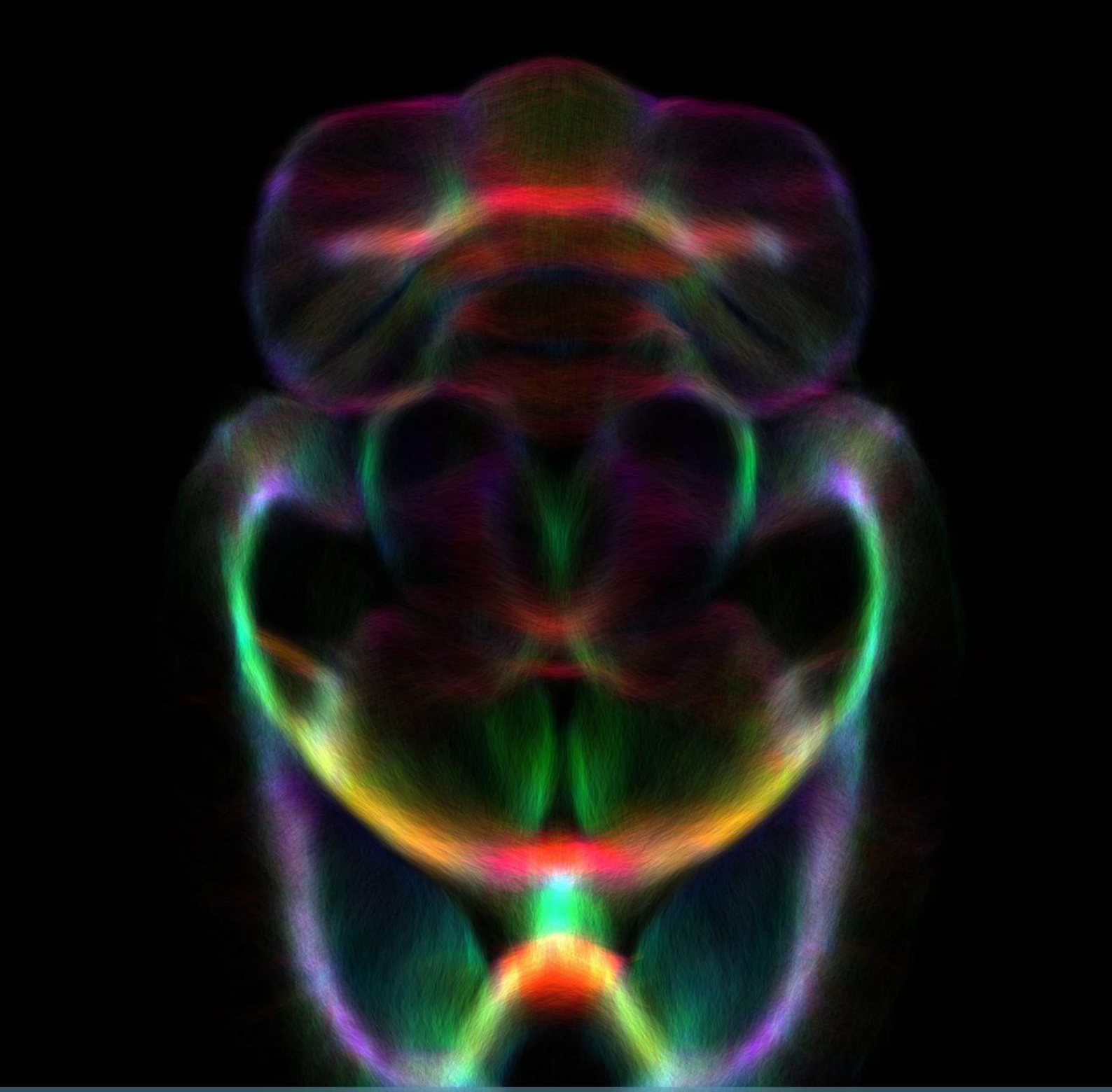
National Imaging Facility

Exploring Inner Space

NIF Quarterly • Q1, 2013

MicroCT scan of a guinea pig skull with a cochlear implant - Jeremy Pinyon & Prof. Gary Housley, scanned with Dr Tzong-tyng Hung, BRIL, UNSW Node



Diffusion-weighted EPI fibre tracking, in-vivo rat study - PI Dr Sandy Shultz, imaging David Wright, 4.7T Florey Node

Director's Message

The National Imaging Facility has been affirmed as part of Australia's research infrastructure, through the CRIS funding, announced as our last newsletter went to press. Once again, we have demonstrated that, by working together, we can achieve great things for the national research effort.

This newsletter, and those in the future, will highlight a wide-range of projects. Some centre on the work of individuals or small groups of individuals, who use our facilities to further knowledge. That is what scientific endeavour is all about. Being able to visualise, through imaging, our scientists are also able to tell a story, which can be appreciated by the wider community. This is important, as it demonstrates the value of science, and may even encourage the younger generation to consider a career in science.

Information technology is constantly identified as a key tool of the future. In NIF, we are building those tools and making them available to our users. One of the great advantages of having an organisation such as NIF, is the opportunity it provides to develop and deliver tools that are part of an even greater collaboration. And so we are working together with our colleagues from the Australian Microscopy and Microanalysis Research Facility, the Australian Synchrotron, and ANSTO, to build a laboratory in the cloud. And we are using national e-Research infrastructure, provided through NeCTAR, to deliver this to the whole research community.

Once again, I want to emphasise, that NIF is more than shiny equipment. Our people are what make NIF effective. For the users of our equipment, the Facility Fellows and Informatics Fellows are a resource that is available for you to use. They are keen to hear about your research problems, and help you find the best solution.

So, I hope that as you read this newsletter, it will inspire you to consider how your research could benefit from using our facilities. They are world-leading, and they are there for you to use.

Professor Graham Galloway
Director of Operations

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NIF News

More than $4 million of funding for NIF

As announced late December 2012, the National Imaging Facility (NIF) was granted with more than $4 million in funding from the Australian Government, Department of Industry Innovation, Science, Research and Tertiary Education (DIIRSTE), under the new Collaborative Research Infrastructure Scheme (CRIS) funding plan.

As a continuation of the National Collaborative Research Infrastructure Strategy (NCRIS) and Education Investment Fund (EIF) that have funded NIF since 2007, the CRIS funding will be used to support Australia's pioneer imaging scientists.

Directed by Professor Graham Galloway, a pioneer in biomedical Magnetic Resonance Imaging research, National Imaging Facility is a nation-wide organisation that provides state-of-the-art imaging capabilities of animals, plants, and materials. Established in 2007 as one of the four Characterisation Capability projects implemented by the Australian Government, NIF is an integrated imaging technology-based facility with currently over 60 scientists and and staff members. NIF merges the expertise of neuroscientists, imaging researchers and clinicians, platform engineers and computational scientists across 13 major universities and research institutes in Australia.

NIF is growing strong and is looking forward to work with scientists to produce Australia's best research achievements. "NIF will continue to focus on providing open access of an array of world-leading imaging instrumentation and aptitudes to the Australian research community", says Prof. Graham Galloway.

NIF's grid of imaging capabilities ('Nodes') spread across all mainland state capitals in Australia, with head office located within the Centre for Advanced Imaging at the University of Queensland.

Put Politicians in the Image: High-Level Delegation visits CAI - UQ

Early February 2013, former QLD Science Minister Ros Bates visited the Centre for Advanced Imaging (CAI) - a prestige landmark imaging facility that is part of the NIF Strategic Roadmap for Australian Research Infrastructure.

CAI has some of the most powerful and advanced imaging instruments available in the world, including a world-first commercially available combined preclinical MR/PET, and an animal MRI scanner that captures images of body tissues at a resolution of tens of microns.

Ms Mates praised the ground-breaking work of the scients at the Centre for Advanced Imaging, which is attracting international collaborations through its world-class people and facilities.

Researchers at the Centre are using the latest magnetic resonance imaging technology to study new treatments—such as the drug IVIg—to rescue brain tissue in stroke victims.

"If scientists can discover how and why this drugs stop the death of brain cells, they will greatly improve the outcome of stroke sufferers and save millions of dollars in health care." Ms Bates said.

For more info about CAI and their research projects, please visit www.cai.uq.edu.au.

Preclinical MR/PET imaging scanner, Bruker Biospin

NIF Focus Story

UQ Node: CT Scan, Not Only a Medical Technique

The NIF – UQ Node has put a different spin on CT scan. Through a collaborative research project, NIF – UQ Node Facility Fellow Dr Karine Mardon is working with Luc Turner (PhD student, School of Chemical Engineering, UQ) to investigate the mechanisms controlling coal permeability. Fracture porosity represents the primary permeability regions for gas flow during coal seam gas (CSG) production. However, fracture mineralisation is known to significantly reduce permeability. By utilising state-of-the-art CT technology (Siemens Inveon preclinical CT scanner, located at the Centre for Advanced Imaging, UQ), the extent of fracture connectivity and mineralisation in core coal samples can be determined.

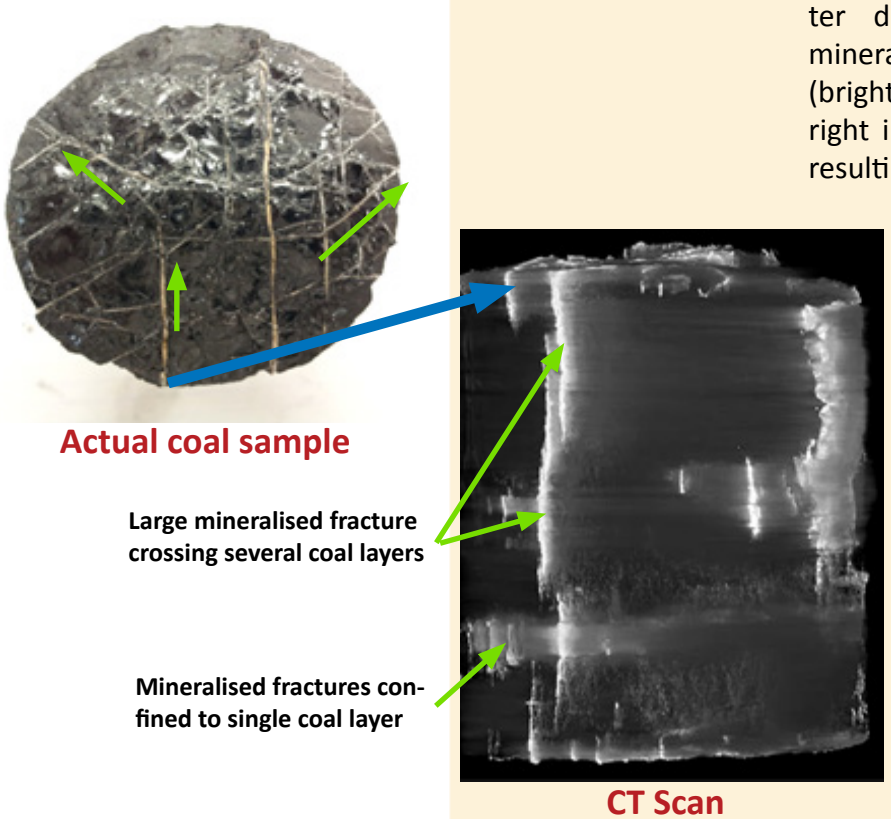


Figure 1: *Actual sample (Top view) and CT scan of coal core sample performed on the NIF instrument (Inveon Preclinical CT, Siemens) (Bottom view, 53 µm resolution, low magnification, bin 2).*

The NIF Informatics Fellow Dr Andrew Janke is using *Mink-toolkit* (software developed at UQ) to calculate the total volume of fractures as well as quantitative assessment of coal mineralisation before and after coal stimulation experiments in order to further elucidate the mechanisms controlling coal permeability.

As shown in Figure 2, the left of the figure is the original data with a dual ended colourmap in order to better demonstrate the mineralised fractures (bright white/red). The right image shows the resulting detected mineralised fractures via intensity thresholding and connected component filtering. This is an ongoing collaborative project. For more details, please contact Dr Karine Mardon at NIF - UQ Node.

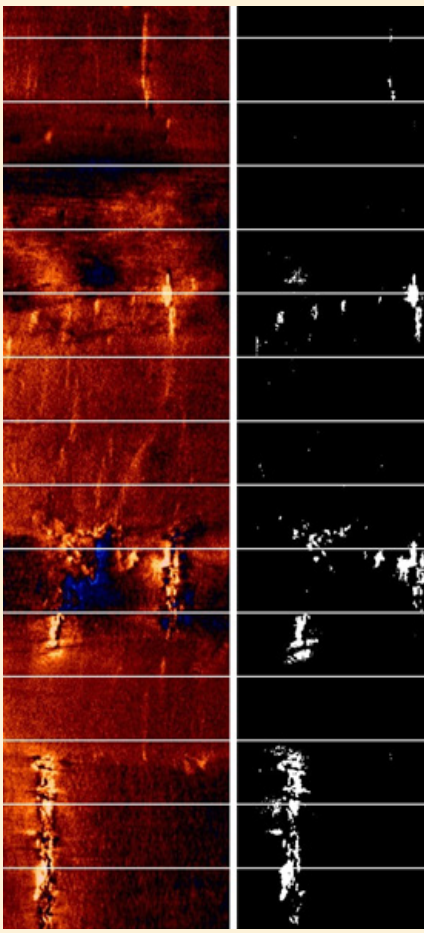


Figure 2

About Dr Karine Mardon:

Dr Karine Mardon received her PhD in Radiopharmacology from University of Paris XII in 1994. With an impressive professional profile in both industry and academia, she has extensive experience in *in vitro* and *in vivo* preclinical research particularly in the development and characterisation of radiopharmaceuticals for SPECT and PET. She has joined NIF - UQ Node in 2010 as an imaging professional for preclinical PET/CT.

NIF Focus Story

UWS Node - Industry Collaboration: MRI Your Grapes

Wine grape production in Australia has increased rapidly over the past 20 years. As reported by the Australian Wine and Grape Industry, Australia produces on average 1.56 million tonnes of wine grapes every year, and has exported $1.99 billion worth of wine to the world in 2011 [1]. With the wine market expecting to grow to $3.2 billion over the next three years [2], comprehensive investigation of grape quality and physiology (such as water content), is therefore of great interest to the wine industry.

By utilising diffusion tensor imaging (DTI) technology, imaging experts at the NIF – University of Western Sydney (UWS) Node have been able to provide detailed images of grape berry morphology, based on the analysis of the random thermal motion of water molecules. DTI is one of the most notable recent developments in the field of nuclear magnetic imaging (MRI) [3]. While DTI has proven to be a powerful tool for studying neural fibre tract networks, applications outside the traditional neurological imaging field have been rarely explored [3].

In a novel partnership between Dr Simon Clarke and Dr Suzy Rogiers of the National Wine & Grape Industry Centre, Charles Sturt University, Mr Ryan Dean at the University of Western Sydney, and the NIF UWS Node, growth and development of wine grapes (*Vitis Vinifera L*) were examined using the Bruker Avance 500 MHz wide-bore NMR spectrometer (11.7T MRI). Grapes with a range of ages from within a month after the grape vines have flowered through to harvest age, were imaged.

Qualitative analysis provided by DTI technology has revealed a strong relationship between the internal morphology of the grape berries and the principle direction of the water diffusion. This relationship remains relatively consistent throughout the growth of grapes. Water molecules diffusing through the elongated parenchyma cells of the berry mesocarp (the flesh of the grape) results in a pattern which roughly radiates from the centre of the berry. In the exocarp (the skin of the grape) water diffuses tangentially to the surface of the fruit due to the flat shape of the epidermal cells. Notably, in very young seeds (berries of an age less than thirty days after flowering), highly anisotropic diffusion occurs through the integument tissue which encases the liquid endosperm.

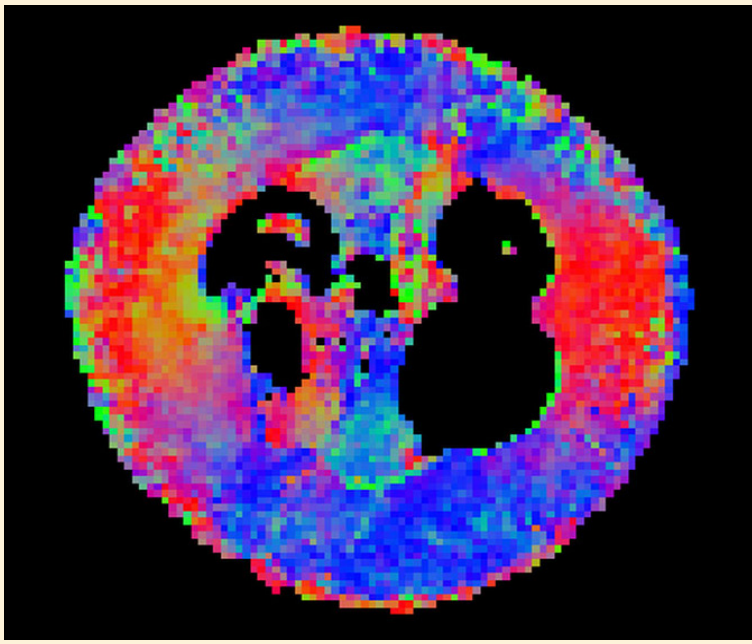


Figure 1: *A diffusion tensor image of a Semillon grape berry aged 41 days after flowering. The image is a transverse section, close to the berry centre. The colours indicate the direction of principle diffusion (red = left-right, blue = up-down, and green = in-out).*

The collective diffusion imaging analysis of grape berries at various development stages provided a solid foundation for future grape plant physiological studies, particularly in relation to grape damage due to excessive water uptake and also mechanical injury.

As noted by Mr Dean – one of the lead researchers for this collaborative project – "The discovery of how the water transport through the integument in very young seeds can help us to understand the formation of seeds in early development stages of grapes. NIF provided us with access and expertise to a powerful

MRI technique, allowing us to take the high resolution diffusion images we required for this project. Without such resolution, we might not have spotted such important details."

The significant findings observed in this study confirmed the broad applicability and capability magnetic resonance imaging technology has to offer.

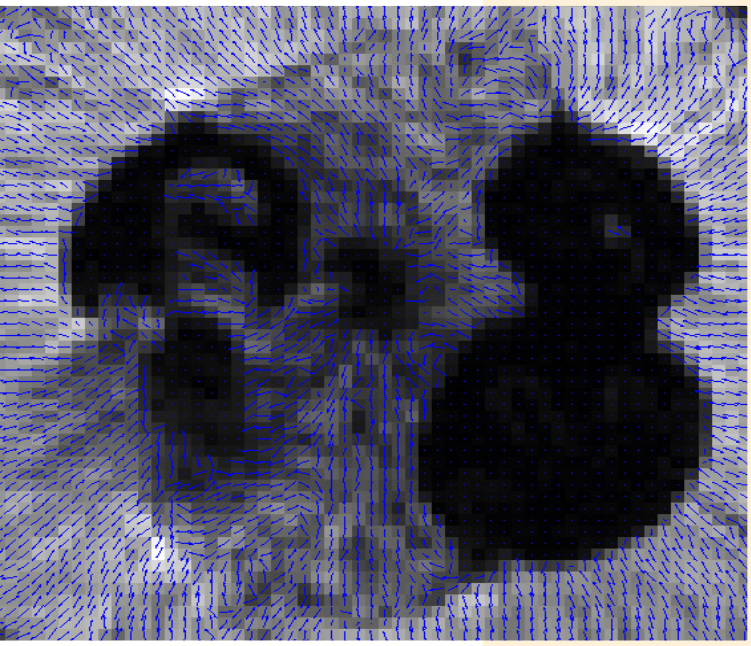


Figure 2: *A diffusion vector map of the Semillon grape berry shown in Figure 1. The vectors indicate the direction of principle diffusion within each individual voxel.*

For more details about the project and imaging enquiries, please contact Dr Tim Stait-Gardner and Prof. Bill Price, at the UWS Node.

[1] Australian Wine Industry Review – 25 May 2012

[2] Australian Bureau of Agricultural and Resource Economics and Sciences - Australian Wine Grape Production Projections 2012-13

[3] Dean, R. J. et al, Diffusion Tensor Imaging (DTI) Studies of the Grape Berry, Diffusion Fundamentals, Experiment and Application, 16 (2011) 29, 1-2.

About UWS Node:

The NIF UWS Node houses the 7 T Small Animal Scanner and 11.7 T MRI scanner at the Hawkesbury and Campbelltown campuses respectively. Provisions exist for conducting imaging of small animals under anaesthesia in a specialised live animal imaging probe with ancillary respiratory monitoring equipment and cardiac gating. In addition to 1H, the node is also able to conduct imaging using heteronuclei such as ^{13}C, ^{19}F, ^{23}Na and ^{31}P.

Directed by Prof. William S. Price, an expert with more than 20 years of experience in the field of nuclear magnetic resonance (NMR), the UWS Node is amongst the best of its kind for NMR diffusion and MRI diffusion experiments. With an impressive research profile in academia and world leading research institutions, Prof. Price is currently the Director of the Biomedical Magnetic Resonance Facility, and also the Chair of Nanotechnology in the School of Science & Health and the School of Medicine at the University of Western Sydney. He leads a research group with 11 PhD students and 2 honours students.

Dr Tim Stait-Gardner is the NIF Facility Fellow at UWS Node. As an expert in MRI and Quantum Physics, Dr Stait-Gardner oversees the external usage of the 11.7 T MRI and 7 T Animal MRI located respectively at UWS's Campbelltown and Hawkesbury campuses. The UWS NIF node is currently engaged in a number of collaborations initiated through NIF ranging from tracking microcapsules in the abdominal cavity of mice through studies comparing lizard brains across closely related species.

For more information about NIF UWS Node and example projects, please visit www.anif.org.au.

Dr Tim Stait-Gardner

NIF Focus Story

Informatics

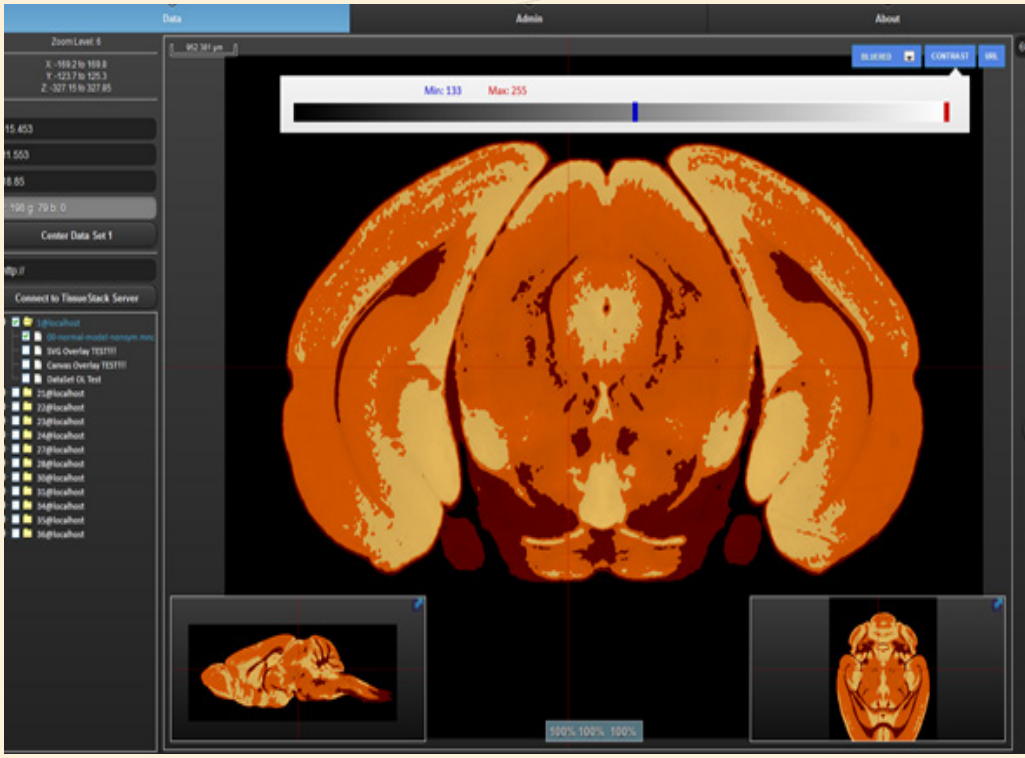
TissueStack is Awesome

In the medical science field, Digital Imaging Processing (DIP) plays an important role in the analysis, interpretation and modification of digital data. It is a rapidly evolving area due to the technological advances in digital imaging, computer processors and mass storage devices [1]. DIP and information extraction from images have become indispensable aspects of experimental workflow in medical science research, particularly in cell biology and neuroscience [2].

Supported by the Australian national Data Service (ANDS), Informatics Fellow Dr Andrew Janke at the NIF - UQ Node and his team have been working on developing TissueStack [3, 4], an integrated web-based digital imaging processing service. The objective of the system is to automate direct data tiling and display of images in real world coordinates.

Special features include:

1. Interactive combination (or adjacent) display of multi-scale MRI, histology, nomenclature data and corresponding project metadata;
2. Display common co-ordinate system between two datasets;
3. An interface that links additional anatomy metadata such as lobe and structure names to the imaging data that is being presented, allowing linkage of labeled data and structure names to specific co-ordinates or areas;
4. A plugin architecture such that future modules for additional reference data can be added. This mechanism allows external or future developers to implement and add new functionality;
5. Easy download/installation/configuration on a standard architecture by a relatively competent user for use at local sites;
6. Allows for data display from multiple sources – a single TissueStack client can connect to multiple servers;
7. Simple external query interface that allows other applications and researchers to integrate the data in the application to their own systems.



The TissueStack system is available at: http://tissuestack.com/desktop.html

[1] Seemann, T., Digital Image Processing using Local Segmentation, 2002, Doctor of Philosophy, Monash University, Australia.

[2] Swedlow, J. R., and Eliceiri, K. W., Open source bioimaging informatics for cell biology, Trends Cell Biology, 2009, 19, 656-660.

[3] http://tissuestack.com/desktop.html

[4] http://tissuestack.blogspot.com.au

This project is supported by the Australian National Data Service (ANDS). ANDS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy Program and the Education Investment Fund (EIF) Super Science Initiative.

Characterisation Virtual Laboratory (CVL)

The developed TissueStack system will also form part of the Neuroimaging application of the Characterisation Virtual Laboratory – an orchestration of specialised image interrogation technologies, data storage facilities, and specialised data processing engines. The CVL is currently being developed to compliment the powerful imaging technologies and expertise provided by the Australian National Characterisation Council – including powerful microscopes at the Australian Microscopy and Microanalysis Research Facility (AMMRF), high-resolution imaging equipment at the National Imaging Facility (NIF), unique nuclear capabilities at the Australian nuclear Science & Technology Organisation (ANSTO), and rapid acquisition X-ray imaging at the Australian Synchrotron (AS).

The Characterisation Virtual Laboratory will:

1. Integrate Australia's imaging equipment with specialised High Performance Computing capabilities provided by MASSIVE (Multi-modal Australian ScienceS Imaging and Visualisation Environment) and NCI (National Computational Infrastructure) and with data collections provided by RDSI nodes;

2. Provide scientists with a common environment for analysis and collaboration, the Characterisation VL Desktop;

A mockup of the Neuroimaging Workbench

3. Produce three exemplar platforms for multi-modal or large-scale imaging in:
   - **Neuroimaging** – University of Queensland
   - **Structural Biology** – Monash University
   - **Energy Materials** – Australian National University, University of Sydney

Each of the research applications ('Drivers') is being led by a world-class research group. It is supported by an Australian research consortium and is in a national research priority area. The results of this development will be distributed to a community through CVL 'Workbenches' – specialised configurations of the CVL Desktops that gather a collection of tools which are essential to the community, and address the specific integration challenges for multi-modal and multi-scale imaging.

For more information about TissueStack and CVL, please contact Dr Andrew Janke, UQ Node Informatics Fellow.

About Dr Andrew Janke:

Dr Andrew Janke is the Facility Fellow for Informatics at the Queensland Node of NIF. He has a background in MRI image analysis via supercomputing and MRI imaging research. His current research interests and responsibilities include: Integration of the NIF with the ANDS, (Australian National Data Service), Databasing and atlasing of large cohorts (n = 10,000+), Distributed HPC in neuro-informatics, Normative human brain ageing and Automated analysis and quality control in neuro-informatics.

Do you have news?!

Published a paper? Formed new collaborations? Discovered something? Any updates from your Node — we need to know!

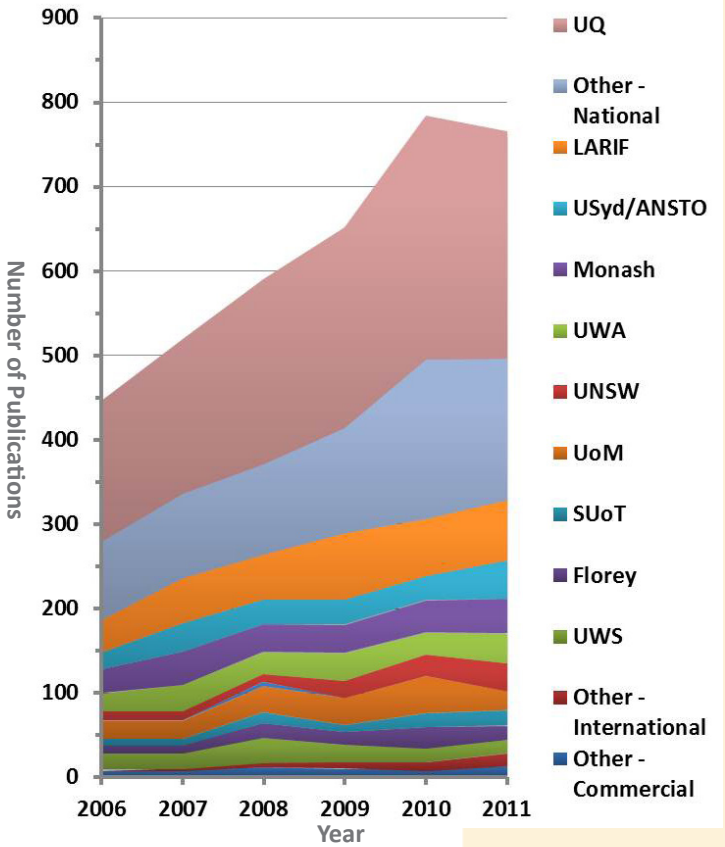
Email: communications@anif.org.au
Or: a.chen1@uq.edu.au

NIF Updates

NIF Nodes Publications

As an integrated imaging facility that is one of only a handful in the world, NIF has provided expertise and access to some of the world's best imaging capability for the Australian research community. Together as a collaborative team, the hardwork and accomplishments of NIF and our users have not gone unoticed. One of the key indicators of NIF's success is the growth of publications. As shown by the recent investigation conducted by *Raven Consulting Group*, the below diagram summarises how total publications from the researchers making use of NIF infrastructure has grown since NIF was established. The data (representing the origin of the user, not the node they accessed) shows that over the whole analysis period (2006 – 2011), research publication output has doubled with an approximate 10% per annum increase every year.

Well done to NIF! For more info on the investigation conducted by Raven Consulting Group, please contact communications@anif.org.au.



Subsidised Access

The NIF Subsidised Access funding scheme aims to provid research support and expertise to researchers, to assist in achieving critical data to solve scientific problems of significance.

In the most recent round (Round 19), NIF has awarded four projects, totalling **$11,428**.

- **Dr Blake Cochran (University of New South Wales)** - *Determining the impact of apoliprotein A-I on glucose biodistribution in the db/db mouse model of type-2 diabetes.*
- **Dr Roger Bourne (University of Sydney)** - *Diffusion decay in the prostate in vivo.*
- **Mr Sean Hattton (University of Sydney)** - *An animal model of post-traumatic stress order: Is grey matter loss in patients explained by dentritic atrophy?*
- **Dr Richard Thomson (Monash University) -** *Using MR-based measures of functional connectivity to study the brain effects of transcranial magnetic stimulation.*

NIF is looking forward to continue to support the Australian research community. The next round of NIF Subsidised Access will close 29th April, 2013. For application details, please go to: *www.anif.org.au/access/access-pricing/access-subsidy.html*.

NIF is pleased to sponsor the one-day workshop on Neuroimaging data analysis with a critical emphasis on methods, which will be hosted by NeuRA and NIF - University of New South Wales Node. The workshop is open to all researchers with an interest in neuroimaging and will aim to cover the main statistical methods and their pitfalls in the field.

To register, please go to: *www.sna.neura.edu.au*.

Neuroscience Research Australia
Discover. Conquer. Cure.

Centre for Advanced Imaging - a prestige landmark imaging facility that is part of the NIF Strategic Roadmap of Australian Research Infrastructure.

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

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