MAGNETOM Spectra

A Tim+Dot System

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MAGNETOM Spectra

It's the key to 3T.

MAGNETOM Spectra offers you Siemens 3T image quality – an outstanding signal to noise ratio and high image homogeneity. With Tim TX TrueForm and Tim 4G RF technology, it enables high resolution images at an unprecedented level of accuracy and detail in this particular product range.

In addition to its unchallenged image quality, MAGNETOM Spectra offers an intelligent usability concept. Having the full range of leading applications available on the one side as well as reducing complexity and increasing diagnostic confidence on the other, is a key strength of MAGNETOM Spectra.

It runs Dot engines (Day optimizing throughput) – the toolset that allows you to personalize and streamline your examinations in a smart way. Due to its guiding concept, even novice users can obtain the best possible results for virtually any type of patient easily, simplifying scanning and even minimizing post-processing efforts.

MAGNETOM Spectra provides uncompromised patient care, which is closely connected to increasing access to premium diagnostic technology for patients all over the world. MAGNETOM Spectra's attractive cost position and total cost of ownership enables this kind of access to 3T for patients and clinicians alike.

What completes MAGNETOM Spectra as a sound investment is that we have made no compromises in system quality. Highest standard in software applications and coils, excellent usability with integrated Dot engines – all the features complete this newest addition to the Siemens 3T MRI portfolio.

With its latest technology platform, MAGNETOM Spectra offers you an excellent long-term perspective.

Clinical excellence, consistently. With Tim+Dot.

Tim 4G (Total imaging matrix) Technology

Tim 4G is Siemens ultimate innovation technology that unlocks imaging power like never before.

4G Flexibility

- High-density coil array for high resolution and an imaging distance up to 205 cm with no coil repositioning
- Excellent flexibility of any coverage up to whole body
- Up to 120 coil elements combined with 24 channels for flexible Parallel Imaging

4G Accuracy

- DirectRF™. Tim's new all digital-in/digital-out design for true signal purity
- From meters to microns. High resolution imaging even when zooming in on multistation images
- TrueForm Magnet and Gradient Design. Cylindrically optimized homogeneity volume that matches the true form of the human body

4G Speed

- Faster and simpler exam set-up and improved SNR with Direct Connect™ coils
- Tim 4G processing speed
- iPAT² technology. Parallel acquisition in two directions for fast 3D data

High image quality and excellent coverage with Tim's new 4G technology

Tim+Dot. Together, the

Preliminary Edition - 2/2012

Dot (Day optimizing throughput) Engine

Dot is the next movement in MRI and with MAGNETOM Spectra you are part of it. Dot offers a customizable framework to help optimize every part of your MR workflow.

Dot is personalized

- Optimized exam strategies. Your customized protocols are proposed based on the patient's condition or clinical indication
- Consistent, high quality exams even when conditions change
- Dot speaks your clinical language. Customize Dot to create strategies tailored to your clinical practice

Dot is guided

- Real-time on-board guidance. Dot guides you, intuitively, even through complicated exams
- Integrated decision points. The user can add or eliminate protocols or groups of protocols with the click of a button
- Customizable to your standards, to follow your standards of care

Dot is automated

- Intelligent, workflows. Dot engines can be tailored to your clinical needs
- Effortless set-up. Dot links your protocols and procedures
- Timing is synchronized. Dot integrates AutoVoiceCommands ensuring the synchronized timing of breathing, scanning. In addition, contrast timing is more accurate due to AutoBolus Detection.

+Dot

Increased image consistency and diagnostic confidence with Siemens unique Dot Engines

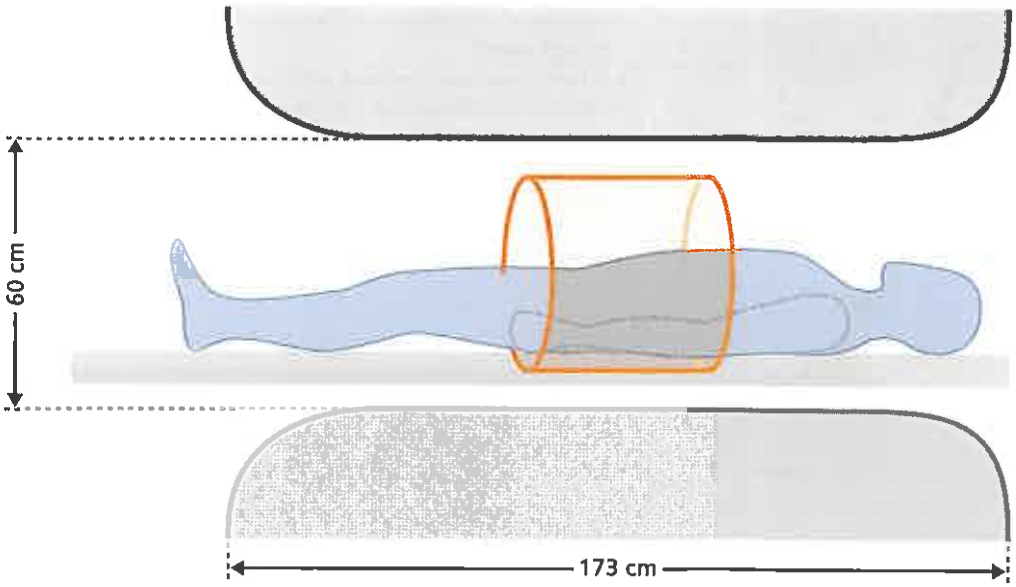
y redefine productivity.

Preliminary Edition - 2/2012

Magnet System

General	
Superconducting Magnet	Short-bore, patient-friendly 3 Tesla design with high homogeneity
	Easy siting due to AS (Active Shielding) and E.I.S. (External Interference Shielding) magnet technology
TrueForm Magnet Design	TrueForm magnet design produces a cylindrically optimized homogeneity volume that corresponds better to the true form of the human body. This results in better image quality as well as better fat saturation for the whole area covered in a scan. TrueForm reduces the overlap needed between steps for large virtual FoV exams and thus reduces the number of steps needed for a given scanning range
Magnet Parameters	
Operating field strength	3 Tesla
Magnet type	Superconductor
Field stability over time	<0.1 ppm/h
Weight (with cryogens)	5500 kg
Magnet length	1.63 m
Inner diameter[1)]	60 cm
System length cover to cover	1.73 m

[1)] Incl. shim coils, gradient coil, RF body coil



Homogeneity (based on highly accurate 24 plane plot)		
TrueForm magnet design with a cylindrically optimized homogeneity volume for higher image quality		
10 cm DSV	Guaranteed	0.02 ppm
	Typical	0.003 ppm
20 cm DSV	Guaranteed	0.075 ppm
	Typical	0.03 ppm
30 cm DSV	Guaranteed	0.3 ppm
	Typical	0.2 ppm
40 cm DSV	Guaranteed	1.4 ppm
	Typical	1.2 ppm
50×50×45 cm^3 DEV	Guaranteed	4.0 ppm
	Typical	3.6 ppm

In compliance with the German "Qualifikationsvereinbarung".

Standard deviation Vrms (volume root-mean square) measured with highly accurate 24 plane plot method (20 points per plane).

Standard active shim with 3 linear and 1 non linear channel (2nd order)

DSV = Diameter spherical volume (x, y, and z direction), DEV = Diameter elliptical volume

Shimming		
Both: passive and active shimming. Passive shimming during installation.		
Standard active shim with 3 linear channels (1st order) and one 2nd order channel. Full 5-channel non-linear (2nd order) shim as option.		
3D Shim	Patient-specific automated shim	
	Time to shim	Approx. 30 s

Shielding		
Active Shielding (AS)	5th generation active shielding (AS) technology with counter coils	
Fringe field (axial × radial)	0.5 mT[1]	4.6×2.6 m
	0.1 mT	6.8×3.9 m
External Interference Shield (E.I.S.)	Patented shielding system integrated into the magnet	
	Continuous compensation and automatic suppression of external magnetic field interferences during measurement (caused by moving ferromagnetic objects or nearby power lines)	

Magnet Cooling System	
Zero Helium boil-off technology	
Refill interval (typical)[2]	Not applicable
Boil-off rate (typical)[2]	0.0 l/year
Max. helium capacity	Approx. 1280 liters

1) Pacemaker safety limit

2) For typical clinical use, depending on sequences and operating time with running helium compressor. The system needs to be serviced at regular interval. Undisturbed magnet cooling for 24 hours and 7 days a week

Gradient System

XG Gradients: General Features
• Actively shielded (AS) whole-body gradient coil system • Extremely low eddy currents • Water-cooled coil and amplifier for maximum performance • All axes force compensated

Gradient Performance For Each Axis	
Max. amplitude	33 mT/m
Min. rise time	264 µs
Max. slew rate	125 T/m/sec
Vector Gradient Performance (vector addition of all 3 gradient axes)	
Max. eff. amplitude	57 mT/m
Max. eff. slew rate	217 T/m/s
Gradient duty cycle	100%

XG Gradients: Amplifier	
Water-cooled, highly compact, modular design	
Ultra-fast solid-state technology with very low switching losses	
Max. output voltage[1)]	1125 V
Max. output current[1)]	330 A
XG Gradients: Resolution Parameters	
Min. FoV	5 mm
Max. FoV[2)]	500 mm
Slice thickness 2D	min. 0.1 mm max. 200 mm
Partition thickness 3D	min. 0.05 mm max. 20 mm
Slab thickness 3D	min. 5 mm max. 500 mm
Max. matrix	1024
Highest in-plane resolution	12 µm

1) Values for each of the 3 gradient axes
2) Depending on the application, the maximum FoV in the z-direction can be up to 45 cm

Sequences				
		Matrix		
		64	128	256
Spin Echo	min. TR [ms]	8.0	8.6	8.9
	min. TE [ms]	3.1	3.5	3.7
Inversion Recovery	min. TR [ms]	30	30	31
	min. TE [ms]	3.1	3.5	3.7
	min. TI [ms]	24	24	24
2D GRE	min. TR [ms]	0.71	0.97	1.11
	min. TE [ms]	0.26	0.26	0.26
3D GRE	min. TR [ms]	0.71	0.97	1.11
	min. TE [ms]	0.26	0.26	0.26
TrueFISP	min. TR [ms]	2.24	2.68	3.56
	min. TE [ms]	1.0	1.19	1.54
TSE (HASTE)	min. Echo Spacing [ms]	2.84	3.06	3.52
	min. TR [ms]	8.0	8.6	8.9
	min. TE [ms]	3.1	3.5	3.7
	max. Turbo Factor = 512			
Turbo GSE	min. Echo Spacing [ms]	0.78	0.92	1.54
	min. TR [ms]	7.8	8.4	9.0
	min. TE [ms]	4.5	5.0	5.5
	max. Turbo Factor	65	65	65
	max. EPI Factor = 21			
EPI (single-shot and multi-shot)	min. Echo Spacing [ms]	0.36	0.6	0.97
	min. TR [ms]	10	10	10
	min. TE [ms]	2.3	2.5	3.5
	min. Measurement time	17	25	38
	max. EPI Factor = 256			
Diffusion Imaging	Max. b-value [s/mm^2]	10 000	10 000	10 000
	Min. TE [ms] with b = 1000 [s/mm^2]	51	53	62

All matrices without interpolation. Combinations of the stated parameters are not always possible; some parameters may require optional application packages.

DirectRF™ Technology

General

Tim's new all digital-in/digital-out design integrates all RF transmit and receive components at the magnet

- Optical RF system improves SNR by reducing electrical noise and increasing signal detection
- Optical links between magnet and equipment room to achieve highest RF stability
- Transmit path is integrated in the magnet housing
- Receive path is integrated in the magnet housing
- Dual-Density Signal Transfer technology enables ultra-high density coil designs by integrating key RF components into the local coil.
- Receiver with high dynamic range without adjustments

Direct Transmit Technology

Frequency stability (5 min)	$\pm 2\times10^{-10}$	
Frequency control	32 bits (0.03 Hz)	
Phase control	16 bits (0.006 degrees)	
Body coil	Integrated whole body no tune transmit/receive coil with 32 rungs	
	Optimized RF efficiency and signal-to-noise ratio (SNR)	
Transmitter path	Transmit amplitude	16 bit control 25 ns resolution
	Gain stability (after first minute)	<0.1 dB (1 s) <0.3 dB (5 min)
Transmit amplifier	Extremely compact, water-cooled solid state amplifier, fully integrated at the magnet as part of DirectRF technology	
	Transmit amplifier bandwidth	800 kHz
	Peak power	20 kW

TimTX TrueForm

TimTX TrueForm includes innovative techniques in the RF excitation hardware as well as new application and processing features enabling uniform RF distribution in all body regions. TimTX TrueForm for MAGNETOM Spectra consists of TrueForm excitation, which uses amplitude and phase transmission settings optimized for dedicated body regions. Feeding the 2 ports of the integrated body coil with an optimized weighting yields a homogeneous B1 distribution

TimTX TrueForm is supported by:

- a-SPACE, which is a version of the SPACE sequence. a-SPACE uses composite adiabatic excitation pulses, which are insensitive to B1 spatial variations.
- B1 Filter, which is an adaptive inline image filter that reduces any remnant B1 effects without affecting image contrast.

RF Receiver Technology

The revolutionary Total imaging matrix optimizes coil positioning and virtually eliminates coil changing times. It also features Dual-Density Signal Transfer technology in the local receive coils, which enables the high density design. All local coils are no tune coils. Further Tim4G features are AutoCoilSelect for dynamic, automatic, or interactive selection of the coil elements within the FoV.

Receive path	Number of coil elements	Up to 96 (standard) or even 120 (optional with Tim Whole Body Suite)
	Number of independent receiver channels	24
	Quadrature demodulation and filtering	Digital
	Receiver bandwidth	500 Hz –1 MHz (for each channel)
	Receiver signal resolution	32 bit
	ADC sampling rate	80 MHz
	Preamplifier noise figure	<0.5 dB
	Dynamic range at coil connector (referred to 1 Hz resolution bandwidth)	164 dB instantaneous at receiver 169 dB with automatic gain control at local coil connector

Coils

Standard Integrated Whole-Body Coil

- No-tune transmit/receive coil with 32 rungs
- Enabling TimTX TrueForm technology

3T Tim Matrix Coils

The Tim Matrix coils are designed for highest image quality in combination with easy handling. High-element coils increase SNR and reduce examination times. DirectConnect™ and SlideConnect™ technology reduce patient set up time. Light weight, ergonomically designed coils enable highest patient comfort.

- No coil changing with multi-exam studies saves patient setup time
- All coils are time-saving "no-tune" coils
- Low-noise preamplifiers
- AutoCoilSelect for dynamic, automatic, or interactive selection of the coil elements within the Field of View

Standard Coils

Head/Neck 16 (DirectConnect)	Application area	Head and neck
	Dimensions with look out mirror (L×W×H)	440 mm × 330 mm × 370 mm
	Weight	4.7 kg
Spine 24 (DirectConnect)	Application area	Spine
	Dimensions (L×W×H)	1200 mm × 489 mm × 63 mm
	Weight	11 kg
Body 6 (SlideConnect)	Application area	Thorax, Heart, Abdomen, Pelvis, Hip
	Dimensions (L×W×H)	322 mm × 520 mm × 70 mm
	Weight	1.6 kg
Flex Large 4	Application area	Multi purpose
	Dimensions (L×W)	516 mm × 224 mm
	Weight	550 g
Flex Small 4	Application area	Multi purpose
	Dimensions (L×W)	366 mm × 174 mm
	Weight	450 g
Accessories	• Flex Coil Interface 3T	

Combination of all coils possible for large Field of View exams

Patient Handling

General

Tim and Dot help increase patient comfort and improve workflow efficiency.

- Set up the patient once, no repositioning, no changing of coils needed
- Scan range of 205 cm[1] allows for whole body examinations with full usage of the surface coils, without the need for patient repositioning
- Ultra-light weight coils
- Imaging with optimized high element surface coil
- Remote table move
- Feet-first examinations for many applications (e.g. cardiac, liver, upper abdomen, pelvis, colonography, body angio) reduces the level of anxiety experienced by highly claustrophobic patients
- AutoPosition for selected exams
- In-room Dot Display: Patient preparation is smooth with all patient data displayed right at the scanner. Dot gives the user advice during the positioning process – very helpful in the case of ECG, for example

Patient Positioning Aids

Standard set of cushions for comfortable and stable patient positioning together with safety straps.

Additional positioning supports (optional):
Set of vacuum cushions (large, medium, small) with vacuum pump

Tim Table

Comfortable patient table solution which fits the needs for patients up to 200 kg supporting full weight capacity in vertical and horizontal movement. Integrated coils for fast patient preparation and enhanced user comfort. Examinations of patients up to 205 cm[1]. Integrated infusion stand.

Max. patient weight for vertical and horizontal table movement		200 kg (440 lbs)
Max. scan range		140 cm, opt. 205 cm[1]
User can adjust the table speed with two predefined speed mode buttons or accelerate continuously with the wheel on the Dot Control Centers		
Vertical table movement	Range	52–89 cm (+12 mm)[2][3]
	Speed	60 mm/s; one click table up
Horizontal table movement	Max. range	2750 mm
	Max. speed	200 mm/s
	Position accuracy	+/–0.5 mm
Continuous table movement during scan capable		

[1] Optional with Tim Whole Body Suite

[2] Including Heightening Kit, if necessary

[3] Depending on the floor conditions

Dot Control Centers

Ergonomically designed control unit integrated into the front cover, configurable to be positioned on the right side or left side of the patient tunnel. Optional available are two Dot control Centers on both sides of the patient tunnel.

- Continuous table movement or two speed predefined levels
- Automatic transfer from any vertical position to home position
- Automatic transfer to isocenter
- Automatic transfer from any horizontal position to home position
- In bore ventilation (6-step regulation)
- In bore lighting (6-step regulation)
- Headphone volume adjustment (6-step regulation)
- In room loudspeaker adjustment (6-step regulation)
- Laser light localization
- Start scan
- Alarm off
- Horizontal table movement, lighting adjustments, and ventilation are also possible from the console

Dot Display

Dot Display with user guidance for fast and efficient exam preparation and start of measurement at the scanner. Display of physiological curves and guidance for patient set up of triggering device.

Color LCD Monitor	13.3"; 16 : 10
Horizontal frequency	15.0–80.0 kHz
Vertical frequency	50.0–85.1 kHz
Screen Matrix	1280×800 pixels

Physiological Measurement Unit (PMU) – Wireless Physio Control

Synchronizes the measurement with the physiological cycles (triggering to minimize motion artifacts caused by cardiac and respiratory movements). The physiological curves are visualized at the Dot Display.

Wireless Sensors	Wireless Vector ECG/respiration and pulse sensors for physiologically synchronized imaging, rechargeable battery-powered – for optimized patient handling
Physiological Signals	• ECG (3 channels) • Pulse • Respiration
	ECG Triggering: • Acquisition of multiple slices, e.g. of the heart, at different phases of the cardiac cycle • Excellent image quality by synchronizing data acquisition with cardiac motion
	Peripheral PulseTriggering: • Reduces flow artifacts caused by pulsatile blood flow • Excellent image quality by synchronizing data acquisition to the pulsatile blood flow
	Respiratory Triggering: • Excellent image quality by synchronizing data acquisition with the respiratory motion
	External Triggering : • Interface for trigger input from external sources (e.g. Patient Monitoring System) inside the examination room • Interface for trigger input from external sources (e.g. pulse generator, trigger sources for fMRI) outside the examination room • Optical trigger output for fMRI
	Retrospective gating for ECG, peripheral pulse and external trigger input

Patient Communication

Ergonomically designed patient communication unit – may be placed at any convenient location on the workplace table.

- Intercom system incorporating active noise cancellation for improved patient communication
- Assistance call via squeeze-bulb for the patient
- Response to the patient's activation of the squeeze-bulb via communication unit
- Table stop
- Sequence stop
- Volume of speaker in control room
- Volume of speaker and headphones in examination room for voice commands
- Connection to external audio system
- Independent volume control of voice and music
- Pneumatic system of ergonomically designed headphones
- Loudspeaker
- Microphone
- Automatic and freely programmable voice commands for breath-hold examinations

Noise Reduction Features

General Features

- Acoustically optimized mountings for all components including gradient coil and body coil
- Minimized structure borne noise transfer to building
- Noise attenuating foam between gradient coil and cover, and between magnet and cover
- Encapsulation of noise producing components

Gradient

- Special epoxy resin and casting technology for damping vibrations
- Reduction of gradient stray field to decrease eddy currents
- Noise-optimization of the MR system with an acoustically soft but mechanically rigid mounting of the gradient coil inside the magnet
- Force compensation for all axes

Magnet

- Encapsulation of the entire magnet
- Efficient floor decoupling for reduction of noise transferred to the building
- Noise-optimized cold head

Body Coil

Material of supporting tube of the body coil is optimized for low vibration and noise

- In order to achieve maximum noise reduction, the body coil tube was extended beyond the gradient coil
- Copper structures are slotted and glued to the tube to reduce high frequency noise
- The Body coil is acoustically decoupled by special suspensions

Sequence Design

Optimized sequence timing.

- Sequences automatically avoid parameter settings that cause the gradient coil to resonate
- No relevant application drawbacks – no increase in sequence parameters, e.g. full performance

"Whisper Mode"

The "Whisper Mode" is a user selectable mode that reduces the max. slew rate and max. amplitude of the gradients and enables very quiet imaging techniques.

Acquisition Parameters

Acquisition Parameters[1]		
2D	Number of slices	1–128 (steps of 1)
	Slice order	Sequential or interleaved
3D Slabs/Partitions	Number of 3D partitions for matrix 256×256	4–512
	Number of 3D Slabs (3D volumes)	1–128 (steps of 1)
Acquisition Matrix	Frequency encoding (true imaging matrix without interpolation or oversampling)	64–1024 (in steps of 2; sequence dependent)
	Phase encoding	32–1024 (in steps of 1)
Reduced Matrix	Phase resolution (rectangular matrix)	32×n ... n×n (steps of 1)
	Slice resolution (3D volumes)	50–100%
Partial Fourier Imaging	Phase partial Fourier (Half Fourier)	4/8–1 (steps of 1/8)
	Read partial Fourier (asymmetric echo)	Selectable
	Slice partial Fourier (3D volumes)	5/8–1 (steps of 1/8)
Rectangular Field of View	In phase encoding direction	3–100%
Averaging	Number of data acquisitions	1–32 (steps of 1)
	Averaging mode	Short term, Long term (LOTA)
Oversampling	Read oversampling	100% standard
	Phase oversampling	0–100% (steps of 12.5%)
	Slice oversampling (3D volumes)	0–100% (steps of 12.5%)
Interpolation	In plane interpolation	Selectable (factor of 2)
	3D interpolation (3D volumes)	Selectable (up to factor of 2)
Serial Acquisitions	Number of repeated scans	With constant delay times 1–4096
		With different delay times 1–65
Swap	Exchange of read-out and phase-encoding direction	Yes
Slice orientation	Slice orientation for 2D and 3D scans	Transverse, sagittal, coronal, oblique, double oblique (steps of 0.1°)
	Multi-slice multi-angle (simultaneously)	Yes

[1] Combinations of the parameters stated are not always possible; some parameters may depend on optional application packages

Standard Acquisition and Reconstruction Techniques

Standard techniques

- True Inversion Recovery to obtain strong T1-weighted contrast
- Dark Blood inversion recovery technique that nulls fluid blood signal
- Saturation Recovery for 2D TurboFLASH, gradient echo, and T1-weighted 3D TurboFLASH with short scan time (e.g. MPRAGE)
- Freely adjustable receiver bandwidth, permitting studies with increased signal-to-noise ratio
- Freely adjustable flip angle. Optimized RF pulses for image contrast enhancement and increased signal-to-noise ratio
- MTC (Magnetization Transfer Contrast). Off-resonance RF pulses to suppress signal from certain tissues, thus enhancing the contrast. Used e.g. in MRA
- Argus viewer for reviewing cine studies
- Report Viewer for DICOM structured reports including report editing
- Dynamic Analysis for addition, subtraction, division, standard deviation, calculations of ADC maps, T1 and T2 values, TTP, t-Test, etc.
- Image Filter
- 3D post-processing MPR, MIP, MinIP, SSD
- Flexible film formats and paper print
- Data storage of images and cine AVI files on CD/DVD with DICOM viewer as the viewing tool
- Selectable centric elliptical phase reordering via the user interface
- Inversion Recovery to nullify the signal of fat, fluid or any other tissue

Sequences	
Spin Echo family of sequences	• Spin Echo (SE) – Single, Double, and Multi Echo (up to 32 echoes); Inversion Recovery (IR) • 2D/3D Turbo Spin Echo (TSE) – Restore technique for shorter TR times while maintaining excellent T2 contrast; TurboIR: Inversion Recovery for STIR, DarkFluid T1 and T2, TrueIR; Echo Sharing for dual-contrast TSE • 2D/3D HASTE (Half-Fourier Acquisition with Single Shot Turbo Spin Echo) – Inversion Recovery for STIR and DarkFluid contrast • SPACE for 3D imaging with high isotropic resolution with T1, T2, PD, and DarkFluid Contrast
Gradient Echo family of sequences	• 2D/3D FLASH (spoiled GRE) – dual echo for in-/opposed phase imaging 3D VIBE (Volume Interpolated Breathhold Examination) – quick fat saturation; double echo for in-phase/opposed phase 3D imaging; DynaVIBE: Inline 3D elastic motion correction for multi phase data sets of the abdomen; Inline Breast Evaluation • 2D/3D MEDIC (Multi Echo Data Image Combination) for high resolution T2 weighted orthopedic imaging and excellent contrast • 2D/3D TurboFLASH – 3D MPRAGE; single shot T1 weighted imaging e.g. for abdominal imaging during free breathing • 3D GRE for field mapping • 2D/3D FISP (Fast Imaging with Steady State Precession) • 2D/3D PSIF – PSIF Diffusion • Echo Planar Imaging (EPI) – diffusion-weighted; single shot SE and FID e.g. for BOLD imaging and Perfusion-weighted imaging; 2D/3D Segmented EPI (SE and FID) • ce-MRA sequence with Inline subtraction and Inline MIP • 2D/3D Time-of-Flight (ToF) Angiography – single slab and multi slab; triggered and segmented • 2D/3D Phase Contrast Angiography • *syngo* BEAT Tool – TrueFISP segmented; 2D FLASH segmented; Magnetization-prepared TrueFISP (IR, SR, FS); IR TI scout; Retrogating

Standard Fat/Water Imaging
• Fat and Water Saturation. Additional frequency selective RF pulses • Quick FatSat • SPAIR: robust fat suppression for body imaging using a frequency selective inversion pulse • Fat/Water Excitation. Spectral selective RF pulses for exclusive fat/water excitation • Dixon technique for fat and water separation – available both based on VIBE (2 point Dixon) and Turbo Spin Echo (3 point Dixon) sequence

Standard Flow Artifact Reduction

- LOTA (Long Term Data Averaging) technique to reduce motion and flow artifact
- Pre-saturation technique. RF saturation pulses to suppress flow and motion artifacts
- Tracking SAT bands maintain constant saturation of venous and/or arterial blood flow, e.g. for 2D/3D sequential MRA
- TONE (Tilted Optimized Non-saturating Excitation). Variable excitation flip angle to compensate inflow saturation effects in 3D MRA. TONE pulse selectable depending on the desired flow direction and speed
- GMR (Gradient Motion Rephasing). Sequences with additional bipolar gradient pulses, permitting effective reduction of flow artifacts

Standard Scan Time Reduction

Elliptical scanning reduces scan time for 3D imaging

iPAT – integrated Parallel Acquisition Technique high-performance and flexible Parallel Imaging with integrated AutoCalibration	Two algorithms – mSENSE and GRAPPA – for maximum quality for all applications
	iPAT is compatible with all relevant sequence techniques (e.g. SE, TSE, SPACE, MEDIC, TIRM DarkFluid, HASTE, EPI, MPRAGE, 3D VIBE, FLASH, TrueFISP, TurboFLASH, FLASH Phase Contrast, etc)
	iPAT is compatible with all multi-element coils, as well as coil combinations
	Tim Assistant facilitates optimized iPAT settings. Higher speed and temporal resolution can be used for: • Improved image resolution • Improved image quality due to reduced artifacts
	T-PAT with mSENSE and GRAPPA for advanced parallel imaging provides fast high-resolution dynamic imaging
	3 different calibration techniques can be used: • AutoCalibration with an integrated reference (calibration) scan to additionally save on total scan time • TurboCalibration uses a separate measurement directly before the actual measurement. Images measured using TurboCalibration are characterized by reduced PAT artifacts. • T-PAT and PAT averaging for motion artifact suppression using Self-Calibration
iPAT²	More slices and coverage in the same breath-hold by applying PAT in 2 directions simultaneously (phase-encoding direction and 3D direction for 3D sequences)
	The effective PAT factor can be maximized, and PAT applications are extended. Typical clinical applications are MR Angiography or ultrafast isotropic T1-weighted 3D imaging of the head