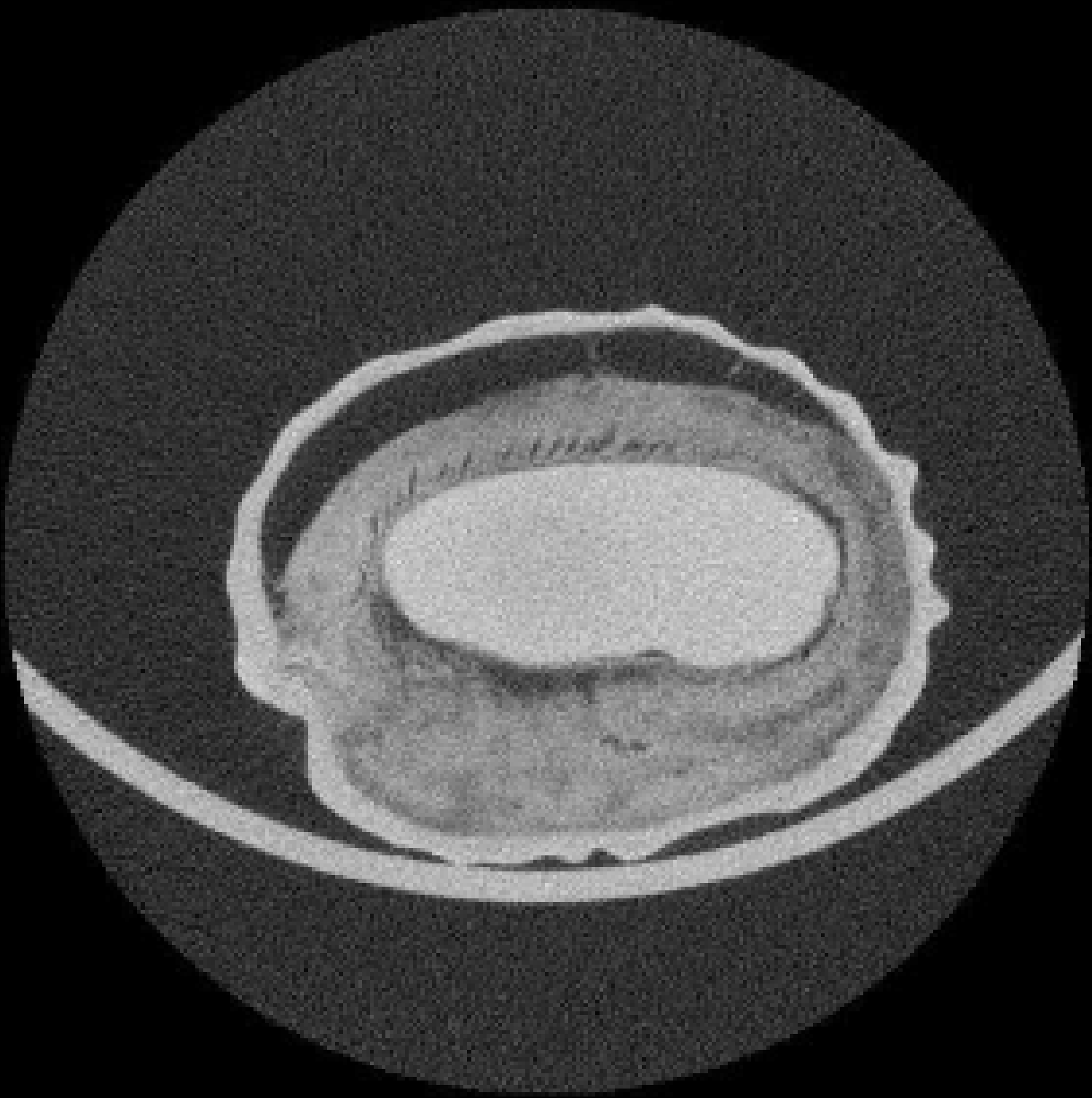
National Imaging Facility

Exploring Inner Space

NIF Quarterly • Q2, 2015

Computer Tomography (CT) image of Achacha, a highly prized tropical fruit originated from Bolivia - Dr Tim Stait-Gardner, Ms Robyn Grey, Biomedical Magnetic Resonance Facility (BMRF), NIF - University of Western Sydney node.



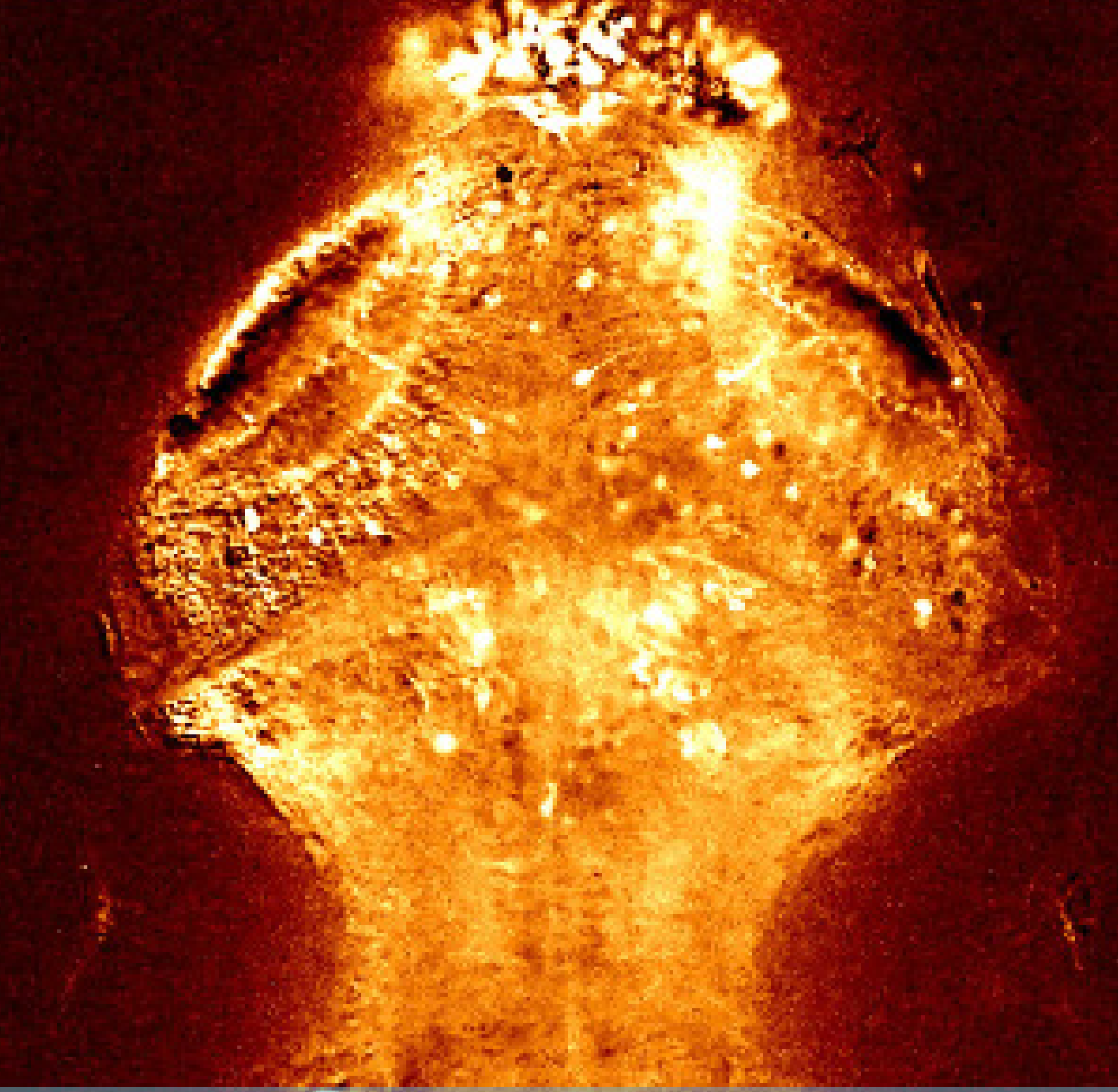


Image post-processing and time-series analysis of neuronal activity in a zebrafish - Dr Andrew Janke, NIF - Informatics

Director's Message

"National Research Infrastructure [NCRIS] is more than the hardware to deliver world-leading science."

Building Relationships - a part of modern research culture. It has been highlighted across all reviews of NCRIS, that infrastructure is more than the hardware to deliver world-leading science. Earlier this year, the scientific community backed the NCRIS model, through the campaign to secure the funding for the salaries of the scientists and managers who make NCRIS work. And NIF has demonstrated that time and again.

So in this note to our readers, I highlight the relationships across the NIF family, relationships that extend across scientific, geographic and societal boundaries. Whether being in front of the pack, as a recently appointed Member of the Order of Australia, standing in front of a class of secondary school students, or hosting a symposium, NIF is proud of the enthusiasm with which our members participate and make a difference in society.

And our dedication to working with the researchers is no different. Reflecting on the words of Associate Professor Hamilton-Craig, it takes more than the final experiment to produce that high-impact paper, for which we all strive. Whether it be safety, developing new ways of analysing and presenting your data, or removing artefacts, there is a wealth of expertise available to support your research. And so NIF will work with you in understanding your question, in planning your research, and addressing the mundane as well as the exciting, to ensure that your experiments are effective, ethical and safe.

So, as you read this newsletter, take the opportunity to get to know the people. They may work across the city or across the nation. Wherever they are, they are ready to give you advice about your research.

In closing, it is with mixed feelings that we say farewell to our Scientific & Engagement Manager, and editor of this newsletter, Dr Annie Chen. Annie has contributed so much to the management of NIF, and importantly, promoting NIF. So while sad to see her leave, I am sure that you join me to congratulate Annie on taking the next step in her career, and wish her every success.

Professor Graham Galloway
Director of Operations

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NIF News

UWS Biomedical Magnetic Resonance Facility

Official Launch of Bruker 14.1 T MRI & Perkin-Elmer Quantum GX MicroCT

On the 31st March 2015, the internationally renowned Biomedical Magnetic Resonance Facility (BMRF) at the University of Western Sydney (UWS) hosted the 6th NMR, MRI and Diffusion Symposium to celebrate the recent technology expansion - a Bruker 600 MHz (14.1 T) wide-bore spectrometer, and a Perkin-Elmer Quantum GX microCT imaging system.

The refurbished BMRF was opened by UWS's Vice-Chancellor Professor Barney Glover, by congratulating the BMRF team and welcoming the invited speakers including Professor Jörg Kärger (Leipzig), Professor Peter Basser (US National Institutes of Health), Dr Kirk Feindel (University of Western Australia), Dr Konstantin Momot (Queensland University of Technology).

"The expanded NMR facility is a shining example of the kinds of research happening across our universities in collaboration with business and industry to drive Australian innovation." Says Professor Glover.

As part of the National Imaging Facility (NIF) network, the BMRF is a focal point for more than 100 Higher Degree Research students and Australian academics, including clinicians, biochemists, chemists and physicists. A public workshop was also held as part of the celebration to highlight the industrial and medical applications of NMR/MRI.

"The events will highlight the potential for NMR, MRI and diffusion techniques in fields as diverse as medicine, environmental monitoring, mining and manufacturing." Says Professor Bill Price, Director of the BMRF and also NIF-UWS node.

Biomedical Magnetic Resonance Facility, University of Western Sydney.

This new instrument was acquired through an Australian Research Council Linkage Infrastructure, Equipment and Facilities (ARC LIEF) grant (LE140100009, Price et al. "Ultra-high resolution magnetic resonance imaging (MRI) system for physical applications") and will be made available to the wider research community via NIF. The new MRI will provide unique insights into a diverse variety of areas. Expected outcomes will range from agricultural advances, higher performing energy storage solutions, to more effective cancer treatments and advance Australia's fundamental scientific capabilities.

Importantly, the node has amassed a world recognised concentration of expertise from fundamental magnetic resonance development (i.e., quantum mechanics and pulse sequence design) to application support and data modelling. The operation of the instrument requires specialist input and a high degree of training and the node's expertise can be drawn upon by researchers and collaborators accessing the equipment. Projects already planned for the instrument include: probing glutathione interactions in biological systems; probing antibiotic peptide assembly using diffusion NMR (dNMR); probing the chemical stability of peptide structures; probing cellular uptake using dNMR; establishing imaging markers representative of oncology pathology and treatment outcome; measuring grey matter loss in animal models of synaptic dysfunction; understanding diffusion in non-molecular solvents and understanding reaction outcomes in these systems; among others.

In addition to the new MRI, the node has also obtained a Perkin-Elmer Quantum GX microCT imaging system for high performance computed tomography (CT) imaging. Mice, rats and rabbits can all be imaged with this instrument at resolutions approaching 4.5 µm. The microCT will complement the MRIs and will widen the array of projects possible at the UWS node.

For more information and capabilities offered at NIF-UWS node and BMRF, http://www.uws.edu.au/nanoscale/nanoscale_organisation_and_dynamics/bmrf,

Or contact NIF-UWS node Director Prof. Bill Price w.price@uws.edu.au or Facility Fellow Dr Tim Stait-Gardner t.stait-gardner@uws.edu.au.

Key Facts:

- The Bruker 14.1 T system is 280,000 times stronger than the Earth's magnetic field.
- The 14.1 T magnet contains hundreds of kilometres of superconducting wire carrying a current of 234 amps.
- 750 litres of liquid helium and an equal volume of liquid nitrogen are required when the magnet is initially charged.
- To keep the coils in a superconducting state they are immersed in 130 litres of liquid helium. This helium is topped up every couple of months. Every week the magnet is topped up with liquid nitrogen.

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NIF News

Queen's Birthday Honours 2015

Dr Tim Kuchel
Order of Australia (AM)
Member of General Division

As announced in the prestigious Queen's Birthday honours list 2015, NIF's Dr Tim Kuchel (Director, NIF-Large Animal Research & Imaging Facility node), was recognised and appointed a Member of the Order of Australia (AM), for his *'significance service to veterinary science, particularly the humane care and treatment of animals in research activities.'*

"I am very pleased and honoured that the work of my team and many other excellent people has been so acknowledged." Said Dr Kuchel, who also heads the Preclinical, Imaging and Research Laboratories (PIRL) at South Australian Health & Medical Research Institute (SAHMRI).

"My interest in animal ethics stemmed from the obvious clinical improvements which could be made to the way in which animal research used to be conducted," he said.

As a vet who became an academic with a keen interest in the humane treatment of animals in medical research, Dr Kuchel is dedicated to understand and implement our evolving appreciation of what 'the best possible way' actually is, and how to have that approach adopted broadly throughout the research community. Congratulations Tim for the prestigious honour!


QUEEN'S BIRTHDAY HONORS

Mixing research and animal ethics

Tim Kuchel
Order of Australia (AM)
Member of General Division

By Genevieve Cooper

A vet who became an academic with a keen interest in the humane treatment of animals in medical research has been appointed a Member of the Order of Australia (AM).

Tim Kuchel of Stirling said it was gratifying that his contribution to science and ethics was seen to have merit.

"I am very pleased and honored that the work of my team and many other excellent people has been so acknowledged, but as we often playfully say, there is more work needed," he said.

An interest in biology sent Dr Kuchel to Queensland to study veterinary science as a university student.

After graduating he worked for three years in Clare in a mixed practice with the late Dr Dick Wilson before pursuing post graduate study in Melbourne and taking up a junior research fellow position at Cambridge.

His time at Cambridge cemented his interest in research, particularly in projects where he could bring a "comparative medicine approach".

"My interest in animal ethics stemmed from the obvious clinical improvements which could be made to the way in which animal research used to be conducted," he said.

Dr Tim Kuchel of Stirling has been appointed a Member of the Order of Australia (AM) for his service to veterinary science, particularly the humane treatment of animals in research.

"It has been particularly rewarding to have been around at the time when refinements to animal-based research have been so obviously implemented."

Those refinements have come about through the upgrading of the Prevention of Cruelty to Animals Acts in many Australian States which led to new regulations and controls and the establishment of animal ethics committees (AECs).

Dr Kuchel said society gave conditional support to the use of animals in scientific research providing they were "used in the best possible way".

Moved to Stirling

"It is the work to understand and implement our evolving appreciation of what 'the best possible way' actually is, and how to have that approach adopted broadly throughout the research community and through AECs, that has occupied much of my research interest over the years," he said.

Dr Kuchel returned to Australia in the early '80s to teach at the University of Queensland before moving to Stirling and taking up a position with the IMVS (Institute of Medical and Veterinary Science).

He is currently a director at the SA Health and Medical Research Institute and has been involved

For science to continue to advance human and animal medicine ... the use of animals in experimentation is still necessary

– Dr Tim Kuchel

in numerous professional bodies associated with animal science and welfare.

Dr Kuchel said animal ethics were constantly evolving, largely due to a shift in society values as communities became more urban in experience and background.

"For science to continue to advance human and animal medicine, and for fundamental discoveries to continue to be made about animal and human biology, the use of animals in experimentation is still necessary," he said.

"The way in which the scientific community makes that point to the broader community is very important.

"To a certain extent, the confidence the scientific community enjoys from the public is predicated upon the attempt we make to keep faith with the key requirement that the use of animals must be explicitly necessary and must be done in the best possible way."

For more information about accessing and work that are conducted at NIF-LARIF node, please go to http://anif.org.au/facility_updates/large-animal-research-imaging-facility/

Welcome to NIF!

Dr Steffen Bollmann, UQ node

Dr Steffen Bollmann is a post doctoral research fellow at the Centre for Advanced Imaging, UQ. He obtained a bachelor's degree in science / biomedical engineering at the Ilmenau University of Technology, followed by a Masters degree in biomedical engineering & bioelectromagnetism. Following this, Steffen completed a PhD investigating multimodal imaging in ADHD children, adolescents and adults at the Neuroscience Centre Zurich and the Centre for MR-research, University Children's Hospital Zurich.

Steffen joined the Centre for Advanced Imaging, University of Queensland, in October 2014, where he is applying his expertise in multimodal imaging in the group of A/Prof. Markus Barth to integrate high resolution structural and functional data in neurodegenerative diseases.

In collaboration with Dr Viktor Vegh and Dr Kieran O'Brien he investigates ways of improving the coil combination of phase data for quantitative susceptibility imaging.

To exploit the higher resolution possible at ultra high field systems, Steffen compared the suitability of different sequences for volumetric analyses at 3T and 7T.

In collaboration with Dr Lars Marstaller, Steffen worked on the automatic multispectral segmentation of hippocampal subfields on high resolution structural T1 and T2 weighted datasets.

For projects and collaborative opportunities, please email steffen.bollmann@cai.uq.edu.au.

CSIRO's '*Scientists in Schools*'

Dr Andrew Janke, UQ node

NIF Informatics Fellow Dr Andrew Janke visited Year 9 science students at Cavendish Road State High School, Brisbane, as part of CSIRO's national program 'Scientists in Schools'. With the goal to engage and motivate Australian primary and secondary school students, this program promotes and broadens awareness the types and variety of exciting careers available in the sciences.

As the students at Cavendish Road SHS are currently undertaking studies in Chemistry and have been learning about the structure of atoms and radioactivity, Andrew introduced the eager Year 9 students to PET and MRI imaging technologies, the process of creating a radioactive isotope, embedding it into a glucose molecule, delivering it to a patient and then running a PET scan. Students were able to ask some insightful questions into the processes that Dr Janke's lab goes through in their daily work, and about the exciting possibilities in a career in science.

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NIF News

Official Launch

Preclincial 9.4 Tesla MRI at NIF
University of Western Australia node

Harry Perkins Institute of Medical Research.

On 24th June 2015, the National Imaging Facility flagship Bruker BioSpec 9.4 T MRI that is located within the Harry Perkins Institute of Medical Research, was officially opened by the Chief Scientist for Australia Prof. Ian Chubb.

Hosted by the Centre for Microscopy, Characterisation and Analysis (CMCA) at University of Western Australia (UWA), the NIF-UWA node flagship capability 9.4 T MRI is a high performance multi-nuclear system for non-invasive high-resolution imaging and spectroscopy in preclinical, preserved sample, plant and materials research. A range of volume, surface, and phased array imaging coils are available to accommodate specific preclinical needs, in addition to planar surface coils for materials applications. The instrument has the latest generation of parallel receive and transmit hardware to decrease experiment time without compromising imaging resolution or contract, and is fitted with three sizes and strengths of imaging gradients to best tailor to the diverse needs of both preclinical and materials researchers.

The preclinical 9.4 T MRI is managed by NIF Facility Fellow Dr Kirk Feindel, who also heads the MRI Technique Group and the in-vivo Bioimaging Facility at CMCA. Dr Feindel oversees operation of the MRI facility, including study design and implementation, student and staff training, and development of collaborative research projects. His education, training, and experience in neuroscience, chemistry, physics, and magnetic resonance can often provide interdisciplinary insight and assist in the development of successful MRI research solutions.

For current projects and collaborative opportunities at NIF-UWA node, please contact kirk.feindel@uwa.edu.au.

For more information about CMCA, please go to http://www.cmca.uwa.edu.au/facilities/bioimaging/magnetic-resonance-imaging-mri.

Official launch of NIF-UWA node flaghship MRI; L - R NIF-UWA node and CMCA Director Prof. David Sampson, Australia Chief Scientist Prof. Ian Chubb, UWA Chancellor Dr Michael Chaney AO, Prof. Paul Johnson, NIF Director Prof. Graham Galloway, and AMMRF COO Dr Miles Apperley.

About Bruker BioSpec 9.4 T MRI:

- Bruker 9.4T actively-shielded superconducting magnet (H-1 @ 400 MHz)
- Bruker Avance III digital RF system with 8-channel transmit/receive capabilities
- Three interchangeable imaging gradient sets: (1) ID = 20 cm, Max gradient = 0.3 T/m; (2) ID = 11.4 cm, Max gradient = 0.66 T/m; (3) ID = 6.0 cm, Max gradient = 1 T/m
- AutoPac motorised bed/sample-positioning system
- Temperature controlled beds with active feedback
- Anaesthetic vaporiser
- Temperature, ECG, Respiratory, 02 sat monitoring
- ECG and respiratory gating
- Volume RF coils with ID ranging from 154mm to 15mm
- Planar surface RF coils (e.g. for materials imaging)
- Parallel imaging (GRAPPA) using phased-array head or body coils (preclinical)

Dr Kirk Feindel, preclinical 9.4 T MRI.

NIF Focus Story - 1

International Collaboration -

Studying the Architecture of Healthy and Diseased Muscles with Diffusion Tensor Imaging

Studies conducted by Dr Bart Bolsterlee, Neuroscience Research Australia; imaging component supported by NIF-University of New South Wales Facility Fellow Dr Michael Green.

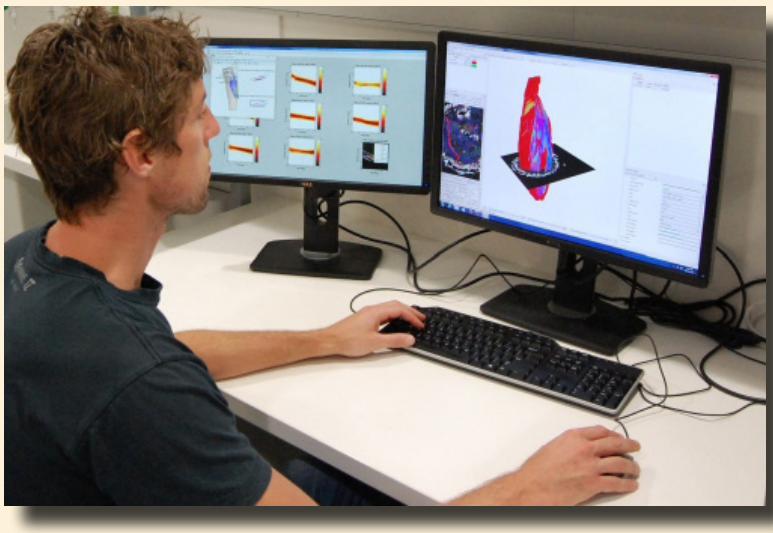


Figure 1. *Researcher Bart Bolsterlee working on three-dimensional reconstructions of muscles from diffusion tensor images at NeuRA, NIF-UNSW node.*

Challenge

Following a stroke or spinal cord injury some people develop stiff joints, referred to as contractures. Patients with contractures can rotate the contracted joints less than normal people can, which often makes it difficult for them to go about their daily tasks. If contractures in the ankle develop, patients might even not be able to walk anymore, making them wheelchair-bound. It is not well understood why contractures develop. Also, it is not clear whether they result from changes in the muscle or changes in the tendon, which is why researchers and clinicians are very interested in the mechanical properties of these tissues. Experimentally, ultrasound is often used to visualize and measure the structure of a muscle. But a problem with ultrasound is that it only provides a two-dimensional image of a muscle, while muscles often have complex, three-dimensional shapes. Magnetic resonance imaging (MRI) can reveal the three-dimensional shape of muscles, but not until recently could the direction of fibres within a muscle, which is highly relevant for its mechanical properties, be determined from MRI. The use of diffusion tensor imaging (DTI) to make three-dimensional reconstructions of muscles, which include fibre directions, has recently taken off and is expected to shed light on what happens inside the muscle when people develop contractures and how that is different from normal muscles.

How did the facility help?

In an international collaboration between Delft University of Technology in the Netherlands and Neuroscience Research Australia (NeuRA), University of New South Wales, Australia, the 3T Philips Achieva scanner at NeuRA was used to make MRI and DTI scans of the lower legs of eight healthy subjects.

Outcomes

The image data were used to make three-dimensional reconstructions of the medial gastrocnemius muscle, a calf muscle that is for example important for walking and is sometimes involved in ankle contractures. Never before has this muscle been reconstructed in so much detail. In a first study, the three-dimensional models were used to determine the accuracy of two-dimensional ultrasound measurements of the lengths and orientations of muscle fascicles. But with these detailed models of the muscle, the door is open to answer many other research questions. For example, how is the muscle's design different between healthy subjects and patients that have experienced a stroke and developed an ankle contracture? And how does the three-dimensional shape of muscles change when moving a joint or activating the muscle? The anatomical detail of muscles that DTI provides, opens many exciting opportunities for improving our understanding of the normal function of muscles and how that is different from muscles affected by disease.

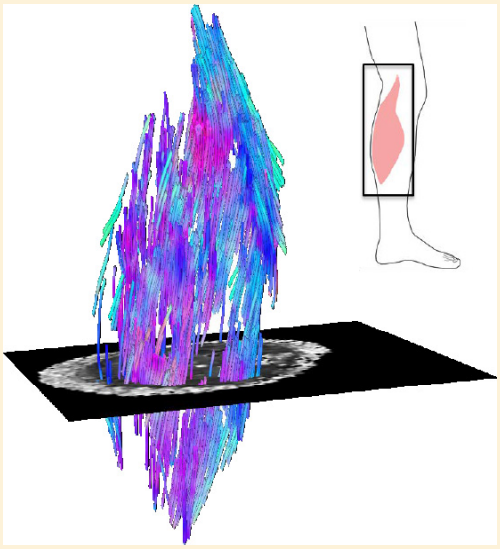


Figure 2. *Example of a 3-D model of the medial gastrocnemius muscle.*

NIF Focus Story - 2

Informatics:

Reducing Artefact in Simultaneous EEG-fMRI using Carbon Fibre Loops and Iterative Analysis

Through measuring and recording electrical activities in the brain, Electroencephalography (EEG) is a key tool in the diagnosis and management of neurological disorders, such as epilepsy, sleep disorders, and encephalitis. EEG is typically non-invasive and can be used simultaneously with Functional Magnetic Resonance Imaging (fMRI) so that high-temporal-resolution data can be recorded at the same time as high-spatial-resolution data, however, since the data derived from each occurs over a different time course, the data sets do not necessarily represent exactly the same brain activity.

NIF Informatics Fellow Dr David Abbott and his team have previously developed a procedure to reduce motion and ballistocardiogram artefact in EEG recorded during fMRI, using carbon fibre loops to record and subtract the artefact [1]. They have now adapted the approach for use with a commercial EEG-fMRI device, including a new iterative analysis approach to reduce residual gradient artefact.

In currently available commercial EEG-fMRI systems, gradient artefact is fully recorded by the EEG system and a gradient-artefact-removal post-acquisition processing step is performed - typically a template of temporal length TR (the MRI repetition time) is determined by averaging the EEG over a number of successive time windows each of length TR. This can provide a good estimate of the gradient artefact, whilst the physiological signals of interest tend to average close to zero in the template. However subject motion can contaminate the average gradient artefact template. This then degrades the corrected EEG for the entire time period for which the affected gradient template is used (usually much longer than the motion event).

Methods

Motion detection loops together with the following iterative approach were employed to mitigate this issue:

Iteration 1: Conventional average gradient artefact correction is employed, then fitted motion-loop signals are subtracted from the resultant EEG.

Iteration 2: Potential extreme motion events are identified as unusually large amplitude variation in the EEG of iteration1. The average gradient artefact correction is repeated, excluding contaminated epochs from the template.

Iteration 3: This final iteration avoids average gradient template contamination by more subtle motion events that can now be identified from the improved motion loop signals of the second iteration, because the motion loops are no longer substantially contaminated by propagated artefact from extreme motion events. The more subtle motion events may not have been easily detected in the EEG at the first iteration because they are more effectively reduced by the motion loop subtraction.

Example studies: A healthy male subject aged 25 years studied with a Siemens TRIO MRI, and a female epilepsy patient (electrographic diagnosis of continuous spikes and waves during sleep (CSWS)) aged 12 years studied with a Siemens Skyra MRI. A Siemens transmit/receive circularly polarised head coil was used to acquire fMRI (EPI sequence; TR=3.0s; TE=30ms; flip angle = 85°; FOV = 216 x 216 mm; 72 x 72 matrix; voxel size 3 x 3 x 3 mm; 44 contiguous slices, providing whole-brain coverage). EEG was acquired using a Brain Products' MR-compatible 32-channel EEG system; electrodes arranged according to the international 10-20 system.

Results

The motion reduction procedure substantially reduced the effect of motion-related artefact in both studies, whilst retaining the epileptiform activity in the EEG of the epilepsy patient.

The 3-step iterative procedure provided improved artefact reduction, mitigating issues related to motion artefact propagation due to contaminated average gradient template.

An example for the healthy control is shown in the figure. In each of (a) through (d) the same epoch is shown with different processing applied. In each case:

- the upper four traces are selected EEG traces
- the lower 3 traces (orange shading) are the corresponding motion loop signals.
- an extreme motion event occurred during the last 3 seconds of the 10-second EEG epoch shown.

(a) is the conventional result without motion loop subtraction.

(b) the gradient artefact correction has been re-run, excluding the use of the severe motion event from the gradient artefact correction template.

(c) is the result of the first iteration of the motion-loop correction procedure. i.e. the same EEG shown in (a) has been subjected to motion-loop subtracting: the extreme motion event was too large to be completely removed (suggesting substantial non-linear effects), however the smaller propagated artefact has been virtually eliminated from the EEG.

(d) the iterative process has been fully applied and this provides the cleanest EEG signal of all.

NIF Focus Story - 2

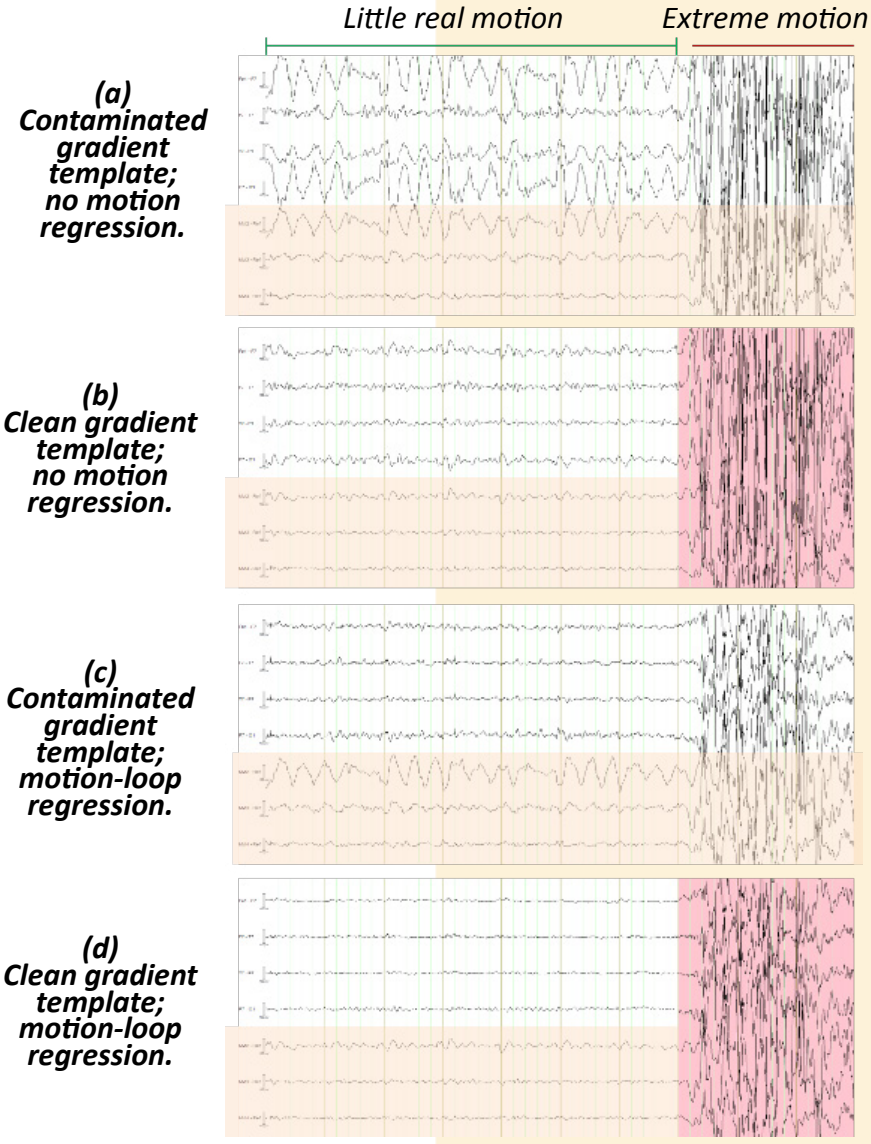


Figure 1: *The same 10 second epoch of EEG acquired simultaneously with fMRI in a healthy control is shown with different processing applied (see results text for full description). The first 7 seconds is largely free of real motion, whilst large real motion is present in the last three seconds of this epoch. (a) Average gradient artefact template subtraction 'propagates' motion artefact to unaffected regions in conventional post-processing; (b) Iteration without motion loops can be helpful; however iteration with motion loops ((a) then (c) then (d)) effectively eliminates the problem.*

Conclusion

The use of carbon fibre motion-detection loops together with an iterative processing approach can provide a high level of artefact reduction in EEG acquired during fMRI.

Acknowledgements

We acknowledge support from the National Health and Medical Research Council of Australia; the facilities, and the scientific and technical assistance of the National Imaging Facility at the Florey node; and the Victorian Government's Operational Infrastructure Support Program.

References

1. Masterton RAJ, Abbott DF, Fleming SW, Jackson GD. Measurement and reduction of motion and ballistocardiogram artefacts from simultaneous EEG and fMRI recordings. NeuroImage 37(1):202-211 (2007)

For further details, please see the following recently published paper: Abbott DF, Masterton RAJ, Archer JS, Fleming SW, Warren AEL, Jackson GD. Constructing carbon fiber motion-detection loops for simultaneous EEG–fMRI. Frontiers in Neurology (Section: Brain Imaging Methods) 5(260)1- 16 (2015).

Meet Dr David Abbott:

Dr David Abbott is an experienced physicist-neuroscientist specialising in development and application of advanced neuroimaging techniques for basic & clinical research.

His work includes development and optimisation of image acquisition and analysis methods, paradigm design for brain mapping experiments, and application of these techniques to answer fundamental questions in neuroscience. He is a leading scientist in the field of functional magnetic resonance imaging (fMRI) in Australia. Applications include studies of epilepsy, stroke, cerebral palsy, sleep apnoea and glaucoma, and studies of the healthy brain. David has a particular interest in simultaneous EEG / fMRI applied to improve understanding of seizures in epilepsy. He has published over ninety peer-reviewed publications and these have accumulated more than 4,500 citations. David is also the principal author of iBrain™ neuroimaging software.

Dr David Abbott is a NIF Informatics Fellow, based at The Florey Institute of Neuroscience and Mental Health. For current projects at the NIF - Florey node and collaborative opportunities, please email david.abbott@florey.edu.au.

NIF Focus Story - 3

Clinical Research:

Improving Clinical Imaging for Tissue Characterisation in Cardiology

Cardiovascular diseases (CVDs) represent a severe socioeconomic burden to our aging society. Cardiovascular magnetic resonance imaging (MRI) is the gold-standard imaging method to guide diagnosis and therapy (Budoff, Cohen *et al*. 2005, Hundley, Bluemke *et al*. 2010).

Currently, MRI has limited resolution and capability for characterisation of heart tissue. Increasing the magnetic strength of the MRI scanner has been shown to improve the resolution of images (Moser 2010, Niendorf, Sodickson *et al.* 2010, von Knobelsdorff-Brenkenhoff, Frauenrath *et al.* 2010, Suttie, Delabarre *et al.* 2012, von Knobelsdorff-Brenkenhoff, Tkachenko *et al*. 2013). MRI at a strength of 7T may provide a non-invasive method to map heart muscle tissue with high definition resolution, giving doctors greater information about heart attack scars and enabling better diagnosis and design of treatment.

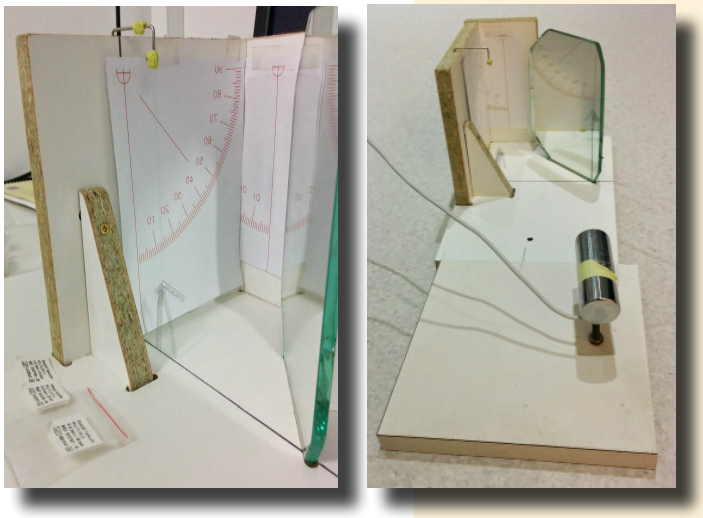
The vast majority of people who have had a heart attack have a stent implanted in their coronary arteries to aid blood flow. However, there are currently no coronary artery stents proven safe for use in 7T MRI. Stents approved for use in Australia are generally metallic and mostly magnetic. Depending on its magnetic properties, the MRI interacts with an object by pulling on it, rotating it or heating it up. This year, Siemens released the first clinical MRI for sale. Therefore, it is imperative to understand the safety of stents in 7T, so that gravely sick patients do not miss out on this technology.

At NIF, through collaboration with Siemens, the first two 7T MRI research scanners for humans in the Southern Hemisphere were acquired and officially commissioned in 2015. One located at Centre for Advanced Imaging (CAI), NIF-University of Queensland node, and one at Melbourne Brain Centre, NIF-University of Melbourne node. At the UQ node, researchers are testing the stents commonly implanted at The Prince Charles Hospital in Brisbane to determine whether they are safe in the 7T MRI environment. The reserch team has established links with industry so that manufacturers have donated coronary artery (CA) stents for safety testing. Innovative ways are designed to implement the established American Society for Testing and Materials test method standards, because of the small size of CA stents. Researchers also hope to develop methods to predict the safety limits of CA stents of a given material, to simplify the regulatory process and aid future design of the implants.

> *"Doing cutting edge research is not only about high impact papers. This research requires careful planning and ensuring that pushing the limits is not compromising safety and ethics. One of the strengths of working with NIF is the broad expertise base, which can deliver the total package, where everything is considered."*
>
> A/Prof. Christian Hamilton-Craig,
> Cardiologist,
> Prince Charles Hospital, Brisbane.

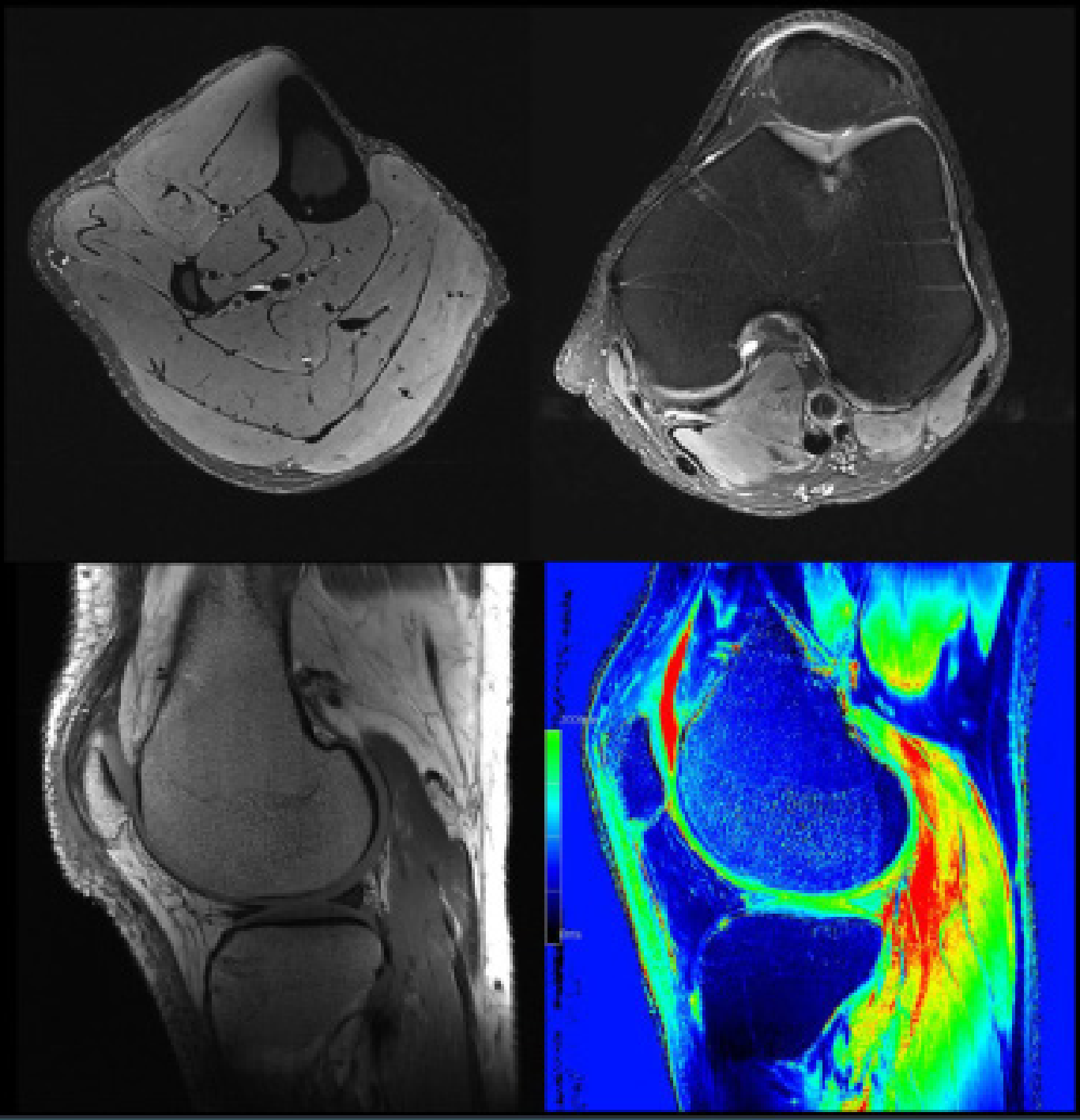
This research work would not be possible without the 7T MRI at NIF – UQ node. The expertise provided by NIF and Siemens has been invaluable. The team is incredibly knowledgeable; led by Cardiologist, A/Prof. Christian Hamilton-Craig, NIF National Director, Prof. Graham Galloway, Dr Jessica Cameron, NIF 7T Facility Fellow, Dr Steffen Bollmann, 7T Siemens Scientist, and Dr Kieran O'Brien, working with the engineering team at CAI, Alan Pringle and Don Maillet. Through collaborations with the Prince Charles Hospital, the team has been able to ensure the project will make the greatest impact clinically.

The researchers have identified some models of CA stents that are safe to enter the 7T MRI and some that do not pass the conservative thresholds for safety. This will enable the next step in the research plan: to invite participants who have had heart attacks to be scanned using the 7T MRI, so that the improvements in resolution of heart muscle tissue can be assessed.



Apparatus for measuring the magnetically induced dsplacement force.

For more information about the NIF flagship 7T MRI at UQ node, access to the capability, current projects and collaboration opportunities, please contact NIF-UQ node Director Prof. Ian Brereton i.brereton@uq.edu.au, or NIF-UQ node 7T MRI Facility Fellow Dr Steffen Bollmann steffen.bollmann@cai.uq.edu.au.



NIF Nodes:

University of Queensland

University of Western Australia

University of New South Wales

University of Sydney / ANSTO

University of Western Sydney

University of Melbourne

Monash University

Florey Institute of Neuroscience and Mental Health

Swinburne University of Technology

Large Animal Research & Imaging Facility

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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