www.cai.centre.uq.edu.au

The University Of Queensland
AUSTRALIA

Research Training Guide

Centre for Advanced Imaging

Be at the forefront of cutting-edge imaging research

Welcome to the Centre for Advanced Imaging, St Lucia

The Centre for Advanced Imaging (CAI) is a strategic initiative of The University of Queensland and reflects the growth in biotechnology and biomedical research requiring spectroscopic and imaging research capabilities.

CAI is an integrated research facility harnessing the spatial resolution of ultra-high-field magnetic resonance imaging (MRI), and the sensitivity of positron emission tomography (PET) in detecting molecular targets and the geometrical and electronic structural characterisation of molecules, using high-resolution nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) spectroscopy. CAI researchers work on innovations in spectroscopic and imaging technology, imaging biomarker development and in biomedical research disciplines. They often work in collaboration with clinical research sites and other local, national, and international research institutes and companies.

Areas of Research

Comparative Oncology

Imaging Technology Development and Engineering

Molecular Imaging

Biomedical Imaging

Material Science and Imaging

Data Processing and Computational Analysis

Structural Biology and Chemistry

Programs and Areas of Research

The Centre has a vibrant and diverse student population, with students from over twenty different countries around the world. The Student Association (STAC) organises social and networking events, educational seminars and participates in the Anuual CAI Symposium. Through STAC, the Centre provides a supportive and cohesive environment for students as they progress throughout their research programs and develop into early career.

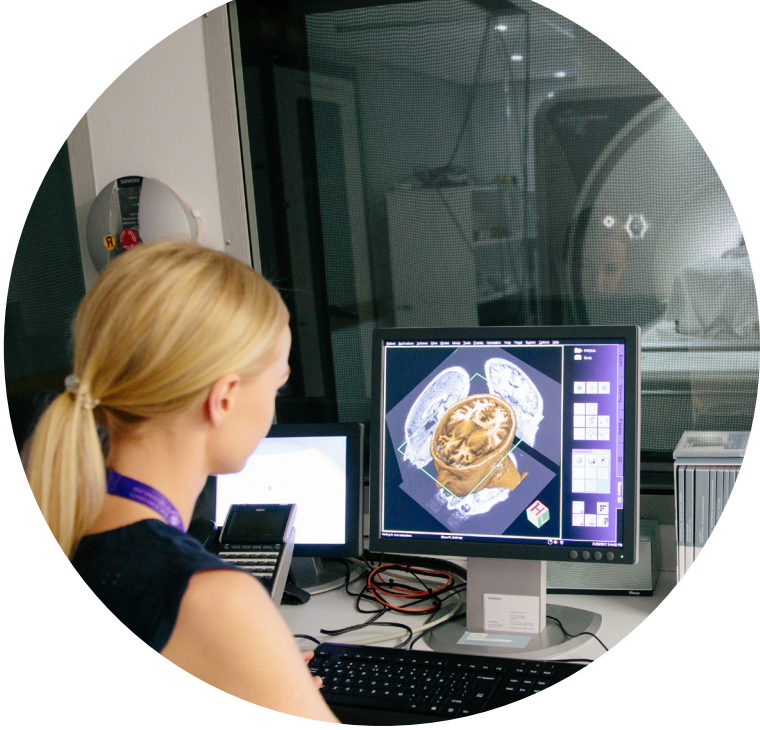
CAI offers research training through Honours Programs, Research Masters (MPhil) and PhD Programs. Research at CAI is broadly divided into three strategic research themes. There is natural synergy between the themes and CAI research projects commonly span two or more research themes, highlighting the interdisciplinary nature of research at the Centre.

Program Options		
Undergradute Research	Winter Research Program Summer Research Program Honours Research Program	4 - 6 weeks 6 - 10 weeks 1 year full-time
Postgraduate Research	Coursework Masters Research Master of Philosopy (MPhil)	4 or 6 units 1.5 - 2 years full-time
Higher Degree by Research (HDR)	Doctor of Philisopy (PhD)	3 years full-time

Our Research Themes

Advanced Imaging, Diagnostic & Spectroscopic Technologies

- Magnetic Resonance Methods, Applications, Measurement and Translation
- Systems Biology, Metabolomics and Megavariate Data Methods
- EPR imaging of free radicals in biology
- Ultra-low field MR
- Nanomedicine: development of multimodal molecular imaging probes for theranostics
- Simultaneous PET-MRI
- Ultra-high field MR (human, preclinical, miscroscopy)
- Software Development



Advanced Imaging of Structure Function and Disease

- Comparative Oncology
- Ageing and Degenerative Disorders
- Nanomedicine: development of multimodal molecular imaging probes for theranostics
- Imaging Genetics
- Epilepsy: Human neuroimaging, animal models and histological analysis
- Simultaneous PET-MRI
- Ultra-high field human MR
- Spinal cord injury
- Neuroinflammation and Diseases of White Matter
- Cancer Metabolism and Emerging Biomarkers
- Systems Biology, Metabolomics and Megavariate Data Methods

Advanced Molecular Characterisation & Design

- Protein Structural Biology
- Biological and Inorganic Chemistry
- Nanomedicine: development of multimodal molecular imaging probes for theranostics
- Systems Biology, Metabolomics and Megavariate Data Methods

Research Projects

Professor David Reutens

Researcher biography

Professor Reutens was appointed as the Inaugural Director of the Centre for Advanced Imaging in 2008. Previously, he was the Professor of Neuroscience at Monash University and Director of Neurology at Southern Health. Prof. Reutens is also a clinical neurologist specialising in epilepsy as the Director of Epilepsy Services and a senior staff specialist at the Royal Brisbane and Women's Hospital. He directs the Australian Mouse Brain Mapping Consortium, which notably created the most detailed MRI-based mouse brain atlas in the world.

Research in the Reutens Lab focuses on neurological disorders, such as epilepsy, stroke and dementia, and the development of imaging methods to better understand, diagnose and manage them.

Areas of research

- Comparative Oncology
- Epilepsy: Human neuroimaging, animal models and histological analysis
- Simultaneous PET-MRI
- Ultra-low field MR

Contact

pa@cai.uq.edu.au or +61 7 336 54237
cai.uq.edu.au/profile/102/david-reutens

Professor Kris Thurecht

Researcher biography

Professor Thurecht's research focusses on the development of polymer and nanoparticle-based devices for nanomedicine. For polymers to be truly effective in nanomedicine, they must incorporate new therapies while maintaining their physical and chemical integrity.

This can only be achieved by developing a strong understanding of the fundamental properties of the nanomaterial-delivery system, in addition to identifying and successfully delivering new therapies.

Central to the development of these future therapeutic platforms, is the field of theranostics, where molecular imaging plays a key role in understanding the dynamics of polymeric nanomedicines. Prof Thurecht's team works across the boundaries of chemistry and materials; and biology and imaging science to probe how nanomaterial properties affect their function in living animals.

Areas of research

- Nanomedicine and the development of multimodal molecular imaging probes for theranostics
- Polymer chemistry
- Simultaneous PET-MRI
- Comparative Oncology

Contact

k.thurecht@uq.edu.au or +61 7 334 60344
cai.uq.edu.au/profile/121/kristofer-thurecht

Associate Prof. Rajiv Bhalla

Researcher biography

Associate Professor Rajiv Bhalla is a group leader and Head of Radiochemistry at the Centre for Advanced Imaging.

His primary research interest is in the development of novel positron emission tomography (PET) and single-photon emission computed tomography (SPECT) ligands. Molecular imaging agents continue to play an increasingly important role in modern healthcare. PET and SPECT are remarkably sensitive non-invasive imaging techniques that provide valuable information at the cellular level. These imaging agents (or radiopharmaceuticals) contain a radioisotope incorporated into drug molecules and are widely used to diagnose neurology, oncology and cardiovascular diseases. A/Prof Bhalla's research develops new labelling strategies and chemistry for a wide range of radioisotopes; supporting the synthesis of novel PET and SPECT diagnostic agents.

Areas of research

- Radiochemistry
- Inorganic chemistry
- Development of novel radiolabelling strategies
- PET and SPECT imaging agents

Contact

r.bhalla@uq.edu.au or +61 7 334 60335
cai.uq.edu.au/profile/122/rajiv-bhalla

Associate Prof. Martijn Cloos

Researcher biography

Associate Professor Martijn Cloos (PhD, 2012) is the Ultra High Field Facility Fellow at The University of Queensland's Centre for Advanced Imaging. His area of research is focused on the intersection between physics, engineering and medicine, with the aim to develop new technology and methods to enhance the capabilities of ultra high field magnetic resonance imaging and open new windows of opportunity to study the human body.

Martijn completed his doctoral research at NeuroSpin, part of the French Alternative Energies and Atomic Energy Commission (CEA), and graduated (summa cum laude) with a PhD in Physics from University Paris Sud (France). After graduation, he accepted a postdoctoral position at the New York University School of Medicine's Centre for Biomedical Imaging. In 2015, he joined the New York University School of Medicine's faculty to start his own research group in the centre for advanced imaging innovation and research (CAI2R). Early 2020, Martijn moved to Queensland and commenced the position of Ultra High Field Facility Fellow at the Centre for Advanced Imaging. In addition, he is also associated with Kyoto University (Japan) as a visiting lecturer.

Areas of research

- MR Methods, Applications, Measurement and Translation
- Ultra-high field human MR

Contact

m.cloos@uq.edu.au or +61 7 336 54250
cai.uq.edu.au/profile/1791/martijn-cloos

Associate Prof. Jeff Harmer

Researcher biography

Associate Professor Jeffrey Harmer is a principal research fellow and Electron Paramagnetic Resonance Group Leader at the CAI. The EPR facility is state-of-the art and the largest in Australia and in the Southern hemisphere with an impressive range of spectrometers.

His research focuses on the development and application of Electron Paramagnetic Resonance (EPR) spectroscopy to determine molecular structure, dynamics and function of molecules containing unpaired electrons (paramagnetic materials). A main focus is understanding the structure and function of proteins, for example (1) to determine how Non-Ribosomal Peptide Synthetase enzymes produce antibiotics, (2) how P450 enzymes select substrates and drugs for catalysis with potential biotechnology applications, and (3) the molecular mechanisms of manganese recognition and acquisition by pathogenic bacteria. Alongside applications, the group works on computation methods to determine structural models of proteins by e.g. combining molecular dynamics simulation with experimental distance constraints measured by EPR on spin labelled proteins.

Areas of research

- Protein structure and function characterisation using spin labelling and EPR experiments
- Computational models of protein structure using experimental data from EPR
- Catalysis by metalloenzymes and interaction of active sites with substrates and drugs
- Characterisation and function of reactive paramagnetic molecules
- Quantum chemistry calculations (DFT) for reactive paramagnetic molecules

Contact

jeffrey.harmer@cai.uq.edu.au or +61 7 334 60351
cai.uq.edu.au/profile/120/jeffrey-harmer

Associate Prof. Mehdi Mobli

Researcher biography

Associate Professor Mobli is a UQ Development Fellow and a group leader at the Centre for Advanced Imaging. He has over a decade of experience in method development and high impact research in the field of NMR spectroscopy.

He is working to develop several enabling technologies in this field, including the development of a theoretical framework for predicting the NMR spectrum of small organic molecules and development of alternative methods for acquiring and processing NMR spectra. He has been successful in applying these advances to key biological problems including research into the structural basis of voltage gating in voltage gated ion channels and transcriptional pausing in bacteria.

Areas of research

- Structural Biology
- High-throughput multidimensional NMR
- Protein structure, function and dynamics
- Structure-based drug design
- MR methods, applications, measurement and translation

Contact

m.mobli@uq.edu.au or +61 7 334 60352
cai.uq.edu.au/profile/118/mehdi-mobli

Associate Prof. Viktor Vegh

Researcher biography

Associate Professor Vegh's interests lie in the research and development of magnetic resonance imaging methods to improve the diagnosis and monitoring of neurological diseases and disorders; and to understand the underlying biological and physical processes influencing the magnetic resonance imaging signal. His current work covers:

• High-field MRI: using multiple MRI contrasts to develop biomarkers and enhance the power of diagnosis in neurological disorders

• Ultra-low field MRI: developing instrumentation for the purpose of studying processes that occur on a relatively short timescale with application in studies on chemical exchange and diffusion

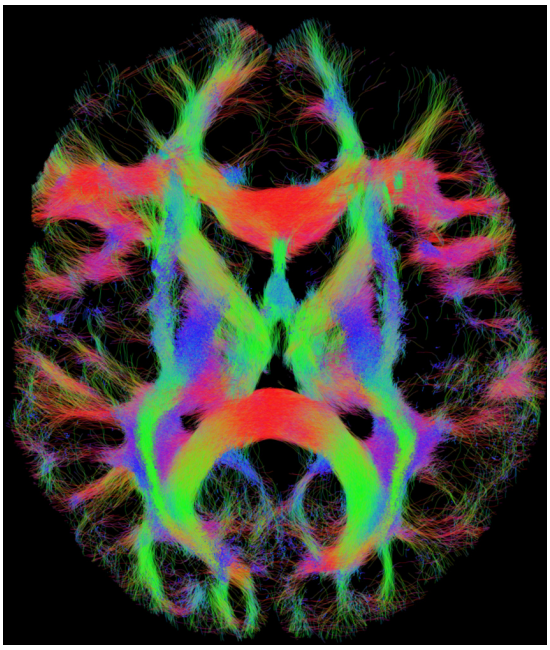
• Diffusion imaging: exploring the importance of anomalous diffusion in the brain and how it changes with tissue structure and architecture

Areas of research

- Cancer metabolism and emerging biomarkers
- Epilepsy: Human neuroimaging, animal models and histological analysis
- Neuroinflammation and diseases of white matter
- Ultra-high field human MRI
- Ultra-low field MRI

Contact

viktor.vegh@cai.uq.edu.au or +61 7 334 60363
cai.uq.edu.au/profile/103/viktor-vegh



Dr Craig Bell

Researcher biography

As modern medicine increasingly demands for non-invasive methods to diagnose and track disease, the use of fluorescence imaging as a highly sensitive imaging technique has meant that this technology can been used extensively for in vitro and small animal in vivo studies.

Dr Bell's research focusses on the development of degradable polymer devices for imaging and tracking of disease and cellular processes by using a tool-kit of controlled polymerisation techniques, along with polymer and molecular coupling methodologies.

The incorporation of degradable moieties into these constructs allows for enzymatic and hydrolytic degradation for complete body clearance of these constructs and for tracking of these devices in vivo.

Areas of research

- Nanomedicine and the development of multimodal molecular imaging probes for theranostics
- Fundamental polymer chemistry
- Development of degradable polymers using controlled polymerisation techniques
- Polymeric nanomedicine synthesis and development
- Construction of multimodal imaging probes for use as polymeric theranostics

Contact

c.bell1@uq.edu.au or +61 7 334 60359
cai.uq.edu.au/profile/494/craig-bell

Dr Yanni Chin

Researcher biography

Dr Yanni Chin is a Research Fellow at the Centre for Advanced Imaging. Her areas of expertise include protein/peptide structural biology and NMR spectroscopy. Over the years she has characterised over 30 molecular structures of animal venom-derived peptides. Her work has contributed to the development of venom-based therapeutics that target diseases such as chronic pain and epilepsy.

Peptides exhibit a wide range of biological activities. Their unique pharmacological profiles have made them attractive drug-leads for the development of novel therapeutics. Dr Chin's research has the focus on characterising these bioactive peptides in regards to their structures, mechanism of actions and molecular interactions with their targets. The information will provide guidance for rational development of peptide-based therapeutics.

Areas of research

- Structural Biology
- NMR spectroscopy on biomolecules
- Biomolecular (protein-protein, protein-peptide or protein-membrane) interactions
- Drug discovery and development

Contact

y.chin1@uq.edu.au
cai.uq.edu.au/profile/2031/yanni-chin

Dr Gary Cowin

Researcher biography

Dr Gary Cowin is the Facility Fellow for the Queensland Node of the Australian National Imaging Facility (NIF) as part of the National Collaborative Research Infrastructure Scheme (NCRIS), based at CAI.

Areas of research

- Simultaneous dynamic MRI-PET imaging
- Simultaneous PET 18F-FDG & MRI Gadolinium contrast agent imaging
- Novel PET tracer imaging using MRI-PET
- Molecular imaging of novel contrast agents
- Prostate imaging for detection of cancer
- Development of MR techniques for non-invasive determination of liver steatosis and fibrosis
- Monitoring changing fat distribution in diabetes and exercise trials
- Application of ultra high field MRI for spinal cord imaging
- MRI zebrafish brain atlas
- Lung imaging with hyper polarised Helium or Fluorine gas in humans and animals

Contact

gary.cowin@cai.uq.edu.au or +61 7 336 58378
cai.uq.edu.au/profile/105/gary-cowin

Dr Nick Fletcher

Researcher biography

Dr Nicholas Fletcher is a postdoctoral researcher at the Centre for Advanced Imaging and Australian Institute for Bioengineering and Nanotechnology.

His current research works to develop polymer-based devices that are able to image both tumors in vivo and deliver theraputic payloads.

This encompasses the synthesis as well as in vitro and in vivo evaluation of multifunctional polymers incorporating: peptide or oligonucleotide aptamers for cellular targeting, fluorescent dyes, flourine

containing monomers for 19F MRI and radioisotope chelating moieties for PET to enable multimodal imaging; and reversible linkage of oligonucleotides for targeted delivery of gene therapies.

Areas of research

- Nanomedicine and the development of multimodal molecular imaging probes for theranostics
- Polymer chemistry

Contact

n.fletcher1@uq.edu.au or +61 7 334 60359
cai.uq.edu.au/profile/138/nicholas-fletcher

Dr Nyoman Kurniawan

Researcher biography

Dr Nyoman Kurniawan is a Research Fellow at the Centre for Advanced Imaging. He is also the Facility Manager of the 16.4T Microimaging System.

His current research interests are in diffusion magnetic resonance imaging of mouse neuroanatomy, with view to study neurological disease model; including developmental abnormalities and spinal cord motor neuron diseases. Dr Kurniawan researches the development of high resolution 3D mouse brain atlas, high resolution diffusion imaging of zebra fish brain, and the detection of neuronal activity using in-vitro MRI.

Areas of research

- Neurological disease models
- Spinal cord injury
- Developmental abnormalities
- in vitro MRI

Contact

nyoman.kurniawan@cai.uq.edu.au
cai.uq.edu.au/profile/110/nyoman-kurniawan

Dr Horst Schirra

Researcher biography

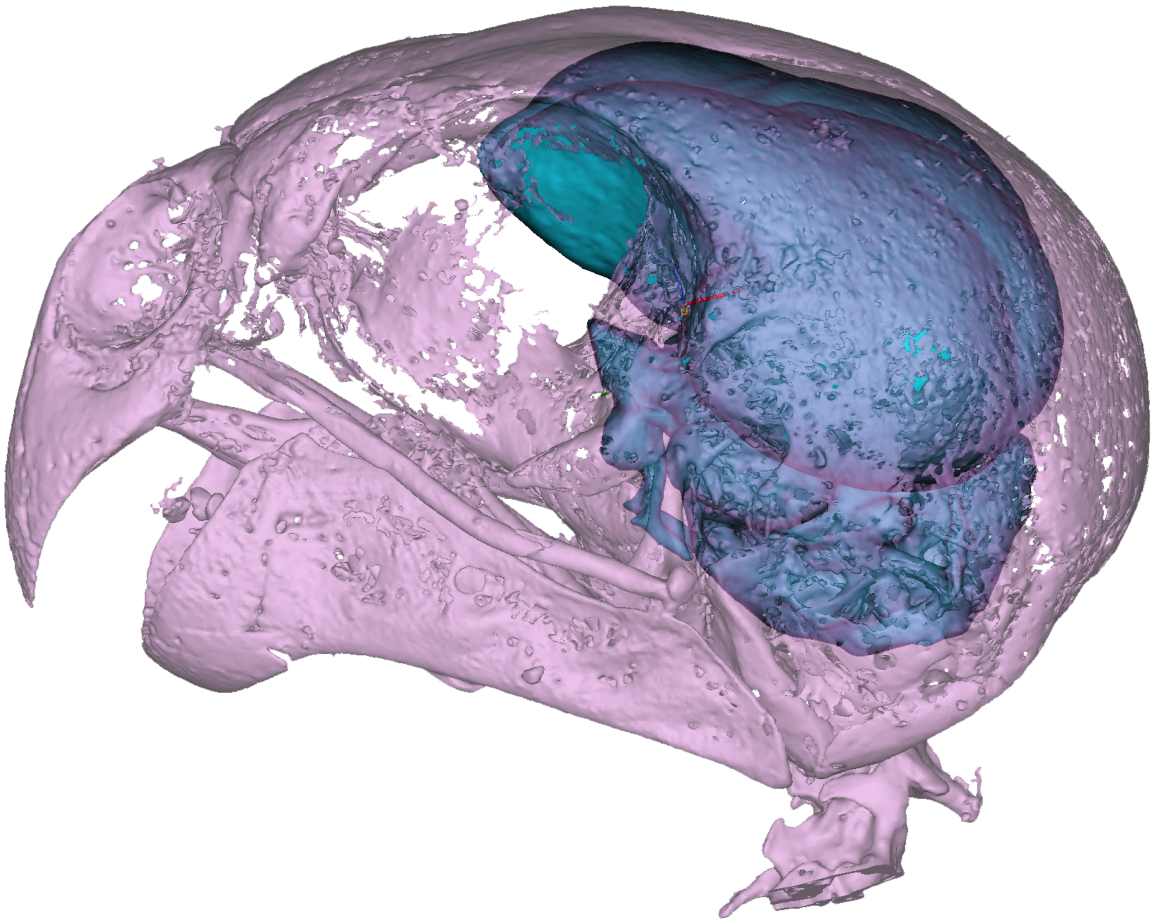
Dr Horst Joachim Schirra is a Research Fellow at the Centre for Advanced Imaging. He is also the Manager of the Metabolomics Facility. He is one of the leaders of NMR-based metabolomics in Australia. Dr Schirra uses NMR-based metabolomics to investigate the basic principles of metabolic regulation and the role they play in fundamental biological processes (such as ageing, hibernation, inflammation and hypometabolism), in environmental change, and in the development of disease, especially obesity and cancer. To achieve this aim, he uses high-throughput NMR sprctroscopy and statistics to understand how external triggers, such as drugs, disease, mutations etc., influence and change the metabolism of a subject. The identified metabolic changes are then either used to understand the mechanism of disease or to enable early diagnosis. Dr Schirra's research aims to integrate metabolomics with other –omics methods and computational simulations of metabolism.

Areas of research

- Metabolism and Epilepsy
- NMR-based Metabolomics and Analytical Systems Biology
- Genome-scale metabolic modelling of C. elegans, and computational modelling/simulation of metabolism.
- Metabolic Regulation
- Characterising the role of the enzyme dihydrolipoamide dehydrogenase
- Integration of metabolomics with genomics and proteomics
- Expanding the toolbox of computational methods to analyse metabolomic data.
- Metabolomics and Environmental Research: (1) livestock science, (2) food security.

Contact

h.schirra@uq.edu.au or +61 7 334 60345
cai.uq.edu.au/profile/147/horst-schirra



Image

CT image of a night parrot (Pezoporus occidentalis) skull. Imaged by Dr Karine Mardon in collaboration with the Queensland Museum.

Building 57
The University of Queensland
St Lucia 4072

T: +61 7 3365 4100
E: hdr@cai.uq.edu.au

www.facebook.com/**UQ.CAI**
www.twitter.com/**UQ_CAI**