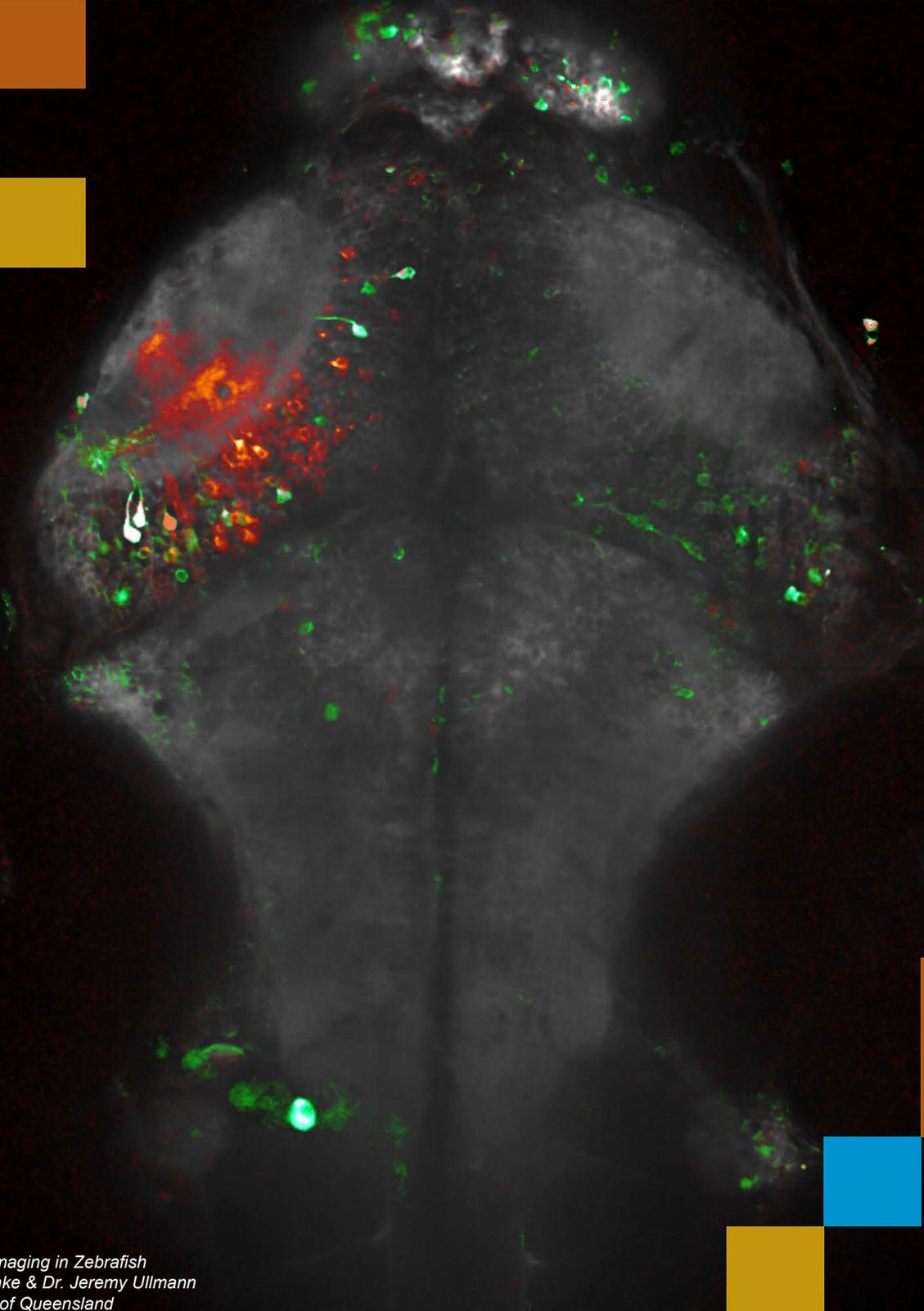


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National Imaging Facility Quarterly Newsletter Q4, 2015



Calcium gated imaging in Zebrafish
- Dr. Andrew Janke & Dr. Jeremy Ullmann
- The University of Queensland

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DIRECTOR'S MESSAGE



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Innovation, innovation, innovation! Unless you have been hiding under a very big rock, which I know you haven't, this is a word with which you have become increasingly familiar. And for research infrastructure, we cannot ignore the demand to promote change. As we end 2015, NIF welcomes a new Scientific and Engagement Manager, and Saba brings fresh ideas, as you can see in the format of this newsletter. The old wasn't wrong, but I want to exhort all of you to be open to change, and ready for new challenges, whilst maintaining our passion for discovery science.

I am sure we all see our research as innovative, but a bit like translation, we probably all have a different idea as to what innovation means. Innovation, like translation, embraces developing our research to be relevant to the end-user.

What does that mean for infrastructure? We need to engage with the wider research community, and support all researchers, as they migrate across boundaries of academia, health provision and industry. Our newsletters abound with examples of NIF doing that, and this newsletter is no different. From better methods of identifying epilepsy,

or demonstrating the benefits of nutrition on mood and cognition, to optimizing desalination plants, researchers are using NIF facilities at the interface with industry. As researchers consider how imaging can help them understand lung disease or augment conventional autopsy, NIF Facility Fellows are working alongside end-users to change the way they work. And our Informatics Fellows are building new analysis tools and sharing model datasets, to support innovative research across domains. NIF is getting out into the research community at events like eResearch Australasia, or through our international partnership through Global BiImaging, looking for more opportunities to engage. I hope that you enjoy reading about these great projects, and we look forward to sharing your project in the future.

While 2015 started with the challenge of uncertainty, it closes with a vision for the future. As we consider the opportunities for 2016 and beyond, I wish you all a very joyous Christmas and a Happy New Year. I trust it is a safe one, and a time of relaxation and renewal, in preparation for an exciting year in research.

Professor Graham Galloway
Director of Operations



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EU Horizon 2020-Funded Global BiImaging Project

INTERNATIONAL
COLLABORATION

On December 1st 2015, the EU Horizon 2020-funded Global BiImaging (GBI) project was kicked off. The EU Horizon 2020, which is the biggest EU research and innovation programme, aims to achieve economic growth with its emphasis on excellent science, industrial leadership and tackling societal challenges.

National Imaging Facility (NIF) and Australian Microscopy & Microanalysis Research Facility (AMMRF) are excited to announce their inclusion in GBI project and look forward to exchanging knowledge and experience with Euro-BiImaging and their international collaboration partners.

The GBI project is built on three existing collaboration agreements for successful operation of imaging infrastructures, which Euro BiImaging has signed with the two NCRIS supported projects, AMMRF and NIF and with India-BiImaging.

The GBI alliance reflects the current revolution in imaging technologies

that supports biomedical science from visualization of molecules inside cells through to imaging processes occurring in the whole animal. GBI will work to facilitate access to a global network of these imaging platforms; enable exchange of experience in technology development; explore standardisation of access protocols, data formats and processing protocols. Such standardisation, together with the sharing of data, will facilitate transglobal collaborative discovery projects with translation to multi-centre clinical trials.

GBI will also enable the identification and sharing of best practice in facility operation and management, new open access data analysis tools and properly curated image storage systems. Other proposed activities include joint international training and exchange programmes for building staff expertise and the further development of MyScope™, AMMRF's online training tool.

Through this interconnected collaborating infrastructure,

Australian researchers will have the opportunity to engage with multi-lateral, international biomedical microscopy and imaging facilities.

GBI will establish the foundation for a long-term alliance for mutual benefit between Euro-BiImaging and its international partners with the aim of providing sustainable services in imaging technologies to the international scientific community. Improved international connections will also be able to support Australian industry and the Australian Government's Innovation Agenda.

The AMMRF's CEO, Dr Miles Apperley, will represent the Australian partners on the GBI management board as they create the global network of state-of-the-art research infrastructure in imaging.

The Global BiImaging Project relates to the Horizon 2020 topic INFRASUPP-6-2014 – international cooperation for research.



ABOUT EURO-BIOIMAGING

Euro-BiImaging (EuBI) is a large-scale pan-European research infrastructure project on the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap. Preparatory Phase of the project lasted from Dec 2010 to May 2014 and was funded by the EC. Euro-BiImaging is now in the interim phase, with representatives of 14 countries and European Molecular Biology Laboratory (EMBL) as international organisation working together towards the implementation of the infrastructure and governing Euro-BiImaging development through Euro-BiImaging Interim Board. The infrastructure is supported by the national imaging communities of 25 European countries and by the official Euro-BiImaging Industry Board.

Recently, the EuBI Interim Board approved the proposal of a tripartite coordinating Hub - hosted by Finland (Turku BiImaging at Åbo Akademi University and University of Turku), Italy (University of Torino) and the European Molecular Biology Laboratory (EMBL Heidelberg) - and ratified the nomination of 28 imaging facilities as candidates to become the first generation of EuBI Nodes. These 28 imaging facilities are located in 10 European countries and the EMBL, and offer a powerful portfolio of 36 different state-of-the-art technologies in the fields of biological and medical imaging. For more information, please visit:

www.eurobioimaging.eu



Abnormal brain areas common to the focal epilepsies

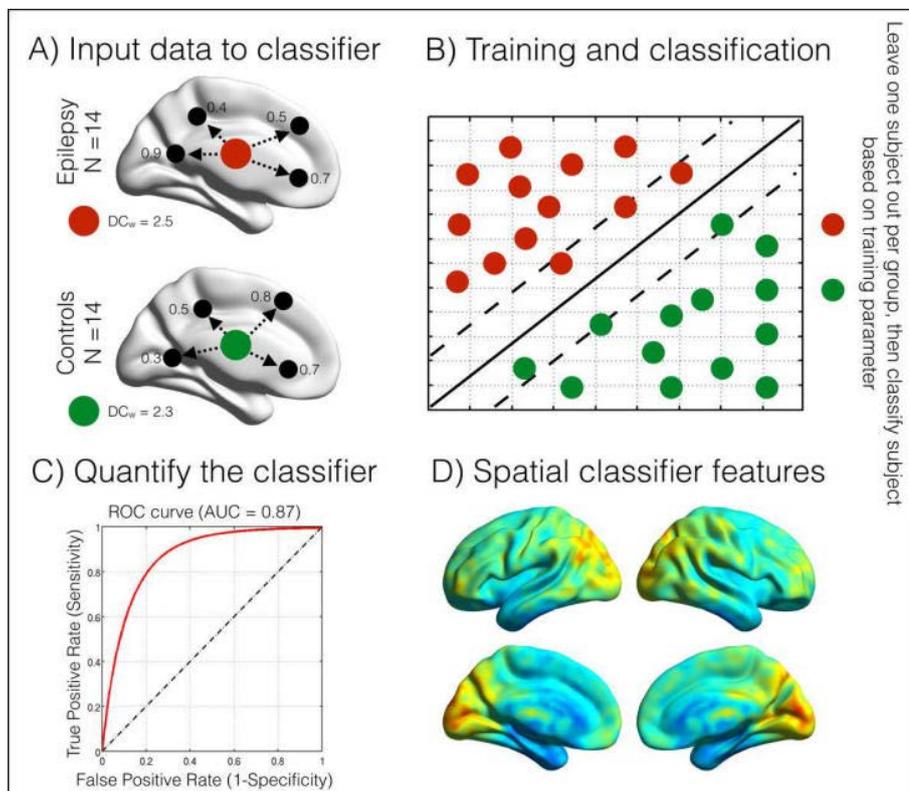
A group of scientists at Florey Institute may soon be able to diagnose a common form of epilepsy after a simple 10-minute brain scan. The result? Patients will commence immediate treatment and minimize the risk of further damage caused by seizures.

New research published in Brain Connectivity shows that people with focal epilepsy seemingly share characteristic brain network connectivity in three precise regions of the brain, even though the seizure site is in heterogeneous brain regions.

People with focal epilepsy, including all the patients in this new study, have slower psychomotor reflexes, and neuropsychological symptoms such as depression and working memory deficiencies.

About one per cent of the population will develop epilepsy at some point in their lifetimes, with childhood and old age being more vulnerable periods. Over half of all diagnosed epilepsies are focal in nature, arising in specific brain regions.

Mangor Pedersen, together with a team led by Professor Graeme Jackson at the Florey node of National Imaging Facility (NIF), used functional Magnetic Resonance Imaging (fMRI) scans obtained on a 3T Siemens Trio located at the Melbourne Brain Centre, Austin Hospital campus. The analysis techniques used in this study may be used to target MR biomarker data allowing patients to be classified as having focal epilepsy, versus other types of epilepsy.



An overview of the MVPA process. A) An example DC_w for a single node (red/green). B) Data is trained to search for discriminative spatial patterns between groups, while one subject per group is left out. The left-out subject is subsequently classified based on the obtained training parameters. C) The classifier performance is quantified using ROC curve analysis. D) Voxel-wise output maps relative to the importance of the classifier are obtained.

The team scanned brains of 14 people with focal epilepsy, and compared them to 14 age- and sex-matched people without the disease. The group then used two connectivity measures - a local network between one voxel and the 27 surrounding voxels (about one cubic centimeter of brain), and a more distributed network from each single voxel connected to all the other voxels in the brain - to show abnormal connectivity in three brain regions of people with focal epilepsy.

The three common brain areas in people with focal epilepsy were both shallow & deep brain regions

in the temporal lobe (just in front of and above the ear) and the prefrontal cortex (at the front of the head in between the eyes). What amazed the researchers was that passing the connectivity results through a multivariate pattern analysis (a “machine learning algorithm”) differentiated healthy people from those with focal epilepsy with almost 90 per cent accuracy.

Mangor said of the work, “Focal epilepsy is a disease where seizures originate from different areas of the brain. In this study we tested whether patients had any brain markers in common.



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RESEARCH
ACTIVITIES

We used network connectivity and pattern analysis to classify brain patterns at a single subject level. We hope that this work is a preliminary step towards using

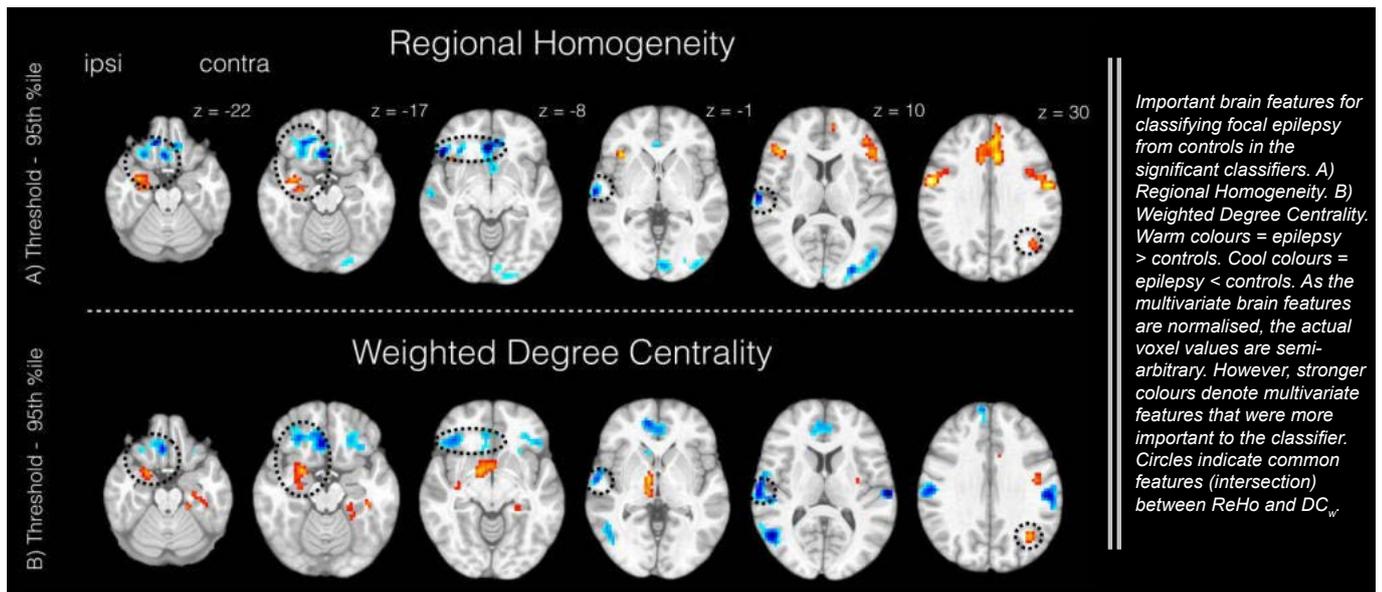
network analysis from functional imaging and pattern analysis to detect focal epilepsy biomarkers.”

The work is the culmination of three years’ hard work as part of Mangor’s Ph.D research. However, he is not content to leave it there, saying “we now need to shore up these findings firstly by scanning more patients.” Other future experiments are to scan people with co-morbidities, like depression, but not focal epilepsy. This will help assess the reliability of the clinical fMRI classification.

Collaborators

Mangor Pedersen, Evan K. Curwood, David N. Vaughan, Amir H. Omidvarnia, and Graeme D. Jackson.

- The Florey Institute of Neuroscience and Mental Health, Austin Campus, Melbourne, VIC, Australia.
- The University of Melbourne, Florey Department of Neuroscience and Mental Health, Melbourne, VIC, Australia.
- Department of Neurology, Austin Health, Melbourne, VIC, Australia.



Cancer Research

Lung Cancer is a lethal adult cancer accounting for the most cancer-related deaths worldwide. The most common form, non-small cell lung carcinoma (NSCLC), represents more than 80% of all cases. Advanced NSCLC is poorly responsive to therapy and the mechanisms responsible for its resistance and aggressive behaviour are not well defined¹.

A study, collaborated by Children’s cancer institute and the University of New South Wales Australia, revealed how bIII-tubulin influences tumor growth in NSCLC, defining new biologic functions and mechanism of action of bIII-tubulin in tumorigenesis.

The study used micro-CT scanning

to monitor the presence of lung tumors in mouse models. The micro-CT data were acquired using the Inveon system (Siemens) and tumor margins were identified by contrast thresholding, which allowed the tumor margins (soft tissue density) to be defined against the surrounding lung (air density).

The results showed for the first time that stable suppression of bIII-tubulin in NSCLC cells alters the expression of key proteins involved in regulating tumorigenic and metastatic potential, alters cell morphology, increases anoikis sensitivity, and modulates PTEN/AKT signaling. It was also demonstrated that knockdown of bIII-tubulin in NSCLC cells

decreases the incidence and growth of lung tumors in two different preclinical mouse models.

Collaborators

Joshua A. McCarroll, Pei Pei Gan, Rafael B. Erlich, Marjorie Liu, Tanya Dwarte, Sharon S. Sagnella, Mia C. Akerfeldt, Lu Yang, Amelia L. Parker, Melissa H. Chang, Michael S. Shum, Frances L. Byrne, and Maria Kavallaris.

- Children’s Cancer Institute, Lowy Cancer Research Centre, Randwick, University of New South Wales, Australia.
- ARC Centre of Excellence in Convergent Bio-Nano Science and Technology, Australian Centre for NanoMedicine, University of New South Wales, Australia.

1. McCarroll, Joshua A., et al. “TUBB3/βIII-Tubulin Acts through the PTEN/AKT Signaling Axis to Promote Tumorigenesis and Anoikis Resistance in Non–Small Cell Lung Cancer.” *Cancer research* 75.2 (2015): 415-425.

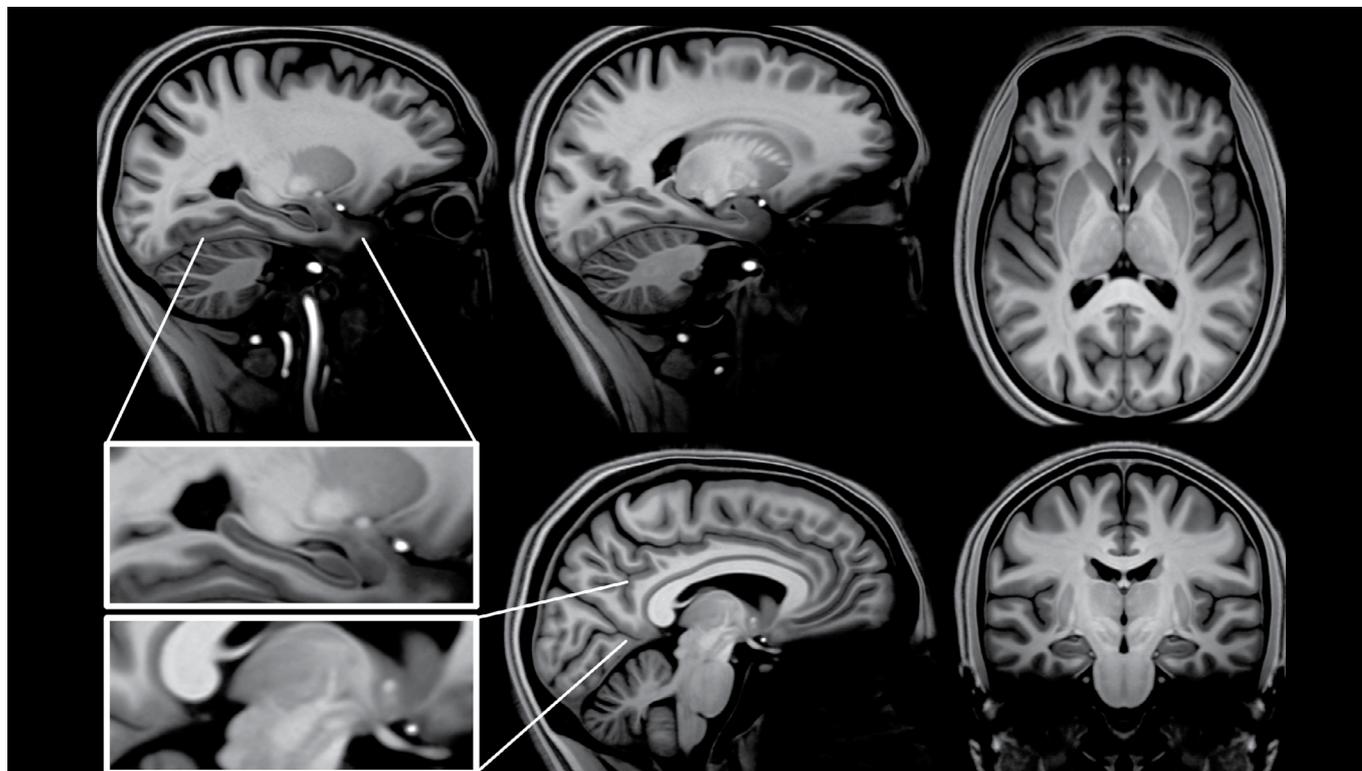


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Resolution for a Better Health

A 7T Human Brain Microstructure Atlas by Minimum Deformation Averaging at 300 μ m

RESEARCH
ACTIVITIES



Atlases of the human brain have an important impact on neuroscience. The emergence of ever more sophisticated imaging techniques, brain mapping methods and analytical strategies has the potential to revolutionize the concept of the brain atlas. Atlases can now combine data describing multiple aspects of brain structure or function at different scales from different subjects, yielding a truly integrative and comprehensive description of this organ¹. Such description will be fundamental in helping us understand the brain bases of many disorders.

Digital MRI atlases serve to integrate data from differing modalities, stereotactic localisation, automated region identification, automated segmentation and direct comparisons between individuals². While paper atlases can provide exquisite detail of delineated structures, they are typically based upon an individual subject's histology and as such make it difficult to identify structures in novel subjects in an automated fashion.

Recently, at The University of Queensland, the most highly detailed atlas of human cortical mid-brain was generated through a minimum deformation average (MDA) from a population of subjects based upon the high resolution 7T MR imaging. The modelling process presented in this study demonstrated high level of details and resolution, which can lead to more precise stereotaxic surgery, targeting regions deep within the intact brain for diseases such as Parkinson.

Collaborators

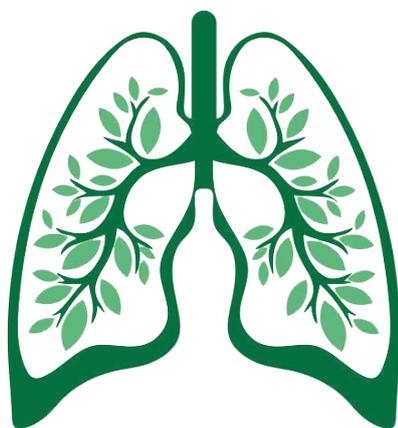
Andrew L Janke, Kieran O'Brian, Steffen Bollmann, Tobias Kober, and Markus Barth

- Centre for Advanced Imaging, University of Queensland, Brisbane, Australia.
- Siemens Healthcare Pty Ltd, Brisbane, Australia.
- Advanced Clinical Imaging Technology, Siemens Healthcare AG, Lausanne, Switzerland

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2. Evans AC, Janke AL, Collins DL, Baillet S. Brain templates and atlases. *Neuroimage* 2012

- Lung Health Awareness Month - "Research Imaging Snapshot" Symposium

NEWS



Foundation Australia.

November this year, which was the Lung Health Awareness Month, National Imaging Facility*, along with many other organizations, participated in the raising awareness campaign initiated by Lung

Every year, 1 in 7 Australians die because of lung diseases such as Chronic Obstructive Pulmonary Disease (COPD), asthma, bronchiectasis, lung cancer, influenza, and pneumonia. 14% of all deaths in Australia are caused by lung diseases, which remain undiagnosed as people ignore or are not aware of their symptoms such as breathlessness and productive cough¹.

In 2008, for the first time in Australia, a group of scientists at National Imaging Facility investigated and confirmed the feasibility of functional Magnetic Resonance Imaging (fMRI) of the lung using hyperpolarised helium, which was transported from Germany due to limited availability outside of North America and Europe, and demonstrated an innovative technology that can be translated into routine clinical applications.

Examples of applications that can benefit from this technology include early detection and investigation of airway diseases such as Asthma or COPD, early detection of obliterative bronchiolitis after lung transplantation, and further research into innovative functional lung imaging techniques².

**National Imaging Facility enables and encourages collaborative studies and projects that impact the detection and potential treatment of lung diseases by making state-of-the-art imaging technologies more widely available than ever before, as well as, sharing expertise which results in far more effective use of the available resources.*

The "Research Imaging Snapshot" Symposium was held on 11th November this year in the Auditorium at South Australian Health & Medical Research Institute (SAHMRI) and featured a number of internal and external speakers.

This workshop featured scientific presentations about imaging-related research in Adelaide, within SAHMRI but also at Adelaide University, SA Health and Forensic Science SA. The workshop, which was free of charge for participants and was sponsored by BRUKER and SAHMRI Research Services, aimed to share scientific advances in the field, highlight imaging opportunities and present research outcomes.

The workshop covered a range of topics in small and large animal imaging, forensic MR and CT imaging, molecular imaging techniques (PET, SPECT and optical imaging), phenotyping, oncology and fetal cardiac research. Other imaging techniques like DEXA, maldi or confocal spectroscopy were also covered. Dr Tim Kuchel, Dr Marianne Keller and Raj Perumal gave an overview of the new SAHMRI North Terrace preclinical imaging facility and research activities at the SA node of the National Imaging Facility.



Dr. Tim Kuchel - SAHMRI Node



It was well attended and Marianne was congratulated for organising a very successful inaugural imaging symposium. SAHMRI looks forward to organising this workshop annually to promote imaging research and foster research development and collaboration.

1. <http://lungfoundation.com.au/patient-support/living-with-a-lung-condition/statistics/>
2. Thien, Francis, et al. "Feasibility of functional magnetic resonance lung imaging in Australia with long distance transport of hyperpolarized helium from Germany." *Respirology* 13.4 (2008): 599-602.



News

- eResearch Australasia 2015

The growing use of information technology and high speed networks within the research community has led to the creation of the term “eResearch”, which is the use of distributed computing resources to provide researchers with access to very large data collections, unique scientific facilities (such as imaging technologies provided by National Imaging Facility), high performance analysis, and modelling & visualization of data.

National Imaging Facility exhibited at eResearch Australasia 2015, which was held at the Brisbane Convention & Exhibition Centre, October 19 - 23, to share their vision and achievements on technological platforms and methods that enhance researchers’ ability to collect, share, analyse, store, and retrieve information.

National Imaging Facility is actively involved in working on strategies that deliver integrated eResearch and works closely with the national eResearch capabilities such as National eResearch Collaboration Tools and Resources (Nectar), Australian National Data Service (ands), and QRIScloud on data curation, repository, and analysis.



National Imaging Facility

Working with National eResearch Capabilities

- Data Curation
- Data Repository
- Data Analysis

Exploring Inner Space

CVL Characterisation Virtual Laboratory

nectar

ands

QRIScloud

NCRIS National Research Infrastructure for Australia An Australian Government Initiative

www.anif.org.au

NEWS



Determining Cause of Death

The Coronial autopsy – post-mortem examinations performed for the Coroner at his or her direction, are considered to have a special purpose for determination of cause of death and documentation of findings that may have forensic significance for determination of manner of death and use in court if required. Written reference to the autopsy, which is a medical examination, appears in the 12th century, although human dissection for scientific purposes precedes this. Post-mortem examination for investigation of unexplained death dates back to pope Innocentius III in the 13th century.

In a collaborative project, carried out by Forensic Science SA and South Australian Health & Medical Research Institute (one of the

National Imaging Facility nodes), a review of 97 cases was performed to predict the cause of death using full body Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) facilities available at Preclinical Imaging and Research Laboratories (PIRL). Full body CT was performed for all cases with MRI of the head in 59, neck in 54, chest in 56, abdomen in 10 and lower limbs in 2. The cause of death could be predicted from the scan findings in 36% of the cases. This rate might seem low, but it is a good rate compared to other studies in the literature. In the future it is hoped that surface render images may be used in court to show the position of injuries without having to show autopsy photographs and 3-D printed models could be used to demonstrate body injuries in cases of head trauma.

Collaborators

Neil Langlois: Forensic Science SA, South Australia
Tim Kuchel and Raj Perumal: South Australian Health & Medical Research Institute, Australia

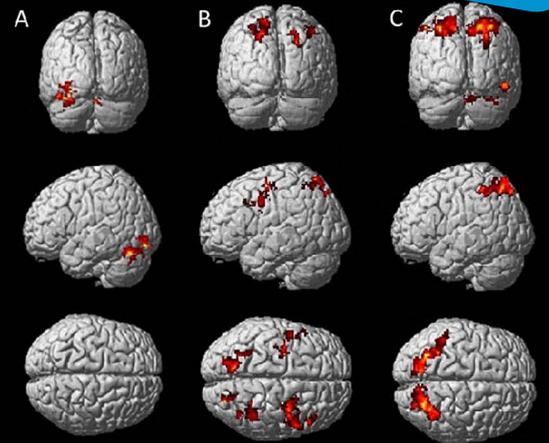
Project Contact: Neil Langlois
E: neil.langlois@sa.gov.au



Effects of Good Nutrition

Insufficient vitamin intake can impair several aspects of cognitive functions and mood. Research studies have shown that multivitamin supplementations can reduce scores on depression, anxiety and stress. In particular, the dietary status of certain B vitamins (e.g., folate, vitamins B6 and B12) has proven to have a key role in a host of physiological processes critical to human health. They have been positively associated with aspects of cognition, such as information processing, recall and verbal ability¹.

A project was conducted to explore the acute effects of different multi-vitamin preparation with and without guaraná on mood, cognitive performance and brain activation in healthy young adults. The project, which was funded by Bayer healthcare and used the facilities provided by National Imaging Facility, showed that multivitamins with guaraná improve performance of a working memory/attentional task that may be attributable to the activation of working memory/attentional networks as revealed by Functional Magnetic Resonance Imaging (fMRI). This was the first fMRI experiment demonstrating that a multivitamin supplementation with and without guaraná impacts both neural activity and cognition².



Views of brain surfaces showing activation during the Rapid Visual Information Processing task for (A): multivitamins without guaraná over placebo, (B) multivitamins with guaraná over placebo, and (C) multivitamins with guaraná over multivitamins without guaraná.

Collaborators

Centre for Human Psychopharmacology, Swinburne University of Technology, Melbourne, Australia
Bayer Consumer Care Ltd., Basel 4002, Switzerland

Project Contact: Andrew Scholey
E: andrew@scholeylab.com

1. White, David J., et al. "Effects of Four-Week Supplementation with a Multi-Vitamin/Mineral Preparation on Mood and Blood Biomarkers in Young Adults: A Randomised, Double-Blind, Placebo-Controlled Trial." *Nutrients* 7.11 (2015).
2. Scholey, Andrew, et al. "Acute effects of different multivitamin mineral preparations with and without Guarana on mood, cognitive performance and functional brain activation." *Nutrients* 5.9 (2013): 3589-3604.

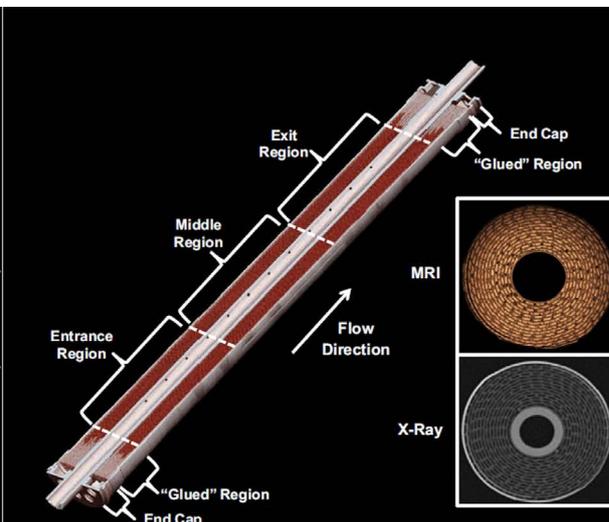


NIF Stories

- Magnetic Fields to Strengthen the Field of Desalination (UWA Node)

Highly populated areas and arid zones around the world suffer from vulnerability to freshwater availability. It has been projected (in 2013) by the Food and Agricultural Organization of the United Nations¹ that by 2025 there will be 1.8 billion people living in countries or regions with absolute water scarcity, and two-thirds of the world population could be under water stress conditions². Hence, developing a technology, such as using membranes to desalinate, that can reduce the overall cost of desalination has paramount importance and is the modern interest and focus of the industry.

Professor Michael Johns and his team at the university of Western Australia use imaging methods for a suit of industrial processes/systems including desalination membranes. They rely on National Imaging Facility (NIF) high field 9.4 T (400 MHz) MRI scanner located in Centre for Microscopy, Characterization and Analysis at Perkins to complete high-resolution MRI experiments on reverse osmosis membrane systems (ROMS), which are used in industrial desalination plants. Identifying and optimizing when ROMS require cleaning or replacement can significantly improve plant efficiency and reduce operational costs. The team is now working toward a low cost NMR-based mobile technology solution for early detection.



CT scan of the reverse osmosis (RO) membrane module, with the location of the entrance, middle and exit regions shown. Insert pictures shows examples of high field MRI and X-ray images obtained. CT scan parameters: 120kV/500mAs, 0.5mm resolution. MRI parameters: slice thickness 1mm, 1024x1024 pixels, field of view 60 mmx60 mm, in-plane resolution 59 µmx59 µm.

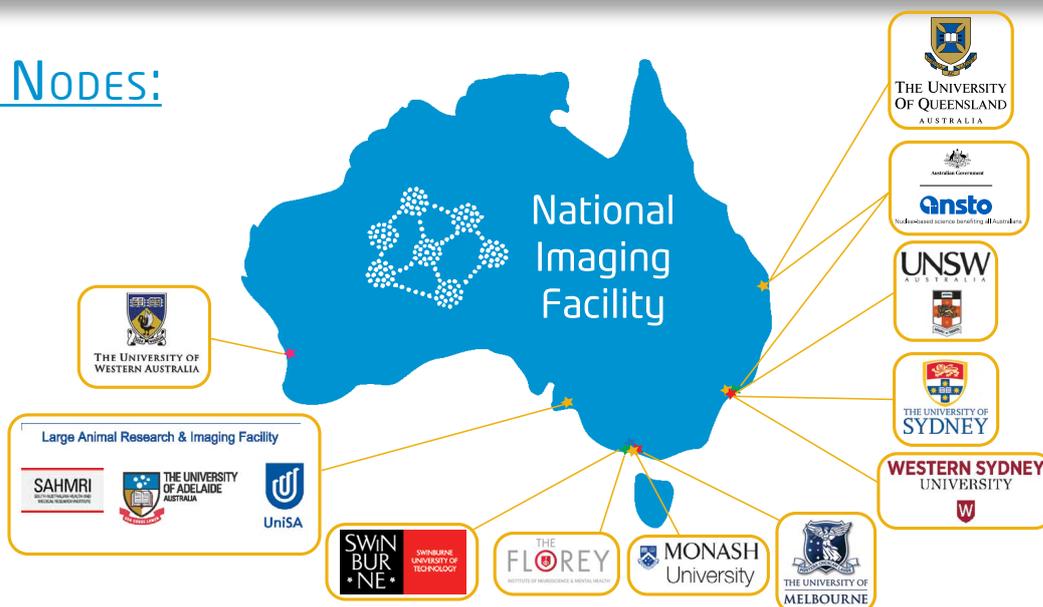
INDUSTRY PROJECTS

Collaborators

E.O. Fridjonsson, S.J.Vogt, and M.L.Johns: School of Mechanical and Chemical Engineering, The University of Western Australia, Australia

J.S.Vrouwenvelder: Wetsus, European Centre of Excellence for Sustainable Water Technology, The Netherlands Department of Biotechnology, Faculty of Applied Sciences, Delft University of Technology, The Netherlands Biological and Environmental Sciences and Engineering Division, Water Desalination and Reuse Center, King Abdullah University of Science and Technology, Saudi Arabia

NIF NODES:



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2. Fridjonsson, E. O., et al. "Early non-destructive biofouling detection in spiral wound RO membranes using a mobile earth's field NMR." Journal of Membrane Science 489 (2015): 227-236



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