THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Create change

CENTRE FOR ADVANCED IMAGING

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.

The 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 at CAI

- Imaging Technology Development and Engineering
- Molecular Imaging
- Biomedical Imaging
- Material Science and Imaging
- Data Processing and Computational Analysis
- Structural Biology and Chemistry

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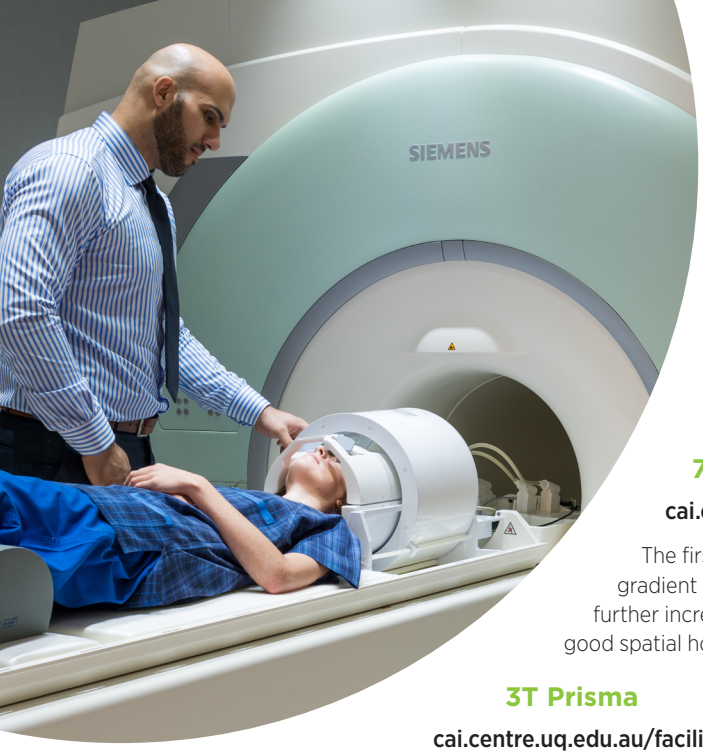

HUMAN IMAGING

The CAI houses whole-body scanners and ultrasound. These are available for research studies ranging from neurology, cardiology, angiography, oncology and musculoskeletal, paediatrics and engineering. Research is conducted on state-of-the-art equipment, with access to world-class expertise.

Whole-body MRI scanners

7T Magnetom

cai.centre.uq.edu.au/facilities/human-imaging/7t-magnetom

The first of its kind in Australia, the Siemens 7T MRI provides a high-performance gradient system with multi-receive and multi-transmit radiofrequency capabilities. These further increase the sensitivity available at the ultra-high field strength while maintaining good spatial homogeneity.

3T Prisma

cai.centre.uq.edu.au/facilities/human-imaging/3t-magnetom-prisma

The Siemens Magnetom Prisma provides an upgraded system with new MRI applications to deliver higher anatomical detail. The facility has a wide range of coils, software and peripheral equipment to support research studies in neurology, cardiology, angiography, oncology, orthophaedics, paediatrics and cognitive neuroscience.

Ultrasound

cai.centre.uq.edu.au/facilities/human-imaging/ultrasound

The high performance Siemens Acuson S3000 ultrasound can be used for a wide variety of studies including fetal monitoring, the assessment of musculoskeletal structures, blood flow velocity and organ perfusion.

HIGH-RESOLUTION NMR SPECTROSCOPY

The high-resolution nuclear magnetic resonance (NMR) facility at CAI caters for spectroscopic investigations in solution with applications across the chemical, biochemical and physical sciences.

Avance 900

cai.centre.uq.edu.au/facilities/high-resolution-nmr-spectroscopy/avance-900

This Bruker instrument is the highest field system in Australia and is optimised for biomolecular studies. It provides high-resolution, three-dimensional structures of membrane proteins, complex carbohydrates, nucleic acids and protein-protein complexes and is able to map macromolecular interactions. These studies are not possible on lower field systems. The system offers unparalleled sensitivity and resolution for NMR-based metabolomics studies.

Avance 700

cai.centre.uq.edu.au/facilities/high-resolution-nmr-spectroscopy/avance-700

The Bruker 700 MHz spectrometer is optimised for life science and chemical research in metabolomics, biochemistry, chemistry, structural biology, nutritional science and molecular diagnostics. The instrument is equipped with a cooled SampleJet high-throughput sample handling and analysis system.

Avance 500

cai.centre.uq.edu.au/facilities/high-resolution-nmr-spectroscopy/avance-500

The Bruker Avance 500 MHz high-resolution NMR spectrometer, interfaced to a 11.7 Tesla 51 mm bore magnet, is for use in research applications in the chemical, physical and biological sciences.

Avance 300

cai.centre.uq.edu.au/avance-300

The Bruker Avance 300 solid state NMR is designed for material characterisation, using a combination of spectroscopy and relaxometry. It is non-destructive and requires only small quantities of material for analysis.

CAI researchers have extensive experience with a wide-variety of studies and are available to provide expert guidance with project planning, data analysis and optimisation.

MOLECULAR IMAGING

Molecular imaging is a form of biomedical imaging, which is rapidly growing in importance in the applied life sciences, and contributes in the advancement of biomedicines.

Inveon PET/CT

cai.centre.uq.edu.au/facilities/animal-imaging/inveon-petct

This Siemens instrument is capable of providing three-dimensional Computed Tomography (CT) and Positron Emission Tomography (PET) images of a live mouse and rat and fixed samples. The system can deliver high-resolution CT images with a maximum field-of-view of 80 mm x 50 mm. The minimum resolution achievable with the PET scanner is approximately 1 mm (maximum field-of-view of 120 mm) with a high sensitivity in the pico-molar range. The PET scanner measures the distribution of molecular imaging probes labelled with positron-emitting radionuclides produced by a cyclotron (i.e. ^{18}F, ^{11}C, ^{64}Cu).

Mass Spectrometry Imaging

cai.centre.uq.edu.au/facilities/molecular-imaging/mass-spectrometry-imaging

A Bruker Autoflex MALDI-TOF/TOF MSI facility is available for both advanced MSI and protein analysis. The technology is an ideal platform for mass analysis of biomolecules and characterisation of protein folding and sequencing, including biomarker studies in cancer and drug distribution.

Biograph Horizon PET/CT

cai.centre.uq.edu.au/facilities/molecular-imaging/biograph-horizon-pet-ct

The CAI human Siemens Biograph Horizon human scanner provides high resolution three-dimensional CT and PET images of humans and large animals, enabling registration and fusion of physiologic and anatomic information. The PET scanner has an axial field-of-view of 164 mm and time-of-flight reconstruction capability. The CT component produces high-resolution images used for fast attenuation correction maps of the PET images and allows anatomical reference for the fused PET and CT images.

Autoradiography

cai.centre.uq.edu.au/facilities/molecular-imaging/autoradiography

The Biospace Lab Beta Imager is a digital autoradiography system providing real time imaging. The distribution of radiolabelled probes can be visualised in tissue sections and different energy beta emitters can be separated. The Beta imager offers improved sensitivity and a spatial resolution of 50-200 µm depending on isotope and zoom.

Optical Imaging

cai.centre.uq.edu.au/facilities/molecular-imaging/optical-imaging

The Bruker In Vivo MS FX Pro provides multimodal X-ray, multispectral fluorescence, luminescence and radioisotopic imaging within a single unit. The system is fully automated, facilitating high throughput imaging for detection of molecular and cellular biomarkers with anatomical localisation.

Optoacoustic Tomography

cai.centre.uq.edu.au/facilities/molecular-imaging/optoacoustic-tomography

Optoacoustic imaging is used to detect, track and monitor the behaviour of molecules under physiological conditions, often without the use of a contrast agent, and offers improved spatial resolution over traditional optical imaging (down to 150 µm). Applications include real-time analysis of tumour microenvironment and observation of growth of some tumours through monitoring of endogenous molecules.

ANIMAL IMAGING

The primary capabilities of CAI's animal facilities are structure, function and molecular imaging in live animal, fixed tissue or materials.

9.4T Pre-clinical Imaging

cai.centre.uq.edu.au/facilities/animal-imaging/94t-pre-clinical-imaging

The Biospec 9.4T is a 400 MHz 30 cm 8 channel transmit/receive imaging system that is capable of state-of-the-art MRI of live small animals and fixed samples from 10 mm to 150 mm in diameter. The system is equipped with a cryoprobe surface coil for imaging with the highest sensitivity available and coils are available for imaging proton, fluorine, phosphorous, carbon and sodium.

Clinscan PET-MR

cai.centre.uq.edu.au/facilities/molecular-imaging/clinscan-pet-mr

The world's first Bruker ClinScan MR/PET enables translational research and molecular imaging, combining a 7T animal MRI with a PET camera to allow simultaneous acquisition of MRI or MRS and PET images. PET-MR imaging holds great promise for multimodal imaging approaches to the study of metabolic processes involved in disease such as cancer and neurodegenerative disease, and the development of targeted or smart drugs and theranostic imaging agents. The technology exploits the exquisite anatomical imaging of MRI combined with dynamic metabolic measurement by PET imaging.

MR MICRO-IMAGING

Magnetic resonance (MR) microimaging is used to probe the microscopic properties of small biological and non-biological samples.

Avance 16.4T

cai.centre.uq.edu.au/facilities/microimaging/avance-164t

The 700 MHz wide-bore micro-imaging system is capable of providing extremely detailed images of intact biological specimens. This spectrometer allows live mouse, fixed tissue and sample imaging from 4 mm to 30 mm diameter. Probes are available for imaging proton, fluorine and carbon.

EPR SPECTROSCOPY

cai.centre.uq.edu.au/facilities/epr-spectroscopy

Multifrequency continuous wave (CW) and pulsed electron paramagnetic resonance (EPR) spectroscopy are powerful tools for structurally characterising molecules containing one or more paramagnetic centres. Examples include free radicals, transition metal ions and multiatom clusters found in such diverse areas as nanomaterials, materials science, structural biology and chemistry, food science, radiation dosimetry and medicine.

Non-invasive EPR imaging offers the capacity to spatially locate paramagnetic molecules in small animals and bulk materials.

Facilities at CAI include:

- a Bruker Elexsys E500 CW (Q-, X-, S-band) variable temperature (1.5-400K) EPR Spectrometer
- a Bruker Elexsys E580 Pulsed (Q-, X-band) variable temperature (1.5-300K) EPR/ENDOR/ELDOR Spectrometer
- a Bruker Elexsys E540 (X-, L-band) Imaging Scanner
- EPR software (XSophe, Molecular Sophe) for the analysis of CW and pulsed EPR/ENDOR spectra

CYCLOTRON AND RADIOCHEMISTRY

cai.centre.uq.edu.au/facilities/cyclotron-and-radiochemistry

The cyclotron and radiochemistry facilities contain an IBA 18/18MeV cyclotron capable of accelerating negative ions H- up to 18 MeV with two internal proton sources and eight independent exit and extraction ports. Eight targets are able to be simultaneously mounted on the cyclotron for radioisotope production and research activities. Generated radioisotopes are delivered to a suite of hotcells suitable for purification, manipulation, research synthesis and dispensing.

The CAI is a foundation partner in

The University of Queensland
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QNN
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