The $38M ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP) headquartered at the University of Adelaide was launched and commenced operations. The Adelaide Optofab Node of the Australian National Fabrication Facility commissioned its 3D Ceramic and Metal Printer and completed print jobs for industrial and research clients. The SA State Government extended the funding for the Photonics Catalyst Program due to high levels of demand. 6 Photonics Catalyst Program Projects initiated. 167 peer reviewed journal papers (16% increase from 2013). 189 research members. $12.5M total grant income in 2014. $2M in industry grant funding in 2014 (25% increase from 2013). 7 high impact publications including Nature Chemistry, Nature Reviews Immunology and Chemical Society Reviews. 3 Commercial Accelerator Scheme Grants awarded to members. 3 Photonics Catalyst Program Projects initiated. The $38M ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP) headquartered at the University of Adelaide was launched and commenced operations.
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IPAS Overview
Introduction from the Deputy Vice-Chancellor and Vice-President (Research)

The Research Institutes at the University of Adelaide bring together world-leading researchers, supported by high-quality infrastructure and an innovative culture, to tackle State and National Research Priorities. The multi-disciplinary focus of the Institutes provides a collaborative platform for research partnerships across the University, and with other organisations.

The IPAS vision is to pursue a transdisciplinary approach that brings together experimental physicists, chemists, material scientists, biologists, experimentally driven theoretical scientists and medical researchers. These researchers are working together to create new sensing and measurement technologies in order to solve some key societal challenges. These new technologies have the potential to change the questions scientists can ask, stimulate the creation of new commercial ventures, and create a new profession of transdisciplinary problem-solvers.

IPAS is continuing to grow from strength to strength, as is demonstrated by its spawning of the new ARC Centre of Excellence for Nanoscale BioPhotonics, and the Institute’s continuing growth in research income and outputs, facilities and commercialisation successes. This Report provides a glimpse of the immense scope and quality of research undertaken within IPAS throughout 2014.

Report from the Board Chair

2014 was the fifth year of operation for IPAS and the Institute continues to grow on its record of research excellence. The 167 peer-reviewed journals published during 2014 are evidence of a sustained, high-quality research output by IPAS members.

I am always delighted when members of the Institute receive recognition. Congratulations to Prof Tanya Monro, Prof Andre Luiten, Prof Peter Hoffmann, Dr Stephen Warren-Smith, Dr Jiangbo (Tim) Zhao and Dr Erik Schartner on being acknowledged for their research achievements.

The South Australian State Government has also been key to our success through their continued support, and I acknowledge and thank them. The Defence Science and Technology Organisation (DSTO) have continued to provide significant support for a range of defence-related projects and I would like to thank them for their ongoing support.

In August the Institute gained a new Director, Prof Andre Luiten. I would like to thank the outgoing Director, Prof Tanya Monro, for her leadership in establishing IPAS and wish her all the best in her new role as the Deputy Vice Chancellor Research and Innovation at the University of South Australia.

I would like to acknowledge and thank my fellow members of the IPAS Board, IPAS Director Prof Andre Luiten, the IPAS Professional Team, and the researchers and staff for their invaluable contributions.

Professor Mike Brooks
Deputy Vice-Chancellor & Vice-President (Research)
Message from The Director

Prof Tanya Monro, IPAS Director, January to August 2014

The Institute for Photonics and Advanced Sensing (IPAS) was formally launched on Friday 13 November 2009. Over the last five years, the Institute’s focus has been on creating high impact research, world leading infrastructure, and developing a dynamic transdisciplinary team with links with industry. This strategy has produced outstanding results - IPAS now has nearly 200 researchers, predominantly co-located in the purpose-built $100M The Braggs building, with an annual grant income over $12M, and working with over 20 companies. None of this could have been achieved without the buy-in of our research members to this vision and an amazing professional staff team.

The culmination of this effort, and recognition of our achievements, came with the award of the new $38M ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP). This new Centre provides extraordinary opportunities for researchers to work in leading international and national teams on tangible challenges emerging in neuroscience, reproductive biology and cardiology.

IPAS has created a community and a culture of researchers with a “can do” attitude. We have shown that it is possible to do the highest quality fundamental result while partnering effectively with industry. With the recent move into the ‘accelerator’ facilities in The Braggs, a strong and growing global reputation, the critical mass of expertise, projects and equipment, and a strategic plan co-created by our members, IPAS is positioned for successful into the future.

Message from The Director

Prof Andre Luiten, IPAS Director, August to December 2014

On 11 August, I was thrilled to be appointed IPAS Director and build on the fantastic legacy of Prof Tanya Monro. My appointment has provided the opportunity for IPAS to appoint a new Deputy Director and I had the great pleasure in announcing A/Prof Heike Ebendorff-Heidepriem as Deputy Director alongside Prof Peter Hoffmann. Heike leads the critical glass and fibre research within the Institute.

During the last 5 years IPAS has focused on transdisciplinary opportunities, research excellence, and commercial engagement. The next phase for IPAS is the consolidation, broadening and strengthening of these three foundational pillars that make IPAS special. It is my goal to foster the environment and culture in which great science and high impact research can truly thrive. At the same time we are developing strategies for researchers to push their research breakthroughs into real-world products - a path that requires strong engagement with industry.

It is rare for any important discovery to lie within a single academic discipline and thus an Institute that covers the full spectrum from fundamental research though to applied research and onto translational products will naturally draw strength from a transdisciplinary approach.

I look forward to continuing to support IPAS members to achieve their research aspirations and work together to create a dynamic, transparent and collaborative research Institute.
The IPAS Student Experience

Study at IPAS

IPAS Honours, Masters and PhD opportunities are world class and guided by dedicated 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, others have started up companies based on their research or have secured employment with industry partners or defence organisations (including Schlumberger, DSTO, BAE Systems, Maptek, Coherent, Lastek and the Australian Antarctic Division).

IPAS Science Network

The Science Network team has been created to strengthen the bond between science disciplines of the University and bring together members and non-members of IPAS for fun networking events and professional development activities. The IPAS Science Network represents the needs of the students within IPAS and supports students in all aspects of their postgraduate experience.

The IPAS Science Network team are Jonathan Hall (Chair), Matthew Briggs (Vice-Chair), Myles Clark (Treasurer), Kelly Keeling (Secretary), Georgina Sylvia (Media), Elizaveta Klantsataya, Chao Zhang and Parul Mittal.

IPAS Student Prizes

In January 2014, all IPAS students were invited to present their research in a five-minute talk. An IPAS-sponsored Disciplinary Prize and a Merry Wickes-sponsored Transdisciplinary Prize, both worth $1,000 were on offer.

The winners were announced at the IPAS New Year Event held in late January.

- Mr Malcolm Purdey – Disciplinary Prize; and
- Ms Elizaveta Klantsataya and Ms Tess Reynolds – Transdisciplinary Prize (joint winners).
The high-level research at IPAS creates a very stimulating work environment.
IPAS Research
IPAS Science Themes and Theme Leaders

The breadth of research conducted by IPAS members is categorised under six Research Themes, each led by a pair of Theme Leaders who are knowledgeable of the science and research programs within the Theme. The role of the Theme Leaders is to advocate for the needs arising from the Theme, to develop strategies to grow opportunities for the Theme, and to facilitate action within the Theme. The Theme Leaders are responsible for facilitating opportunities between IPAS Themes, endorsing applications for internal IPAS Schemes, and organising annual Theme events.

**Novel Light Sources**
- **James Anstie**
  - Precision Measurement, Frequency Comb Spectroscopy

**Chemical and Radiation Sensing**
- **David Lancaster**
  - Short to Mid-infrared Waveguide and Fibre Lasers
- **Nigel Spooner**
  - Luminescence Analysis, Radiation Sensing, Optical Dating

**Optical Materials and Structures**
- **Georgios Tsiminis**
  - Spectroscopy, Optical Fibre Sensors, Photonics, Chemical Sensing
- **Heike Ebendorff-Heidepriem**
  - Glass Science, Fibre Fabrication and Characterisation
- **Shahraam Afshar V**
  - Theoretical Photonics, Nonlinear Guided Optics, Optical Fibres

**Molecular Materials and Surfaces**
- **Andrew Abell**
  - Surface Chemistry, Protein and Peptide Synthesis
- **Tak Kee**
  - Spectroscopy and Organic Materials for Sensing

**Biological Sensing and Medical Diagnostics**
- **Peter Hoffmann**
  - Proteomics, Biomarker Discovery, Biological Sensors
- **Mark Hutchinson**
  - Neuroscience, Immunology, Pharmacology, Pain, Addiction, Spinal Cord Injury

**Atmosphere, Space and High Energy Astronomy**
- **Gavin Rowell**
  - High Energy Astrophysics, Cosmic Ray Detection
- **David Ottaway**
  - Solid State Lasers, LIDAR Sensors, Gravitational Wave Detection
Theme Goals

The six Research Themes have helped us to better communicate the work we do with our partners and stakeholders, and have served to crystallise transdisciplinary projects that sit outside traditional discipline boundaries.
ARC Centre of Excellence for Nanoscale BioPhotonics

The new ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP) was launched by Senator Bridget McKenzie on 21 November 2014 at the University of Adelaide. Centre Director Prof Mark Hutchinson and Chief Investigators Prof Tanya Monro, Prof Andrew Abell, Prof Steve Nicholls and A/Prof Jeremy Thompson are IPAS members. With a vision to create windows into the body, CNBP researchers are studying and manipulating nanoscale interactions between light and matter to measure and sense inside living biological systems.

The CNBP brings together physicists, material scientists, chemists, embryologists, neuroscientists and cardiologists from the University of Adelaide, Macquarie University and RMIT University with key international, national and industry partners. The emerging convergence of nanoscience and photonics offers the opportunity of using light to interrogate nanoscale domains, providing unprecedentedly localised measurements. This will allow biological scientists and clinicians to understand how single cells react to and communicate with their surroundings. This science will underpin a new generation of devices capable of probing the response of cells within individuals to environmental conditions or treatment, creating innovative and powerful new sensing platforms.

A Centre of research excellence, CNBP is a leader in nanoscale biophotonics. CNBP values ensure that alongside academic excellence, CNBP researchers embrace the growing need to communicate their research to diverse audiences, commercialise research outcomes and provide a nurturing environment to train future generations of researchers.

Top Left: CNBP Launch: CNBP Director Prof Mark Hutchinson, Vice-Chancellor & President Prof Warren Bebbington, Senator Bridget McKenzie & ARC CEO Aidan Byrne. Top Right: Dr Sanam Mustafa, CNBP Director Prof Mark Hutchinson, Ms Vicky Staikopoulos. Above: CNBP Adelaide Node members.
CNBP Case Studies:

Dr Sabrina Heng and Ms Xiaozhou (Michelle) Zhang
Photoregulation of Proteases Activity in Solution and on Surfaces

We have developed a new approach to control protease activity in solution and on an optical fiber using light. This approach is based on the use of enzyme inhibitors containing a spiropyran (photoswitch) that acts as both a regulator and peptide backbone surrogate, where the component spiropyran can be reversibly photoswitched between a spiropyran isomer and a less active merocyanine isomer upon irradiation with UV and visible light respectively, both in solution and once bound to the surface of a microstructured optical fiber (MOF). This work was motivated by the fact that the ability to detect the on/off binding of a bio-ligand to a complementary surface bound receptor provides a basis of real-time sensors of wide applicability.

This is the first report on the use of a MOF to control and detect photoisomerism in proteases, with increased sensitivity while using only nanoliter sample volumes when compared to previous solution and surface-based experiments. Such a sensor will have the advantages of making multiple measurements on a single sample or in a single sampling volume without the need to change the sensor, thereby potentially extending the sensor’s useful lifetime. This is particularly significant for biological applications where sample sizes are often limited. In addition, the modular design of our inhibitors sets the scene for future studies to develop a range of inhibitors to target different proteases. This work is the result of an interdisciplinary effort, which spans the fields of synthetic chemistry, computational chemistry and optics.

Left: Molecular modeling results of a photoswitchable inhibitor in the active site of alpha-chymotrypsin; Right: Dr Sanam Mustafa

Dr Sanam Mustafa
Understanding Pain: Identifying a Pain Biofingerprint

Clinically, understanding pain states and their response to different drug treatments currently relies upon patient self-assessment using an arbitrary pain scale. Experimentally, the activation of signalling pathways responsible for pain are investigated by examining the presence of pro-inflammatory markers. However, the presence of pro-inflammatory markers are only one aspect of pain signalling and do not give an insight into the global changes that occur during pain. In this project, we aim to characterise pain vs. no pain states on a global level. Ultimately, this will allow the effective evaluation of pain and effectiveness of pain relief therapies in patients.

For more information please see www.cnbp.org.au
RESEARCH THEME:
Novel Light Sources

IPAS novel light sources research combines fundamental and applied physics to generate and deliver tailored light for medicine, national security, industrial and environmental monitoring, and fundamental physics applications.

Our world leading research includes:
- Fibre and planar waveguide lasers
- Frequency combs
- Ultra-narrow-linewidth lasers
- Fibre-based nonlinear devices
- High-power solid-state lasers
- Fibre-based super-continuum sources.

Real world applications for these sources include:
- High-speed and high-resolution molecular spectroscopy for trace-gas detection
- Precision measurement
- Laser radar
- Defence precision technologies
- Laser-based electronic warfare systems
- Coherent LIDAR for wind-field measurements
- Airborne methane detection using differential absorption LIDAR

Fibre and Planar Waveguide Lasers

Our Fibre and Planar Waveguide Lasers research is focussed on developing and optimising new laser materials and concepts in fibre and planar waveguide lasers. Our research is driven by the challenge to develop lasers that operate in fringe regimes and possess extreme capabilities from compact architectures. Recent work has focussed on short-pulse generation (ns to fs), with applications including biophotonics, defence, mining, and surveying.

Precision Measurement

A defining feature of our technological society is a hunger for more accurate and precise measurement and sensing. Important real world applications such as: the Global Positioning System (GPS), magnetic imaging, radar, optical fibre communications and even mobile phones, all rely on developing ever more accurate and precise measurements. The Precision Measurement Group works within IPAS to build instruments to meet this technological demand. We develop and extend measurement platforms of high value to fundamental physics; with an increasing focus on industrial, medical and defence contexts.

Nonlinear Optics

Our expertise in modelling nonlinear processes in nanoscale waveguides could provide future solutions for high-speed optical switches, laser sources and sensing architectures. The ongoing development of fundamental theory has led to new models that predict a novel ‘selfflipping of polarization states’ that are being explored via two new collaborations. We hold high hopes for some very interesting new light sources in the near future.

Solid State Lasers

Solid-state laser research at IPAS focuses on the development of low noise and high-power systems for specific applications including ultra-high precision measurement, spectroscopy, and remote sensing. World-leading achievements include the highest brightness, high power cryogenic Yb:YAG laser and pulsed Er:YAG lasers that are pumped by inexpensive laser diodes for remote sensing applications. This year we have demonstrated the shortest pulses ever achieved by an Er:YAG laser, thus enabling the development of laser-range-finder systems that replace more complicated systems based on non-linear optics.
RESEARCH THEME: Novel Light Sources

1. WORLD’S MOST SENSITIVE THERMOMETER

Demonstrated the world’s most sensitive thermometer at room temperature. The relative speed difference between two colours of light travelling inside a crystalline disk optical-resonator was used to measure temperature with a precision of 30 billionths of a degree.

Collaboration with University of Western Australia, University of Queensland and Australian National University.

Wenle Weng (pictured), James Anstie, Andre Luiten (pictured)

2. MID-IR FIBRE LASER

Demonstration of the longest wavelength emission from a doped fibre laser operating at room temperature. The laser has potential applications for greenhouse gases monitoring, early disease detection and laser defence systems.


Ori Henderson-Sapir (pictured), Jesper Munch, David Ottaway

3. INFRARED CHIP LASER

Demonstration of a cm-scale chip laser that maintains perfect beam quality while its wavelength (or infrared colour) can be continuously varied.

Collaboration with Macquarie University.


David Lancaster (pictured), Tanya Monro

Research Theme

Novel Light Sources

Key Contacts:

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Coherent Laser Radar
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Silica and Soft Glass Fabrication Facilities
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RESEARCH THEME:
Chemical and Radiation Sensing

IPAS chemical and radiation sensing research uses in-house and specialty optical fibres, extensive knowledge of optical spectroscopy and unique surface coatings to develop novel optical fibre-based sensing architectures.

We explore the limits of detection, including:
- Ultra-small volume samples
- Low concentrations
- Obtaining results in difficult to access areas.

Working with end-users and industry, we develop these sensors for monitoring water quality, corrosion, wine maturation, embryos, soil nutrients, radiation fields, fuel degradation and explosives. This research is also creating new forms of fibre-based radiation dosimeters for the medical, mining and defence industries.

IPAS radiation sensing also utilises luminescence produced by ionising radiation absorbed in environmental materials both for radiation dosimetry and as the “clock” in a wide range of collaborative luminescence dating applications with industry and academia.

Chemical Sensing

Our chemical sensing research includes:
- Dip-sensors for hard to access regions including hazardous environments and in vivo
- Distributed sensors to enable information across a platform or structure
- Liquid and gas sensing approaches: fluorescence, Raman, plasmonic resonances and other spectroscopic techniques
- Analytes successfully sensed include hydrogen peroxide (H₂O₂), aluminium ions (Al³⁺), free SO₂, nitroaromatic explosives and metal ions.

In partnership with other IPAS researchers, we have developed new functional structure surfaces to enable advanced sensor functionality. We solve problems in collaboration with irrigation companies, defence organisations, embryologists and oenologists.

Radiation Sensing

Radiation Sensing in IPAS focuses on the development and application of new radiation dosimetry tools for both fundamental research and real-world applications, in health, defence and industry. Examples include:
- Fibre-based distributed dosimeters for mining and industrial applications
- Fibre-tip sensors for use in vivo in cancer treatment
- Forensic luminescence techniques for detection of prior exposure to ionising radiation
- Detection and quantification of radionuclides for mining and geochronology

Environmental Luminescence and Optical Dating

The IPAS Environmental Luminescence laboratory, now named “The Prescott Environmental Luminescence Laboratories”, hosts one of the most comprehensive suites of luminescence research equipment in the world. The suite includes the world’s most sensitive TL (thermoluminescence) spectrometer, a photon-counting imaging system (PCIS) developed in collaboration with ANU, state-of-the-art TL/OSL (optically-stimulated luminescence) Risø readers, fluorescence analysis facilities, and specialised apparatus for the measurement of luminescence kinetics and signal stability.

Luminescence dosimetry techniques are highly versatile; they are able to accurately measure ages from the present day back 500,000 years and quantify doses as low as a fraction of one day’s background radiation. Our research is advancing these techniques and further extending the applicability of luminescence analysis.
RESEARCH THEME: Chemical and Radiation Sensing

1. UNDERSTANDING STROKE

Georgios Tsiminis (pictured), Erik Schartner, Stephen Warren-Smith, Tanya Monro

Development of an optical fibre system to deliver light deep inside the brain of a mouse to create a stroke and collect a signal from the stroke-inducing dye, therefore monitoring the process in real time. This is the first time this has been done in the brain of a living animal.

Collaboration with South Australian Health & Medical Research Institute.

2. COPPER URANIUM RESEARCH HUB

Nigel Spooner (pictured), Heike Ebendorf-Heidepriem, David Ottaway

The Research Hub will develop, test and commercialise new methods to purify uranium and copper concentrates to ensure Australia is a world leader in copper production and associated technology.

Led by the Institute for Mineral and Energy Resources, University of Adelaide. Collaboration with Monash University, University of Queensland, University College London, DSTO, Environment Protection Authority, SA Museum, and BHP Billiton.

3. DATING NEANDERTHAL ORIGINS

Lee J Arnold (pictured), Martina Demuro

Novel luminescence dating techniques and anatomical analyses of 17 hominin skull specimens to confirm the “accretion model” of Neanderthal evolution at Sima de los Huesos, Atapuerca, Spain.

Collaboration with CENIEH, Complutense University of Madrid, University of the Basque Country, BGC, AMNH, Binghamton University, MNHN, University of Zaragoza.


Supported by ARC DP130200033.
RESEARCH THEME:
Optical Materials and Structures

Capabilities
IPAS delivers vertically integrated expertise and facilities, from modelling to device fabrication.

Modelling
- A suite of analytical, numerical and finite-element modelling tools to predict the optical properties of waveguides and fibres with complex structures
- New theoretical frameworks to explore waveguides and fibres with extreme properties and nanoscale features
- A pulse propagation model to predict how a pulse propagates along a fibre
- Waveguide and fibre design based on reversed engineering techniques
- A suite of numerical and finite-element modelling tools to find resonance modes of microsphere and microdisk cavities.

Fabrication of glasses and fibres
- Controlled atmosphere glass batching, melting and annealing
- Soft and hard glass preform extrusion
- Soft and hard glass preform ultrasonic milling
- Soft glass and silica fibre drawing.

Characterisation
- High-resolution electron and atomic force/scanning near-field optical microscopes (AFM/SNOM)
- Transmission spectrometers and ellipsometers spanning from the ultraviolet to the far-infrared spectral region (200 nm-30 μm)
- Optical profiler to measure surface roughness
- Simultaneous thermal analysis (STA/TGA/DSC)
- Fibre loss measurement.

Research
Our research ranges from fundamental science to application-driven design and development, including:
- Development of glasses with enhanced infrared transmission and optical nonlinearity
- Nanophotonic glasses created by embedding nanocrystals in glass
- Advanced technologies for processing and shaping glass
- Design and fabrication of micro and nanostructured soft glass and silica optical fibres
- Design and fabrication of microspheres and fibre tapers
- Development of speciality doped, active and passive silica fibres, including singlemode germano-silica, rare-earth doped silica and double/triple clad fibres
- Advancing 3D printing of metals and ceramics
- Advanced light propagation theory within optical fibres and planar waveguides.

Key areas of strength include:
- Tellurite and fluoride glasses (both passive and active)
- Advanced preform technologies (extrusion and drilling based)
- Development of glasses and fibres capable of transmitting light in the mid-infrared that underpin new sensing platforms and lasers
- Custom silica fibres for fibre lasers, including air-clad rare-earth doped fibres
- Suspended and exposed core silica fibres for sensing.
### RESEARCH THEME: Optical Materials and Structures

**1. 3D-PRINTED DYES**

Heike Ebendorff-Heidepriem, Alastair Dowler, Luis Lima-Marques, Tanya Monro

3D-printed dies for the extrusion of optical fibre preforms demonstrates a viable alternative to conventionally machined dies. Offers unprecedented die design flexibility for advanced fluid flow control.


**2. NANO-DIAMOND DOPED GLASS**

Yinian Ruan (pictured), Heike Ebendorff-Heidepriem, Hong Ji, Tanya Monro

Development of a method to incorporate a controlled amount of diamond nanoparticles into tellurite glass without decreasing the transmission of the host glass. Achieved by determining the chemical interactions between the nanoparticles and glass during fabrication conditions.

Collaboration with RMIT University.


**3. MATHEMATICALLY MODELLING FIBRES**

Roman Kostecki (pictured), Heike Ebendorff-Heidepriem, Stephen Warren-Smith, Tanya Monro

Special optical fibres, made from glass with holes and slots smaller than a human hair, can be used as detectors in liquids, structures or other mediums. We have extended modelling of capillary drawing to suspended core fibres, which enables prediction of conditions to make these fibres with different structures.

Collaboration with DSTO.

RESEARCH THEME: Molecular Materials and Surfaces

IPAS research in Molecular Materials and Surfaces spans the following areas:

- Chemical surface coatings
- Surface functionalisation strategies
- Organic synthesis
- Molecular-based sensors
- Bioelectronics
- New materials for gas storage or separation for renewable energy applications
- Platforms for catalysis.

Our researchers include ARC Future and DECRA Fellows, with expertise ranging from fundamental chemistry to analyte-specific sensor development (an IPAS strength). Key infrastructure is available in the School of Physical Sciences, including:

- Synthetic laboratories (wet and dry)
- High field NMR spectroscopy and X-ray diffraction structure determination
- Mass spectrometry
- Automated and semi-preparative HPLC
- Time-resolved laser spectroscopy
- Materials characterisation capabilities.

Biological and Chemical Surface Functionalisation

Biological and Chemical Surface Functionalisation work at IPAS combines organic synthesis, supramolecular chemistry and surface science to functionalise the surface of a glass optical fibre and other surfaces, enabling the detection of specific chemicals and biomolecules.

New Bioactive Compounds

We design, synthesise and test inhibitors to solve clinical challenges. Our investigations concentrate on proteolytic enzymes and biotin protein ligase as associated with the development of new antibiotics. We work to incorporate molecular ‘switches’ that when activated, mimic a key protein or peptide. Our aim is the improved treatment and diagnosis of Alzheimer’s, traumatic brain injury, cataracts and cancer.

Novel Materials Synthesis

Novel Materials Synthesis group design and synthesise nanostructured materials. Some of these compounds display novel interactions and behaviour that we exploit to develop sensors as well as for use in separation science and as platforms for catalysis.

Charge Transfer and Bioelectronics

Our Charge Transfer and Bioelectronics work focusses on the design and synthesis of peptides with specific secondary structures whose electronic properties we then theoretically and electrochemically evaluate on surfaces.

Functional Organic Materials

IPAS researchers working on ground breaking research in the area of Functional Organic Materials are developing the chemistry of ‘networked polymers’. These materials are synthesised from high symmetry building blocks linked via strong, irreversible covalent bonds. This emerging field has tremendous potential for new and more efficient catalysis platforms, sensing, storage and separation solutions.

Time-Resolved Laser Spectroscopy

Energy and charge transport in organic materials researchers at IPAS use time-resolved spectroscopic techniques to investigate energy and charge transport processes of organic photovoltaic materials. These materials, which include semiconducting polymers and organic crystals, exhibit not only the photovoltaic effect but also the abilities to sense the presence of a number of airborne chemical species. Our current work focusses on controlling the photophysical and -chemical pathways to maximise generation of charged species in these materials.
RESEARCH THEME: Molecular Materials and Surfaces

1. **X-RAY CRYSTALLOGRAPHY**
   - Witold Bloch (pictured), Christian Doonan, Chris Sumby

   A flexible framework material was used to provide molecular-level insight into the products formed from important inorganic reactions. The X-ray crystallographic structure can be determined without actually crystallizing the product.

2. **MOLECULAR-BASED ELECTRONIC DEVICES**
   - John Horsley (pictured), Jingxian Yu, Andrew Abell

   Traditional techniques for fabrication of electronic components are restricted by physical limitations. This work investigates the use of peptides for such components, and demonstrates new means to fine tune their rates of electron transfer.

   Collaboration with Flinders University.

3. **SELENIUM LINK TO FERTILITY**
   - Melanie Ceko (pictured), Hugh Harris

   Synchrotron imaging of bovine ovaries showed that selenium was localised to specific cells in developing ovarian follicles. This research has for the first time shown how much of a critical role selenium plays at the earliest stages of a woman's fertility.

   Collaboration with the Robinson Research Institute and the Australian Synchrotron.

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**Research Theme**

Molecular Materials and Surfaces

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- **Peptide Synthesis & Purification Facility**
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- **Australian National Fabrication Facility (ANFF) Optofab**
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RESEARCH THEME: Biological Sensing and Medical Diagnostics

IPAS research in this Theme seeks to:

- Create measurement tools to enable new questions to be asked in biology and medicine (this activity is driven through the ARC Centre of Excellence for Nanoscale BioPhotonics, see page 9 and 10)
- Develop improved medical diagnostic techniques, including ‘point of decision’
- Advance next generation proteomics technologies for cancer diagnostics and treatment
- Discover and detect biomarkers using Tissue Imaging Mass Spectrometry
- Investigate proteins and peptides underpinning the development and prevention of diseases.

Biomarker Discovery

This work investigates cancers through the identification of new biomarkers, increasing our capacity to detect, identify and quantify proteins and peptides with high sensitivity and accuracy. We use mass spectrometry and 2D gel electrophoresis combined with difference gel electrophoresis fluorescence labelling and isotopic labelling for protein identification and quantification. Driven by the need for the early diagnosis of cancer and monitoring of the disease’s progression, it also provides a better understanding of the disease at a molecular level.

Tissue Imaging Mass Spectrometry

In recent years, we have implemented and improved matrix-assisted laser desorption/ionization (MALDI) imaging mass spectrometry (IMS) in our laboratories. MALDI-IMS determines the spatial distribution of unknown compounds in tissue sections. Tissue sections prepared using the standard clinical pathology procedure, formalin fixed paraffin embedding (FFPE), can be used. During the last decade this technique has been developed as a powerful tool for the discovery of new markers which correlate with disease severity or metastasis as well as for the confirmation of known markers like HER2 receptor status.

Protein Structure, Function and Interactions

Research efforts are directed towards development of new approaches (primarily using mass spectrometry and complementary biophysical methods such as nuclear magnetic resonance spectroscopy, circular dichroism, fluorescence spectroscopy, electron microscopy) to obtain insight into the 3D structure, function and interactions of macromolecules, such as proteins and DNA, important in biology.

Biosensing Platform Development

Harnessing breakthroughs from our other Themes, we create new biosensing tools for advancing biological research, and collaborate with medical researchers to enable translation to clinical applications.

New sensor architectures include:

- Small-volume in-fibre fluorescence assays
- Fibre-tip sensors for in vivo diagnostics
- A multi-channel sensor for virus, bacteria and biomarker detection for gastric cancer.

Central Nervous System Nanoscale Biosensing

Our brains and spinal cords are comprised of billions of highly diverse and specialised cells working in concert, allowing us to process a multitude of conscious and unconscious pieces of information. However, we still only understand a fraction of the complexity of brain function in health, let alone how the brain changes in disease. To tackle the new frontiers in brain and behavioural research we need to ask our scientific questions of smaller and smaller numbers of cells, in very discrete brain regions. Unfortunately, the existing technologies don’t allow this. Therefore, through the use of novel nanoscale biosensors our research aims to go beyond the limits of detection imposed by current tools. With these new tools we will ask questions of the brain and spinal cord that was once thought to be science fiction.
Circulating immune cells that migrate into the “brain in pain” have been implicated as vital contributors to the creation and maintenance of pathological persistent pain. This understanding creates opportunities to intervene in the pain epidemic.

Collaboration with University of Colorado Boulder.

We studied the performances of dye doped microspheres, supporting Whispering Gallery Modes, positioned onto the tip of a microstructured optical fibre, as an in-vivo biological sensor. We show that this microsphere can be turned into a laser source, enabling improvement of the sensing performances.

Further development of N-linked glycan MALDI imaging mass spectrometry by implementing improved sample preparation and structural characterization (LC-MS/MS). The approach will be applied to formalin-fixed paraffin-embedded cancer tissues to develop novel diagnostic methods. Collaboration with Macquarie University and Bruker Pty. Ltd.
**RESEARCH THEME: Atmosphere, Space and High Energy Astronomy**

The team has a wealth of experience in developing the technologies that underpin remote sensing. Our members contribute to international projects such as the Laser Interferometer Gravitational Wave Observatory (LIGO), the High Energy Stereoscopic System (HESS) and the Pierre Auger Observatory.

**Gravitational Wave Detection with LIGO**

Einstein predicted the existence of gravitational waves, and our researchers are part of the LIGO team that is building a $300M instrument to detect them. We have developed a range of laser systems and optical sensors for advanced gravitational wave detection.

**Light Detection and Ranging (LIDAR)**

We are developing differential absorption LIDAR (DIAL) to remotely sense chemicals in the atmosphere including CH4, water vapour sensing and SOx. We are developing coherent laser radar (CLR) systems for a range of eye-safe LIDAR applications including:

- Monitoring dust and pollution emanating from mining and industrial sites
- Mapping wind speeds for wind farm site assessment
- Turbine prediction and turbulence detection for aerospace applications.

Our unique solid-state laser platforms in the near infrared (eye-safe band) and fibre lasers in the mid-infrared underpin these exciting technologies.

**High-Energy Astrophysics**

High-energy cosmic messengers such as gamma and cosmic rays enable us to study the processes in extreme objects like supernova explosions, pulsars and black holes. Detecting gamma and cosmic rays requires advanced techniques to filter the atmospheric background and apply atmospherics transmission. Our researchers are currently working on projects including the design of gamma ray telescopes and ultra high-energy cosmic ray detectors.

**Gamma-Ray Astronomy**

The High Energy Stereoscopic System (HESS) is an array of five gamma-ray telescopes in Namibia and is being used to reveal the nature of cosmic-ray and electron accelerators in our galaxy and beyond. The Adelaide team focuses on gamma-ray sources in our Milky Way galaxy and how these objects can influence its evolution. The team also leads Australia’s efforts in developing the next generation gamma-ray facility known as the Cherenkov Telescope Array (CTA) which will be 10 times more sensitive than HESS using an array of up to 100 telescopes.

**Cosmic-Ray Astronomy**

The Pierre Auger Observatory (PAO) in Argentina is the world’s largest cosmic-ray detector. Cosmic-rays are the charged particles continually raining down on Earth from outer space and their origin remains a mystery. PAO is being used to measure the energies, directions and elemental composition of the highest energy cosmic-rays. The Adelaide team leads efforts in reconstructing these cosmic-ray parameters and the calibration of this data by accurately measuring the atmosphere’s properties at the PAO site.

**Space and Atmospheric Physics**

The atmosphere and near space environment are critical to life on earth. We use a network of radars, lidars and passive optical instruments to study the structure and dynamics of the atmosphere to validate numerical weather and climate models provided by CSIRO and BOM. We use an extensive instrument cluster located at Buckland Park Field Site to map the winds, temperature and density of the atmosphere from the ground to 90 km. We also contribute to the instrument cluster at Davis Station in Antarctica. We are continually developing new instruments and analysis techniques including the development of a powerful Rayleigh Lidar for measuring densities and temperatures in the 30 to 90 km region in collaboration with the Australian Antarctic Division and the Leibniz Institute for Atmospheric Physics in Germany, and a novel UHF radar for measuring winds and turbulence in the lowest 500 m of the atmosphere in collaboration with a local company, ATRAD Pty Ltd.
**RESEARCH THEME: Atmosphere, Space and High Energy Astronomy**

**1. NEW GAMMA-RAY SOURCES**

- Gavin Rowell (pictured), Phoebe De Will, James Cheuk-Heng Lau

**NEW GAMMA-RAY SOURCES**

HESSJ1641-463 is one of a new class of gamma-ray sources in our Milky Way that appear only at the highest gamma-ray energies measured so far. This new source could result from cosmic-rays accelerated to about 1000 TeV by an adjacent supernova remnant.

**2. NEUTRON STARS**

- David Ottaway (pictured), Jesper Munch, Peter Veitch

**NEUTRON STARS**

Neutron stars are amongst the most dense objects in the known Universe. Rapidly spinning pulsars are a class of neutron stars that are extremely rotationally symmetric. Data from the LIGO and Virgo detectors was analysed to show that these neutron stars have ellipticities < 1ppm. Collaboration with the LIGO and Virgo.

**3. PHOTOGRAPHING THE ATMOSPHERE**

- Iain Reid (pictured)

**PHOTOGRAPHING THE ATMOSPHERE**

We have shown that you can learn a lot about a little-known part of our planet’s atmosphere, just by using a special kind of camera. The region we have studied is just below where air ends and space begins. Collaboration with ATRAD Pty Ltd.

---

**Key Contacts:**

- Light Detection and Ranging (LIDAR)  
  A/Prof Peter Veitch  
  peter.veitch@adelaide.edu.au

- Gravitational Wave Detection (LIGO)  
  Dr David Ottaway  
  david.ottaway@adelaide.edu.au

- High Energy Astrophysics  
  Dr Gavin Rowell  
  gavin.rowell@adelaide.edu.au

- Atmospheric and Space Physics  
  Prof Iain Reid  
  iain.reid@adelaide.edu.au
Pilot Project Scheme

In 2011, IPAS launched its first Pilot Project Scheme with the aim of driving the development of new research projects and directions. To be selected, projects had to demonstrate the potential to lead to external funding.

The Scheme encourages collaborative projects within and across discipline boundaries, and provides the IPAS Scientific Management Committee (SMC) with information on IPAS activities, capabilities, strengths, and opportunities to enable strategic decision-making.

In 2014, $103k of funding was allocated to IPAS members across the following seven projects:

- **Suspended-core optical fibers: rewiring atom chips with light** – Dr Brenton Hall, Prof Andrei Sidorov, Prof Andre Luiten
- **Adding electrical conductivity to glass and fibres** – A/Prof Heike Ebendorff-Heidepriem, Dr Shahraam Afshar
- **A compact femtosecond mid-infrared laser** – A/Prof David Lancaster, A/Prof Ju Han Lee, Prof David Kielpinski
- **High power cryogenic femto-second laser collaboration** – Prof Jesper Munch, A/Prof Peter Veitch, Dr Miftar Ganija
- **Dual wavelength seeding of Er:YAG lasers for remote sensing of methane from airborne platforms** – Dr David Ottaway, A/Prof Peter Veitch, Mr Myles Clark
- **Identification of spoilage micro-organisms in beer using mass spectrometry profiling** – Dr Florian Weiland, Dr O Johan R Gustafsson, Dr Stephan Meding
- **Towards a light-driven, biocompatible sensor for the rapid detection of bacterial toxins** – Dr Sabrina Heng, Dr Christopher McDevitt, Prof James Paton, Mr Roman Kostecki

The 2013 Scheme has led to many positive outcomes including building teams who are now an integral part of the Centre of Excellence for Nanoscale BioPhotonics (CNBP), and multiple journal publications and conference talks.
Working with Industry / Commercialisation
The Photonics Catalyst Program (PCP), a joint initiative between the Department of State (DSD) and IPAS, is connecting South Australian Industry with emerging laser and sensor technologies capable of transforming their businesses. It is creating a South Australian based ecosystem of expertise and capabilities in photonics supporting the development of cutting-edge photonic products through unique project based collaborations between researchers, industry, end-users and government.

The Program facilitates the development of advanced photonic devices by coordinating the efforts of key stakeholders. It provides funding mechanisms for engagement, the development of prototypes, testing of photonic devices and the adoption of new light based technologies. We have a particular focus on finding solutions, creating new products and advanced manufacturing opportunities for South Australia.

The $750,000 Program will fund 15 new industry-focussed projects between IPAS researchers and local companies over the next 2 years. Participants in the PCP will receive a commercial and technical feasibility assessment of their project and up to $45,000 worth of research and development services to assist with the development of their new photonics product or prototype.
Examples of projects funded so far under this Program are:

**S J Cheesman**  
The engineering and testing of high temperature optical fibre sensors at the Nystar Metals and Minerals Processing Facility, Port Pirie.

**Maptek**  
Enhancing the performance of Maptek’s I-Site Laser Scanner through the use of 3D metal printing.

**ATRAD**  
Developing a sensor flown on weather balloons from airports to detect freezing conditions in the atmosphere and alert pilots to icing hazards.

**Ellex Medical**  
Collaborating on a photonics based project.

**Coopers Brewery**  
Developing new photonic analytical methods to improve the quality of brewed products.

**Scantech**  
Collaborating on a minerals analysis project.

**Unnamed Adelaide based company**  
Working on a novel product for orthopaedic surgery.

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Commercialisation

One of the key aims of IPAS is to combine research excellence with a strong industry focus and collaborative culture. The team at IPAS work closely with Adelaide Research and Innovation (ARI), the commercialisation company of the University of Adelaide, to create a culture of innovation within the Institute, foster industry-led collaborations and contract research, and to develop technology licence agreements.

The commercial objectives of IPAS are to accelerate the process of getting products to market, helping the growth of photonics and advanced sensing sectors in Australia, creating new opportunities and jobs for graduates and researchers outside traditional academic roles and securing an untied income stream to the Institute. Through their research, IPAS members have built a significant portfolio of patents.

IPAS Patented Technologies

**Microstructured fibres and nanowires**

Our microstructured optical fibre sensors, developed in both soft and silica glasses, allow us to measure ultra-low concentrations of chemicals in nanolitre volumes of liquids. Active IPAS programs are developing this technology for sensing a range of analytes in applications such as IVF, wine production, soil nutrient monitoring, corrosion and mineral exploration.

**Gastric cancer biomarkers**

Peter Hoffmann and his team have discovered a panel of biomarkers that may potentially be used to diagnose gastric cancer in humans. This technology received additional funding through the ARI Commercial Accelerator Scheme in 2014 for additional research.

**Q-switched laser**

Major applications for this include coherent laser radar (LIDAR) and other remote sensing applications, including gas detection. This technology is under discussion for licensing in 2015.

**A new class of antibiotic**

Andrew Abell and his team have patented a new class of antibiotic for treating Staph aureus infections. Further research has identified a new candidate molecule that will be researched in 2015.

**Waveguide chip laser**

The Waveguide laser is a new laser architecture based on waveguides written in rare earth doped fluoride glass. These lasers have achieved near-perfect beam quality lasing at 1.1 μm, 1.9 μm, 2.1 μm, and 2.9 μm with broad tunability, and are potentially the longest wavelength planar waveguide lasers ever demonstrated. The lasers are anticipated to be used in gas detection, long-range laser radar applications, free-space optical communication, medical diagnostics, laser surgery, optical pumping of longer wavelength lasers, material processing and security applications. This technology is currently in licensing negotiations with a South Australian based startup company led by the inventors of the technology.
Whispering gallery mode sensor

Our whispering gallery mode sensor comprises microspheres attached to the end of optical fibres. This kind of architecture allows very sensitive measurements to be made in vivo.

Device and method for sensing a chromatic property of foodstuff (browning sensor)

A novel browning sensor was developed by a team of researchers working at IPAS. The inventors secured IPAS Pilot Project funding in order to fund the demonstration of the sensor, and the Institute supported the inventors by funding the patenting of the sensor. The Institute is delighted that a new sensing technology developed by its researchers is being commercialised by a new start-up company led by the inventors who have licensed the technology from the University of Adelaide. Due to commercial advancements the technology has been assigned to the company.

Optical fibre radiation sensor

We have developed an optical fibre radiation dosimeter capable of instant readouts of ionising radiation and accumulated radiation doses. We are now working with oncologists to understand how this highly accurate measure of the radiation dose applied to tumours during radiotherapy can be clinically applied.

Dual wavelength pumped laser system

David Ottaway, Jesper Munch and Ori Henderson-Sapir have developed the first erbium-doped zirconium-fluoride-based glass fibre laser operating well beyond 3 μm with significant power. This fibre laser achieved 260 mW in CW at room temperature. The use of two different wavelength pump sources allows us to take advantage of the long-lived excited states that would normally cause a bottleneck, and this enables maximum incident optical-to-optical efficiency. This technology was funded by the ARI Commercial Accelerator Scheme in 2014 to further develop the technology and is currently being evaluated by an interested third party.

Autoantibody biomarker candidates for early ovarian cancer

Peter Hoffmann, Martin Oehler and Karina Martin identified a panel of auto-antibodies which have been shown to be discriminators between early ovarian cancer and healthy/benign controls. Ovarian cancer is the leading cause of death from gynaecologic malignancies in Australia. It presents at a late clinical stage in more than 80% of patients, and is associated with a 5-year survival of only 35% in this group. In contrast, the 5-year survival for patients with organ-confined stage I ovarian cancer exceeds 90%, and most patients are cured of their disease.

An optical sensor

A novel method for coating of temperature-sensitive materials has been developed to allow for rapid fabrication of probes for bio-applications. This dip coating method allows the temperature to be recorded at the tip of a standard silica optical fibre with good spatial resolution.

Distributed high temperature sensing for furnace monitoring and control

A technology for accurately measuring real time high temperature sensing in a harsh industrial environment which is currently undergoing trials.

High performance portable optical clock

This clock is anticipated to provide a new standard in accuracy and stability for use in applications including data transfer in telecommunications, stock market transactions GPS, navigation systems, precision measurement radio astronomy and timekeeping.

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Industry Collaboration

IPAS engages with industry via consultancy, contract research, collaborative research and Federal Government grants such as industry-linkage schemes. Commercial contracts with IPAS are handled by Adelaide Research and Innovation (ARI), who manage The University of Adelaide’s commercial and consultancy partnerships, form new business ventures based on University expertise and develop the University’s innovative ideas and technologies with commercial potential.

IPAS welcomes interactions from potential collaborators in all scientific fields. IPAS already collaborates with many commercial and development organisations including:

- Australian Cultural Heritage Management (ACHM)
- AOFR Pty Ltd
- ATRAD Pty Ltd
- Austofix
- Australian Seafood CRC
- BAE Systems Australia
- BHP Billiton
- Biosis
- Bruker Daltonik GmbH
- Bruker Pty Ltd
- Calpain Therapeutics Pty Ltd
- Chevron Energy Technology Pty Ltd
- Cook Medical Australia
- CPR Pharma Services Pty Ltd
- CRC for Plant Biosecurity
- Deep Exploration Technology CRC
- Defence Science and Technology Organisation (DSTO)
- Demould Tooling Services Pty Ltd
- Ellex Medical Pty Ltd
- Fertility SA
- Finders Fertility
- Heraeus, Germany
- Maptek Pty Ltd
- Medical & Scientific Services Pty Ltd
- Menlo Systems GmbH, Germany
- MOG Laboratories Pty Ltd
- OSRAM GmbH, Germany
- OZ Minerals
- Pernod Ricard Australia
- Phebra Pty Ltd
- PicoQuant, Germany
- Quintessence Labs Pty Ltd
- Red Chip Photonics
- Reproductive Health Science
- SA Pathology
- Scantech
- SJ Cheesman
- Trajan Scientific and Medical
- Treasury Wines Estates
- Yalumba Wines.

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2014 Activities
Congratulations to all of this year’s winners

**Australian Optical Society WH Beattie Steel Medal**
Congratulations to Adj Prof Tanya Monro on being awarded the Australian Optical Society (AOS) WH Beattie Steel Medal in recognition of her leadership and significant contribution to the field of optics.

**Commission on Symbols, Units, Nomenclature, Atomic Masses and Fundamental Constants**
Congratulations to Prof Andre Luiten who has been appointed to the Commission on Symbols, Units, Nomenclature, Atomic Masses and Fundamental Constants (SUNAMCO) of the International Union of Physics and Applied Physics. Established in 1931, SUNAMCO is for the exchange of information about the fundamental constants, measurements and units that are at the foundation of all science.

**Human Proteome Organisation (HUPO) Council**
Congratulations to Prof Peter Hoffmann for being appointed to the Human Proteome Organisation council. HUPO is an international scientific organization representing and promoting proteomics through international cooperation and collaborations by fostering the development of new technologies, techniques and training.

**University of Adelaide Faculty of Sciences Daniel Walker Medal**
Congratulations to Dr Stephen Warren-Smith for winning the new University of Adelaide Faculty of Sciences Daniel Walker Medal awarded annually to the best Early Career Researcher in the Faculty.

**7th HOPE Meeting with Nobel Laureates**
Congratulations to both Dr Jiangbo (Tim) Zhao and Dr Erik Schartner who were successful in their application to the Australian Academy of Science’s National Committee for Physics to attend the 7th HOPE Meeting with Nobel Laureates in Japan, 1-5 March 2015 in Tokyo.
IPAS Seminars

In 2014 IPAS hosted the following visiting speakers:

17 January: Prof Tingyun Wang, Shanghai University, China. Title: Special optical fibers and sensors.


25 February: Dr Andreas Hartmann, Griffith Hack. Title: IP Workshop on Patents.

11 March: Dr Nathan Langford, University of London, UK. Title: Progress towards practical quantum information processing with photons.

12 March: Prof Ulrich Steiner, University of Cambridge, UK. Title: Nano-structured energy materials made by polymer self-assembly.

10 April: A/Prof Peng Xi, Peking University, China. Title: RESOLFT optical nanoscopy with organic and inorganic dyes.

15 April: Prof Gordon Wallace, University of Wollongong. Title: Additive fabrication and medical bionics.

22 April: Dr Volker Buschmann, PicoQuant, Germany. Title: Advanced confocal fluorescence microscopy techniques: from single molecule to ensemble studies.

24 April: Prof Jeremy O’Brien, University of Bristol, UK. Title: Quantum technologies.

6 May: Prof Neil Champness, University of Nottingham, UK. Title: Surface supramolecular chemistry: understanding self-assembly at the molecular level.

8 May: Prof Yuri Kivshar, Australian National University. Title: Controlling electromagnetic waves with plasmonics and metamaterials.

15 May: Dr Dusan Losic, University of Adelaide.

17 June: Prof John Arkwright, Flinders University. Title: In-vivo optical fibre monitoring and measurement - a perfect confluence of clinical need and technical capability.

19 June: Mr Angus Netting, Adelaide Microscopy. Title: Advanced microscopy and microanalysis: materials characterization and beyond.

27 June: A/Prof Siddharth Ramachandran, Boston University, US. Title: Can fibers replace all (most) lasers? aka Nonlinear optics with bessel beams in fibers.

1 July: A/Prof Rich Mildren, Macquarie University. Title: Lasers and laser phenomena involving undoped synthetic diamond.

16 July: Dr Fetah Benabid, University of Bath, UK. Title: Kagome hollow-core PCF is going extreme.

25 July: Dr Stephen Gensemer, CSIRO. Title: Precision quantum phase measurements in a juggling atomic clock.

7 October: Prof Achim Peters, Humboldt-Universitaet zu Berlin. Title: Advanced diode lasers systems for precision measurements in space (and on Earth).

20 October: Dr Martin Gorjan, Ludwig-Maximilians-Universitaet Muenchen Fakultae fuer Physik Am, Garching, Germany. Title: The face of high-power lasing.

6 November: Prof Shizhang Qiao, University of Adelaide. Title: Nanostructured materials for energy-relevant electrocatalytic process.

10 November: Dr Irina Kabakova, University of Sydney. Title: Enhancing and inhibiting stimulated Brillouin scattering in photonic integrated circuits.
IPAS Global Collaborators
IPAS members collaborate with academic teams across the world, seeking complementary skills and teams in order to solve global research challenges. In 2014 IPAS members collaborated with researchers located in the following organisations:

**CANADA**
- University of Laval
- University of Toronto

**JAPAN**
- Nagoya University
- University of Tokyo

**KOREA**
- University of Seoul

**SINGAPORE**
- Defence Science Organisation

**SOUTH AMERICA**
- São Paulo State University, Brazil
- University of Buenos Aires, Argentina

**UNITED KINGDOM**
- University of Aberystwyth
- University of Leicester
- University of Nottingham
- City University London
- Optoelectronics Research Centre, University of Southampton

**USA**
- California Institute of Technology
- Caltech
- Clemson University
- Cooperative Institute for Research in Environmental Sciences
- CReOL, The College of Optics and Photonics, University of Central Florida
- Georgia Institute of Technology
- Massachusetts Institute of Technology
- National Center for Atmospheric Research
- National Institute of Standards and Technology
- NorthWest Research Associates
- Princeton University
- Syracuse University
- University of California, Berkeley
- University of California, Davis
- University of California, Merced
- University of Colorado, Boulder
- US Army Research Laboratory

**CHINA**
- Beijing University of Technology
- Center for Space Science & Applied Research, CAS
- East China Normal University
- Huazhong University of Science & Technology
- Institute of Geology & Geophysics, CAS
- Peking University
- Shanghai Jiao Tong University
- Shanghai University of Electric Power
- Yanshan University

**MAINLAND EUROPE**
- Danish Technical University, Denmark
- Dublin Institute for Advanced Studies, Ireland
- Heinrich-Heine-Universität Düsseldorf, Germany
- Helmholtz-Zentrum Geesthacht, Germany
- Helmholtz Zentrum München, Germany
- Humboldt University, Germany
- Institut d'Optique, France
- Leibnitz Institute of Photonic Technology, Jena
- Institute for Atmospheric Physics at the University of Rostock, Germany
- Jagiellonian University, Poland
- Laboratoire de Météorologie Dynamique, École Polytechnique, France
- Leibniz-Institut für Analytische Wissenschaften, Germany – ISAS – e.V., Dortmund, Germany
- Max Planck Institut für Kernphysik, Germany
- Physikalisch-Technische Bundesanstalt, Germany
- Université de Neuchâtel, Switzerland
- Université Claude Bernard Lyon 1, France
- University of Bonn, Germany
- University of Cologne, Germany
- University of Copenhagen, Denmark
- University of Jena, Germany
- Université de Limoges, France
- University of Milan, Italy
- University of Trento, Italy
- University Paris-Sud, France
- Uppsala University, Sweden
- Vrije Universiteit Brussel, Belgium

**NEW ZEALAND**
- Lincoln University
- University of Auckland
- University of Canterbury
- University of Otago
IPAS Australian Collaborators

IPAS members collaborate with universities, research organisations and defence industries across Australia. Major collaborators are shown on the adjoining maps:

- **NATIONAL**
  - Australian Defence Force Academy
  - Commonwealth Scientific and Industrial Research Organisation
  - Defence Science and Technology Organisation
  - National Measurement Institute

- **SOUTH AUSTRALIA**
  - Flinders University
  - SA Pathology
  - South Australian Government
  - South Australian Museum
  - South Australian Health and Medical Research Institute
  - South Australian Research and Development Institute
  - University of South Australia

- **NEW SOUTH WALES**
  - Macquarie University
  - University of Newcastle
  - University of New South Wales
  - University of Sydney
  - University of Western Sydney

- **VICTORIA**
  - Monash University
  - RMIT University
  - Swinburne University
  - University of Melbourne

- **QUEENSLAND**
  - Griffith University
  - University of Queensland

- **TASMANIA**
  - Australian Antarctic Division

- **WESTERN AUSTRALIA**
  - University of Western Australia

- **AUSTRALIAN CAPITAL TERRITORY**
  - Australian National University
### IPAS Visitors

In 2014 IPAS hosted the following visitors:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Country</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr Naveed Ahmed</td>
<td>University of Applied Sciences (Ernst-Abbe-Hochschule)</td>
<td>Germany</td>
<td>8 months</td>
</tr>
<tr>
<td>Ms Reenu Baby</td>
<td>Cochin University of Science and Technology</td>
<td>India</td>
<td>6 months</td>
</tr>
<tr>
<td>Mr Nicolas Bourbeau Hebert</td>
<td>University of Laval</td>
<td>Canada</td>
<td>1 year</td>
</tr>
<tr>
<td>Dr Liyun Ding</td>
<td>Wuhan University of Technology</td>
<td>China</td>
<td>1 year</td>
</tr>
<tr>
<td>Mr Klaus Doeringshoff</td>
<td>Humbolt University</td>
<td>Germany</td>
<td>5 weeks</td>
</tr>
<tr>
<td>Prof Jerome Genest</td>
<td>University of Laval</td>
<td>Canada</td>
<td>1 year</td>
</tr>
<tr>
<td>Dr Niels Krogsgaard-Larsen</td>
<td>University of Copenhagen</td>
<td>Denmark</td>
<td>1 year</td>
</tr>
<tr>
<td>Prof Ju-Han Lee</td>
<td>University of Seoul</td>
<td>Korea</td>
<td>1 year</td>
</tr>
<tr>
<td>Ms Fayth Lim</td>
<td>Nanyang Polytechnic</td>
<td>Singapore</td>
<td>3 months</td>
</tr>
<tr>
<td>Ms Vernise Lim</td>
<td>Nanyang Polytechnic</td>
<td>Singapore</td>
<td>3 months</td>
</tr>
<tr>
<td>Dr Danilo Manzani</td>
<td>São Paulo State University</td>
<td>Brazil</td>
<td>1 year</td>
</tr>
<tr>
<td>Dr Louis Marmet</td>
<td>National Research Council</td>
<td>Canada</td>
<td>1 year</td>
</tr>
<tr>
<td>Mr Vincent Michaud-Belleau</td>
<td>University of Laval</td>
<td>Canada</td>
<td>1 year</td>
</tr>
<tr>
<td>Dr Sana Amairi Ep Pyka</td>
<td>Humboldt University</td>
<td>Germany</td>
<td>3 months</td>
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<tr>
<td>Ms Juliane Schuppich</td>
<td>German University of Technology Ilmenau</td>
<td>Germany</td>
<td>6 months</td>
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<tr>
<td>Ms Jun Shi</td>
<td>Huazhong University of Science and Technology</td>
<td>China</td>
<td>1 year</td>
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<tr>
<td>Ms Camalia Tan</td>
<td>Nanyang Polytechnic</td>
<td>Singapore</td>
<td>3 months</td>
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<tr>
<td>Mr Qi-An Tan</td>
<td>Nanyang Polytechnic</td>
<td>Singapore</td>
<td>3 months</td>
</tr>
<tr>
<td>Dr Shinya Yanagimachi</td>
<td>National Metrology Institute of Japan</td>
<td>Japan</td>
<td>3 months</td>
</tr>
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</table>
### Research Grants Held

In 2014 IPAS members were involved in the following research grants:

*Note that in some cases only a proportion of the total funding awarded for each project was or will be received by the University of Adelaide.*

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Project ID</th>
<th>IPAS Investigators</th>
<th>All Investigators</th>
<th>Project Title</th>
<th>Duration</th>
<th>Total Funding Awarded for the Project</th>
<th>Total Funding Awarded for the Project for 2014</th>
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<td>ARC, Australian Laureate Fellowship</td>
<td>FL130100044</td>
<td>Monro, TM</td>
<td>Monro, TM</td>
<td>Controlling light to understand and drive nanoscale processes</td>
<td>2013-2018</td>
<td>$2,965,000</td>
<td>$590,000</td>
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<td>ARC, Super Science Fellowships</td>
<td>FS110200009</td>
<td>Monro, TM, Spooner, NA</td>
<td>Monro, TM, Cooper, A, Salamonsen, LA, Norman, RJ, Spooner, NA</td>
<td>Transformational diagnostics</td>
<td>2011-2014</td>
<td>$835,200</td>
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<td>ARC, Future Fellowship</td>
<td>FT130100195</td>
<td>Arnold, L</td>
<td>Arnold, L</td>
<td>Trying times: Millennial to million year luminescence chronologies for improved reconstructions of Australian megafaunal extinctions</td>
<td>2013-2017</td>
<td>$755,320</td>
<td>$188,830</td>
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<td>Scheme</td>
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<td>IPAS Investigators</td>
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<td>Total Funding Awarded for the Project</td>
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<td>ARC, Future Fellowship</td>
<td>FT100100400</td>
<td>Doonan, CJ</td>
<td>Doonan, CJ</td>
<td>Open framework organic materials for CO2 capture and conversion</td>
<td>2010-2014</td>
<td>$706,052</td>
<td>$88,319</td>
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<td>ARC, Discovery Early Career Researcher Award</td>
<td>DE130100689</td>
<td>George, J</td>
<td>George, J</td>
<td>Applying nature’s chemistry to the synthesis of complex bioactive natural products</td>
<td>2013-2015</td>
<td>$375,000</td>
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<td>ARC, Discovery Early Career Researcher Award</td>
<td>DE120102028</td>
<td>Light, PS</td>
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<td>Integrated gas photonics</td>
<td>2012-2014</td>
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<td>ARC Discovery Project</td>
<td>DP140100176</td>
<td>Harris, H</td>
<td>Lay, PA, Harris, HH, Paterson, DJ, Tobin, MJ, de Jonge, MD, Glover, CJ, Puskar, L, Vogt, S, Finney, L</td>
<td>Pushing the boundaries of multi-modal biospectroscopic microscopies</td>
<td>2014-2016</td>
<td>$519,790</td>
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<td>ARC Discovery Project</td>
<td>DP130101827</td>
<td>Abell, AD, George, J</td>
<td>Abell, AD, George, J</td>
<td>Taking nature’s lead in the development of new and improved enzyme inhibitors</td>
<td>2013-2015</td>
<td>$390,000</td>
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<td>ARC, Discovery Project</td>
<td>DP130104129</td>
<td>Luiten, AN, Hartnett, JG, Light, PS</td>
<td>Luiten, AN, Hartnett, JG, Light, PS, Peters, A, Kessler, T</td>
<td>Ultra-high spectral purity lasers for tests of relativity and atomic clocks</td>
<td>2013-2015</td>
<td>$850,000</td>
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37 IPAS Annual Report 2014 / 2014 Activities
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<tr>
<th>Scheme</th>
<th>Project ID</th>
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<th>All Investigators</th>
<th>Project Title</th>
<th>Duration</th>
<th>Total Funding Awarded for the Project</th>
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<tr>
<td>ARC, Discovery Project</td>
<td>DP130101541</td>
<td>Stokes, YM, Ebendorff-Heidepriem, H</td>
<td>Stokes, YM, Crowdy, DG, Ebendorff-Heidepriem, H</td>
<td>Shining the light on geometry of microstructured optical fibres</td>
<td>2013-2015</td>
<td>$350,000</td>
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<td>DP120100582</td>
<td>Abell, AD</td>
<td>Abell, AD, Wegener, KL, Callen, DF, Ginsberg, MH</td>
<td>Defining peptide structure and function: the shape of things to come</td>
<td>2012-2014</td>
<td>$355,000</td>
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<td>ARC, Discovery Project</td>
<td>DP120100898</td>
<td>Munch, J</td>
<td>Blair, DG, Ju, L, Chunngong, Z, Munch, J, Whitcomb, SE, Chen, Y, Harry, GM, Gossler, S</td>
<td>Three-Mode interactions and optical springs in high power optical cavities</td>
<td>2012-2014</td>
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<td>ARC, Discovery Project</td>
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<td>Rowell, GP</td>
<td>Burton, MG, Rowell, GP, Hollenbach, DJ</td>
<td>Dark gas and the formation of molecular clouds</td>
<td>2012-2014</td>
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<td>ARC, Discovery Project</td>
<td>DP120100901</td>
<td>Monro, TM</td>
<td>Monro, TM, Prawer, S</td>
<td>Nanodiamond in glass: A new approach to nanosensing</td>
<td>2012-2014</td>
<td>$360,000</td>
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<td>LP140100589</td>
<td>Ottaway, D, Veitch, P, Lancaster, D</td>
<td>Ottaway, D, Veitch, P, Lancaster, D, Penley, ME, Goldstein, B</td>
<td>Laser airborne methane sensor</td>
<td>2014-2017</td>
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<td>ARC, Linkage Project</td>
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<td>Vincent, R, Hamilton, M</td>
<td>Quantifying the flux of fugitive greenhouse gases associated with coal seam gas and calibrating it to natural baseline and anthropogenic sources</td>
<td>2014-2017</td>
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<td>ARC, Linkage Project</td>
<td>LP130101133</td>
<td>Monro, TM, Withford, MJ, Johnson, PA</td>
<td>Compact and versatile chip lasers for three-dimensional mine surveying</td>
<td>2013-2016</td>
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<td>LP120200605</td>
<td>Luiten, AN, Graham, BF, Luiten, AN, Johns, ML, May, EF, Marsh, KN, Fridjonsson, EO</td>
<td>Avoiding cryogenic solids formation in liquefied natural gas production</td>
<td>2012-2016</td>
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<td>ARC Linkage Project</td>
<td>LP120100483</td>
<td>Monro, TM, Taylor, DK, Rose, LE, Lathey, KA, Jones, I</td>
<td>Smart Bungs for wine monitoring</td>
<td>2012-2014</td>
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<td>ARC, Linkage Project</td>
<td>LP110200142</td>
<td>Hartnett, JG, Park, SE, Lee, SB, Santarelli, G</td>
<td>Realisation of an ultra stable local oscillator using an ultra low vibration pulse tube cryocooler</td>
<td>2011-2014</td>
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<td>ARC, Linkage Project</td>
<td>LP110200736</td>
<td>Monro, TM, Thompson, JG, Abell, AD</td>
<td>Nanosampling sensors for real time embryo monitoring</td>
<td>2011-2014</td>
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<td>ARC, Linkage Infrastructure, Equipment and Facilities</td>
<td>LE140100131</td>
<td>Monro, TM</td>
<td>Clark, AS, Gibson, BC, Monro, TM, Mitchell, A, Reilly, DJ, Greentree, AD, Peruzzo, A, Xiong, C, Husko, C</td>
<td>National facility for cryogenic photonics</td>
<td>2014</td>
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<td>ARC, Linkage Infrastructure, Equipment and Facilities</td>
<td>LE140100122</td>
<td>Sumby, CJ, Losic, D</td>
<td>Gerson, AR, Sumby, CJ, Smart, RS, Evans, DR, Losic, D, Murphy, PJ, Marschner, P, Qiao, S</td>
<td>Microdiffraction: advanced capabilities for spatial resolution, trace phase detection and solid object analysis</td>
<td>2014</td>
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<td>NHMRC, Project Grant</td>
<td>APP1066781</td>
<td>McColl, S</td>
<td>McColl, S, Comerford, I</td>
<td>Chemokine receptors and the control of Th17-mediated inflammation</td>
<td>2014-2016</td>
<td>$769,192</td>
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<td>APP1061819</td>
<td>Thompson, J</td>
<td>Robker, R, Carroll, J, Thompson, J, Lane, M</td>
<td>The obesity prone oocyte- causes, consequences, treatments</td>
<td>2014-2016</td>
<td>$499,169</td>
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<td>NHMRC, Project Grant</td>
<td>APP1030247</td>
<td>McColl, S</td>
<td>McColl, S, Comerford, I, Brown, M</td>
<td>Regulation of the anti-tumour immune response by the chemokine decoy receptor CCX-CKR</td>
<td>2012-2014</td>
<td>$543,675</td>
<td>$181,225</td>
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<td>Deep Exploration Technologies (DET) Cooperative Research Centre (CRC)</td>
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<td>Monro, TM, Ebendorff-Heidepriem, H</td>
<td>Monro, TM, Ebendorff-Heidepriem, H</td>
<td>Lab-At-Rig future, Module 5b: Optical fibre technology</td>
<td>2014-2015</td>
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<td>Cooperative Research Centre (CRC) for Plant Biosecurity</td>
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<td>Nguyen, L</td>
<td>Hill, K, Nguyen, L</td>
<td>Program 2 Effective Detection &amp; Response - Developing tools for in-field surveillance of pathogens</td>
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<td>$255,000</td>
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<td>Collaborative Research Infrastructure Scheme (CRIS)</td>
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<td>Optofab Adelaide Node</td>
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<td>Federal Government</td>
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<td>Ebendorff-Heidepriem, H</td>
<td>Ebendorff-Heidepriem, H</td>
<td>Optofab NCRIS</td>
<td>2014</td>
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<td>BioPlatforms Australia</td>
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<td>Hoffmann, P</td>
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<td>2014-2015</td>
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<td>SA State Government, DFEEST, South Australian Collaboration Pathways Program</td>
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<td>Monro, TM</td>
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<td>Support for the ARC Centre of Excellence for Nanoscale BioPhotonics</td>
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<td>SA State Government, PRIF, International Research Grant</td>
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<td>Luiten, A</td>
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<td>2014-2016</td>
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<td>Ebendorff-Heidepriem, H</td>
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<td>Pushing the limits of silica-based optical fibres</td>
<td>2013-2015</td>
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<td>SA State Government, PSRF</td>
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<td>Monro, TM, Thompson, JT</td>
<td>Monro, TM, Norman, R, Thompson, J, Robertson, S, Fraser, M, Giliam, K, Semmler, J, Maddocks, S</td>
<td>Sensing Technologies for Advanced Reproductive Research (STARR)</td>
<td>2011-2014</td>
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<td>SA State Government, DSD</td>
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<td>Photonics Catalyst Program</td>
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<td>National Breast Cancer Foundation, Novel Concept Grant</td>
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<td>Monro, TM</td>
<td>Monro, TM, Callen, D, Grantley, G</td>
<td>Developing new approaches to define breast tumour margins at the time of surgery</td>
<td>2013-2014</td>
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<td>Ovarian Cancer Research Foundation (OCRF)</td>
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<td>Hoffmann, P</td>
<td>Oehler, M, Hoffmann, P</td>
<td>Autoantibody biomarkers for ovarian cancer detection</td>
<td>2014-2015</td>
<td>$265,000</td>
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<td>Ovarian Cancer Research Foundation (OCRF)</td>
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<td>Hoffmann, P</td>
<td>Oehler, M, Hoffmann, P</td>
<td>Ovarian blood proteomic signatures of ovarian cancer</td>
<td>2014-2015</td>
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<td>Asian Office of Aerospace Research and Development (AOARD)</td>
<td>Lancaster, D, Monro, T, Ebendorff-Heidepriem, H, Ottaway, D</td>
<td>Lancaster, D, Monro, T, Ebendorff-Heidepriem, H, Ottaway, D</td>
<td>Leaky channel mode germinate glass fibre lasers for high power operation in the short to mid-infrared</td>
<td>2014</td>
<td>$110,000</td>
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<td>Deutscher Akademischer Austausch Dienst (DAAD), Group of eight Australia – Germany Joint Research Cooperation Scheme</td>
<td>Luiten, A</td>
<td>Luiten, A</td>
<td>Ultra-stable optical frequency references for Earth and Space applications</td>
<td>2014-2015</td>
<td>$20,000</td>
<td>$10,000</td>
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2014 Publications

Journal Articles


9. Aasi, J, ..., Hosken, DJ, ..., King, EJ, ..., Munch, J, ..., Ottaway, DJ, ..., Veitch, PJ, ..., Stappers, BW (2014), Gravitational waves from known pulsars: Results from the initial detector era, Astrophysical Journal 785 (2), 119.

10. Aasi, J, ..., Hosken, DJ, ..., King, EJ, ..., Munch, J, ..., Ottaway, DJ, ..., Veitch, PJ, ..., Von Kienlin, A (2014), Search for gravitational waves associated with γ-ray bursts detected by the interplanetary network, Physical Review Letters 113 (1), 011102.

11. Aasi, J, ..., Hosken, DJ, ..., King, EJ, ..., Munch, J, ..., Ottaway, DJ, ..., Veitch, PJ, ..., Zlochower, Y (2014), The NINJA-2 project: Detecting and characterizing gravitational waveforms modelled using numerical binary black hole simulations, Classical and Quantum Gravity 31 (11), 115004.

12. Aasi, J, ..., Hosken, DJ, ..., King, EJ, ..., Munch, J, ..., Ottaway, DJ, ..., Veitch, PJ, ..., Zweizig, J (2014), Application of a Hough search for continuous gravitational waves on data from the fifth LIGO science run, Classical and Quantum Gravity 31 (8), 085014.


50. Ceko, MJ, Atkin, JB, Harris, HH (2014), Speciation of copper in a range of food types by X-ray absorption spectroscopy, Food Chemistry 164, 50-54.


57. Demuro, M, Arnold, LJ, Pare´s, JM, Sala, R (2014), Extended-range luminescence chronologies suggest potentially complex bone accumulation histories at the Early-to-Middle Pleistocene palaeontological site of Hue´scar-1 (Guadix-Baza basin, Spain), Quaternary International doi:10.1016/j.quaint.2014.08.035.


62. Elias, AK, Scanlon, D, Musgrave, IF, Carver, JA (2014), SEVI, the semen enhancer of HIV infection along with fragments from its central region, form amyloid fibrils that are toxic to neuronal cells, Biochimica et Biophysica Acta - Proteins and Proteomics 1844 (9), 1591-1598.


64. Evans, JD, Sumby, CJ, Doonan, CJ (2014), Post-synthetic metalation of metal-organic frameworks, Chemical Society Reviews 43 (16), 5933-5951.


84. Hughes, P, Spooner, N, Questiaux, D (2014), The central lowlands of the Hunter Valley, NSW Why so few early sites have been found in this archaeologically-rich landscape, Australian Archaeology 79, 34-44.


125. Rankine, D, Keene, TD, Doonan, CJ, Surnby, CJ (2014), Reprogramming kinetic phase control and tailoring pore environments in Colland Znl metal-organic frameworks, Crystal Growth and Design 14 (11), 5710-5718.


IPAS Committees

IPAS Board

Joe Flynn  Mike Brooks  Cathy Foley  Andrew Holmes  Warren Harch  Neil Bryans  Peter Gray  Andrew Dunbar  Amanda Hayworth

IPAS Scientific Management Committee

Tanya Monro  Andre Luiten  Heike Ebendorff-Heidepriem  Peter Hoffmann  David Lancaster  Andrew Abell  Nigel Spooner  James Anstie

Mark Hutchinson  Georgios Tsiminis  Shahraam Afshar V  Tak Kee  Chris Sumby  Gavin Rowell  David Ottaway
IPAS Professional Team

Piers Lincoln
Institute Manager

Dale Godfrey
Grants Developer

Luis Lima-Marques
Laboratory Manager

Sara Leggatt
Executive Assistant / Senior Office Administrator

Olivia Towers
(part-time)
Administration & Marketing Officer

Silvana Santucci
(part-time)
Administration Officer

Jason Dancer
(part-time)
Financial Accountant

Valerie Morris
(part-time)
Commercial Development Manager

IPAS Science Network

Jonathan Hall
Chair

Matthew Briggs
Vice-Chair

Myles Clark
Treasurer

Kelly Keeling
Secretary

Georgina Sylvia
Media

Elizaveta Klantsataya
Committee Member

Chao Zhang
Committee Member

Parul Mittal
Committee Member

IPAS Overview

IPAS Research

Working with Industry / Commercialisation

2014 Activities

IPAS Governance and Infrastructure
The Braggs – IPAS Headquarters

Facilities

The Braggs is a transdisciplinary space that enables the co-location of IPAS researchers and students from a broad range of scientific disciplines. It incorporates a 420-seat lecture theatre, custom designed meeting and communications areas, teaching and research laboratories.

The unique suite of transdisciplinary laboratories contains facilities for:

- Precision measurement of time, temperature and frequency
- Photonic sensor development
- Advanced manufacturing including 3D ceramic and metal printing
- Glass and optical fibre development and processing
- Laser development
- 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 a critical enabler for our new ARC Centre of Excellence for Nanoscale BioPhotonics).

The Precision Measurement Laboratories are equipped with state-of-the-art diagnostic equipment in the optical, microwave and radio-frequency domains. The laboratories have an ultra-high performance “frequency comb” that allows measurement and generation of optical signals with an exactly known frequency. The combination of this frequency comb and other high precision clocks allow ultra-sensitive measurements, ranging from the presence of certain trace chemicals through to high-precision physical measurements of magnetic fields, refractive index or temperature.

All of The Braggs Labs, from the Luminescent Laboratories in the basement, to the Atmospheric Sensing Laboratories on the roof with direct access to the atmosphere, are fully equipped to ensure that the researchers are able to undertake outstanding science.
Optofab – Facilities in Adelaide

The Australian National Fabrication Facility

Established under the National Collaborative Research Infrastructure Strategy, the Australian National Fabrication Facility (ANFF) links eight university-based nodes to provide researchers and industry with access to state-of-the-art fabrication facilities. The capability provided by ANFF enables users to process materials (glasses, metals, composites and ceramics, polymers and polymer-biological moieties) and transform these into structures that have applications in sensors, medical devices, nanophotonics and nanoelectronics.

The ANFF difference

Opening the doors to world-class infrastructure is only the first step. Without dedicated staff to support access, breakthrough research remains just an idea. Each ANFF node has experts on hand who are experienced in meeting user requirements and maintaining leading-edge instrumentation to assist researchers. Over 60 technical staff positions are funded through the program. Researchers can either work at the node under expert guidance, or to contract for the fabrication of specialised products at a reasonable cost.

Optofab node of ANFF

Optofab, led by Prof Michael Withford of Macquarie University, consists of four facility centres at Macquarie University, Bandwidth Foundry International, University of Sydney and the University of Adelaide. The headquarters located at Macquarie University.

Ultrasonic Mill

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

Funded under the Australian National Fabrication Facility (ANFF), IPAS has installed a DMG Ultrasonic 20 linear that 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 Ceramic Printer

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 projects and industry requirements. 3D printing complements traditional development and manufacturing methods and reduce the time and cost of designing metal or ceramic parts by printing them directly from digital input. In September of this year, IPAS commissioned a Phenix PXM selective laser melting printer, which is now available to both Researchers and Industry for their 3D printing requirements.

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)
- DMG Ultrasonic 20 linear, 5-axis milling machine with ultrasonic milling capability for machining of glass, ceramics and metals
- 3D printing – metals and ceramics

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 on an hourly rate or 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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Research Facilities

A number of world-class research facilities underpin the vital research conducted by IPAS members, including:

- Precision Measurement Laboratories
- Soft Glass and Fibre Fabrication
- Silica Glass and Fibre Fabrication
- Characterisation Facilities
- Surface Science and Surface Chemistry
- ANFF Optofab Facilities in Adelaide including 3D Ceramic and Metal Printing
- The Adelaide Proteomics Centre
- The STARR Lab (Reproductive Biophotonics)
- Atmospheric Physics – Buckland Park
- Advanced LIGO and the Gingin Facility
- Bragg X-ray Crystallography Facility
- Environmental Luminescence

These facilities service the needs of IPAS researchers and offer contract services to researchers and companies across the world. The optical fibre fabrication facilities at IPAS form part of the Australian National Fabrication Facility (ANFF), which links eight facility nodes to provide researchers and industry with access to state-of-the-art fabrication facilities.

The STARR Lab (Reproductive Biophotonics)

Preventable reproductive disease costs Australia more than $3B per year and affects more than 25% of women between 15 and 45 years of age. Additionally, reproductive efficiency and pregnancy loss is a major economic issue in livestock breeding, and directly impacts on other industries such as agriculture. At present it is not possible to monitor developing embryos or assess the uterine environment non-destructively, which is essential to improving productivity, cost efficiency and assisted reproductive technology techniques.

The STARR Lab was established to underpin the development of photonics-based reproductive health technologies, enabling SA's reproductive health researchers and clinicians to lead their field in the adoption of emerging optical fibre-based technologies. These emerging sensing platforms will provide a richer understanding of the science of early embryo development, as well as improved diagnostics of endometriosis, reproductive cancers and infertility.

Our partners

The STARR facility is a $1.4M initiative supported by the South Australian Premier’s Science and Research Fund (PSRF) and is a partnership between The University of Adelaide, Robinson Institute, IPAS, Cook Australia Pty Ltd, Flinders Reproductive Medicine Pty Ltd, Fertility SA Pty Ltd and Reproductive Health Science Pty Ltd.

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Prof Tanya Monro is an ARC Georgina Sweet Laureate Fellow and Bid Leader of the ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP). Tanya is a Fellow of the Australian Academy of Science (AAS), the Australian Academy of Technological Sciences and Engineering (ATSE) and the Australian Institute of Physics. She is a member of the Prime Minister’s Commonwealth Science Council (CSC), the AAS National Committee for Physics, South Australian Economic Development Board, where she chairs the Science, Innovation and Commercialisation subcommittee and a member of South Australia’s Riverbank Authority. She is a member of the SA Premier’s Science & Industry Council, and is Chair of the Council of the National Youth Science Forum (NYSF). Tanya is also an inaugural Bragg Fellow of the Royal Institution of Australia (RIAus).

Tanya obtained her PhD in Physics in 1998 from the University of Sydney, for which she was awarded the Bragg Gold Medal. She came to the University of Adelaide in 2005 as inaugural Chair of Photonics. She has published over 500 papers in refereed journals and conference proceedings and raised approximately $140M for research.

Prof Andre Luiten 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.

He 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. He has published over 90 papers in refereed journals and books and raised approximately $13M for research.

A/Prof Heike Ebendorff-Heidepriem is the Associate Director of the Optofab node of the Australian National Fabrication Facility (ANFF). 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.

Heike was awarded the Woldemar A. Weyl International Glass Science Award in 2001 and the International Zwick Science Award in 2009. She has published over 200 refereed journal papers and conference proceedings, including 16 review papers and 9 postdeadline papers, and raised approximately $12M for research.

Prof Peter Hoffmann is the National NCRIS facility for Tissue Imaging Mass Spectrometry. Peter is the Vice President of the Australasian Proteomics Society, Conference Chair for the National Meeting of the Australasian Proteomics Society, and the South Australian Representative of the Australian Peptide Society.

Peter obtained his PhD in Analytical Chemistry from Saarland University, Germany in 1999. He came to the University of Adelaide in 2005 to establish the Adelaide Proteomics Centre. He has published over 70 papers in refereed journals and raised approximately $8.5M for research.

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