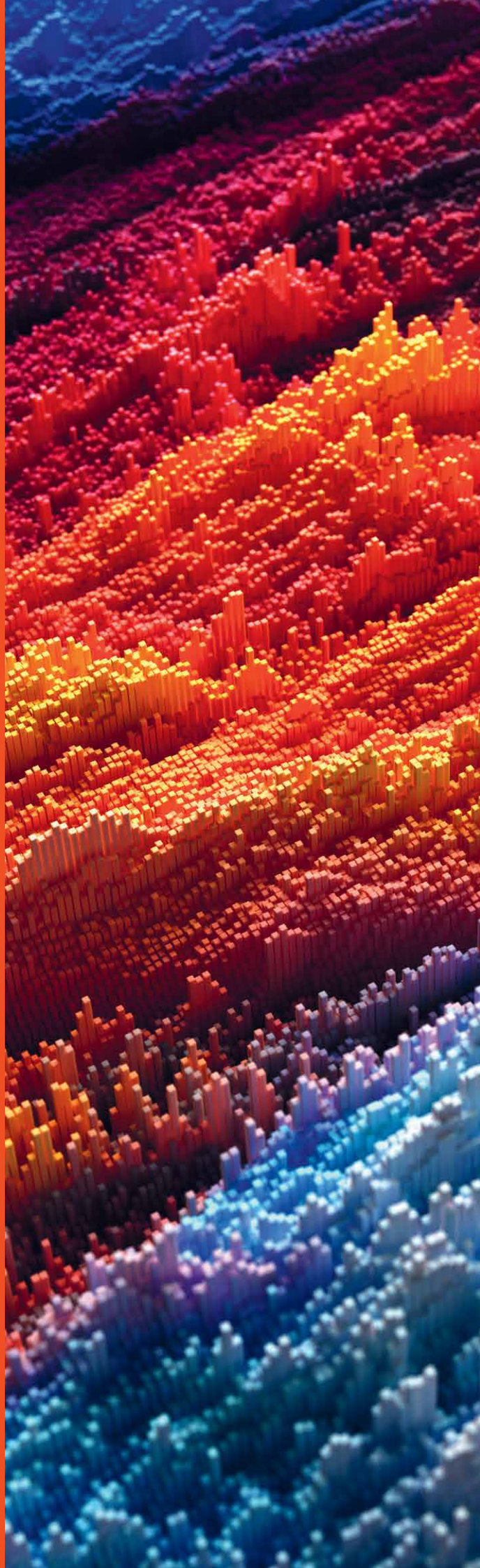
THE UNIVERSITY OF SYDNEY

Sydney Nano strategy

2019 and beyond



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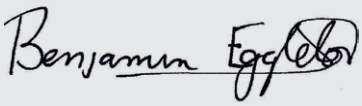
Message from the Director

I would like to take this opportunity to share my enthusiasm for the future of the University of Sydney Nano Institute.

In 2018, I was appointed as director and since then I have been able to meet with many members and supporters of Sydney Nano as we explore how we can reach our mission of transforming our economy, society and everyday life through multidisciplinary research in nanoscale science and technology. We have already broadened our engagement, revised our strategy, restructured the leadership team and selected our inaugural Grand Challenges. From 2019 onwards we will bring this strategy to life and I am excited to turn our programs into successes and create impact and return on investment.

I believe that Sydney Nano will change the direction of nanoscience and technology in Australia and globally – nanoscience will impact on both fundamental research and the very fabric of our society, economy and our daily life. I look forward to reaching out across the whole University and building the large-scale, multidisciplinary collaborations that are needed to achieve this global impact.



Professor Ben Eggleton
Director, Sydney Nano

Professor Ben Eggleton

Professor Eggleton has been an ARC Laureate Fellow and founding director of the ARC Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS). His groundbreaking research into nanoscale optical waveguides underpins novel applications in telecommunications, quantum technologies and sensing.

An alumnus, Professor Eggleton completed his undergraduate and PhD studies at the University of Sydney. He held several roles in industry, including at prestigious Bell Laboratories in the United States, where he was director of photonics devices research, before joining the University again in 2003 as professor of physics.

Since then, he has received more than $54 million in research grants while at the University, including a Discovery grant and an ARC Linkage grant in 2018 to develop advanced technologies to enhance satellite communications, radar systems and surveillance capabilities for defence, as well as lay the groundwork for future fifth-generation wireless communications.

Professor Eggleton is one of the most highly cited academics at the University, with an h-index of 67 (Web of Science). He is the author or co-author of more than 480 journal publications, and has won several prizes, including NSW Scientist of the Year for Physics and Astronomy, the Eureka Prize for Leadership in Science, the Pawsey Medal, the Walter Boas Medal, and a Vice-Chancellor's Award for Excellence for Outstanding Research.

Professor Eggleton is a Fellow of both the Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering. He is also co-director of the NSW Smart Sensing Network. Professor Eggleton commenced as Director of Sydney Nano in May 2018.

The next giant leap is seriously small.

The University of Sydney Nano Institute strategy

The University of Sydney Nano Institute strategy aligns with the University's frameworks, in particular, its strategy for 2016-2020 and the Sydney Model for Multidisciplinary Institutes (MDIs).

The University's Strategic Plan aims to position our university as the best in Australia and a leading institution globally. We aim to do this by enabling a culture of research excellence, offering a distinctive Sydney education and providing a culture built on our values. We are aiming to create and sustain a university in which, for the benefit of both Australia and the wider world, the brightest researchers and the most promising students, can thrive and realise their potential.

The Sydney Model for MDIs is an endorsed horizontal structure (across many faculties) that enables, facilitates and promotes transformational activities and translational outcomes that would otherwise not be possible through existing faculty and university structures.

The model's core criteria are for our work to be:

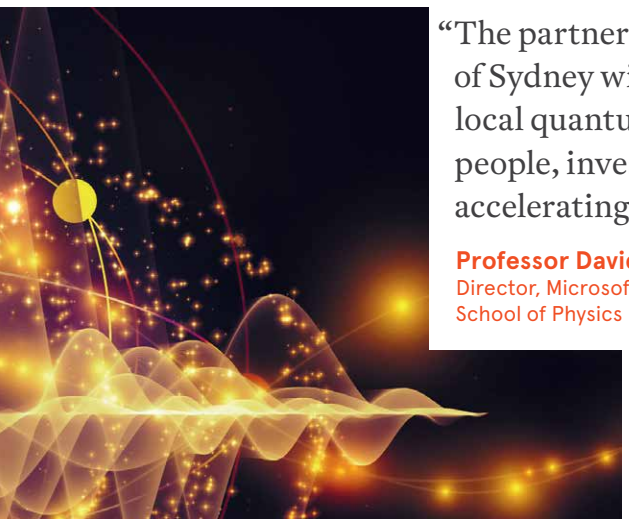
- transformational and strategic in orientation and implementation
- large scale, multidisciplinary and cross-faculty
- translational with a focus on national and global challenges
- representative of the vast array of research strengths across the university
- inspirational, invoking the creativity and innovation of our researchers.

Our vision is to be globally trusted and recognised experts in nanoscience and technology.

Our mission is to transform our economy, society and everyday life through multidisciplinary research in nanoscale science and technology.

Our purpose is to enable, facilitate and promote transformational activities and translational outcomes in nanoscience and technology that would otherwise not be possible through existing faculty and university structures.

Sydney Nano is not separate to faculties. We facilitate transformational and translational research projects that are populated by academics who belong to faculties.



"The partnership between Microsoft and the University of Sydney will allow us to help build a rich and robust local quantum economy by attracting more skilled people, investing in new equipment and research, and accelerating progress in quantum computing."

Professor David Reilly
Director, Microsoft Quantum Laboratory
School of Physics

Academic framework

At Sydney Nano, we like to say that the next giant leap is seriously small. Revolutionary changes in science and technology have opened up access to the nanoscale and together we are tackling some of the most challenging problems that humanity faces: capturing water from air; using nanotechnology for carbon-neutral manufacturing; developing safe and sustainable nanotechnology; creating molecular nanorobots for health care; discovering new techniques for the simulation of next-generation materials; and delivering cures for neurological diseases.

The ongoing strategic research framework of Sydney Nano is based on themes and domains. These focus on multidisciplinary research and bring together disciplines to focus on a set of shared goals.

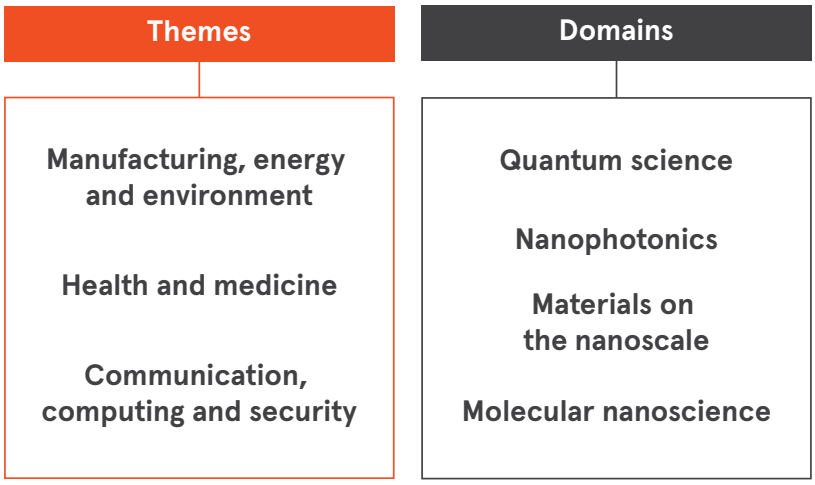
Themes

Sydney Nano research is focused on three interlinked end-user and industry-focused Themes, as shown in the figure below. These Themes directly address societal challenges and will help to build a knowledge and technology-based economy.

Domains

Our research is divided into four Domains, as shown below, which provide a framework that brings together disciplines to focus on a set of shared goals. The Domains interact to work towards the overall objectives of Sydney Nano. Each Domain is led by a research expert.

Research framework



"The academic programs of Sydney Nano are truly multidisciplinary, creating cutting-edge opportunities."

Professor Thomas Maschmeyer
Founder and Director,
Gelion School of Chemistry

Grand Challenges

Some of the grand challenges facing humanity today include water security, greenhouse gas emissions, toxicity of nanomaterials, inoperable conditions, hurdles in quantum technology development and untreatable neural diseases. Our aim is to discover groundbreaking solutions to these challenges.

Bringing together researchers from across the University, the multidisciplinary solutions for our Grand Challenge initiative will be enabled by advances in nanoscience and nanotechnology. The current Grand Challenge projects are:

1. **Advanced Capture of Water from the Atmosphere (ACWA)**
   Developing a low-cost method to capture enough water from the atmosphere to alleviate the effect of drought by providing water for consumption by humans and animals, and for irrigating plants.
2. **CO_2 Zero**
   Reducing CO_2 emissions in manufacturing processes and converting CO_2 into commercial products through nanocatalysis.
3. **Safe-by-design nanotechnology**
   Developing a regulation framework to assess safety, efficacy and toxicity, and guide the future development of nanomaterials – across drug formulations, food additives and biosensors.
4. **Nanorobotics for health**
   Building autonomous, programmable nanorobots to navigate through the body to detect and treat early disease.
5. **Computational materials discovery**
   Simulating new materials from a single atom to fully functioning devices using quantum computers, multiscale simulation, artificial intelligence and machine learning.
6. **Unlocking the neural interface**
   Rethinking the means of intervention into the human nervous system to make untreatable neurological diseases treatable, and to transform treatments into comprehensive cures.

Underpinning platforms

The academic framework is underpinned by enabling capabilities platforms. These platforms provide the state-of-the-art specific research infrastructure required to conduct research on the nanoscale. These platforms comprise innovative synthesis and manufacturing technologies, analytical and imaging tools, data processing as well as prototyping.

"Being associated with Sydney Nano means that I have access to seminars and workshops – there's a great educational aspect to the institute and being a participant has also provided opportunities to interact with people from different research fields, which is something I find very valuable."

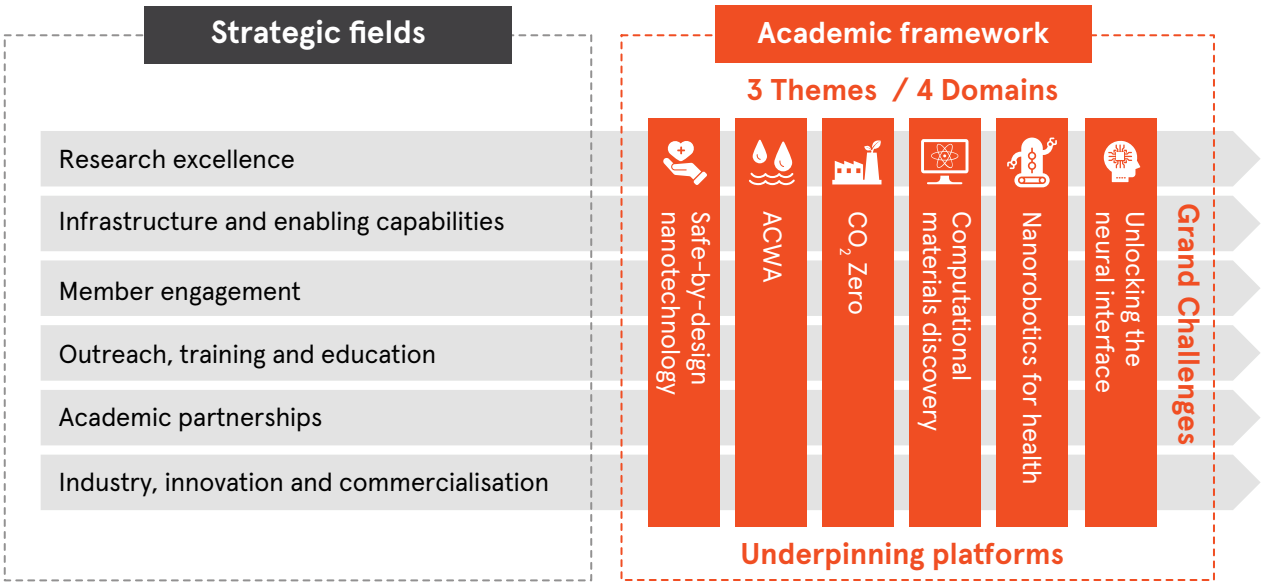
Christina Limantoro
PhD student
School of Chemistry

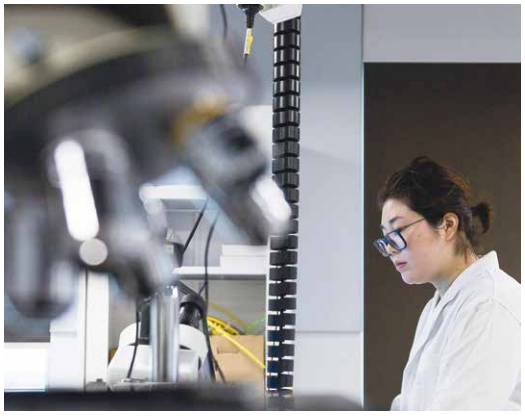
Strategic fields

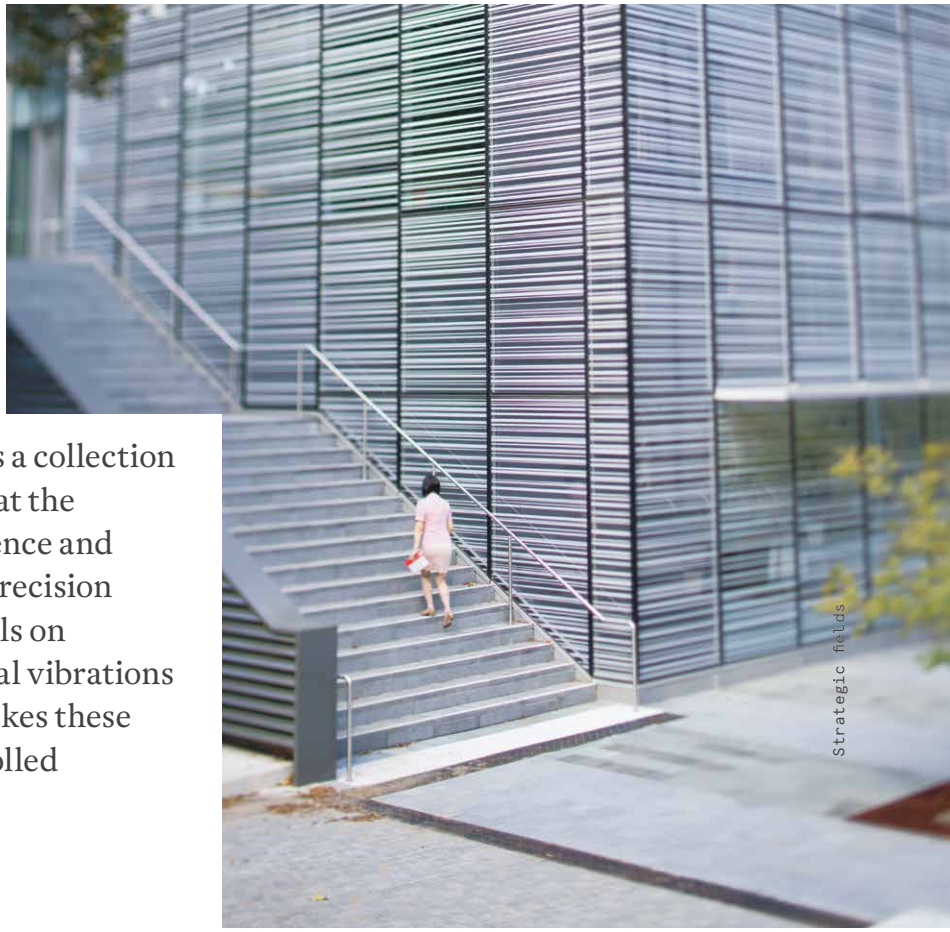
Six strategic fields form the basis of the Sydney Nano strategy, as shown below. Each is linked to the academic framework and will support the Grand Challenge projects.

1. Research excellence
2. Infrastructure and enabling capabilities
3. Member engagement
4. Outreach, training and education
5. Academic partnerships
6. Industry, innovation and commercialisation

Interconnection between strategic fields and academic framework







"The Sydney Nanoscience Hub houses a collection of research lab facilities that operate at the frontier of capability in quantum science and precision metrology. In our highest precision laboratories, a combination of controls on temperature, air pressure, mechanical vibrations and electromagnetic interference makes these spaces among the most tightly controlled environments in the world."

Professor Michael J Biercuk
CEO, Quantum Control Laboratory
School of Physics

Strategic field 1: Research excellence

Strategic objectives:

- enable, foster and coordinate multidisciplinary and cross-faculty programs of the highest quality that address the most important problems
- translate knowledge into beneficial public and/or commercial impact
- attract and retain world-class researchers and thought leaders.

We will achieve these objectives through:

- our strategic framework of Themes and Domains
- identifying, establishing and supporting impactful Grand Challenges and projects
- working closely with the DVC Research, deans and heads of school in recruiting strategic hires
- creating a stimulating and empowering environment in which excellence in research is prized.

Strategic field 2: Infrastructure and enabling capabilities

Strategic objectives:

- enable access to world-class research infrastructure
- maximise the return on the University's investment in state-of-the-art research infrastructure.

We will achieve these objectives through:

- facilitating the optimal use of the Sydney Nanoscience Hub
- supporting the development and use of the University's Core Research Facilities
- facilitating the equipment platform accessible through and by our Members
- influencing the development of the Western Sydney campus
- gaining access to national and international research infrastructure.

Strategic field 3: Member engagement

Strategic objectives:

- engage researchers at all academic levels, across disciplines and faculties
- provide added value to our Members
- enhance academic performance and career development
- establish an empowering community of scholars, marked by diversity and global orientation.

We will achieve these objectives through:

- funding and award schemes, and a mentoring program
- academic and networking events that will strengthen the Sydney Nano Community
- regular engagement with Members through the Early Career Researcher (ECR) Ambassadors
- creating the foundation of a Sydney Nano ECR Network
- implementation of the University's diversity practices in our activities.

"Sydney Nano is the reason I returned to Australia; the high quality facilities and strong community were enticing and exceeded other institutions in the United States and Europe."

Dr Shelley Wickham
Westpac Fellow
School of Chemistry and School of Physics

The Sydney Nano structure

- Our structure brings together more than 400 academic and professional staff from all faculties and service units.
- Members are conducting nano-related research at the University of Sydney.
- Participants are PhD students and postdocs working with Members.
- Both receive defined benefits including funding opportunities.
- Our community comprises academic and professional staff at the University and abroad who work with Sydney Nano or have a general interest in nanoscience and technology.
- We seek a wide and inclusive representation from all disciplines and a higher proportion of women than usual in STEM areas.

Strategic field 4: Outreach, training and education

Strategic objectives:

- support high quality education in nanoscience and technology, and enable research-led, student-driven laboratory learning in multidisciplinary contexts
- enhance capabilities of postgraduate students through training in distinctive and transferrable skills
- be recognised for excellence in nanoscience and technology communication
- promote the University of Sydney as a destination for the best students.

We will achieve these objectives through:

- eliciting the strong involvement of research-active Sydney Nano Members in the development and delivery of nanoscience and technology education units
- exploring a potential doctoral training program
- the foundation of a Sydney Nano Student Society
- a Sydney Nano Student Ambassador program
- public lectures by eminent international researchers
- participation in the Sydney Science Festival
- Sydney Nano open days
- supporting a research program in science communication
- development of a Sydney Nano citizen science project.

Strategic field 5: Academic partnerships

Strategic objectives:

- actively engage in collaborative research and reciprocal exchanges with preferred partner universities and research institutes
- establish strategic institute-to-institute partnerships with leading nano institutes
- cooperate with national and international government-funded institutions and regulatory bodies.

We will achieve these objectives through

- close cooperation with the Office of Global Engagement and active participation in its programs
- development and signing of MoUs with leading nano research institutes with similar missions and complementary capabilities direct approaches to target partners.

Strategic field 6: Industry, innovation and commercialisation

Strategic objectives:

- be the trusted and recognised experts for industry partners looking for nano-based solutions
- support translating inventions into commercially valuable innovation
- foster entrepreneurial activities.

We will achieve these objectives through:

- proactive engagement with top-level executives of major enterprises in Australia
- a deep understanding of and addressing industry needs
- advising and supporting Members in their efforts to engage with industry and commercialise their research output.

"Sydney Nano enabled me to enter into global academic partnerships crucial for my research and was instrumental in initiating two industry partnerships to help develop medical technologies."

Associate Professor Wojciech Chrzanowski
Vice President, Asian Federation for Pharmaceutical Sciences
School of Pharmacy

The Sydney Nanoscience Hub

A world-class building for nanoscale research and education.

The Sydney Nanoscience Hub (SNH) is the most technically sophisticated building of its kind in Australia, and among just a few of its type and performance, worldwide. It opens up opportunities for our work and has been built with the future in mind.

State-of-the-art infrastructure

- The SNH is a centrepiece of a University-wide commitment to 21st century science and innovation.
- SNH was the recipient of a Commendation Award in the Educational Architecture category at the Australian Institute of Architects NSW Chapter Awards 2016 and the NSW Master Builders Award for Construction and Design Excellence 2016.

Cleanroom facility

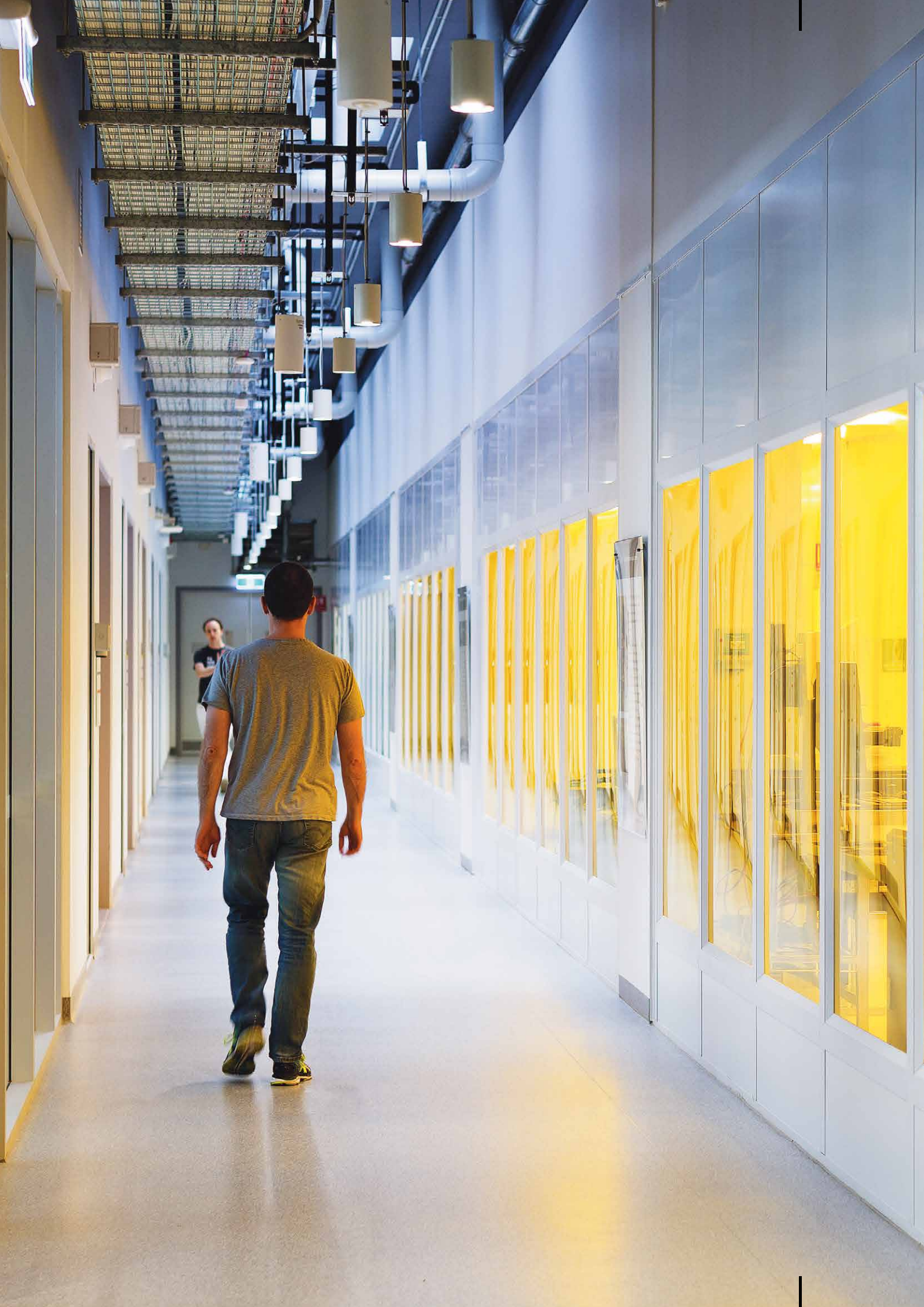
- 10,000m² teaching and learning facilities accommodating a range of pedagogical styles.
- 32 nanoscience research laboratories comprising high-precision designs created for specific kinds of research including features such as decoupled floors to create an incredibly stable environment for measurement accuracy, air-conditioning enabling precise temperature stability and imperceptible airflow and electromagnetic shielding to prevent outside interference.

Laboratories and teaching spaces

- 900m² clean room of ISO class 5. Capabilities include world-class photolithography, which is the highest resolution lithography platform in Australia.

Core research facilities

- The Research and Prototype Foundry offers instruments for the fabrication of devices and structures with features on the micro and nanoscale, with specialised processes allowing users to make devices and prototype new ideas.
- Sydney Analytical provides state-of-the-art instruments and technical expertise for sample characterisation.
- Sydney Microscopy and Microanalysis is a cross-disciplinary research centre which explores physical and biological structures at the micro, nano and atomic scales.



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