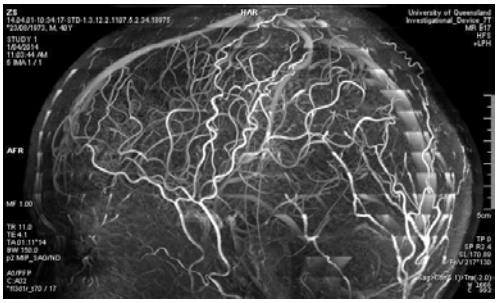
Centre for Advanced Imaging Summer Research Projects 2017/2018

Project title:	**Ultra-high field human magnetic resonance imaging**
Project duration:	The project will run for a period of 6 weeks (winter) or 10 weeks (summer).
Description:	The Centre for Advanced Imaging houses Australia's first 7T human magnetic resonance imaging scanner and the project involves the acquisition and post-processing/analysis of imaging data. Specifically, methods involving diffusion MRI, perfusion MRI, such as intra-voxel incoherent motion (IVIM) modelling, and functional MRI, as well as analysis of anatomical data. Validation and testing will be performed on test objects and with the aid of human subjects.
Expected outcomes and deliverables:	Students will learn about different types of magnetic resonance imaging data, how the instrument works and types of contrasts that can be derived from magnetic resonance images. Successful applicants will have a unique opportunity to work directly with a state-of-the-art human imaging instrument and develop algorithms for image processing that can potentially be used by other groups across the globe. Students are expected to engage with one magnetic resonance imaging sequence and implement the image analysis technique. Students will analyse phantom data and human data, primarily working with two dimensional images. Statistical and graphical comparisons between existing methods and the novel will also be an outcome of this project. Students are expected to produce plots and graphs of their results and be able to discuss their findings. At the completion of the project, students will give a 15-20 minute oral presentation as part of the Centre for Advanced Imaging seminar series. Students will have the opportunity to participate in publications relating to their research. 
Suitable for:	This project is open to applicants with a background in information technology, engineering, physics, mathematics or equivalent. Students are expected to be able to program in C/C++ and Matlab.
Primary Supervisor:	Markus Barth
Further info:	Please contact supervisor prior to submitting an application: m.barth@uq.edu.au

Centre for Advanced Imaging Summer Research Projects 2017/2018

Project title:	**Protein splicing of multi-domain proteins for structural studies**
Project duration:	6 – 10 weeks
Description:	Nuclear Magnetic Resonance is a powerful method for studying the three dimensional structures of proteins as well as their interactions and dynamics. The method, however, is traditionally limited to small and often single domain proteins, due to problems associated with signal overlap of large proteins. In the Bio-NMR group we are developing an in vivoprotein ligation method for segmental labelling of multi-domain protein such that each domain can be studied by NMR spectroscopy in isolation. The project involves optimisation of over-expression protocols for intein mediated protein ligation, segmental isotope labelling and its purification using chromatographic techniques. The proteins to be investigated include bacterial transcription factor (NusA) and Toll like receptors in the innate immune system. The isotope labelled proteins will subsequently be used for structural analysis by NMR spectroscopy.
Expected outcomes and deliverables:	The student will have the opportunity to learn a variety of state-of-the-art biochemical techniques including: in vivoprotein ligation; over-expression, isotopic labelling, different protein purification techniques and basic bio-NMR spectroscopy.
Suitable for:	The project would suit students with a background in biology/chemistry and would be suitable for candidates looking to progress to honours and/or a PhD.
Primary Supervisor:	A/Prof Mehdi Mobli
Further info:	Email: m.mobli@cai.uq.edu.au

Centre for Advanced Imaging Summer Research Projects 2017/2018

Project title:	**Targeting bacterial transcription for antibacterial drug development**
Project duration:	6 – 10 weeks
Description:	The BioNMR group at the CAI is currently leading a structure based drug design project aimed at developing a new class of antibiotics. The aim is to develop an antibiotic with mode of action of inhibiting the interaction between the essential transcription factor NusA and its binding partner DNA-dependent RNA polymerase (RNAP). We are currently determining the structure of N-terminal domain of the bacterial transcription factor NusA in complex with RNA polymerase (RNAP) using advanced solution state NMR methods involving lanthanide labelling coupled with mutagenic analysis. The structural data is then used to design and refine a pharmacophore, for in silico screens, and testing of small molecules for their ability to specifically inhibit the interaction between NusA and RNAP using in vitro and in vivo assays. The student will have the opportunity to learn a variety of state-of-the-art biochemical techniques including: in vivoprotein ligation; over-expression, isotopic labelling, different protein purification techniques and basic bio-NMR spectroscopy.
Expected outcomes and deliverables:	Broadly, scholars will gain skills in one or several of: molecular biology, protein chemistry, biomolecular NMR, paramagnetic NMR. Specifically, scholars will produce NusA cysteine mutant, derivatize cysteine with lanthanide binding tags, and use the paramagnetism of lanthanide to determine the complex structure between NusA and RNAP, which will produce data for publications.
Suitable for:	This project is suitable to applicants with a chemistry or biochemistry background and would be suitable for candidates looking to progress to honours and/or a PhD.
Primary Supervisor:	Xingying Jia and A/Prof Mehdi Mobli
Further info:	Email: m.mobli@cai.uq.edu.au

Centre for Advanced Imaging Summer Research Projects 2017/2018

Project title:	*Design and test of 3D magnetometer array for Ultra Low Field-MRI.*
Project duration:	*10 weeks*
Description:	MRI is a powerful medical and scientific tool. However, its access is constrained by its high economical cost. The Centre For Advanced Imaging is currently developing new approaches to advance MRI towards portability and affordability. MRI experiments heavily rely in knowing the magnetic field distribution in space to generate an image. Proposed summer research project focuses on the design and construction of a 3D magnetometer array to map the magnetic field inside an Ultra Low Field-MRI instrument. The student will be involved in the design and the development of the magnetometer. He/she will be developing required hardware and software with the goal to perform real time magnetic field measurements.
Expected outcomes and deliverables:	The student will build a 3D magnetometer array. This includes the design of the PCB, programming of the microcontroller, communication protocols between microcontroller and computer, and visualisation of the field map. This project offers the student opportunity to design the hardware (PCB holding the magnetometer array and communication port layout) and software (Arduino IDE and Matlab/Python) required for the measurements, data transfer, post-processing and visualisation.
Suitable for:	This project is suitable for students of Electric engineering, biomedical engineering or similar with interest in designing hardware and software for digital electronics.
Primary Supervisor:	*Ruben Pellicer Guridi/Dr Michael Vogel/Jiasheng Su*
Further info:	For further details please send an email to Ruben Pellicer Guridi (ruben.pellicer@uq.edu.au) or Michael Vogel (michael.vogel@cai.uq.edu.au)

Centre for Advanced Imaging Summer Research Projects 2017/2018

Project title:	**Polymers in Nanomedicine: Development of Polymeric Theranostics.**
Project duration:	*10-12 weeks*
Description:	 PET-CT image of tumour-targeted nanomedicine. Recent synthetic advances that facilitate control over polymer structure and functionality have led to the advent of polymer theranostics; devices capable of simultaneously diagnosing disease, delivering a therapy and monitoring the treatment and disease progression. While the potential application of such nanomaterials is tremendous, *in vivo* monitoring remains a significant scientific challenge. While the ultimate aim in polymer theranostics is the development of a multi-modal, multi-functional, biodegradable delivery device with the possibility of facile conjugation of therapeutics, imaging agents and targeting moieties, current methodologies are plagued by poor drug loading, inefficient cell uptake, targeting inefficiencies, synthetic complexities or a combination of all of these factors. This project explores the design, synthesis and preclinical testing of polymeric theranostics that incorporate various molecular imaging modalities (PET, MR, Optical Imaging) as a means of monitoring drug and gene therapies.
Expected outcomes and deliverables:	The project will equip scholars with a range of synthetic and analytical skills for the development and characterisation of nanomedicines (e.g. ligation strategies for imaging agents and targeting ligands) as well as provide exposure and initial instruction on the advanced imaging modalities at CAI (e.g. PET-MR; PET-CT, MR, Optical). The generation of publications following the research project is also possible.
Suitable for:	This project is open to all students with a desire to engage in imaging sciences. However, given the broad nature of the field, students having 2nd-3rd year chemistry background will be better placed to achieve the goals of the project.
Primary Supervisor:	Dr Kristofer Thurecht
Further info:	For further details, please send enquiries to: k.thurecht@uq.edu.au