UNSW Nuclear Innovation Centre

Advancing Australia's nuclear technology for global impact

UNSW SYDNEY

2024 Annual Report

Powering the Future of Nuclear Technology

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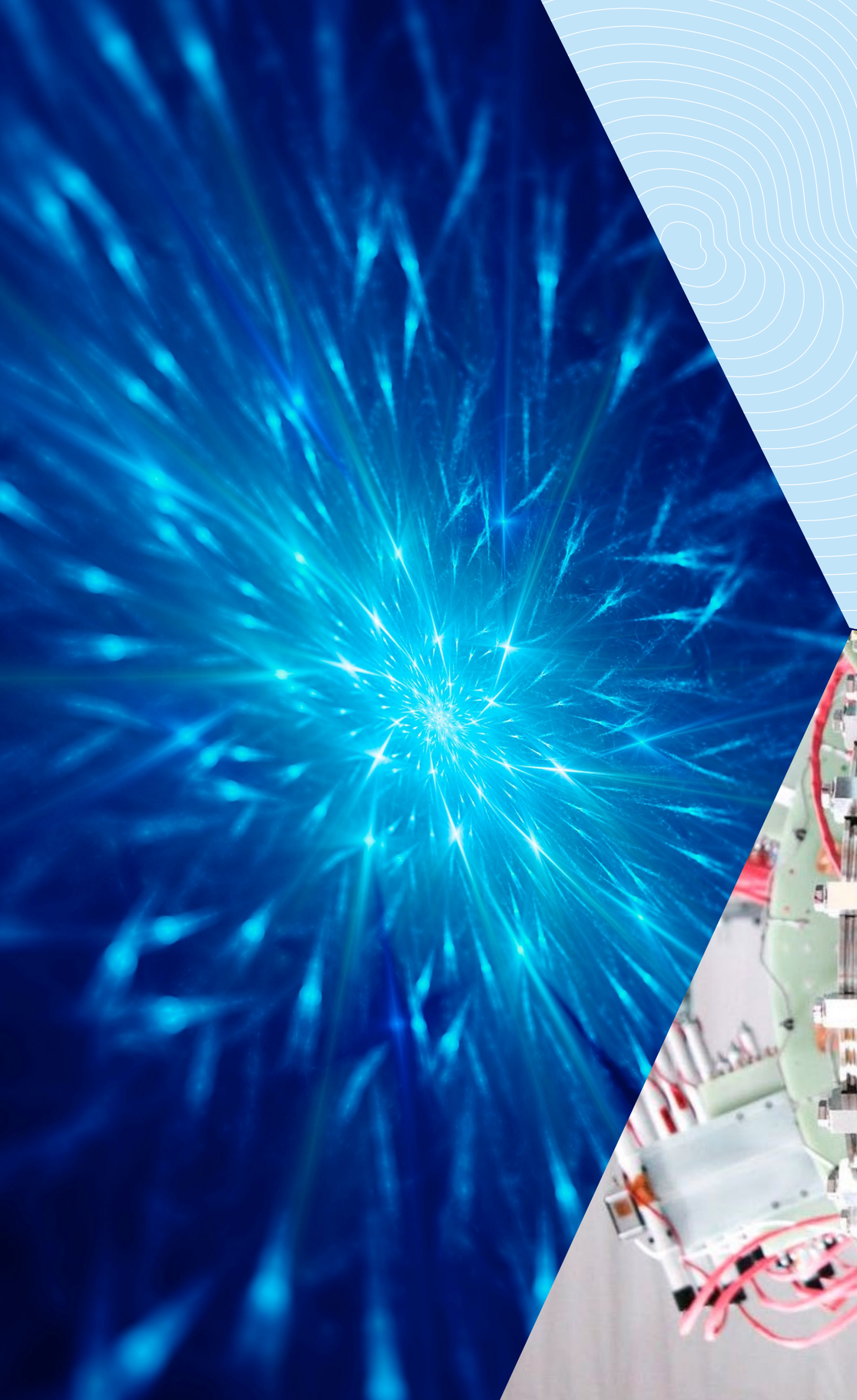
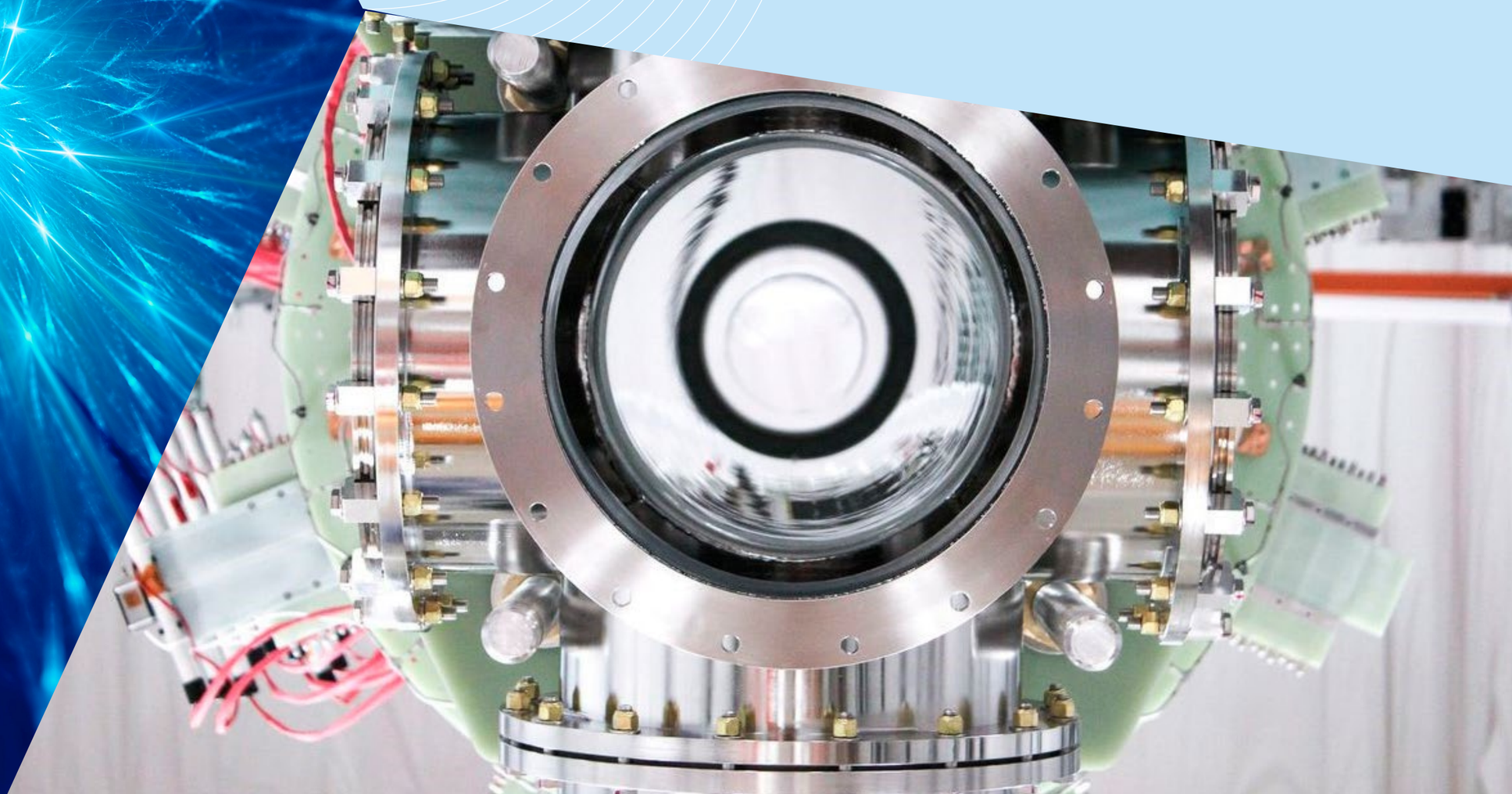




Acknowledgement of Country

UNSW respectfully acknowledges the Bidjigal, Biripai, Dharug, Gadigal, Gumbaynggirr, Ngunnawal and Wiradjuri peoples, on whose unceded lands we are privileged to learn, teach and work. We honour the Elders of these Nations, as well as broader Nations that we walk together with, past and present, and acknowledge their ongoing connection to culture, community and Country.

Message from the Director

I am immensely proud to deliver the UNSW Nuclear Innovation Centre's first annual report, detailing our remarkable growth and achievements in our launch year.

UNSW Sydney has a long history in nuclear engineering, dating back to 1954 when it became the first university in Australia to offer a nuclear engineering program. Seventy years on, the Centre is ensuring the University remains at the forefront of nuclear innovation, combining cutting-edge research with world-class education.

UNSW's commitment to excellence and its standing as Australia's top-ranked university for engineering and technology make it uniquely positioned to support a new era of nuclear capability. Our mission at the Centre is to build a full suite of education and research training programs needed to ensure innovation, excellence and success in all Australia's nuclear endeavours.

None of this would be possible without the generous support of the Sir William Tyree Foundation. The incredible $7.5 million gift will drive the Centre's vision over the next decade, enabling UNSW to maximise its contribution to Australia's nuclear research and training community.

This year, we launched a Nuclear Engineering minor degree, welcoming our first cohort of students alongside a bespoke graduate certificate program for the Department of Defence. Our short courses – developed with leaders from MIT, Imperial College London and the Stimson Center – are connecting and inspiring a generation of nuclear professionals. Learning initiatives such as the AtomCraft project are giving students hands-on experience in nuclear technology, right here on campus.

Our research portfolio is expanding rapidly, bringing together experts from UNSW, ANSTO, the University of Sydney and the University of Wollongong. Our advisory board includes two chief scientists, while our research community includes world-renowned scientists such as Scientia Professors Ewa Goldys, Victor Flambaum and David Waite, who are pioneering work on radiopharmaceutical healthcare, the

Th-229 atomic clock and radionuclide transport in the biosphere, respectively. Associate Professor Patrick Burr is employing the OPAL reactor at Australia's Nuclear Science and Technology Organisation (ANSTO) for fusion materials research. Professor Anatoly Rozenfeld and Ewa Goldys are driving advancements that will transform health care, while early-career academics Dr Matthew Brand and Dr Jennifer Stansby are making groundbreaking contributions to radiation damage measurement and reactor fuel design.

In our first year, our priorities have been to set up our governance, build education programs, attract and recruit talent to the Centre, and to build the learning communities that are our foundation. As we enter our second year, we will continue to attract students and talent, and place increasing emphasis on research training and building research communities across universities and industry partners to realise ambitious collaborative research programs.

My sincere thanks go to our exceptional team, especially Program Manager Barbara Vidos, and the dedicated UNSW professional staff who have supported us throughout the year.

The Nuclear Innovation Centre's first year has been extraordinary, and I am excited to see how we grow together to seize the opportunities ahead.

Associate Professor Edward Obbard
Director, UNSW Nuclear Innovation Centre

Establishment and governance

70 years of nuclear innovation at UNSW

UNSW Sydney made history in 1954 as the first university in Australia to offer a nuclear engineering program. Its founding vice-chancellor, Sir Philip Baxter, was a nuclear engineer and the Chairman of the Australian Atomic Energy Commission, indicating UNSW's early leadership in the field.

Building on this proud legacy, UNSW is expanding its nuclear research and education program. In September 2021, the AUKUS trilateral security partnership was announced. With the help of its allies, Australia will operate and must safely regulate nuclear-propelled submarines in the next 10 to 20 years. The Government estimated that by 2040, the nuclear submarine enterprise will employ 20,000 people nationwide.

Australia is already a leading global supplier in nuclear medicine and uranium mining, all of which need a supply of people, innovation and expertise.

Australia has very few civilian organisations that are independent of both industry and government and can provide expert technical and policy advice on nuclear matters – yet this expertise is more critical now than ever.

A thriving civilian nuclear academic community that connects civil society with the Defence-led effort will drive excellence in safety and technical decision-making and help tackle the urgent challenges of pace and scale in Australia's nuclear development.

Launching the UNSW Nuclear Innovation Centre

On 22 February 2024, UNSW launched the Nuclear Innovation Centre – a dynamic hub uniting experts across disciplines and industries to advance Australia's nuclear science industry. From medicine to space exploration, irradiated materials to mining, the Centre fosters collaboration, drives innovation and propels nuclear science and engineering in Australia forward.

"Australia has a long and proud history of excellence in nuclear science and technology, and UNSW has led the way. I can't think of a better time – or a better place than UNSW – to inaugurate a Nuclear Innovation Centre."

Pat Conroy, Minister for Defence Industry, Minister for International Development and the Pacific

Prime Minister Anthony Albanese, US President Joe Biden and British Prime Minister Rishi Sunak met in San Diego in March 2023 to finalise the AUKUS agreement.

From left: Minister for Defence Industry Pat Conroy, Assistant Minister for Defence Matt Thistlethwaite, Dr Peter Tyree AM, Associate Professor Edward Obbard, Professor Verity Firth AM, Professor Sarah Maddison, Robyn Fennell and Lieutenant Colonel Jasmine Diab at the launch of the Centre in February 2024.

"We are growing a nuclear workforce in Australia grounded in academic excellence, diversity and social inclusion, which in turn are foundations for nuclear safety in all of Australia's nuclear activities."

Edward Obbard, Associate Professor and Director of the Centre

Ideally located near ANSTO and a major population centre, UNSW has also been the top university for nuclear engineering education and research in Australia since 2014, making it uniquely positioned for impact. The University is training students from the Department of Defence in nuclear engineering and, through UNSW Canberra at the Australian Defence Force Academy, in nuclear naval propulsion. In 2024, the Faculties of Engineering and Arts, Design & Architecture launched a new minor degree in Nuclear Engineering, driving further progress.

The Sir William Tyree Foundation's investment in the future

The generous $7.5 million donation from the Sir William Tyree Foundation builds on decades of longstanding support. In 2014, the Foundation helped establish Australia's first Master of Engineering Science (Nuclear Engineering) at UNSW. Over a partnership spanning 50 years, the Tyree Foundation has also backed energy, medical innovation and women in engineering initiatives at UNSW.

The gift to the UNSW Nuclear Innovation Centre is enabling research scholarships in nuclear engineering, including the training of 40 top-tier nuclear experts, at a time when Australia is facing a significant shortage of nuclear expertise and the workforce to meet the nation's needs.

"Sir William believed Australia must capitalise on nuclear technologies, and I'm sure he'd be proud of our role in progressing nuclear education and research that will develop the technologies and skills for all possible nuclear futures."

Robyn Fennell, Sir William Tyree's daughter and Chair of the Sir William Tyree Foundation Board

From left: Sir Robin Grimes, Robyn Fennell and Dr Peter Tyree AM

UNSW Nuclear Innovation Centre Executive Team

- **Associate Professor Edward Obbard,** Director
- **Associate Professor Patrick Burr,** Deputy Director Research Collaboration
- **Dr Jennifer Stansby,** Diversity Engagement Partner
- **Barbara Vidos,** Program Manager

Members

Name	Faculty or organisation
Associate Professor Neda Aboutorab	UNSW Canberra
Professor Christoph Arns	Engineering
Professor Seher Ata	Engineering
Professor Lyria Bennett Moses	Law & Justice
Professor Julian Berengut	Science
Dr Dhriti Bhattacharyya	Science/ANSTO
Dr Matthew Brand	Engineering
Associate Professor John Daniels	Science
Professor Andrew Dempster	Engineering
Dr Juan Pablo Escobedo Diaz	UNSW Canberra
Professor Clinton Fernades	UNSW Canberra
Professor Michael Ferry	Science
Scientia Professor Victor Flambaum	Science
Dr Emmanuel Flores Johnson	ANSTO
Dr Esmat (Anna) Ghorbanpour	Engineering
Dr Nicholas Gilmore	Engineering
Associate Professor Bernd Gludovatz	Engineering
Scientia Professor Ewa Goldys	Engineering
Associate Professor Ehab Hamed	Engineering
Dr Tracey Hanley	UNSW Defence Research Institute (DRI)
Professor Salil Kanhere	Engineering
Professor Matthew Kearnes	Arts, Design & Architecture
Dr Taehwan Kim	Engineering
Associate Professor Pramod Koshy	Science
Professor Jay Kruzic	Engineering
Professor Francois Ladouceur	Engineering
Associate Professor Kevin Laws	Science
Associate Professor Xiaopeng Li	Engineering
Dr David Lyons	UNSW Canberra
Dr Graeme Melville	Engineering
Professor Brett Molesworth	Science
Adjunct Professor Ondrej Muransky	Engineering/ANSTO
Dr Luiz Bortolan Neto	Engineering/ANSTO
Associate Professor Robert Niven	UNSW Canberra
Adjunct Associate Professor Giancarlo Pascali	Science/ANSTO
Professor Hamid Roshan	Engineering
Dr Ivo Seitenzahl	UNSW Canberra
Dr Samaneh Setayandeh	Engineering
Professor Neeraj Sharma	Science
Joshua Sherman	UNSW Defence Research Institute (DRI)
Professor Warren Smith	UNSW Canberra
Dr Minh Ngoc Tran	ANSTO
Scientia Professor David Waite	Engineering
Dr Zhiyang Wang	ANSTO
Professor Guan Yeoh	Engineering
Professor Jianqiang Zhang	Science

Steering Committee

- **Professor Julien Epps,** Dean of Engineering
- **Scientia Professor Sven Rogge,** Dean of Science
- **Professor Andrew Lynch,** Dean of Law & Justice
- **Professor Cheryl Jones,** Dean of Medicine & Health
- **Professor Frederik Anseel,** Dean of Business School
- **Professor Emma Sparks,** Dean and Rector, UNSW Canberra at ADFA
- **Professor Claire Annesley,** Dean of Arts, Design & Architecture

International Advisory Board

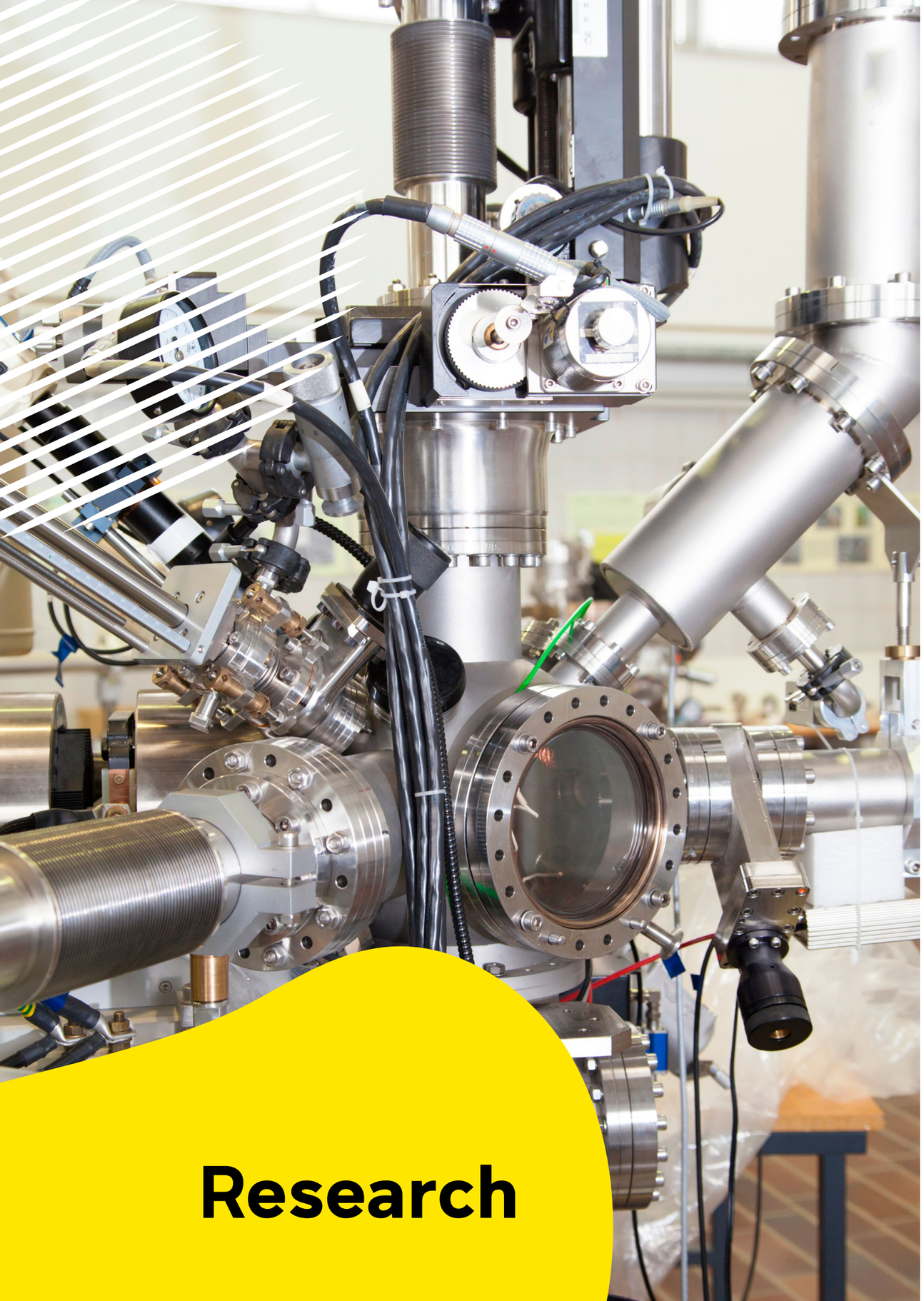
- **Professor Robert Clark,** Chair of the International Advisory Board
- **Professor Robin Grimes,** Imperial College London
- **Dr Cindy Vestergaard,** Senior Fellow and Director of Converging Technologies and Global Security at the Stimson Center
- **Dr Gregory Clark,** Fellow at the Australian Academy of Science

Facilities Group

A collaborative effort between UNSW and ANSTO, the UNSW Nuclear Innovation Centre Facilities Group aims to advance nuclear research and education through shared facilities and minimising resource duplication.

Members

- **Associate Professor Edward Obbard**
- **Dr Jennifer Stansby**
- **Scientia Professor David White**
- **Associate Professor Pramod Koshy**
- **Professor Neeraj Sharma**
- **Dr Daniel Gregg (ANSTO)**



Research

Increasing the scale and excellence of UNSW nuclear research

Our founding research themes unite engineers, scientists, and law policy and social science experts, cementing the cross-disciplinary, cross-industry nature of the Centre.

Nuclear education and public engagement

Australian people and organisations are trying to rapidly enhance their understanding of nuclear technology. To achieve this, formal and informal education programs need to be designed and delivered. Renewed research is needed to explore engineering pedagogy and public perceptions and attitudes towards nuclear technology alongside new nuclear deployments in Australia and internationally.

Nuclear safety and materials

Materials research provides the understanding to support nuclear safety based on component lifetime, safety margins and reactor life-extension. Safety and mission-critical decisions are based on cutting-edge science that describes the expected behaviour of nuclear fuels, waste forms and nuclear structural materials in service and over extended timescales in long-term storage.

Reactor engineering and control systems

Nuclear safety and future innovation in nuclear engineering design requires a research-based understanding of operational regimes in the reactor core, provided by reactor physics, thermal hydraulics and nuclear chemical engineering. This must integrate with human operators, designers and regulators, with excellent safety culture. Immediate challenges for deploying nuclear technology in Australia include advancing technology for monitoring, surveillance and non-destructive evaluation in nuclear reactors.

Nuclear fusion

Nuclear fusion is moving from physics research to early engineering applications, with all the associated engineering challenges of this transition. Fusion is a rich area for engineering/physics collaboration across UNSW, and an area of high interest for young researchers.

Nuclear waste pathways

UNSW has extensive experience in the examination of existing and potential nuclear waste repositories. UNSW geochemists and environmental engineers are currently assessing the optimal approaches for the remediation and containment of the radioactive by-products of nuclear processes and studying how best to engage public stakeholders on matters concerning waste and recycling.

Societal impact in nuclear

Recognising that nuclear technology supports every one of the UN Sustainable Development Goals, the Centre hosts discussion and research with academic and industry partners to refine societal impact alignment and communication strategy around positive impact of national nuclear capability in engineering education, nuclear medicine, Indo-Pacific strategy, achieving net-zero and energy security.

Projects

With our objective to translate and commercialise our innovation and research discoveries to end users both internationally and (subject to Australian policy guidance) also nationally, our ongoing collaborations have generated breakthrough innovations and intellectual property.

Accelerated qualification of uranium diboride fuel

This project combines our expertise in neutron scattering measurements with ab-initio modelling to predict and measure fundamental properties of UB_2 related to its use as a nuclear reactor fuel. Combining these methods shortens the development time for a new nuclear fuel and accelerates nuclear innovation. UB_2 is an exciting new fuel material with combined high density and high thermal conductivity for use in space power reactors and thermal rocket propulsion, as well as a burnable absorber in conventional power reactors.

- **Principal investigator:** Associate Professor Edward Obbard
- **Involving:** Dr Jennifer Stansby, Associate Professor Patrick Burr, Melody Ranger (PhD candidate)
- **Partners:** ANSTO, University of Texas at San Antonio

Associate Professor Edward Obbard

As the Director of the UNSW Nuclear Innovation Centre, Associate Professor Obbard leads nuclear engineering research, education and social engagement across the University. With a background in materials engineering, Edward's research focuses on understanding performance limits and improving materials for the extreme conditions of nuclear reactor cores. From 2010 to 2015, he worked as a facility scientist at ANSTO, designing a post-irradiation examination (PIE) hot cell facility for the OPAL research reactor. At UNSW, Edward lectures in reactor physics, thermal hydraulics, nuclear safety and safeguards. He also co-chairs the OECD-NEA working group 'Rethinking the Relationship Between Nuclear Energy and Society', and his work on blockchain technology for nuclear materials accounting earned him the 2021 Innovation in Global Security Prize from the Geneva Centre for Security Policy.

Melody Ranger (PhD candidate)

As part of her research with Associate Professor Edward Obbard and Patrick Burr on nuclear fuel, Melody was able to use samples of the new fuel and used DFT calculations to assess the solution of fission products in it. She then presented the work both at the NuMat24 conference in Singapore in October and the CAMS2024 conference in Adelaide in December.

The Sir William Tyree Foundation Travel Award enabled collaboration across countries and the advancement of knowledge in nuclear fuels.

Development of low neutron absorption low-temperature beta-Zr alloys

This project aims to develop a new alloy of zirconium (Zr) to be used in nuclear rockets for space. The rocket engines operate at temperatures that are too high for conventional Zr alloys (~1200°C). This project draws knowledge from the titanium industry, to stabilise the high-temperature phase (β phase) of Zr, using alloys additions. An additional challenge is that these alloying additions must not significantly sacrifice the exceptional neutron transparency of pure Zr. The project is chiefly experimental in nature. If successful, the researchers will produce the first β-Zr alloy that is stable from 400°C to more than 1400°C, and will enable a new design of reactor cores for space exploration. The feasibility study started in September 2024 and identified a set of alloying additions that have promising potential to meet our objectives. Additionally, Honours student Sergio Bao Hou has been trained on instruments and inducted to the relevant labs.

- **Principal investigator:** Associate Professor Patrick Burr
- **Involving:** Associate Professor Kevin Laws, Lucy Chen (PhD candidate), Sergio Bao Hou (Honours student)
- **Partner:** Los Alamos National Laboratory

Associate Professor Patrick Burr

Associate Professor Burr is an ARC Industry Fellow and an Associate Professor in Nuclear Engineering at UNSW, with a PhD in computational materials science from Imperial College London (2015). His research focuses on understanding the degradation mechanisms of materials used in demanding energy applications. He achieves this using atomic-scale simulations, often coupled with advanced experimental methods. Patrick has authored 80-plus articles, book chapters and patents on nuclear materials, materials fusion energy, nuclear fuels, hydrogen-tolerant materials, materials for photovoltaics and new methods for modelling defects and radiation damage.

Phase stability of tungsten boride for fusion reactor shielding

Tungsten boride is an attractive material for shielding high-energy neutrons in a fusion reactor because the boron absorbs the neutrons, and the tungsten stops the gamma rays. This project has researched the crystal structure, the exact composition and the phase stability of the epsilon phase in the tungsten boron system so that fusion reactor developers and cutting-edge fusion startup companies can properly include this material in their design calculations.

- **Principal investigator:** Dr Samaneh Setayandeh
- **Involving:** Dr Jennifer Stansby, Associate Professor Edward Obbard, Associate Professor Kevin Laws, Sercan Cetinkaya (PhD candidate)
- **Partners:** ANSTO, Tokamak Energy

Dr Samaneh Setayandeh

Dr Setayandeh is a research fellow in the Nuclear Engineering Group at UNSW, holding a PhD in condensed matter physics from Griffith University (2021), following a master's degree in condensed matter physics from University of Isfahan, Iran. Her research centres on the physics of energy-related materials, such as superconductors and hydrogen storage materials, and the degradation mechanisms of materials used in harsh environments. Samaneh uses atomic-scale simulations, often in combination with experimental techniques, to achieve these insights.

Sercan Cetinkaya

Sercan fabricated WB samples using arc melting and performed neutron diffraction experiments at ANSTO for this research. When attending the TMS2024 and CAMS2024 conferences, he gave oral presentations and discussed his research findings, highlighting the impact of the work conducted with ANSTO at UNSW.

Precision gene therapy for vision disorders with nano-syringe technology

The UNSW startup EosGene Therapeutics has pioneered NanoSyringe technology, an innovative platform that transforms gene therapy delivery. By targeting diabetic retinopathy, a leading cause of vision loss, this light-activated liposomal nanoparticle system ensures precise therapeutic delivery. The liposomes are triggerable by high-energy radiation, opening another field for therapeutic nuclear medicine applications. This is the first gene therapy delivery system combining light-triggered precision and cost-effective scalability.

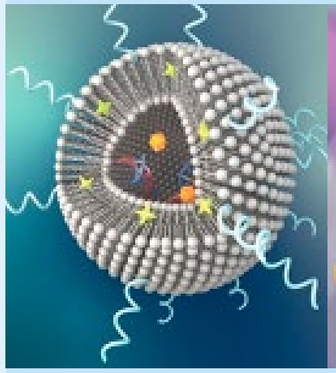
Current anti-VEGF treatments require frequent injections, burdening patients and healthcare systems. This solution offers a one-time treatment with localised activation, reducing the need for repeated interventions while improving safety and efficacy. Our advancements have the potential to reduce healthcare costs significantly and improve patient compliance, creating a paradigm shift in managing vision-related disorders. The research is unlocking broader applications in ophthalmology and beyond, advancing gene therapy and reach.

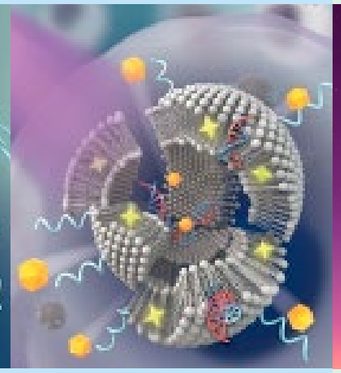
The work led to preclinical studies demonstrating 85 per cent gene knockout efficiency in targeted tissues, and partnerships with leading research institutions such as the UNSW RNA Institute and Westmead Hospital.

- **Principal investigator:** Professor Ewa Goldys
- **Involving:** Dr Yağiz Aksoy (Royal North Shore Hospital), Associate Professor Wei Deng (University of Technology, Sydney), Associate Professor Gerald Liew (ophthalmologist, University of Sydney Westmead Clinical School), business advisor John Martin

Scientia Professor Ewa Goldys

Professor Goldys is an accomplished researcher and Deputy Director of the Australian Research Council (ARC) Centre of Excellence for Nanoscale BioPhotonics (CNBP), overseeing partnerships, knowledge transfer and research commercialisation. Her leadership contributed to securing $23 million in ARC funding, matched by $17 million from partners, and leveraging an additional $155 million for industry-funded projects, spin-offs, and translational research outcomes. She has led significant initiatives, including the $2 million FABLS network, fostering interdisciplinary fluorescence research. A pioneer in advanced imaging, Ewa developed a novel autofluorescence metabolic fingerprinting method for disease diagnostics, earning a Eureka Prize in 2016. Her work in fluorescent and luminescent nanomaterials, including breakthroughs in upconversion nanoparticles, has driven advancements in imaging and sensing, with her findings published in prestigious journals such as *Nature Nanotechnology* and *Advanced Materials*. She has authored more than 315 publications (h-index: 41), delivered more than 50 invited talks, and played a key role in international biophotonics initiatives, conferences and strategic planning. She was appointed Scientia Professor at UNSW, the University's highest accolade for research performance.





Thorium-229 nuclear clock

In 2024, the realisation of the thorium-229 nuclear clock was ranked as the number one achievement in one of the global selections of the 10 best scientific results of the year. Three international experimental groups measured the transition frequency of the thorium-229 isomer using laser spectroscopy. The race is now on to design and build a nuclear clock that may be more accurate than all atomic clocks in existence and be a unique test bed for 'new physics' effects, such as sensitive detection of well-motivated dark matter candidates such as axions.

Researchers at UNSW made key theoretical contributions that underpinned this breakthrough. The thorium-229 nucleus features a uniquely low-energy transition, enabling the development of a nuclear clock that could potentially surpass the precision and stability of current atomic clocks. UNSW researchers demonstrated how this nuclear transition could be used to detect potential variations in fundamental constants of nature, such as the fine-structure constant and the strength of the strong nuclear force.

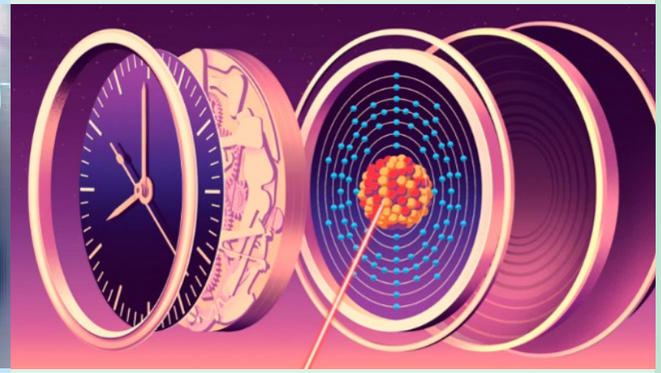
UNSW scientists also conducted calculations on the electron bridge process, wherein the electron cloud in thorium atoms acts as an antenna, transferring laser energy to the nucleus. This mechanism enhances the rate of nuclear clock transitions by several orders of magnitude, which could significantly improve the clock's performance.

This achievement underscores the critical role of UNSW research in leadership in fundamental nuclear physics and how the Centre is advancing technologies with profound implications for science and society.

- **Principal investigator:** Professor Victor Flambaum
- **Partners:** Australian Research Council, the TACTICa experimental group at Johannes Gutenberg University Mainz.

Scientia Professor Victor Flambaum

Professor Flambaum is a distinguished physicist with a Doctor of Physical and Mathematical Sciences degree (1987), a PhD (1978) from the Novosibirsk Institute of Nuclear Physics and a Bachelor of Science in Physics with Excellence from Novosibirsk State University (1974). He was the leading scientist at the Institute of Nuclear Physics, and full professor at Novosibirsk State University. Since 1991, he has been Chair of Theoretical Physics at UNSW, and was appointed Scientia Professor in 2003, the University's highest accolade. Victor's research spans atomic, nuclear, particle, molecular and statistical physics, as well as general relativity and astrophysics, with more than 500 publications and approximately 35,000 citations (h-index: 97). He has held prestigious visiting fellowships, including at Harvard University, Princeton University and the Joint Institute for Laboratory Astrophysics, and has delivered more than 250 invited talks at international conferences and numerous institutions worldwide. His work has featured extensively in top-tier journals, including *Science*, *Nature Physics* and *Physical Review Letters*.



Design of novel zirconolite glass-ceramics for actinide immobilisation

Zirconolite is a candidate material (wasteform) for the immobilisation of actinide (U/Pu/Th) wastes and a component of ANSTO's Synroc (Synthetic Rock) technology, which is under development at ANSTO. Zirconolite is a geochemically stable titanate mineral with demonstrated ability to immobilise uranium in the geological environment for billions of years. This collaborative project between ANSTO and UNSW investigated the addition of glass to the wasteform design to form glass-ceramics with the aim of improving flexibility to accommodate heterogeneous wastes and to simplify the processing requirements. A range of glass-ceramics with varying glass contents and compositions were prepared and the phase assemblage, phase composition, speciation and partitioning determined.

The analytical results showed that the effectually designed glass-ceramics added flexibility to the wasteform design. Further, the addition of glass was demonstrated to significantly enhance the potential to simplify processing requirements by lowering the temperature required to fabricate phase-pure zirconolite glass-ceramics and minimise undesirable phase formation. These advancements have significant potential in nuclear waste treatment and will continue to be investigated for the implementation of actinide waste immobilisation.

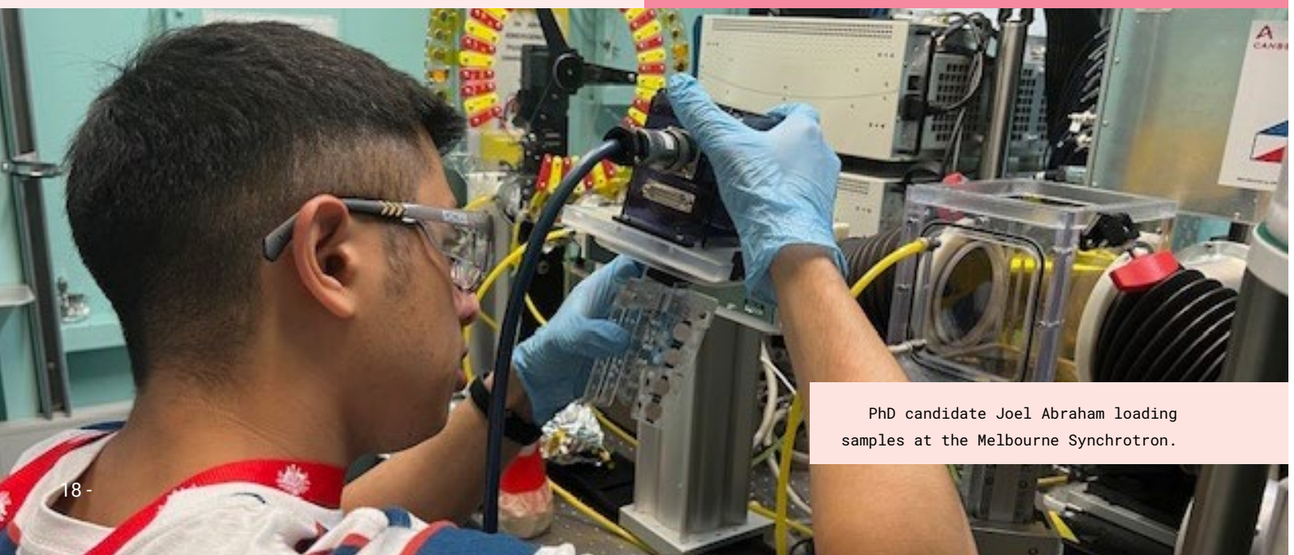
- **Principal investigator:** Associate Professor Pramod Koshy
- **Involving:** Joel Abraham (PhD candidate, UNSW/ANSTO), Dr Daniel Gregg (ANSTO), Professor Charles Sorrell (UNSW), Dr Rifat Farzana (ANSTO), Dr Ghazaleh Bahmanrokh (ANSTO), Dr Pranesh Dayal (ANSTO), Dr Rohan Holmes (ANSTO), Dr Jessica Hamilton (Australian Synchrotron)
- **Partner:** ANSTO

Associate Professor Pramod Koshy

Associate Professor Koshy's research focuses on developing advanced materials for environmental and energy applications, with an emphasis on transforming waste materials and industrial by-products into high performance, economically viable solutions. As the co-leader of the NEMCAT (Novel Engineered Materials for Conventional and Applied Technologies) group at UNSW Sydney, Pramod investigated the structure-property relationships of conventional and advanced materials. He led the Vecor-UNSW collaborative research program under the Australian Trailblazer for Recycling and Clean Energy initiative. The Australian Research Council awarded Pramod a mid-career industry fellowship in 2024 to develop innovative materials from fly ash for use in paints and plastics. With more than 150 publications, four international patents and extensive supervisory experience for HDR and Honours students, Pramod is also a celebrated educator, having received the Australian Citation Award, the Faculty of Science Teaching Excellence Award and the Vice-Chancellor's Excellence in Teaching Award.

UNSW and ANSTO: Powering innovation through collaboration

This collaborative research project realises the joint commitment of UNSW and ANSTO to train the next generation of nuclear scientists. Through the project, the researchers not only successfully developed novel zirconolite-glass ceramic composition, but Joel Abraham completed his PhD thesis in January 2025. A new PhD candidate project to investigate the dissolution behaviour of these glass ceramics is underway.



PhD candidate Joel Abraham loading samples at the Melbourne Synchrotron.

Radiation damage in heterogenous materials

It is often assumed that a material's microstructure does not influence the number of point defects created by radiation. This project challenged that assumption and developed a method to track damage in multi-phase microstructures. The findings revealed that materials morphology can significantly impact the amount of damage sustained in each phase.

This new method is advancing our understanding of the mechanisms that drive radiation damage in materials such as Zircaloy. It has also opened new pathways for materials optimisation to enhance their performance in harsh radiation environments.

- **Principal investigator:** Matthew Brand
- **Involving:** Associate Professor Patrick Burr, Associate Professor Edward Obbard
- **Partners:** Manchester University, Birmingham University

Dr Matthew Brand

Dr Matthew Brand completed his PhD in nuclear materials in 2024 at UNSW, after graduating with the University Medals in Mechanical Engineering and Advanced Physics at UNSW in 2020. His research focuses on understanding and characterising the radiation damage and shielding properties of materials used in nuclear environments. He has developed computational methods to accelerate the determination of these responses, and his codes are currently used by industry for the design of fusion reactors. Matthew has authored multiple patents, industry reports and journal articles.

Material selection charts for radiation shielding

Engineering designs for extreme radiation environments, such as compact fusion reactors and nuclear space propulsion, seek increasingly smaller or lighter material solutions, and will expose them to harsher radiation fields than seen previously. This project has produced the first nuclear material selection charts, by reformulating the problem of radiation transport using the framework of material selection. These charts can efficiently compare the performance of all existing materials for a given problem of radiation shielding. They have revealed materials that outperform what is currently the best standard in the fusion industry.

- **Principal investigator:** Dr Matthew Brand
- **Involving:** Associate Professor Patrick Burr, Associate Professor Edward Obbard
- **Partner:** Tokamak Energy

Proton-boron fusion

The goal of this project is to establish an experimentally proven analysis framework underpinning the future development of a viable hydrogen-boron fusion reactor. In that sense, the project seeks to federate the various experimental and theoretical advances made over the past decades, improve the state of knowledge in non-thermal fusion and, in doing so, help establish the viability of the approach promoted by UNSW's industry partner HB11 Energy.

Indeed, due to recent advances in laser technology – and in particular chirped pulsed amplification (CPA) – it is now believed that a viable path to fusion can rest on the fusion of hydrogen (H) with boron (B), in its boron-11 isotope form. The successful implementation of a hydrogen-boron fusion reactor would be of immense economic importance. Such reactors would provide a reliable, base-load-capable and clean energy source, enabled by a fuel (hydrogen and boron) that is abundant and easily sourced.

- **Principal investigator:** Professor François Ladouceur
- **Involving:** Dr Esmat Ghorbanpour, Professor Alexander Fuerbach (Macquarie University), Professor Dimitri Batani (Université de Bordeaux), Dr Fabio Belloni (European Commission, Directorate-General for Research and Innovation), Dr Igor Morozov (Macquarie University), Dr Sergey Pikuz (HB11 Energy)
- **Partners:** HB11 Energy, Macquarie University, Université de Bordeaux, European Commission

Professor François Ladouceur

Professor Ladouceur's scientific contribution covers a wide area of photonics technologies – from telecommunications to sensing, fabrication to simulation. François has led large-scale projects targeting the development of novel hybrid opto-electronics devices from their early design phase to their commercial realisation. In the process, he has gained considerable expertise in modelling, design, packaging and interfacing.

Dr Esmat Ghorbanpour

Dr Ghorbanpour's research covers a wide range of topics in nuclear and laser-plasma physics, focusing on achieving breakthroughs in laser-driven fusion through the partnership between UNSW and HB11 Energy. She possesses a strong foundation in plasma physics theory and phenomenology, including applications in inertial confinement fusion.

Anna's research career started at University of Guilan in Iran, where she obtained both her Master's and PhD in nuclear physics, focusing on theoretical and simulation work in inertial confinement fusion. Subsequently, as a visiting researcher at the Università degli Studi di Milano-Bicocca in Italy, she conducted experimental research on plasma diagnostics in a turbulent magnetised plasma device.

Evaluating the performance of an engineered cover at the Little Forest Legacy Site

The Little Forest Legacy Site (LFLS) is a low-level radioactive waste site under the control of ANSTO. Collaborative research at LFLS investigating the mobilisation of contaminants, waste stabilisation and site remediation has been ongoing between ANSTO researchers and UNSW for more than 10 years. The LFLS is currently subject to major site modifications, with the installation of an engineered cover over the legacy trenches to mitigate the infiltration of rainfall and surface water into the trenches. In this research collaboration, the behaviour of the site before and after the installation of the engineered cover is being examined, with studies of both the legacy trench area as well as test trenches constructed in the vicinity of the legacy trenches.

- **Principal investigators:** Dr Andrew Kinsela, Professor David Waite
- **Involving:** Ziqi Zhou (PhD candidate), Dr Tim Payne (ANSTO)
- **Partner:** ANSTO

Scientia Professor David Waite

Professor Waite, from the UNSW Water Research Centre and the School of Civil & Environmental Engineering, is a globally recognised expert in environmental chemistry, with more than four decades of contributions to understanding the behaviour of elements such as iron, manganese and uranium in natural and engineered systems. He has authored more than 350 peer-reviewed articles and secured more than $16 million in research funding for advancements in water quality and treatment technologies. As the leader of the Biogeochemical Engineering & Management (bioGEMS) research group, he focuses on preventing environmental degradation and improving human health through collaborative projects with academia, industry and organisations such as ANSTO. Recently appointed Executive Director and CEO of the UNSW Centre for Transformational Environmental Technologies (CTET), David is also a fellow of the Royal Australian Chemistry Institute (RACI), the Royal Society of Chemistry (UK) and the Royal Society of New South Wales, and a foreign member of the US National Academy of Engineering. He has received prestigious accolades, including the RACI Environment Medal, and serves as an Associate Editor of *Environmental Science &Technology.*

Advanced shielding materials for compact fusion reactors

This project aims to predict how materials used for shielding sensitive components in nuclear fusion reactors will degrade over time, through a combination of experimental irradiation campaigns, multi-scale modelling and advanced characterisation techniques. The researchers are using this knowledge to design advanced alloys for radiation shielding, which are critical for the development of more compact fusion reactors, with lower construction costs and shorter assembly time. These advanced shield materials may also be used in other applications in radiation fields (for example, in space and nuclear medicine). The project also seeks to extend the Australian nuclear research capability by developing an innovative technique to study radiation damage using the OPAL reactor at ANSTO.

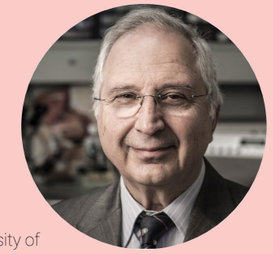
- **Principal investigator:** Associate Professor Patrick Burr
- **Involving:** Associate Professor Edward Obbard, Associate Professor Bernd Gludovatz, Associate Professor Kevin Laws, Dr Matthew Brand, Dr Samaneh Setayandeh
- **Partners:** Tokamak Energy, ANSTO, Imperial College London

Improving Boron Neutron Capture Therapy for more precise cancer treatment

In collaboration with the University of Wollongong (UoW), ANSTO's Health Research and Technology group has developed a novel Quad-MOSFET device to enhance quality control in accelerator-based Boron Neutron Capture Therapy (BNCT), an advanced cancer treatment. This innovative device distinguishes between thermal, epithermal and fast neutrons amidst photon backgrounds, enabling accurate real-time neutron beam monitoring. The team is currently evaluating a prototype using ANSTO's Dingo thermal neutron imaging instrument, with plans for future trials at international BNCT facilities. This development aims to improve BNCT precision and safety, potentially leading to more effective cancer treatments.

- **Principal investigator:** Professor Anatoly Rozenfeld (University of Wollongong)
- **Involving:** Dr Klaudiusz Jakubowski (PhD candidate), Dr Mitra Safavi-Naeini (ANSTO), Dr James Vohradsky (University of Wollongong)
- **Partner:** ANSTO

Distinguished Professor Anatoly Rozenfeld



Professor Rozenfeld is the Director and founder of the Centre for Medical Radiation Physics (CMRP) at the University of Wollongong, and is globally recognised for his pioneering research on semiconductor radiation detectors and their applications in radiation therapy, radiation protection, nuclear medicine and space sciences. He has led significant advancements in proton and heavy ion therapy in Australia, and founded multiple international workshops and conferences on dosimetry and cancer treatment technologies. With more than 400 publications, 19 patents and $19 million-plus in competitive grants, his contributions have earned numerous accolades, including the NSW Premier's Award for Outstanding Cancer Researcher of the Year (2022), the IEEE NPSS Glenn F. Knoll Radiation Instrumentation Outstanding Achievement Award (2023) and the Australian Nuclear Association Award (2023). His research and medical radiation physics at CMRP School of Physics are internationally recognised, and he serves on prestigious committees, including the Australian Space Agency's Space Medicine Committee and the International Commission on Radiation Units (ICRU). Anatoly has more than 500 publications and his h-index is 57.

Dr Klaudiusz Jakubowski

Dr Jakubowski is a post-doctoral research fellow in ANSTO's Health Research and Technology group, focusing on developing neutron capture enhanced particle therapy. He contributes to radiobiological research and advances in neutron detection technology. During his joint PhD at the University of Wollongong and ANSTO, he developed the first validated functional Monte Carlo model of the Dingo thermal neutron beamline and created advanced real-time neutron beam-monitoring devices. Klaudiusz's technical skills include programming in Python, C++ and MATLAB, as well as proficiency with high-performance computing and the Geant4 simulation toolkit. Previously, he served as an assistant radiotherapy physicist at Imperial College Hospital in London. He holds a Master of Medical Physics and a Bachelor of Biophysics from the University of Silesia in Katowice, Poland.

Supporting ASNO and IAEA in new technologies for nuclear safeguards

A previous partnership between UNSW and the Stimson Center think tank in the US resulted in a software demonstration for the Finnish Radiation and Nuclear Safety Authority (STUK) showing how blockchain could be used for nuclear material accounting and control. Associate Professor Edward Obbard is an invited expert contributing to the International Atomic Energy Agency (IAEA) member state support program task on Exploratory Cooperation on Safeguards Applications of Distributed Ledger Technology, assisted by the Australian Safeguards and Non-Proliferation Office (ASNO). This project aims to implement homomorphic encryption in a model blockchain-based state system for account and control of nuclear material, researching a novel way to provide continuity of knowledge over nuclear material without disclosing specific quantities. It will enhance reputation and build expertise and international networks to meet Australia's critical challenges in nuclear safeguards.

- **Principal investigator:** Associate Professor Edward Obbard
- **Involving:** Associate Professor Helen Paik (UNSW School of Computer Science and Engineering)
- **Partners:** ASNO, IAEA, Stimson Center

Associate Professor Helen Paik (CSE)

Associate Professor Paik began her computing career as a junior application programmer with IBM Australia in 1998 before transitioning to academia to pursue her passion for teaching and research. After earning her PhD in computer science (web data integration) from UNSW in 2004, she worked on business process and workflow management systems at Queensland University of Technology before returning to UNSW, where she is now a senior lecturer in the School of Computer Science and Engineering. Her expertise spans service-oriented software design, distributed data and application integrations, with a current research focus on blockchain and distributed ledger technology. Her projects explore applications in distributed data analytics, data management, cybersecurity, privacy and distributed identity management.

Refractory high-entropy alloys for advanced nuclear applications

Compositionally complex alloys (CCAs), including medium- and high-entropy alloys (M/HEAs), can offer exceptional mechanical properties, thermal stability and corrosion resistance, which make them candidate materials for nuclear applications. This project evaluates thermal stability, phase formation and mechanical performance in terms of strength and fracture resistance of an existing TiZrNbHfTa refractory HEA (both irradiated and unirradiated), develops design considerations for HEAs in nuclear environments using advanced nuclear property calculations, and establishes a novel strategy for the development of CCAs that are suitable for future fission and fusion applications.

- **Principal investigator:** Associate Professor Bernd Gludovatz
- **Involving:** Dr Michael Moschetti, Professor Jay Kruzic, Associate Professor Patrick Burr, Associate Professor Edward Obbard, Dr Jean-Philippe Couzinié (Université Paris-Est Créteil), Dr Anton Hohenwarter (University of Leoben), Professor Peter Hosemann (UC Berkeley), Dr Alan Xu (ANSTO), Dr Dhriti Bhattacharyya (ANSTO)
- **Partners:** The Australian Institute of Nuclear Science and Engineering (AINSE), ANSTO, Université Paris-Est Créteil, University of Leoben, UC Berkeley

Associate Professor Bernd Gludovatz

Associate Professor Gludovatz was educated at the University of Leoben in Austria where he received his Master of Science in 2006 and his PhD in 2010, both in materials science and engineering, as a student of Professor Reinhard Pippan. Subsequently, he worked as a post-doctoral fellow of Professor Robert O. Ritchie at the materials sciences division of the Lawrence Berkeley National Laboratory in the United States before joining UNSW as a senior lecturer of mechanical and manufacturing engineering in 2017. Bernd's research interests are in the mechanical behaviour of structural materials (particularly the mechanisms underlying deformation), fracture and fatigue of advanced metallic alloys, nature-inspired composites and biological materials. Additionally, he is interested in the analysis of components that fail in service.

Using neutron scattering methods to understand materials

Neutron scattering methods are essential for materials characterisation. These techniques provide unique insights into materials structure and dynamics. We have been using neutron-scattering techniques to understand materials for a variety of applications. Furthermore, we are able to interrogate real-world devices, such as batteries, while they operate. This provides unparalleled insight into materials and device function.

- **Principal investigator:** Professor Neeraj Sharma
- **Involving:** Dr Jennifer Stansby, Dr Matthew Teusner, Zhao Chen (PhD candidate), Jian Peng (PhD candidate), Dilan Thilankarathna (PhD candidate), Professor Vanessa Peterson (ANSTO), Dr Jitendra Mata (ANSTO), Professor Max Avdeev (ANSTO), Dr Nicolas de Souza (ANSTO)
- **Partner:** ANSTO

Professor Neeraj Sharma

Professor Sharma, an ARC Future Fellow at UNSW, specialises in solid-state chemistry, focusing on designing new materials and understanding their structure-property relationships. With a PhD from the University of Sydney and post-doctoral experience at ANSTO, he has held prestigious fellowships, including an ARC Discovery Early Career Researcher Award and an AINSE Research Fellowship. Neeraj has received numerous accolades, such as the NSW Premier's Prize for Science and Engineering (2019), the RACI Rennie Memorial Medal (2018), and the Australian Synchrotron Research Award (2018). With more than 165 publications and 30-plus invited talks, his highly collaborative research often involves *in situ* or operando studies of materials, particularly in batteries, to uncover structural features driving superior performance.

Mechanistic understanding of tri-structural isotropic-coated particle fuel behaviour

Often dubbed as the most robust nuclear fuel form, TRi-structural ISOtropic (TRISO) fuel is designed for high-temperature advanced reactor operation for industrial processes such as hydrogen production and steel smelting, small/microreactors for dispatchable power (AI data centres, remote locations and military operations) and space power reactors. Its multi-layered structure ensures exceptional safety and fission product retention, enabling reliable, dispatchable power in remote and demanding environments. Despite being an enabler for many nuclear technologies, much is still unknown about how these fuels behave real-time in relevant nuclear environments. This project combines the researchers' expertise in *in situ* neutron scattering analysis, synchrotron 3D imaging and computational finite-element analysis to study, explain and predict this behaviour mechanistically. By integrating these methods, the researchers aim to address the research gap holistically, using representative material properties and fuel conditions to enhance our understanding of TRISO fuel behaviour.

- **Principal investigators:** Associate Professor Edward Obbard, Dr Jennifer Stansby
- **Involving:** Associate Professor Patrick Burr, Harvey Ling (PhD candidate)
- **Partners:** ANSTO, Canadian Nuclear Laboratories, Oak Ridge National Laboratory (ORNL), Idaho National Laboratory, University of East Anglia, Imperial College London, University of Oxford, University of Bristol, Chalmers University of Technology

Methods of implementation and sequestration of iodine in UO2 nuclear fuels

Corrosive iodine is formed during fission of uranium in UO2 nuclear fuels. This iodine oxidises zirconium claddings used as sheaths for fuel. In addition to extreme mechanical interaction between the fuel pellets and cladding, this can lead to stress corrosion cracking (SCC) of the cladding and fuel failure. Nowadays, reactors are limited in their ramping capacity to mitigate this interaction, however, with the introduction of small modular reactors and their potential to be used in a load-following scenario (requiring more strenuous ramping on nuclear fuels), SCC becomes a primary concern for fuel lifetimes. This project aims to utilise facilities at ANSTO and Royal Institute of Technology (KTH) in Sweden to fabricate UO2 fuel with additives that can delay the release of or sequester iodine, thereby delaying SCC and potentially increasing fuel lifetimes.

- **Principal investigator:** James Portwin (PhD candidate)
- **Involving:** Associate Professor Patrick Burr, Associate Professor Edward Obbard, Dr Jessica Veliscek Carolan (ANSTO), Dr Tim Ablott (ANSTO), Professor Gordon Thorogood (ANSTO), Professor Pär Olsson (KTH), Dr Mikael Jolkkonen (KTH), Elina Charatsidou (PhD candidate, KTH), Maria Giamouridou (PhD candidate, KTH)
- **Partners:** ANSTO, KTH

James Portwin presenting at the Minerals, Metals, and Materials Society annual meeting 2024 (right) and at the European school on nuclear materials science (ESNMS) (below).

Life prediction and optimisation of advanced first-wall fusion materials

This research focuses on accelerating the development of radiation-tolerant materials for fusion energy, in collaboration with HB11 Energy and Tokamak Energy. Specifically, it seeks to understand the degradation mechanisms of the 'first wall' component, which is exposed to high energy radiation. In turn, this will enable accurate life assessments of the component, and inform how to optimise materials for longer-lasting fusion devices, help bridge the gap from TRL 3 to 6, and provide valuable inputs for techno-economic models and licensing applications. The fellowship will also enhance Australia's prominence in international fusion energy research.

- **Principal investigator:** Associate Professor Patrick Burr
- **Partners:** Tokamak Energy, HB11 Energy

Corrosion-resistant nuclear fuel materials

Next-generation nuclear fuels such as uranium mononitride (UN) are designed to improve the economics of nuclear energy. The high uranium density and thermal conductivity increases reactor efficiency and extends fuel lifetimes. However, the deployment of UN is hindered by its reactivity with steam. This project seeks to understand the corrosion mechanisms of UN fuel combined with additives such as Zr and Cr. *In situ* neutron scattering is used to monitor reactions in real time, tracking structure evolution on the atomic scale. Samples are prepared overseas by international collaborators at Los Alamos National Laboratory (LANL), KTH Sweden and the University of Texas at San Antonio (UTSA), and experiments take place at the Australian Centre for Neutron Scattering at ANSTO.

- **Principal investigator:** Dr Jennifer Stansby
- **Involving:** Associate Professor Edward Obbard, Associate Professor Patrick Burr
- **Partners:** LANL, KTH, Westinghouse, UTSA, ANSTO

Dr Jennifer Stansby

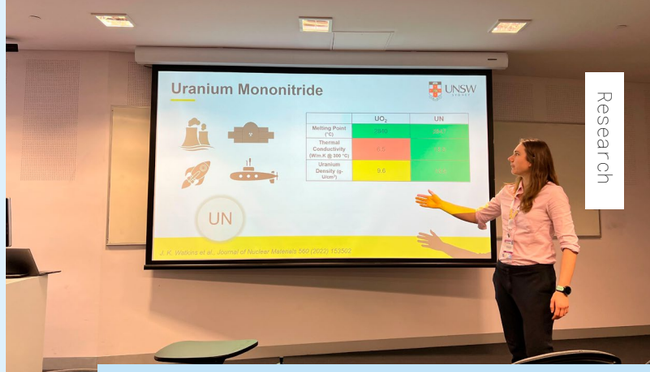
Dr Jennifer Stansby is an Associate Lecturer in Nuclear Engineering at UNSW and visiting Research Fellow at the UTSA Extreme Environments Materials Lab. Her research aims to develop and discover new materials that will extend the fuel cycle length in nuclear reactors, improving the prospects of nuclear power. This is achieved by tuning the chemical composition of solid-state materials to optimise their physical properties and then using advanced *in situ* characterisation methods to evaluate and understand the materials' performance. Jenny transitioned to the field of nuclear during her first Postdoctoral Fellowship at UNSW upon graduating with a PhD in Chemistry on energy storage materials from UNSW/ANSTO in 2021.

Dr Jennifer Stansby preparing samples for neutron scattering experiments.

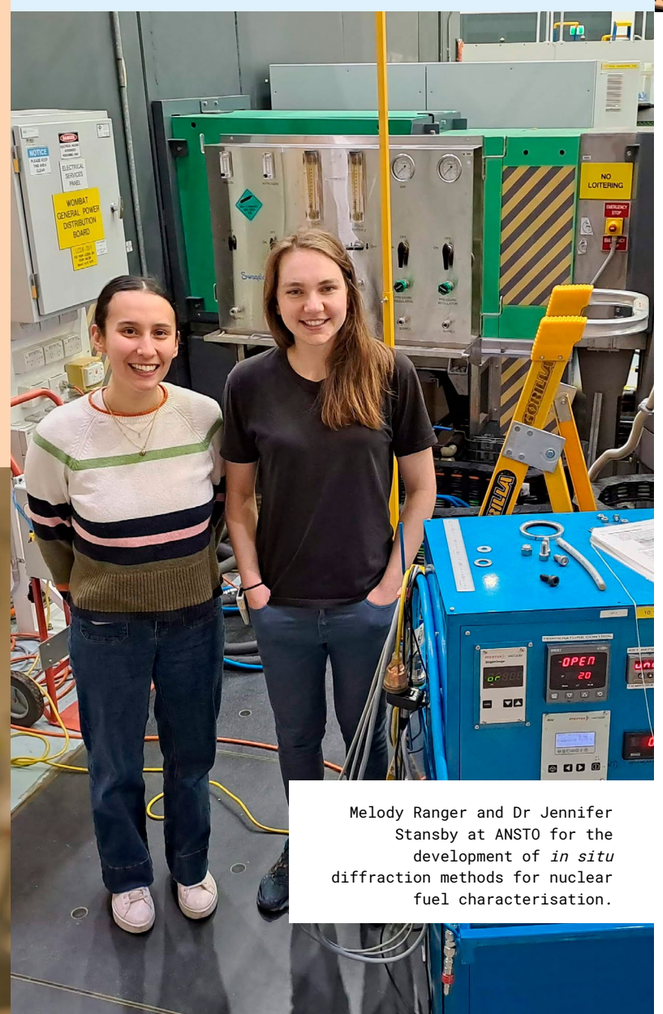
SIMFUEL: Simulated high-burnup nuclear fuel

Traditional nuclear fuel qualification methods using post-irradiation examination (PIE) studies are both timely and costly. SIMFUEL aims to replicate the chemical state of solid fission products generated during irradiation, expediting our understanding of the materials' behaviour at high burnup towards the end of its time in a reactor and enabling down-selection for the PIE studies. This project focuses specifically on solubility and speciation of fission products in uranium mononitride, and their effect on the physical properties of the fuel such as thermal expansion.

- **Principal investigator:** Dr Jennifer Stansby
- **Involving:** Associate Professor Edward Obbard, Melody Ranger (PhD candidate)
- **Partners:** KTH, ORNL, ANSTO



Dr Jennifer Stansby and Melody Ranger presenting the research at CAMS2024 and NuMat 2024.



Melody Ranger and Dr Jennifer Stansby at ANSTO for the development of *in situ* diffraction methods for nuclear fuel characterisation.

Accelerated fuel development by *in situ* neutron diffraction

The development and qualification of high-performance fuels hinder the deployment of advanced nuclear reactors that will play a key role in achieving net-zero targets. Traditional ex-situ experimental methods are unable to capture material changes in real time and may not provide representative bulk characterisation. The team has developed *in situ* neutron scattering techniques to provide a greater understanding of fuel behaviour under transient conditions, allowing the community to better predict fuel performance and optimise future fuel compositions.

- **Principal investigator:** Dr Jennifer Stansby
- **Involving:** Associate Professor Edward Obbard, Associate Professor Patrick Burr, Melody Ranger (PhD candidate)
- **Partners:** LANL, KTH, UTSA, ORNL, ANSTO

DFT modelling of tungsten boride for prediction of defect propagation

As fusion power reactors advance, developing effective shielding materials becomes crucial. The epsilon phase of tungsten boride shows promise in this role. This project predicts defect propagation from radiation damage in the epsilon phase, providing valuable insights into its behaviour. The findings will aid in designing more resilient shielding materials for fusion reactors and help bridge gaps in understanding defect propagation in this material.

- **Principal investigator:** Dr Samaneh Setayandeh
- **Involving:** James Oh (Master's student), Associate Professor Patrick Burr, Abid Hossain Khan (PhD candidate), Melody Ranger (PhD candidate), Associate Professor Edward Obbard
- **Partner:** Tokamak Energy

Vacancy diffusion in non-stoichiometric ε-WB 2-x

The epsilon phase of tungsten boride is a promising candidate for shielding in tokamak fusion reactors. Thus, boron and tungsten self-diffusion govern the material's response to both radiation damage and the extreme high temperatures it will face. This project models the self-diffusion of boron and tungsten in the hypo-stoichiometric ε phase of tungsten boride, marking the first migration simulations in the correct composition and stoichiometry, which previous studies overlooked. By exploring the impact of stoichiometry on defect migration, this research helps predict structure-property relationships, offering new insights into how material composition affects defect dynamics and properties.

- **Principal investigator:** Dr Samaneh Setayandeh
- **Involving:** Dr Matthew Brand, Associate Professor Patrick Burr, Abid Hossain Khan (PhD candidate), Associate Professor Edward Obbard
- **Partner:** Tokamak Energy

Discovering new nuclear materials and using neutron methods in characterisation

This project aims to synthesise new materials for the nuclear industry, prioritising stability under radiation, thermal, pressure, or a combination of these factors. While materials are often tested for thermal and pressure stability, their radiation tolerance is frequently overlooked. The project looks to provide a basis so that thermal and pressure-stable materials can be tested for radiation tolerance.

Neutron scattering experiments are key to understanding thermal and pressure stability. Variable temperature and pressure neutron scattering tests provide a foundation for further radiation-based studies.

An example of the team's work in this space is the discovery of zero thermal expansion materials, now being evaluated for pressure stability. These zero thermal expansion materials show no volume change over wide temperature ranges, some from 4 to 1400 K.

- **Principal investigator:** Professor Neeraj Sharma
- **Involving:** Dr Helen Maynard-Casely (ANSTO), Liam McKinlay (PhD candidate)
- **Partner:** ANSTO

Modelling hydrogen embrittlement of nuclear fuel cladding

Hydrogen embrittlement is the limiting factor that affects how long we can keep fuel in the reactor, and how much energy we can extract from fuel before discharging it. This project uses atomic-scale modelling techniques, accelerated by machine-learning methods to simulate the formation and growth of hydrides in the zirconium fuel cladding. The researchers are also using state-of-the-art experimental techniques – including *in situ* electron backscatter diffraction (EBSD) and cryogenic atom probe tomography (cryo-APT) – to investigate the hydrogen-trapping mechanism that may be used to develop a mitigation strategy for hydrogen embrittlement.

In 2024, the team developed new machine-learning inter-atomic potentials that accelerate the simulation by several orders of magnitude, while maintaining most of the accuracy of quantum mechanical methods.

- **Principal investigator:** Associate Professor Patrick Burr
- **Involving:** Abid Khan (PhD candidate), Lucy Chen (PhD candidate), Dr Samaneh Setayandeh
- **Partners:** University of Sydney, Queens University Canada, University of Manchester, University of Oxford, Imperial College London

Collaborative partnerships

The UNSW Nuclear Innovation Centre is dedicated to advancing nuclear education, research and policy expertise in Australia. It fosters connections between researchers, educators and industry leaders worldwide. Partners and collaborators include:

Academic research partners

- Australian National University
- Imperial College London
- Massachusetts Institute of Technology
- University of Wollongong
- University of Sydney
- KTH Royal Institute of Technology, Sweden

Industry partners

- ANSTO
- Huntington Ingalls Industries (HII)
- Babcock International Group
- Los Alamos National Laboratory
- Stimson Center
- Tokamak Energy
- Boss Energy
- Bechtel
- Westinghouse
- ASA Defence
- HB11 Energy

Australia-France (AUFRANDE) collaboration

The Centre actively participates in the Australia-France Network of Doctoral Excellence (AUFRANDE) and will host two doctoral candidates from its unique PhD training program, co-funded by the European Union. This program connects research centres in France and Australia. One project will focus on the theoretical study of laser-driven nuclear interactions, while the other will explore its experimental aspects.

Participants: Professor François Ladouceur, Professor Alexander Fuerbach (Macquarie University), Professor Dimitri Batani (Université de Bordeaux), Dr Sergey Pikuz (HB11 Energy), Anton Moroz (PhD candidate), Alessandro Milani (PhD candidate)

Accelerated fuel qualification mini symposium

On 16 May 2024, the UNSW Nuclear Engineering Research Group and UNSW Nuclear Innovation Centre hosted a mini symposium on accelerated fuel qualification (AFQ) at UNSW. The event featured presenters from UNSW, MIT and ANSTO, who discussed nuclear research techniques to accelerate the development, licensing and qualification of nuclear fuel. The symposium provided an opportunity for knowledge-sharing and collaboration among experts.

Presenters included:

- Associate Professor Edward Obbard (UNSW)
- Dr Jennifer Stansby (UNSW)
- PhD candidate Melody Ranger (UNSW)
- PhD candidate Harvey Ling (UNSW)
- Professor Koroush Shirvan (MIT)
- Professor Vanessa Peterson (ANSTO)
- Dr Joseph Bevitt (ANSTO)
- Professor Anna Paradowska (ANSTO)

From left: Rhys Johnston, Abid Hossain Khan, Marcus Borscz (at the back), Harvey Ling (front), Professor Koroush Shirvan, Associate Professor Edward Obbard, Melody Ranger, Dr Matthew Brand (back), Dr Samaneh Setayandeh, Tina Baradaran at the mini symposium in 2024.

Nuclear regulator partners

- The Australian Safeguards and Non-Proliferation Office (ASNO)
- Radiation and Nuclear Safety Authority (STUK)
- The Swedish Radiation Safety Authority, Strålsäkerhetsmyndigheten

International organisations

- The International Atomic Energy Agency
- The Organisation for Economic Co-operation and Development Nuclear Energy Agency (OECD NEA)

Future Defence & Security Expo 2024

The UNSW Future Defence & Security Expo, held in August 2024, showcased research designed to bolster national resilience and social stability. Cutting-edge technologies, strategic research and industry collaboration came together to redefine Australian security.

The Centre participated in the Societal Resilience, Security & Stability track, highlighting its expertise in providing specialised training in nuclear engineering and technology for defence purposes.

Education and training

Developing the next generation of nuclear experts

UNSW is cultivating a growing cohort of nuclear engineering talent, equipping undergraduate and postgraduate students with the expertise to drive a cutting-edge, sovereign nuclear industry.

Undergraduate Nuclear Engineering minor program

The Nuclear Engineering minor, launched in 2024 with 36 students enrolled, allows students to combine expertise from traditional engineering disciplines with specialised knowledge to solve the challenges facing nuclear technology.

Master of Engineering Science (Nuclear Engineering)

The only master's degree in nuclear engineering in Australia. Since its launch in 2014, when annual enrolments were low, the program has seen remarkable growth, particularly following support from the Tyree Foundation in 2021. Enrolments have now reached a record high. The program attracts a diverse cohort, including professionals from the Australian Department of Defence and ANSTO, looking to advance their expertise in nuclear technology.

AtomCraft: The world's first student-led fusion energy reactor

The AtomCraft project, started in 2023 and led by Associate Professor Patrick Burr, represents a groundbreaking initiative in nuclear fusion research. The project aims to design, build and operate a small tokamak reactor, done entirely by undergraduate engineering and physics students. This is made possible due to support from the UNSW Nuclear Innovation Centre, the Digital Grid Future Institute and the Australian Research Council.

Looking like a small, doughnut-shaped device, the tokamak introduces students to the challenges of achieving and sustaining plasma at extreme temperatures, crucial for understanding fusion reactions. The reactor will not use tritium or deuterium, but it still serves as a great research and educational tool.

The project is structured to provide students with real-world experience, mirroring the demands of a professional engineering or startup environment. The students gain hands-on expertise in areas such as assembly integration, plasma modelling and systems testing. The program also emphasises the importance of interdisciplinary teamwork, with students from faculties including Arts, Design & Architecture, Business and Engineering all contributing to its success.

Through partnerships with the broader nuclear industry, AtomCraft looks to both strengthen Australia's nuclear supply chain and radiation applications, and inform public discourse on energy policy. Students are encouraged to analyse public perceptions and communicate the societal benefits of nuclear energy.

This aligns with the UNSW Nuclear Innovation Centre's mission to integrate education, research and industry collaboration. By bridging these areas, the AtomCraft team is advancing Australia's technological capabilities and contributing to global efforts for sustainable energy solutions.

"There's a sense that we're working on something special, on the cutting edge of world-changing engineering. AtomCraft is one of the most exciting projects on campus, and we look forward to being part of Australia's future fusion industry."

Marcus Borscz, student

"We aim to become the go-to university for future talent in fusion engineering... Last term – only three months into our endeavour – 20 per cent of our students received job offers with our industry partners, despite them still having years to go before receiving their degrees."

Associate Professor Patrick Burr

Australian Graduate School of Engineering courses

The UNSW Nuclear Innovation Centre cultivates a hands-on learning approach combined with strong leadership to drive advancements in nuclear technology. Participants include executives, researchers, Defence personnel (both uniformed and non-uniformed), students, academics and policymakers – fostering expertise and leadership across the sector.

Through its partnership with the Australian Graduate School of Engineering (AGSE), the Centre delivers continuing professional development for engineers and industry professionals across Australia and internationally.

Learning by Doing and Excellence in Nuclear Engineering course

In May 2024, experts from MIT and UNSW delivered a one-day course examining the foundations of nuclear and radiation safety in Australian law, demonstrating how innovators navigate regulatory constraints to create impactful engineering and research initiatives.

Meeting the goals of the AUKUS security partnership between Australia, the UK and the US demands immediate transformation within engineering organisations, coupled with long-term commitments to research, education and innovation, to sustain Australia's strategic edge in nuclear technology.

Associate Professor Edward Obbard led the course, discussing workforce, safety culture and the complexities of Australia's emerging nuclear sector. Renowned nuclear law expert Helen Cook provided insights into the legal considerations for nuclear innovators in Australia. Professors Jacopo Buongiorno and Koroush Shirvan from MIT shared their hands-on learning approach to innovation, using MIT's Centre for Advanced Nuclear Energy Systems (CANES) as a case study. At CANES, faculty, students and professional staff collaboratively operate a research reactor, bridging technical rigour with practical application.

Nuclear safeguards roundtable

On 28 February 2025, the UNSW Nuclear Innovation Centre hosted a roundtable discussion on Nuclear Safeguards and Training, bringing together representatives from Defence, the Australian Submarine Agency and the Department of Foreign Affairs and Trade. Expertly facilitated by Professor Sir Robin Grimes, Dr Cindy Vestergaard, Brigadier Dr Ian Langford (the PLuS Alliance) and Associate Professor Edward Obbard, the discussion explored perspectives from AUKUS partner countries on international nuclear safeguards and nuclear training in Australia.

Science Diplomacy: Case Studies of Nuclear Mindset in Action course

Delivered in September 2024, this course explored the dynamic interplay between nuclear technology, science diplomacy and global events. Through case studies on the Iran Joint Comprehensive Plan of Action (JCPOA), the AUKUS trilateral partnership and the nuclear security challenges at Ukraine's Zaporizhzhia power plant, participants learned how technical excellence in nuclear science has shaped major world events. Leading experts in nuclear science, international law and national security – Professor Robin Grimes of Imperial College London, Dr Cindy Vestergaard of the Stimson Center and Dr Ian Langford of the PLuS Alliance – shared their valuable insights.

The course provided foundational knowledge in nuclear science and international treaties, making it accessible to participants from diverse backgrounds. Attendees gained unique perspectives on leveraging technical expertise and science diplomacy to strengthen international collaboration, build partnerships, and address global challenges. Understanding technical and geopolitical factors is becoming essential for professionals working in international relations, foreign affairs and national security.

Eminent researcher seminar series

Through a dynamic series of seminars featuring leading nuclear science researchers, the UNSW Nuclear Innovation Centre is sharing knowledge about the latest cutting-edge research and fostering valuable connections across the profession.

Professor Anatoly Rozenfeld, Director of the Centre for Medical Radiation Physics (CMRP) at the University of Wollongong, gave a presentation on semiconductor sensors for radiation shielding, focusing on two applications of semiconductor sensors developed at CMRP. With his research team he demonstrated that increasing shield thickness doesn't necessarily lead to a reduction in biologically relevant dosage, and that changing the sequence of layers in multilayer shields can affect biological dosage.

Dr Michael Moody, Director of ANSTO's Nuclear Materials Research and Technology Group, gave a presentation on microscopy at the atomic scale to address materials challenges for future fission and fusion reactors. He discussed key projects at the Nuclear Materials Research and Technology Group at ANSTO, including development of the atomic-scale microscopy technique, APT. APT characterisation has the potential to offer new understanding into the degradation of reactor materials subjected to a combination of high temperatures, corrosive media and neutron irradiation, particularly at the earliest stages of microstructural damage.

Previously Head of the Atom Probe Research Group in the Department of Materials at the University of Oxford before joining ANSTO, Michael has led efforts in advancing APT techniques. He holds a PhD from the University of South Australia and worked as a research associate at the Australian Centre for Microscopy and Microanalysis at the University of Sydney.

Driving diversity in nuclear education

A recent review from the Australian Government states: "Our current STEM pipeline won't meet the forecast demand for STEM skills to drive productivity and meet tomorrow's challenges."

Broadening participation from underrepresented groups is necessary to meet the growing demand for a nuclear workforce in Australia. As a highly interdisciplinary sector, nuclear needs the different viewpoints and experiences to provide alternative perspectives and ideas in order to solve complex problems and create a strong safety culture. By embracing a variety of experiences and viewpoints, the sector can accelerate progress and ensure sustainable growth.

UNSW lecturer Dr Jennifer Stansby has been appointed as the Centre's Diversity Engagement Partner, tasked with benchmarking current enrolments and reviewing curriculum and marketing efforts, as well as ensuring Open Day representation, outreach and the improved visibility of role models.

The UNSW Nuclear Innovation Centre aims to achieve gender parity across its education programs, with an initial target of 35 per cent female representation by 2027.

This effort is based on research into excellence and innovation. Companies with the most diverse workforces have been found to outperform competitors with the least diverse workforces, since a diverse workforce is more innovative, profitable and effective.

Jennifer's other work focuses on advanced technology fuels, where she leads a three-year project at the Australian Centre for Neutron Scattering at ANSTO, investigating new materials for use in nuclear reactors. She has always had a passion for mentoring and elevating Australia's nuclear sector.

"Embracing diversity is key to advancing Australia's nuclear science and engineering industry."

Dr Jennifer Stansby

Dr Jennifer Stansby at UTSA Lab, 2024.

Sir Robin Grimes, Lucy Chen and Harvey Ling in Singapore for NuMat 2024.

Travel, collaboration and innovation on a global scale

Sir William Tyree Foundation scholarships

Since 2021, the Sir William Tyree Foundation has been advancing the careers of UNSW nuclear engineering students, equipping them with critical skills to shape the workforce of the future. By offering a combination of master's, research and travel scholarships, the Tyree Foundation has created invaluable opportunities for scholars to engage with global experts, broaden their research perspectives and contribute to developments in the nuclear field.

Tyree Foundation Travel Awards

Thanks to the Tyree Foundation's generosity and vision, 10 outstanding students and early-career professionals were awarded travel scholarships in 2024, enabling them to attend prestigious conferences such as NuMat 2024 in Singapore, COSIRES in Canada and CAMS2024 in Adelaide. This invaluable support has opened doors for future opportunities and collaboration, further empowering these scholars to make significant contributions to the nuclear field.

From left: Harvey Ling, Abid Hossain Khan, Dr Samaneh Setayandeh, Lucy Chen, Melody Ranger, Dr Matthew Brand and James Portwin at NuMat 2024.

NuMat 2024, Singapore

Established in 2012 in association with the *Journal of Nuclear Materials*, the Nuclear Materials Conference (NuMat) serves as an umbrella for international meetings on nuclear materials science related to fission and fusion reactors and the overall nuclear fuel cycle.

Dr Matthew Brand did a flash talk and poster presentation on work conducted in partnership with Tokamak Energy, titled 'Material selection charts for the shielding of critical components'. He was able to make new connections with leading researchers and discuss the ongoing work with colleagues from Imperial College London, University of Birmingham, Tokamak Energy and MIT.

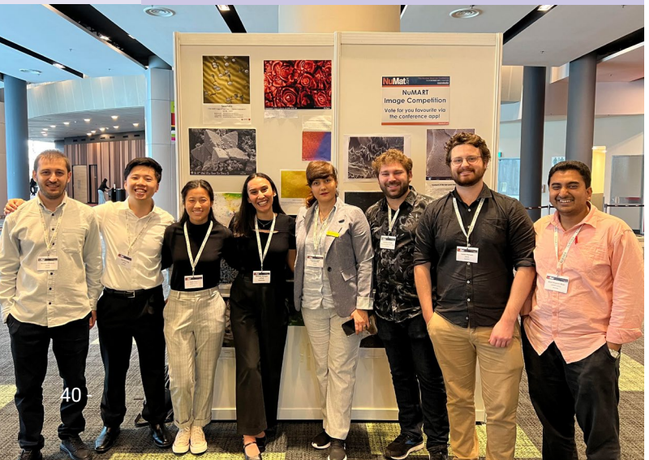
Dr Samaneh Setayandeh's oral presentation on 'ε-Phase of Tungsten Boride' led to potential collaborations with Imperial College London and Oak Ridge National Laboratory. Her poster on 'Dielectric Properties of β-Ga2O3' opened doors for future collaboration with the Air Force Research Laboratory.

PhD candidate **Melody Ranger** presented posters on UN Simfuel thermal expansion and UB_2 fission product. This led to a collaboration with Denise Adorno Lopes from Oak Ridge National Laboratory, who is developing a machine-learning potential that can predict the chemical state of fission products in new fuels, and who can use Melody's data to validate her model.

PhD candidate **Sercan Cetinkaya** presented a poster on 'Oxidation resistance of WB2-x in air and steam from *in situ* neutron diffraction'. He had valuable discussions with academics from Imperial College London about the epsilon phase of WB, and also connected with ASTAR researchers who expressed interest in experimental collaborations. Sercan also discussed a potential partnership with Oak Ridge National Laboratory.

Attending his first international conference, PhD candidate **Harvey Ling** presented a poster on his work with the gap conductance rig. He engaged with the global nuclear materials community and gained ideas for potential directions in his work.

From left: Sercan Cetinkaya, Harvey Ling, Lucy Chen, Melody Ranger, Dr Samaneh Setayandeh, Dr Matthew Brand, James Portwin and Abid Hossain Khan.



From left: Dr Matthew Brand, Sercan Cetinkaya, Lucy Chen, Melody Ranger, Harvey Ling, Abid Hossain Khan and Dr Jennifer Stansby.

CAMS2024, Adelaide

The eighth conference of the Combined Australian Materials Societies brought together experts and practitioners from various domains, emphasising innovation, sustainability and practical applications.

Lucy Chen presented her recent PhD research, 'Hydrogen trapping of β phase in two-phase titanium alloys', broadening her understanding of current research and making new connections.

PhD candidate **Harvey Ling** presented a poster on his work with a gap conductance rig and gained knowledge at sessions such as how to use time-resolved X-ray imaging techniques for different materials and how to utilise neutron diffraction for residual stress measurements.

PhD candidate **Sercan Cetinkaya** gave an oral presentation on 'Revisiting the composition and crystal structure of WB2−x using neutron diffraction' and found new insights in materials design and fabrication for harsh conditions.

PhD candidate **Abid Hossain Khan** shared the novel methodology adopted in his research with materials science and engineering experts, and received feedback and opportunities for collaboration.

UNSW Associate Lecturer **Dr Matthew Brand** talked about the research he did for his PhD, in a presentation titled 'Material selection charts for radiation shielding in extreme environments'. He provided visibility to the work he is doing at UNSW and generated discussion and interest in the topic.

COSIRES, Canada

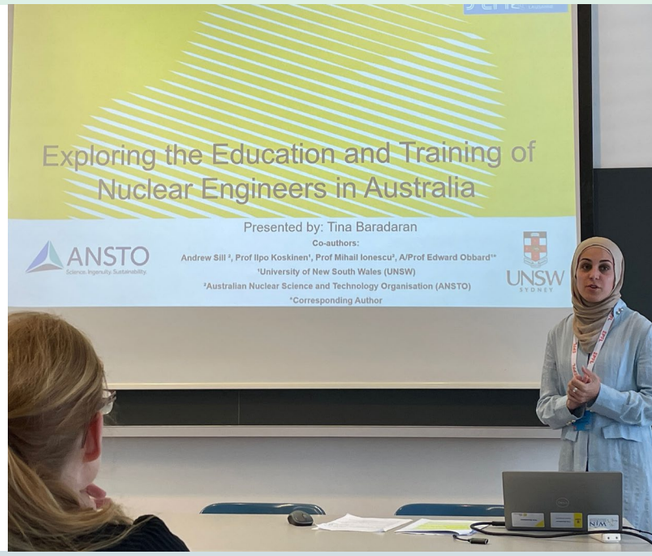
The conference of COmputer Simulation of IRradiation Effects in Solids (COSIRES) is a leading venue for presenting and discussing advances in the computational investigation of materials phenomena caused or influenced by all forms of irradiation. In 2024, it was held in Kingston, Ontario.

PhD candidate **Abid Hossain Khan** presented a poster titled 'Machine-Learning Interatomic Potentials for Hydrogen-Defect Interactions in Zirconium'. He joined the Computational Materials Physics research group as a visiting research student under the supervision of Professor Laurent Karim Béland, gaining invaluable knowledge and skills to design and conduct his PhD research efficiently.

Dr Matthew Brand delivered an oral presentation on his PhD research, receiving valuable feedback and ideas about how his work could be improved and applied in new, relevant directions.

ANSTO FutureNow scholarship

In September 2024, **Tina Baradaran** (right), a recipient of an ANSTO FutureNow scholarship, attended the 52nd Annual Conference of the European Society for Engineering Education (SEFI) at École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland. With more than 550 participants from 36 countries, the theme of the conference was 'Educating Responsible Engineers'. Tina participated in workshops, research papers and panel discussions, enhancing her knowledge and pedagogical approaches to teaching sustainability, diversity, ethics and technical content.



CSIRO: Early to mid-career fellowship program

The fellowship program supports the International Hydrogen Reseach Collaboration Program, which is led by CSIRO and supported by the Australian government and in-kind contributions from Australian Hydrogen Research Network.

PhD candidate **Lucy Chen** was awarded the CSIRO Int-H2 Fellowship, receiving $25,000 to support travel activities in the hydrogen space. Lucy has been presenting modelling work from her PhD focused on Hydrogen Trapping at Nb-rich Microstructural Features in Neutron-irradiated Low-Sn ZIRLO. She was able to find potential collaboration partners in Dr Mark Wenman and his PhD student Junting Zhang from Imperial College London to further investigate some of the modelling work, and she received funding to travel to the University of Manchester, where she will spend three months in 2026 performing experiments with equipment at the Royce Institute.

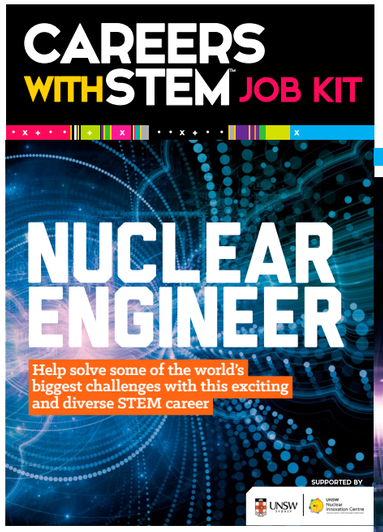
Nuclear Innovation Bootcamp 2024 participants.

Community and industry engagement

Making connections through outreach

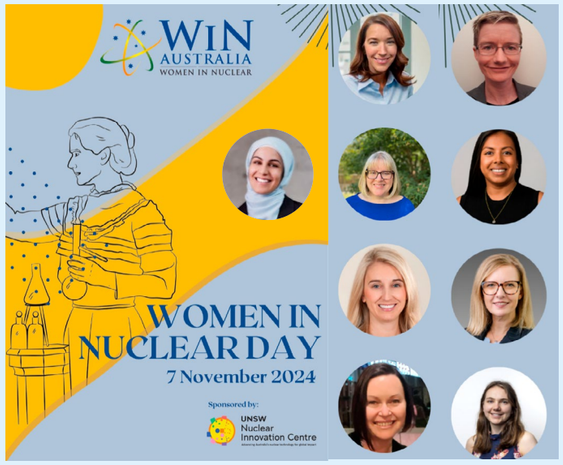
Careers with STEM Job Kit

The UNSW Nuclear Innovation Centre played a key role in creating the Careers with STEM Job Kit, designed to inspire school students exploring their future careers. Highlighting the advantages of a nuclear engineering career, the kit covers everything from the different applications of nuclear science to salary expectations and societal impact. Featuring interviews with UNSW's Tina Baradaran, Marcus Borscz and Casey Alston, the kit became CareerswithSTEM.com's second-most downloaded product in spring 2024, with impressive engagement stats.



Women in Nuclear Day

The Centre sponsored the first-ever Women in Nuclear (WiN) Day event at UNSW, showcasing the exciting world of nuclear science and the incredible careers and opportunities in the field. The November 2024 event included speakers **Tina Baradaran**, **Dr Jo Lackenby**, **Dr Sheruna Naidoo**, **Ashley Schneider**, **Dr Jennifer Stansby**, **Kirsty Braybon**, **Professor Maria Rost Rublee**, **Helen Cook**, **Dr Cathy Moloney** and **Jasmin Diab**.



AtomCraft end-of-year showcase

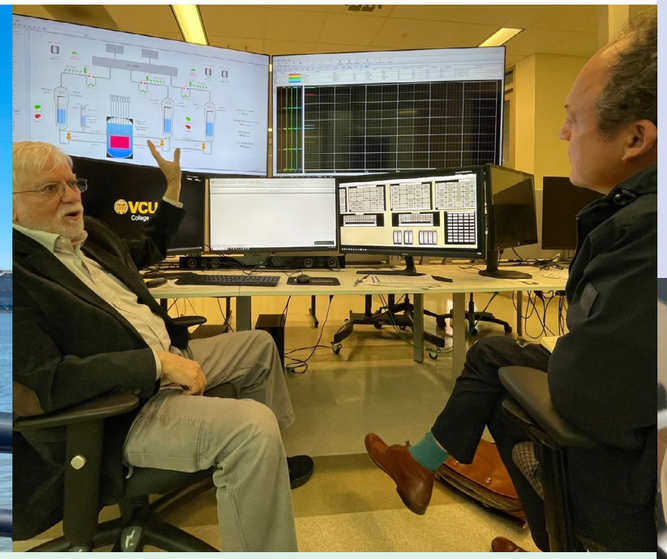
This event featured student work, stalls and presentations, with prototypes and other work completed in the first year of the AtomCraft project on display.

Engineering the Future: Navigating a Nuclear Tomorrow

This expert panel discussion held in February 2025 explored the future of nuclear innovation in Australia, addressing the transformations and adaptations the country may soon see. The panel featured **Dr Cindy Vestergaard**, **Sir Robin Grimes** and **Professor Ian McGill**, and was facilitated by **Associate Professor Edward Obbard**.

Visits to universities

Associate Professor Edward Obbard visited **Virginia Commonwealth University** in Newport News, Virginia in March 2024 to research educational nuclear reactor simulators and visit the Newport News shipyard with HII industry partners.



In June 2024, **Dr Matthew Brand** visited **MIT** to discuss potential future collaborations. In particular, he met with Professor Mike Short, who later examined his PhD thesis. During the visit, they began planning experiments to be conducted at MIT to validate the theories developed in his research. He was also given a tour of MIT's extensive facilities, giving him invaluable insights for designing future experiments.

Ten bachelor's degree students from the Medical Radiation Physics department at the University of Wollongong (led by **Professor Anatoly Rozenfeld** and **Dr Linh Tran**) visited the Nuclear Reactor at **Dalat Nuclear Research Institute** in Vietnam, to get hands-on experience in nuclear reactor technology, nuclear medicine and proton therapy. The December 2024 trip was funded by the Government's New Colombo Plan program.

Left: Students visiting Dalat Nuclear Research Institute in Vietnam.

Undergraduate students (rigth) from both the Bachelor of Medical Radiation Physics and the Bachelor of Science degrees at the University of Wollongong visited the proton therapy facility at the **National Cancer Centre**, Singapore, in December 2024.

Tina Baradaran (left) visited the **CROCUS** nuclear research reactor at the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, which has been offering hands-on teaching experiences to nuclear engineering students since 1983. The zero-power reactor has been a valuable educational tool for more than 40 years. Tina had the rare opportunity to tour the facility, fulfilling a long-held dream. She likened the experience to exploring an underground Swiss bank vault, with the reactor as the "treasure".

Dr Jennifer Stansby (right) participated as a mentor at the 2024 Nuclear Innovation Bootcamp at the University of Wyoming in July.

Associate Professor Patrick Burr visited the control room (left) of the research reactor at the **University of Utah** in Salt Lake City.

Industry and government consultations

House Select Committee on Nuclear Energy parliamentary inquiry

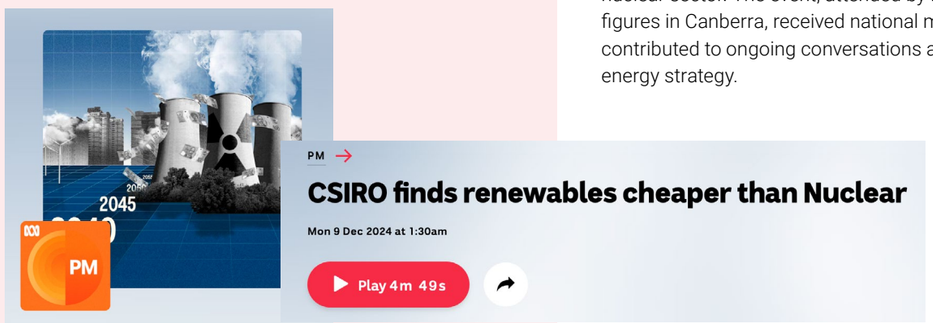
Associate Professor Edward Obbard offered the full cooperation and expert services of the UNSW Nuclear Innovation Centre for the House Select Committee to evaluate nuclear energy as part of the energy mix. He provided a written submission and presented the latest evidence and information to the committee in person.

To compare nuclear to renewables is a false choice and, in fact, nothing more than a clever way to procrastinate and delay the reckoning that I describe. The greatest challenge of using nuclear energy is developing the skills pipeline and community of expertise. At the UNSW Nuclear Innovation Centre, we are already working with trusted partners in the UK and USA to grow a skilled and expert nuclear workforce. We must not be irked by the mention of nuclear energy in research agreements when our allies are openly exploiting its civilian benefits. We should help them to do this, because everyone's CO_2 goes into the same atmosphere.

Associate Professor Edward Obbard

CSIRO GenCost report consultation

Associate Professor Patrick Burr participated in a workshop with the Australian Academy of Science and the Academy of Technological Sciences and Engineering in July 2024 on providing input to the annual CSIRO GenCost report, an economic report estimating the cost of building new electricity generation, storage and hydrogen production in Australia out to 2050. Professor Ken Baldwin was subsequently interviewed about the workshop's impact on the report.

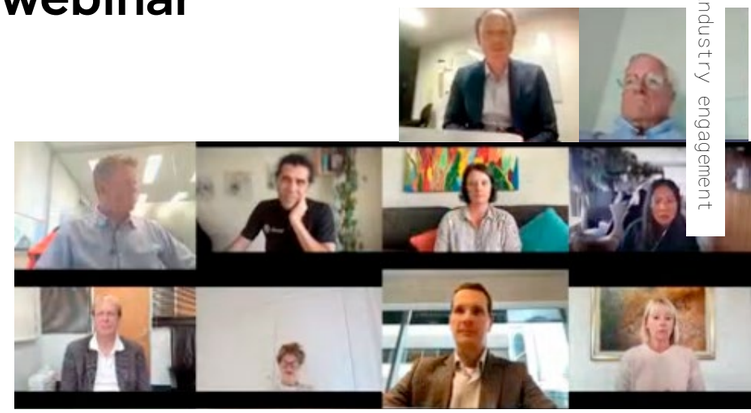


Minerals Council of Australia's energy panel

As part of Minerals Week 2024, Associate Professor Edward Obbard joined a panel discussion on the role of nuclear energy in Australia's future. Addressing an audience of political leaders and policymakers, he emphasised the nation's need for reliable and resilient energy beyond 2050, as well as the importance of building sovereign capability and developing new skills in the nuclear sector. The event, attended by key government figures in Canberra, received national media coverage and contributed to ongoing conversations about Australia's energy strategy.

Sir William Tyree Foundation's 'Engineering the future: Power' webinar

The Scholars, Alumni + Friends Network hosted an 'in conversation' event on the exciting trends and dynamic future of power. Associate Professor Edward Obbard moderated the panel consisting of Tomas Keraitis of Aurecon, Professor Klaus Regenauer-Lieb of Curtin University and Leigh Staines of Queensland Manufacturing Institute. The webinar, which was made public, provided insight into the future of power and gave scholars access to key education and career contacts.



Tokamak Energy partnership

The UNSW Nuclear Innovation Centre has forged key industry collaborations that bridge academia and industry, driving innovation in nuclear technology.

UNSW researcher **Dr Matthew Brand** is working with UK-based fusion reactor developer Tokamak Energy to identify the best materials for shielding reactor magnets from extreme radiation conditions.

Tokamak Energy aims to produce power via compact spherical tokamak reactors, and Matthew has developed novel methods to screen for new and exotic shielding materials – an innovation that has become integral to the company's workflow and has led to new patents.

Through this partnership, Matthew undertook a secondment at Tokamak Energy, gaining firsthand experience in the fusion industry. Alongside fellow UNSW researchers, he continues to collaborate with Tokamak Energy on the radiation properties of tungsten borides, with more work planned for 2025.

Media coverage and societal impact

Video: Nuclear Materials by Patrick Burr

In this publicly available video, Associate Professor Patrick Burr explains how innovative materials can harness uranium's energy density, leading to more efficient energy production and reduced nuclear waste. He highlights how UNSW research addresses the critical link between materials innovation and the future of sustainable energy, and how understanding materials capable of withstanding the extreme conditions of fusion reactions can help us overcome the technical barriers to a truly transformative energy system that can address global demands.

Interview: Edward Obbard on Sky News

In an interview with Sky News in December 2024, Edward Obbard commented on statements made by Minister for Climate Change and Energy Chris Bowen and Leader of the Opposition Peter Dutton on the future of energy in Australia, bringing an educated and scientific perspective to the national conversation.

"I think that this sort of 'deadlineism' we have, as in saying nuclear is too slow, is actually a form of procrastination, because given that in the future we're going to have to shift to a grid that is nuclear and renewables, surely the only thing to do is to start as soon as you can. Not starting because you're worried you won't be done by 2030 or 2050 is basically procrastination, isn't it?"

Associate Professor Edward Obbard

Feature story: Nuclear News magazine article on AtomCraft

The flagship magazine of the American Nuclear Society, *Nuclear News*, featured UNSW's AtomCraft project in its October 2024 issue. The five-page article describes the AtomCraft team, the context around nuclear energy in Australia and the impact that the project is having on the fusion field and the next generation of students. The story features interviews with Associate Professor Patrick Burr and students Rose Naji, Anastasia Smyth, Arkansh Maheshwari and Rok Willesee, and mentions various Centre members and their research activities.

The cross-disciplinary AtomCraft team. (Photo: University of New South Wales)

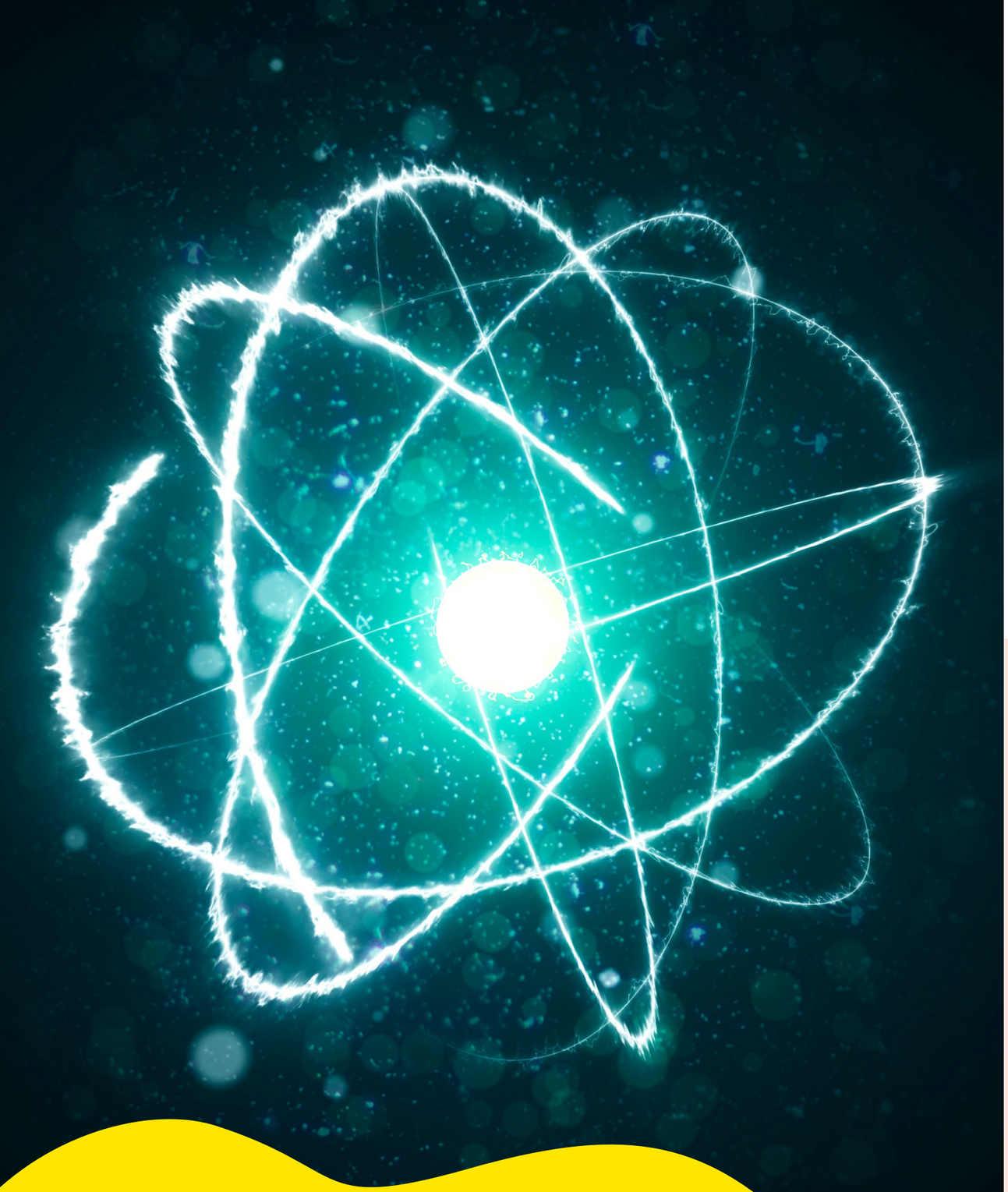
Australian undergrads are crafting a tokamak device

Opinion: Edward Obbard in *The Daily Telegraph*

In his opinion piece, 'More energy, less smog: It's a step in the right direction', Associate Professor Edward Obbard reflects on his time as a PhD candidate in the heavily polluted city of Shenyang, China, where coal dominated every aspect of energy use. This experience shaped his view of nuclear energy as a viable solution to provide millions with increased energy consumption and a better quality of life without the environmental toll of coal.

Supporting Peter Dutton's proposal for nuclear power in Australia, Edward Obbard highlights its economic and employment benefits, noting that a twin-unit plant could create more than 1000 long-term, high-quality jobs in diverse fields such as engineering, chemistry and project management, fostering regional development and supporting Australia's energy transition. He also underscores a critical challenge in the Coalition's nuclear plan: the lack of a sufficiently trained workforce.

See the appendix for a sample list of recent media articles and appearances featuring the activities of the Centre.



Looking ahead

Expanding Australia's nuclear expertise

In our first year, our priorities were to set up our governance, build education programs, attract and recruit talent to the Centre and build the learning communities that are our foundation. In our second year, we are continuing to attract students and talent and will place increasing emphasis on research training and building research communities across universities and industry partners to realise ambitious collaborative research programs.

Growing our educational offerings

Undergraduate degree development: We are in the process of designing a new undergraduate nuclear engineering program, laying the foundation to prepare the next generation of leaders in the field. Significant progress is being made to ensure the program meets the needs of both industry and academia.

Academic recruitment goals: With an expanded team, we are setting new recruitment goals to further enhance our capacity for research and teaching. These efforts will strengthen our educational offerings and support the growing demands of the industry.

Defence training: Our training programs with the Department of Defence continue to grow, supporting the professional development of Australia's defence workforce.

Upcoming events

2025 Sydney Nuclear Festival

From 21 July–8 August 2025, the Nuclear Innovation Centre is hosting three consecutive events at UNSW Sydney.

Nuclear Innovation Bootcamp

19 July – 2 August 2025

With a core objective of nurturing innovation and excellence in the nuclear sector, the intensive two-week Nuclear Innovation Bootcamp (themed 'Innovating in Australia for Global Impact') will bring together 30 top-tier students and early-career professionals from Australia and around the world. UNSW has been awarded prestigious hosting rights in a competitive process by the US Nuclear Innovation Alliance, also our partners in delivery. Through keynote speeches, panel discussions, hands-on workshops, and collaborative projects, participants will explore key topics such as nuclear safety, sustainability, medical applications, environmental solutions and social license, equipping them with essential skills and real-world insights into nuclear innovation.

Nuclear Futures: Shaping dialogue in a changing world

4–5 August 2025

In collaboration with the OECD Nuclear Energy Agency (NEA) Global Forum on Nuclear Education, Science, Technology and Policy, the two-day Nuclear Futures workshop will bring together 50 emerging leaders from Australia and around the world. Pioneering an innovative approach to attracting and engaging young professionals, the workshop aims to foster dialogue on the future of nuclear technology in Australia and its wider social and policy implications.

Australian Nuclear Academics Discussion Meeting

6–7 August 2025

The inaugural Australian Nuclear Academics Discussion Meeting provides an opportunity for all Australian nuclear academics and scientific collaborators to meet and network. By providing time for people to share their research in a seminar setting and socialise, the meeting will not only nurture innovation and excellence but also help build a cohesive Australian nuclear research community. This meeting sets the stage for future gatherings hosted by other partners across Australia, strengthening national collaboration.

Appendix

Publications of the UNSW Nuclear Innovation Centre

In its inaugural year, members of the Nuclear Innovation Centre published more than 40 research papers. With a steady output of internationally recognised work, the Centre is cementing its position as a leading institution for nuclear engineering research.

Abraham JL, Dayal P, Farzana R, Bahmanrokh G, Aughterson RD, Zhang Z, Holmes R, Hamilton JL, Sorrell CC, Koshy P and Gregg DJ (2025) '**Effect of glass content on the phase assemblage and processing requirements of zirconolite glass-ceramics for actinide immobilisation**', *Journal of the European Ceramic Society*, 45(2):116890, doi:10.1016/j.jeurceramsoc.2024.116890.

Archer J, Villani E, Gazi M, Pastuovic Z, Peracchi S, Vohradsky J, Pan V, Roberts M, Hynds D, Guatelli S, Petasecca M, Lerch M, Bortoletto D, Tran L and Rosenfeld A (26 October 2024) '**Characterisation of the Effects of Radiation Damage on Low Gain Avalanche Diodes for Low-LET Microdosimetry**', in 2024 IEEE Nuclear Science Symposium (NSS), Medical Imaging Conference (MIC) and Room Temperature Semiconductor Detector Conference (RTSD), 2024 IEEE Nuclear Science Symposium (NSS), Medical Imaging Conference (MIC) and Room Temperature Semiconductor Detector Conference (RTSD), *IEEE*, Tampa, FL, USA, doi:10.1109/NSS/MIC/RTSD57108.2024.10657806.

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Chen Yi-Sheng, Huang C, Liu P-Y, Yen H-W, Niu R, Burr P, Moore KL, Martínez-Pañeda E, Atrens A and Cairney JM (2024) '**Hydrogen trapping and embrittlement in metals – A review**', *International Journal of Hydrogen Energy* S0360319924013326, doi:10.1016/j.ijhydene.2024.04.076.

Christensen JB, Muñoz ID, Bilski P, Conte V, Olko P, Bossin L, Vestergaard A, Agosteo S, Rosenfeld A, Tran L, Knežević Ž, Majer M, Ambrožová I, Parisi A, Gehrke T, Martišíková M and Bassler N (2024) '**Status of LET assessment with active and passive detectors in ion beams**', *Radiation Measurements*, 177:107252, doi:10.1016/j.radmeas.2024.107252.

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Funding

From	Amount	To	For
Sir William Tyree Foundation	$7,500,000	UNSW Nuclear Innovation Centre	To support scholarships, fellowships, and the Tyree Nuclear Fellow position, facilitating progression from lecturer to professor in Nuclear Engineering.
Australian Research Council, Tokamak Energy, ANSTO	$1,024,000	Associate Professor Patrick Burr, Associate Professor Edward Obbard, Associate Professor Bernd Gludovatz, Associate Professor Kevin Laws, L Edwards, S Humphry-Baker, J Astbury, C Wilson	Linkage project for the research: 'Advanced shield materials for compact fusion energy'.
Australian Research Council, HB11 Energy	$1,406,000 ($353,000 from HB11 Energy)	Associate Professor Patrick Burr	Mid-career industry fellowship for the research: 'Life prediction and optimisation of advanced first-wall fusion materials'.
Australian Research Council	$1,200,000	Liao, Dr Ranming Niu, Chen, Kalantar-Zadeh, Julie M. Cairney, Li, Associate Professor Bernd Gludovatz, Wang, Associate Professor Patrick Burr, Huang, Yang, Mateti, Cai, Nguyen	Linkage Infrastructure, Equipment and Facilities scheme for the research: 'In-situ nanomechanical testing for materials under extreme environments'.
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ANSTO	$196,200 (in-kind)	Dr Samaneh Setayandeh	Irradiation Time at ANSTO: awarded as the sole Lead CI.
UCM Grants	$8000 (in-kind)	Dr Samaneh Setayandeh	Awarded as the sole Lead CI.
IRN-FACES Grants	$9000	Dr Samaneh Setayandeh	
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Australian Institute of Nuclear Science and Engineering	Confidential	Dr Jennifer Stansby	AINSE Early Career Researcher Award.
Department of Defence	Confidential	Associate Professor Edward Obbard, Associate Professor Patrick Burr	UNSW Graduate Certificate Programs for Department of Defence Nuclear Engineers.
The National Computational Merit Allocation Scheme 2025	Confidential	Associate Professor Patrick Burr	Grant scheme for access to high-performance computing (HPC) resources.
The National Health and Medical Research Council	$88,000	Distinguished Professor Anatoly Rozenfeld (University of Wollongong)	A visit with students to JAPAN HIT and the Vietnam nuclear reactor in 2025 for hands-on training.

From	Amount	To	For
Australian Research Council (ARC)	$500,000	Professor Anatoly Rozenfeld, Professor Marco Petasecca, Professor Michael Lerch, Dr Linh Tran, Dr Andrew See	To develop Space Radiation Monitoring system for Space missions.
NHMRC Ideas grant	$758,000	Professor Anatoly Rozenfeld, Dr Linh Tran, Professor Michael Lerch, Professor Marco Petasecca, Nick Depauw, Professor Harald Paganetti, Associate Professor Michael Jackson, Associate Professor Verity Ahern	To develop QA microdosimetry system for proton therapy.
NHMRC Development grant	$943,000	Dr Linh Tran, Professor Anatoly Rozenfeld, Professor Marco Petasecca, Professor Michael Lerch, Associate Professor Verity Ahern, Associate Professor Michael Jackson	To commercialise QA microdosimetry system for proton therapy.
NSW Space Research Network	$120,000	Professor Nicholas Ekins-Daukes, Dr Michael Nielsen, Professor Anatoly Rozenfeld	To investigate radiation damage of UNSW proposed innovative solar cells.
UNSW Engineering	Confidential	UNSW Nuclear Innovation Centre	Senior Lecturer role Co-funding the Centre's Program Manager role.
UNSW Canberra	Confidential	UNSW Nuclear Innovation Centre	Co-funding the Centre's Program Manager role.

Featured in the media

A sample list of recent media articles and appearances featuring the research and activities of the Centre.

Sky News TV appearance by Associate Professor Edward Obbard on the COP28 call to triple nuclear pledges
https://www.youtube.com/watch?v=qOucI9FfxhQ

ABC News article on AtomCraft
https://www.abc.net.au/news/2024-06-08/unsw-students-work-on-small-nuclear-fusion-reactor/103945790

The Australian newspaper special report: 'Enlisting a nuclear-skilled future'
https://www.theaustralian.com.au/special-reports/enlisting-a-nuclearskilled-future/news-story/970a384e766ef2e6dbefca13de2d6f40?btr=401fae95c8ac3d1ad83aeecc444afbf4

The Sydney Morning Herald newspaper report on the Coalition pledge to ditch nuclear sites if earthquake zones are declared unsafe
https://www.smh.com.au/politics/federal/coalition-pledges-to-ditch-nuclear-sites-if-earthquake-zones-are-declared-unsafe-20240826-p5k5d5.html

ABC Radio's 'The World Today' program on universities expanding course offerings for AUKUS
https://www.abc.net.au/listen/programs/worldtoday/universities-look-at-expanding-course-offerings-for-aukus/102205694

Coverage of the launch of the UNSW Nuclear Innovation Centre
UNSW launches Nuclear Innovation Centre to advance Australia's nuclear technology (proactiveinvestors.com.au)

UNSW launches new nuclear innovation program | Sky News Australia

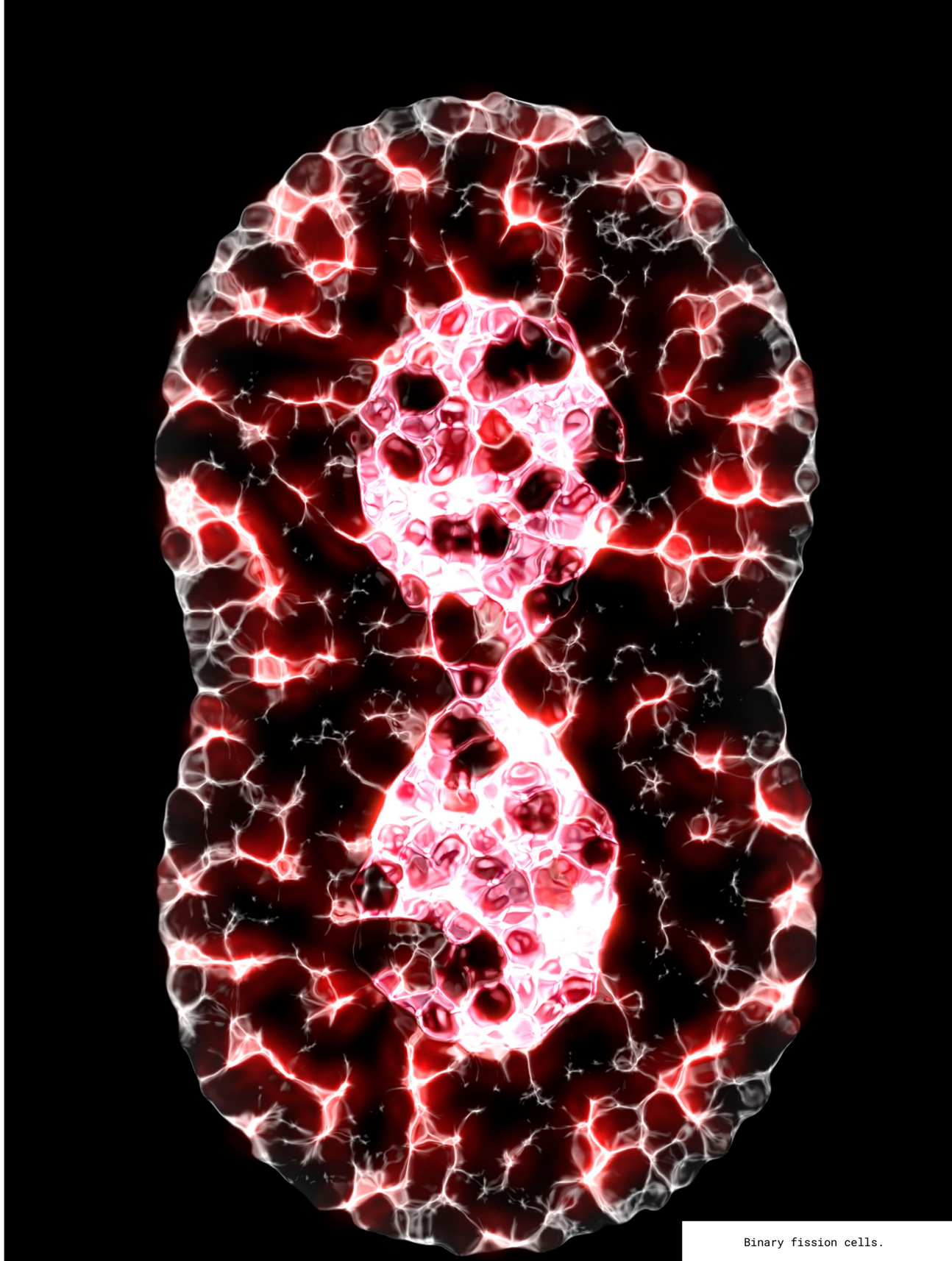
Sky News: https://www.youtube.com/watch?v=rBAzFDuF1GQ

UNSW launches new nuclear innovation program | The Chronicle

Nuclear Innovation Centre officially opens in Sydney | The Chronicle

UNSW launches Nuclear Innovation Centre with $7.5M donation from Tyree Foundation - Australian Manufacturing

Opening of the UNSW Innovation Centre | Defence Ministers



Binary fission cells.

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