HITACHI

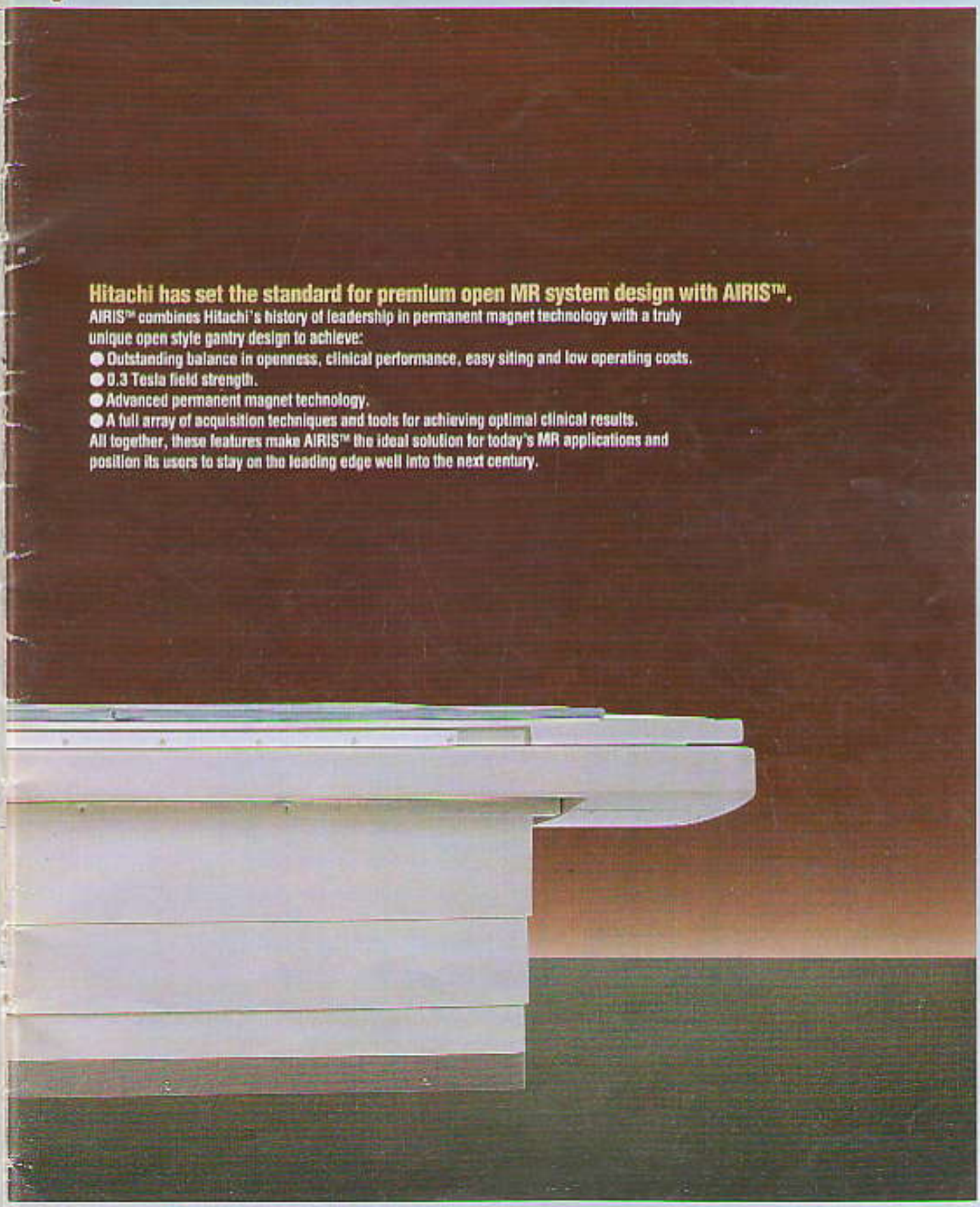
Premium Open Design MR Imaging System

AIRIS™

MAGNETIC RESONANCE
IMAGING SYSTEM

Introducing AIRIS™. The Open MR

System with Premium Performance.

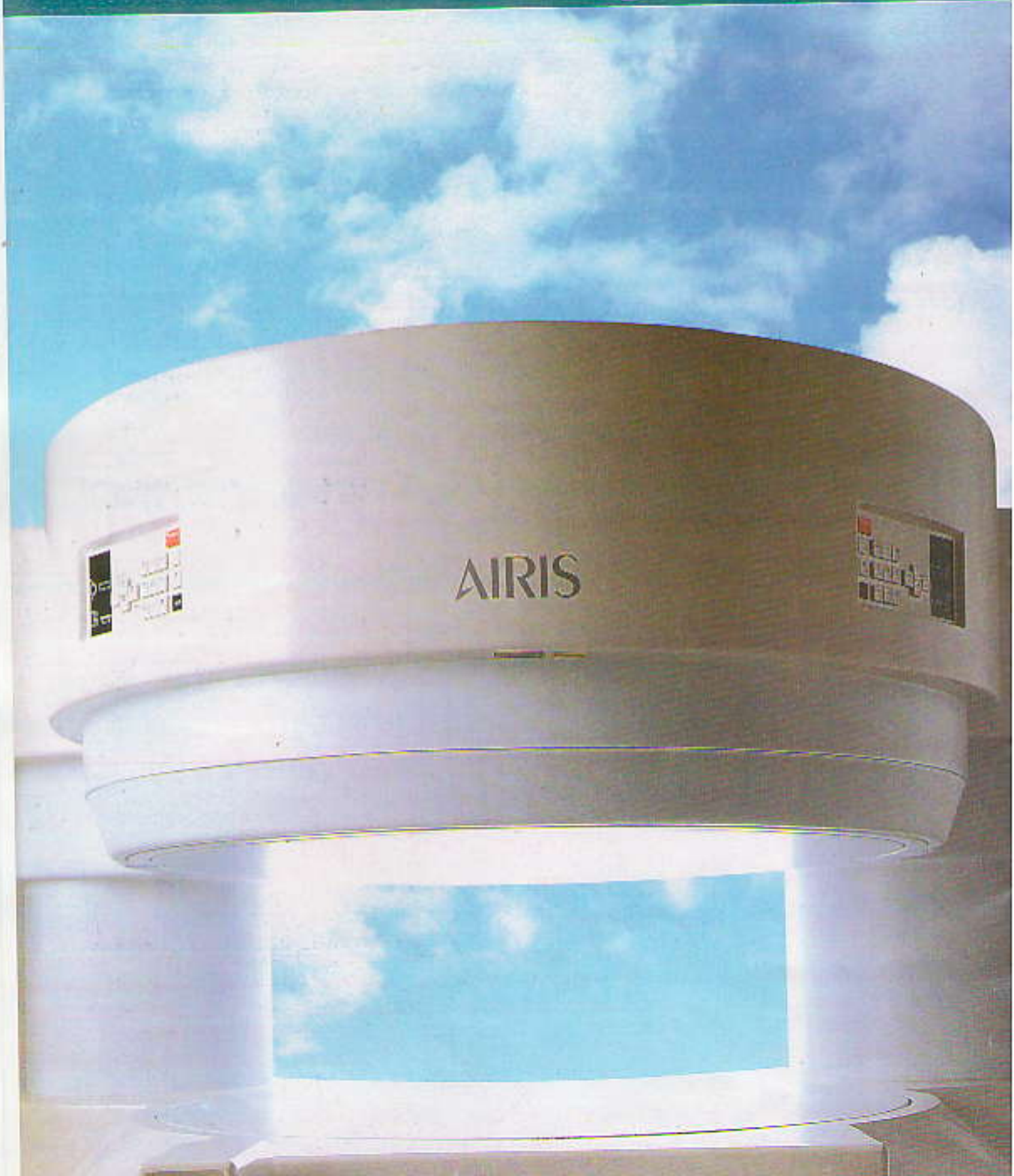


Hitachi has set the standard for premium open MR system design with AIRIS™.
AIRIS™ combines Hitachi's history of leadership in permanent magnet technology with a truly unique open style gantry design to achieve:

- Outstanding balance in openness, clinical performance, easy siting and low operating costs.
- 0.3 Tesla field strength.
- Advanced permanent magnet technology.
- A full array of acquisition techniques and tools for achieving optimal clinical results.

All together, these features make AIRIS™ the ideal solution for today's MR applications and position its users to stay on the leading edge well into the next century.

AIRIS™ is "Open".



Hitachi's open-design meets the clinical requirements of MR today and is ready for the future

The openness of AIRIS™ can not be achieved with conventional MRI systems.

By minimizing the size of the vertical support structures, and moving them as far as possible away from the patient, AIRIS™ achieves virtually unrestricted access in front, back and both sides.

This creates a comfortable environment for the patient while providing maximum access for technicians and physicians.

The AIRIS™ open design is also well positioned for future MR applications which will likely require greater access to the patient.

The motorized AIRIS™ patient table is extra wide for added comfort and may be lowered to 45cm from the floor for quick and easy patient transfer and positioning.

AIRIS™ is Patient-Friendly

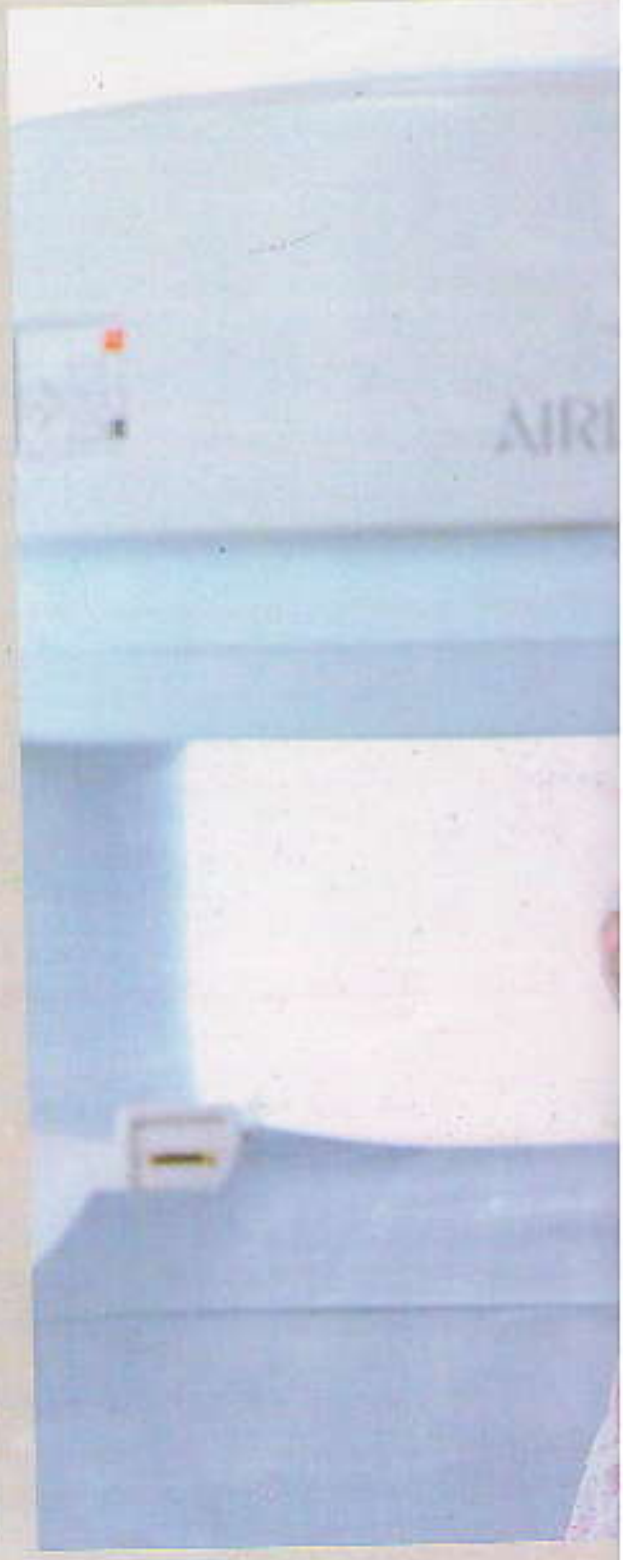
The large magnet opening of AIRIS™ virtually eliminates the anxiety and claustrophobia often experienced by patients in the narrow bore of conventional MR imaging systems. It also allows someone to be in attendance with the patient during the exam for comforting reassurance.

Children and elderly patients, who are often difficult to image, particularly like the openness of AIRIS™.

Patients may even be scanned in a seated position.

AIRIS™ Puts Patients at Ease.

The unique open design of AIRIS™ allows the patient's head to stay outside the magnet when imaging the lower abdomen and extremities. It also allows a clear view of the patient during the exam, thus eliminating the need for special observation mirrors. Also, the patient can be easily accessed and positioned from the rear of the gantry.



The ultra-large magnet opening of AIRIS™ easily accommodates very large patients who can not be imaged in conventional narrow-bore MR systems. Hitachi has developed a special over-size QD body coil specifically for achieving excellent clinical results on large patients.

Hitachi has developed special flat-type gradient coils for AIRIS™ which maintain a comfortable environment for the patient by greatly suppressing the acoustic pulse sound heard during the exam.

In designing AIRIS™, Hitachi has paid special attention to design, operation and colors which are pleasing to patients and help them to stay relaxed.

Motorized lateral movement of the tabletop facilitates positioning of the shoulder or extremities in the center of the field for consistently high image quality.

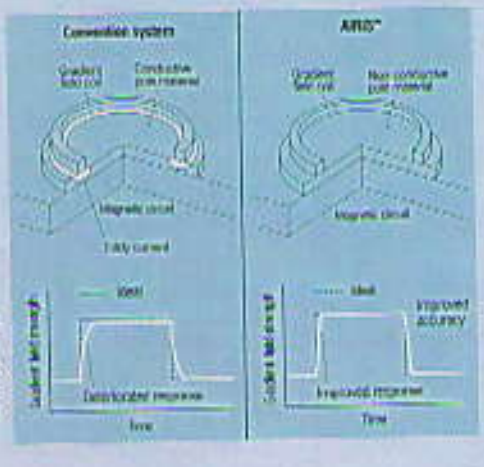
The low table height and large tabletop width (80 cm) of AIRIS™ will further help to eliminate patient anxiety.

0.3 Tesla Field Strength For High Imag

The AIRIS™ operates at 0.3 Tesla, providing high signal to noise ratio (SNR) for all clinical procedures including; FSE (fast spin echo), MRA (magnetic resonance angiography) and high resolution imaging.

Self-shielded magnet design eliminates eddy currents

The AIRIS™ permanent magnet utilizes non-conductive rare-earth pole materials, together with a unique design, to avoid gradient bounce-back resulting from eddy currents. The need for expensive active shielding, which is required on conventional MR systems, is thus eliminated.



Eddy current:

When a strong current flows through a gradient field coil a magnetic flux is created. If magnetically conductive materials are present within the flux area eddy currents result, which deteriorate the response of the gradient field strength and degrade image quality.

NEOMAX™...the strength and stability of AIRIS™.

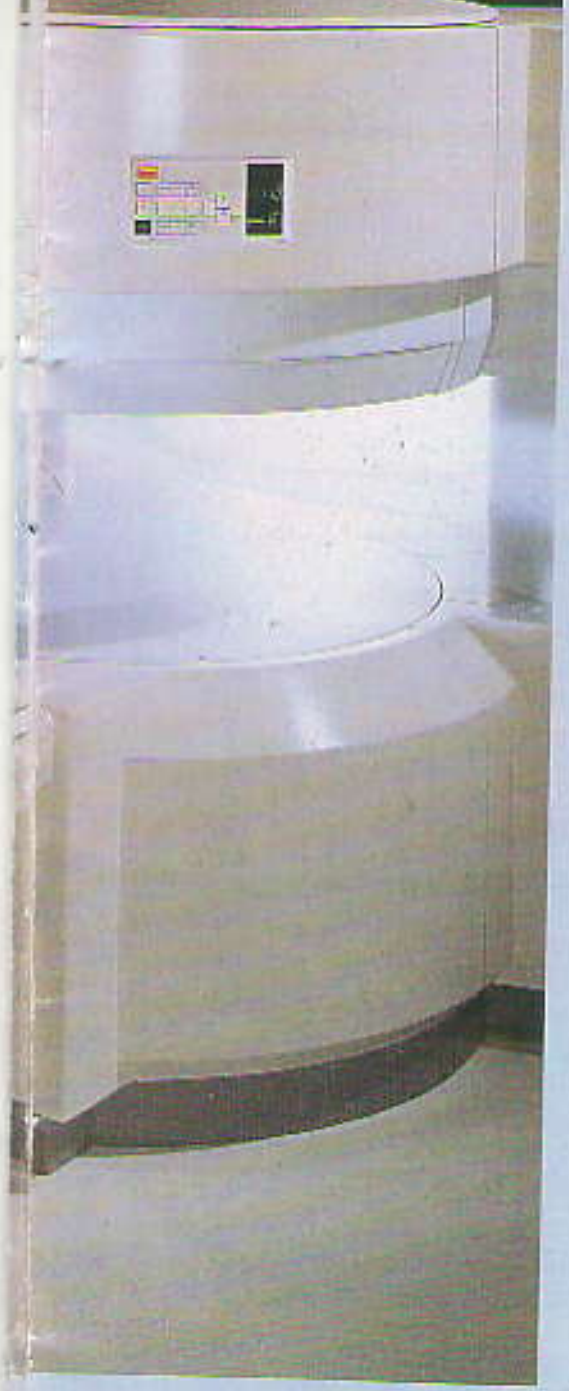
AIRIS™ utilizes a revolutionary permanent magnet material called NEOMAX™. It delivers more field strength per kilogram than other magnetic materials thereby achieving higher field strength, with higher homogeneity and stability, while maintaining easy siting.

Time change of field strength

Generation of static magnetic field for MRI

Item	Permanent magnet	Resistive magnet	Superconductivity magnet
Static strength (T)	About 0.3	About 0.25	0.3 to 2 or more
Weight (ton)	4 to 10	3 to 10	3 to 10
Field direction	Perpendicular to body (also, parallel to body)	Parallel to body (also, perpendicular to body)	Parallel to body
Fringe field	Small	Medium	Large
Field stability	Good	Poor	Excellent
No. of components	Small	Large	Large
Cooling materials	Not required	Not required	Required
Cooling water	Not required	Required	Required (refrigeration)
Power consumption	Small (about 2 kW)	Large (about 20 kW)	Medium (about 10 kW)

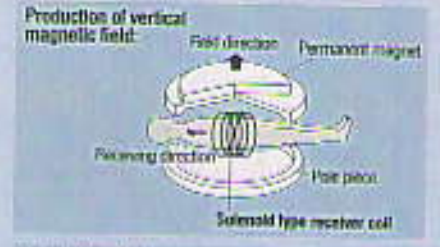
Quality.

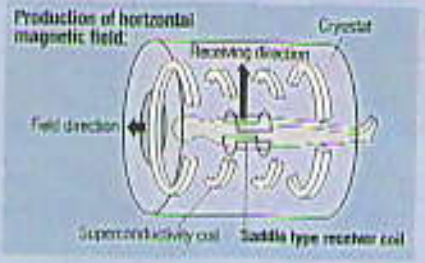


0.3 Tesla vertical magnetic field and solenoid-type coils assure high image quality.

Unique quadrature solenoid RF coils:

AIRIS™ employs Hitachi's unique, high sensitivity quadrature solenoid RF coils, in combination with the vertical magnetic field, to further extend the high SNR. The sensitivity is 1.4 times greater than achievable with saddle type coils.





Flat transmitter coil and active coupling:

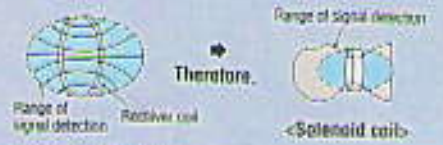
AIRIS™ employs a flat-type RF transmitter coils for open design.
The flat transmitter coil shows an improved uniformity of transmission. Combined use of the flat transmitter coil and a flat QD transmitter coil assures improved transmission efficiency.

Also, with a future applications taken into consideration, the RF amplifier for AIRIS™ is designed to have a large capacity to accommodate the use of future pulse sequence development.

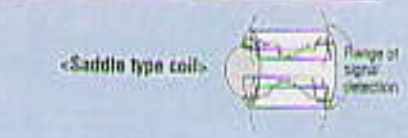
Active couping is utilized between the transmitter and receiver coils to enable small coils to provide high contrast (GE) imaging with a low flip angle, which is difficult with conventional passive coupling.

Merit 1 of solenoid coil:

- Even a small solenoid coil assures a wide field of view (FOV) in the vertical direction.
- The cervical region of the patient can be visualized in a wide FOV simply with a coil wound around the neck.
- Patients may be imaged in flexion or extension positions.

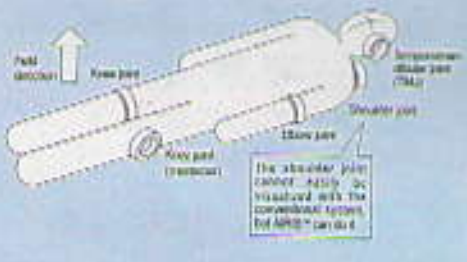


The range of signal detection by the solenoid coil is elliptic as shown.



Merit 2 of solenoid coil:

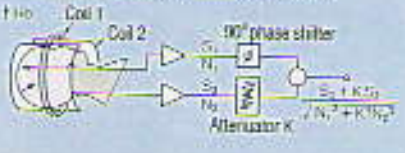
- Because of the vertical field of AIRIS™, lateral regions of the patient's body can easily be examined just with an ordinary receiver.
- Shoulder joints, which are difficult to image in the narrow bore of conventional MR imaging systems, may be easily done with AIRIS™.



QD (quadrature detection) coils for higher image quality:

For higher image quality and patient throughput, dual QD coils are available which combine two coils that are sensitive in different directions and geometrically perpendicular (90°) to each other.

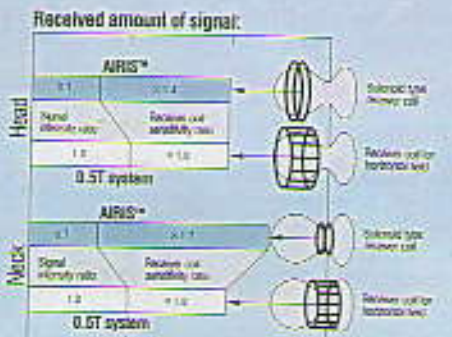
Principle of QD coil in vertical field system:



With AIRIS™ you receive image quality beyond the scope of other open systems and rivaling that of higher field strength systems.

Comparison in quality of regional images:

Received amount of signal:



Specialized Acquisitions.

Fast spin echo (FSE)*:

FSE reduces the time required for data acquisition without affecting image resolution or contrast. Echo train lengths of up to eight echoes are used for both single and dual contrast FSE. Single contrast FSE replaces the conventional T-2 weighted single echo sequence while dual contrast FSE provides both a proton density-weighted and T-2 weighted image. The same speed increase is also available for IR (inversion recovery), including Fast STIR, which suppresses the signal from fat.

- FSE
  - T2-weighting
  - T1-weighting (fast-IR)
  - T1-weighting with fat signal suppression (fast-STIR)
  - Dual contrast imaging (proton density-/T2-weighting)
  - High-definition imaging

High Resolution Imaging (in 512 x 512 matrix)*:

High matrix acquisitions with FSE provide the increased resolution necessary for some clinical applications.

Dual contrast imaging*:

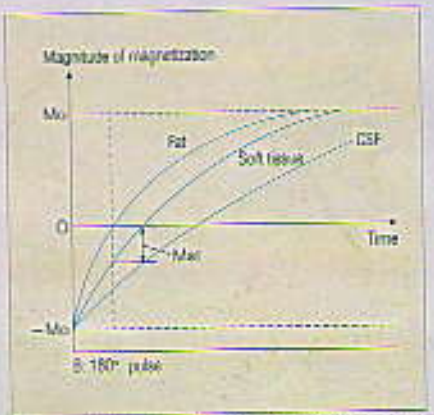
Provides both proton density-weighted and T-2 weighted images.

Fast-IR*:

FSE is conducted in an IR sequence to produce T1-weighted images.

Fast-STIR*:

Fast-STIR greatly reduces acquisition time and is utilized with fat signal suppression in an IR sequence. Fat has a small T1 value and short relaxation time and may be suppressed by imaging for a short TI (inversion time). This technique is particularly effective for detecting lesions in fatty regions such as surrounding the optic nerve.



Change of vertical magnetization after RF pulse is applied

FLAIR** and Fast FLAIR**:

In imaging with the FLAIR technique, CSF (cerebrospinal fluid) signal can also be suppressed. FLAIR technique can shorten the imaging time by conducting FSE along with this technique.

MR angiography (MRA)

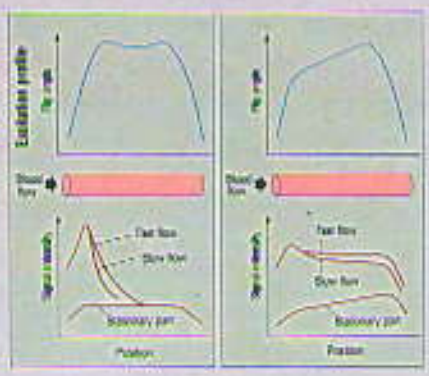
High resolution/High definition angiography*:

Asymmetric measurement imaging (AMI) and half Fourier transform can be effective in visualizing small blood vessels. AIRIS™ offers 512 x 512 matrix high resolution/high definition imaging without any increase in acquisition time.

Versatile technique High definition MRA

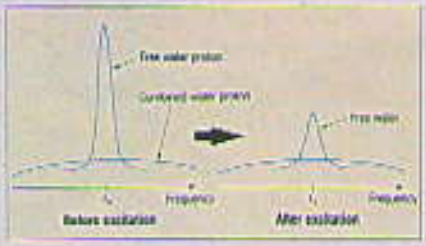
SSP (sloped slab profile)*:

This technique suppresses the blood flow signal saturation caused by multiple excitations and is effective for improving contrast when imaging peripheral blood vessels.



MTC (magnetization transfer contrast)*:

By applying specialized RF pulses, it is possible to alter magnetization transfer and vary tissue image contrast. In combination with MRA, MTC reduces the overall signal intensity from the background tissue (cerebral parenchyma), thereby increasing the contrast between the bright blood vessels and the darkened stationary tissue.



Conventional technique:

SSP + MTC

MOTSA (multiple overlapping thin slice acquisition)*:

Airis supports up to eight simultaneous overlapping 3-D MRA data sets. Additionally, the Hitachi MIP processing accurately adapts to multiple overlapping slabs resulting in a high quality MRA spanning many high detail 3-D slabs.

Volume Rendered MIP

This technique is used to visualize vascular system in 3-D with improved visual depth cues. Overlapping vessels are more easily distinguished.

Walking Presaturation:

When acquiring sequential 2-D MRA, a walking presat can be defined, in addition to static presat regions, to yield either an arteriogram or a venogram.

AIRIS™ Acquisition Techniques and Too

Rectangular FOV:

Most body parts have one dimension which is longer than the other . By using rectangular FOV imaging, you can acquire the image data corresponding exactly to the anatomic region being studied. This proportionately reduces scan time without impacting resolution, contrast or the FOV size..

Half scanning:

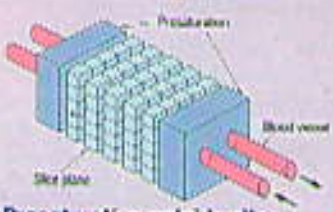
Half-scanning saves time without loss of image resolution or contrast by acquiring one half the image data and applying the mathematical property of conjunctive symmetry to complete the image.

By increasing the number of signal averaging steps with half scanning, a region with body motion can be pre-excited to prevent reception of signals which will cause artifacts.

This technique can be used in combination with any of the following anti-aliasing techniques:

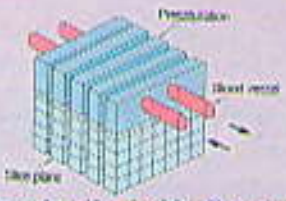
Presaturation:

Blood flow- or body motion-caused artifacts can be suppressed by applying a presaturation pulse to pre-excite the region being imaged.



Presaturation outside slice plane:

By setting a presaturation region in parallel to a slice plane, blood flow and motion artifacts can be suppressed.



Presaturation inside slice plane:

Limiting a presaturation area within the same slice plane suppresses artifacts due to abdominal or cardiac motion.

Rephasing:

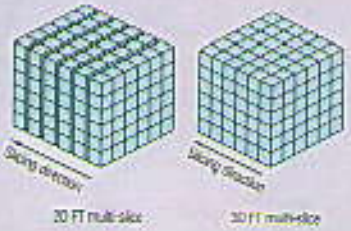
This technique can be applied to both SE and GE to suppress blood flow or motion artifacts. SE sequence rephasing helps in the diagnosis of spinal and intervertebral disc disorder. GE sequence rephasing increases contrast of CSF (cerebrospinal fluid).

Contiguous slices:

Since AIRIS™ uses digital RF pulsing, it is possible to slice a region without any inter-slice cross-talk. With this technique, inter-slice gaps can be set for contiguous slices without any incorrect covering of a region or with a wider covering.

3D FT measurement:

Because of the large-capacity memory incorporated in AIRIS™, a region which has some thickness can be measured by 3D FT in an ideal gapless manner without interference from continuous slices. The availability of thin slice images with high signal-to-noise (S/N) ratio can widen the clinical applicability of MRI to include cranial nerves.



2D FT multi-slice 3D FT multi-slice

Off-center FOV:

Thanks to the open design of AIRIS™, the table and patient can be moved laterally to position the region of interest in the center of the magnetic field. AIRIS™ also allows you to move the FOV off the center of the magnet for greater positioning flexibility.

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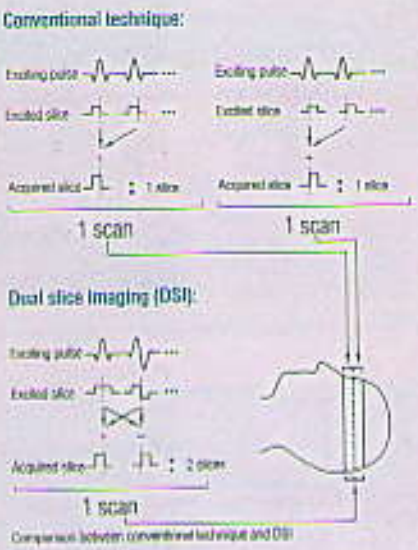
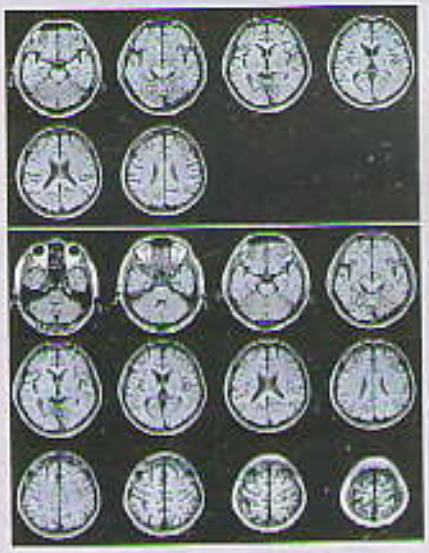
DSI (dual slice imaging):

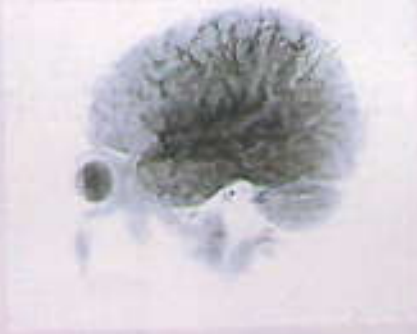
This technique doubles the number of slices acquired in a T1-weighted protocol. Two slices are excited simultaneous, thus doubling the anatomical coverage without loss of resolution.





SARGE (steady-state acquisition with rewound gradient echo)**

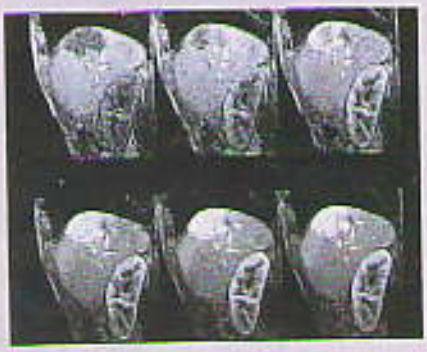
This technique provides high quality T2-weighted images in a short time and with high SNR.



Dynamic scanning:

With this function, physiological processes may be imaged dynamically rather than with a series of static images. The dynamic scanning software package on the AIRIS™ can generate uptake curves based on a protracted series of post contrast images.

Because of the open design of AIRIS™, contrast medium may be administered without removing the patient from the magnet. Scan start and stop may be initiated from the control panel located on either side of the magnet.



Breath Hold scanning:

Rapid scanning is required to reduce the effects of patient motion. In AIRIS™, short TR and FA (flip angle) can be selected to visualize the abdomen while the patient is holding their breath.

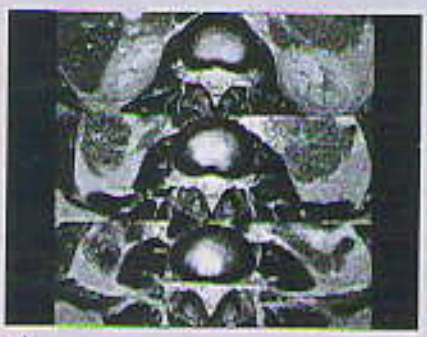
Image Display and Processing.

Multi-angle / Multi-slice imaging:

Images can be obtained at arbitrary inter-slice gaps and slice angles in one imaging sequence. This function is particularly effective for imaging a curved section of anatomy such as the spine.

Aliasing artifact elimination:

To eliminate aliasing caused when a region under examination is larger than the FOV, an appropriate number of encoding steps is automatically set. Depending upon a desired resolution and scan time, this function can be performed in any of the following three modes:



TIME: Scan is done for the same time as programmed protocol.
RES: Scan is done with the same resolution as programmed protocol.
RAEM: When the number of signal averaging steps is even, the area from which the data is to be acquired is automatically doubled and the number of averaging steps is reduced in half. In this mode, the scan time and resolution are the same as the programmed protocol.

Realtime MPR (multiplanar reconstruction):

Volumetric MR image data sets can be viewed in realtime, from any orientation independent of the original acquisition orientation. This technique includes:

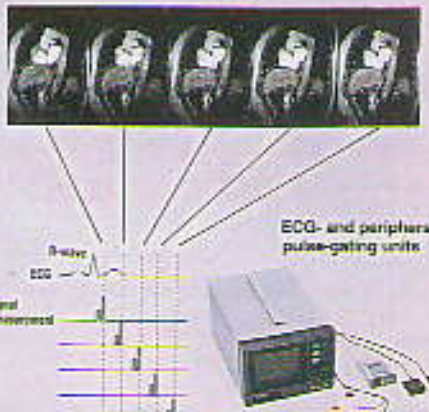
- **Non-oblique MPR**
  Non-oblique MPR for arbitrary position
- **Single-oblique MPR**
  Single-oblique MPR for arbitrary angle
- **Curved MPR**
  MPR for arbitrary curved plane
- **Radial MPR**
- **Multi-slice MPR**

ECG- and peripheral pulse-gating:

Used to freeze motion blurring caused by the beating heart and to view the heart specifically during each cardiac phase.

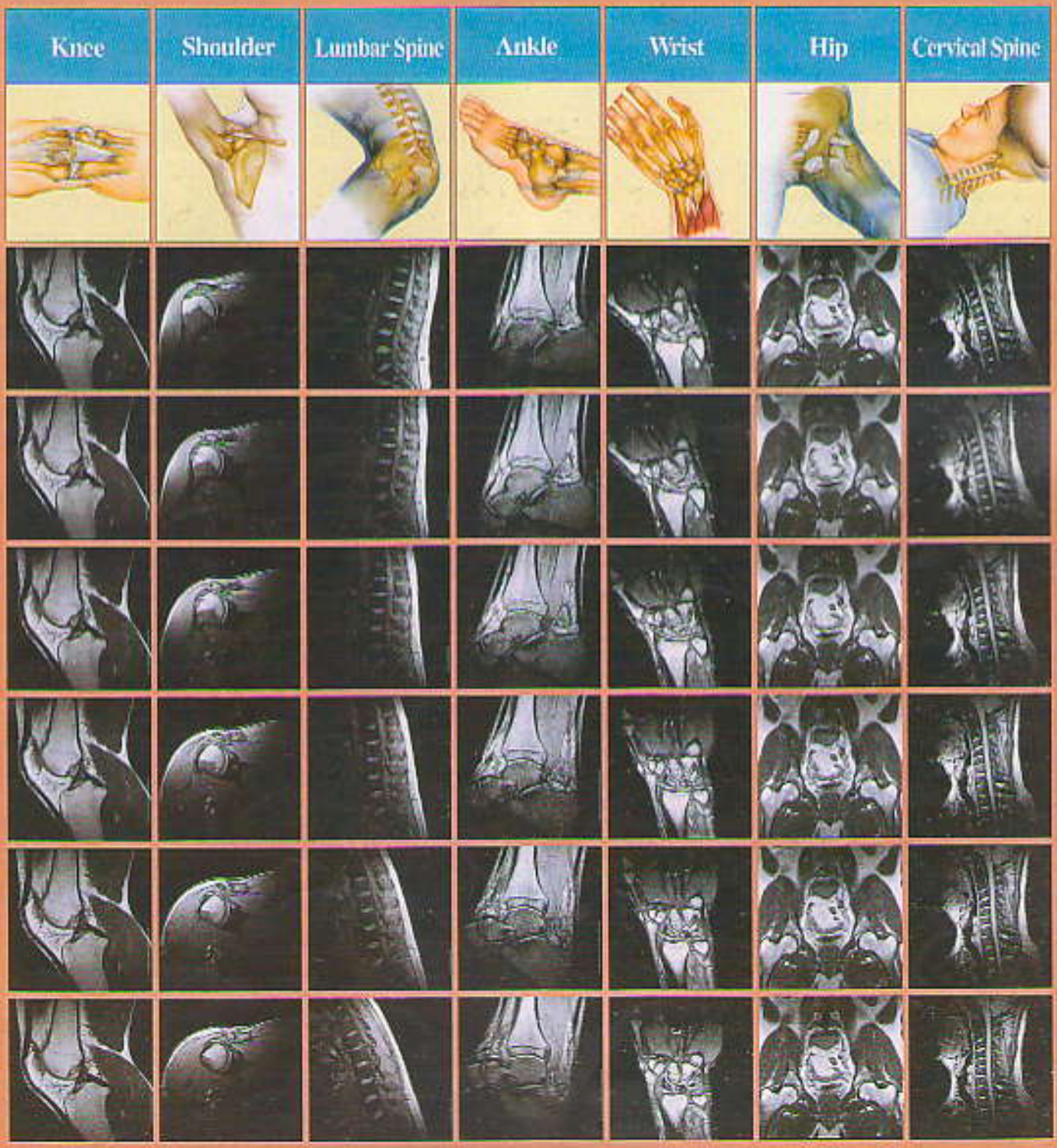
Moving images can be viewed in cine mode on the monitor screen.

Motion of the myocardium, etc. can be visualized with an SE sequence, while blood flow and valvular regurgitation in the heart, turbulent flow in aneurysms, etc. can be imaged with a GR (gradient echo with rephasing) sequence. A VTR interface is provided for recording to video tape.



Joint Motion Alternative™.

The wide-open design of the gantry makes AIRIS™ ideally suited for acquiring dynamic images of joints. By combining rapid imaging with high resolution and superb musculoskeletal contrast, AIRIS™ is able to capture information associated with the actual motion of joints. Joint motion procedures have been developed for a wide variety of applications including:



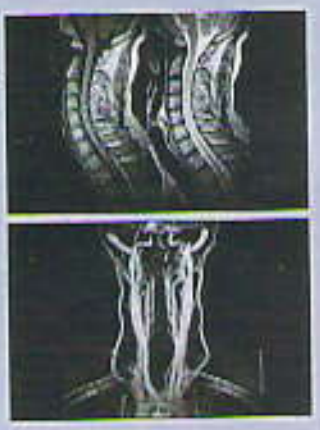
Coils for all regions

Head QD coil:

The high sensitivity QD solenoid head coil is made in two parts for easy removal.

Joint coil:

The compact shape is comfortable for the patient and suitable for many applications.



Flexible body QD coil:

QD solenoid design for high sensitivity.

Flexible body coil:

The coil length is adjustable to closely fit various shapes and regions.

TMJ (temporomandibular joint) coil (option):

The ability of MRI to image bone and soft tissues makes it the preferred diagnostic modality for examining TMJ. Hitachi has developed a specialized coil to optimize image quality for unilateral or simultaneous bilateral examinations.

Small joint coil (option):

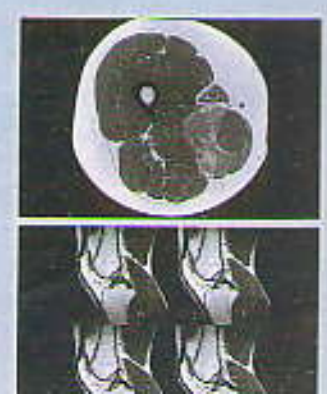
Used for imaging small joints such as the wrist, knee, and ankle.

Large joint coil (option):

Other coils

In addition, a knee QD coil is available as an option.

The full range of high sensitivity coils extends the diagnostic applications of AIRIS™.



Easy Operation

AIRIS™ employs Hitachi's advanced multi-processor system for multi-job/multi-task operations. This high-performance computer system performs image processing and MOD retrieval promptly, easily and accurately. Fast image reconstruction improves patient throughput and efficiency of diagnosis. The computer architecture is designed to accommodate future upgrades.

High speed image reconstruction and image processing:

At the heart of AIRIS™ is an array of 32 bit processors and LSIs which have been developed exclusively for optimized image and multi-task processing.

Large capacity memory:

The large 160 MB memory enables high speed processing and display for memory intensive applications like multi-slice and 3D image reconstruction.

Large capacity file:

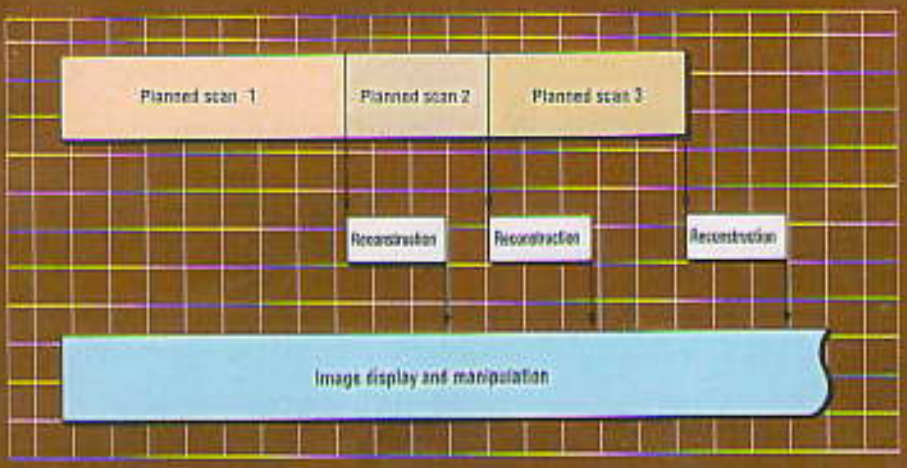
The 1.1 GB hard disk drive can store up to 6000 images at 256 x 256 matrix. Also included is a 600MB removable magneto-optical disk drive for storing up to 4400 256 x 256 images per disk.

Automatic coil identification

AIRIS™ automatically detects and notifies the operator of the coil in use.

Multi-job/multi-task:

AIRIS® incorporates Hitachi's unique multi-bus architecture for fast data transfer and simultaneous multi-function operation. This greatly improves operating efficiency and system up-time reliability.

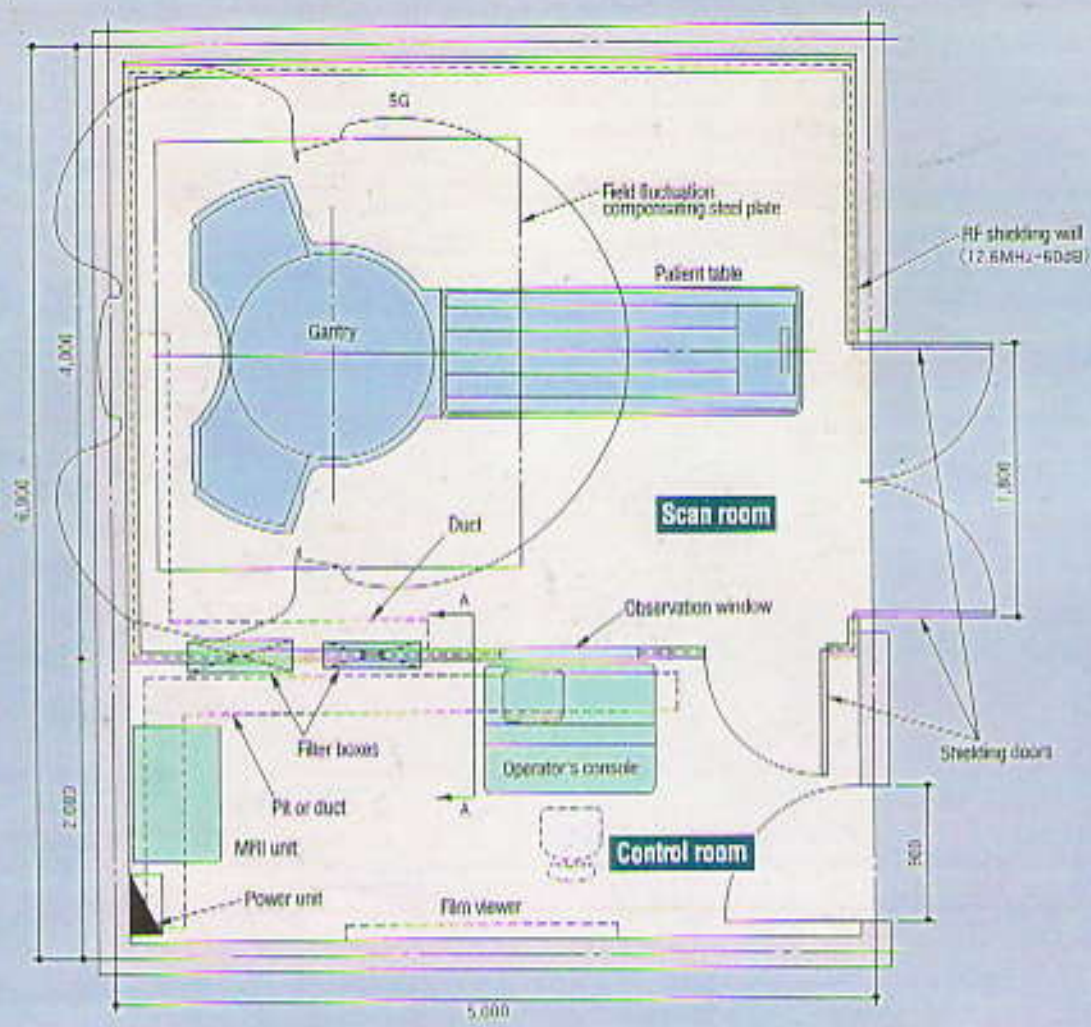


Direct scan start:

Acquisition start and termination the control panels located on an

Easy Siting Simplifies AIRIS™ Installat

Example layout (1/50 in mm):



The Superior Economics of AIRIS™.

AIRIS™ uses the world's strongest permanent magnet. To maintain stability of the magnetic field the magnet is heated to a constant temperature, which is slightly above the ambient temperature of the scan room.

The total power costs for AIRIS™ is extremely low. Also, the other operating costs, which are associated with conventional MRI systems (resistive and superconductive), are eliminated; no cooling water; no electric power (to the magnet); no cryogens.

And because of the high reliability of AIRIS™, maintenance cost are lower as well.

ion.

Facilities:

● RF shielding
The scan room must be RF shielded to 60 dB in a field of 12.5 ± 0.5 MHz in central frequency.

● Air-conditioning
Air conditioning is required to maintain the ambient room temperature and humidity within the recommended operating range. (see Environment conditions below)

Power requirements:

Single-phase 200 V AC, 8 kVA (for MRI system)

Grounding:

100 Ω or less is grounding resistance for MRI system only

Installation spaces:

● Scan room
(where the gantry and patient table are installed)
Standard required floor space: 20 m² (4 m x 5 m)
Ceiling height: 2.2 m or more
Required floor strength: 3.0 t/m² ≦ (2.5 x 3.0 m)

● Control room
(where the MRI unit, operator's console, laser multiformat camera, air conditioner and other components are installed)
Standard required floor space: 10 m² ≦ (4 m x 2.5 m)

Environmental conditions:

● Ambient temperature
(a) Scan room ··· 20 to 28°C
(within ± 3°C/h in temperature fluctuation)

(b) Control room ··· 20 to 28°C

● Relative humidity ··· 45 to 80%

Specifications:

● Magnetic field:
Static field strength ····· 0.3 Tesla
H resonant frequency ····· 12.7 MHz

● Imaging:
Imaging method ····· 2D FT and 3D FT
Imaging parameters and operations ····· Protocol-programmed
Imaging coverage ····· Whole body
Field of view ····· 120,150 to 350(320)mm in diameter
Pulse sequences ····· (a) Spinecho (SE)
(b) Inversion recovery (IR)
(c) Gradient echo (GE)
(d) T1 and T2 weighting
Slice thickness ··· 1 to 50 mm (2D FT and 3D FT)
(a) Transaxial
(b) Sagittal
(c) Coronal
(d) Oblique
(e) Multi-angle
Multi-slice ····· 64 slices max.
(128 slices max for 3D FT)
Multi-echo ····· Up to 4th echo
Multi-slice/multi-echo ··· 128 slices/scan max.

● Measurement and reconstruction:
Automatic imaging function ·····
Frequency locking, automatic tuning; automatic gain control

Imaging matrix ····· (128 to 256) x 256
(64 to 256) x 256
Rectangular field of view
Scan to display time ··· 2 sec or less (for 256 x 256)
Display matrix ····· 512 x 512

● Image manipulation:
Measurement of distance between 2 points; image profiling; ROI setting; histogram; cine display; others
Realtime MPR

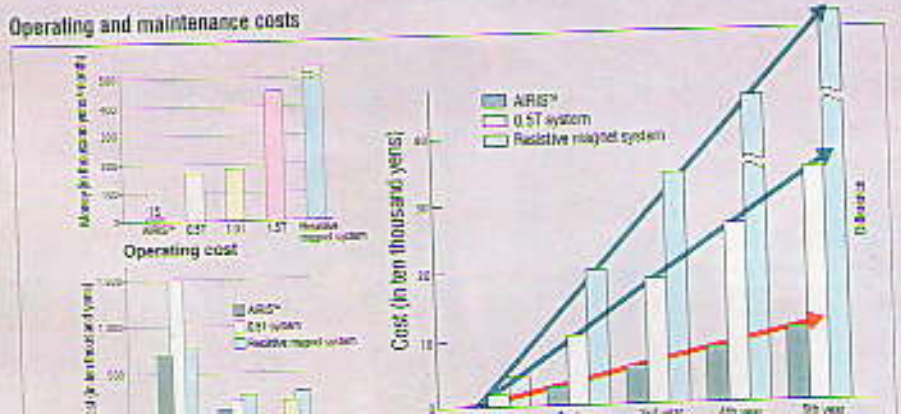
System configuration:

● Standard configuration
Gantry ····· 1
Patient table ····· 1
Operator's console ····· 1
MRI unit ····· 1
ECG-/peripheral pulse-gating unit ····· 1
Filter box ····· 1
Standard set of accessories ····· 1
Receiver coils, including ····· 1
(Head QD coil, flexible QD body coil, flexible body coil and joint coil)

Options:

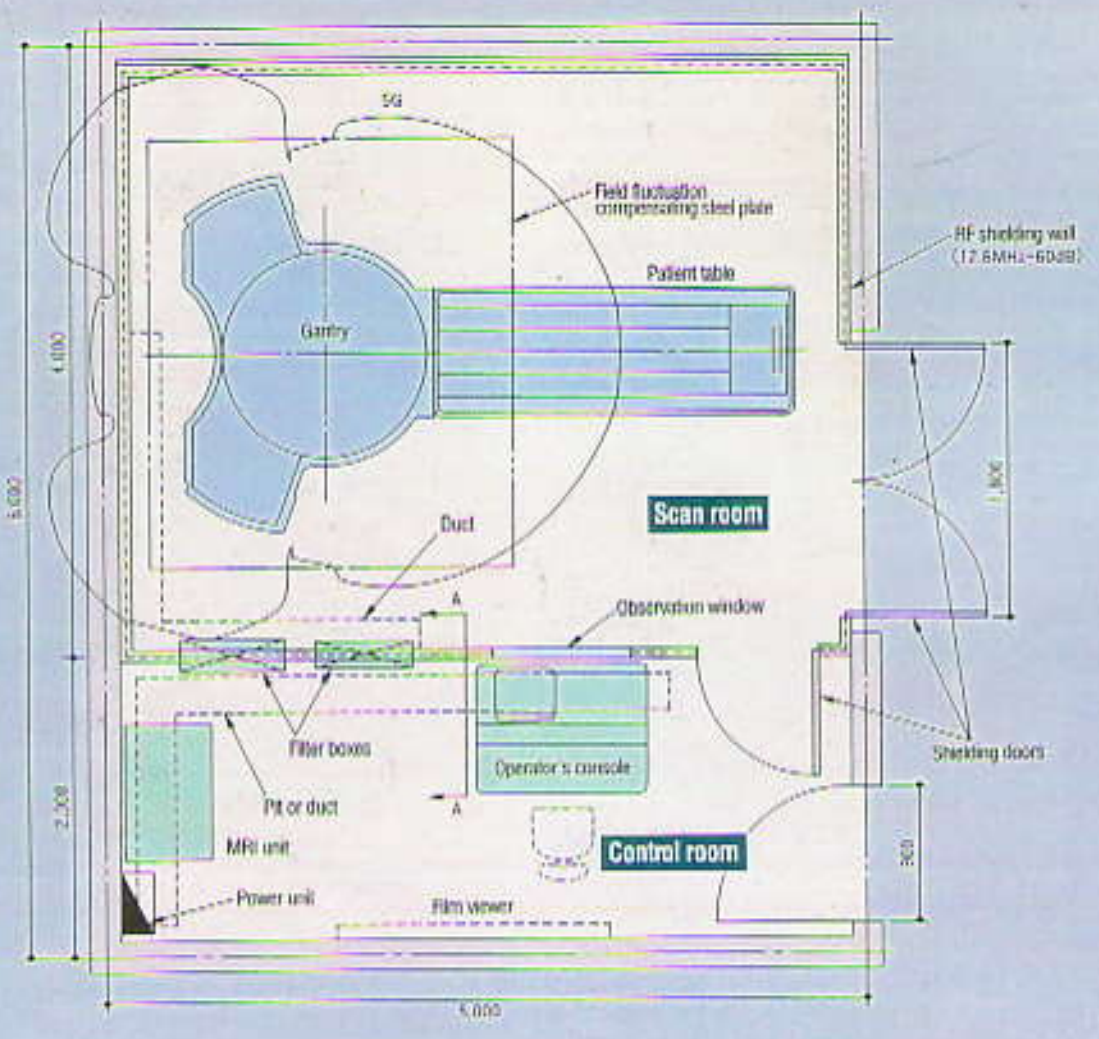
- Multiformat camera (laser type)
- Knee QD coil
- TMJ coil
- Small joint coil
- Large joint coil
- Diagnostic console
- Fast scan package (FSE and DSI)
- MRA and display

Operating and maintenance costs



Easy Siting Simplifies AIRIS™ Installat

Example layout (1/50 in mm):



The Superior Economics of AIRIS™.

AIRIS™ uses the world's strongest permanent magnet. To maintain stability of the magnetic field the magnet is heated to a constant temperature, which is slightly above the ambient temperature of the scan room.

The total power costs for AIRIS™ is extremely low. Also, the other operating costs, which are associated with conventional MRI systems (resistive and superconductive), are eliminated; no cooling water, no electric power (to the magnet), no cryogens.

And because of the high reliability of AIRIS™, maintenance cost are lower as well.

JQA-0449
ISO 9001

AIRIS™

MAGNETIC RESONANCE IMAGING SYSTEM

- Specifications and appearance subject to change without prior notice.
- For correct use of the equipment, be sure to read the Instruction Manual.

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