Ultra-deep insights at

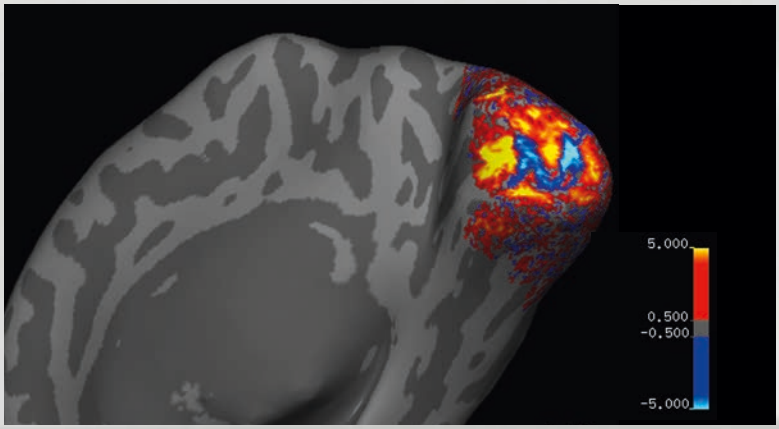
Leading in research

In your quest for new insights, you need freedom to explore. No matter the research field you are leading in – powerful high-end MRI solutions support you. You are able to bring disruptive changes to help answer fundamental questions of mankind. Answers that help improve diagnostics and help fight the most threatening diseases. Brilliant imaging results, cutting-edge technology, strong collaboration, and open architecture help you drive innovation.

You are an MRI leader.

Whether you are just beginning to work with MRI or you are at the forefront of research. With Siemens MAGNETOM MRI systems, you can be sure to lead. In your clinical field, your research, your business environment – to achieve our joint mission of advancing human health.

Leading. With MAGNETOM.



0.2 mm resolution. With MAGNETOM.

MAGNETOM 7T[1] provides unique opportunities in life sciences and technology. Working at the forefront of research, you need a powerful tool that supports your vision and helps translate ideas into measurable facts and efficient solutions.

With its ultra-high resolution, enhanced fMRI, and spectroscopy capability, MAGNETOM 7T allows you to visualize anatomical detail and functional information as never before – supporting neuroscience studies and clinical research with ultra-deep insights.

With MAGNETOM 7T, Siemens introduces a robust research instrument that is not only powerful in its visualization capacity, but open for further development. Enabling you to explore in depth – and reach high goals.

MAGNETOM 7T
See things differently.

MAGNETOM 7T.

See things differen

Magnet – compact, but very powerful

MAGNETOM 7T[1] actively-shielded magnet makes the system more compact without compromising performance. 60 cm patient bore.

Siting and installation

MAGNETOM 7T requires a room of only 5 x 5 x 8 meters. Due to cold shipment, installation is faster, reducing costs.

RF transmit and receive system

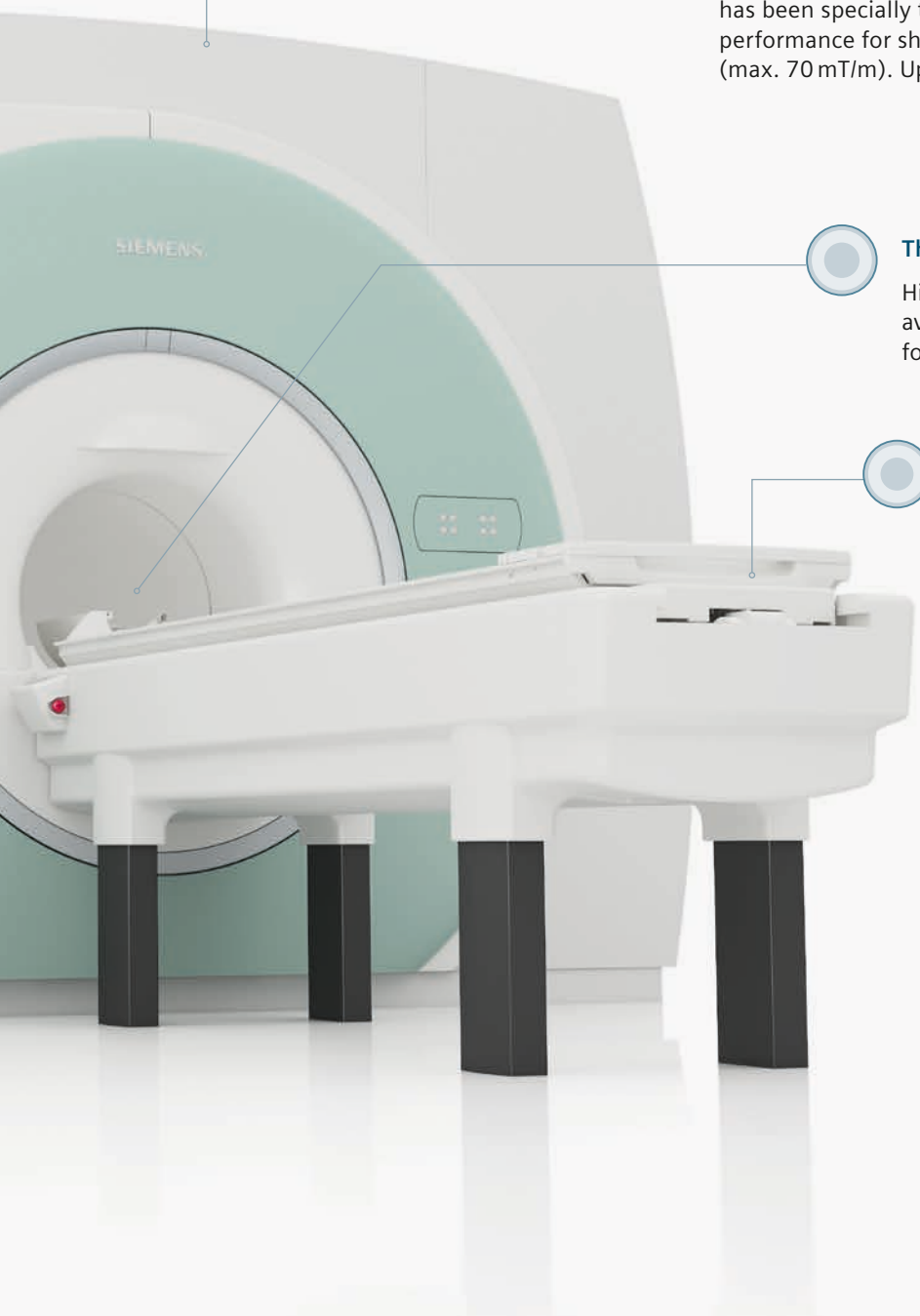
Well established technology for flexibility, accuracy, and speed. 32 RF channels and optional 8 channels TX array.

New views – with the multinuclear imaging option

Explore new research possibilities beyond hydrogen mapping. An optional hardware and software package prepares your MAGNETOM 7T for spectroscopy and nuclear imaging.

tly.

MAGNETOM 7T is a powerful solution intended for exploring new boundaries and setting new trends.



Stable, fast, and reliable gradient system

The whole-body SC72 gradient engine has been specially tuned for 7T needs. High performance for shorter TE and higher SNR (max. 70 mT/m). Up to 3rd order shim coils.

The right RF coils for research

High-performance, UHF-dedicated coils available. Easy integration and support for your own coil developments.

UHF-optimized patient table technology

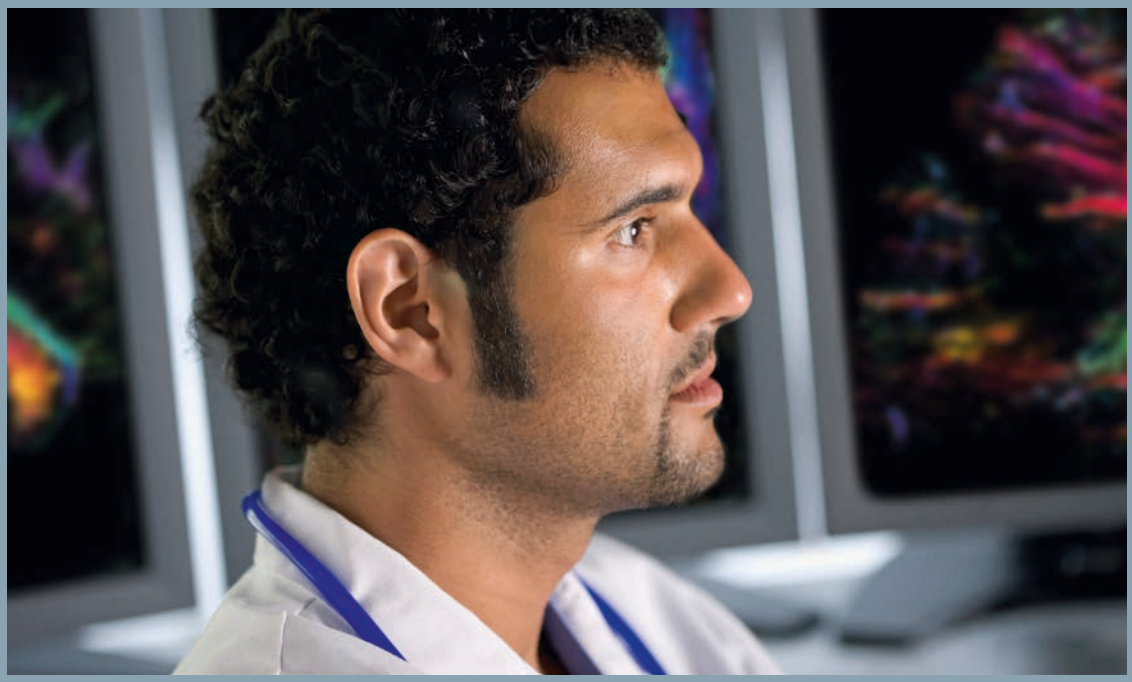
Variable speed patient table adjusted to the fringe field improves patient/volunteer comfort.

“A great thought something

begins by seeing differently. ”

Albert Einstein

Fine structures within the thalamus
Tractography of 1 mm isotropic resolution, *syngo* RESOLVE, displayed as Track Density Image (TDI) 200 micron super-resolution. Short TE, high SNR
MPI, Leipzig, Germany



MAGNETOM 7T provides a significant improvement in imaging sensitivity, allowing us to perform clinical imaging of unseen precision. For clinical radiologists like me, this is the instrument to explore unchartered territory in neurological and musculoskeletal diseases. For example, when exploring the disease progression in MS, 7T provides the best contrast for the visualization of the ultrastructure of MS plaques at 200 micron image resolution. Or, for cartilage imaging in combination with Sodium and CEST imaging, 7T provides unseen details with perfect contrast for analyzing cartilage damage.[2]

Prof. Siegfried Trattnig
Director of the MR Centre of Excellence, MedUni Wien, Vienna, Austria

>60%

of all ordered ultra-high field systems in the world are Siemens systems

Status: 06/2013

Set the trends.
With 7T.

Lead the way in imaging research

Magnetic resonance imaging at field strengths of 7 Tesla has been set apart by its users as the premier tool of the elite, unlocking new frontiers in medical imaging and research. As more hardware and applications are designed and implemented, ultra-high field MRI technology has become compulsory for leading institutions that strive to remain on the cutting edge of imaging research.

Open your eyes for new sights and possibilities

A better signal to noise ratio (SNR) that enables submillimeter spatial resolution in-vivo makes it now possible to visualize anatomic structures never seen before with any imaging device. In addition, the high sensitivity to flow and the effects of magnetic susceptibility at 7T have enabled users to observe and analyze tissue metabolism and function at a level once thought impossible.

Shape the future of MRI

The enormous potential of 7T imaging has also come with a variety of challenges. Factors such as B1 inhomogeneity and high installation costs have hindered some customers in their quest to become part of the ultra-high field MRI community. However, the MAGNETOM 7T[1] actively-shielded, whole-body MRI research platform opens up the scope of research and solutions to many of these challenges.
This is the right system for pioneers and trendsetters who change the game in MRI and strive to advance human health.

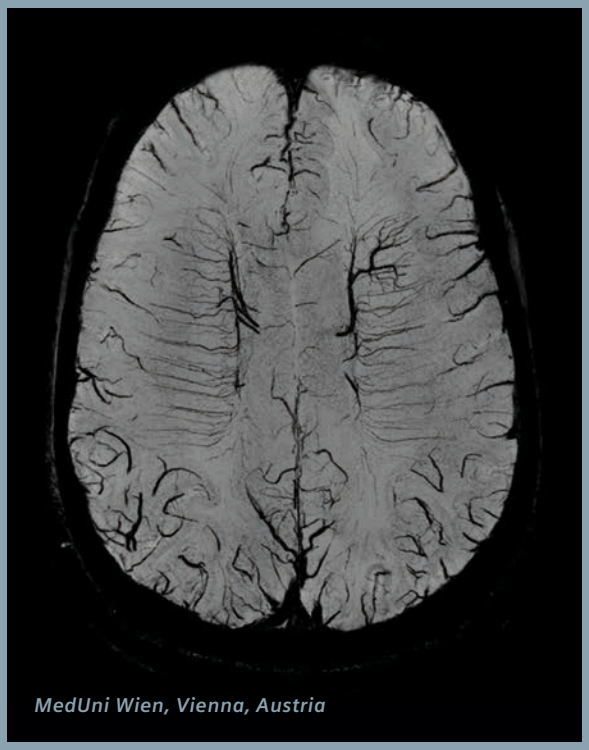
Beyond field strength

By overcoming challenges, innovations made at UHF MRI trickle down to lower field strengths and are translated, for example, into new coil concepts, parallel transmission applications, optimized sequences, and more.

Ultra-high field MRI is different

Characteristics	Challenges	Benefits and promise
SNR~B0 SAR~B0[2]	• Volume coverage, smaller flip angles, longer breath holds • Motion sensitivity for high-resolution imaging	• High spatial and temporal resolution for anatomical and functional MRI • X-nuclei • Shorter scan times
Relaxation times (T1↑, T2↓, T2*↓)	• Lower SNR, e.g. for Diffusion MRI	• Non-CE Angio (ToF), ASL • SWI, BOLD fMRI
Susceptibility effects	• Geometric distortions • Intravoxel dephasing	• SWI, BOLD fMRI • Phase-based image contrast
B1 inhomogeneity	• Spatial flip angle and contrast variation	• Electrical Property Mapping EPM • Parallel imaging (TX and RX)
Chemical shift	• Fat/water misregistration • Need for broad band pulses	• Spectral resolution (MRS, CEST...) • Fat saturation

CMRR, Minneapolis, Minnesota, USA



MedUni Wien, Vienna, Austria

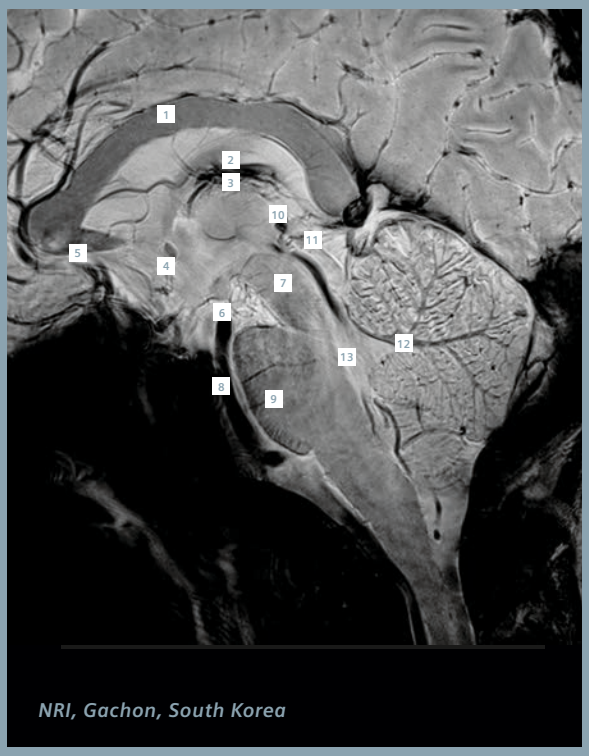
SWI at 7T

- Higher SNR, higher spatial resolution, 0.2 mm in-plane
- TR/TE/α 51/28/40, FoV 192x256, matrix 384x512, 1 mm thickness, 48 sections

- Minimum intensity projection: over 17 sections

7T Time-of-Flight (ToF) imaging with reduced SAR

- 7T ToF imaging with 500 micron isotropic resolution, whole brain
- Venous saturation pulses enabled
- VERSE technique used for SAR reduction
- 1 TX/24 RX channel coil
- Coronal Maximum Intensity Projection (MIP)
- Image corrected for receive profile



NRI, Gachon, South Korea

7T at histology level

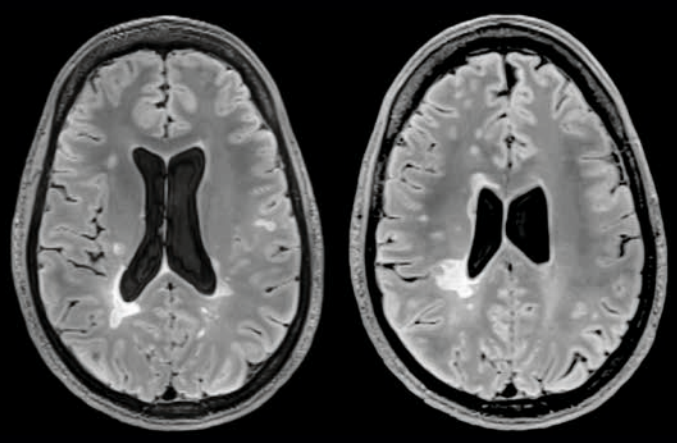
- T2 FLASH FatSat, matrix 1024
- 48 nl voxels in TA 8 min
- 32-channel head array RX coil and detonable birdcage TX coil

1 Corpus Callosum
2 Internal Cerebral Vein
3 Thalamus
4 Anterior Commissure
5 Anterio Cerebral Artery
6 Mammilary Body
7 Red Nucleus
8 Basilar Artery
9 Basal Pons
10 Pineal Gland
11 Superior & Inferior Colliculi
12 Cerebellum White Matter
13 4th Ventricle

Multiple Sclerosis – 7T microscopic imaging of brain pathology

3D SPACE DIR, GRAPPA 2, TR 3000 ms, TE 279 ms, TI 2180 ms, matrix 224x320, effective SL 0.8 mm

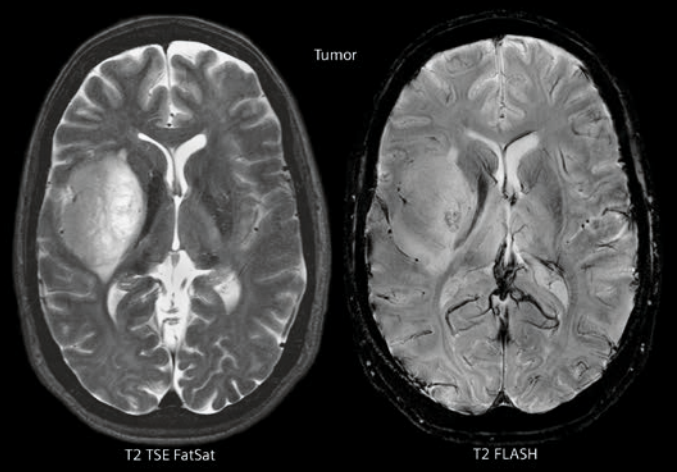
- Early pathology detection
- Ultra-high resolution
- Increased contrast-to-noise ratio



MedUni Wien, Vienna, Austria

Tumor – 7T microscopic imaging of brain pathology

Clear visualization of tumor borders and inner structures



Erwin L. Hahn Institute for MRI, Essen, Germany

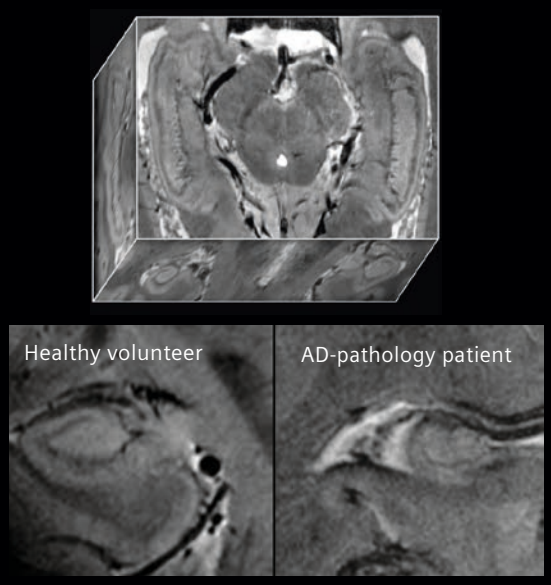
40%

6 out of US' top 15 best hospitals (2012-2013) work with MAGNETOM 7T in research endeavours.

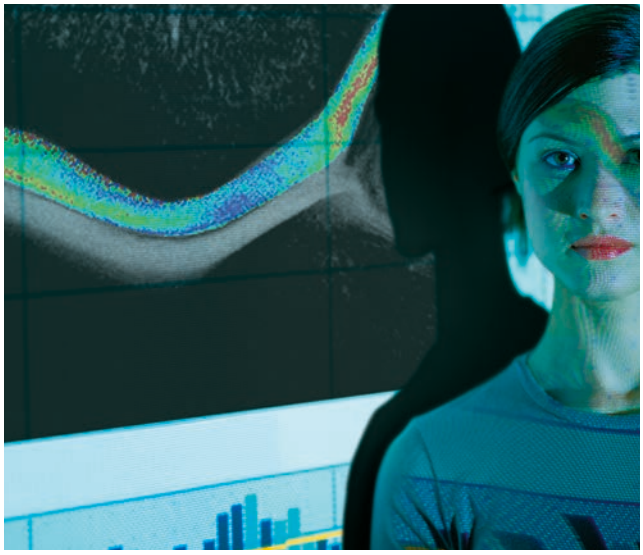
MR histology in-vivo

TR 50 ms, TE 25 ms, FA 10, matrix 512 x 576 (partial k-space acquisition 6/8) with restricted hippocampal area (~ 2 cm) with 60 slices

- High resolution hippocampal imaging
- Normal versus Alzheimer's disease
- Total acquisition time:
  14 minutes with isotropic resolution of 0.35 x 0.35 x 0.35 mm



NRI, Gachon, South Korea



Set the trends. With 7T.

Translating research into clinical applications.

Be at the forefront of life sciences. MAGNETOM 7T[1] is a powerful asset that supports you in answering today's most relevant clinical research questions. Uncover anatomic and physiological details that can be only seen with ultra-high field MRI – and add value to diagnostics.

- **Visualize neurological detail with submillimeter accuracy**
  Ultra-high spatial resolution, enhanced contrast, fMRI, and MRA help you find answers to your questions and improve diagnostics – for example for Multiple Sclerosis, Alzheimer's and Parkinson's disease.
- **Refine diagnostics for the whole body**
  Ultra-high spatial resolution and enhanced contrast reveal the finest details throughout the body – such as the cervical spine, knee, bones, muscles, and cartilage.
- **Explore the metabolism with multinuclear imaging**
  Ultra-high field multinuclear imaging opens up new research possibilities – visualizing 13C, 23Na, 31P, and others.
- **See the essence – with ultra-high spectral resolution**
  MAGNETOM 7T offers outstanding spectroscopy performance that allows you to obtain biochemical information about tissues.
- **Improve planning and diagnosis**
  Images acquired with ultra-high resolution MRI can help you improve surgery planning and stroke diagnoses.

> *Seven Tesla clearly opens the door to better understanding of the morphological and structural changes in dementia and motor diseases, such as Alzheimer and Parkinson's disease. 7T imaging with isotropic resolution on the 300 micron level provides quantitative in-vivo information of hippocampal volume changes hitherto unseen. In Parkinson's disease, the superb T2* weighted contrast of the sub-thalamic region of the brain may potentially alter the treatment with Deep Brain Stimulation as it allows precise positioning of the DBS electrodes.*[2]

Prof. Zang-Hee Cho
Director of Neuroscience Research Institute (NRI), Gachon University of Medicine and Science, Icheon, South Korea

- **Focus on your research**
  MAGNETOM 7T with *syngo*® MR software – including Inline Technology, 1D/2D PACE, iPAT, and Phoenix. Increasing number of dedicated sequences and protocols in development by the UHF community.

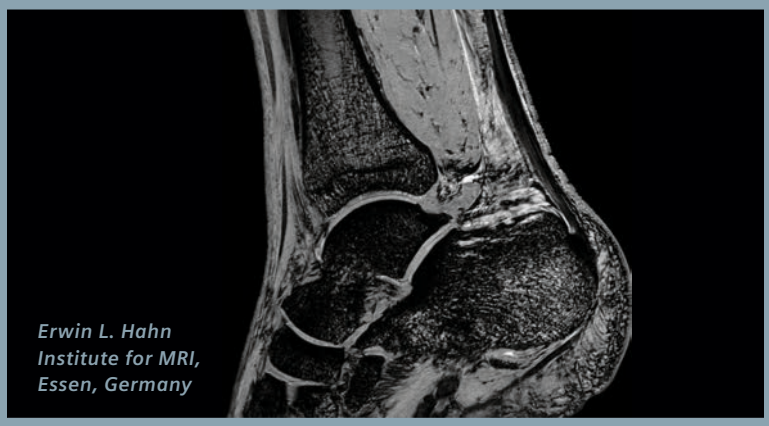
Anaplastic Astrocytoma

WHO III, T2 TSE, ToF MRA MIP, SWI minIP,
matrix 512, TA 7:19 min

DKFZ, Heidelberg, Germany

Microscopic imaging of the ankle joint

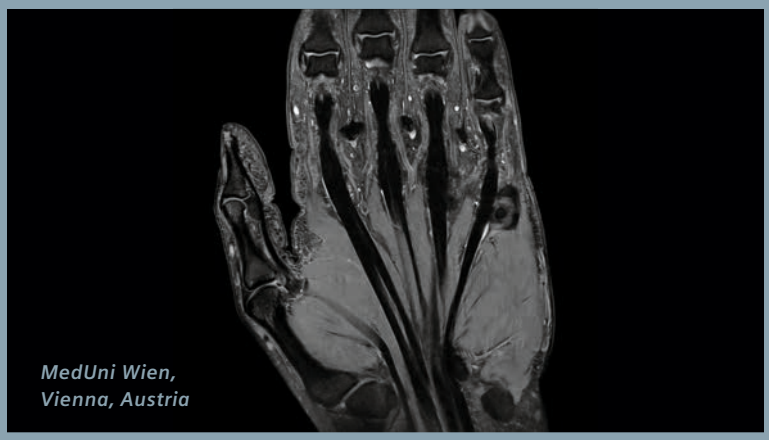
3D FLASH, matrix 512, GRAPPA 2,
SL 1 mm, TA 5:05 min



*Erwin L. Hahn
Institute for MRI,
Essen, Germany*

Microscopic imaging for orthopedics

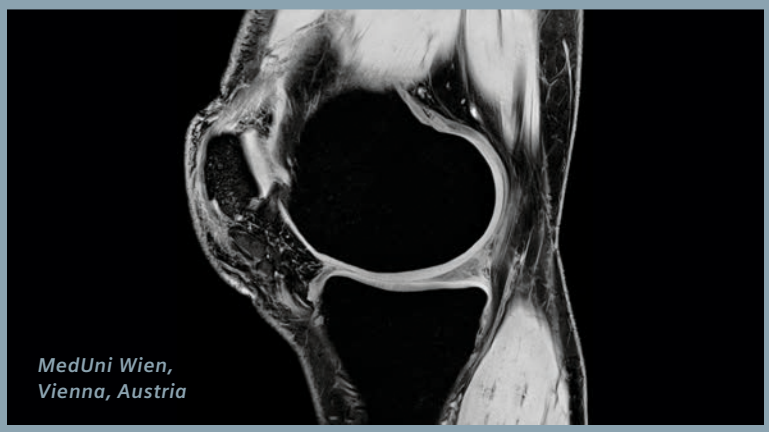
PD TSE FatSat, matrix 640,
SL 1 mm, TA 13:39 min



*MedUni Wien,
Vienna, Austria*

Microscopic imaging of the knee

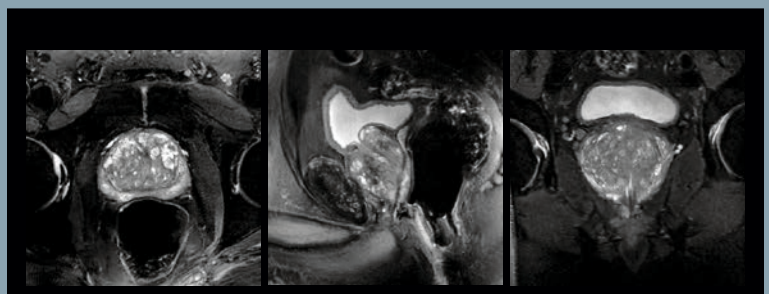
T1 FLASH FatSat 0.24 x 0.24 x 2.0 = 0.12 mm³,
28 channel QED knee coil



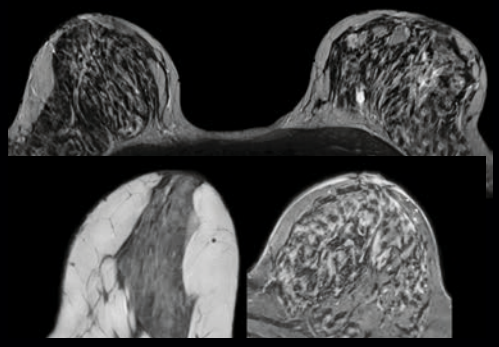
*MedUni Wien,
Vienna, Austria*

Prostate Imaging at 7T

T2 TSE, prolonged 150 degree pulses.
8-ch external body array coil with
B1+-shimming, TA < 2 min / direction



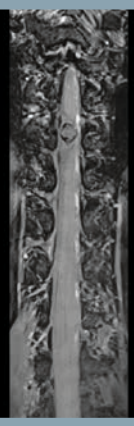
*Radiology, Radboud University Nijmegen, The Netherlands /
Erwin L. Hahn Institute for MRI, Essen, Germany*



NYU, New York, USA

Mammography at 7T

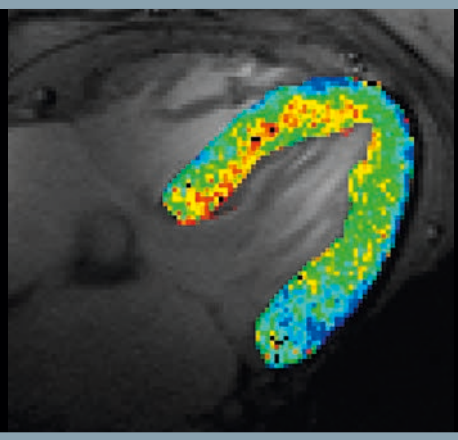
T2 TSE, matrix 384, GRAPPA 2, SL 1.5 mm,
TA 3:41 min



Erwin L. Hahn Institute for MRI, Essen, Germany

Spinal imaging at 7T

T1 3D FLASH SPAIR, MPR, matrix 576, effect.
SL 0.69 mm, 120 partitions, GRAPPA 2,
TA 9:05 min

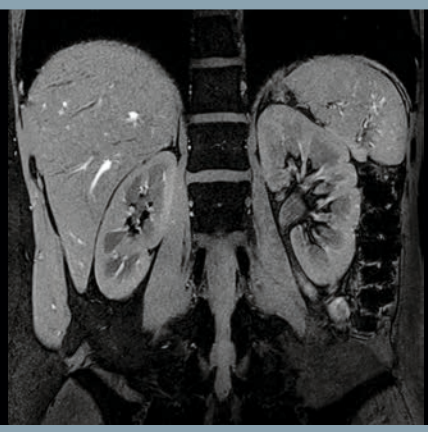


B.U.F.F., Berlin, Germany

Cardiac imaging at 7T

Parametric mapping of the myocardium.

T* map of a 4 chamber of the heart.
1.1 x 1.1 mm^2 in-plane spatial resolution,
2.5 mm slice thickness.



Erwin L. Hahn Institute for MRI, Essen, Germany

Abdominal imaging at 7T

T1 FLASH FatSat, matrix 512, GRAPPA 2

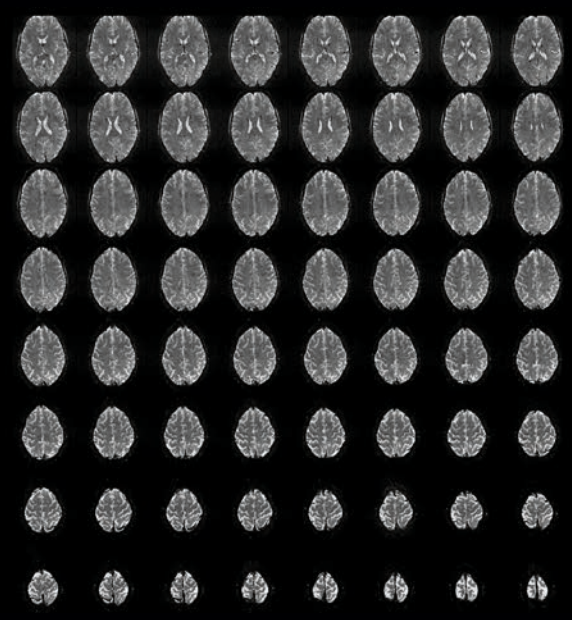
CMRR, Minneapolis, Minnesota, USA

Renal angiography at 7T

- Non-contrast enhanced, with dynamically applied B1+ shimming
- Respiratory triggered turbo-flash (TFL) sequence

Functional MRI at 7T

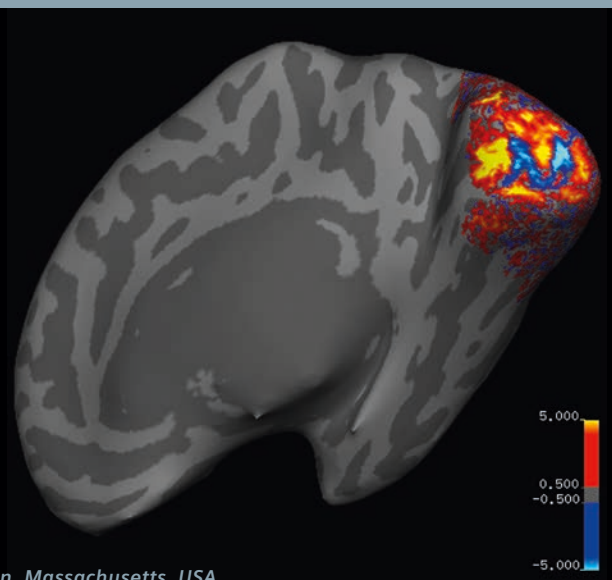
- EPI with 0.75 mm isotropic resolution
- Reduced partial volume effects
- Less through-plane dephasing
- Less physiological noise contribution
- Allows direct visualization of functional activity on EPI images



MGH/MIT, Boston, Massachusetts, USA

High-resolution BOLD fMRI

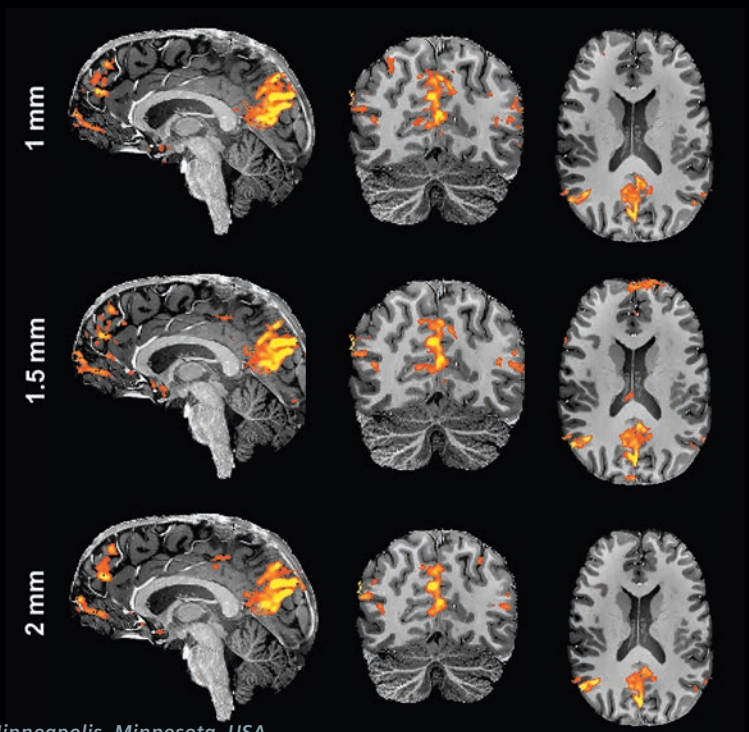
- Cortical-layer-specific activation with ultra-high resolution fMRI
- 1 mm isotropic resolution, inflated view
- Study of fine grained activation patterns within cortical areas
- Increased spatial specificity in submillimeter isotropic voxels



MGH/MIT, Boston, Massachusetts, USA

High-resolution resting state fMRI

- High functional specificity and fCNR
- Reduced partial volume effects
- Separations of detailed spatial features within the default mode network
- Single subject analysis
- High function to anatomy correspondence



CMRR, Minneapolis, Minnesota, USA

Set the trends. With 7T.

Exploring the unseen in neuroscience.

An excellent choice for neurosciences studies: MAGNETOM 7T[1] offers high reproducibility and stability for neurosciences studies. For the first time, it brings ultra-high resolution human fMRI out of the animal realm.

- **Refined brain studies with ultra-high resolution fMRI**
  Visualizing neuronal function with submillimeter accuracy, you benefit from enhanced ultra-high resolution fMRI – including improved BOLD, Diffusion, Perfusion, and Angiography.
- **Augmented cognitive studies**
  Improved BOLD fMRI capacity optimizes measuring and mapping of neural activity – highly reproducible and stable.
- **Exploring brain connections at 7T**
  The high performance gradient system for Diffusion MRI maximizes SNR and allows non-invasive imaging for fiber tracking with shorter TE.
- **Focus on your research**
  MAGNETOM 7T with *syngo* MR software – including Inline Technology, 1D/2D PACE, iPAT, and Phoenix. Increasing number of dedicated sequences and protocols in development by the UHF community.

> *The increased spatial resolution offered by MAGNETOM 7T MRI enables us to study fine grained activation patterns within cortical areas and investigate detailed functional topography of the cerebral cortex in individual human subjects. This will provide us with a deeper understanding of the human brain and its connectomics on healthy and diseased populations.*[2]

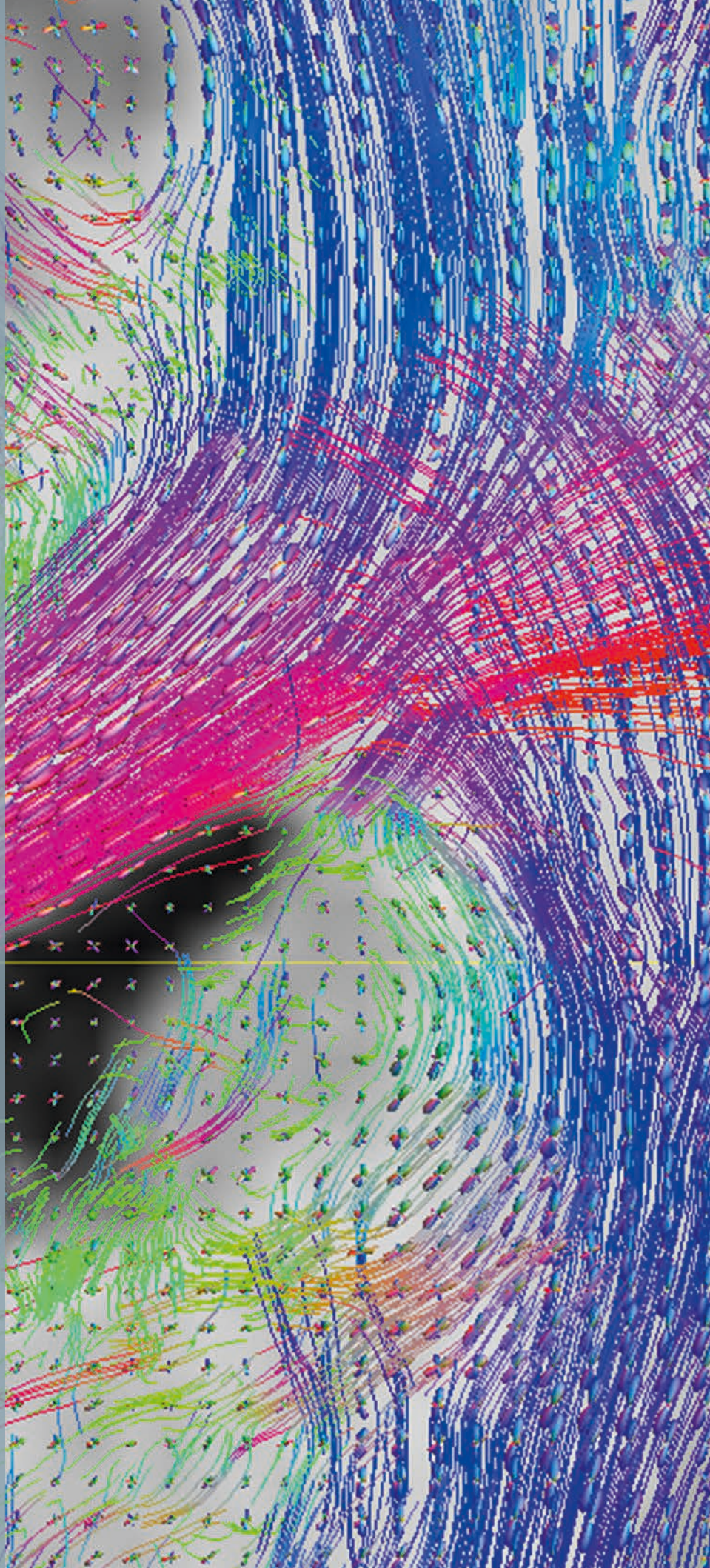
Prof. Kamil Ugurbil
Director of the Center for Magnetic Resonance Research (CMRR), Minneapolis, Minnesota, USA

Diffusion tractography

- Short TE, high SNR

Sub-millimeter resolution for Diffusion MRI

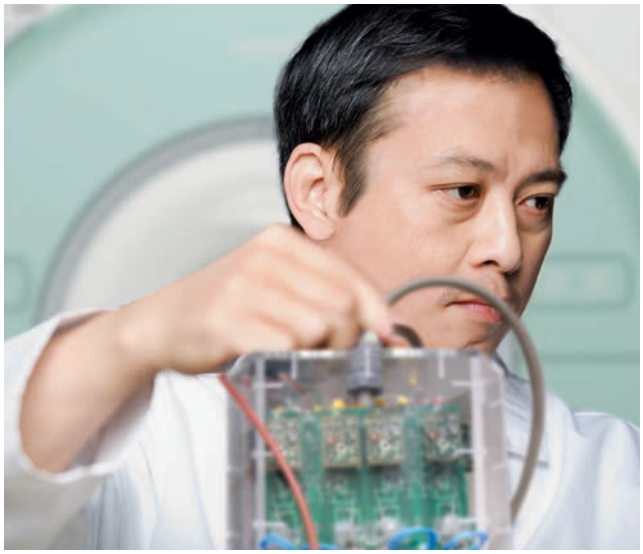
- Example: coronal view of the right hemisphere
- Fiber crossings resolved with ultra-high resolution – 800 micron isotropic resolution
- Robust reconstruction of multiple fiber directions per voxel
- Combination of zoomed imaging with parallel imaging



MPI, Leipzig, Germany

>70%

ISMRM 2011:
of all abstracts on 7T co-authored by industry, more than 70% were done in collaboration with Siemens



UHF dedicated coils:
- Head 1TX/32RX, see picture no.1
- Knee 1TX/28RX, see picture no.2
- Loop TX/RX, see picture no.3
- Tune-Up Coil
- Dual tuned head coil 1H / X-Nuclei (choice of 23Na, 31P, 13C or 19F)
- Dual tuned surface coil 1H / X-Nuclei (choice of 23Na, 31P, 13C or 19F)

7T is the technology driver.

Opening up innovation.

Designed as an open research platform, MAGNETOM 7T[1] provides the flexibility you need to work on cutting-edge UHF technology:

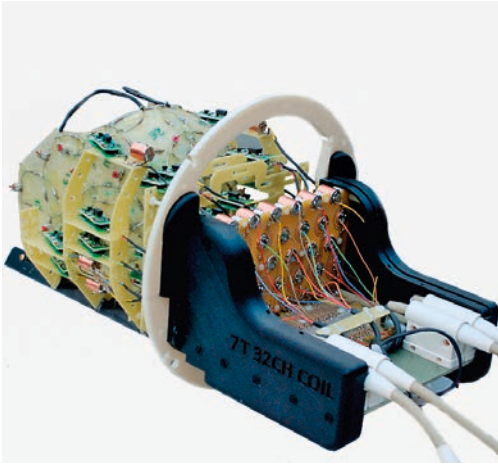
- **Be the first to get the best out of 7T**
  MAGNETOM 7T is packed with the latest technology and offers countless research possibilities – supporting also higher field strengths: 9.4T, 10.5T, and even 11.7T.
- **Innovate 7T hardware**
  The open platform is a flexible basis for your UHF hardware development such as coils, gradient inserts, dynamic shimming, high-channel (p)TX, and gradient arrays. Siemens offers support for the integration of your innovations.
- **Develop 7T sequences**
  Work with the same tools that Siemens uses in-house. The IDEA software allows a high level of flexibility – to create and modify pulse sequences with direct access to the Image Calculation Environment (ICE) and imaging protocols.
- **Translate your ideas to other field strengths**
  Within the permeable platform, your innovations apply to different field strengths – changing the game in MRI technology.

7 Tesla – RF coil technology

Siemens is a proven leader in RF technology. This expertise, combined with strong collaborations with leading research institutions across the world, is an essential element for getting the most out of the greater MR signal at 7T. Coil design is more challenging at ultra-high field due to dielectric effects. Multiple coil designs are being explored at several institutions.

Example of a 7T dedicated coil development.

32 channel brain receive array from MGH, Boston, USA.



With the increases in sensitivity and contrast at 7T, we have been able to study biological function at an unprecedented level. This has driven the ultra-high field technology to innovations in multiple domains. For example, the development of highly parallel RF coils for 7T is challenging and needs a state-of-the-art receiver system with an open system environment. In addition to the receive side, together with Siemens and MIT, we have been able to develop accelerated parallel transmit methods that significantly lower SAR deposition while performing new levels of shaped excitation.

MAGNETOM 7T provides the best possible open but safe hardware and software environment to explore these new transmit and receive concepts, all of which have proved essential to allow ultra-high fields to fulfill their potential for the benefit of human health.[2]

Prof. Lawrence L. Wald
Director, MGH NMR Core at Martinos Center,
Department of Radiology, Boston, Massachusetts, USA

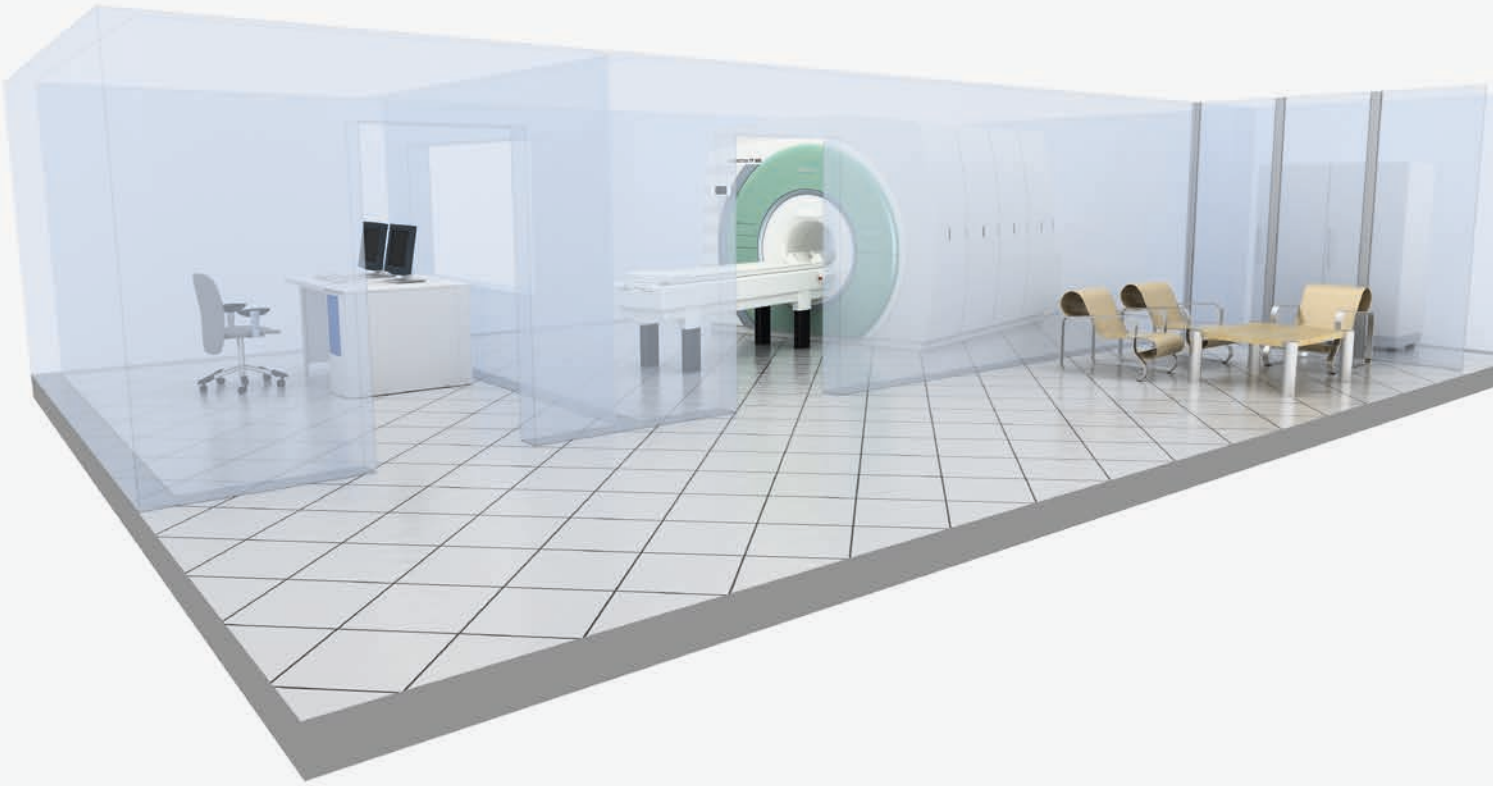
Fostering research & collaboration.

Meet the largest UHF community.

With MAGNETOM 7T[1], you broaden research funding opportunities and your scope of possibilities. From optimal installation to reliable support, you can count on a valuable partner – Siemens is the trendsetter in UHF MRI.

- **Exchange your ideas with peers**
  Benefit from Siemens' vast collaboration network – at user meetings and via our UHF online community.
- **Make a safe investment, stay at the cutting edge**
  MAGNETOM 7T is part of Siemens' strong innovation chain and there will be continuous upgrades – Tim 4G upgrade starts with 48RX and up to 64/128 channels.
- **Stand out – with 7T research**
  Open up funding opportunities and your scope of possibilities – with MAGNETOM 7T, your institution sets the pace at the frontier of life sciences.
- **Shape the future of clinical care**
  The 7T platform strengthens your leadership – and offers a clear advantage for research, publishing, and opinion leadership.
- **Partner with the leading UHF company**
  With a market share of over 60%, Siemens is the leading manufacturer of ultra-high field MRI – fostering strong collaborations with the community.

Installation of Europe's first whole body actively-shielded 7T MRI system. University of Oxford, FMRIB Centre, 2011.

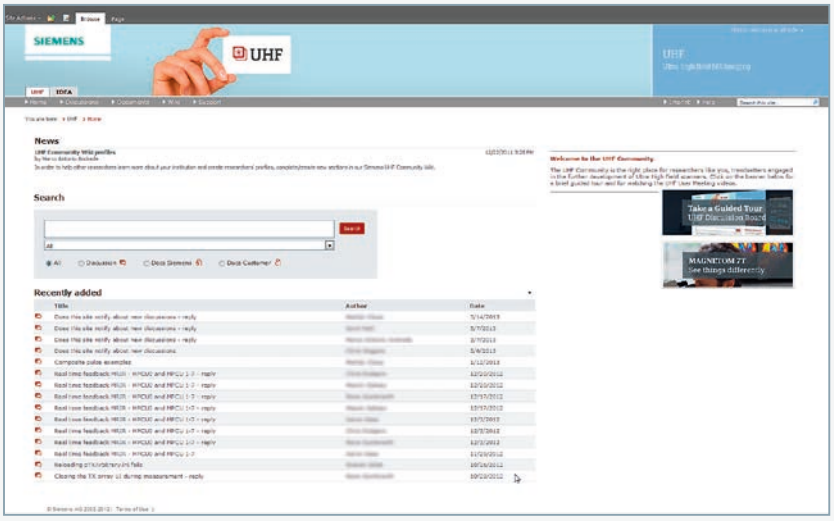


> *When we were in the position to order a 7 Tesla system, Siemens was the logical choice.*[2]

Peter Jezzard, PhD,
Professor of Neuroimaging,
University of Oxford, Oxford, UK

www.mr-idea.com

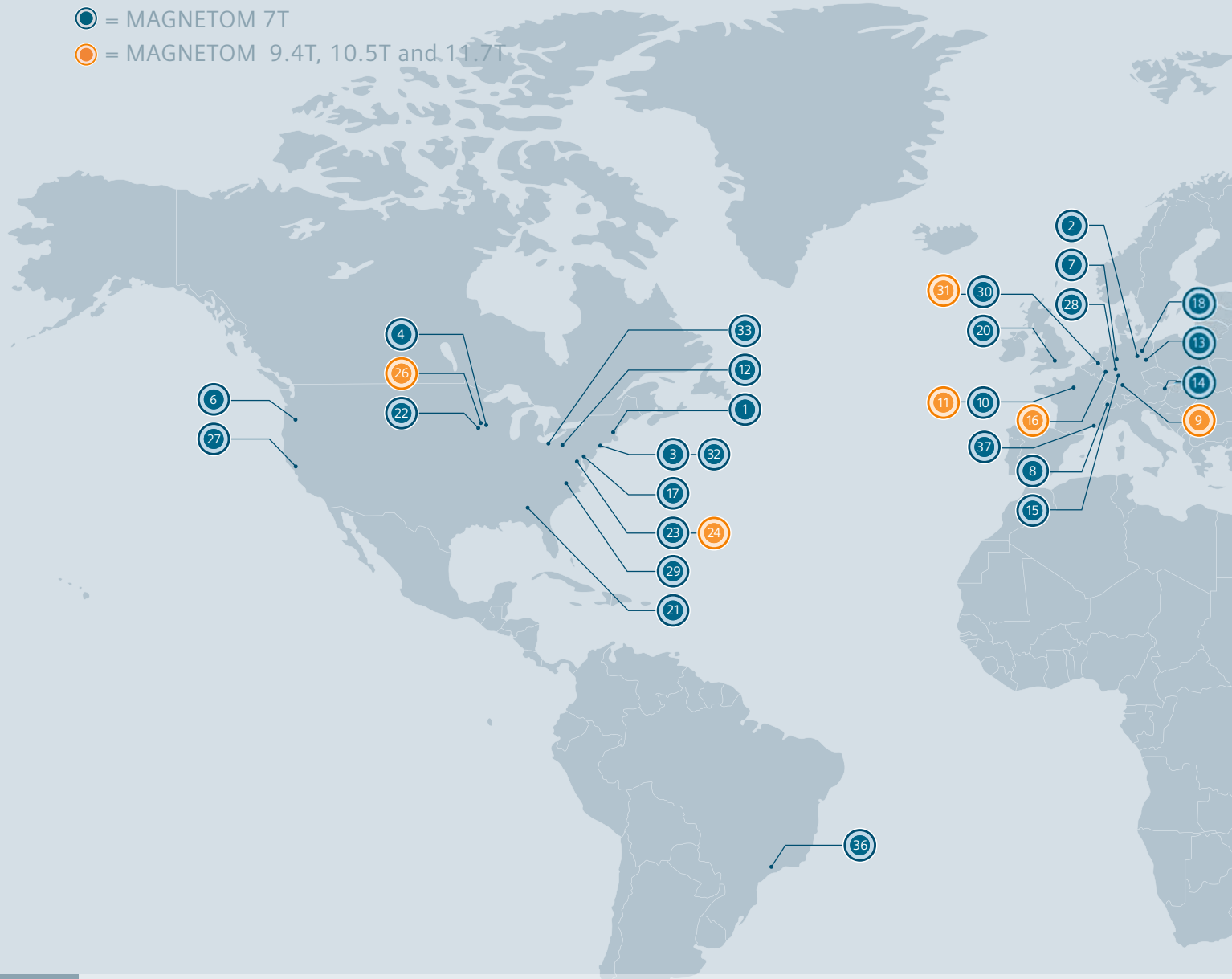
To gain access to the UHF online community, please contact: idea.med@siemens.com



Future starts with a vision.
Siemens UHF MRI.

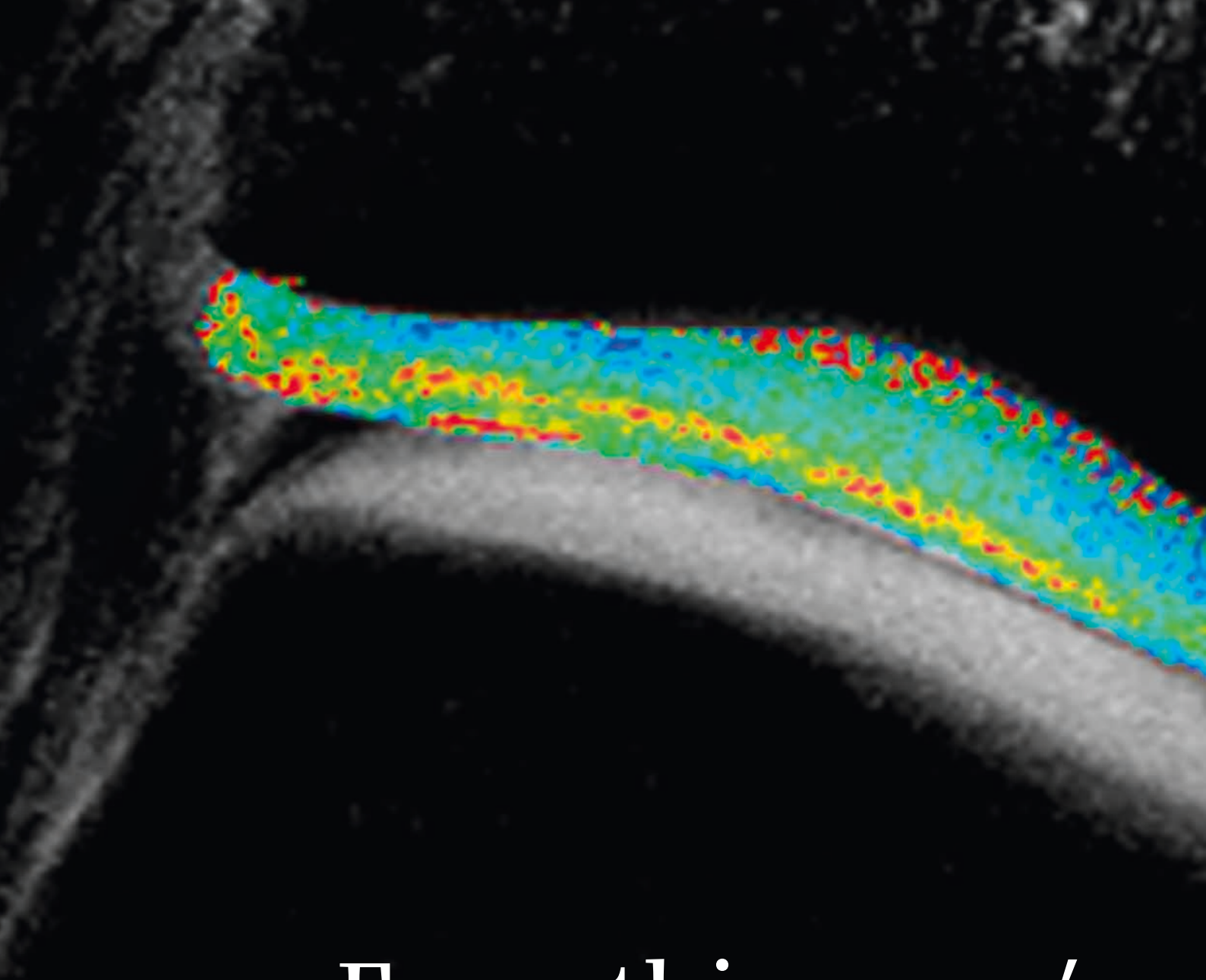
Systems installed and projects in progress (as of June 2013).

● = MAGNETOM 7T
● = MAGNETOM 9.4T, 10.5T and 11.7T

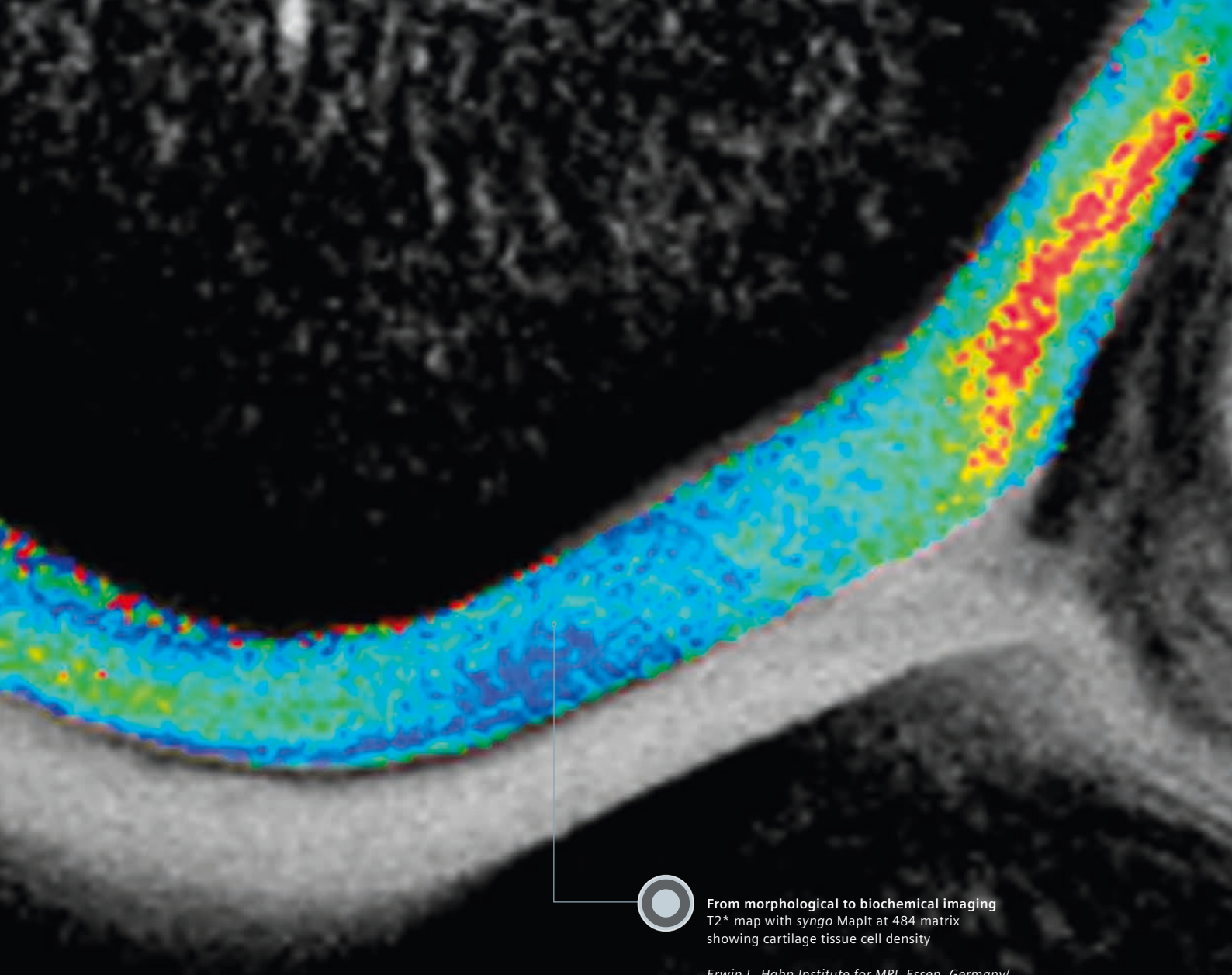


1. Athinoula A. Martinos Center for Biomedical Imaging of MGH and MIT, Boston, Massachusetts, USA
2. Leibniz Institute for Neuro-Biology (LIN), Magdeburg, Germany
3. Bernard and Irene Schwartz Center for Biomedical Imaging (CBI) of New York University Langone Medical Center, New York City, New York, USA
4. Center for MR Research (CMRR), University of Minnesota, Minnesota, Minneapolis, USA
5. Neuroscience Research Institute (NRI) of Gachon University of Medicine and Science, Incheon, South Korea
6. Advanced Imaging Research Center (AIRC), Oregon Health & Science University, Portland, Oregon, USA
7. Erwin L. Hahn Institute for Magnetic Resonance Imaging (ELH), Essen, Germany
8. Center for Imaging in Biomedicine (CIBM), École polytechnique fédérale de Lausanne (EPFL), Lausanne, Switzerland
9. Max Planck Institute for Biological Kybernetics (MPI KYB), Tübingen, Germany (9.4T)
10. NeuroSpin, French Alternative Energies and Atomic Energy Commission (CEA), Saclay, France
11. NeuroSpin, French Alternative Energies and Atomic Energy Commission (CEA), Saclay, France (11.7T)
12. Magnetic Resonance Research Center (MRRC), University of Pittsburgh Medical Center (UPMC), Pittsburgh, Pennsylvania, USA
13. Max Planck Institute for Human Cognitive and Brain Sciences (MPI), Leipzig, Germany
14. Excellence Center for Highfield MR, Medical University of Vienna (MUW), Vienna, Austria
15. German Cancer Research Center (DKFZ), Heidelberg, Germany
16. Institute of Neuroscience and Medicine (INM), Research Centre Jülich, Jülich, Germany (9.4T)
17. Center For Magnetic Resonance And Optical Imaging (MMRRCC) University of Pennsylvania Health System (HUP), Philadelphia, Pennsylvania, USA
18. Berlin Ultrahigh Field Facility (B.U.F.F.), Experimental and Clinical Research Center (ECRC), Berlin, Germany
19. State Key Laboratory of Brain and Cognitive Science, Institute of Biophysics, Chinese Academy of Sciences (CAS), Beijing, China

20. Oxford Centre for Functional MRI of the Brain (FMRIB), University of Oxford, Oxford, UK
21. Magnetic Resonance Imaging Research Center, Auburn University, Auburn, Alabama, USA
22. Center for MR Research (CMRR), University of Minnesota, Minnesota, Minneapolis, USA
23. Functional MRI Facility (FMRIF), National Institute of Mental Health and Neurological Disorders and Stroke, National Institutes of Health (NIH-NIMH & NINDS), Bethesda, Maryland, USA
24. National Institute of Neurological Disorders and Stroke, National Institutes of Health (NIH-NINDS), Bethesda, Maryland, USA (11.7T)
25. NICT, Osaka, Japan
26. Center for MR Research (CMRR), University of Minnesota, Minnesota, Minneapolis, USA (10.5T)
27. Center for Imaging of Neurodegenerative Diseases (CIND), San Francisco VA Medical Center, UCSF, San Francisco, California, USA
28. German Center for Neurodegenerative Diseases (DZNE), Bonn, Germany
29. Biomedical Research Imaging Center (BRIC), University of North Carolina (UNC), Chapel Hill, North Carolina, USA
30. Maastricht Brain Imaging Centre (M-BIC), Maastricht University, Maastricht, The Netherlands
31. Maastricht Brain Imaging Centre (M-BIC), Maastricht University, Maastricht, The Netherlands (9.4T)
32. Mt Sinai School of Medicine, New York City, New York, USA
33. Cleveland Clinic, Cleveland, Ohio, USA
34. Centre for Advanced Imaging, University of Queensland, Queensland, Australia
35. Royal Melbourne Hospital, University of Melbourne, Victoria, Australia
36. University of Sao Paulo (USP), Sao Paulo, Brazil
37. CEMEREM (Centre d'Exploration Métabolique par Résonance Magnétique), Marseille, France



Everything you've



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Order No. A91MR-95-2C-7600 | Printed in Germany | CC 819 06131. |

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