GE Healthcare

Optima™ MR450w

Technical Data

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The world of MR is always changing.

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 overcome traditional limitations of wide-bore MR, offering 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.

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. But it's about more than the bore. Built on a fully redesigned MR platform, the Optima MR450w offers a range of advanced new functionality, making it a workhorse system for practices of all sizes and specialties.

The Optima MR450w is the right MR system in so many ways.

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 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 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 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 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

GE utilizes a Large Volume RMS (LVRMS) procedure to determine the field homogeneity after integrating the gradients, RF body coil, and system electronics. LV-RMS measurements utilize a large phantom placed within the bore, and because the data is obtained using the entire imaging chain, it reflects the results that clinicians will experience with day-to-day scanning.

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	4,871 kg with cryogens and gradient coil
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 1 Gauss = 6.2 m x 3.7 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 Dual-flared patient bore 2 way in-bore intercom system Adjustable in-bore lighting system Adjustable in-bore patient ventilation system

Diameter Elliptical Volume	ppm
20 cm x 18 cm (R x Z) volume	<= 0.10
30 cm x 27 cm (R x Z) volume	<= 0.50
42 cm x 36 cm (R x Z) volume	<= 1.0
47 cm x 42 cm (R x Z) volume	<= 1.25

Large Volume Root-Mean-Square (LV– RMS) method is an imaging based method with over 173,000 measurements collected over a spherical volume after linear and higher order shims have been adjusted.

Gradients

Premium clinical performance is enhanced with the Optima MR450w 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	34 mT/m
Slew Rate per axis	150 T/m/s
Maximum FOV	50 cm
Gradient Duty Cycle	100%

Gradient amplifier (water cooled)	
Gradient Amplifier Current and Voltage	660 Amps/1650 Volts Peak
Control	• Frequency dependent feed-forward model • 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.

Quiet 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 implemented Quiet Technology on many components of the system 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.

Optical RF

The new RF acquisition technology of the Optima MR450w 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, completely 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.

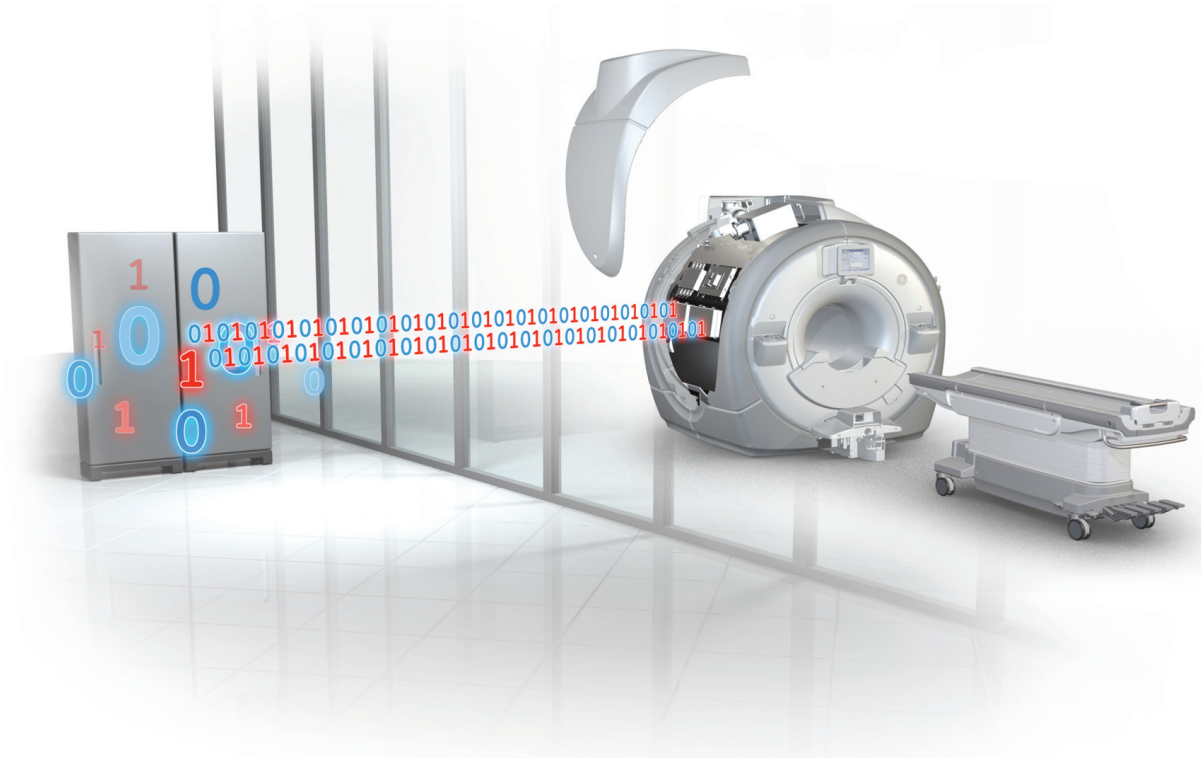
The OpTix acquisition technology enables higher image quality especially for data-intensive (3D) applications. When combined with GE's use of high-density surface coils, the optical receive chain is a critical path for ensuring clear signal reception and data analysis. To help ensure that the high-density approach will be maintained, the scalable Optima MR450w 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	
Simultaneous RF receivers	16 or 32
Coil input ports	40, 72 or 137
Quadrature demodulation	Digital
Receiver sampling frequency per channel	80 MHz
Maximum imaging bandwidth per channel	1 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 2 kW Head
Maximum RF field with integrated body coil	>20 uT
Transmit gain	>100 dB (40 dB coarse/ >84 dB instantaneous)
RF exciter frequency range	63.86 ± 0.650 MHz
Frequency resolution	<0.6 Hz/step
Frequency stability	1 part per billion (0 to 50C)
Phase resolution	0.005 degree/step
Amplitude control	16 bit with 50 ns resolution
Amplitude stability	<0.1 dB over one min. at rated power
Digital RF pulse control	2 amplitude modulators, 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 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 features a powerful volume reconstruction engine (VRE 2.0) 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 2.0 uses 64-bit computing, delivering high acquisition memory and fast performance. Parallel processing and dedicated network cards 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)	5400 2D FFTs/second (256 x 256 full FOV) – 32 channel configuration
CPU	Four dual core AMD Opteron 2218 CPUs (eight 2.6 GHz cores) – 32 channel configuration
Memory	32 GB ECC DDR2 667 RAM – 32 channel configuration
Hard disk storage	2 x 73 GB (16 channel configuration) 4 x 73 GB (32 channel configuration)

High-density surface coils

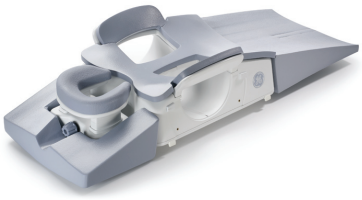
The RF architecture of the Optima MR450w comes with a 16-channel design as standard or an optional 32-channel configuration. It provides compatibility with surface coils developed by GE as well as coils developed by other vendors.

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.

HD Body Array

- 12-channel, phase array coil
- Optimized for parallel imaging techniques
- 48 cm S-I coverage



HD Breast Array

- 8-channel, 8-element phased array design
- Optimized for parallel imaging techniques
- VIBRANT compatible
- Biopsy compatible for both medial and lateral approaches
- Open design allows access to the breast for biopsy or needle localization procedures
- 20x21x10 in (50x54x25cm)

HD Cardiac Array

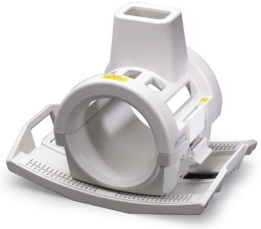
- 8-channel, 8-element phased array design
- Anatomically-optimized elements in the FOV
- Optimized for parallel imaging techniques performed in double oblique scan planes
- 34 cm S-I coverage
- 18x20x5 in (46x50x13 cm)

Head-Neck-Spine Array

- 16-channel, 29-element modular phased array design:
  - ▸ 12-element brain
  - ▸ 16-element NV
  - ▸ 5-element anterior neck
  - ▸ 8-element thoraciclumbar spine
- Brain, neck and spine imaging without changing a coil
- Optimized for parallel imaging techniques
- 3 separate coils that may be plugged in simultaneously
- 90 cm S-I coverage
- 48x18x15 in (122x46x38 cm)

GP Flex Array

- Receive-only, multi-purpose coil
- Flexible positioning



Quad/Extremity Knee/Foot Array

- Transmit/receive single channel multi-purpose coil
- High uniformity and SNR
- Flexible positioning

HD Wrist Coil

- 8-channel, phased array coil
- Optimized for parallel imaging

HD Foot/Ankle Coil

- 8-channel, 8 elements
- Novel "ski boot" design keeps foot flexed for proper anatomical positioning
- Adjustable flexion and stabilization pads for optimal comfort
- Full foot imaging, including toe coverage
- 21x11x13 in (53x28x33 cm)

HD Knee Array

- 8-channel, 9-element phased array design
- Transmit/receive tapered design reduces aliasing artifacts
- Optimized for parallel imaging techniques
- Confidence in injury evaluation
- 16 cm S-I coverage
- 16x14x8 in (39x35x19 cm)

HD Shoulder Array

- 8-channel, 8-element concentric array design
- Unique Concentric Array Technology 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
- 25x23x25 in (10x9x10cm)

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

The Optima MR450w includes a transmit and receive 8 channel hypertronics coil connection port. For facilities with an existing GE HD scanner, many surface coils can be shared between systems.

The following coils are also compatible with the Optima MR450w:

- HD Spine Array
- HD Neurovascular Array
- HD Brain Array
- HD 8-Channel Body Array
- HD Transmit and Receive Hand and Wrist Array
- Endorectal Array and Adapter

Workflow

Express exam streamlined workflow

The 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 Optima MR450w's patient setup and workflow features.

Express patient table

Unique to GE, the fully detachable Express patient table incorporates the Liberty™ 2.0 Docking System which improves 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 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 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 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 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)
Vertical speed	4.0 cm/sec
Total cradle length	210.8 cm
Total cradle travel	286.2 cm
Positioning accuracy	+/- 0.5 cm
Maximum patient weight for scanning	227 kg (500 lbs)
Patient transport accessories	Self-storing non-ferrous IV pole Positioning pads Immobilization straps Table pad and head coil accessory
Landmarking	- Laser alignment with S/I and R/L alignment - IntelliTouch Landmarking Capability (optional)

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 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 ergonomically 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) (Optional)

Simplify exam preparation and reduce the time between patients with the Optima MR450w 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 also 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.

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

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

Workflow

Optima MR450w express exam

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

The Optima MR450w 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 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 assured 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

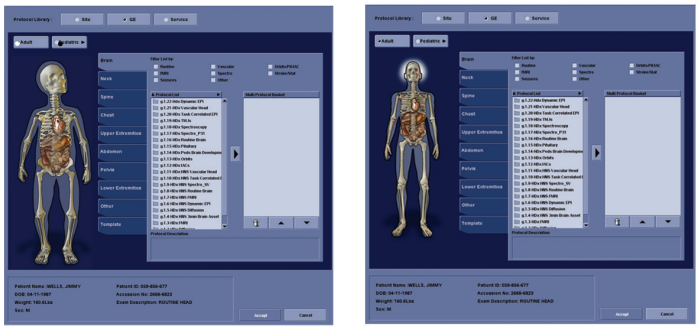
The modality worklist (MWL) provides an automated method of obtaining exam and protocol information for a patient directly from a DICOM Worklist server. For sites with full DICOM connectivity, once a patient has been selected from the MWL, a new session is opened on the host interface and the iROC will 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 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.

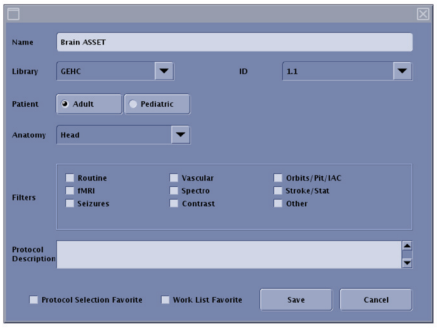
The ConnectPro software enables the DICOM worklist server class for the Optima MR450w Operator's Console. This software may require separate gateway hardware to connect non-DICOM-compatible HIS/RIS systems to the MR system.

Protocol libraries and properties

The Optima MR450w 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.



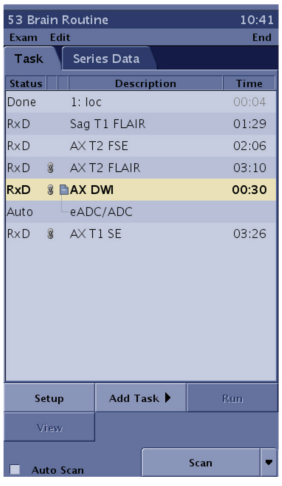
Each protocol or series can be saved with user-defined properties to simplify search and selection for future use. Favorite protocols can be highlighted for quick selection from the Modality Worklist or other libraries.

ProtoCopy

Standard on every Optima MR450w 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.

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.

Workflow

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.

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 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/Minimum Intensity 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 compute and save
Image Fusion	Automatic compute and save
IVI (Volume Viewer)	Automatic load
Pasting	Automatic compute and save
SER (Functool)	Automatic compute and save
StarMap (Functool)	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 workflow, high-resolution anatomical images can be automatically 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. High-resolution 2D and 3D data sets can be fused with the following parametric and computed maps. 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 user interface and acquisition parameters helps ensure that each acquisition is tailored for every patient. However, the technologist steps are kept consistent.

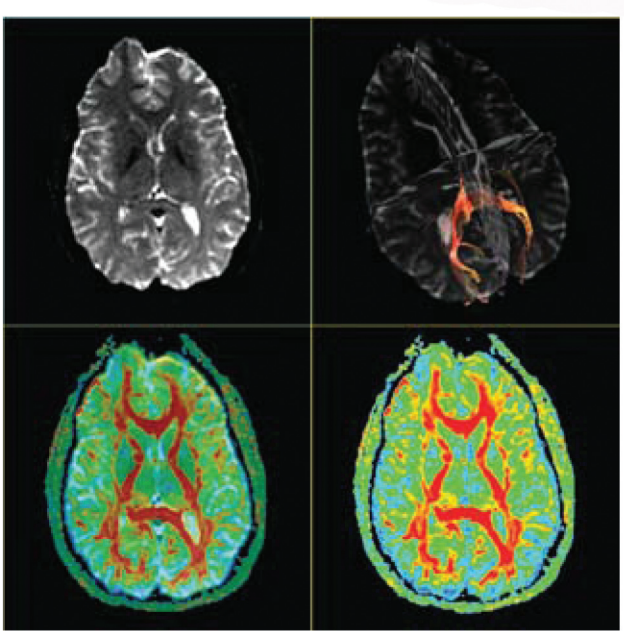


Image fusion	
MR Standard	3D Registration
ADC/eADC	3D Registration
Diffusion Tensor	3D Registration
functional MRI	Reformat
BrainSTAT	3D Registration
SER (Signal Enhancement Ratio)	Reformat
T2 Mapping	Reformat
Spectroscopy (Brain, Prostate and Breast)	Reformat

Computing platform

Operator console

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

DICOM

The Optima MR450w 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 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® 5160 3.0 GHz Processor 1.3 GHz System Bus 4 MB full-speed L2 Advanced Transfer Cache 64 Bit word size
Host memory	8 GB DDR2-667 FBD DIMMs
Graphics subsystem	Main Display: NVidia® Quadro® FX 560 - 128 MB DDR Graphics Memory - Spec PROE-04: 28.45 - Spec TCVIS-01: 6.87 - Spec 3DMAX-04: 27.90
Cabinets	Single, tower configuration
Disk subsystem	System Disk: 73 GB, 15,000 RPM, SAS Drive Image database 2x73 GB, 15,000 RPM, SAS Drive 400,000 uncompressed 256 x 256 image files Maximum rates 300 MB/s
Network	3 x Gigabit (10/100/1000) Ethernet Ports

Image interchange	
DVD Interchange	DVD-RW Average 35,000 images per 4.7 GB DVD

Filming	
Filming	Drag and drop filming One-button print series One-button print page Multi-image formats – 1:1, 2:1, 4:1, 6:1, 9:1, 12:1, 15:1, 16:1, 20:1, 25:1 and 35 mm slide DICOM basic grayscale print service class DICOM basic color print service class

Wide-screen display monitor	
Display monitor	24" widescreen LCD flat panel 1920 x 1200 dot resolution Non-interlaced, flicker free presentation. Contrast ratio 800:1 Digital DVI interface

Display	
AutoView	560 x 560 image window (standard)
Window/Level (W/L)	7 user-programmable keys on scan control keyboard plus one key for returning to prior setting 6 user-programmable buttons in image viewer Arrow keys on scan control keyboard On-image through middle mouse button Save State stores user-selected image orientation, user annotation and window level.
Image display	Zoom/Roam/Flip/Rotate/Scroll Explicit Magnify and Magnifying Glass Image Measurement Tools Grid On/Off Cross Reference/User Annotation Exam/Series Page Hide Graphics/Erase Annotation/Screen Save Accelerator Command Bar Compare Mode/Reference Image/ Image Enhance ClariView Image Filtering Smooth and Sharpen Edge Filters Minified Reference Scoutview Cine Paging (up to 4 windows and 128 images/window) Add/Subtract/Edit Patient Data
Image display	256 Image buffer (256 x 256) at 30 fps
Image annotation	Shadowed to permit ease in reading Two graphic/text planes overlay the entire screen. Grid placement with anatomical reference on an image. Drawing and annotation may be added to and removed from images

ScanTools

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

Pulse sequences and imaging options	
Spin Echo	The gold standard for generating T1, proton density and T2 images.
Fast-Spin Echo (FSE) 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.
3DFRFSE	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 FGRE SPGR 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 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) 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 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) 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 detailed 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 enables advanced MR-image post-processing using a wide range of sophisticated algorithms, including: ADC maps and eADC maps Correlation Coefficients for mapping of motor strip and visual/auditory stimuli NEI (Negative Enhancement Integral) MTE (Mean Time to Enhance) Positive Enhancement Integral Signal Enhancement Ratio Maximum Slope Increase Maximum Difference Function 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 – Liver Acquisition with Volume Acceleration	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 2D ARC to reduce scan time and minimize parallel imaging artifacts.

Imaging options

Imaging options		
Pulse sequence imaging options	• ASSET • ARC™ • Blood Suppression • Cardiac Gating/Triggering • Cardiac Compensation • Classic • DE Prepared • EDR • Flow Compensation • Fluoro Trigger • Full Echo Train • IDEAL • IR Preparation • Magnetization Transfer • MRCP	• Multi-Station • Multi-Phase/Dynaplan • Navigator • No Phase Wrap • Real Time • Respiratory Compensation • Respiratory Gating/Triggering • Sequential • SmartPrep™ • Spectral Spatial RF • Square Pixel • T2 Prep • Tailored RF • Zip 512/Zip 1024 • 3D Slice Zip x 2 (Z2)/Zip x 4 (Z4)
Parallel imaging 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. Auto-Calibrating Reconstruction (ARC) parallel imaging eliminates breath-hold mismatch errors by imbedding the calibration data within the scan data. In addition, this unique reconstruction permits small FOV imaging by minimizing focal parallel imaging artifacts from the exam. Supporting both 1D and 2D acceleration, net acceleration factors of up to 4 can be achieved. With the Optima MR450w system, the following applications are parallel imaging enabled.	• 2D FSE • 2D FRFSE • 2D FSE-IR • 2D T1FLAIR • 2D FSE Double IR • 2D FSE Triple IR • 2D T2MAP • 2D FSE-XL IDEAL • 2D FRFSE-XL IDEAL • 2D SSFSE • 2D SSFSE-IR • 2D SSFSE MRCP • 2D SSFSE 3-plane • 3D FRFSE • 3D CUBE T2 • 3D FRFSE HYDRO • 3D CUBE T2 FLAIR • 2D FGRE • 2D FSPGR • 2D FIESTA • 2D FIESTA Fat Sat • 2D FIESTA Fast CARD • 2D FIESTA Fast CINE • 2D MDE • 2D MFGRE • 3D TOF GRE • 3D TOF SPGR	• 3D FGRE • 3D FSPGR • 3D FGRE IDEAL • 3D FSPGR IDEAL • 3D BRAVO • 3D Quick STEP • 3D Fast TOF GRE • 3D Fast TOF SPGR • 3D FIESTA • 3D MDE • 3D MERGE • 3D TRICKS • 3D LAVA • 3D LAVA-Flex • 3D Dual Echo • 3D VIBRANT • 3D VIBRANT-Flex • 2D GRE-EPI • 2D SE-EPI • 2D DW-EPI • 2D DT-EPI • 2D FMRI EPI • MR Echo Fast GRE Timecourse • MR Echo FIESTA Timecourse • MR Echo MDE • MR Echo Realtime • MR Echo Function CINE

Applications

Neuro applications

PROPELLER HD

PROPELLER HD is a technique derived from fast spin echo (FSE) for brain imaging and named for its unique k-space acquisition, in which data are acquired in radial "blades" that rotate similar to the propeller on an airplane until the acquisition is completed.

Since each blade passes through the center of k-space, PROPELLER HD has unusually low sensitivity to motion artifacts and exceptionally high contrast-to-noise properties. This makes it ideal for producing high-resolution image quality even under challenging circumstances.

Available in all-imaging planes, PROPELLER HD provides the contrast and resolution that delivers real clinical impact. T2 FSE PROPELLER HD creates T2-weighted images that are degraded much less by head motion than conventional FSE, with a 25-75% increase in contrast to noise without any time penalty. Imagine acquiring a motion-free scan, virtually every time, and even on the most difficult of patients.

T2 FLAIR PROPELLER combines T2 FLAIR image contrast with the tolerance of motion and superb contrast-to-noise characteristic of PROPELLER.

Diffusion-weighted PROPELLER is an alternative to the more conventional technique based on echoplanar imaging, which tends to be compromised in the presence of large changes in magnetic susceptibility. Diffusion-weighted PROPELLER can produce high quality images in the skull base even in the presence of dental work, craniotomies or other abnormalities that cause a magnetic field disturbance.

PROPELLER 2.0

Significantly reduces motion artifacts and optimizes tissue contrast, in all planes, helping visualize even small or subtle lesions without compromising image resolution or prolonging scan time (compared to conventional techniques).

3D Cube

Cube utilizes eXtended Echo Train Acquisition (XETA) technology to acquire a single-slab 3D FSE imaging sequence that applies modulated flip angle refocusing RF pulses that enables very long echo trains to generate T2-weighted soft tissue images with reduced blurring.

SWAN

SWAN lets you visualize and clearly delineate small vessels and microbleeds, 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.

3D BRAVO

BRAVO incorporates 2D ARC parallel imaging with 3D IR-prepared 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.

3D COSMIC

Coherent Oscillatory State Acquisition for the manipulation of imaging contrast. 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 T2 imaging through the cervical spine.

Applications

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.

IDEAL

This sequence and reconstruction package acquires multiple echoes at different echo times with a fast spin echo readout to create water-only, fat-only, as well as in-phase and out-of-phase images. IDEAL is designed for imaging those difficult regions such as the neck and spine where inhomogeneous magnetic fields yield failures with traditional fat saturation 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.

BrainSTAT

The BrainSTAT post processing application automatically generates parametric maps for neuro Blood Flow, Blood Volume, Mean Transit Time, and Time to Peak signal intensity. A Gamma Variant fitting algorithm is used to automatically estimate the arterial input function, then calculate the values for the four parametric maps. The maps may be saved in DICOM format and fused with high resolution anatomic data sets for improved visualization of tissue and anatomy.

BrainWave Real Time

ScanTools includes 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 terabyte 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 Terra 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.

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.

Applications

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 hardware that provides trigger signal to support this synchronization – 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 CSI 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 anatomy.

PROSE

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

Cardio-vascular 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.

Applications

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 with freeze motion without 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 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 – without compromising spatial resolution. This technology is now integrated with Elliptical- Centric data sampling to create the ideal imaging technique for contrast-enhanced MRA of the lower extremities in even the most challenging circumstances.

Easy to set up and easy to use, TRICKS rapidly generates time-resolved 3D images of blood vessels to meet the challenge of capturing peak arterial phases with minimal venous contamination. With TRICKS, the different vascular phases can be extracted, quickly and easily, 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 (less than 1 second switch over), as soon as the operator is satisfied with the level of vessel enhancement. The result is an interactive, ASSET compatible, accurate 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 different T2 and T2* weighting. Post-processing of the images is employed to generate gray scale and color maps of the T2 or 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 for the evaluation of the vascular tree. 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 6 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.

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.

Applications

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 uses VAST (Variable Sampling in Time) technology to acquire 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.

Body Applications

LAVA and LAVA-Flex

Liver Acquisition with Volume Acceleration with Flex processing. Based in the standard LAVA sequence, LAVA-Flex uses self-encoded 2D ARC parallel imaging and a new reconstruction algorithm to generate water-only, fat-only, in-phase and out-of-phase images from a single scan.

Applications

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, the improved SNR of the 3D acquisition permits the thinner slices than are traditionally available using 2D techniques.

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.

3D FRFSE

Coupled with respiratory gating, this 3D FSE sequence uses a novel "recovery" pulse at the end of each echo train to recapture signal for the next repetition. These features result in high-resolution three-dimensional images for MR cholangiopancreatography (MRCP) studies.

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.

3D Cube

Cube utilizes eXtended Echo Train Acquisition (XETA) technology to acquire a single-slab 3D FSE imaging sequence that applies modulated flip angle refocusing RF pulses that enables very long echo trains to generate T2-weighted soft tissue images with reduced blurring.

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 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 different T2 and T2* weighting. Post-processing of the images is employed to generate gray scale and color maps of the T2 or T2* signal decay across the echoes, which can be useful in the assessment of the presence of iron.

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:

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 faster than previous generations and 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 improved productivity and image quality.

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 systolic phase and offers the following:

- Optimized spatial saturation gap to improve fat suppression and background suppression. With this saturation gap optimization, higher views per segment (vps up to 48) can be used, resulting in significant scan time reduction.
- Peripheral Gating that minimizes the pulsatile artifacts.
- Optimized view ordering to improve arterial signal.
- ASSET acceleration compatibility to reduce scan time.

Applications

InHance Inflow IR

InHance Inflow IR is a new angiographic method, which has been developed to image renal arteries. It has an ability to suppress static background tissue and venous flow. This sequence is based on 3D FIESTA, which improves SNR as well as produces bright blood images. A selective inversion pulse is applied over the region of interest, which inverts arterial, venous, and static tissue. At the null point of the venous blood, an excitation pulse is applied to generate signal. The net result is an angiographic image with excellent background suppression that is free of venous contamination. Uniform fat suppression is achieved using a spectrally selective chemical saturation (SPECIAL) technique to provide uniform fat suppression while respiratory gating compatibility reduces respiratory motion artifacts during free-breathing renal exams.

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 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 unique bilateral shimming and a patented fat-suppression technique developed specifically for breast imaging. This enhanced version of VIBRANT for Optima MR450w allows the slices to be acquired in either the sagittal or axial orientation. It also provides for the automatic subtraction of pre-contrast images from post-contrast images to highlight abnormalities.

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 anatomy.

Musculoskeletal Applications

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.

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.

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.

Applications

Pediatric Applications

PROPELLER HD

PROPELLER's ability to compensate for patient motion makes it an ideal sequence for pediatric imaging where motion often plagues the exams.

Since each blade passes through the center of k-space, PROPELLER has unusually low sensitivity to motion artifacts and exceptionally high contrast-to-noise properties. This makes it ideal for producing high-resolution image quality even under challenging circumstances.

Available in all-imaging planes, PROPELLER provides the contrast and resolution that delivers real clinical impact. T2 FSE PROPELLER creates T2-weighted images that are degraded much less by head motion than conventional FSE, with a 25-75% increase in contrast to noise without any time penalty. Imagine acquiring a motion-free scan, virtually every time, and even on the most difficult of patients.

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.

3D Cube

Cube utilizes eXtended Echo Train Acquisition (XETA) technology to acquire a single-slab 3D FSE imaging sequence that applies modulated flip angle refocusing RF pulses that enables very long echo trains to generate T2-weighted soft tissue images with reduced blurring.

BRAVO

BRAVO incorporates 2D ARC parallel imaging with 3D IR-prepared 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.

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 with freeze motion without 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.

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 – without compromising spatial resolution. This technology is now integrated with Elliptical- Centric data sampling to create the ideal imaging technique for contrast-enhanced MRA of the lower extremities in even the most challenging circumstances.

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

Scan parameters

Slice thickness, FOV, matrix	
Minimum slice thickness in 2D	0.7 mm
Minimum slice thickness in 3D	0.1 mm
Minimum FOV	10 mm
Maximum FOV	500 mm
Min/max matrix	64–1024

2D Spin Echo	
Minimum TR (128x128)	8 ms
Minimum TR (256x256)	9 ms
Minimum TE (128x128)	2.0 ms
Minimum TE (256x256)	2.2 ms

2D Fast-Gradient Echo	
Minimum TR (128x128)	2.3 ms
Minimum TR (256x256)	3.1 ms
Minimum TE (128x128)	0.8 ms
Minimum TE (256x256)	1.0 ms

3D Fast-Gradient Echo	
Minimum TR (128x128)	1.2 ms
Minimum TR (256x256)	2.0 ms
Minimum TE (128x128)	0.4 ms
Minimum TE (256x256)	.5 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)	5.0 ms
Minimum TE (64x64)	1.1 ms
Minimum TE (128x128)	1.2 ms
Minimum TE (256x256)	1.6 ms
Minimum slice thickness	0.6 mm
ESP at 25 cm FOV	64x64: 0.472 ms 128x128: 0.728 ms 256x256: 1.12 ms
ESP at 50 cm FOV	64x64: 0.328 ms 128x128: 0.480 ms 256x256: 0.744 ms
ESP at 99 cm FOV	64x64: 0.228 ms 128x128: 0.320 ms 256x256: 0.556 ms
Maximum b value s/mm2	10,000
Images/second (64x64)	39
Images/second (128x128)	20
Images/second (256x256)	9
Maximum diffusion tensor directions	150
Minimum shots	1

2D Fast-Spin Echo	
Minimum TR (128x128)	8 ms
Minimum TR (256x256)	8 ms
Minimum TE (128x128)	2.0 ms
Minimum TE (256x256)	2.4 ms
Minimum slice thickness	0.7 mm
Minimum ESP 128x128	2.0 ms
Minimum Echo train	1
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 MR system with an LCC (CXK4) magnet. More detailed information is available on request.

Typical room layouts	
	System configuration minimum values
Magnet room	
W x D	3.6 m x 6.2 m
Minimum ceiling height	2.5 m (8 ft. 2.4 in.)
Equipment room	
W x D	2.4 m x 6.7 m
Control room	
W x D	1.5 m x 2.2 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 grounded WYE with neutral and ground (5-wire system)
- Note: Neutral must be terminated inside main disconnect control.

Alternate configuration:

- 3-phase DELTA with ground (4-wire). Recommend corner grounded Delta configuration.

Voltage:

- 480 / 415 / 400 / 380 Vrms

Frequency:

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

Siting and other specifications

Power consumption

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

Power consumption	
Continuous sustained power (> 5 seconds)	91 kVA
Heat shield compressor	9 kVA

Optima MR450w water requirements	
Maximum heat removal to customer-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 unique 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. 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 system complies with all applicable safety standards, including but not limited to UL60601-1 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).

About GE Healthcare

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 and efficiency around the world.

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imagination at work