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Value from Innovation

ECHELON Smart

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FUJIFILM Healthcare Corporation

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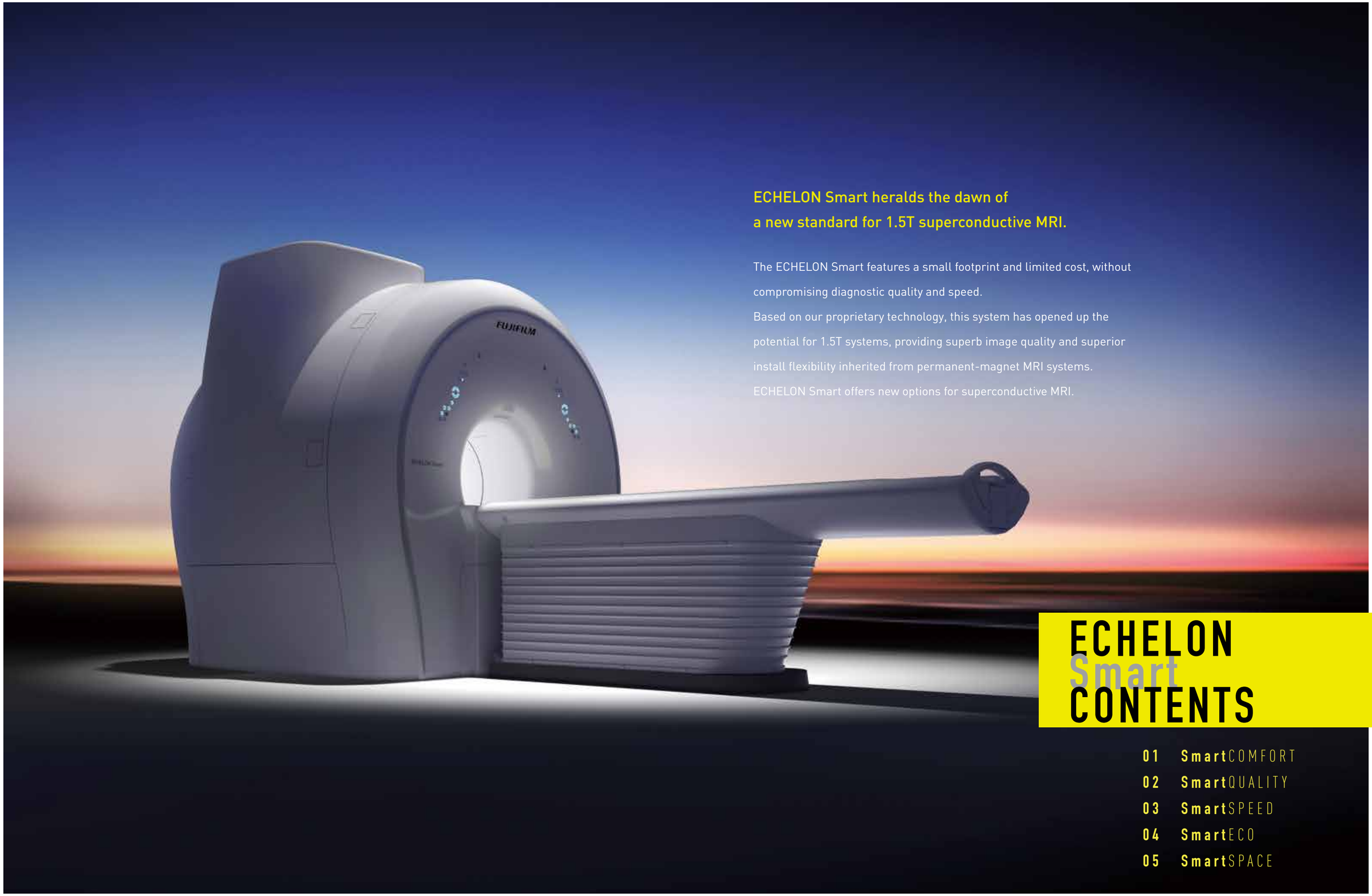


ECHELON Smart heralds the dawn of a new standard for 1.5T superconductive MRI.

The ECHELON Smart features a small footprint and limited cost, without compromising diagnostic quality and speed.
Based on our proprietary technology, this system has opened up the potential for 1.5T systems, providing superb image quality and superior install flexibility inherited from permanent-magnet MRI systems.
ECHELON Smart offers new options for superconductive MRI.

ECHELON Smart CONTENTS

01 SmartCOMFORT

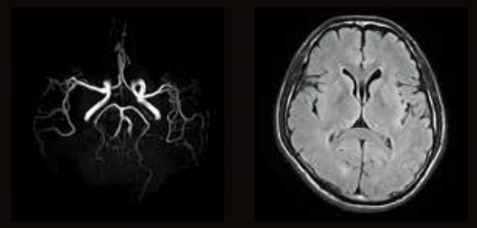
Patient-friendly Quiet Examination

Various technologies exist to reduce MRI imaging noise. However, low-noise MRI systems often compromise on image quality or extend imaging time, making them unsuitable for routine use.

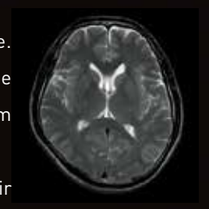
Other approaches need special hardware that prevents their widespread acceptance.

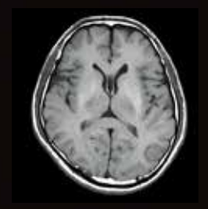
Our SmartCOMFORT noise reduction technology reduces the acoustic noise by up to 96%†.

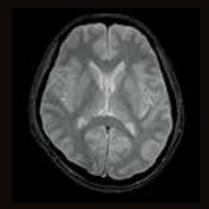
† Varies with the imaging conditions.



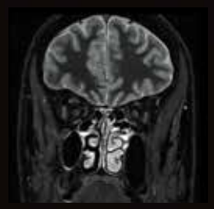
SmartCOMFORT **ON**

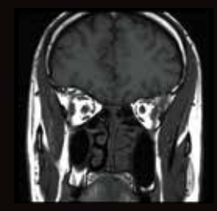


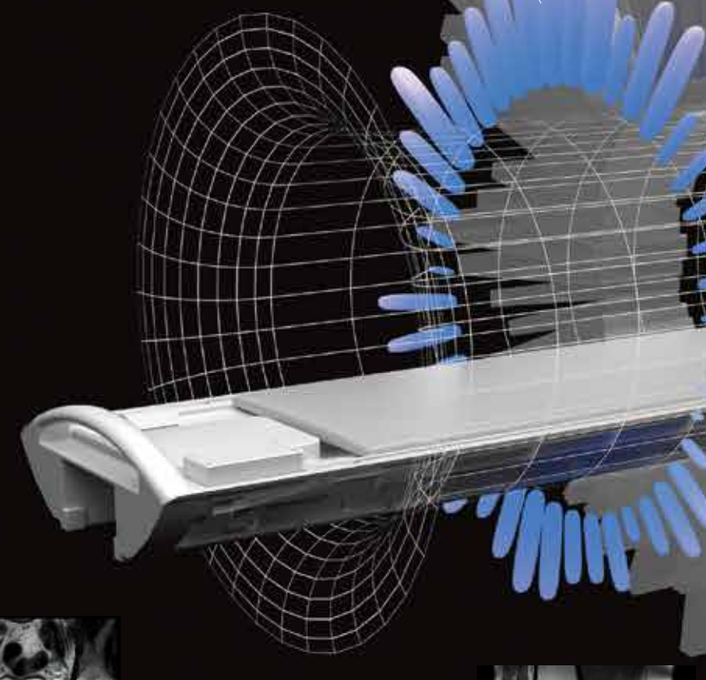


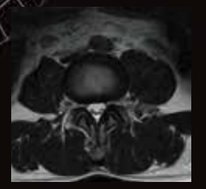


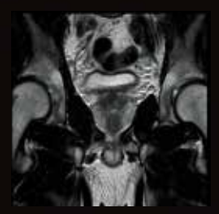
SmartCOMFORT **OFF**

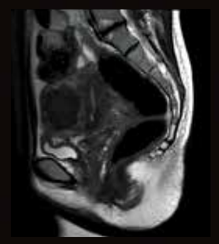










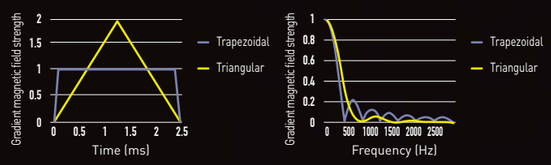


96% REDUCTION

Our noise reduction technology has minimal impact on image contrast or imaging time.

With SmartCOMFORT, the gradient magnetic field pulse form has been changed and the imaging parameters adjusted, keeping a balance between the imaging time, contrast, image SN ratio, and spatial resolution to reduce any impact the noise reduction technology may have.

Changing the waveform of the gradient magnetic field changes the frequency characteristics.

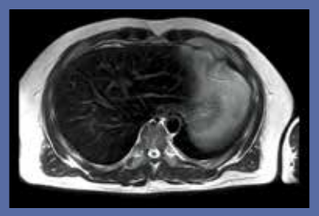


Gradient magnetic field pulse forms and frequency components

Principle of imaging noise reduction

The gradient magnetic field waveform is given by the product of the applied current and application time. This waveform also changes the sound quality.

SmartCOMFORT can be used together with the motion artifact reduction technology, RADAR†. † RADial Acquisition Regime



Example of RADAR + SmartCOMFORT image

02 SmartQUALITY

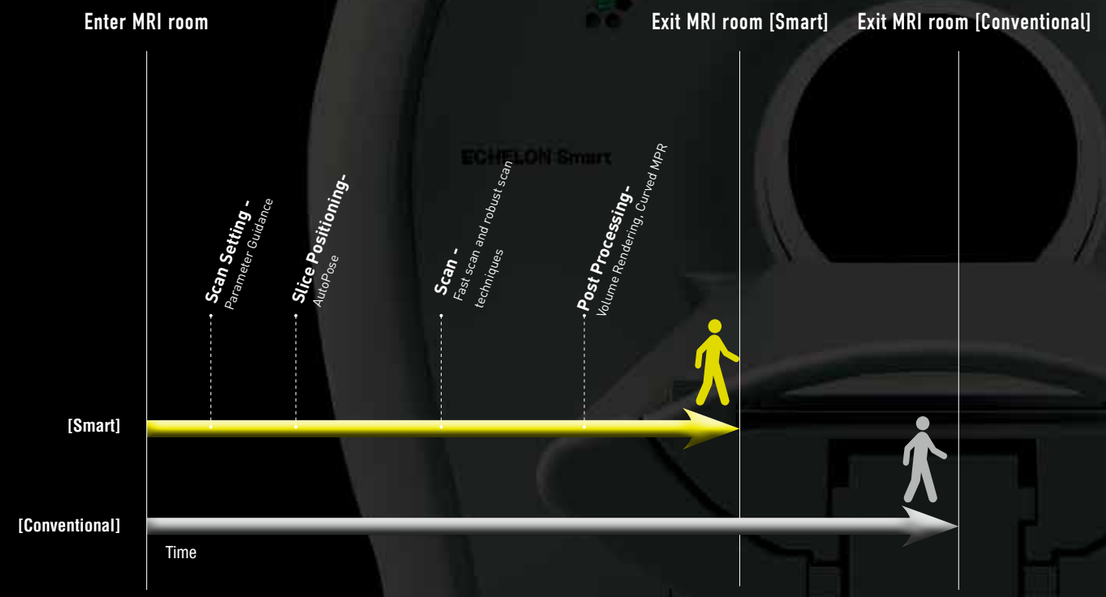
Superb Image Quality Realized by Sophisticated Technologies

The advanced specification of MRI sub-systems makes the most important impact on the delivery of image quality without compromise. ECHELON Smart is equipped with powerful sub-systems which includes the SmartENGINE which supports high quality imaging and high performance RF system to empower robust imaging technologies.

03 SmartSPEED

Reduction of Total Examination Time

To boost your productivity, ECHELON Smart offers features that streamline workflow and enhance throughput, such as AutoPose and Parameter Guidance function for easy and fast operation. Fast scan capabilities and robust scan techniques to reduce re-scanning contribute to shorter scan times, and on-console analysis functions reduce the transfer time of data to the workstation. With the SmartSPEED feature, your operational efficiency is improved.

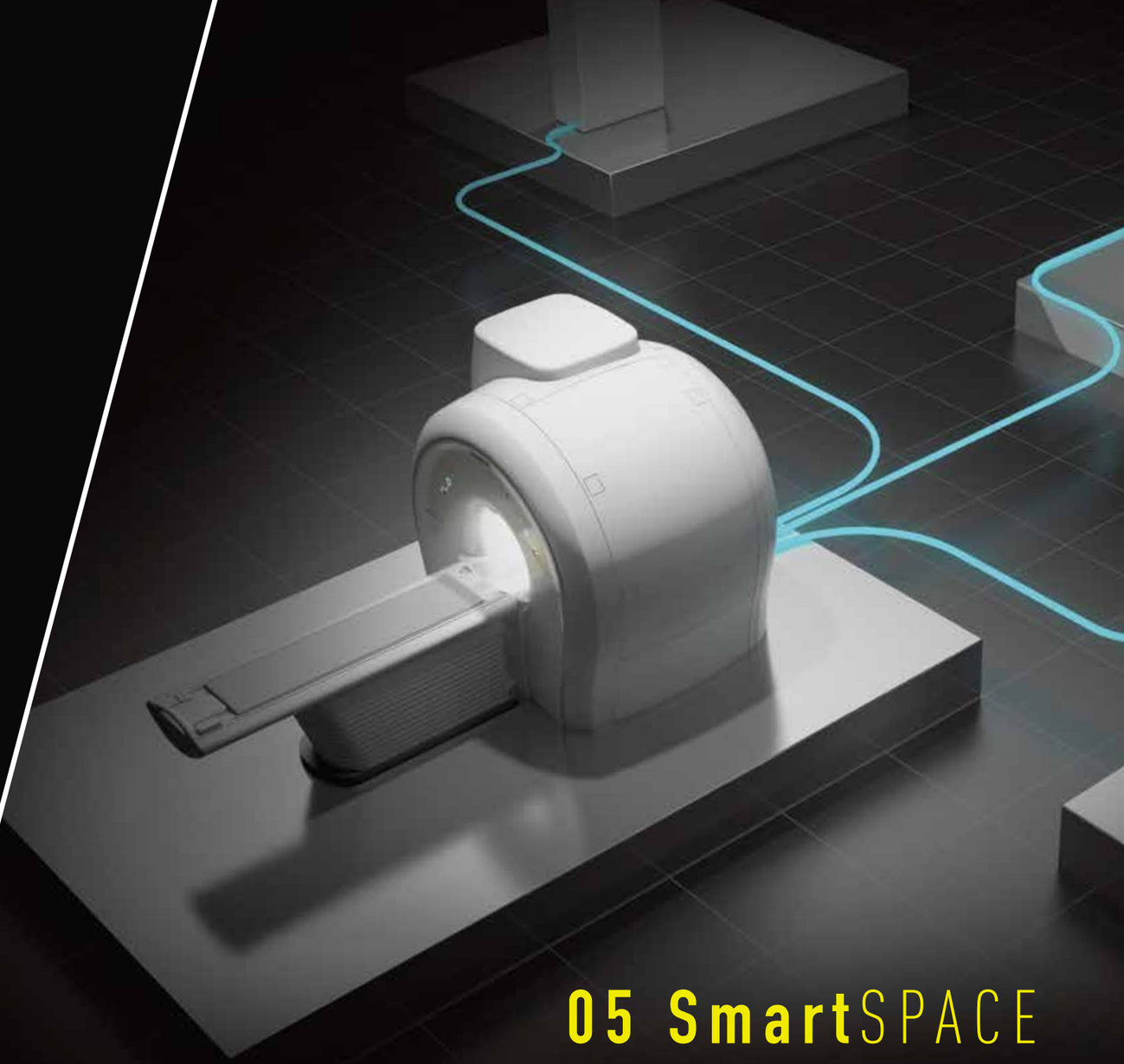


04 SmartECO

Ecological with Economical Running Cost

17% LESS

Superconductive MRI systems generally command high running costs.
This cost is mainly related to the high power consumption of the cooling system necessary to maintain superconductivity.
ECHELON Smart is equipped with an energy saving function that can stop the cooling system for a certain length of time during periods of non-use or on non-consultation days.
This function effectively reduces the power consumption whilst maintaining zero boiling off of the helium.
Moreover, as the heat emission from the cooling system itself also decreases during these periods, the power consumption of its heat-dissipating unit is also cut.



05 SmartSPACE

Small Footprint and Flexible Layout

It is often a matter of concern whether there is sufficient space in the equipment room for a superconductive MRI system installation.
ECHELON Smart has an extended cable length between the main MRI gantry and the power unit in the equipment room.
This enables flexible layouts that can remove some of the hurdles faced when introducing an MRI system.

ECHELON Smart CONTENTS

Attain "high image quality" and "high speed" in clinical practice with the combination of our applications, operations, and hardware.

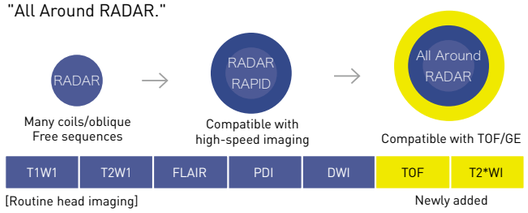
Smart APPLICATION

Applications which enhance the usefulness of head and thoraco-abdominal images.

All Around RADAR

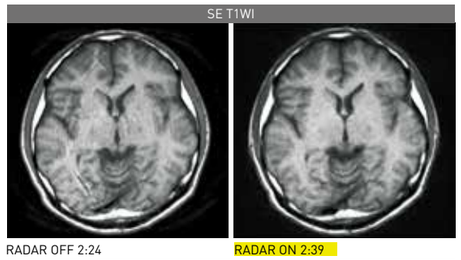
Combined use of RADAR in sequences required for routine head examinations

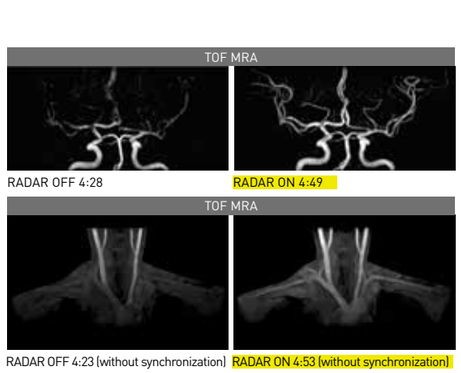
RADAR mitigates motion artifacts enhancing ease of use when imaging with many sequences, all receiver coils, and arbitrary cross-sections. RADAR can be used in combination with high-speed imaging. ECHELON Smart supports TOF and GrE sequences and is compatible with the combined use of RADAR for most of the sequences required for routine head examinations, thus realizing "All Around RADAR."



Effects of RADAR in TOF MRA and GrE T2*WI

RADAR has been applied to GrE sequences using a high-precision signal correction technology. This has enabled the combined use of RADAR in all sequences required for routine head examinations.

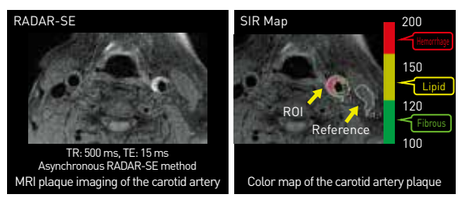




Plaque Imaging†

For diagnosis of plaque characteristics

Diagnosis of carotid artery plaque characteristics requires an MR image with high T1 contrast.



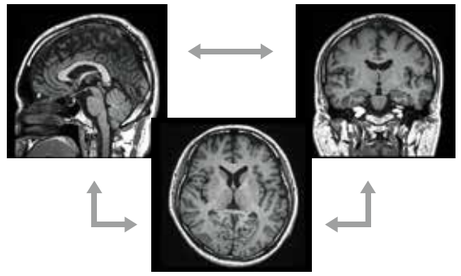
The asynchronous RADAR-SE method to which Radial Scan has been applied maintains a constant TR without influence from pulsation, and can conduct imaging with a high T1 contrast appropriate for diagnosis of plaque characteristics.

By normalizing the ROI signal strength to a reference, the SIR Map displays a color map of signal strength ratios. Applying this to Plaque Imaging could facilitate diagnosis of the plaque characteristics.

isoFSE

High-definition 3D imaging made possible by optimizing RF application patterns

isoFSE is a high-speed 3D imaging function for isovoxels. The flip angles of refocus pulses of FSE are varied to suppress the influence from signal strength fluctuations of MultiEchoes and enable high-definition 3D imaging. The optimization of these application patterns results in high contrasts achieved with T1WI, T2WI, and FLAIR images. The high spatial resolution volume data acquired in imaging can be used to reconstruct images of any cross-section in MPR processing.



Reconstruction available for any cross-section

BeamSat TOF†

Greater visibility of hemodynamic changes, for example, due to stenosis.

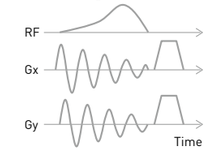
Addition of hemodynamic information to TOF

Pencil-beam type pre-saturation (BeamSat) pulses based on the application of local excitation are used in TOF imaging to selectively suppress some of the blood flow signals required for identification of the hemodynamics.

If imaging is conducted with BeamSat pulses specified for a target blood vessel, the flow signals of that vessel can be suppressed, and the dominant region can be identified. BeamSat pulses can be set to arbitrary positions and angles using a special GUI. The positions of BeamSat pulses can be set freely with respect to a target vessel.

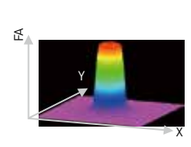
Subtraction of images with and without BeamSat pulses can be displayed in a reversed black-and-white image to visualize it as in MR-DSA.

[BeamSat pulse excitation chart (schematic diagram)]

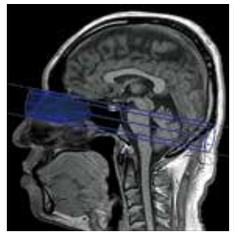


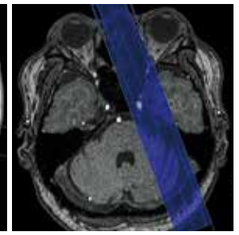
High-precision control of pre-saturation pulses using the spiral-type two-dimensional excitation method

[BeamSat pulse excitation profile]



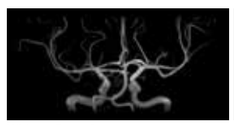
Beam-form pre-saturation pulse realized by a high system performance



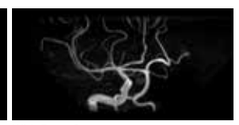


[Special GUI for BeamSat]
In the BeamSat display, the continuous line represents a nearer part and the broken line a part farther than the scanogram; the hatched part is a cross-section between a BeamSat and a scanogram.

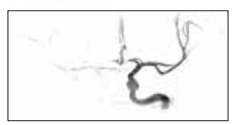
BeamSat pulse setting example on the left ICA
SAG cross-section: Position contacting nasal root/sella turcica
AX cross-section: Position contacting pyramid/clivus



Without BeamSat



With BeamSat



Subtraction image
(reversed black-and-white image)

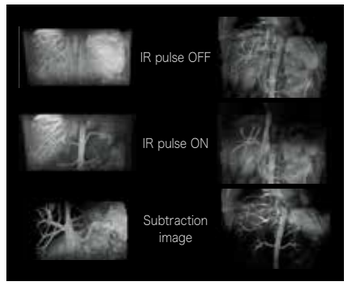
† Optional

Smart APPLICATION

VASC-ASL (Veins and Arteries Sans Contrast-Arterial Spin Labeling)

Visualization of fast blood flow in renal arteries and portal veins

VASC-ASL is a non-contrast imaging method that can visualize fast blood flow in the renal artery and portal vein in the abdomen. This feature visualizes blood flows labelled with IR pulses using the 3D BASG sequence and does not require ECG/pulse wave synchronization.
Selectively applying IR pulses upstream in the blood vessels to be visualized and acquiring images when the blood flow is Null enables the incoming labelled blood flow to be visualized as Black Blood. Therefore, by capturing images twice with selective IR pulses ON and OFF and acquiring a subtraction image, blood flows labelled with IR pulses will be visualized as a high-intensity area.

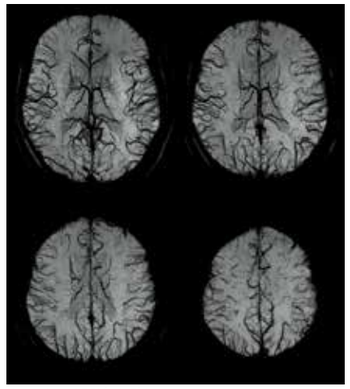


(a) Portal veins (b) Renal arteries
Examples of VASC-ASL images

BSI (Blood Sensitive Imaging)†

Image acquisition by sensitively reflecting differences in magnetic susceptibility

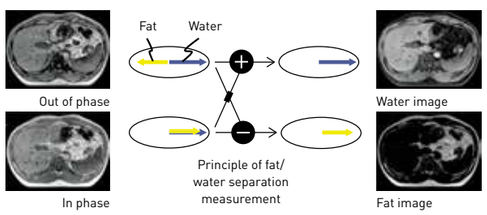
High-speed, high-resolution 3D T2*WI imaging is used to acquire images that sensitively reflect differences in magnetic susceptibility. Our BSI offers high-speed imaging due to EPI measurement.
Venous blood and hemorrhage cause loss of signals in T2* images due to BOLD (blood-oxygen level dependent) effects. BSI performs minimum intensity projection (minIP) processing and superimposes phase information to further increase the contrast of images.

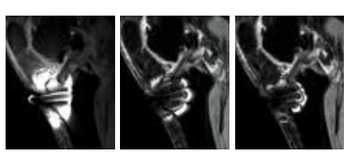

Examples of BSI (minP) images

FatSep

Fat suppression method resistant to changes in magnetic susceptibility using frequency differences between water and fat

Using the difference in resonant frequencies between water and fat protons due to chemical shifts, both water and fat images can be acquired in one round of imaging. FatSep acquires data when the MR signals of water and fat are respectively in-phase and out-of-phase, and adds or subtracts them to generate water and fat images.
FatSep can output images according to a degree of change in magnetic susceptibility. If there is a greater change in magnetic susceptibility, Fine mode can be selected to give a high-definition phase map and enhance the image quality.

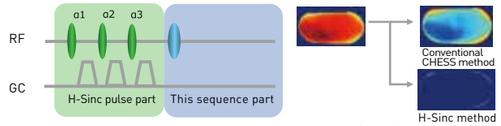



FatSat FatSep Normal FatSep Fine

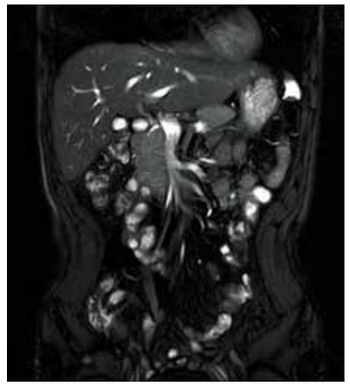
H-Sinc

Fat suppression method resistant to non-uniform RF radiation

Uniform RF radiation is one element required to achieve a high fat suppression effect. In general, achieving uniform RF radiation in a large FOV is difficult. H-Sinc applies more than one CHESS pulse to realize fat suppression, minimizing the impact from non-uniform RF radiation. A stable fat suppression effect can be achieved even over a large range.



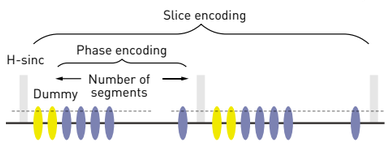
H-Sinc


Wide-range, stable fat suppression with H-Sinc

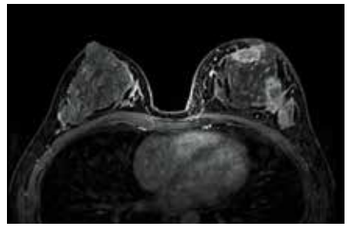
TIGRE

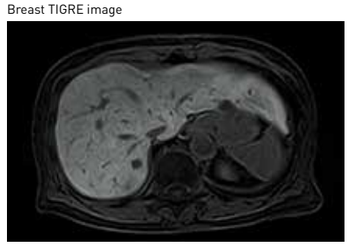
Acquisition of clear images with high-precision fat suppression

The use of TIGRE enables dynamic imaging in organs such as the liver. The large fat component in the abdomen and breast regions require high-precision fat suppression. We have realized uniform fat suppression effects and dynamic imaging in the abdomen and breast through combined use of high uniformity of the static magnetic field and H-Sinc which corrects for RF non-uniformity.



TIGRE principle diagram

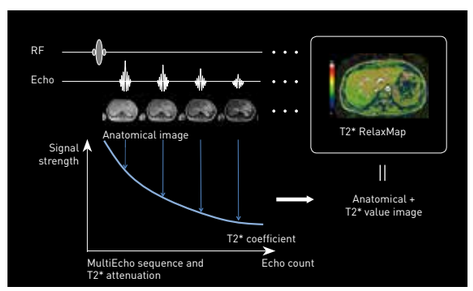

Breast TIGRE image


Abdominal dynamic image (TIGRE)

T2* RelaxMap/R2*RelaxMap†

Color map display of T2* values to improve the visibility of iron deposition

This function can map the distribution of T2* values to improve the visibility of iron deposition in liver tissue. A special sequence based on the GRE method (ADAGE) is available to acquire MultiEcho images used to automatically calculate T2* values. When analysis is conducted on the console, a color map of these T2* values is superimposed on a morphological image to create a T2* RelaxMap. You can also create an R2 (Relaxation rate) map based on 1/T2* values. The relative color display of an area with shortened T2* values can be used as a quantitative evaluation of iron deposits.

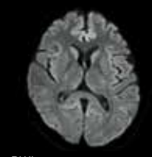


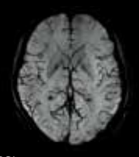
† Optional

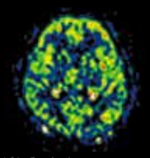
Smart IMAGE GALLERY

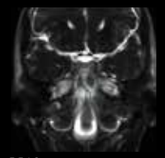
NueroVascular-Image


3D-TOF MRA (MIP)

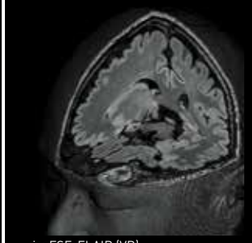

DWI

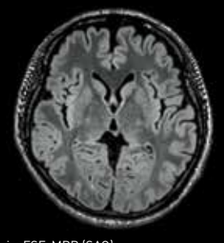

BSI

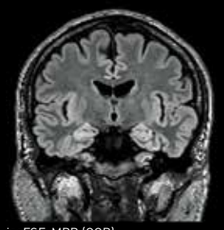

ASL-Perfusion


BPAS


3D-TOF WideMRA (MIP)

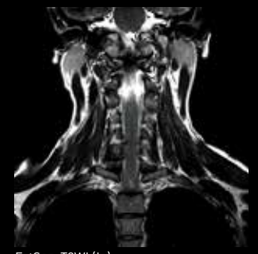

isoFSE-FLAIR (VR)

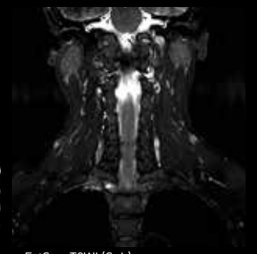

isoFSE-MPR (SAG)


isoFSE-MPR (COR)

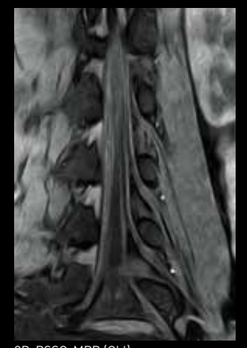
Spine-image

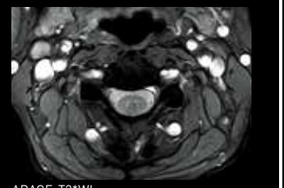

WholeSpine-T2WI


FatSep-T2WI (In)


FatSep-T2WI (Sub)


3D-BASG (MIP)


3D-RSSG-MPR (Obl)


ADAGE-T2*WI

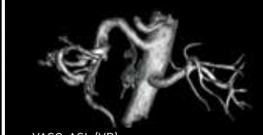

HighRes-T2WI


HighRes-T2WI (Reverse)

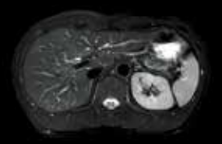
Body-image


3D-isoFSE MRCP (MIP)

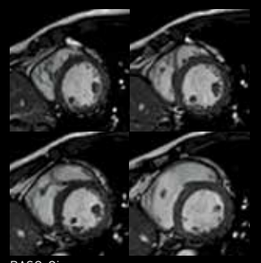

VASC-ASL (MIP)


VASC-ASL (VR)


VASC-ASL (MIP)


RADAR-FatSat T2WI (RG)


Body-DWI (Reverse)


BASG-Cine


VASC-FSE (MIP)

MSK-image

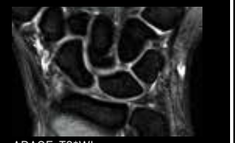

WholeBody-DWI (MIP)

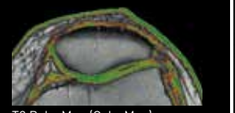

HighRes-PDWI


ADAGE-T2*WI


FatSat PDWI


HighRes-T2WI


ADAGE-T2*WI


T2 RelaxMap (ColorMap)

Smart OPERATION

A comprehensive range of features that streamline operation for greater diagnostic performance

Workflow Coil System

Receiver coils support ease of patient setting and offer superb image quality

The number of receiver coils that must be set prior to the examination is minimized to reduce replacement time and effort. With a system designed for ease of use and with the adoption of special receiver coils for individual regions, significant reduction in examination time is attained whilst maintaining high image quality.

Workflow Coil System

for head & neck

for spine

for abdomen

for joints

Workflow coil system　Setting examples

[Spine examination]
- Head and neck coil (posterior side) + WIT spine coil

[Head and neck examination]
[Spine examination]
- Head and neck coil

[Abdomen examination]
-Head and neck coil [posterior side] + WIT spine coil + Flex body upper coil

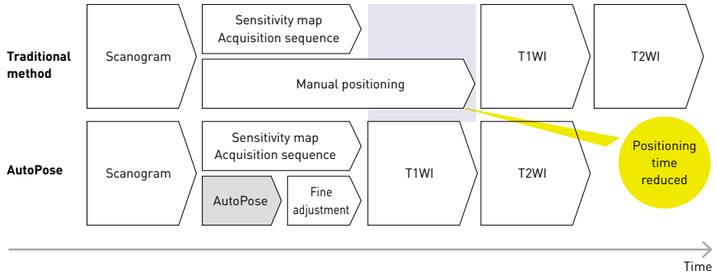
[Extremity examination]
-Head and neck coil [posterior side] + WIT spine coil + GP flex coil

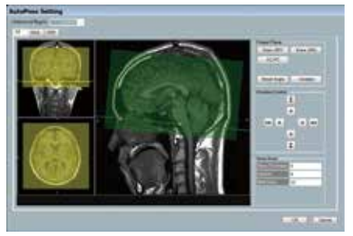
To boost your productivity, ECHELON Smart offers features that streamline workflow and enhance throughput, such as AutoPose and Parameter Guidance function for easy and fast operation.

AutoPose

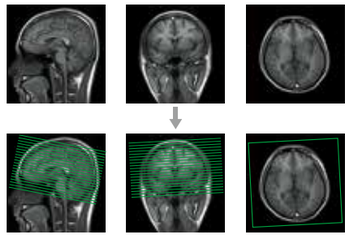
Operation time reduced with assistance for selecting the imaging cross-section

Slice line setting can be time-consuming even for experienced operators. AutoPose helps you to determine the slice line more quickly and accurately. Following the acquisition of a scanogram, the AutoPose process takes one or two seconds to move the slice line automatically to the preset cross-section. During the acquisition of a sensitivity map, fine manual adjustment of the slice line can be performed, ready for imaging to start.





[Slice line preset window]
This function is available immediately after installation using registered preset cross-section settings that suit the needs of your medical institution.



[AutoPose slice line]
The one or two second AutoPose processing sets the slice line according to the cross-section setting registered for your medical institution.

User Interface

Streamlines setting and changing of protocols

An easy-to-use interface is available.

Suggestion UI

Supports change of imaging conditions

This function provides guidance for parameter settings. During protocol change, several candidates are displayed to allow the operator to select the parameter most appropriate for that particular scenario.

Smart HARDWARE

Our technologies enhance image quality

ECHELON Smart is equipped with powerful sub-systems which includes the SmartENGINE which supports high quality imaging and high performance RF system to empower robust imaging technologies.

SmartENGINE

Optimizing the image SN ratio on multi-channel receiver coils

The ECHELON Smart is powered by a high-speed A/D converter (Analog to Digital Converter) which directly digitizes the high frequency signal, suppressing noise to enhance image quality. It also incorporates an optimum image synthesizing technique allowing the precise adjustment of the image synthesis ratio taking into account the noise correlation during composition of signals from the elements to improve the total image SN ratio by 8%† and thus provide excellent clinical images.This technology is particularly effective for multi-channel receiver coils in which the coil elements are segmented.

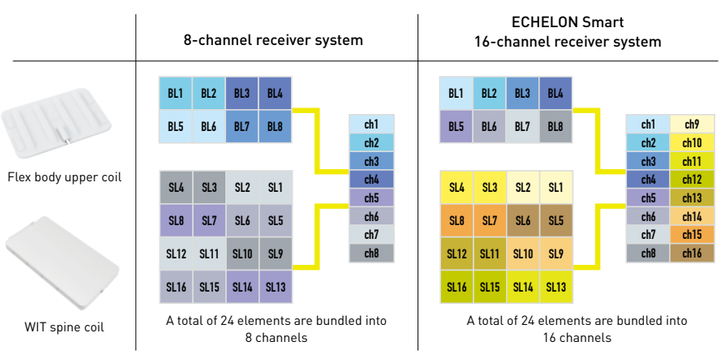
† Varies by receiver coil and imaging conditions.

16-channel receiver coil imaging setting

16ch Receiver System

Doubling the number of receiver coils to improve the reception sensitivity and stability during high-speed imaging

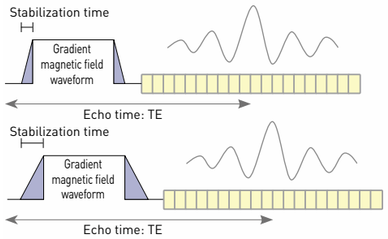
The elements of the receiver coils have been downsized to double the number of receiver channels from 8 to 16. This has improved the receiver sensitivity, achieved a high image SN ratio, and realized low-noise receiver from multi-channel receiver coils in the abdomen and other regions, for which independent receiver was not possible using an 8-channel system. When the RAPID high-speed imaging function is used, the greater the number of receiver coil elements, the more redundantly the expansion information can be obtained. This ensures stable imaging.

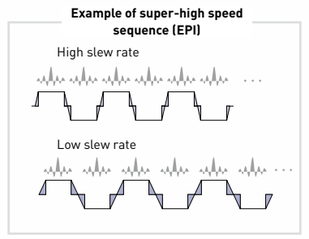


High Performance Gradient System

High slew rate compatible with high-speed and high-performance imaging

Shortening the TE (echo time) for signal receiver is essential for achieving high-speed imaging, excellent MRA images, and high-performance imaging. ECHELON Smart's powerful gradient magnetic field system with a high slew rate power supply of 130mT/m/s can shorten the gradient magnetic field stabilization time and consequently can further shorten the minimum TE. Furthermore, this slew rate is sufficient to support super-high speed sequences such as EPI that generate echo signals continuously. By reversing the gradient magnetic field, it is effective for imaging that requires high-speed switching without influencing the image quality.

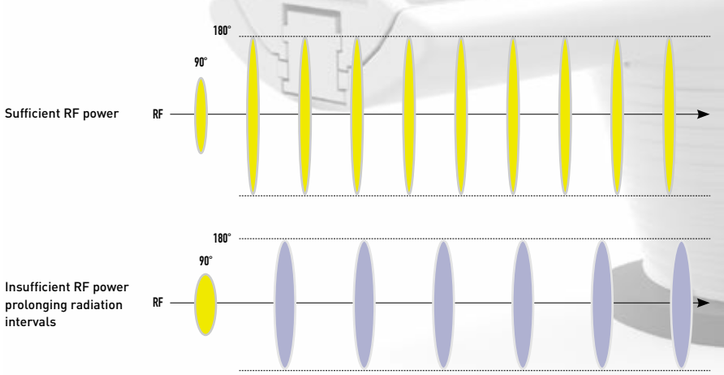




High Performance RF System

RF power output that ensures stable maintenance of radiation waveforms

ECHELON Smart is equipped with an RF power output of 18 kW. This is sufficient to provide clear images without deterioration of image quality even in the FSE sequence that applies refocus pulses continuously.

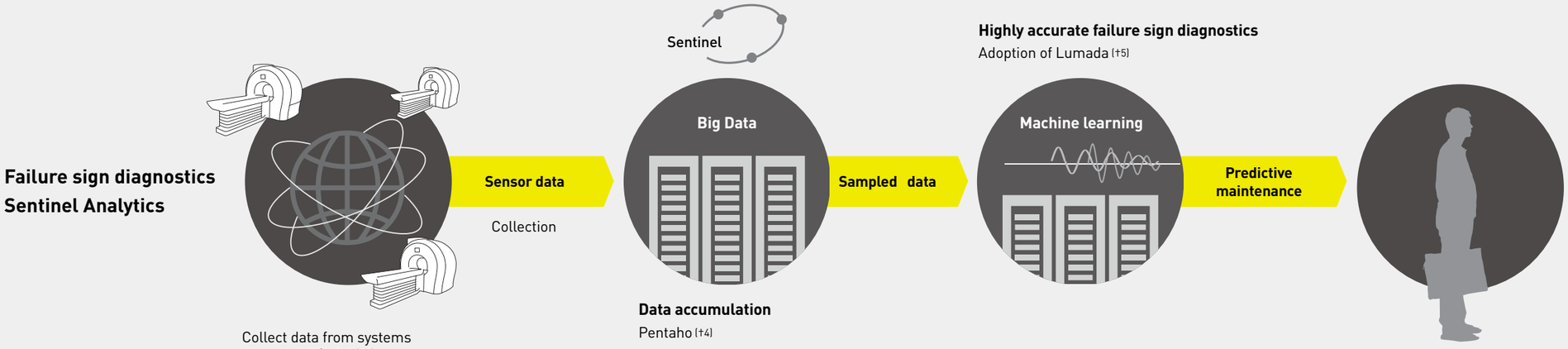


Sentinel Analytics (†1)

Improving the uptime through failure sign diagnosis

Achieving higher uninterrupted system availability and optimizing maintenance costs remain challenges for conventional remote support services for medical devices. We have accumulated and analyzed Big Data to develop a new system that utilizes its "Failure Sign Diagnosis Service" to launch "Sentinel Analytics," a failure sign diagnostic service for superconductive MRI systems.

With the failure sign diagnosis based on IoT (†2), the inspection and parts replacement cycles can be optimized and the system's up time can be improved.



Major features and advantages

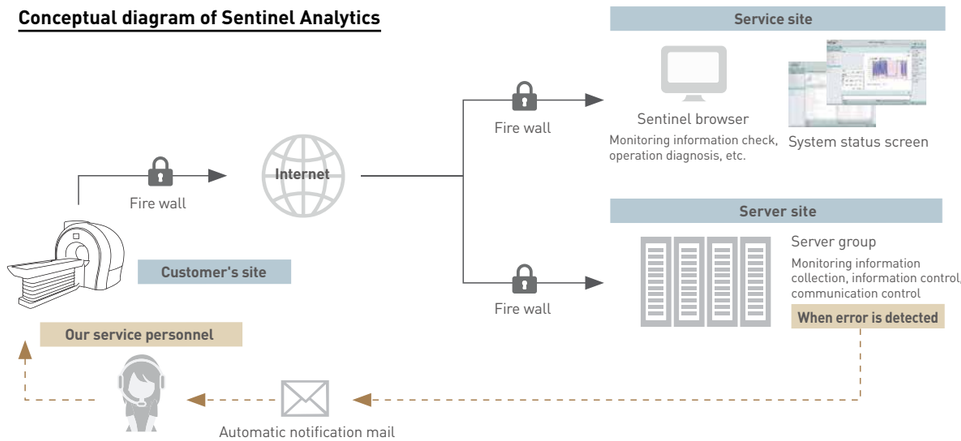
Constant system monitoring
The Sentinel server monitors the system status 24 hours a day.

Automatic notification feature
When the Sentinel server detects either a malfunction or a lowered performance of the system, an alert is automatically reported to our service site. This helps to prevent the occurrence of a malfunction. Furthermore, a corrective measure is quickly taken in case of malfunction.

Direct connection feature
This feature provides service via direct connection of the service site and your system.To track down the causes of a malfunction, we check artifacts and abnormal images, check image data before reconstruction (raw data) and run test programs on the system.

Security
Such features as encryption of communication data and communication based on mutual authentication are available to protect patient information. Furthermore, the specification does not allow recognition of personal information included in Patient Lists and images (such as an patient's name, sex, weight, age, and date of birth) on the Sentinel server and the Service Site.

Conceptual diagram of Sentinel Analytics



†1 Service contract is required.
†2 IoT (Internet of Things) : A system in which various devices with communication functions exchange information via the Internet to realize identification, monitoring, and control of such devices.
†3 M2M (Machine-to-Machine) : A system of direct exchange of information between machines via a network without human intervention.
†4 Pentaho : Big Data analysis software available from Hitachi Vantara LLC.
†5 Lumada : Lumada is Hitachi's IoT Core Platform.