

Core Research *Facilities*



THE UNIVERSITY OF
SYDNEY

Capabilities overview



We recognise and pay respect to the Elders and communities past, present, and emerging of the lands that the University of Sydney's campuses stand on. For thousands of years they have shared and exchanged knowledges across innumerable generations for the benefit of all.

Cover: An expert staff process engineer at work in the Research and Prototype Foundry.



Core Research *Facilities*

Capabilities overview

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“World-class infrastructure, user-centric processes and the skills, talents and passions of a professional team dedicated to supporting the research ambitions of the institution and our partners—this is the essence of Sydney's Core Research Facilities.”

Welcome

Professor Simon Ringer

Pro-Vice-Chancellor (Research Infrastructure)



Welcome

At the University of Sydney, research infrastructure is a vital pillar of our commitment to research excellence.

Our research infrastructure includes eight world-class Core Research Facilities managed by teams of expert technical, operations and academic staff. These research facilities are designed to enable our research community to tackle the most important research challenges of our time, spanning climate change, health, self-reliance and much more. The Core Research Facilities

are supported by expert technical specialists and are proudly home to numerous examples of first-in-country research capabilities.

Critically, our research infrastructure solutions underpin our partnerships with governments, industry and across the tertiary sector.


Sydney's Core Research Facilities bring together state-of-the-art instrumentation, outstanding people and excellent user-focused processes. They provide staff and students from the University and

our partners around the world with an exceptional basis from which to drive outstanding fundamental and translational research. The facilities are designed for use by researchers and industry in the physical, medical, life and engineering sciences and throughout the humanities and social sciences.


If you or your team could benefit from the facilities at Sydney, I encourage you to make contact to discuss the possibilities.


Our research services

 **Project development**
Our specialist staff scientists and engineers can help design your research project from the ground up, ensuring you get the most from our facilities.


 **Instrument training**
Through comprehensive one-on-one training, you will acquire the skills to operate the full range of instruments required by your research.

 **Regulatory compliance**
You will be guided through the necessary safety, ethics and building access protocols tailored to your project's scope.

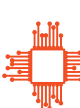
 **Lab support**
Expert staff are a constant presence in each of our facilities, and are available at any time to provide hands-on technical assistance.

 **Data analysis and visualisation**
We have vast capabilities and expertise for advising and supporting you in analysing, visualising and publishing your research data.

 **Contract research and testing**
We have a strong track record of providing high-quality research and testing services for clients, and can accommodate small and large scale projects.

 **Assistance with grant preparation**
Up-to-date facility access information is an important part of any grant application. We can assist you with this during the grant-writing process.

 **Assisted access to national research facilities**
With our established networks of research partners, we can assist you in accessing specialist research facilities throughout Australia.

 **Guidance on advanced computing**
Through consultation, training courses or one-on-one support, we can help you with all your HPC, VRD and research data needs.

Major partner research organisations:



Access



Consultation

Our experts will work with you to put together a viable project design, taking into account factors such as experimental scope, instrument requirements, and budget.



Activation

We will assist you in registering your project in our online Facility Access System, and will guide you through any regulatory approvals necessary.



Induction

We will organise a bespoke training program specific to your needs, giving you autonomous access to our facilities to complete your project.



Supervision

Our specialist staff scientists and engineers will be onsite to provide any technical assistance you require.

Sydney Research Infrastructure Access Grants

The Sydney Research Infrastructure Access Grants program is designed to invest in and drive research excellence across the University by providing small grants to University of Sydney researchers whose opportunities to access the Core Research Facilities may otherwise be limited.

The grants aim to support important research that would significantly benefit from use of the University's Core Research Facilities, as well as supporting preliminary, supplementary or additional research related to funded research projects, to best leverage the outcomes from awarded grants.

Interested in applying? Find out how:

– sydney.edu.au/research/facilities/access-grants

Facts and figures

8

openly available specialist facilities

120

onsite experts providing guidance and research services

520

instruments available for users

Research and Prototype Foundry

Fabrication at micro and nano scale

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The Research and Prototype Foundry, based at the Sydney Nanoscience Hub, offers instruments for the fabrication of devices and structures with features on the micro and nanoscale, with specialised processes allowing users to prototype new optical chips, electronic devices and new quantum science and technology devices.

Our goal is to provide ready access to state-of-the-art tools for micro and nano fabrication (including lithography, etching, deposition and metrology) backed up by a team of expert process engineers.

More information

- sydney.edu.au/research-and-prototype-foundry

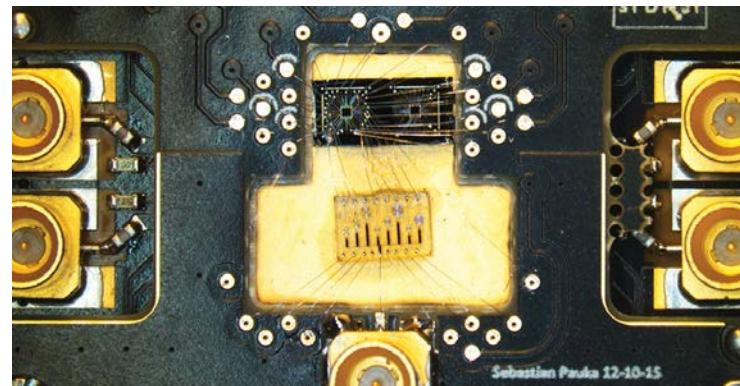
Research in action ►

Quantum devices, such as quantum computers, get their extraordinary performance from manipulating individual quantum particles. This picture shows such a device with five GaAs quantum dots for confining and manipulating single electrons. The 20-nanometer-wide gold gates were written using the Research and Prototype Foundry's Elionix electron beam lithography system.

Device image credit: Sebastian Pauka.

Our capabilities

- **Lithography**
 - Electron beam lithography and photolithography
 - Spin coating and developing
- **Etching**
 - Dry and wet etching tools
 - HF vapour etching
- **Deposition**
 - ALD, PECVD, e-Beam, thermal evaporator and a sputterer
 - Double-angle evaporation for superconducting-based quantum technologies
 - Electroplating
- **Metrology**
 - High-end Zeiss scanning beam systems: HIM and FIB-SEM.
 - AFM, profilometry, ellipsometry and probe station with parametric analyser
- **Packaging**
 - Wafer bonder and sub-micron die bonder
 - High accuracy dicing and wire bonder
 - Desktop chemical mechanical polishing
- **Fibre and FBG**
 - Fibre drawing of polymers and soft glasses
 - Advanced Fibre Bragg Gratings



Sydney Analytical

Chemical, biological and materials analysis

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Sydney Analytical is the University's core research facility dedicated to materials, chemical and biological analysis. Our instruments are operated in four clusters: vibrational spectroscopy, x-ray techniques, magnetic resonance, and drug discovery.

We provide instruments and services to researchers from across the spectrum of life and physical sciences, engineering, and beyond.

More information

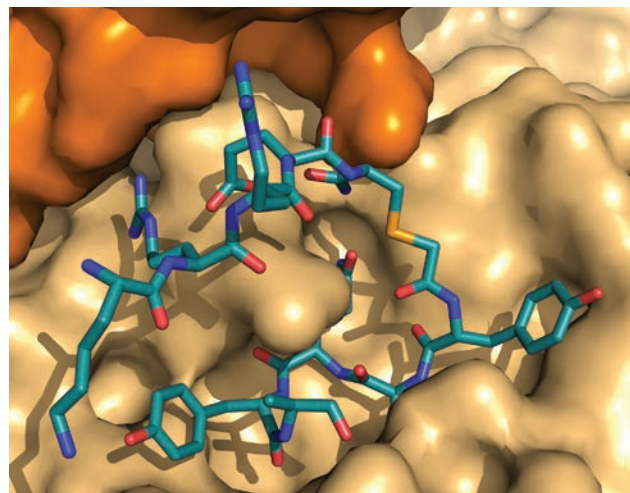
– sydney.edu.au/sydney-analytical

Our capabilities

- Vibrational spectroscopy: Raman, infrared and near-infrared spectrometers, offering 2-D and 3-D mapping at resolutions down to nanometres with AFM/spectrometer techniques
- X-ray diffraction (single-crystal and powder X-ray), light and X-ray scattering
- X-ray spectroscopy: XPS and UPS mapping (30 μm) and depth profiling, XRF
- Portable spectrometers: Raman, infrared and XRF
- Specialist capability in the characterisation of cultural heritage materials
- Residual stress analysis, cutting and polishing, thermal analysis
- Controlled sample environments, including temperature, pressure and battery cells
- Support for early-stage drug discovery: protein production and characterisation, protein X-ray crystallography, fragment-based drug discovery, and cyclic peptide screening
- Magnetic resonance: NMR spectrometers from 300 to 800 MHz and EPR

Research in action ►

In work published in *Chemical Science*, a team led by Professor Richard Payne (School of Chemistry) used Sydney Analytical's cyclic peptide screening facilities to identify inhibitors of the SARS-CoV2 main protease. Working with researchers from Sydney's School of Life and Environmental Sciences, Australian National University, Kirby Institute and University of California San Diego, they showed that these novel molecules potentially inhibited SARS-CoV2 replication and bound to the active site of the viral protease. This paves the way for the development of new drugs to treat COVID-19.





Sydney Cytometry

Quantitative cell sorting and analysis

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Jointly operated by the University of Sydney and the Centenary Institute, Sydney Cytometry provides access to cytometry and cell-sorting techniques for researchers both internal and external to the University. We are committed to the development and transfer of expertise in quantitative cell science to answer questions in cell biology and biomedical research, applied clinical research and trials, and the diagnosis of cancer and other health disorders.

More information

- sydneycytometry.org.au

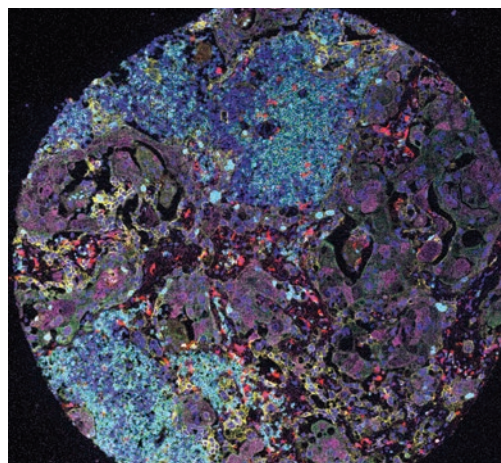
Research in action ►

Our imaging mass cytometer plays a crucial role in enhancing our understanding of the mechanisms behind cancer progression into metastasis by characterising the intricate tumour microenvironment. By examining the interplay between immune cells and tumours in patients' biopsies, a team led by University of Sydney researchers uncovered subsets of lymphocytes that act as a protective barrier against metastasis.

Image: Angela Ferguson and Mainthan Palendira.

Our capabilities

- Cell analysis by fluorescence-based flow cytometry. The facility provides a range of instruments including basic 3-laser, 10-parameter cytometers, a unique custom-built instrument with 10 lasers and 30 parameters, and two full-spectrum flow cytometers with 3 lasers and 5 lasers, both equipped with the enhanced small particle detection to study particles from 100 nm in size
- Cell and tissue analysis by imaging flow cytometry and high-content bio imaging
- Cell and tissue analysis by mass cytometry that enables the simultaneous localisation of up to 45 different molecules at microscopic resolution
- Cell sorting via automated magnetic separation or high-throughput droplet-based cell sorting of multiple populations at speeds up to 30,000 cells per second
- Genomic cytometry enabled by the BD Rhapsody, a cellular capture system that isolates single cells for further RNA sequencing
- Spatial multiomics capability provided by the Nanostring CosMX Spatial Molecular Imaging system





Sydney Imaging

Biomedical imaging

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Offering world-class imaging capabilities and technical expertise, Sydney Imaging is a unique facility for research and education in the field of biomedical science. We provide access to a diverse range of preclinical and clinical imaging modalities, and a world-class hybrid theatre providing the capability for translational research along with training and development of specialised and complex surgical skills.

More information

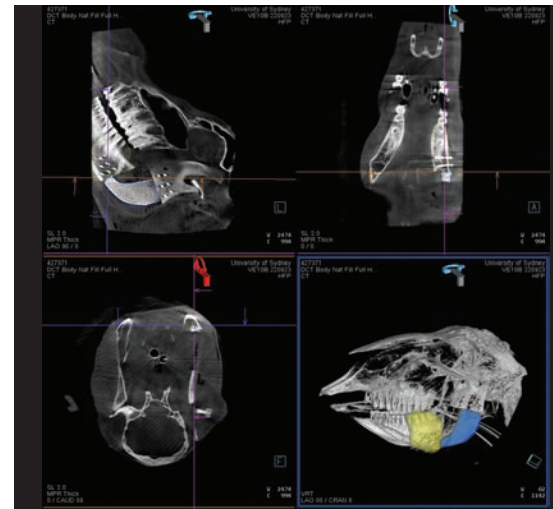
- sydney.edu.au/sydney-imaging

Our capabilities

- MRI (preclinical): 3T, 7T
- PET/MRI (preclinical): 3T
- PET/CT (preclinical)
- Body composition EchoMRI (for awake animals)
- Optical bioluminescence and fluorescence imaging
- High-frequency ultrasound
- Photoacoustic imaging
- 3D microCT
- 2D x-ray with DXA camera (preclinical)
- Hybrid operating theatre
- Artis Pheno C-arm: x-ray, fluoroscopy and CT
- Specialist clinical ultrasound (including TOE echocardiography)
- Kuka LBR Med Surgical Robot
- Small Animal Radiation Research Platform – (Kolling)
- Total Body PET (clinical)
- MRI (clinical): 3T (I-MED Radiology)

Research in action ►

The Integrated Prosthetics and Reconstruction research group have been utilising the Hybrid Theatre's Siemens Artis Pheno robotic C-arm and Pre-Clinical Imaging's MILabs micro-CT to investigate the use of 3D-printed devices as a substitute for bone deficits, aiming to improve the quality of life for human cancer patients who require bone reconstruction. The Artis Pheno is being used to produce in vivo CT images (shown) with 4D reconstruction to track healing rates at different time points. Once the in vivo work is complete, the team utilise the micro-CT for in-depth analysis of integration between the native tissue (seen here in yellow) and an implanted 3D-printed device (in blue).





Sydney Informatics Hub

Research data analysis and training

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The Sydney Informatics Hub works with and supports the research community by providing comprehensive research data services, leveraging staff expertise and capabilities in high performance computing, data analytics, bioinformatics, research data management, statistics and strategy.

More information

- sydney.edu.au/informatics-hub

Research in action ►

PREDICT-19 is a global research consortium advancing our understanding of COVID-19 severity and looking for biomarkers for early clinical interventions. Sydney Informatics Hub analysed gene expression of hundreds of patients using NCI Gadi's supercomputer with University of Sydney clinicians and found differences between mild and severe cases. The work has resulted in four publications in the last year, with further manuscripts in preparation.

Our capabilities

- Expert data analytics consultancy and training
- Statistical consulting and support (including experimental design, optimal statistical analyses and training)
- Data science, AI, bioinformatics, natural language processing, computer vision image processing, geospatial tools, analytics, visualisation, software development, application and publishing support and training
- Building fit-for-purpose national research platforms to support scalable, findable, accessible, interoperable and reusable research practices as a node of NCRIS facilities including the Australian BioCommons
- Advice, training, and support on computing infrastructure including High Performance Computing (Artemis, Pawsey, NCI), Argus Virtual Research Desktops, Research Data Store (RDS) and cloud platforms
- Research data planning, collection and storage
- Digital research tool support, consultancy and training for a range of research software (including GitHub Enterprise, Australian Text Analytics Platform, CLC Genomics, Ingenuity Pathway Analysis)



Sydney Manufacturing Hub

Additive manufacturing and materials processing

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Additive manufacturing of advanced metals, ceramics and polymers, materials processing capabilities, materials testing platforms and world-class expertise are the essence of the Sydney Manufacturing Hub. Geared to support research on the design and development of new materials, manufacturing processes and integration, this unique research-focused manufacturing facility enables concept-to-production capabilities in the areas of health, defence, transport, oil & gas, mining and construction. Facilitating researcher-industry interfaces is a specialty.

More information

- sydney.edu.au/manufacturing-hub


Research in action

Sydney Manufacturing Hub assisted researchers from the University of Sydney who were working to understand the process and property relationships of additively manufactured tin-bronze (Cu-10Sn) alloys to achieve higher mechanical and functional performance. A range of parameters were developed and the fully-dense parts were successfully 3D printed in our facility using the laser powder bed fusion process, achieving much higher strength while maintaining ductility compared with a conventional cast sample.

Our capabilities

- 3D printing: a digitally enhanced alternative to conventional subtractive manufacturing
- Printing materials, including:
 - Metals (Stainless steel, Al, Ni, Ti, bronze and other alloys)
 - Ceramics (Al_2O_3 , SiN, ZrO_2 , etc)
 - Polymers (PLA, ABS, nylon, PEEK, PEKK, ULTEM)
- Printing technologies:
 - Direct Metal Laser Melting
 - Electron Beam Melting
 - Vat Photopolymerisation
 - Fused Filament Fabrication
- Heat treatment:
 - Programmable inert/active atmosphere furnaces
 - Oil and salt baths, drying ovens
 - Metal melting, alloying and casting
- Design:
 - SolidWorks computer-aided design (CAD)
 - Materialise Magics
 - Simplify3D
 - FLOW-3D
- Finishing:
 - Electrical discharge machining
 - Blasting cabinets, ceramic mass-finisher and lapidary tumbler
- Characterisation:
 - Hardness tester
 - Nanoindenter
 - Confocal laser scanning microscope





Sydney Mass Spectrometry

Proteomics, metabolomics and lipidomics analysis

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Sydney Mass Spectrometry supports research with global impact through a portfolio of over 20 mass spectrometers for proteomics, glycomics, metabolomics, lipidomics, and mass spectrometry imaging applications.

We partner with research groups both internal and external to the University to answer questions in biomedical research, plant biology, applied animal and human clinical research, neuroscience and many other areas.

More information

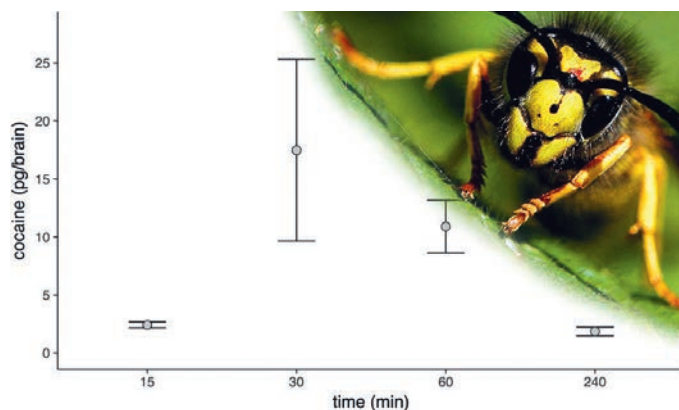
– sydney.edu.au/mass-spectrometry

Research in action ►

The concentration of cocaine in the brains of honey bees was directly measured using a QTRAP mass spectrometer. Why? Honey bees are a well-established model for behavioural studies, and the research group were able to show that cocaine may act by directly altering DNA methylation. Their observations could shed light on why cocaine has such an enduring impact on behaviour.

Our capabilities

- We have several orbitrap platforms (HFX, 480, Eclipse) and 6600 and 7600 Triple ToFs dedicated to discovery proteomics, including phosphoproteomics
- Glycomics using an Orbitrap Fusion with ETD
- Targeted metabolomics and lipidomics on three QTRAPs or two TSQ Altis QQQs
- Multiple discovery metabolomics/lipidomics platforms including Q Exactive HFX, Synapt G2 Si, Lumos
- Mass spectrometry imaging via MALDI (UltrafleXtreme TOF-TOF) or DESI (Synapt G2 Si)
- A Lumos (with ETD, UVPD, 1M) for cross-linking interactomics analysis and other applications
- Bioinformatics suite equipped with over 6 high-performance data-processing workstations and a wide range of analysis packages



Sydney Microscopy & Microanalysis

Micro, nano and atomic-scale exploration

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One of the largest and most comprehensive facilities of its kind in the world, Sydney Microscopy & Microanalysis enables insights into how materials work – at the scale of living cells, tissue, molecules, crystals and even individual atoms.

The facility offers access to specialist staff, instruments and training to enable research into physical and biological structures across a variety of lengths and time scales. This expertise extends from specimen preparation to data capture and data analysis, and can be used across multiple disciplines.

More information

– sydney.edu.au/microscopy-microanalysis

Our capabilities

- Atom probe tomography
- Transmission electron microscopy
- Atomic force microscopy
- Scanning electron microscopy
- X-ray microscopy
- Light and laser microscopy
- Super-resolution microscopy
- Correlative light and electron microscopy
- Cryo electron microscopy
- Expert specimen preparation
- Image visualisation



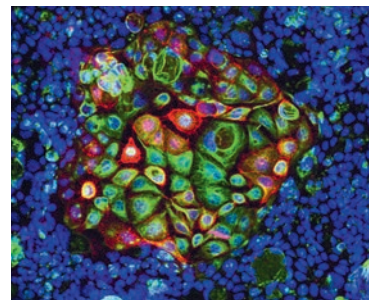
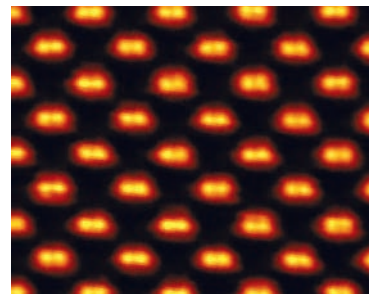
Research in action ►

Our facilities support research into both inorganic and biological structures such as the examples pictured on the right.

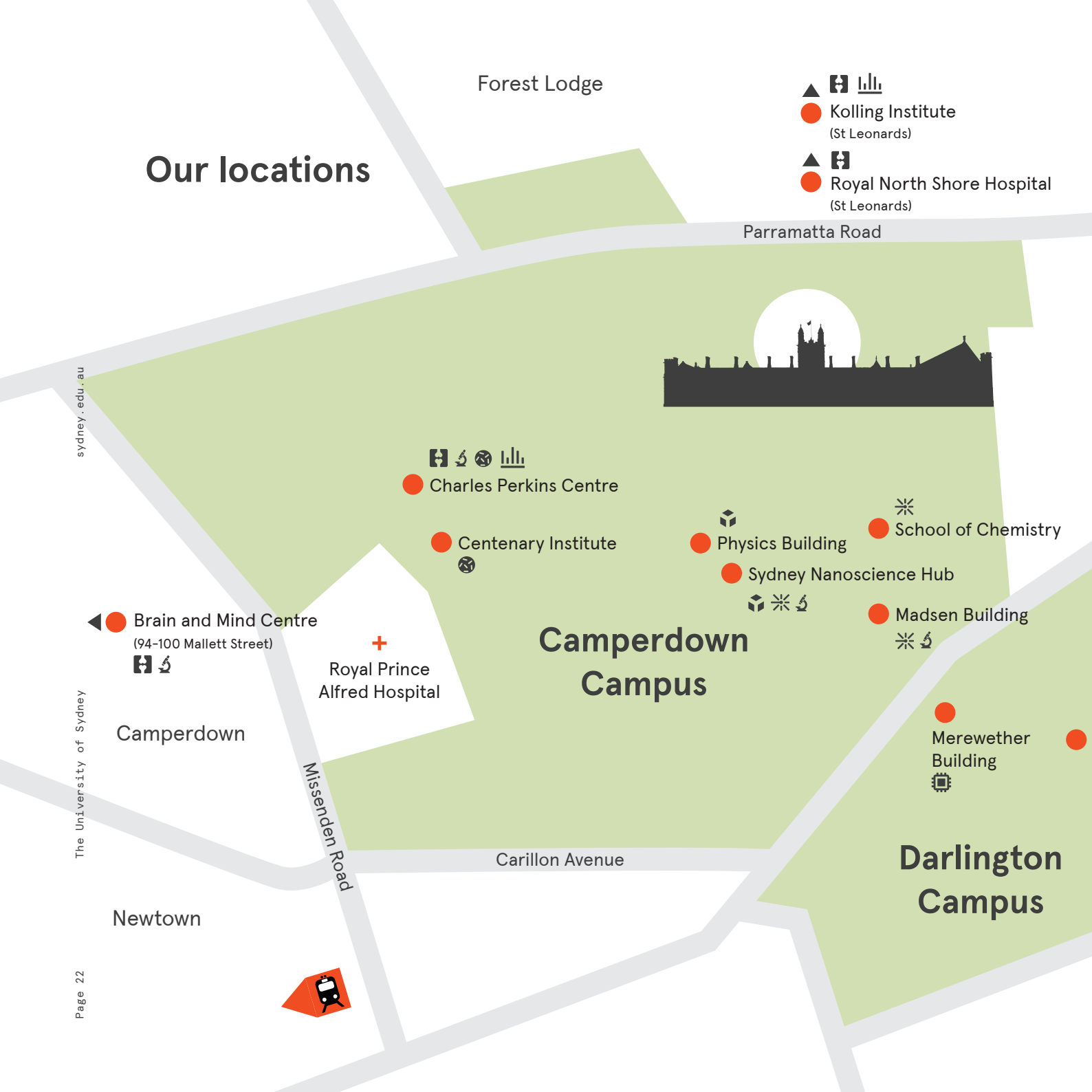
Top: Aberration-corrected scanning transmission electron micrograph of GaN imaged along the [211] zone axis, demonstrating

spatial resolution better than 0.6 Ångström, recorded on the new double-corrected FEI Themis-Z microscope operated with monochromator excited at 300 kV.

Below: Confocal micrograph of colorectal cancer cells at the micrometre scale.



Our locations



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