More than MR imaging

Intra-operative MR enables superb resection in Hamburg

Herlev radiation oncology team explains what MRI can bring

Neuro MR

Pediatric neuro imaging gets boost from Ingenia 3.0T at Phoenix Children’s Hospital

OSU Researchers look into mechanisms of MS using 7T MRI
Dear Friends,

This first theme in this issue of FieldStrength is “More than just MR imaging.” We’re building a portfolio of MR solutions that give Philips customers the ability to go beyond MRI diagnostics, such as MR-guided interventions, treatment planning, combined modalities and IT solutions.

Philips has created a new segment that is driving the adoption of MR-guided therapies such as the development of MR High Intensity Focused Ultrasound, and use of MRI in radiation therapy planning as in Herlev, Denmark.

The intra-operative MR-OR suite in Hamburg allows surgeons to acquire MR images during their surgery, and the PET/MR system in Geneva offers the advantages of both PET and MR in one examination.

The second part of this issue provides some interesting articles on high-end neuro MRI. Although pediatric imaging presents more challenges than MRI of adults, impressive results are obtained with Ingenia 3.0T at Phoenix Children’s Hospital, and with the Achieva 3.0T 32-channel Head coil in Bosisio Parini, Italy.

You can also read about the noteworthy research on multiple sclerosis using Achieva 7.0T performed at Ohio State University, and enjoy the article on the fascinating neuro scientific studies performed at Tohoku University in Japan.

Enjoy reading this issue of Philips FieldStrength!

Falko Busse

Dr. Falko Busse
VP, General Manager MR-Therapy, Philips Healthcare

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**dS-SENSE propels Ingenia’s imaging speed**

Scanning on Ingenia with dS-SENSE is much faster than previous parallel imaging

**Ingenia** is a champion in parallel imaging, which is enabled by dS-SENSE. The smart design of Ingenia with dS-SENSE provides consistent high quality imaging with faster scanning than before. In addition, digital broadband Ingenia with **dStream** provides up to 40% higher SNR and accelerates patient management.

Philips pioneered parallel imaging in commercially available MR scanners in 2001. Philips’ SENSE parallel imaging on Achieva and Panorama systems features efficient implementation of the calibration so that the acceleration factor equals the SENSE factor instead of being less. Ingenia’s dS-SENSE again reduces the calibration time significantly and the reference scan is integrated in the calibration phase. More importantly, Ingenia empowers the use of higher SENSE acceleration factors than previously used in routine clinical practice. This is possible because of Ingenia’s high quality system and coil design.

**Why is dS-SENSE so fast?**

Several factors contribute to the sensational performance of dS-SENSE on Ingenia. dStream provides higher SNR than analog imaging, which can be traded for speed. The geometry of Ingenia coils is optimized for high SENSE performance: size, location and number of coil elements are made as effective as possible. Data reconstruction has been optimized and the dS-SENSE algorithm is sensitized for the high signal close to the coil elements. All of this has resulted in a geometry factor of up to 2 times better for dS-SENSE compared to previous SENSE.

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**Survey Plan Scan Scan**

**No parallel imaging**

Survey Plan Scan Scan

**Non-SENSE parallel imaging**

Survey Plan | Repeat calibration in each scan

**SENSE**

Survey Plan Scan Scan

**dS-SENSE**

Survey Plan Scan Scan

**Why is dS-SENSE so fast?**

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**dS-SENSE factor 8 in MRA**
Furthermore, SmartSelect provides automatic selection of the coil element combination that yields the best result for each selected FOV. This improves workflow by enabling a “connect and go” method of working, and it always provides the best possible SNR for the exam.

Exploiting the higher acceleration in clinical strategies
In SE or FFE sequences, dS-SENSE can be used to speed up scans, or the speed can be traded for higher resolution. In EPI scanning, where echo train length determines distortion, the feasibility of higher dS-SENSE factors therefore provide Ingenia with improved distortion control. This provides opportunities for new protocol strategies.

For instance, diffusion weighted imaging is usually done in axial orientation to reduce distortion due to B0 inhomogeneity. On Ingenia with dStream and dS-SENSE this can now be a coronal acquisition.

In the example below, coronal scanning reduced scan time by a factor of 3 with clearly better image quality than the reformatted coronal view from the axial acquisition.
Intra-operative MR enables superb resection in Hamburg

Asklepios clinic takes full advantage of dual-use Achieva MR-OR scanner

When constructing a new neuro-OR building at Asklepios Clinic (Hamburg, Germany), the decision was made to include an intra-operative MR suite. To offset the potentially high costs of an MR system that might only be used a few times per week, a dual-use suite was designed for use both intra-operatively and by outpatients. So far, more than 1,000 patients have been scanned, about 30 of whom were examined intra-operatively.

Paul Kremer, MD, PhD, is head of the neurosurgical department at Asklepios Clinic, one of the first non-academic neurosurgery departments with intra-operative MRI. He helped to implement the intra-operative MRI suite in Heidelberg in 1995, then brought the concept to Asklepios, where the intra-operative MR suite was installed in July 2011.

“The difference between our center and others in the region is that we have a head and neck center, which includes ENT, facial maxillofacial surgery, neurosurgery, neurology, neuroradiology, neuropediatrics and neuropathology,” says Dr. Kremer. “We do intra-operative MRI on Tuesdays and Fridays so we can share the imaging time with the other departments.”

Dr. Kremer says the intra-operative MRI is usually used for patients who are having surgery for gliomas, both malignant and benign. “It’s very important to check the resection because it’s difficult during the microsurgery to determine the tumor margins. It’s very difficult. That is why we perform intra-operative MRI, including different image types – T1- or T2-weighted imaging – to check the resection. In Heidelberg several studies were performed on the benefits for the patient, and these indeed showed a large benefit for the patient.”

Special solutions for intra-operative MRI

There are several good reasons to have a dual-use MR scanner, from both a scheduling aspect and an economic one, but several challenges had to be overcome first.

“When using an MRI scanner only for intra-operative use, just one or two times a week, it’s too expensive,” says Dr. Kremer. “But the door between the OR room and the MR room allows us to directly go from the OR into the MR room for intra-operative MRI. And when the door is closed, the scanner can be used independently for regular MRI examinations. This is a very good approach.”

Special solutions were designed for intra-operative MR. “We use a trolley to transport the tabletop with the patient from the OR to the MRI system, and it works very smoothly,” Dr. Kremer explains. “Also very important is head fixation for neuro procedures. Fixation devices are usually made of metal, but we have found an MR-compatible solution.”
“The door between the OR and MR room allows direct transfer. When the door is closed, the scanner can be used independently for regular MRI examinations. This is a very good approach.”

**Resection of anaplastic astrocytoma**

A 31-year-old female with an incompletely resected tumor in another neurosurgical unit some months before. Pre-operative T2-weighted MRI demonstrates a huge residual tumor mass right temporal. The tumor was resected under neuro-navigational guidance. Intraoperative T1-weighted and FLAIR images show a complete tumor resection, however, some fluid contents within the resection area make interpretation of the intra-operative images more difficult. The patient could be discharged from the hospital 10 days after surgery with the recommendation of following chemotherapy.
Dr. Kremer explains that at Asklepios, the MR room and the OR room share an air-conditioning system, so the air in the magnet room is filtered by the same system as the OR. “First, the MR room is cleaned the day before a procedure,” says Dr. Kremer. “Then we clean the magnet again one hour before the procedure. The room is closed for about half an hour, and all the air is treated again. The patient’s head and surgical wound still is open but covered, and the patient is transported into the magnet room.”

“It sounds like a difficult process, with the sterilization system, the trolley system, the head fixation system and the navigation system all working at the same time,” says Dr. Kremer. “But the results are very impressive.”

**Resolution to see small remnants**

“We have found the image quality is very good,” says Dr. Kremer. “In Heidelberg we used a 0.2T magnet, and the imaging quality was quite nice. Now we have the Philips Achieva 1.5T magnet and the image quality is outstanding. It helps that the head of the patient is fixed into the head fixation system so the patient is lying motionless. We have the resolution to see small tumor remnants — it’s really impressive.”

“The time it takes for intra-operative imaging is about half an hour,” explains Dr. Kremer. “We bring the patient into the magnet, which is done quickly, then perform the imaging, and then the patient comes back into the OR and we can start the surgery again. If there are some tumor remnants we resect again; if not, we close the wound. We go back and forth as much as we need to.”

Generally, the same sequences are used before and during the surgery. “If the tumor has shown contrast enhancement before, we also scan sequences with gadolinium during surgery; if there’s no enhancement we use T2-weighted or FLAIR sequences. We can also do fiber tracking if we want.” In the near future, the clinic plans to begin using fMRI as well.

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**Glioma resection**

A 44-year-old male demonstrating a multifocal recurrence of a malignant glioma underwent surgery. Intraoperative images show a small residual enhancing mass at the level of the corpus callosum, which was resected directly after intraoperative MRI. Postoperative contrast-enhanced T1-weighted MRI did not show any enhancing lesion residues.
Philips intra-operative MRI takes next step with Ingenia MR-OR*

Philips has been a leader in interventional MR since 1995, and has been offering both 1.5T and 3.0T MR-guided neurosurgery. An MR-OR suite for intra-operative MRI adds value to neurosurgical facilities, supporting resection procedures that can save precious time for both surgeon and patient: when intra-operative MR reveals incomplete resection, the resection can be completed in the same procedure and reduce the need for subsequent surgery. When Philips introduced Ingenia, the first digital broadband MR system, the next generation MR-OR was conceived as well.

Wide-bore Ingenia 1.5T and 3.0T use dStream architecture, so that the signal is digitized in the coil at the patient and transported via fiber-optic cables, increasing SNR by up to 40% compared to its predecessor. MR-OR using Ingenia 1.5T or 3.0T provides faster, easier and comfortable intra-operative MRI. The dual-room concept is designed for high-end intra-operative MR with smooth workflow. It is developed to offer MR and OR, which can be used together or alone to promote high usage and cost effectiveness. For intra-operative use, the Ingenia is combined with a Maquet OR table, a choice of two types of head frames, and coils. It can be combined with neuro navigation systems such as those from BrainLAB or Medtronic.

MR-OR provides MRI during neurosurgery, enabling surgeons to see the results of the surgery before finishing it. Smooth in-line transfer of the patient between MR and OR keeps transfer times down to just a few minutes.

With front and rear docking capabilities to increase flexibility and throughput, as well as a 70 cm bore, the Ingenia MR-OR system is developed for both brain and spine neurosurgery, with a focus on fast, smooth workflow. It’s the most versatile and fastest intra-operative MRI ever developed by Philips.

* Earliest availability of Ingenia MR-OR is expected end 2012.

“After intra-operative imaging the patient comes back into the OR. If there are some tumor remnants we resect again. We go back and forth as much as we need to.”
MR guidance provides detailed soft tissue images during interventional pain treatment

Open MRI practice is using Panorama HFO for lumbar radicular pain therapy guidance

The 360 MRT Practice for Open MRI (Schwerin, Germany) has been performing MR-guided periradicular interventional pain therapy since May 2011. Focusing on musculoskeletal MRI, with some neuro and abdominal work, the practice scans more than 10 patients a day on its Panorama HFO.

User experiences

Sebastian Retzlaff, MD, the founder of this private practice, says he is one of the first physicians to use open MRI instead of CT in periradiculoplasty (PRT) procedures. He says he appreciates the detailed soft tissue images, as well as the lack of radiation.

“The standard modality is CT-guided PRT, but personally, I strongly prefer MRI for this purpose. Unlike with CT, we can really see the nerve root on MR images, and the control of the needle tip is excellent. Also, in a young patient, for instance a woman still in her childbearing years, we might not want to use CT because of that accumulated dosage.”

“With the Panorama’s openness, reaching the patient is easy in patients of any size. And the image quality is very good,” he adds.

Dr. Retzlaff performs this PRT procedure in patients with lumbar radicular pain, but he excludes patients with unspecific low back pain. “I only use it in patients with a compression of at least one or two well-defined nerve roots.”

**PRT begins and ends with MRI**

Dr. Retzlaff starts with MR imaging prior to the PRT process. “We begin with diagnostic lumbar MRI, and then we proceed with a physical examination. It’s important to determine whether there is nerve root compression.”

The treatment itself generally begins the next day. With the patient lying on the symptomatic side in the magnet, a localizer sequence is performed first to find the proper segment. When the best path for the needle is determined, Dr. Retzlaff finds the proper puncture point using the in-room monitor and his outstretched index fingers, and marks it on the skin. This is enabled by the system’s real-time interactive package. The patient is

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**MR-guided PRT of left S1 nerve root**

36-year-old male with acute pain and dysesthesia in left S1 dermatome, weak left Achilles tendon reflex. No paresis in left M. triceps surae. Conservative treatment over 3 weeks without success. Diagnostic lumbar spine MRI showed 5 lumbar vertebrae and one lumbalized sacral vertebra and a left mediolateral disc prolapse in L5/S1 with nerve root compression S1 left.

MR-guided PRT was done on Panorama HFO with ST Multi Purpose L coil using T1wTSE for needle visibility and fast fluoroscopic imaging. TR 600 ms, TE 10 ms, slice thickness 5.0 mm, in-plane resolution 0.89 x 2.53 mm, TSE factor 36, scan time 3.0 seconds, NSA 1, and CLEAR for image homogeneity. The in-room monitor shows the needle position. Interactive software allows fast and interactive navigation of the needle device.

Images show the position of needle tip and the surrounding bony and soft tissue structures at the level S1/ S2. The needle is well visible thanks to the circumscribed distortion of magnetic field homogeneity by the needle. Periradicular pain therapy with MR guidance provides a truly visible nerve root without ionizing radiation.

“We can really see the nerve root, and the control of the needle tip is excellent.”
slid slightly out of the magnet while the skin is disinfected and a sterile covering is placed on the back. The needle, the Invivo 22 G puncture needle, is inserted approximately 1 cm at the marker and the patient is moved into magnet again. Under MR guidance the needle is then pushed forward to the neuroforamen, the iliosacral joint space or facet joint. When MR images show that the targeted position is reached, the patient is moved slightly out of the magnet again, and an injection is given.

**Visualizing the needle**

“During the procedure I want to follow the needle in the tissue. I want to see the vertebrae, the joints, the neuroforamen, the nerve roots, the muscles and so on, in addition to visualizing the needle position,” says Dr. Retzlaff. “Remember that the metal needle does not create MR signal, but is visible thanks to the well-defined ‘artifact’ it creates. With gradient echo sequences being very sensitive to this kind of artifact, the artifact would be much too large and the nerve root and the surrounding structures could not be visualized with the needle, which may be 2-3 cm in the images – much too large to meet a small nerve root of 2-3 mm in diameter. So, we need a very fast interactive sequence that is not too sensitive for metal artifacts. We use a turbo spin echo sequence, which makes the needle very visible, without influencing the surrounding structure. Sometimes it helps to switch readout gradient direction.”

The interactive MR fluoroscopy sequence used for the real-time visualization is T1TSE interactive, TR 600 ms, TE 10 ms, slice thickness 5.0 mm, in-plane resolution 0.89 x 2.53 mm, TSE factor 36, scan time 3.0 seconds, NSA 1, CLEAR. The coil used is ST Multi Purpose L.

**Practical experience**

“It takes some practical skill to give the needle the right direction in the initial placement when the patient is outside the gantry,” says Dr. Retzlaff. “Then, MRI Fluoroscopy provides one slice or two slices in perpendicular orientations with a refresh rate of 3 seconds. The MR technologist needs to learn which slice position and orientation the radiologist needs to see while navigating the needle through the neuroforamen. The procedure now typically takes 10 to 15 minutes. We’re still in the learning curve, so it will become even shorter.”

"The team at the University Clinic of Magdeburg has much more experience on these interventional procedures on the Panorama – I learned this procedure from them," Dr. Retzlaff adds.

Dr. Retzlaff says he wouldn’t use anything but MR for PRT. “I think use of MR guidance will grow for PRT and many other interventional procedures.”

MR-guided PRT of left L5 nerve root

36-year-old female with acute pain and dysesthesia in left L5 dermatome, slight weakness in left M. extensor hallucis longus. Conservative treatment over 3 weeks without success. Diagnostic lumbar spine MRI showed a left mediolateral disc prolapse in L4/5 with nerve root compression L5 left.

MR-guided PRT was done on Panorama HFO with ST Multi Purpose L coil using T1wTSE for needle visibility and fast fluoroscopic imaging, TR 600 ms, TE 10 ms, slice thickness 5.0 mm, in-plane resolution 0.89 x 2.53 mm, TSE factor 36, scan time 3.0 seconds, NSA 1, and CLEAR for image homogeneity. The in-room monitor shows the needle position. Interactive software allows fast and interactive navigation of the needle device.

Images show the position of needle tip and the surrounding bony and soft tissue structures at the level L5/S1. The needle is well visible thanks to the circumscribed distortion of magnetic field homogeneity by the needle. Periradicular pain therapy with MR guidance provides a truly visible nerve root without ionizing radiation.
“Performing this application requires interactive MR software, an in-room monitor and an MR-compatible needle.”
Herlev radiation oncology team explains what MRI can bring

The radiotherapy unit at Herlev University Hospital investigates use of MRI for radiotherapy treatment planning

In radiotherapy planning, it is important to determine the tumor position and shape with high precision. Traditionally, CT images are used for planning, but there is a worldwide trend of growing MRI use in Radiation Oncology. The Herlev team uses MRI in a large fraction of its patients as the excellent MR soft tissue contrast helps to clearly delineate lesions.

The radiotherapy unit in the oncology department at Herlev University Hospital, close to Copenhagen in Denmark, takes in about 3,000 patients every year, which adds up to more than 55,000 treatments on 10 linear accelerators. The Philips Panorama HFO adds MRI to help clinicians to prepare and plan for radiotherapy treatment in cancer patients.

“We see many advantages of using MRI in the radiotherapy process,” says Poul F. Geertsen, MD, PhD, head of radiotherapy at the hospital. The soft tissue visualization is obviously much better on MR than CT. We get true sagittal and coronal images, and much better definition of the outline of the tumor (gross tumor volume, GTV). “An optimized definition of the tumor volume provides the potential for margin reduction, with reduced toxicity.”

Special attention for geometric precision

“For RT planning it is crucial to correctly determine the tumor location and geometry,” says chief physicist Brian Holch Kristensen. “Therefore, we use a dedicated toolset, containing, for example, a flat tabletop, an external laser bridge and gradient distortion correction algorithms software.

The open Panorama MR system offers the space needed. “The patient setup on the tabletop is very strict for radiotherapy work. Immobilization devices such as casts, masks and supports have to fit within the scanner, and must be fixed via the tabletop’s indexed edges. For instance, in head and neck tumors we use a thermoplastic mask made of MR compatible materials that can be easily used in combination with the Panorama coils, with good image quality. Also, a normal MRI scanner has a curved tabletop and cushioning, but we use a flat, hard tabletop that supports high reproducibility of the patient’s position from CT and MR imaging to treatment planning and delivery and between different treatments.”

“We do more QA than in a normal scanner,” he adds. “As it’s very important that the tumors are properly visualized, phantom testing is performed on the system once a week, to test the image distortion, and external laser and geometry precision in general. We have special QA phantoms to test all these things.”

MR incorporated in treatment planning workflow

“We fuse the MR images onto a CT image before treatment planning,” says Dr. Kristensen. “To best register the MR images to CT, our ExamCards are optimized for radiotherapy;
similar image acquisition parameters are needed, so we do axial MRI scans with the same slice thickness, and of course the same patient fixation and fiducial markers. The fiducial markers used in prostate are also quite visible using MRI. We export the images to our radiotherapy treatment planning system (RTP) and handle the images further in that system.

“We need the high soft tissue contrast of an MRI scan to visualize the tumor,” explains Dr. Kristensen. “MR is usually combined with CT, because we still use CT to calculate the dose distribution. It’s the combination of the two modalities that currently produces the best results. Nevertheless, we are working on MRI only in brain and for some indications in the pelvic area as well.”

“For RT planning it is crucial to correctly determine the tumor location and geometry.”

Prostate

It is important to delineate the prostate accurately for radiotherapy planning to be able to spare normal tissue when irradiating. The prostate is easily identified on axial MRI compared to CT. Furthermore, coronal or sagittal MR scans help to define the top and bottom (base/apex) well, whereas this is very difficult on CT. It is very important for the patient to be able to spare the bladder, rectum and penile bulb (erection).

Fiducial markers (arrows) are often used within the prostate to identify the prostate at the treatment unit (linac). These markers are also used to transfer the MRI information (delineation) onto CT images. Full body image fusion is not accurate because the prostate moves between scans. However, Nitinol markers are visible on both CT and standard T2 MRI.
"Advantages of using MRI in RT planning are the superb soft tissue visualization and true sagittal and coronal images, providing much better definition of the outline of the tumor."

**Modalities and team members work together**

“Several types of treatment are supported by MR imaging, including external beam radiation and brachytherapy,” says Dr. Geertsen. “Normally, a patient is scanned one week before treatment to help better define the tumor positioning and size for the planning. Some patients are also scanned up to two times per week after the start of treatment to follow tumor response, for instance by looking at tumor response with diffusion weighted imaging.”

“The MR scan is done by the same person who scans on CT. The scans are viewed by a radiologist and a radiation oncologist together; every day from 11:00 to 1:00, the radiologist comes to our department and sits with the oncologist to view MRI images, CT images, or both. Then we export it out to a third-party treatment planning system.”

“That collaboration is very important,” he adds. “An MRI scanner can be very challenging to run in the best manner, so it’s best to work together. If we have any downtime, we can even share a machine.”

**Reference**

BH Kristensen, FH Laursen, V Løgager, PF Geertsen, A Krarup-Hansen
Dosimetric and geometric evaluation of an open low-field magnetic resonance simulator for radiotherapy treatment planning of brain tumours
Radiotherapy & Oncology 87 (2008) 100-109
http://www.thegreenjournal.com/article/50167-8140/08/00/43-1/abstract

**Anal cancer**

A soft tissue tumor can be very difficult to see on CT. With MRI the tumor is much better visualized. In addition, the possibility to acquire true sagittal MR images helps to visualize the top and bottom of the tumor.

**Brain**

On CT the tumor cannot be seen, but on contrast-enhanced T1 MRI the tumor is clearly seen. The radiation dose calculated on both modalities shows that the dose calculation can be done directly on the MRI omitting the CT.
Ingenia configuration for RT planning in development

Philips Ingenia, the first-ever digital broadband MR system, features dStream technology. In the Ingenia configuration for RT planning, Ingenia’s fast scanning and high SNR are combined with a flat tabletop allowing patients to be scanned in the treatment position. The flat tabletop is compatible with the FlexTrak trolley, for easy patient transport from MRI to treatment suite. Ingenia’s superb field homogeneity together with the one-click Travel-to-scan capability and the external laser positioning system benefit precise RT treatment planning.

Ingenia is designed for a smooth and efficient workflow. Coils that are easy to set up help reduce patient setup time and increase speed, also when scanning for radiotherapy planning.

With all the advantages of the Oncology Configuration, plus easy coil handling and simplified workflow in a powerful 1.5T or 3.0T system, Ingenia is outlined to be a powerful system in MR-RT treatment planning.

Panorama HFO Oncology Configuration

The Philips Panorama HFO Oncology Configuration helps radiation oncologists to fully benefit from MRI’s excellent soft-tissue contrast by providing a means of repeatable patient positioning from scanning to planning to treatment. The spacious 160 cm-wide patient aperture of the system facilitates patient positioning, while dedicated software and hardware tools support patient immobilization and alignment.

Panorama HFO Oncology Configuration with external laser positioning system for patient alignment, and flat table top for imaging the patient in treatment position. The system offers dedicated ExamCards for Radiation Therapy and supports CT and MR fusion.
University Hospital Geneva (Geneva, Switzerland) is one of the two largest academic hospitals in Switzerland. The hospital recently installed the Ingenuity PET/MR system, the first in Europe. Philips’ Ingenuity TF PET/MR is a hybrid modality that combines the Achieva 3.0T MR scanner with Time-of-Flight PET technology.

University Hospital Geneva uses PET/MR in oncology patients

Ingenuity TF PET/MR gains interest for imaging oncology patients
Osman Ratib, MD, PhD, professor and chair of the department of medical imaging and information sciences and head of the nuclear medicine division, says, “Our hospital has a history of developing collaborative projects between radiology, nuclear medicine and radio-oncology, typically for hybrid imaging and for research in new imaging modalities.”

Different types of oncology patients undergo PET/MR
Clinically, the Ingenuity TF system at the hospital is used about 20% of the time as a PET/MR system and 80% as a dedicated MRI scanner. “Our first goal was not to shift business from our PET/CT to the PET/MR, but to evaluate cases that could clinically benefit from the combination of PET/MR,” explains Prof. Ratib. “This results in up to five patients a week for PET/MR and 12-13 patients a day for routine MRI such as neuro and MSK.”

Dr. Ratib uses PET/MR for patients who would typically have both a PET/CT and an MRI as part of their clinical workup. “In patients with head and neck cancers, for instance, anatomical exams for pre-op, post-op and post-treatment are very complex, so PET/CT alone is usually not enough, and most patients will also get an MR exam in addition. Now they can have both PET and MRI done at the same time, and we can reduce radiation exposure by using just PET/MR,” says Prof. Ratib.

“MRI provides information that PET/CT doesn’t have,” says Prof. Ratib. “Many prostate patients, who would previously undergo both PET/CT and MR, are now just referred for one combined PET/MR exam. In addition, PET/MR is ideal for some cancer patients who often don’t get the PET/CT study at all to avoid the CT radiation. I wouldn’t use PET/MR for every cancer patient, but in those complex cases it is invaluable.”

In Geneva, PET/MR is also used in pediatric oncology. “PET/MR is a great option for young patients who need repetitive scans to follow up on recurrence of tumors, particularly brain tumors. And MRI has an exquisite quality of soft tissue identification and characterization that CT doesn’t have.”

Dr. Ratib is also seeing a high level of interest from oncologists in the staging of gynecological cancers; MRI is the imaging modality of choice in those cases, and PET brings the molecular component to help identify where the tumor is and how far it extends.

System setup and course of the examination
Unique in the design of the Ingenuity PET/MR system is that it combines two powerful, proven Philips imaging systems. For easy operation, the system features a single, integrated user interface for MR and PET. The two machines were already established systems,” says Dr. Ratib. “Philips added special magnetic shielding on the PET side and brought them together so they are attached to the same bed and operate in the same room. So, we have two top-of-the-line clinical machines in one place.”

Dr. Ratib confirms that the MR image quality produced by the PET/MR system matches the quality of the stand-alone Achieva 3.0T.

PET/MR of 68-year-old male with prostate cancer and metastatic disease in the pelvic bone.

*The system does not expose the patient to ionizing radiation, only the dose contribution from the PET radiopharmaceutical.

“Many prostate patients, who would previously undergo both PET/CT and MRI, are now just referred for one combined PET/MR exam.”
“The Ingenuity PET/MR system combines two powerful, proven Philips imaging systems. For easy operation, the system features a single, integrated user interface for MR and PET.”

B-cell lymphoma of the left sinus with no metastatic disease. PET/MR images are shown in all 3 imaging planes for a clear picture of the pathology in a very critical nasal cavity area.

Comparison of PET only and PET/MR in a staging examination for oncology.
A PET/MR exam starts with the MR acquisition, for instance with whole body imaging and a T1-weighted FFE for the attenuation correction. Dr. Ratib recently added a 3D whole body Dixon acquisition sequence that provides additional high-resolution anatomical images. After that, the table with the patient is rotated and moved to the PET machine. And finally the study is completed with specific diagnostic protocols dedicated to a given body part.

“We had to optimize the protocols so they don't take too long. Furthermore, we analyze the whole body images because every suspicious lesion, even outside the area of interest, might require additional dedicated MRI sequences. Instead of having the patient come back, we do it right away. We then match these additional high-resolution MR images with the whole body PET data to better identify lesions where abnormal tracer uptake is identified.”

Superb image quality with Time-of-Flight

“The Time-of-Flight (TOF) PET technology allows us to acquire images in a much shorter time, with enhanced SNR and spatial resolution, and faster reconstruction,” Dr. Ratib says. “It was the first machine with TOF in our institution, and we clearly saw the difference. During the initial testing phase, patients underwent a PET/CT first and a PET/MR after that, so there was a delay between scans causing decay in the radioactive tracer. Still, the image was actually much better, because the quality of PET with TOF compensated for reduced activity of the tracer.”

Dr. Ratib will continue to validate what PET/MR can bring to clinical practice. “Anticipating that it will become more widely available, we chose to begin with very basic applications that would previously be on two separate machines. We think PET/CT still has its clinical applications, but PET/MR has really added value to that subset of clinical areas.”

“\textit{The Time-of-Flight technology allows us to acquire images in a much shorter time.}”
Pediatric neuro imaging gets boost from Ingenia 3.0T

At Phoenix Children’s Hospital, clinicians are seeing more detailed images and improved workflow.
Phoenix Children’s Hospital (Phoenix, Arizona, USA) is a large free-standing pediatric hospital, newly opened with more than 500 beds. A tertiary care referral center treating complex neurological, cardiovascular, hematological, gastrointestinal and MSK disorders, the hospital is supported by pediatric subspecialists in every major discipline. In addition to standard neuro imaging of the brain, neck and spine, it also offers fMRI, perfusion studies, diffusion tensor imaging and MR spectroscopy. The hospital has several Philips 1.5T scanners and installed Ingenia 3.0T in November 2011.

“We have scanned more than 700 patients on Ingenia, ranging from the evaluation of common neurological conditions such as headaches up to complex conditions such as epilepsy, tumors of the brain and spine and genetic and metabolic brain disorders,” says Jeffrey H. Miller, MD, pediatric neuroradiologist. “We also routinely image patients following traumatic brain injuries and newborns with neonatal encephalopathy.”

“Pediatric neuro MR is much different than MRI in adults,” he explains. “We deal with all sizes of children, requiring modifications to several parameters such as FOV, voxel size and slice thickness. The conditions of many of these children are very complex, and require additional sequences, advanced imaging techniques and often repeated imaging to follow complex disease processes.”

Advantages of high resolution
Dr. Miller says Ingenia’s high-resolution imaging provides better delineation of subtle abnormalities, such as cortical malformations in patients with seizure disorders that may not be detectable at lower field strengths or in exams done with lower resolution imaging.

“Our standard brain MRI exam now consists of very high-resolution 1 mm 3D T1 and no gap 2 mm axial T2 imaging.”

Neonate day 1 – Achieva 1.5T

Neonate day 4 – Ingenia 3.0T

Neonate brain
A neonate underwent MRI on the first day of life on Achieva 1.5T and three days later on Ingenia 3.0T. For children under 2 years of age Dual IR sequences are used to obtain high-resolution T1 and T2 images in a single acquisition. These sequences allow a more accurate depiction of white matter maturation than conventional spin echo T1 imaging, especially at 3.0T, due to the lengthened T1.
The ability to perform advanced imaging techniques such as perfusion, spectroscopy and diffusion tensor imaging allows additional characterization of disease processes that may be more difficult when just evaluated with conventional imaging,” he says. 

“Ingenia’s biggest benefit for techs is the coil convenience.”

“Ingenia’s biggest benefit for techs is the coil convenience,” says Amber Pokorney, MR technologist at Phoenix Children’s. “The coils are so much more manageable than previous types of coils. They’re much easier to handle and have just one easy-to-use plug that plugs right into the table, so we don’t have to worry about the cables laying on the patient. And the added signal allows us to obtain a lot of detail.”

“We mostly use the Posterior coil, which is integrated into the tabletop. Not having to reposition patients is very helpful, especially if they’re anesthetized. It has improved our workflow because we can do multi-station exams – like covering brain, neck and spine – without having to interrupt the scanning to reposition the patient or position the coils.”

“Intrathecal lipoma in 11 y/o
11-year-old male with intrathecal lipoma involving descending nerve roots. In the spine, gradient sequences (modified e-THRIVE for T1 and T2 FFE) are used to overcome flow artifacts and decreased T1 contrast limitations common in axial 3.0T spine imaging. The addition of fat saturation pulses to the T2 FFE sequences has enabled better delineation of areas of intrathecal fat seen against the background CSF. Arrows point to fat extending along existing nerve roots on the right.

“Techs love dStream coils and SmartSelect
Ingenia’s dStream coils offer huge advantages for timesavings, patient comfort and workflow. Because the signal is digitized directly in the coil and sent through fiber optic cables, Ingenia can provide up to 40% more SNR than analog technology.

“The ability to perform advanced imaging techniques such as perfusion, spectroscopy and diffusion tensor imaging allows additional characterization of disease processes that may be more difficult when just evaluated with conventional imaging,” he says. 

“With the increased field strength and the increased SNR on Ingenia, our standard brain MRI now consists of very high resolution 1 mm 3D volumetric T1 imaging and no gap 2 mm axial T2 imaging. This higher resolution imaging has enabled us to better delineate small abnormalities and detect subtle changes such as abnormal gray/white matter differentiation in cases of potential cortical malformations in patients with epilepsy. The 3D T1 post-contrast at 1 mm resolution reconstructed has enabled us to have a higher sensitivity for small contrast-enhancing abnormalities. And by using 3D acquisitions, we’re able to reconstruct additional planes of view and thus save scan time. With these volumetric data sets we also have good anatomic reference images as underlay for all of our DTI and fMRI studies. And we are increasingly utilizing these 3D data sets for fusion with metabolic imaging such as PET and SPECT.”
Another well-appreciated time-saver is Ingenia’s SmartSelect feature, which automatically selects the appropriate coil elements for each scan.

**Special imaging sequences**

In addition to the fast workflow with the easy-to-use coils, Dr. Miller and his team have been optimizing sequences and ExamCards to provide the image quality and speed they need.

“One of the challenges of pediatric compared to adult neuro imaging is trying to evaluate the maturational changes of white matter taking place in children less than 2 years of age. For these children we use Dual IR sequences to obtain high resolution T1 and T2 images in a single acquisition. These sequences allow a better depiction of white matter maturation than conventional spin echo T1 imaging, especially at 3.0T, due to the lengthened T1.”

“We find the angiographic imaging is very high resolution as well,” he adds. “We get very good non-contrast neck imaging with Ingenia’s 3D multi-chunk inflow MRA with very homogeneous WATS background fat suppression.”

**Confident diagnostics and avoiding extra pre-surgical rescan**

“Ingenia’s advantages have had a big impact on the diagnostic side of imaging,” says Dr. Miller. “Being able to produce such high-resolution imaging has allowed us to really have a great sensitivity for abnormalities, especially within the brain. It gives us a lot more confidence that we’re not missing anything when the exams are normal.”

“We have a very busy neurosurgical service, which relies heavily on imaging guidance for a lot of the neurosurgical procedures, for instance shunt catheter placement, tumor resection, and placement of electrocortical monitoring grids. Our standard brain T1 and T2 scans are of such a thin slice thickness that they’re easily imported into the neurosurgical image guidance system without having to rescan those patients at higher resolutions just for the procedure,” Dr. Miller explains. “We see a reduction in our need to re-image patients to obtain high-resolution studies since we can use our standard scans for image guidance.”

Overall, Dr. Miller is very pleased with the hospital’s Ingenia system. “Philips’ support has been excellent in helping us to navigate the optimization of the technology, and to translate that technology into beneficial imaging specialized for pediatrics according to our needs,” he adds.

“**We use Dual IR sequences to obtain high resolution T1 and T2 images in a single acquisition.**

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**Abnormal enhancing foci in 7 y/o**

7-year-old male with seizures and small focal T2 hyperintense and contrast enhancing foci (white arrows). The exact location of this abnormality is difficult to discern on FDG PET-CT. Fusion of the PET and contrast enhanced MRI allow precise localization of the lesion (arrow).
High spatial resolution reveals excellent detail in pediatric neuro imaging

Achieva 3.0T with 32-channel SENSE Head coil has become the system of choice in Bosisio Parini, Italy

The E. Medea Research Institute in the northern Italian town of Bosisio Parini, is dedicated to pediatric rehabilitation. The institute’s Pediatric Imaging Unit uses an Achieva 3.0T. According to pediatric neuroradiologist Filippo Arrigoni, MD, the system’s performance with Philips’ 32-channel head coil is so impressive that they now use this configuration exclusively for all their pediatric neuro examinations.

“We can easily visualize the olivary nuclei in the medulla – a very small structure that can’t be visualized with normal resolution”

Higher resolution shows olivary nuclei in medulla
6.5-year-old male suffering from headache. Normal medulla. The higher resolution images (top row) clearly show both olivary nuclei in the medulla (white arrows). With a slightly lower resolution (bottom row) the olivary nuclei can’t be recognized. Achieva 3.0T with 32-channel SENSE Head coil.
The center focuses on the rehabilitation of pediatric patients between the ages of 0 and 18 years with neurological disorders, both congenital and acquired. It chose the Achieva 3.0T for its high-resolution imaging capabilities, which is especially important for accurate diagnosis in pediatric patients. Next to that, Achieva 3.0T was chosen because the center focuses heavily on research into pediatric neurology for which, nowadays, 3.0T is a prime requirement.

“You can’t treat children with neuro disorders like small adults,” says Dr. Arrigoni. “The challenges in imaging their brains are often quite different because their brains are still maturing. What’s more, many of our patients have some form of brain malformation and neuro-degenerative disorder and these continue to develop as their brains develop, so we need to be able to clearly recognize this to understand the morphology. This means that high resolution is the most important criterion for us.”

To achieve this, the Imaging Unit has found the Achieva 3.0T combined with Philips’ 32-channel head coil to be an excellent solution. “The 32 channels can be looked on as a sort of coin that you can spend either on speed or resolution,” he says. “For us speed is not the priority and we have developed sequences focusing on high resolution because we need to go into the finer detail of the pediatric brain anatomy and structure.”

Finer detail reveals small alterations in the pediatric brain

The unit has developed sequences giving very high resolution as fine as 0.3 mm to 1.1 mm which, according to Dr. Arrigoni, produce excellent results in imaging both the normal anatomy of the brain and brain malformations. “We can, for example, easily visualize the olivary nuclei in the medulla – a very small structure that can’t be visualized with normal resolution,” he observes. “And in brain malformations with, for example, heterotopic gray matter or polymicrogyria commonly associated with epilepsy, we can see small alterations in pathology that cannot be visualized without sequences of this kind.”

Sequences are adapted to each patient

Dr. Arrigoni works mostly with a slice thickness of 3 mm or less which he believes is essential for performing good exams on children. “This is not only because their brain anatomy is smaller but also because their brains are developing and we need the finer slices to capture subtle changes in the anatomy over time,” he says.
“We also adjust our sequences to each patient. We first perform a 3D T1 scan on each patient to give us an idea of the problem, after which we can decide which resolution, which type of scan and which TR and TE to use,” says Dr. Arrigoni. “Typically the 3D T1 scan is performed with 1 mm resolution and isotropic voxels from which we can reconstruct images of the brain in all the planes we want. Following this we perform 2-dimensional T2-weighted TSE sequences in two planes, usually axial and coronal with a resolution of 0.45 x 0.45 and 3 mm slices. If we see something interesting, we may decide to use a higher resolution, for example 0.3 x 0.3 and 1.1 mm slices, then FLAIR in two planes with resolution of 0.7 x 0.7 and 3 mm slices.”

Depending upon indications, they then perform specific DTI sequences which they have developed in collaboration with Dr. Pierpaoli at NIH.

“DTI is particularly valuable for the analysis of white matter abnormalities in patients with white matter diseases such as Pelizaeus-Merzbacher disease and MLC (megalencephalic leukoencephalopathy with subcortical cysts), a genetic disease affecting cerebral myelin. These diseases, which are quite rare in the population, have similar patterns under MRI and can be more clearly depicted with DTI, which helps in diagnoses.”

**Future ambitions**

Dr. Arrigoni and his colleagues also find DTI with the Achieva 3.0T and 32-channel head coil an extremely powerful research tool.

“For example, we have a large group of Duchenne syndrome patients at the institute. This is a disease caused by a genetic anomaly that affects mostly motor function but in some cases also mental function, depending upon the position of the genetic anomaly in the chromosome.

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**Neurofibromatosis type 1**

5.5-year-old female with neurofibromatosis type 1 and a small corpus callosum. Multiple hyperintense rounded lesions (white arrows) are evident in the basal ganglia and thalami in the coronal images. Axial images with very high resolution provide a better definition of these lesions. The patient also has a small corpus callosum (sagittal image) with hyperintense lesions in the right Probst bundle (black arrows). DTI tractography shows a small but apparently complete corpus callosum.

Achieva 3.0T with 32-channel SENSE Head coil.
The aim here is to use DTI to gain a better understanding of the correlation between genetic pattern and fiber arrangement.“

In addition, the group is using DTI to conduct research into the rehabilitation of children with cerebral palsy. “We perform MRI exams on the children before and after intensive rehabilitation therapy and use DTI and fMRI to investigate if any changes in motor function can be related to changes in brain structure to assess the effects of therapy.

“We're certainly very impressed with the 32-channel Head coil and use it exclusively for all our MRI exams, even though it is rather large for some of our patients,” concludes Dr Arrigoni. “This is such an outstanding coil that my hope is that Philips will in future consider introducing a smaller version specifically for pediatric patients.”

**Lissencephaly**

11-year-old female with mental delay and epilepsy caused by a complex brain malformation. A severe lissencephaly with subcortical band heterotopia is evident in the posterior regions of the brain (white arrows). Multiple periventricular nodular heterotopias are also shown (black arrows). The last three images show the axial plane at different resolution. Achieva 3.0T with 32-channel SENSE Head coil.
IDAC research aims to clarify brain processes across ages

Brain development in healthy children and cognitive intervention in healthy adults are studied using fMRI, DTI, ASL on Achieva 3.0T

Prof. Ryuta Kawashima, MD, PhD, is Director of the Smart Ageing International Research Center at the Institute of Development, Aging and Cancer (IDAC) of Tohoku University, Japan. He uses functional brain imaging in his research on improving the cognitive function in people of all ages. He worked with a leading game manufacturer to create the game “Brain training – How old is your brain?” based on his studies on brain training with reading, writing and arithmetic tasks. The royalties helped Prof. Kawashima to buy a Philips Achieva 3.0T MR scanner to perform functional brain research at IDAC.

“We combine research in brain function imaging, cognitive science, and psychology with the ultimate aim of contributing to a healthy aging society,” says Prof. Kawashima. “We have developed various stimuli and activities to maintain and improve cognitive functions. We study the effect of various entertainment forms involving cognitive stimuli on the health of mind and body. We believe this research will help us to identify intellectual activities to promote cognitive development in infants. Our research on smart aging also aims to ensure a healthier long lifespan by maintaining intellectual stimulation later in life.”

Development of cognitive function

“Development of cognitive function

“Development of cognitive function

“Development of cognitive function

“Development of cognitive function

“We are performing an extensive study on brain development and maturation in healthy children,” explains Yasuyuki Taki, MD, PhD, IDAC radiologist and Associate Professor of Developmental Cognitive Neuroscience. “We are building a large database of brain MRI and cognitive function data at different ages for 302 healthy children. Using brain MRI, we collected anatomical images, cerebral blood flow images, and DTI / fiber tracking. As for the cognitive function, we collect WAIS/WISC III intelligence scores to get full-scale intelligence information.”

“We are analyzing the correlation between age and brain measures determined with MRI, such as regional gray matter volume, white matter volume, regional cerebral blood flow, and fractional anisotropy. This will help to understand the mechanisms of normal brain development and maturation in children. Then we also analyze the correlation between full-scale IQ or the score of a subtest and several brain measures as described above. Our ultimate goal is to contribute to clarifying the correlation between brain development and cognitive development in healthy children.”

“The ultimate aim of our research is to contribute to a healthy aging society.”
White matter structures underlying emotional intelligence

DTI was used in a study on the association between white matter (WM) integrity and emotional intelligence (EI). Fractional anisotropy (FA) of voxels was used as a measure for the WM structural integrity. A questionnaire was used to determine factors for ability to understand emotions with regards to oneself, others, and specific situations.

**Intrapersonal EI factor**
Positive correlation between FA and intrapersonal EI factor is overlaid on FA images of a participant. Significant positive correlation is seen in a WM region in the right anterior insula, which is one of the important nodes of the somatic marker circuitry (SMC) where emotion-based biasing is integrated in higher brain regions. Results may suggest that WM integrity here may increase the brain’s ability to integrate somatic states information, leading to higher intrapersonal EI.

**Interpersonal EI factor**
Positive correlation between FA and interpersonal EI factor is overlaid on FA images of a participant. Significant positive correlation is seen in a WM region extending to the inferior longitudinal fasciculus (ILF). The results suggest that the highly integrated ILF is playing a key role in interpersonal EI by causing an increase in brain function related to connecting visual information with facial, emotional, and paralinguistic information.

See also Takeuchi et al., *Human Brain Mapping*, 2011; Article first published online.
Cognitive neuroscience

“I have been using fMRI to identify the brain regions involved in face recognition, a cognitive process of interest as it is considered a hallmark of the cognitive representation of the self, which also underpins higher social ability,” says Motoaki Sugiura, MD, PhD, Associate Professor of cognitive neuroscience. “Unfamiliar faces and friend’s faces are presented in a random order. The BOLD signal responses to the different face types show which brain regions are involved in individual face recognition.”

“A similar study on differences between healthy young and older adults in brain activations during face-name associations showed a greater retrieval success activity in the hippocampus in the young subjects than in the older subjects. In addition, functional connectivity between hippocampal and ATL activations was higher for young than for older adults. These age-related differences could relate to a decline in relational memory and a poorer retrieval of peoples’ names by older adults.

“We believe our research will help to identify the type of intellectual activities that can improve the quality of life at different ages,” concludes Prof. Kawashima.

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H Takeuchi, A Sekiguchi, Y Taki, S Yokoyama, Y Yokogawa, N Komuro, T Yamanouchi, S Suzuki, R Kawashima
Training of Working Memory Impacts Structural Connectivity

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Is my face attractive?

Self-face evaluation is relative to the attractiveness of others. The subject’s task was to evaluate faces of oneself (S), a close friend (F) and another (O) while these were inserted in a series of attractive and unattractive faces shown to the subject. Positive or negative evaluations were evoked by placement in the sequence of unattractive and attractive portraits.

The posterior cingulate cortex (PCC) and ventral tegmental area (VTA) show more activation from the positive modulation for S than for O. These results suggest that the PCC and the VTA are the neural correlates of positive self-face evaluation.

This map shows positive correlation between estimated cortical activation in PCC for positive self-face evaluation and self-esteem of participants. Similar results are found in VTA and between S and F. The results suggest a neural relationship between self-face evaluation and self-esteem.

See also Oikawa et al., Neuroimage, 2012; 59: 3668-76.

“Face recognition is considered a hallmark of self cognitive representation.”
Achieva 3.0T comes through earthquake with little damage

On March 11, 2011, the Great East Japan Earthquake with a magnitude of 9.0 struck Tohoku area, the most disastrous earthquake ever experienced. The IDAC MRI facility was almost intact after the earthquake, with only small cracks on the wall of building and floor of the MRI room. However, after power restoration, there were problems found in the magnet control unit, and helium levels were decreasing day by day. Finally, it was established that there was no severe damage to the magnet, and in about a month the MRI facility was in working order again.
Researchers look into mechanisms of multiple sclerosis using 7T MRI

The mechanisms that cause multiple sclerosis (MS) are thought to be an inflammatory process that starts around blood vessels in the brain. Through these vessels, macrophages and T cells enter the brain and cause an inflammatory process that leads to demyelination. Researchers at Ohio State University (Columbus, Ohio USA) are using the Achieva 7.0T MRI system to study this process.

Physicist Petra Schmalbrock, PhD, is Associate Professor of Radiology at the Ohio State University Department of Radiology, Wright Center of Biomedical Imaging. She explains how MR is being studied for its usefulness in diagnosing and assessing MS. “Sequences that are typically used are FLAIR, pre-and post-contrast T1W, and T2W. On FLAIR, MS lesions are well visible as bright spots. In the T1-weighted images, MS lesions appear dark, and there aren’t as many as on FLAIR. Eventually, the T1 images show a persistent black lesion, and the assumption is that the tissue has been destroyed. The inflammatory process is considered to be most active when lesions are seen bright (enhanced) on post-contrast images. This is thought to occur because the disease begins around small vessels, and gadolinium will leak out of these small vessels into the active lesion. However, the enhancing lesions come and go rather quickly, usually within a few weeks, yet the inflammatory process continues probably much longer.”

Dr. Schmalbrock is collaborating with neurologist/pathologist David Pitt, MD, Assistant Professor of Neurology at the Ohio State University and using Achieva 7.0T to gain understanding of the mechanisms of MS progression. The ultimate goal is to help better develop treatment plans.

White matter lesions with different iron content

“In order to study MS, we characterize white matter lesions. The most widely accepted mechanism is that small vessels break open, and inflammatory cells (macrophages and T cells) can enter the brain tissue and cause an inflammatory response,” says Dr. Schmalbrock. “We study MS brain specimens to characterize these cells. The macrophages can either be pro-inflammatory or anti-inflammatory and contain different amounts of iron depending on their polarization state. The anti-inflammatory cells have less iron than the pro-inflammatory macrophages. That’s where the ultrahigh field MR imaging comes in: it’s more sensitive than low field to the effects of iron, and it provides higher resolution to see more of the structural detail in these MS lesions.”

There are several aspects to the white matter lesions study. Active, demyelinating inflammation occurs during the early, so-called relapsing remitting phase of the disease while
We found significantly more iron lesions in the relapsing remitting patients than in the secondary progressive patients.

it is absent in the later phase, called secondary progression. “We’re studying the two stages of the disease,” says Dr. Schmalbrock, “And we’ve found significantly more iron lesions in the relapsing remitting patients than in the secondary progressive patients. This supports our hypothesis that iron lesions tell us something about the inflammation mechanism.”

The other aspect is comparing the gadolinium-enhancing lesions with the iron-containing lesions. “Interestingly, these might reflect different aspects of inflammation. The gadolinium enhancement reflects active demyelination and the iron longstanding, chronic inflammation process which leads ultimately to tissue degeneration and cannot be seen with gadolinium enhancement.”

**Basal ganglia are also affected**

It has been shown that iron also accumulates in the basal ganglia of MS patients. Dr. Schmalbrock is now studying whether iron in basal ganglia can be an indicator for disease advancement and perhaps can serve as a predictor. The mechanism of this iron accumulation is not fully understood. “We are just beginning some follow-up studies.
"We have developed a 7.0T white matter attenuated sequence, which may increase sensitivity and allow us to count the cortical MS lesions.

Cortical lesion
Achieva 7.0T images of a 30-year-old male. A cortical lesion is marked. Other potential lesions that were only visible by the readers on the color-indexed image are marked by the arrows. The color magnitude phase images were computed off-line from the scanner reconstructed real and imaginary components by the bright-to-dark setting from the magnitude and the color by assigning each color of a color wheel to the different phase angles.

Acquisition parameters:

<table>
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<tr>
<th>Sequence</th>
<th>Coil</th>
<th>TR [ms], flip, TE [ms]</th>
<th>TS / TI [ms]</th>
<th>Acq voxel [mm³]</th>
<th>Scan time [min]</th>
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<td>TI 2800</td>
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<td>16ch Nova</td>
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<tr>
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<td>16ch Nova</td>
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<td>4720 / 925</td>
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<td>9:00</td>
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</table>

WHAT = white matter attenuated, TS = shot interval, TI is inversion time.
*7T-WHAT, 7T GM attenuated, and 7T-T1_TFE use an adiabatic inversion pulse with a pulse setting of 2000 selected under control parameters.
We enrolled patients before they started their treatment and they will regularly come back over the next year, to see how they’ve changed.”

**Multiple sclerosis also affects the cortex**

The third study involves cortical lesion imaging. Initially, MS was thought to be only a white matter disease, but more recent pathology studies have also found disease activity in the cortex. Cortical lesions are thought to develop at later stages in the disease. “How that happens is not understood, but it may relate to the progression of cognitive function problems and permanent damage. Cortical lesions are almost impossible to visualize with conventional MRI because the spatial resolution is insufficient and contrast is weak between lesions and normal gray matter.”

“We have developed a 7.0T sequence that we call White Matter Attenuated sequence, which may increase sensitivity and allow us to count the cortical lesions. We are comparing this method with high-resolution susceptibility weighted imaging that was shown to be successful for cortical lesion imaging by researchers from the Massachusetts General Hospital. We are currently developing a model that estimates how well a given MRI technique may visualize cortical lesions.”

“Ultrahigh field MRI has some practical limitations, such as lack of homogeneity because the RF waves do not evenly propagate through the brain, and adjacent air and brain tissue, which can lead to artifacts. But the advantage is that ultrahigh field MRI can help detect more subtle changes that couldn’t be visualized in conventional MRI,” says Dr. Schmalbrock. “I would say MS is really the most promising application for ultrahigh field MRI right now.”

“7.0T MRI is more sensitive than low field to the effects of iron, and provides higher resolution to see more structural detail in MS lesions.”

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**Reference**

Using IntelliSpace Portal for assessment of cartilage

IntelliSpace Portal is a thin-client solution, designed to work virtually anywhere and without the need for a special workstation. Cartilage Assessment is one of the powerful applications offered on IntelliSpace. It features creation of rectangular and curved layered ROIs, and for detailed cartilage analysis it provides subdivision of different layers in cartilage. The package also provides calculated T2 values (T2 being usually higher in damaged cartilage). The possibilities this cartilage package offers are developed to support patient communication, to evaluate disease progression and to compare results in follow-up after therapy.

Benefit from the immediate results

Users of postprocessing packages often indicate that reduction of postprocessing time and reproducibility of results are important conditions for adoption of analysis tools in clinical routine. That’s why IntelliSpace Portal is designed for fast and easy processing. The Cartilage Assessment application is an excellent example of this philosophy.

When the package opens, it has already selected the correct image series from the study, and the T2 map is shown as a fused overlay on the original series. The screen layout supports the physician by providing the relevant information at a glance.
Follow the task-guided workflow

The left part of the screen provides task guidance: all choices are presented in a logical order with default choices already pre-selected. This guided workflow makes the package easy to use; it requires only a few clicks for fast and easy viewing. This helps to obtain reproducible results – even between different users – and to reduce training efforts of staff.

1. Rectangular layered ROI
A rectangular layered ROI can be used to quickly analyze focal lesions. The ROI can be divided in 1 to 3 layers.

2. Curved layered ROI
A curved layered ROI can be used to segment a complete cartilage structure. By placing multiple points to define the ROI, the actual curvature of the cartilage can be followed.

Layers and Segments
Drag the slider to quickly change the number of layers in the ROI within the range from 1 to 3. Curved layered ROIs can further be divided into segments to help analyze cartilage structure.

3. Optimize Color Overlay
See tip 5 on using these tools to optimize the color maps display.

4. Generate Maps
Use this button to produce the T2 color maps, optionally rename the generated series. Drawn ROIs will not be displayed on the maps.

Click the question mark to reveal relevant tips.

Adapt the T2 color map to your preference

At first use, the default “Reversed Rainbow” style will show, with a T2 value range of 1 to 81 ms. This can be changed according to your preference and new settings can be stored. Changing the color scale affects the visualization of the results in the graph viewer.

The T2 value range can be changed to preset 0-100 ms, or a user defined range can be set via Modify range.
**TIP 4**

**Drawing a rectangular layered ROI for focal lesion analysis**

A rectangular layered ROI can be used to analyze focal lesions. A default ROI has three layers and can be drawn in the anatomical viewer or directly on the color map.

![Image of anatomical viewer with rectangular ROI]

Draw the ROI by placing the first point on the bone-cartilage interface on one side of the lesion and the second point on the other side of the lesion. Then drag the cursor to the cartilage surface for placing the third point. This finishes the ROI drawing.

The table viewer shows the average T2 value per layer for each ROI. The graph viewer displays the average T2 values in a bar chart. Bar color corresponds to the average T2 value in the selected color scale.

Click on an ROI in the table viewer to jump to the slice it is drawn on – useful when ROIs are in different slices.

The graph viewer only shows graphs of the selected ROI. Click in the table viewer to quickly select ROI’s. Up to three rectangular layered ROIs can be displayed simultaneously in the graph viewer.

---

**TIP 5**

**Drawing a curved layered ROI adapted to the cartilage shape**

A curved layered ROI is used to analyze a complete cartilage structure. The curved ROI can be adapted to the actual shape of cartilage.

![Image of anatomical viewer with curved ROI]

A curved layered ROI can be drawn on the anatomical image or directly on the color map. When drawing on the color map, it might be useful to adapt the opacity of the color map with the slider, or by dragging with the right mouse button in the color map directly.

Click the “Draw bone surface” icon, and draw a line across the bone-cartilage interface by placing multiple points. Double click the last point to finalize. As this is a precise task, it is important to zoom in to the assessed area.

Then draw the cartilage surface in a similar manner.

After drawing, segments can be resized, for instance to the lesion size or weight-bearing area.

The ROI name can be changed by clicking on it.
Cut out colors for enhanced visibility of results

Two types of cut-out are possible to create a clear display of relevant results.

The option "Suppress colors outside ROIs" provides good results with curved ROIs where the cartilage structure has been segmented by the user. It affects only the slices with the ROI.

Manual cut-out is recommended for rectangular ROIs, or when only color maps are generated. A manual cut-out will propagate over all slices.

Example: micro fracture treatment results

A curved layered ROI is drawn on a knee after micro fracture treatment. Segment B was resized to the size of the treatment area. The graph viewer provides an easy way to see the results in a glance. It displays all three segments, each subdivided into three layers. Segment B, the treatment area, shows slightly increased T2 in the deep layer, but the intermediate and superficial layers have the highest T2 (blue in this case). Usually damaged cartilage has higher T2 values.
Combining science and art with the Achieva 3.0T

Fruitful phantoms

In his quest to find the ideal phantom for image quality control, MR technologist Andy Ellison at Boston University Medical School hit on something beautiful. He started imaging fruit and vegetables on the university’s Achieva 3.0T and thanks to the system’s exceptional resolution he has created a series of truly striking dynamic and static images which he now shares on his popular blog. Some of his high-resolution images are included here, but if you want to see the full series – which is growing all the time – then visit his blog at http://insideinsides.blogspot.com.
MR-guided interventional course held at Magdeburg

Spacious Panorama HFO provides MR imaging during interventional procedures

The International School of Image-Guided Interventions (Magdeburg, Germany) was co-founded by Prof. Jens Ricke, MD, who has pioneered MR-guided interventions at the Clinic for Radiology and Nuclear Medicine in Magdeburg. As part of the school’s curriculum, a two-day course recently familiarized participants with use of the Panorama High Field Open scanner in MR-guided interventions.

Panorama’s 160 cm, wide-open aperture allows it to support many different minimally invasive interventions where MRI’s high soft tissue contrast and imaging in multiple orientations can be useful. These include MR-guided tumor ablation in the liver with RF ablation or brachytherapy, biopsy procedures such as free-hand breast biopsy, pain therapy, drainage placement, nephrostomy and more. Panorama HFO enables good patient access and MR imaging during the procedure.

The interventional course is held at the Center for Radiology of University Hospital Magdeburg and led by Frank Fischbach, MD and K. Strach, MD. Two 2-day courses were held in February 2012, each attended by four pairs of users, a pair being the interventional radiologist plus his/her technologist. It provided theoretical sessions on interactive MR, safety aspects and MR compatible materials like catheters, clips and biopsy systems. In addition there was the extensive practical experience for each interventional team, with the interventionalist at the Panorama HFO MR scanner and technologist at the console, using anatomic and non-anatomic phantoms. Intervventional HFO users from Norway, Belgium and Germany attended the courses.

Ole Einar Heieren, MD, radiologist at Ulleval University Hospital, Oslo was one of the participants in the course. “The 2-day hands-on workshop in Magdeburg for interventions on the Philips Panorama was very well organized, interesting and useful. We look forward to using the knowledge and the developed MR sequences for interventions in clinical practice at the university hospital in Oslo,” he commented at the end of the course.

For more information on the course, see www.dafnt.com/training-courses.
NetForum has a lot to offer for Philips MR users

NetForum is the online community for users of Philips MR, CT and NM systems. NetForum content helps you to learn more about Philips products from the people whose opinions you value the most: your peers. The content is organized in three sections: Explore, Operate and Grow. Learn more and sign up at:

www.philips.com/netforum

Don't miss this on NetForum

**New Pediatric ExamCards**
Some dedicated pediatric ExamCards were recently added to NetForum. Sets of Achieva 3.0T ExamCards for children of different ages were shared for shoulder, elbow and wrist. Achieva 1.5T ExamCards were added for pediatric IBD and urography.

*Get there via: Operate > ExamCards > Pediatric*

**Ingenia – Content overview**
Start here for a quick overview of all available Ingenia content. New ExamCards, Case Studies, Best Practices and Web Seminars are being added regularly.

*Get there via: Explore > Clinical News > MRI*

Most popular MRI NetForum contributions in first quarter of 2012

1. **Application Tip**  Metal artifact reduction for MRI of metal prostheses and implants
2. **ExamCard**  1.5T hip with prosthesis using MARS protocol
3. **ExamCard**  Ingenia 3.0T Breast - WellStar Health System, Atlanta
4. **Application Tip**  Tips for body diffusion weighted imaging (DWI)
5. **Application Tip**  Tips for non-contrast MRA
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FieldStrength is published three times per year for users of Philips MRI systems. FieldStrength is a professional magazine for users of Philips medical equipment. It provides the healthcare community with results of scientific studies performed by colleagues. Some articles in this magazine may describe research conducted outside the USA on equipment not yet available for commercial distribution in the USA. Some products referenced may not be licensed for sale in Canada.
Education calendar 2012

Breast MR

European Workshop on MRI-guided vacuum breast biopsies
Bruges, Belgium
Dates: October 25-26
For radiologists with experience in breast imaging. Organized by Dr. Casselman, AZ St. Jan.
Info: bemecke@mammotome.com
Phone: +49 40 393559116

Advanced Breast MRI Workshop
Cleveland, OH, USA
Dates: T.B.A.
2.5-day course for radiologists and technologists with basic understanding of breast imaging. Course includes didactic, hands-on and clinical reviews. Breast biopsy and post processing packages will also be covered.
Info: kara.grey@philips.com

Breast MR with guided biopsy
Reston, VA, USA
Dates: August 7-8; Nov. 1-2
This 100-case course is designed to provide practicing radiologists with an intensive, hands-on experience in reading breast MRI. Participants will develop their interpretive skills through extensive case reviews at individual work stations.
Info: www.acr.org
Email: EDCTR-WebReg@acr-arrs.org
Phone: +1 800-373-2204

Musculoskeletal MR

Erasmus course on MRI: Musculoskeletal II
Valencia, ES
Date: September 24-28
Info: www.adredit.uv.es/emrvalencia2012/
Email: maria.jose.garcia@adredit.uv.es

Current issues of MRI in orthopaedics and sports medicine
San Francisco, CA, USA
Date: August 26-29
Info: www.stollerscourse.com

Cardiac MR

Cardiac MR courses at CMR Academy
German Heart Institute, Berlin
All courses are for cardiologists and radiologists. Some parts will be offered in separate groups.
Info: www.cmr-academy.com
Email: info@cmr-academy.com
Phone: +49-30-4502 6280

Complete course
Dates: Part 1: Oct. 22 - Nov. 30
Part 2 - home study:
Intensive course including hands-on training at the German Heart Institute, and reading and partially quantifying over 250 cases.

Compact course
Dates: Aug. 27-31; Oct. 22-27
CMR diagnostics in theory and practice, including performing examinations and case interpretation.

CVMRI Practicum: New Techniques and Better Outcomes
St. Luke’s Episcopal Hospital, Houston, TX, USA
Date: October 20-23
On principles and practical applications of Cardiac MRI.
Info: ddees@siele.com and lvillareal@siele.com

Cardiac MRI Training
Washington Hospital Center, Washington, DC, USA
Date: 3-month fellowship
Open for cardiologists, radiologists, and others interested in learning more about CVMR in a high-throughput clinical site focusing on a variety of clinical problems. Organized by Dr. Fuisz.
Info: www.cvmri.com
Email: pamela.cl.wilson@medstar.net
Phone: +1-202-877-6889

MR Spectroscopy

MR Spectroscopy course
Zurich, Switzerland
Date: July 30 – August 3, 2012
Theory sessions and daily practical scanning and post-processing sessions in small groups.
Info: www.biomed.ee.ethz.ch/education
Email: henning@biomed.ee.ethz.ch

Advanced MR Spectroscopy
Cleveland, OH, USA
Date: T.B.A.
MR engineers, research technologists, physicians, and physicists of Philips MR sites, interested in MR spectroscopy. Participants require basic MR scanning experience. Note that class size for this course is limited.
Info: vicki.milligan@philips.com

Register on NetForum to have free access to online training modules on use of Philips MR scanners and packages, use of coils, use of EWS, MR safety.

NetForum
www.philips.com/netforum
**General MR**

**Essential Guide to Philips in MRI**  
Cheltenham, UK  
**Dates:** November 5-8  
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.  
**Info:** education@cobalthealth.co.uk

**Philips North America off-site training courses**

**Dates:** upon request  
**Info:** kara.grey@philips.com  
**Phone:** +1-440-483-3555  
**Fax:** +1-440-483-7946

### Regional Registry Review
**Cleveland, OH, USA or facilities across U.S.**
Two-day didactic course covering MR physics and cross sectional anatomy. This course is designed as an overview course to assist MR technologists in taking the ARRT MR registry exam.

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

### MRI Essentials for Philips users
**Cleveland, OH, USA**
This comprehensive course for technologists covers all basic scanning and system functionality. Lectures cover MRI safety, scan parameters, and pulse sequences.

### Advanced MRI for Philips users
**Cleveland, OH, USA**
Didactic and hands-on course covering advanced applications including advanced scan parameters, pulse sequences, advanced neuro, ortho, body and breast imaging techniques.

### Cardiac imaging for Philips users
**Cleveland, OH, USA**
Didactic and hands-on course covering all cardiac views, heart valves, Q-flow, coronary arteries and the postprocessing packages on the EWS.

### 1H Basic spectroscopy imaging
**Cleveland, OH, USA**
Didactic and hands-on course covering Basic 1H Spectroscopy for the brain, prostate, and breast. This course also covers postprocessing packages on the system.

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**Events calendar 2012**

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<th>Event</th>
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<td>July 29 - Aug 2</td>
<td>The American Association of Physicists in Medicine - AAPM</td>
<td>Charlotte, NC, USA</td>
<td><a href="http://www.aapm.org">www.aapm.org</a></td>
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<td>Aug 25-29</td>
<td>European Society of Cardiology - ESC</td>
<td>Munich, Germany</td>
<td><a href="http://www.escardio.org">www.escardio.org</a></td>
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<td>Sep 7-8</td>
<td>Highfield MR in Clinical Applications</td>
<td>Bonn, Germany</td>
<td><a href="http://www.highfieldmr-bonn.de">www.highfieldmr-bonn.de</a></td>
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<tr>
<td>Sep 15-19</td>
<td>Cardiovascular and Interventional Radiological Society of Europe - CIRSE</td>
<td>Lisbon, Portugal</td>
<td><a href="http://www.cirse.org">www.cirse.org</a></td>
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<tr>
<td>Sep 19-21</td>
<td>MRA Club</td>
<td>Utrecht, Netherlands</td>
<td><a href="http://www.mraclub.com">www.mraclub.com</a></td>
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<tr>
<td>Sep 20-23</td>
<td>European Society of Neuroradiology - ESNR</td>
<td>Edinburgh, UK</td>
<td><a href="http://www.esnr2012.org">www.esnr2012.org</a></td>
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<tr>
<td>Sep 26-29</td>
<td>European Society of Stereotactic and Functional Neurosurgery - ESSFN</td>
<td>Lisbon, Portugal</td>
<td><a href="http://www.essfn2012.org">www.essfn2012.org</a></td>
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<tr>
<td>October 3-7</td>
<td>American Society of Head Neck Radiology - ASHNR</td>
<td>Miami Beach, FL, USA</td>
<td><a href="http://www.ashnr.org">www.ashnr.org</a></td>
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<tr>
<td>October 4-6</td>
<td>European Society for MR in Medicine and Biology - ESMRMB</td>
<td>Lisbon, Portugal</td>
<td><a href="http://www.esmrmb.org">www.esmrmb.org</a></td>
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<td>October 6-10</td>
<td>Congress of Neurological Surgeons - CNS</td>
<td>Chicago, IL, USA</td>
<td><a href="http://www.cns.org">www.cns.org</a></td>
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<tr>
<td>October 12-13</td>
<td>European Society of Breast Imaging - EUSOBI</td>
<td>Barcelona, Spain</td>
<td><a href="http://www.eusobi.org">www.eusobi.org</a></td>
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<tr>
<td>October 19-24</td>
<td>American College of Gastroenterology - ACG</td>
<td>Las Vegas, NV, USA</td>
<td><a href="http://www.acgmeetings.gi.org">www.acgmeetings.gi.org</a></td>
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<tr>
<td>October 24-27</td>
<td>European Association of Neurosurgical Societies - EANS</td>
<td>Bratislava, Slovakia</td>
<td><a href="http://www.eans.org">www.eans.org</a></td>
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<tr>
<td>October 28-31</td>
<td>American Society for Therapeutic Radiology and Oncology - ASTRO</td>
<td>Boston, MA, USA</td>
<td><a href="http://www.astro.org">www.astro.org</a></td>
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<tr>
<td>Nov 25-30</td>
<td>Radiological Society of North America - RSNA</td>
<td>Chicago, IL, USA</td>
<td><a href="http://www.rsna.org">www.rsna.org</a></td>
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