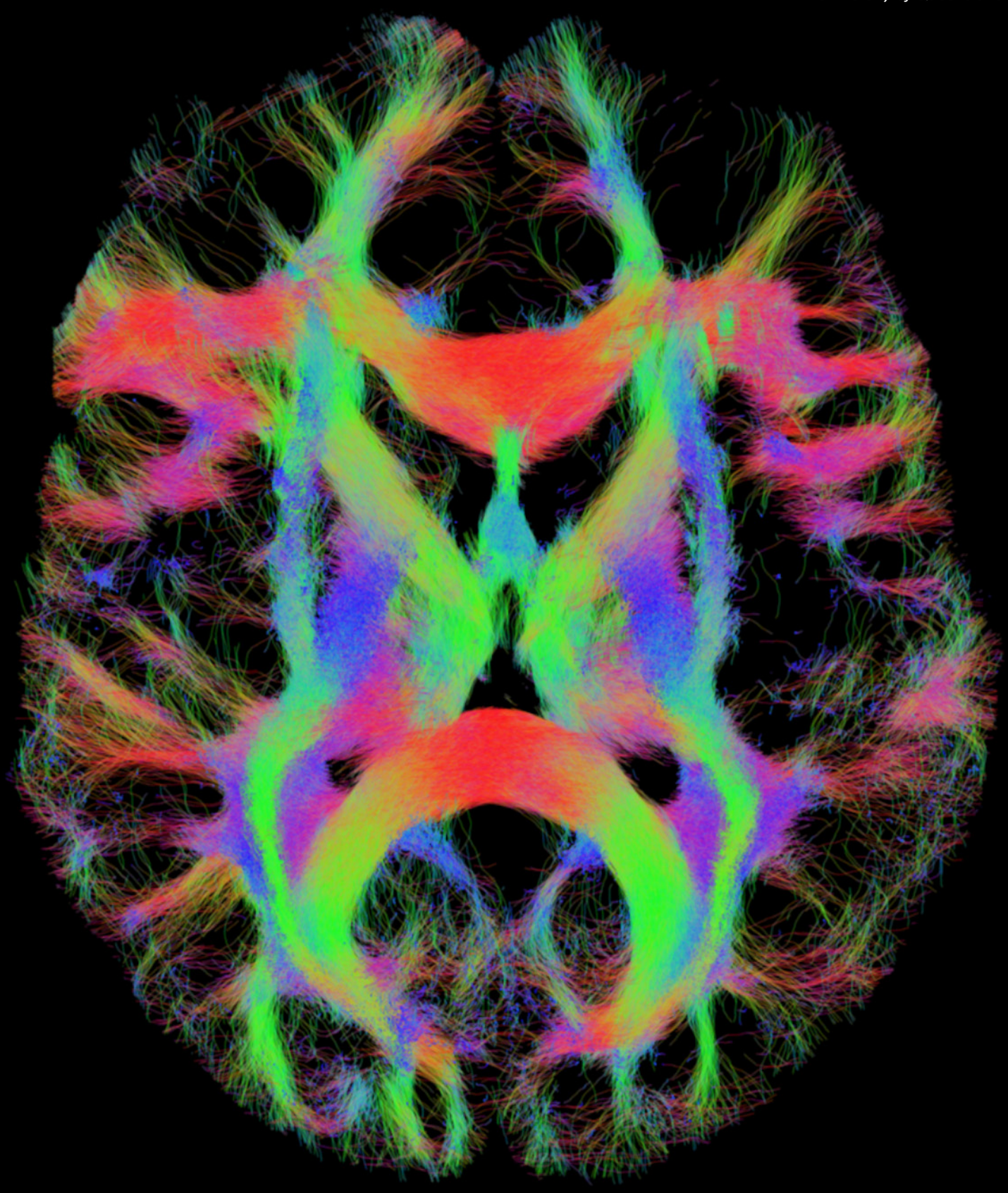
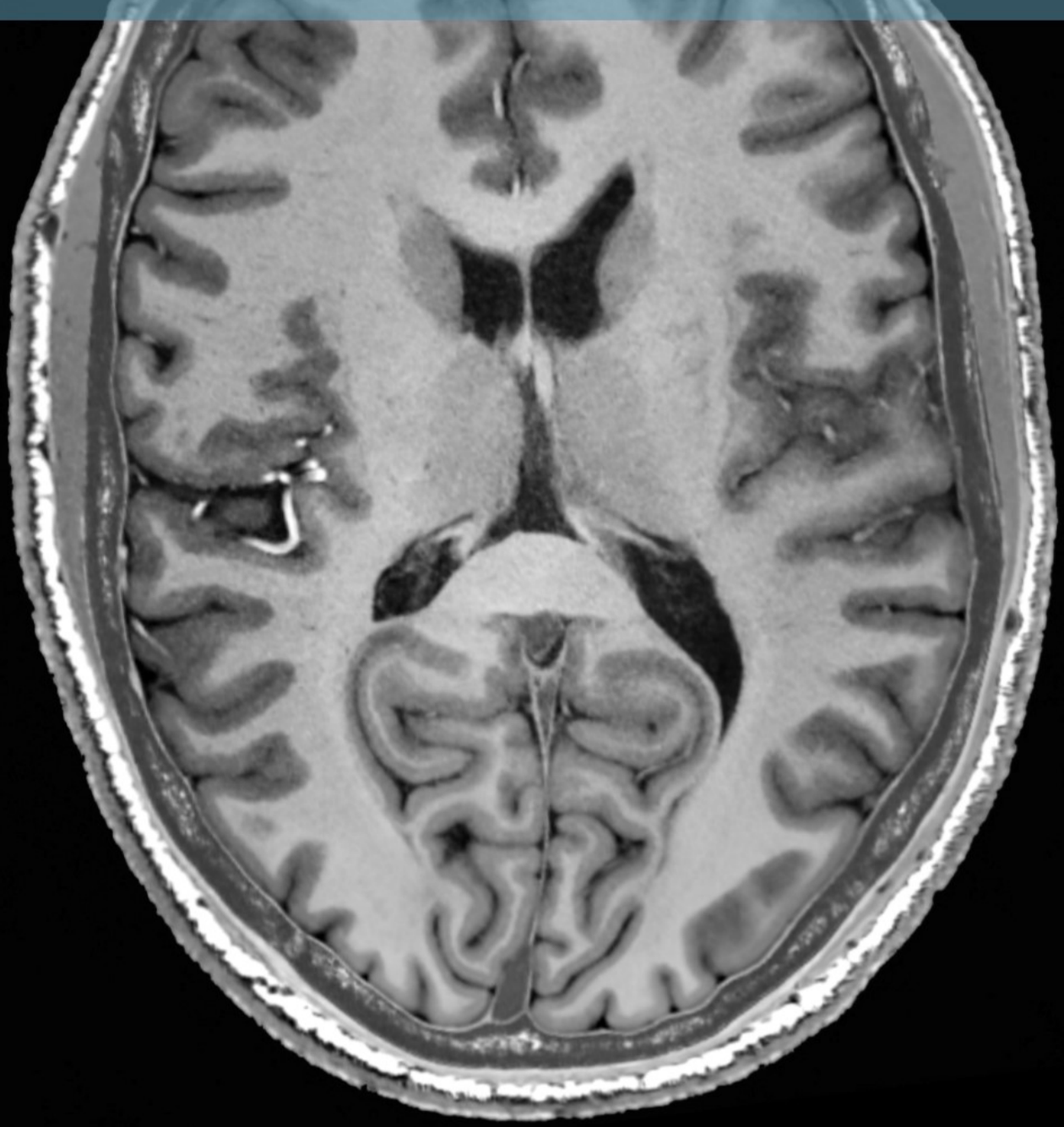
National Imaging Facility

Exploring Inner Space

NIF Quarterly • Q2, 2014

Fibretracts of the Brain
- Farshid Sepehrband, Dr Kieran O'Brien, A/Prof. Markus Barth,
Centre for Advanced Imaging,
University of Queensland





Highest spatial resolution T1 weighted anatomical image of the human brain at 7 Tesla in vivo with whole brain coverage - more than 20x higher spatial resolution compared to standard 1mm protocols.
- Dr Andrew Janke, Dr Kieran O'Brien, A/Prof. Markus Barth;
Centre for Advanced imaging, University of Queensland.

Director's Message

Two weeks ago, the NIF Node Directors re-iterated the vision of NIF:

"An Australia-wide collaborative network of world class imaging infrastructure."

Collaboration is about working alongside others. In this Quarterly newsletter, we highlight collaborations with people, institutions, industry, other research capabilities and now continents. The National Imaging Facility is part of a research eco-system, where our expertise and technology come alongside your expertise and research questions. Read, and be inspired, not just by what others have achieved, but be bold to envisage what you can achieve.

What did NIF achieve in Brussels? Collaborative Research Infrastructure is a new paradigm in provision of world-leading capability, one in which Australia is a pioneer. Like all new paradigms, it requires effort to establish best practice, define KPIs and train personnel. Working alongside Euro-BioImaging allows NIF to share the load and validate what we are doing. Both NIF and Euro-BioImaging have identified translation of biomedical science to clinical medicine as key research areas, in which imaging is a natural partner. The operative word is partner – we in imaging-land need to work alongside leaders in translating health discovery. So, we plan to grow the collaboration with Therapeutic Innovation Australia, the European Advanced Translational Research Infrastructure and the European Clinical Research Infrastructure Network and learn about quality systems, documentation, the importance of time-frames, and much more that is critical to engagement with industry.

Ultra High Field MRI is at the cutting edge, and the vendors rely heavily on academic advances to understand needs, as well as solutions. So, why not collaborate directly, which is exactly what is happening at the University of Queensland NIF node, where industry and academics will work alongside each other. Collaboration that will bring benefits to the whole Australian research community. Learn about the 7T, and dream of what you can do. Then talk to Markus, Kieran and Aiman, and make the dream a reality.

And there is more – stories of collaboration with CSIRO, Queensland Institute for Medical Research, Griffith University tell you about the advances being made in new imaging agents, that could be used in your cancer research, while at the University of Western Sydney, they are imaging agents that could deliver drugs to the place they are needed most, the diseased cells.

NIF was established to work alongside you, enabling your research to be world-leading.

Come and join the team.

Professor Graham Galloway
Director of Operations

"National Imaging Facility is part of a research eco-system, where our expertise and technology come alongside your expertise and research questions."

NIF News

NIF leading the way in international research infrastructure collaboration: MoU signed between NIF and Euro-BioImaging

On the 8th of May 2014 in Brussels, Belgium, National Imaging Facility (NIF) and Euro-BioImaging (EBI) have jointly signed a Memorandum of Understanding, which recognises the desire of both research infrastructures to enter a mutually beneficial alliance to deliver cutting edge imaging capabilities to support multidisciplinary scientific communities across the globe.

Operating as expansive networks of imaging research capabilities across Australia and Europe, respectively, NIF and EBI shares the common goal of providing essential expertise and open access to world leading imaging and analysis capabilities for animals, plants, and materials.

"NIF greatly values the opportunity to work closely with our international colleagues at Euro-BioImaging to achieve shared vision in fostering innovative research through imaging technologies." Said Prof. Graham Galloway, NIF Director of Operations.

Imaging was identified in the Research Strategy Roadmaps of both Australia and Europe as an enabling technology that supports many national research priorities, such as healthy aging, energy, social sciences and humanities, and climate and environmental sciences.

The signing ceremony of this Memorandum of Understanding between the two networks of imaging research capabilities was held at the Australian Embassy, with Ms Nicola Gordon-Smith, Deputy Head of Mission, Australian Embassy to Belgium and Luxembourg and Mission to the European Union and NATO, and Prof. Octavi Quintana-Trias, Principal Adviser, Directorate-General for Research and Innovation, present as formal dignitaries for both Australia and European Union.

This collaborative framework establishment was part of a two-day meeting 'Connecting Global Research Infrastructure', which was an outcome from the 3rd EU-Australia Workshop that was held in Canberra, November 2013. The purpose of this meeting was to further consolidate a collaborative relationship between the Australia and Europe to drive a common approach in investing and prioritising collaborative global research infrastructures.

The 'Connecting Global Research Infrastructure' meeting was also attended by colleagues from Therapeutic Innovation Australia (TIA), European Advanced Translational Research Infrastructure in Medicine (EATRIS), and European Clinical Research Infrastructure Network (ECRIN). As a collaborative effort, the involved international research capabilities are working towards establishing common policies in scientific research management, access and preservation of large and complex data, and training of scientific expertise.

More details on the signing ceremony and photos can be seen on the Australian Embassy Belgium and Luxembourg and Mission to the European Union and NATO website http://www.eu.mission.gov.au/bsls/140508AustraliaEU140508AustraliaEU.html.

Prof. Graham Galloway (National Imaging Facility Director; left) and Prof. Oliver Speck (Euro-BioImaging, Medical Imaging, Scientific Coordinator; right).

National Imaging Facility
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NIF Quarterly • Q2, 2014

NIF News

Signing Ceremony for UQ-Siemens Australia Collaboration in Ultra High Field MRI

Funded by the Australian Education Investment Fund (EIF), the first in southern hemisphere Siemens Healthcare '7T Magnetom' human MRI system was installed and commissioned in February, 2014. The 38.6 tonnes imaging infrastructure is located at the Centre for Advanced Imaging, University of Queensland, and is a flagship imaging capability for the NIF-UQ node. It provides the most powerful imaging quality for visualising anatomical detail and function information. Key technical features of the system include a high-performance gradient with multi- receive/transmit radiofrequency capabilities, which further increases sensitivity. The 7T will be used for a broad range of applications, including neuroscience, engineering, imaging, and theranostics.

To celebrate the commissioning of the 7T, a collaborative agreement will be signed between the University of Queensland and Siemens Australia, on the 27th June 2014. The research agreement will be officially signed by UQ Vice-Chancellor Prof. Peter Høj, and Siemens Australia Executive Vice-President for Finance, Toby Carrington. This collaborative research framework will further consolidate the research partnership between UQ and Siemens Australia, to jointly deliver world leading imaging technologies to the Australian research community.

The signing ceremony is also part of an exciting week of three scientific symposia which are hosted by the Centre for Advanced Imaging. Building on UQ's strong record in magnetic resonance technology and engineering, the symposia will keep keen imaging scientists at the forefront of imaging research, and also provide opportunities for researchers from other disciplines to find out about various imaging technologies and the diversity of applications imaging is capable of.

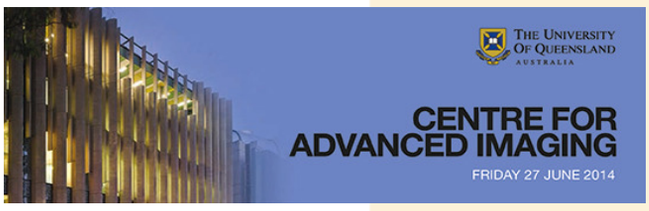
Starting 24th June 2014, the CAI Symposia will cater to a wide range of interests:

- Days 1 and 2 will be held in conjunction with the inaugural scientific meeting of the Australian Society for Molecular Imaging (ASMI)

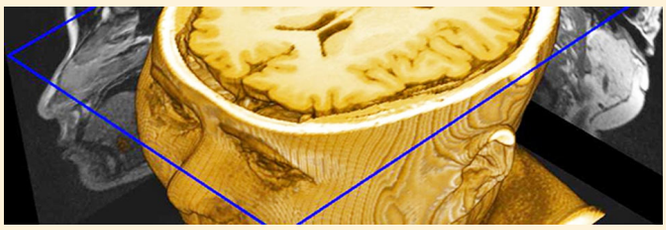
- Days 2 and 3will be concurrent sessions devoted to Bio Magnetic Resonance in Molecular Structure.

- Days 3 and 4 will be devoted to Ultra-high Field MRI.

For more information about the symposia, facilities and collaboration opportunities with NIF-UQ node at the Centre for Advance Imaging, please go to: www.anif.org.au, or www.cai.uq.edu.au.



MOOC Bioimg101x



MOOC (Massive Open Online Courses) for Bioimaging 101x was officially launched on the 7th of April, 2014! It is a 10-week course delivered by the edX platform. The course is targeted at general public - high school level science background is all that is required.

"Most people will have a need for advanced imaging sometime during their life. With the misinformation sometimes portrayed in TV dramas, which can exaggerate the benefits or over-emphasise the risks, it is important to give people an understanding of what to expect if their doctor sends them for a PET scan, for example." Says NIF's Director, and Bioimg101x Course Coordinator Prof. Graham Galloway.

Biomg101x is designed by a number of Facility Fellows at the UQ Node. Over ten weeks, the course will provide an introduction to modern imaging modalities, the scientific principles behind imaging, and key applications of the technologies, from neurological diseases to cancers. Bioimg101x will take students through a journey of a fictional patient exposing to various medical imaging technologies. The course also offers advanced modules for professional development, particularly across health, engineering and IT industries.

Congratulations MOOC Bioimg101x team! The course launch was a success with 10,000+ enrolments. Find out more about the course https://www.edx.org/course/uqx/uqx-bioimg101x-introduction-biomedical-1429#.U127Yk2_nL-

Do you have news?!

Published a paper? Formed new collaborations? Discovered something? Any updates from your Node — we need to know!
Email: communications@anif.org.au

FOLLOW US ON TWITTER
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NIF Focus Story - 1

UQ Node:

Ultra high field human MR at 7T

As MRI is a very versatile technique that can provide important insights into the body non-invasively and without dangerous side effects, there is considerable effort to increase its capabilities for human in vivo imaging. In pre-clinical imaging, higher magnetic field strengths already provide higher sensitivity and higher spatial resolution, and this is now possible for humans with the development of 7 Tesla (T) whole body scanners. On February 14th 2014 the first human images in the southern hemisphere were acquired on the 7T scanner (Magnetom 7T, Siemens Healthcare) located at the NIF-UQ Node, hosted by the Centre for Advanced Imaging (CAI), University of Queensland.

In addition to this state-of-the art equipment, a multi-disciplinary team of scientists and engineers will contribute their expertise to perform research on the 7 Tesla system. A/Prof. Markus Barth was recruited to lead the 7 Tesla research program and just relocated from the Donders Institute for Brain, Cognition and Behaviour (Nijmegen, the Netherlands), where he has been working on the 7 Tesla system at the Erwin L. Hahn Institute for MR Imaging. At CAI the team of scientists and engineers comprises Dr Kieran O'Brien (Siemens Scientist), Donald Maillet (System Engineer), Rients Lootsma (Siemens Engineer), and Aiman Al-Najjar (Facility Manager). Scientific collaborations with researchers at QBI and ITEE at UQ, Siemens Healthcare, QIMR and the hospitals in Brisbane ensure that a broad range of research themes and applications is covered.

Currently, the most important benefit at 7T is that spatial resolution can be improved significantly due to the higher available signal. In addition, image contrasts, that are less prominent at lower field strength, can reveal new information about tissue parameters at 7T. For example, the phase image shows excellent contrast between grey and white matter due to different magnetic susceptibility. This helps to identify very small venous vessels and small bleedings in the brain. As such, MR phase information can be used as a very sensitive disease marker, e.g. for tumor angiogenesis or iron accumulation in certain brain structures in Parkinson's disease, or for monitoring disease progression in Multiple Sclerosis.

Using accelerated, high resolution Functional Magnetic Resonance Imaging (fMRI) one can image the working human brain *in vivo*, e.g. by decoding MRI time series (brain reading). The aim of one project is to improve decoding accuracy at ultra high field by developing optimised MRI sequences and protocols (3D EPI and multiband/simultaneous multi-slice EPI) to detect activation small functional units (cortical layers and columns).

Also research questions using diffusion MRI which enables imaging of fibre tracts in the brain benefit from the higher spatial resolution. The stronger gradient set and advanced acquisition schemes enable this higher resolution despite shorter T2* decay at high field. It is also difficult to achieve a good radiofrequency (RF) transmit homogeneity at 7T and special RF pulses have to be designed to obtain accurate tissue contrast. By using multiple transmit coils this homogeneity can be improved significantly by finding optimal RF waveforms. Additionally, specific absorption rate (SAR) requirements have to be met to be able to perform the experiment.

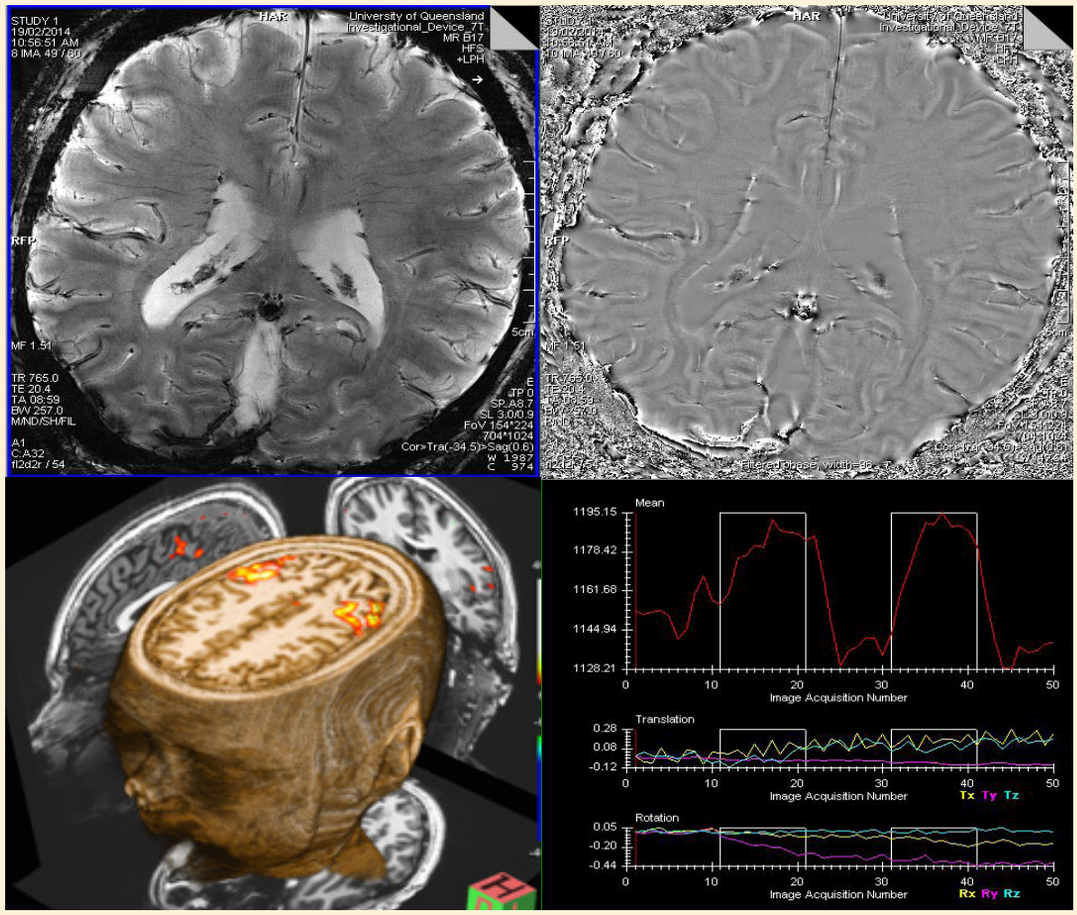

Figure 1 (top): *Magnitude and phase image of the human brain acquired with a 2D gradient echo sequence. Very small anatomical structures such as small veins are clearly visible with an in-plane resolution of 220µmx220µm.* **Figure 2 (bottom):** *3D anatomical image overlaid with areas that are functionally active during a bilateral finger tapping task. Spatial resolution, speed, and contrast are increased at 7T.*

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NIF Quarterly • Q2, 2014

Since the commissioning of the system mid February the research was mainly focused on MRI method development, particularly on neuroimaging and imaging of joints. Several other areas will also profit from the higher field strength, such as MR spectroscopy and spectroscopic imaging, X-nucleus imaging and spectroscopy, as well as imaging and spectroscopy of other areas of the body, for example cardiac and spine, however, this will require the acquisition or development of specific RF coils.

The Siemens human 7T MRI is a flagship instrument of the UQ Node of the National Imaging Facility, of which NIF a research network of 10 Australian universities and the Australian Nuclear Science and Technology Organisation, with more than $150M worth of imaging infrastructure. Building on UQ's strong record in magnetic resonance technology and engineering, the state-of-art scanner is an exciting opportunity for scientists and engineers in Queensland and beyond to play a significant role in the next generation of medical technology.

For further information on accessing the imaging facilities, current research projects and collaborative opportunities available at the NIF-UQ node, please contact UQ Node Director Prof. Ian Brereton at i.brereton@uq.edu.au; for info on 7T, please contact A/Prof. Markus Barth at m.barth@uq.edu.au.

Meet The Team:

The 7T research team at the NIF-UQ node, Dr Kieran O'Briab (left), A/Prof. Markus Barth (middle), and Mr Aiman Al Najjar (right).

As the Facility Fellow at the NIF-UQ node, A/Prof. Markus Barth leads the 7T research program. Having obtained his PhD in Technical Physics from the Technical University of Vienna, and having worked in the field of MRI at the Medical University of Vienna (Austria) and the Donders Institute for Brain Cognition and Behaviour (Radboud University, Nijmegen, The Netherlands) for the last 15 years, A/Prof. Barth has become an expert in advanced MR imaging methods. His main contributions have been made in the field of (cognitive) neuroscience and functional MRI, as well as clinical applications at high and ultra high field. Recent groundbreaking achievements include the development of accurate detection of layer specific functional activation in the human brain and ultra-fast MRI.

Dr Kieran O'Brien (Scientist MR, Siemens Ltd, Australia & New Zealand; Adjunct Research Research Fellow, CAI, UQ) is responsible for supporting R&D activities at the CAI. Kieran completed his PhD in Bioengineering on Cardiac flow imaging at The University of Auckland, New Zealand in 2009. For the last 4 years, he has been a member of the collaborative Siemens-CIBM research team in Lausanne, Switzerland where he was primarily responsible for the optimisation of Diffusion, 7T T1w imaging and RF pulse optimisation. Kieran's expertise lies within the fields of method and sequence development.

Mr Aiman Al Najjar manages the routine operations of wholebody MRI scanners at the Centre for Advance Imaging facilities at the St Lucia campus, and the Wesley Hospital. Currently, they consist of a 1.5T Siemens Sonata, 3T Siemens Trio and 7T Magnetom Human MRI. He has experience in Neuroimaging, Functional MRI and Musculoskeletal imaging. Aiman is responsible for Liaison with researchers within the University and external organisations regarding MRI Scanner requirement, MR Protocol setup and MR Operator training and sign off. He is also the course coordinator and tutor for Brain and Spine MRI course.

About Siemens Magnetom 7T MRI

Magnetic resonance imaging (MRI) is an imaging technique that uses strong magnets and radio waves to investigate the anatomy and function of the body. The patient is placed on a moveable bed that is inserted into a circular magnet with a very high magnetic field (main component of the MRI scanner). This creates a tiny magnetisation of protons in the human body, which is then flipped with radio waves. When relaxing back, this produces a faint signal that is detected by the receiving part of the MRI scanner. A higher magnetic field results in a higher signal. The received signal is processed by a computer, and an image is produced. The technique is widely used in hospitals for medical diagnosis and disease follow-ups.

Nerdy facts about the 7T:

- After weeks of floating over the ocean, the system was delivered to NIF-UQ Node on the 27th November 2013.
- The 7T weighs 38.6 tonnes (~154,400 packets of Tim Tams!).
- Bore size 60cm.
- System length 317.5 cm.
- Magnet field strength is 140,000 times stronger than Earth's magnetic field.
- 20,000L of liquid Helium were used to cool down the magnet to -270°C!
- First human image was acquired on the 14th February, 2014.

National Imaging Facility
Exploring Inner Space
NIF Quarterly • Q2, 2014

NIF Focus Story - 2

UQ Node:

EphA2 as a Diagnostic Imaging Target in Glioblastoma

Gliomas are the most commonly occurring primary brain tumours, signified by their invasive potential and increased capacity for proliferation. These tumours have a uniformly poor prognosis, with glioblastomas (grade IV gliomas as characterized by guidelines set down by the world health organization, WHO), having a median overall survival of less than one year. The current standard treatment for high-grade gliomas includes a combination of surgical resection, followed by radiation therapy and administration of temozolomide (TMZ) or other, case specific, chemotherapy. Despite continuing improvements in surgical techniques, chemotherapy and radiation therapy, prognosis still remains poor. Currently, there is significant interest in developing image guided therapy planning strategies to improve this poor patient prognosis. Metabolic imaging using PET, in particular, imaging areas of metabolically active regions of tumour or regions of high proliferation has been highlighted as having great potential to improve treatment planning for glioma.

Over the past 20 years there has been a growing interest in the use of highly specific biological molecules, targeted towards a unique hallmark of a disease and labeled with a positron emitter, as diagnostic PET tracers. This approach has become particularly popular in oncology where the profile of overexpressed receptors in diseased tissue is large.

The Eph receptor tyrosine kinases (RTKs) and their Eph-interacting ligands (ephrins) are the largest subfamily of tyrosine kinases consisting of 16 Eph receptors and 9 ephrin ligands. The complex bidirectional signaling mechanisms between Eph RTKs and ephrin ligands have been shown to influence cell morphology, adhesion, migration, invasion, proliferation and survival. As such, many studies have linked Eph and ephrin expression levels with tumour progression and metastatic spread and, as a consequence, patient survival. EphA2 overexpression has been observed in a number of GBM derived cell lines and levels of EphA2 are significantly higher in GBM tissue than in normal brain tissue. As such, EphA2 is an attractive target for the development of targeted diagnostic and therapeutic agents.

As a collaborative effort between CSIRO, QIMR and UQ, Dr Simon Puttick (Australian Institute of Bioengineering and Nanotechnology, UQ) is currently investigating the efficacy of a ^{64}Cu labeled monoclonal antibody (mAb) specific to EphA2 as a diagnostic imaging agent for glioma. By employing preclinical PET/CT imaging technology available at the NIF-UQ node, preliminary results in mouse models of glioblastoma have shown that uptake and retention of the ^{64}Cu-mAb in the tumour is high and that tumour to brain contrast is significantly higher than ^{18}F-FDOPA, a current clinical tracer for proliferation. Due to the long half-life of ^{64}Cu and the facile and fast labeling chemistry, these results suggest that the ^{64}Cu-mAb specific to EphA2 may be a suitable tracer for glioma treatment planning in areas with limited access to cyclotron produced ^{18}F tracers.

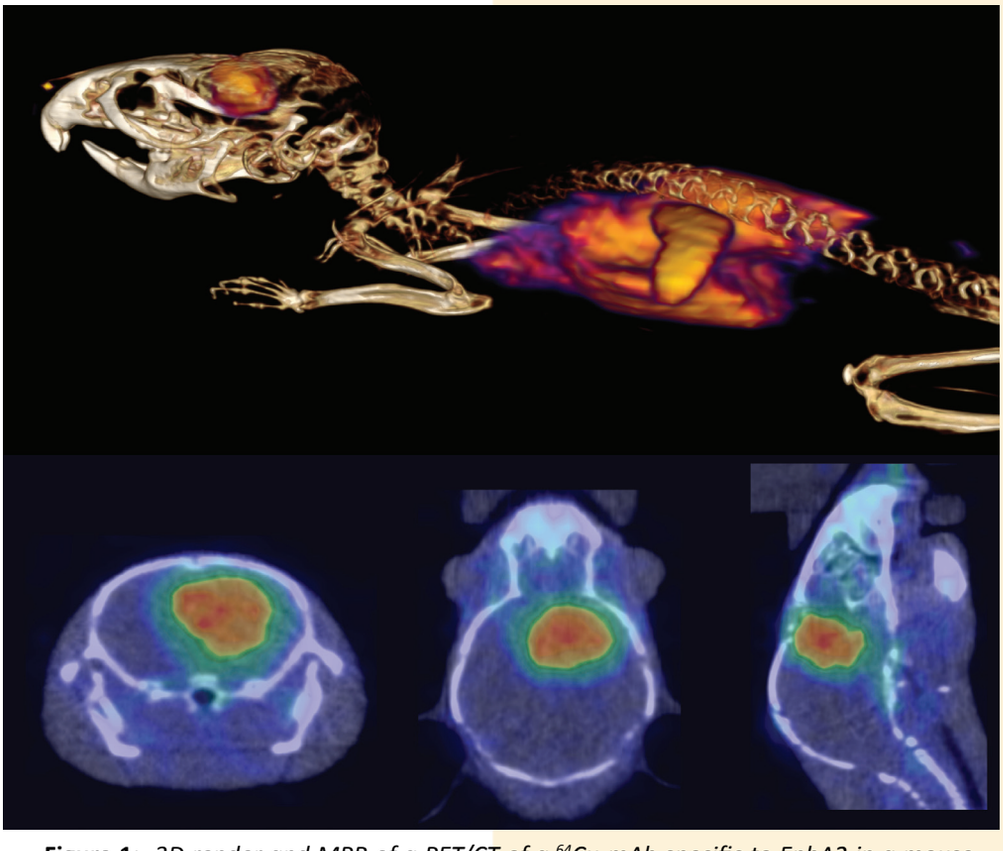


Figure 1: *3D render and MPR of a PET/CT of a ^{64}Cu-mAb specific to EphA2 in a mouse model of glioblastoma.*

For more details about the project please contact the project leader Prof. Stephen Rose at stephen.rose@csiro.au or Dr Simon Puttick at s.puttick@uq.edu.au.

For more details about the PET/CT imaging component and access to imaging facilities at NIF-UQ node, please contact Dr Karine Mardon at k.mardon@uq.edu.au.

National Imaging Facility
Exploring Inner Space
NIF Quarterly • Q2, 2014

NIF Focus Story - 3

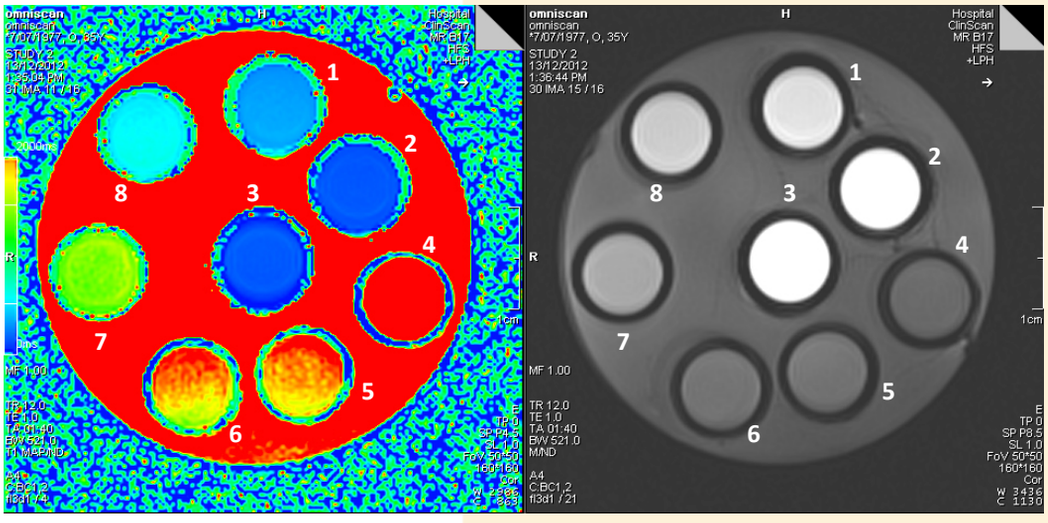
Development of single modal and bimodal imaging agents for imaging tumour hypoxia

Over 85% of human cancers are solid tumours and the prognosis for patients with advanced solid tumours is poor owing to their resistance to conventional chemo- and radiotherapies. In solid tumours vasculature is poorly formed and ineffective, limiting the blood supply to the tumour mass and in turn reducing delivery of oxygen to tumour cells. At a molecular level, low oxygen (hypoxia), induces the activation of hypoxia-inducible factor (HIF). High levels of HIF regulate a signalling cascade involving approximately a hundred genes that initiate adaptive cellular functions that allow solid tumour cells to survive hypoxia, proliferate and metastasize. Carbonic anhydrase IX (CA IX) is one of the most highly induced HIF responsive genes and is a recently validated diagnostic target for tumour hypoxia. It is overexpressed and sustained in a number of solid tumours including breast, brain (glioblastoma), clear cell renal, colorectal, head and neck and non-small cell lung carcinomas, while it is commonly absent in the corresponding normal tissue. CA IX expression and tumour hypoxia are negative prognostic factors and their precise imaging is of great relevance to therapy planning.

MRI/PET hybrid imaging modalities integrate the benefits of sensitivity and high resolution imaging to allow 'the best of both worlds'. Currently there is no small molecule dual modality imaging probe to target CA IX. This PhD project encompasses the design of single and bimodal probes that incorporate an aromatic sulfonamide moiety; a classical small molecule CA binding ligand and the use of the MRI/PET hybrid scanner to reveal their properties.

As a collaborative effort between researchers from Griffith University (Eskitis Institute for Drug Discovery), University of Queensland (Centre for Advanced Imaging), and Maastrict University (Maastricht Radiation Oncology; Netherlands), single modal and bimodal probes targeting CA IX have been designed and synthesised to host both gadolinium for MRI imaging and a radiometal for PET. Gadolinium has been pre-inserted into the probes; samples were prepared at various concentrations in water and the probe relaxation parameters compared to Omniscan, a clinically used relaxation agent. T1, T2 and T2* relaxation parameters were obtained for our first Gd-based probe and compared to Omniscan.

Initial results were inconclusive due to an error in the scanning parameters attributed to the recent installation of the equipment; it is shown that the T2 and T2* relaxation times are shorter than the T1. Comparison of the T1 times however showed that our complex at 1 mM was a promising relaxation agent. Several new complexes have been designed and synthesized to further improve relaxation parameters, targeting relaxation levels similar to the clinical standard Omniscan. In a parallel study conducted at Griffith University, we found that in the presence of the target protein, our Gd-based probes relax water better than the probe alone, alluding to differently designed experiments on the MR/PET scanner. Use of the hybrid imaging modality will allow the first images of a small molecule bimodal probes targeting CA IX to be obtained. Success of this project may lead to a clinically used probe for the early detection of hypoxic tumours.



Sample number	Sample	Concentration (mM)	T1 (ms)	T2 (ms)	T2* (ms)
1	Omniscan	1.0	205	270	200
2	Omniscan	2.5	88	92	77
3	Omniscan	5.0	76	40	37
4	Our sample	0.0375	3000	-	-
5	Our sample	0.075	1100	-	-
6	Our sample	0.15	1200	-	-
7	Our sample	0.424	1000	-	-
8	Our sample	1.0	415	630	377

Figure 1: T1 weighted image obtained on the 7T hybrid MR/PET scanner of our single modal Gd-based probe in water (various concentrations) alongside the clinical sample Omniscan. **Table 1:** Comparison of the T1, T2 and T2* results obtained for Omniscan and our designed compound.

For more information about the project, please contact A/Prof. Sally-Ann Poulsen (Griffith University) at s.poulsen@griffith.edu.au.

For the MR/PET imaging component, please contact NIF-UQ Node Facility Fellows Dr Karine Mardon at k.mardon@uq.edu.au; Dr Gary Cowin at gary.cowin@cai.uq.edu.au.

A/Prof. Poulsen would like to thank Anthony Fowler for theoretical radiation training at UQ and Dr Sue Boyd for assisting in the method development to calculate relaxation properties at Griffith University.

A Cancer Council Queensland grant (commencing 2014) was awarded to support this research project.

NIF Focus Story - 4

UWS Node:

Spatial and temporal control of drug release through pH and alternating magnetic field induced breakage of Schiff base bonds

In this study, a new class of polymer-nanoparticle composite based drug carriers and MRI contrast agent that respond simultaneously to both a change in pH and heat generated by AMF to achieve a 'burst' release of a molecule (for instance a cancer drug) via bond breakage, is presented. This unique combination allows temporal and spatial control over the release of the drug, that is, the drug will only be released in large quantity in diseased cells and remain sequestered in diseased cells (see Scheme 1). This has the potential to reduce the negative side effects of certain cancer drugs to cancer patient.

The efficacy of this polymer–nanoparticle composite as an MRI contrast agent was assessed though spin–spin relaxivity measurements. As a collaborative project between the University of New South Wales and the NIF node at University of Western Sydney, a Bruker Avance 11.7 T wide-bore spectrometer was used to measure the spin–spin relaxivity at various concentrations 0.00–0.10 g L^{-1} of the nanocomposite.

It was found that the relaxivity of the nanocarriers is 86.2 mM^{-1} s^{-1} at 11.7 T. This is comparable to the commercially available Feridex magnetic iron oxide nanoparticle MRI contrast agent, which has a T_2 relaxivity of 98.2 mM^{-1} s^{-1}.

A P(DEGMA-co-OEGMA-b-[TMSPMA-co-VBA])@silica@magnetite polymer–nanoparticle composite has been developed as a platform for controllable drug release. The nanocomposite facilitates controllable release of therapeutic molecules through breakage of pH and heat labile Schiff base bonds that bind the molecules to the polymer. This enables dual-stimuli responsive drug release in response to the acidic microenvironment of cancerous cells and heat generated by the magnetite nanoparticles when subjected to an alternating magnetic field, thereby permitting spatial and temporal control over 'burst' release of the drugs. The nanocomposite has also been shown to be effective at improving magnetic resonance imaging contrast through enhancement of spin–spin relaxivity.

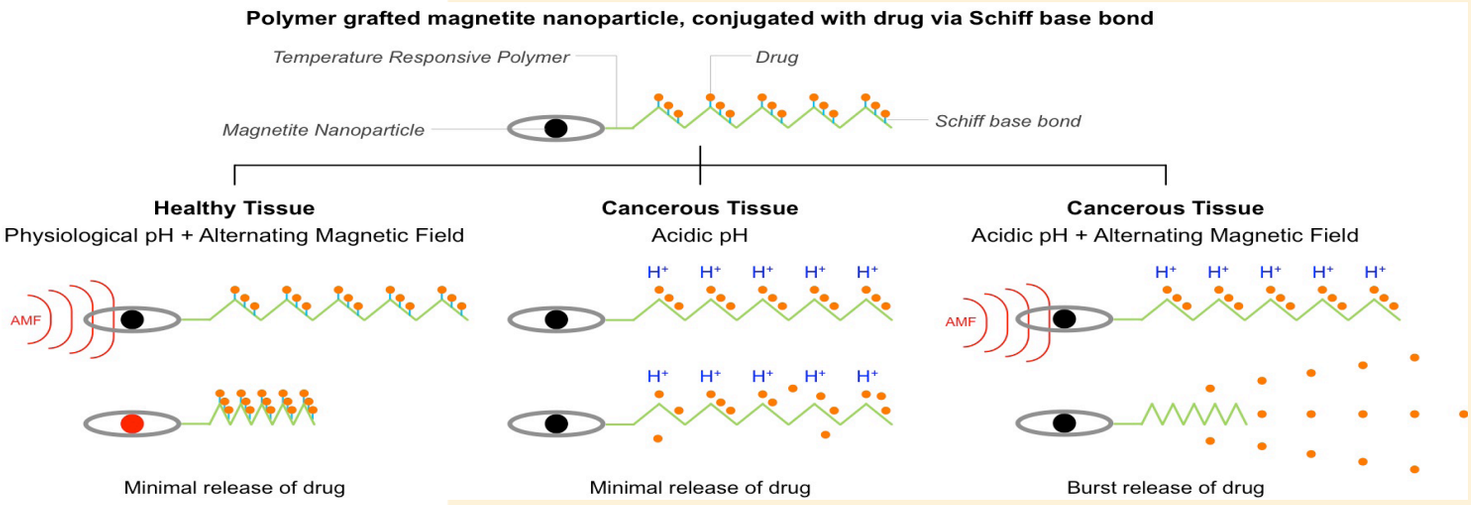
Selected Publication

Spatial and Temporal Control of Drug Release Through pH and Alternating Magnetic Field Induced Breakage of Schiff Base Bonds (2014). Alexander E. Dunn, Douglas J. Dunn, Alex Macmillan, Renee M. Whan, Timothy J. Stait-Gardner, William S. Price, May Lim, Cyrille Boyer. Polymer Chemistry, accepted 9 March 2014. DOI: 10.1039/C4PY00150H

For more information about the project, please contact Dr May Lim (UNSW) m.lim@unsw.edu.au.

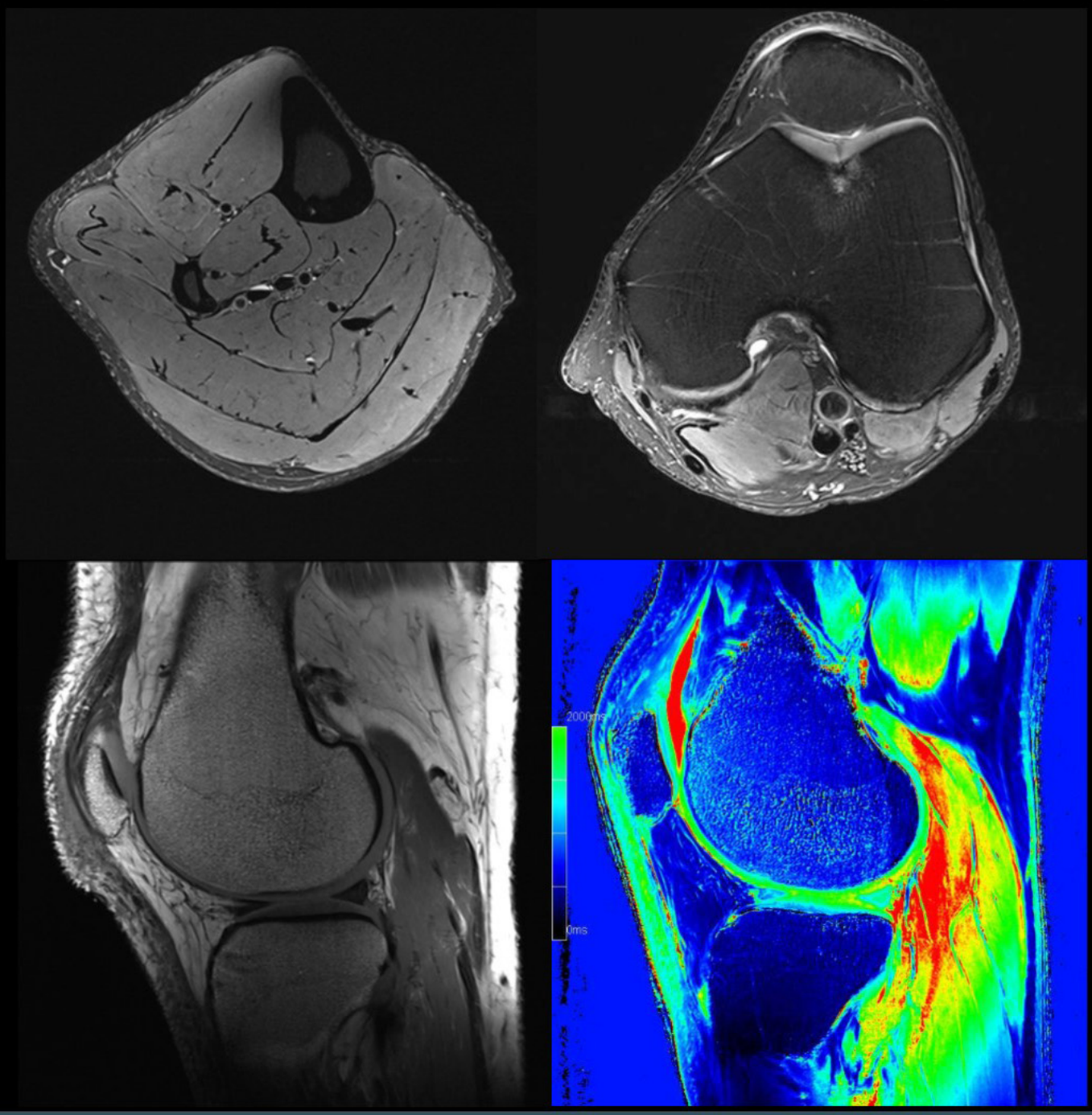
For the spectroscopic imaging component, please contact Dr Tim Stait-Gardner (NIF-UWS) t.stait-gardner@uws.edu.au.

Dr May Lim would like to thank the National Imaging Facility for the Subsidised Access Grant to use UWS's Bruker Avance 11.7 T wide-bore NMR spectrometer.



Scheme 1 Temporal and spatial controlled release of a model therapeutic compound from P(DEGMA-co-OEGMA-b-[TMSPMA-co-VBA]) diblock copolymer grafted onto silica coated acicular magnetite nanoparticles. A) in healthy tissue (pH 7.4), application of an alternating magnetic field causes the particle to heat up above the lower critical solution temperature (LCST) of the polymer, resulting in a contraction of the polymer chains, with a minimal release of the therapeutic compounds due to only partial hydrolysis of Schiff base bonds. B) in cancerous tissue (pH ~ 5.5), an acidic environment causes a slow hydrolysis of Schiff base bonds, again resulting in minimal release of the model therapeutic compound. C) Application of an alternating magnetic field (AMF) in acidic environments (such cancerous tissue) achieves a synergistic effect whereby a rapid hydrolysis of Schiff base bonds is observed due to the increase in temperature and low pH, resulting in a 'burst' release of the model therapeutic compound.

Musculoskeletal imaging at 7T: (clockwise) muscle fascicles of the calf; PD axial slice of the knee; colour coded sagittal T1 map of the knee; high resolution, sagittal T1-weighted image of the knee joint.
- Aiman Al Najjar, Dr Kieran O'Brien, A/Prof. Markus Barth, Centre for Advanced Imaging, University of Queensland.



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