

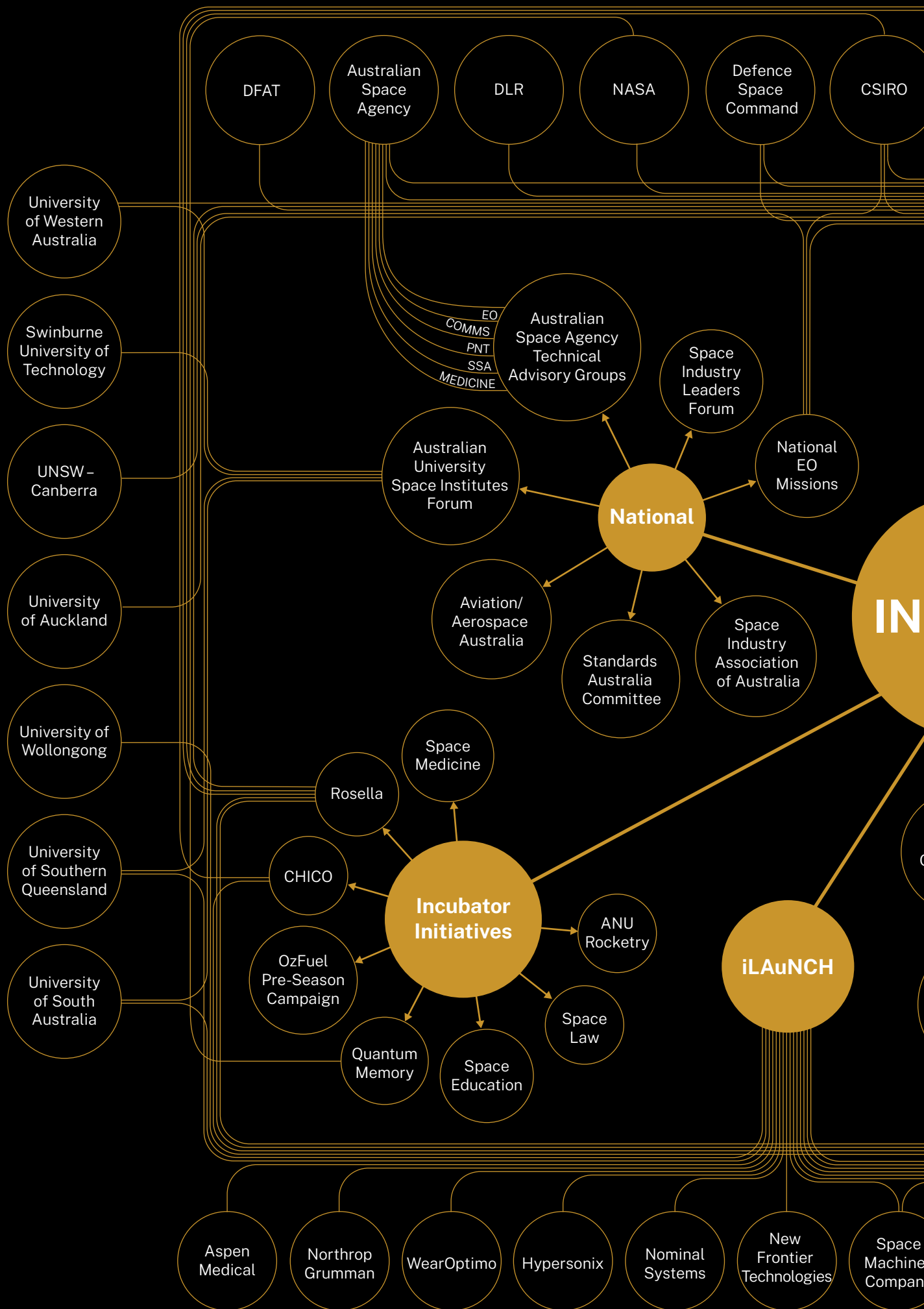
ANU Institute for Space

YEAR IN REVIEW 2022-23

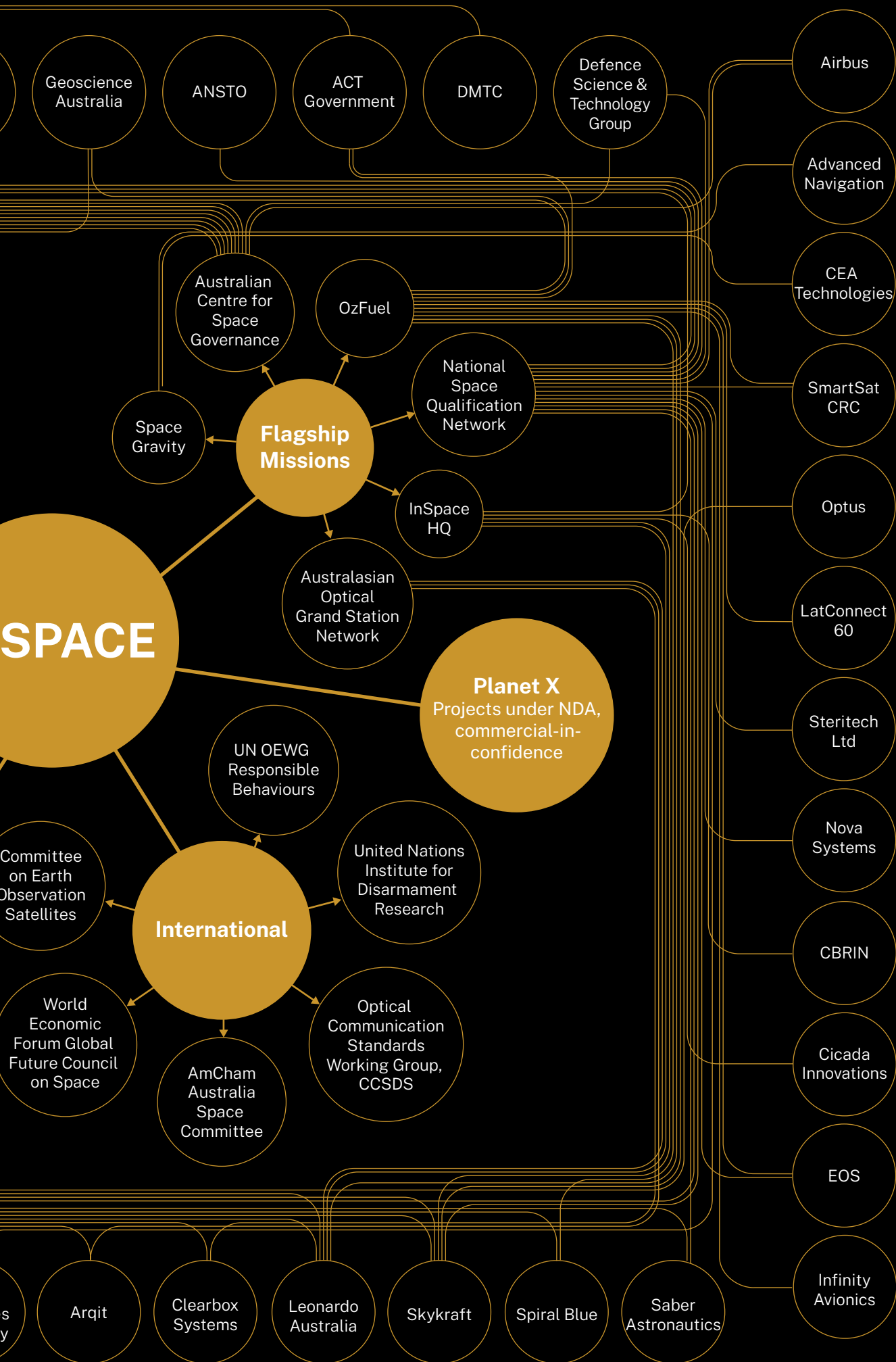
Advancing Australia Through Space



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Get in touch to learn more and meet our space experts.



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FOREWORD BY THE CHAIR OF THE BOARD

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InSpace strives to advance Australia through excellence in research and continue the ANU founding legacy by addressing enormous societal, technological, and international change for the betterment of Australia and its people. InSpace is run by a dynamic team of people bringing professionalism and international experience to create a vibrant and progressive Institution.

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KEITH NUGENT

Deputy-Vice Chancellor for Research and Innovation

Chair of the Board

Just a few years ago, few people saw the possibility of Australia with a growing space industry.

As part of an expert reference group considering the creation of a national space agency, Professor Anna Moore was a strong supporter of founding the Australian Space Agency, and through her work, she was able to link dozens of multidisciplinary researchers across the Australian National University (ANU) to help advance Australia's growing national space effort.

Space research at ANU was so compelling that we created Australia's first multi-disciplinary space institute, The Australian National University Institute for Space (InSpace) with Professor Moore as its director.

InSpace strives to advance Australia through excellence in research and continue the ANU founding legacy by addressing enormous societal, technological, and international change for the betterment of Australia and its people. InSpace is run by a dynamic team of people bringing together professionalism and international experience to create a vibrant and progressive institution.

The depth and breadth of space research at the ANU includes space communication, exploration, building sovereign capability, and translating space innovation back to Earth to benefit all Australians. InSpace combines those disciplines with space law, economics, medicine, and the humanities to create strong, sustainable, holistic outcomes for Australia and the world.

As InSpace grows, it is addressing society's biggest challenges: societal resilience, climate change, quantum communications, and a sustainable space sector, which includes a diverse set of voices.

AN INTRODUCTION FROM OUR DIRECTOR **PROFESSOR ANNA MOORE**

What an amazing four years it has been since the the Australian National University (ANU) Institute for Space (InSpace) was founded in 2018.

InSpace connects ANU Space research with society's biggest challenges to deliver positive impact. We do this by shaping and growing the Australian space ecosystem in partnership with Industry, Government, and Communities.

This year, we have seen great success in most of our endeavours and we have surpassed our financial goals for the University and its researchers. That success and impact is a direct result of the hard work and dedication of the InSpace Mission Control and Mission Specialist teams.



It's great to see more of our team members representing the research sector in national and international leadership positions and an increase of funding for research that can translate to space and better life on Earth.

A highlight of the year was when InSpace was awarded Research Organisation of the Year 2022 at the Australian Space Awards. This was a deeply important moment for our team. While onstage collecting our award, it was glaringly obvious that we were the only team with women as our majority and not minority. It was a powerful statement to our industry that diversity and inclusion isn't just possible, it's for the best.

Every day we strive to champion people from diverse backgrounds to enter and excel in the Australian space industry. We want to be the change that our industry needs, and excelling at our work is another example of the benefits a diverse team brings.

Our inaugural InSpace Showcase in November 2022 was a triumph and gave

us a chance to present three of our core missions to an audience of over 200 people, covering topics from fire and water resilience monitoring, advanced optical communications and quantum to space medicine. We opened with our own bespoke theme tune specially composed for us by Professor Kim Cunio, Head of the ANU School of Music. All of this, once again, shows our commitment to multidisciplinary collaboration.

This year we were also part of a \$50M winning University Trailblazer bid, which will allow ANU researchers to translate essential research for space exploration, launch, and communication, through to manufacturing products.

Finally, we found our home at our new InSpace headquarters, which has allowed us to host Industry, Government, and Defence, and strengthen our ties to these critical space stakeholders.

Congratulations to my team for a great year and we are looking forward to delivering for ANU again in 2023.



PROFESSOR ANNA MOORE

Director, ANU Institute for Space
Vice Chancellor's Entrepreneurial Professor



Left to right: Amit Parashar, Kryisia Derecki, Emily Schuster, Professor Anna Moore, Lisa O'Farrell, Dr Kate Ferguson, Dr Cassandra Steer

InSpace Mission Control is a team of world-class space industry professionals working to support space initiatives at the ANU and develop new opportunities for cross-disciplinary collaboration with the global space industry.

INSPACE MISSION CONTROL

In 2022, our multicultural team was named Research Organisation of the Year at the 2022 Australian Space Awards.

Our team believes strong diversity of thought is crucial to success. InSpace believes it is invaluable for younger generations to see scientists and space industry professionals from diverse backgrounds.

The InSpace Mission Specialist team has a 2:1 ratio of women to men, while in Australia, only about 13% of STEM-qualified occupations are held by women. InSpace champions the idea that all people can have a career in space. To support this, our hiring practices reinforce diversity of all kinds.

At InSpace we are looking to build the next generation of capabilities to provide impact and outcomes for ANU space research as well as the Australian space sector.



Dr Cassandra Steer speaking at the Inaugural ANU InSpace Showcase in November 2022



ANU InSpace team winning Research Organisation of the Year 2022 at the Australian Space Awards



ANU Vice Chancellor Professor Brian Schmidt talking at the InSpace Showcase 2022

WHAT WE DO

IT'S A NEW SPACE AGE

Space is more than the traditional image of astronauts exploring our solar system or astronomers looking through telescopes. It is about innovation, technological advancement, and making life better for people on Earth. It is about satellites and the valuable space data they collect, space medicine advances that translate to your local hospital, and rovers and robotics that work off-world and in places on Earth humans cannot reach.

THE BURGEONING SPACE GENERATION

Space research at ANU is not just creating game-changing innovation that will accelerate our future space industry; it is shaping and growing the next generation of Australians who will think nothing of working off-world, using space to reach their goals, and innovating to save our planet while sustainably exploring the next.

INSPACE: A BEACON OF LIGHT

The ANU Institute for Space is here to shine a light on opportunities for ANU researchers to supercharge Australia's space capabilities. We work to produce positive outcomes for enhancing, enabling, and engaging in space development to progress sovereign capability and increase Australian manufacturing, know-how, and technology.

COLLABORATION AND TRANSLATION

Today, more than ever before, collaboration is critical for Space advancements. Across the Australian National University, researchers from many disciplines are applying their world-class expertise to space-related research. InSpace looks to harness the work of these world-leading experts by making them our Mission Specialists. We support them and their endeavours with our Mission Control team. The Mission Control team creates national initiatives and generates external funding for our Flagship Missions and other space-related projects. InSpace translates space research and technology in order to tackle some of society's biggest challenges, building strong partnerships and commercial connections with national and international space agencies and companies. The Mission Control team advocates for research capabilities for local and remote communities, government, and defence.



Professor Anna Moore speaking at the 14th Andy Thomas Space Foundation Australian Space Forum 2022



AmCham Gala Dinner. Left to right: ANU Chancellor Hon Julie Bishop, ANU InSpace Director Professor Anna Moore, ANU InSpace Business Development Manager Dr Kate Ferguson, Professor Ute Roessner



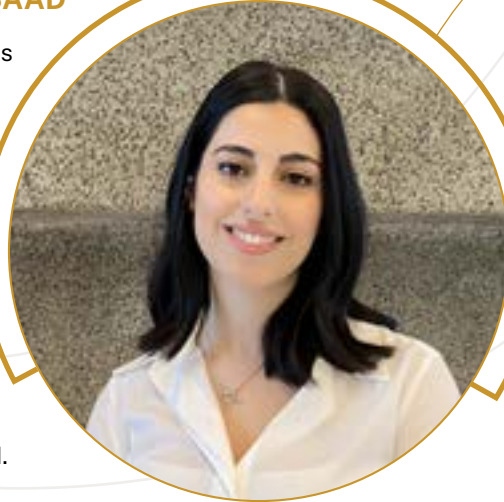
International Space Congress, Paris, France. Left to right: Dr Cassandra Steer, Professor Anna Moore, Associate Professor Francis Bennet, Dr Kate Ferguson, Dr Joice Matthew, Professor Junichiro Kawaguchi

MISSION SPECIALISTS

Meet the researchers working to support space initiatives across ANU and develop new opportunities for cross-disciplinary collaboration with the global space industry.

DR ZENA ASSAAD

Dr Zena Assaad is an aerospace engineer who studies human-machine teaming and safety assurance of robotics, autonomous systems, and AI (RAS-AI). As machines transition from tools to teammates, the safety implications of humans working alongside machines will require a more nuanced understanding of risk. Dr Assaad is currently developing a safety framework that will allow humans to operate safely alongside machines. Dr Assaad is a senior research fellow at the School of Engineering and is also a fellow with the Trusted Autonomous Systems Defence Cooperative Research Centre (TAS DCRC). As a committee member of the ISO Artificial Intelligence Trustworthiness Committee, she contributes to the development of standards towards trustworthy AI.



ASSOCIATE PROFESSOR FRANCIS BENNET

Associate Professor Francis Bennet is an expert in adaptive optics for astronomical instrumentation, space situational awareness, and laser communication. He takes quantum communications experiments from the lab to space, enabling a global quantum encrypted communications network. This includes working on the development of a satellite to test quantum communication between space and the ground and creating a prototype to demonstrate high-speed optical communications between Earth and Lunar spacecraft equipped for optical communication. Francis also leads the ACT Node of the Australasian Optical Ground Station Network, is an Associate Professor at the Research School of Astronomy and Astrophysics and is a member of the Australian Space Agency's Technical Advisory Group on Advanced Communications.



DR CAITLIN BYRT

Dr Caitlin Byrt is a biologist who studies proteins found in cell membranes throughout many organisms. These proteins can help plants survive droughts as well as life in space. They can be used to filter valuable nutrients from wastewater or filter drinking water and can even be used in soft robotics. Caitlin is co-founder and director of Membrane Transporter Engineers, a company working on advancing the function of membrane separation technologies to enable the harvest of valuable resources from liquid wastes. Caitlin is an ARC Future Fellow at the Research School of Biology.





PROFESSOR JOHN CLOSE

Professor John Close is an experimental and theoretical physics researcher whose research focusses on harnessing the properties of ultra-cold atoms to develop quantum sensors to measure gravitational fields and magnetic fields with applications in underground structure mapping and navigation on Earth and in space. His work is multidisciplinary, and he has broad collaborations with Earth Science, Biology, and Industry. He is a professor in the Department of Quantum Science and Technology, a Senior Fellow of the Higher Education Academy, former Head of the Department of Quantum Science, former elected member of ANU Council, and current Head of ANU Defence Engagement. John was awarded the Australian Defence Industry Prize for Academic of the Year and the Australian Defence Industry Prize for Excellence in 2020.

DR DORIS GROSSE

Dr Doris Grosse is an optical instrument scientist specialising in adaptive optics and the space environment. She investigates the characteristics and whereabouts of space debris to reduce its threat, making space safer and more sustainable so humans can rely on and benefit from satellites for centuries to come. Doris is also expanding her expertise in optical communications by working on space to ground laser communications. Doris serves as a member of the World Economic Forum's Global Future Council on Space and is a research fellow at the Research School of Astronomy and Astrophysics.



PROFESSOR PENNY KING

Professor Penny King examines surface and interior processes on planetary bodies, aiming to improve our understanding of the fundamental aspects of how materials in the solar system behave. Her work creates better tools to explore our solar system and the deep Earth and understand climate change. Penny is a champion for diversity in STEM industries, a Professor in the Research School of Earth Sciences, and Associate Dean (Research) in the College of Science.

PROFESSOR PING KOY LAM

Professor Ping Koy Lam is a world-leading expert in quantum optics, quantum key distribution, quantum repeaters, and quantum optical information processing.

Ping Koy is working to build the next generation of communication via lasers, securing it with quantum key distribution to create virtually unhackable communication. He was the chief scientist and co-founder of QuintessenceLabs, a spin-off company that commercialises quantum communication technology. Ping Koy was elected to Fellow of the Australian Academy of Science in 2020. He is a program manager of the Centre for Quantum Computation and Communication Technology and a 2015 ARC Laureate Fellow. He works in the Department of Quantum Science and Technology in the Research School of Physics.



ASSOCIATE PROFESSOR MARIA RACIONERO LLORENTE

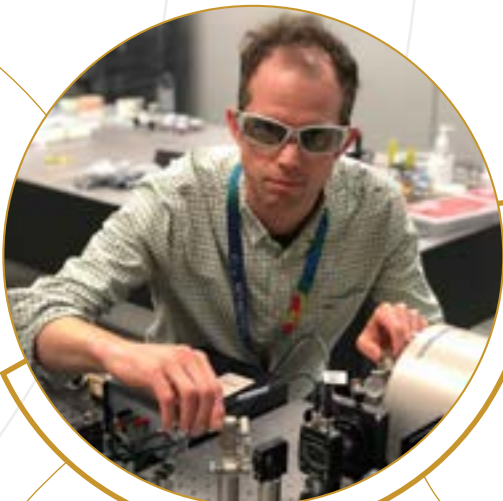
Associate Professor Maria Racionero Llorente is an expert in public economic theory, including optimal taxation theory and methods to improve gender equity in public policy. Maria is a great example of the multidisciplinary researchers adding diversity of thought to InSpace. She is keen to contribute her public economics expertise to address issues with market decentralisation, market failures and regulation of the space economy. Maria is an Associate Professor in the College of Business and Economics.



PROFESSOR ROBERT MAHONY

Professor Robert Mahony's research interests are in non-linear control theory with applications in robotics, geometric optimisation techniques, and systems theory. Using his specialised knowledge of aerial robotics, Robert has developed prototype autonomous aerial water gliders that can carry enough water to saturate specific targets and stop fires before they can spread, contributing to the goals of InSpace's OzFuel mission. Robert is a Professor in the School of Engineering. He is also an Institute of Electrical and Electronics Engineers Fellow.





PROFESSOR KIRK MCKENZIE

SmartSat Professorial Chair for Precision Measurement in Space

Associate Professor Kirk McKenzie and team are developing lasers for precise measurements that will map Earth's gravitational field from space to understand important processes like water movement and climate change. Kirk leads one of the Moon to Mars missions to develop laser measurement technology for deployment on the next NASA Gravity Recovery and Climate Experiment (GRACE) mission, in partnership with CEA Technologies. Kirk is Associate Professor and Senior Fellow at the Centre for Gravitational Astrophysics.

PROFESSOR AIR VICE-MARSHAL (RETIRED) TRACY SMART AO

Professor Air Vice-Marshal (Retired) Tracy Smart AO is Professor of Military and Aerospace Medicine in the College of Health and Medicine. She is currently developing aerospace medicine educational offerings and is a co-investigator on the iLaunch 'Manufacturing wearable-based health solutions for space medicine' project. Professor Smart recently won the Royal Australasian College of Medical Administrators (RACMA), Distinguished Fellow Award.



PROFESSOR PAUL TREGONING

Professor Paul Tregoning is a geophysicist who uses Earth observation data from satellites to study how the Earth surface changes through geophysical processes, including tectonic deformation, climate-driven variations in sea level, and melting of polar ice caps. Paul is a member of the NASA Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) mission and a Fellow of the International Association of Geodesy. Paul is a member of the ANU Institute for Climate, Energy and Disaster Solutions, ANU Institute for Water Futures, and Professor at the Research School of Earth Sciences. He is also a member of the Australian Space Agency's Technical Advisory Group on Earth Observation as well as Positioning, Navigation and Timing.



DR EMMA TUCKER

Dr Emma Tucker is an emergency medicine registrar (Australasian College for Emergency Medicine) at the Calvary Emergency Department in Canberra and a senior research fellow in space medicine at the College of Health and Medicine. Emma's research specialty is the effect of microgravity on the cardiovascular system. After completing a PhD in astrophysics and a medical degree, Emma had an aerospace medicine clerkship at NASA's Johnson Space Center. She is a member of the Australian Space Agency's Technical Advisory Group on Space Medicine and Life Sciences.

ASSOCIATE PROFESSOR MARTA YEBRA

Associate Professor Marta Yebra uses satellite data to support fire managers with critical information to make decisions to prevent, respond to and recover from bushfires. She leads the multidisciplinary InSpace OzFuel team. This team is designing Australia's first satellite mission to help forecast areas where bushfire fuel conditions create the highest risk of fires starting or burning out of control. Marta is also Director of the ANU Bushfire Initiative, Associate Professor in Remote Sensing at the Fenner School of Environment & Society and the School of Engineering. She is also a member of the Australian Space Agency's Technical Advisory Group on Earth Observation.

Professor Yebra was finalist for the Academic of the Year – Space Awards and the Earth Observation Australian – Significant Contribution to the Development of the Australian Earth Observation Community and its Capabilities.





Photo Credit:
Seth Lazar, Professor of Philosophy at the Australian National University

VALUE INSPACE BRINGS TO ANU

The ANU Institute for Space creates pathways to commercialise promising space research across the University.



11/2022 114/lifetime
Proposals submitted



\$21.5M/2022 \$32M/lifetime
Amount of funding InSpace brought
into the Australian National University

2

MOUs signed
in 2022

13

Non-disclosure
agreements
signed in 2022

1

Letter of
Agreement –
NASA Optical
Terminal Study

In 2022, InSpace supports:

4 Institutes | 7 ANU Colleges



47 Companies InSpace partners with in 2022



8 National space agencies InSpace works with in 2022

\$200M

ANU Infrastructure supporting space industry growth in 2022

4:1

ROI ANU investment

FLAGSHIP MISSIONS

Every few years, InSpace chooses research with national significance and turns that research into Flagship Missions. These Mission outcomes align with the Australian Space Agency priority areas and federal government priorities in defence, home affairs, and science.

In addition to national contributions, Flagship Missions form a critical link between the space infrastructure and researchers at ANU InSpace and the global space industry. Our Flagship Missions are nationally recognised as major initiatives with substantial potential for research translation, with an immediate impact and return on investment. Flagship Missions benefit from an intense one-year period of work with our team of world-class space industry professionals to boost their capacity and enhance their capability. This is done through forming robust multidisciplinary teams, bringing in funding, and guiding the program toward maturation. We also promote each Flagship Mission's impact in the space ecosystem, both nationally and internationally.

“ Flagship Missions form a critical link between the space infrastructure and researchers at ANU InSpace and the global space industry.

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“ Our Flagship Missions are nationally recognised as major initiatives with substantial potential for research translation, with an immediate impact and return on investment.

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FUTURE OF COMMUNICATIONS FROM OPTICAL TO QUANTUM

Our society is critically reliant on satellite to earth communications for a range of daily activities, from navigation and weather predictions to supporting national security. Communication satellites have transformed our lives through connecting societies across the globe, as well as connecting continents and remote communities, which is a great story for Australia. However, the reality is that these connections are not always secure and data breaches are commonplace, which ultimately has a negative impact on society. There is a national need and demand to increase bandwidth to provide more connectivity whilst also increasing security.

InSpace's Mission Specialists' work at ANU means that Australia is poised to become the global hub for the next satellite communication evolution thanks to the development of optical communication. This is a breakthrough technology that will help us leapfrog to next-generation capability and allow unprecedented high volumes of data to be transmitted in real-time, with substantially enhanced security.

“

The proposed Australasian Optical ground station network (AOGSN) will be critical infrastructure that will transform the way satellites communicate with Earth. ”

ANU is leading the development of an integrated, optical satellite telecommunications research network to enable next-generation, secure satellite communications for Australia's nation-critical capabilities. The proposed Australasian Optical Ground Station Network (AOGSN) will be critical infrastructure that will transform the way satellites communicate with Earth. This network will also have quantum capability built in from the start to provide the underlying infrastructure to network quantum devices and establish a quantum internet for improved computation, sensing accuracy, and provably secure communications.

MISSION GOAL: To create an integrated, quantum-upgraded, laser communications network, providing significantly improved telecommunications capability, security, and resilience across Australia

ANU TEAM: Associate Professor Francis Bennet, Professor Ping Koy Lam, Associate Professor Matt Sellars

PARTNERS: Defence, Science and Technology Group, University of Western Australia, University of Auckland, NASA Goddard Space Flight Centre, NASA Glenn Research Center, German Aerospace Center DLR, Arqit, Clearbox Systems, Leonardo Australia

- 2022 MILESTONES:**
- InSpace established a Letter Agreement with NASA to cooperate on developing a low-cost, multi-mission optical ground station.
 - The ANU Optical Ground Station (OGS) received \$1.7 million through the iLAUNCH Trailblazer Hub to develop an advanced optical data receiver instrument for optical and quantum communication and to define the scope of future optical ground station networks.
 - The 70 cm telescope for the ANU OGS was delivered and tested tracking satellites. The construction of the facility housing the ANU OGS started in Dec 2022, with completion expected in Mar 2023.

RESILIENCE MISSION

A FIRE RESILIENT AUSTRALIA

Catastrophic bushfires are increasing all over the world. It's undeniable that Australia faces a future living with bushfires. Between climate volatility and a rise in extreme weather events, it's vital that we work with our communities, our industries, and our governments to build our resilience infrastructure to ensure a safe environment for us all to live.



MISSION GOAL: To develop, test, and deploy a satellite that will monitor forest flammability, thereby protecting Australia from catastrophic bushfires and informing fire management and response operations.

ANU TEAM: Associate Professor Marta Yebra, Professor Rob Sharp, Dr Nicolas Younes

PARTNERS: Skykraft, UNSW Canberra, Spiral Blue, Geoscience Australia

- 2022 MILESTONES:**
- The OzFuel Phase A Concurrent Design Facility Study report was released in November. This report, funded by the SmartSat CRC, outlines the technical design and payload options for the OzFuel-1 mission. Twenty-eight experts from ANU and other organizations participated in the five-day study.
 - The OzFuel team also undertook a field campaign to verify and validate preliminary remote sensing requirements and to measure biochemical properties of eucalypts over time. This data will help verify sensor designs, design the data products for the mission, and provides input for machine learning algorithms. In addition, the teams designed and started a drought experiment to understand how eucalypt trees respond to drought conditions.

The Australian National University (ANU) and its partners have developed a Resilience Mission to provide landscape flammability risk data at a continental scale to support effective planning and preparation.

Over the past three years, ANU has made major investments in developing a new spaceborne sensor, OzFuel. This sensor has been designed to be sensitive to leaf-level flammability traits in eucalypt trees, as well as being capable of detecting changes in the flammability traits of other bushfire fuels. With the data provided by the OzFuel sensor, we can mitigate fire risks by knowing where the fuel is, how much there is, how dry it is, and what the risk is to communities.

The Resilience Mission will be a satellite mission with the OzFuel sensor as its payload to provide the nation with the

most cost-effective way to measure the daily to weekly changes of bushfire risk over the whole of the Australian landmass, as well as on a global scale.

The experts driving the Resilience Mission combine: world class research in remote sensing of bushfires, innovation by leveraging advanced instrumentation technologies from astronomy to develop the OzFuel sensor, and key industry partnerships in space systems technology.

The Resilience Mission aims to utilise the OzFuel advanced sensor system to acquire high spatial, spectral, and radiometric resolution data. The mission will provide this data freely to anyone involved in assessing bushfire risk, predicting fire behaviour, informing suppression efforts, and planning prescribed burns, and other users to make our communities more resilient.



NSQN – NATIONAL SPACE QUALIFICATION NETWORK ENABLING AUSTRALIAN SPACE MANUFACTURING

The National Space Qualification Network evolved from the desire to provide a high-quality sovereign space qualification service to help grow the Australian Space Manufacturing Industry. The consortium of six founding partners – The Australian National University, Australian Nuclear Science and Technology Organisation (ANSTO), Steritech, University of Wollongong Australia, Saber Astronautics, and Nova Systems – came together to drive the vision of Australian-led and managed space testing facilities.

Preparing the Australian industry to launch their products into space requires the highest level of reliability for mission success in extreme environments. The NSQN will provide a combined total of \$1 billion of space qualification infrastructure for immediate, cost-effective testing and accelerated space mission design and delivery.

The new radiation capabilities are world-leading and will accelerate Australian space manufacturing growth, which drives the increased international competitiveness for Australian space technology.

With the NSQN, businesses can boost space mission assurance and success through know-how, rigorous testing, and qualification right here in Australia.

MISSION GOAL: Build the next generation of Australian space testing qualification capabilities and drive and shape space testing education and culture

ANU TEAM: InSpace, National Space Test Facility (NSTF), Heavy Ion Accelerator Facility (HIAF)

PARTNERS: Australian Space Agency, ACT Government, ANSTO, Steritech, University of Wollongong Australia, Saber Astronautics, Nova Systems

- 2022 MILESTONES:**
- Established the NSQN brand and launched the [NSQN website](#).
 - Established the space qualification and space testing facilities.
 - Supporting the Australian space manufacturing industry to design, test and develop products locally.
 - Building a space qualification body of knowledge for the national space sector.



ANU HIAF Irradiation Beamline



ANU National Space Testing Facility

AUSTRALIAN CENTRE FOR SPACE GOVERNANCE

ENHANCING SUSTAINABLE SPACE POLICY

MISSION GOALS:

- Serve the nation's space law and governance needs (government, industry, and broader stakeholders)
- Provide space law and governance education and training nationally
- Produce interdisciplinary research to solve national and global space governance challenges

ANU TEAM:

Dr Cassandra Steer, Associate Professor Maria Racionero Llorente, Dr Elise Stephenson, Dr Zena Assaad, National Security College

PARTNERS:

Flinders University, Griffith University, RMIT, University of Adelaide, UNSW Canberra, Western Sydney University, Geoscience Australia, Department of Defence

2022 MILESTONES:

- ACSG received a \$950k contract from Geoscience Australia to research 'Responsible Governance of Earth Observation Data' and hired a postdoctoral researcher for two years to lead that research agenda.
- ACSG was commissioned by Defence to design and deliver a one day 'Space Security' course to senior decision makers from 22 federal government departments, in collaboration with the ANU National Security College in August 2022.
- ACGS appeared at, and made submissions to, the UN Open Ended Working Group on Reducing Space Threats Through Norms, Rules and Principles of Responsible Behaviours in Geneva in September 2022.
- ACGS partnered with the ANU Global Institute for Women's Leadership on consultations to the Australian Space Agency on diversity and inclusivity in the space sector.

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The ACSG are committed to the values of interdisciplinary collaboration, to safety, security, and sustainability in space, and to diversity and inclusivity in the space sector. ”

The Australian Centre for Space Governance (ACSG) advocates for Australia's interests in space in the 21st century and advances the agenda for responsible space governance.

Australia is at an inflection point as it grows its civil and defence space sector and emerges as a responsible space actor at a complex moment in geopolitical history. As Australia seeks to grow its sovereign capabilities, to partake in the global space economy, and to assert itself as a space middle power, we have the potential to shape international norms of responsible behaviour in space. We can contribute to solving the challenges of safety and sustainability in space and be world leaders in space applications such as communications, climate change response, space situational awareness, and regional security. A strong and deliberate foundation is required to underpin technological capabilities and operations. It is this foundation that will inform policies, strategies, and regulatory frameworks, and the ACSG aims to support the building of this foundation.

The ACSG brings together national expertise in space law, governance, policy, security, property, history, philosophy, and political and social sciences to answer these needs.

The ACSG is committed to the values of interdisciplinary collaboration, to safety, security, and sustainability in space, and to diversity and inclusivity in the space sector. We will ensure that Australia fulfils its potential as a space middle power and that the national space sector engages fully with Indigenous Australians, incorporating Indigenous co-design and governance values to the use of land, sea, and skies for space activities.



An aerial photograph of a dry, cracked landscape. The ground is a mix of light brown and tan colors, with numerous deep, dark cracks running across it. A small, irregular pool of water is visible in the lower right quadrant, reflecting the sky. The overall scene suggests a severe drought or arid environment.

“

...quantify Australia's water resources and measure continental drought impacts, polar icecap melt, sea level rise, and global effects of climate change. ”

SPACE GRAVITY GLOBAL WATER SECURITY



The Space Gravity Flagship Mission aims to accelerate the development of innovative new gravity sensing technologies for Earth Observation and geodetic applications. The Flagship Mission will develop next-generation laser interferometry and inertial sensor payloads for international missions. These sensors will measure Earth (and planetary) gravitational data from space to quantify Australia's water resources and measure continental drought impacts, polar icecap melt, sea level rise, and global effects of climate change.

MISSION GOALS: Develop new types of gravity sensors using quantum technologies, advancing data analysis for Australia's water management and climate monitoring; continue Australian partnerships to NASA/German GRACE missions

THE ANU TEAM: Professor Paul Tregoning, Research School of Earth Sciences; Professor Kirk McKenzie, Centre for Gravitational Astrophysics; Professor John Close, Research School of Physics

PARTNERS: Advanced Navigation, CEA Technologies, NASA/JPL

2022 MILESTONES:

- Completed the Australian Space Agency Feasibility Demonstrator: Laser Technology for the next GRACE mission grant, partnering with CEA Technologies.
- Tested the CEA Technologies Scale Factor Unit prototype in the NASA/JPL flight-testbed.



iLAUNCH ADVANCING AUSTRALIA'S SPACE CAPABILITIES

ANU InSpace in partnership with program leader University of South Queensland, and in collaboration with University of South Australia and over twenty industry organisations, founded iLAUNCH — the Innovative Launch, Automation, Novel Materials, Communications, and Hypersonics program. Together, we strive to build Australia's sovereign space capability, through addressing critical gaps and accelerating development of a manufacturing sector. Supported by \$50 million in funding from the Australian Government's inaugural \$362.5 million Trailblazer Universities Program and with a total of \$180 million to invest in industry research, commercialisation and advancing manufacturing, we are committed to Australia's burgeoning space industry. We will achieve this through growing our commercially viable civil rockets, rocket test and launch facilities, rapid satellite manufacturing, space qualification design and knowledge and advanced communication and quantum technologies. Ultimately, to prepare Australia for a successful and sustainable space mission success.

The program's comprehensive training, education, and outreach programs will help to produce the next generation of industry professionals. Its commercialisation branch will translate research outcomes into commercially viable products, simultaneously developing Australia's sovereign capability in space and creating an industry which can deliver products onto the international market. This holistic approach to developing a vibrant research and development ecosystem will contribute to attracting and retaining talent, as well as securing a pipeline of highly skilled workforce to regional Australia and creating a legacy in space for the benefit of Australia and the Australian community.

Learn more: <https://www.unisq.edu.au/research/ilaunch>

- MISSION GOALS:**
- Mature high-end, infrared sensor electronics to enable advanced Earth and space observation missions
 - Develop and space-qualify non-invasive medical sensors that can operate and communicate in the space environment
 - Develop compact optical receiver systems for next-generation optical and quantum communications
 - Develop advanced carbon composite structures for space launch vehicles
 - In partnership with Space Machines Company, develop and qualify for flight readiness their Optimus first-generation space transport and logistics platform
 - In collaboration with Skykraft, evolve their current spacecraft platform and payload capabilities with a coordinated ground test and flight validation programme

ANU TEAM: Professor Patrick Kluth, Professor Rob Sharp, Dr Joice Mathew, Mr Ian Price, Mr Annino Vacarella, Mr Brian Taylor, Mr Alexey Grigoriev, Mr David Chandler, Mr Eduardo Trifoni, Mr Nicholas Herrald, Dr Lex van Loon, Professor Klaus-Martin Schulte, Dr Emma Tucker, Professor Tracy Smart, Associate Professor Francis Bennet, Associate Professor Tony Travouillon

PARTNERS: **Education:** University of Southern Queensland, University of South Australia

Industry: Aspen Medical, Arqit, Clearbox Systems, EOS, Hypersonix, Leonardo, Motherson, New Frontier Technologies, Nominal Systems, Northrop Grumman, RTI, Saber Astronautics, SkyKraft, Southern Launch, Space Machines Company, Spiral Blue, QPE Advanced Machining, WearOptimo

At InSpace our focus is to translate ANU space research capabilities to address some of the biggest challenges faced by society, and since joining I have enjoyed the multidisciplinary approach we take to tackle these problems to achieve tangible outcomes.

I am looking forward to bringing my experience in leading deep tech start-ups, research management, delivering major enterprise change programmes, and international experience to support the institute with its objectives to support the Australian space sector.

Our aim is to partner with industry, government, and academia to delivery impact through projects that translate our research. Some examples include, making more resilient communities (through OzFuel), developing a space qualification body of knowledge to support the Australian space manufacturing sector (NSQN), and being a partner of choice to industry and their space research needs.

So, I am looking forward to furthering our outreach engagement with industry and government and looking to expand our international connections and follow with more collaboration in the Indo-Pacific region.

I have a particular interest in AI and Robotics and I am working with ANU researchers specialising in this area, so watch out for more news on this for potential new Flagships in 2023.



DEPUTY DIRECTOR AMIT PARASHAR

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Our aim is to partner with industry, government, and academia to delivery impact through projects that translate our research. ”



InSpace Showcase 2022 Engaging with our Community Networking Event.

DEPUTY DIRECTOR DR CASSANDRA STEER

I have been involved with InSpace since 2020. By contributing my expertise in space law and governance, I have been part of expanding the multidisciplinary team at ANU into law and the humanities, which is what makes ANU InSpace unique compared with other university space institutes. In 2022, I joined the Mission Control team as Deputy Director, overseeing all Mission Specialists. It has been an absolute joy to work with the dedicated team of professionals in Mission Control in a diverse and collaborative environment.



Diversity and inclusivity are issues close to my heart. There is research-based evidence that diverse teams are more productive, more innovative, and retain more of their employees. InSpace lives and breathes the values of diversity and inclusivity. InSpace has partnered with the Australian National University's Gobel Institute for Women's Leadership on a variety of initiatives, starting with hosting a national gathering of women space professionals during World Space Week, and working towards the establishment of a 'women in space' national network in 2023. We have also contributed to the ACT Space Strategy, part of which focuses on Indigenous engagement and on supporting women's careers in space.

The diversity of disciplines across ANU represented at InSpace was highlighted at our Inaugural Showcase in November 2022. Three short presentations were given, each consisting of three Mission Specialists from different research schools, highlighting how today's space research will make a difference for the lives of Australians over the next decade.

We chose to highlight:

- **'Fire and Water: Earth Observation for Climate Action'**

Australia could be leaders in specific technologies for predicting and mitigating bushfires and in gravity measurements for water management. As a nation dependent on these technologies, we have a moral obligation to advance them for our own, our regional, and our global climate needs. It is critical that we expand our understanding and definition of the natural environment to include space to ensure sustainability of the environment, which we depend on for climate data.

- **'Future of Communications: From Light to Quantum'**

The need for more secure, reliable, and rapid communications for remote communities, national security, and international cooperation has become more evident than ever through the Covid-19 pandemic. A ground station network will be a game-changer for national security and for our contribution to the ecosystem of regional, international, and cis-lunar security.

- **'Space Medicine for Earthlings'**

ANU researchers are leading the world with the development of 'digital twins' to study the impact of space travel on individuals. Digital twin technology has applications on Earth, as we learned in the pandemic that not all Australians have access to proper healthcare. Regional, rural, and remote Australians, particularly in Aboriginal and Torres Strait Islander communities, can benefit from the digital twin technology. 'Hospital in the home' also becomes possible for aged care.

The inaugural InSpace Showcase was attended by federal and local government representatives, national space industry representatives, and researchers. Our message hit home as to why space matters and is relevant across disciplines. Fulfilling Australia's potential as an effective space actor requires us to think about our values as a 21st century nation and ask: why are we conducting space research? How do we depend on space? And, how can we benefit even more greatly from growing our existing strengths and capabilities and maximising the opportunities before us? This requires investment in capabilities which will have benefits not only short term, but for future generations. I look forward to working with our Mission Specialists in 2023 to continue this impactful messaging across ANU, the ACT, and nationally.

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There is research-based evidence that diverse teams are more productive, more innovative, and retain more of their employees. InSpace lives and breathes the values of diversity and inclusivity. ”

I am Kate Ferguson, head of business development at InSpace. I have been here for three years, and in that time, I have relished the opportunity to work on dynamic projects with inspiring people. We have had another busy and impressive year, from being a finalist at the AmCham Alliance Awards for Space, to joining the InSpace team in Paris for the International Astronautical Congress on behalf of ANU and the ACT Government. We are hitting the ground running in 2023 with a focus on continuing our successful translation of technological capabilities and an eye, as ever, to the sky in working to support more innovative space endeavours.



BUSINESS DEVELOPMENT MANAGER INDUSTRY WINS AND NEWS



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We are hitting the ground running in 2023 with a focus on continuing our successful translation of technological capabilities and an eye, as ever, to the sky in working to support more innovative space endeavours. ”

INSPACE 2022 HIGHLIGHTS:

- ANU is the major university partner of the University of Southern Queensland-led iLAUNCH Hub, a \$50 million hub funded under the University Trailblazer program. With over 20 industry partners, ANU will accelerate the translation of essential research for Earth observation, advanced communications, space medicine, space platforms, and materials development.
- ANU signed a Letter Agreement with NASA to cooperate in the development of a low-cost, multi-mission optical ground station.
- ANU is part of the Airbus-led Strategic Partner consortium announced in 2022 for the Resilient Multi-Mission Space (RMS) STaR Shot program. The RMS STaR Shot is aimed at demonstrating leap-frog future exemplar space technologies and capabilities for the ADF, including identifying opportunities and pathways for transitioning research into capability.
- ANU was contracted by Geoscience Australia to research 'Responsible Governance of Earth Observation Data.' The work of former Business Development Manager Jia-Urnn Lee was instrumental in negotiating and closing the contract for \$950,000, a significant sum for humanities research in space. Issues covered by this research agenda include detailing how EO data is used for agriculture, mining, defining voting electorates, providing climate change data, maritime surveillance, defence applications, and evidence in the courtroom for environmental litigation, native title, and international criminal law.



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Inside backcover – Seth Lazar, Professor of Philosophy at the Australian National University





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Get in touch to learn more and meet our space experts.

