THE UNIVERSITY of ADELAIDE

Annual Report
2020

INSTITUTE FOR PHOTONICS AND ADVANCED SENSING

adelaide.edu.au/ipas

WELCOME.

WE HOPE THAT, THROUGH THE POWER OF LIGHT, WE CAN ENHANCE OUR COMMUNITY'S HEALTH, PROSPERITY AND SAFETY.

A strong commitment to research excellence and impact has defined the University's history, and our research mission will be increasingly important in a world defined by accelerated knowledge creation and transition to a more resilient economy.

The University's research institutes showcase and strategically support some of our finest talent in pursuit of multidisciplinary, large-scale research and innovation outcomes, with the capacity to pursue higher-risk, cutting-edge projects.

The Institute for Photonics and Advanced Sensing (IPAS) brings together a significant number of researchers, working towards creating knowledge and disruptive new technologies to address opportunities in areas including health, the environment, mining and defence. One of its major strengths is combining scientific and technical excellence with a track record of strong external engagement to facilitate industry development.

IPAS has an inspirational culture, deeply rooted in engagement, with university stakeholders, industry partners, students of all ages or the broader community. IPAS members strive to inspire communities and future generations of scientists through exciting outreach activities and showcasing the incredible research taking place in their labs.

This report provides an overview of the substantial range of high-quality activities undertaken throughout 2020. It provides excellent examples of how world-class fundamental research driving impact can be undertaken in partnership with industry for the greater benefit of society.

Professor Anton Middelberg

Deputy Vice-Chancellor and Vice-President (Research)

REPORT FROM THE BOARD CHAIR

Dr Warren Harch, IPAS Board Chair

2020 was an incredibly productive year for IPAS, with the Institute further cementing its status as a trusted partner for Defence.

The substantial overall growth and capabilities of the Institute demonstrate that it is tracking well in the key research strategies of IPAS - excellence, innovation, global and enabled. Specific highlights include:

Over $7m in new funding for Defence collaborative projects

• Leading the establishment of a world-leading ecosystem of people, facilities and partnerships in Quantum Materials, through a focussed co-investment and collaboration strategy with Industry, Defence and Government.

• Tripling of the number of high-impact papers (published in journals with an impact factor over 10).

• 2 IPAS start-ups have secured several million in funding to bring their technology to market.

I would like to acknowledge and thank my fellow members of the IPAS Board, IPAS Director Prof Andre Luiten, the IPAS Executive Team, and the researchers, staff and students for their tireless and instrumental contributions. In particular I would like to recognise Elodie Janvier, IPAS Strategic Research Development Manager for receiving the University Award for Outstanding Achievement in the category of Excellence in Research (Professional) for her contribution to driving the research success in IPAS.

380+ PUBLICATIONS

10+ JIF* **33** PUBLICATIONS

5+ JIF* **90** PUBLICATIONS

* Journal impact factor

10 RESEARCH LEADERS

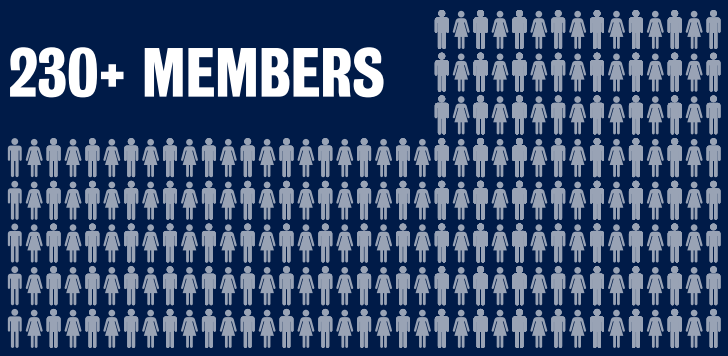
$15m RESEARCH FUNDING (2020)

07 START-UPS LAUNCHED

06 AREAS OF STRENGTH

RATED 5, 'WELL ABOVE WORLD STANDARD', ACROSS THE BOARD IN ALL FOUR AUSTRALIAN RESEARCH COUNCIL EXCELLENCE IN RESEARCH FOR AUSTRALIA ASSESSMENT ROUNDS (2010, 2012, 2015, 2018)

230+ MEMBERS



12 HONOURS STUDENTS
15 MASTER-DEGREE STUDENTS
66 PHD STUDENTS

IPAS's vision is to develop innovative sensors to make the world healthier, wealthier and safer. I think you can see from the stories contained in this years' report that we are accomplishing across the spectrum of our vision.

Professor Andre Luiten,
FAIP GAICD FTSE, Chair of Experimental Physics

DIRECTOR'S REPORT

2020 has been a most challenging year for the globe. Relatively speaking, we have been very lucky in Australia and we should all be thankful for that. It is a credit to our members that, despite all these difficulties, this has been a very productive year for IPAS. In fact, by many measures it has been our best year ever. I couldn't be any prouder to head this amazing team of people that continues to deliver the scientific breakthroughs that meet numerous global challenges.

The list of achievements you will find listed in this report is mind-blowing: prestigious awards, fellowships and appointments, numerous large research grants and contracts as well as just celebration of start-up companies that draw on intellectual property developed by IPAS. One of these companies, Cryoclock, has attracted incredible attention and is at the vanguard of the fast-growing photonics industry that is boosting the economic outlook of South Australia. SA is currently generating the nation's second highest revenue per capita from these critical photonic industries. Starting down this same innovation journey, we see IPAS members Prof Heike Ebendorff-Heidepriem, Dr Yunle We and Dr Tim Zhao, who have launched a new venture "EZY-GLAS", that will commercialise a patented new approach to making coloured glass. Another recent highlight sees IPAS start-up Miniprobes awarded $1M from MTP Connect to make brain surgery safer. The Miniprobes team also demonstrated the world's smallest flexible camera-like device that looked inside blood vessels to better understand the causes of heart attack and heart disease progression. This game-changing research was not only published in a prestigious academic journal but also attracted the attention of various media channels and was filmed by Channel 10. One very pleasing element of the list of achievements you will find herein is the diversity and breadth of members that are attracting these accolades: IPAS is a large family of excellence.

I would also like to tell you a little about our work on putting together a new strategic plank for IPAS, which will have all its foundational elements in place by mid 2021. By way of background, over the next 20 years, many people are convinced that there is going to be a technological revolution in which quantum tools end up in just about every technological device. Australia is striving to build up its sovereign capability in this area and IPAS has committed to being a leading player in this quantum-enabled world.

IPAS has worked with schools in the Faculties of Sciences and ECMS to respond to this potential by seeding a major activity in a field called "quantum materials". This is an exciting new discipline at the boundary of condensed matter physics, quantum physics, material sciences, chemical engineering, and optoelectronics. We have partnered with global technology powerhouse Silanna Group, Australia's only semiconductor design and manufacturing company, and DST Group, to install $25m of quantum materials manufacturing labs at the University of Adelaide. These facilities create a unique and attractive ecosystem to grow new semiconductor materials at the quantum scale, design new solid-state devices and train a future quantum workforce for Australia. The University has also made a major appointment, Prof Glenn Solomon, in Quantum Materials under the Top Talent scheme, paralleled by the appointment of a new Head of Electronic Engineering, Prof Nelson Tansu, with an equally outstanding background in this quantum electronics field. These investments, and the critical mass that we are creating, is going to spawn a quantum manufacturing industry for South Australia.

As you read this annual report, I am sure that you will be impressed by the amazing impact and outcomes that have been achieved by the collective and collaborative efforts of our truly brilliant researchers and members. As always, if you can see ways in which we can help you, or you us, then do not hesitate to get in contact with me.

Prof Andre Luiten
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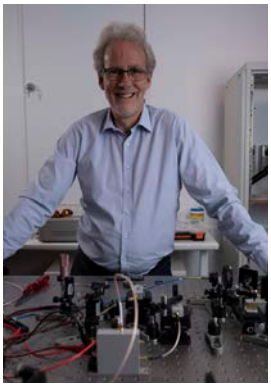
CONGRATULATIONS



Prime Minister Prize for Science

Congratulations to Prof Peter Veitch, the Centre of Excellence for Gravitational Wave Discovery (OzGrav) and all IPAS/ OzGrav Adelaide team members for being awarded the Prime Minister's Prize for Science. What a wonderful recognition of such a tremendous and profound achievement.

SUPERSTAR of STEM and InDaily 40 under 40

Congratulations to Dr Jiawen Li for being nominated as a 2020-2021 SUPERSTAR of STEM. Jiawen is one of 60 brilliant women scientists to smash stereotypes of what a scientist, technologist, engineer or mathematician look like. Jiawen was also named in the 2020 InDaily 40 under 40 awards, which highlight the innovation, commitment and diversity of South Australia's young leaders.

IPAS Director elected Fellow of the Australian Academy of Technology and Engineering (ATSE)

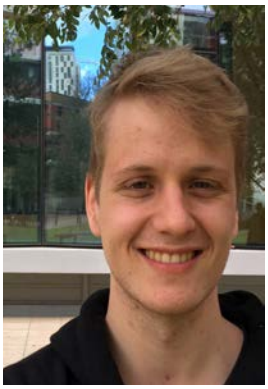
Congratulation to Prof Andre Luiten on his prestigious election as a new Fellow of the Australian Academy of Technology & Engineering (ATSE). Andre is joining Australia's leading innovators and experts in engineering, applied science, and technology.

Heart disease prevention awarded the Heart Foundation Vanguard Grant

Congratulations to Dr Christina Bursill for being awarded a 2020 Heart Foundation Vanguard grant. This prestigious funding will help Christina to further investigate the role of the glycome in atherosclerosis.

FoS Executive Dean Awards

Congratulations to Prof Heike Ebendorff-Heidepriem and Dr Danny Wilson for being awarded the Faculty of Sciences Executive Dean Prizes for the Research Leadership and Mid-Career Research Excellence Award respectively.



Nicholas Schumann – 2020 Fulbright sholarship

Congratulations to Nicholas Schumann who was awarded the 2020 Fulbright scholarship, to spend 6 months at Utah Valley University working on the design and synthesis of novel and potent inhibitors of Hip1, a drug target for Tuberculosis.

SA Young Tall Poppy of the Year

Congratulations to IPAS/CNBP member, Dr Kylie Dunning, who was awarded the prestigious South Australian Young Tall Poppy of The Year 2020.

Kylie's research is helping those with infertility issues by developing new non-invasive tech to confirm successful IVF procedures. Kylie is also actively engaged sharing her passion for science with the community.

AIP (Australian Institute of Physics) Silver Bragg Medal

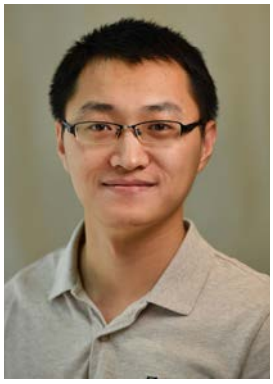
Congratulations to Mr Thomas Kong for being awarded the prestigious AIP (Australian Institute of Physics) Silver Bragg medal for 2019 for his outstanding achievement in the final year of his Physics degree.

Best ECR Presentation at the Victorian Branch of the Royal Australian Chemical Institute

Congratulations to Aimee Horsfall who was awarded the Best Early Career Researcher presentation at the Peptide Users Group virtual symposium. Aimee presented to the group, a part of the Victorian Branch of the Royal Australian Chemical Institute, a talk titled 'A fluorescent 310-helical peptide constraint'.

University's Research Excellence Awards

Congratulations to Elodie Janvier (pictured) and Dr Jiawen Li for being awarded the University Award for Outstanding Achievement in the categories of Excellence in Research Professional Staff and Early Career Researcher respectively.



IPAS PhD students awarded the Dean's Commendation for Doctoral Thesis Excellence

Congratulations to Drs Yunle Wei (pictured), Nathanial Wilson and Milad Dakka for being awarded the Dean's Commendation for Doctoral Thesis Excellence.

Australasian Institute of Mining and Metallurgy (AusIMM) 2020 Education Endowment Fund scholarship

Congratulations to Tom Payten on winning the AusIMM 2020 EEF scholarship. The AusIMM Awards have been recognising outsdaning contributions to AusIMM and professional excellence in the resources sector for more than 80 years.

RESEARCH WITH IMPACT

The Institute for Photonics and Advanced Sensing drives a transdisciplinary approach to science and excellence in research through the development of disruptive new sensing and measurement technologies.

At IPAS we give businesses and organisations a competitive advantage through next-generation technologies offering greater sensing reach and more precise measurement.

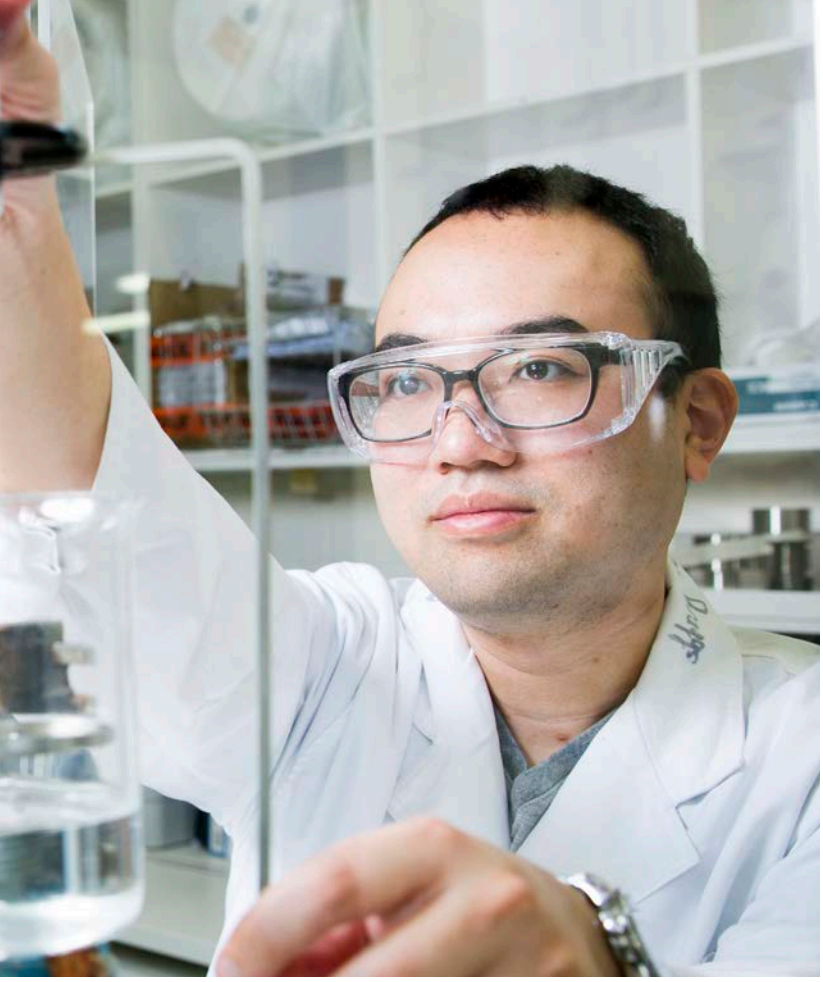
Our engagement with industry ranges from solving specific end-user problems to providing access to cutting-edge manufacturing infrastructure for proof-of-concept materials and prototype devices.

This work's outcomes and impacts, some of which you'll learn about in the following pages, range from scientific discoveries and innovations, to spin-out companies and job creation. Over 40 per cent of our income is connected to industry.

Our areas of strength

IPAS's industry-leading research is focused on six key areas:

- Defence and Security
- Space Science & Astrophysics
- Health and Biotech
- Energy, Mining and Resources
- Advanced Manufacturing
- Agri-food and Wine



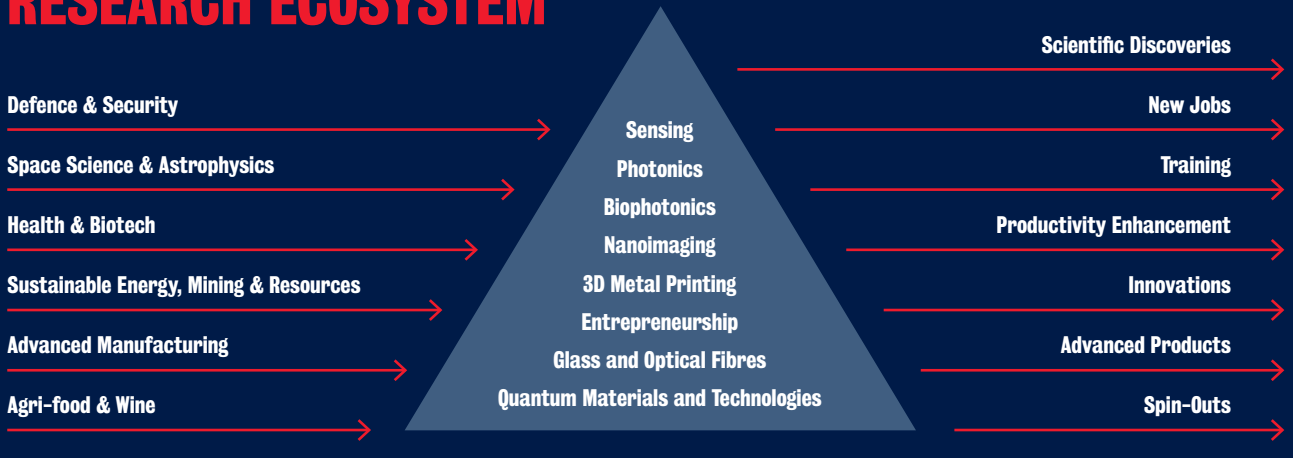
Outstanding transdisciplinary headquarters

Our $96M headquarters, The Braggs, is a unique transdisciplinary University of Adelaide building that enables IPAS researchers to be co-located with students from a broad range of scientific fields.

The building also houses a similarly wide range of state-of-the-art facilities. These support research in:

- precision measurement—time, temperature and frequency
- photonic sensor development
- advanced manufacturing, including 3D metal printing and ultrasonic milling
- glass and optical-fibre development and processing
- laser development
- luminescence dating and radiation measurement
- quantum materials.

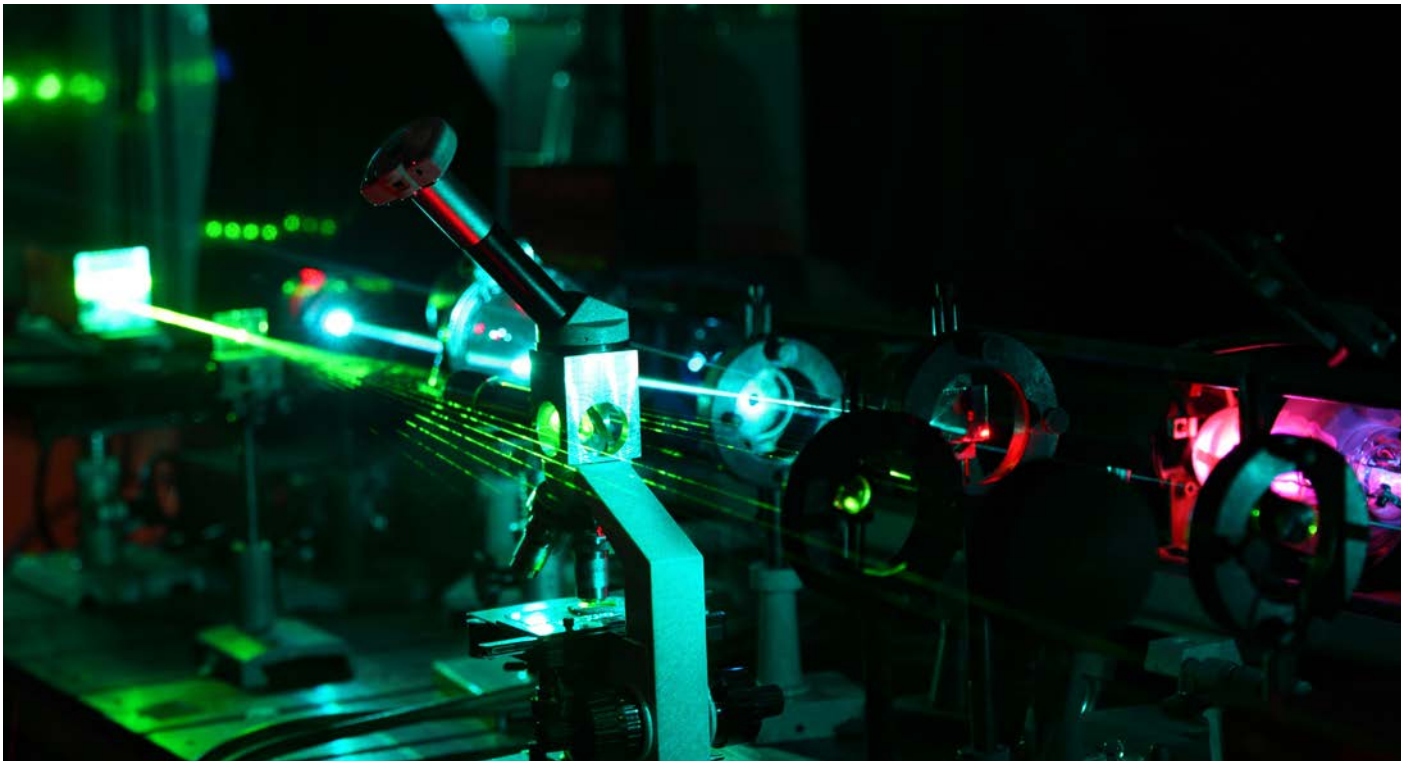
IPAS TRANSDISCIPLINARY RESEARCH ECOSYSTEM



Themes **Capabilities** **Impact**

Research Themes

DEFENCE & SECURITY



Chaos in fiber lasers and amplifiers: breaking through nonlinear and thermal limits for the near-infrared and beyond

Prof Heike Ebendorff-Heidepreim, Prof David Ottaway, Dr Ori Henderson-Sapir, Dr Ka Wu, Dr Stephen Warren-Smith, Dr Linh Nguyen, in collaboration with the US Air Force Office of Scientific Research

The output power and performance of near infrared high power fibre lasers has increased dramatically over the last two decades. Since the early demonstration of a kilowatt level continuous wave (CW) high power fibre laser, continuous improvements in both fibre beam quality and power scaling has led to state-of-the-art fibre lasers. The scaling of CW power beyond kilowatt levels sets however significant challenges in overcoming limits imposed by nonlinear and thermal effects.

Using our advanced specialty optical fiber fabrication capabilities, and funded under a US$1M grant from the US Air Force Office of Scientific Research, an IPAS team is investigating novel techniques based on chaotic ray dynamics and active mode control that will allow for high beam quality lasing and amplification using highly multimode large core area fibres to dramatically suppress nonlinear and thermal effects. This will open new opportunities in applications such as remote sensing, manufacturing, and power scaling for defence applications.

New $60m World-Class Ecosystem in Quantum Materials and Devices

Prof Andre Luiten, Prof Heike Ebendorff-Heidepreim, Prof Glenn Solomon, Prof Nelson Tansu, Prof Peter Veitch, Prof Christophe Fumeaux, Prof David Lewis and Dr Giuseppe Tettamazi, in collaboration with the Defence Science and Technology Group and Silanna

Quantum materials and devices have led to a wide range of technologies with great societal and economic impacts, such as transistors and memory for computers, lasers for medicine and communications, light-emitting diodes for energy-efficient lighting, and devices for power electronics. The global market capitalisation of the semiconductor industry is valued at AU$550 billion per year, with an expected growth exceeding AU$1.3 trillion by 2030.

Recognising the tremendous potential for a sovereign capability that will meet the growing need of Industry and Defence, IPAS has led the creation of a world-leading ecosystem in Quantum Materials located in proximity with Lot Fourteen - South Australia's innovation precinct, Defence Science and Technology (DST), the Australian Space Agency (ASA) and Silanna, the largest semiconductor company in Australia's R&D facilities. This provides a unique opportunity to translate fundamental research discoveries into practical implementation in industries, laying the foundation required to build Quantum Technologies-based industry with a value exceeding $1 billion in South Australia.

Research Themes

SPACE SCIENCE & ASTROPHYSICS

Credit: HESS/Vikas Chander

Development of Satellite Optical Systems for Earth Observation Science

A/Prof Martin O'Connor in collaboration with the Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Earth Observation is the fastest growing sector of the global space economy, already providing $5.6 billion of value to the Australian economy.

IPAS and CSIRO have launched a new joint laboratory for Satellite Optical Systems development and testing with the high-level goal of developing high-performance imaging systems to meet the specific requirements of Earth Observation needs of Australia.

Launched at IPAS headquarters in November 2020, this exciting new capability will act as a focal point for collaboration with space industry companies, Defence Science and Technology and the Australian Space Agency for development of optical systems for satellites and to establish optical testing capabilities for satellite and remote sensing instrumentation.

We believe that this new laboratory will deliver state-of-the-art imaging technology for Earth Observation satellites that will give Australia's space industry a great boost forward.

First ever detection of monster black hole collision

Prof David Ottaway, Prof Peter Veitch, the ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav) and the LIGO and Virgo Scientific Collaboration.

IPAS researchers are part of a team of scientists who have reported the first ever direct observation of two monster black holes which have collided to form an even more massive object: an intermediate-mass black hole, about 150 times heavier than the Sun.

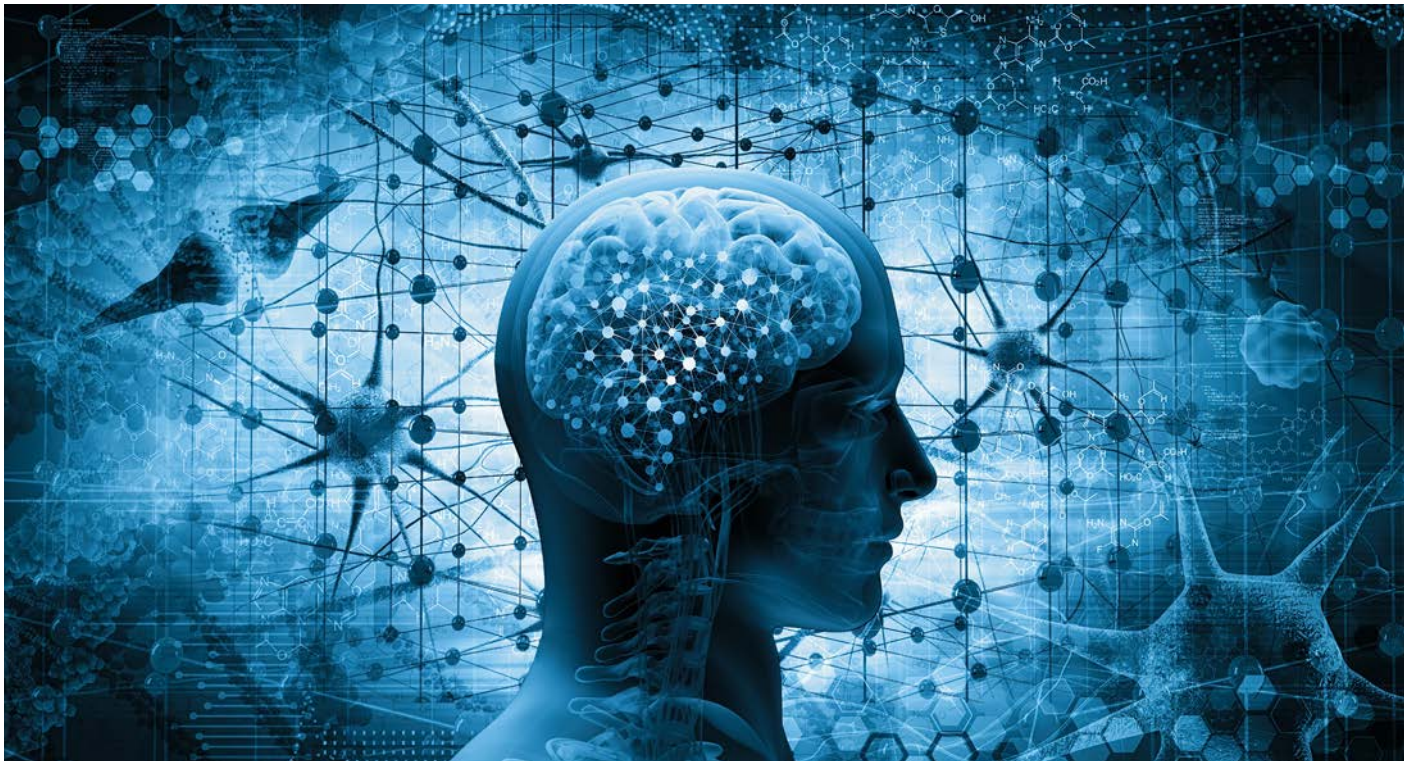
This is a huge step towards understanding the link between the smaller black holes that have been seen by gravitational wave detectors and the massive black holes that are found in the centre of galaxies.

The universe was around seven billion years old when these two black holes collided. As the gravitational waves rippled out through the universe, the universe was expanding.

We are witnessing the birth of an intermediate mass black hole: a black hole almost twice as heavy as any black hole previously observed with gravitational waves. These intermediate mass black holes could be the seeds that grow into the supermassive black holes that reside in the centres of galaxies.

Research Themes

HEALTH & BIOTECH



Outstanding successes in NHMRC grants

It has been very inspirational to see brilliant IPAS early and mid-career researchers' major success in the 2020 round of NHMRC Ideas Grants where the success rate was below 10% nationally. With talented leadership and creative research, these emerging IPAS leaders and their senior colleagues are undertaking innovative research to solve significant medical problems:

• Katharina Richter, Roman Kostecki, Heike Ebendorff-Heidepriem, Markus Trochsler, Roger Narayan - $999,581- Improving clinical outcomes of antimicrobial resistant infections with a drug-free intervention.

• Jiawen Li, Johan Verjans, Robert McLaughlin - $992,112 - Serial imaging of molecular and microstructural changes in atherosclerosis: tracking plaques towards destabilisation.

• Kylie Dunning with international collaborators Kishan Dholakia and Ellen Anckaert - $1,266,777 - A new light on diagnosing embryo health -Development of a novel and non-invasive diagnostic to improve IVF success.

• Danny Wilson in collaboration with RMIT, Monash and International partners - $989,043 - Host-directed therapy for malaria: host cell signalome as a target.

IPAS Start-up Miniprobes receives $1M from MTP Connect to make brain surgery safer

Prof Robert McLaughlin, Miniprobes

Brain tumours are the leading cause of cancer-related death in children and have one of the largest disease burdens across all ages because of the high fatality rate. Needle brain biopsies are a standard part of diagnosis. However 2-3% of patients will suffer permanent disability and 1% will die.

IPAS researcher and Managing Director of Miniprobes, Professor Robert McLaughlin has led the development of a smart brain biopsy needle that can both detect cancer cells and warn neurosurgeons before they hit a blood vessel.

Miniprobes has received $1 million from the Australian Government's BioMedTech Horizons program in 2020 to commercialise this technology and bring it into the hospital.

The smart needle will make brain biopsies safer for patients. At the same time, it will make surgery faster by giving the surgeon a needle that can see where it is going, so they can accurately take the biopsy sample from the most aggressive part of the brain tumour.

Research Themes

SUSTAINABLE ENERGY, MINING & RESOURCES

Prototyping a Low-Noise Scalar Magnetometer

Dr Rujie Li, Dr Chris Perrella in collaboration with Electromagnetic Imaging Technology Pty Ltd

Magnetic Sensing has been used as a key technology for energy and minerals exploration since the 19th century. The depth, nature and size of mineral deposit determines the magnitude, direction and frequency of the magnetic response that needs to be detected by the sensor. The sensitivity limit of typical commercial sensors is such that economically valuable deposits can be missed with conventional exploration techniques. More sensitive solutions exist but they are rarely applied due to high costs, bulk size and fragility.

Funded under a CSIRO Science and Industry Endowment Fund Ross Metcalf STEM+ Business Fellowship, this project will build on IPAS's existing collaboration with Electromagnetic Imaging Technology Pty Ltd (EMIT) in Western Australia to develop a high-performance scalar magnetometer which will put EMIT at the forefront in real-world geophysical exploration.

On conveyor belt laser identification of minerals

Prof Nigel Spooner in collaboration with the CRC ORE and Scantech

Laser-based sensing technology is a rapidly evolving field and recent advances in other industries and non-mining applications are revolutionising the possibilities of decisions based on real-time data.

Identifying the presence of the contaminant fluorine in real-time within mineral structures is currently challenging and relies upon off-line laboratory analysis with long turn-around times that are not appropriate for real-time decision making. Current fast analysis methods such as PGNAA and x-ray analysis don't work for light elements such as fluorine. Fast offline analysis methods such as XRF and ICP still need sample preparation and typically a 24-hour turnaround for results. Techniques which allow for speciation such as XRD and automated mineralogy need highly trained operators and are time-consuming, labour-intensive techniques.

Funded under a $1.3m CRC ORE grant and partnered with Adelaide mining technology company Scantech, this project is developing a new cross-belt sensor technique requiring no sample preparation and based on novel fluorescence signatures discovered at IPAS, for real-time identification of fluorine abundance and mineral speciation.

Research Themes

ADVANCED MANUFACTURING

Smart design technology enabling the mid-infrared revolution

Prof Heike Ebendorff-Heidepriem, Prof Yvonne Stokes, Dr Stephen Warren-Smith in collaboration with IRflex

While mid-infrared (MIR) lasers have become indispensable to key industries ranging from research and healthcare to defence, industrial deployment of this technology has been hampered by the lack of cost-effective MIR optical fibres.

Prof Heike Ebendorff-Heidepriem and her team were awarded a $312,066 ARC Linkage project in collaboration with US based company IRflex to overcome this barrier through the creation of an innovative design toolkit for the fabrication of complex optical fibre structures.

This efficient and commercially viable concept-to-manufacture development process will pave the way towards the MIR fibre technology revolution and will yield significant economic benefits spanning industrial process controls and environmental monitoring to hazardous chemical detection and biological sensing.

DEWC-SP1 payload launched on a TED-01 DART rocket

IPAS Optofab Team in collaboration with DEWC Systems

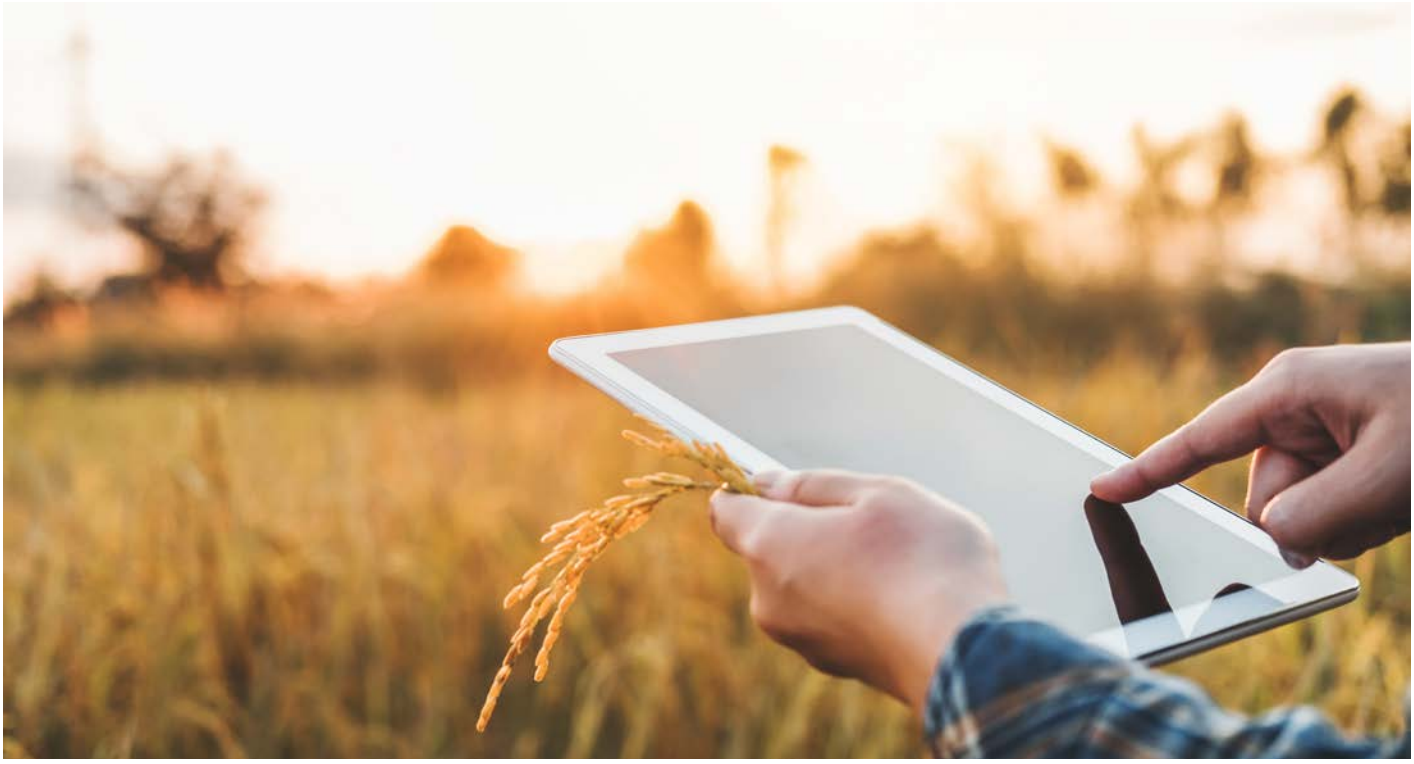
The Optofab Adelaide team manufactured key specialised elements of the DEWC-SP1 payload launched by Southern Launch on 14 September 2020 on a TED-01 DART rocket.

The payload itself is less than 27 cm long and 3 cm in diameter and weighs less than 500 grams. This miniaturised suite of antennas, sensors and communication links required ingenious engineering and robust manufacturing given it had to endure up to 50 times its own weight due to the G-forces at launch, freezing temperatures in space and extreme heat as it reaches up to five times the speed of sound re-entering Earth's atmosphere.

The mission aims to survey the radiofrequency environment of the atmosphere at the 100km mark, further informing sovereign space-based capabilities for electronic warfare in Australia. Future iterations of the payload will be placed on satellites in low-Earth orbit, continuously monitoring radio signals and keeping soldiers safe from enemy forces.

Research Themes

AGRI–FOOD & WINE



IVOS Biosensor Device: Linking stress with agricultural asset & land management practice

Dr Roman Kostecki, Prof Heike Ebendorff-Heidepriem

IPAS Researchers have developed a unique sensor, the 'In-Vivo Oxidative Stress Biosensor' (IVOS) device that can measure metabolic balance and reveal oxidative imbalances in plants, animals and by all likelihood, humans. To the best of our knowledge, there is currently no other reliable, dynamic and real-time measure of the oxidative stress profile of a living system.

Data collected by the sensor is expected to provide unique insights in health status, enabling management decisions for optimal performance and output. The reach of applications is enormous, and we are initially pursuing opportunities in medium-to-high value agricultural plant and animal systems.

If used as an early-warning alert-based system for agriculture, the real-time stress signalling should enable tighter irrigation control and decision support for nutrient, herbicide or pesticide application. For livestock, the IVOS device may reveal stress, infection or wellbeing parameters previously not attainable in living and growing animals. Ultimately, agile land and live-asset management in agribusinesses will translate into reduced operating costs, improved water management practices that may increase yield, productivity and profitability through increased production efficiency and quality.

Measurement of wool follicle density and diameter

Prof Robert McLaughlin in collaboration with Australian Wool Innovation Limited, Miniprobes, Davies Livestock Research Centre and the Australian Institute for Machine Learning (AIML)

For wool producers, sale price of wool is largely determined by quantity and quality (primarily thickness) of wool fibres. Decreasing the thickness of the wool by one micron will increase its value by approx. 10%. However, selecting sheep with high quantity (high density of wool follicles) and quality (small diameter) wool is difficult. At present there is no economically viable solution as producers would have to use histology, involving a small biopsy sample of the animal's skin, chemically processing it and analysing it under a microscope, costing over $100 per animal and taking several weeks.

To tackle this challenge, a team led by IPAS is bringing together world-leading researchers in optical imaging, machine learning and livestock breeding and management, are developing an optical scanner that can perform 'instant histology' on a fresh skin biopsy sample within a few minutes to measure wool follicle density on-farm. It will provide wool producers and stud breeders with a fast, low-cost method to quantify follicle density and wool diameter in sheep to allow early identification of high value sheep, increasing productivity and facilitating increased rate of genetic improvement.

RESEARCH SPIN-OUTS

MINIPROBES

Miniprobes Pty Ltd commercialises high-precision, low-cost optical scanning technologies developed at IPAS. The company's initial foci is in producing and distributing the Smart Needle - a handheld device ideally suited for the livestock industry.

The Smart Needle provides high-resolution imaging deep within tissue. It can quantify the microstructure of meat and measure intramuscular fat, which is a strong indicator of meat-eating quality. With seed funding from Meat & Livestock Australia, the company is working with researchers at IPAS to develop a product for meat processing plants. This has the potential to allow meat producers to rapidly identify premium meat product for local markets, and provide a guarantee of meat quality for Australian export markets.

EZY-GLAS

EZY-GLAS Technology Pty Ltd, established in 2020, is commercializing eco-friendly coloured glass manufacturing technology developed at IPAS. The company's vision is to provide coloured glass products for use in glass art, printing and other high-value applications where product identity, safety and quality are prerequisites.

Compatible with commercial glass mass-production facilities, the technology employs non-toxic materials to impart any type of clear glass with unlimited colour choices and unique dichroic colour effect. The produced coloured glasses have been successfully employed by local glass artists at Jam Factory to make glass sculptures. The company is also exploring other market opportunities such as 3D glass printing, and coloured inks for scientific/medical instrument.

EZY-GLAS

QUANTX LABS– CRYOCLOCK

QuantX Labs is the most successful start-up company spun out from IPAS. It was founded on the Institute's exceptional Sapphire Clock technology and is rapidly expanding into other areas including Quantum Sensing.

QuantX Labs aims to be the premier, sovereign provider of the highest precision timing and sensor products used in defence, space and critical infrastructure. The QuantX Labs team have more than 70 years combined experience in the invention and development of precision measurement devices. They have a "passion for precision" and believe that precision measurement is a major driving force for all human endeavour.

Cryoclock, their flagship product, is the world's most precise clock – thousands of times more precise than current timing, losing just one second for every 40 million years of operation. This leading-edge technology is just one of many being developed for a range of sovereign and global applications including Australia's Jindalee Operational Radar Network (JORN).

Their production and test facility, based at the Lot Fourteen Innovation precinct, is providing a unique sovereign industrial capability to support Australian Defence and Space programs in radar, sensing, quantum technology and timing/positioning networks.

3D METAL PRINTING

The IPAS Optofab Adelaide team established a state-of-the-art 3D metal printing facility in Edinburgh, with three state of the art Renishaw AM400 3D metal printers and ancillary equipment.

The University has partnered with Amaero International Limited (ASX:3DA), a world leader in metal additive manufacturing to run this facility as a commercial print bureau.

Amaero raised $18m in 2020 and the facility is now a key infrastructure in the Global Amaero organisation.

Amaero is a strategic partner of the University of Adelaide, working collaboratively to make Adelaide a leader in 3D printing research, education, training and manufacturing.

PROF ANDRE LUITEN

IPAS Director and Chair of Experimental Physics

Prof Andre Luiten FAIP GAICD FTSE is Director of the Institute for Photonics and Advanced Sensing (IPAS) and Chair of Experimental Physics at the University of Adelaide. He is a Fellow of the Australian Institute of Physics and of the Australian Academy of Technology and Engineering.

Andre obtained his PhD in Physics from the University of Western Australia in 1997, for which he was awarded the Bragg Gold Medal. He has subsequently held three prestigious Fellowships from the ARC. For his efforts Andre was the joint inaugural winner of the WA Premier's Prize for Early Career Achievement in Science. Andre came to the University of Adelaide in 2013 to take up the Chair of Experimental Physics and a South Australian Research Fellowship from the Premier's Research and Innovation Fund.

Andre's work is aimed at the development of state-of-the-art instruments across many diverse fields of physics. He has published 6 book chapters and authored 131 journal papers (with over 5,600 citations), has over 110 conference papers, and has raised over $34M for research. The excellence of his research has been recognised by the award of the Barry Inglis Medal from the National Measurement Institute, which acknowledges outstanding achievement in measurement research and excellence in practical measurements, the Australian Institute of Physics' Alan Walsh Medal for Service to Industry and the prestigious 2018 Eureka Prize for Outstanding Science in safeguarding Australia.

Andre is also the co-founder and managing Director of QuantX Labs, a successful start-up commercialising the world's most precise clock (Cryoclock) and developing the highest precision timing and sensor products.

IPAS GOVERN

NANCE

PROF HEIKE EBENDORFF-HEIDEPRIEM

IPAS Deputy Director and Deputy Director of the Optofab node of the Australian National Fabrication Facility (ANFF)

Prof Heike Ebendorff-Heidepriem is Deputy Director of the Institute for Photonics and Advanced Sensing (IPAS) and Director of the Optofab Adelaide Hub at the Australian National Fabrication Facility (ANFF). She is Senior Investigator of the ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP). In 2017 she became a Fellow of the Optical Society of America, an honour awarded by peers for having "made significant contributions to the advancement of Optics".

Heike obtained her PhD in chemistry from the University of Jena, Germany in 1994 and subsequently held two prestigious fellowships. From 2001-2004 she was with the Optoelectronics Research Centre at the University of Southampton, UK. Heike came to the University of Adelaide in 2005. She was awarded the Woldemar A. Weyl International Glass Science Award in 2001, the International Zwick Science Award in 2009, the University of Adelaide Women's Research Excellence Mid-Career Award in 2015, and the Winnovation SA Technology Award from the SA Women in Innovation and Technology in 2017.

Heike has published over 370 refereed journal papers and conference proceedings, including 5 review papers and 9 postdeadline papers, and raised over $36.8M in research funding. Heike's research focuses on the development of novel optical glasses, fibres, surface functionalisation and sensing approaches.

IPAS EXECUTIVE COMMITTEE

Prof Andre Luiten
IPAS Director

Prof Heike Ebendorff-Heidepriem
IPAS Deputy Director

Piers Lincoln
IPAS Institute Manager

Elodie Janvier
IPAS Strategic Research Development Manager

Dr Georgina Sylvia
Project Manager, Defence Projects

Thanh Nguyen
IPAS Research Support & Marketing Officer

Luis Lima-Marques
IPAS Laboratory Manager

Prof Robert McLaughlin

Prof David Ottaway

Dr Rohan Glover
IPAS Science Network Committee Co-Chair

Dr Anna Radionova
IPAS Science Network Committee Co-Chair

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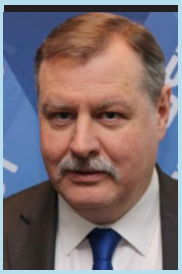

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Ms Amanda Heyworth

Prof Anton Middelberg

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Prof Heike Ebendorff-Heidepriem


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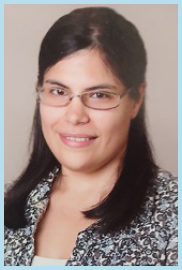

Dr Anna Radionova


Dr Rohan Glover


A/Prof Martin White

THE IPAS STUDENT EXPERIENCE

OUR GRADUATES HAVE GONE ON TO POSTDOCTORAL ROLES AT LEADING RESEARCH ORGANISATIONS WORLDWIDE

Study at IPAS

IPAS Honours, Masters and PhD opportunities are world-class and guided by research scientists who are global leaders in their field. As well as working on blue sky research, we also work in partnership with government and industry on projects aimed at delivering real-world outcomes e.g. new products and starting new technology companies. Our graduates have gone on to postdoctoral roles at leading research organisations worldwide, while others have started up companies based on their research or have secured employment with industry partners or defence organisations (including Trajan Scientific and Medical, Ellex, Schlumberger, BAE Systems, Australian Bureau of Statistics, Maptek, Coherent, Lastek, the Defence Science and Technology Group and the Australian Antarctic Division).

IPAS Science Network

The Science Network has been created to strengthen the bond between science disciplines of the University and bring together members and non-members of IPAS for networking events and professional development activities.
The IPAS Science Network represents the needs of the students and ECRs within IPAS, with the added focus of supporting students in all aspects of their postgraduate experience.
The co-Chairs of the Science Network sit on the IPAS Scientific Leadership and Executive Committees.

IPAS SCIENCE NETWORK COMMITTEE

Dr Anna Radionova
Co-chair

Dr Rohan Glover
Co-chair

Dr Sarah Scholten

Dr Erik Schartner

Dr Jiawen Li

Dr Jillian Moffatt

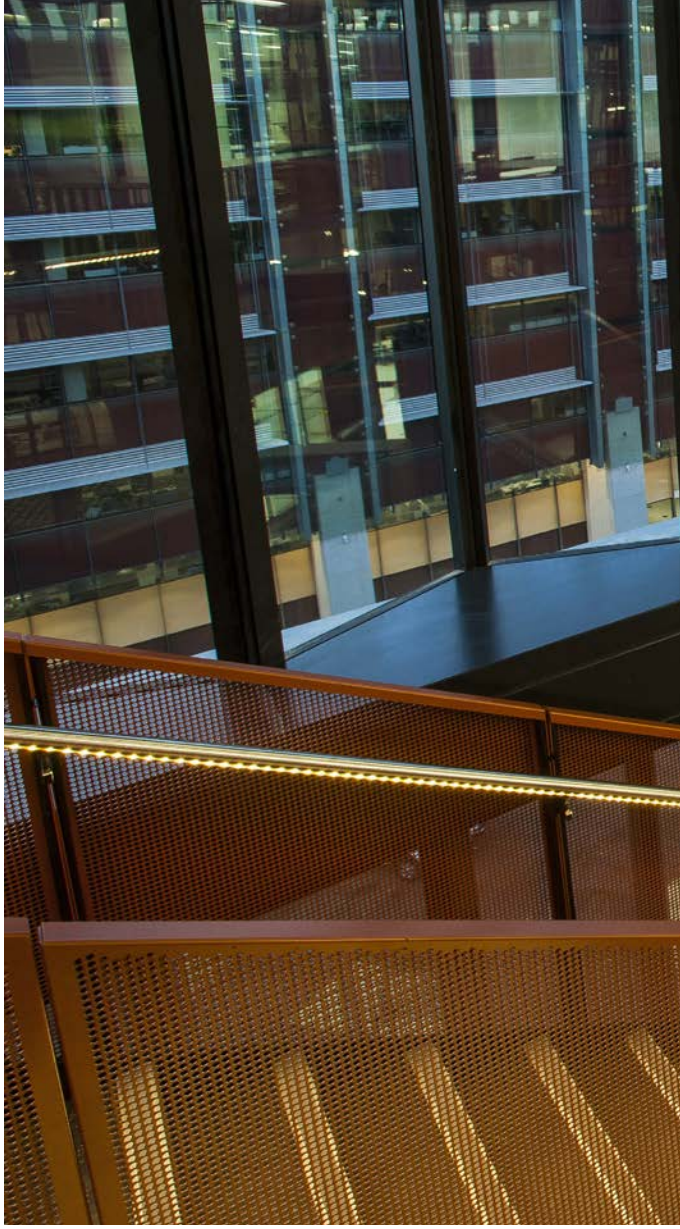
Craig Ingram

Zac Holmes

Elodie Janvier

Thanh Nguyen

STUDENT PRIZES



Students were invited to present their 2020 research in a three-minute talk. The Tanya Monro best presentation prize and the Merry Wickes sponsored transdisciplinary prize were on offer.

The winners were announced at the IPAS annual New Year event. We would like to thank Merry Wickes for her ongoing support of the transdisciplinary prize.

- Miss Sabrina Slimani, PhD student - Tanya Monro Best Student Oral Presentation Prize
- Mr Mohammad Istiaque Reja, PhD student - Merry Wickes Transdisciplinary Oral Presentation Prize

Miss Sabrina Slimani, PhD student

Quantum clock synchronisation protocols are known to be more accurate than classical protocols but are yet to be developed for commercial use over long distances due to attenuation of the light signal in the fibre between the clocks. Through collaboration between IPAS, Cryoclock, DSTG and SmartSat, my research aims to devise an improved quantum clock synchronisation protocol to synchronise clocks over free space. The novel approach can be used to improve clock synchronisation in telecommunications and satellites to benefit multiple industries such as defence and health.

IPAS provides a wonderful environment to engage with fellow researchers and students across many disciplines. This provides endless opportunities to collaborate with colleagues to share and develop research ideas in addition to building networks for future research developments.

Miss Sabrina Slimani, recipient of the Tanya Monro Best Student Oral Presentation Prize

Mr Mohammad Istiaque Reja, recipient of the Merry Wickes Transdisciplinary Oral Presentation Prize

Mr Mohammad Istiaque Reja, PhD student

Reports show that almost half of the studied industrial accidents are due to the malfunction of the temperature and pressure sensors. This demonstrates how important it is to accurately measure these two critical physical parameters to ensure safe working conditions and efficient operations in industries. My research, under the supervision of Prof. Heike Ebendorff-Heidepriem, Dr. Stephen Warrensmith and Dr. Linh Nguyen, aims to develop an optical fibre sensor for simultaneous measurement of extreme temperature and pressure. The asymmetrically designed microstructured fibre allows hydrostatic pressure to induce stress at the optical fibre core, making it highly sensitive to pressure. The sensor will also be based on pure silica, which allows it to operate at a very high temperature.

IPAS is full of vibrant researchers with strong expertise and experience in their respective fields. Here, researchers from diverse backgrounds collaborate to overcome major scientific challenges in a welcoming and collegial atmosphere. Having been exposed to such a lively research environment brings out the best of ourselves and makes us a better researcher.

OPTOFAB – FACILITIES AT IPAS

Optofab – Facilities in Adelaide

Optofab – Facilities in Adelaide specialises in optical fibre, glass and functional optical materials production. The range of key services offered include:

- Soft glass fabrication
- Soft and hard glass and polymer preform extrusion
- Doped silica preform fabrication
- Soft glass fibre drawing, including microstructured fibres
- Silica fibre drawing, including microstructured fibres
- Surface functionalisation of glasses and fibres
- Scanning Near Field and Atomic Force Microscopy (SNOM/AFM via Adelaide Microscopy)
- DMG DMU-20 Linear Ultrasonic, 5-axis milling machine with ultrasonic milling capability for machining of glass, ceramics and metals
- 3D printing – metals and polymers

5-Axis Ultrasonic Mill

New high-tech materials and the higher demands being placed on surface quality and precision have made the utilisation of new manufacturing technologies and machining methods indispensable.

DMU-20 Linear Ultrasonic Mill offers the perfect solution by combining precision and versatility at a level of efficiency that was inconceivable only a few years ago. Specialised machining requirements are now available for soft, hard and advanced high-performance materials, which have been traditionally difficult to machine.

3D Metal and Polymer Printing

3D printing facilitates rapid prototyping and manufacturing, allowing for the fast availability of functional prototypes for product development, as well as on demand manufacturing for research and industrial requirements. 3D printing complements traditional development and manufacturing methods, reducing the time and cost of designing metal or polymer parts by printing them directly from digital input. In September 2014, IPAS commissioned a 3D Systems ProX 200 selective laser melting printer, and made it available to both researchers and industry for their 3D printing requirements. In October 2019, the University and Amaero International Limited signed a Strategic Partnership Agreement, making available three state of the art Renishaw AM 400 3D printing machines located at Amaero's Adelaide facilities, available to IPAS researchers and clients. In 2021, a Stratasys Fortus 450mc was added to the line-up of printers. This adds to our existing polymer offering, and now includes all the Stratasys FDM materials, such as ANTERO, ULTEM, ST-130 and NYLON 12 CARBON FIBRE.

Accessing the Facilities

The ANFF seeks to enhance national and international collaborations and enable world-class research by providing access to specialised facilities. Direct access to instrumentation is provided at an hourly rate or via a Fee-for-Service basis. Research Collaborations, Contract R&D and Consulting are also welcomed. Dedicated staff are on hand to discuss your requirements and assist accessing these leading-edge research capabilities.

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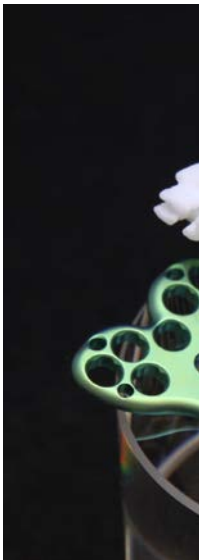
Optofab ANFF



IPAS RESEARCH FACILITIES

The Braggs is a unique transdisciplinary building that enables the co-location of IPAS researchers and students from a broad range of scientific disciplines and facilities including:

- Precision measurement of time, temperature and frequency
- Photonic sensor development
- Advanced manufacturing including 3D polymer and metal printing (ANFF Optofab)
- Glass and optical fibre development and processing
- Laser development
- Quantum materials and devices
- Luminescence dating and radiation measurement
- Synthetic and surface chemistry.

The Braggs is an accelerator facility, designed to speed up the pace of research by bringing together all the people working in these disparate disciplines and providing them with facilities required to progress further than would be possible in a traditional physics or chemistry lab. For example, we now have the ability to bring clinical samples into the laboratories to test them using new measurement tools developed within our labs.

Other world-class research facilities underpinning the vital research conducted by IPAS members include:

- Reproductive BioPhotonics Lab
- Atmospheric Physics – Buckland Park
- Advanced LIGO and the Gingin Facility
- The Adelaide Proteomics Centre
- Bragg X-ray Crystallography Facility

These facilities service the needs of IPAS researchers and offer contract services to researchers and companies across the world.

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STRATEGIC PARTNERS

THE SILANNA GROUP

IPAS, along with the Faculties of ECMS and Sciences, has partnered with global technology powerhouse Silanna Group and the South Australian government to set up “picoFAB” and "Q FAB" at the University. These advanced laboratories allow designing and engineering of new semiconductor materials at the level of individual atoms.

The Silanna Group was founded in 2006 and is Australia’s only semiconductor design and manufacturing company. With its head office in Brisbane and additional operational, manufacturing and design centres in Sydney, USA, UK and Singapore, Silanna supplies high-technology microelectronic chips to the global communications, space, defence and medical markets. The company’s silicon-on-sapphire radio-frequency antenna switch, for example, is used extensively in smart phones and space satellites, as well as in NASA’s Mars rovers.

Located at the University of Adelaide’s North Terrace campus, the picoFAB has been collaboratively designed by Silanna and the University of Adelaide, and brings world-leading capability to South Australia, not least to the Quantum- materials, sensing and communication research at IPAS, enabling precise engineering of new semiconducting crystal structures for use in the commercialisation of new and innovative semiconductor devices.

With over $25m in new facilities, Silanna is currently leading the development of the next (4th) Generation Gallium Oxide Semiconductor materials in Adelaide, which opens up the deep UV to the mid IR spectrum.

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Chief Scientist of the Silanna Group, Dr Petar Atanackovic, in the picoFAB facility at the University of Adelaide.

Silanna

HIPS

THE UNIVERSITY OF ADELAIDE
A TRUSTED DEFENCE PARTNER

The University of Adelaide has a long and proud history of partnering with Australia's defence sector. Our involvement has ranged from co-developing Australia's first satellite and rocket-launch capability with Defence in the 1960s, to working with Defence and industry on game-changing autonomous systems research and radar-enhancing technology today.

The University of Adelaide is a destination of choice for world-leading defence-focused researchers, high-achieving students, and government and industry partners. Our Defence stakeholders include:

- DSTG
- Vice Chief of the Defence Force Group
- Defence Chief Information Officer Group
- Deputy Secretary Capability Acquisition and Sustainment Group
- Australian Geospatial-Intelligence Organisation
- Australian Signals Directorate
- US Air Force Office of Scientific Research
- Direction générale de l'armement, France
- BAE Systems Australia
- Lockheed Martin Australia
- Boeing Defence Australia
- Dassault-Systèmes
- Australian Submarine Corporation
- Naval Group (France)
- Raytheon
- Inovor Technologies
- Defence Teaming Centre
- Electro Optic Systems.

The University is also a founding member of South Australia's Defence Innovation Partnership.

Australian Government
Department of Defence
Defence Science and Technology Group

OUR PARTNERS

HOW WE CAN HELP

At IPAS we're striving to establish our institute as a thriving research-and-development hub for the local and broader photonics industry, and all who benefit from it. In doing so we seek to enhance our State's -and Nation's- advanced manufacturing capabilities and global competitiveness, and create significant employment opportunities.

As part of this mission, we would be delighted to apply our capabilities in support of your own business' or organisation's goals. Partnering with IPAS will give you access to the world-class expertise and state-of-the-art facilities required to elevate your research and development to the next level.

So if you're ready to take that step, don't hesitate to contact us.

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