GE Healthcare

MR Field Notes

Vol. 1, No. 2 Spring 2005

Contents

RF Coils ... They've Come a Long, Long Way

From single loop, to quadrature pair, to phased array, radio frequency (RF) imaging coils have grown in variety and technology, while applications for them have proliferated. The latest breakthrough: coils dedicated exclusively for high density imaging. These coils target specific anatomy and make it possible to achieve the highest possible signal-to-noise ratio (SNR). Will the increase in coil choices ever cease? Not as long as technology keeps improving.

Having a variety of imaging coils on site makes it possible for you to handle a wide range of imaging situations. Making the correct coil selection for a given exam plays a critical role in determining the quality of MR images you acquire. Your job is to find the right coil for the specific application you're performing.

A coil's geometry always plays an important part in optimizing your results. It must be large enough to fit around the patient comfortably and obtain a satisfactory field-of-view (FOV). Yet the larger a coil is, the less sensitive it will be as a receiver, hence SNR may be lower. The closer a coil's position to the area of interest, the stronger the signal will be, therefore, the SNR will be higher.

Optimal coil designs differ depending on the body part being imaged. Let's look at some basic differences in coil design and technology.

Receive-Only vs. Transmit/Receive

Imaging coils receive and/or transmit the RF signal. Receive-only coil designs only receive the MR signal, using the body coil as a transmitter. These designs come in a variety of shapes, configurations, and sizes. They include surface and phased array coils. Receive-only coils are effective because, with a relatively simple design, are used, together with the (transmit) body coil, to provide uniform excitation over the entire volume of interest. The downfall of this approach is a higher whole-body SAR, leading to fewer slices and susceptibility to artifacts due to signal from excited tissue outside the volume of interest.

Transmit/receive coils transmit RF then change to a receive mode to receive the MR signal. This kind of coil reduces whole body SAR, allowing acquisition of more slices and significantly reducing artifacts due to tissue outside the volume of interest. The coil design is more complex, however, and yields reduced B_1 field uniformity over the volume of interest.

Surface Coils

A surface coil is a receiver coil with a definite area of sensitivity from which it receives signal. Outside this area it receives minimal signal. This configuration improves SNR because the signal, received from a smaller, specific area, competes with less noise than it would with a larger coil, such as the body coil.

The sensitivity area relates to the diameter of the coil. By Increasing coil size, the area of sensitivity also increases. But as with most MR princi-

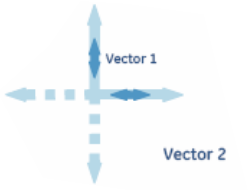
RF Coils Have Come a Long Way (continued from

ples, you pay for gain. Not only is the amount of MR signal increased, but the amount of noise the area receives increases as well. Coil engineers must strike a balance between the size of the coil area and increased SNR. One advantage of surface coils is their optimum sensitivity for tissue close to the coil. Image intensity fades, however, as distance between the coil and the ROI increases.

Signal Detection with Surface Coils

The spins produce a net field vector that rotates in a plane around the magnet's Z-axis. Since the vector rotates, the signal is described as "circularly polarized".

The net field vector can be resolved into two orthogonal (right angle) oscillating vectors. These can be oriented in any direction in a plane orthogonal to the magnet's Z-axis as long as the two vectors remain orthogonal. When one vector is maximum, the other is minimum.



Linear Coils

Linear coils are receive-only devices sensitive to only one oscillating vector. As the rotating vector aligns with the coil, the signal peaks. When the magnetization vector unaligns with the coil, the signal is at its weakest. A coil operating in this way is said to be "linearly polarized".

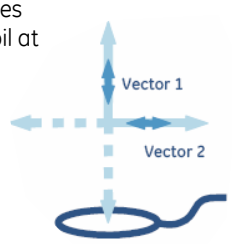
Linear coils are now found mostly as components in phased array units such as CTL spine coils

Quadrature Coils

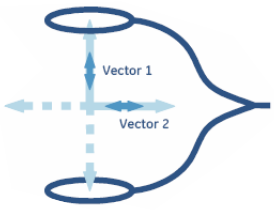
Quadrature coils employ two pairs of coils arranged about the signal source to further improve performance. This configuration presents a dilemma because it delivers signals from two vectors of opposite phase to manage.

Signal Detection with Linear Coils

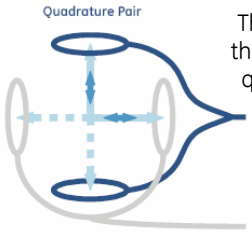
As Vector 1 becomes aligned with the coil at 360° and 180°, the signal is strong. When vector orientation changes to the 90°/270° axis, signal from Vector 2 is lost.



Two opposed linear coils can be connected together for more uniform coverage of the volume, but they are still only sensitive to one oscillating vector.

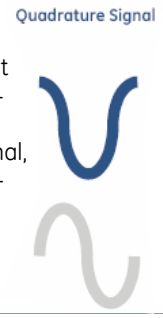


Signal Detection with Quadrature Coils



The illustration on the left shows the quadrature pair with the two signals not in phase.

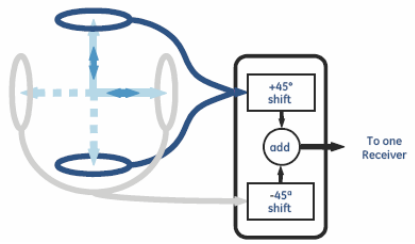
The illustration on the right shows the quadrature signal. Note that when one vector is at maximum signal, the other vector is at minimum signal.



The simplest way around this uses a special quadrature combiner, which combines the signals while taking the phase difference between them into consideration. A coil operating in this way is "circularly polarized".

SNR can be improved with quadrature coils by as much as 40% for volume designs. Since these coils require only one receiver, this technology is simple and relatively inexpensive. Quadrature coils are also less sensitive to artifacts when they are tilted to accommodate the patient. Sensitivity of orthogonal elements must be uniform over the volume of interest, however, or the SNR benefit is reduced and uniformity may suffer. Volume coils, such as the 1-channel transmit/receive head coil, are well suited for quadrature operation.

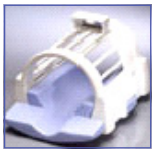
Quadrature Combiner



A quadrature combiner allows two quadrature channel signals to be received by one receiver.

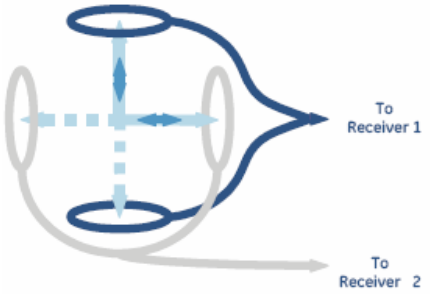
Phased Array Coils

A better solution for quadrature signal reception connects each of the quadrature channels to a separate receiver. Called a quadrature phased array design, this arrangement, though not circularly polarized has the same sensitivity as one that is.



Another way to create a quadrature element pair adds an additional "figure eight" or "butterfly" element, sensitive only to the horizontal component of the field. This arrangement can be found in flat coils such as those used to image the spine.

Signal Detection with Phased Array Coils



With Phased Array Coils, each quadrature channel is connected to a separate receiver channel.

Continued on page 3

RF Coils Have Come a Long Way (continued from page 2)

The design choice producing the best image quality brings the signal from each element in the quadrature pair out to a separate receiver. When the number of receivers is limited, combining two quadrature elements into a single signal routed to one receiver provides an acceptable trade-off.

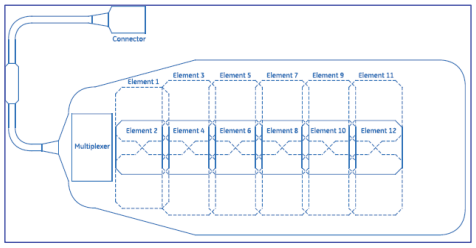
Signal Detection with Phased Array Coils

Left illustration shows a linear coil only sensitive to the vertical component of the field. The illustration on the right shows an addition of a butterfly element, providing sensitivity only to the horizontal component

Twelve Quadrature Elements to 8 Receivers

The EXCITE HD 8-channel CTL spine array coil features twelve elements leading to 8 receivers. Receiver switching is accomplished within the coil interface multiplexer.

Phased array technology takes advantage of multi-channel imaging, which produces increased SNR over linear and quadrature coils. A phased array coil achieves the sensitivity of a small surface coil over a larger FOV. The development of phased array coils has improved MR image quality and expanded applications for MR imaging.



Are more channels always better?

More channels equal better imaging, right? That depends. As the number of channels increases, the elements become smaller and penetration may be compromised. Additionally, SNR may increase near the surface of the coil, but not deep within the patient. Such factors will need to be considered as coils with more and more channels are designed. On the other hand, reducing coil diameter and adding elements can deliver a dramatic increase in SNR, the 8-channel brain phased array coil is one example of this. More elements also allow for the design of coils optimized for ASSET imaging and can enhance the ASSET reduction factor. Furthermore, coil utility can be improved with the addition of elements without sacrificing SNR. For example, in imaging the peripheral vasculature or the spine, regions of interest can be more precisely defined to suit a patient's size and the anatomy being imaged.

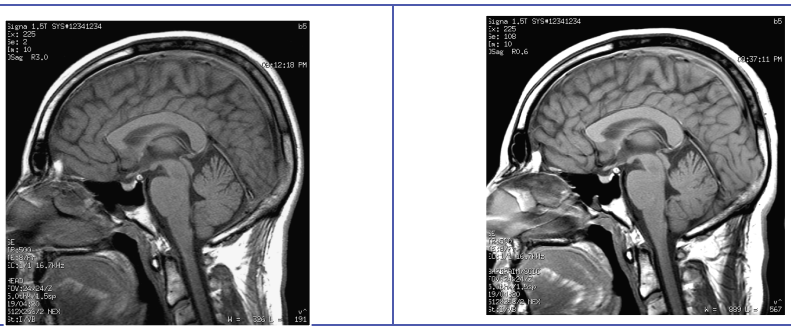
Clinical Impact of 8-Channel Coils

Eight-channel surface coils can help you improve productivity, a crucial consideration in today's competitive scanning environments. These devices can be optimized for parallel imaging techniques, improved SNR, and can provide better image resolution. Parallel imaging techniques, like ASSET, reduce scan times, which can decrease patient exam times. Reduced coil diameter together with the 8-channel phased array elements over a given volume increase SNR and thereby resolution.

How does this impact your routine imaging? Let's compare the 1-channel transmit/receive Head coil and the EXCITE 8-channel High Resolution Brain coil.

1-Channel Transmit/Receive Head Coil
28 cm diameter
38 cm S/I coverage
Brain, Neck, and TMJ

8-Channel High Resolution Brain Coil
24 cm diameter— increases SNR
30 cm S/I coverage – increases SNR
Brain and TMJ
ASSET x2 optimized – reduces scan time



Routine T1-Weighted Imaging SNR Comparison

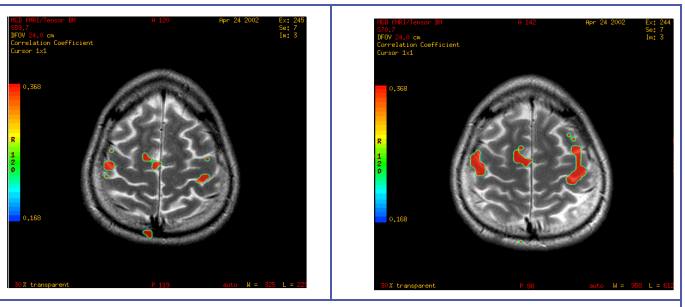
The image on the left was acquired with the 1-channel transmit/receive head coil and the right image was acquired with the 8-channel high resolution brain coil. Note the higher SNR on the image acquired with the 8-channel coil.

The 8-channel brain coil's decreased diameter provides increased SNR. The coil is intended only for brain imaging, and you can use it with ASSET to help optimize your scan time.

Using National Electric Manufacturers Association (NEMA) methodology, SNR measurements over different diameters of acquired images with both coils were recorded. At 10 cm, a 40 to 45% SNR increase of the 8-channel brain coil versus the 1-channel head coil was measured. At 20 cm, that percentage rose to 80 to 85%. On average, the 8-channel brain coil has 40% more SNR than the 1-channel head coil, which delivers higher image quality for an improved diagnosis.

Continued on page 4

At the edge of an image, comparisons of NEMA SNR measurements showed that the 8-channel brain coil has 90 to 95% more SNR. This is useful for applications such as fMRI for motor or visual strip mapping.



fMRI Imaging SNR Comparison
The fMRI images above were acquired with the finger-tapping motor paradigm. The EXCITE 8-channel coil image (right) shows a noticeable increase in SNR over the 1-channel head coil image (left), resulting in a more comprehensive demonstration of neuronal activation.

The new 8-channel coils for 1.5T include a breast and knee coil as well as a 16-channel, 32 element, lower leg array. These new coils expand GE's current offering, which include a brain coil, neurovascular coil, 8-channel torso array, cardiac, and a CTL spine array. 3.0T users can also take advantage of 8-channel coils with the 3.0T brain, neurovascular, and cardiac coils.

Coil Selection Tips
GE offers a wide variety of coils from which to select for the variety of imaging exams you may encounter. As long as you take the time to use your expertise and your imagination, you'll find a coil for every imaging application. During your coil selection, remember these basic rules of thumb:

- Match the coil to the anatomy or area you're going to image – this will let you optimize the SNR for the desired scan time.
- Match the FOV to the size of the coil or number of coil elements selected
  >If the receiver coil is larger than the FOV, signal from tissue outside the FOV can be aliased into the FOV. Workaround – use No Phase Wrap to oversample in the phase direction. Although this removes the aliased signal, the overall SNR will not improve.
  >Smaller coils reduce the area of coverage, yet increase the inherent SNR of images and therefore fewer signal averages are needed.
  >Individual patient anatomy may sometimes make it difficult to use the appropriate coil. It may be necessary to use an alternative coil (such as a Flexcoil) to get the best image possible. While image quality may suffer, the alternative is no image at all.
  >Always read the manual for the particular coil configuration you're using. And always be aware of and follow safe MR scanning procedures. Ω

Coil-induced Artifacts

It is important for you to recognize, understand, and manipulate the coil to reduce or avoid coil-induced artifacts that may appear in your images. The improper use of coils ... wrong coil configuration, improper patient positioning, poor FOV selection ... is a major cause of image artifacts. Appropriate coil selection along with an awareness of how these artifacts happen can help you eliminate them.

Shading
Shading artifacts, displaying as areas of reduced signal intensity or bands of signal cancellation, often result from improper coil or patient positioning. These artifacts can be easily corrected by repositioning the coil and/or the patient so that the coil receives signal that best represents the patient. The anatomy of interest should be placed in the center of the magnetic field, within the center of the coil, and within the group of sections to be acquired.

Axial abdomen image with bands of signal cancellation (shading) due to incorrect patient positioning.

Inhomogeneous bright spots or a drop in coil signal on the image can also be prevented by making sure the patient does not come in direct contact with the coil. If the patient is likely to come in contact with the coil, it is recommended that you place a pad or folded sheet between the patient and the coil.

Tips for coil positioning:

- Choose the coil most appropriate for the corresponding anatomy of interest and required FOV.
- Landmark on the coil marker, not on the patient's anatomy. The landmark line(s) on the coil indicate the center of the coil or each coil configuration. Imaging coils will function most accurately when placed at the magnet's isocenter.
- If the coil has multiple configurations, select the appropriate number of elements according to the area that needs to be covered.
- If the coil has multiple configurations, center the coil elements corresponding to the coil configuration chosen over the region of interest.

Continued on page 5

Coil-induced Artifacts (continued from page 4)

- Select a coil configuration and FOV based on the number of elements chosen.
- Consult individual coil manuals for FOV coverage and be conscious of the coil's limitations when selecting FOV.

Non-Uniformity of Signal

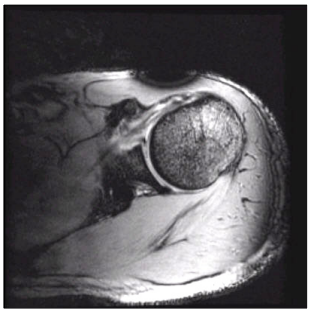
The RF receiver detects signals closest to it most efficiently. This characteristic may cause a non-uniformity of signal in the image. The effect is more pronounced with surface coils than with volume coils, appearing as localized bright areas close to the coil. Signal variability may also result in incomplete fat suppression when chemical fat suppression techniques are used. To minimize the chance of this happening, try a different coil or use a STIR sequence rather than trying additional fat saturation techniques.

Coil intensity correction techniques can also be applied to correct the non-uniformities in signal. Phased array UnifoRmity Enhancement (PURE) and Surface Coil Intensity Correction (SCIC) are two techniques designed to minimize surface coil intensity variations. PURE or SCIC can be used with compatible surface coils. PURE can also be used with the 8-channel transmit/receive high resolution knee coil by MRI Devices.

	***Uncorrected***
	***Corrected with SCIC***
	***Corrected with PURE***

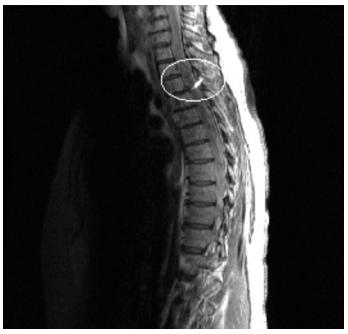
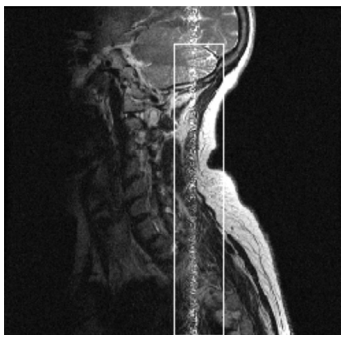
RF Inhomogeneity

Failure of an RF coil can cause intensity variation across an image. This often indicates the failure of a coil element or the presence of ferromagnetic material in the imaged object. Check with the patient to make sure that nothing on them or in them is causing the artifact. If you suspect a faulty coil element, check each element using manual prescan. If you isolate a faulty element discontinue using the coil and consult with your service engineer.

	
Defective Coil Element Note the loss of signal intensity in the lower right corner of the axial abdominal image due to a failure in a coil element.	**Metal on Patient** Axial shoulder image displaying a drop in signal intensity caused by a ferromagnetic object on the patient.

Peripheral Signal Artifacts

Peripheral signal artifacts appear as either bright spots or as ribbons of signal smeared through the image. We sometimes refer to these artifacts as Star Artifacts (bright spot) or Annefacts (ribbon). Basically, both have the same root cause: Signals are generated outside the desired FOV and the receiver is able to detect them.

	FSE sagittal thoracic spine image presenting a **Star artifact**. The image was acquired with CTLMID, 38 cm FOV, and the phase and frequency swapped. The artifact could have been prevented by not swapping phase and frequency and using a 3-coil selection, such as USCTS234 so the surface coil coverage would closer match the scan FOV.
	FSE sagittal cervical spine with **annefact**. The image was acquired with CTLOP, 24 cm FOV, and the phase and frequency swapped. The artifact could have been prevented by not swapping phase and frequency and using a 2-coil selection, such as CS12 so the surface coil coverage would closer match the scan FOV.

Continued on page 6

Coil-induced Artifacts (continued from page 5)

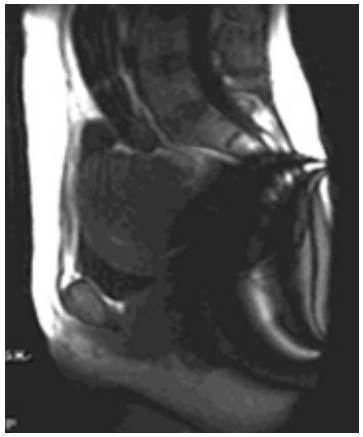
Star artifact signals, which appear as a bright star close to the middle of the image, originate very far from isocenter. In that non-linear region, the free induction decay (FID) signal coming off the RF 180 pulse or from a SAT pulse is not crushed out and aliases back into the image.

Annefact appears in Fast Spin Echo (FSE) scans as smeared, bright, ghosting signals through the image in the phase direction. It typically appears on sagittal spines or pelvis scans using a phased array surface coil. Like a Star artifact, its origin is far from isocenter, where the gradients are non-linear. Uncompensated eddy currents in this area cause phase errors in the compressed signal and smear it through the image.

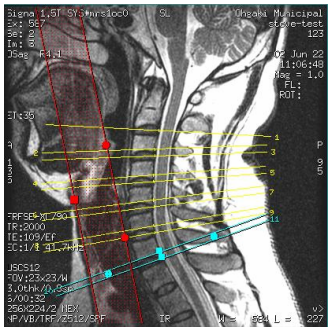
By selecting the receive coils that match the imaging FOV (i.e., LS45, LS56, CS12, etc.), you can lessen the likelihood of picking up the peripheral signals that are generated outside the FOV.

Coil Malfunctions

Coil decoupling mechanisms are circuits activated by diodes to prevent radio-frequency currents from flowing in the receive-only coil during transmission from the body coil. This results in local distortion of the transmit field and signal intensity variations within the image (right). If you suspect a coil malfunction, consult your service engineer and discontinue use of the coil.



Zipper Artifact with Zoom Mode on TwinSpeed Systems



The left image displays the axial c-spine prescription with an angled anterior SAT pulse. The 3-coil CTL (CS123) was used in the Zoom mode to acquire the right axial image showing the zipper artifact. This was caused by signal being received from tissue excited by the anterior saturation pulse outside the FOV that wrapped into the imaging volume in the phase direction. This artifact could be eliminated by switching to Whole mode or by using the 2-coil CTL (CS12).

If you operate a Twin*Speed* system, you should be aware of a zipper artifact that can occur while using Zoom mode. Most of these artifacts are caused by the ineffective dephasing of the magnetization outside the effective length of the gradient coil. Although the prescribed FOV and its orientation are well controlled in the Zoom mode, the spatial saturation (particularly in the A, P, R, and L directions) cannot be controlled and may cause zipper artifacts. Other saturation techniques such as fat saturation and magnetization transfer (MT) can also produce this type of artifact. By selecting the correct receive coil and/or placing the spatial saturation band carefully, you can eliminate or minimize the zipper artifact. Ω

Raise Your Coil Consciousness

RF energy from scanning can cause localized warming at contact points between the patient/bore and patient/RF coil, causing discomfort, tingling sensations, or skin irritations similar to sunburn. RF can heat non-compatible surface coils, damaged surface coils, surface coils that are not properly plugged in, and improperly routed coils, which can result in patient heating. If you are operating a scanner and your patient tells you he or she is experiencing a burning sensation, stop the scan.

People are always talking about not closing the loop on quality, but when it comes to MR safety, there are loops you will want to keep open to prevent patient discomfort. To help prevent a patient burn from closed loops formed by clasped hands, hands touching the body, from thighs touching, or from the patient's breasts contacting the chest wall over a small area, insert non-conducting pads at least 0.25 inches thick between touching parts.

Patient positioning and coil awareness can affect the safety of the scan procedure. The following safety precautions should always be taken.

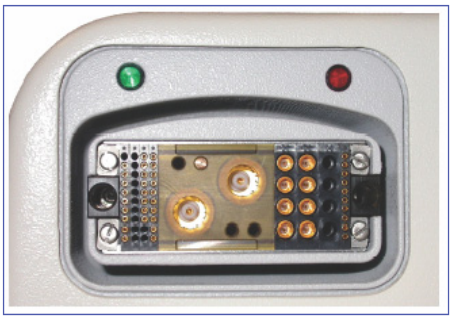
- Position the patient properly.
- Use the supplied coil pads with the coil at all times. The coil should never come into contact with the patient.
- Do not allow the patient to directly contact the surface of the bore; use non-conductive padding.
- Never let the coil's RF cables come into contact with the patient. Position cables under a cushion whenever possible.
- Do not loop or cross cables. Keep them straight, positioned down the center of the magnet, directly out the bore.
- Use only approved, undamaged RF coils.
- Inspect coils for damage and wear. Do not use a coil that is not functioning properly, e.g., tuning problems or intermittent poor quality images. Ω

Coil Reliability Improvements

With the introduction of Signa EXCITE HD, several improvements in coil reliability have been made. These additions include Coil Identification (ID), Automatic Identification, and changes to surface coil connections.

ID Check

Coil ID confirms that the coil you have plugged into the system matches the coil selected in the scan prescription, also assuring that the coil is properly seated in the port.



Coil indicator lights next to each coil port let you know when your coil connection is secure. When a coil is connected to any of the three ports, both light-emitting diodes (LEDs) illuminate, then one will stay on.

- If the red light stays on, the coil is faulty or there is some other problem. Check the message area and follow the directions to correct the problem. Scanning is not allowed.
- If the green light stays on, the first level of Coil ID related checks have passed and further checks will be performed during scan prescription. Even though the green light is on, you may still be prevented from scanning. The correct coil must be selected from the Scan Rx Desktop in order to successfully begin scanning.

Automatic Identification

Automatic coil detection activates if the coil plugged in has a Coil ID chip. When a coil is automatically detected, it appears in the Coil Names window. You must still select the correct coil configuration before downloading the acquisition, except if a receive-only coil is plugged into either port. In this case you can scan with the Body coil.

Surface Coil Connections

Coils are plugged into the coil port carriage. Your system's carriage port will have one of two configurations, depending on if you have an 8- or 16-channel Signa EXCITE HD system or if you have a 4-channel or upgraded 8-channel Signa EXCITE HD system.

For Signa EXCITE 3.0T systems, use only Signa EXCITE 3.0T coils. These coils are labeled "3T". If you plug a 3.0T coil into a 1.5T system, you will not be able to scan.

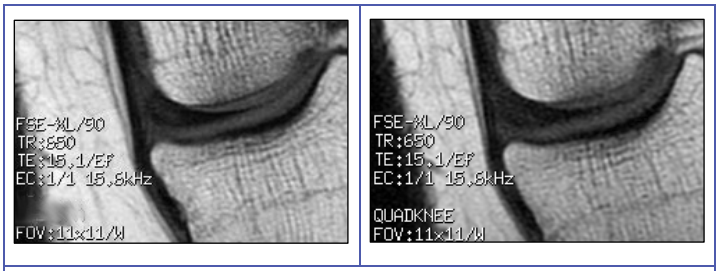
8- or 16-Channel EXCITE HD System (left) and 4-Channel or Upgraded 8-Channel EXCITE HD System (right)
The left port is for transmit/receive coils introduced in EXCITE HD or later. The left and right ports are for 8-channel receive-only coils. 16-channel coils must be plugged into both the left and right ports. All coils plugged into the outer ports must have a Coil ID chip installed. The middle port is a legacy port for 1.5T systems. The upper slot is for legacy transmit/receive coils and receive-only single channel surface coils. All coils plugged into the upper middle slot must have a Coil ID chip. The bottom slot is for phased array coils and may or may not have a Coil ID. A 3.0T system has only a single slot for the middle port that can be used for head or phased array coils with Coil ID chips installed. Ω

What's New?

The EXCITE HD architecture presents a real breakthrough for musculoskeletal MR imaging with the 1.5T EXCITE HD 8-Channel Knee Array coil. With its unmatched SNR, its ability to provide the most uniform fat saturation, and its ASSET and PURE compatibilities, this coil outperforms both the Quadrature Extremity and the 4-channel Phased Array Knee coils.

SNR

The Quadrature Extremity coil has limited SNR for applications such as cartilage osteoarthritis with T2 mapping (a work-in-progress) and ultra-high resolution of the cartilage structure. The 4-channel Phased Array Knee coil provides a slight improvement in SNR performance.



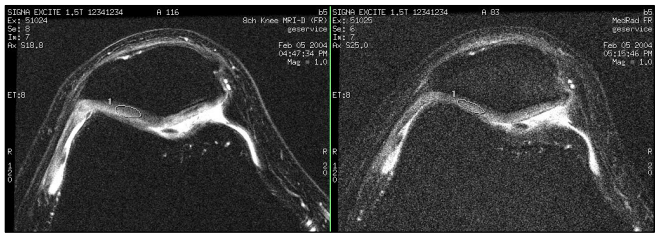
Phased Array Knee and Quadrature Extremity Coils - SNR Comparison
The image on the left was acquired with the 4-channel Phased Array Knee coil and the right image was acquired under the same conditions with the Quadrature Extremity coil. Note the improved SNR with the Phased Array Knee coil.

Continued on page 8

What's New? (continued from page 7)

The new EXCITE HD Knee coil delivers a significant SNR gain over existing 4-channel designs. Because of its 8-channel design, each RF element in this coil is smaller. While it gathers the same amount of signal, the smaller phased array elements significantly reduce the amount of noise collected. The EXCITE HD Knee coil provides up to 100% more SNR than the single channel Quadrature Extremity coil.

Some of the SNR improvement results from making the coil smaller, yet it still accommodates a large patient body habitus. The internal diameter of the coil tapers to the knee. The head end features a flared contour for the thigh, while the foot end has a flared contour for the calf. The coil is designed to fit 95% of the patient population.



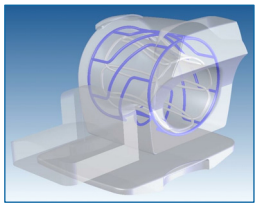
EXCITE HD Knee and Phased Array Knee Coils – SNR Comparison
The image on the left was acquired with the 8-channel EXCITE HD Knee coil and the right image was acquired under the same conditions with the 4-channel Phased Array Knee coil. Note the significant SNR increase with the EXCITE HD Knee coil.

SNR Improvements with the EXCITE HD Knee Array Coil
This sagittal FSE image was acquired with the EXCITE HD Knee Array coil in just 4 minutes. Imaging parameters include: 24 slices, 10 cm FOV, 3.5 slice thickness, and chemical fat saturation. The image was corrected with PURE.

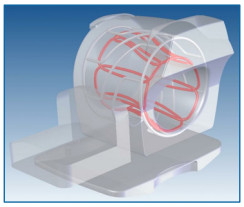
Hybrid Technology

The EXCITE HD Knee coil is a transmit/receive coil incorporating unique hybrid technology that allows eight phased array elements and a separate quadrature bird cage to function together in one coil. The bird cage coil is used for RF power transmission and for signal reception during prescan and PURE calibration sequences. The bird cage has a twisted design for a more uniform RF deposition within the excitation of the volume, thus providing signal uniformity across the whole imaging volume. The eight phased array elements, tapered to the knee anatomy for optimum SNR performance, receive the MR signals.

With the transmit/receive coil design and hybrid technology, you no longer have to worry about aliasing from the opposite leg as you would with conventional phased array receive-only knee coils. Just make your patient comfortable and concentrate on the leg you're scanning!



Quadrature Bird Cage
The bird cage component of the coil is used for RF transmission and signal reception for Auto-shim and PURE calibration.



Phased Array Elements
The eight phased array elements are used during data acquisition for signal reception.

PURE

The increasing number of smaller elements in phased array coils leads to more signal attenuation at depth and therefore more signal-to-noise variation across the imaging volume. The EXCITE HD Knee coil, with eight RF elements, has 32% more signal attenuation from the periphery to the center of a volume. To avoid seeing a hypersensitive signal around the knee, you must correct the images with PURE. PURE applies a correction based on the coil's sensitivity profile and does not change the SNR or contrast in the image.

Uncorrected Image
Sagittal T1-weighted image of the knee with no correction displays increased signal intensity at the periphery of the knee.

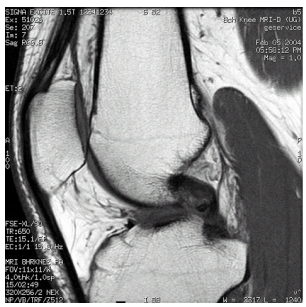


Image Corrected with PURE
Same sagittal T1-weighted image corrected with PURE. Note the decrease in signal variation across the image.

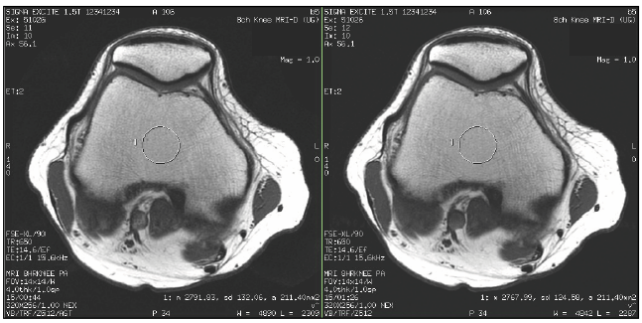
ASSET

The EXCITE HD Knee Array coil is optimized for ASSET imaging in the A/P and R/L directions. ASSET scans use the same calibration scan, collected with the bird cage coil, as PURE. ASSET may be applied to decrease scan time in examinations where short scan times are crucial ... with claustrophobic patients, for example.

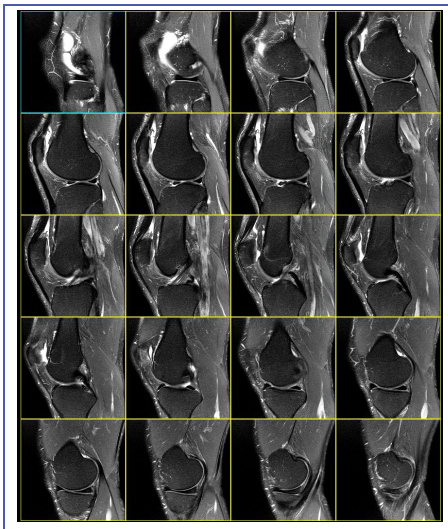
Chemical Fat Saturation

The EXCITE HD Knee Array's hybrid technology, which uses the bird cage coil to collect the autoshim data in the transmit/receive mode, means this coil provides unmatched chemical fat saturation. You'll see uniform signal within the field and uniform fat suppression across the entire imaging volume.

Continued on page 9



ASSET Image Comparison
The axial FSE knee image on the left was acquired with ASSET x2 in 44 seconds. The right axial FSE knee image was acquired under same conditions without ASSET in 1 minute, 26 seconds. Both images are uncorrected and display matching window widths and window levels as determined by the ROI.

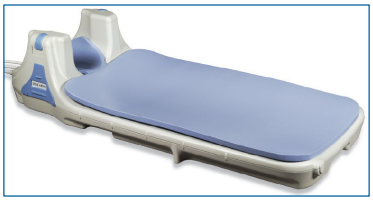


Chemical Fat Saturation
Fat suppression Improvements with the EXCITE HD Knee Array Coil Sagittal Fast Spin Echo images acquired with Fat SAT. Note homogeneous fat suppression across entire volume of images. These images were corrected with PURE calibration.

Protocol Adjustments
The higher SNR in the EXCITE HD Knee Array coil enables you to make changes in your protocol strategy. To take advantage of the additional SNR and increase spatial resolution, you may want to reduce the FOV somewhat and slightly increase the frequency matrix size and receive bandwidth.

For example, if you previously used the Quadrature Knee Coil by Medical Advances, you may adjust an FSE sequence in the following way. Instead of a 14 FOV, lower the FOV to 12. If the matrix was 256x256, raise the frequency matrix to 320. By not adjusting the phase matrix, you'll be able to keep the same scan time. And, since you have more signal, you can raise the receive bandwidth a little (from 16 to 21), while maintaining the same echo spacing. Try similar adjustments with your existing knee protocols to find a new protocol that meets your imaging needs with the 8-channel EXCITE HD Knee Array coil.

8-Channel CTL Spine Array Impacts 3.0T Users
The new EXCITE HD 8-Channel CTL Spine Array coil sets a new standard for full spine clinical 3.0T imaging. Its quadrature phased array design includes 12 elements that provide excellent SNR and uniform coverage resulting in high-resolution images of the spine from the cervical through the lumbar spine.



The cervical region is designed for imaging the cervical spine and neck, and for neck MRA applications.
The coil covers extended regions of interest including the thoracic and lumbar anatomical areas. It accommodates the full range of patient sizes, including the taller patient population.

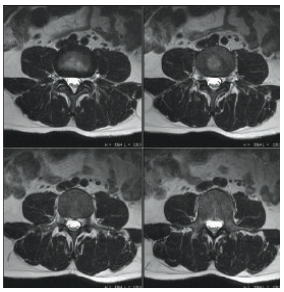
The use of SCIC is recommended with this coil to reduce surface coil intensity variations. Protocols for the 8-channel CTL Spine coil can be found in the GE Protocol Menu on your system. These protocols are routine clinical protocols developed in collaboration with clinical test sites.

Other New Coils

T1 FLAIR Sagittal Cervical Spine

T2 FRFSE Sagittal Thoracic Spine

T2 FSE Lumbar Spine

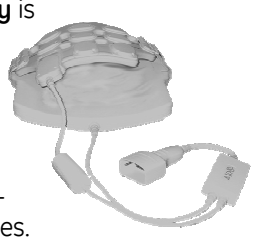


T2 FRFSE Lumbar Spine

Continued on page 10

In addition to the new 1.5T coils, HD Breast Array and HD Lower Leg Array, which were highlighted in the last issue of MR Field Notes, GE Healthcare has several new imaging coils designed for 3.0T systems.

The **3.0T HD Shoulder Array** coil is new technology for 3.0T EXCITE HD users, providing them with an additional orthopedic imaging application. The 3-channel Shoulder Array is a receive-only coil. The coil design enables you to obtain high resolution images of the shoulder and contiguous anatomy. The coil is optimized for ASSET applications in the R-L and A-P directions.



The **3.0T 8-Channel HD Cardiac Array** is a high-resolution coil used to image the cardiovascular system on GE Signa EXCITE HD 3.0T systems. It is capable of ASSET scans to reduce the required breath-hold time, which improves patient comfort and helps produce more diagnostically useful images.

The **3.0T 8-channel HD Neurovascular Array** is a receive-only coil designed to give optimum SNR and uniform coverage of the head and neck. This coil has an excellent ergonomic design, which incorporates soft, flexible components that conform to the patient anatomy to accommodate various body contours while improving patient comfort. The coil geometry is optimized for ASSET applications in R-L and A-P directions.

Medrad is introducing a new **1.5T 8-Channel Neurovascular (NV)** coil that incorporates 8 elements in the head section and 4 elements in the retractable chest section designed for optimal neurovascular imaging. The full mode provides a maximum 46 cm FOV and allows you to acquire high SNR images of the carotid arteries, soft tissue neck, cervical spine, brachial plexus, and aortic arch. The Head mode activates 8 receivers and 8 elements in the head configuration to image the brain and Circle of Willis, acquire EPI images, and use the PROPELLER imaging technique for reduced motion artifact and enhanced contrast-to-noise properties.

The cervical spine and anterior coil elements can be activated with the Neck mode. The Neck mode can acquire images of the soft tissue in the neck and cervical spine up to a 24 FOV. The Full, Head, and Neck modes are designed for ASSET imaging, but they are not compatible with spectroscopy. There is a special Spectroscopy mode that activates the head section for both single and multi-voxel spectroscopy imaging.

The coil also features a Head/Neck configuration for extended superior/inferior coverage. Ω

Coil FAQs

Q: We have a 9.0 system and are upgrading to EXCITE HD. Will we still be able to use all of our coils?

A: You'll still be able to use the same coils, however, they will need to be updated. Connectors in the HD system are different and the connectors on the coils you're using now will have to be modified to fit.

Q: When can I use the body coil for localizing with another coil plugged in?

A: As long as the system allows you to scan, go ahead and use the body coil for localizing. Make sure, however, that the coil you'll use for scanning is plugged in and its ID has been selected when you do the localizer scan.

Q: My imaging facility has a 1.5T EXCITE II system and is interested in purchasing the new EXCITE HD Knee Array coil. Is this coil compatible with our system?

A: No, the EXCITE HD Knee Array coil is only compatible with 1.5T EXCITE HD systems due to the system architecture. The EXCITE HD Knee Array coil has a unique transmit and receive design that prevents aliasing from outside the knee anatomy. It incorporates a hybrid technology that uses a separate birdcage coil for transmission and a set of phased array elements for reception. The system architecture in previous systems does not allow use of the body coil when a transmit/receive coil is inside the bore. The hardware system was modified with the EXCITE HD systems to accommodate this technology and allow coils to operate in this way.

Q: When using the Medrad NV8 coil with PROPELLER DWI, the sequence did not reduce motion. Is this a coil problem or a PSD problem?

A: Neither. PROPELLER DWI is not intended to nullify motion. The PROPELLER DWI sequence is used to reduce susceptibility artifacts from metal. Use the PROPELLER T2 sequence or PROPELLER T2 FLAIR to reduce patient motion artifacts.

Q: The Body Array coil has a Coil ID sticker and I have a green light on the coil port but I receive an error when I download the acquisition, what is preventing me from downloading?

A: A coil with Coil ID is automatically detected and shown in the Coil Names window, but you must still select the correct coil. The system will not allow you to click the Download button unless the coil plugged in matches the coil selected in the Coil Names window. An error message posts if there is no match. Change the coil selection in the protocol to match the actual coil that's plugged in. The exception to this situation is if a receive-only coil is plugged into either port. In this case you can scan with the Body coil. Ω

Useful Links

The University of British Columbia has web pages that include MR images with artifacts and explanations. You can also view small images of these artifacts with no explanations in order to quiz yourself on possible causes.
http://www.rad.pulmonary.ubc.ca/stpaulsstuff/MRartifacts.html

Frank Shellock, PhD, is a physiologist with more than 17 years of experience conducting laboratory and clinical investigations in the field of magnetic resonance imaging. As a commitment to the field of MRI safety, bio effects, and patient management, he created and maintains a great MR safety web site. www.MRIsafety.com

USA Instruments, Inc. (USAI) engineers, manufactures, and markets RF coils for MRI, providing technically superior products with higher quality and reliability at competitive prices. Check out their website to find current products and work-in-progress coils.
www.usainstruments.com

Invivo was formed by Intermagnetics General Corporation Medical Advances and MRI Devices. You can access MRI Devices Corp. and Medical Advances, Inc. separate websites from their home page. Invivo leads the markets for MRI devices and flexible patient monitoring by maintaining a competitive edge through research and technology.
http://www.invivoresearch.com/index.html

MEDRAD offers a wide range of MR products, including MR compatible injection systems, surface coils, patient monitors, sound systems, syringes, and disposables. Check out their site to view their latest products.
www.medrad.com Ω

General Electric reserves the right to make changes in specifications and features shown herein, or discontinue the product described at any time without notice or obligation. Contact your GE Representative for the most

For more than 100 years, scientists and industry leaders have relied on General Electric for technology services and productivity solutions. So no matter what challenges your healthcare system faces — you can always count on GE to help you deliver the highest quality services and support. For details, please contact your GE Healthcare representative today.

GE Healthcare
Waukesha, Wisconsin
U.S.A.

imagination at work