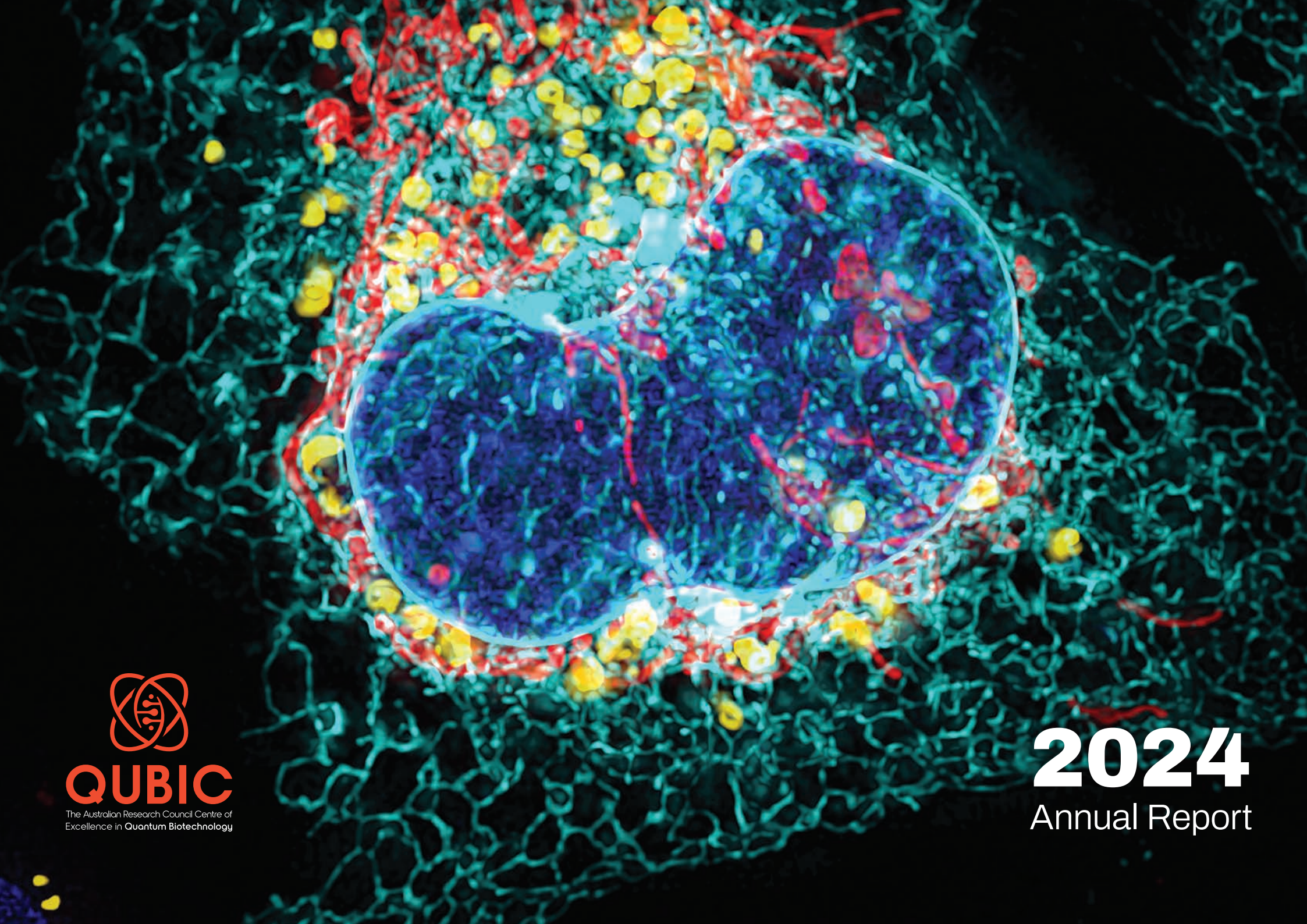

QUBIC

The Australian Research Council Centre of Excellence in **Quantum Biotechnology**

2024 Annual Report

Acknowledging Our Key Partners

Industry and Government Partners

Silanna Group

ORICA

EVIDENT OLYMPUS

3i Intelligent Imaging Innovations

Q-CTRL

CSIRO

Queensland Government

Department of the Environment, Tourism, Science and Innovation

National University Partners

The University Of Queensland AUSTRALIA

University of Wollongong Australia

The University of Melbourne

Flinders University

UTS

International University Partners

Berkeley University of California

Universität Stuttgart

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University of Glasgow

Massachusetts Institute of Technology

University of Surrey

Medizinische Universität Innsbruck

UVIC

Johns Hopkins University

University of Exeter

Contents

Cover image: A super-resolution live-cell microscopy image capturing multi-organelles interactome during cell division with the following labels: red for mitochondria, bright blue for the endoplasmic reticulum (ER), yellow for lysosomes, and dark blue for the nucleus.

Captured by Dr Leo Zhang, University of Technology Sydney

1 INTRODUCTION

Vision, Purpose, Values

Vision

Our **vision** is to lead the world in launching the emerging field in quantum biotechnology and to forge an enduring legacy for Australia at its forefront.

Purpose

QUBIC's **purpose** is to drive the adoption of quantum technologies in biotechnology by developing ground-breaking new quantum technologies designed for biological applications, proving their capabilities, and transitioning them into everyday bioscience tools used in research and by industry.

Our shared sense of purpose and set of **values** are at the heart of everything we do.

Collaboration

Teamwork is at our core. We engage respectfully with one another and our communities. We recognise the strength in diversity and actively seek to collaborate across disciplines, cultures, and partnerships to achieve shared goals.

Integrity

We are committed to maintaining the highest standards of integrity in all aspects of our operations. We are honest, ethical and principled.

Empowered

We celebrate our differences and ideas that break the mould. We encourage openness and excellence in a safe and inclusive environment.

Excellence

We strive for the highest standards. We are dedicated and committed to our work to achieve outstanding results that benefit our community and the world around us.

Innovation

We are the pioneers in our field, leading the charge and championing groundbreaking innovations and bold solutions to complex challenges.

Message from the Director

As Centre Director, I am proud of our achievements in 2024. It has been inspiring to see our vision taking shape through the dedication of our team and partners.

In our inaugural year, we have established a robust foundation in research, governance, and engagement, and advanced strategic initiatives to secure new opportunities. This positions the Centre to lead the international development of quantum biotechnologies and their applications.

We fully established our three core research themes: Molecules, Cells, and Brain. The Centre now comprises over 100 researchers, including postdoctoral fellows and students. A key goal has been to foster collaboration across themes, nodes, and disciplines, creating a cohesive research effort capable of addressing significant problems at scale. Strategies such as targeted workshops and a collaborative cross-node research funding scheme have been implemented. A notable outcome is a focused research effort on TDP-43, a protein critical in dementia progression, leveraging quantum technologies across the Cells and Brain themes. One major achievement was the first observation of a neural action potential using quantum diamond voltage sensing. As our research program matures, we expect our outputs to grow in both number and impact.

Our Chief Investigators have secured over $40M in new external research funding, enabling the expansion and acceleration of QUBIC-related research including the Queensland Quantum Decarbonisation Alliance to apply quantum technologies toward achieving net-zero; Centre of Research Excellence in Mechanisms in Neurodegeneration, a collaborative initiative to explore neurodegenerative diseases; and a major Chan-Zuckerberg Initiative grant to enhance deep tissue imaging with quantum tools. This funding supports cross-Centre collaborations, strengthens industry partnerships, and builds engagement with international experts.

QUBIC is dedicated to taking the research we do into application and impact, and bringing the broader community along with us. To enable this, we have established four Portfolios focused on research translation, training, engagement, and equity. It has been wonderful to see these Portfolios having an impact on Australia's broader society. Initiatives include supporting underrepresented school students to participate at the National Youth Science Forum (NYSF), bringing together hundreds of participants from research, industry and government at the Qx Symposium (Queensland's Advanced Technologies Future) to drive quantum innovation, and launching the ASPIRE Postdoctoral Fellowships to excellent under-represented early-career researchers.

The Mentoring, Training, and Development Portfolio launched a fantastic Summer School and Mentoring Program. Outreach and Engagement sponsored underrepresented school students for the National Youth Science Forum (NYSF) and developed activities for NYSF 2025. Research Translation appointed a Research Translation Manager and co-hosted the QX 2024 event with over 200 attendees. The Inclusion, Diversity, Ethics, and Access Portfolio rolled out the ASPIRE ECR Fellowships and proposed a Fostering an Inclusive Science Scheme.

We have identified quantum algorithms as a key growth area, with forthcoming hires in 2025. New funding will allow us to establish a parallel stream of research on quantum magnetic encephalography (MEG) applications, in partnership with the Australian Institute of Sport, Queensland Brain Institute, and others.

I want to extend a heartfelt thank you to everyone at QUBIC for their dedication and hard work in 2024 in advancing quantum technologies within the life sciences. Your contributions are invaluable, and together, we are making remarkable strides. I am excited for what lies ahead in 2025 as we continue to push boundaries and deliver transformative advances in quantum biotechnology.

Professor Warwick Bowen
CENTRE DIRECTOR

Message from the Advisory Board Chair

My friends and colleagues often ask me, “Alan what’s new?” Over the years I have primed them to expect a somewhat interesting answer. Their expectations are exceeded when I answer that I’m chairing the Australian Centre of Excellence for Quantum Biotechnology!

From the title, they are sure that the Centre is exciting and special, but none of them knows what it is. They know the two words individually but not in juxtaposition. In contrast, everybody thinks they know what Quantum Computing is, but most of them are kidding themselves. They are more candid in the case of Quantum Biotechnology; they instantly know that they do not know.

We have two challenges when it comes to communicating the work of QUBIC – our professional communication to colleagues, and our outreach and communication to policy makers and the broader public.

On the first challenge, QUBIC hit the ground running. This was evident to me, to my fellow members of the Advisory Board and to the members of the International Scientific Advisory Council, at the inaugural QUBIC symposium in Noosa. We were all impressed by the astonishing range of topics and progress described in the posters and talks. All indications are that this year will continue to produce novel results leveraging quantum technologies to advance medical diagnostics, improved biocatalysts, optical imaging and contact-free recording of electrical brain activity.

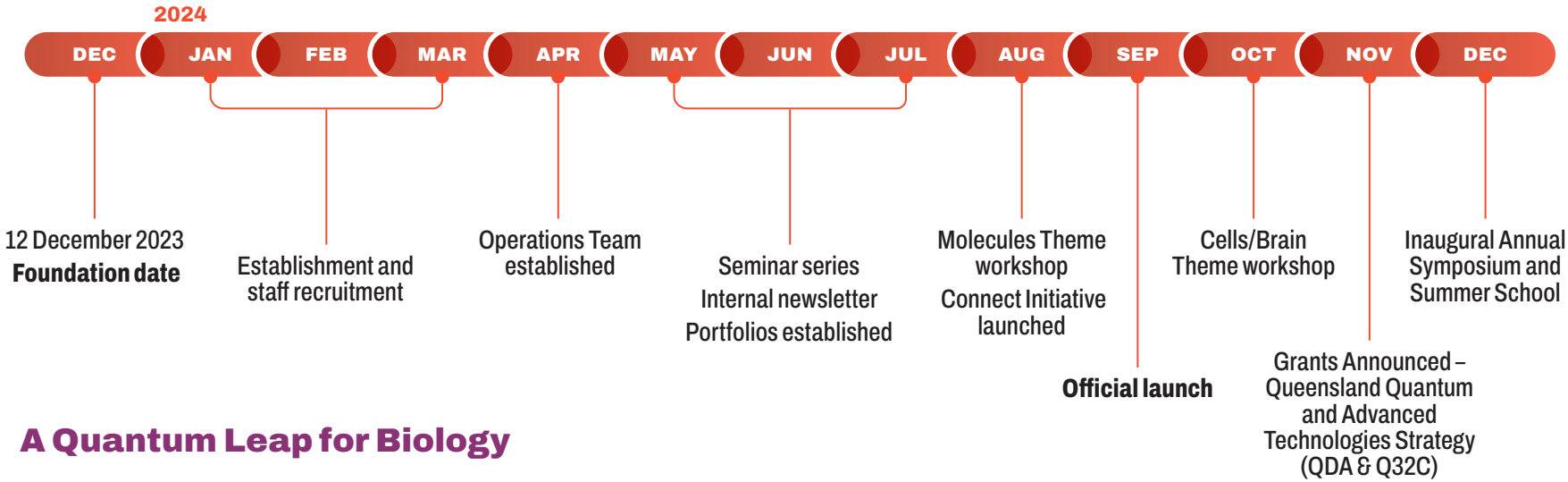
On the second challenge, our outreach and external communication, I am delighted that the Centre has run and will continue to run community outreach programs for children and adults. If these programs achieve their goals, participants should be able to go home and tell their friends and family what quantum biotechnology is and why it is important.

Why do I care? For many reasons. I want young people and adults alike to have deeper insights into the world around them. I want them and their political representatives to appreciate that fundamental research becomes the translational research that becomes the next round of technology that improves our health, our wealth, and our ability to undertake the next round of fundamental research. I want parents, teachers, career advisers and school leavers to appreciate in every cell of their bodies the importance of knowledge in creating a vibrant society.

It is particularly satisfying to see QUBIC contributing to that awareness through its fundamental and translational research combined with its outreach and communications programs. It is a pleasure to be associated with Warwick Bowen, the leadership team, and all of you who are contributing to the success of QUBIC. On behalf of all the members of the QUBIC Advisory Board, I applaud and thank you.

Dr Alan Finkel
ADVISORY BOARD CHAIR

Year 1



A Quantum Leap for Biology

The University of Queensland hosted the official launch of the ARC Centre of Excellence in Quantum Biotechnology (QUBIC) on 2 September 2024. This $45 million initiative brings together five Australian universities, alongside industry and government partners, to advance the integration of quantum technologies with the life sciences. Led by Professor Warwick Bowen, QUBIC

L-R Adjunct Professor Christine Williams, Dr Alan Finkel AC FAA FTSE, The Honourable Gabrielle Upton, Dr Richard Johnson, Professor Warwick Bowen, Professor Halina Rubinsztein-Dunlop, Professor Deborah Terry AO, Ms Rachael Birks.

aims to develop new tools and approaches for biotechnology, with applications across health, energy, and agriculture. The launch event provided an opportunity to formally introduce the centre's vision, research program, and collaborative team, including contributions from CSIRO and other key stakeholders. It also marked the beginning of efforts to build Australia's quantum biotechnology workforce and strengthen national capabilities in diagnostics, manufacturing, and bioscience innovation.

2024 in Numbers

- **14** Centre Seminars
- **11** Connect Initiative Projects with **17** researchers
- **2** Theme Workshops
- **1** Summer School with **60** attendees
- **1** Symposium with **115** attendees
- **5** new Centre AIs recruited
- **7** new HDR students started.

Looking Forward: 2025 Centre Priorities

QUBIC's strategic priorities for 2025 are to lead the work in quantum research for the public good. From early cancer diagnostics, to better understanding brain disease, to improved agricultural sustainability, and to engage to drive these discoveries towards impact and bring the next generation into the quantum revolution. We are delighted that these priorities align strongly with the International Year of Quantum Science and Technology.

INTERNATIONAL YEAR OF Quantum Science and Technology

As part of our ongoing commitment to inclusion, ethics, and access, we will continue to foster a diverse and equitable STEM culture. This includes deepening our engagement through initiatives like the inSTEM Conference, a cross-Centre event supporting underrepresented groups and driving inclusive practice across the research sector.

In 2025, QUBIC's strategic research and engagement priorities are:

- Strengthen our collaborative ecosystem to build national capability and translate research into societal and economic benefit.
- Host the inaugural International Conference on Quantum Technology in the Life Sciences (qLIFE), bringing the global quantum biotechnology community to Australia, showcasing the country as a premier research destination, and fostering robust networks and collaborative research partnerships.
- Enhance engagement with schools and the Australian community through initiatives like the National Quantum and Dark Matter Road Trip and increased involvement with the National Youth Science Forum.
- Achieve globally recognised research outcomes across all Research Themes, leading quantum biotechnology research in established areas and pioneering new directions.

2

OUR EXPERTISE

Partner Organisations & Institutions

Our Expertise

QUBIC is pioneering advancements in quantum technologies, poised to revolutionise our ability to model and observe biological processes that were once invisible. Our research program is meticulously designed to be deeply interdisciplinary, bringing together experts in quantum physics, biophysics, biology, chemistry, and the humanities to address significant real-world challenges.

We have established a unique environment for translating quantum technologies into life sciences applications, thereby contributing to the growth of Australia's quantum economy and the training of a future quantum workforce. The Centre aims to drive substantial social and economic impacts across healthcare, biosecurity, energy, and agriculture by fostering collaborations between industry and academia.

Administered by The University of Queensland, QUBIC has nodes at The University of Melbourne, the University of Technology Sydney, the University of Wollongong, and Flinders University. We have seven industry and governmental partners, including Evident, Silanna and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). We are partnered with 12 leading international universities, including MIT, Johns Hopkins, and the French National Centre for Scientific Research.

"At QUBIC, we've built a unique environment where quantum technologies are translated into life sciences applications, driving innovation, growing Australia's quantum economy, and training the next generation of quantum leaders."

Prof Warwick Bowen, Centre Director

This legend represents QUBIC's Themes, Committees, and Portfolios, and highlights the people driving these initiatives forward.

Themes

- MOLECULES
- CELLS
- BRAIN

Committees

- EXECUTIVE
- RESEARCH
- EARLY/MID CAREER RESEARCHER

Portfolios

- RESEARCH TRANSLATION
- MENTORING, TRAINING & DEVELOPMENT
- OUTREACH & ENGAGEMENT
- INCLUSION, DIVERSITY, ETHICS & ACCESS

The University of Queensland

Research Infrastructure

As QUBIC's largest node, The University of Queensland (UQ) is home to a vibrant ecosystem of researchers, laboratories, and cutting-edge facilities that power the Centre's mission to transform the life sciences through quantum technologies.

Located across the St Lucia campus, six of QUBIC's Chief Investigators lead research spanning quantum measurement, live-cell imaging, molecular simulation, and responsible innovation. Their work is supported by a rich network of infrastructure that enables world-class discovery and translation.

Quantum Measurement and Microscopy

At the School of Mathematics and Physics, Centre Director **Prof Warwick Bowen** leads research in quantum sensing and precision measurement. His laboratories are equipped with:

- Low-noise laser systems and precision test equipment
- Nanolithography and microfabrication tools at the Centre for Microscopy and Microanalysis (CMM) and ANFF-Q
- Semiconductor packaging systems at the UQ Precision Technologies Translation Hub.

These capabilities underpin the development of novel quantum microscopes for probing single molecules and cells.

Optical Physics and Light-Matter Interaction

Deputy Director **Prof Halina Rubinsztein-Dunlop** also operates within SMP, where her team explores quantum-based methods for manipulating light at the atomic and nanoscale. Her work is enabled by:

- Narrow-band lasers and spatial light modulators for shaping optical potentials
- Nanofabrication facilities for constructing micro- and nanoscale structures.

Live Cell Imaging and Deep Tissue Microscopy

At the Institute for Molecular Bioscience (IMB), Node Lead **Prof Jenny Stow** investigates membrane trafficking and subcellular dynamics using advanced imaging. Her research is powered by:

- Over 20 state-of-the-art light and fluorescence microscopy systems, including lattice light sheet microscopy
- High-performance data pipelines for AI-driven image analysis
- Access to IMB's mass spectrometry facility and UQ's CMM.

Biophysics and Biomaterials

Prof Alan Rowan, Director of the Australian Institute for Bioengineering and Nanotechnology (AIBN), leads research into the physical properties of biological systems. His team benefits from:

- Novel quantum microscopes and Australia's only high-resolution confocal-rheometer
- Access to the Protein Expression Facility, National Biologics Facility, and Australian Organoid Facility, all housed at AIBN.

Responsible Innovation and Policy

Dr Allison Fish, based in the School of Law and the Centre for Policy Futures, leads interdisciplinary research on the ethical and legal dimensions of emerging technologies. Her team uses:

- Archival research, ethnography, and policy analysis
- Advanced computing resources and databases to explore the societal impact of quantum biotechnology.

Molecular Simulation and High-Performance Computing

In the School of Chemistry and Molecular Biosciences, **Prof Alan Mark** uses molecular dynamics simulations to understand protein behaviour. His work is supported by:

- UQ's 14,000-core Bunya supercomputing cluster
- National allocations through NCI and Pawsey, totalling over 5 million core hours annually
- Dedicated cloud and in-house computing resources for web-based molecular modelling tools.

Our People

Chief Investigators

Prof Warwick Bowen
Centre Director

Professor Warwick Bowen is internationally recognised for pioneering research at the intersection of nanotechnology and quantum science, including quantum sensing, nanophotonics, and bioimaging. He is the Centre Director, a Fellow of the Australian Institute of Physics, and leads the Quantum Optics Laboratory at UQ. His research spans fundamental questions in quantum physics to applied technologies such as next-generation medical and navigation sensors. His lab collaborates closely with industry and leverages advanced nanofabrication and cryogenic facilities at UQ. Professor Bowen has supervised over 30 postgraduates, many of whom have received prestigious awards including Fulbright Scholarships and national science prizes.

Prof Halina Rubinsztein-Dunlop
Centre Deputy Director
Chair, Research Translation Portfolio

Professor Halina Rubinsztein-Dunlop is a globally recognised physicist and pioneer in laser micromanipulation, biophotonics, and quantum atom optics. She leads major research programs at UQ and serves as Centre Deputy Director. Her groundbreaking work on the mechanical action of light has advanced fields from DNA twisting to cell adhesion. She was the first to demonstrate angular momentum transfer at the microscopic scale. Her group's recent observation of Onsager vortex clusters marked a major milestone in fluid turbulence research. A Fellow of multiple scientific academies, she has received numerous prestigious awards, including the AO, Mees Medal, and Eureka Prize, and is a passionate advocate for science education and women in STEM.

Prof Jennifer Stow
Node Leader
Chair, Outreach & Engagement Portfolio

Professor Jennifer Stow is a molecular cell biologist and NHMRC Leadership Fellow at UQ's Institute for Molecular Bioscience. Trained at Monash and Yale, she held faculty roles at Harvard/MGH, where she uncovered key roles for GTPases in protein trafficking. Her lab pioneered live-cell imaging to study inflammation, cancer, and macropinocytosis, identifying novel pathways and drug targets. She has published over 200 papers with 15,500+ citations and received multiple fellowships and awards, including the ANZSCDB President's Medal. An EMBO Associate Member, she leads IMB Microscopy and contributes to QUBIC through research and mentorship. Professor Stow fosters a diverse and inclusive lab culture, with strong international collaborations and a legacy of successful alumni.

Prof Alan Mark
Molecules Theme Lead

Professor Alan Mark is a biophysical chemist with a distinguished international career spanning Australia, Switzerland, and the Netherlands. He held postdoctoral roles at ANU and the University of Groningen before joining ETH Zurich, where he became Oberassistant in 1996. In 1998, he was appointed Professor of Biophysical Chemistry at Groningen and received the prestigious Swiss Ruzicka Prize. He joined UQ in 2005 as an ARC Federation Fellow and was later awarded a Vice Chancellor's Senior Research Fellowship. Professor Mark is affiliated with UQ's Institute for Molecular Bioscience and the Australian Infectious Diseases Research Centre. His research focuses on molecular simulations and their applications in understanding biological systems and disease mechanisms.

Dr Allison Fish
Chair, Inclusivity, Diversity, Ethics & Access Portfolio

Dr Allison Fish is an interdisciplinary scholar working at the nexus of law, socio-cultural anthropology, and science and technology studies. Her research explores how legal frameworks, technological systems, and cultural practices shape the governance of scientific knowledge and enable responsible innovation. Before joining UQ, she was an Assistant Professor at Indiana University's School of Informatics and Computing. At UQ, she holds roles as Senior Lecturer in the Law School and Senior Research Fellow and Director of Research at the Centre for Policy Futures. Dr Fish brings a unique perspective to QUBIC, integrating policy and legal insights into the development of ethical and socially responsive scientific practices.

Prof Alan Rowan

Professor Alan Rowan is a leading researcher in chemistry and biology, known for pioneering work in processive catalysis and functional self-assembly. His recent breakthrough—the first truly biomimetic hydrogel mimicking the extracellular matrix—has major implications for cell behaviour and biomedical applications, including wound care and drug delivery. Professor Rowan's research spans magnetic materials, supramolecular catalysis, and nanophotonics, with a focus on understanding hierarchical materials at the molecular level. He has published nearly 300 peer-reviewed works with over 12,000 citations and supervised more than 45 PhD students. His innovative approach continues to shape the future of molecular science and biotechnology.

The University of Queensland

Our People

Bowen Lab

RESEARCH FELLOWS


Dr Nishta Arora


Dr Nathaniel Bawden


Dr Benjamin Carey


Dr Lars Madsen


Dr Igor Marinkovic


Dr Nicolas Mauranyapin


Dr Pavlina Naydenova


Dr Jesse Slim


Dr Alex Terrasson

HIGHER DEGREE RESEARCH STUDENTS


Beng Jiong Ang


Kyle Clunies-Ross


Max Foreman


David John


Marino Lara Alva


Jackson Lucas


Lauren McQueen


Jack Moody


Heehun Sung


Poh Meng Yeo

Rubinsztein-Dunlop Lab

RESEARCH FELLOW


Dr Alexander Stilgoe

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Patrick Grant


Lachlan Miller


Mark Watson

Mark Lab

RESEARCH FELLOWS

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Dr Martin Stroet

HIGHER DEGREE RESEARCH STUDENTS

Callum Macfarlane

Abhay Sharma

Stow Lab

RESEARCH FELLOWS

Dr Claudia Stocks

HIGHER DEGREE RESEARCH STUDENT

Vrushali Maste

Fish Lab

RESEARCH FELLOWS

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Dr Alana Brekelmans

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Dr Omkar Nadh Pattela

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Dr Marita Rodriguez

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Rowan Lab

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Dr Guy Barry
PARTNERSHIPS AND TRANSLATION MANAGER

Rebecca Hobden
COMMUNICATIONS AND ENGAGEMENT COORDINATOR

Oliver Hipwell
MANAGEMENT ACCOUNTANT

Natasha Alagar
SENIOR ADMINISTRATION OFFICER

Kaerin Gardner
SENIOR ADMINISTRATION OFFICER

The University of Melbourne

Research Infrastructure

The University of Melbourne brings together a diverse and powerful network of researchers, laboratories, and facilities that support the Centre's mission to advance quantum biotechnology. Four Chief Investigators lead research across biophysics, quantum sensing, data science, and quantum computing, each supported by world-class infrastructure.

Live Cell Imaging and Molecular Dynamics

At the Cellular Biophysics Laboratory, **A/Prof Elizabeth Hinde** investigates how proteins behave and interact inside living cells. Her lab is equipped with:

- Advanced fluorescence lifetime and correlation spectroscopy systems for tracking protein diffusion and interactions at the single-molecule level
- A confocal laser scanning microscope with time-resolved detection for orbital tracking and fluctuation spectroscopy
- A widefield TIRF microscope for lifetime-based FRET detection and single-molecule tracking.

These tools enable high-resolution, real-time imaging of cellular processes, critical for understanding disease mechanisms and therapeutic responses.

Dr Elizabeth Hinde in the lab

Multi-Omics and Quantum Bioinformatics

Prof Kim-Anh Lê Cao leads a team developing statistical and computational methods to make sense of complex biological data. Her lab specialises in:

- Multivariate analysis and dimension reduction for large-scale omics datasets
- Development of the internationally recognised mixOmics R toolkit
- Emerging approaches in spatial transcriptomics and quantum computing for biomarker discovery.

Her work bridges biology and data science, creating scalable tools with real-world applications in health and microbiome research.

Quantum Sensing and Diamond-Based Technologies

The Quantum Sensing Lab (QSL), led by **Prof Lloyd Hollenberg** and **A/Prof David Simpson,** is a hub for quantum materials and sensing innovation. The lab houses:

- Widefield and confocal quantum microscopes for imaging magnetic and biological systems
- A cryogenic magnetic microscope capable of imaging from 4 K to 320 K
- The National Facility for Quantum Grade Diamond, which engineers isotopically pure diamond for quantum sensing applications.

These capabilities support QUBIC's mission to develop quantum-enabled tools for probing biological systems with unprecedented sensitivity.

Quantum Computing and Software Innovation

The IBM Quantum Network Hub, established in 2018 and led by **Prof Lloyd Hollenberg,** provides researchers and students with access to world-leading quantum computing platforms. Spanning multiple faculties, the Hub supports:

- Research in quantum information, algorithms, and applications
- Development of quantum software for fields including quantum chemistry and bioinformatics.

This infrastructure positions The University of Melbourne as a national leader in quantum computing and its integration into biotechnology.

Our People

Chief Investigators

A/Prof David Simpson

Node Leader

Associate Professor David Simpson is a Haimson Associate Professor in Physical Biosciences at The University of Melbourne. He specialises in diamond-based quantum sensors for biomedical and precision magnetometry applications. His research has led to high-resolution imaging techniques that reveal electrical and magnetic properties of biological systems, advancing diagnostics and disease understanding.

A/Prof Simpson holds a PhD in applied physics from Victoria University and has spent over a decade translating quantum technologies into real-world solutions. He is co-founder of two start-ups—Chromos Laboratories and FeBI Technologies—focused on applying quantum sensing to neurological and iron-related disorders. His work bridges fundamental physics and clinical innovation.

Dr Elizabeth Hinde

Dr Elizabeth Hinde is a cellular biophysicist and ARC Future Fellow at The University of Melbourne, where she is an Associate Professor in the School of Physics. Her research develops advanced fluorescence lifetime and correlation spectroscopy techniques to investigate how nuclear architecture influences DNA target search and genome integrity in live cells.

Dr Hinde's work bridges physics and biology, offering new insights into cellular regulation and disease mechanisms. She is also the current President of the Australian Society for Biophysics and plays a leading role in promoting interdisciplinary research and scientific collaboration within the biophysics community.

Prof Lloyd Hollenberg

Professor Lloyd Hollenberg is a Melbourne Laureate Professor and Thomas Baker Chair in Physics at The University of Melbourne. Internationally recognised for his work in quantum computing and quantum sensing, he directs the IBM Quantum Hub and was awarded an ARC Laureate Fellowship in 2013.

Originally trained in theoretical particle physics, he transitioned to quantum technologies in 1999 and has published over 250 papers. His team achieved the first quantum measurements in a living cell, earning the 2013 Eureka Prize. Professor Hollenberg is a Fellow of the Australian Academy of Science and recipient of major awards including the Walter Boas Medal, Victoria Prize, and Royal Society (Victoria) Medal for Excellence in Scientific Research.

Prof Kim-Anh Lê Cao

Professor Kim-Anh Lê Cao is a statistical genomicist and Director of Melbourne Integrative Genomics at The University of Melbourne. She develops computational methods and software to interpret complex biological data, with a focus on integrating multi-omics for biomedical research. Trained in mathematical engineering and statistics (PhD, Université de Toulouse), she has held leadership roles across biomedical institutes and secured three consecutive NHMRC fellowships.

Professor Lê Cao received the Australian Academy of Science's Moran Medal and is a champion for women in STEMM through programs like Homeward Bound and Superstars of STEM. She also serves as Research Coordinator in the School of Mathematics and Statistics and actively promotes inclusive, interdisciplinary science.

The University of Melbourne

Our People

Simpson Lab

RESEARCH FELLOWS


Dr Galya Haim


Dr Daniel McCloskey


Dr Eliza Rokhsat

HIGHER DEGREE RESEARCH STUDENTS


Tuesday Couzens


Claire Dawson


Angela Hermann


Hunter Johnson


Charlie Pattinson


Trent Ralph


Dhilan Vallury


Ella Walsh


Di Wang

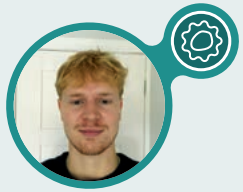
Hinde Lab

RESEARCH FELLOWS


Dr Jieqiong Lou


Dr Michael Mlodzianoski

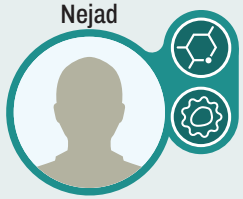
HIGHER DEGREE RESEARCH STUDENTS


Paul Armitage


Blake Bishop


Nazanin Ghaderi Nejad


Shikun Ma


Julissa Sánchez-Velásquez


Tao Sun

Hollenberg Lab

HIGHER DEGREE RESEARCH STUDENTS


Floyd Creevey


Michael Jones


Haiyue Kang

Lê Cao Lab

HIGHER DEGREE RESEARCH STUDENTS


Chengyi Ma


Xiaochen Zhang

Professional Team


Kate Hall
NODE ADMINISTRATOR

Research Infrastructure

The University of Technology Sydney (UTS) is home to Chief Investigators **Distinguished Prof Dayong Jin, Prof Jiajia Zhou,** and **A/Prof Irina Kabakova.** Based in the Faculty of Science and the Institute for Biomedical Materials and Devices (IBMD), their research is powered by a world-class environment designed to accelerate innovation in quantum biotechnology.

A State-of-the-Art Science Precinct

QUBIC's research at UTS is conducted within the UTS Science Precinct, a $230 million facility that houses the IBMD. This hub includes:

- Two advanced nanophotonics laboratories
- Three biophotonics laboratories
- A nanoparticle synthesis laboratory
- 200 m² of analytical laboratories
- A microfluidics fabrication LIEF facility
- A volumetric imaging LIEF facility
- A newly funded live-cell imaging LIEF facility (2025)
- A PC2 laboratory under construction for live-cell super-resolution microscopy and temperature sensing.

These facilities provide a robust foundation for developing and applying quantum-enabled imaging and sensing technologies.

Advanced Imaging and Sensing Capabilities

The IBMD is equipped with a suite of custom-built and commercial tools that support QUBIC's mission to observe biological systems with unprecedented clarity and precision. These include:

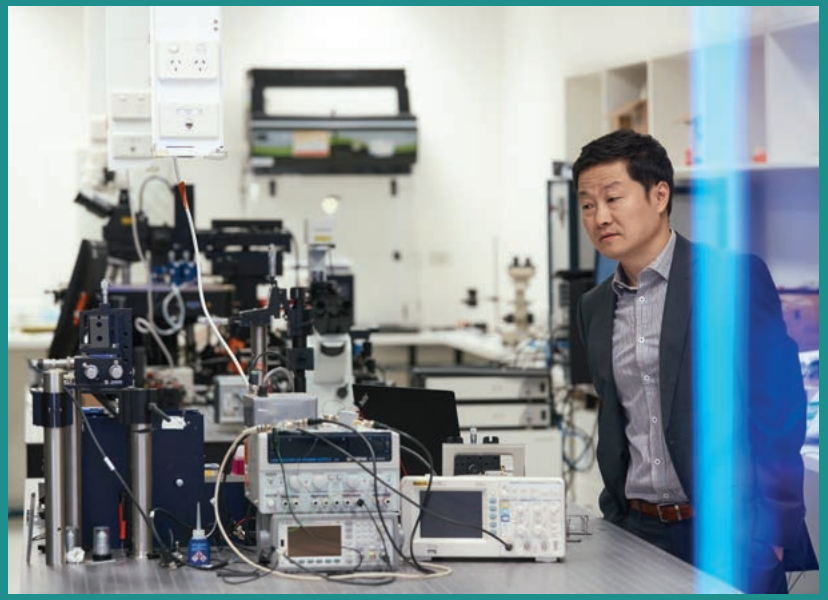
- Upconversion microscopy systems for confocal, widefield, and TIRF imaging, temperature sensing, and optical cooling
- A volumetric imaging facility and spinning disk microscopy
- An upconversion 96-well plate reader and bench-top lateral flow assay readers
- Standardised tools for material synthesis and characterisation, including DLS, Zeta potential, and optical spectroscopy systems.

Pioneering Quantum Imaging Platforms

As part of QUBIC's research program, UTS is establishing new capabilities in quantum and near-infrared imaging, including:

- Quantum upconversion microscopy
- Quantum Brillouin microscopy
- NIR-II spectroscopy.

These platforms are designed to push the boundaries of biological imaging—enabling researchers to study cells, tissues, and molecular interactions in real time, with minimal disruption.



University of Technology Sydney

Our People

Chief Investigators

Distinguished Prof Dayong Jin
Chair, Research Committee

Professor Dayong Jin is a Distinguished Professor at UTS and Director of the Institute for Biomedical Materials and Devices. An ARC Laureate Fellow and Fellow of the Australian Academy of Technology and Engineering, he develops biotechnologies by integrating photonics, materials science, and biomedical engineering. He founded the ARC IDEAL Hub and is a Clarivate Highly Cited Researcher. His innovations have earned major awards, including the Eureka Prize, Prime Minister's Malcolm McIntosh Prize, and APEC Science Prize. Professor Jin's work spans quantum sensing, nanotechnology, and analytical chemistry, with a focus on research translation and commercialisation, including the 2022 KCA Award for Best Invention.

A/Prof Irina Kabakova
Cells Theme Leader

Associate Professor Irina Kabakova is an optical physicist at UTS, specialising in microscopy techniques based on Brillouin light scattering. Her research maps viscoelastic properties of cells and tissues at the microscale, with applications in mechanobiology, drug development, and diagnostics. She also focuses on photonic integration and miniaturisation to translate lab imaging technologies into clinical tools. Dr Kabakova is Associate Head of School (Education and Students) in the School of Mathematical and Physical Sciences and leads research within both the ARC Centre of Excellence in Quantum Biotechnology (QUBIC) and the Centre of Excellence for Optical Microcombs (COMBS), contributing to next-generation biomedical imaging platforms.

Prof Jiajia Zhou
Node Leader

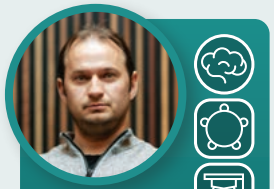
Professor Jiajia Zhou is an ARC Future Fellow and NHMRC Investigator at UTS, and a core member of the Institute for Biomedical Materials and Devices. Her research focuses on engineering ultra-small nanoparticles with preserved optical properties for applications in display technologies, security inks, bioimaging, and sensing. She has contributed to rapid COVID-19 antigen testing and pathogen detection in the food industry. Her current work, aligned with QUBIC, explores quantum probes and sensors to advance our understanding of biological systems. Dr Zhou also serves as Associate Editor for the Journal of Luminescence and actively mentors emerging researchers, with PhD opportunities available in her group.

Our People

Jin Lab

RESEARCH FELLOWS

Dr Meryem-Nur Duman



Dr Sergey Kruk

Baokai Wang

Dr Zhichao Yang

HIGHER DEGREE RESEARCH STUDENT

Fei Su

Kabakova Lab

RESEARCH FELLOWS

Dr Isa Ahmadalidokht

Hadi Mahmodi

HIGHER DEGREE RESEARCH STUDENT

Mahya Mohammadi

Zhou Lab

RESEARCH FELLOWS

Dr Nisha Mehta

Dr Martin Sadraeian

HIGHER DEGREE RESEARCH STUDENT

Yitong Zhao

Professional Team

Anne Devenish-Meares
NODE ADMINISTRATOR

University of Wollongong

Research Infrastructure

At the University of Wollongong, QUBIC research is led by Chief Investigators **Prof Lezanne Ooi** and **Prof Haibo Yu,** whose teams are based in the School of Science and work within the world-class Molecular Horizons research facility. This $80 million investment into the life sciences provides a cutting-edge environment for exploring molecular and cellular processes using advanced imaging and computational tools.

A Purpose-Built Home for Precision Science

QUBIC research is housed in the Paul Wellings Building, a facility designed specifically to support highly sensitive microscopy and laboratory work. It features:

- A suspended, ferrous-free slab made from glass fibre reinforced polymer to eliminate vibration and electromagnetic interference
- Structural glass elements that allow natural light into lab spaces and showcase research to the public.

This unique architectural design ensures optimal conditions for high-resolution imaging and reflects the Centre's commitment to precision and transparency in science.

Advanced Imaging and Analysis Facilities

The building hosts the Fluorescence Analysis Facility, which supports a wide range of biological and environmental applications. Key capabilities include:

- 11 high-end fluorescence microscopes, including confocal, super-resolution, and high-throughput imaging systems
- Six multi-parameter flow cytometers, including a cell sorter
- Mass photometry for precise molecular analysis.

These tools enable researchers to visualise and quantify cellular processes in real time, supporting QUBIC's mission to understand life at the molecular level.

Integrated Support for Molecular and Cellular Research

The facility's technical team provides expert support in cell and molecular analysis, helping researchers apply advanced imaging techniques across diverse applications—from neuroscience and cancer biology to environmental monitoring.

With access to PC1, PC2, and PC3 laboratories, researchers at Wollongong are equipped to conduct work across a range of biosafety levels, further expanding the scope and impact of QUBIC research.

Our People

Chief Investigators

Prof Lezanne Ooi
Brain Theme Leader
Node Leader

Professor Lezanne Ooi is a neuroscientist at the University of Wollongong, where she leads research into neurodegenerative diseases using advanced cellular imaging and stem cell models. Her lab has characterised over 100 induced pluripotent stem cell lines and investigates conditions such as motor neuron disease, vanishing white matter disease, and Parkinson's. She has received funding from the Michael J. Fox Foundation and contributes to understanding lipid and metabolite biomarkers in neurodegeneration. Professor Ooi serves on advisory boards for GenieUs Genomics and the International Society for Neurodegenerative Diseases, and is NSW representative on the Australian Neuroscience Society Council. She is committed to mentoring and science outreach.

Prof Haibo Yu
Chair, Mentoring, Training & Development Portfolio

Professor Haibo Yu leads the Computational Chemistry and Biophysics Group at the University of Wollongong and is affiliated with Molecular Horizons. His research combines physics-based and data-driven computational methods to study complex molecular systems and design molecules with novel functions. He received his PhD from ETH Zürich and completed postdoctoral training in the USA before establishing his group at UOW in 2010. An ARC Future Fellow, he currently serves on the ARC College of Experts and previously on the Scientific Advisory Committee for the National Computational Merit Allocation Scheme. Within QUBIC, Professor Yu investigates quantum effects in biology using multiscale simulations to bridge quantum theory and biological function.

Ooi Lab

RESEARCH FELLOWS

Dr Dzung Do-Ha

Dr Qiang Zhu

HIGHER DEGREE RESEARCH STUDENT

Emma De Costa

Yu Lab

RESEARCH FELLOWS

Dr Nehad Elsalamouny

Dr Anjay Manian

HIGHER DEGREE RESEARCH STUDENTS

Holden Paz

Zahra Raza

Jiawa Wang

Professional Team

Aneesh Issac
NODE ADMINISTRATOR

Flinders University

Research Infrastructure

Flinders University is home to QUBIC Chief Investigator **Prof Michelle Coote,** whose research group operates within the Flinders Institute for Nanoscale Science and Technology in the College of Science and Engineering. Contributing to QUBIC's Molecules Theme, the Coote group combines theoretical and experimental approaches to uncover new chemical mechanisms and design innovative reactions and catalysts.

Computational Chemistry and High-Performance Computing

The Coote group's theoretical research is powered by access to leading-edge computing infrastructure, including:

- Flinders University's Deep Thought cluster, with 1,376 cores and over 6 TB of RAM, supporting large-scale molecular simulations
- Australia's most powerful supercomputer, the Gadi HPC cluster at the National Computational Infrastructure (NCI), with access to over five million core-hours annually through national merit allocations
- Plans for dedicated HPC resources at Flinders beginning in 2025, reflecting ongoing investment in computational chemistry.

These resources enable the group to simulate complex molecular systems and explore non-traditional methods of bond activation with high precision.

Experimental Chemistry and Reaction Engineering

In 2023, Flinders University established a new purpose-built chemical synthesis laboratory through a $2.2 million investment. This facility supports the synthesis and characterisation of small molecules and polymers, and includes:

- A Uniqsis PhotoSyn photoreactor with a wide range of light sources for photochemical experiments in batch and flow
- A comprehensive electrochemistry suite, including Gamry potentiostats, ElectraSyn reactors, and a continuous-flow ElectroCell MicroFlow Cell
- A Vapourtec R-Series continuous flow reactor with in-line monitoring and automated screening capabilities.

These tools allow researchers to explore novel reaction pathways and develop new catalytic systems with real-time feedback and control.

Advanced Analytical and Materials Characterisation

Within the Flinders Institute, the group also has access to a broad suite of analytical facilities, including:

- The Flinders Analytical suite, featuring mass spectrometry (UPLC, LCMS, MALDI-TOF), gas and liquid chromatography, ICP-OES, and polymer characterisation tools (TGA, GPC, DSC)
- Materials characterisation platforms such as CT, SEM, AFM, Raman spectroscopy, XRD, and photoemission electron spectroscopy, supported by the Flinders Microscopy and Microanalysis node of Microscopy Australia.

Together, these capabilities support QUBIC's mission to understand and manipulate molecular systems with quantum precision—advancing the frontiers of chemical design and discovery.

Our People

Chief Investigator

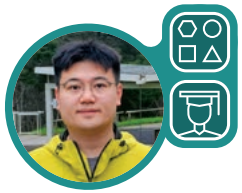
Prof Michelle Coote
Node Leader

Professor Michelle Coote is a Matthew Flinders Professor of Chemistry at Flinders University and a Fellow of the Australian Academy of Science. Formerly a Georgina Sweet ARC Laureate Fellow at ANU, she has held postdoctoral roles in polymer physics and computational chemistry. Her research combines theory and experiment to develop innovative synthetic methods and catalysts, with a focus on non-traditional bond activation using electricity and light. Professor Coote earned her PhD in polymer chemistry from UNSW and has received numerous accolades, including the 2021 RACI Leighton Memorial Medal. She is an Executive Editor of JACS and continues to lead pioneering work in physical organic chemistry and molecular design.

RESEARCH FELLOW

Dr Asja Kroeger

HIGHER DEGREE RESEARCH STUDENT



Zhipeng Pei

Partner Investigators

Prof Jim Al-Khalili
University of Surrey, UK

Prof Julie Biteen
University of Michigan, USA

Dr Timothy Doran
Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Prof Reuven Gordon
University of Victoria, Canada

Prof Liam Hall
Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Prof Fedor Jelezko
Ulm University, Germany

Dr Justine Lacey
Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Prof Miles Padgett
University of Glasgow, Scotland

Prof Martin B Plenio
Institute of Theoretical Physics and Centre for Quantum Biosciences, Ulm University, Germany

Prof Monika Ritsch-Marte
Medical University of Innsbruck, Austria

A/Prof Gabriela Schlau-Cohen
Massachusetts Institute of Technology, USA

Dr Chiara Stringari
French National Centre for Scientific Research (CNRS)

Prof Frank Vollmer
University of Exeter, UK

Prof Laura Waller
UC Berkeley, USA

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Stuttgart University, Germany

Prof Chris Vale
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Dr Rodney Appleby

Orica Australia

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Science Integrity Digest

A/Prof Yun Chen

John Hopkins University

Dr Nicholas Condon

The University of Queensland

Dr Kim Everuss

Evident Scientific

A/Prof Marta Garrido

The University of Melbourne

A/Prof Ivan Kassal

University of Sydney

Mr Norbert Krause

Silanna Semiconductor

Dr Tyler Neely

The University of Queensland

Prof Megan O'Mara

The University of Queensland

Prof Takeshi Ohshima

National Institutes for Quantum Science and Technology (QST)

Dr Manolo Per

Data 61 / Commonwealth Scientific and Industrial Research Organisation (CSIRO)

A/Prof Peter Reece

University of New South Wales

Prof Jeffrey Reimers

University of Technology Sydney

Prof Pankaj Sah

The University of Queensland

A/Prof Alexander Solntsev

University of Technology Sydney

Prof Ruth Wallace

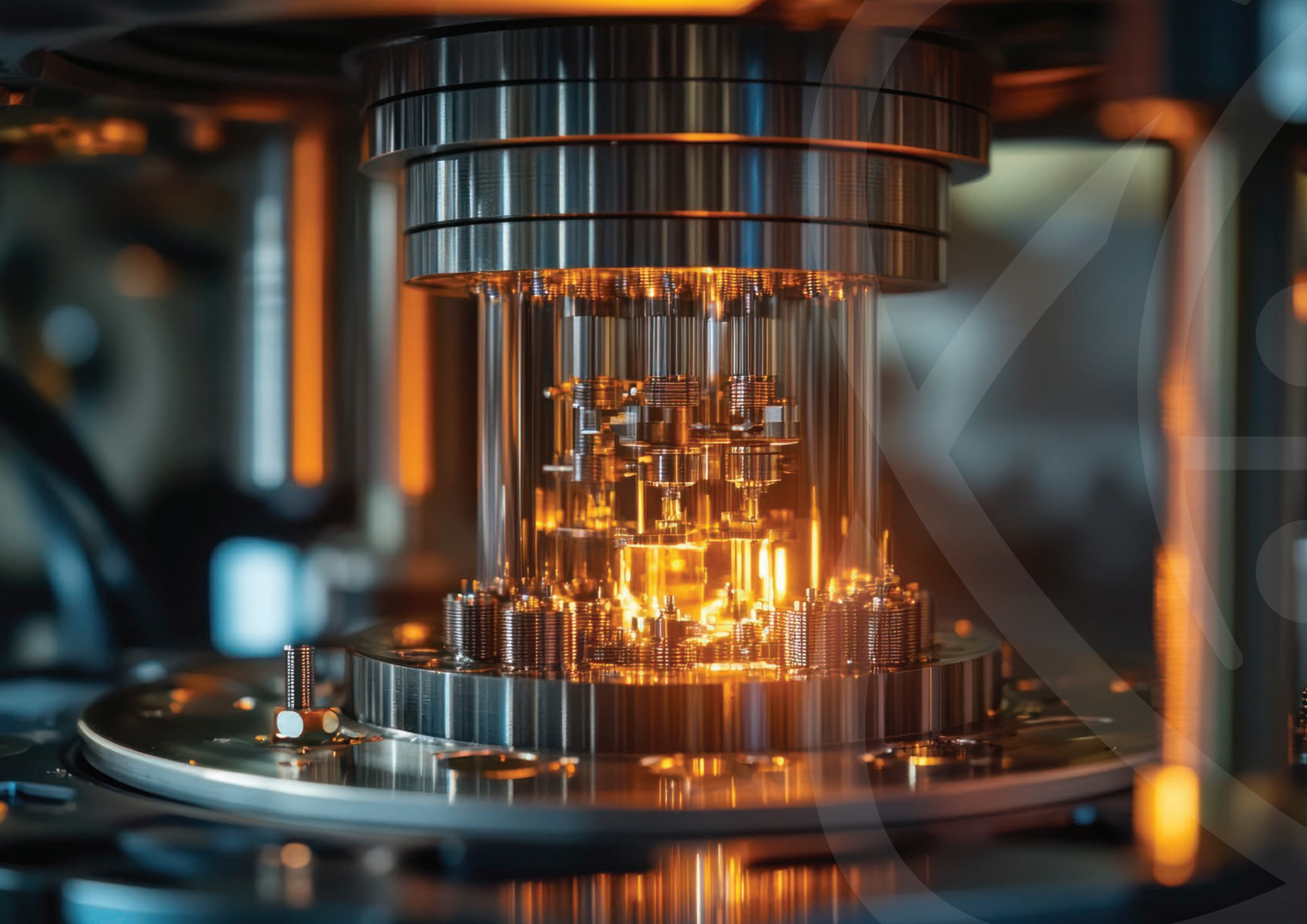
Charles Darwin University

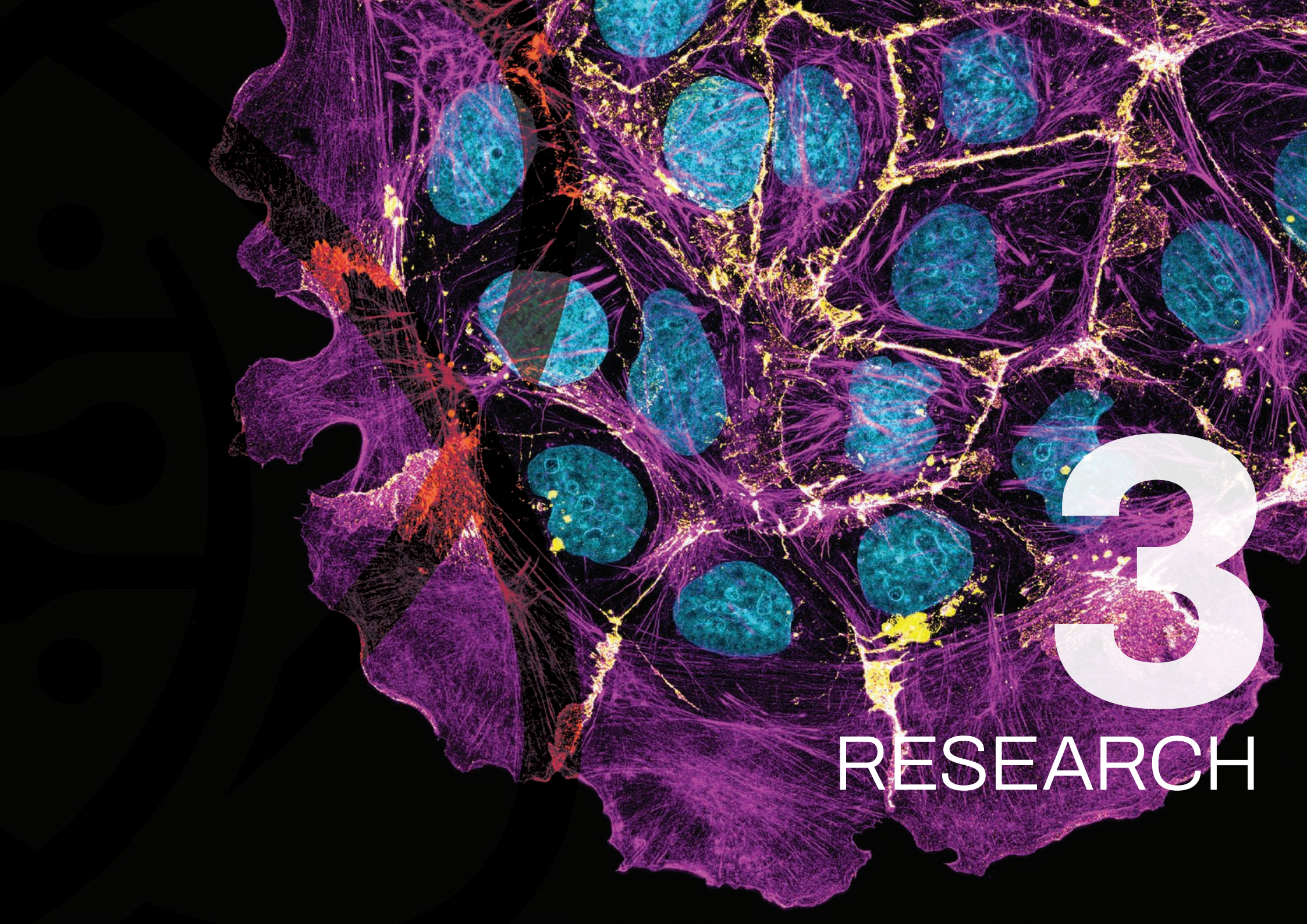
Prof Uta Wille

The University of Melbourne

Dr Leo Zhang

University of Technology Sydney





3 RESEARCH

Message from the Research Committee Chair

It is with great pride that I report on our first year's remarkable achievements and advancements in the field of quantum biotechnology.

Our collaborative efforts across multiple nodes have led to groundbreaking discoveries and innovations, underpinning our commitment to pushing the boundaries of science. We have made significant strides in quantum-controlled studies, voltage sensing and imaging, rapid diagnostic systems, and advanced microscopy techniques.

Our lead node at The University of Queensland has achieved the first all-optical trapping of single proteins using metamaterial cavities, paving the way for quantum-controlled studies of protein dynamics. Researchers at The University of Melbourne node have developed a voltage-sensing and imaging technique and succeeded in measuring the single action potential from signal neurons. The University of Technology Sydney node has invented a rapid screening system to diagnose bacterial antibiotic resistance, towards clinical translations and commercialisation opportunities. The University of Queensland node has also pioneered a new quantum-limited microscopy technique for unlabelled cell imaging, enabling multiparameter analysis with applications in IVF, bacterial infections, and stem cell therapies.

Our researchers have collectively published 31 papers, spanning diverse fields from quantum chemistry and technologies to biomedical imaging. Among these, four high-impact review papers were featured in prestigious Nature journals.

Throughout 2024, QUBIC's Research Committee facilitated robust research collaboration and program planning, strengthening interdisciplinary research across our network. We held six Research Committee meetings, planned the scientific program for our annual symposium, and supported 11 projects involving 17 researchers, allocating $34,795 from a $40,000 travel funding budget to foster inter-node collaboration.

Two inaugural workshops under QUBIC's Molecules, Cells, and Brain themes further advanced collaboration, bringing together 70 attendees from all five nodes and nine research groups. These initiatives strengthened interdisciplinary collaboration, highlighted EMCR contributions, and laid the groundwork for sustained engagement and impactful research within QUBIC. In 2025, we look forward to a QUBIC Joint Themes Workshop encompassing all themes (Molecules, Cells, and Brain), marking a unique opportunity for Early and Mid-Career Researchers to present their research projects, foster collaboration across the Centre, and strengthen interdisciplinary connections.

The Centre attracted significant funding in its first year, enabling advancements in quantum technologies across its nodes. This includes four CTCP Grants for projects such as the development of a quantum spectroscopy system with undetected photons, quantum cascade lasers for infrared cancer diagnostics, and the integration of voltage sensing technology with tissue culture systems. The Queensland Quantum Decarbonisation Alliance, led by QUBIC researchers at UQ, received funding of $30m ($15m in cash, $15m in-kind), leveraging quantum computing and sensing for decarbonisation. Additionally, ARC LIEF funding of $1.6 million will support the establishment of a National Live Cell Analytics Facility for organelle interactomes.

As we reflect on our first year, we are inspired by the progress made and the potential that lies ahead. Together, we will continue to push the boundaries of quantum and biotechnologies, fostering innovation and collaboration to achieve transformative outcomes.

Distinguished Professor Dayong Jin
RESEARCH COMMITTEE CHAIR

Our Research Themes

The Centre bridges quantum and biological sciences, fostering a multidisciplinary environment for transformational research. Our interdisciplinary team spans quantum physics, biophysics, photonics, chemistry, biology, and the humanities, focusing on biomolecules at the quantum-classical intersection to tackle key technological and theoretical challenges.

We have three Research Themes, focused on the three sizescales important to biology: Molecules, Cells, and Brain. Each Theme is underpinned by both theory and experimental capabilities. Theory, Simulation and Quantum Computation focuses on sustaining quantum coherence under physiological conditions. We're exploring collaborations with IBM and Psi-Quantum to help develop algorithms that push the boundaries of classical computation, aiming to control enzyme catalysis and address challenges in hydrogen and ammonia production.

Our experimental aspects focus on three themes: Molecules, Cells and Brain. Molecules, targets single-molecule detection and manipulation, allowing us to observe and control biological assemblies at the single-molecule level. By using advanced quantum technologies, we achieve high sensitivity and speed in detecting and manipulating molecular interactions, enabling us to understand the structure and behaviour of proteins and other biomolecules in unprecedented detail. Cells, addresses challenges of cellular imaging by introducing new high-speed and label-free imaging modalities based on classical and quantum experimental approaches. Non-classical states of light, such as entangled photons and squeezed light are used to reach beyond the classical limits of signal detection and broaden the spectral range of imaging to obtain rich information on cellular behaviour, including active and emergent phenomena in single cells. The Brain theme utilises quantum nanodiamond sensors and quantum optomechanical magnetometers for imaging complex, many-cell neuronal networks and registering electromagnetic activity of the entire brain.

Our **Molecules theme** aims to understand and manipulate peptides and proteins using quantum technologies, achieving high sensitivity and speed in molecular interaction studies.

Our **Cells theme** research employs advanced quantum imaging and sensing technologies to investigate cellular dynamics with nanoscale resolution and ultra-high sensitivity, minimising damage to biological samples.

Our **Brain theme** advances neural imaging through quantum technologies, aiming for real-time imaging of brain electromagnetic fields at sub-cellular resolution. This includes developing quantum-enabled microscopes and room-temperature MEG for non-invasive brain mapping.

Theme 1: Molecules

Theme leads

Prof Alan Mark
The University of Queensland

Dr Liam Hall
CSIRO

Overview

Diagnosing diseases at the molecular level requires a deep understanding of how proteins move and interact. Current techniques struggle to resolve the rapid dynamics essential to protein function, and existing modelling methods often lack the precision needed for accurate predictions.

We're developing quantum sensors to measure protein motions faster than is currently possible and quantum simulations to model them more precisely.

Our focus on biomolecules at the quantum-classical intersection aims to address pivotal technological and theoretical challenges. We explore and manipulate single biomolecules by leveraging advanced quantum technologies, uncovering how quantum effects can influence biological outcomes.

Single Molecule Detection and Manipulation

We are redefining the frontiers of observing and controlling the structure and dynamics of biological assemblies at the single-molecule level. We aim to simultaneously probe the 3D structure, track atomic motions, and manipulate the dynamics of peptides and proteins. By integrating advanced technologies—quantum defects in nano-diamonds, upconversion nanoemitters, and far-sub-wavelength optical cavities—we will achieve unprecedented sensitivity and speed.

Quantum defects in nano-diamonds enable us to detect magnetic field-dependent signals from single molecules, while upconversion nanoemitters help isolate specific signals from background noise. Far-sub-wavelength optical cavities enhance resonance signals and facilitate energy manipulation in collective vibrational modes. Our initial efforts focus on optimising these technologies to deepen our understanding of protein structure and dynamics, ultimately progressing toward complex systems like catalysis.

Theory, Simulation, and Quantum Computation

Alongside our technological advancements, we are enhancing theoretical frameworks for modelling molecules. Our research seeks to accurately simulate biological systems at the atomic level. Understanding these principles is vital for realising the full potential of quantum technologies.

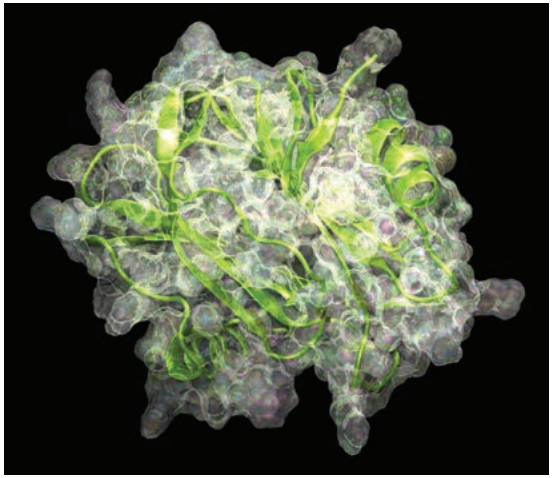
We're controlling enzyme catalysis and addressing grand challenges in hydrogen and ammonia production. By improving the representation of quantum effects in simulations, particularly entanglement and superposition, we can move beyond current limitations that restrict studies to small models. Quantum computing holds the promise of accurately simulating complex molecular processes, enabling us to explore how biological systems have evolved to leverage quantum effects.

We are collaborating with partners to develop innovative algorithms that will push the boundaries of classical computation. Together, we aim to harness these advances to tackle the grand challenges at the forefront of our research.

Key Achievements

The Molecules Theme has made significant strides in advancing quantum technologies and computational techniques to address complex molecular challenges. Key milestones have been met, and several promising new research directions have been identified.

- **Significant advancements in nanoscale sensing and optical biosensing.**
  The Simpson Lab developed techniques that improved nanoscale ESR and NMR readout by four times using NV centres, while the Bowen Lab achieved all-optical trapping of single proteins using metamaterial cavities, enabling extended monitoring. The Yu Lab made progress in optical biosensing by utilising polarisability and fluorescence. Additionally, near-surface NV centres in diamond were created by the Simpson Lab, significantly enhancing sensor sensitivity.



- **Enhancing accuracy and reliability in computational methods for simulating enzymatic systems, molecular forces, and biomolecule phase transitions.**
  The Yu Lab improved the reliability of QM/MM simulations for enzymatic systems, and the Hollenberg Lab adapted Quantum Computed Moments (QCM) methodology for molecular force computations in collaboration with CSIRO. The Mark Lab advanced multiscale modelling of TDP-43 phase transitions and refined force fields for biomolecule simulations, achieving notable improvements in accuracy and transferability.
- **Partnering with the Defense Advanced Research Projects Agency (DARPA) to create quantum light sources on chips for protein detection.**
  The Bowen Lab was awarded $1.5M for a significant new collaboration with Stanford University to develop on-chip quantum light sources for protein detection and applying them into single molecule sensing.
- **Identifying the smallest functional NV-centre model with implications for quantum spin state studies.**
  The Simpson, Mark, and Riemers Labs identified the smallest functional NV-centre model, exploring potential metal analogs with significant implications for quantum spin state evolution studies.

In addition to these milestones, the Molecules Theme has identified new research directions, including leveraging the $30 million Queensland Quantum Decarbonisation Alliance for sustainability applications, collaborating with the Sanger Institute on genome data quantum computing, and developing optical and computational techniques for detecting modified doping agents.

Researcher spotlight

Dr Nehad Elsalamouni is an early-career researcher focused on computational biophysics and biosensor design. Yu Lab, University of Wollongong

Impact Story

Cracking a Cancer Code: How Simulations Are Guiding Smarter Drug Design

Some of the most important breakthroughs in medicine happen at the tiniest scales, like inside our cells, where proteins quietly control life and disease. One such protein, NHE1, plays a key role in helping cancer cells survive in harsh environments.

In a study published in The Journal of Physical Chemistry B, Centre researchers from the University of Wollongong used powerful molecular simulations to reveal detailed insights into how this protein interacts with potential drug molecules. Their findings offer a detailed map of how to block NHE1's activity, paving the way for more targeted and effective cancer treatments.

This work reflects QUBIC's mission to understand life at the molecular level using advanced computational tools. While this study uses classical simulations, it lays the foundation for future quantum-enhanced approaches that could model even more complex biological systems with greater precision.

By showing how drug molecules can latch onto NHE1 and shut it down, the research provides a critical piece of the puzzle in designing next-generation therapies, not just for cancer, but also for heart disease and other conditions where this protein plays a role.

By unlocking molecular-level insights through advanced simulation, this work lays the foundation for a new era of precision medicine.

Published paper: ***Ion Transport and Inhibitor Binding by Human NHE1: Insights from Molecular Dynamics Simulations and Free Energy Calculations*** **(2024)**

Theme 2: Cells

Theme leads

A/Prof Irina Kabakova
University of Technology Sydney

Dr Elizabeth Hinde
The University of Melbourne

Overview

Living cells are highly dynamic systems, where essential functions emerge from the activity of motor proteins and the constant reshaping of internal fibrous networks. Fundamental processes—such as cell signalling, volume regulation, and division—are driven by nanoscale molecular interactions. To explore these complex behaviours, we are developing cutting-edge quantum microscopy and sensing technologies that allow us to observe cells in unprecedented detail. Our innovations will offer faster measurement speeds, nanoscale spatial resolution, and exceptional sensitivity—enabling real-time study of living cells with minimal photodamage to delicate biological structures.

In 2024, the Cells Theme has made significant progress in advancing imaging technologies and quantum-enabled approaches for imaging living cells and characterising organelle-specific properties and functions.

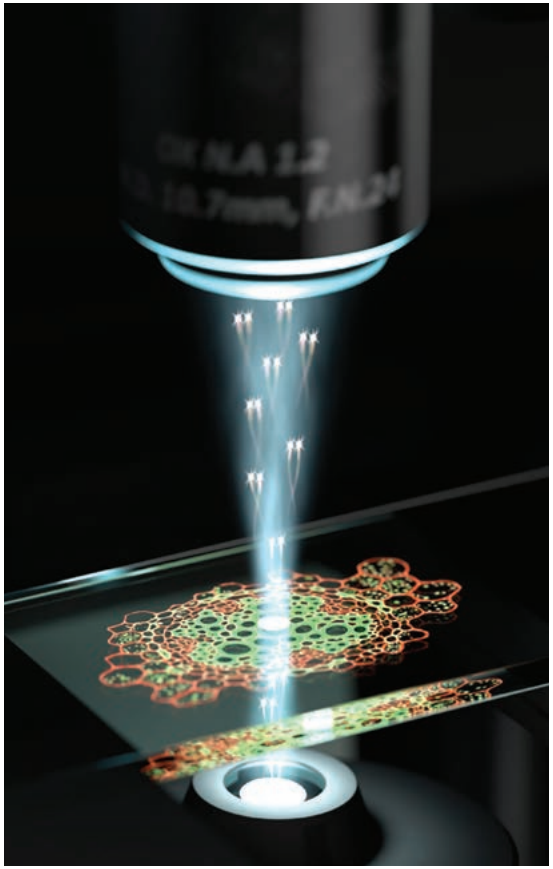
Quantum Imaging Breakthroughs in Living Cells

The main achievements for quantum-enhanced and quantum-enabled approaches were reported for quantum Raman imaging of living cells, demonstrating dynamic imaging of an entire yeast cell within a record time of only 18 seconds. This became possible by careful optimisation of measurement parameters and the use of bright squeezed light to improve the signal-to-noise ratio of Raman light detection.

New levels of precision were also reached for Rotational Optical Tweezers (ROT) measurement, pushing its detection sensitivity to the quantum limit. Ballistic measurements using ROT determine the viscosity of fluids much faster than conventional methods. They have the unique advantage of being calibration-free and use only low laser powers that limit adverse heating effects in biological systems.

New Frontiers in Live Cell Imaging and Microscopy

The first year of the Centre brought many new ideas and developments in the field of live cell imaging, sensing and microscopy. The new research directions identified can be broadly classified into label-free and labelled imaging techniques. For the label-free measurements, a new Light Interference Energetics Microscopy (LIFE) and fast Brillouin imaging have been developed to map cell metabolism and mechanical properties, both of which can serve as important markers of cellular health or indicate pathological processes in cells and tissues. For the labelled advanced imaging methods, the team has developed new Rotational Optical Coherence Scattering (ROCS) microscopy and fast Lattice Light-Sheet microscopy to visualise inter-organelle tubules, advanced molecule uptake studies, and perform quantitative 3D imaging of cells.



2024 Highlights

- Demonstration of quantum-enhanced Raman imaging of living cells with record imaging speed
- Development of Light Interference Energetics Microscopy (LIFE) for unlabelled cell imaging
- Development of fast Brillouin-Fluorescence imaging
- Reaching the quantum detection limit for Rotational Optical Tweezers measurement
- Organelle-specific nanothermometry for Golgi, ER and mitochondria
- Development of Rotational Optical Coherence Scattering (ROCS) Microscopy.

Researcher spotlight

Dr Alex Terrasson is an early-career researcher in the field of quantum optics and biosensing. His research focuses on quantum-enhanced imaging and optical tweezers applied to viscosity and biology measurements. Bowen Lab, The University of Queensland

Looking Ahead: 2025 Priorities

- Quantum-sensing and quantum microscopy based on entangled-photon sources (fluorescence, fluorescence life-time, mid-IR, THz)
- Optimisation and first applications of LIFE microscopy
- Integrating nano-diamond quantum probes with Lattice Light Sheet microscopy
- Development of super-resolution nanothermometry for living cell sensing
- Optimisation of fast Brillouin-Fluorescence imaging system and its application to cancer cell mapping.

Researcher spotlight

Dr Nicolas Mauranyapin is a postdoctoral fellow with over six years of post-PhD research experience specialising in optics, biosensing, bioimaging, quantum optics, and nanomechanics. Bowen Lab, The University of Queensland

Impact Story

Quantum Microscopy Breakthrough Could Help Detect Hidden Threats in Our Food and Bodies

What if we could see the invisible? For example, the tiny molecules that signal disease or contamination without harming the cells we're measuring.

Centre researchers from The University of Queensland have developed a new quantum-enhanced approach to Raman microscopy that uses quantum light to fingerprint molecules in biological samples in greater detail with less damage. This breakthrough could transform how we detect disease, monitor food safety, and study living cells in real time.

The microscope uses a special form of light called squeezed light that allows scientists to gather more information while avoiding damage and disruption on delicate samples. This is a turning point for studying living cells, where traditional imaging methods can be too harsh or too slow to capture fast-moving processes.

The technology builds on QUBIC's mission to develop quantum tools that reveal how life works at the smallest scales. It's part of a broader effort to understand how cells function, adapt, and sometimes fail, all insights that are essential for tackling diseases and improving health.

By combining quantum technologies with microscopy, the team has opened a new window into the living world. This technical achievement is an exciting new way to explore life, protect health, and respond to challenges we can't yet see.

Published paper: ***Fast biological imaging with quantum-enhanced Raman microscopy*** **(2024)**

Theme 3: Brain

Theme leads

Prof Lezanne Ooi
University of Wollongong

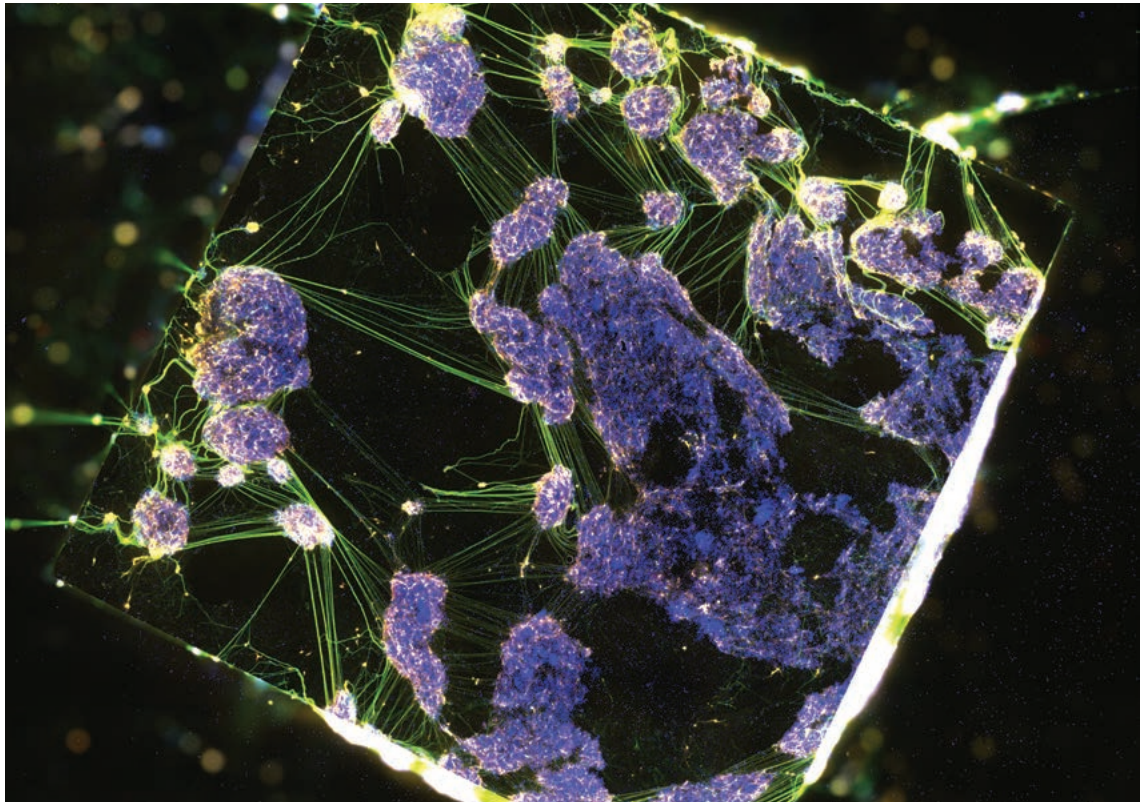
A/Prof David Simpson
The University of Melbourne

Overview

QUBIC's Brain Theme is focused on advancing our understanding of the brain through quantum technologies and imaging techniques. Our vision is to unlock the mysteries of neural networks and brain function by developing revolutionary tools for brain imaging at unprecedented resolution and scale.

Our overarching grand challenge is to achieve real-time imaging of brain electromagnetic fields at sub-cellular resolution. The human brain has 86 billion neurons connected through 100 trillion synapses and represents one of the most complex systems in nature. Unravelling how this intricate network gives rise to cognition, perception, and behaviour requires observing neural activity across the brain with single-cell precision.

This program focuses on quantum microscopy in developing novel quantum-enabled microscopes to push the boundaries of neural imaging; room-temperature magnetoencephalography (MEG) with record-breaking sensitivity for non-invasive brain mapping; and real-time quantum-enabled brain imaging in model organisms.



Key Achievements

The Brain Theme has made significant advancements in quantum-enabled technologies for neuroscience, achieving key milestones and driving innovative applications in brain research.

Quantum-Enabled Electrophysiology

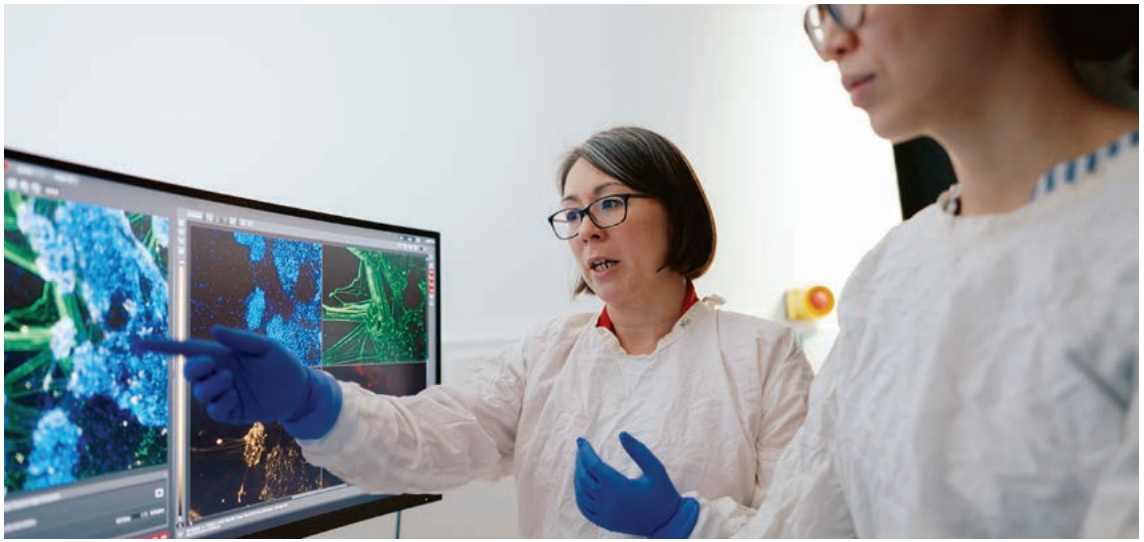
The Simpson Lab demonstrated the first single action potential recording using diamond voltage imaging technology, representing a major step forward in electrophysiological measurements. The next step will be to build another all optical electrophysiology set-up in another node in the Ooi lab at UOW. This will allow the transition towards measurements in cells and organoids (3D tissue structures).

Looking Ahead: 2025 Priorities

- Develop the first all-optical quantum electrophysiology microscope that enables recordings of neuronal activity in neurons, organoids and whole brains
- Develop the first quantum light-sheet microscope and combine this with novel upconverting nanoparticles to provide unprecedented neuronal imaging capabilities at physiologically relevant low light intensities
- Demonstrate room temperature magneto-encephalography (MEG) with record sensitivity
- Cross Theme activities in TDP-43 condensate formation and aggregation, including modelling, in-vitro and in-cell experiments
- Cross Theme activities in optomechanical measurements of single cells.

"Prolonged NIR-II luminescence with strong temperature resilience enhances the clarity and penetration depth of optical imaging techniques, offering potential benefits for applications that demand stable performance in thermally challenging environments."

Prof Jiajia Zhou,
University of Technology Sydney



Impact Story

Heat-Activated Imaging: New NIR-II Material Glows for a Longer Lifetime

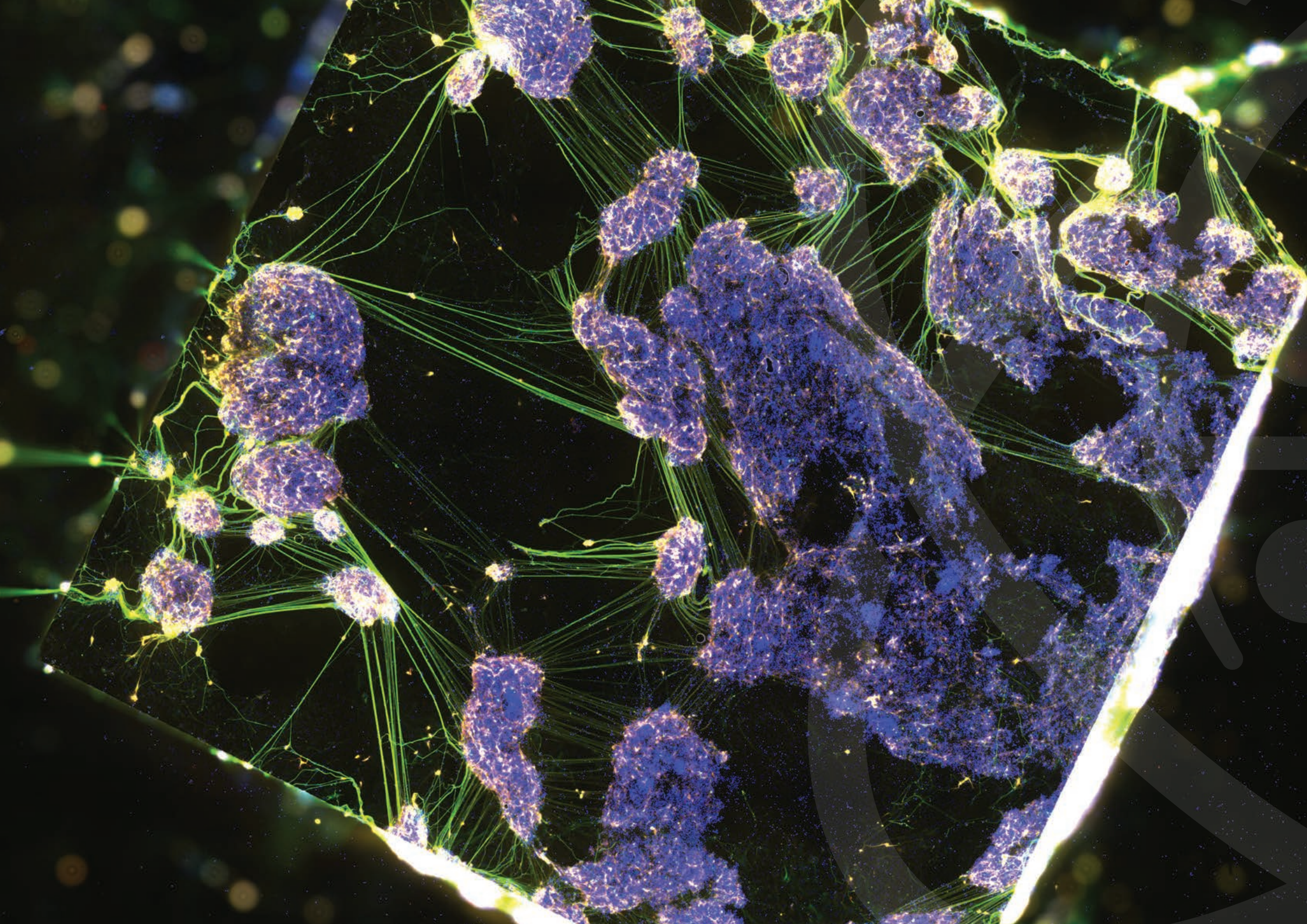
Seeing deep into the brain without harming delicate tissue is one of the biggest challenges in medical imaging. Centre researchers have developed a new material that could help by glowing longer and more stably as temperatures rise.

In research published in Nano Letters, our team at the University of Technology Sydney created a material that emits long-lasting near-infrared (NIR-II) light, which is ideal for deep-tissue imaging. Unlike traditional materials that fade when they heat up, this one becomes even more luminous, making it easier to see what's happening inside the body, which is potentially useful during surgery or in areas where temperature changes are common.

This research supports QUBIC's mission to develop quantum-enabled technologies that reveal the inner workings of living systems. The material leverages the quantum properties of lanthanide ions, namely their stable, discrete energy levels by pairing special energy levels of different ions to enable more efficient energy transfer at higher temperatures. This clever design turns thermal fading, which is a long-standing problem, into an advantage allowing for clearer, more stable imaging when it's needed most.

This innovation demonstrates how quantum-inspired materials can enhance optical performance, particularly for deep tissue imaging. By advancing the fundamental understanding of energy transfer in lanthanide systems, this work contributes to the development of next-generation imaging materials that could support neurological research, where non-invasive, high-resolution access to brain structures is critically needed.

Published paper: ***Thermally Prolonged NIR-II Luminescence Lifetimes by Cross-Relaxation (2024)***



4

CAPACITY BUILDING AND CULTURE

Inclusivity, Diversity, Ethics & Access

Creating a Culture Where Everyone Can Thrive

At QUBIC, inclusivity, diversity, ethics and access are not just values, they are essential to scientific excellence and innovation. We believe that a diverse and inclusive research environment leads to better ideas, broader perspectives, and more impactful outcomes. By actively removing barriers and creating opportunities, we are building a Centre where everyone, regardless of background, identity, or circumstance can contribute and succeed.

This year, QUBIC launched the Inclusivity, Diversity, Ethics and Access (IDEAs) Portfolio, a cross-Centre initiative to embed inclusive practices into every aspect of our research culture. From scholarships and fellowships to training and outreach, our programs are designed to support underrepresented groups, foster ethical research, and ensure that QUBIC is a welcoming and empowering place for all.

The QUBIC Early-Mid Career Researcher (EMCR) Committee was established in 2024 and fosters a sense of belonging and professional growth through inclusive networking, development opportunities, and cross-node collaboration. Committed to diversity and inclusion, the committee creates welcoming spaces, both online and in-person that support connection, knowledge-sharing, and equitable participation across all five QUBIC nodes.

Demographics

Program Personnel	Woman / Female	Man / Male	Non-binary	Different Term	Prefer not to answer	Total
Chief Investigators	9	7	0	0	0	16
Postdoctoral Researchers / Research Fellows	14	26	0	0	0	40
Administrative Staff	7	2	0	0	0	9
Total	**30**	**36**	**0**	**0**	**0**	**65**

Student Personnel						
PhD Students	19	24	0	0	0	43
Honours / Masters	0	4	0	0	0	4
Undergraduate Students	1	1	0	0	0	2
Total	**20**	**29**	**0**	**0**	**0**	**49**

Culturally and Linguistically Diverse (CALD) Personnel	51

Initiatives

The following initiatives were implemented in 2024 to support our community:

Aspire Fellowship
Two-year salary support for an early-career researcher to join a QUBIC Chief Investigator's group, supporting career progression and research excellence.

Responsible Science Initiative
A Centre-wide program providing training and resources on ethics, equity, openness, reproducibility, and responsible authorship.

Caregiving Support Program
Practical support for researchers balancing caregiving responsibilities, enabling participation in conferences, events, and professional development.

National Equity Support
Funding for underrepresented students and researchers to attend key STEM events, including the inSTEM Conference and the National Youth Science Forum (NYSF).

LGBTQ+ Inclusion Awareness Training
An expert-led Summer School workshop building foundational knowledge and practical skills to support LGBTQ+ inclusion through engaging activities and discussions.

Mentoring Program
QUBIC's mentoring program, launched via MentorLoop, fosters inclusive, ethical, and accessible career development by connecting researchers across nodes and ARC Centres.

2024 Highlights

Responsible Science Seminar

Over 150 attendees joined Dr Elisabeth Bik's powerful talk on scientific integrity, hosted by QUBIC's UTS node.

Embedding IDEAs Across QUBIC Events

From LGBTQIA+ awareness training at the Summer School to authorship workshops at the Cells and Brain Theme Workshop, IDEAs topics were integrated into all major QUBIC activities.

Partnership with the Native Academy of Space, Science and Innovation (NASSI)

QUBIC hosted Indigenous high school students for lab tours and welcomed NASSI Director Dr Samarra Toby as a keynote speaker at the Annual Symposium.

Scholarship Support for NYSF

Travel scholarships enabled LGBTQIA+ and regional students to attend the NYSF STEM Summit and Year 12 Summer Program.

"I would not have been able to attend this awesome program without their [QUBIC's] help. I had an amazing time and I was able to network with a broad range of people from various different STEM fields!"

Zeb, NYSF travel scholarship recipient

Looking Ahead: 2025 Priorities

- Launch the Responsible Science Seminar Series and website, with a focus on early-career researchers
- Refine and expand 2024 initiatives based on community feedback
- Lead QUBIC's contribution to the inSTEM Conference, advancing equity across the ARC Centre network.

Aspire Fellowship: Advancing Neurodegenerative Disease Research

Dr Nehad Elsalamouny, a postdoctoral researcher at the University of Wollongong, was awarded the inaugural Aspire Fellowship.

"My Aspire Fellowship project focuses on designing new protein binders that target TDP-43, a protein linked to several neurodegenerative diseases. Using a combination of AI-driven and physics-based approaches, I aim to develop nanobodies for precise imaging, quenchbodies for real-time biosensing, and binders that can help modulate TDP-43's pathological interactions—advancing both diagnostics and therapeutics.

I completed my PhD in synthetic and computational chemistry at the University of Wollongong in 2021 and have since worked as a postdoctoral researcher in protein design, collaborating across academia and industry.

Having immigrated to Australia from Egypt in 2014, I've built my life and career here while raising two young children. This fellowship supports my transition to independent research and allows me to continue contributing meaningfully at UOW—both scientifically and personally. As a woman from a culturally diverse, non-English speaking background, I'm also committed to equity in STEM, championing inclusive representation through my role in QUBIC's IDEAs Portfolio."

Creating Connections & Advancing Collaboration

A Year of Firsts

In 2024, QUBIC made significant strides in fostering collaboration and creating connections within the quantum biotechnology community. Through a series of events, including the inaugural Annual Symposium, Summer School, and theme-specific workshops, we brought together researchers, partners, and experts from around the world. These initiatives not only showcased the Centre's emerging talent and cutting-edge research but also strengthened interdisciplinary connections and set the stage for future innovations. The following highlights capture the essence of our efforts and their contributions to the Centre's mission.

QUBIC Inaugural Annual Symposium

The Centre's inaugural Annual Symposium was held from 8-11 December in Noosa and was a real highlight on the 2024 calendar, bringing the whole Centre together for the first time to share research and engage in insightful discussions.

Prof Jenny Stow speaks at the Symposium

Over 115 Centre members, partners and experts in quantum and biotechnology from around Australia and the world, came together for cutting-edge science talks, collaborative sessions from our Portfolios, and inspiring presentations across our three themes: Molecules, Cells, and Brain.

The Symposium showcased QUBIC's emerging talent and fostered meaningful connections within the QUBIC community. A standout was the 3MT Pitch and Poster Session, where students and early-career researchers presented their innovative ideas and research findings in a vibrant and engaging manner. Everyone's enthusiasm and contributions made it a truly memorable occasion.

"The event was a real highlight for me, as it brought the entire Centre together to share our research and engage in insightful discussions."

Professor Warwick Bowen, Centre Director

Inaugural Summer School Ignites Innovation

Following the Symposium was QUBIC's inaugural Summer School, organised and facilitated by the Mentoring, Training and Development Portfolio and the Early Mid-Career Researcher Committee. The Summer School provided a valuable opportunity for participants to deepen their understanding of quantum biotechnology while building meaningful connections across disciplines. The mix of technical sessions, professional development, and networking events fostered an engaging and collaborative atmosphere, allowing attendees to exchange ideas, explore new perspectives, and gain insights beyond their immediate fields of expertise. The interdisciplinary nature of the program encouraged researchers to think broadly about the challenges and opportunities in quantum biotechnology, while the informal discussions and social events helped strengthen professional relationships. As the first edition of this initiative, the summer school set a strong foundation for future training and collaboration, reinforcing the importance of continuous learning and cross-disciplinary engagement within the QUBIC community.

Molecules Theme Workshop: Quantum Sensing Meets Molecular Science

Held at The University of Queensland's Moreton Bay Research Station on Stradbroke Island, the Molecules Theme Workshop brought together 30 researchers from across five institutions. The focus: exploring how quantum tools like NV-centres in nanodiamonds can be used to study single biomolecules in solution.

Sessions ranged from responsible science and quantum sensing to computational chemistry, with strong engagement from early and mid-career researchers. The relaxed island setting fostered open discussion, new ideas, and future collaborations.

Cells & Brain Theme Workshop: Quantum Insights into Toxic Proteins in Neurodegeneration

In October 35 researchers gathered in Wollongong for a joint Cells and Brain Theme Workshop focused on understanding TDP-43, a protein linked to neurodegenerative disease. Day one explored biological and computational studies of TDP-43, while day two showcased quantum imaging and sensing techniques from Brillouin and FLIM to LIFE microscopy and NV diamond sensors.

The workshop concluded with a collaborative session identifying key research questions and quantum approaches to tackle them. The event successfully bridged disciplines and institutions, laying the groundwork for future joint projects.

"The success of these workshops has set the stage for next year's meeting, which will be a combined workshop with the Molecules, Cells and Brain themes coming together to focus on further collaboration and research by our EMCRs."

The Connect Initiative: Fostering Interdisciplinarity and Innovation

The Connect Initiative addresses the key challenges of highly multidisciplinary research by fostering interdisciplinarity and innovation across the Centre. It includes an internship program to connect students with industry and government, a travel program to link students with international partners, and an exchange program to embed quantum researchers in biotechnology labs and bioscience researchers into quantum labs. These initiatives will broaden researchers' skills and build an interdisciplinary culture.

Throughout 2024, the QUBIC Research Committee facilitated robust research collaborations and strengthened interdisciplinary research across Centre networks. There was $34,795 allocated from $40,000 in travel funding to support 11 projects involving 17 researchers, fostering inter-node collaboration. For example, Dr Daniel J. McCloskey from The University of Melbourne is travelling to Wollongong for 10 days to work on Diamond Voltage Imaging Microscopy, exemplifying the type of interdisciplinary collaboration promoted by the committee.

Research Translation

Translating fundamental discoveries & technologies into socioeconomic benefit

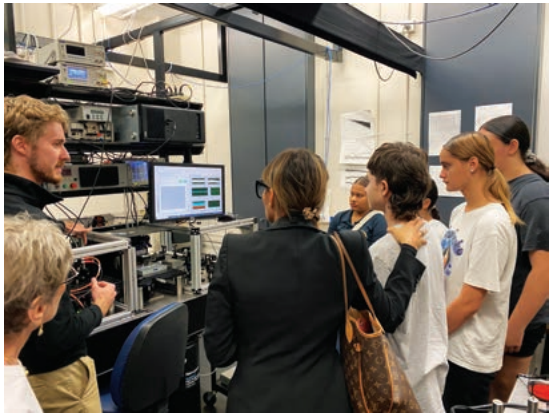
QUBIC is dedicated to facilitating real social change and economic activity through quantum biotechnologies. By establishing a global nexus of innovation, fostering industry and government linkages, and creating a cross-disciplinary, innovation-focused ecosystem, the Centre aims to translate fundamental discoveries and technologies into socioeconomic benefits for Australia.

The Research Translation Program (RTP) is a key portfolio of the Centre, designed to deliver comprehensive translation, intellectual property (IP), and commercialisation training and mentoring. It builds robust industry, government, and commercial relationships to benefit QUBIC researchers and manages the Research Translational Laboratory (RTL). The RTL provides bespoke funding to facilitate the translation of QUBIC research into prototypes, proof-of-principle demonstrations, or other impactful outcomes. These programs are crafted to ensure that our students and early to mid-career researchers have the greatest opportunities to actively participate in translation activities. The aims of the program are to:

- **Provide Training:** Equip QUBIC members with the skills to transform and translate basic research findings into tangible outcomes that contribute to societal betterment.
- **Enhance Knowledge and Skills:** Navigate the complex landscape leading to commercialisation.
- **Encourage and Support:** Motivate Centre members who are keen to translate their research results into practical applications.
- **Fund Translational Research:** Offer fellowships and equipment funding to support translational research efforts.

Establishing Translational Opportunities

The primary goal of the RTP is to encourage serendipitous discoveries in translation and to streamline this process through our programs. A key initiative has been the creation of funding opportunities that RTP will offer throughout the duration of QUBIC. These opportunities have been formalised, approved by the RTP Committee, and are available to all QUBIC students and researchers.



- **QUBIC Translation Facilitation Project** funds QUBIC researchers to enable proof of concept translational studies.
- **QUBIC Translation Fellowship** funds six months full time or 12 months part-time development of ideas and translation of research.

These translational opportunities are designed to provide students and researchers with initial, non-competitive funding to take the first steps in translation by conducting proof-of-concept activities that are typically not covered by academic funding. The aim is to offer numerous opportunities for early-stage ideas to be tested without the risk of discouraging industry partners. This stage also allows for acceptable failure and go/no-go decisions, significantly facilitating project development.

Research Translation Resources and Training

This year, QUBIC launched initiatives to support researchers in turning scientific breakthroughs into real-world solutions, designed to build capability across the Centre and foster a culture of innovation and impact.

A highlight was the Research-to-Industry Experience Workshops, where practical sessions on CV writing for industry, pitching research to non-academic audiences, and networking with industry partners helped researchers build confidence and connections beyond academia.

Online Research Translation Hub

In 2025, we'll establish a dedicated platform to guide researchers through the translation journey—covering essential topics such as What is research translation?, Is my research translatable?, and Steps in the translation process. This hub serves as a go-to resource for anyone looking to explore the commercial or societal potential of their work.

Together, these tools support QUBIC researchers to identify translational opportunities early, navigate the path to impact, and engage more effectively with industry and community partners.

"Through these efforts, RTP can support QUBIC researchers in translating their work into impactful real-world applications."

Prof Halina Rubinsztein-Dunlop

Translation Facilitation in Action

Harnessing Red Light to Improve Honeybee Health and Honey Production

This year a Translation Facilitation Project was awarded to harness red light to improve Honeybee health and honey production. Honeybees are vital to Australia's agriculture and economy, supporting crop growth, livestock feed, and food production through pollination services valued at over $14 billion annually. Studies show that red light exposure may significantly enhance honeybee health. This project aimed to assess whether this could be utilised in cost effective ways in beekeeping practices.

This project was led in the field by Dr Nicolas Mauranyapin from QUBIC who worked together with Simon Chatburn (Head Beekeeper) from HoneyHunters Australia. The team developed modifications to the HoneyHunter beehives to enable red light illumination. As this report goes to print, these modifications have been installed in sixty hives in regional Queensland to test the effect of red light on bee heath and hive productivity.

Bees are critical for pollination in our natural parks and communities. However, biosecurity threats such as the Varroa mite are putting significant pressure on Australian bees, highlighting the importance of improving their resilience.

Dr Nicolas Mauranyapin (left) and Mr Simon Chatburn (right) on site at HoneyHunters Australia located at Sandy Creek about 100km outside of Brisbane.

Partnerships & Industry

Overview

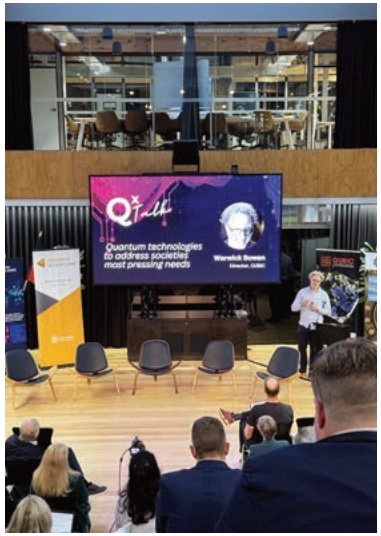
In 2024, QUBIC significantly advanced its mission to foster collaboration and drive the adoption of quantum technologies through a series of strategic industry, government, and community engagement activities. By organising and participating in events such as Quantum Meets Health, in collaboration with prominent partners like Australia's Chief Scientist, AusBiotech, CSIRO, the Queensland Government, and TAFE Queensland, QUBIC successfully brought together quantum experts, researchers, and industry leaders.

These initiatives, along with other key events like those outlined below underscored our commitment to integrating quantum technologies into various sectors, enhancing innovation, and building robust partnerships across the quantum ecosystem, significantly strengthening ties within Australia's innovation landscape and promoting quantum research and education.

Through these engagements, QUBIC continues to build partnerships and raise awareness of quantum technologies across diverse sectors.

Prof Halina Rubinsztein-Dunlop speaking at Quantum Australia

Prof Warwick Bowen at the QUBIC booth at Quantum Australia



Prof Bowen at QX Queensland's Advanced Technologies Future

Prof Warwick Bowen at SomethingQ

Shaping the Future of Quantum Innovation: Spotlight on 2024 Engagements

Quantum Australia (20 February)

Hosted by Sydney Quantum Academy, Prof Halina Rubinsztein-Dunlop and A/Prof David Simpson spoke at the conference about Research Translation and Applications in Quantum Sensing, and QUBIC exhibited at this event.

Science Meets Parliament (20 March)

A delegation of QUBIC researchers from across nodes attended this event to drive the conversation around quantum science and technology in the life sciences.

Office of Games Engagement Launch (18 June)

A special event to celebrate and showcase UQ's Olympic engagement for the 2032 Games with QUBIC in attendance showcasing the future of quantum technologies in sport.

QX Queensland's Advanced Technologies Future (13 August)

Co-hosted with the Queensland Government and EQUS, this event brought together policymakers, investors, and researchers to explore the future of quantum innovation and education in Australia.

SomethingQ (26 August)

QUBIC researchers connected with startups and investors, while also participating in the Female Founders ConnectX and Innovation Ecosystem Mixer—strengthening ties across Queensland's innovation landscape.

Quantum Meets Health (5 September)

In partnership with Australia's Chief Scientist, AusBiotech, CSIRO, and others, QUBIC co-led this landmark event to explore how quantum technologies can transform healthcare. QUBIC researchers contributed as speakers, panellists, and thought leaders.

Inside Advanced Manufacturing Tour (9 September)

As part of a state-wide initiative, QUBIC opened its labs to students and the public, offering hands-on insights into how quantum research is shaping the future of manufacturing.

Native Academy of Space, Science and Innovation (24 September)

QUBIC hosted Indigenous high school students with Dr Samarra Toby for a lab tour, inspiring future careers in STEM and showcasing the real-world applications of quantum science.

PhD Scholarships: Cultivating Future Leaders in Quantum Biotechnology

DETSI X QUBIC PhD Scholarships

In a bold step to harness quantum technologies for environmental sustainability, the Queensland Government's Department of the Environment, Touriem, Science, and Innovation (DETSI) committed $900,000 over three years to support early career research at QUBIC's University of Queensland node.

This investment is focused on developing quantum biotechnology solutions to pressing environmental and sustainability challenges—from monitoring ecosystem health to advancing green technologies for agriculture and medicine.

In 2024, two outstanding PhD candidates were awarded DESI scholarships, with their research commencing in 2025. Their projects reflect the diversity and ambition of QUBIC's mission to apply quantum science for global good:

Sylvia Tan Jin Hui

Measuring environmental stressors and the resilience of cell pathways for nutrition and drug delivery.

Dan Lei

Quantum microbial imaging.

These scholars will work at the cutting edge of quantum sensing and imaging, helping to build a more sustainable and resilient future for Queensland and beyond.

CSIRO Next Generation Quantum Graduates Program

In 2024, QUBIC welcomed its first cohort of Next Generation Quantum PhD Scholars—a group of seven outstanding students selected through the CSIRO Next Generation Quantum Graduates Program (NGQGP). This national initiative is designed to equip Australia's future quantum workforce with the skills, experience, and industry connections needed to thrive in a rapidly evolving, problem-driven landscape.

These scholarships support cutting-edge, cross-disciplinary research at the intersection of quantum technologies and life sciences—spanning quantum physics, biophysics, biology, chemistry, and even the humanities. Each student is co-supervised by QUBIC researchers and industry partners, ensuring their work is grounded in both academic excellence and real-world relevance.

A key feature of the program is a six-month industry internship, paired with a tailored professional development program that builds leadership, communication, and innovation skills. Industry partners include CSIRO, Orica, Q-CTRL, Silanna, Elemental Instruments, and international collaborators from the UK, Germany, and Canada.

Together, these students represent the next wave of quantum innovators—working on projects that could transform sectors from health and agriculture to clean energy and national security.

Program Awardees

Patrick Grant – The University of Queensland

Biohydrodynamics of bacterial-based active matter

Flocks of birds, schools of fish, even swarms of bacteria, life shows us incredible phenomena but why we see them remains a mystery. My projects looks to the microscale, examining swarms of bacteria as active matter and will develop models that may reveal key insights into these curious phenomena.

Hunter Johnson - The University of Melbourne

Fabricating fluorescent, nanopatterned diamond sensors for biological voltage imaging

Thinking too hard about how the billions of cells in the brain connect, speak, and listen to each other is enough to make my head hurt. Using fluorescent diamonds, I am working to shed light on the cellular roadmap formed by brain cells grown in the lab.

Jackson Lucas - The University of Queensland

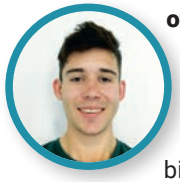
Probing biological dynamics with ultrafast viscosity measurement

I develop laser-based technologies to study how individual proteins bind to cell receptors. This could improve drug discovery by making treatments more targeted and effective.

Callum Macfarlane - The University of Queensland

Development of novel computational algorithms for biotechnological applications

Based in the Molecular Dynamics group at The University of Queensland my project focuses on improving our ability to calculate interactions between molecules at the atomic level, allowing us new insights into drug and material design. Specifically, I am developing new algorithms to represent electrostatic interactions using both classical and quantum computing.



Jack Moody - The University of Queensland

Deep Tissue Imaging

Deep Tissue imaging is important for medical diagnostics and for understanding the function of biological organisms. This project aims to improve medical imaging by using quantum properties of light to better track how light moves through tissue, extending the depth and resolution of imaging.

Zahra Raza - University of Wollongong

Multiscale simulations of TDP-43

My project involves using computer models and simulations to study a protein called TDP-43. This protein is one of the causes for the formation of clumps in the brain that lead to neurodegenerative diseases like Alzheimer's, dementia and ALS. Learning more about this protein could help us prevent these devastating conditions.

Katherine Rock - The University of Queensland

Missing inventions - Why are STEM women underrepresented in patenting?

Women are underrepresented in patenting; in 2019 women comprised only 12% of inventors. The STEM (science, technology, engineering and mathematics) talent pipeline does not fully explain this underrepresentation. Indeed, there is a significant "gap" between the number of women graduating and working in STEM fields and the proportion of women named as inventors on patents. This project aims to understand: What causes **the "patenting gap"**? Why are women **underrepresented in inventing**? Are we **missing inventions**? Quantum biotechnology—a combination of life and physical sciences—offers a fascinating context to investigate the patenting gap in an emerging and multidisciplinary field.

"The scholarship program provides opportunities to communicate with other aspiring researchers from different backgrounds. This is an essential skill to collaborate across disciplines, and I love hearing about what other researchers do with their time! I'm excited to collaborate with other teams within QUBIC on connecting neuroscience and quantum sensing."

Hunter Johnson,
The University of Melbourne

Mentoring, Training & Development

At the heart of QUBIC's mission is the goal to define and grow the emerging field of quantum biotechnology. This means not only advancing research, but also nurturing the next generation of researchers equipped to lead in a multidisciplinary, impact-driven environment.

The Mentoring, Training and Development (MTD) Portfolio plays a central role in this mission by designing and delivering programs that support career development, foster collaboration, and build the skills needed to translate discovery into real-world outcomes.

2024 Highlights

A Centre-wide Mentoring Program

Launched via Mentorloop, this program connects researchers across nodes and disciplines, ensuring tailored support and guidance at every career stage.

The Annual Quantum Biotechnology Summer School

More than just a training event, the Summer School is a cornerstone of QUBIC's development strategy. It brings together students, early-career researchers, and senior leaders to explore the Centre's interdisciplinary themes, build cross-disciplinary understanding, and develop essential skills from science communication to research translation and inclusive leadership.

A 3MT Pitch and Poster Session at the Annual Symposium

Designed to sharpen communication skills, this initiative gave ECRs and students a platform to present their research to diverse audiences.

Undergraduate Internship Program

Developed to provide hands-on experience in quantum biotechnology, this program helps students apply their research in real-world contexts and build professional networks.

Education Pipeline Initiatives

From school outreach to undergraduate and Master's-level engagement, QUBIC is laying the groundwork for a future-ready quantum workforce. The first cohort of Summer Internship students will begin in January 2025.

In Focus: The Inaugural Summer School

Held in December at The University of Queensland, the first QUBIC Summer School brought together 60 participants from across the Centre. The program blended scientific training with professional development, covering topics such as:

- Interdisciplinary research in quantum biotechnology
- Grant writing and publication strategies
- Research translation and industry engagement
- Science communication and AI tools
- Inclusive practices in STEM.

The event fostered a strong sense of community, with networking sessions and social activities that helped build lasting cross-node and cross-discipline connections.

"The Summer School set the tone for how we grow as a Centre not just through research, but through shared learning, collaboration, and a commitment to inclusive excellence."

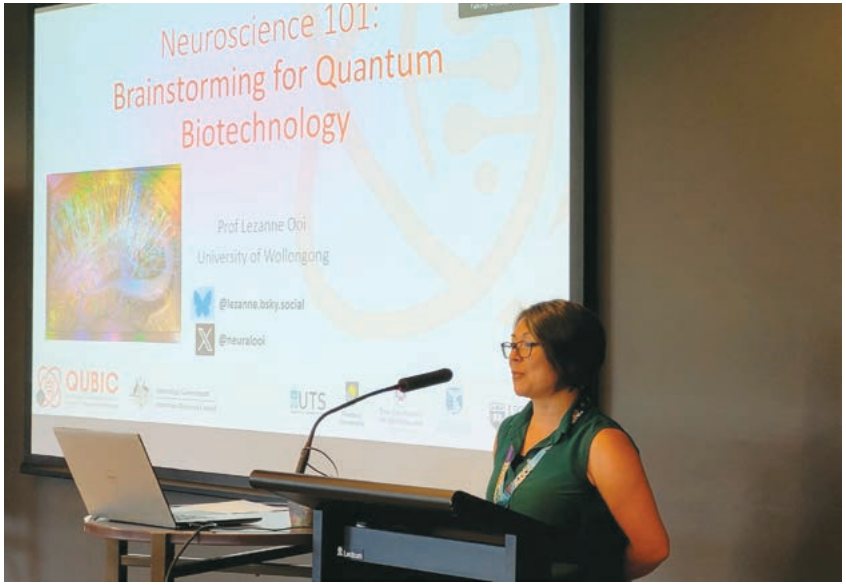
Prof Haibo Yu, MTD Portfolio Chair

2025 Priorities

- Transferable skills training (writing, communication, leadership)
- Quantum Futures Seminar Series
- Quantum Biotechnology Education (including outreach using quantum microscopes).

Key Data

- **5** Summer Internship Programs
- **60** Summer School attendees
- **8** ECR talks at the Annual Symposium
- **52** ECR posters at the Annual Symposium.



Outreach & Engagement

Inspiring the Next Generation and Connecting with Communities

QUBIC is committed to making quantum biotechnology accessible, exciting, and relevant to the broader public. In an era where quantum science is rapidly advancing, the Centre plays a vital role in demystifying complex technologies, inspiring future scientists, and building public trust and understanding.

Through Outreach and Engagement, QUBIC is developing a national presence as a go-to source for quantum biotechnology education and engagement. Our focus includes schools, regional and remote communities, and the general public ensuring that the benefits of quantum science are shared widely and equitably.

2024 Highlights

- Established the O&E Portfolio Committee, bringing together Chief Investigators and Early-Career Researchers from across QUBIC to guide and deliver outreach activities.
- Partnered with the National Youth Science Forum (NYSF) to support remote students with scholarships and campus visits, with the first QUBIC lab tour scheduled for early 2025.
- Hosted Indigenous high school students from the Native Academy of Space, Science and Innovation for a hands-on day of lab tours and demonstrations at UQ.
- Sponsored student-led conferences, including the KOALA physics conference at The University of Melbourne.
- Developed a QUBIC Outreach Toolbox, featuring science games, quizzes, optics demos, and microscopy activities—co-created by attendees at the Annual Symposium.
- Engaged with the public in regional communities about how quantum technologies can be used in Motor Neuron Disease research.

David Simpson at the Koala Physics Conference

Looking Ahead: 2025 and the International Year of Quantum

In 2025, QUBIC will play an active role in the International Year of Quantum Science and Technology, with a packed calendar of public events, school outreach, and national collaborations, including:

- **World Science Festival Brisbane** Showcasing quantum imaging and microscopy to the public.
- **National Quantum and Dark Matter Road Trip** In partnership with the Dark Matter CoE and EQUS, bringing quantum science to rural and remote communities.
- **The Great Little Microscopy Challenge** A hands-on school program where students build LEGO microscopes and explore quantum imaging through inquiry-based learning.

Native Academy of Space, Science and Innovation

In one of the year's most memorable visits, QUBIC welcomed a group of Indigenous high school students to its UQ node. Led by enthusiastic ECRs, the students explored laser optics labs, learned how light can manipulate matter, and toured the Institute for Molecular Bioscience to see how cells and bacteria are grown and imaged. The visit sparked curiosity, inspired questions, and opened doors to future careers in science and technology.

"Wow! Lasers, optics, physics, microscopes and macrophages!"

Student from the Native Academy of Space, Science and Innovation

Dzung Do-Ha speaking at the MND Pedal Cure Fundraiser event

5 GOVERNANCE

Message from the Chief Operating Officer

It's a privilege to contribute to QUBIC's inaugural annual report and to reflect on a year of foundational work and meaningful progress. Since stepping into the role of Chief Operating Officer during a period of transition, my focus has been on stabilising operations, strengthening internal coordination, and supporting the recruitment of a capable and values-driven professional team.

As with any Centre in its establishment phase, the pace and complexity have been considerable. We've worked to meet ambitious expectations while building the systems, processes, and governance structures needed to support QUBIC's long-term success. This has included recruiting staff across executive support, communications and engagement, translation and partnerships, and node administration — each contributing to the Centre's daily operations and broader goals.

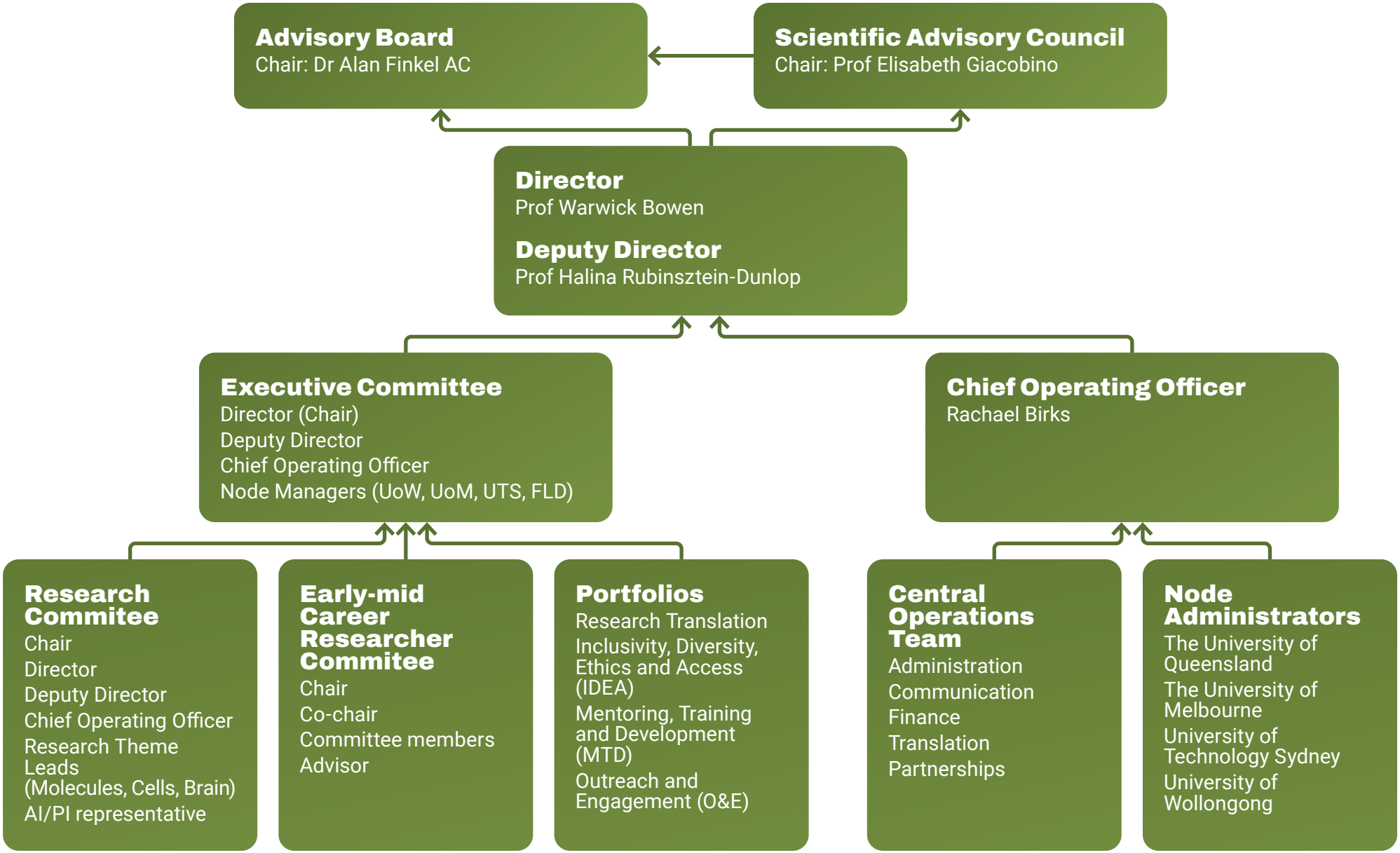
In a fast-moving and often high-pressure environment, I've been guided by a commitment to collaboration, professionalism, and continuous improvement. While much of this work happens behind the scenes, it plays a vital role in enabling QUBIC's research and collaboration. I'm grateful to the team members who've contributed during this foundational phase and remain focused on fostering a culture of integrity, respect, and shared purpose.

QUBIC aspires not only to scientific excellence, but also to be a community that empowers its people, values diverse perspectives, and leads with intention. As we move into the next phase of activity, we'll continue to embed scalable systems, strengthen cross-node coordination, and support the Centre's growth and long-term impact.

Ms Rachael Birks
CHIEF OPERATING OFFICER, QUBIC

"This year has been one of laying essential foundations — strengthening operations, building a values-driven team, and establishing systems that support QUBIC's long-term success. All central to enabling the Centre's research, collaboration, and future impact."

Governance Structure



Advisory Bodies

Advisory Board

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6 PERFORMANCE

Key Performance Indicators

Standard Key Performance Indicators for ARC Centres of Excellence

Performance measure	Target	Actual	2024 Performance rate (50% / 100% / 150% / 200%)	2025	2026	2027	2028	2029	2030
1 Number of research outputs									
Journal articles	40	31	78%	60	80	85	85	85	85
Conference publications (including abstracts)	10	20	200%	17	34	51	51	51	51
Patents	0	2	200%	1	1	1	1	1	1
Invited, keynote and plenary talks	10	106	1060%	30	30	35	35	45	45
2 Quality of research outputs									
Journal publications in top 25% by CiteScore Percentile (obtained from the SciVal database)	80%	89%	111%	80%	80%	80%	80%	80%	80%
Cross discipline/node publications	10%	37%	370%	20%	25%	30%	40%	50%	50%
ECR and MCR fellowships awarded (internal and external)	4	7	175%	6	8	8	8	8	4
Student awards	5	14	280%	10	15	15	15	15	15
3 Workshops/conferences held/offered by the Centre	3	20	667%	4	5	5	5	5	3
4 Training courses held/offered by the Centre	3	12	400%	6	6	6	6	6	5
5 Additional researchers working on Centre research									
Postdoctoral researchers	8	22	275%	17	17	17	17	8	4
Honours, undergraduate and Masters students	8	9	112%	17	17	17	17	8	4
PhD students	17	31	182%	17	17	24	17	8	4
Associate Investigators	6	5	83%	10	10	10	10	10	5

Key Performance Indicators

Performance measure	2024 Target	2024 Actual	2024 Performance rate (50% / 100% / 150% / 200%)	2025	2026	2027	2028	2029	2030
6 Postgraduate completions	0	–		3	12	24	24	24	24
7 Mentoring programs offered by the Centre	3	4	133%	3	3	3	3	3	3
8 Presentations/briefings									
To the public	10	5	50%	10	10	10	20	20	20
School engagement activities	10	4	40%	10	10	15	15	20	20
To industry/government/business/end users	5	22	440%	17	17	17	17	17	17
9 New organisations collaborating with, or involved in, the Centre	1	6	600%	2	4	5	5	5	5
Centre-specific KPIs									
Translational research activities initiated	4	9	225%	6	8	10	10	10	10
Startups	0	–	–	0	0	1	2	2	3
Additional research income $,000	0	–	–	1,000	1,500	2,000	2,500	3,000	3,000

Finance

Statement of Income & Expenditure

Statement of Income and Expenditure for the period ending 31 Dec 2024[1]

Reporting Period	2023/24[1] Actual ($)	2025 Forecast ($)
Opening Balance	–	10,024,968
INCOME		
ARC Centre of Excellence Grant[2]	10,753,654	5,807,379
Administering and Collaborating Organisation Contributions		
The University of Queensland	1,155,511	742,478
The University of Melbourne	331,753	273,323
University of Technology Sydney	396,381	387,925
University of Wollongong	272,285	138,062
Flinders University	54,777	59,239
Partner Organisation Contributions	250,000	125,000
State Government Contributions	750,000	150,000
TOTAL INCOME	**13,964,361**	**7,683,406**
EXPENDITURE		
Personnel	2,712,263	4,010,885
Scholarships	45,506	588,617
Equipment	443,460	303,365
Maintenance and Consumables	167,261	406,925
Travel	265,548	485,426
Other	305,356	650,185
TOTAL EXPENDITURE	**3,939,393**	**6,445,403**
BALANCE CARRIED FORWARD[3]	**10,024,968**	**11,262,971**

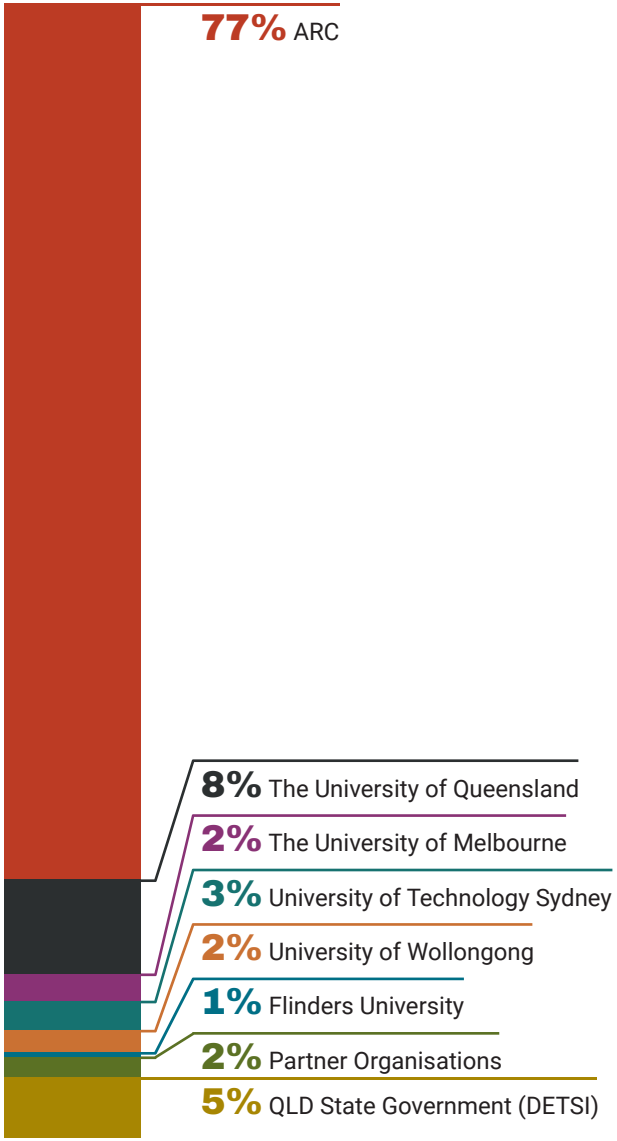
In-Kind Contributions for the period ending 31 Dec 2024

Reporting Period	2023/24 Actual ($)
The University of Queensland	1,746,991
The University of Melbourne	811,859
University of Technology Sydney	485,500
University of Wollongong	1,515,210
Flinders University	136,591
Partner Organisations	409,426
TOTAL IN-KIND CONTRIBUTIONS	**5,105,577**

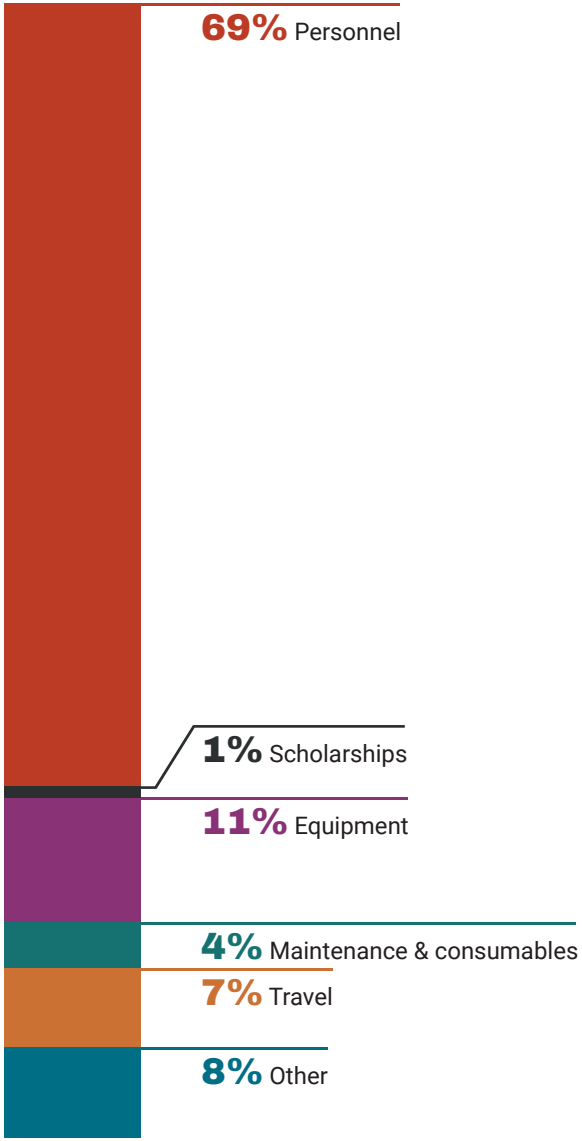
Notes to the Financial Statement

1. The reporting period is inclusive of 2023 given the Centre commenced mid-December 2023.
2. ARC Centre of Excellence Grant Funds are inclusive of Annual Indexation.
3. The carry forward balance includes funds reserved for final year operations due to the Centre commencing mid-December 2023.

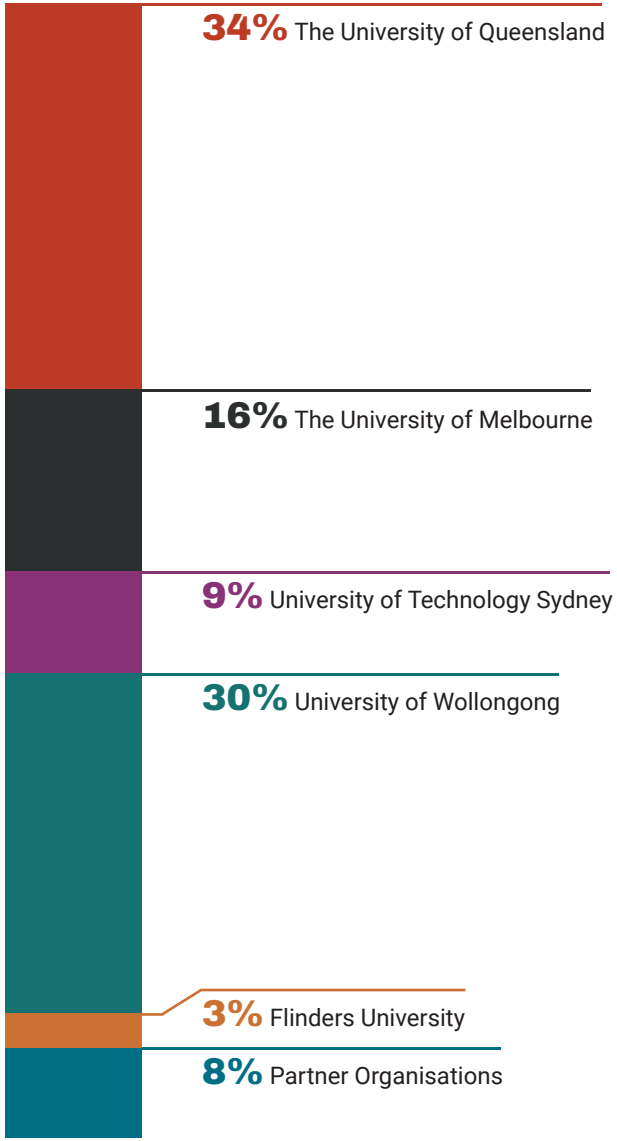
Income Source



Expenditure



In-Kind Contributions



Publications

1 Adekola, T. ***Intellectual Property and Local Pharmaceutical Production: Defining the Need and Meeting the Challenge.*** Contemporary Issues in Intellectual Property Law in Africa, 84-102 (2024).

2 Balaji, S., Fish, A., Sherman, B. ***Disclosure of country of origin in patent applications might not help to protect genetic resources and traditional knowledge.*** Nature Plants, 11, 4–5 (2024).

3 Bowen W.P., Chrzanowski H.M., Oron D., Ramelow S., Tabakaev D., Terrasson A., Thew R. ***Quantum light microscopy.*** Contemporary Physics, 64(3), 169-193.

4 Cai, Y., Shang, Y., Lu, M., Jin, D., Zhou, J. ***Polarized Upconversion of sub-100 nm Single Nanoparticles.*** Nano Letters, 24 (35), 10915-10920 (2024).

5 Chen, J., Chen, F., Wang, X. *et al.* ***Ultra-fast photoelectron transfer in bimetallic porphyrin optoelectrode for single neuron modulation.*** Nature Communications, 15(1) (2024).

6 Cun, W.Y., Bate, C.E., Srikhanta, Y.N. *et al.* ***Design, Synthesis, and Evaluation of Cephamycin-Based Antisporulation Agents targeting Clostridioides difficile.*** Journal of Medicinal Chemistry, 67(1) 450-466 (2024).

7 Defienne, H., Bowen, W.P., Chekhova, M. *et al.* ***Advances in quantum imaging.*** Nature Photonics, 18(10) 1024-1036 (2024).

8 El Salamouni, N.S., Buckley, B.J., Lee, R, *et al.* ***Ion Transport and Inhibitor Binding by Human NHE1: Insights from Molecular Dynamics Simulations and Free Energy Calculations.*** Journal of Physical Chemistry B, 128(2) 440-450 (2024).

9 El Salamouni, N.S., Cater, J.H., Spenkelink, L.M. and Yu, H. ***Nanobody engineering: computational modelling and design for biomedical and therapeutic applications.*** FEBS Open Bio, 15: 236-253 (2025).

10 Filipe, E.C., Velayuthar, S., Philp, A. *et al.* ***Tumor Biomechanics Alters Metastatic Dissemination of Triple Negative Breast Cancer via Rewiring Fatty Acid Metabolism.*** Advanced Science, 11(23) (2024).

11 Greenall, H., Carey, B.J., Bulla, D. *et al.* ***Quantitative profilometric measurement of magnetostriction in thin-films.*** Applied Surface Science, 662 (2024).

12 Ho, J., Yu, H., Shao, Y., Taylor, M., Chen, J. ***How Accurate Are QM/MM Models?*** The Journal of Physical Chemistry A, 129, 6, 1517–1528 (2025).

13 Ivanchenko, O., Odnoroh, M., Rolle, F. *et al.* ***2-Cyanopropan-2-yl versus 1-Cyanocyclohex-1-yl Leaving Group: Comparing Reactivities of Symmetrical Trithiocarbonates in RAFT Polymerization.*** Macromolecular Rapid Communications, 45(19) (2024).

14 Kabakova, I., Zhang, J., Xiang, Y., *et al.* ***Brillouin microscopy.*** Nature Reviews Methods Primers, 4(8) (2024).

15 Mahmodi, H., Poulton, C.G., Leslie, M.N. *et al.* ***Principal component analysis in application to Brillouin microscopy data.*** JPhys Photonics, 6(2) (2024).

16 McCloskey, D.J., Roberts, D., Rodgers, L.V.H. *et al.* ***Methods for Color Center Preserving Hydrogen-Termination of Diamond.*** Advanced Materials Interfaces, 11(24) (2024).

17 Navarathna, A., Carey, B.J., Bennett, J.S. *et al.* ***Silicon double-disk optomechanical resonators from wafer-scale double-layered silicon-on-insulator.*** Optics Express, 32(23) 41376-41389 (2024).

18 Qiao, L., Li, M., Cui, Y. *et al.* ***Giant Carrier Mobility in a Room-Temperature Ferromagnetic VSi2N4 Monolayer.*** Nano Letters, 24(21) 6403-6409 (2024).

19 Sadraeian, M., Kabakova, I., Zhou, J. *et al.* ***Virus inactivation by matching the vibrational resonance.*** Applied Physics Reviews, 11(2) (2024).

20 Stilgoe, A.B., Favre-Bulle, I.A., Watson, M.L. *et al.* ***Shining Light in Mechanobiology: Optical Tweezers, Scissors, and Beyond.*** ACS Photonics, 11(3) 917-940 (2024).

21 Stilgoe A.B., Nieminen T.A., Rubinsztein-Dunlop H. ***Computational toolbox for scattering of focused light from flattened or elongated particles using spheroidal wavefunctions.*** Journal of Quantitative Spectroscopy and Radiative Transfer, 331 (2025).

22 Stocks, C.J., Li, X., Stow, J.L. ***New advances in innate immune endosomal trafficking.*** Current Opinion in Cell Biology, 89 (2024).

23 Szabo, R., Dobie, C., Montgomery, A.P. *et al.* ***Synthesis of α-Hydroxy-1,2,3-Triazole-linked Sialyltransferase Inhibitors and Evaluation of Selectivity Towards ST3GAL1, ST6GAL1 and ST8SIA2.*** ChemMedChem,19(16) (2024).

24 Tarsitano, M., Liu Chung Ming, C., Bennar, L., Mahmodi, H. *et al.* ***Chlorella-enriched hydrogels protect against myocardial damage and reactive oxygen species production in an in vitro ischemia/reperfusion model using cardiac spheroids.*** Biofabrication, 17 (2024).

25 Tarsitano, M., Liu Chung Ming, C., Idais, D., Mahmodi, H., *et al.* ***Sericin improves alginate-gelatin hydrogels' mechanical properties, porosity, durability, and viability of fibroblasts in cardiac spheroids.*** International Journal of Bioprinting, 11(1), 327–346 (2025).

26 Terrasson, A., Mauranyapin, N.P., Casacio, C.A. *et al.* ***Fast biological imaging with quantum-enhanced Raman microscopy.*** Optics Express, 32(21) 36193-36206 (2024).

27 Westra van Holthe, N.J., Wang, Z., Lauko, J. *et al.* ***Controlling ligand density and viscoelasticity in synthetic biomimetic polyisocyanide hydrogels for studying cell behaviours: the key to truly biomimetic hydrogels.*** Materials Advances, 5(23) 9458-9470 (2024).

28 Yu, L., Diaz, J., Kroeger, A.A. *et al.* ***Chiral Brønsted Acid-Catalyzed Regio-, Diastereo-, and Enantioselective Formal [2 + 2 + 2] Cycloaddition of 3-Vinyl-1H-indoles with Nitrosobenzenes.*** ACS Catalysis, 14(17) 13269-13282 (2024).

29 Zhang, L., Wen, S., Khan, J.U. *et al.* ***Ultrasensitive Rapid Antigen Test by Geometric Lateral Flow Assays and Highly Doped Upconversion Nanoparticles.*** Analytical Chemistry, 96(42) 16581-16589 (2024).

30 Zhang, M., Wang, B., Cai, Y. *et al.* ***Thermally Prolonged NIR-II Luminescence Lifetimes by Cross-Relaxation.*** Nano Letters, 24 (16), 4877-4884 (2024).

31 Zhang, W.Q., Capelli, M., Li, S. *et al.* ***Fluorescent emission of NV centers in diamond pillars embedded in optical fibers: optimization using a hybrid model.*** Optics Express, 32(26) 46062-46079 (2024).

Outreach & Engagement Activities

QUBIC Seminars

- **9 May** – Prof Dr Heine Linke (Lund University, Sweden), Network-based biocomputation
- **22 May** – Prof Warwick Bowen (UQ), Welcome to QUBIC
- **19 June** – Dr Martin Sadraeian (UTS), Advanced Upconversion Nanoparticle Imaging of SARS-CoV-2 Spike Endocytosis in Live Cells
- **2 July** – Dr Rebecca Coates and Dr Mohan Baruwal Chhetri (CSIRO), Quantum Readiness Across Australian Industry Sectors
- **17 July** – A/Prof Irina Kabakova (UTS), Brillouin microscopy
- **24 July** – Prof Marta Garrido (UoM), Whole Head Optically-Pumped Room Temperature MEG
- **7 August** – Mark Watson (UQ), Investigating the Ballistic Regime with Rotational Optical Tweezers
- **28 August** – Dr Allison Fish and Dr Brad Sherman (UQ), Law, policy, and regulatory issues at the frontiers of the biological sciences
- **4 September** – A/Prof Peter J. Reece (UNSW), Optically Trapped Nanodiamonds for Nanoscale Magnetic Resonance Sensing
- **2 October** – Dr Guy Barry (UQ), Commercialisation at QUBIC
- **16 October** – Dr Muhammad Usman (CSIRO), Advancing Quantum Machine Learning
- **21 October** – Dr Elisabeth Bik (Stanford), Errors and Misconduct in Biomedical Research
- **30 October** – Michael Jones (UoM), Quantum computed moments and application to quantum chemistry
- **4 November** – Dr Phillip Ernst (PsiQuantum), Applying a utility-scale photonic quantum computer to decarbonisation and beyond

Centre Events

- **21-23 August** – Molecules Theme Workshop, Merging Theory with Experiment: Possibilities at the single molecule level
- **14-15 October** – QUBIC Cells and Brain Theme Workshop – Quantum approaches to study the proteinopathy of TDP-43
- **9-11 December** – Annual Symposium
- **11-14 December** –QUBIC Summer School, UQ

External engagement

- **9 February** – FightMND PedalCure Fundraiser event in collaboration with MND researchers at UOW, Dr Dzung Do-Ha presented about quantum technologies to help fight MND, Mollymook (public)
- **20 February** – Quantum Australia Conference, QUBIC booth and talks by Prof Halina Rubinsztein-Dunlop and A/Prof David Simpson, Sydney (government and industry)
- **22 February** – UK Quantum Delegation meeting and tour with Prof Warwick Bowen (government and industry)
- **20-21 March** – Science Meets Parliament attended by A/Prof Irina Kabakova, Prof Lezanne Ooi and Dr Alex Stilgoe, Canberra (government and industry)
- **April** – The Final countdown? Preparing for the Quantum Age, Science at Melbourne Public Lecture by Prof Lloyd Hollenberg, Melbourne (public)
- **April** – Quantum Biotechnology (industry)
- **23 April** – Heads of Zeiss visit UQ node for meeting and lab tour, UQ (industry)
- **May** – LIFE microscopy: Quantum Engineered Imaging (industry)
- **May** – Quantum Biotechnology (industry)

- **1 May** – Career pathway presentation to female high school students from culturally and linguistically diverse backgrounds, Dr Dzung Do-Ha, Wollongong (schools)
- **15 May** – International Day of Light Career Presentation with A/Prof Irina Kabakova , Sydney (public)
- **June** – Optomechanical magnetometry for through-earth communications (industry)
- **13 June** – Centre Director invited to attend the Queensland Quantum and Advanced Technologies Strategy Launch, Brisbane (government and industry)
- **18 June** – Invited guest and booth to Launch of the UQ Office of Games Engagement for UQ node, Brisbane (government and industry)
- **24-28 June** – Year 10 Physics Work Experience Program, UoM (schools)
- **August** – Quantum Biotechnology (industry)
- **13 August** – Queensland's Advanced Technologies Future (QX), co-hosted by QUBIC with government and CoE partners, Brisbane (government and industry)
- **26 August** – Something Digital (Something Fest) talks from Prof Warwick Bowen, participation and collaboration, Brisbane (government and industry)
- **2 September** – QUBIC Launch, UQ (government, industry, partners)
- **5 September** – Quantum Meets Health, booth exhibit and talks by Prof Warwick Bowen, Prof Halina Rubinsztein-Dunlop, Prof Allison Fish, Prof Lezanne Ooi, Brisbane (government and industry)
- **9 September** – Inside Advanced Manufacturing (IAM) industry and public tours, UQ, Dr Guy Barry (industry)
- **10 September** – Presentation at TechWeek24, Dr Pavlina Naydenova (government)
- **19 September** – Presentation at ANFF - AFOSR Technical exchange Meeting, Dr Pavlina Naydenova, Brisbane (government)
- **24 September** – Native Academy of Space, Science and Innovation lab tour with Halina Rubinsztein-Dunlop, UQ (schools)
- **24 September** – Presentation to Advanced Materials and Battery Council, The possibilities and trajectory of quantum computing and sensing by Prof Warwick Bowen, Brisbane (industry)
- **27 September** – How to improve Scientific Writing Workshop with A/Prof Irina Kabakova, Sydney (public)
- **9 October** – Presentation at Biotech X on Quantum technologies for the life sciences, Prof Warwick Bowen, Basel, Switzerland (industry)
- **23 October** – Dean's Public Lecture, A/Prof David Simpson, Melbourne (public)
- **24 October** – CSIRO Quantum Engagement Day, Prof Warwick Bowen (government and industry)
- **November** – Quantum Computing Tutorial for Secondary Students Conference, Prof Lloyd Hollenberg, Melbourne (schools)
- **November** – Quantum-Inspired Therapeutic Roundtable, Invest Victoria, Prof Lloyd Hollenberg, Melbourne (government)
- **November** – Quantum for Pharma (industry)

Boards and Committees

National Quantum Advisory Committee – Prof Lloyd Hollenberg

Standards Australia – QT-001 Quantum Technologies – Prof Halina Rubinsztein-Dunlop

Outreach & Engagement Activities

News and Media

Date	Outlet	Title	Type	Link
16 August	Scimex	Launching Australian Science and Technology Careers at the National Youth STEM Summit	Article	Read here
2 September	News Medical Life Sciences	New research initiative aims to position Australia at the forefront of quantum biotechnology	Article	Read here
3 September	UQ News	A quantum leap for biology	Article	Read here
3 September	American Biotech News	New research initiative aims to position Australia at the forefront of quantum biotechnology	Article	Read here
3 September	Ma Clinique	Une nouvelle initiative de recherche vise à positionner l'Australie à l'avant-garde de la biotechnologie quantique	Article	Read here
3 September	The Quantum Insider	The University of Queensland Launches $30.2M Quantum Biotechnology Initiative to Address Global Health, Energy and Agriculture Challenges	Article	Read here
3 September	The Life Sciences Magazine (Pinterest)	Australia's Quantum Leap: New Initiative to Drive Biotechnology...	Post	
3 September	Writers: Life Sciences Magazine	Australia's Quantum Leap: New Initiative to Drive Biotechnology Innovation	Article	Read here
3 September	Nachrichten Welt	Ein Quantensprung fur die Biologie	Article	
3 September	Twitter @quantumdaily The Quantum Insider	The University of Queensland launched a AU$45 million — about $30.2 million US — ARC Centre of Excellence in Quantum Biotechnology (QUBIC) to address global challenges in health, energy, and agriculture. @UQ_News	Post	
3 September	Twitter @uq_news UQ	#UQ has launched QUBIC - the ARC Centre of Excellence in Quantum Biotechnology, paving the way for advancements in health, energy and agriculture...	Post	
4 September	Targeted News Service (Print Edition)	The University of Queensland: A Quantum Leap for Biology	Article	
4 September	Twitter @qwcevent Quantum World Congress	RT @QuantumDaily: The University of Queensland launched a AU$45 million -- about $30.2 million US -- ARC Centre of Excellence in Quantum Biotechnology (QUBIC) to address global challenges in health, energy, and agriculture.	Post	
5 September	HPC Wire	The University of Queensland Launches Quantum Computing Initiative to Advance Biotechnology	Article	

Date	Outlet	Title	Type	Link
5 September	Inside Quantum Technology	The University of Queensland launches quantum computing initiative to advance biotechnology	Brief	
11 September	Twitter @agiledigital	Australia is set to lead in quantum biotechnology with the launch of QUBIC....	Post	
13 September	Twitter @dynexmoonshots	QT @UQ_News: It's great to see @UQ_News launch a $45 million research initiative, @arc_qubic, to bridge #quantum and biological sciences...	Post	
15 October	The National Tribune	UQ to lead race in anti-doping detection with quantum sensor technology	Article	Read here
15 October	UQ News	UQ to lead race in anti-doping detection with quantum sensor technology	Article	Read here
15 October	Targeted News Service (Print Edition)	UQ to Lead Race in Anti-Doping Detection With Quantum Sensor Technology	Article	
16 October	ABC Radio Queensland Southern Drive	Professor Warwick Bowen speaks on developing quantum sensing technology to detect EPO doping, aiming to ensure a clean and fair competition for athletes in the 2032 Olympics.	Radio	Listen here
26 October	The Sydney Morning Herald	'It's an arms race': The new technology set to give drug-testers upper hand before Brisbane 2032	Article	Read here

Awards, Honours & Prizes

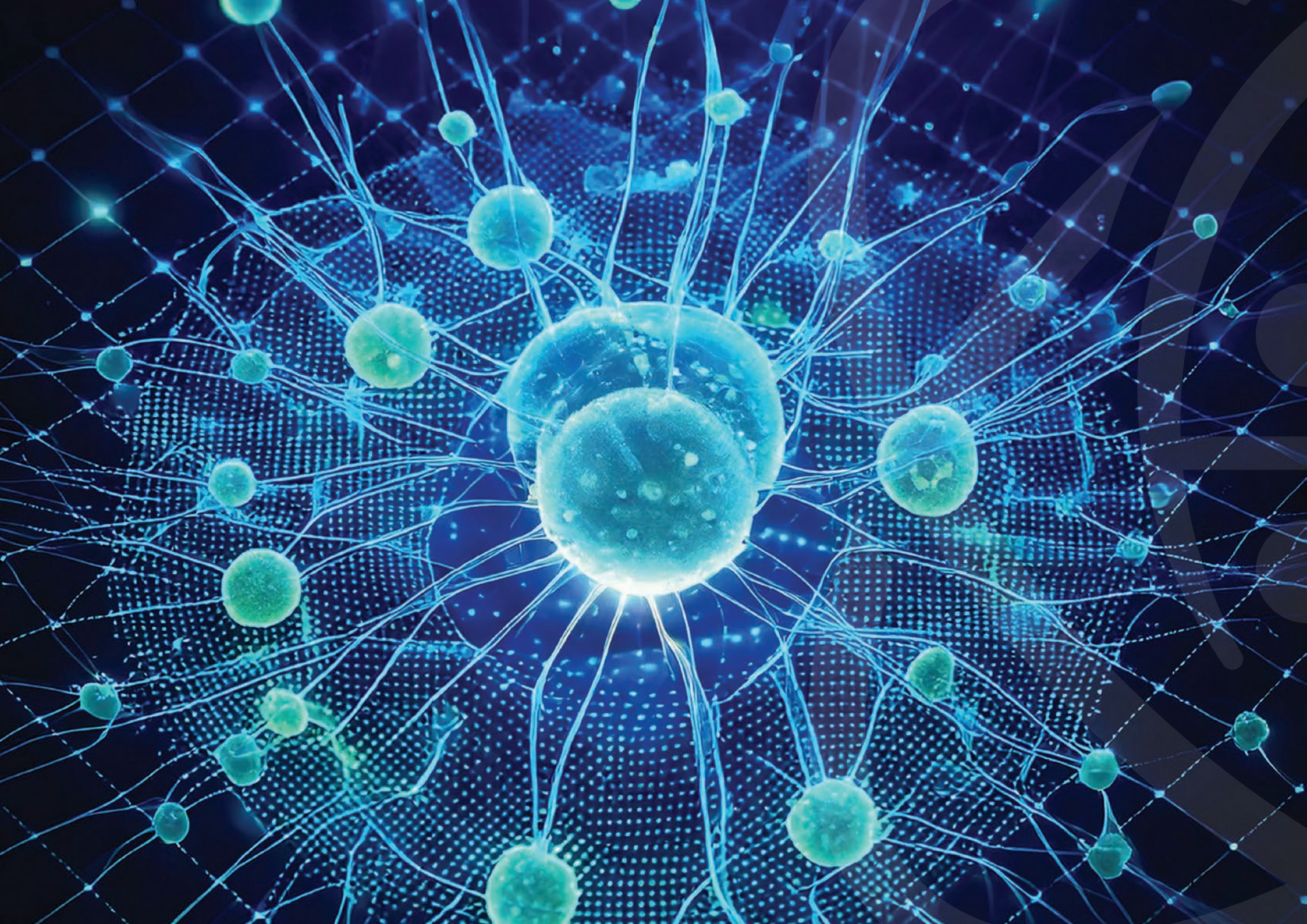
Awardee Name	Details
David Simpson	Awarded the 2024 Australian Institute of Physics Alan Walsh Medal for his groundbreaking work on diamond quantum sensor.
David Simpson	Awarded an ARC Mid-Career Industry Fellowship for his research into next generation diamond quantum sensors for future industries.
Jiajia Zhou	Awarded the 2024 Australian Academy of Science Pawsey Medal.
Halina Rubinsztein-Dunlop	Awarded an Honorary Doctor of Science honoris causa in optics and photonics from the University of Glasgow in June 2024 for her unwavering commitment to the field of physics and advancing women in science.
Halina Rubinsztein-Dunlop	Awarded the 2024 SPIE Directors' Award from the International Society of Optics and Photonics where she has contributed extensively to the society throughout her career.
Patrick Grant and Mark Watson	Both awarded Best Student Oral Presentation at the SPIE-OTOM Optics and Photonics Conference 2024. **Patrick** Tracking Active Matter Particles with Deep Track. **Mark** High Bandwidth Rotational Optical Tweezers for ultrafast and calibration free viscometry in fluids.
Mark Watson	SPIE AIP 2024, Melbourne – Best Student Paper – "Measurements of Hydrodynamic Interactions and Viscometry using Rotational Ballistic Tweezers".
Mark Watson	PhD candidate from the Optical Micromanipulation Group attended the 73rd Lindau Nobel Laureate Meeting in Germany. His research investigates how light interacts with tiny systems.
Mahya Mohammadi	International Research Scholarship – Mahya was the only student from UTS Faculty of Science who received this prestigious scholarship (37,000/annum).
Patrick Grant	CSIRO Next Generation Quantum Graduates Program – Biohydrodynamics of bacterial-based active matter.
Hunter Johnson	CSIRO Next Generation Quantum Graduates Program – Fabricating fluorescent, nanopatterned diamond sensors for biological voltage imaging.
Jackson Lucas	CSIRO Next Generation Quantum Graduates Program – Probing biological dynamics with ultrafast viscosity measurement.
Jack Moody	CSIRO Next Generation Quantum Graduates Program – Deep Tissue Imaging.
Zahra Raza	CSIRO Next Generation Quantum Graduates Program – Multiscale simulations of TDP-43.
Jiawa Wang	Joint UOW-CSC PhD Scholarship - Multiscale modelling of homologous recombination.
Angela Hermann	Best Poster Award at KOALA Conference 2024, People's Choice Awards.
Vrushali Maste	Poster Prize and People's choice awards, QUBIC Annual Symposium Dec 2024.
Kyle Clunies-Ross	First place in 3-Minute Thesis Poster Pitch and tied first People's choice award, QUBIC Annual Symposium Dec 2024.
Katherine Rock	CSIRO Next Generation Quantum Graduates Program – Missing inventions - Why are STEM women underrepresented in patenting?
Max Foreman	2025 John Monash Scholar.
Callum Macfarlane	CSIRO Next Generation Quantum Graduates Program – Development of novel computational algorithms for biotechnological applications.
Dr Daniel McCloskey	Awarded a McKenzie Postdoctoral Fellowship from The University of Melbourne that contributes to research excellence and builds the capability of high calibre scholars at the pivotal early career stage.

Members involved	Name of award grant scheme	Description of award/grant	Funding source	Grant ID	Total funding (AUD)
Warwick Bowen, Jennifer Stow, Dayong Jin, Jiajia Zhou	CZI Deep Tissue Imaging II	Quantum triangulation for deep tissue imaging in NIR-II	Chan Zuckerberg Initiative (CZI), USA		$3,900,000
Warwick Bowen, Alan Mark	QDM (Qld Quantum Decarbonisation Mission)	Queensland Quantum Decarbonisation Alliance (QDA)	Queensland Government Department of the Environment, Tourism, Science and Innovation		$30,000,000
Warwick Bowen, Halina Rubinsztein-Dunlop, David Simpson, Igor Marinkovic, Tyler Neely, Pavlina Naydenova, Nicolas Mauranyapin, Benjamin Carey, Nathaniel Bawden, Fernando Gottardo	Q32C (Qld 2032 Olympic and Paralympic Games Challenge)	Multiple projects: • Quantum-Enabled Low Field Magnetic Resonance Imaging: Technology providing high-performance athletes with advanced imaging capabilities, enhancing injury diagnosis and treatment • Quantum Concussion Diagnostics: Rapid and accurate on-field concussion assessment for athlete safety across various sports • Quantum Exo-Garment: Wearable technology measuring muscle function, to optimise performance and prevent injuries • Quantum Assays for Anti-Doping Control: State-of-the-art method to ensure fair competition by detecting performance-enhancing substances with unprecedented accuracy • Quantum Sensors for Bioelectrics: Quantum sensors for sports assessments through contactless measurement of bioelectrical fields to monitor heart function • Quantum Sensors for Iron Deficiency Detection: Quantum sensors for the ultrasensitive measurement of iron, to optimise athlete health and performance • Strike while the iron's hot • Cavity-Enhanced Rydberg Quantum Sensors for Bioelectrics	Queensland Government Department of the Environment, Tourism, Science and Innovation		$4,700,000

Grant Success

Members involved	Name of award grant scheme	Description of award/grant	Funding source	Grant ID	Total funding (AUD)
Alex Solntsev, Dayong Jin, Jiajia Zhou, Irina Kabakova, Martin Sandraeian	CTCP (Critical Technologies Challenge Program)	Next-Generation Quantum Spectroscopy Diagnostic Platforms for Heart Disease	Australian Government Department of Industry, Science and Resources		$392,000
Warwick Bowen, Benjamin Carey, Nathaniel Bawden, Fernando Gottardo	CTCP (Critical Technologies Challenge Program)	Magnetic through-earth communications for mining	Australian Government Department of Industry, Science and Resources		$252,000
Warwick Bowen	CTCP (Critical Technologies Challenge Program)	Terahertz Quantum Technology	Australian Government Department of Industry, Science and Resources		$415,000
Warwick Bowen	DARPA	Developing on-chip squeezed light sources and applying them into single molecule sensing. $10.6M, led by Stanford University, QUBIC subcontract ($1.5M) led by Prof Warwick Bowen	The Defense Advanced Research Projects Agency (US Department of Defense)		$1,500,000
David Simpson	CTCP (Critical Technologies Challenge Program)	Quantum Enabled Platform for neurological drug discovery	Australian Government Department of Industry, Science and Resources		$329,000
David Simpson	Australia's Economic Accelerator (AEA) Ignite	Advancing Quantum Tech to transform the diagnosis and management of iron disorders	Australian Federal Government		$322,000
David Simpson	ARC Mid Career Industry Future Fellowship	Next generation diamond quantum sensors for future industries	Australian Research Council (ARC)	IM240100073	$1,140,000
Dayong Jin, Jiajia Zhou & Leo Zhang	ARC Linkage Infrastructure, Equipment and Facilities (LIEF)	National Live Cell Analytics Facility for Organelles' Interactome Discovery"	Australian Research Council (ARC)	LE250100063	$2,184,950
Lezanne Ooi	ARC Linkage Infrastructure, Equipment and Facilities (LIEF)	Mass Spectrometer for Label-Free Molecular Imaging at Ultra-High Resolution	Australian Research Council (ARC)	LE250100150	$1,281,990
Lezanne Ooi	Michael J Fox Foundation for Parkinson's Research (MJFF)	Phenotyping environmental exposure to long-lasting chemicals, nanoplastics and pesticides in iPSC dopaminergic neurons and glia	Michael J Fox Foundation for Parkinson's Research (MJFF)	MJFF-025644 2025-2026	$384,075

Members involved	Name of award grant scheme	Description of award/grant	Funding source	Grant ID	Total funding (AUD)
Lezanne Ooi	Michael J Fox Foundation for Parkinson's Research (MJFF)	Assessment of electrophysiological and mitochondrial phenotypes in neurons, astrocytes and microglia from SNCA triplication lines	Michael J Fox Foundation for Parkinson's Research (MJFF)	MJFF-025639 2025-2026	$410,755
Lezanne Ooi	MNDRA MonSTaR MND Research Grant	Screening small molecules to promote innervation in a motor neuron disease neuromuscular junction patient stem cell model 2025	Motor Neurone Disease Research Institute Of Australia		$1,000,000
Lezanne Ooi	NHMRC Centres of Research Excellence	Centre of Research Excellence in Mechanisms In NeuroDegeneration – Alzheimer's Disease (MIND-AD CRE)	National Health and Medical Research Council (NHMRC)	NHMRC CRE 2035494	$5,000,000
Haibo Yu	ARC Discovery Project	Hydrogen storage and delivery by novel hydrogen-rich molecules	Australian Research Council (ARC)	DP250103803	$540,000
Haibo Yu	National Computational Merit Allocation Scheme	Computer simulations of molecular systems and computer-aided molecular design	National Computational Infrastructure (NCI) Australia	NCMAS-2024-47	$432,000
Qiang Zhu	University of Wollongong Vice-Chancellor's Research Fellowship	Physics and Data-Driven Approaches for Biomolecular Condensates	University of Wollongong		$530,000
Elizabeth Hinde and Michael Mlodzianoski	Pierce Bequest	Quantum enhanced fluorescence lifetime imaging	The University of Melbourne		$20,000



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