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

Barrow Neurological Institute: research to make clinical MR faster and better

Philips Ingenia 1.5T ranked #1 in latest KLAS MR report
Dear Friends,

At Philips, we recognize your need to accommodate a larger number and variety of patients each day, while at the same time dealing with the increased diversification of MRI procedures. Our exhibition at ISMRM displays solutions designed to accelerate patient management, enhance patient imaging and simplify case reporting – so that you can increase the efficiency and quality of care to your patients. Ingenia with dStream delivers imaging strategies once thought unattainable to the routine, that are only made possible through close collaboration with our clinical partners.

In this special issue of FieldStrength you can read how acquisition times for five main MRI exams have been reduced to less than 8 minutes by UMC Utrecht. The article on Elkeriekh Hospital in Helmond shows which other measures can help to actually increase patient throughput.

At this year’s ISMRM, the Philips Healthcare Gold Corporate Symposium features two expert users, who are also featured in this special issue of FieldStrength. Pediatric radiologist Jeffrey Miller, MD, of Phoenix Children’s Hospital, demonstrates how Ingenia 3.0T has uplifted imaging in small children, one of the most challenging patient groups for MRI. Researcher Jim Pipe, PhD, of Barrow Neurological Institute strives to make clinical MR faster and better. He uses Ingenia 3.0T for research on accelerating MRI and improving image quality.

Don’t miss the article on pCASL high performance brain perfusion imaging without contrast agent, used by CHC Saint Joseph Hospital, Liege in 100 patients with brain tumor or suspicion of brain tumor.

Henry Ford Health System has transformed its care by using intraoperative MR during neurosurgery now virtually every day. The team built a solid routine and sees advantages for patients as well as benefits for the hospital. And when not in use for intraoperative MR, the MR scanner is fully operational for diagnostic MR exams.

The News section provides a convincing before-and-after comparison of SmartPath to dStream, which converts an existing Achieva or Intera into a state-of-the art MR scanner with dStream digital platform. This gives access to broader clinical capabilities and allows increasing throughput by up to 30%.

Also read about another exciting initiative: Philips and Elekta recently established the research consortium on MRI-guided radiation therapy after developing a first prototype together with UMC Utrecht.

This is how we transform care, together. I hope you enjoy reading this issue of FieldStrength.

Paul Folkers, PhD
Head of MRI Marketing, Philips Healthcare
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You may also like to visit www.philips.com/ismrm
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.

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

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.

"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."

"We are beginning to also feed these high-resolution data sets into off-line post-processing programs to create segmented tissue classification images and quantitative determinations of parameters such as white and gray matter volumes and cortical thickness. These voxel-based morphology (VBM) techniques require high-resolution 1 mm isotropic volume data sets which we now acquire routinely. The goal of this additional image processing is to eventually provide clinicians with quantitative measurements of specific cerebral tissue components that could prove useful in diagnosing, characterizing and monitoring disease processes which conventional imaging fails to elucidate."

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

“While spine imaging at 3.0T can be challenging, standard sagittal spin echo spine sequences on our Ingenia are as good as or better than at 1.5T,” Dr. Miller says. “We also use a modified e-THRIVE for T1 and T2 FFE 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 provides better delineation of areas of intrathecal fat seen against the background CSF.”

“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.

Visit NetForum to download Ingenia 3.0T pediatric neuro ExamCards contributed by Dr. Miller.

**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).
Barrow Neurological Institute research strives to make clinical MR faster and better

Partnership between Barrow and Philips focuses on advancing MR technology by using Ingenia 3.0T in research projects.

Barrow Neurological Institute is a center of neurological excellence contained within St. Joseph’s Hospital and Medical Center (Phoenix, Arizona, USA). It recently acquired its first Philips MR system, an Ingenia 3.0T. The system comes with a five-year agreement between Philips and St. Joseph’s to pursue research that will advance MR technology by accelerating MRI and improving image quality, for example, by reducing motion-related image disturbances.

“I think the big reason to have fast MR is because we can’t afford long MR scan times anymore.”

Principle of PROPELLER and MultiVane techniques
Conventional methods collect data along horizontal lines that fan all of k-space. PROPELLER and MultiVane data are collected as rotating blades. One echo train collects all data for one blade. The images obtained by Fourier transforming each blade illustrate that the low spatial frequencies are collected by each blade (red circle), while edge information corresponds to the orientation of the blade in high-frequency space (blue and yellow arrows). When combined all data produce a complete sharp image.
Barrow Neurological Institute plans to use the Ingenia to help reach the goal of “making clinical MR faster and better,” according to Jim Pipe, PhD, director for neuroimaging research at the Institute. As the inventor of the PROPELLER (Periodically Rotated Overlapping Parallel Lines with Enhanced Reconstruction) technique, which Philips applies in MultiVane, as well as chair of the 2012 International Society for Magnetic Resonance in Medicine (ISMRM) Meeting, Dr. Pipe is at the forefront of MR technology research, particularly in regards to fast sequences and motion correction.

Developing spiral MR for robust and fast clinical use

One aspect of Barrow’s research is the development of spiral MR. “Spiral MR has been used in research for quite a while, but is not used clinically very much at all because it is not very robust,” Pipe says. “However, it has the potential to make it possible to generate images with the same SNR, quality and content as normal images, but collected in less time and with reduced motion artifacts.” He estimates that if technical hurdles are solved, spiral imaging could reduce neuro scan times – and ultimately exam times – by a factor of 2 to 3.

“The desire to go faster should follow patients, because they want to get the exam over as quickly as they can, and it also fits well with the economics of healthcare, because we have to become more efficient with these expensive tools.”
Speed addresses both clinical and economic issues
Higher scan speed allows for faster imaging with less motion-related blurring, or higher resolution in the same scan time. In addition to the clinical benefits, Dr. Pipe sees an important economic benefit. “If we could change MR so that we could do five-minute exams that cost a couple hundred dollars, rather than 45-minute, thousand dollar exams, it would really change the paradigm of how we use MR,” he says. “In the United States, for example, we spend roughly 20 billion dollars each year on MR. If we could even cut those 45-minute times in half, and then charge 60% of the current charge so we are still making more per hour, we can save billions of dollars in healthcare costs without compromising patient care quality at all.”

Dr. Pipe acknowledges that not all exams will be as short as five minutes, and that such a change requires more than just technical advancement, but calls it the motivating factor. “When I give educational talks, I point out that we are not making fast images just because it is cool. I think the big reason to have fast MR is because we can’t afford long MR scan times anymore.”

He adds, “The desire to go faster should follow patients, because they want to get the exam over as quickly as they can, and it also fits well with the economics of healthcare, because we have to become more efficient with these expensive tools.”

Additional areas of study include fMRI, MR angiography
In addition to developing fast sequences, the Institute’s Ingenia system will be used to further develop non-cartesian motion reduction techniques, such as MultiVane, and for a wide variety of research. Leslie Baxter, PhD, also of Barrow, will use Ingenia 3.0T for fMRI studies of deep brain stimulation and depression, pre-surgical planning, and other fMRI applications. Barrow also may use the scanner for research on various other topics, including cardiovascular imaging and Alzheimer’s research, in cooperation with other Phoenix institutions including Mayo Clinic and Banner Health.

“The research changes all the time, but we are always interested in making clinical MRI really good, and we want to remove all the technical boundaries so that the only things limiting us are physics and physiology,” Dr. Pipe summarizes.

Although his scanning experience with Ingenia is still limited, Dr. Pipe is very positive about the system. “The neuro images are quite good,” he says. “This is our first system with a 70 cm bore, which is fantastic from a patient point of view. Our early impressions of dStream are really good, and there is a lot of flexibility that will be very advantageous to us.” But he reserves his highest praise for Philips personnel.

“My biggest incentive for working with Philips is the people. I have admired the work of a lot of folks within Philips for a long time, and I am thrilled to be able to work with them,” he says. “The desire at Philips to challenge the status quo of MR is very exciting to me. I think we share a lot of the same vision and enthusiasm.”

Spiral imaging
Spiral imaging has the potential to create images with the same quality as conventional methods, but in less time and with reduced motion artifacts. Spiral scanning measures more of the data in k-space each TR. If the technical barriers to making this technology truly robust can be solved, spiral imaging could improve nearly every type of MR scan.

Creative design of 3D spiral-based trajectories opens up the possibilities for improving more applications.
“We wanted to produce images that sufficiently support the clinical decision process but without adding more sequences than necessary.”

Acquisition in less than 8 minutes for five most common MRI exams

University Medical Center Utrecht (UMCU) uses Ingenia 1.5T to design significantly faster imaging while maintaining diagnostic quality

The UMCU team recently developed fast Ingenia 1.5T ExamCards for the five most common exams, each of which require less than 8 minutes scan time. This is a scan time reduction of more than 50% compared to their standard protocols, and still satisfies the image quality criteria defined by the ACR Clinical Image Quality Guide.

Faster imaging that still supports diagnosis

UMCU, in the Netherlands, installed Philips Ingenia 1.5T in 2010. Since then, Tim Leiner, MD, PhD, cardiovascular radiologist and Associate Professor of Radiology at UMCU, has built up considerable expertise in working with this system. The team developed five exams with scan times of less than 8 minutes for brain, cervical spine, knee, foot/ankle and liver. Together these exam types make up 85% of clinical exams performed in typical MRI practices today. Compared to UMCU’s standard clinical MR exams, the number of sequences was reduced and individual sequences were adjusted to meet the recommendations by the American College of Radiology (ACR).

“Our starting point was the ACR minimum requirements for sequence types, image contrast, anatomic coverage, imaging planes and spatial resolution, which we incorporated into the scan protocols,” says Dr. Leiner. “We wanted to produce images that sufficiently support the clinical decision process but without adding more sequences than necessary. This resulted in the five exams taking less than 8 minutes.”
To assess the image quality of the newly optimized fast ExamCards, 40 patients were scanned with both the new and existing protocols for brain, cervical spine, knee or foot/ankle. Results of a blind test2 showed that the image quality, SNR and artifact presence were not significantly different (p>0.05) although the mean perceived image quality was slightly lower for the fast ExamCards. The UMCU team is now assessing the diagnostic quality of the new optimized ExamCard images. “Before we share these new protocols with others, we want to be sure that their diagnostic values are as good as those of the longer exams.”

How Ingenia contributes to reducing scan time

“Thanks to Ingenia we have been able to reduce scan time so much,” says Dr. Leiner. “That’s because Ingenia is a digital broadband MR system that digitizes the signal at the source in the coil. Thanks to this dStream platform it provides up to 40% higher SNR than our analog system. In addition, Ingenia has dS SENSE next generation parallel imaging that allows us to use higher acceleration factors.”

“With Ingenia we also got access to the mDIXON technique that can really modify the way MR is done,” says Dr. Leiner. “With mDIXON multiple contrasts can be acquired at the same time. Acquiring both water and fat images in one scan has interesting implications, as often both a T1-weighted sequence and a fat-suppressed T1 sequence are needed. Now with mDIXON, both fat-suppressed and non-fat suppressed images are acquired together in just one scan, so imaging time is substantially reduced. In addition, mDIXON also provides in-phase and out-phase images. I think the mDIXON technology is really a game changer. This Philips implementation is, in my opinion, very elegant, because it is compatible with very fast imaging.”

“Ingenia is capable of producing very high image quality, but instead of pursuing ever-sharper images, we wanted to see how much image quality we could tradeoff for speed, and still produce clinically relevant images. After all, radiology is ultimately not about making images, it’s about supporting clinical decision-making. We managed to halve the imaging time and still get the key information that influences clinical management.”

Comparing fast and normal brain images

Ingenia 1.5T fast and standard MR brain images show nearly identical appearance of image contrast and lesion conspicuity in right cerebral hemisphere.
**More than short scan times: faster workflow**

In addition to optimizing ExamCards for speed, the UMCU team takes full advantage of the Ingenia’s workflow acceleration features. The posterior coil integrated in the table eliminates coil handling from a significant portion of all exams. The wide bore and lightweight coils are designed for easy patient handling and to enhance patient comfort. “A comfortable patient is less likely to move, which will benefit image quality,” says Dr. Leiner.

SmartAssist reduces the number of manual actions as it automatically positions the table and starts the scanning, automatically plans the scan, reduces the number of processing steps, and automates coil element selection.

All of this can help reduce total patient examination time by up to 30%.

**Will faster scanning change the role of MR?**

“Traditionally, the aim was to image everything, but that is simply not necessary for many patients,” says Dr. Leiner. “The fast protocols are designed, for instance in new patients with pain, to determine what the problem is. For complex disease or very specific clinical questions more extended exams will still be needed.”

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**Comparing fast and normal imaging in cervical spine**

In cervical spine the total scan time in the ExamCard is reduced from 15:01 min. in the normal protocol to 7:54 min. in the fast exam.

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**Fast Ingenia 1.5T ExamCards developed at UMC Utrecht**

### Brain

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<tr>
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<td>DWI SENSE</td>
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### Foot/Ankle

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### Liver

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<td>T2 tra</td>
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<td>T2 tra fat sup</td>
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“Thanks to Ingenia we have been able to reduce scan time so much.”

“We don’t know exactly how healthcare institutes will take advantage of the faster scanning,” says Dr. Leiner. “However we may expect that MR use will continue to grow rapidly. The two main drawbacks of MRI today are the long waiting lists and the relatively high cost. If faster scanning can help to reduce exam time slots and increase patient turnover, this will make MR more cost-effective and help to reduce waiting times. Our waiting times with these fast protocols are now approximately one day only. Another consequence could be that MR may become the preferred first exam for some patient groups, for instance, patients with knee pain or chronic headaches.”

A true paradigm shift for users and patients

“Often when significant improvements are made in hardware or software, there may not automatically be a high impact on the users or the patients,” says Dr. Leiner. “But here we are seeing a synergistic convergence of several innovations. We have the Ingenia with powerful hardware and software. We have the new fast protocols. And we have the patient-friendly wide bore and the dStream coils. It is this convergence that is creating a truly radical change for users and patients.”

Comparing fast and normal imaging in the knee

In the fast exam, T2-weighting and spatial resolution are both slightly decreased. Despite this, the area of bone marrow edema in the medial femoral condyle is clearly visible and of similar extent as in the normal imaging protocol. Total scan time is reduced by 65% in the fast exam.

Comparing fast and normal imaging in foot/ankle

In the fast exam, total scan time is reduced by 70%. In the example images shown scan times have significantly dropped, while voxel sizes have only slightly increased.
I think mDIXON is really a game changer as it is compatible with very fast imaging.”

Comparing image quality of fast and normal exams
Images of 32 patients from the fast ExamCards and the normal UMCU ExamCards for brain, cervical spine, knee and foot/ankle were assessed by an experienced radiologist, who was blinded to acquisition type. Each image was rated for image quality, perceived SNR, and artifact presence. The results show no significant differences, i.e. p>0.05.

Complete Ingenia 1.5T liver exam in 7.5 minutes
The exam starts with coronal T2W, in-phase and out-of-phase T1W*, DWI, axial T2W and fat suppressed T2W. For functional evaluation three 3D volume T1W acquisitions are done for arterial, portal and venous. Because mDIXON is used, 3D water images and fat images are obtained as well, without adding acquisition time.

References
2 T Leiner, E Alberts, N Blanken, M Stoesz, M Hartjes, J Hendrikse MR Examination Times of Less than 8 Minutes for 4 Common Indications ISMRM 2013
Elkerliek Hospital achieves major improvements in patient throughput

Installing **Ingenia 1.5T** and taking a fresh look at departmental procedures helps increase patient throughput and reduce waiting time.
The recent installation of an Ingenia 1.5T with its potential for fast, easy workflow and enhanced scanning possibilities stimulated the MRI unit at Elkerliek Hospital (Helmond, The Netherlands), to re-evaluate its clinical strategies and scanning procedures and make plans to improve efficiency. The unit is now already seeing increased patient throughput and a reduction in patient waiting time, with further improvements expected in the future.

Elkerliek Hospital has two MRI scanners: an Ingenia 1.5T system at its center in Helmond and an Achieva 1.5T in Deurne. The Ingenia is a recent acquisition, replacing an aging Intera 1.0T system. The installation of this state-of-the-art scanner at Helmond prompted the unit to perform a thorough reappraisal of its procedures. “The aim here was not only to realize the full potential of Ingenia’s advanced capabilities, but also to look at general improvements we could make in our current mode of working,” says Jan op ‘t Hoog, Section Manager responsible for, among other things, the radiology department at Elkerliek.

Identifying areas for improvement
With the support of Philips Healthcare Consulting, the unit organized a Kaizen event, a one-week workshop involving radiologists, technologists, administrative support staff and management, aimed at analyzing processes and brainstorming to identify potential areas for improvement.

As a precursor to this, the MRI unit also subscribed to the Philips Utilization Services, which provides automated collection of usage data and a clear display of statistics on a secure page on NetForum.

“Identification of areas for improvement was enlightening. The comparison with the performance benchmark, obtained from the cohort of similar Philips MRI systems, showed that our efficiency was already somewhat above the average before we undertook any actions,” says Helma Hertenberg, Radiology Departmental Manager responsible for MRI.

“The results were enlightening. The comparison with the performance benchmark, obtained from the cohort of similar Philips MRI systems, showed that our efficiency was already somewhat above the average before we undertook any actions,” says Helma Hertenberg, Radiology Departmental Manager responsible for MRI.

“Some shortcomings were still identified, however”, she says. “For instance, our patient waiting list had been growing steadily in recent years. During the workshop it quickly became clear that this was largely due to our planning system being far from optimal. The system had evolved over time, with minor adjustments on the fly to correct for small problems without ever looking at the whole picture. As a result, the planning no longer reflected the real situation. Some exams overran the allotted time and others were completed earlier than planned, which often left us with unproductive time between exams. Time was also reserved for urgent cases, which by their nature are difficult to predict. These were often planned during breaks, when only one technologist was available, putting further strain on the planning schedule.”

“Ingenia 1.5T is less dependent on coil changes, so exam grouping is now based on scan time required, which makes the whole planning much easier and more flexible.”

Old planning (top) and new planning (bottom)
Urgent exams (red) and inpatients (green) were previously often planned during breaks when only one tech is available. Waiting times for outpatients (blue) used to be long. Brown are simple exams, other colors represent time dedicated to special exams.
“Now the process is more strictly organized, and we know exactly what information we can expect from the exams.”

### Average values

<table>
<thead>
<tr>
<th></th>
<th>Elkerleik Starting situation</th>
<th>6th month after start</th>
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<td>Ingenia 120</td>
<td>Achieva 85</td>
<td></td>
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<tr>
<td>Waiting time</td>
<td>Ingenia 5-35 d</td>
<td>Achieva 5-21 d</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>6th month after start</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5-23 d</td>
</tr>
<tr>
<td>Exams per day</td>
<td>Ingenia 16</td>
<td>Achieva 21</td>
<td></td>
</tr>
<tr>
<td>Procedure time</td>
<td>Ingenia 33 min.</td>
<td>Achieva 25 min.</td>
<td>6th month after start</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>29 min.</td>
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<tr>
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<td>36 min.</td>
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<tr>
<td>Exam time</td>
<td>Ingenia 21 min.</td>
<td>Achieva 15 min.</td>
<td>6th month after start</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18 min.</td>
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<td></td>
<td></td>
<td></td>
<td>20 min.</td>
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<td>Scan time</td>
<td>Ingenia 19</td>
<td>Achieva 13</td>
<td></td>
</tr>
<tr>
<td>Patient change time</td>
<td>Ingenia 12</td>
<td>Achieva 11</td>
<td></td>
</tr>
<tr>
<td>[min]</td>
<td></td>
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</table>

*Average benchmark Philips 1.5T MRI systems in the Netherlands

### Knee – old

The new ExamCard for knee shows a scan time reduction of 39%.

### Knee – new

The new brain ExamCard shows a scan time reduction of 30%.

### FieldStrength - Special issue ISMRM 2013

Ingenia 1.5T performance improvement. Utilization graphs help to monitor the improvements achieved.
What helped improve efficiency at Elkerliek:

- Use of Philips Utilization Services for monitoring performance
- Involvement of all stakeholders in defining improvement
- Smarter exam planning:
  - Shorter blocks to reduce time loss within blocks
  - Combine exams in blocks: similar length for Ingenia, similar anatomy for Achieva
  - Reduce number of slots reserved for (relatively) urgent patients
- Better informed patients help reduce preparation time
- Better information exchange between radiologist, technologist and referring physician
- Radiologists specify standardized exam protocols, making work easier for techs and planning more predictable
- Standardized room layout and patient preparation (e.g. IV contrast) enhance efficiency
- Organizing continuous education/information sharing

The lack of predictability in exam times was aggravated further by the fact that the radiologists in the unit all had their preferred sets of protocols for specific clinical questions, that they expected the technologists to follow. “It became clear during the Kaizen event that the exam scheduling and the work of the technologists could be much easier if the radiologists all agreed on the same protocols to follow,” observes radiologist J.P. (Hans) Westerhof, MD, PhD, Medical Manager of the radiology department at Elkerliek.

Smarter exam planning
The first phase of the improvement plan was aimed at improving the efficiency of the planning system. Drawing on the experience of the Philips consultants, a new planning system was designed to improve usage over the working day. Elkerliek’s MRI schedule is divided into blocks of exams with similar characteristics. The old planning system used relatively large blocks over the day, increasing the risk of losing time between the exams within a block. So, one of the changes implemented was to decrease the duration of the blocks and to increase planning flexibility.

“The for the Achieva 1.5T in Deurne, the patients are grouped according to exam type to save on coil changes, for example, brain exams or orthopedic exams,” says Helma Hertenberg. “But the Ingenia 1.5T is less dependent on coil changes, so here the planning is based only on the scan time required, which makes the whole planning much easier and more flexible.”

The second phase aims at reducing the number of slots kept in reserve for urgent patients. Since waiting times were long, slots had to be reserved for patients who need to be scanned within 10 days. However, reducing the time lost between exams, reducing the exam duration and working some extra days have decreased waiting time and thus reduced the necessity to reserve slots for urgent patients during normal working time.

Standardized and faster ExamCards
For Ingenia 1.5T, the team is looking at the possibilities to reduce scan times of ExamCards and to reduce the total number of ExamCards. This third phase is currently still in progress. The brain ExamCard was meticulously reviewed in relation to the clinical question and which sequences are really used by the radiologist, and to potential improvements offered by the Ingenia 1.5T system. The new brain ExamCard takes 10:42 minutes scan time, 30% faster than previously. For the knee, scan time is reduced by as much as 39% to 13:45 minutes.* In addition, some of the sequences in both knee and brain now also provide better image quality.

With the standardized exam protocols and ExamCard names, the radiologists can now specify well in advance which ExamCard they require for each referral, again making the time for the exam more predictable.

Significant reductions in waiting time
“For us, a major criterion of success was clear: reduced patient waiting time. In the past waiting time was not only too long, but also inconsistent, varying in some instances from say 10 days to 35 days, depending on the exam,” points out Jan op’t Hoog. “Now, waiting time is already significantly shorter. At this moment no exam has a waiting time of more than 23 days and we are working on further improvements in the future. We are also achieving more consistent waiting times for different exams.”

The unit’s radiologists also see important improvements. “For the radiologists, it was a useful opportunity to optimize all individual protocols in the ExamCards, to develop and discuss shortcuts, and to really evaluate what we need for our diagnoses and what would be superfluous to our needs,” says Dr. Westerhof. “Now the process is more strictly organized, and we know exactly what we can expect from the exams.”
Intraoperative MR team focuses on patient care and productivity

Henry Ford Health System uses Achieva 1.5T in the midst of neurosurgery to help resect tumor and preserve normal brain

The MR-OR system is used mainly for brain tumor surgeries, where it helps neurosurgeons to remove as much tumor as possible during surgery. In addition, the hospital’s movement disorder neurosurgery team uses it for Deep Brain Stimulation placement for patients with Parkinson’s disease and essential tremor. This procedure is done entirely within the MRI room, operating in the back of the magnet.

When not needed for intraoperative imaging, the MR system is used as a diagnostic scanner, so it is essentially used around the clock, thanks to the dual-room setup. Approximately 4700 diagnostic scans have been performed on the system since installation, 140 of which have been intraoperative.

Team effort and planning come to fruition

Steven Kalkanis, MD, says the implementation of the MR-OR solution was a multi-disciplinary team effort that took about a year in planning. “An essential initiative we undertook to ensure success was the concept of our team. We assembled an important team of neurosurgeons, anesthesiologists, radiologists, radiation physicists, nurses and scrub technicians, because this is not only a diagnostic scanner but an OR scanner.”

Major advantages for patient, neurosurgeon, hospital

“Monitoring the extent of resection is the biggest advantage of the MR-OR,” says Dr. Kalkanis. “With the immediate feedback of intraoperative MRI, we can make real-time adjustments when necessary. That is very comforting, and it allows us to be more aggressive when it’s appropriate.”
Gross total resection of brain tumor using intraoperative MRI

A 64-year-old man presents with gustatory hallucinations and paresthesias for more than a year. Preoperative MR on the day of surgery shows a new focus of contrast enhancement in the medial left temporal lobe. Our surgeon used navigation to target this enhancement area and remove the abnormal tissue.

The intraoperative study showed the surgical tract extending from the left lateral temporal region up to the medial temporal tip. Post-contrast T1 images showed that the enhancing nodular tumor was just above and slightly posterior to the medial tip of the surgical track. Postoperative imaging shows a complete resection of the left medial temporal lobe neoplasm. Pathological diagnosis was Dysembryoplastic Neuroepithelial Tumor (DNET). Intraoperative MRI showed the remaining tumor tissue which was essential to the success of this surgery.

Achieva 1.5T was used with Noras coil and integrated head holder frame. Standard imaging was done, T2, FLAIR, DWI, T1 and T1 post-contrast at contiguous thin cuts to load onto the Brainlab sky navigation system.
“We basically use the MR-OR every day and we are currently figuring out how we can do more than one case in a day, because our demand has become so much greater.”

The hospital benefits as well, by having a differentiator in a very competitive environment. Lisa Scarpace, Clinical Coordinator MRI, says, “We’re doing leading-edge medical procedures very efficiently here. Patients are coming to us because we have the intraoperative MRI, and our results are really excellent because of it.”

Start-to-finish simplicity
A typical MR-OR procedure is quite efficient. Less than 24 hours before the surgery, patients have a preoperative scan. “If the tumor enhances, we’ll do T1 non-contrast and T1 gadolinium scans to map it out,” explains Dr. Kalkanis. “If it’s a non-contrast enhancing tumor we’ll typically use a FLAIR or a T2 sequence.”

The patient comes to the OR with fiducial markers placed on the scalp. A preoperative scan is done to register the markers. Then an anesthetic is administered, and the patient is positioned in the head holder. “We then plan out our incision, make an incision in the scalp, remove a portion of the bone, and begin the resection. Soon, the tumor begins to look more normal along the margins. This is the critical step. Without the intraoperative MRI, most surgeons would stop at this point so as not to harm the patient and rely on radiation and chemotherapy afterward.”

“Instead, the patient is smoothly transferred into the MR scanner, and FLAIR, T2, DWI, T1 non-contrast and T1 post-contrast scans are performed. This takes about 20 or 25 minutes, and within minutes those images are being beamed back into the OR. And if there is tumor remaining, we can actually mark out on the image where our new target is, and link the stereotactic wand to the new intraoperative MR scan that is pinpointing where the residual tumor is. We then remove any residual tumor, and close up.”

“In about 75% of cases we do one intraoperative scan; in the others we need more than one. We get a formal post-operative MRI scan the following day, and those generally show complete resection.”

“Possibly most remarkable is the short time needed for intraoperative MR scanning,” Dr. Kalkanis says. “In an internal study* we found that our overall operative time was increased by only 38 minutes without any added complications, which includes about 22 minutes of scan time. The extent of resection was increased by over 40% in more than half the cases.”

Workflow
The Henry Ford team was worried that using the MR-OR system would add complexity and time to their cases, but Dr. Kalkanis says, “It became easier over time. Having people designated within each group as experts who are always there for every case makes all the difference in the world. Everyone knows his or her role in the overall structure, and it truly is routine. Every moment is accounted for, and it works out very well.”

“The way the MR-OR is configured adds to workflow efficiency,” he says. “It looks like a regular OR, but as soon as the sliding doors open, it’s immediately linked to the Achieva system. The beauty of this setup is that we haven’t changed our instruments in the OR, we haven’t changed our approach, we don’t stand in a different way.”

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*These numbers may not be typical for all facilities
“Possibly most remarkable is the short time needed for intraoperative MR scanning.”

Teamwork is the key to success
Dr. Kalkanis points out the most important aspect of the project. “The biggest initiative we undertook to ensure success was the concept of our team. For every single patient, we include someone from each department.”

Lisa Scarpace emphasizes, “We had great training at the beginning. We had full OR staff (nurses, anesthesia and housekeeping), full radiology staff and all the surgeons there for three days. At first, everyone fought it, but in the end, that’s what made our team so cohesive.”

The economic picture
“We basically use the MR-OR every day,” says Lisa Scarpace. “And we are currently figuring out how to move things around so we can do more than one case in a day, because our demand has become so much greater.”

“For us, it’s a consideration of patient care,” she says. “When after surgery it turns out that a little bit of tumor is left, patients may need extensive radiation or chemotherapy, or sometimes a patient needs to be taken back to surgery a second time within the same week. MR-OR helps us monitor the extent of resection, that is a big advantage. Our surgeons are used to the system now, and they are confident that their patients will not need extensive radiation or chemotherapy.”

“Looking at the benefits of intraoperative MR and knowing that it only adds about a half hour of additional time, makes it an easy choice,” adds Dr. Kalkanis.

Reference
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Clinical evaluation and follow-up results for intraoperative magnetic resonance imaging in neurosurgery
Neurosurgery 2000 May;46(5):1112-20; discussion 1120-2
Liege hospital studying pCASL for brain perfusion without contrast

pCASL is an arterial spin labeling technique showing high SNR and good sensitivity to whole brain perfusion.

CHC Saint Joseph Hospital (Liege, Belgium) is using Pseudo-Continuous Arterial Spin Labeling (pCASL) for high performance brain perfusion imaging without contrast. The pCASL technique combines advantages from continuous ASL and pulsed ASL, such as high SNR and high labeling efficiency. Benedicte Martin, MD, and Pierre Reginster, MD, demonstrate the strengths of pCASL.

**Pierre Reginster, MD**

“pCASL performs as a high SNR method for ASL, with good sensitivity to perfusion. We compared imaging of contrast-enhancing brain tumors with pCASL and DSC (Dynamic Susceptibility Contrast imaging). In 38 exams of 28 patients we found a significant correlation between measured pCASL and DSC signal ratios and between visual scores of enhancement, and significantly lower artifact scores with pCASL than with DSC.”

“pCASL may be a good alternative to DSC and presents two advantages: the absence of injection of a contrast agent, which allows us to increase the frequency of controls in patients with renal failure; and the reduction of artifacts, contributing to good quality exams of some tumors near the skull base.”

“pCASL combines advantages from continuous ASL and pulsed ASL, such as high signal-to-noise ratio and high labeling efficiency. It is implemented with background suppression pulses that help improve signal-to-noise ratio.”

**Bénédicte Martin, MD**

“Using the neurovascular 16-channel coil and a 3.0T system, we have evaluated pCASL in about 100 patients that presented with brain tumor or suspicion of brain tumor, and in follow-up after treatment.”

“pCASL is a good alternative for patients with contraindications for contrast media, especially for patients with renal failure.”
**pCASL of right frontal glioblastoma**

As pCASL does not need any contrast agent, it may be a patient-friendly and economic alternative for dynamic susceptibility contrast imaging. Whole brain pCASL was acquired using Achieva 3.0T TX, 16-channel NeuroVascular coil, 13 slices, voxels 2.73 x 2.73 x 7 mm, scan time 4:08 min. The overlay is created on IntelliSpace Portal.

**pCASL of left frontal metastasis**

Whole brain pCASL was acquired using Achieva 3.0T TX. The overlay is created on IntelliSpace Portal.
pCASL for highly sensitive non-contrast brain perfusion

pCASL (Pseudo-Continuous Arterial Spin Labeling) is designed to provide high performance brain perfusion imaging at 1.5T and 3.0T without using contrast agent. It uses Arterial Spin Labeling (ASL, a subtraction technique) and may be used, for instance, in vascular and oncology exams in the brain. pCASL aims to be an alternative with better SNR – roughly 50% higher – than the pulsed ASL method used before.

**Pulsed Arterial Spin Labeling – STAR**

In the pulsed ASL method STAR, a slab is inverted before image acquisition to label blood over a short period of time and create the perfusion contrast in the brain. In the control situation no inversion is used. Subtraction of images with and without label yields perfusion images.

**Different labeling in pCASL**

pCASL is a pseudo-continuous ASL technique where blood is inverted for a longer period of time. This allows efficient inversion of the blood leading to increased SNR in the perfusion images. A train of short and discrete RF pulses to invert the arterial blood is applied in a thin slab. This is followed by a fast readout covering the entire brain.

**Advantages of pCASL**

When comparing STAR and pCASL side by side, the higher SNR and the ability of pCASL to better visualize gray matter perfusion are evident.

Furthermore, pCASL’s high SNR allows to use isotropic resolution, which enables multiplanar reformatting. Color-based relative quantification of pCASL is available on the console and on IntelliSpace Portal.
Philips and Elekta establish research consortium on MRI-guided radiation therapy

MD Anderson Cancer Center is the second member of the research consortium, which will comprise leading radiation oncology centers and clinicians

Prior to setting up the research consortium, Elekta, Philips and the University Medical Center Utrecht built and tested a prototype system that integrates a linear accelerator and a 1.5T MRI system. The success of these efforts has enabled the project to move to the next phase of development and testing by the select group of consortium partners.

The MRI-guided radiation therapy system* – uniting state-of-the-art MRI with a cutting edge radiation therapy system – will provide physicians with exceptional images of a patient’s soft tissues and tumor during radiation therapy. This breakthrough innovation also aims to enable clinicians to adapt treatment delivery in real time.

Elekta, Philips and UMC Utrecht recently welcomed MD Anderson Cancer Center (Houston, Texas, USA) as a collaborator in the research consortium dedicated to advancing the development of MRI-guided radiation therapy.

“The development of a meaningful, yet complex innovation like the MRI-guided radiation therapy system* can only be done in partnership with leading healthcare innovators, both from an industrial, as well as a clinical perspective,” says Gene Saragnese, CEO Imaging Systems at Philips Healthcare.

*The integrated MRI-guided radiation therapy system is in development and not available for sale.
Transform to digital for expanded clinical capabilities and speed

SmartPath to dStream converts Achieva or Intera into a state-of-the-art digital broadband system

SmartPath to dStream offers all the benefits of a digital broadband architecture, without the cost and hassle of installing a completely new system. It transforms an existing Philips MR system into a digital broadband MR scanner. This not only saves money on the magnet itself, but also saves the reconstruction work and cost that would be necessary for magnet replacement.

**Achieva**
- T2W TSE, Torso XL coil, 0:30 min.
- VISTA FLAIR, 8:16 min
- Cine B-TFE conventional 3.0T

**SmartPath to dStream**
- T2W TSE, d5 Torso, 0:14 min.
- BrainView FLAIR MPR, 4:53 min.
- Cine B-TFE with MultiTransmit 4D

- Enhanced SNR, uniformity and speed
- Enhanced volumetric imaging
- Enhanced uniformity and contrast
dStream digital technology

dStream is a digital broadband architecture that Philips first introduced with Ingenia. This technological breakthrough brings outstanding clinical capabilities, excellent patient experience and exceptional workflow. By reusing the existing magnet, SmartPath to dStream now offers users of Achieva or Intera access to all these benefits without the need to install a completely new system. The digital platform provided by SmartPath to dStream provides higher SNR than the original system. The integrated posterior coil, the easy coil handling and many automated steps in exam planning streamline workflow and can bring up to 30% improvement in throughput.

Channel independence

As the digitization of signal occurs in the coil, the number of channels available is determined by the coil, rather than the system. This enables plug-and-play expansion of clinical capabilities without major hardware upgrades, resulting in lower lifecycle costs and improved economic value.

Advanced techniques for excellent imaging

dStream captures a high purity MR signal directly in the coil on the patient. Fiber-optic cable is used for broadband data transmission without signal loss. The result is a high SNR, similar to Ingenia. SmartPath to dStream also provides dS SENSE parallel imaging for outstanding image quality and speed. For 3.0T systems, dStream with MultiTransmit 4D enhances image uniformity, reduces dielectric shading and helps manage local SAR, even during real-time applications.

Enhanced workflow

The FlexCoverage posterior coil is integrated underneath the tabletop, which provides increased patient space in routine applications like spine and body. FlexStream is designed to streamline workflow by shortening exam setup times, and reducing the number of repetitive tasks. Faster scanning and improved workflow can bring up to 30% improvement in throughput in a variety of routine exams.

For more information, see www.philips.com/SmartPathtodStream
Ingenia 1.5T enters at #1 in latest KLAS MR report

Phillips Ingenia 1.5T:
Rank 1
Score 92.2%
Evangelism 80%

Phillips Ingenia 1.5T was ranked as number 1 in the latest KLAS performance report MRI 2012 released in November. Ingenia 1.5T was also highest in both Score and Evangelism. Particularly in Evangelism, the distance from the number 2 was quite significant (66% versus 80% for Philips Ingenia 1.5T). Evangelism indicates how likely users are to recommend the scanner to others. The score is based on surveying organizations using MR scanners.

Ingenia 3.0T did not have enough customer interviews to meet minimum KLAS Confidence levels. However, from interviews that did take place it was given a Score of 90.2.

Ingenia 1.5T tops in all Special Report Categories
Along with achieving top spot for the KLAS top score and the KLAS evangelism, the Ingenia also received highest ratings in all measured categories of Body Imaging*, Breast Imaging, Non-Contrast Imaging, Fat Saturation, OEM Coils (Quality and Availability), Scanning Speed, Workflow/Patient Throughput (outside of scan time)*, Delivery of New Technology, Money’s Worth* and Average Hours Lost per Service Incident.

* indicates where Ingenia tied with one other vendor for top place

For more information, see:
MRI 2012: Broadening your Field of View
November 2012
www.KLASresearch.com
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“100% would buy again.”

Some quotes from the report

“Philips setting the bar high with Ingenia. Though late to the wide-bore party with the Ingenia, Philips did it right. …”

“… Digital coils offer a better upgrade path and better images with less noise. …”

In the section “Which vendors have the best service?” the report states:

“Philips’ efforts with their new Ingenia 1.5T have absolutely made a difference for their customers. …”

“… Their renewed dedication to support with their new scanner has their Ingenia customers singing their praise.”

“When asked if they would buy it again, 100% of participants with Ingenia 1.5T responded that they would.”
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