. • Inhalation: Not expected to be a problem. • Ingestion: Not expected to be a problem.

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Liquid in Body 530 mm phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• 99.6 - 99.96% water • 0.02 - 0.37% sulfuric acid • 0.03 - 0.08% copper(II)sulphate
Toxicity	• LD-50: 300 mg/kg (ORL-RAT, copper (II) sulfate) • LD-50: 2.14 mg/kg (ORL-RAT, sulfuric acid)
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in AC-PC Bottle phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• >99.0% water • >0.25<1.0% Nickel Chloride-6-Water
Toxicity	• LD-50: 175 mg/kg (ORL-RAT, Nickel Chloride-6-Water).
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: immediately remove contaminated clothes. Immediately remove residue substance (e.g. rinse with plenty of water). In case of serious exposure call a doctor. • Ingestion: Let victim drink 1 or 2 glasses of water. In case of general disorder call a doctor. • Inhalation: Bring victim immediately into fresh air, let rest and if necessary call a doctor. • Eyes: Rinse for a long time with plenty of water. In case of eye-sight disturbance consult a doctor.

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Spectroscopy phantoms

Proton Phantoms

Liquid in proton sphere phantoms A	
Personal protection	• Eyes: safety goggles
Constituents	• 5 ml/l 98% acetate (CH3COOH) • 10 ml/l 80% ethanol (CH3CH2OH) • 8 ml/l 98% Phosphorus acid (H3PO4) • 1 ml/l 1% arquad solution + 120 mg/l CuSO4 in demi water.
Total contents	• 524 ml
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Phosphorus phantoms

Liquid in phosphorus sphere phantoms B	
Personal protection	• Eyes: safety goggles
Constituents	• 30 g/l Methyl phosphoric acid P(OH)2O(CH3) in demi water
Total contents	• 524 ml
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in phosphorus disk phantoms A	
Personal protection	• Eyes: safety goggles
Constituents	• 300 mM H3PO4(phosphor acid) solution

Liquid in phosphorus disk phantoms A	
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in phosphorus disk phantoms B	
Personal protection	• Eyes: safety goggles
Constituents	• 300 mM H3PO2(phosphoric acid) solution
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in Gradient System

Gradient amplifier	
Constituents	• Distilled water 50% • Dowtherm SR1 9 (dyed pink) 50%, consisting of: – Ethylene glycol CAS#000107-21-1 (>95%) – Dipothassium Phosphate CAS#007758-11-4 (<3%) – Water CAS#007732-18-5 (<3%)
Toxicity	The coolant may irritate the skin by contact.
Emergency actions in case of a leakage	• Absorb the liquid with an appropriate absorbent (e.g. powersorb, dry sand, diatomite etc.). • Dispose the used absorbent of (in plastic bags) according local legislation for chemical waste. • After a leakage, the gradient amplifier cooling system needs topping up. Contact Philips Customer Support.
First aid	• Skin contact: Immediately remove contaminated clothing and rinse the skin with plenty of water. • Eyes: Rinse for a long time with plenty of water.

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Gradient coil coolant	
Constituents	• Distilled water (approximately 30 l) • Inhibitor, AZ8104 from Betz Dearborn (6ml) • Biocide, Spectrus NX 1164* or Spectrus 1106* from Betz Dearborn (2.7 ml)
Toxicity	The coolant may irritate the skin by contact.
Emergency actions in case of a leakage	• Absorb the liquid with an appropriate absorbent (e.g. powersorb, dry sand, diatomite etc.). • Dispose the used absorbent of (in plastic bags) according local legislation for chemical waste. • After a leakage, the gradient coil cooling system needs topping up. Contact Philips Customer Support.
First aid	• Skin contact: Immediately remove contaminated clothing and rinse the skin with plenty of water. • Eyes: Rinse for a long time with plenty of water.

* Biocide, Spectrus NX 1164 or Spectrus 1106 is depending on your region.

Network safety, security and privacy

Customer Role in the Product Security Partnership

We recognize that the security of Philips Healthcare products is an important part of your facility's security-in depth strategy. However, these benefits can only be realized if you implement a comprehensive, multilayered strategy (including policies, processes, and technologies) to protect information and systems from external and internal threats.

Following industry-standard practice, your strategy should address physical security, operational security, procedural security, risk management, security policies, and contingency planning. The actual implementation of technical security elements varies by site and may employ a number of technologies, including firewalls, virus-scanning software, authentication technologies, etc.

As with any computer-based system, protection must be provided such that firewalls and/or other security devices are in place between the medical system and any externally accessible systems.

Although the system incorporates state-of-the-art protection mechanisms to protect it against the intrusion of malware (viruses etc.) a remote probability remains that a system can become infected. In all circumstances system safety remains secure, but the user might notice unfamiliar system behavior and/or performance. If this happens repeatedly, e.g. also after the system has been switched off and on again, the user is advised to call Philips Customer Service to have the system checked and if needed cleaned from malware.

The USA Veterans Administration has developed a widely used Medical Device Isolation Architecture for this purpose. Such perimeter and network defenses are essential elements in a comprehensive medical device security strategy.

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NOTICE

The internal electronic log files generated by this product as a part of its normal operations, will contain the names of storage folders created by the user, and therefore will include any patient, clinician or other personal identifying information used in such folder names.

In the course of maintenance, monitoring or repair of this product or of related development and other product-related activities, Philips may access, store or otherwise use those log files.

Any connection of a device to a hospital network should be done with appropriate risk management for safety, effectiveness, and data and systems security. For guidance on risk management, see the IEC-80001-1 standard.
Additional security and privacy information can be found on the Philips product security website at http://www.philips.com/productsecurity. Please review Philips product security policies regarding remote service, patch management, anti-virus software and more in the “Product Security Policy Statement” and additional information sources available through this website.

CAUTION

The internal electronic log files generated by this product as a part of its normal operations, will contain the names of storage folders created by the user, and therefore will include any patient, clinician or other personal identifying information used in such folder names. In the course of maintenance, monitoring or repair of this product or of related development and other product-related activities, Philips may access, store or otherwise use those log files.

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Alarms Overview

Auditory alarms that can occur at the operator's console are:

1. Nurse call (medium priority)
   This alarm is triggered when the patient presses the nurse call twice or longer than 1.5 sec. A buzzer alarm alerts the operator.

The sound pressure of the Nurse call is designed to be at least 80 dB(A).

During patient preparation, explain the function of the nurse call to the patient. Test that the nurse call functions properly for each new patient. The operator must be in the examination room or the control room to be notified by this alarm.

Visual alarms that can occur at the operator's console are:

1. Nurse call (medium priority)
   When the patient presses the nurse call twice or longer than 1.5 sec, a light on the operator-patient intercom switches on.
2. Tabletop moves (medium priority)
   When the system automatically moves the tabletop, a pop-up indicates that the tabletop is moving.

3. High SAR (low priority)
   When a scan is performed in first level controlled operating mode based on SAR, an alarm symbol is shown on the user interface in front of the scan SAR value.
4. High risk of PNS (low priority)
   When a scan is performed in first level controlled operating mode based on PNS, an alarm symbol is shown on the user interface in front of the scan PNS value.
5. High SED (medium priority)
   When delivered SED exceeds 7.0 kJ/kg, an alarm symbol appears in front of the SED value in the Patient Status Area.

The operator must be at the console to be notified by these alarms. There is no need to verify these visual alarms.

Important messages and indications

Important messages and indications are displayed in the language of the user interface. The table below displays the English messages and their translation.

Messages	
English	**Translation**
Allow First Level Controlled Operating Mode for SAR? Medical supervision of the patient is required. Whole Body SAR of scan is between 2 and 4 W/kg. See Instructions for Use. Allow all scans which require Whole Body SAR > 2 W/kg? • Confirm and Start • Cancel	**Allow First Level Controlled Operating Mode for SAR?** Medical supervision of the patient is required. Whole Body SAR of scan is between 2 and 4 W/kg. See Instructions for Use. Allow all scans which require Whole Body SAR > 2 W/kg? • Confirm and Start • Cancel
Allow First Level Controlled Operating Mode for PNS? Medical supervision of the patient is required. Peripheral Nerve Stimulation of scan is between 80 and 100 %. See Instructions for Use. Allow all scans which require PNS > 80%? • Confirm and Start • Cancel	**Allow First Level Controlled Operating Mode for PNS?** Medical supervision of the patient is required. Peripheral Nerve Stimulation of scan is between 80 and 100 %. See Instructions for Use. Allow all scans which require PNS > 80%? • Confirm and Start • Cancel

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Messages	
English	**Translation**
High total SED Total (delivered + scheduled) SED exceeds the recommended maximum of 7.0 kJ/kg. See Instructions for Use Lower the scan time or the SAR of the remaining scans to reduce the SED. • **Continue without modification** • **Modify examination**	**High total SED** Total (delivered + scheduled) SED exceeds the recommended maximum of 7.0 kJ/kg. See Instructions for Use Lower the scan time or the SAR of the remaining scans to reduce the SED. • **Continue without modification** • **Modify examination**
Recommended SED exceeded Total (delivered + scheduled) SED exceeds the recommended maximum of 7.0 kJ/kg in the next scan. See Instruction for Use. If clinical benefit exceeds the risk of high SED: • Make sure medical supervision is in place. • **Accept high SED, continue scanning** • **Stop scanning**	**Recommended SED exceeded** Total (delivered + scheduled) SED exceeds the recommended maximum of 7.0 kJ/kg in the next scan. See Instruction for Use. If clinical benefit exceeds the risk of high SED: • Make sure medical supervision is in place. • **Accept high SED, continue scanning** • **Stop scanning**
Patient Ventilation Warning **Sufficient patient ventilation is required.** The patient ventilation is below the recommended level. Press <Modify…> to modify the patient ventilation level. Refer to the Instructions for Use for information about patient ventilation. Press <Proceed> to proceed with the current patient ventilation level. Press <Cancel> to cancel the scan. • Modify • Cancel • Proceed	**Patient Ventilation Warning** Sufficient patient ventilation is required. The patient ventilation is below the recommended level. Press <Modify…> to modify the patient ventilation level. Refer to the Instructions for Use for information about patient ventilation. Press <Proceed> to proceed with the current patient ventilation level. Press <Cancel> to cancel the scan. • Modify • Cancel • Proceed
Moving TableTop The tabletop is moving automatically. • Stop	**Moving TableTop** The tabletop is moving automatically. • Stop

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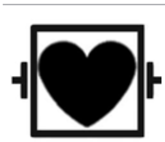
Messages	
English	**Translation**
Enable Remote Desktop Session A Remote Desktop session has been requested. If you accept this Remote Desktop request, you confirm that you know that this is an authorized Remote Desktop session. You further confirm that you are the responsible local operator for the system during this Remote Desktop session and have been fully informed about the possible consequences regarding Safety, Security and Privacy arising from permitting remote operation of the system, including those discussed in the system's "instructions for use". During a single windows Take Over session, you must stay at the system console and monitor the activities performed by the remote user. You can end the Remote Desktop session any time by pressing the "STOP" button on your screen. As the operator of the system, you are responsible for the safe and secure use of the system. Note that certain private information, including electronic Protected Health Information (ePHI) about patients, will become accessible to the remote operator. Be sure to stay within your institution's policy regarding disclosure of confidential information to third parties. • I Agree • Exit Session	**Enable Remote Desktop Session** A Remote Desktop session has been requested. If you accept this Remote Desktop request, you confirm that you know that this is an authorized Remote Desktop session. You further confirm that you are the responsible local operator for the system during this Remote Desktop session and have been fully informed about the possible consequences regarding Safety, Security and Privacy arising from permitting remote operation of the system, including those discussed in the system's "instructions for use". During a single windows Take Over session, you must stay at the system console and monitor the activities performed by the remote user. You can end the Remote Desktop session any time by pressing the "STOP" button on your screen. As the operator of the system, you are responsible for the safe and secure use of the system. Note that certain private information, including electronic Protected Health Information (ePHI) about patients, will become accessible to the remote operator. Be sure to stay within your institution's policy regarding disclosure of confidential information to third parties. • I Agree • Exit Session
Scanner Patient position needs to be defined. Press 'Proceed' to reuse the current position, or use the light visor. • Proceed	**Scanner** Patient position needs to be defined. Press 'Proceed' to reuse the current position, or use the light visor. • Proceed
Planscan Position of the tabletop changed since acquisition of survey. Please select recent survey. • Close	**Planscan** Position of the tabletop changed since acquisition of survey. Please select recent survey. • Close
Warning dS HeadNeck coil is connected. Scanning with a tilted HeadNeck coil is not allowed. Refer to the Instructions for Use for information about the dS HeadNeck coil. Press <Cancel> to stop scanning. Press <Proceed> to start scanning, only if the ds HeadNeck coil is not tilted. • Cancel • Proceed	**Warning** dS HeadNeck coil is connected. Scanning with a tilted HeadNeck coil is not allowed. Refer to the Instructions for Use for information about the dS HeadNeck coil. Press <Cancel> to stop scanning. Press <Proceed> to start scanning, only if the ds HeadNeck coil is not tilted. • Cancel • Proceed

Messages	
English	**Translation**
Patient Ventilation Control Current patient ventilation level Level 5 is recommended. Use the <+> and <-> buttons above to modify the patient ventilation level. Refer to the Instructions for Use for information about patient ventilation. • Proceed	**Patient Ventilation Control** Current patient ventilation level Level 5 is recommended. Use the <+> and <-> buttons above to modify the patient ventilation level. Refer to the Instructions for Use for information about patient ventilation. • Proceed
Scanning in First Level Controlled Operating Mode Medical Supervision of the patient required.	Scanning in First Level Controlled Operating Mode Medical Supervision of the patient required.
Specific Absorption Rate: <baseline value> W/Kg Scanning in First Level Controlled Operating Mode Medical Supervision of the patient required.	Specific Absorption Rate: <baseline value> W/Kg Scanning in First Level Controlled Operating Mode Medical Supervision of the patient required.
Peripheral Nerve Stimulation: <baseline value> % Scanning in First Level Controlled Operating Mode Medical Supervision of the patient required.	Peripheral Nerve Stimulation: <baseline value> % Scanning in First Level Controlled Operating Mode Medical Supervision of the patient required.

Symbols on System, Coils and Accessories

The following symbols may be used on your Philips system, on accessories and packaging, as well as at the examination room.

General symbols	Source	Meaning
	IEC 60417-5840	Type B applied part. To identify a type B applied part complying with IEC 60601-1.
	IEC 60417-5333	Type BF applied part. To identify a type BF applied part complying with IEC 60601-1.
	IEC 60417-5336	Defibrillation-proof type CF applied part. To identify a defibrillation-proof type CF applied part complying with IEC 60601-1 .

Mandatory Action symbols	Source	Meaning
	ISO 7010-M002	Refer to instruction manual/booklet.
	ISO 7010-M003	Wear ear protection.
		ONLY screened and approved devices allowed in scanning room.

Prohibition symbols	Source	Meaning
	ISO 7010-P007	No access for people with active implanted cardiac devices.
		Metallic implants prohibited.
	ISO 7010-P014	No access for people with metallic implants.
		Loose ferromagnetic objects and mechanical watches prohibited.
		Loose ferromagnetic tools prohibited.

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Prohibition symbols	Source	Meaning
		Wheel chairs and equivalent metal objects prohibited.
		Magnetic media prohibited (credit cards, diskettes, magnetic tapes).
	ISO 7010-P012	No heavy load.
		Do not scan pediatric patients under 15 kg (33 lbs) with this coil.

Hazard Identification symbols	Source	Meaning
	ISO 7010-W001	General warning sign.
	ISO 7010-W006	Warning: Magnetic field.
	ISO 7010-W005	Warning; Non-ionizing radiation.
	ISO 7010-W024	Warning: Crushing of hand.

Hazard Identification symbols	Source	Meaning
		Danger of clamping.
	ISO 7010-W004	Warning: Laser beam.
	IEC 60825-1	Laser radiation: Do not stare into beam. Class 2 Laser Product .

Alarm symbols	Source	Meaning
	IEC 60417-5307	Low priority alarm.
	IEC 60417-5307	Medium priority alarm.

Marking on Emergency Magnet Off label	Source	Meaning
		Person trapped by an object that is attracted by the magnet.

Environmental symbol	Source	Meaning
	SJ/T 11364-2014 Figure 2, Mark II	The environment-friendly use period of this product is 50 years. (according to People's Republic of China Electronics Industry Standard SJ/T11364-2014)

Other symbols	Source	Meaning
SN	ISO7000-2498	Serial number
REF	ISO7000-2493	Catalogue number
	ISO7000-3082	Manufacturer
	ETL listed	Intertek ETL recognized component
	ISO7000 3500	To indicate on product or product packaging that relevant information for use of the product is available in electronic form rather than, or in addition to, printed paper form.

Disposal symbol	Source	Meaning
	Directive 2012/19/EU WEEE Symbol	Waste electrical and electronic equipment.

Marking on FlexTrak	Meaning
	Total Mass and safe working load
	FlexTrak Marking

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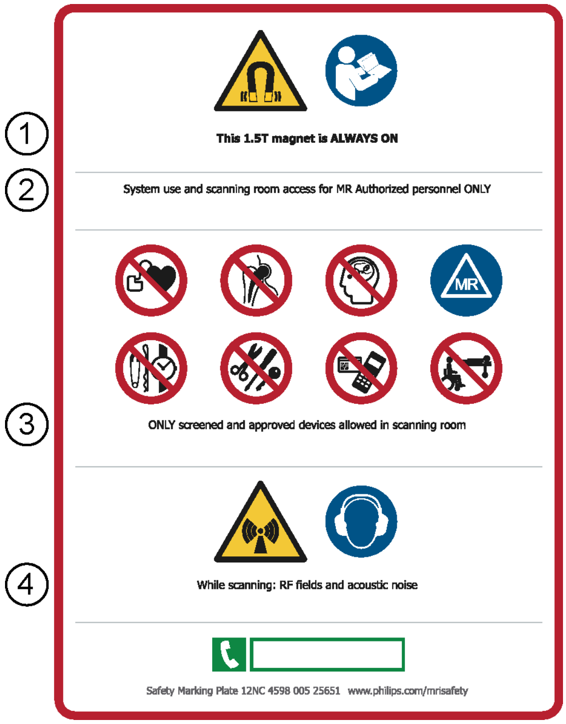
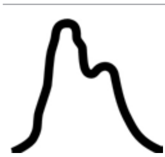
Safety marking plate	Explanation
	Examination room door safety marking plate. The individual symbols are explained in other parts of this section. Text on the safety marking plate: 1. This 1.5T (3.0T) magnet is ALWAYS ON 2. System use and scanning room access for MR Authorized personnel ONLY 3. ONLY screened and approved devices allowed in scanning room 4. While scanning: RF fields and acoustic noise

Medical symbols	Meaning
	ECG
	Peripheral pulse/blood pressure

Referenced standards for symbols on the system

- IEC 60417:2002 DB, Graphical symbols for use on equipment.
- ISO 7010:2011, Graphical symbols – Safety colours and safety signs – Registered safety signs.
- ISO 7000:2014 (ed. 5.0), Graphical symbols for use on equipment - Registered symbols.
- EN 50419:2006, Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE).
- IEC TR 60878:2015 (ed. 3.0), Graphical symbols for electrical equipment in medical practice.

You can find definitions of used symbols in the symbol glossary on the following website: http://www.symbols.philips.com

Accessories list

The following Accessories are provided with the system to enable specific procedures or to ensure safety:

- All RF coils.
- PPU Sensor for wireless physiology.
- Pediatric PPU Sensor.
- FlexTrak.
- MR Elastography.
- Acoustic Hood.

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3 Start up and switch off

System start up

NOTICE

If your system has been upgraded to the current release, your hardware may differ from the systems described in this manual.

If this is the case please refer to the Instructions for Use originally delivered with your System for proper system startup and switch off. Even when this system is switched off some subsystems remain powered.

Powering and system startup must be performed by a Philips service engineer. This includes final adjustments of hardware compensation and control settings.
Under normal circumstances it is not possible to switch off the system completely or partly. When not in use the system will switch into standby mode after approximately two hours of inactivity. Power consumption is then minimized.

Contact your Philips service engineer if a serious reason exists that requires the complete system to be switched off.

WARNING

The system and all subsystems remain powered.

Danger of an electric shock.

CAUTION

System switch off and opening the technical cabinets may only be done by or under guidance of Philips service.

CAUTION

Helium boil-off will occur when the system is completely switched off. The cryogen cooler will not work and the system may quench.

Note that Helium boil-off does not occur on BlueSeal systems.

Computer start up and shut down

The computer is started by the Philips service engineer.

Keep the computer running permanently.

It is sufficient to exit the system software and to switch off the display. When the computer runs, the system remains available for remote servicing and performs scheduled tasks (quality checks).

- Only switch off the computer if a system hang up occurs.
- Never exit the system software while a background process (such as hard copy, DVD recording, or Network) is still running.
- Switch off the display unit on the operator's console at night.

Computer start up

If a computer malfunction occurs, refer to chapter “Computer malfunction” on page 953 for instructions on how to proceed.

If the computer has accidentally been switched off, do one of the following:

If the computer is located in the control room

► Make sure that there is no (bootable) CD or DVD in your computer. The system may try to start up from the CD drive.

► Use the power button to turn the computer on.

If the computer is located in the technical room

► In the technical room, open the global Mains Distribution Unit (gMDU) (see figure).

► Do NOT remove the red panel (see figure).

► Flip the DACC switch (check the service key sticker to locate the correct switch) to the off position.

► Flip the switch back on again.

► Close the gMDU cabinet when finished.

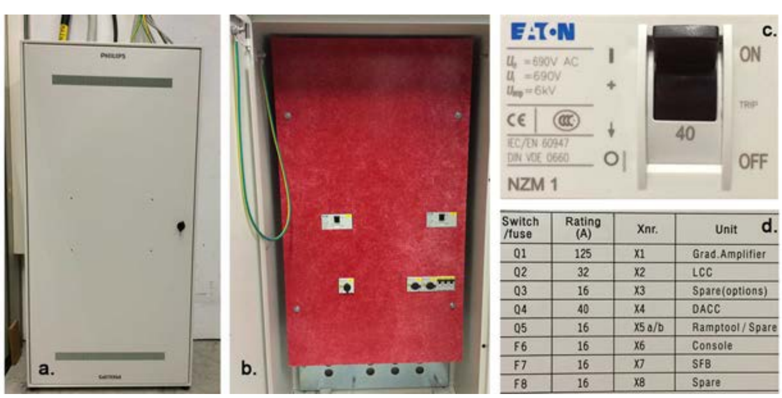

Fig. 19: Examples of: (a) a closed gMDU, (b) the red panel inside a gMDU, (c) a DACC switch and (d) a service key sticker.

Computer logon

Once the computer is started up, the logon screen appears. To log on:

1. Press the **Ctrl**, **ALT**, and **Delete** keys on the keyboard.
2. In the logon dialog box, type in the user name and password.
3. Click **OK** or press the **Enter** key.

⇨ The application software starts.

NOTICE

After first logon, enter a different password of at least seven characters.

Initial settings for username and password are "MRuser" and "Philips".

To view who is currently signed in, press the **Ctrl**, **ALT**, and **Delete** keys on the keyboard. The user name is displayed in the subsequent dialog box. To exit the dialog box, press the **Esc** key on the keyboard or click **Cancel**.

Computer shut down

It is strongly recommended to keep the computer running permanently (refer to chapter “Computer start up and shut down” on page 106).

If it is necessary to shut the computer down, this can be done in different ways.

To shut the computer down with the start menu:

- ► Press the **Windows** key on your keyboard to show the Windows taskbar.
- ► Click the **Shut Down** button (the button may also be labeled **Log off**)

  If the button is labeled **Log off**, click the arrow next to the button and select **Shut down** from the menu.

To shut the computer down from the application software:

- ► Exit the application software as described in chapter “Exit application software” on page 107 to display the logon screen.
- ► Press the **Ctrl**, **ALT** and **Delete** keys on the keyboard to display the logon dialog box.
- ► Click **Shut down**.

Exit application software

Fig. 20: 5: System menu.

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To exit the application software:

1. On the **System** menu, click **Exit**.
2. In the Exit Confirmation window, click **Yes** to exit the software. Click **No** to cancel.

The **Stop** status box is displayed until the software has been logged off.
The logon dialog box is displayed.

To start-up the application software again, log on as described in chapter “Computer start up and shut down” on page 106. The application software starts up automatically.

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4 System Overview

Major components of your system:

MR Scanner

For more information, refer to chapter “MR Scanner” on page 110.

Radio Frequency System

- RF coils.

  A transmit coil transmits the RF pulses into the patient. A receive coil receives the MR relaxation signals subsequently emitted by the patient. Available coil types on your MR systems are transmit-/receive-coils and receive-only coils.
- RF transmitter.
  The RF transmitter generates the RF pulses.
  On 3.0T systems the RF transmitter has MultiTransmit capability (with MultiTransmit capable coils).
- RF receiver and spectrometer.

  These analyze the MR signals emitted by the patient.

For more information, refer to chapter “Coils and Coil Solutions” on page 173.

Wireless Physiology

Wireless Physiology provides synchronization of the MRI sequences with physiology signals. The systems detects respiration, VectorCardioGraphy (VCG) and peripheral pulse (PPU)signals.
For more information, refer to chapter “Physiology” on page 133.

Operator's Console

- Computer system (Windows operating system and MR system software) and an external DVD recorder.
- A wide-screen display unit with USB connectors.
  The operator's console monitor is not a Primary Diagnostic Monitor. Image appearance does conform the DICOM GSDF standard.
- Keyboard and a mouse.
- Patient-operator intercom with nurse call reset.

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MR Scanner

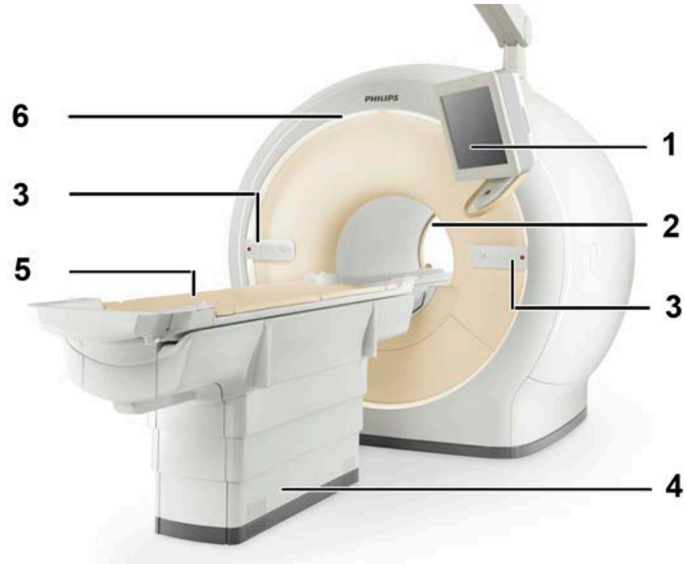

Fig. 21: Ingenia MR system.

Number	Description
1	Examination Room Display (ERD)
2	Magnet bore with gradient coils and System Body coil
3	User Interface Module (UIM)
4	Patient support
5	Tabletop
6	Magnet with Ambient ring

Magnet and magnet bore

Philips' MR imaging systems are available with different magnet field strengths.

During an examination the patient is positioned in the magnet bore of the system. Gradient coils, the System Body coil and a patient ventilation system are integrated in the magnet bore.

Gradient system

The gradient coils, which are integrated in the system, provide the relative small magnetic field variations needed for the localization of the weak magnetic resonance relaxation signal emitted by the human body.

Philips' MR imaging systems are available with different gradient field strengths.

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Tabletop and patient support

During a MR examination, the patient is positioned on a tabletop which is carried by the patient support.

The tabletop can be moved longitudinally to transport the patient into the magnet. It can also be moved vertically for convenient patient transfer.
The tabletop movement can be controlled by means of the UIM (see section below).

The patient support has an integrated Posterior coil.

On the tabletop sockets are available for connecting coils, headset and nurse call.

User Interface Module (UIM)

This panel comprises buttons and switches for patient support control, acquisition control and patient comfort.
For more information, see chapter “Panels” on page 111.

Ambient ring (and bore illumination)

The Ambient ring and the bore illumination can be switched on and off by means of the UIM, see chapter “Panels” on page 111.

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Panels

User Interface Module (UIM)

There is a UIM located on both sides of the magnet bore. Both panels have the same functionality, but the layout is mirrored.

NOTICE
In this section only the UIM at the left side of the magnet bore is displayed.

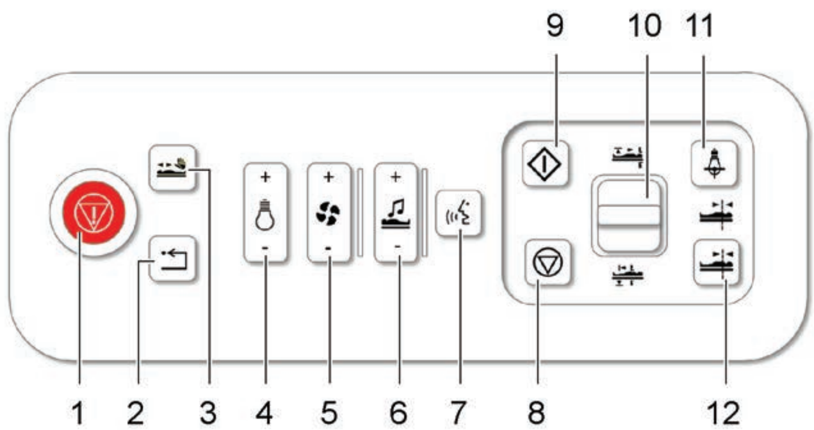

Fig. 22: UIM (left side)

Number	Buttons and switches
1	Emergency Table Stop
2	Resume
3	Manual mode
4	Bore illumination / Ambient ring
5	Ventilation
6	Music volume
7	Talk
8	Stop scan
9	Start scan/Pause scan
10	Tumble switch
11	Light visor
12	Travel to scanplane (TTS)

You can find definitions of used symbols in the symbol glossary on the following website: http://www.symbols.philips.com

Emergency Table Stop

Pressing the Emergency Table Stop button will stop the tabletop movement. This can be reset using the Resume button.

Resume

Pressing this button will reset the tabletop after an emergency stop of tabletop movement. Operation is re-enabled.

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Manual mode

Manual mode can be used to toggle between motorized and manual mode. The LED next to the button illuminates when the tabletop is in manual mode. Tabletop position information is available in manual mode.

Bore illumination and Ambient Ring

The Bore illumination can be adjusted using the button on the UIM.

The Ambient Ring is switched on by pressing the plus side (+) of the button for 2 seconds. The Ambient ring is switched off by pressing the minus side (-) for 2 seconds. There is only one level for the Ambient Ring.

The Ambient ring is also switched on when the operator logs in to the system and switched off at logout.

NOTICE

During acquisition the operation of the Bore illumination and Ambient Ring button is ignored.

Ventilation

The amount of ventilation through the magnet bore can be controlled with the Ventilation button. There are 5 levels available, including off. The level is indicated on the LED bar.
Also see chapter “Adjust Ventilation in Bore” on page 365.

NOTICE

Ventilation air is not sterile.

Music volume

This button can be used to adjust the volume of music for the patient. There are 5 levels available. The level is indicated on the LED bar.

Talk

The Talk button enables communication between the operator in the examination room and the patient wearing a headset.

Press the Talk button when the headset is plugged in.
This connects the magnet microphone to the patient headset (the button lights green), and switches off the music speakers in the examination room. This allows easy communication with the patient. Once pressed, it will remain active until pressed again (the button light goes off).

The Talk button on the intercom at the console can temporarily overrule the magnet microphone, but cannot switch it off.

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NOTICE
Remember to turn on the music after talking to the patient.

NOTICE
Unplug the head set when not used.

Stop scan

Pressing the Stop scan button will stop the currently running scan.

Pressing this button will also abort tabletop movement during a MobiTrak scan.

NOTICE
Pressing the Stop scan button twice will also stop image reconstruction.

Start scan / Pause scan

This button can be used to start a scan in the examination room.

When this button is pressed during a scan the scan is paused. Pressing the button again will resume the scan.

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NOTICE
In a MobiTrak scan this button will also initiate tabletop movement and start the scan automatically.

Tumble switch

The Tumble switch initiates all motorized movements of patient support and tabletop.

Horizontal and vertical movement

With the Tumble switch the patient support is moved:

- up or down when the tabletop is totally moved out of the magnet bore. The vertical speed is fixed.
- in or out the magnet bore when the patient support is at its highest position. Two speeds are available.

Operating the Tumble switch

Push the Tumble switch up for the up or in movement of the tabletop and push the switch down for the out or down movement.

The up/in and out/down symbols above and below the Tumble switch are only visible when this function is available.

Light visor

NOTICE

Before operation, read and familiarize yourself with the warnings in the safety chapter how to use the light visor.

By pressing this button a laser light beam is projected onto the patient.
This selects the patient reference point, i.e. the plane which will be positioned in the isocenter of the magnet.

- The laser light will automatically switch off after 60 seconds.
- Typical use of the light visor is only once for every patient.
- Use of the light visor during the execution of scan or ExamCard will be ignored: a new patient reference point cannot be defined.

Travel to scanplane (TTS)

After selecting the patient’s reference point with the light visor, the travel to scanplane function can be used.
Press the TTS button once to select the travel-to-scanplane mode. Raise the tumble switch to the ’up/In’ position and hold it until the tabletop automatically stops and the patient reference point has reached the isocenter.

Pressing the TTS button for 2 seconds will initiate automatic tabletop movement without using the tumble switch. The tabletop will stop when the patient reference point has reached the isocenter.

Patient reference point

After the patient reference point is positioned in the isocenter of the magnet, a survey is performed and all subsequent scans are planned with the information of this patient reference point. All tabletop movements which are required for optimal image quality are deduced from this point.

NOTICE

Do not leave the patient unattended until the tabletop has reached the isocenter.

Starting scan automatically (AutoStart)

The AutoStart functionality automatically starts the next item of the ExamCard, mostly the Survey scan, when you close the door to the examination room. AutoStart also works for paused dynamic scans.

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▷ Prerequisite: Centering with the light visor is completed and the travelling to scanplane procedure is initiated. Consequently the **Start scan/Pause scan** button is active.
Coils that have a fixed position (see table below) do not require using the light visor.

► To enable AutoStart, press the **Start scan/Pause scan** button.

⇨ To indicate that AutoStart is enabled, the **Start scan/Pause scan** button starts blinking.
Note: press the **Stop scan** button to stop AutoStart. The scan will not abort but return to active.

► Close the door to the examination room.

⇨ The next item of the ExamCard automatically starts.

AutoStart while in the examination room

You can also enable AutoStart when staying in the examination room during scanning.

▷ Prerequisite: Centering with the light visor is completed and the travelling to scanplane procedure is initiated. Consequently the **Start scan/Pause scan** button is active.
Coils that have a fixed position (see table below) do not require using the light visor.

► Close the examination room door.

► To enable AutoStart, press the **Start scan/Pause scan** button.

⇨ To indicate that AutoStart is enabled, the **Start scan/Pause scan** button starts blinking.
Note: press the **Stop scan** button to stop AutoStart. The scan will not abort but return to active.

► Press the **Start scan/Pause scan** button again.

⇨ The next item of the ExamCard automatically starts.

Coils with fixed position and Auto-iso

Coils that have a fixed position do not require the use of the light visor. Instead traveling to scanplane can be initiated immediately: the isocenter is travelled to automatically based on coil characteristics.

Coils with fixed position: Light visor is not needed for isocenter positioning	
• dS HeadSpine • dS HeadNeckSpine • dS Head 32ch 3.0T coil	Only when the coil top is used
• dS Shoulder 8ch and dS Shoulder 16ch • dS Knee 8ch, dS Knee 16ch and dS T/R Knee 16ch • dS FootAnkle 8ch and dS FootAnkle 16ch	Under all circumstances

Sockets for Coils, Headset and Nurse Call

Coil, headset and nurse call connection sockets are located at the corners of the tabletop, see figure below.

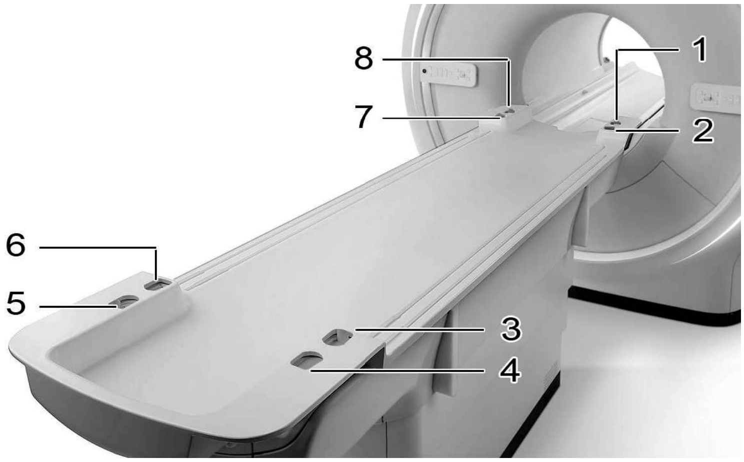

Fig. 23: Coil, headset and nurse call sockets.

Numbers	Socket type
1	FlexConnect socket.
2	Not used.
3	FlexConnect socket.
4	Not used.
5	Headset and Nurse call socket.
6	Not used.
7	FlexConnect socket.
8	Headset and Nurse call socket.

Disconnect all coils which are connected to the FlexConnect sockets and disconnect the nurse call and the headset before removing the tabletop with the FlexTrak.

NOTICE

Verify that the coil cables and connectors cannot get squashed while removing or placing the tabletop.

dStream Interface

The dStream interface is used to connect some dedicated coils. The interface must be positioned at the magnet end of the tabletop.

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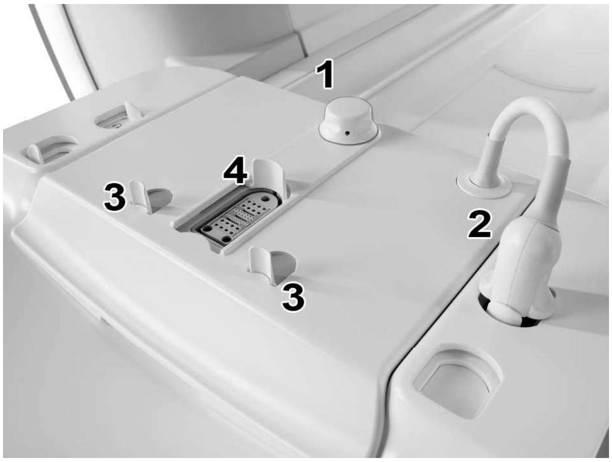

Fig. 24: dStream Interface.

Number	Description
1	ME coil connector release knob.
2	Connection lead and connector.
3	SE (Single Element) socket
4	ME (Multi Element) socket

An ME coil connector is easily released by turning the release knob (1). LED’s next to the knob indicate that coils are connected.

Coil socket for Transmit-/Receive coils (optional)

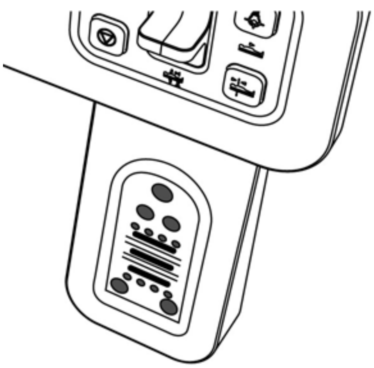

Fig. 25: Transmit-/Receive coil socket at left UIM.

An optional coil socket to connect Transmit-/Receive coils is located below the UIM on the left side of the magnet.

For more information on how to connect a coil to which socket, refer to chapter “Connectors and Plugs ” on page 252.

Patient Observation System

The Patient Observation System (POS) is an option that is available for all Philips MRI systems. It allows you to observe the patient using a camera and a monitor. This can be useful when direct visual contact is not possible. The POS has no interaction with the MRI system.

The camera is positioned in the examination room in such a way that the image provides full view of the patient in the magnet bore. The monitor, together with the camera interface box, is positioned near the operator's console.

The camera is always on. To switch the monitor off:

- ► Press the on/off button at the bottom of the monitor.
- ► Press the on/off button at the bottom of the monitor again to switch the monitor back on again.

If the image from the camera is not clear, contact your Philips service engineer.

Devices and controls essential for system safety

The following devices on the system and in the examination room are considered to be essential for system safety and should therefore never be removed, modified, over-ridden or disabled:

- Emergency Magnet Off buttons.
  Buttons are located inside and outside the examination room.
- Nurse call button.
- Emergency Table Stop buttons on the UIM and the keyboard.
- RF door switch.
- Quench pipe inside and outside the examination room.
- RF examination room configuration.
- Patient ventilation.

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5 Tabletop and trolleys

This chapter provides information about the preparation of an MRI examination.

Note that for every new patient the following items must be replaced (if applicable):

- Mattress paper.
- Ear plugs.
- ECG pads.
- Endo coil probe or cover (condom).

Preparation of the tabletop

This section describes the workflows needed to prepare the tabletop for an examination including:

- Moving the tabletop to its end stop,
- Lowering the tabletop.

Moving the Tabletop to its End Stop

The end stop is the position where the tabletop is moved totally out of the bore.The tabletop can only be lowered when it is at the end stop.

- ► **Under motor control**: Press the tumble switch down to the `Out/down' position and hold it there until the tabletop automatically stops at the end stop.
- ► **Under manual operation** (alternatively): Press the `Manual' button and move the tabletop out of the magnet manually until the end stop is reached. The tabletop then locks into place automatically.

Fig. 26: User Interface Module (UIM). 1: 'Manual' button, 2: Tumble switch.

Lowering the Tabletop

The tabletop needs to be lowered so that the patient can get on it easily.

- ► Lower the tabletop to the appropriate height by pressing the tumble switch down to the 'Out/down' position and holding it there until the appropriate height is reached.

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- The table should not be at its lowest position when a heavy patient is placed upon it. It should be raised at least 15 cm from its lowest point to ensure ease of vertical movement.
- To ensure optimum vertical and horizontal table movement, don't exceed the maximum allowed patient weight.

Refer to the Instructions for Use for the maximum allowed patient weight for table and trolley.

Moving patient to isocenter

This workflow describes how to position the patient in the isocenter. This includes the workflows:

- Raising the tabletop to working level
- Centering by means of the light visor,
- Travelling to scanplane,
- Return to scanplane after moving the tabletop out of the magnet.
- Manual operation.

Related User Interface Module (UIM) Buttons

Fig. 27: User Interface Module (UIM) at the magnet, with 1: 'Manual' button, 2: Tumble switch, 3:'Light visor' button, 4: 'Travel-to-scanplane' button, 5: Indicator for isocenter positioning.

Raising the Tabletop to Working Level

▹ The patient is positioned on the tabletop with the coils and all required positioning aids. The tabletop is still lowered.

► Raise the tumble switch (2) to the `Up/in' position and hold. Release the switch when the tabletop is in its highest position.

⇨ The tabletop is now at working level.

NOTICE

When holding the tumble switch continuously in the up/in position, the tabletop movement continues in horizontal direction after reaching its highest position.

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Centering by means of the Light Visor

- ► Raise and hold the tumble switch (2) again to the `Up/in' position to horizontally move the tabletop until the area of interest is near the magnet bore or at the magnet bore.
- ► Press the 'Light visor' button (3) once to switch on the light visor beams.
  The light visor beams indicate the mid-sagittal and a transverse plane.
- ► Raise the tumble switch (2) to the ’Up/In’ position and hold it until the area of interest lies within the light visor beams.
  Coil and area of interest do not have to be in the middle of the beams. The closer the area to be imaged is to the isocenter, the better the image quality.

  The indicator for isocenter positioning (5)

  - lights green when isocenter positioning is possible with the current light visor position.
  - flashes green when isocenter positioning is not possible with the current light visor position.
    Reposition the patient feet-first or move him/her closer to the magnet.

Travelling to Scanplane

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NOTICE

The examination/patient data must be entered before the 'Travel-to-scanplane' button can be used.

- ► Press and hold the ’Travel-to-scanplane’ button (4) for about 2 seconds.
  Alternatively, briefly press the 'Travel-to-scanplane' button (4) and raise the tumble switch (2) to the ’Up/In’ position and hold it until the isocenter is reached.
- ⇨ The tabletop will automatically be moved into the magnet until the isocenter is reached.

- Care should be taken that cables (coils, VCG) or tubes (IV drip, catheter) do not get caught.
- Verbal or physical contact is reassuring to a patient.
- Note that if the ’travel-to-scanplane’ tumble switch (2) is released before table motion has ceased, the table will stop before reaching the isocenter.

  The indicator for isocenter positioning flashes green to indicate that the isocenter has not been reached yet. In this case, raise the switch again and the tdfletop will resume its predefined travel.

NOTICE

In order to stop automatic table movement, touch the tumble switch or press the 'Travel-to-scanplane' button.

Return to scanplane after moving the tabletop out of the magnet

This function makes it possible to return to the original position after the table has been moved. This feature is especially helpful for studies with contrast agent administration.

- ► Use the tumble switch to move the table out of the magnet after the scans have been performed.
- ► After administering contrast agent, simply press and hold the ’Travel-to-scanplane’ button (4) again for about 2 seconds.

  The tabletop will stop at the previously indicated isocenter position.

NOTICE

Do not move the table right out to the end stop, and do not press the 'Light visor' button.

These actions would reset the isocenter position.

For manual operation

- ► Release the tabletop by pressing the ‘Manual’ button (1).
- ► Move the tabletop manually towards the magnet until the area of anatomical interest lies within the light visor beams.
- ► Press the ‘Manual' button (1) again to lock the tabletop.
- ► Press the 'Travel-to-scanplane' button (4).
- ► Raise the tumble switch (2) to the ’Up/In’ position and hold it until the isocenter is reached.

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FlexTrak patient transportation system and trolleys

The FlexTrak allows patient preparation for an examination while the previous patient is being scanned. Positioning of coils, positioning aids, monitoring and triggering equipment can be done outside the examination room.

For generic safety information, cautions and warnings refer to chapter “Safety” on page 125.

Safety

WARNING

Tilted tabletop due to incompatible patient transportation system.

Risk of patient falling off tabletop and serious injury.

• Only use the patient transport system intended for your system.

- **On Achieva/Multiva systems: only use the Achieva/Multiva trolleys.**
- **On digital MR systems: only use the FlexTrak.**
  FlexTrak systems and compatible tabletops are labeled with FlexTrak Label.

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FlexTrak

The following warnings apply to the use of the FlexTrak and HA FlexTrak (Height Adjustable) patient transport systems.

General

Safe working load

The safe working load for the tabletop using the FlexTrak is 250 kg. This is the total weight of patient, coils and positioning aids.
The maximum total mass of the FlexTrak is:

- Fixed height version: 360 kg.
- Variable height version (VH): 390 kg.

WARNING

Confirm that the tabletop is locked securely on the FlexTrak before the patient is moved, positioned or transported.

WARNING

Cardiopulmonary resuscitation (CPR) on FlexTrak may not be effective.

Risk of death.

- **Only perform CPR on a patient while the CPR performer stands next to the trolley.**

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When the caregiver climbs on the FlexTrak to perform CPR, the risks are:

- The tabletop may bend too much or break due to the applied forces.
- The tabletop may fall off the FlexTrak.

These effects can cause the CPR to be unsuccessful, cause serious injury or death.

WARNING

Patient falling off the Fixed Height FlexTrak or HA FlexTrak

Risk of serious patient injury.

- **Park the FlexTrak with the non side-rail side to the wall and apply the wheel locks when a patient is left unattended on the FlexTrak.**
- **Apply the wheel locks before a patient is moved to the tabletop.**
- **Apply the wheel locks when the FlexTrak is parked.**
- **Put the side rail up once the patient is positioned on the tabletop.**
- **Avoid fast movement, especially around corners.**
- **Fixate the patient if necessary.**

WARNING

Do not move the FlexTrak by means of the tabletop. Use the handle bar or the horizontal support.

WARNING

Fingers, hands, or other extremities of the patient get stuck or hit.

Risk of serious patient injury.

- **Watch patient extremities during transfer onto the tabletop.**
- **Make sure that patient extremities remain on the tabletop during transportation and docking to the patient support.**
- **Use the arm supports or fixate the patient and extremities if necessary (for example for sedated patients).**

Examination room

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WARNING

Verify that there are no magnet objects present on the tabletop before entering the examination room.

Such objects will be attracted by the magnet and may lead to serious or fatal injury of the patient or personnel and may cause system malfunctions.

CAUTION

Verify that no cables and connectors are hanging down from the tabletop when it is taken over from the patient support onto the FlexTrak or vice versa.

This could lead to damage.

NOTICE

FlexTrak is adjusted for docking to only one side of the patient support.

Please contact Philips Customer Service if you want to change the docking side.

Overview FlexTrak

The FlexTrak is the dedicated patient transportation system for your MR system. There is a height adjustable (HA) and a fixed height (FH) version available.

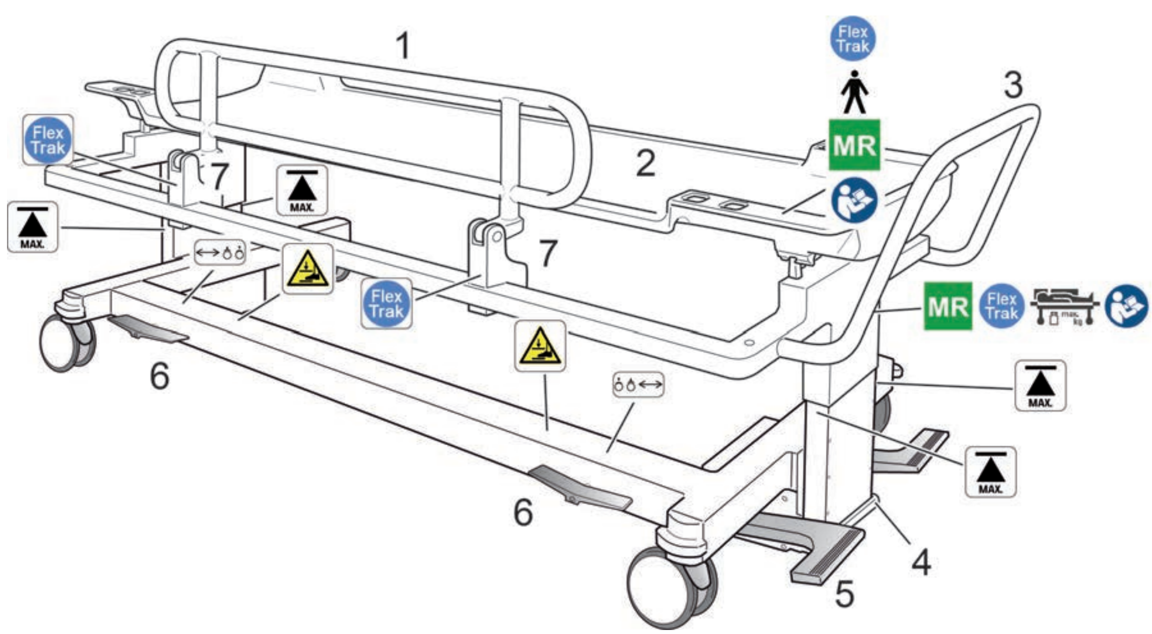

Fig. 28: F lexTrak components, warning signs and labels. by example of the height adjustable version.

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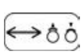
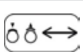
No./Label	Description	FlexTrak versions
1	Side rail.	HA FlexTrak.
2	Tabletop.	All.
3	Handle bar.	All.
4	Bumper.	HA FlexTrak.
4	Foot lever for height adjustment.	HA FlexTrak.
5	Swivel wheel lock pedal.	All.
6	Bumping blocks.	All.

No./Label	Description	FlexTrak versions
	Label: FlexTrak. Label also present on matching patient support.	All.
	Label: MR Safe	All.
	Label: Maximum working load.	All.
	Warning label: danger of clamping.	HA FlexTrak.
	Label: maximum height of the FlexTrak.	HA FlexTrak.
	Label: swivel wheel pedal positions.	All.
	Label: swivel wheel pedal positions.	All.
	Label: Mandatory action; read manual.	HA FlexTrak.

Operation

Swivel wheels

The swivel wheels can be locked with the foot operated pedals. Both wheels on one end are locked simultaneously.

Unlock

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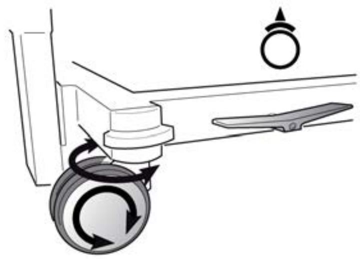

Fig. 29: Unlock

Set the pedal in horizontal position:

- The wheel turns freely.
- The swivel turns freely.

Use unlocked wheels for transport of the FlexTrak.

Swivel lock

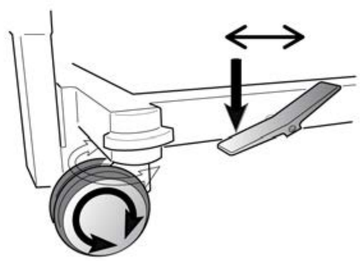

Fig. 30: Swivel lock

Press the pedal down towards the wheel:

- The wheel turns freely.
- The swivel will automatically lock when the swivel wheel is turned in longitudinal direction.

Use the swivel lock on one axis to improve manoeuverability during transport of the FlexTrak.

Wheel lock

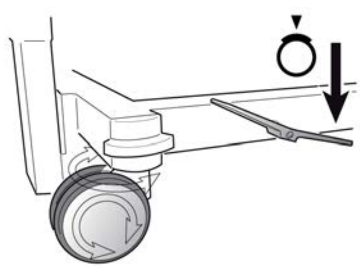

Fig. 31: Wheel lock

Press the pedal down away from wheel:

- The wheel is locked.
- The swivel is locked.

Lock all wheels:

- Before positioning a patient on the tabletop.

- In park position of the FlexTrak.
- When the FlexTrak is docked at the patient support.

Height adjustment (HA FlexTrak only)

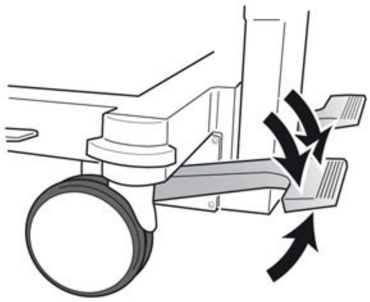

Fig. 32: Foot lever

- Increase the HA FlexTrak height by operating the foot lever repeatedly downwards.
- Decrease the HA FlexTrak height by lifting the lever carefully but completely up with the top of your foot until the desired height has been reached.

NOTICE

Decrease the FlexTrak height gently when a patient is on the tabletop.

NOTICE

Move the FlexTrak to its highest position to correct a possible height difference on each side of the FlexTrak.

In some cases the FlexTrak height can differ causing a mild decline of the tabletop. This can be corrected by moving the FlexTrak to its highest position.

Side rail (HA FlexTrak only)

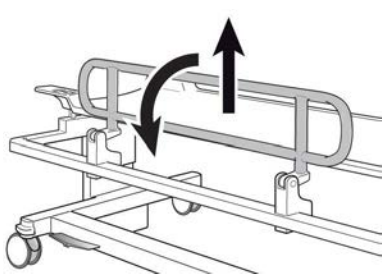

Fig. 33: Fold down

Fold down

- Pull the side rail up, out of its locking position.
- Fold the side rail carefully down.

CAUTION

Do not let the side rail fall down.

Fold up

- Fold up the side rail until it snaps into its locking position.

WARNING

Verify that nothing gets clamped while folding the side rail up, e.g. fingers and infusion lines.

Docking and undocking

CAUTION

Before docking and taking over the tabletop by and from the patient support, make sure to set the HA FlexTrak in its highest position by operating the foot levers.

The HA FlexTrak must be at its maximum height to avoid possible damage. Over hours the trolley height may show a slight decrease.

Docking

- ► Lower the patient support to its lowest position.
- ► HA FlexTrak:
  increase the FlexTrak height to its maximum: the maximum height indication label is completely visible.
- ► Unlock the swivel wheels of the FlexTrak and position it at the patient support.

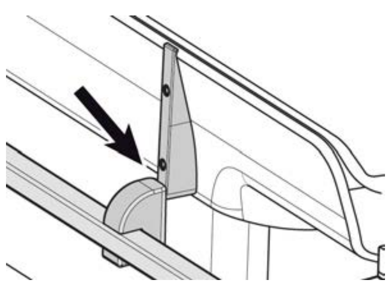

Fig. 34: Bumping blocks

- ► Dock the FlexTrak sideways to the patient support. Both bumping blocks of the FlexTrak must touch the bumping blocks of the patient support.
- ► Apply the wheel locks.

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- Move the patient support up until the tabletop is taken over by the patient support.
  The tabletop is automatically released from the FlexTrak and engages to the patient support.

NOTICE

The FlexTrak can remain at the patient support while scanning. Verify that the FlexTrak stays at its maximum height and the side rail is folded down.

Undocking

- Move the patient support up to its maximum position.
- HA FlexTrak:
  increase the FlexTrak height to its maximum: the maximum height indication label is completely visible.
- Unlock the swivel wheels of the FlexTrak and position it at the patient support.
- Dock the FlexTrak sideways to the patient support.
  Both bumping blocks of the FlexTrak must touch the bumping blocks of the patient support.
- Apply the wheel locks.
- Lower the patient support until the tabletop is released and engaged to the FlexTrak.
- Lower the patient support completely.
- Unlock the wheels and remove the FlexTrak sideways.

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6 Physiology

This chapter describes features and components of *Wireless Physiology* and gives relevant workflow information.

What are the main features of Wireless Physiology?

- *Wireless Physiology* provides synchronization of the MRI sequences with the physiology signals.
- The physiology signals are displayed in the **Patient Status Area** on the operator's console.
- If correctly used, *Wireless Physiology* reduces image artifacts caused by breathing, pulsatile flow and cardiac motion.
- *Wireless Physiology* utilizes sensors for
  - respiration,
  - VCG (VectorCardioGraphy),
  - plethysmography (Peripheral Pulse Unit PPU).

WARNING

Do not use the physiology signals for monitoring or diagnostic purposes.

The physiology signals are distorted when the patient is inside the magnet.

Components of Wireless Physiology

Wireless Physiology consists of the following components:

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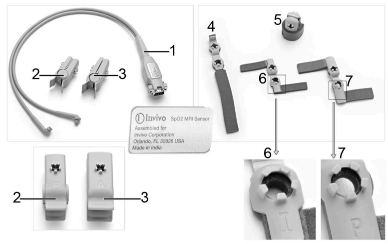
Item	Image
SpO_2 grip sensors for PPU Two different sets are available.	Either you have this set of grip sensors:  Or this one: 
Respiratory belt	
Wireless-VCG battery module • possibly with connection for the respiratory belt; • configuration-dependent with a long ECG cable.	
Wireless-PPU battery module (including connection for the respiratory belt)	

Item	Image
Battery charger	
Wireless basic triggering unit (wBTU)	located in the magnet room (no image)

Ordering of consumable items and equipment

To order consumable items for physiology sensors and cables, please contact your Philips Healthcare representative.

To order special equipment (e.g. for pediatric examinations), please use the following website:

http://www.invivocorp.com

Wireless-PPU and Wireless-VCG battery module

The wireless-PPU and the wireless-VCG battery modules are essential in connecting physiological sensors to your MRI system.

These battery modules look identical with two exceptions:

1. indication of the device type: VCG or SpO_2 (in case of PPU).
2. the connectors on the battery modules.

	Connectors on wireless battery module		
Module	**for VCG**	**for SpO_2 sensors (PPU)**	**for respiratory belt**
Wireless-VCG battery module	**yes**	**no**	**yes** (Might not be available in some cases)
Wireless-PPU battery module	**no**	**yes**	**yes**

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Fig. 35: Wireless PPU battery module. 1: Connector of respiratory belt, 2: Connector of Peripheral Pulse Unit (PPU), 3: Indicator of the device type: VCG or SpO_2 (in case of PPU), 4: Indication of current network, 5: Indicator of battery status

Indicator of battery status

The table below lists the LED indications for battery and communication status.

Color	Solid or Blinking	Battery Status	Communication Status
No color	Solid	No battery inserted or too low battery power	Not applicable
Green	Blinking	Battery power is okay	No communication with wBTU
Green	Solid	Battery power is okay	Good communication with wBTU
Red	Blinking	Battery power is low	No communication with wBTU
Red	Solid	Battery power is low	Good communication with wBTU

Tab. 3: Battery and Communication Status

Exchanging battery

- Press on the battery levers and slide the battery out of the wireless battery module.
- To insert a battery, slide the battery into the battery compartment.

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Fig. 36: Left: Pressing on battery levers and sliding battery out of wireless battery module. Right: Wireless battery module from the back with battery removed.

NOTICE

When a battery is inserted into the battery compartment, you can select the wireless network A, B, C, D or E as adjusted in the wBTU so that wireless communication is enabled.

The procedure is described in the paragraph below.

Selecting wireless network

▹ The wireless network has to be selected only once by the Philips service engineer during device installation.

▹ The wireless network selection is persistent.

▹ The wireless network has to be selected in the **Physiology Properties** window on the MR console.
See chapter "Display of physiology signals" on page 139.

► Press on the battery levers to slide the battery a bit out of the wireless battery module.

► Reinsert the battery into the battery compartment.

⇨ The network LED's start blinking.

Fig. 37: Left: Reinserting the battery into the battery compartment. Right: Pressing on the text field to go through the networks.

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- ► Press on the text indicating the type of the device (SpO_2 or VCG) to enable the network selection procedure.
- ► Press again on this text field to go through the networks A to E.
- ⇨ The current network is indicated by the blinking LED.
- ► To confirm the selection of the current network, press on the text field a little bit longer until the LED doesn't blink anymore, but burns constantly.

NOTICE

A different type of Wireless-VCG (+ cable) and Wireless-PPU module is provided with the Expression MR400 MRI Patient Monitoring System.

Interoperability with this Monitoring system is provided and the Wireless-VCG and Wireless-PPU modules can be used for triggering.
More information about Expression MR400 modules is described in the **Expression MR400** User Manual.

Battery charger

The battery charger is used offline to charge the lithium batteries for the wireless and the wired units of VCG and PPU.

NOTICE

The battery charger is not MR compatible and should only be used in the control room.

Parts of the battery charger

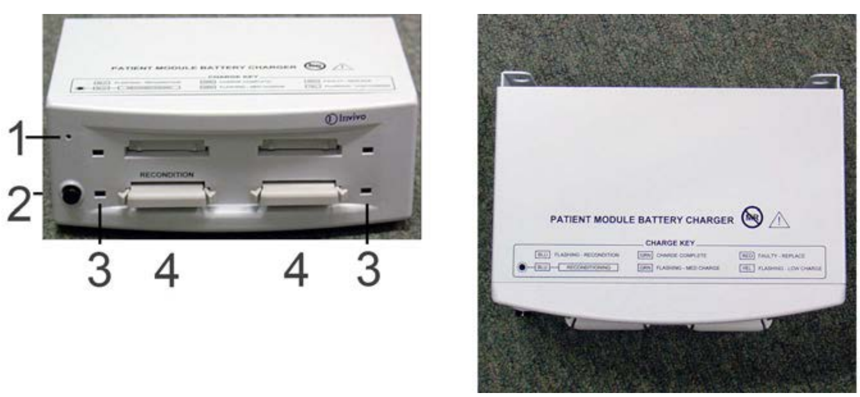

Fig. 38: Left: Front side of the battery charger. Right: Top side of the battery charger. Depending on your system configuration, your battery charger may be slightly different.

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Nr.	Part	Description
1	Charger power (green LED)	The charger power indicates when +24Vdc input from the AC adapter is present.
2	Battery discharge switch	When pushed, the battery in the lower left-hand battery slot will be put in a re-conditioning discharge cycle. The associated battery charge LED will illuminate solid blue.
3	Battery charge RBG LEDs	These LED’s indicate the current status of the batteries inserted in the battery slot(s).
4	Battery slots	Each battery slot provides for insertion of a separate lithium battery for recharging purposes.

RGB LED display	Status
Solid green	The battery is fully recharged and ready for reuse.
Flashing green	The battery currently has a medium charge and is successfully recharging.
Flashing yellow	The battery currently has a low charge and is successfully recharging.
Solid red	A faulty or dead battery is in the slot. Discard the battery.
Solid blue	The battery in the lower left-hand battery slot is currently in a reconditioning discharge cycle.
Flashing blue	The battery requires reconditioning. This battery must be inserted into the lower left-hand battery slot to be reconditioned.
Extinguished	No battery is inserted in the battery slot.

Tab. 4: Status of the Battery Charge RGB LEDs

Battery charging time

Recharging a complete empty battery takes about 8 hours maximum.

It is advised to put the batteries on the charger when not in use.

Cleaning

- Regularly clean the contacts of the battery pack according to the manufacturer's Instructions for Use.
- Always unplug the charger before cleaning.

Display of physiology signals

When you use VCG, PPU or the respiratory belt on a patient, the physiology signals are displayed

- in the **Patient Status Area**.

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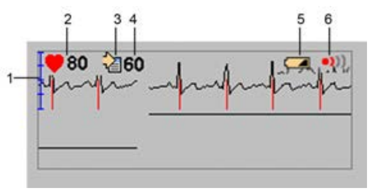
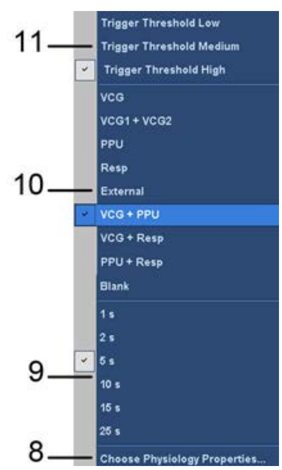
Physiology Display

The **Physiology Display** panel is available in the **Patient Status Area** (lower left corner on the operator's console). It allows you to

- view up to two physiology signals at the same time,
- view the battery status of the currently used VCG or PPU module (which is only indicated if low),
- view the status of the wireless communication (which is only indicated if low) (not applicable for Wired Physiology),
- view the signal strength of the VCG signals,
- open the **Extended Physiology Display** where you can
  - view which VCG calibration is currently used.
- open the **Physiology Properties** window where you can
  - adjust the display of the physiology signals,
  - check the status of wireless communication (not applicable for Wired Physiology).
  - select the VCG calibration method (automatic or manual),

Physiology Display	Extended Physiology Display	Right mouse menu of Physiology Display
		
Available in **Patient Status Area**.	► To open the **Extended Physiology Display**, click anywhere in the **Physiology Display**.	► To open this menu, right-click the **Physiology Display**.

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Number	Item	Explanation
1	**Signal strength**	**Only applicable for VCG:** Indicates the strength of the VCG signal. • The VCG signal is measured with a mV indicator. • One step of the caliper is 0.5 mV.
2	**Heart rate**	Displays the patient heart rate in beats per minute.
3	**Update heart rate** in ExamCard properties	Copies the current heart rate to the ExamCard properties of the current ExamCard
4	**Entered heart rate**	Displays the entered heart rate as also displayed in the ExamCard properties. You can edit this text field and enter a heart rate value.
5	**Battery low**	Indicates that the battery of the VCG or PPU module is low. The VCG or PPU signal may deteriorate.
6	**Wireless communication strength**	Indicates that the wireless communication strength is low. The VCG signal may deteriorate. Not applicable for Wired Physiology
7	**Manual VCG calibration method in use**	**Only applicable for VCG** Indicates that manual calibration is performed instead of automatic calibration. Available in **Extended Physiology Display.**
8	**Choose Physiology Properties ...**	Allows you to • adjust the display settings for the physiology signals. • select the VCG calibration options. • change the trigger threshold during the examination. For more information about trigger threshold, see chapter “Troubleshooting” on page 165. The button flashes yellow when the battery status or the wireless communication strength is low.
9	**Time range**	Allows you to set the time range to 1, 2, 5, 10 or 25 seconds.

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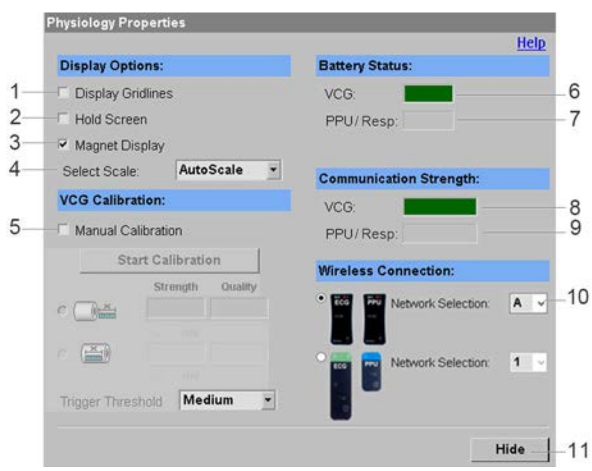
Number	Item	Explanation
10	**Physiology signals**	Allows you to select the physiology signals for display: • **VCG**, • **PPU**, • **Resp** (Respiratory), • **External**, • combinations of the above: **VCG+PPU**, **VCG+Resp**, **VCG+External**, **PPU+Resp**, **PPU+External**, **Resp+External** • **VCG1+VCG2** • **Blank**: no physiology signal.
11	**Trigger threshold**	**Only applicable for VCG:** Allows you to change the trigger threshold to adjust the sensitivity for the detection of R-peaks. See chapter “Troubleshooting” on page 165 (section Low signal quality).

Adjusting the display of the physiology signals

► In the **Physiology Display**, right-click to open the **Physiology Properties** window.



► To enable or disable

- the display of **Grid lines (1)**
- the function **Hold Screen (2)**
- physiology signals on the **Magnet Display (3)** (only available on Achieva systems, depending on their configuration).

select or deselect the corresponding check boxes.

► To select the scale of the signal, select **AutoScale** or **Fixed scale (4)**.

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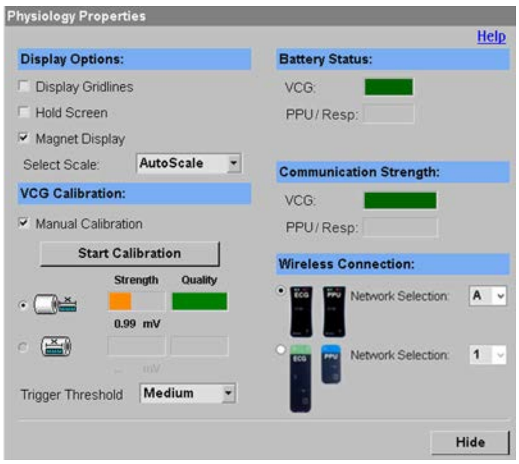
- With **AutoScale**, the scale is automatically adapted to the maximum detected signal in the displayed time span (after a complete sweep of the signal).
- **Fixed scale** is only available for VCG.
  Possible values: 0.5 mV, 1.0 mV, 2.0 mV, 5.0 mV, 10.0 mV. The mV values represent the full peak-peak dynamic range.
  Signals higher than the maximum value are skipped.
  For VCG1+VCG2, the same scale is applied for both signals.
  The mV-indicator in the **Physiology Display** is modified according to the selected scale.

► To perform manual calibration of the VCG signal, select **Manual calibration (5)** and then click **Start Calibration**.



With manual calibration, you can retrieve calibration results and select the trigger threshold for VCG R-peak detection. For more information, see chapter “VCG calibration” on page 159.

► Click **Hide (11)** to hide the window.

NOTICE

When you change any setting of VCG calibration, this change has immediate effect on the R-peak detection.

This is valid for: manual or continuous VCG calibration, inside or outside bore VCG calibration and change of the trigger threshold.

Checking battery status and communication strength

▷ **Only applicable for wireless modules:**

► Visually check the battery status **(6,7)** (VCG and/or PPU/Resp).

► Visually check the communication strength **(8,9)** (VCG and/or PPU/Resp).

► Click **Hide (11)** to hide the window.

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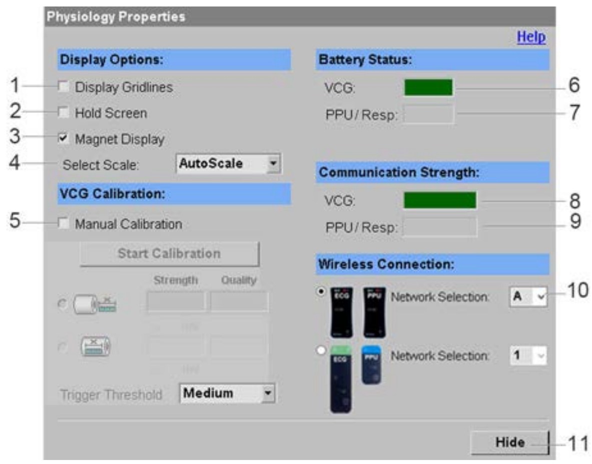
Selecting the wireless network

For wireless physiology, you need to select the wireless network.

► In the **Physiology Display** panel, right-click to open the **Physiology Properties** window.
For compatibility with InVivo monitoring equipment (e.g. Expression), ensure that all components (VCG or PPU battery module, operator's console and InVivo monitor) are on the same wireless network.



► To select the wireless network, select **A, B, C D or E** for **Network Selection (10)**

- **Note**: Module type and related network selection must be selected if interoperability with **Expression MR400** is provided.

► Click **Hide (11)** to hide the window.

Respiratory Belt

Property	Description
Purpose	To detect the patient’s breathing through abdominal or chest wall motion
Applications	• Respiratory Compensation: to reduce motion artifacts due to breathing • Visualization of the patient’s breathing
Limitations	The respiratory signal cannot be used for monitoring or diagnostic purposes other than determining the respiration wave for MR imaging

WARNING

Do not use the physiology signals for monitoring or diagnostic purposes.

The physiology signals are distorted when the patient is inside the magnet.

Positioning of the Respiratory Belt

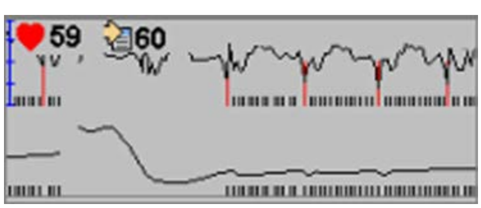
- Place the belt on the patient’s upper abdomen or lower chest (whichever expands most during inspiration - preferably the area to be scanned).

  For optimal signal, place the belt directly under the coil in longitudinal direction.
- Use a velcro strap to affix the sensor.
- Connect the flexible tube to the wireless module (or to the UIM).

NOTICE

Avoid excessive bending of the flexible tube as this may impair detection of the patient's respiration.

- Check the respiratory signal in the **Physiology Display** window.



- Position the patient in the magnet.

If the Respiratory Signal appears to weaken

Instruct the patient, between scans, to breathe more deeply during the scan (thus creating more movement at the sensor).

Related Parameters

- Respiratory Compensation

For more information, refer to the system's **Help Topics**.

Peripheral Pulse Sensor

Property	Description
Purpose	Cardiac Triggering: Acquisition of imaging data at defined moments in the cardiac cycle. The trigger signal is derived from changes in capillary blood flow during the cardiac cycle. It is transmitted via fiber optics.
Applications	• Suppression of artifacts caused by flow of blood or CSF in the spine • Pulse rate monitoring
Limitations	May alternatively be used for cardiac imaging or angiography, although there is an inherent delay from the time of the R-peak until flow change is registered in the finger.

WARNING

Do not use the physiology signals for monitoring or diagnostic purposes.

The physiology signals are distorted when the patient is inside the magnet.

SpO_2 and Pulse Rate Accuracy

Pulse oximetry measurements are statistically distributed.

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Quick Connect SpO_2 MRI Sensor: components and applications

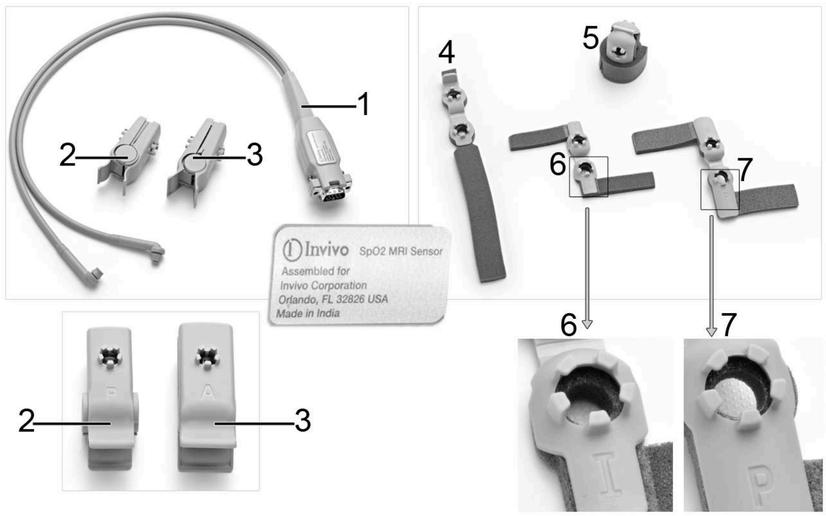

Fig. 39: PPU SpO_2 MRI sensor. 1: Sensor cable, 2: Reusable grip sensor Pediatric (P), 3: Reusable grip sensor Adult (A), 4-7: Disposable grip sensors in different sizes where 4 - Neonatal (N), 5 - Adult (A), 6 - Infant (I), 7 - Pediatric (P). Depending on the system configuration, different grip sensors may be available. For more information about these sensors, see the dedicated Instructions for Use.

The sensor cable has two legs, a receiver side (no light when powered) and an emitter side (illuminates red when powered). Both fiber optic tips of the cable legs are identical in size and can be snapped into either of the two retainers on the attachments.

The SpO_2 attachments for PPU are delivered in two different types and in up to four different sizes.

Attachment	Application	Preferred location	Alternate locations
Reusable Clip A	Adult: more than 40 kg	Any adult finger, preferably index	-
Reusable Clip P	Pediatric: between 10 kg and 50 kg	Any pediatric or small adult finger, preferably index	-
Disposable Grip A	Adult: more than 40 kg	Any adult finger, preferably index	Toe
Disposable Grip P	Pediatric: between 10 kg and 50 kg	Any pediatric or small adult finger, preferably index	Toe
Disposable Grip I	Infant: between 5 kg and 15 kg	Any infant or small pediatric's finger, preferably index or thumb	Big toe
Disposable Grip N	Neonate: between 1 kg and 5 kg	Any neonate's foot	Hand or wrist

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NOTICE

The patient weights above are given for orientation only. The size of the chosen limb is more important in determining the attachment type to use.

Positioning of the Peripheral Pulse sensor

NOTICE

Do not place the wireless unit in proximity of the System Body coil.

- Push the fiber optic tip into the retainer of the attachment firmly until you hear the click. Assure the sensor cable is snug on the attachment and does not fall off. It may swivel but not wiggle.
- Repeat for the other cable leg.
- Attach to limb. Light may shine on top or on bottom of the limb.

NOTICE

Failure to insert the tip properly will compromise the measurement accuracy, and may cause error messages to be displayed on the monitor or prevent a reliable measurement.

- Select the proper attachment for the application.

NOTICE

Make sure the sensor windows are completely covered by skin or nail.

NOTICE

Always select the attachment that provides a snug fit.

NOTICE

Avoid placing the sensor on extremities with an arterial catheter, intravascular venous infusion line, or inflated blood pressure cuff. Failure to do so may result in inaccurate readings or false alarm indications.

- Apply the attachments.

NOTICE

Fit the sensor while the patient is outside the magnet.

NOTICE

The finger must not be moved during the scan.

Reusable Clips

- Press the clip to open.
- Push the clip over a finger so either fiber head is on the top over the root of the nail and the other fiber head opposite to it. It does not matter which head is on top.
- Assure that the finger is touching the stop at the cushion and lays nicely centered in the clip.

NOTICE

You may swivel each fiber head into a position that provides most comfort to the patient and bends the cable least.

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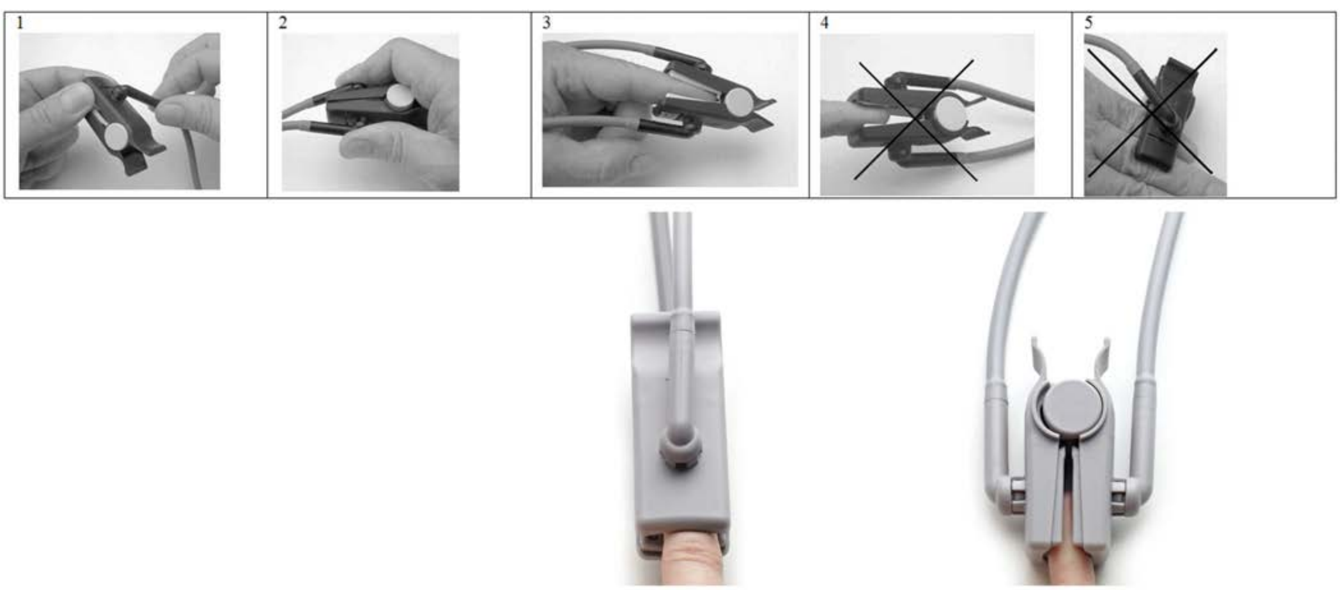

Fig. 40: PPU SpO_2 attaching reusable clip A.

Disposable Grips A, P and I

- Lift off the release liners that protect the adhesive.

- Put the finger or toe onto either side of the attachment - they are symmetrical - such that the tip covers the window completely and the finger does not protrude over the hinge.
- Close the grip.
- If the fit is good, press the attachment firmly on the finger or toe. If the fit is not good, reposition the attachment.
- Wrap the foam wings around the finger and attachment and stick to the opposing grip side. Do not stretch the foam to apply excessive pressure.

NOTICE

You may swivel each fiber head into a position that provides most comfort to the patient and bends the cable least.

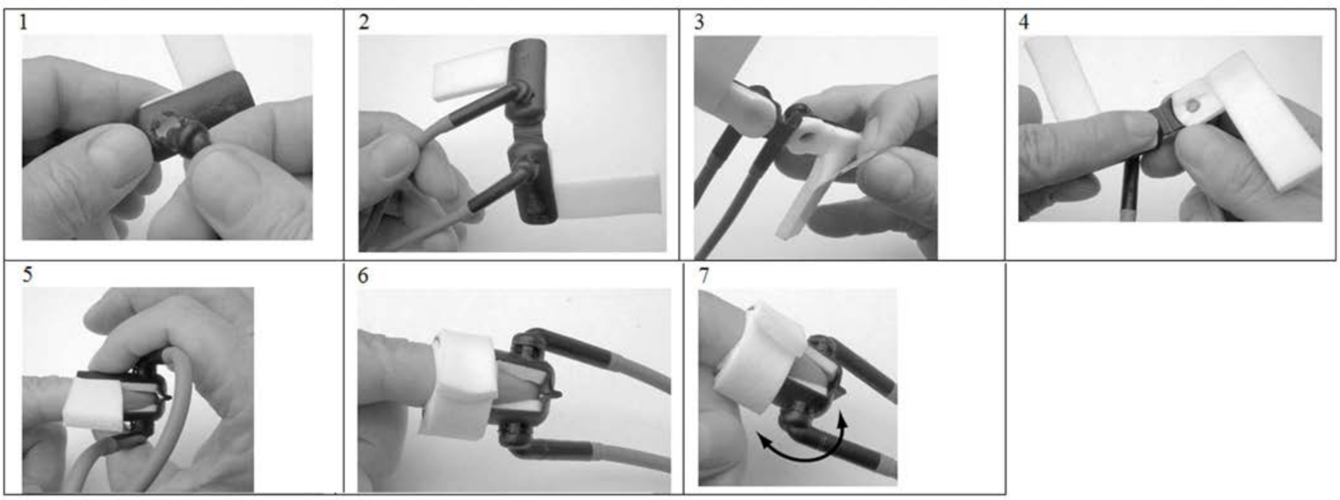

Fig. 41: PPU SpO_2 attaching disposable clip A.

Fig. 42: PPU SpO_2 attaching disposable clip I.

Disposable Grip N

- Lift the release liners that protect the adhesive part.
- Foot application: Align the hinge on the outside facing ridge of the foot. Make sure the attachment is as far as possible toward the small toe but never over it.
  Hand/wrist application: Align the hinge on the outside facing ridge of the hand or wrist. You may have to swivel the fiber heads to an optimal position to ease the application.

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- If the hinge is in line with the ridge of the foot/hand/wrist, press one side to the skin.
- Wrap the other side around the limb pulling the long foam piece gently.
- Press both fiber heads gently to attach the adhesives.
- Secure the longer foam piece by pressing it firmly to the foam/adhesive of the opposing side.
- Assure the two fiber heads are opposing and have good skin contact. The angle between the two fiber heads should be as small as possible not exceeding 45°. If the attachment opens too much, reattach or try another side.

NOTICE

You may swivel each fiber head into a position that provides most comfort to the patient and bends the cable least.

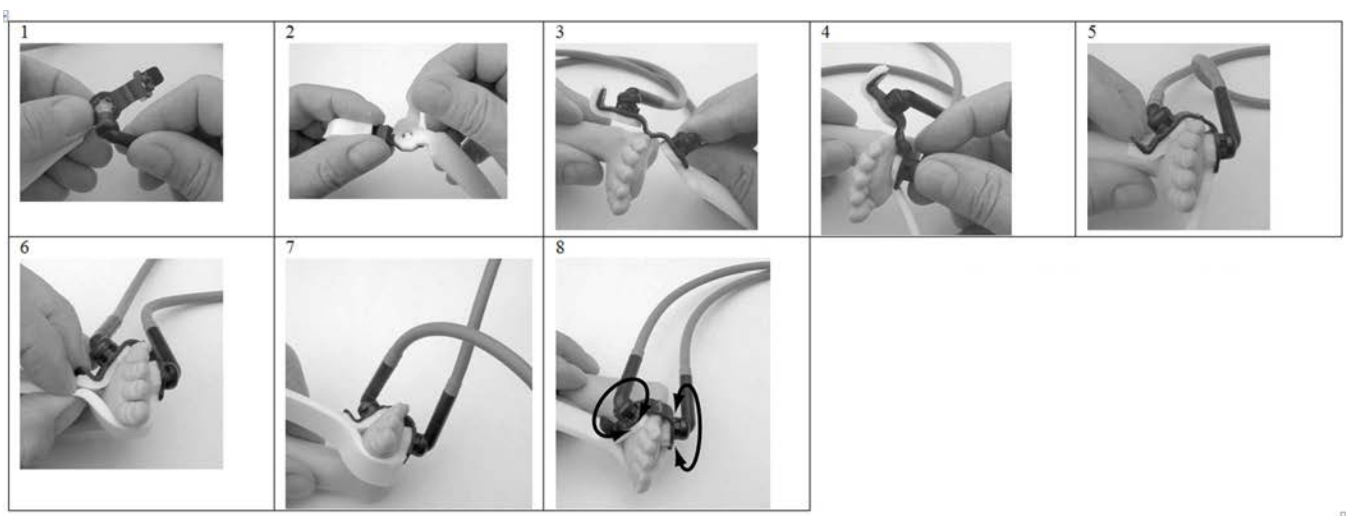

Fig. 43: PPU SpO_2 attaching disposable clip N.

Displaying the PP sensor signal

- Check the PP sensor signal and the trigger pulses in the display, see chapter “Display of physiology signals” on page 139.

NOTICE

Instruct the patient that the finger must not be moved during the scan.

If the signal is too weak,

- fit the sensor to another finger on the same hand or on the other hand.

- keeping the finger warm may help.
  Excessive pressure on the finger will decrease the blood flow and weaken or suppress the signal.

VCG (VectorCardioGraphy)

Property	Description
Purpose	Cardiac Triggering: Acquisition of imaging data at defined moments in the cardiac cycle.
Applications	• Imaging of the heart at various phases of the cardiac cycle • Suppression of artifacts caused by heart motion • Suppression of artifacts caused by flow of blood or CSF • Imaging arteries with TRANCE
Limitations	The VCG signal cannot be used for monitoring or diagnostic purposes.

With VCG, the electrical activity of the heart is modeled as a vector. During the cardiac cycle this vector changes magnitude and orientation. The vector's projection on to a plane gives a spatial plot of the heart's electrical activity.

By connecting the tips of the vector at different moments loops are generated describing the different cycles of the electrical activity of the heart: P-, QRS- and T-loop. Thus, using spatial information of the ECG the QRS-loop can be differentiated from the loops of the artifacts.

Safety

WARNING

Do not use the physiology signals for monitoring or diagnostic purposes.

The physiology signals are distorted when the patient is inside the magnet.

WARNING

Only use the appropriate InvivoMDE™ battery pack with the VCG module.

This battery pack may only be charged with the InvivoMDE™ battery charger.

Connecting VCG to the patient

Patient preparation and electrode positioning play an important role in obtaining high quality VCG signals. The recommended workflow is described in this section.

The quality of the VCG signal is also influenced by other factors. For more information, see chapter "Factors affecting the VCG signal" on page 158.

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WARNING

Wrong usage of ECG electrodes.

Risk of patient skin burns

- **When positioning ECG electrodes for the VCG module:**
  - **Only use MR Safe or MR Conditional electrodes and leads.**
  - **Make sure electrodes have not passed their expiration date. ECG electrodes can dry out resulting in bad electrical contact.**
  - **Properly prepare the patient and apply electrodes correctly.**
  - **Never reposition or reuse electrodes. Always use new electrodes.**
  - **Always carefully read and strictly follow the Instructions for Use of the electrode manufacturer.**

NOTICE

For best results, it is recommended to use the Philips M2202A radio translucent foam monitoring electrode.

(http://shop.medical.philips.com)

WARNING

Do not use pediatric ECG electrodes on adults or Adult ECG electrodes on pediatric patients.

The use of wrong ECG electrodes may result in skin burns.

Preparing the patient's skin

► Prepare the patient's skin according to the electrodes manufacturer's Instructions for Use.

To reduce skin impedance and to ensure good contact between electrodes and skin, proper skin preparation is required. Proper skin preparation

- prevents electrodes from coming loose and consequently avoids signal loss.
- prevents high skin impedance that leads to noise in the VCG and to warming of the skin.

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Position the electrodes

NOTICE

Position the electrodes as described in this section.
Do not use the alternative lead placements that are described in the manuals of InVivo monitoring equipment (e.g. Expression, Expression MR400). Do not use the lead placement instruction as indicated on the label of the VCG-cable.

These alternative lead placements are not optimized for the purpose of cardiac synchronization in MRI-sequences.

- ► Position the first electrode below the first intercostal space, just left of the sternum.
- ► Position the second electrode just left of xiphoid, approximately 10 cm to 15 cm below the first one.
- ► Position the third electrode at the patient's left side, forming a 90° angle with the other two electrodes. Keep the distance between black and red similar to the distance between white and black. If positioned correctly, the imaginary line (between the second and the third electrode) runs under the nipple line.
- ► Position the fourth electrode just below the second electrode.
- ► Connect the leads to the electrodes.

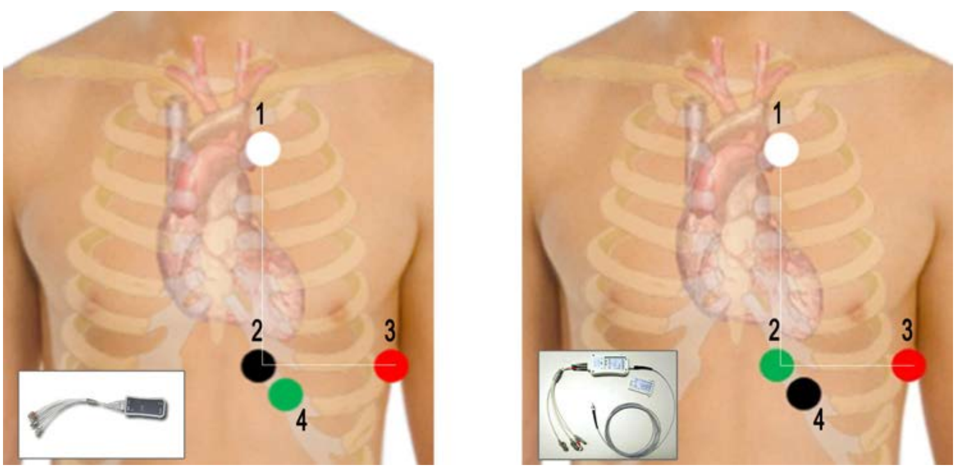

Fig. 44: The black and green electrodes are exchanged from wireless physiology to wired physiology, while white and red are identical.

- ► Make certain that the cables are correctly inserted into the VCG module.

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NOTICE

The color coding is compliant with international standards.

The recommended lead positioning provides proper interoperability with the Precess monitor of Invivo.

Color Codings of the ECG/VCG clips

Color of the Clip	Function with Wireless Physiology	Function with Wired Physiology	Physiology Display
white	active 1	active 1	upper trace VCG1
red	active 2	active 2	lower trace VCG2
green	common ground	common active	
black	common active	common ground	

NOTICE

Color coding as described above follows the AAMI/AHA (American standard) color coding standard. With Expression MR400 monitor, cables may be provided that follow the IEC (European standard) color coding Standard.

Function of the clips in the IEC color coding standard:

- Red = active 1 /upper trace VCG1
- Green = active 2 / lower trace VCG2
- Black = common ground
- Yellow = common active

Deviations from the recommended electrode positioning

Under certain conditions, you can deviate from the recommended electrode positioning.

1. **In patients with sternal wires:**
   - Position the white and black electrodes more towards the patient's right side.

   – Alternatively position them on the patient's back.
   – Take care that you do not place the leads too high on the back (consider the imaginary nipple line).
2. **Patient dependent in case of insufficient VCG signal:**
   – The optimal distance between the electrodes varies per patient.
   – A greater distance increases the SNR of the QRS-complex, but also noise and baseline distortions (T-wave artifact).
   – A smaller distance decreases the SNR of the QRS-complex, and also decreases baseline distortions (T-wave artifact).

NOTICE

When using InVivo monitoring equipment (e.g. Expression, Expression MR400) in an MRI-environment, ensure that the monitor is in Magnet mode. This ensures that the scanner controls the Module Filter settings.
The warning ‘Interoperability Mode Disabled’ is displayed in the PSA when Magnet mode is disabled

For more information about magnet mode, see the InVivo user documentation.

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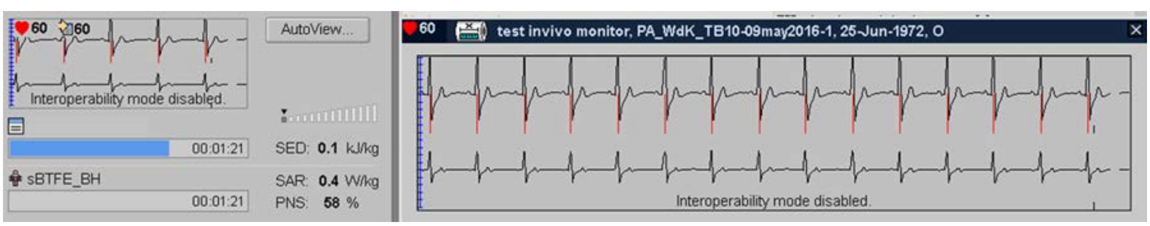

Fig. 45: Warning: Interoperability Mode Disabled

Placing the VCG battery module

▷ The electrodes are positioned. The leads are connected. The cables are correctly inserted in the VCG battery module.

► Put the VCG battery module on the tabletop either between the legs or to the side.

► If you put the VCG battery module to the side, you can place the knee cushion on top of the VCG module.

► Place the cable in a straight line and fixate it with a velcro strap. You can use one strap for VCG battery module and respiratory belt.
Make certain that the cable is not under tension.

► Let the patient deeply breathe in and out to make certain that leads and cables don't move during deep inspiration and expiration.
If leads and cables move, fix them with straps.

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► Make certain you adhere to the following warnings.

WARNING

Do not place the VCG battery module (VCG or PPU unit) directly on the patient's skin.

Direct contact may cause heating of the skin. Keep a distance to the patient's skin of at least 1 cm using pads of the standard auxiliary set.

WARNING

Do not place the VCG battery module (VCG or PPU unit) close to the imaging volume.

This may cause image artifacts.

WARNING

Avoid cable loops and twisted cables.

Loops can cause excessive heating of the cables which may result in burns upon (full or partial) contact to patient's skin.
Special attention is needed when VCG is used with Transmit-Receive coils.

Checking the VCG signal

▷ The patient is positioned on the tabletop with coil and physiology sensors connected, still outside the magnet bore.

► Before moving the patient to the isocenter, check the VCG signal in the **Physiology Display** panel. For more information, see chapter “Display of physiology signals” on page 139.

► In the **Physiology Display** panel, select one of the following:

- **VCG**:
  This signal corresponds best to a conventional ECG signal. It is always shown when you select **VCG+Resp** or **VCG+PPU** for display. It is a calculated signal in which both traces VCG1 and VCG2 together are projected on one axis.
- **VCG1+VCG2**:
  The separate traces VCG1 and VCG2 are displayed simultaneously.

VCG1 corresponds to the signal measured *between the white and the black clip* (between white and green for wired system).
VCG2 corresponds to the signal measured *between the red and the black clip* (between red and green for wired system).

► Visually evaluate the signal:

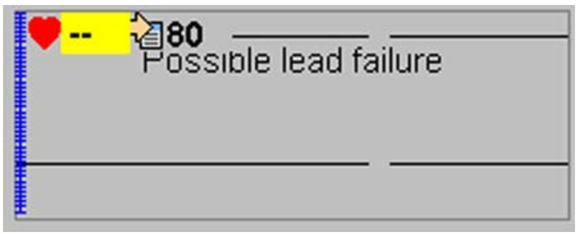
- Verify that the VCG baseline is clean.

- Verify that the R-peak is clearly visible.

► If one of these criteria is not met, remove the VCG leads and electrodes, and recommence VCG placement.
For more information, see chapter “Connecting VCG to the patient” on page 152.

Insufficiently connected leads

When leads are not properly connected, an error message "Possible lead failure" is displayed in the Physiology Display panel.



Factors affecting the VCG signal

For successful cardiac triggering of MR scans, a good VCG signal with a clearly detectable R-peak is a prerequisite.

However the VCG signal and the calibration of the VCG signal are affected by several factors:

Position of the electrodes and the distance between electrodes

Wrong electrode placement leads to disturbances in the VCG signal.

- Make certain that the electrodes are positioned correctly. See chapter “Connecting VCG to the patient” on page 152.

Patient respiration

Some trigger loss may occur during inspiration. The severity depends on the position of the electrodes.

- Make certain that the electrodes are positioned correctly. See chapter “Connecting VCG to the patient” on page 152.

Flowing blood and magnetic field

The VCG signal changes in the presence of a static magnetic field, since flowing blood (especially in the aortic arch) induces voltages that are superimposed on the measured VCG-signal. Alterations of the VCG-signal are mainly seen in the baseline and are usually superimposed on the T-wave. The distortion is referred to as T-wave artifact or the Magneto-hydrodynamic effect (MHD). The strength of the induced voltages increases with higher field strength, and is more severe with the patient inside the bore.

- To reduce this artifact, avoid measurement of the VCG in the area of the aortic arch.

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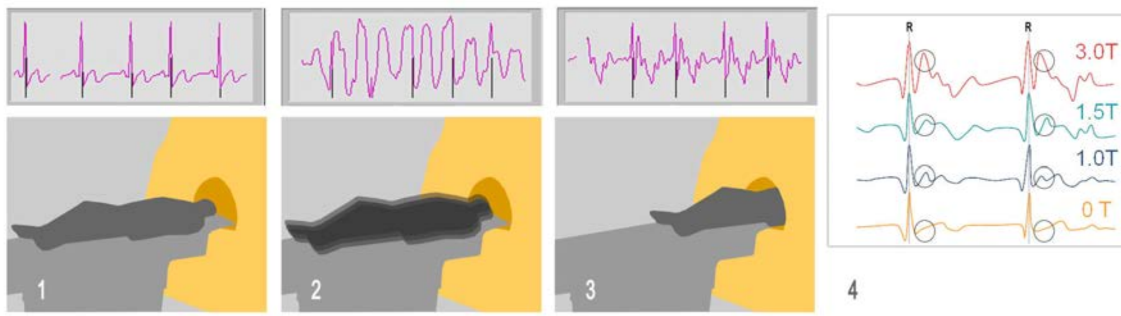
Motion

Table motion, as well as patient motion causes the VCG signal to rapidly change. For cardiac triggered scans, patient motion negatively impacts the reliability of VCG triggering.

- Avoid table motion at all times. Instruct the patient to lie still to avoid motion.

Effects of magnetic field and motion on the VCG signal



1	Patient outside the bore. Lying still. Perfect VCG signal.
2	Patient outside the bore. Moving. Disturbed VCG signal.
3	Patient inside the bore. Lying still. Disturbed VCG signal.
4	T-wave artifact (indicated by circle) in VCG. Most likely occuring with the patient inside the bore.

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VCG calibration

In all scans that make use of VCG, VCG calibration is required to ensure correct triggering.

VCG calibration analyzes the detected ECG-signal to determine the R-peak in the QRS-complex: A trigger algorithm determines which peak in the detected ECG-signal is marked as R-peak. A trigger marker is assigned to the signal (and displayed in the **Physiology Display**) if all criteria of the trigger algorithm are met.

Factors affecting the VCG calibration

When the VCG calibration is disturbed, it can happen that trigger markers are assigned to the incorrect signal or are not assigned at all.

VCG calibration results are affected by the same factors as the VCG itself. For more information, see chapter “Factors affecting the VCG signal” on page 158.

Methods of VCG calibration

VCG calibration can be performed in two ways:

1. It is recommended to use manual VCG calibration for problem-free cardiac triggering in all patients.
   For more results, see chapter “Manual VCG calibration” on page 160.

2. Continuous VCG calibration is easy to use. It is the default VCG calibration method. For more information, see chapter “Continuous VCG calibration” on page 171.

Manual VCG calibration

You can either perform manual or continuous VCG calibration. It is recommended to use manual VCG calibration for smooth cardiac triggering in all patients.

What are the main features of manual VCG calibration?

- Manual VCG calibration allows you to determine the conditions under which the VCG calibration is performed.
- Manual VCG calibration analyzes 15 seconds of VCG data to ensure accurate detection of R-peaks in all patients, also in patients at low heart rate or in arrhythmic patients.
- Manual VCG calibration can be initiated at any moment in the workflow. It is recommended to execute it before moving the patient to the isocenter.
- You start and adjust Manual VCG calibration in the **Physiology Properties** window.
- You can adjust the trigger threshold during cardiac triggered scans to adjust the sensitivity for the detection of R-peaks.
- When calibration data is available, trigger markers and the patient's heart rate are displayed in the **Physiology Display** panel.
- Calibration data that is collected, is applied to all subsequent scans until
  - you initiate a new VCG calibration,
  - you recall a previously stored VCG calibration,
  - you disable manual calibration.
- Results of manual VCG calibration depend on the tabletop position.
- The VCG calibration results are provided with an indication of *signal strength* (amplitude of the R-peak in mV) and *trigger quality* (number of false positive and false negative signals).
- All VCG calibration results are reset when you enter a **New Exam**.

Influence of the tabletop position on VCG calibration

The tabletop position affects VCG calibration, leading to different VCG calibration results depending on the tabletop position:

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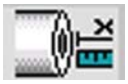
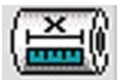
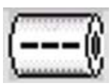
Icon	Tabletop position	Description	Results stored as
	**Outside the bore** recommended edge of tabletop < 450 mm in the magnet bore	The patient is positioned and ready to be moved to the isocenter. This is the recommended tabletop position, because flow artifacts, induced by the presence of the magnetic field, are minimized.	**Outside bore**
	**Inside the bore** edge of tabletop > 450 mm in the magnet bore	The patient is positioned at isocenter position.	**Inside bore**
	**Unknown position**	If patient support is not powered.	**Inside bore**
	no information about tabletop position	VCG calibration is not yet performed.	No results are stored yet.

The tabletop position is defined relative to the edge of the head end of the tabletop and NOT to the light visor. This definition allows for a new **outside bore** calibration during an examination when moving the patient bed partially out of the bore.

Use of VCG calibration results

- If both types of calibration results are available, you can select which calibration results are used to detect R-peaks.
- The type of calibration results used is displayed in the **Physiology Properties** window and in the **Extended Physiology Display**.
- The calibration results are overwritten when you start a new calibration on the same tabletop position.

Calibrating the VCG signal manually

Starting and executing manual calibration

▷ You have entered the examination data of the patient.

▷ You have positioned the patient on the tabletop with nurse call, hearing protection, coil, VCG, PPU (recommended, but not mandatory) and respiratory belt.

▷ The tabletop is still outside the bore, since this position is recommended for manual VCG calibration.
Alternatively you can perform manual VCG calibration inside the bore.

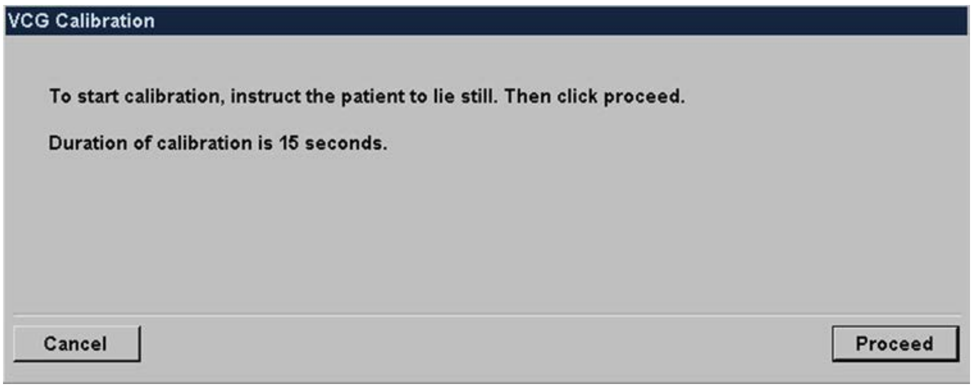
► To open the **Physiology Properties** window, right-click in the **Physiology Display** panel and select **Choose Physiology Properties ...**.

► Select **Manual calibration**.
This setting is persistent over examinations.

- Trigger markers are not yet displayed on the VCG signal in the **Physiology Display**, but only when VCG calibration is complete.
- The patient’s measured heart rate is not yet displayed.

► Click **Start Calibration**.
Alternatively click the yellow blinking **measured HR** icon in the **Physiology Display** panel

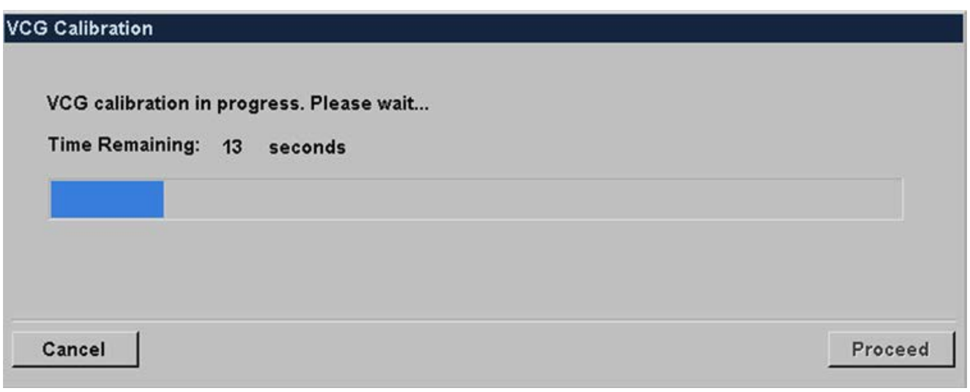
⇨ A message is displayed indicating that VCG calibration is requested and the duration of the calibration is 15 seconds.



► Instruct the patient to lie still and to breathe regularly.

► To start VCG calibration, click **Proceed**.
Alternatively to stop the VCG calibration, click **Cancel**.

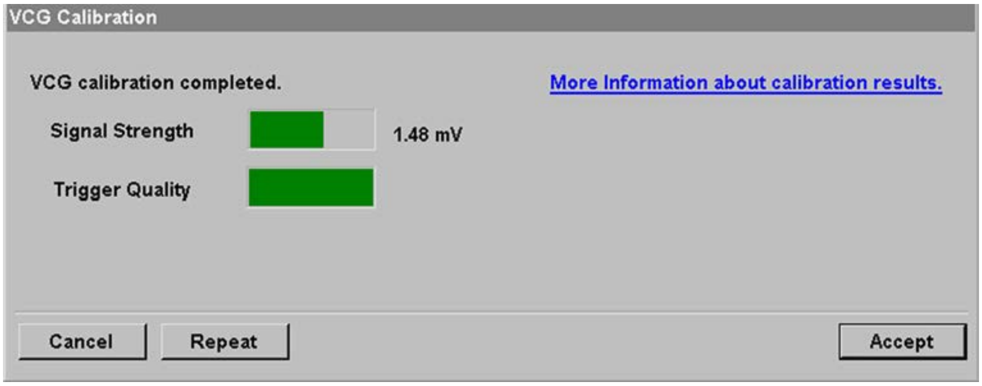
⇨ During calibration, a message pops up telling that VCG calibration is in progress and indicating the remaining time.



Calibration results

Upon completion of manual VCG calibration, the results are automatically analyzed and displayed as:

- Signal strength (as color scale and expressed in mV)
- Trigger quality (as color scale).

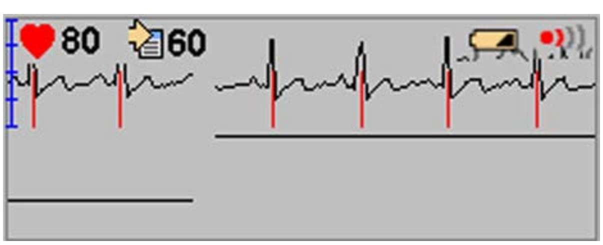


Color scale	Description	Signal strength	Trigger quality (Percentage of false signals)
	Excellent results. Proceed.	>2.0 mV	<5%
	Very good results. Proceed.	1.5 mV - 2.0 mV	between 5% and10%
	Good results. Proceed.	1.0 mV - 1.5 mV	between 10% and 15%
	Sub-optimal results. Corrective actions recommended.	0.6 mV - 1.0 mV	between 15% and 20%
	Bad results. Corrective actions strongly recommended.	<0.6 mV	>20%

Effects of manual VCG calibration visible in displays

In the **Physiology Display**

- The results of the calibration are applied immediately to allow visual inspection of the VCG triggering quality.
- The patient's measured heart rate is displayed.
- Trigger markers are overlaid on the VCG signal.

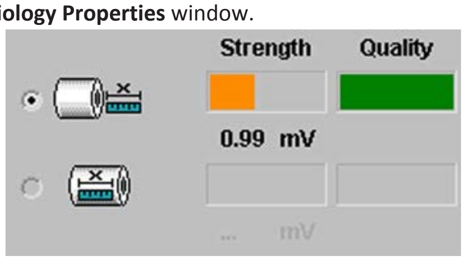


In the **Extended Physiology Display**

- The VCG calibration icon indicates successful manual VCG calibration.

Performing clinical scans based on the calibration results

► Continue depending on the quality of the results.

If the results are good, very good or excellent	If the results are sub-optimal or bad
► Click **Accept**. ⇨ The results are stored with their tabletop position. You can access the stored calibrations results in the **Physiology Properties** window.  ► To switch between different VCG calibration results (if available), click the toggle button. ► Move the tabletop to the isocenter and start the examination. ► Control if the measured heart rate corresponds with the entered heart rate in the **ExamCard properties**. ► To update the entered heart rate with the current heart rate (if needed), click the **Update heart rate** icon.  Alternatively, enter the value in the text field or in the **ExamCard properties**.	► Click **Cancel** to discard the results. Previous results (if available) are applied for this scan. OR ► Take corrective actions. For more information, see chapter “Troubleshooting” on page 165. ► Click **Repeat** to discard the results and repeat the calibration.

Usage of manual VCG calibration results

Stored manual VCG calibration results are applied until the operator:

- initiates a new VCG-calibration.
- recalls a previously stored VCG-calibration.
- disables manual calibration.

Repeating manual VCG calibration

Repeat a manual VCG calibration in case of

- unsatisfactory results of the recent VCG calibration (e.g. low signal, low quality)

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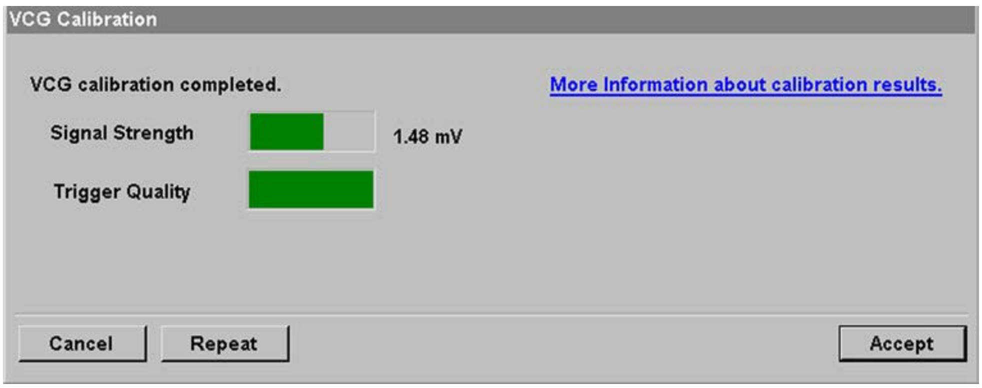
- change in patient conditions during the examination (e.g. size of MHD-artifact disturbs triggering, change in heart rhythm / breathing conditions during stress)

Troubleshooting

Upon completion of manual VCG calibration, the results are automatically analyzed and displayed as:

- Signal strength (as color scale and expressed in mV)
- Trigger quality (as color scale).



Color scale	Description	Signal strength	Trigger quality (Percentage of false signals)
	Excellent results. Proceed.	>2.0 mV	<5%
	Very good results. Proceed.	1.5 mV - 2.0 mV	between 5% and10%
	Good results. Proceed.	1.0 mV - 1.5 mV	between 10% and 15%
	Sub-optimal results. Corrective actions recommended.	0.6 mV - 1.0 mV	between 15% and 20%
	Bad results. Corrective actions strongly recommended.	<0.6 mV	>20%

If the VCG calibration results are sub-optimal or bad, corrective actions are recommended:

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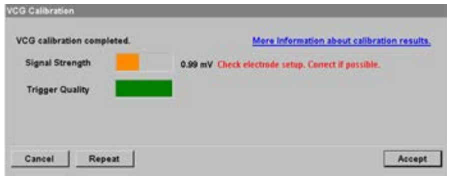
Low signal strength

Problem

The main cause of low signal strength is a sub-optimal lead placement (for example skin preparation, position of electrodes, distance between electrodes). A message is displayed when the detected signal strength is 1.0 mV or lower.

Patient condition can also lead to low signal strength.

Message on screen



VCG Calibration completed

- Signal strength (<1.0 mV)
- Trigger quality

Check electrode set-up. Correct if possible.

Countermeasures

- ► Check, and if possible, correct the electrode set-up.
  See chapter “Connecting VCG to the patient” on page 152.
- ► Click **Repeat** to start a new calibration.

Alternatives

- Click **Accept** to continue with the sub-optimal results, or
- click **Cancel** to discard the results and continue with a previously stored VCG calibration results.

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Low signal quality

Problem

During the evaluation of the results, a percentage of false positive, false negative and not-classified signals is calculated.

False positive and false negative signals are more likely to occur in case of patient motion. A message is displayed when the percentage of detected false signals is > 15%.

Message on screen

VCG Calibration completed

- Signal strength
- Trigger quality

Patient may have moved. Recommended to repeat.

Countermeasures

- ► Instruct the patient to lie still before repeating the calibration.
- ► Click **Repeat** to start a new calibration.
- ► If false positive or false negative signals occur during calibration, change the **trigger threshold** parameter for the cardiac triggered scans to avoid the false positive and negative signals.

  In the **Physiology Properties** window, set the **trigger threshold** to:

- **Low**: With a low threshold for trigger detection, more waves in the waveform are marked as R-peak. A low threshold reduces the possibility of missed triggers (false negatives).
- **Medium**: This is the recommended setting and by default used for each patient at **New Exam**. An average threshold value is used.
- **High**: With a high threshold for trigger detection, less waves in the waveform are marked as R-peak. A high threshold reduces the possibility of false positive triggers (for example triggers on T-wave)

Alternatives

- Click **Accept** to continue with the sub-optimal results, or
- click **Cancel** to discard the results and continue with a previously stored VCG calibration results.

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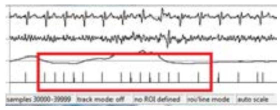
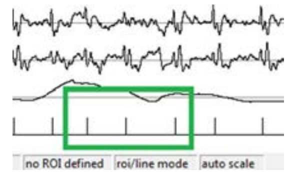
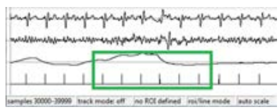
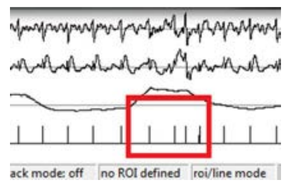
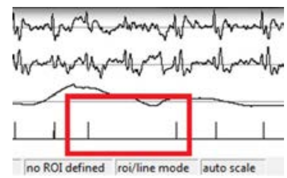
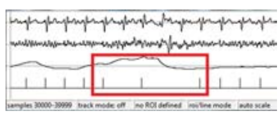
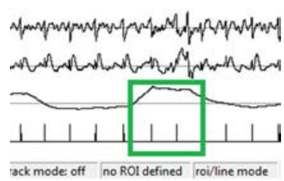
Effects of trigger threshold

Trigger threshold	Patient 1	Patient 2	Patient 3
Low	 false positive signals		 no false positive or false negative signals
Medium	 no false positive or false negative signals	 false positive signals	 false negative signals
High	 false negative signals	 no false positive or false negative signals	

NOTICE

When you change any setting of VCG calibration, this change has immediate effect on the R-peak detection.

This is valid for: manual or continuous VCG calibration, inside or outside bore VCG calibration and change of the trigger threshold.

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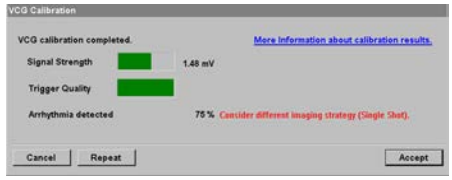
Philips

Arrhythmia detected

<table>
<tr><td>Problem</td><td>During the evaluation of the results, the number of RR-intervals with different duration than the average RR-interval is determined.

A message is displayed if more than 25% of the RR-intervals have a different duration than the other RR-intervals.</td></tr>
<tr><td>Message on screen</td><td>

Arrhythmia detected.

Consider different imaging strategy (Single shot).</td></tr>
<tr><td>Countermeasures</td><td>For mild to average arrhythmia:
In prospective triggered scans, disable arrhythmia rejection.
Modify the entered heart rate: enter the high value from the observed heart-rate range, so that triggers are detected even at short RR-intervals.
For average to severe arrhythmia:
Use prospective triggered cine sequences instead of retrospective triggered cine sequences.
Use Single shot sequences. The temporal and spatial resolution is lower, but all image data is acquired in one single RR-interval.
Use real-time (dynamic sequences) for function-cine. The sequence is not cardiac triggered. It is meant to visualize the heart motion over multiple cardiac cycles.</td></tr>
</table>

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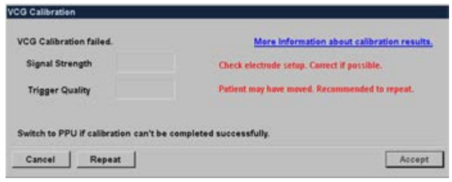
VCG calibration failed

Problem

VCG calibration can fail due to several reasons:

- VCG calibration cancelled by the operator,
- very low VCG signal,
- high noise levels in the VCG baseline,
- bad electrode contact (loose electrode).

Message on screen



Check electrode setup. Correct if possible.

Patient may have moved. Recommended to repeat.

Switch to PPU if calibration can't be completed successfully.

Countermeasures

► Check, and if possible, correct the electrode set-up. See chapter “Connecting VCG to the patient” on page 152.

Alternatively continue without manual VCG calibration and use PPU-triggering instead. The R-peak detection is delayed compared to R-peak detection with VCG, but the duration of the detected RR-interval is comparable.

► Connect PPU and change the **trigger device** from **ECG** to **PPU** in the scan protocols.

► To make sure that the displayed heart rate is based on the PPU signal, select **PPU** for display in the **Physiology display**.

► For retrospective triggered scans, the first image of the cine loop is not at end-diastole but occurs in mid-diastole.

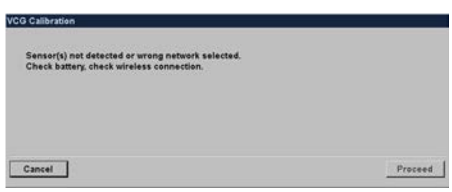
For prospective triggered scans, the timing occurs at *trigger delay time + R-peak detection-delay*. If desired, this can be compensated for: Change the **trigger delay** to **user defined** and reduce the trigger delay with the R-peak detection-delay.

Sensor not detected

Problem

If the system detects a problem with the sensor or the network when a manual calibration is started, a message is displayed.

Message on screen



Sensor(s) not detected or wrong network selected.

Check battery, check wireless connection.

Countermeasures

► Check if the battery is correctly inserted, and if the correct network is selected.

► Rectify the problem.

► Click **Proceed** to continue with the calibration.

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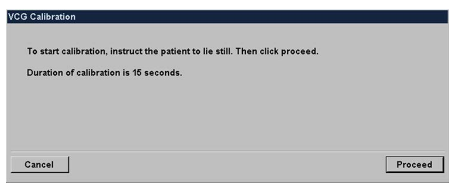
Lead off detected

Problem	If the system detects a lead-off situation when manual calibration is started, a message is displayed.	
Message on screen		Lead-off detected. Check electrode setup. Correct if possible.
Countermeasures	► Check, and if possible, correct the electrode set-up. See chapter “Connecting VCG to the patient” on page 152. ► Click **Proceed** to continue with the calibration.	

VCG calibration not performed

Problem	You can not start a cardiac triggered scan if manual VCG calibration is enabled, but not performed. When you click **Start scan**, the scan does not start, but the calibration is requested instead.	
Message on screen		To start calibration, instruct the patient to lie still. Then click **Proceed**. Duration of calibration is 15 seconds.
Countermeasures	► Start VCG calibration.	

Continuous VCG calibration

Continuous VCG calibration is designed to automatically determine the R-peak for the purpose of correct triggering of all scans where VCG is used. Continuous VCG calibration requires no user interaction. Consequently results cannot be optimized. It is the default VCG calibration. Alternatively you can use manual calibration. For more information, see chapter “Manual VCG calibration” on page 160.

What are the main features of continuous VCG calibration?

- It analyzes and calibrates VCG data continuously.
- The VCG calibration data of the 7 seconds prior to the start of each scan is used throughout the scan.
  This leads to a forced delay of 7 seconds for each scan.
- When calibration data is available, trigger markers and the patient's heart rate are displayed in the **Physiology Display** panel.
- The disadvantages of continuous VCG calibration are:

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– Different VCG calibration results for each scan lead to differences in triggering efficiency between scans.
– It is not possible to determine the conditions under which VCG calibration is performed.
– You cannot change the trigger threshold. It is always **high**.

Enabling continuous VCG calibration

Continuous VCG calibration automatically takes place when manual VCG calibration is disabled.

► Deselect **manual calibration** in the **Physiology Properties** window.

Continuous versus manual VCG calibration

	Manual VCG calibration	Continuous VCG calibration
Calibration duration	• single calibration of 15 seconds prior to first scan • valid for all subsequent scans	• continuous calibration: 7 seconds prior to each scan
Triggering efficiency	• predictable for all scans	• possibly different between scans
User interaction	• required	• not required
VCG calibration conditions	• can be defined	• cannot be defined (because it is fixed)
Location of calibration	• recommended: outside bore • alternatively: inside bore	• always inside bore (last 7 seconds prior to scan)
Patient instructions	• can be given	• cannot be given
Trigger threshold	• can be modified • can be set to high, medium or low	• cannot be modified • is always high
Display of trigger markers / heart rate	• only after manual calibration	• immediately after 7 seconds of calibration

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7 Coils and Coil Solutions

This chapter describes the coils and the coil solutions available for your system and how to apply them.

NOTICE

Refer to the Maintenance chapter for full information on cleaning of the system and coils.

NOTICE

As most of the photographs in this chapter have been taken in a non-clinical environment, it is possible that in some of the photographs the patient's clothing is not suited for a real MR examination.

Patients may also be shown without headset and nurse call.

CAUTION

Do not leave any dS coils connected to the FlexConnect sockets when the MR system is not used.

During breaks and in between different patients the coils must be disconnected.

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FlexConnect sockets and coil connectors

For proper functioning of dStream coils it is essential that the lenses of FlexConnect sockets and coil connectors are clean. See the cleaning chapter for more information.

General coil safety

Only coils that have been proven safe and compatible on the Philips MR system shall be used. Coded connectors and software keying are provided to control the use of coils. Refer to the Instructions for Use of the coil for further safety instructions.

Safety and performance considerations

Receive coils have safely been used to investigate any anatomy. The coil insulation prevents accidental contact with the conductive metal parts. Each coil has been specially designed for prolonged safe and reliable operation.

Safety measures

WARNING

Never use surface coils, cable traps and cables which are damaged.

A damaged cable or connector is hazardous because of high voltage across the cable during the transmit phase of the system. Sharp edges may cause injury to patient's skin.

Coils must be returned to the manufacturer's Customer Support for replacement if there is any suspected damage to either the external covering or the coil's internal components. The patient must never be allowed to come into contact with the internal coil connections.

WARNING

Do not simultaneously touch the coil connector contacts and the patient to prevent potential harm for the patient.

WARNING

Do not scan with an incomplete base coil. The protective lids on the contacts of base coil must be present at all times.

These lids can be removed for cleaning purposes.

dS Anterior coil

WARNING

Do not use the dS Anterior coil upside down.

This may cause excessive local heating.

dStream Interface

CAUTION

Do not sterilize the dStream Interface.

Sterilizing the dStream Interface will damage it.

About Coils

The most important aspects of coils are described in the following paragraphs.

Transmit- and Receive-Coils

The built-in Body coil acts as the RF transmitter for receive-only coils: it transmits the RF signal to the patient. It works in conjunction with the dStream Coils.

dStream Coil Solutions

dStream coil solutions are:

- the term for all available coils on your system.
- phased-array coils and as a consequence compatible with CLEAR and dS-SENSE.
- receive-only coils if not otherwise labeled.
  A 'T/R' in the coil name identifies a coil as Transmit/Receive coil.
- available as integrated or dedicated coil solution.
  - **Integrated Coil Solution**
    combination of coils with the dS Posterior coil for multiple applications.
  - **Dedicated Coil Solution**
    single coil designed for a single application.

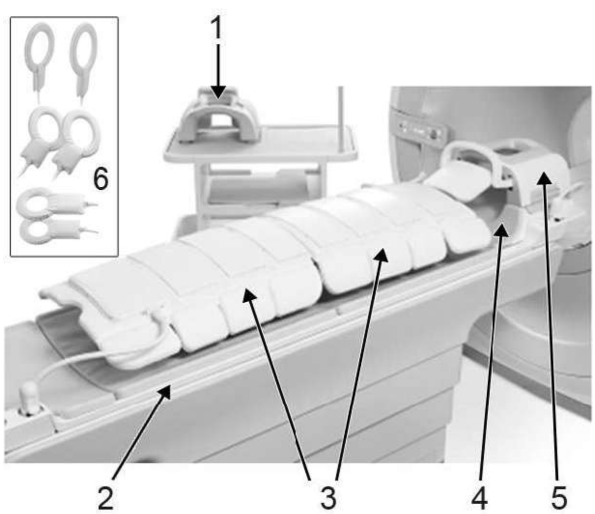

Fig. 46: Coils making up the Integrated Coil Solutions: 1- dS Head top coil, 2 - dS Posterior coil (built-in coil in patient support), 3 - 2 x dS Anterior coil, 4 - dS Base coil, 5 - dS HeadNeck top coil, 6 - dS Flex coil in 3 sizes.

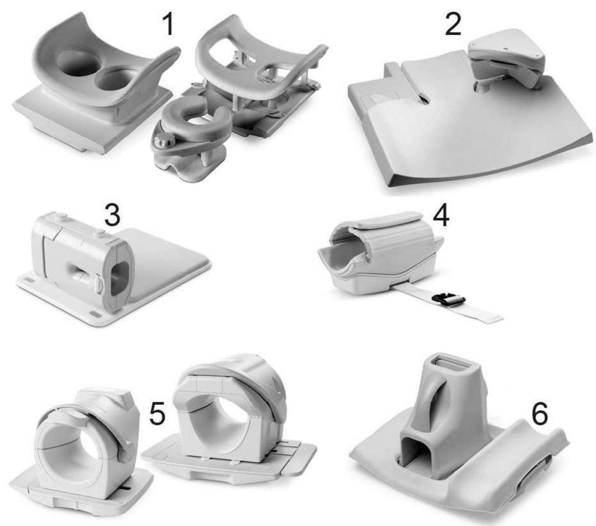

Fig. 47: Dedicated coils meant for dedicated applications: 1 - dS Breast 7ch and dS Breast 16ch coils, 2 - dS Shoulder 8ch coil, 3 - dS Wrist 8ch coil, 4 - dS Small Extremity 8ch coil, 5 - dS Knee 8ch, dS Knee 16ch and dS T/R Knee 16ch coils, 6 - dS FootAnkle 8ch coil.

More information

- about the available dStream coils can be found in the section 'Available Coils' of this chapter.
- about the available dStream Coil Solutions can be found in the chapter 'Coil Solutions and Patient Positioning'.
- about patient and coil positioning can be found in the chapter 'Coil Solutions and Patient Positioning'.

Integrated Posterior coil

The patient support of your system has an integrated dS Posterior coil. The dS Posterior coil automatically repositions in the patient support according to the desired isocenter and Field-of-View.

There are three markers on each side of the tabletop representing the range of the dS Posterior coil.

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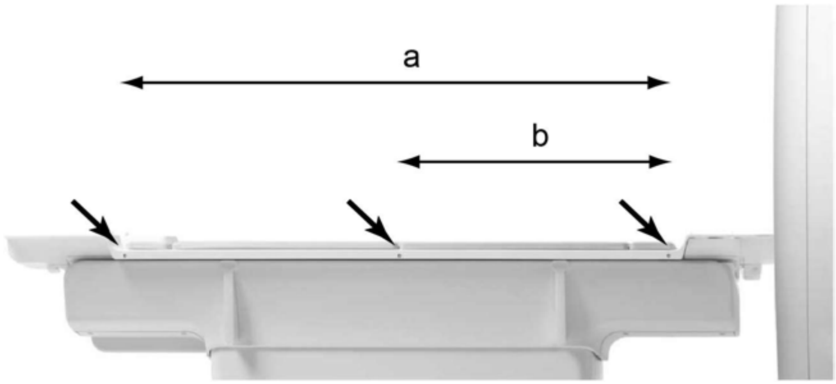

Fig. 48: dS Posterior coil range markers

Range a.

The markers represent the maximum available range of the tabletop in which the dS Posterior coil can be used for scanning.

Range b.

This is the range between the middle marker and the marker at the magnet end side of the tabletop. It represents the maximum available range with which scanning is possible without using the dS Posterior coil.
Any point within this range can be positioned in the isocenter.

Disengage coil

The dS Posterior coil can be disengaged by means of the eponymous parameter in the **ExamCard Properties** window.

About Coil Solutions

Coil choice is crucial in obtaining optimum image quality in all MR examinations.

SmartSelect and the dStream Coil Solutions facilitate this important choice.

SmartSelect

SmartSelect is a method that selects the best suited coils and coil elements for each examination:

- The MR system automatically detects the connected coils.
- By default it selects the best-suited coil and coil elements for optimal signal-to-noise ratio for the current stack and/or scan.

For information about SmartSelect, see chapter “Coil Selection” on page 446

dStream Coil Solutions

A dStream coil solution is a recommended coil combination for a specific MRI application.

You can connect multiple coils to the system which then work

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- in conjunction with the integrated dS Posterior coil, or
- in conjunction with each other, or
- as dedicated (stand-alone) coils.

The table lists the available dStream Coil Solutions with their applications and which coil parts contribute to a specific dStream Coil Solution. A detailed description of all dStream Coil Solutions can be found in chapter “Available Coils and Coil Solutions” on page 179.

dStream Coil Solution	Applications	Connected Coils (integrated or dedicated)
dS HeadSpine	• Neuro imaging: Brain, Spine (cervical, thoracic, lumbar), Total Spine and Total Neuro examinations • Head examinations	dS Base, dS Posterior, dS Head
dS HeadNeckSpine	• Neuro imaging: Brain, Spine (cervical, thoracic, lumbar), Total Spine and Total Neuro examinations • Head and neck examinations • Neurovascular examinations • Pediatric examinations	dS Base, dS Posterior, dS HeadNeck
dS TotalSpine	• Total Spine • Spine (cervical, thoracic, lumbar)	dS Base, dS Posterior
dS Torso	• Body applications: Torso, Chest, Pelvis • Cardiac Imaging • Peripheral Vascular examinations	dS Posterior, dS Anterior
dS WholeBody	• Whole Body • DWIBS (Diffusion Weighted Whole Body Imaging with Background Body Signal Suppression) • Peripheral Vascular examinations	dS Base, dS HeadNeck, dS Posterior, 2 x dS Anterior
dS Flex Breast	Breast Imaging	Flex L, dS Posterior, Breast mattress
dS Breast 7/16ch	Breast Imaging	dS Breast 7/16ch
dS Flex S	Multi Purpose, e.g.: • Joints • Pediatric examinations • Brachial plexus • Cardiac imaging	Flex S, dS Posterior
dS Flex M		Flex M, dS Posterior
dS Flex L		Flex L, dS Posterior
dS Shoulder 8ch dS Shoulder 16ch	Shoulder	dS Shoulder 8ch dS Shoulder 16ch
dS Wrist 8ch	Wrist	dS Wrist 8ch

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Philips

dStream Coil Solution	Applications	Connected Coils (integrated or dedicated)
dS HandWrist 16ch	Hand and wrist	dS HandWrist 16ch
dS Knee 8/16ch	Knee	dS Knee 8/16ch
dS FootAnkle 8ch dS FootAnkle 16ch	Foot, Ankle	dS FootAnkle 8ch dS FootAnkle 16ch
dS SmallExtremity 8ch dS SmallExtremity 16ch	• Hand, wrist, elbow • pediatrics	dS SmallExtremity 8ch dS SmallExtremity 16ch

Tab. 5: Overview of dStream Coil Solutions

Available Coils and Coil Solutions

Coil compatibility

The below list provides an overview of coil/system compatibility. Some legacy coils can only be used on Ingenia systems.

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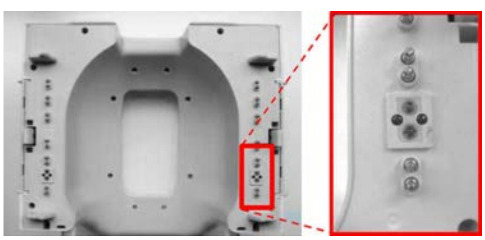
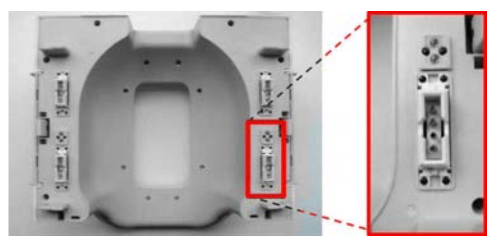
	Ingenia only	All Systems
dS Anterior coil	• Large baluns and cable exit to the side.  • No grip. • 1.5T 12nc numbers: 4510-010-0723x • 3.0T 12nc numbers: 4510-010-1290x 4510-010-7120x	• Small baluns and cable exit in head direction.  • Has a grip.  • 1.5T 12nc numbers: 4598-001-1839x • 3.0T 12nc numbers: 4598-001-1840x
dS Base and dS Head or dS HeadNeck tops	• dS Base and dS Head or dS HeadNeck tops both have 12 paired contacts.  • 1.5T 12nc numbers: dS Base; 4510-010-0047x or 4598-001-7121x dS Head; 4510-010-0831x or 4598-001-7122x dS HeadNeck; 4510-010-0048x or 4598-001-7123x • 3.0T 12nc numbers: dS Base; 4510-010-1292x or 4598-001-7117x dS Head; 4510-010-1293x or 4598-001-7118x dS HeadNeck; 4510-010-1294x or 4598-001-7119x	• dS Base and dS Head or dS HeadNeck tops have 4 paired contacts.  • 1.5T 12nc numbers: dS Base; 4598-000-9794x dS Head; 4598-000-9795x dS HeadNeck; 4598-000-9796x • 3.0T 12nc numbers: dS Base; 4598-000-9797x dS Head; 4598-000-9798x dS HeadNeck; 4598-000-9799x

	Ingenia only	All Systems
dS Wrist	dS Wrist 8ch coil according as shown the picture below: • NO superman position support. • Base plate without cable holders. 	dS Wrist 8ch coil with redesigned base plate as shown in the picture below: • Superman position support. • Additional redesigned base plate with pre-amplifier holders for correct cable routing. 
dS Breast 7ch & 16ch diagnostic (dS Breast 16ch not available for Ingenia S)	• Multiple accessory parts.	• Redesigned accessories (two parts) and thinner mattress to accommodate for more patient sizes in the 60 cm/23.6 in. bore.
Tilting device for the Base	• Allowed.	• NOT allowed. • NOT supported.

dS System Body coil

Fig. 49: Built-in dS System Body coil in the bore.

Type of coil	Transmit/Receive coil
Design	Built-in cylindrical volume coil
dS-SENSE-compatible	No
CLEAR-compatible	No
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	Imaging large parts of the body

General remarks	All receive-only coils use the dS System Body coil for transmission.
User Interface Name	Q-Body
Connector	not applicable

Tab. 6: Overview

dS HeadSpine

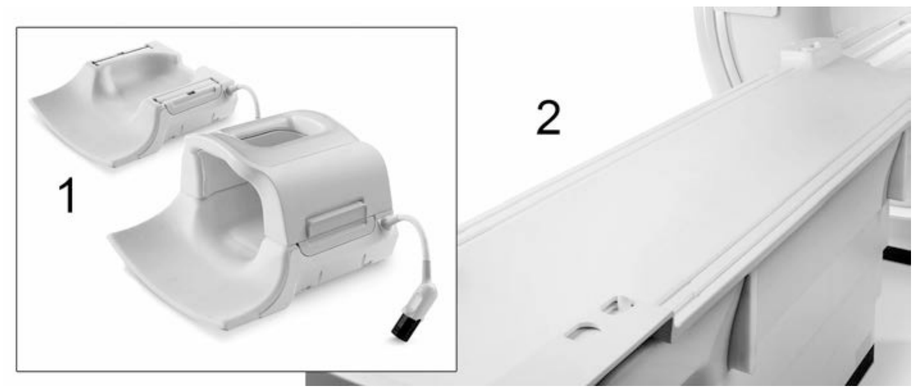


Fig. 50: Components of the dS HeadSpine coil solution. 1: dS Base coil and dS Head top coil attached to the dS Base coil. 2: Patient support with the built-in dS Posterior coil.

Type of coil	• Phased-array detection • Receive coil solution
Design	• Volume coil • Integrated coil solution including the dS Posterior coil, the dS Base coil and the dS Head top coil.
Coverage	• 30 cm with 15 channels (head examinations) • 90 cm with 52 channels (total neuro examinations)
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	• Head and brain examinations • Spine examinations: cervical, thoracic, lumbar and total spine • Total neuro
User Interface Name	Posterior, Base, Head

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dStream Interface	not required
Connector	FlexConnect socket/connector

Tab. 7: Overview

dS HeadNeckSpine

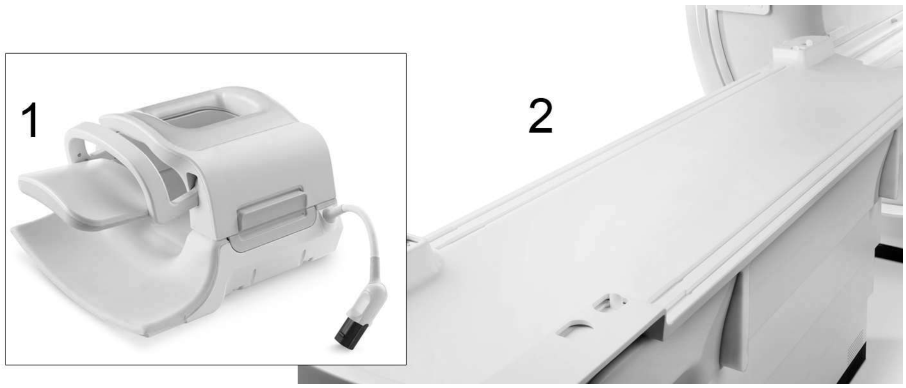

Fig. 51: Components of the dS HeadNeckSpine coil solution. 1: dS HeadNeck top coil attached to the dS Base coil. 2: Patient support with the built-in dS Posterior coil.

Type of coil	• Phased-array detection • Receive coil solution
Design	• Volume coil. • Integrated coil solution including the dS Posterior coil, the dS Base coil and the dS HeadNeck top coil.
Coverage	• 45 cm with 20 channels (head/neck examinations) • 90 cm with 52 channels (total neuro examinations)
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	• Neuro imaging: Brain, Spine (cervical, thoracic, lumbar), Total Spine and Total Neuro examinations • Head and neck examinations • Neurovascular examinations • Pediatric examinations
User Interface Name	Posterior, Base, HeadNeck

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dStream Interface	not required
Connector	FlexConnect socket/connector

Tab. 8: Overview

dS TotalSpine

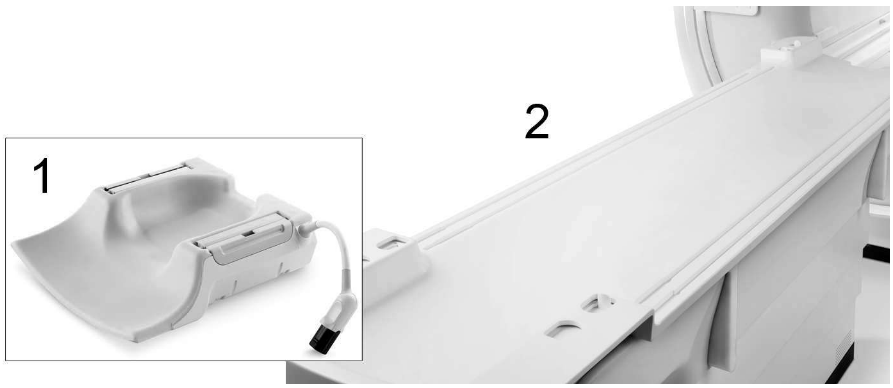

Fig. 52: Components of the dS Total Spine coil solution. 1: dS Base coil. 2: Patient support with the built-in dS Posterior coil.

Type of coil	• Phased-array detection • Receive coil solution
Design	• Surface coil. • Integrated coil solution including the dS Base coil and the dS Posterior coil.
Coverage	90 cm with 44 channels
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	• Spine examinations: cervical, thoracic, lumbar and total spine
User Interface Name	Base, Posterior
dStream Interface	not required
Connector	FlexConnect socket/connector

Tab. 9: Overview

dS Head 32ch 3.0T coil

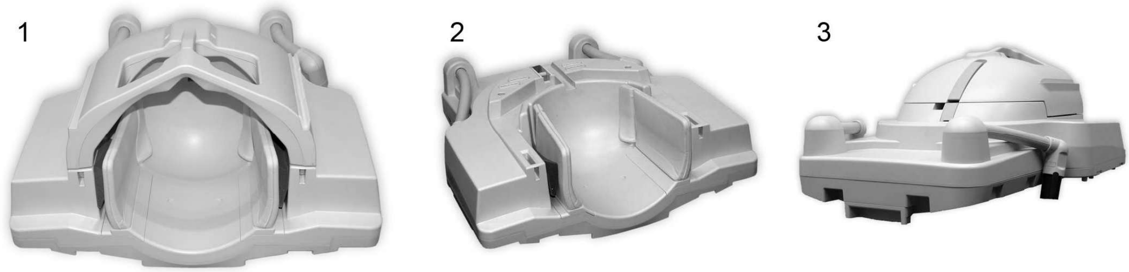

Fig. 53: dS Head 32ch 3.0T coil. 1: Front view of complete coil. 2: Front view of posterior coil section. 3: Rear view of complete coil.

Type of coil	• Phased-array detection • Receive coil
Design	Volume coil consisting of posterior and anterior coil section. Two coil connectors.
Dimensions	Height (AP): 38 cm, width (RL) : 46 cm, length (FH): 59 cm
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes
Applications	• High-resolution head examinations • High-resolution pediatric examinations
Markers on the coil	In the middle of the coil (FH direction) for light visor positioning
User Interface Name	dS Head1-32ch and dS Head2-32ch (for the two coil sections)
dStream Interface	not required
Connector	dStream socket/connector on the dStream Interface

T/R Head coil

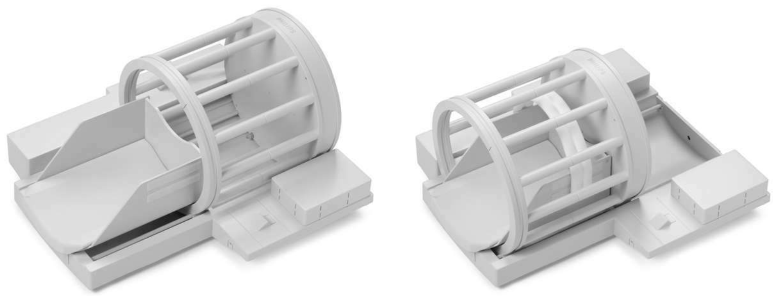

Fig. 54: T/R Head coil.

Type of coil	• Quadrature detection • Transmit/Receive coil solution
Design	Volume coil
Coverage	Head down to C3
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	No
CLEAR-compatible	No
MultiTransmit-compatible	No
Applications	Head and brain examinations
Markers on the coil	In the middle of the coil (FH direction) for light visor positioning
User Interface Name	T/R Head
dStream Interface	not required connects to T/R interface on the gantry

Tab. 10: Overview

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dS Torso

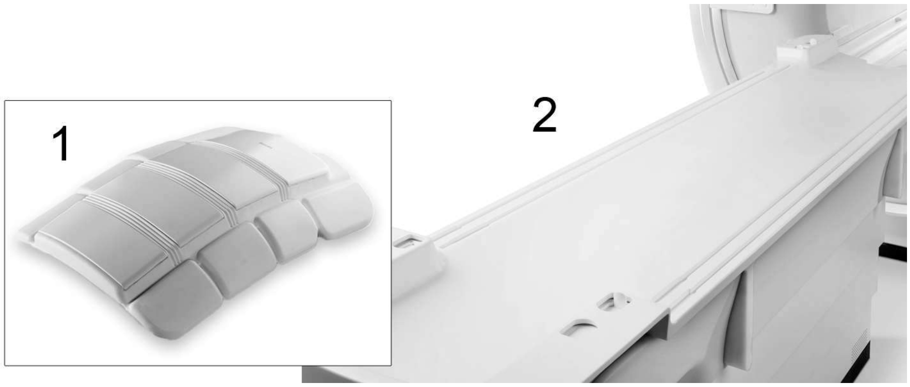

Fig. 55: Components of the dS Torso coil solution. 1: dS Anterior coil. 2: Patient support with the built-in dS Posterior coil.

Type of coil	• Phased-array detection • Receive coil solution
Design	• Volume coil • Integrated coil solution including the dS Posterior coil and the dS Anterior coil.
Coverage	60 cm with 32 channels
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	• Body applications: Torso, Chest, Pelvis • Cardiac Imaging • Peripheral Vascular examinations
User Interface Name	Posterior, Anterior
dStream Interface	not required
Connector	FlexConnect socket/connector

Tab. 11: Overview

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dS WholeBody

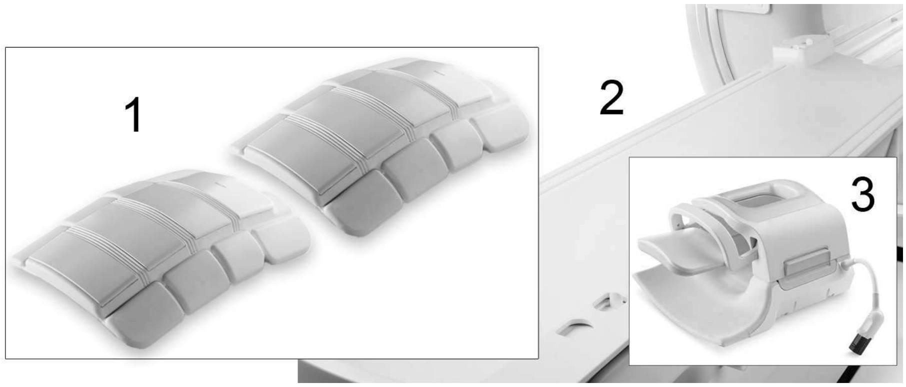

Fig. 56: Components of the dS Whole Body coil solution. 1: two dS Anterior coils. 2: Patient support with the built-in dS Posterior coil. 3: dS HeadNeck top coil attached to the dS Base coil.

Type of coil	• Phased-array detection • Receive coil solution
Design	• Volume coil • Integrated coil solution including the dS Posterior coil, the dS Base coil, the dS HeadNeck top coil and two dS Anterior coils.
Coverage	200 cm with 108 channels
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	• Whole Body • DWIBS (Diffusion Weighted Whole Body Imaging with Background Body Signal Suppression) • Peripheral Vascular examinations
User Interface Name	Posterior, Base, HeadNeck, Anterior
dStream Interface	not required
Connector	FlexConnect socket/connector

Tab. 12: Overview

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dS Endo 1.5T and dS Endo 3.0T

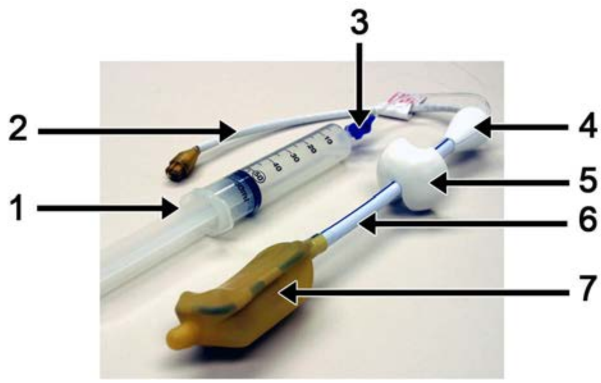

Fig. 57: dS Endo coil with its components: 1 - luer lock syringe used for inflation, 2 - probe cable, 3 - valve for luer lock syringe, 4 - grip, 5 - migration stop, 6 - plastic rod, 7 - non-permeable balloon.

The label on the coil says: **eCoil 1.5T** and **eCoil 3.0T**.

Type of coil	• Linear detection • Receive-only
Design	• RF coil which can be positioned inside the rectum. The RF coil is fixed inside a non-permeable balloon; both are mounted on a plastic rod which extends to a grip. The coil amplifier and decoupling electronics are placed in a small box. • The dS Endo 3.0T coil can be filled with air or fluids whereas the dS Endo 1.5 T coil can be filled with air only.
Dimensions	Cross-section 48 mm fully inflated
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Only in combination with the Posterior coil and/or Anterior coil.
CLEAR-compatible	
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	• Rectum • Prostate • Cervix
Contraindications	The dS Endo coils have several contraindications, e.g. inflammatory bowel disease. Please refer to chapter “Positioning with the dS Endo coil solution” on page 270 for the complete list.
General remarks	Before starting an examination, make sure that the coil is connected to the amplifier box.
User Interface Name	Endo

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dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

dS Breast 16ch

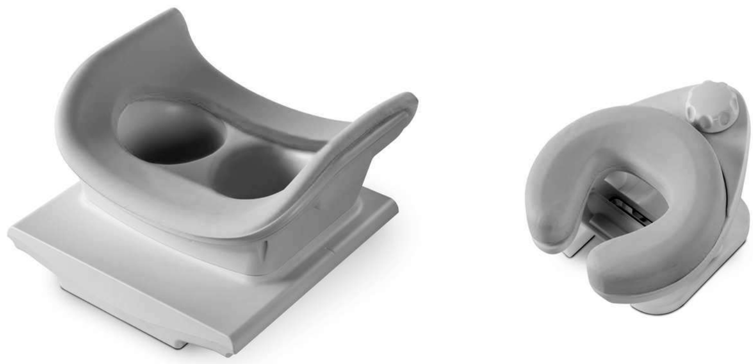

Fig. 58: dS Breast 16ch coil solution: coil and head support.

Type of coil	• 16 channel phased-array coil • Receive-only
Design	Volume coil with an aperture in which the breasts can be positioned.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	Breast Imaging (both breasts simultaneously)
General remarks	Do not combine this coil with other coils.
Limitations	This coil cannot be used for biopsy.
User Interface Name	Breast-16
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 13: Overview

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dS Breast 7ch

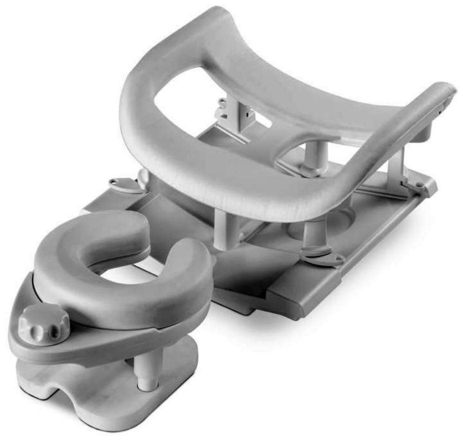

Fig. 59: dS Breast 7ch coil solution: coil with head support.

Type of coil	• 7 channel phased-array coil • Receive-only
Design	Volume coil with an aperture in which the breasts can be positioned. A separate head support is provided.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T)
Applications	• Breast Imaging (both breasts simultaneously) – also with unilateral and/or bilateral immobilization • Biopsy with the biopsy kit
General remarks	Do not combine this coil with other coils.
User Interface Name	Breast-7
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 14: Overview

Delivery Contents

In the delivery of the dS Breast 7ch coil solution, the following kits are included:

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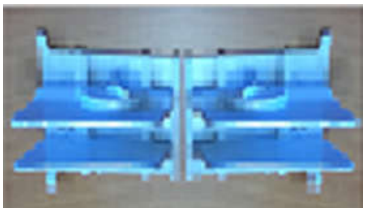
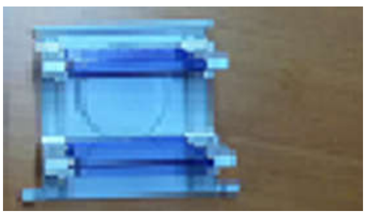
Figure of the kit	Kit	Purpose of the kit
	Bilateral CC immobilization kit	Diagnostic imaging only
	Bilateral M-L immobilization kit	Diagnostic and interventional imaging
	Unilateral CC immobilization kit	Interventional imaging
	Interventional biopsy kit	Breast biopsy

For more information refer to chapter “Breast Biopsy with dS Breast 7ch” on page 281 and chapter “Breast Immobilization with dS Breast 7ch” on page 279.

dS Breast Adaptive 16ch

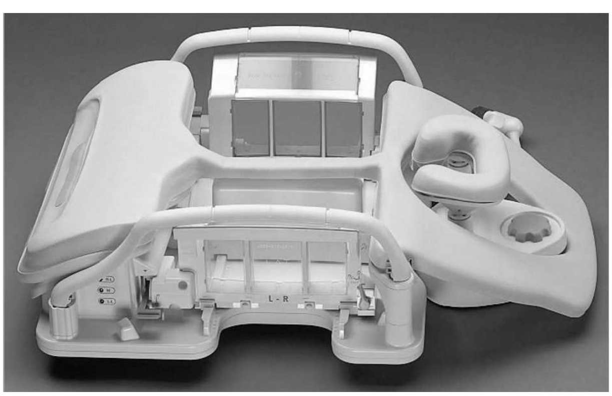


Fig. 60: dS Breast Adaptive 16ch coil solution: coil and head support.

Type of coil	• 16 channel phased-array coil. • Receive-only. • Adaptive coil elements adjusting to patient's breast size.
Design	• Volume coil with an aperture in which the breasts can be positioned. • Open access design. • With comprehensive set of dedicated positioning aids and auxiliaries.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	• Breast Imaging (both breasts simultaneously). • Biopsy.
General remarks	Do not combine this coil with other coils.
User Interface Name	dS Breast 16ch Adaptive
dStream Interface	not required
Connector	FlexConnect socket/connector

Tab. 15: Overview

Delivery Contents: Coil

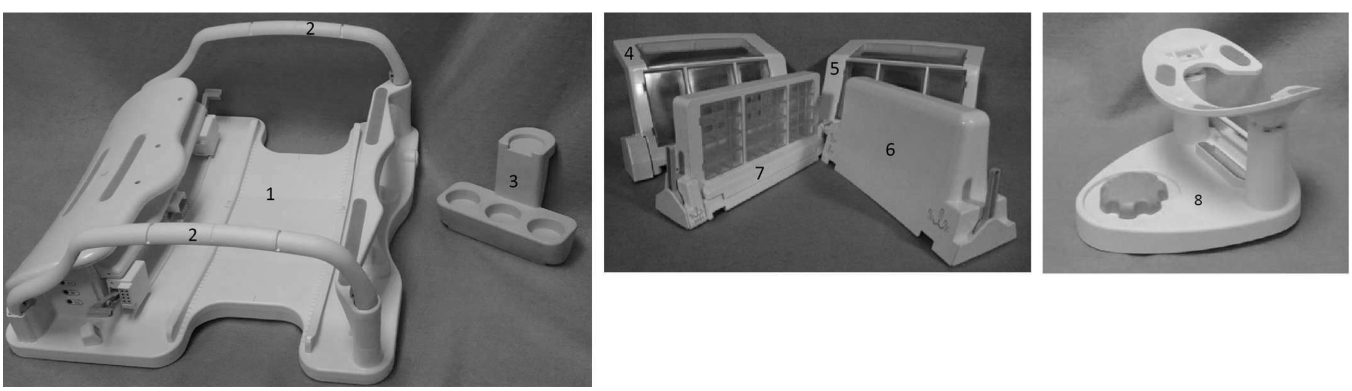


Fig. 61: Coil components.

Number	Description
1	Coil base
2	Handrail
3	Phantom holder
4	Lateral left plate

Number	Description
5	Lateral right plate
6	Medial Diagnostic Plate
7	Medial Biopsy Plate
8	Head Support

Delivery Contents: Breast Coil Pads

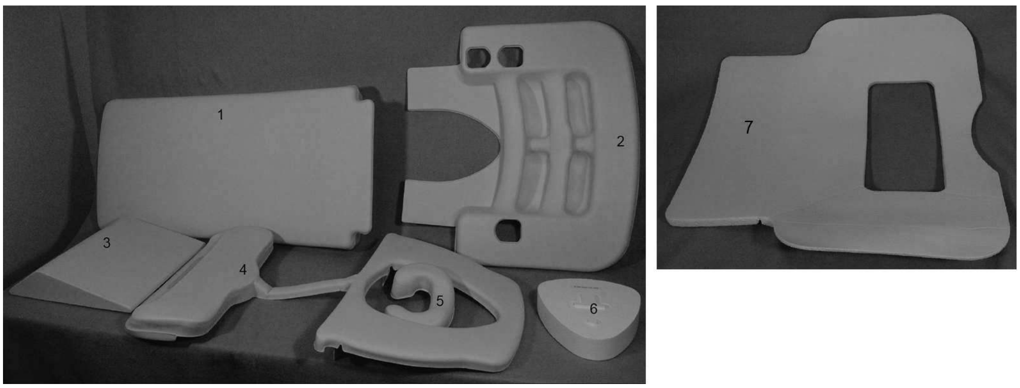


Fig. 62: Breast Coil Pads.

Number	Description
1	Ramp pad
2	Arm support pad
3	Ankle bolster
4	Patient pad
5	Head support pad
6	Head support 2nd spacer
7	Patient top sling pad
8	System cable cover (not shown)

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Delivery Contents: Breast Coil Auxiliaries

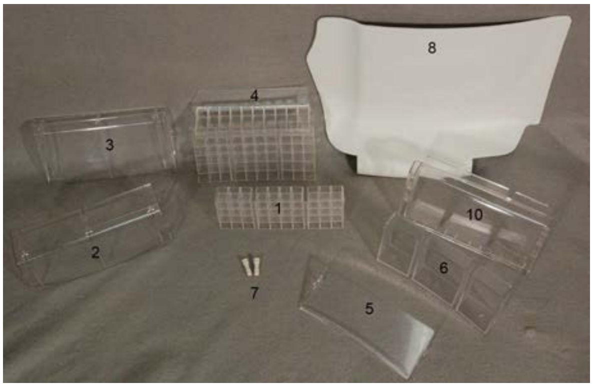

Fig. 63: Breast Coil Auxiliaries.

Number	Description
1	Medial Grid Plate
2	Medial Saddle Spacer Insert
3	Medial Saddle Spacer Attachment
4	Lateral Grid Plate
5	Lateral Solid Axilla Support
6	Lateral Solid Immobilization Plate
7	Sealed Fiducial Assembly
8	Breast Blocker Plate (Left)
9	Breast Blocker Plate (Right) - not shown
10	Lateral Solid Spacer Insert

dS Flex S, M, L

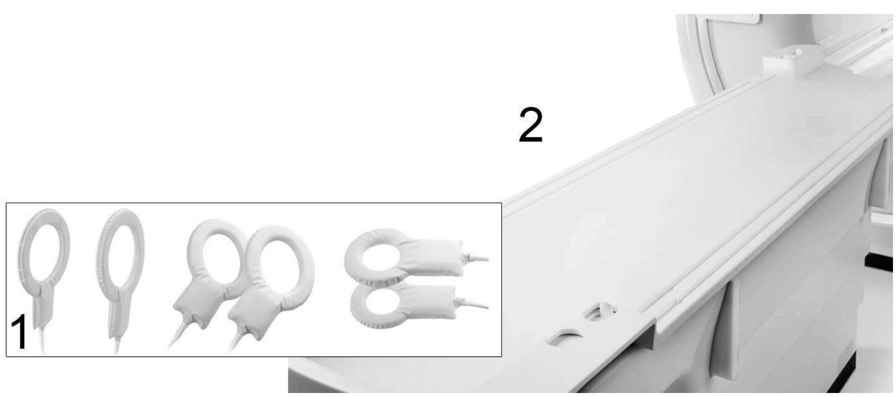

Fig. 64: Components of the dS Flex coil solutions. 1: dS Flex coil in three sizes. 2: Patient support with the built-in dS Posterior coil.

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Type of coil	• Phased-array detection • Receive coil
Design	• Volume coil • Integrated coil solution including the dS Posterior coil and either the dS Flex S or the dS Flex M or the dS Flex L coils
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	Imaging of small Fields of View from 5 cm to 20 cm in multiple applications
User Interface Name	• when used in combination with the dS Posterior coil: Posterior, Flex (S, M or L) • when not used in combination with the dS Posterior coil: Flex (S, M or L)
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 16: Overview

dS Flex S, M and L coils

The dS Flex coil is available in three sizes: S, M and L.

Coil	Coverage	Applications
dS Flex S	• 10 cm with 2 channels • in combination with dS Posterior coil up to 4 channels	• TMJ’s, orbits, I.A.C. • Small joints, e.g. elbow • Superficial vessels (carotid arteries) • Pediatric imaging
dS Flex M	• 15 cm with 2 channels • in combination with dS Posterior coil up to 6 channels	• Shoulder (ABER positioning) • Elbow, Ankle • Pediatric imaging • Carotid Arteries
dS Flex L	• 20 cm with 2 channels • in combination with dS Posterior coil up to 8 channels	• Brain and brain intervention • Brachial Plexus • Pediatric imaging

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NOTICE

Single dS Flex coils of different sizes can be combined with each other and with the dS Posterior coil.

Using dS Flex coils with or without the dS Posterior coil

By default, the dS Flex coils are used in combination with the dS Posterior coil to achieve optimum image quality.

► To use the dS Flex coils without the dS Posterior coil, enable *Disengage Posterior coil* in the **ExamCard Properties** window.

⇨ The dS Posterior coil is disengaged for the current ExamCard as long as *Disengage Posterior coil* remains enabled.

dS Flex Breast

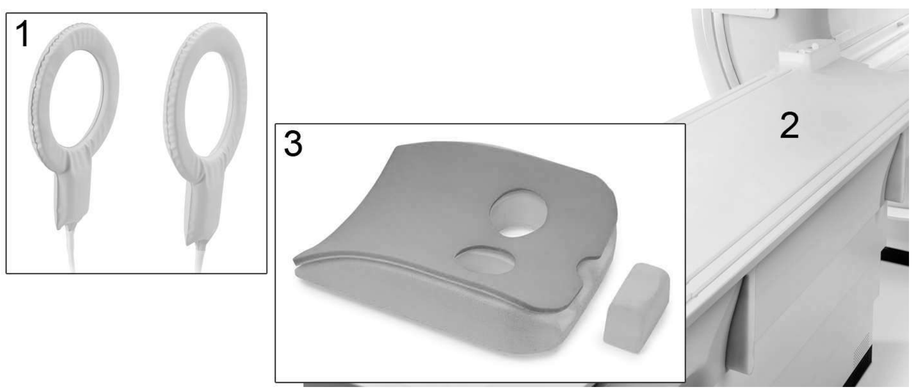

Fig. 65: Components of the dS Flex Breast coil solution. 1: dS Flex L coil. 2: Patient support with the built-in dS Posterior coil, 3: Breast mattress.

Type of coil	• Phased-array detection • Receive coil
Design	• Volume coil • Integrated coil solution including the dS Posterior coil and the dS Flex L coils and the breast mattress.
Coverage	45 cm with 8 channels in left-right direction
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	Yes (only applicable for 3.0T systems)
Applications	Breast Imaging (both breasts simultaneously)

User Interface Name	Posterior, Flex L
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 17: Overview

dS Shoulder 8ch

Fig. 66: dS Shoulder 8ch coil solution.

Type of coil	• 8 channel phased-array coil • Receive-only
Design	Rigid volume coil consisting of base plate and anterior coil part plus inferior, anterior and posterior pad. The posterior coil elements are integrated in the base plate. The anterior coil part is adjustable in height.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Shoulder imaging.
General remarks	Do not combine this coil with other coils.
User Interface Name	Shoulder-8
dStream Interface	not required
Connector	FlexConnect socket/connector

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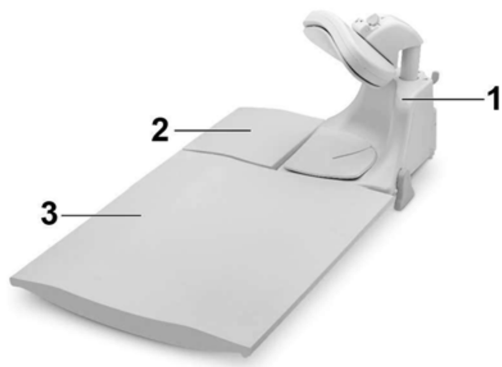
dS Shoulder 16ch



dS Shoulder 16ch coil solution.

1. Coil itself with anterior and posterior pad
2. Small mattress
3. Large mattress

Type of coil	• 16 channel phased-array coil • Receive-only
Design	Rigid volume coil with dedicated mattresses and pads. The anterior coil part is adjustable in height.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Shoulder imaging.
General remarks	Do not combine this coil with other coils.
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

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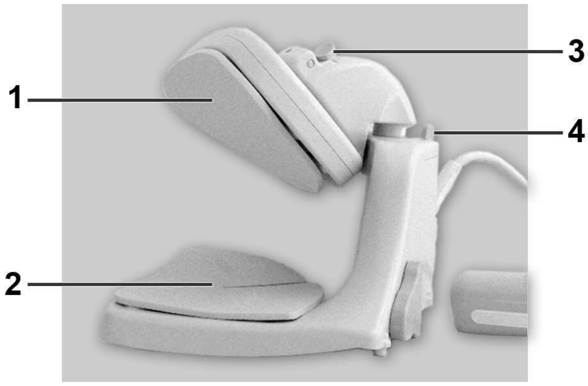
Coil components

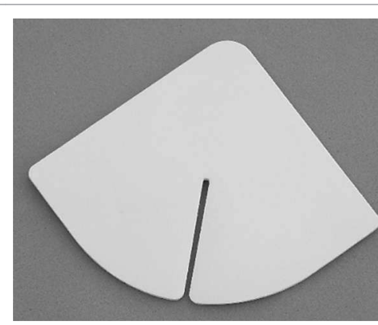


1. Anterior coil with anterior pad
2. Posterior coil with posterior pad
3. Anterior Tilt Lock

   To tilt the anterior coil against or away from the patient's chest, release the Anterior Tilt Lock. When done lock again.
4. Anterior Height Lock

   To adjust the height and the rotation of the anterior coil, release the Anterior Height Lock. When done lock again.

Delivery contents

Item/Purpose	Quantity	Photo
Coil itself	1	
Posterior coil pad To cover the posterior surface of the coil	1	

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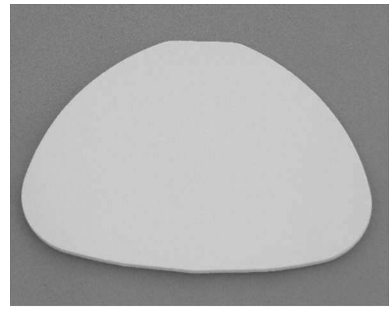
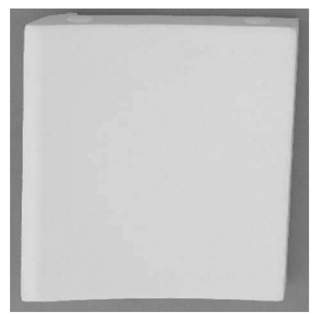
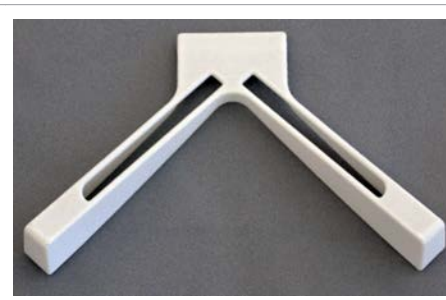
Item/Purpose	Quantity	Photo
Anterior coil pad To cover the anterior surface of the coil	1	
Small table mattress To maintain an even tabletop surface beside the coil	1	
Large table mattress To cover the tabletop below the coil	1	
Phantom holder For service use only.	1	
SPT positioner For service use only.	1	

dS Wrist 8ch

Fig. 67: dS Wrist 8ch coil solution.

Type of coil	• 8 channel phased-array coil • Receive-only
Design	Rigid volume coils of 8 elements that closely encircle the wrist for high SNR. One-piece, hinged design for easy patient set-up. To reduce patient motion artifacts, the dS Wrist coil includes two rigid base plates to fixate the coil; one for over-head and one for at the side examinations.
Dimensions	210 mm x 570 mm x 500 mm (outside dimensions)
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Wrist imaging.
General remarks	• Do not combine this coil with other coils. • The coil can be used at the patient's side, with the joint vertically, and over-head with the joint horizontally. • Applying CLEAR gives excellent homogeneity throughout the images.
User Interface Name	Wrist-8
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 20: Overview

Positioning aids for the dS Wrist 8ch coil

The following positioning aids are available for the coil and should be used for all examinations for optimum patient comfort and image quality.

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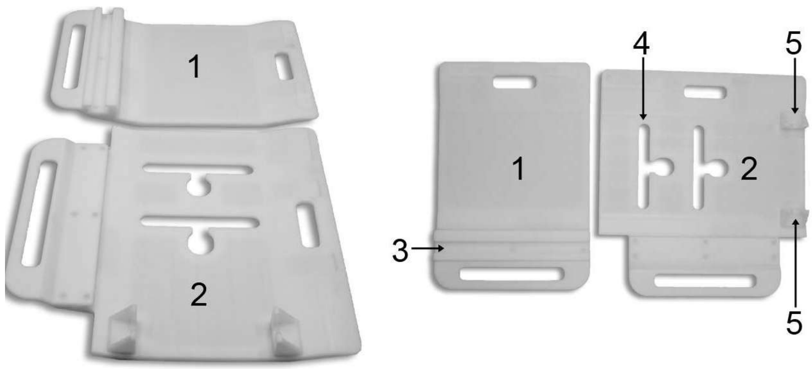

Fig. 68: Base plates to fixate the coil on the tabletop. 1 - Base plate for examinations at the patient's side, 2 - Base plate for examinations overhead, 3 - Groove to slide in the coil for examinations at the side, 4 - Transverse slots to slide in the coil for overhead examinations, 5 - Cable holders.

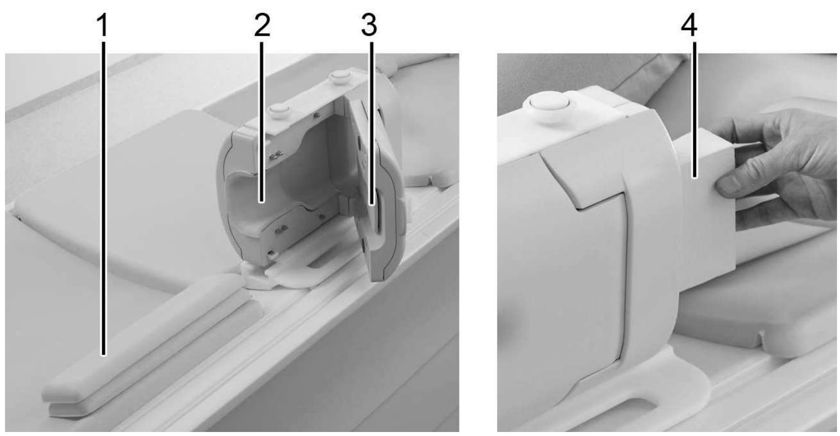

Fig. 69: Pads for the dS Wrist 8coil.

Number	Quantity	Purpose
1	2	
2	1	To be inserted into coil
3	1	To be inserted at the lateral side of the coil. The little slot is for the window on the coil.
4	2	To be put under the fingers to keep the digits straight.

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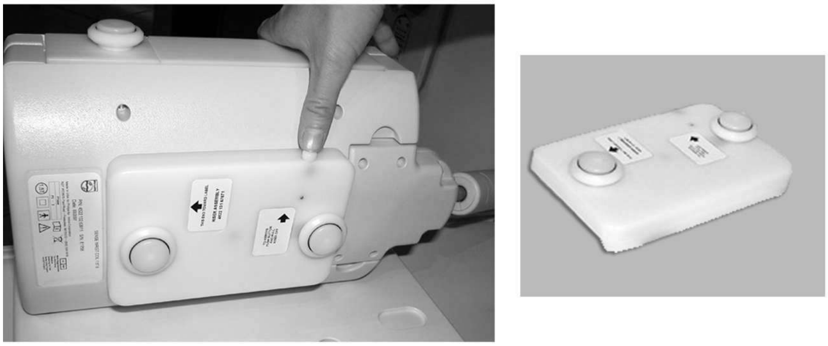


Fig. 70: The mount adaptor has to be attached to the coil for overhead positioning and removed for positioning at the patient's side.

dS HandWrist 16ch

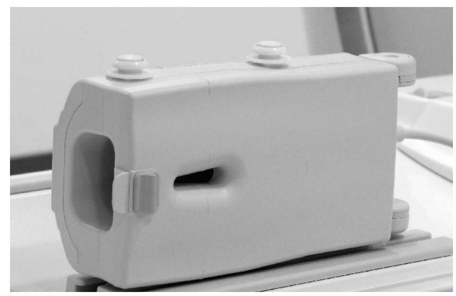
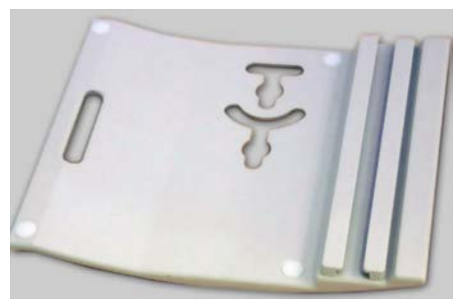
dS Wrist 16ch coil solution

Type of coil	• 16 channel phased-array coil • Receive-only
Design	Rigid volume coils that closely encircle the wrist for high SNR. One-piece, hinged design for easy patient set-up. To reduce patient motion artifacts, the dS Wrist coil includes two rigid base plates to fixate the coil; one for overhead and one for at the side examinations.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	High resolution wrist and hand imaging.

General remarks	• Do not combine this coil with other coils. • The coil can be used at the patient's side, with the joint vertically, and over-head with the joint horizontally.
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 21: Overview

Delivery contents

Item/Purpose	Quantity	Photo
Coil itself with 2 markers (for hand and wrist) on top of it for isocenter positioning	1	
Base plate To immobilize the coil in a fixed left or right position	1	
Mount adaptor To fix the coil to the base plate for superman position	1	

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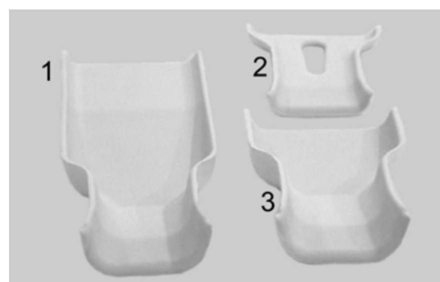
Item/Purpose	Quantity	Photo
Wedge pad To immobilize the fingers and to give good flat surface for the palm of hand to rest.	1	
Elbow/arm pad To support the arm parallel to the coil	1	
Palm pads 1. **Long anterior palm pad** To place between the patient's palm and the coil 2. **Posterior palm pad** To place between the posterior surface of the patient's hand and the coil 3. **Short anterior palm pad** To add extra padding if needed, for example for smaller patients	1	

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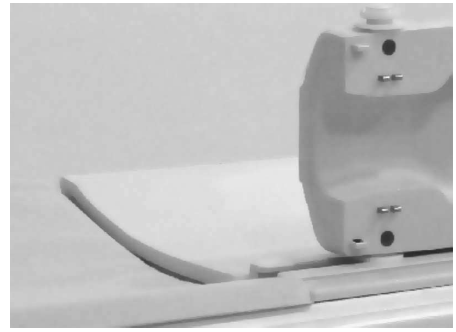
Item/Purpose	Quantity	Photo
Base plate mattress To cover the base plate when scanning with the patient's hand by their side	1	
Phantom For service use only	1	

dS Knee 16ch and dS T/R Knee 16ch

Fig. 71: dS Knee 16ch coil solution.

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Type of coil	16 channel phased-array coil • on 1.5T: Receive-only, • on 3.0T: Transmit/Receive
Design	Rigid volume coil consisting of a coil base (base plate with the posterior coil part attached to it) and an anterior coil part plus positioning aids. The dS T/R Knee 16ch coil has one cable coming out of the top of the coil that splits into 2 connectors to connect into the T/R socket and the dStream socket on the dStream interface.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Knee imaging, feet-first examinations
General remarks	Do not combine this coil with other coils.
User Interface Name	Knee-16
dStream Interface	required
Connector	• dStream socket/connector on the dStream Interface for dS Knee 16ch coil • T/R socket and dStream socket/connector on the dStream Interface for dS T/R Knee 16ch coil

Tab. 22: Overview

Safety

WARNING

Do not scan body parts other than the lower limbs with the dS T/R Knee 16 coil.
Do not scan pediatric patients under 15 kg (33 lbs) with the dS T/R Knee 16 coil.

Label on the coil: Do not scan pediatric patients under 15 kg (33 lbs) with this coil..

dS Knee 8ch

Fig. 72: dS Knee 8ch coil solution.

Type of coil	• 8 channel phased-array coil • Receive-only
Design	Rigid volume coil
Dimensions	FH: 37 cm, AP: 28 cm, LR (coil): 32 cm, LR (base): 45 cm
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Knee
Markers on the coil	In the middle of the coil (FH direction) for light visor positioning
Limitations	• This coil should only be used for ‘Feet first’ studies.
General remarks	• Applying CLEAR gives excellent homogeneity throughout the images. • Do not combine this coil with other coils.
User Interface Name	Knee-8
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 23: Overview

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dS FootAnkle 8ch

Fig. 73: dS FootAnkle 8ch coil solution.

Type of coil	• 8 channel phased-array coil • Receive-only
Design	Rigid volume coil consisting of base plate with foot support and the coil plus positioning aids.
Dimensions	• Inner dimensions: FH: 200 mm, LR: 105 mm, AP: 270 mm. • FOV: FH: 220 mm, LR: 120 mm, AP: 280 mm.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Foot, Ankle.
General remarks	• Applying CLEAR gives excellent homogeneity throughout the images. • Do not combine this coil with other coils.
Markers	Landmark on top of the handle for isocenter positioning.
User Interface Name	Foot/Ankle
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 24: Overview

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dS FootAnkle 16ch

dS FootAnkle 16ch coil solution

Type of coil	• 16 channel phased-array coil • Receive-only
Design	Rigid volume coil consisting of base plate with foot support and the coil plus positioning aids.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Foot, Ankle.
General remarks	• Do not combine this coil with other coils. • With the tilt device, the coil allows to image the ankle in tilting position.
Markers	Landmark on top of the handle for isocenter positioning.
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 25: Overview

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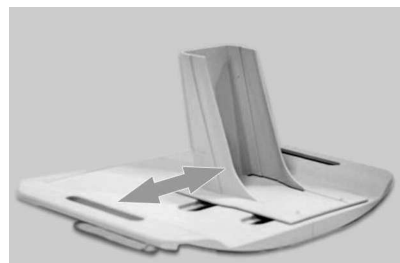
Delivery contents

Item/Purpose	Quantity	Photo
Coil itself For imaging	1	
Base plate and foot support To hold coil in place and stabilize foot	1	
Coil mattress To support the unaffected leg, for comfort	1	
Foot support pad To aid in immobilizing foot, for comfort	1	
Wedge pad To flex ankle if needed and immobilize foot	1	

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Item/Purpose	Quantity	Photo
Small pad To immobilize toes	1	
Tilt device To raise the head end of the base plate for patient comfort	1	
Phantom holder For service use only	1	

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dS SmallExtremity 8ch

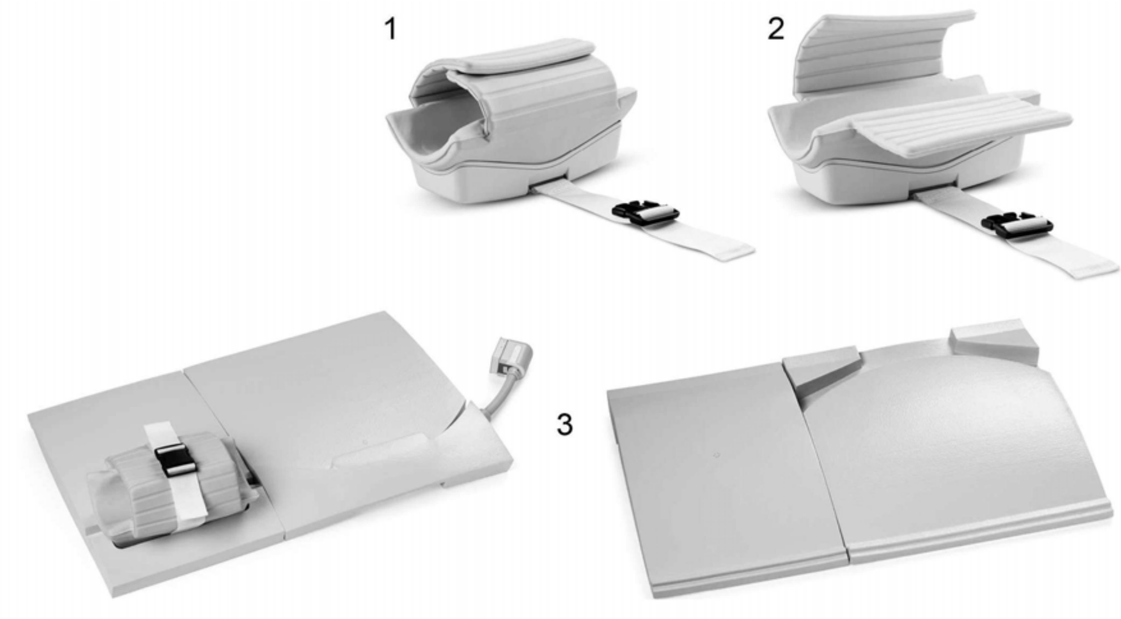
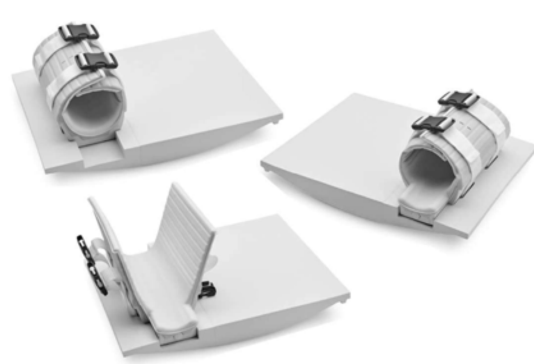


Fig. 74: dS Small Extremity8ch coil solution. 1: Closed coil. 2: Open coil. 3: Dedicated mattresses.

Type of coil	• 8 channel phased-array coil • Receive-only
Design	Wrap-around coil on coil base with dedicated mattress.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Small extremities, e.g. • Elbow, Wrist, Hand • Pediatrics
General remarks	Do not combine this coil with other coils.
User Interface Name	SmallExt8
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 26: Overview

dS SmallExtremity 16ch



dS Small Extremity 16ch coil solution on the coil mattress

- open
- closed

Type of coil	• 16 channel phased-array coil • Receive-only
Design	Wrap-around coil on coil base with dedicated mattress.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Small extremities, e.g. elbow, wrist, hand
General remarks	Do not combine this coil with other coils.
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

Tab. 27: Overview

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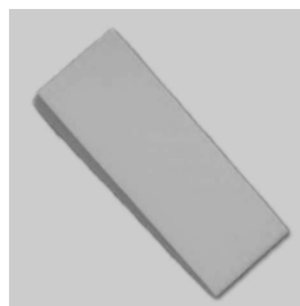
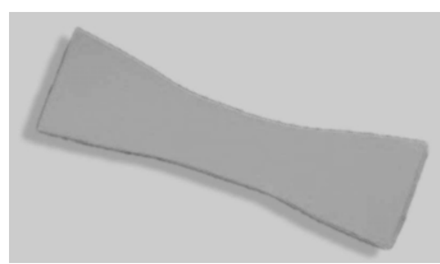
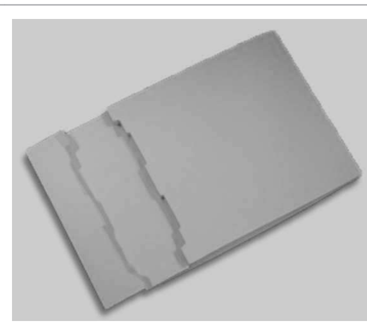
Delivery contents

Item/Purpose	Quantity	Photo
Coil itself For imaging	1	
Hand/small part pad To help immobilize the hand or smaller extremities	1	
Finger wedge pad To keep the hand straight for hand/finger imaging when placed under the fingers.	1	
Elbow pad To increase patient comfort for elbow imaging by providing a slight bend in the elbow	1	
Coil mattress To support the coil and maintain optimal left/right offset (by cut-out)	1	

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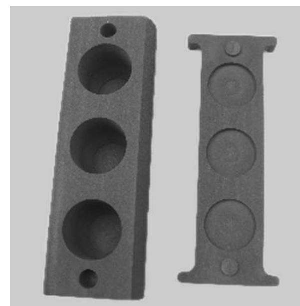
Item/Purpose	Quantity	Photo
Cable mattress To route the cable for safety and patient comfort	1	
Phantom holder For service use only	1	

dS Pediatric Head-Spine 8ch coil

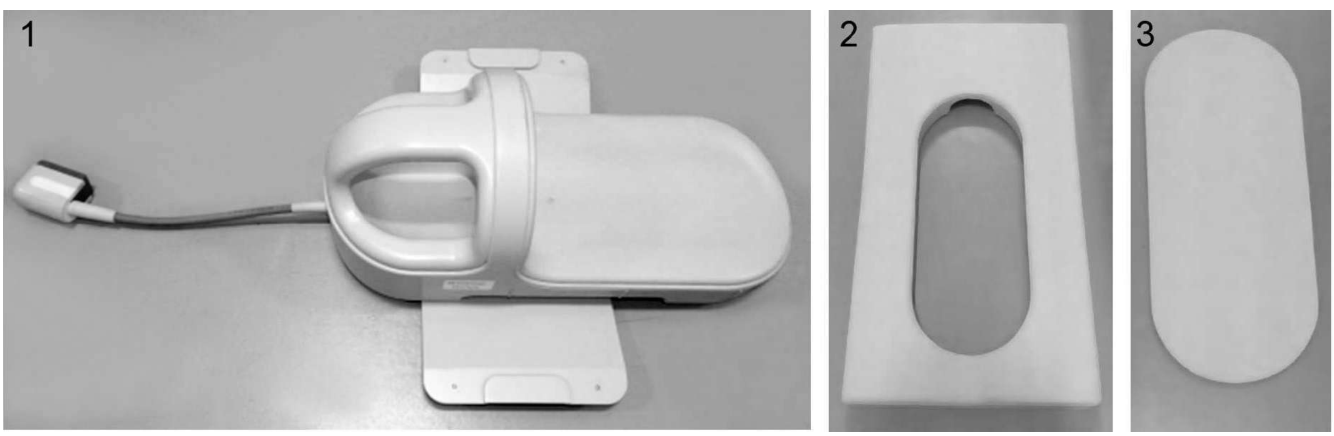


Fig. 75: 1 - dS Pediatric Head-Spine 8ch coil, 2 - table pad, 3 - patient pad.

Type of coil	• 8 element phased-array coil • Receive-only
Design	Rigid volume coil with table pad and patient pad
Dimensions	Height 26 cm, width 30 cm, length 65 cm
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes

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CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	Pediatric head and spine
Multi coil imaging	No
Dual coil imaging	No
User Interface name	dS Ped. HeadSpine 8ch
dStream Interface	required
Connector	dStream socket/connector on the dStream Interface

dS Pediatric Body-Cardiac 8ch coil

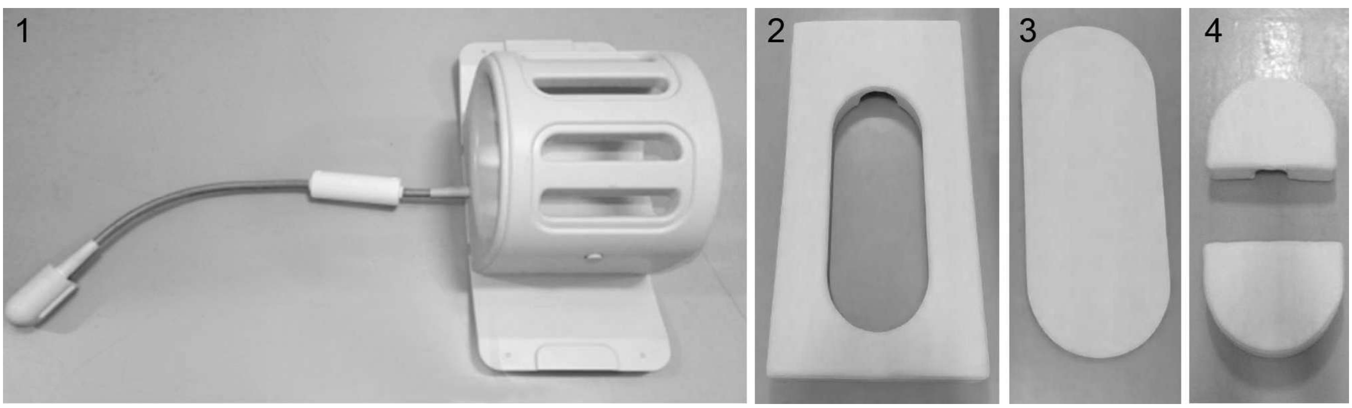

Fig. 76: 1 - dS Pediatric Body-Cardiac 8 ch coil, 2 - table pad, 3 - patient pad, 4 - torso inserts.

Type of coil	• 8 element phased-array coil • Receive-only
Design	Rigid volume coil consisting of posterior and anterior coil part plus table pad, patient pad and torso inserts.
Dimensions	Height 26 cm, width 30 cm, length 26 cm
Available for	On the sticker on the posterior coil part, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit-compatible	No
Applications	• Pediatric torso imaging: designed for examinations of neonates and babies below 8 kg.
Multi coil imaging	No
Dual coil imaging	No

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User Interface Name	dS Ped. Body-Cardiac 8ch
dStream interface	required
Connector	dStream socket/connector on the dStream Interface

dS Microscopy coils

Fig. 77: dS Microscopy coils.

Type of coil	• Linear detection • Receive-only
Design	• Surface coil, • Rigid housing, • Single loop.
Dimensions	Large coil: 47 mm; Small coil: 23 mm (coil's inner diameter)
Available for	On the connector, you see the size of your coil, the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
MultiTransmit compatible	No
Applications	Applications requiring small FOV with high SNR, e.g. skin, eyes, small joints, superficial vessels, pediatric and nipple imaging. Placed around a finger, against the skin or close to the body surface.
General remarks	To ensure a flat surface, the coils can be 'closed' with special coil inserts.
Limitations	• Make sure, that the coil is not positioned in the transverse plane. Coils work best when positioned in coronal or sagittal plane. • The coil may not be used in the mouth.

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Multi coil imaging	Yes
Dual coil imaging	Yes You can combine two Microscopy coils of the same size or of different size.
User Interface Name	Micro-23, Micro-47
dStream Interface	required
Connector	Litton socket on the dStream Interface
Specification area	• Microscopy 47 mm coil: cylindrical; D (diameter) = 80 mm, H (height) =20 mm • Microscopy 23 mm coil: cylindrical; D (diameter) = 40 mm, H (height) =20 mm Recommended value according to Philips self-test: H = 20 mm

Phosphorous coil (P-140/P-140-Flex)

Type of coil	• Linear detection • All purpose ^{31}P Transmit/Receive
Design	Surface loop coil with a diameter of 14 cm Slots around the edge of the coil can be used to attach straps to keep the coil positioned properly. A small disk buried at the center of the coil contains both water and methylphosphonic acid (also in Sphere b); it can be used as a marker of coil position. • P-140: Manual Tuning. Two long attached rods allow for manual tuning and matching to optimize performance. • P-140-Flex: Fixed tuning and matching.
Available for	3.0T
SENSE-compatible	No
CLEAR-compatible	No
MultiTransmit- compatible	No
Applications	MR Phosphorous Spectroscopy, e.g. leg, muscle, brain, liver, heart.
General remarks	• The plane of the coil should be kept parallel to the main magnetic field. • Proton decoupling and Nuclear Overhauser Enhancement (NOE) irradiation are provided by the Body coil. SAR is calculated on a scan-by-scan basis and takes into account both, the proton and phosphorous pulses.
Multi coil imaging	No
Dual coil imaging	No
User Interface Name	P-140/P-140-Flex

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Fig. 78: Phosphorous coil.

SmartExam and Coils

SmartExam is a tool that automates planning, scanning and processing in brain, knee, shoulder, breast, cervical and lumbar spine examinations.

Supported coils for SmartExam

For optimum quality of SmartExam, use the supported coils:

Anatomic area	Supported coils
Brain	• dS Base and dS Head top • dS Base and dS HeadNeck top, • dS Head 32ch 3.0T
Cervical spine	• dS Base and dS Posterior
Lumbar spine	• dS Posterior
Breast	• dS Breast 7ch • dS Breast 16ch (Ingenia only)
Shoulder	• dS Shoulder 8ch
Knee	• dS Knee 8ch • dS Knee 16ch 1.5T • dS Knee 16ch 3.0T

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8 Positioning Aids

This chapter shows the positioning aids that are delivered with your system: the basic set and the optional positioning aids. For most of them, application examples are given and their purpose is explained.

NOTICE

Philips' positioning aids are not made with natural rubber.

Basic Set

Mattresses

Three different types of mattresses are available:

Item	Quantity
Long Mattress (in figures indicated as LM)	2
Short Mattress (in figures indicated as SM)	2
T-Shape Mattress (in figures indicated as TM)	1

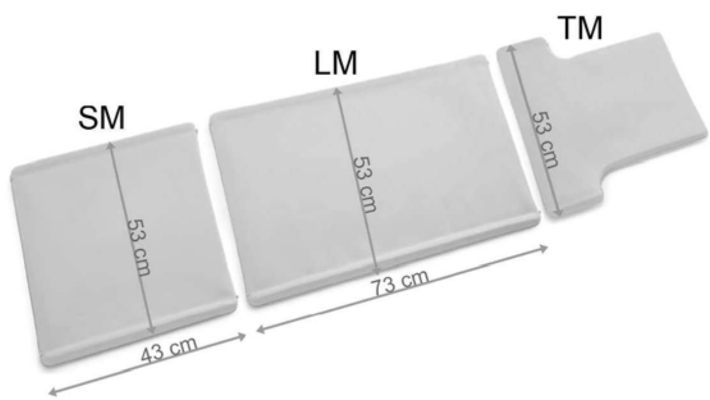

Fig. 79: Long mattress (LM), Short mattress (SM), T-shape mattress (TM).

They can be positioned in different ways depending on the type of examination.

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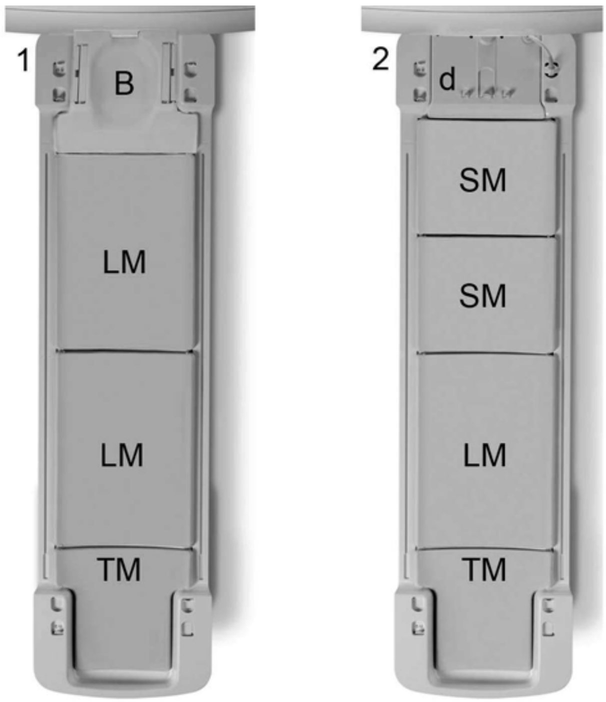
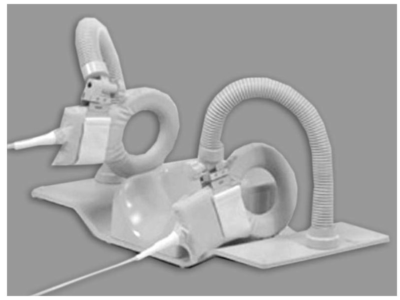


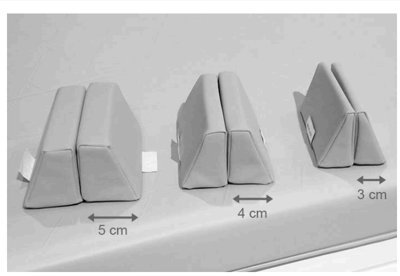
Fig. 80: Examples with the Base (B) and the d-Stream interface (d) of how to place the long mattress (LM), the short mattress (SM) and the T-shape mattress (TM) on the tabletop.

NVC stability pad

Item/Purpose	Quantity	Photo	Application Example
NVC Stability pad and NVC stability pad - thin Pad to aid in positioning • for all types of head and spine examinations with the dS Base coil. • for all types of examination with the TMJ holder.	1		

Item/Purpose	Quantity	Photo	Application Example
TMJ holder Coil holder to be used for TMJ, orbit or carotid examinations with the dS Flex and the dS Microscopy coils.	1		

Sandbags and wedges

Item/Purpose	Quantity	Photo	Application Example
Sandbag 3.6 kg MR Safe non-magnetic artifact-free sandbags of different weights to aid in patient positioning. Strong, durable and sealed to prevent leakage. Stain-resist-ant coating.	2		
Wedges 30° **Wedge 15°** Wedges of different shapes to aid in patient positioning. Stain-resistant coating.	2 2		
Foam Wedges Foam wedges in different sizes to aid in patient positioning.	6		

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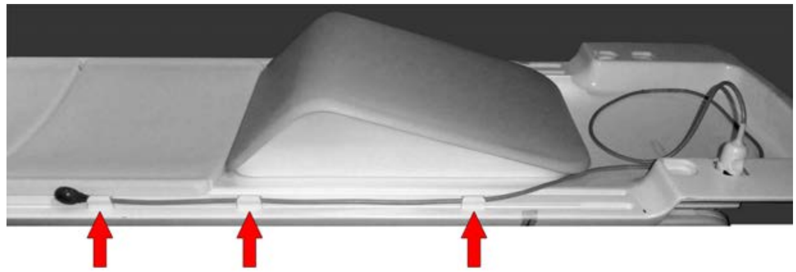
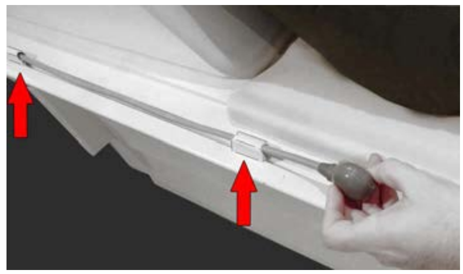
Straps

Item/Purpose	Quantity	Photo	Application Example
Extremity Strap, medium	2		
Extremity Strap, large To strap around an extremity in order to fix e.g. a coil.	3		
Head/Orbit Strap To strap around the head in order to fix e.g. a coil.	2		
Shoulder/Hip Strap To strap around the shoulder or hips in order to fix e.g. a coil.	3		
Soft Body Strap To slide into the grooves of the tabletop on both sides and strap above the body in order to fix e.g. a coil.	1		

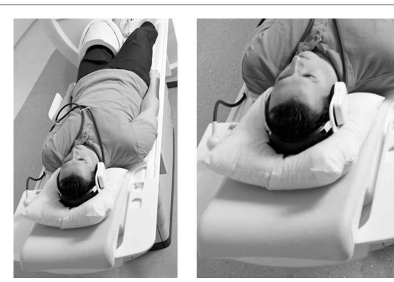
Passive Headset and Nurse Call

Refer to the 'Instructions for Use' chapter 'Safety' and 'System Overview' for full information on headset and nurse call.

Item/Purpose	Quantity	Photo	Application Example
Passive Headset To provide hearing protection for the patient.	1		
Nurse Call To allow for communication between the patient and the operator at all times.	1		
Extended Nurse Call To allow for feet-first prone imaging with breast solutions.	1		

Correct usage with cable clips (indicated by arrows)	
Correct usage with cable clips (indicated by arrows)	
Wrong cable placement: 1. Cable is not fixed with cable clips and hangs alongside the patient support. 2. The nurse call is plugged in at the wrong side. It should always be plugged in at the feet side.	

Supports

Item/Purpose	Quantity	Photo	Application Example
Knee Support To support the lower extremities while maintaining hip flexion, and to help relieve lower back stress and pain. Stain-resistant coating.	1		
Head- / Leg Support To extend the tabletop as head or leg support for very tall patients. Stain-resistant coating.	1		

Item/Purpose	Quantity	Photo	Application Example
Arm Support To ensure secure hand and arm positioning during table movement.	2		

Pediatric Package

Item/Purpose	Quantity	Photo	Application Example
Baby support for the dS HeadNeck-Spine coil solution To safely position babies on Base coil and tabletop.	1		
Pediatric strap, medium and large	2 each		
Anterior coil frame To safely position the Anterior coil for pediatric examinations.	1		
Pediatric knee support	1		

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Item/Purpose	Quantity	Photo	Application Example
Child elevation mattress	1		
Comfort pad	1		

Infusion supports

Item/Purpose	Quantity	Photo	Application Example
Arm Board To ensure secure hand and arm positioning during table movement.	2		

The use of contrast agent is normally based on non-contrast images. When contrast agent is necessary, the arm board can be used as an aid for convenient injection needle insertion.

The arm board can be used with almost every coil and in combination with the trolley.

Workflow

- Move the patient partially out of the magnet. Keep the tabletop partly in the bore to maintain the same off-center positioning.
- Place the arm board with its top corner under the shoulder of the patient.
- Push the arm board further under the body of the patient. The patient’s body weight will fix the arm board in place and provide stability for insertion of the infusion needle.
- Insert the infusion needle and connect the infusion lines.
- Remove the arm board and return the patient to scan plane.
- Continue the examination with the administration of contrast agent.

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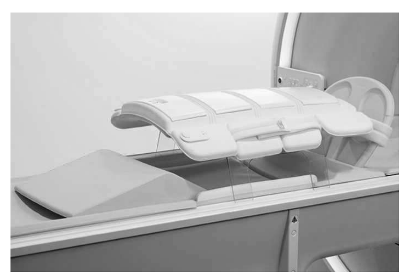
WARNING

Before starting a scan which initiates tabletop movement, always check that nothing can get caught or hit during tabletop movement.

Check patient, patient extremities, clothing, equipment and positioning aids. Guide cables and intravenous lines.

Angiography Package

Item/Purpose	Quantity	Photo	Application Example
Feet Immobilizer To ensure patient immobilization (to obtain good subtraction images) To reduce venous enhancement by positioning the lower legs higher than the upper legs and increasing flow to the capillary bed.	1		
Pediatric Knee Support To support the lower extremities in examinations of the peripheral vessels. Stain-resistant coating.	1		
Anterior Coil Frame To safely position the Anterior coil for angiographic examinations.	1		
Arm Board To ensure secure hand and arm positioning during table movement.	2		

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FlexTrak

The FlexTrak patient transportation system is optional. More information, see chapter “Tabletop and trolleys” on page 121.

Mattresses

The trolley mattresses are the same as described in the chapter “Basic Set” on page 223 with the exception of the Head/Leg support.

Drip stand

Item/Purpose	Quantity	Photo	Application Example
Drip stand	1	 	To hang up infusion bottles or similar equipment.

Soft body strap with holder

The soft body strap is the same as in described in the chapter “Basic Set” on page 223.

FlexTilt

FlexTilt is a tilting device which can be used to position the Base coil (with or without Head or HeadNeck top coil) in an angle. This is especially helpful for patients who cannot comfortably lie flat with their head in the Base coil.

Fig. 81: Left: FlexTilt device on lowest level. Right: FlexTilt device on different levels.

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Fig. 82: Base coil and FlexTilt. Left: Lowest level. Right: Highest level.

Recommended Use

FlexTilt is especially designed for the following situations:

Kyphotic spine: These patients are unable to put their head on the head cushion of the Base coil. By tilting the coil, the patient is able to lie in the magnet bore for any examination.

Claustrophobic patients: FlexTilt is convenient for patients with claustrophobia because FlexTilt enables the patients to look more forward into open space.

Serious illness: Patients who are seriously ill can suffer from swallowing issues. Tilting the coil might help to overcome this problem.

Workflow

- ► Place the FlexTilt device between the Base coil and the tabletop.
- ► Position the patient on the tabletop with the head in the Base coil.
- ► Tilt the tilting device to an angle convenient for the patient.
- ► Optional: Depending on the type of examination, attach the Head or the HeadNeck top coil to the Base coil.

Fig. 83: Examples of positioning with FlexTilt from lowest level (1) to highest level (3).

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Fig. 84: Examination on the highest tilting level with a top coil attached: HeadNeck top coil (left) or Head top coil (right) .

Breast Pads

The breast pads are designed for ease of use in breast imaging. They can be used with the dS Breast 16ch and the dS Breast 7ch coil.

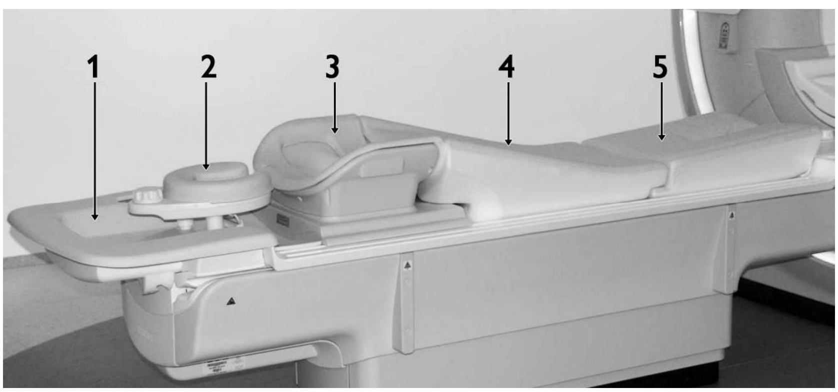

Fig. 85: Setup for a breast examination with the breast pads and the dS Breast 16ch coil.

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Number	Item	Photo	Description/Purpose
1 and 2	**Head/Arm support** (1 - Arm support, 2 - Head support)		The shape of the mattress facilitates the examination setup: • It is to be positioned at the rear end of the tabletop. • It determines the position of the breast coil on the tabletop. • The elevated border is meant to serve as arm support.
3	**Cover pad** for the breast coil		The breast cover pad is designed for maximum patient comfort. • There is no padding between the two breasts in order to reduce the pressure on the sternum.
4	**Ramp** with velcro on the bottom (left: top view, right: bottom view)		The ramp is designed for maximum patient comfort. • The velcros on the underside of the ramp allow easy combination of the ramp with the leg cushion.
5	**Ramp extension** with recess for the cables		The ramp extension is designed for maximum patient comfort. • The velcros on the cushion are meant for easy combination of the ramp extension with the ramp. • Further the ramp extension covers the coil cable.

Coil Caddy

The Coil Caddy can be used to store the coils and positioning aids.

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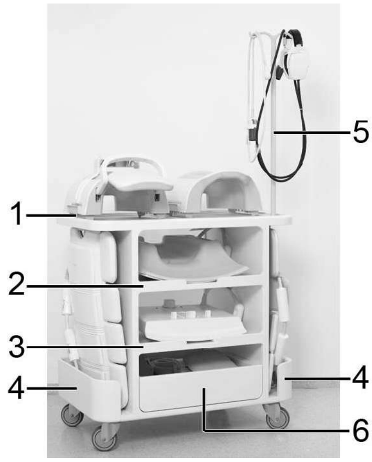

Fig. 86: Coil Caddy with shelf space for Head top and Head/Neck top coils (1), shelves for Base coil (2) and dStream interface (3), side shelf for the Anterior coil (4), drip stand (5) and drawer for positioning aids (6).

Acoustic Hood

The Acoustic Hood for the Ingenia system is designed to be used for pediatric imaging with:

- the Posterior coil,
- the Base coil (with or without Head or HeadNeck top coil),
- the Anterior coil, together with the pediatric support,
- dS Ped HeadSpine 8ch coil,
- dS Ped TorsoCardiac 8ch coil,
- or the dS Head 32ch 3.0T coil.

It will provide good acoustic noise damping for vulnerable neonatal and pediatric patients requiring MR examinations.

Fig. 87: Acoustic Hood.

MR scans can be very loud although the level of noise is different for different types of scan methods. Technological developments and new techniques are becoming widely utilized for pediatric patients. The acoustic sensory system degrades slowly after birth. Many premature patients are scanned while their acoustic sensory systems are still in development and should be

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protected. Very small children will not always tolerate a headset. Other accessories, such as Mini-Muffs provide some noise damping (~7dB). The Acoustic Hood will provide additional noise damping of around 8 dB.

Safety

NOTICE

Use earplugs.

When the Acoustic Hood is positioned correctly, it provides additional noise damping of around 8 dB.

WARNING

Verify that the Acoustic Hood is always at least 10 cm away from the ventilation outlet.

Do not block the flow of air through the bore and around the patient when the Acoustic Hood is used.

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NOTICE

Patient monitoring is advised.

NOTICE

Place the Acoustic Hood over the patient and coil before moving the patient into the bore.

In this way one will have control over peripheral equipment, cables, tubes and lines.

NOTICE

If an adjustment is made to the position of the Acoustic Hood, always pull it straight watching carefully that cables, tubes and lines are not affected by the movement.

NOTICE

Do not sterilize or disinfect the hood.

Cleanabilty is limited because of the sound absorption characteristics of the Acoustic Hood. The Acoustic Hood is water repellent, but cannot be sterilized or disinfected. If it becomes very dirty we advise that a new one be purchased.

Patient Positioning

► Complete positioning of the patient.

For most of the examinations, proceed as follows:

- Optional: Depending on the size of the pediatric patient, place the pediatric support of the dS HeadNeckSpine coil solution on the tabletop.
- Position the pediatric patient on the tabletop (or on the pediatric support).
- Attach the HeadNeck top coil to the Base coil.
- Place the anterior coil frame above the patient's body and position the Anterior coil on it.
- Connect the Anterior coil to the FlexConnect socket.

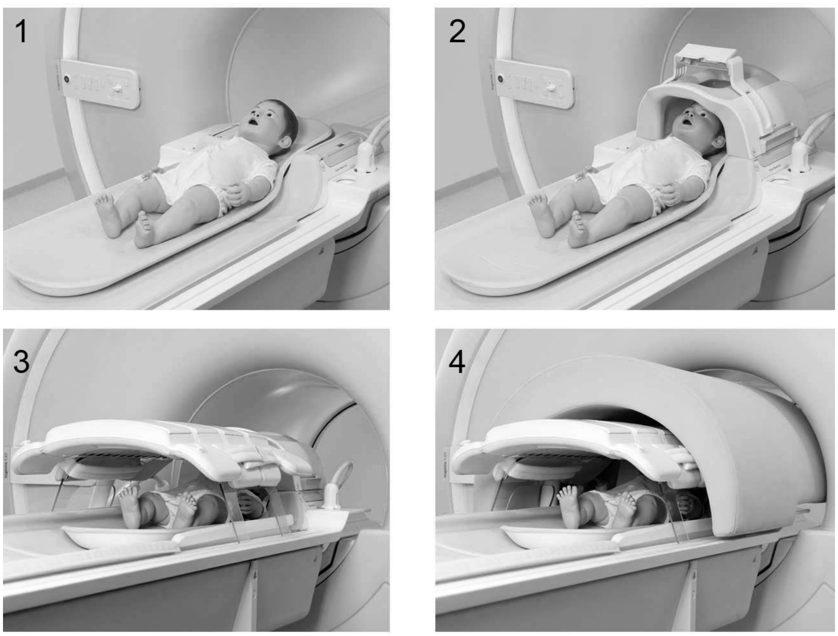

Fig. 88: 1: Pediatric patient on the pediatric support. 2: The HeadNeck top coil is attached to the Base coil. 3: The Anterior coil is positioned on top of the anterior coil frame. 4: The Acoustic Hood is placed in the bore too.

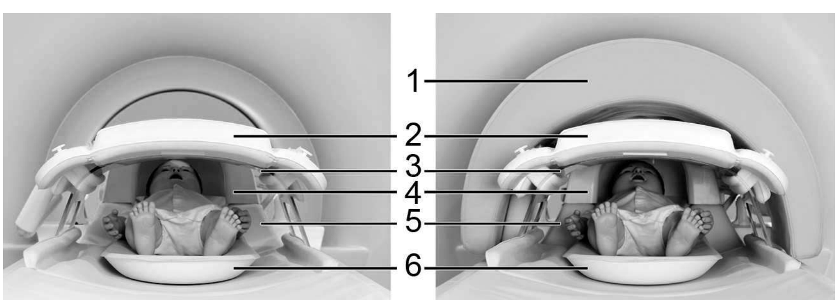

Fig. 89: Acoustic Hood (1) with Anterior coil (2) on the anterior coil frame (3), Base (5) with HeadNeck top coil (4) and pediatric support (6).

► Move to the light visor selection point. First use the light visor.

► Then position the Acoustic Hood over the coil and the patient.

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- Ensure that all lines and peripheral equipment are correctly positioned.

WARNING

Check that the hood is correctly positioned by positioning the step in the correct place.

This means that the Acoustic Hood extends over the end of the tabletop – leaving the head of the baby near the center of the Acoustic Hood, thus providing good acoustic protection. This position will be the same for both head and body scans of a baby.

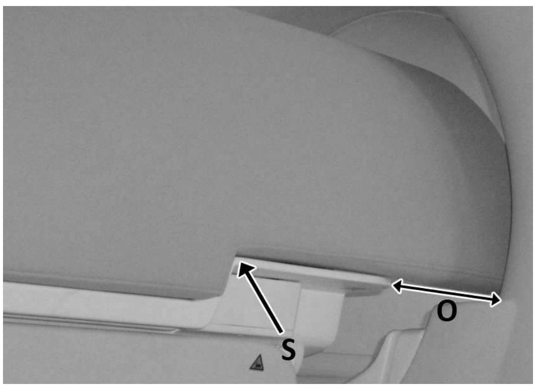

Fig. 90: Acoustic Hood on the tabletop where 'S' indicates the step and 'O' the part extending over the tabletop.

- Travel to isocentre.

  Guide the Acoustic Hood if necessary during travel to isocentre.

Patient Monitoring during the Examination

- For **head examinations of a baby**, the Acoustic hood will not interfere with the ventilation in the bore.
  However it is advised to monitor the temperature of the patient during scanning.
- For **body or spine scans of a baby**, the Acoustic Hood can be moved to cover the ventilation exits. In this case it is advised to push the Acoustic Hood back into the bore so that there is a 10cm gap between the ventilation exit and the Acoustic Hood.
  Please also note that it is always important to monitor the temperature of the baby and to use low SAR.

After the Examination

- When the examination is complete, first remove the Acoustic Hood and then lower the patient support.

  This is important as the Acoustic Hood extends over the end of the tabletop.

Storage of the Acoustic Hood

When not in use, store the Acoustic Hood upright so that the shape is maintained.

Lifetime of the Acoustic Hood

NOTICE

Sound absorbing properties of the Acoustic Hood are guaranteed over a lifetime of 3-5 years when stored upright.

Head-and-Arm Support

The head-and-arm support facilitates comfortable positioning of the arms upwards (above the head).

Components

Arm support (Rigid frame with detachable soft padding)	Head support	Combined
		

Applications

- Body examinations with the arms up in head-first or feet-first patient position.

Benefits of using the head-and-arm support for body examinations

With the arms positioned above the head, fold-over artifacts are prevented in body examinations. This allows for a narrowed acquisition volume and RL fold-over direction instead of AP. Compared to an examination with the arms at the side, the head-and-arm support allows the usage of much higher dS-SENSE factors in RL direction. The higher dS-SENSE factors provide the benefits:

- shorter breath-hold durations,
- less breath holds needed,
- improved image quality (less blurring in TSE, less distortion in DWI),
- improved image sharpness,

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- comfortable positioning of the arms.

Use

You can use the head-and-arm support with the dS Torso and the dS TotalSpine coil solution.

Positioning the patient with the head-and-arm support

▷ For feet-first and head-first positioning:

► Remove the dStream interface from the tabletop.

► Put the head support at the outermost end of the tabletop:

- for head-first examinations at the magnet end of the tabletop.
- for feet-first examinations at the distal end of the tabletop.

► Place the arm support around the head support.

► Position the patient on the tabletop with the arms upwards on the arm support.

► Proceed as usual with patient positioning for body examinations.

► When you move the patient to the isocenter, carefully check that the patients' arms do not touch the bore.

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9 Positioning

This chapter provides some general information about positioning and describes the positioning procedures for the various MRI examinations .

NOTICE

Before you start using any of the coils, refer to the ’Instructions for Use’ for full information on safety aspects.

About Positioning in general

- Be aware that the first consideration in positioning is comfort, in the patient's interest and to minimize motion artifacts.
- Use positioning cushions, sandbags and immobilization straps for comfort and stability.

  Normal X-ray positioning cushions may also be used.
- Ensure that patients fit easily into the system when positioned off-center or semi-sitting.

  If positioned semi-obliquely for a shoulder examination, the patient's raised shoulder may impede passage into the system.
- Use the arm supports to prevent the patient from grabbing around the table sides and pinching the fingers during horizontal table motion.

WARNING

Verify that patient’s hands are on the tabletop before moving the tabletop into the magnet to avoid finger pinching.

Fingers can get pinched between tabletop and the system covers.

The special arm supports (see Positioning Aids) can be used to avoid finger pinching. The arm supports prevent the patient from grabbing around the table sides avoiding finger pinching during tabletop movement.

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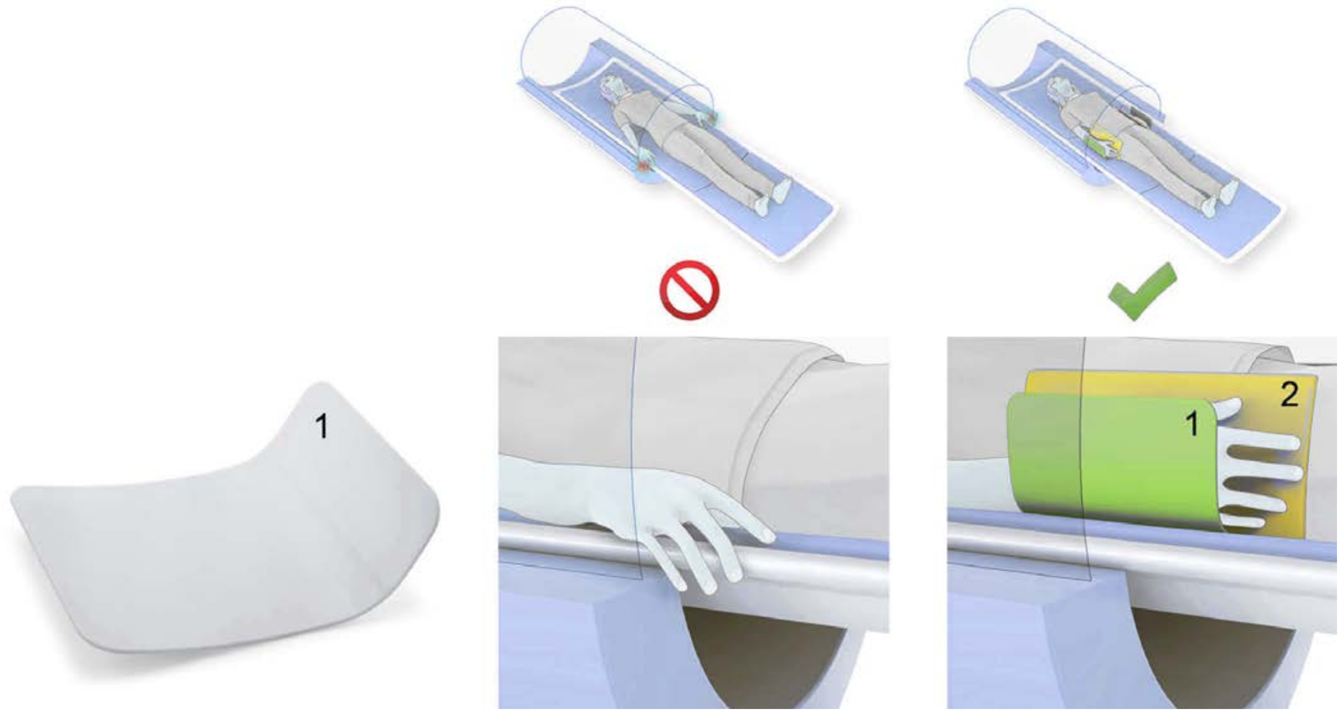

Fig. 91: Left: Arm support. Middle: Incorrect patient positioning. Right: Advised patient positioning with arm support (1) and padding (2).

Safety

Ensure clearance between body parts and the bore wall, primarily for air flow. Avoid large area contact between body parts and the bore wall.
A dry, small rolled towel (made from non-conductive material, for example linen or cotton) can be used to create a clearance of more than 5 mm between body parts and bore. This ensures only a minimum disruption of airflow through the bore.
Wrapping in sheets is inadequate, because it does not ensure air flow over the body part and traps in heat.

WARNING

If patient body parts touch, high-frequency current loops may form within the body.

Risk of patient burns

- **Secure a minimum of 2 cm clearance between body parts.**
- **When necessary, use the positioning aids to obtain sufficient clearance.**

Current loops are formed when two parts of the human body come into contact (skin to skin) or almost come into contact, e.g.:

- Both thighs are in contact.
- Both knees are in contact.

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- Both ankles are in contact.
- Arms and hands touching other body parts.
- Both hands are in contact. This especially is possible for scanning with breast coils when patients are imaged lying prone with both arms extended above the head.

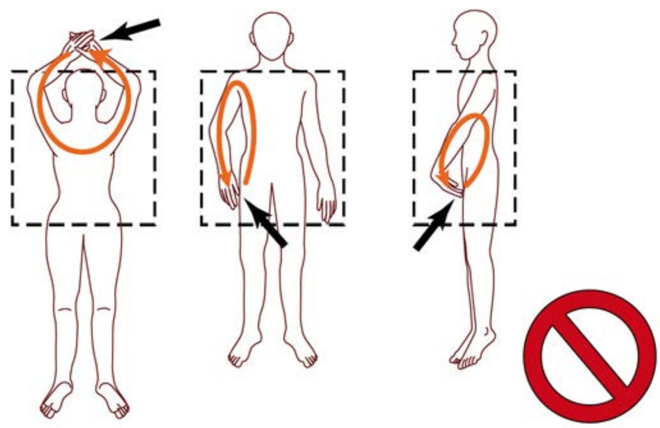

Fig. 92: Current loops (curved arrows) and locations where heating can occur (black arrows).

Contact between body parts must be prevented as shown in the picture below:

- Example 1: positioning the patient appropriately. No skin to skin contact.
- Example 2: padding between arms and body.
- Example 3: padding between thighs and ankle.

A minimum of 2 cm clearance must be secured. When necessary, use the positioning aids to obtain sufficient clearance .

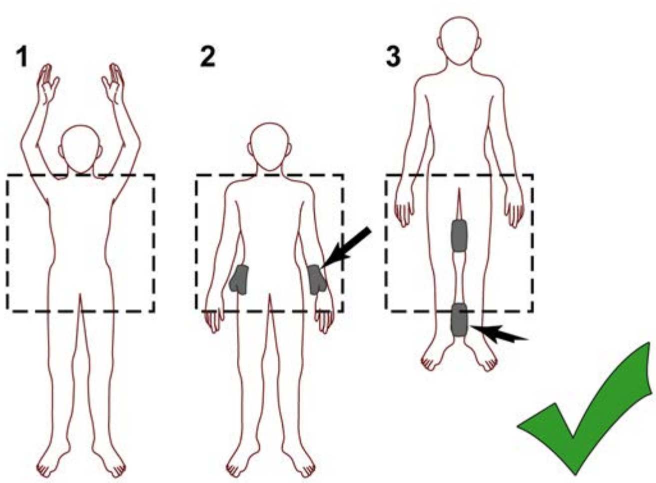

Fig. 93: Avoiding current loops.

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Hearing Protection and Nurse Call

Hearing Protection

Basic hearing protection must be worn by the patient during scanning. Such hearing protection is provided by appropriately fitted earplugs with sufficient damping (>30 dB).

NOTICE

Typical damping characteristic of the Philips' headset is 20 dB in the 1 kHz range.

WARNING

Always apply hearing protection to the patient and anyone else present in the examination room before start scanning.

Without hearing protection, noise levels may be high enough to cause discomfort or result in temporary or even permanent loss of hearing.

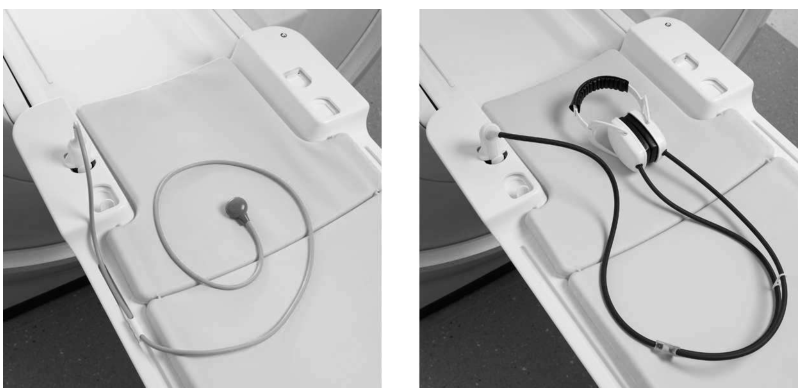

Fig. 94: Nurse call (left) and headset (right).

Fig. 95: Patients with headset and nurse call.

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Nurse Call

WARNING

The 'Nurse call pinch ball' must be given to every patient.

This allows for communication between the patient and the operator at all times. Check correct functioning of the 'Nurse call system' before each examination.

Its use should always be demonstrated. If it is pressed quickly twice or once for a longer period, the alarm bell will be heard and the light will be activated on the intercom.

- Plug the nurse call connector into the socket.
- Fix the cable of the nurse call with 3 cable clips.

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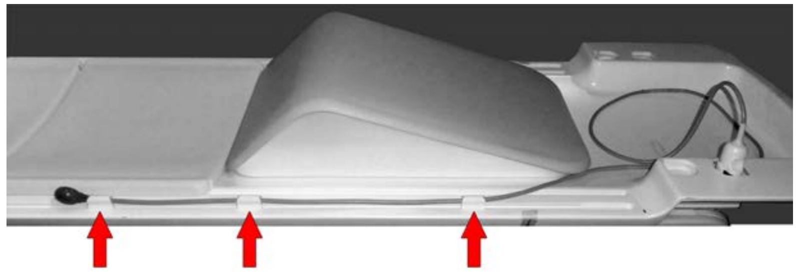
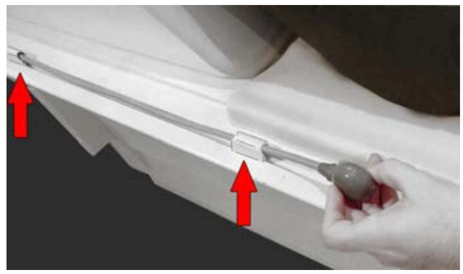
Correct usage with cable clips
(indicated by arrows)



Correct usage with cable clips
(indicated by arrows)



Wrong cable placement:

1. Cable is not fixed with cable clips and hangs alongside the patient support.
2. The nurse call is plugged in at the wrong side. It should always be plugged in at the feet side.

Observation of the patient

Observation of the patient is reassuring for patient and operator. It may be directly from the console or via a video camera or mirror. Voice contact via the intercom should be demonstrated to each patient.

Mattress and Coil Concept

Optimum patient positioning is crucial for a successful MR examination. The setup of coils and mattresses is an essential part of patient positioning. Understanding the mattress and coil concept allows for a smart setup of every MR examination.

Two different methods

There are two different methods of setting up coils and mattresses on the patient support.

The choice made depends on the respective application and will influence the further setup of the examination.

1. **Without the dStream interface (utilizing integrated coils)**: applicable for
   - Head and Neck examinations
   - Neuro imaging: Brain, Spine and Total Spine examinations

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- Shoulder examinations
- Body and Whole Body examinations
- Cardiac imaging
- MR Angiography

2. **With the dStream interface (utilizing dedicated or dS Flex coils)**: applicable for
   - All MusculoSkeletal (MSK) examinations, e.g. shoulder with dS Flex coils, wrist, hand, knee, ankle, foot
   - Breast imaging

Fig. 96: dStream Interface on the tabletop.

Mattresses and coils on the patient support

For the setup of all MR examinations, the following principle applies at all times:

The patient support is fully covered by mattresses and coils for any examination.

The coils and the short and long mattresses are designed such that they completely fill up the space on the patient support when they are combined in the correct way:

1. Either Base, two long mattresses and one T-shape mattress
2. Or dStream interface, two short mattresses, one long mattress and one T-shape mattress.

NOTICE

The short mattresses are of the same size as the dedicated coils (with their mattresses) that are used in combination with the dStream Interface.

The short mattresses are to be substituted by a dedicated dStream coil for a specific clinical examination.

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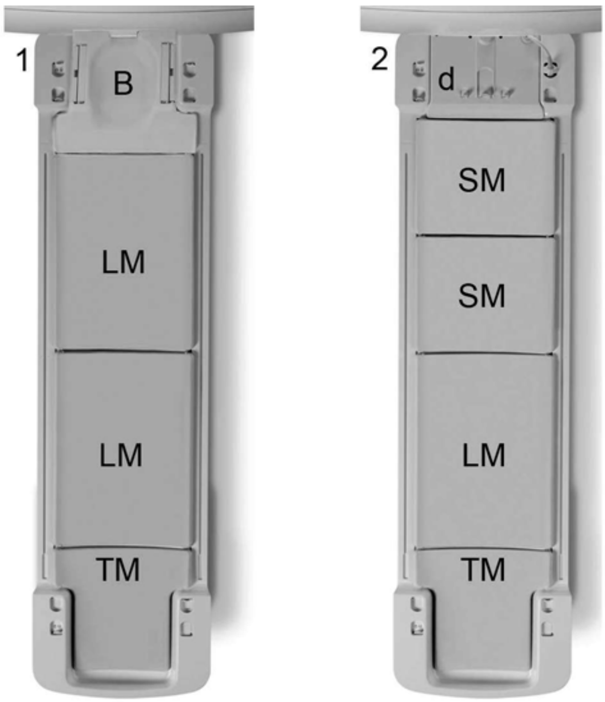

Fig. 97: The Mattress and Coil Concept.

1	Base coil (B), two long mattresses (LM) and one T-shape mattress (TM)
2	dStream Interface (d) with two short mattressses (SM), one long mattress and one T-shape mattress (TM).

NOTICE

Without the dStream interface, always leave the Base coil on the tabletop as head support, even when not in use.

One exception to this rule is the dS Shoulder 8ch coil.

Overview of different positioning possibilites with the dStream Interface

Depending on the type of examination, it might be necessary to change the order of short and long mattresses in combination with the dStream interface.

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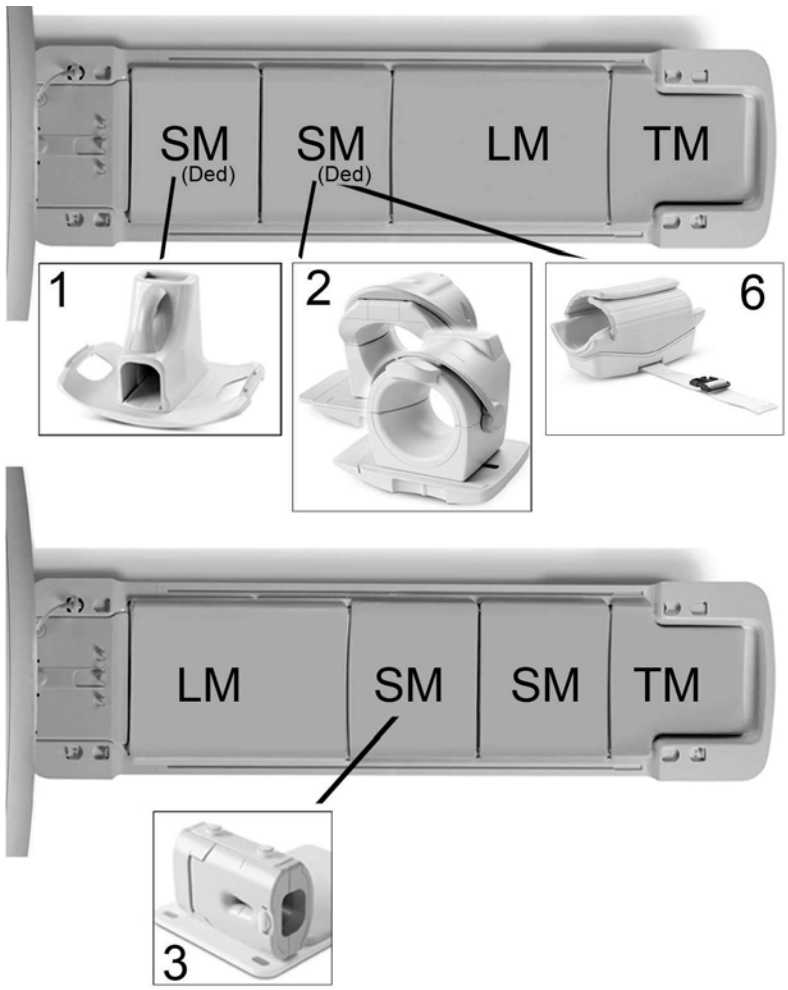

Fig. 98: Preferred locations for the dedicated coils in combination with the dStream Interface (LM - long mattress, SM - short mattress, TM - T-shape mattress, Ded - Dedicated mattresses of the Small Extremity coil).

1	dS FootAnkle 8ch coil for feet or ankle examinations in Feet-First position
2	Knee coils (dS Knee 8ch coil, dS Knee 16ch, dS Knee T/R 16ch coil) for knee examinations in Feet-First position
3	dS Wrist 8ch coil for wrist examinations in Feet-First position with the wrist at side
6	dS Small Extremity 8ch coil with dedicated mattresses for elbow examinations in Head-First position Note that the dS Small Extremity 8ch coil is to be used with its dedicated mattresses (ded).

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NOTICE

The breast coils are delivered with dedicated mattresses. None of the above described setups applies for these coils. For more information, please refer to the chapter “Positioning for Breast Examinations” on page 276.

Connectors and Plugs

The MR system provides two different kinds of coil sockets:

- FlexConnect sockets on the tabletop
- dStream sockets on the dStream Interface.

FlexConnect sockets

The figure shows the FlexConnect sockets and also the headset and nurse call sockets.

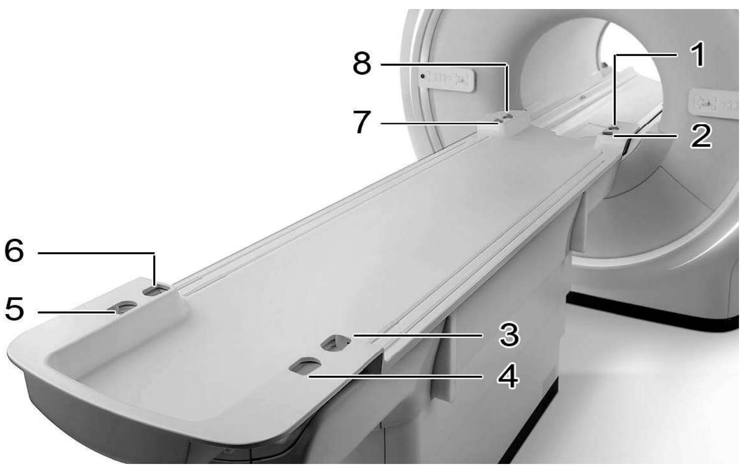

Fig. 99: Coil, headset and nurse call sockets.

Numbers	Socket type
1	FlexConnect socket.
2	Not used.
3	FlexConnect socket.
4	Not used.
5	Headset and Nurse call socket.
6	Not used.
7	FlexConnect socket.
8	Headset and Nurse call socket.

FlexConnect sockets

These sockets are to be used for

- dS Base coil

- dS Shoulder 8ch coil
- dS Anterior coil(s)
- dStream Interface

Fig. 100: Connected to the FlexConnect socket: on the left the Base coil, on the right the dStream Interface.

NOTICE

The short cable length of the dS Base coil, the dS Shoulder 8ch coil and the dStream Interface forces the operator to use the FlexConnect closest to these devices at the magnet side.

In such a way, mistakes are prevented.

dStream socket

The dStream socket is available on the dStream Interface.

This socket is to be used for the coils:

- dS Breast 7ch and dS Breast 16ch
- dS Knee 8ch, dS Knee 16ch and dS Knee T/R 16ch
- dS Wrist 8ch
- dS FootAnkle 8ch
- dS SmallExtremity 8ch
- dS Flex

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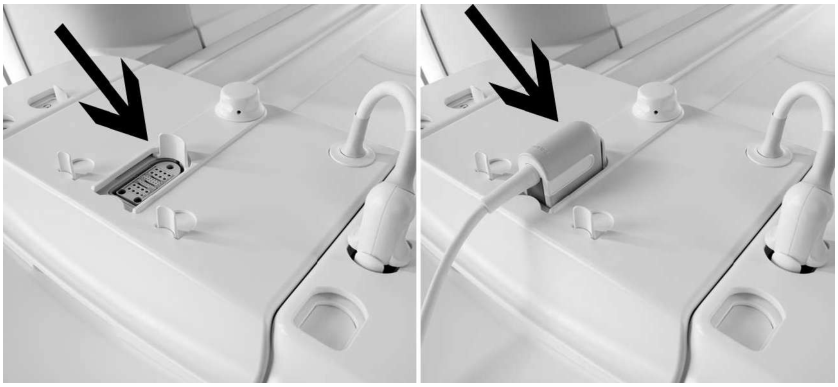

Fig. 101: dStream interface on the patient support plugged into FlexConnect socket. Left: Open socket for the connection of a dStream coil. Right: dStream coil is connected.

NOTICE

The dStream socket/connector and the FlexConnect socket/connector are different in shape and size.

In such a way, mistakes are prevented.

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Procedure of plugging in

An empty socket is protected by a sliding disk.

- ► Place the connector against the lever of the sliding disk.
- ► Move the connector further against the lever to open the socket.
- ► When the socket is completely open, plug the connector into the socket.

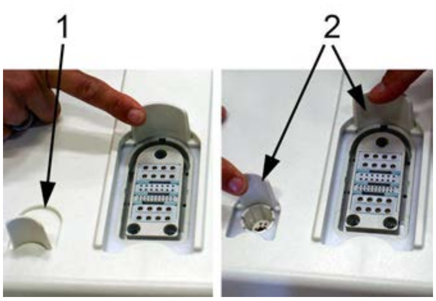

Fig. 102: Closed and open sockets with levers and sliding disk.

1	Sliding disk
2	Levers

Procedure of disconnecting a coil from the dStream Interface

- ► Turn the knob.

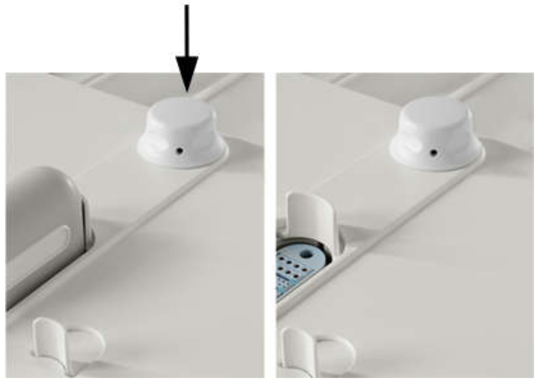

Fig. 103: The arrow indicates the knob. Turn this knob to disconnect a coil.

Coil and patient positioning

- Prepare the tabletop with coil(s), mattresses and, if required, the dStream interface.
- Position the patient on the tabletop with hearing protection, nurse call and the appropriate positioning aids and, if required, wireless PPU or VCG.

  For more information on positioning, see the following sections.

Positioning for Head, Head/Neck and Spine Examinations

CAUTION

Damaged coil or mirror due to collision with the magnet.

Risk of injury

- **To tilt the dS Head or dS HeadNeck coil, only use the tilting device dedicated for your system.**
- **When the tilting device is in use, watch that the mirror does not collide with the magnet during tabletop movement.**

The set-up of a head examination, a head/neck examination or a spine examination are very similar.

- The dS Posterior coil and the dS Base coil are used for all these examinations.
- Depending on the type of examination, the dS Head top or the dS HeadNeck top coil are also used.

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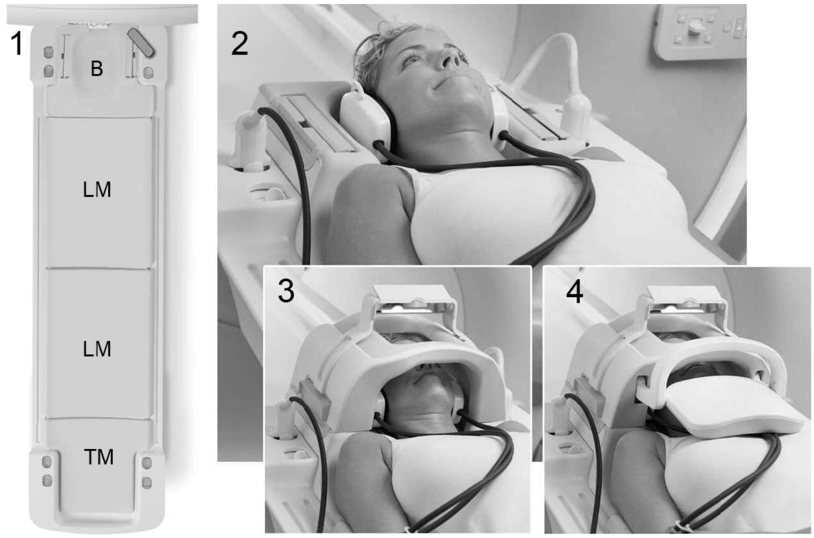

Fig. 104: Positioning for spine, head, head/neck and total neuro examinations.

1	Schematic set-up: T-Shape mattress (TM), two long mattresses (LM) and the dS Base coil (B) on the tabletop with the dS Base coil connected to the FlexConnect socket.
2	Positioning for **Cervical, Thoracic, Lumbar and Total Spine examinations**: patient on the tabletop.
3	Positioning for **Head and Total Neuro examinations**: patient on the tabletop. The dS Head top coil is attached to the dS Base.
4	Positioning for **Head/Neck examinations**: patient on the tabletop. The dS HeadNeck top coil is attached to the dS Base.

Workflow

1. Place the dS Base coil and two long mattresses on the tabletop.
2. Connect the dS Base coil to the FlexConnect socket.

Fig. 105: 1: Base on tabletop, 2: Base with pad and mirror, 3: Base with Head top coil, pad and mirror.

3. Position the patient supine on the tabletop with their head in the dS Base coil.
4. Use the small wedges to immobilize the head by placing them firmly between the head and the sides of the support.

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5. Use the knee cushion to increase patient comfort.

Fig. 106: Set up for a spine examination. Example of a pediatric examination.

6. Optional: Attach the mirror to the base.

Fig. 107: Positioning for spine examinations. 1: Without mirror. 2: With mirror. 3: The mirror.

7. **For head, head/neck and total neuro examinations:**
   - Attach the dS Head or the dS HeadNeck top coil to the dS Base coil.

     Use the dS Head top coil for head and total neuro examinations.
     Use the dS HeadNeck top coil for head/neck examinations.
   - Optional: Attach the mirror to the dS Head or dS HeadNeck top coil.
   - For the dS HeadNeck top coil: Adjust the movable part of the coil so that it is as close to the patient's chest as possible.

NOTICE

While closing the coil verify that the patient's skin cannot be pinched between coil parts.

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Fig. 108: Left: Set-up for head and total neuro examinations. Right: Set-up for head/neck examinations.

Fig. 109: The figure shows the possible positions of the movable part of the coil.

Detach the dS Head or dS HeadNeck top coil from the dS Base coil

- Press the buttons at both sides of the coil to release the dS Head top coil or the dS HeadNeck top coil from the dS Base coil.
- Lift the top coil with both hands.

Fig. 110: The arrows indicate the buttons that need to be pressed to release the top coil in order to detach it from the dS Base coil.

Lift the coil up

- Hold on to the base to lift up and carry the coil.

NOTICE

Never lift the coil by holding on to the dS Head (or dS HeadNeck) top coil.

This might lead to severe damage of the coil.

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Fig. 111: Left: Correct way of how to lift up the coil. Right: Wrong way.

FlexTilt in head, head/neck and spine examinations

FlexTilt is a tilting device which can be used to position the dS Base coil (with or without dS Head or dS HeadNeck top coil) in an angle. This is especially helpful for patients who cannot comfortably lie flat with their head in the Base coil.

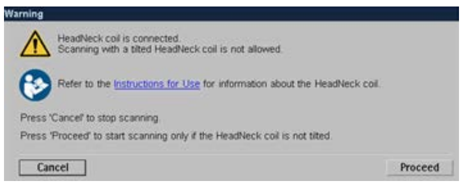
FlexTilt cannot be used for all types of dS-HeadNeck coil types:

WARNING

1.5T dS-HeadNeck coil of types 45980009796* and 45980017123*:
Do not tilt the coil or put it on padding. This may cause local heating of the patient.

Always position the coil flat on the tabletop.

At the start of a scan a warning message is displayed when a 1.5T dS HeadNeck coil of types 45100100048* and 45980017123* is connected to the system.



HeadNeck is connected.
Scanning with a tilted HeadNeck coil is not allowed.

Refer to the Instructions for Use for information about the HeadNeck coil

Press 'Cancel' to stop scanning.
Press 'Proceed' to start scanning only if the HeadNeck coil is not tilted.

|Cancel| or |Proceed|

To start scanning a deliberate action is required:
Read the warning text and verify that the dS HeadNeck coil is not tilted. Click Proceed to start scanning.

Workflow

- Place the FlexTilt device between the dS Base coil and the tabletop.
- Position the patient on the tabletop with the head in the dS Base coil.
- Tilt the tilting device to an angle convenient for the patient.
- Optional: Depending on the type of examination, attach the dS Head or the dS HeadNeck top coil to the dS Base coil.

Fig. 112: Examples of positioning with FlexTilt from lowest level (1) to highest level (3).

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Fig. 113: Examination on the highest tilting level with a top coil attached: dS HeadNeck top coil (left) or dS Head top coil (right) .

Positioning for Head Examinations with the dS Head 32ch 3.0T coil

For head examinations on 3.0T, the dS Head 32ch 3.0T coil is an alternative solution to the integrated Base with the Head or HeadNeck top.

The examination with the dS Head 32ch 3.0T coil is a Head-First examination with the patient supine.

1. Place the dS Head 32ch 3.0T coil, two long mattresses and the T-shape mattress on the tabletop.

   The coil is positioned correctly when the tab on its posterior section fits into the notch on the table.

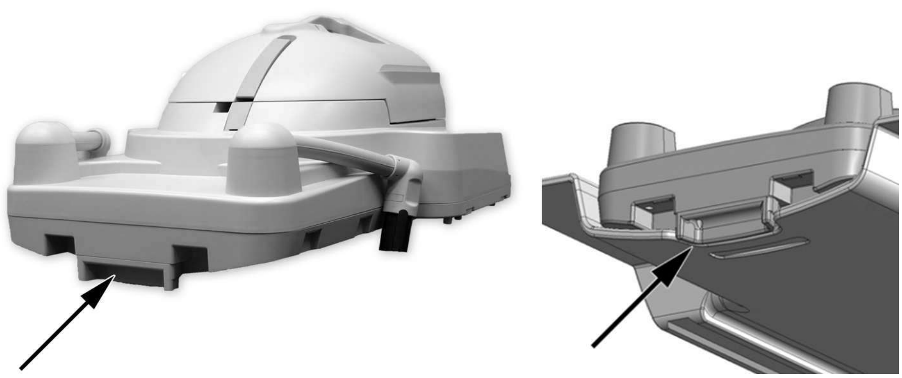

Fig. 114: Left: Rear view of the dS Head 32ch 3.0T coil. The arrow points to the part of the posterior section that is supposed to fit into the notch on the table. Right: The posterior section fits into the notch on the table.

2. Insert both FlexConnect connectors into the sockets.

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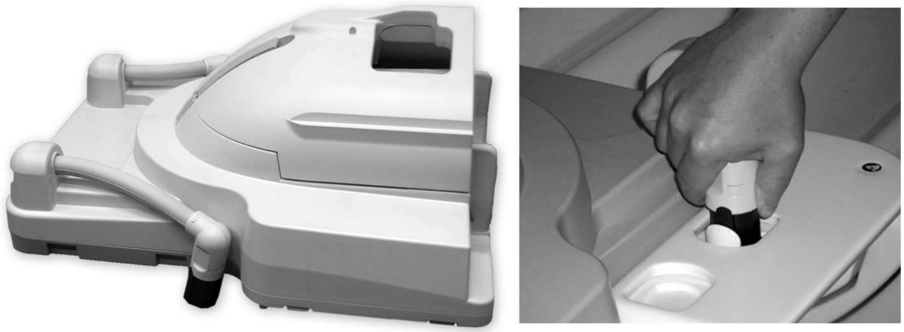

Fig. 115: Left: dS Head 32ch 3.0T coil with the two FlexConnect connectors. Right: Inserting one of the connectors into a socket.

3. Unlatch and remove the anterior section of the coil in preparation for the patient to be positioned:
   - Tilt the lever on the anterior section upwards to unlock this section.
   - Carefully raise the anterior section at the cranial side and take it off the posterior section.
   - To attach the anterior section back to the posterior one, proceed in the same way in reverse order.

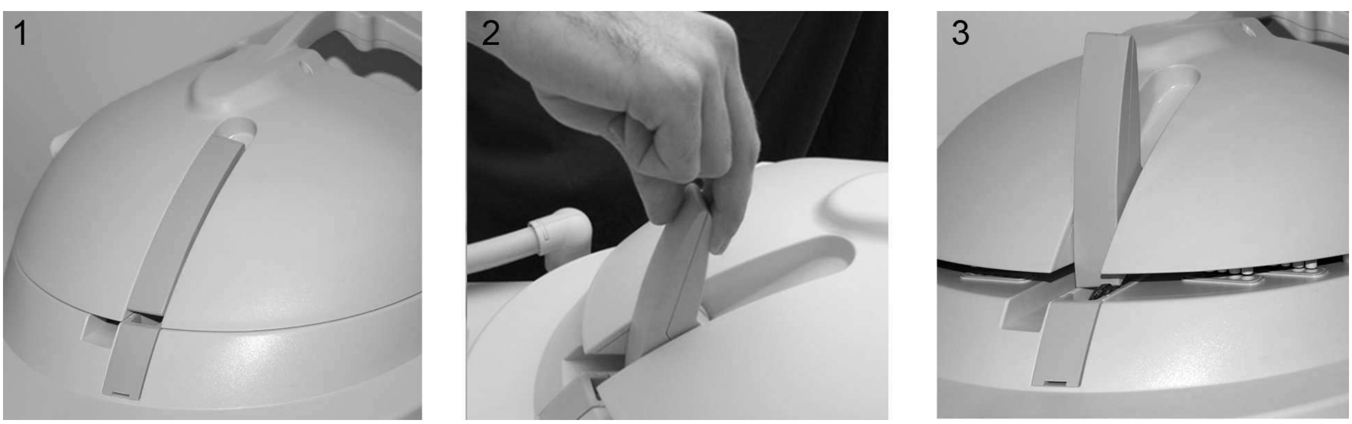

Fig. 116: 1: The anterior section attached to the posterior section. 2: Tilting the lever to unlock the anterior section. 3 : Anterior section is unlocked.

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Fig. 117: Tabletop setup with long mattresses and knee support, posterior coil section connected to dStream interface.

4. Position the patient with his/her head in the posterior section of the coil.

   Make sure that the patient's head is centered in the posterior section and that the patient's shoulders touch the coil pads.

   - Optional: Place the EEG cable in the EEG groove of the posterior section.

5. Provide hearing protection for the patient.

   - For maximum patient comfort it is recommended to use both earplugs and headset.

     The advantages are optimum noise reduction and good communication via the intercom.

   - For improved signal-to-noise ratio, it is recommended to use earplugs and foam wedges.

     The advantage is less noise breakthrough. However the patient will experience a higher noise level, and the communication via the intercom could be affected.

Fig. 118: Alternative ways of positioning. Left: with earplugs and headset, right: with earplugs and foam wedges.

6. Optional: Place the EEG cable in the EEG groove of the posterior section.
7. Attach the anterior section to the coil.
8. For isocenter positioning, use the patient's eyebrow line as landmark.

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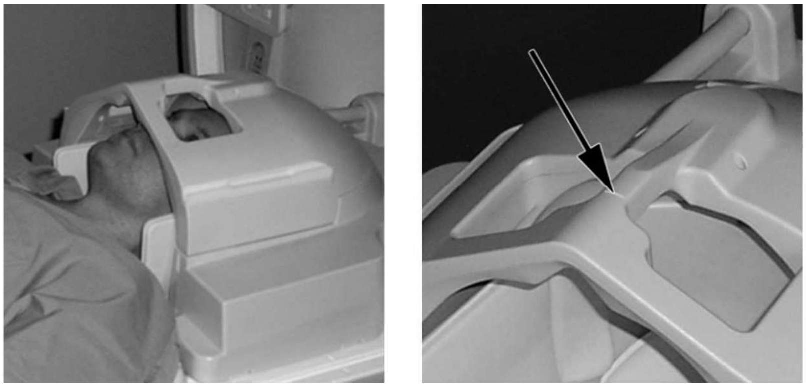

Fig. 119: Left: Patient' positioning with anterior section attached to posterior section. 3: It is recommended NOT to use the marker on the coil for isocenter positioning. Recommended is to use the patient's eyebrow line as landmark.

Fig. 120: Mirror on the coil to enable the patient to look outside the bore.

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NOTICE

While closing the coil verify that the patient's skin cannot be pinched between coil parts.

Positioning for Head Examinations with the T/R Head coil

The examination with the T/R Head coil is a Head-First examination with the patient supine.

- ► Place the coil and the mattresses on the tabletop.

  Make sure the head support is secure.
- ► Position the patient with their head in the head support.
  - If the patient has a short neck, it is advisable to place some padding under the shoulders.
  - Use the small wedges to immobilize the head by placing them firmly between the head and the sides of the support.
  - Use the head fixation strap for extra immobilization.
- ► Pull the sliding part gently over the head and face.
  - Pull gently on both sides of the coil, close to the base.

- Pull the coil all the way down so that it 'clicks' into position: this may not be possible with patients with large shoulders or a short neck. In this case, the coil will function normally, although the head appears lower in the survey image.

► Attach the optical mirror to the coil or use the comfort zone so that the patient can look outside the bore.

This can be reassuring for patients.

Fig. 121: Ready for a head/brain examination with the T/R Head coil.

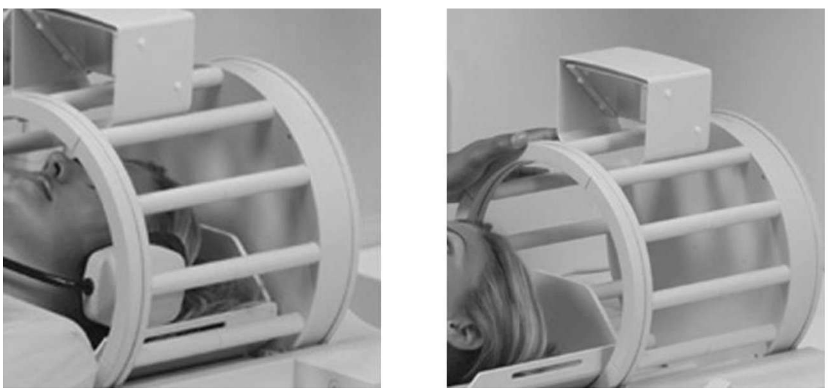

Fig. 122: T/R Head coil with mirror.

Positioning for Body Examinations

Body examinations (e.g. cardiac imaging and all organs of chest, abdomen, pelvis and peripheral angiography) make use of the dS Torso coil solution with its components dS Anterior coil and dS Posterior coil.

Both the Head-First and the Feet-First positions are suitable for an examination with the dS Torso coil solution.

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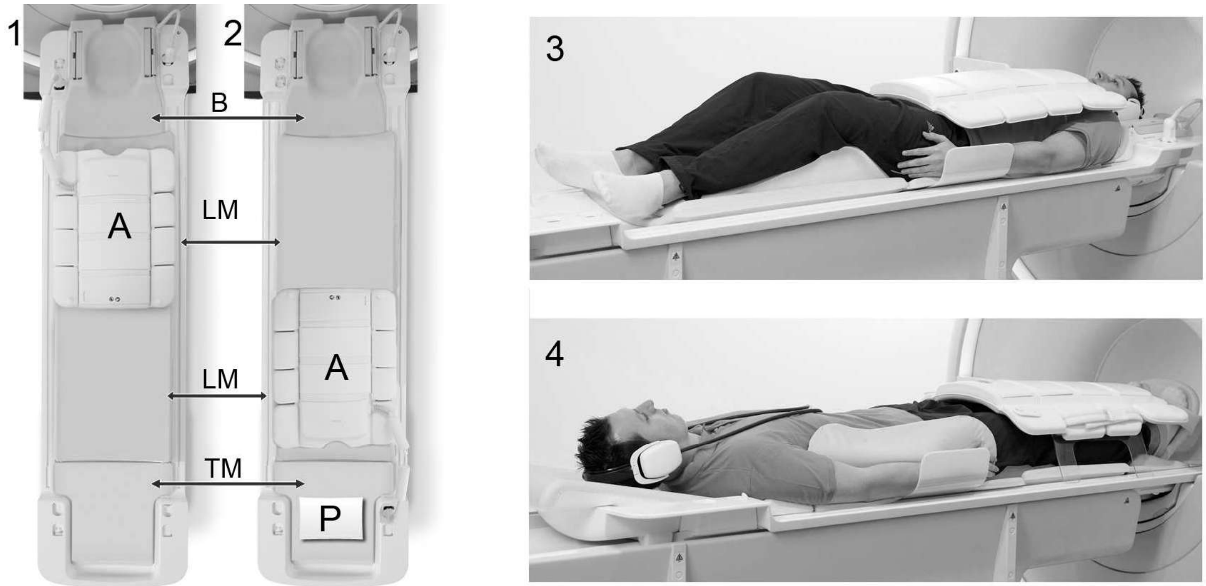

Fig. 123: Positioning with the dS Torso coil solution.

1	Schematic set up of a Head-First examination: dS Base, two long mattresses (LM), one T-Shape mattress (TM), and one dS Anterior coil (A) on the patient's chest connected to a FlexConnect socket.
2	Schematic set up of a Feet-First examination: dS Base, two long mattresses (LM), a pillow (P) on the T-Shape mattress at the bottom of the tabletop, and one dS Anterior coil (A) on the patient's chest connected to a FlexConnect socket.
3	Patient positioned head-first on tabletop with one dS Anterior coil on his chest. Set up for body examination.
4	Patient positioned feet-first on tabletop with one dS Anterior coil on his legs. Set up for peripheral angiography.

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Workflow for a Head-First or Feet-First examination

The workflow for a Head-First or Feet-First examination are identical except for the set up on the tabletop.

▷ The dS Base, two long mattresses and one T-shape mattress are placed on the tabletop.

1. Position the patient supine on the tabletop
   - for Head-First examinations: with their head on the dS Base;
   - for Feet-First examinations: with their head on the T-shape mattress or if used the Head/Leg support.
2. For cardiac imaging, place VCG electrodes and connect the leads properly.
3. Place the dS Anterior coil on the patient's chest.
4. If necessary place the respiratory belt between patient and coil.
5. The arms of the patient can either be positioned above the head or at the side.
   - For optimal results, position the patient's **arms above the head**.

Use the delivered positioning aids to support the patient's arms and position the patient as comfortable as possible.

- With the **arms at the side**, use a strap to fix the arms so that they cannot move.

  Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.

6. Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.
7. Optional: Strap the coil around the patient.

   Straps are recommended but not required.
8. Connect the dS Anterior coil to the FlexConnect socket.

Fig. 124: 1: Base on tabletop with dS Anterior coil (The shown cable layout may differ from the actual one). 2: Patient prepared for Head-First examination. 3: Patient prepared for examination with strap for coil and arms. A pad is placed between the patient's body and his arms.

Fig. 125: 1: Feet-first examination with additional dS Anterior coil and feet immobilizer. 2: with optional padding betweeen body and arm, 3: with optional strap.

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9. Use the knee cushion to increase patient comfort.

NOTICE

You can place the dS Anterior coil on top of the anterior coil frame, e.g. for pediatric patients.

Fig. 126: Left: Anterior coil frame. Right: dS Anterior coil on top of the anterior coil frame (The shown cable layout may differ from the actual one).

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Positioning for Whole Body and MobiFlex Examinations

Use the dS Whole Body coil solution with its components: dS Posterior coil, two dS Anterior coils, the dS Base coil and the dS HeadNeck top coil.

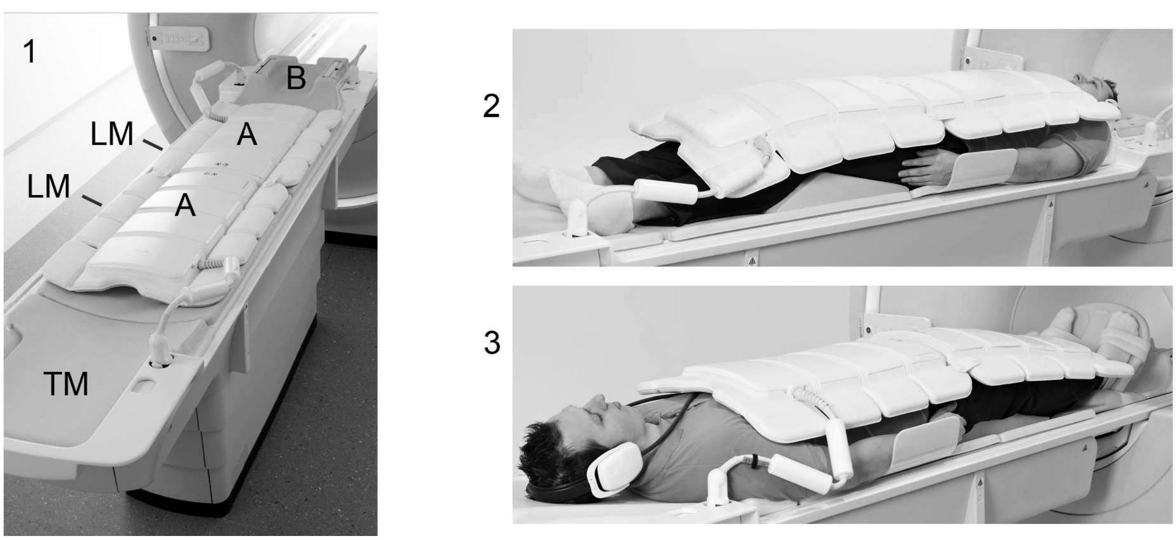

Fig. 127: Positioning with the dS Whole Body coil solution.

1	Schematic set up of a Whole Body examination: dS Base, two long mattresses (LM), one T-shape mattress (TM), and two dS Anterior coils (A) connected to the FlexConnect socket.
2	Setup for Whole Body examination: Patient positioned head-first on tabletop with two dS Anterior coils on his body. The dS HeadNeck top coil is not yet attached to the dS Base coil.
3	Setup for MobiFlex examination: Patient positioned feet-first on tabletop with two dS Anterior coils on his body. The feet immobilizer is placed in front of the dS Base coil.

Workflow

▷ The dS Base, two long mattresses and one T-shape mattress are placed on the tabletop.

1. Position the patient supine on the tabletop
   - for head-first examinations: with their head on the base;
   - for feet-first examinations: with their head on the T-shape mattress or if used the Head/Leg support.
2. For optimal results, position the patient's arms along the body and use arm supports.
3. Use the knee cushion to increase patient comfort.
4. Place two dS Anterior coils on the patient, one on the chest and and one on the legs.

NOTICE

Make sure that the dS Anterior coils do not overlap.

This can affect the image quality due to coupling of the coils.

5. Use the dedicated clips to attach the two dS Anterior coils to each other.

Fig. 128: Two dS Anterior coils attached to each other by means of the dedicated clips.

6. Connect the dS Anterior coils to the FlexConnect sockets.
7. Optional: Strap the coil around the patient.

   Straps are recommended but not required.

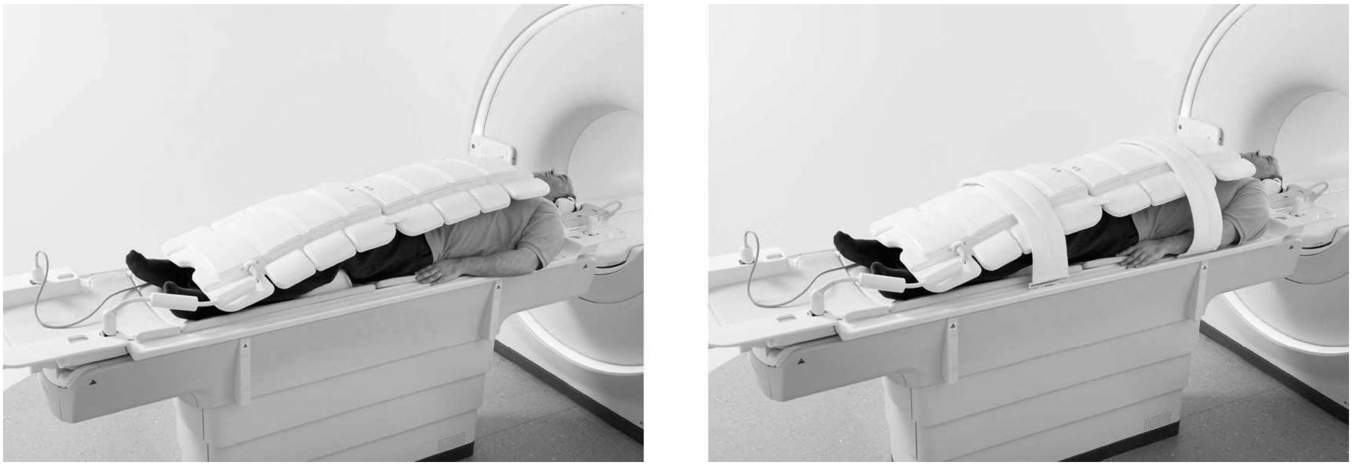

Fig. 129: Patient prepared for Head-First Whole Body examination with two dS Anterior coils (and dS HeadNeck top coil). 1: without straps. 2: with coils and arm strapped. 3: clips to attach the two dS Anterior coils to each other.

8. Optional: for Head-First Whole Body examinations attach the dS HeadNeck top coil to the dS Base coil.
9. If necessary place the respiratory belt between patient and coil.

NOTICE

You can place the dS Anterior coils on top of the anterior coil frame(s), e.g. for pediatric patients.

Fig. 130: Left: Anterior coil frame. Right: dS Anterior coils on top of the anterior coil frame(s).

Positioning with the dS Endo coil solution

The label on the coil says: eCoil 1.5T and eCoil 3.0T.

This section describes how to insert the coil, how to position the patient, how to remove and store the coil.

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Contraindications

WARNING

Do not use the coil when any of the following is indicated:

- **Inflammatory bowel disease i.e. ulcerative colitis or Crohn’s disease etc.**
- **Latex sensitivity.**
- **Radiation or surgery of the prostate, rectum or surrounding area within the last 8 weeks.**
- **Rectal fistula.**
- **Severe hemorrhoids.**
- **Rectal obstruction or stricture.**
- **Impacted or excessive stool in the rectum.**
- **Stricture of the anal canal.**
- **Any exclusion normally recognized for intrarectal and endorectal devices.**
- **Gold seed fiducial markers within the last 3 weeks. Consult the responsible physician and the instructions of the manufacturer of the gold seed fiducial markers.**
- **Brachytherapy seeds within the last 12 weeks. Consult the responsible physician and the instructions of the manufacturer of the brachytherapy seeds.**

Insertion of the coil

NOTICE

The probe of the coil is intended for single use only.

The interface device is reusable.

NOTICE

This product contains natural rubber and DEHP.

Natural rubber can cause allergic reactions such as itching, fever, dyspnea, urtication, asthma, hypotension, and shock. When these symptoms occur, immediately stop using the coil and take proper action. For USA only: refer to FDA March 29, 1991 Medical Alert on latex product. DEHP may cause birth defects or other reproductive harm.

CAUTION

Avoid excessive bending of the coil rod.

Excessive bending can lead to leakage of the non-permeable balloon.

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1. Use a lubricating gel on the outside of the probe to ease insertion into the rectum.

NOTICE

Too much lubricant may create signal artifacts on the images.

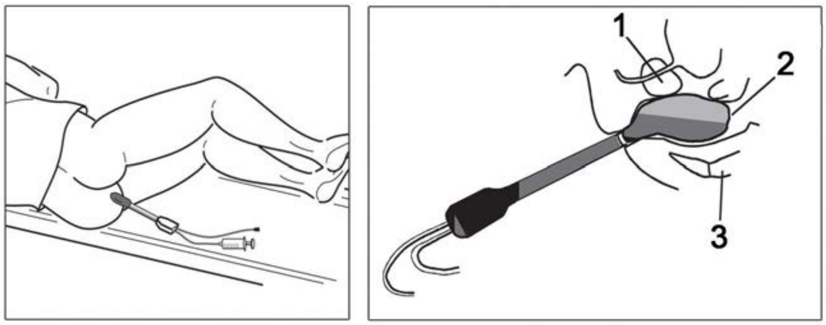

Fig. 131: Left: Insertion of the dS Endo coil. Right: Location of the coil when inserted (1 - Prostate, 2 - Rectum, 3 - Spinal column).

2. Position the patient feet-first in left or right decubitus position, with the knees pulled-up.
3. Squeeze the balloon gently to remove the air and thus ease insertion.
4. Maintain alignment and orientation of the blue stripe with the anterior midline of the patient.
5. Care should be taken when inserting the coil into the rectum; this should be done slowly, according to the patient's tolerance.
6. After positioning the coil, the balloon must be inflated to permit the coil loop to take up its natural form:
   - The inflated balloon makes it possible not only to position the coil close to the prostate, but also to prevent further movement of the coil in the rectum.
   - The balloon is inflated using the enclosed luer-lock syringe which fits into a valve located close to the grip.
7. Place the migration stop on the shaft.
8. Inflate the balloon. During inflation, continuously check with the patient if it is still tolerable. Inflate the balloon to the greatest volume that the patient can tolerate (60 cc to 100 cc).
9. When the balloon is inflated, the patient must turn to a supine position. This is the appropriate position for the examinations.

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WARNING

Liquid may leak from the balloon of the dS Endo 3.0T coil.

Risk of irritation.

- **Only use liquid that is approved by the manufacturer of the dS Endo 3.0T coil for inflation of the balloon.**

CAUTION

After insertion, do not rotate the coil once the balloon is inflated.

Positioning and connecting

Examinations with the dS Endo coil can only be performed with the patient in Feet-First position. The dS Endo coil works in conjunction with the Posterior coil. Furthermore it is possible to also use the Anterior coil.

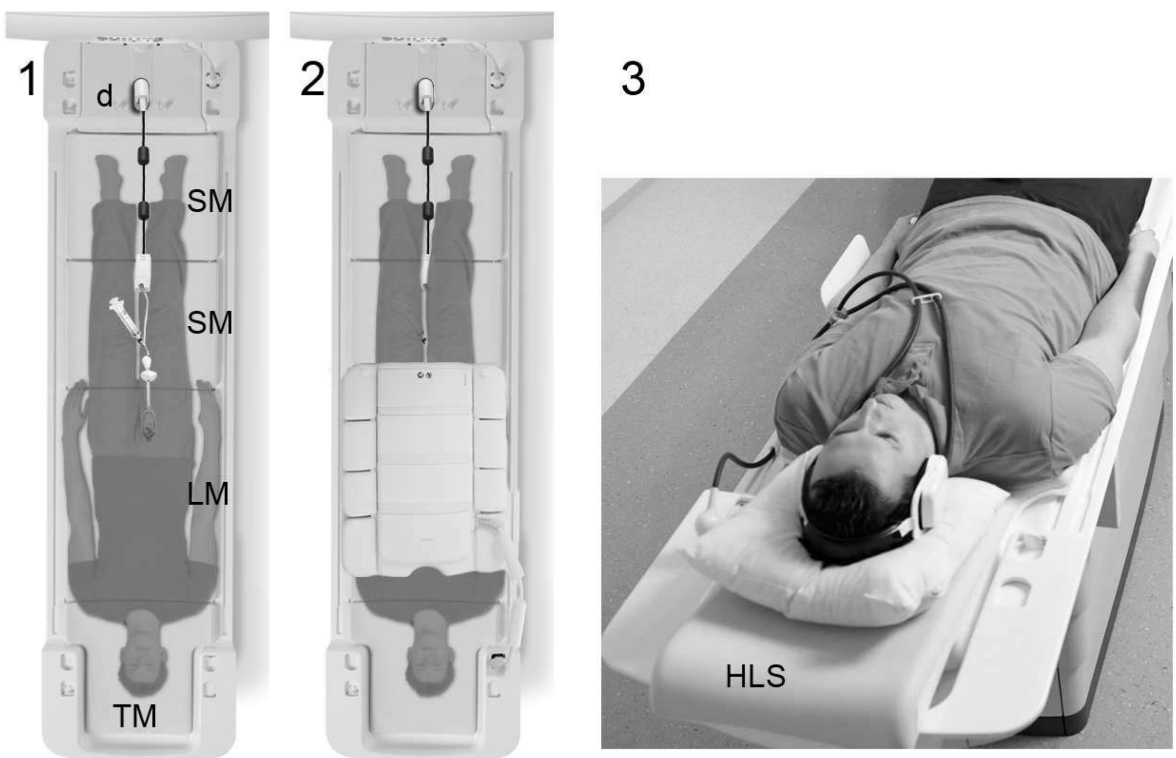

Fig. 132: Positioning with the dS Endo coil solution.

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1	Schematic set-up for examination with dS Endo coil: the dStream Interface (d), two short mattresses (SM), a long mattress (LM) and T-Shape mattress (TM) on the tabletop with the dS Endo coil connected to the dStream Interface. Patient on tabletop in Feet-First position.
2	Schematic set-up as in 1), but then with the optional Anterior coil.
3	Patient on the tabletop with the Head-/Leg support in order to perform examinations on tall patients.

The following instructions have to be followed strictly to avoid patient injury or damage to the coil:

1. Prepare the tabletop as shown in figure 132 on page 273:
   - for tall patients with the Head-/Leg support,
   - for other patients with a pillow.
2. Position the patient feet-first supine in the middle of the tabletop, with the cable routed straight away from the patient.

1. Place the preamplifier box on the table and connect the probe cable to it.
2. Route the probe cable and preamplifier box between the patient’s legs parallel to the axis of the bore. Make sure that the cable and the amplifier box do not touch either the patient or the bore (see figure).
3. Route the cable of the amplifier box to the dStream interface and connect it.
4. Recommended: Place the Anterior coil on the patient and connect the coil to the socket at the handgrip side of the tabletop. See figure 132 on page 273.

NOTICE

Always connect the Anterior coil to the socket at the handgrip side. See figure 132 on page 273.

It is strongly advised against connecting the Anterior coil to the socket at the magnet side, as in this configuration the patient cannot be positioned in a manner in which they do not touch the dStream interface.

5. Move the patient into the isocenter of the magnet.

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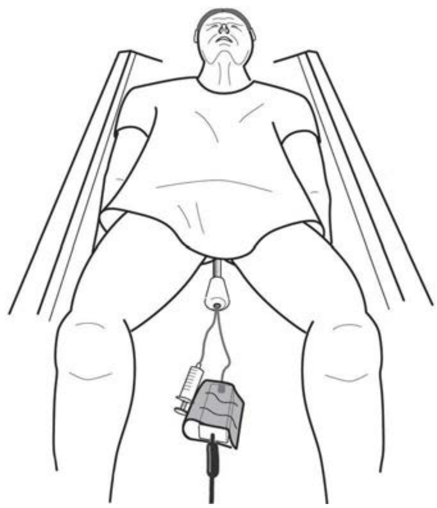

Fig. 133: Routing of the Endo coil cable and amplifier box.

WARNING

Do not scan with the patient in decubitus position when using the dS Endo coil. Only scan in the supine or prone position with the endo coil in the center of the body coil.

Scanning with the patient in decubitus position could result in excessive coil heating and ultimately causing burns to the patient.

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Removing the coil

CAUTION

After the examination, fully deflate the balloon before removing the coil.

1. To deflate the balloon use the stopcock close to the grip, place the luer-lock syringe on the valve and withdraw the syringe plunger.
2. Remove the coil.

Coil storage

1. Store the dS Endo coil in the original shipping container to prevent bending of the shaft.
2. Avoid transporting and storing the dS Endo coil solution at extreme temperatures and humidity as this may cause damage to the system.

Emergency Patient Evacuation

In an emergency situation that requires a quick evacuation of the patient from the examination room do the following:

1. Stop the scan.
2. Move the patient on the tabletop out of the magnet bore.
3. Disconnect the probe from the dStream Interface and evacuate the patient from the examination room.
4. After the patient is evacuated, deflate the balloon and remove the coil.

More information

For more information, refer to the Safety chapter of the Instructions for Use.

The Safety chapter contains generic warnings. Furthermore cleaning and disinfection of the coil are covered.

Positioning for Breast Examinations

Breast examinations can be performed with the following coil solutions:

Coil Solution	Application
dS Breast 16ch	optimally suited for high resolution imaging
dS Breast 7ch	ideal for routine imaging and breast biopsy
dS Breast Adaptive16ch	optimally suited for high resolution imaging and breast biopsy
dS Flex Breast	ideal for routine imaging

NOTICE

Patient positioning is identical for the dS Breast 16ch and the dS Breast 7ch coil solution.

Positioning with the dS Breast 16ch / 7ch coils

The breast examination is to be performed prone in feet-first position.

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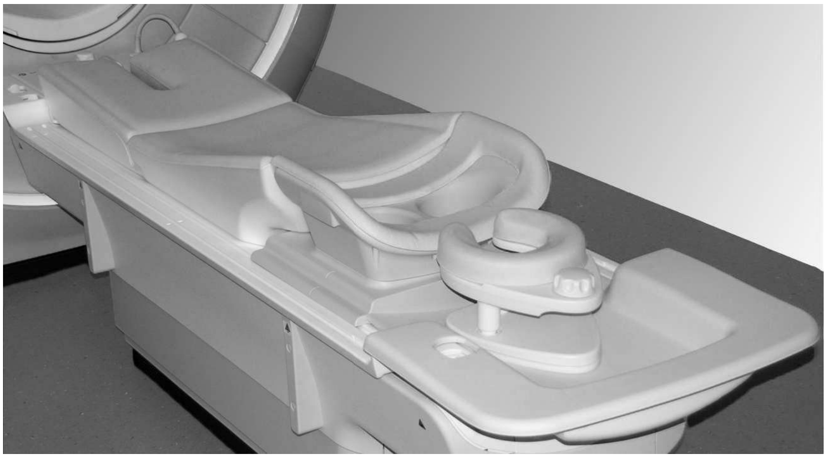

Fig. 134: Positioning with the dS Breast 16ch / 7ch coil solution. Left: tabletop ready for breast examination: d-Stream interface, ramp extension, (abdomen) ramp, dS Breast coil, head/arm support. Right: Patient positioned on the coil prone feet-first with head set.

NOTICE

A dedicated nurse call is delivered with the breast coils.

Feet-first breast examinations require a nurse call with a longer cable than usual.

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Workflow: Coil positioning

- ► Place the arm support on the tabletop.
- ► Position the head support on top of this mattress.
- ► Place the breast coil on the tabletop adjacent to the arm support.
- ► Put the breast coil cover pad on the coil.
- ► Plug the coil cable in the socket of the dStream interface.
- ► Place the ramp and the ramp extension on the tabletop adjacent to the coil.

  Make sure that the ramp and the ramp extension are fixed together by means of the velcro tape.

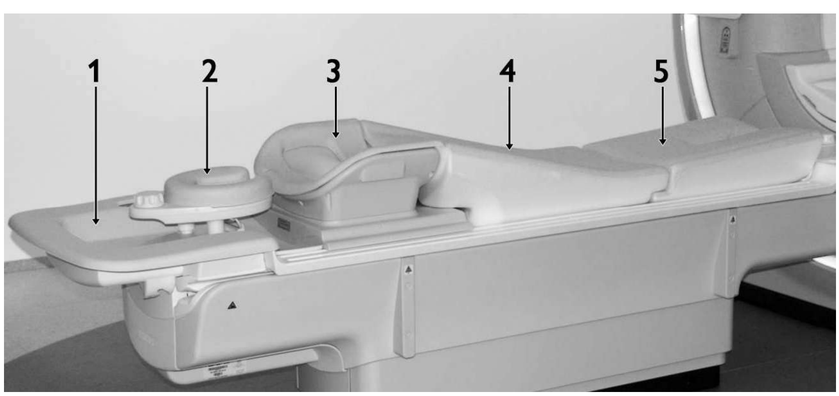

Fig. 135: 1 - Arm support. 2 - Head support. 3 -dS Breast 16ch coil with cover pad. 4 - Ramp. 5 - Ramp extension.

NOTICE

Note that without a patient lying on it, the ramp is higher than the coil. However with a patient on the coil, the ramp will be squeezed down to the same height.

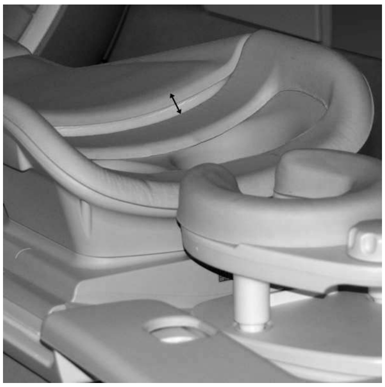

Fig. 136: The image shows the difference in height between ramp and coil when no patient is positioned.

Workflow: Patient positioning

- Prepare the patient as usual for an MR examination.

  It is advisable to have the patient strip to the waist and to remove any zip fasteners in the waist area.
- Prepare the tabletop as shown above.
- Position the patient prone on the breast coil, with the head on the head support.
- Adjust the height of the head support.
- Ask the patient to place the arms either next to her head on the arm support or alongside her body.
- Ensure that the breasts are hanging freely in the coil, and that the breasts and the axilla area are free of folds.
- Center the light visor to the middle of the breast, and move the patient into the isocenter.

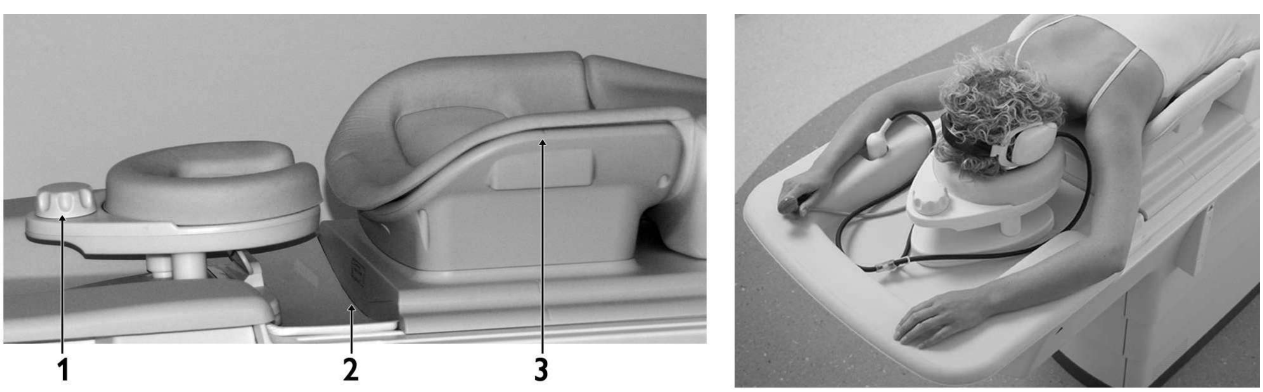

Fig. 137: Left: 1 - Knob to adjust the height of the head support. 2 - dS Breast 16ch coil is placed adjacent to the arm support. 3 - Marker for isocenter positioning on the coil. Right: Patient positioned on the coil prone feet-first with head set.

Breast Immobilization with dS Breast 7ch

Breast immobilization can be used to reduce motion artifacts. Additional advantage of immobilizing the breast in cranial-caudal direction is the reduction of the breast volume and the number of slices required to cover the breast tissue in scanning procedures. This helps in reducing the scan time.

In the delivery of the dS Breast 7ch coil solution, different immobilization kits are included for diagnostic and/or interventional purposes. This section describes each kit with its components, its purpose and a workflow description.

Bilateral CC Immobilization kit

The Bilateral CC Immobilization kit is provided with the dS Breast 7ch coil solution for diagnostic imaging only. It consists of a base plate and two cranio-caudal compression plates. The compression plates are to be mounted on the base plate. The complete setup is to be inserted into the coil and locked in place.

Workflow

- ► Place the compression plates close to each other before inserting the base plate into the coil.
- ► Insert the base plate into the coil.
- ► Lock the base plate lockers.
- ► Position the patient as usual.
- ► Adjust the compression plates and lock the position of the compression plates.

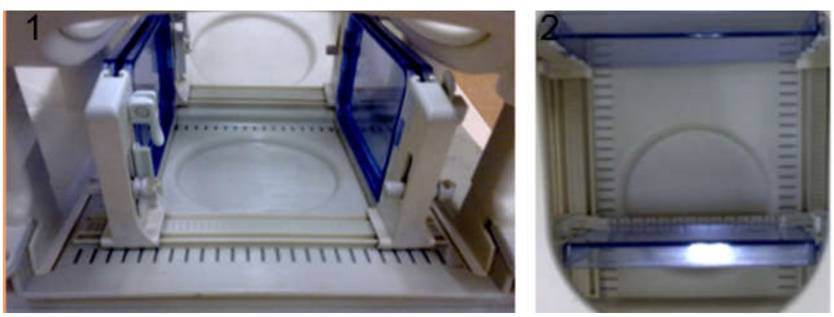

Fig. 138: Left: Base plate and cranio-caudal compression plates. Right: complete setup placed in the coil with the base plate lockers (b) and the compression plate lockers (c).

Bilateral M-L Immobilization kit

The Bilateral M-L Immobilization kit is provided with the dS Breast 7ch coil solution for diagnostic imaging and for lateral and/or medial breast biopsy. It is compatible with both, the grid and the pillar method.

It consists of a base plate and two medio-lateral compression plates. The compression plates are to be mounted on the base plate. The complete setup is to be inserted into the coil and locked in place.

Workflow

- ► Insert the base plate into the coil.

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- Lock the base plate lockers.
- Slide the medial plate in.
- Position the patient as usual.
- Slide the lateral plate in.
- Adjust the compression plates and lock the position of the compression plates.

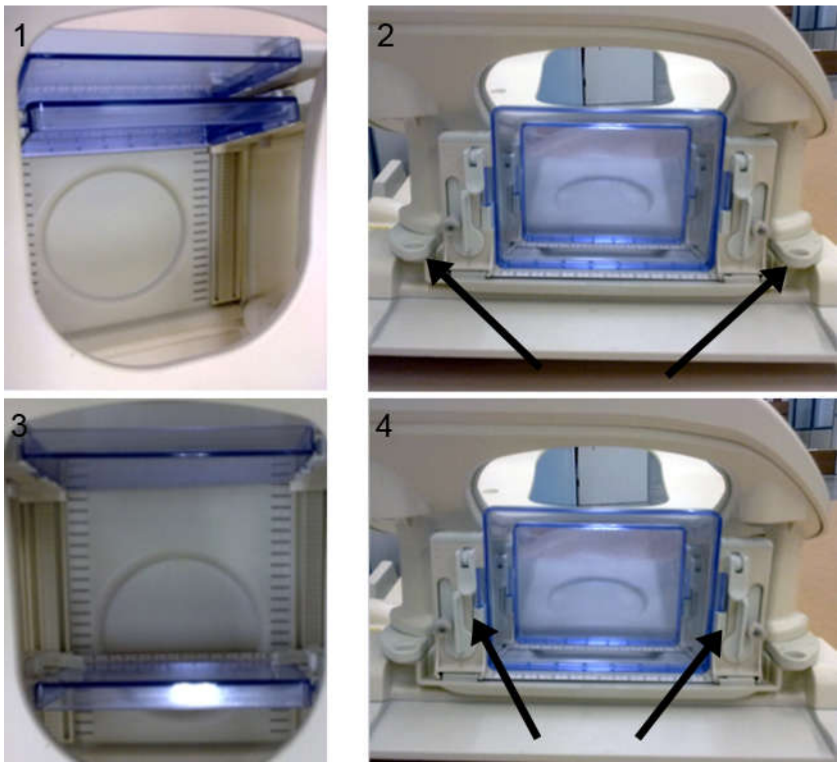

Fig. 139: 1: Compression plates on base plate, inserted into coil. 2: The arrows indicate the base plate lockers. 3: Compression plates adjusted. 4: The arrows indicate the compression plate lockers.

Unilateral CC Immobilization kit

The Unilateral CC Immobilization kit is provided with the dS Breast 7ch coil solution for cranial interventional purposes only. It is compatible with both, the grid and the pillar method.

It consists of a base plate and two cranio-caudal compression plates. The compression plates are to be mounted on the base plate. The complete setup is to be inserted into the coil and locked in place.

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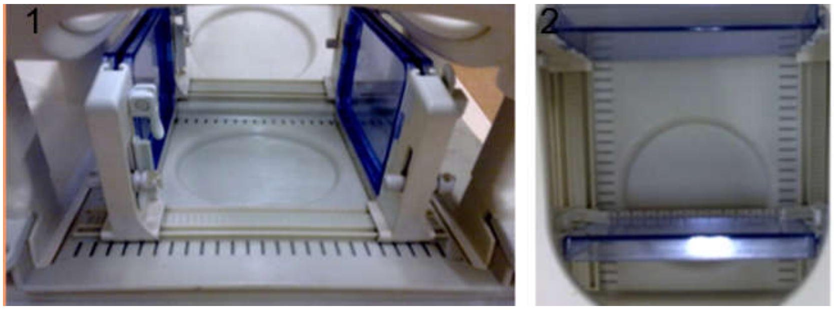

Fig. 140: Left: Base plate and cranio-caudal compression plates. Right: Base plate and medio-lateral compression plates.

Use of the cranio-caudal compression plates

- Place the compression plates close to each other before inserting the base plate into the coil.
- Insert the base plate into the coil.
- Lock the base plate lockers.
- Position the patient as usual.
- Adjust the compression plates and lock the position of the compression plates.

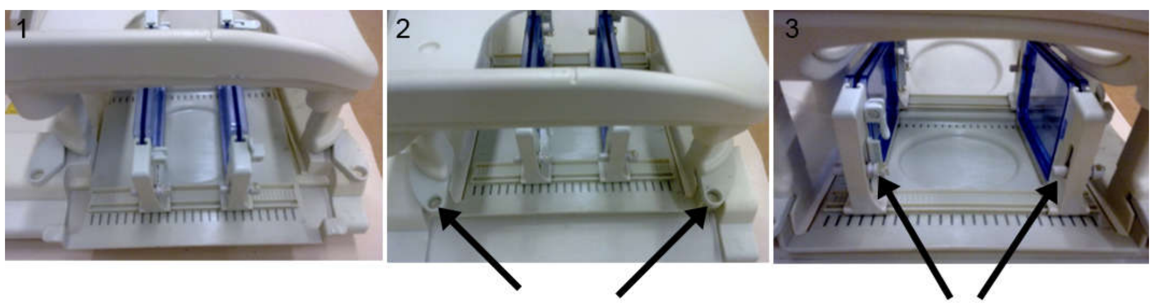

Fig. 141: 1: Compression plates on base plate, inserted into coil. 2: The arrows indicate the base plate lockers. 3: The arrows indicate the compression plate lockers.

Breast Biopsy with dS Breast 7ch

Breast Biopsy Components

The coil can be used for biopsy in combination with the corresponding biopsy kit. For information about content and assembly of the biopsy kit, please refer to the user documentation provided with the biopsy kit.

Breast Biopsy Methods

Immobilization is required when localization or biopsy procedures are intended. Unilateral or bilateral breast immobilization can be performed.

There are two different biopsy methods:

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- Grid method (lateral or medial access)
- Pillar method (lateral or medial access)

Both methods can be performed either with lateral or medial access.

Fig. 142: Left: Grid method. Right: Pillar method.

Breast Biopsy Device Preparation

For information about content and assembly of the biopsy kit, please refer to the user documentation provided with the biopsy kit.

Breast Biopsy Workflow

Make sure that you are familiar with the set up and function of the biopsy device prior to use with a patient.

Preparation

1. Prepare the patient as usual for an MR examination.
    - It is advisable to have the patient strip to the waist and to remove any zip fasteners in the waist area.
    - Imaging is best performed when the breasts can hang freely in the coil aperture.
2. Prepare the tabletop in the same way as for Breast imaging.

Patient Positioning

1. Position the patient prone on the breast coil, with the head on the head support. Adjust the height of the head support by means of the lever.
2. Place the medial plate in all the way prior to patient positioning. Wait until the patient is lying down to place lateral rail.
3. Ask the patient to place the arms either next to her head or alongside her body.
4. Ensure that the breasts are hanging freely in the coil, and that the breasts and the axillae area are free of folds.
5. Use compression from both medial and lateral sides.

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- Tissue should be slightly pushing through the immobilization system. Do not over-compress since this will constrict arteries.

6. Place a vitamin E capsule (serves as marker) onto the immobilization system, away from suspected lesion location.
7. Center the light visor to the middle of the breast, and move the patient into the isocenter.

Determine needle entry point - Imaging Protocol and Calculation

The determination of the needle entry point requires the acquisition of a number of imaging series. The calculation based on these series can be performed with a DynaCAD system or manually.

1. Acquire a survey scan.
2. Make sure the marker (vitamin E capsule) is included in the FOV.
3. Perform a dynamic e-THRIVE protocol, containing 3 dynamics.
   - The first dynamic serves as a mask.
   - Proceed as usual with regular dynamic breast imaging.

Calculation of FH- and AP-offset and needle depth

1. If a DynaCAD system is available, the needle entry point (relative to the position of the marker) and needle depth needed to target the lesion are calculated automatically.
2. If a DynaCAD system is not available, then manual targeting has to be performed in the following way:

1. Find the lesion on the dynamic e-THRIVE sequence. Draw a region-of-interest (ROI) over the lesion. Copy the ROI to all slices. Note the slice number of the slice containing the lesion.
2. Find the marker (vitamin E capsule). Draw a region-of-interest (ROI) over the marker. Note the slice number of the slice containing the marker.
3. The FH offset is given by the number of slices between the marker and the lesion multiplied by the slice thickness.
4. Draw straight lines between the ROI of the marker and the ROI of the lesion. There should be a 90 degree angle between both lines.
5. The vertical line length specifies the needle entry point relative to the marker in AP direction.
6. The horizontal line length specifies the required needle depth.

Performing Breast Biopsy

1. Place the needle block in the grid.
2. Place the needle block holder in an adjacent grid slot.
3. Lock the needle block holder by depressing the tab. This will prevent the needle block from coming out when the needle is withdrawn.
4. Insert the needle to the required depth and rescan at this location to verify the proper needle placement.

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5. Once verified, obtain lesion sample.

Positioning with the dS Breast Adaptive 16ch coil

The dS Breast Adaptive 16ch coil provides means for breast immobilization. Immobilization can useful for diagnostic procedures, for localization and/or for biopsy procedures.

The breast examination is to be performed prone in feet-first position:

Fig. 143: Prone feet-first positioning with the dS Breast Adaptive 16 ch coil solution.

NOTICE

A dedicated nurse call is delivered with the breast coils.

Feet-first breast examinations require a nurse call with a longer cable than usual.

Workflow: Coil Setup for Diagnostic Purposes

- Place the arm support pad on the tabletop at the handgrip side of the tabletop. Be sure connector openings are accessible.
- Place the coil base on the tabletop directly next to the arm support pad.

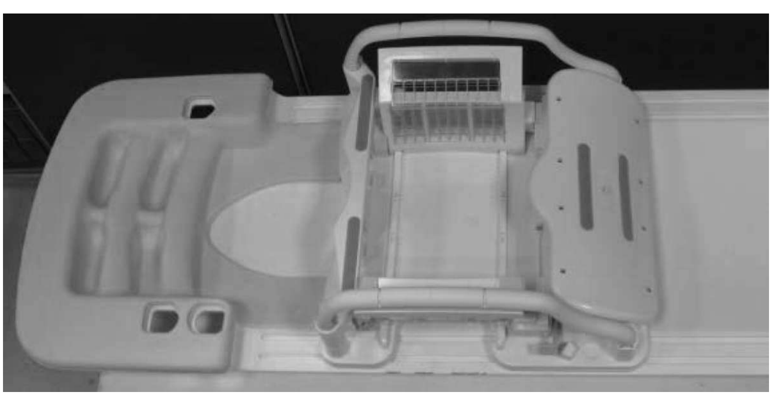

Fig. 144: Arm support pad and coil base on tabletop.

- Connect the coil to the FlexConnect socket at the handgrip side of the tabletop.
- Place the head support with the head support pads in the cut-out of the arm support pad.

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Fig. 145: Head support in the cut-out and coil base connected to FlexConnect socket.

- ► Slide the medial diagnostic plate along rails to the center of the coil.
  For diagnostic exams, ensure the medial diagnostic plate is in the unlocked position and insert onto the coil base.

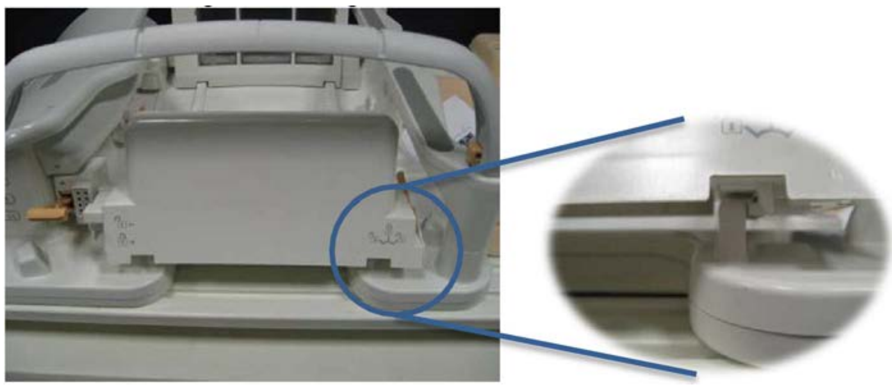

Fig. 146: Sliding the medial diagnostic plage.

- ► Center the plate on the coil base so the edges of the plate align with the alignment marks.
- ► Secure the plug connection between the plate and the carriage. Verify that a positive connection is made by checking the status indicator lights.

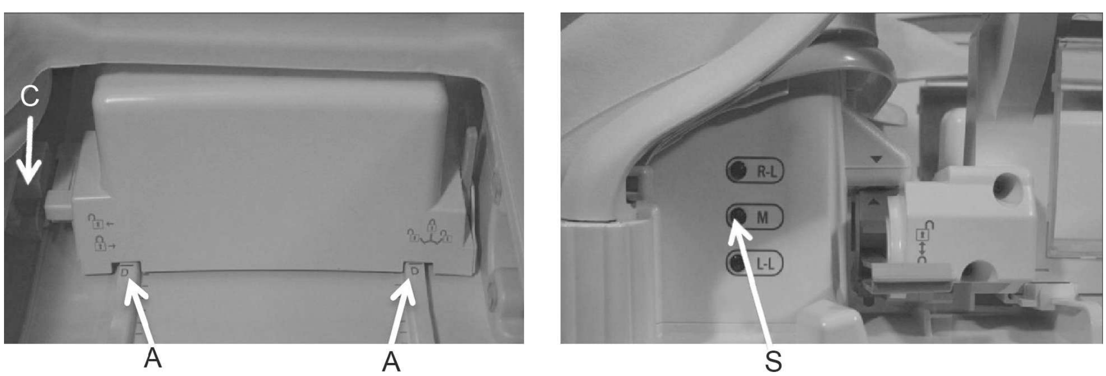

Fig. 147: Left: Centered plate aligned with the alignment marks (A). C indicates the connection that needs to click into a locked positioning. Right: The arrow indicates the status indicator lights (S).

- ► Attach the patient pad to the coil base utilizing velcro attach points. Lock the medial diagnostic plate.

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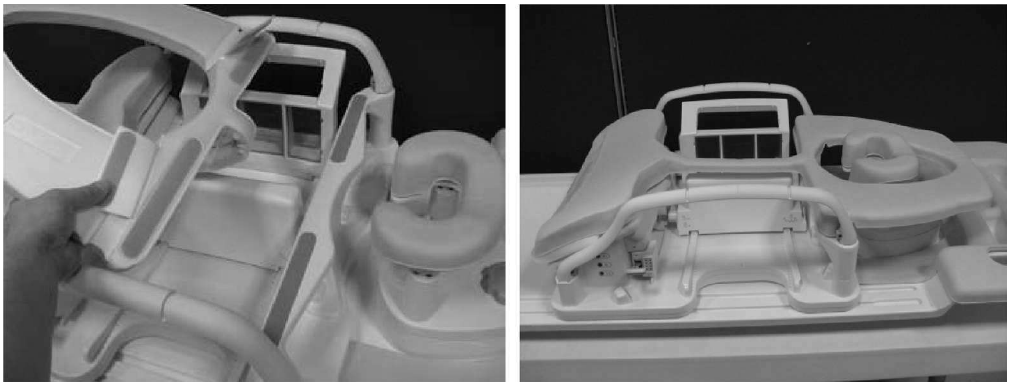

Fig. 148: Attaching patient pad to coil base.

- Place the ramp pad on the tabletop against the coil and attach it to the patient pad using velcro attach point.

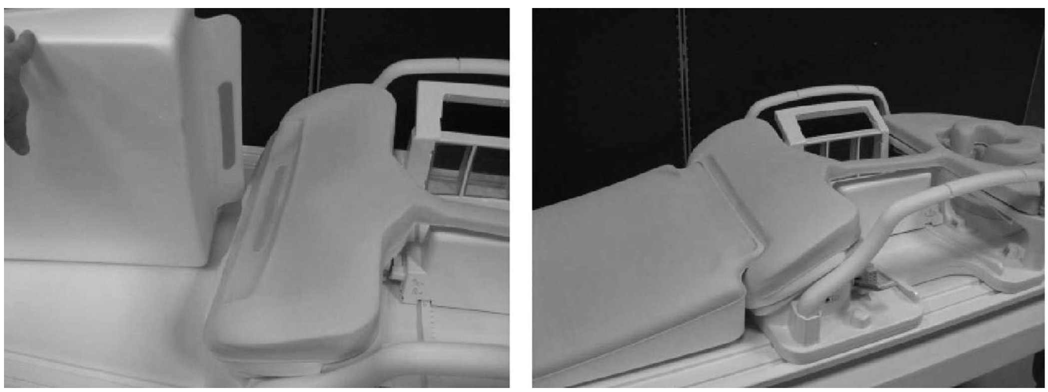

Fig. 149: Placing ramp pad.

- Attach the patient top sling pad to the handrails utilizing clips to secure.

Fig. 150: Patient top sling pad attached to handrails. The rails have 3 line markings, and the sling pad clips are centered so you can see each of the markings in between the clips.

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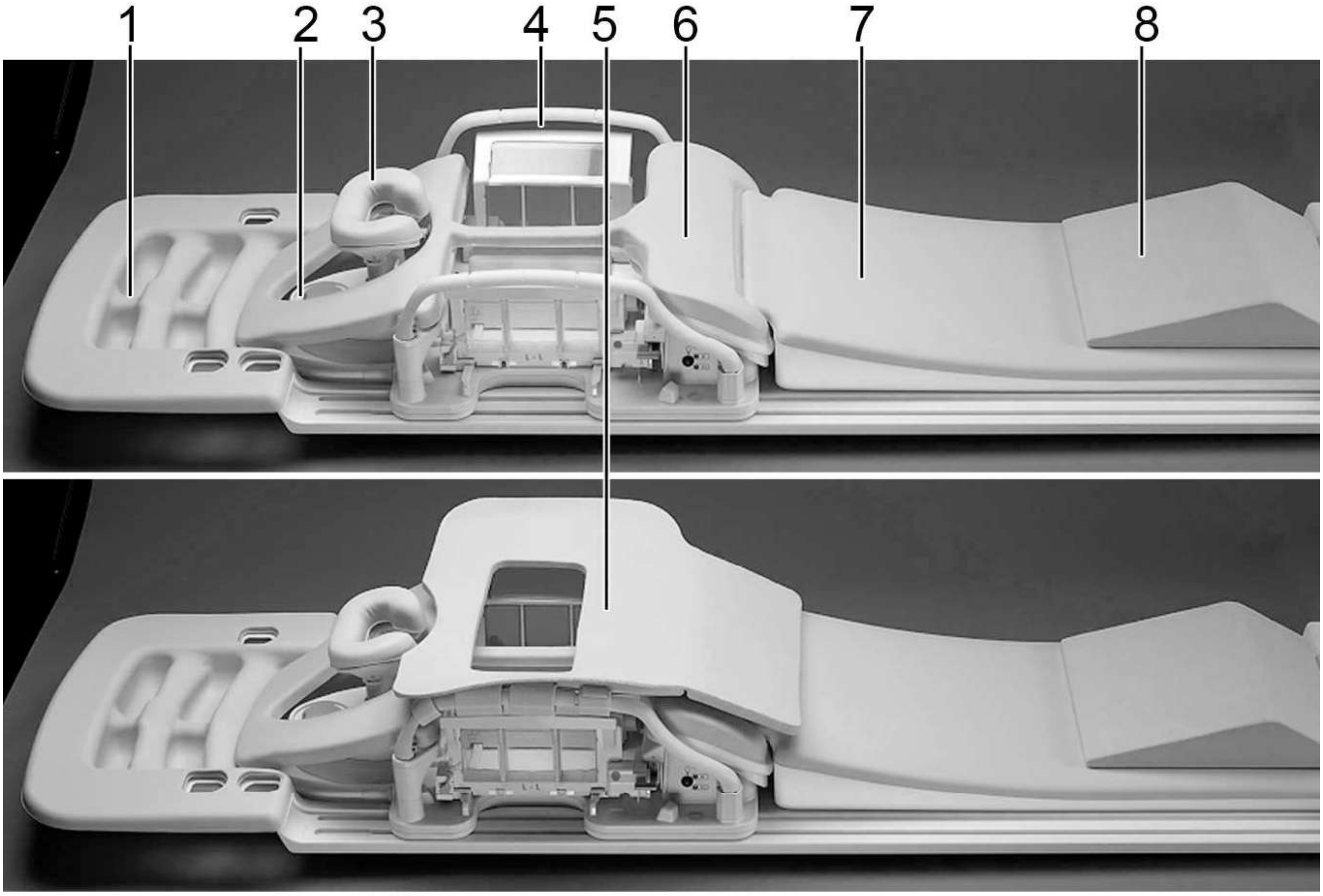

Fig. 151: This figure shows the complete set up of coil and pads for an examination (except for the coil cable), where: 1 - arm support pad, 2 - head support spacer, 3 - head support with head support pad, 4 - coil base, 5 - patient top sling pad, 6 - patient pad, 7 - ramp pad, 8 ankle bolster.

Workflow: Patient positioning

- Prepare the patient as usual for an MR examination.

  It is advisable to have the patient strip to the waist and to remove any zip fasteners in the waist area.
- Prepare the tabletop as shown above.
- Load the patient on top of the coil utilizing handrails.
- Instruct the patient to grasp arm support pad hand grip features avoiding the cable.

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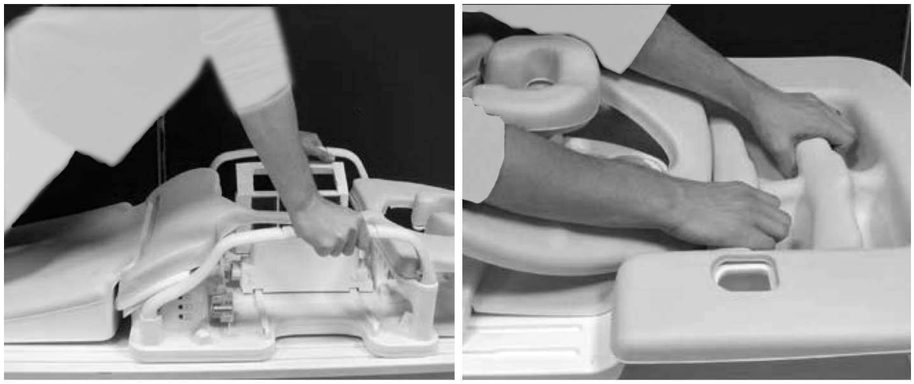

Fig. 152: Patient on tabletop. Left: patient utilizing handrails. Right: grasping arm support pad hand grip features.

- Ensure that the breasts are hanging freely in the coil, and that the breasts and the axilla area are free of folds.
  This can be achieved when the base of the breast is at the edge of the pad, and any belly is up on the patient top sling pad, to keep it out of the hole.
- Place the ankle bolster under the patient's ankles.
- Adjust the height of the head support as needed.
  You can remove the pad under the headrest if the headrest is too tall. Optionally an angled sponge can be used on the headrest to relieve occasional pressure on the cheeks.

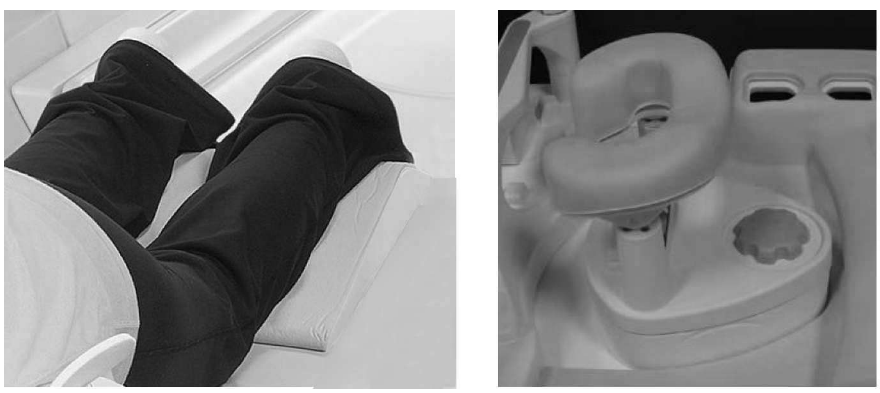

Fig. 153: Left: Ankle bolster under the patient's ankles. Right: Head support.

- Center the light visor to the middle of the breast, and move the patient into the isocenter.

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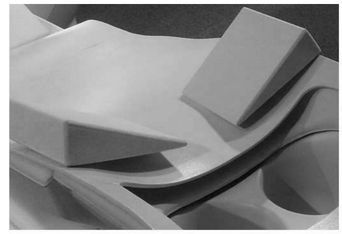

Fig. 154: Left: Patient positioning prone feet-first, still without headset and nurse call. Right: Additionally you can use the wedges 15° under the lateral ribs.

Workflow: Lateral Setup

- Confirm lateral axilla supports are installed in each lateral plate.

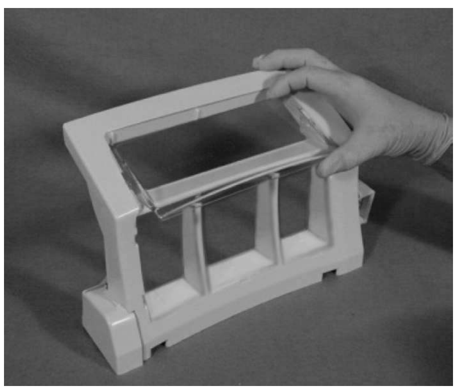

Fig. 155: Installing lateral axilla supports.

- Ensure the lateral frame assembly has its lever in the unlock position and attach onto the coil base. Secure the plug connection between the frame and the carriage (1). The connector carriage must be positioned at the lateral most extent in order to secure the frame connection. Verify that a positive connection is made by checking the status indicator light. Position the breast tissue so that the nipple is facing downward and centered within the aperture opening. Slide the lateral frame to immobilize tissue. Once positioned, lock the frames by rotating lever (2). Verify electronic connection via indicator lights.

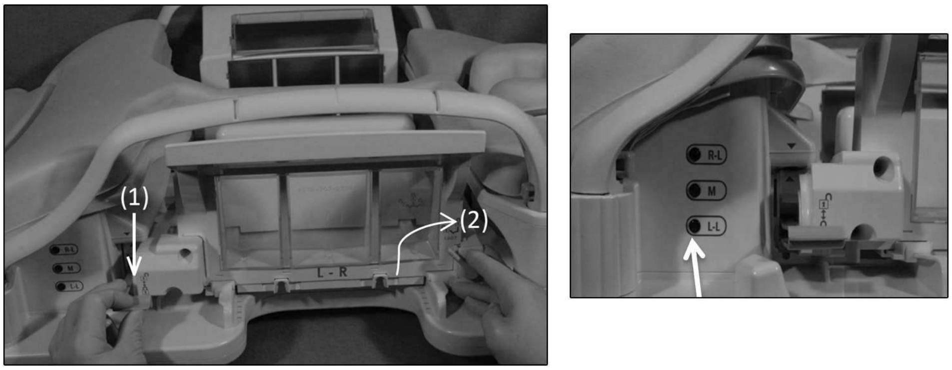

Fig. 156: Left: Lateral frame assembly attached to coil base with: 1 - carriage, 2 - rotating lever. Right: The arrow indicates the status indicator lights where the abbreviations stand for: R-L = right lateral, M = medial, L-L = left lateral.

- ► Adjust patient tissue as needed through access areas in lateral plates.
- ► Install lateral solid immobilization plates in each lateral plate

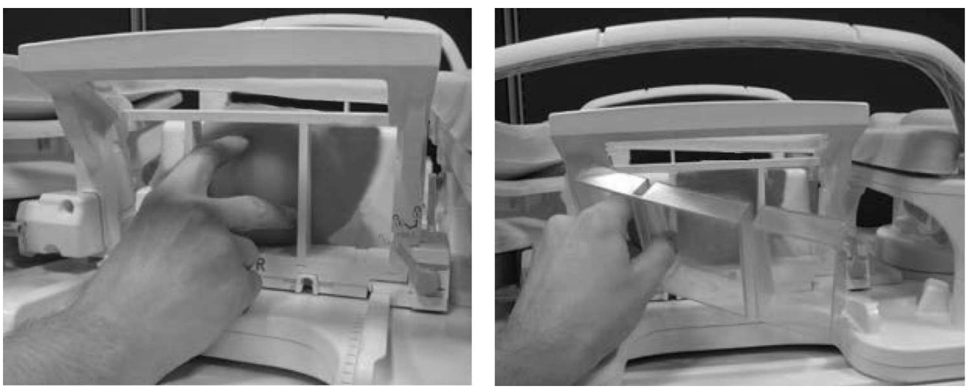

Fig. 157: Left: adjusting patient tissue. Right: Installing lateral solid immobilization plates.

- ► Center the light visor to the middle of the breast, and move the patient into the isocenter.

Workflow: Accessory Setup of the Grid Localization System

- ► (Optional) For maximum immobilization use the medial saddle and additional medial clip-on spacer(s).

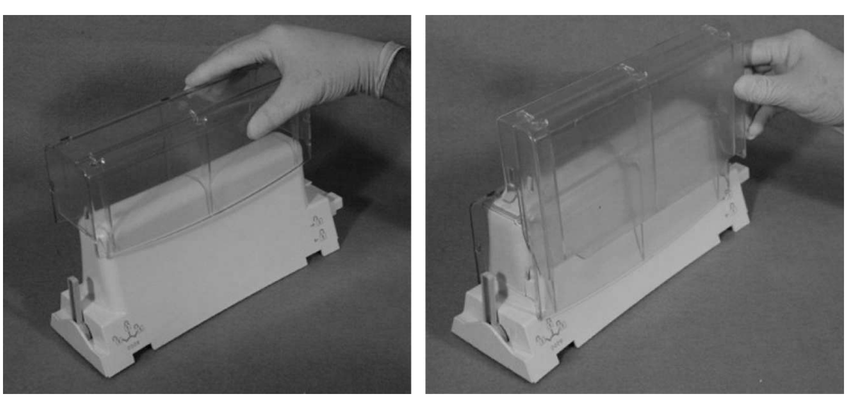

Fig. 158: Use of medial saddle and additional medial clip-on spacer.

► Insert the grid plate into the lateral frame assembly. Attach two (2) sealed fiducial assemblies to the bottom of the lateral frame assembly.

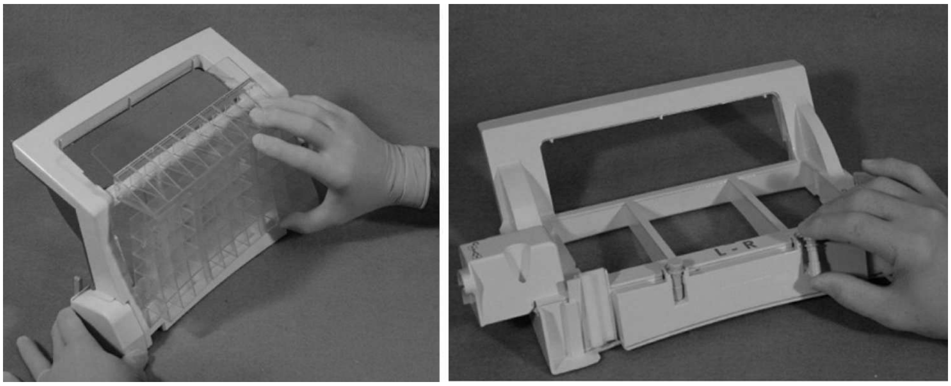

Fig. 159: Left: Inserting grid plate. Right: Attaching two sealed fiducial assemblies.

Workflow: Lateral Accessory Setup of the Grid Localization System

► Insert the lateral solid plate and the axilla solid plate in the lateral frame assembly. Note that the solid plate in the lateral side is only needed with a medial-only biopsy.

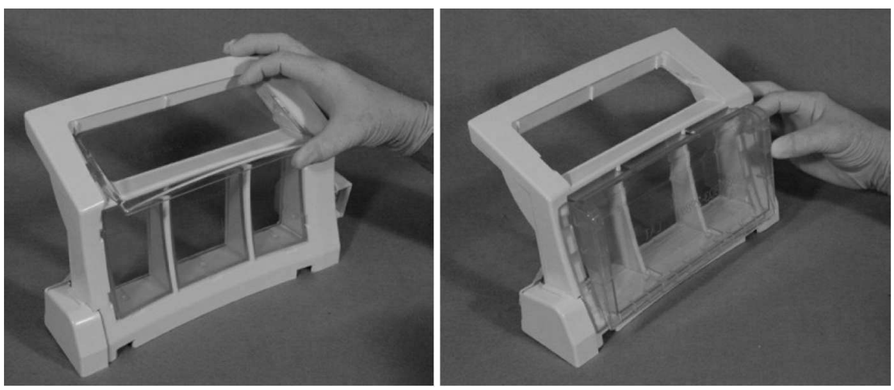

Fig. 160: Lateral frame assembly: Left: Inserting lateral solid plate. Right: Inserting axilla solid plate.

► (Optional) For maximum immobilization use the lateral spacer plate.

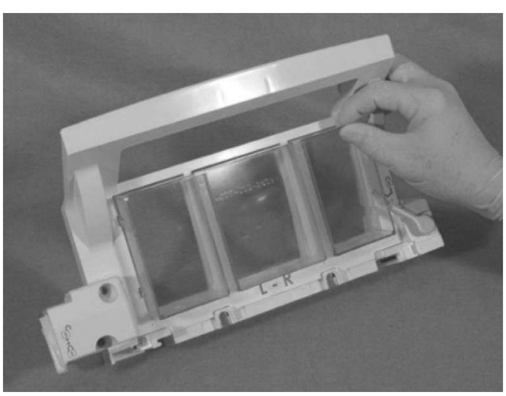

Fig. 161: Using the lateral spacer plate.

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Workflow: Medial Biopsy Setup of the Grid Localization System

- Attach two (2) sealed fiducial assemblies to the bottom of the medial biopsy frame.

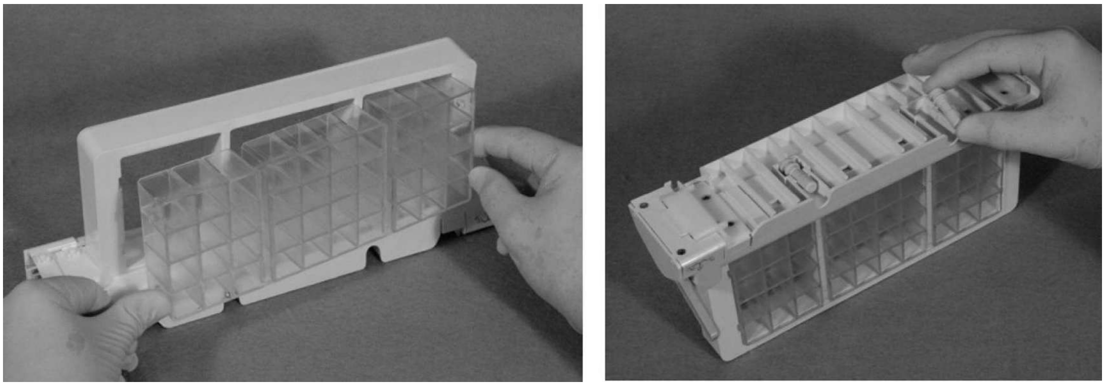

Fig. 162: Left: Inserting the medial grid plate. Right: Attaching 2 sealed fiducial assemblies to the bottom of the medial biopsy frame.

- Place the breast blocker over the contra-lateral aperture blocking off the opening.

Fig. 163: Breast blocker placed over the contra-lateral aperture.

- Slide the medial and lateral frames to immobilize tissue. When the breast tissue is sufficiently immobilized, lock the levers to secure each frame. Work from the unaffected side, reaching under the breast blocker plate to the affected side of the medial biopsy grid plate.
- Remove the medial diagnostic plate from the coil base and replace it with the assembled medial biopsy frame and grid. If doing a medial biopsy, fiducials need to be in the slots. Secure the plug connection between the medial biopsy frame and the carriage connection. Verify that a positive connection is made by checking the status indicator light.

Fig. 164: Left: Medial biopsy frame and grid in place. Right: The arrow indicates the status indicator lights.

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► Insert the medial grid plate into the medial biopsy frame assembly. Align arrows with grid plate and frame.

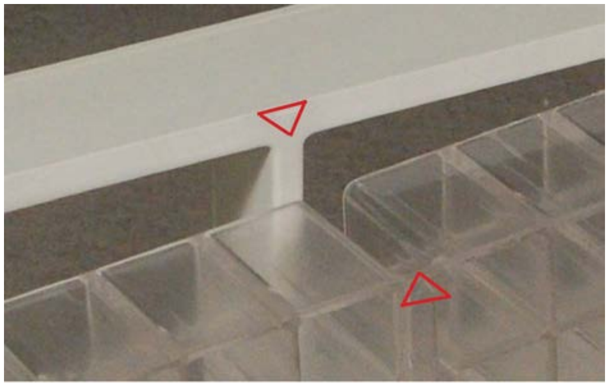

Fig. 165: Align arrows on medial grid plate and medial biopsy frame assembly when inserting the medial grid plate.

NOTICE

Grid can only be inserted from one side with arrows facing up.

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Breast Biopsy with dS Breast Adaptive 16ch

Breast Biopsy Components

The coil can be used for biopsy in combination with the corresponding biopsy kit. For information about content and assembly of the biopsy kit, please refer to the user documentation provided with the biopsy kit.

Breast Biopsy Device Preparation

For information about content and assembly of the biopsy kit, please refer to the user documentation provided with the biopsy kit.

Breast Biopsy Workflow

Make sure that you are familiar with the set up and function of the biopsy device prior to use with a patient.

Preparation

1. Prepare the patient as usual for an MR examination.
   - It is advisable to have the patient strip to the waist and to remove any zip fasteners in the waist area.
   - Imaging is best performed when the breasts can hang freely in the coil aperture.
2. Prepare the tabletop in the same way as for Breast imaging.

Patient Positioning

1. Position the patient prone on the breast coil, with the head on the head support. Adjust the height of the head support by means of the lever.
2. Place the medial plate in all the way prior to patient positioning. Wait until the patient is lying down to place lateral rail.
3. Ask the patient to place the arms either next to her head or alongside her body.
4. Ensure that the breasts are hanging freely in the coil, and that the breasts and the axillae area are free of folds.
5. Use compression from both medial and lateral sides.
   - Tissue should be slightly pushing through the immobilization system. Do not over-compress since this will constrict arteries.
6. Place a vitamin E capsule (serves as marker) onto the immobilization system, away from suspected lesion location.
7. Center the light visor to the middle of the breast, and move the patient into the isocenter.

Determine needle entry point - Imaging Protocol and Calculation

The determination of the needle entry point requires the acquisition of a number of imaging series. The calculation based on these series can be performed with a DynaCAD system or manually.

1. Acquire a survey scan.
2. Make sure the marker (vitamin E capsule) is included in the FOV.
3. Perform a dynamic e-THRIVE protocol, containing 3 dynamics.
   - The first dynamic serves as a mask.
   - Proceed as usual with regular dynamic breast imaging.

Calculation of FH- and AP-offset and needle depth

1. If a DynaCAD system is available, the needle entry point (relative to the position of the marker) and needle depth needed to target the lesion are calculated automatically.
2. If a DynaCAD system is not available, then manual targeting has to be performed in the following way:

1. Find the lesion on the dynamic e-THRIVE sequence. Draw a region-of-interest (ROI) over the lesion. Copy the ROI to all slices. Note the slice number of the slice containing the lesion.
2. Find the marker (vitamin E capsule). Draw a region-of-interest (ROI) over the marker. Note the slice number of the slice containing the marker.
3. The FH offset is given by the number of slices between the marker and the lesion multiplied by the slice thickness.
4. Draw straight lines between the ROI of the marker and the ROI of the lesion. There should be a 90 degree angle between both lines.
5. The vertical line length specifies the needle entry point relative to the marker in AP direction.

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6. The horizontal line length specifies the required needle depth.

Performing Breast Biopsy

1. Place the needle block in the grid.
2. Place the needle block holder in an adjacent grid slot.
3. Lock the needle block holder by depressing the tab. This will prevent the needle block from coming out when the needle is withdrawn.
4. Insert the needle to the required depth and rescan at this location to verify the proper needle placement.
5. Once verified, obtain lesion sample.

Positioning with the dS Flex Breast coil solution

Use the Breast mattress in conjunction with the dS Flex-L coil solution and the Posterior coil to provide high quality SENSE imaging of the breasts.

The dS Flex L-coils fit precisely into the mattress.

The mattress comprises of two parts: a solid foam base and a flexible cover which fits onto the top side of the base.

The base of the mattress has recesses on the top into which the elements of the Flex-L coil fit. Along either side of the top of the base are grooves into which the cables of the coil should be placed. This gives the required separation between the patient's skin and the cables ensuring both safety and comfort.

The flexible cover is designed to fit on the top of the base and cover the coil and cable. Both the base and cover are designed for ease of cleaning.

- ► Place the dStream interface on the tabletop and connect it to the socket at magnet side.
- ► Place the foam base of the breast mattress on the tabletop.
- ► Place the dS Flex L coils into the recesses and the cables into the grooves.
- ► Place a short mattress above the cables on the tabletop.
- ► Place the cover of the breast mattress on the foam base with the coils.
- ► Place the head support in front of the breast mattress at magnet side.

Fig. 166: 1: Breast mattress: solid foam base on tabletop. 2: with coils in recesses, 3: with mattress above the cables, 4: with cover on top.

- Prepare the patient as usual for an MR examination.

  It is advisable to have the patient strip to the waist and to remove any zip fasteners in the waist area.
- Position the patient head-first prone on the breast coil, with the head on the head support.
- Ask the patient to place the arms either next to her head or alongside her body.
- Ensure that the breasts are hanging freely in the coil, and that the breasts and the axilla area are free of folds.
- Center the light visor to the middle of the breast, and move the patient into the isocenter.

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Fig. 167: Patient positioned with the dS Flex Breast coil solution.

Positioning for Shoulder Examinations

Shoulder examinations can be performed with the following coil solutions:

Coil Solution	Application
dS Shoulder 16ch	optimally suited for high resolution and routine imaging
dS Shoulder 8ch	routine imaging
dS Flex coil solutions	routine imaging

Positioning with the dS Shoulder 16ch coil

The shoulder examination with the dS Shoulder 16ch coil is to be performed with the patient supine Head-First.

Preparing the tabletop for a shoulder examination with the dS Shoulder 16ch coil

- ▹ The dStream interface is on the tabletop and plugged into the FlexConnect socket.
- ► For the first use of the coil: attach the anterior and posterior coil pad to the coil using the attached velcro tabs.

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► Place the coil at the head end of the tabletop leaving room for a pillow.

► Secure the coil:

- Verify that the feet on the bottom of the coil are aligned with the groove on the table. This helps to immobilize the coil.

- Turn the lateral stabilizing legs of the coils up so that the coil is laying in the tabletop groove.

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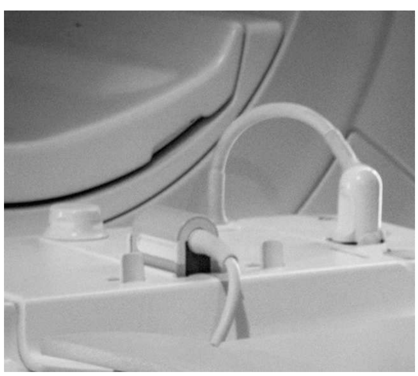
- Turn the medial stabilizing legs of the coils down to level the coil to the curved tabletop.

► Connect the coil to the dStream socket on the dStream interface.



► Place a pillow on the tabletop such that it does not lie on the dStream interface.

► Place the dedicated table mattresses on the tabletop, with their track on the bottom side in the table groove to keep the mattresses in place.

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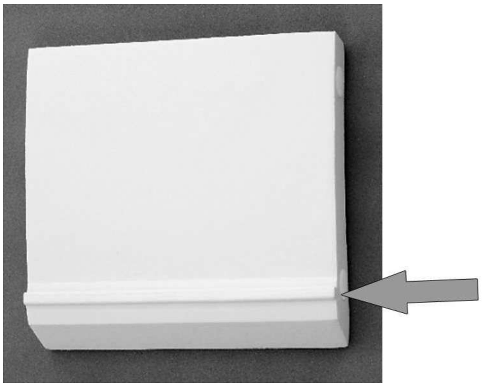
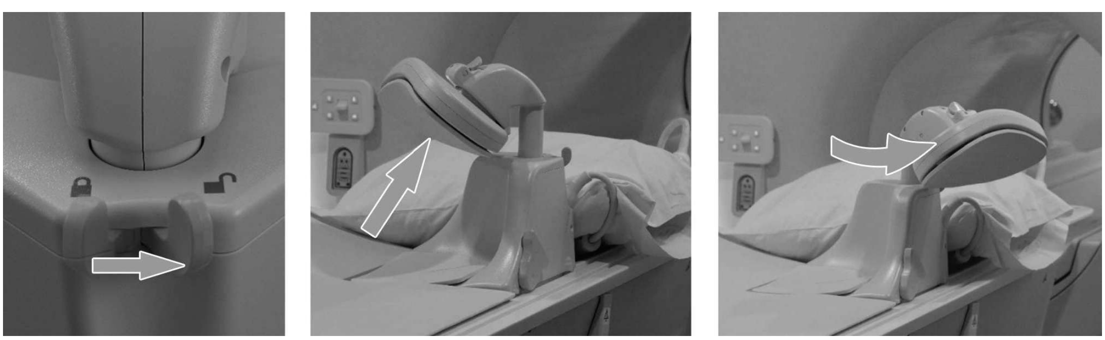


- the small one beside the coil
- the large one below the coil to cover the tabletop

► To move and rotate the anterior coil to the side, unlock the Anterior Height Lock. Lift the anterior coil up to the maximum height and rotate it laterally.



Patient positioning for a shoulder examination with the dS Shoulder 16ch coil

1. Lay the patient on the coil and move them up and lateral so that their shoulder fits comfortably against the posterior coil.

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2. Rotate the anterior coil over the patient. Lower it until it touches the patient's shoulder.

3. To align the anterior coil with the anatomy, unlock the Anterior Tilt Lock. Adjust the angle of the anterior coil so that the apex of the coil touches the edge of the shoulder and the base of the coil is just above the chest. The angle can vary greatly depending on patient shape and size.

   Verify that the anterior coil is parallel to the patient's chest. Adjust the anterior coil till this is the case.

4. Lock both locks.

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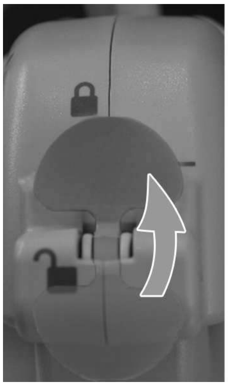
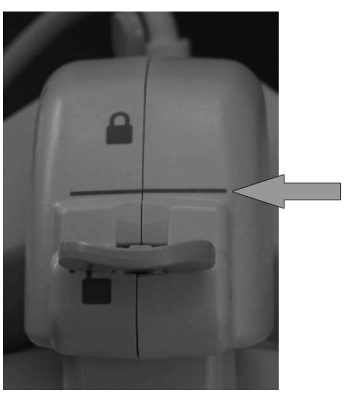



5. Place the knee cushion under the patient's knees and a sandbag under their arm for comfort.

6. Establish a landmark using the reference mark on top of the coil.



7. When the examination is completed, release the Anterior Tilt and Anterior Height Lock. Lift the anterior coil to the maximum height and rotate it laterally before sitting the patient up.

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Positioning with the dS Shoulder 8ch coil

Shoulder examinations make use of the dS Shoulder 8ch coil solution.

The shoulder examination is to be performed in Head-First position.

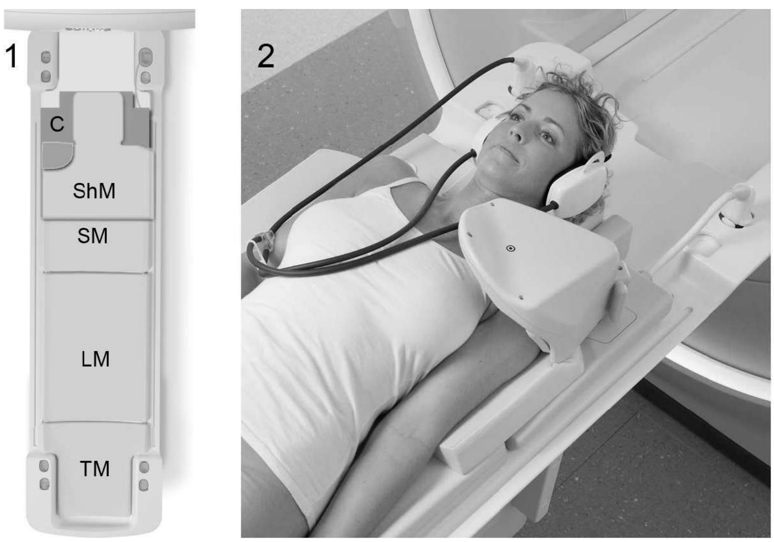

Fig. 168: Positioning with the dS Shoulder 8ch coil solution.

1	Schematic set up of a shoulder examination: the coil (C), the Shoulder mattress (ShM), two short mattresses (SM) on top of each other, two long mattresses (LM) on top of each other and the T-shape mattress (TM)
2	Patient on tabletop positioned in dS Shoulder 8ch coil.

NOTICE

Place the dS Shoulder 8ch coil as close as possible to the outermost end of the tabletop.

Use the dedicated shoulder mattress and two long mattresses with this coil.

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NOTICE

Use the dedicated head support and the wedge 15° to support the head. Do not cover the coil with a pillow.

Workflow

1. Prepare the tabletop as shown above.
2. Connect the dS Shoulder 8ch coil to the FlexConnect socket.
3. Place the posterior pad on the base plate for best image quality and patient comfort.

Fig. 169: Connected Shoulder coil on tabletop (the shown posterior pad may differ from your actual one).

4. Position the patient supine on the tabletop with his/her head on the head support of the Shoulder coil.
5. Open the connector on the base plate.
6. Make sure that the cup-shaped anterior pad is securely attached to the anterior coil.
7. Insert the anterior coil part into the connector. There is a groove in the coil's pillar and the connector which allows inserting in only one way.
   Do not use the handles on the coil pillar during insertion.
8. Assure that the coil locks in place with an audible click.

Fig. 170: 1: Opening connector on base plate. 2 and 3: Inserting the anterior coil part into connector.

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9. Press the handles at the anterior coil's pillar and adjust the height and the angulation of the anterior coil part.
    - Make sure that shoulder tissue is not extruded from between the anterior coil and the base plate.
    - Align the lateral portion of the anterior coil with the base plate.

Fig. 171: 1: Set-up of a right shoulder examination. 2: Set-up of a left shoulder examination. 3: Adjusting the height of the anterior coil part.

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NOTICE

To achieve optimal image quality, the lateral edge of the anterior coil part should be parallel to the lateral edge of the base plate.

10. Use the knee cushion to increase patient comfort.
11. Prevent contact between the patient and the bore wall at the contra-lateral side.
12. Move the patient into the isocenter and perform the MR examination.
13. After the examination gently pull the anterior coil part out of the base plate.

Fig. 172: Patient positioned ready for the examination. Left: complete setup. Right: The lateral portion of the anterior coil is aligned with the base plate.

Positioning for Hand and Wrist Examinations

Hand and wrist examinations can be performed with the following coil solutions:

Coil Solution	Application	Examination	Patient orientation/position
dS HandWrist 16ch	optimally suited for high resolution and routine imaging	**With the hand at the side**	feet-first supine
		Overhead positioning (superman)	head-first prone
dS Wrist 8ch	routine imaging	**With the hand at the side**	feet-first supine
		Overhead positioning (superman)	head-first prone

Alternatively you can use the dS SmallExtremity 16ch coil, the dS SmallExtremity 8ch coil and the dS Flex coil solutions.

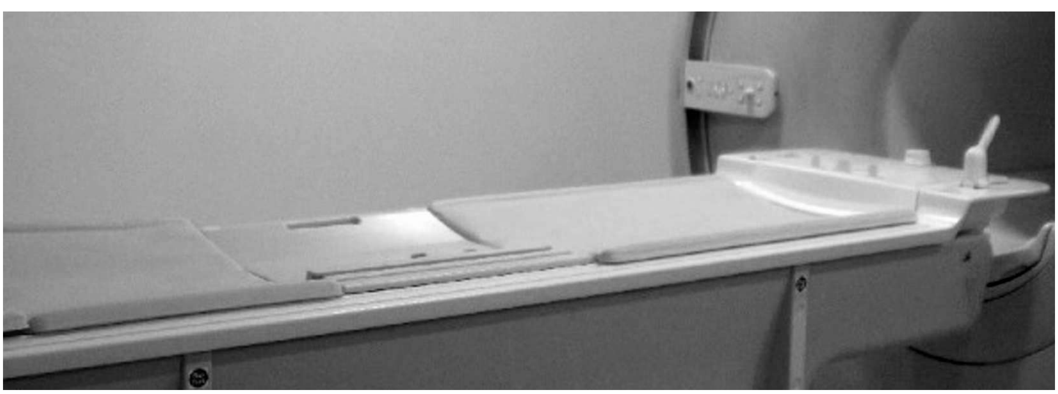
Hand/wrist with the hand at the side - dS HandWrist 16ch

Hand/wrist examinations with the dS HandWrist 16ch coil are to be performed with the patient either prone with the arm overhead, or supine with the arm at side. This section describes how to position the patient supine with the arm at the side.

Preparing the tabletop for hand/wrist with the hand at the side and the dS Hand/Wrist 16ch coil

▷ The dStream interface is on the tabletop and plugged into the FlexConnect socket.

► Put a short mattress on the tabletop beside the dStream interface. Place the base plate next to it with the groove on top of the base plate on the affected side (with Feet-First supine positioning).



Verify that the rail is in the table groove and the base is placed securely.

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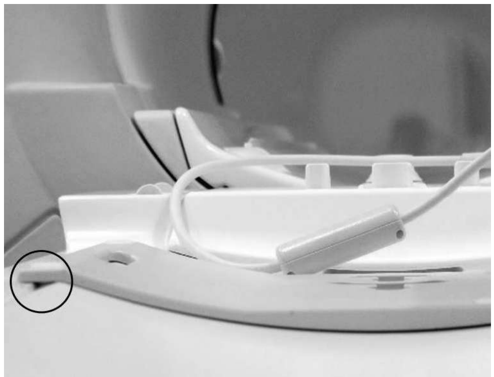

► Attach the coil to the base plate: slide the coil onto the base plate (hubs of coil go into rail on base plate) with the cable pointing towards the bore. Then add the base plate mattress.

► Connect the coil to the dStream socket on the dStream interface.

► Open the coil: pull the lock button towards the wrist end of the coil and pull the coil open.

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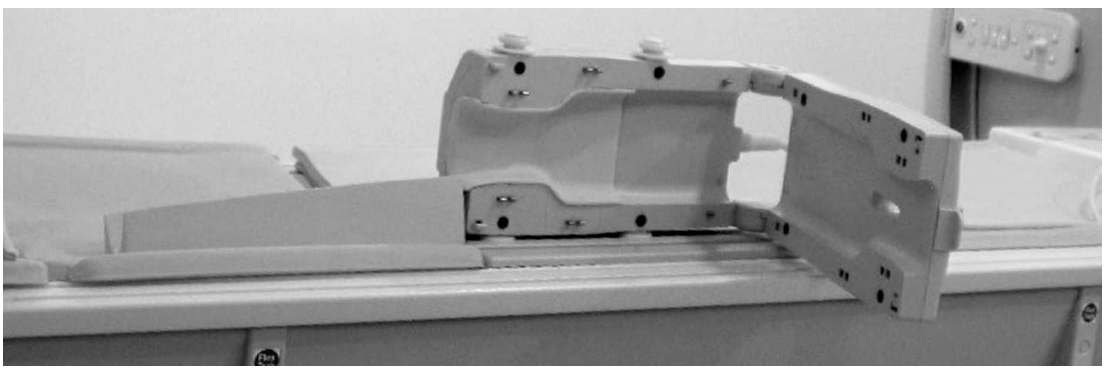
► Place pads for patient comfort:

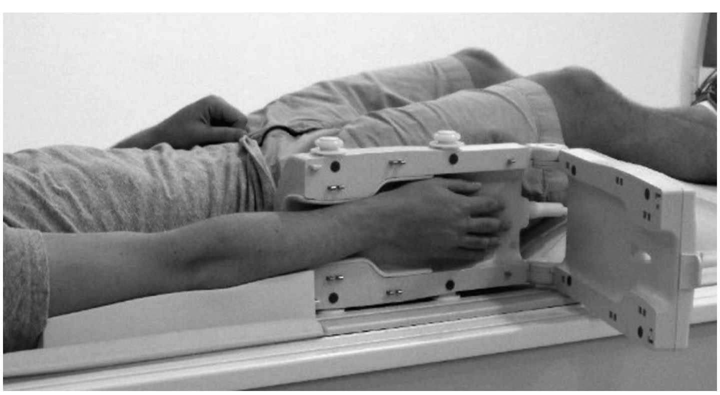
- On the medial side of the coil: either the long or short palm pad
- Against the coil: the elbow/arm pad with the thick side to the coil
- For smaller patients, add an extra palm pad.



Patient positioning for hand/wrist at the side with the dS Hand/Wrist 16ch coil

► Position the patient **Feet-First supine** on the tabletop with their hand vertically in the coil.

Place the knee cushion under the patient's knees for comfort.



► Place the posterior palm pad over the patient's hand.

This pad is optional for patients with large hands, because it could hamper the coil being closed.

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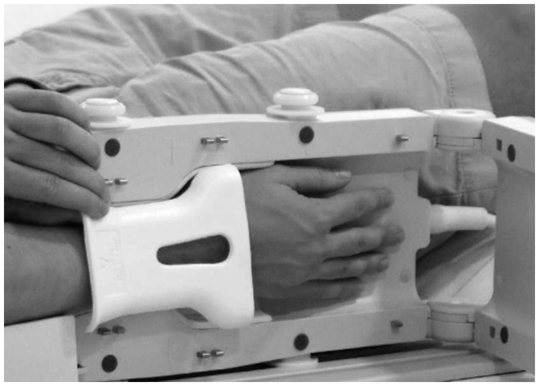
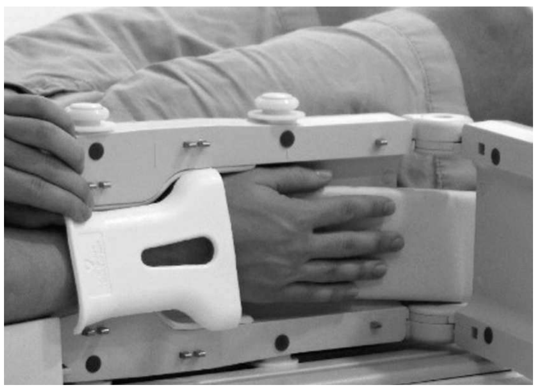


► Place the wedge pad under the patient's fingers to hold the fingers straight.



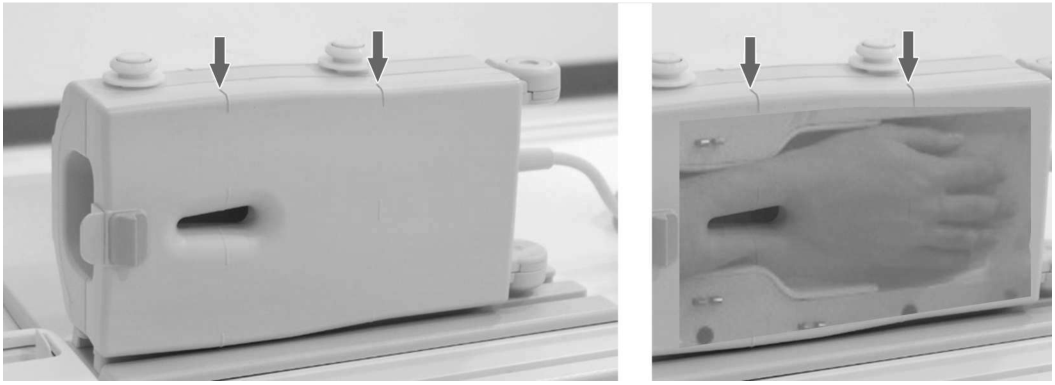
► Close the coil carefully. Pay attention to the patient’s fingers.
Depending on the size and shape of the patient’s hand you may have to remove some of the pads.

NOTICE

Scanning impossible with the coil not fully closed

Always fully close the coil. Push the top end down until it fully closes.

► Use the landmarks on top of the coil for isocenter positioning.



- Prevent contact between the patient and the bore wall at the contra-lateral side.

Hand/wrist with the hand overhead - dS HandWrist 16ch

Hand/wrist examinations with the dS HandWrist 16ch coil are to be performed with the patient either prone with the arm overhead, or supine with the arm at side. This section describes how to position the patient prone with the arm overhead.

Preparing the tabletop for hand/wrist with the hand overhead and the dS HandWrist 16ch coil

- ▷ The dStream interface is on the tabletop and plugged into the FlexConnect socket.
- Place the base plate on the tabletop beside the dStream interface. Cover the remaining tabletop with mattresses.

  If the patient is tall, also place the head-/leg support on the tabletop to support the patient's feet.

  Verify that the rail is in the table groove and the base is placed securely.

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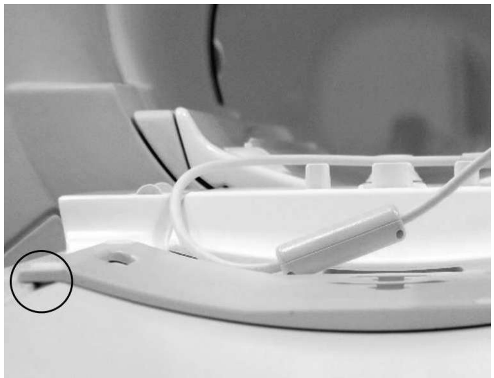
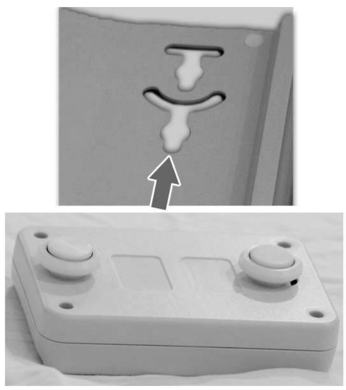
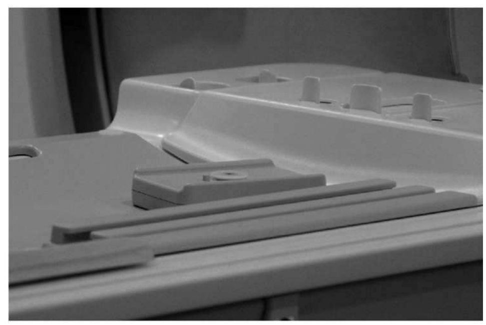


► Connect the mount adaptor to the base plate:

- align the two hubs on the mount adaptor to the holes in the base plate;
- then push up so that the hubs are in the two grooves allowing lateral motion and rotation of the mount adaptor.

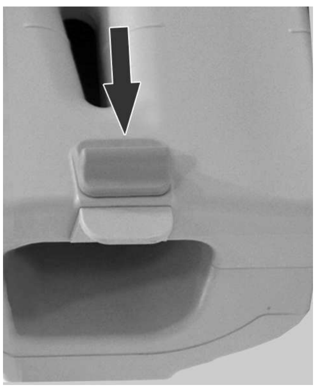




► Attach the coil to the mount adaptor on the base plate, with the cable pointing to the head end.

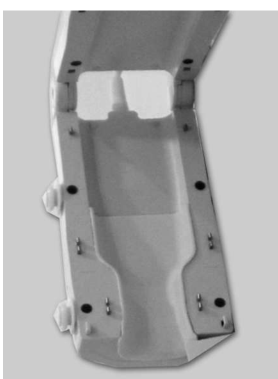
► Route the cable towards the bore and connect the coil to the dStream socket on the dStream interface. Verify that there are no loops in the cable.

► Open the coil: pull the lock button towards the wrist end of the coil and pull the coil open.



► Place pads for patient comfort:

- On the bottom of the coil: either the long or short palm pad
- For smaller patients, add an extra palm pad.



Patient positioning for hand/wrist overhead with the dS HandWrist 16ch coil

► Rotate the coil for the appropriate wrist.

► Position the patient **Head-First prone** on the tabletop with their hand in the coil. Put a pillow under the patient's chest for comfort.

Fine-tune the coil angle to make the patient as comfortable as possible.

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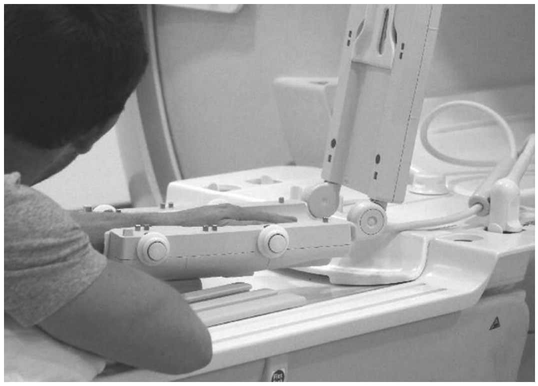

► Place the posterior palm pad over the patient's hand.

This pad is optional for patients with large hands, because it could hamper the coil being closed.

► Place the finger pad under the patient's fingers to hold the fingers straight.

► Close the coil carefully. Pay attention to the patient’s fingers.
Depending on the size and shape of the patient’s hand you may have to remove some of the pads.

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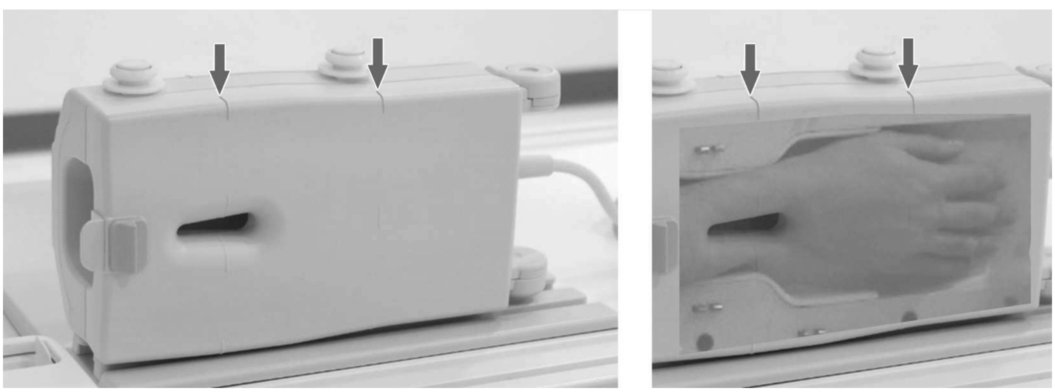
NOTICE

Scanning impossible with the coil not fully closed

Always fully close the coil. Push the top end down until it fully closes.

- To slightly elevate the patient's legs, put a pillow under their ankles.
- Use the landmarks on top of the coil for isocenter positioning.



- Prevent contact between the patient and the bore wall at the contra-lateral side.

Wrist with the hand at the side - dS Wrist 8ch coil

The wrist examination can be performed in Feet-First position with the hand at side or in Head-First position with the hand overhead. This section describes how to position the patient Feet-First supine with the arm at the side.

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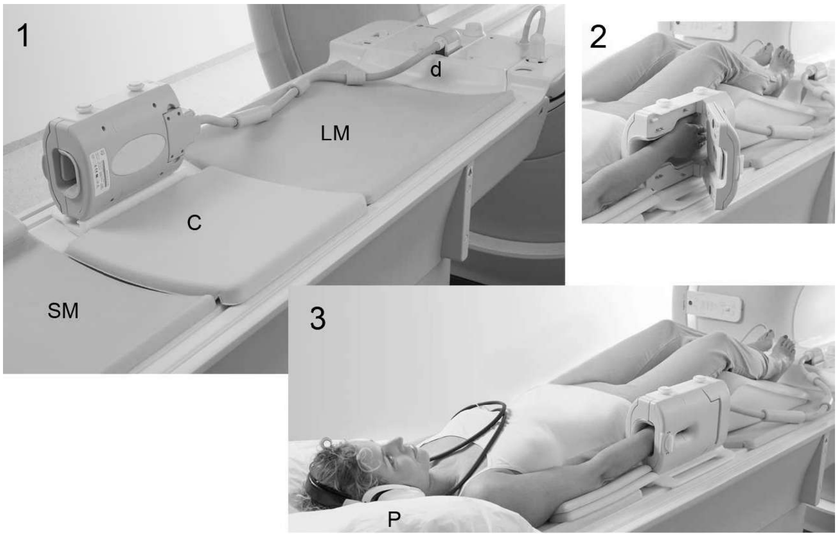

1	Schematic set up of a wrist examination: the dStream Interface (d), one long mattress (LM), the coil (C), one short mattress (SM) and a pillow (P) on the T-shape mattress at the end of the tabletop.
2	Patient placing their hand in the coil for an examination in Feet-First position with the hand at side.
3	Patient positioned on tabletop in Feet-First position with the hand at side.

1. Prepare the tabletop as shown above with the base plate for examinations at the side.
2. Set up the coil for the examination:
   - Slide the coil vertically into the groove of the base plate.
   - Remove the mount adaptor from the coil if applicable.
   - Put the coil mattress on the base plate.
   - Connect the coil to the dStream socket on the dStream interface.

NOTICE

Make sure that the groove in the base plate is on the side of the wrist to be examined.

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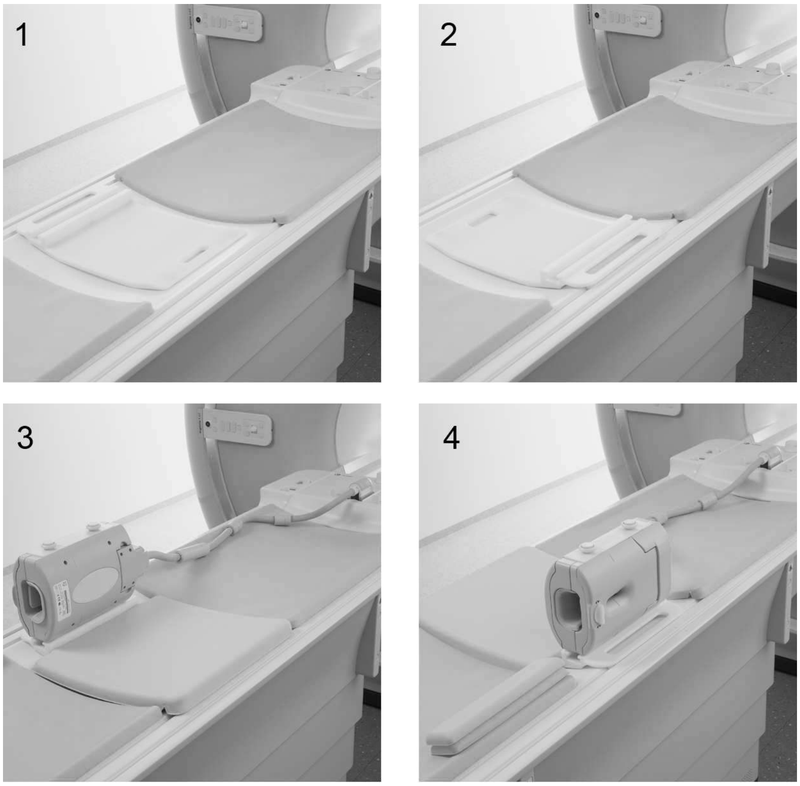

Fig. 173: 1: Baseplate on tabletop for left wrist examination. 2: Baseplate on tabletop for right wrist examination. 3: Coil set up for left wrist examination. 4: Coil set up for right wrist examination.

3. Position the patient on the tabletop: supine and Feet-First with their hand (vertically) in the coil.

Fig. 174: Left: Open coil. Right: Patient on tabletop with hand in coil.

4. Close the coil.
5. Insert padding into the coil through the opening, underneath the fingers.

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Fig. 175: Left: Closing the coil. Right: Inserting padding.

6. Place thin cushions under the upper arm for patient comfort.
7. Prevent contact between the patient and the bore wall at the contra-lateral side.

Fig. 176: Patient positioned ready for wrist examination.

NOTICE

While closing the coil verify that the patient's skin cannot be pinched between coil parts.

Wrist with the hand overhead - dS Wrist 8ch coil

The wrist examination can be performed in Feet-First position with the hand at side or in Head-First position with the hand overhead. This section describes how to position the patient Head-First prone with the hand overhead.

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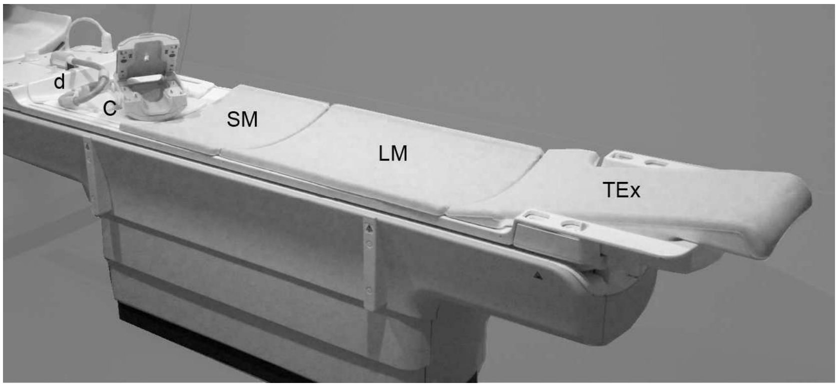

Fig. 177: Setup for overhead examinations. d - dStream interface, C - coil (on base plate), SM - short mattress, LM - long mattress, TEx - Head- / Leg Support.

1. Prepare the tabletop as shown above with the base plate for overhead examinations.

NOTICE

Make sure that the short longitudinal slot in the base plate is on the side of the wrist to be examined.

2. Attach the mount adaptor to the coil if applicable.

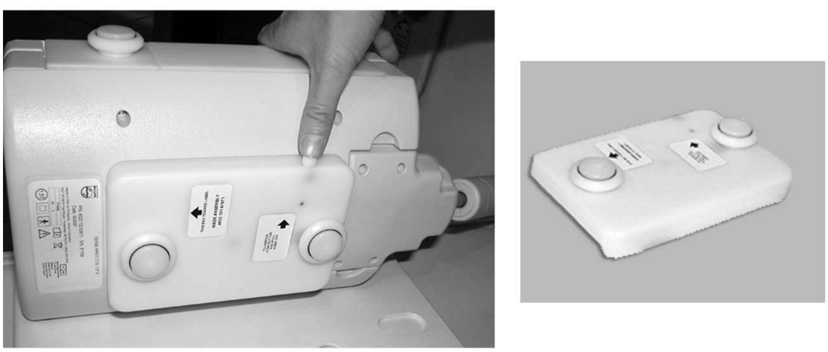

Fig. 178: The mount adaptor has to be attached to the coil for overhead positioning and removed for positioning at the patient's side. Left: Removing the mount adaptor. Right: mount adaptor removed.

3. Slide the coil horizontally into the transverse slot of the base plate.
4. Angle the coil for right or left wrist examinations.

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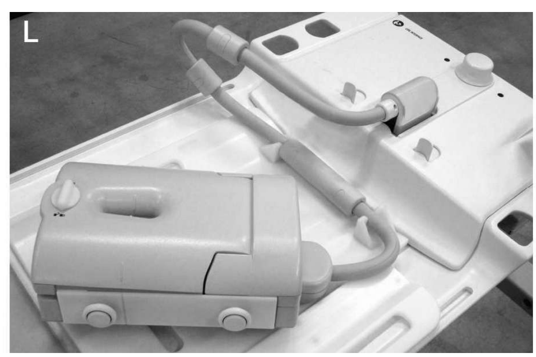
5. Press the coil cable with the balun into the cable holders (clips in the base plate).
6. Connect the coil to the dStream socket on the dStream interface.
7. Put a pillow on the tabletop below the coil. Position the patient prone with the hand in the coil and the upper body on the pillow.
8. Use cushions so that the patient lies comfortable.
9. Insert padding into the coil for patient comfort.
10. Close the coil.
11. Insert padding into the coil through the opening, underneath the fingers.
12. Prevent contact between the patient and the bore wall at the contra-lateral side.

For the contra-lateral wrist:

- Completely disconnect the coil and remove the cable from the cable holders.
- Angle the coil and connect as shown in the image:



NOTICE
While closing the coil verify that the patient's skin cannot be pinched between coil parts.

Positioning for Knee Examinations

Knee examinations make use of the dS (T/R 3.0T) Knee 16ch or dS Knee 8ch coil solution.

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The knee examination is to be performed in Feet-First position.

Fig. 179: Positioning with the dS Knee 16ch coil solution.

1	Schematic set up of a knee examination: the dStream Interface (d), one short mattress (SM), the coil (C), one long mattress (LM) and a pillow (P) at the very end of the tabletop.
2	Patient on tabletop and Head/Leg support positioned in dS Knee 16 ch coil.
3	Patient on tabletop positioned in ds Knee 8 ch Knee coil.

Workflow

1. Prepare the tabletop as shown above.
2. Connect the coil to the dStream socket on the dStream interface.
3. **Only for the dS T/R Knee 16ch coil on 3.0T systems:** Also connect the coil to the Transmit plug at the Patient Support Control Panel.
4. Set up the coil for the examination:
   - Slide the posterior coil part to the left or to the right for a left or right knee examination.
   - Put the thin and/or thick wedge pad in the coil for small knees.
   - Put the knee pad on the coil base around the posterior coil part.

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Fig. 180: Set up with dS Knee 8ch coil. 1: Coil on the base plate. The arrow indicates the groove in the base plate. 2: Set up of a left knee examination. 3: Set up of a right knee examination.

Fig. 181: Set up with dS Knee 16ch coil. 1: Coil on the base plate. The arrow indicates the groove in the base plate. 2: Set up of a left knee examination. 3: Set up of a right knee examination.

5. Position the patient supine with:
    - the affected side knee in the posterior coil
    - unaffected side knee on knee pad.

Fig. 182: Left knee examination feet-first.

6. Carefully place the anterior coil part on the posterior coil part.
7. Close the coil by moving the U-bolt.

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Fig. 183: Closing the dS Knee 8ch coil: first putting the anterior coil part on the posterior coil part, and then closing by means of U-bolt.

Fig. 184: Closing the dS Knee 16ch coil by means of the U-bolt.

8. Use the light visor and move the patient’s knee to the isocenter.

Fig. 185: Left knee examination feet-first. Left: Examination with the dS Knee 8ch coil. Right: Examination with the dS Knee 16ch coil.

NOTICE

While closing the coil verify that the patient's skin cannot be pinched between coil parts.

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Positioning for Foot and Ankle Examinations

Foot and ankle examinations can be performed with the following coil solutions:

Coil Solution	Application
dS FootAnkle 16ch	optimally suited for high resolution and routine imaging
dS FootAnkle 8ch	routine imaging
dS Flex coil solutions	routine imaging

Foot and Ankle Examinations with dS FootAnkle 8ch coil

Foot and ankle examinations make use of the dS FootAnkle 8ch coil solution.

The foot and ankle examinations are to be performed in Feet-First position with the patient supine.

Fig. 186: Positioning with the dS FootAnkle 8ch coil solution.

1	Schematic set up of the foot or ankle examination in Feet-First positioning: the dStream Interface (d), the coil (C), one short mattress (SM), one long mattress and one T-shape mattress (TM).
2	Foot/ankle examination in Feet-First position.

Workflow

1. Prepare the tabletop as shown above.
2. Set up the coil for the examination:
   - Slide the foot support to the left or the right side to accommodate left or right foot and ankle examinations.
   - Put the coil mattress with integrated unaffected foot pad over the coil.
   - Insert the foot support pad into the foot support for patient comfort and good fixation.

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Fig. 187: Preparation. Left: coil in base plate. The groove is visible. Right: Coil in base plate. FootAnkle pad on top of the base plate.

Fig. 188: Examination set up. Left: left side examination, right: right side examination.

3. Position the patient supine with:
   - affected foot in the foot support
   - unaffected foot on the FootAnkle pad.
4. Use the strap to immobilize the foot to be examined.
5. To improve patient comfort, the knee supports can be used.
6. Carefully slide the coil onto the foot support with both hands.
7. Connect the coil to the dStream socket on the dStream interface.

NOTICE

Special attention is needed in case of patients with damaged feet and toes, e.g. as in diabetes.

NOTICE

There are no latches, the coil is held in place by gravity.

Fig. 189: 1: Affected side foot in foot support. 2: Sliding the coil onto the foot support. 3: Connecting the coil.

8. Insert the toe wedge pad into the coil through the opening, underneath the toes. This pad can help keep the forefoot immobile.
9. Use the landmark on top of the handle for isocenter positioning.

Fig. 190: Positioning. 1: Positioning of the feet in the coil and on the pad. 2: inserting toe wedge pad through opening. 3: Toe wedge pad in coil, and landmark for isocenter positioning (arrow).

Fig. 191: Ready for the examination.

NOTICE

While closing the coil verify that the patient's skin cannot be pinched between coil parts.

Positioning aids

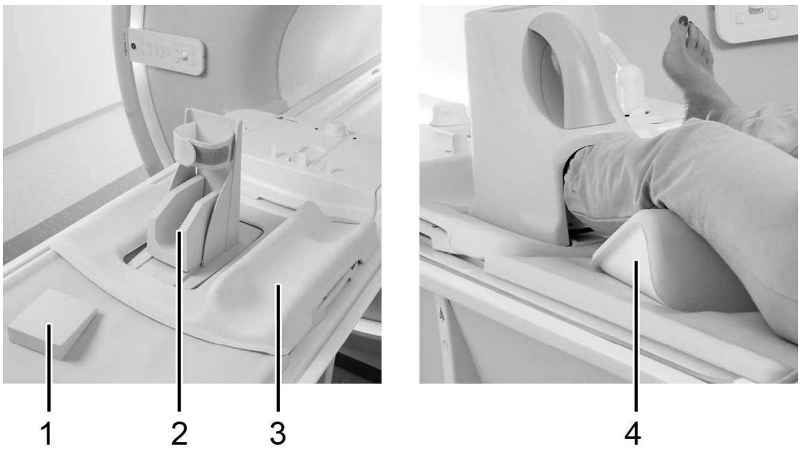


Fig. 192: Positioning aids. 1: Toe wedge pad. 2: Foot support pad. 3: FootAnkle pad. 4: Dedicated knee support.

Foot and Ankle Examinations with dS FootAnkle 16ch coil

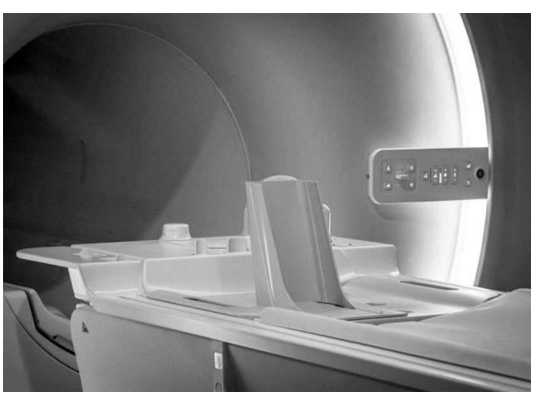
The foot and ankle examinations with the dS FootAnkle 16ch coil are to be performed in Feet-First position with the patient supine.

Preparing the tabletop for a foot and ankle examination with the dS FootAnkle 16ch coil

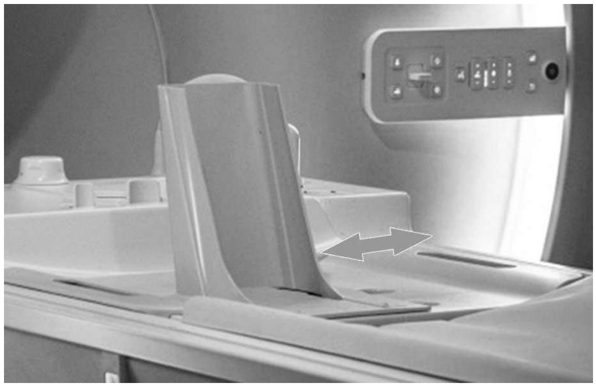
▷ The dStream interface is on the tabletop and plugged into the FlexConnect socket.

1. Put the base plate with foot support at the end of the tabletop. Verify that the tracts on the base plate are secure in the table grooves.

   Place the table mattresses next to the coil.

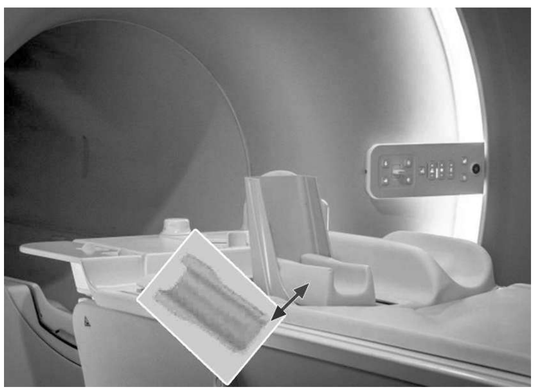
   

2. Slide the foot support to the left or the right side to accommodate left or right foot and ankle examinations.



3. Put the coil mattress over the base plate.

   Insert the foot support pad into the foot support with the wider part against the vertical plate.



4. Optionally: to increase patient comfort, place the tilt device under the base plate with the thin end towards the magnet.

   - Verify that the tract on the tilt device is aligned with the groove on the tabletop.
   - Verify that the base plate is securely aligned with the tilt device before placing the patient's foot in the coil.

Patient positioning for a foot and ankle examination with the dS FootAnkle 16ch coil

1. Position the patient supine with:

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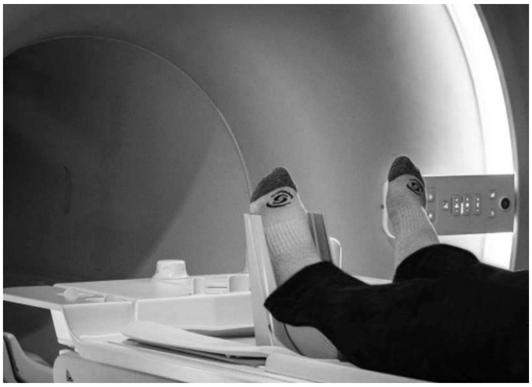
Move the patient down so that their heel is all the way against the vertical plate.



- affected foot in the foot support
- unaffected foot on the coil mattress.

2. Optional - for ankle imaging only: have the patient flex their foot forward and place the wedge pad behind the patient's foot.

3. Place wedges under the patient's knees for comfort.
   With the tilt device in place, consider using a pillow under the patient's knees.
4. Carefully slide the coil onto the foot support with both hands.

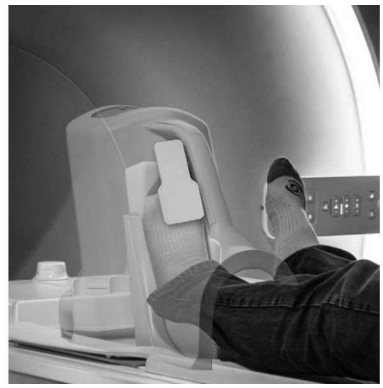
There are no latches, the coil is held in place by gravity.

- Verify that the patient's skin cannot be pinched between coil parts.
- Take care of the patient's toes.

NOTICE

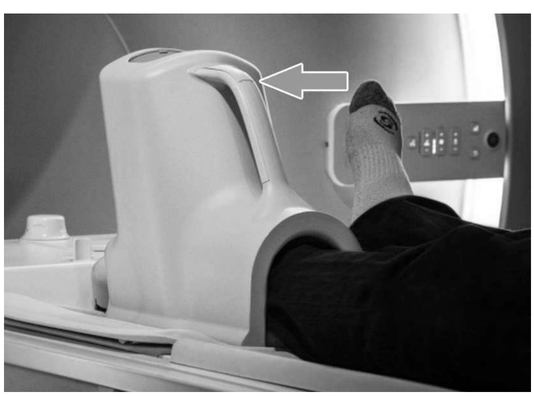
Special attention is needed in case of patients with damaged feet and toes, e.g. as in diabetes.

5. Insert the small pad into the coil through the opening, underneath/in front of the toes. Fold the pad double if needed.



6. Connect the coil to the dStream socket on the dStream interface.

7. Use the landmark on top of the handle for isocenter positioning.



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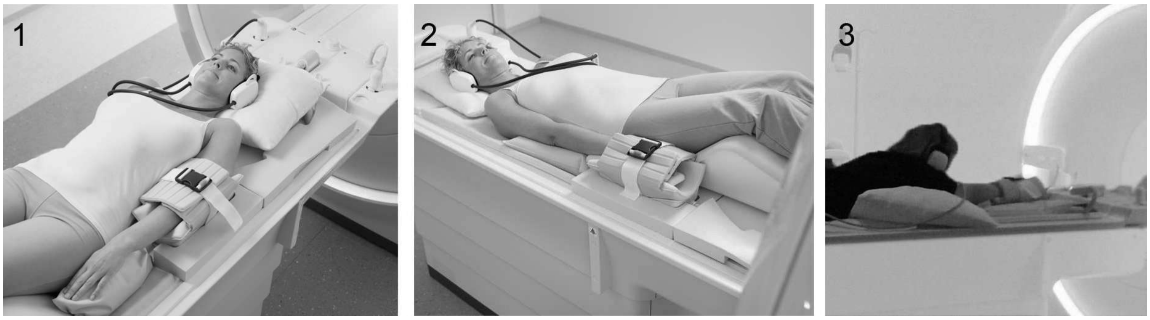
Positioning with the dS SmallExtremity 8ch coil

Elbow and hand/wrist examinations make use of the dS SmallExtremity 8ch coil solution.



Number	Examination	Patient orientation	Patient position
1	**Elbow with the arm at the side**	head-first	supine
2	**Hand/wrist with the arm at the side**	feet-first	supine
3	**Overhead positioning (superman)** - suited for elbow, hand or wrist	head-first	prone

Elbow positioning with the arm at the side

This section describes how to position the patient with the arm at the side. Alternatively the patient can be positioned with the arm overhead (see instructions chapter “Overhead (superman) positioning ” on page 333).

► Prepare the tabletop for left- or right-sided examinations with

- the dStream interface (d)
- the dedicated mattress with the cable groove (Mg)
  The groove has to be at the side of the anatomy of interest.
- the dedicated mattress with the coil cut-out (Mc)
  The cut-out has to be at the side of the anatomy of interest.
- the long mattress (LM)
- and the T-shape mattress (TM).

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- Put the coil in the notch of the mattress so that the coil lies stable.
- Place the cable in the groove.
- Connect the coil to the dStream socket on the dStream interface.

Fig. 193: Left: Tabletop set up for a left side examination. Right: Tabletop set up for a right side examination.

- Position the patient **head-first supine** on the tabletop with their elbow in the lower coil part.
- Use cushions for patient comfort and stability.
- Wrap the coil around the patient's elbow and close the strap.
- Put sandbags under the patient's lower arm.
- Prevent contact between the patient and the bore wall at the contra-lateral side.

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Fig. 194: Ready for elbow examination in head-first position.

Hand/wrist positioning with the hand at the side

- Prepare the tabletop for left- or right-sided examinations with
  - the dStream interface (d)
  - the dedicated mattress with the cable groove (Mg)
    The groove has to be at the side of the anatomy of interest.
  - the dedicated mattress with the coil cut-out (Mc)
    The cut-out has to be at the side of the anatomy of interest.
  - the long mattress (LM)
  - and the T-shape mattress (TM).

- Put the coil in the notch of the mattress so that the coil lies stable, and place the cable in the groove.
- Connect the coil to the dStream socket on the dStream interface.

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- Position the patient **feet-first supine** on the tabletop with their hand/wrist in the lower coil part.
- Use cushions for patient comfort and stability.
- Wrap the coil around the patient's hand/wrist and close the strap.
- Put sandbags under the patient's lower arm.

  The wrist can be positioned with the thumb up.
- Prevent contact between the patient and the bore wall at the contra-lateral side.

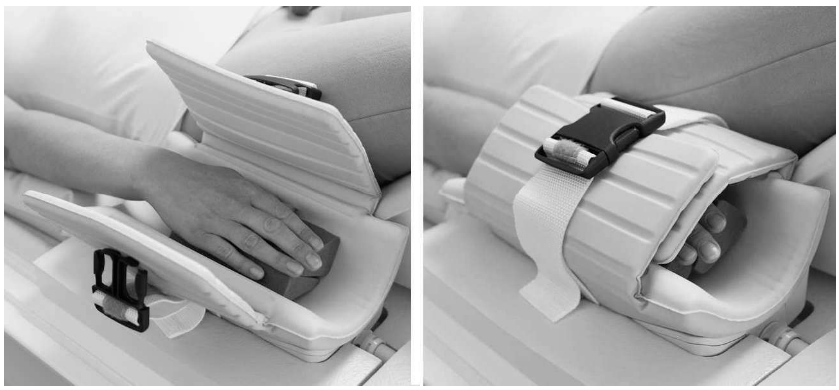

Fig. 195: Hand/wrist positioning with the dS SmallExtremity 8ch coil.

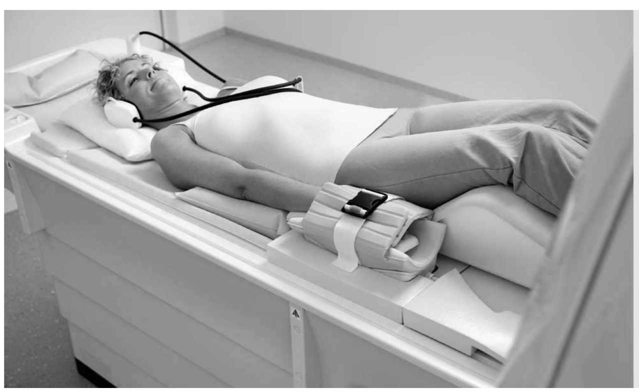

Fig. 196: Ready for hand/wrist examination in feet-first position.

Overhead (superman) positioning

el

Overhead positioning can be used for hand, wrist or elbow examinations.

- Prepare the tabletop for left- or right-sided examinations with
  - the dStream interface (d)
  - the two short mattresses (SM)
  - the long mattress (LM)

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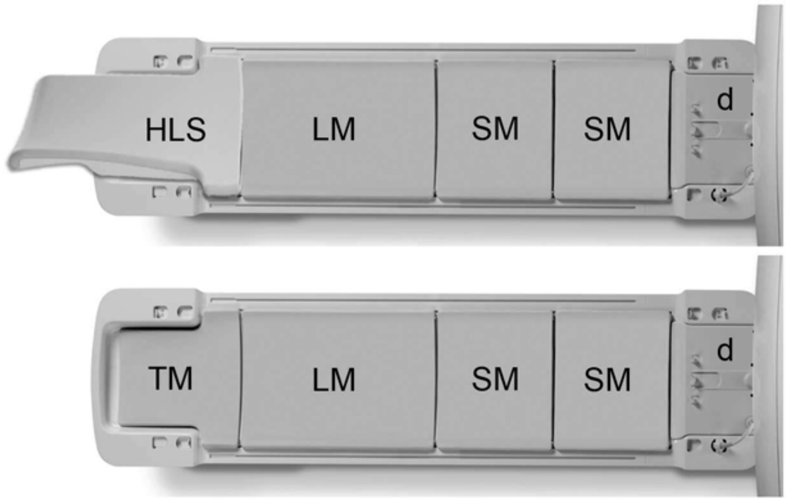
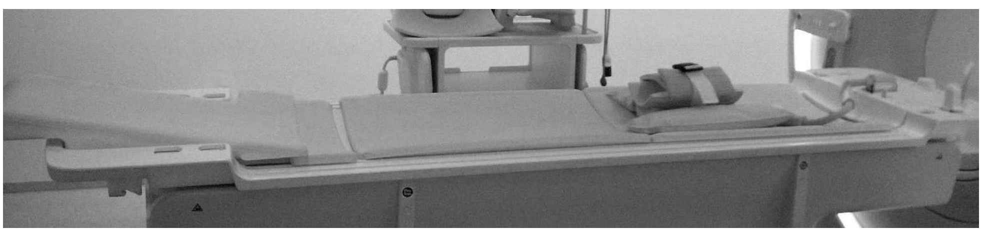
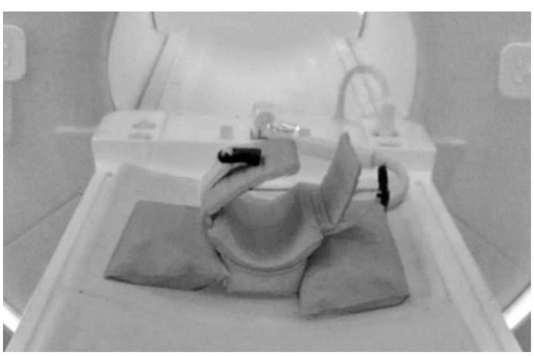
- and the T-shape mattress (TM).
  Alternatively use the head-/leg support (HLS). In superman position, the patient's feet may be off the end of the table.



► Place the coil on the short mattresses on the tabletop.



► Put sandbags on either side of the coil to stabilize.



► Connect the coil to the dStream socket on the dStream interface.
The cable must not be looped or touching the dStream interface.

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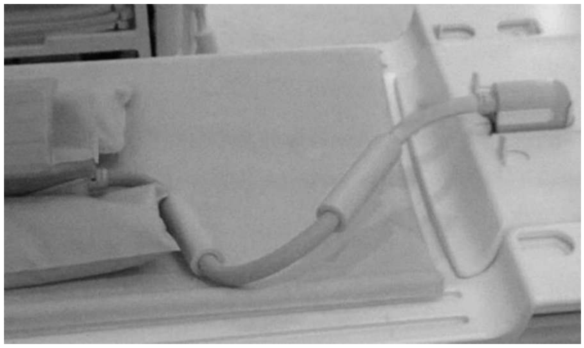

- Put the wedge 15° in front of the coil to support the arm. Place the wider part next to the coil.

- Put a pillow on the tabletop below the coil.
- Position the patient **head-first prone** on the tabletop with their hand, wrist or elbow in the coil and the upper body on the pillow.
- Use cushions for patient comfort and stability.
- Insert padding into the coil for patient comfort.
- Wrap the coil around the patient's hand, wrist or elbow and close the strap.
- Prevent contact between the patient and the bore wall at the contra-lateral side.

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Positioning with the dS SmallExtremity 16ch coil

You can use the dS SmallExtremity 16ch coil solution for elbow and hand/wrist examinations.

Examination	Patient orientation	Patient position
With the arm at the side suited for elbow, hand or wrist	feet-first	supine
Overhead positioning (superman) - suited for elbow, hand or wrist	head-first	prone

Elbow positioning with the arm at the side

Elbow examinations with the dS SmallExtremity 16ch coil are to be performed with the patient either prone with the arm overhead, or supine with the arm at side. This section describes how to position the patient supine with the arm at the side.

Preparing the tabletop for elbow at the side with the dS SmallExtremity 16ch coil

► Prepare the tabletop for left- or right-sided examinations with
- the dStream interface (d)
- the dedicated mattress with the cable groove (Mg)
  The groove has to be at the side of the anatomy of interest.
- the dedicated mattress with the coil cut-out (Mc)
  The cut-out has to be at the side of the anatomy of interest.
- the long mattress (LM)
- and the T-shape mattress (TM).

► Place another long mattress on top the first one.

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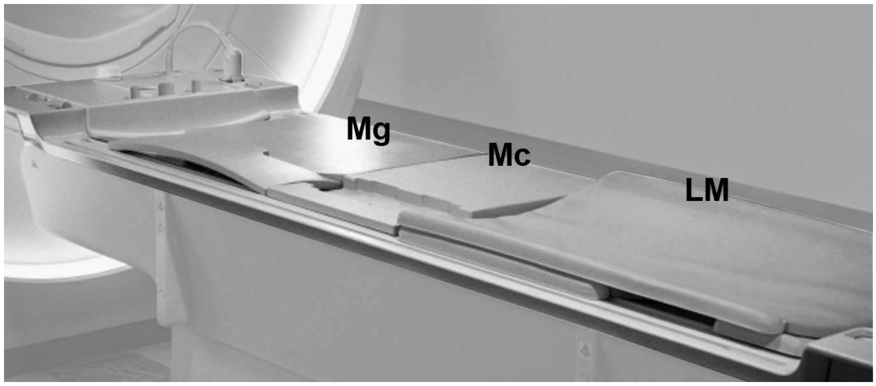
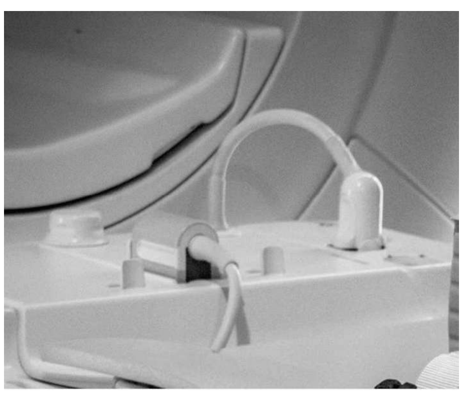


► Place the coil in the cut-out of the mattress such that it lies stable.
Route the cable under the cable mattress.

► Connect the coil to the dStream socket on the dStream interface.



► Place pads in the coil for patient comfort:

- For adult-sized patients, place the elbow pad in the coil.

This pad keeps a slight bend in the elbow.

- For pediatric and smaller patients, use the hand/small part pad to immobilize the elbow.

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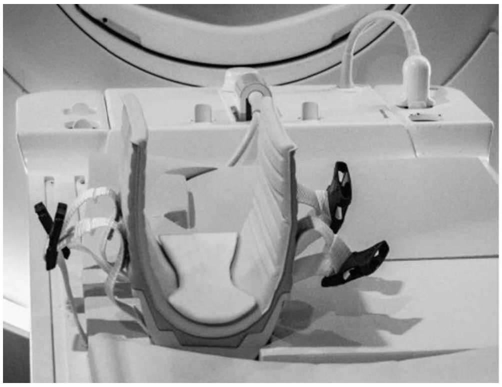

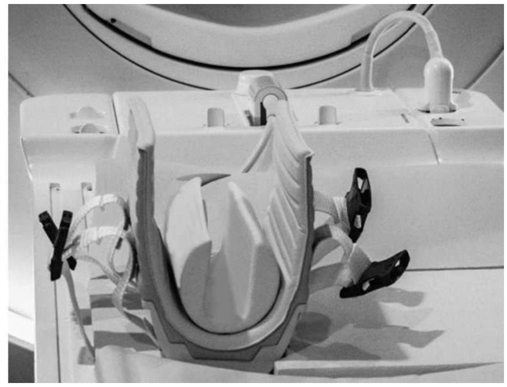

Patient positioning for elbow at the side with the dS SmallExtremity 16ch coil

► Position the patient **head-first supine** on the tabletop with their elbow in the coil.

Use extra pads for patient comfort and stability.

Put sandbags under the patient's hand and lower arm.

► Wrap the coil around the patient's elbow so that the flap with the centering mark is on the top. Closing the coil in the opposite direction may result in decreased image quality.

Close the buckle clip and tighten the straps.

► Place the knee cushion under the patient's knees for comfort.

► Prevent contact between the patient and the bore wall at the contra-lateral side.

Hand/wrist positioning with the hand at the side

Hand/wrist examinations with the dS SmallExtremity 16ch coil are to be performed with the patient either prone with the arm overhead, or supine with the arm at side. This section describes how to position the patient supine with the arm at the side.

Preparing the tabletop for hand/wrist with the hand at the side and the dS SmallExtremity 16ch coil

► Prepare the tabletop for left- or right-sided examinations with

- the dStream interface (d)
- the dedicated mattress with the cable groove (Mg)
  The groove has to be at the side of the anatomy of interest.
- the dedicated mattress with the coil cut-out (Mc)
  The cut-out has to be at the side of the anatomy of interest.
- the long mattress (LM)
- and the T-shape mattress (TM).

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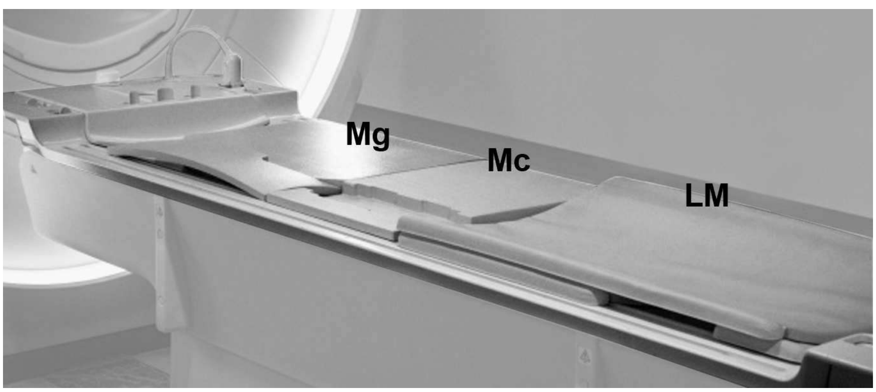
► Place another long mattress on top the first one.



► Place the coil in the cut-out of the mattress such that it lies stable.
Route the cable under the cable mattress.

► Connect the coil to the dStream socket on the dStream interface.

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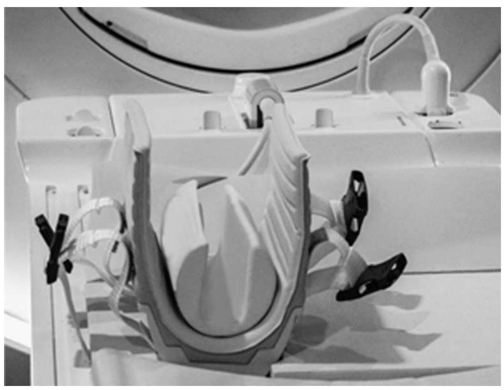
► Place the hand/small part pads in the coil for patient comfort:

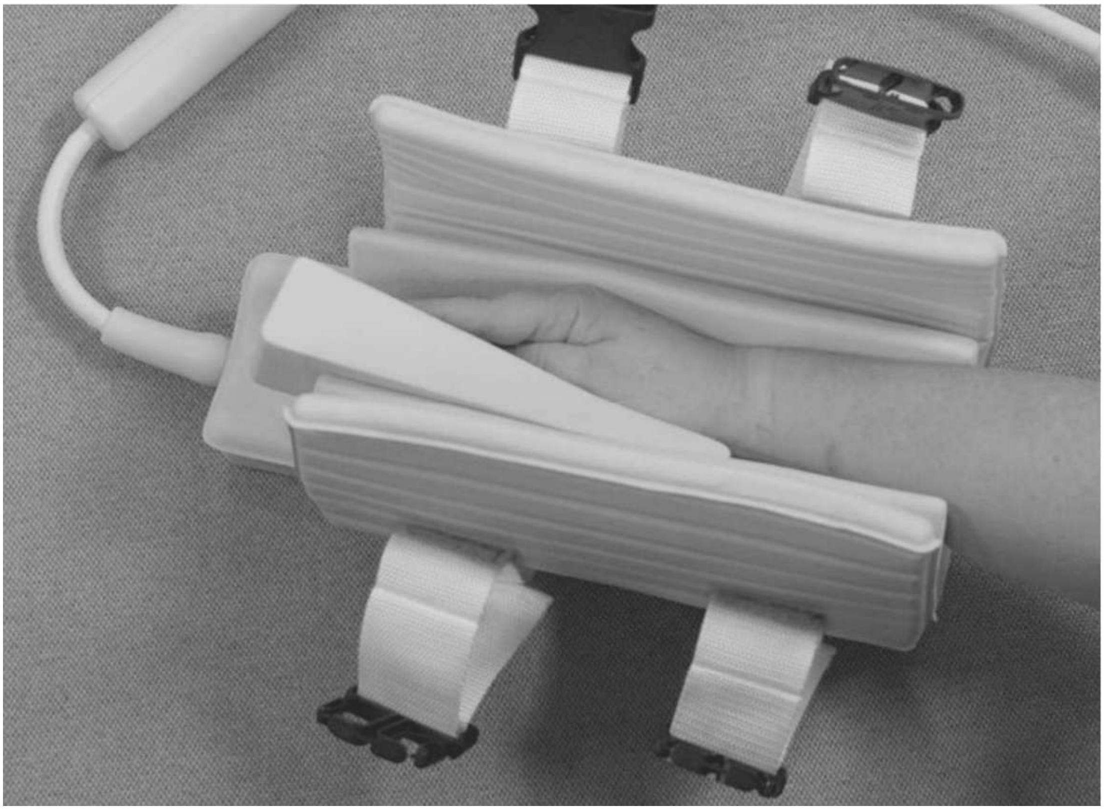


Patient positioning for hand/wrist at the side with the dS SmallExtremity 16ch coil

► Position the patient **feet-first supine** on the tabletop with their wrist/hand in the coil (in the hand/small part pad).

Put sandbags or pads under the patient's upper arm.

► Place the finger wedge pad under the fingers to keep the hand straight.



► Wrap the coil around the patient's elbow so that the flap with the centering mark is on the top. Closing the coil in the opposite direction may result in decreased image quality.

Close the buckle clip and tighten the straps.

► Place the knee cushion under the patient's knees for comfort.

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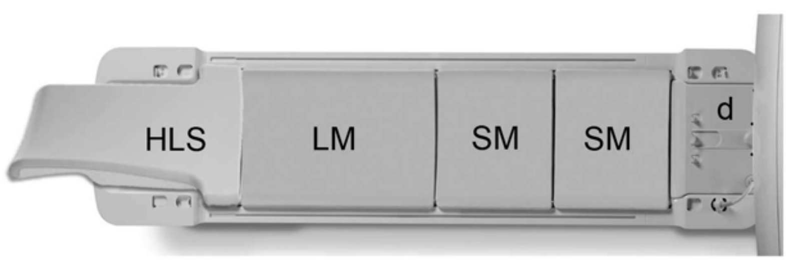
► Prevent contact between the patient and the bore wall at the contra-lateral side.

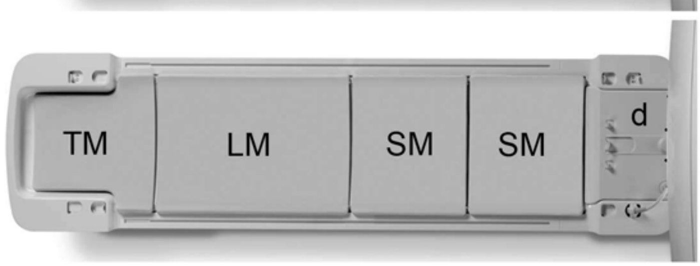
Hand/wrist/elbow overhead (superman) positioning

Hand/wrist or elbow examinations with the dS SmallExtremity 16ch coil are to be performed with the patient either prone with the arm overhead, or supine with the arm at side. This section describes how to position the patient prone with the arm overhead (superman).

Preparing the tabletop for overhead examination with the dS SmallExtremity 16ch coil

► Prepare the tabletop for left- or right-sided examinations with
- the dStream interface (d)
- the two short mattresses (SM)
- the long mattress (LM)
- and the T-shape mattress (TM).
  Alternatively use the head-/leg support (HLS). In superman position, the patient's feet may be off the end of the table.





► Place the coil on the tabletop. Put sandbags on either side of the coil to stabilize it.

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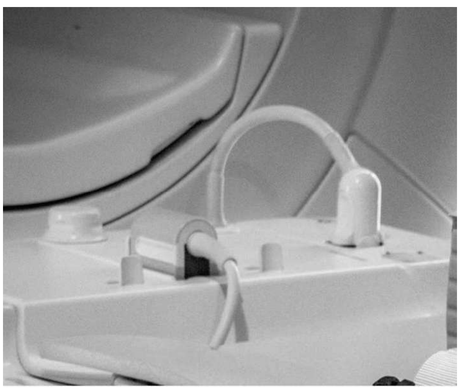
- Connect the coil to the dStream socket on the dStream interface.

  The cable must not be looped or touching the dStream interface.



- Place the hand/small part pads in the coil for patient comfort:

Patient positioning for hand/wrist at the side with the dS SmallExtremity 16ch coil

- Position the patient **head-first prone** on the tabletop with their wrist/hand or elbow in the coil and the upper body on a pillow.

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NOTICE

Prevent looping or crossing cables.

Place a pad to separate the cable if needed.

► Wrap the coil around the patient's hand/wrist or elbow so that the flap with the centering mark is on the top. Closing the coil in the opposite direction may result in decreased image quality.

Close the buckle clip and tighten the straps.

► Place the knee cushion under the patient's knees for comfort.

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► Prevent contact between the patient and the bore wall at the contra-lateral side.

Positioning with the dS Flex coil solutions

The dS Flex coil solutions can be used for a wide range of applications such as joints and pediatric imaging. They consist of two dS Flex coils and the dS Posterior coil. Depending on the size of the anatomy to be examined, either the Small (S) or the Medium (M) or the Large (L) coil solution can be selected.

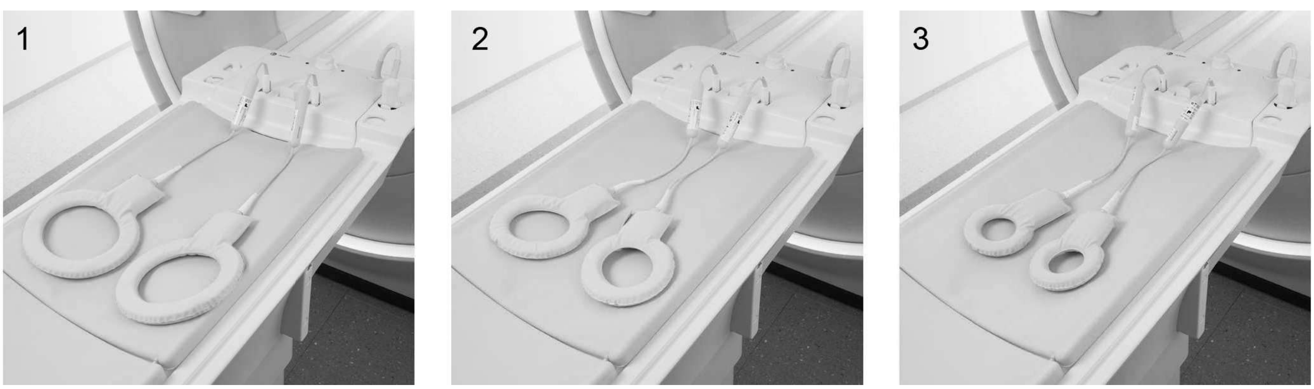

Fig. 197: dS Flex coil solution. 1 - L, 2 - M, 3 - S.

Positioning in general

► Place either one dS Flex coil or both dS Flex coils on the anatomy to be examined.

You can either scan with two dS Flex coils and the dS Posterior coil or with just one dS Flex coil and the dS Posterior coil.

NOTICE

Single dS Flex coils of different sizes can be combined with each other and with the dS Posterior coil.

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Using dS Flex coils with or without the dS Posterior coil

By default, the dS Flex coils are used in combination with the dS Posterior coil to achieve optimum image quality.

- ► To use the dS Flex coils without the dS Posterior coil, enable *Disengage Posterior coil* in the **ExamCard Properties** window.
- ⇨ The dS Posterior coil is disengaged for the current ExamCard as long as *Disengage Posterior coil* remains enabled.
- ► Fix the coil(s) with a strap.
- ► Connect the coil to the Flex socket on the dStream interface.
- ► Especially for shoulder and wrist examinations: prevent contact between the patient and the bore wall at the contra-lateral side.

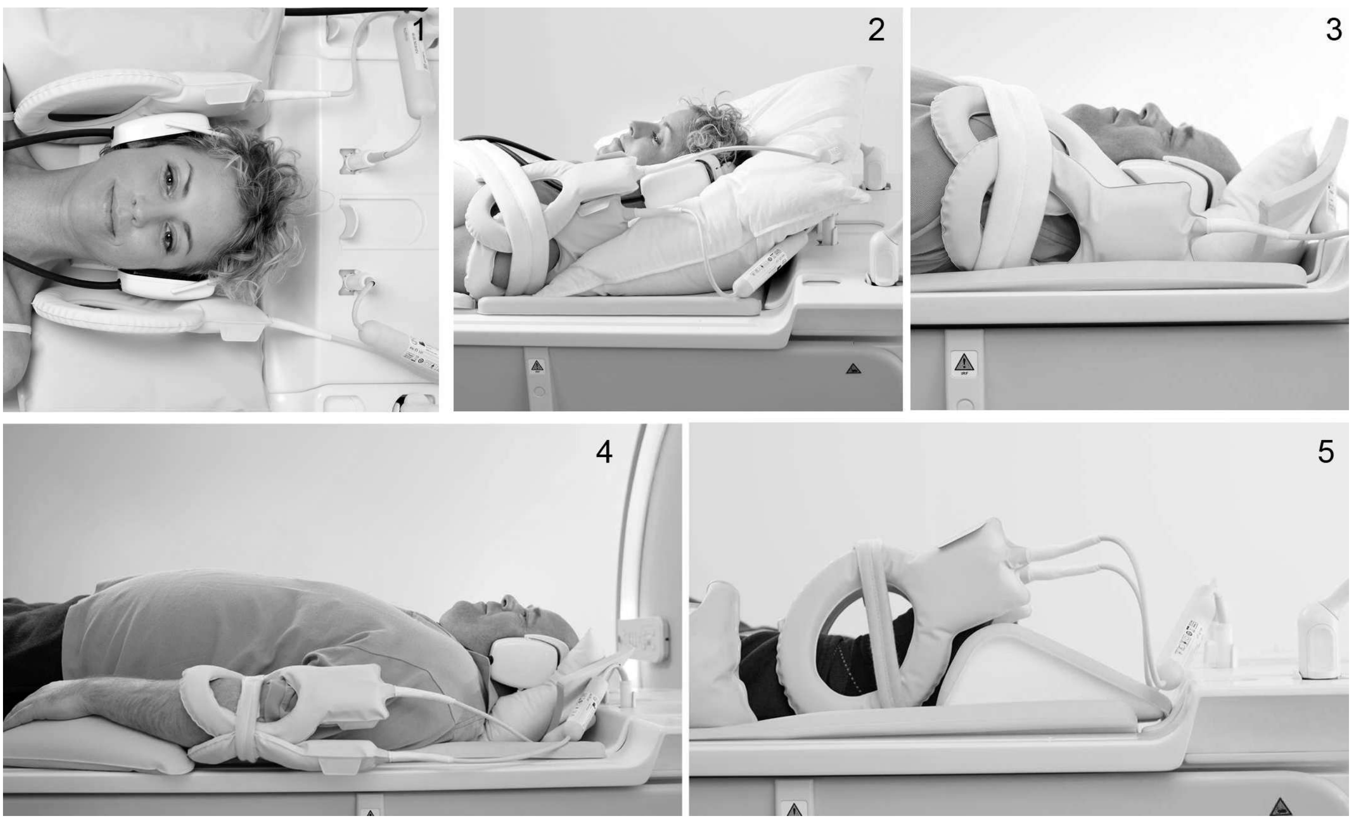

Fig. 198: Examples of how to use the dS Flex coil solutions. 1: Neck examinations, 2 and 3: Shoulder examinations, 4: Elbow examination, 5: Foot examination.

Positioning for examinations with the TMJ coil holder

TMJ, orbit or carotid examinations make use of the TMJ coil holder and the dS Flex coil solution.

Preparing the tabletop

- ► Place the TMJ coil holder on the tabletop.

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- Place the NVC Stability pad on the TMJ coil holder.
- Optionally: Put the 15° angle sponge or the “Mickey Mouse” pad underneath the NVC Stability pad for comfort.

- Attach the Flex coil of your choice for the exam.

Positioning the patient

- Position the patient on the tabletop with their head on the NVC Stability pad.
- Place the coils as close as possible to the anatomy of interest.

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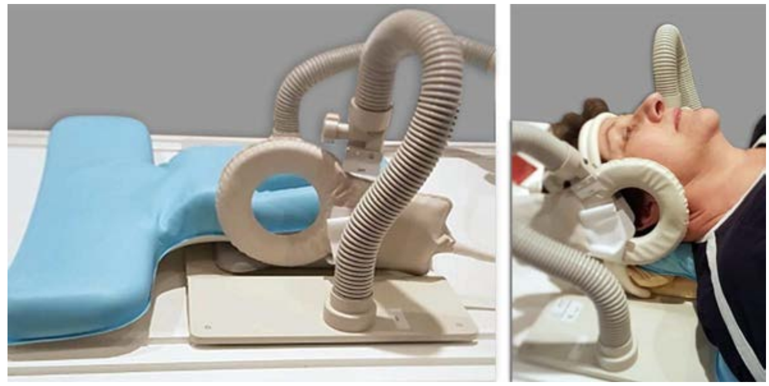
Positioning examples

TMJ	
Orbits	
Carotids	

Positioning for Pediatric Examinations

Positioning for Pediatric Head and Spine Examinations

- Place the dStream interface on the tabletop and connect it.
- Place the dS Ped HeadSpine 8ch coil on the tabletop with the base plate aligned to the table groove.
- Connect the coil to the dStream interface.

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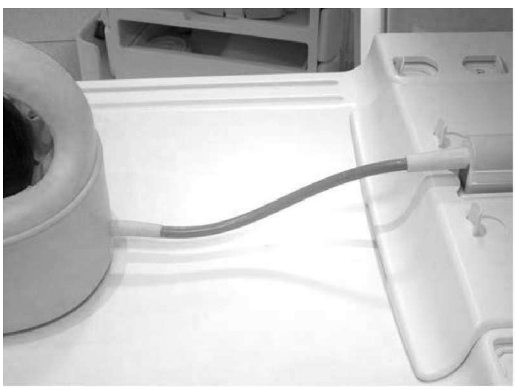
Fig. 199: Coil on the tabletop connected to the dStream interface.

- Verify that the coil is placed as far away from the dStream interface as possible so that the cable is not bent, but runs as straight as possible.
- Check that the base plate is slid into the table groove so that the coil is stable.



- Position the table pad to fit around the Pediatric Head Spine coil with the cable cutout over the coil cable.
- Put the patient pad on the coil.

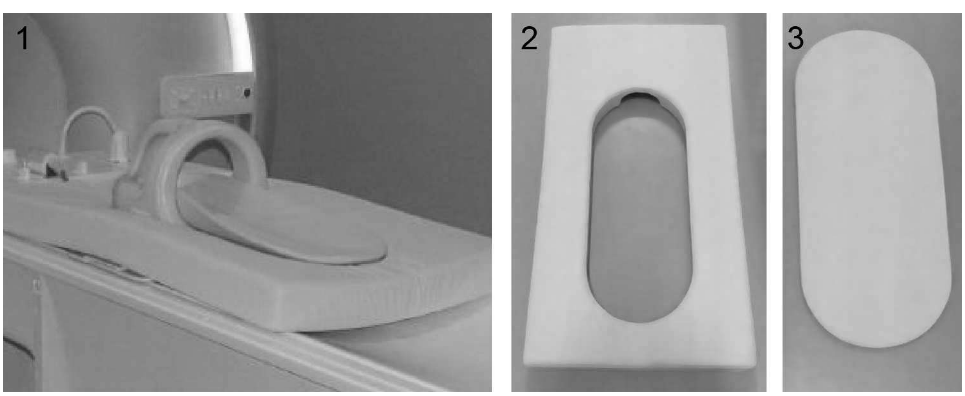


Fig. 200: 1- Coil on the tabletop with the table pad around the coil and patient pad on the coil, 2 - table pad, 3 - patient pad,

- Position the child in the coil with the head in the cage-like coil part.

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Fig. 201: Pediatric patient in the coil.

Positioning for Pediatric Torso and Cardiac Examinations

Coil handling

- Carry the dS Pediatric TorsoCardiac 8ch coil in one piece. To do so, hold on to the posterior part and lift the coil.
- Never lift the coil by gripping through the holes of the anterior part.

NOTICE

Light-weight connection between anterior and posterior part

This connection is not designed to hold the two parts together when only holding the anterior part.

Positioning

- ► Place the dStream interface on the tabletop and connect it.
- ► Place the dS Pediatric TorsoCardiac 8ch coil on the tabletop with the base plate slid into the table groove.
- ► Connect the coil to the dStream interface.

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Fig. 202: Coil on the tabletop connected to the dStream interface.

- Verify that the coil is placed as far away from the dStream interface as possible so that the cable is not bent, but runs as straight as possible.
- Check that the base plate is slid into the table groove so that the coil is stable.
- Position the table pad around the coil with the cut-out over the coil cable.
- Position the two torso inserts to fill the voids making sure the one with the cable cutout is at the cable end of the coil.

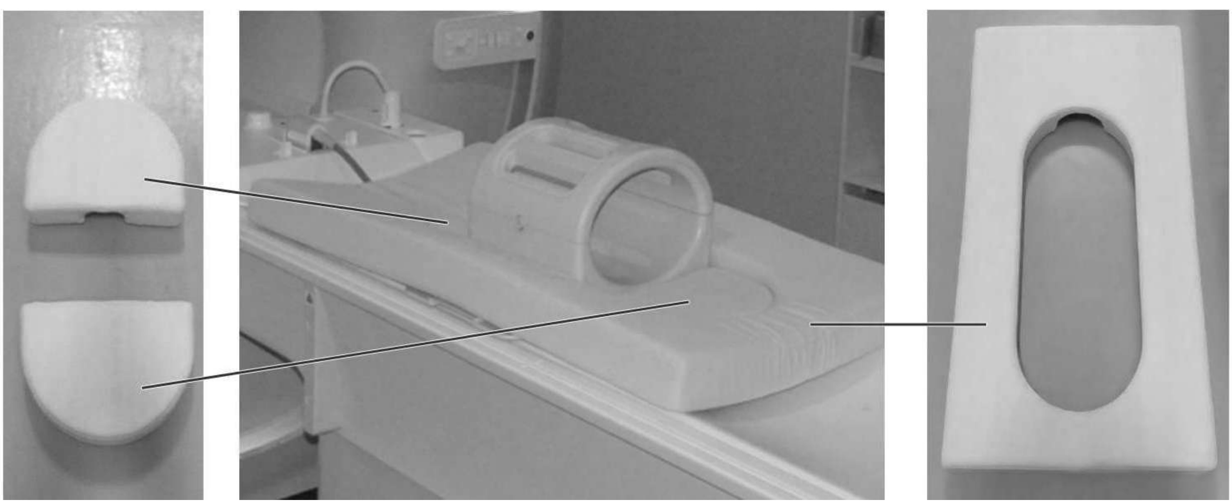

Fig. 203: Tabletop prepared with the coil, torso inserts (also left image) and table pad (also right image).

- Position the patient pad on the coil.

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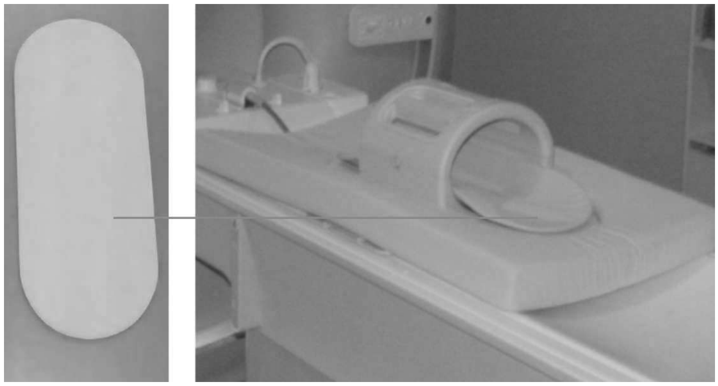

Fig. 204: Tabletop prepared with coil, torso inserts, table pad and patient pad (also left image).

- Press the yellow buttons at the side of the coil and detach the anterior coil part.
- Position the pediatric patient on the patient pad.
- Place the anterior coil part on the posterior coil part and close the coil.

Fig. 205: Positioning with the SENSE Pediatric Body/Cardiac coil.

Positioning with the dS Microscopy coils

1. Place the dStream interface on the tabletop and connect it.
2. Connect the dS Microscopy coil to one of the small sockets on the dStream interface. The arrows indicate these sockets.

3. Position the patient on the tabletop either feet-first or head-first **as close as possible to the isocenter**. The preferred patient position depends on the type of the examination and the size of the patient. Most important is that the patient position allows the coil to be positioned on the area of interest with a coil cable that runs straight.

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4. Do not position the coil in the transverse plane with respect to the bore axis.
   Coils work best when positioned in coronal or sagittal plane.

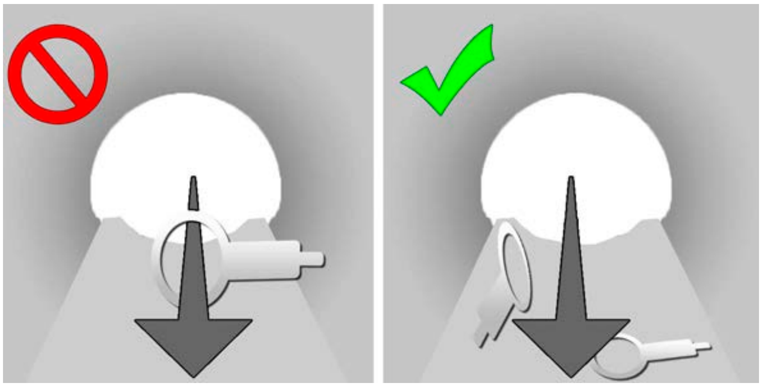

Fig. 206: Incorrect (left) and correct (right) positioning of the Microscopy coil. The arrow indicates the axis of the main magnetic field.

5. To achieve the best possible image quality, make sure that both the coil and the anatomy are perfectly immobilized. Use sandbags and/or straps.

Eye studies

To avoid eye movement, ask the patient to close the eyes or to focus on a specific point in the bore or via a mirror on the wall behind the scanner.

Positioning examples

Fig. 207: Positioning examples with the Microscopy coils: orbit, ear, skin.

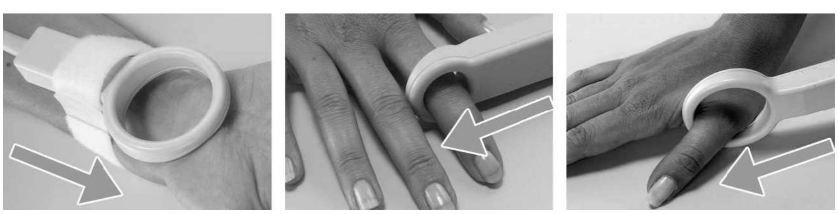

Fig. 208: Positioning examples with the Microscopy coils: placed against the skin, around a digit and around a thumb. The arrow indicates the axis of the main magnetic field.

Scanning

- Start with a large FOV (450 mm) to find the location of the coil.
- SmartSelect will only work with the Posterior coil in scan position. If the Posterior coil is used in holdback position, manual selection of the Microscopy coil is necessary.

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► Proceed with a multistack small FOV (15 mm) survey.

► Then perform high resolution scans.

Positioning with the Phosphorous P-140 and P-140-Flex coil

► The plane of the coil should be kept parallel to the main magnetic field.

WARNING

Use of the Phosphorous coils P-140 and P-140-Flex close to the eyes.

Risk of heating of the eyes.

- **Keep a distance to the eyes of at least 6 cm (2.5 inches) in all directions.**

CAUTION

Handle the coil with care to prevent damage.

- **After unpacking a new coil or storage, the coil requires 24 hours of acclimatization before first use.**
- **Carry the coil by its housing only.**
- **Do not handle the coil by its cables or connectors.**
- **Avoid coil jolts.**

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10 Patient comfort

Patient comfort is important for the good outcome of MR examinations.

Your Philips MRI system comes with several items and features that contribute to patient comfort. Some of these are standard, others optional.

- Ventilation in the magnet bore. See chapter “Adjust Ventilation in Bore” on page 365
- Positioning aids. See chapter “Positioning Aids” on page 223
- In-bore Experience, consisting of:
  - AutoVoice

    To guide the patient through the examination in their own language, announcing breathholds, table movement and scan duration. See chapter “AutoVoice” on page 357
  - ComfortTone

    To reduce acoustic noise levels. ComforTone is a setting under the SofTone parameter.
  - The in-bore video solution.

    To create a calming environment for the patient through video and audio. The in-bore video solution also provides an indication of scan progress and examination duration, and provides additional breathhold guidance. For more information about the In-bore solution refer to the Instruction for Use of the Ambient experience.

AutoVoice

AutoVoice provides the option to give pre-recorded, automated instructions to the patient during scanning. Use AutoVoice to instruct or inform the patient about:

- Breathholds
- Scan duration
- Tabletop movement

Preferred instruction settings can be set at system level. Settings related to language and breathholds can also be customized at examination level or scan level.

Preset instructions

Presets of AutoVoice instructions are delivered with the MRI system. These Philips presets are available in various languages and cannot be changed.

To view the instructions that are available in the presets:

► Click **System**, then **AutoVoice**.

► In the **AutoVoice** window, click the **Customize instruction set** tab.

► Click the arrow next to the drop-down menu and select the language you want to view.

⇨ The list with instructions available within the chosen set is shown.

You can also create your own presets and save them as a new set of instructions. Refer to chapter “Customize instruction sets” on page 361

Set AutoVoice on system level

To enable AutoVoice on system level and to define which features of AutoVoice to use:

► Click **System**, then **AutoVoice**.

⇨ The **AutoVoice** window opens.

► On the **Settings** tab, click the **AutoVoice** check box, to enable, or disable AutoVoice.

Once AutoVoice is enabled, select the type of instructions or information you want AutoVoice to provide.

► Click the check box in front of an instruction to enable or disable it. You can select:

- Guide all patients through breathhold scans.
- Inform all patients about the duration of the scan before the start of each scan.
- Warn all patients before the table moves.

The recovery time controls the interval between successive breathhold instructions in a single scan. To set the recovery time:

► Click the **Recovery time for all patients, between successive breathholds in a single scan** drop-down list

► Select the preferred recovery time from the preset list (5–30 seconds).

You can still change the recovery time between successive breathholds for individual examinations. Refer to chapter “Set AutoVoice on examination level” on page 358.

To select the default AutoVoice language:

► Click on the **Instruction set** drop-down menu arrow.

► Select the desired default language for AutoVoice.

The selected instructions are played for all patients during all scans.

You can still change language settings for individual examinations. Refer to chapter “Set AutoVoice on examination level” on page 358.

If language is changed at examination level, the system will reset to the default language for the following new examination.

Set AutoVoice on examination level

AutoVoice button

Use the **AutoVoice** button in the **Patient Status area** (PSA) to:

- Enable or disable AutoVoice for the current examination only.
- Change the AutoVoice language for the current examination only.
- Adjust the breathhold settings for the current examination only. Breathhold settings that can be adapted at examination level are:

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- Breathhold guidance (automated or manual)
- Recovery time between successive breathholds in a single scan

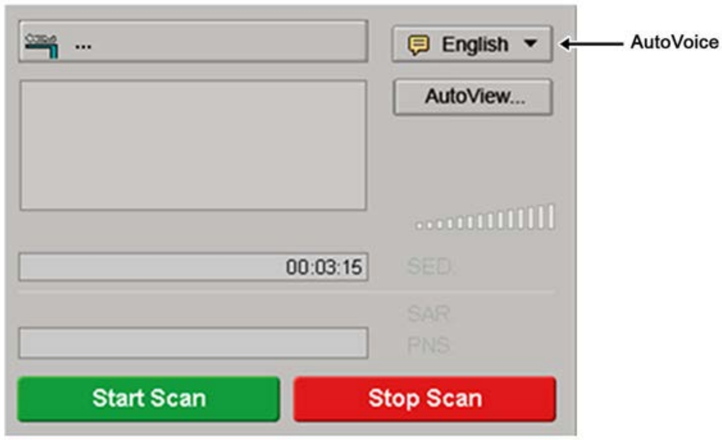
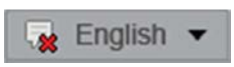


Fig. 209: The AutoVoice button in the Patient Status area.

The AutoVoice button can appear in three different states.

	AutoVoice is disabled.
	AutoVoice is enabled. Selected language is English.
	AutoVoice is enabled and an instruction is playing. Selected language is English.

Enable or disable AutoVoice on examination level

To enable or disable AutoVoice for an individual patient:

- ► In the **Patient Status area**, click the **AutoVoice** button.
- ► Click **AutoVoice - On** or **AutoVoice - Off**, depending on the current AutoVoice settings
- ► Select whether you want AutoVoice on or off for this examination.

If AutoVoice is disabled at system level, but enabled at examination level, the instructions that are selected at system level will be played.

For example:

- At system level both **Guide all patients through breathholds** and **Warn all patients before table moves** are selected but AutoVoice is disabled.
- You then enable AutoVoice at examination level.
- Both the breathhold instruction and the information about table movement will be played during the examination.

Change AutoVoice language at examination level

To change the AutoVoice language for an individual patient:

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- In the **Patient Status area**, click the **AutoVoice** button.
- Do one of the following:
  - Click on a frequently used language, listed in the drop-down menu
  - Click **More** and select a language from the displayed list of languages.

The selected language is used for the current examination only. For subsequent examinations, the system will use the default language again.

Breathhold guidance

The AutoVoice button allows you to set **Breathhold guidance** to automated or manual. The current selection for breathhold guidance is shown in the AutoVoice button drop-down menu.

- Automated: The system gives the breathhold instructions to the patient without your input. If the respiratory belt is connected, initiation of the instructions is based on the signal from the respiratory belt. Once the breathhold instruction is played, the system starts the scan automatically.
- Manual: a pop-window appears before the start of the breathhold. Refer to chapter “” on page 360. You can provide the instruction yourself or let AutoVoice play an instruction. Once the patient has started the breathhold, you are required to manually initiate the scan.

To select Breathhold guidance mode:

- In the **Patient Status area**, click the **AutoVoice** button.
- Click **Breathhold guidance** and select either **Automated** or **Manual.**

The selected Breathhold guidance mode is applied to the whole examination for the current patient but can be changed between scans of an examination, if required.

When AutoVoice is disabled at system level but enabled in the Patient Status area, breathhold guidance will automatically be set to **Manual**.

Recovery time examination level

Some patients require a longer or shorter period of time to recover between breathholds, than the time set at system level. For these patients, you can set the recovery time on an individual basis. To do so:

- In the **Patient Status area**, click the **AutoVoice** button.
- Click **Recovery time**. The current selection is shown in the menu.
- Select the preferred recovery time from the preset list (5-30 seconds).

Breathhold pop-up window

A pop-up window appears when:

- A breathhold scan is started with AutoVoice disabled.
- Breathhold guidance is set to **Manual**.

The pop-up window shows an enlargement of the physiology window. You can choose to give the breathhold instruction yourself or to use one of the pre-recorded breathhold instructions for this scan.

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To give the breathhold instruction yourself:

- ► Provide the breathhold instruction by using the operator-patient intercom.
- ► Once the patient holds his/her breath, click **Continue scan**.

To use one of the pre-recorded breathhold instructions for this scan:

- ► Click the **Play** button on the instruction you want to use (direct, normal or long).
- ► Once the patient holds his/her breath, click **Continue scan**.

Breathhold settings on scan level

For each breathhold scan, settings are displayed on the Physiology tab in the parameter editor window (see table). All or some of these settings can be adjusted, depending on the type of scan.

Breathhold mode	Indicate whether breathholds must be done during inspiration or expiration.
Slices/breathhold	Set the number of slices that must be scanned during a single breathhold.
Breathhold duration	Set the duration of the breathhold in seconds.
Voice instruction (AutoVoice only)	Select the type of instruction that must be played: direct, normal, or long duration.
Breathhold guidance (AutoVoice only)	Select the type of breathhold guidance. Select 'Use AutoVoice settings' to use the system level settings (when enabled on system level), auto voice will be used. Select 'Manual' to force a manual instruction, even when autovoice is enabled on system level.

Tab. 28: Breathhold parameters on scan level.

Customize instruction sets

The AutoVoice preset instructions are listed in the AutoVoice window. To view the presets:

- ► Click **System**, then **AutoVoice**.
- ► Select the **Customize instruction sets** tab.
- ⇨ The list with all available instructions within a set are displayed.

The Phillips presets are available in various languages. To select a different language:

- ► Click the arrow next to the drop-down menu.
- ► Select the language you want to use.

A brief description of each instruction is listed:

- Instruction label: the name of the specific AutoVoice instruction.

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- Duration: time (in seconds) required to play the instruction.
- Instruction text: the actual text of the instruction (displayed in the selected UI language).

► To play an instruction, click the **Play** icon in front of the instruction.

Creating a customized set

To create a customized set of AutoVoice instructions:

► Click **Add set** and do one of the following:

- To create a whole new set, click **Create a new set**.
- To copy the current set and make adaptations to it, click **Duplicate current set**.
- To import a set from another location, click **Import set from a file**.

The Philips presets cannot be changed but they can be duplicated and then customized. The Philips presets are indicated by a lock icon behind the name of the preset.

Create a new set

When you click **Add set** and **Create a new set**, a pop-up window appears.

► Enter a name for the new set.

► Click **Create**.

⇨ A new list with all required instructions appears. The description shows a window for the new instruction text that can be entered in the **Edit and Record instruction** window and the text used in the last selected preset.

⇨ The new name is added to the language drop-down menu.

- Each instruction must be recorded manually
- Instructions without recording are indicated with a red asterisk and a **Record** button.
- Instructions with a red asterisk must be recorded before the set can be used during scans.
- Instructions with a recording are indicated with black text and a **Play** button.
- The notice 'Incomplete' is added behind the name of a set for which not all instructions are recorded.

To record a new instruction, do one of the following:

► Click the **record** button in front of the instruction you want to record.

► Click the instruction you want to record. The line becomes highlighted in yellow. Then click the **Edit** button at the right-end of the instruction.

⇨ The **Edit & Record Instruction** window opens. Refer to chapter “Edit and record instructions” on page 364 for further information.

Duplicate and adapt a current set

When you click **Add set** and **Duplicate current set**, a pop-up window appears.

► Enter a name for the duplicate set. The system provides a name suggestion.

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- ► Click **Duplicate**.
- ⇨ A copy of the list you duplicated appears. The description shows both the text of the original set and a window to contain the text for the adapted set.
- ⇨ The new name is added to the language drop-down menu.

To play a recording, click the **Play** button in front of an instruction.

To edit or record an instruction:

- ► Click the instruction you want to edit. The instruction line becomes yellow.
- ► Click the **Edit** button at the right-end of the instruction.
- ⇨ The **Edit & Record Instruction** window opens. Refer to chapter “Edit and record instructions” on page 364 for further information.

Import a set from a file

Once you click **Add set** and **Import set from a file**:

- ► Navigate to the location of the set you want to import. Select the file.
- ► Click **Open**.
- ► If the name of the file is already present in the preset list, you are prompted to either type another name or to save over the existing file. Click **Import** to import the file under the selected name.

  When the import is complete, the message **Import successful** is displayed.
- ► Click **OK**.
- ⇨ The set is imported and the name of the file is added to the drop-down menu.

Delete or rename a set

Philips preset instructions cannot be deleted or renamed. These presets are indicated with a lock icon behind the name.

To delete a customized set:

- ► Select the set you want to delete.
- ► Click the **Delete** button.
- ► Confirm that you want to delete the set, click **Yes**.

To rename a customized set:

- ► Select the set you want to rename.
- ► Click the **Rename** button.
- ► Type the new name and click **Rename**.

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Export a preset

To export a preset for back-up or use on other systems:

- ► Select the preset you want to export.
- ► Click the **Export** button.
- ► Choose the location where you want to save the preset.
- ► Click **Save**.
- ⇨ The preset is saved with an .ISD extension.

Edit and record instructions

In the **Edit & record instruction** window:

- ► Click in the **Instruction text:** box.
- ► Type the text of the new instruction.

To make a new recording:

- ► Click the **Record** button.
- ► Press the **Talk** button on the operator-patient intercom. The recording starts when the **Talk** button is pressed.
- ► Speak the instructions into the microphone of the operator-patient intercom.
- ► To stop the recording, release the **Talk** button on the operator-patient intercom.
- ► To hear the new instruction, click the **Play** button.
- ► If you want to re-record the instruction, repeat the steps above.
- ► Click **OK** to save and go back to the instruction set.

While recording the instruction, the sound waves are indicated in blue in the **Edit & Record instruction** window. You can increase or decrease the period of silence before and after an instruction. To do so

- ► Hover the cursor over one of the two vertical blue lines. The cursor changes to a horizontal arrow.
- ► Click the blue line and drag to the left or right.
- ⇨ The silent period is indicated with a horizontal blue line. Silent periods are increased (or decreased) per second. The number of seconds is indicated underneath the vertical line. Once you release the vertical line, the silent period is set. You can see the total duration of the instruction underneath the right vertical blue line.

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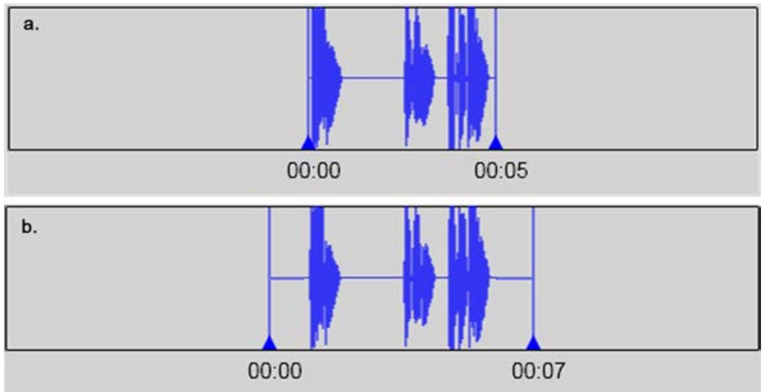

Fig. 210: Sound waves indicated in the Edit & Record window. Without (a) and with (b) an extra silent period before and after the instruction.

Adjust Ventilation in Bore

The MR system has a recommended ventilation level. This is a static level based on average scans and system specific conditions.
The system does not change the recommended ventilation level for e.g. high SAR scans, examination room temperature and patient weights, clothing and conditions. It is solely the responsibility of the operator to determine the level of ventilation for different scans and conditions together with the patient.

NOTICE

For interventional procedures it is advised to scan with patient ventilation switched off and in normal operating mode. Recommended examination room temperature is 21 °C (70 °F).

The ventilation in the bore can be adjusted from the UIM chapter “User Interface Module (UIM)” on page 111, as well as from the console.

Workflow

1. Select 'Examination' and 'Adjust Ventilation in Bore...‘ from the System menu.
   The Patient Ventilation Control is displayed.

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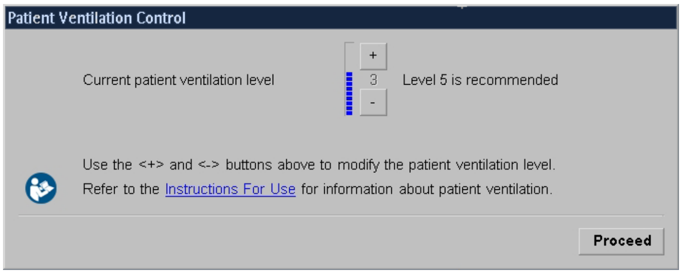

Fig. 211: Patient Ventilation Control with the text: Current patient ventilation level. Level 3 is recommended. Use the <=> and <-> buttons above to modify the patient ventilation level. Refer to the Instructions For Use for information about patient ventilation. |Proceed|

2. If below recommended level, the ventilation level is automatically set to the recommended level.
3. This control displays the current ventilation level and the recommended level.
4. Manipulate the current level by clicking the plus and minus buttons.
5. Click 'Proceed' to close the window.
   Note that a Patient Ventilation Warning is displayed if the patient ventilation level is below the recommended level and a scan is started:

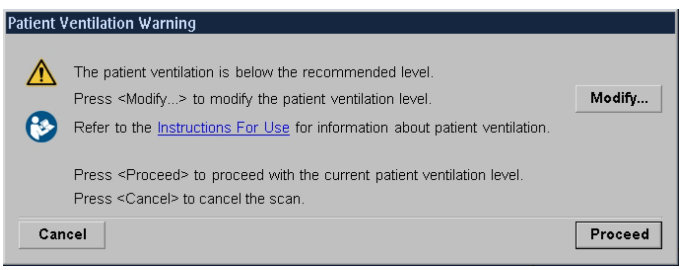

Fig. 212: Patient Ventilation Warning.

Text displayed in warning dialog
The patient ventilation is below the recommended level. Press <Modify...> to modify the patient ventilation. Refer to the Introductions for Use for information about patient ventilation.
Press <Proceed> to proceed with the current patient ventilation. Press <Cancel> to cancel the scan.

The Patient Ventilation Warning requires a deliberate action by clicking one of the following buttons:

- Modify...
  The Patient Ventilation Control is displayed again to modify the ventilation to the recommended level.
- Cancel
  The scan is not started. The Patient Ventilation Warning disappears.
- Proceed
  The set ventilation level is accepted. The Patient Ventilation Warning disappears and a scan can be started.

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NOTICE

Once Proceed is clicked and ventilation is below recommended level, the set level is accepted for the current scan and all subsequent scans of the current patient.
The Patient Ventilation Warning will not be displayed anymore for this patient.

With a new patient and ventilation set below recommended level, the Patient Ventilation Warning is displayed again when a scan is started.

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11 Operator's Console

Keyboard and Mouse Interaction

The keyboard and the mouse are used to input information to the computer.

Mouse

The mouse has three buttons: a left, a middle and a right button. In these Instructions for Use, the following terms are used when referring to the use of the mouse:

- "Click" refers to a single click with the left button.

  "Double-click" refers to a double click with the left button.
- "Right-click" refers to a single click with the right button.
- "Drag" refers to moving the mouse while pressing down the left button.
- "Right-drag" refers to moving the mouse while pressing down the right button.
- Other mouse actions such as combinations of mouse buttons are described where applica-ble.

Keyboard

The keyboard is used to enter text such as patient data and annotations. At times, keyboard entry is disabled by the system. When this occurs, all new keystrokes are ignored and an audi-ble signal is sounded. To rectify this, click on the window to make it active.

A keyboard overlay shows the functions of all function keys on your keyboard in the system ap-plication software.

Fig. 213: Keyboard overlay.

Windows Start key

Pressing the Windows Start key opens the Windows Start menu with Windows functionality, but also dedicated MR functionality.

Fig. 214: Windows Start key.

The Keyboard Function Keys

Help Topics... <F1>

To open the Help system.

New Examination... <F2>

To enter and to select examination data (e.g. patient name, birth date, patient weight) in order to scan a new examination.

Open for Review... <F3>

To display the list of examinations in order to view the imaging series of an examination.

Administration <F4>

To open the Patient Administration panel in order to e.g. copy, transfer, delete and import examinations and/or images.

For more information, see chapter “Administration (Patient Database)” on page 849.

Refresh <F5>

To refresh the screen and to make the latest changes visible.

Manage Job Queue ... <F6>

To check the status of background processes. For more information, see chapter “Check status of background processes with the Job Queue” on page 856.

Autoview <F7>

To display the latest reconstructed image of the current scan.

Start Scan <F8>

To start the next scan or ExamCard.

Menu Bar <F10>

To highlight **patient menu** on the menu bar.

Stop Scan <F12>

To stop the current scan.

- Pressing |F12| (or clicking 'Stop Scan') ONCE will stop the scan immediately: all high power RF and Gradient output is terminated, including acoustic noise. The reconstruction commences if enough data is available.
- If tabletop movement is initated by the TTS function, pressing |F12| (or clicking 'Stop Scan') will abort tabletop movement.

Play (Movie) <Pause>

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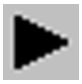

- To play (or pause/stop) the current dataset as a movie.

NOTICE

To view a MultiMovie, link the viewports first and then click 'Play (movie)'.

A MultiMovie shows multiple imaging series in a movie in parallel. For information about linking, refer to chapter “Review toolbar” on page 402.

The Movie functionality is a generic functionality occuring in Graphical PlanScan and all Review and Analysis packages. For more information about movies, refer to chapter “On Toolbars” on page 381.

Operator-Patient Intercom

The Operator-Patient Intercom enables communication with the patient, it provides music to the patient and signals when the patient uses the nurse call.

Fig. 215: Operator-Patient intercom

Number	Description
1	Microphone
2	Emergency Table Stop button*
3	Talk volume
4	Music volume

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Number	Description
5	Patient music on/off
6	Talk and Nurse call light ring
7	Listen on/off
8	Listen volume

*) Note that depending on your system configuration the intercom may not have an Emergency Table Stop button.

You can find definitions of used symbols in the symbol glossary on the following website: http://www.symbols.philips.com

Emergency Table Stop button*

This button has the same functionality as the Emergency Table Stop button on the UIM. Pressing the Emergency Table Stop button will stop the tabletop movement. This can be reset using the Resume button.

Talk volume +/- button

Use this button to adjust the talk volume to the patient. The level is indicated on the LED bar next to the button.

Music volume +/- button

Use this button to adjust the music volume for the patient. The level is indicated on the LED bar next to the button.

Patient music on/off Button

Use this button to toggle the music for the patient on and off. The button icon lights up when music is turned on. Music is muted while the talk button is pressed.

Talk and Nurse call light ring

Press and hold this button to talk to the patient, releasing it will stop communication. Music is muted while the talk button is pressed.

When the pinch ball of the nurse call is pressed more than once within 4 seconds or for more than 1.5 seconds, a beep sounds and the light ring around the talk button flashes to attract the attention of he operator. Press the talk button to stop the beep and the flashing of the light ring.

Listen on/off Button

Use this button to toggle the listen function on and off. The button icon lights up when the listen function is turned on. The listen function is muted while the talk button is pressed.

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Listen volume +/- button

Use this button to adjust the speaker volume of the intercom. The level is indicated on the LED bar next to the button.

Help and User Documentation

Both the Help information and the user documentation are available on the system. Furthermore there is an editable Help available for the ExamCards.

The user documentation also includes a Technical Description, a DICOM Conformance Statement and other information.

Within the application software

From within the MR application software, the Help information and the user documentation can be viewed in the configured application language.

Context sensitive Help

1. Move the cursor on a field that you want more information about.
2. Press |F1| on your Keyboard.

If the selected field includes context sensitive information the related topic is displayed on your screen. If not available, the start page of the Help is displayed and you can search for a topic manually.

Help

The Help system is a compilation of information from the Instructions for Use (three volumes), the Technical Description and the parameter help.

1. Select ‘Help’ on the main menu bar.
2. Select ‘Help topics’. The Help is displayed.

You can search through the help using the table of contents, the index or the word search.

User Documentation

The user documentation includes the Instructions for Use (three volumes), the Technical Description and the DICOM Conformance Statement.

1. Select ‘Help’ on the main menu bar.
2. Select ‘User Documentation’.

A browser window is opened where you can select the user documentation.

From the Windows Start menu

All provided documents can be accessed from the Windows start menu:

1. Press the Windows Start key.

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2. Select **MR-User documentation** and **Index**.
3. Scroll to the required language and select the document you want to view:
   - Help system
   - Instructions for Use
   - Technical Description
   - DICOM Conformance Statement.

Website

You can download the Instructions for Use document also from this website: https://www.philips.com/ifu.
There you can also find instructions on how to order a printed version of the Instructions for Use.

Download

- ► Find the part number of the document you want to download.
  This number can be found on the back cover of the versions that are present on the console. The part number consists of 12 digits, e.g. 4598 014 44051.
- ► Enter the IfU part number in the search field of the website and click the search symbol.
- ► Click on the search result to open the document in your browser.

Note that it is only possible to find the correct document by using the part number from the documents on your console. A search on release number, product and language gives multiple results.

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Introduction to the User Interface and General Information

iPatient provides patient-centric workflow: An intiuitive interface allows users to adapt imaging to the patient in a consistent manner, aided by SmartExam, SmartSelect and user guidance.

This chapter gives an introduction to the user interface and describes generic functionality available throughout the complete user interface with respect to planning, scanning, reviewing and analysis.

Viewports and Windows

A **window** is a visual area containing some kind of user interface. The windows in the MRI user interface have a rectangular shape that can overlap with the area of other windows. They are used for multiple purposes, e.g. they may allow input to processes, or they are used to display notifications and error messages.

A **viewport** is a window dedicated to the display of images, e.g. MR slices, reformats or parameter maps.

Viewport Buttons

► Click any of the viewport buttons in the upper right corner of each viewport to:

- Hide the Toolbar
- Maximize or Minimize the View
- Close the View.

Typical Buttons

Depending on the kind of window, several controls/buttons apply:

Control/Button	Function
Hide	Hides the window.
OK	Leaves the window/browser/editor with changes made, but without applying the current changes.
Apply	Leaves the window/browser/editor with changes made, and applies the current changes.
Proceed	Leaves the window/browser/editor: confirms a selected procedure and goes ahead.
Cancel	Leaves the window/browser/editor without any changes.

The |ESC| key on the keyboard can also be used to close windows similar to Cancel.

Switch between views

One view is always the “current view. If a series is displayed in that view, it is the "current series".

To select another view as current view

► Click on another view.

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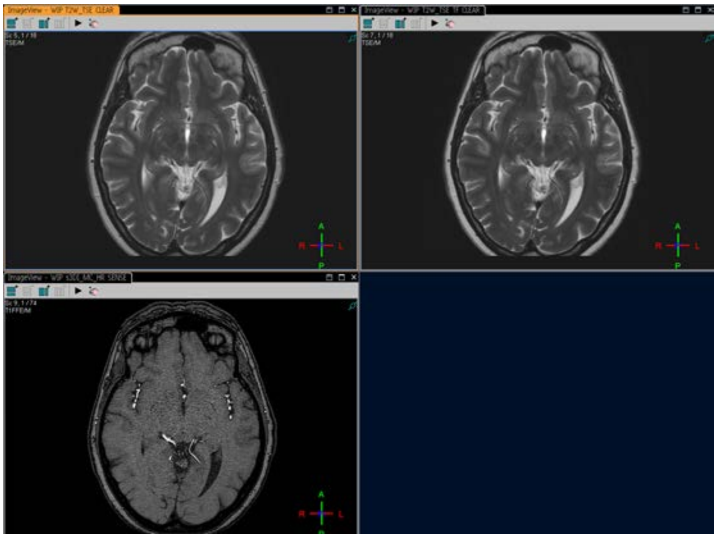

Fig. 216: 3 views in a tiled view: the upper left one is the current one (with orange tab and orange border).

The various controls

The MR User Interface has various controls especially set up to meet the specific requirements of each application. These controls are:

- the **main menu bar** with comprehensive menus to access essential functionality.
- the **application-specific toolbars**, e.g. for planning or reviewing.
  For easy and quick access, the most important functions can be performed via these toolbars.
- dedicated functionality on all **panels** on the system.
- various **right mouse menus** (context menus)

  Right mouse menus are available throughout all applications to facilitate the use of the system and to offer various interaction possibilities.

  – Simply right-click on any viewport/screen area to access the right mouse menu.
- **Keyboard**

  Keyboard functions can be used for several purposes, e.g. for scrolling through images by means of the arrow keys.

Most of the functions in planning, reviewing or postprocessing can be performed via all controls. It's purely a matter of taste which control is going to be used.

For more information about the keyboard functions, refer to chapter “Keyboard and Mouse Interaction” on page 369.

More information about the right mouse menus is available where applicable.

Notifications and Alerts

Standard notifications and error messages show up in the bottom row of windows.

Alerts or notifications that require user attention pop up in dedicated windows.

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Image Information

Information about images and imaging series is given at different locations in the Review and Analysis packages.

About Imaging Series

Information about the imaging series can be displayed when hovering the cursor over the Thumbnail View:

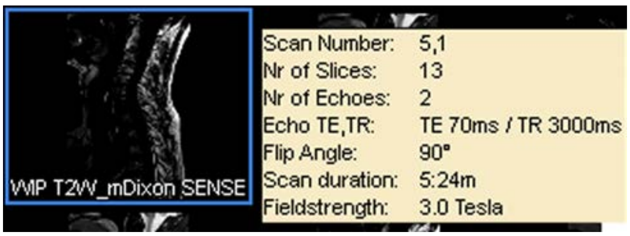

Fig. 217: Information about imaging series in tooltip.

Image Information

Image information in the upper left corner of every image appears when you open an imaging series in any of the Review or Analysis packages.

Every image is displayed with text information:

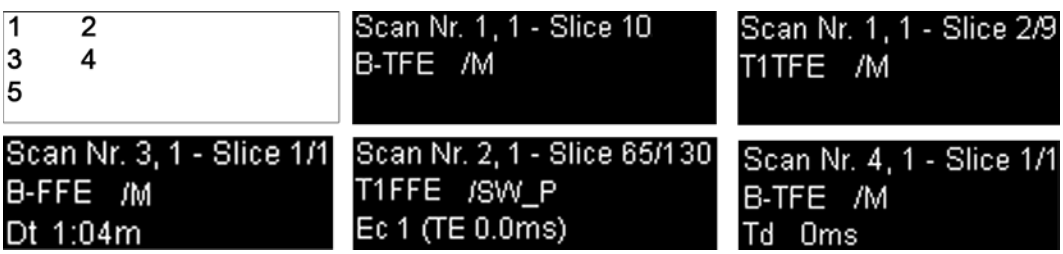

Fig. 218: Typical examples. The upper left image shows the format of the image information: see table below.

Number	Representing	Possible values
1	scan number	1,1 or 2,1 or 3,1 or 4,1 where the first digit increases for scanning steps and the second digit for the postprocessing steps
2	slice number	mostly 2 numbers separated by a "/" where the first digit is the current slice number and the second digit the total number of slices in this series
3	scan technique	e.g. (T)SE - (Turbo) Spin Echo, FFE - Fast Field Echo, (B-)TFE - (Balanced) TFE

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Number	Representing	Possible values
4	image type	e.g. M - Modulus, P - Phase, R - Real, I - Imaginary, SW_M,R,I,P - Susceptibility Weighted-M,R,I,P
5	More	• empty - if not applicable • Dt (dynamic time) - only applicable for dynamic imaging series • Td (Trigger delay) - only applicable for triggered imaging series • Ec1, Ec2 - only applicable for multi-echo imaging series

Tab. 29: Format

Graphical information per viewport

By default, the following graphical information is given in every viewport:

- The fold-over indicator
  that indicates the fold-over direction in which typically MR artifacts occur.
- The 3D coordinate system
  that indicates the Head-Feet (H_F), the Anterior-Posterior (AP) and the Left-Right (LR) direction.
- If applicable a Link symbol
  indicating that imaging series are linked.

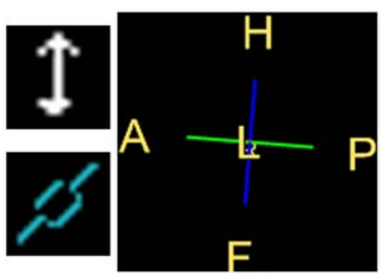


Fig. 219: Fold-over indicator, 3D coordinate system and Link symbol.

Increasing/decreasing the amount of information

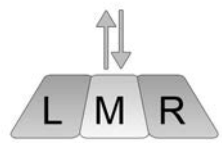
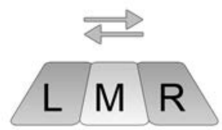
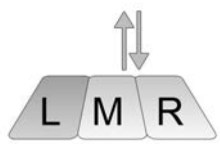
In ImageView, you can increase or decrease the amount of information by means of the button 'Image Information' which is available on the ImageView toolbar. For more information, refer to chapter “Toolbar” on page 518. The amount of information displayed cannot be changed in Review or Analysis packages other than ImageView.

Windowing, Zooming and Panning

Zoom, Pan, Window width and level

Zooming, panning and windowing are performed via direct mouse actions.

Direct mouse actions must start in the current viewport. Mouse movement is not limited to this viewport but to the viewing area of the screen.

Parameter	Mouse button(s) and movement	Movement and Effect
Window level (Brightness)	middle 	• upwards = darker • downwards = brighter
Window width (Contrast)	middle 	• to the right = less contrast • to the left = more contrast
Zoom	middle + right 	• upwards = zooming in; Max. zoom factor of 8 • downwards = zooming out; Min. zoom factor of 0.25
Pan	middle + left 	• to pan in all directions.

Scrolling through images

The way of scrolling through images depends on the view settings and the number of image attributes.

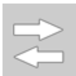
You can use the mouse or the arrow keys to scroll through images.

To scroll through ...	Press the arrow keys	Mouse movement	Effect on image attribute
1st image attribute			Movement to the right increases (to the left decreases) the number of the image attribute.
2nd image attribute			Upwards movement increases (downwards decreases) the number of the image attribute.
3rd image attribute	not applicable		Movement right-upwards increases (left downwards decreases) the number of the image attribute.

Example: Scrolling in a scan with only one image attribute

The image dataset has only slices.

Through slices (or resulting) maps



- ► In the image (or map) viewport, drag to the left or to the right.
- ► Alternatively use the left and right arrow keys.

Example: Scrolling in a scan with two image attributes

The dataset consists of multiple dynamics with multiple slices. The first image attribute are the dynamics, the second one are the slices. First all slices for the first dynamic are displayed, then all slices for the second dynamic and so on.

Through dynamics

- ► In the image viewport, drag to the left or to the right.

Through slices

- ► In the image viewport, drag up- or downwards.

Generic functions for images

The functions listed below can be performed throughout the complete user interface. They are available via the right mouse menus of the image viewports.

In Right Mouse Menus

Interaction Mode

- can be used to define the left mouse usage for interaction with images.

By default, dragging (by means of left mouse button) is used for scrolling. However, depending on the preference of the user, this can be changed. The following options can be enabled:

Possible setting	Corresponding icon	Description (left mouse)
Scroll (default)		Drag to scroll through the dataset.
Zoom		Drag to zoom.
Pan		Drag to pan.
Gray Level		Drag to adjust the gray level.

In the Review and Analysis packages, more options might be available.

Reset Window (Viewing)

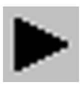
To reset images to original window level and width.

Reset Zoom / Pan (Viewing)

To reset images to original zoom and pan values.

On Toolbars

Play (Movie) <Pause>



- To play (or pause/stop) the current dataset as a movie.

NOTICE

To view a MultiMovie, link the viewports first and then click 'Play (movie)'.

A MultiMovie shows multiple imaging series in a movie in parallel. For information about linking, refer to chapter “Review toolbar” on page 402.

Movie ToolBox

- To adjust the movie settings.
- ► Select 'Movie ToolBox' from the Movie drop-down menu besides the icon.

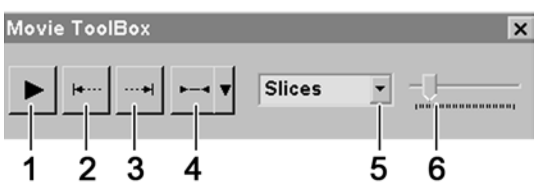


Fig. 220: Movie ToolBox.

Number	Purpose/ Description
1	Click this button to toggle between Play, Pause and Stop movie mode.
2	Click this button, then scroll to the image to start the movie with and click 'Play Movie'.
3	Click this button, then scroll to the image to end the movie with and click 'Play Movie'.
4	Select the type of movie from the drop-down menu: • cyclic (loop): the images are displayed in the order 1 ... n, 1 ... n etc. • bounce (yoyo): the images are displayed in the order 1 ... n, n ... 1, 1 ... n, etc.
5	Select type of image for the movie, e.g. slices or phases.
6	Adjust the movie speed by dragging the slider.

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Viewing

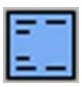
To adjust the viewing settings:

Orientation (Viewing)

To change the orientation of the images:

- Mirror, Flip,
- Rotate clockwise, Rotate counterclockwise,
- Reset orientation,
- Display Images in Radiological View

Image Information (Viewing)



- To define the amount of displayed image information:
- minimum: no text is displayed,
- standard: scan, image number and the scan name are displayed,
- maximum: also the offcenter values, the window values (width and level) and the caliper are displayed.

Interpolate (Viewing)

To interpolate the image(s).

Invert Gray Level (Viewing)

- To invert the images of the current dataset (change black and white in the grayscale).

Capture ...

To capture images and save them. Type of image and destination are to be defined in the 'Capture' pop-up window. Check according to your preferences:

- 'Capture Selected Image' captures the current image.
- 'Capture ImageView' captures the current image including orange border and ImageView tab.
- 'Capture Full Screen' captures the full screen.
- 'Capture Slices' captures all slices of the current imaging series.
- 'As Displayed and Annotated' or 'As Acquired' allow to capture images with or without their window/zoom settings and annotations.
- 'Save to External Folder' allows to save the data to an external folder.

  In this case, it is necessary to browse to this external folder.
- 'Save to Patient Database' allows to save the data to the patient database.

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- In order to include the hospital name, check the eponymic option.

The function 'Capture ...' as part of Viewing is only available in Review and Analysis packages, not in Graphical PlanScan.

Save Presentation State <Ctrl+S> (Viewing)

To save a special way of presenting images.

Reload Presentation State <Ctrl+R> (Viewing)

To reload a special way of presenting images.

Reset Window (Viewing)

To reset images to original window level and width.

Reset Zoom / Pan (Viewing)

To reset images to original zoom and pan values.

Generate Series and ExamCards

Once the 'Generate Series' function is used and a new imaging series generated, a postprocessing item will be added to the ExamCard. The performed operation will be part of the current ExamCard and in such a way will automatically be performed whenever the ExamCard is executed again.

ROIs

In MRI, a Region of Interest (ROI) is a selected subset of voxels within a dataset: contours need to be drawn to define the region of interest.

The ROI function is only applicable within some of the postprocessinges packages.

In the following sections, the various ROI functions *Draw, Propagate, Edit, Rename and Delete* are described.

NOTICE

Not all of these ROI functions are not available in every package.

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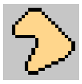
Draw a ROI

-> Smoothed Polygon



Click to start up the ROI definition.
Draw with the left mouse button (no dragging).
Click as often as needed to add new points and to define a smoothed polygon.
Control points are created / deleted by pressing |Shift| and clicking on a contour or point.
Double-click to end drawing and to confirm the shape.
Clicking |ESC|, the entire contour is cancelled.

-> Ellipse

Click twice to define one axis of the ellipse, click once more to define the other axis of the ellipse.
The area of the shape and the intensity mean value will be displayed by default.
To move the shape, drag the center of the shape.
To modify the shape, drag the outer edge of the shape.

-> Freehand

Click to start up the ROI definition.
Draw with the left mouse button (no dragging).
Click to end drawing and to confirm the ROI.
The area of the shape and the intensity mean value will be displayed by default.

Delete and copy a ROI

1. Right-click on the ROI to open the ROI context menu.
2. Select any of the options:
   - Cut <Ctrl+X>
   - Copy <Ctrl+C>
   - Copy To All
   - Delete <Del>
   - Delete All

Rename a ROI

You can rename existing ROIs.

► Right-click on a ROI and select 'Rename'.

- It is advised to rename the ROIs for easier identification (e.g. left breast, right breast, tumor, cyst). It might be helpful to add the slice number to the name so that navigation to the respective ROI is facilitated.
- If multiple ROIs are renamed to the same name, automatically a numerical extension is added to this name, e.g. Hemisphere, and Hemisphere 2

Edit a ROI

- |Ctrl| in combination with the left mouse click, selects respectively deselects a ROI.
- |Shift| in combination with the left mouse click enter the ’ROI Edit’ mode.

Scaling of Imaging Series

Imaging series are linearly scaled.

Scaling is unique per imaging series. As a consequence, the scaling will also be different in e.g.

- imaging series with and without fat suppression:
- pre- and post-contrast imaging series

NOTICE

To ensure the same scaling for pre- and post-contrast imaging series, these scans should be scanned in dynamic mode.

The ExamCard function 'Split Dynamics' can be used to ensure a similar scaling of all required scans.

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Screen Layout, Menus and Windows

Screen Layout

Planning, scanning, reviewing and postprocessing can be done in one MRI environment. Screen areas are reserved for specific operations such as planning or reviewing.

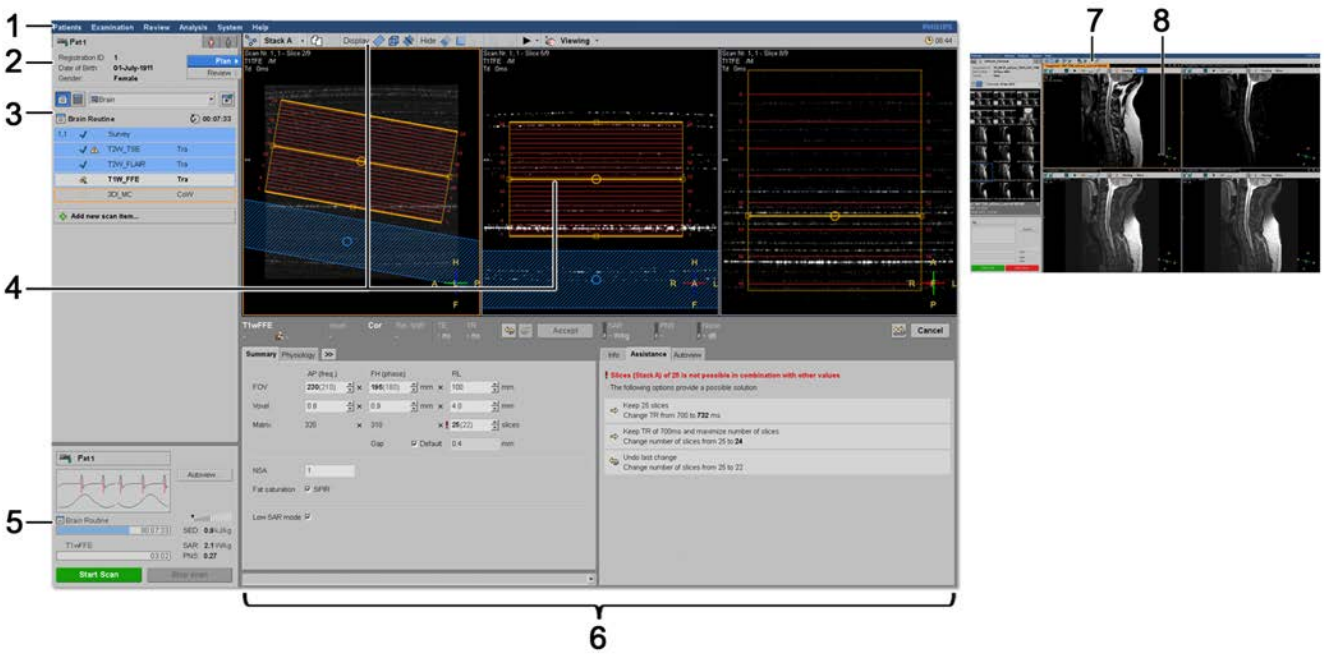

Fig. 221: Screen layout in Plan mode (large image) and in Review mode (small image).

Number	Item	Purpose/Description	More information
1	**Main menu bar**	To access the corresponding menus with comprehensive functionality.	chapter “Main menu bar and corresponding menus” on page 387
2	**Launch pad** with one tab for scanning and two tabs for reviewing, the buttons 'Plan' and 'Review' and information about the current examination.	To switch between reviewing and scanning tabs and to switch between Plan and Review mode.	chapter “Launch Pad” on page 392
3	**List View**= (Current ExamCard) or **Thumbnail View** (Pictorial Index)	To toggle between List View (Current ExamCard) and Thumbnail View (Pictorial Index) List View shows the items of the current ExamCard whereas Thumbnail View shows a representative image per series of all imaging series, e.g. scans, reformats.	chapter “List View or Thumbnail View” on page 393
4	**Graphical PlanScan area** with Planning toolbar.	To graphically plan the imaging series of an examination.	chapter “Graphical PlanScan area ” on page 395

Number	Item	Purpose/Description	More information
5	**Patient Status (PS)** area	To monitor scan progress and to monitor the status of the patient during the examination: physiology signals and e.g. SAR, SED and PNS.	chapter “Patient Status area” on page 400
6	**Parameter Editor** or **ExamCards Window**	To access everything around parameters via the Scan Dashboard, the Parameter Groups tabs, and the Scan Assistance. To manage ExamCards in different views.	chapter “Parameter Editor” on page 437 chapter “ExamCards window” on page 424
7	**Review toolbar**	To enable/disable/adjust generic reviewing settings.	chapter “Review toolbar” on page 402
8	**Reviewing area**	Reserved for reviewing imaging series with a user-defined layout.	chapter “Reviewing area” on page 404

Main menu bar and corresponding menus

Fig. 222: Main menu bar in Plan and Review mode. Menus or menu options that are not applicable will be grayed out.

The Main menu bar allows to access menus with comprehensive functionality:

1. Patients menu
2. Examination menu
3. Review menu
4. Analysis menu
5. System menu
6. Help menu

When function keys are part of a menu option, the indicated function key can be pressed instead of selecting a menu option, e.g. <F2> means that the function key F2 can be pressed instead of selecting the function 'New Examination' from the Patients menu.

Patients menu

This section describes the menu options that are available via the 'Patients' menu.

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New Examination... <F2>

To enter and to select examination data (e.g. patient name, birth date, patient weight) in order to scan a new examination.

Open for Review... <F3>

To display the list of examinations in order to view the imaging series of an examination.

... or <Patient Name>

To switch between reviewing and scanning (examination) tabs.
This is an alternative to the 3 buttons in the chapter “Launch Pad” on page 392.

Three menu options are available which represent the three patients slots available for scanning and viewing. They are displayed as:

- ...
  when this patient tab is not filled with an examination
- <patient name>
  when this patient tab is filled with an examination

Administration <F4>

To open the Patient Administration panel in order to e.g. copy, transfer, delete and import examinations and/or images.

For more information, see chapter “Administration (Patient Database)” on page 849.

Close Exam...

To close the current examination.

Examination menu

This section describes the menu options that are available via the 'Examination' menu.

Autoview <F7>

To display the latest reconstructed image of the current scan.

Reuse Scan Items (from Previous Examinations) ...

To display the list of examinations in order to select and consequently reuse scan items from a previous examination.

- ► Browse to the patient and the ExamCard to be reused.
- ► Drag this ExamCard into List View.

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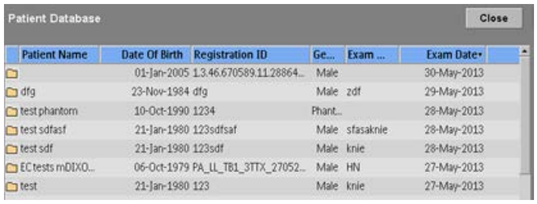

Fig. 223: Patient Database.

NOTICE

This function can be used to display the imaging parameters of previously scanned series.

Repeat Prescans

To repeat previously performed prescans for the current ExamCard.

Note that **Repeat Prescans** is disabled (grayed out) when a scan set with multiple scans is in execution.

SmartExam

To access SmartExam related functionality for the current examination. This menu entry opens a submenu with several SmartExam options:

- Show SmartGeometries
- Improve SmartGeometries with Current Planning ...
- Reset to SmartPlan
- Analyze SmartSurvey
- Stop offline analyzing

For more information, see chapter “SmartExam” on page 470.

Enable Automatic Start Scan

To enable/disable the automatic start of a scan.

Enable Autopush to Workstation

To enable/disable the automatic transfer of an examination to a workstation (if connected) upon completion.
For more information, see chapter “Autopush to Workstation and to DICOM Node” on page 504.

Save ExamCard

To save the current ExamCard under a user defined name.

Adjust Ventilation in Bore ...

To increase or decrease the ventilation in the bore. For more information, see chapter “Adjust Ventilation in Bore” on page 365.

Depending on your system's configuration, this menu option is available or not.

Choose Physiology Properties ...

- To select the physiology signal (e.g. VCG, PPU, Respiratory) for display and adjust the display settings.
  For more information, refer to chapter “Display of physiology signals” on page 139.

Navigator Display ...

To enable/disable the display of navigator data.

Data Monitoring...

To monitor data transfer.

Review menu

The Review menu gives access to the reviewing packages that are available on your MRI system, e.g. ImageView, VolumeView.

For more information about these packages, see chapter “Reviewing images” on page 517.

NOTICE

Depending on the commercially available options on your MRI system, less packages could be available.

Analysis menu

The Analysis menu gives access to the postprocessing packages that are available on your MRI system:

- PicturePlus
- Diffusion Registration
- Diffusion
- ImageAlgebra
- Basic T1 Perfusion
- QFlow
- NeuroPerfusion
- FiberTrak
- IViewBOLD

- SpectroView

For more information about these packages, see chapter “Analyzing MR datasets” on page 551.

NOTICE

Depending on the commercially available options on your MRI system, less packages could be available.

System menu

This section describes the menu options that are avaiable via the 'System' menu.

Capture the Screen ... <Ctrl+P>

- To make a screen capture and save it into a DICOM file with a default name.
  This function is available in the 'System' menu and on the Review toolbar.

Manage Job Queue ... <F6>

To check the status of background processes. For more information, see chapter “Check status of background processes with the Job Queue” on page 856.

Print History

To display the previously initiated printing job by means of the Job Queue, see chapter “Check status of background processes with the Job Queue” on page 856.

Enable Autopush To DICOM Node

To enable/disable the automatic transfer of an examination to a DICOM node (if connected) upon completion.
For more information, see chapter “Autopush to Workstation and to DICOM Node” on page 504.

Manage Hospital ExamCards ...

To open the ExamCard Editor. For more information, see chapter “ExamCard Editor” on page 426.

SmartExam Tools

To modify SmartExam settings and/or the SmartGeometry database by means of the options:

- User Confirmation Mode
- Add Sample Data Allowed
- SmartGeometry Database Editor ...
- Export SmartGeometry Database ...

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- Import SmartGeometry Database ...

For more information, see chapter “SmartExam” on page 470.

SPT ...

To access the System Performance Tool (SPT).

Feedback ...

To give customer feedback and report an issue to Philips.

For more information, see chapter “Customer Feedback” on page 886.

AutoVoice settings

To customize AutoVoice settings on system level and to create customized instructions. For more information, refer to chapter “AutoVoice” on page 357.

Image Display Settings

To customize image orientation and slice order settings for image review. For more information, refer to chapter “Image Display Settings” on page 543.

Exit

To exit the system software.

Help menu

This section describes the menu options that are available via the 'Help' menu.

User Documentation...

To access and open the User Documentation via the User Documentation window.

Help Topics... <F1>

To open the Help system.

About ...

To display system name, System Reference Number (SRN), field strength, technical and regulatory information.

Launch Pad

The Launch Pad allows to switch between up to three examinations. For this purpose, three examination tabs are available, one for scanning/planning and reviewing, the other two only for reviewing. They can be filled with three different examinations which can be processed at the same time and easily be switched between.

Furthermore the Launch Pad allows to switch between Plan mode and Review mode for the examination currently being scanned.

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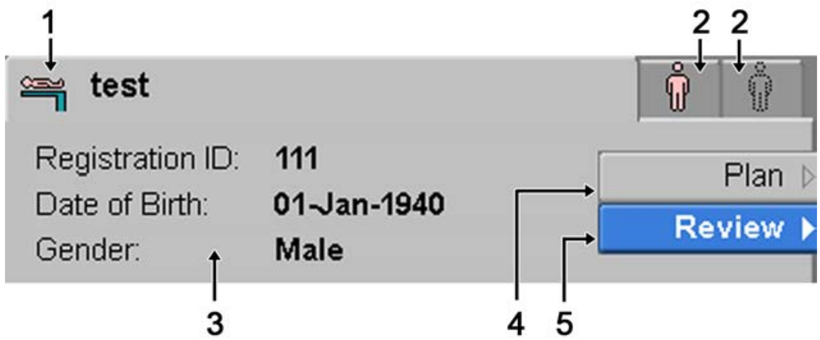
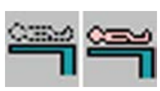
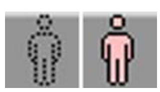


Fig. 224: Launch Pad. 1 - Scanning Tab button. 2 - Reviewing Tab button. 3 - Registration ID, Date of Birth and Gender of current examination. 4 - Plan button. 5 - Review button. Note that the Plan and Review button are only available for the currently scanned patient (in the scanning tab).

Switch between Reviewing and Scanning/Planning Examination Tabs

► To switch to the examination in another tab, click on any of the buttons representing these tabs:

Button	Type of tab	To replace an examination in this tab, use:
	Scanning	'New Examination' from the Patient menu An empty tab is indicated by the button with black outline. The colored button represents a tab with an examination loaded.
	Reviewing	'Open for Review' from the Patient menu An empty tab is indicated by the button with black outline. The colored button represents a tab with an examination loaded.

Switch between Planning and Reviewing

When the scanning tab is selected, the buttons 'Plan' and 'Review' are available. They allow to switch between planning and reviewing for the current examination.

► Click the 'Review' button to switch to the reviewing environment.

The complete image area can be used for reviewing.

► Click the 'Plan' button to switch to the planning environment.

In planning mode, the image area is reduced to 3 view ports in the upper part of the screen. In the lower part, the Parameter Editor with its components is displayed.

List View or Thumbnail View

You can toggle between the List View which displays the Current ExamCard AND the Thumbnail View (Pictorial Index) which displays thumbnails of all imaging series for the current examination.

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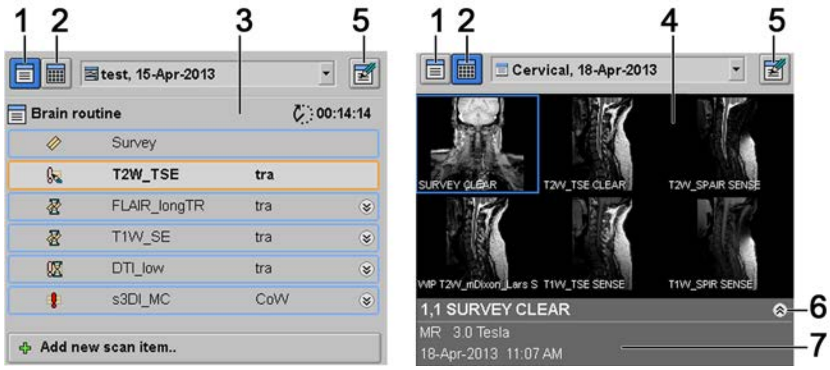

Fig. 225: Left: Current ExamCard in List view, Right: Thumbnail View. 1 - 'Switch to List View' button (left: enabled, right: disabled), 2 - 'Switch to Thumbnail View' button (left: disabled, right: enabled), 3 - Current ExamCard, 4 - Thumbnail View, 5 - ExamCard Properties button (in both images: enabled), 6 - Button to expand/collapse the information about the current imaging series (blue frame around thumbnail), 7 - Information about imaging series. This information can be expanded by clicking '6' ('Expand' button).

The **ExamCard Properties** button is only available in Plan mode.

Thumbnail View

The Thumbnail View (also referred to as Pictorial Index) is particularly useful in reviewing imaging series as it gives a preview of the imaging series. It shows one thumbnail (representative image per series) per imaging series, e.g. for scan protocols, reformats, if applicable.
The Thumbnail View is empty for a new examination.

At the bottom of the Thumbnail View, image information about the current imaging series is displayed. This information can be expanded or collapsed.
Hovering the cursor above the thumbnails also displays some of this information.

List View

The List View shows the ExamCard that is currently in use at the system for

- planning (including automatic planning by means of SmartExam)
- scanning
- automatic processing (SmartLine processing).

In order to start scanning, it is required to select an ExamCard and make it the current one.

To make an ExamCard the current ExamCard,

► simply drag and drop the required ExamCard from the (Single or Double) ExamCard Database View (see ExamCard Manager) into the List View.

  The ExamCard opens and automatically shows up with all its ExamCard items:

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Graphical PlanScan area

In a MRI examination, first survey images are performed. The consecutive scans are planned on these survey images (mostly orthogonal images in multiple orientations), in the Graphical PlanScan area.

Images from any other series can also be used for planning purposes. Furthermore you can plan on movies. This is especially helpful in Cardiac imaging.

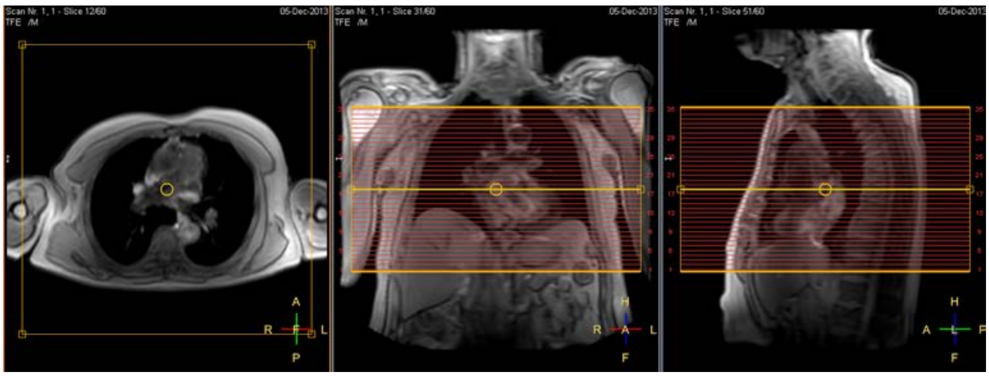


Fig. 226: Graphical PlanScan area: toolbar and viewports.

In the Graphical PlanScan area, the Planning toolbar and the PlanScan Overlay are the essential tools.

Initiate planning in the Graphical PlanScan area

► Double-click on a scan protocol in the List View to initiate planning.

Graphical PlanScan starts up with its planning toolbar and three view ports with images and overlay.

Load images into the three viewports of the Graphical PlanScan area

▷ After completion of the survey images:

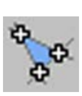
► drag the completed EC item (e.g. survey) from the List View into the Graphicl PlanScan area.

If the EC item consists of images of different orthogonal orientations (e.g. Multistack Survey), an image of each orientation will automatically be displayed in every viewport.

Planning toolbar

The planning toolbar is only available in Plan mode. It offers the following functions:

3 Point Planscan



- To enable/disable 3 Point Planscan.
  3 Point Planscan is a tool which helps to define an irregular plane. The plane is determined by the placement of three points on two or more images of different orientations.

Workflow

- ► Activate ’3PPS’.
  The 3PPS specific toolbar is displayed instead of the normal planning toolbar.
- ► Place the three points on any of the three images selected in the planning view ports:
  - Click the icon for point 1 on the toolbar, then click in the image to define point 1.
  - Click the icon for point 2 on the toolbar, then click in the image to define point 2.
  - Click the icon for point 3 on the toolbar, then click in the image to define point 3.
- ► To restart or change the positioning of the points click |Off|.
- ► Click the icon |Compute plane| to perform the Three-point planscan.
- ► Click the icon |3PPS| again to return to normal planscan.
  The angulation from the 3 Point PlanScan are taken over and displayed.
- ► Proceed with routine planning.

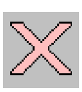
Stack A, B, ... drop-down menu

- To switch between stacks during planning.

Add Current Geometry

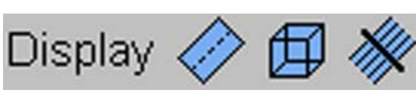
- To add the current geometry to the geometry database for reuse.

Delete Current Geometry



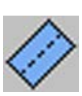
- To delete the current geometry from the geometry database.

Display ...



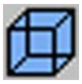
To adjust the display of the imaging volume in planning mode.

Box Mode



- To display the imaging volume as box.

3D Mode



- To display the imaging volume in 3D mode.

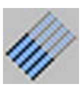
All Mid Planes

- To enable/disable the display of all midplanes.

Hide/Show

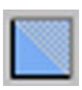
To hide/show the display of the imaging stack, the imaging volume or the slab.

Hide/Show Stack



- To hide/show the current stack.

Hide/Show Volume



- To hide/show the current volume.

Hide/Show Slab

- To hide/show the current REST slab.

Scan Align

- To align scans, especially with table movement to cover long anatomical areas.

Ortho

- To plan the current stack or volume orthogonal to the slice in the current viewport.
  Ortho copies the angles from the image in the current viewport.

► In a planning viewport, scroll to the slice which you want to plan the stack orthogonally to.

► Click the **Ortho** button.

⇨ The planning of the current stack or volume is updated immediately.

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Center

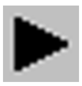
- To plan the current stack or volume with the same offcenter values as the slice in the current viewport.
  center copies the offset from the image in the current viewport.

► In a planning viewport, scroll to the slice which you want to use to center the stack.

► Click the **center** button.

⇨ The planning of the current stack or volume is updated immediately.

Play (Movie) <Pause>



- To play (or pause/stop) the current dataset as a movie.

NOTICE

To view a MultiMovie, link the viewports first and then click 'Play (movie)'.

A MultiMovie shows multiple imaging series in a movie in parallel. For information about linking, refer to chapter “Review toolbar” on page 402.

The Movie functionality is a generic functionality occuring in Graphical PlanScan and all Review and Analysis packages. For more information about movies, refer to chapter “On Toolbars” on page 381.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

PlanScan Overlay

This PlanScan overlay includes the display of volume or the stack(s) of slices, and if applicable e.g. (REST) saturation slab, shim box or navigator.
It can be adjusted by means of the functions available on the toolbar, see chapter “Planning toolbar” on page 395.

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Display Conventions

Color	Item displayed
yellow	center slice and outer slices of stack or volume that is to be planned, or cross-sections with these slices
red	every slice of stack or volume that is to be planned, or cross-sections with these slices
blue	saturation (REST) slabs For information about REST slabs, see Help.
green	shim volume For information about RF Shimming, see Help. For information about B0 Shimming, see Help.
white	navigator For information about Navigators, see Help.

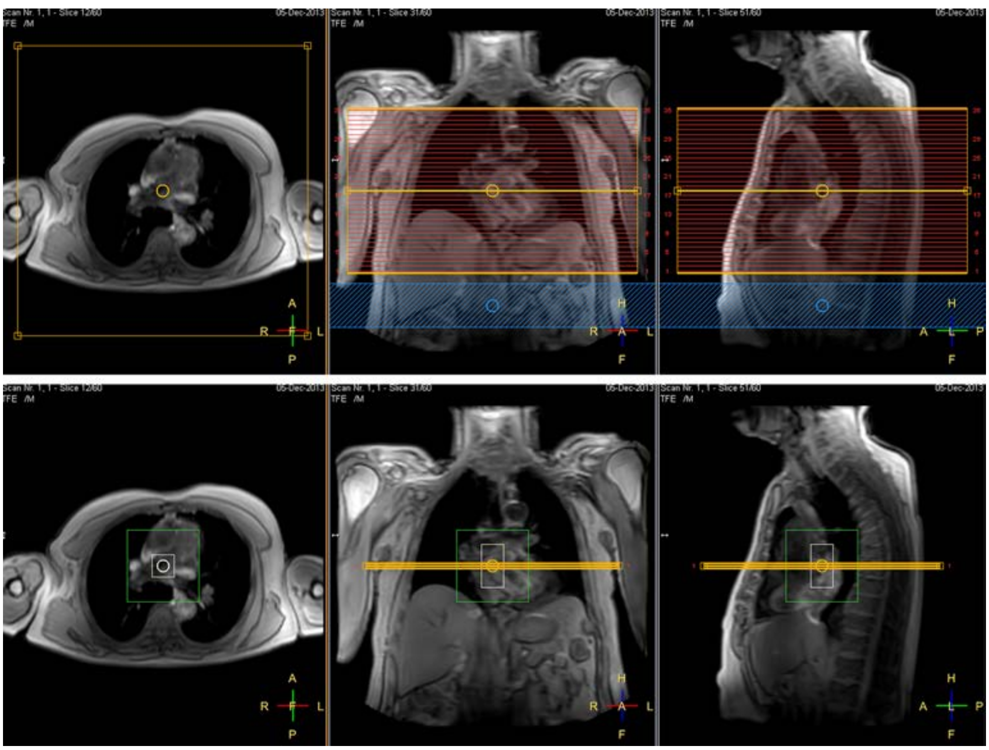

Fig. 227: Examples of planscan overlay according to above conventions.

NOTICE

To see the slice intersections (as slices or as a box), the (survey) image must be perpendicular to the planned slices.

When the (survey) image is parallel to the planned slices, the box slice intersection is displayed.

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NOTICE

All images on the screen must have been scanned with the same subanatomy and patient position (Head first/Feet first, supine/prone).

Exit Planscan

► Click |Accept|.

The status of the EC item being planned changes to 'ready to run'.

Another scan can be planned while execution of the scan(s) is in progress.

NOTICE

Clicking |Accept| accepts any changes made to parameters while clicking |Cancel| concedes that all changes made will be lost.

Patient Status area

In the Patient Status (PS) area , information about the currently running scan and ExamCard is available.

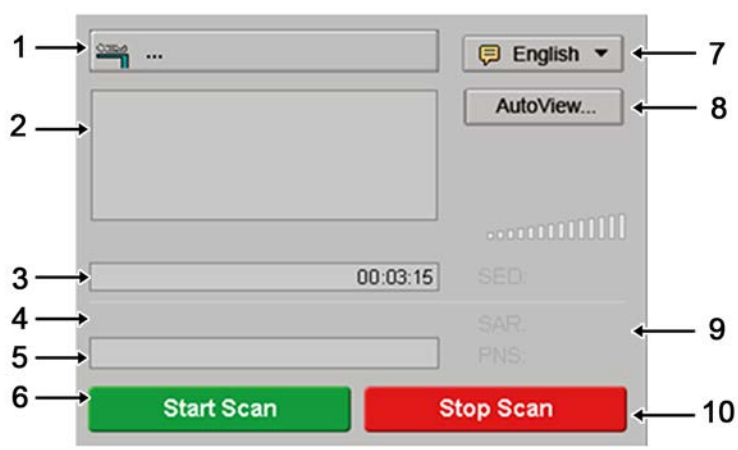


Fig. 228: Patient Status area. 1 - Patient name, 2 - Reserved for physiology signal (if connected), 3 - Scan progress bar, 4 - Message line, 5 - ExamCard progress bar, 6 - Start Scan button, 7 - AutoVoice button, 8 - Autoview button, 9 - Status indication area, 10 - Stop Scan button.

Status Indication area

The Status Indication area indicates the status of:

- SED (Specific Energy Dose),
- SAR (Specific Absorption Rate),
- PNS (Peripheral Nerve Stimulation).

Scan Assistance

By clicking on the tabs, the Scan Assistance allows to switch between the display of:

- Info,
- Assistance,
- Autoview.

Info

The Info tab gives information about the current ExamCard or the current scan protocol. Two types of information are available according to the template information: 'Tips' and 'Info' where 'Info' describes the protocol or ExamCard and 'Tips' includes planning tips.

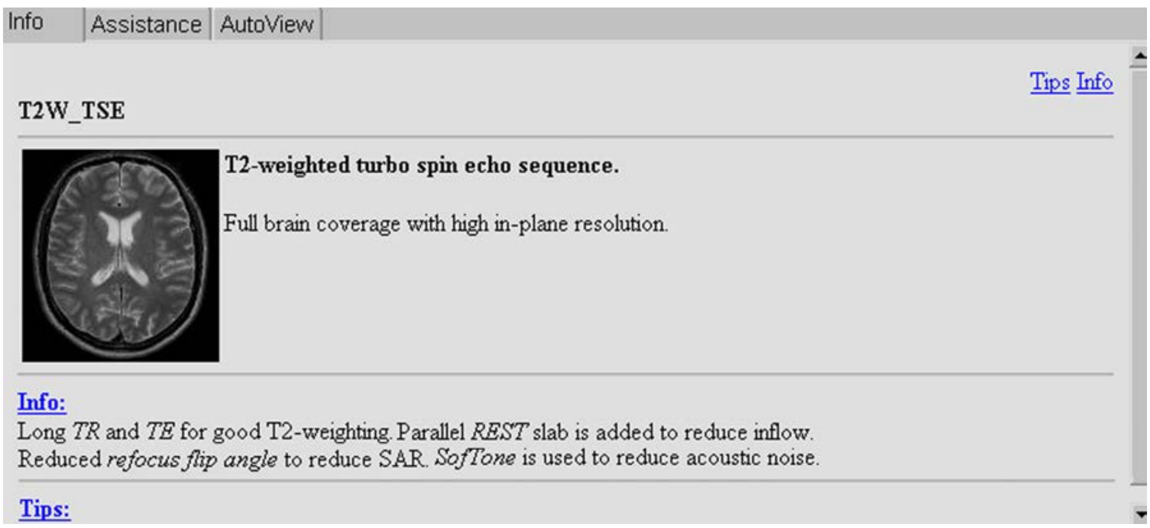


Fig. 229: Info about the current scan protocol.

The 'Info' for ExamCards or scan protocols in the Hospital Database can be edited according to the changes made to the ExamCard.

Edit the Info

- ► Right-click on an ExamCard or a scan and select 'Edit'.
- ► Modify the info text.
- ► Deselect 'Edit' when completed.

Assistance

The Assistance tab gives tips on how to efficiently solve conflicts.

Fig. 230: Conflict: "Current parameter set is invalid. Click Undo (if available) to reverse changes or resolve conflict manually." Proposal for solution: "Select one of the following parameter adjustments: Undo last change. Change SENSE from Yes to No."

AutoView

AutoView is a tool that allows to monitor scanning and reconstruction. If enabled, the latest reconstructed image of the scan currently in progress is displayed here.

Review toolbar

The Review toolbar is only available in Review mode. It applies for all Review and Analysis packages available and offers generic review functions.

To access Review mode

►  Click any of the Reviewing Tab buttons to switch to a reviewing tab.

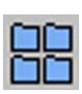
OR

►  Click the Scanning Tab button to switch to the scanning tab, and then click the '**Review**' button.

The Review toolbar will be displayed.

The Functions on the Review toolbar

Tile All Views



- To arrange all views in a tiled layout.

Tab All Views

- To arrange all views in a tabbed layout.

Link

- To apply a link between selected imaging series.

► Select multiple imaging series in multiple viewports:

click on the first viewport, keep |Shift| or |Ctrl| pressed and click on the other viewports.

► Click 'Link'.

► Select from the drop-down menu:

- Scroll/Movie
  Scrolling through images occurs simultaneously with linked imaging series. All image views of linked series show images with identical slice positions or with slice positions as close to each other as possible. The same applies for movies of linked imaging series.
- Zoom/Pan
  Zooming/panning occurs identically for linked imaging series.
- Gray Level
  Gray level adjustments are automatically performed for all linked imaging series.
- All
  Scroll/Movie, Zoom/Pan and Gray Level will be applied in the same way for linked imaging series.

A Link symbol is displayed in the upper right corner of the viewport when imaging series are linked.

Unlink All

- To remove all links between selected views.

Add to Link

- To add the current imaging series to the current link.

► Click 'Current Link' and select the link where you want to add a scan to.

► Select one or multiple imaging series.

► Click 'Add to Link'.

Remove from Link

- To remove the current imaging series from the current link.

Capture the Screen ... <Ctrl+P>

- To make a screen capture and save it into a DICOM file with a default name.
  This function is available in the 'System' menu and on the Review toolbar.

Set Selected Viewer as Source for Cross-Reference

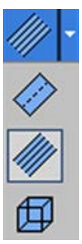
- To select a viewer as source for cross-reference in order to display cross reference lines on the other viewers.
  This function works in close cooperation with the function 'Enable Stack display mode selection'.

► Click the viewer that is supposed to be the source for cross-reference.

► Click 'Set Selected Viewer as Source for Cross-Reference'.

► Click 'Enable Stack display mode selection' and select any of the options for the cross-reference display.

Enable Stack display mode selection



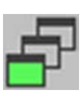
- To enable the display of cross-reference lines on the viewers other than the source for cross-reference viewer.
  This function works in close cooperation with the function 'Set Selected Viewer as Source for Cross-Reference'.

► Once a source for cross-reference is defined, click 'Enable Stack display mode selection'.

► Select any of the options for the cross-reference display from the drop-down menu:

- Box Mode
- Slice Mode
- 3D Mode.

Package Manager



- To open the Package Manger.
  The Package Manager is used to easily switch between examinations/views and to stop the execution of packages.
  For more information, refer to chapter “Package Manager” on page 405.

Reviewing area

All viewports are available for reviewing by means of the Review and/or Analysis packages and can be divided in as many view ports as required.

The Review toolbar and various controls of the Review and Analysis packages offer the most important functions. For more information, see chapter “Review toolbar” on page 402, chapter “Reviewing images” on page 517, and chapter “Analyzing MR datasets” on page 551.

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Select an examination

Select an examination from the list of examinations

1. Select 'Open for Review' from the 'Patient' menu.

   The list of available examinations with scans/reconstructions is displayed.
2. Select an examination from the list.
3. Click 'Proceed'.

   The selected examination becomes the current examination.

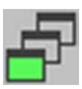
Select an examination by switching between the reviewing slots

► Click on another 'Reviewing Slot' button.

Package Manager

The Package Manager is used to easily switch between examinations/views and to stop the execution of packages.

Furthermore the Package Manager assists the user in avoiding performance degration of the system. Performance degration may occur when too many packages are opened or too many instances of a package are opened.

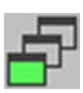
 The system status is indicated on the Reviewing toolbar as part of the 'Package Manager' icon. The icon is:

- Green; at normal system performance.
- Yellow; when system performance may degrade.

  It is advised to close packages.
- Red; when the maximum number of packages is reached.

  The workflow cannot be continued.

Access the Package Manager

►  Click the 'Package Manager' icon on the Reviewing toolbar.

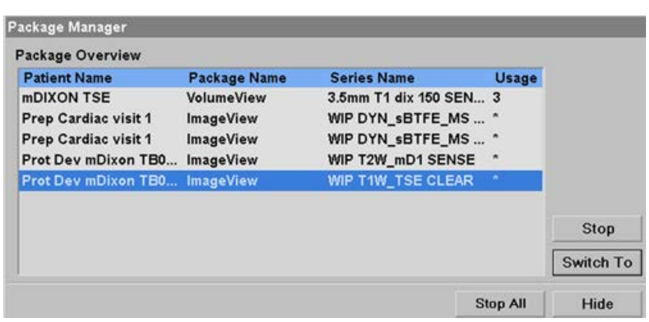


Fig. 231: Package Manager window with the Package Overview.

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For every currently loaded package, the following items are displayed in columns:

- Patient Name,
- Package Name,
- Series Name,
- Usage:
  Estimated memory usage, rated with one, two or three stars. The more stars, the higher the memory usage.

The window always stays on top and can be closed by clicking |Hide|.

Switch views

- ► Select the package to switch to by clicking on it.
  For ease of display, you can sort the packages by case, package, used data set or estimated memory usage by clicking in the header of the overview.
- ► Click 'Switch To'.

Stop packages

One or more packages can be stopped by the Package Manager:

- ► Select a package by clicking on the package line or select more packages simultaneously by using the |Ctrl| or |Shift| key on your keyboard.
- ► Click |Stop| or |Stop All|.

  The selected package or packages are stopped and removed from the overview.

Warnings

In the Package Manager window, warnings are displayed when:

- System performance may degrade (yellow indicator);

  ‘System performance may degrade. Avoid this by closing packages.’
- Too many instances of packages are open (red indicator);

  ‘Maximum number of packages already active.'

In the latter case the Package Manager is displayed automatically.

Physiology signals

When you use VCG, PPU or the respiratory belt on a patient, the physiology signals are displayed in the **Patient Status Area**.

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Fig. 232: Physiology signals (VCG and respiratory signal) displayed in the Patient Status Area with actual heart frequency.

For more information about the display of physiology signals, see chapter “Display of physiology signals” on page 139.

Settings window

► Click 'Settings'.

A window pops up with three tabs representing parameters in three tabs: Display, Stacks and Propagate.

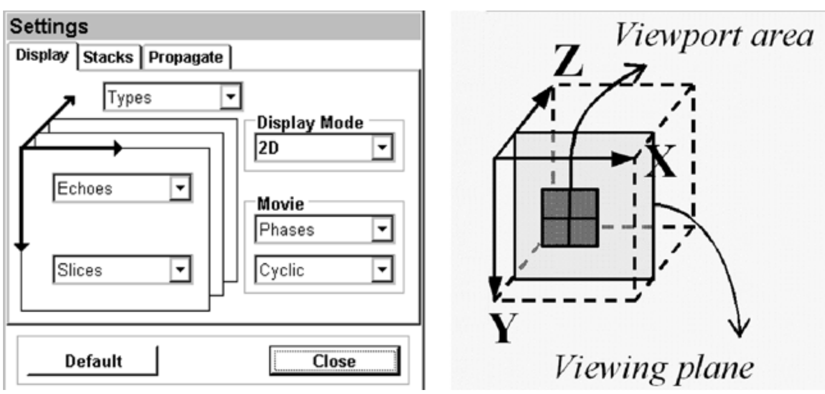

Fig. 233: Left: Settings window. Right: Directions for Display Settings.

Display settings

1. Click ’Display’ to open the window as shown in the figure above.

   The three image directions indicated by arrows are associated with image dimensions, also referred to as image attributes as slices, phases, types, echoes, dynamics, chemical shifts and also stacks.

   The rows and columns of the viewport area are ordered in two directions: X and Y. If available, the Z direction is associated with a third dimension.

2. Select a display mode and assign image dimensions to the image directions.

Display mode ’1D’

- Images are arranged along one dimension only. Actually all images are displayed in one row (X direction) which is wrapped to fill the entire screen. (Y and Z dimension are not used).
- With a data set containing multiple image dimensions, select another dimension for the X-direction if necessary.
- This mode can be used for all scans with one image dimension only, but is also suitable for scans with more dimensions.
- Sometimes this is referred to as ’Stack View’.

Display mode ’1D nested’

- All images of the data set are displayed along one dimension only in a nested sorting order, no matter how many dimensions are included. This requires a dialog to select the sorting priority for each dimension.
  - Click on an image dimension to make it current.
  - Click |Up| or |Down| to move it within the list of dimensions.
  - Click |Default| to restore the default settings.

Display mode ’2D’

- Two imaging dimensions are shown in the viewport area, one along the X-direction, one along the Y-direction and in case of more than 2 dimensions as layers in the Z-direction.
- Sometimes this is referred to as ’Matrix View’.

Display mode ’2D wrapped’

- This mode is comparable to the 2D mode, however the X-dimension is wrapped so that all image in that direction are visible.
- This mode is typically used for image data sets with few images in one dimension (e.g. image type). This dimension is preferably displayed in the X-direction.

1. Click |Default| to restore the default settings.

Stack settings

1. Click ’Stacks’ to specify how to display stacks and enable any of the stack display options.
   - Reverse stacks: to enable reverse stack order.
   - Merge stacks: by default ’stacks’ represent one imaging dimension. When ’Merge stacks’ is enabled, the multiple stacks of a multistack scan will be considered as one dimension. This means that e.g. using the Movie fuction all images are scrolled through, and not only the current stack.
   - Stack slice order: to enable reverse slice order within stacks.
2. Click |Default| to restore the default settings.

Propagate settings

1. Click ’Propagate’ to specify how view and window settings are propagated to preceding or following images.
2. Click |Default| to restore the default settings.

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3. Click |Close| to leave the 'Settings' window.

Customizing your system

To display the Windows **Taskbar** and **Start button** press the **Windows key** on your keyboard.

Hospital administrator and user accounts

About accounts

The default user account "MRuser" can be used by different system operators, but does not provide a personified logging of the actions done by each operator.

Personified user accounts providing the logging of the actions done by each individual user may be required by legislation: for example HIPAA. Each of these individual users has the same permissions and rights as the default system user.

User accounts should be managed by the hospital administrator.
It is also possible to create multiple hospital administrator accounts.

Connect system to hospital Active Directory

Domain privileges are needed to connect the system to the hospital Active Directory.

- Logon as Hospital Admin.
- Configure DNS in **Network and Sharing Center** on the Windows **Control Panel**.
- Add the system to the Hospital Domain in **System** on the Windows **Control Panel**.

Change password Policies

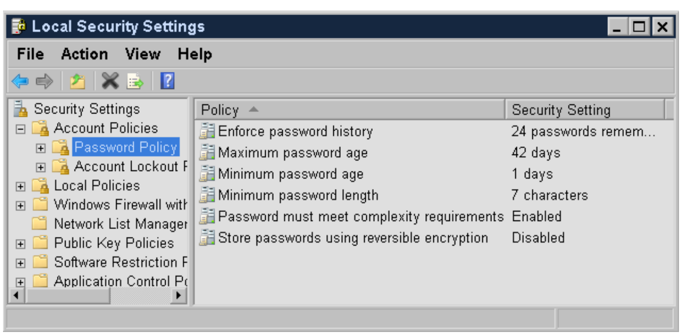

Fig. 234: Password Policies

- Click Windows **Start** and select **MR System Management** and **System Management**.

Create a new local user account

1. Logon with username HospitalAdmin (not case sensitive).
2. Password: 'Hospital' (case sensitive) at first logon. You have to replace and confirm the initial password 'Hospital' by another password of minimum 7 characters *). The system does not start, but a restricted Windows environment is opened.

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3. Open the Windows start menu, select **Systems Management** and **User Management (Operators)** or **User Management (Hospital Administrators)**.
   The **MR User Manager** panel for user accounts or administrator accounts is displayed.
4. Select **User** and **Add Local user**.
5. Enter a personal username, a full name, an account description and define and confirm a password of minimum 7 characters for the new user.

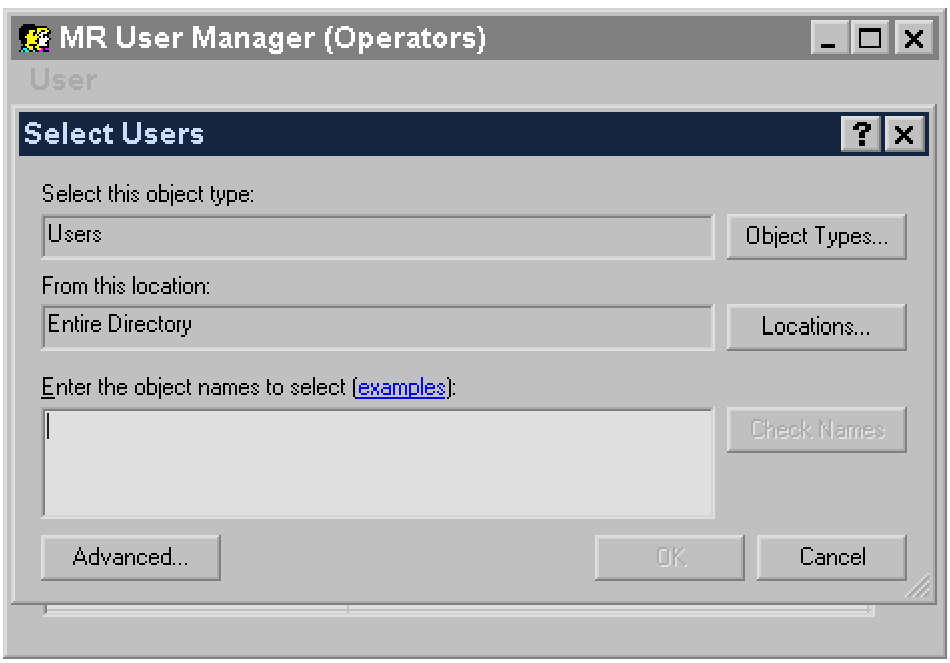
*) *The Password policy can be changed by the Hospital Admin.*

NOTICE

On first login the new user or administrator is forced to change the password (minimum 7 characters).

Create an Active Directory (AD) account

The system must be connected to Hospital Active Directory for creating an AD account.



- Select **User** and **Add AD user**.
- The **Select User** dialog appears. Enter username (Check names).
- Depending on the account type of the hospital admin (local or domain) a domain password is needed.

Edit an account

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1. Open the **User Management (Operators)** or **User Management (Hospital Administrators)** panel.
2. Right-click on a user in the list and select **Properties** or select a user in the list and click on **User** and **Properties.**
3. Change the account as required:
   - Full name.
   - Account description.
   - Password.
   - Disable the user account.
   - Enable/disable blocking of the user account during a certain time when the wrong password is entered repeatedly (Blocking time and occurrence of wrong password to be set by the Service Engineer).
   - Delete the user account.

Delete an account

An account can be deleted in the **User Management (Operators)** or **User Management (Hospital Administrators)** panel.

- Right-click on a user in the list and select **Delete user** or select a user in a list and click on **User** and **Delete user**.

NOTICE

The system provides functionality to synchronize with customer Active Directory.

Hospital/Institution name setting

The hospital or institution name can be changed:

1. Click the Windows **Start button** and select **MR User** and **MR System**. The MR System Properties window is displayed.
2. Select a name from the scroll list or enter a new name and click **Apply.**

NOTICE

A new name entered will be added to the scroll list.

3. Click **OK**, the system will warn you that changes will only take effect after reboot of your system.

After rebooting your system the hospital or institution name will have changed.

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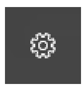
Language settings

The application software and the Windows operating system can be set to the following languages:

English	Danish	German
Greek	Spanish	French
Italian	Japanese	Norwegian
Dutch	Russian	Swedish
Simplified Chinese (PRC)		

Change the language setting

Note that for switching languages, language must should be installed. Contact Philips service.

1. Open the windows start menu by pressing the **Windows Key on your keyboard** and click the settings icon  to open the settings panel.
2. Click **Time & language** to open the Time & Language settings page and select **Region & Language**.
3. Select the **Keyboard and Language** tab.

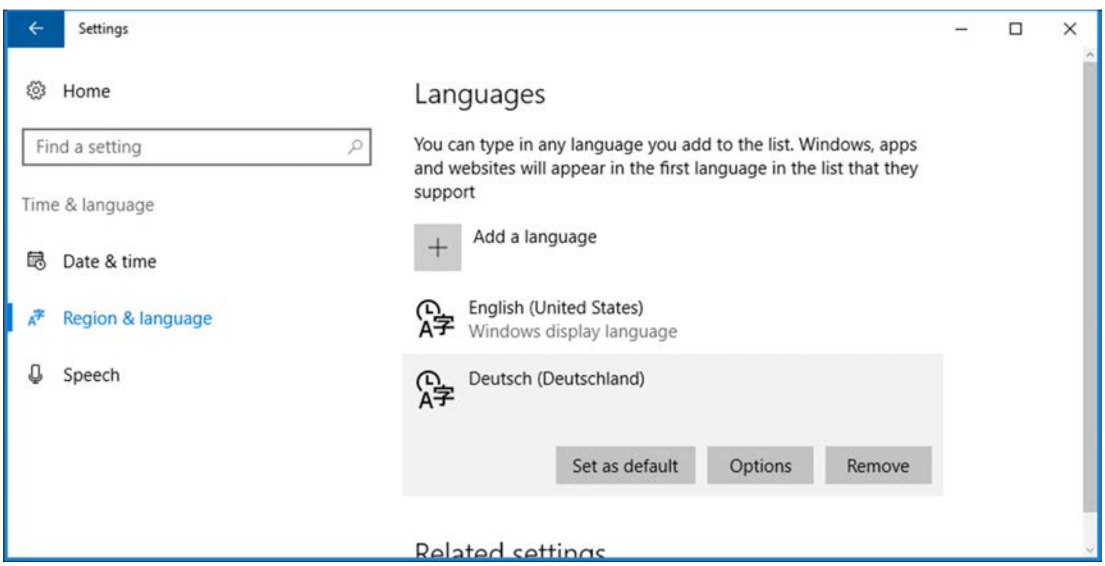


Fig. 235: Region & Language settings

4. Click **Set as default** to set your language.
5. Close the settings page and reboot your system.

Note that the changed language only comes into effect after a reboot of your system.

12 Entering examination data

Enter new examination data manually

1. From the main menu, select **Patients** , then **New examination**.
2. Enter the examination data.
   - To proceed to the next data field, press **Tab** or click on a field to make it current. The pointer identifies the active data field.
   - All fields with an asterisk (*) are mandatory.

WARNING

Verify that the patient date of birth is filled-in correctly.

Sound levels may be unacceptable for patient of below 3 years of age and a warning is displayed.

WARNING

Verify that the patient weight is filled-in correctly.

Incorrect weight leads to incorrect SAR values. SAR values are calculated based on patient weight.

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Format of the examination data

Examination data	Format / comment
Patient	
Patient name	Maximum of 64 characters.
Registration ID	Maximum of 64 characters.
Date of birth / Age	The format of the date is configured at system installation. Correct format for the date is shown in the input field. Age is calculated based on the entered date of birth and can not be changed.
Gender	Male, Female, or Phantom.
Patient weight	The unit of weight (kg or lbs) is configured at system installation. Value can not be greater than 400 kg (881 lbs). Alternatively enter the patient weight in the ExamCard Properties.

Examination	
Examination name	Maximum of 64 characters.
Accession number	Maximum of 16 characters.
Examination date	Today, Tomorrow, or Customized date. Correct format for the Customized date is shown in the input field.
Referring physician	Maximum of 64 characters.
Performing physician	Maximum of 64 characters.
Study comments	Maximum of 64 characters. Use this input field to provide any additional information relevant to this patient (for example if a patient is claustrophobic).
Allowed SAR mode	Normal, 1st level. If you select Normal, the SAR for all scans for this patient will be restricted to normal operating mode.
Patient conditions	
Pregnant	Yes, No, Possibly. Refer to chapter “Patient conditions” on page 414.
Implant	Yes, No. Refer to chapter “Patient conditions” on page 414.
Medical alerts	Maximum of 64 characters.
Allergies	Maximum of 64 characters.

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NOTICE

Date format and weight unit are set at system installation.

To change the date format or weight unit, contact your Philips service engineer .

Patient conditions

In the section **Patient conditions**, it is mandatory to select whether the patient:

- Is pregnant (female patients only).
- Has an implant.

System restrictions may be required to scan these patients.

NOTICE

System restrictions for pregnant patients or patients with an MR Conditional implant may have a negative impact on image quality or increase scan time.

Pregnant patients

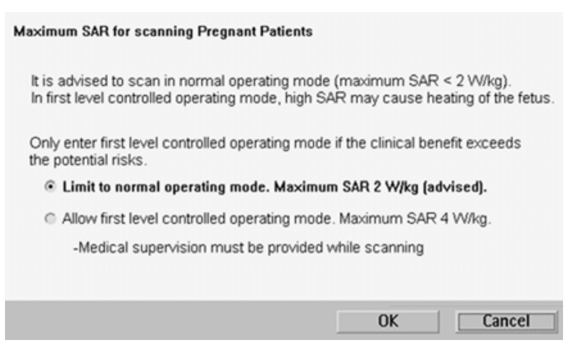
For a patient who is or may be pregnant:

- ► Select Pregnant **Yes** or **Possibly**.
- ⇨ **Allowed SAR mode** is automatically set to **Normal**. The Examination conditions window turns yellow and the SAR restriction for normal operating mode (< 2W/kg) is shown.

It is advised to restrict SAR to normal operating mode (maximum <2 W/kg). In first level controlled operating mode (maximum SAR <4 W/kg), high SAR may cause local heating of the fetus. Scanning is not recommended in the first trimester of pregnancy.

It is still possible to scan a pregnant patient in first level controlled mode. Only enter first level controlled operating mode if the clinical benefit exceeds the potential risks. To scan in first level controlled mode:

- ► For **Allowed SAR mode**, select **1st Level**.
- ⇨ A pop-up window about the maximum SAR for pregnant patients appears (see table).
- ► Select whether the examination should be limited to normal operating mode (maximum SAR < 2 W/kg), or whether first level controlled operating mode (maximum SAR < 4 W/kg) is allowed. For 3.0T systems, RF shimming is not allowed when first level controlled operating mode is selected.
- ► Click **OK** to proceed.
- ⇨ The **Allowed SAR mode** selection is set to **1st level**. In the New Examination window, no restrictions are shown under the Examination conditions.



Maximum SAR for scanning pregnant patients

It is advised to scan in normal operating mode (maximum SAR <2 W/kg). In first level controlled operating mode, high SAR may cause heating of the fetus.

Only enter first level controlled operating mode if the clinical benefit exceeds the potential risks.

0 Limit to normal operating mode. Maximum SAR < 2 W/kg (advised).

0 Allow first level controlled operating mode. Maximum SAR < 4 W/kg.

- Medical supervision must be provided while scanning.

- **OK**
- **Cancel**

Patients with implants

Under certain circumstances, it is possible to scan patients with an implant, refer to chapter “MR implant labeling” on page 29. The user interface provides you with guidance.

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- Select Implant: **No**, for a patient without an implant.
- Select Implant: **Yes**, for a patient with an implant.

A pop-up window appears.

Indicate which MR label the implant has: MR Safe, MR Unsafe, or MR Conditional.

- If you click **MR Safe**, you can scan the patient without further conditions.
- If you click **MR Conditional**, you are asked to verify and enter specified conditions for the implant in ScanWise Implant.
- If you click **MR Unsafe**, you are not allowed to perform an MRI scan.

NOTICE

If the implant is labeled MR Conditional, refer to the user documentation of the implant or contact the implant manufacturer to obtain the implant-specific conditions.

For **implants without adequate MR labeling**, a **medical decision** may declare such devices MR Conditional. In all other case, implants are considered MR Unsafe.

For every patient, a qualified physician must evaluate the risk-benefit ratio of the MRI examination before scanning.

ScanWise Implant

If you select **MR Conditional**, the ScanWise Implant wizard opens. The wizard facilitates compliance with the implant-specific conditions, as specified by the implant manufacturer.
For implants without adequate MR labeling, a medical decision may declare such devices **MR Conditional**.
A short outline of the ScanWise Implant wizard is provided in the table. On the user interface, a red asterisk indicates conditions for which it is mandatory to provide information. Click on any specific condition on the left side of the wizard to go directly to the input screen for that condition.

Field strength	Confirm that the implant documentation states that scanning is allowed at the field strength of your system. If the field strength of your system is different than what is specified for the implant, scanning is not allowed. You are taken back to the new examination window.
Spatial field gradient	Enter a spatial field gradient value, if the implant documentation specifies one. A red area appears in the field map on the screen. The red areas indicate the areas around the system where the specified spatial field gradient value is exceeded. Click **Details** to view more detailed field maps. Make sure that the implant does not touch the red areas indicated on the field maps. Click **Print**, to print a paper copy of the field maps. Note that, to print a copy of the field map, a printer must be connected to the operator's console.

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RF energy	Select the RF energy control type specified in the implant documentation: SAR-whole body, SAR-head or B1+rms. NOTE: Do not confuse the different RF energy control types.: • Even if you perform a head scan, the specified SAR type for the implant may still be whole body. • Make sure that you do not enter a B1+rms value when a SAR control type is selected. Check that the unit on the UI (µT or W/kg) is the same as the unit for the value that you copy from the implant documentation. • If both SAR and B1+rms are specified, choose B1+rms as RF control type. Enter the maximum RF energy value specified for the implant. The RF energy will be restricted to the value entered for the RF energy control type that you selected.

Additional	If dB/dt is specified in the implant documentation, enter the value on this screen. The dB/dt of all scans, including all prescans, will be limited to the value entered. If dB/dt is not specified in the implant documentation, keep the option **Not specified** selected. If maximum gradient slew rate is specified in the implant documentation, enter the value on this screen. The gradient slew rate of all scans, including all prescans, will be limited to the value entered. If gradient slew rate is not specified in the implant documentation, keep the option **Not specified** selected. If any other conditions are specified in the implant documentation, enter them in the **Additional comments** text box. NOTE: the system is not restricted based on text entered in this text box. Additional conditions or comments that the implant documentation specifies may include, but are not limited to: • Use of a specific coil. • Configuration of the implant itself. • Special patient preparation (such as no sedation, good communication, etc.).
Confirm	This screen provides an overview of all the implant-specific data that have been entered. Double-check all the data. Check the box to confirm that: • All data was entered correctly. • The physician who is responsible for scanning this patient, approves the patient for MR scanning. Click **Confirm** to proceed. Click **Previous** to go back into ScanWise Implant and to change the entered values. Click **Print** to print a paper copy of the implant conditions summary.

Tab. 30: Explanation of the ScanWise Implant screens

In the New Examination window:

- Specified conditions are shown under the Examination conditions heading, which is highlighted in yellow.
- If a spatial field gradient value has been specified, click the **...** button to view the field maps that indicate the areas which the implant must not touch.
- Click Implant **Yes** to reenter ScanWise Implant and make changes if necessary.

Once you start scanning, the conditions are also shown in a yellow box at the top of the List View for the current ExamCard.

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Finalize new examination data entry

If all entered examination data are correct.

- Click **Confirm and proceed** to proceed.
- Click **Enter** to save all entered data for a later time.

Select existing patient data

To use data from a patient who is already in the database:

1. From the main menu, select **Patients**, then **New Examination**.
2. Select a patient from the patient list.
    - Click **Patient name** to sort the patient data in alphabetical order.

Select patient data from the RIS

If the operator console is connected to the Radiology Information System (RIS), you can copy data from the RIS to the operator console.

1. From the main menu, select **Patients**, then **New Examination**.
2. Click **More...**, then **RIS**.

    The RIS worklist appears with patients for the current day (today) and the following day (tomorrow). Downloading the list can take a few minutes.
3. Click on a patient to select data. Click **Enter**.

    You can select only one patient at a time.
4. The patient entry is transferred to the new examination window.

    Repeat to select more patients.
5. Click **Proceed** to proceed with selected patients. Click **Cancel** to cancel the current selection and return to the new examination window Click **Refresh** to refresh the downloaded list from the RIS.

After the scan, you can mark the examination data. To do so:

- ► Select the examination in **Patient Administration**.
- ► Click one of the following:
- **Ready**, if the examination was completed successfully.
- **Incomplete**, if the examination was not completed.

A Modality Performed Procedure Step (MPPS) message is then sent to the RIS. The scan data is also automatically stored to PACS.
The MPPS informs a DICOM partner about what has been performed by tracking the acquisition status. MPPS partners are for example a PACS or RIS.

Combine Accession Numbers for multiple RIS entries

If several studies for one patient are scheduled separately on the RIS, you can use the **Combine Accession Number** functionality to combine them into a single study. The rationale behind combining several study requests from RIS is based on reimbursement requirements. For example, there may be no reimbursement for a Total Neuro examination, but there is for an examination of the *Spine* and an examination of the *HeadCNS*. However, for the patient it is more convenient if the examination is performed in one go, as one examination.

When combined examinations are sent to PACS, the examination data in the PACS need to be split to accommodate for the initial request of multiple examinations.

Workflow

▷ In the RIS, two entries with different accession numbers are present for one patient, for example a Spine and a Head CNS examination.

► From the main menu, select **Patients > New examination**.

► Click **RIS**.

► In the new window, select the examinations to be combined, then click **More...**.
The **Worklist (RIS)** window opens.

► When examinations are combined into one, a common examination name has to be chosen. To do so:
Select the future common examination name from the **Procedure Setup Description** drop-down menu, in this case either: **Spine** or **HeadCNS**.

► Perform the examination as usual.

► After completion of the examination, click **Patients** >**Administration** or press **F4** on the keyboard.

► Click the combined examination to make it the current examination.

► Click **Ready** to report back to the RIS that the examination is completed.
Currently only the specified procedure step will be reported back to the RIS as completed. If the combined examination has been set to Spine, Spine will be set to completed whereas HeadCNS will still be there in the RIS view.

Entering Asian patient names

If your system is set to Japanese or Simplified Chinese, it is automatically possible to enter patient names in the selected language. If your system is set to another language, use the *Windows© Input Method Editor (IME)* to enter Chinese, Japanese or Korean names.

Fig. 236: Windows© Input Method Editor (IME)

Refer to the Microsoft (MS) Windows help for more information.

For Asian languages the 'Patient name' line consists of three fields:

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- Field 1 (left), name in Latin characters, maximum 64 characters.
- Field 2 (middle), name in ideographic characters, maximum 30 characters.
- Field 3 (right), name written phonetically, maximum 30 characters.

Fig. 237: Example of the 3 input fields for 'Patient name'.

Changing MS Windows input settings

Change the MS Windows input settings when your patient name language is different than your system language.

1. Press the **Windows** key on your keyboard to show the Windows task bar.
2. Select **Start > Control panel**.
3. Double-click the **Region and Language** icon.

   The Region and Language window is displayed.
4. Click **Change keyboards...**.

NOTICE

Do not change the default input language.

5. In Installed Services:

   Check your keyboard layout (Chinese, Japanese or Korean).

   If your keyboard layout is not present in the field, click **Add...**:

   - On the ‘Add Input Language’ window select the input language from the top scroll list and your keyboard layout.
   - Confirm by clicking **OK**.
6. Confirm by clicking **OK** to close the window..
7. Click **OK** to close the 'Region and Language' window.

   The IME is displayed on your screen. If the IME is not visible press the **Windows** key on your keyboard.
8. Select the patient name language on the IME.
9. From the main menu bar, select **Patients > New Examination**.
10. Enter the patient name as described below.

Entering Japanese patient names

1. Field 1: Enter the patient name in Latin characters.
2. Field 2 and 3:

- Open the IME (Input Method Editor): right-click in the field and select **Open IME** or press **Alt + ~**.
- Enter the patient name.
- Press the **Space Bar**, open the scroll list with the **arrow-down** key. To select the correct writing:
  - Use the arrow keys and press **Enter**
  - Right-click, select the correct writing with the cursor and press **Enter**.

3. To close the IME, right-click in a field and select **Close IME** or press **Alt + ~**.

Reconversion

If an incorrect writing is chosen in field 2 or 3 it can be corrected:

- Highlight the name to be changed.
- Right-click in the field and select **Reconversion**
- Select the new writing and press **Enter**.

Entering Chinese names

1. Field 1: Enter the patient name in Latin characters.
2. Field 2:
   - Right-click in the field to open the IME (Input Method Editor) and select **Open IME** or use shortcut keys **Alt + ~**.
   - Enter the required character(s).
   - Press **Enter** or the **Space Bar** to confirm or press the **Arrow-back** key to open a list with proposed characters. Select the correct character and press **Enter** to confirm.
3. Field 3: Enter the patient name phonetically in Pinyin.

NOTICE

To close the IME, right-click in any field of the IME and select **Close IME** or use shortcut keys **Alt + ~**.

NOTICE

When the IME is active click **Ctrl + Space Bar** or **shift** to switch between entering Latin and ideographic characters.

Entering Korean names

1. Field 1: Enter the patient name in Latin characters.
2. Field 2 and 3: Enter the patient name in Korean characters.

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13 ExamCards

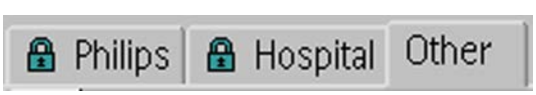
ExamCards are essential for successful MR examinations. This chapter provides information about ExamCards and how to work with them.

What are the main features of ExamCards?

- An ExamCard (EC) is the electronic version of a clinical MRI examination procedure. It has to be defined once and can then be reused for other patients with similar examinations to simplify the daily routine.
- An ExamCard consists of ExamCard items (see chapter “ExamCard Items” on page 430):
  - Scan protocols (for example survey, T1- and T2-weighted scans in different orientations)
  - SmartLine processing steps
    which are postprocessing presets that are automatically performed as part of an ExamCard.
    For more information, see chapter “SmartLine Processing” on page 471.
- An ExamCard contains
  - Geometry reuse:
    Scan protocols within an ExamCard can share the same geometry settings.
    If you plan one scan protocol with a specific geometry, all scan protocols with the same geometry are planned automatically.
    Geometries are mapped by name.
  - Information about the ExamCard and the scan protocols:
    A short description is available with an example image.
  - ExamCard Properties:
    ExamCard Properties are parameters that are valid for the complete examination, such as **Patient position** (for example: supine or prone).
    For more informatiation, see chapter “ExamCard Properties” on page 427.
- ExamCards are organized in ExamCard databases.
- You can create your own ExamCards according to your specific needs.

ExamCard Databases

You find examples of ExamCards and scan protocols in the ExamCard databases (EC databases), and you can store your own ExamCards here.



An EC database can be locked or unlocked:

- Locked EC databases cannot be changed, deleted or overwritten.
- A lock is indicated by the **Lock** icon besides the EC database name.

EC database	Database contents	Properties of the EC database
Philips	Philips ExamCards and scan protocols	• ExamCards and scan protocols in this database can only be used for scanning. • The *Philips EC database* is always locked and cannot be changed or overwritten.
Hospital	Hospital ExamCards and scan protocols	• ExamCards and scan protocols in this database can be used for scanning. They can be changed, deleted and overwritten. • The *Hospital EC database* can be locked using password protection. For more information, see chapter “ExamCard Databases password protection” on page 464.
Other	Reserved for *Import and Export* of ExamCards and scan protocols	• ExamCards and scan protocols can always be stored in this database. • The *Other EC database* cannot be locked.

With Central Protocol Management (CPM) being used in your institution, your Hospital ExamCard database is locked and you cannot edit it.
For more information about CPM, see chapter “Central Protocol Management (CPM)” on page 507 and the Instructions for Use of CPM.

Some ExamCards are delivered as an example and as starting point for the creation of your own ExamCards. You find them in the *Philips EC database* in the folder **ExampleCards**.

More information

ExamCards and EC databases can be accessed in different ways:

- in the *ExamCards* window, see chapter “ExamCards window” on page 424,
- in the *ExamCard Editor*, see chapter “ExamCard Editor” on page 426,

Working with ExamCards

Detailed information on how to work with ExamCards is provided in the sections:

- Run an ExamCard, see chapter “Running an ExamCard” on page 449.
- Create/Edit an ExamCard, see chapter “Create (and/or Edit) an ExamCard” on page 452.

ExamCards window

The *ExamCards* window is the starting point in every examination: it opens automatically when you enter new examination data or select a patient for scanning. For more information, see chapter “Entering examination data” on page 413.

What are the main functions of the ExamCards window?

In the *ExamCards* window,

- You select an ExamCard for execution for the current examination.
- You create a new ExamCard for the current examination.
- You edit (copy, modify, rename, delete, import and export) an existing ExamCard for the current examination.
- You edit EC items (scan protocols) with the Parameter Editor. For more information, see chapter “Parameter Editor” on page 437.
- Eventually you save this ExamCard so that you can reuse it in other examinations.

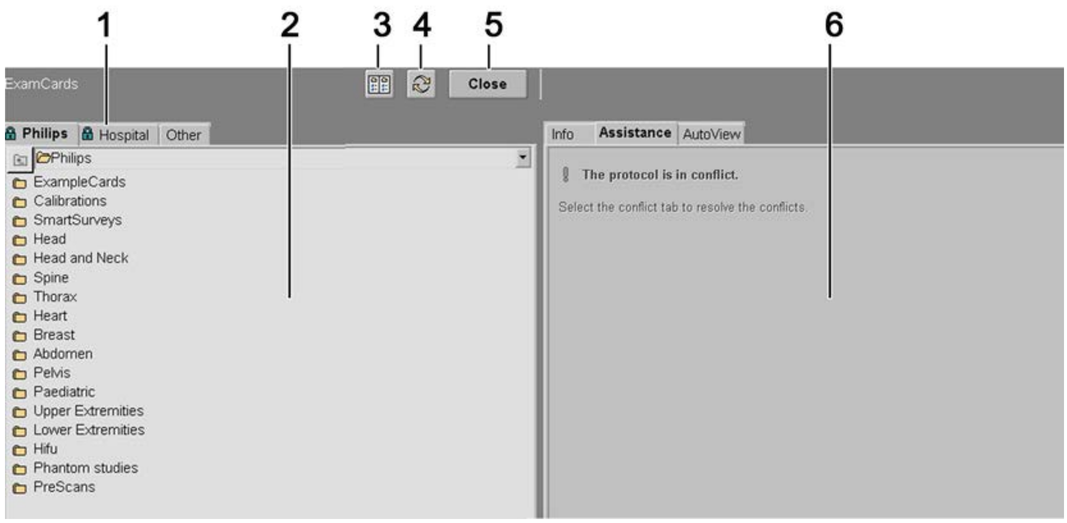


Fig. 238: ExamCards window including ExamCard Dashboard (dark gray area with buttons 3, 4, and 5).

1	Tabs to switch between the ExamCard databases: Philips, Hospital, Other, and to browse to Exam-Cards and scan protocols. For more information, see chapter “ExamCards” on page 423.
2	EC Database View. The figure shows the *Single EC Database View*. You can enable the *Double EC Database View* with button**3**.
3	**Toggle database view** button to switch between the two EC database views: • *Single EC Database View* which shows only one EC database. • *Double EC Database View* which shows two EC databases aside: The *Double EC Database view* allows inspection of the ExamCard databases in two different browsers at the same time. ExamCards can be easily dragged from one EC database to another one, either within one browser or from one browser to the other.
4	**Refresh ExamCards views** button to make the most recent changes to the EC database visible, for example after an import of ExamCards.
5	**Close** button to close the *ExamCards* window.
6	*Scan Assistance* with three tabs and a viewport. For more information, see chapter “Scan Assistance” on page 435.

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Working with ExamCards

Detailed information on how to work with ExamCards is provided in the sections:

- Run an ExamCard, see chapter “Running an ExamCard” on page 449.
- Create/Edit an ExamCard, see chapter “Create (and/or Edit) an ExamCard” on page 452.

ExamCard Editor

The *ExamCard Editor* enables you to modify your ExamCard database at any time, independently of the current examination.

What are the main functions of the ExamCard Editor?

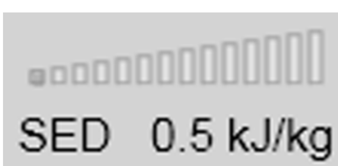
In the *ExamCard Editor*,

- You create a new ExamCard independently of the current examination.
- You edit (copy, modify, rename, delete, import and export) an existing ExamCard independently of the current examination.
- You edit EC items (scan protocols) with the Parameter Editor. For more information, see Parameter Editor.
- Eventually you save this ExamCard so that you can reuse it in the examinations.

You perform these actions in the same way as in the *ExamCards* window, but independently of the current examination.

The *ExamCard Editor* provides you with

- realistic information about *SED (Specific Energy Dose)*, and
- the *scan information page*. For more information, see chapter “Display the Scan Information Page” on page 443.



The calculation of the SED is based on the knowledge of the patient weight, and the values on the *scan information page* are coil dependent. For a calculation as accurate as possible, you must enter a patient weight and select the coil you are going to use.

Starting up the ExamCards Editor

► On the **System** menu, click **Manage Hospital ExamCards...**.
Alternatively press **Ctrl+M**.

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Fig. 239: 1: Selected ExamCard, 2: toggle view, either ExamCard databases or ExamCard Properties, 3: the Info/Assistance tab where you can view or enter information about the ExamCard.

ExamCard Properties

ExamCard Properties are parameters that are valid for a complete ExamCard.

What are the main functions of the ExamCard Properties?

- *ExamCard Properties* have to be defined once for an ExamCard.
- *ExamCard Properties* are valid and used for all ExamCard items.
- Here you define patient-dependent information, for example patient positioning and heart rate, but also the network nodes to transfer the resulting imaging series to upon completion.

Accessing the ExamCard Properties

You can access the *ExamCard Properties* in two different ways:

1. Click the **ExamCard Properties** button  in the List View.
2. The *ExamCard Properties* automatically open in the *ExamCard Editor* when you create a new ExamCard.
   For more information, see chapter “ExamCard Editor” on page 426.

Presentation of the ExamCard Properties

The *ExamCard Properties* are presented in slightly different ways, depending on how you access them. However these are the same parameters in both windows.

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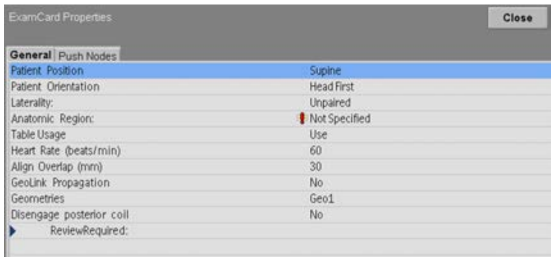
if you access them with the button , a list of parameters is shown. The tabs **General** and **Push Nodes** both provide you with EC Properties.

If you access them in the *ExamCard Editor*, some of the parameters are presented graphically. The tabs **Basic** and **Advanced** provide you with EC Properties.



The various ExamCard Properties

Depending on the access way, the various ExamCard Properties are available in the tabs **General**, **Push Nodes**, **Basic** or **Advanced**.

WARNING

Verify that the patient weight is filled-in correctly.

Incorrect weight leads to incorrect SAR values. SAR values are calculated based on patient weight.

EC Property	Possible values	Description
Patient weight	<numerical value: kg or lbs>	The unit of weight (kg or lbs) is configured at system installation. Value can not be greater than 400 kg (881 lbs). This value is mandatory and has to be entered before you start an examination. If it is not entered, a conflict occurs and scanning is not possible.
Patient Position	• Supine, Prone, DecubRight, DecubLeft	The settings *Supine, Prone, DecubRight, DecubLeft* are meant for all kinds of examinations, except for elbow and wrist.
	• ExoRotation, Neutral, EndoRotation, SupermanSupine, SupermanProne	The settings *ExoRotation, Neutral, EndoRotation, SupermanSupine, SupermanProne* are meant for elbow and wrist. *Neutral (2)* is the position between *ExoRotation (3)* and *EndoRotation (1)*.

EC Property	Possible values	Description
		 
Patient Orientation	• HeadFirst • FeetFirst	
Laterality	• Left • Right • Unpaired • Both • Mixed	The parameter *Laterality* is primarily used for paired anatomies such as knee, shoulder, ankle etc. The laterality value can be used by PACS systems. • Left or Right - to be used for left or right joint • Unpaired - to be used for unpaired anatomies, e.g. abdomen • Both - to be used when both joints are scanned within one scan • Mixed - to be used when both joints are scanned within one ExamCard, but in different scans
Anatomy	DICOM values in alphabetical order: for example • Abdomen • Breast • Chest • Head	The value of the parameters **Anatomy** and **Anatomic region** is used • to display the images correctly. For more information, see chapter "Image Display Settings" on page 543. • by **Analysis** package to select the default *basic processing script*.
Anatomic Region	DICOM values in alphabetical order: for example • Brain • Cerebellum • Circle of Willis	
Table Usage	• Use • Ignore	
Heart rate [bpm]	<numerical value: beats per minute>	

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EC Property	Possible values	Description
Align overlap [mm]	<numerical value>	**Align overlap** is needed for multi-station scans such as Whole body where stations need to be fused. For best fusing results of sagittal and coronal images, we advise a 30 mm overlap between the stations. Since **Align overlap** is a parameter on ExamCard level, also transverse scans are scanned with an overlap of 30 mm. Consequently some of them are acquired twice. To avoid this, change **Align overlap** to 0 prior to scanning the transverse scans.
GeoLink propagation	• No (Default) • Yes	**GeoLink propagation** propagates the SmartLine processing steps to all scans of the same GeoLink. **Use case 1: Running a SmartLine postprocessing step** • With **GeoLink propagation = No**, a SmartLine postprocessing step is only added to the current scan. • With **GeoLink propagation = Yes**, a SmartLine postprocessing step is added to all geo-linked scans (scans with the same GeoLink as the current scan). **Use case 2: Loading imaging series into Review packages (e.g. VolumeView)** • With **GeoLink propagation = No**, a only the current imaging series is loaded into these packages. • With **GeoLink propagation = Yes**, all geo-linked imaging series (scans with the same GeoLink as the current scan) are loaded into these packages. For more information about GeoLinks, see chapter "ExamCard Items" on page 430. For more information about SmartLine processing, see chapter "SmartLine Processing" on page 471.
Geometries	List of available EC geometries	
Disengage Posterior Coil	• No • Yes	This parameter is automatically set to **Yes** or **No** depending on the used coil/coil solution.
Push nodes	List of available network nodes	The setting of this parameter is persistent. This means that even after restarting the system, the setting will be the same. When 'Push to workstation' is enabled, the examination will automatically be pushed to the selected push node.

ExamCard Items

An ExamCard item (EC item)

- is part of the ExamCard.
- is either a scanning or a postprocessing step.
- corresponds to a single row in the ExamCard.

NOTICE

The maximum number of ExamCard items is 250.

The display of the EC items changes in real-time from planning to scanning and to scan completion:

- different status icons are used,
- EC items are displayed in different colors: ,
  - prior to scanning in gray,
  - when completed scan in blue.

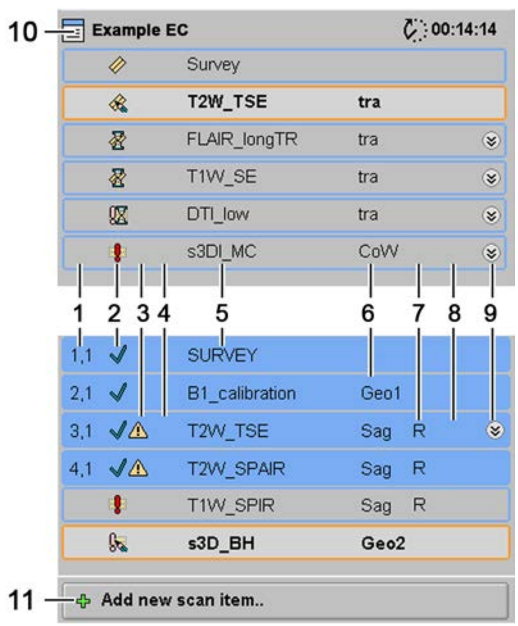


Fig. 240: Example of ExamCard showing EC items. On top: during planning, Bottom: partly scanned.

Number	Item (More information in the following sections)
1	EC item number (appears only when scanning is completed)
2	Status information about the EC item
3	if applicable: Warning signs indicating that scan item are executed in first level control mode due to high SAR (Specific Absorption Rate), high PNS (Peripheral Nerve Stimulation) or high SED (Specific Energy Dose).
4	Properties of the EC item

Number	Item (More information in the following sections)
5	Name of the EC item
6	Geometry name of the EC item
7	Geometry Link
8	Laterality: R(ight), L(eft), B(oth), blank - if not specified
9	Expand and Collapse buttons
10	EC Header Line with ExamCard icon, ExamCard name and the remaining ExamCard duration. This is the remaining scan time for the complete ExamCard.
11	Possibility to add a new scan item from the ExamCard databases.

ExamCard Item Number

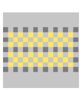
EC items are numbered by two digits where the first digit increases for scanning steps and the second digit for postprocessing steps. The *ExamCard item number* appears only when scanning is completed.

Number	Serie characteristics
1.1.	Survey
2.1.	T2w/TSE
2.2.	PicturePlus image enhancement (postprocessing)
3.1.	DWI
3.2.	Diffusion postprocessing

Tab. 31: Example

Status information about the EC item

Icons indicate the current status of an EC item.

Button	Status of the EC item
	The item needs planning.
	The item is being modified.
	The item is ready to run as it is fully planned.
	The item contains a parameter conflict.

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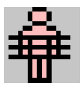
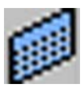
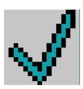
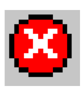
Button	Status of the EC item
	The item containing a parameter conflict is being modified.
	The item awaits update.
	The item awaits resources and is started as soon as sufficient resources are available.
	The item is being prepared for execution.
	The item is in progress.
	The acquisition of the item is completed, and the reconstruction is in progress.
	The item is successfully completed.
	The item is aborted, either by the operator or scanner or reconstruction fault.
	The item is invalid and cannot be executed, e.g. because it originates from an older release.

Properties of the scan item

The *Properties* column provides information in the following order on

- High SAR (Specific Absorption Rate), high PNS (Peripheral Nerve Stimulation) or high SED (Specific Energy Dose) values
- *User start required* or *Manual start*
- Breathholds
- Table movement

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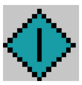
Button	Property	Description
	Warning	• Operator attention is required due to high SAR, PNS or high SED.
	User start required	• User start is required. The scan will not start automatically.
	Manual start	• Scan stops after the preparation phase. Manual start is required.
	Breathhold	• Scan stops when breathhold commands are required.
	Table movement	• Operator action is required in order to perform table movement.

Geometry Name (or GeoName)

The *GeoName* is used to simplify planning:

Scans sharing the same *GeoName* by default have

- the same number of stacks,
- the same orientation,
- each stack with identical angulations and offcenters.

► To change the *GeoName*, click the *GeoName* field.

A blue border around the field indicates that the *GeoName* can be changed now.

► Enter a *GeoName*.

Geometry Link (or GeoLink)

The *GeoLink* between scans includes that scans with different geometry parameters are linked to each other. The linked protocols are combined within a geometrically linked group.

A *GeoLink*

- groups scans that are planned at once within Graphical PlanScan.
- aligns scans within the *GeoLink* group (which is applied constantly when planning the *GeoLink* until it is switched off).
- includes that all scans within a geometrically linked group get the same scan number.
- is only possible for scans of the same scan type.
- can be defined only once under a specified name.
  For example, if a scan of a *GeoLink* is stopped or aborted, the remaining scans of this same link have to be updated to another link name.

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Button	Property	Description
	Geometry link	• The current item belongs to a geometrically linked group with a group name of [A ... Z]. .

Typical applications are examinations with a large Field-of-View in Feet-Head direction, such as *MobiFlex* and *whole body imaging*. These examinations are performed in multiple stations with table movement between the stations to cover the complete area.

Laterality

When applicable, the *laterality* (**R** for right, **L** for left, **B** for both, or blank (if not specified) is displayed here. The parameter laterality is primarily used for paired anatomies such as knee, ankle, shoulder and elbow. The laterality value is used by PACS systems.

NOTICE

It is recommended to store dedicated left and right ExamCards.

Expand and Collapse button

Click **Expand** to expand an ExamCard item and show the corresponding *SmartLine* postprocessing step.

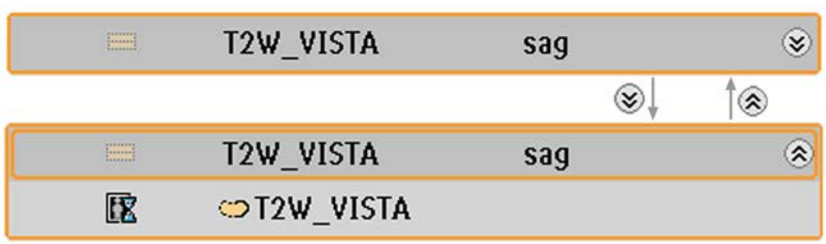

Fig. 241: Expand and Collapse buttons in ExamCards.

Scan Assistance

By clicking on the tabs, the Scan Assistance allows to switch between the display of:

- Info,
- Assistance,
- Autoview.

Info

The Info tab gives information about the current ExamCard or the current scan protocol. Two types of information are available according to the template information: 'Tips' and 'Info' where 'Info' describes the protocol or ExamCard and 'Tips' includes planning tips.

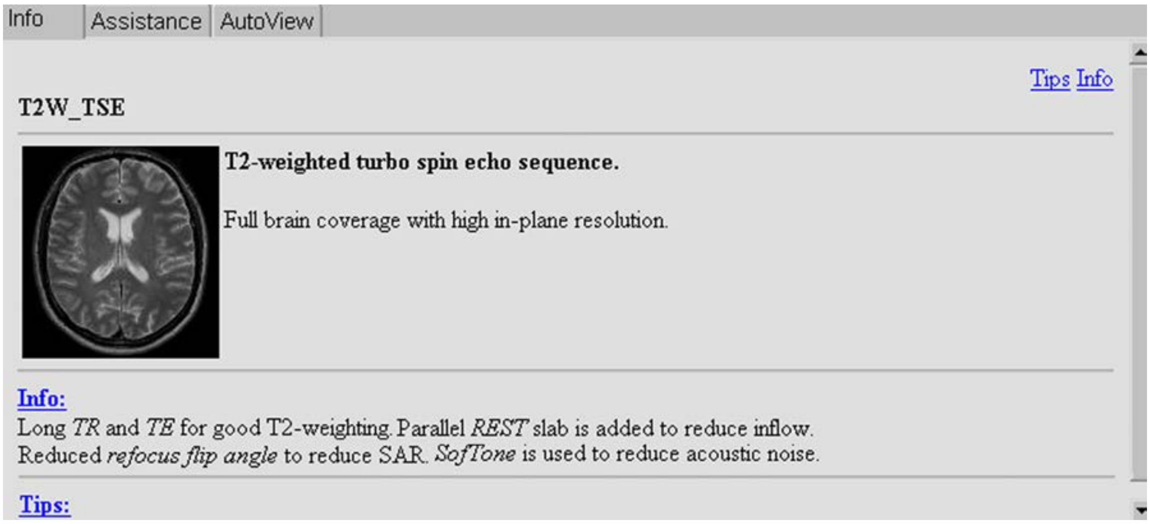

Fig. 242: Info about the current scan protocol.

The 'Info' for ExamCards or scan protocols in the Hospital Database can be edited according to the changes made to the ExamCard.

Edit the Info

- ► Right-click on an ExamCard or a scan and select 'Edit'.
- ► Modify the info text.
- ► Deselect 'Edit' when completed.

Assistance

The Assistance tab gives tips on how to efficiently solve conflicts.

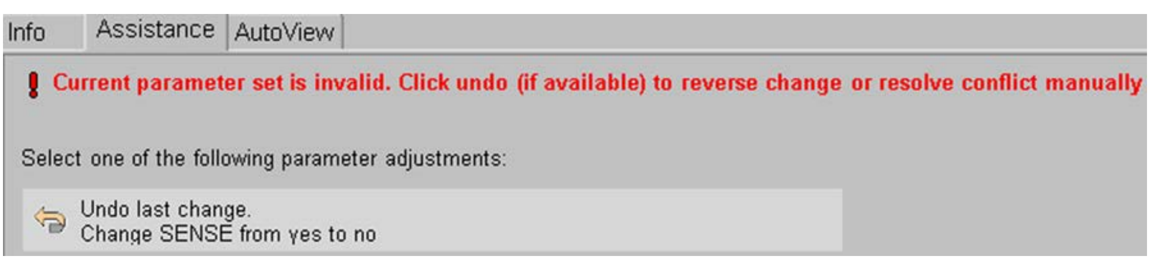

Fig. 243: Conflict: "Current parameter set is invalid. Click Undo (if available) to reverse changes or resolve conflict manually." Proposal for solution: "Select one of the following parameter adjustments: Undo last change. Change SENSE from Yes to No."

AutoView

AutoView is a tool that allows to monitor scanning and reconstruction. If enabled, the latest reconstructed image of the scan currently in progress is displayed here.

Parameter Editor

The Parameter Editor consists of multiple components:

- **Dashboard** which displays information about the currently planned EC item (see chapter “Dashboard” on page 437),
- **Parameter Groups tabs** which allow to access all imaging parameters (see chapter “Parameter Groups tabs” on page 438),
- **Summary tab** which allows to modify the most important imaging parameters (see chapter “Summary tab” on page 439).

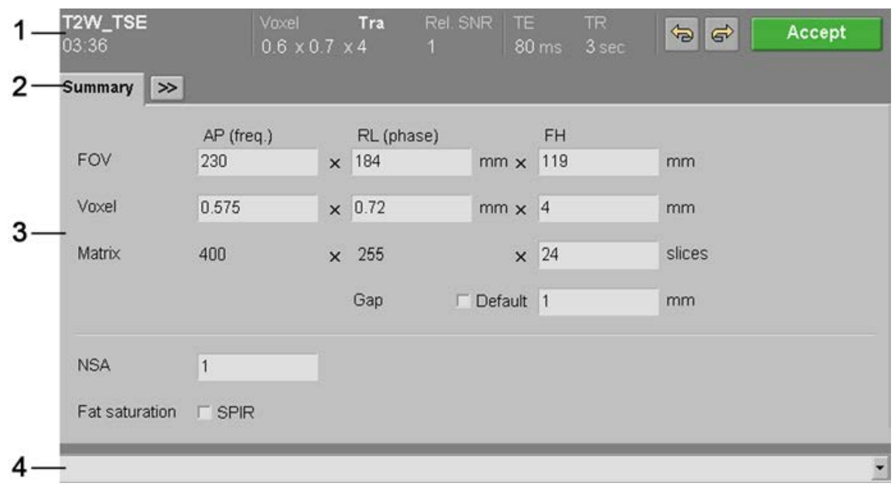

Fig. 244: Parameter Editor with: 1 - Dashboard, 2 - Parameter Groups tabs, 3 - Summary tab, 4 - Bottom line reserved for messages and alerts.

Via the Parameter Groups tabs, more tools/windows can be accessed:

- **Extended Parameter Editor** which allows to edit all imaging parameters (see chapter “Extended Parameter Editor” on page 440),
- **Coil Selection UI** which allows to change the automatic coil selection (see chapter “Coil Selection” on page 446),
- **Conflicts page** which shows conflicting parameters (see chapter “Conflicts page” on page 448).

Dashboard

The Dashbard is a control panel housing instrumentation and controls for scanning operation. It shows the effects of the planned protocol on SAR, SED and PNS immediately during planning. In such a way, planning can be optimized for each patient individually.

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Fig. 245: Dashboard with information (e.g. Rel. SNR, TE, TR, PNS, SAR) about EC item and the control buttons: 1 - Undo and Redo (the previous action), 2 - Accept (planning), 3 - Reset (to initial values), 4 - Cancel (planning).

For more information about SAR (Specific Absorption Rate), SED (Specific Energy Dose) and PNS (Peripheral Nerve Stimulation), refer to the Safety chapter.

Parameter Groups tabs

The MR imaging parameters are divided into different parameter groups. Initially the 'Summary' group is displayed.

The Parameter Groups tabs allow to access the

- **Summary** parameter group:
  - Simply click the button 'Summary' to access this group.
- **Physiology** parameter group, if Wireless Physiology is connected:
  - Simply click the button 'Physiology' to access this group.
- **Extended parameter groups**:
  - Click the arrows button to expand/collapse the tabs and to show/hide the extended parameter groups.
  - Click any of the tabs to access one of the extended parameter groups.

Fig. 246: Parameter Groups tabs. Upper row: Summary tab and arrows button to expand the parameter groups. Lower row: Summary tab, tabs for the extended parameter groups and the arrows button to collapse the extended parameter groups tabs.

Button	Parameter group	More information
Summary	The most commonly used parameters for easy access	chapter “Summary tab” on page 439
Geometry	Geometry related parameters	chapter “Extended Parameter Editor” on page 440
Contrast	Contrast related parameters	chapter “Extended Parameter Editor” on page 440
Motion	Motion related parameters	chapter “Extended Parameter Editor” on page 440
Dyn/ang	Dynamic or angio related parameters	chapter “Extended Parameter Editor” on page 440

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Button	Parameter group	More information
Postproc	Parameters to control automatic post-processing	chapter “Extended Parameter Editor” on page 440
Offc/ang	Offcenters and angulations of stacks, slabs and navigators	chapter “Extended Parameter Editor” on page 440
Coils	Coil selection parameters. (Opens the Coil Selection UI)	chapter “Coil Selection” on page 446
Conflicts	No parameters, but occuring conflicts resulting from conflicting parameter settings	chapter “Conflicts page” on page 448

Summary tab

The Summary tab is meant to quickly check a scan protocol prior to execution. The most commonly used parameters are displayed:

1. Field of View (FOV) in all directions (selection, phase- and frequency-encoding direction) in millimetres,
2. Voxel size in all directions (selection, phase- and frequency-encoding direction) in millimetres,
3. Matrix size in all directions (selection, phase- and frequency-encoding direction) in number of voxels x number of voxels x number of slices,
4. Slice Gap (which can be enabled or disabled by checking the checkbox, and which can be adjusted by typing in a value) in millimetres,
5. Number of Signals Averaged (NSA),
6. Fat Saturation by means of SPIR (SPectral Inversion Recovery) (which can be enabled or disabled by checking the checkbox).

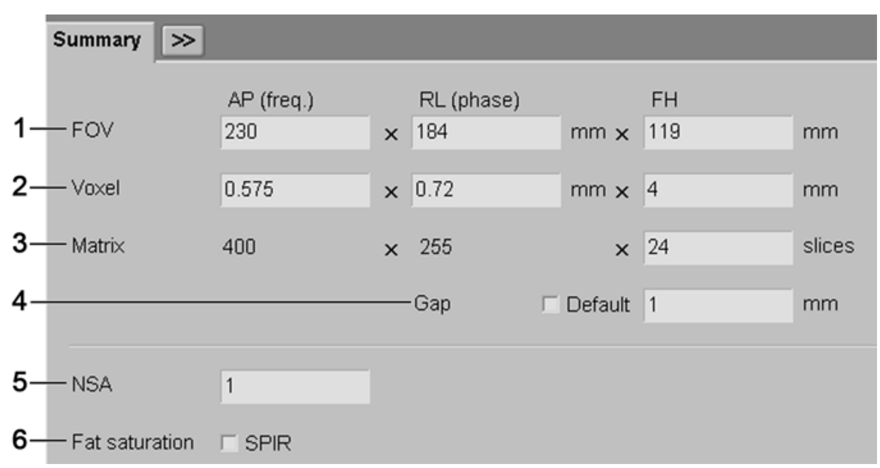

Fig. 247: Summary tab.

Extended Parameter Editor

The Extended Parameter Editor allows modification of the items of an ExamCard on parameter level.

To open the Extended Parameter Editor

1. Double-click on an ExamCard scan protocol in order to open it in the Parameter Editor.

   The Parameter Editor opens automatically for the current ExamCard item.
2. Click on the arrows next to the **Summary** tab to display the extended parameter group tabs.
3. Click on one of the tabs **Geometry**, **Contrast**, **Motion**, **Dyn/Ang**, **Postproc**, **Offc/Ang** to open the Extended Parameter Editor.

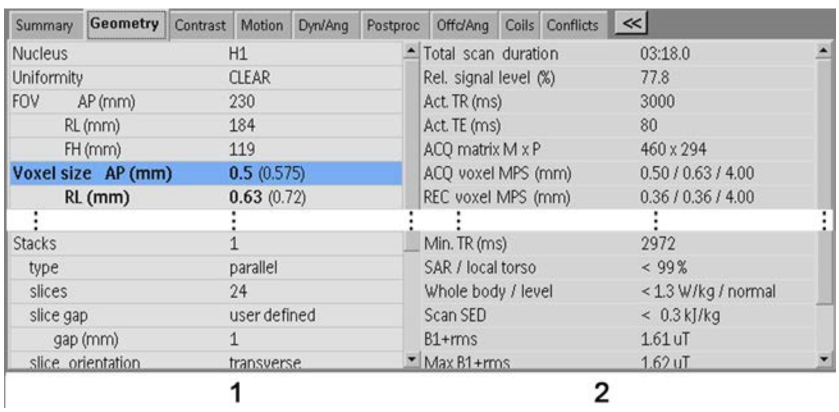

Fig. 248: Extended Parameter Editor. 1 - Parameters per group, 2 - Detailed information about the currently planned scan.

The selected parameter group is displayed on one or more pages. A scroll bar indicates if more parameters are available.

Besides the parameters with their current values, detailed information about the currently planned scan is given, see chapter “Display the Scan Information Page” on page 443.

Navigation and Editing

Select a parameter for editing

- Click to select the parameter that has to be modified.

  The parameter will be highlighted.

  Once a parameter group has been selected, you can scroll to another parameter as follows:
- Use the |Arrow down| or |Arrow up| to scroll within a parameter group.

Alternatively you can **search for a parameter**:

1. Type in the first letter of the required parameter’s name.

   The cursor jumps to the first parameter starting with this letter.

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2. Repeat typing in the first letter of the required parameter’s name.

   The cursor jumps to the next parameter starting with this letter.

Example

- Required parameter: REST
  - Typing in "R", the cursor jumps to "Respiratory compensation".
  - Typing in "R"once more, the cursor jumps to "REST".

Modify the current imaging parameter

The current imaging parameter is the highlighted parameter (blue). There are different ways of how to change the value of the current imaging parameter:

1. Enter the value manually:
   - Click into the value field to make it current.
   - Click again to position the cursor in the value field.
   - Delete with the |Del| or |Backspace| key and enter the value with the keyboard.
2. Select the value from the drop-down menu (applicable for parameters with text values):
   - Click to open the drop-down menu,
   - and select the value; or select the value field, type in the first letter of the wanted value and press the |Enter| key when the right value is displayed.
3. Increase/decrease the parameter values (especially used for numerical values) with arrow keys and 'Arrow up'/'Arrow down' buttons as shown in the table:

Effect	Keyboard arrow keys	 buttons
To increase parameter value by one	Press **->** key.	Click the 'Arrow up' button.
To increase parameter value to highest possible value.	Press and hold |Shift|, then press **->** key.	Press and hold |Shift|, then click the 'Arrow up' button.
To decrease parameter value by one	Press **<-** key.	Click the 'Arrow down' button.
To decrease parameter value to lowest possible value	Press and hold |Shift|, then press **<-** key.	Press and hold |Shift|, then click the 'Arrow down' button.

Fig. 249: Left: selecting value from drop-down menu. Right: using 'arrow up/down' buttons to increase/decrease a numerical value.

Restore original value

Pressing |Shift|+|Enter| restores the original (preset or last stored) parameter value.

’Undo’ Function

An ’Undo’ function is available by means of pressing ’Ctrl’ + ’Z’ or by clicking the 'Undo' icon.

The 'Undo' function doesn't work after having clicked 'Accept' (to accept the changes made).

Display helptext for imaging parameter

► Press |F1| or select 'Help Topics' from the Help menu to display the information about the current imaging parameter.

NOTICE

Not all combinations of parameter values are possible.

This will be indicated by a conflict on the 'Conflict' page. To solve the conflict, refer to the ’Conflicts' tab and the 'Assistance'.

Parameter benefits and trade-offs

NOTICE

For information about all MR imaging parameters, refer to the Parameter Help.

Press |F1| or select 'Help Topics' from the Help menu.

The relationships between MR imaging parameters are complex. The table shows the effects of increasing or enabling a parameter (set to “Yes”) on scan time, resolution, signal-to-noise ratio (SNR) and artifact level for some parameters.

↓ lower, ↑ higher, = unchanged, * more information available in following table

PARAMETER	Scan time	Resolution	SNR	Artifacts
NSA	↑	=	↑	↓
REST	↑	=	=	↓
Voxel Size	↓	↓	↑	↓/↑
FOV (in combination with fixed matrix size) *	=	↓	↑	=
FOV (in combination with fixed voxel size) *	↑	=	↑	=
Rectangular FOV (%)	↑	=	↑	=

PARAMETER	Scan time	Resolution	SNR	Artifacts
Scan percentage (%)	↑	↑	↓	=
Slice thickness	=	↓	↑	=
Scan matrix	↑	↑	↓	=
Halfscan	↓	=	↓	↑
SMART	=	=	=	↓
Water Fat Shift	=	=	↑	↑
3D Slices	↑	=	↑	=
SE Flip Angle	=	=	↓	=
Flowcomp FFE, TSE	=	=	↓	↓
Flowcomp SE	=	=	=	↓
Partial Echo	=	=	↓/↑	↓/↑
SPIR / ProSet	↑	=	=	↓
SENSE	↓	=	↓	=

The effect of the parameter FOV can differ depending on the way of working: you can either adjust the **matrix size** or the **voxel size**. The table illustrates the effects.

Way of working	FOV	Scan matrix	Pixel size	TE	TR	Scan time	SNR
Matrix size	↓	=	↓	↑ 1)	↑ 2)	↑	↓ 3)
Voxel size	↓	↓	=	=	=	↓	↓ 4)

Footnotes:

1. This is valid in case of TE = shortest.
   For TE = user defined, this could lead to a conflict
2. This is valid in case of TR = shortest.
3. This is caused by smaller voxels.
4. This is caused by the reduction of scan time.

Display the Scan Information Page

The Scan Information Page (also referred to as Info Page) is automatically displayed in the Parameter Editor window when an extended parameter group is worked on. It is not available together with the **Summary** tab. The Scan Information Page displays the most important scan characteristics of a planned EC item, e.g. total scan duration and Rel. SNR.

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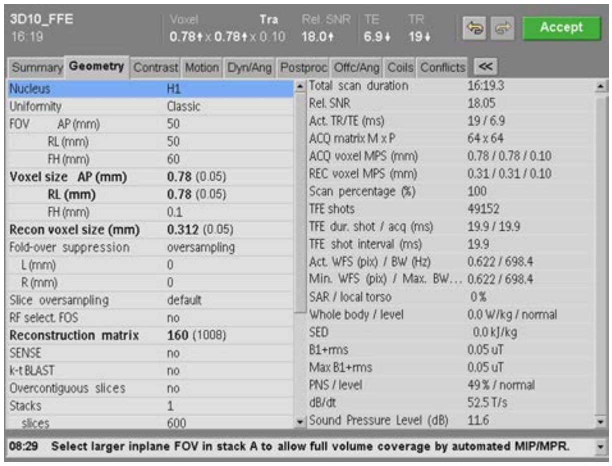


Parameter Editor.

Left: Geometry tab.

Right: Info Page.

The Info Page displays generic scan characteristics which are displayed for every current EC item (e.g. total scan duration, Rel. SNR), but also dedicated scan characteristics such as Minimum TI, Number of Packages or Minimum Slice Gap which only apply for specific scan methods. The table below lists the generic scan characteristics applicable for every kind of scan.

Item displayed	Description
Total scan duration	Scan duration per current ExamCard item.
Rel. SNR	Relative Signal-to-Noise Ratio, more info see below.
ACQ heart phases	Actual number of acquired heart phases.
REC heart phases	Actual number of reconstructed heart phases
ACQ matrix M x P	Acqusition matrix Measurement x Preparation direction.
ACQ voxel MPS (mm)	Acquisition voxel size in Measurement, Preparation and Slice selection direction in millimetres.
REC voxel MPS (mm)	Reconstruction voxel size in Measurement, Preparation and Slice selection direction in millimetres.
Scan percentage (%)	Current scan percentage considering all imaging parameters.
Actual WFS (pix) / BW (Hz)	Actual Water-Fat Shift in pixels and Bandwidth in Hertz.
SAR / head	Specific Absorption Rate / head in %. Depending on the anatomy scanned, the SAR could also be indicated as e.g. SAR/local torso or SAR/local extremities.
Whole body / level	Whole Body SAR in W/kg, and the level indicated as normal or first level controlled operating mode.
SED	Specific Energy Dose in kJ/kg.
B1+rms	Average RF deposition in the patient, also denoted as B1+RMS in uTesla.
Max B1+rms	Maximum Average RF deposition in the patient, also denoted as Max B1+RMS in uTesla.

Item displayed	Description
PNS / level	Peripheral Nerve Stimulation, and the level indicated as normal or first level controlled operating mode..
dB/dt	The strength of the switching gradient used for imaging.
Sound Pressure level (dB)	Sound pressure level. The sound pressure level is given with respect to an internal acoustic reference level which can be understood as the standard system noise level. Accordingly, negative/positive values indicate that the actual sound pressure level is below/above this reference level.

More information on SAR, SED, B1, PNS and dB/dt can be found in the safety chapter of the IFU and the Technical Description.

Extended Functional Options on the Scan Information Page

If functionality of the commercial package EFO (Extended Functionality Options) is being used, an informational parameter **EFO Options used** is shown on top of the Info Page. This parameter indicates the number of EFO SW Options used.

Relative SNR

The Relative SNR

- shows the effects on the SNR (Signal-to-Noise Ratio) when modifying parameters.
- is displayed as factor where a value of 1.0 is identical to the SNR of the original scan protocol.
- is not an absolute value, but relative to the SNR of the initial scan protocol.

It is important to realize that the Relative SNR is based on a relative calculation.

Example

If the original slice thickness is halved, the displayed Relative SNR will be 0.5 (relative to the original procedure).

If this procedure is saved and retrieved again, the Relative SNR will still be displayed as 0.5. Modifications are always relative to the starting point which is the original scan protocol.

Parameters affecting the Relative SNR-calculation

The SNR of a scan and in such a way the Relative SNR-calculation is affected by e.g.: NSA, TR, TE, Flip angle, inversion time, voxel size, slice thickness, halfscan, FOV, (RFOV, matrix size, scan percentage) and water-fat shift .

The **`Reference Tissue'** parameter is also included in the RSL-calculation, but it does not affect the SNR of the image. It can be set to e.g. white matter, muscle, liver, bone marrow and CSF. The T1- and T2-values of the tissues are taken into account to give a more realistic interpretation of the SNR changes.

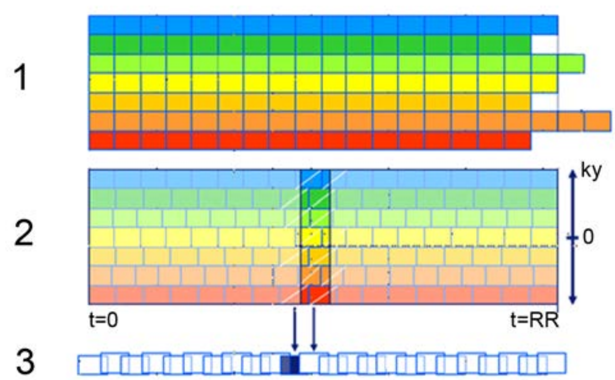
E.g., in a Spin Echo sequence a relatively small change in TE will cause a more rapid loss of signal in liver tissue than in white brain matter. That is why it is advised to leave this parameter set to white matter in brain imaging.

Actual phase percentage

The actual phase percentage relates to the parameter ’Phase percentage’ (motion page). This parameter determines the fraction of the number of requested phases that is acquired.

With ’Number of phases’ set to 30 and a phase percentage of 67%, only 20 phases are acquired and reconstructed to 30 phases.

With retrospective TFE, TFE shots are continuously acquired, mapped and stretched to an average RR-interval and finally reconstructed to the requested number of phases.



Actual phase percentage with retrospective TFE:

1. Acquisition (18 phases, 7 heart beats).
2. Stretching to average RR-interval.
3. Reconstruction (24 phases, 75% phase percentage).

Actual phase percentage with retrospective TFE.

The number of 20 acquired phases can only be achieved if 20 TFE shots fit exactly into one cardiac cycle. Generally this is not the case, but the actual acquired number of phases is a fraction higher or lower.

When 20.5 phases are acquired and reconstructed to 30 phases, this leads to an actual phase percentage of (20.5/30)*100=68.3%

- As long as the actual phase percentage is close to the requested phase percentage, the resulting image will be fine. The difference can increase when higher TFE-factors are used, and in that case you might need to tune the sequence (change number of phases, spatial resolution and/or SENSE factor) to avoid that the actual phase percentage is much lower than the requested phase percentage: this could lead to increased temporal blurring.

Coil Selection

The MR system automatically detects the connected coils. By default it uses **SmartSelect** (automatic coil selection) to select the best-suited coil and coil elements for optimum signal-to-noise ratio.

In the **Coils** tab of the **Parameter Editor**,

- You can view the connected coils as detected by the MR system.
- You can check if **SmartSelect** is enabled (which is the default setting).

- You can disable **SmartSelect**.

Viewing the connected coils

▷ In the **Parameter Editor**:

► Click the **Coils** tab.

The **Coils** tab opens and shows the connected coils.

SmartSelect

SmartSelect selects the best-suited coil and coil elements for optimum signal-to-noise ratio for the current stack and scan. **SmartSelect** is based on a coil reference scan.

The coil reference scan

- is automatically performed during the scan preparation phase.
- is repeated whenever the patient is repositioned or after tabletop movement.
- does not appear as scan item in the ExamCard.

By default, **SmartSelect** is enabled.

► To disable **SmartSelect**, deselect **SmartSelect** in the **Coils** tab of the **Parameter Editor**.

With SmartSelect enabled (default setting)	With SmartSelect disabled
• The MR system automatically selects the best-suited coil elements and uses them throughout the examination. • You cannot change the selection.	• The System Body coil is used.

NOTICE

In clinical routine MR examinations, use SmartSelect for ease of use and optimal image quality.

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SmartSelect procedures

Procedure	Workflow step	More information
Scanning with SmartSelect (automatic coil selection)	► Inspect the Coil Selection tab to see which coils are selected by the system.	The coil selection is a result of the CoilSurvey scan. By default the coil (and coil elements) for optimal signal-to-noise (SNR) ratio for the current stack and/or scan is selected.
Selecting the System Body coil	► To select the System Body coil for receiving, disable **SmartSelect**.	• Since the System Body coil is an integrated coil, it is always displayed as connected coil. • By default, the System Body coil is never selected when SmartSelect is enabled. • Other coils normally have a higher SNR than the System Body coil.
Scanning with a transmit/ receive (T/R) coil (T/R Head coil or T/R Knee coil)		• When a T/R coil is connected, the T/R coil is used for scanning (transmit and receive). The System Body coil is not used to transmit (neither is it used to receive signal). • Since the System Body coil is an integrated coil, it is always displayed as connected coil.

Conflicts page

1. Click the |Conflicts| tab (from the Parameter Groups tabs) to display the occuring conflicts resulting from the current parameter settings.

   The conflicting parameters are displayed.

Fig. 250: Parameter Groups tabs.

2. Modify their settings to solve the conflict.
3. For advice how to solve the conflict best, click 'Assistance' in the Scan Assistance window, see chapter “Assistance” on page 436.

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Running an ExamCard

Select an ExamCard and make it the Current ExamCard

▷ In the ExamCards Window:

1. Select either the **Philips** or the **Hospital** database.

NOTICE

The database ’Other’ is meant for importing and exporting.

2. Browse to the required ExamCard:
   - Double-click on the required anatomy (first time: ExampleCards folder).

     The required anatomy folder opens, and the list of available subanatomies is displayed.
   - Double-click on the required subanatomy.

     The required subanatomy folder opens, and the list of available items (ExamCards and scan protocols) is displayed.

     ExamCards are indicated by the ExamCard icon: 
3. Drag and drop this ExamCard into the List View, OR

   hover over the ExamCard, click the green plus icon .

   In both cases, the ExamCard opens in the List View and expands so that all ExamCard items within this ExamCard are visible.

Start the ExamCard

1. Click **Start scan** to start the ExamCard.

   The survey procedure starts. The survey images will automatically be loaded into the viewports.

Plan the items of the ExamCard geometrically

You plan the EC items in the Graphical PlanScan area, see chapter “Graphical PlanScan area ” on page 395.

1. Select suitable images for planning.

   Scroll to the slice best suited for planning. Window, zoom and pan to optimize the display of anatomic structures needed for planning.
2. Double-click on an ExamCard item to enable planning.

   The icon 'Being Modified'  indicates the ExamCard item currently being planned or modified.

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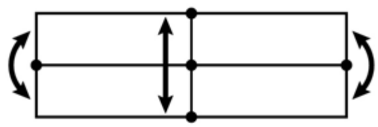
3. Move the volume, stack or slab:
    - Click on the circle in the center.
    - Drag in any direction.
      The values of the Offcenter parameters are automatically adapted.
4. Angle the volume, stack or slab:



    - Click on one of the outer squares on the mid slice.
    - Drag up- or downwards to change the angulation. The values of the Angulation parameters are automatically adapted.
5. Optional:
    - Drag the upper or lower yellow line to change the gap.
    - Press and hold |Shift|, drag the upper or lower yellow line to change the number of slices.
6. Repeat the previous steps for all ExamCard geometries.
7. Click **Accept** to accept the planning.
   Clicking **Cancel** ends the planning session without applying the changes.

Resume the ExamCard

1. Click **Start scan** to resume the ExamCard.

   All of the items within the ExamCard will be performed now.

Tabletop movement during scanning

If an ExamCard issue requires tabletop movement for optimum isocenter positioning, a message will pop up asking if tabletop movement can be performed. If this is confirmed, another message will pop up indicating that the tabletop is moving automatically. In order to stop this automatic tabletop movement, click **Stop**.

Moving TableTop

The tabletop is moving automatically.

- Stop

For more information, see Safety chapter.

Stopping reconstruction

Image reconstruction takes place during and at the end of every scan. Under certain circumstances image reconstruction blocks scanning of the next scans, since it uses scan resources.

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You only stop the reconstruction when reconstruction is not beneficial and hinders your workflow:

<table>
<tr><th>Scenario</th><th>Consequences</th></tr>
<tr><td>

- You stop a scan. Acquisition is not completed.

  Reconstruction of the partially acquired data is still ongoing.
- You stop the reconstruction.

</td><td rowspan="2">

Acquisition data are partially or completely lost.
To obtain all images, rescanning is needed.

- Depending on the scan type and the moment that you stop the reconstruction, some images might be available in the examination database, for example the first dynamic series of a dynamic scan.
- A message in the scanner status bar informs you about the status.

If the imaging parameter **Save raw data** is enabled, you can perform delayed reconstruction to calculate as many images as possible of the partially acquired data.

</td></tr>
<tr><td>

- A scan aborts. Acquisition is not completed.

  Reconstruction of the partially acquired data is still ongoing.
- You stop the reconstruction.

</td></tr>
<tr><td>

- The acquisition of the current scan is completed.

  The reconstruction is ongoing, but takes very long and hinders the next scan to start.
- You stop the reconstruction.

</td><td>

Acquisition data are partially or completely lost.
To obtain all images, rescanning is needed.

- Depending on the scan type and the moment that you stop the reconstruction, some images might be available in the examination database, for example the first dynamic series of a dynamic scan.
- A message in the scanner status bar informs you about the status.

To prevent rescanning of the scans where you foresee long reconstruction times:

- enable the imaging parameter **Save raw data**,
- and perform delayed reconstruction when the acquisition is completed, see chapter “Delayed reconstruction” on page 502.

</td></tr>
</table>

How do you stop the reconstruction?

► Right-click on the ExamCard item (scan protocol) in the List View.

► Click **Stop reconstruction**.

- When EC items are grouped, you can only stop the reconstruction of single EC items of this group, when the acquisition of the group is completed.
- You cannot stop suspended scans.

⇨ **Stop reconstruction** switches off the automatic start of the next scans.

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Create (and/or Edit) an ExamCard

You can create and/or edit ExamCards In the *ExamCards window* and the *ExamCard Editor*. This section describes how to proceed in the ExamCards window.

NOTICE

The maximum number of ExamCard items is 250. The maximum number of inline postprocessing steps is 6.

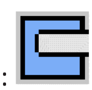
Select scan protocols

1. Select either the **Philips** or the **Hospital** database.
   The database **Other** is meant for importing and exporting.
2. Browse to the required scan protocol(s):
   - Double-click on the required anatomy.

     The folder opens, and the list of available subanatomies is displayed.
   - Double-click on the required subanatomy.

     The folder opens, and the list of available items (ExamCards and scan protocols) is displayed.
3. Click on the required scan protocol(s).

   Multiple selections are possible.

   - Scan protocols are indicated by the Scan Protocol icon: 
4. Drag and drop the scan protocol(s) into List View,

   OR hover over the ExamCard, click the green plus icon ,
   OR double-click the scan protocol.

   In all cases, the scan protocol will be added to the current ExamCard in ListView.

Change the ExamCard name

► Click on the ExamCard Header.

► Right-click on the ExamCard Header and select 'Edit Name' from the context menu.

► Edit the current name or enter a new name.

Select and deselect EC items

Selecting/Deselecting	Procedure	Effect
Select one item	Click on the item’s name.	The border color of the selected item(s) will change.
Select multiple consecutive items	Hold |Shift| while dragging over the items.	

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Selecting/Deselecting	Procedure	Effect
Select multiple individual items	Hold |Ctrl| while clicking on the items.	
Deselect	Hold |Ctrl| while clicking on the item.	

Fig. 251: Selected (lower row) and non-selected item upper row).

Duplicate, Copy, Cut, Paste, Delete and Move items

All these functions work on selected items only.

► Select an item first and then proceed as described below.

	Procedure	Effect
Duplicate an item	► Drag while keeping |Ctrl| pressed.	The item is copied to the current ExamCard, thus generating a duplicate.
Copy an item	► Either: • Press the combination of |Ctrl| and |C|. Or: • Right-click on the EC window and select 'Copy' from the EC context menu.	The item is copied to the clipboard.
Cut an item	► Either: • Press the combination of |Ctrl| and |X| . Or: • Right-click on the EC window and select 'Cut' from the EC context menu.	The item is removed from the current Exam-Card and moved to the clipboard.
Paste an item	► Either: • Press the combination of |Ctrl| and |V| . Or: • Right-click on the EC window and select 'Paste' from the EC context menu.	The item is moved from the clipboard to the current ExamCard. It will be inserted after the currently selected item.
Delete an item	1. Either: • Right-click on the EC window and select 'Delete' from the EC context menu. Or: • Press the |Del| key.	The item is deleted from the current Exam-Card. Items can only be deleted if they are not yet executed (prepared, running, in reconstruc-tion or similar).

	Procedure	Effect
Move an item	1. Drag the item to the desired position.	Items can only be moved if they are not yet executed (prepared, running, in reconstruction or similar). Otherwise a copy will be created.
Print an item	1. Right-click on a sequence in the ExamCard editor. 2. Select ’Save Protocol to Text File’. 3. Open the text file with e.g. Notepad. 4. Print the text file.	The scan protocol will be saved to a text file and can then easily be printed.

Assign a scan geometry to an item

Initially a geometry named "Geo1" is assigned to a scan protocol when dragged into ExamCard.

ExamCard items with the same geometry name have the same slice orientation, the same off-centers and angulations.

1. Click on the ’Geometry’ column to select it for editing.
2. Enter a Geometry name, edit the current name or select an existing geometry from the drop-down list.

For survey scans, the geometry name can be deleted. Doing so indicates that the scan does not need further planning and is ready to run.

Propagate the coverage

Scans sharing the same geometry (same geometry name) by default have

- the same number of stacks,
- the same orientation,
- each stack with identical angulations and offcenters.

Enabling ’Propagate Coverage’, these scans do also share

- the FOV (including RFOV and fold-over direction)
- the slice coverage (volume in slice direction):
  - In 3D scans, the number of slices will be adapted.
  - In 2D scans, the slice thickness will never be touched, but only the FOV, the rectangular FOV and the fold-over direction.
  - In M2D and MS scans, it depends on the kind of scan from which the geometry has to be taken over. Refer to the table below for more informations.

The following parameters are affected by 'Propagate Coverage':

- Number of stacks and/or slices
- FOV in measurement, phase and slice direction
- Slice thickness and gap

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- Fold-over direction and the amount of fold-over suppression
- Fat shift direction

NOTICE

When using ’Propagate Coverage’, always be aware of the fact that the fold-over direction is taken over.

Take over geometry	What happens?
3D scan -> M2D or MS	• The number of slices will be adapted such that the coverage of the M2D or MS scan is identical to the 3D scan.
M2D or MS -> M2D or MS	Number of slices • The number of slices will always be taken over to guarantee comparable slices. Slice thickness and slice gap • If the slice thickness has initially been the same, it will stay the same and changes to this parameter will be taken over, i.e. increasing the slice thickness from 5 mm to 6 mm, all other scans will also increase from 5 mm to 6 mm - if their initial value has been 5 mm. The slice gap will be adapted also. • If the slice thickness has initially NOT been the same, the slice thickness and the slice gap will be adapted to the new slice distance (distance between adjacent slice centers) where the thickness / gap ratio stays the same. I.e. changing the slice thickness from 5 mm to 4 mm, in a scan with initially 4 mm / 0.8 mm will change to 4.58 mm / 0.92 mm. This is done in such a way with respect to IR scans where typically a slice gap of 20% of the slice thickness is used.

Workflow

1. Select multiple ExamCard items with the same geometry name in order to propagate the coverage.
   To select multiple successive items, press |Shift| and click to select.
   To select multiple items, press |Ctrl| and click to select.
2. Right-click and select ’Propagate Coverage’ from the context menu.
   A checkmark indicates that 'Propagate Coverage' is enabled.
3. Double-click one of the EC items (with 'Propagate Coverage' enabled) to open it for editing.
4. Change geometry parameters as needed.
5. Click 'Accept' to confirm planning.
6. Automatically all other EC items with 'Propagate Coverage' enabled will have the same coverage settings.

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Link items (GeoLink)

For more information about GeoLink, see chapter "ExamCard Items" on page 430.

1. Move the cursor over the 'GeoLink' column.

   The geometry field turns blue.
2. Click on the column to select it for editing.
3. Enter a letter representing the geometrically linked group, e.g. 'X'.

Insert a user start / manual start prior to an item

1. Move the cursor over the 'Characteristics' column.

   Blue borders appear around the geometry field.
2. Click on the column to select it for editing.
3. Click on the arrow symbol to display a drop-down menu.
4. Select 'User Start Required'.

   To indicate the pause or the manual start (e.g. after an injection), the corresponding symbol appears in this column.

Fig. 252: Inserting a user or manual start.

You can also select 'Requires Manual Start |Ctrl|+|U|' from the right mouse menu, or press |Ctrl|+|U|.

Group and ungroup items

Main purpose of grouping scans is to make sure that a scan is not started before another one is planned. Group items cannot be modified after the scan has been started.

This is especially relevant for contrast uptake studies e.g. BolusTrak where the pre-contrast scan, the 2D real-time reconstructed scan and the post-contrast scan are typically grouped. In such a way, the subtraction results will be reliable due to identical pre- and post-contrast scans.

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Philips

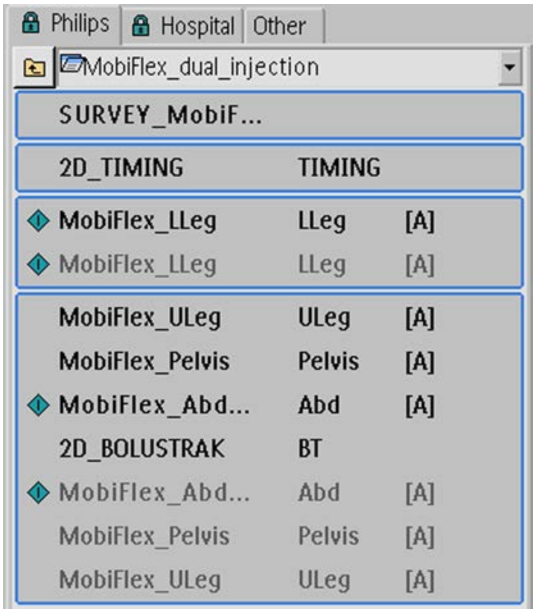

Fig. 253: Grouped items within a MobiFlex ExamCard.

Workflow of Grouping

1. Select multiple consecutive items.
2. Right-click on the ExamCard window and select 'Group' from the ExamCard context menu (alternatively press |Ctrl|+|G|).

   Instead of a border around every item, the group of items will be surrounded by one border only.

Workflow of Ungrouping

1. Click on the group to make it current.
2. Right-click on the ExamCard window and select 'Ungroup' from the ExamCard context menu (alternatively press |Ctrl|+|G|).

   Instead of a border around the group, now every item will be surrounded by its own border.

Split dynamics

1. Click on the group to make it current.
2. Right-click on the ExamCard window.

   The context menu appears.
3. Select "Split".

   The current dynamic scan consisting of multiple dynamic series will be split up in single scans.

   The resulting ExamCard items cannot be ungrouped, but unsplit: right-click and select 'Unsplit'.

Align scans

1. Click ’Scan Align’ on the planning toolbar in Graphical PlanScan.

Scan Align

- To align scans, especially with table movement to cover long anatomical areas.

This function is comparable to the imaging parameter ’Stack Align’.

Start the ExamCard

1. Click |Start scan| to start the ExamCard.

   The survey procedure starts. The survey images will automatically be loaded into the view-ports (when no geometry name was assigned to the survey scan).
2. Plan the items of the ExamCard geometrically; see GPS.

Adjust the ExamCard properties

► Click on the ExamCard Properties button  in the List View.

► Select either **General** or **Push nodes**.

► For **General**: set the general ExamCard parameters to the appropriate value.

► For **Push nodes**: Select the push node for this ExamCard.

For more information about the ExamCard Properties, see chapter “ExamCard Properties” on page 427.

Enable or disable ’Push to workstation’

► Right-click on the ExamCard header (name).

► Select ’Enable Autopush to Workstation’.

The checkmark indicates that the function is enabled.

► Optionally for the current ExamCard this function can also be enabled from the main menu bar 'Examination'.

After selecting the whole ExamCard, it is possible to deselect series. In general, pushing to a workstation is possible on ExamCard level, but also on scan level and postprocessing step level.

Resume the ExamCard

1. Click |Start scan| to resume the ExamCard.

   All of the items within the ExamCard will be performed now.

   When an item is finished, the scanner will automatically proceed with the next item in the list, if the item is planned and has the status ’Ready to run’.

Save the ExamCard

1. Click on the ExamCard header to enable editing of the ExamCard’s name. Rename the ExamCard.
2. From the main menu bar, select 'System' and then 'Manage ExamCards'.
3. Browse to the anatomy / subanatomy folder where the ExamCard has to be saved in.
   - Double-click on the desired anatomy folder.

     The folder opens, and the list of available subanatomies is displayed.
   - Double-click on the desired subanatomy folder.

     The folder opens, and the list of preset procedures and ExamCards is displayed.
4. Select the current ExamCard by clicking on the header.
5. Drag the ExamCard into the open folder.

Alternatively:

- ► Right-click on the ExamCard in List View.
- ► Select 'Save ExamCard'.

  The ExamCard will automatically be saved in the folder 'Other'/'Saved'.

Save some items of the current ExamCard as a new ExamCard

1. Click on the ExamCard header to enable editing of the ExamCard’s name. Rename the ExamCard.
2. From the main menu bar, select 'System' and then 'Manage ExamCards'.
3. Browse to the anatomy / subanatomy folder where the ExamCard has to be saved in.
   - Double-click on the desired anatomy folder.

     The folder opens, and the list of available subanatomies is displayed.
   - Double-click on the desired subanatomy folder.

     The folder opens, and the list of preset procedures and ExamCards is displayed.
4. Select the several items of the ExamCard which have to be saved within a new ExamCard by clicking on them combined with pressing |Ctrl|.

   An orange frame marks the selected items.
5. Drag the ExamCard items as a new ExamCard into the open folder.

Preparation of ExamCards

ExamCards can be created and edited without a current examination/case in any of the viewing slots. This facilitates the preparation of ExamCards without a patient who needs to be scanned.

Preparing ExamCards in such a way is referred to as ExamCard Prep Mode.

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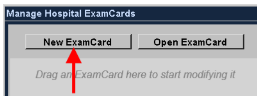
Creating a new ExamCard in the EC Editor

You can create and/or edit ExamCards In the *ExamCards window* and the *ExamCard Editor*. This section describes how to proceed in the *ExamCard Editor*.

▷ In the *ExamCard Editor*:



► Click **New ExamCard**.

The **ExamCard Properties |Basic|** window opens as part of the *ExamCard Editor*.

Mandatory fields are displayed in red with an asterisk.

► Enter the name of the new ExamCard in the field **ExamCard name**.
Choose a unique name that represents the application or the content of the ExamCard.

► Select **Age is less than 3 years** for pediatric patients below 3 years.
Deselect **Age is less than 3 years** for patients above 3 years.

This entry is only used for theoretical SED calculations within this Editor. Once you scan a patient with this ExamCard, the actual SED is calculated based on the actual patient data as entered via **New Examination...**.

► Enter a value for the patient's **weight**.

This entry is only used for theoretical SED calculations within this Editor. Once you scan a patient with this ExamCard, the actual SED is calculated based on the actual patient data as entered via **New Examination...**.

NOTICE

Pay special attention to the parameters Anatomy, Anatomic Region, Laterality and Patient Position.

The display of the resulting imaging series is based on the settings of these parameters.
For more information, refer to chapter “Image Display Settings” on page 543 and to chapter “ExamCard Properties” on page 427.

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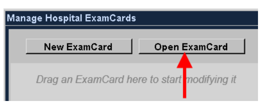
- Select the **Anatomy** for this ExamCard.
- Select the **Anatomic Region** for this ExamCard.
- Select the **Laterality** for this ExamCard:
- To select the **Patient Position**, drag the scroll bar and click any of the icons.
- To select any of the **Coils**, drag the scroll bar and click the image of the coil you want to scan with.
- **Add new scan item** or **Add SmartSurvey**
- Click **Advanced** to access the advanced ExamCard Properties.
- Enter text in the **Info** tab.
- Click **Save ExamCard**.
- Click **Close** to close the ExamCard window.
- Click **Hide** to hide the window.

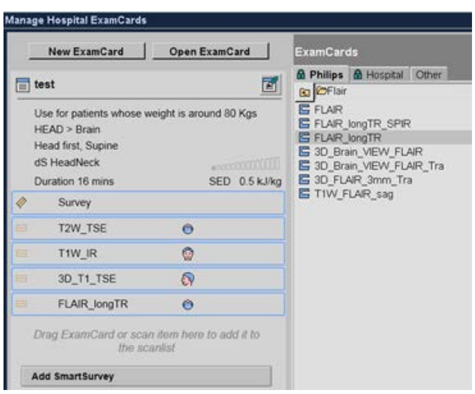
Editing an existing ExamCard in the EC Editor

▷ In the *ExamCard Editor*:



- Click **Open ExamCard**.

  The EC databases are displayed.
- Browse to the ExamCard that you want to edit, and drag it into the *Current ExamCard (List View)* of this window.



- To add EC items to the current ExamCard, drag these items from the EC databases into the ExamCard.

- To edit the ExamCard properties, click the *Show ExamCard properties* icon.
  For more information, see chapter “ExamCard Properties” on page 427.
  When you are done, click **Close** to go back to this window.

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- To edit an EC item (imaging protocol), double-click it.
  It opens in the *Parameter Editor* and you can edit it as usually.
  For more information, see chapter “Parameter Editor” on page 437.
- To edit the attributes of an EC item, click in the corresponding columns in the *Current ExamCard (List View)*.
  For more information, see chapter “ExamCard Items” on page 430 and chapter “List View or Thumbnail View” on page 393.
- To make the ExamCard a Smart ExamCard, click **Add SmartSurvey**. Then proceed as usual.
  For more information, see chapter “SmartExam” on page 470.
- Click **Save ExamCard**.
- Click **Close** to close the ExamCard window.
- Click **Hide** to hide the window.

ExamCard Exchange

ExamCard Exchange is an internet-based service that enables fast and simple download of ExamCards from NetForum.

The ExamCard Exchange functionality provides ExamCard download at the touch of a button

- Philips updates of ExamCards
- Customer ExamCards

For information on how to import/export ExamCards and/or ExamCard databases, see chapter “Export/Import of ExamCards” on page 466.

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Connect to NetForum

It is possible to connect to NetForum in two ways.

Directly from the scanner

- via a secure, fast and reliable connection

1. Press the Windows Start key or click the Windows Start button.
2. Select ’Favorites’.
3. Select ’Philips NetForum Community’.

From any PC connected to the Internet

1. Connect to the Internet as usual.
2. Go to the website http://www.philips.com/netforum.

Different User Levels on NetForum

Much of the information on NetForum (www.philips.com/netforum) is accessible for any visitors of the site.

However, registration is required for:

- Downloading ExamCards -Viewing restricted content, for instance scan protocols, some application tips
- Online training modules on use of Philips MR scanners and packages, use of coils, MR safety.
- Submitting content
- Utilization services

Register / login for ExamCard Exchange

On a first time vist, it is necessary to register. When registration already has taken place, the login can be performed at once.

To register

- ► Click |Register|.
- ► Enter your data.
- On a first time visit, the web site will try to acquire the configuration of the MR scanner automatically. Clearly this is only possible if the website is accessed directly from the scanner.
  - The website server will build configuration data of the user and save it for later use.
  - If the information has been retrieved automatically, then the server will show a summary to the user and ask for confirmation.
  - If confirmed, the user will be taken to the next page. If not, the user is informed about possible consequences and taken to the manual configuration page.
- If there is no access to the internet, a semi-automatic procedure is available. The user will be instructed to copy a configuration file from the scanner to the computer that does have access to the internet and where the configuration file can be uploaded to the scanner.

To login

1. Enter your User-ID.
2. Enter your Password.

Download or upload protocols

1. Connect to NetForum.
2. Select ’Magnetic Resonance’ /’International’ or ’USA’.
3. Login as registered user.
4. Click ’ExamCard Sharing’ to access ExamCards for download.

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NOTICE

Images being exported with the ExamCard may not contain any patient data.

This is the customer's responsibility.

ExamCard Databases password protection

To store ExamCards in the Hospital ExamCard database

- To remove the **Lock**, right-click in the EC database window.
- Click **Unlock ExamCards Database**.

  If the **Hospital** EC database is password protected, you are asked to enter the password.

  Once the lock is removed, the **Lock** icon is not longer shown in the **Hospital** tab. ExamCards can now be saved in the **Hospital** EC database.
- Drag and drop ExamCards into the **Hospital** ExamCard database to save them there.

Password Protection of the EC Hospital folder

To ensure consistency and to protect the quality of the ExamCards, the contents of the **Hospital** folder can only be modified by authorized operators.

NOTICE

The default password is: Philips

Enabling or disabling the EC Hospital folder password protection

- Select the **ExamCard password manager** from the **Windows Start** menu.
- Enter the current password. Press **Enter** or click **OK**.

  The **ExamCard password manager** opens.

► Do any of the following:
  - Click **Disabled** to disable (hospital) **Database locking**.
  - Click **Enabled** to enable (hospital) **Database locking**.

► Click **OK** to confirm.
Click **Cancel** to close the window without any changes.

A message is displayed that the database is locked or unlocked and that the changes are activated after a reboot.

► Reboot the system.

Change the password

▷ You are logged in as **MRUSER**.

► Select the **ExamCard password manager** from the **Windows Start** menu.

► Enter the current password. Press **Enter** or click **OK**.

The **ExamCard password manager** opens.

► Enter the new password
  - in the field **New password** and
  - in the field **Confirm password**.

► Click **OK** to confirm.
Click **Cancel** to close the window without any changes.

A message is displayed that the database is locked or unlocked and that the changes are activated after a reboot.

► Reboot the system.

Reset the password

▷ You are authorized to reset the password when you are the hospital administrator or a Philips service engineer:

► Log in to the MR system as hospital administrator.

► Select the **Password Reset** application from the **Windows Start** menu.
The **Password Reset** window opens.

► Choose the password type, in this case **ExamCard Password**.

► Click **Yes**, to confirm.

The current password is reset to the default password (Philips).

A message is displayed that the default password is activated after a reboot.

► Reboot the system.

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Export/Import of ExamCards

ExamCards can be exported/imported for several purposes:

1. Use/reuse of an EC or EC DB on another Philips MRI scanner.
2. Backup of the Hospital ExamCard database.
3. Availability of several EC DBs to switch between for scanning.

NOTICE

When an ExamCard or ExamCard database is to be reused on another Philips MRI scanner, always make sure that the configuration of the systems are identical. Otherwise the ExamCard(s) might not work or even provide lower quality than expected.

ExamCards can be exported/imported in two ways:

- Specific ExamCard(s), or
- The complete Hospital ExamCard database.

Export specific ExamCards

In order to export hospital ExamCards:

- ► Right-click on the ExamCard or ExamCards in the ExamCard database.
  (Multiple selection is possible in combination with the |Alt| or |Ctrl| key.
- ► Select ’Export ExamCards...’.
- ► Select the directory/drive to be copied to.

Make sure that the releases are the same or newer for the system where you want to import an ExamCard to.

NOTICE

The function ’Export to NetForum’ exports the selected ExamCard(s) to the FTP-destination E:\\Export\ExamCards*.NetForumExamCard.

Import ExamCards

In order to import ExamCards from a directory or drive,

1. Right-click in the ExamCard database.
2. Select ’Import ExamCards...’.
3. Browse to the ExamCard which has to be imported.

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4. Double-click on this ExamCard. The ExamCard will be copied into the Inbox in the ExamCards database.
5. Return to the ExamCard environment to proceed.

During import of ExamCards from the ExamCards database, geometry filtering takes place which removes the unused geometries from the ExamCard.

Export Hospital ExamCard Database

- Right-click on any of the tabs (Philips, Hospital, Other) in the ExamCards window.
- Select ’Export ExamCard Database As …’ from the right-mouse menu (context menu).
- Browse to the desired folder and enter a name which represents the current ExamCard database.

NOTICE

Do not use spaces or special characters in the file name.

- Click ‘Save’ to start the export procedure to the desired folder.

  In the bottom row of the ExamCards window, the progress will be indicated: “Preparing for export of Database. Please wait.” “Export of Database completed.”

  The ExamCard database is saved as Database Archive file in a zip file format.

Import Hospital ExamCard Database

Four slots are available for ExamCards databases. Slot 1 is reserved for the ‘Default Database’ which is the current Hospital EC database. It is greyed out and cannot be overwritten. The slots 2 to 4 can be filled with any ExamCard database. Initially these slots are empty and marked as “…”.

- Right-click on any of the tabs (Philips, Hospital, Other) in the ExamCards window.
- Select ’Import ExamCard Database’ from the right-mouse menu.
- Click on the slots where to import the database to.
- Browse to the ExamCard database to be imported.
- Click ‘Open’ to start the import procedure of the desired ExamCard database.

  In the bottom row of the ExamCards window, the progress will be indicated: “Importing Database. Please wait.” and “Importing of Database completed.”

  When importing of the database is completed, the slot will automatically be renamed to the name of the ExamCard Database. In order to switch to this database, you still need to select it by means of ’Select Hospital ExamCard Database’.

Select Hospital ExamCard Database

- ► Right-click on any of the tabs (Philips, Hospital, Other) in the ExamCards window.
- ► Select ’Select ExamCard Database’ from the right-mouse menu.
- ► Select the EC database you want to use by clicking on the corresponding slot.

  The ’Hospital’ tab will be replaced by the selected ExamCard database.
- ► To return to your Hospital ExamCard database, select ’Select ExamCard Database’ again and select ’Default Database’ in the first slot.

Administration of ExamCards

Saving and retrieving of examinations AND ExamCards

ExamCards are saved to and retrieved from the patient database with the examination.

- Saving an examination will also save the corresponding ExamCard
  - when saving into any patient database;
  - when exporting to devices such as DVD.
- Retrieving an examination will also retrieve an ExamCard
  - when retrieving from any patient database;
  - when importing from devices such as DVD.

NOTICE

ExamCards are not retrieved from datasets acquired with previous software releases.

Automatic ExamCard backup

- A backup of ExamCards is automatically generated and preserved for 3 hours. This can be especially helpful after crashes.
  - Simply reselect the examination and the ExamCard will be restored including planned geometry.
  - Double-click on the ExamCard to confirm.

ExamCards Restart (EC Restart)

ExamCards are automatically restarted when a failure in the ExamCards application occurs. This prevents the need of restarting the complete application software and consequently saves time.

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What are the main properties of ExamCards restart?

- During EC restart, the system's functionality is restricted.
  - Planning and scanning cannot be performed

    If an ExamCard is running, it aborts.
  - In the planning viewports the planning geometry (lines) is cleared.
  - Reviewing and analyzing of images is still possible.

    However it is not possible to generate new imaging series.
- After restart, the ExamCards application is functional again.

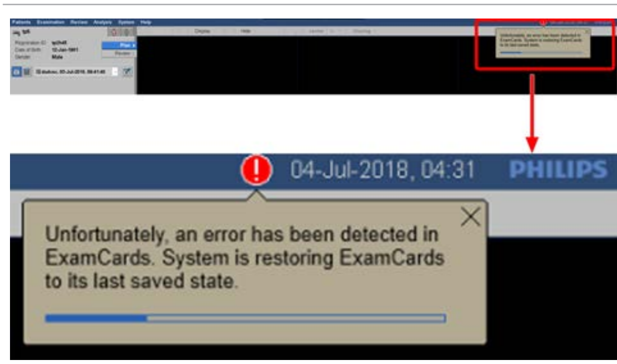
  ExamCards are restored to the last saved state.
  - The aborted ExamCard is populated and available after EC restart.
  - The ExamCard items retain their state (completed, aborted, not started yet).
  - The previous planning and reviewing sessions are restored.
    Any parameter modifications made to non-executed scans during that examination may be lost.
  - The ExamCard items show the previously opened analysis and review packages as inline steps (stippled).
  - A previously completed QuickSurvey is retained. It is not necessary to acquire a new QuickSurvey.
  - When you were editing an ExamCard independently of a patient examination (in Prep mode without entering patient data), after EC restart this ExamCard is not restored for editing.
- You are notified about the EC restart and about its progress.

How are you notified about the ExamCards restart?

- By a message in a pop-up window.

  The message is cleared once the process is restored.
- By an icon on the system tray of the main menu bar.

  The icon is cleared once the process is restored.
- The progress of restart is also indicated on the system tray.



Icon and message on system tray.

The progress is indicated by the progress bar.

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What is not restored by ExamCards restart?

Anything that is not restored by EC restart, has to be redone:

- You have to plan the non-executed scans to make them ReadyToRun.

  You can still use the already performed survey for planning.
- To continue with Smart Planning, you have to redo the SmartSurvey.
- Since any parameter modifications made to non-executed scans may be lost, you have to check and probably modify these parameters again.

SmartExam

SmartExam is a tool that automates planning, scanning and processing in brain, knee, shoulder, breast, cervical and lumbar spine examinations. Automatic planning and scanning is realized by SmartPlan, automatic processing by SmartLine Processing.

SmartPlan

SmartPlan makes use of an algorithm that automatically detects some typical anatomic structures in a Smart survey, e.g. corpus callosum for brain examinations, but also symmetry aspects are taken into account.

These typical structures are recognized, stored and used as a reference for further automatic planning.

SmartPlan is available for head, knee, shoulder, breast, cervical and lumbar spine examinations. It is a tool that helps in automatically planning scans with respect to the geometry parameters ’offcenter’ and ’angulation’.

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Geometry databases

SmartPlan makes use of geometry databases which specify the way of planning for each anatomy. These geometry databases are predefined with the most common way of planning and allow for the immediate use of SmartExam. If another way of planning is preferred, user-specified Smart geometries can be created:

NOTICE

For shoulder, breast, cervical and lumbar spine, all angulations in the Philips geometry databases are set to zero.

This is also referred to as ’Snap-to-table’.

NOTICE

If you mirror or flip the source images, SmartPlan cannot analyze the images properly.

In this case, SmartLine processing steps (such as calculation of Maximum Intensity Projections or Multiple Planar Reformats are not performed.

Prerequisites for SmartExam

There are several prerequisites for a Smart ExamCard.

Smart survey

- The Smart ExamCard has to start with a Smart survey. The Smart survey is a dedicated 3D survey scan covering the anatomic region completely.

  Parameters of the Smart survey cannot be changed.

SmartGeometries

- In a Smart ExamCard, only SmartGeometries can be planned automatically.
- Existing ’normal’ geometries need to be
  - replaced with existing SmartGeometries
  - converted into SmartGeometries.

Refer to the Coils chapter to find out which coils can be used and are supported for SmartExam.

SmartLine Processing

Once the **Generate Series** function is used during the analysis with a postprocessing package,

- a new imaging series is generated,
- a postprocessing item is added to the ExamCard.

  The performed operation is part of the current ExamCard and in such a way automatically performed whenever the ExamCard is executed again.

SmartLine Processing applies for the following postprocessing packages:

- Picture Plus
- Diffusion
- Diffusion registration
- VolumeView
- MobiView
- Basic T1 Perfusion
- Neuro (T2*) Perfusion
- Image Algebra
- IViewBOLD (in this case, the IViewBOLD will only be launched with the correct paradigm)

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NOTICE

The maximum number of SmartLine processing steps is 6.

Smart MPR

If a 3D scan is planned using SmartExam (e.g. VISTA Knee or 3D-TFE Brain) angulations can be stored relative to the volume in the Smart MPR.

This means that if this ExamCard is stored with the SmartLine MPR, every MPR will have the same orientation.

Adding a postprocessing step to an ExamCard

► Switch from the Thumbnail View to the List View.

► Start up the postprocessing package:

- Right-click a suitable scan and select the postprocessing package.

A tentative step is visible in the ExamCard.

► Click the **Generate series** icon (while the ExamCard is running).

The postprocessing step is added to the ExamCard.

► Close the package as usual.

► Save the ExamCard to the database.

⇨ The next time that this ExamCard is performed, postprocessing steps are already part of the ExamCard.

Example of ExamCard with SmartLine processing steps

6.1 - original scan

6.3 - subtraction processing step

6.4 - MIP processing step of 6.3

6.5 - PicturePlus processing step of 6.4

6.6 - MIP processing step of 6.3

When you double-click any of the SmartLine processing steps, the red-rimmed checkboxes indicate the series which are used as processing input. For example: with a subtraction you can indicate if the source data set is used for a subtraction, or a resulting series from another SmartLine processing step.

Performing Automated Processing

- If no user interaction is required, the postprocessing step is carried out automatically as soon as the source images are available.
- If user interaction is required, double-clicking the processing step opens the package. This allows for customization of the parameters.

- A pause can be specified for a processing step in the ExamCard. A double-click is necessary to open the package allowing for manual parameter adjustments.

SmartExam Spine

A SmartExam Spine examination requires additional features to cope with variations in planning procedures compared to head, knee and shoulder examinations.

Every spine examination is unique. It is not always known beforehand at which disc level the transverse scans need to be positioned. SmartExam Spine comes with a unique graphical user interface. A schematic drawing of the spine allows easy definition of the precise levels for each stack.

Often a high resolution scan is necessary to determine the precise locations at which the transverse stacks must be planned. A Philips-unique snapping mechanism is implemented: dragging a stack in the graphical planscan user interface from one disc level to another results in the stack snapping precisely to the new disc level. This snapping occurs according to the user prefered planning as learned during the training phase.

If necessary, all stacks can be freely manipulated to tweak and train SmartExam planning better. The graphical planscan user interface automatically differentiates between manual fine tuning of individual stacks and dropping stacks at different levels.

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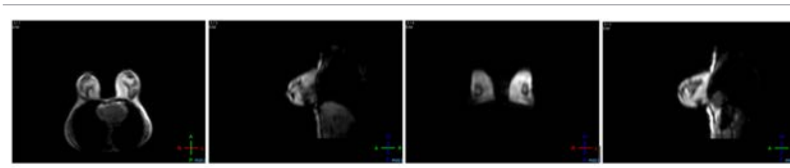
NOTICE

Severe pathology or metal might cause SmartExam Spine to fail.

SmartExam Breast

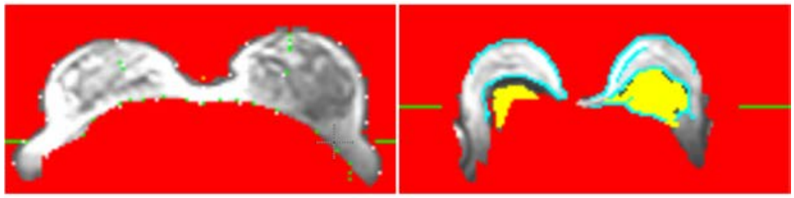
Different to other anatomies, Image Based (IB) Shimming is automatically performed as part of SmartExam Breast, based on the **SmartBreast shimming** algorithm.

SmartBreast shimming requires that a SmartBreast survey is performed. The SmartBreast survey is designed to acquire the entire volume of tissue placed in the breast coil. It is important to position the patient so that they are in the center of the chosen coil. As with other Smart Surveys, first 3D images are acquired, then orthogonal reconstructions (including both left and right breasts) are created and automatically updated in the view ports upon completion of the SmartExam analysis.



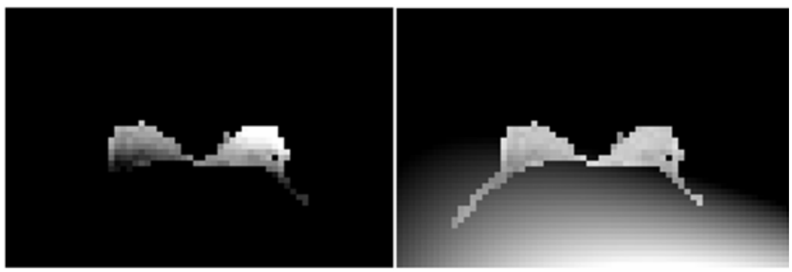
Smart Surveys with the orthogonal reconstructions.

To provide optimal shimming for the tissue of interest, **SmartBreast shimming** uses the 3D volume acquired during the SmartBreast Survey: an automatic segmentation is performed that excludes the lungs, heart, arms and silicone if present.



Segmentation of the breasts to exclude lungs, heart, arms and silicone.

Shimming is performed on the remaining breast and axillae, leading to a uniform flip angle in the areas of interest and uniform fat suppression. Optimal shimming is obtained by calculating a B0 map before shimming and making adjustments to the shim in order to optimize the B0 in the segmented area.



B0 maps.

Once calculations are completed they are available to the system to be applied to any sequence in which **SmartBreast shimming** is the enabled shim parameter.

NOTICE

To utilize the segmentation algorithm for the SPIR and SPAIR sequences, enable SmartBreast shimming by the 'Shimming' parameter on the 'Contrast' tab.

A shim box is not visualized, and the values calculated by SmartBreast shimming are used.

Additionally, if performing on a 3.0T system, RF shimming must be adaptive and therefore a B1 calibration scan is required.

A system with SmartBreast enabled is delivered with trained Smart Geometries. The Smart-Breast geometries are trained at 0 angle, covering the breasts:

- Cor_PH –centered right to left
- Sag_PH – centered foot to head according to the breast tissue
- Tra_PH – centered to just anterior to the subcutaneous adipose tissue and chest wall, mid-way right and left between the breasts.

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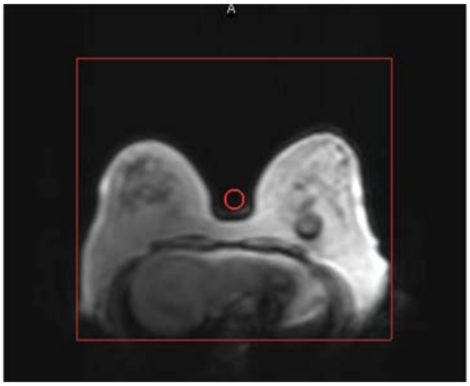

Planning example.

If the provided Smart Geometries do not meet the user's individual needs, site specific geometries can be trained. For more information, refer to the section SmartExam: Workflow ’Set up a Smart ExamCard’.

Related parameters

- Shim (values relevant for SmartExam Breast: IB-Volume, SmartBreast)
- RF Shim (values relevant for SmartExam Breast: IB-Volume, SmartBreast)
- Interactive F0

Smart Editor

The Smart Editor

- is the essential tool in creating and modifying a Smart ExamCard.
- can be used to add a Smart survey to the current ExamCard.
- is to be used to assign existing SmartGeometries to scans or to create new SmartGeometries.
- indicates if the name of a SmartGeometry is known or unknown, unique or double.

  If the new name conflicts with existing SmartGeometry names, this will be indicated by an exclamation mark.

The SmartExam Editor can be accessed from the Examination menu via 'SmartExam' and 'Show SmartGeometries'.

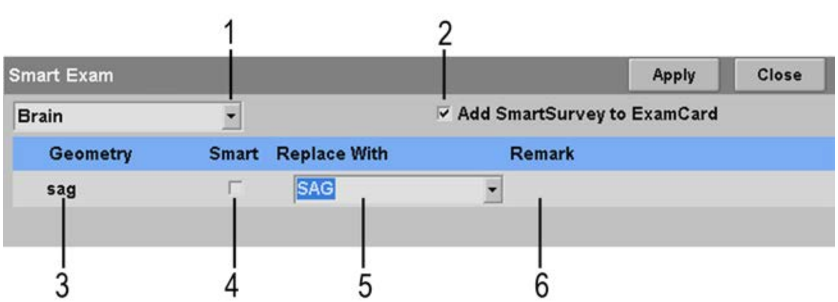

Fig. 254: Smart Editor.

1	Drop-down menu for the selection of the anatomic region
2	Enable/disable 'Add SmartSurvey to ExamCard' by checking
3	Name of the non-Smart geometry
4	Enable/disable SmartGeometryby checking
5	SmartGeometry name
6	Reserved for remarks like 'New Smart Geometry' or similar

For more information about SmartExam, refer to chapter “SmartExam” on page 470.

SmartGeometry Database Editor

The SmartGeometry Database Editor:

- Allows to view the existing SmartGeometries for all anatomic regions: the Philips prelearned ones and the user defined ones;
- Can be used to e.g. delete all samples of a user defined SmartGeometry.

NOTICE

Philips prelearned SmartGeometries are grayed out and cannot be deleted.

To open the SmartGeometry Database Editor

► Select **SmartExam Tools** from the **System** menu.

► Select **SmartGeometry Database Editor...**.

More about SmartExam

You can access more possibilities concerning SmartExam:

- from the **ExamCard** right mouse menu
- from the **System** menu **> Smart Exam Tools**
- from the **Examination** menu **> Smart Exam**

Confirm vertrebrae count

- is valid for spine only,

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- confirms/changes labeling of the detected vertebrae.

Improve SmartGeometries with current planning

- allows to improve SmartGeometries with the current planning even if the SmartGeometry is already validated or matured.
- allows to add samples of current planning even though scanning has not been performed.

Reset to SmartPlan

- resets the offcenter and angulation parameters of all geometries to the values of the SmartExam algorithm. Manual corrections are undone.

Importing ExamCards

When you import a Smart ExamCard with SmartGeometries which are unknown to the system, the new SmartGeometry will automatically be created. This will indicated by a message: "The new SmartGeometry has been created in the SmartGeometry database."

Locking or unlocking SmartGeometries

To protect your Smart geometries from being overwritten, you can lock them.

▷ You can only lock the SmartGeometries when the hospital database is password-protected.

► To lock or unlock your Smart geometries, from **System > SmartExam Tools** click **SmartPlan databases locked**.

► Then enter the password (identical to hospital database password-protection). Confirm with OK.

SmartPlan databases locked is a toggle setting.

- The checkmark indicates that the SmartPlan databases are locked.
- The checkmark disappears when the SmartPlan databases are unlocked and can be edited.

SmartExam Tools: User Confirmation Mode

- toggles between user confirmation mode and automatic confirmation mode.

SmartExam Tools: Add Sample Data Allowed

- adjusts how newly planned samples are treated:

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Add Sample Data Allowed	Effect
If **Unchecked**	• You are not prompted to add samples to the SmartGeometry Database. • Samples are not added to a SmartGeometry. This is the default setting.
If **Checked**	• You are prompted to add manually planned samples to the SmartGeometry Database at the end of the examination: *"Adding manually planned samples to the SmartGeometry database? OK or Cancel"* • To add the samples to a SmartGeometry, click **OK**. To discard the samples, click **Cancel**. The dialog is only displayed if any of the SmartGeometry plannings is modified and confirmed.

NOTICE

Samples are never automatically added to a SmartGeometry.

User confirmation is always required in the Add Sample dialog.

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SmartExam Tools: Export SmartGeometry Database ...

- allows to export a SmartGeometry database to another device/directory.
- can only be done if the ExamCard window is empty (no current ExamCard) or if the current ExamCard does not contain any SmartGeometries.

SmartExam Tools: Import SmartGeometry Database ...

- allows to import a SmartGeometry database from another device/directory.
- can only be done if the ExamCard window is empty (no current ExamCard) or if the current ExamCard does not contain any SmartGeometries.

Setting up a Smart ExamCard

Selecting an ExamCard

1. Browse to the ExamCard that you want to make a Smart ExamCard.
2. Drag this ExamCard into the List View.

Alternatively drag scan protocols into the ExamCard window to create a new ExamCard.

NOTICE

For joint or extremity examinations, ensure that the ExamCard parameter ’Laterality’ is set to left when scanning the left extremity and set to right when scanning the right extremity.

Opening the SmartEditor

► From the Examination menu, select **SmartExam** and then **Show SmartGeometries**.
The SmartExam Editor opens.

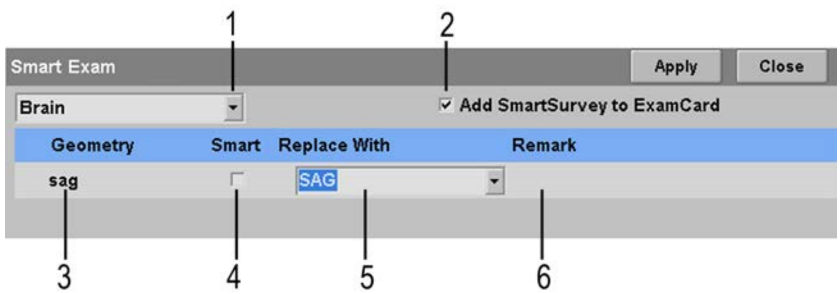

Fig. 255: Smart Editor.

1	Drop-down menu for the selection of the anatomic region
2	Enable/disable 'Add SmartSurvey to ExamCard' by checking
3	Name of the non-Smart geometry
4	Enable/disable SmartGeometryby checking
5	SmartGeometry name
6	Reserved for remarks like 'New Smart Geometry' or similar

Selecting the Anatomic Region

1. Click on the **anatomic region** drop-down menu.
2. Select one of the anatomic regions:
   - Brain
   - Knee
   - Shoulder
   - Breast
   - Cervical spine
   - Lumbar spine

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NOTICE

In case of ’Cervical spine’ or ’Lumbar spine’, one more column will be displayed in the Smart Editor window: the ’Grid Snap’ column.

This ’Grid Snap’ column only applies for spine acquisitions.

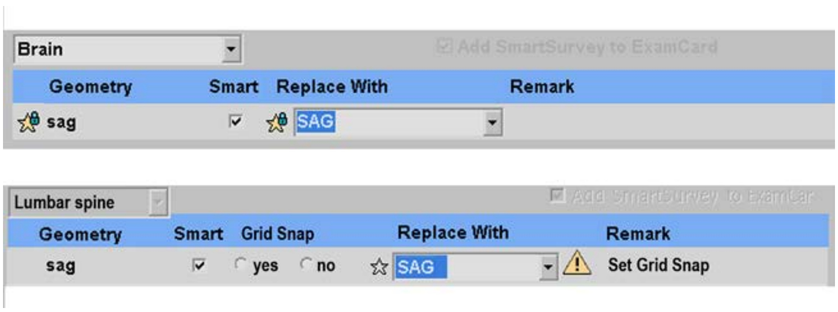

Fig. 256: SmartEditor without Grid Snap for Brain and with Grid Snap for Lumbar Spine.

Adding a SmartSurvey to the current ExamCard

A Smart ExamCard has to start with a SmartSurvey. This SmartSurvey is a dedicated 3D survey scan that covers the chosen anatomic region completely.

1. Make sure that **Add SmartSurvey to ExamCard** is enabled.

   A check sign indicates that the function is enabled.

   A Smart survey scan will be added to the current ExamCard.

Converting an ExamCard geometry into a SmartGeometry

In order to convert a scan within an ExamCard into a smart scan, you can perform one of the following actions:

1. Create a new SmartGeometry
2. Assign an existing SmartGeometry to the scans
3. Convert an existing named geometry into a SmartGeometry

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Philips

<table>
<tr><th>Create a new SmartGeometry</th><th>Assign existing SmartGeometries to scans</th><th>Convert named geometries into SmartGeometries</th></tr>
<tr><td>1. Enable 'Smart' by clicking on the Smart entry field.
A check sign indicates that the function is enabled.</td><td>1. Enable 'Smart' by clicking on the Smart entry field.
A check sign indicates that the function is enabled.</td><td>1. Enable 'Smart' by clicking on the Smart entry field.
A check sign indicates that the function is enabled.
For spine only:
Set Grid Snap is displayed as remark indicating that Grid Snap has to be set to either yes or no.</td></tr>
<tr><td>1. Enter a SmartGeometry (in the field ’Replace with’) by typing a new name.
Alternatively, existing SmartGeometries can be assigned to scans.</td><td>1. Click on the ’Replace with’ drop-down menu to display the existing SmartGeometries.
2. Select one of these SmartGeometries.</td><td>1. Set ’Grid Snap’ to ’no’ for the SmartGeometries where acquisition is always done for a the same range, e.g. in the sagittal spine.
2. Set ’Grid Snap’ to ’yes’ for the SmartGeometries where acquisition is done on different disc levels, e.g the transverse spine.</td></tr>
<tr><td colspan="3">► Click Apply.
The Smart survey will be added to the current ExamCard. The geometries in the ExamCard window will be replaced.</td></tr>
</table>

NOTICE

Each SmartGeometry name should refer to a unique planning.

Use unique geometry names throughout all anatomic regions.

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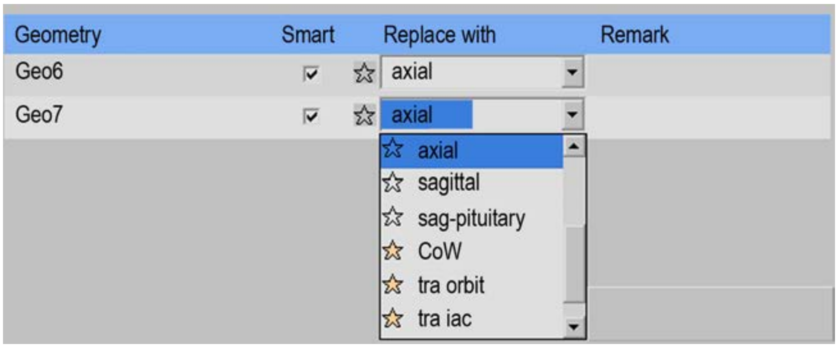

Fig. 257: Selecting an existing SmartGeometry from the 'Replace with' drop-down menu.

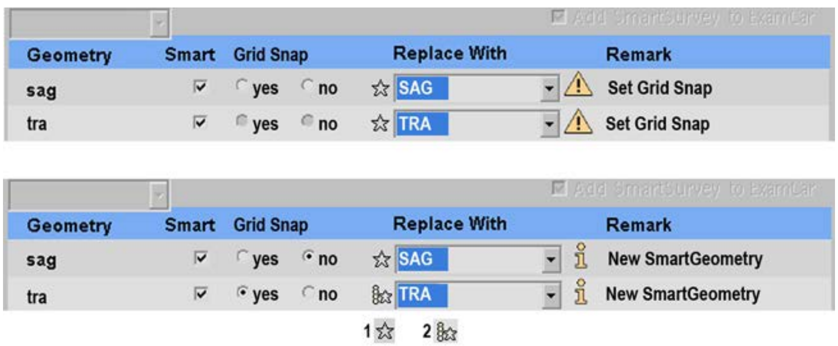

Fig. 258: Converting spine geometries into Smart spine geometries: In the upper image Smart is enabled with Grid Snap not yet defined. The message 'Set Grid Snap' is displayed as remark. In the lower image 'Grid Snap' is set to 'no' for the sagittal Smart spine geometry and to 'yes' for the transverse Smart spine geometry. Note the different Smart icons besides the new geometry name.

1	Smart icon: not level specific.
2	Smart icon: level specific.

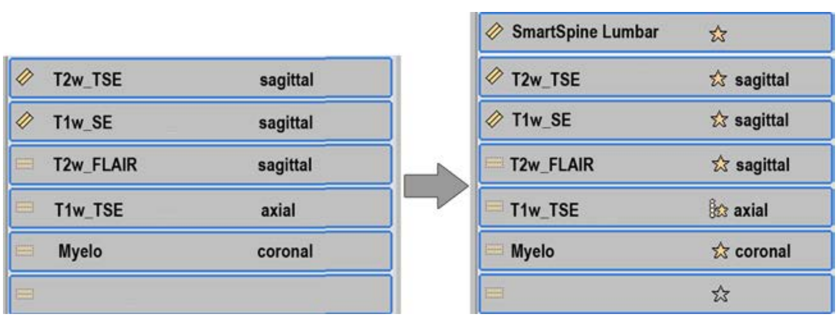

Fig. 259: Example: After applying the changes, the geometries have been replaced by SmartGeometries and the SmartSurvey has been added to the ExamCard. Note that the T1w_TSE axial scan is level specific.

NOTICE

Smart geometries can be locked to protect them against being overwritten.

For more information, see chapter “More about SmartExam” on page 476.

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Validating a Smart ExamCard

A newly defined SmartGeometry has to be planned and executed several times before it turns into a validated SmartGeometry and doesn't require planning anymore. Proceed as follows:

▷ Before entering an examination where SmartGeometries will be updated, make sure **Add Sample Data Allowed** under **System > SmartExam Tools** is checked.

► Start the Smart ExamCard that needs to be validated.
The SmartSurvey and the reference scan are executed automatically.

► When the SmartSurvey is completed, double-click on the EC items of the diagnostic scans to plan them.

► Plan as accurately as possible. Keep in mind that the planning contributes to the SmartGeometry samples.

► Start the planned diagnostic scans.

► After completion of the last scan, you are prompted to add manually planned samples to the SmartGeometry Database:
"Adding manually planned samples to database? OK or Cancel"
To add the samples to a SmartGeometry, click **OK**. To discard the samples, click **Cancel**.

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NOTICE

First add samples to the SmartGeometry database. Only then move the patient out of the bore.

Otherwise the samples are lost and cannot be added to the SmartGeometry database anymore.

Optional: Replace the Non-Smart ExamCard by the new Smart ExamCard

► First open the ExamCard database.

► Then click **Delete** to delete the old ExamCard. Click **Proceed** to confirm.

► Rename the current Smart ExamCard to indicate that it is a Smart ExamCard.

► To save this new Smart ExamCard, drag it into the Hospital folder. This ExamCard can now be used for all similar examinations.

Adding samples to a SmartGeometry

To improve your SmartGeometries, you can add samples (relevant plannings from other examinations) to your SmartGeometry.

▷ Before entering an examination where SmartGeometries will be updated, make sure **Add Sample Data Allowed** under **System > SmartExam Tools** is checked.

► Scan the SmartExam EC to completion.

At the end of the EC, you are prompted by the popup to update the SmartGeometries,

  - if planning was manually confirmed,
  - if more samples are needed to reach validation or maturity.

► Confirm to update the SmartGeometries.

  - If there is no prompt at the end of the EC, select **New Examination**.
    The popup to update should now be received.
  - If no prompt to update is given, immediately cancel entering a new Exam.
    Click **Examination > SmartExam > Improve SmartGeometries** with current planning.

► Proceed with the next examination.

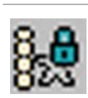
Executing a Smart ExamCard

A Smart ExamCard can contain Smart items in different states. Depending on the status of the Smart items, the workflow is different. This section describes:

- Smart icons indicating the status of Smart items
- Workflow ’Smart items are in validating mode’
- Workflow ’Smart items are validated’
- Parameters ’Laterality’ and ’Patient Position’
- Switch to User-Confirmation Mode

Smart icons indicating the status of Smart items

The states are indicated by Smart icons. Note that Philips delivers predefined SmartGeometries. These predefined SmartGeometries are locked and as a consequence cannot be modified or deleted. They allow immediate usage of SmartExam without the need of validating SmartGeometries.

Icon	Status of the item	More about the status
	User-defined Smart item that is validated (enough planning examples) or mature.	Final status. A SmartGeometry is **validated** when 10 samples are added to it. A SmartGeometry is **mature** when 20 samples are added to it.
	User-defined Smart item that is in validating mode (not enough planning examples).	Collect more planning examples to finalize the validating process.
	Locked SmartGeometry.	This Philips preset SmartGeometry cannot be deleted nor modified.
	Locked level-specific (e.g. transverse spine) SmartGeometry.	This Philips preset SmartGeometry cannot be deleted nor modified.

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NOTICE

Validated geometry databases for the SmartExam anatomic regions are provided with your system which can immediately be used.

Workflow 'Smart items are in validating mode'

When the Smart items of the ExamCard are still in 'validating mode', the workflow is:

1. Select an ExamCard.
2. Start the ExamCard (to acquire survey images).
3. Plan the items of the ExamCard geometrically within the Graphical PlanScan OR fine-tune the suggested planning and confirm.
4. Resume the ExamCard.
5. When the ExamCard is finished, you are asked to add (or 'not to add') the samples to the SmartGeometry database.

Workflow 'Smart items are validated'

When the Smart items of the ExamCard are 'validated', the workflow is:

1. Select an ExamCard.
2. Start the ExamCard (to acquire survey images).

   With user confirmation disabled, the validated items will show up as 'ready to run'  and all the items of the ExamCard are planned and will run automatically.
   The Smart items in validating mode have to be planned.

Parameters 'Laterality' and 'Patient Position'

Always ensure that the settings of the parameters 'Laterality' and 'Patient Position' correspond to the actual patient position. Otherwise SmartExam will detect inconsistencies between positioning and parameter settings, and will abort the scan.

This is especially true for knee and shoulder examinations.

Laterality

For knee and shoulder examinations, ensure that the ExamCard parameter 'Laterality' is set to left when scanning the left extremity and set to right when scanning the right extremity.

Patient position

For knee examinations, ensure that the knee is positioned supine when the parameter 'Patient position' is set to 'supine'.

Be careful with heavy exo-rotation, since a 'decub-right' or 'decub-left' position might be detected instead of a 'supine' patient position.

Switch to User-Confirmation Mode

A validated Smart ExamCard will be executed automatically. However, it is possible to ask for user confirmation of the planning.

► To do so, select 'SmartExam Tools' from the System menu, and enable 'User Confirmation Mode'..

With user confirmation enabled, the ExamCard will stop so that planning can be inspected and/or modified.
With user confirmation disabled, the system automatically confirms Smart planning.

Workflow SmartExam Spine

For SmartExam Spine acquistions, two features have been introduced:

- Vertebrae labelling and
- (disc) Level specific scanning.

Vertebrae labelling

Vertebrae labelling has to be confirmed to allow level specific scanning.

1. Start the SmartExam Spine ExamCard.
2. When the SmartSurvey is finished, thevertebrae labelling window pops up.
3. When labelling is correct press |Proceed| to continue.
4. Adjustments can be made by clicking the ‘up’ or ‘down’ arrow
5. Check ’Manual’ to continue with manual planning.
6. Click |Proceed| to continue.

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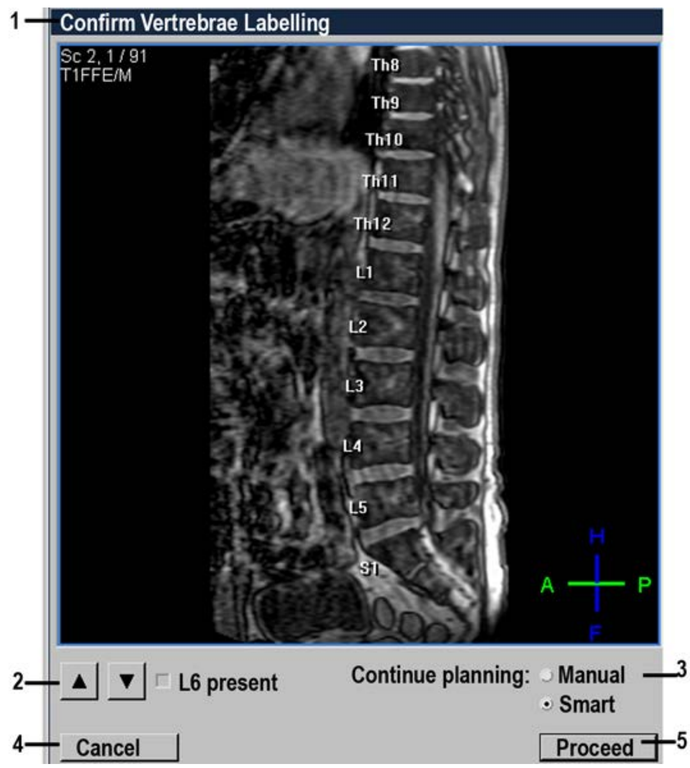

Fig. 260: Vertebrae labelling window.

1	Window 'Confirm Vertebrae Labelling'
2	Click 'Up' or 'Down' to fine-tune the vertebrae labelling. Check 'L6 present' if L6 exists in a patient.
3	Continue planning: Manual or Smart. This allows to switch from 'Smart' planning to 'Manual' planning or vice versa.
4	Click |Cancel| to quit without any changes.
5	Click |Proceed| to confirm the vertebrae labelling.

Level specific scanning

In all scans with a level specific Smart Geometry (if 'level specific' is enabled by means of a checkmark), another tab is available in the Parameter Editor: the 'smartstacks' tab.

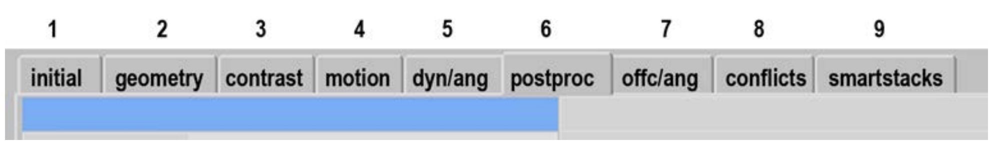

Fig. 261: Tabs in planning a level specific scan.

1	initial
2	geometry

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3	contrast
4	motion
5	dyn/ang
6	postproc
7	offc/ang
8	conflicts
9	smartstacks

Clicking on the 'smartstacks' tab, the level specific planscan user interface (UI) pops up.

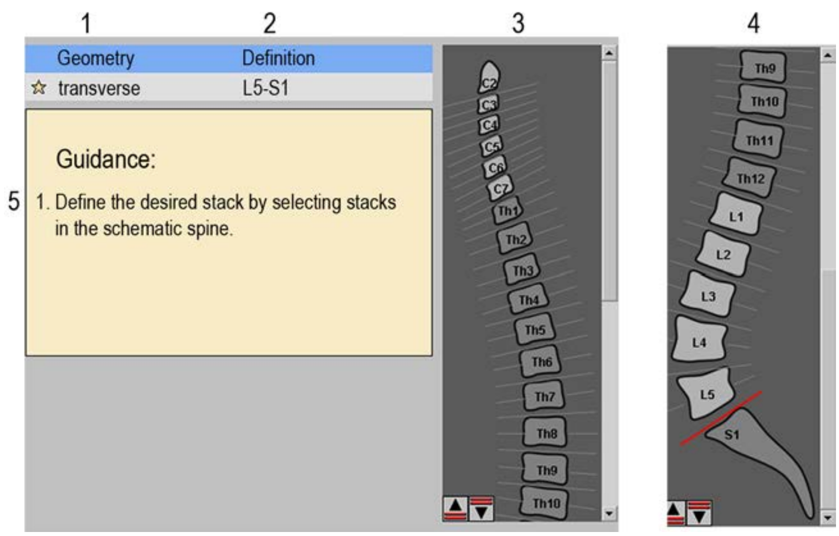

Fig. 262: Level specific planscan UI.

1	Indication of the scan 'Geometry' (in this case: transverse)
2	Indication of the level 'Definition' (in this case: L5 - S1)
3	Schematic display of the upper spine (use scrollbar to scroll down or up) with • gray lines representing possible new stacks • red line representing defined stack • arrows up/down to shift the stacks up or down
4	Schematic display of the lower spine (use scrollbar to scroll up or down). • gray lines representing possible new stacks • red line representing defined stack • arrows up/down to shift the stacks up or down
5	Window with Guidance (in this case: Define the desired stack by selecting stacks in the schematic spine)

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You can **define the disc levels to be scanned** beforehand or after scanning the high resolution sagittal scan. Both ways are described here:

Workflow: Define the disc level(s) to be scanned beforehand

1. In the Parameter Editor, click on the ’smartstacks’ tab.

   The graphical planscan user interface pops up.
2. Use the scrollbar to scroll to the required disc level.
3. Click on a gray stack line to add a stack.
4. Click on a red stack line to remove this stack.
5. Click on the ’Up’ or ’Down’ arrow to shift the stacks up or down.
6. Start the ExamCard.

Workflow: Define the disc level(s) after scanning on the high resolution scan

1. Check the high resolution T2w sagittal scan.
2. In Planscan, drag the stacks to the desired scanning location.
3. The snapping mechanism (’Grid Snap’) recognizes the levels automatically and snaps the transverse stacks to the required levels.
4. Resume the ExamCard.

NOTICE

During the validating phase, fine tuning adjustments can be made without snapping.

ContrastCards for Contrast Administration

ContrastCards facilitate the administration of contrast agent injections in post-contrast and dynamic scans. Contrast Cards allow you to store data of the contrast agent injection with the examination. The contrast agent injection itself is not affected by ContrastCards.

ContrastCards allow the registration of

- the type of contrast agent
- the concentration of the contrast agent
- the recommended dosage
- the volume of the contrast agent for injection
  Based on patient's weight and dosage, contrast agent administration calculates and proposes a volume for injection (body weight x ml/kg dosage = ml volume).
- the contrast agent route (e.g. intravenous)
- and the point in time of injection:
  - for dynamic scans: the dynamic scan number of contrast agent administration
  - for non-dynamic scans (pre- and post-contrast) if contrast agent injection occurs at start of scan

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ContrastCards work with presets for contrast administration.

- These presets allow you to predefine and easily apply contrast agent scripts. For more information about contrast administration presets, see chapter “Presets for contrast administration” on page 492.
- You can share the presets for contrast administration among your MRI systems.

ContrastCards make use of a timer which facilitates the timing of the injection related to the start of the scan.

The implementation of ContrastCards meets the DICOM requirement.

Implementation of ContrastCards

ContrastCards are implemented in the ExamCard environment. The *Contrast Injection Parameters* window opens when

- you enable contrast injection  for a scan in an ExamCard.

  This allows you to select a preset for contrast administration.
- you click the contrast injection icon of a scan in an ExamCard.

  This allows you to enter and edit mandatory contrast agent information.

Contrast injection is enabled from the drop down menu or from the right-mouse menu.

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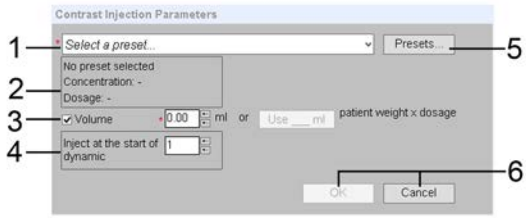
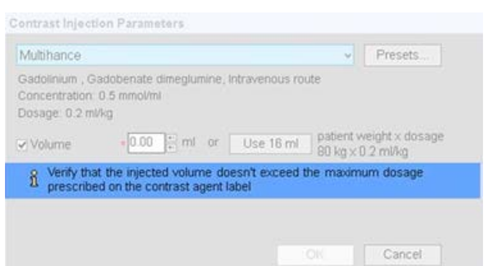
Contrast Injection Parameters window



1. Drop-down menu for the selection of presets for contrast agent injection
2. Display of data of selected preset:
   - contrast agent and route
   - concentration (mmol/ml)
   - dosage (ml/kg)
3. Entry field for volume
   - either enter value manually,
   - or accept automatically calculated proposal (body weight x ml/kg dosage = ml volume)
4. Drop-down menu for the selection when contrast agent is injected:
   - Inject at: start of scan,
   - Inject at: start of dynamic number X,
   - if user confirmation is needed for contrast agent injection.
5. Presets button to create/edit presets
6. **OK** to accept, **Cancel** to close window without changes



Message about injected volume

Carefully read the contrast agent label and look up the maximum dosage prescribed.

The dialog guides you with the message:

"Verify that the injected volume doesn't exceed the maximum dosage prescribed on the contrast agent label."

Identification of images with Contrast Administration

- Images where Contrast Administration was used, are labeled **contrast** on the top right of an image.
- The contrast delay time (time between injection and scan start) is shown on the top middle of an image.

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Presets for contrast administration

Presets for contrast administration store contrast-agent specific attributes.
Use these presets to avoid repetitive typing when you enter mandatory contrast agent information.

You can add new presets and you can modify, delete and share them among MRI systems. The presets are password-protected.

Contrast-agent specific attributes stored in presets	Possible values
Commercial name (of contrast agent)	Free text uniquely identifying the preset such as • Magnevist
Ingredient	Drop-down menu with • Gadolinium (which is the default setting) • Iodine • Carbon dioxide • Barium
Agent	Free text such as • Gadopentetate
Route	Drop-down menu with • intravenous (which is the default setting) • intra-arterial • intramuscular • subcutaneous • intracutaneous • intraperitoneal • intramedullary • intrahecal • intra-articular • intraepithelial • topical • oral • transluminal • intraluminal • extraluminal • by inhalation

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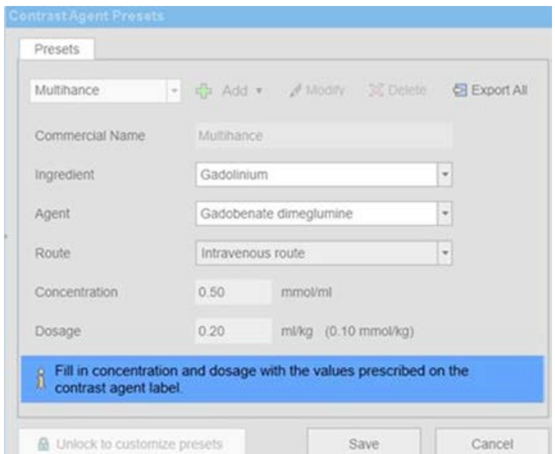
Contrast-agent specific attributes stored in presets	Possible values
Concentration	numerical value in **mmol/ml**
Dosage	numerical value in **ml/kg** and **mmol/kg**

Guidance

Carefully read the contrast agent label and look up the maximum dosage prescribed. The Contrast Agent Presets window guides you with the message:



Fill in concentration and dosage with the values prescribed on the contrast agent label.

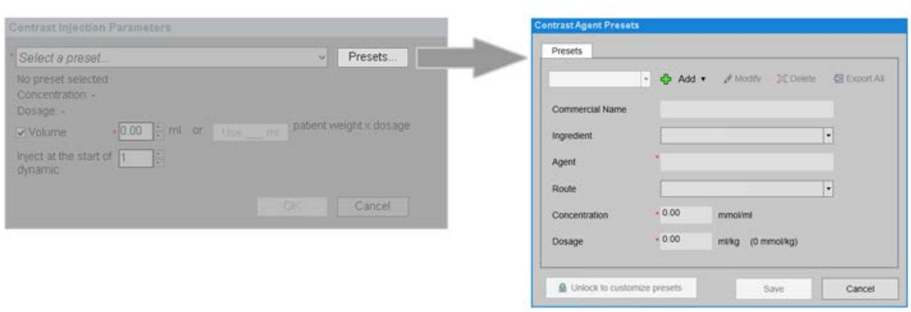
Adding a new contrast administration preset

Objective of this workflow is to add a new preset for the registration of contrast agent injection.

- You add new presets independent of an examination.
- During an examination you select the preset instead of having to enter all mandatory contrast-agent specific attributes manually.

► Do any of the following:

- On the **System** menu, select **Contrast Preset Settings**.
- In the Contrast Injection Parameters window, click **Presets...** .



► To unlock the preset database, click **Unlock to customize presets** and enter the password.

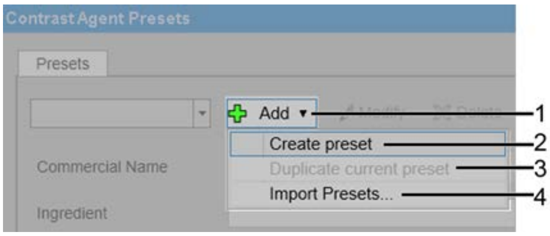
► Click **Add (1)**, then do any of the following:

- Select **Create new preset (2)** from the drop-down menu.

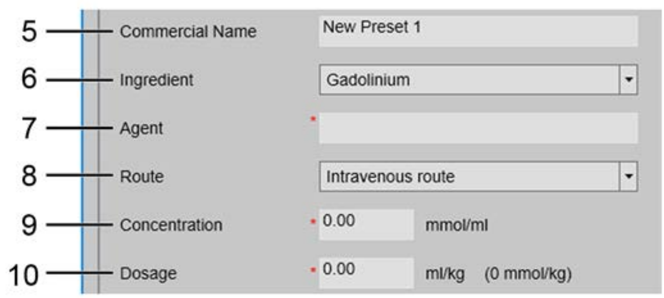
This option allows to create a new preset from scratch.

- Select **Duplicate current preset (3)** from the drop-down menu.

This option allows to modify a duplicate of the current preset and save under a different name.



► Enter or select values for all contrast-specific attributes. All fields are mandatory, missing fields are marked by a red asterisk.
For more information about contrast-agent specific attributes, see chapter “Presets for contrast administration” on page 492.



- Specify a unique **commercial name (5)**.
  The commercial name is also used as preset name.
- Select an **ingredient (6)** from the drop-down menu.
- Enter free text for the **agent (7)**.
- Select the **route (8)** from the drop-down menu.
- Enter the **concentration (9)** in **mmol/ml**.
- Enter the **dosage (10)** in **ml/kg**.

► Do any of the following:

- To save the preset when all mandatory fields are entered correctly and to close the window, click **Save**.
- To close the window without saving, click **Cancel**.

Modifying a contrast administration preset

Objective of this workflow is to modify a preset for the registration of contrast agent injection.

▷ In the Contrast Administration window:

► Click **Presets...** .

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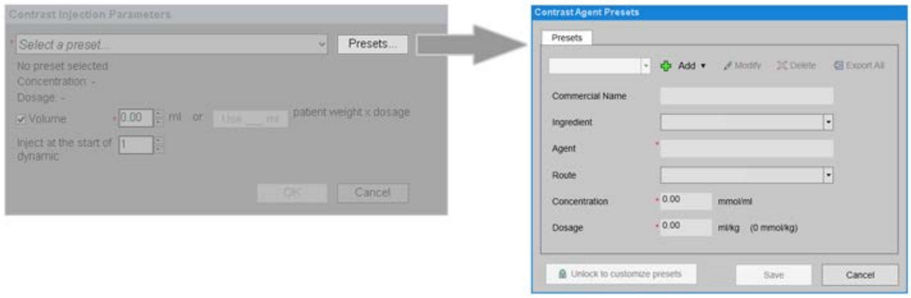


- To unlock the preset database, click **Unlock to customize presets** and enter the password.
- Select the preset you want to modify from the preset drop-down menu, then click **Modify**.

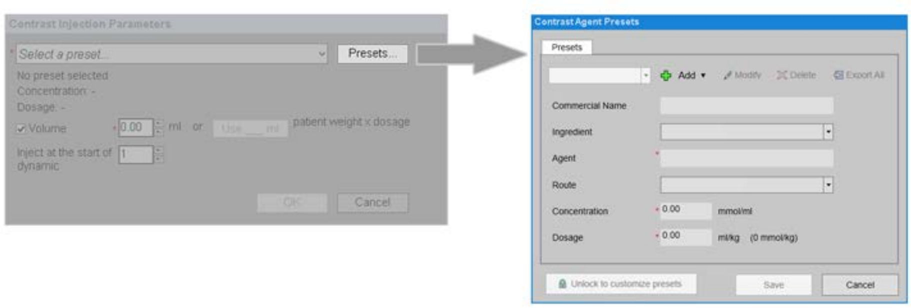
- Modify the values for the contrast-specific attributes you want to change. All fields are mandatory, missing fields are marked by a red asterisk.
  For more information about contrast-agent specific attributes, see contrast-agent specific attributes.
- Do any of the following:
  - To save the preset when all mandatory fields are entered correctly and to close the window, click **Save**.
  - To close the window without saving, click **Cancel**.

Deleting a contrast administration preset

Objective of this workflow is to delete a preset for the registration of contrast agent injection.

▷ In the Contrast Administration window:

- Click **Presets...** .



- To unlock the preset database, click **Unlock to customize presets** and enter the password.
- Select the preset you want to delete from the preset drop-down menu, then click **Delete**.

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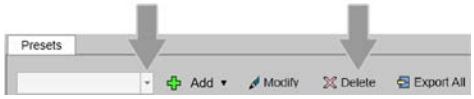


⇨ A query pops up: *Are you sure you want to delete <preset name>?*

► Do any of the following:

- To delete the preset, click **Yes**.
- To still keep the current preset, click **No**.

Sharing contrast administration presets among MRI systems

You can share contrast administration presets among your MRI systems. This avoids the need of manually entering identical presets at all systems.

To copy contrast administration presets from one MRI system to other MRI systems:

- First you export your presets to a USB stick.
- Then at the other MRI systems you import these presets from the USB stick.

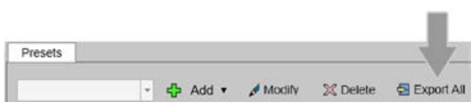
You can also use the Export/Import functionality to backup your presets.

Exporting presets

▷ In the Contrast Agent Settings window:

► To unlock the preset database, click **Unlock to customize presets** and enter the password.

► To export all contrast administration presets, click **Export All**.



► To select the destination, browse to the desired folder (possibly located on a USB stick) and enter a folder name which represents the contrast administration presets.

► To start the export procedure, click **Export**.

- Every preset is saved as a separate file.
- The name of the preset is used as name of the file.
- If a file of the same name already exists, it is overwritten by the newest version.

⇨ When the export is completed, the message "Successfully exported x presets" is displayed where x is the number of presets exported.

Importing presets

▷ In the Contrast Agent Settings window:

► To unlock the preset database, click **Unlock to customize presets** and enter the password.

► To import contrast administration from a folder, click **Add (1)** and select **Import presets... (2)** from the drop-down menu.

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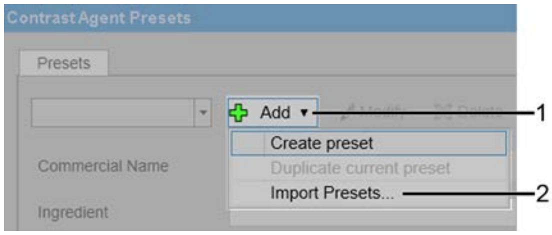

► To select the source, browse to the desired folder (possibly located on a USB stick).

► Select the presets you want to import.

- To select one preset, click on its name.
- To select multiple consecutive presets, hold **Shift** while dragging over the presets.
- To select multiple individual presets, hold **Ctrl** while clicking on the presets.

► To start the import procedure, click **Import**.

If a preset of the same name already exists, it is overwritten by the newest version.

⇨ When the import is completed, the message "Successfully imported x presets" is displayed where x is the number of presets imported.

Registering contrast injection

You execute this workflow to register data of the contrast injection (such as contrast agent, injected volume)

- in post-contrast scans,
- in dynamic scans.

Enabling contrast injection in post-contrast scans

▷ In the current ExamCard or when editing an ExamCard in the ExamCard Editor:

► Right-click the post-contrast or dynamic scan in the ExamCard, then select **Requires Contrast Injection**.

The Contrast Administration window opens.

► Select a preset from the preset drop-down menu. Then click **OK** to confirm and to close this window.

If no presets are available yet, the Contrast Agent Settings window opens and you are requested to create a preset.
For more information, see chapter “Presets for contrast administration” on page 492.

⇨ The injection icon indicates that contrast injection is enabled.
The red asterisk indicates that some contrast injection information is still missing.

Running an ExamCard with contrast injection enabled

► Select an ExamCard with contrast injection enabled.

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► To enter the missing mandatory contrast information, click the injection icon.

The Contrast Administration window opens:

- Contrast agent data is retrieved from the preset (which is stored with the ExamCard) and displayed.

- Based on patient's weight and dosage, contrast administration calculates and proposes a volume for injection (body weight x ml/kg dosage = ml volume).

► Verify that all contrast-agent specific attributes are entered correctly.
If needed, select another preset from the preset drop-down menu.

► To enter the volume in ml, do any of the following:

- Click **Use x ml** to accept the automatically calculated volume in ml.
- Enter a user-defined volume in ml at the red asterisk.

NOTICE

Carefully read the contrast agent label and look up the maximum dosage prescribed.

The dialog guides you with the message: "Verify that the injected volume doesn't exceed the maximum dosage prescribed on the contrast agent label."

► In post-contrast scans, select **Inject at: start of scan**.
In dynamic scans, select **Inject at: start of dynamic nr**, and enter the dynamic number.

► Click **OK** to confirm and close the window.

⇨ The injection icon indicates that contrast injection is enabled and that all contrast injection information is entered. The scan is now ready to run.

⇨ 

► Execute the ExamCard as usual:
Start ExamCard, run survey scan, plan scans, resume ExamCard when planning is finished.

Before the contrast agent scan is going to start, the ExamCard pauses with the messages:

"Scan is paused to inject x ml of <contrast agent>."

► Inject contrast agent, and at the same time do any of the following:

- Click **Start Timer**.

The timer (located besides the remaining scan time) starts and indicates how much time elapsed since contrast agent injection.

Click **Start Scan** when sufficient time elapsed.

The current scan starts immediately and the ExamCard proceeds as usual.

- Click **Start Scan & Timer**.

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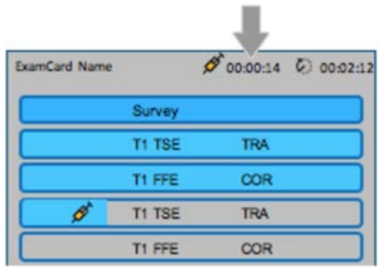
The timer (located besides the remaining scan time) starts and indicates how much time elapsed since contrast agent injection.

The current scan starts immediately and the ExamCard proceeds as usual.



- Click **Cancel**.

The Contrast Injection window closes.

The contrast agent information is stored as DICOM attribute.

Retrieving contrast agent of previously performed scans

You need to retrieve the contrast agent information of a previously performed scan.

► On the **System** menu, click **Open for Review...** and select the previously performed examination.

► In the List View, hover over the Injection enabled icon of the previously performed contrast agent scan.

⇨ The contrast agent information is displayed such as:

"Completed - Injection of 16 ml of Magnevist-Gadopentetate at start of dynamic 2."

"Completed - Injection of 12 ml of Magnevist-Gadopentetate."

Alternatively you retrieve contrast agent information in the Image information of an imaging series, see chapter “Image Information” on page 377.

Quick Surveys

Survey images of sufficient image quality are required to plan an examination. For time efficiency, you need survey images in a very short time.

What are the main features of Quick Surveys?

- Quick Surveys skip certain preparation phases and pre-scans with the purpose of speeding up.
- Quick Survey scans provide you with adequate image quality which is very well suited for planning.

Requirements of a Quick Survey

You can only convert a survey scan into a Quick Survey, if it meets the following requirements:

- It is the first (non-aborted) scan after the light visor is (re)set.
- It has no named geometry defined.
- The scan time does not exceed 15 seconds per stack (on average) before converting into a Quick Survey.
- It is no SmartSurvey scan.
- It is not a spectroscopy, but an imaging survey.
- It is no pre-scan.
- It is no interactive scan.
- The scan produces modulus images only.
- It does not use SENSE, CLEAR, k-t BLAST, k-t SENSE.
- It does not use CS-SENSE.

Preparation phases, pre-scans and imaging parameters affected by Quick Surveys

In a Quick Survey, certain preparation phases and pre-scans are skipped. This is realized by automatically setting certain imaging parameters to well-defined values. The affected imaging parameters are hidden and you cannot change them.

The table lists which preparation phases and pre-scans are skipped, what is performed instead and which imaging parameters are affected.

Skipped	Instead performed	Affected imaging parameter
Preparation phases	Automatic preparation is performed.	**Preparation mode** is set to **auto**.
SENSE reference scan	Classic uniformity is used.	**Uniformity** is set to **classic**.
B0 pre-scan	B0 compensation is switched off.	**Shimming** is set to **no**.
B1 pre-scan	B1 shimming is switched off.	**MultiTransmit** (only 3.0T systems) is switched off.
Coil survey pre-scan	Preferred coils are automatically selected by an algorithm based on the connected coils. If this algorithm cannot be used, the coil survey pre-scan is executed.	Not applicable

Behavior of Quick Survey scans

Survey scans that meet most of the Quick Survey requirements behave differently based on their position in the ExamCard or execution list (List View).

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Example of two identical Quick Surveys at position 1 and position 2	
1. Quick Survey (referred to as QSurvey-1) 2. Quick Survey (referred to as QSurvey-2) 3. T2W 4. and so on	• Since QSurvey-1 is at position 1 in the execution list, it is fully qualified as Quick Survey. – Preparation phases and pre-scans are skipped. – Imaging parameters affected by Quick Survey are neither visible nor accessible. • Since QSurvey-2 is at position 2 in the execution list, it is not qualified as Quick Survey. – Preparation phases and pre-scans are not skipped. – The imaging parameters affected by Quick Survey are visible and accessible. • Since QSurvey-1 and QSurvey-2 are executed differently with different total scan times, the resulting image quality is of comparable, but not of identical quality.

Converting a survey into a Quick Survey

The purpose of this workflow is to convert a conventional survey into a Quick Survey. The workflow covers both situations:

- The survey is part of an ExamCard.
- The survey is a separate scan protocol in your protocol database.

▷ In the ExamCard Editor or in the ExamCard window:

► Browse to the survey scan you want to convert into a Quick Survey and double-click.
This survey scan can be part of an ExamCard or can be a separate scan protocol in your database.

The Parameter Editor opens.

► Verify that the survey scan meets the requirements of a Quick Survey, see chapter “Quick Surveys” on page 499.

► When all requirements are met:
open the Postproc tab, set the imaging parameter **Quick Survey** to **yes** or to **default**.

► Click **Proceed** to save the survey as Quick Survey.
It is recommended to save the Quick Survey under a new name.

► To save the ExamCard with the Quick Survey, right-click on the ExamCard and select **Save ExamCard**.
It is recommended to save the ExamCard under a new name.

Running an ExamCard with Quick Survey

The purpose of this workflow is to run an ExamCard which uses a Quick Survey instead of a conventional survey.

▷ Prerequisite: AutoStart is enabled.

- Position the patient on the tabletop.
- Move the patient to the isocenter.
- Press **Start scan** at the UIM.
- Leave the examination room and close the door.

  With AutoStart enabled, the survey automatically gets started now, if no table movement is required.

⇨ When you reach the operator's console, the survey is running or first images are already available.

- Start planning and proceed as usual.

Delayed reconstruction

In general, MRI scans are automatically reconstructed immediately after their acquisition. However the automatic reconstruction can be switched off, and a manual reconstruction can be performed instead.

Such a delayed reconstruction can be performed at anytime, and the reconstruction parameters can be defined according to the user's personal preference. This offers the possibility to generate multiple imaging series with different reconstruction settings and compare them on completion.

Parameters that can be defined during the delayed reconstruction are e.g. :

- Uniformity,
- Recon voxel size,
- Reconstruction matrix,
- Preset window contrast,
- Multichannel images.

Delayed reconstruction is integrated in the ExamCard overview.

A prerequisite for delayed reconstruction is that raw data are saved during scanning.

Workflow

- Make sure that the parameter 'Save raw data' is enabled in the scan where delayed reconstruction is to be used.

  This postproc parameter can be set to 'Yes' or 'No'. ’Yes’ will save the raw data and allow for delayed reconstruction.

- After scan completion, right-click on the scan in the List View.
- Select 'Reconstruction' and 'Delayed Reconstruction' from the right-mouse menu.

  A Delayed Reconstruction processing step is automatically added to the current ExamCard under the corresponding scan.

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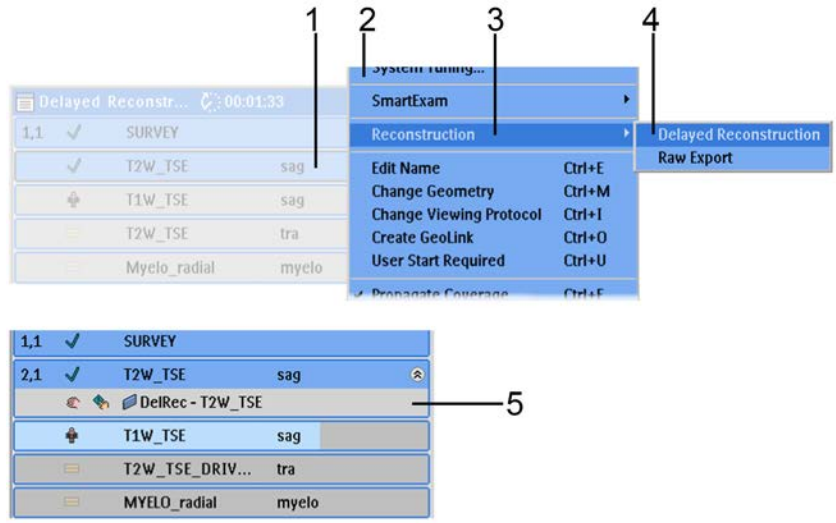

Fig. 263: Adding a Delayed Reconstruction processing step to the current ExamCard. 1: Scan to add delayed reconstruction to. 2: (Extract of) Right-mouse menu. 3: 'Reconstruction' option. 4: 'Delayed reconstruction' option. 5: Delayed Reconstruction processing step is added to the ExamCard.

- ► Rename the delayed recon processing step so that it can easily be identified.
- ► Double-click the delayed recon processing step.

  The Delayed Recon Parameter Editor opens with the subset of parameters available for delayed reconstruction.
- ► Edit the parameters as usual in the ExamCard environment.

  The user interface is identical to the ExamCard Parameter Editor.
- ► Click 'Accept' to confirm the parameters.
- ► To start the reconstruction, click the 'User Specified Pause' icon in the delayed recon processing step.

  Delayed reconstruction is performed as background process and doesn't affect the performance of the system, e.g. the acquisition of further scans.

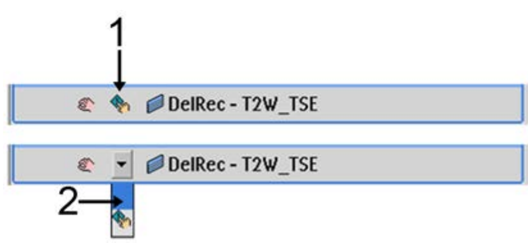

Fig. 264: Click 'User Specified Pause' icon to start the reconstruction. 1: click the icon first, 2: then click the empty space under the arrow.

Reuse of Delayed Reconstruction processing steps

Once a Delayed Reconstruction processing step is defined, it can easily be reused:

- Simply drag and drop it to another scan in the same ExamCard.
- Or right-click on the source to copy this step,

and then right-click on the destination scan to paste it.

Note that the result may depend on the source data.

It is recommended to rename copied processing steps immediately for ease of identification.

NOTICE

You can also copy/paste or drag/drop a delayed recon processing step to another ExamCard in the Hospital dababase.

Autopush to Workstation and to DICOM Node

When an ExamCard is finished, the reconstructed imaging series are stored in the database of the MRI system.

To transfer these images to any other destination, you have two options:

1. Manual transfer:
   You transfer the complete examination, or imaging series one-by-one in the Administration window, see Administration chapter.
2. Recommended automatic transfer:
   You use the Autopush function which automatically transfers reconstructed imaging series, inline (postprocessing) steps and delayed reconstruction upon completion.

On the MRI system, two different ways of Autopush are available:

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Autopush	Available on	Transferred data	Transfer destination	Validity
Enable Autopush to DICOM Node	• **System** menu	All reconstructed imaging series, inline (postprocessing) steps and delayed reconstructions of all examinations	All destinations configured by the Philips service engineer (with *EWS* or *IntelliSpace Portal* template)	This is a system setting. As long as this function is enabled, transfer takes place automatically.
Enable Autopush to Workstation	• **Examination** menu • Right-mouse menu of ExamCard header • Right-mouse menu of ExamCard item	All selected imaging series of selected examinations **Advanced Properties...** allows you • To select or deselect imaging series, inline (postprocessing) steps and delayed reconstruction. • To customize the transfer settings.	All currently selected *Push Nodes* (as defined in the ExamCard properties)	This is a persistent setting. The setting is saved with an ExamCard. However, the *Push Nodes* are not saved with the ExamCard. They are a system setting: • They apply to all *Push-Nodes* transfers. • They are stored in the system settings of the logged-in user.

Enabling Autopush to DICOM node

You use this function to transfer all reconstructed imaging series, all inline (postprocessing) steps and all delayed reconstructions of all examinations automatically to the configured data node.

▷ Precondition: A data node (using the *EWS* or *IntelliSpace Portal* template) is set up by the Philips service engineer.
If a suitable data node is not configured, the function **Enable Autopush to DICOM node** is grayed out and not available.

► On the System menu, click **Enable Autopush to DICOM node**.

⇨ A checkmark on the System menu indicates that **Enable Autopush to DICOM** node is enabled.

⇨ As long as this function is enabled, all imaging data that is stored to the database, is automatically transferred to the configured data node upon completion of the ExamCard.

Enabling Autopush to Workstation

You use this function to automatically transfer selected ExamCard items to the currently selected *Push Nodes* upon completion. Valid ExamCard items are imaging series, inline (postprocessing) steps and delayed reconstructions.

Prior to the first execution of the ExamCard, you select the ExamCard items for automatic transfer (which are then saved with the ExamCard) and the *Push Node*.
After the execution of the ExamCard, the data transfer takes place automatically.

Enabling automatic transfer of a complete ExamCard

- Do any of the following:
  - Right-click on the ExamCard header of the current ExamCard. Then select **Enable Autopush to Workstation**.
  - Click in the ExamCard header. Then on the Examination menu, select **Enable Autopush to Workstation**.

  A checkmark indicates that **Enable Autopush to Workstation** is enabled.
- On the **Push nodes** tab of the ExamCard Properties, select the *Push Node* for automatic transfer.
  Multiple selections are possible. Note that the transfer takes longer with multiple *Push Nodes*.

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Enabling automatic transfer of most of the items of an ExamCard

- First enable automatic transfer of a complete ExamCard as described in the workflow above.
- To exclude an ExamCard item from the selection:
  - Right-click on this ExamCard item. Then select **Advanced Properties...**
    The **Advanced Properties** window opens.
  - Deselect **Enable Autopush to Workstation**.
  - To close the window, click **Hide**.
  - Repeat this workflow for all ExamCard items that you want to exclude.

Enabling automatic transfer of only a few items of an ExamCard

- Right-click on the ExamCard item that you want to select for automatic transfer. Then select **Advanced Properties...**
  The **Advanced Properties** window opens.
- Select **Enable Autopush to Workstation**.
- To close the window, click **Hide**.
- Repeat this workflow for all ExamCard items that you want to select.

Customizing transfer settings

With the Autopush function, you have the possibility to customize the automatic transfer of ExamCard items.
You use the **Advanced Properties...** of an ExamCard item:

- to change the order of the image attributes
- to reverse the slice order
- to select or deselect imaging series from automatic transfer

Note that these transfer settings only apply to the transferred imaging series. They do not affect the presentation of the imaging series on the MR console.

- ► To customize the transfer settings of an ExamCard item, right-click on this ExamCard item. Then select **Advanced Properties...**
  The **Advanced Properties** window opens.
- ► To change the order of image attributes, first select an attribute and then click on the Up or Down arrow.
- ► To select or deselect the current imaging series, click **Enable Autopush to Workstation**.
- ► To reverse the slice order, click **Descending slice order**.
- ► To close the window, click **Hide**.
- ► Repeat this workflow for all ExamCard items that you want to customize.

Central Protocol Management (CPM)

Central Protocol Management (CPM) is a software cloud solution which is part of PerformanceBridge and which you enter via the **PerformanceBridge portal**. CPM is to support the MRI operator in the standardization of MRI ExamCards that are used on connected MRI systems of the same field strength, system type, gradient, and software level.

CPM aims at improving workflow efficiency and standardization of ExamCards:

- It provides a central repository for all *Hospital ExamCards* for all connected MRI systems.
- It enables editing of ExamCards in the central repository (with validity check).
- It makes central ExamCards available for the use on local MRI systems.

The CPM service solution is compatible with Philips MRI systems on software release 5.4 and higher.

For more information, see Instructions for Use of CPM.

How does CPM affect your work?

With CPM,

- the *Hospital ExamCard (EC) database* is locked  for any ExamCard editing on your local MRI system.
  - You cannot unlock the *Hospital EC database*.

   - Authorized operators edit *Hospital ExamCards* only centrally, but not on the local MRI systems.
- the *Other EC database* is not locked.
   - To edit local ExamCards on your MRI system, save the ExamCard to the *Other EC database*.
   - Distribute the validated ExamCard to connected MRI systems via CPM.

Shimming

B0 shimming is used to optimize the B0 magnetic field homogeneity:
Shimming involves a preparation phase or a B0 prescan in which the small inhomogeneities in the subject are measured and corrected.

Applications

- SPIR and ProSet scans
   - For optimal fat or water suppression, the homogeneity should be significantly better than 3.4 ppm (frequency difference water/fat) over the volume of interest
- Scans with large off-centers
- EPI and GRASE sequences
- Balanced FFE / TFE

Shimming method	Explanation
Default	Automatic shimming is automatically performed in scans utilizing • water or fat suppression techniques (SPIR, SPAIR and ProSet) and/or • balanced FFE / TFE. Only first order shim corrections are performed. In all other kind of scans, shimming is not performed.
Auto	**Auto**(matic) shimming is done over the whole volume representing the stack(s) in a scan. • In multistack scans, auto shim is applied separately to each stack. • Auto shim cannot be combined with radial stacks. • Only first order shim corrections are performed.
Volume	**Volume** shimming allows to draw a user defined volume targeting first order optimization to that region, no matter how many stacks are defined. • During planning, a shim volume VOI appears inside the FOV frame. The size and shape of this VOI can be manipulated and optimized. • Volume shimming can be combined with parallel and radial stacks. • Only first order shim corrections are performed.

Shimming method	Explanation
SmartShim	**SmartShim** performs an image-based B0 shim, based on an automatically inserted B0-Prescan. • On 3.0T systems, higher order shim correction (2nd order) is applied. (Most 3.0 T systems are equipped with the higher order shim hardware). In multistack scans, only first order shim corrections (linear) are applied. • On 1.5 T systems, only first order shim corrections (linear) are applied. • Shimming is performed over the whole imaging volume. A volume shim box is not applied for the B0 shim. • SmartShim is recommended for foot/ankle imaging and whole body diffusion imaging (DWIBS). • When **SmartShim** is combined with another technique also requiring a B0-Prescan, an additional prescan is inserted.
SmartBreast	This is an Image Based shimming technique. The shim volume is selected based on a "Smart" (derived from SmartExam) segmentation. This setting is applicable for SmartExam Breast examinations.
IB-volume	This is an Image Based shimming technique. • Shimming is only performed in the user defined shim volume. • Higher order shim correction (2nd order) is applied on 3.0T systems (most 3.0 T systems are equipped with the higher order shim hardware). • On 1.5 T systems, only first order shim corrections (linear) are applied. • A B0 field map calibration scan is required for IB-volume. (**B0 field map = calibrate**)
PB auto	**PB auto** shimming utilizes multiple pencil beams (PB) acquisitions to compute shim values. • Higher order correction (1st and 2nd order) is possible. • Optimization is targeted using the center of the first stack. • PB auto shimming can be combined with parallel and radial stacks. • PB auto shimming for MRI is available on 3.0T systems only.
PB volume	**PB volume** shimming uses the same shimming algorithm as **PB auto** but allows to define a optimal (cubic) target volume. • Higher order correction (first and second order) is possible with this technique. • Optimization is targeted using the target volume (to be chosen freely). • PB volume shimming can be combined with parallel and radial stacks. • PB volume shimming for MRI is available on 3.0 T systems only.

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More information

- In Online Help (**F1**): Enabling shimming

14 Interactive Scanning

About Interactive Scanning

Interactive Scanning is a tool to be used whenever planning is difficult, e.g. due to complex anatomy as in the heart, the pancreas or the parotids. It can be used to track spatial and temporal changes. Interactive Scanning means that specific scan parameters (geometry and a few contrast parameters) are changed while scanning whereas the effect is to be seen in real-time. In such a way the optimal slice plane can quickly be found e.g. in case of difficult anatomies.

Imaging parameters which can be modified interactively are:

- Orientation parameters as offcenters, angulations, slice orientation
- FOV and slice thickness
- Flip angle (in gradient echo techniques)
- Trigger delay
- TFE prepulse on/off and TFE prepulse delay time
- Viewing settings as windowing or display of mirrored, flipped or rotated images

The key to Interactive Scanning is that scan geometry can be stored and be re-used in the following scans.

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Interactive scans

- Can be combined with:
  - Any scan technique like SE, FFE, TSE, GRASE or EPI
  - Respiratory and/or cardiac triggering
- Have the following constraints:
  - Single-slice
  - Single-phase
  - Not combinable with dynamic scan mode

Interactive Modes

Interactive Scanning can be performed in two different modes. Toggling between these modes is possible at any time during the interactive session.

Continuous mode

Also referred to as real-time mode.

The same slice is scanned repeatedly until a user action (e.g. a right click) instructs the scanner to use different scan parameters for the next image(s).

The ‘Image delay’ field (‘Scan parameters’ subwindow) defines the time between two images (relative to the time needed to scan a single image).

Applications

- Cardiac examinations
- Functional joint studies
  - Typically gradient echo scans.
  - TSE is not used due to saturation effects unless DRIVE is enabled.

Single-image mode

Means that only one single image is scanned after the user triggers the scanner, for example through a right-click.

Applications

E.g. for tracking a needle in a biopsy guidance. Typically TSE scans which provide high spatial resolution and are less sensitive for field inhomogeneities.

Interactive Scanning Workflows

Interactive Scanning parameter

- ► Click the 'Geometry' tab to access the geometry parameter subset.
- ► Set the parameter 'Interactive Positioning' to 'Yes' to enable interactive scanning.

All geometries that exist in ExamCards or are entered before Interactive Scanning is started, show up in Interactive Scanning (even if all scans are deleted again before Interactive Scanning is started).

Workflow

- ► Start an interactive scan.

  During preparation the ’Interactive viewer’ window pops up.
- ► Click |Scan pars...| in the ‘Interactive viewer’ window.

  The scan parameters window pops up.
- ► Change the scan parameters.

  The modified parameter settings will be used for the acquisition of the next image of the same scan.
- ► Click on |Rescan| to rescan the image or scan a new image with modified parameters.
- ► Store the geometry under a certain name or store an image in the patient database.
- ► Click |Next scan| to stop the interactive scan.

  The next scan in ListView will be started automatically and, if the ’used geometry’ parameter is set, will take over the previously stored geometry.

More about Interactive Scanning

► Right-click in the Interactive viewer window
  - To retrieve the current scan parameters and pass them to the scanner
  - To scan an image and display the new image in the current viewport.

In single mode a right-click is necessary while in continuous mode every change is applied immediately.

Different ways of how to scan a new image

- By modifying the yellow intersection lines; Click/drag the offcenter and angulation handles of the yellow intersection line displaying intersections between images in different viewports.
- By clicking |Tra|, |Sag|, or |Cor| to scan a transverse, sagittal, or coronal image through the offcenter of the current image.
- By clicking |Orthog. flip| to scan an image orthogonal to current one.
- By clicking |Tilt| and define the tilt ’Angle’ to scan a tilted image.
- By clicking |Pull/push| and define the step size in the ‘Step’ field (in mm) to scan a parallel image.
- By clicking |Inplane transf| to scan a translated or rotated image.
  - Move the red cross to where the offcenter of the next image should be.
  - Rotate the cross to define the rotation for the next image.
- By using 3-point Planscan: Click |P1*| and defining the P1 point. Drag P1 for repositioning.
  - Click |P2*| and |P3*| to define P2 and P3 in a similar way.
  - Click |Scan| to scan an image through P1, P2 and P3 with its offcenter in the centre of gravity of the triangle.

Store geometry for later use

► Click ‘geom’ |Store|.

All geometries will be stored in ExamCards. An asterisk after the name indicates that a geometry was already stored. If the slot was already filled it will be overwritten.

Scan with stored geometry

► Select a geometry.

Store image

► Click ‘image’ |Store| to store the current image with its geometry, window and view settings etc. (without graphical overlays) in interactive memory.

The image is also stored in the patient database (within current scan).

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Measure the distance between two points

► Click |Distance|, define two points on the same or on different images.

Display conventions

Radiol. view

- Corresponds to looking towards the lower left front side of the patient:
  - Transverse image: "A" near the top,"L" on the right,
  - Sagittal image: "H" near the top, "P" on the right,
  - Coronal image: "H" near the top, "L" on the right.

Ignore view

- Results in a view "as close as possible" to the previous image.

  Useful when rotating an image plane to prevent a sudden 'flip' of the orientation.

User defined view

- Means that viewing directions and in-plane rotations can be redefined through the mirror and rotate buttons.

Intersection mode button

- Allows the user to toggle between three different modes:
  - Current image shown on other images (default mode). Each non-current image is overlaid with an yellow intersection line, indicating how the current image intersects the non-current image.
  - No intersection lines shown.
  - Non-current images shown on current image.

    The current image is overlaid with at most three intersection lines in different colors indicating how the current image is intersected.

Redefine the patient coordinate system with |Rotate view|

- Used to redefine the AP and RL axes of the patient coordinate system, in case the patient does not lie exactly aligned with the L,P,H axes in the scanner.

With a transverse image in the current viewport:

► Click |Rotate view|.

  A red cross appears representing the (AP, RL) axis pair.

► Rotate the cross to define the new axes for the patient coordinate system.

► Right-click to store the orientation.

  The stored definition is used for scanning and displaying subsequent images.

► Click |Rotate view| again and right-click in the viewport to reset the coordinates to the original view.

NOTICE

Only if the current image is really transverse (with angulations (0,0,0)), the patient related axes relate to the system axes by rotation around the FH axis only.

The effect is only visible in the orientation of the images displayed within the Interactive Viewer.

If these images are stored in the database and loaded outside the Interactive session, the redefined orientation is not used.

‘Previous image’ and ‘Next image’

In the current viewport up to 16 previous images can be retrieved even if these images were not stored. ‘Image’ |Previous| and ‘image’ |Next| are only active in ‘Single image’ mode.

Hide the ‘Interactive viewer’ window

For switching to another viewing context the interactive viewer window must be hidden by clicking the |Interactive| button. It can be mapped to the foreground by once again clicking the |Interactive| button.

Toggling Interactive switches back and forth between normal planning and interactive until |Next| or |Stop Scan| is pressed.

NOTICE

When applicable, warnings are displayed in the ‘Scanner Status’ window.

Tips and Hints

Complete visualization of a duct

To check if e.g. a duct is completely visualized in a slice, it is recommended to scan with a 90° flipped slice orientation. On the resulting slice, the duct can be seen in the third dimension making optimal planning possible.

Double-oblique planning

To define a view orthogonal to two other views, it is recommended to

- Push the first oblique to another viewport,
- Define the second oblique with 90° tilt on this first oblique,
- Push that to another viewport,
- Define the final view with 90° tilt on the second oblique,
- Check if the yellow intersection line is perpendicular on both orthogonal views.

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15 Reviewing images

You review images in the Review packages:

Package	Description
ImageView	To view images (incl. movies)
VolumeView	For the calculation of Minimum / Maximum Intensity Projections, MultiPlanar Reformats and for Surface Rendering
MobiView	Fusing and viewing package for acquisitions in multiple stations, e.g. whole body, total spine, MRA.

You use the **Image Display Settings** tool to determine how slices are displayed.

Start up a Review or Analysis package

▷ In Review mode:

► Select the imaging series first and then the Review or Analysis package.
You can select multiple scans.

- To select multiple successive imaging series, press |Shift| and click to select.
- To select multiple imaging series, press |Ctrl| and click to select.

There are different ways of how to start up a Review or Analysis package.

1. Right-click on an imaging series in Thumbnail View and select the required package from the context menu.
2. Click on an imaging series in Thumbnail View and select the required package from the 'Review' or ‘Analysis’ menu.
3. Double-click on an imaging series in Thumbnail View. The default package (ImageView) opens automatically.
4. Drag an imaging series from List or Thumbnail View into the reviewing area. The default package (ImageView) opens automatically.

NOTICE

Only those Review or Analysis packages are displayed in the pop-up or 'Review' or 'Analysis' menu which apply to the current scan.

The other packages are either not in the list or they are grayed out.

The selected and thus the current view is indicated by an orange tab and border.

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ImageView

The ImageView package is optimized for viewing images.

Documentation

The following paragraphs give the following information:

- Screen layout,
- Toolbar,
- More Functions within ImageView.

For information about workflows, refer to chapter “ImageView: Workflows” on page 524.

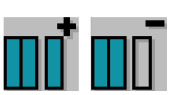
Screen layout

The ImageView package has a default layout of 2x2 viewports with the ImageView toolbar.

Fig. 265: ImageView layout with one large viewport.

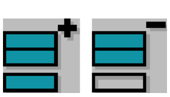
Toolbar

Add / Remove Row and Add / Remove Column



- To add a column (to the right) or to remove a column.

OR/AND



- To add a row (below) or to remove a row.

- These function only affect the layout, not the current image data set.

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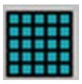
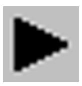
- Alternatively press |Ctrl| and
  - the |Arrow down| or the |Arrow up| keys to add/remove a row.
  - the |Arrow right| key or the |Arrow left| key to add/remove a column.

Standard Layouts



- To select any of the standard screen layouts:
  1x1, 1x2, 1x3, 2x2, 2x3, 2x4, 3x3, 3x4

Play (Movie) <Pause>



- To play (or pause/stop) the current dataset as a movie.

NOTICE

To view a MultiMovie, link the viewports first and then click 'Play (movie)'.

A MultiMovie shows multiple imaging series in a movie in parallel. For information about linking, refer to chapter “Review toolbar” on page 402.

The Movie functionality is a generic functionality occuring in Graphical PlanScan and all Review and Analysis packages. For more information about movies, refer to chapter “On Toolbars” on page 381.

Text Box

- To overlay a text box to the images.

OR

- To overlay an arrow with text box to the images.

Select an option from the drop-down menu.
The Text Box with and without arrow can also be enabled via 'Annotation' from the right-mouse menu for every image.

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Measurements

To perform measurements on the imaging series and overlay them and the results to the images.

- Depending on the type of graphical object chosen, different numeric results are provided.
- Every graphical object is defined by one or more anchor points. The anchor points are visible upon creation and when the graphical object is 'current': simply click on a graphical object to make it current.
- Graphical objects can be modified in size or shape by dragging any of these anchor points. They can be moved to another location by dragging the object anywhere else.
- Dedicated right mouse menus offer more functionality such as the calculation and display of histograms and profiles.

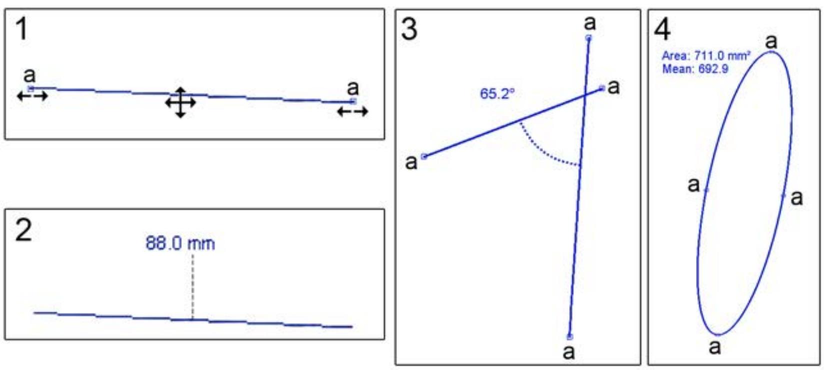
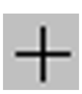


Fig. 266: Examples of measurements (inverted display). 1 - line with the anchor points (a) and the transform possibilities. 2 - line with measurement (not current, no anchor points). 3 - Open Angle measurement with anchor points, 4 - Ellipse measurement with anchor points.

The available options for measurements are listed here:

-> Point



Click on an image to mark a point. The intensity value for this point will be displayed.

-> Line

Click and drag to draw a line. Release to stop drawing. The length of the line will be displayed. Press |Shift| while dragging to get an orthogonal line, either horizontal or vertical.

-> Open Angle

Click four times to define an open angle. The angle will be displayed.

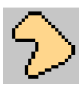
-> Ellipse

Click twice to define one axis of the ellipse, click once more to define the other axis of the ellipse.
The area of the shape and the intensity mean value will be displayed by default.
To move the shape, drag the center of the shape.
To modify the shape, drag the outer edge of the shape.

-> Rectangle

Click twice to define one border of the rectangle (the width), click once more to define the length of the rectangle.
The area of the shape and the intensity mean value will be displayed by default.

-> Smoothed Polygon



Click to start up the ROI definition.
Draw with the left mouse button (no dragging).
Click as often as needed to add new points and to define a smoothed polygon.
Control points are created / deleted by pressing |Shift| and clicking on a contour or point.
Double-click to end drawing and to confirm the shape.
Clicking |ESC|, the entire contour is cancelled.

-> Freehand

Click to start up the ROI definition.
Draw with the left mouse button (no dragging).
Click to end drawing and to confirm the ROI.
The area of the shape and the intensity mean value will be displayed by default.

-> Right Mouse Menus

Right-click on any graphical object to have the following additional functionality available:

- Histogram (available for all measurements except 'Open Angle' and 'Point')
- Profile (available for the 'Line measurement')

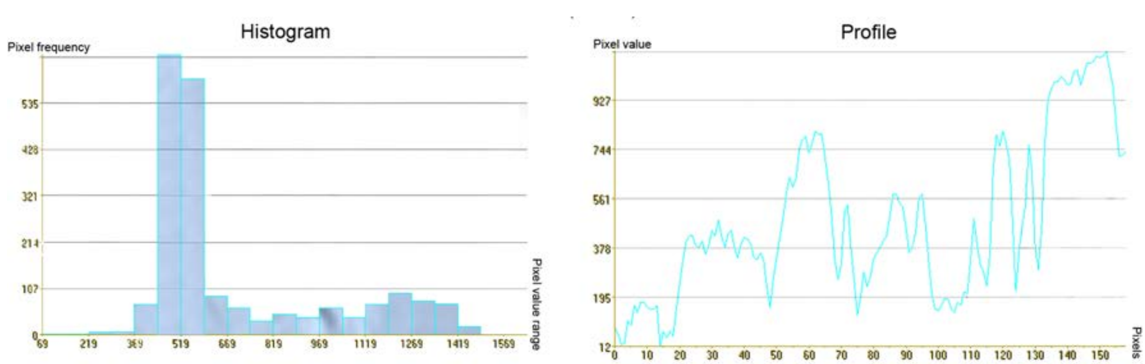


Fig. 267: Inverted displays of: Left - Histogram (pixel frequency versus pixel value range, and right - Profile (pixel value versus pixels.

- Add Text
  to add descriptive text to the graphical object

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- Show Details
- Color
  to edit the color settings of the graphical object:
- Properties

  to display and edit the properties of the graphical object such as ...
- Cut |Ctrl|+X
- Copy |Ctrl|+C
  to copy the current graphical object to the clipboard for reuse on another image
- if applicable: Paste |Ctrl|+V
  to paste the graphical object from the clipboard to the current image
- Copy To All
  to copy the current graphical object to all images in the imaging series
- Delete |Del|
  to delete the current graphical object

Lock Drawing Mode

- To lock the drawing mode.
  This means that once drawing mode is enabled, it stays enabled and more contours can be more defined in one go for ease of use.

Hide/Show All Graphic Objects

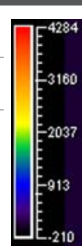
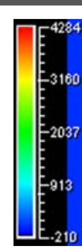
- To enable/disable the display of all graphic objects including ROIs, annotations and lines.

Color LUT (Look-Up Table)

- To select the color look-up table for the maps:

When a color LUT is selected, a vertical color scale bar is shown alongside each image.

The window width and level can be adjusted with all types of color LUT.

Values: Display	GrayScale	Rainbow	Blue To Red
Maximum	White		
	Gray		
Minimum	Black		

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

- In ImageView, these are Display parameters (e.g. order of image attributes on screen), Stacks parameters (e.g. order of stacks) and Propagate parameters (how to propagate view and window settings).

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

More

► Click the arrow besides 'More'.

⇨ The 'More' menu opens.

► Click on any menu option to select it.

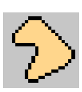
Time-Intensity Diagram (TID)

To calculate and display a Time-Intensity Diagram.
The calculation of a TID requires to define a Region-Of-Interest (ROI).

► Click on "Time Intensity Display".

► Select a type of ROI and draw the ROI as described below:

-> Smoothed Polygon



Click to start up the ROI definition.
Draw with the left mouse button (no dragging).
Click as often as needed to add new points and to define a smoothed polygon.
Control points are created / deleted by pressing |Shift| and clicking on a contour or point.
Double-click to end drawing and to confirm the shape.
Clicking |ESC|, the entire contour is cancelled.

-> Freehand

Click to start up the ROI definition.
Draw with the left mouse button (no dragging).
Click to end drawing and to confirm the ROI.
The area of the shape and the intensity mean value will be displayed by default.

For both ROI's, the shape is automatically copied to all images of the (dynamic) series and the TID displayed.

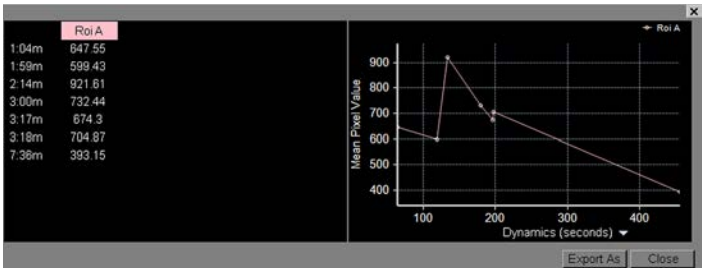


Fig. 268: TID Display with numeric ROI data on the left, the TID on the right and the buttons 'Export as' and 'Close'. To export the TID, click the button 'Export as', browse to the desired folder and click 'Save'.

Delete All Graphics

To delete all graphics such as ROI's or lines.

Deselect All Images

To deselect all images.

More Functions within ImageView

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

ImageView: Workflows

For information

- about generic image functions, see chapter “Generic functions for images” on page 380.
- about ImageView and the ImageView toolbar, see chapter “ImageView” on page 518.

Start up ImageView

Preferred workflow

▷ In Review mode:

► Drag an imaging series from List or Thumbnail View into any viewport of the reviewing area.

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The ImageView  package opens.

Typical ImageView workflows

- **Windowing, zooming and panning**: see chapter “Windowing, Zooming and Panning” on page 378.
- **Scrolling**: see chapter “Introduction to the User Interface and General Information” on page 374.
- **Changing the layout**: see chapter “Toolbar” on page 518.
- **Reviewing Planscan**: see chapter “Review toolbar” on page 402.
- **Comparing imaging series**: see chapter “Review toolbar” on page 402.
- **Performing measurements**: see chapter “Toolbar” on page 518.
- **Playing a movie**: see chapter “Toolbar” on page 518.

VolumeView

The VolumeView package is to be used for the calculation of Minimum / Maximum Intensity Projections, MultiPlanar Reformats and for Surface Rendering.

Documentation

The following paragraphs give the following information:

- Suitable scans
- Screen layout
- Toolbar
- Generate Series window
- Navigation
- More Functions within VolumeView

For information about workflows, refer to the sections chapter “VolumeView: MaxIP and Min-IP” on page 533, chapter “VolumeView: MPR” on page 534, chapter “VolumeView: Surface Rendering” on page 535.

Suitable Scans

The VolumeView package provides different render modes (algorithms) to calculate projections and / or reformats of the original data set.

The table below shows the algorithms available in VolumeView and the types of suitablescans.

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Render Mode	Suitable scans
Maximum Intensity Projection (MaxIP)	• 3D PCA scan • 3D/M2D Inflow scan • CE-MRA scans
Minimum Intensity Projection (MinIP)	• Black blood scan • VENBOLD (PRESTO based) scans • as slab MIP in Susceptibility weighted scan • as slab MIP in M2D balanced-FFE
MultiPlanar Reformat MPR)	• 3D scan. Best results are achieved with thin slices and preferably isotropic voxels.
Surface Rendering (shaded or unshaded)	• 3D scan. Best results are achieved with thin slices and preferably isotropic voxels.

Screen layout

The Volume View package has a default layout of one large and three small viewports.

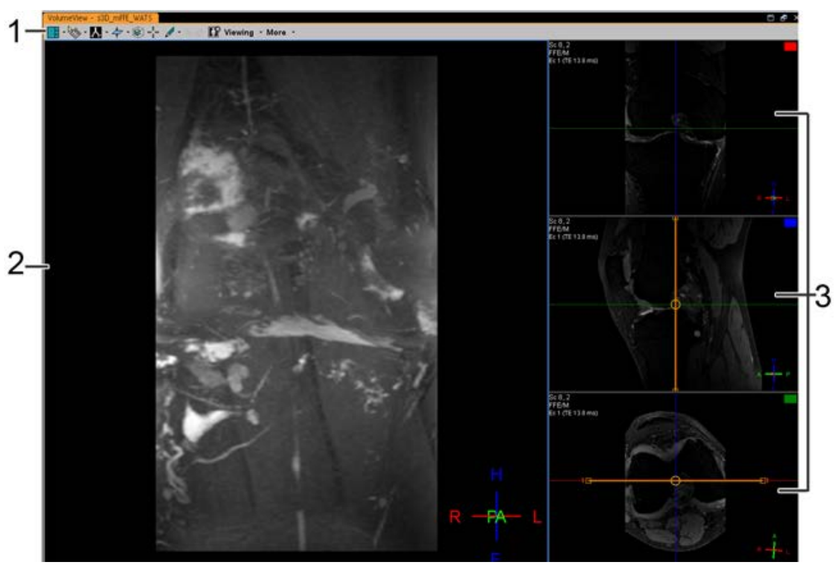

Fig. 269: VolumeView screen layout.

1	VolumeView toolbar
2	3D view calculated in real-time, by default: a MaxIP
3	Orthogonal views that serve as reference views (from top to bottom: coronal, sagittal, transverse view). Each of the views is overlaid by colored lines indicating the position of the shown slices. The slices in the 3D view are linked to the slices in the orthogonal views.

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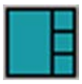
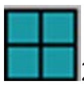
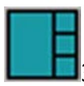
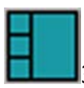
Toolbar

Layout

- To select another screen layout.



► Click 'Layout' and select:

- 1x1: Displaying calculated image over whole volume.
- 2x2: Displaying transverse original and sagittal reference in upper row, coronal reference and whole volume in lower row
- 3 right: Displaying transverse original, sagittal and coronal reference on the left side, whole volume image on the right side
- 3 left: Displaying transverse original, sagittal and coronal reference on the right side, whole volume image on the left side

View

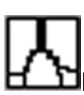
- To display any non-rotated orthogonal view, click the <View> button successively.

  Alternatively you can select any option from the <View> drop-down menu:
  - Transverse, Coronal or Sagittal
  - Rotate Left 90, Rotate Right 90
  - Rotate Top 90, Rotate Bottom 90

Render Mode

- To select the render mode.

► Click 'Render Mode' and select:

- MPR (Multiple Planar Reformat)
- MinIP (Minimum Intensity Projection)
- MaxIP (Maximum Intensity Projection) which is the default setting

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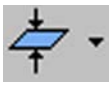
- Shaded Surface (Rendering)
- Unshaded Surface (Rendering)

Thickness



- To adjust the thickness of the real-time calculated object in the preview.

► Click 'Thickness' and select:

- 1, 2, 3 or 4 slices in case of MPR
- Maximum, Minimum, 50%, 20% or 10% in case of MaxIP or MinIP (where 100% refers to the complete imaging volume)

Display Clipbox

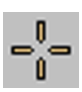
- To view the edges of the data set and to enable interaction to reduce the volume of interest.

► Click 'Display Clipbox'.

► Drag the sides of the Clipbox with |CTRL| being pressed to reduce the volume in all directions.

Rotating the object enables viewing for the sides of the Clipbox from different angles.

Center point



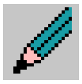
- To define a center point used as reference for subseuent actions.

► Click 'Center point' to enable point selection mode.

► Click on the image to select the center of rotation.

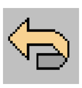
The images and the colored lines on the images will be updated according to this center point. The MIP can also rotate around this point.

Draw Contour



- To draw a contour and to go for a non-cubic volume. Select/enable:
  - Cut outside: After drawing, the area outside the border will be cut away (Default).
  - Cut inside: After drawing, the area inside the border will be cut away.
  - Polygon: Point-to-point drawing where the points are connected in a straight line. Double-click to close the contour (Default).
  - Bezier: Point-to-point drawing where the points are connected in a curved line. Double-click to close the contour.
  - Free: click and draw while keeping the mouse pressed.
  - AutoCut Mode: If enabled, cutting will automatically occur when drawing is complete (Default).

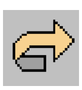
Undo



- To undo the last action.

  This function can be used to undo multiple actions.

Redo



- To redo the last action.

  This function can be used to redo multiple actions.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up. It allows to specify which images are to be generated in which manner.

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

More

► Click the arrow besides 'More'.

⇨ The 'More' menu opens.

► Click on any menu option to select it.

Reset All

- Click 'Reset All' to reset the orientation and to delete already drawn contours.

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Reference Image Type

- To select the reference image type.

Can be set to:

- Source/Reformat
- Full Volume

Generate Series window

Out of the original dataset, you can easily generate new imaging series consisting of MaxIP, MinIP or MPR images.

You can

- set up and save protocols for the calculation of MaxIP, MinIP or MPR
- select and reuse the saved protocols for any other dataset.
- edit existing protocols
- delete protocols.

The Generate Series window shows up after clicking 'Generate Series'. It allows for the specification of the newly generated imaging series with respect to stack, propagation and geometry parameters.

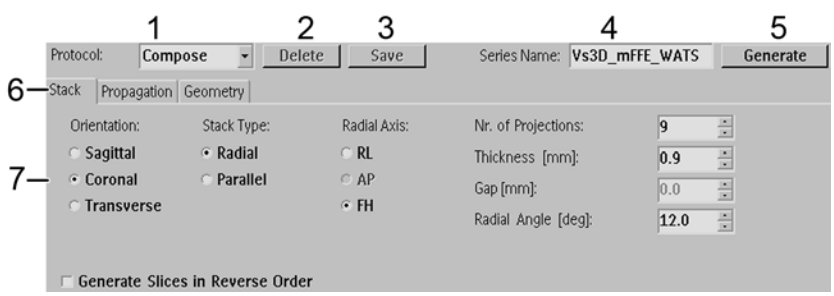

Fig. 270: Generate Series window in VolumeView

1	To select a protol. 'Compose' allows to compose a new protocol.
2	To delete the current protocol
3	To save the current protocol
4	To enter a series name for the new imaging series
5	To generate a new imaging series with the given name
6	To switch between the 'Generate series' parameter subsets, click on any of the tabs: Stack, Propagation, Geometry.
7	To change respectively enable or disable the Stack, Propagation or Geometry parameters.

Stack parameters in the Generate Series window

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Parameter	Possible settings	Description
Orientation	• Sagittal • Coronal • Transverse	To define the orientation of the newly generated imaging series.
Stack Type	• Radial • Parallel	To define the stack type of the newly generated imaging series, e.g. for MPR preferably parallel or for MaxIP and MinIP preferably radial.
Radial Axis	• RL • AP • FH	To define the radial of the newly generated imaging series if 'Stack Type' is set to radial.
Nr. of projections	1 ... • Can be entered numerically. • or via mouse interaction in the orthogonal views: press <SHIFT> and drag the outer yellow projection lines.	To specify the number of projections of the newly generated imaging series.
Thickness [mm]	[mm] • Can be entered numerically. • or via mouse interaction in the orthogonal views	To specify the thickness of each projection.
Gap [mm]	[mm] • Can be entered numerically. • or via mouse interaction in the orthogonal views: drag the outer yellow projection lines.	To specify the gap between the projections. Applicable for parallel stack only.
Radial Angle [deg]	[deg] • Can be entered numerically. • or via mouse interaction in the orthogonal views: drag the outer yellow projection lines.	To specify the radial angle between the projections if 'Stack Type' is set to radial.
Generate Slices in Reverse Order	• Disabled • Enabled	To generate a new imaging series with the slices in reverse order.

Propagation parameters in the Generate Series window

The Propagation parameters define how the settings are propagated. If propagation is applied e.g. for Dynamics, the settings of the current dynamic will be propagated to the Preceding or Following dynamics:

- Dynamics (preceding, following)

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- Phases (all phases or the current phase, if not checked)
- Stations (all stations or the current station, if not checked)
- b-values (all b-values or the current b-value, if not checked)
- Diff.(usion) directions (all diffusion directions or the current diffusion direction, if not checked)

Select 'Single Axis' for multiple stacks or multiple stations.

You can also enable/disable 'Generate Orthogonals'. If enabled, three orthogonal MaxIPs will be calculated additionally.

Geometry parameters in the Generate Series window

The Geometry parameters allow entering of the offcentre and angulation values numerically, but also definition if the angulation of the new series is relative to the Volume or relative to the Magnet.

Select 'Magnet' for multiple stations. This compensates for planning differences between stations and aligns the new imaging series.

Navigation

The 3D view and the orthogonal views can be used for navigation.

Scrolling

To scroll through the orthogonal views to any desired location, drag the colored lines.

You can scroll within the preview if the <Thickness> is less than Maximum. Right-click in the 3D view and select Push/Pull. Drag to navigate through the volume.

To scroll through multiple dynamics if available, drag to the left or to the right on any of the orthogonal views. Alternatively you can press the left and right arrow key.

NOTICE

For DWI scans, drag diagonally to scroll through b-values.

Rotate in any direction

To rotate the dataset in any direction, right-drag on the 3D preview.

To display any non-rotated orthogonal view, click the <View> button successively. Alternatively you can select any option from the <View> drop-down menu.

More Functions within VolumeView

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

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Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

- Right-click on any image to access the right mouse menus.

Next Station and Previous Station

To display another station, right-click on any of the small viewports and select <Next station> or <Previous station>.

Hide Lines, Show Lines, Show Outline and Show Slices

Right-click on orthogonal view to toggle the display.

VolumeView: MaxIP and MinIP

Starting up VolumeView

1. Right-click on a suitable scan in the Thumbnail View.

   A context menu appears.

2. Click **VolumeView**.

   The VolumeView package opens.

Optional: Selecting the Image Type

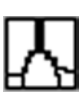
- Drag to the left or to the right on the orthogonal views to select another image type, e.g. in a PCA imaging series PCA/M or FFE/M images.

Selecting the Render Mode

For Maximum Intensity Projection (MaxIP)

- This step can be skipped, since **MaxIP** is the default setting.

For Minimum Intensity Projection



- Click **Render Mode** and select **MinIP** from the drop-down menu.

Defining the volume to be reconstructed

You can define the volume of interest in several ways, e.g. using the clipbox function or drawing a contour.

The most common way of drawing a contour is described here.

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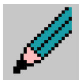

1. Click **Draw Contour** to define the volume of interest.
   - Default settings are: Free, Cut Outside, AutoCut Mode Enabled.
2. For Free:
   - click once to start drawing,
   - move the mouse to define the contour,
   - click once more to close the contour.

Calculating the result images as new imaging series

- Click **Generate Series** to calculate a new imaging series out of the original data set.

  A new window pops up.
- Click **Stack** to define orientation, stack type (e.g. radial for a Single- and Multi-Station MaxIP or parallel for a slab MinIP), projections, radial axis and angle.
- Enter a series name and click **Generate** to generate new imaging series.

VolumeView: MPR

Starting up VolumeView

1. Right-click on a suitable scan in the Thumbnail View.

   A context menu appears.

2. Click **VolumeView**.

   The VolumeView package opens.

Selecting the Render Mode

For Multiple Planar Reformats

- Click **Render Mode** and select **MPR** from the drop-down menu.

Calculating the result images as new imaging series

- Click **Generate Series** to calculate a new imaging series out of the original data set.

  A new window pops up.
- Click **Stack** to define orientation, stack type (e.g. radial for a Single- and Multi-Station MaxIP or parallel for a slab MinIP), projections, radial axis and angle.
- Enter a series name and click **Generate** to generate new imaging series.

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VolumeView: Surface Rendering

NOTICE

Only one object can be rendered at a time.

Starting up VolumeView

1. Right-click on a suitable scan in the Thumbnail View.

   A context menu appears.

2. Click **VolumeView**.

   The VolumeView package opens.

Selecting the Render Mode

- ► Click **Render Mode**.

- ► Select **Shaded Surface Rendering** (surface rendering with use of light source)

  OR

- ► Select **Unshaded Surface Rendering** (surface rendering without use of light source)

Defining the volume

If necessary, define the volume to be reconstructed.

MobiView

MobiView can be used to fuse multistation datasets being acquired as different stacks in Head-Feet direction.

Typically, MobiFlex (or MobiTrak) and Whole Body scans are viewed in this way.

WARNING

After applying the fusion operation, double-check whether the result of the fusion operation is correct. Always keep the original images.

Horizontal lines on the image indicate where the operation took place. Check for any artifacts that could indicate a fusion error, like cut-off objects or anatomy. The fused images must be of the same acquired plane. Be aware that the resolution at the edges of a station can be lower than in the center.

Documentation

The following paragraphs give the following information:

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- About Fusing
- Screen layout
- Toolbar
- More Functions within MobiView

For information about workflows, refer to the section chapter “MobiView Workflow” on page 541.

About Fusing

Fusing

- creates one image from multiple images acquired at several stations.
- executes the following tasks:
  - Zooming of the images.
  - Panning in the image directions.
  - Propagating these view settings to all images in such a way that the different stations are aligned if being displayed in a column.
  - Fusing the images and creating one image.
  - Removing the overlapping area either smooth or with a hard-cut.
- includes that the fusing area is clearly indicated by markers on the fused images.

NOTICE

Unfuse the images in case of artifacts.

This is to make sure that previously present artifacts which have not been visible on screen prior to fusing are not mistakenly interpreted as pathologies.

Screen layout

The MobiView package automatically comes up with a screen layout related to the number of stacks within the selected scan, e.g.

- If the scan contains of 3 stations, the default screen layout is 3 x 3.
- If the scan contains of 5 stations, the default screen layout is 5 x 5.
- Corresponding slices (same AP, RL offcenter values) are automatically combined within one view.

Image Info Display

The matrix information in the Image Info corresponds to the fused image.

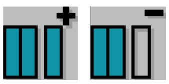
E.g. the matrix is displayed as "252 / 3518 x 512r"

- where 252 represents the initially scanned resolution per station of 252 in FH direction

- where 3518 represents the resolution of the fused images in FH direction
- where 512r represents the resolution in LR direction (r=reconstructed).

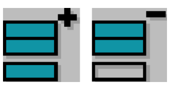
Toolbar

Add / Remove Row and Add / Remove Column



- To add a column (to the right) or to remove a column.

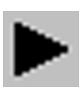
OR/AND



- To add a row (below) or to remove a row.

- These function only affect the layout, not the current image data set.
- Alternatively press |Ctrl| and
  - the |Arrow down| or the |Arrow up| keys to add/remove a row.
  - the |Arrow right| key or the |Arrow left| key to add/remove a column.

Play (Movie) <Pause>



- To play (or pause/stop) the current dataset as a movie.

NOTICE

To view a MultiMovie, link the viewports first and then click 'Play (movie)'.

A MultiMovie shows multiple imaging series in a movie in parallel. For information about linking, refer to chapter “Review toolbar” on page 402.

Movie ToolBox

- To adjust the movie settings.
- ► Select 'Movie ToolBox' from the Movie drop-down menu besides the icon.

Fig. 271: Movie ToolBox.

Number	Purpose/ Description
1	Click this button to toggle between Play, Pause and Stop movie mode.
2	Click this button, then scroll to the image to start the movie with and click 'Play Movie'.
3	Click this button, then scroll to the image to end the movie with and click 'Play Movie'.
4	Select the type of movie from the drop-down menu: • cyclic (loop): the images are displayed in the order 1 ... n, 1 ... n etc. • bounce (yoyo): the images are displayed in the order 1 ... n, n ... 1, 1 ... n, etc.
5	Select type of image for the movie, e.g. slices or phases.
6	Adjust the movie speed by dragging the slider.

Toggle or Select the Running Attribute

- To toggle between running attributes or to select a running attribute, e.g. echoes, slices, dynamics, image types.

Windowing Options

- To change the windowing characteristics for the multiple stations.
  Possible values are:
  - None
    Each station is displayed with its own window settings: in each station the maximum intensity is displayed white and the minimum intensity black.
  - Automatic
    The stations are windowed automatically based on the intensity values of all stations together: the maximum intensity of all stations is displayed white, the minimum intensity of all current stations is displayed black.
  - MIP
    The maximum intensity values of the stations are upscaled and the lower intensity values of the stations are downscaled to achieve a Maximum Intensity Projection (MIP) effect in the images.

Fusing Mode

To fuse stacks from multiple stations in different ways:

Fuse Hardcut

- Hardcut Fusing Mode is to be used for scans without overlap between stacks.
  It is typically used in sagittal and coronal multiple station imaging series.
- First half of the overlapping area is 100% of the first image, other half is 100% of the other image.

Fuse Smooth

- Smooth Fusing Mode is to be used for scans with overlapping stacks.
  It is typically used in sagittal and coronal multiple station imaging series.
- A smooth transition between images is created by using a sinusoidal function.

Merge Series

- Merge Series is to be used for multiple station imaging series acquired in transverse orientation.
- When enabled, it allows to easily scroll through the complete set of transverse images acquired for the multiple stations.
- Merged imaging series stay merged when they are transferred to PACS.

Select No Fusing Mode

- 'No Fusing Mode' disables fusing.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up where the name of the new series can be entered.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

To adjust the viewing settings:

Orientation (Viewing)

To change the orientation of the images:

- Mirror, Flip,
- Rotate clockwise, Rotate counterclockwise,
- Reset orientation,
- Display Images in Radiological View

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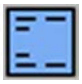
Image Information (Viewing)



- To define the amount of displayed image information:
- minimum: no text is displayed,
- standard: scan, image number and the scan name are displayed,
- maximum: also the offcenter values, the window values (width and level) and the caliper are displayed.

Interpolate (Viewing)

To interpolate the image(s).

Invert Gray Level (Viewing)

- To invert the images of the current dataset (change black and white in the grayscale).

Capture ...

To capture images and save them. Type of image and destination are to be defined in the 'Capture' pop-up window. Check according to your preferences:

- 'Capture Selected Image' captures the current image.
- 'Capture ImageView' captures the current image including orange border and ImageView tab.
- 'Capture Full Screen' captures the full screen.
- 'Capture Slices' captures all slices of the current imaging series.
- 'As Displayed and Annotated' or 'As Acquired' allow to capture images with or without their window/zoom settings and annotations.
- 'Save to External Folder' allows to save the data to an external folder.

  In this case, it is necessary to browse to this external folder.
- 'Save to Patient Database' allows to save the data to the patient database.
- In order to include the hospital name, check the eponymic option.

The function 'Capture ...' as part of Viewing is only available in Review and Analysis packages, not in Graphical PlanScan.

Save Presentation State <Ctrl+S> (Viewing)

To save a special way of presenting images.

Reload Presentation State <Ctrl+R> (Viewing)

To reload a special way of presenting images.

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Reset Window (Viewing)

To reset images to original window level and width.

Reset Zoom / Pan (Viewing)

To reset images to original zoom and pan values.

More Functions within MobiView

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

- ► Right-click on any image to access the right mouse menus.

Store Fused Images

The fused images are stored in an image file.

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MobiView Workflow

NOTICE

If the scans which have to be fused don’t have GeoLinks (e.g. due to scan aborts), select multiple scans to overcome this problem: in this case, fusing will be done for these multiple scans.

Starting up MobiView

1. Right-click on a suitable scan in the Thumbnail View.

   A context menu appears.

2. Click **MobiView**.

   The MobiView package opens.

Fusing the coronal or sagittal imaging series

NOTICE
Adjust window width and level of each station prior to fusing.

1. Select **Fuse Hardcut** or  **Smooth Fuse** from the toolbar.
2. Check whether the result of the fusion operation is correct.
   Fused images can be windowed and zoomed in the usual way as other images.

NOTICE
The fusing area is indicated by markers on the multistation images.

Merging the transverse imaging series

NOTICE
Adjust window width and level of each station prior to fusing.

1. Select **Merge Series** from the toolbar.
2. Check whether the result of the fusion operation is correct.
   Merged images can be windowed and zoomed in the usual way as other images.

NOTICE
The fusing area is indicated by markers on the multistation images.

Saving the fused images to database

1. Click **Generate Series** to save the fused images to database.
2. Click **Yes** to confirm.
   - Each time the **Generate Series** button is clicked, the fused data is stored as a new series.
   - The name of this new series is derived from its original name extended with a "m".
   - The saved images will be marked as derived images, i.e. not originally scanned images.
   - The fusing area indication is saved with the images.

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Workflow for Multi-Station imaging series with Multiple Image Types

With multiple stations and multiple image types, fusing automatically occurs for one image type, e.g. Modulus or InPhase image.
In order to also fuse the second image type, proceed as follows:

For coronal or sagittal multi-station imaging series

- ► Select your imaging series and start up MobiView.
- ► Select the first image type (e.g. InPhase image).
- ► Fuse the images (either Smooth  or Hardcut ) and store the resulting fused image.
- ► Select the second image type (e.g. Water image).
- ► Fuse the images and store the resulting fused image.

For transverse multi-station imaging series

- ► Select your imaging series and start up MobiView.
- ► Select the first image type (e.g. InPhase image).
- ► Merge the images  and store the resulting merged image.
- ► Select the second image type (e.g. Water image).
- ► Merge the images and store the resulting merged image.

Image Display Settings

Image Display Settings allows you to customize image orientation and slice order settings for image review. You can change the way you look at the images (image orientation) and the way images are numbered (slice order) at system level. You can:

- Change the default display settings.
- Create customized settings for specific anatomies.

Settings apply to the operator's console, remote workstations and PACS systems.

NOTICE

Ensure that information regarding patient position, patient orientation and anatomic region is entered correctly in the ExamCard Properties (see chapter “ExamCard Properties” on page 427). This makes sure that image display is correct for each anatomy and each way of positioning.

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View Image Display Settings

To view and customize image display settings:

- ► Click **System**, then **Image Display Settings**.
- ⇨ The Image Display Settings window opens.

The **Display settings for:** field shows for which anatomies the displayed settings are applicable.

The display settings for each plane are indicated by an image.

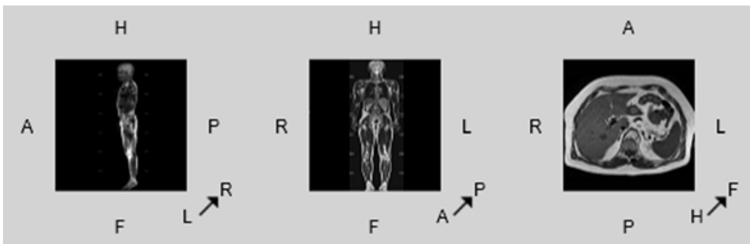


Fig. 272: Images indicate the display settings and slice order for each plane: sagittal, coronal and transverse.

You can change default settings using the buttons described in chapter “Change Image Display Settings” on page 544.

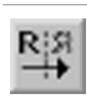
When you create customized settings for specific anatomies, a new field is added underneath the default field (chapter “Anatomy-specific Image Display Settings” on page 546). The top field always displays the default settings.

Change Image Display Settings

The image display settings are locked and require a password to change.

To unlock the image display settings:

- ► Click **Unlock to customize settings**.
- ► Type the password in the password box. To obtain the password, contact your Philips service engineer or system administrator.
- ► Click **OK**.
- ⇨ Image display change buttons appear underneath each image.

		
Mirror image button (sagittal orientation only)	Flip image button	Change slice order button

Tab. 32: Image display change buttons

Mirror or flip image

- Point the cursor in the field that requires a change. The whole field turns yellow and buttons appear underneath each plane.
- Click the **Mirror image** button (sagittal only) or **Flip image** button under the plane you want to change.

  The images that indicate display settings change direction accordingly.
- Click the button again to return to the previous setting.

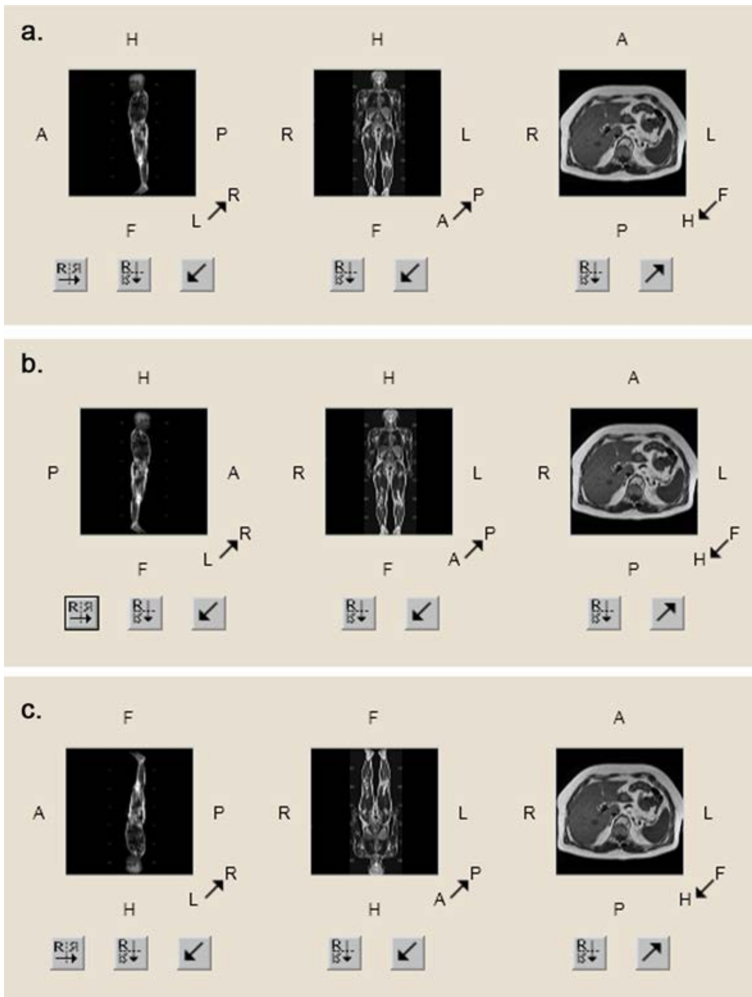


Fig. 273: The images indicate the selected display settings. a.Original settings. b. Sagittal plane image display settings are mirrored. c. Sagittal and coronal plane image display settings are flipped.

Slice order

- To change slice display order, click the **change slice order** button under the plane for which you want to change the reviewing slice order.

  The direction of the arrow indicating the slice order changes. The arrow on the slice order button also changes direction.
- Click the **change slice order** button again to return to the previous setting.

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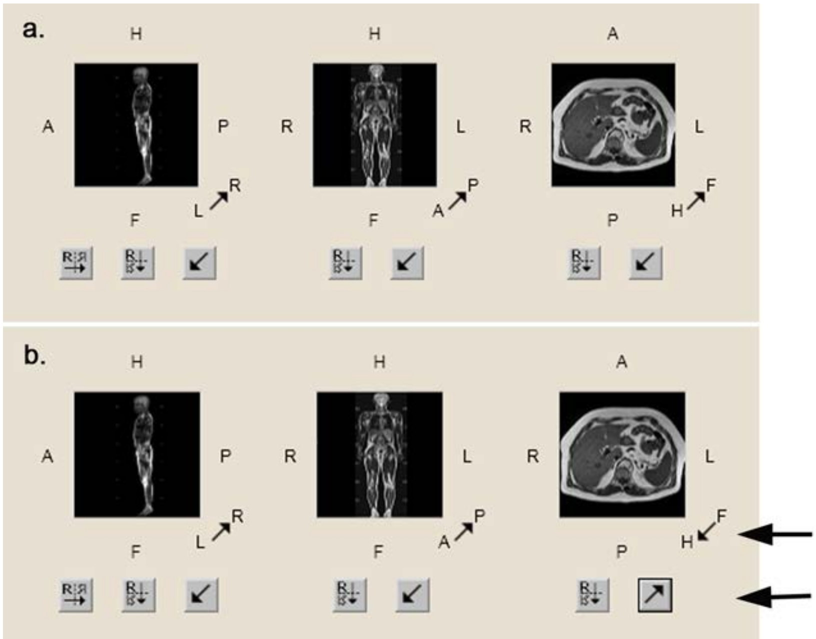

Fig. 274: Change of slice order. a. Original settings. b. Slice order change for transverse orientation. The arrow indicating the slice order and the arrow on the slice order button both change direction.

Save changes

- Click **Save** to save changes you made to the image display settings.
- Click **Reset** at the left top, to remove all changes and to return to previously saved settings but to remain within the Image Display Settings window.
- Click **Cancel** to close the Image Display Settings window without saving changes.

Anatomy-specific Image Display Settings

You can set display settings for specific anatomies.

- In the **Display settings for:** field, point at the required anatomy.
- In the pop-up window, click **Customize display settings for <selected anatomy>***.

Alternatively:

- Click the **Create separate display settings for:** drop-down arrow.
- Select the required anatomy.
- ⇨ A new field appears underneath the default field.

* The name of the selected anatomy appears here.

To customize the display settings for the selected anatomy:

- Use the buttons as described in chapter “Change Image Display Settings” on page 544.

To ensure consistency, the sagittal slice order of unpaired anatomies (head, neck, spine, thorax, abdomen, breast, and pelvis) can only be set in the default settings at the top. To change the sagittal slice order for unpaired anatomies, first change the default settings, then create the required anatomy-specific settings.

NOTICE

When display settings are already customized for an unpaired anatomy, sagittal slice order can no longer be changed at default level. To change the sagittal slice order for unpaired anatomies, remove anatomy-specific settings for unpaired anatomies first. The sagittal slice order for paired anatomies such as knee and elbow can always be customized.

Anatomy-specific settings that differ from the default settings are highlighted in yellow.

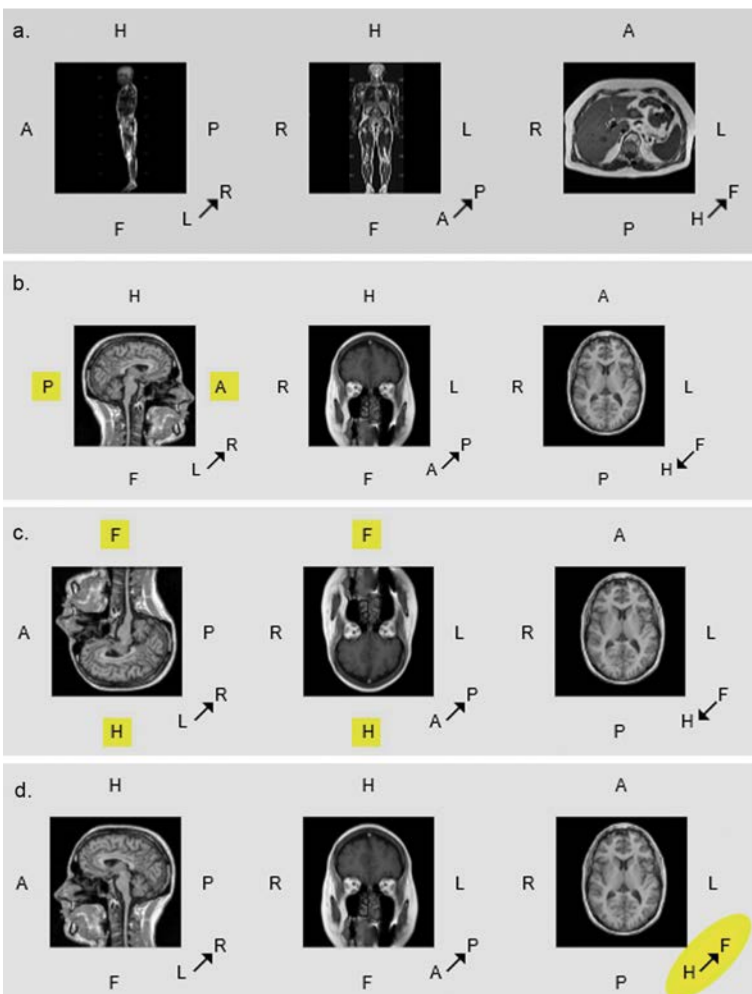

Fig. 275: Image display settings that are different from default settings are highlighted in yellow. a. Default settings. b. Mirrored settings for sagittal head images. c. Flipped settings for sagittal and coronal head images. d. Slice order change for transverse head images.

To assign multiple anatomies to a customized display setting.

► Click the **Add Anatomy** drop-down arrow within the customized field.

► Select the required anatomy from the drop-down menu

► To add additional anatomies, repeat the process.

NOTICE

Customized settings cannot be combined for all anatomies. Paired anatomies (hips, knees, ankles, feet, shoulders, elbows, wrists, and hands) cannot be combined with head, neck, thorax, spine, abdomen, breast, and pelvis anatomies.

Examinations with paired anatomies

When you create a custom setting for a paired anatomy, the new field automatically shows left and right settings. For sagittal images, it is possible to mirror or change the slice order settings for the left or the right side only. Flipping an image is always applied to both sides, as are slice order changes for coronal and transverse images.

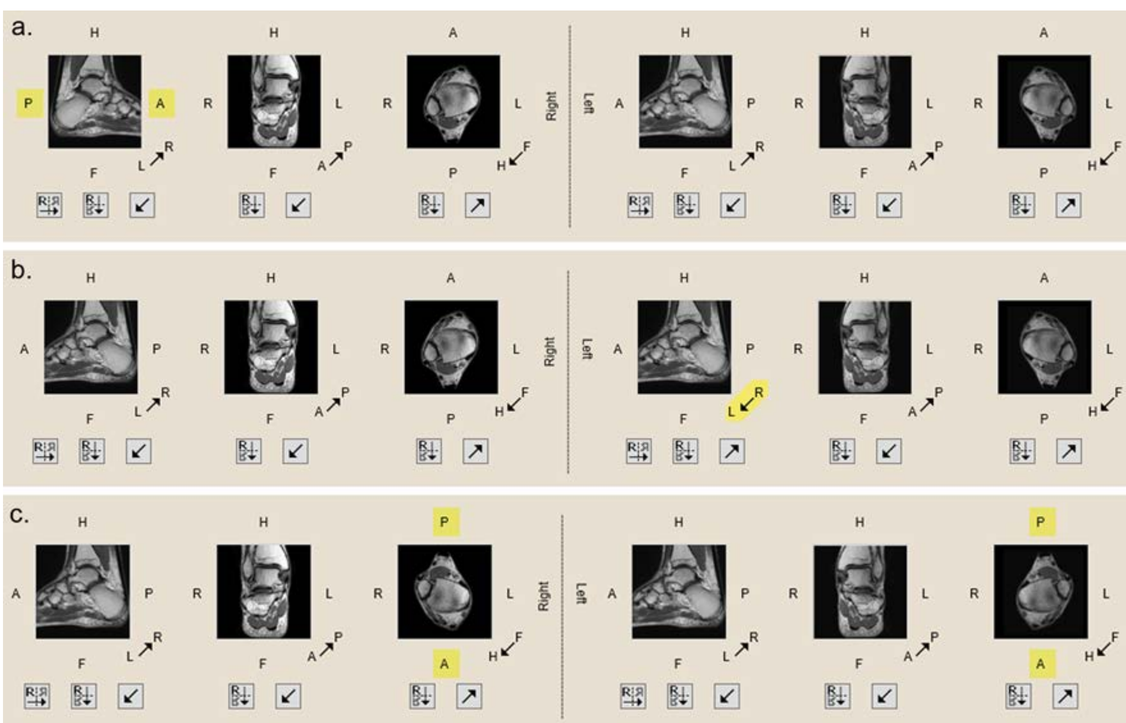

Fig. 276: Image display settings that are different from default settings are highlighted in yellow. a. Mirrored sagittal images for the left ankle only. b. Slice order change for sagittal images of right ankle only. c. Flipped images for transverse ankle images, applicable for both sides.

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Removing display settings for specific anatomies

To remove an anatomy with customized Image Display Settings:

- ► Hover over the anatomy name.
- ► In the pop-up window, click **Remove customization**. The anatomy reappears in the default field.

Save settings

- ► To save changes to Image Display Settings, click **Save**.
- ► To close the Image Display Settings window without saving changes, click **Cancel**

Exporting and importing Image Display Settings

You can export customized image display settings to:

- Load settings onto another scanner.
- Create a back-up.

To export Image Display settings:

- ► Click **Export**, at the top right of the Image Display Settings window.
- ► Click **Browse** and navigate to the location where you want to save the settings.
- ► Click **OK**.
- ⇨ The Browse For Folder window disappears. The destination address appears in the Export Preset window.
- ► Click **OK** to finalize export. The Image Display settings are saved under file name Export.preset.

To import Image Display Settings:

- ► Click **Import**, at the top right of the Image Display Settings window.
- ► Click **Browse** and navigate to the location where previously stored settings are saved.
- ► Select the required file and click **OK**.
- ► Click **OK** in the Import Preset window to start the import.

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16 Analyzing MR datasets

You analyze/postprocess images in the Analysis packages:

Package	Description
PicturePlus	To enhance images
Diffusion registration	To correct for patient movement which occured during a dynamic scan
Diffusion	To calculate parametric diffusion maps, e.g. ADC or FA maps
FiberTrak	To visualize diffusion tensor data in the form of white matter tracts
ImageAlgebra	To perform image arithmetics e.g. subtract images
QFlow	Quantitative Flow postprocessing package
Neuro T2* Perfusion	To evaluate neuro T2* dynamic scans and generate numerical and graphical results and maps
Basic T1 Perfusion	To evaluate T1 dynamic scans and generate numerical and graphical results and maps
SpectroView	Postprocessing package for MR Spectroscopy
IViewBold	Real-time and postprocessing package for BOLD imaging

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QFlow package

The Quantitative Flow postprocessing package calculates quantitative information as flow velocity or flow rate.

It also allows you to compare two different QFlow scans within one examination.

Q-flow

WARNING

For Q-Flow measurements the field-of-view (FOV) must be positioned in the isocenter of the magnet to avoid misinterpretations due to incorrect Q-Flow calculations.

WARNING

The option to export the results to a file just gives the user a momentary snapshot of the results as displayed on screen.

The correctness of these values is inconclusive.

Documentation

This chapter gives the following information:

- Suitable Scans
- Screen layout
- Toolbar
- Navigation matrix
- More Functions within QFlow
- Results

More information

- Quantitative Flow measurements, see chapter “Quantitative Flow (QFlow, QF)” on page 685,
- Workflows, see chapter “QFlow Analysis” on page 557,
- Quantitative Flow comparison, see chapter “QFlow Comparing scans” on page 559.

Suitable Scans

Suitable scans are Quantitative Flow scans which are triggered PCA scans containing at least PCA/Phase images and FFE/Modulus and optionally PCA/Modulus images.

Reliable results are achieved when the scan has been acquired perpendicular to the vessel(s) of interest.

Screen layout

The QFlow package has a default layout of four viewports.

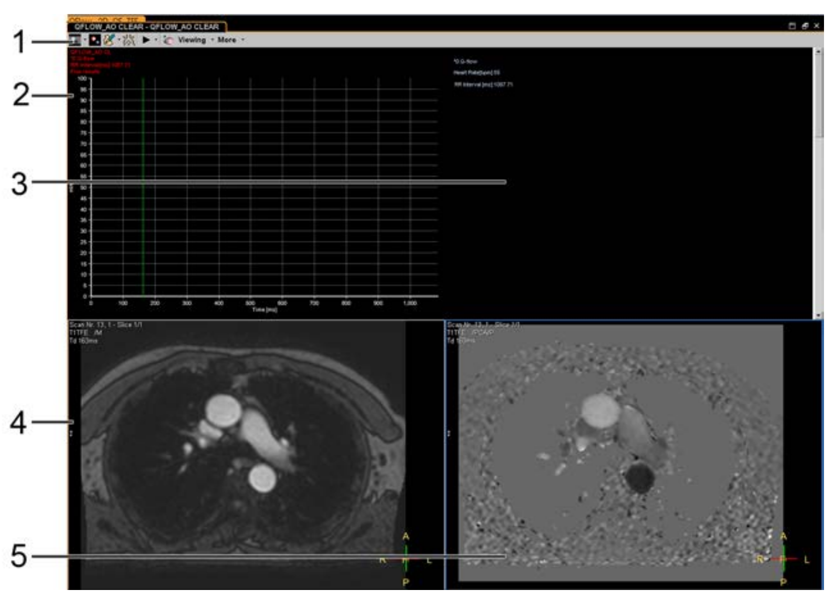
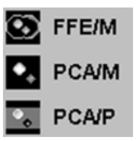


Fig. 277: QFlow screen layout.

1	Toolbar
2	Reserved for graphical results
3	Reserved for numerical results (table)
4	large FFE/M image
5	large PCA/P image, optionally to be replaced by other image types

Toolbar

Display/Hide FFE/M, PCA/M, PCA/P



► From the drop-down menu, select any image type for display in the right lower viewport:

from left to right: FFE/M, PCA/M, PCA/P
PCA/P Color overlays the PCA/P color mask to the recently chosen image type.

Display/Hide PCA/P Color Images

► Click to enable/disable the overlay of the PCA/P Color image to the image in the right lower viewport.

Draw Selected Contour

► Click 'Draw Selected Contour' to draw a ROI:

- Smoothed Polygon
- Ellipse
- Freehand
- Single Click.

Enable / Disable Active Contours

► Click 'Enable / Disable Active Contours' to enable or disable automatic contour detection.

By default, ’Active Contours’ is disabled to allow for automatic contour detection and adaptation.

Play (Movie) <Pause>

- To play (or pause/stop) the current dataset as a movie.

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NOTICE

To view a MultiMovie, link the viewports first and then click 'Play (movie)'.

A MultiMovie shows multiple imaging series in a movie in parallel. For information about linking, refer to chapter “Review toolbar” on page 402.

The Movie functionality is a generic functionality occuring in Graphical PlanScan and all Review and Analysis packages. For more information about movies, refer to chapter “On Toolbars” on page 381.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

More

► Click the arrow besides 'More'.

⇨ The 'More' menu opens.

► Click on any menu option to select it.

Results Setup ...

► Click 'Results Setup ...’ to set up the results screen.

The 'Results Setup' window opens.

► Select the vessel to display the results for.

► Specify if the results are to be displayed inverted.

► Select the display type and the unit.

Export Results

► Click 'Export Results' to export the results and browse to an export destination.

Link Time Points

To link multiple time points, also for movie display.

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More Functions within the QFlow package

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

Results

Graphical results and numerical results are presented in the reserved viewports.

The display of numerical results cannot be changed. The display of the graphical results however can be displayed in different ways:

► Right-click on the graphical results and select the result to be presented:

- Area
- Maximum Velocity
- Minimum Velocity
- Mean Velocity
- Peak Velocity
- Nr Pixels (number of pixels)
- Flux
- Standard Deviation.

A detailed description follows:

General Results

Heart Rate [bpm]	• As derived from acquisition.
RR Interval [ms]	• As derived from acquisition.

Flow Analysis Results for each ROI (vessel contour)

The results are available per slice, per phase and per vessel.

Positive flow is flow into the plane (maximum positive: displayed white), e.g. in Feet-to-Head direction and in Right-to-Left direction.

Negative flow is flow out of the plane (maximum negative: displayed black), e.g. in Head-to-Feet direction and in Left-to-Right direction.

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Trigger delay [ms]	• Time between R-peak and acquisition of the specific slice.
Flux [ml/s]	• Blood volume that passes the contour per second. This is the same as ’mean velocity * area'. Note that this value is only calculated if the flow direction is perpendicular to the image.
Area [cm2]	• Area of the pixels that are partially or fully included in the contour. To visualize this area, right-click in an image viewport and select 'Filled graphics'.
Nr. of pixels	• Pixels that are partially or fully included in the contour.
Mean velocity [cm/s]	• Mean blood flow velocity.
Maximum velocity [cm/s]	• Highest measured positive flow in the contour.
Minimum velocity [cm/s]	• Highest measured negative flow in the contour.
Peak velocity [cm/s]	• Either maximum velocity or minimum velocity, whichever has the highest absolute value.
Velocity Standard Deviation [cm/s]	• Standard deviation of the mean velocity.

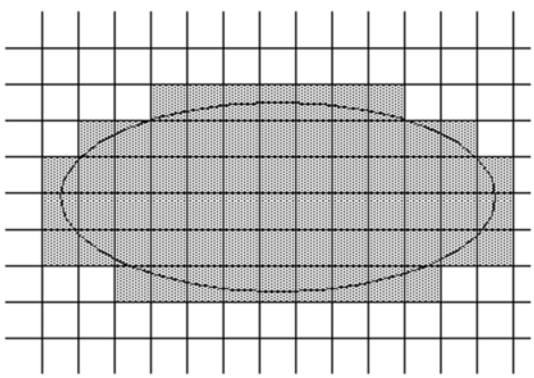


Fig. 278: The pixels that are taken into account for quantitative flow calculations.

Flow Analysis Results for a collection of ROI’s

These results are only generated for multiphase scans.

Temporal integral values of flux:

Forward flow volume [ml]	• Amount of positive flow.
Backward flow volume [ml]	• Amount of negative flow.
Regurgitant fraction	• Fraction of backward to forward flow.
Stroke volume	• Absolute value of the difference between forward and backward flow.
Absolute stroke volume	• Absolute value of forward flow PLUS absolute value of backward flow.
Mean flux [ml/s]	• Stroke volume x heartbeat / 60

Temporal integral values of mean velocity:

Stroke distance	• Netto distance the blood proceeds in the vessel in 1 RR-interval.
Mean velocity	• Stroke distance x heartbeat / 60

Note that the units for each result type can be chosen by the user. Available units are:

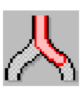
Result	Available units	Default unit
Area	mm^2, cm^2	cm^2
Velocity	mm/s, cm/s, m/s	cm/s
Flux	mm^3/s, ml/s, ml/min, 1/min	ml/s
Volume	mm^3, ml, cc, cm^3	ml
Distance	cm, mm, m	cm
Time	ms, s	depends on length of series

QFlow Analysis

Starting up the QFlow package

1. Right-click on a suitable scan in the Thumbnail View.

   A context menu appears.



2. Click **QFlow**.

   The QFlow package opens.

Preparing the environment for drawing a ROI

► To select the end diastolic FFE/M image:

Drag to scroll through the images.

The end diastolic FFE/M image shows the largest diameter which is best for the automatic contour detection.

Selecting the type of ROI

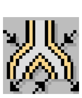
► Click **Setup Contours**.

► Select the type of ROI to be drawn: Freehand (default), Single Click, Ellipse or Bezier.

Note that for correct contour detection, a freehand ROI has to be drawn. A Single Click ROI works best with large vessels.

► Click **Ok** to confirm.

Active Contours algorithm



► **Active Contours** is disabled by default to allow for automatic contour detection and adaptation.

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Drawing a ROI

For Smoothed Polygon, Ellipse, Freehand:

- ► Click **Draw Selected Contour**.
- ► Click once in the image viewport to start drawing a ROI.
- ► Move the mouse to define the contour.
- ► Double-click to close the contour.

  The drawn contour will be adapted to the closest automatically detected contour if **Active Contours** is enabled.

For Single Click ROI:

- ► Click once within the vessel.

  The contour detection algorithm will automatically come up with the vessel contour.

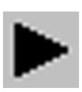
Propagating the ROI to the other images

- ► Right-click on the ROI and select **Propagate All** to propagate the ROI to all images.

NOTICE

Repeat the steps of drawing a ROI and propagating the ROI if more ROIs for several vessels have to be drawn.

Checking the ROIs on all images



- ► Use the movie function to check the ROIs on the images.

Displaying the results

A graphical chart and the numerical results (in a table) are automatically displayed in the upper viewports.

- ► Click **Results Setup ...**.

  The 'Results Setup' window opens.
- ► Click to select any of the display options as:
  - Select the vessel to display the results for.
  - Define if the results are to be displayed inverted.
  - Select the result type.
  - Select the unit.
- ► Right-click on the image to open a pop-up menu offering the possibilities:
  - Window (settings): No copy, Copy to right, Copy to all
  - Interpolate
  - Filled graphics

- Display analysis graphics
- ► Right-click on the image and select an image type for display.
- ► Scroll through the **numerical results** by means of the vertical scroll bar on the right side.
- ► Right-click on the **graphical chart** and select an item for display:
  - Area
  - Maximum velocity
  - Minimum velocity
  - Mean velocity
  - Peak velocity
  - Nr. of pixels
  - Flux
  - Standard deviation
- ► Click on the graphical chart to navigate through images.

  In the lower viewports the corresponding image will be displayed indicated by a vertical line on the graphs.

Exporting and printing the results

1. Click the **Export results** button from the **More** drop-down menu.
2. Select an **Export** destination.
3. Click **Okay** to confirm.
4. Hardcopies can be performed in the usual way.

NOTICE

The results are exported as CSV (Comma Separated Values) file.

This file type has to be opened via Microsoft Excel in order to present the results.

QFlow Comparing scans

The QFlow package allows to compare QFlow scans within one examination: for example scan X and scan Y.

- ► Analyze scan X with QFlow, as described in chapter “QFlow Analysis” on page 557.
- ⇨ Numerical and graphical results are displayed.
- ► To compare scan X with scan Y, drag scan Y into one of the QFlow view ports.
- ⇨ Numerical and graphical results of scan X are still displayed.
- ► Analyze scan Y with QFlow as described in chapter “QFlow Analysis” on page 557.
- ⇨ When the analysis of scan Y is finished, the results for both QFlow scans are displayed.

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If you don't want to compare the scans X and Y, but only replace X by Y for analysis:

- right-click on scan Y and select QFlow (instead of dragging scan Y into one of the viewports),
- or drag scan Y into both QFlow view ports (instead of dragging scan Y into one of the viewports).

PicturePlus

PicturePlus applies a filter that reduces the visibility of noise and artifacts, thereby enhancing the anatomical structures in the images. It uses an intelligent algorithm of smoothing and edge enhancement, e.g. background noise is smoothed while vessels are sharpened.

Documentation

The following paragraphs give the following information:

- Suitable Scans
- User Interface
- Workflow

For more information about workflows, refer to chapter “PicturePlus Workflow” on page 563.

Suitable Scans

PicturePlus can be used for most image types (incl. modulus, real, flow) and all processed images (MPR, MaxIP, MinIP, subtracted images). New imaging series containing the enhanced images can be easily generated and stored.

Screen layout

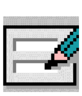
PicturePlus has a default layout of one viewport showing the center slice of the current scan.

Toolbar

Presets drop-down menu

- To display the list of available PicturePlus presets and select one of them for further processing.

Edit Presets



► To open the PicturePlus presets Editor and to edit the presets.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up. It allows to specify which images are to be generated in which manner.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

PicturePlus Presets Editor

Preferred combinations of edge enhancement and smoothing can be saved as PicturePlus presets.

Create and edit a PicturePlus preset

You can edit existing PicturePlus presets or create new presets.

► Click on the ’Presets ...’ to open the Preset Editor.

The Preset Editor opens. The available presets are displayed along with their names, smoothing and edge enhancement settings.

► Click on a preset to make it current

► **To create a new preset**, click on 'Add' (+).

The new preset is a copy of the current preset.

- Enter a new name for this preset.
- Click on the ’Smooth plus’/’minus’ buttons to increase or decrease smoothing.
- Click on the ’Edge plus’/’minus’ buttons to increase or decrease the edge enhancement.
- Click on 'Update' to update the changes in the list of presets.
- Click on 'Save' to save the preset.
- To close the Preset Editor, click on 'Hide'.

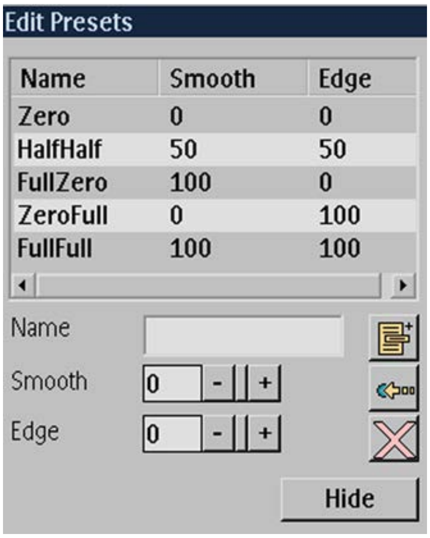
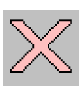


Fig. 279: Preset Editor.

Delete a PicturePlus preset

- ► Open the Preset Editor.
- ► Selet the preset to be deleted.



- ► Click on the 'Delete' button to delete the current preset.

More Functions within PicturePlus

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

- ► Right-click on any image to access the right mouse menus.

Interaction Mode

- can be used to define the left mouse usage for interaction with images.

The table below lists the functions which are specific for this package. For information about the generic functions, see chapter “Generic functions for images” on page 380.

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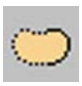
Possible setting	Corresponding icon	Description
Enhance		Drag to adjust the image enhancement.

PicturePlus Workflow

Starting up PicturePlus

1. Right-click on a suitable scan in the Thumbnail View.

   A context menu appears.



2. Click **PicturePlus**.

   PicturePlus opens.

Enhancing Images

It is possible to define the degree of smoothing and edge enhancement:

► **To change edge enhancement**, right-drag horizontally.

Movement to the right increases and movement to the left decreases edge enhancement.

► **To change smoothing**, right-drag vertically.

Downward movement decreases smoothing. Upward movement increases smoothing.

► **To select one of the PicturePlus presets**,

- click in the ’Presets’ field
- select a preset from the drop-down menu and
- click ’Apply’.

Generating a new imaging series

► Click ’Generate series’.

A new imaging series will be generated within the current examination.

Image Algebra

The Image Algebra package can be used to perform pixelwise image calculations, e.g. subtracting one dynamic scan from the consecutive dynamic scans. A preview is available which shows the resulting image for the current scan/scans. New imaging series can be easily generated and stored.

Documentation

The following paragraphs give the following information:

- Available Calculations
- User Interface

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- Workflow

For information about workflows, refer to chapter “Image Algebra Workflow” on page 568.

Available Calculations

The package provides the possibility to perform different calculations for two e.g. (groups of) slices or dynamic scans, being referred to as A and B. It is possible to apply a weighting factor, depending on the type of calculation for A or for B.

Addition of images

- Result = A + B

Subtraction of images

- Result = B - A or
- Result = A - B

Relative subtraction of images

- Result = ((B - A) / (A + B) / 2) * 100
- Result = ((A - B) / (A + B) / 2) * 100

Ratio calculations

- Result = (B / A) * 100
- Result = (A / B) * 100

Cumulation

- Result = Sum of multiple echoes

Magnetic Transfer Coefficient

- Result = ((B - A) / B) * 100
- Result = ((A - B) / A) * 100

ASL subtraction

where ASL stands for Arterial Spin Labeling

- Result = B - A

Requirements for Image Algebra datasets

The components A and B can be images of one scan, but also images of different scans. In order to perform calculations with A and B, they have to have the same slice distance (slice thickness and slice gap), FOV and patient position.

Screen layout

The Image Algebra package has a default layout of four viewports.

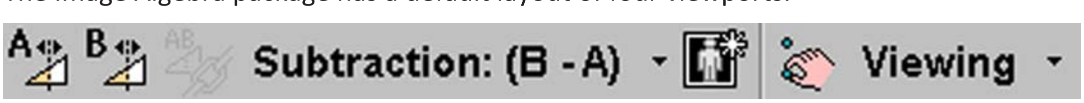

Fig. 280: Image Algebra screen layout

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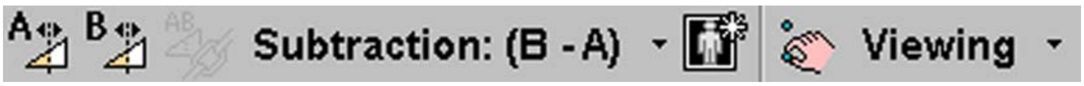
1	Toolbar
2	Sliders for weighting factor and for slice selection
3	Component A
4	Preview, calculated in real-time
5	Component B

Toolbar

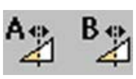


Adjust B0 Threshold

- To adjust the B0 threshold and to enable (default) or disable the display of the threshold mask.

  Setting a threshold mask will exclude background pixels from the functional map calculations. All pixels with values below the mask value will be displayed blue. Only pixels with intensity above the mask value are used for the calculations, colored areas will be excluded from the calculation

In Image Algebra, you can adjust the threshold values for the components A and/or B, and in such a way focus on specific anatomy.



► Click 'Threshold A' or 'Threshold B' to enable the display of the threshold mask.

► Right-drag up- and downwards to adjust the threshold.

Link Threshold for A and B

► To link the thresholds for A and B: adjusting 'Threshold A', 'Threshold B' will automatically be adjusted in the same way.

Select the Operation drop-down menu

► To select the required operation from the drop-down menu, e.g. addition, subtraction, relative subtraction, ratio calculations, cumulation, magnetic transfer coefficient calculation and ASL subtraction.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up. It allows to specify which images are to be generated in which manner.

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Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

Sliders

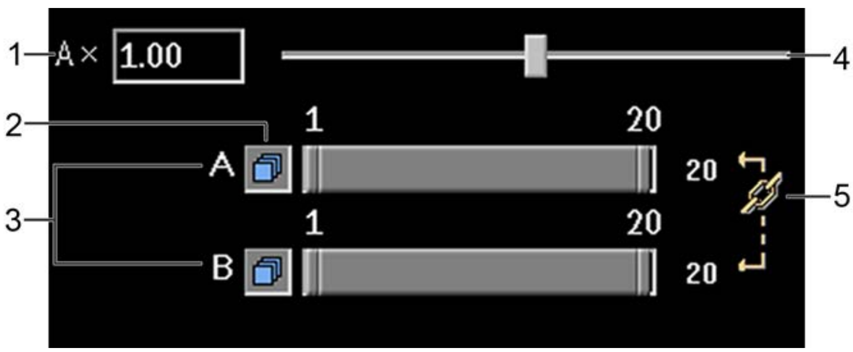

Fig. 281: Image Algebra sliders viewport.

1	Display of weighting factor for A (or possibly for B), in this case: 1.00 You can apply a weighting factor, and in such a way perform calculations with defined percentages of A or B.
2	Selection Icon: Toggle between single selection and range selection ("Switch to single selection" and "Switch to range selection")
3	Sliders for slice selection (depending on setting: either single slice selection or range selection) Note that for a dynamic scan another slider for the dynamic scans is available.
4	Slider for weighting factor for A (range: from 0.0 to 2.0)
5	Display of link symbol if A and B are linked for image selection

More about the Sliders for Slice Selection

You can select either multiple images or a single image as A and/or B.

Single selection for a single image

- ► Click on the selection icon and ’Switch to single selection’.

  A single selection box is displayed on the bar representing the slices.
- ► Drag the box to the position of the required slice.

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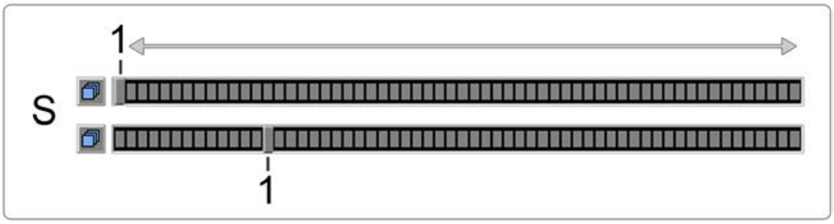


Fig. 282: Sliders: Single selection (S) with the single selection box (1): in the upper example, the first image is selected. In the lower example, the single selection box is dragged to another slice.

Range selection for multiple images

- Click on the selection icon and 'Switch to range selection'
- Drag the anchor points at the outer edges of the range bar to select the range.

  The selected slices will be indicated as slice number on top of the slider.

Fig. 283: Sliders: Range selection (R) with anchor points (1 and 2) at the outer edges of the range bar.

Example: Dynamic scan

With dynamic scans, a slider bar for A and B is available for the dynamic scans and another one for the slices.

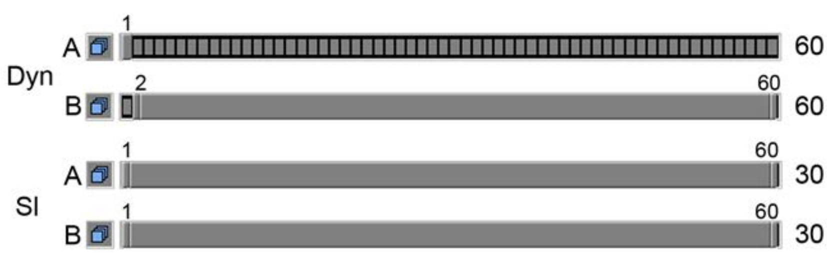


Fig. 284: The figure shows the example of a subtraction (B-A): post-contrast scan minus pre-contrast scan. The components A and B consist of 60 dynamics and 30 slices each. The selected range for A is: dynamic 1, all slices (pre-contrast scan). The selected range for B is: dynamic 2 to 60, all slices. In this case, dynamic 1 will be subtracted from the dynamics 2 to 60 for all slices.

More Functions within ImageAlgebra

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

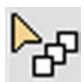
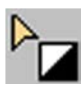
Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

- ► Right-click on any image to access the right mouse menus.

Interaction Mode

- can be used to define the left mouse usage for interaction with images.

Possible setting	Corresponding icon	Description
Scroll (default)		Drag to scroll through the dataset.
Threshold		Drag to adjust the B0 threshold.

Set As Mask (Defining)

Image Algebra Workflow

Starting up Image Algebra

You can perform Image Algebra either on two different scans or on a single dynamic scan. This requires the selection of one or two scans when starting up the package.

1. Select the scan(s):

   A context menu appears.

   - To perform Image Algebra with a single dynamic scan, right-click on this scan in the Thumbnail View.
   - To perform Image Algebra with different scans, press and hold |Shift| and then click in the Thumbnail View to select the two scans.

2. Select **ImageAlgebra**.

   The ImageAlgebra package opens.

Selecting the type of operation

- ► Click on the field **Select the operation** to display the drop-down menu with the available algorithms.

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► Click to select the required algorithm.

Selecting the images for processing (A and B)

► Click on the selection (toggle) icon and **Switch to single selection** or **Switch to range selection**.

► Select the images for A and B by dragging the slider.

Applying a weighting factor

► Define the weighting factor by clicking on the slider and dragging.

The image in the preview is updated in real-time.

Adjusting the threshold values

► Click on either of the threshold buttons.

► Drag up- and downwards to adjust the threshold.

Generating a new imaging series

► Click ’Generate series’.

A new imaging series will be generated within the current examination.

Diffusion Registration package

The Diffusion Registration package is a postprocessing package. It can be used to correct for patient movement which occured during a dynamic brain scan. In such a way, diffusion registration improves image quality in calculated diffusion images.

- Images of successive dynamic series are compared.
- Images are realigned to correct for motion.
- A new series with the corrected images is generated in the patient database.
- The processing step ’Diffusion Registration’ is stored in the current ExamCard and will be performed automatically when the ExamCard is executed again.

It is recommended to execute this package on all brain diffusion data prior to any kind of post-processing.

For information about workflows, refer to chapter “Diffusion Registration Workflow” on page 569.

Diffusion Registration Workflow

1. Right-click on a suitable diffusion dataset in the Thumbnail View.

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A context menu appears.

2. Click ’Diffusion Registration’.

   The diffusion registration is performed as a background process.

   The start of this background process is indicated on screen: ’The registration has been submitted’.
3. From the main menu bar, select 'System' and then 'Manage Job Queues' to check the status of the package.
4. The new imaging series appears automatically in the Thumbnail View when the diffusion registration process is finished.

   The new imaging series can be recognized by the prefix ’Reg’.
5. View the new imaging series with the ’ImageView’ package.
6. Compare the diffusion registered images with the original images in movie mode to get an impression on the effects of the diffusion registration package.

NOTICE

When the diffusion registration package is part of an ExamCard, it will be performed as a background function without notifying the user.

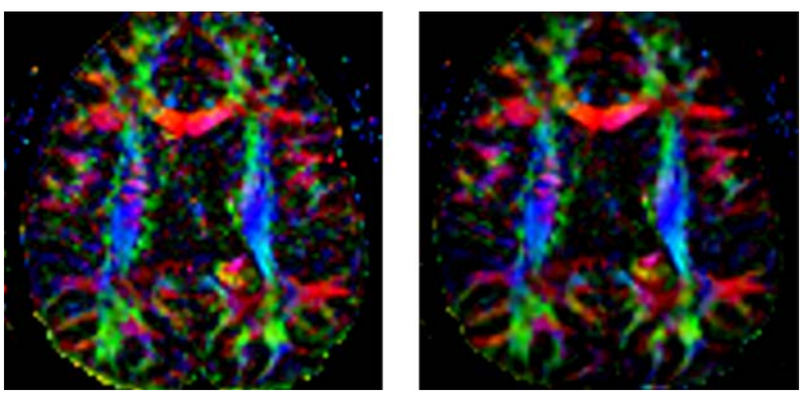

Fig. 285: A diffusion map (FA map) without diffusion registration (left) and with diffusion registration (right).

Diffusion package

The process of diffusion of water molecules through brain tissue can be measured using MRI with diffusion weighted scanning. The actual diffusion properties depend on the local tissue. Furthermore, the water diffusion can be anisotropic: fast diffusion in one direction and slow diffusion in other directions.

For ease of evaluation, the Diffusion package generates various parameteric maps related to diffusion weighted and diffusion tensor imaging. New imaging series can easily be generated and stored.

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WARNING
For ADC measurements the field-of-view (FOV) must be positioned in the isocenter of the magnet to avoid misinterpretations due to incorrect ADC calculations.

Documentation

The following paragraphs give the following information:

- User Interface
- Parametric Maps
- Transfer of DWI iso and ADC images

For information about workflows, refer to chapter "Diffusion Workflow" on page 577.

Screen layout

The Diffusion postprocessing package has a default layout of two large viewports.

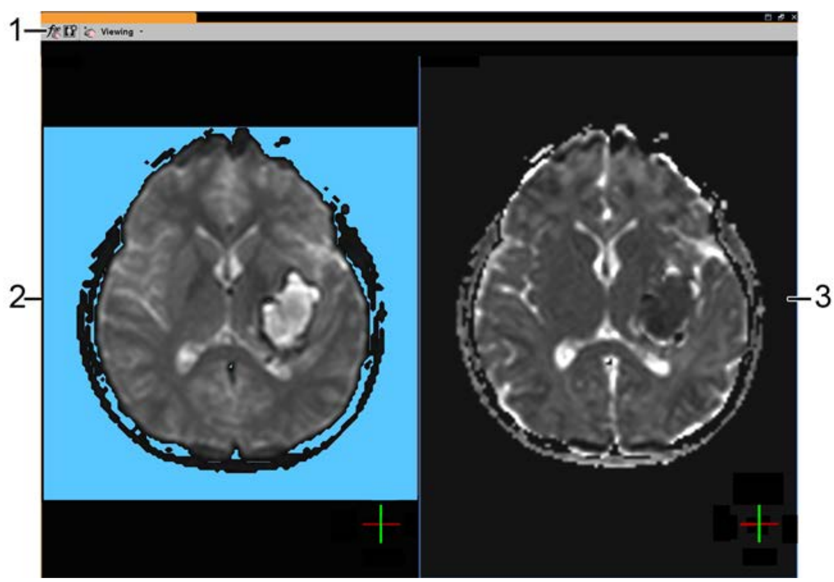

Fig. 286: Screen layout of Diffusion postprocessing package.

1	Toolbar
2	Center b0 slice with threshold mask (blue) overlaid
3	Corresponding map, calculated in real-time

Toolbar

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Select b-values

► To select at least 2 b-values for processing.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up. It allows to specify which images are to be generated in which manner.

Possible maps are:

- DWI iso map, ADC map, eADC map, ADC iso map, eADC iso map, FA (greyscale) map, FA color map and/or cDWI maps.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

More Functions within the Diffusion package

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

Interaction Mode

- can be used to define the left mouse usage for interaction with images.

The table below lists the functions which are specific for this package. For information about the generic functions, see chapter “Generic functions for images” on page 380.

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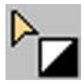
Possible setting	Corresponding icon	Description
B0 Threshold		Drag to adjust the B0 threshold.

Adjust B0 Threshold

- To adjust the B0 threshold and to enable (default) or disable the display of the threshold mask.

  Setting a threshold mask will exclude background pixels from the functional map calculations. All pixels with values below the mask value will be displayed blue. Only pixels with intensity above the mask value are used for the calculations, colored areas will be excluded from the calculation

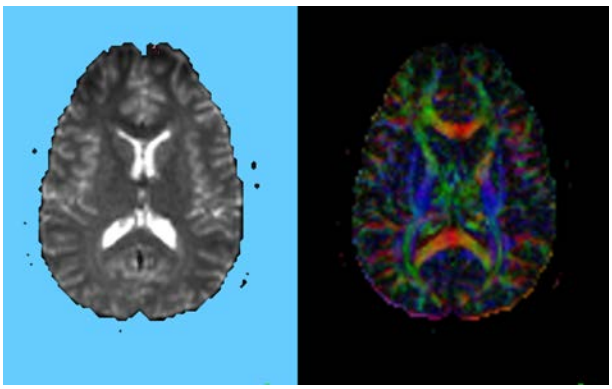


Fig. 287: Left: Adjusting the B0 Threshold. Right: FA color map calculated in real-time.

Parametric Maps

The results will be provided as parametric maps. The type of the map is indicated in the map's scan type field.

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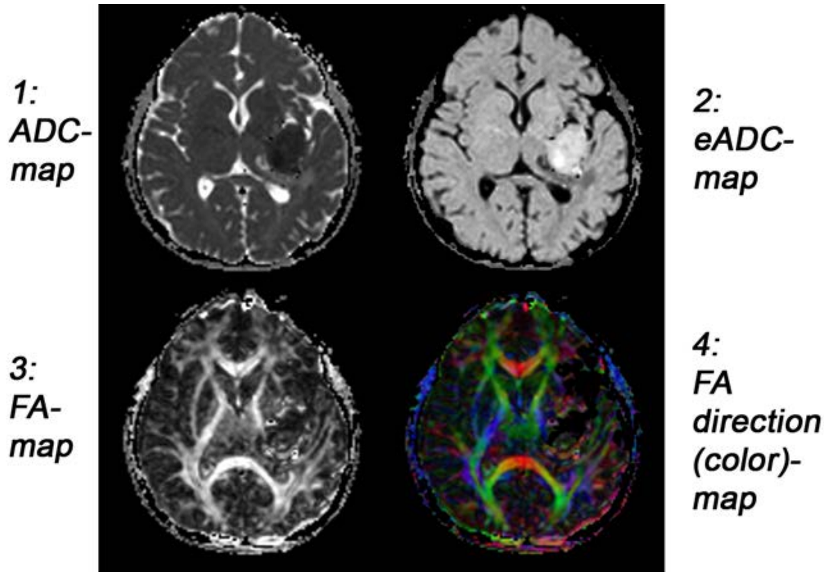

Fig. 288: Example of ADC and eADC map, FA and FA color map.

Scrolling through the maps shows which types of maps are available for the current scan (not all types of maps are suitable for every type of diffusion scan).

If an ADC iso and eADC iso map are available, directional ADC and eADC maps can also be generated (even though they are not available in the preview).

DWI iso

The DWI iso map is calculated by first finding the average ADC from all of the available gradient directions.

This average ADC is then used together with the b=0 image to create the DWI iso map. Since this uses all available directions, the SNR of the DWI iso map is improved especially with DTI scans.

- DWI iso images are identical to the isotropic images if 3 diffusion directions are scanned.
- The DWI iso images show a better image quality when the number of diffusion direction increases. The DWI iso images will have less noise. There is an increase in signal when more than 16 directions are acquired. Higher signal gives a sharper appearance.
- The option to create DWI iso images is not available for diffusion scans that are acquired with gradient overplus as the P_oblique, M_oblique and S_oblique directions are not saved in the database. The DWI iso option is also only available when 2 b values are selected, and when the lowest b value is less than or equal to 100.

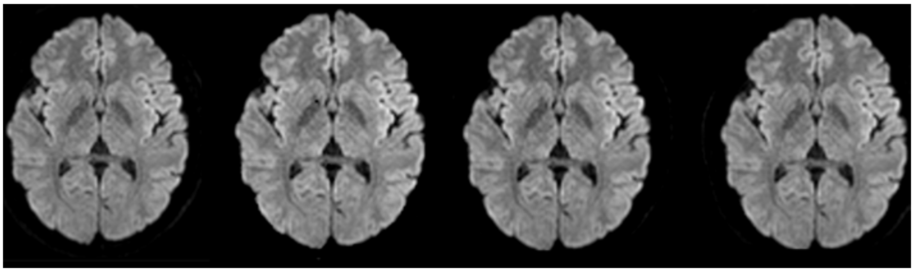

Fig. 289: DWI isotropic images acquired in 6 directions. From left to right: Default DWI iso image without diffusion registration being used. Postprocessed DWI iso map without diffusion registration being used. Default DWI iso image with diffusion registration being used. Postprocessed DWI iso map with diffusion registration being used.

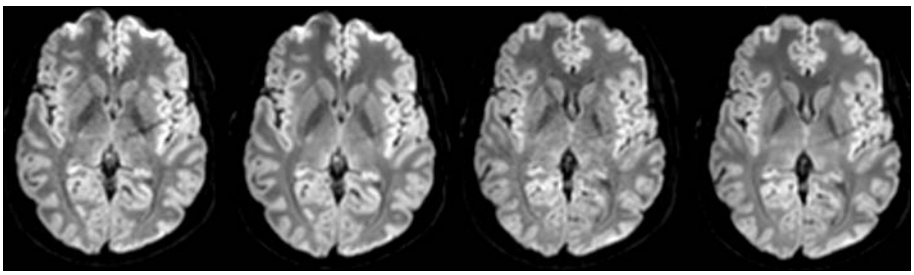

Fig. 290: DWI isotropic images acquired in 32 directions. From left to right: Default DWI iso image without diffusion registration being used. Postprocessed DWI iso map without diffusion registration being used. Default Default DWI iso image with diffusion registration being used. Postprocessed DWI iso map with diffusion registration being used.

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ADC and ADC iso

The Apparent Diffusion Coefficient (ADC) identifies the average diffusion as measured by the diffusion imaging sequence.

The ADC is given in ’mm^2/s’ and can be expected to have an order of magnitude of 0.6 to 1.0 x 10^{-3} mm^2/s for a tissue like white matter.

The ADC can be obtained for each separate diffusion direction (identified as ’ADC’) but also the average or isotropic ADC (ADC iso) can be obtained when enough non-colinear diffusion directions were acquired.

NOTICE

The values given by the map are multiplied by a factor of 1000 for display purposes. Thus, an ADC map ROI mean value of '900' is identical to an ADC of 0.9 x 10^{-3} mm^2/s.

Tissue characteristics	Signal DW images	Signal ADC maps	Signal eADC maps
High ADC (rapid diffusion)	hypointense, more signal attenuation	High signal intensity	Low signal intensity
Low ADC (slow diffusion)	hyperintense, less signal attenuation	Low signal intensity	High signal intensity

Tab. 33: Signal in ADC and eADC maps

ADC maps provide anisotropic information and are available for each diffusion direction: S, M, P.

eADC and eADC iso

The exponential-ADC or eADC is used to show the diffusion weighting effect of a tissue. The eADC is calculated as exp(-b*ADC). In the eADC maps, CSF has very low signal so that subtle periventricular (e)ADC differences are more easily noticed.

FA (Fractional Anisotropy) map

Fractional anisotropy (FA) maps can be calculated from the DTI information. The FA values indicate the degree of anisotropy and range from 0 to 1. In case of no anisotropy (or normal isotropic diffusion, e.g. in grey matter tissue) the FA equals 0. For most white matter regions the FA value is much higher (for example, in the corpus callosum the FA value is around 0.6).

At least six different diffusion directions are needed to uniquely describe the diffusion pattern and to calculate the diffusion tensor matrix per pixel. From this calculation, the fractional anisotropy can be displayed in a FA map. High signal intensity corresponds to high fractional anisotropy and low signal intensity to low anisotropy.

Two different types ofFA map are available: FA greyscale map (also referred to as FA map) and FA color map.

FA (greyscale) map

Directional information is not provided.

FA Color map

The color indicates the most important diffusion direction:

- Blue for FH-direction.
- Red for RL-direction.
- Green for AP-direction.

Computed DWI (cDWI)

cDWI is a mathematical computation technique which calculates high b-value image from DWI MR Images acquired with at least two different lower b-values. cDWI indirectly reduces the total acquisition time by creating synthetic high b-value images based on the input of acquired low-b value images rather than spending time in acquisition.

The synthetic b-value image is generated using the mono-exponential model.

Transfer of Diffusion Parametric Maps

Diffusion data and interoperability

To enable easy transfer of the calculated maps, it is possible to generate separate imaging series of these maps (e.g. DWI iso and ADC) with the Diffusion processing package.

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The generated series can be recognized by a prefix in both the Thumbnail Viewer as well as in the Administration window. These prefixes help in easily selecting the imaging series for transfer to a PACS or other network node.

Type of generated series	Prefix
DWI iso	iso
ADC	d
EADC	e
FA	fa
FA color	fac
cDWI	c

Diffusion Workflow

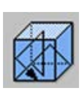
Starting up the Diffusion package

1. Right-click on a suitable diffusion dataset (at least two different b-values) in the Thumbnail View.

   A context menu appears.

NOTICE

Use a registered dataset if available.



2. Click **Diffusion**.

   The Diffusion package opens, and the center slice with a corresponding map is shown.

Navigating through images

Through slices (or resulting) maps

- In the image (or map) viewport, drag to the left or to the right.
- Alternatively use the left and right arrow keys.

Adjusting the B0 Threshold

By default, the 'Adjust Threshold' function is automatically enabled: the threshold mask is laid over the original image.

Setting a threshold mask will exclude background pixels from the functional map calculations.

1. Right-drag up- and downwards to adjust the threshold.

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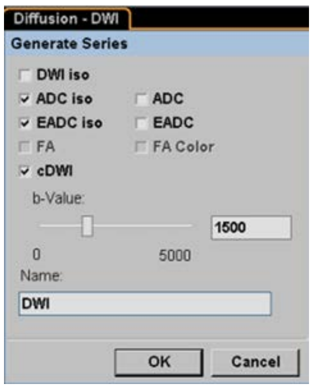
Selecting b-values

1. Click **Select b-values**.
2. Select at least two b-values which are to be processed.
3. Click **Okay** to confirm the selection.

Generating a new imaging series

1. Click **Generate series**.
2. Select the map type to be calculated:



- **DWI iso** (Diffusion Weighted Imaging) map
- **ADC iso** (Apparent Diffusion Coefficient isotropic) map -
- **ADC** (Apparent Diffusion Coefficient) map
- **eADC iso** (Exponential Apparent Diffusion Coefficient isotropic) map -
- **eADC** (Exponential Apparent Diffusion Coefficient) map -
- **FA** (Fractional Anisotropy gray scale) map
- **FA color** (Fractional Anisotropy color) map
- **cDWI** (Computed DWI), see chapter “Diffusion imaging” on page 701.

3. Only when you selected cDWI:

   To select the required synthetic b-value for computation, drag the b-value slider. Alternatively enter b values numerically in the text box.
4. Define a unique name for the new series in the entry field.
5. Click **Okay** to confirm and to start the calculation.

   The new imaging series can be recognized by a prefix, see chapter “Transfer of Diffusion Parametric Maps” on page 576.

FiberTrak package

The FiberTrak (FT) package enables visualization of the diffusion tensor data in the form of white matter tracts. In order to achieve FiberTrak results an algorithm is applied using specific settings. These fibertract settings include signal-threshold, FA values and curvature of the fiber-tract.

WARNING

When fibertract settings are changed to low values (meaning no signal threshold, very low FA, and very high curvature acceptance) the white matter tracts may include erroneous results.

This may consequently lead to misdiagnoses.
It is advised to use default settings whenever possible.

WARNING

With FiberTrak the resulting fibers depend strongly on the parameter settings in the package.

Low SNR in the DTI dataset can influence the results, leading to structures without anatomical relevance.

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Documentation

The following paragraphs describe:

- Requirements for a FT dataset
- User Interface of the FiberTrak package

For more information about workflows, refer to chapter “Fiber Tracking Workflow” on page 594 and to chapter “FiberTrak: Advanced Workflows ” on page 596.

Requirements for a FT dataset

Diffusion tensor data with a minimum of 6 diffusion directions is used to calculate the preferred diffusion direction. This diffusion direction indicates the orientation of the local fibertracts. The FiberTrak package uses all this information to delineate the various fibertract bundles.

In order to provide good Fiber Tracking results, a certain minimum quality of data is needed. ExamCards and preset procedures may be used to generate such data.

Diffusion Tensor Imaging (DTI) scan

At least 6 diffusion directions are needed. This corresponds to the setting ’low’ of the imaging parameter ’DTI directional resolution’.

However, it is better to use the setting ’medium’ which includes 15 diffusion directions. This provides a better rotationally invariant accuracy of fiber directions.

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Typical scan characteristics

- Medium DTI (15 directions)
- Single-shot SE-EPI scan
- SENSE factor in the range of 1.5 to 3.0
- Isotropic data if possible

NOTICE

DTI data can be processed by means of the Fiber Trak package when being acquired with releases from Release 10 onwards.

Anatomical reference scan

In order to visualize the obtained tracts with respect to the anatomical and pathological features, any scan may be used as an anatomical reference. However, it is advised to use scans with a high through-plane resolution. For example, T1w 3D/TFE protocols can be used as they show a clear delineation of white and grey matter.

User Interface

Screen Layout

The FiberTrak package has a default layout of one large viewport and three small viewports.

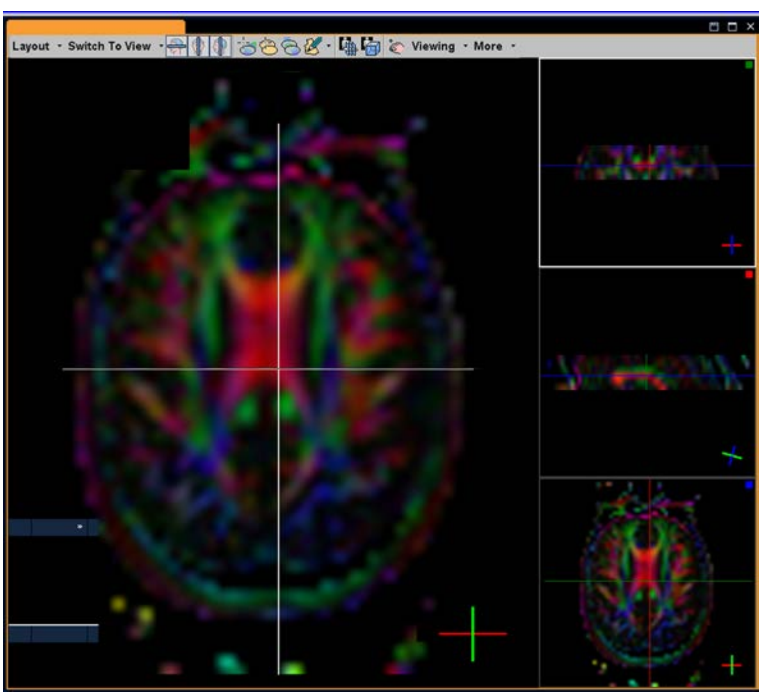


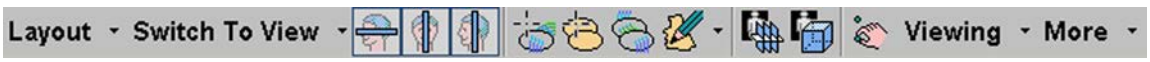
Fig. 291: FiberTrak package layout with the 3D view on the left and the orthogonal views on the right hand side.

The large viewport contains the 3D view which is meant to display the dataset and the obtained fibers in a 3D manner. Rotating, panning and zooming this 3D view allows viewing of white matter tracts from all angles.

The orthogonal views serve as reference views (from top to bottom: coronal, sagittal, transverse view). Each of the views is overlaid by colored lines indicating the position of the shown slices. The slices in the 3D view are linked to the slices in the orthogonal views.

The image type being displayed in the 3D or the orthogonal viewports can be chosen freely, either FA, B0, Anatomical, ADC iso, eADC iso or DWIiso map. For more information, see chapter “Colors: Fibers and ROIs” on page 592.

Toolbar



Layout

- offers options:
  - to show or hide statistics (see chapter “Statistics: Fibers, ROIs and current voxel” on page 593)
  - to show or hide orthogonal views
  - to reset the layout to the default FiberTrak package layout.

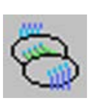
Switch To View

- defines the orientation in which the large viewport (3D view) is viewed: either transverse, sagittal or coronal.

View Slices: Show Transverse, Show Sagittal, Show Coronal

- allows the display of a transverse, sagittal or coronal slice in the 3D view or display of the corresponding reference line in the non-rotated 3D view.

Track Single ROI Fibers



- Can be used to define a single ROI. Fibers will automatically be tracked for each single ROI. For more information, refer to chapter “Fiber Tracking Workflow” on page 594.

Define multiple ROIs

- Can be used to define multiple ROIs consecutively. To start the fiber calculation, select ’Track Multiple ROI Fibers’.

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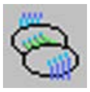
Track Multiple ROI Fibers

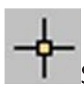


- Can be used to track multiple fibers if multiple ROIs have been drawn. Only those fibers will be tracked which originate from all of the ROIs. For more information, refer to chapter “Fiber Tracking Workflow” on page 594.

Select ROI Type

- To select a ROI type.

► Click on the down arrow besides the icon to display the possible options.

- Freehand ROI(default)
- Seeded-2D ROI
- Seeded-3D ROI
- Single-Point ROI

2D Cross-section Tract Series

- Can be used to generate 2D cross-section tract series of the FiberTrak dataset. For more information, refer to chapter “Output Series” on page 596.

3D Projection Tract Series

- Can be used to generate 3D projection tract series of the FiberTrak dataset. For more information, refer to chapter “Output Series” on page 596.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

The Settings icon serves to define the initial colors for ROIs, fibers and the default image type for the 3D view and the orthogonal view. See chapter “Colors: Fibers and ROIs” on page 592 for more information.

Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

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More

- ► Click the arrow besides 'More'.
- ⇨ The 'More' menu opens.
- ► Click on any menu option to select it.

Algorithm Settings

- enables determination of the algorithm for fiber calculation and the definition of Seeded-2D and -3D ROIs.
- is also available via the right mouse menu of the Fiber and ROI legend. See chapter “Algorithms: Fibers and Seeded ROIs” on page 591 for more information.

Save Statistics

- saves the ’statistics’ concerning ROIs, fibers and the current voxel in the directory ’E:/Export’. The file name includes patient and scan name. It is a tabulated file with the extension ’.tsv’ which can be opened by packages like Microsoft Excel. For more information, see chapter “Statistics: Fibers, ROIs and current voxel” on page 593.

Fiber Legend

The fiber legend shows the list of fibers for the current dataset. The list of fibers contains the name of the fiber set (e.g. fiber01) and the color that is assigned to it.

The checkmark indicates that the fiber is displayed.

Fiber display features

The legend can be used to modify many of the fiber display features. right-click on the name of a fiber in the Fiber Legend to

- select all or no fibers,
- show or hide the current fiber,
- rename or delete the current fiber,
- change the color of the current fiber,
- modify the algorithm settings with respect to fibers, 2D and 3D seeded ROIs. See section chapter “Algorithms: Fibers and Seeded ROIs” on page 591 for more information.

Fiber Statistics

The legend can be extended to display statistical information on fibers, ROIs and the current voxel.

- ► Click on the arrows icon to open the Fiber Statistics window. Clicking on the mirrored arrow symbol closes the statistics window again. See chapter “Statistics: Fibers, ROIs and current voxel” on page 593 for more information.

ROI Legend

The ROI legend shows the list of ROIs for the current dataset with ROI names (ROI01, ROI02 etc.) and the color that is assigned to the ROI. The checkmark indicates that the ROI is displayed. Note that only displayed ROIs will be taken into account in the multiple ROI FiberTrak calculation.

ROI display features

The legend can be used to modify many of the ROI display features. right-click on the name of a ROI in the ROI Legend to

- select all or no ROIs,
- show or hide the current ROI,
- rename or delete the current ROI,
- merge multiple ROIs into a single ROI,
- change the color of the current ROI,
- change the type of ROI into either ’include’ (default) or ’exclude’. The latter means that this ROI will be used to exclude tracts in the fibertract algorithm.

See chapter “ROIs” on page 587 for more information on ROIs.

See chapter “Algorithms: Fibers and Seeded ROIs” on page 591 for more information on algorithms.

Navigation

In this section, various navigation possibilities are described. The 3D view or the orthogonal views can be used for navigation.

Zooming, panning and windowing are performed as usual.

Scroll through the dataset

- ► Right-click on an image.

- ► Select ’Scroll’.
  This is the default setting.
- ► Drag in the 3D view to scroll through the slices.

  OR:

► Drag the colored lines (blue: FH-, green: AP- and red: RL-image position) on the orthogonal views to any desired location. The image in the 3D view will be updated to the current location.

Rotate the dataset

► Right-drag on the 3D view to rotate in any direction.

By default, all of the orthogonal planes will be displayed in the 3D view. The intersection of the shown slices is accentuated by a white line. Note that the display of the orthogonal planes can be enabled or disabled.

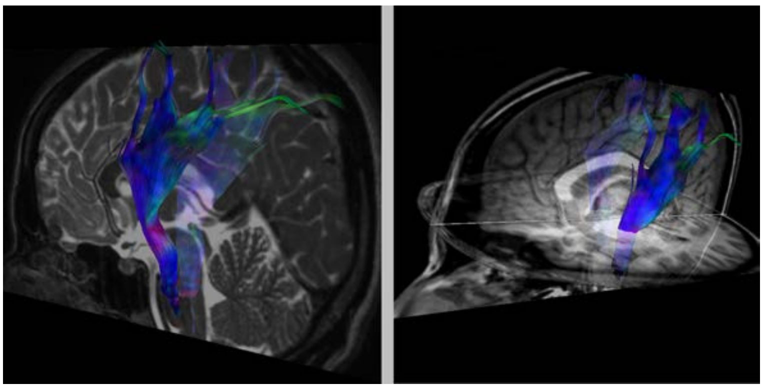


Fig. 292: Rotated 3D views without and with transverse plane being displayed.

View Slices: Show Transverse, Show Sagittal, Show Coronal

- allows the display of a transverse, sagittal or coronal slice in the 3D view or display of the corresponding reference line in the non-rotated 3D view.

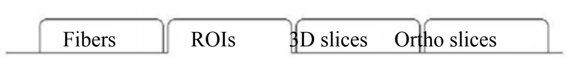
Switch to an orthogonal view

- Select ’Switch To View’ from the FiberTrak toolbar: either transverse, sagittal or coronal. The image in the 3D view will be replaced by either an orthogonal (non-angulated) transverse, sagittal or coronal view.

Modify display for 3D view and Orthogonal views

The image display in the 3D viewport and the orthogonal viewports can be chosen. FA coloring of the selected image type can be enabled or disabled to overlay FA colors to the current image.

► Click on the ’Settings’ icon from the FiberTrak toolbar.



► Select ’3D Slices’ or ’Ortho Slices’.

► Select either

- FA
- B0

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- Anatomical
- ADC iso
- eADC iso
- DWI iso

► Select or deselect ’FA coloring’ to switch FA coloring ON or OFF.

View cross-sections or projections

Within the orthogonal views, there are two ways to view the obtained fibertracts. Default is that the complete tract is projected on top of the selected slice: even when the tract is actually "behind" the viewed slice. The second option is called "cross section". With this view only the intersection between the tracts and the current slice in the orthogonal view is displayed.

► Right-click on any of the orthogonal viewports.

► Select 'View Fibers' and then either ’Projection’ or ’Cross-Section’.

NOTICE

When reformatted output is generated with the ’2D-Cross section Tract series’ tool the "cross section" view is chosen, indepedent of the setting in the orthogonal view.

Adjust Opacity

- The opacity parameter allows to make the slices translucent to different extents in order to facilitate viewing of the fibers.

  Right-click on the view, select 'Opacity' and then drag up and downwards to adjust the opacity.

More Functions within FiberTrak

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

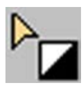
They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

Interaction Mode

- can be used to define the left mouse usage for interaction with images.

The table below lists the functions which are specific for this package. For information about the generic functions, see chapter “Generic functions for images” on page 380.

Possible setting	Corresponding icon	Description
Track Single ROI Fibers		The left mouse can be used to define a single ROI. Fibers will automatically be tracked for each single ROI.
Define Multiple ROIs		The left mouse can be used to define multiple ROIs consecutively. To start the fiber calculation, select ’Track Multiple ROI Fibers’.
Opacity		Drag to adjust the opacity. See section ’Navigation’ for more information.
Threshold		Drag to adjust the b0 threshold. See section ’Algorithms: Fibers and Seeded ROIs’ for more information.

Fiber Colors

- changes the colors of the displayed fibers.
- is also available via the Fibers and ROI Legend. See chapter “Colors: Fibers and ROIs” on page 592 for more information.

ROI Colors

- can be used to change ROI colors
- is also available via the Fibers and ROI Legend.

ROIs

Fibers can be calculated from either a single ROI or multiple ROIs.

This section describes the

- available ROI Types
- available ROI Operations.

ROI Types

Different ROI types are available for optimum results.

Freehand ROI

The freehand ROI enables the drawing of an irregular ROI within a given slice.

In case of multiple ROI fibertracking, it is advised to draw the ROI slightly larger than the given bundle. It is important to ensure that the whole bundle is included.

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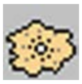


Seeded-2D ROI

The seeded-2D ROI can be used to identify regions with a single mouse click. These ROI's will be perpendicular to the tract at the place of the mouse click and are thus not in-plane but optimized to best delineate the local tract.

The plane of a 2D-seeded ROI's is made to be perpendicular to the local preferred diffusion direction. As an example, in the mid-sagittal plane the cortical spinal tract will show up with a blue FA color (feet-head direction). If - with a single mouse click - a 2D seeded ROI is drawn in this tract the final ROI will be transverse, and thus will not fall within the sagittal plane. In this manner the optimal ROI is generated to identify the tract.

The size of the seeded-2D ROI depends on the settings of the ROI algorithm. See chapter “Algorithms: Fibers and Seeded ROIs” on page 591 for more information on this algorithm and on how to change the settings.

Example for Middle Cerebellar Peduncle (MCP)

An example of using multiple seeded-2D ROIs is given below for the middle cerebellar peduncle (MCP).

- Set the interaction mode to ’Multiple ROI’ and the ROI type to ’Seeded 2D’.
- Create two seeded-2D ROIs, each by a single mouse click on the green areas with the white arrows.
- Perform fiber tracking by clicking on the ’Track Multiple ROI Fibers’ icon.

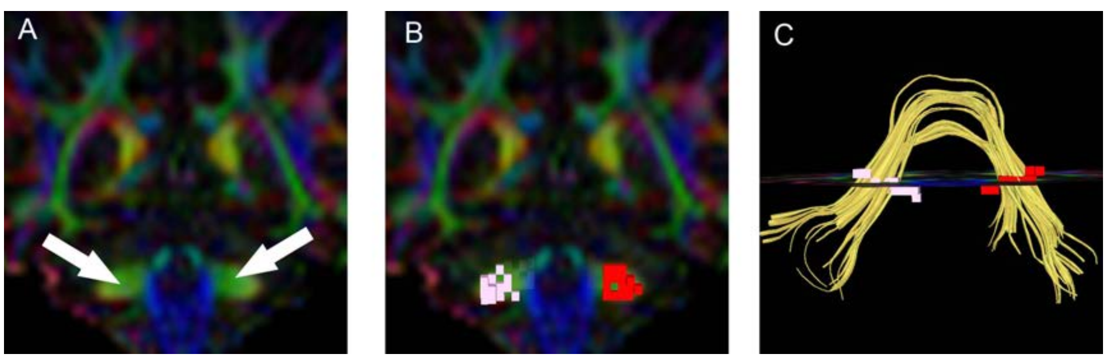
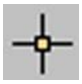


Fig. 293: MCP Example

A	A coronal view is given at the height of the MCP. The two white arrows indicate the crossing of the MCP in this plane
B	Two seeded-2D ROIs have been created in both (green) areas of the MCP.
C	The final result is shown in a transverse view. Note that the ROI's do not fall within the coronal plane, but are perpendicular to the MCP.

Seeded-3D ROI

The seeded-3D ROI uses the seeding algorithm to create a 3D region of interest. These regions are thus larger. This ROI type is best used in combination with single-ROI Fibertracking to identify a large number of starting points.



Single Point

The single-point algorithm can be used to identify "single" tracts. In combination with the "Track Single ROI Fibers" interaction mode it can be used to identify tracts in a fast manner:

- Keep the left mouse button pressed while dragging the mouse over the data in the 3D viewport.

  The tracts, originating from the current pixel, will be shown and updated in real-time.

ROI Operations

Most fiber bundles can be defined using 2 or 3 correctly placed ROI's. Within the FiberTrak package only the ROI's which are visible are used in the generation of fiber bundles. Special possibilities exist to manipulate ROI's to improve the obtained fibertracts.

Select the best suited ROI type

- Click on the ROI icon or select ’ROI settings’ from the FiberTrak menu.
- Select either of the ROI types.

Hide, rename or delete a ROI

- Right-click on a ROI or on a ROI name in the ROI legend.
- Either select ’hide’, ’rename’ or ’delete’ (or press |Delete| key). In case of renaming, a new name needs to be entered.

Change the ROI color

- Right-click on a ROI or on a ROI name in the ROI legend.
- Select ’Change Color’. The ’Color Settings’ window will open.
- Select either ’Fixed’ or ’Directional’ where
  - Fixed stands for a fixed color to be used, e.g. red only
  - Directional stands for the standard color codes being used within diffusion weighted imaging: Blue for FH-direction, Red for RL-direction, Green for AP-direction.
- Select any color.
- Click ’Okay’ to apply the changes. Clicking ’Cancel’ leaves the window without any changes.

Change the ROI ’Include/Exclude’ type

In some cases the obtained fibertracts may have too many extensions. For example, they include many more white matter tracts than of interest in a certain pathology. In this case it is useful to define a ROI to exclude certain tracts.

- Right-click on a ROI or on a ROI name in the ROI legend.
- Select ’Type’.
- Select either ’Include’ or ’Exclude’.
  - Include: the ROI will be used as a criterion. The resulting fiber must pass through the given ROI.
  - Exclude: the resulting fibers must not pass through that ROI.

Example

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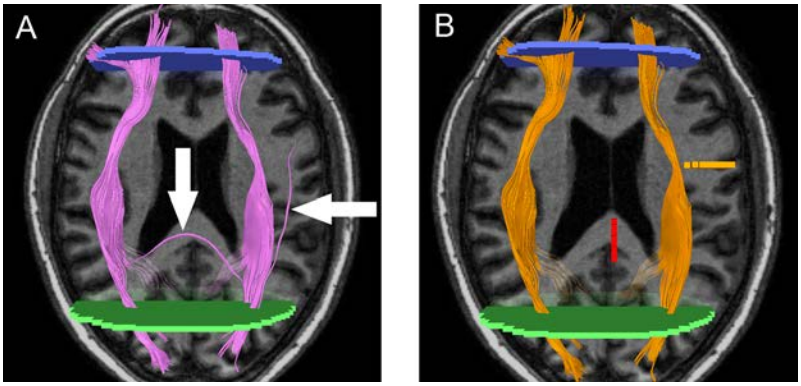

Fig. 294: Example of an Exclude ROI. A: The left and right inferior fronto-occipital (IFO) tracts are generated using two large ROIs. This IFO result (in purple) does also show two spurious tracts (see arrows). B: In order to remove these tracts, two ROIs were created and set to 'exclude' (orange and red ROI). With the total setup of four ROIs, the IFO will be generated as shown in orange.

Merge ROIs

It is also possible to turn separately drawn ROIs into one single ROI with the 'Merge' function. Such a merged ROI is then considered as a single ROI by the FiberTrak package.

- Select multiple ROIs by clicking on their names in the ROI legend with |Ctrl| being pressed.
- Right-click on either of the selected ROIs.
- Select 'Merge' and the current ROIs will turn into a single ROI.

  The colors of the individual ROIs will now be identical while the multiple entries in the legend will be reduced to a single entry.

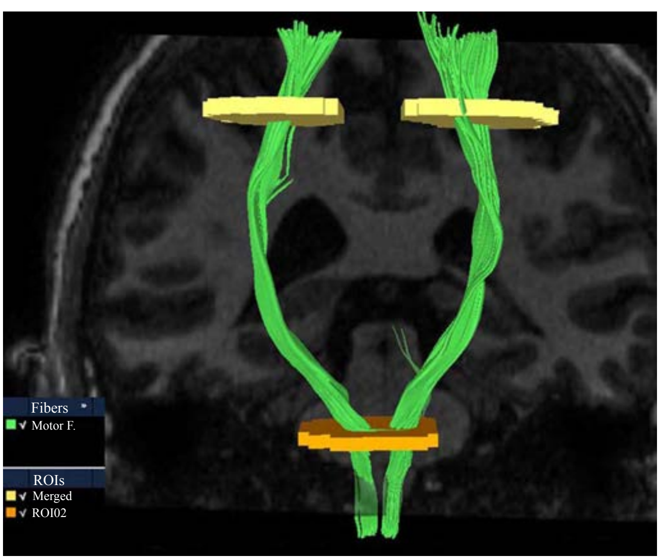

Fig. 295: Example: Two ROIs were defined to identify one tract that includes both, the left and the right corticospinal tract. The upper ROI (yellow) consists of two individual manually drawn ROI's which were merged so that the left and right motor tracts are defined as one.

Modify ROI colors

The ROI colors can be modified using the ROI right mouse menu.

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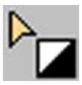
Algorithms: Fibers and Seeded ROIs

This section describes the algorithms for fiber calculation and Seeded ROI definition together with the involved parameters. The results of the white matter tracts will depend on the applied algorithm settings. Also the setting of the (B0) threshold has an effect.

Adjust Threshold



The B0-threshold identifies which pixels will be used in the fibertracking process. If the value of that pixel in the non-diffusion-weighted image (or the b=0 image) is lower than the threshold value it is excluded from processing. Tracts may thus end at this position. Note that the b=0 image can be viewed via the ’Settings’ button (selecting ’B0’ image).

Fibers

Starting points

There are two processes to define white matter tracts: a single ROI approach and a multi-ROI algorithm. The main difference between the two approaches relates to the starting points from which fibers are displayed.

In case of a single ROI

Only the pixels within this single ROI will be used as starting points to find fiber bundles. Tracts will be displayed immediately and the ROI will not be saved or displayed.

With multiple ROIs

The ROIs are the criteria for newly created bundles. Only fiber tracts that pass through all defined and visible ROIs will be shown. Note that hidden ROIs will not be considered. In order to find all the bundles two sets of starting points are used: all pixels within the ROIs and pixels within and around obtained fibers.

End / Stop fibertracts

Each fibertract will be extended until one of the following criteria is no longer met.

Minimum FA

- As soon as the FA is smaller than the threshold value the tract will no longer be continued.

Maximum Angle Change

- When the tract has a too high curvature the tract will no longer be continued.

Minimum length

- Fibers shorter than this minimum length will be discarded.

NOTICE

For existing tracts, the settings can be changed by using the Fiber Legend right mouse menu ’Fiber Algorithm’ and modify the settings for each specific tract.

Optimum Settings for FiberTrak algorithm

It is difficult to define the best settings for the fibertracking. They depend on the actual quality of the data, the curvature of the expected tracts, and many other qualities of the underlying data. For testing, one could change the chosen algorithm settings for a given tract by pressing the right-mouse-button on the fiber and change settings in the given window. Lowering the FA and enlarging the Angle options will yield more fibers. This should only be done as long as the resulting tracts are shown as a coherent fiberbundle. Erroneous fibers will be shown when these values are too low.

Seeded-2D and Seeded-3D ROI

The size of seeded ROIs also depends on the parameters

- Minimum FA
- Max. Angle Change [%]

NOTICE

For new tracts or new seeded ROIs, these settings can be changed via ’Algorithm Settings’ from the FiberTrak menu.

NOTICE

For new seeded ROIs, the size of the ROIs depends on the parameters Minimum FA and Maximum Angle Change. These settings can be changed via the ’Settings’ icon from the FiberTrak toolbar.

Colors: Fibers and ROIs

It is possible to change the colors of new or existing ROIs and fibers.

Define initial colors

The initial values will be used for every FiberTrak session.

- Click on the ’Settings’ icon of the FiberTrak toolbar.

Change colors for current FT session

- Select ’ROI Colors’ or ’Fiber Colors’ either/or
  - from the right mouse menu of the Fiber legend or the ROI legend.
  - from the FiberTrak menu (item belonging to ’ROI settings’).

See section ’Change the ROI color’ for more information.

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Statistics: Fibers, ROIs and current voxel

Statistical information concerning fibers, ROIs and the current voxel is provided in the Fiber Statistics window.

This window can be accessed in two different ways:

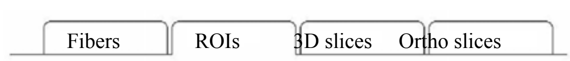
- ► Click on the arrows symbol within the fiber legend.

  Clicking on the mirrored arrow symbol closes the statistics window again.

  OR:

- ► Select ’Layout’ / ’Show Statistics’ from the FiberTrak menu.

To display Fiber and ROI Statistics



- ► Click on either of the tabs.

  The current voxel statistics show the values of ADC, FA etc. for the voxel at the pointer’s position.

Results

The following results per fiber, ROI (each identified by name) or voxel are shown. Note that for various statistics the result is given as the average plus or minus its standard deviation.

FA value

- Average FA value for current fiber, ROI or voxel.

ADC value

- Average ADC value [10^{-3} mm^2/s]for current fiber, ROI or voxel.

Voxels

- Number of voxels included in current ROI or fiber where the voxel size is equal to the original reconstructed DTI dataset.

Lines

- Number of lines included in current fiber.

Length [mm]

- Length of current fiber.

Coordinates [mm] (LPH)

- Coordinates of current voxel with respect to the patient frame where L stands for Left, P for Posterior and H for Head. The LPH frame has the three axis in the Left-Right, Posterior-Anterior and Head-Feet direction respectively.

Eigenvalues: primary, secondary, tertiary

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- The Eigenvalues [10^{-3} mm^2/s] are the apparent diffusion coefficients along the preferred diffusion direction (primary) and two slower diffusion directions (secondary and tertiary). The direction of these three principle diffusion directions (PDD) are given with respect to the LPH patient frame. The LPH frame has the three axis in the Left-Right, Posterior-Anterior and Head-Feet direction respectively.

Save Statistics

The statistics can be saved in a file for further processing. This can be done via ’Save Statistics’ which is available

- in the FiberTrak menu.
- in the right mouse menu in the Fiber legend if the Fiber Statistics window is open.

This function saves the ’statistics’ concerning ROIs, fibers and the current voxel in the directory ’E:/Export’. The file name includes patient and scan name. It is a tabulated file with the extension ’.tsv’ which can be opened by packages such as Microsoft Excel.

Fiber Tracking Workflow

Start up FiberTrak

1. Right-click on any DTI dataset in the Thumbnail View.
   A context menu appears.

2. Click 'FiberTrak’.
   The FiberTrak package opens.

Load anatomical data

1. Drag the required anatomical dataset into the package from the Thumbnail View.

Navigate through the data

There are various ways to navigate through the data. It is important to identify the structures of interest prior to tracking fibers and to display them in the 3D view in such a way that ROIs can easily be drawn. The most important navigation tools are:

Scroll through the dataset

- ► Right-click on an image.

- ► Select ’Scroll’.
  This is the default setting.
- ► Drag in the 3D view to scroll through the slices.
  OR:

► Drag the colored lines (blue: FH-, green: AP- and red: RL-image position) on the orthogonal views to any desired location. The image in the 3D view will be updated to the current location.

Rotate the dataset

► Right-drag on the 3D view to rotate in any direction.

See chapter “Tips for Fiber Tracking” on page 598 for an example concerning the IFO.

Track fibers

Either single ROI or multiple ROI Fiber Tracking can be performed. Single ROI Fiber Tracking is fast in delineating fibertracts, but may be less accurate. Multiple ROI Fiber Tracking is the method of choice for a more accurate determination of the complete fibertract bundle.

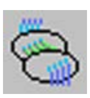
For more information, see chapter “Algorithms: Fibers and Seeded ROIs” on page 591.

1. Click ’Track Single ROI Fibers’ on the toolbar.
2. Draw a freehand ROI (default ROI type) manually. The fibers originating from this ROI will be shown immediately.

   This can be done repeatedly.

   OR

3. Click ’Define multiple ROIs’ on the toolbar.
4. Draw multiple freehand ROIs (default ROI type) manually which should all include the requested fiber.



5. Click ’Track Multiple ROI Fibers’ (toolbar or via right-click on image) when all ROI’s are drawn. Tracts will be generated if they comply to the criterion that they pass through all ROIs.

Generate result series

▷ On the FiberTrak toolbar,

1. select either/or
   -  ’2D Cross-section Tract Series’
   -  ’3D Projection Tract Series’ .
2. Specify the series:
   - In case of 2D Cross-section Tract Series: select orientation, slice range and the number of frames.
   - In case of 3D Projection Tract Series: define the number of frames and store viewpoints.

     See section ’Output Series’ for more information.
3. Click ’Generate’ to start the calculation.

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The resulting color images can be sent to PACS or general archive.

View FiberTrak results in movie mode

▷ In ImageView,

1. Click the ’Movie’ icon to view the generated FiberTrak series in movie mode.
2. Right-click when the movie is running to export such movies to a user defined network drive or USB device.

FiberTrak: Advanced Workflows

This section provides more information about the FiberTrak package in order to achieve best results and to optimally handle the package:

- ROIs
- Algorithms: Fibers and Seeded ROIs
- Colors: Fibers and ROIs
- Statistics: Fibers, ROIs and current voxel
- Output Series
- Tips for Fiber Tracking

Output Series

The FiberTrak package can generate output series of the FiberTrak dataset. It is possible to render 2D cross-section or 3D projection tract series.

2D Cross-section Tract Series

The ’2D Cross-Section Tract Series’ will show slices of the dataset where the intersection of fibers is shown. Note that the coloring of the orthogonal view is used for the slices.

3D Projection Tract Series

In some cases, a 3D rotating, zooming and moving view of the resulting tracts is needed to view the interaction of tracts and pathology. The ’3D Projection Tract Series’ are made by defining a script consisting of multiple viewpoints. The series is generated from smooth transitions between these viewpoints.

Creating and viewing of 2D Cross-section Tract Series

1. Click ’2D Cross-section Tract Series’ on the FiberTrak toolbar.

   The window to define 2D Cross-section tract series will open.

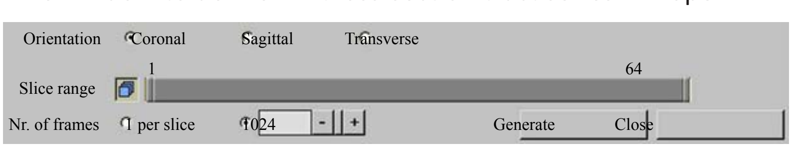


Fig. 296: Window to define 2D Cross-section tract series.

2. Define the orientation of the resulting series by selecting / deselecting either: coronal, sagittal or transverse.
3. Define the slices to be included in the calculation of the tract series:
   - Click on the selection icon to toggle between ’range selection’ (where multiple images can be chosen) and ’single selection’ (where only one slice can be chosen).
   - Select the slice or the slice range by clicking on the slider besides the icon and by dragging. The selected slice(s) will be indicated as slice number on top of the slider and as red lines or red box on the orthogonal views.

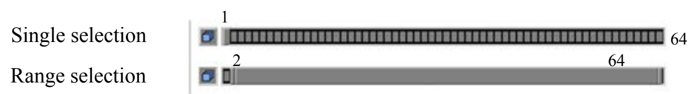


Fig. 297: Example: The upper row shows a single selection of slice 1. The lower row shows a range selection of slices 2 to 64.

4. Define the number of frames
   - either by selecting ’1 per slice’ where one frame will be calculated per slice.
   - or by setting a number of frames where interpolation will occur between slices in order to reach the required number of frames.
5. Click |Generate| to generate the output series.

   Clicking |Close| closes the window without generating output series.
6. Define the image resolution (128, 256, 512 or 1024) of the 2D tract series and enter a series name.
7. Click |OK| to confirm.

   The output series will be generated.

Creating and viewing of 3D Projection Tract Series

3D Projection Tract Series are created by defining multiple viewpoints to a script (list of stored viewpoints). These viewpoints can also be deleted or updated within the script.

1. Click ’3D Projection Tract Series’ on the FiberTrak toolbar.

   The window to define 3D Projection tract series will open.
2. Navigate through the FiberTrak dataset to display the data at the first desired viewpoint.

   Note that all elements of navigation can be used to define each view in the script. E.g. transparancy can be differently between views so that it appears that a slice is slowly disappearing.

3. Click on the ’Add’ icon to add this viewpoint to the script. This view will be saved as ’view0 (start)’.
4. Navigate through the FiberTrak dataset to display the data at the next desired viewpoint.
5. Define the number of frames between the previous and the current viewpoint, e.g. 20.
6. Repeat the steps 3 to 5 as often as required.
7. Click |Preview| to check if the viewpoints have been chosen correctly.

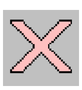
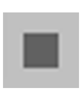
If necessary,

8. Select a viewpoint by simply clicking on it. Navigate to a different view and click |Update| to change this viewpoint.
9. Click |Generate| to generate the output series. Clicking |Close| closes the window without generating output series.
10. Define the image resolution (512 or 1024) of the 3D tract series and enter a series name.
11. Click |OK| to confirm.

    The output series will be generated.

Script Editor ’3D Projection Tract Series’

The script editor offers several options concerning the adminstration of these scripts, e.g. scripts can be stored, deleted or a preview can be generated. The following table summarizes the possibilities.

Icon	Description
	A new script will be created. All of the entry fields within the ’3D Projection Tract Series’ will be cleared in order to enter new values and to save new views.
	The current script will be stored. It will be necessary to enter a name for this script.
	The current script will be deleted.
	The current script will be shown as a preview.
	The preview will be stopped.
	The current viewpoint will be updated to the actual navigation settings.

Tips for Fiber Tracking

Drawing ROIs in Multiple ROI Fibertracking

When a fiber is to be identified using two ROIs it is important that the ROIs are created in the correct fashion. One example is given below:

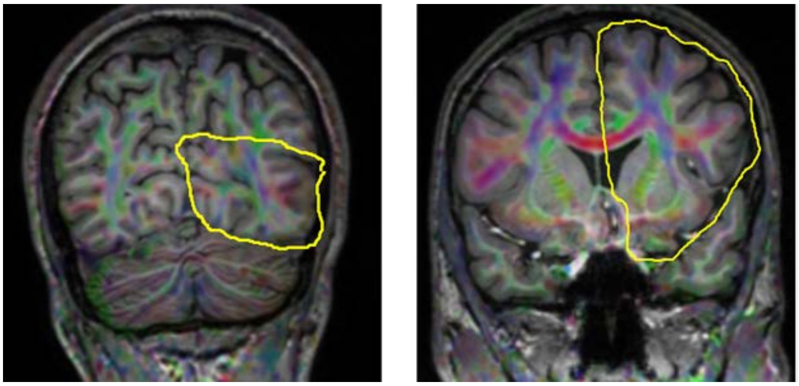


Fig. 298: Coronal planes of occipital and frontal lobe with ROIs.

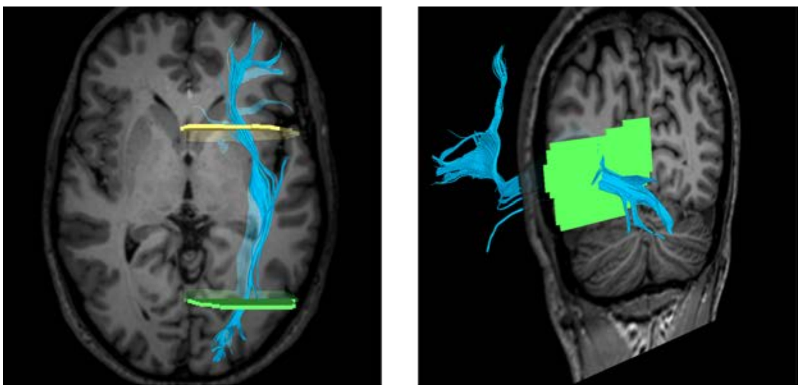


Fig. 299: Resulting fibers. Left: Transverse view. Final tract.. Right: Oblique coronal view. The ROI fully includes the tract. If the ROI had been too small, only part of the IFO would have been identified.

In order to identify the "inferior fronto-occipital fasciculus" (IFO), two (coronal) ROIs have to be defined in the frontal and occipital lobe respectively. It is advised to overlay FA colors to the anatomical background to guide the drawing of ROIs. The given delineation (yellow line) is clearly drawn in a "wide" manner: the combination of the two ROI's will identify the tract.

Quick Fiber Search

In some cases it is convenient to perform a quick search for tracts first, after which the accurate delineation can take place. One way to do this is to combine ’Single ROI Fiber Tracking’ with a freehand ROI. Drawing a ROI anywhere in the images will quickly identify the tracts in this area.

Combine fMRI results with the FiberTrak results

It is possible to combine fMRI results with the FiberTrak package. In order to do so the fMRI results should have been saved from within the IViewBOLD package into a separate series. These series can simply be loaded into the FiberTrak package and viewed as the "anatomic".

IViewBOLD

The IViewBOLD package can be used in two different ways since the package can be used in two modes:

1. The default mode is the **Real-time BOLD analysis**. The data will be analyzed as soon as BOLD scanning has started.
2. The other mode is the **Postprocessing mode** (for existing BOLD scans). In this case, the real-time data from active BOLD scans will be ignored and detailed processing and analysis can be done on existing datasets.

WARNING

Misinterpretation of the results of the IViewBold technique is possible due to several causes on the system for which operator attention and training is required.

Overlaying the resulting parameter maps from the BOLD analysis on anatomical images, is very helpful in finding the anatomical location of specific areas in the parameter maps. However the anatomical location of these areas should be verified using the source images from the dynamic scan at all times. This verification is required since various factors (like patient movement and differences in scan techniques) may disturb the geometrical correspondence between the overlaid parameter map and the anatomical image resulting in an under/over estimation of the activation area.

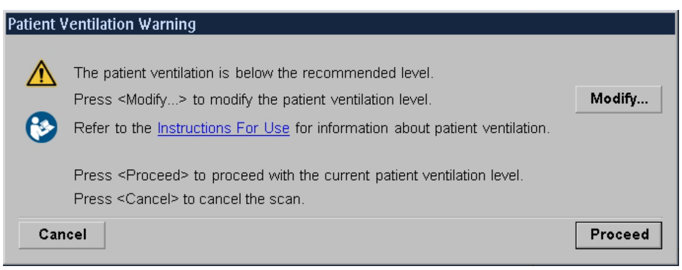


Fig. 300: Patient Ventilation Warning.

Text displayed in warning dialog
The patient ventilation is below the recommended level. Press <Modify...> to modify the patient ventilation. Refer to the Introductions for Use for information about patient ventilation.
Press <Proceed> to proceed with the current patient ventilation. Press <Cancel> to cancel the scan.

The Patient Ventilation Warning requires a deliberate action by clicking one of the following buttons:

- Modify...
  The Patient Ventilation Control is displayed again to modify the ventilation to the recommended level.
- Cancel
  The scan is not started. The Patient Ventilation Warning disappears.

- Proceed
  The set ventilation level is accepted. The Patient Ventilation Warning disappears and a scan can be started.

WARNING

For the interpretation of the displayed correlation values and its threshold, the user is referred to the literature. Interpretation is the sole responsibility of the interpretor.

Correlation of the functional images and their underlying anatomical images may be influenced by patient motion and therefore depends on the accuracy of fixation of the patient. The operator is responsible for the correspondence between the programmed paradigm and the actually applied paradigm.

WARNING

Attention is needed for operator instructions displayed on the viewing screen.

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Documentation

The following paragraphs give the following information:

- User Interface
- Statistical Parametric Maps (SPMs): t-test map, Standard Deviation map, Statistical and viewing parameters
- Time-Intensity Diagram

For information about workflows, refer to chapter “BOLD imaging Workflow” on page 610, to chapter “BOLD imaging: Paradigm Handling” on page 613 and to chapter “BOLD imaging: Esys synchronization” on page 617.

User Interface

Screen layout

The IViewBOLD package has a layout of up to four tile viewers, depending on the number of tasks performed.

In a tile viewer, the following items are displayed:

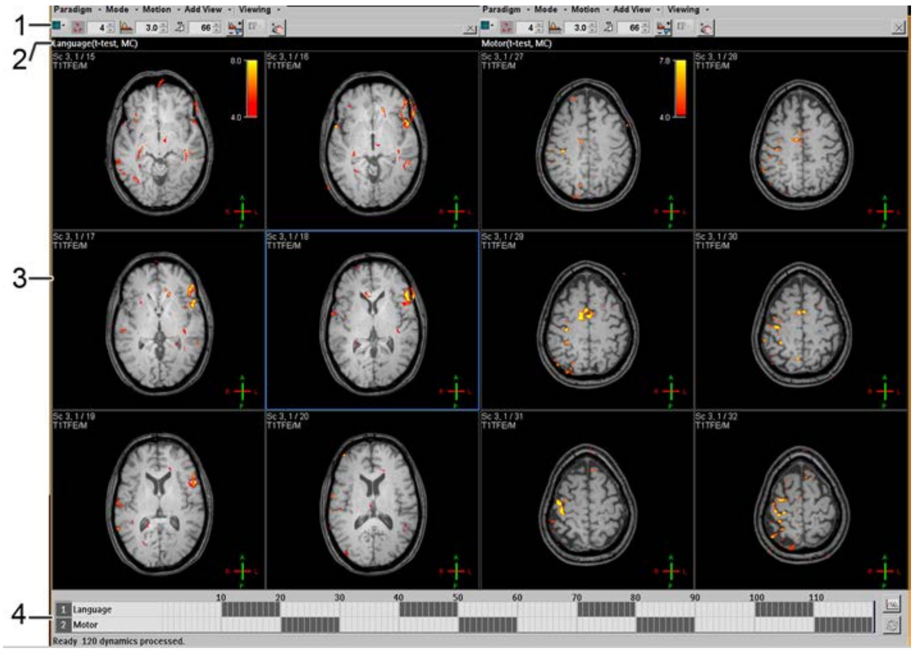

Fig. 301: Default screen layout of IViewBOLD for a BOLD measurement running two tasks (represented in two tile viewers): a language and a motor task. These areas highlight Broca's and the motor areas respectively.

1	Toolbar with control buttons for the parameters
2	SPM identification line with the statistic’s name, e.g. Left (t-test), Right (t-test, MC), STD - where MC stands for motion correction and STD for standard deviation
3	Images and/or SPMs in viewports
4	Dynamic task display: The Dynamic Task Display can be extended with the Time Intensity Diagram. See chapter “Calculate a TID” on page 613 for more information.

Toolbar

Besides many generic toolbar functions, the IViewBOLD toolbar allows to create, edit and delete paradigm; and to change the viewing parameters of the Statistical Parametric Maps (SPMs). Real-time mode and Motion Correction can be enabled.

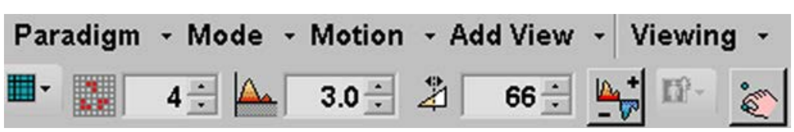

Fig. 302: Icons from left to right: Cluster Size, t-test Threshold, Mask Threshold and Negative Statistics.

Paradigm

allows to: Select Paradigm, New Paradigm, Edit Paradigm.
See chapter “BOLD imaging: Paradigm Handling” on page 613 for more information.

(Real-Time) Mode

This function enables or disables Real-Time Mode.

NOTICE

When the IViewBOLD package is started, without a selected scan in the Thumbnail View, the package will start in real-time mode.

This is only possible for the acquisition context.

In real-time mode, a message is displayed indicating that the system is waiting for a new scan to start: "Waiting for new scan to start."

Motion

- allows to enable or disable Motion Correction.
- allows to save motion corrected series as new imaging series.

Motion Correction

- registers images with respect to the first dynamic.
- performs a rigid transformation of the volume.
- is enabled by default.

The use of Motion Correction is indicated by the abbreviation MC in the heading of a SPM view.

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NOTICE

This option is not available if the loaded scan has been corrected already.

Save Motion Corrected Series

This function saves motion corrected series as new imaging series.

When this option is enabled, a complete registered series will be saved to the database the next time that the SPM’s are computed. Afterwards this option will be disabled again automatically.

Add View -> ’SPM name’ (as defined in paradigm)

This function adds another tile viewer of the chosen SPM to the current layout.

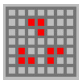
Viewing

The Viewing drop-down menu is a generic menu occuring in Graphical PlanScan and all Review and Analysis packages. For more information, please refer to chapter “On Toolbars” on page 381.

Layout

- To select another screen layout.

Cluster (Size)



The SPMs provide a statistical view on whether the time intensity changes are corresponding to the applied paradigm. However, statistics do not provide an absolute answer, and it is possible that a pixel will have a high t-test value. Such spuriously activated pixels (called "false positives") can generally be found spread out over the image.

Clustering is used to identify with an even larger likelihood which areas are reacting to the applied paradigm assuming that neighboring pixels with high t-test values more robustly identify a main response.

Only pixels belonging to clusters of the entered size or larger are displayed.

A cluster is defined, after application of the threshold, as a group of pixels within a slice that are connected to each other in horizontal or vertical (not diagonal) direction. Positive and negative pixels are not considered part of one and the same cluster.

Threshold

For the ’Standard Deviation’ statistic, only pixels with a value at or above the threshold value are displayed as part of the color overlay.

For the ’t-test’ statistic, pixels with a value at or above the threshold value are displayed as part of the color overlay. Also pixels with a value at or below minus the threshold value are displayed if the ’Negative Statistics’ option is checked.

Thresholds are always equal to or larger than zero.

Mask

The mask function excludes pixels from being displayed. Only pixels with intensity above the mask value are displayed. Masking is based on the pixel values of the first dynamic scan of the functional dataset.

Negative Statistics

If enabled, the negative statistics are displayed combined with the positive values in viewing the SPMs.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up where the name of the new series can be entered.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

SPM Identification

This line indicates the type of SPM which is displayed in the tile viewer.

SPM type	Description
(t-test, MC)	t-test statistical map calculated from a dynamic scan on which retrospective motion correction is applied
(t-test)	t-test statistical map
(STD, MC)	standard deviation map calculated from a dynamic scan on which retrospective motion correction is applied
(STD)	standard deviation map

More Functions within IViewBOLD

Adjust Blending and Threshold

This function allows to adjust the threshold and the blending (or transparancy) with the mouse.

1. Right-click on a map.
2. Select ’Adjust Blending and Threshold’.
3. Drag up- and downwards to adjust the threshold.
4. Drag to the right or the left to adjust the blending.

Load anatomical reference images

You can load an anatomical scan as underlay by simply dragging it from the List View into the package.

- Only one anatomical underlay can be loaded into the package.
- You can hide the anatomical scan (per tile viewer).

NOTICE

Also MPRs (Multiple Planar Reformats) and Fiber Tracking results (2D Cross-section results only) can be used as underlay.

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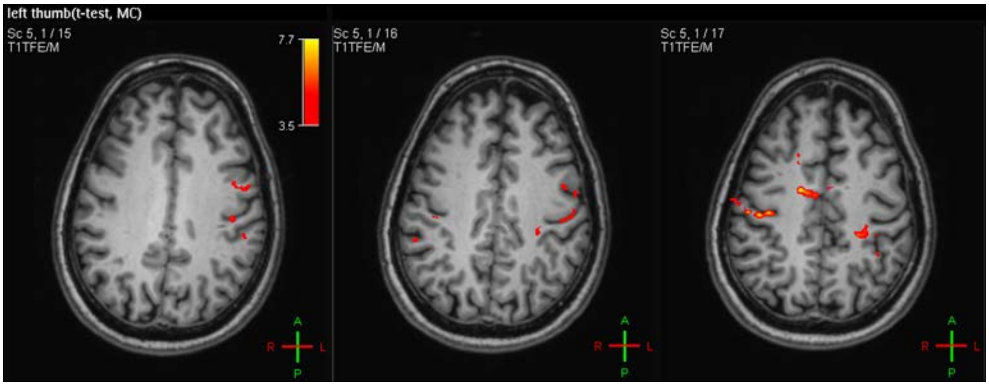

Fig. 303: FLAIR sequence underlaid as anatomical reference.

SmartLine Processing

When the paradigm is stored as part of an ExamCard and this ExamCard is executed again, the IViewBOLD package will automatically be launched with the correct paradigm: The paradigm choice is stored in the current ExamCard.

Statistical Parametric Maps (SPMs)

In order to assess the likelihood that certain brain areas show a signal correlation with the applied paradigm, statistical tests are performed for each voxel. This results in theStatistical Parametric Maps (SPMs).

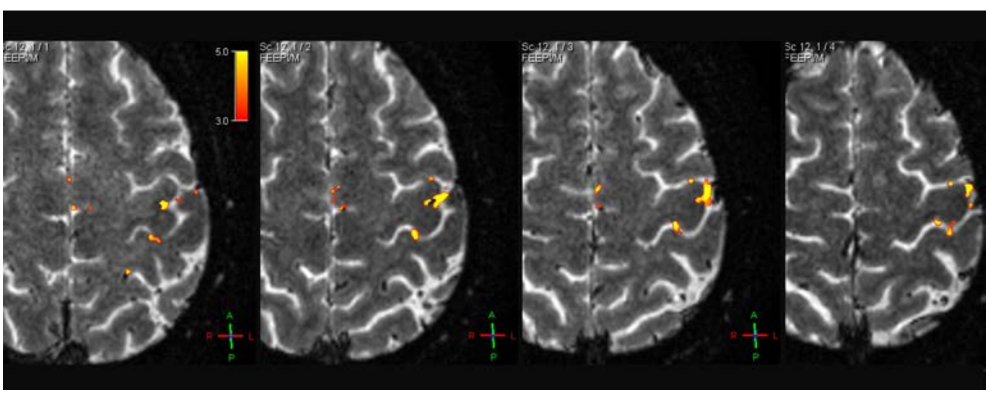

Fig. 304: Statistical Parametric Maps.

The IViewBOLD package calculates the t-test map for each task and if required also the Standard Deviation map.

t-test map

Statistical Parametric Maps (SPM) are a statistical tool to assess the statistical significance of a priori models of brain activation. As every statistical tool, SPMs cannot provide certainty of localization of brain function.

The SPMs are based on the General Linear Model (GLM). The GLM assumes that time intensity pattern of a pixel can follow certain predefined patterns. These are for example:

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1. a general offset (the "average" signal of brain tissue)
2. a linear signal change in time
3. a time pattern following the applied instructions (paradigm)

The contribution of all these different sources of temporal variance, either noise or real brain function (correlating with the paradigm), can be separated with the GLM. The significance of the paradigm time pattern can be assessed with a t-test SPM at each location in the brain.

The t-test identifies the certainty with which the third component (the paradigm) is needed to explain (part of) the time intensity changes.

With a perfect non-changing time-pattern it is unlikely that the third component is needed to explain the observed signal pattern of that pixel. However, if the signal pattern of a pixel closely follows the applied paradigm it is highly likely (high t-test value) that the applied paradigm correlates to such signal changes.

Standard Deviation map

The Standard Deviation indicates the range of variation of a pixel's intensity over time.

- A small SD indicates that the pixel's intensity over time is close to the average.
- Head motion will increase the SD, especially at the edges of the brain.

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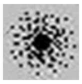
Statistical and viewing parameters

For each SPM, a number of parameters is defined.

- Smoothing (Width)
- Hemodynamic Delay
- Threshold
- Cluster (size)
- Map Color Range
- Negative Statistics
- Mask

Smoothing (Smoothing width)



- is used to prepare images for the statistical calculation and reduce the noise level.
- increases the statistical power at the cost of spatial resolution.
- means that the value of every pixel is replaced with a weighted average of a group of pixels around that pixel (also referred to as kernel).
  - This kernel is a square of 1x1, 3x3 up to 9x9 pixels.
  - The pixels in the kernel are weighted using a Gaussian distribution.
- is the Full-Width-Half-Maximum (FWHM) of the Gaussian curve given in pixel sizes.

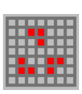
  A large width will cause a broad smoothing effect. Note that smoothing is only applied for the kernel. A large width thus requires a large kernel (see table below).

Smoothing Width	Yields a Kernel Size of
• 0 - 0.6	• 1 pixel
• 0.7 - 1.2	• 9 pixels (3x3)
• 1.3 - 1.9	• 25 pixels (5x5)
• 2.0 - 2.7	• 49 pixels (7x7)
• 2.8 - 3.4	• 81 pixels (9x9)
• >= 3.5	• 81 pixels (9x9, cut off)

Hemodynamic Delay

- accounts for the physiological delay of the hemodynamic response with respect to the start of the paradigm.
- shifts the task combination by the specified number of dynamics in the calculation of the SPM.

Cluster (Size)



The SPMs provide a statistical view on whether the time intensity changes are corresponding to the applied paradigm. However, statistics do not provide an absolute answer, and it is possible that a pixel will have a high t-test value. Such spuriously activated pixels (called "false positives") can generally be found spread out over the image.

Clustering is used to identify with an even larger likelihood which areas are reacting to the applied paradigm assuming that neighboring pixels with high t-test values more robustly identify a main response.

Only pixels belonging to clusters of the entered size or larger are displayed.

A cluster is defined, after application of the threshold, as a group of pixels within a slice that are connected to each other in horizontal or vertical (not diagonal) direction. Positive and negative pixels are not considered part of one and the same cluster.

Threshold

For the ’Standard Deviation’ statistic, only pixels with a value at or above the threshold value are displayed as part of the color overlay.

For the ’t-test’ statistic, pixels with a value at or above the threshold value are displayed as part of the color overlay. Also pixels with a value at or below minus the threshold value are displayed if the ’Negative Statistics’ option is checked.

Thresholds are always equal to or larger than zero.

Map Color Range

The displayed pixels of the SPMs are colored according to gradually changing colors.

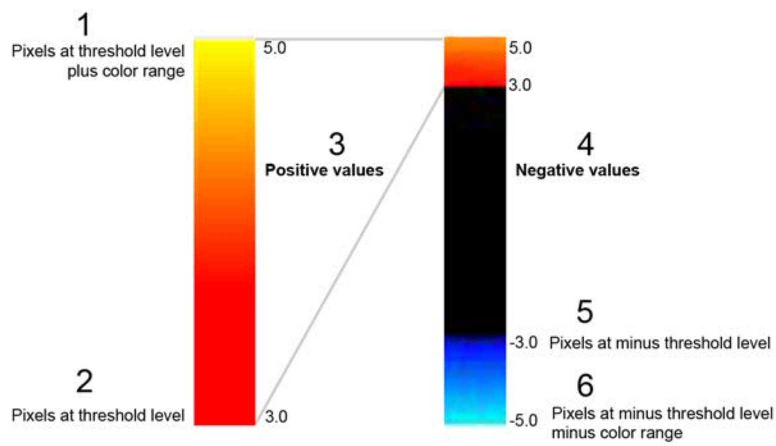


Fig. 305: Color bar and color coding with positive or negative values. With this example, a color overlay will be displayed when the t-test is larger than 3.0. At the value of 5.0 the color will be bright yellow indicating a large correlation with the applied paradigm.

1	Pixels at threshold level plus color range
2	Pixels at threshold level
3	Positive values
4	Negative values
5	Pixels at minus threshold level
6	Pixels at minus threshold level minus color range

Note that the threshold only forms one end of the color range in the paradigm. This can be changed in the viewers where the SPMs are displayed.

Negative Statistics

If enabled, the negative statistics are displayed combined with the positive values in viewing the SPMs.

Mask

The mask function excludes pixels from being displayed. Only pixels with intensity above the mask value are displayed. Masking is based on the pixel values of the first dynamic scan of the functional dataset.

Time-Intensity Diagram (TID)

The TID can be used to review the signal response over time. If the signal response was taken from a region of interest with a high statistical value, the response should closely follow the applied paradigm.

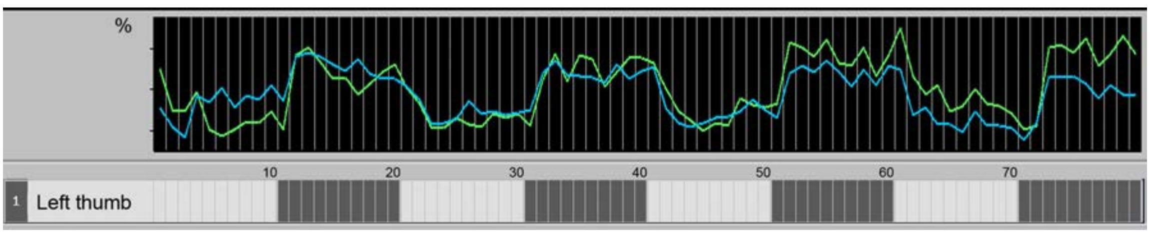


Fig. 306: TID result for a paradigm of single-thumb motion, based on 2 ROIs: an average signal response of about 3% is given. The signal plateau during activation is only reached after about 2 dynamics which is related to the physiological delay in the hemodynamic response of the brain.

The display of the TID can be changed via the TID right mouse menu. The following parameters can be enabled or disabled:

Parameter	Description
Autoscale	Automatic scales the graphs such the graph display makes optimum use of the space available. Either for horizontal and vertical axis.
Autoscale horizontal	Or for horizontal axis only.
Autoscale vertical	Or for vertical axis only.
Relative values	Enables or disables display of relative values. Note that the baseline is defined as the mean value of the 10% lowest values over all measured timepoints within the ROI.

BOLD imaging Workflow

Patient preparation and positioning

BOLD imaging demands for optimum patient cooperation.

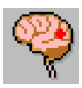
- Instruct the patient carefully about what to expect and about the paradigms he/she has to perform. It might be helpful to train the patient already outside of the scanner.
- Tell the patient what he/she has to do, e.g. "Move the right thumb", and practice.
- Tell him/her also what is not desired, e.g. "Do not move the whole hand or even the arm" as this might give a stimulus correlated activation which may influence the functional result.
- With visual stimulations, ensure that the patient can see the required information on screen by means of a mirror on the coil.
- Position the patient as usual.

Start up IViewBOLD

Real-time BOLD analysis

1. Start a BOLD imaging ExamCard.

   In general, a survey and a reference scan are performed.



2. Select ’IViewBOLD’ from the Analysis menu (without selecting a thumbnail dataset).

   In real-time mode, a message is displayed indicating that the system is waiting for a new scan to start: "Waiting for new scan to start."

   The IViewBOLD package opens with the last-used paradigm.

NOTICE

When the IViewBOLD package is started, without a selected scan in the pictorial index, the package will start in real-time mode.

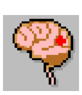
This is only possible for the acquisition context.

3. Optional: Select a paradigm if the current paradigm is not the correct one (or edit the current paradigm or generate a new paradigm).
4. Instruct the patient and start the BOLD scan.
5. View the SPMs in real-time.

Postprocessing (existing BOLD scans)

1. Right-click on a suitable BOLD dataset (minimum of 6 dynamics) in the Thumbnail View.

   A context menu appears.



2. Click ’IViewBOLD’.
3. The IViewBOLD package opens with the last-used paradigm.
4. Optional: Select a paradigm if the current paradigm is not the correct one (or edit the current paradigm or generate a new paradigm).

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5. Click ’Compute’ to calculate the Statistical Parametric Maps (SPMs).

   In the info line, the message appears: ’Analyzing scan. X dynamics processed. ... Ready.’

NOTICE

In real-time mode, the computation is performed automatically.

6. View the SPMs.

View the SPMs

Statistical Parametric Maps (SPMs) are computed using the General Linear Model (GLM) and represent the results of statistical tests (e.g. t-tests), computed at every voxel in the images. These t-tests will show a larger value when it is even more likely that the signal changes ’follow’ the applied paradigm.

Modify the results display

1. Click on the up/down arrows besides the toolbar icons to increase or decrease the values of 'Cluster Size', 'Threshold', 'Mask' or manually enter a value.
2. Click ’Negative Statistics’ to enable or disable this function.

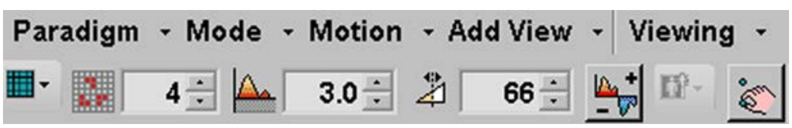


Fig. 307: Icons from left to right: Cluster size, Threshold, Mask, Negative Statistics.

3. To change the color range: mid-drag while pressing the |Ctrl| key.

   Horizontal movement increases or decreases the color range, vertical movement shifts the range. The SPM and the tile viewer will automatically be refreshed.

Load anatomical reference images

1. Drag the required anatomical dataset from the pictorial index into the package .

NOTICE

MultiPlanar Reformats and Fiber Tracking results (2D cross-section) can be used as an underlay.

Enable or disable Motion correction

1. Enable or disable ’Motion correction’ from the ’IViewBOLD’ menu.

2. Click ’Compute’ to recalculate the maps.

Adjust Blending and Threshold

1. Right-click on a map.
2. Select ’Adjust Blending and Threshold’.
3. Drag up- and downwards to adjust the threshold.
4. Drag to the right or the left to adjust the blending.

Save results

1. Right-click on a map.
2. Select ’Save results’.
3. Select either ’Statistics’ or ’Color Overlay’.

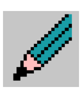
   A new series will be generated.

   The new series can be viewed with ImageView.

Calculate a TID

1. Click ’Show Time Intensity Curve’ to open the TID window.

2. Click ’ROI type’ and select the ROI type:
   - Freehand (for any kind of shape),
   - Bezier (for paraboloid or sinusoid shape of ROI),
   - Ellipsoid (for circular or any kind of ellipsoid ROI)



3. Click ’Draw ROI’.
   - Click once to start drawing.
   - Drag to define the contour.
   - Click to close the contour.

4. Click ’Compute’ to calculate the TID.
5. Right-click on the graph display to access the right mouse menu and change the graph display.

For more information, chapter “Time-Intensity Diagram (TID)” on page 610.

BOLD imaging: Paradigm Handling

This paragraph describes how to handle paradigms in the IViewBOLD package:

- Select a paradigm
- Set up a new paradigm
- Edit a paradigm (starting up with the current paradigm)

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- Paradigm Editor
- Delete a paradigm

Select a paradigm

- ► Select 'Select Paradigm' from the IViewBOLD toolbar.
  A list of the available paradigms is displayed.
- ► Select the desired paradigm.
- ► Click |Ok| to apply the selected paradigm.
  Clicking |Cancel| closes the dialog box without applying the changes made.

NOTICE
The 'Select paradigm' option is disabled when a calculation is running.

Delete a paradigm

1. Select 'IViewBOLD' on the toolbar.
2. Select 'Select Paradigm'.
   A list of the available paradigms is displayed.
3. Select the paradigm that has to be deleted.
4. Click |Delete|.
   A prompt appears:
   'Are you sure you want to permanently delete the selected paradigm?'
5. Click |Yes| to delete the paradigm.
   Clicking |No|, no paradigm is deleted.
   The list of paradigms will be updated.

Set up a new paradigm

- ► Select 'New Paradigm' from the IViewBOLD toolbar.
  The paradigm editor opens with an empty (paradigm editor) dialog box.
- ► Create a paradigm according to the tasks performed and save this paradigm under a new name.

See chapter "Paradigm Editor" on page 615 for more information.

Edit a paradigm

- ► Select 'Edit Paradigm' from the IViewBOLD toolbar.The paradigm editor opens and displays the settings of the current paradigm.

- Edit the settings of the chosen paradigm.
- After editing, |OK| can be used to apply this paradigm.

  Or |Save| can be used to save the changes for later usage.

For more information, see chapter “Paradigm Editor” on page 615.

Paradigm Editor

The paradigm editor allows to define and edit paradigms. The figure shows the layout of the paradigm editor.

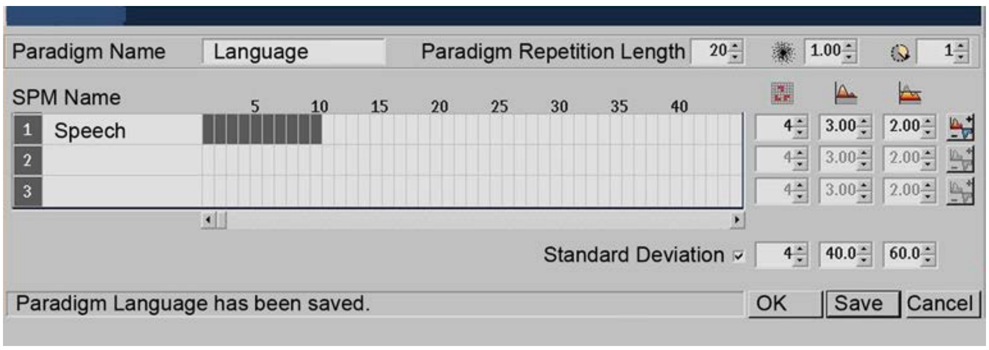

Fig. 308: Definition of a language-speech paradigm using the paradigm editor: generation of words during the first 10 dynamics, rest during the 10 next dynamics. Note that "Paradigm Repetition Length" equals 20 to include both 10 dynamics of activation, and 10 dynamics of rest.

Paradigm Name

- Enter a paradigm name.

  The name should reflect the general identity of the BOLD examination.

Paradigm Repetition Length

- Specify the paradigm repetition length, either numerically or by using the up- and down arrows.

  The paradigm repetition length is defined by the number of dynamics which are to be performed repeatedly, e.g. the paradigm repetition length is 20 in an experiment of 10 activation dynamics alternating with 10 rest dynamics.

NOTICE

In the above example, the ’Paradigm Repetition Length’ is set to 20 and the language task (active) is defined as dynamics 1 to 10. This automatically results in dynamic 11 to 20 being the dynamics in rest.

SPMs

- Enter a SPM name, e.g. ’visual’.

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- Drag the left mouse on the grid to mark or unmark the dynamic scans with brain activation (the dynamics where a stimulus is presented or a task has to be performed).

Only 50 dynamics are visible simultaneously. To view more dynamics, a scrollbar can be used.

See chapter “Statistical Parametric Maps (SPMs)” on page 606 for more information on the statistics.

NOTICE

Dynamics in rest may not be marked as task, because all inactive dynamics are considered as reference in the SPM calculation.

If however this would be the case, an error message would be displayed in the bottom line: ’Task 1 has all dynamics defined as active’.

Icons

- Click on the up/down arrows to increase or decrease the values or manually enter a value.

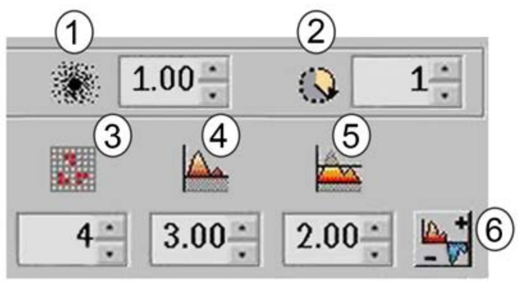

Fig. 309: Icons

1	Smoothing
2	Hemodynamic Delay
3	Cluster Size
4	Threshold
5	Map Color Range
6	Negative Statistics

See chapter “Statistical and viewing parameters” on page 607 for more information.

Standard Deviation

- Click on the check box to enable or disable the calculation of the standard deviation map. By default, the calculation of the standard deviation map is disabled.

Save the paradigm

- Click |Save| to save the paradigm.

The paradigm is only saved, but not applied in this case.

In case of saving a paradigm without changing its name, a window pops up: "Confirm file replace: Paradigm already exists. Do you want to replace it?"

Click |Yes| to confirm file replacement.

Asterisk

An asterisk behind the name of the current paradigm indicates that the original paradigm has been edited (but has not been saved).

NOTICE

The Info line at the bottom of the window indicates if a paradigm is valid or not and gives hints on how to correct a problem.

- Click |Ok| to apply the paradigm and to leave the paradigm editor.

  Clicking |Cancel| closes the dialog box without applying the changes made.

BOLD imaging: Esys synchronization

This chapter describes the basic functionality of the Esys Synchronization Protocol (ESP). This synchronization will assure that the Esys will initialize, start paradigms etc., all automatically, started from instructions sent by the scanner. ESP will also update the operator behind the scanner console of the status of the Esys. This means that the operator will no longer need to perform any activity on the Esys itself during standard clinical BOLD imaging, when the ESP is used.

Workflow

1. Turn the Esys on.
2. Enter the patient and examination data at the scanner’s console.

   The patient name and session number will be sent to the Esys when the first fMRI BOLD scan is performed. This creates a new unique Esys session linked to this patient name.
3. Prepare the patient and position him/her in the scanner with the required Esys devices:
   - keyboard with buttons needed for paradigm interaction
   - a display attached to the head coil
   - the dedicated Eloquence headset
4. Select and start a BOLD ExamCard with IViewBOLD as inline processing step.

   The surveys and reference scans are performed.

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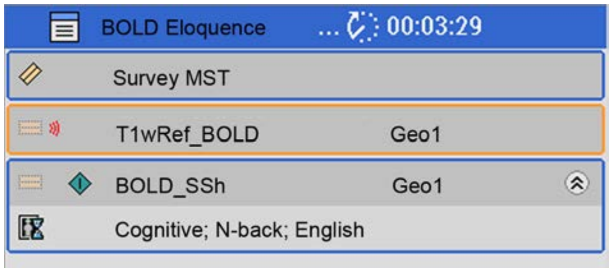

Fig. 310: Typical BOLD ExamCard with IViewBOLD SmartLine processing step.

5. Plan the anatomical scans and resume the ExamCard.

   The ExamCard is executed.

   When the BOLD scan is started, the paradigm name and the specific timings of the BOLD experiment are sent to the Eloquence. Then the instructions of the paradigm are started at the Esys.

6. Let the patient confirm by pressing the ’Okay’ button that he/she understood the instructions.
   - Automatically, the information that the Eloquence and the patient are ready is sent to the scanner. The IViewBOLD package and the ExamCards info bar display an appropriate message.
   - When the preparation of the BOLD scan is finished, a pop-up window appears to start the BOLD scan.

7. Click |Proceed| to start the BOLD scan.
   - The FBI box creates an RF-trigger which identifies the exact beginning of the paradigm.
   - When the scan is finished, an ’end’ message is sent to the Esys, and the Esys will get ready for the next paradigm.
   - The IViewBOLD package is launched automatically with the correct paradigm.

8. Proceed with the IViewBOLD analysis.

Add IViewBOLD SmartLine processing to ExamCard

In general, postprocessing steps can be added to the ExamCard as SmartLine processing steps which are executed automatically as part of the ExamCard.

This chapter describes how to add an IViewBOLD processing step to an BOLD ExamCard.

Workflow

1. Select a preferred BOLD ExamCard or preset procedure.

NOTICE

Do not yet start the scan.

2. Start IViewBOLD.
3. Select or create a paradigm with a name that exactly matches the name of the paradigm on the Esys (including language). For example, if you want to start the "Cognitive" paradigm, using the run name "N-Back" with the language set to "Italiano", a paradigm must be started/created with the following name: "Cognitive+N-Back+Italiano".

NOTICE

The paradigm name, run name and language must be separated by + characters.

4. Make sure that all the settings for analysis are set correctly. Note that the information on timing (e.g. how many dynamics for a certain block etc) will be sent to the Esys, and this will influence the actual paradigm run.
5. Start the BOLD scan.
6. Close the IViewBOLD package when the scan is finished.

   Now there is a newly created processing step with the name of the desired paradigm, and linked to the performed BOLD scan.
7. Save the ExamCard.

   The next time that this ExamCard is executed, the IViewBOLD package and the Esys will start automatically.

NOTICE

Not only the entire ExamCard will be saved, but also the processing step itself (with a specific paradigm name).

In this way, various processing steps can be saved and attached to BOLD scans at any time. Each processing step will be linked to a specific paradigm and run so that the processing steps basically determine which paradigm is chosen.

NOTICE

Make sure that the correct paradigm name is used with the notation "Paradigm+ Run+Language" where the three components exactly match the paradigm name on the Esys.

More about the synchronization

- In case of a scan abort initiated by the operator, the paradigm-run will automatically be stopped.

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- If the Eloquence doesn’t know the paradigm name (e.g. due to a typo), the Eloquence will respond with a message "Paradigm is not available, cannot proceed". In this case, the sequence can be stopped or continued.
- If the paradigm cannot be run because of timing problems, the Eloquence will respond with a message "Paradigm available, but cannot proceed". In this case, the sequence can be stopped or continued. In this case the synchronization of the paradigm will very likely be incorrect. Reasons for timing problems might be a conflict between paradigm repetition length (in ms) and a TR which has been set to a too large value.

Protocol requirements

In order to assure correct synchronization, the following prerequisites must be met:

- The parameter ’Synch. ext. device’ must be set to ’Yes’ and the first RF trigger must be set to the dynamic ’1’.
- A manual start is needed.
- The parameter ’Real-time reconstruction’ must be enabled to allow for the presentation of pre-scan calibrations and presentation of instructions to the patient.

Neuro T2* Perfusion package

This postprocessing package is meant to evaluate dynamic T2* studies and generate numerical and graphical results and maps.

The NeuroPerfusion tool is able to measure Index and Negative Integral (NI) using a deconvolution between the time courses of tissue signal and an Arterial-Input-Function (AIF).

WARNING

The results of deconvolution perfusion analysis may under- or overestimate the true perfusion depending on various factors.

- **Inaccurate definition of the AIF. The AIF may suffer from partial-volume effects, thus it does not represent a 100% blood signal. For this reason the AIF time course will not correctly represent a 100% blood signal.**
- **Patient motion. Patient motion during the scan may introduce irregularities in the definition of the AIF and individual tissue signal time courses, causing deviations from the correct Index and Negative Integral.**
- **Temporal resolution. The temporal resolution of the measurement may be too low, causing large errors on the blood flow/volume results.**
- **Poor bolus injection. If the contrast bolus is too slow, the Index and Negative Integral may be incorrectly calculated.**

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Documentation

The following paragraphs give the following information:

- User Interface
- Results

For information about workflows, refer to chapter "Neuro T2* Perfusion Workflow" on page 628.

User Interface

Screen layout

The Neuro T2* Perfusion package has a default layout of four viewports.

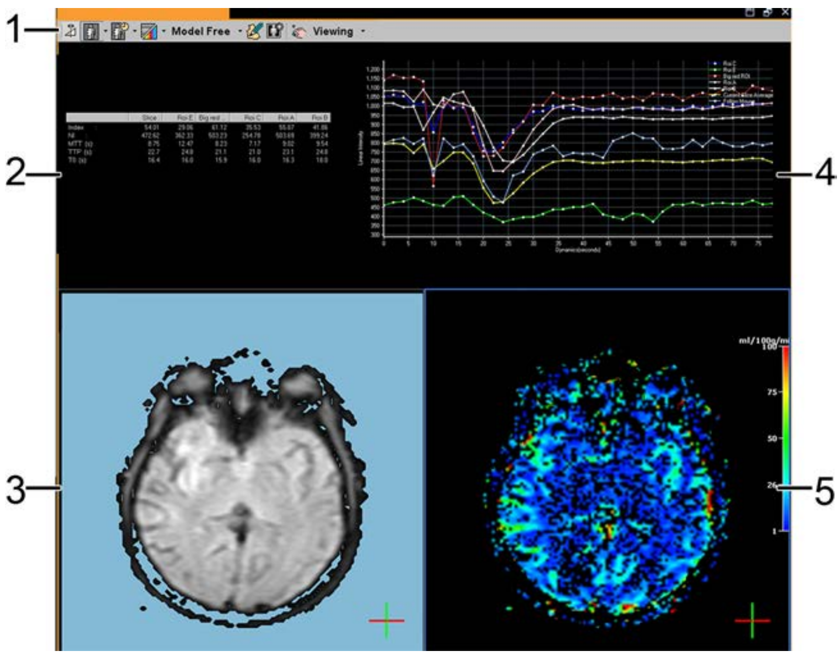


Fig. 311: Screen layout of T2* Analysis package.

1	Neuro T2* Perfusion toolbar
2	Numerical results
3	Original image (with threshold mask overlaid) in the middle of the imaging volume
4	Graphical results
5	In real-time calculated Parametric map

Toolbar

Adjust B0 Threshold

- To adjust the B0 threshold and to enable (default) or disable the display of the threshold mask.

  Setting a threshold mask will exclude background pixels from the functional map calculations. All pixels with values below the mask value will be displayed blue. Only pixels with intensity above the mask value are used for the calculations, colored areas will be excluded from the calculation

Apply Spatial Smoothing

- To spatially smooth the resulting maps.

  Possible settings are: None (no smoothing), Weak, Medium or Strong.

  Spatial smoothing smoothes the maps ONLY, not the original images. Spatial smoothing doesn’t have any effect on the numerical results.

Apply Temporal Smoothing

- To temporally smooth the resulting maps.

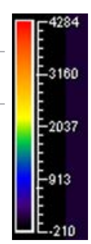
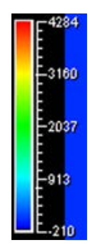
  Possible settings are: None (no smoothing), Weak, Medium or Strong.

Color LUT (Look-Up Table)

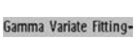
- To select the color look-up table for the maps:

When a color LUT is selected, a vertical color scale bar is shown alongside each image.

The window width and level can be adjusted with all types of color LUT.

Values: Display	GrayScale	Rainbow	Blue To Red
Maximum	White		
	Gray		
Minimum	Black		

Fitting routine



► To select a fitting routine for the calculation of the maps.

The initial Neuro Perfusion maps are based on automated fitting routines. Three different routines are available:

1. **Gamma Variate Fitting**

   This is the automated fitting routine that is used by default. It is based on a curve fit algorithm.

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2. **Model free**

   The 'model-free' algorithm does not make any assumptions about the contrast agent bolus passage through the brain. Instead it uses numerical integration to calculate the Negative Integral and the MTT, then derives the other parameters from those values.

3. **Arterial Input Function (AIF)**

   Using the AIF, another algorithm (deconvolution) is used that is based on the knowledge of the Arterial Input Function to calculate the perfusion values. As such the AIF method is an alternative to the default perfusion calculation.

   With the AIF calculation the curvature of the intensity curve of an arterial vessel is used to calculate the perfusion maps. This AIF needs to be identified by the user.

Draw ROI

- Click to start up the ROI definition.
- Draw with the left mouse button (no dragging).
- Click to end drawing and to confirm the ROI.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up. It allows to specify which images are to be generated in which manner.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

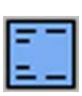
To adjust the viewing settings:

Orientation (Viewing)

To change the orientation of the images:

- Mirror, Flip,
- Rotate clockwise, Rotate counterclockwise,
- Reset orientation,
- Display Images in Radiological View

Image Information (Viewing)



- To define the amount of displayed image information:

- minimum: no text is displayed,

- standard: scan, image number and the scan name are displayed,
- maximum: also the offcenter values, the window values (width and level) and the caliper are displayed.

Interpolate (Viewing)

To interpolate the image(s).

Invert Gray Level (Viewing)

- To invert the images of the current dataset (change black and white in the grayscale).

Capture ...

To capture images and save them. Type of image and destination are to be defined in the 'Capture' pop-up window. Check according to your preferences:

- 'Capture Selected Image' captures the current image.
- 'Capture ImageView' captures the current image including orange border and ImageView tab.
- 'Capture Full Screen' captures the full screen.
- 'Capture Slices' captures all slices of the current imaging series.
- 'As Displayed and Annotated' or 'As Acquired' allow to capture images with or without their window/zoom settings and annotations.
- 'Save to External Folder' allows to save the data to an external folder.

  In this case, it is necessary to browse to this external folder.
- 'Save to Patient Database' allows to save the data to the patient database.
- In order to include the hospital name, check the eponymic option.

The function 'Capture ...' as part of Viewing is only available in Review and Analysis packages, not in Graphical PlanScan.

Save Presentation State <Ctrl+S> (Viewing)

To save a special way of presenting images.

Reload Presentation State <Ctrl+R> (Viewing)

To reload a special way of presenting images.

Reset Window (Viewing)

To reset images to original window level and width.

Reset Zoom / Pan (Viewing)

To reset images to original zoom and pan values.

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More Functions within the Perfusion packages

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

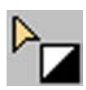
They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

Interaction Mode

- can be used to define the left mouse usage for interaction with images.

The table below lists the functions which are specific for this package. For information about the generic functions, see chapter “Generic functions for images” on page 380.

Possible setting	Corresponding icon	Description
Threshold		Dragging the left mouse adjusts the threshold.
Draw freehand ROI		Dragging the left mouse, a freehand ROI can be drawn. Releasing the left mouse button, the freehand ROI will be closed and the interaction mode will be set to its default setting ’Scroll’ again.

View

- To select the type of image to be displayed:
  - the Source Image or
  - the Subtracted Image.

Set as Subtraction Reference

- To select a dynamic other than the first one as subtraction reference.

For subtraction purposes, by default the first dynamic (precontrast) is selected as reference. A different dynamic can be used as reference via this function.

NOTICE

This function is applicable only to T1 Perfusion.

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Set as Mask

Enabled / disabled.

Modify the Results Display

1. Right-click on the graph viewport.
2. Select one of the options (see table) to modify the display.

Function	Possible values
Autoscale	Enabled/Disabled: If enabled, the graph will be automatically scaled.
Intensity	Enabled/Disabled: If enabled, intensity will be displayed versus time as graph (TID).
Base-log Corrected	Enabled/Disabled: If enabled, the graph will be base-log corrected (practically a sort of inversion).The vertical axis (intensity) uses a logarithmic scale resulting in an optimized display of the graphs.
Deconvolution	Enabled/Disabled.
Follow Mouse	Enabled/Disabled: If enabled, results per pixel will be generated where the results originate from the current pointer position.
Current Slice Average	Enabled/Disabled: If enabled, the graph displays the current slice average.
AIF Average	Enabled/Disabled: If enabled, the graph displays the AIF average.
ROI Average	Enabled/Disabled: If enabled, the graph displays the ROI average.

Results of the Neuro T2* Perfusion package

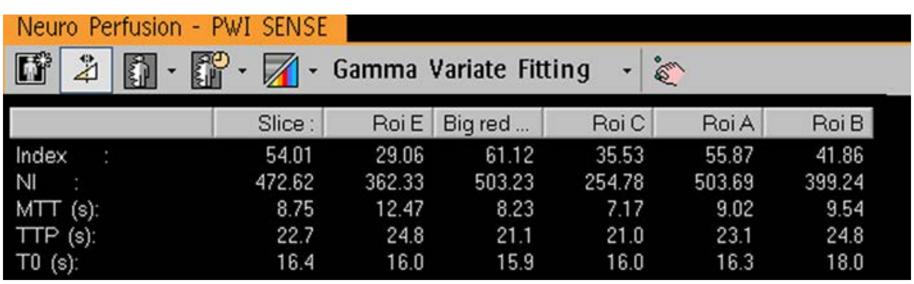
The package calculates the following results:

Graphical and numerical results

- The graphical results present a **Time-Intensity Diagram** (intensity versus time).

  In 'Follow Mouse' mode, the graph correlates to a specific pixel and shows the intensity value (intensity) over the time for this pixel.
- The results will be provided as **parametric maps** and in a **table of results**.

  Scrolling through the maps, the type of the map is indicated in the map's scan type field. The used values can be found in the descriptions below in brackets.



Neuro Perfusion - PWI SENSE

Gamma Variate Fitting

	Slice :	Roi E	Big red ...	Roi C	Roi A	Roi B
Index :	54.01	29.06	61.12	35.53	55.87	41.86
NI :	472.62	362.33	503.23	254.78	503.69	399.24
MTT (s):	8.75	12.47	8.23	7.17	9.02	9.54
TTP (s):	22.7	24.8	21.1	21.0	23.1	24.8
T0 (s):	16.4	16.0	15.9	16.0	16.3	18.0

Fig. 312: Example of Table of Results as shown on screen. The table contains one column per ROI.

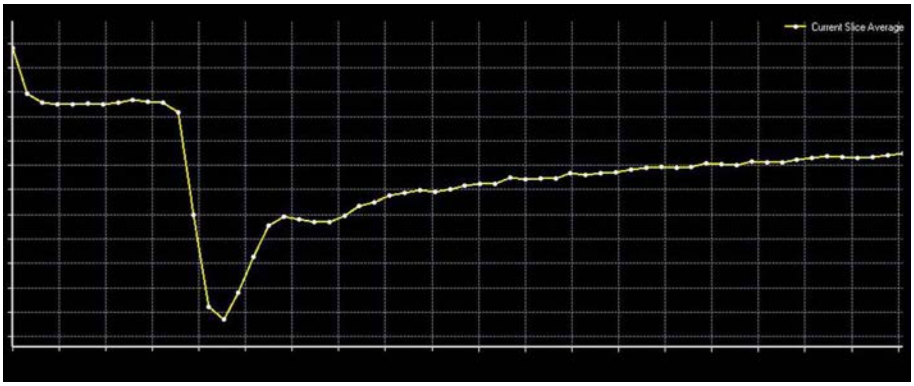


Fig. 313: Graphical results within Neuro T2* Perfusion package.

NOTICE

You can drag the columns to change their order in the table.

NOTICE

The table of results will not be updated with a new ROI column when a new ROI is drawn in AIF mode.

Right-click on the AIF graphs and select 'Proceed'. Then the results will be recalculated.

The figure below gives an overview of the T2* Analysis results.

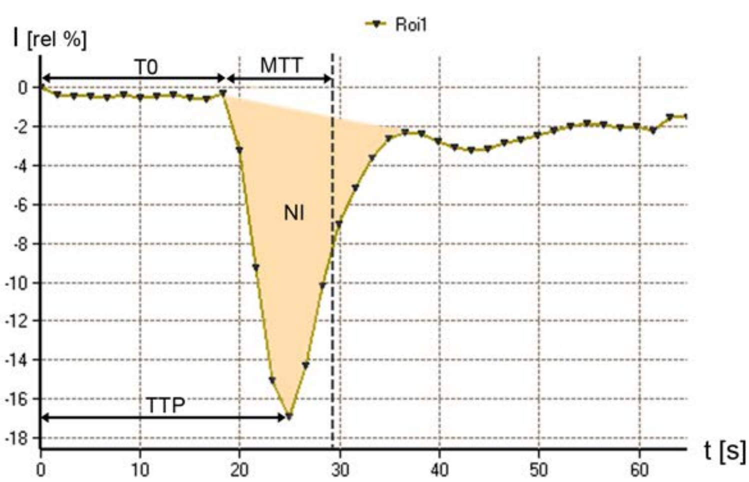


Fig. 314: Time Intensity Diagram with definitions of NI, T0, TTP, MTT.

Mean Transit Time [s] (MTT)

- The mean transit time of the bolus.

T0 - Time of Arrival [s] (T0)

- Arrival of the contrast agent, i.e. begin of the enhancement curve.

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Time to Peak [s] (TTP)

- Time till contrast agent bolus reaches peak intensity.

Negative Integral (NI)

- Calculated area under the curve.

Index (Index)

- Defined as NI divided by the MTT.

NOTICE

Using the AIF function, also the Index and the Negative Integral will be displayed with units: Index [ml/100g/min} and Negative Integral [ml/100g].

The calculation is based on known delay-insensitive deconvolution techniques and results may be influenced by incorrect assumptions in such a model.

Delay maps with AIF algorithm

If the AIF algorithm has been chosen for processing, the ’Generate Series’ window provides the possibility of enabling the calculation of a ’Delay’ map. For each pixel, the delay map shows the time between the AIF peak contrast agent concentration, and the tissue peak contrast agent concentration. The time is measured in seconds, with accuracy defined by the TR of the acquisition sequence.

Neuro T2* Perfusion Workflow

Start up the Neuro T2* Perfusion package

1. Right-click on a suitable neurological perfusion data set in the Thumbnail View.

   A context menu appears.

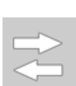
2. Select 'Neuro T2* Perfusion’.

   The package opens.

Moving the cursor over either the original image or the map, the curve and the numerical results originating from the current pixel will be shown.

Navigate through images

Through dynamics



- ► In the image viewport, drag to the left or to the right.

Through slices

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► In the image viewport, drag up- or downwards.

Through maps

1. In the map viewport, drag to the left or to the right.

Adjust the threshold

By default, the 'Adjust Threshold' function is automatically enabled: the threshold mask is laid over the original image.

Setting a threshold mask will exclude background pixels from the functional map calculations.

1. Right-drag up- and downwards to adjust the threshold.

Calculation of the perfusion results using the AIF

1. Select ’Arterial Input Function’ from the 'Select Algorithm' drop-down menu.

   A red square shows up in the image viewport. This red square spans the size of 7 by 7 voxels. In the right viewport the dynamic curves of these 7x7 voxels are shown.
2. Move the red square to the arterial vessel from which the AIF is supposed to be derived.
3. Click on the individual graphs if they are to be included in the definition of the AIF.

   The selected graphs will be green.
4. Right-click on the graphs and press 'Proceed' to confirm.

   Now the AIF is identified and the resulting maps will be shown.

Generate results

Results per pixel

In order to generate results per pixel, you have to select a pixel. This can easily be done by pointing at a pixel on the original image or the map. Prerequisite is that the pointer is in the ’Follow Mouse’ mode.

1. Right-click on the curve view port.
2. Click to enable ’Follow Mouse’.
3. Move the pointer over the image or the map.

   Results will be updated with every move of the pointer.

Results per ROI

1. Right-click on one of the image viewports and set the Interaction mode to ’Draw ROI’.
2. Drag the left mouse over the image to draw a ROI.

   Release the left mouse button to close the ROI.

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3. Right-click on the graph and select ’ROI average’.

You can draw up to 5 ROIs on any desired slice. Scroll through the slices between drawing if necessary.

- When 5 ROIs are drawn, the function 'Draw ROI' is automatically disabled.
- The 5 ROIs are initially called ROI A, ROI B, ROI C, ROI D and ROI E. The names are given in a random order.

Generate a new imaging series

► Click ’Generate series’.

A new imaging series will be generated within the current examination.

Note that several output choices are provided in the ’Generate’ box.

Basic T1 Perfusion package

This postprocessing package is meant to evaluate dynamic T1 studies and generate numerical and graphical results and maps.

Documentation

The following paragraphs give the following information:

- User Interface
- Results

For information about workflows, refer to chapter “Basic T1 Perfusion Workflow” on page 638.

User Interface

Screen layout

The Basic T1 Perfusion package has a default layout of four viewports.

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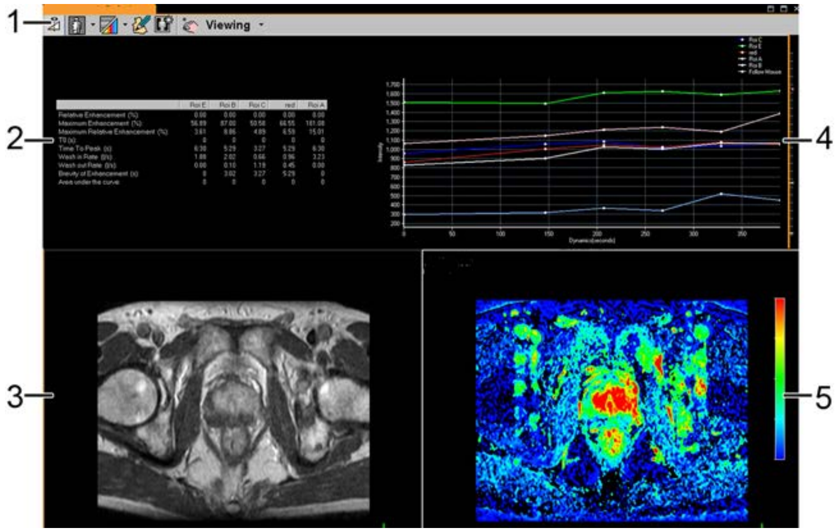

Fig. 315: Screen layout of Basic T1 Perfusion package.

1	Basic T1 Perfusion toolbar
2	Numerical results
3	Original image in the middle of the imaging volume
4	Graphical results
5	In real-time calculated Parametric map

Toolbar

Adjust B0 Threshold

- To adjust the B0 threshold and to enable (default) or disable the display of the threshold mask.

  Setting a threshold mask will exclude background pixels from the functional map calculations. All pixels with values below the mask value will be displayed blue. Only pixels with intensity above the mask value are used for the calculations, colored areas will be excluded from the calculation

Apply Spatial Smoothing

- To spatially smooth the resulting maps.

  Possible settings are: None (no smoothing), Weak, Medium or Strong.

  Spatial smoothing smoothes the maps ONLY, not the original images. Spatial smoothing doesn’t have any effect on the numerical results.

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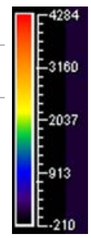
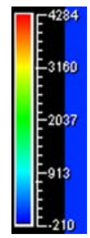
Color LUT (Look-Up Table)

- To select the color look-up table for the maps:

When a color LUT is selected, a vertical color scale bar is shown alongside each image.

The window width and level can be adjusted with all types of color LUT.

Values: Display	GrayScale	Rainbow	Blue To Red
Maximum	White		
	Gray		
Minimum	Black		

Draw ROI

- Click to start up the ROI definition.
- Draw with the left mouse button (no dragging).
- Click to end drawing and to confirm the ROI.

Generate Series

- To calculate a new imaging series with the newly generated images.

A 'Generate Series' window pops up. It allows to specify which images are to be generated in which manner.

Settings

- To adjust settings in the 'Settings' window, in most packages: display, stacks and propagation settings.

Viewing

To adjust the viewing settings:

Orientation (Viewing)

To change the orientation of the images:

- Mirror, Flip,
- Rotate clockwise, Rotate counterclockwise,
- Reset orientation,
- Display Images in Radiological View

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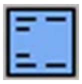
Image Information (Viewing)



- To define the amount of displayed image information:

- minimum: no text is displayed,
- standard: scan, image number and the scan name are displayed,
- maximum: also the offcenter values, the window values (width and level) and the caliper are displayed.

Interpolate (Viewing)

To interpolate the image(s).

Invert Gray Level (Viewing)

- To invert the images of the current dataset (change black and white in the grayscale).

Capture ...

To capture images and save them. Type of image and destination are to be defined in the 'Capture' pop-up window. Check according to your preferences:

- 'Capture Selected Image' captures the current image.
- 'Capture ImageView' captures the current image including orange border and ImageView tab.
- 'Capture Full Screen' captures the full screen.
- 'Capture Slices' captures all slices of the current imaging series.
- 'As Displayed and Annotated' or 'As Acquired' allow to capture images with or without their window/zoom settings and annotations.
- 'Save to External Folder' allows to save the data to an external folder.

  In this case, it is necessary to browse to this external folder.
- 'Save to Patient Database' allows to save the data to the patient database.
- In order to include the hospital name, check the eponymic option.

The function 'Capture ...' as part of Viewing is only available in Review and Analysis packages, not in Graphical PlanScan.

Save Presentation State <Ctrl+S> (Viewing)

To save a special way of presenting images.

Reload Presentation State <Ctrl+R> (Viewing)

To reload a special way of presenting images.

Reset Window (Viewing)

To reset images to original window level and width.

Reset Zoom / Pan (Viewing)

To reset images to original zoom and pan values.

More Functions within the Perfusion packages

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

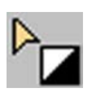
They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

Interaction Mode

- can be used to define the left mouse usage for interaction with images.

The table below lists the functions which are specific for this package. For information about the generic functions, see chapter “Generic functions for images” on page 380.

Possible setting	Corresponding icon	Description
Threshold		Dragging the left mouse adjusts the threshold.
Draw freehand ROI		Dragging the left mouse, a freehand ROI can be drawn. Releasing the left mouse button, the freehand ROI will be closed and the interaction mode will be set to its default setting ’Scroll’ again.

View

- To select the type of image to be displayed:
  - the Source Image or
  - the Subtracted Image.

Set as Subtraction Reference

- To select a dynamic other than the first one as subtraction reference.

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For subtraction purposes, by default the first dynamic (precontrast) is selected as reference. A different dynamic can be used as reference via this function.

NOTICE
This function is applicable only to T1 Perfusion.

Set as Mask

Enabled / disabled.

Modify the Results Display

1. Right-click on the graph viewport.
2. Select one of the options (see table) to modify the display.

Function	Possible values
Autoscale	Enabled/Disabled: If enabled, the graph will be automatically scaled.
Intensity	Enabled/Disabled: If enabled, intensity will be displayed versus time as graph (TID).
Base-log Corrected	Enabled/Disabled: If enabled, the graph will be base-log corrected (practically a sort of inversion).The vertical axis (intensity) uses a logarithmic scale resulting in an optimized display of the graphs.
Deconvolution	Enabled/Disabled.
Follow Mouse	Enabled/Disabled: If enabled, results per pixel will be generated where the results originate from the current pointer position.
Current Slice Average	Enabled/Disabled: If enabled, the graph displays the current slice average.
AIF Average	Enabled/Disabled: If enabled, the graph displays the AIF average.
ROI Average	Enabled/Disabled: If enabled, the graph displays the ROI average.

Results of the Basic T1 Perfusion package

The package calculates the following results:

Graphical and numerical results

- The graphical results present a **Time-Intensity Diagram** (intensity versus time).

  In 'Follow Mouse' mode, the graph correlates to a specific pixel and shows the intensity value (intensity) over the time for this pixel.
- The results will be provided as **parametric maps** and in a **table of results**.

  Scrolling through the maps, the type of the map is indicated in the map’s scan type field. The used values can be found in the descriptions below in brackets.

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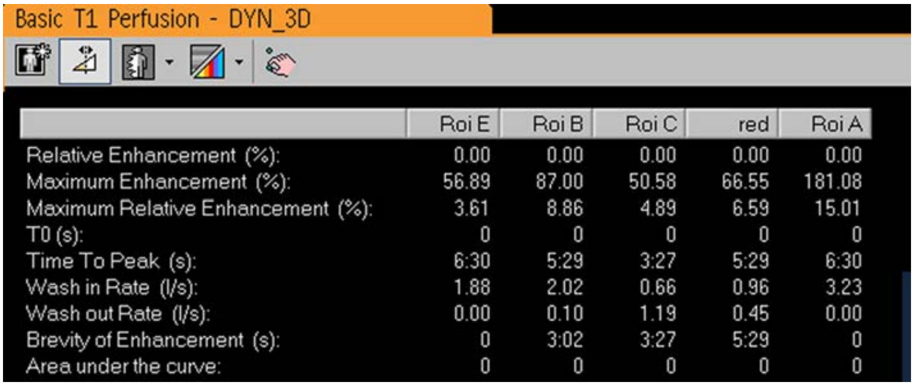

Basic T1 Perfusion - DYN_3D

	Roi E	Roi B	Roi C	red	Roi A
Relative Enhancement (%):	0.00	0.00	0.00	0.00	0.00
Maximum Enhancement (%):	56.89	87.00	50.58	66.55	181.08
Maximum Relative Enhancement (%):	3.61	8.86	4.89	6.59	15.01
T0 (s):	0	0	0	0	0
Time To Peak (s):	6:30	5:29	3:27	5:29	6:30
Wash in Rate (l/s):	1.88	2.02	0.66	0.96	3.23
Wash out Rate (l/s):	0.00	0.10	1.19	0.45	0.00
Brevity of Enhancement (s):	0	3:02	3:27	5:29	0
Area under the curve:	0	0	0	0	0

Fig. 316: Example of Table of Results as shown on screen.

The figure below gives an overview:

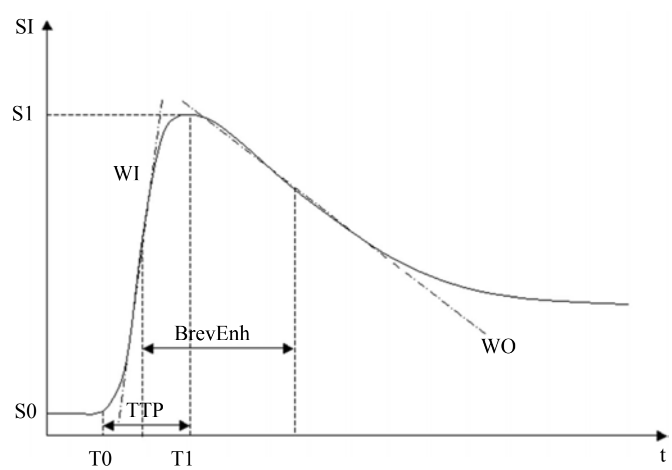

Fig. 317: Results.

Abbreviation	Description
SI	Signal intensity
t	Time
S0	Initial intensity
S1	Peak intensity
T0	Time of Arrival (time of initial intensity)
T1	Time of peak intensity
WO	Wash-Out Rate
WI	Wash-In Rate
TTP	Time to Peak
BrevEnh	Brevity of Enhancement

Relative Enhancement [%] (RELENH)

- The signal enhancement of a pixel of certain dynamic relative to that same pixel in the reference dynamic. The reference dynamic is normally the first, pre-contrast dynamic. The reference dynamic can be set to another dynamic via the right mouse menu function ’Set as Subtraction Reference’.

$$\text{Relative Enhancement} = \left[\frac{I(D)}{I(Dref)} - 1 \right] \times 100$$

Fig. 318: Formula

- where I(D) stands for pixel intensity of current dynamic and I(Dref) stands for pixel intensity of reference dynamic.

Maximum Enhancement (MAXENH)

- Difference between peak intensity S1 and S0.

Maximum Relative Enhancement [%] (MAXRELENH)

- Maximum of all relative enhancements over all dynamics.

T0 - Time of Arrival [s] (T0)

- Arrival of the contrast agent, i.e. begin of the enhancement curve.

Time to Peak (TTP)

- Time between T0 and the time of peak intensity (T1).

Wash-In Rate [l/s] (WASHIN}

- Maximum slope between T0 and time of peak intensity T1.

$$\text{Wash-In} = \text{Maximum} \left[\frac{I(D) - I(D-1)}{T} \right]$$

Fig. 319: Formula

Wash-Out Rate [l/s] (WASHOUT)

- Maximum slope between time of peak intensity T1 and the end of the measurement.

$$\text{Wash-Out} = \text{ABS} \left(\text{Maximum} \left[\frac{I(D) - I(D-1)}{T} \right] \right)$$

Fig. 320: Formula

Brevity of Enhancement [s] (BREVENH)

- Time between point of maximum wash in rate and maximum wash out rate.

Area under the curve (AREACURV)

- Sum of all intensities under the curve.

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Basic T1 Perfusion Workflow

Start up the Basic T1 Perfusion package

1. Right-click on a suitable perfusion data set in the Thumbnail View.

   A context menu appears.

2. Select 'Basic T1 Perfusion'.

   The package opens.

Moving the cursor over either the original image or the map, the curve and the numerical results originating from the current pixel will be shown.

Navigate through images

Through dynamics

► In the image viewport, drag to the left or to the right.

Through slices

► In the image viewport, drag up- or downwards.

Through maps

1. In the map viewport, drag to the left or to the right.

Adjust the threshold

By default, the 'Adjust Threshold' function is automatically enabled: the threshold mask is laid over the original image.

Setting a threshold mask will exclude background pixels from the functional map calculations.

1. Right-drag up- and downwards to adjust the threshold.

Generate results

Results per pixel

In order to generate results per pixel, you have to select a pixel. This can easily be done by pointing at a pixel on the original image or the map. Prerequisite is that the pointer is in the ’Follow Mouse’ mode.

1. Right-click on the curve view port.
2. Click to enable ’Follow Mouse’.
3. Move the pointer over the image or the map.

   Results will be updated with every move of the pointer.

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Philips

Results per ROI

1. Right-click on one of the image viewports and set the Interaction mode to ’Draw ROI’.
2. Drag the left mouse over the image to draw a ROI.

   Release the left mouse button to close the ROI.
3. Right-click on the graph and select ’ROI average’.

You can draw up to 5 ROIs on any desired slice. Scroll through the slices between drawing if necessary.

- When 5 ROIs are drawn, the function 'Draw ROI' is automatically disabled.
- The 5 ROIs are initially called ROI A, ROI B, ROI C, ROI D and ROI E. The names are given in a random order.

Generate a new imaging series

► Click ’Generate series’.

A new imaging series will be generated within the current examination.

SpectroView

The SpectroView package is used to present spectroscopy data after processing. Single Voxel (SV) and Chemical Shift Imaging (CSI) datasets can be analyzed. SpectroView handles both time and frequency domain data presented in the following form possibilities.

- Graphs
  - Processed spectra
  - Fitted spectra
- Tables providing information on
  - Peak position including label
  - Amplitude
  - Ratios
- Metabolite images (in color overlay)
- Ratio images (in color overlay)
- Spectral grids on reference images
  - Display of user-selected subset from an array of spectra

Using the basic script tool, additional apodization and processing steps for time domain data can be performed.

Documentation

The following paragraphs give the following information:

- User Interface

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For information about workflows, refer to the sections chapter “SpectroView Workflow” on page 646, chapter “SpectroView: Advanced Workflows” on page 654 and to chapter “SpectroView: Process Unsuppressed Water Data” on page 674.

User Interface

Screen Layout

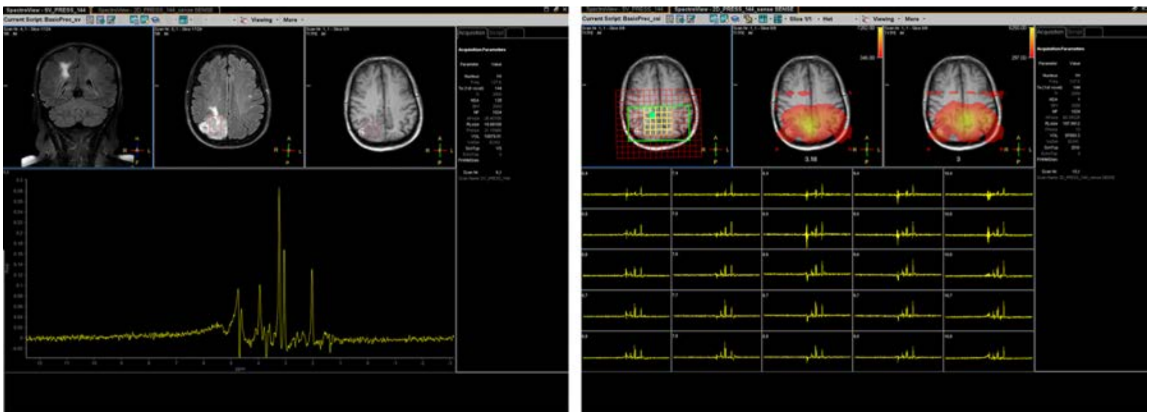

Fig. 321: SpectroView layout: Left for Single Voxel (SV), right for Chemical Shift Imaging (CSI).

For wide screen consoles, the SpectroView package has a default layout of three small viewports for anatomical images and maps, one large viewport for the graph of the spectrum (spectra) and two tables.

The results table is shown below the graph.

In the viewport on the right hand side of the screen, the tabs allow to toggle between acquisition parameters, script parameters and status information.

The Status tab appears when an error has been detected after the last script has been run. It will be colored red and be brought to the front. It contains information about failing voxels where only the first 5 failing voxels are identified, followed by a " multiple errors occurred" message if more voxels failed.

The planscan images in the ’Image Display Area’ are overlaid by the position and orientation of the single voxel or spectral grid.

SpectroView Toolbar

SpectroView Toolbar

For easy and quick access, the most important functions can be performed via the SpectroView toolbar. Depending on the dataset (SV or CSI) being analyzed the toolbar is slightly different. The table lists the icons used and gives an explanation:

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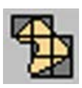
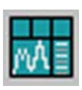
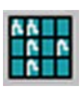
Corresponding icon	Menu item text	Description
	Select Script	• Allows to select a script. • chapter “Select a script” on page 647
	Run Script	• Allows to run a script. • chapter “Run the Script” on page 648
	Edit Script	• Allows to edit a script. • chapter “Scripts and script handling” on page 654
	Save Script	• Allows to save an edited script. • chapter “Scripts and script handling” on page 654
	Delete Script	• Allows to delete a script. • chapter “Scripts and script handling” on page 654
	Select Relevant Voxels	• Allows to select the voxels for result display. • chapter “Select Relevant Voxels” on page 649
	Modify Layout	• Allows to modify the layout. • chapter “Modify Layout” on page 651
	Graph Display Mode	• Allows to modify the display of the graph. • chapter “Optimize spectrum display” on page 651
None	Select Slice	• Toggle between slices in multislice 2D- or 3D-SI datasets. Processing is performed on a slice by slice baseis.
	Store Processing Parameters	• Stores the processed FD (frequency domain) spectrum and the corresponding script parameters and, in case of CSI, selected voxels to the database. A new series name can be specified.
	Process Unsuppressed Water Data	• Allows to switch between the suppressed and unsuppressed data sets, if a series contains unsuppressed water data.
	Expert Mode	• To make some advanced features appear, you need to activate “Expert Mode”.

Corresponding icon	Menu item text	Description
	Peak Editor	• Opens the peak editor. chapter “Customization using the Peak Editor” on page 672
	Delete Series Preferences	• Can be used to erase all Series Preferences for this series. chapter “Series Preferences Database” on page 674 for more information.

More

As part of the toolbar a **More** drop-down menu is available. It offers the following options:

- Delete Script
- Peak Editor
- Delete Series Preferences
- Enable CSV Output

More Functions within SpectroView

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

Right-mouse menus in SpectroView are described in this section. They are available for:

- Anatomical image (overlaid grid)
- Map
- Spectrum
  - Spectrum for CSI dataset
  - Spectrum for SVS dataset
  - Spectrum Display Options

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Available options	Description
Show Grid	To show/hide the grid overlay per viewport.
Use for Underlay Image	To select a different anatomical underlay image.
Running Attribute	To select the running attribute if more attributes are present in the anatomical series.
Select All Processed Voxels	To select all voxels that were processed with the last used script.
Settings	These options can be used in the same way as throughout the complete user interface.
Reset Window	
Reset Zoom/Pan	
Interpolate	
Export Picture	
Export Picture As	

Tab. 34: Anatomical image (overlaid grid)

Available options	Default	Description
Adjust blending and threshold	OFF	If selected, dragging the left-mouse up and down changes the threshold of the color overlay. Dragging the left-mouse left to right changes the opacity of the color overlay
Show Grid		To show/hide the grid overlay per viewport.
Interpolate Maps		Allows to display map images calculated by SpectroView in non-interpolated mode (color reflects metabolite value or ratios for the corresponding voxel) or interpolated mode (colors/values are "smoothed" across voxel boundaries).
Display Map		Enables the display of maps.
Settings		These options can be used in the same way as throughout the Advanced Viewing Environment.
Reset Window		
Reset Zoom/Pan		
Interpolate		
Export Picture		
Export Picture As		

Tab. 35: Map

Spectrum

Dependent on the selected dataset (SVS or CSI), different features are available. The tables below describe these features.

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Available options	Default	Description
Show Annotation	OFF	Enables or disables the display of an abbreviated list of spectrum qualities in the upper left corner of the spectrum viewport.
CSI Graph Annotation	NAA/Cr and Cho/Cr	Specifies which quantities are displayed in the upper right corner of each spectrum box, Choices include whatever metabolite map quantities are currently displayed in the middle and in right viewports as well as some standard peak area ratios: NAA/Cr, Cho/Cr, NAA/Cho, Cho/NAA, and (if applicable) Cho/Ct and (Cho+Cr)/Cit.
Spectrum Display Options		Allows to optimize the spectrum display. chapter “Optimize spectrum display” on page 651 for more information on the available options.
Subtract Baseline From Graph Display	OFF	Subtracts the fitted baselines from both the original and fitted spectrum.
Display Graph: x,y		To select the spectrum from voxel x,y for display only. Disabling the step switches back to the last used selection.
Display Time Domain Data for Voxel x.y	OFF	Allows inspection of the time-domain data within a pop-up window.
Graph Display Mode	Geometrical	Sets the type of display for selected spectra: • Horizontal: displays spectra horizontally. • Stack displays spectra vertically. • Geometrical: displays spectra corresponding to the arrangement of voxels. • Compressed: displays spectra in a square or rectangle array with a minimum of blank entries.
Phase Mode	Modulus for CSI max. echo, Real for CSI half echo	Defines which part of the spectrum is displayed. • Real: real component. • Imaginary: imaginary component. • Phase: phase information. • Modulus: magnitude. • Power: modulus squared spectral signal.
Display Average	OFF	Computes and displays an average of all selected spectra in single voxel format, if enabled. The table of results will be updated to show the values of the average spectrum. Choosing this entry runs the script again for the selected set of voxels and then displays the average with fitted spectrum in single voxel format. Clicking this entry again returns to multi-voxel display, with only that spectra, that contributed to the average selected. Screen layout matches SVS layout.

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Available options	Default	Description
Line Display	OFF	Active only for stack display. Enables or disables display of a vertical line that follows the position of the mouse, for comparing peak positions in different spectra.
Set Spectrum Limits	---	Specifies left/right values for X-axis and minimum/maximum for Y-axis.
Display Full Width	OFF	Displays the full spectrum if enabled.
Display Full Height	---	Scales the spectrum amplitude so that the tallest peak fills the spectrum viewport.
Reset View	---	Restores default chemical shift limits and adjusts the spectrum amplitude to display its full height. Note: The default display range is defined in the selected script. An autoscale mechanism is used to zoom the spectrum to fill the entire spectrum display area.

Tab. 36: Spectrum for CSI dataset

The graph display mode is also accessible via the main toolbar. For more information on horizontal, vertical, geometrical and compressed display, refer to the section ’Modify Layout.

Available options	Default	Description
Show Annotation	OFF	See table above: ’Spectrum for CSI dataset’.
Spectrum Display Options		chapter “Optimize spectrum display” on page 651for more information on the available options.
Subtract Baseline From Graph Display	OFF	See table above: ’Spectrum for CSI dataset’.
Display Time Domain Data for Voxel x.y	OFF	
X-axis Units	ppm	Changes the X-Axis units to Hz or ppm.
Phase Mode	Real for SVS	See table above: ’Spectrum for CSI dataset’.
Difference Mode	OFF	Enables or disables the possibility of adding vertical lines which can serve as markers for comparison. Two nr’s for each line indicate peak position and amplitude. Dx and Dy represent the difference in position and the difference in amplitude between the selected points. The integral of the spectrum between 2 markers is displayed as well.
Set Spectrum Limits	---	See table above: ’Spectrum for CSI dataset’.
Display Full Width	OFF	
Display Full Height	---	
Reset View	---	

Tab. 37: Spectrum for SVS dataset

Available options	Default	Description
Show Spectrum	ON	Enables or disables the display of the original spectrum.
Show Metabolite Labels	ON	Enables or disables the display of the metabolite names in the spectrum.
Show Fitted Spectrum	ON	Enables or disables the display of the fitted spectrum.
Show Fitted Baseline	ON	Enables or disables the display of the fitted baseline.
Show Residual	OFF	Enables or disables the display of the difference spectrum.

Tab. 38: Spectrum Display Options

The Spectrum Display Options can be used to modify the display of the spectrum with respect to the graph and metabolite labels.

SpectroView Workflow

The table summarizes the workflow for processing of spectral data:

	Single Voxel Spectroscopy (SVS)	Chemical Shift Imaging (CSI)
1	• Start up SpectroView	• Start up SpectroView
2	• Select a script	• Select a script
3		• Select relevant voxels
4	• Run the script • If necessary: zooming and panning.	• Run the script
5	• Optimize the spectrum display	• Optimize the spectrum display
6	• Modify the layout	• Modify the ayout
7	• Create screen captures • Storage and export of data	• Create screen captures • Storage and export of data

Start up SpectroView

► Right-click on a suitable spectroscopic dataset in the Thumbnail View.

A context menu appears with several selection possibilities.

► Click on the ’SpectroView’ icon.

The SpectroView package opens.

Fig. 322: SpectroView icon

Alternatively:

- Double-click on a spectroscopic dataset OR

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- Drag a spectroscopic dataset into the viewports.

NOTICE

If ’Anatomic Region’ is specified on ExamCard level, the corresponding Basic script is automatically executed for processing time domain data.

NOTICE

If no ’Anatomic Region’ is specified on ExamCard level, a pop-up is displayed, indicating that a ’brain’ processing script is executed.

After processing, a new Basic script can be selected.

NOTICE

If voxels fail, there will be a pop-up after all voxels have been processed, that gives information about the error(s).

More information is found in the ’Status’-tab.

Select a script

A script is a set of processing steps that are performed to analyze and display a spectrum (or set of spectra).

The possibilities within a script are different depending on the type of the selected dataset.

Type of dataset	Icon	Possibilities
Time Domain dataset		The script will allow for pre-processing steps via a ’basic processing’ script.

For more information on scripts

- See chapter “Scripts and script handling” on page 654.
- See chapter “Processing steps” on page 656.

Default processing script

When you open a spectroscopic dataset in SpectroView, the system automatically comes up with a default script, dependent on the selected dataset. This default script is indicated as ’current script’ in the toolbar.

NOTICE

This default script depends on the setting of the general imaging parameter ’Anatomical Region’.

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NOTICE

In case of a time domain dataset, this is the BasicProcessing sript.

Workflow ’Select script’

1. Click on the ’Select Script’ icon on the toolbar.

   The ’Script Selection’ window opens showing the list of available scripts.

   By default, only those scripts are displayed which are compatible with the currently selected dataset. To display also the scripts which are not compatible with the current dataset, disable one of the filters ’Nucleus’, ’Anatomy’, ’Field’ and/or ’TE’.
2. To select a script, double-click it, or click once and then click |OK|.

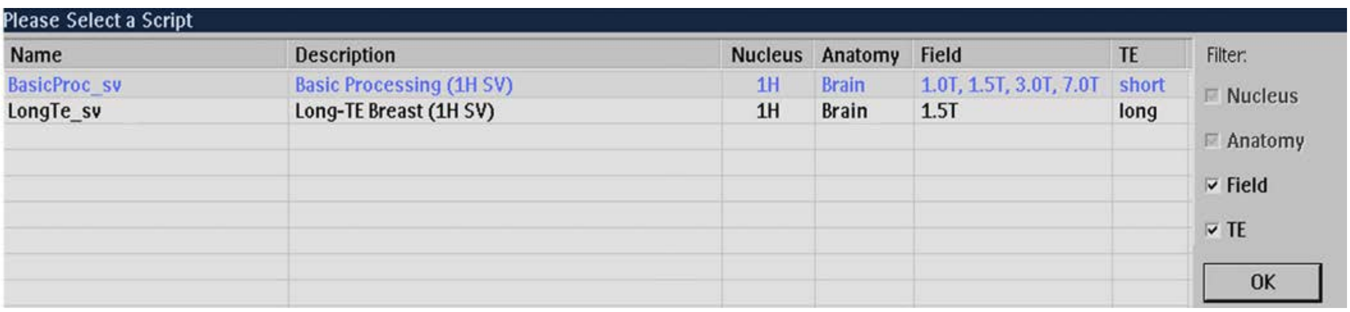


Fig. 323: Script selection window (English only). Currently selected dataset is a MRS proton short-TE dataset acquired in the brain on a 1.5T system. Only compatible scripts are listed since all filters are enabled. If you disable ’Anatomy’, besides the brain scripts also the muscle, breast and prostate scripts will be shown.

Run the Script

1. Click on the ’Run Script’ icon on the toolbar.

   Alternatively click |Run| within the script editor.

Zoom, Pan and Window for SpectroView

If necessary, zooming and panning can be performed now.

To zoom the spectrum,

- press middle and right mouse simultaneously. Move the mouse up and down to increase or decrease the displayed peak heights. Move the mouse left and right to increase or decrease the displayed chemical shift range.

To pan the spectrum,

- press middle and left mouse simultaneously. Move the mouse to pan the spectrum.

To change color range and threshold of color overlays,

- Press <CTRL> and middle mouse simultaneously to change the color settings. OR

- Select "adjust blending and threshold" from the image viewport menu to adjust treshold or opacity of the color overlay. If selected, dragging the left-mouse up and down changes the threshold of the color overlay. Dragging the left-mouse left to right changes the opacity of the color overlay.

This is only relevant for CSI data where metabolite maps are generated:

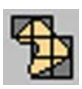
Select Relevant Voxels

NOTICE

This operation is only valid for CSI data sets or for dynamic single voxel data sets.

There are two possibilities of how to select relevant voxels, either by clicking on voxels or by drawing a ROI.

In both cases:



1. Click on the ’Voxel selection’ icon in the toolbar.

   The drop-down menu opens.
2. Select one of the possibilities:
   - Select Individual Voxels
   - Select Voxels by Drawing

In voxel selection mode, the left mouse behaviour in the spectral grid is changed.

In case of ’Select Voxels by Drawing’

1. Draw a freehand ROI by holding the left mouse and selecting a region over which you want to investigate. The voxels are automatically included based on the ROI drawn

In case of ’Select Individual Voxels’

1. Click on a voxel to select it.

The corresponding spectrum and the table of results will be displayed. The screen layout matches the SVS screen layout. (Note that the table of results will only be shown if a script has been run before).

A new single click will select a new voxel and deselect the previously selected voxel. The spectrum and the table of results will be displayed again.

Multivoxel Selection Mechanisms

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1. Click to select another voxel while simultaneously pressing <CTRL>.

   <CTRL> + left mouse click will select any unselected voxel and deselect any selected voxel. The other voxel will be selected additionally to the previously selected one. The spectra from the selected voxels are displayed.
2. Click to select one voxel, click once more to select another voxel while simultaneously pressing <Shift>.

   The two points define a box. All voxels in this box will be selected. The spectra from the selected voxels are displayed.

NOTICE

Voxel select can be chosen before a script is run to choose which voxels get processed.

If no voxels are chosen before processing, a default grid of 5x5 voxels in the PRESS volume is displayed after processing.

Voxel color description

To facilitate further processing, the voxels are overlaid by a colored grid to indicate their current processing state:

- Blue outline: Voxels have been included in processing steps.
- Yellow shaded voxels: Voxel is currently displayed.
- Red outline: Voxel failed processing.

Right-clicking in the image display viewport and selecting "select all processed voxels", the previously processed voxels will be reselected.

NOTICE

Following the initial script generation, additional voxels can be added to the original processing as long as the script has not been changed.

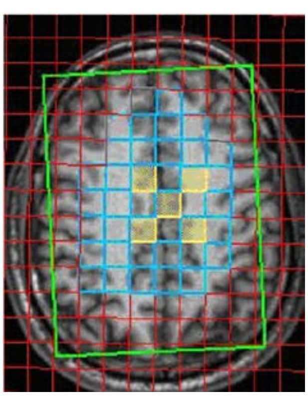

Fig. 324: Example of voxel colors.

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Optimize spectrum display

The spectrum display can be modified for any single spectrum display: SVS, one voxel CSI or one average of CSI.

1. Right-click on the spectrum display area to access the ’spectrum display’ context menu. This menu offers possibilities as e. g.
   - show or hide list of spectrum data
   - show or hide spectrum and/or metabolite labels
   - show fitted spectrum and/or fitted baseline
   - select spectrum component for display (e.g. modulus, real)
2. Access the spectrum viewport context menu for multi-voxel display, via a right mouse click on the spectrum grid area. This menu offers possibilities as e.g.
   - show or hide list of spectrum data
   - specify quantities to be displayed
   - set spectrum limits
   - define type of display for spectra
   - select spectrum component for display (e.g. modulus, real)

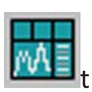
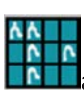
See section chapter “User Interface” on page 640, for more information on both menus.

Modify Layout

1. Click on the Layout icon to change the screen layout and select an option:

   The resulting layout will be:

   As layout requirements are different for SVS and CSI-cases, either one of the icons is grayed out, depending on the scan that is currently selected in SpectroView.

   - the default screen layout with three image viewports at the top of the screen, a graph display area and a result display area.
   - a screen with spectra only. The graph display area will be enlarged to fill the entire screen.
   - a screen with a table of results only. The result display area will be enlarged to fill the entire screen.
   - a screen with spectra on the image.

In case of CSI

1. Select the type of display from an array of selected spectra.

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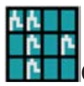
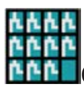
2. Click on either of the following icons:

   - Horizontal display: The graphs are displayed horizontally. This is a multiple graph area mode.
   - Stack display: The graphs are displayed vertically in one box with no dividing lines. This is a multiple graph area mode.

     Spacing between spectra in stack display mode can be changed as follows: Press <Shift> and simultaneously, press both middle and right mouse icons. Moving the mouse upwards increases the space between spectra; moving the mouse down decreases the spacing between spectra. This does not affect the spectra themselves and is not applicable in other CSI display modes.
   - Geometrical display (default layout): The graphs are displayed in viewports being structured in the same layout as in the CSI grid. Voxels that are not selected in the CSI grid have an empty corresponding graph.
   - Compressed display: The graphs are displayed compactly, one by one in a square or rectangular array with a minimum of blank entries.

Create screen captures

There are different possibilities to create screen captures. These are listed below:

- Select ’Screen Capture’ or ’Screen Capture as’ from the Tools menu.
- Select ’Print Screen’ via the corresponding icon on the general toolbar.
- Select ’Export Picture’ to store the current viewport with overlays included as a *.png file in the E:\export directory.

Storage and export of data

There are three different data formats with respect to storage of data:

1. DICOM-data (that is stored in the database) For single voxel, entry x.1 = time domain data, entry x2 to x.n are processed spectra. For CSI, x.1 is time-domain data, x.2 is image series.

   Each time a processing script is performed, the results can be stored via the toolbar option ’Store Processing Parameters’. A new entry is added to the database.
2. Export of spar/sdat This export functionality is available in research tools only: If a spectroscopy dataset is selected for export in the DBIMEXP-research tool, spar/sdat data is exported to E:\export. In case of CSI series, par-rec data of the corresponding spectroscopic images is also exported.
3. Output to a spreadsheet application

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– Create a file named csvoutput.txt in E:\export. (empty file, it is used as a flag to tell SpectroV to enable CSV output.)
– Only if enabled: Each time you run a script, the following files are placed in the G:\site \spectro folder:
  [name].Fdd.csv - the Frequency Domain Data from the BasicProcessing Script
  [name]Baseline.csv - the fitted baseline data
  [name]Fitted.csv - the fitted peak data
  [name]ScaledRaw.csv - the scaled unfitted data
  [name]Script.txt - a textual description of the script used to produce the results
  [name]Table.csv - the table of Processing Results

By default this is disabled to prevent unnecessary pollution of the export directory. This function can be enabled via the toolbar function 'More'/'Enable CSV Output'. When the package gets closed the functionality is disabled by default.

NOTICE

In case of running BasicProcessing Script, the only files created are "Fdd.csv" and "Script.txt".

These files use the naming scheme:

<patient name>-<DICOM Study ID>-<DICOM Series ID>-<Date>-<Time>filename.ext

- <patient name> = the patient name with all the illegal filename characters and whitespace removed
- <DICOM Study ID>
- <DICOM Series ID>
- <Date> = the date of the script run
- <Time> = the time of the script run

The ".csv" files can be opened directly in Microscoft Excel and contain headers identifying each column. The data will contain X, Y, Z and T (time for dynamics) voxel coordinate columns (voxels are 4-dimensional objects).

- For single slice data sets, the Zcoord column will always be "1"
- For non-dynamic data sets, the Tcoord column will always be "1"
- For single voxel data sets, the coordinates will always be (1,1,1,t).
- In CSI data sets, the voxel with coordinate (-1,1,1,t) is the "average voxel", it contains the average of all the currently selected voxels.
- Spectrum values in these files are expressed in PPM

A maximum of 20 datasets can be present in the folder. If more than 20 sets are in the folder, SpectroView deletes the oldest set, as determined by the timestamp in the filename.

SpectroView: Advanced Workflows

This section provides more information about the SpectroView package in order to achieve best results and to optimally handle the package.

It covers:

- User Interface
- Scripts and script handling
- Processing steps
- Customization using the Peak Editor
- Series Preferences Database

Scripts and script handling

A script is a set of (pre-)processing steps that are performed to analyze and display a spectrum (or set of spectra). There are two different types of scripts:

- Basic Processing Scripts

  A Basic Processing Script defines the pre-processing steps that can be enabled or disabled.

- Fitting Scripts

  A Fitting Script defines the processing steps that can be enabled or disabled for the fitting process.

  – chapter “Processing steps” on page 656 for more information about the (pre-) processing steps.

Scripts can be selected from a list, modified and then saved with changes.

The following paragraphs describe the script handling how to edit and save a script and how to delete a script.

Edit Script

It is possible to define user defined scripts. This can be done by editing an existing script:

1. Click on the ’Edit Script’ icon in the toolbar.

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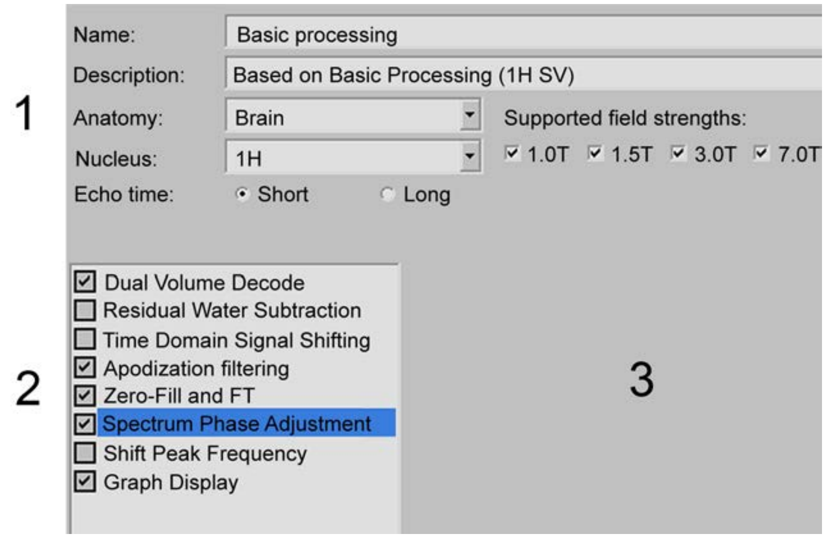

The script editor displays

- the name of the current script
- a description of the script and its purpose
- anatomy, nucleus, echo time and supported field strengths
- a list with all possible processing steps, each with a checkbox to allow the user to enable or to disable the corresponding step.

2. Select a nucleus: for example ^{1}H.
3. Set the Echo time property to ’short’ or ’long’ (longer than 75 ms).
4. Click in the Field Strength checkboxes to specify whether this script is tuned for a specific field strength or a range of field strengths.

NOTICE

The properties ’Nucleus, Echo Time and Supported Field Strengths’ are only used to drive the Script Selection Dialog filtering.

Changes to these properties do not impart any automated tuning to an existing script.

5. Click on the checkbox of a processing step to enable or disable the step for the script.

   The enabled step will be highlighted. Once a step is highlighted, a page of parameters associated with the step will be displayed.
6. Set the parameters to the desired values.chapter “Processing steps” on page 656 for more information on the processing steps and corresponding parameters. chapter “Scripts and script handling” on page 654 for more information on the scripts.

NOTICE

Edited scripts are renamed using the following format: <unnamed>date-time.

7. Click |Cancel| to close the dialog box without applying the changes made.

   Clicking |Run| applies the script immediately and exits the script editor.

   Clicking |Ok| can be used when a script has not been saved yet. It closes the dialog box and stores the edited script temporarily until another script or spectroscopic data set is selected. The edited script can still be run or edited later. This is an useful option in order to judge the quality of a script prior to saving.
8. Save Script

   The script is only saved, but not applied in this case.

   - Click the 'SaveScript' icon in the toolbar to save the script.
   - Enter a name (when editing a Philips supplied script) and optionally a script description.

Delete Script

- Click 'Delete Script' on the SpectroView toolbar to delete the current script.

Processing steps

This section describes the processing steps which can be performed within a basic processing script and/or fitting script.

Once a processing step is enabled, a page of parameters associated with the step will be displayed in the Script Editor.

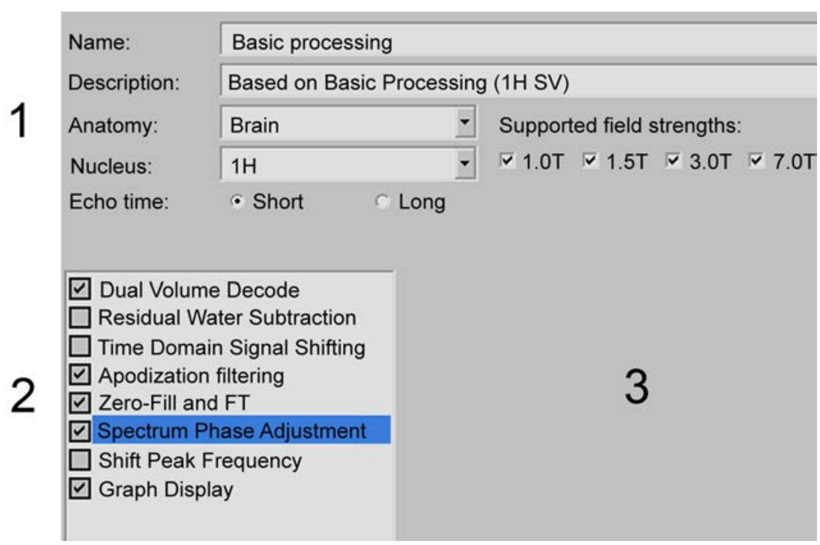

Fig. 325: Processing steps in Basic Processing Script for Single Voxel Imaging.

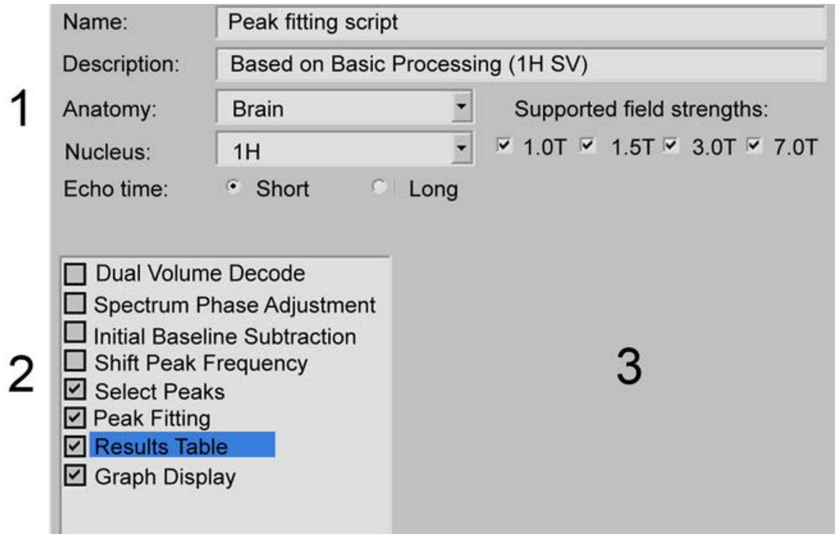

Fig. 326: Processing steps in Peak Fitting script.

1	General properties
2	Processing steps
3	Reserved for parameters belonging to the selected and thus highlighted processing step

Available pre-processing steps in Basic Processing Script

For Single-Voxel Spectroscopy	For Chemical Shift Imaging
• Dual Volume Decode	
• Residual Water Subtraction	• Residual Water Subtraction
• Time Domain Signal Shifting	• Time Domain Signal Shifting
• Apodization Filtering	• Apodization Filtering
• Zero-Fill and FT	• Zero-Fill and FT
• Spectrum Phase Adjustment	• Spectrum Phase Adjustment
• Shift Peak Frequency	• Shift Peak Frequency
• Graph Display	• Graph Display
	• Integration Ranges for Maps

Available processing steps in Peak Fitting Script

For Single-Voxel Spectroscopy	For Chemical Shift Imaging
• Dual Volume Decode	
• Spectrum Phase Adjustment	• Spectrum Phase Adjustment

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For Single-Voxel Spectroscopy	For Chemical Shift Imaging
• Initial Baseline Subtraction	• Initial Baseline Subtraction
• Shift Peak Frequency	• Shift Peak Frequency
• Select Peaks	• Select Peaks
• Peak Fitting	• Peak Fitting
• Results Table	• Results Table
• Graph Display	• Graph Display
	• Generate Maps
	• Correct for DSA Filter

Dual Volume Decode

- is used to decode the (A+B) and (A-B) encoding used in Dual Volume acquisitions. There are no adjustable parameters for this script step.
- appears at the top of all single voxel BasicProcessing scripts and at the top of all single voxel Peak Fitting scripts.

Residual Water Subtraction

- removes residual water signal by applying a high pass filter over which data points are combined and subtracted from the original signal.
- gives the possibility to adjust the high pass filter by means of a slider.

Typical application

If the water suppression applied during acquisition is imperfect, the residual water peak can at times interfere with the metabolite peaks of interest. One way to minimize its effect is to apply a high pass filter in the time domain (D. Marion, M. Ikura, and A. Bax, "Improved Solvent Suppression in One- and Two-Dimensional NMR Spectra by Convolution of Time-Domain Data," J. Magn. Reson. 84, 425-430, 1989). Because water is at or near resonance, a high pass filter will selectively remove the low frequency water signal.

High Pass Filter

The filter works by first smoothing the input time-domain signal using Gaussian convolution. Each point is replaced by the average over a Gaussian-weighted window of points with a user adjustable width. The smoothed version of the input signal is then subtracted from the original signal to leave only the higher frequency "wiggles."

Slider values

The slider defines the width in points (specifically the FWHM) of the Gaussian-weighted window of time-domain points.

Narrow window - broad filter

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Only a few neighboring points are averaged together to replace each input point. Only the highest frequency wiggles are smoothed away. When this function is subtracted from the original, only the highest frequency wiggles remain: a broad filter has been applied in the frequency domain.

Wide window - narrow filter

Many points are averaged together, resulting in a very smooth function. When this is subtracted from the original, only frequencies very close to resonance will be affected: a narrow filter had been applied in the frequency domain

Time Domain Signal Shifting

- Can be used to shift the time domain signal to either remove spurious signals or to align spectra. It will not be applied with standard acquisitions.
- Can be done with
  - Shift with zero padding

    This is a function to shift a time domain signal with an integer number of sample points by inserting zeroes. The point index for each point is changed by the parameter shift. The shift can be negative. Points that fall outside the array will be lost. If shift is greater than the total number of points N the result will be all zeroes. Typical use of the function is to remove spurious signals at the beginning of a FID that can cause baseline distortions in the spectrum.
  - Cyclically shift

    This is a function to shift a time domain an integer number of sample points. The point index for each point is changed by the parameter shift. The shift can be negative. Points that fall outside the array will be appended at the other end. If shift is greater than the total number of points N, the result will be identical to a cyclic shift with parameter <shift> = (<shift> - k *N) points where k is any integer number. Typical use of the function is to align spectra.

Note that the default shift is zero.

Apodization Filtering

- improves the signal-to-noise in a dataset by partially filtering out the noise in a MRS signal prior to Fourier transform (FT): before the Fourier transform (FFT) there is a decaying signal in a constant background of noise. This means that the signal to noise in the first points of the signal is better than in the last points of the signal. A weighting function can be applied to emphasize the points with good signal to noise. The best weighting function is one that follows the decay of the signal. Because the peak areas should not be changed, the function must not change the data point of the FID corresponding to time zero. The intensity of this point before FFT is proportional to the total of the peak areas.
- allows to choose more than one filter if requested.
- The choice of filters includes the following:

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Available Filters	Description of Filter
Gaussian Multiplication	• Applied to transform a Lorentzian line shape to a more compact Gaussian shape (the foot of a Gaussian is smaller than Lorentzian shape, thus overlap of peaks is reduced). • This can only be positive apodization. • It causes a line broadening effect.
Exponential Multiplication	• Applies a decaying exponential to increase the apparent SNR at the cost of a reduction in resolution. • Can be applied as an apodization or negative (for cancellation of T_2 decay). • Use of a positive value gives a an effect equal to 'Lorentzian line broadening'.
Convolution Difference	• Can be used as a method for broad line suppression. • The signal is multiplied with an exponential filter as in the exponential multiplication function. The result of this operation is subtracted from the original filter. • The difference is then scaled.
Lorentzian-to-Gaussian	• To change a line shape that is naturally Lorentzian, to a Gaussian line shape (if this is preferred for analysis or presentation) • The signal is first multiplied with a Lorentz window with a negative line width parameter. Then the signal is filtered with a Gaussian function.
Broad Line Suppression	• Multiplies the time domain signal with a function that has low intensity in the first few data points and is unity for all other points. • Filters out broad line components
Sine Window	• Applies a filter for suppressing artifacts in spectroscopic images. • Usually not applied to the time domain of chemical shift data, but on the spatially encoding dimensions in a one or two-dimensional spectroscopic imaging
Sine Squared Window	• This is the squared sine function. It is equivalent to 1/2 times a sine function of double width plus a lift of 1/2. • This is known as the Hanning window.

It is often easier to use the exponential multiply and Gaussian multiply functions rather than the LG function. Performing the function in two steps allows more flexibility. It is therefore the most commonly used form of apodization filtering.

Use the Exponential multiplication with a negative line broadening value to get a line sharpening (or de-convolution of the Lorentzian line shape). Combine this with a gaussian multiplication with a positive line broadening value. This positive line broadening must exceed the (negative) EM line sharpening value to have a noise filtering effect.

An example that should work for most proton spectra:

- Gaussian +3Hz, Exponential -1.5 Hz

This will result in an effective line broadening of 1,5 [Hz].

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Related parameters

This section describes all related parameters of this script step, for all selectable filters.

Symmetry point

- is a value between 0.0 and 100.0 % giving the relative position of the echo top in the FID.
- is the point where the filter function should have the value one and should correspond with time point zero.
  – For a half echo FID (echo acquisition = half) it is at the start of the FID: the symmetry point = 0%.
  – For a full or symmetric echo (echo acquisition = symmetric) the echo top position will be in the middle at 50 %.
  – For maximum echo (echo acquisition = maximum) the position of the echo top will be somewhere between 0 and 50 %.

The symmetry point can either be selected at "echo max": the echo top position is automatically defined, or at "xxx%", to manually specify the echo top position.

Gaussian mult [Hz], Exp mult [Hz]

- sets the line broadening values for the respective filters.

Line broadening [Hz]

- appears when the Convolution Difference (CD) filter is selected. The purpose of the CD filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines.
- is the estimated line width of the broad component. Broad peaks decay quickly in the time domain; hence the CD filter has a small value at the echo center (as defined by the symmetry point). Away from the echo center, it climbs quickly to a value of unity. As a result, broad signal components are suppressed, whereas narrow components (which decay slowly in the time domain) are only slightly affected.
- The filter function is defined as follows:

  Wi = 1 - SC exp[-N |i/N - SP| pi LB / (2 BW)]

  where

  Wi = weighting factor for time point i

  i = time point index

  N = number of acquired time-domain points

  SP = symmetry point of filter

  SC = scale factor (0.0 < SC < 1.0)

  LB = line width of the broad component

  BW = bandwidth

Scale factor

- appears when the Convolution Difference (CD) filter is selected. The purpose of the CD filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines.

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- controls how completely the broad component is minimized. Allowed values for SC lie between zero and one.

Peak width [Hz]

- appears when the Lorentz-Gauss Multiply (LGM) filter is selected. The purpose of the LGM filter is to convert Lorentzian lineshapes to Gaussian lineshapes to improve resolution. (Lorentzian lines have broader "tails" than Gaussian lines with the same full width at half-maximum).
- should be set to the line width for which the user desires the filter to work best.

Suppression factor

- appears when the Broad Line Suppression (BLS) filter is selected. The purpose of the BLS filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines.
- controls how completely the broad component is minimized.

Cut-off frequency

- appears when the Broad Line Suppression (BLS) filter is selected. The purpose of the BLS filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines. (As such, it is similar to the Convolution Difference filter.)
- is the estimated dividing line in Hz that separates the width of broad components from the width of narrow components. Broad peaks decay quickly in the time domain; hence the BLS filter has a small value at the echo center (as defined by the symmetry point). Away from the echo center, it climbs quickly to a value of unity. As a result, broad signal components are suppressed, whereas narrow components (which decay slowly in the time domain) are only slightly affected.
- The filter function is defined as follows:

  Wi = 1 / { 1 + SF exp[-N |i/N - SP| pi Fc / (2 BW)] }

  where

  Wi = weighting factor for time point i

  i = time point index

  N = number of acquired time-domain points

  SP = symmetry point of filter

  SF = suppression factor

  Fc = cut-off line width between broad and narrow features

  BW = bandwidth

Final points to zero

- allows the user to zero out a selected number of points at the end of the time-domain signal -- the ultimate filter. Choosing 200, for example, will set the last 200 time-domain signal points equal to zero.

Multiple filters: workflow

1. Define first set of filter parameters.

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2. At the top of the parameter panel, set ’Number of Filters’ from ’1’ to ’2’.
3. At the top of the parameter panel, set ’Edit Filter’ to ’2’.
4. All the parameters should be "reset" and you can now set them for ’Filter 2’.
5. To change the parameters for ’Filter 1’, change ’Edit Filter’ to ’1’.
6. For only 1 filter, change ’Number of Filters’ to ’1’.

Note that the order of filter selection doesn't matter as they are all multiplication filters.

Zero-Fill and FT

FT

- This processing step cannot be disabled, FT is always performed.To view time domain signals, select right mouse menu item ’Display time domain signal for voxel x,x’.

DC correction

- Enables or disables the use of DC correction (to remove DC offset). A DC offset can be caused by hardware imperfections, or by the presence of a non-relaxed low-frequency signal (typically water), and will be presented as a spike.
- The window width is defined as a percentage of the total acquisition window, and is selectable between 1 and 15%.

Zero-Fill

- Is used to increase the number of points in a spectrum to a user defined value. The apparent digital resolution of the spectrum will be increased by increasing the digital number of points.

More about zerofill

The acquisition time should be set to record the FID or echo until well past the point where the signal disappeared into the noise. Rather than recording a signal with nothing in it but noise, some additional resolution may be obtained by zero filling.

Doubling the signal length by appending zeros will actually add information present in the imaginary part of the complex points to the absorption spectrum. Zero filling more than a factor two will just interpolate the spectrum without adding any more real definition.

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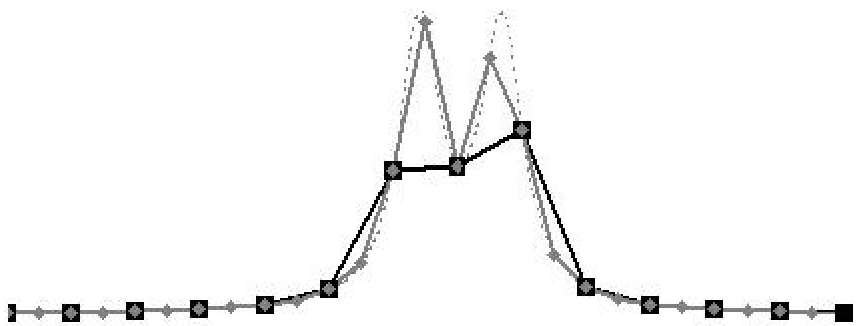

Fig. 327: Zero filling results in interpolation in the frequency domain. The black line is a two peak spectrum with a low resolution. Zero filling the data to double the amount of points reveals two resolved peaks (gray line). The dashed thin grey line shows the smoothing effect of further zero filling. The resolution can improve significantly and a zero filled spectrum will look better.

Zerofill the spectral transform to

- defines the total number of points in the spectrum (= acquired number of points + zerofilled number of points)
  - Recommended value: twice as high as the acquired nr of points.
  - If zerofilling is not required, the number selected should be equal to the acquired number of points.

Spectrum Phase Adjustment

- Allows the user to correct the phase of the spectrum using both zero-order (global) and first-order (linear) terms.
- Both auto phasing and manual phasing can be selected.

  Although any spectrum can be adjusted, this capability is most relevant for (a) non-proton spectra or (b) proton spectra acquired without an unsuppressed reference scan.

Autozeroth (global) term

- Zero order phase correction; being used if there are small delays between the transmit and reception of the signal in which the phase error has an influence on all peaks.
- Correction on a voxel-by-voxel basis.

Autofirst (linear) term

- First order phase correction in the case of phase differences which are present over various resonance frequencies.
- Correction on a voxel-by-voxel basis.

Manual Phase Adjustment

If enabled,

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- the selection of the above options is disabled.
- the script will stop once phase adjustment is required, popping up a separate window in which both global and linear phase correction can be manually adjusted by the user:

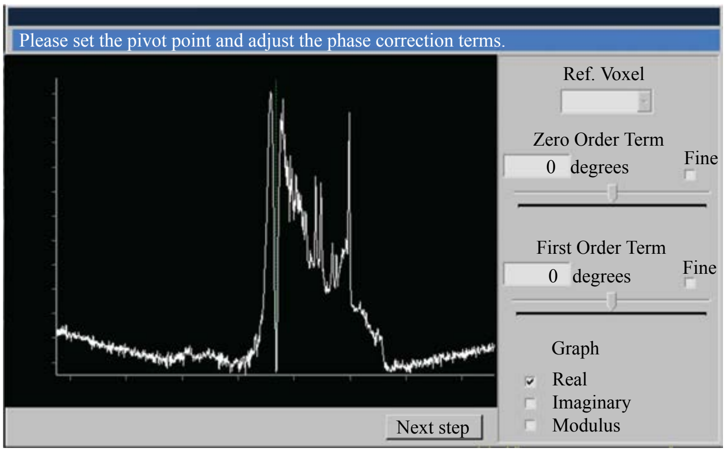

Fig. 328: Window 'Manual Phase Adjustment': Sliders are just to interactively change the phase. Radio buttons are available for fine adjustments: the step size is reduced. Once phasing is completed, press 'Next Step' to resume the execution of the Basic Processing script.

Provide phase values below

- allows you to program exact values into the script itself. The default values shown here represent the values specified during the last Manual Phase Adjustment, as supplied by the Series Preferences database. As in Manual Adjustment, these values are applied to all selected voxels. Clinically, this option is probably not useful, but for experiments requiring you to process the same dataset using the same parameters more often– this improves workflow.

Integration Ranges for Maps

- allows the upper and lower bounds of a peak to be selected (in ppm) to which the estimated metabolite map is created

Initial Baseline Subtraction

Distortion of the spectral baseline caused by broad line resonances or missing data points can be corrected for visual presentation with the function 'Initial Baseline Subtraction'.

'Initial Baseline Subtraction' is used to remove large distortions from the spectral baseline as they might confound later processing steps.

In this initial step, the ci variables are adjusted quickly and without knowledge of peak positions. As such, this step is omitted by default for short-TE brain spectra – the simple-minded algorithm does not distinguish well between broad peaks and true baseline variation."

'Baseline estimation occurs again during the fitting process, where it is done more accurately.

'Baseline Polynomial Terms' parameter

The baseline is modeled as a function of position x across the analysis range (e.g. 4.5 ppm to 0.0 ppm) with x defined from -1.0 to 1.0. The baseline is assumed to be a polynomial of x; for example:

$c_3x^3 + c_2x^2 + c_1x + c0$.

Using a slider, the user can choose the degree of the polynomial - the highest power of x to be considered and in such a way the number of terms. The ci variables are adjusted for the best fit - quickly and without knowledge of peak choices here in this step - and later with more care during the peak fitting process.

Select Peaks

The next step for processing is to select and/or deselect the peaks that need to be fitted and quantitated.

'Metabolites' parameters

A list of metabolite peak names is provided in which the user can select or deselect the peaks of choice.

Note that the default ON/OFF settings for peak selection are defined by the target anatomy and TE as conveyed by the choice of the script.

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Peak Fitting

An iterative nonlinear least-squares technique is used to fit spectra as the sum of a set of peaks (each modeled as a linear combination of a Gaussian and a Lorentzian function) plus a baseline (modeled as a polynomial function of position). In particular, an algorithm developed by Marquardt and Levenberg is used that efficiently searches for the best fit. This fitting process generates a list of optimized peak heights, widths, positions, and areas.

Definitions

Brief definitions are as follows:

Iterative

The fitted spectrum is not calculated in one shot. Rather, the initial estimate of the fitted spectrum is refined over a series of steps (typically 6 to 10).

Nonlinear

Some of the variables in the fitted spectrum are not simply scaling factors (like the variables that describe the baseline), but rather are incorporated within the model functions used for the fit. An example is the set of peak width variables, these appear in the expressions for Gaussian and Lorentzian line shapes in complicated ways.

Least-squares fit

The least-squares fit minimizes the sum over the analysis range of $(p_i - f_i)2$, where

- p_i is the value of the initial spectrum at point i

- f_i is the value of the fitted spectrum at point i.

Parameters

Analysis Range parameter

These parameters refer to the range of chemical shifts (expressed in ppm). which has to be considered while fitting the spectrum. The start and end value of this range can be entered as left and right analysis limit.

The default range is 4.35 ppm to 0.0 ppm.

Display Range parameters

These parameters refer to the default range of chemical shifts (in ppm) to be displayed after the script is run. The initial choice is from 4.0 to 0.0 ppm. These limits can be modified using the context menu (activated with a right-mouse click) in the spectrum viewport.

Gaussian Percentage parameter

This parameter defines the percentage of Gaussian character of the fitted peak lineshapes. The default value is 85%, based on trial-and-error adjustment of proton brain spectra. In general, metabolite peaks for in vivo proton spectroscopy are more Gaussian in nature than Lorentzian. An example of both lineshapes is presented in figure.

Gaussian Percentage	Effect
0 %	Pure Lorentzian line.
100%	Pure Gaussian line.

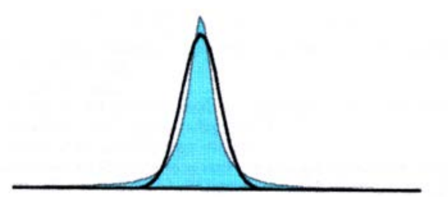

Fig. 329: Lorentzian (shaded area) versus Gaussian (black line) lineshape. The two peaks shown have the same integral area.

The Gaussian line is broader near the resonance frequency but trails off to zero more rapidly than the Lorentz line.

Baseline Terms parameter

This parameter specifies how many polynomial terms are used to model the baseline during the peak fitting process. A similar parameter is used in the ‘Initial Baseline subtraction’ step. Both functions correct for distortions of the spectrum baseline.

However, the initial baseline subtraction is to remove large variations in the baseline so that automatic peak assignment is more likely to succeed. It is done quickly without any prior knowledge where the peaks are. It’s too crude a technique for short TE spectra, because it can’t readily distinguish between broad J-coupled (or lipid) peaks and rolls in the baseline. It is much better at long TE where the difference between peak and baseline is more obvious.

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During the actual fitting process, the baseline (or the "residual baseline," if it has been trimmed in the residual baseline subtraction step) needs to be included as part of the overall spectrum fit. Otherwise the peaks will not be modeled properly. The baseline function should be flexible enough to follow the baseline, but not so flexible that it interferes with fitting the peaks themselves. As noted above, the Baseline Terms slider controls this flexibility by specifying the number of polynomials terms used during the fitting process.

Phase Parameter

Either the real spectrum or the modulus spectrum can be used in the fitting process. "Real" is the default for single-voxel acquisitions, and "Modulus" is the default for CSI. However, if the CSI echo acquisition type was set to half echo instead of maximum, this phase parameter should be changed to "Real."

Lock Relative Frequency parameter

When this fitting parameter is enabled, the number of free variables used to model the positions of N peaks is reduced from N to one. It makes use of the fact that peak positions are usually not independent of each other. For example, if the NAA peak position is known, one expects creatine to be 1.01 ppm away, choline to be 1.20 ppm away, etc. Reducing the number of free variables typically makes for a more robust fit.

Lock Releative Frequency	Effects
ON	• More robust fit. • Less chance of peak functions moving away from their initial positions to fit baseline features.
OFF	• Better fine control of the fitting. If peak positions are free to move a little bit, then J-coupled lineshapes and moderately misshapen singlet peaks can be modeled more precisely. • Safer in general, when spectrum quality is high (i.e. minimal baseline variation, minimal peak shape distortion and good SNR).

Lock Widths parameter

This feature is similar to locking relative peak frequencies and is intended primarily for long TE spectra. It is well known that the linewidths of NAA, Creatine and Choline are inherently similar. They should widen together when the shim is bad and narrow together when the shim is good. Based on this knowledge it is possible to replace three separately adjustable widths with one overall width parameter.

Lock Widths	Effects
ON	• Useful when the SNR is low and peak shapes are distorted by noise in the spectrum. • Ignores any possible differences between peak widths. • The peak area ratio value is not likely to be distorted by baseline noise on peak shapes. • All resulting peak area ratios will equal the corresponding peak height ratios.
OFF	• Better fine control of the fitting.

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Parameter(s)	How to change the parameter value
Left analysis limit	Enter value in data entry box. Default: 4.2 ppm.
Right analysis limit	Enter value in data entry box. Default: 0.0 ppm.
Left display limits	Determines which part of the spectrum is displayed initially.
Right display limits	Determines which part of the spectrum is displayed initially.
Baseline terms	Slider to change the number of baseline polynomials. Maximum: 15, Default: 9.
Gaussian percentage	Slider to change this percentage. Default: 85%.
Phase	Real / Modulus Determines phase aspect during peak fitting
Lock relative frequency	Click in checkbox to select or deselect. Default: ON.
Lock widths	Click in checkbox to select or deselect. Default: OFF.

Tab. 39: Parameters for processing step 'Peak Fitting'

Peak Editor

The Peak Editor makes it possible to add peaks into the peak fitting table. This peak will show up in the ’Edit script’ environment. chapter “Customization using the Peak Editor” on page 672 for more information.

Shift Peak Frequency

If peaks are not located correctly during the fitting routine, a manual assignment of peak positions can be performed. If peaks are assigned to their correct value, it will improve the fitting of the lesser, more difficult peaks.

- You can select “Specify shift interactively” to manually assign a ppm-position to a selected peak.
- You can deselect "Specify shift interactively", you have to specify the frequency shift value in ppm in the supplied textbox.

  The default values shown in the textbox will represent the values specified during the last interactive Shift Peak Frequency, as supplied by the Series Preferences database.

Workflow

If ’Shift Peak Frequency’ is enabled, the execution of the script is stopped, and a pop-up window allows the user to manually assign a ppm-position to a selected peak. Once completed all steps, the processing script is resumed.

The workflow is the same for SVS and CSI, but in SVS there is no "reference voxel" (step 2):

1. From the "Peak" ComboBox, select the peak to shift.
2. If CSI, select the reference voxel from the "Ref Voxel" ComboBox. Refer to the graphs in the graph area to find a voxel that has a good spectrum that can be used to set the shift.

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3. A graph of the reference voxel is displayed and the cursor is labeled with the selected peak and positioned at a point determined by the "Peak Fitting" algorithm. The annotation in the graph describes the X and Y coordinates of the peak, as located by "Peak Fitting".
4. Examine the X coordinate and verify that it is located on the correct PPM value.
5. If it IS on the correct X PPM value, go to step 8
6. If it IS NOT on the correct X PPM value, use the mouse to move the cursor to the correct value. Click on the "Re-Process" button.
7. The pop-up will close, the "Peak Fitting" step will be repeated, the pop-up will return and the graph will now show the corrected result. If the X PPM value is not correct, go back to step 4. If the X PPM value is correct, continue with step 8.
8. Click on the 'Next Step' button to continue processing.

NOTICE

User definition of peaks is mainly important for multi-nuclei spectroscopy, where ppm-positions are usually assigned/changed for PCr.

In general, this step is not required for proton spectroscopy.

Results Table

You may specify up to 4 different denominators (or none at all), including unsuppressed water which will be provided in the Results Table ratio calculations. The Results Table will contain the height and area ratios for each denominator. Your selection of denominators is determined by the peaks specified in the Select Peaks script step.

All Peak Fitting scripts have been defined with Cr as a single ratio, to provide backward compatibility with R2.5. When running older user-defined scripts, which don't have a Results Table step, we assume the same single Cr ratio to provide backward compatibility.

Correct for DSA Filter

NOTICE

This processing step is only available for datasets acquired prior to R2.

The processing step is disabled in all Philips Scripts.

This processing step

- is available for CSI data sets only and is only applicable if a DSA filter was applied during reconstruction.
- corrects for the intensity distorting effects of the DSA filter used by the reconstructor.

The DSA filter is a method to reduce residual water signals during reconstruction. The DSA filter works by shifting all FIDs over n points and subtracting these from the originals. The signals with zero frequency (water frequency) will then be nulled. The other frequencies are also attenuated except for an optimum frequency. Depending on the selected optimum frequency, the appearance of spectra, extracted from a CSI data set will be different as different weighting is applied to the various points in the spectrum. This will also have an influence on peak fitting and the results.

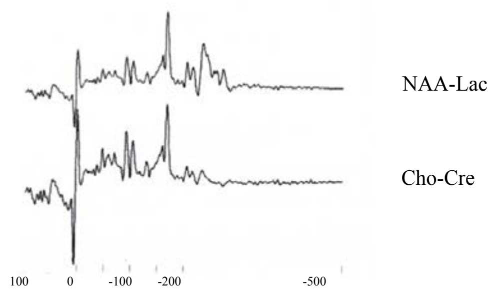

Fig. 330: Effect of DSA filter with different optimum frequency on the appearance of a spectrum.

In the figure above, the upper row shows a spectrum from a CSI data set with DSA filter optimized for NAA and lactate. The lower row shows the same spectrum with DSA filter optimized for choline and creatine.

The DSA filter does a good job of removing large residual water peaks, and hence it is applied by default during reconstruction. The DSA filter correction step in the script does not change the appearance of spectra. Instead, when enabled, it compensates for the frequency-dependent effect of the filter. It corrects the reported values of peak heights, peak areas, peak height ratios, and peak area ratios. It also corrects how these quantities are displayed in metabolite maps and ratio maps.

Generate Maps

This step is used to generate maps based on individual metabolites or ratios between metabolites.

Individual metabolite maps

Once a metabolite has been selected a choice can be made whether to generate metabolite maps.

- based on the fitted area where fitted area is based on FWHM

or

- based on the fitted height where fitted height is based on the overall intensity of the peak.

Ratio Maps

To create a ratio map, select a single metabolite in both the numerator and denominator. Multiple selections of metabolites in both/either the numerator or denominator can also be utilized for grouped ratios.

To add or remove a map

- Select the metabolites of interest (maps) in either one or both columns. Then click 'Add' or 'Remove'.

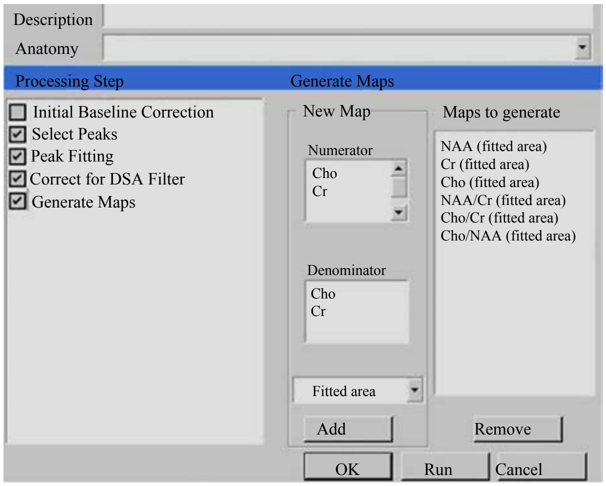

Fig. 331: Example: Window 'Generate Maps'.

Graph Display

This function enables or disables the display of graphs with the spectral results. It also configures the layout. It allows to define the following:

- Display mode: geometrical, compressed, horizontal or stack
- Layout: default, full-screen graph or full-screen table
- Spectrum display options: enables/disables display of spectrum, fitted baseline, fitted spectrum, residual or metabolite labels
- Spectrum limits: Override X and Y range
- Show annotation: enabled or disabled.

These functions are only available via the graph right-mouse menu.

Customization using the Peak Editor

The Peak Fitting algorithms in SpectroView use a database of known peaks with attributes to drive the fitting, display and calculation results.

Commonly accepted peak definitions (known as PDPs or Philips Defined Peaks) are provided by default and may not be modified or deleted.

Users may add their own peak definitions to the database and may edit them or delete them. This can be done by means of the Peak Editor.

This section describes the Peak Editor and the following issues:

Start up the Peak Editor (PE)

1. Select 'Peak Editor' from the SpectroView toolbar.

The Peak Editor opens.

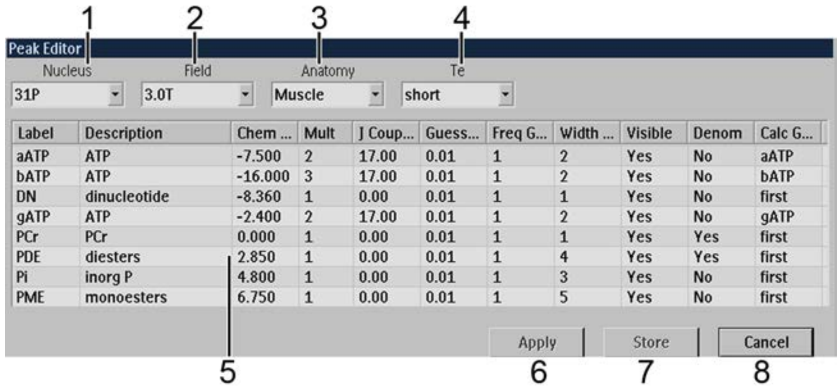

Fig. 332: Peak Editor layout.

1	Peak database filter combo box: Nucleus
2	Peak database filter combo box: (Magnetic) Field
3	Peak database filter combo box: Anatomy
4	Peak database filter combo box: Echo time Te
5	List of peaks
6	Control box: Apply
7	Control box: Store
8	Control box: Cancel

Peak database filter combo boxes

When a dataset is loaded, appropriate peaks are selected from the peak database according to the nucleus, field strength, anatomy and Te of this dataset. These filters are set to the values found in the currently loaded dataset. However, these filters may be changed at any time.

Table of peaks

The table shows all peaks which are part of the database.

Control buttons

Cancel

- exits the Peak Editor and discards all changes made in the current instance of the dialog. Changes made in previous instances of the dialog (by using the Apply button) remain in effect.

Apply

- applies changes to the database and exits the Peak Editor, but does not save the database to disk. The peak changes are immediately available for the next script run, but if you exit SpectroViewing without doing a Store, all applied changes will be discarded.

Store

- saves the updated database to disk and exits the Peak Editor. Once changes are saved to disk, they will be permanent, even across software updates.

Peak attributes

The table below lists the peak attributes which are supported in the peak database.

Add a new peak

Series Preferences Database

The Series Preferences Database facilitates the workflow for those series that do not have the proper anatomy settings included. Whenever loading such a series, it is necessary to specify the correct anatomy (e.g. brain or prostate).

SpectroView maintains a database containing “preferences” for the last series (approximately last 100 series) that were processed. For each series, the following information is captured:

- Anatomy
- Expert Mode On/Off
- Shift Peak Frequency Reference Voxel
- Shift Peak Frequency Shift Value
- Shift Peak Frequency Reference Peak
- Shift Peak Frequency Graph Cursor Position
- Shift Peak Frequency Graph X and Y Axis Scaling
- Manual Phase Adjust Reference Voxel
- Manual Phase Adjust Pivot Point
- Manual Phase Adjust Zeroth Order Correction
- Manual Phase Adjust First Order Correction
- Manual Phase Adjust Graph Phase Real/Imaginary/Modulus
- Manual Phase Adjust Graph X and Y Axis Scaling

When a series is reloaded, these preferences are also reloaded and applied to the ScriptEditor, interactive dialogs, etc.

Since it is possible you might make a mistake during processing (like selecting the wrong anatomy), you can clear all the preferences for the current series by clicking on the “Delete Series Preferences” menu item or button.

SpectroView: Process Unsuppressed Water Data

An exciting feature of SpectroView is the ability to visualize and fit the unsuppressed water signal. The benefits are as follows:

- The width of the water peak is a straightforward measure of shim quality.

- Artifacts are often easier to see (and interpret) in an unsuppressed water spectrum than in a normal suppressed spectrum.
- Most important, the size of the unsuppressed water peak is a useful denominator for peak area ratio (or height ratio) calculations. Moreover, if the water concentration is known for the tissue of interest, absolute metabolite concentrations can be estimated.

Workflow

1. Start up SpectroView with a suitable dataset. The dataset loads.

2. Click the ’Process Unsuppressed Water Data’ icon to start the analysis.

   The icon remains highlighted. The dataset reloads, now with the unsuppressed water data information.

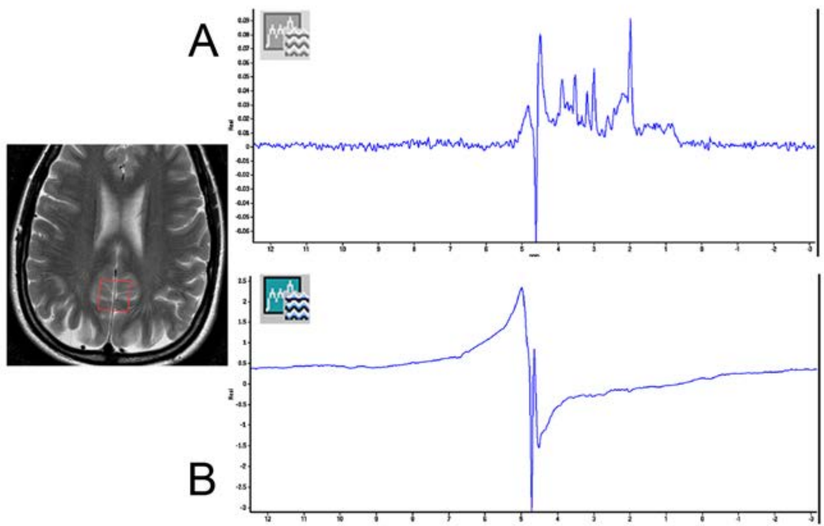

Fig. 333: Spectra: initially and after starting the analysis 'Unsuppressed water'. A - A typical SV spectrum as initially displayed, acquired with Spectral Correction ON. B - Unsuppressed water spectrum is distorted because Residual Water Subtraction is ON.

3. Select a basic processing script which is optimized for unsuppressed brain water.

   Make sure that the following parameters are set as follows:
   - Residual Water Subtraction: Off
   - Spectrum Phase Adjustment: On, and set to Auto Zeroth Order
   - Use the same apodization filter settings for water and for metabolites

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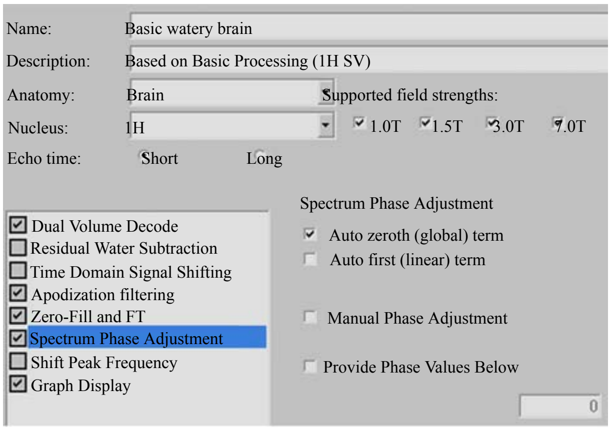

Fig. 334: Example: Script parameters of basic processing script for unsuppressed water analysis.

NOTICE

If you start off with Unsuppressed Water in SpectroView, it might be necessary that you create a new script with settings as described above.

4. Run this script.

   Figure shows the resulting spectrum.

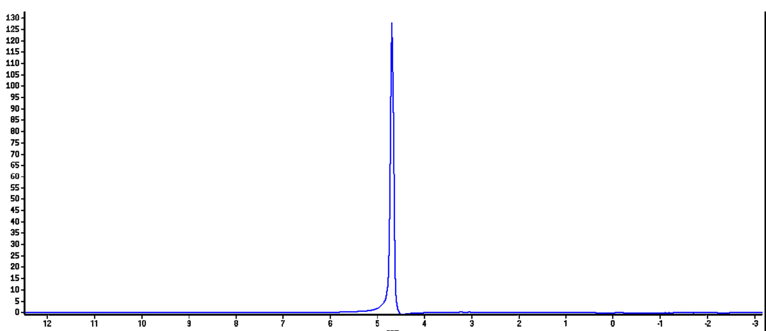

Fig. 335: Unsuppressed water, auto-phased and undistorted by “residual” water subtraction.

5. Select a water-fitting script for the brain.

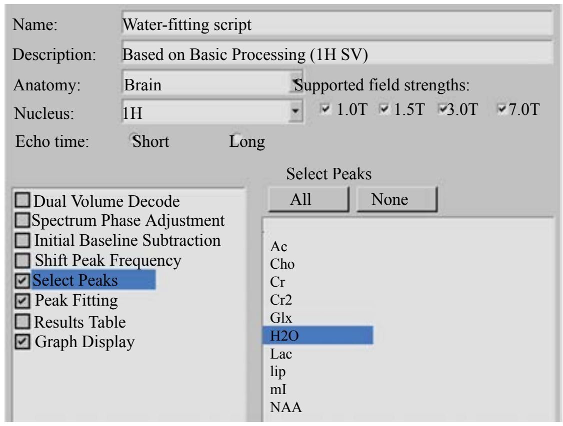

Fig. 336: Water-fitting script for the brain: Dual Volume Decode = off, Spectrum Phase Adjustment = off, Initial Baseline Subtraction = off, Shift Peak Frequency = off, Select Peaks = on, Peak Fitting = on, Results Table = off, Graph Display = on.

NOTICE

If you start off with Unsuppressed Water in SpectroView, it might be necessary that you create a brain water-fitting script.

In this case, start up with the standard water-fitting script and change its anatomy to ’Brain’.

6. Run this script. Figure shows the result.

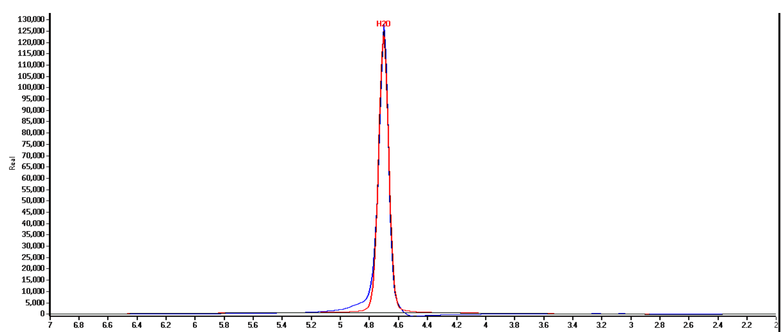

Fig. 337: Peak fitting results for the analysis 'Unsuppressed water'. Although the peak area and peak height are the quantities needed for ratio calculations, the peak width is valuable too as a measure of shim quality.

7. After analysis of the unsuppressed water is done, return to the usual water-suppressed spectrum by clicking off the "Process Unsuppressed Water Data" icon.

8. Select a generalized brain-fitting script to display metabolite ratios with respect to unsuppressed water.

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NOTICE

If you start off with Unsuppressed Water in SpectroView, it might be necessary that you create a new generalized brain-fitting script.

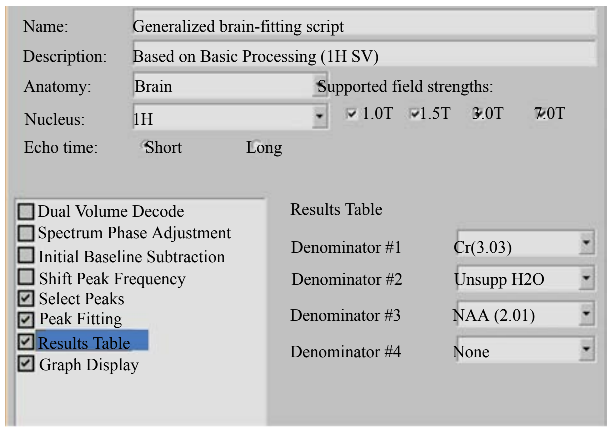

Fig. 338: Generalized brain-fitting script, processing step: Results Table. In this example, NAA has been selected as “Denominator #3” as well.

9. Run this script. Figure shows the results.

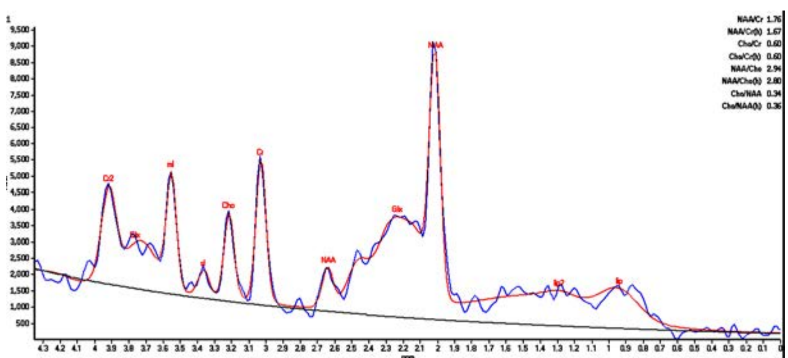

Fig. 339: Results: Metabolite ratios with respect to unsuppressed water.

A table is also displayed providing the ratios in numeric values.

Make sure that ’Unsupp. H_2O’ is selected as one of the denominators on the Results Table script page.

Truncate Graph Peak

When processing unsuppressed water data, the resulting spectra often looks like this:

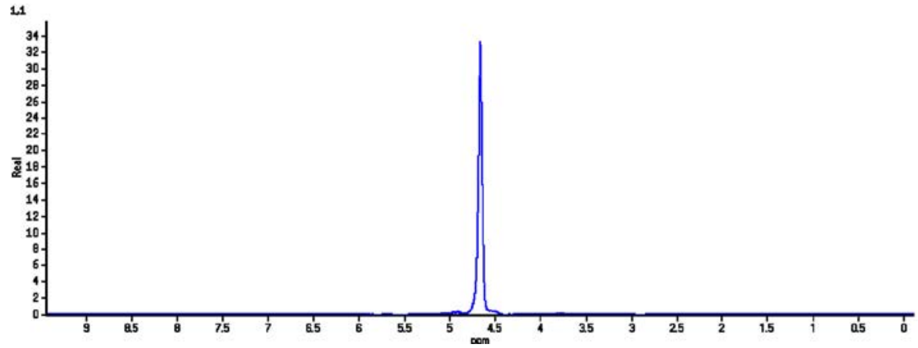

Fig. 340: The overwhelming water peak causes smaller peaks and ripples to be scaled down to a flat line.

To overcome this situation, you can use the option ’Truncate Graph Peak’ from the graph right-mouse menu. This option only appears when “Expert Mode” is enabled, since careless use can cause misleading results. Once activated, we see:

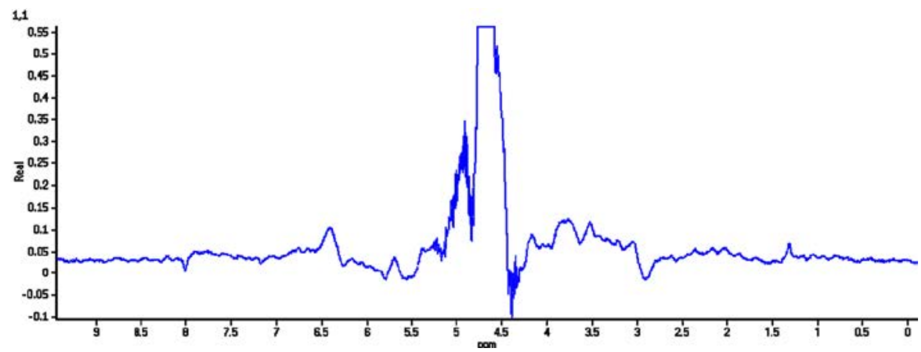

Fig. 341: Now the details of the “noise” surrounding the water peak can be visualized.

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17 MR Angiography (MRA)

MRA is a method of visualizing vessels,

- either non-invasive (without the use of contrast media)
- or invasive (with the use of contrast media: Contrast-Enhanced MRA).

Maximum and Minimum Intensity Projection

MRA scans provide you with many slices which can be viewed one by one. To view the complete vessel tree in a convenient way, calculate Maximum and Minimum Intensity Projections from the MRA slices.

The Maximum Intensity Projection (MaxIP) is an algorithm, which is commonly used in MR Angiography. Based on the projection direction, the voxels of a 3D dataset (acquired by the M2D, MS or 3D scan mode) are examined along the projection rays. Each projection ray will select the maximum voxel intensity along that ray. The maximum value of each ray corresponds to a specific pixel in the projection image.

The calculation of a Minimum Intensity Projection is comparable, but in this case each projection ray will select the minimum voxel intensity along that ray. This Minimum Intensity Projection is to be calculated for Black Blood imaging.

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Inflow MRA

Inflow MRA is based on enhancement of flowing blood and suppression of stationary tissue.

Applications

- Intra- and extracranial vessels,
- Carotid arteries,
- Origins of vertebral and carotid arteries, pulmonary vessels,
- Depiction of the aortic arch and neck vessels,
- Femoral and popliteal arteries and the vessels in the hand,
- Screening vascular anomalies all over the body.

Preparing the patient for an inflow MRA scan

M2D-, 3D-, Multichunk 3D-Inflow and TONE do not require special patient preparation.

► For Gated, Dual-Gated and Turbo Inflow MRA, connect VCG to the patient.

Planning Inflow MRA scans

Inflow MRA techniques are performed without contrast agent. You can perform these MRA scans as part of every MR examination.

▷ With the patient positioned in the isocenter,

▷ with a current ExamCard,

▷ with survey or anatomical images to plan on,

► Select a MRA inflow scan protocol and add it to your ExamCard.
Skip this step, if an angio scan protocol is already part of your ExamCard.

- **3DI**: 3D Inflow
- **M2DI**: M2D Inflow

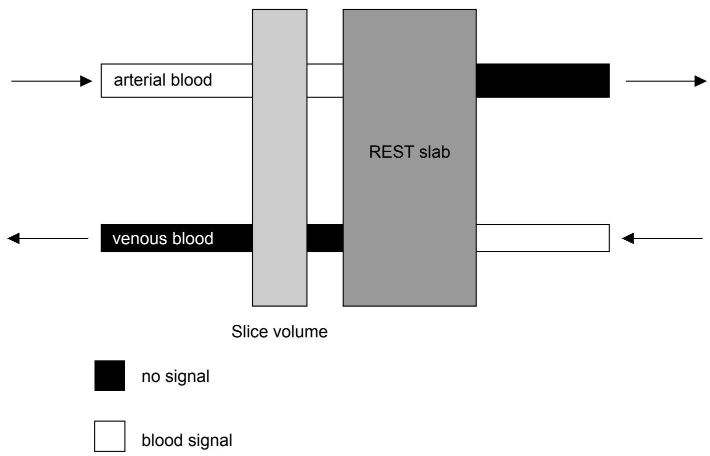
► Select suitable images for planning.

Scroll to the slice best suited for planning. Window, zoom and pan to optimize the display of anatomic structures needed for planning.

► Plan the stack/volume as perpendicular as possible to the vessels of interest.

► Verify that the REST slab is placed correctly to selectively suppress arterial or venous blood.

If a free REST slab is used, drag this REST slab to the vessels that need to be suppressed.



Analysis of MRA datasets

- Use **VolumeView** for the calculation of MaxIPs.

  See chapter “VolumeView: MaxIP and MinIP” on page 533.
- Use **PicturePlus** for image enhancement.

  See chapter “PicturePlus” on page 560.

Maximum Intensity Projections of inflow images

3D-Inflow (inverse display)	**Multichunk 3D-Inflow**	**TONE** in Multichunk 3D-Inflow

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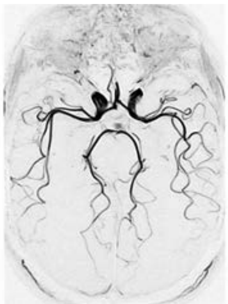
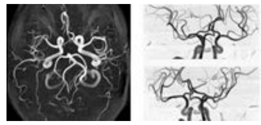
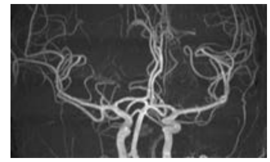
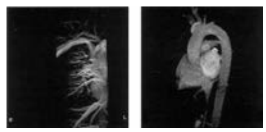
Philips

		
M2D Gated Inflow (inverse display)	**Turbo Inflow**	
		

More information

- about artifacts, see chapter “MRA inflow artifacts” on page 908

Phase Contrast Angiography (PCA)

PCA is based on phase differences of flowing spins compared to spins of stationary tissue. A flow sensitive and a flow compensated (reference) scan are acquired. An automatic complex subtraction of these scans is performed.

PCA provides two types of images:

- PCA-M images (suppressed background, bright vessels).
- FFE-M images (soft tissue images).

Applications

- Intra- and extracranial vessels
- Carotid arteries
- Origins of vertebral and carotid arteries, pulmonary vessels
- Depiction of the aortic arch and neck vessels
- Screening vascular anomalies all over the body.

Preparing the patient for an inflow MRA scan

2D- and 3D PCA do not require special patient preparation.

► For Gated and Cine PCA, connect VCG to the patient.

Planning PCA scans

PCA techniques are performed without contrast agent. You can perform these MRA scans as part of every MR examination.

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▷ With the patient positioned in the isocenter,

▷ with a current ExamCard,

▷ with survey or anatomical images to plan on,

► Select a PCA scan protocol (with **PCA** in the name) and add it to your ExamCard.
Skip this step, if an angio scan protocol is already part of your ExamCard.

► Select suitable images for planning.

Scroll to the slice best suited for planning. Window, zoom and pan to optimize the display of anatomic structures needed for planning.

► Plan the stack/volume on the vessels of interest:

- Scan orientation may be the same as the vessel plane. Benefit: Fewer slices are needed to cover the entire vessel.
- This means that you can plan the stack/volume in vessel plane, perpendicular to them or in any other plane.

► If you use a REST slab in the scan protocol, drag this REST slab to the vessels that need to be suppressed.

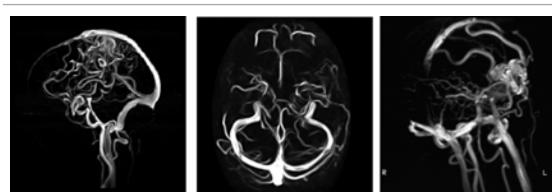
Analysis of MRA datasets

- Use **VolumeView** for the calculation of MaxIPs.

  See chapter “VolumeView: MaxIP and MinIP” on page 533.
- Use **PicturePlus** for image enhancement.

  See chapter “PicturePlus” on page 560.

Maximum Intensity Projections of PCA images

3D PCA of the brain: PC velocities 50 cm/s, 15 cm/s, 30 cm/s.	**Gated PCA** of renal arteries	
		

More information

- about artifacts, see chapter “Aliasing in PCA” on page 909

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Quantitative Flow (QFlow, QF)

Quantitative Flow measurements are performed as 2D- or 3D-Phase Contrast Angiography (PCA) technique with data acquisition synchronized to the heart cycle.

Cardiac synchronization (retrospective triggering, alternatively also prospective or gating) with VCG is needed.

Applications

- Flow measurement in any vessel.

Sequence

- A flow sensitive and a flow compensated (reference) scan are acquired.
- Phase subtraction is done resulting in a flow image.

Properties

- Multiphase acquisition providing
  - PCA-M images (suppressed background, bright vessels).
  - FFE-M images (soft tissue images).
  - PCA-P images (flow images).
- Quantitative results as velocity (cm/s) or flow rate (ml/s).

Preparing the patient for a QFlow scan

► For QFlow measurements, connect VCG to the patient.

Planning QFlow scans

▷ With VCG connected to the patient,

▷ with the patient positioned in the isocenter,

▷ with a current ExamCard,

▷ with survey or anatomical images to plan on,

► Select a QFlow scan protocol (with **QFLOW** in the name) and add it to your ExamCard.
Skip this step, if an angio scan protocol is already part of your ExamCard.

► Select suitable images for planning.

Scroll to the slice best suited for planning. Window, zoom and pan to optimize the display of anatomic structures needed for planning.

► Plan the stack/volume *perpendicular* to the vessel of interest.

QF measurements should always be made in a plane orthogonal to the vessel. Otherwise the area covered will be larger and the QF measurement overestimated.

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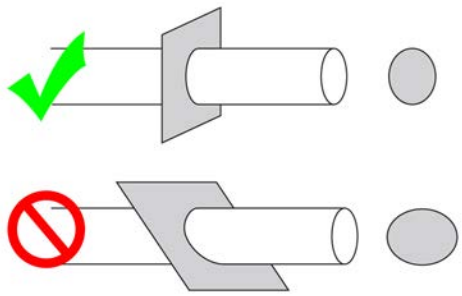
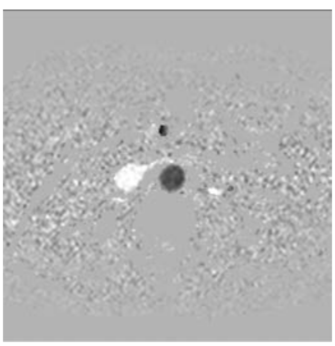
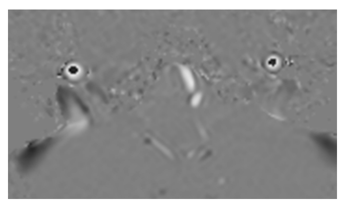


► If a REST slab is used, drag this REST slab to the vessels that need to be suppressed.

QFlow Analysis

► Use the **QFlow analysis** package for the calculation of various results.
See chapter “QFlow package” on page 551.

Examples of QFlow images

QFlow (PCA-P image)	**QFlow with aliasing artifact** (PCA-P image)
	

More information

- about artifacts, see chapter “Aliasing in PCA” on page 909.
- about VCG, see chapter “VCG (VectorCardioGraphy)” on page 152.
- about the QFlow analysis package, see chapter “QFlow package” on page 551.
- about how to perform a QFlow analysis, see chapter “QFlow Analysis” on page 557.

Contrast-Enhanced MRA (CE-MRA)

Contrast-enhanced MRA is based on T1 shortening of blood by means of contrast agent.

Contrast agent is injected as a bolus. The CE-MRA scan is started when the bolus arrives at the region of interest.

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Philips

Applications

- Carotid arteries,
- thoracic and abdominal vessels,
- peripheral vessels from abdominal aorta down to pedal arch,
- Whole Body MRA.

Properties of CE-MRA

- Is minimally invasive (intravenous contrast injection).
- Provides short single breath-hold scan times.
- Can be acquired parallel to a vessel for large coverage.
- Short scan times (slices can be acquired in vessel plane).
- VCG triggering is not required in areas of pulsatile flow.

Running a CE-MRA scan upon bolus arrival (BolusTrak)

The BolusTrak functionality offers the possibility to track the bolus and immediately start the CE-MRA scan on bolus arrival. Part of the realization are real-time reconstruction and -viewing.

1. Select a BolusTrak ExamCard

   which typically consists of:

   - Survey scan.
   - Preparation-only scan or Pre-contrast scan.
   - 2D Real-Time reconstructed scan (BolusTrak scan).
   - Post-contrast scan (diagnostic scan).

2. Start the ExamCard.

   The survey is performed.

3. Plan the ExamCard items.
4. Resume the ExamCard.

   The Preparation-only scan or Pre-contrast scan is performed.

   Then the ExamCard pauses.

5. Start the contrast agent injection as a bolus simultaneously with the 2D real-time reconstructed scan:

   Click **Resume** to do so.

6. Check the arrival of contrast agent in real-time in the **AutoView** window.
7. To interrupt the 2D real-time reconstructed scan and to start the post-contrast scan, click **Proceed** when you see the bolus arrive.

   You can execute the post-contrast scan with breath-hold commands.

8. Perform postprocessing, e.g. subtraction of pre-contrast mask, Maximum Intensity Projection (MaxIP).

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The total procedure can be run first without contrast agent to make the patient familiar with the examination procedure.

Time schedule of 3D high spatial resolution scan

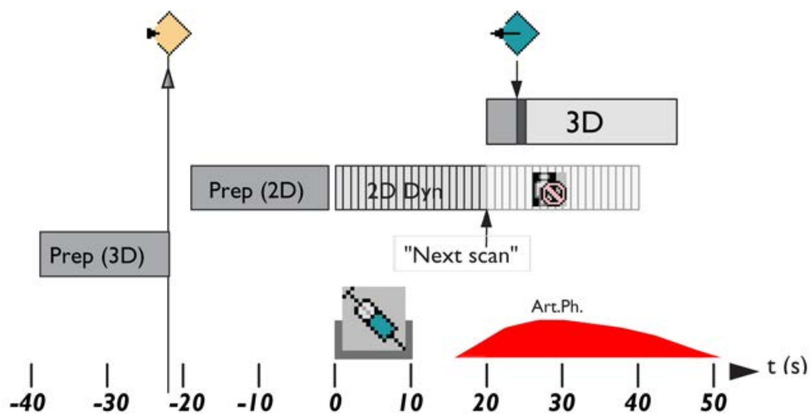
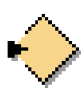


Fig. 342: Time schedule for 3D high spatial resolution.

Text/Icon	Description	Text/Icon	Description
Prep (3D)	Preparation phases of 3D scan (Prep-only or Pre-contrast scan)	**BolusTrak**	Preparation phases of 2D Dyn scan
BolusTrak	2D real-time reconstructed scan	**3D**	Post-contrast scan
Art.Ph.	Arterial Phase	**"Next scan"**	User presses "Next scan" button
	Store Preparation		Restore preparation
	Injection		Aborted scan

Tabletop movement in MobiFlex and MobiTrak scans

WARNING

Before starting a scan which initiates tabletop movement, always check that nothing can get caught or hit during tabletop movement.

Check patient, patient extremities, clothing, equipment and positioning aids. Guide cables and intravenous lines.

Tabletop movement between stacks is mandatory. It can be initiated by:

- clicking **Proceed** on the operator's console/keyboard.
- clicking **Travel to scanplane** on the operator’s console.

- pressing **Start scan** at the magnet.
- With the tumble switch at the magnet.

Total table stroke is computed at the start of the scan

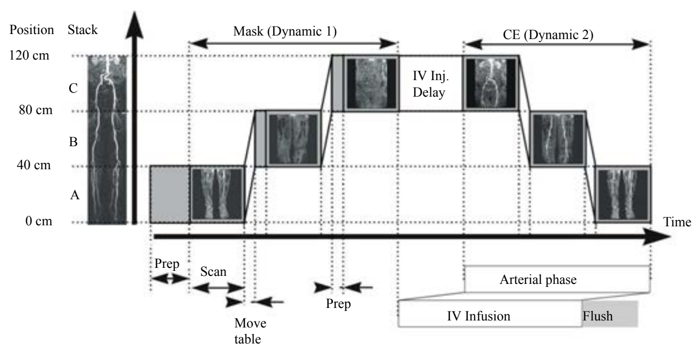
The total travel distance for the tabletop to reach optimal positions for all scans and all stacks, is computed at the start of the ExamCard and displayed on the Scan safety message(s) screen.

If the table can not move in far enough for one of the stacks, the scan does not start. Adjust the feet-head offcenter of stack A or reposition the patient.

Running a MobiTrak scan

Schematic timing diagram of the MobiTrak technique:

First, three mask stacks are acquired, then the three contrast-enhanced (CE) stacks.



1. Patient preparation and patient and coil positioning.
2. Start the MobiTrak ExamCard:

   Transverse survey scan in three stacks is performed with tabletop movement during stacks. MaxIPs are automatically calculated.

   - Two dynamic scans, each consisting of three stacks: Stack A: lower legs, Stack B: upper legs, Stack C: abdomen. Abdominal stack with breathhold commands.
3. Plan the MobiTrak scan on the sagittal MaxIPs of the survey scan. Easiest is to align the stacks and define a stack overlap.
4. **Resume** the ExamCard.

   Contrast bolus timing scan and test bolus injection are performed:

   - Dynamic coronal scan (for visualization of entire aorta) started together with the test bolus injection.
   - To be planned just before the abdominal aortic bifurcation. Use the **Reset** geometry function.
   - To determine the acquisition delay between the contrast injection and the second dynamic scan. It equals the contrast bolus arrival time just before the abdominal aortic bifurcation.
5. Perform MobiTrak scan first dynamic

- Acquires pre-contrast images in three stacks with table movement.
- To be used for subtraction.

6. Start the contrast agent infusion
7. MobiTrak scan second dynamic
   - To be started after the acquisition delay (see contrast bolus timing scan).
   - Acquires contrast-enhanced images in three stacks with table movement.

NOTICE

Always allow automatic table movement.

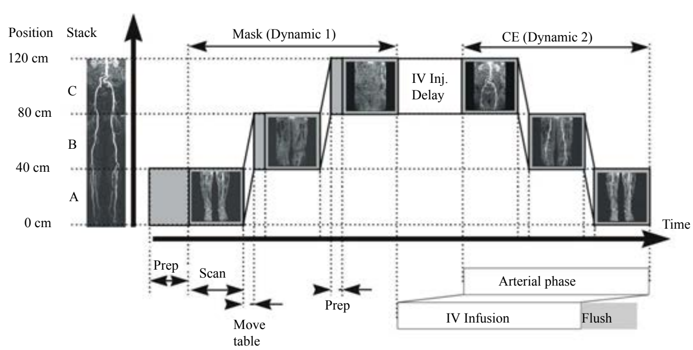
In this way, the scan will be started as soon as the table has reached the optimal position without prompting for an additional |Proceed|.

8. Postprocessing MobiFlex with Review packages: calculation and combination of MaxIPs of the three stacks.

Running a MobiFlex scan

Schematic timing diagram of the MobiFlex technique:

First, three mask stacks are acquired, then the three contrast-enhanced (CE) stacks.



MobiFlex ExamCard

The table summarizes the scans of a typical MobiFlex ExamCard with e.g. their item properties and their GeoLinks.

Scan	EC Item properties	Geo Link	Part of anatomy	Comparable to
1		A	Lower Legs	Scan 1, dyn=1
2		A	Upper Legs	Scan 2, dyn=1

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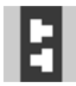
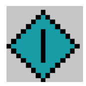
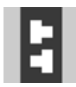
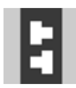
Scan	EC Item properties	Geo Link	Part of anatomy	Comparable to
3	 	A	Abdomen	Scan 3, dyn=1
4		BolusTrak scan in order to track the bolus arrival		
5	  	A	Abdomen	Scan 3, dyn=2
6		A	Upper Legs	Scan 2, dyn=2
7		A	Lower Legs	Scan 1, dyn=2

Workflow

1. Patient preparation and patient and coil positioning
2. Setup or select a MobiFlex ExamCard including Geometrical Links.
   - 6 scans for 3 stations (8 scans for 4 stations on 3.0T) plus a BolusTrak scan.
     All stations need to have the same GeoLink (same bookmark behind the sequence).
   - BolusTrak scan prior to post-contrast scans (injection enabled).
   - Abdominal stack with breathhold commands.
   - Manual start for post-contrast scans.

NOTICE

If you like to have pre-contrast source images, integrate your subtraction postprocessing into your ExamCard. Three types of images will be available.

To do so, disable the imaging parameter 'Immediate subtraction' in the sequence.

3. Perform the transverse survey scan in three stacks
   - Table movement during stacks.
   - Automatically calculated MIPs.
4. Fuse the automatically calculated MIPs.
5. Plan the scans on fused sagittal MIP's of the survey scan.

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- Use the |Scan Align| button of the ExamCards window to align the scans (comparable to ’Stack Align’ function).
- For shorter scan times, reduce the number of slices and increase the slice thickness.

6. Perform MobiFlex scans pre-contrast
   - Acquires pre-contrast images in three scans with table movement.
   - To be used for subtraction.
7. Perform the BolusTrak scan with the start of the contrast agent infusion.
8. Check the bolus arrival in the |Autoview| window.
9. Press 'Next Scan' upon arrival of the bolus in the abdominal aorta to abort the BolusTrak scan.

   MobiFlex scans post-contrast are automatically started due to the ’Fast next scan’ functionality.
   - Acquires contrast-enhanced images in three scans with table movement.

NOTICE

Always allow automatic table movement. In this way, the scan will be started as soon as the table has reached the optimal position without prompting for an additional |Proceed|.

10. Postprocessing MobiFlex:

    MIP calculation of the three scans and combination of the MIPs.

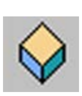
NOTICE

Undo subtraction can be done by means of a weighting factor of +1 after a subtraction having been performed with a weighting factor of -1 .

Postprocessing MobiFlex and MobiTrak

Calculate Multistation MIPs

1. Select one of the pre- or post-contrast scans.



2. Click the **Volume View** button.
3. Select the left upper view port.
4. Select the 2nd dynamic (subtracted images).

5. Click **Generate series** to calculate a set of new images out of the original data set -> a new window pops up.

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6. Click **Stack** to define orientation, stack type, projections, radial axis and angle, e.g. coronal orientation, radial, FH axis, 9 projections, 12 degrees.
7. Click **Propagation** and set propagation to **All stations** and **Single Axis**.
8. Click **Geometry** with an **Angulation relative to: Magnet**.
9. Click **Generate** to run the protocol.
10. View the resulting images.
11. Hardcopies can be performed in the usual way.

Viewing these MIPs with Review packages (multistation view)

Use the MobiView package to view these MaxIPs.

Fusing multiple stations created by the MobiFlex/MobiTrak package could lead to a mismatch in the connection between the stations. The area of overlap is indicated by brackets. In case of doubt, it is best to use the 'hard cut' fusing algorithm.

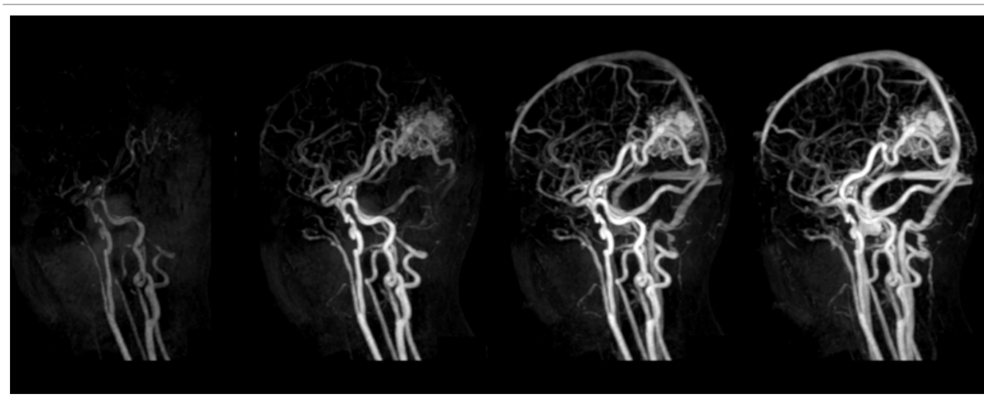
Running a 4D-TRAK scan

4D-TRAK (4D Time-Resolved Angiography using Keyhole) brings a new dimension to CE-MRA. It provides drastic scan speed increases for high spatial and temporal resolution CE-MRA scans. 4D-TRAK utilizes the 3D-FFE scan technique and combines the advantages of dS-SENSE, Keyhole and CENTRA.

4D-TRAK might be used to aid in evaluation of brain AVM, congenital heart diseases, cardiac function, hemodialysis shunts and in diabetes patients with short arterio-venous transit time in lower legs/feet.

Examples of 4D-TRAK MaxIPs

4D-TRAK: 4 dynamics. From left to right: early to late dynamic.



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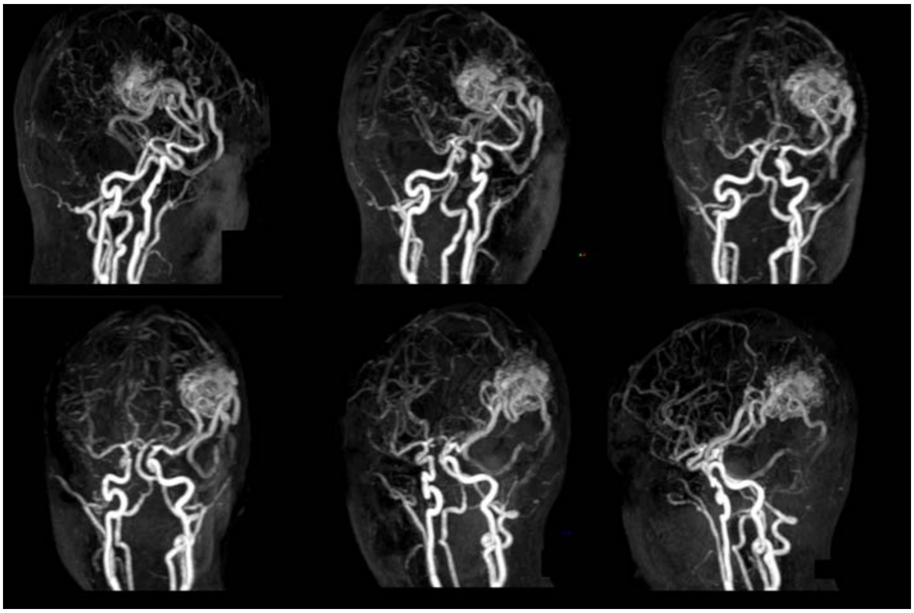
4D-TRAK: Different Maximum Intensity Projections of the same dynamic.



TRANCE techniques

TRANCE, b-TRANCE and 4D-TRANCE are techniques for non-contrast enhanced angiography.

Comparison of the TRANCE techniques

Application	Femoral arteries, popliteal arteries and hand vessels	Renal arteries	Brain
MRA technique	**TRANCE**	**b-TRANCE**	**4D-TRANCE**
Description	3D-TSE technique for non-contrast enhanced peripheral angiography. Subtraction technique.	3D-balanced-TFE technique for non-contrast enhanced renal angiography. Inflow technique. b-TRANCE suppresses parenchyma and venous structures with a slab-selective inversion prepulse and a REST slab inferior to the imaging slab overlying the abdomen wall. Free breathing is enabled by the use of navigator gating.	3D-TFE/EPI sequence visualizing vascular morphology and dynamic blood flow without the use of a contrast agent by labeling circulating protons in arterial blood with an Arterial Spin Labeling (ASL) technique. 4D-TRANCE can be performed • non-selectively. • selectively, focusing on a targeted vessel.
Cardiac synchronization	Triggering with VCG is needed.	Triggering with VCG is needed.	Not needed.

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Application	Femoral arteries, popliteal arteries and hand vessels	Renal arteries	Brain
Data acquisition in cardiac cycle	It is important to consider diastole or systole during acquisition, since the contrast is determined by the flow velocity.	It is not necessary to consider diastole or systole during acqusition, since the contrast is determined by the inversion delay time.	Not applicable
Appearance of vessels	The blood flow velocity **in arteries** varies, depending on the cardiac phase: • Data acquisition in systole results in signal voids in the arteries (due to dephasing). • Data acquisition in diastole results in hyperintense signal in the arteries (hardly any dephasing). The blood flow velocity in **veins** is slow and stays relatively constant over time. • Data acquisition in systole and in diastole results in white veins.	The arteries appear bright due to the inflow of non-saturated blood from the aorta within the inversion delay time.	The arteries appear bright and the veins dark, since the signal of labeled blood fully decays by the time it enters the veins.
Analysis	Use **VolumeView** for the calculation of MaxIPs.	Use **VolumeView** for the calculation of MaxIPs.	Use **VolumeView** for the calculation of MaxIPs.
Analysis	**ImageAlgebra** is needed.	**ImageAlgebra** is not needed, since the background is suppressed during acquisition and does not need to be subtracted afterwards.	

Running a TRANCE scan in the lower extremities

Recommended Analysis packages:

- Q-Flow for flow measurement,
- ImageAlgebra for subtraction.

To obtain an image with arteries only

1. Perform two TRANCE data acquisitions:
   - one with systolic triggering, and
   - one with diastolic triggering.
2. Determine the trigger delay with a flow measurement in the vessel of interest.

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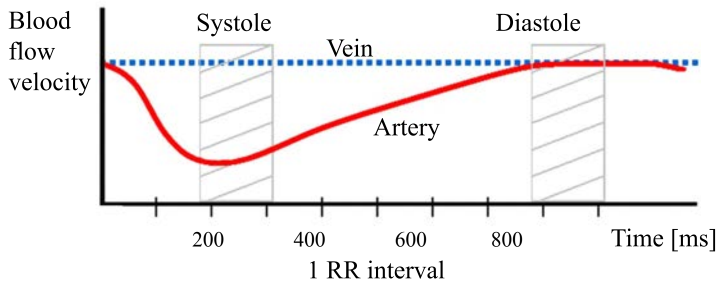

Fig. 343: Schematic example of a flow measurement with correct trigger delay times: in this case, the systolic trigger delay would be about 175 ms. The diastolic trigger delay would be about 775 ms or 'longest'.

3. Subtract the resulting images. Because the veins and the background have the same signal intensity in both the diastolic and systolic images, they are not visible after subtraction. The result of the subtraction is an image with arteries only.

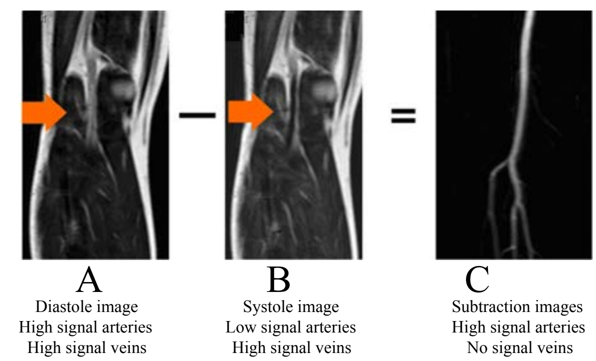

Fig. 344: Diastole image (A) minus systole image (B) results in a subtraction image (C).

4. Process the subtracted data by means of **VolumeView** to obtain a MIP of the total 3D-data-set. Multiple stations are possible. The example shown overleaf is a 2 station TRANCE of the peripheral arteries.

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Philips

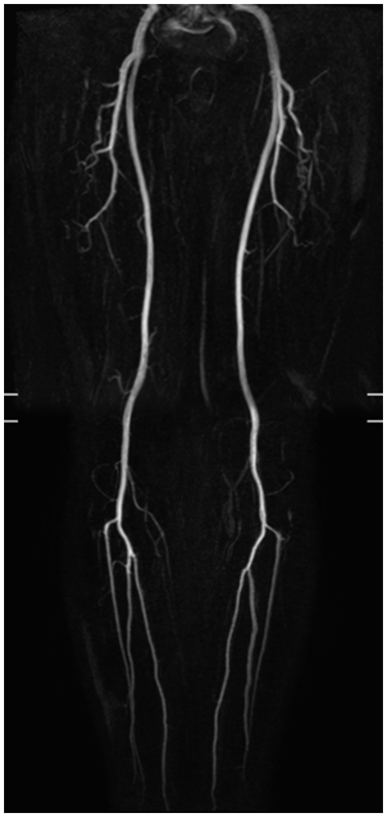

Fig. 345: 2-station TRANCE scan acquired on a 1.5 T system.

More about b-TRANCE

NOTICE

Due to the selective inversion prepulse, only a relatively small volume can be acquired.

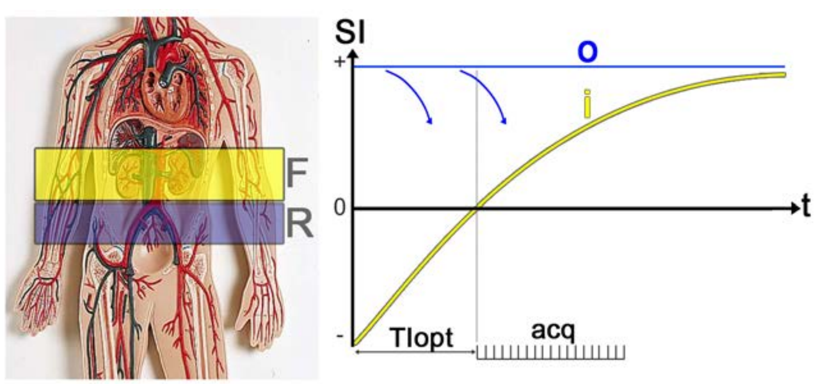

Fig. 346: Left: The selective inversion prepulse coincides with the FOV (F). The REST slab (R) prevents venous inflow. Right: Signal Intensity (SI) versus time (t). With the optimal TI (TIopt), the acquisitoin (acq) takes place after zero crossing of the curve inside FOV (i). Inflow of fresh spins from outside the FOV (o) occurs.

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Running a 4D-TRANCE scan

▷ The patient is already positioned on the tabletop. The examination is already entered or selected. (Cardiac synchronization is not needed.)

► Select and start the Philips 4D-TRANCE ExamCard.

An anatomical survey is performed.

► Plan the sagittal and coronal PCA surveys on the anatomical survey.

► Start and run the PCA surveys.

► Plan the 3D Inflow scan on the survey images.

► Start and run the 3D Inflow scan.

► Select the 4D-TRANCE scan of your preference:

- selective (with parameter **ASL label type: free**), or
- non-selective.

► Plan the 4D-TRANCE scan on the images of the PCA scan and the 3D-Inflow scan.

► Check the Scan Information page for the **Label delays 1st/delta/last** in milliseconds.

When the **Label delay: last** is much longer than the T1 relaxation time of blood, blood signal has already decayed during the last measurements.

To decrease the **Label delay: last**, reduce the number of phases.

► Open the 4D-TRANCE imaging series in **Volume View** and calculate Maximum Intensity Projections.

► View the resulting imaging series with **ImageView.**

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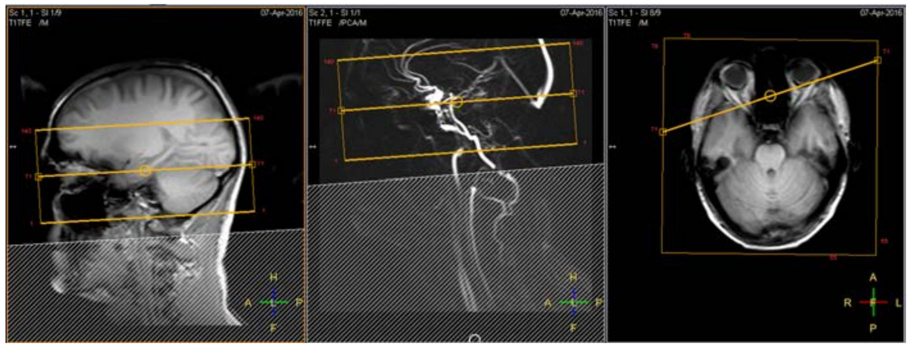
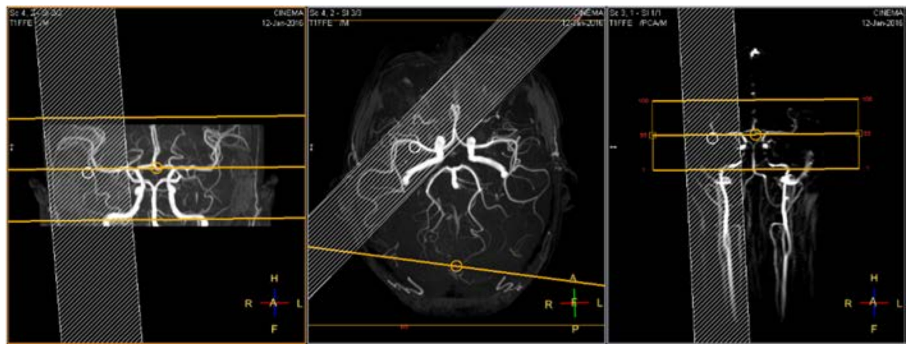
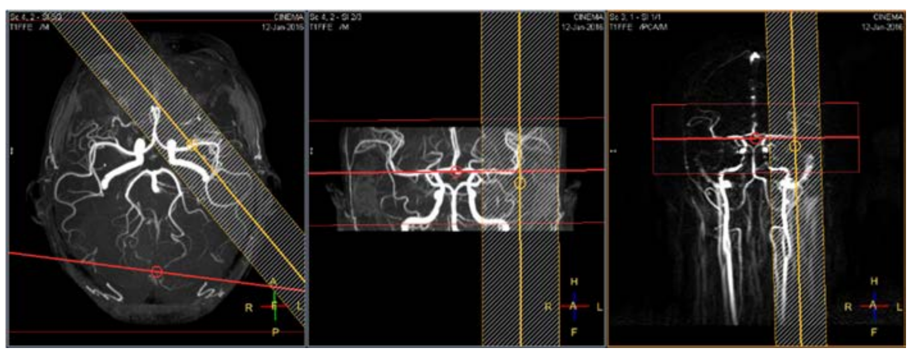
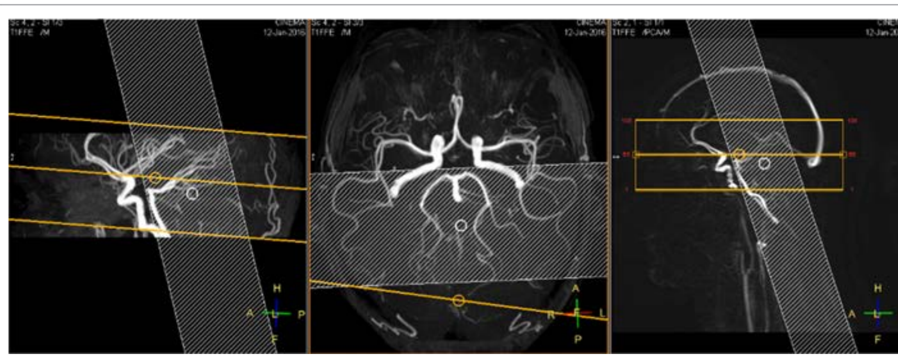
Examples of how to plan the 4D-TRANCE scan

Non-selective planning	
Selective planning of the right internal carotid artery	
Selective planning of the left internal carotid artery	
Selective planning of the vertebrobasilar artery	

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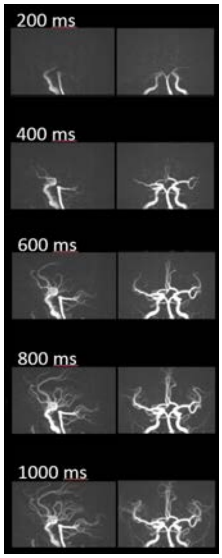
Resulting imaging series



Non-selective 4D-TRANCE:

sagittal and coronal Maximum Intensity Projections,

acquired with an phase interval of 200 ms

More information

- About Arterial Spin Labeling, see chapter “Arterial Spin Labeling (ASL)” on page 706
- In the Online Help/Parameters: parameter **Arterial Spin Labeling**
- In the Online Help/Parameters: **Reference tissue** (about the T1 relaxation time of blood)

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18 Diffusion imaging

er

Diffusion sequence	• Excellent non-invasive method of measuring the diffusion characteristics of biological tissue. • Based on Spin Echo.
Properties	• Incorporates Diffusion Weighted Imaging (DWI) and Diffusion Tensor Imaging (DTI). • Very sensitive to motion (for Multishot scanning)
Scan methods	• Single-Shot sequences (without PPU) • Multishot sequences (with PPU for cardiac synchronization and fewer artifacts)
Applications	• Neuro imaging • Abdominal imaging

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Preparing the patient for a diffusion scan

► Since DW sequences tend to be very sensitive to e.g. motion of the head and brain tissue due to blood pulsation, patient preparation and good immobilization are crucial for good results.

► For Multishot sequences, connect PPU to the patient.

Selecting diffusion scans

► Select a diffusion scan protocol (with DWI or DTI in the name) and add it to your ExamCard. Skip this step, if a diffusion scan protocol is already part of your ExamCard.
  - **DWI**: Diffusion Weighted Imaging
  - **DTI**: Diffusion Tensor Imaging

Analysis of diffusion datasets

- For the registration of the datasets as preparation of the analysis, use the **Diffusion Registration** package,
  see chapter “Diffusion Registration package” on page 569.
- To calculate parametric maps (e.g. ADC-, eADC-, FA-map), use the **Diffusion** package,
  see chapter “Diffusion package” on page 570.
- To track fibers for diffusion tensor data with at least 6 diffusion directions, use the **FiberTrak** package ,
  see chapter “FiberTrak package” on page 579.

Dedicated diffusion sequences

For the dedicated diffusion sequences, Philips imaging protocols are delivered with the system. It is recommended to use these protocols.

Diffusion sequence	Short description	More information
DWIBS	Diffusion Weighted Whole Body Imaging with Background Body Signal Suppression	• Instructions for Use: Positioning for Whole Body • Instructions for Use: MobiView analysis package
IRIS	Multishot diffusion with zoom imaging for spine examination The abbreviation stands for: Image Reconstruction using Image-space Sampling.	-

Computed DWI (cDWI)

cDWI is a mathematical computation technique which calculates high b-value image from DWI MR Images acquired with at least two different lower b-values. cDWI indirectly reduces the total acquisition time by creating synthetic high b-value images based on the input of acquired low-b value images rather than spending time in acquisition.

The synthetic b-value image is generated using the mono-exponential model.

Philips imaging protocols suited for cDWI are provided with your system.

► To calculate the high b-value cDWI images, use the **Diffusion** package, see chapter “Diffusion Workflow” on page 577.

Quality improvements for diffusion sequences

To improve the quality of diffusion sequences, use any of the following packages/techniques:

- The Diffusion registration package allows you to correct for patient movement which occured during a dynamic scan.
  - Application: Diffusion imaging in all anatomies.
  - More information chapter “Diffusion Registration package” on page 569.
- **LOVA ADC** (Low Variance ADC) allows you to correct for the non-linearity of the diffusion gradient.
  - Applications: Diffusion Weighted Imaging in all anatomies. Especially meant for large FOV, e.g. abdomen.
  - To enable LOVA ADC, set the parameter **ADC correction** to **yes**.

    More information in the Online Help **(F1)**: Enabling LOVA ADC
  - **LOVA ADC** is not available on all MRI system types.

- **EPIC Brain** allows you to enable EPI geometry correction in the brain in dynamic FFE- and SE-EPI scans, and in diffusion EPI scans.
  - Application Brain only: especially DWI, DTI and BOLD imaging.
  - To enable EPIC Brain, set the parameter **EPI Geometry Correction** to **yes**.

    More information in the Online Help **(F1)**: Enabling EPIC Brain

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19 Perfusion Imaging

The term perfusion refers to the process of nutritive delivery of arterial blood to a capillary bed in tissue.

There are different methods in MRI to measure tissue perfusion in vivo:

1. One method is based on the injection of a paramagnetic contrast agent that changes the magnetic susceptibility of blood.
   – Contrast agent will be injected as a bolus.
   – Simultaneously, a fast dynamic scan will be started.
   – This dynamic scan will be evaluated with postprocessing packages.
2. The other method is based on Arterial Spin Labeling (ASL) where arterial blood is magnetically tagged before it enters the tissue of interest. The amount of labeling is measured and compared to a control obtained without spin labeling.

Basic T1 Perfusion

T1 perfusion studies are based on the fact that gadolinium-based contrast agent shortens the T1 relaxation times of tissues.

Acquisition

To observe the changes of the T1 relaxation time and in such a way the contrast-uptake, run a dynamic T1w scan, e.g. 3D T1-FFE or -TFE scan.

Applications

Typical applications are contrast-uptake studies in the body, e.g. abdomen and thorax, and neurology.

Contrast agent bolus injection

Contrast agent has to be injected as a bolus.

Analysis

Use the **Basic T1 Perfusion** package for evaluation of the scan.
See chapter “Basic T1 Perfusion Workflow” on page 638.

This package calculates functional and parameter maps for any kind of contrast-uptake dynamic study. New imaging series can be easily generated and stored.

Analyses are stored in the current ExamCard and performed automatically when the ExamCard is executed again. For more information, see chapter “SmartLine Processing” on page 471.

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Neuro T2* Perfusion

Paramagnetic contrast agents influence the local magnetic field and reduce the T2* of surrounding tissue.
Neuro T2* Perfusion is also referred to as Dynamic Susceptibility Contrast (DSC) imaging.

Acquisition

To observe the changes of the T2* relaxation time, a sequence which is sensitive to T2* changes has to be executed, e.g.:

- PRESTO scan (TE larger than TR).
- Multishot FFE-EPI scan with relatively long TE.

Bolus passage in the brain takes approximately 10 s. The minimum temporal resolution should be 2 s.

Properties

With such a sequence, it is possible to image microscopic flow, i.e. flow at the capillary level.

- Signal decreases during bolus passage (due to reduced T2* of surrounding tissue).
- Signal restores partially directly after the passage.
- Contrast changes are proportional to the concentration of contrast agent.

Applications

Typical applications are cerebral perfusion studies:

- Assessment of tissue viability and function.
- Characterization of disease processes with microvascular alterations as e.g. lesion characterization.

Contrast agent bolus injection

Contrast agent has to be injected as a bolus.

Analysis

Use the **Neuro T2* Perfusion** package for evaluation of the scan.
See chapter “Neuro T2* Perfusion Workflow” on page 628.

This package calculates functional and parameter maps for any kind of contrast-uptake dynamic study. New imaging series can be easily generated and stored.

Analyses are stored in the current ExamCard and performed automatically when the ExamCard is executed again. For more information, see chapter “SmartLine Processing” on page 471.

Arterial Spin Labeling (ASL)

Arterial Spin Labeling (ASL) is a method to obtain brain perfusion imaging without the use of contrast agent. ASL uses magnetically labeled blood in the arterial blood stream as an endogenous trace.

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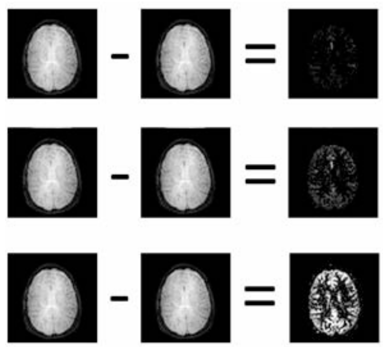
The ASL sequence consists of a labeling and a control part. Perfusion images are automatically generated by subtracting the label images from the control images.

Control - Label = Perfusion (example of 3 dynamics)



Perfusion estimation relies on the signal changes (1%-2%).

Applications

- Cerebral perfusion studies.
- MR Angiography in the brain, see chapter “TRANCE techniques” on page 694.

Basic ASL-sequence

The ASL sequence is a dynamic sequence. Depending on the clinical question, you can perform ASL as single-phase or as multi-phase sequence using different ASL techniques.

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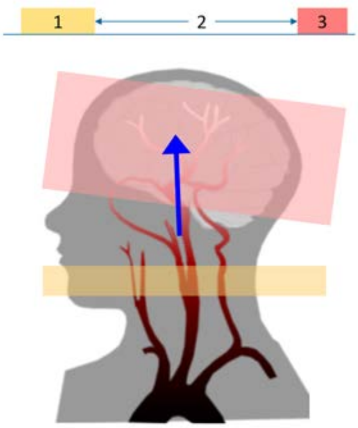
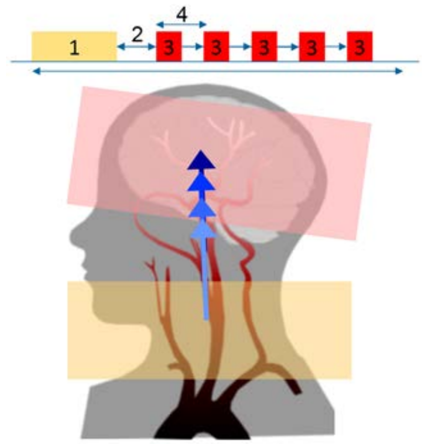
Single-Phase ASL - using the pCASL method



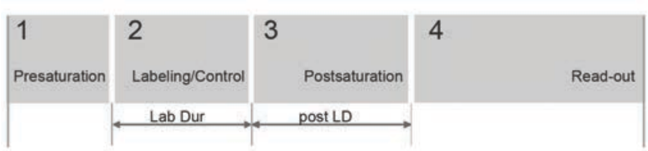
1. Labeling and control
2. Post-label delay
3. Image acquisition

Multi-Phase ASL - using the STAR method



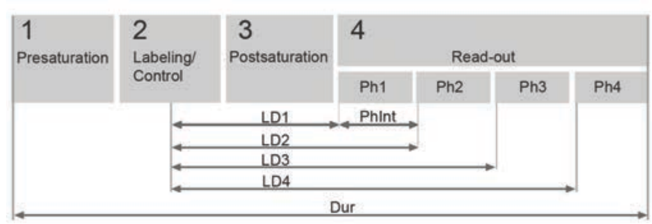
1. Labeling and control
2. Label delay
3. Image acquisition
4. Phase interval

In multiphase ASL, perfusion is measured at multiple time points after labeling: the same area is imaged multiple times after labeling (or control). This results in multiple perfusion images.



1. Pre-saturation
2. Labeling/Control
3. Post-saturation
4. Read-out

- post LD - post label delay
- Lab Dur - Label duration



1. Pre-saturation
2. Labeling/Control
3. Post-saturation
4. Read-out

- Ph1, 2, 3, 4 - Phase 1, 2, 3, 4
- LD1, 2, 3, 4 - Label delay 1, 2, 3, 4
  - where LD1 is displayed as **Label delay 1st** on the Scan Information page
  - where LD4 is displayed as **Label delay last** on the Scan Information page
- PhInt - Phase interval

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Single-Phase ASL - using the pCASL method	Multi-Phase ASL - using the STAR method
	where the phase interval is displayed as **Label delay delta** on the Scan Information page • Dur - Duration of label and acquisition cycle

Reconstruction

Depending on the settings of ASL imaging parameters, different types of images are reconstructed and available for viewing.

Image type	Available?	How to proceed?
Subtracted imaging series	ASL scans automatically provide subtracted imaging series.	Evaluate the subtracted imaging series with **ImageView**.
ASL source images	ASL source images (label, control) are not available by default.	To have these ASL source images available, set the parameter **ASL source images** on the **Postproc** tab to **last control** or **all**. Evaluate the ASL source images with **ImageView**.
Normalized pCASL images (Perfusion data is normalized by a proton density weighted scan.)	ASL normalized pCASL images are not available by default.	To acquire normalized pCASL images, set the parameter **ASL -> normalized** on the **Dyn/Ang** tab to **yes**. This is the default setting in Philips 3D pCASL preset procedures.

More information

- In the Online Help/ Parameters: Parameter **Arterial Spin Labeling** .

Planning and running Single-Phase ASL using pCASL

This workflow applies for:

- **3D pCASL**:

  3D pCASL acquisition with GRASE read-out, providing normalized images, using a 4 pulse background suppression scheme.
- **pCASL**:

  Multislice pCASL with EPI read-out, using a 2 pulse background suppression scheme.

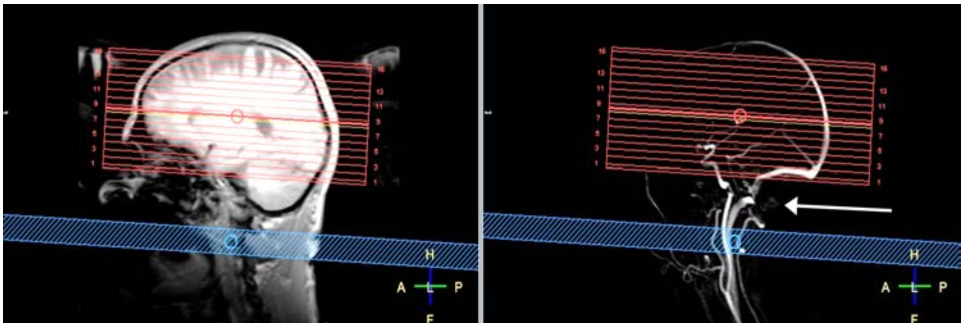
▷ The patient is already positioned on the tabletop. The examination is already entered or selected. (Cardiac synchronization is not needed.)

► Select, start and run a multi-stack anatomical survey.

► Select, start and run a 2D-PCA survey.

- Select and plan the pCASL scan on the sagittal images of the 2D-PCA and the anatomical survey:

  Make sure to exclude the carotid siphon (indicated by the white arrow in the image).



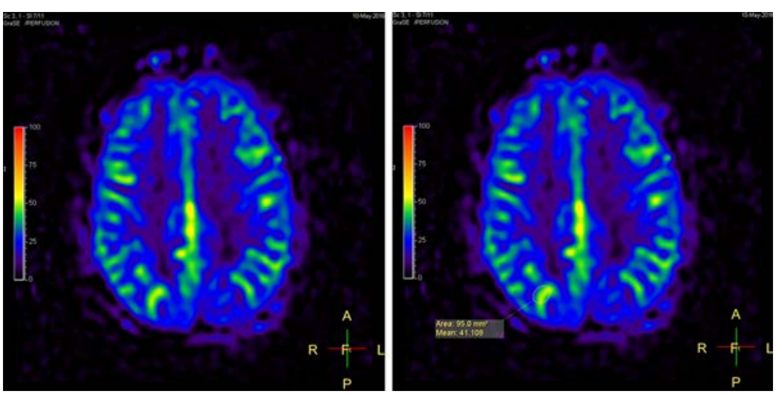
- If needed, adjust the value of the parameter **ASL post label delay** according to the recommended values in the table below.
- Start and run the pCASL scan.

⇨ When the scan is finished, subtracted imaging series are automatically calculated.

- View the subtracted images with ImageView.
  Depending on the setting of the ASL parameters **ASL normalized** on the **DynAng** tab and **ASL source images** on the **Postproc** tab, subtracted images with or without normalization are available, and possibly also ASL source images.
- If ASL normalized images are available,

• you can view them in color or in black and white. Right-click on the image to change the display.

• you can get numeric results. Draw a ROI on the normalized image.



Recommended values for the post label delay in pCASL

neonates	2000 ms
children	1500 ms
healthy subject < 70 years	1800 ms

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healthy subject > 70 years	2000 ms
Adult clinical patient	2000 ms

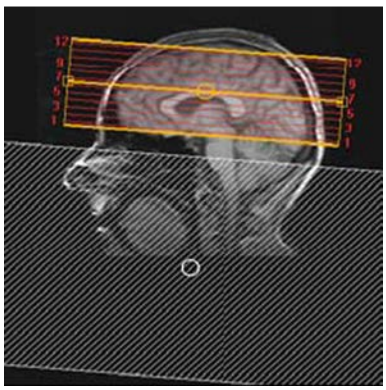
Planning and running Multi-Phase ASL using STAR

▷ The patient is already positioned on the tabletop. The examination is already entered or selected. (Cardiac synchronization is not needed.)

► Select, start and run a multi-stack anatomical survey.

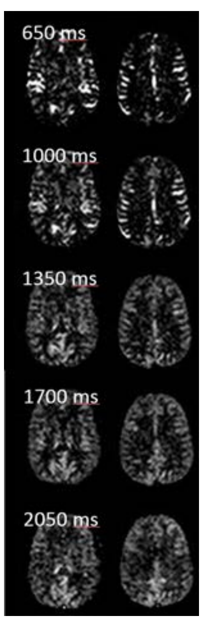
► Select, start and run a 2D-PCA survey.

► Select and plan the STAR scan on the sagittal images of the 2D-PC and the anatomical survey:



► Adjust the value of the parameters **ASL label delay** and **ASL phase interval**.

Example images with different label delays:



► Start and run the STAR scan.

⇨ When the scan is finished, subtracted imaging series are automatically calculated.

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- View the subtracted images with ImageView.
  With STAR, background suppression varies over slices due to different label delay times depending on the slice position.

20 Cardiac Imaging

Planning the Cardiac Views

Planning the cardiac views is complex because angulations in the 3 different directions could be necessary to visualize the different connections between chambers.

Important is to follow a systematic way to create the different views. Always plan perpendicular on the previous scan.

Useful tools to facilitate planning are:

- the Interactive Scanning Tool
- 3 Points Planscan
- PlanAlign.

Interactive Scanning Tool

Interactive scanning is especially useful for cardiac imaging, because the required geometry angulations can be found in real time for the different cardiac views.

An interactive scan has to fulfil the following prerequisites:

- One slice only
- Scan mode 2D, M2D or MS
- Cardiac triggering possible
- One heart phase only
- No dynamic scan
- Any scan technique as SE, FFE, TFE, TSE, GRASE or EPI.

When the correct planes have been found and saved in the interactive scan:

- |Next scan| has to be clicked in order to start the next scan in List View which is the diagnostic scan (e.g. a breath-hold scan). The geometry parameters are automatically taken over.
- |Stop Scan| has to be clicked to plan the next scans with use geometry (the stored geometry parameters within interactive).

For cardiac applications, interactive scanning should be performed in continuous mode which is also referred to as real-time mode.

NOTICE

TSE is not used due to saturation effects using continuous mode.

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NOTICE

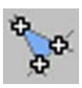
3 Points Planscan can also be used during interactive scanning.

NOTICE

Interactive scanning can be combined with SENSE. Use phase oversampling (P os factor) to avoid SENSE backfolding.

3 Points Planscan (3PPS)

3 Point Planscan



- To enable/disable 3 Point Planscan.
  3 Point Planscan is a tool which helps to define an irregular plane. The plane is determined by the placement of three points on two or more images of different orientations.

Workflow

- ► Activate ’3PPS’.
  The 3PPS specific toolbar is displayed instead of the normal planning toolbar.
- ► Place the three points on any of the three images selected in the planning view ports:
  - Click the icon for point 1 on the toolbar, then click in the image to define point 1.
  - Click the icon for point 2 on the toolbar, then click in the image to define point 2.
  - Click the icon for point 3 on the toolbar, then click in the image to define point 3.
- ► To restart or change the positioning of the points click |Off|.
- ► Click the icon |Compute plane| to perform the Three-point planscan.
- ► Click the icon |3PPS| again to return to normal planscan.

  The angulation from the 3 Point PlanScan are taken over and displayed.
- ► Proceed with routine planning.

PlanAlign

PlanAlign is developed for applications where double oblique scans are made with large angulations in e.g. cardiac scanning. It is a powerful tool to avoid in-plane rotation and to avoid SENSE artifacts. When switched to yes, any modification of the angulations will result in a recalculation of the angulations such that the resulting images show no in-plane angulation.

- Transverse scans are aligned such that the horizontal image direction (RL) is in a non-angulated coronal plane.

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- Sagittal scans are aligned such that the vertical image direction (FH) is in a non-angulated coronal plane.
- Coronal scans are aligned such that the vertical image direction (FH) is in a non-angulated sagittal plane.
- Double angulated coronal scans tending to sagittal are aligned like sagittal scans. This means that the scans are aligned such that the vertical image direction (FH) is in a non-angulated coronal plane.

NOTICE

When the geometry has been planned using InterActive scanning, PlanAlign will be set to ’No’.

Basic Views

Below a poster will illustrate how to obtain the different basic views.

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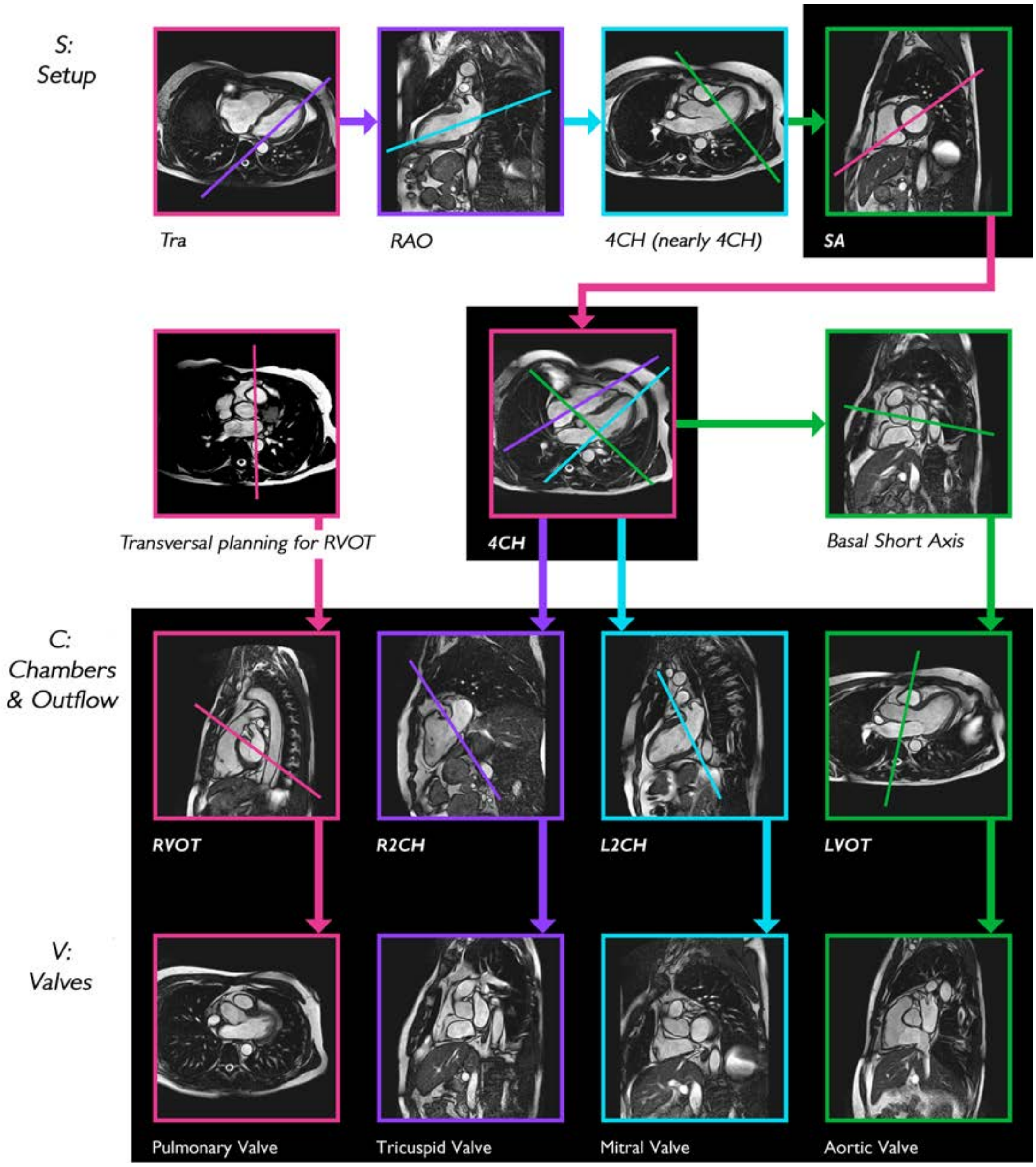

Fig. 347: Cardiac Views where S stands for Setup, C for Chambers & Outflow and V for Valves.

- Start with a transverse image through the left ventricle.
- Define the RAO (Right Anterior Oblique) or VLA (Vertical Long Axis) view on the transverse image by selecting a line through apex and centre of mitral valve.
- Define an approximate Four Chamber or HLA (Horizontal Long Axis) view on the RAO by defining a line through the apex and centre of the mitral valve.
- Define the Short Axis view, three methods are available:

  Place a line orthogonal to the (long axis) line through the apex and the centre of the mitral valve (this is the most accurate method).

Place a line parallel to the mitral valve (this method makes it easier to decide whether to include the basal slice/s during post-processing).

Place a line orthogonal to the septum (this is the best method for Right Ventricle view).

- ► From the Short Axis view, the true Four Chamber view can be defined by placing a line through the centre of the Left Ventricular Cavity and the inferior margin of the right ventricle.

Outflow Tracts

Right Two Chamber (R2CH) view

- can be derived from the true Four Chamber view.
- can be defined by placing a line through the tricuspid valve parallel to the septum.

Left Two Chamber (L2CH) view

- can be derived from the true Four Chamber view.
- can be defined by placing a line through the apex and the center of the mitral valve.

Left Ventricular Outflow Tract (LVOT)

- can be derived from the true Four Chamber view.
- An additional basal short axis scan can be defined which is used to plan the Left Ventricular Outflow Tract (LVOT) by placing a line through the Left Ventricle and Aorta.

Right Ventricular Outflow Tract (RVOT)

- is best planned on a transverse view that shows the pulmonary artery valves.

Pulmonary valve

- is planned on the RVOT by placing a line through the pulmonary valve seen already on the RVOT view.

Tricuspid valve

- is planned on the R2CH by placing a line through the tricuspid valves seen on the R2CH view.

Mitral valve

- is planned on the L2CH by placing a line through the mitral valves already seen on the L2CH view.

Aortic valve

- is planned on the LVOT by placing a line through the aortic valves already seen on the LVOT.

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Cardiac Anatomy

Image sets (Black blood or white blood in 3 orientations: Sag, Cor, Tra).

Abbreviation	Explanation
AA	Ascending aorta
Arch	Aortic arch
DA	Descending aorta
IVC	Inferior vena cava
LA	Left atrium
LB	Left bronchus
LPA	Left pulmonary artery
LPV	Left pulmonary vein
LSPV	Left superior pulmonary vein
LV	Left ventricle
MPA	Main pulmonary artery
PA	Pulmonary artery
RA	Right atrium
RB	Right bronchus
RPA	Right pulmonary artery
RPV	Right pulmonary vein
RV	Right ventricle
SVC	Superior vena cava

Tab. 40: List of Abbreviations

Cardiac Function

Cine scans are typically used to study wall motion and ventricular function. A variety of scan methods are available for cine scans. However, balanced FFE is the preferred method for breath-hold cine scans.

Stress-Test (Physical or Dobutamine)

The workflow as presented here is based on the standardized acquisition guidelines by the SCMR (Society for Cardio-vascular Magnetic Resonance). More information can be found on the website of the SCMR: www.scmr.org

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The intention of this section is only to give an illustration of how the workflow may look like in clinical practice. Philips Healthcare cannot take liability for dose regimen, infusion schemes etc.

Coronary artery disease can result in inducible ischemia. One of the first signs for myocardial ischemia is myocardial wall motion abnormality that occurs much earlier than ECG changes or anginal pain. Cine scans acquired under stress conditions can therefore help to identify these inducible ischemic areas.

The left ventricle is divided into 17 segments following the standards suggested by the American Society of Echocardiography. For all the segments the wall motion is classified as normal, hypokinetic, akinetic or dyskinetic.

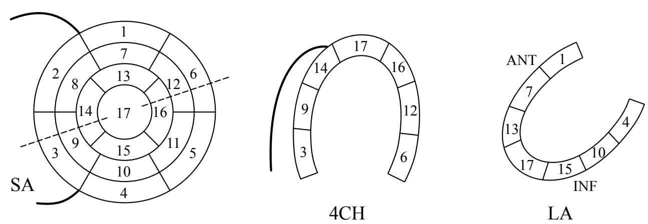

Fig. 348: Segmentation of the left ventricle according to the standards of the American Society of Echocardiography in the views: SA - Short Axis, 4CH - Four Chamber, LA - Long Axis.

Label	Heart segment	Label	Heart segment	Label	Heart segment
1	basal anterior	7	mid anterior	13	apical anterior
2	basal anteroseptal	8	mid anteroseptal	14	apical septal
3	basal inferoseptal	9	mid inferoseptal	15	apical inferior
4	basal inferior	10	mid inferior	16	apical lateral
5	basal inferolateral	11	mid inferolateral	17	apex
6	basal anterolateral	12	mid anterolateral		

Tab. 41: Labeling of Heart Segments

Workflow

All 17 segments can be covered using a combination of three SA slices, a 4CH slice and a L2CH slice.

Step	Scan / Action
1	Survey scan
2	L2CH- and 4CH-scans
3	Three-slice SA scan
4	Dobutamine infusion
5	Three-slice SA-, L2CH- and 4CH-scans
6	Dobutamine infusion

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Step	Scan / Action
7	Three-slice SA-, L2CH- and 4CH-scans
8	Next stress levels: Repeat the steps 7 and 8 for each stress level.

Tab. 42: Workflow Overview

Workflow Step-by-Step

- ► Perform the survey scan.
- ► Plan and perform the L2CH- and 4CH-scans following the approach as described in the section Planning the cardiac views .
- ► Plan the three-slice SA scan on the 4CH view such that the most apical slice covers segments 13-16, the mid slice covers segments 7-12 and the most basal slice covers segments 1-6.
  - Set the number of slices to five for planning purposes only.
  - Select an end-systolic image.
  - Position the slices: first one on apex, fifth through mitral valve.
  - Set the number of slices back to three: leaving the slice position and slice gap unchanged, these three slices now cover the desired cardiac segments.
- ► Perform this scan.

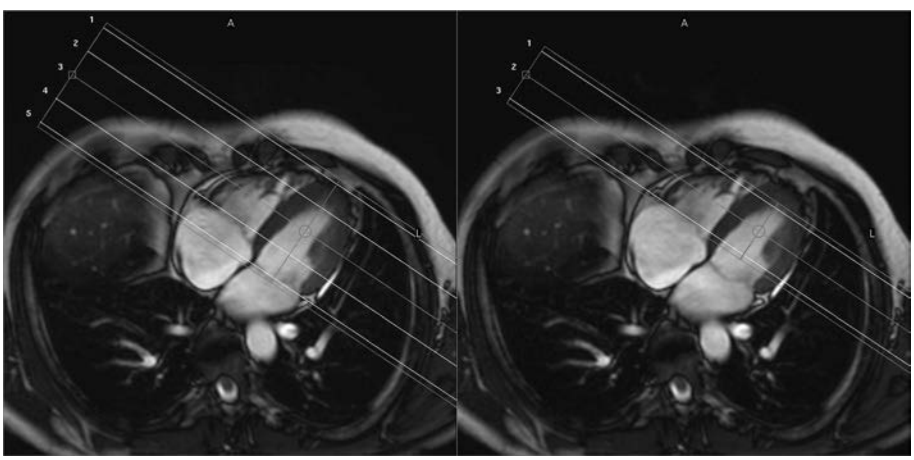

Fig. 349: Planning three SA slices on end-systolic 4CH view.

- ► Start the Dobutamine infusion to stress the patient’ s heart.
- ► Repeat the Three-slice SA-, the 4-CH- and the L2CH-scans after 3 min. of infusion.
- ► Increase the Dobutamine infusion rate to reach the next stress level.
- ► Repeat the Three-slice SA-, the 4-CH- and the L2CH-scans after 3 min. of infusion.
- ► Repeat the two previous steps for each stress level.
- ► If at the maximum stress level the sub-maximum age-predicted heart rate (= 0.85 x (220 - age)) is not reached, give atropine and repeat the three scans again.

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NOTICE

The patient's cardiac frequency will most likely vary depending on the stress level.

For each stress level the cardiac frequency should be adjusted.

When the TFE shot mode is set to 'default' this change in heart rate will not lead to a change in breath-hold duration or number of phases.

Make sure that the cine scans tolerate a certain variation in heart rate. This can be achieved by setting the R-R window range to 25%, 35%.

Myocardial Perfusion (Temporal Enhancement)

The workflow as presented here is based on the standardized acquisition guidelines by the SCMR (Society for Cardio-vascular Magnetic Resonance). More information can be found on the website of the SCMR: www.scmr.org

The intention of this section is only to give an illustration of how the workflow for myocardial perfusion may look like in clinical practice. Philips Healthcare cannot take liability for dose regimen, infusion schemes etc.

About Myocardial Perfusion

MRI can be used to analyze myocardial perfusion using first pass contrast passage enabling the detection of perfusion abnormalities.

To perform good quality perfusion scans with a high temporal resolution, dynamic slices have to be acquired as quickly as possible. In order to carefully study the contrast uptake all dynamic scans belonging to one slice should be performed at the same moment within the cardiac cycle. That is the reason that cardiac perfusion scans are cardiac triggered.

Obvious compromises have to be made regarding the image quality, or more specific, spatial resolution. The aim is now to find the right balance between the number of slices, the spatial resolution and the temporal resolution.

Following the standards suggested by the American Society of Echocardiography the left ventricle can be divided into 17 segments.

A three-slice approach as presented in the Cookbook is sufficient to cover 16 out of those 17 segments: the highest possible spatial resolution is chosen where three slices fit in a single heart beat. The number of dynamic scans and thus the number of R-R intervals determine the total scan time.

The aim of perfusion scanning is to identify inducible ischemia areas which often (in the presence of coronary artery stenoses) only occurs under stress conditions. Therefore the perfusion scan should be done both in rest and during stress, such as pharmacological vasodilatation. This can be achieved using e.g. adenosine or dipyridamole.

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Workflow

Survey scan

First a survey scan is performed after which a 4CH view and a L2CH view is performed under rest conditions as described in the section Planning the cardiac views . The three-slice SA scan is planned such that each slice covers six segments of the left ventricle (See “Stress perfusion" workflow below for more information about slice positioning).

Stress perfusion

The next step is first to perform the stress perfusion. Stress is done first to have the best image quality for the most important scan since there is no enhancement yet due to earlier contrast injections. The perfusion scan is planned exactly the same as the three-slice SA scan to cover 16 out of the 17 segments. Foldover-artifacts have to be avoided. Therefore it is advised to first run the scan without contrast to make sure that no backfolding is present. This is especially important in the case that a (b)TFE SENSE scan is used. If necessary the FOV has to be increased. During the test scan also the breath-hold instruction can be practiced with the patient.

Although adenosine mainly acts as a vasodilator also the heart rate increases. Therefore the scan should be defined such that it will run with higher heart rates. The simplest choice available is reducing the in-plane resolution. Decreasing the matrix size ensures that all three slices still fit into the R-R interval.

Adenosine infusion

After the test scan the infusion of adenosine is started to stress the patient’s heart. In the Cookbook an infusion rate of 140 ig/kg/min is suggested for maximum six minutes. During stress examinations monitoring of the patient is mandatory. Among blood pressure, pulse oximetry and symptoms also the heart rhythm is monitored.

Contrast injection

The best results for contrast uptake curves are obtained when a short compact bolus injection is used. The Cookbook suggests a Gd-DTPA contrast dosage 0.05 mmol/kg body weight applied with an injection rate of 4 ml/s. A saline flush of 20 ml with the same injection rate is necessary to facilitate a compact bolus passage.

Performing perfusion scan

The perfusion scan is started 4 minutes after the start of the adenosine infusion.

When the perfusion scan is running and the first images appear in the autoview window the contrast injection is started.

Carefully the contrast arrival is monitored and at the desired moment a breath-hold instruction is given. The breath-hold command is needed to ease postprocessing afterwards. Ask the patient to hold their breath as long as possible when the contrast agent is to arrive in the right ventricle which in most of the patients happens roundabout after twice inhaling and exhaling. If the patient cannot hold breath anymore, let him/her breathe once and then hold breath again. Alternatively, let the patient breathe shallowly after he/she cannot hold breath anymore.

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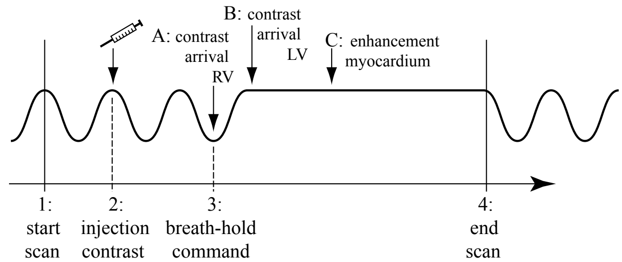

Fig. 350: Perfusion sequence

1	Start scan
2	Injection contrast
3	Breath-hold command
4	End scan
A	Contrast arrival RV (right ventricle)
B	Contrast arrival LV (left ventricle)
C	Enhancement myocardium

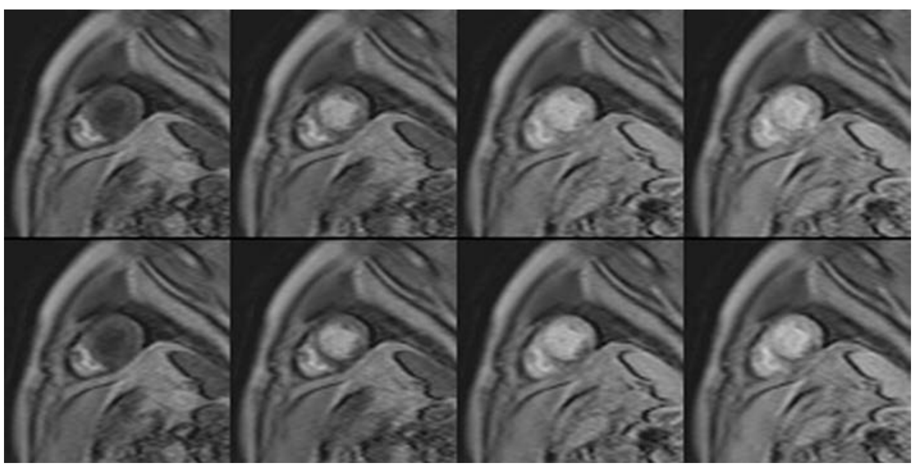

Fig. 351: Example of myocardial perfusion scans at rest and at adenosine stress.

Fifteen minutes after termination of the adenosine infusion the heart has recovered from the applied stress. Then the perfusion scan can be repeated during rest.

Image analysis and postprocessing

After excluding the left ventricular cavity and the pericardium, the myocardium is divided into 6 equiangular segments per slice following the standards suggested by the American Society of Echocardiography. Postprocessing can be performed on IntelliSpace.

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Late Enhancement (Spatial Enhancement)

The following paragraphs describe the late enhancement technique and workflow. It comprises these chapters:

- About Late Enhancement
- Workflow
- Phase Sensitive Inversion Recovery (PSIR)

The intention of this section is only to give an illustration of how the workflow for viability examinations using late contrast enhancement looks like in clinical practice. Philips Healthcare cannot take liability for dose regimen, infusion schemes etc.

Different MRI techniques can be used to visualize injured myocardium.

- Cine scans are used to look at wall thickness.
- Low doses dobutamine stress examinations have the potential in differentiating between viable myocardium (stunned and hibernating) and non-viable myocardium.
- Only the late contrast enhancement scans have the potential of visualizing the transmural extend of an infarction.

About Late Enhancement

Damaged cells take up contrast agent while in viable myocardium the contrast agent stays extracellular. The contrast washout for damaged cells evolves much slower than the washout of the extracellular contrast only. After a while the contrast concentration for viable myocardium is much lower than for injured myocardium. And thus the T1 relaxation rates evolve at different rates. An inversion pulse is then applied and the inversion time is chosen such that the normal myocardium appears black, maximizing the contrast between normal (black) and injured (white) myocardium.

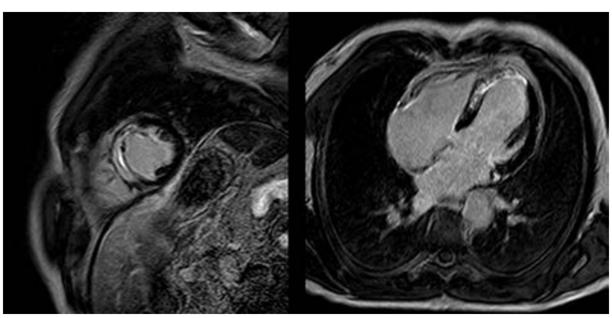

Fig. 352: Example of late enhancement scans.

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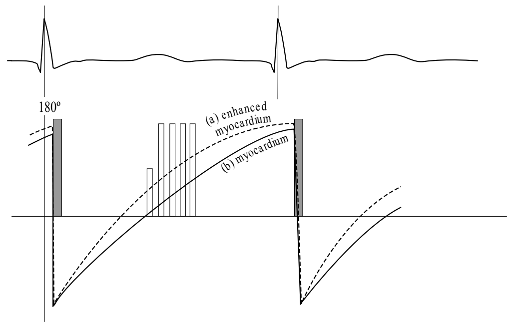

Fig. 353: The inversion pulse is used to cancel out any signal from the myocardium. Infarcted areas where still contrast is visible show high signal intensities. a - Enhanced myocardium curve, b - (unenhanced) myocardium.

Workflow

Prior to performing the viability scan it is necessary to wait until the contrast agent has cleared from the (non-damaged) myocardium. This usually takes 10 minutes. During this time any kind of other scans can be performed, such as series of cine scans. 10 minutes after the (last) contrast injection the late enhancement scans can be performed.

Late Enhancement sequence

This sequence is a single-phase multishot TFE scan that utilizes a single 180º-inversion prepulse.

- The shots should be acquired in mid-diastole to keep the cardiac motion as small as reasonable.
- The inversion delay time to cancel the normal myocardium is patient dependent and can not be calculated on beforehand. It also depends on the time after the contrast injection. A longer time after injection results in a slower T1 relaxation and less contrast in the (non-damaged) myocardium. Longer inversion times should be used. Usually the inversion time varies in a range of 200 to 300 ms.

There are three ways to find out the patient specific inversion time:

1. Use a “Look-Locker” sequence which is a cine scan that utilizes a single inversion pulse applied once every heart beat immediately after the R-peak. T1 relaxation is made visible over the individual cardiac phases.
2. By trial and error: Start with a TI of 200 ms, then increase the TI using small steps of 20 or 30 ms.
3. Change the inversion delay in real-time during an interactive scan. Make sure that the scan is running in continuous mode. The inversion time depends on the steady state that is reached over multiple heartbeats.

Remember that the inversion time found is valid only for a small period of time. Due to the washout of the contrast media from the myocardium the T1 relaxation rate decreases slowly over time.

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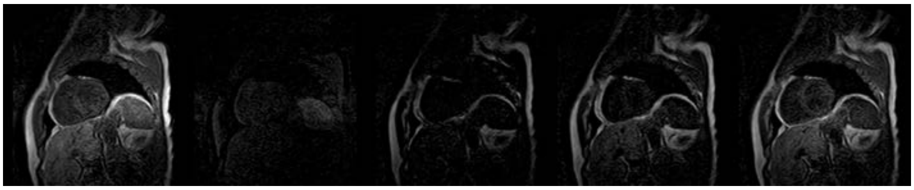

Fig. 354: 'Look-Locker' technique to quickly find the zero crossing point of the myocardium within a breath-hold.

Tips and hints

Depending on the parameter settings, specific effects could occur:

Effect / Appearance	Cause	Measure
Speckled appearance of the myocardium: appears as suppressed myocardium interspersed with white spots.	It occurs if the TI is very close to the optimal inversion delay.	Increase the TI by just 10 ms to attain optimal suppression.
Dark signal at the endocardial boundary	It is caused by a slightly shorter effective TI of the tissue at the blood-myocardial interface (especially with large voxels).	Increase the TI to obtain uniform suppression of the myocardium.
Insufficient suppression / lack of contrast of myocardium over a broad range of TI	This indicates that the contrast has either washed out (i.e. the scanning is done much later, e.g. more than 30-min. after injection) or insufficient amount of Gd-DTPA was injected.	It may be helpful to check if the entire double dose of Gd-DTPA was given (check for leaks etc.).
The blood-pool appears too dark	The TI is too short.	Increase its value to allow sufficient recovery.
Less contrast between blood-pool and injured myocardium	The TI is too long.	Decrease its value.
SNR is too low	Due to the inversion prepulse, the SNR will be relatively low, especially if the heart rate is high and magnetization cannot recover completely before the next TFE shot is acquired (in the next RR-interval).	To increase SNR, the TFE shot interval can be set to 'user defined' and then to 2 beats to allow for more recovery, but the scan will take longer.

Tab. 43: Effects, causes and measures

Phase Sensitive Inversion Recovery (PSIR)

The PSIR ("AutoViability") IR-TFE sequence can be used for late enhancement assessment. The advantage of this technique is that it is less sensitive to suboptimal inversion delays.

PSIR is a 2 heart-beat sequence

PSIR needs 2 cardiac cycles (per inversion prepulse).

- It is more robust against variations in heart rate, and the SNR and CNR will both be better compared to a single heart-beat technique.
- It is intrinsically slower than single heart-beat techniques.
- The loss in imaging speed can be compensated for by using SENSE.

In the PSIR sequence, the second heartbeat is used for determination of the phase. The inversion pulse is given only once every two heartbeats, so that the acquisition in the second heartbeat has had more time for relaxation (so that the magnetization of all tissues should be positive again), and can be used as a reference.

PSIR provides Corrected Real Images

The “CR” image type (Corrected Real) is the desired final phase corrected image.

NOTICE

PSIR and imaging parameters: not all can be combined, others are mandatory.

Halfscan and partial echo cannot be used with PSIR.

SENSE can be used with PSIR.

CLEAR is mandatory with PSIR.

Related parameters

- TFE prepulse (no, saturate, invert)
- PSIR (no, yes)
- Flip angle (default: 5°)

  The flip angle parameter “Flip angle (deg)” specifies the flip angle of the 2nd TFE shot in the 2nd heart beat, which is typically taken smaller than the flip angle in the 1st heart beat (to prevent saturation).

Tips & Tricks

MR cardiac analysis on the EWS

PSIR datasets can be analyzed by means of the 'Spatial Enhancement' application in the Cardiac Explorer.

They cannot be analyzed by means of the 'Spatial Enhancement' application on the EWS, since they contain CR-images. Analysis can only be performed on the IR-M images, even if the image contrast is suboptimal due to incorrect inversion delay time.

Work-around

- Use 'Split image types' in Review Case to separate the CR-images from the IR/M images.
- Load the IR/M images in the 'Spatial Enhancement' application.

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- For optimal contrast in the IR/M image, use IR_TFE_LL_2beats to determine the optimal inversion delay time for the PSIR sequence prior to scanning PSIR.

Optimal inversion delay time

PSIR uses two RR intervals per inversion pulse. Compared to enhancement techniques which use a single RR interval per inversion pulse, a longer TI should be used for PSIR (because there is more time for relaxation). It's always better to use an inversion delay time which is a bit too long (with positive myocardium). This will result in optimal contrast between normal and scarred myocardium. This is less important for PSIR scans, where a too short TI still results in optimal contrast between the normal and scarred myocardium in the CR-image.

2D vs 3D

PSIR can be used for 2D and 3D, but for practical reasons, PSIR is mainly useful for 2D imaging. This is mainly because of breathhold times.

Navigator echo technique and PSIR

When using navigators with PSIR, the following happens with respect to the acceptance of RR intervals.

- If the first RR interval is accepted, also the second one will be accepted.
- If the first RR interval is rejected, also the second one will be rejected.

T1 mapping

T1 mapping is a method that provides T1 maps of the myocardium. It is based on the Modified Look-Locker Inversion Recovery (MOLLI) technique.
T1 maps are parametric images calculated pixel-wise where the pixel value represents the T1 value per pixel.

Application

- Myocardial tissue.

Diffuse myocardial fibrosis and other remodeling of the extracellular space are common pathological features of many cardiac diseases. These changes can be measured non-invasively with MRI through changes in **native** and **enhanced** myocardial T1 relaxation times.

What are the main properties of T1 mapping?

- T1 maps are provided for native and enhanced scans.
  Optimized acquisition schemes are available which take the different T1 values in native and enhanced scans into account.
- Images are usually acquired in standard cardiac planes.
- Cardiac triggering and breathhold technique are used to compensate for cardiac and respiratory motion.

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- T1 mapping is enabled with the imaging parameter **T1 mapping**.
- Philips native and enhanced imaging protocols utilizing T1 mapping are delivered with the MR system (Folder: *Heart->Function non-cine->Mapping*). It is recommended to use these protocols. They make use of acquisition schemes that are optimized for long (native) and short (enhanced) T1 times based on literature findings.

References

For more information about T1 mapping, see literature.

Patient positioning

- ► Position the patient on the tabletop with VCG, respiratory belt, cardiac coil, headset, and nurse call.
- ► Explain and practice the breathhold procedure with the patient.
  The quality of the T1 maps directly depends on the quality of the breathhold.
- ► Instruct the patient not to touch the VCG module and cables.
- ► Check the quality of the VCG signal prior to scanning.

Running the native T1 scan

- ► Enter the examination data at the console.
- ► Select a cardiac ExamCard with native and enhanced T1 mapping imaging protocols, preferably in more than one imaging plane.
  Images are usually acquired in standard cardiac planes.
- ► Enter the cardiac frequency in the **ExamCard Properties** window.
- ► Start, and eventually plan and resume the ExamCard.
  The survey and the cardiac scans are performed.
- ► Give breathhold instructions during the native T1 mapping scan.
  The quality of the T1 maps directly depends on the quality of the breathhold.
  - The breathhold takes around 11 seconds.
    Since the number of ECG triggered images must be a whole number, the acquisition and recovery periods are rounded to the nearest multiple of the RR-period to ensure an adequate duration and hence the breathhold time is 11 to 12 seconds. The resulting number of images is different depending on the heart rate of the patient.
  - For patients with a heart rate of 60 beats per minute and a RR-interval of 1 second, 8 images are acquired with the native acquisition scheme.
    With a higher heart rate, the RR interval is shorter and more images are acquired during the breathhold.

Administering contrast agent

- ► Inject the contrast agent.

Running the enhanced T1 scan

- ► Wait at least 15 minutes before you start the enhanced T1 mapping scan.

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- Give breathhold instructions during the enhanced T1 mapping scan.
  The quality of the T1 maps directly depends on the quality of the breathhold.
  - The breathhold takes around 12 seconds.
    Since the number of ECG triggered images must be a whole number, the acquisition and recovery periods are rounded to the nearest multiple of the RR-period to ensure an adequate duration and hence the breathhold time is 11 to 13 seconds. The resulting number of images is different depending on the heart rate of the patient.
  - For patients with a heart rate of 60 beats per minute and a RR-interval of 1 second, 9 images are acquired with the enhanced acquisition scheme.
    With a higher heart rate, the RR interval is shorter and more images are acquired during the breathhold.

Viewing the parametric maps

- View the native and the enhanced T1 mapping imaging series as usual with **ImageView**.
  These series contain:
  - acquired images with different inversion delay times,
  - calculated T1 maps, labeled **/T1map**,
  - confidence maps (goodness-of-fit map) as overlay of the T1 maps.
    The confidence maps indicate the quality of the T1 maps.
- *To scroll through the images with different inversion delay times*, drag to the left or to the right on the image viewport.
  Alternatively use the left and right arrow keys.
- *To scroll to the T1 maps*, drag diagonally on the image viewport.
  The T1 maps and the confidence maps are displayed right behind the first inversion delay time image.
  A checkerboard pattern indicates the areas with too low reliability in the data. The confidence map provides the best representation of the reliability of the acquired data. If the confidence map shows poor quality, the scan needs to be acquired again.

Obtaining T1 values

To obtain the T1 values, draw a ROI on a T1 map with confidence overlay.

- Right-click the T1 map with confidence overlay and select the desired ROI type from the provided options.
- Draw a ROI.
  Do not include areas of low confidence such as the checkerboard areas and vascular structures.
- Copy and paste the ROI to the T1 map without confidence overlay.
- Note the mean value of the ROI on the T1 map without confidence overlay as the T1 value.

  The numerical T1 values are displayed in milliseconds (ms).

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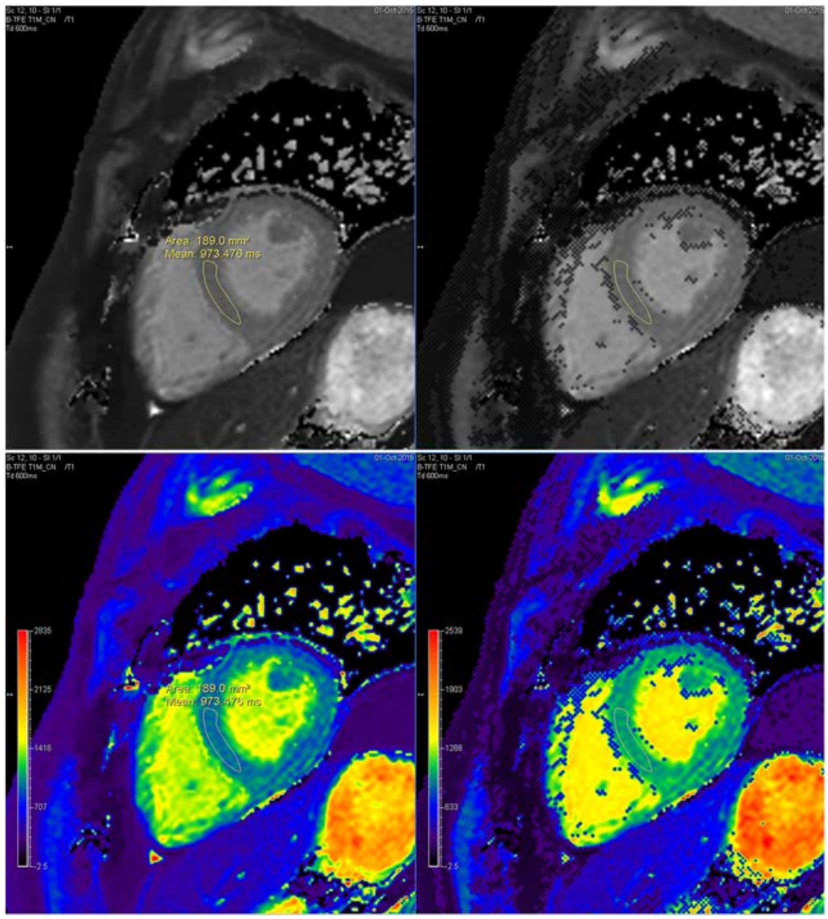
NOTICE

Possibly false results

To avoid any possible bias in the results, DO NOT use T1 values from the T1 map with confidence overlay, because the pixels with low confidence are not automatically excluded.



Optional: Obtaining time-intensity diagram

- On the **ImageView toolbar**, click **More** and then **Time Intensity Display**.
- Select a ROI type, either **Smoothed Polygon** or **Freehand**.
- Draw a ROI.
- Select IR delay time.

  ROI is automatically copied to all images. Time-intensity diagram is displayed as connection of unfitted data points.

More information

- Imaging parameter **T1 mapping** in Online Help system (F1 key)

- Background information in Online Help system (F1 key)

Coronary Angiography

MRI of the coronary arteries, with the advent of the MotionTrak method is now feasible in a clinical setting.

This chapter will introduce the various aspects needed to perform a successful coronary examination. Covered here will be the utilization of MR methods, scan parameters, a recommended clinical scan procedure and angulation techniques.

About Coronary Angiography

Coronary scans can be made with a variety of techniques:

Balanced TFE is the most frequently used method because it is fast due to the very short TR's that are used and it gives a nice strong signal from blood. Other methods include TFE and Black Blood TSE.

Breath holding could be used for respiratory motion reduction, but the total breath-hold time available is not sufficient to achieve good quality images. Another problem for breath-hold approaches is the high risk of unwanted movement of the diaphragm during breath holding.

The best way to acquire high-resolution images is to correct for any respiratory motion using navigators. Navigators correct for sub-millimeter motion and allow for longer scan times, more data acquisition and thus a higher spatial resolution. In the past these scans could easily exceed 10 minutes of scanning, but good results can be obtained in scans that last for a more practical 3 to 5 minutes of effective scan time.

There are two different approaches: the whole heart approach and the targeted approach where typically one scan is needed to catch the right coronary artery (RCA) in one scan, and a second scan is needed to catch the left coronary artery (LCA) and circumflex (LCX) together.

Remark

The most frequently made mistake is to determine the spatial resolution of coronary scan from the voxel size only (FOV and scan matrix), totally ignoring the influences of respiratory motion to the resolution. In other words, decreasing the acquisition resolution from 0.7 mm to 0.5 mm does not improve the resolution if the total amount of respiratory blurring is more then 0.7 mm. Try not to focus too much on the voxel size alone. Focussing on patient comfort is more important, reducing the risk of patient motion gives much better results!

Workflow

The best results are achieved when the patient is not moving at all since very small vessels are to be imaged. The slightest movement of the patient during scanning results in blurred images. It is therefore important to make sure that the patient lays very comfortable inside the magnet. Music through the head phones can help to create a more relaxed atmosphere. Explain to the patient the importance of keeping still during the whole examination.

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Procedure

This procedure describes the targeted approach for the coronary arteries and the whole heart examination.

Multistack survey

- can best be performed in a breath hold (expiration).

  This allows for better planning of the navigator beam that is used for respiratory gating and motion tracking.

High Temp Cine scan

- is a b-FFE cine scan with a sufficient number of phases (40 or more) to allow the precise determination of the trigger delay and shot duration.
- ► Position the scan in transverse orientation through the left and right ventricle. The idea is that this scan shows the motion of RCA and thus the precise moment that diastole starts and early systole begins.
- ► Acquire this scan in free breathe as breath-hold might affect the patient's heart rate. It is important to define the precise start of diastole during free breathe since the actual coronary scan is acquired in free breathe too (navigator).

Coronary survey (only needed for the targeted appraoch)

- is a high-resolution survey scan that covers the whole heart and that is needed for planning of the coronary scans.
- utilizes SENSE b-TFE to speed up the image acquisition.
- uses a navigator for respiratory gating and motion tracking. Position the navigator on the right hemi diaphragm.
- uses a trigger delay set to mid-diastole (if higher heart rates result in conflicting parameters, the trigger delay could also be set to longest).

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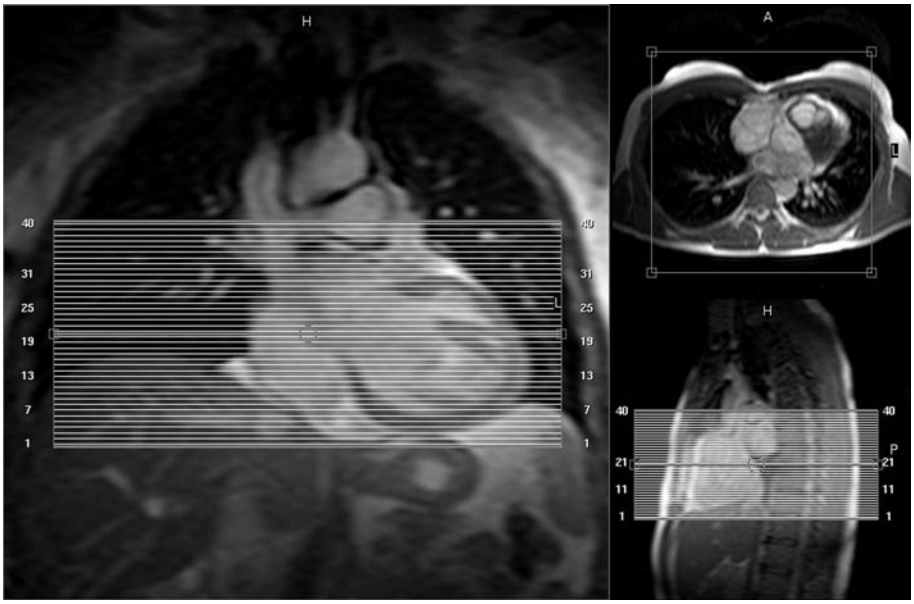

Fig. 355: Coronal image that shows the main pulmonary artery: position the stack such that the first slice is located halfway the pulmonary artery, including as much of the heart as possible.

While this scan is running, the precise trigger delay and shot duration can now be determined from the previous high temp cine scan:

- Browse through the phases and find out at what moment diastole starts. This should be the trigger delay for the coronary scan.
- Browse through the phases to find the precise moment that the right coronary artery starts moving again at early systole. The difference between this moment and the previously mentioned trigger delay is the acquisition duration. The acquisition duration is displayed on the info page and can be controlled by changing the TFE factor.
- Alternatively, the TFE shot duration can be set in milliseconds directly on the 'Contrast' tab. The TFE factor is automatically calculated and displayed on the info page.

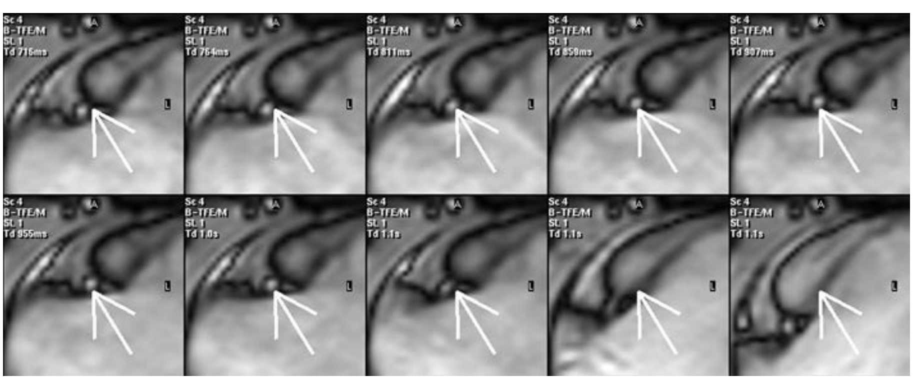

Fig. 356: Browse through the phases of the high temp cine scan to find out the precise moments where the coronary motion starts and stops.

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Coronary scan

Coronary scan	Approach
Whole Heart Coronary scan	for whole heart approach
Right Coronary scan (RCA)	for targeted approach

Tab. 44: Use one of these coronary scans

- ► Enter the trigger delay as found using the High Temp Cine scan.
- ► Adjust the TFE factor or the TFE shot duration on the 'Contrast' tab.

When the images of the previous scan (coronary survey) are loaded into the main planning viewport, three-points-planscan can be used to position the stack of slices such that they cover the whole right coronary artery at once. To avoid any risk of respiratory ghosting artifacts over the image select a feet-head fold-over direction.

For the whole heart approach, the examination would be finished by now. For the targeted approach, another scan for the LCA could be necessary.

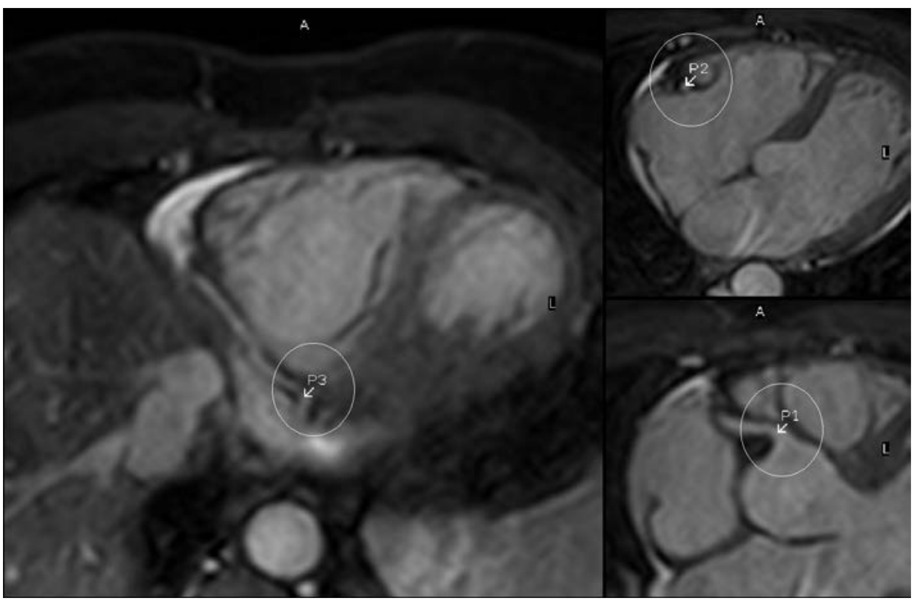

Fig. 357: Place the first point at the origin of the RCA, the second point more lateral at the most apical position and the third point at the most distal, inferior position.

Left coronary artery (LM, LAD and LCX) scan - for targeted approach

- The left main (LM), left anterior descending (LAD) and the left circumflex (LCX) can be acquired in a single 3D volume.
- Use three-points-planscan to position the stack.
- Fold-over direction should be set to LR to avoid any risk of respiratory ghosting artifacts.

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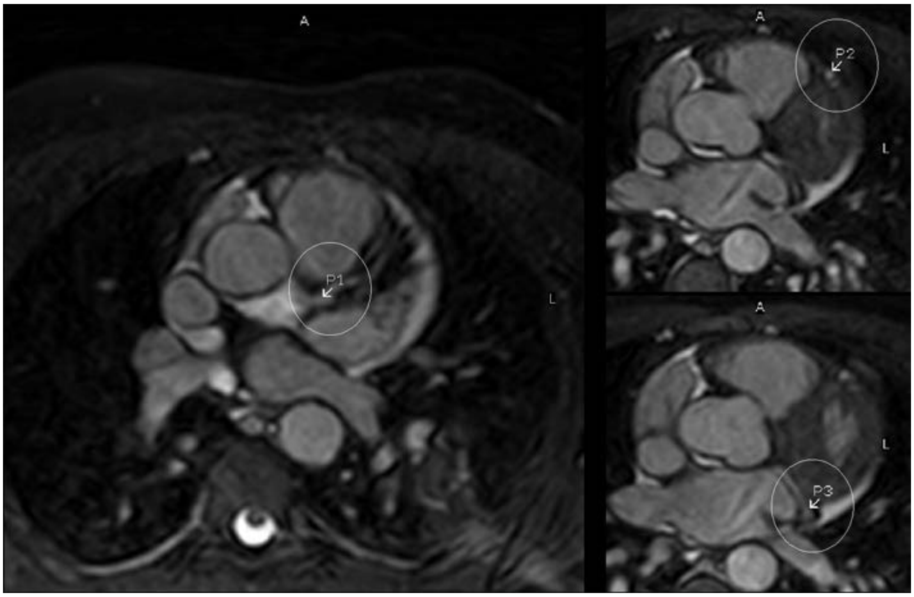

Fig. 358: Place the first point at the origin of the LM, the second point more distal in the LAD and the third point at the LCX.

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Technical background

The coronary scans make use of the '3D-K-space shutter' which saves 20% of the scan-time and increases signal to noise. The technique utilizes a radial profile order, which means that the outer corners of 3D K-space are not acquired during acquisition resulting in improved image quality. As a result of this radial profile order, each individual TFE shot starts at the center of 3D K-space (low-high profile order). Because of this REST and SPAIR or SPIR pulses become more effective. Therefore it is also allowed to select fold-over suppression with only 1 NSA (implicit use of REST slabs).

A SPAIR or SPIR fat suppression pulse is used to enhance the contrast between the coronary artery and the surrounding epicardial fat.

A T2Prep pulse is used to further enhance the contrast between the coronary arteries and the myocardium. The T2Prep pulse is a non-selective pre-pulse that suppresses tissues with short T2 relaxation's using a train of refocusing pulses over a short period of time. Both the number of refocusing pulses (1, 2 or 4) and the period of time (echo time) can be adjusted for the T2Prep pulse.

It is recommended to use volume shim, which is done selectively over a volume that can be freely chosen, but is restricted to a minimum value. Large transitions as air/tissue boundaries should be excluded from the selected volume and also areas where large homogeneity variations occur. When 'ShimAlign' is set to 'yes', any modification of the stack off-centers and angulations will result in a recalculation of the shim volume such that the shim volume will be aligned to the stack:

- Off-centers are adjusted such that the volume will be inside the stack.
- Angulations will be equal to the stack.

- The volume will be slightly thicker than the stack allowing easier selection in planscan mode.

Sequence description

In order to eliminate the contribution of fat signal into the navigator beam a second SPIR pulse is implemented to suppress the fat in the navigator beam. This results in a steady navigator signal. The excitation of the navigator is moved close to the acquisition train to ensure a minimum amount of residual motion. The order of pulses is:

- T2 prep pulse
- SPIR for navigator
- Navigator
- SPIR for image acquisition
- Implicit REST for fold-over suppression
- Acquisition train (Balanced TFE, TFE or TFE-EPI)

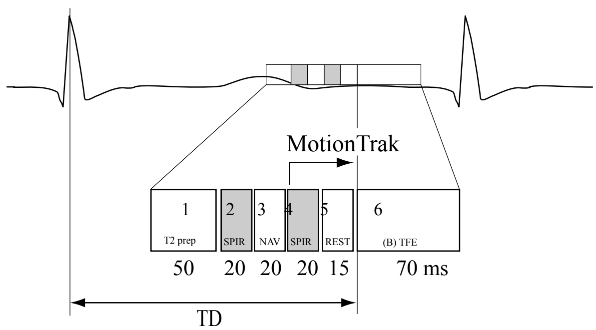

Fig. 359: Navigator coronary sequence.

1	T2 prep
2	SPIR
3	Navigator
4	SPIR
5	REST
6	(B)-TFE

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SENC (Strain Encoding)

Property	Description
Pulse Sequence	SENC (Strain ENCoding) is a technique to image the contracting heart muscle in a quantitative way. • The SENC acquisition takes place at the Philips MRI system. • The acquisition data is intended to be processed with the *MyoStrain* application by the company *Myocardial Solutions* (http://www.myocardialsolutions.com/).
Properties	• SENC provides modulus images which are needed to calculate the SENC strain images. These strain images contain the quantitative information. • SENC scans also provide SENC anatomy images. They can be used to check the planning, arrhythmia, motion artifacts, and image quality in general.
Applications	• Cardiac imaging: SENC supports strain measurements in the left and right ventricle.
Scan modes	• Single-Shot TFE-Spiral

What is SENC?

SENC (Strain ENCoding) is a technique to image the contracting heart muscle in a quantitative way.

One SENC scan results in time series of images (typically 20 heart phases) of a single slice, where the pixel value in each image represents strain (contraction or expansion relative to some reference point in the cardiac cycle). Strain is a dimension-less number (expressed as a percentage) and can be directly interpreted as a quantitative measure. Only strain in a direction perpendicular to the slice orientation is measured. By scanning a few well-defined cardiac views, enough information can be collected to image strain in all relevant directions covering the whole heart.

SENC can be considered as a form of cardiac tagging – however it does NOT require elaborate processing by way of tracking line or grid patterns.

- SENC measures strain directly.
- SENC does not rely on phase information and avoids difficulties with phase unwrapping.
- SENC has an extremely fast acquisition (1 single heartbeat per slice orientation).
  - One slice acquired in a single heartbeat, providing typically 20 cardiac phases, triggered to an R wave.
  - The readout technique is spiral, with typically 3 spiral interleaves per cardiac phase.
- SENC does not require breath holding. It can be performed with respiratory triggering.

The most critical success factor is planning accuracy: the better the SENC images are planned, the better the strain images.

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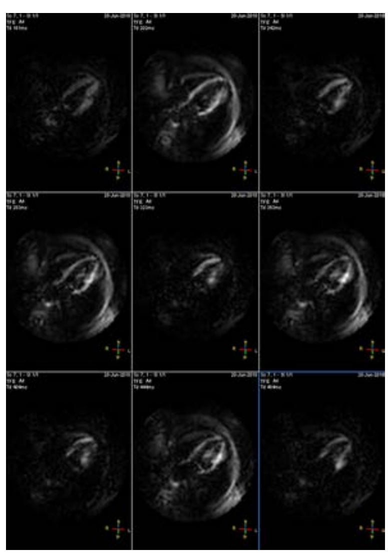
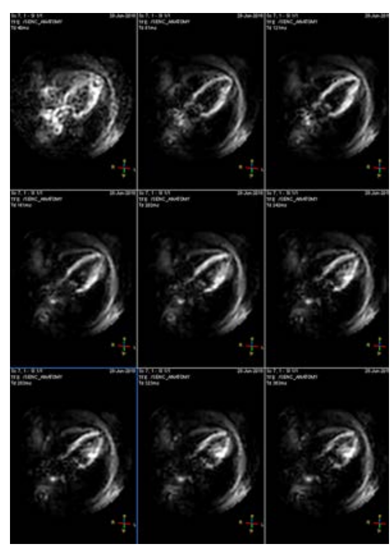
How does SENC work?

SENC applies a tagging pulse complex at the start of the cardiac cycle, immediately after the R-wave. The tagging pulse complex produces a sinusoidal modulation of Mz magnetization, in a direction perpendicular to the slice. The modulation typically consists of a few full periods across the slice thickness. During subsequent signal readout, the sinusoidal modulation must be demodulated in order to see a net signal. That demodulation is effected by applying a kz decoding gradient, much like a kz phase encoding gradient. In order to measure relative deformation (compression or expansion of the sinusoidal pattern), it is useful to demodulate not at the exact modulation frequency, but instead at two slightly different frequencies called the low and high tuning respectively. The combination of the two differently tuned images allows a calculation of real strain.

The tagging process itself provides a volume selective excitation. Since only tagged tissue is imaged, this prevents backfolding in spiral imaging and allows to use a small Field of View, planned closely around the heart.

SENC images

SENC provides different image types at different heart phases covering the complete cardiac cycle:

SENC image type	SENC modulus images	SENC anatomy images
Purpose/description	Needed to calculate the SENC strain images. They do not provide useful visual information. Instead use the SENC anatomy images to judge image quality.	Meant to judge image quality of the SENC scan: • check for SNR (signal-to-noise ratio) • possible patient movements
Provided where	• Outcome of acquisition • Need to be pushed to computer with analysis software for the calculation of the strain images.	• Outcome of acquisition
Example images		

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References

For more information about SENC, see literature.

Scanning with SENC

Use SENC in cardiac imaging to evaluate, for example, left ventricular function.

Patient positioning

- Position the patient on the tabletop with VCG, respiratory belt, cardiac coil, headset, and nurse call.
- Instruct the patient not to touch the VCG module and cables.
- Check the quality of the VCG signal prior to scanning.

Selecting the ExamCard for SENC

- Enter the examination data at the console.
- Select the cardiac ExampleCard SENC.
  This ExampleCard provides guidance on planning. It contains the following Philips imaging protocols:

Imaging protocol	Number of breath-holds
Multistack survey (3 planes)	
Pseudo 2CH CINE scan	1
Pseudo 4CH CINE scan	1
Short axis CINE (5 planes including the valves)	5
True long axis CINE 2CH	1
True long axis CINE 3CH	1
True long axis CINE 4CH	1
SENC long axis views 2CH, 4CH, 3CH	3
SENC short axis basal SAB	1
SENC short axis mid SAM	1
SENC short axis apical SAA	1

Planning and scanning

- Start the ExamCard and as such the Multistack survey.
- Do one of the following to update the cardiac frequency:

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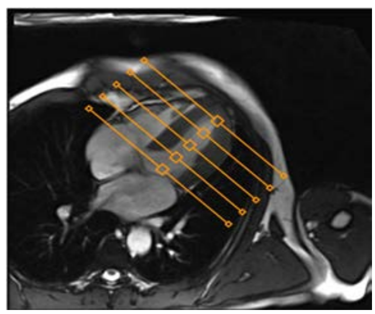
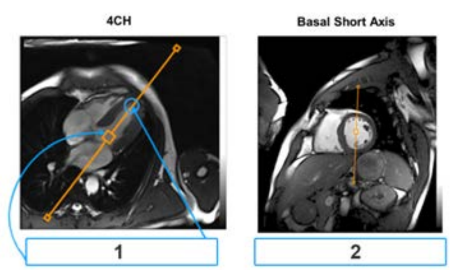
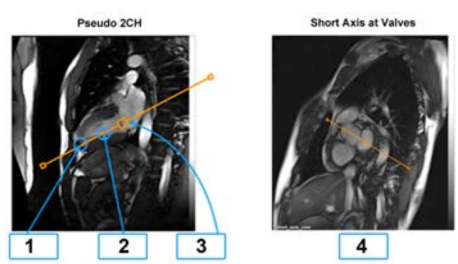
- Enter the cardiac frequency in the **ExamCard Properties** window. Regularly check and update throughout the complete examination.
- Update the cardiac frequency using the **Update Heart Rate** button. This function is linked to the ExamCard properties.

► Plan all scans as shown in the following.
Start, and eventually plan and resume the ExamCard.

Imaging protocol	How to plan?	Planning example
Pseudo 2CH CINE scan	• Center on left ventricle utilizing all 3 planes of the Multistack survey.	-
Pseudo 4CH CINE scan	• Cut plane parallel on long axis 2CH bisecting the blood pool equally.	-
Short axis CINE (5 planes including the valves)	• Use Pseudo 4CH as reference. • Select end-systolic time frame centered on the left ventricle. • Increase the distance factor to image from the base to the apex of the heart.	
True long axis CINE 2CH	• FOV centered on the left ventricle. • The slice must bisect the apex in the Pseudo 2CH view. • Parallel to the septum and equidistantly away from right ventricle insertion points.	 1. Cut plane should bisect LV apex and mitral valve. 2. Cut plane parallel to ventricular septum on short axis view.
True long axis CINE 3CH	• FOV centered on the left ventricle. • Bisect the apex in the 2CH view. • Bisect the LV outflow tract on the short axis view.	 1. Cut plane to bisect the apex. 2. Avoid papillary muscle. 3. Cut plane to bisect mitral valve. 4. Bisect LV outflow tract on Basal Short Axis.

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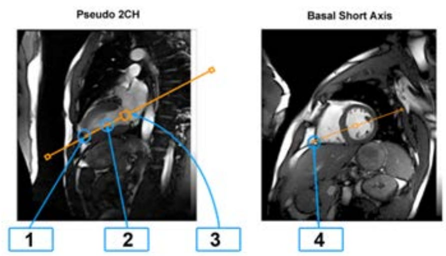
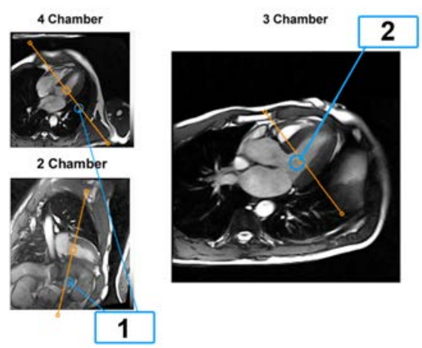
Imaging protocol	How to plan?	Planning example	
True long axis CINE 4CH	• FOV centered on the left ventricle. • The slices must bisect the apex in the 2CH and 3CH views.		1. Rotate to go through the apex. 2. Avoid papillary muscle. 3. Cut plane to bisect mitral valve. 4. Place center of the plane on the most angled portion of the right ventricular wall.
SENC long axis views 2CH, 4CH, 3CH	• Use same geometry names as for Cine 2CH, Cine 3CH and Cine 4CH . • Move the center of the LV to the center of the FOV (away from the FOV edges). • Capture the cardiac cycle.	-	
SENC short axis basal SAB	• Plan on the 3CH view at the end-systolic time frame. • Place the slice just below the plane of the valves. • Check the slice orientation on 2CH, 3CH and 4CH views. Check that the plane is orthogonal to all walls in the long-axis views (2CH, 3CH, 4CH).		1. All planes should be orthogonal to LV walls. 2. Place slice just below open leaflets of valves.

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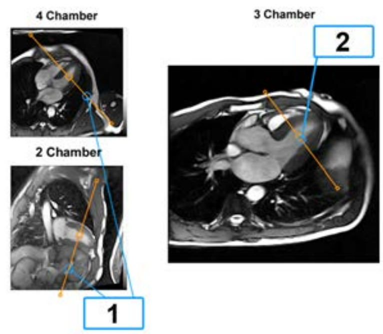
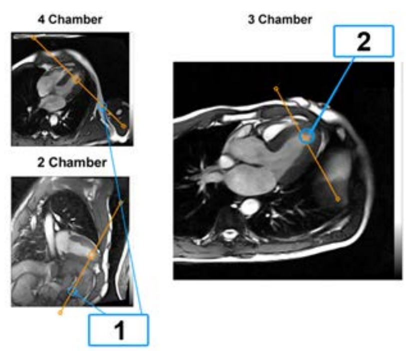
Philips

Imaging protocol	How to plan?	Planning example	
SENC short axis mid SAM	• Use the same geometry name as for the SAB scan. • Change the geometry name to SAM. This action takes over the slice position of the SAB scan. • Plan on the 3CH view at the end-systolic time frame. • Adjust the plane mid-distance to the apex. • Ensure the plane is orthogonal to walls in the long axis views (2CH, 3CH, 4CH). • Capture the cardiac cycle.		1. All planes should be orthogonal to LV walls. 2. Move plane towards apex.
SENC short axis apical SAA	• Use the same geometry name as for the SAM scan. • Change the geometry name to SAA. This action takes over the slice position of the SAM scan. • Plan on the 2CH view at the end-systolic time frame. • Move the plane close to the apex. • Ensure the plane is orthogonal to walls in the long axis views (2CH, 3CH, 4CH). • Capture the cardiac cycle.		1. All planes should be orthogonal to LV walls. 2. At ES, towards tip of the blood pool.

Reviewing the images

- ► Review the SENC anatomy imaging series with **ImageView**, preferably as movie.
- ► To scroll through the image types, drag to the left or to the right on the image viewport. Alternatively use the left and right arrow keys.
- ► To scroll through the heart phase images, drag diagonally on the image viewport.

Typical SENC parameter settings

- To automatically transfer the SENC modulus images to the workstation with the postprocessing software, the Philips SENC imaging protocols have **Autopush to Workstation** enabled.
- To automatically calculate the SENC anatomy images, the Philips SENC imaging protocols have the imaging parameter **Calculated images** set to **SENC anatomy**.
- Since one slice is measured within one heartbeat, there are no problems with variations of the cardiac cycle. **Arrhythmia rejection** is not needed.
- The recommended values of the **SENC strain range parameter** are +5% , -30%.

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21 BOLD Imaging

BOLD imaging	• Helps identifying active regions of the brain relying on local metabolic and hemodynamic changes which occur in activated cortical brain.
Contrast mechanisms	• BOLD (Blood Oxygen Level Dependent): During brain activation (increase of metabolism), the oxygen consumption of local tissue increases by approximately 5%. • Vasodilatation: Vasodilatation occurs resulting in a local increase of blood volume and flow by 20% to 40%. The above hemodynamic response to brain activation leads to an increased local oxygen level resulting in a signal increase in T2*W sequences.
Scan methods	The BOLD effect is visible in heavily T2*weighted scans.
Properties	• The BOLD contrast mechanism will benefit from high field strengths. • Signal changes are typically in the order of 1% to 4%.
Analysis	• To indicate those pixels with a significant increased signal intensity. • Can be performed with **IViewBOLD** package, see chapter “IViewBOLD ” on page 599.

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Quality improvements for diffusion sequences

To improve the quality of BOLD MRI, use EPIC Brain:

- **EPIC Brain** allows you to enable EPI geometry correction in the brain in dynamic FFE- and SE-EPI scans, and in diffusion EPI scans.
  - Application Brain only: especially DWI, DTI and BOLD imaging.
  - To enable EPIC Brain, set the parameter **EPI Geometry Correction** to **yes**.

    More information in the Online Help **(F1)**: Enabling EPIC Brain

Paradigms

In general in BOLD imaging, instructions need to be given to the patient. These instructions are focused on delineating a certain area of brain function. As an example, the instruction could be to move the right thumb or to hold still. In this case, the instruction would be "move" or "hold still". This set of instructions is called a paradigm.

A paradigm

- is the pattern of brain activation (a stimulus is presented or a task is executed).
- consists of blocks (of fixed duration) of brain activation alternating with blocks of rest (or with a control task).
- is characterized by
  - the length of activation(s) and rest in dynamics
  - the task being performed.

- may be more complicated
  – consisting of different tasks, even of different intensities
  – with varying length of the activation or rest blocks.
- is called ’block paradigm’ if the activation and control tasks are performed for a duration of at least a few dynamics.
- is called ’event-related paradigm’ if the stimuli and the applied instructions or events will only last for a very short period. For example, the instruction to identify a picture of a person as known or unknown only activates the brain for a very short period.

Example

Brain activation can be detected with a very wide range of paradigms. Simple paradigms can be visual (different hemifields, flickering or static, moving or static), silent- or overt speech to identify Broca's and/or Wernicke's area, depicting motor activity of the different hand digits, listening to auditory stimuli etc.

More advanced paradigms focus on memory (by showing "new" versus "old" faces and places), attention (the "no-go" tasks) etc.

Motor tasks

The patient is asked to perform a motoric task e.g. to tap his/her index finger.

Visual stimulation

The patient is confronted with visual stimulation e.g. a flashing checkerboard.

Auditory stimulation

The patient is confronted with auditory stimulation e.g. auditory presentation of words.

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Paradigm synchronization with the scanner

The purpose of a BOLD examination is to analyze brain activity as a response to the applied paradigm. In order to do this, it is essential to know the timing of the paradigm with respect to the acquisition of the T2*weighted dynamic scan.

Correct timing can be obtained by using stimulus presentation devices that can automatically synchronize with the scanner. In this case, the scanner will provide a start signal to the paradigm system (or software) so that both scanner and paradigm apparatus start at the same time.

Paradigm synchronization can be facilitated by the use of the Esys system and/or the FBI box.

Functional Brain Imaging box (FBI box)

The FBI box generates trigger pulses (TTL pulse of 4 V of around 5 microseconds) for an external device to identify the start of the next instruction for the patient.

The trigger signals must be set by the user with the imaging parameters "Start at dyn" and "Interval (dynamics)" which appear when "Synch. external device" has been set to "Yes" (dyn/angio page).

The paradigm is started and thus synchronized automatically with help of the FBI box.

Example

Visual stimulation is presented to the patient via a projection screen in the magnet room. The patient display is controlled by the device (either Esys or a third party system) connected to the FBI box.

NOTICE

The FBI trigger device can often not be connected to a PC directly.

In this case, use a converter that translates the FBI signal to a chosen keyboard signal. These converters are offered by various companies.

Each time the (next) trigger is detected, the next visual input is given (e.g. by the next power-point slide).

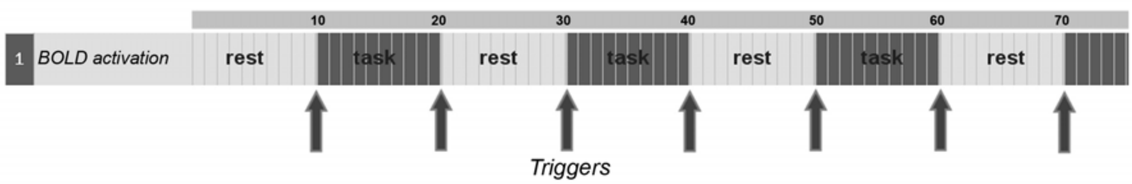

Fig. 360: Schematic presentation of trigger with respect to dynamic sequence. An example is given of a simple block paradigm whereby dynamics of a resting state are interleaved with blocks of scanning whereby the patient has to perform a certain task. Both the resting and task related blocks take 10 dynamics of scanning. The first trigger is given at the 11th dynamic in order to have the first automated instruction last during the first 10 dynamics. For example: a slide saying "Do Nothing" could have been started even before the start of the scan. After the scan has started, and finished the first 10 dynamics the FBI box will trigger the next instruction providing the correct instruction. Also it can be seen that the following triggers will be obtained at each 10th dynamic.

WARNING

Manufacturer recommends the proper use of the Functional Brain Imaging box in connection with external devices that are compliant with IEC 60950 class I or class II equipment.

Only devices that are compliant with the aforementioned IEC standards may be connected to the box outside the examination room.

NOTICE

Place the Functional Brain Imaging box in a location where Electro-Static Discharges (ESD) are unlikely to occur.

A false trigger could temporarily invalidate synchronization of the fMRI acquisition and the paradigm display, resulting in minor loss of statistical power.

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Esys

The Esys system is a turnkey fMRI stimulus system that can be used to provide any visual or auditory stimulus, and is able to handle patient responses using button boxes.

It includes an LCD visual display, crystal clear audio system, and button response unit for data collection. The software provides for experiment creation, precise delivery of brain stimulation, protocol planning, behavioral data analysis and patient management.

Esys is the only fMRI stimulus delivery system that has been tested and certified for compatibility with Philips MRI scanners. For more information on the Esys system, refer to the 'Esys Instructions for Use'.

See section 'Esys synchronization' for more information on how to use the Esys with the Philips MRI system.

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22 MR Spectroscopy

Magnetic Resonance Spectroscopy (MRS) works on the same basic principles as MR Imaging (MRI): the real differences are in the manipulation of the signal during and after acquisition. Certain atomic nuclei in the human body, such as the protons (of water and other compounds with hydrogen atoms), have a net magnetic field as a result of their spinning motion. When these spinning nuclear magnets are placed in an external magnetic field the rotation is changed into a precession around the external magnetic field.

For more information about MR Spectroscopy, press **F1** to open the Online Help and browse to Scan Methods and more/MR Spectroscopy.

Proton MR Spectroscopy: Clinical Applications

MR spectroscopy can be used in all anatomical regions. It is a non-invasive study that can provide information on chemical composition and metabolism of an area of interest, that might be useful for diagnostic purposes. Literature discusses the predictive value of MR spectroscopy in the course of some diseases.

All Ingenia coils available can be used for MR spectroscopy.

General

This section gives some general tips and hints with respect to planning and scanning for MR Spectroscopy.

Planning Offcenters and Angulations

- In SI scans (2DSI and 3DSI) only the slice angulation and the in-plane offcenters of the VOI can be planned independently from the stack. The other offcenters and angulations are equal to the stack.
- It is possible but not recommended to use the same geometry name for SV and SI scans, because a SV scan can not change all the VOI offcenters and angulations in a SI scan. Some of these parameters are fixed by the stack.

Propagate Coverage

- Only if ’Propagate Coverage’ is enabled, the VOI sizes are shared between scans with the same geometry name.
  - Exception: The VOI thickness (slice coverage) in 2DSI scans can not be changed by another scan with the same geometry name, because it is determined by the stack coverage. So SV and 3DSI scans can reuse the VOI thickness of a 2DSI scan via ’Propagate Coverage’, but a 2DSI scan can not use the VOI thickness of SV and 3DSI scans.

VOI Alignments

- The VOI offcenter and angulation alignment settings are shared over all scans with the same geometry name.

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- SV scans (where VOI alignment is not applicable, so disabled) switches off the VOI alignments in SI scans with the same geometry name.

Imaging and Spectro

- Imaging scan and SV scan with the same geometry name do not share anything.
- Imaging scan and SI scan with the same geometry name have the same stack geometry. The stack sizes are only shared if ’Propagate Coverage’ is enabled.
- If an imaging scan and SI scan have the same geometry name, and the geometry of the imaging stack is changed, then also the stack in the SI scan and the VOI geometry will change (because some VOI parameters are related to this stack).
  - If alignments are switched ON in the SI scan, then all offcenters and angulations are changed in the VOI.
  - If alignments are switched OFF, then the VOI receives the through-plane offcenter and the in-plane angulations of the stack.

SmartPlan

- SmartPlan learns the VOI offcenters, angulations and sizes.
- SmartPlan automatically plans the VOI offcenters and angulations of scans using a smart named geometry.
- SmartPlan only plans the VOI sizes in a spectro scan.
- VOIs automatically planned by SmartPlan must always be confirmed in the PlanScan environment, because planning a VOI is very criticial.

Hold Geometry

- If the user starts planning a spectro scan with a geometry name for the first time (so the named geometry does not yet contain a planned VOI), then at the start of planning the VOI offcenters and angulations of the latest planned VOI are copied to this scan. This latest planned VOI is stored in the so called ’hold geometry’.

Scanning and default script for SpectroView postprocessing

- SpectroView comes up with a default script for postprocessing. This default script depends on the setting of the general imaging parameter ’Anatomic Region’.

Scanning with the phantom

Phantom scanning can be useful for testing or training purposes and it can be used as a reference for spectral quality in order to test the system’s stability.

The spectroscopy package includes a phantom, phantom A, and a positioning plate.

The phantom can be placed

- on the positioning plate in theload ring of the Q-Head coil, the H-Head coil or the Transmit/Receive Head coil,
- on the head rest of the SENSE Head coil.

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- on top of Surface or SENSE coils.

Phantom A is a sphere of 10 cm diameter, containing the following compounds resolved in water:

- 5 ml 98% acetate (CH_3OOH)
- 10 ml 80% ethanol (CH_3 CH_2OH)
- 8 ml 98% phosphoric acid (H_3PO_4)
- 1 ml 1% arquad solution + 120 mg/ml $CuSO_4$

Because the phantom contains high concentrations of alcohol and acetate, a good signal-to-noise spectrum can be obtained in only a few measurements.

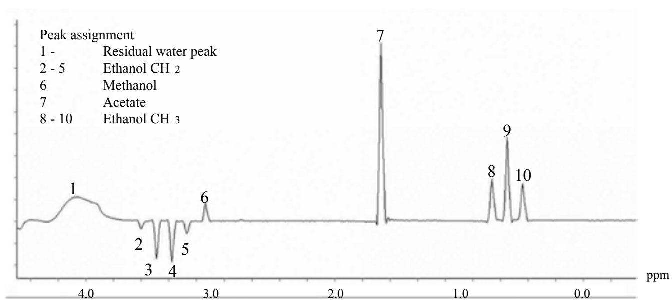

Fig. 361: Water-suppressed spectrum of phantom sphere A.

The ethanol CH_2 signal is a J-coupled signal, with a J-coupling constant very similar to that of lactate (~ 7Hz). The peaks will have positive sign at very short TE and at TE = 288 ms, but will be inverted at the echo time of 144 ms, which was used in this figure.

Preset procedures

Philips database: ExamCards and preset procedures

Preset procedures for spectroscopy are present in the Philips database. They are grouped together in spectro folders per anatomy. Subfolders can be present in the spectro folder for separate applications.

The Philips database contains ExamCards with spectroscopy scans for various anatomical regions. ExamCard features like sharing geometry are implemented for optimal workflow.

Example of Spectroscopy procedures for the head

- Spectroscopy_1H
  - with subfolders Brain, Hippocampus
- optional: Spectroscopy_31P

Naming in MRS Preset Procedures

Term in name	Standing for
SV	Single Voxel
2D	Two dimensional Spectroscopic Imaging (Chemical Shift Imaging)
TSI	Turbo Spectroscopic Imaging
3D	Three dimensional Spectroscopic Imaging
MS	Multislice
PRESS / STEAM / SE / sLASER	Indicating the VOI selection method
'Number'	Indicating the echo time

Brain

Proton spectroscopy in the brain is currently the most common spectroscopy application. It might be used to aid in evaluation of e.g. tumors, abcesses, white matter diseases (like Alzheimer), temporal epilepsia etc.

More specific, spectroscopy may help in the evaluation of

- Tumor grading / assessment
- Typing (benign / malignant / recurrent / necrosis)
- Assessment of response to therapy

Spectroscopy findings in tumor analysis might show:

Metabolite	Related to
Increased choline	rapid cell turnover in solid portion of the tumour
Decreased choline	necrosis if in central portion
Decreased NAA	non-neuronal origin of tumour
Decreased Cr/PCr	compromise energy state of tumour tissue
Increased lactate	product of anaerobic glycolysis

Coil choice

All coil solutions available can be used to perform spectroscopy.

A dedicated head coil is preferred for brain spectroscopy for optimal signal-to-noise ratio, shortest possible echo times and least chemical shift displacement in volume selection at high field strengths.

Scan mode

Both, Single Voxel Spectroscopy and Spectroscopic Imaging are widely used in brain applications.

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	Single Voxel Spectroscopy (SVS)	Spectroscopic Imaging
Advantages	• Good signal to noise spectrum in relatively short scan time, and • Shimming is usually much better due to smaller volume size.	Information about metabolic distribution is available in a larger region.
Disadvantages	• Only one spectrum from a block-shaped volume is acquired: – no spatial information is available. – partial volume effects can occur.	A relatively long scan time is required for generally lower SNR per spectrum. Note that scan time reduction can be achieved by using TSI and/or SENSE, at the cost of spectral resolution and/or signal to noise.

Tab. 45: SVS versus SI

Performing proton spectroscopy in the brain

SVS workflow

1. Acquire anatomical images in at least two orthogonal directions with an intersection to the area of interest.
2. Select procedure for SVS.
3. Graphically resize and position the VOI in planscan.
4. Start scan.
5. Open monitoring window to view the results in real-time.
6. When reconstruction is complete, open the series in SpectroView. Do any of the following:
   - Double-click on the scan in the planning list.
   - Drag and drop the scan from the planning list into the viewing window.
7. Run appropriate script for processing.
8. Create DICOM screen capture.

Spectroscopic Imaging workflow

1. Acquire anatomical images in the imaging plane required for CSI with an intersection to the area of interest.
   - Position center slice of the stack in the required position of the CSI-scan: the geometry used for this scan can be used to plan the CSI-scan
2. Select preset procedure for CSI.
3. Select geometry of the required anatomical, to copy the planning.
4. Change in-plane VOI size and position REST slabs.
5. Start scan.
6. When reconstruction is complete, open the series in SpectroView. Do any of the following:
   - Double-click on the scan in the planning list.

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- Drag and drop the scan from the planning list into the viewing window.

7. Run appropriate script for processing.
8. Create DICOM screen capture.

Alternative workflow

A possible workflow is to acquire a set of fast spectroscopic images, that serve as a kind of metabolic screening. One or more high-resolution single voxel scans are planned on these metabolite maps.

The FOV and scan matrix define the spatial resolution of the resultant spectroscopic image, while the VOI size (and the REST slabs surrounding the VOI) define the signal generating area.

Volume selection method

If short TE spectra are to be acquired, STEAM, PRESS, and sLASER can be used as a volume selection method.

PRESS

The shortest possible TE is limited by the fact that three RF pulses and slice selection gradients must be applied for full volume selection. Depending on (amongst others) the system's field strength and the used B1-transmit field, the shortest possible TE in a PRESS sequence is ~ 22 ms.

sLASER

sLASER is a variation of the PRESS technique.

For the dS Head 32ch 3.0T coil, the minimum TE is around 30 ms.

STEAM

As in PRESS, also three RF pulses and slice selection gradients are applied. However, as the magnetization is flipped back in the longitudinal plane between the second and third RF pulse, the effective TE is much shorter with an approximate value of 7 ms.

STEAM has a relatively low signal-to-noise ratio. However, shorter TE on the other hand results in increased signal-to-noise ratio again, and extra signals of tissues with short T_2 relaxation times.

Note that, with shorter TE, water suppression might be less optimal: At longer TE, residual water signal is reduced due to T_2-decay, that is relatively fast for water in comparison to the T_2-decay of brain metabolites.

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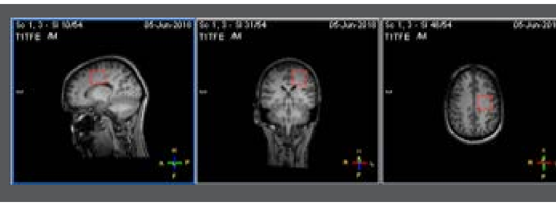
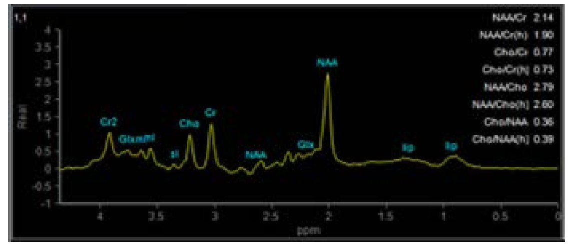
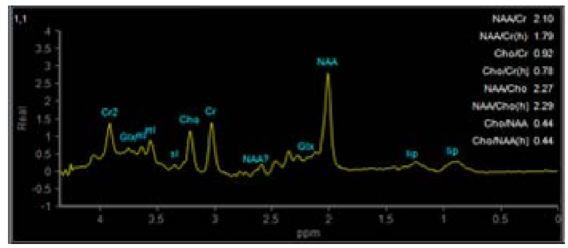
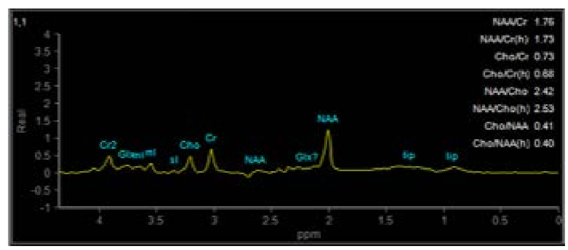
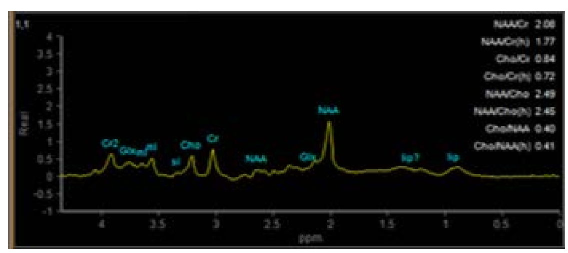
Comparison	
SV PRESS TE 35 ms	
SV sLASER TE 35 ms	
SV STEAM TE 35 ms	
SV STEAM TE 9 ms	

- The comparison SV PRESS TE 35 ms and SV sLASER TE 35 ms show equal SNR.
- The comparison SV PRESS TE 35 ms and SV STEAM TE 35 ms show reduced SNR for the latter spectrum.
- The comparison SV STEAM 35 ms and SV STEAM 9 ms show increased SNR for the latter spectrum due to reduced T2 relaxation in all metabolites.

More information

- In the Online Help (**F1**): Imaging parameter **VOI selection method**
- In the Online Help (**F1**): Overview of volume selection techniques in **Scan Methods -> MRS -> Volume selection methods**

Volume selection for CSI

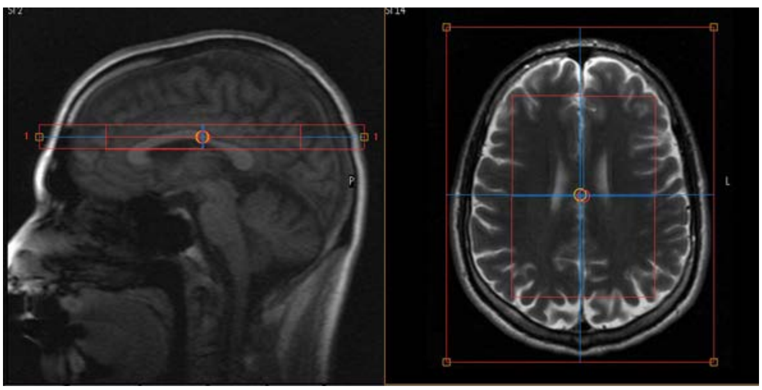
Full volume selection

Full volume selection can be used for spectroscopic imaging in the brain.

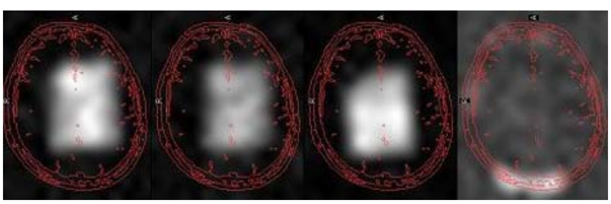
It can be combined with PRESS, sLASER and STEAM.

The VOI selected is the signal generating area and should include only tissue of interest (no air-tissue interfaces, no fat from surrounding skull.) Outer volume suppression is optimal, as no signal is selected.

The drawback of full volume selection is that the size of the VOI in general is limited, as it is a box-shaped volume that doesn't correspond well with the shape of the brain. If combined with circular REST, then the VOI may be larger.



Planscan example full volume selection.



Full PRESS volume selection centered on NAA (3rd image). The maps of choline (1st) and creatine (2nd) come from a slightly different position due to chemical shift displacement. Note that the signal from outside the volume is hardly generated. Lipid image (4th) is almost empty. Note: volume selection by sLASER reduces inplane chemical shift displacement at 3T.

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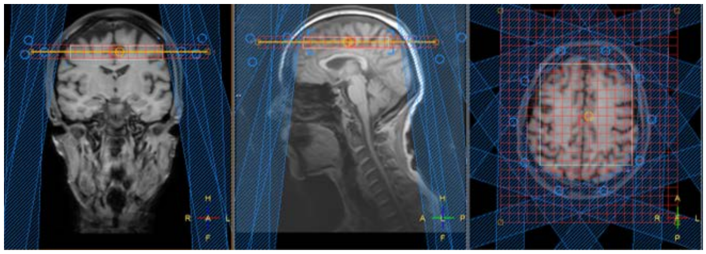
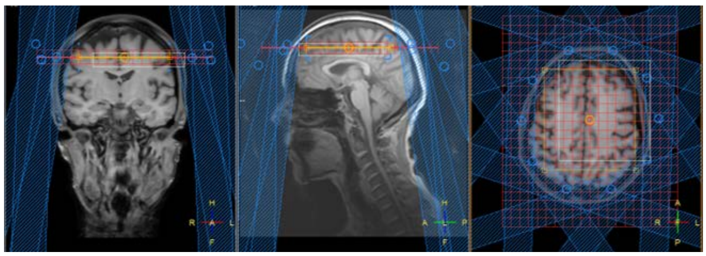


Chemical shift displacement sLASER



Chemical shift displacement PRESS

Chemical shift displacement

- Chemical shift displacement occurs in all three dimensions as slice selective gradients are applied in three dimensions if full volume selection is enabled.
- The adiabatic refocusing pulses in sLASER significantly reduce chemical shift displacement in the refocusing directions at 3T (see figures). Recommendation: use sLASER for 2DSI on brain at 3T.

Slice selection

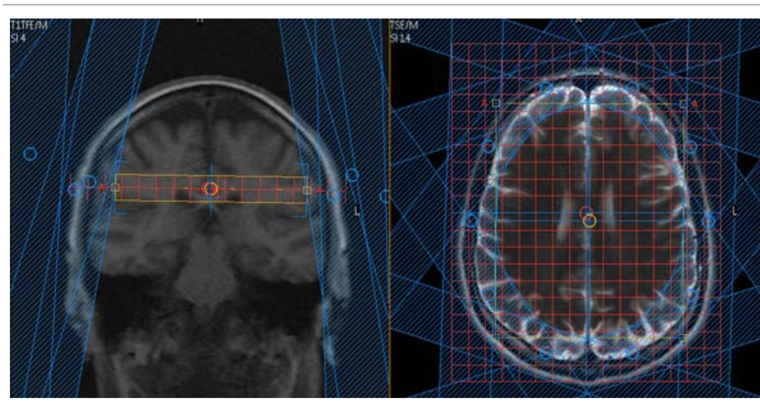
Slice selection can be performed instead of full volume selection (as in MR imaging).

It cannot be combined with STEAM.

The VOI in planscan determines the shim volume, but everything within the selected slice will generate signal.

To avoid fold-over, it is important that the slice FOV is large enough: all signal generating areas must be included in the selected FOV.

With SE technique, REST slabs are to be used for outer volume suppression. Use of circular REST is optimized for brain spectroscopic imaging, as the REST slabs nicely define a circular-shaped volume, that corresponds with the shape of the brain.



Planscan example with circular REST.

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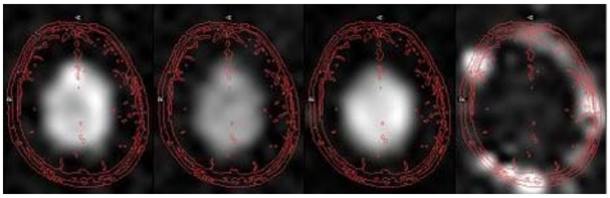
Chemical shift displacement

- only occurs in the direction in which a slice selective gradient is applied. This is in the 'through-plane' direction.



Slice selection combined with circular REST for outer volume suppression. Chemical shift displacement is not seen in plane, but outer volume suppression by REST slabs only is less complete.

Choice of TE

The choice of TE is based on the metabolites of interest: if T_2-relaxation times of the metabolites of interest are relatively short (eg. Myo-Inositol), the TE must be kept short to detect the signal before T_2-decay is complete.

The TE determines much of the appearance of the spectrum: signals with short T_2 generate broad peaks in the spectrum (Fourier Transform on a fast decaying signal), and can even disappear in the baseline. On the other hand, they will become invisible at long TE, leaving a spectrum with fewer peaks and a smoother baseline.

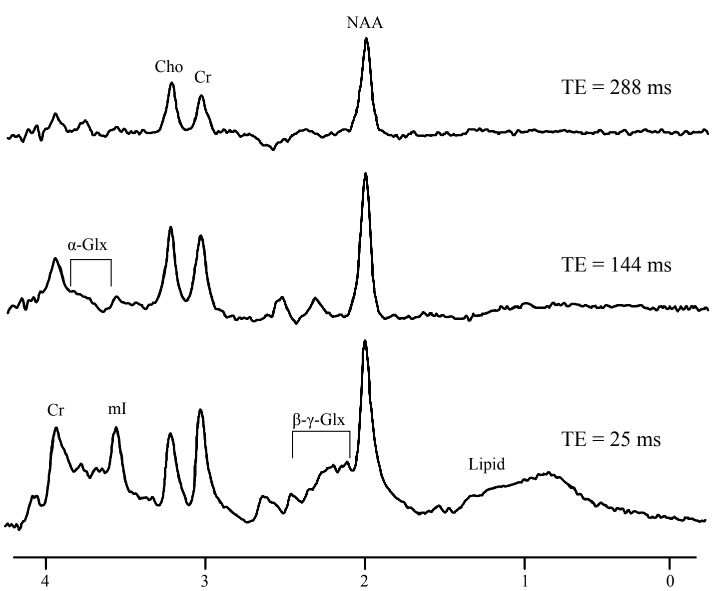


Fig. 362: Proton echo volume brain spectra with different echo times.

Effects of TE on J-coupling

The spin coupling patterns of proton spins can cause phase twists and inversion of peaks (or groups of peaks). A clear example is the CH_3-group of lactate, which gives rise to a doublet at ~1.3 ppm.

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The scalar coupling gives rise to a phase evolution of the methyl doublet, which is in-phase every 144 ms (= 1/J = 1/7 s). For TE = 144 ms the resonance shows a phase of 180° leading to a negative in-phase doublet, whereas an echo time of 288 ms gives rise to a positive in-phase doublet. Since only in-phase resonances can be quantified, the signal of lactate is best detected at TE = 144 ms or TE = 288 ms.

At TE = 1/J, the phase of the lactate doublet is opposed to the phase of the other metabolites.

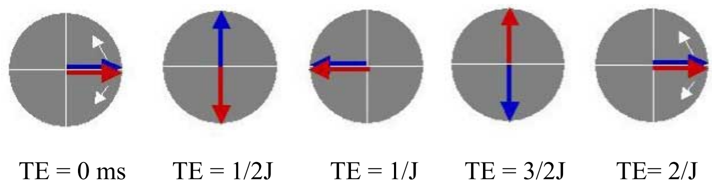

Fig. 363: Evolution of lactate signal.

NOTICE

The real signal aspect of a spectrum must be measured to observe the negative phase of the lactate peak.

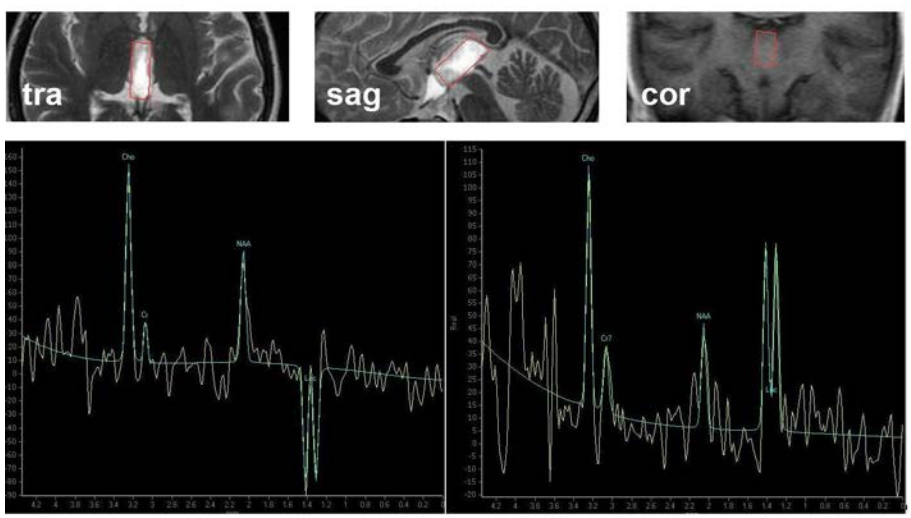

Fig. 364: SVS with different TE's. Left: TE=144ms. Sign of lactate signal is opposed to rest of spectrum. Right: TE=288ms. Sign of lactate signal is inverted and in phase with rest of spectrum.

Very short TE may be used to get the lactate peak nearly in phase, but the lactate signal will often be difficult to quantify because of the underlying lipid resonances.

Lactate detection and TE at 3.0T

The chemical shift caused by J-coupling of weakly coupled systems (like lactate) is independent of main magnetic field strength. The optimal echo time for lactate detection at 3.0T is therefore equal to the echo time used at 1.5T which is 144 ms and/or 288 ms.

However, the bandwidth of the selection pulses at 3.0T is smaller, and the CH-lactate signal at ~4.1 ppm is not included in the excitation over the entire VOI. If the CH-group does not feel the inversion pulse, J-coupling with the CH_3-group and phase evolution of the CH_3-doublet will not occur. Therefore, the resultant signal of lactate at TE = 144 ms is (partly) cancelled out:

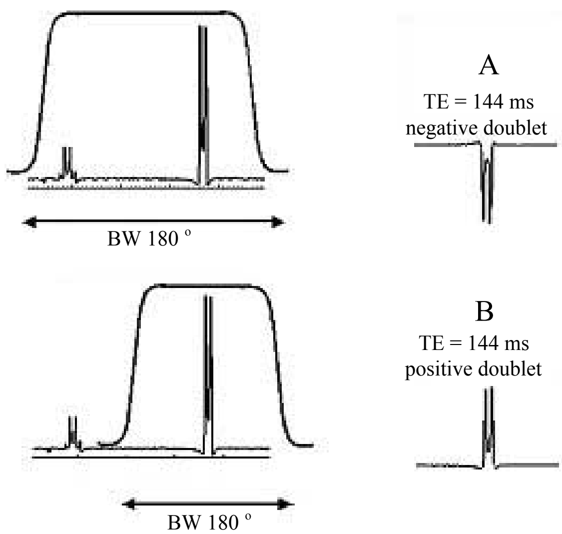

Fig. 365: Bandwidth at 1.5T (above, A: TE = 144 ms, negative doublet) and 3.0T (below, B: TE = 144 ms, positive doublet) and its influence.

The recommended VOI selection method for lactate detection is sLASER, since the bandwidth of the adiabatic refocusing pulses used in sLASER is larger than in the conventional PRESS sequence. Due to the larger bandwidth, the chemical displacement artifact, which is larger at 3.0T compared to 1.5T, is reduced when sLASER is used (see detailed explanation of effect of chemical shift displacement below).

It is recommended to set Plan Scan Metabolite to Creatine (~3.0 ppm) which is close to the central point of the two lactate signals (1.3 and 4.1 ppm).

A problem with lactate PRESS spectroscopy (or that of any J-coupled metabolite) is chemical shift displacement. In particular, the PRESS box that corresponds to the CH_3 protons of lactate (at 1.33 ppm) is shifted relative to the PRESS box associated with the CH protons (at 4.11 ppm), as illustrated in figure. This effect can be minimized by using the sharp pulse.

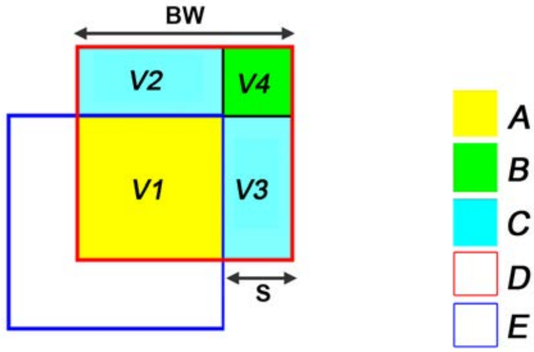

Fig. 366: Spatial interferences in lactate PRESS signal at TE 144 ms.

This drawing shows the displacement due to the two refocusing pulses in the sequence. (There is also a smaller displacement perpendicular to the page associated with the excitation pulse, but it doesn't give rise to signal cancellation.) BW is the refocusing pulse bandwidth (specifically the FWHM) in Hz, and S is the chemical shift difference between the CH and CH_3 protons in Hz. S increases linearly with field strength, and BW generally reduces with increasing field strength.

The crux of the problem is that the evolution of the CH_3 spins depends on the pulses experienced by the CH spins to which they are J-coupled. Yablonskiy et al. (Magn. Reson. Med. 39, 169-178, 1998) have described this dependence in terms of a very simple four-compartment model for the CH_3 PRESS box:

1. In volume V1, the PRESS box intersection, the CH protons experience both of the refocusing pulses. As a result, the corresponding CH_3 doublet inverts at TE 144 ms, TE 432 ms, etc.
2. In volume V2, the CH protons experience the first refocusing pulse but not the second one.
3. In volume V3, the CH protons experience the second refocusing pulse but not the first one.
4. In volume V4, CH protons are untouched by refocusing pulses. As such, the CH_3 protons contribute to (positive) spin echoes for any value of TE - just like uncoupled spins.

Signal loss due to spatial interference thus occurs at TE 288 ms as well, even though the contributions from volumes V1 and V4 are in phase. The loss is minimized, however, if the first echo time is made as small as possible.

Spectral resolution

The spectral resolution (Δv) is expressed as the smallest frequency difference that can be separated in the resulting spectrum, and is determined by the received bandwidth and the number of samples.

In practice, the spectral resolution in Hz must be at least twice as high as the chemical shift to be detected, to clearly resolve the two peaks.

In brain, choline (~3.2ppm) and creatine (~3.0ppm) are two of the main metabolites of interest. The chemical shift of these metabolites is very small (0.158 ppm, from "proton NMR chemical shifts and coupling constants for brain metabolites", by Govindaraju et al. NMR Biomed. 2000; 13: 129-153) and high spectral resolution is required to resolve the two peaks.

Example

On 1.5T, a ppm value of 0.158 ppm corresponds to 10 Hz.

To accurately separate choline and creatine, a spectral resolution of < 5Hz is required. To obtain this, the Tacq must be > 200 ms (number of samples / BW < 0.2).

Bandwidth

The selected bandwidth must be large enough to include all frequencies present in the spectrum of interest to avoid fold-over.

Increasing spectral resolution results in

- Better spectral separation
- Lower signal-to-noise ratio (but only if sampling continues after T_2 has decayed)
- Longer Tacq

The Tacq is checked against the repetition time. Repetition time in brain spectroscopy is usually in the order of 1500 - 2000 ms to allow sufficient T_1-relaxation and long Tacq can be used without any problems.

Spectral resolution in TSI at 3.0T

In Turbo Spectroscopic Imaging (see **Spatial Localization** in the Help), the echo spacing is the time available to sample the signal, which in turn determines the maximal obtainable spectral resolution.

Example

To accurately separate choline and creatine, a spectral resolution of < 5Hz is required. To obtain this, the Tacq must be > 200 ms (number of samples / BW < 0.2).

Tacq of ~ 200 ms, as described in the example above, will fit in an echo spacing of 288 ms, optimal for lactate detection.

At 3.0T, the chemical shift differences are twice as high as compared to 1.5T. To accurately separate choline and creatine at 3.0T, Tacq can therefore be twice as short and an echo spacing of 144 ms would be sufficient. Use of shorter echo spacing allows for the longer echo train before T_2 decay is (nearly) complete. In practice, a TSI factor of 6 can be used in combination with echo spacing = 144 ms.

With an ES = 144 ms at 3T, it is possible to reconstruct lactate maps, but signal modulation in K-space, related to the alternation in lactate phase as a function of echo number, will cause some spatial ringing and blurring of lactate maps (and the corresponding spectra).

Shimming method

Shimming is required for each spectroscopy scan. The shim methods available are described in more detail in the chapter on ’Preparation phases’.

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Single voxel

Small volumes in non-moving tissue are usually relatively easy to shim. Both PB-shim and iterative VOI can be used and the results for both techniques will be equally good. Advantage of PB-shim is the reduced preparation time with respect to iterative VOI.

Note that if the shim volume is located close to air-tissue interfaces, PB-shim might be less effective and Iterative VOI could be used instead.

2DSI / 3DSI

The effectiveness of PB-shim tends to increase with increasing VOI size and it is the method of choice for the larger volumes which are used in 2DSI. As field homogeneity varies more over larger volumes, the use of higher order shimming (3.0T only) is recommended.

Water suppression method

The available water suppression methods are listed in the table below.

Water suppression method	Characteristics
VAPOR	• T1 and b1 insensitive • Slightly increased shortest TR (when compared to excitation) • Recommended for brain
Excitation	• Requires AWSO (Automated Water Suppression Optimization), therefore has longer scan time than VAPOR (which does not require AWSO)
Inversion	• Increased shortest TR • Optimal for ’one’ water component only
BASING pulse	• Not recommended for brain • Not in combination with STEAM

More information

- In the Online Help (**F1**): Imaging parameter **Water suppression**
- In the Online Help (**F1**): Overview of water suppression techniques in **Scan Methods -> MRS -> Preparation phases**

Coverage: Multislice versus 3D

If coverage of a larger volume is required, both 3D spectroscopic imaging and multislice spectroscopic imaging can be used.

Multislice spectroscopic imaging

This technique is time-efficient as the acquisition of the second (and other) slices is performed during the remainder of the repetition time of the first slice. The number of slices that can be added to a single-slice acquisition is limited to the Tacq (and the time required for prepulses) for the first slice and the TR of the sequence.

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Example

- TR 2000 ms, minimal TR 800 ms
  - a second slice can be added to the sequence without any cost.
  - to add a third slice, the TR must be increased to ~2400 ms.

Multislice is especially beneficial for those volumes that have large dimensions in-plane and relatively small dimension through-plane which is mainly the case in brain spectroscopic imaging.

- Slice gaps can be used.
- Slice definition is improved in comparison to 3D.

3D spectroscopic imaging

This technique can be selected to cover a larger volume. Phase encodings are performed in 3 dimensions for spatial resolution. Scan time increases linearly for each slice added to the sequence. 3D also provides a higher SNR.

3D is mainly beneficial for those volumes that have comparable dimensions in all directions.

Fast imaging mode

Spectroscopic imaging scans have long scan times, as spatial encoding is performed with phase encodings only.

Fast imaging mode can be used to reduce scan time, where the selected TSI factor is the scan time acceleration factor.

The readout time of the signal is restricted by the echo spacing selected.

	CSI	TSI
Scan time	• long	• reduced
Tacq	• long Tacq allowed	• limited to ES
Spectral resolution	• higher due to long Tacq	• lower due to limited Tacq
Half echo	• possible due to long Tacq	• impossible due to limited Tacq
Resulting spectra	• Real spectra due to half echo	• Modulus spectra

Tab. 46: CSI versus TSI

Fast imaging mode is best used for long-T_2-metabolites, and therefore very useful for brain spectroscopic imaging.

More information

- More information on Spatial Localization can be found in the Help.

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SENSE in Spectroscopic Imaging

SENSE can be used to reduce scan time. As phase encodings are performed in two dimensions in spectroscopy, SENSE reduction factors can be applied in two directions simultaneously. Note that the information from a reference scan is required to perform SENSE. As spectroscopy in general is part of a comprehensive brain examination, the refscan data from the examination is valid for spectroscopy as well.

For brain spectroscopy in general the SENSE Head Coil will be used. SENSE in this coil is allowed in the AP- and RL-direction. This is optimal for transverse slices.

Tips and hints

- Avoid intrinsic fold-over in all directions in which SENSE is applied.
- Recommended SENSE factors: not higher than 2 in both directions. Note that SNR reduces with increasing SENSE factors.
- Both full PRESS, sLASER, or SE-slice selection can be used:
  - Full PRESS or sLASER will have less foldover artifacts.
  - REST slabs for outer volume suppression can equally be used.

Example

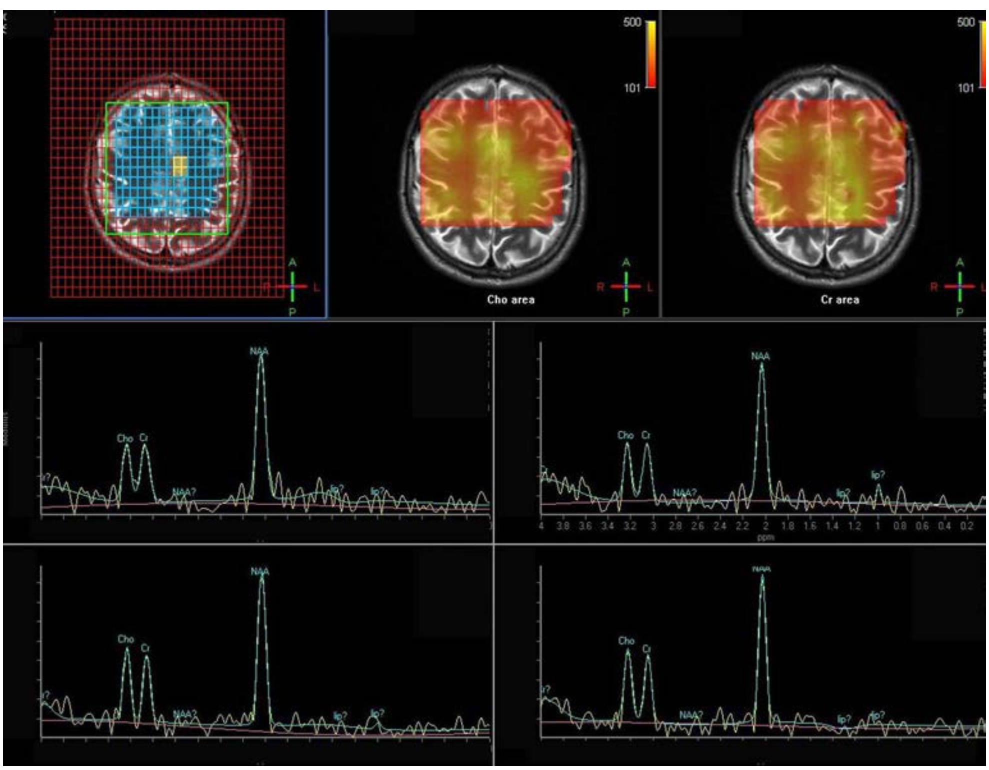

Fig. 367: 3D TSI in the brain. SENSE factor 2x2, TSI factor 3, scan time 1:30 min.

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Hippocampus

Spectroscopy is regularly performed in the hippocampus region. As the hippocampus is located close to the petrous bones, the maxillary sinus, larger arteries like the carotids, and close to the caudate nuclei (high iron content), susceptibility can give rise to problems. Good shim is more difficult to obtain, as a result water suppression is harder to achieve and spectral lines can become wider.

Scan mode

Both Single Voxel Spectroscopy and Spectroscopic Imaging can be performed in the hippocampus.

Single Voxel Spectroscopy

Single Voxel Spectroscopy is most commonly used as volume positioning is most easily performed. A spectrum is usually acquired on the right and left side for comparison reasons.

Spectroscopic imaging

Spectroscopic Imaging will generate spatial information and allows for inclusion of both hippocampi in one measurement. It is however more difficult to perform the planning, as air-tissue interfaces can not be excluded always, and pulsatile flow of the large arteries, crossing the CSI-slice, might generate some artifacts.

Planning the volume

Planning of the spectroscopy volume is critical in the hippocampal region and determines the outcome of the resultant spectra to a great extent.

Single Voxel

1. Acquire anatomical images parallel and orthogonal to the hippocampus.
2. Avoid positioning the VOI close to air-tissue boundaries as much as possible (1mm of distance can make all the difference!).
3. Select "shifted metabolite displayed" in post-proc to display the selected volumes of the other metabolites, to check if these volumes are not including air-tissue interfaces.
4. If required, change the chemical shift direction (geometry) to manipulate the position of the shifted VOI.
5. Use RF transition pulse "sharp" for improved voxel definition.

   Note that "sharp" increases the shortest possible TE. For long TE spectra, the TE is not affected.
6. Use volume selection method sLASER to reduce chemical shift displacement at 3T.
7. REST slabs can be used to cover areas of susceptibility.

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2D Spectroscopic Imaging

1. Acquire anatomical images in the imaging plane required for CSI with an intersection to the area of interest.
2. Avoid positioning the VOI close to air-tissue boundaries as much as possible (1mm of distance can make all the difference!).
3. Use full volume selection, not SE-slice.
4. Select "shifted metabolite displayed" in post-proc to display the selected volumes of the other metabolites, to check if these volumes are not including air-tissue interfaces.
5. If required, change the chemical shift direction (geometry) to manipulate the position of the shifted VOI.
6. Use RF transition pulse "sharp" for improved voxel definition.

   Note that "sharp" increases the shortest possible TE. For long TE spectra, the TE is not affected.
7. Use volume selection method sLASER to reduce chemical shift displacement at 3T.
8. Circular REST slabs with a high REST angulation can be used to cover areas of susceptibility (skull base).

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Shimming

The standard preset procedures are optimized to generate good results. However, in spectroscopy, large differences over the patient population exist and shim results can greatly vary over patients (e.g. due to the larger size of the maxillary sinus).

Iterative VOI

Iterative VOI might be the method of choice as it is less sensitive to susceptibility changes than PB-shim. The shim results can be examined already during preparation, by popping-up the monitoring window ("windows"-key, click monitoring in taskbar).

If shimming is completed, the FWHM of the water peak is displayed. If this value is larger than usual, the water suppression window should be widened, to obtain full water suppression of the entire water peak.

The position of the metabolites of interest should be taken into account: the signal of choline, at a distance of ~1.4 ppm on the right of water, should NOT be hit by the water suppression pulses.

Inspect monitoring during iterative VOI shimming to judge the water peak’s width.

REST slabs can be used to add extra outer volume suppression to reduce spurious signals of non-suppressed water.

Prostate

Regular MR imaging is well used for prostate imaging. It is known however, that differentiation between benign hyperplasia and malignant carcinoma is not always easy. Additionally, normal appearing prostate MRI doesn't always exclude presence of cancer.

MR spectroscopy is considered a helpful tool as a non-invasive monitoring of metabolite changes that might precede anatomical changes in pathological processes.

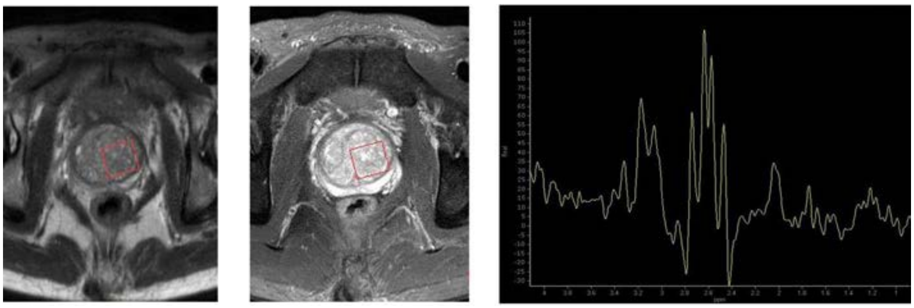

Fig. 368: SVS, TR 1200 ms, TE 132 ms at 3.0T.

The main metabolite of interest in prostate spectroscopy is citrate (~2.6 ppm), that is the most dominant signal in normal prostate tissue. Changes in citrate level and, additionally, in choline levels, are said to be indicators of pathological changes:

- High level of choline, reduced level of citrate in tumors.
  - Possibly caused by cells that produce citrate being replaced by malignant epithelial cells.
- High level of choline-containing metabolites can be seen in BPH (benign prostate hyperplasia), while citrate level remains constant.
  - Possibly caused by increased rate of cell proliferation.

Patient preparation and coil choice

Patient preparation

The prostate is a relatively small structure, and its position in the abdomen can slightly vary due to bowel motion, bladder filling etc.

If the position of the prostate changes during the spectroscopy scan, partial volume effects occur, and the resultant spectra will not be optimal.

It is therefore important to prepare the patient:

- Make sure patient has empty bladder
- Avoid scanning directly after lunch (bowel motion)
- Consider use of intra-muscular glucagon immediately before acquisition to reduce effects of bowel peristaltis
- If the Endo-coil is used: cleanse rectum prior to examination
- Timing: post-biopsy haemorrhage can obscure MR images of the prostate, complicating MRS planning: avoid scanning within 3 weeks after biopsy.

Coil choice

Since all Ingenia coils can be used for MR spectroscopy, coil selection will depend on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy. For prostate examinations, the dS Torso coil solution is applicable

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Scan method

Single Voxel Spectroscopy

Can easily be performed in the prostate to acquire a good signal-to-noise spectrum in a few minutes.

In general CSI (2D or 3D) is preferred, as spatial information can be obtained.

2DSI

- Small volume, thin slice for good spatial resolution
- FOV not large enough to prevent fold-over: full PRESS volume selection
- Large number of phase encodings required for optimal point spread function: lots of "empty" voxels outside the selected (PRESS) volume.
- Single slice not optimal for coverage of prostatic gland.

NOTICE

Multislice should not be used as a full PRESS volume selection is required.

3DSI

- block-shaped volume can best be adapted to the size / shape of the prostate.
- Number of phase encoding steps in-plane reduced, and increased in slice direction: total number of steps sufficient for good voxel delineation.

Once planning of 2DSI / 3DSI is finished, one can acquire a quick SVS with equal volume positioning to make sure that spectrum quality is edequate before spending long scan times on CSI.

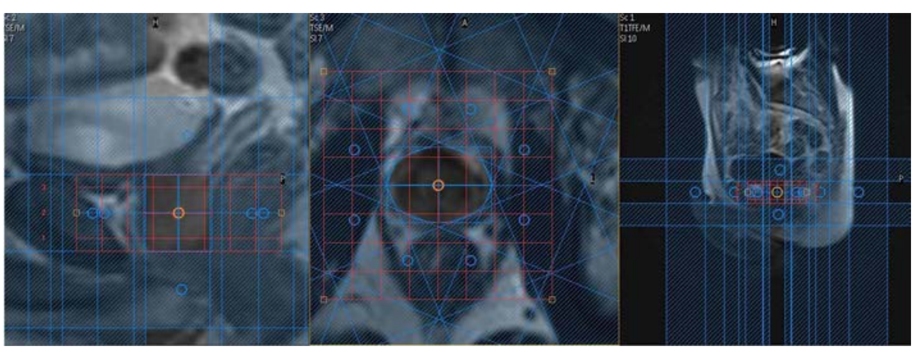

Fig. 369: Examples.

Planning the volume

Volume positioning in prostate spectroscopy is critical, and should be performed very carefully:

- Include only prostate tissue in the VOI for optimal shimming (surrounding fat causes susceptibility changes).

- Optimal shimming is required to separate choline, creatine (and spermine), and to separate J-coupling of citrate.

NOTICE

If fat tissue is completely excluded from the VOI, fat suppression is not required.

- Use anatomical (T2) image with fat suppression in at least one plane: the (high signal of) prostate gland is nicely separated from the suppressed fat.
- REST can be used
  - for additional volume definition
  - to suppress unwanted signals of surrounding fat
  - to define a smaller volume within an overprescribed volume (to reduce chemical shift displacement).

Choice of TE

The echo time chosen determines the appearance of the spectrum and mainly is of influence on the appearance of J-coupled systems. Citrate is a strongly coupled system, splitting into a quartet. The appearance of the citrate peak rapidly changes with varying echo times, and its behaviour is field strength dependent.

Reference article for 3T:"optimizing PRESS localized citrate detection at 3T", from A. Trabesinger et al, MRM 54:51-58 (2005)

Optimal TE

Citrate has a positive sign.

- for 1.5T: 120 ms - 130 ms.
- for 3.0T: 132 ms

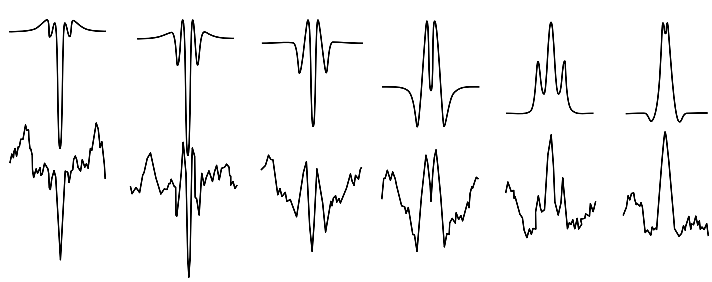

Fig. 370: Citrate peak appearance.

Examples

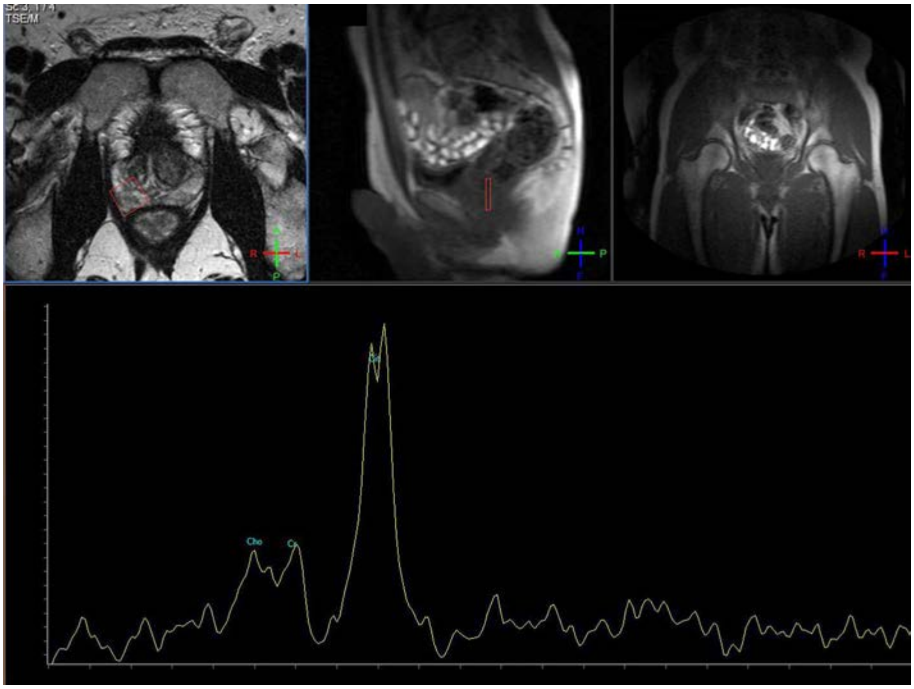

Fig. 371: SVS prostate in a volunteer on a 1.5T system: TE 120 ms.

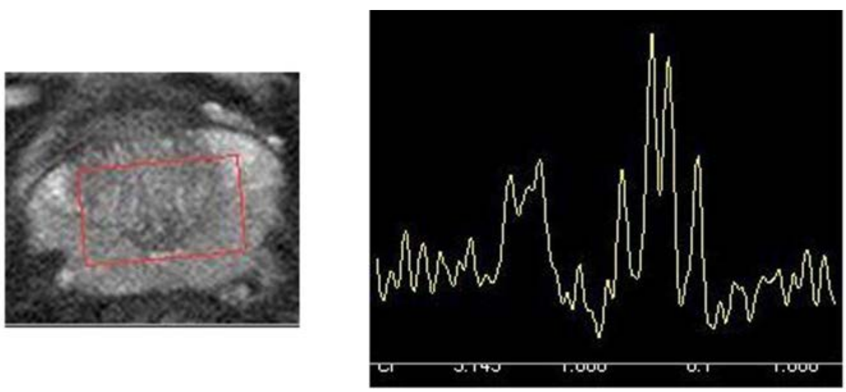

Fig. 372: SVS prostate in a volunteer on a 3.0T system: TE 132 ms.

Water and fat suppression

All available suppression techniques can be used for water and fat suppression. This section describes the most commonly used techniques for prostate spectroscopy.

Fat suppression

Fat suppression is required for prostate spectroscopy if the volume is larger than the prostate gland. This is usually the case in CSI.

SPAIR fat suppression

- is used best to obtain homogeneous fat suppression, independent of B1-variations.

- The SPAIR IR delay is to be set such that fat signal is nulled at the time of the excitation. The optimal delay is related to the SPAIR-TR, that can be found on the info page.
- If SPAIR-TR is sufficiently long to allow (nearly) complete T_1-relaxation of the fat signal, the SPAIR-IR delay is equal to the STIR-inversion delay time for fat suppression.

At field strength	SPAIR-IR delay
1.5T	+/- 165 ms
3.0T	+/- 200 ms

Tab. 47: Guideline for optimum abdominal fat suppression

- The SPAIR offset determines the transition between non-suppressed and suppressed tissue, and should be chosen such that the adjacent metabolites of interest are not suppressed. The closest metabolite of interest is citrate, at ~2.6 ppm. Suppression can safely be performed up to ~2.0 ppm, leading to a frequency offset of +/- 0.7 ppm.

BASING pulse

The BASING pulse can also be added to the sequence for (additional) fat suppression. Optimization is not required. Additional pulses and gradients are placed in the sequence, thereby increasing the shortest TE. As the optimal TE in prostate spectrscopy is usually long, the pulse will easily fit in.

Frequency offset of the pulse must be set to the fat frequency.

Advantage

- no prepulse
- doesn’t add to minimal TR

Disadvantage

- Fat suppression might be less complete

Water suppression

Water suppression can be performed using either a water suppression prepulse, like excitation, or using the BASING pulse, or using a combination of both techniques.

If SPAIR and WS excitation are combined, the water suppression prepulses are the first pulses of the sequence. WS excitation angle is such that both water and fat signals will be nulled at the start of the excitation.

Breast

Breast spectroscopy is regularly performed, mainly to measure choline levels (and choline/fat or choline/creatine ratios) in the volume of interest.

Coil choice

Since all breast coils can be used for MR spectroscopy, coil selection will depend on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy.

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Planning the volume

Single Voxel Spectroscopy is most commonly performed. Two approaches for SVS planning are described below.

First approach

Plan the volume size such that only lesion is included, leading to no partial volume effects with fatty tissue, but also leading to a (slight) underestimation of the metabolite levels, as the lesion is not completely included.

Advantages

- As surrounding fatty tissue is not included in the VOI, fat suppression might not be required. This allows for detection of free lipids.
- Shimming is easy, no susceptibility changes in the VOI.

Second approach

Plan the volume size such that the complete lesion is included, including some of the surrounding fat tissue. Better estimation of metabolite levels in the lesion. Fat suppression should be applied to suppress fat tissue.

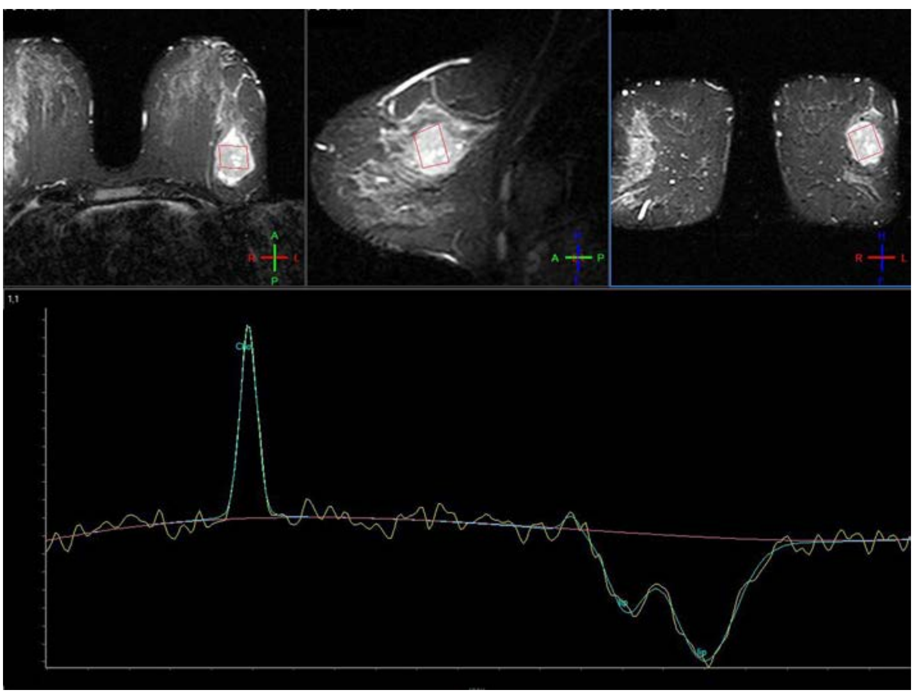

Fig. 373: SVS in breast tumor: TR 1500 ms, TE 270 ms. Elevated choline level.

Water and fat suppression

All available suppression techniques can be used for water and fat suppression. For more information refer to the section on prostate.

NOTICE

Multiple suppression techniques can be combined to suppress a specific tissue's signal.

Example

Use SPAIR and BASING pulse for fat suppression.

Choice of TE

The recommendations for the TE are:

- Use a long TE for choline detection of ~288 ms.
- Use a short TE to measure water/fat or choline/fat ratios.

Liver

The main application of liver spectroscopy is measuring water/fat ratios to detect fatty liver. Additionally, evaluation of lesions can be performed. In this case, choline and creatine are the main metabolites of interest.

Coil choice

Since all Ingenia coils can be used for MR spectroscopy, coil selection will depend on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy. For liver examinations, the dS Torso coil solution is applicable.

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Planning the volume

Single Voxel Spectroscopy is most commonly performed. Two approaches for SVS planning are described below.

Complete liver evaluation

- Plan a large volume including a large part of the liver.
- Avoid to position the VOI close to the rims of the liver to ensure that surrounding tissue (lungs!) will not move in and out of the selected volume during breathing.

Lesion evaluation

- Adapt the VOI size to the lesion.
- Avoid partial volume effects with surrounding liver tissue.

Water and fat suppression

All available water and fat suppression techniques can be applied for liver spectroscopy as well. In examination of fatty liver, however, suppression is not used as the main metabolites of interest are water and fat. Concentrations of water and fat are high, and the number of measurements to obtain good signal-to-noise ratio is relatively low.

For more information refer to the corresponding section on prostate.

Choice of TE

A short TE should be used as fat has a relatively short T_2 relaxation time. At long TE, the fat signal has decayed to a greater extent as the signal of water, leading to incorrect ratio values.

The recommendations for the TE are:

- Use a short TE to measure choline/creatine, creatine/fat or choline/fat ratios.

Note that STEAM could be used to achieve shortest possible TE.

Respiratory compensation

Free breathing experiments are mainly performed. As liver tissue moves in and out of the selected volume, partial volume effects can be present. Depending on the voxel position this can be more severe. The least motion will occur when the volume is positioned more posterior or more inferior.

Breathhold imaging by means of dynamic scans

Dynamic scanning can be used to divide the acquisition into several breathholds.

In this case, it is advised to use PB-autoshim instead of iterative VOI shimming, as the preparation phase can be performed in breathhold as well.

Muscle

Proton spectroscopy is mainly performed in muscle tissue to measure intra-and extra-myocellular lipids and energy metabolism disorders. Splitting of the fat peak is mainly caused by the fact that the fibers of the muscle are parallel to the magnetic field.

Coil choice

Since all coils can be used for MR spectroscopy, coil selection will depend on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy.

Planning the volume

Single voxel techniques and CSI can be used.

As the main metabolite of interest is fat being present in the muscle, it is very important that surrounding fat signals are not included in the volume of interest.

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Another point of attention is the presence of vessels, as (pulsatile) flow can cause ghosting artifacts in phase encoding direction. As two phase encoding directions are used in spectroscopy, ghosting could occur in two directions.

REST slabs can be positioned around the volume of interest to suppress the signals of flowing blood, thereby reducing possible ghosting.

Choice of TE

- A short TE (of approximately 40 ms) is mainly used to reliably detect the fat signal.
- A long TE (of approximately 288 ms) is mainly used to detect creatine and TMA (trimethylammonium).

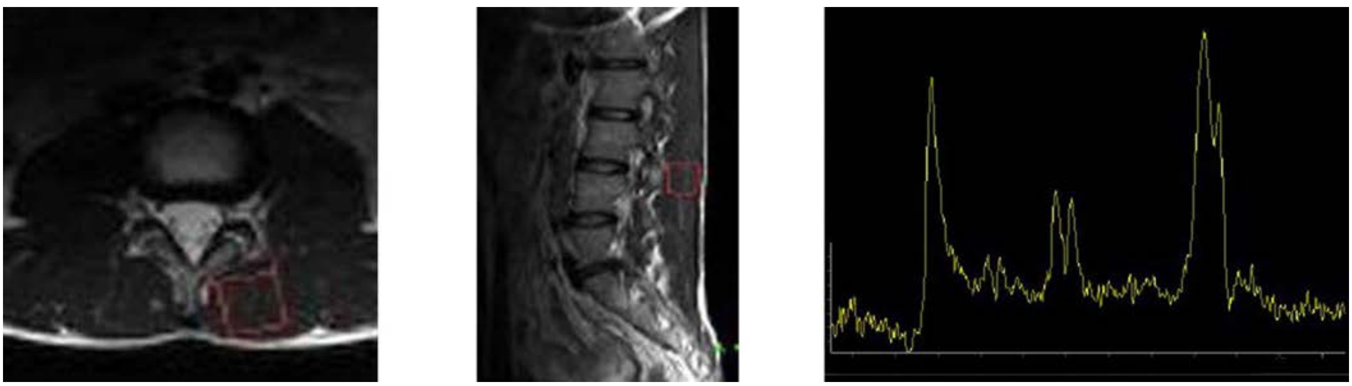

Fig. 374: Spine muscle spectrum at 3.0T. TR 2000 ms, TE 40 ms. Elevated choline level. The two left images show the VOI, the right image the zoomed spectrum.

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MultiNuclei (MN) MR Spectroscopy

Proton resonances are not always uniquely identifiable as the MRS fingerprints of different molecules may overlap. Thus spectroscopy of other nuclei is also interesting for biochemical or clinical research. Some compounds that are not readily identified in in-vivo proton spectra, are easily identified in ^{31}P or ^{13}C spectra.

Besides Proton spectroscopy, Phosphorous spectroscopy is the most commonly used one. Molecules that are examined in Phosphorous Spectroscopy are:

- Phosphorous (^{31}P);
- Adenosine triphosphate (ATP);
- Phospho-creatine (PCr);
- Inorganic phosphate (Pi);
- Phospho-monoesters;
- Phospho-diesters.

Pulse sequences and MRS protocols

Six main scan types are available for ^{31}P Spectroscopy:

- No localization: ’Pulse and Acquire’
- Single voxel, localized with ISIS (Image Selected In-vivo Spectroscopy; FID based volume selection method)
- Single voxel parameter series
- Double voxel (an extension of ISIS that acquires data from two aligned voxels, using a 16-step localization cycle).
- One dimensional Spectroscopic Imaging (typically with two dimensions of spatial localization to define a bar).
- Two dimensional Spectroscopic Imaging (typically with slice selection, i.e. one dimension of spatial localization).

The scan setup is very flexible: phase encoding and spatial localization dimensions can be specified independently (the ’FID volume sel changes’ parameter may need to be set to user defined). However, more extensive spatial localization requires a longer TR to stay below SAR limits. The minimum TR for Single Voxel ISIS in the brain is 5000 ms. Slice selected 2DSI requires fewer pulses, and hence TR can be reduced to ~4000 ms.

^{31}P imaging protocols and ExamCards are provided for the most common anatomical areas.

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Planning

For accurate planning, make use of the marker in the Phosphorous coil which is buried at the center of the coil.

Localize the marker in the phosphorous coil

1. Acquire images in all three orthogonal directions with the Q-Body coil.

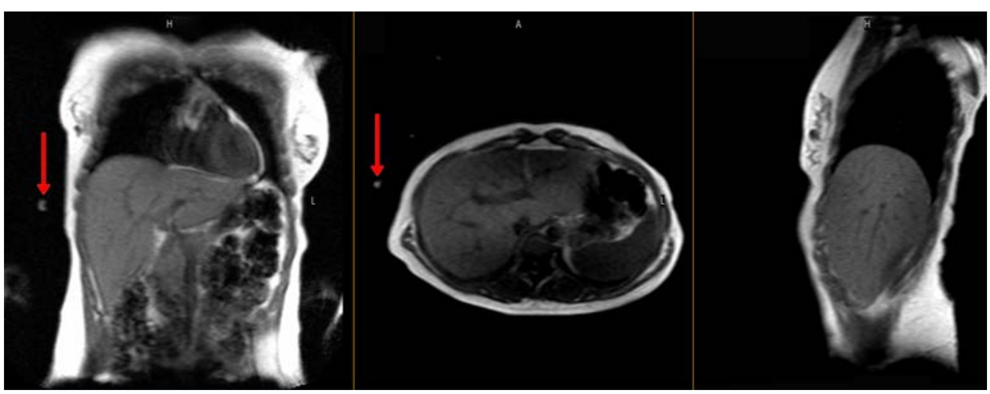

Fig. 375: Localization of the marker. The red arrows indicate the position of the marker.

2. Position the volume of interest at the same level as the marker in the coil.
   - This will provide the best SNR.
   - The penetration depth of the coil is ± half the diameter of the coil.

Acquiring Data

Once planning is completed and 'Start Scan' has been pressed, the following steps are executed:

- Manual adjustment of coil tuning and matching.
- Preparation phases/steps of other nucleus measurement (shimming, F_0 determination etc.; this can be skipped for repeated scans of the same voxel).
- Measurement.

Manual tuning and matching

An MRI coil is part of a tuned circuit, and for maximum performance, its resonance frequency should equal that of the nuclei of interest: 51.73 MHz for ^{31}P at 3.0T. Moreover, to minimize the amount of reflected power, its impedance should be 50 ohms. Because the presence of a patient "loads the coil" and greatly changes the characteristics of the tuned circuit, long flexible rods attached to variable capacitors are used to optimize coil sensitivity for a particular anatomy.

Fig. 376: Tuning (left) and Matching (right).

In manual tuning mode, low power RF is swept through the resonance frequency, and reflected power is monitored as a function of frequency:

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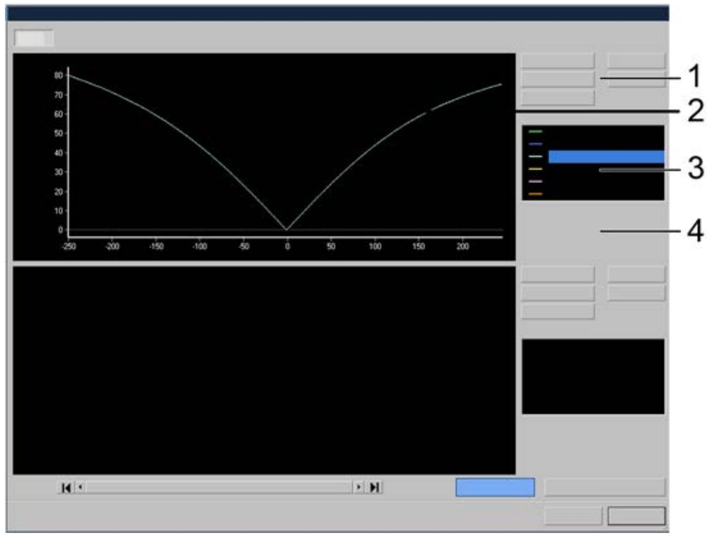

Fig. 377: Manual Tuning window. 1 - Buttons with functions like 'Autoscale', 'Show grid' and 'Show dots'. 2 - tuning signal presented as intensity versus frequency [kHz], 3 - signal types, 4 - numeric display of minimum and maximum values.

- The rod that is attached closer to the center of the coil adjusts the tuning - the frequency at which the tuned circuit resonates. Turning it will move the ’V’ on the display left or right. When adjusted properly, it should be centered at zero frequency offset.
- The rod that is attached closer to the cable adjusts the matching - the impedance of the loaded coil. Turning it adjusts the sharpness and depth of the ’V’. When adjusted properly, the ’V’ should be as sharp as possible, and the reflected power minimized at zero offset frequency.

Tips and hints for coil tuning and matching

- ► Click on ’Display on Magnet’ in the monitoring window to display the manual tuning window on the magnet-mounted screen.
- ► For better visualization of the ’V’, turn on the ’Autoscale’ and ’Grid’ display options.

Coil response on resonance is characterized by a quality factor Q. SNR is proportional to $Q^{1/2}$. Patient loading lowers Q, but correct tuning and matching can minimize the drop. The system calculates Q after manual tuning and before each subsequent scan.

NOTICE

Make sure that the cables are connected to the MN box.

Loose cable connections at the MN box will give noise on the tuning/matching curve with a low power response and will finally result in bad spectra.

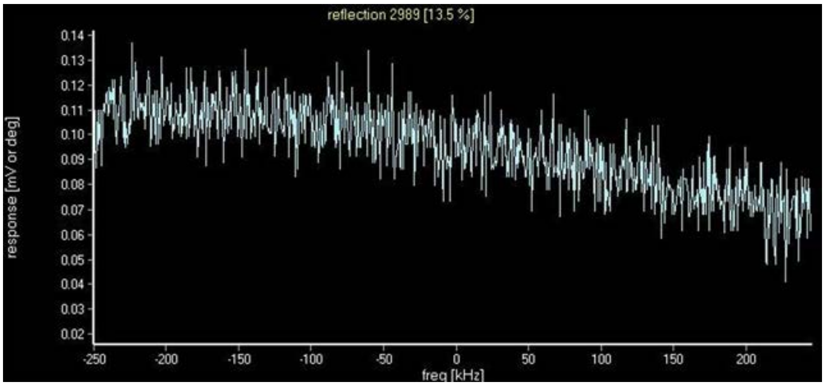

Fig. 378: Bad tuning/matching curve resulting from loose cable connections to MultiNuclei box.

Preparation of other nucleus measurement

The preparation steps F_0 determination, power optimization, and shimming are actually performed on the proton signal from the selected voxel or VOI. The only user-selectable step is the shimming, with three choices for the higher order shimming (HOS) parameter when planning the scan:

Type of HOS	Way of working	Advantages	Disadvantages
HOS = NO	• launches iterative shim which seeks to maximize peak height by cycling through adjustment of the static currents supplied to the X, Y, and Z gradients.	• A monitor window display for a visual assessment of the shim prior to the acquisition. • Less sensitive to motion.	• Very slow. • Can be less accurate when local minima in field inhomogeneity are present.
HOS = First	• uses a fast pencil beam projection method to set the first-order shim currents.		
HOS = Second	• uses a fast pencil beam projection method to set both, the first- and second-order shim currents (this choice is available only if second-order shim hardware is present and operational).	• Fast. • Employs the five second-order shims (Z2, X2-Y2, XY, XZ and XZ) for better homogeneity over large voxels.	• No visible display of shim quality prior to scanning. • Possibly more sensitive to motion.

Tab. 48: Table title

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Measurement

For single voxel acquisitions, a spectrum monitor window displays an update of the averaged signal, once dummy shots are completed. Note that for ISIS, an accurate assessment of the localized spectrum is available only after every eighth shot (i.e., after excitation 8n, with n=1,2,...).

A spectrum monitoring window also appears for 1D Spectroscopic Imaging, but it displays the collected signal from the entire volume, and is therefore not a real representation of the final results. No spectrum monitoring is available for 2DSI.

Processing with SpectroView

This section gives some tips and hints for a phosphorous measurement being processed with SpectroView.

Basic processing

Once a time-domain spectroscopy dataset is selected, a Basic processing script is executed automatically to generate a frequency domain spectrum for display.

Different basic scripts are available, for both single voxel and CSI data, and optimized for various anatomic regions. If none is specified, a pop-up will be presented to allow selection of the anatomic region, before the basic script is executed.

Single Voxels

Once time-domain processing is complete, or after choosing a spectrum from the Pictorial Index, select a script from the drop-down menu in the SpectroView toolbar. All the scripts which are relevant for the selected anatomy will be available.

Either run the appropriate script as it is or edit the script.

Select peaks

The list of in vivo metabolites from which to choose includes ATP, PCr, Pi (inorganic phosphate), PME (phosphomonoesters), PDE (phosphodiesters), and "dnt" ("dinucleotide" - a small peak near the a-ATP doublet that has been variously labeled in the literature).

Default choices for each script and possible changes are detailed in the following table.

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Script	Default metabolites	Changes to consider
31PMuscle_sv	PCr, ATP, Pi	Add PDE if the spectrum is proton decoupled. Add dnt if the SNR is good.
31PLiver_sv	ATP, Pi, PME, PDE	PCr shouldn’t appear in liver spectra, but it usually does a contaminant from surrounding muscle - if so, add it. Add dnt if the SNR is good.
31PBrain_sv	PCr, ATP, Pi, PME, PDE	Add dnt if the SNR is good.

In the 31P_Phantoms_sv script, there are three entries for the three 31P phantoms:

- ’Disk A’ = phosphoric acid (singlet at 2.86 ppm relative to PCr)
- ’Disk B’ = hypophosphorous acid (triplet centered at 13.53 ppm, JPH =549 Hz)
- ’Sphere B’ = methylphosphonic acid (quarted centered at 32.5 ppm, JPH = 17.2 Hz)

Peak Fitting

Some modifications to consider are as follows:

- The default Gaussian character is 50%. However, if Gaussian or Gaussian-to-Lorentzian apodization has been applied to the data in the time domain, a better choice would be ~90%.
- The number of baseline terms characterizes the flexibility of the baseline function during the fitting process - more terms allow for more wiggle. For spectra without underlying broad components - like those from muscle - the number of baseline terms should be small (0-2). For brain spectra, more terms (7-9) may be needed to fit the broad phospholipid hump centered roughly on the PDE peak.
- If the SpectroView fit is to be used for pH information, Lock Relative Frequency should be OFF to let the fitted Pi and PCr chemical shifts vary independently. However, unless the SNR is very good, these extra degrees of freedom can impair the robustness of the fit. More reliable results can be obtained with Lock Relative Frequency = ON. (For pH measurements, right-mouse-click in the graph area to turn on Difference Mode, then move the vertical line cursors to the Pi and PCr peaks for a display of their chemical shift difference.)

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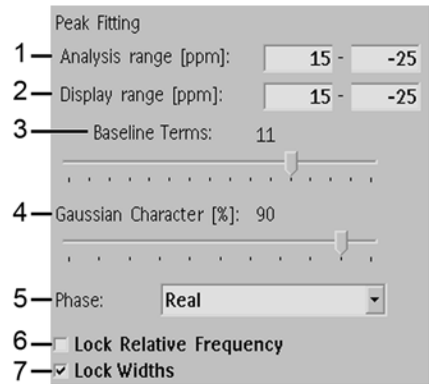

Fig. 379: Peak fitting parameters in the script Parameter Editor where 1 - Analysis range, 2 - Display range, 3 - Baseline Terms (slider), 4 - Gaussian Character (slider), 5 - Phase, 6 - checkbox 'Lock Relative Frequency', 7 - 'Lock Widths'. Note that 'Lock Relative Frequency' is disabled.

- If peaks are not located correctly during the fitting routine, a manual peak assignment can be performed. This function is also used to center the PCr-peak to 0 ppm.

2D CSI Data

If processing 2D CSI data, enable ’Voxel selection’ by clicking on the corresponding icon.

Select all voxels of interest to be proceeded.

Possible scripts are:

- 31PMuscle_csi
- 31PLiver_csi
- 31PBrain_csi
- 31P_Phantoms_csi

These are nearly identical to the single voxel scripts. Additionally, metabolite and/or ratio maps can be generated.

To specify a ratio map, choose a numerator from the left column and a denominator from the right column. All metabolites selected for maps must also be chosen for fitting on the ’Select Peaks’ page.

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Examples of 3.0T with the P-140 Coil

2DSI of calf muscle

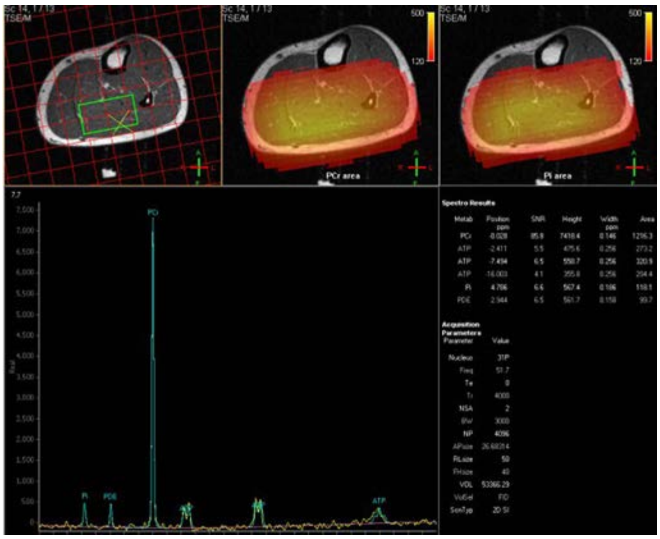

Fig. 380: Calf muscle spectral results.

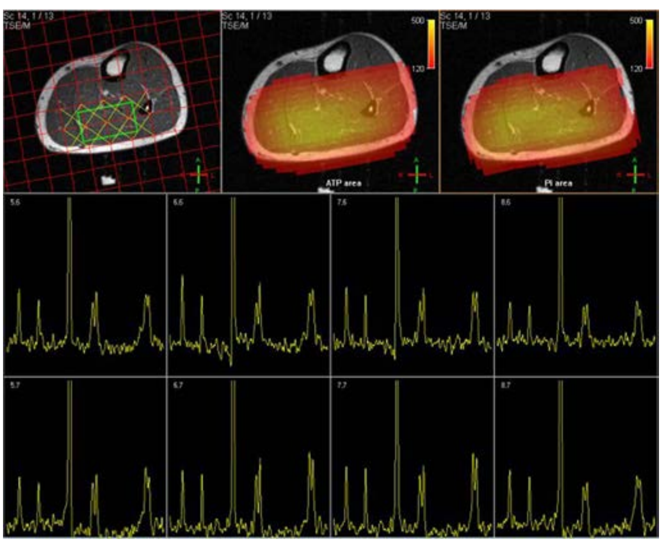

Fig. 381: Calf muscle spectral results.

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Brain Single Voxel

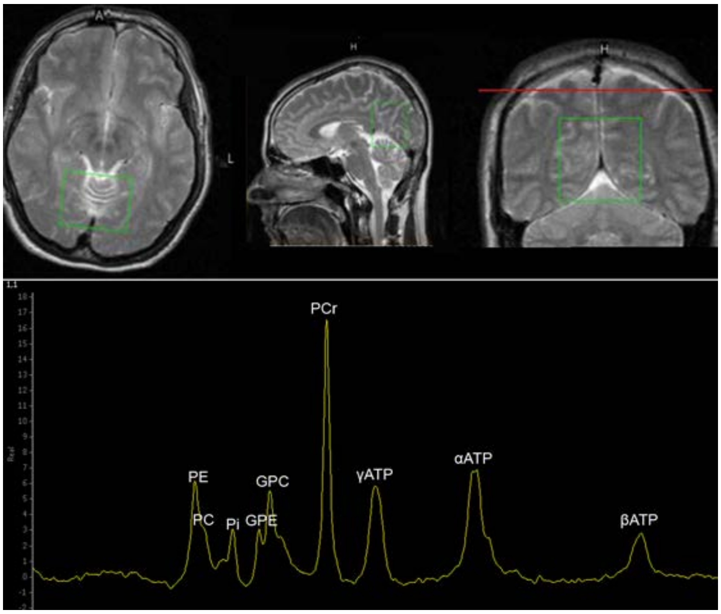

Fig. 382: Brain pulse acquired results. Resolved phosphomonoesters and phosphodiesters: PE = phosphorylethanolamine, PC = phosphorylcholine, Pi = inorganic phosphate, GPE = glycerophosphorylethanolamine, GPC = glycerophosphorylcholine, PCr = Phosphocreatine, γATP = gamma ATP, αATP = alpha ATP, βATP = beta ATP.

Brain 2DSI

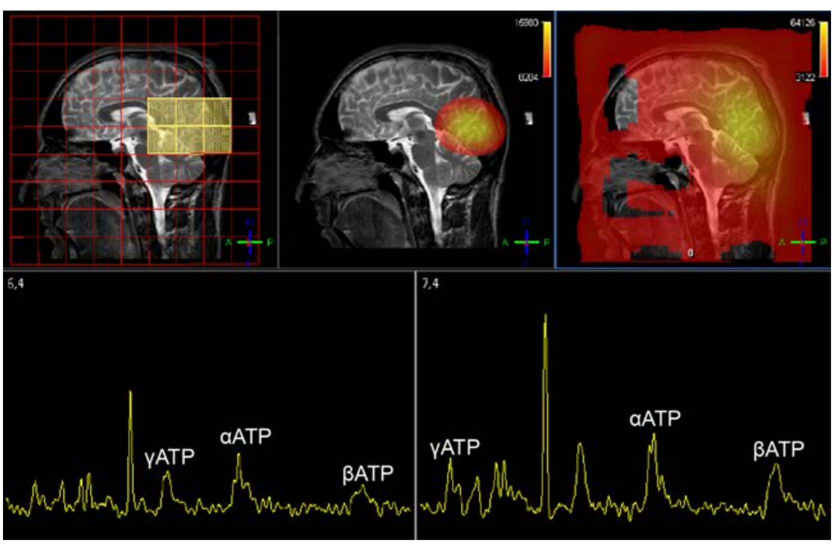

Fig. 383: Brain 2DSI results. Upper row: planning. Lower row: spectra from two voxels.

Liver Single Voxel

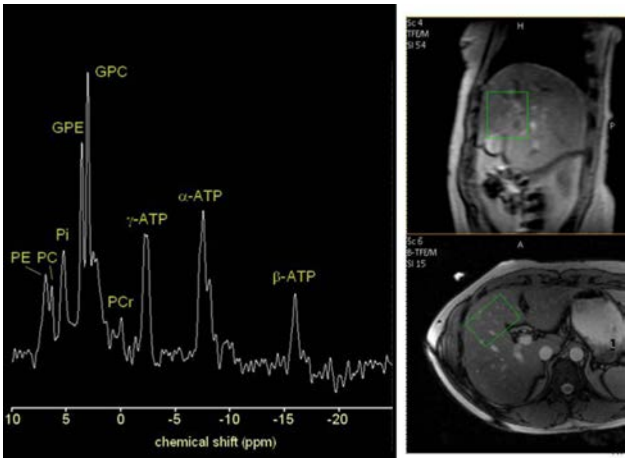

Fig. 384: Liver SV spectral results.

Liver 2DSI

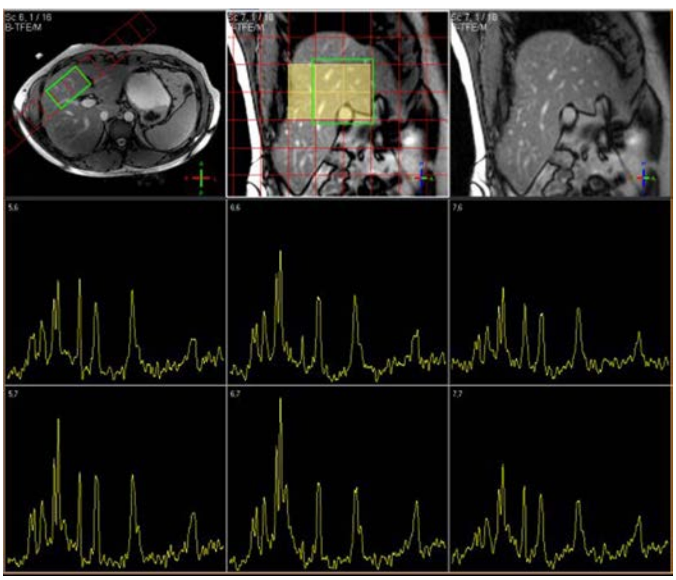

Fig. 385: Liver 2DSI spectral results.

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31P Liver Metabolite Maps

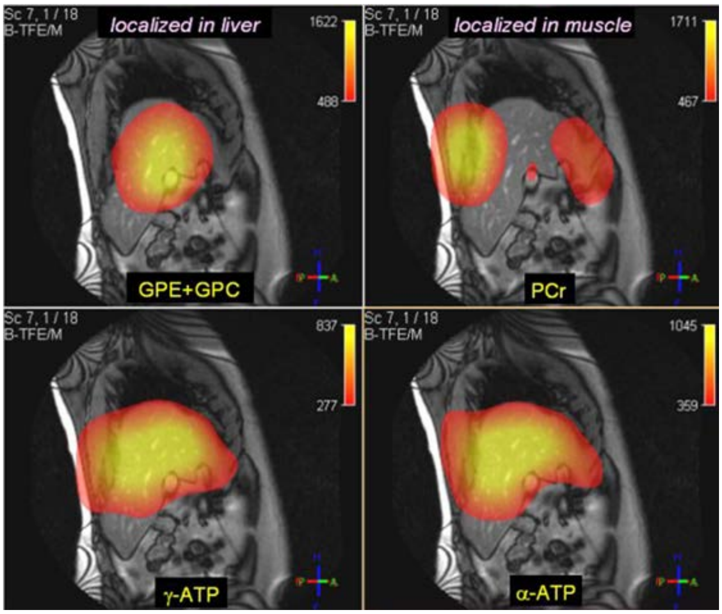

Fig. 386: 31P Liver Metabolite maps.

MEGA

Property	Description
Pulse Sequence	MEGA is a spectral editing and subtraction technique designed for the detection of the neu-rotransmitter GABA at 3.0 ppm in the brain.
Properties	• Is a technique utilizing J-editing with subtraction of spectra. • Provides a spectrum with GABA peak. • Is used with the volume selection method PRESS.
Limitations	Only available on 3.0T MRI systems.
Applications	• Brain
Scan modes	• SV

Tab. 49: Overview

What is MEGA?

MEGA (named after its inventors Mescher and Garwood) is a spectral editing and subtraction technique designed for the detection of GABA. GABA (ɣ-aminobutyric acid) is the major inhibitory neurotransmitter in the central nervous system. All resonance signals (peaks) of GABA are overlapping with other resonances, making direct detection impossible. The MEGA technique separates GABA signals from stronger overlying signals of other metabolites.

Artifact level

Since MEGA is a subtraction technique, there is always the risk of data corruption by motion between the acquisition of the ON and the OFF spectrum. It is recommended to set frequency stabilization equal to VOI to update the b0 at the start of each dynamic to compensate for field drift.

Data Export

All ON and OFF acquisitions of a MEGA scan are stored and exported separately in the order in which they are acquired. Data can be exported as DICOM or SDAT/SPAR files.

SpectroView

When loading a MEGA dataset into SpectroView:

- Choose Brain for Anatomy.
- All ON and OFF spectra are separately shown in the order of acquisition.
- Select the GABA script to display the averaged difference spectrum (based on all ON-OFF spectra of the complete dataset) and showing the fitted GABA signal at 3.0 ppm.

SpectroView is unable to open MEGA data that have been exported to PACS and are re-imported from PACS.

More information

- In the Online Help (**F1**): imaging parameter MEGA ON
- In the Online Help (**F1**): imaging parameter MEGA OFF
- In the Online Help (**F1**): imaging parameter Frequency stabilization
- In the Online Help (**F1**): Scan Methods MEGA with information how MEGA works

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23 MR Elastography (MRE)

MR Elastography (MRE) is a software and hardware option intended for use on Philips MRI Systems for producing images representing tissue stiffness of the abdominal area, such as liver and muscle. MRE XD allows for FFE and SE-EPI acquisition whereas MRE only allows for FFE acquisition.

MRE relies on a phase-sensitive gradient echo or spin echo acquisition, acquired at multiple time points for each planned slice. This acquisition is performed while an external device (Resoundant device) provides vibration at a predetermined frequency.

NOTICE

The Resoundant device is labeled as MR Unsafe. Do not take it into the examination room.

MRE generates FFE or SE-EPI Modulus, and MRE Phase images. MRE Phase images are sensitive to the external vibration and can be processed to produce images representing tissue stiffness, called MRE Stiffness images.

MRE Stiffness images, when interpreted by a trained physician, provide additional information that may assist diagnosis.

MRE in MRI examinations

Philips imaging protocols that use MRE are delivered with the MR Elastography feature. It is recommended to use these MRE protocols.

Enable or disable MRE

MRE can be enabled or disabled. Go to the **Motion** tab and click the imaging parameter **MRE Enable**.

The MRE Enable parameter can be set to:

Possible values	Effect
No	MRE is disabled
Yes	MRE is enabled

Performing an MRE examination

To perform an MRE Examination:

1. Prepare the tabletop for head-first imaging. Add the MRE band to the normal setup for standard liver imaging.

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Fig. 387: Placement of the MRE Band (black). If the respiratory belt is used for the examination, place an extra Velcro strap to secure the respiratory belt.

2. Place the patient in the head-first and supine position on the tabletop

Fig. 388: Head-first and supine position.

3. Provide the patient with hearing protection such as ear plugs and a headset.
   - Use an active headset to allow you to give breathhold instructions.
4. Use the positioning aids to help the patient lie comfortably.
5. If used, secure the respiratory belt to visualize the breathing pattern of the patient.
6. Place the passive driver of the Resoundant device over the liver of the patient. Use the xyphoid as a landmark.
   - Place the passive driver slightly to the right of the patient's xyphoid.
   - Route the air hose for the passive driver either towards the feet or towards the head of the patient, depending on the setup of the air hose in the scanner room.
   - Make sure that the air hose is properly secured to the connectors.

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Philips

Fig. 389: Place the passive driver slightly to the patient's right of the xyphoid and route the air hose towards the feet or towards the head.

7. Secure the passive driver using the MRE band.
   – Fasten the MRE band tight but make sure the patient can breathe comfortably.

Fig. 390: Final position of the passive driver, secured with the MRE band.

8. Place the coil on the patient. Make sure to route the air hose so that the patient remains comfortable during the examination.

Fig. 391: Proper coil placement. Use the strap to ensure coil stability during liver and any subsequent MRE acquisitions.

9. Secure and connect the coil.

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10. Landmark as for a standard liver examination.
    – Watch the passive driver tubing when the patient is moved into the bore. Ensure that the tube does not disconnect during tabletop movement.
11. If MRE is performed together with a standard liver examination, run other scans as required, either before or after the MRE acquisition is performed.
12. The MRE sequence is added to the examination queue like any other imaging sequence.
    – Accuracy of MRE Stiffness images is optimized when the acquisition parameter voxel size is small (<2 mm) in at least one dimension.
13. Plan the MRE acquisition to cover the desired liver anatomy. Plan REST slabs above and below the slice group.
    – For the most accurate location, use a survey or other acquisition that used the same breathhold technique.
    – If possible, try to avoid vascular structures during planning.

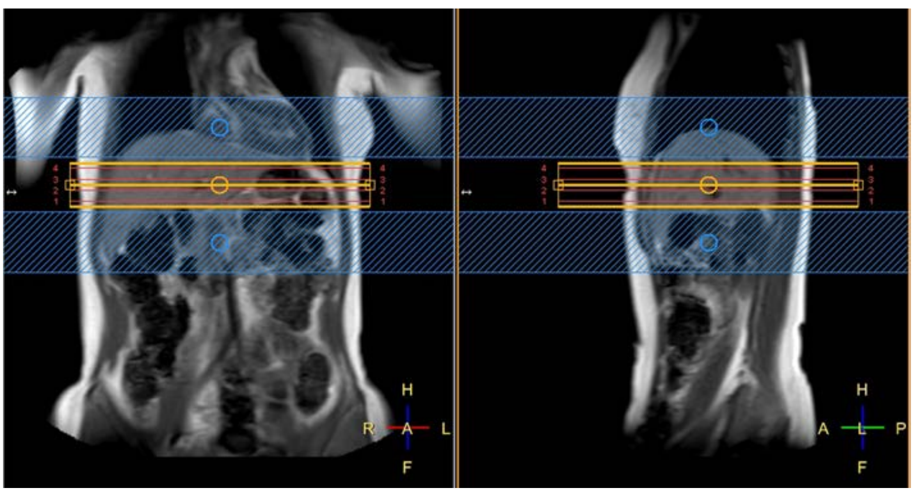

Fig. 392: Planning of a four-slice MRE acquisition.

14. Enable Patient Experience Scan.
    – Go to the **Motion** tab. Set the parameter **Patient Experience Scan** to **Yes**. The patient experience scan is added before the actual MRE acquisition.
    – The patient experience scan helps to prepare the patient for the MRE acquisition. It is a prescan that uses the same breathhold time and wave amplitude as the MRE acquisition.
    – During the patient experience scan, give the patient the breathhold instructions that will be used for the MRE acquisition.
    – Upon completion, check with the patient if the breathhold times and wave amplitude are acceptable.
    – Based on patient response, continue with the MRE acquisition or adjust the breathhold time or wave amplitude and repeat the patient experience scan.

    To control the amplitude of the applied mechanical wave, go to the **Motion** tab and change the **Wave Amplitude** parameter.

15. Run the MRE acquisition as one slice per breathhold for FFE acquisition and multiple slices per breathhold for SE-EPI acquisitions.
    - The preferred breathhold mode is expiration.
    - Pay attention to the breathhold time. The slice will be acquired four times during a breathhold, to generate data necessary for MRE outputs.
16. Process MRE acquisition outputs in the provided package (see chapter “MREView package” on page 793 for processing workflow).
17. Review processed outputs of the package, paying special attention to the confidence overlay.
18. Upon completion of the scan session, remove the tabletop from the magnet, to the full out position.
19. Remove the coil and place back in its storage location.
20. Undo the elastic strap holding the passive driver in place and remove the passive driver. Secure the passive driver and hose in its storage location.

MREView package

The MREView package uses an algorithm developed by The Mayo Clinic and Resoundant Incorporated. This algorithm allows you to process acquired MRE data into MRE Stiffness images that represent the tissue stiffness of the target organ.

The package allows you to:

- Visually assess the acquired data in color waves, to ensure that the MRE data was acquired with the driver activated.
- Create MRE Stiffness images with confidence overlays.
- Draw ROI.
- Obtain stiffness values for the drawn ROI.

Entering the MREView package

Entering the MREView package.

1. To enter the MREView package, do one of the following:
    - In plan function, right-click on the completed MRE scan in the scan queue.
    - In review, right-click on the image thumbnail of the completed scan.
2. Choose **MREView** from the drop-down list.

The MREView package contains four viewports. Three viewports provide images created from the acquired MRE data. The fourth viewport provides a data table of the ROI and associated values.

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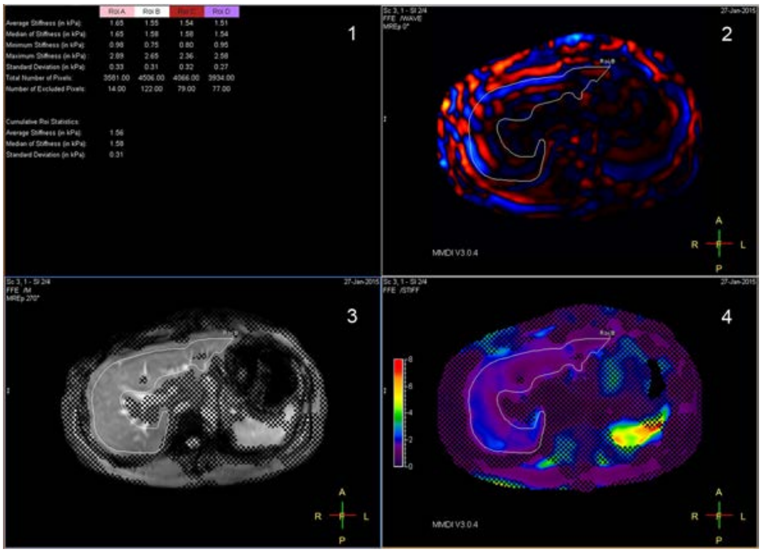


1. Data table
2. MRE Wave images
3. Modulus images of FFE or SE-EPI acquisition
4. MRE Stiffness images

MRE Wave images	Represent the shear waves created in the target tissue. These images provide a visual check that the driver was enabled.
FFE or SE-EPI Modulus images	Provide the anatomic information of the obtained slices, based on the acquired data. Draw ROIs in this image.
MRE Stiffness images	Color images with a scale of 0-8 kPa and a goodness-of-fit confidence overlay.

Using the MREView package

Use the next steps to process MRE images.

1. Play the MRE Wave images movie in the upper right viewport to make sure that shear waves are present.

   To play the movie, right-click the **Play** icon on the toolbar.

2. Review the MRE Stiffness image in the lower right port. Right-click and choose **View**, then **Confidence overlay**.

   A checkerboard pattern indicates the areas with too low estimation reliability in the data to provide an accurate representation of the tissue stiffness. The confidence overlay provides the best representation of the reliability of the acquired data. Examples of images with and without this overlay are provided in figure MRE Confidence overlay.

   To remove the confidence overlay, right-click **View**, then **Source image**.

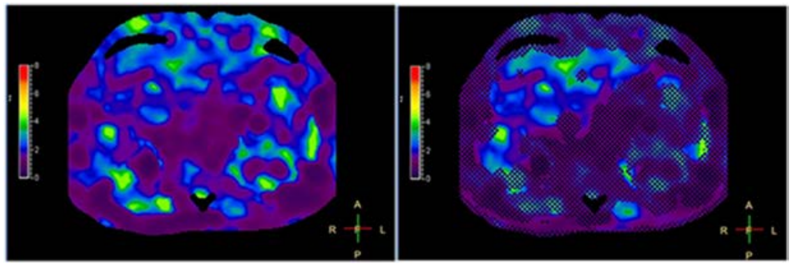
3. To obtain numeric values of the representative stiffness, draw an ROI on the Modulus image in the lower left viewport. Use the areas of tissue that demonstrate high estimation reliability. To facilitate this process, the confidence overlay is also shown in this viewport.
4. Right-click and select the desired ROI type from the provided options.
5. Draw the ROI in the liver parenchyma. Take care to avoid the checkerboard areas and vascular structures. All drawn ROIs propagate to the MRE Stiffness images and MRE Wave images in their respective viewports.

NOTICE

To ensure that only reliable pixels are used in the stiffness calculation, areas of low estimation reliability in the drawn ROI are removed from the reported stiffness values. Although vascular structures are generally marked as area of low estimation reliability, some vascular structures may remain. Avoid vascular structures in ROI measurements. They can result in an over or under estimation of the calculated stiffness value for the drawn ROI.

6. Upon completion of the ROI, the data table in the upper-left viewport reports: the average, median, maximum and minimum stiffness values, the standard deviation, the total number of pixels in the ROI, and the number of pixels within the ROI that fall outside of the areas of high estimation reliability. In addition, the table provides cumulative statistics for all ROIs drawn.
7. Repeat steps 2–5 for alternative areas of the same slice or on different slices of the loaded dataset.
8. To capture slices and tables, do one of the following:
   - On the package toolbar, choose **Analyze and Capture** to create a DICOM capture of each of the slices of the MRE Stiffness images, with ROIs and associated table.
   - Create grayscale maps of the MRE Stiffness images and MRE Wave images via the **Generate** function of the package.

     Once generated maps are added to the patient database, load maps into ImageView and apply the appropriate Look-up Table (LUT). To adjust the map scale, use the middle-mouse. Draw ROIs via ImageView and report stiffness in kPa. To save the changes, click **Viewing** on the ImageView toolbar, then **Save Presentation State**.



Color MRE Stiffness Images from acquired MRE data. The checkerboard pattern on the right represents low estimation reliability.

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Philips

WARNING

Misinterpretation due to wrong stiffness values

Risk of inappropriate or lack of treatment

- **Verify that liver signal is as expected, by carefully inspecting the quality of the MRE Modulus images in the MREView package.**
- **Verify presence of alternating red and blue bands on the MRE Wave Images by using the movie function of the MREView package.**
- **Do not determine stiffness values outside the MREView package. This may cause incorrect estimation of stiffness values, in particular when voxels with low confidence are included.**

Alternating red and blue bands on the MRE Wave images indicate the presence of shear waves necessary for evaluation of MRE data. Absence of these alternating red and blue bands could indicate that the passive driver was improperly placed or disconnected, or that the Resoundant device was not active during the acquisition. Check that the passive driver is connected and properly placed, and that the Resoundant device is active. Then reacquire the data.

Typical MRE measurements on a Philips MRI system vary by 10-15% when repeated in individuals. Proper ROI placement, as described, avoids stiffness estimates with low estimation confidence. When measurements above the confidence threshold are compared, reproducibility is similar to that reported in published literature.

Typical stiffness values for normal liver are 2.2 ± 0.3 kPa. ROI values above 2.93 kPa are indicative of fibrosis (Yin et. al. Clin Gastroent Hep, 2007).

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24 SyntAc or Multi-Dynamic Multi-Echo (MDME)

SyntAc is a dynamic fast imaging method which produces multi-contrast data that is intended to be processed with the SyMRI processing application by SyntheticMR AB, Sweden:

http://www.syntheticmr.com

What are the main properties of SyntAc?

- SyntAc provides a single MR scan with multiple contrast weightings as input for SyMRI processing software.
- The SyntAc sequence acquires four dynamics with two echoes (also known as MultiDynamic MultiEcho MDME).
- SyntAc can only be used in brain imaging of pediatric and adult examinations.
- SyntAc acquisitions provide you with Modulus and Phase images.

SyntAc scanning and postprocessing

- Philips imaging protocols utilizing SyntAc are delivered with the MR system. It is recommended to use these protocols.
- Always check the individual SyntAc images for gross artifacts.
- SyntAc images are intended for processing with the SyMRI application, product of SyntheticMR AB, Sweden.
- SyMRI calculates T1, T2 and PD parameter maps and generates synthetic images (T1W, T2W, FLAIR).
- Refer to the SyMRI User Manual for further instructions and image quality considerations.
- It is recommended to process the data with SyMRI for a quality check prior to releasing the patient from the MR system.
- To generate synthesized images in multiple orientations, SyntAc must be scanned in each orientation separately.

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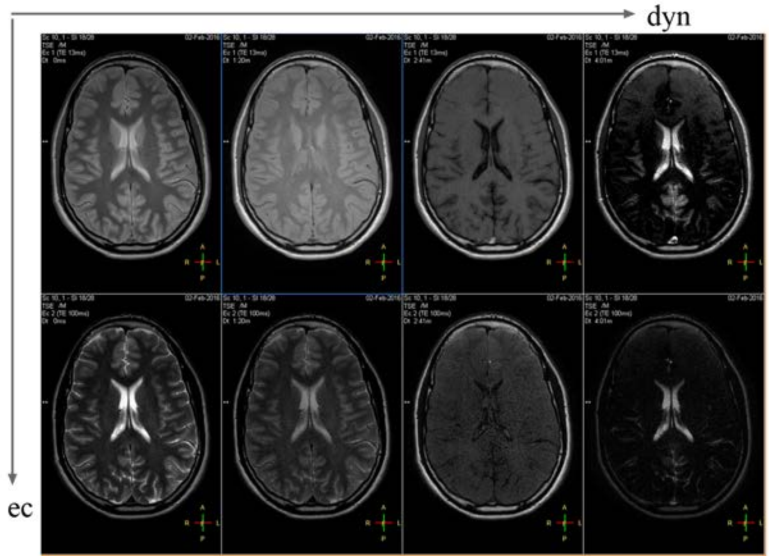
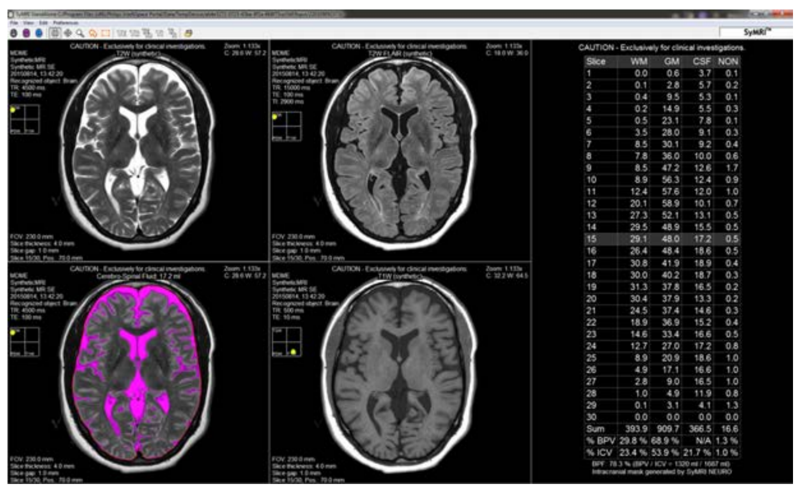
Acquired images:

- 4 dynamics
- 2 echoes

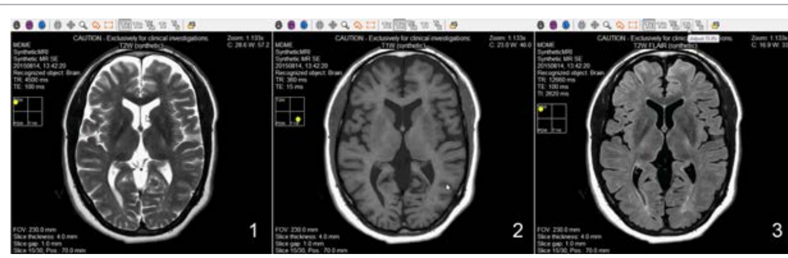


Synthesized images



Adjusting contrast:

1. adjusting TE
2. adjusting TR
3. adjusting TI



More information

- In the Online Help/Scan Methods: How does SyntAc work?
- In the Online Help/Parameters: How to enable SyntAc? (MDME imaging parameter)

25 Imaging techniques

3D APT

Property	Description
Pulse Sequence	3D APT (in the following referred to as APT) is an amide proton saturation technique which uses a multi-point mDIXON 3D-TSE sequence to produce an APT weighted (APTW) image contrast.
Properties	• APT scans provide APTW images with a color map (overlay). • APT scans provide S0 images as anatomical reference. S0 images (obtained by detuning the saturation pulses) are used in calculating APTW contrast. They show anatomical information and could be used to check for SNR (signal-to-noise ratio) and possible patient movements.
Limitations	• APT imaging is not designed to support absolute quantification. • Contrast agent spoils the effects of APT. Therefore always perform APT as pre-contrast scan.
Applications	• Brain imaging without the use of contrast agent: differentiate tissues on protein density
Contrast is determined by	• Amount of proteins and peptides that are rich in amide groups, in imaging area
Scan modes	• 3D

Tab. 50: Overview

What is APT?

APT imaging is based on a saturation transfer technique. The scan is designed to show higher APT contrast in areas where there is increase in amide proton concentration, and thereby protein density.

How does APT imaging work?

The APT sequence is based on multi-point mDIXON 3D-TSE using fat suppression.

The resonance frequency of amide protons is lower than the resonance frequency of water: the water-amide shift is -3.5 ppm.

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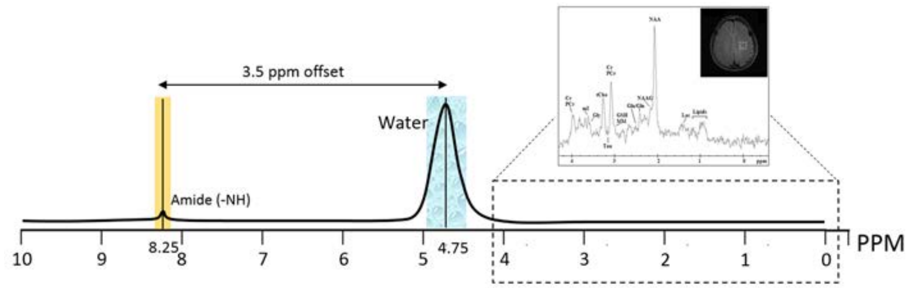
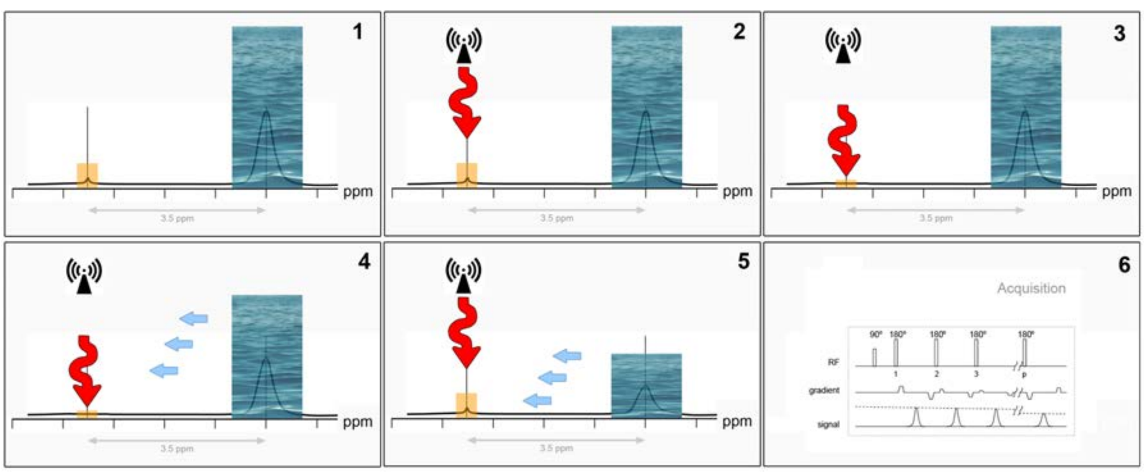


- A frequency-selective saturation pulse with the resonance frequency of the amides is applied for 2 seconds (recommended duration).
- This pulse saturates the amide protons.
- Subsequently the amide protons exchange magnetization with the free water pool.
- This magnetization exchange eventually leads to a saturation of the water pool.
- The essence of APT imaging is the signal reduction of the water pool in tissue of high protein density.
  - Depending on the tissue type, the magnetization exchange rate is different.
  - This magnetization exchange rate is expressed as asymmetric Magnetization Transfer Ratio (MTR) in percentage terms.
- APT scans provide APTW images with a color map and S0 images as anatomical reference which could be used to check for possible patient movements.



APT weighted images

The APTW images are displayed with a color overlay representing the asymmetric MTR on a scale of -5% to +5%.

In tissue, local increase of APTW contrast could be suggestive of a lesion.

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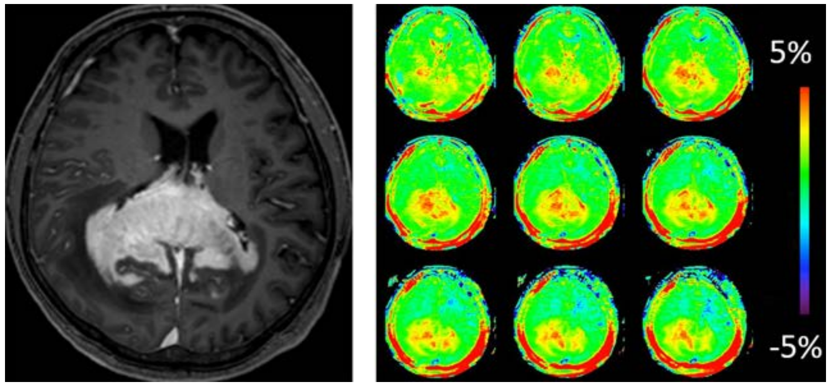


Courtesy:

Kyushu University Hospital; Fukuoka, Japan

S0 images

S0 images are 3D-TSE images obtained by detuning the saturation pulses. They are used as reference in the calculation of MTR asymmetry.

You can use the S0 image as anatomical reference and to check for possible patient movements. Patient movement may produce unreliable APTW images.

More information

- In the Online Help **(F1)**: What is APT and how does it work? chapter “” on page 799
- In the Instructions for Use: Scanning with APT chapter “Scanning with APT” on page 801
- In the Online Help **(F1)**: Enabling APT
- In the Online Help **(F1)**: Controlling the amount of APT

Scanning with APT

Use APT in brain imaging to differentiate tissues based on contrast reflecting the amount of proteins and peptides that are rich in amide groups.

Positioning

► Position the patient on the tabletop with their head in the head coil.

► Place wedges on both sides of the head for immobilization.

► Close the coil and move the patient to the isocenter.

Scanning

▷ The patient is registered and selected for scanning.

► Select an ExamCard with an APT imaging protocol, or add an APT imaging protocol to the current ExamCard.

NOTICE

Philips imaging protocols utilizing APT are delivered with the MR system. These protocols use a maximum SENSE factor of 1.6. It is recommended to use the default Philips protocol without changing any parameters.

Changing parameters can degrade SNR, affect homogeneity correction etc., eventually masking out pixels and introducing higher variability in APT images.

NOTICE

Always perform APT as pre-contrast scan.

Contrast agent spoils the effects of APT.

- ► Start the ExamCard.
- ► Plan the ExamCard items on the images.
- ► Plan the APT protocol in the region of interest.
- ► Run the APT scan.
- ⇨ APT scans provide APTW images with a color map and S0 images for anatomical reference.

Controlling the amide proton saturation

To control the amide proton saturation, decrease the imaging parameters **APT saturation duration (ms)** and **APT saturation B1 rms (µT)** on the Contrast tab. This affects directly the Magnetic Transfer Ratio (MTR).

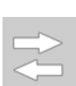
NOTICE

It is recommended to leave these parameters unchanged.

Reviewing and navigating through images

- ► Review the APT scan in ImageView.
- ► Navigate through APTW maps and S0 images:

Through image types (maps)



- ► In the image viewport, drag to the left or to the right.
  Or use the left-right arrow keys.

Through slices

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► In the image viewport, drag up- or downwards.
Or use the up-down arrow keys.

Selecting color display

► Select the color look-up table for the APTW maps and S0 images:

- Applicable are: **GrayScale** or **APTW**.
- The other color look-up tables are grayed out, since they are not applicable.

NOTICE

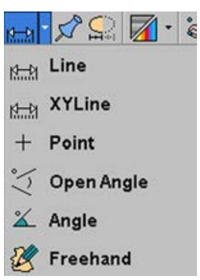
The color scale of APT maps and S0 images is locked to -5 % to +5 %.

You cannot adjust window width and window level.

Obtaining mean pixel values

▷ in ImageView on an APTW map:

► From the Measurement drop-down menu on the toolbar, select **Freehand**.



► Draw a ROI with the left mouse button. Click to end drawing and to confirm the ROI.

⇨ The area of the shape and the intensity mean value are displayed.

Black pixels are excluded from the drawn ROI. They are not taken into account for the numeric results.

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Philips

Compressed SENSE (CS-SENSE)

Property	Description
Pulse Sequence	• Compressed SENSE is an acceleration technique that is less sensitive to noise break-through than SENSE at high reduction factors. It allows to increase resolution and/or coverage without a scan time penalty.
Properties	• Compared to similar scans with (dS-)SENSE, but without Compressed SENSE: – Shorter scan times, or – Higher signal-to-noise ratio, or – Higher spatial resolution or larger coverage. • To be used with all SENSE compatible coil solutions.
Applications	• All clinical areas.
Limitations	• Cannot be used in EPI scans and Multislice-TSE when Partial NSA is used. • Cannot be used in non-cartesian scans such as MultiVane. • Cannot be used with OMAR when set to SEMAC+VAT. • Cannot be used in MR Spectroscopy. • Cannot be used with dedicated temporal sub-sampling methods (such as k-t BLAST).
Contrast is determined by	• Contrast parameters of the imaging sequence being combined with Compressed SENSE.
Scan modes	• 3D, MS, 2D, M2D Compressed SENSE allows for highest acceleration in 3D scans.

Tab. 51: Overview

What is Compressed SENSE?

Compressed SENSE accelerates imaging, because it undersamples k-space and consequently saves time. Undersampling k-space leads to incoherent aliasing in the image domain. This aliasing is resolved by Compressed SENSE, a non-linear iterative reconstruction technique

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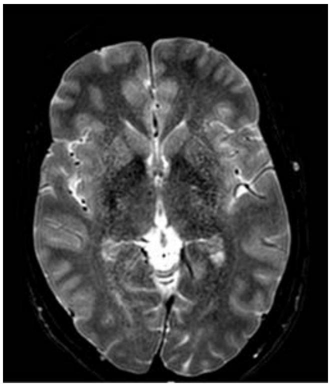
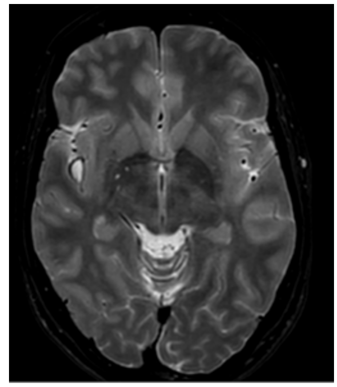
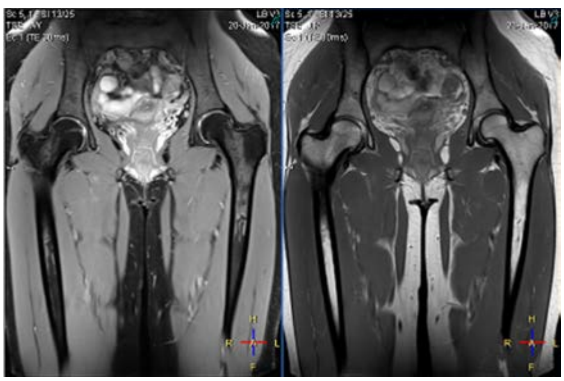
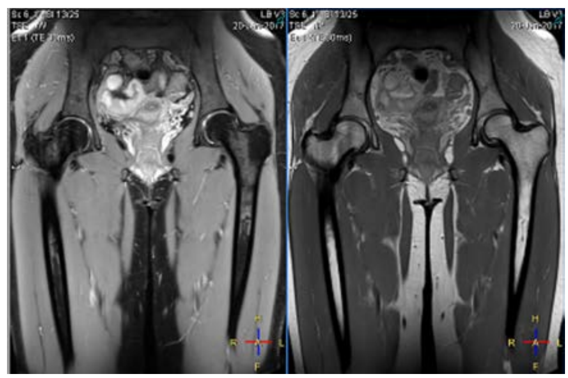
dS SENSE (no Compressed SENSE)	**Compressed SENSE**
	
• SENSE reduction factor: 4.23 x 2.12 • Scan time: 2:05 min	• CS-SENSE reduction factor: 9 • Scan time: 2:05 min
	
• SENSE reduction factor: 2.5 • Scan time: 5:42 min	• CS-SENSE reduction factor: 3.08 • Scan time: 4:06 min

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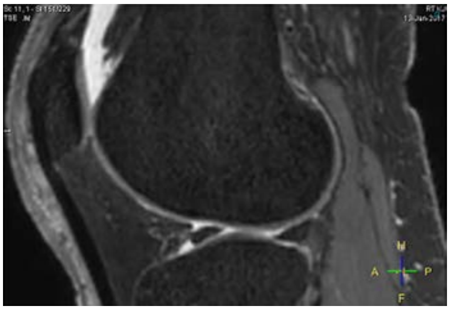
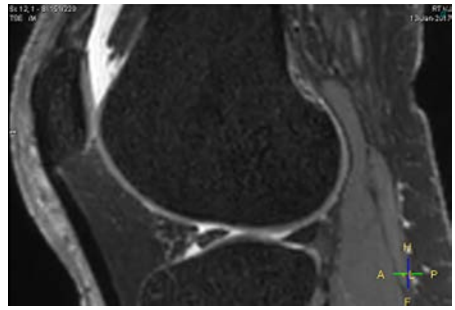
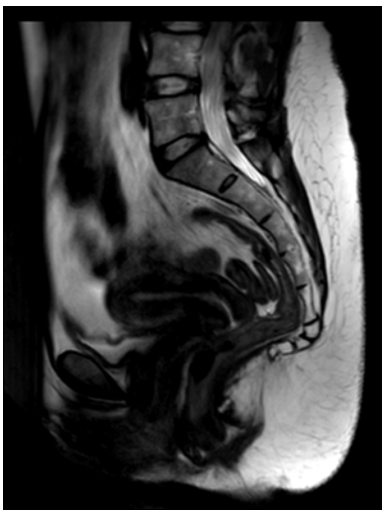


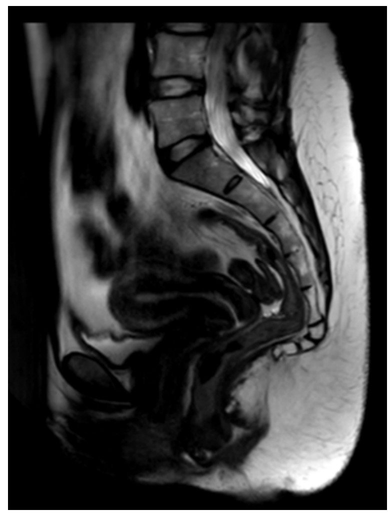
- SENSE reduction factor: 2.2 x 2.2
- Scan time: 5:43 min



- CS-SENSE reduction factor: 6.94
- Scan time: 4:01 min



- Scan time: 5:13 min



- Scan time: 3:30 min

How does Compressed SENSE work?

Compressed SENSE makes use of *incoherent undersampling of variable density* in combination with *iterative (non-linear) reconstruction*.

Incoherent undersampling of variable density compared to other sampling strategies

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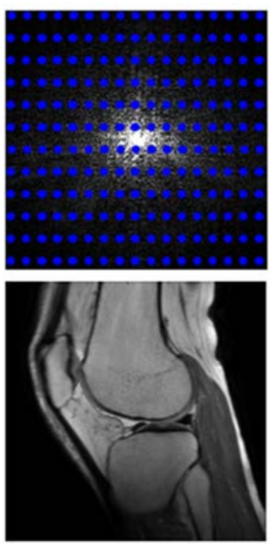
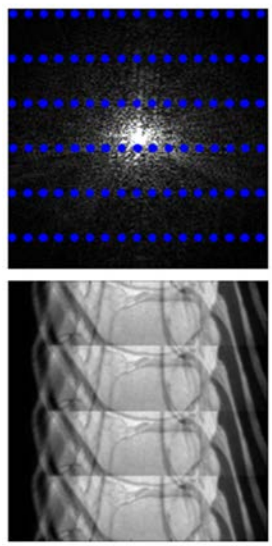
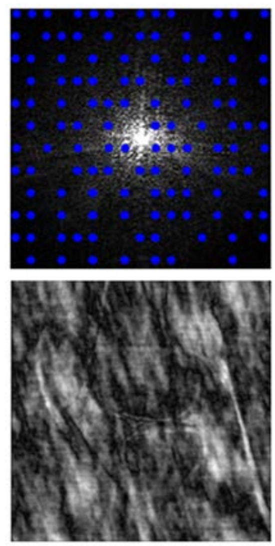
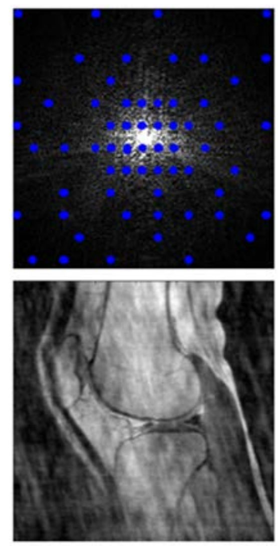
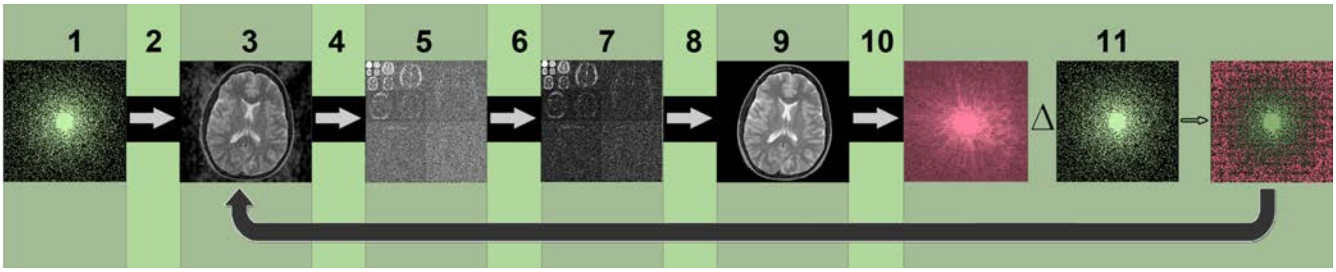
Uniform sampling	Uniform undersampling	Incoherent undersampling of fixed density	Incoherent undersampling of variable density
• k-space is sampled in a uniform way.	• k-space is sampled in a regular way with fixed density.	• k-space is sampled in a random way with fixed density.	• k-space is sampled in a random way with variable density. • Resulting in an image with incoherent noise-like aliasing
k-space and corresponding image:	k-space and corresponding image:	k-space and corresponding image:	k-space and corresponding image:
			

Iterative (non-linear) reconstruction

The purpose of non-linear iterative reconstruction is to get rid of the incoherent noise-like aliasing and to produce a clean artifact-free image.

For that reason, the image needs to be transformed to the wavelet space. MRI image information in the wavelet space is sparse, which allows to identify noise quite easily and consequently enables denoising. After denoising, the data is tranformed back to image space, then to k-space and eventually checked against the originally measured k-space data. This procedure is repeated in a loop:



1. Incoherently undersampled k-space
2. Fourier transform (k-space to image) using coil-sensitivity data and regularization information
3. Reconstructed image (corresponding to incoherently undersampled k-space)
4. Wavelet transform (image to sparsity)
5. Corresponding sparsity presentation
6. Denoising
7. Denoised sparsity presentation
8. Inverse wavelet transform (sparsity to image)
9. Reconstructed image (after denoising)
10. Comparison with originally acquired k-space
11. Output of comparison is used as input for next reconstruction round.

This is repeated iteratively till convergence is reached and the resulting image is free of aliasing artifacts.

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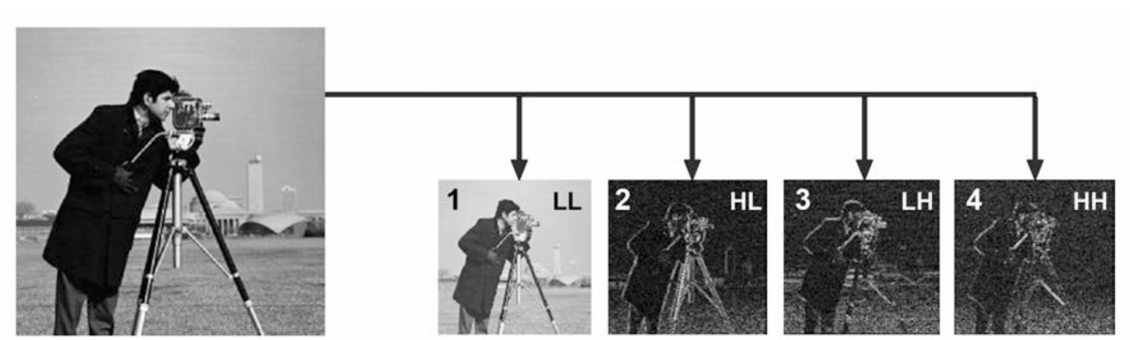
Wavelet transform and sparsity: from image to wavelet space

The wavelet transform transforms the image to wavelet space. The wavelet transform is equivalent to a series of special high- and low pass filters followed by downsampling, along the rows and the columns. In this way details are extracted at various wavelet scales. The full image is split up into four image types one-quarter of the original image size:

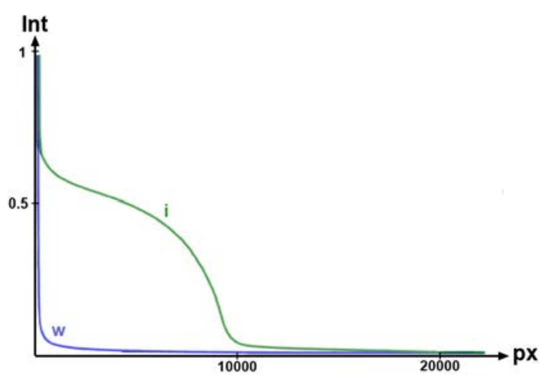


1. A low resolution image or average image (low-low **LL** filter).
2. Vertical details image for the original image scale (high-low **HL** filter).
3. Horizontal details image for the original image scale (low-high **LH** filter).

4. Diagonal details image for the original detail scale (high-high **HH** filter).

The low resolution image (**LL**) is split further into its own average, horizontal, vertical and diagonal coefficients. As such the image information is split into details and contrast information at multiple scales. This is a multi-resolution analysis.

Most of the high-value "pixels" (correctly wavelet coefficients) in this wavelet space diagram are in the top left, and a lot of the diagram is dark. The representation is sparse. The wavelet space diagram has the same number of values as the image, but the information is contained in fewer values.



Scaled signal intensity (Int) versus pixel count (Px)

- w - wavelet
- i - image

Since the distributed aliasing (as a result of random k-space undersampling) is noise-like in this domain, it can be removed by using a threshold. With such a threshold, some values are dropped and, along with them, the low-intensity artifact from the random undersampling, without losing much image information.

If the threshold is too low, aliasing is not completely removed. If the threshold is too high, signal from the object could be suppressed. In both cases, artifacts could occur in the resulting images. The threshold is automatically derived and optimized depending on each individual scan

How does Compressed SENSE behave?

Compressed SENSE and SENSE behave very much alike with respect to acceleration, patient motion and aliasing artifacts.

For information about the effects of acceleration and patient motion, about Compressed SENSE artifacts and how to avoid them, see chapter "Compressed SENSE Artifacts" on page 902.

More information

- In the Online Help **(F1)**: What is Compressed SENSE and how does it work?
- In the Instructions for Use: Scanning with Compressed SENSE chapter “Scanning with Compressed SENSE” on page 810
- In the Online Help **(F1)**: Enabling Compressed SENSE
- In the Online Help **(F1)**: Controlling Compressed SENSE
- In the Instructions for Use: Flame artifact with Compressed SENSE and how to overcome? chapter “Flame artifact with Compressed SENSE” on page 904

Scanning with Compressed SENSE

Use Compressed SENSE

- to scan faster with virtually equivalent image quality, preferably in 3D-scans, or
- to gain spatial or temporal resolution due to higher signal-to-noise ratio with similar scan times.

NOTICE

Gaining confidence

When you get started with Compressed SENSE, perform the same scans in different clinical areas with and without Compressed SENSE to gain confidence. Compare the results and decide how to proceed.

For information about the behavior of Compressed SENSE, about possible artifacts and how to deal with them, see chapter “Compressed SENSE Artifacts” on page 902.

Scanning and viewing

▷ The patient is registered and selected for scanning.

► Do any of the following:

- Select an ExamCard with a Compressed SENSE imaging protocol.
- Add a Compressed SENSE imaging protocol to the current ExamCard.

Philips imaging protocols utilizing Compressed SENSE are delivered with the MR system. It is recommended to use these protocols and use them as a starting point for own hospital-specific protocols.

► Start the ExamCard.

► Plan the ExamCard items on the images.

► Run the ExamCard.

► Review the images in ImageView.

⇨ Compressed scans provide the same images and image types as scans without Compressed SENSE.

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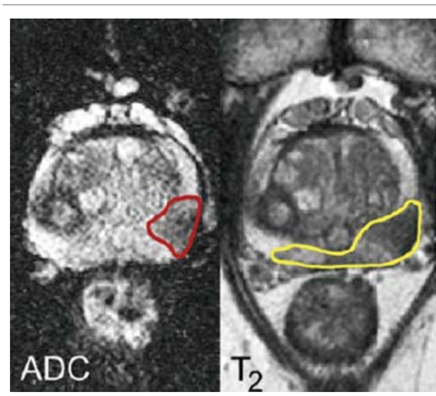
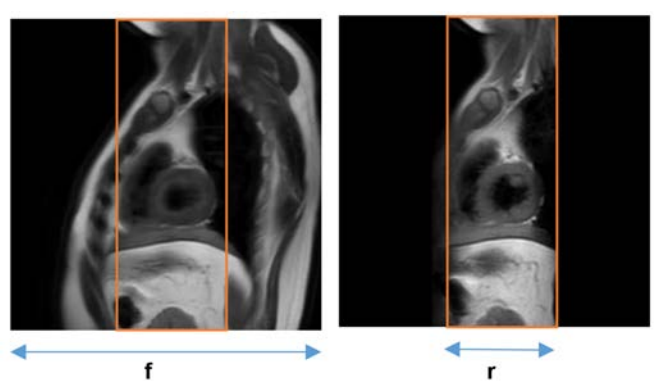
Zoom

Zoom is a reduced-FOV method.

Zoom behaves differently dependent on the parameter **scan mode**.

With scan mode MS	With scan mode 2D, M2D, 3D
• enables non-coplanar **zoom imaging**. (by means of non-coplanar excitation and REST slabs which are not visible in PlanScan) • provides (relative to small FOV acquisitions without **zoom imaging** enabled): – Excellent outer volume suppression, enabling small FOV acquisitions without oversampling, thus enabling low EPI factors. – possibly increased SAR, – possibly increased PNS.	• enables orthogonal zoom. A smaller FOV is excited in phase-encoding direction where the excitation pulse is orthogonal to the slice selective refocusing pulses. • enables fast dynamic TSE and GRASE imaging by measuring a smaller number of profiles in one single shot or in multiple shots. – The smaller number of profiles is realized by using a smaller FOV in fold-over direction. • Backfolding is avoided as selective RF excitation refocusing pulses are used to limit the FOV in fold-over direction. NOTE: FH fold-over direction in combination with Zoom (scan mode 2D, M2D, 3D) is not recommended
Application: high resolution DWI and DTI images in brain, spine and prostate. To acquire single-shot and multi-shot SE-EPI high-resolution DWI or -DTI images with small FOVs and limited distortion. Zoom imaging reduces distortion artifacts.	**Application:** high-resolution cardiac imaging. To acquire 2D, M2D (or 3D) Single Shot or MultiShot TSE or GraSE images with small FOV in fold-over direction. Zoom enables a shorter (single) shot, and/or shorter scan time.
IRIS (Image Reconstruction using Image-space Sampling) Multishot diffusion technique with zoom imaging for spine examination. Philips imaging protocols are delivered with the system. It is recommended to use these protocols.	
 European Journal of Radiology 80 (2011) e34-e41	 f = full FOV, r = reduced FOV

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More information

- Imaging parameter **Fold-over suppression** in Online Help system (**F1** key)

Planning a scan with Zoom

▷ In the Parameter Editor:

► Open a MS SE-EPI diffusion imaging (DWI and DTI) scan protocol, or a 2D/M2D TSE/GRASE scan protocol .

► Click the **Geometry** tab to display the geometry parameters of the scan protocol.

► Set the parameter **Fold-over suppression** to **zoom**.

► Reduce the FOV in fold-over direction, either graphically or numerically.

► Depending on the scan protocol, a conflict may pop up to force the scan into 2 packages.

NOTICE

With zoom imaging in MS SE-EPI diffusion imaging, scanning of at least 2 packages is mandatory.

► When complete, press **Proceed** to save your scan protocol.

Black Blood imaging

Black blood imaging is a method where the signal of flowing blood is suppressed.

Most black blood methods rely on intrinsic flow phenomena.
On your MR system, two additional black blood methods are available:

1. Double Inversion Recovery,
2. MSDE (Motion Sensitized Driven Equilibrium).

Applications

- Brain,
- Nerve imaging in brachial and lumbar plexus,
- Liver (flow ghost suppression of aorta).

More information

For more information about these methods, see the parameter help texts:

- Black Blood pulse (TSE) ,
- Black Blood pulse (TFE) ,
- MSDE mode .

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MSDE

MSDE stands for Motion Sensitized Driven Equilibrium and is a black blood method.
It applies a magnetization preparation sequence that causes moving spins to dephase, and thereby suppresses signal from blood vessels with sufficient flow. This is achieved by additional flow crushing gradients.

You can use MSDE in 2D-, M2D- and 3D-TSE and -TFE sequences.

You can either select one of the predefined MSDE modes designed for specific applications, or you can set up your own MSDE sequence by setting the parameter **MSDE mode** to **user defined**.

Enabling Black Blood Imaging

- ► Open a 2D-, M2D- or 3D-TSE or -TFE scan protocol.
- ► Click the **Contrast** tab to display the parameters related to the contrast of the scan protocol,
- ► In the TSE scan protocol:
  - set the parameter **BB pulse** to **yes** or **MSDE**.
- ► In the TFE scan protocol:
  - set the parameter **TFE prepulse** to **black-blood**, and
  - set the parameter **bb pulse type** to **default** or **MSDE**.

3D NerveVIEW

3D NerveVIEW allows to image the nerves in the brachial and lumbar plexus. It is the recommended technique for nerve imaging in combination with

- MSDE to suppress blood,
- STIR or SPAIR to suppress fat.

Brachial plexus as 3D NerveVIEW (Nerve STIR) with MSDE and Refocusing control	Brachial plexus as 3D NerveVIEW (Nerve STIR)
	

MultiBand SENSE (MB SENSE)

MultiBand SENSE is a software option intended for use on Ingenia, Ingenia CX, Ingenia Ambition and Elition, 1.5T and 3.0T Systems. It is indicated for use in Magnetic Resonance Imaging of the brain for:

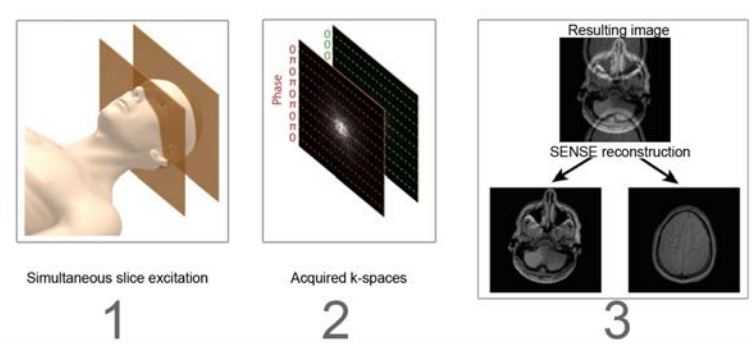
- BOLD fMRI
- Diffusion Weighted Imaging

MultiBand SENSE consists of an acquisition and reconstruction technique allowing simultaneous excitation of multiple volumes to accelerate imaging acquisition times, or increasing coverage, or number of diffusion directions without increasing scan time.

How does MultiBand SENSE work?

The MultiBand SENSE technique enables simultaneous excitation and acquisition of multiple volumes for multislice single-shot EPI sequences. The simultaneous volume excitation is done using a multi-band RF pulse. The simultaneously acquired volumes are unfolded by means of the SENSE algorithm. The image unfolding is improved by introducing a linear phase in k-space in the phase direction depending on the volume position. This results in a spatial shift of the aliased pixels in imaging space.

MultiBand SENSE allows for shorter TRs with the same in-plane resolution and coverage in the slice direction and consequently leads to shorter scan times. Alternatively the time savings by the MultiBand acquisition can also be used to keep the TR unchanged and acquire more slices in the same time.



Principle of MB SENSE with MultiBand x2.

1. Simultaneous excitation of 2 slices.
2. Acquired k-spaces of these 2 slices.
3. one resulting image before SENSE reconstruction, two resulting images after SENSE reconstruction.

MB SENSE makes use of a B0 prescan to optimize the SENSE algorithm.

Application

Multislice single-shot EPI brain scans:

- BOLD fMRI
- Diffusion Weighted Imaging

Restrictions

- You can only use MB SENSE with the
  - dS Head 32ch 3.0T coil.
  - dS HeadSpine coil 1.5T and 3.0T
  - dS HeadNeckSpine coil 1.5T and 3.0T
- Implants that are MR Conditional cannot be scanned using MB SENSE.
  Instead a conflict occurs, since the B0 prescan is not compatible with implants.

MB SENSE in MRI examinations

Philips imaging protocols utilizing MB SENSE are delivered with the MR system. For ease of use, it is recommended to use these MB SENSE protocols.

MB SENSE Imaging Parameters

MB SENSE can be enabled, disabled and adjusted by means of the imaging parameters **MB SENSE** and **MB factor** on the *Geometry* tab.

Parameter	Possible values	Effect
MB SENSE	• No • Yes	• MB SENSE is disabled. • MB SENSE is enabled.
MB factor	• **2 ... 4** for SE-EPI (Diffusion)	Multiple slices are acquired per excitation, depending on the MB factor. • Only integer numbers can be used. • The higher the factor, the faster the scan. • The number of acquired slices has to be a multiple of the **MB factor**. A **MB factor** of 3 acquires 3 slices per excitation. This allows for multiples of 3 slices (e.g. 6, 9, 12). • This range only applies for the dS Head 32ch 3.0T coil. For the other coils, **MB factor** is restricted to 2.
MB factor	• **2 ... 8** for FFE-EPI (BOLD fMRI)	See above.

When MB SENSE is combined with SENSE, the two SENSE factors multiply. The higher their product, the higher the likelihood of artifacts. It is therefore advised to carefully select the SENSE factors used.

Related parameters MB SENSE

- MB SENSE ,
- MB factor .

4D-TRAK XD

4D-TRAK XD (4D Time-Resolved Angiography using Keyhole) provides high spatial and temporal resolution CE-MRA scans.

4D-TRAK XD utilizes the 3D-FFE scan technique and combines the advantages of dS-SENSE, Keyhole, CENTRA and Viewsharing.

4D-TRAK might be used to aid in evaluation of brain AVM, congenital heart diseases, cardiac function, hemodialysis shunts and in diabetes patients with short arterio-venous transit time in lower legs/feet.

NOTICE

4D-TRAK XD is not available in Japan.

Running a 4D-TRAK XD scan

▷ The patient is positioned on the tabletop with the best-suited coil for the anatomy of interest and all required positioning aids (see Coils chapter in the Instructions for Use for information on coil choice).

▷ The images of the survey scan and the anatomical scans are available for planning.

► Add a 4D-TRAK XD scan to your current ExamCard.

► Plan the slices, preferably in plane with the vessels.
As such less slices are needed to cover the vessels.

► Start the scan.
The first dynamic (which serves as a non-contrast scan) is performed.
After its completion, scanning is paused for contrast agent injection.

► Inject contrast agent as a bolus.

► Press **Proceed** to resume the scanning.
The dynamic series are acquired automatically, one after the other.

► View the resulting images with **ImageView**.

► Calculate Maximum Intensity Projections with **VolumeView**.

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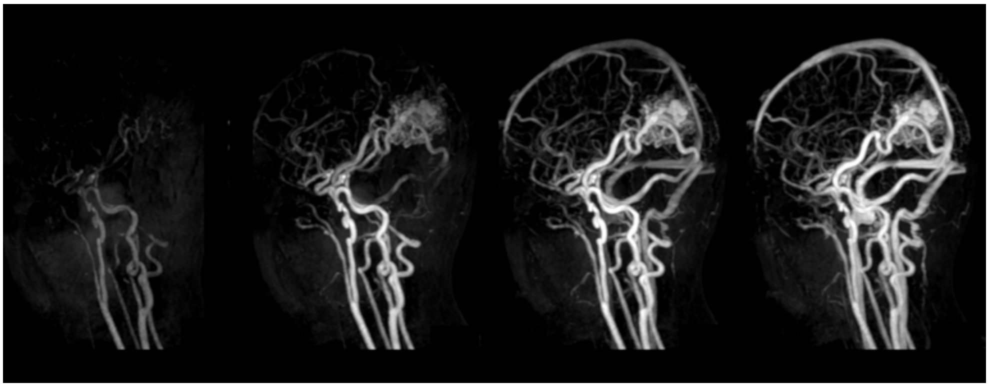
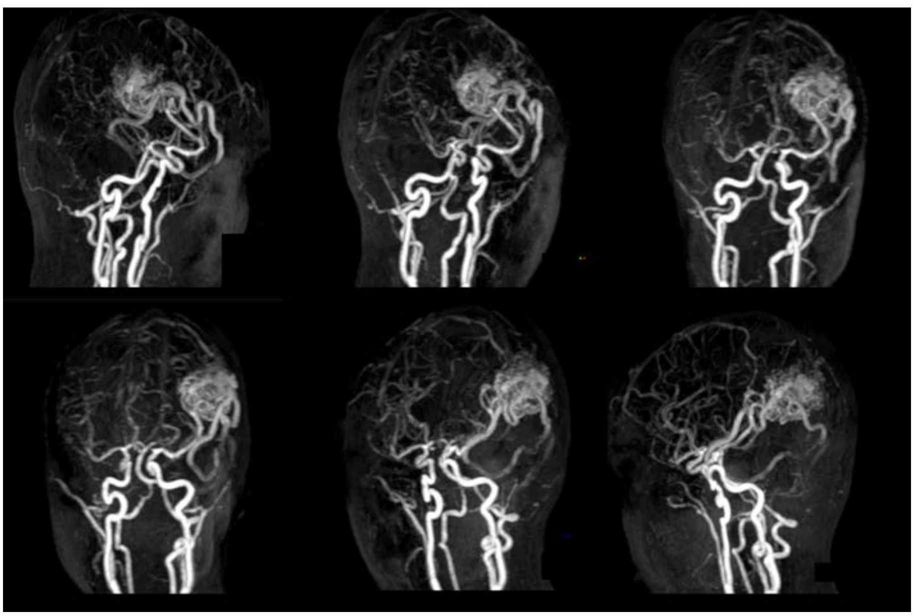
Examples of 4D-TRAK XD Dynamics and MaxIPs

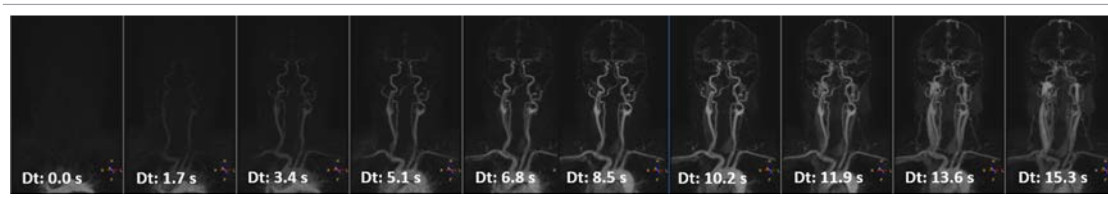
4D-TRAK XD (without the use of Viewsharing) 4 dynamics. From left to right: early to late dynamic.



4D-TRAK XD (without the use of Viewsharing): Different Maximum Intensity Projections of the same dynamic.



4D-TRAK XD: 10 dynamics in carotid arteries, from early to late dynamic.



Related parameters 4D-TRAK XD

- Keyhole,
- Keyhole central size (%),
- Keyhole measurements,

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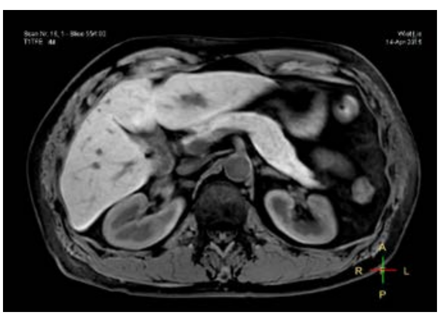
Philips

- Keyhole reference scan,
- Viewsharing,
- Viewsharing - peripheral density (%),
- Viewsharing - sharing direction,
- CE-angio profile order,
- CE-angio profile orders for stacks A, B, C, ...
- CENTRA,
- CENTRA percentage (%),
- Mask.

3D VANE XD

3D VANE XD is a free breathing acquisition method to achieve distortion-free images in 3D/FFE and 3D/TFE body imaging.

You can use it for late enhancement scans, especially in patients who cannot hold their breath as long as needed.
You cannot use it for dynamic acquisitions.



3D Free Breathing e-THRIVE

Comparison of 3D Free Breathing versus 3D Breathhold

	3D Free Breathing (FB)	3D Breathhold (BH)
Suited for patients	that cannot hold the breath as long as needed in a Breathhold sequence.	that can hold the breath as long as needed.
Use	• pre-/post-contrast acquisition, • late enhancement, • not suited for dynamic acquisition due to too long scan times.	• dynamic acquisition, • pre-contrast acquisition, • late enhancement.
Can be combined with	e-THRIVE and mDIXON (3D/T1-TFE, 3D/T1-FFE)	all 3D/FFE and 3D/TFE acquisitions

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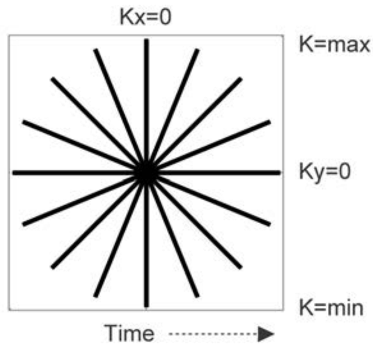
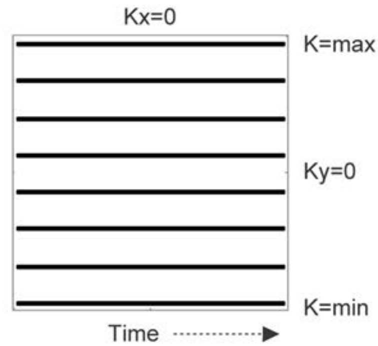
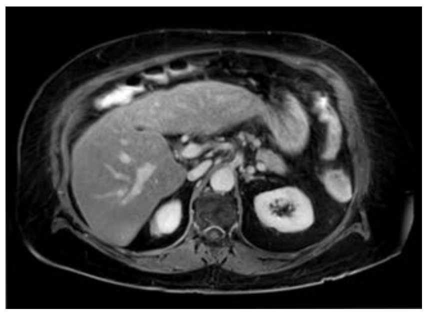
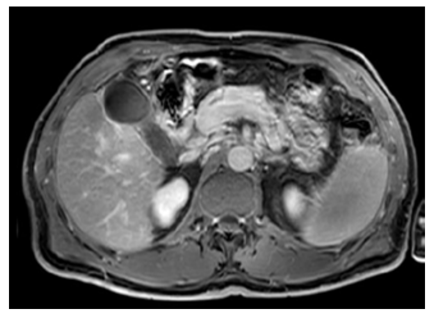
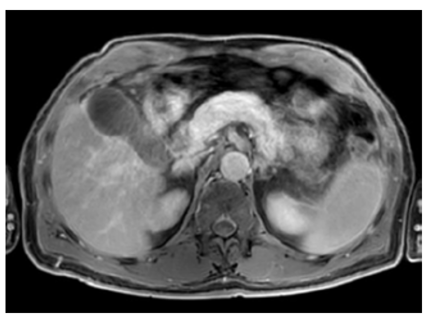
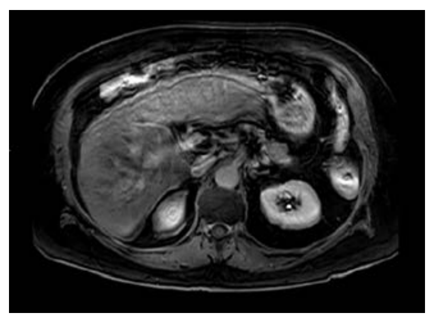
	3D Free Breathing (FB)	**3D Breathhold (BH)**
Imaging parameter **Acquisition mode**	**radial** 	**cartesian** 
Example of good image quality		
Likelihood of breathing artifacts	Depending on the breathing pattern, blurring can still be induced. 	When the breathhold cannot be hold, blurring is induced. 

Imaging parameter: Acquisition Mode = Radial

The **radial acquisition mode** in 3D Free Breathing provides a higher robustness to motion due to:

- intrinsic oversampling of the center of k-space,
- benign undersampling behavior,
- phase correction of the closest radial reversed radial profiles.

Radial Pseudo golden angle sampling is performed.

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Imaging parameter: Radial percentage (%)

A high **Radial percentage (%)**

- improves SNR,
- decreases undersampling streaking artifacts,
- but increases scan time.

4D FreeBreathing

Property	Description
Pulse Sequence	• Free-breathing motion-robust 4D contrast-enhanced MRI • Available on 1.5T and 3.0T
Properties	• Allows to follow T1 contrast enhancement in the organs of interest by continuous acquisition over a period longer than a breath-hold. • Continuous coverage of the arterial phase. • Motion-robust imaging reduces artifacts due to breathing motion, cardiac pulsation and intestinal motion. • Free-breathing technique making use of either VitalEye, or respiratory sensor or intrinsic navigators. • Real-time reconstruction for direct assessment of image quality in pre-contrast dynamic series. • Variable phase definition. • To be used with SPAIR.
Applications	• All anatomies, especially abdomen.
Contrast is determined by	• Contrast parameters of the imaging sequence being combined with 4D FreeBreathing.
Scan modes	• Dynamic 3D/TFE

What is 4D FreeBreathing?

4D FreeBreathing is a motion-robust imaging technique (extension of 3DVANE XD) now allowing for the acquisition of dynamic 3D/TFE contrast-uptake studies.

How does 4D FreeBreathing work?

4D FreeBreathing is a motion-robust sampling method due to an intrinsic oversampling of the center of k-space. It offers the unique advantage of capturing contrast uptake efficiently independent of the scan geometry.

4D FreeBreathing makes use of:

Variable-Density Golden-Angle Radial Stack-of-Stars Acquisition

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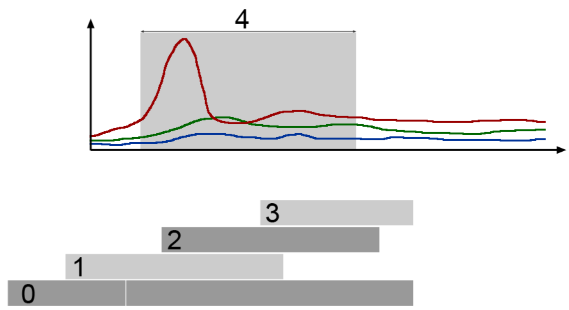
- The 3D-acquisition is performed in a sliding window fashion (making use of overlapping dynamic blocks).
- k-space sampling is optimized for scan time and optimal contrast visualization.



Acquisition with overlapping dynamic blocks for continuous coverage of the arterial phase

- 0 = Pre-contrast phase
- 1 = Dynamic 1
- 2 = Dynamic 2
- 3 = Dynamic 3
- 4 = Arterial phase

Respiratory Soft Gating

- The respiratory cycle is continuously sampled by either intrinsic navigators, by VitalEye (if available) or by the respiratory belt.
  VitalEye has the advantage of continuously detecting motion over time with potentially sharper images.

  From the respiratory cycle, the different breathing states are determined.
- k-profiles are measured continuously and weighed retrospectively according to their breathing state (smart weighting).

The advantage of respiratory soft gating (compared to conventional gating techniques) is that the dynamic scan times are independent of the respiratory cycle.

More information

- In the Online Help **(F1)**: Enabling 4D FreeBreathing (with the parameter Dynamic study)
- Related parameters in the Online Help **(F1)**:
  - Motion oversample factor
  - Intrinsic correction
- In the Instructions for Use: 3D VANE XD chapter “3D VANE XD” on page 818

Scanning with 4D FreeBreathing

Use 4D FreeBreathing for motion-robust imaging in contrast-enhanced MRI.

The workflow is identical to any other dynamic contrast-enhanced MRI with a stop between pre- and post-contrast dynamic series.

NOTICE

Philips imaging protocols utilizing 4D FreeBreathing are delivered with the MR system. It is recommended to use the default Philips protcol without changing any parameters.

Changing parameters can degrade SNR and negatively affect image quality.

MultiTransmit

Property	Description
Pulse Sequence	• Parallel RF transmit technology. MultiTransmit technology addresses 3.0 T challenges at the source: it prevents dielectric shading effects and it adapts the RF transmit sources to each patient's unique anatomy to obtain uniform RF and a lower local RF deposition. For a detailed description see text below.
Properties	• Only available on 3.0T. • MultiTransmit is always on.
Applications	• Liver imaging • Pelvic imaging • Breast imaging • Brain and Spine imaging. • Cardiac imaging

Tab. 52: MultiTransmit - Overview

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Important

It is not allowed to perform a MultiTransmit scan with the patient in left or right decubitus position.

MultiTransmit Technology

MultiTransmit technology can be explained in the easiest way by comparing

- single or multiple RF-transmission on the MR system
  to light transmission with single or multiple light sources.

Fig. 393: Light source versus MR system to explain MultiTransmit technology.

Single light source versus multiple light sources

Illuminating an object by a single light source results in unwanted shading. This is comparable to the dielectric shading on a conventional 3.0T MR system (without MultiTransmit).

Illuminating the same object by multiple light sources, hardly any shading effects will occur. This corresponds to the situation with MultiTransmit.

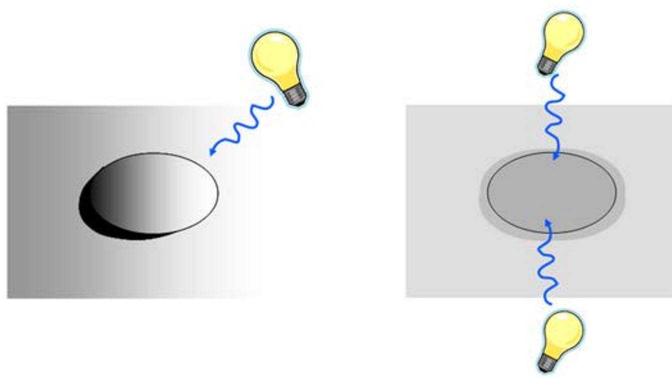

Fig. 394: Single light source versus multiple light sources

Depending on the object's shape it might be necessary to adapt the light characteristics (e.g. power, angle) for optimum results. In a comparable way, MultiTransmit adapts the RF transmit sources to each patient's unique anatomy to obtain uniform RF and a lower local RF deposition.

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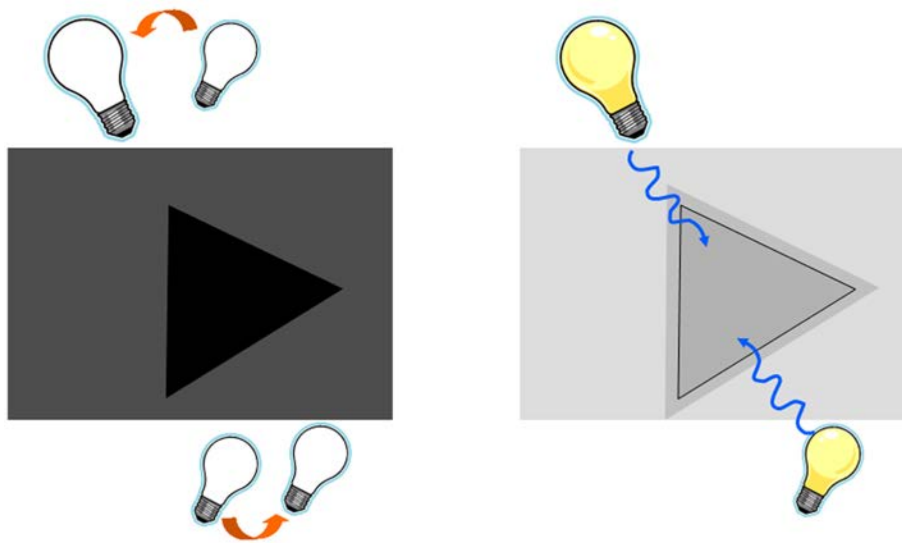

Fig. 395: Adapting the light characteristics depending on the object's shape.

With MultiTransmit, the power, amplitude, phase and waveform of all RF sources are automatically adjusted for optimal uniformity in each patient's unique anatomy. In such a way, it is possible that MultiTransmit provides better signal uniformity and better consistency.

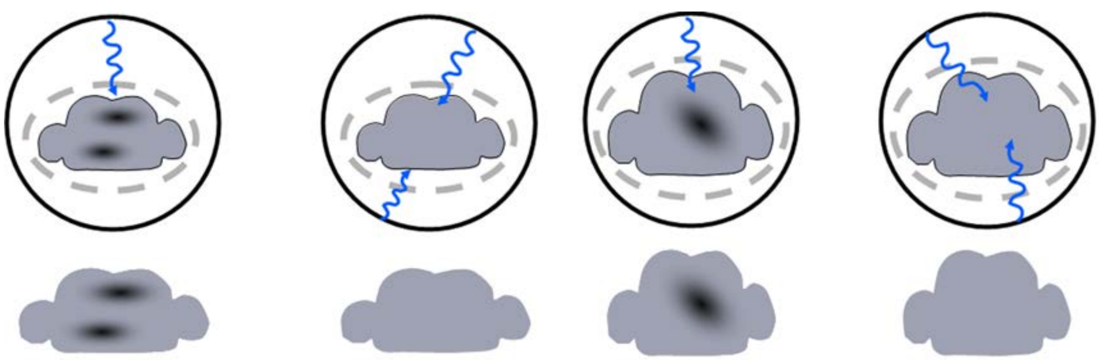

Fig. 396: Left: patient 1, single transmit versus MultiTransmit. Right: patient 2, single transmit versus MultiTransmit.

MultiTransmit ExamCards

MultiTransmit ExamCards make use of the **MultiTransmit** technology and **RF shimming**.

NOTICE

The MultiTransmit technology is by default enabled on MultiTransmit capable systems.

Use the parameter **RF Excitation Mode** in the ExamCard properties to deactivate MultiTransmit: select **Circular Polarized** to deactivate.

NOTICE

Performing a Multi-transmit scan with patient position decubitus (left or right) is not allowed.

For more information on all parameters, refer to the system's **Help Topics** which include the parameter help texts.

RF Shim

This parameter allows to shim the B1 magnetic field in different ways:

1. **Fixed**

   Automatically selects MultiTransmit settings that can be applied to a wide range of applications. This setting can be used to speed up examinations that don’t suffer from B1 inhomogeneity. A B1 calibration scan is not required.
2. **Adaptive**

   A volume shim box (fixed size: 350 mm RL, 300 mm AP) is automatically placed in the center of the FOV. A B1 calibration scan is automatically performed.
3. **Smart**

   In SmartExam breast examinations, you can also select ’Smart’. By means of segmentation, the breasts and the axillae are included in the shimming area whereas the lungs, the heart and silicones are excluded. A B1 calibration scan is automatically performed.
4. **Volume**

   – A volume shim box can be positioned around the area of interest in which RF shimming is applied.

   – A B1 calibration scan is automatically performed.

   – The size and position of the RF-shim volume will be identical to the size and position of the B0-shim volume.

NOTICE

The option 'Volume' is available with the dS Torso coil solution for cardiac triggered scans and InterActive scans.

In other types of scans, this option is not visible.

B1 Calibration scan

The B1 calibration scan is needed if ’RF shim' is set to Adaptive, Volume or Smart. It results in B1 maps which are automatically stored and not visible for the user.

Since the succeeding scans make use of the B1 map, the B1 calibration scan is the first scan to be run after the survey.

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The B1 calibration scans are inserted and performed automatically. They are of forced transverse orientation with a fixed FOV. This fixed FOV depends on the application and is of the order of 530 mm in RL direction and 450 mm in AP direction.

If you want to repeat the automatically performed B1 calibration scan, select **Repeat Prescans** from the Examination menu.

NOTICE

For cardiac imaging, it is crucial that the B1 calibration scan is planned and acquired through the middle of the left ventricle.

Reference scan

If a Reference scan is required for a clinical scan that uses RF shim (adaptive, Volume or Smart), it will be inserted into the ExamCard automatically. In this case, the reference scan makes use of RF shim adaptive.

MultiTransmit Workflow

The section describes a workflow with **MultiTransmit** and **RF Shim** set to Adaptive, Volume or Smart in the anatomical scans.

Positioning and survey

(applicable for all applications)

- ► Position the patient with a MultiTransmit-capable coil on the patient support.
- ► Perform a standard survey, in case of body scans in expiration.
- ► If navigators are to be used in abdomen and pelvis imaging, plan a dedicated survey to aid in positioning.

Planning for brain

- For normal brain imaging, position the B1 map at the level of the corpus callosum.
- For IAC or orbit examinations, position the B1 map at these specific areas.

Planning for abdomen, pelvis and breast

- ► Plan the clinical scans.

  You do not have to plan the B1 calibration scan, since it is inserted and performed automatically. The reference scan is automatically inserted into the ExamCard.
- ► Press **Start Scan** to resume the ExamCard.

If you want to repeat the automatically performed B1 calibration scan, select **Repeat Prescans** from the Examination menu.

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Planning for spine

- Plan the clinical scans.

  The B1 calibration scan is inserted and performed automatically.
- Press **Start Scan** to resume the ExamCard.

Planning for cardiac

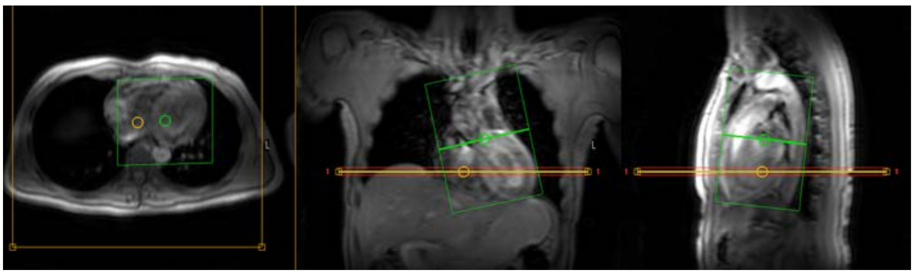

Fig. 397: Planning for cardiac imaging.

O-MAR (Orthopedic Metal Artifact Reduction) and O-MAR XD

Property	Description
Pulse Sequence	• Acquisition and reconstruction technique that helps reduce susceptibility artifacts caused by the presence of metal in both in-plane and through-plane dimensions compared to conventional MR imaging techniques. • Turbo Spin Echo method in combination with VAT (View Angle Tilting). • Only for O-MAR XD: Slice-selective TSE acquisition with multiple encodings per excited slice (also known as SEMAC) to recover off-resonant signal caused by magnetic field inhomogeneities, and to reduce through-plane distortions.
Properties	• O-MAR and O-MAR XD improve visualization of tissue in the vicinity of passive MR Conditional and MR Safe orthopedic implants. • O-MAR and O-MAR XD reduce image distortions due to magnetic field inhomogeneities, caused by the presence of metal. – O-MAR (without SEMAC) reduces in-plane distortions. – O-MAR XD (with SEMAC) reduces in-plane and through-plane distortions.

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Property	Description
Limitations	• With larger VAT view angles (which correspond to small readout bandwidths), edges along the slice selection direction might appear more blurry. • The amount of artifact reduction is limited by the chosen SEMAC distortion correction factor which in turn affects scan time. • O-MAR XD (with SEMAC) is not compatible with Compressed SENSE. • O-MAR and O-MAR XD are both not compatible with Uniformity correction. • Only O-MAR (and not O-MAR XD) can be combined with mDIXON TSE.
Applications	• Anywhere where the presence of metal affects image quality, especially MSK. Always use ScanWise Implant in combination with O-MAR or O-MAR XD for safe scanning of patients with implants.
Contrast is determined by	Contrast parameters of the imaging sequence being combined with O-MAR.
Scan modes	• 2D, M2D, MS

How does O-MAR work?

O-MAR is based on the Turbo Spin Echo method in combination with VAT (View Angle Tilting) to reduce in-plane distortions due to magnetic field inhomogeneities, caused by the presence of metal. To further reduce in-plane and through-plane distortions a slice selective TSE acquisition with multiple encodings per excited slice (aka SEMAC) is used to recover off-resonant signal caused by magnetic field inhomogeneities.

Since metallic orthopedic implants are increasingly common in patients, the need to apply MRI techniques in the vicinity of embedded metallic hardware is growing. However, MRI images acquired in the close proximity to metal suffer from artifacts. O-MAR addresses this problem by offering advanced encoding algorithms that help reduce susceptibility artifacts.

O-MAR produces images which represent a combination of signals acquired at different off-resonant frequencies, with the purpose to reduce the susceptibility related distortions in patients with MR Safe and MR Conditional metal implants.

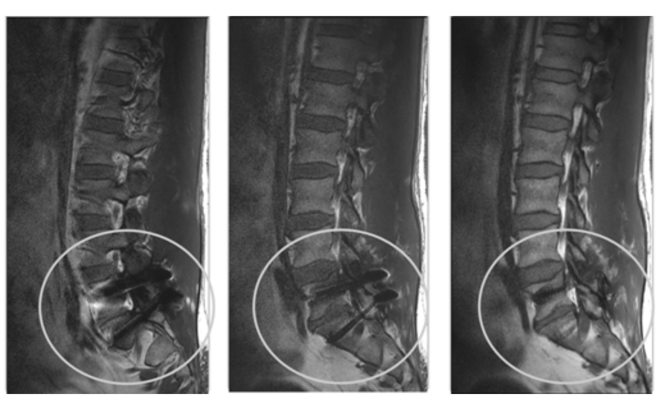

Fig. 398: Comparison of left: Standard Spin Echo, middle: VAT Spin Echo, right: Through-Plan Corrected image.

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Fig. 399: Comparison left: Standard-TSE, right: SEMAC.

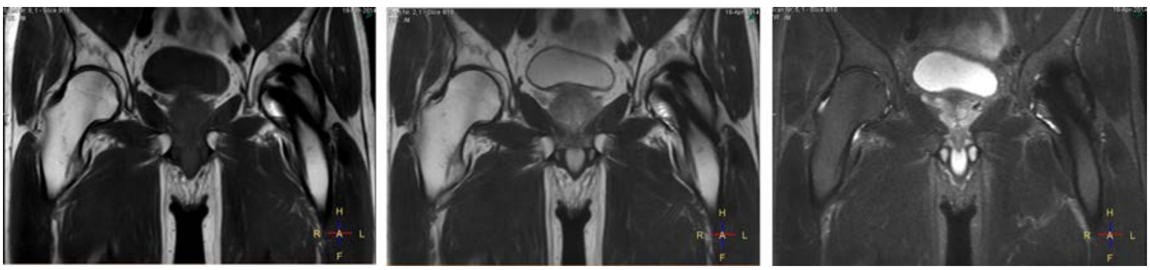

Fig. 400: O-MAR supports all clinically relevant contrasts such as T1W, T2W, STIR (from left to right), but also PDW.

Compatibility for MR Safe and MR Conditional implants only

For information about safety related to MR Safe and MR Conditional implants, refer to chapter “Safety” on page 27.

NOTICE

MR Safe and/or Conditional Implants

Prior to examining patients with MR Safe and/or MR Conditional metal implants, always check the implant's MR compatibility as given by the implant's manufacturer. In case of doubt, contact the implant's manufacturer.

O-MAR Methods

O-MAR can be done in different ways. They are described below:

TSE-based SENSE reference scan

In O-MAR scans, the SENSE reference scan is TSE-based in order to increase the robustness of the SENSE unfolding algorithm in the presence of susceptibility artifacts.

MARS

A slice selective TSE scan with high readout bandwidth and high resolution is used.

SEMAC

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Acquisition relies on the SEMAC (Slice Encoding for Metal Artifact Correction) technique which uses a slice selective TSE acquisition. Multiple z-encodings per excited slice are used to recover off-resonant signal caused by magnetic field inhomogeneities. The output image for each slice represents a combination of the signal acquired at different off-resonant frequencies.

VAT

VAT (View Angle Tilting) technique is used to reduce in-plane distortions due to magnetic field inhomogeneities. For this, the gradient applied during slice selection is reapplied during the signal readout.

SEMAC in more detail

SEMAC is a multi-spectral sequence which acquires additional off-resonant data in order to recover signal and to reduce signal-voids and through-plane distortions. The number of additional z-encodings, the SEMAC factor, used for that purpose is defined by the chosen distortion correction and is indicated on the Info page. In reconstruction, the off-resonant signal of each slice is combined into one final image per slice.

Effects of choosing SEMAC

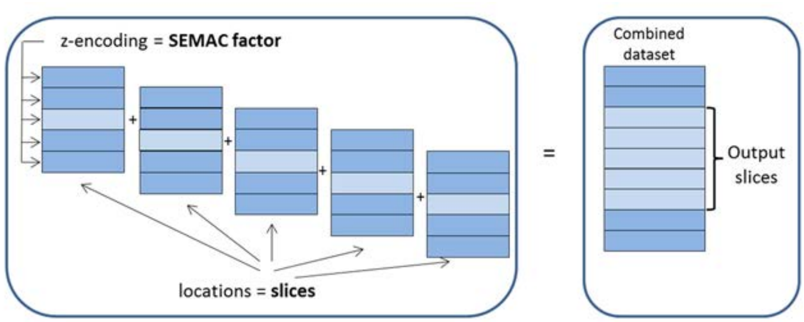
- The scan time is increased as a result of the additional z-encodings.
- A minimum number of 2 packages is required.
- The signal is increased as a result of the combination of multiple images into one.
- RF shimming is not allowed in combination with SEMAC.

Effects on the number of slices

- The minimum number of slices is equal to the SEMAC factor.
- If the number of slices is equal to the SEMAC factor, only the central slice of the image stack will be corrected optimally.
- If the number of slices is larger than the SEMAC factor, more slices around the center of the image stack will be corrected optimally.

Multistack imaging

For multistack imaging, all stacks need to contain the same number of slices.

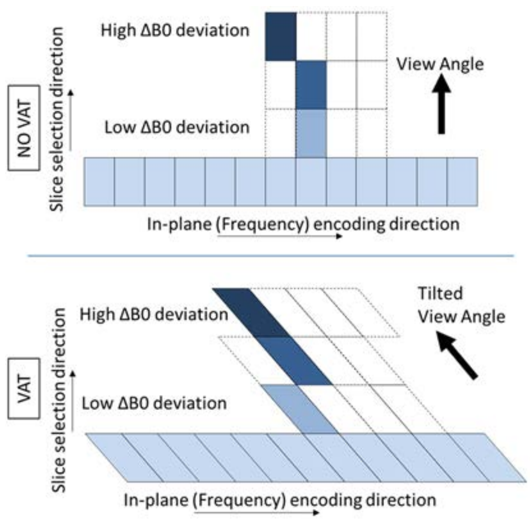


More about VAT

The VAT functionality consists of reapplying the selection gradient during the signal readout and thereby tilting the viewing angle. The view angle is proportional to the ratio of the selection and readout gradient.

Effects of choosing VAT

- With larger view angles which correspond to small readout bandwidths, edges along the slice selection direction might appear more blurry.
- No change in scan time.
- No change in SNR.



O-MAR Imaging Parameters

To enable O-MAR

O-MAR can be enabled or disabled by means of the imaging parameter **O-MAR** on the *Geometry* tab.

This parameter can be set to:

Possible values	Effect
No	O-MAR is disabled.
MARS+VAT	O-MAR is enabled making use of MARS and VAT techniques.
SEMAC+VAT	O-MAR is enabled making use of SEMAC and VAT techniques.

When O-MAR by means of SEMAC+VAT is enabled, another parameter pops up:

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Parameter	Possible values	Effect
Distortion correction	weak, medium, strong	Parameter controls the level of distortion correction for SEMAC+VAT. Changing this parameter could affect the scan time, since it controls the number of z-encodings per slice.

More info

- How to enable O-MAR?
- Distortion correction.

Spiral Brain

Spiral Brain is a spiral acquisition technique to provide fast and robust T1 weighted SE imaging and Time of Flight imaging in the brain.

Property	Description
Pulse Sequence	Spiral acquisition technique.
Properties	• Can be used in Spin Echo, FFE and TFE. • Compared to cartesian acquisition techniques: – Allows considerable scan time reduction. – Reduction of flow artifacts in T1 SE post-contrast images. – Better visibility of peripheral vessels in 3D inflow angiography (time of flight).
Limitations	• Allows to adjust the window in which spiral interleaves (comparable to shots) are acquired. – The larger the window, the more k-space points and less spiral interleaves are acquired. – With a shorter spiral acquisition window, the bandwidth increases and blurring decreases. – A long acquisition window can have some negative effects on the image quality, e.g. blurring and susceptibility artiacts might increase. • The spiral fold-over artifact might occur when the FOV is planned too small and fold-over suppression is not applied.
Applications	• Brain: robust T1 weighted SE imaging and Time of Flight imaging.
Contrast is determined by	Contrast parameters of the imaging sequence being combined with Spiral Brain.
Scan modes	• 2D, 3D, M2D, MS

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More information

- In Instructions for Use: **Spiral Fold-Over Artifact** chapter “Spiral Fold-Over Artifact” on page 917
- Imaging parameter **Acquisition Mode** in Online Help system (**F1**)
- Imaging parameter **Spiral Acquisition Window** in Online Help system (**F1**)
- Imaging parameter **Spiral Deblurring** in Online Help system (**F1**)

bFFE XD

bFFE XD is a technique to reduce banding artifacts in balanced FFE sequences for inner-ear imaging.

More information

- Imaging parameter **Banding Reduction** in Online Help system (**F1**)
- Imaging parameter **Contrast Enhancement (=Balanced)** in Online Help system (**F1**)
- Scan method **balanced FFE** in Online Help system (**F1**)

3D non-selective FFE and TFE

Allows you to enable the use of a non-selective block pulse (without the use of a slice selection gradient). Compared to the standard situation, which has selective pulses, this means:

- Shorter repetition times, or a better SNR with the same TR.
- Shorter echo times.
- Better volume definition and less signal drop in the outer slices.

Application

- Neuro imaging
- Cardiovascular imaging

More information

- Imaging parameter **3D non-selective** in Online Help system (**F1**)

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26 Printing

Printing can be performed as

- **Print Image**
  The purpose of this function is to compose a printout with multiple images of different series with a customizable layout.
- **Print Series**
  The purpose of this function is to compose a printout with multiple images of one or more series (maximum of 6 series) with layouts that have previously been predefined and set up.

The function **Print History** from the **System** menu allows to manage the printing jobs in the same way as the function **Manage Job Queue** manage all other types of jobs. Furthermore **Print History** enables you to easily redo a printing job by clicking 'Retry Jobs'.

User Interface

Printing in Overall Toolbars and Menus

Printing functions are available in toolbars and right mouse menus:

1. in the right mouse menu of the Thumbnail View;
2. in the Printing drop-down menu of the ImageView toolbar;
3. in the right mouse menu of ImageView.

Icon	Function	Shortcut	Description	Available in
	**Add Series To Print Setup**	Ctrl+Shift +S	To add series to the Print Setup. This function opens the window **Print Setup (S)** where (S) stands for series, if this window is not in use.	• right mouse menu of the Thumbnail View • **Printing** drop-down menu of **ImageView** toolbar
	**Add Image To Print Setup**	Ctrl+Shift +I	To add images to the Print Setup. This function opens the window **Print Setup (I)** where (I) stands for image, if this window is not in use.	• **Printing** drop-down menu of **ImageView** toolbar • right mouse menu of **ImageView**

Tab. 53: Available Print functions

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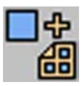
Print Setup

Print Setup allows

- setting up the printout with respect to output device, format and layout;
- adding ROIs, annotations and lines to the printout;
- creating and editing print presets.

Print Setup is available for **Print Image** and for **Print Series**.
It opens automatically in a dedicated window when images or series are added to it:

-  **Add Series To Print Setup** opens the **Print Setup(S)** window where S stands for series.
  When **Multiple Series (A|B or A|B|C)** is enabled, this is indicated in the toolbar tab as **Print Setup(MS)**.
-  **Add Image To Print Setup** opens the **Print Setup(I)** window where I stands for image.

Print Setup Toolbars

The toolbars for **Print Setup(S)** and **Print Setup(MS)** are the same whereas the toolbar for **Print Setup(I)** is slightly different.

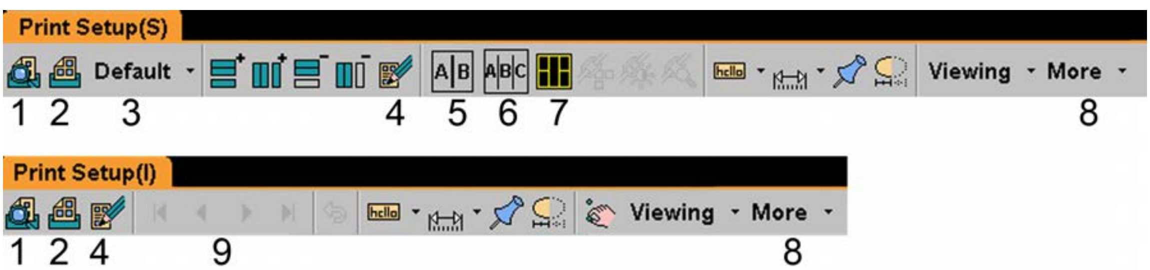


Fig. 401: Toolbars Print Setup(S) and Print Setup(I). Functions which are also available in ImageView or Review or Analysis packages are neither numbered in this figure nor described in the section below.

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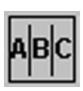
Number	Icon	Function(and Shortcut)	Description
1		**Print Preview (Ctrl +Shift+Q)**	To display the **Print Preview**. • This function can be used to verify the correct setup of the printout prior to printing. • The function **Print Settings** which is available in the **Print Setup(S)** and **Print Setup(I)** windows determines the printout and the **Print Preview**. • Example of preview and output on paper, see figure 407 on page 838.
2		**Print (Ctrl +Shift+P)**	To print the printout according to the settings as defined by means of **Print Setup** and **Print Settings**.
3	**Default** drop-down menu	Select Preset (initially 'Default')	To select any of the available presets so that the print setup is ready for printing with the selected preset values or settings.
4		**Print Settings**	To adjust print settings such as layout, annotation and format.
5		**Multiple Series 2**	To enable Multiple Series printout for 2 series and to allow for this series to be loaded for printing. When Multiple Series printout is enabled, the toolbar of the Print Setup is displayed as **Print Setup(MS)**.
6		**Multiple Series 3**	To enable Multiple Series printout for 3 to 6 series and to allow for these series to be loaded for printing. When Multiple Series printout is enabled, the toolbar of the Print Setup is displayed as **Print Setup(MS)**.
7		**Load Protocol**	To load a printout protocol for Multiple Series that has previously been saved.
8	**More** drop-down menu	**More** functions	**More** provides the functions: **Save Layout** *Only available for Print Image:* **Enable Move Image Mode** When enabled, images can be moved to other locations in the **Print Setup(I)**. *Only available for Print Image:* **Delete the current Page** To delete all images from the current page to be able to newly set up the printout. This function needs to be used in order to remove empty pages. **Delete All Graphics**

Number	Icon	Func-tion(and Shortcut)	Description
9		**Scroll**	To scroll through pages in **Print Setup(I)**.
Others	Please refer to chapter “Toolbar” on page 518 for information about the other icons available on the **Print Setup** toolbars.		

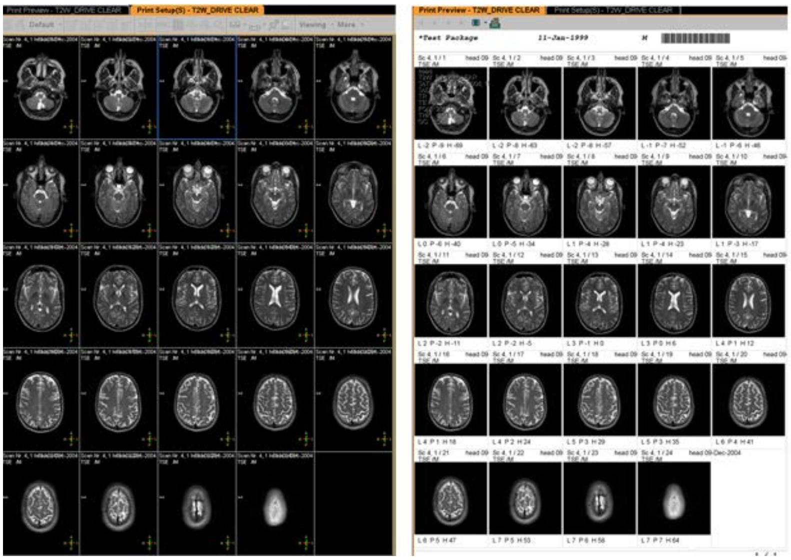


Fig. 402: Print Preview. Left: Output on film. Right: Output on paper.

Print Setup Right Mouse Menus

Print Setup right mouse menus are slightly different for **Print Image** and **Print Series**. They provide many of the functions which are also available via the **Print Setup** toolbar or which are used throughout all postprocessing packages. These are the functions available:

Available in Print Setup ...			
(I)	(S)	Function	Description
Yes	Only for **Print Setup(MS)**	**Split Vertical**	To split a cell in Print Series(I) to allow for an even more flexible layout.
Yes	Only for **Print Setup(MS)**	**Split Horizontal**	To split a page in Print Sereis(MS) to allow for more series to be put on the Print medium.
No	Yes	**Propagation Scope**	To adjust how view/window settings are propagated to the other images.
Yes	Yes	**Remove Image**	To remove the current image from the printout.
Yes	Yes	**Remove Page**	To remove the current page from the printout.

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Available in Print Setup ...			
(I)	(S)	Function	Description
Yes	Yes	**Reset Window**	To reset the window settings to the initial ones.
Yes	Yes	**Reset Zoom/Pan**	To reset the viewing settings to the initial ones.

Print Settings

The **Print Settings** are part of Print Setup, and as such accessible via the **Print Setup(I)** and **Print Setup(S)** toolbars.

For **Print Image** and for **Print Series**, **Print Settings** allows

- to adjust the layout of the printout.
- to enable or disable the display of various forms of annotation on the printout.
- to select printer, film size, number of copies and number of pages.

For **Print Series**, additional functionality is available which allows:

- to create, edit or delete protocols for the Print procedure.
- to enable, disable or edit the display of planscan images on the printout.
- to specify image range and way of sorting on the printout.

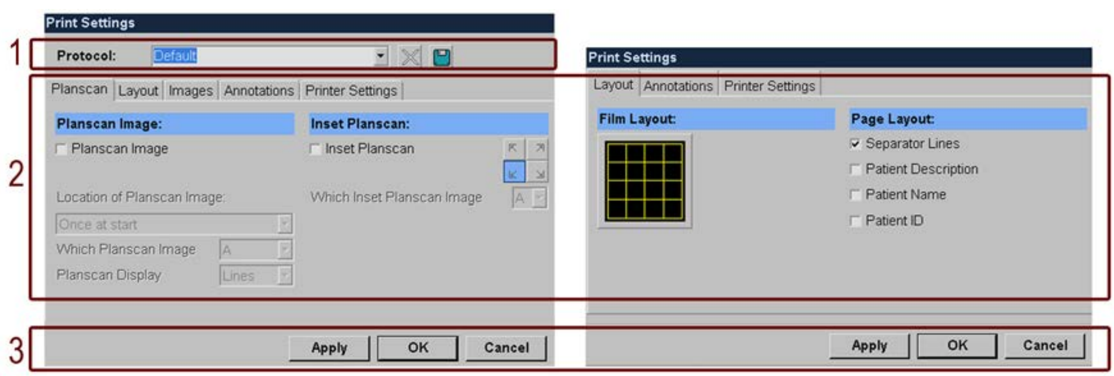
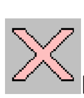


Fig. 403: Print Settings windows. Left: for Print Series. Right: for Print Image. 1 - Print Protocol Area, 2 - Parameter Area where parameters can be accessed via the tabs, 3 - Control Area.

Print Protocol Area

The Print Protocol Area is only available for Print Series. The following controls are available here:

- Drop-down for the Print protocols:

  either select an existing print protocol or enter a name for a new protocol.
- Delete icon to delete the currently selected Print protocol.

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- Save icon to save the current settings as a Print protocol.

NOTICE

Print protocols can be set up for up to six series within one printing job.

Parameter Area with Tabs

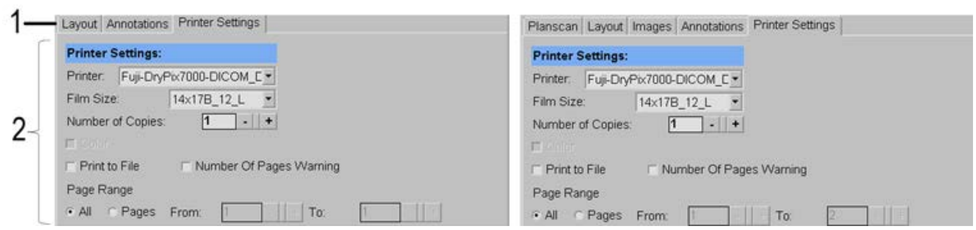

Fig. 404: Parameter Area with: 1 - tabs, 2 - Different parameters for editing depending on the tab selection.

NOTICE

In Print Series, more tabs are available than in Print Image.

This is caused by the fact that Print Series offers more functionality with respect to the creation of Print protocols.

Layout Tab

The Layout tab is available for Print Series and Print Image, however with slight differences.

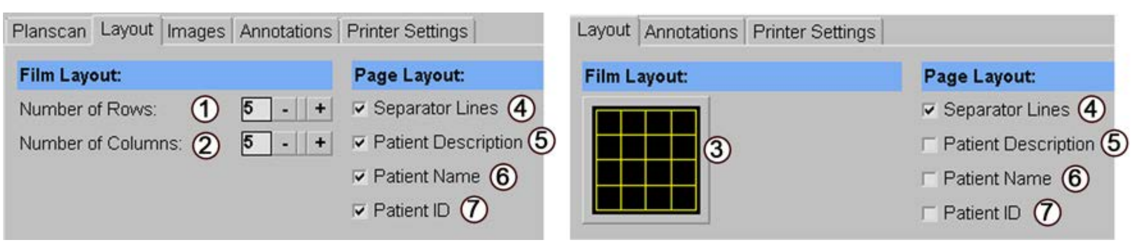

Fig. 405: Layout tab: Print Series (left) versus Print Image (right). See table for more information.

Number	Function	Possible Values	Description
1	**Number of Rows**	• up to 8 rows	This parameter specifies the number of rows on the printout(s).
2	**Number of Columns**	• up to 8 columns	This parameter specifies the number of columns on the printout(s).
3	**Film Layout**	• All film layouts ever created and saved	Any layout can be selected for Print Image.

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Number	Function	Possible Values	Description
4	**Separator Lines**	• Checked • Unchecked	The display of separator lines can be enabled/disabled.
5	**Patient Description**	• Checked • Unchecked	The display of the patient description can be enabled/disabled.
6	**Patient Name**	• Checked • Unchecked	The display of the patient name can be enabled/disabled.
7	**Patient ID**	• Checked • Unchecked	The display of the patient ID can be enabled/disabled.

Tab. 54: Layout tab

Annotations Tab

The Annotations tab is available for Print Series and Print Image, however with slight differences.

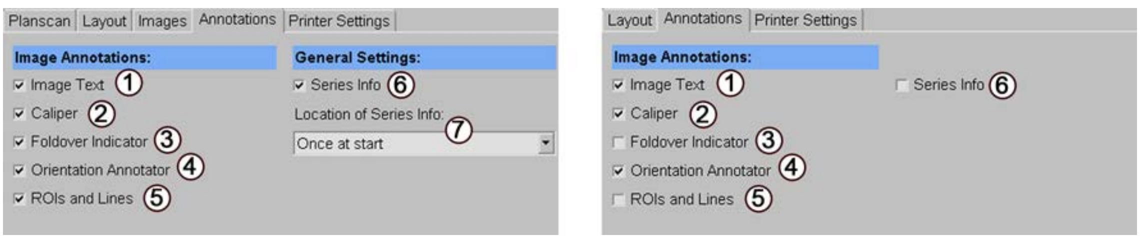

Fig. 406: Annotations tab: Print Series (left) versus Print Image (right). See table for more information.

Number	Function	Possible Values	Description
1	**Image Text**	• Checked • Unchecked	The display of Image Text can be enabled/disabled.
2	**Caliper**	• Checked • Unchecked	The display of the Caliper can be enabled/disabled.
3	**Fold-over Indicator**	• Checked • Unchecked	The display of the Fold-over Indicator can be enabled/disabled.
4	**Orientation Annotator**	• Checked • Unchecked	The display of the Orientation Annotator can be enabled/disabled.
5	**ROIs and lines**	• Checked • Unchecked	The display of ROIs and lines can be enabled/disabled.

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Number	Function	Possible Values	Description
6	**Series Info**	• Checked • Unchecked	The display of Series Info can be enabled/ disabled.
7	**Location of Series Info**	• Once at start • Every page	If enabled, the location of the Series info can be selected.

Tab. 55: Annotations tab

Printer Settings Tab

The Printer Settings tab is available for Print Series and Print Image, however with slight differences.

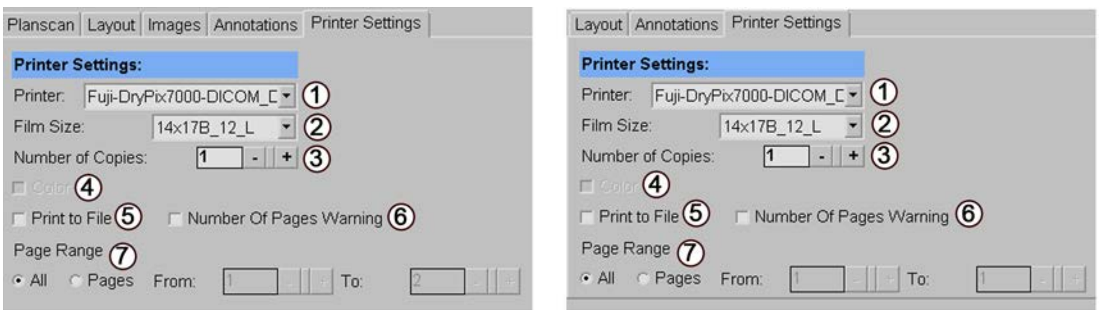

Fig. 407: Printer Settings tab: Print Series (left) versus Print Image (right). See table for more information.

Number	Function	Possible Values	Description
1	**Printer**	• Any printer available	Any configured printer can be used as output device and selected in this drop-down meny.
2	**Film Size**	• Any film size available	Any film size for the printout can be selected in this drop-down menu.
3	**Number of Copies**	• 1 to 100	The Number of Copies can be increased or decreased by clicking the +/- buttons.
4	**Color**	• Checked • Unchecked	Depending on the printer connected, a color printout can be enabled/disabled.
5	**Print to File**	• Checked • Unchecked	Print to File can be enabled/disabled. Note that this function can only be selected when a printer is configured (even though it doesn't require a printer).
6	**Number of Pages Warning**	• Checked • Unchecked	This parameter enables/disables if a message will be displayed indicating the total number of pages.
7	**Page Range**	• All • User Defined: From ... To ...	This parameter specifies which pages of the Print Setup will be printed.

Tab. 56: Printer Settings tab

Planscan Tab

The Planscan tab is available for Print Series only.

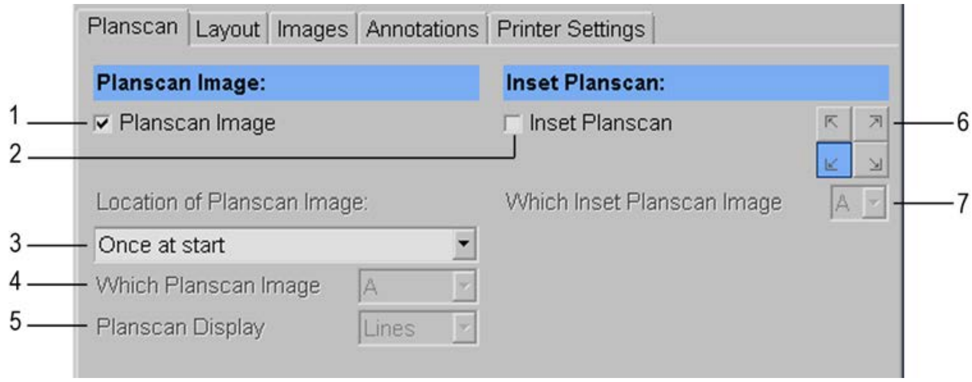

Fig. 408: Planscan tab: available for Print Series only.

Number	Function	Possible Values	Description
1	**Planscan Image**	• Checked • Unchecked	The display of the Planscan Image can be enabled/disabled.
2	**Inset Planscan**	• Checked • Unchecked	The display of the Inset Planscan can be enabled/disabled.
3	**Location of Planscan Image**	• Once at start • Once at end • Repeated at the start of each film • Repeated at the end of each film	This parameter specifies the location of the Planscan Image on the film(s).
4	**Which Planscan Image**	• A • B • C • All	This parameter specifies which Planscan Image will be used.
5	**Planscan Display**	• Lines • Box	This parameter specifies how the Planscan will be displayed.
6	**Inset Planscan**	 upper or lower left or right corner	This parameter (icons only) specifies the location of the Inset Planscan.
7	**Which Inset Planscan image**	• A • B • C	This parameter specifies which Inset Planscan image will be used.

Tab. 57: Planscan tab

Images Tab

The Images tab is available for Print Series only.

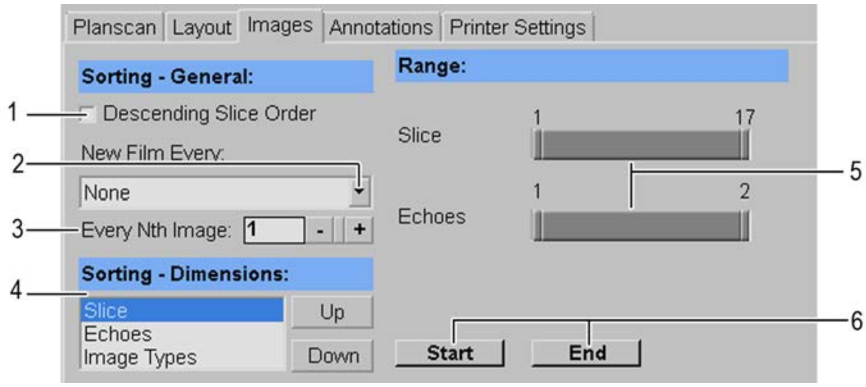

Fig. 409: Images tab: available in Print Series only. The number of slider bars displayed as "Range" depend on the types of images in the series.

Number	Function	Possible Values	Description
1	**Descending Slice Order**	• Checked • Unchecked	If enabled, descending slice order will be used for printing. If disabled, ascending slice order will be used.
2	**New Film Every**	• None • to be defined	This parameter specifies when a new film will be started.
3	**Every Nth Image**	• Any number	Click +/- to increase/decrease n.
4	**Sorting Dimensions**	• Order of attributes, such as: slice, dynamics, image types. • Attributes can be moved up or down by means of the eponymous buttons.	The parameter affects the order of images on the printing output.
5	**Range** (here Slice/ Echoes)	• There is a slider per attribute, e.g. a slider for slices, another one for echoes. The attributes depend on the type of the scan. Other options besides slices and echoes are e.g. image types, dynamics.	Drag the slider to define start and end slice or echo.
6	**Range Start/End**	• Pressed • Not pressed	• To select the first image, click on this image and then click 'Start'. • To select the last image, click on this image and then click 'End'.

Tab. 58: Images tab

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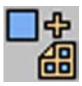
Control Area

For an image of the Control area, figure 408.

- ► Click |Apply| to apply the changes.
- ► Click |OK| to save the changes without applying.
- ► Clicking |Cancel| closes the window without applying the changes made.

Workflows

Create Predefined Layout for Print Image

►  Right-click on an image in **ImageView** and select **Add Image To Print Setup**.

The window **Print Setup(I)** opens with its default layout.

► First change the layout:

- To resize a cell, drag the lines up- or downwards or to the left or right.
- To create multiple cells out of one, right-click on this cell and select 'Split Horizontal' or 'Split Vertical'.

You can undo ONE action when dragging images or resizing cells.

► Click **Print Settings** in order to create/edit a predefined layout for Print Image.

- Click the **Layout** tab and edit according to your preferences.
- Click the **Annotations** tab and edit according to your preferences.
- Click the **Printer Settings** tab and edit according to your preferences.

► Click |OK| to save these settings with the selected layout.

Available layouts are displayed as icon showing their rows/columns.

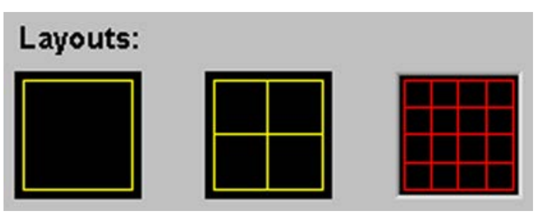
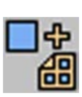


Fig. 410: Example of Print Image Layouts.

Create Protocol for Print Series



► Select '**Add Series To Print Setup**'

- in the right-mouse menu of the Thumbnail View,
- in the Printing drop-down menu of the ImageView toolbar.

The window '**Print Setup(S)**' opens with its default layout.

► First change the layout:

- Select another layout or add/remove columns and/or rows.
- To print multiple series, click one of the 'Multiple Series' buttons (A|B or A|B|C).

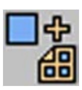
The **Print Setup(S)** wiil then be renamed to **Print Setup (MS)** and the printing area will be split in two or three parts, every part meant for one series.

► Click '**Print Settings**' in order to create/edit a protcol for Print Series.

- Click the 'Planscan' tab and edit according to your preferences.
- Click the 'Layout' tab and edit according to your preferences.
- Click the 'Images' tab and edit according to your preferences..
- Click the 'Annotations' tab and edit according to your preferences.
- Click the 'Printer Settings' tab and edit according to your preferences.

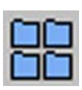
► Enter a name for the protocol, and click |Save| to save these settings as protocol.

Print Image



► Right-click on an image in **ImageView** and select **Add Image To Print Setup**.

The window **Print Setup(I)** opens with its default layout.



► Click **Tiled View** to display the windows **ImageView** and **Print Setup(I)** besides each other.

► In **ImageView**, select more images that have to be placed on the printout.

► Click **Add Image To Print Setup** for every image needed.

► Repeat the last two steps as often as required.

Optional: In order to *select multiple images*, hold |Ctrl| while clicking on the images. Then select **Add Image To Print Setup**.

► Images of the multiple selection are indicated by a blue selection icon.

Fig. 411: ImageView and Print Setup(I) windows besides each other. Multiple images are selected in ImageView indicated by the blue selection icon. The right-mouse menu is open showing the option 'Add Image To Print Setup'.

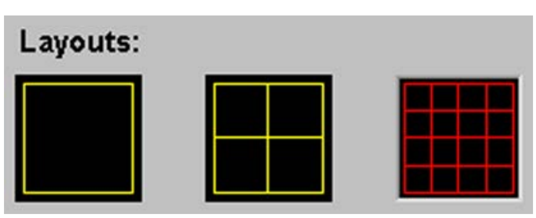
- Optional: right-click on any cell and select any of the available options to e.g. remove an image or reset view/window settings.
- Optional: to resize a cell, drag the lines up- or downwards or to the left or right.
- Optional: to create multiple cells out of one, right-click and select 'Split Horizontal' or 'Split Vertical'.
- Optional: select **Enable Image Move Mode** from the More drop-down menu (toolbar) and drag the images to other positions.

  You can undo ONE action when dragging images or resizing cells.

NOTICE

If there is an image in the target cell already, this image will be lost if another image is dragged to this location.

- In order to select a preset for **Print Image**, click **Print Settings**, and select one of the available layouts.



- To move images from one cell to another, in **Print Setup(I)** click and drag this image to the new location.

► Click **Print Preview** to verify everything is set up as needed.

► Click **Print** to initiate printing.

Print Series

► Right-click and select **Add Series To Print Setup**:

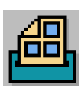
- in the right-mouse menu of the Thumbnail View,
- in the Printing drop-down menu of the ImageView toolbar.

The window **Print Setup(S)** opens with its default layout.

► Click the Print Preset drop-down menu and select a Print protocol.
For information on how to set up such a print protocol, refer to chapter “Create Protocol for Print Series” on page 845.

► Optional: right-click on any cell and select any of the available options to remove an image or reset view/window settings.

► Click **Print Preview** to verify everything is set up as needed.



► Click **Print** to initiate printing.

27 Administration (Patient Database)

The ‘Administration’ area provides the functions:

- Display of databases from storage devices connected to the computer system.
- Manipulation of these databases where patient folders or scans can be copied to other destinations or deleted.

Network

The network facility can be used to exchange images and data with other systems (RIS, PACS).

Start up Administration

- Select ‘Administration’ from the ’Patient’ main menu or press |F4|.

  This will open the main window of Administration.

Workflow ’Storage and transfer of patient data’

1. **Step 1:** Select the source database or device.
2. **Step 2:** Select the data (examinations/series/images).
3. **Step 3:** Select the destination database or device.
4. **Step 4:** Check the status of background processes with the **Job Queue**.

The figure shows where these steps can be performed in the Administration window.

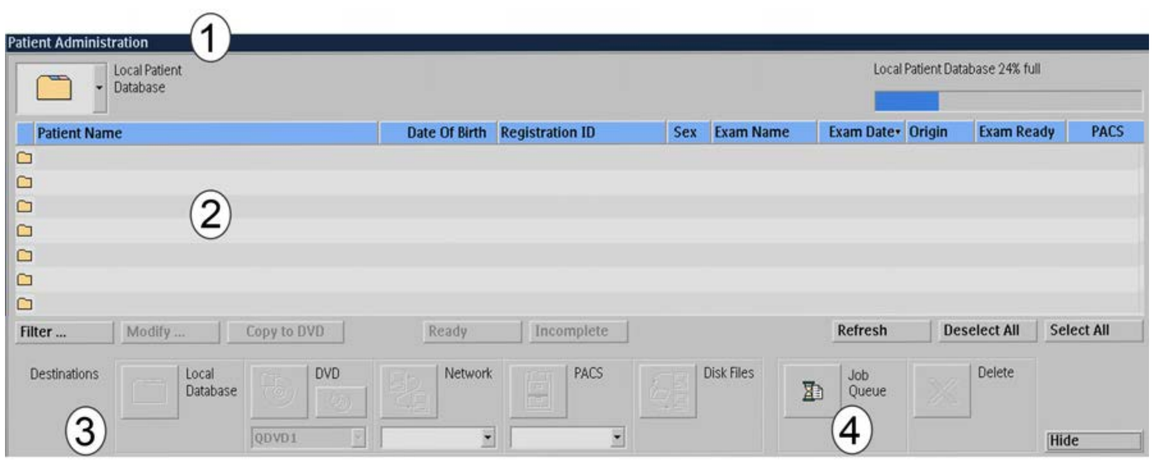


Fig. 412: Administration window. The numbers 1 to 4 indicate the workflow order as listed above.

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NOTICE

In case the transfer is interrupted due to network failure, it may be needed to logout or restart the computer.

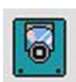
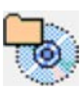
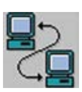
Afterwards the "failed" job in the queue must be reselected and submitted again.

Select the source database or device

The current source database or device is indicated in the source selector field. By default, the source device is defined as 'Local Patient Database'.

1. Click on the arrow in the source selector field.
2. Select the source database or device from the drop-down menu.

   The content of the selected database or device will be listed.

Icon	Description
	Local Patient Database (default setting)
	MOD
	DVD
	Queue DVD
	DICOM Network Node
	PACS (Archive)
	Disk files

Select data from source database

Select examinations

1. Click on an examination to select it.

   You can select multiple examinations:

- Hold |Ctrl| and select multiple single examinations, or
- Hold |Shift| and click on two examinations successively to select these two examinations AND the examinations which are between them in the list.

2. Continue
   - either with ’Select destination database or device’ chapter “Select destination database or device” on page 852
   - or with ’Select series’:

Select series

To display the series within an examination,

1. click on the folder icon of an examination or double-click on an examination.

   The list of series for the current examination is displayed.

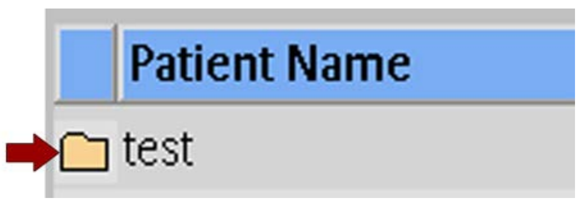


Fig. 413: Folder icon in list of examinations.

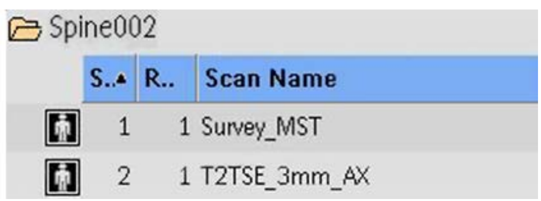


Fig. 414: List of series for the current examination.

NOTICE

About 1300 items can be listed.

If a list contains too many items, a message "List contains too many items to be displayed at once" is displayed. Use the ‘Filter ... ’ option to find other selections.

2. Click on a series to select it.
3. Continue
   - either with ’Select destination database or device’ chapter “Select destination database or device” on page 852
   - or with ’Select images (or an image range)’:

Select images (or an image range)

It is possible to select a subset of images.

NOTICE

This function cannot be used with PACS as destination.

1. Click the |Scan| button to open the ’Select image range’ window.

   The ’Select image range’ window opens.

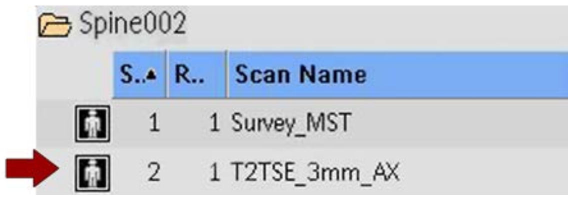


Fig. 415: Scan button.

2. Select the required image type (e.g. SE/M, FFE/M, FFE/P).
3. For the selected image type, define

	Range	Step (size)
Slice	e.g. 5-15	e.g. 1
Echo	e.g. 1	e.g. 1
Phase	e.g. 1	e.g. 1
Dynamic scan	e.g. 1	e.g. 1
Chemical shift	e.g. 0	e.g. 1
Gradient orien(tation)	e.g. 1	e.g. 1
Diffusion BVal(ues)	e.g. 1	e.g. 1

Functions within ’Select image range’ window:

Button / Function	Description
Reset	To deselect: all ranges are reset to their default ranges.
Invert	To invert selection: selected image types are deselected and vice versa.
Cancel	To exit this window without selection.
Delete	To delete all selected images.
Keep	To keep all selected image and delete the rest.
Select	To confirm selection and exit this window.

Select destination database or device

When the source data selection is complete, select the destination database or device.

1. Click on any of the applicable destination devices.

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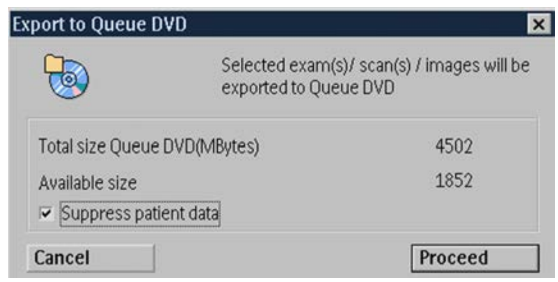
Grayed-out devices are currently not available, or are not allowed to be used, i.e. a PACS only accepts complete scans/series.

Fig. 416: Toolbar for the selection of destination devices.

Number	Function	More ...
1	Local Patient Database (default setting)	
2	Queue DVD	Export to Queue DVD. • Allows to suppress patient data.  **Fig. 417:** Export to Queue DVD window indicating the total size and the available size on the DVD. The checkbox allows to enable the suppression of patient data.
3	DICOM Network Node	
4	PACS (Archive)	
5	Disk files	Export to Disk Files, see more info below. • Allows to suppress patient data. • Allows to select Enhanced or Classic Dicom. Classic Dicom is recommended for multivendor applications. • Allows to export scans to a number of different research formats.
6	Queue Manager	
7	Delete	1. Click |Delete| to delete the selected source data. This command works on local database, local disk file or Queue DVD only. 2. If applicable, answer the questions in the pop-up dialogue boxes and click |Proceed|.

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NOTICE

You can only suppress patient data (and/or enter an alternative patient name) when you copy an examination or series to Queue DVD or disk files.

Patient data cannot be suppressed when you copy an examination or series to other locations or burn them to DVD.

Export to Disk Files

▹ Destination device is selected as 'Disk Files'.

► Click on one of the tabs to select the type of export:

- Dicom Export
- Non Dicom Export

Dicom Export

Output: Exported Dicom data can be imported at other MR consoles or any Dicom Viewers.

► Select the source data for export, e.g. a single or multiple examinations, a single or multiple imaging series.

► Browse to the destination device and folder.

► Select the output format by checking one of the options: Enhanced Dicom or Classic Dicom.

► Enable the suppression of patient data by checking this option.
If done so, you can enter an alternative patient name.

► Click 'Proceed' to export data.

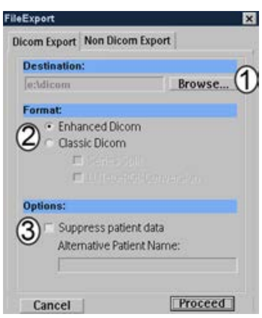

Fig. 418: FileExport 'Dicom Export' with 1 - Destination (folder) to browse to, 2 - Selection between Enhanced and Classic Dicom, 3 - functionality 'Suppress patient data'.

Non Dicom Export

Output: exported non-dicom data is provided in the different research formats.

- XML-REC:
  This format is generally used for Philips PRIDE and home-built packages based on IDL or MATLAB.
- NIfTI:
  This format is generally used for fMRI analysis packages like SPM, BrainVoyager and FSL.

- SPAR-SDAT:
  This format is generally used for spectroscopy packages like jMRUI and LCMODEL.

► Select the source data for export, e.g. a single or multiple imaging series.

► Browse to the destination device and folder.

► Enter an Export file name or check 'Use Scan Name' to use the name of the scan as file name.

► Select the export type by checking.
  Note that by default all possible export types are selected for export.

► Click 'Proceed' to export data.

Fig. 419: FileExport 'Non Dicom Export' with 1 - Destination (folder) to browse to, 2 - Specification of Export File Name, 3 - Check boxes for the selection of the Export Type.

Export of image and video data

WARNING

To limit the output size, Export2Office uses storage formats with lossy compression.

This compression can result in loss of detail.

DICOM Export: Series Split functionality

Imaging series with multiple dimensions (such as echoes, dynamics, or b-values) can be split into multiple series during DICOM export. This allows for an image sorting order based on the series number and is especially useful for those PACS/Workstations that cannot sort on these dimensions.

Each new series can easily be identified since its series number is derived from the series number of the original dataset.

Splitting is done in case of

- MultiEcho scans (resulting in a series per echo)
- Dynamic scans (resulting in a series per dynamic)
- Diffusion scans (resulting in a series per b-value)
- conventional DICOM MR images

- SC (Secondary Capture) images, e.g. screen grabs
- Private images (imaging protocols, ExamCards)

With the Series Split functionality, the presentation states will not be exported.

During import on the MR console, the new split series will be merged into one series again.

NOTICE

For automatic Series Split functionality you need a special configured network node.

The network nodes can be configured according to your needs together with your Customer Support Organization.

Check status of background processes with the Job Queue

The status of background processes (including image transfer) can be viewed using the tool ’Job Queue’.

To open the Job Queue

1. Select ’Manage Job Queue’ from the ’System’ menu or from the ’Administration’ window.

   A list of jobs with the job name, patient name, status, priority and submit time is displayed in the Job Queue window.

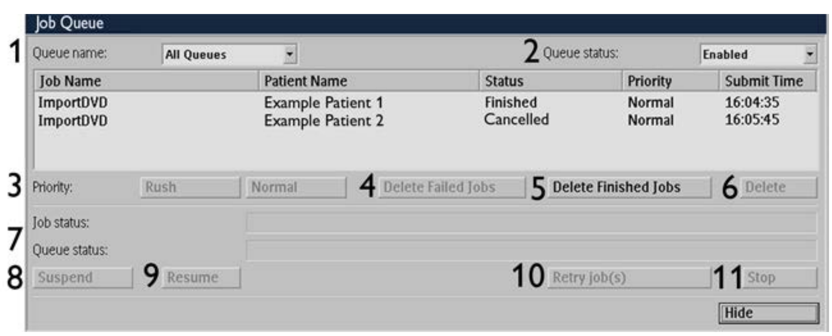

Fig. 420: Job Queue window.

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Number	Drop-down or button	Possible values	Description
1	Queue name	• All queues (default) • Image transfer • MIP, • MPR, • Postprocessing • RIS	• to select which queues are displayed in the Job Queue window
2	Queue status	• Disabled • Enabled	• to dis/enable background jobs; - to disable/enable one of the queues
3	Priority	• Normal • Rush	• to set the priority: higher priority with |Rush|
4	Delete failed jobs	-	• to delete failed jobs from the queue
5	Delete finished jobs	-	• to delete finished jobs from the queue
6	Delete	-	• to delete the current job from the queue
7	Job status / Queue status	-	• displays the information concerning the current job
8	Suspend	-	• to stop the current job, but keep it in the queue
9	Resume	-	• to resume the selected (suspended) job
10	Retry (jobs)		• to retry a previously failed job
11	Stop	-	• to stop the current job
	Hide	-	• to hide the Job Queue window

More functions within Administration

Modify display of the list of examinations

For each storage device it can be specified which data columns are displayed or hidden in the Administration window:

Data columns to be hidden or displayed are:

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- Date of birth
- Exam date
- Exam name
- Patient name
- Registration ID
- Sex

1. Right-click in the (blue) header of the patient list to display the Show/Hide columns dialog window.
2. Select the data to be hidden in the 'Show' list and click |Hide|.
3. Select the data to be displayed in the `Hide' list and click |Show|.
4. Click |Proceed|.

Refresh

- Click |Refresh| to update the display of the examinations window.
  - This does not change the selection state. Opened exams will stay open.

Deselect All and Select All

- Click |Select All| to select the entire list.
- Click |Deselect All| to deselect all files.

Manipulate a selected patient list

- Click |Filter ...| to display the ’Filter ...’ menu.

  It allows selective display of parts of the patient list according to the selection criteria. The following find criteria can be entered:

Find criterion	To be entered as
Patient name	String including wild cards *.
Registration ID	String including wild cards *.
Date of birth	Date in the current date format.
Exam name	String including wild cards *.
Exam date	Date in the current date format. Specified as interval from ... to ...
Exam status	’Ready’ or ’Not Ready’: to find patients which are (not) ready according to the RIS.

Functions to be used within this menu:

Button / Function	Description
Clear	To clear all search fields.
Cancel	To exit this window without taking filter settings into account.
Display all	To display the contents of the storagedevice and exit this window.

Button / Function	Description
Apply filter	To apply the filter settings without exiting this window.
Proceed	To apply the filter settings and exit this window.

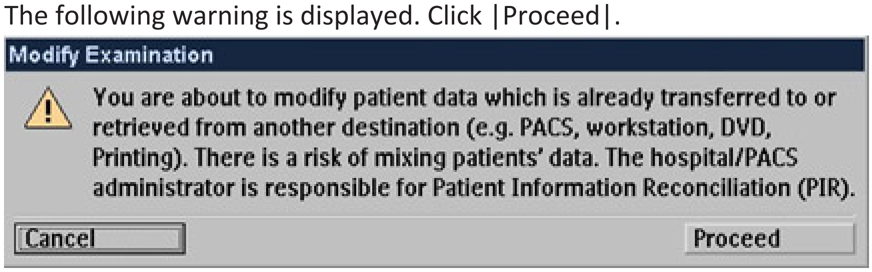
Sorting order

- Click one of the following buttons in the Main Menu bar to present the contents in a different order:
  - |Patient name|
  - |Date of birth|
  - |Registration ID|
  - |Exam Name|
  - |Exam Date|
  - |Sex|
  - |Origin|
  - |Exam ready|.

Modify examination data

Patientexamination data of local and retrieved examinations can be modified.

1. Select the examination whose examination data have to be modified.
2. Click |Modify|.
3. Enable |Presentation mode|.
4. The following warning is displayed. Click |Proceed|.



   Modify Examination warning:
   You are about to modify patient data which is already transferred to or retrieved from another destination (e.g. PAC, workstation, DVD, Printing). There is a risk of mixing patients' data. The hospital/PACS administrator is responsible for Patient Information Reconciliation (PIR).

5. Modify the examination data, e.g. delete existing data, enter new data.
6. Click |Proceed| to confirm.

   An asterisk in front of the patient name indicates a modified examination.

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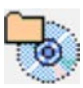
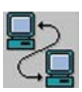
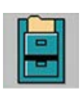
More about storage devices

The following storage devices can be available on the system. They can easily be recognized by their icons.

NOTICE

Contact your local Customer Support Organization for setup.

Icon	Storage device
	Local Patient Database • containing the patient examination list
	DVD • contents of the currently assigned (DICOM) DVD. • DICOM media.
	Queue DVD • content of the selected Queue (DICOM) DVD slots. There are 5 Queue DVD slots available. chapter “More about data transfer to DVD” on page 862
	DICOM Network Node • contents of the currently configured DICOM network node. Remote (DICOM) patient databases. Accessible via drop-down menu in the |Network| destination.
	PACS • contents of the currently assigned PACS Remote (DICOM) patient databases. Accessible via drop-down menu in the |Archive| destination.
	Disk files (Local DICOM directory) By default, files are written to E:\DICOM. It is also possible to browse to a different destination folder, create a new folder or copy to a PC via a network connection.

Database capacity indicator bar

In the upper right corner, a blue bar is available which indicates how much space of the current database/device is used.

The bar color changes to red when 80% or more are used.

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NOTICE

With DVD the indicator shows 100% always, multi session for DVD discs is not supported.

Retrieving data from PACS

During retrieval of data from a PACS, the scanner allows to delete data from the patient just being retrieved. Please check the QueueManager for completion of the job before taking new actions within administration.

DICOM

Please refer to the ‘DICOM Conformance Statement’.

NOTICE

Prior to examination transfer to PACS, make sure that the examination is not in use in the viewing and/or scanning environment.

Otherwise it (or parts of it) could be locked and not be transferred. In this case, a message appears describing the cause of the problem.

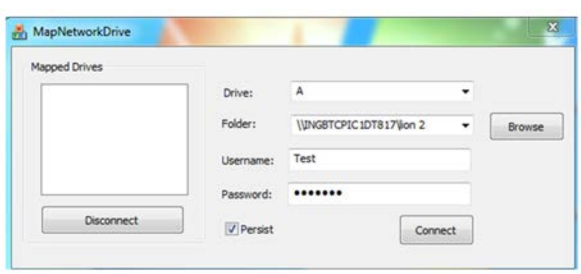
Export to Disk Files: Map network drive

You map a network drive from the **Export to Disk Files** window.

- The selected drive is mapped under the current user.
- The mapping is persistent over reboots.

► In the **Export to Disk Files** window, click the **Shared network drive setup** button.

A new window opens.



► Fill all mandatory fields.

► To finalize the setup and to connect to the newly defined network drive, click **Connect**.

► Close the window.

The file browser in the Export to Disk Files window refreshes automatically and displays the contents of the mapped network drive.

More about data transfer to DVD

A DVD provides high-capacity storage of images.

NOTICE

The DVD recorder is compatible with Philips DVD+RW 4-speed media only.

NOTICE

Only perform one action at the time with DVD storage: writing a DVD, storage to Queue DVD or browsing a Queue DVD slot.

General

The DVD writer is a consumer product. The lifetime of consumer products in general is less than the lifetime of medical products. Of course lifetime also depends on the usage.

If writing to DVD is unsuccessful, please retry with a new DVD+RW 4x before contacting a Philips representative.

NOTICE

The quality of a DVD will decrease over time.

For long-term storage it is advised to use an approved medical archiving solution (e.g. PACS).

Queue DVD

A Queue DVD is a storage directory for data before it is written to a DVD.

There are five Queue DVD slots available to compile patient data for multiple DVD’s.

Refreshing of the information on Queue DVD

- Click the |Refresh| button for a complete rewrite of the directory. This may take several minutes. Click |Cancel| to cancel the operation.
- Select ‘QDVDx’ from the pull-down menu for a fast refresh.

Copy to DVD

It is also possible to write directly to a DVD by clicking the button |Copy to DVD| while you are in local database control.

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This function can be used to quickly provide a patient with a copy of the exam or for Philips Service or Application Support services.

DICOM viewer

On every DVD a DICOM viewer will be installed. This viewer enables viewing of images on every PC running Windows XP.

In Windows Explorer, the DICOM viewer can be started by double-clicking on 'pmsdview.exe'.

This viewer is not intended for clinical and/or diagnostic purposes.

To read data from a DVD

- ensure that the DVD is placed in the DVD reader and not in the DVD burner.

About DVDs

- Use Philips 4-speed DVD+RW media (medical grade) only. Other types are not supported.
- Please handle DVDs according to the manufacturer's instructions. Realize that DVDs are vulnerable and need to be handled with care.
- Do not use adhesive labels on the DVD. These labels may cause unbalance to the DVD and the adhesive can damage the surface.
- For labeling only use special pens available for writing on DVDs.
- Remove fingerprints on DVDs according to the manufactures instructions at www.philips.com (consumer products).
- The DVD content is optimized for backup of the patient image data. Next to image data it also contains the "presentation states" (Window width, level, pan and zoom settings, ROIs, annotations, lines) and private objects for MRS. Basic DICOM viewers might not be able to handle these presentation states or private objects or enhanced DICOM objects.
- A DVD can contain about 30000 to 40000 images. In case of large datasets this limit can be reached for one patient. Divide the examination by opening the examination in 'Administration' and selectively write scans to DVD.

NOTICE

Take extra care when modifying the patient data in combination with storage on DVD.

The same image data with the original patient data and the modified patient data cannot be stored on the same DVD.

Procedure

1. Select the local patient database.
2. Select the data to be transferred.
3. Select one of the five Queue DVD slots.

Fig. 421: Queue DVD slots.

4. Start the transfer by clicking on the |Export selection to Queue DVD| button.
5. Answer the questions in the pop-up dialogue boxes and click |Proceed|.

   The above steps can be repeated until the selection is completed.
6. Select 'Queue DVD'  in the top-left corner of the Administration window.
7. Start the transfer to DVD by clicking on the |Copy all to DVD| button. The DVD is automatically ejected when the writing session has finished.

If writing to DVD was succesfull, the data is automatically removed from the Queue DVD slot.

NOTICE

During a writing session the status can be displayed by pressing the |Windows| key to display the Windows task bar and selecting the application tab 'Burn DVD'.

NOTICE

The DVD content is automatically verified after the writing session.

A window is displayed to indicate the result (when the host is not being rebooted).

NOTICE

It is recommended to check to contents of the DVD after writing.

Check images randomly using the viewer on the DVD.

NOTICE

Copy data to DVD is only available as a single session.

It is not possible to copy additional data to an existing DVD (no multi session).

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Using USB storage devices

NOTICE

Using USB devices might be disabled by your system administrator.

Using USB storage devices can be enabled by the Hospital Admin.

USB storage devices (flash drives, hard drives) are recognized by the system and can be used for exchanging data. The operating system automatically assigns a drive letter to the device.

CAUTION

Do not remove the USB storage device without using the "Safely Remove Hardware" option.

Removing the device without using this option can corrupt the data on the USB memory device.

NOTICE

The USB storage device may contain confidential information.

Take appropriate measures to protect this information. It is not possible to prevent the transfer of data to removable media.

Enable USB Devices (by Hospital Admin)

- Logon as Hospital Admin.
- Click on the Windows **Start Button** and select **MR System Management** followed by **System Management** and **Enable or Disable Removable Media.**

- Click **Yes** to enable or **No** to disable the use of USB devices.

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Using "Safely Remove Hardware" option

1. Close all applications that access the USB storage device.
2. Select ‘system’ -> ‘show taskbar’ or press the |windows| key on your keyboard to show the Windows taskbar.

3. left click once on the ‘Safely Remove Hardware’ icon in the notification area of the taskbar and select ‘Safely remove USB Mass Storage Device - Drive (<drive letter>:)’.
4. You can safely remove your USB storage device when the ‘Safe To Remove Hardware’ message appears.

USB Hard Drives

NOTICE

Connecting a USB-powered external hard drive may cause the USB ports of the host computer to stop working. All USB connected devices will not work anymore.

The hard drive may consume too much power causing the host computer to shut down the USB ports.

When this occurs the USB ports can be reactivated by:

1. Disconnect the USB hard drive.
2. Shut down the host computer and remove the power for 10 seconds.
3. Reconnect the power and start up the host computer.
   The USB ports are reactivated.

The problem can be prevented by using an external USB drive with an external power connection or using an external drive with a data USB cable and a power-to-USB cable.

When using a power-to-USB cable:

- ► First connect both USB cables to the computer.
- ► Connect the power-to-USB cable to the external device.
- ► Connect the USB data cable to the device.

DICOM Configuration

This functionality enables you to set up a DICOM node.

What are the main functions of DICOM Configuration?

- **DICOM Configuration** shows you the available network nodes connected to the MR console as part of the hospital network, and gives you information about their status.

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- It allows you to add new nodes, modify existing nodes and delete obsolete network nodes from the list.
- Furthermore you can test the connection with this functionality.

Adding a new DICOM node and Modifying an existing DICOM node

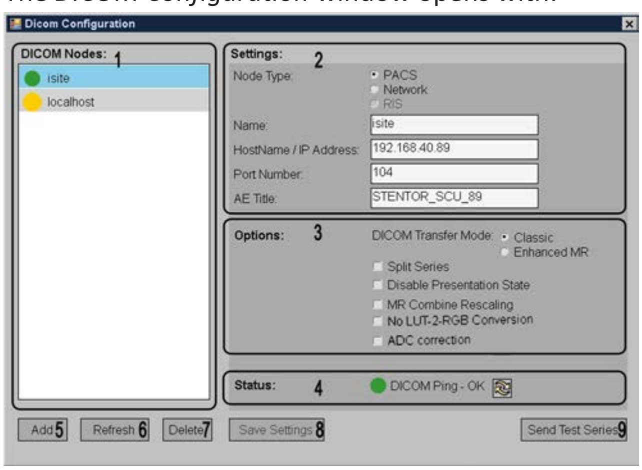
▷ A prerequisite is that a workstation, PACS- or RIS-system is connected to your hospital network just like the MR console.

▷ Before you start, contact your IT department to get to know technical data of the DICOM node:

- Host name or IP address,
- port number,
- AE Title.

  The AE Title consists of numbers and letters, is case-sensitive and has a maximum of 16 characters.

► On the **System** menu, click **DICOM Configuration**.
The *DICOM Configuration* window opens with:



- a list of the configured **DICOM nodes (1)** with their status:
  - *Green*: node is connected and configured as DICOM node.
  - *Yellow*: node is connected, but not recognized as DICOM node.
  - *Red*: node is NOT connected.
- the **Settings (2)** of the current node.
- the **Options (3)** for the current node.
- the **Status (4)** of the current node.
- the buttons **Add** a (node) **(5)**, **Refresh** (the display) **(6)**, **Delete** (a node) **(7)**, **Save Settings (8)** and **Send Test Series (9)**.

► To add a new DICOM node, click **Add**.
To modify an existing DICOM node, double-click the name of the DICOM node.

► Select the **Node type**: *PACS*, *Network* (workstation) or *RIS*.

- Enter a **Name** for the new node.

  We advise to use a name that represents the node and its characteristics best, such as *IntelliSpace*, or *PACS split*.

- Enter the **Address**, the **Port Number** and the **AE Title** of the node.

- If applicable: set the **DICOM Transfer Mode** to either *Classic* or *Enhanced MR*.

  Classic DICOM is recommended for multi-vendor applications, *Enhanced MR* for Philips applications.

- If applicable: To split series according to their image attributes, select **Split Series**.

  Split Series is only applicable in series that consist of multiple echoes, multiple dynamics or multiple b-values. If **Split Series** is enabled,

  - in a multi-echo acquisition, the slices of each echo are transferred separately.
    This results in multiple series on the DICOM node: series 1 = echo 1, series 2 = echo 2, and so on.
  - each dynamic scan of a dynamic series is transferred separately.
    This results in multiple series on the DICOM node: series 1 = dynamic 1, series 2 = dynamic 2, and so on.
  - in a diffusion series, the slices of each b-value are transferred separately.
    This results in multiple series on the DICOM node: series 1 = b-value 1, series 2 = b-value 2, and so on.

  To transfer a multi-echo, dynamic or diffusion imaging series as one serie (independently of their image attributes), deselect **Split Series**.

- To transfer the imaging series with presentation state, deselect **Disable Presentation State**. This is the default setting and the preferred situation.

  The presentation state is a DICOM property that describes how to display the images. It contains the viewing data:

  - *windowing* and *rescaling* information,
  - *zooming*, *panning*, *rotation* and *mirroring* settings,
  - *slice order, mirroring, rotation* settings,
  - *ROIs, annotations*, *lines* and *graphics*.

  If the presentation state (and consequently all viewing data) is transferred to the DICOM node, you view the images with the same viewing settings on MR console and DICOM node.

  If you select **Disable Presentation State**, these viewing data are not transferred. Only a limited set is transferred to the DICOM node: *window width*, *window level*, *ROIs*, *annotations* and *lines*.

- To maintain the scaling of your MR images when you transfer to non-Philips DICOM nodes, select **MR Combine Rescaling**.

  Non-Philips DICOM nodes do not understand the rescale information in Philips MR images. Consequently the images can be displayed too light or too dark.
  Be aware that you lose quantitative information such as ADC values, if you enable this option.

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- ► To switch off the automatic conversion of color Look-Up Tables (LUT) to RGB color secondary capture, select **No LUT-2-RGB Conversion (Other)**.

  This setting only applies for *Classic MR* transfer mode.

  - Not all *Classic MR* DICOM nodes receive color images (e.g. parametric maps with color LUT) correctly with color. Therefore MR images that contain color LUT information are automatically converted and exported as secondary capture color RGB images.
  - If your *Classic MR* DICOM node does not need this automatic conversion, enable **No LUT-2-RGB Conversion** to prevent it. In general, conversion can lead to the loss of DICOM attributes such as geometry information.

- ► Switch on **ADC correction**, if your DICOM node doesn't receive the windowing/rescaling values of ADC data correctly.

  - The ADC values are very small values (in the range of 10^{-3} mm^2/s) which are not received well by all DICOM nodes.
  - To display correct values on the DICOM node, **ADC correction** rescales the windowing/rescaling values to 1000 times higher values.

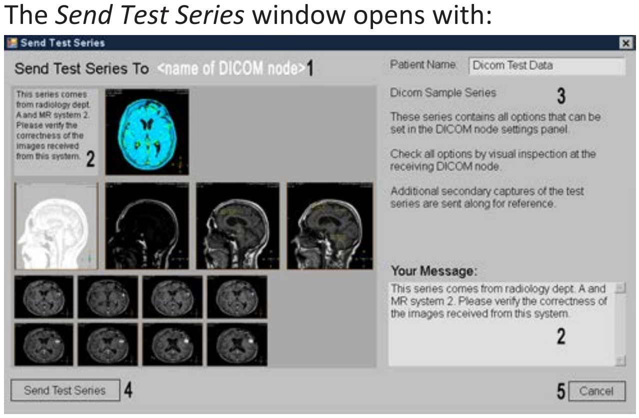
- ► To save the current settings of the node and to test the connection, click **Save Settings**.

- ► To update the status display of the current node, click the *Refresh* icon in the **Status** panel. This takes up to 5 seconds.

  To update the status display of all nodes, click **Refresh**.
  This takes up to 5 seconds per node.

Testing the configured node

- ► To test if the connection is correctly configured, click **Send Test Series**.
  The *Send Test Series* window opens with:



  - thumbnail images of the test series,
  - the name of the configured *DICOM node (1)*.
  - *Your Message (2)*. This is informal text you can enter with the test job.
  - the *Patient Name and information (3)* about the test series.
  - the button **Send Test Series (4)** to start the test, and the button **Cancel (5)** to close the window without starting the test.

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There are three different test series available. They contain different types of images and all options that can be set in the DICOM node **Settings** panel. Additional secondary captures of the test series are also provided and sent along for reference. The transfer of test series can take up to a few minutes.

► Check if the test series have been sent to the receiving DICOM node correctly:

- Check if the series have arrived at the DICOM node.
- Visually inspect the images.

► Close the window by clicking the **x** in the upper right corner.

A message pops up that a restart is required to make this new DICOM node effective.

You can choose to restart the system now or later.

Deleting an obsolete DICOM node

► On the **System** menu, click **DICOM Configuration**.

► Select a DICOM node from the list.

Its settings are displayed in the right part of the window.

► To remove this network node from the list, click **Delete**.

Split Exam

Split Exam provides you the ability to separate imaging series acquired during a single scan session into multiple scan instances. This allows for correct association of imaging series to ordered/scheduled examinations to facilitate proper reporting, data handling and billing activities.

Split Exam allows you to:

- **Split and Copy**

  This option creates a copy of the selected scan items and places them in the new examination location, leaving the selected scan in the original examination.

- **Split and Move**

  This option removes the selected scan items from the original examination and places them in the new examination.

Before you start

To ensure proper handling of the Split Exam functionality, establish the proper workflow in regards to MPPS (Modality Performed Procedure Step) with the facility defined RIS administrator .

Splitting the examination

NOTICE

All open instances of the patient examination to be split must be closed prior to beginning the Split Exam action.

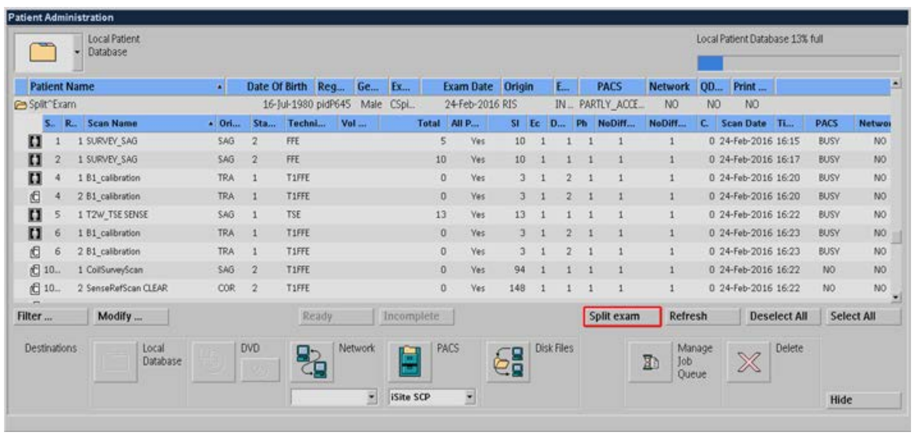
▷ Upon completion of the MRI examination:

► On the **Patients** menu, click **Close Exam**.

► On the **Patients** menu, click **Administration**.

The Patient Administration window opens.

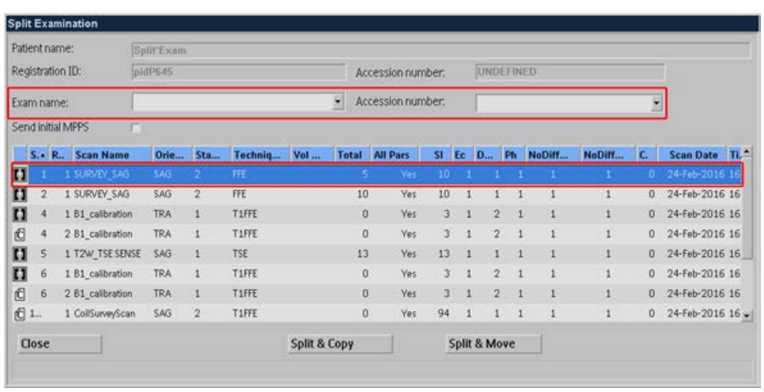
► Select the examination that you wish to split. Then click **Split Exam**.



► The Split Examination window opens.

► Enter the **Exam name** and, if applicable, the **Accession number** to be applied to the New examination that will be created by the Split Exam action ...

► Select the scan items that will be associated with the entered **Exam Name** and **Accession Number**.



► To create a copy of the selected scan items in the new location, click **Split & Copy**.

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The Split Exam action is immediately performed in the background.

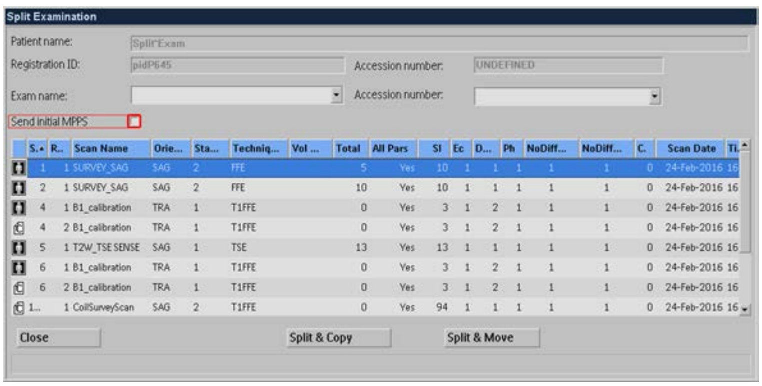
► To move the selected scan items to the new location, click **Split & Move**.

The Split Exam action is immediately performed in the background.

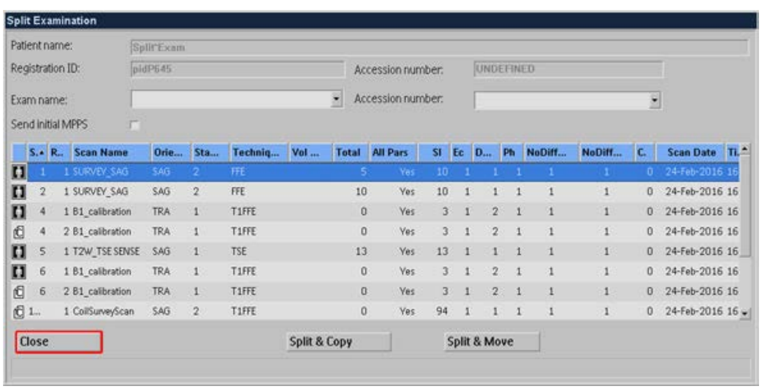
NOTICE

Moved scan items cannot be returned to their original location.

► If a RIS is configured and MPPS update is required by the hospital workflow, click **Send initial MPPS**.



► To close the window, click **Close**.



► To track the progress of submitted Split Exam job's progress, click **Manage Job Queue**.

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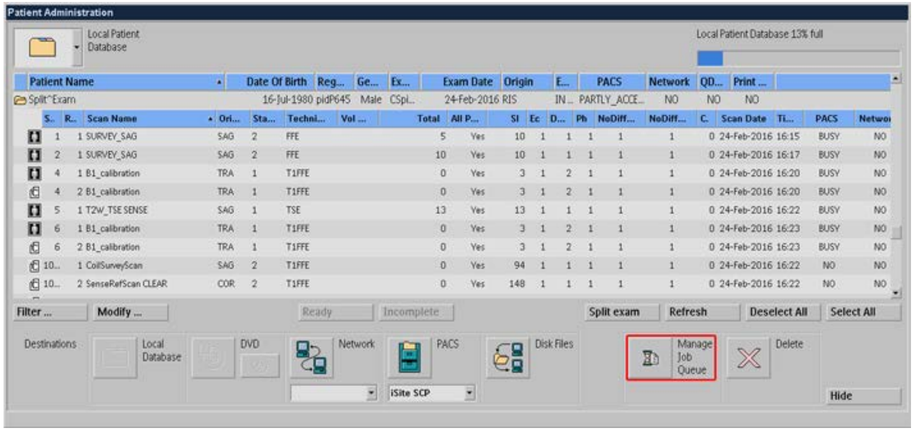

⇨ Once Split Exam job is completed, both the original and the split examination can be transferred to available network nodes.

28 Software update, Communication, Remote Connection and Feedback

Philips Software Update installation

This section describes the Philips Software Update functionality.
Your system may receive software updates to improve system performance. The system notifies the user when updates are available.

Software update installation can be performed by the user.
When required, permission for software installation can be assigned to the hospital or service administrator only. Contact Philips Service.

Notification and Installation

At system login a notification pop-up window is shown to inform the user that software updates are available to be install.

NOTICE

The displayed approximate installation time includes reboot and restarts.

► login to the system.

⇨ A notification pop-up window is displayed.

Philips Software Update is available to install.

Approximate installation time ... minutes.[1]
Archive patient data and finalize jobs in the current Job Queue before installation.

Do you want to install it now?

Buttons: Remind me later, Install.

[1]*This is the approximate installation time including reboot and restarts.*

► Archive patient data that is present on your system, refer to the **Administration chapter** of the IFU.

► Finalize the jobs in the Jobs Queue.

► Click **Install**.

⇨ An installation pop-up window is displayed.

Note: click **Remind Me later** to postpone installation.

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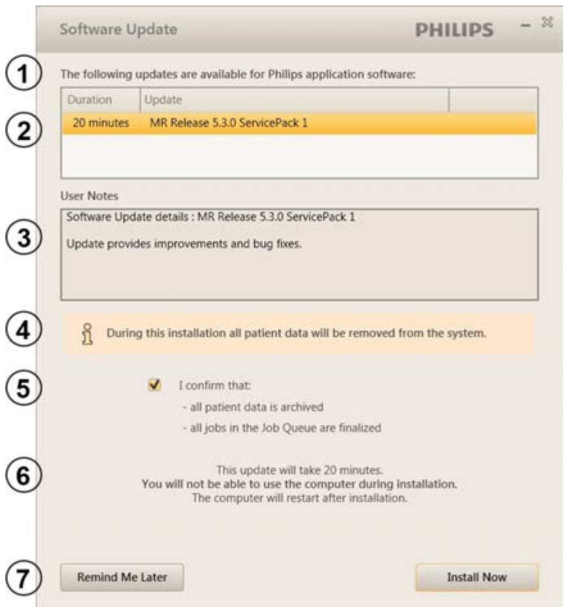
NOTICE

When software update installation cannot be initiated a popup windows displays: Available updates cannot be installed. Contact Philips Service to resolve the issues.



Software Installation

1. The following updates are available for Philips application software:
2. List: *Available updates and duration (installation time)*.
3. User Notes about the updates
4. ! During this installation all patient data will be removed from the system.[1]
   Archive patient data and finalize the jobs in the Jobs Queue before installation.[2]
5. I confirm that:
   - All patient data is archived
   - all jobs in the Jobs Queue are finalized
6. This update will take ... minutes.
   You will not be able to use the computer during installation.
   The computer will restart after installation.
7. Buttons: **Remind me later**, **Install Now**.

[1] *displayed when the update process removes patient data.*

[2] *displayed when the update process does not remove patient data.*

► Select **I Confirm that** to confirm that all patient data is archived and the jobs queue finalized.

⇨ Installation information is displayed (6).

► Click **Install Now** to start installation.

Note: click **Remind Me later** to postpone installation. Click **Remind Me later** on the notification popup.

NOTICE

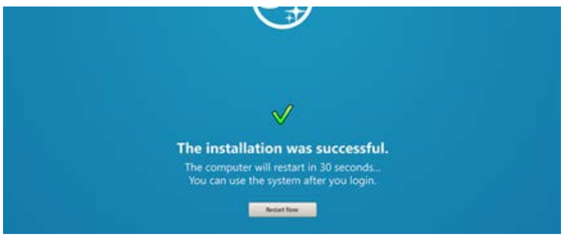
The notification pop-up window is displayed at every new login until the update has been installed successfully.

Installation process

During installation a screen is shown displaying the progress of the installation.

1. Software installation is in progress
   Preparing for installation...
2. About ... minutes remaining.
3. The computer may restart more than once during the installation process.
   Do not power off the computer during installation.

The following screen is shown when the installation was successful. The computer is restarted automatically after 30 seconds.



1. The installation was successful
   The computer will restart in 30 seconds...
   You can use the system after login.
2. Button: **Restart Now**.

► Click **Restart Now** to force an immediate computer restart if desired.

► login after the computer has restarted.

⇨ A pop-up window is displayed.

Philips Software Updates installed successfully.

Your application software is updated to version ...

Button: **OK**.

► Click **OK** to close the pop-up window.
You can start using your system.

Maintenance required

After successful installation an additional pop-up window may be displayed that your system requires maintenance.

Maintenance is required.

Your system needs additional maintenance.
Contact Philips Service.

You can continue using your system.

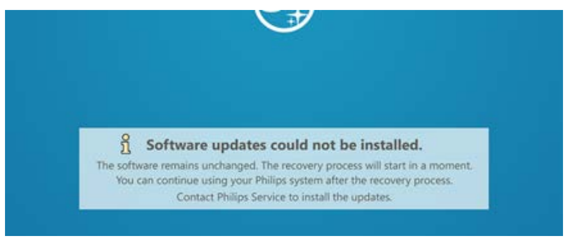
Button: **OK**.

- ► Contact Philips Service.
- ► Click **OK** to close the pop-up window.

You can start using your system.

Installation failed

When software update installation fails this is briefly shown on the installation screen. Your system is recovered to the previous software version.



! Software updates could not be installed.

The software remains unchanged. The recovery process will start in a moment.
You can continue using your Philips system after the recovery process.
Contact Philips Service to install the updates.

- ► login to the system.
- ⇨ A pop-up window is displayed.

Philips Software Update could not be installed.

A problem occurred and updates could not be installed.
You can continue using your system as usual.
Contact Philips Service.

Button: **OK**.

- ► Contact Philips Service.
- ► Click **OK** to close the pop-up window.

Restore patient data

- ► Restore patient data after successful installation. Refer the **Administration chapter** of the IFU.

NOTICE

Only necessary when patient data was removed during installation.

When patient data is removed during installation this is mentioned in the installation pop-up window.

Start software installation after postponing

When software installation is postponed, the installation can manually be started from the windows taskbar later.

► Press the **Windows key** on your keyboard to display the Taskbar.

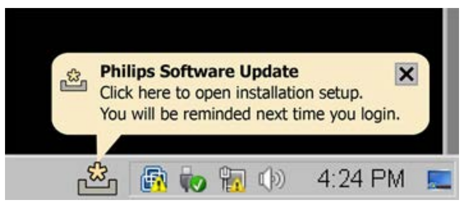


Fig. 422: RSI icon.

► Double-click the **Philips Software Update icon** on the Windows Taskbar.

⇨ The installation pop-up window is displayed.

Notification without permission to install

When the logged-in user does not have permission to start update installation, a window is displayed to inform the user that software updates are available to install, and to login with a hospital or service administrator account.

Philips Software Update is available to install.

Approximate installation time is ... minutes.
Archive patient data and login in with a Hospital or Service admin account to install the updates.

Buttons: **Learn More**, **Close**.

► Click **Learn More**.

⇨ An information pop-up window is displayed.

Software Installation

1. The following updates are available for Philips application software:
2. List: *Available updates and duration (installation time)*.
3. User Notes about the updates
4. login with a Hospital or Service administrator account to install the updates.
5. Button: **OK**.

- ► Click **OK** to close the information window.
- ► Notify the Hospital or Service administrator that updates are available.
- ► Click **Close** to hide the notification pop-up window.

The system can be used normally until update installation is performed.

NOTICE

The notification pop-up window is displayed at every new login until updates have been installed successfully.

Philips Communication Toolbox (PCT)

Philips Communication Toolbox, in this section referred to as PCT, is an extension on Microsoft Skype for Business©*.
PCT is enabled for facilities using Microsoft Skype for Business. Communication with external Skype for Business users may be restricted by local network policy.

To communicate with other Skype for Business users PCT offers:

- Instant messaging (IM).
- Audio (group) calls.
- Sharing of files and screen shots.
- Desktop sharing and remote control.

For description of basic Skype for Business functionality please refer to www.microsoft.com.

** Microsoft, Skype for Business and Exchange are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.*

Start up and Exit

Start up PCT

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1. Press the **Windows** key on your keyboard and select **Philips Communication Toolbox** to start the application.

Sign in

1. When not shown, click the **Skype** icon in the top-right corner of your desktop to open the Sign-in window.
2. Sign in with your Sign-in address to connect to the server.
   Note to sign out first if the previous operator did not sign out correctly.

Sign out and Exit

1. Close the communication screen and click the **Skype** icon to show the main PCT window.
2. Click the **drop-down arrow** next to the settings icon. This icon is located on the right below your name.
3. In the drop-down list select **File** and **Sign Out** to end all communication, the application remains running in the background, or
4. Select **File** and **Exit** to end all communication and to exit the application.

NOTICE

You may want to sign out of PCT when you end your shift or scan session to prevent other operators to use your account.

Desktop sharing and Remote Control

1. Connect to the remote contact via IM or Call.

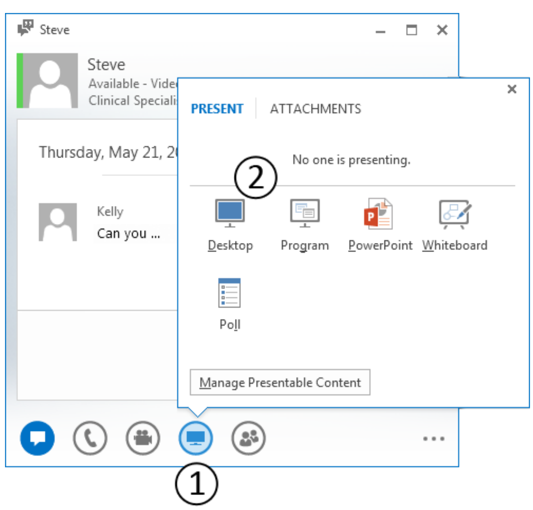

Fig. 423: Communication screen, desktop sharing

2. Click on the **Present** icon (1) in the communication window.

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Philips

3. Select the **Desktop** icon (2) to share your screen. Your contact needs to actively accept to be able to see you screen.
   A yellow frame around your desktop and a Sharing Bar is displayed indicating that desktop sharing is active.
4. Click **Give Control** on the Sharing Bar and select your contact's **name**.
   A warning is shown to make you aware of your responsibilities that come with giving control to the remote user, see warning popup and text below.
5. Select **I confirm that** and click **Continue to Share Desktop** to start remote control.
   Remote control allows the remote user to initiate a scan and table movement. Always adhere to the obligations described in the warning.

Remote Desktop warning
The following text is shown on the popup:

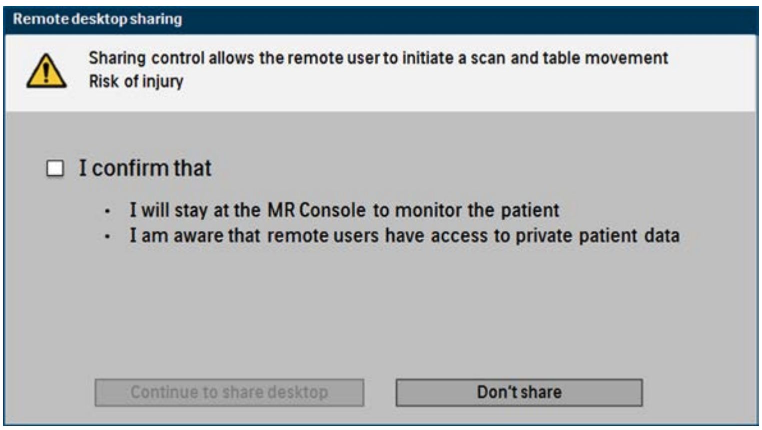

Fig. 424: Remote Desktop Warning, see complete text below.

I confirm that

- I will stay at the MRI Console to monitor the patient.
- I am aware that remote users have access to private patient data.

Stop Remote Control
Click **Give Control** on the Sharing Bar and select **Take Back Control**.
Remote control will stop but your desktop is still shared with your contact.

Stop Desktop Sharing
Click **Stop Presenting** on the Sharing Bar to stop sharing your desktop.
Communication with your remote contact remains possible.

Remote Desktop

This section describes the Remote Desktop application of your system.

Remote Desktop enables remote support or assistance on your system.
This functionality enables remote users to access your system:

- ViewOnly: remote viewing of the system desktop.
- TakeOver: remote control of the system desktop.

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In a ‘Single Session’ (ViewOnly or TakeOver) you allow the remote user to view your system or control your system for one session only. After a session is stopped or after a log-off or reboot of your system the remote connection has to be re-enabled by the local user.

In ‘Fixed Duration’ (TakeOver) you allow the remote user to control your system for a limited time period, from 1 to 60 hours. The remote user can access your system independently for the complete duration of the session by using a password protected connection. This password is set at the connection start up.
When a reboot of the system is necessary, it can be done by the remote user. After starting a Fixed Duration session the assistance of the local user is not required.

A Fixed Duration session may be used to service your system during the time that it is not used.

WARNING

Fixed duration session shall only be performed with appropriate safety, security and privacy measures taken according to hospital policies.

Every session can be stopped at all times by the local user. The remote connection is then closed and has to be re-enabled by the local user if necessary. This also applies to a Fixed Duration session.

NOTICE

When starting a Remote Desktop session a dialog box appears displaying a warning text. The session cannot be started before the local user agrees by clicking the |I agree| button.

WARNING

During a single TakeOver session, the local user must stay at the system console and monitor the activities performed by the remote user.

WARNING

The local user must be present at the console at all times during scanning of a patient in a Remote Desktop session.

WARNING

The local user is responsible for ensuring the safe and secure use of the system and for the safety of his patient. It is possible to terminate a session at all times using the |Stop| button on the screen.

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WARNING

Only expert users are allowed to run a TakeOver session.

WARNING

During a TakeOver Fixed Duration session where the local user is not present, the local user has to verify that no person is present in the examination room. Take appropriate measures to inform people that a TakeOver session is running.

Remember that scanning is only possible when the door of the examination room is closed.

Workflow

Contact Philips customer support in case of a system failure or problem. The service engineer may want to view your system desktop while you are scanning or access it to remotely service your system.

NOTICE

It is advised to keep contact on the phone for the complete length of the session.

1. Click the Windows |Start| button, go to |MR user| and select |Enable Remote Desktop| to start the Remote Desktop application. A dialog box appears displaying the following text:

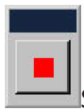
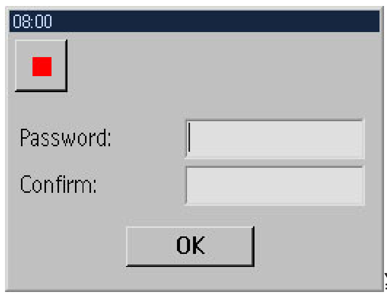
   Enable Remote Desktop Session
   A Remote Desktop session has been requested.
   If you accept this Remote Desktop request, you confirm that you know that this is an authorized Remote Desktop session.
   You further confirm that you are the responsible local operator for the system during this Remote Desktop session and have been fully informed about the possible consequences regarding Safety, Security and Privacy arising from permitting remote operation of the system, including those discussed in the system's "instructions for use".
   During a single windows Take Over session, you must stay at the system console and monitor the activities performed by the remote user. You can end the Remote Desktop session any time by pressing the "STOP" button on your screen. As the operator of the system, you are responsible for the safe and secure use of the system.
   Note that certain private information, including electronic Protected Health Information (ePHI) about patients, will become accessible to the remote operator. Be sure to stay within your institution's policy regarding disclosure of confidential information to third parties.
   |I Agree| or |Exit Session|

2. If in doubt about the message click |Exit Session| to cancel. Click |I agree| to confirm.
   An ‘Enable Remote session’ box appears on the screen.

3. Select:

   (a) |Single Windows Session| or
   (b) |Fixed Duration| and the amount of time (1 to max. 60 hours) you allow the remote user to access your system, and click |OK|.

   The application is active and a ‘VNC’ icon is displayed in the tray of your Windows taskbar.

   - Single Windows Session
     A red Stop button appears on the screen. With this button you can stop the session. The button always stays on top and can be placed anywhere on the screen.
   - 

     ¥Fixed Duration
     A dialog box appears on the screen with a |Stop| button and fields to enter/confirm a password.

NOTICE

The password has to be entered by the remote user.

4. Inform the service engineer that the application is active.
   The service engineer will start up the remote connection and a ‘VNC server acceptance’ box appears on the screen.

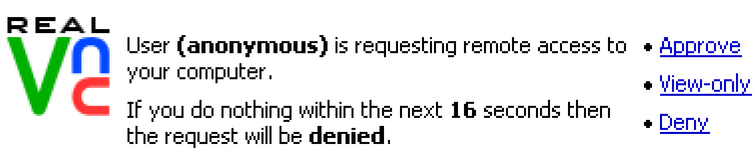


Fig. 425: VNC server acceptance box

5. Click:
   - |Approve| to confirm a TakeOver session or
   - |View only| to confirm a ViewOnly session.

When the Remote connection is active the background color of the ‘VNC’ icon in the tray of your Windows taskbar changes from white to black.

For a Fixed Duration the service engineer has to enter a password. After the password has been confirmed the box minimizes to the |Stop| button. With this button you can stop the session. The button always stays on top and can be placed anywhere on the screen. The remaining session time is displayed in the header of the button.

NOTICE

Error messages may appear on the screen when the password is not entered correctly.

These messages are for the remote user only.

Stopping a session

The local user can stop a Remote Desktop session at all times:

- Click the red |Stop| button to stop the session. A confirmation box appears on the screen: 'Are you sure you want to stop the remote session'.
- Click |OK| to confirm. The session is stopped.

When finishing a Single Windows Session the local user as well as the remote user can close the session.

NOTICE

The start/stop of every Remote Desktop session is logged by your system.

The Remote Service Network logs who has been the remote user.

Customer Feedback

Problems found while working with the system can be described using the Feedback tool.

The problem reports can be read out by your Philips service engineer.

NOTICE

Please inform your local Philips service engineer when you have submitted feedback.

Preparing DICOM images

If you want to include DICOM images in your feedback, you have to prepare these images first.

► Clean the *Disk Files* partition first:

  - On the **Patient** menu, click **Administration**.

  Alternatively press **F4**.

  - Select **Disk Files** as source database or device.

- Click **Select All**.
- Click **Delete** to clean the *Disk Files* partition.

► Select the images you want to include and choose the destination:

- On the **Patient** menu, click **Administration**.

Alternatively press **F4**.

- Select **Local Patient Database** as source database or device.
- Select the images to be included.
- Select **Disk Files** as destination.
- Optional: **Enable Suppress Patient Data**.
- Press **Proceed** to confirm.

The selected images will be combined in a zip file on the *Disk Files* partition.

Providing customer feedback

1. On the **System** menu, click **Feedback...**.
   The *Customer Feedback* window opens.
2. Click the **Feedback** tab, if it's not active. Fill in the empty data fields:
   - **Hospital Name**:
     Is filled in automatically. You cannot change the value.
   - **System ref number**:
     Is filled in automatically. You cannot change the value.
   - **Occurence date/time**:
     Enter date and time when the problem occurred, or select the date from the calendar drop-down list.
   - **Submitter**:
     Enter your name.
   - **Description**:
     Give a short description of the error case.
   - **Actions prior to error**:
     Describe which actions have been done just before the error occured.
3. Check the box **Include DICOM images** if you want to include the prepared images (see workflow 'Prepare DICOM images') with the problem report.

NOTICE

An error message is diplayed if no DICOM images can be selected, because they have not been prepared.

In this case, follow the directions given to include DICOM images.

4. Click **Proceed** to submit your feedback.
5. Inform your local Philips service engineer that feedback has been submitted.

29 Artifacts

Artifacts can occur in MRI for a number of reasons, degrading the image quality and sometimes hindering diagnosis. They may be caused by technical problems and data handling or by physiological effects from the patient. Since most artifacts can be reduced, it is important to recognize them, and to know what can be done to prevent them.

This includes methods of correcting or mitigating such artifacts (e.g. changing bandwidth, gradient moment nulling, pre-saturation, B0 and RF shimming, etc.).

Artifacts on high field strengths

Dielectric shading effect

Artifact appearance	Hypo- or hyperintense areas.
Caused by	Non-uniform RF distribution in the body, caused by changes of the RF wave due to the electrical properties of tissue. This physical phenomenon is more pronounced at 3.0T since the RF wavelength at 3.0T (approximately 25 cm) approaches the size of the body, resulting in a standing wave.
Countermeasures	• MultiTransmit technology addresses this problem at the source, no additional countermeasures have to be taken. • On 3.0T systems without MultiTransmit technology, dielectric shading effects can occur depending on the patient, particularly in body imaging. To avoid these effects, it is advised to used Body tuned CLEAR - a specific B1 filter that is designed to overcome receive inhomogeneities in body imaging.

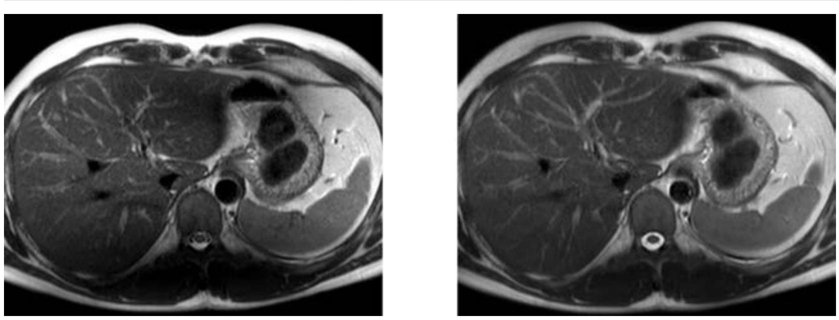


Fig. 426: Left: Dielectric shading effect on 3.0T system without MultiTransmit. Right: Same patient scanned with MultiTransmit. No dielectric shading.

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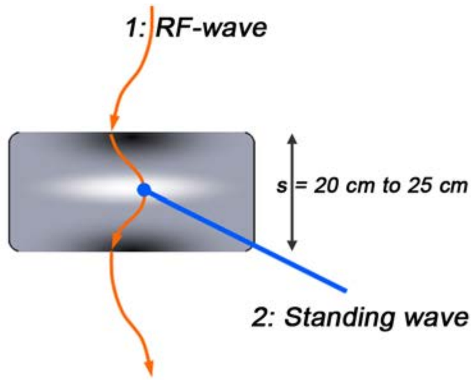

Fig. 427: Formation of dielectric shading on 3.0T system using single transmission (no MultiTransmit). Without Multi-Transmit , a standing wave (2) could be generated since the wavelength of the RF-wave (1) at 3.0T lies in the same range as the size of the body: 20 cm to 25 cm.

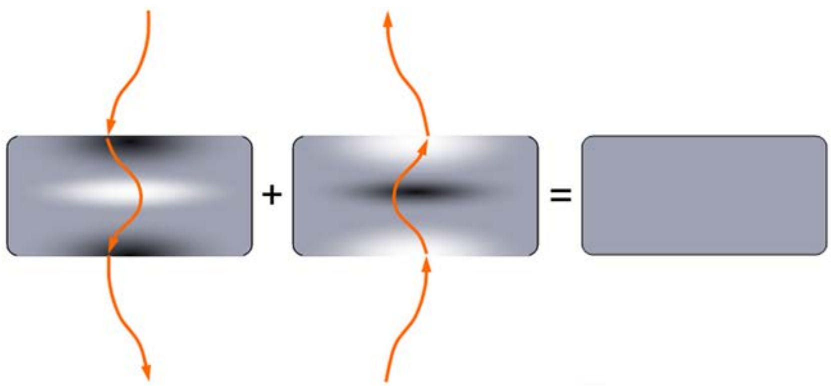

Fig. 428: MultiTransmit technology is designed to avoid the occurence of dielectric effects. With MultiTransmit, simultaneous parallel RF transmission fully adresses the dielectric shading effect.

Motion artifacts

Patient motion is the largest physiological effect that causes artifacts. Motion during the acquisition results in inconsistencies in phase and amplitude, which lead to blurring and ghosting. These artifacts appear in the phase encoding direction, independent of the direction of the motion. The different motion artifacts and their remedies are shown below.

Cardiac motion artifact

Artifact appearance	Blurring and ghosting.
Caused by	Signal variation during data collection due to movement of the heart.
Countermeasures	• Cardiac Synchronization. • Triggering in combination with Flow Compensation and REST provides maximum artifact reduction.

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Related topics	• Cardiac Synchronization • REST
Preset Procedures	Cardiac Synchronization is used in all heart and thorax procedures to suppress these artifacts.

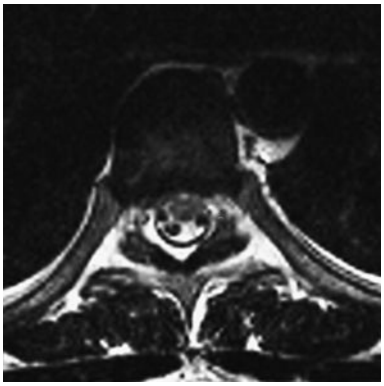

Fig. 429: T-spine image without cardiac triggering.

Artifact caused by breathing

Artifact appearance	Blurring and ghosting.
Caused by	Signal variation during data collection due to movement of the chest and the abdominal wall.
Countermeasures	Respiratory Compensation techniques: • Respiratory Triggering: for TSE and TFE scans with a long TR (1800 ms ... 2500 ms). • Breathhold techniques: to be used in FFE- and TFE. • PEAR to be used in SE, FFE and IR. Navigator echo technique
Related topics	• Respiratory Triggering. • Breathhold techniques. • PEAR. • SMART.

Respiratory compensation

- is the recommended method for abdominal scans.
- is of minor importance in the thorax area. Most artifacts are caused by cardiac motion.
- should be combined with Cardiac Synchronization in lung imaging.
- is not necessary in the pelvic area, but improves SE images.

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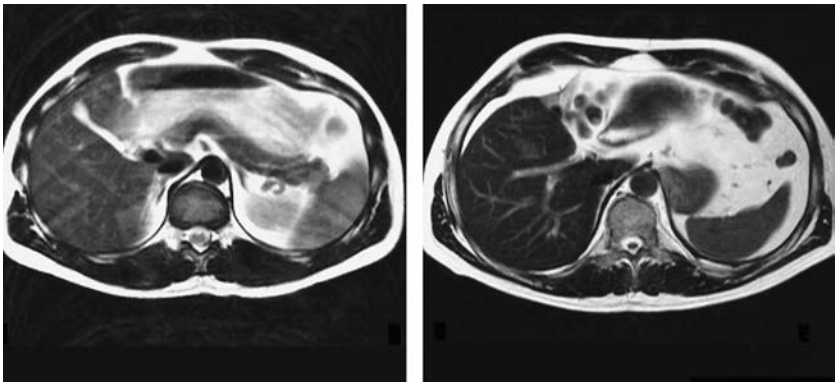

Fig. 430: Transverse abdomen, left: without RC, right: with RC.

Artifact due to blood flow

Artifact appearance	Repeated ghost signal in the phase encoding direction or unwanted high blood signal.
Caused by	Flowing blood due to a misregistration effect of blood flowing within or through the image plane, because of the difference in time between the preparation and read-out gradient.
Countermeasures	• REST and Shared REST: especially useful when applying two parallel REST slabs in transverse imaging to saturate the signal of blood flowing through plane. Blood will appear as a signal void instead of high signal intensity. • REST in combination with Flow Compensation (FC) for optimum results. • REST in Inflow MRA to suppress venous or arterial flow. • Cardiac Synchronization in MRA to get rid of pulsation artifacts of vessels.
Related topics	• REST (Regional Saturation Technique).

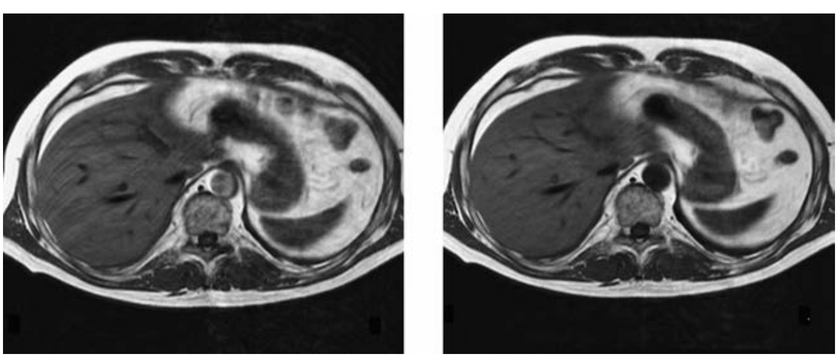

Fig. 431: Transverse scan of abdomen, left: without REST and FC, right: with REST and FC.

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CSF pulsation artifact

Artifact appearance	Ghost artifacts superimposed in the image.
Caused by	Signal variations during data collection due to pulsatile CSF flow.
Countermeasures	• Flow Compensation has proved to be very useful in sagittal spine images and axial liver images. • Cardiac Triggering is an additional option if Flow Compensation is applied and there are still flow artifacts. • Inherently compensated: b-FFE (balanced FFE).
Related topics	• Flow Compensation. • Cardiac Triggering. • b-FFE.

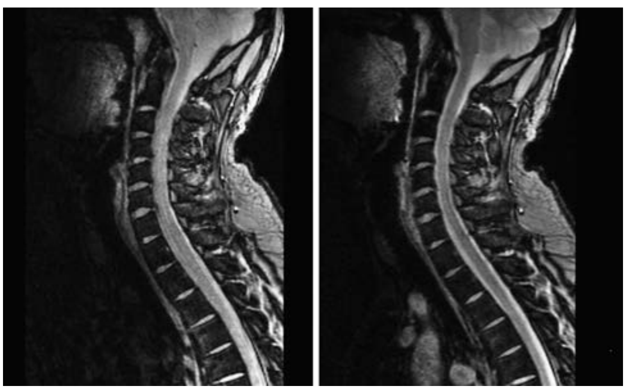

Fig. 432: C-spine, left: without FC, right: with FC.

Flow void artifact

Artifact appearance	Black hole like artifacts in axial and sagittal T2W TSE scans with a high TSE-factor.
Caused by	Fast flowing CSF.
Countermeasures	• Increasing the TSE-factor (minimize echo spacing) so that the scans are less sensitive to flow. • Flow Compensation. • Cardiac Triggering. • Use of b-FFE (balanced FFE). • Performing a 3D TSE multichunk instead of a MS TSE scan.
Related topics	• Flow Compensation. • Cardiac Triggering.

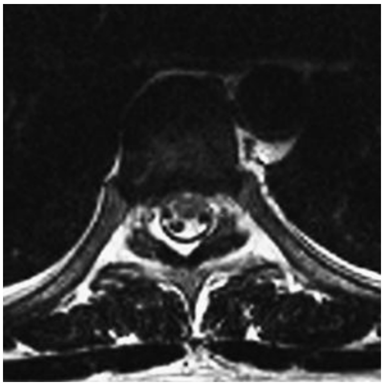

Fig. 433: Transverse TSE spine with flow voids.

Chemical shift artifacts

Water-Fat shift

Artifact appearance	Hypo- and hyperintense lines between tissue boundaries • in frequency encoding direction for non-EPI/GRASE scans • in phase encoding direction for EPI/GRASE scans.
Caused by	Resonance frequency diffference between water and fat resulting in displacement between water and fat by a number of pixels. The hypointense lines are originated by empty voxels and hyperintense lines by superimposed signals.
Countermeasures	• Set the parameter WFS (Water-Fat Shift) to a user defined value. Note that using a smaller WFS decreases the artifact at the cost of SNR. • Change the Fat-Shift direction.
Related topics	• Water-Fat Shift. • Fat-Shift Direction.

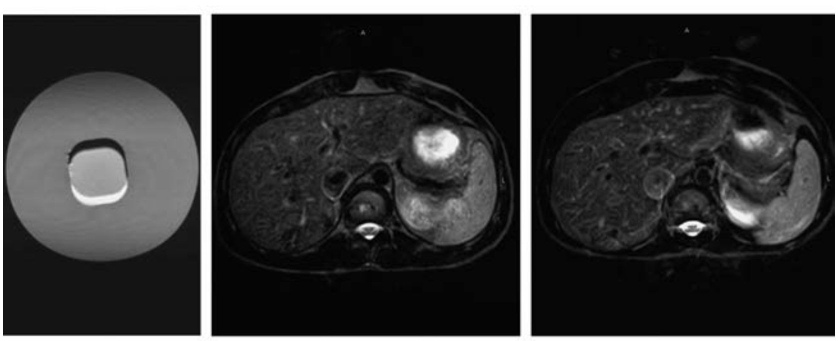

Fig. 434: From left to right: WFS on phantom. Small WFS. Large WFS.

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NOTICE
The chemical shift artifact increases with the field strength.

Water-Fat dephasing

Artifact appearance	Signal dephasing in voxels containing both water and fat showing up as black lines around anatomic structures.
Caused by	• Resonance frequency differences between water and fat AND • Use of an 'out of phase TE' (water and fat signals are out of phase).
Countermeasures	• Choose an 'in phase echo time' (field strength dependent). See table below.
Related topics	• Water-Fat Shift. • Fat Shift Direction.

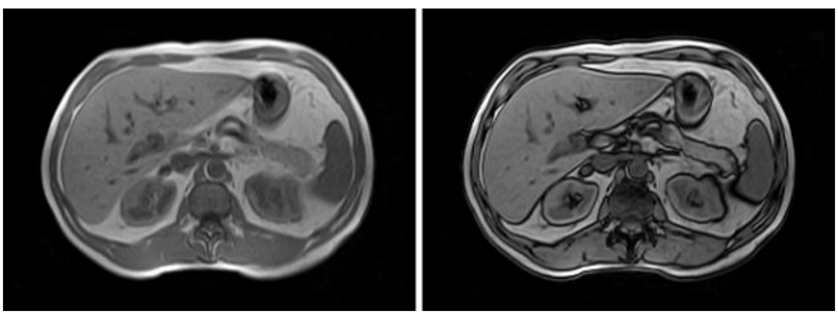

Fig. 435: Left: water and fat are in phase, right: water and fat are out of phase.

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In phase TE’s and out of phase TE’s

	1.0T	1.5T	3.0T
In phase TE [ms]	6.9	4.6	2.3
	13.8	9.2	4.6
	20.7	13.8	6.9
	27.6	18.4	9.2
		23.0	11.5
Water and fat are in phase when the TE is a multiple of ... [ms]	6.9	4.6	2.3
Out of phase TE [ms]	3.45	2.3	1.15
	10.35	6.9	3.45
	17.25	11.5	5.75
	24.15	16.1	8.05
		20.7	10.35

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NOTICE

These values are based on calculations.

Actual values depend on fat characteristics.

Aliasing artifacts

Aliasing artifacts are also referred to as fold-over artifact.

Artifact appearance	Tissue outside the FOV which is folded back into the image, most commonly occuring in fold-over direction (phase encoding direction). • In 3D scans also possible in slice direction.
Caused by	The spins within the FOV acquire a maximum phase shift of n x 360°. Spins just outside the FOV have a phase shift of more than one cycle. This results in misregistration of those spins.

Countermeasures	• Fold-over suppression: Signal from outside the FOV is suppressed. • Increase RFOV so there is no tissue outside the FOV. • Change the fold-over direction if possible so there is no tissue to fold back. This also depends on other artifacts that might occur. • Use REST slabs to saturate tissue outside the FOV.
Related topics	• Fold-over suppression. • REST. • RFOV. • SENSE.

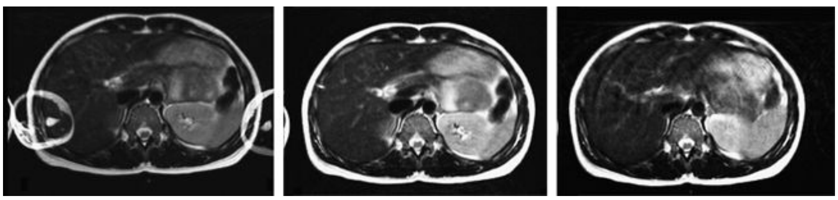

Fig. 436: Transverse scan. Left: Fold-over Direction=LR, no Fold-over Suppression. Middle: Fold-over Direction=AP, no Fold-over Suppression. Right: Fold-over Direction=RL with Fold-over Suppression.

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Magnetic material artifacts

Artifact appearance	Signal loss around ferromagnetic material or metallic material.
Caused by	• Magnetic field distortions by ferromagnetic metal implants such as hip prostheses, surgical wires and clips, and also some eye cosmetics and small metallic particles. • Eddy currents induced in non-ferromagnetic metallic material by switching gradients.
Countermeasures	• Remove any kind of ferromagnetic and metallic material.

Susceptibility artifacts

Artifact appearance	• Signal dephasing resulting in misregistration at interfaces of tissues with different magnetic susceptibility. • in FFE- and EPI-scans.
Caused by	• Different magnetic susceptibility (different local magnetic fields). For example, at interfaces between air and tissue, inhomogeneities are induced.

Countermeasures	• Larger matrix size or smaller FOV (smaller pixels). • Shorter TE. • A smaller WFS value and control of Fat Shift Direction. • Full acquisition (scan percentage 100%).
Related topics	• FFE and EPI. • Fat Shift direction.

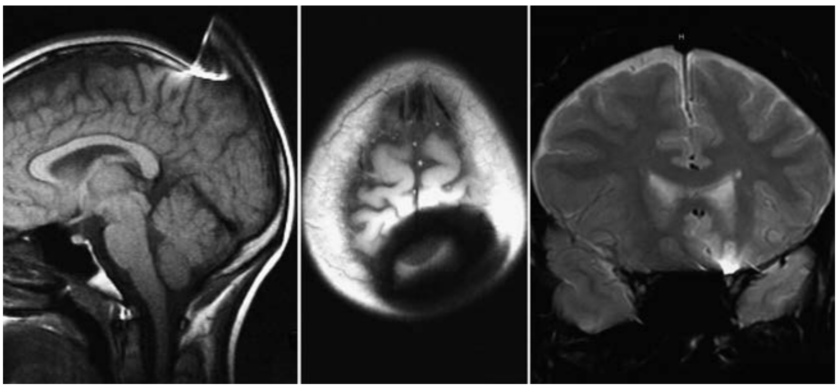

Fig. 437: Left: Sagittal brain with magnetic field distortion (hairpin). Middle: Same patient, transverse scan. Right: Susceptibility artifact in EPI scan.

Ringing (Gibbs) artifacts

Artifact appearance	Ring like or linear truncation artifact, also called Gibbs artifact.
Caused by	Reduced acquisition. The artifacts are induced by high contrast transititions, and are particularly common with scan percentages below 80%.
Countermeasures	• Ringing filtering: Pre-reconstruction filter which also smooths the image. • Higher 'Scan Percentage' value.
Related topics	• Scan Percentage.

Zebra stripe artifact

Artifact appearance	Zebra stripes.
Caused by	REST saturation pulse interfering with the data acquisition in 3D-TSE scans.
Countermeasures	• Change the number of REST slabs. • Decrease the TSE factor. • Use an even number of 'true' NSA.

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NOTICE

This artifact does not occur anymore in TSE scans with more than 1 ‘true’ NSA.

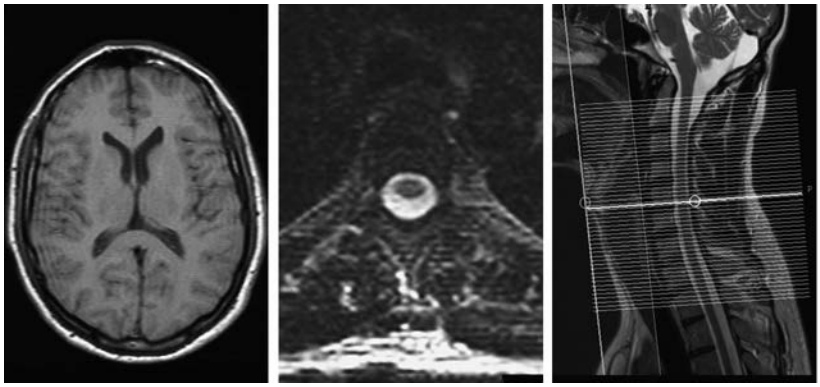

Fig. 438: Left: 60% scan percentage without ringing filter. Middle: Zebra stripe artifact. Right: Planscan 3D-TSE.

REST artifact

Artifact appearance	Signal distortion in the region where the REST has been applied.
Caused by	Two free REST slabs which intersect each other.
Countermeasures	Applying the REST slabs such that they do not overlap.
Related topics	REST.

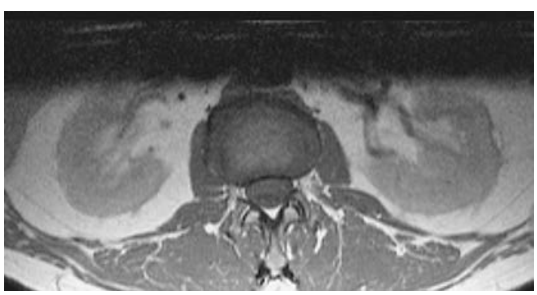

Fig. 439: REST artifact.

Multiple stack artifact

Artifact appearance	Black line artifacts in a multistack scan where slices of the different stacks overlap or cross over.
Caused by	When the stacks are measured in one package, the measurement is done in an interleaved manner. Interference between the different slices occurs which results in signal loss.

Countermeasures	• Planning the stacks in different packages (Parameter 'Stacks as packages'). • Changing the position or angulation of the stacks such that they do not overlap.
Related topics	• Stacks.

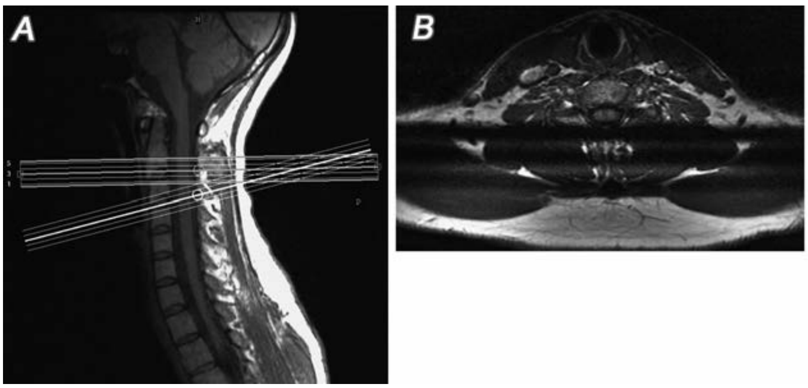

Fig. 440: A: Planscan of B. B: Transverse spine imamge with multistack artifact.

SENSE Artifacts

Intrinsic backfolding

Artifact appearance	Backfolding in the center of the image or or the 3D volume: • in-plane (fold-over direction) in M2D and MS scan mode, • also in slice direction in 3D scan mode
Caused by	FOV, RFOV or 3D volume have been planned too small. Special attention has to be given to double-oblique cardiac scans.
Countermeasures	Enlarge FOV, RFOV or 3D volume. Increase the flexible fold-over suppression area.

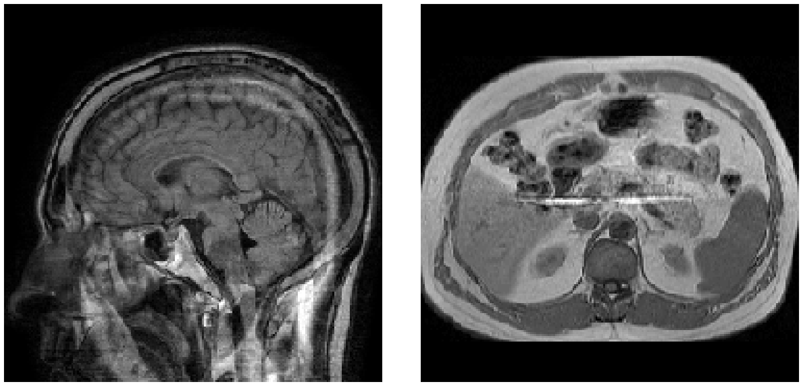

Fig. 441: Left: 3D - intrinsic backfolding in slice direction. Right: MS - intrinsic backfolding in plane.

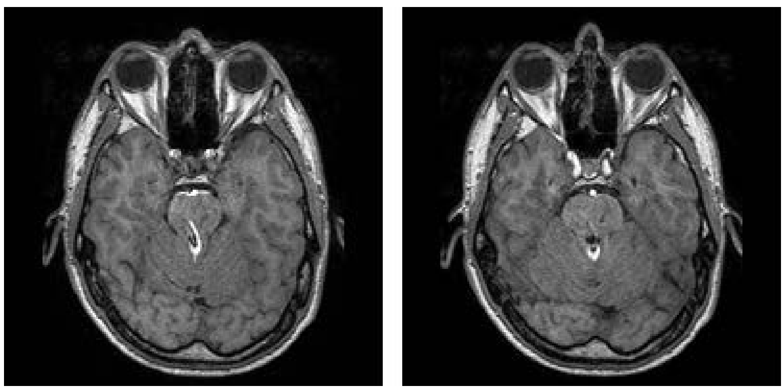

Fig. 442: Left and right: The ear folds back in MS scan.

Intrinsic backfolding of artifacts

Artifact appearance	Fold-over of ghost artifacts from just outside the FOV.
Caused by	FOV, RFOV or 3D volume have been planned slightly too small.
Countermeasures	Enlarge FOV, RFOV or 3D volume. Increase the flexible fold-over suppression area.

Cut-line artifacts

Artifact appearance	Dark area separated from a bright area by a cut-line.
Caused by	The coil elements move during the scan due to breathing.
Countermeasures	Right mouse: repeat prescans.

Single-shot sequences and Fat Shift Direction

Artifact appearance	Susceptibility related artifact in single-shot EPI sequences with SENSE, fold-over direction AP and fat shift direction A(nterior): • E.g. high signal at the border of the frontal sinus. • Especially in b0 images in diffusion weighted scans. Less pronounced in high-b images which in turn might result in low signal in the calculated ADC-map.
Caused by	Fat shift direction set to A(nterior) in these scans.
Countermeasures	Set the ’Fat shift direction’ to ’P(osterior)’ in all cases.
Related topics	SENSE. Fat shift direction.

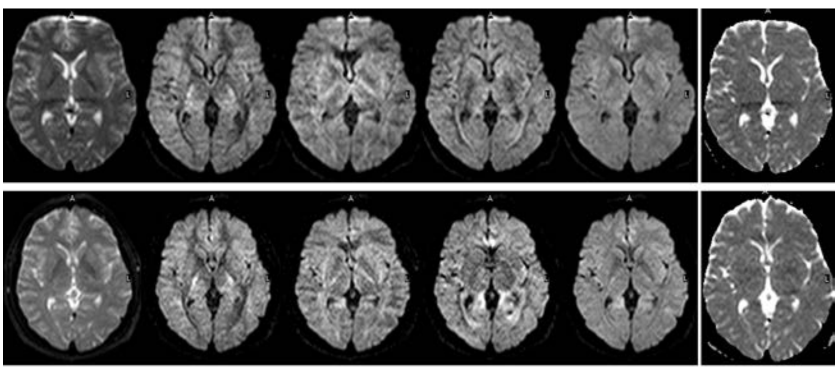

Fig. 443: Upper row: Fat Shift Direction = Anterior. Lower row: Fat Shift Direction = Posterior.

Compressed SENSE Artifacts

Acceleration and effects of the reduction factor

Compressed SENSE and SENSE behave very much alike with respect to acceleration, patient motion and aliasing artifacts.

With high acceleration in Compressed SENSE and SENSE scans, noise breaks through and aliasing artifacts may occur.
The images below show that the Compressed SENSE images are equally affected as SENSE images: The higher the reduction factor, the noisier the images and the more aliasing artifacts appear.

- To improve SNR, decrease the **reduction factor** (**CS-SENSE reduction factor** in Compressed SENSE).
- To reduce aliasing artifacts, decrease the **reduction factor** (**CS-SENSE reduction factor** in Compressed SENSE).

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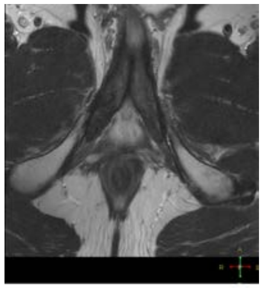
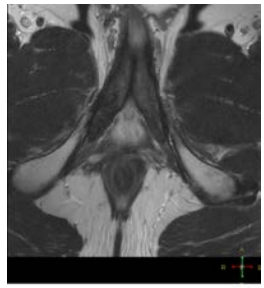
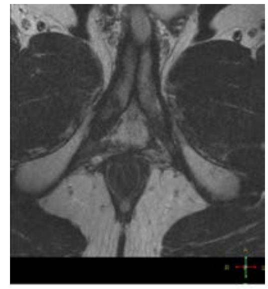
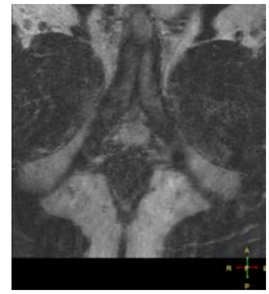
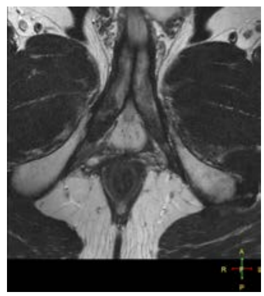
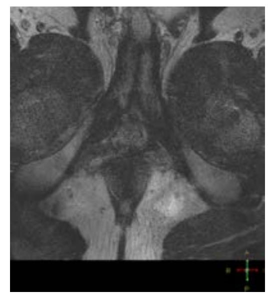
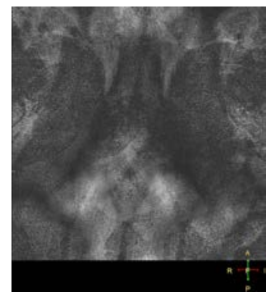
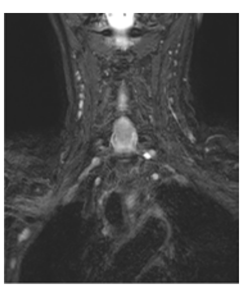
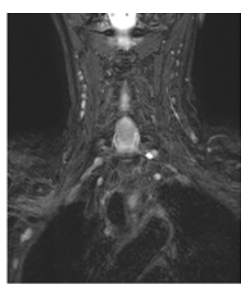
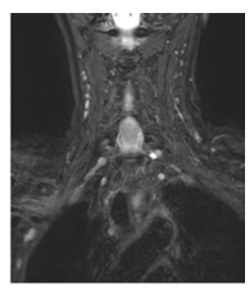
Comparison	Reduction factor 1	Reduction factor 2	Reduction factor 5	Reduction factor 10
Compressed SENSE				
SENSE	-			

Noise appearance in Compressed SENSE

In Compressed SENSE, the **Denoising** imaging parameter allows you to qualitatively specify the amount of denoising in Compressed SENSE image reconstruction.

Possible values are **no**, **weak**, **medium** and **strong**.

- When set to **no**, denoising does not take place.
- When set to **weak**, **medium** or **strong**, denoising takes place with increasing strength. This means less noise in the images, but more artificial smoothing.

Weak denoising	Medium denoising (system default)	Strong denoising
		

Use this parameter to set a balance between the amount of noise and the smoothness of images, according to user preference.

- To improve SNR, increase **Denoising**, for example from medium to strong.
- To reduce blurring, decrease **Denoising**, for example from medium to weak.

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Philips

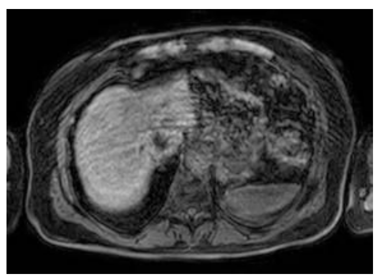
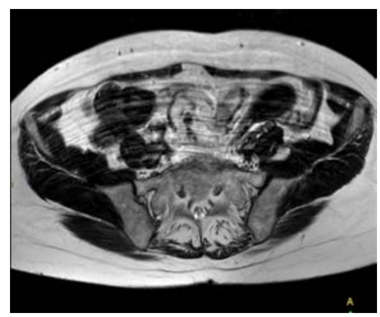
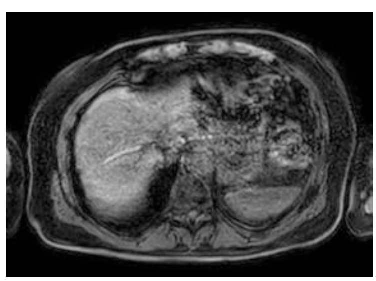
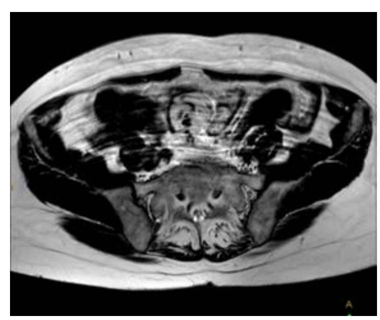
Patient motion and aliasing artifacts

Compressed SENSE and SENSE behave very much alike with respect to acceleration, patient motion and aliasing artifacts.

Aliasing artifacts may occur due to patient motion during the Compressed SENSE reference scan, between the reference scan and the clinical scan, or during the clinical scan.

The table below compares aliasing artifacts in Compressed SENSE and SENSE scans with similar acceleration factors:

- It shows that aliasing artifacts are similar in SENSE and CS-SENSE when similar acceleration factors are used.
- It provides you with countermeasures for SENSE and CS-SENSE.

Comparison with similar acceleration factors	Resulting image when patient motion occurs during the reference scan or between reference scan and clinical scan	Resulting image when patient motion occurs during the clinical scan
Compressed SENSE		
SENSE		
Countermeasure	In SENSE and Compressed SENSE: Repeat the reference scan.	In SENSE and Compressed SENSE: Repeat the clinical scan.

Flame artifact with Compressed SENSE

Artifact appearance	Stripes in scans with Compressed SENSE
Caused by	Caused by difference in imaging sequence between SENSE reference scan and clinical scan.

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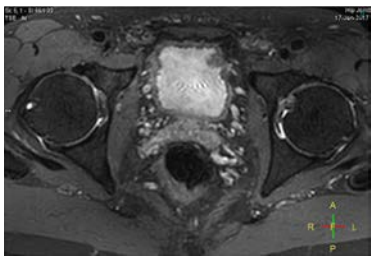
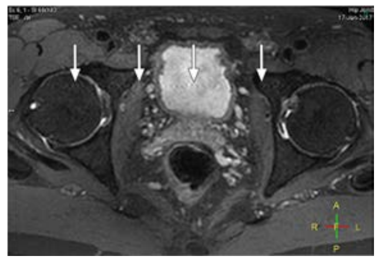
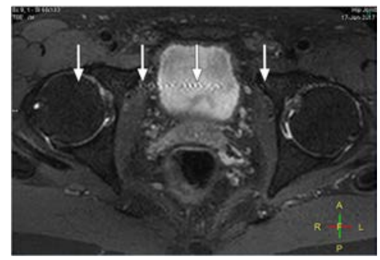
Philips

Countermeasures	• Decrease the CS-SENSE reduction factor. • Use REST slabs.
Related topics	• SENSE

Influence of Compressed SENSE and the CS-SENSE factor

SENSE	Low CS-SENSE reduction factor	High CS-SENSE reduction factor
		
Identical scan and reconstruction resolution, same NSA		
Scan time: 6:39 min	Scan time: 4:39 min	Scan time: 3:29 min

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Fat suppression artifact

Artifact appearance	Fat is not completely suppressed using the SPIR-, SPAIR- or ProSet-technique.
Caused by	• locally distorted magnetic field (B0): water could partially be suppressed instead of fat. and/or • locally distorted RF field (B1): the flip angle used for the SPIR- and ProSet-pulse could slightly vary over the FOV.
Countermeasures	• There are several ways for complete fat suppression. See following list.
Related topics	• STIR. • SPIR. • SPAIR. • ProSet. • Shimming.

NOTICE

SPAIR, SPIR and ProSet are critical with regard to the magnetic field homogeneity.

Countermeasures

Patient preparation

- Remove all metal (also dentures, dental devices) from the patient.
- Ask the patient to remove eye make-up (often containing metallic particles).
- Make sure the patient has been to the toilet, because high signal intensities (e.g. full bladder) may disturb the autoshim.

Positioning

- Ensure that the area of interest is as close as possible to the isocenter (less than 80 mm in any direction).
- Always move the table whenever ‘travel to scan plane’ is prompted.
- Avoid placing two objects (knees, ankles) in one FOV.
- Do not use sandbags inside or near the FOV, because they may enlarge susceptibility effects.
- In some cases, the use of pads made out of special material (e.g. satpads®) may help. Note that by putting the pad between surface coil and patient, the SNR may adversely be affected (larger coil-patient distance).

Parameter settings

- Adjust the FOV to the anatomy of interest.
- Use volume shimming and select the area that needs to be fat suppressed.

Alternative

Do not use spectral fat suppression on anatomies that suffer from large susceptibility effects (neck, cervical spine, thoracic spine). Use STIR instead.

STIR-sequence

- IR or IR-TSE with a short TI.
- providing good fat suppression.
- not useful in combination with contrast agents since they will suppress all tissues with a short T1 including contrast enhanced tissues.

Quadrupole artifact

Artifact appearance	Signal intensity variations with SPIR, especially in abdomen and pelvis.
Caused by	Eddy currents in the patient. This results in B1 disturbance from left to right and from anterior to posterior.

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Countermeasures	STIR or SPAIR instead of SPIR.
Related topics	• STIR. • SPIR. • ProSet. • Shimming.

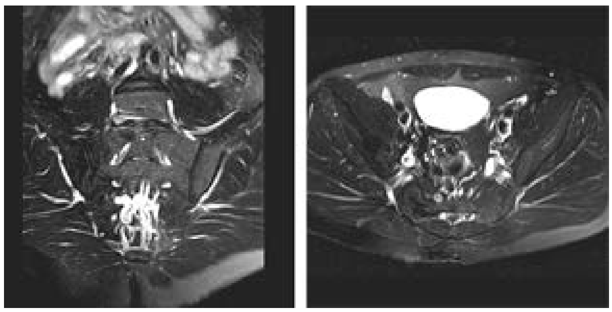

Fig. 444: Left: Coronal oblique. Right: transverse.

NOTICE

Both, SPIR and ProSet are very critical with regard to the magnetic field homogeneity.

Flame artifacts

Artifact appearance	Hypo- and hyperintense lines in flame shape, especially at tissue borders.
Caused by	High-intensity signal from tissue outside the FOV is folded back into the image, mostly caused by arms positioned alongside the body.
Countermeasures	• Use ENCASE in coronal 3D-FFE/-TFE scans. • Increase the FOV so there is no tissue outside the FOV. • Change the fold-over direction if possible so there is no tissue to fold back. This also depends on other artifacts that might occur. • Use REST slabs to saturate tissue outside the FOV.
Related topics	• Fold-over suppression. • REST.

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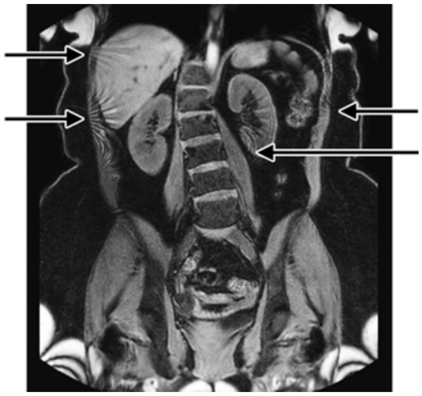

More information

- In the Online Help: How does ENCASE work?
- In the Online Help: How to enable ENCASE?

MRA inflow artifacts

Venetian blind artifact

Artifact appearance	Dark bands (signal decrease) at the end of a volume in the MIP's (Maximum Intensity Projection) of a multichunk 3D Inflow MRA-technique. The larger the volume, the more prominent this effect.
Caused by	Saturation effects.
Countermeasures	• TONE. • CHARM. The artifact doesn't occur anymore with CHARM being introduced with Release 9.
Related topics	• TONE. • CHARM.

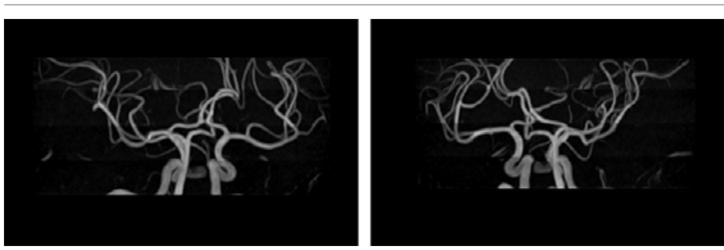

Fig. 445: Left and right: MIP oblique Multichunk scan.

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Staircase artifact

Artifact appearance	Staircase in the MIPs of an M2D Inflow technique.
Caused by	Saturation effects.
Countermeasures	• Use a slice gap with a negative value. Normally an overlap of 25% - 30% is sufficient.

Aliasing in PCA

Artifact appearance	Decreased signal intensity in the centre of the vessel. If a scan is made with a PC velocity smaller than the peak blood velocity, the signal in the middle of the vessel is aliased and presented as backward flow.
Caused by	Aliasing.
Countermeasures	► Select the maximum (peak) velocity in the vessel somewhat higher. • Start with a flow measurement in the vessel of interest. • Draw a ROI in the vessel and generate a Time Intensity Diagram (TID). • Select the appropriate velocity encoding by means of this TID. ► Make the scan with a lower PC velocity to get a good impression of the vessel lumen. *The aliasing artifacts in the centre are in this case not important and might not even be noticed in a MaxIP.*
Related topics	• PCA, see chapter “Phase Contrast Angiography (PCA)” on page 683.
	• QFlow, see chapter “Quantitative Flow (QFlow, QF)” on page 685.

Relation between signal intensity and velocity encoding in PCA-M image

The signal intensity depends on the PC velocity: it increases to a maximum PC velocity 1, drops then and increases again until PC velocity 2. Then the maximum signal intensity at PC velocity 2 is smaller than that compared to PC velocity 1, due to spin dephasing.

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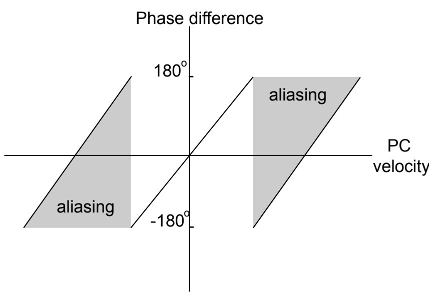
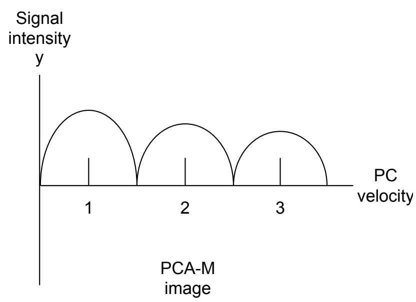
Linear relation between phase (difference) and PC velocity

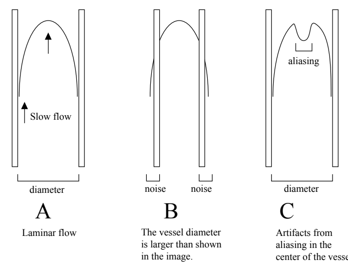


Signal intensity and PC velocity encoding in PCA-M image

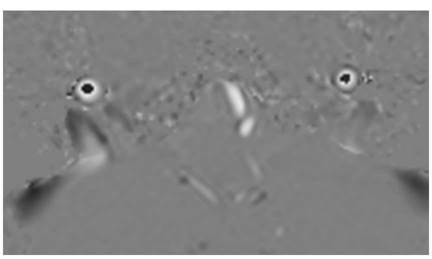


PCA cross section through vessels:

In a straight vessel, there is only laminar flow.
The velocity differs over the lumen: in the centre the highest, at the vessel wall much slower. This difference in velocities is seen as phase dispersion: the signal intensities are a mixture of the velocities over the vessel lumen.Phase dispersion might result in a decrease of signal intensity.



QFlow: Aliasing in the center of the vessels



Fat ghosting in zoom imaging

Artifact appearance	Fat outside the FOV which is superimposed to the image as ghost artifact, most commonly occuring in fold-over direction (phase encoding direction). • In 3D scans also possible in slice direction.
Caused by	Different resonance frequencies of fat and water. This leads to phase differences and consequently to ghost artifacts.
Countermeasures	• Shimming. • Change the fold-over direction if possible. • Use REST slabs to saturate fat outside the FOV. • Use a fat suppression technique such as SPIR or SPAIR.
Related topics	• Fat suppression. • REST.

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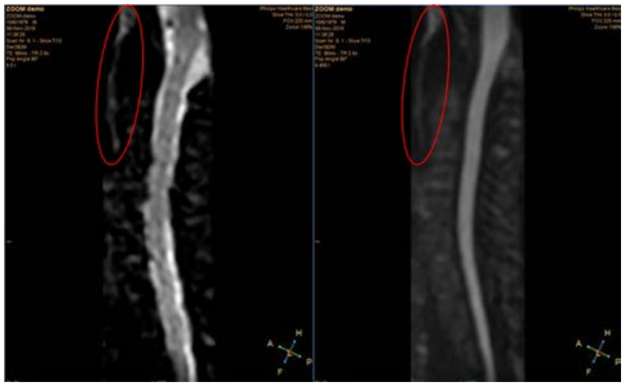

Sagittal DWI spine scans utilizing zoom imaging with ghosting artifacts from fat.

MR Spectroscopy Artifacts

Like MR-imaging, MR-spectroscopy techniques can suffer fromartifacts. Some of these artifacts are hard to recognize, but can completely alter the outcome of the spectrum. It is important to recognize the artifacts and to know how to avoid them.

Truncation at the end of the signal

Artifact appearance	Artifacts presented as sinc wriggles around the peaks appear in the spectrum. The wriggles are mainly seen around the residual water peak.
Caused by	Signal sampling is stopped before the signals have decayed to (close to) zero resulting in abrupt signal intensity changes which cannot be handled well by theFourier transform.
Countermeasure / Solution	Re-acquisition with increased Tacq is the best solution, but time is not always available to do so. For signal to decay completely to zero, the Tacq should be at least 5 x T_2* relaxation time. Increase Tacq by: • Increased number of sampled with equal bandwidth. • Reduce bandwidth with equal number of samples. If re-acquisition is not an option, filtering of the time domain signal is used to influence the signal such that abrupt signal intensity changes are removed. Note that linewidth increases by applyingfilters.

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Philips

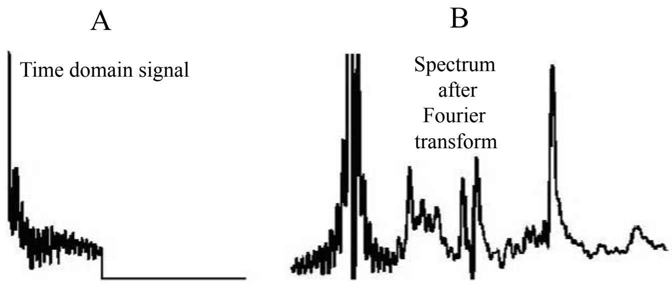

Fig. 446: Time-domain signal (A) that is cut off before signal has decayed, and the resulting spectrum (B). The baseline is distorted by sinc wriggles.

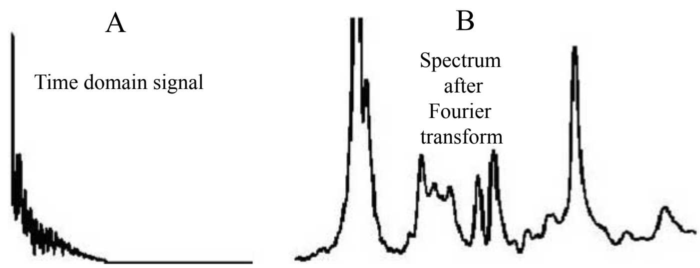

Fig. 447: Same time domain signal (A), with additional Gaussian filtering applied (6Hz). No truncation artifacts in resulting spectrum (B), at the cost of spectral resolution.

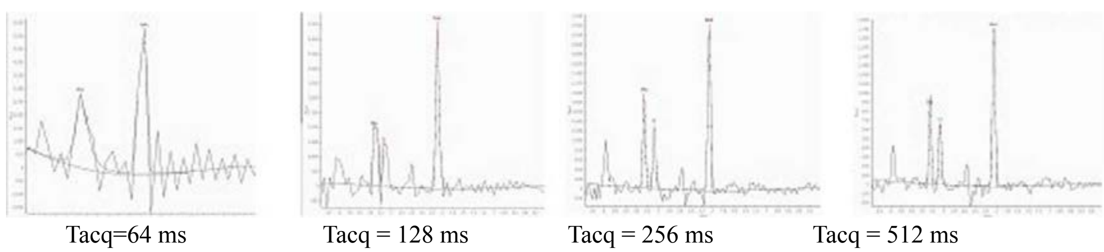

Fig. 448: Image examples in healthy volunteer: SVS TE 144 ms. Different Tacq's.

Truncation with maximum echo sampling

Artifact appearance	Artifacts presented as sinc wriggles appear around the baseline of the spectrum.
Caused by	If maximum echo signal sampling is used and signal sampling only starts close to the echo top position, abrupt signal intensity changes which cannot be handled well by the Fourier transform will occur at the start of signal sampling. This will mainly happen if maximum echo is used with short TE.
Countermeasure / Solution	Asymmetric filtering is applied with the symmetry point set to the echo top position.

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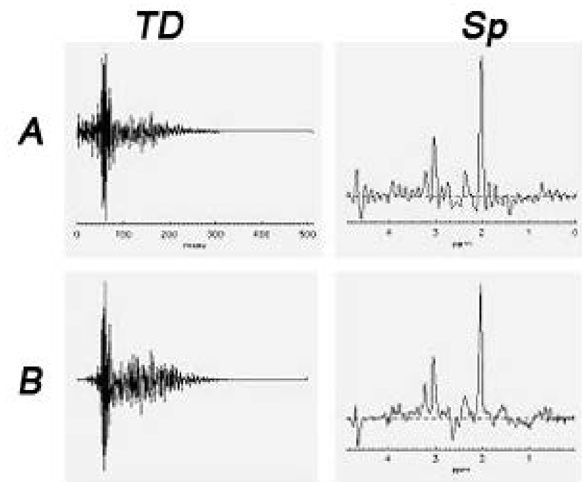

Fig. 449: A: Unfiltered signal versus B: filtered signal (asymmetric filter) where TD is the time domain signal and Sp thespectrum: truncation effect is seen in the unfiltered time domain signal, resulting in wriggles in the baseline of the spectrum whereas the artifacts are minimized when applying an asymmetric filter.

Saturation

Artifact appearance	Saturation effects in the spectrum.
Caused by	Incomplete T_1 relaxation. To maximally measure the metabolite signals, full T_1-relaxation is required before the next excitation is performed. Saturation effects are seen if T_1-relaxation is not complete. The amount of saturation is different for the various metabolites and saturation effects will affect the values found during peak fitting. Even though the saturation effect is not hindering spectral quality, it is mentioned in the artifact section, as it something to be aware of.
Countermeasure / Solution	To allow full T_1-relaxation, the TR used should be ³ 5*T_1 of the metabolite of interest. As T_1-relaxation times of metabolites are long, scan times would increase tremendously.

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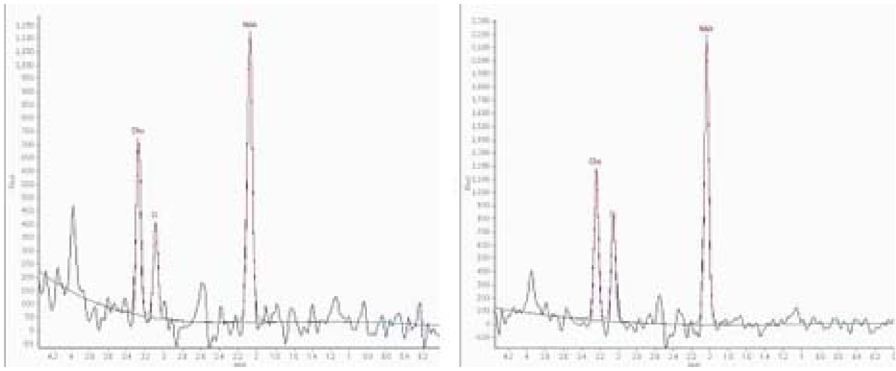

Fig. 450: Brain spectra (inverted) from a healthy volunteer. The Cho/Cre ratio is changed from 1.69 (1000 ms) to 1.44 (4000 ms).

NOTICE

If full T_1-relaxation is not achieved within the TR chosen, it is important to acquire some start-up acquisitions.

These shots are used to place the spin system into steady state.

Frequency drift

Artifact appearance	Increased linewidths. Peaks smear out.
Caused by	Frequency drift. As part of the preparation phases, af0 determination is performed. During the long spectroscopy scan, thisf0 frequency could change slightly,
Countermeasure / Solution	• Save each FID separately, correct for the drift in post-processing.

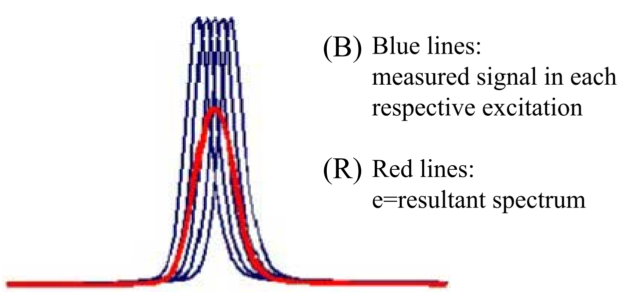

Fig. 451: As the frequency of the peak slightly changes over time, the resultant spectrum will show up as a broader peak with reduced amplitude. Blue lines (B): measured signal in each respective excitation, Red lines (R): resultant spectrum.

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Ghosting

Artifact appearance	Distorted spectra in row of voxels with equal phase encoding gradient. For CSI: even in two directions as phase encodings is done in two directions.
Caused by	(Pulsatile) through-plane flow: Like in MR imaging, (pulsatile) through-plane flow can cause ghosting in the phase encoding directions in spectroscopic imaging.
Countermeasure / Solution	To reduce the signal intensity of through-plane flow, parallel REST slabs can be positioned above and below the stack of CSI-slices.

Baseline distortions

Artifact appearance	Baseline distortions, mainly seen in short TE spectra.
Caused by	Signals of fast realaxing macromolecules and/or signals of unsuppressed water which are still present in the first few points in the time domain signal. These baseline distortion hamper good fitting and quantification.
Countermeasure / Solution	• In time-domain: take out the first points of the FID with shift with zero padding. • In frequency-domain:fit polynomial spline.

It is caused in the first few points in the time-domain signal, where signals of fast-relaxing macromolecules and/or signals of non-suppressed water are still present.

These baseline distortion hamper good fitting and quantification.

DC-Offset

Artifact appearance	Spike signal in the spectrum at zero frequency.
Caused by	Time domain signal decay to a constant, but not to zero.
Countermeasure / Solution	• Phase cycling, to cancel the effect in subsequent measurements. • Subtract the last 10% of the FID.

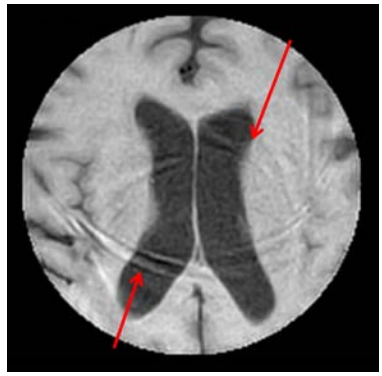
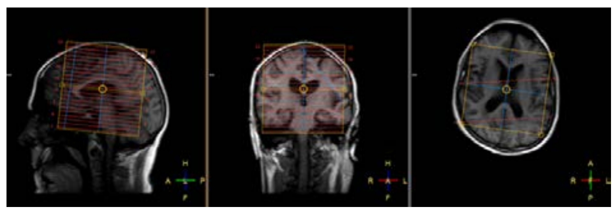
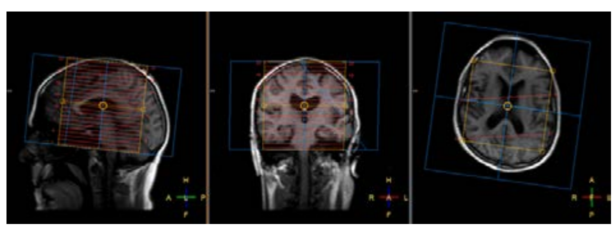
Incomplete water suppression

Artifact appearance	Wriggle artifacts around the (residual) water peak.
Caused by	Incomplete water suppression: residual water signal from outside of the volume of interest gives rise to stimulated echoes, causing artifacts.
Countermeasure / Solution	• Phase cycling (is already implemented in preset procedures). • REST slabs around the VOI to suppress non-suppressed water. • Longer duration of the spoiler gradients.

Residual signals

Artifact appearance	Signals around -2ppm and +10ppm in corrected spectra.
Caused by	Presence of high fat signal in the reference measurement.
Countermeasure / Solution	Reprocess without use of reference measurement.

Spiral Fold-Over Artifact

Artifact appearance	Fold-over artifacts when using Spiral Brain. 
Caused by	Planning with an FOV that is too small and without fold-over suppression. 
Countermeasures	Use fold-over suppression: Only one value needs to be filled out, this value will be distributed symmetrically. Example of a symmetric distributed fold-over value (in this case AP and LR have the same fold-over value): 
Related topics	• Imaging parameter **Fold-over suppression** • Imaging parameter **Acquisition mode = spiral**

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30 Maintenance and Quality assurance

Planned maintenance, Quality assurance and routine user checks are necessary to keep the system operating safely, effectively and reliably.

Philips offers service agreements that include maintenance and repair support. For more details, contact your Philips representative.

Planned maintenance

The operator should always take all practical steps to make sure that the planned Maintenance Program is fully up to date and that all routine user checks have been satisfactorily completed before using the system to examine a patient.

Planned maintenance may only be carried out by qualified and authorized Customer Support technicians. Philips provides a full planned maintenance and repair customer support on both a call basis and a contract basis. Full details are available from your Customer Support Organization.

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Routine user checks program

Routine user checks

The scheduled routine user checks are as follows:

Routine check	Daily	Weekly	Time (min.)
Nurse call	+	+	1
Check Emergency Table Stop buttons on both UIM's*	+	+	1
Patient support	+	+	5
Coils and positioning aids	+	+	10
Magnet check		+	5
Check virus scanner definition date. The last update should not be older than one week.	+		2
Operator's console		+	5
Printer		+	5
Periodic Image Quality Test (PIQT)		+	15

* When pressed, the **Emergency Table Stop** button lights up. Press the **Resume** button to exit the stop mode. When a failure occurs the following message appears on the console:
"Possible failure of Emergency Table Stop button at magnet <location of the button>.
Press the **Emergency Table Stop** button fully. If this does not resolve the issue, call your Philips service engineer."

** Check coils and positioning aids for damage to coverings and connectors.

Weekly magnet check

NOTICE

Does not apply to BlueSeal systems.

This magnet check must also be performed during holiday periods.
Measure the helium level in the magnet cryostat and note the measured values in the logbook.

- Check if the sound of the compressor is still normal.

CAUTION

The compressor for the helium refrigerator must always be running.

Excessive helium boil-off occurs if this unit is switched off.

- Measure the helium level in the magnet cryostat and note the measured values in the log book:
  - Logon to the system.
  - Click the Windows **Start** button on your screen or press the **Windows key** on your keyboard.
  - Select **MR User.**
  - Select **Display Helium Level.**.

The Helium Level is displayed in a pop-up window.

NOTICE

The helium level is displayed with a delay of 20 seconds. Do not use the **Enter** key during that time.

NOTICE

Please contact your local Philips service if significant helium boil-off is observed.

MR systems that are equipped with a zero helium boil-off cooling system have no helium boil-off under normal operating conditions.

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Topping up liquid helium

NOTICE
Does not apply to BlueSeal systems.

Magnet coils must be immersed in liquid to ensure that they remain superconductive. The minimum acceptable helium level for the magnet is 30%.

If the helium level is 30% or lower, contact your helium supply organization.

Anti-virus updates

The MR system is equipped with anti-virus software which is designed to detect viruses on your system and to deny access to infected files, before they can do any damage.

Anti-virus definitions should be updated on a regular basis, usually every day. The Anti-virus definitions update mechanism automatically looks for updated virus definition files at a preconfigured time (as set by service engineer or hospital administrator) and installs them, if available.

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NOTICE
It is the responsibility of the system operator to daily check if the anti-virus definitions are up to date.

Check the anti-virus definitions date

- Right-click on the virus scan icon in the tray of the windows task bar and select ‘About...’.
- In the displayed window check the "DAT Created ON" date.

An update is neccessary if the date of the definitions is older than 7 days (compare with current date).

Update the anti-virus definitions

- Right-click on the virus scan icon in the tray of the windows task bar and select ‘Update Now ...’.
  The anti-virus definitions are automatically updated.
- After the update has finished recheck the date of the definitions.

Periodic Image Quality Test (PIQT)

NOTICE

It is advised to use the PIQT over any other quality assurance program.

PIQT offers an automated and consistent test procedure.

A regular (weekly) execution of predefined scans to monitor the system performance enables early detection of any system deterioration.

PIQT is based on three scans made with the 200 mm head phantom. The scans and analyses are performed automatically and the results are stored. The service engineer can (remotely) access the results of the PIQT.

NOTICE

Apart from the automatic evaluation, it is recommended that the images are visually inspected by the operator or a physicist.

NOTICE

Further options for evaluation and inspection are available in PIQT. For more information please contact your Philips service representative.

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The scans are performed with the following coils:

Possible Coils	
1.5 T systems	**3.0 T systems**
dS Head	dS Head
Q-Body	Q-Body

Performing PIQT scans

The PIQT test will take approximately 15 minutes. ExamCards are not supported in the applications PIQT and SPT (System Performance Test).

1. Select 'SPT' from the System menu.
2. Click the ‘PIQT’ icon or select |File| followed by |Perform PIQT| on the main menu bar. The PIQT windows opens.
3. Follow the instructions on the PIQT window:
   position the phantom in the head section of the coil and move the coil to the isocenter.

4. Click |Proceed| to start the scans.
   The PIQT procedure will run automatically making survey scans, making PIQT scans and evaluating the results.

Remove the phantom when the scans are finished. The system is available for routine use. The PIQT program will analyze the images in the background.

Quality Assurance (QA) Tool for (BOLD) Stability

In order to make sure that the very small BOLD (fMRI) signal is not superimposed by noise, all noise contributions need to be minimized for optimum BOLD results.

The QA Tool provides means to measure stability based on an ACR method. It calculates all *Function Biomedical Informatics Research Network (FBIRN)* metrics based on a predefined protocol according to FBIRN guidelines:
Friedman L, and Glover GH. "Report on a multicenter fMRI quality assurance protocol" JMRI 23:827–839 (2006) .

NOTICE

It is advised to run the QA Tool on a regular base, preferably once a week.

Items needed for QA Tool Stability

The following items are needed:

- Sphere A phantom

  The Sphere A phantom is a 10 cm diameter sphere with a water-based solution. The second choice is the FBIRN gel phantom which is a bigger (17 cm diameter) sphere.
  The air bubble in the phantom needs to be as small as possible.
- dS HeadSpine coil solution (Base coil and Head top coil)
- Foam Pads
- Straps
- Sandbags

Fig. 452: Items needed for QA tool for Stability, Ingenia system.

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Workflow QA Tool Stability

- ► Select **SPT** from the System menu.
  The System Performance Tool window opens.
- ► Click **+** to expand the **Batch files** and **+** again to expand the **FMRI** folder.
- ► Right-click on the coil folder and select **Run Batch**.

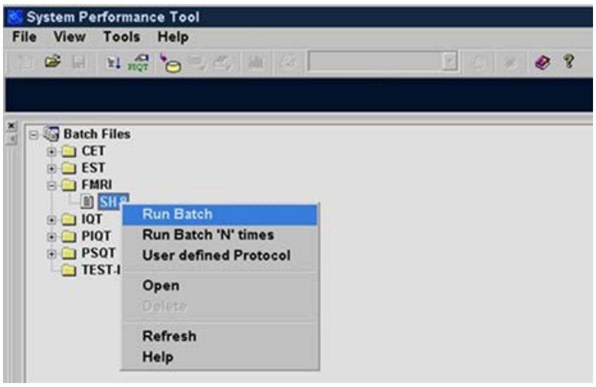

Fig. 453: System Performance Tool window: right-mouse menu with **Run Batch** selected.

- ► Follow the instructions in the window:
  - Set up the phantom in the Head coil, using foam pads to raise it close to the center of the coil.
  - Secure it with foam wedges or straps.
  - Do not use a sandbag in the Head coil. A sandbag can be used on top of the coil to ensure proper connection of the coil.
  - Landmark to the center of the phantom and move the table to the scan plane.

Fig. 454: Set up Ingenia.

- ► Start the acquisition: Click **Proceed** to start the scans.
  The procedure will run automatically making all scans needed.

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NOTICE

The scan starts after a waiting period to avoid fluid motion artifacts. Do not skip this waiting time

Skipping the waiting time can result in automatic plan scan problems and can have negative influence on the IQ results.

- Press **Analyze** to analyze the results and to display and evaluate the results.
- Remove the phantom when the scans are finished. The system is available for routine use.

The following results will be provided:

- Residual Noise graph
  RMS Stability graph
- SFNR image
- Static spatial noise
- numeric results, e.g. Drift, Standard deviation, SNR summary value, SFNR summary value, Noise spectrum peak

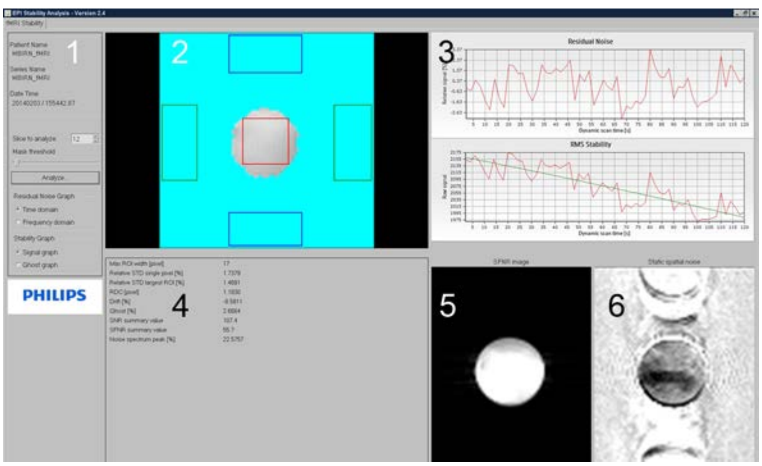

Fig. 455: QA results of a poorly performing system where 1 - Control Area, 2 - Threshold mask overlaid to image with ROIs as used for the calculation, 3 - Residual Noise and RMS Stability graphs, 4 - numeric results, 5 - SFNR image, 6 - Static Spatial Noise image. The Static Spatial Noise image shows many ghosts which is an indication for a poorly performing system.

NOTICE

No additional actions are needed when all parameters are within specifications.
If parameters are out of specification, repeat PIQT the next day to determine if this is consistent.
If parameters are still out of specification request support from your service organization. No additional actions are needed when all parameters are now within specifications.

ACR Accreditation

Accreditation by the American College of Radiology requires phantom data acquisition and analysis, which can be a challenging and time-consuming process. The ACR test software has been developed to provide setup guidance and to automatically perform the acquisition and analysis.

The ACR test software performs the acquisition, position checking, and analysis for the ACR weekly and triennial phantom testing. Weekly tests will typically be performed at the same time each week by a MR technologist; the triennial tests will be performed once every three years by a MR physicist or scientist.

Benefits of the ACR test software are that it

- Saves valuable system time by performing the analysis automatically.
- Simplifies the acquisition by using acquisition parameters matching those required by the ACR guidelines.
- Reduces test failures from incorrect positioning by providing setup instructions and feedback if the ACR phantom is incorrectly positioned.
- Strengthens the QA program by reducing variability of results through a repeatable analysis method.
- Provides center frequency (CF) and transmit gain (TG) values required for Weekly QC.
- Reports values needed for both Weekly QC and Triennial tests for records and accreditation submission.
- Provides another tool to help Philips personnel on-site to troubleshoot ACR-related issues.

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Overview of available ACR Weekly and Triennial Tests

	Weekly Tests	Triennial Tests
Purpose	Weekly Quality Control requirement	Submission for re-accreditation
Frequency	Weekly, at the same time each week	Once every three years
Who runs this test?	MR technologist	MR physicist or scientist
Tests that are run	• Geometric Accuracy • High-Contrast Spatial Resolution • Low-Contrast Detectability (LCD) • Transmit Gain (TG) • Table Position Accuracy (TPA) • Center Frequency (CF)	• Geometric Accuracy • High-Contrast Spatial Resolution • Low-Contrast Detectability (LCD) • Slice Thickness Accuracy • Slice Position Accuracy • Image Intensity Uniformity (IIU) • Percent Signal Ghosting (PSG)

Acquisition information

The table lists the scans that are performed as part of the weekly or triennial tests.

Scan type	Weekly or Triennial
Sagittal Scout	Weekly and Triennial
Axial Scout	Weekly and Triennial
Coil Survey Scan	Weekly and Triennial
SENSE Reference Scan	Weekly and Triennial
ACR Sagittal Locator	Weekly and Triennial
ACR Axial T2 Dual Echo	Triennial
ACR Axial T1	Weekly and Triennial

Performing the ACR test

Before you begin

- Your system should always be up to date with its preventive maintenance.

  Additionally, it is recommended to run a Periodic Image Quality Test (PIQT) prior to ACR testing to ensure system performance is within the manufacturer's specifications.
- Make time available for the ACR test: Approximately 20 to 30 minutes are needed to complete the ACR tests.

  When an ACR test is cancelled, it cannot be resumed, but it must be started from the beginning.

Equipment needed

- dS HeadSpine coil (dS Base and dS Head top)
- NVC-ACR Phantom holder
- ACR Phantom
- Nonferrous level used to align the phantom
- Positioning pads- Small (3cm) grey foam wedge set
- ACR Log Sheet: this may be an online spreadsheet, or in paper form
- (Optional) USB storage drive: If you plan to email or store the test results in a location other than the MR system, you can use a USB data drive to copy the test results.

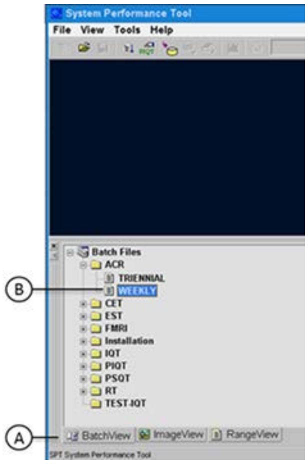
Setting up the ACR test

► To start the System Performance Tool (SPT), from the main menu bar select **System -> SPT...**.

⇨ The System Performance Tool opens in a new window.

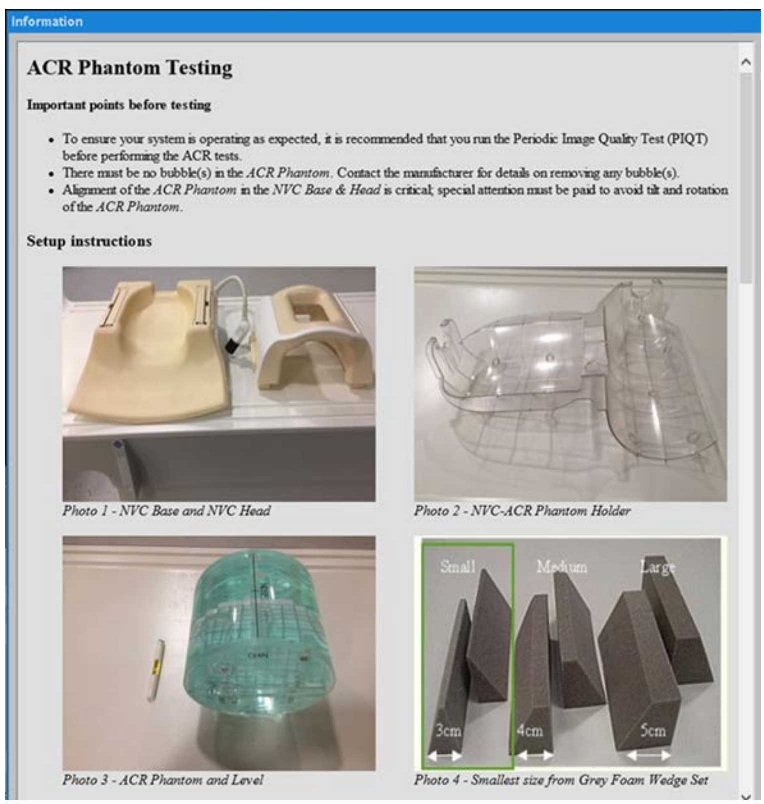
► In the System Performance Tool window, click the **BatchView (A)** tab.
The tests that are available on the system are displayed, in a folder structure.

► To select the appropriate test, expand the **ACR** folder and then click **TRIENNIAL** or **WEEKLY (B)**.



► To run the test, right-click on the test and select **Run Batch**.

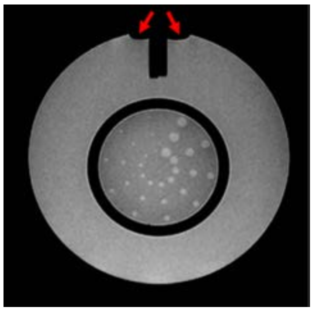
⇨ When you select the test to run, instructions for correct phantom placement are displayed on the screen.

⇨ 

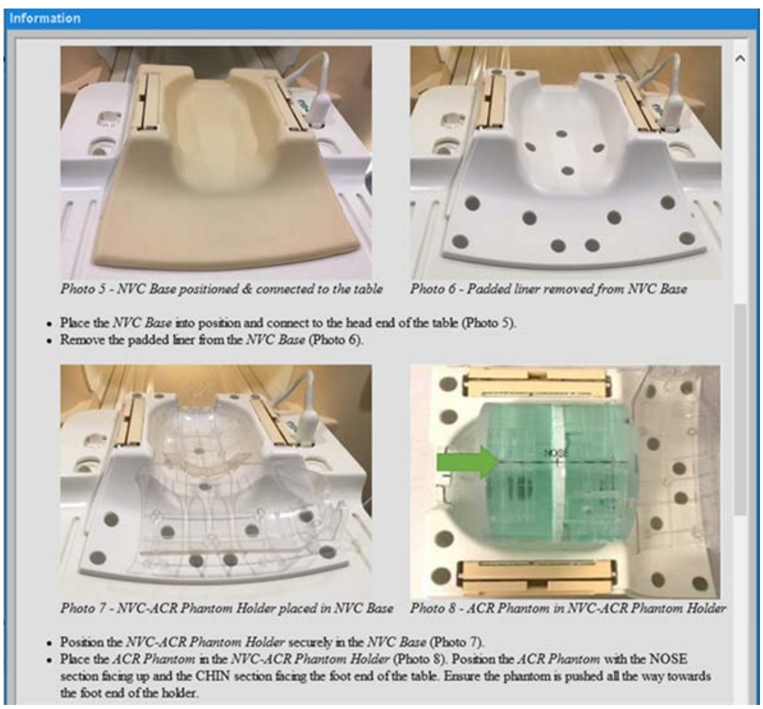
Setting up the phantom

► Before you work with the phantom, carefully read chapter “Liquids in phantoms” on page 86.

- Check the phantom for air bubbles.
  If you find air bubbles in the phantom, ACR tests cannot be run. Instead contact the phantom manufacturer for phantom fluid replenishment.
  Large air bubbles would appear as a void at the top of the axial image (red arrows):



- With the dS Base of the dS HeadSpine coil on the tabletop: remove the base padded liner from the base.
- Place the NVC-ACR phantom holder into the dS Base coil.
- Position the ACR phantom in the NVC-ACR phantom holder.



- Attach the NVC Head coil top portion to the NVC base.
- Slide the ACR Phantom to the correct position in the coil.
- Use the non-ferrous leveling tool to ensure the phantom is level.
- Insert the small grey foam wedges to secure the phantom in the head coil.

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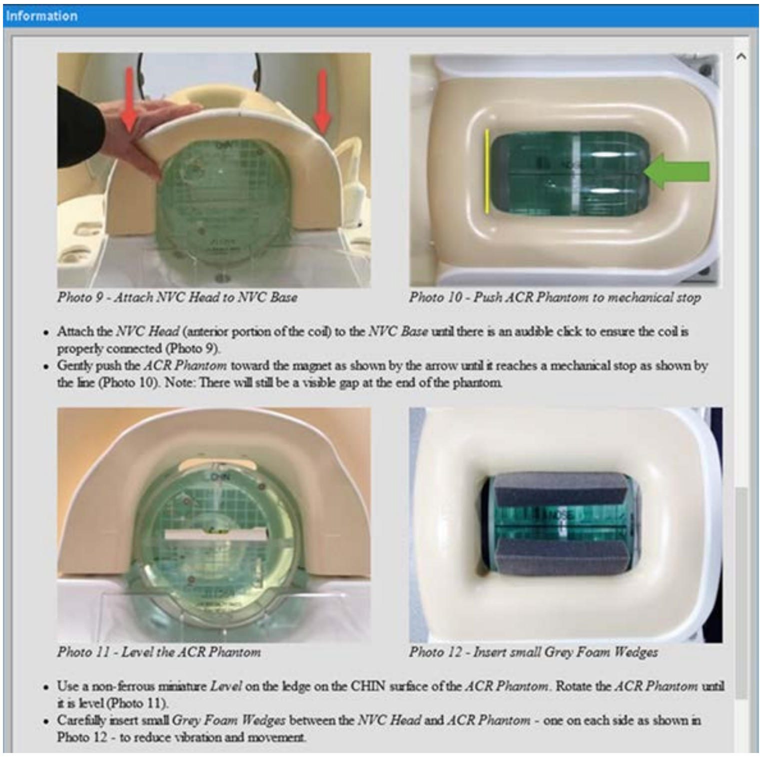
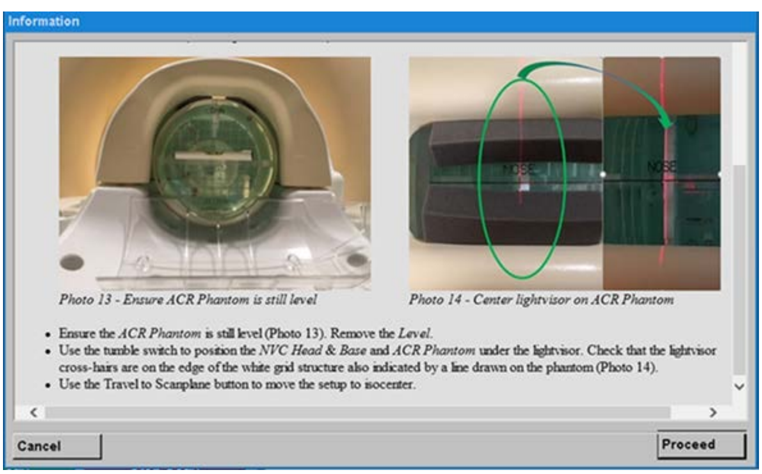


► Verify phantom rotation using the non-ferrous level.

► Position the light visor cross-hairs on the edge of white grid structure, then move setup to isocenter.



Running the ACR test

► In the Information dialog window, click **Proceed**.

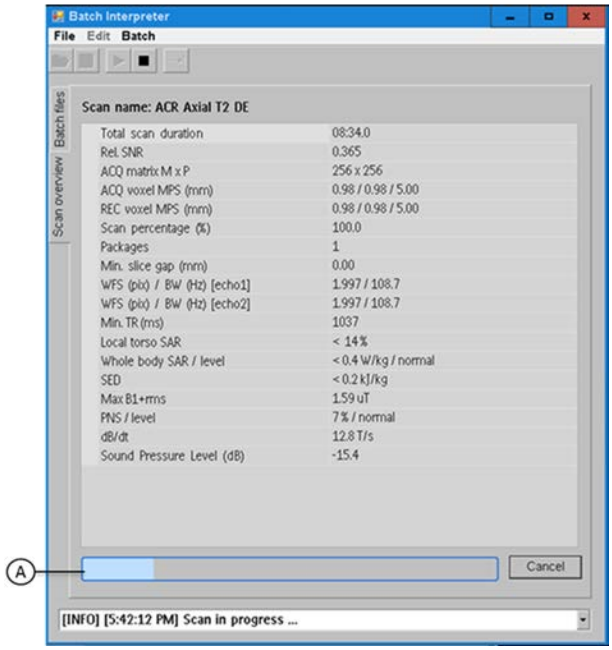
⇨ The acquisition starts.

⇨ Phantom scans are evaluated:

• If the phantom is correctly positioned, the test runs until completion.

- If the phantom is not correctly positioned, an error message describes the problem and recommends how to correct the positioning.

⇨ The current scan and remaining scan time are displayed on the screen. The status bar (**A**) indicates the progress where



⇨

- light gray indicates the preparation phases.
- pale blue indicates the acquisition progress.
- darker blue indicates the reconstruction progress.

⇨ When the acquisition is completed, the following message displays:
Batch execution finished successfully.

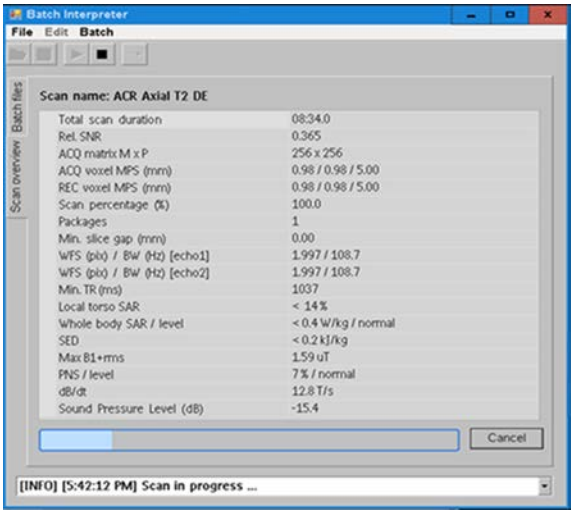
► Click **OK** to proceed to data analysis.

► Upon completion of the acquisition, remove the phantom, positioning aids, and the coil from the scanner and safely store them.

Stopping the ACR test

You may need to stop the ACR test to perform an emergency examination.

► In the **Batch Interpreter** window, click **Cancel**.



- The message *"Scan stopped by the operator. Press Proceed and close Batch Interpreter UI to continue"* appears. Click **Proceed**.
- Close the **Batch Interpreter** window.
- Remove the phantom, positioning aids, and the coil from the scanner and safely store them.

Analyzing the ACR data set

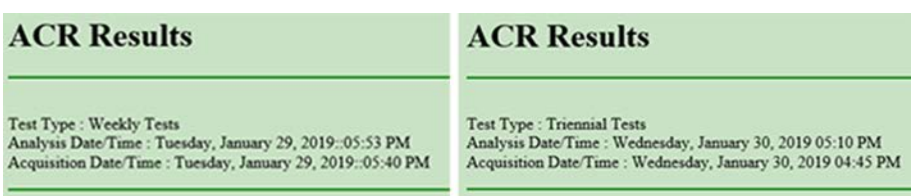
Running analysis

After the acquisition is complete, the data set automatically begins analysis and generates a report.

Viewing analysis results

The results are displayed when the analysis has completed.

Examples of ACR results



Slice Position Accuracy:

Region of Interest (ROI) Signal Intensity Measurement Table:

Scan	Slice/Echo	Mean Value	WL	WW
ACR-T1	Sl1 / E1	1839	919	1
ACR-T1	Sl11 / E1	1820	910	1
ACR-T2	Sl1 / E2	953	476	1
ACR-T2	Sl11 / E2	933	466	1

Geometric Measurement Table:

Scan	Slice/Echo	Left Bar	Right Bar	Offset
ACR-T1	Sl1 / E1	0.0	1.0	1.0
ACR-T1	Sl11 / E1	0.0	3.9	3.9
ACR-T2	Sl1 / E2	0.0	1.0	1.0
ACR-T2	Sl11 / E2	0.0	2.9	2.9

Slice Thickness Accuracy:

Region of Interest (ROI) Signal Intensity Measurement Table:

Scan	Slice/Echo	Mean Top	Mean Bottom	Dev.[%]	WL	WW
ACR-T1	Sl1 / E1	310	314	1.1%	156	1
ACR-T2	Sl1 / E2	159	163	2.2%	80	1

Distance Measurement Table:

Scan	Slice/Echo	Top	Bottom	Sl Th
ACR-T1	Sl1 / E1	53.7	53.7	5.4
ACR-T2	Sl1 / E2	49.8	50.8	5.0

Image Intensity Uniformity:

Max Min Mean Intensity Value Table:

Scan	Slice/Echo	Max.Mean	Min.Mean	PIU[%]
ACR-T1	Sl7 / E1	1979	1777	94.6 %
ACR-T2	Sl7 / E2	1031	937	95.2 %

% Signal Ghosting:

Region of Interest (ROI) Measurement Table:

Scan	Slice/Echo	Center	Top	Bottom	Left	Right
ACR-T1	Sl7 / E1	1861	2.2	1.7	3.0	3.6

Calculated Ghosting Level Table:

Scan	Slice/Echo	Ghosting[%]
ACR-T1	Sl7 / E1	0.074

Geometric Accuracy:

Window Width / Level Table:

Scan	Slice/Echo	Mean Value	Window Width	Window Level
ACR Sag Localize	Slice 1 / E1	1142	1142	571
ACR-T1 Axial	Slice 1 / E1	1340	1340	670
ACR-T1 Axial	Slice 5 / E1	1539	1539	769

Geometric Measurement Table:

Scan	Slice/Echo	Axis	Measured
ACR Sag Localize	Slice 1 / E1	Top-Bottom	147.46
ACR-T1 Axial	Slice 1 / E1	Top-Bottom	189.45
ACR-T1 Axial	Slice 1 / E1	Left-Right	190.43
ACR-T1 Axial	Slice 5 / E1	Top-Bottom	189.45
ACR-T1 Axial	Slice 5 / E1	Left-Right	188.48
ACR-T1 Axial	Slice 5 / E1	Diag-UL	190.59
ACR-T1 Axial	Slice 5 / E1	Diag-UR	190.59

High-Contrast Resolution:

Region of Interest (ROI) Signal Intensity Measurement Table:

Scan	Slice/Echo	Evaluation	1.1 mm	1.0 mm	0.9 mm
ACR-T1	Slice 1 / E1	UL Hor(row)	1 (4)	1 (1,2,3,4)	0
ACR-T1	Slice 1 / E1	LR Ver(Col)	1 (1,2,3,4)	1 (1,2,3,4)	0
ACR-T2	Slice 1 / E2	UL Hor(row)	1 (1,2,3,4)	1 (1,2,3,4)	0
ACR-T2	Slice 1 / E2	LR Ver(Col)	1 (1,2,3,4)	1 (1,2,3)	0

Low-Contrast Detectability:

ACR T1 Axial (Slice 8 -11):

Scan	Slice/Echo	Resolved
ACR-T1	Slice 8 / E1	9
ACR-T1	Slice 9 / E1	10
ACR-T1	Slice 10 / E1	10
ACR-T1	Slice 10 / E1	9

ACR T2 Axial (Slice 8 -11):

Scan	Slice/Echo	Resolved
ACR-T2	Slice 8 / E2	9
ACR-T2	Slice 9 / E2	10
ACR-T2	Slice 10 / E2	9
ACR-T2	Slice 10 / E2	9

Center Frequency, Transmit Gain & Table Position:

Center frequency (Hz)	127761813
Transmit Gain	0.8642 / 0.8739
Table Position (mm)	0.30

Saving the results as PDF file (optional)

The report data is automatically saved and can be viewed at any time.

- ► To save the report, for both weekly and triennial, as a PDF file which can be printed, click in the test report window.
- ► Press the ALT key on the keyboard.
  The menu toolbar displays.
- ► Do any of the following:
  - Click **File -> Print**.
  - Press **CTRL+P**.
- ► Select **Printer: Microsoft print to pdf**.
- ► Select the destination of the file.
  To save to the USB drive, in the **Devices and drives** section, click the drive.
- ► Enter a file name and click **Save**.

Transferring the results to the ACR Test Log

NOTICE

To view the ACR large Phantom Weekly QC Form, visit the ACR website

https://www.acraccreditation.org

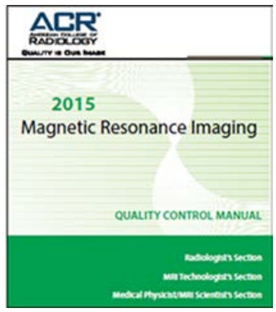
To store the ACR test data in online files, follow the following workflow:

- ► Locate the log file or sheet.
- ► Copy the test result data to the log file.
- ► Save or store the log file as directed by your organization.

If test results do not meet ACR requirements

The ACR Weekly QC Log includes the acceptable range of test results. Acceptable test result ranges for both the Triennial and Weekly tests can be found in the Phantom Test Guidance for Use of the Large MRI Phantom for the MRI Accreditation Program document and the 2015 MRI Quality Control Manual. Both guides are available on the ACR website.

If the test indicates the system fails to meet the ACR requirements, you should contact your Philips Service Representative.



Managing report data

After the ACR tests are analyzed, the results are displayed in the ACR Test Tool. Report data is displayed using HTML, which includes text and screen shots of the phantom test images for the most recent Weekly and Triennial test.

Datasets of ACR Test

When the test report dataset is saved, it is separated and stored in different locations:

Type of dataset	File type	Location of storage
Exam (source) images	DICOM	patient database
Analysis results	xml	
Screen shots of exam images (optionally)	pdf	

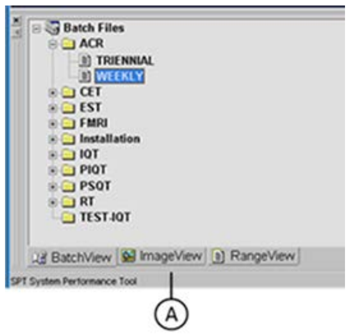
Available previous exam results

You can view results from previous tests:

- **Latest report**: this includes
  Analysis test data of the most recent Weekly or Triennial test.
- **All reports**: this includes
  - Analysis test data from the most recent Weekly or Triennial test.
  - Analysis test data from all the previous Weekly or Triennial tests.

Viewing previous exam results

► In the **System Performance Tool** window, click the **ImageView** tab **(A)**.



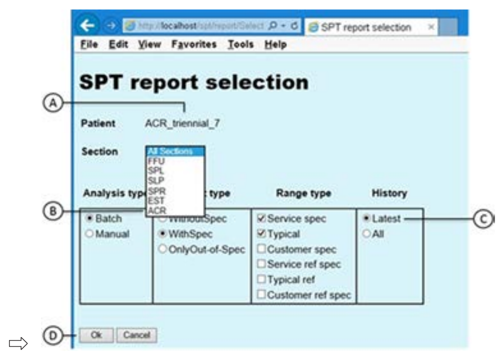
► In the **Patient name** column, click the data set to be viewed.

ACR datasets are labeled:

- ACR_triennial
- ACR_weekly

► From the **Tools** menu, select **Generate Reports...**

⇨ The **SPT report selection** window opens:



► In the Patient area, verify that the dataset to view is Weekly or Triennial **(A)**.

► From the **Section** dropdown menu, select **ACR (B)**.

► In the **History** list **(C)**:

- Click **Latest** to view the report from the most recent test.
- Click **All** to view all reports from the tests.

► Click **Ok (D)**.

A report is generated.

Error messages

If there are problems during scanning, an error message is displayed.

The table lists the error messages with possible resolutions.

Error message	Possible resolution
"**Tabletop needs to be moved in order to disengage posterior coil for scanning.** Move tabletop remotely to disengage the posterior coil? Press Yes to move tabletop remotely. Press No to move tabletop at magnet."	Click **Yes** to move the tabletop remotely.
"Analysis failed for ... **ERROR: Wrong phantom is detected.** Possible cause(s): Phantom other than ACR phantom was used. Possible solution(s): Use the ACR phantom."	Use the ACR Phantom.
"Analysis failed for ... **ERROR: The phantom is incorrectly rotated.** Possible cause(s): Phantom is not positioned correctly. Possible solution(s): Please reposition the phantom following on-screen instructions and run the test again."	Reposition the ACR Phantom and verify with the non-ferrous level.
"Batch terminated- Scan not performed; scan definition failed. Press Proceed and close Batch Interpreter UI to continue."	Plug in the coil.
"Scanner Error- Cannot determine optimum RF power"	Advance the tabletop to the iso-center.
"Batch Interpreter Error- Aborted"	Close the RF door; Door Open during scanning.
"SPT Error- Spectrometer not available"	Cycle power, restart the system. If this doesn't resolve the error, call Philips Service.

Troubleshooting the ACR test results

The ACR test results may be inaccurate due to some common issues that can be easily remedied.

Troubleshooting

Issue	Area	Cause of issue	Relevant for
Phantom positioning error	Phantom setup	Philips phantom holder was not used.	weekly and triennial tests
Phantom rotated	Phantom setup	Phantom was not leveled accurately.	weekly and triennial tests
Excessive vibration	Phantom setup	Small grey foam wedges were not used to stabilize the phantom.	weekly and triennial tests

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Issue	Area	Cause of issue	Relevant for
First slice much lower intensity	Phantom setup	Phantom is not advanced into coil until mechanical stop.	weekly and triennial tests
Test failure	High-Contrast Spatial Resolution	Phantom placement is incorrect.	weekly and triennial tests
Test failure	Low-Contrast Detectability (LCD)	Phantom placement is incorrect.	weekly and triennial tests
Bright artifacts on the edge of the FOV in Spin Echo sequences	Artifacts	Spurious echo. Expected artifact with Spin Echo NSA =1.	weekly and triennial tests
Center frequency cannot be determined	Center Frequency determination	System issue. Contact Philips Service.	weekly test
Transmit Gain cannot be determined	Transmit Gain determination	Inaccurate positioning of the light visor on the edge of the grid portion of the phantom.	weekly test
Measurement failure	Table Position Accuracy	Air bubbles in phantom	weekly test
Measurement failure	Geometric Accuracy	Air bubbles in phantom	triennial test
Test failure	Slice Thickness Accuracy	Gradient or RF Chain issue. Contact Philips Service.	triennial test
Test failure	Slice Position Accuracy	Phantom placement is incorrect.	triennial test
Test failure	Image Intensity Uniformity (IIU)	Coil malfunction. Shim issue. Contact Philips Service.	triennial test
Test failure	Percent Signal Ghosting (PSG)	Possible RF shielding issue. Ancillary euipment interference. Contact Philips Service.	triennial test

Cleaning and Disinfection

Cleaning and disinfection of your MRI system must comply with all applicable laws and regulations which have the force of law within the jurisdiction(s) in which your system is located.

- Cleaning and disinfection may only be performed by appropriately trained personnel.

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- Before cleaning and disinfecting the MRI system, system components and positioning aids, it is essential that you read and familiarize yourself with all Warnings and Cautions given in this Instructions for Use.

Cleaning

Cleaning is the physical removal of foreign material, e.g. dust, soil, organic material such as blood, secretions, excretions and microorganisms. Cleaning generally removes rather than kills microorganisms.
Cleaning is accomplished with water, detergents and mechanical action.

Cleaning is an essential prerequisite for effective disinfection.

Disinfection

Disinfection is the process of eliminating or reducing harmful microorganisms from inanimate objects and surfaces.

Levels of disinfection

The level of disinfection required for a device is dictated by the type of tissue with which it is in contact during use. The table below shows which level of disinfection needs to be performed depending on the classification of the device.

Classification	Definition (type of tissue)	Level of disinfection
Critical	Device contacts otherwise sterile tissue (for example, intraoperative applications)	Sterilization
Semi-critical	Device contacts mucous membranes (for example, intracavity applications)	High *
Noncritical	Device contacts intact skin	Intermediate or low *

* In some countries, disinfection is not differentiated in low, intermediate and high level.

The disinfection of the MRI system, components and positioning aids is classified as non-critical and requires intermediate or low level disinfection.

Low level disinfectants kill most vegetative bacteria and some fungi as well as enveloped (lipid) viruses (e.g., hepatitis B, C, hantavirus, and HIV). Low level disinfectants do not kill mycobacteria or bacterial spores.
Intermediate level disinfectants kill vegetative bacteria, most viruses and most fungi but not resistant bacterial spores.

Cleaning agents and disinfectants

Only use the cleaning agents and disinfectants that are listed in this section.
Philips cannot be held liable for damage caused by the use of different products or compositions.

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Recommended for cleaning

Use only mild household cleaning agents, diluted in water. Use a soft damp cloth. Do not apply large amounts of water.

Recommended for disinfection

Only the described disinfectants are tested and recommended by Philips.

Tested and recommended disinfectant	Disinfection level
Isopropanol 70%	Intermediate
Ethanol 70%	Intermediate
Chlorhexidine 0.5% in 70% ethanol	Intermediate
1:200 Bleach solution (250 ppm chlorine) (5 ml household bleach in 1 L water)	Low

Guidelines for the use of cleaning agents and disinfectants

- Always adhere to the safety instructions of the cleaning agents.
- If a premixed solution is used, be sure to observe the solution expiration date.

NOTICE

Inappropriate cleaning agents or disinfectants may cause discoloration, damage or structural weakening of the equipment.

- Check the constituents and concentration of cleaning agents and disinfectants before use.
- Never use aggressive detergents, organic solvents or abrasive cleaning agents.
- Never use iodine or colored disinfectants.
- Never use a bleach solution of more than 250 ppm.
- Never use bleach wipes.
- If you are not sure about the properties of a disinfectant agent, do not use it.

- Never mix different cleaning and disinfecting solutions because hazardous gases may develop.

WARNING

Ignition of disinfecting spray.

Risk of serious injury or death.

- **Do not use flammable or potentially explosive disinfecting sprays.**

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Factors affecting the efficacy of a disinfectant solution

- Duration of exposure
- Age of the solution
- Concentration of the disinfectant
- Way of storage
- Resistance of the contaminant
- Organic matter on the item to be disinfected

General cleaning instructions

- Use soft cloths, disposable tissues and wipes.
- Only use commercially available MR Safe and MR Conditional equipment and tools. Strictly follow the manufacturer's instructions.
- Never use cleaning equipment that contains ferromagnetic material.

Preventing residue on MRI system

Use sheets or MR compatible examination table paper to cover the tabletop before positioning a patient. Be aware that the use of sheets and paper without actual cleaning and disinfection does not prevent the spread of infectious agents.

Protecting yourself and others

As an operator, wash and disinfect your hands (hand sanitizer) after each patient.

WARNING

Infectious residue

Risk of cross-infection

- **Always clean and disinfect the bore, tabletop, mattresses, positioning aids, coils, physiology sensors and cables after each examination of (injured or infectious) patients where contamination may have occurred.**
- **Use proper personal protection and precautions when removing blood or residual contrast medium.**

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Handling liquids

WARNING

Electrical conductive path due to excessive liquid

Risk of electric shock

- **Never allow water or other liquids to enter the system, system components, coils, coil contacts (of separable coils) and connectors.**
- **Verify that all parts of the system, coils and positioning aids are completely dry before starting an examination.**

If liquid has entered the system, contact your Philips service engineer.

See the table in section **Components, procedures and frequency** for cleaning frequencies.

Components, procedures and frequency

The following table gives an overview of system components and cleaning and disinfection procedures.

Three different procedures have been identified for cleaning and disinfection. These are:

1. **Regular** procedure: applicable for hard and soft closed-cell surfaces.
2. **Other** procedures: applicable for other surfaces and components.
3. **Fabric and foam** procedure: applicable for soft open-cell surfaces.

Component of MR system	Cleaning	Disinfection	Procedure	Frequency
• Magnet covers / Gantry • Ambient ring • Patient support • Trolley (FlexTrak)	Yes	Yes	Regular	Weekly *
• Magnet bore • Tabletop	Yes	Yes	Regular	After each patient **
• UIM panel	Yes	Yes	Other	Weekly *

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Coils	Cleaning	Disinfection	Procedure	Frequency
• Rigid coils • Soft and flexible coils • Coil cables	Yes	Yes	Regular	After each patient **
• Coil connectors and sockets	Yes	No	Other	Weekly *
• Endo coil with disposable probe	Yes	Yes	Other	After each patient **

Positioning Aids	Cleaning	Disinfection	Procedure	Frequency
• All positioning aids, except for straps and foam wedges	Yes	Yes	Regular	After each patient **
• Straps • Foam wedges	Yes	No	Fabric and foam	After each patient **

Physiology Equipment	Cleaning	Disinfection	Procedure	Frequency
• Leads and cables • Respiratory belt • Wireless-PPU and Wireless-VCG battery module	Yes	Yes	Regular	After each patient **
• PPU and reusable clips	Yes	Yes	Other	After each patient **

Operator's console	Cleaning	Disinfection	Procedure	Frequency
• Monitor displays • Printer	Yes	No	Other	Weekly *
• Keyboard • Operator-patient intercom	Yes	Yes	Other	Weekly *

Examination room	Cleaning	Disinfection	Procedure	Frequency
Coil cabinet and coil caddy	Yes	Yes	Regular	Weekly *
Examination room floor	Yes	No	Other	Weekly *

* Or as required.
** Recommended.

Full system cleaning

Clean all components of the MRI system before first use of the system and after maintenance.

Cleaning and disinfecting: regular procedure

This cleaning procedure applies for:

- All components of the MRI system
- All coils, except for coil connectors and sockets, and the Endo coil with disposable probe
- All positioning aids, except for straps and foam wedges
- Leads, cables, respiratory belt of physiology equipment
- Coil cabinet and coil caddy

Inspection

- ► Inspect coils and cables for damage such as cracks, splitting, sharp edges, or projections.
  If damage is evident, discontinue use of the coils or cables and contact Philips Customer Service.
- ► Inspect the surface of positioning aids like supports, wedges, mattresses and sandbags regularly for breaches, tears or frays.
- ► In case of damaged material:
  - Remove and replace breached, torn or frayed mattresses, supports, wedges, and sandbags immediately.
    The internal spongy structure cannot be cleaned and disinfected adequately.
  - Do not use patches to repair tears and holes.
    Patches do not provide an impermeable surface.
- ► To easily detect biological material, inspect the surfaces using black light.
  A black light provides ultraviolet light that is especially sensitive in detecting biological material such as blood, prints and body fluid. This material lights up under black light exposure.

  If biological material remains after proper cleaning, it may indicate the surface is breached, frayed or torn allowing fluids to enter the structure.

Cleaning: regular procedure

1. Prepare a mild soap or detergent solution (preferably liquid soap based, rather than antiseptics).
2. Take a soft cloth and damp it in the mild soap or detergent solution.
   Do not apply large amounts of water.
3. Only applicable for tabletop: Thoroughly remove any solid matter in the grooves of the tabletop using a soft cloth or a tissue.
4. Use a swab or toothpick to remove dirt from hardware joints and parts difficult to reach.
5. Wipe hard surfaces with the soft cloth until all visible signs of surface contaminants are removed.
6. Remove remaining particulate and cleaning residue with a cloth dampened with clean water.
7. Towel dry with a soft cloth.
8. Dispose of any used cleaning materials in accordance with your facility's disposal protocols.

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Disinfecting: regular procedure

1. Clean the surface according to the instructions above.
2. Wipe the surface with a soft cloth dampened in a recommended disinfectant.
3. When alcohols are used: air dry the surface.
4. When bleach solution is used:
   - Allow at least 1 minute contact time for bleach solution.
   - Always wipe surfaces with a cloth dampened with clean water to remove the bleach solution.
   - Air dry or dry with a clean cloth.
5. Dispose of any used disinfection materials in accordance with your facility's disposal protocols.

Cleaning and disinfecting: other procedures

Keyboard and UIM

1. Remove any solid matter around keys and buttons with a swab or toothpick.
2. Clean by wiping the keys and the sides with a soft cloth or tissue dampened in a mild soap or detergent solution and wipe dry.
3. Disinfect the surface by wiping the keys and the sides with a soft cloth or tissue dampened in a recommended disinfectant.
4. When alcohols are used: air dry the surface.
5. When bleach solution is used: wipe the surface with a cloth dampened with clean water to remove the bleach solution. Air dry or dry with a clean cloth.

Monitor displays

▷ Before cleaning turn off the display and unplug the power if possible.

► Wipe with a soft cloth moistened with soap and water. Alternatively use a window cleaner.

Printer

► Clean the printer according to the manufacturer's instructions.

Examination Room

► Clean the floor according to your facilities' cleaning protocol.

FlexConnect sockets and connectors

For proper functioning of dStream coils it is essential that the lenses of FlexConnect sockets and coil connectors are clean.

Clean the lenses by using the special cleaning kit, which is provided with the system.

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Endo coil with disposable probe

Cleaning and disinfection

Discard the probe in a hazard waste container. The probe (endo coil) is for single use only.

Clean and disinfect the interface device after each use with one of the following solutions:

- Distilled water, mild dish detergent
- 10% bleach/90% distilled water solution
- Hydrogen peroxide
- Isopropyl alcohol
- Formula 409
- Lysol disinfectant
- Methylated spirits (90% ethanol, 9.5% methanol, 0.5% pyridine)

NOTICE

Inappropriate cleaning agents

Risk of material damage

- Never use solutions containing amines, strong alkalis, esters, iodine, aromatic or chlorinated hydrocarbons, or ketones.

NOTICE

Do not sterilize any part of the coil.

Sterilizing may damage the equipment.

PPU sensor and reusable clips

Cleaning PPU sensor and reusable clips

To clean the sensor (cable) and the reusable clips complete the following steps:

- ► Disconnect the PPU sensor from the Wireless-PPU battery module.
- ► To remove dirt and dust, wipe the surface with a lint-free cloth, moistened with warm water (40°C/104°F maximum) for 30 seconds to 1 minute to ensure proper cleaning.
  To remove stains, scrub briskly with the moistened cloth.
- ► Inspect the PPU sensor and reusable clips for any cracks, holes, tears, cuts, etc. that could affect operation and replace as necessary.

Disinfecting PPU sensor and reusable clips

1. Clean the surface according to the instructions above.

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2. Only use the recommended liquid surface disinfectants:
   - CaviWipes.
   - Alcohol (70%).
   - Antibacterial soap (10% Triclosan).

NOTICE

Do not sterilize any part of the PPU sensors and reusable clips.

Sterilizing may damage the equipment.

Cleaning: fabric and foam procedure

Foam wedges and straps have an open structure surface and can not be disinfected.

1. Wash the straps in a mild soap or detergent solution (preferably liquid soap based, rather than antiseptics).
   Straps are also machine washable at 40°C using a mild detergent.
1. Rinse with clean water.
2. Air dry the straps until they are completely dry.

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31 Product Disposal

Final disposal

Final disposal: the system is disposed of in such a way that it can no longer be used for its intended purpose.

The User is responsible for proper disposal of the system.

Philips MRI systems are designed and manufactured to comply with relevant guidelines for environmental protection. As long as the system is properly operated and maintained, it presents no environmental risks. However, the system contains materials that could be harmful to the environment if disposed of incorrectly.

Do not dispose of the MRI system, or any parts of the system, with industrial or domestic waste. During disposal, special attention must be paid to:

- Cooling fluids
- Phantom fluids
- Batteries
- Helium

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NOTICE

Lithium battery cells of type CR2032 used in the host computer contain perchlorate material, special handling may apply.

See https://www.dtsc.ca.gov/hazardouswaste/perchlorate/index.cfm.

The system software stores sensitive personal information. Disposal of the MRI system is therefore also subject to privacy related (local) legislation.

For advice and information regarding proper disposal of your MRI system, contact your Philips Healthcare representative or go to https://www.philips.com/a-w/about/sustainability/sustainable-planet/circular-economy/product-recycling-services.html.

Philips can assist in:

- Recovery of reusable parts.
- Recycling of useful materials by competent disposal companies.
- Effective and safe disposal of the MRI system.

Passing the product on to another user

If this product passes to another user, it must be in its complete state, including all product support documentation.
Make the new user aware of the support services that Philips provides for installing, commissioning and maintaining the product.
Before passing on the product or taking it out of service, all patient data must be (backed up elsewhere if necessary, and) unrecoverable on the product.

It must be remembered by all existing users that passing on medical electrical products to new users may create serious technical, medical and legal risks (including, but not limited to privacy). Such risks can arise even if the product is given away. Existing users are strongly advised to seek advice from their local Philips representative before committing themselves to passing on any product. Alternatively, contact the manufacturer.

Once the product has been passed on to a new user, a previous user may still receive important safety-related information, such as bulletins and field change orders. In many jurisdictions, there is a clear duty on the previous user to communicate such safety-related information to new users. Previous users who are not able or prepared to do this should inform Philips about the new user, so that Philips can provide the new user with safety-related information.

China RoHS declaration table

Name and content of hazardous substances in products

	Hazardous substances or elements					
Name of the parts	Pb	Hg	Cd	Cr(VI)	PBB	PBDE
Magnet + peripherals	X	O	X	O	O	O
System cabinets	X	X	O	O	O	O
RF-coils	X	O	O	O	O	O

This table was developed according to the provisions of SJ/T 11364.

O: The content of such hazardous substance in all homogeneous materials of such component is below the limit required by GB/T 26572.
X: The content of such hazardous substance in at least one homogeneous material of such component is beyond the limit required by GB/T 26572.

Toxic or hazardous substances and elements

REACH Declaration

REACH requires Philips Healthcare (PH) to provide chemical content information for Substances of Very High Concern (SVHC) if they are present above 0.1% of the article weight.

Components within electric and electronic equipment may contain phthalates above the threshold Bis(2-ethylhexyl)phthalate (DEHP), CAS nr.: 117-81-7 .

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The SVHC list is updated on a regular basis. Therefore, refer to the following Philips REACH website for the most up-to-date list of products containing SVHC above the threshold: http://www.philips.com/about/sustainability/REACh.page.

32 Error procedures, Security and Privacy

This chapter provides information about error procedures for computer malfunction, defective hardware, malware detection and error messages possibly occurring when scanning is not possible. Furthermore this chapter covers the features that are implemented for security and privacy. For more information about technical security controls embedded in the system, see Technical Description, chapter Networking and Security.

Error procedures

NOTICE

Error Messages concerning recoverable errors can usually be accepted by pressing the Return key.

Scan not possible

When scanning is not possible, various error messages may appear on the text screen, either during the preparation phase or during measurement. Proceed as follows:

- Correct errors such as: Incorrect coil... , Connector not in... .
- Write the Error message and/or number, date and time in the system logbook.

Computer malfunction

If the application software does not respond (hang-up), stop the application:

1. On the main menu, click **System**, then **Exit**.

To restart the computer:

- ► Press the **Windows** key on your keyboard to show the Windows taskbar.
- ► Click **Start**, then click the arrow next to the **Shut down** button (the button may also say **Log off**).
- ► Select **Restart** to restart the computer.

On occasion it may be necessary to reset the computer by switching the power off. To do this:

- If the computer is located in the control room, use the power button to reset the computer.
- If the computer is located in the technical room:
  - In the technical room, open the global Mains Distribution Unit (gMDU).
  - Do NOT remove the red panel in the cabinet.

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  - Flip the DACC switch (check the service key sticker to locate the correct switch) to the off position.
  - Wait 30 seconds and flip the switch back on again.
  - Close the gMDU cabinet when finished.

If the computer or application software still does not respond, notify your Philips service engineer

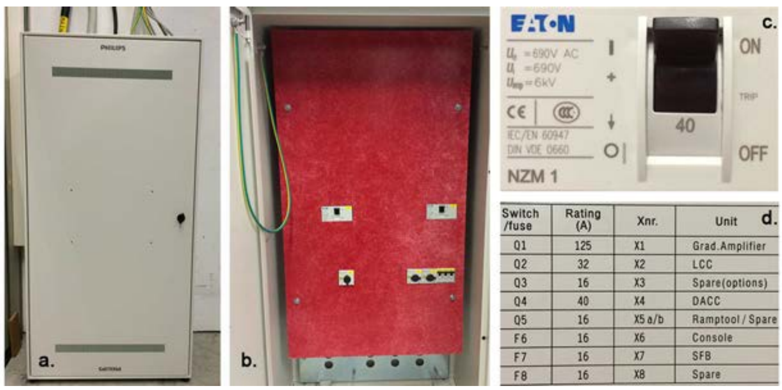

Fig. 456: Examples of: (a) a closed gMDU, (b) the red panel inside a gMDU, (c) a DACC switch and (d) a service key sticker.

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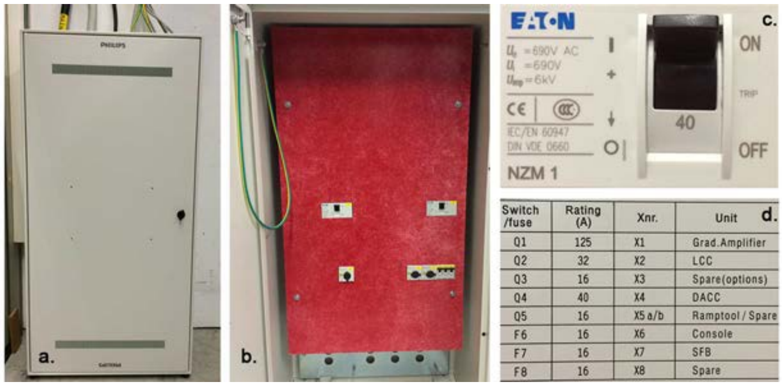

Fig. 457: Examples of: (a) a closed gMDU, (b) the red panel inside a gMDU, (c) a DACC switch and (d) a service key sticker.

Defective hardware

WARNING

If any part of the equipment or system is known (or suspected) to be defective or incorrectly-adjusted, DO NOT USE the system until a repair has been made.

Operation of the equipment or system with defective or incorrectly-adjusted components could expose the operator or the patient to safety hazards. This could lead to fatal or other serious personal injury, or to clinical misdiagnoses.

WARNING

Never use surface coils when coil or cables are damaged.

A damaged cable or connector is hazardous because of high voltage across the cable during the transmit phase of the system. Sharp edges may cause injury to patient's skin.

NOTICE

Damaged coils which are returned to Philips Healthcare must be cleaned by the user as well as practically possible.

For Japan: please contact Philips Healthcare Japan for instructions before returning damaged coils.

Malware detection

If the virus scanning software has detected infection by malware, there is no possibility to use automatic repair utilities because the integrity of the repaired software cannot be guaranteed.

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In case of infections, always contact your local Philips Customerr Service representative to assess and repair the system.

Be sure to also adhere to local procedures regarding malware infection of customer systems (this may e.g. include disconnect from the network).

Security and Privacy features implemented

It is the policy of Philips Healthcare to adhere to all required standards and regulations. To assist the hospital, the following functionality has been added to the system:

Access control

Intended to restrict access to the system to authorized users only:

- Customizable on/off, a user log-on/log-off procedure is required to gain access to the system.
- Access to the system is granted according to a customizable list of authorized users.
- Username/Password authentication is supported for Active Directory and Local users. 2-Factor authentication is supported for Philips Engineers only.
- The system provides functionality to synchronize with customer central user account administration, LDAP only.
- The system supports only single user sessions. It does not provide functionality to register multiple simultaneous users or to switch between users other than via log-off / log-on.
- The system does not support single sign-on for situations where the system works together with other (optional) systems or is part of another system, e.g. extra workstations. Single sign-on is also not for some optional software components that require additional login.

Audit trail

Required to log user activities which are information-security critical:

- Applies to logging-on, reading and/or modifying clinical information.
- Requires that means be provided for auto-backup on a hospital server, e.g. the use of an external standard 'Syslog' server.
- The creation of an audit trail on the local system is not supported.

Network time synchronization

Intended to synchronize system time to an external time-standard:

- "uses a standard Network Time Protocol (NTP)
- "the coupling is configured by Field Service during system installation.

Security and node authentication

Intended to secure the exchange of clinical data and restrict this exchange to pre-determined nodes:

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- Applies to RIS/CIS and PACS nodes, e.g. archives and viewers
- Does not apply to Field Service access
- Uses standard Transport Layer Security Protocol
- The user can decide at installation to use encryption on a per node basis (this may result in reduced performance).

Computer systems cannot be guaranteed to be safe in an insecure network. The user should provide some level of network protection e.g. installing firewalls.

Implementation

In order to meet the requirements described above, the system implements the solution defined by the Integrating the Healthcare Enterprise (IHE) year 4 Basic Security profile.

- The Basic Security Integration Profile establishes security measures which, together with the Security Policy and Procedures of the Enterprise, provide patient information confidentiality, data integrity and user accountability. For more information see the DICOM Conformance Statement.

Field Service

Field Service is used to enable the following configuration items based on information supplied by the hospital:

- Authentication and encryption
- Time synchronization
- Configuration of the 'Syslog' server
- Configuration of any other programs, e.g. tools used to install certificates.

Certificates

Certificate requests should be handled by the hospital. The hospital should decide on a procedure to create the Certificate request and import the certificates.

The hospital should also define the types of certificates required, for example:

- The certificate of the machine itself
- The certificates of the machines it chooses to trust
- The certificate of the Certificate Authority (CA).

Certificates should always be signed by someone else, i.e. no self-signed are allowed. However, the signer of the certificate need not be present on the system. Self-signed certificates are the certificates required by the Integrating the Healthcare Enterprise (IHE).

The following should also be specified:

- The location of the certificates (local machine)
- The location of the tools for certificate installation.

Certificates should be used between nodes to enable them to validate the identity of each other.

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It is the responsibility of the Healthcare Enterprise (HE) to define the maximum validity period of certificates in its security policy.

Other Security and Privacy features addressed

HIPAA defines a number of physical and technical safeguards which are either required or addressable. Some features that could implement these functions are differently or not implemented for reasons mentioned below.
This section also lists other information related to security features that are not implemented and that the owner of the systems should be aware of.

Backup procedure

It is not the intended use of the system to permanently store (sensitive) personal information. Information should be exported to a storage device as soon as possible.

Emergency Access Procedure

The system allows the creation of multiple users. A user account that serves as a generic emergency account can be created. However the user should be aware that the knowledge of this generic account and access to the system should be restricted to avoid unwanted access to (sensitive) personal information. Note that there is no built in function that will allow or enforce the user of such an account to enter their real name. Also it is not possible to clearly mark data output (e.g. screen, print-out, exported data to DVD) as being created during emergency access operation.

Automatic logoff

An auto-logoff feature is not implemented since it contradicts the intended use of the system. Manual logoff using a ‘short-cut’ key combination is not implemented for the same reason. A configurable screen save function with password protection is available.

Encryption

The system supports encryption of personal data on hard-drive and removable media (USB devices). Hard drive encryption can be activated by Philips Service Engineers.

Physical access to system

Some parts of the systems are located in the technical area of a system. Access to these locations is assumed to be restricted. Usually, the components in the operator or examination room are more readily accessible and therefore the following characteristics shall be taken into account for system operation and access control:

- The computer case is 'service friendly'; opening and removal of e.g. hard disk without use of tools may be possible; computer case can be locked (e.g. by cable lock etc.); there are no front side accessible drives etc.
- The boot order for the system is DVD - Hard Disk. By inserting a bootable CD/DVD the system may start up from those and thus access may be gained to the system including information stored in it.

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- There is no detection of unauthorized physical access into the system e.g. via tamper proof seals.
- The integrity of most of the Philips application software is checked when the systems starts, for data this is not done.
- By default the system BIOS is not password protected and can be accessed during startup of the system if unauthorized access to the system is possible.
  On request Philips Service Engineers are instructed by guidelines how to password protect the BIOS

Network firewall configuration

If the system is placed behind a network firewall (this is preferred), then the following ports should be allowed to pass through for the system to operate correctly in a network under normal operating conditions:

- Clinical use: ICMP:Echo, ICMP:Echo-Reply, TCP:104[1)]
- emote service: TCP:22[2)], TCP:5900[2)], TCP:9903, TCP:9044 or outbound: TCP:443[2)]

[1)] *default port might be reconfigured. It is assumed that outbound traffic is unrestricted.*
[2)] *depending on configuration of the system (ISSLLink or VPN) .*

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