GE Healthcare

# Optima MR450w with GEM

## Technical Data

The GEM Suite cannot be put into service until it has been made to comply with CE marking. It may not be available in all regions.

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# The world of MR is always changing.

Patients expect the right MR experience. Patient expectations of MR have shifted in recent years, as people have begun demanding a better, more comfortable scanning experience. Increasing the size of the bore is a good first step — but it's only the beginning. The right system should offer both excellent images and a user-friendly experience. Patients should be more comfortable during their scan, and clinicians more comfortable in making a definitive diagnosis. All the while, organizations should expect their MR system to help them deliver solid financial returns, maintain a high standard of patient safety, and increase the quality of their care.

The Optima MR450w with GEM Suite is wide-bore MR done right. Thanks to cutting-edge technologies, we've advanced the capabilities of wide-bore MR by delivering both uncompromised image quality and high productivity — all with an expansive 50cm field of view. The Optima MR450w offers a range of advanced functionality, making it a workhorse system for practices of all sizes and specialties. Meanwhile, the new GEM Suite of coils takes the MR experience to new levels. The system is also extremely accessible. Its cost and capabilities make it ideal for first-time MR customers who can make it their only scanner, as well as established MR users seeking a versatile, hard-working system.

**The right capabilities**

Advanced functionality gives clinicians the tools they need to make definitive diagnoses — and help grow practices.

**The right experience**

Exclusive ease-of-use features and the new GEM Suite of coils help make life easier for both patients and technologists.

**The right investment**

Administrators can drive new levels of productivity, scanning a broader patient population on a more predictable schedule.

# Magnet

### The foundation for quality and flexibility

When it comes to improving the patient experience and providing high image quality no other component of an MRI system has greater impact than the magnet. The Optima MR450w with GEM system features a short, wide bore magnet that delivers a large field of view. The magnet geometry has been optimized to reduce patient anxiety by providing more space in the bore and more exams with the patient's head out of the magnet. The 50cm field of view provides uniform image quality and may reduce exam times since fewer acquisitions may be necessary to cover large anatomy.

### Easy siting and affordable operation:

Complemented by GE's active shielding technology, the Optima MR450w with GEM has very flexible installation specification for easy siting. And with zero-boil-off technology helium refills are effectively eliminated, thus reducing operating costs and maximizing uptime (versus previous generation products).

### Magnet enclosures

This magnet enclosure system is designed to provide several benefits for the patient and technologist:

- Patient anxiety is eased, resulting in reduced exam time for uncooperative patients
- Technologists have easy access to the patient

### Magnet shim

High homogeneity is assured – our Optima MR450w with GEM magnet provides excellent results for:

- Large FOV imaging up to 50 cm
- Off-center FOV imaging such as elbow, shoulder and wrist imaging
- Robust fat saturation required for abdominal, breast and musculoskeletal imaging
- High-performance applications, such as cardiac, fMRI, diffusion tensor and spectroscopy

| Magnet Specifications | |
|---|---|
| Magnet Length | 145 cm |
| Operating field strength | 1.5T (63.86 MHz) |
| Magnet shielding | Active |
| EMI shielding factor | 96% |
| Size (W x L x H) | 2.10 m x 1.45 m x 2.36 m |
| Magnet weight | 3,692 kg |
| Magnet cooling | Cryogenic (liquid helium) |
| Long-term stability | < 0.1 ppm/hour |
| Cryogen refill period | Zero boil off* |
| Fringe field (axial x radial) | 5 Gauss = 4.0 m x 2.5 m<br>1 Gauss = 5.7 m x 3.4 m |
| Manufacturer | GE Healthcare |

*Under normal operating conditions

| Patient focused design | |
|---|---|
| Patient Bore (L x W x H) | 105 cm x 70 cm x 70 cm |
| Patient Aperture | 76 cm |
| Patient comfort module | Head or feet first entry<br>Dual-flared patient bore<br>2 way in-bore intercom system<br>Adjustable in-bore lighting system<br>Adjustable in-bore patient ventilation system |

| Diameter Volume (x, y, z) | Typical ppm | Guaranteed ppm |
|---|---|---|
| 10cm DSV | 0.007 | 0.02 |
| 20cm DSV | 0.035 | 0.06 |
| 30cm DSV | 0.11 | 0.18 |
| 40cm DSV | 0.5 | 0.7 |
| 45cm DSV | 1.2 | 1.6 |
| 50 x 50 x 45cm | 2.3 | 3.6 |
| 50cm DSV | 3.3 | |

Volume Root-Mean-Square (V–RMS) values are computed from 24 measurements on each of 32 planes with linear terms set to zero.

# Gradients

Premium clinical performance is enhanced with the Optima MR450w with GEM gradient system. Gradient speed, accuracy, and reproducibility are critical for all acquisitions, but the performance is especially important in challenging acquisitions, such as fMRI and diffusion tensor imaging.

| Gradient performance | |
|---|---|
| Amplitude per axis | 44 mT/m |
| Slew Rate per axis | 200 T/m/s |
| Maximum FOV (x, y, z) | 50 cm |
| Gradient Duty Cycle | 100% |

| Gradient amplifier (water cooled) | |
|---|---|
| Gradient Amplifier Current and Voltage | 830 Amps/1650 Volts Peak |
| Control | • Frequency dependent feed-forward model<br>• Digital PI feedback control loop |

The gradients are non-resonant and actively shielded to minimize eddy currents. The gradient coil and the RF body coil are integrated into a single module, which is both water and air cooled for excellent duty-cycle performance and patient comfort.

### Fidelity, accuracy, and reproducibility

Gradient systems have historically been defined in terms of peak amplitude (mT/m) and slew rate of the generated field (T/m/s). While these parameters are important in achieving high temporal resolution parameters such as TR's and TE's, applications such as fMRI, Propeller, TRICKS, and spectroscopy rely more heavily on gradient fidelity, accuracy, and reproducibility.

Fidelity is defined as the degree to which an electronics system accurately and reproducibly amplifies an input signal. Applied to MR gradient systems, gradient fidelity refers to the system's ability to generate requested waveforms. The high fidelity of the Optima MR450w gradients is achieved through the use of innovative design of the digital control architecture within the gradient amplifier. This architecture has two digital control paths.

- Dedicated active feedback loop to regulate current errors
- Innovative feed-forward model to match amplifier output to gradient coil

| Gradient subsystem gradient fidelity, accuracy, reproducibility parameters | |
|---|---|
| Maximum integrated error* | 0.48 ppmFS-s |
| Shot-to-shot* | 0.16 ppmFS-s |
| Symmetry error* | 0.32 ppmFS-s |

* Typical gradient fidelity expressed in a relative scale is derived from the following measurements of integrated errors in micro-Amperes-second (μAs). Maximum Error is the maximum integrated current error over a full-scale, echo-planar gradient waveform. Shot-to-Shot is the largest difference between integrated errors across waveforms,. Symmetry Error is the largest difference in integrated current error when comparing positive and negative gradient waveforms.

## ART (Acoustic Reduction Technology)

State-of-the-art clinical imaging demands the routine use of ultra-fast imaging techniques. At 1.5T, the strong gradients interact with the magnetic field to create mechanical forces resulting in acoustic noise. GE has introduced ART to reduce acoustic noise and improve the patient environment.

### Gradient Coil Isolation and Acoustic Dampening

The full performance of the Extreme Gradient Driver is used while helping to maintain a safe environment for the patient. Clear separation between the gradient coil, RF body coil, and patient support structures ensures minimal component interactions. In addition, mass-damped acoustic barriers are used under the system enclosures to further reduce acoustic noise for the patient.

### RF Coil Isolation

During gradient pulses, the RF body coil acts as a secondary source of noise. To further reduce the noise heard by the patient, the RF body coil has been optimally designed with mass-damped copper traces.

### Vibro-acoustic Isolation

To isolate the magnet from the building and reduce the transmission of acoustic noise in the structure, GE has designed a vibroacoustic-dampening pad that sits under the feet of the magnet. The dampening characteristics of the pad are optimized based on the magnet geometry and weight.

### Gradient Waveform Optimization

User selectable mode to further reduce acoustic noise.

# Optical RF

The new RF acquisition technology of the Optima MR450w with GEM enables greater clinical performance and higher image quality especially for data-intensive applications and provides an improvement in SNR versus previous generation systems.

### OpTix (Optical RF receive technology)

The OpTix RF system enables high-bandwidth, high channel count reception with improved SNR over conventional MR receiver designs. Conventional MR scanner designs place the RF receivers in the electronics room where the MR signal is subject to significant electrical noise prior to being digitized. The OpTix optical RF receivers are located on the magnet system inside the shielded scan room, isolated from external noise sources.

The MR signal is digitized within the scan room and then optically transmitted to the reconstruction engine in the electronics room.

Since losses are inherent with conventional wire designs, the close proximity of the receivers to the patient reduces noise and improves image quality.

The OpTix acquisition technology enables higher image quality especially for data-intensive (3D) applications. When combined with GE's use of high-density surface coils, the optical receive chain is a critical path for ensuring clear signal reception and data analysis. To help ensure that the high-density approach will be maintained, the scalable Optima MR450w with GEM architecture is designed to expand in the future.

Optical RF technology increases SNR for all volume acquisitions, independent of which surface coil is being used.

| OpTix optical RF architecture | |
|---|---|
| Coil input ports | 138 |
| Quadrature demodulation | Digital |
| Receiver sampling frequency per channel | 80 MHz |
| Receiver dynamic range at 1Hz BW | >165 dB |
| Receiver resolution | Up to 32 bits |

## Transmit RF

| Standard RF transmit architecture | |
|---|---|
| RF amplifier | Air cooled, small footprint |
| Maximum output power | 16 kW Body<br>2 kW Head |
| Maximum RF field with integrated body coil | >20 uT |
| Transmit gain | >100 dB (40 dB coarse/<br>>84 dB instantaneous) |
| RF exciter frequency range | 63.86 ± 0.650 MHz |
| Frequency resolution | <0.6 Hz/step |
| Frequency stability | 14 part per billion (0 to 50C) |
| Phase resolution | 0.005 degree/step |
| Amplitude control | 16 bit with 12.5 ns resolution |
| Amplitude stability | <0.1 dB over one min. at rated power |
| Digital RF pulse control | 2 amplitude modulators,<br>2 frequency/phase modulators |

# Volume reconstruction engine

Reconstruction performance today is challenged by explosive growth in data, and increased computational complexity. The amount of data to be stored and processed continues to increase with the advances in MR system technology. The Optima MR450w with GEM meets that challenge head-on with innovations in reconstruction to take full advantage of computing power by leveraging both software and hardware technology.

The Optima MR450w with GEM features a powerful volume reconstruction engine (VRE) that enables real-time image generation, even when massive parallel-imaging datasets are involved.

The reconstruction engine features onboard memory and local raw data storage to support and maintain simultaneous data acquisition and reconstruction under the most demanding applications.

VRE uses 64-bit computing, delivering high acquisition memory and fast performance. Parallel processing and high-speed interconnects provide scalable memory and throughput.

The acquisition-to-disk feature automatically expands the memory capacity per the demands of the application.

| Reconstruction engine | |
|---|---|
| 2D FFT/second (256 x 256 full FOV) | 13,000 2D FFTs/second |
| CPU | Dual Intel Nehalem Processor Quad core |
| Memory | 36 GB ECC DDR3 1333 |
| Hard disk storage | 4x146 GB |

# GEM Suite

### Description

The GEM Suite consists of a set of receive-only RF arrays designed for use with the Optima MR450w with GEM 1.5T MR system. GEM stands for Geometry Embracing Method, an approach to MR imaging that reflects the importance of conforming the geometry of the equipment and technology to that of the patient.

The Suite includes a head and neurovascular array, a posterior imaging array embedded in the Express patient table, an anterior array, a small anterior array, and a peripheral vascular array. The Suite is indicated for use for: head, neck, brachial-plexus, spine, pelvis, hips, prostate, abdominal, cardiac, lower extremities, blood vessels, and long bone MSK imaging. The combined use of the entire GEM Suite was designed to facilitate high-resolution, high-SNR whole-body imaging from the top of the head down to the feet.

### Coil Mode Configuration

The 1.5T GEM Suite was designed to reduce multiple physical coil changes within a single exam and between different exams, and to improve patient comfort. The system will automatically select the coil mode configuration that best fits the selected region of interest.

## GEM Express Table & Posterior Array (PA)

The GEM Express Patient Table is a mobile patient transport device that includes an embedded high-density, posterior RF array. Fully detachable, the GEM Express patient table offers numerous benefits, described below in the Workflow section.

Additional patient tables may be purchased for use with the same Optima MR450w with GEM Suite system. The integrated posterior array is an optional accessory with each additional table.

### *Geometric Optimization*

The GEM Posterior array has optimal coil element geometry for each patient and targeted anatomy. The GEM Posterior Array uses optimized element layouts for the cervical-to-thoracic spine transition, thoracic and lumbar spine, and the body. This approach maximizes the signal-to-noise ratio by matching the geometry of the coil elements to the anatomical size and shape of the anatomy.

The posterior array is designed to support parallel imaging in all 3 scan planes, and the system will automatically select the appropriate subset of coil elements based upon the prescribed field-of-view.

The Express patient table also includes an innovative and adjustable comfort tilt feature to lift the patient's neck and conform to the patient's natural anatomy, to increase patient comfort.

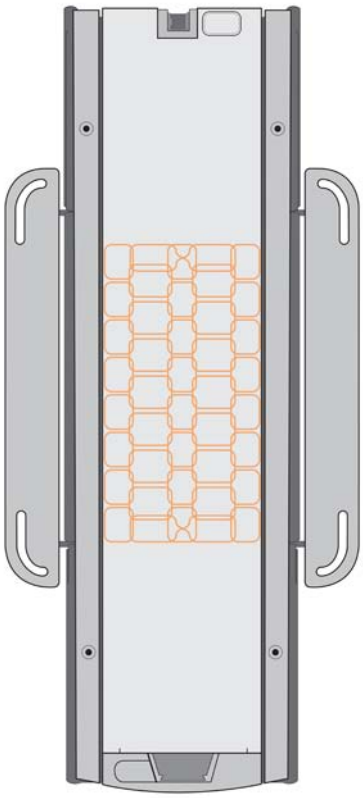
### *Symmetric Scan*

The Express patient table and embedded GEM coil is designed to accommodate head-first or feet-first imaging for all supported exams.

The Integrated Posterior Array is symmetrically positioned within the patient supporting cradle, and coil connection ports are located at both ends of the detachable table. This design enables all components of the GEM Suite to support either patient orientation and help ensure the most comfortable patient position.

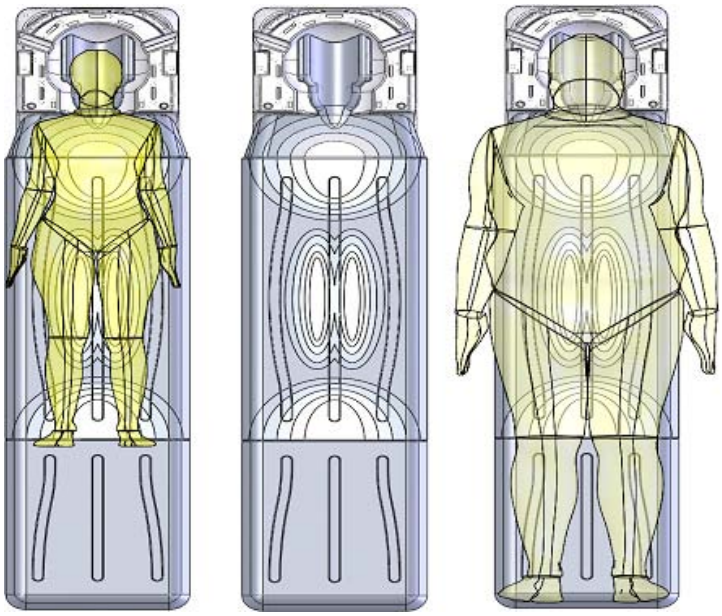
Whole body imaging may also be supported in the feet-first orientation.

| GEM Posterior Array Specifications |
| --- |
| Length: 100 cm (39.4 in)<br>Width: 40 cm (15.7 in) |
| S/I Coverage: 100 cm (39.4 in)<br>Head-first or feet-first imaging<br>Elements: 40 |



GEM Express Table illustrating layout of the PA elements

## *Patient Comfort Pads*

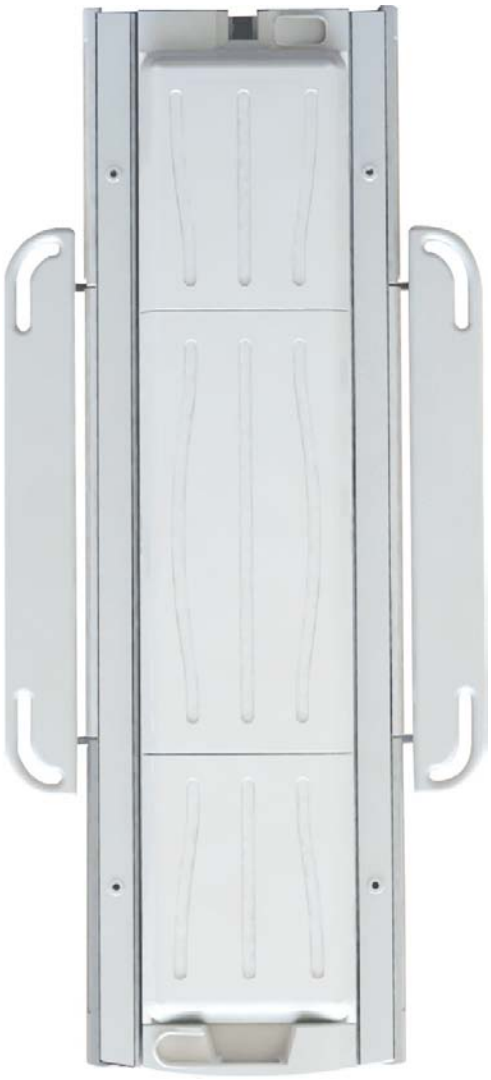


Petite Female | Comfort Pad Stiffness map | Very Large Male

To improve patient comfort and safety, the GEM Suite includes an innovative set of Patient Comfort pads.

The pads are designed with variable density foam that uniquely compresses based on patient geometry and weight. Certain sections of the GEM Suite pads are designed to compress more easily than others and this optimal design may minimize pressure points and improve patient comfort. The pads have been designed to support a wide range of patient sizes and weights.

The pads are made with UltraFresh protective coating, are strong, fluid-proof, air tight, and easily cleanable. An anti-skid undersurface reduces pad movement and thus may simplify patient setup and egress.



GEM Express Table with Patient Comfort Pads

## GEM Head & Neck Unit (HNU)

The GEM HNU is a standard component of the GEM Suite. The HNU consists of four imaging components: a head base-plate, an anterior neuro-vascular face-array, the GEM cervical array, and the open face adapter. The coil maybe positioned at either end of the GEM table to support head-first or feet-first imaging.

The open-face design provides a patient-friendly feel. The base plate may be used with the dedicated GEM cervical array for C-spine imaging. Alternatively, the base plate may be used with the open face adapter to accommodate cervical spine exams in large or claustrophobic patients. Improved access and patient comfort may be achieved through elevation of the superior end of the coil. The HNU with anterior NV Face-Array consists of 21 elements arranged to provide parallel imaging support in all 3 planes.

### Head Neck Unit NV Specifications

Length: 49.5 cm (19.5 in)
Width: 38.8 cm (15.3 in)
Height: 36.8 cm (14.5 in)
Weight of HNU base: 5.6 kg (12.3 lb)
Weight of Anterior Adapter: 3.2 kgs (7.1 lb)
S/I Coverage: 50 cm (19.7 in), when combined with the PA and AA
R/L Coverage in head mode: 24 cm (9.4 in)
R/L Coverage for NV: 50 cm (19.7 in), when combined with the PA and AA
Head-first or feet-first imaging
Up to 28 elements in the FOV, when combined with the PA and AA
Acceleration factors: 1D R=3, 2D R=6

### Head Neck Unit Cervical Specifications

Length: 49.5 cm (19.5 in)
Width: 38.8 cm (15.3 in)
Height: 33.6 cm (13.2 in)
Weight of Cervical Adapter: 1.9 kgs (4.2 lbs)
S/I Coverage: 28 cm (11 in)
R/L Coverage: 24 cm (9.4 in)
Head-first or feet-first imaging
Up to 20 elements in the FOV, when combined with the PA

### Head Neck Unit with Open Face Adapter Specifications

Length: 49.5 cm (19.5 in)
Width: 38.8 cm (15.3 in)
Height: 25.7 cm (10.1 in)
Weight of Open Face Adapter: 1.5 kgs (3.3 lbs)
S/I Coverage: 28 cm (11.0 in) with all 7 elements
R/L Coverage: 24 cm (9.4 in)
Head or Feet-first imaging
Up to 12 elements in the FOV, when combined with the PA

HNU with anterior NV Face-Array

HNU Cervical Array

HNU Open Face Adapter

HNU with comfort tilt adapter

### GEM Anterior Array (AA)

The GEM AA is a standard component of the GEM Suite that facilitates chest, abdomen, pelvis, and cardiac imaging with the GEM RF coil suite. The GEM AA is lightweight, flexible, thin and pre-formed to conform to the patient's size and shape. With 54 cm of S/I coverage, the coil permits upper abdominal and pelvic imaging without repositioning the patient.
The 16 element electrical design supports parallel imaging in all 3 planes.

GEM Anterior Array

| Anterior Array Specifications |
|---|
| Length: 57.4 cm (22.6 in) |
| Width: 70.2 cm (27.6 in) |
| Height: 3.6 cm (1.4 in) |
| Weight: 2.4 kg (5.3 lb) resting on patient<br>3.6 kg (7.9 lb) with cable |
| S/I Coverage: 54 cm (21.3 in) |
| R/L Coverage: to the full 50 cm (19.7 in) FOV of the system |
| Head or Feet-first imaging |
| Up to 36 elements in the FOV, when combined with the PA |
| Acceleration factors (with PA): 1D R=3, 2D R=9 |

### GEM Small Anterior Array (Optional)

The GEM Small Anterior Array is a receive-only, high-density RF coil designed to produce images with optimal signal to noise ratio and uniform coverage for cardiovascular, pulmonary, renal, and abdominal imaging. The light-weight coil design contains 16 channels, with parallel imaging capability in all three dimensions to speed up high-resolution, breath-held, and free breathing cardiovascular exams.

GEM Small Anterior Array

| Optional Small Anterior Array Specifications |
|---|
| Length: 45 cm (17.7 in) |
| Width: 40.5 cm (15.9 in) |
| Height: 4.5 cm (1.8 in) |
| Weight: 2.94 kg (6.5 lbs) |
| S/I Coverage: 27 cm (10.6 in) |
| R/L Coverage: 35 cm (13.8 in) |
| Head-first or feet-first imaging |
| Up to 33 elements in the FOV, when combined with the PA |

## GEM Peripheral Vascular/Lower Extremity Array (PVA) - Optional

The GEM PVA is an optional component of the GEM Suite that facilitates imaging of the thighs and lower legs. The high-density layout supports parallel imaging in all 3 planes. The coil incorporates an innovative hinge design between the upper & lower elements to simplify patient setup. In addition, to improve patient comfort, the lower leg section of the coil is fully supported by the GEM table and not the patient.

GEM PVA in un-folded position

| Optional Peripheral Vascular/Lower Extremity Array Specifications |
|---|
| Length: 105 cm (41.3 in) |
| Width: 2nd station - 51.6 cm (20.3 in) |
| 3rd station - 64.2 cm (25.3 in) |
| Height: 24.8 cm (9.8 in) |
| Weight: 9.1 kg (20.0 lb) |
| S/I Coverage: 104 cm (49.9 in) overall |
| 2nd station - 52.0 cm (20.5 in) |
| 3rd station - 52.0 cm (20.5 in) |
| R/L Coverage: to the full 50 cm (19.7 in) FOV of the system |
| Head-first or feet-first imaging |
| Up to 35 elements in the FOV, when combined with the PA |
| Acceleration factors: 1D R=3, 2D R=6 |

## PA Invisibility and Compatible Features

The GEM PA is designed to be used in conjunction with the GEM head-neck and cervical imaging unit, the GEM anterior array, and GE peripheral vascular array. When needed, the GEM Posterior Array has also been designed to become invisible when additional surface coils are placed directly on top of the table. With innovatively designed electronic decoupling circuits, the Posterior Array can support additional coils directly on top of its surface with no impact to image quality. This feature is critically important for technologist workflow, especially for breast and musculoskeletal exams.

## Additional high-density surface coils

The RF architecture of the Optima MR450w with GEM is a 32-channel system.

It provides compatibility with surface coils developed by GE as well as coils developed by other vendors.

Surface coils are developed to provide anatomical coverage with optimized image quality. Coverage is maintained while providing high-density arrays focused around the anatomy of interest to promote high image quality and short scan times.

The scanner comes with a split-top, transmit/receive head coil as standard. Optional coils are shown here. A comprehensive list of compatible surface coils from GE and 3rd party vendors is available from your GE sales representative.

### HD Breast Array

- 8-channel, 8-element phased-array design
- Optimized for uniformity, parallel imaging and VIBRANT
- Bilateral and unilateral breast imaging
- Biopsy plates available
- Coil dimensions: 53 x 53 x 24 cm (21 x 21 x 9 in)

### HD Knee Array

- Hybrid transmit/tapered phased-array design
- 8-channel, 9-element phased-array design
- High SNR for knee imaging
- Coil dimensions: 39 x 32 x 19 cm (16 x 13 x 8 in)

### HD Foot/Ankle Array

- 8-channel, 8-element phased-array design
- "Chimney" design adds versatility for high SNR foot and ankle imaging
- Coil dimensions: 41 x 33 x 39 cm (16 x 13 x 15 in)

### Quad Lower Extremity Coil

- 12-rung, transmit /receive birdcage coil
- "Chimney" design adds versatility for ankle and foot imaging
- Sensitive volume covers 22 cm FOV for knee imaging and 28 cm FOV for foot imaging
- Coil dimensions: 48 x 31 x 36 cm (19 x 12 x 14 in)

### HD Wrist Array Coil

- 8-channel, 8-element phased-array coil
- High SNR to enable high spatial resolution images
- Position overhead or at patient's side
- Coil dimensions, including base: 34 x 23 x 21 cm (13 x 9 x 6 in)

### 8-channel HD Shoulder Array

- 8-channel, 8-element concentric array design offers uniform depth penetration while maximizing signal-to-noise ratio
- Optimized for off-center imaging and joint visualization
- Homogenous imaging FOV and robust fat saturation
- Flexible housing contours to shoulder anatomy for easy set up and patient comfort
- 20 cm S-I coverage
- 25 x 23 x 25 cm (10 x 9 x 10 in)

### 3-channel HD Shoulder Array

- 3-channel, 3-element open phased array design
- Optimized for off-center imaging
- Homogenous imaging FOV and robust fat saturation
- PURE compatible

# MR Enabled Therapy Accessories

### Radiation Oncology Options

Combining the Optima MR450w with GEM advanced imaging capabilities with the Radiation Oncology Options offering helps minimize potential registration errors between MR and CT within radiation treatment plans, for improved confidence in tumor targeting and preservation of healthy tissue. Additionally, seamless integration with AdvantageSim MDtm simulation software and Integrated Registration on the GE AW workstation allows MR images to be to easily incorporated into the Radiation Oncology workflow.

### MR Guided Focused Ultrasound

Your facility can offer a completely non-invasive treatment for uterine fibroids with the addition of an ExAblate MR guided Focused Ultrasound therapy table to your MR system. In partnership with InSightec Ltd., GE MR is the industry leader in this advanced technology, based on procedure volumes in excess of 6,500 women treated worldwide.

### Surgical Suite

The Surgical Suite offering is an effective solution for incorporating MR imaging into your surgery center. Through seamless integration with surgical navigation systems, surgeons can retrieve archived images and fuse them with newly acquired intra-operative MR images. This advanced technology can assist in real-time surgical decision making and improved tumor resections.

# Workflow

## Express Exam streamlined workflow

The GEM Suite, Express patient table, IntelliTouch technology and in-room operator console (iROC) streamline the Optima MR450w workflow and help you improve patient care by letting you keep your focus where it's needed most – on your patient.

With Express Exam, entire exams are completed in just a few mouse-clicks due to the automated acquisition, processing, and networking capabilities of the patient setup and workflow features of the Optima MR450w.

### GEM Suite

The GEM Suite of coils helps dramatically improve patient setup and workflow. Because the posterior array is embedded in the table and because the coils are significantly lighter than previous generations, MR technologists are required to lift and handle up to 38% less weight. Also, the posterior array becomes invisible to the system when other surface coils are deployed, so that special handling and configuration steps are not required to scan with options such as the breast array. Finally, to help reduce anxiety and improve compliance, the symmetric scan feature of GEM Suite means that patients can be scanned feet-first for any exam.

### Express patient table

The fully detachable Express patient table helps improve safety, exam efficiency, and patient comfort.

### Safety

Easily docked and undocked by a single operator, the patient table is simple to move in and out of the exam room for patient transport and preparation. These become vital features in those instances where multiple patient transfers can negatively impact patient care or when emergency evacuation is required; the table can be undocked and removed in under 30 seconds with just one technologist. In time-sensitive situations there is no need to remove or disconnect surface coils as the system can automatically disconnect the coils for you. The mobility and safety features of Optima MR450w with GEM patient table can obviate the need for MR-compatible emergency equipment or a second technologist.

### Exam efficiency

In addition to being fully detachable, the Optima MR450w with GEM Express patient table can offer multiple surface coil connectors. With dual 32-channel connectors at the foot end of the table (optional), the patient can be fully prepared for an exam outside of the scan room, thus further reducing the necessary steps before starting acquisition.

With a second table, the next patient can be positioned outside the magnet room while the current patient is undergoing an examination.

### Patient comfort

The Express detachable table can reduce patients' anxiety and provide patients personal discretion by preparing them for the exam outside the scan room. Reduced patient table transfers for inpatients or trauma patients can improve overall patient care.

The Express patient table offers optional head- or feet-first imaging. Additionally, feet-first positioning facilitates run-off studies and set-up for claustrophobic patients.

### Ergonomics

With one hand and one simple motion, the integrated arm boards and IV pole can be optimally positioned to support the patient for safe transport and injections. This unique capability of the Optima MR450w with GEM table also makes it ideally suited for multi-station exams with no scan room intervention, such as time-resolved vascular imaging.

### High-density coil interface

Optima MR450w with GEM technology takes the guesswork out of coil plug-in and identification by automatically identifying the coil that is connected. Through prominent visual indicators near the coil connection port, it allows the technologist to ensure a secure coil connection, virtually every time.

| Patient table | |
|---|---|
| Patient table | Detachable and mobile |
| Min/max table height | 70 to 93 cm, continuous |
| Patient table drive | Automated, power driven vertical and longitudinal |
| Longitudinal speed | 30 cm/sec (fast) and 0.5 cm/sec (slow)<br>15 cm/sec for patient positioning |
| Total cradle length | 210.8 cm |
| Total cradle travel | 278.1 cm |
| Scannable range | 205 cm |
| Positioning accuracy | +/- 0.5 cm |
| Maximum patient weight for scanning | 227 kg (500 lbs) |
| Maximum patient weight (detached and mobile) | 227 kg (500 lbs) |
| Maximum lift capacity | 227 kg (500 lbs) |
| Patient transport accessories | Self-storing non-ferrous IV pole<br>Positioning pads<br>Immobilization straps |
| Landmarking | - Laser alignment with S/I and R/L alignment<br>- IntelliTouch Landmarking Capability (optional) |
| Coil connection ports | Two high density auto-coil sensing connection ports |

### IntelliTouch patient positioning

IntelliTouch technology can enhance exam productivity by eliminating the need for laser alignment and reduces the number of steps for patient preparation.

For those patients where more precise alignment is desired, lasers may be used for either the selection or confirmation of landmark positioning.

The Optima MR450w with GEM system has automated many routine tasks to both simplify patient preparation and reduce errors. With IntelliTouch technology, the following tasks can be completed by simply touching the side of the table and pressing the advance to scan button.

- Landmark the patient
- Activate the surface coil
- Center the patient in the bore
- Start scanning
- Acquire, process and network images

### Dual system control panels

For operation on either side of the scanner, two ergonomi-cally designed control panels are integrated into the front of the system enclosures. These panels incorporate backlit buttons to guide the user to the next logical step in exam setup.

A trackball and select buttons guide the use of the in-room operator console.

From the system control panels you can:

- Position the table
- Home position
- Stop table
- Control multiple levels of in-bore ventilation and lighting
- Enter patient weight
- Enter patient orientation and patient position
- AutoStart – initiate the scanner to automatically acquire, process, and network images

### In-room operator console (iROC)

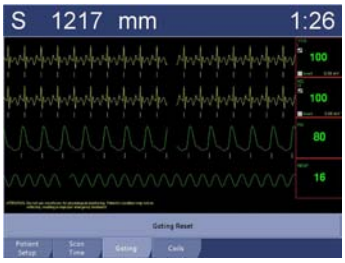
Simplify exam preparation and reduce the time between patients with the Optima MR450w with GEM high-resolution, color in-room operator console.

By consolidating all controls into one place, the iROC provides real-time feedback to the user to help ensure that any necessary changes in patient setup are quickly and clearly related back to the user. The iROC enables the user to visualize cardiac and respiratory waveforms directly in the exam room – eliminating the need for the technologist to leave the room and improving the patient experience. The iROC also allows for the integration of third-party interfaces and tools.

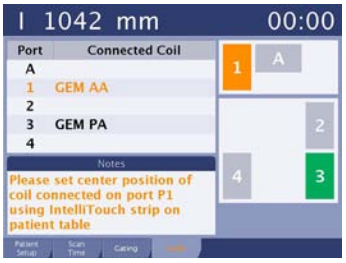
Mounted on the front of the magnet, the display provides realtime interaction with the scanner and the host computer. The user has direct control or selection of the following:

- Display of patient name, ID, study description
- Display and entry of patient weight
- Display and entry of patient orientation and patient position
- Cardiac waveform display and EKG lead confirmation with gating control: trigger select, invert and reset
- Respiratory waveform display
- IntelliTouch technology landmarking
- AutoStart – initiate the scanner to automatically acquire, process, and network images
- Display connected coils and coil status
- Display of table location and scan time remaining
- Screen saver
- Display and navigate through a CADstream SureLoc report

The iROC simplifies patient workflow by reducing the time burden of today's most challenging exams. Together, the significant advances of the Optima MR450w with GEM improve careby enabling technologists to help maintain their focus where it is needed the most – on the patient.





# Optima MR450w with GEM Express Exam

The Optima MR450w with GEM scan interface incorporates many features designed to lighten the workload by automating many routine steps.

The Optima MR450w with GEM includes an automated protocol-driven user interface designed for consistency in generating high- quality imaging for all patients and from all technologists. Designed for efficiency, the Optima MR450w with GEM computer platform is built upon a parallel, multiprocessor design that delivers the simultaneity and speed needed for advanced clinical operation. Productivity, efficiency and streamlined data management are achieved through simultaneous scanning, reconstruction, filming, archiving, networking and post-processing.

Though the protocol-driven workflow can dramatically simplify and automate image acquisition and processing, the flexibility that is synonymous with GE systems is maintained. If desired, the user can have complete control of exact sequence parameters for site optimization and patient specific situations.

### Modality worklist

The modality worklist (MWL) provides an automated method of obtaining exam and protocol information for a patient directly from a DICOM Worklist server. For sites with full DICOM connectivity, once a patient has been selected from the MWL, a new session can be opened on the host interface and the iROC will highlight the relevant exam details. For sites that do not have full connectivity, minimal data entry (patient number and weight) is necessary prior to starting a new session. Additional data fields for patient-sensitive information such as allergies, pre-medication, pregnancy status, and history are provided

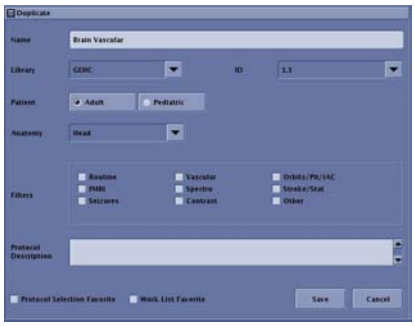
The Optima MR450w with GEM MWL provides complete control of the MRI protocol prescription. The protocol may be selected well in advance of the patient's arrival at the MR suite, thereby simplifying exam preparation and reducing necessary work by the technologist during the time-critical procedure.

The ConnectPro software enables the DICOM worklist server class for the Optima MR450w with GEM Operator's Console. This software may require separate gateway hardware to connect non-DICOM-compatible HIS/RIS systems to the MR system.

### Protocol libraries and properties

The Optima MR450w with GEM system provides the user with complete control of protocols for simple prescription, archiving, searching, and sharing. The protocols are organized into two main libraries, GE Optimized and Site Authored. For quick search and selection, each protocol may be archived with independent properties based on patient demographics, anatomy, type of acquisition, or identification number. For commonly used protocols, a favorites flag may be used for quick selection from the Modality Worklist or for sharing across other libraries.

Adult and Pediatric Protocol libraries for simple management of exams.



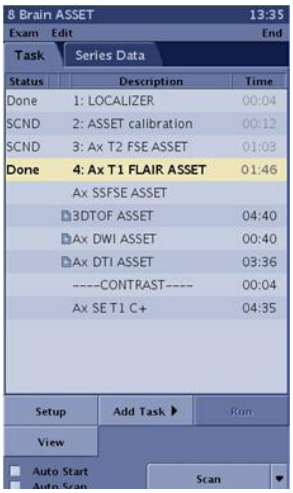
Each protocol or series can be saved with user-defined properties to simplify search and selection for future use. Favorite protocols can be highlighted for quick selection from the Modality Worklist or other libraries.

## ProtoCopy

Standard on every Optima MR450w with GEM system, the ProtoCopy feature enables a complete exam protocol to be shared with the click of a mouse. The exam protocol can originate from either a library or previously acquired exam. This enables routine archive of protocols for emergency backup and simple management of libraries across multiple systems.

## Workflow manager

Once a protocol has been selected for an exam, it is automatically loaded into the Workflow Manager. The Workflow Manager controls image prescription, acquisition, processing, visualization, and networking and may fully automate these steps if requested.




The Workflow Manager automatically loads the protocol and controls image prescription, acquisition, processing,and visualization

## AutoStart™

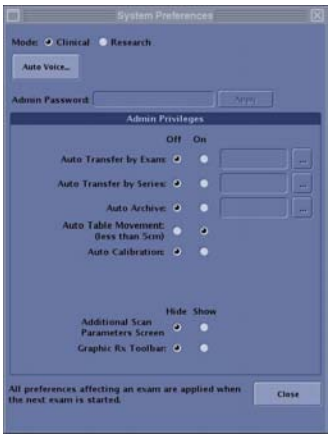
If AutoStart is selected, once the landmark position has been set and the technologist exits the scan room, the Workflow Manager will automatically start the acquisition.

## AutoScan™

With AutoScan enabled, the Workflow Manager will sequentially go through the list of prescribed series without any user interaction. Once a series has been completed, the next series will be scanned automatically. For series requiring contrast, the system will await user interaction.

## Auto calibration

An Auto Calibration preference can be selected from either the system or exam level. When turned on, this option automatically acquires a calibration scan prior to a series that requires calibration (for example, PURE or ASSET options). The reduced time lapse from the calibration scan to scan acquisition minimizes possibility of patient movement and thus improves image quality.




Automatic Calibration screen

## Auto coil prescription

Optima 450w with GEM systems introduces a new coil selection user interface that includes an Automatic Coil Selection option when using any of the GEM coil configurations. This option automatically sorts the coil configuration list from best to last and highlights the optimum GEM coil configuration based on the protocol's scan parameters and the patient position relative to the GEM coil. A visual representation of the GEM coil extent and the coverage of the selected coil is displayed at the bottom of the screen.

GEM Suit screen with Automatic Coil Selection option

## Ready Brain Application

An MRI examination of the brain consists of a number of connected steps. Ready Brain provides the flexibility to automate a number of these connected steps ranging from acquiring a localizer image, prescribing acquisition planes, scanning relevant series, performing post-processing up to transferring the final image data to a reading station. By standardizing the steps of an exam and the location of the scan planes, such automation could result in greater consistency, especially in longitudinal follow-up.

Ready Brain features an automatic localizer, automatic calculation of the mid-sagittal plane for 2D/3D prescription and determination of the AC-PC line, and correction for extreme (>45 degree) rotation.

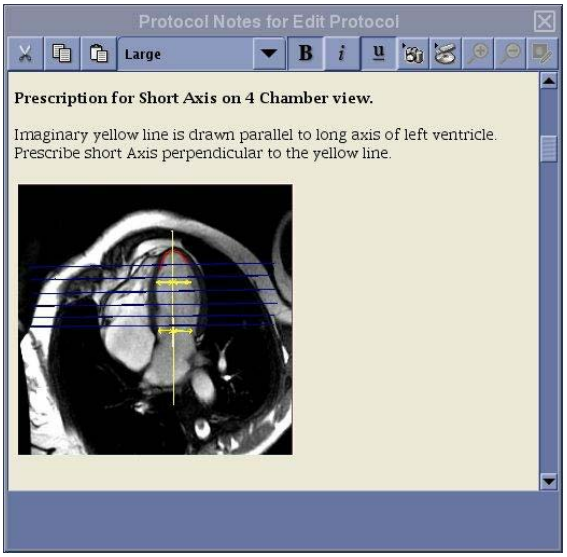
## Linking

Linking automates the prescription of images for each series in an exam. Once the targeted anatomical region has been located the Linking feature combines information from a prescribed imaging series to all subsequent series in the Workflow Manager. All series that have been linked may automatically be prescribed (Rx) and no further interaction will be needed by the technologist to initiate the scan. The user has control over which specific parameters can be linked together. Series can have common fields of view, obliquity, slice thickness, anatomical coverage, saturation bands, or shim volumes. Multiple series can be linked together and saved in the Protocol Library or edited in real time. Linking may be used with any anatomy and with any acquisition. Once the first volume is prescribed, all other subsequent series with the same planes can be automatically prescribed and acquired.


Linking.

## Protocol notes

Each protocol defined by the MR staff includes Protocol Notes. The content the MR staff adds to the Protocol Notes, on a series-by-series, basis can include text and images. Protocol Notes allow the MR staff to communicate protocol parameters, graphic prescription locations, etc. that are specific to your site. Protocol Notes appear below AutoView.




## AutoVoice™

The AutoVoice feature will ensure that consistent and repeatable instructions are presented to the patient for each and every exam. User selectable, pre-recorded instructions are presented at defined points in the acquisition. This helps ensure that the patient is in the right position and is fully aware of the next step in the acquisition process. AutoVoice is particularly helpful during breath-hold exams. The AutoVoice feature includes instructions in over 14 languages and the user can create and include their own unique voice instructions for local needs.

## Inline viewing

Inline viewing allows the user to conveniently view, compare, and analyze images without having to switch to the Browser.

Simply select the series to view from the Workflow Manager and the images are displayed along with standard image display tools. Image comparisons can be easily done by selecting multiple series at a time. The integrated viewer allows the user to seamlessly move between scanning and image viewing.

## Inline processing

The Optima MR450w with GEM workflow automates many of the routine tasks that previously required user interaction. This dramatically reduces the workload for the user and helps ensure that consistent and repeatable images are presented for review. Processing steps are automatically completed immediately after the data has been reconstructed and the images saved into the database. These automated processing steps can be saved in the Protocol Library to ensure consistent exam workflow for each type of patient.

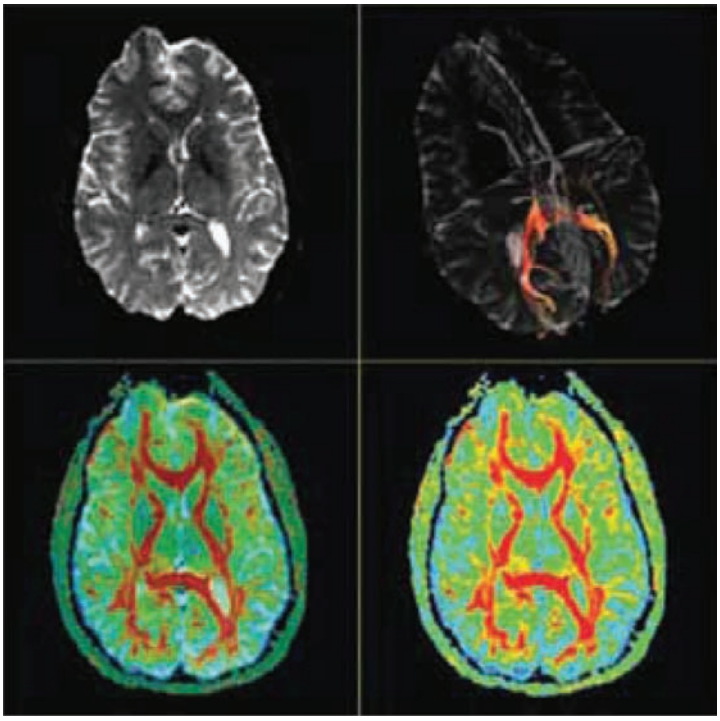
For certain tasks, such as vascular segmentation, the user must accept the results, or complete additional steps prior to saving the images to the database. In these cases the data is automatically loaded into the appropriate tool, then the system will await further instruction by the user. Examples of fully automated and partially automated inline processing include:

| Inline processing capabilities | |
|---|---|
| Diffusion Weighted Images ADC/ eADC Maps | Automatic compute and save |
| Diffusion Tensor Images FA/ADC Maps | Automatic compute and save |
| Image Filtering: A-E, SCIC, PURE | Automatic compute and save |
| Maximum/MinimumIntensity Projection | Automatic compute and save |
| Reformat to orthogonal planes | Automatic compute and save |
| T2 Map for cartilage evaluation | Automatic compute and save |
| FiberTrak | Automatic load |
| Spectroscopy – Single voxel brain and breast metabolite | Automatic compute and save |
| 3D Volume Viewer | Automatic load |
| Spectroscopy – 2D/3D Chemical Shift Imaging | Automatic load |
| BrainStat (Functool) | Automatic load |
| Image Fusion | Automatic load |
| IVI (Volume Viewer) | Automatic load |
| Pasting | Automatic load |
| SER (Functool) | Automatic load |
| eDWI | Automatic compute and save |
| 3D ASL | Automatic compute and save |

## Image fusion

To better visualize tissue and contrast, multiple images from separate acquisitions can be overlaid on one another. With the new Optima MR450w with GEM workflow, high-resolution 2D and 3D anatomical images can be fused with functional data or parametric maps for improved visualization for the user. The data is registered using translation and rotation to ensure accurate fusion.

The automated workflow features of the system can be used for any anatomy and for any sequence. When combining the technology of AutoStart,™ Linking, Inline Processing, AutoVoice,™ and the AutoScan™ features, an entire exam can be completed with just a few actions. The flexibility of the Optima MR450w with GEM user interface and acquisition parameters helps ensure that each acquisition is tailored for every patient. However, the technologist steps are kept consistent.



| Image fusion | |
|---|---|
| MR Standard | 3D Registration |
| ADC/eADC | 3D Registration |
| Diffusion Tensor | 3D Registration |
| Functional MRI | Reformat |
| BrainSTAT | 3D Registration |
| SER (Signal Enhancement Ratio) | Reformat |
| T2 Mapping | Reformat |
| Spectroscopy (Brain, Prostate and Breast) | Reformat |

# Computing platform

## Operator console

The Optima MR450w with GEM system comes equipped with a scan control keyboard assembly that contains intercom speaker, microphone and volume controls, and an emergency stopswitch. Start-scan, pause-scan, stop-scan, and table advance to isocenter hot keys are also included.

## DICOM

The Optima MR450w with GEM system generates MR Image, Secondary Capture, Structured Report, and Gray Scale Softcopy Presentation State (GSPS) DICOM objects. The DICOM networking supports both send and query retrieve as well as send with storage commit to integrate with the site's PACS archive. DICOM filming support includes both Basic Grayscale and Basic Color Print Service Classes. Additionally, the Optima MR450w with GEM system supports the CT and PET image objects for display allowing the user to refer to previous studies.

| Computing platform | |
|---|---|
| Main CPU | Dual Core Intel Xeon 3500<br>3.2 GHz Processor<br>1.333 GHz Dual Front Side Bus<br>8 MB L2 Cache |
| Host memory | 16 GB DDR3-1333 FBD DIMMs |
| Graphics subsystem | Main Display:<br>Nvidia Quadro FX580<br>- 512 MB GDDR3 Memory |
| Cabinets | Single, tower configuration |
| Disk subsystem | System Disk: 146 GB, 15,000 RPM, SAS Drive |
| Network | Gigabit (10/100/1000) Ethernet |

| Image interchange | |
|---|---|
| DVD Interchange | DVD-RW<br>Average 35,000 images per 4.7 GB DVD |

| Filming | |
|---|---|
| Filming | Drag and drop filming<br>One-button print series<br>One-button print page<br>Multi-image formats From 1 to 24 images displayed simultaneously in various layouts<br>DICOM basic grayscale print service class<br>DICOM basic color print service class |

| Wide-screen display monitor | |
|---|---|
| Display monitor | 24" widescreen LCD flat panel<br>1920 x 1200 dot resolution<br>Contrast ratio 500:1<br>Digital DVI interface |

| Display | |
|---|---|
| AutoView | Dedicated image review window |
| Window/Level (W/L) | 6 programmable window/level preset keys in viewer, plus one key for returning to prior setting<br>6 user-programmable buttons in image viewer<br>Arrow keys on scan control keyboard<br>On-image through middle mouse button<br>Save State stores user-selected image orientation, user annotation and window level. |
| Image display | Zoom/Roam/Flip/Rotate/Scroll<br>Explicit Magnify and Magnifying Glass<br>Image Measurement Tools Grid On/Off<br>Cross Reference/User Annotation<br>Exam/Series Page<br>Hide Graphics/Erase Annotation/ Screen Save<br>Accelerator Command Bar<br>Compare Mode/Reference Image/ Image Enhance<br>ClariView Image Filtering<br>Smooth and Sharpen Edge Filters<br>Minified Reference Scoutview<br>Cine Paging (up to 4 windows and 128 images/window)<br>Add/Subtract/Edit Patient Data |
| Image display | 256 Image buffer (256 x 256) at 30 fps |
| Image annotation | Shadowed to permit ease in reading<br>Two graphic/text planes overlay the entire screen.<br>Grid placement with anatomical reference on an image.<br>Drawing and annotation may be added to and removed from images |

# ScanTools

The Optima MR450w with GEM scanner comes standard with a package of pulse sequences and applications optimized for 1.5T performance.

| Pulse sequences and imaging options | |
|---|---|
| 3D Gradwarp | 3D GradWarp is a technique integrated into image reconstruction that helps reduce image distortion by compensating for gradient non-linearities in all three dimensions. This correction differs from the default 2D correction that is conventionally performed by incorporating the slice direction into the processing. |
| Spin Echo | The gold standard for generating T1, proton density and T2 images. |
| Fast-Spin Echo (FSE)<br>Fast-Spin Echo XL (FSE XL) | These techniques use echo-train technology to reduce the time for image acquisition. T2 image blurring is minimized by shorter echo spacing. |
| Fast-Recovery Fast-Spin Echo (FRFSE-XL) | The sequence of choice for high-quality, high-speed, and high-contrast T2-weighted imaging in neurological, body, orthopedic, and pediatric applications. Compared to FSE, FRFSE allows shorter acquisition times or increased slice coverage. |
| 3D FRFSE | 3D FRFSE is a sequence for creating high-resolution, three-dimensional T2-weighted images of all anatomies and is especially useful for MR cholangiopancreatography (MRCP) studies. |
| Single-Shot Fast-Spin Echo (SSFSE) | An ultra-fast technique that permits complete image acquisition following a single RF excitation. It can acquire slices in less than one second, making it an excellent complement to T2-weighted brain and abdominal imaging and MRCP studies. |
| GRE<br>FGRE<br>SPGR<br>FSPGR | This suite of gradient-echo techniques uses short TR and TE to generate T1- or T2-weighted images in far less time than conventional SE. The ultra-short TR and TE possible with these sequences also ensure the performance needed for state-of-the-art vascular and contrast-enhanced MRA studies. |
| 2D and 3D Dual Echo Gradient Echo | A vital tool for abdominal imaging. This variation on conventional gradient echo provides a pair of images for which the signals from water and fat either are in-phase or out-of-phase. By design, all of the images acquired within a single breath-hold are in perfect registration. |
| SPECIAL | Spectral Inversion at Lipids (SPECIAL) is a spectral spatial inversion technique for fat saturation in 3D FGRE pulse sequences. |
| T1 FLAIR<br>T2 FLAIR | T1 and T2 Fluid Attenuated Inversion Recovery (FLAIR) pulse sequences have been designed expressly for neuro applications. FLAIR allows suppression of signal from cerebrospinal fluid (CSF). In addition to this capability, T1 and T2 FLAIR add extraordinary contrast between white and gray matter to T1- and T2-weighted brain and spine imaging. |
| Echo Planar Imaging (EPI)<br>FLAIR Echo Planar Imaging | Essential tools for any high-throughput site employing advanced techniques. Echo planar imaging is what enables rapid imaging. And both echo planar and FLAIR echo planar techniques make it easier to generate neuro studies from uncooperative patients who simply refuse to stay still long enough for conventional techniques. |
| 2D and 3D Time of Flight (TOF) Imaging<br><br>2D-Gated TOF Imaging | 2D TOF Imaging, 2D Gated TOF Imaging, 3D TOF Imaging and Enhanced 3D TOF Imaging are all ideal for MR angiography. Based on conventional gradient echo scanning, TOF imaging techniques rely primarily on flow-related enhancements to distinguish moving from stationary spins. |
| 2D Phase Contrast (2DPC)<br>3D Phase Contrast (3DPC) | These techniques demonstrate flow velocities and directional properties in vessels and other moving fluids such as cerebral spinal fluid and aortic flow. |
| SmartPrep™ | SmartPrep uses a special tracking pulse sequence to monitor the MR signal through a user-prescribed volume to detect the arrival of an injected contrast bolus and to trigger the acquisition, for optimum contrast enhancement. |
| Double/Triple IR | These pulse sequences are included to allow black-blood imaging for studies of cardiac morphology. Triple IR adds fat suppression to black-blood imaging. |

# ScanTools

| Pulse sequences and imaging options continued | |
|---|---|
| FastCINE | This pulse sequence is included specifically for studies of cardiac function. Through the use of retrospective gating, it allows full R-R coverage. |
| iDrive Pro | iDrive Pro brings real-time interactive imaging to the MR system, making it easier to generate detaile diagnostic information on just about any anatomy. This includes organs that are subject to motion artifacts, such as spine, heart, diaphragm and GI tract. The iDrive Pro technique allows the user to change scan parameters on the fly, during scanning, to evaluate the results immediately. |
| IVI | An interactive user interface that allows operators to remove background from MR angiography images. The result: angiographic and maximum intensity (MIP) projections in multiple scan planes. The processed images are saved automatically as a distinct series for quick recall. |
| Reformat | An online tool that allows the operator to convert image data sets from the acquired plane into orthogonal or oblique views. The reformat tool is easy to use and particularly useful for the interrogation of 3D datasets with complex anatomy. Reformatted images can be saved into the database for further review or filming. |
| FuncTool Performance | FuncTool Performance provides advanced capabilities by using a wide range of sophisticated algorithms, including:<br>- ADC maps and eADC maps<br>- Correlation Coefficients for mapping of motor strip and visual/auditory stimuli<br>- Maximum Difference Function<br>- Difference Function |
| Auto TR | Auto TR dropdown menu replaces the TR dropdown menu located on the Graphic Rx desktop. Displays lowest TR value of each series. |
| EPI and DW-EPI | Standard on all systems are gradient echo, spin echo, flair, and diffusion-weighted echo planar imaging. The standard EPI sequence supports single and multi-shot imaging, multi-phase imaging, as well as cardiac gating. Diffusion EPI produces images that can detect acute and hyper-acute stroke with b-value up to 10,000 s/mm2, multi-NEX compatibility and the ability to generate ADC and T2-weighted TRACE images. The FLAIR option suppresses the CSF signal component to ease interpretation. |
| LAVA | LAVA is a three-dimensional (3D) spoiled gradient echo technique designed specifically to image the liver with unprecedented definition, coverage, and speed. Excellent fat suppression, through a version of the SPECIAL technique customized for the liver, is one of the reasons for the high definition of anatomical structures. The coverage and speed of LAVA are the result of short TR, innovative use of partial k-space acquisition, and advanced parallel imaging. What is the clinical benefit of LAVA? It enables the high-quality 3D MR imaging of the liver during short breath-holding periods. |
| BRAVO | Brain Volume imaging is a high-resolution 3D imaging technique designed to produce heavily T1-weighted isotropic images of the brain. BRAVO uses 1D ARC to reduce scan time and minimize parallel imaging artifacts. |
| 2D and 3D MERGE | Multiple Echo Recombined Gradient Echo (MERGE) uses multiple echoes to generate high-resolution images of the C-spine with excellent gray-white matter differentiation. By combining early echoes with high SNR and late echoes with improved contrast, the result is improved cord contrast within the spinal column. |

# Imaging options

| Imaging options | | |
|---|---|---|
| **Pulse sequence imaging options** | • ASSET<br>• ARC™<br>• ART<br>• Blood Suppression<br>• Cardiac Gating/Triggering<br>• Cardiac Compensation<br>• Classic<br>• DE Prepared<br>• EDR<br>• Flow Compensation<br>• Fluoro Trigger<br>• Full Echo Train<br>• IDEAL<br>• IR Preparation<br>• Magnetization Transfer<br>• MRCP | • Multi-Station<br>• Multi-Phase/Dynaplan<br>• Navigator<br>• No Phase Wrap<br>• Real Time<br>• Respiratory Compensation<br>• Respiratory Gating/Triggering<br>• Sequential<br>• SmartPrep™<br>• Spectral Spatial RF<br>• Square Pixel<br>• T2 Prep<br>• Tailored RF<br>• Zip 512/Zip 1024<br>• 3D Slice Zip x 2 (Z2)/Zip x 4 (Z4) |
| **Parallel imaging**<br><br>Array Spatial Sensitivity Encoding Technique (ASSET) imaging option is a 1D image-based parallel imaging technique used to speed data acquisition. For temporally sensitive acquisitions, ASSET reduces image blurring and motion, and enables greater anatomical coverage. Parallel imaging acceleration factors ranging from 1-3.0 are supported depending on the coil selected.<br><br>Auto-Calibrating Reconstruction (ARC) is a data-driven parallel imaging technique that synthesizes missing data from neighboring source data in all three imaging dimensions: slice, phase and frequency. Fewer calibration lines are required and reconstruction accuracy and speed is improved resulting in highly accelerated MR data acquisition with improved image quality and reduced artifacts.<br><br>ARC is auto-calibrating, which means that it requires no coil sensitivity map and is therefore less sensitive to motion artifacts that would occur between the calibration and accelerated scan. It can be used with tight FOVs that are smaller than the anatomy being imaged and thus allow high resolution imaging.<br><br>Since there is no calibration scan required and fewer artifacts, the ARC exam is typically shorter in comparison to other parallel imaging techniques.<br><br>ARC is compatible with most PSDs and coils. It does not require a calibration scan.<br><br>The following applications are parallel imaging enabled. | • 2D FSE<br>• 2D FRFSE<br>• 2D FSE-IR<br>• 2D T1 FLAIR<br>• 2D FSE Double IR<br>• 2D FSE Triple IR<br>• 2D T2 MAP<br>• 2D FSE-XL IDEAL<br>• 2D FRFSE-XL IDEAL<br>• 2D SSFSE<br>• 2D SSFSE-IR<br>• 2D SSFSE MRCP<br>• 2D SSFSE 3-plane<br>• 3D FRFSE<br>• 3D FRFSE HYDRO<br>• 2D FGRE<br>• 2D FSPGR<br>• 2D FIESTA<br>• 2D FIESTA Fat Sat<br>• 2D FIESTA Fast CARD<br>• 2D FIESTA Fast CINE<br>• 2D MDE<br>• 2D MFGRE<br>• 3D Cube (PD, T1, T2, T2 FLAIR)<br>• 3D TOF GRE<br>• 3D TOF SPGR<br>• 3D FGRE<br>• 3D FSPGR<br>• 3D FGRE IDEAL | • 3D FSPGR IDEAL<br>• 3D BRAVO<br>• 3D Quick STEP<br>• 3D Fast TOF GRE<br>• 3D Fast TOF SPGR<br>• 3D FIESTA<br>• 3D Heart<br>• 3D MDE<br>• 3D MERGE<br>• 3D TRICKS<br>• 3D LAVA<br>• 3D LAVA Flex<br>• 3D Dual Echo<br>• 3D VIBRANT<br>• 3D VIBRANT Flex<br>• 2D GRE-EPI<br>• 2D SE-EPI<br>• 2D DW-EPI<br>• 2D DT-EPI<br>• 2D FMRI EPI<br>• Cine IR<br>• FGRE Time Course<br>• Inhance 2.0 Application Suite<br>• MR Echo FGRE Time Course<br>• MR Echo FIESTA Time Course<br>• MR Echo MDE<br>• MR Echo Realtime<br>• MR Echo Function<br>• eDWI |

# Applications

### 3D GradWarp

3D GradWarp is a technique integrated into image reconstruction that helps reduce image distortion by compensating for gradient non-linearities in all three dimensions. This correction differs from the default 2D correction that is conventionally performed by incorporating the slice direction into the processing.

## Neuro Applications

### 3D ASL (Arterial Spin Labeling)

3D ASL utilizes water in arterial blood as an endogenous contrast media to help visualize tissue perfusion and provide quantitative assessment of cerebral blood flow (CBF) in ml/100 g/min. The quantitative CBF maps can be generated and stored in DICOM format.

3D ASL deploys stacked spiral FSE readout with modulated flip angle to acquire 3D volumetric data with increased SNR and minimal image distortion. The 3D data can be reformatted to axial, sagittal, coronal or oblique planes. A pulsed-continuous labeling is applied to label arterial blood close to the imaging volume thus improving conspicuity of flowing blood.

Selective, interwoven pulses are then used to saturate and invert the imaging volume, in order to achieve better back-ground suppression, and reduce sensitivity to motion.

3D ASL helps generate robust, reproducible images and perfusion maps with high SNR, reduced motion artifacts and less distortion in high magnetic susceptibility regions.

### PROPELLER 3.0

PROPELLER 3.0 has been developed to reduce effect of patient voluntary and physiologic motion (breathing, flow, peristaltis), and reduce magnetic susceptibility artifacts. PROPELLER 3.0 helps generate consistently good, diagnostic quality images even for challenging patients and difficult to image anatomies. PROPELLER 3.0 uses innovative radial k space filling pattern that, compared to the Cartesian method, is inherently less sensitive to motions such as CSF and blood flow, breathing, patient tremor or voluntary movements. In addition, a sophisticated motion correction post-processing algorithm is deployed to further reduce effects of rigid motions. The oversampling of the k space center typical for radial k-space filling also yields increased SNR and an excellent tissue contrast.

PROPELLER 3.0 has been enabled for T1 FLAIR, T2, T2 FLAIR imaging in all planes, axial diffusion weighted imaging for brain, T2 weighted imaging for cervical spine, excellent T2 weighted imaging for Body, and T2/PD weighted imaging for MSK.

### IDEAL

IDEAL provides consistent, robust fat and water separation every time, also in difficult to scan anatomies and presence of high magnetic susceptibility effect. Four different contrasts: water only, fat only, in-phase, out-of-phase are generated from a single acquisition, to help facilitate more confident diagnosesand reduce repeat exams. IDEAL acquires multiple echoes at different TE times to generate phase shifts between water and fat, allowing for more accurate pixel-by-pixel water and fat separation, while retaining maximum of SNR. IDEAL can be utilized with FSE-based contrasts such as T1, T2, PD.

### Cube 2.0

Cube is a technique and replaces several slice-by-slice, plane-after-plane 2D FSE acquisitions with a single 3D volume scan – providing you with T1, T2, T2 FLAIR or PD contrast. You can easily reformat sub-millimeter isotropic volume data from a single acquisition into any plane – without gaps and with the same resolution as the original plane. ARC parallel imaging helps eliminate artifacts while accelerating image acquisition.

### 3D BRAVO

BRAVO incorporates ARC parallel imaging with 3D IR-pre-pared FSPGR acquisition to produce isotropic T1-weighted volumes. The center of k-space is over sampled and serves as the calibration data for the parallel imaging reconstruction.

### eDWI

The enhanced Diffusion Weighted Imaging technique has been designed to provide high signal-to-noise-ratio diffusion images of the liver and brain with short-acquisition time. Its multi-B feature is designed to provide measurement of apparent diffusion coefficient (ADC) map with reduced effect of perfusion. In addition, "3 in 1" technique applies diffusion weighting to all three gradients simultaneously, helping improve sensitivity. Built in tetrahedral feature applies four different diffusion weighing combinations of x, y, and z gradients simultaneously to acquire isotropic diffusion weighted images with high signal to noise ratio and shorter TE. Its smart NEX feature significantly reduces the acquisition time. Inversion recovery has been deployed to provide robust fat suppression. Enhanced DWI package includes the acquisition sequence and post-processing tools.

### SWAN

SWAN lets you visualize and clearly delineate small veins, as well as large vascular structures, and iron or calcium deposits in the brain. SWAN captures a broad spectrum of contrast characteristics specific to a wide range of tissue components using a multi-TE acquisition technique. The multi-TE approach is inherently less affected by chemical shift, leading to clear images. The end result is a sub-millimeter-resolution 3D dataset, which integrates a broad range of distinct tissue contrasts with excellent susceptibility information and high SNR.

# Applications

### 3D COSMIC

This is a 3D sequence used to image axial c-spine. COSMIC uses modified fast GRE pulse sequence with steady-state free precession segmented multi-shot centric k-space acquisition. This improves the CNR and SNR of c-spine tissue including the spinal cord, vertebral disks, nerve root canal and contrast between CSF and nerve roots.

### 2D and 3D MERGE

Multiple Echo Recombined Gradient Echo (MERGE) uses multiple echoes to generate high-resolution images of the C-spine with excellent gray-white matter differentiation. By combining early echoes with high SNR and late echoes with improved contrast, the result is improved cord contrast within the spinal column.

### 3D FIESTA-C

This phase-cycled FIESTA reduces sensitivity to susceptibilities that may be encountered when imaging in the posterior fossa. It provides exquisite contrast that is ideally equated for visualization of the internal auditory canal. It is also ideally suited for T1 imaging through the cervical spine.

### 3D FIESTA

3D FIESTA (Fast Imaging Employing Steady-state Acquisition is a technique that uses an extremely short repetition time (TR) between RF pulses such that high-resolution 3D volume images can be acquired rapidly. The 3D FIESTA technique is especially useful for the rapid acquisition of high-spatial-resolution images of static structures such as cochlea, internal auditory canal, or joints.

### Diffusion Tensor Imaging with Fiber Tracking

This package expands EPI capability to include diffusion tensor imaging, a technique that acquires diffusion information in up to 150 different diffusion directions. It generates image contrast based on the degree of diffusion anisotropy in cerebral tissues such as white matter. FuncTool capabilities on the console (included with ScanTools) create Fractional Anisotropy (FA), Apparent Diffusion Weighted (ADC) and T2-Weighted TRACE maps.

The optional FiberTrak post-processing utility generates eigen-vector information from the diffusion tensor acquisition and processing. Using a robust and efficient seeding process, three-dimensional renderings of the diffusion along white matter tracts are generated.

### BrainSTAT

BrainSTAT is a standard post processing application that automatically generates parametric maps for Cerebral Blood Flow, Blood Volume, Mean Transit Time, and Time to Peak signal intensity. A Gamma Variate Fitting algorithm is used to automatically calculate the values for the four parametric maps. The maps may be saved in DICOM format and fused with high-resolution anatomic datasets to provide reference to tissue and anatomy.

An optional add-on to the Brain STAT package enables the user to automatically, or manually specify the arterial-input function (AIF) based on the temporal form of the signal, to calculate normalized values of the Blood Flow, Blood Volume, Mean Transit Time, and Time to Peak signal intensity based on the vascular flow dynamics of a specific patient.

### BrainWave Real Time

ScanTools pulse sequences include the ability to detect the signal intensity changes (BOLD) during pre-determined tasks (paradigm) using single-shot EPI and then Map these changes as color maps with FuncTool on host and/or on AW.

BrainWave RT offers further enhancement to the above functionality with real time applications and image database. It allows a single technologist to acquire, process and display BOLD (Blood Oxygen Level Dependent) fMRI studies acquired with synchronized stimuli. It is very comprehensive, interfacing with the host's database and equipping you with all the real-time functionality you need – including paradigm control and development, and real-time display of color activation, overlaid on source EPI images.

The main features are:

- 50,000 image storage per series with data acquisition rates up to 20 image/s
- Display of 2D activation maps overlaid over echo planar source images in real time.
- Multiple 2x2 and 4x4 display.
- Optional saving of raw data in research mode for off-line analysis with 200,000 images.

# Applications

### BrainWave Post-Acquisition on console

This high-performance software allows you to produce, from raw fMRI data, phenomenally detailed brain images displaying functional activation. Display alternatives for these maps include cross-sectional displays, activation Z-maps and composite paradigm displays.

The features include:

- Integration in to the operator console.
- Special graphic user interface for image analysis.
- Data quality check, motion correction, temporal filtering and spatial smoothing to optimize statistical analysis and mapping.
- Multiple regression analysis.
- The structural MRI scan is segmented using completely automatic threshold and histogram methods and mathematical morphology techniques.
- Rapid retrospective motion correction.
- Sophisticated visualization techniques including true volume rendering, light box and orthogonal displays.

### BrainWave Fusion

BrainWave Fusion is an optional package that provides the ability to fuse high-resolution anatomical images with fMRI activation maps and diffusion tensor fiber maps. This package is useful for evaluating the spatial relationship between activation patterns, fiber tracts, and underlying anatomy and pathology.

### BrainWave Lite Hardware

The image processing algorithms in BrainWave packages such as BrainWave RT and BrainWave PA, depend heavily on proper synchronization of scanning with stimulus presentation to the subject (patient) being scanned.

BrainWave Lite Hardware provides this GE-designed hard-ware that provides trigger signal to support this synchroniza-tion – thereby paving the way for convenient compatibility and selection of vendor-supplied sensory equipment such as headphone, microphone and glasses. (Not included)

BrainWave Lite Hardware includes:

- A dedicated computer workstation.
- Equipment rack and penetration panel waveguide insert.
- Cedrus patient response pads, and related cabling and connectors.
- It is designed to deliver visual and auditory stimuli and receive a tactile response. The computer includes preset paradigms and software tools to generate custom protocols.
- The visual and auditory output can be coupled to fMRI delivery systems purchased separately from other vendors

## Spectroscopy applications

### PROBE PRESS single voxel spectroscopy

PROBE PRESS single-voxel spectroscopy allows you to non-invasively evaluate the relative concentrations of in-vivo metabolites and lets you acquire and display volume-localized, water-suppressed H1 spectra in single voxel mode. The package includes automated recon, acquisition set-up and graphic prescription of spectroscopic volumes.

The standard sequence consists of three slice-selective RF pulses with crusher gradients. The PRESS sequence makes use of reduced flip angles to decrease minimum TE time of the sequence. The key advantage of PRESS (over STEAM) is that it provides up to twice the SNR and hence decreased exam time or voxel size. It is the sequence of choice for all Hydrogen single voxel spectroscopy data acquisitions with TE values ≥ 35 ms.

### PROBE – STEAM single voxel spectroscopy

Stimulated Echo Acquisition Mode acquires a stimulated echo from the localized volume. The basic sequence consists of three slice selective 90-deg RF pulses and a set of crusher gradients. Though STEAM provides more accurate voxel localization, it has inherently lower SNR compared to PRESS. Moreover, since echo times available with STEAM can be shorter, it is better suited than PRESS for chemical species that have shorter T2.

### PROBE – 2D CSI

This extends the PROBE-PRESS capabilities with simultaneous multi-voxel in-plane acquisitions. Post- processing, including the generation of metabolite maps is automatically generated with FuncTool Performance package.

### PROBE – 3D CSI

This extends the PROBE-2D CSI capabilities to add 3D multi-voxel acquisitions. (PROBE 2D CSI is mandatory).

### BREASE

This is a TE averaged PRESS spectroscopy acquisition that provides the necessary biochemical information to help characterize breast tissue.

# Applications

### PROSE

PROSE (PROstate Spectroscopy and imaging Examination), is a noninvasive imaging technique to evaluate prostate lesions.

## Cardio-vascular Applications

### Inhance 2.0 Application Suite

The Inhance application suite consists of several new sequences designed to provide high-resolution images of the vasculature with short-acquisition times and excellent vessel detail. These new sequences include:

### Inhance Inflow IR 2.0

Inhance Inflow IR is a non-contrast-enhanced MR angiography technique that has been developed to image arteries with ability to suppress static background tissue and venous flow. This sequence is based on 3D FIESTA, which improves SNR and produces bright blood images. Selective inversion pulses are applied over the region of interest to invert arterial, venous, and static tissue. At the null point of the background tissue, an excitation pulse is applied to generate signal. The net result is an angiographic image with excellent background suppression.

Uniform fat suppression is achieved using a spectrally selective chemical saturation (SPECIAL) technique while respiratory gating compatibility reduces respiratory motion artifacts during free-breathing renal exams.

### Inhance 3D Velocity

Inhance 3D Velocity is designed to acquire angiographic images in brain and renal arteries with excellent background suppression in a short scan time. By combining a volumetric 3D phase contrast acquisition with parallel imaging, efficient k-space sampling, and pulse sequence optimization, Inhance 3D Velocity is capable of obtaining the whole neurovascular anatomy in approximately 5~6 minutes. Furthermore, background suppression is improved by the optimized pulse sequence design, resulting in better visualization of small branches. Respiratory triggering is also compatible with Inhance 3D Velocity to enable abdominal angiography, specifically renal arteries. The results are excellent productivity and image quality.

### Inhance 3D DeltaFlow

Inhance 3D DeltaFlow is a 3D non-contrast-enhanced MRA application for peripheral arterial imaging. It is based on cardiac gated 3D fast spin echo and acquires two echoes viz., one in diastole and the other in systole. Slow arterial flow during diastole results in bright arteries in the diastole images while faster arterial flow during systole results in dark arteries in the systole images. A subtraction of the systole images from diastole images provides arterial only images with excellent suppression of venous and background signal. Interleaved acquisition and parallel imaging (ASSET) with optimized k-space trajectory helps reduce motion misregistration and improve vessel visualization respectively. In addition the use of partial-Fourier and coronal plane acquisition allows for considerably reduced scan time.

### Inhance 2D Inflow

The Inhance 2D Inflow pulse sequence is designed to acquire angiographic images of arteries that follow almost a straight path (i.e. femoral, popliteal, and carotid arteries). Arterial blood flow is faster during the systolic phase and slows down during the diastolic phase. Therefore, Inhance 2D Inflow is designed to acquire data during the systolic phase. It features an optimized spatial saturation gap to improve fat suppression and background suppression. Peripheral Gating is deployed to minimize the pulsatile artifacts. Inhance 2D Inflow is compatible with ASSET acceleration to reduce scan time.

### 3D Heart

3D Heart is a 3D FatSat FIESTA or 3D IR Prep FGRE sequence optimized to provide whole-heart coverage with excellent image quality. 3D FastSat FIESTA is aimed for coronary artery imaging or cardiac chamber imaging and 3D IR Prep FGRE is aimed for a high resolution myocardial viability assessment with delayed enhancement techniques. The whole heart volume is acquired in several slabs, using a multi-slab localizer that allows easy whole-heart prescription, compared to prescribing specific anatomical views in 2D acquisitions . A T2 preparation is deployed to improve the contrast to noise ratio between myocardium and the coronary for 3D FatSat Fiesta. A navigator echo pulse that detects motion of the diaphragm is utilized to enable free breathing acquisition. The navigator has been optimized to improve robustness, and includes a slab-tracking feature that automatically shifts slab positions based on the detected diaphragm location to improve motion suppression and increase scan efficiency. The multi-slab acquisition minimizes the effect of respiratory drift and heart rate variability on image quality. Furthermore, the SNR is improved with mulit-slab due to less blood saturation effect. An optimized phase ordering and steady state preparation has also been used to improve CNR and SNR.

### Cine IR (Cine Inversion Recovery)

Cine IR can be very useful for approximating the myocardial null point for a subsequent myocardial viability assessment with delayed enhancement (MDE) techniques.

Cine IR is a conventional ECG-gated, gradient-recalled echo FASTCARD or FASTCINE acquisition sequence with a multi-phase readout and an inversion recovery (IR) preparation.

A single adiabatic inversion pulse is generated upon detection of the cardiac R-wave to trigger the multi-phase readout.

Multi-phase images are generated within the cardiac cycle, each at a progressively longer TI time.

### FGRE Time Course (Fast Gradient Recalled Echo Time Course)

The FGRE Time Course PSD is a fast gradient-echo sequence optimized for time-course studies. FGRE TC utilizes single-echo acquisition to help reduce sensitivity to echo mis-alignment or system calibrations variations, which can result in robust image quality with less ghosting and artifact reduction. ASSET parallel imaging and shortened RF pulse design are incorporated to help improve temporal resolution and reduce motion related artifacts. In addition to selective notch pulse, it also supports non-selective saturation pulse for excellent background suppression and multi-plane imaging capability.

# Applications

### iDrive Pro Plus

iDRIVE Pro Plus expands the capabilities of standard iDrive Pro with:

- Geometric changes to image plane location, obliquity, rotation, center FOV and FOV size
- Contrast parameters such as spatial pre-saturation on/off, special sat pulses, flow comp and RF spoiling
- Application of a non-selective IR pulse
- Swapping phase and frequency

It starts with an intuitive point-and-click user interface and live, on-image navigation icons. It continues with click-of-the-mouse image book-marking and a suite of localization and drawing tools, and includes capabilities from 10-level undo/redo, built-in time, autoNEX and click-of-the-mouse display/review/save, all to streamline even the most complex exams and manipulations.

### MR Echo

MR Echo expands on the capability provided by I-Drive Pro Plus. Presently, patients have to undergo multiple breath-holds to achieve the 'whole heart coverage' for wall motion and other studies. MR Echo employs a bright blood ultra-fast FIESTA sequence, which virtually eliminates the need for breathholding. An intuitive interface enables the operator to quickly scan the heart in any orientation and to save real time images to the browser through bookmarks. Additionally, a Scan and Save mode enables high resolution heart imaging with VCG and enables multiple functional images over many slices to be prescribed and scanned in a single breath-hold. The operator immediately visualizes scan time for the number of prescribed slices enabling each scan to be tailored to the patient's breath-hold capability. All images acquired in Scan and Save are stored in the browser while the operator immediately continues with real time scanning. MR Echo is able to significantly reduce typical cardiac exam times (compared to previous generation techniques).

### TRICKS

Time Resolved Imaging of Contrast KineticS (TRICKS) technology uses intricate temporal sampling with complex data recombination to accelerate the temporal resolution of 3D dynamic imaging – with virtually no compromise in spatial resolution. This technology is integrated with Elliptical-Centric data sampling to create an excellent imaging technique for MRA in even the most challenging circumstances.

Easy to set up, TRICKS rapidly generates time-resolved 3D images of blood vessels to help meet the challenge of capturing peak arterial phases with minimal venous contamination. With TRICKS, the different vascular phases can be extracted after image acquisition.

### Fluoro-Triggered MRA

Fluoro-triggered MRA (FTMRA) is designed to capture angiographic images at the precise moment of peak opacification. Rather than automating the image-acquisition upon detection of the bolus arrival, FTMRA allows the operator to trigger each acquisition almost instantly as soon as the operator is satisfied with the level of vessel enhancement. The result is an interactive, ASSET compatible, approach to contrast-enhanced MRA.

### 2D FIESTA CINE

Fast Imaging Employing STeady state Acquisitions is a fully balanced steady-state coherent imaging pulse sequence that has been designed to produce high SNR images at very short TR. The pulse sequence uses fully balanced gradients to re-phase the transverse magnetization at the end of each TR interval. This sequence accentuates the contrast of anatomy with high T2/T1 ratios (such as the cardiac blood pool), while suppressing the signal from tissues with low T2/T1 ratios (such as muscle and myocardium). This enhances the contrast between the myocardium and the blood pool.

### StarMap

StarMap is a technique that acquires multiple echoes at different TE times at each location resulting in images that represent variations of T2* weighting. Post-processing of the images is employed to generate gray scale and color maps of the T2* signal decay across the echoes, which can be useful in the assessment of the presence of iron.

### QuickSTEP

QuickSTEP is an automated multi-station acquisition. This application automatically prescribes, acquires, and combines images from multiple stations for fast acquisition and exam completion. To complete the entire exam in as little as 7 minutes, the system will automatically acquire mask datasets from multiple stations without any user intervention. Secondary images are then acquired at the same independent table positions. The system will automatically subtract the mask images from the secondary dataset and combine the resulting images from the multiple stations into one series. The user only needs to complete a quick review of the data prior to insertion of images into the database.

# Applications

### 3D FatSat FIESTA

3D FatSat FIESTA is software designed for imaging of the coronary arteries. The software acquires 3D images using FIESTA (Fast Imaging Employing STeady-state Acquisition). Fat suppression is applied to accentuate the coronary arteries. The use of VAST (Variable Sampling in Time) technology greatly shortens breath-holding requirements or allows for higher spatial resolution.

### 2D IR Prepared Gated FGRE

Vital to MRI myocardial assessments, this technique can help distinguish living tissue from dead and therefore have a major impact on patient management – particularly on revascularization strategies. This pulse sequence uses an IR prepared, cardiac-gated fast gradient echo sequence to acquire images whose appearance depends on the tissue's T1 relaxation time. The IR-preparation step allows various tissues to be suppressed or enhanced. The IR prep pulse in this sequence is non-selective; i.e., it excites the entire volume inside the body coil, rather than a specific slice. That means that it can suppress both the myocardium and the blood flowing into the slice.

### 3D IR Prepared Gated FGRE

3D IR Prepared Gated FGRE is an advanced tool for myocardial assessment. It acquires extensive volumes of data, rather than merely single slices, during breath holds, with acquisitions gated to the cardiac cycle. The software applies a non-selective inversion recovery magnetization preparation step to create T1-weighted tissue contrast and suppress the signal from certain tissues.

### Navigators

This software package is designed for use in conjunction with 3D IR Prepared FGRE or 3D FatSat FIESTA for Cardiac Imaging. It consists of navigators that make it possible to track the diaphragm and use the information to acquire crisp 3D gradient-echo images of the heart even while the patient breathes.

### Cardiac Tagging

Used to improve visualization of contractile function, this tagging application combines cardiac-gated FastCINE gradient-recalled echo to acquire data throughout the cardiac cycle, with spatial SAT pulses applied throughout the FOV. Using the operator's choice of diagonal stripes or a grid pattern, tagging is applied once per R-R interval immediately following the R-wave ECG trigger, just before the start of data acquisition.

### Fast Gradient Echo using EPI Echo Train

This technique combines a short-TR FGRE (Fast GRadient Echo) pulse sequence with an EPI echo train to acquire multiple views, or phase encoding steps, per TR. It features uniform RF excitation, centric phase encoding, segmented k-space filling, retrospective gating in FastCARD-ET, EPI-caliber interleaving, and EPI-like acquisition of multiple views in one TR. Multi-phase FGRET is useful for applications such as multi-slice, multi-phase imaging of myocardial function.

### Real Time FGRE-ET

Also known as Fluoro MRI, this pulse sequence (whose name is an acronym for Fast Gradient Echo using an EPI EchoTrain) uses a short TR FGRE pulse sequence with the ability to acquire multiple views, or phase-encoding steps, per TR via an EPI echo train. The result is a highly useful combination of gradient-echo and EPI features, such as:

- Uniform RF excitation
- Centric phase encoding
- Segmented K-space filling
- Retrospective gating in FastCARD-ET
- Interleaving, as in EPI
- Acquisition of multiple views in a single TR

Used in conjunction with iDrive Pro Plus, the real-time version of this pulse sequence is essentially a single-slice version of standard FGRET. That makes it especially useful for obtaining higher-resolution interactive cardiac images.

### Spiral Imaging

Developed to acquire high-resolution images in far less than one second, Spiral Imaging is ideally suited for imaging moving structures such as the coronary arteries. Instead of collecting data in the conventional rectilinear grid pattern, it simultaneously applies the x and y gradients in conjunction with a 2D GRE or SPGR pulse sequence, and then interpolates the data onto a rectilinear grid for image generation. Non-gated sequences can be used with one or more slice locations; gated acquisitions can be conducted in sequential or non-sequential mode.

The advantages of Spiral Imaging include fast acquisition from the more efficient k-space data collection, high SNR from over-sampling of the center of k-space, and intrinsic flow- and motion-compensation from the short echo times.

# Applications

## Body Applications

### LAVA Flex

LAVA Flex is a 3D FSPGR imaging technique that acquires fat/water in phase and out of phase echoes in a single acquisition. Up to 4 types of image may be reconstructed within one acquisition: in phase, out of phase, water only, fat only. The water only contrast differs from a conventional fat suppressed image in that an inversion prep pulse is not applied for fat suppression. In fact, the fat information is removed leaving a water only image that may potentially be used in place of a LAVA type image. LAVA Flex uses ARC. (Auto Calibrating Reconstruction for Cartesian Sampling), a 2D self-calibrated parallel imaging technique that allows for acceleration in both phase and slice directions for supported coils.

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PROPELLER 3.0 has been enabled for T1 FLAIR, T2, T2 FLAIR imaging in all planes, axial diffusion weighted imaging for brain, T2 weighted imaging for cervical spine, excellent T2 weighted imaging for Body, and T2/PD weighted imaging for MSK.

### eDWI

The enhanced Diffusion Weighted Imaging technique has been designed to provide high signal-to-noise-ratio diffusion images of the liver and brain with short-acquisition time. Its multi-B feature is designed to provide measurement of apparent diffusion coefficient (ADC) map with reduced effect of perfusion. In addition, "3 in 1" technique applies diffusion weighting to all three gradients simultaneously, helping improve sensitivity. Built in tetrahedral feature applies four different diffusion weighing combinations of x, y, and z gradients simultaneously to acquire isotropic diffusion weighted images with high signal to noise ratio and shorter TE. Its smart NEX feature significantly reduces the acquisition time. Inversion recovery has been deployed to provide robust fat suppression. Enhanced DWI package includes the acquisition sequence and post-processing tools.

### MR Touch

MR-Touch is a non-invasive method to measure relative tissue stiffness with MR.

MR Touch™ is a new acquisition and reconstruction technique that combines hardware, and acquisition and reconstruction algorithms to produce Elastograms, color-coded anatomical images showing varying degrees of elasticity or stiffness. The image contrast is related to relative stiffness of soft tissue and is generated from the real-time data acquisition during tissue palpation with low amplitude and low frequency sound waves. The hardware component is comprised of an active sound wave generator and a passive transducer that produces small vibrations in the area of the patient to be scanned. The MR-Touch acquisition software is an evolutionary improvement to the gradient echo sequence. The acquisition software also triggers the sound wave generator to produce synchronized vibrations on the surface of the patient during the data acquisition. The reconstruction algorithms generate images that show the propagation of waves through the tissue (phase images) and also the corresponding strain wave and relative stiffness images. Parallel imaging is used to accelerate image acquisition.

MR Touch is designed to enable physicians to evaluate relative liver and muscle tissue stiffness.

### 3D Dual Echo

With improvements in parallel imaging and RF coil arrays, volumetric imaging in the body is becoming a standard of care. The 3D Dual Echo sequence produces in-phase and out-of-phase images in a single breath-hold. As a result, the high-resolution images are in perfect alignment simplifying the diagnostic process. In addition, 3D Dual Echo ensures that the out-of-phase echo is acquired first. The result is improved SNR compared to 2D Dual Echo. 3D Dual Echo also permits thinner slice imaging.

### 2D FatSat FIESTA

Fast Imaging Employing STeady-state Acquisition (FIESTA) is designed to produce high SNR images extremely rapidly and with excellent contrast between tissues. The contrast relies on a steady state for the transverse magnetization, which builds as a series of radio frequency pulses and special gradient pulses are repeated after an extremely short repetition time, TR. FIESTA accentuates the signal from tissues that have a long T2 and short T1. FIESTA has the capability to suppress the signal from fat, especially to create more contrast between the vasculature and surrounding tissues.

# Applications

### Single-Shot Fast-Spin Echo

An ultra-fast technique that permits complete image acquisition following a single RF excitation. It can acquire slices in less than one second, making it an excellent complement to T2-weighted brain and abdominal imaging and MRCP studies.

### Cube 2.0

Cube is a 3D isotropic imaging technique with sub-millimeter spatial resolution and excellent contrast to help visualize even diminutive lesions. Cube can replace several slice-by-slice, plane-after-plane 2D FSE acquisitions with one single 3D scan. You can easily reformat sub-millimeter isotropic volume data into any plane - without gaps, and with the same resolution as the original plane. Cube is enabled for T1, T2, T2 FLAIR or PD contrasts. Our new self-calibrating parallel imaging engine ARC helps eliminate artifacts while accelerating image acquisition.

### Respiratory Triggering

For patients that cannot hold their breath, respiratory triggering provides the answer. By synchronizing the acquisition to the respiratory cycle, high-resolution images virtually free of breathing artifacts are obtained.

### StarMap

StarMap is a technique that acquires multiple echoes at different TE times at each location resulting in images that represent variations of T2* weighting. Post-processing of the images is employed to generate gray scale and color maps of the T2* signal decay across the echoes, which can be useful in the assessment of the presence of iron.

## Breast Applications

MRI has been shown to be beneficial in the evaluation of the breast providing high-resolution images of breast anatomy. The Optima MR450w with GEM system provides a full compliment of breast imaging applications and protocols that generate both temporal and spatial resolution for highly detailed diagnostic breast.

### VIBRANT

VIBRANT (Volume Imaging for Breast AssessmeNT) permits high definition bilateral imaging of both breasts in the time that it normally takes to image a single breast. VIBRANT integrates ASSET technology with bilateral shimming and a patented fat-suppression technique developed specifically for breast imaging. This enhanced version of VIBRANT for Optima MR450w with GEM allows the slices to be acquired in either the sagittal or axial orientation.

### VIBRANT Flex

VIBRANT Flex uses a time-efficient dual-echo acquisition with 2D ARC parallel imaging to produce water-only, fat-only, in-phase, and out-of-phase images of the breast in a single scan. The Flex processing eliminates fat saturation failures in inhomogeneous regions to provide a clear depiction of the underlying breast anatomy.

### BREASE

BREASE is a TE averaged PRESS spectroscopy acquisition that provides the necessary biochemical information to help characterize breast tissue.

## Musculoskeletal Applications

### PROPELLER 3.0

PROPELLER 3.0 has been developed to reduce effect of patient voluntary and physiologic motion (breathing, flow, peristaltis), and reduce magnetic susceptibility artifacts. PROPELLER 3.0 helps generate consistently good, diagnostic quality images even for challenging patients and difficult to image anatomies. PROPELLER 3.0 uses innovative radial k space filling pattern that, compared to the Cartesian method, is inherently less sensitive to motions such as CSF and blood flow, breathing, patient tremor or voluntary movements. In addition, a sophisticated motion correction post-processing algorithm is deployed to further reduce effects of rigid motions. The oversampling of the k space center typical for radial k-space filling also yields increased SNR and an excellent tissue contrast.

PROPELLER 3.0 has been enabled for T1 FLAIR, T2, T2 FLAIR imaging in all planes, axial diffusion weighted imaging for brain, T2 weighted imaging for cervical spine, excellent T2 weighted imaging for Body, and T2/PD weighted imaging for MSK.

# Applications

### IDEAL

Areas such as the foot/ankle, shoulder, and off-isocenter wrist make fat saturation a challenge. With IDEAL, water, fat, in-phase, and out-of-phase images can be generated even in the presence of large static field variations. This sequence can produce consistent and reliable images in challenging anatomical areas.

### 3D FIESTA

3D FIESTA (Fast Imaging Employing Steady-state Acquisition) inherent sensitivity to fluids makes this an ideal sequence for orthopedic applications. In knee imaging, 3D FIESTA uses an extremely short repetition time (TR) between RF pulses such that high-resolution 3D volume images can be acquired rapidly. The 3D FIESTA technique is especially useful for the rapid acquisition of high-spatial-resolution images of static structures such as cochlea, internal auditory canal, or joints.

### CartiGram

CartiGram is a non-invasive T2 mapping package that provides high-resolution maps of the T2 values in cartilage and other tissues. The imaging results are color coded to highlight those structures with increased water-content yielding elevated T2 values.

## Pediatric Applications

### 3D ASL (Arterial Spin Labeling)

3D ASL utilizes water in arterial blood as an endogenous contrast media to help visualize tissue perfusion and provide quantitative assessment of cerebral blood flow (CBF) in ml/100 g/min. The quantitative CBF maps can be generated and stored in DICOM format.

3D ASL deploys stacked spiral FSE readout with modulated flip angle to acquire 3D volumetric data with increased SNR and minimal image distortion. The 3D data can be reformatted to axial, sagittal, coronal or oblique planes. A pulsed-continuous labeling is applied to label arterial blood close to the imaging volume thus improving conspicuity of flowing blood.

Selective, interwoven pulses are then used to saturate and invert the imaging volume, in order to achieve better background suppression, and reduce sensitivity to motion.

3D ASL helps generate robust, reproducible images and perfusion maps with high SNR, reduced motion artifacts and less distortion in high magnetic susceptibility regions.

### PROPELLER 3.0

PROPELLER 3.0 has been developed to reduce effect of patient voluntary and physiologic motion (breathing, flow, peristaltis), and reduce magnetic susceptibility artifacts. PROPELLER 3.0 helps generate consistently good, diagnostic quality images even for challenging patients and difficult to image anatomies. PROPELLER 3.0 uses innovative radial k space filling pattern that, compared to the Cartesian method, is inherently less sensitive to motions such as CSF and blood flow, breathing, patient tremor or voluntary movements. In addition, a sophisticated motion correction post-processing algorithm is deployed to further reduce effects of rigid motions. The oversampling of the k space center typical for radial k-space filling also yields increased SNR and an excellent tissue contrast.

PROPELLER 3.0 has been enabled for T1 FLAIR, T2, T2 FLAIR imaging in all planes, axial diffusion weighted imaging for brain, T2 weighted imaging for cervical spine, excellent T2 weighted imaging for Body, and T2/PD weighted imaging for MSK.

### Diffusion Tensor Imaging with Fiber Tracking

This package expands EPI capability to include diffusion tensor imaging, a technique that acquires diffusion information in up to 150 different diffusion directions. It generates image contrast based on the degree of diffusion anisotropy in cerebral tissues such as white matter. Functool capabilities on the console (included with ScanTools) create Fractional Anisotropy (FA), Apparent Diffusion Weighted (ADC) and T2-Weighted TRACE maps.

The optional FiberTrak post-processing utility generates eigen-vector information from the diffusion tensor acquisition and processing. Using a robust and efficient seeding process, three-dimensional renderings of the diffusion along white matter tracts are generated.

### Cube 2.0

Cube is a 3D isotropic imaging technique with sub-millimeter spatial resolution and excellent contrast to help visualize even diminutive lesions. Cube can replace several slice-by-slice, plane-after-plane 2D FSE acquisitions with one single 3D scan. You can easily reformat sub-millimeter isotropic volume data into any plane - without gaps, and with the same resolution as the original plane. Cube is enabled for T1, T2, T2 FLAIR or PD contrasts. Our self-calibrating parallel imaging engine ARC helps eliminate artifacts while accelerating image acquisition.

### BRAVO

BRAVO incorporates ARC parallel imaging with 3D IR-pre-pared FSPGR acquisition to product isotropic T1-weighted volumes. The center of k-space is over sampled and serves as the calibration data for the parallel imaging reconstruction.

### Inhance Application Suite

The Inhance application suite consists of several new sequences designed to provide high-resolution images of the vasculature with short-acquisition times and excellent vessel detail. These new sequences include:

### eDWI

The enhanced Diffusion Weighted Imaging technique has been designed to provide high signal-to-noise-ratio diffusion images of the liver and brain with short-acquisition time. Its multi-B feature is designed to provide measurement of apparent diffusion coefficient (ADC) map with reduced effect of perfusion. In addition, "3 in 1" technique applies diffusion weighting to all three gradients simultaneously, helping improve sensitivity. Built in tetrahedral feature applies four different diffusion weighing combinations of x, y, and z gradients simultaneously to acquire isotropic diffusion weighted images with high signal to noise ratio and shorter TE. Its smart NEX feature significantly reduces the acquisition time. Inversion recovery has been deployed to provide robust fat suppression.
Enhanced DWI package includes the acquisition sequence and post-processing tools.

### Inhance Inflow IR 2.0

Inhance Inflow IR is a non-contrast-enhanced MR angiography technique that has been developed to image arteries with ability to suppress static background tissue and venous flow. This sequence is based on 3D FIESTA, which improves SNR and produces bright blood images. Selective inversion pulses are applied over the region of interest to invert arterial, venous, and static tissue. At the null point of the background tissue, an excitation pulse is applied to generate signal. The net result is an angiographic image with excellent background suppression and free of venous contamination.

Uniform fat suppression is achieved using a spectrally selective chemical saturation (SPECIAL) technique while respiratory gating compatibility reduces respiratory motion artifacts during free-breathing renal exams.

### Inhance 3D Velocity

Inhance 3D Velocity is designed to acquire angiographic images in brain and renal arteries with excellent background suppression in a short scan time. By combining a volumetric 3D phase contrast acquisition with parallel imaging, efficient k-space sampling, and pulse sequence optimization, Inhance 3D Velocity is capable of obtaining the whole neurovascular anatomy in approximately 5~6 minutes. Furthermore, background suppression is improved by the optimized pulse sequence design, resulting in better visualization of small branches. Respiratory triggering is also compatible with Inhance 3D Velocity to enable abdominal angiography, specifically renal arteries. The results are excellent productivity and image quality.

### Inhance 3D

Inhance 3D DeltaFlow is a 3D non-contrast-enhanced MRA application for peripheral arterial imaging. It is based on cardiac gated 3D fast spin echo and acquires two echoes viz., one in diastole and the other in systole. Slow arterial flow during diastole results in bright arteries in the diastole images while faster arterial flow during systole results in dark arteries in the systole images. A subtraction of the systole images from diastole images provides arterial only images with excellent suppression of venous and background signal. Interleaved acquisition and parallel imaging (ASSET) with optimized k-space trajectory helps reduce motion misregistration and improve vessel visualization respectively. In addition the use of partial-Fourier and coronal plane acquisition allows for considerably reduced scan time.

### Inhance 2D Inflow

The Inhance 2D Inflow pulse sequence is designed to acquire angiographic images of arteries that follow almost a straight path (i.e. femoral, popliteal, and carotid arteries). Arterial blood flow is faster during the systolic phase and slows down during the diastolic phase. Therefore, Inhance 2D Inflow is designed to acquire data during the systolic phase. It features an optimized spatial saturation gap to improve fat suppression and background suppression. Peripheral Gating is deployed to minimize the pulsatile artifacts. Inhance 2D Inflow is compatible with ASSET acceleration to reduce scan time.

### 3D Heart

3D Heart is a 3D FatSat FIESTA or 3D IR Prep FGRE sequence optimized to provide whole-heart coverage with excellent image quality. 3D FastSat FIESTA is aimed for coronary artery imaging or cardiac chamber imaging and 3D IR Prep FGRE is aimed for a high resolution myocardial viability assessment with delayed enhancement techniques. The whole heart volume is acquired in several slabs, using a multi-slab localizer that allows easy whole-heart prescription, compared to prescribing specific anatomical views in 2D acquisitions . A T2 preparation is deployed to improve the contrast to noise ratio between myocardium and the coronary for 3D FatSat Fiesta. A navigator echo pulse that detects motion of the diaphragm is utilized to enable free breathing acquisition. The navigator has been optimized to improve robustness, and includes a slab-tracking feature that automatically shifts slab positions based on the detected diaphragm location to improve motion suppression and increase scan efficiency. The multi-slab acquisition minimizes the effect of respiratory drift and heart rate variability on image quality. Furthermore, the SNR is improved with mulit-slab due to less blood saturation effect. An optimized phase ordering and steady state preparation has also been used to improve CNR and SNR.

### MR Echo

MR Echo expands on the capability provided by I-Drive Pro Plus. Presently, patients have to undergo multiple breath-holds to achieve the 'whole heart coverage' for wall motion and other studies. MR Echo employs a bright blood ultra-fast FIESTA sequence, which virtually eliminates the need for breath-holding. An intuitive interface enables the operator to quickly scan the heart in any orientation and to save real time images to the browser through bookmarks. Additionally, a Scan and Save mode enables high resolution heart imaging with VCG and enables multiple functional images over many slices to be prescribed and scanned in a single breath-hold. The operator immediately visualizes scan time for the number of prescribed slices enabling each scan to be tailored to the patients breath-hold capability. All images acquired in Scan and Save, are stored on the browser whilst the operator immediately continues with real time scanning. MR Echo is able to significantly reduce typical cardiac exam times (compared to previous generation techniques).

### Diffusion Tensor Imaging with Fiber Tracking

This package expands EPI capability to include diffusion tensor imaging, a technique that acquires diffusion information in up to 150 different diffusion directions. It generates image contrast based on the degree of diffusion anisotropy in cerebral tissues such as white matter. Functool capabilities on the console (included with ScanTools) create Fractional Anisotropy (FA), Apparent Diffusion Weighted (ADC) and T2-Weighted TRACE maps.The optional FiberTrak post-processing utility generates eigen-vector information from the diffusion tensor acquisition and processing. Using a robust and efficient seeding process, three-dimensional renderings of the diffusion along white matter tracts are generated.

# Scan parameters

| Slice thickness, FOV, matrix | |
|---|---|
| Minimum slice thickness in 2D | 0.2 mm |
| Minimum slice thickness in 3D | 0.1 mm |
| Minimum FOV | 10 mm |
| Maximum FOV | 500 mm |
| Min/max matrix | 32–1024 |

| 2D Spin Echo | |
|---|---|
| Minimum TR (128x128) | 3.6 ms |
| Minimum TR (256x256) | 4.2 ms |
| Minimum TE (128x128) | 1.7 ms |
| Minimum TE (256x256) | 2.0 ms |

| 2D Fast-Gradient Echo | |
|---|---|
| Minimum TR (128x128) | 0.7 ms |
| Minimum TR (256x256) | 0.9 ms |
| Minimum TE (128x128) | 0.2 ms |
| Minimum TE (256x256) | 0.2 ms |

| 3D Fast-Gradient Echo | |
|---|---|
| Minimum TR (128x128) | 0.7 ms |
| Minimum TR (256x256) | 0.9 ms |
| Minimum TE (128x128) | 0.2 ms |
| Minimum TE (256x256) | 0.2 ms |
| Minimum slice thickness | 0.1 mm |

| Echo Planar Imaging | |
|---|---|
| Minimum TR (64x64) | 4.0 ms |
| Minimum TR (128x128) | 5.0 ms |
| Minimum TR (256x256) | 6.0 ms |
| Minimum TE (64x64) | 1.1 ms |
| Minimum TE (128x128) | 1.4 ms |
| Minimum TE (256x256) | 1.8 ms |
| Minimum slice thickness | 0.6 mm |
| ESP at 25 cm FOV | 64x64: 0.456 ms<br>128x128: 0.656 ms<br>256x256: 1.056 ms |
| ESP at 50 cm FOV | 64x64: 0.320 ms<br>128x128: 0.452 ms<br>256x256: 0.656 ms |
| ESP at 99 cm FOV | 64x64: 0.228 ms<br>128x128: 0.320 ms<br>256x256: 0.556 ms |
| Maximum b value s/mm2 | 10,000 |
| Images/second (64x64) | 120 |
| Images/second (128x128) | 20 |
| Images/second (256x256) | 30 |
| Maximum diffusion tensor directions | 150 |
| Minimum shots | 1 |

| 2D Fast-Spin Echo | |
|---|---|
| Minimum TR (128x128) | 3.6 ms |
| Minimum TR (256x256) | 4.2 ms |
| Minimum TE (128x128) | 1.7 ms |
| Minimum TE (256x256) | 2.0 ms |
| Minimum slice thickness | 0.2 mm |
| Minimum ESP 128x128 | 1.7 ms |
| Maximum ETL for SSFSE | 264 |

Note: Optional software packages may be required to achieve certain specifications above.

# Siting and other specifications

This section provides an overview of the siting requirements for a Optima MR450w with GEM MR system with an LCC (CXK4) magnet.More detailed information is available on request.

| Typical room layouts | |
|---|---|
| Magnet room | 3.6 m x 6.2 m<br>2.5 m (8 ft 2.4 in)<br>min ceiling height |
| Equipment Room | 10.8 sq m |
| Control room | 3.2 sq m |

| Fringe field | | |
|---|---|---|
| | Axial | Radial |
| 0.5 mT (5 Gauss) | 4.0 m | 2.5 m |
| 0.1 mT (1 Gauss) | 5.7 m | 3.4 m |

### Electrical supply requirements

Supply system recommended configuration:

- 3-phase DELTA with ground (4-wire)

Alternate configuration:

- 3-phase grounded WYE with neutral and ground (5-wire system)
- Note: Neutral must be terminated inside main disconnect control.

Voltage:

- 480 / 415 / 400 / 380 Vrms

Frequency:

- 50 ± 3.0 Hz or 60 ± 3.0 Hz
  (Local voltage adaptation may be required)

### Power consumption

Power consumption depends on actual usage. The following values are an approximation.

| Power consumption | |
|---|---|
| Maximum continuous sustained power (> 5 seconds) | 91 kVA |
| Heat shield compressor | 9 kVA |
| **Optima MR450w with GEM water requirements** | |
| Maximum heat removal tocustomer-supplied water | 49 kW |
| Water flow | 114 liters/min (30 gpm) minimum at a maximum temperature of 10 degrees C |
| **Workspace monitor position** | |
| | Maximum field strength |
| LCD flat panel monitor | 5 mT (50 Gauss) |

### Alternative environments

Modular buildings may also be available (including air-conditioning, heating, chiller, RF shielding, additional magnetic shielding in walls). Contact your local GE representative for GE certified designs and vendors. Please ask your local GE sales representative for a comprehensive installation and siting manual.

### Filming considerations

DICOM Print will be used exclusively for software filming to DICOM Print peripheral devices.

### Accessory package

- SPT phantom set with storage cart
- Customer diagnostic software
- Operator manuals
- Patient log books

### Emergency stop

Disconnects electrical power from RF and gradient components in the magnet room (duplicate control at the magnet).

### InSite™ remote diagnostics

GE remote service and applications support including magnet monitoring. Also allows downloading of applications software such as eFlex trials program. Connectivity to InSite allows for use of TiP Virtual Assist (TiP VA) in order to receive real-time applications help from a GE expert.

# Other miscellaneous

### Accessories package

A comprehensive suite of MR compatible accessories are available on the Optima MR450w with GEM. Please contact your GE representative for details.

### Warranty

The published GE warranty in effect on the date of shipment shall apply. GE reserves the right to make changes.

### GE regulatory compliance

The Optima MR450w with GEM system is designed to comply with all applicable safety standards, including but not limited to IEC 60601-1 and IEC60601-1-2 (Electromagnetic Compatibility). Laser alignment devices contained within this system are appropriately labeled according to the requirements of the FDA's Center for Devices and Radiological Health (CDRH).

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GE Healthcare provides transformational medical technologies and services that are shaping a new age of patient care. Our broad expertise in medical imaging and information technologies, medical diagnostics, patient monitoring systems, drug discovery, biopharmaceutical manufacturing technologies, performance improvement and performance solutions services help our customers to deliver better care to more people around the world at a lower cost. In addition, we partner with healthcare leaders, striving to leverage the global policy change necessary to implement a successful shift to sustainable healthcare systems.

Our "healthymagination" vision for the future invites the world to join us on our journey as we continuously develop innovations focused on reducing costs, increasing access and improving quality around the world. Headquartered in the United Kingdom, GE Healthcare is a unit of General Electric Company (NYSE: GE). Worldwide, GE Healthcare employees are committed to serving healthcare professionals and their patients in more than 100 countries. For more information about GE Healthcare, visit our website at www.gehealthcare.com.

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imagination at work

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