# FieldStrength

Publication for the
Philips MRI Community

ISSUE 50 – 2014 / 1

## Neuro MR

**Advanced and explorative neuro MR solutions**

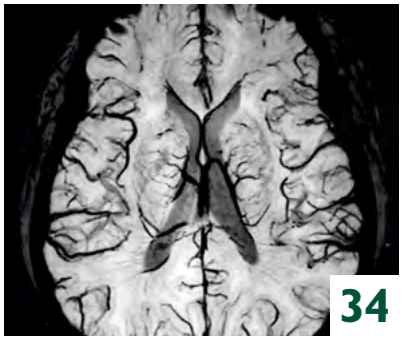
**Shandong MIRI explores MR neurography in extremities**

## Control your fat imaging

**Robust mDIXON TSE at Aarhus University and Oakland Children's**

**mDIXON Quant in fatty liver disease at UT Southwestern**

# Dear Friends,



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*Nearly 18 months ago, I took over the R&D leadership for Philips MR. As I look at my 20th year in the Healthcare business, I bring in varied experience from NM/PET, DICOM, HL7, X-Ray, Interventional X-Ray, MR and the Healthcare IT domains.*

*Over the past year, we have invested heavily in a complete software, workflow and applications refresh while continuing to enhance the dStream platform. We have done this through strong customer engagement and collaboration to be a more intuitive and quantitative MR solutions provider. ISMRM is a perfect venue to share these new ideas and innovations, and critically to enhance relationships.*

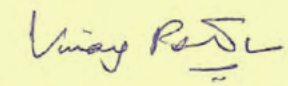
*This issue of FieldStrength re-emphasizes our neuro imaging focus, through work done on peripheral neuro imaging at Shandong University, on MultiVane XD and Diffusion TSE. Our collaboration with Kumamoto University in developing enhanced susceptibility weighted imaging, as well as research on multi-band SENSE drives this focus.*

*We offer intuitive, fast, robust and high quality clinical imaging through mDIXON – in articles from Aarhus and Oakland Children's Hospital. From UTSW, you will see the use of mDIXON Quant to create fat fraction maps for non-invasive assessment and monitoring of fatty liver and a glimpse into our digital journey on dStream at Hennepin County Medical Center where SmartPath to dStream converts an Achieva system to a high performance dStream digital broadband system, avoiding system down time and siting issues.*

*With the excellent work by these users coupled with close customer collaboration we strive to further expand MR techniques for enhancing its use in current and new application areas.*

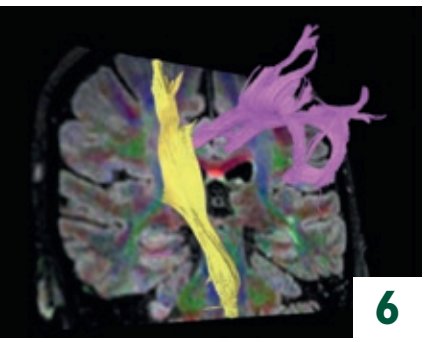
*I look forward to seeing many of you at ISMRM and to continue our collaborative relationship.*

*I hope you enjoy this issue!*



**Vinay Parthan**

*Vice President, MR R&D, Philips Healthcare*



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**Neuro MR**

Read about the exciting work of our users and the advanced and explorative solutions that Philips provides to enhance your neuro practice and to discover innovative pathways.

The Philips team would like to welcome you to our booth at ISMRM 2014

You may also visit www.philips.com/ismrm

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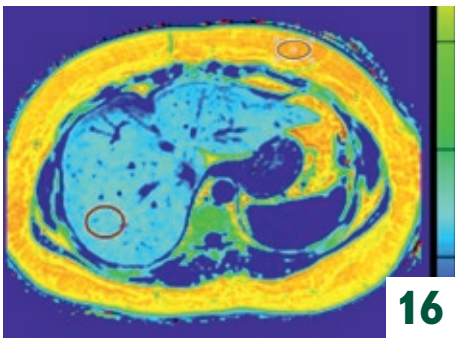

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PHILIPS

# Advanced and explorative neuro MR solutions

Enhance your neuro practice and discover novel clinical pathways

### Grow your referral value in neuro MR

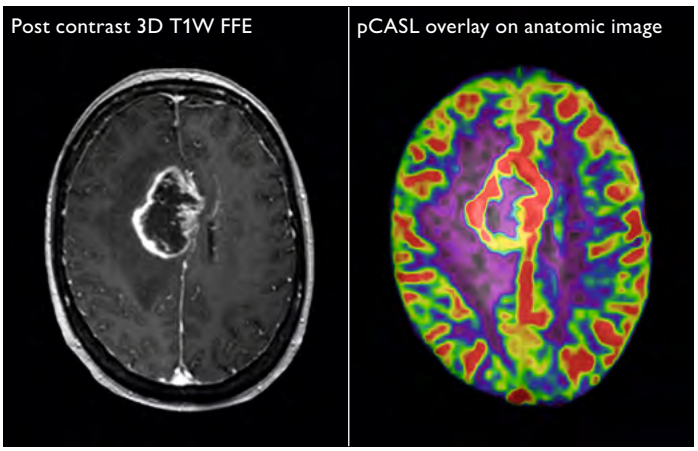
Our advanced diagnostic solutions are designed to help explore new clinical pathways and expand your practice. A comprehensive set of imaging techniques and visualization tools are ready for mainstream clinical practice. Recent additions are our high performance SWIp for susceptibility weighted imaging, our pCASL for non-contrast brain perfusion imaging and our high-end DWI technologies. All are available on our digital dStream MR platform.

### Intellispace portal for multi-modality viewing and analysis

For advanced visualization and analysis, IntelliSpace Portal provides applications for easy, multi-modality and multi-vendor viewing and processing of neuro MR data.

### Dedicated offerings for neuroscientists

A comprehensive, robust set of tools is available to help neuroscientists perform their daily research studies with confidence. These include high-end DTI, fMRI and quality assurance tools.




Courtesy of CHC St. Joseph Hospital, Liege, Belgium

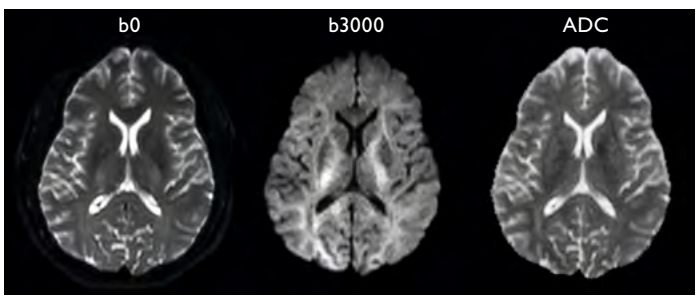
## High quality diffusion weighted imaging, extended parameter space

### DWI in challenging areas

**Diffusion TSE** is an alternative for diffusion EPI in challenging areas as the EPI readout is prone to distortion artifacts. Diffusion TSE uses an optimized slice profile to provide distortion-free DWI with excellent SNR and sharpness. It can be combined with dS SENSE to reduce scan time. Read more on page 38.

### High quality fat-free DWI

**LIPO** provides excellent quality fat suppression in diffusion weighted images, even in challenging areas and for high b-values. LIPO uses a gradient reversal method for fat saturation to achieve high quality fat-free DWI at 3.0T.




DWI with LIPO fat suppression, Ingenia 3.0T

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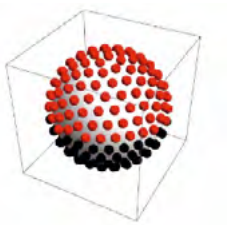
### DTI with high number of b-values and directions

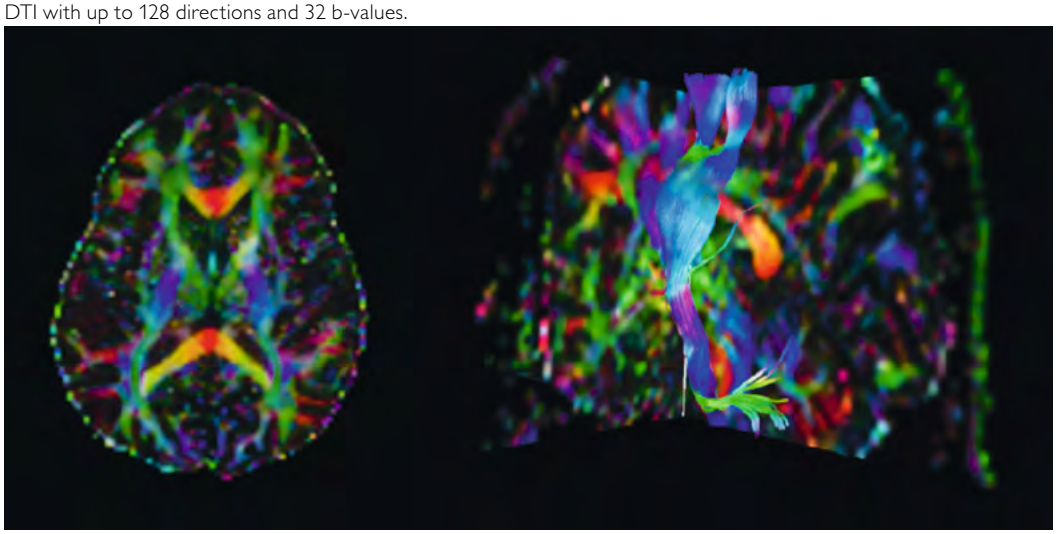
**DTI** is now possible with up to 128 directions and up to 32 b-values with very high quality thanks to dS SENSE. This provides neuro functional imaging with high definition of fiber tracks in the brain and spine. A user may use more directions instead of multiple averages to increase SNR.

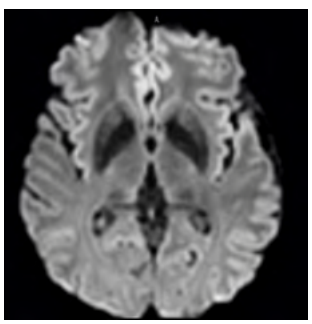
Fiber tracks can easily be obtained on the console or IntelliSpace Portal for advanced neuro-functional analysis.



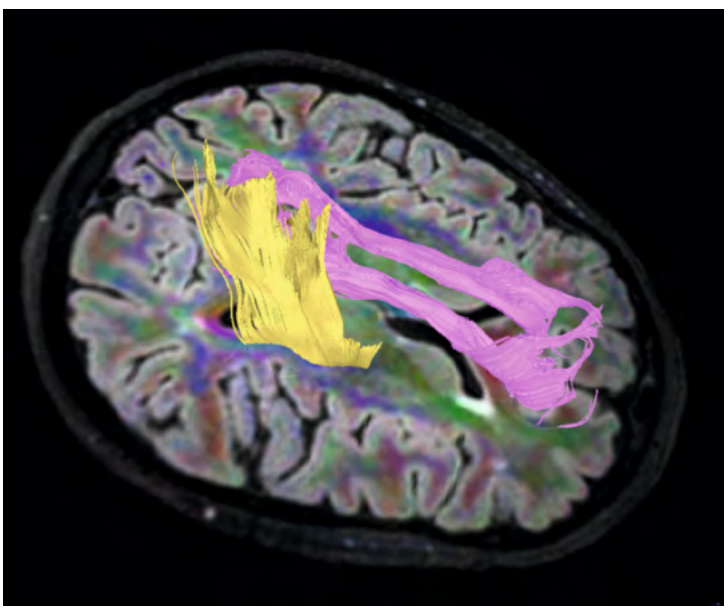
128 gradient directions

DTI with up to 128 directions and 32 b-values.



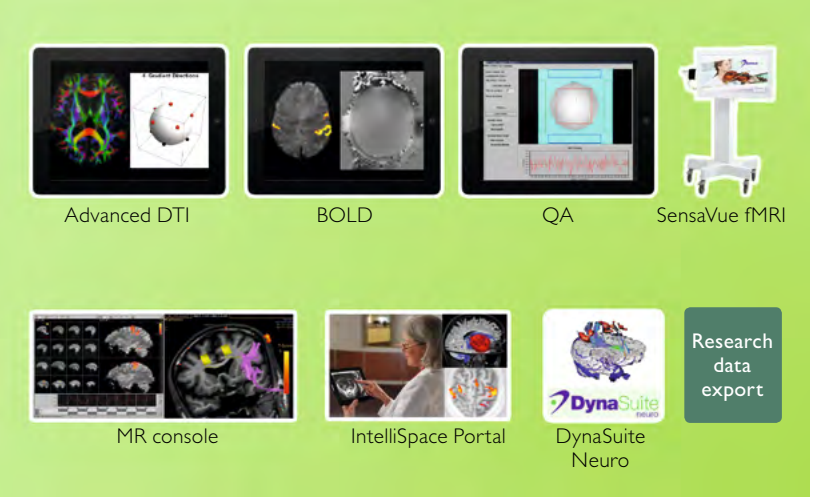


Ingenia 3.0T, DTI with 128 directions and dS SENSE 3.



Fiber tracking, 128 directions, 2 × 2 × 2 mm.
50 slices, TE 81 ms, TR 2710 ms, scan time 16 min.

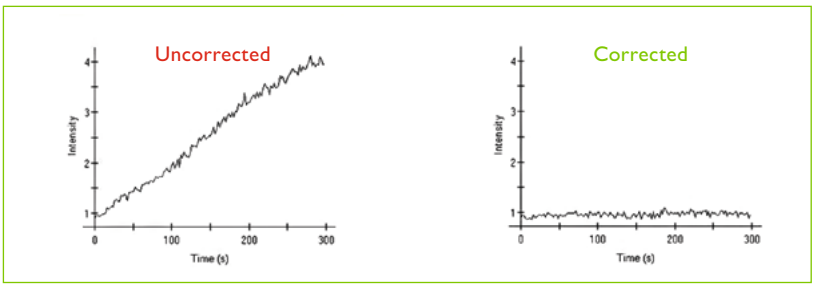
# A comprehensive offer for fMRI with confidence




Researchers using fMRI on a routine basis to explore connectivity of the brain are well aware that measuring small fMRI signals requires high quality equipment and control over factors potentially influencing the measured signal. To support the confidence in such fMRI results on a daily basis, we offer a comprehensive set of robust hardware and software tools.

Strong gradients together with the 32-channel 3.0T dS Head coil deliver state-of-the-art image quality, speed and spatial resolution in advanced neuro and neuroscience applications. Compared to the standard head coil the 32-element digital coil offers improved SNR in the periphery of the brain (cortex) and improved dS SENSE performance.

The scanner console provides real-time feedback and results during fMRI studies. Synchronization of SensaVue with the scan protocols can be controlled from the scanner console. IntelliSpace Portal and DynaSuite Neuro offer extended options for convenient viewing and processing of fMRI data.

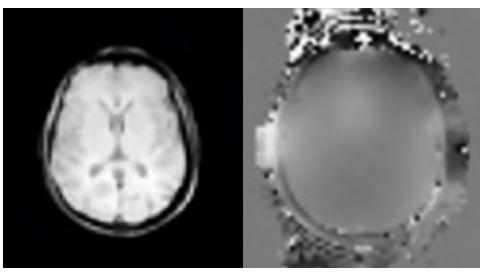



Nyquist ghost level during a 5 minute EPI scan without and with correction.

## Quality assurance tool

Stability and quality assurance are important for robust fMRI. A quality assurance (QA) tool is available to measure fMRI stability and analyze the fBIRN metrics[1]. This QA test is fully integrated in the system, so it can easily be performed regularly to monitor system performance.

Stability is further improved by the introduction of a new algorithm that significantly reduces the normal increase of the Nyquist ghost level over time[2].



Magnitude B0 map Phase B0 map

## B0 mapping

With B0 mapping, our fMRI solution offers not only measurement of the magnitude images, but also the phase images, which can help neuroscientists to correct for EPI distortion.

## References

1. Friedman L, Glover GH
*Report on a Multicenter fMRI Quality Assurance Protocol*
J Magn Reson Imaging 2006;23:827–839
2. Geerts L, Hey S, Koonen J, Chen Z
*Reducing Nyquist Ghost level for fMRI*
OHBM 2013, #3474

**Dr. Pedersen** is Consultant Radiologist at Aarhus University Hospital, Department of Radiology, Aarhus, Denmark. He graduated Aarhus University, where his PhD (1993) and DMSc (2000) were later obtained. He was a full-time MR imaging researcher before becoming a specialist in Radiology in 2007. Dr. Pedersen has 113 peer reviewed publications in international journals, mainly within cardiovascular and oncology MRI.

# mDIXON saves time and provides homogeneous fat saturation

**Clinicians at Aarhus University perform efficient, reliable oncology imaging with mDIXON**

*"We definitely see improvements when exams include imaging before and after contrast, and we need to get images with and without fat suppression."*

**Breast cancer with bone metastases**
After six series of treatment this patient was referred to MRI. Total spine T2W mDIXON TSE and T1W TSE imaging was done in two stations to visualize the metastasis in Th11. Excellent fat suppression is seen, including the neck region. Only one mDIXON TSE scan provides images with and without fat suppression and thus saves almost half the time compared to traditional imaging.

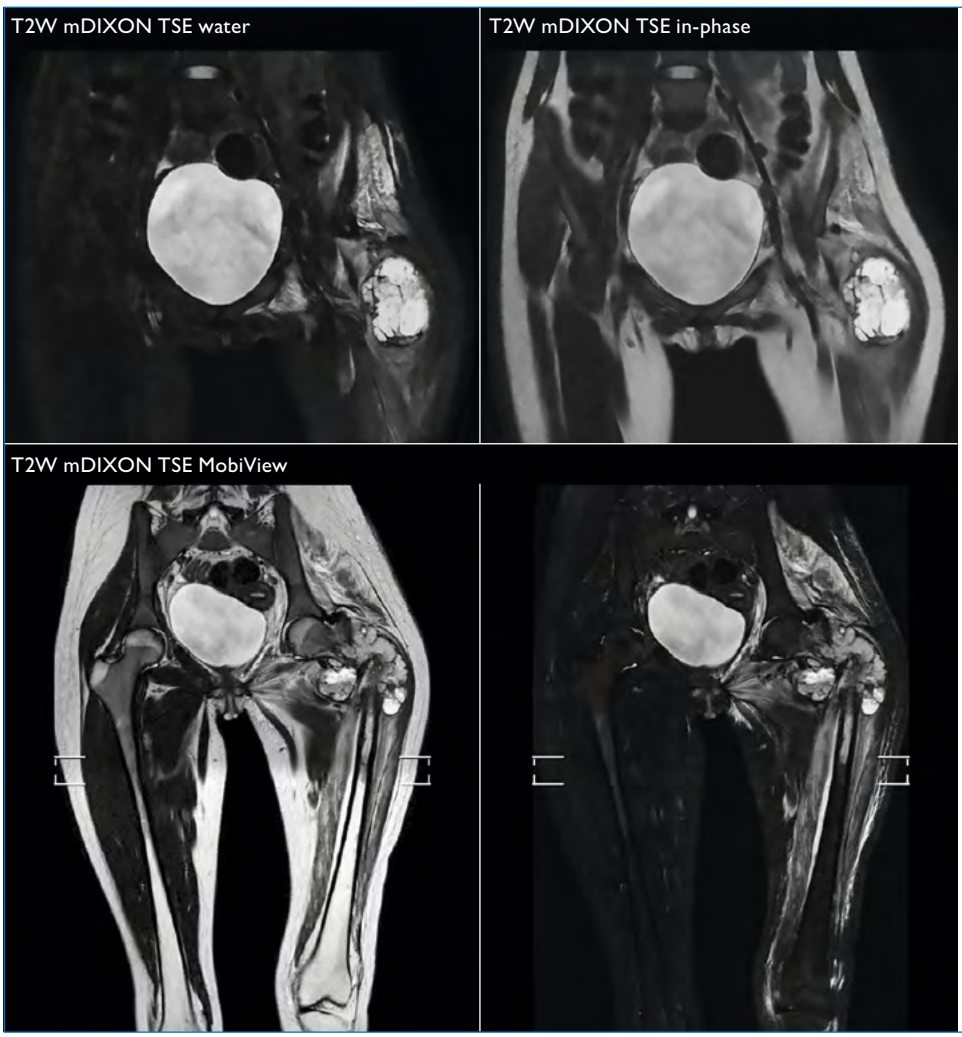
Aarhus University Hospital (Aarhus, Denmark) serves its community and the surrounding region with both specialized and general medicine. The radiology department, serving the departments of oncology, orthopedics, gastroenterology and abdominal surgery, is using Ingenia 1.5T with dStream. The department has implemented several mDIXON techniques and now benefits from the time saving, homogeneous fat suppression and consistent high quality.

### No need to choose between shorter exam and more information

Consultant Radiologist Erik Morre Pedersen, MD, has been using mDIXON TSE, mDIXON FFE and mDIXON Quant on Ingenia 1.5T. "The two-point mDIXON that Philips provides is faster than the traditional three-point implementation, which makes the method suitable for routine use," says Dr. Pedersen. "From only one mDIXON acquisition, four different kinds of images can be reconstructed: water, fat, in-phase and out-of-phase images."

"So, mDIXON FFE may replace in-phase and out-of-phase imaging as done in abdominal imaging. One mDIXON TSE acquisition may replace the two scans with and without fatsat, which can save time in pre- and post-contrast imaging. And in applications where time limitations make us only take either fatsat or non-fatsat (although we prefer to have both for a diagnosis) mDIXON TSE will provide the other 'for free.'"

"Using mDIXON FFE and TSE, we are now able to use new imaging setups. We are implementing that in some head/neck and pelvic imaging. In some knee exams we use mDIXON TSE in combination with the 3DView sequence. And then we've done MSK cases using T1 mDIXON TSE before and after IV contrast, and that we are definitely going to pursue."




**Young girl with osteogenic sarcoma, preoperative assessment**

Preoperative MRI in this young girl demonstrates the large tumor with a necrotic component and areas of fluid. The tumor extends down into the proximal part of femur. Edema is seen along the femoral shaft down to the knee and in the gluteal muscle. T2W mDIXON TSE in-phase and water images show the superb fat suppression of mDIXON TSE. The two-station MobiView also demonstrates the high quality mDIXON TSE fat suppression over a large region, and images with and without fast suppression are obtained in about half the time needed for two conventional scans.

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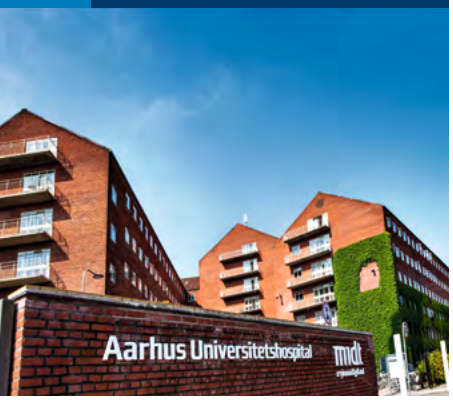



*"mDIXON provides homogeneous fat suppressed images."*


**Breast cancer with extensive bone metastases**
After three series of treatment with Xeloda and Zometa this patient was referred to MRI. Total spine T2W mDIXON TSE was done in two stations and reconstructed into in-phase and water images. The high quality of the fat suppressed mDIXON TSE images is demonstrated; note the superb fat suppression in the neck region. These images are obtained in about half the time needed for conventional imaging techniques. Total spine T1W TSE was also done but not shown here.

### Homogeneous fat suppression, without adding time

"In addition to its ability to save time, mDIXON TSE shines by consistently producing very homogeneous fat suppression. We can now scan larger areas with a homogeneous fatsat. In the spine, for instance, we can now do a T2 mDIXON TSE with equivalent resolution and obtain image series with and without fatsat in the same time needed for the traditional STIR sequence. We experience flexibility in changing TE and finding the right balance between resolution and SNR," Dr. Pedersen says.

"We are really happy with the SNR of mDIXON compared to STIR, which is otherwise a robust workhorse in T2-weighted fatsat imaging. mDIXON TSE inherently has more SNR at the same resolution and the same scan time."

### mDIXON TSE in oncology imaging

"In oncology imaging we use T2 mDIXON TSE when visualizing soft tissue and bone tumors, such as in hands, long bones, spine and bones of the pelvis," Dr. Pedersen says. "We save time in cases where we want images both with and without fatsat, and mDIXON provides very homogeneous fat suppressed images."

"We definitely see time improvements when exams include imaging before and after contrast, and we need to get images with and without fat suppression. mDIXON saves up to about half the time in acquiring these, and provides excellently homogeneous fat suppression. We think it's really a gain here, both from an image quality and a time-saving point of view."

### Boosting quality and speed in liver and whole body imaging

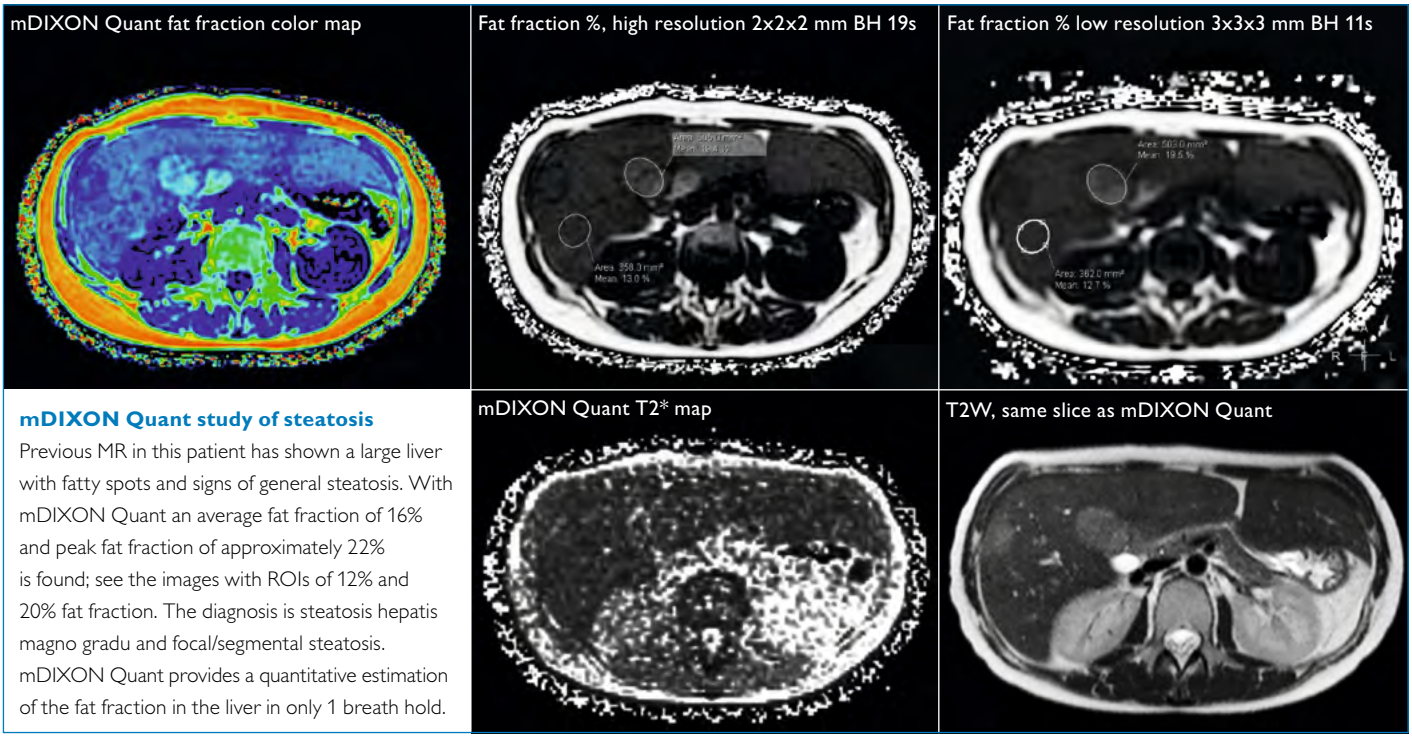
In liver imaging Dr. Pedersen uses mDIXON FFE for his T1-weighted 3D scanning. "For instance, in dynamic contrast-enhanced liver imaging with multiple phases, we prefer mDIXON FFE over the other 3D gradient echo fatsat sequences."

"We also use it where we used to do in-phase and out-of-phase, like in adrenal imaging and other abdominal imaging where we want to be sure whether there's fat or not; we can now acquire both in one acquisition."

### Using dS SENSE to speed up scans, shorten breath holds, reduce artifacts

In abdominal imaging, Dr. Pedersen also exploits the benefits of the high dS SENSE acceleration factors that Ingenia 1.5T with dStream offers. "We do some of our coronals – where phase encoding is left-right – with a dS SENSE factor of 4, with good results," he explains. "In other directions we can generally push our dS SENSE factors at least 25% to 50% higher, in order to shorten breath holds or reduce the number of breath holds."

"Even when using dS SENSE factor 2 (our standard on older systems), we notice that we can save more time using Ingenia, as we do not need




**mDIXON Quant study of steatosis**
Previous MR in this patient has shown a large liver with fatty spots and signs of general steatosis. With mDIXON Quant an average fat fraction of 16% and peak fat fraction of approximately 22% is found; see the images with ROIs of 12% and 20% fat fraction. The diagnosis is steatosis hepatis magno gradu and focal/segmental steatosis. mDIXON Quant provides a quantitative estimation of the fat fraction in the liver in only 1 breath hold.

*"The great potential of mDIXON Quant lies not only in its results, but also in the fact that these can be obtained in a fast and efficient breath hold and are postprocessed immediately."*

to make the FOV as large as we used to for avoiding fold-over effects. And a smaller FOV corresponds to increasing the acceleration."

"Also in some of our mDIXON sequences we push the dS SENSE factors a little higher, especially to save a few seconds in FFE sequences for abdominal imaging done with breath holds, or to get a little increase in resolution." he adds.

## Where dS SENSE particularly helps

"We have had some pediatric abdominal patients where we could actually shorten the breath holds to 10 seconds without sacrificing resolution. We also have older patients where we have to have short breath holds. In other cases, we use dS SENSE to increase resolution in the same breath hold time."

"Basically, I think we have taken the opportunity to create a set of more robust protocols with short breath holds, because that is very important in scanning, especially in the elderly."

## mDIXON Quant provides more information in less time

Dr. Pedersen has just begun to use mDIXON Quant, which provides quantitative fat fraction mapping. "This allows us to look at specific portions of the liver that might be diseased," he says. "It used to be a very tedious task to quantify anything in the liver. Now, with mDIXON Quant, we can do a full 3D acquisition in one breath hold. The results are immediately reconstructed on the scanner and we can work with them right away without time-consuming post-processing."

Dr. Pedersen is working with the hospital's gastroenterologists to select patients for the mDIXON Quant technique. "We are looking at patients with known fatty livers who need to be followed over time. Another group could be patients where a needle biopsy is not a good option, for instance due to problems with coagulation. mDIXON Quant opens a window for these patients, allowing to follow the status of the liver over time without needle biopsies."

"The great potential of mDIXON Quant lies not only in the results it gives, but also in the fact that these can be obtained in a fast and efficient breath hold and are postprocessed immediately."

## Conclusion

Dr. Pedersen believes mDIXON is a genuine improvement, especially in fat suppressed MRI. "It's not just stronger gradients or a wider magnet, it's really a whole new way of doing things. It's fast enough that we are willing to use it, and it's flexible enough to adopt it to our clinical questions. I think that will really make a difference in the way we do a lot of MRI in the future." ■

**Dr. Taylor Chung** is a clinical pediatric radiologist. He serves as the Associate Director in the department of Diagnostic Imaging at Children's Hospital & Research Center Oakland in Northern California, USA. His interests are in pediatric body and cardiovascular MR.

# Robust fat suppression and shorter exams in pediatric imaging

**Oakland Children's Hospital uses the mDIXON TSE technique for obtaining images with and without fat suppression in a single scan**

*"The most significant benefit of the mDIXON TSE method is the robust fat and water separation."*

MR imaging of pediatric patients can be challenging, as they are prone to movement and difficulties holding their breath. Clinicians at Children's Hospital & Research Center Oakland (CHRCO, Oakland, California, USA), have started using 2-point mDIXON TSE as it addresses challenges related to fat suppression imaging. They obtain robust and homogeneous fat suppression in various parts of the body with different types of weighting (T1, T2, proton density) by using mDIXON TSE, as it can shorten total examination time.

"In MRI, fat suppression is used to help increase the conspicuity of pathology and distinguish the high signal intensity of fatty tissue from pathology," says Taylor Chung, MD, pediatric radiologist at CHRCO. "I have been very interested in applying the Dixon method of separating water and fat clinically for many years because of its robustness, but scan times of the early 3-point Dixon techniques were too long for routine clinical use. Philips has developed the faster 2-point mDIXON method with TSE, which is very advantageous."

Dr. Chung has begun to add mDIXON TSE to clinical exams, mainly MSK, of pediatric patients performed on Achieva 3.0T. "This allows us to directly compare mDIXON TSE to conventional TSE with fat suppression (SPIR and SPAIR). After systematically looking for any differences, we intend to switch to using just mDIXON TSE."

*"When the fat suppression is not good in the post-contrast T1-weighted scan, then we're in trouble. That's why a robust fat and water separation like mDIXON TSE is a great method there."*


**Neuroblastoma in 2-year-old girl**

Sedated 2-year-old girl with neuroblastoma. The post-contrast T1W TSE axial image of the neck shows failing fat suppression around the top of the right shoulder, while good fat suppression is seen on the mDIXON TSE image. Both images show the extensive tumor extending through the right-side neural foramen and exerting mass effect upon the cervical cord. This is also shown well on the coronal mDIXON TSE image.


**Tenosynovitis in 4-year-old girl**

4-year-old girl with suspected idiopathic inflammatory arthritis and wrist pain. She has significant tenosynovitis around the flexor tendons in her hand. The T2W TSE with SPIR fat suppression shows high signal intensity in the marrow of the proximal phalanx of the thumb and adjacent soft tissue medially. This high intensity proved to be due to inhomogeneous fat suppression, as on the mDIXON water image no increased signal intensity is seen in the same regions. Abnormal high signal intensity tissue is seen surrounding the flexor tendons, which showed contrast enhancement on the T1W images (not shown).

CONTINUE

*"I can get images with and without fat suppression in the same acquisition, which cuts down on the time of the entire exam."*


**Meniscus in 6-year-old**

A 6-year-old girl with knee pain underwent an MRI exam, because the referring physician wanted to exclude the presence of discoid meniscus. After the first 10 minutes of scanning the patient started to move in the scanner. Coronal and sagittal mDIXON TSE were used to effectively get the fat suppressed and non-fat suppressed images and decrease the total examination time. High-resolution knee MR was achieved successfully. Acquired voxel size 0.2 x 0.3 x 3 mm, 30 slices, in 3:11 min. for each mDIXON TSE sequence with SENSE on Achieva 3.0T. There was no discoid meniscus seen.

*"Being able to effectively get the images with and without fat suppression (water-only image and in-phase full image) in the same acquisition, is very helpful because some of our pediatric patients can't hold still for very long."*

### Shorter exam times

"The mDIXON TSE sequence gives us – in a single acquisition – the water-only image, the fat-only image, and the 'full image' (water-and-fat image, both in-phase and opposed-phase). The water-only image is equivalent to a fat-suppressed image," says Dr. Chung. "The advantage of getting the water-only image and the in-phase full image in the same acquisition is that it cuts down on the time of the entire exam. This is very helpful, as some of our pediatric patients can't hold still for very long. Because it's only one scan, we also avoid the problem of a patient moving in between scans with and without fat suppression, so there's no spatial misregistration."

"For instance, in a knee exam, we would normally include TSE PD-weighted scans with and without fat suppression, which are two separate scans. When we change to just one mDIXON TSE PD-weighted scan, we'll get the advantage of a shorter exam time as this is only one scan. So, the real time saving is not in the mDIXON TSE sequence itself, but in the shorter overall exam time. In fact, the mDIXON TSE is a longer scan – however, we can take advantage of the fact that the 2-point mDIXON method has increased SNR and we use a combination of decreasing NSA and/or adding SENSE to reduce the scan time. The scan time of an mDIXON TSE sequence can be made comparable to a conventional proton density TSE sequence with fat suppression, depending upon how much image noise you want to tolerate. We are still optimizing parameters to see whether we can reduce scan times and still be satisfied with the resulting image."

### Robust fat suppression

"With conventional sequences, it can be difficult to obtain good fat suppression, for instance, when imaging soft tissue masses along the side of the body, at the head and neck and shoulder areas, around the ankles, or imaging around the orbits and the sinuses," says Dr. Chung. "mDIXON TSE helps tremendously in these challenging areas. It is a very robust sequence, since it is not sensitive to magnetic field (B0) homogeneity. This robustness allows us to maintain good quality and performance, even in areas with significant perturbation of the B0 field. We find that we can rely on mDIXON TSE to give us excellent homogeneous 'fat suppression' in the water-only images."

"The mDIXON TSE advantage applies to T1 and T2 weighting, which is quite important," continues Dr. Chung. "If we have problems with the traditional fat suppression in T2-weighted images, we can compromise and utilize a different type of fat suppression like inversion recovery. But in traditional T1-weighted imaging with fat suppression, there is no other choice, especially after giving contrast. When the fat suppression is not good in the post-contrast T1-weighted scan, then we're in trouble. That's why a robust fat suppression like mDIXON TSE is a great method there."

### Diagnostic confidence, benefit for patients

"If we can avoid troublesome inhomogeneous fat suppression artifacts versus real pathology, there is no need to add another sequence in another imaging plane or to find a different way to suppress fat; therefore we would be able to shorten the exam time. The shorter overall examination time achieved with mDIXON TSE, together with robust fat suppression, is a great benefit," says Dr. Chung. "Even before we start the MR examination, we know we're going to get the information; there's no choice between doing one scan or another. We don't need to run extra sequences to get what we need. It has a huge impact on our pediatric patients, when we can say, 'just hold on for five minutes and we'll be done' instead of 10 or 15 minutes. And it also means we can potentially decrease the sedation time for some patients."

### Advantages combine into a great solution

"The most significant benefit of the mDIXON TSE method is the robust fat and water separation. It consistently provides high quality effective fat suppression with the water-only image because the method is not sensitive to magnetic B0 field inhomogeneity," says Dr. Chung. "The Dixon method for clinical MR examination has been around for over 20 years, but it always took too long. Philips developed the 2-point mDIXON method and now we have shorter overall scan times and at the same time have high quality fat suppressed images. We have started using mDIXON TSE in MSK, but I think it has the potential to be used much broader; it gives the most robust fat suppression we can get."

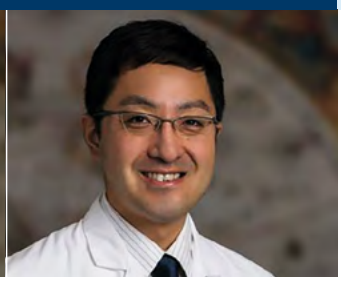
*"Even before we start, we know we're going to get that information; there's never a choice between doing one scan or another. We don't need to run extra sequences to get what we need."*

# mDIXON Quant non-invasively aids in high quality assessment of fatty liver disease

**UT Southwestern collaborates with Philips on a fast and robust, non-invasive method to measure fat in liver**

User experiences

**Ivan Pedrosa, MD**, Chief of MRI and Associate Professor of Radiology.



**Takeshi Yokoo, MD, PhD**, Assistant Professor of Radiology.

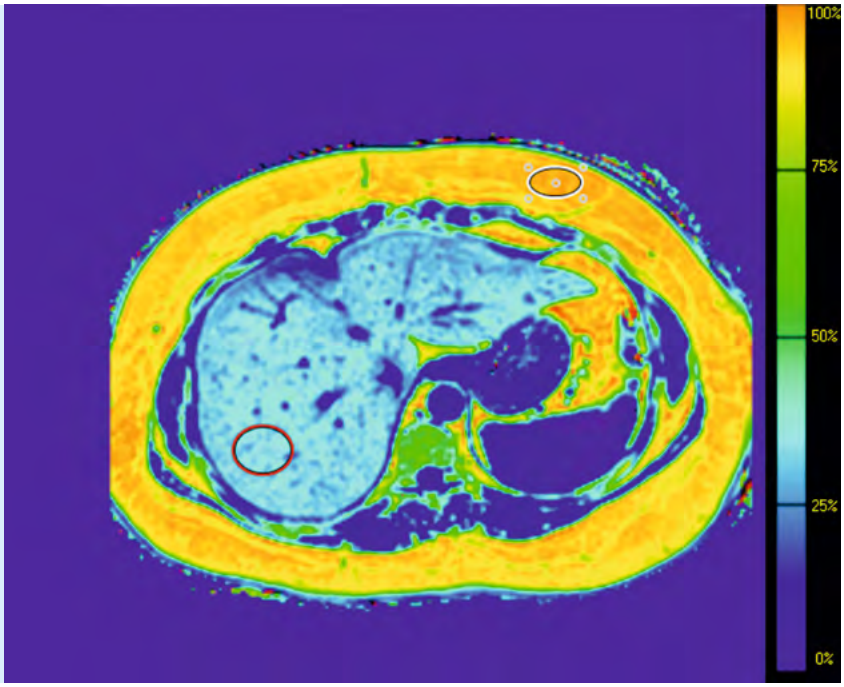
University of Texas Southwestern (UT Southwestern) Medical Center in Dallas, Texas, USA, recently collaborated with Philips to optimize and verify mDIXON Quant, a low flip angle, multi-echo, multi-peak method that enables robust and high quality quantification of fat deposition in the liver. UT Southwestern operates three Philips MR systems clinically; an Achieva 1.5T, Achieva 3.0T TX, and Ingenia 1.5T. Additionally, two Achieva 3.0T systems and a 7.0T system are housed in the Advanced Imaging Research Center.

A healthy liver has about 5%-6% fat content. When the amount of fat in the liver exceeds that amount, the result is fatty liver disease, which affects between 3% and 33% of people worldwide.[1] While classically described in patients with excessive alcohol consumption, fatty liver not related to alcohol, called Non-Alcoholic Fatty Liver Disease (NAFLD), is now considered the most common type of fatty liver disease in the western world.[2] The risk of NAFLD is multifactorial, however it is most often associated with obesity.[3]

Patients with NAFLD are at high risk of steatohepatitis, which can lead to cirrhosis and possibly liver failure. In addition, the exact relationship between NAFLD and other health problems is not completely understood. "There are other entities that are associated with NAFLD, such as diabetes and hypertension, and we are trying to understand if they are a consequence or a cause of the disease," says Ivan Pedrosa, MD, Chief of MRI and Associate Professor of Radiology at UT Southwestern Medical Center. "There is evidence indicating that patients with NAFLD have a higher risk for liver cancer and cardiovascular events."

## Imaging aids diagnosis

Despite these severe consequences, NAFLD can also be asymptomatic. In those cases, it is often detected when imaging is ordered as a follow-up to an abnormal liver enzyme test that is conducted as part of a routine physical examination. Ultrasound is the most common method to screen for fatty liver disease. However, ultrasound has only




Severe case of fatty liver, 33.3 % (red ROI).

*"mDIXON Quant enables quantification of fat in the liver in a way that is non-invasive, fast, robust and provides high quality results."*

70% sensitivity in detecting abnormal amounts of fat in the liver, and the sensitivity is even lower in obese patients.[4]

"Liver biopsy, while accurate, is invasive and has a risk of complications that are rare but can be life-threatening. Because of that, patients and referring physicians may be reluctant to use liver biopsy for the initial diagnosis of NAFLD, and even more so for a follow-up," says Takeshi Yokoo, MD, PhD, Assistant Professor of Radiology. "Patients can't have a liver biopsy every few months to assess disease progression. In addition, biopsy only assesses a small fraction of the liver, so the sampling error can be significant in patients with heterogeneous fat deposition."

"Spectroscopy can also quantify fat in the liver, but it requires expertise that is not available everywhere, and like biopsy, only measures a small sample of tissue," he notes. "In contrast, mDIXON Quant enables quantification of fat in the liver in a way that is non-invasive, fast, robust and provides high quality results."

## Fruitful collaboration

UT Southwestern has been involved in a collaboration with Philips on the development and evaluation of mDIXON Quant for clinical use.

"It is a perfect synergistic effect of combining expertise to work on a technique that is robust and provides the data that we need," Dr. Pedrosa notes. "We were fortunate to have clinical research at UT Southwestern using spectroscopy to quantify fat in the liver, which provided us with the opportunity to assess mDIXON Quant in human subjects. Being able to correlate data from mDIXON Quant with the spectroscopy data in vivo and to work with Philips scientists to improve the acquisition and reconstruction method using these data allowed us to develop a robust method to quantify fat in the liver."

"We found that mDIXON Quant provides high quality data for the quantification of fat concentration in the liver when compared to spectroscopy and thus opens the door to investigate many clinical questions," he adds. "For example, if losing weight is a method to reduce fatty liver, how much weight does one have to lose? At what point does excess fat become a problem? How effective are various therapies? Having a quantitative measure of fat allows us to conduct studies that will provide answers to clinical questions."

## Standardization key to clinical relevance

"While different MR system vendors measure fat content in the liver in different ways, it is the reproducibility of the results across all vendors and field strengths[5] that is the strength of MR fat quantification in the liver," Dr. Yokoo says. "Fat quantification in the liver now has the potential to become like blood pressure or hemoglobin level. The measurement is reliable,[6] so it can be used to make patient management decisions. Patients can go to different centers, or different MR systems at the same center, and the results can be compared with confidence."

## Important health factor

Both Dr. Pedrosa and Dr. Yokoo expect mDIXON Quant to become a standard part of liver protocols, given that in the United States alone, 20-30 million people have NAFLD.

"Many radiologists are not cognizant of reporting fatty liver as a significant finding, and I think that needs to change," Dr. Yokoo says. "If we believe that hypertension and high cholesterol are important biomarkers to predict future development of coronary disease or poor outcome, liver fat is just as important. So if you think hypertension should be reported, then liver fat should be reported as well."

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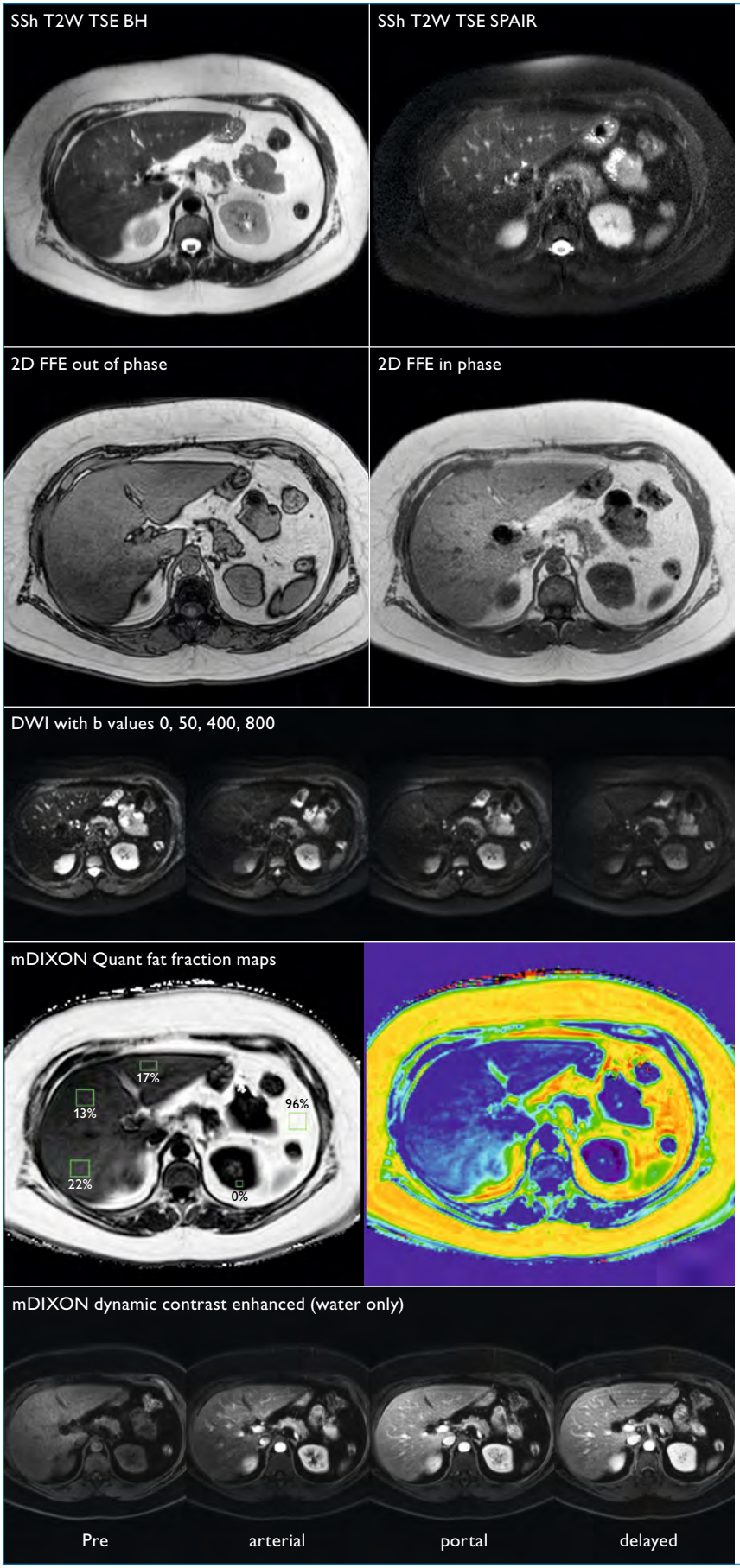


**Liver in obese patient with type II diabetes**

A 50-year-old Caucasian female with obesity, type II diabetes, and abnormal liver enzymes. A non-alcoholic fatty liver is suspected.

High resolution, single shot axial T2W TSE BH and fat saturated (SPAIR) images show no gross abnormality. Axial dual echo T1 2D FFE demonstrates diffuse loss of liver parenchymal signal on the out-of-phase image, compatible with diffuse fatty liver. A blooming susceptibility artifact in the gall bladder fossa, more pronounced on the long TE (in-phase) image, is compatible with metallic cholecystectomy clip(s). The respiratory triggered axial EPI DWI images are within normal limits.

mDIXON Quant fat fraction maps show diffuse fatty liver, slightly heterogeneous across the liver. Fat fraction values ranging from 13-22%, compatible with grade 1-2 steatosis at histology (Tang, et al, Radiology 2013, PMID: 23382291).

The dynamic 3D T1 FFE mDIXON contrast-enhanced series (water only) shows decreased liver parenchymal signal on the pre-contrast image in keeping with fatty liver. Minimal patchy heterogeneity of the arterial enhancement may be related to underlying liver disease. Portal and delayed venous phase images are within normal limits. On other images in the exam (not shown) no definite morphological evidence was seen for cirrhosis or portal hypertension.

Philips Achieva 3.0T TX with SENSE Torso XL coil.
3D T1 FFE mDIXON Quant: TR 6.2 ms, 6 echoes TE1/DTE 1.05/0.8 ms, flip 2 deg, BH 18 sec, matrix 188 x 194, 26 slices of 10 mm. Fat fraction tool allows for color display of fat fraction measurement.

*"Having a quantitative measure of fat allows us to conduct studies that will provide the answers to clinical questions."*


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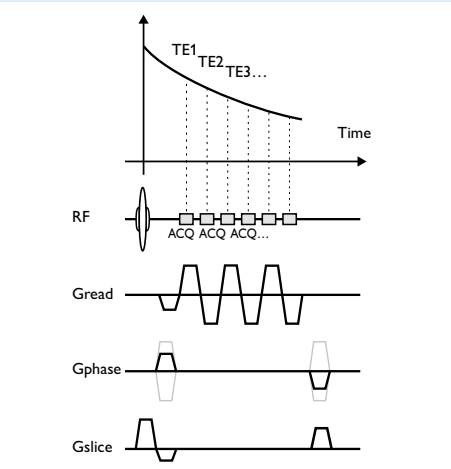
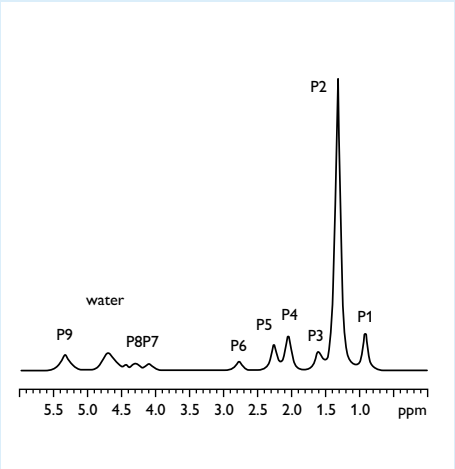
# Multi-echo, multi-peak mDIXON Quant method delivers robust, high quality fat quantification

mDIXON Quant balances accuracy and efficiency in acquiring the data needed for fat quantification in the liver non-invasively, in a single breathhold.

A simple in-phase and out-of-phase acquisition may be used for a qualitative assessment of fat. However, mDIXON Quant uses a 6-echo acquisition for robust and high quality fat quantification. Using a higher number of echoes has the advantage of allowing quantitative assessment, accommodating fat molecules' multiple spectral peaks and enabling T2* correction. T2* correction is necessary because T2* signal decay between echoes influences the relative signal intensity of the fat peaks.



6-echo acquisition



7-peak fat modeling

**Freely selectable echo time**

mDIXON Quant differs from other MR fat quantification methods because its algorithm maintains freedom for the user in selecting echo times. This also provides flexibility in choosing other parameters, such as resolution and field of view.

The 7-peak reconstruction enables robust water/fat separation, which delivers better modeling of heterogeneous fat distribution in the liver.

**Convenient color maps**

mDIXON Quant results can be displayed in a color fat fraction map that visually conveys the amount of fat in the liver, and enables convenient comparison of images acquired at different times.

Another benefit of the mDIXON Quant technique is the possibility to create a T2* map. When paired with fat quantification, this provides a more complete picture of liver health.


**Dr. Tobias Rother** (left) and **Dr. Gerwin Schmidt** (right).

# Fast and easy diagnostic imaging from head to toe

**The Radiology Practice Munich Center is using the speed and convenience of the Ingenia 1.5T with dStream and the flexibility of IntelliSpace Portal**

The Radiology Practice Munich Center (Munich, Germany) offers a broad variety of radiology exams. Cross-sectional imaging stands out, with particular emphasis on MRI for musculoskeletal and oncology imaging. To differentiate themselves from other practices, they acquired the completely digital Philips Ingenia 1.5T to help them broaden their capabilities, particularly in MRI of oncology patients. In addition, they are now using IntelliSpace Portal for viewing, postprocessing and analyzing. It allows combining data from multiple modalities to easily facilitate combined diagnoses.

*"In the past, whole body exams were reserved for special cases only due to the long exam time. Now, the reduced scan time creates a viable option for a wider patient group."*

### Expanding to advanced examinations

"With the Ingenia we can now also offer MRI examinations that are not so typical for outpatient clinics but more usually offered in clinical settings, such as specialized abdominal and whole body scans," says Dr. Gerwin Schmidt, radiologist with a focus on musculoskeletal and oncology imaging. He is enthusiastic about the advantages provided by Ingenia: "We are flexible now and can adjust our examination to each patient and specific diagnostic question. We can fine-tune our whole body imaging to the specific request, for instance to demonstrate a primary tumor size and location or to visualize smaller lesions in an affected area."

Dr. Tobias Rother is radiologist with a special interest in cardiovascular, abdominal and musculoskeletal imaging. "The high quality of the Ingenia images provides an important benefit," he says. "High image quality reduces the uncertainty in reporting – we see abnormalities very clearly. We now also run complex examinations, such as dynamic contrast-enhanced multi-planar imaging. Additionally, we are using newer, special techniques, like whole body diffusion weighted imaging which provide additional information to assist in diagnosis. With Ingenia's digital coil technology and its large field of view of up to 55 cm, we need fewer stations and at the same time we get images of consistently high quality, virtually free of artifacts, all the way to the edge. This high image quality combined with the time saving allows us to now perform these advanced exams in an economically interesting way within a private practice."

"We now also use the mDIXON technique, which provides different contrast types from a single examination. Its fat saturated images demonstrate excellent uniformity in fat suppression, which is very useful in contrast-enhanced examinations. At the same time mDIXON provides in-phase and opposed-phase images as well, which we use for organs like the liver and the adrenal gland."

"With all this extra information, Ingenia is giving us confidence in our diagnoses," says Dr. Schmidt.

### Excellent results, reproducibility and comfort for patients

"For a practice specializing in oncology, the challenge is to capture also the small lesions. This requires a high image quality over a large coverage and the flexibility to combine methods. Ingenia addresses this combination of needs," explains Dr. Schmidt.

"In the past, whole body scans were reserved for special cases only because of the length of the examinations. Now, with the short examination times we can extend Ingenia's technological advances to more patients. The large field of view means children and teenagers can be scanned in just two or three steps. Today, we perform whole body imaging whenever indicated," says Dr. Schmidt. "Ingenia has made it economically viable for the practice to offer such examinations to referring physicians and their patients."

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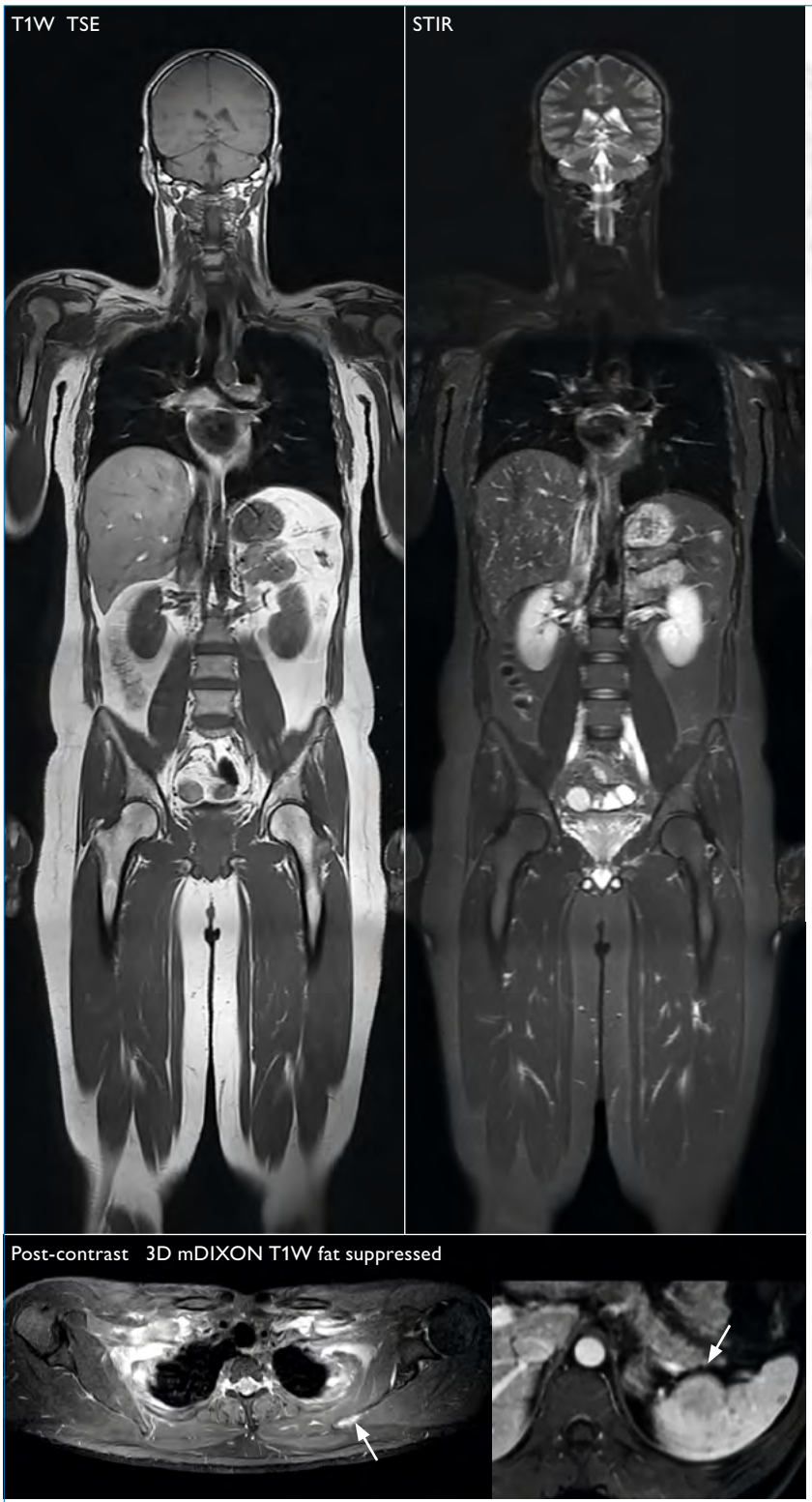




**Skeletal and splenic manifestation of non-Hodgkin lymphoma**

A 33-year-old male with history of non-Hodgkin lymphoma underwent an MRI exam on Ingenia 1.5T to visualize clinically suspected recurrent disease. Whole-body MRI was performed using T1W TSE and STIR imaging (4 stations, matrix 400x400, 6 mm slices). Additional whole-body diffusion imaging (3 stations, matrix 192x192, 6 mm slices) with MIP unmasks a focal area of diffusion restriction in the left scapular region. Subsequent contrast-enhanced 3D mDIXON imaging reveals a bone manifestation of a lesion in the left scapular angle. Furthermore, multifocal splenic infiltration is depicted. Note that the splenic lesions are veiled by the high physiological background diffusion signal in splenic tissue.

The findings are compatible with skeletal and splenic tumor recurrence of non-Hodgkin lymphoma. Further total body follow-up imaging according to therapeutic regime is advised.

Whole-body MRI allows rapid visualization of lesions in this lymphoma patient. A finding of multifocal organ manifestations has a decisive impact on further patient management and therapeutic regime. The fully digital Ingenia 1.5T MR system allows rapid whole body MRI with homogeneous, high image quality in depicting these lesions. Additionally, state-of-the-art techniques such as whole body DWI can be included in the exam protocol, which further enhances the capability for visualizing lesions in oncology patients.

*"In both our locations, we only need to login to IntelliSpace Portal for immediate access to multimodality viewing and processing of all our imaging data."*

"Ingenia coils are much lighter than the coils we had before, and easily adapt to the body form," he reports. "This not only leads to higher quality images, it is also easier for the patients. The automatic selection of coil elements by SmartSelect simplifies patient positioning, makes the work easier for the technologist and reduces examination times still further. Particularly for patients with pain this is a great benefit."

### Viewing and processing independent of location and device

The practice also invested in IntelliSpace Portal, Philips solution for multimodality image viewing and processing. "We have 13 radiologists working at our two sites and we need to view, process and analyze MRI, CT, PET and other images – both our own, and referral images, from a variety of different systems," explains Dr. Rother. "That is why we need a centralized system that allows us, wherever we are, to efficiently evaluate all such results and present these in our reports. IntelliSpace Portal is ideal because we only need to login to have access to multimodality viewing and processing of all our imaging data in consistent and comparable ways."

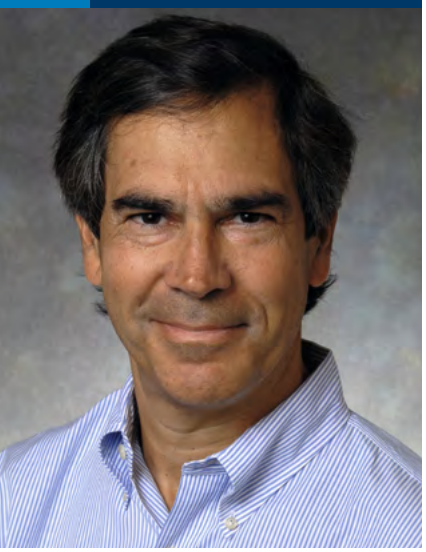
"IntelliSpace packages help us to use diagnostic time effectively and make the most of the ever-improving image quality. For example, the Multimodality Tumor Tracking application lets us calculate the volume of a tumor and easily evaluate its RECIST criteria and compare the results across modalities, such as MRI and CT," Dr. Rother adds.

### Prepared for the future

"With dStream technology and the Ingenia system, we are well prepared for the ever increasing requirements and needs from our referring clinical colleagues," says Dr. Rother. "The all-digital and channel-independent system architecture makes it possible to easily connect new high-channel coils without system hardware upgrade."

"Moreover, we experience Ingenia as a very stable and mature system, which satisfies another important criterion for outpatient use. This bodes well for the future of the Radiology Practice Munich Center and of the Ingenia," he concludes.

*"With Ingenia, we are well prepared for the ever increasing requirements and needs from our referring clinical colleagues."*



**Dr. Truwit** is a neuroradiologist and Professor and Chief of Radiology at Hennepin County Medical Center. He is a graduate of Georgetown University School of Foreign Service and subsequently the School of Medicine. He is a regular lecturer at national and international conferences and holds several medical device patents.

# HCMC chose SmartPath to dStream rather than a new scanner

**Hennepin County Medical Center (HCMC) went for SmartPath to dStream to bring its Achieva 1.5T magnet to a digital broadband MRI system that is virtually new and significantly improves their imaging**

Because HCMC was happy with the performance of its two Ingenia systems, they considered replacing their third scanner, an Achieva 1.5T, with another Ingenia system. However, this was not a viable option due to the associated siting cost. The SmartPath to dStream solution allowed them to get a dStream system in a cost-effective manner, with minimal downtime because the magnet can stay. Now, HCMC has three systems with dStream, all providing terrific scans.

*"The SmartPath to dStream solution allowed us to get to dStream in a cost-effective manner, with minimal downtime."*

www.philips.com/SmartpathtodStream

Hennepin County Medical Center (HCMC, Minneapolis, Minnesota, USA) is among the premiere Level 1 trauma centers in the nation. In the past 12 years, a complete overhaul of its installed equipment has resulted in HCMC having one of the best-outfitted radiology departments in the US Upper Midwest. HCMC is a safety net hospital whose patient population includes a broad array of orthopedic and brain injury patients.

### SmartPath to dStream an easy choice

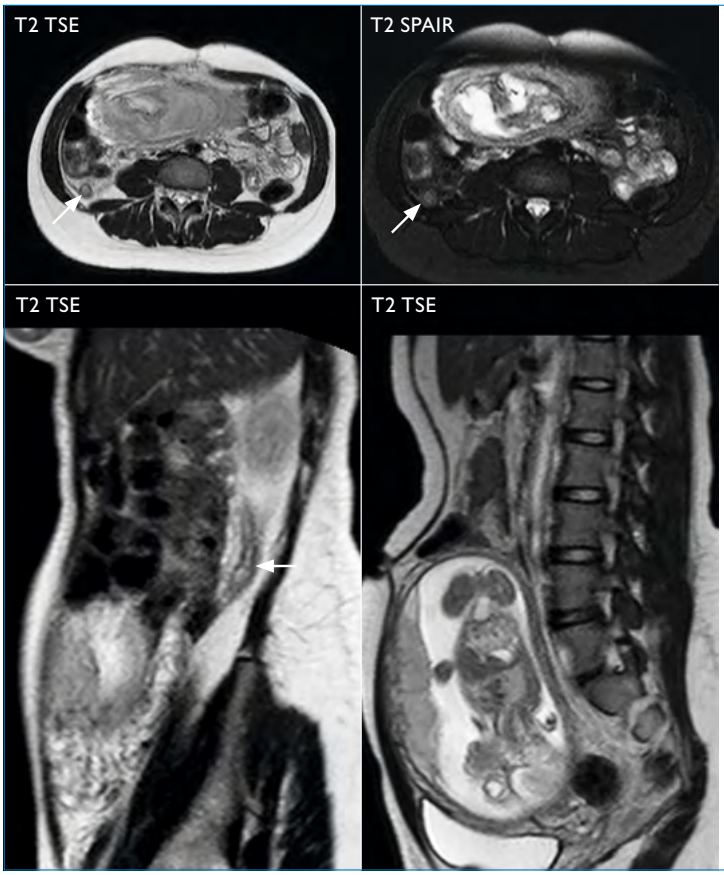
Chip Truwit, MD, FACR, is neuroradiologist and Chief of Radiology at Hennepin County Medical Center. "Already privileged to host both Ingenia 1.5T and 3.0T, we decided to bring SmartPath to dStream to our last scanner, an Achieva 1.5T," he says. "The short version of that story: it's spectacular!"

"After HCMC had installed two Ingenia systems, we were very happy with the image quality; the scans were – and are – exceptional. That was the upside. However, we felt somewhat restrained in scanning patients on the non-dStream Achieva. While we hoped to replace it with another Ingenia system, the siting costs proved to be cost-prohibitive. Fortunately, the SmartPath to dStream solution allowed us to get to dStream in a cost-effective manner, with minimal downtime and avoiding siting issues. There really was no other suitable solution for us at that time."

### Consistent quality on all three systems

"We had very high expectations for SmartPath to dStream to succeed," Dr. Truwit adds. "And indeed the converted dStream system provides the high quality imaging we expected. The scans are remarkable."

"Initially we replaced one of our Achieva 1.5T systems with an Ingenia 1.5T. Until that point, most of our orthopedic MRI was done on our Achieva 3.0T scanner. Almost immediately, our musculoskeletal radiologists shifted the orthopedic MR workload to the Ingenia 1.5T due to the quality of the images. Subsequently, we replaced the Achieva 3.0T with an Ingenia 3.0T. Some musculoskeletal work moved to that scanner, but the images were so good on the Ingenia 1.5T at our outpatient imaging center that we continued to scan many of our outpatients at 1.5T."




### MRI of appendicitis in pregnancy

A 25-year-old female, 20 weeks pregnant, presented with right lower quadrant pain. Her white blood cell count was elevated, measuring 14.6. Ultrasound failed to visualize the appendix. Consequently, the patient was referred for MRI. The scan was performed on a 1.5T SmartPath to dStream system using the integrated Posterior coil and the Anterior coil. The exam includes 3-plane T2-weighted scans, 3-plane B-FFE scans and axial T2W SPAIR, all in breath holds < 15 seconds. The MR images demonstrate a distended appendix with adjacent fat stranding. The diagnosis is acute non-perforated retrocecal appendicitis, surgically confirmed.

MRI successfully supports diagnosing appendicitis in pregnancy without using ionizing radiation or contrast. This 18-minute exam without contrast or ionizing radiation has replaced CT in pregnant women at our institution. We have performed over 60 cases in the last 5 years, with 9 positive, surgically confirmed. We saw no false positives, and to the best of our knowledge, no false negatives either. We usually start with ultrasound, but it is frequently  negative in these patients.

T2-weighted sequences are the mainstay for our diagnosis.
With our SmartPath to dStream system, SENSE and dStream allow us to acquire these faster with improved signal. In these patients, who are often short of breath, the scan can be completed in 15 minutes or less.

Courtesy of Gopal Punjabi, MD, HCMC.

"Before converting the final Achieva there was such a difference between our two Ingenia systems and the non-dStream Achieva, we felt that we were somewhat limited in which patients we could put on that scanner," says Dr. Truwit. "With dStream now up and running on our third scanner, it really makes no difference where we scan; the images look terrific."

"We have the luxury of three dStream scanners. The image quality is so good that most of our work can go on any of the three systems, unless the patient specifically requests one of the large bore Ingenia scanners. That just makes us much more versatile, much more flexible."

### dStream boosts clinical performance

Dr. Truwit is seeing improvements in all types of exams. "We have first optimized our neuro scans and they're looking very good now. As we continue to optimize other scans, we continue to see improvements. Our 3D FLAIR images were already quite good on the Achieva scanners, but they are even better now. The DWI images are much improved, and we have seen improvements in our spin echo T1-weighted sequences as well, which is long overdue."


### Meniscal tear

A 37-year-old male presented with chronic left knee pain and a remote history of injury. Physical exam suggested a meniscal injury. No prior imaging was available. MRI was performed on a 1.5T dStream system using the 16-channel dS Knee coil.  The exam includes sagittal and coronal proton density TSE and T2W SPAIR sequences as well as an axial T2W SPAIR sequence. Sagittal proton density and T2W SPAIR images demonstrate extensive abnormal signal in the body and posterior horn of the medial meniscus with extension to both the tibial and femoral articular surfaces. There is an additional multi-lobular cyst abutting the meniscal root that extends posterior to the posterior cruciate ligament. The diagnosis is a complex horizontal tear involving the body and posterior horn of the medial meniscus with associated para meniscal cyst. The 1.5T dStream system clearly demonstrates the meniscal tear as well as the para meniscal cyst, providing image quality of the pathology and adjacent structures similar to that of 3.0T.

The sagittal proton density-weighted image from pre-dStream Achieva 1.5T in another patient, while still a good quality image, reveals the advantages of the dStream enhancement. Note the image quality of the cartilage, marrow trabeculation, menisci as well as the meniscocapsular ligaments does not quite meet the standard of the 1.5T dStream upgrade.

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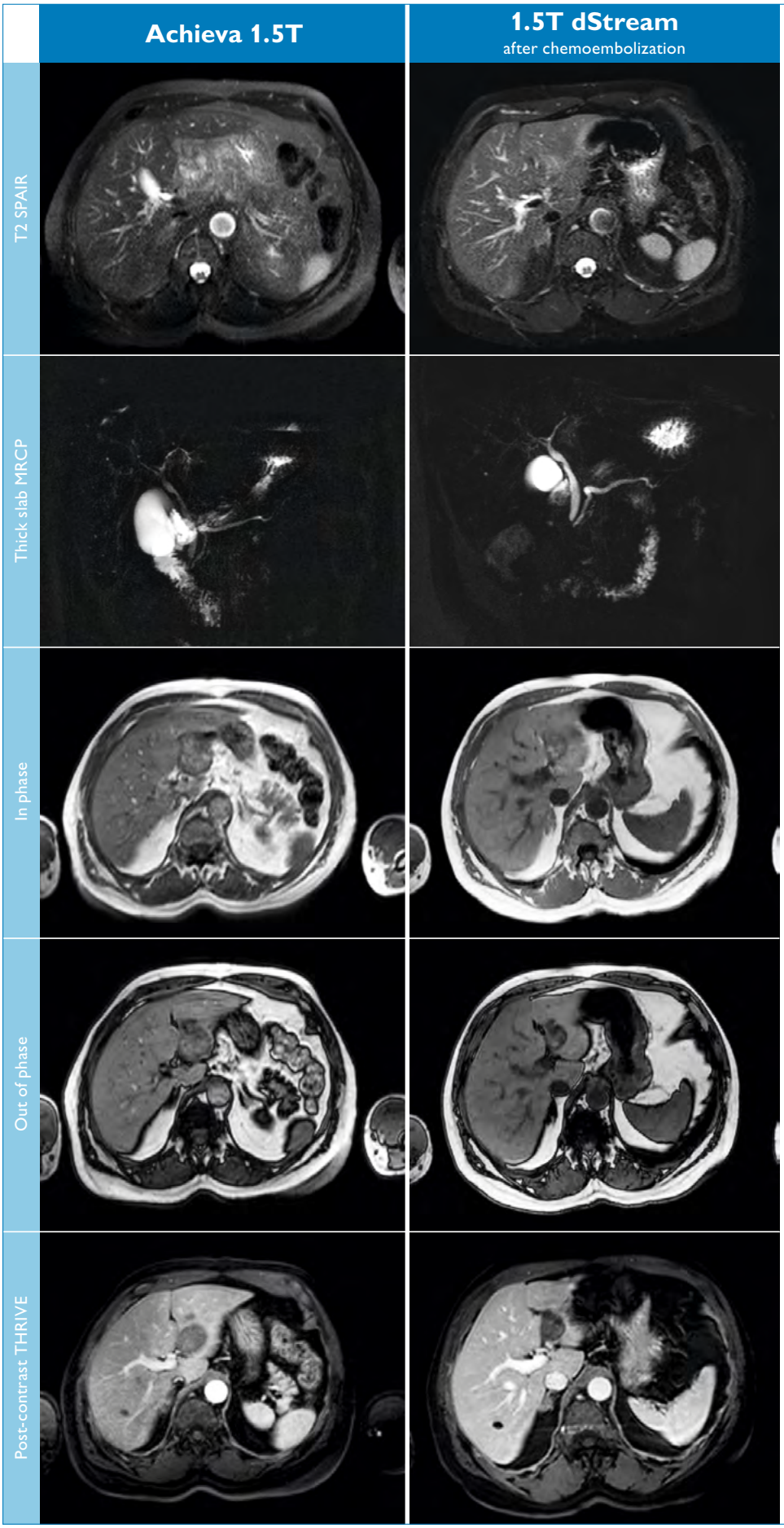



**Comparison before and after SmartPath to dStream**

A 70-year-old male diagnosed with hepatocellular carcinoma underwent MRI before and after chemoembolization. The first exam was performed on an Achieva 1.5T, the second exam in the same magnet following the SmartPath to dStream upgrade.

The comparison shows that imaging with dStream affords improved fat saturation, faster scan times and higher resolution post-contrast images in liver MR. The dStream images show better fat saturation and better liver signal on T2 SPAIR, better MRCP background suppression, less inhomogeneities on in-phase and out-of-phase images. In particular, on the THRIVE sequence, we have better resolution as the slice thickness decreased from 3 mm to 2 mm, while maintaining a similar matrix and FOV. On the T2 SPAIR sequence, we have reduced the slice thickness from 8.5 mm with a 1.5 mm gap to 6.6 mm with a 0.6 mm gap.

In short, combining SENSE and dStream results in improved SNR, which we are able to use either in a shorter scan time or to obtain an image with improved resolution, or both. We are seeing higher resolution while maintaining breath-hold times under 15 seconds.

Courtesy of Gopal Punjabi, MD, HCMC.

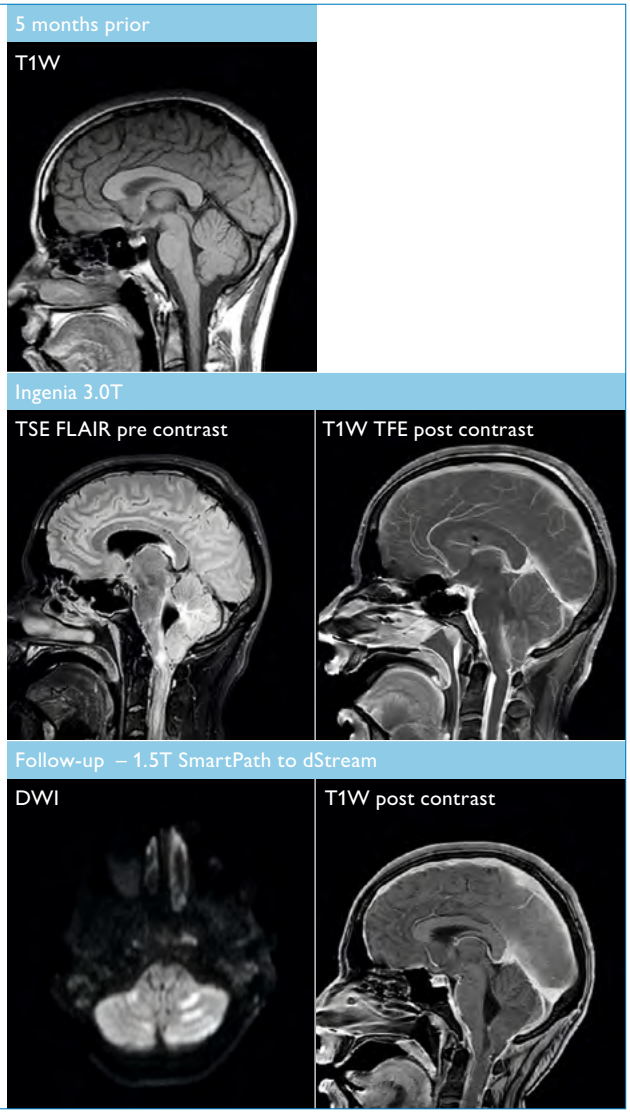
### Hydrocephalus secondary to meningitis and cerebellitis

A 21-year-old man with a history of seizures presented with headache and fevers. A prior study performed at 1.5T (at an outside institution) was unremarkable. The sagittal T1-weighted image reveals normal appearance of the posterior fossa and fourth ventricle. In particular, the cerebellar tonsils are in the normal location.

At the time of presentation, he underwent MR imaging on our Ingenia 3.0T. The sagittal reconstruction from 3D TSE FLAIR sequence shows dramatic signal and morphologic changes involving the posterior fossa and cervical spinal cord. The patient has already undergone ventriculostomy placement for acute hydrocephalus. The sagittal contrast-enhanced T1-weighted gradient echo image shows avid leptomeningeal enhancement. Diagnosis was acute hydrocephalus secondary to meningitis and cerebellitis.

A few months later, a follow-up exam on the 1.5T SmartPath to dStream system shows persistent diffusion restriction and meningeal enhancement. The sagittal contrast-enhanced T1-weighted gradient echo image shows avid leptomeningeal enhancement and tonsillar herniation. The axial diffusion weighted image shows persistent restricted diffusion of inferior cerebellar cortices, a consequence of meningitis and downward compressive forces secondary to acute hydrocephalus. While the continued contrast enhancement was not surprising, the MR images obtained in this patient revealed persistent findings on the DWI, presumably reflecting ongoing cerebellitis, either infectious, traumatic (compressive), or both. In any event, recovery has been very slow, as patient continues to be encephalopathic. Cerebellar tonsils continue to show downward herniation through the foramen magnum.

While 3.0T imaging is excellent, in reality these dStream 1.5T images are essentially comparable and clearly confirm the ongoing pathology.




"We're working toward sets of sequences that not only generate tremendous image quality, but that also take advantage of the increased SNR provided by dStream. We can either improve the signal within the same scan time, or cut scan time while keeping signal the same, or both. I think in our neuro work we've already done both."

### Enhancing productivity with digital coils and ExamCards

"Our technologists appreciate the upgrade to dStream as well, and patient throughput has improved because of it," says Dr. Truwit. "The digital coil connections and the coil built into the table dramatically changed our workflow. Of course, the techs were already used to it on the Ingenia scanners; they're greatly relieved that our last scanner is now up to speed. And ExamCards help to make scanning fast, easy and consistent; our techs also see terrific improvements there. When other MR users visit here, it's been interesting to see how much our MR technologists talk about this particular feature."

### Value for money

"For my money – for Hennepin County's citizens – SmartPath to dStream is a financial win," concludes Dr. Truwit. "Yes, it costs money, but it's less money than a new system. Philips dStream is a tried and true technology now. Upgrading to a dStream system without having to pull the bore out is a great achievement. This really puts Philips in a lass of its own."

*"Upgrading to a dStream system without having to pull the bore out is a great achievement. This really puts Philips in a class of its own."*

**Guangbin Wang, MD, PhD**, is the Chief of MRI at the Shandong Medical Imaging Research Institute, and Professor of Radiology at the Shandong University School of Medicine. He earned his Medical Doctor and Medical Master degrees at Shandong University Medical School, and his Medical Bachelor degree at Qingdao Medical College.

# MR neurography allows clear visualization of peripheral nerves

## Shandong Medical Imaging Research Institute explores DWIBS for MR neurography in extremities

Patients with unexplained pain in the extremities often suspect a muscle, tendon or ligament injury, particularly when exams prove inconclusive. However, at times the actual culprit is pathology of the nerves. At Shandong Medical Imaging Research Institute (PR China), MR neurography is illuminating nerve pathology, making a clinical impact by adding significantly to the findings collected via ultrasound or electromyography.

*"MR neurography has high spatial resolution and a large field of view, so it can help to confirm ultrasound findings when they are inconclusive."*

The Shandong Medical Imaging Research Institute uses four MR systems to provide MR imaging to approximately 200 patients each day. Affiliated with Shandong Medical School, the Shandong Medical Imaging Research Institute is one of the largest medical imaging institutes integrating medical imaging diagnosis, interventional treatment, scientific research and talent training in China.

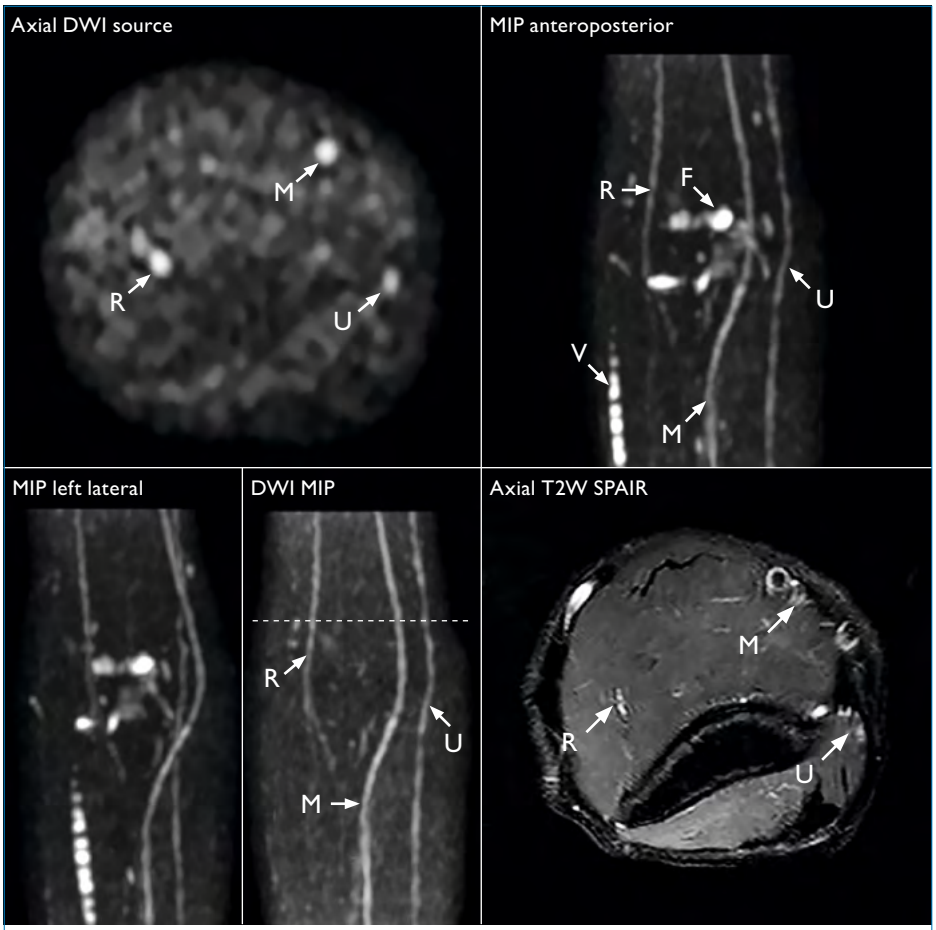
### MR is important adjunct

Guangbin Wang, MD, PhD, Professor of radiology and chief of MRI at the research institute, has recently been exploring how DWIBS (diffusion weighted whole body imaging with background body signal suppression) can be used for MR neurography (MRN) of the peripheral nervous system.

Large FOV DWIBS is already in use for imaging patients with multiple lesions, for instance oncology patients. Its high contrast-to-noise ratio makes it particularly valuable when evaluating small lesions. This strength is also what makes it valuable in MR neurography, which has become an adjunct to ultrasound and electromyography in diagnosing peripheral nerve problems.

### Demonstrates both lesions and nerve damage caused by trauma

Because ultrasound is convenient and less costly, it is a natural first choice for nerve imaging. "However, sometimes ultrasound cannot demonstrate nerve lesions clearly, and the field of view isn't large," Dr. Wang says. "MR neurography has high spatial resolution and a large field of view, so it can help to confirm ultrasound findings when they are inconclusive."




**MR neurography in right elbow**

A 26-year-old healthy male volunteer was examined on Achieva 3.0T TX with SENSE Flex L coil, patient in head-first position, scan time 3:54 min.

The axial DW source image shows the median (M), ulnar (U), and radial (R) nerves. On postprocessed full-volume MIP images in anteroposterior and left lateral projections nerves, articular fluids (F) and vessels (V) show hyperintensity. However, nerves can be easily separated from articular fluids and vessels by rotating in different projections. The postprocessed DW image with MIP reconstruction and volume editing in anteroposterior projection demonstrates the median (M), ulnar (U), and radial (R) nerves. Articular fluids and vessels were removed from this image during postprocessing. Axial T2-weighted SPAIR obtained at same level also shows the median (M), ulnar (U), and radial (R) nerves, but not clearly as MR neurography.

**Lumbar MR neurography**

DWIBS of the lumbar nerve in a 23-year-old healthy male volunteer. Achieva 3.0T TX with 16-channel SENSE XL Torso coil, scan time 3:54 min.

Dr. Wang notes that even when ultrasound or electromyography results in a conclusive diagnosis, MR can be useful to add information for surgical planning. "If ultrasound or electromyography cannot demonstrate the exact position of the lesion, it is difficult to do surgery," he explains. "But after an MR examination, we can demonstrate the lesion's position and shape which can help us determine which type of lesion it is. We give the MRI images to the surgeon to review before the operation."

"MR neurography is also used for patients who have nerve damage as a result of trauma," he adds. "When a patient presents with pain or paralysis, we try to pinpoint the cause." In some cases, the patient history can be used to determine if the pain or paralysis was caused by trauma. "But in other cases, the problem cannot be traced back to a single incident," Dr. Wang says. "In those cases, MR can sometimes help to visualize tumor or inflammation when ultrasound cannot."

"If the patient has a tumor, surgery may be needed. If the pain is caused by inflammation or distortion of the nerve, there are drug treatments available," he says. "The patient history is very important for a clinical diagnosis, but a physician cannot make diagnosis only on history."

## Diagnosing twisted nerves

Dr. Wang points to twisted nerves as a good example of how DWIBS contributes to diagnoses that were very difficult to make without MR neurography. "In cases in the past, we suspected something could be wrong with the nerve, but we didn't realize it was twisted, because we couldn't visualize that on images," he says.

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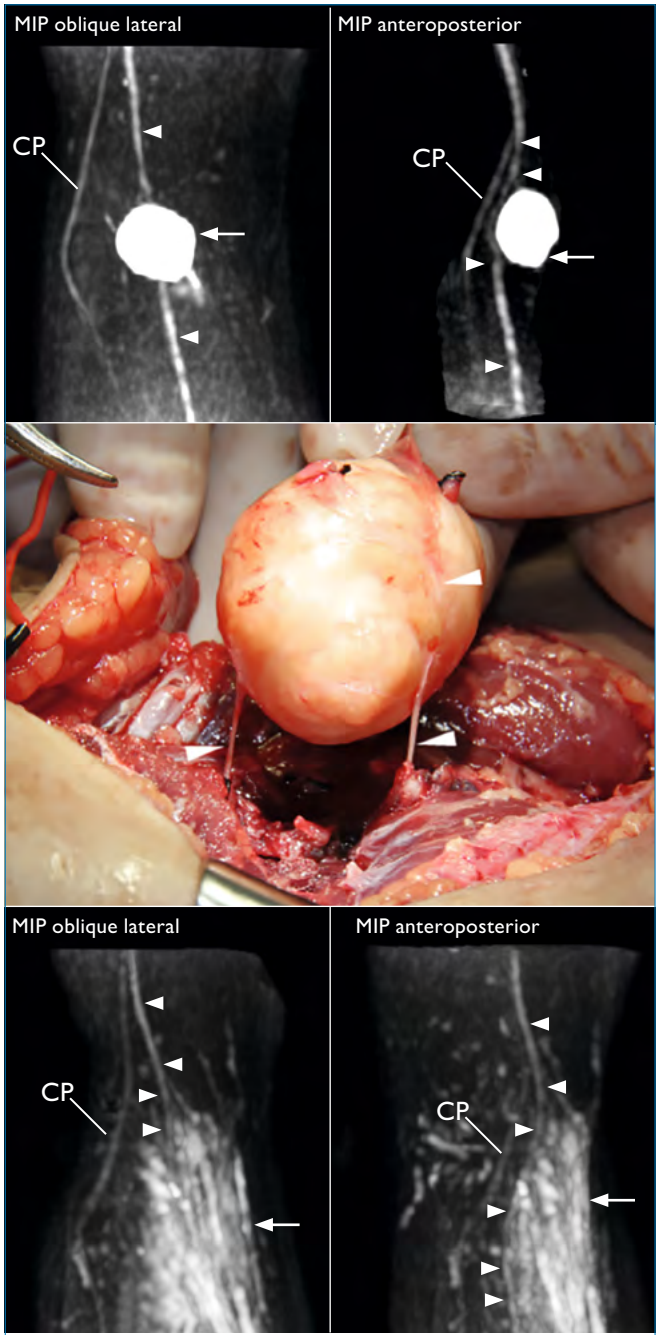
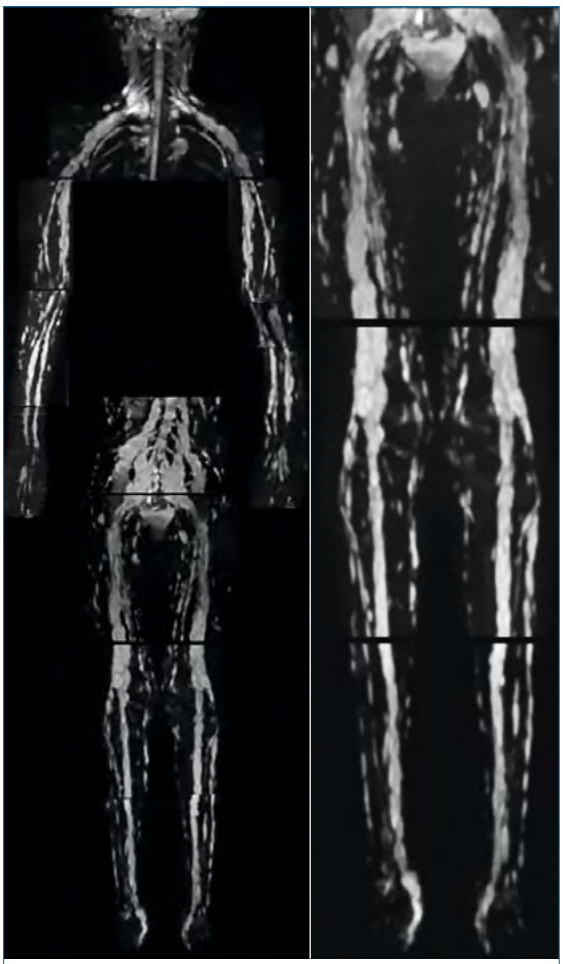



**Tibial nerve schwannoma**

A 31-year-old man with a painless mass in the right leg underwent MR neurography on Achieva 3.0T TX with 8-channel SENSE Knee coil, scan time 3:54 min. MIP in oblique lateral and anteroposterior projection shows extrinsic appearance of the mass (arrow) relative to a compressed and anteriorly displaced right tibial nerve (arrowheads). The common peroneal nerve (CP) is normal. The intraoperative photograph shows the proximal tibial nerve entering the mass and the distal tibial nerve exiting the mass and fascicles (arrowheads) running over surface of mass. Histology demonstrated tibial nerve schwannoma.

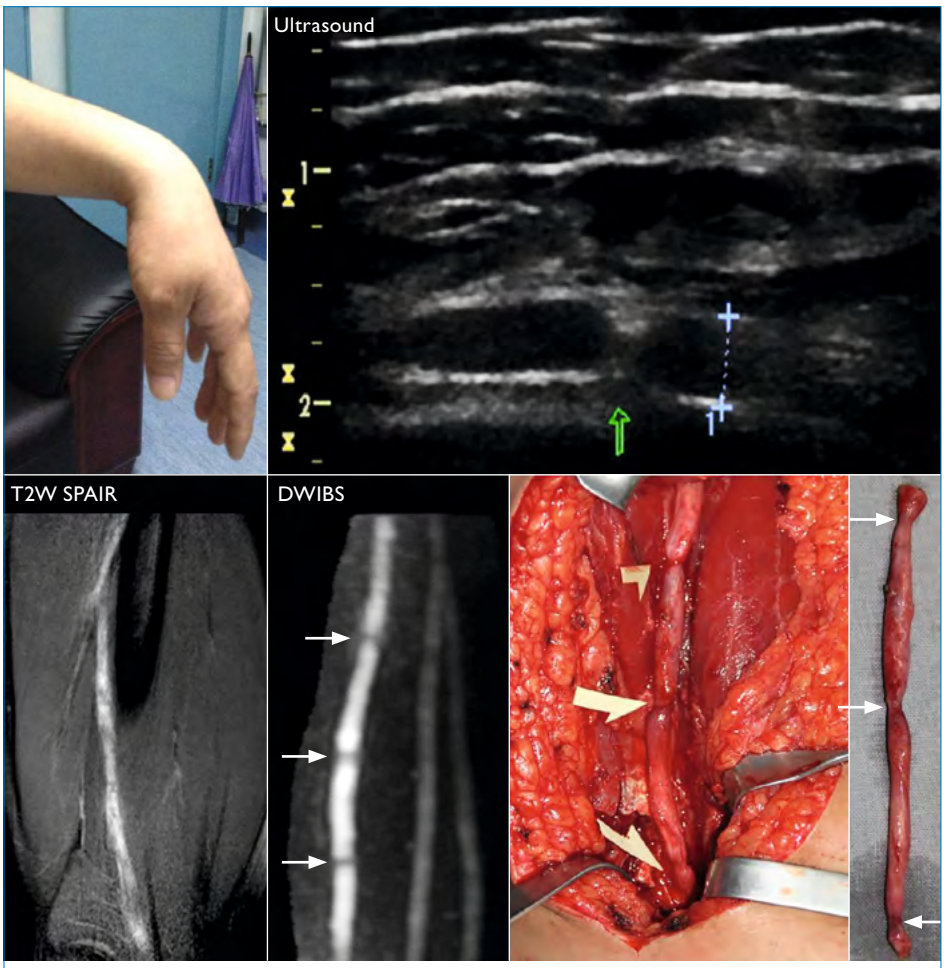
Two months after surgery, follow-up MR neurography in oblique lateral and anteroposterior projection show that it is difficult to differentiate the tibial nerve (arrowheads) from surrounding hypertense tissues in the surgical area.



**Whole body MR neurography in neurofibromatosis**

A 21-year-old woman with multiple masses and atrophy of upper and lower extremities. Plexiform masses along upper and lower extremity nerves and discrete masses in lower extremities are clearly displayed on the anteroposterior projection DWIBS image. Pathological diagnosis is neurofibromatosis (Achieva 3.0T TX).

*"Radiologists are beginning to recognize that we can view disease with a new angle using MR neurography."*




**Paralysis of hand due to radial nerve fascicle torsion**
A 23-year-old male miner with left hand paralysis for three 3 days. Ultrasound shows one hourglass-shaped appearance in the radial nerve fascicle. Coronal T2-weighted SPAIR MRI shows multi-segmental hypointensities. DWIBS demonstrates three segmental hypointensity lesions on the left radial nerve fascicle (Achieva 3.0T TX with Flex L coil, scan time 3:54 min.). Intraoperative photographs shows three segmental hourglass-shaped lesions on the left radial nerve, correspondings to the DWIBS findings. Pathological diagnosis is left radial nerve fascicle torsion.

*"An MR examination can demonstrate the lesion's position and shape. We give the MRI images to the surgeon to review before the operation."*

"Before we started using DWIBS for MR neurography, we were using both T1 and T2 STIR," he explains. "However, we were not satisfied with these STIR techniques for demonstrating lesions near nerves. Using DWIBS, we have even been able to image the ulnar nerve, over its full length, which is about 2 mm in diameter."

## Achieva well-suited for MR neurography

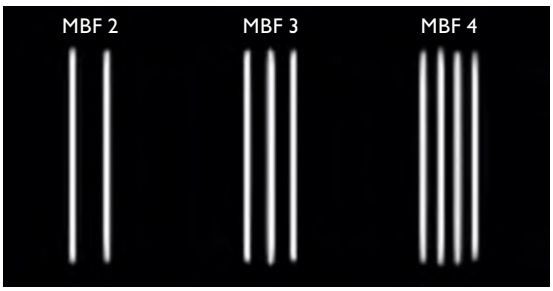
To date, Dr. Wang has studied 51 patients, as well as approximately 50 normal volunteers. All studies were conducted on the Achieva 3.0T TX system, with scan times of 3-5 minutes. Although Shandong has two other 3.0T systems, as well as a 1.5T system, Dr. Wang says that the Achieva 3.0T TX is the only one currently being used for MR neurography. "MultiTransmit helps to shortens scan times and avoid distortion. We get very good contrast between nerves and other soft tissues," he says. Achieva features high gradient linearity, which is particularly important in diffusion weighted imaging for consistent contrast and low geometrical distortion.

"Radiologists are beginning to recognize that we can view disease with a new angle using MR neurography," Dr. Wang concludes. "While ultrasound may always be used first, I think MR neurography can also become common clinical practice."

# Multi-band SENSE to improve imaging speed

As long as MR imaging has existed, there have been ongoing efforts to make it faster. SENSE parallel imaging, a Philips first, has been a breakthrough allowing to cut scan times. After the introduction of dStream, dS SENSE acceleration factors of around 4 are in use in clinical practice.

This article explores possibilities to speed up scanning by simultaneous excitation of two or more slices. Using Multi-band excitation pulses to excite multiple slices at the same time and then acquire the slices simultaneously can speed up scanning. For unfolding the acquired data into images of the two separate slices, the signal from multiple coil elements is processed using a SENSE algorithm.



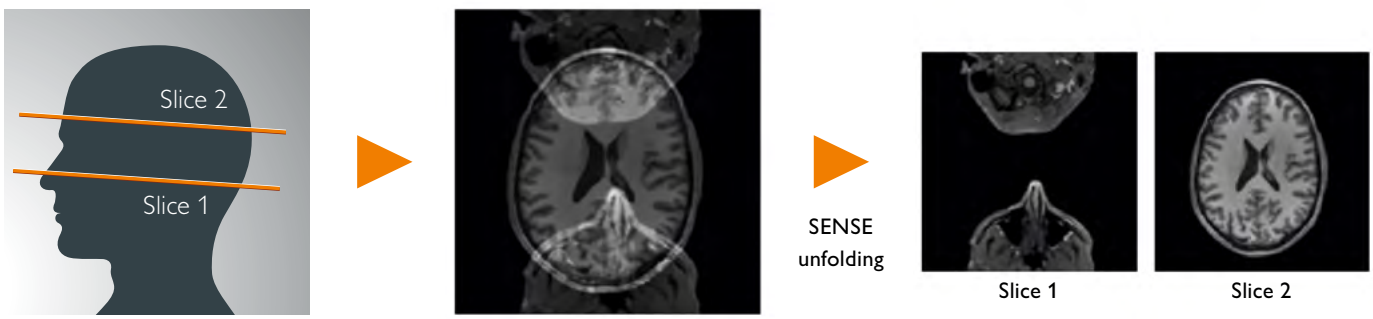

Slice profiles for single shot SE EPI with simultaneous excitation of 2, 3 and 4 slices (Multi-band factors 2, 3 and 4).

## Simultaneous excitation of two or more slices

Using so-called wide-band or multi-band pulses, it is possible to excite multiple slices simultaneously, as illustrated in the figure.

After exciting and acquiring two slices at the same time, the signal measured afterwards is the combination of signals from both slices, so that the resulting image will be the sum of both slices. Applying a SENSE unfolding algorithm allows calculation of the separate images. However, this unfolding can be difficult when coil sensitivity profiles are similar for the two slices, for instance when the distance between slices is small and slices have little difference in geometry factor (g-factor).

## Simultaneous excitation with phase shift: Multi-band SENSE




Simultaneous excitation with phase shift between slices

Measured image

To make unfolding the images easier, a phase shift is applied between the slices during the simultaneous excitation[1,2]. This phase shift increases the distance between aliasing voxels, which facilitates unfolding. For FFE type of images, a phase shift between the slices can be obtained by alternating the phase of the excitation pulses for each k-space line[1]. For example, by switching the excitation pulse 180° for every second line in k-space, a shift of a half FOV is introduced in one of the images.

For single shot EPI acquisitions this approach is not possible, as the entire slice is acquired in a single shot. Therefore, for EPI type of acquisitions gradient blips are played out to achieve a shift[2].

In this manner, it is possible to acquire two slices in the time normally needed to acquire a single slice. This method is called Multi-band SENSE and can also be applied for simultaneous excitation of 3 or 4 slices for further speed-up.

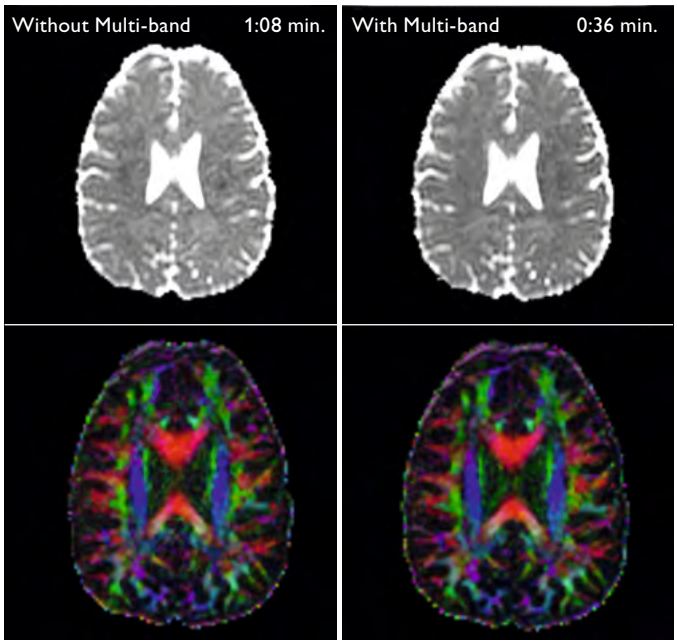
## Preserving high SNR

When applying parallel imaging methods such as SENSE, it is important to consider how SNR is affected. As SNR is proportional to the square root of the number of data points, for normal SENSE acquisitions SNR is reduced by a factor equal to the square root of the acceleration factor R. In addition, SNR depends on the g-factor of the coil setup used, as represented in the formula below.

$$SNR_{sense} = \frac{SNR_{full}}{g\sqrt{R}}$$

With Multi-band SENSE all data is acquired, so there's no intrinsic penalty on SNR because of the acceleration factor. Only g-factor penalties remain. However, as a result of the slice shifting, the g-factor is more favorable compared to plain SENSE, which implies only a very limited impact on SNR:

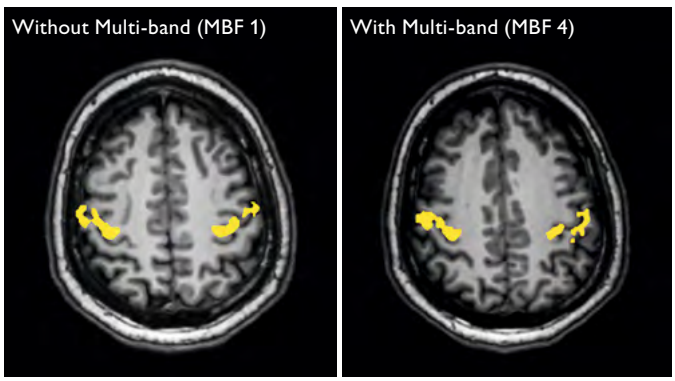
$$SNR_{MB\text{-}sense} = \frac{SNR_{full}}{g}$$




In this example of DTI (6 directions) and FA, adding Multi-band SENSE reduces scan time by almost 50% with comparable SNR (Ingenia 3.0T).

## Multi-band SENSE to speed-up fMRI and DTI

Multi-band SENSE currently attracts a lot of attention among MR scientists. Since the introduction of the blipped approach that allows use of multi-band techniques with EPI read-outs, the possibility to speed up methods like fMRI and DWI/DTI is explored. Initial results show that these types of scans can be performed faster or with higher spatial resolution, which could add to the clinical usefulness of these techniques.



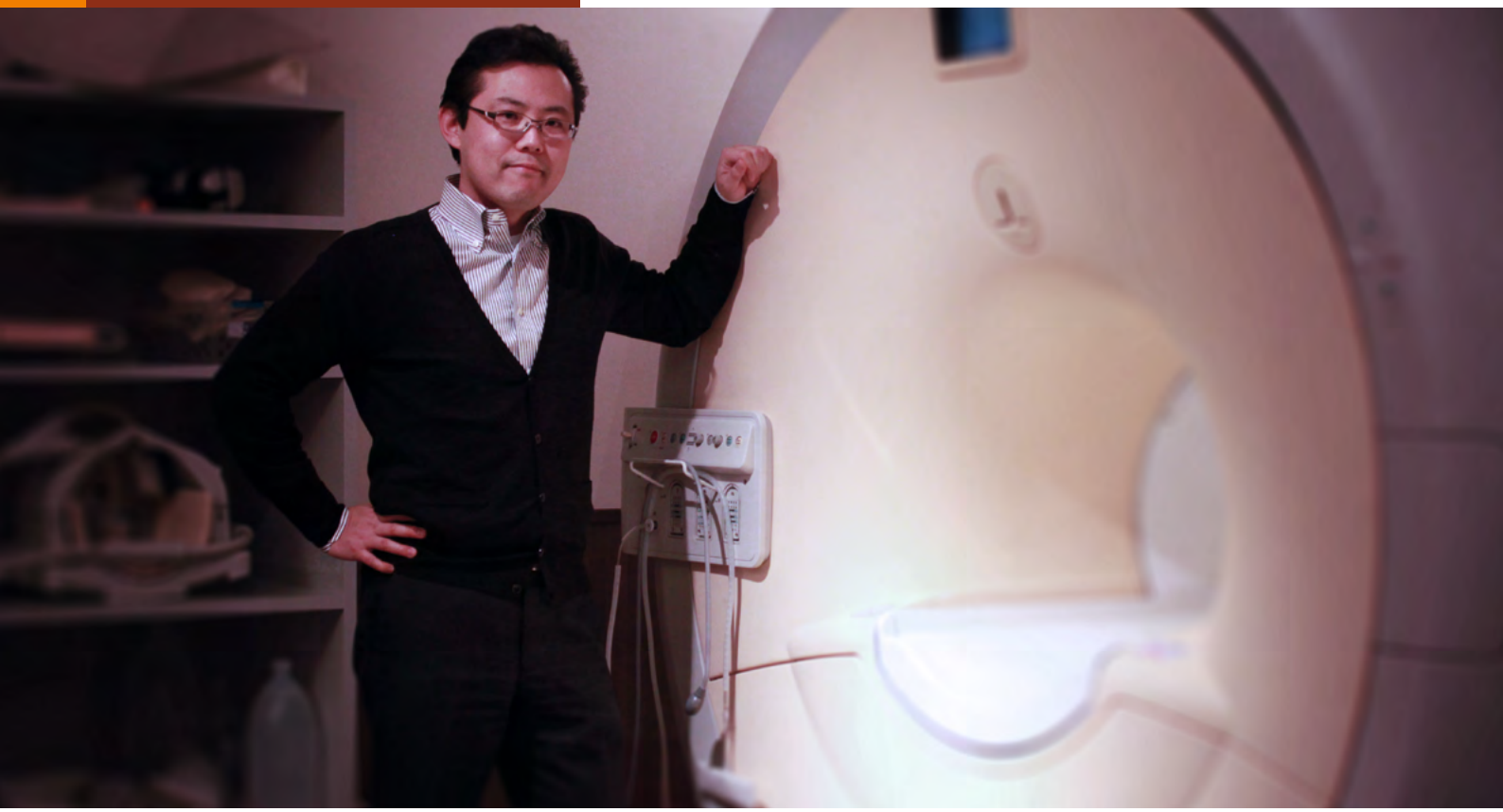

Comparison of BOLD hemodynamic response for a finger tapping fMRI paradigm using single shot FE EPI without Multi-band SENSE (left) and with Multi-band SENSE for simultaneous excitation of 4 slices (right). Ingenia 3.0T with 32-channel Head coil, voxels 2.4 x 2.4 x 4 mm. Without Multi-band TR is 3000 ms, with 4-slice Multi-band TR is 697 ms.

### Multi-band SENSE research demonstrates:

- Scan time reduction by a factor of 2 to 4 is possible
- SNR loss is minimal
- It can be combined with in-plane SENSE

## References


1. Breuer FA, Blaimer M, Heidemann RM, Mueller MF, Griswold MA, Jakob PM
   *Controlled aliasing in parallel imaging results in higher acceleration (CAIPIRINHA) for multi-slice imaging*
   Magn Reson Med 2005;53: 684-691
2. Setsompop K, Gagoski BA, Polimeni JR, Witzel T, Wedeen VJ, Wald LL
   *Blipped-Controlled Aliasing in Parallel Imaging for Simultaneous Multislice Echo Planar Imaging With Reduced g-Factor Penalty*
   Magn Reson Med 2012;67:1210–1224



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# Enhancing susceptibility weighted imaging through collaborative research

**Kumamoto University Hospital, Japan, contributes to the development of Philips susceptibility weighted imaging technology**

At Philips we listen to our customers and continuously collaborate with our clinical partners on developing, testing and evaluating new methods. The insights and contributions of our customers feed into the development of new or improved features.

*"I explored the possibility to make the method sensitive to diamagnetic materials, which could also allow visualization of accumulations containing diamagnetic materials."*

When Tetsuya Yoneda, PhD, physicist at Kumamoto University Hospital in Japan, had discussed his ideas on susceptibility weighted imaging with the Philips Japan clinical science team, it was the start of a fruitful collaboration. The results helped the Philips product development team.

Susceptibility weighted imaging is an MR imaging technique used to visualize susceptibility differences between tissues. Magnetic susceptibility represents the ability of a tissue to become magnetized in a magnetic field. Tissues and substances behave differently in a magnetic field, because they have different paramagnetic and diamagnetic properties that influence T2* and phase.

"The aim in susceptibility weighted imaging is to enhance contrast between materials with different susceptibility to visualize, for instance, deoxygenated blood as a result of the exposed iron it contains. Deoxygenated blood also appears dark on T2*-weighted images, but the sensitivity is higher on susceptibility weighted imaging," says Dr. Yoneda.

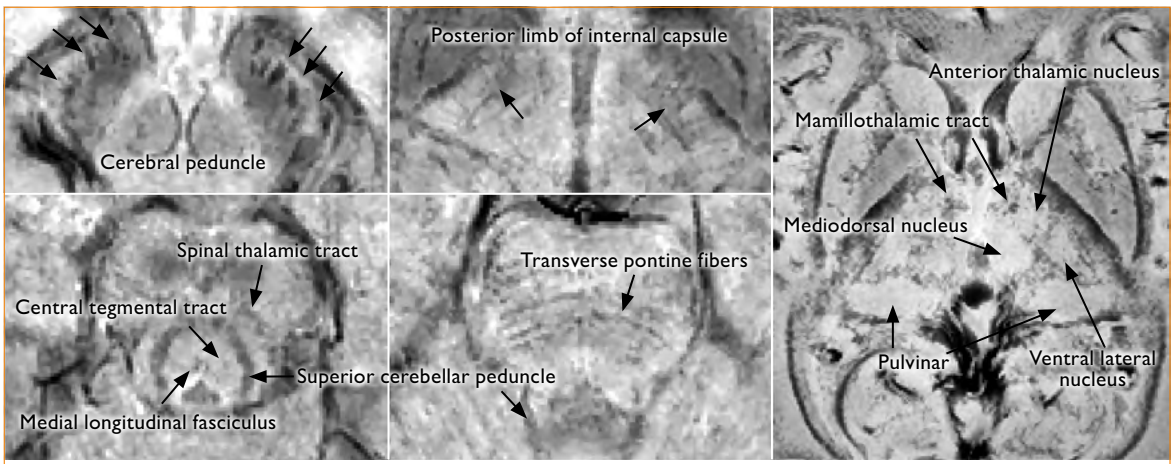
"Susceptibility weighted imaging also uses phase information, which depends on field strength, so the effect is stronger on a 3.0T system," says Dr. Yoneda. "That is why we worked with the Achieva 3.0T TX system. We mainly use the 32-channel head coil as it provides very nice quality imaging."

## Redesigning data reconstruction

"I have worked on the reconstruction algorithm of susceptibility weighted imaging data. The initial susceptibility weighted imaging methods were based on differences in paramagnetic properties, which is sufficient to visualize hemorrhage that contains deoxygenated blood. Additionally, I explored the possibility to make the method sensitive to diamagnetic materials, which could also allow visualization of accumulations containing diamagnetic materials, such as calcifications."

## Balancing scan parameters

In collaboration with technologists, neuroradiologists, medical doctors and the Philips Japan MR team Dr. Yoneda finally achieved the desired results. "The mathematical function is now completely different. It enhances any kind of phase information and not just paramagnetic phase information like in the initial methods on our system," says Dr. Yoneda. "Another difference is that the method eliminates the phase-wrapping artifact from the phase information. That phase wrap arises from long TE, but a long TE is desirable to generate high contrast on the phase information, so we had to find a compromise to get the good contrast."




**Visualizing fine anatomical structures**

These images illustrate the power of the reconstruction with phase difference enhanced imaging (PADRE) to delineate fine anatomical structures. The left and middle images show many brainstem tracts with good contrast. These are very difficult to visualize on conventional MRI sequences. In the right image, neuronal nuclei in the thalamus are easily seen. The capability to delineate neuronal nuclei and tracts – with realistic scan duration, high spatial resolution, high contrast – may be a useful tool for investigating multiple system atrophy as in Parkinson's disease and surgical procedures such as deep brain stimulation.
Achieva 3.0T TX, 3D-T1FFE, 0.5 x 0.5 x 2.0 mm (1.0 mm overcontiguous), TE 23 ms, TR 32 ms, scan time 3:40 min.
Images courtesy of Dr. Kitajima, MD, Kumamoto University.

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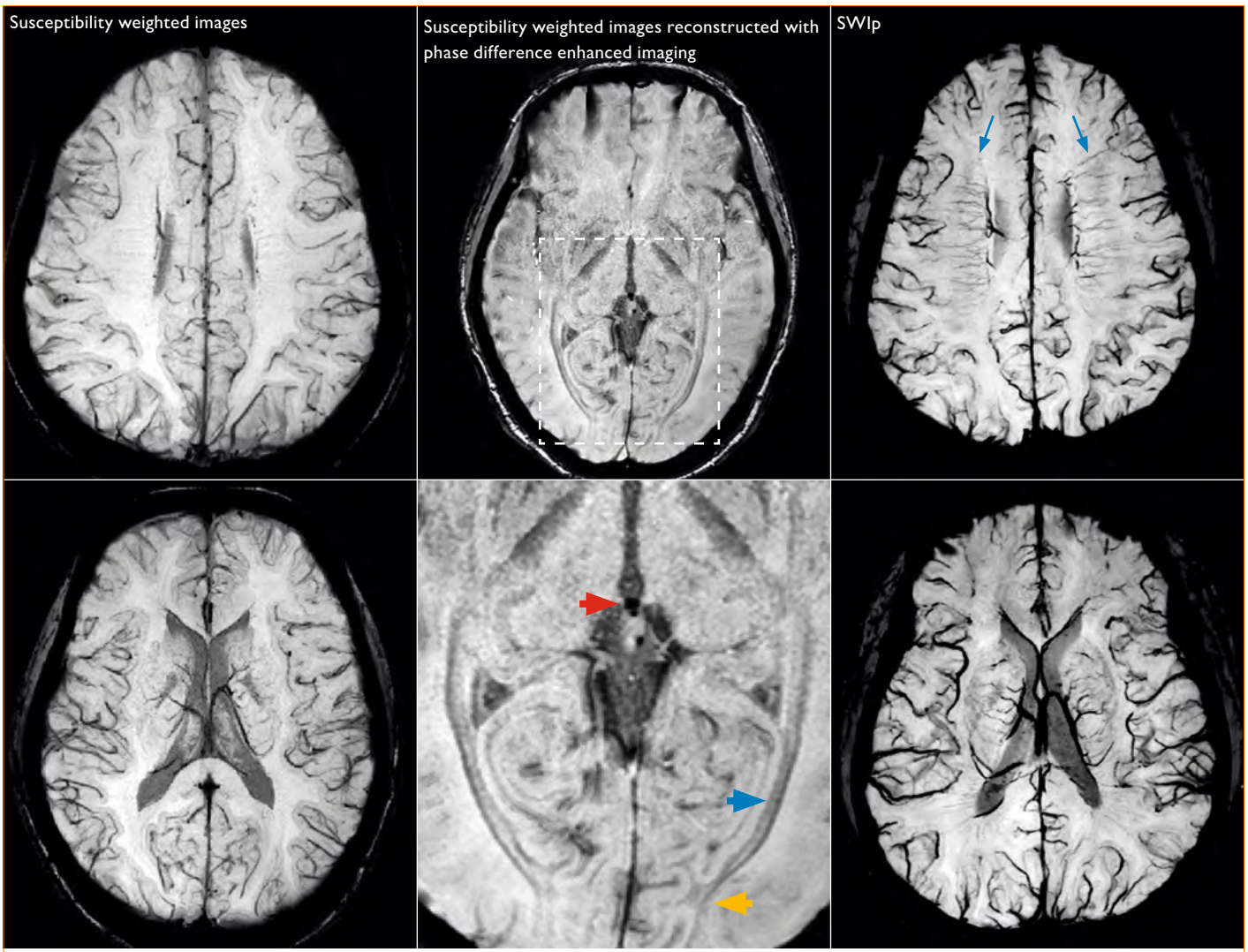



**Susceptibility weighted imaging**

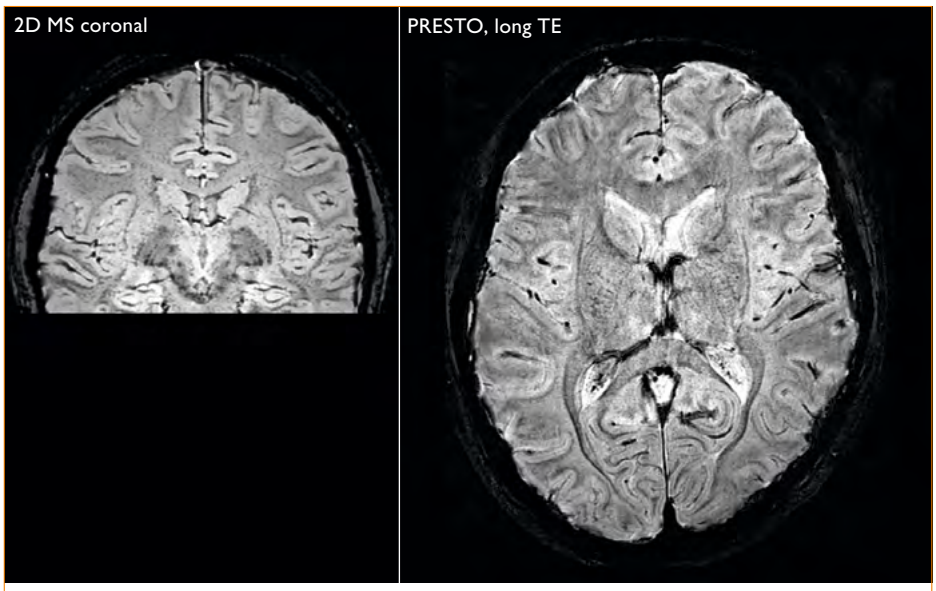
On the susceptibility weighted images many vessels are seen. The SWIp images show also small vessels, and with higher contrast. For instance, the deep medullary veins (blue arrows) are better delineated on the SWIp image. This high contrast delineation of vessels is realized with the multi-echo acquisition, where the short TE magnitude image is used to create a high-signal background with low signal susceptibility artifact; the long TE phase image information is used to create high vessel contrast; and scan time is kept short. The susceptibility weighted images reconstructed with phase difference enhanced imaging (PADRE) show calcification in the pineal body (red arrow). The zoomed image shows white matter tracts such as the optic radiation (blue arrow) which reaches the occipital lobe (orange arrow).

The susceptibility weighted images are acquired by Dr. Yoneda using Achieva 3.0T TX, 3D-T1FFE, 0.45 x 0.45 x 2.0 mm (1.0 mm overcontiguous), TE 20 ms, TR 23 ms. The SWIp images are acquired by Philips using Ingenia 3.0T, 0.4 x 0.6 x 1.0 mm (0.5 mm overcontiguous), TE 7.2, 14.7, 22.2, 29.7 ms, TR 38 ms, SENSE 3.5, 4:08 min.

Kumamoto University Hospital

"High sensitivity for venous blood products makes it possible to see hemorrhage and even microbleeds," says Dr. Yoneda. "Using my method we have also imaged patients with neuro and brain diseases such as arteriovenous malformation, cortical displacement, degenerative diseases such as Parkinson's disease, multiple sclerosis and multiple system atrophy. We are hoping to extend our work to the rest of the body."

The collaboration between Dr. Yoneda and Philips is ongoing and focusing on further exploring together the potential of this technique.




**Different contrast types**

MRI has the ability to use different scan methods to create different contrast types, which is an advantage over other modalities. Usually only the magnitude images are used, but phase difference enhanced imaging reconstruction could be applied to different sequences. In this way, different sequences can naturally make different background contrast, resulting in various types of SWIp-like contrast. We are currently studying the use of PADRE in different sequences to explore whether this could provide useful additions in clinical scanning. Achieva 3.0T TX.

*"The aim in susceptibility weighted imaging is to enhance contrast between materials with different susceptibility to visualize, for instance, deoxygenated blood."*



# SWIp, a fast method with exquisite contrast

In the SWIp method that was launched at RSNA 2013, Philips has included Dr. Yoneda's algorithm in addition to some other innovations. SWIp is now in use at numerous sites around the world.

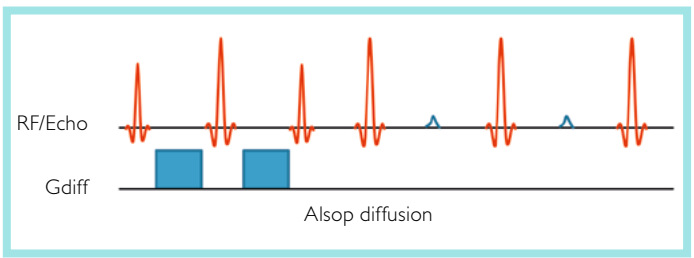
Philips SWIp technology delivers exquisite 3D high-resolution images with superb susceptibility contrast and a high sensitivity for venous blood products. This is due to a powerful combination of multi-echo acquisitions for high SNR and high image quality, along with image processing that is based on phase information. The short scan times and high reliability allow you to easily integrate it into your neuro exams. Phase maps can be made for advanced diagnosis.

# Distortion-free diffusion imaging with TSE

## Diffusion TSE provides high quality DWI in challenging areas

Diffusion weighted imaging (DWI) produces images where tissues or lesions with different diffusion characteristics stand out such as, for instance, oncologic lesions. For DWI in the brain, EPI read-out is frequently used because of the high speed and SNR it provides. However, in areas such as the skull base, the inner ear and the head/neck area, susceptibility differences can result in artifacts on gradient echo EPI images. As TSE sequences are inherently less sensitive to susceptibility differences, TSE-based diffusion can be a good alternative for these areas. At Philips we recently improved our Diffusion TSE method to better meet needs in clinical use.

**A TSE acquisition can be made sensitive to diffusion by using a gradient before and after the 180 degree refocusing pulse, as shown in the figure. This method is known as the Alsop method for Diffusion TSE.**

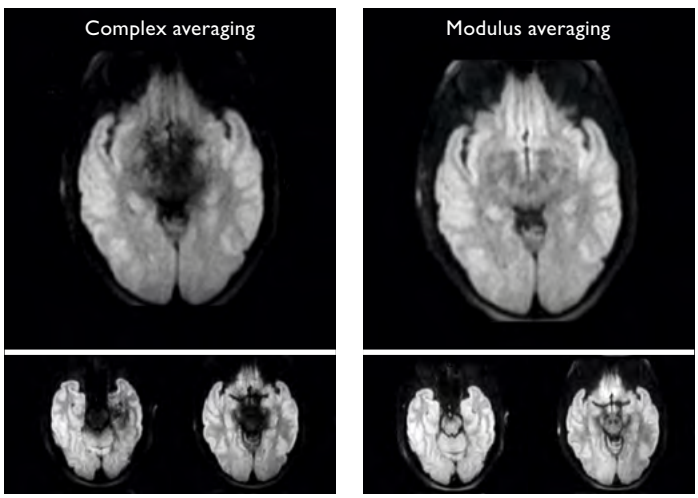



Alsop DC, Phase insensitive preparation of single-shot RARE: applications to diffusion imaging in humans. Magn Reson Med 1997;38:527-5331

**A main challenge in Diffusion TSE imaging, is to get sufficient SNR while maintaining sharp images. With the Alsop method as a starting point, we applied several optimizations to provide pristine image quality.**

### Phase artifacts addressed by averaging

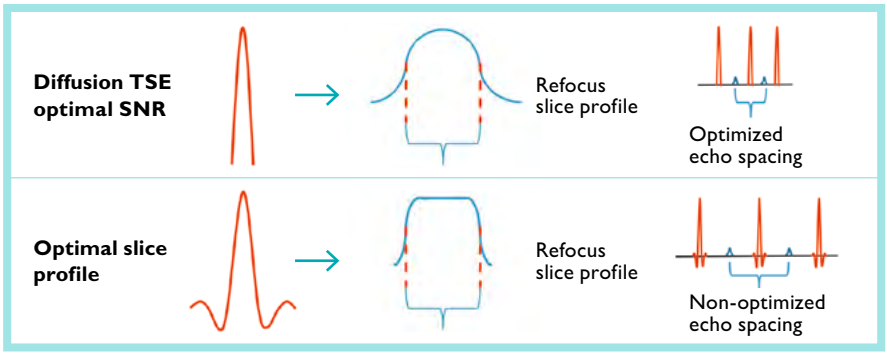
**Using modulus averaging in image space is important for good image quality. When complex averaging is used, phase artifacts can deteriorate image quality. The images on the right show image quality differences between the two methods, especially in areas of high susceptibility.**



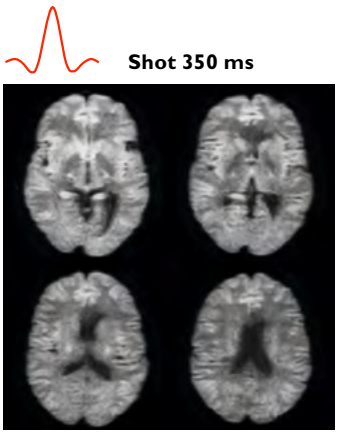

Ingenia 3.0T

### RF pulse shape adapted for faster scanning and reduced blurring

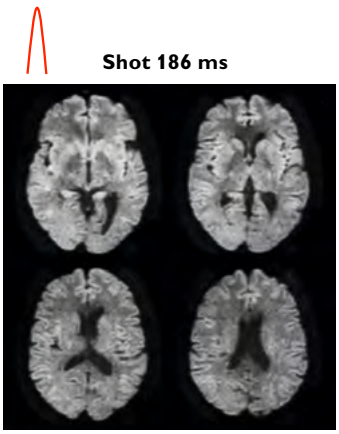
To produce an optimal slice profile, Diffusion TSE by default involves a long RF pulse that produces a very nice refocusing slice profile. We have implemented a shorter RF pulse in the Diffusion TSE method to obtain optimal SNR. This short pulse produces a refocusing slice profile that is somewhat less perfect, but allows to reduce the length of the TSE train.




The short RF pulse will reduce blurring because the echo spacing will become shorter and therefore the shot length will become shorter. Additionally, the short RF pulse will slightly increase SNR due to the shorter shot length enabled. Note that your sequence parameter combination automatically determines which RF pulse will be applied.



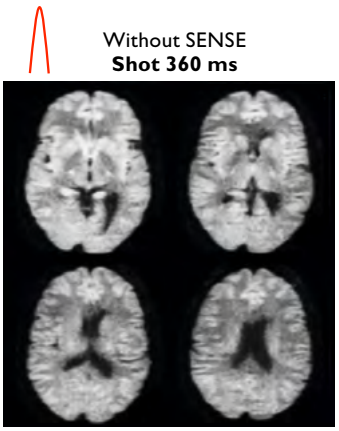

TE 79 ms, echo spacing 7.4 ms, SENSE factor 2



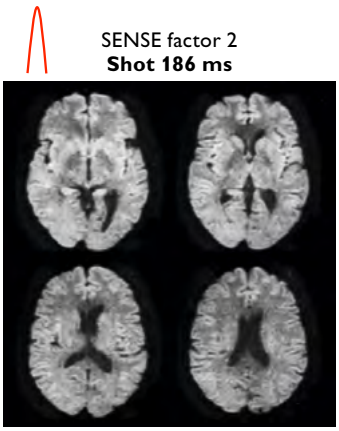

TE 69 ms, TSE echo spacing 4.0 ms, SENSE factor 2

### Compatible with SENSE to benefit quality

Adding SENSE to Diffusion TSE further reduces the shot length, which makes the pulse train shorter, which has a positive effect on the blurring. It also enables single shot Diffusion TSE, avoiding the need for phase navigation and providing robust image quality.




TE 69 ms, TSE echo spacing 4.0 ms




TE=69, TSE echo spacing 4.0 ms

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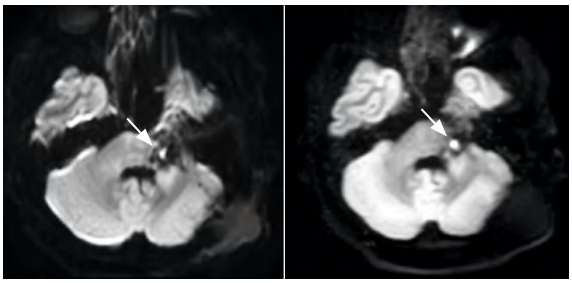
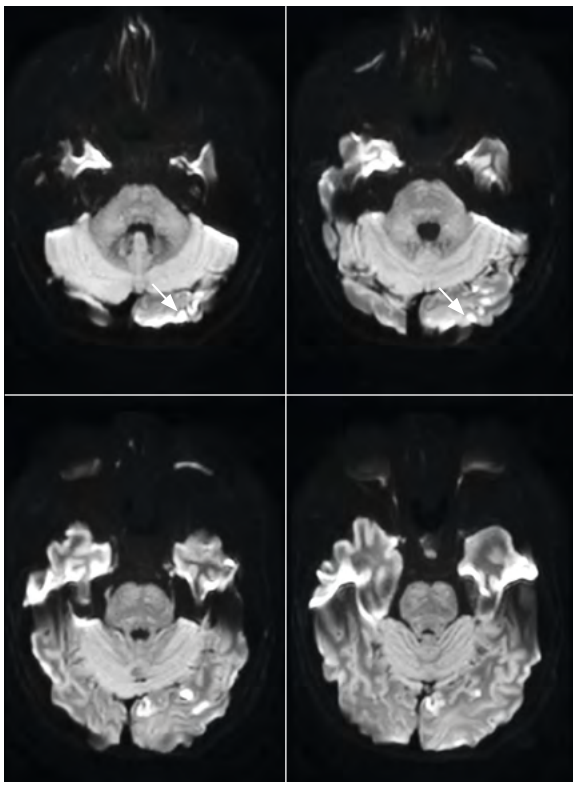
# Advantages in clinical practice

**The clinical examples demonstrate the performance of Diffusion TSE in an area with large susceptibility differences. The Diffusion TSE images show better image quality than EPI diffusion in this anatomy.**

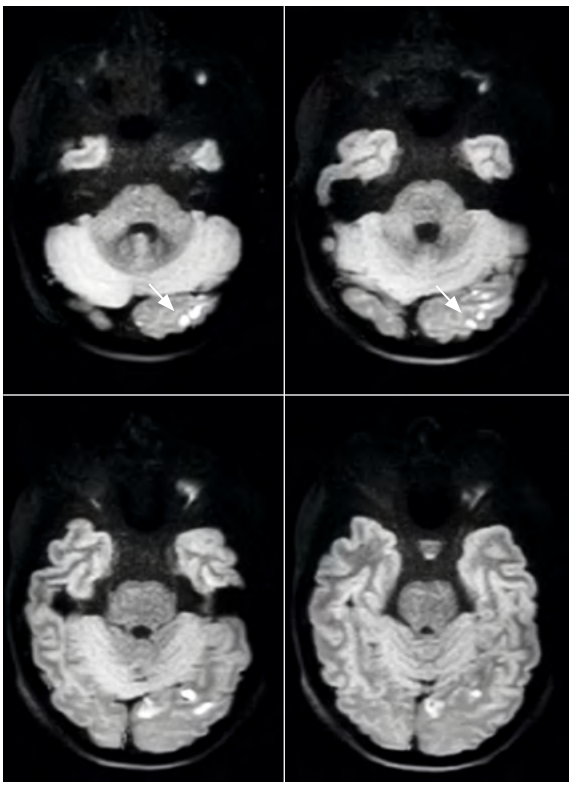


Diffusion EPI Diffusion TSE

Courtesy of Dr. R.K. Gupta, Fortis Memorial Research Institute, Gurgaon, India.



Diffusion EPI



Diffusion TSE

In the EPI diffusion it is difficult to discriminate the lesions from artifacts. In the Diffusion TSE images the lesions are clearly visible. Courtesy of Dr. J. Casselman, AZ St. Jan Brugge, Belgium.


## Summary

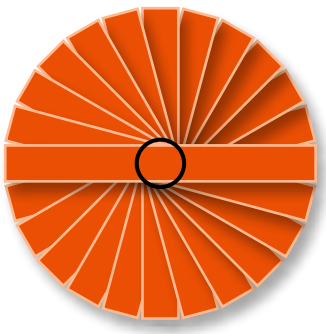
Single shot Diffusion TSE in combination with SENSE delivers robust image quality. It is available on systems delivered after the second quarter of 2014 and preset protocols can be found on the system for transverse skull base imaging and for inner ear imaging.

# MultiVane XD – next generation motion-free imaging

Philips is committed to driving clinical performance by providing premium image quality. Our goal is to consistently deliver diagnostic information in an efficient time slot. MultiVane XD is one of the pillars this builds on; it provides superb motion-free imaging by using robust motion correction. It can be combined with dS SENSE for a high-speed exam.

## MultiVane XD, a robust option that offers more

The Philips MultiVane technique has been in use for some years and has now found an improved successor in MultiVane XD. In MultiVane, data are collected in concentric rectangular blades rotated around the k-space origin. The central region of k-space is sampled for every blade, so the center of k-space is oversampled.

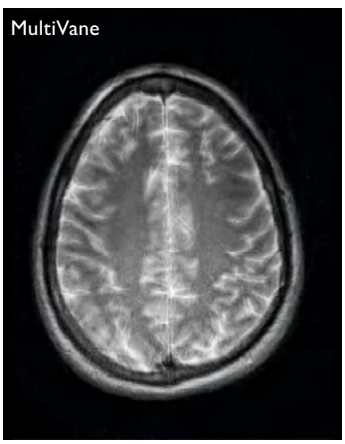


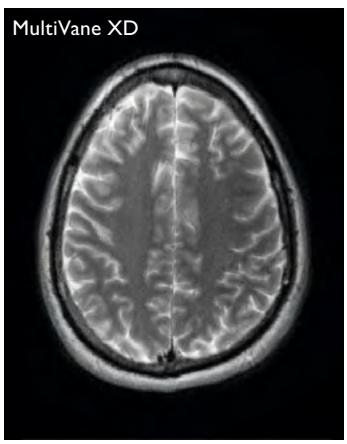
MultiVane data collection in k-space

At the heart of MultiVane XD is an extended reconstruction algorithm[1]. It contains a smart way of analyzing and correcting blades such that image distortions due to both translational and rotational components of rigid body motion are removed. Additionally, the k-space center of blades corrupted with through-plane motion is removed to further decrease motion artifacts.

MultiVane XD can be combined with dS SENSE in all directions to increase acquisition speeds.

MultiVane XD image quality was tested in a study at Barrow Neurological Institute using Ingenia 3.0T[1]. In 99% of image comparisons in volunteers with no motion, small motion or moderate motion, the MultiVane XD image was rated equal to or better than the standard MultiVane image.




## MultiVane XD protocol considerations

In addition to T2W-TSE, FLAIR and T1-FLAIR protocols that were already available with MultiVane, T2*-FFE imaging is now enabled by MultiVane XD. MultiVane XD protocols are available for several anatomies.

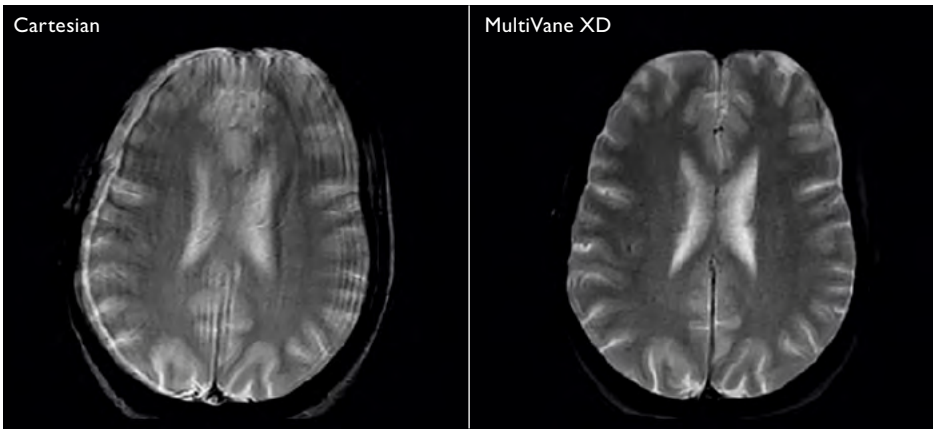
With the extended algorithm[1], the gross motion correction is more robust. It can be switched on in the Motion tab. It is recommended to use minimum or small WFS to prevent water/fat displacement in combination with MultiVane XD.


## References

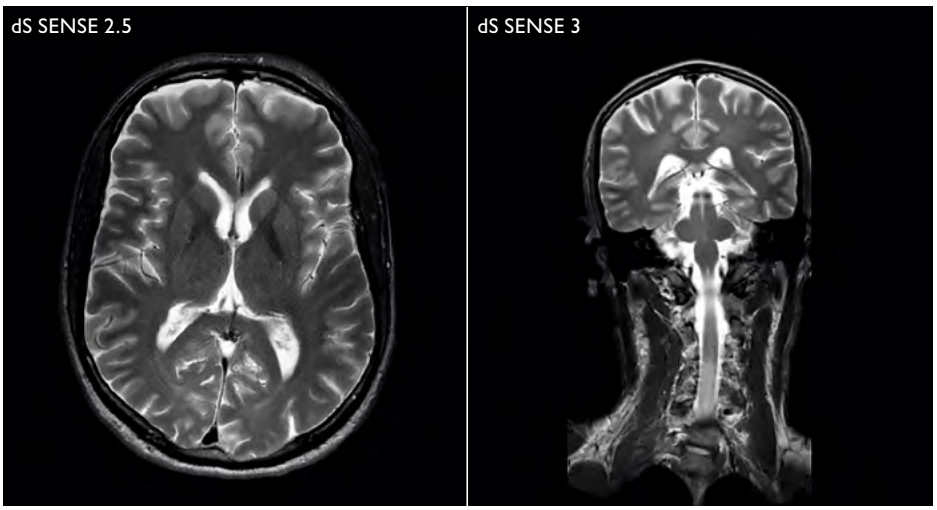
1. Pipe JG, Gibbs WN, Li Z, Karis JP, Schar M, Zwart NR
*Revised motion estimation algorithm for PROPELLER MRI*
Magn Reson Med. 2013 Sep 4. doi: 10.1002/mrm.24929 (Epub ahead of print)

CONTINUE

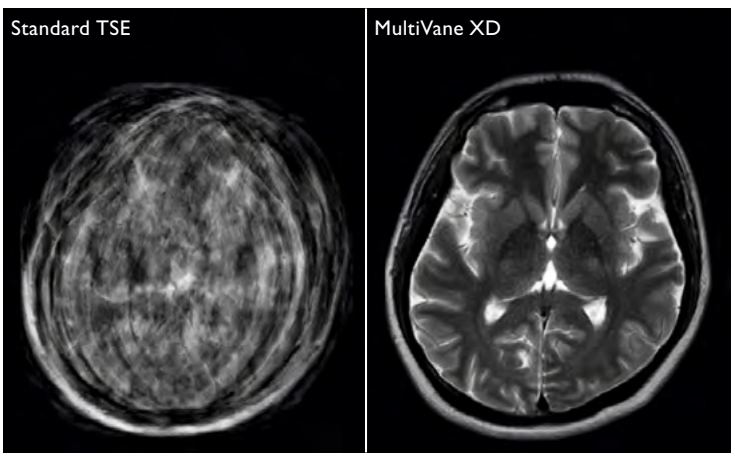
# MultiVane XD in brain



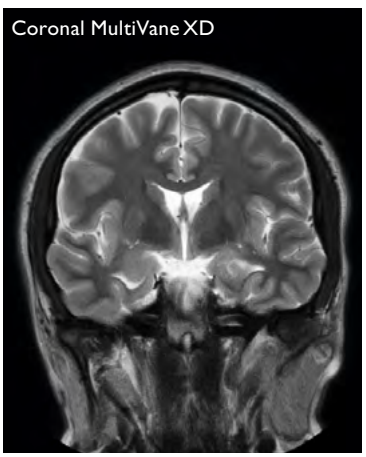

**Cartesian vs. MultiVane XD**
Comparison between normal Cartesian imaging and MultiVane XD in a volunteer moving his head clearly shows the high quality motion correction of MultiVane XD in these Ingenia 1.5T FFE images.




**MultiVane XD compatible with dS SENSE**
Ingenia 3.0T. Courtesy of Barrows Neurological Imaging, Phoenix, Arizona, USA.




**Moving subject imaging**
Standard TSE was done with dS SENSE factor 1.5, scan time 1:18 min. The MultiVane XD scan was done with dS SENSE factor 2, scan time 1:24 min. Ingenia 3.0T.

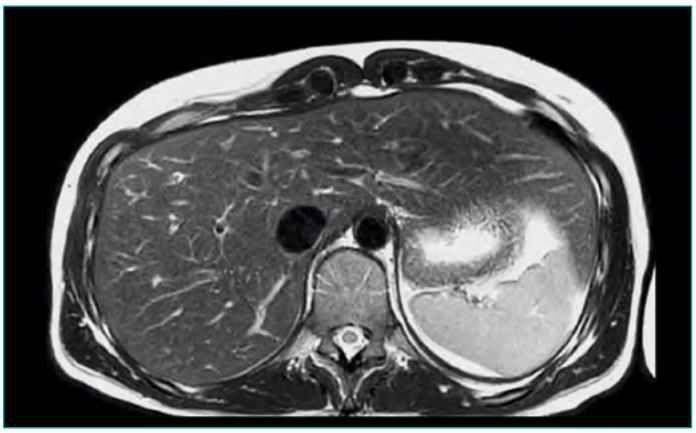



Ingenia 3.0T, dS SENSE factor 2, scan time 1:36 min.

# Liver imaging with MultiVane XD

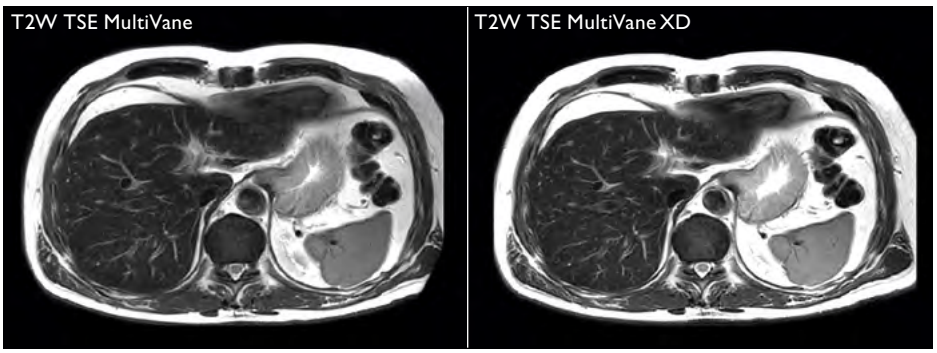
Also in liver imaging, MultiVane XD provides excellent image quality for both T2-weighted and fat suppressed imaging. It is compatible with use of dS SENSE parallel imaging, which helps to accelerate MultiVane XD scans.

MultiVane XD for liver imaging is available on 1.5T and 3.0T systems with dStream digital imaging. Robust protocols are available on these systems.



T2W MultiVane XD on Ingenia 1.5T.
Voxels 1.0 x 1.0 x 5.0 mm, dS SENSE factor 2, scan time 2:36 min.

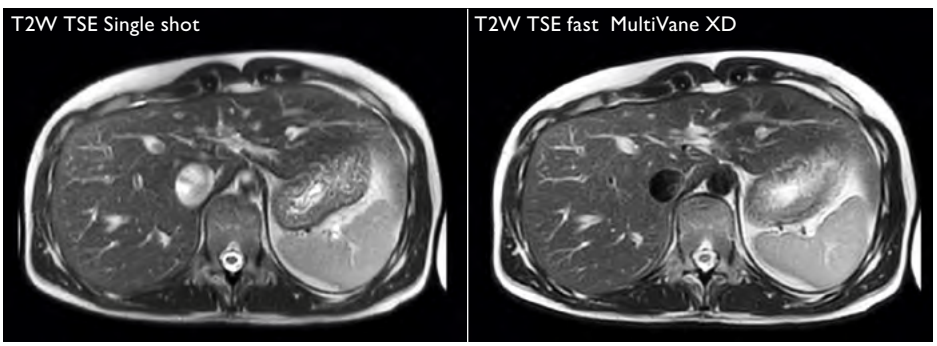
This Ingenia 3.0T example compares MultiVane XD with dS SENSE to MultiVane without SENSE with the same voxel sizes to illustrate that the MultiVane XD scan is faster and overall image quality is better.




Voxels 1.1 x 1.1 x 5.0 mm
Without SENSE, scan time 4:33 min.

Voxels 1.1 x 1.1 x 5.0 mm
SENSE factor 2, scan time 3:30 min.

In this example, the Ingenia 1.5T MultiVane XD scan is faster and shows better image quality and resolution than the single shot scan of the same patient.




Voxels 1.4 x 1.6 x 6.0 mm
SENSE factor 2, scan time 1:45 min.

Voxels 1.5 x 1.5 x 5.0 mm
SENSE factor 2, scan time 1:03 min.

**Summary**

MultiVane XD provides robust motion correction. It can be combined with dS SENSE for a high speed exam. It is available on systems delivered after the second quarter of 2014.

# Education calendar 2014

## Neuro MR

| | | | |
|---|---|---|---|
| **Advanced Neuroimaging (fMRI-DTI-Perfusion)**<br>Hands-on MRI educational courses for MR technologists/radiographers and interested physicians. This course will be carried out on Philips Healthcare equipment. | September 18–20 | ECZ Otwock, Warsaw, Poland | www.esmrmb.org<br>office@esmrmb.org<br>+43-1-535-13-06 |

## Body MR

| | | | |
|---|---|---|---|
| **Liver Imaging Workshop** | September 11-12 | Bologna, Italy | www.esgar.org |
| **Bowel Imaging Workshop** | October 16-17 | Lisbon, Portugal | www.esgar.org |
| **Body and Pelvic MR** | July 11-13<br>October 10-12 | Reston, VA, USA | www.acr.org |
| **Current practice and future trends in Oncologic Imaging** | June 26-28 | Dubrovnik, Croatia | www.oncoic.org |
| **ICIS Annual Teaching Course** | October 9-11 | Heidelberg, Germany | www.icimagingsociety.org.uk |

## Breast MR

| | | | |
|---|---|---|---|
| **European Workshop on MRI-guided vacuum Breast biopsies** | November 27-28 | Bruges, Belgium | www.mammotome.com |
| **Breast MRI course: Case Based Review** | June 12-14 | Enschede, Netherlands | BreastMRIcourse.info |
| **Breast MR with Guided Biopsy** | August 5-6<br>November 4-5 | Reston, VA, USA | www.acr.org |
| **Advanced Course on Multimodality Detection and Diagnosis of Breast Diseases** with 10 Hours MRI | September 2-5<br>October 6-9 | Scottsdale, AZ, USA | MammographyEd.com |
| **Multimodality Approach to Detection and Diagnosis of Breast Diseases** with 8 Hours MRI | November 5-8 | Carrara, Australia | MammographyEd.com |
| **Breast MR Imaging Workshop for Physicians** | July 28-31<br>October 20-24 | Seattle, WA, USA | FirstHill.com |
| **Breast MRI Training Course** | June 6-7 | Dubrovnik, Croatia | EUSOBI.org |
| **Advanced Breast & Female Pelvis MR Imaging** | Oct 30 - Nov 1 | Lisbon, Spain | ESMRMB.org |

## Musculoskeletal MR

| | | | |
|---|---|---|---|
| **Current issues of MRI in orthopaedics and sports medicine** | September 7-10 | San Francisco, CA, USA | www.stollerscourse.com |
| **Musculoskeletal Diseases** | June 28-30 | Hong Kong, China | www.idkd.org/cms/ |

## Cardiac MR

| | | | |
|---|---|---|---|
| **CMR Academy Complete course**<br>Intensive course including hands-on training at the German Heart Institute, and reading and partially quantifying over 250 cases. | Part 1: Oct 27 - Dec 5<br>Part 2: home study<br>Dec 6 - Jan 16, 2015 | German Heart Institute, Berlin | www.cmr-academy.com<br>info@cmr-academy.com<br>Phone: +49-30-4502 6280 |
| **CMR Academy Compact course**<br>CMR diagnostics in theory and practice, including performing examinations and case interpretation | June 16-20<br>October 27-31 | German Heart Institute, Berlin | www.cmr-academy.com<br>info@cmr-academy.com<br>+49-30-4502 6280 |
| **CVMRI Practicum: New Techniques and Better Outcomes** | October 2-5 | Houston, TX, USA | ddees@StLukesHealth.Org<br>+1-832-355-7501 |

## MR Spectroscopy

| | | | |
|---|---|---|---|
| **MR Spectroscopy course**<br>Theory sessions and daily practical scanning and post-processing sessions in small groups | | Zurich, Switzerland | www.biomed.ee.ethz.ch/education/<br>henning@biomed.ee.ethz.ch |

## General MR

| | | | |
|---|---|---|---|
| **Essential Guide to Philips in MRI**<br>Designed for Philips users. Includes 2 days on basics of MR physics and 2 days on advanced concepts. The course can be attended for 2-4 days. | November 10-13 | Cheltenham, UK | www.cobalthealth.co.uk/education |

## Philips North America off-site training courses

**Dates** upon request
**Info:** kara.grey@philips.com
**Phone:** +1-440-483-5355
**Fax:** +1-440-483-7946

**MR Registry Review (Cleveland, OH or at a customer facility)**
This didactic course covers MR physics and crosssectional anatomy. It is designed as an overview course to assist MR technologists in taking the ARRT Registry Exam.

**MRI Basics (Cleveland, OH)**
Designed for novice technologists with little or no previous MR experience. Lectures cover the basic concepts and theory of MRI. This course is entirely didactic and theory based.

**MRI Essentials (Cleveland, OH)**
This comprehensive course for technologists covers Philips MR system hardware, software and basic scanning techniques. It consists of lectures, workstation exercises and hands-on scanning.

**MR Advanced (Cleveland, OH)**
Designed to increase the technologist's knowledge of parameters, post processing features, and scan techniques. It consists of lectures, workstation exercises and hands-on scanning.

**MR Advanced Neuro** for technologists

**MR Basic Cardiac** for experienced radiologic technologists

**MR Advanced Cardiac** for experienced MR cardiac technologists

**MR Basic Breast** for radiologic technologists and professionals

**MR Conversion Course**
for technologists and professionals who would like an understanding of the differences between other vendors and Philips MRI systems.

# Events calendar 2014

| Date | Event | Location | More information |
|---|---|---|---|
| May 17-22 | **American Society of Neuroradiology – ASNR** | Montreal, Canada | www.asnr.org/2014/ |
| June 2-6 | **European Society of Pediatric Radiology – ESPR** | Amsterdam, Netherlands | www.espr.org |
| June 8-12 | **Human Brain Mapping – OHBM** | Hamburg, Germany | www.humanbrainmapping.org |
| June 18-21 | **European Society of Gastrointestinal and Abdominal Radiology – ESGAR** | Salzburg, Austria | www.esgar.org |
| June 25-28 | **Computer Assisted Radiology & Surgery – CARS** | Fukuoka, Japan | www.cars-int.org |
| June 26-28 | **European Society of Musculoskeletal Radiology – ESSR** | Riga, Latvia | www.essr.org |
| July 20-24 | **American Association of Physicists in Medicine – AAPM** | Austin, TX, USA | www.aapm.org |
| Sep 10-14 | **American Society of Head & Neck Radiology – ASHNR** | Seattle, WI, USA | ashnr.org |
| Sep 13-14 | **Cardiovascular and Interventional Radiological Society of Europe – CIRSE** | Glasgow, UK | www.cirse.org |
| Sep 14-17 | **American Society for Therapeutic Radiology and Oncology – ASTRO** | San Francisco, CA, USA | www.astro.org |
| Sep 16-19 | **Magnetic Resonance Angiograpy – MRA club** | Rome, Italy | www.mraclub.com |
| Sep 25-27 | **European Society of Head & Neck Radiology – ESHNR** | Marseille, France | www.eshnr.eu |
| Nov 15-19 | **American Heart Association – AHA** | Chicago, IL, USA | my.americanheart.org |
| Nov 30 - Dec 5 | **Radiological Society of North America – RSNA** | Chicago, IL, USA | rsna.org |

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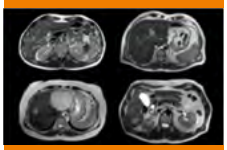

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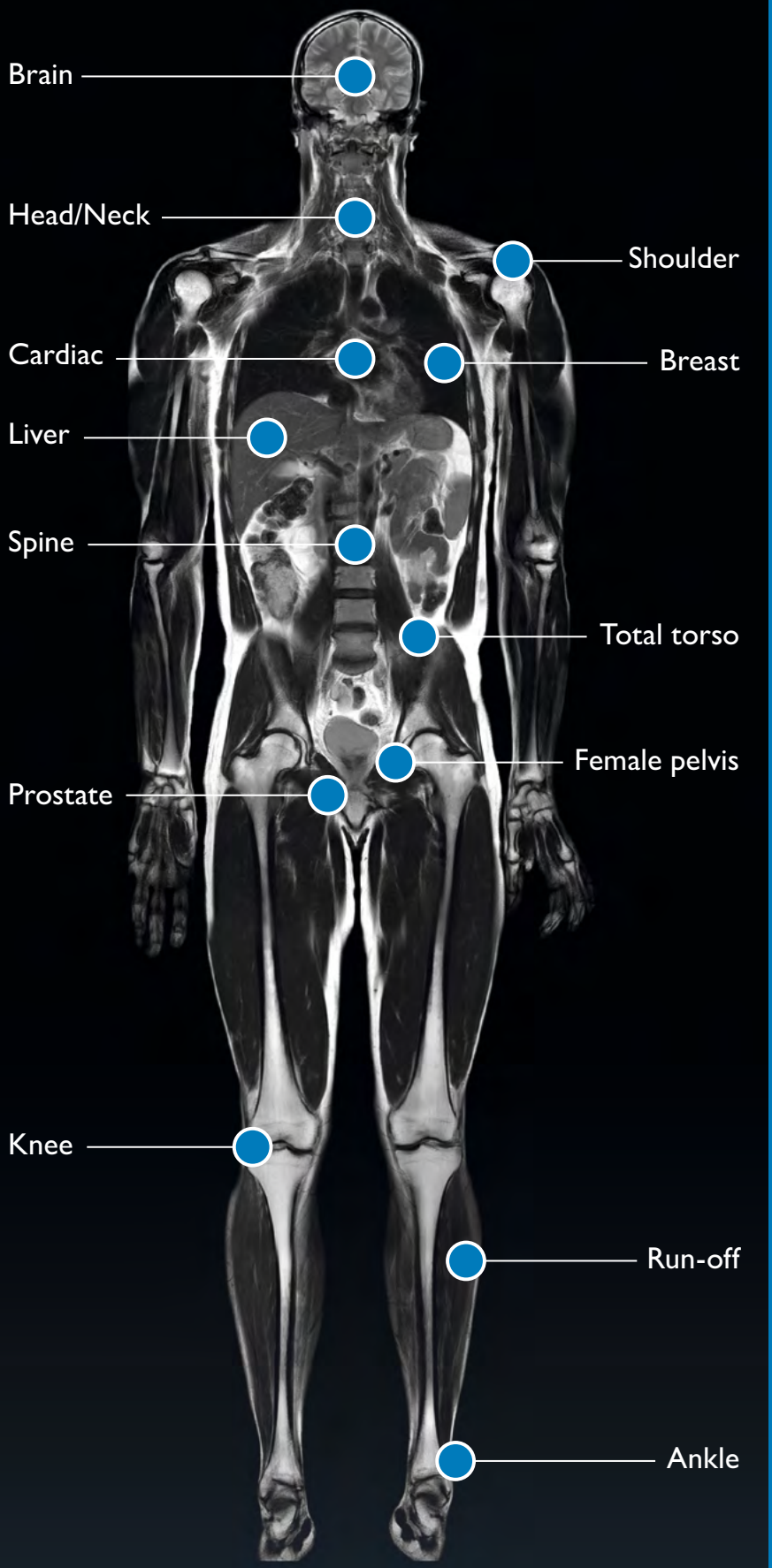


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