2023 PREMIER'S PRIZES FOR SCIENCE & ENGINEERING

GOVERNMENT HOUSE SYDNEY

Wednesday 15 November 2023



The Honour Roll NSW Scientists of the Year

Professor Glenda Halliday AC The University of Sydney Adjunct Professor Jim Patrick AO Cochlear Ltd, Macquarie University

Professor Edward Holmes The University of Sydney

Scientia Professor Rose Amal AC UNSW Sydney

Laureate Professor Nick Talley AC The University of Newcastle

Professor Gordon Wallace AO University of Wollongong

Professor Rick Shine AM The University of Sydney

Laureate Professor Scott Sloan AO The University of Newcastle

Laureate Professor Mark Westoby Macquarie University

Laureate Professor Graeme Jameson AO The University of Newcastle

Laureate Professor John Aitken The University of Newcastle

Scientia Professor Michelle Simmons AO University of New South Wales

Professor Hugh Durrant-Whyte The University of Sydney

Professor Stephen Simpson AC The University of Sydney

Scientia Professor Martin Green AM University of New South Wales

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The 2023 Premier's Prizes for Science & Engineering are an initiative of the NSW Government, led by the Office of the NSW Chief Scientist & Engineer, to recognise excellence in research and education, and to reward those whose cutting-edge work has generated economic, environmental, health, social and technological benefits for New South Wales. **Order of Proceedings**

Welcome to the 2023 Premier's Prizes for Science & Engineering, hosted at Government House, Sydney, on Wednesday 15 November 2023.

Introduction

Master of Ceremonies: Professor Hugh Durrant-Whyte NSW Chief Scientist & Engineer

Keynote Address

Her Excellency The Honourable Margaret Beazley AC KC Governor of New South Wales Patron of the NSW Premier's Prizes for Science & Engineering

Premier's Address (Video)

The Honourable Christopher Minns MP Premier of New South Wales

2023 Premier's Prizes for Science & Engineering Presentation Ceremony

The Honourable Anoulack Chanthivong MP Minister for Innovation, Science and Technology

Address by the 2023 NSW Scientist of the Year





GOVERNMENT HOUSE SYDNEY

Message from Her Excellency The Honourable Margaret Beazley AC KC Governor of New South Wales

A s Patron of the NSW Premier's Prizes for Science & Engineering, I am delighted to be part of the celebration of the eminent community of NSW scientists and engineers, and the educators whose passion inspires scientific curiosity in the next generation.

This year, we again commend those who make the critical discoveries, advances and breakthroughs which demonstrate the humanitarian importance of science, highlighted by these awards. Sadly, we also grieve the loss of several luminaries, including Professor Justin Yerbury AM from the University of Wollongong, last year's recipient of the NSW Premier's Prize for Science & Engineering: Excellence in Medical Biological Sciences award.

This year has also demonstrated the critical role of science, exemplified in one high-profile legal case where scientific developments brought to light new evidence resulting in a pardon. That outcome was significantly propelled by the dedication of scientists who made the research discoveries and connections, understood the implications, and fought for emerging scientific evidence to be considered.

In June this year, I was honoured to host Australia's Chief Scientist, Dr Cathy Foley AO PSM in an Ideas@theHouse presentation on the "Importance of scientific ideas and discovery to Australia's future". The collaborative unity of purpose to which she referred will result in the accelerated application of existing scientific and technological solutions and the development of new ones, important both to society and to the future of our planet. In August, I was also honoured to host Professor Emma Johnston AO, the leading authority on marine ecology, who enlightened the audience on "Marine stewardship and sustainability in a time of acceleration".

These awards create momentum and are a source of pride and inspiration to the entire scientific and engineering community. Congratulations to each of this year's Prize-winners and Finalists. Thank you, to our dedicated community of scientists, researchers, engineers and educators across New South Wales.

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Her Excellency the Honourable Margaret Beazley AC KC Governor of New South Wales



Message from the Premier of New South Wales

I congratulate all the winners of the 2023 Premier's Prizes for Science & Engineering. Our State has a proud history of scientific discovery and engineering excellence.

These awards recognise you – the leading science and engineering researchers in our State – and celebrate how your research is helping improve both lives and livelihoods in NSW.

By shining a spotlight on your remarkable work, we also hope to raise awareness about the contribution scientists and engineers make to our daily lives, and encourage more people to choose a rewarding career in these fields.

In reviewing your achievements, I am struck by the diversity of your research interests and breadth of professional endeavours. What unites our winners is a commitment to excellence – for the good of our economy, environment, health and wellbeing.

On behalf of the Government and people of our State, I congratulate and thank all our winners for their efforts. Well done!

Sincerely,

Chris

Chris Minns MP Premier of New South Wales



Message from the NSW Chief Scientist & Engineer

We clowne to the NSW Premier's Prizes for Science & Engineering. A sincere thank you to our Patron, the Governor of NSW, Her Excellency the Honourable Margaret Beazley AC KC, and Mr Dennis Wilson for their ongoing support and for allowing us to hold tonight's ceremony at Government House.

This event is an important annual celebration of research excellence, especially at our outstanding NSW universities and research organisations. Of special note this year, the 2008 NSW Scientist of the Year, Professor Martin Green, was awarded the Queen Elizabeth Prize for Engineering – the world's premier prize for engineering. In addition, the 2011 NSW Scientist of the Year, Professor Michelle Simmons, was this year's recipient of the Prime Minister's Prize for Science. Martin and Michelle's world leading research in photovoltaics and quantum computing respectively highlights the huge global research talent in NSW.

A key role of my office is to manage the programs and funding which help new companies to develop and commercialise new deep technologies. This year has witnessed exciting news from former recipients of two such programs.

Physical Sciences Fund recipient and green hydrogen company Hysata, which recently opened its new electrolyser manufacturing global headquarters in Port Kembla, last year raised \$42.5 million in series A funding and was named Startup of the Year at the 2023 Startup Daily Best in Tech Awards.

Small Business Innovation & Research program funding recipient Advanced Navigation raised over \$100 million in their series B funding round and recently unveiled a new AI and robotics manufacturing facility in Sydney, based out of the UTS Tech Lab, which will support initiatives between government, academia and industry, driving innovation and knowledge exchange.

Led by my office, the NSW Government is also building a first-of-its-kind RNA Pilot Manufacturing Facility, with initial designs for the new building at Macquarie University now released.

The important work of scientists and engineers never ends. It's appropriate then, that we gather tonight to celebrate exceptional science and engineering leadership in NSW. Please join me in celebrating the achievements of this year's winners.

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Professor Hugh Durrant-Whyte NSW Chief Scientist & Engineer

Premier's Prizes for Science & Engineering

The Premier's Prizes for Science & Engineering reflect the NSW Government's strong commitment to the local research and development community.

The Prizes seek to raise community awareness and appreciation of the important contribution scientists, engineers and educators make to our daily lives, as well as to encourage careers in these fields.

The top award, the prestigious Premier's Prize for the NSW Scientist of the Year, will be presented to an outstanding individual who has made a significant contribution to the advancement of science or engineering which has benefited or has the potential to benefit the people of New South Wales.



2023 Premier's Prizes for Science & Engineering Categories

- Excellence in Mathematics, Earth Sciences, Chemistry or Physics
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Excellence in Biological Sciences (Ecological, environmental, agricultural and organismal)

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 - Excellence in Medical Biological Sciences (Cell and molecular, medical, veterinary and genetics)
- **Excellence in Engineering or Information and Communications Technology**
- 5 NSW Early Career Researcher of the Year (Biological Sciences)
 - NSW Early Career Researcher of the Year (Physical Sciences)
- 7 Leadership in Innovation in NSW
- 8 Innovation in NSW Public Sector Science and Engineering
- 9 Innovation in Science, Technology, Engineering or Mathematics Teaching in NSW



Excellence in Mathematics, Earth Sciences, Chemistry or Physics

Dr Anthony B. Murphy CSIRO

D r Anthony Murphy has performed outstanding research in applied physics and chemistry, with a focus on the

applications of plasmas (ionised gases, often referred to as the fourth state of matter).

In his work with companies, ranging from small to medium enterprises to multinationals, Tony has developed novel processes that apply plasmas to treat hazardous waste and synthesise ammonia, produced computer software to assist arc welding and metal 3D printing, and provided vital data for the design of highvoltage switchgear and aircraft lightning protection. Tony's achievements include:

- development of the PLASCON[®] (now PyroPlas[®]) waste-treatment process, used around the world to destroy ozone-depleting substances (including Australia's stockpiles), greenhouse gases and toxic liquids
- development and transfer to industry of the 'ArcWeld' welding simulation software, which achieves unprecedented accuracy by integrating the arc plasma and welded metal in the calculation, and its extension to metal 3D printing
- calculation of the properties of novel environmentally friendly insulating gases, used by manufacturers to design high-voltage switchgear
- development of novel plasma-catalytic processes to produce ammonia, tailored to the storage of renewable energy.

These achievements benefit the NSW community by reducing ozone-depleting and greenhouse gases and improving conventional and novel manufacturing processes and products.

Tony has won six prestigious international and national awards, most recently the Plasma Chemistry Award of the International Plasma Chemistry Society and Plasma Innovation Prize of the Association of Asia Pacific Physical Societies, Division of Plasma Physics.

Despite his highly commercial research focus, Tony has an outstanding publication record, with 330 journal publications and 12,500 citations, the highest of any thermal plasma researcher, past or present, and an h-index of 53.



Excellence in Biological Sciences (Ecological, environmental, agricultural and organismal)

Professor Shinichi Nakagawa FRSN UNSW Sydney

D rofessor Shinichi Nakagawa has made pioneering

L contributions to the fields of animal behaviour, behavioural ecology and evolutionary biology, with his research profoundly impacting the transparency and reproducibility of results across (and beyond) the ecology and evolution fields.

Some highlights from Shinichi's work include describing a novel framework for research synthesis called 'Research Weaving', combining systematic mapping with bibliometrics, and establishing all-new avenues for future research synthesis. He is also a highly active and effective proponent of transparent and reliable science, co-founding the Society for Open, Reliable, and Transparent Ecology and Evolutionary Biology (SORTEE) and the Australian Reproducibility Network (Aus-RN).

Shinichi's work is of immense value to NSW. In pioneering new ways to enhance reproducibility and transparency, he is improving the quality and validity of all ecology and evolution research across the state and beyond. He is a leading voice advocating for best practices in ecology and evolution, attracting over 13,000 mentions in social network media, newspapers and blogs (Altmetric). His highly influential work has not only introduced statistical methodologies to ecology and evolution but has also added new methods to the field, such as phylogenetic multilevel meta-analysis and effect size statistics comparing variance.

Shinichi's research has appeared in over 330 peer-reviewed journal articles, including *Nature, Nature Communications* and *Nature Ecology & Evolution.* He has an h-index of 79 and his work has attracted over 46,000 citations, with over 33,000 citations since 2018. He has been a Clarivate Highly Cited Researcher every year since 2018.





Excellence in Medical Biological Sciences (Cell and molecular, medical, veterinary and genetics)

Professor Catherine Sherrington The University of Sydney

Professor Catherine Sherrington is internationally recognised for developing and testing novel methods to deliver exercise to prevent falls and enhance mobility.

Falls and mobility impairment are important but neglected public health problems which are increasing as our population ages. Each year over 135,000 Australians aged over 65 are admitted to hospital with injuries from falls, at a cost of \$2.3 billion, and 1.2 million Australians report difficulty or inability walking just 200 metres.

Catherine's research has found mobility benefits from physiotherapy, self-managed home exercise and physical activity coaching, supported by digital technologies such as activity monitors. Economic analyses, rarely used by others in this field, found these programs to be cost-saving or cost-effective. In addition, she has discovered that balance-challenging exercise is most effective for falls prevention and provided direct evidence to guide exercise prescription for people with mental health concerns, hip fracture, Parkinson's disease and stroke.

Catherine's research has impacted global policy and practice, including with the World Health Organization, informing recommendations to guide investment in effective exercise in over 127 clinical and population health guidelines from 26 countries. In NSW, the Ministry of Health used her work to guide inclusion criteria for their web-based database of local exercise opportunities. This resource receives over 5,000 visits a month by health professionals and consumers.

Catherine is ranked fourth in the world for the independent living/falls field of research (Scopus) and has published 330 journal articles, with over 40,000 citations and an h-index of 92 (Google Scholar). She has been awarded over \$28 million from the National Health and Medical Research Council and the Medical Research Future Fund.



Excellence in Engineering or Information and Communications Technology

Distinguished Professor Jie Lu AO Australian Laureate Fellow University of Technology Sydney

D istinguished Professor Jie Lu, Australian Laureate Fellow, is a world-renowned scientist in the field of AI. She is the Director of the Australian Artificial Intelligence Institute (AAII) at the University of Technology Sydney.

Jie has pioneered solutions to two critical problems – machine learning from uncertain data and machine learning for complex decision-making. She is particularly respected for initiating and progressing foundational research on fuzzy transfer learning, concept drift, recommender systems and decision support systems.

She has delivered 45 invited keynotes in Australian and international conferences, and 20 public speeches in Australian and NSW industry events. Her development of diverse AI-based software tools has had significant impact through more than 20 industry projects across the transportation, healthcare and telecommunication sectors.

Specifically related to NSW, Jie has solved challenging problems for Sydney Trains, including a machine learning-based system using Opal card streaming data to predict real-time carriage load of trains to avoid congestion, which was particularly impactful during the COVID-19 pandemic. Her continued training and mentoring of PhD student graduates is positioning NSW as a major player in a critical field for the state's economy and workforce.

Jie has attracted prestigious awards, including the IEEE Transactions on Fuzzy Systems Outstanding Paper Awards (twice), NeurIPS2022 Outstanding Paper Award and Australasian Artificial Intelligence Distinguished Research Contribution Award. In the 2023 Australia Day Honours, she was awarded an Officer of the Order of Australia for outstanding service to research and development in the field of AI.

Her research results have been published in 500 articles with high impact in her field, attracting 22,000 citations, with an h-index of 79.



NSW Early Career Researcher of the Year (Biological Sciences)

Dr Deborah Burnett Garvan Institute of Medical Research

D r Deborah Burnett is an early career immunologist dedicated to advancing our understanding of the body's

protective immune responses. As a co-lead of collaborative initiatives that span research institutions and hospitals, her focus is on enhancing vaccine efficacy against critical infectious threats.

Deborah has made ground-breaking discoveries in antibody protection, which have resulted in the development of cutting-edge research platforms that evaluate vaccine responses against specific infectious disease targets. Her work has yielded publications in prestigious journals including *Science*, *Cell* and *Immunity* and she has filed several patents related to antibody and vaccine design.

To maximise the impact of these cutting-edge platforms, Deborah founded Accelerated Vaccine Triage and Response (AVaTAR), Australia's first dedicated pre-clinical vaccine evaluation R&D Network. AVaTAR is poised to strengthen Australia's preparedness against further pandemics and promote biotech sector growth locally and internationally. This initiative addresses a crucial translational gap in NSW's vaccine development pipeline and has gained endorsements from the NSW Office for Health and Medical Research and MTPConnect.

Deborah's vaccine research has secured \$6.7 million in competitive grant funding to date, including a National Health and Medical Research Council Investigator Grant, a prestigious NSW RNA Future Leaders Grant and a Ramaciotti Award. Her outstanding contributions led to a highly commended Discovery Award from Research Australia in 2022 and, recently, a L'Oréal-UNESCO Women in Science Fellowship. With 25 published journal articles, over 640 citations, two F1000 recommendations and an h-index of 12, Deborah is an emerging leader in vaccine research.

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CATEGORY 6

NSW Early Career Researcher of the Year (Physical Sciences)

Dr Chang Xu The University of Sydney

D r Chang Xu is an internationally recognised expert in Artificial Intelligence (AI) and machine learning.

AI is driving the fourth industrial revolution, but the environmental impact of obtaining state-of-the-art AI models is alarming, equivalent to an average car's five-year emissions. Green AI, with a focus on performance/efficiency trade-offs and emulating the highly efficient human brain, is crucial for the future. Chang's ground-breaking research focuses on minimising the resources required to build next-generation AI systems, thereby reducing the environmental footprint of AI and making it more accessible to the public.

Chang has made remarkable contributions to efficient deep learning. He has developed novel algorithms and theories for energy-efficient training and deployment of deep learning models. His work has had commercial success with Huawei's earphone – FreeBuds – where it intelligently enhances voice and reduces background chatter at a minimal energy cost, thus increasing both the listening experience and battery life. Additionally, he has assisted small businesses and companies in NSW in adopting cutting-edge AI while reducing their financial burden, for instance, by halving their AI computational cost.

Chang received the University of Sydney Vice-Chancellor's Award for Outstanding Early Career Research in 2022. He has an impressive collection of over 150 A* publications, with more than 13,000 citations and an h-index of 54. Citations from his top 10 papers place his work in the top three per cent of his field. He has secured more than \$5.7 million in research funding including an ARC Future Fellowship, a Discovery Early Career Researcher Award and a Discovery Project as the sole chief investigator.



Leadership in Innovation in NSW

Professor Michael J. Biercuk The University of Sydney

Professor Michael Biercuk is an exceptional quantum physicist and innovator who has forged an unbroken path from discovery to commercialisation.

As Director of the Quantum Control Lab at the University of Sydney, Michael has pioneered the development of an entirely new research field called quantum control engineering to address the fundamental challenge holding back widespread adoption of quantum technologies – hardware instability and error.

This research has inspired new commercial software tools, developed by Michael's Sydney-based spin off, Q-CTRL, which enable researchers, developers and end-users to meaningfully benefit from quantum technology. Benchmarking measurements have shown up to a 9,000-fold improvement in the success of quantum computers using Q-CTRL's software. In May 2023, IBM announced this software would constitute the first embedded performance management solution on its quantum computers. Q-CTRL has also demonstrated major advances in quantum sensing, resulting in defence contracts for sovereign capability development in Australia.

Michael has simultaneously led efforts to position Sydney as a quantum tech hub. He has advised the tertiary, commercial and government sectors, and served as the technical lead for the development of the \$150 million Sydney Nanoscience Hub – one of world's most advanced physical science research facilities. He is now leading the redevelopment of Q-CTRL's Sydney headquarters – the first independent commercial quantum facility in Australia.

Michael has published 72 papers with 8,865 citations. He has an h-index of 40 and has secured over \$160 million in competitive research grants. Q-CTRL has attracted \$105 million in venture capital funding to NSW, including the largest Series B of any quantum software company worldwide.



Innovation in Public Sector Science and Engineering

Dr Jodi Rowley The Australian Museum and UNSW Sydney

D r Jodi Rowley is an eminent herpetologist at the forefront of biodiversity conservation, with benefits and outcomes from her research having impacts on a state, national and global scale. Her research directly contributes to

the scientific understanding of amphibians – frogs in particular – especially classification, species distribution, threatening processes and using amphibians as sentinels of ecosystem health.

Jodi is the Curator of amphibian and reptile conservation biology at the Australian Museum and the co-founder and Lead Scientist of the museum's national citizen science project, FrogID, engaging citizen scientists across Australia to record frog calls using the FrogID smartphone app.

In just under six years, FrogID has gathered almost one million frog records across Australia. This is the largest frog dataset in Australia (with 44 per cent of records from NSW) and is a powerful tool to monitor biodiversity, raise awareness of environmental impacts and inform policy for species conservation. Jodi has also co-led the inquiries into ongoing frog mass mortality events in NSW and nationally since 2021.

Jodi holds the first joint academic appointment between the Australian Museum and UNSW Sydney. Still early in her career, she supervises many students, has published over 140 peer-reviewed papers, has an h-index of 35 and been awarded over \$3.4 million in grant funding.

She was named a Fellow of the Royal Zoological Society of NSW in 2022 and recognised at the 2023 Australian Museum Eureka Prizes with the Australian Museum Research Institute Medal. Jodi's passion and enthusiasm make her a widely recognised public commentator on TV, radio, newspapers and social media. She is a valued collaborator and a role model for the rising generation.



Innovation in Science, Technology, Engineering or Mathematics Teaching in NSW

Annie-Louise Martin PLC Sydney

A nnie-Louise Martin is a passionate educator. Staff, students and their families appreciate her love of science and ability to integrate STEM subjects across the curriculum. Her classroom is an evolving treasure trove of inspiration and curiosity.

Annie works collaboratively with classroom teachers to design innovative programs. Lessons are student-centred and learning activities build knowledge and understanding while promoting active engagement and critical thinking. Provocations from literature, the local environment and children's curiosity about their world form the basis of inquiries.

Annie sources everyday materials for hands-on science investigations and inspires her students to carry out fair tests and solve problems. She encourages students' self-belief and sense of agency to carry out independent research then creatively share and present their findings.

Annie goes above and beyond her classroom teaching load. She gives freely of her time to mentor students and meets with their families to ensure science is a highlight of their school experience. She provides countless opportunities for students to embrace further learning and real-world science experiences.

Students have achieved outstanding success with her encouragement and guidance, most notably winning 30 of the 104 national awards since 2013 in the primary school category of the Australian Museum Eureka Sleek Geeks competition.

Annie's desire to make science accessible for all extends to the broader community. She has been involved in curriculum review, science teaching associations, gifted and talented workshops and delivering professional development at conferences and workshops for colleagues in local and international, public and independent schools. Her work has had a very positive impact on science teaching in NSW.



2023 NSW SCIENTIST OF THE YEAR

Emeritus Professor Trevor McDougall AC FRS FAA UNSW Sydney

E meritus Professor Trevor McDougall is globally recognised as a leading expert in the field of physical oceanography and is the world's foremost authority on ocean thermodynamics. He has been recognised for his contribution to our understanding of the fundamental physics of the ocean, including how it moves and how it mixes. His ground-breaking research has impacted all of physical oceanography, including observational oceanography and ocean modelling, and he has also transformed the field of ocean thermodynamics.

Trevor's research focuses on the ocean's role in climate, ocean mixing processes and the thermodynamics of seawater. His major discoveries have positioned Australia at the forefront of ocean physics and climate research. His work has improved the modelling of the effects of climate change and has led to the discovery of several new ocean mixing processes, and the development of new methods of analysing oceanographic data.

Trevor's theoretical discoveries underlie the adoption of the Temporal Residual Mean parameterisation by ocean and climate models. Widely regarded as the most substantial improvement in ocean modelling since 1985, this breakthrough incorporates the effects of mesoscale ocean eddies in climate models. His dedication to advancing ocean modelling techniques has not only expanded our understanding of the coupled atmosphere-ocean-ice climate system but has also opened new avenues for future research.

Trevor's contributions to the field of oceanography includes leading an international group of researchers in redefining the 30-year-old definition of seawater thermodynamics and improving the accuracy of the treatment of 'ocean heat content' by a factor of 100.



2023 NSW SCIENTIST OF THE YEAR

Trevor has received significant recognition and awards during his career, including:

- 2023 Fellow of the International Union of Geodesy and Geophysics
- 2022 Prime Minister's Prize for Science
- 2019 President of International Association for the Physical Sciences of the Oceans, 2019-2023
- 2018 Prize of Excellence, Werner Petersen Foundation
- 2018 Fellow of the American Geophysical Union
- 2018 Companion of the Order of Australia
- 2017 NSW Premier's Prize for Excellence in Mathematics, Earth Sciences, Chemistry or Physics
- 2016 Laureate Professorial Fellowship of the Australian Research Council
- 2015 Henry Houghton chair for visiting senior scientists, Massachusetts Institute of Technology
- 2015 Fellow of the Royal Society of New South Wales
- 2015 Jaeger Medal, Australian Academy of Science
- 2013 Royal Society of Tasmania Medal
- 2012 Fellow of the Institute of Physics (UK)
- 2012 Scientia Professor of Ocean Physics, School of Mathematics and Statistics, UNSW Sydney
- 2012 Fellow of the Royal Society of London
- 2007 Fellow of CSIRO
- 2004 Fellow of the Australian Meteorological and Oceanographic Society
- 1997 Fellow of the Australian Academy of Science

Trevor has over 160 journal publications, 11 book chapters and two books, with over 14,000 citations and an h-index of 55.

The 2022 Premier's Prizes for Science & Engineering (L to R): Professor Hugh Durrant-Whyte, NSW Chief Scientist & Engineer, Dr Sudarshini Ramanathan, Her Excellency The Honourable Margaret Beazley AC KC, Governor of NSW, Professor Anna Giacomini, Dr Jiao Jiao Li, the 2022 NSW Scientist of the Year, Professor Glenda Halliday, Professor David Eldridge, Distinguished Professor Michelle Leishman, Mr Ian Preston, Professor Geordie Williamson, the late Professor Justin Yerbury AM, Professor Luke Wolfenden and the Honourable Alister Henskens MP, former Minister for Science, Innovation and Technology.



