2011 Annual Report
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Our Vision is to become a global hub of disruptive Photonics and Advanced Sensing research, creating transformational new approaches to sensing, and a new profession of transdisciplinary problem solvers.
Executive Summary
IPAS Director’s Snapshot

The Institute for Photonics & Advanced Sensing (IPAS) is one of five research institutes at The University of Adelaide. IPAS fosters excellence in research in materials science, chemistry, biology and physics, and across these boundaries, and develops disruptive new tools for measurement.

IPAS creates the opportunity to invent and harness new tools for measurement to address many of the current exciting big questions in science. Many of the challenges we face as a society can only be solved by pursuing a transdisciplinary approach that brings together experimental physicists, chemists, material scientists, biologists, experimentally-driven theoretical scientists and medical researchers to create new sensing and measurement technologies. This is the vision of IPAS. We work to create new tools that will change the questions scientists can ask, stimulate the creation of new industries, and create a new profession of transdisciplinary problem solvers.

Our research is focused around six Research Themes, which interconnect and allow us to tackle the major challenges facing Australia and the world and which offer particular opportunities for the development of new and disruptive technologies:

- Optical Materials & Structures
- Lasers & Nonlinear Optics
- Surface & Synthetic Chemistry
- Chemical & Radiation Sensing
- Medical Diagnostics & Biological Sensing
- Remote Sensing

An overview of these themes can be seen in a short video which can be found at http://www.adelaide.edu.au/ipas/.

Fast Facts for 2011

- 12 invited talks
- A maximum ERA ranking of 5 in ‘02 Physics’ and ‘0205 Optical Physics’ was given to IPAS’s core research strengths.
- 154 research members, including students.
- $9.9 million in external research income.
- 60% growth on 2010 income.
- Peter Hoffmann appointed as IPAS Deputy Director.
- $1M start-up funding secured from South Australian State Government to attract a new Chair of Experimental Physics.
- New silica fibre fabrication facility operational.
- New biophotonics facility for reproductive health sensing created.
- New $97M headquarters building construction underway.

Professor Tanya Monro, IPAS Institute Director
Executive Summary

IPAS Structures and Governance

Working with Industry / Commercialisation

Director’s Message

IPAS is two years old and it is very exciting for me to be able to share some of our recent research achievements.

In 2011 we were able to capitalise on the research infrastructure, collaborations and expertise that we have been building and this has allowed us to achieve several significant research breakthroughs:

• a new waveguide laser architecture in collaboration with Macquarie University;
• photoinduced electron transfer chemical ion sensing within an optical fibre;
• the discovery that electron transfer in helical structures occurs by a hopping mechanism;
• demonstration of optical fibre aluminium ion sensing utilising novel surface chemistry;
• the development of two biosensor systems with novel approaches to surface plasmon resonance and whispering gallery modes;
• an optical fibre radiation dosimeter capable of instant readout of ionising radiation;
• the discovery of new biomarkers for the early detection of gastric cancer;
• the discovery of high energy gamma-rays from a new type of source, a stellar cluster harbouring an extremely massive star as well as a super-magnetised neutron star (known as a magnetar).
Each of our six research themes have achieved significant growth in research outputs through the hard work of our members coupled with support from our core team and the support schemes that the Institute offers.

It has been particularly pleasing to see the impact our pilot project scheme is making and how this has allowed new threads of research to develop and win follow-on funding, new patents to be filed and new global collaborations to develop.

We continue to work on a spectrum of projects that range from fundamental to applied research projects which gives us a feedstock of new approaches to bring to practical problems and opportunities to drive world-class research as well as engage closely with industry. We secured three industrial linkage grants in laser development, medical diagnostics and wine analysis. The list below shows a cross section of some of the applications we are working on with industrial and government partners:

- **Defence & national security** – corrosion detection, high power lasers and luminescence techniques.

- **Environmental & agricultural monitoring** – laser radar systems for monitoring wind, moisture and pollution in the atmosphere, sensors for monitoring soil and water quality.

- **Medical diagnostics** – rapid virus detection to help prevent global flu pandemics, early detection of cancer biomarkers and technologies to improve IVF success rates.

- **Food & wine** – monitoring of wine maturation, soil nutrient monitoring.

Construction of the illumin8 project, our new headquarters, has started and is scheduled for completion at the end of February 2013. I would like to acknowledge the Australian Federal Government, South Australian State Government, DSTO, Defence SA and The University of Adelaide who have invested over $40M in this project. Illumin8 will house a unique suite of transdisciplinary laboratories including glass development and processing, optical fibre fabrication, laser and device development, luminescence dating, environmental genomics, photonic sensor development, and synthetic, surface and bio-chemistry laboratories.

Ahead of this facility we have been busy with the commissioning and operation of our new Silica Fibre Facility; this is allowing us to develop novel fibre laser technology and new fibre sensing architectures. We are already working with groups from across the globe who are keen to collaborate in this exciting area of research. We have also commissioned our STARR (Sensing Technologies for Advanced Reproductive Research) laboratories in the University’s Medical School building for the development of new reproductive health tools with our academic and commercial partners.

As well as driving the science agenda we have also been actively involved in public engagement in science with a Glass Science meets Art exhibition in May in collaboration with the JamFactory. Several of our research team are members of the Scientists in Schools program and are helping to promote science to the next generation.

I would like to acknowledge the incredible efforts of the IPAS members and thank the senior management team at the University, the IPAS Board, Professional staff team and IPAS committees for all their work in the past year.

Professor Tanya Monro
IPAS Institute Director
Chairman’s Report

2011 was the second year of operations for IPAS and the Institute continues to build on its record of research excellence. The award of maximum ERA ranking of 5 in ‘02 Physics’ and ‘0205 Optical Physics’ reflects the evidence of outstanding performance well above world standard. The 142 papers published in peer-reviewed journals during 2011 are further evidence of a sustained, high-quality research output by all the IPAS members.

I am always delighted when members of the Institute receive awards and recognition and 2011 has been a bumper year for this. I would firstly like to congratulate Professor Tanya Monro for being awarded Scopus Young Researcher of the Year 2011, Australian of the Year 2011 for South Australia and being a finalist in the Eureka Prizes. Congratulations must also go to Dr Tara Pukala for winning a South Australian Tall Poppy Award and to Dr Stephen Warren-Smith, winner of the 2011 South Australia Science Excellence Awards (PhD research excellence) as well as several University medals.

In February we celebrated on the Barr Smith Lawns the next stage in development of the new IPAS headquarters building. The Vice Chancellor Prof James McWha held an illumination ceremony with Senator Hon Kim Carr, the Minister for Innovation, Industry, Science & Research. By the end of the year this project had reached the 1st floor level. I look forward to IPAS members being able to move in, as this will surely catalyse even greater achievements.

DSTO continues to provide significant support for a range of defence-related projects and I would like to thank them for their ongoing support. The South Australian State Government has also been instrumental in our success through their continued support, and I acknowledge and thank them.

The IPAS Board met three times in 2011 and there were numerous one-on-one meetings with Board members and IPAS Director Professor Tanya Monro.

I am delighted to see IPAS continuing to grow from strength to strength, as is attested by the significant growth in research income, membership, facilities and collaborations. IPAS is maturing well and has created a strong global brand and awareness of its ground-breaking research.

I would like to acknowledge and thank my fellow members of the IPAS Board, the IPAS Director Professor Tanya Monro, the IPAS Professional staff team, and the researchers and staff for their invaluable contributions.

Mr Joe Flynn
IPAS Chairman
2011 Highlights

ERA: award of maximum ERA ranking of 5 in ‘02 Physics’ and ‘0205 Optical Physics’.

Grants: $9.9M grant income in 2011 a growth on 60% from 2010.

Publications: 142 peer reviewed journal papers, 41 Conference proceedings and 12 invited talks.


IPAS Silica Fibre Fabrication Facility: fabrication of silica fibres began in April. Six research contracts secured to supply novel fibres to global customers and collaborators.


IPAS Members: 150 research members.

Research Team Growth: 5 new research staff appointed in 2011.

IPAS Deputy Director: A. Prof Peter Hoffmann appointed as IPAS Deputy Director.

Workshops/Conferences:

- IPAS sponsored the Astronomy Society of Australia Annual Scientific Meeting (ASM) 1–3 July, 2011.
- IPAS hosted a Trilateral nanophotonics workshop at McLaren Vale from 24–26 August. With sponsorship from the French Embassy in Australia, the South Australian State Government, The Department of Innovation, Industry, Science and Research (DIIISR), the Italian Consulate and the Australian Nanotechnology Network.
- Patents: Three new patent applications have been filed. One US patent has been granted on nanowires.
- ARC Super Science Fellowships: Six fellows have been appointed and projects are underway.
- Scholarships: IPAS funded seven summer scholarships for 1st to 3rd year students.
- Outreach: IPAS had a number of visits for high school students and hosted three work experience students.
- 2010 IPAS Equipment Scheme: Funding totalling $700k was allocated by the IPAS Science Management Committee.
- STARR Lab: Operations have started. Three projects are currently underway in reproductive health sensing.
illumin8 – The New Headquarters for IPAS

The Australian Federal Government, South Australian State Government, DSTO, Defence SA and The University of Adelaide have invested over $40M to construct a new headquarters for IPAS, which will house a unique suite of transdisciplinary laboratories.

These facilities include glass development and processing, optical fibre fabrication, laser and device development, luminescence dating, environmental genomics, photonic sensor development, and synthetic, surface and bio-chemistry and offices to co-locate IPAS researchers and students from a broad range of scientific disciplines. This will all be located in the University’s new building, which is due for completion in February 2013. illumin8 will also incorporate a 420-seat lecture theatre and other teaching and research facilities.

The following construction activities happened during 2011

- January – Site works were started.
- March – Work began on the 12m deep basement walls.
- May – A 39 million-year-old sample was excavated during the drilling of one of the 24m deep foundation piles.
- July – Diaphragm wall and foundation piling were completed.
- August – Pouring of the concrete basement slab was started and the tower crane was erected.
- November – Ground floor slab completed.
- December – 1st floor slab completed.

On schedule for completion in February 2013
IPAS Research & Facilities
Research Overview

Research Environment

Since IPAS was formed in 2009 support of over $10M has been provided by The University of Adelaide, the SA State Government and DSTO. The Federal Government through the Education Investment Fund has provided funding of $29M towards the construction of the illum8 building, which will serve as the IPAS HQ building.

In 2011, IPAS successfully secured more than $11M in new grant funding, including 5 Discovery Projects, 3 Linkage Infrastructure, Equipment and Facilities (LIEF) grants and 3 industrial Linkage Project grants. 2011 outputs include 142 peer reviewed journal papers and 41 refereed conference papers, with 12 invited talks and a plenary session.

The optical fibre fabrication facilities at IPAS form part of the Australian National Fabrication Facility (ANFF).

IPAS has a strong culture of knowledge-sharing both internally and externally. Weekly seminars are held with the Optics and Photonics research group, and IPAS-wide seminars are held monthly.

The outputs of our members’ research are published in high-impact peer reviewed journals, and presented at national and international conferences. Breakthroughs are disseminated via social media (e.g. Twitter, Facebook, Blogs, Newsletters), after careful assessment of IP considerations.

IPAS provides support to its centres and members in order to maximise their research outcomes and their contributions to the Objectives by:

- Providing access to leverage and seed funding schemes (for equipment, feasibility studies, etc).
- Provision of administrative support – Group & IPAS supported travel organisation, Meeting co-ordination, Recruitment support, Video/tele-conferencing systems, customer relationship management systems, inventory management etc.
- Publicising the achievements of the Institute members, to internal and external audiences via the web, newsletters, media and PR activity.
- Providing research grant support – awareness of programmes, grant development, and finance planning.
- Helping the Centres and members get the best support from the central University systems – IT, Finance, Marketing, HR.
- Providing accurate research statistics to members and ensuring that their research metrics are accurate and optimised.
- Providing commercial support for commercial interactions, contract research, collaborative research, patenting and spin-out activities.
- Providing a new building as the focus for the Institute activities with meeting rooms and other facilities.
- Organisation of workshops and conferences.
ARC Super Science Fellowships

Optical fibre-based sensors have the potential to transform our ability to monitor our environment, protect our nation’s assets and safeguard our citizens, and to offer improved clinical diagnostics and food quality control by creating tools that can detect molecules in real-time within complex samples.

In April 2010, IPAS was awarded six Super Science fellowships from the Federal Government. The aim of this scheme was to attract and retain outstanding early career researchers in key areas of science critical to Australia’s future. These prestigious fellowships have substantial funding support from IPAS and the University, which allows the fellows to purchase key equipment, consumables and to travel for conferences and collaborations.

IPAS ARC Super Science fellows: Dr Kris Roland, Dr Florian Englich, Dr Georgios Tsiminis, Dr Sabrina Heng, Dr Stephen Warren-Smith, Dr Linh Nguyen.
Super Science Projects

Super Science 1: Whispering Gallery Mode-based Capillary Electrophoresis.

Whispering Gallery Mode-based Capillary Electrophoresis is focused on developing a new architecture for enhancing the interactions between light and matter by creating devices for optical-fibre-based cavity ringdown spectroscopy. If successful, this will underpin the development of tools for rapid biological fingerprinting.

Dr Kris Roland.


Label Free Optical Fibre Gas Sensing is focused on developing new label-free optical fibre sensing platforms by exploring the interaction of guided light with paramagnetic analytes under the influence of magnetic fields. The use of specifically tailored fibre geometries and materials for such sensor architectures underpin the development of miniature, selective, optical gas sensors with extremely small sample volumes for chemical, biological, defence and environmental monitoring applications.

Dr Florian Englich.

Super Science 3: Nanomachines: Light Driven On/Off Sensors

Nanomachines: Light Driven On/Off Sensors will develop light-driven nanomachines that can be located on the glass surface within micro and nano-structured optical fibres. The central idea is to create a new type of nanomachine-based sensor that can be remotely controlled via light. For example, these sensors will allow reversible analyte binding and light-assisted expulsion of the analyte after sensing.

Dr Sabrina Heng.


Probing The Seed and The Soil: New Tools for IVF and Women’s Health will, in partnership with Reproductive Health Researchers, work on creating new ways of monitoring the viability of embryos prior to implantation and testing endometrial receptivity, without negative effects. The project will develop new optical fibre based sensing tools to improve the success rates of IVF and women’s health.

Dr Stephen Warren-Smith.

Super Science 5: Blood Typing at Crime Scenes

Blood Typing at Crime Scenes working with genomics researchers will focus on developing forensic field tools for rapid blood typing at crime scenes, developing new DNA detecting optical fibre based sensing tools. The aim is to develop new Forensic Science tools for blood analysis to accelerate crime scene investigations.

Dr Linh Nguyen.

Super Science 6: Detection of Trace Quantities of Explosives

Detection of Trace Quantities of Explosives will collaborate with Defence Scientists from DSTO to develop new tools for the rapid detection of trace quantities of explosives. There is a critical need for new technologies to detect Improvised Explosive Devices (IEDs) in combat zones. This project will build on IPAS expertise in this area to develop novel photonic systems to help solve this problem.

Dr Georgios Tsiminis.
IPAS Pilot Projects Scheme

IPAS launched its first pilot projects scheme in 2011 with the aim of driving the development of new research projects and directions. To win funding the projects had to demonstrate the potential to lead to external funding. The scheme encourages collaborative projects, within and across disciplinary boundaries and provides the IPAS Scientific Management Committee (SMC) with information on IPAS activities, capabilities, strengths, and opportunities to enable strategic decision-making.

Six projects were selected for funding by the IPAS Scientific Management Committee and funding of $50k was allocated across these projects:

- Waveguide laser development – David Lancaster
- Nanocrystals in optical fibre – Heike Ebendorff-Heidepriem
- Alzheimer’s diagnostics – John Carver & Andrew Abell
- Browning sensor for next generation toasters – Sean Manning, Andrew Richardson & Kristopher Rowland
- Whispering gallery mode sensing – Alex Francois
- Developing a new camera system for atmospheric infrared studies – Roger Clay

Incorporation of nanocrystals in glass
Studying for a PhD at IPAS – Case Studies

Witold Bloch

After the completion of my undergraduate degree in chemistry I became interested in the solid-state chemistry of porous coordination polymers (PCPs). My PhD project is focused around the synthesis and study of porous coordination polymers (PCPs) that exhibit dynamic behaviour. Dynamic PCPs can be utilised in applications which are not easily accessible by rigid frameworks. This includes selective guest adsorption or gated adsorption/desorption behavior, which is useful in applications such as gas storage and separation. We have synthesized a dynamic PCP composed of silver(I) and di-2-pyrazinylmethane that is extremely flexible and undergoes reversible solid-state contraction and expansion upon exposure to different guest molecules. We anticipate this material may be applicable to the separation of particular solvents or gases, having the capability to alter its size to accommodate particular guest molecules.

Karina Martin

After completing my undergraduate degree in biochemistry I decided to work towards a PhD with A/Prof Peter Hoffmann at the Adelaide Proteomics Centre researching ovarian cancer biomarkers. Ovarian cancer is the leading cause of death from gynaecological malignancies affecting approximately 1200 women in Australia annually. My PhD project aims to identify ovarian cancer biomarkers that are detectable at early stages of the disease in order to develop an effective early stage diagnostic test. Cancer induced autoantibodies have great potential as an early stage biomarker. I have been working to develop an immunoproteomic approach that has led to the identification of 137 autoantibodies that are differentially present in ovarian cancer patients compared to benign and healthy individuals. These autoantibodies will be verified using protein microarray and subsequently validated as diagnostic indicators for early ovarian cancer.

Sebastian Ng

When I completed my double degree in science and mechanical engineering I secured a Professional Officer role at IPAS working on the development of new silica and germinate fibre lasers. After nine months I decided that I wanted to pursue a PhD in this area. My project is to design, fabricate and test new large mode area silica fibre lasers for high peak power applications like remote sensing, material processing and defence applications. I’m learning how to model and design fibres, then I work with the technical staff to fabricate the preforms and draw these into fibres which I can then characterise in the laser laboratories.
RESEARCH THEME 1: Optical Materials & Structures

Theme Leaders:

A/Prof Heike Ebendorff-Heidepriem
Prof Tanya Monro

Key Contacts:

Soft Glasses & Fibres
A/Prof Heike Ebendorff-Heidepriem
E: heike.ebendorff@adelaide.edu.au

Silica Glasses & Fibres
A/Prof David Lancaster
E: david.lancaster@adelaide.edu.au

Optical Structure Modelling
Dr Shahraam Afshar V.
E: shahraam.afshar@adelaide.edu.au

ANFF Optofab Node Materials Facility
Mr Luis Lima-Marques
E: luis.lima-marques@adelaide.edu.au

Soft glass optical fibre draw
RESEARCH THEME 1: Optical Materials & Structures

Capabilities

- IPAS has complete vertical integration of expertise and facilities from modelling to device fabrication.

Modelling

- Prediction of optical properties of waveguides and fibres;
- New theoretical frameworks to explore waveguides and fibres with extreme properties and nanoscale features.

Fabrication of glasses and fibres:

- Controlled atmosphere glass melting;
- Soft and hard glass preform extrusion;
- Doped silica modified chemical vapour deposition (MCVD) preform lathe;
- Ultrasonic mill;
- Soft glass and silica fibre drawing towers.

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 (200nm-30μm).

Research

Our Optical Materials & Structures research ranges from fundamental science to application driven design and development:

- new glasses with novel optical properties;
- novel nanocomposite materials;
- advanced technologies for processing and shaping glass;
- design and fabrication of micro- and nanostructured soft glass optical fibres;
- specialty rare-earth doped and passive silica fibres, including single-mode germano-silica and double/triple clad fibres;
- development of novel silica and polymer fibres, including the capacity for rare-earth and nanoparticulate doping;
- 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 (both extrusion and MCVD 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 and sensing.
RESEARCH THEME 2: Lasers & Nonlinear Optics

Theme Leaders:

A/Prof David Lancaster  Dr David Ottaway

Key Contacts:

Fibre & Planar Waveguide Lasers
A/Prof David Lancaster  E: david.lancaster@adelaide.edu.au

Nonlinear Optics
Dr Shahraam Afshar V.  E: shahraam.afshar@adelaide.edu.au

Solid State Lasers
Dr David Ottaway  E: david.ottaway@adelaide.edu.au

Silica & Soft Glass Laser Development Facilities
Mr Luis Lima-Marques  E: luis.lima-marques@adelaide.edu.au

Upconversion in a fibre during characterisation tests
RESEARCH THEME 2: Lasers & Nonlinear Optics

Our world leading research in lasers and novel light sources includes:

- Planar waveguide and fibre lasers;
- Solid-state lasers;
- Fibre based super-continuum sources;
- Fibre-based nonlinear devices including optical switches and frequency converters.

Research within IPAS combines fundamental and applied physics to access new laser wavelengths through development of new laser architectures and nonlinear frequency conversion. Real world applications include: Atmospheric and coherent laser radars; gravitational wave detectors; spectroscopic sensors; surgery; and laser based electronic warfare systems.

Fibre & Planar Waveguide Lasers

Our Fibre & Planar Waveguide Lasers research is focused on developing and optimising new concepts in fibre and planar waveguide lasers. This research also drives the development of unique rare-earth doped glasses and fibres at IPAS. The lasers we are developing operate in the mid-infrared allowing new applications in molecular spectroscopy, sensing, surgery, and meeting custom defence needs in countermeasures and sensor validation.

Nonlinear Optics

Laser light in optical fibres can be so intense that it modifies its own frequency and polarisation. We are conducting fundamental research to gain new insight into nonlinear optical processes that occur within a variety of optical fibre materials and geometries.

We also have expertise in modelling nonlinear processes in nano-scale waveguides; these could provide new solutions for high speed optical switches, laser sources and sensing architectures.

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. We have over 60 years experience and know-how and the team have worked on international projects such as LIGO, developed Laser Radars (LIDAR) and have interests in differential absorption LIDAR applications. This has led to world-leading results in cryogenic and compact eye-safe laser systems.

Silica & Soft Glass Laser Development Facilities

The ANFF Optofab node and Soft Glass & Silica Fibre Fabrication facility provides the in-house glasses which underpin many of our novel laser technologies.
RESEARCH THEME 3: Surface Science & Synthetic Chemistry

Theme Leaders:

Key Contacts:

Biological & Chemical Surface Functionalisation
Prof Andrew Abell  E: andrew.abell@adelaide.edu.au

Novel Materials Synthesis
Dr Chris Sumby  E: christopher.sumby@adelaide.edu.au

Functional Organic Materials
Dr Christian Doonan  E: christian.doonan@adelaide.edu.au

Charge Transfer & Bioelectronics
Dr Jingxian Yu  E: jingxian.yu@adelaide.edu.au

IPAS LARGE SCALE FACILITIES

Bragg Crystallography Facility
Dr Chris Sumby  E: christopher.sumby@adelaide.edu.au

Peptide Synthesis & Purification Facility
Prof Andrew Abell  E: andrew.abell@adelaide.edu.au

Australian National Fabrication Facility (ANFF) Optofab
Mr Luis Lima-Marques  E: luis.lima-marques@adelaide.edu.au
RESEARCH THEME 3: Surface Science & Synthetic Chemistry

Research in this theme spans:

• chemical surface coatings;
• surface functionalisation strategies;
• molecular-based sensors;
• bioelectronics
• new materials for gas storage or separation for renewable energy applications, and;
• platforms for catalysis.

Our researchers in this space include ARC Future and Super Science Fellows with expertise from fundamental chemistry to analyte-specific sensor development, highlighting this as an identified strength of IPAS. Key infrastructure is available in the School of Chemistry & Physics, and includes synthetic laboratories (wet and dry), NMR and X-ray structure determination, peptide synthesis and purification, and materials characterisation capabilities.

Biological & Chemical Surface Functionalisation

The Biological & 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.

Novel Materials Synthesis

Our Novel Materials Synthesis group design and synthesise nanostructured materials. Some of these compounds display novel interactions and behaviour which we may then exploit to develop sensors. Such new materials will also be exploited for separation science and as catalysts.

Charge Transfer & Bioelectronics

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

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, more efficient catalyst platforms, sensing, storage and separation solutions.

Centre for Functional Nanomaterials (CFN)

The University has established a stand-alone centre to foster, connect and harness research activities centred on the synthesis, processing and study of nanomaterials. Key research themes in the CFN will include Chemical and Electrical Energy Storage; Energy Waste Management; Heterogeneous Catalysis; and Nanoporous materials for Gas Separations. The Centre is led by Dr Christian Doonan.
RESEARCH THEME 4: Chemical and Radiation Sensing

Theme Leaders:

Prof Nigel Spooner  
Prof Tanya Monro

Key Contacts:

Chemical Sensing  
Prof Tanya Monro  
E: tanya.monro@adelaide.edu.au

Radiation Sensing  
Prof Nigel Spooner  
E: nigel.spooner@adelaide.edu.au

Optical Dating & Environmental Dosimetry  
Prof Nigel Spooner  
E: nigel.spooner@adelaide.edu.au

Environmental Luminescence Facility  
Prof Nigel Spooner  
E: nigel.spooner@adelaide.edu.au

Chemical sensing in liquids using a microstructured optical fibre
RESEARCH THEME 4: Chemical and Radiation Sensing

Using in-house and specialty optical fibre and unique surface coatings, we develop novel optical fibre based chemical sensing architectures. We explore the limits of detection; ultra-small volume samples, low concentrations or difficult to access areas.

We are working with end-users and industry to develop these sensors for monitoring water quality, corrosion, wine maturation, embryos, soil nutrients, fuel degradation and explosives. We are also researching new fibre forms of radiation dosimeters for medicine, industry and Defence.

The IPAS Environmental Luminescence facility hosts the most comprehensive suite of luminescence research equipment in the world. Using this capability we develop new forensic luminescence techniques for detection of prior exposure to ionising radiation, and provide a wide range of luminescence dating services to industry and academia.

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

Working in partnership with our Optical Materials & Surface Functionalisation theme researchers, we are developed new functional structures surfaces to enable advanced sensor functionality. Together we solve problems in partnership with irrigation companies, Defence organisations, embryologists and oenologists.

Radiation Sensing
The Radiation Sensing work focuses on the development of new tools for radiation dosimetry for both fundamental research and applications in health, Defence and industry. Examples include the development of fibre based distributed dosimeters and fibre-tip sensors for use in-vivo in cancer treatment. This Theme is being supported by 3 of our 6 ARC Super Science Fellowships spanning:
• Photoswitchable sensor surfaces
• Explosives detection
• Small-volume gas sensing

Environmental Luminescence
The radiation sensing and Luminescence Analysis takes place in our Environmental Luminescence facility. The suite includes the world’s most sensitive TL spectrometer, a photon-counting imaging system (PCIS) developed in collaboration with ANU, state-of-the-art TL/OSL Risø readers, and specialised apparatus for the measurement of luminescence kinetics and signal stability.

Luminescence techniques are highly versatile, being able to accurately measure ages of up to 500,000 years before present, down to doses as low as a fraction of one day’s background radiation. Our research is advancing these techniques and further extends the applicability of luminescence analysis. We collaborate widely with industry, Defence and academia, including contract Optical Dating services.

Optical Dating & Environmental Dosimetry
Our Optical Dating & Environmental Dosimetry researchers specialise in the physics of luminescence, particularly of minerals and artificial materials, leading to the advancement of luminescence techniques for forensic dosimetry, dose reconstruction following radiological incidents, and the application of TL and Optical Dating to a diverse range of questions in archaeology, geomorphology and palaeohydrology. This includes the dating of ancient ceramics, megafaunal extinctions, and human migrations across Australia (publications in Science and Nature).
RESEARCH THEME 5: Medical Diagnostics & Biological Sensing

Theme Leaders:

Prof Tanya Monro     Dr Peter Hoffmann

Key Contacts:

Biomarker Discovery
Dr Peter Hoffmann     E: peter.hoffmann@adelaide.edu.au

Methathesis and Click Chemistry
Prof Andrew Abell     E: andrew.abell@adelaide.edu.au

Protein Structure, Function and Interactions
Prof John Carver      E: john.carver@adelaide.edu.au

Biosensing Platform Development
Prof Tanya Monro      E: tanya.monro@adelaide.edu.au

Adelaide Proteomics Centre
Dr Peter Hoffmann     E: peter.hoffmann@adelaide.edu.au

STARR Laboratory
Prof Tanya Monro      E: tanya.monro@adelaide.edu.au

Development of whispering gallery mode biosensors
RESEARCH THEME 5: Medical Diagnostics & Biological Sensing

IPAS research in Medical Diagnostics & Biological Sensing seeks to:

• Create measurement tools to enable new questions to be asked in biology & medicine;
• Develop improved medical diagnostic techniques, including ‘point of decision’ technologies;
• Advance next generation proteomics technologies for cancer diagnostics & treatment;
• Discovery and detection of biomarkers using Tissue Imaging Mass Spectrometry;
• Investigate proteins and peptides underpinning the development and prevention of diseases;
• Drug design and development, including the identification and synthesis of novel small molecules to block or activate cellular targets.

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, 2D gel electrophoresis combined with difference gel electrophoresis fluorescence labelling for protein identification and quantification. This work is driven by the need for the early diagnosis of cancer and to monitor diseases progression as well as a better understanding of the disease at the molecular level.

Protein Structure, Function & Interactions

Our focus is chemical, spectroscopic and biophysical investigators of the structures, functions and interactions of peptides and proteins. Nuclear magnetic resonance spectroscopy, circular dichroism, fluorescence spectroscopy, electron microscopy, ultracentrifugation techniques and site directed mutagenesis are used to investigate structure-function relationships of specific amino acids within peptides and proteins.

Biosensing Platform Development

Harnessing breakthroughs from our other themes, we create new biosensing tools for advancing biological research, and by collaborating with medical researchers to enable translation to clinical applications. This area is been supported by 3 of our 6 ARC Super Science Fellowships spanning:

• DNA detection in small volumes
• In-vivo fertility probes
• Protein separation & detection
• New sensor architectures include:
  • Small-volume In-fibre fluorescence assays
  • Fibre-tip sensors for in-vivo diagnostics
  • Multi-channel sensor for virus, bacteria & biomarker detection for gastric cancer

Metathesis & Click Chemistry

We design, synthesise and test inhibitors to solve clinical challenges. Our investigations concentrate on proteolytic enzymes and small heat-shock chaperone proteins (sHsp) associated with amyloid fibril formation. 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, cataract & cancer.
RESEARCH THEME 6: Remote Sensing

Theme Leaders:

Dr David Ottaway
Dr Gavin Rowell

Key Contacts:

Light Detection and Ranging (LIDAR)
Prof Peter Veitch E: peter.veitch@adelaide.edu.au

Gravitational Wave Detection (LIGO)
Dr David Ottaway E: david.ottway@adelaide.edu.au

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

Buckland Park Field Station & Observatory
Prof Iain Reid E: iain.reid@adelaide.edu.au

Development of new lasers for remote sensing applications
RESEARCH THEME 6: Remote Sensing

Remote Sensing research at IPAS includes development of advanced optical systems for:

- Interferometric gravitational waves detection;
- Coherent laser radar systems for measuring wind fields for wind farms and pollutant monitoring from industrial and mining sites;
- ILIDAR systems for measuring traces gases and remote sensing of the atmosphere;
- High energy astrophysics with gamma- and cosmic-rays.

The team has a wealth of experience in developing technologies that underpin remote sensing. IPAS 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

Gravitational waves were predicted by Einstein. Researchers within IPAS are members of the LIGO team which is building a $300M instrument to detect these waves. We have developed a range of laser systems and optical sensors for advance gravitational wave detection.

Light Detection & Ranging (LIDAR)

We are developing coherent laser radar (CLR) systems for a range of eyesafe LIDAR applications including: monitoring dust and pollution emanating from mining and industrial sites, mapping wind speeds for wind farm site assessment and turbine protection, and turbulence detection for aerospace applications. We are also developing differential absorption LIDAR (DIAL) to remotely sense chemicals in the atmosphere including: water vapour sensing, SOx and CH4.

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. The IPAS Remote Sensing Theme is engaged in these research goals. Detecting gamma-rays and cosmic-rays requires advanced techniques to filter the atmospheric background and apply atmospheric transmission. Current projects include the design of gamma ray telescopes and ultra high energy cosmic ray detectors.

Buckland Park Station & Observatory

Buckland Park, a coastal site north of Adelaide, boasts an array of equipment dedicated to studying the atmosphere, including radars (MF and VHF), a radio acoustic sounding system and a 3-field photometer. A LIDAR for measuring temperature, density and wind velocity at altitudes between 10km and 105km was recently added. Combined with the radar and passive optical systems, this facility delivers a unique atmospheric measurement capability extending from the troposphere up to the lower thermosphere.
Research Facilities

Underpinning the research at IPAS are a number of world-class research facilities, these include:

- Soft glass & fibre fabrication.
- Silica glass & fibre fabrication.
- Surface Science & Surface Chemistry.
- 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 also 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 capabilities of each of these areas is explained in the following sections along with contact details of the leaders of these facilities.
Soft Glass and Fibre Fabrication

The optical fibre manufacturing facilities at the Institute for Photonics & Advanced Sensing (IPAS), at The University of Adelaide comprise state-of-the-art fabrication equipment, know-how and capability.

IPAS’ soft glass fabrication facilities support the manufacture of a range of glasses including fluoride, tellurite and germanate. These facilities include equipment for the controlled batching, melting, casting and annealing, which in turn enables production of novel glass compositions, including undoped and doped glasses.

The soft glass production facilities comprise both open-air and controlled-atmosphere glass melting capability. The open-air melting capability consists of a melting furnace with maximum temperature of 1200°C and two annealing furnaces with a maximum temperature of 500°C. The open-air glass melting capability is used to produce a range of tellurite glasses; Na-Zn-La-tellurite glass (undoped or doped with fluorescent rare earth ions) is now routinely made in up to 300g raw material batch sizes.

The controlled-atmosphere glass melting capability consists of a 5-port glove box with integrated melting furnace with a maximum temperature of 800 - 900°C, and an annealing furnace with a maximum temperature of 500°C. A new 6-port controlled atmosphere glove box with one integrated melting furnace and three annealing furnaces was commissioned in 2011.

IPAS has pioneered methods for extruding glass to form structured preforms. These structured preforms can be produced using soft glass and polymer billets. Preforms can be sonically milled and drilled into a range of cladding shapes as required. These preforms are then drawn down in scale into optical fibres. Fibres can be produced as core-clad and microstructured fibres. A large range of custom, specialised and microstructured fibres can be produced; such microstructured fibres having hole sizes in the range of 20nm – 20μm, with almost arbitrary hole shapes and distributions.

Preforms can be produced with a wide range of structures using soft glass and polymer billets. We currently have 2 extrusion rigs:

Our primary rig can extrude preforms at a temperature of up to 700°C and a force of up to 100kN. Preforms can be made from in-house fabricated glasses and commercially sourced glasses, including: tellurite, bismuth, fluoride (ZBLAN), fluoride-phosphate (Schott: N-FK5, N-FK51A), lead silicate (Schott: LLF1, F2, SF6, SF57) and chalcogenide glasses as well as polymers. The structures can include rods of 1 - 20mm diameter, tubes of 10 - 20mm outer diameter and 0.5 - 8mm inner diameter, wagon-wheel structures (suspended core), hexagonal arrays of 1 - 7 rings of air holes and spider-web like structures with large air filling fractions.

A 4m soft glass drawing tower is currently used to draw preforms of 8 - 15mm diameter and up to 180mm lengths into canes of approximately 1mm outer diameter or fibres of 100 - 400μm outer diameter. The temperature range that can be reached in the centre of the hot zone of the RF furnace is approximately 200 - 900°C. Pressure and vacuum can be applied to the preform during caning and fibre drawing. A range of soft glasses and polymer can be drawn from this tower. In addition, the preform can be spun during fibre drawing. On-line coating of fibres with UV-curable polymer can also be performed.

Contact:
A/Prof Heike Ebendorff-Heidepriem
T: +61 (0)8 8303 5028
E: heike.ebendorff@adelaide.edu.au
Silica Glass and Fibre Fabrication

IPAS’ new silica fibre fabrication facility will extend the research capability at IPAS and opens new opportunities as well as enhancing the range of applications for specialty silica fibres from photonics research in new lasers, telecommunications devices, nonlinear optics, sensing, electro-optic devices, to applications-led research in industrial machining and medical treatments.

This facility located at the North Terrace and Thebarton Campuses of The University of Adelaide has taken 3 years and $4.5M to build and is staffed by world class glass fibre formulation and fabrication experts – it represents a state-of-the-art silica glass fabrication facility that further extends IPAS capabilities and opens new opportunities for Australian researchers within these fields.

The North Terrace Silica Preform Facility comprises silica preform production via MCVD, sonic milling and drilling equipment and preform characterisation instruments. The Thebarton Silica Fibre Drawing Facility houses a 6-meter fibre drawing tower and fibre characterisation instruments.

The facility includes a Modified Chemical Vapour Deposition (MCVD) lathe for the fabrication of doped silica preforms (dopants: Ge, P, Al, B, F, rare earths).

The facility includes a Photon Kinetics 2600 preform analyser, allowing for the fully automated refractive index characterisation of optical fibre preforms. This analyser gives us the ability to fully automate preform positioning, facilitating rapid and comprehensive characterization of preform structure. From the refractive index profile data, the PK2600 calculates preform geometry metrics such as core diameter, preform outside diameter, and concentricity. This data also yields equivalent step-index profile parameters, which allow prediction of drawn fibre properties and provide essential preform process feedback.

The 6m drawing tower at this facility will enable the drawing of silica fibres in the temperature range of 1800-2200°C. In addition, this re-configurable and versatile tower will allow draw process modifications, as well as new research and commercial production opportunities of specialised optical fibres.

The facility includes a Photon Kinetics 2200 optical fibre analysis system. This provides a high performance, high capability measurement system for optical fibre. It provides high-speed characterisation of the spectral loss of single-mode and multimode fibres. In addition, a Photon Kinetics 2400 fibre geometry system provides high-speed automated measurements of optical fibre end-face geometry. Repeatable and accurate measurement of parameters such as core and cladding diameter, core and cladding non-circularity, as well as core-cladding concentricity providing invaluable process control information. The facility also operates a re-spooler/fibre proof tester.

Contact:
A/Prof David Lancaster
T: +61 (0)8 8313 0815
E: david.lancaster@adelaide.edu.au
The Adelaide Proteomics Centre

The Adelaide Proteomics Centre (APC) is a joint venture of the University of Adelaide and Hanson Institute, established with support from the Australian Cancer Research Foundation. The Centre offers researchers and industry a state-of-the-art Proteomics facility with the technology to identify proteins, quantify changes in protein expression levels and characterize post-translational modifications.

The Adelaide Proteomics Centre offers a range of standard and custom services for Proteomics and high throughput screening.

The team at APC are equipped to provide expert services in mass spectrometry based protein identification, quantitation, characterisation of post-translational modifications and high throughput screening / QC of small molecules. We also provide expert 2D DIGE characterisation of protein expression and N-terminal sequencing.

The APC is equipped with an Orbitrap LTQ XL ETD (Thermo Fisher Scientific), amaZon ETD (Bruker Daltonics), ultrafleXtreme and ultraflex III MALDI-TOFs (Bruker Daltonics).

For more information on the centre please visit our website:
http://www.adelaide.edu.au/mbs/proteomics/

Contact:
A/Prof Peter Hoffmann
M: +61 (0)434 079 108
T: +61 (0)8 8303 5507
E: peter.hoffmann@adelaide.edu.au

APC offers a range of services for proteomics and high throughput screening.
STARR brings together leading photonics and reproductive health researchers

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. In addition, reproductive efficiency and pregnancy loss is a major economic issue in livestock breeding, directly impacting on other industries such as agriculture. However, at present it is not possible to monitor developing embryos or assess the uterine environment non-destructively. This is essential to improve productivity, cost efficiency and improvement in assisted reproductive technology techniques.

The STARR laboratory was established to underpin the development of photonics-based reproductive health technologies to enable SA’s reproductive health researchers and clinicians to lead in adopting 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 endometriosis, reproductive cancers and infertility. STARR brings together leading photonics and reproductive health researchers with medical instrument providers and clinicians to ensure that the technologies developed are suited for clinical uptake as well as the needs of researchers. The combination of these skills is the first of its type in the world.

The STARR laboratory has been established at the University of Adelaide’s Medical School (South) Building, within a dark room in the Embryo Culture Laboratory. This location allows new sensor concepts to be demonstrated in an environment having access to biological samples, PC2 laboratory facilities and reproductive health scientists.

The comprehensive initial suite of laboratory equipment includes:

- Olympus Confocal Laser Scanning Microscope System
- 2 Optical Tables (1200 x 1800 x 300mm)
- Spectrometers
- Laser sources
- Optical microscopes
- Micrometer stages
- Ultrasonic optical fibre cleavers
- Power meters
- Incubator

Current Research Projects

Optical fibres are a promising technology for biological sensing, with benefits such as multiplexing, and their small size allows them to be minimally invasive probes. A particular design of optical fibre, a microstructured optical fibre, which contains air holes along its length, provides the additional advantage of being both an intrinsic sensor and a sample collector via capillary action. These microstructured optical fibres can collect nanolitres of liquid samples while still making sensitive measurements.

Nanosampling Sensors for Real-Time Embryo Monitoring

We now understand that the potential of every individual is established very early in life, during the periconceptual period when the oocytes mature and embryos are formed. At present, there are no technologies that can non-destructively monitor the local culture environment in which embryos develop.

This project seeks to alleviate this shortfall, by using low-volume sensing methods made possible with microstructured optical fibres to sample the embryo culture medium. These fibres allow nanolitre scale measurements to be performed by drawing liquids into the voids within the optical fibre where they can interact with the light guided in the fibre. This project aims to develop a fibre optic sensor that is capable of taking measurements in and around the embryo culture medium, for hydrogen peroxide sensing, as well as developing measurement methods to record both the temperature and pH of low-volume samples.

Optical Fibre Endometrium Sensors for Women’s Infertility

Women’s infertility is an increasing problem due to pregnancies occurring later in life. While many causes are understood, approximately 25% of cases are unexplained. The receptivity of the endometrium is believed to be a significant factor behind these unexplained cases and thus there is currently a need to develop new tools and techniques for monitoring the endometrium. This will have benefits for both diagnosing infertility and assisting decisions on IVF implantation.

This project aims to develop a microstructured optical fibre sensor for the measurement of proteins in endometrial fluid. The sensor will be made sensitive to proteins that have previously been identified as markers of infertility, such as proprotein convertase 6, and will be measured using a modified enzyme activity assay that will be coated onto the internal walls of the fibre.


Our Partners

The STARR facility is a $1.4M initiative by the State SA’s 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

Contact:
Prof Tanya Monro
M: +61 (0)400 649 369
T: +61 (0)8 8303 3955
E: tanya.mono@adelaide.edu.au
Optofab Adelaide Node – The Australian National Fabrication Facility

Established under the National Collaborative Research Infrastructure Strategy, the Australian National Fabrication Facility (ANFF) links 8 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 hard materials (metals, composites and ceramics) and soft materials (polymers and polymer-biological moieties) and transform these into structures that have application in sensors, medical devices, nanophotonics and nanoelectronics.

The Nodes

The nodes, which are located across Australia, draw on existing infrastructure and expertise. Each offers a specific area of expertise including advanced materials, nanoelectronics & photonics and bio nano applications. Our commitment to providing a world-class user facility is underpinned by the sharing of best practice in service provision across the nodes.

The ANFF Difference

Of course, 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 to assist researchers, experienced in meeting user requirements and maintaining leading-edge instrumentation. In fact, over 60 technical staff positions are funded through the program. Researchers are able to either work at the node under expert guidance, or to contract for specialised products to be fabricated at a reasonable cost.

Optofab Node of ANFF

Optofab consists of four centres of facilities and expertise based at Macquarie University, Bandwidth Foundry International, University of Sydney and the University of Adelaide, with the headquarters at Macquarie University.

Optofab offers specialist dedicated staff that are on hand to provide services & technical support to users where appropriate in microprocessing and microfabrication of fibre, planar and bulk optical materials which include silica, silicon, lithium niobate and polymers. There are also a number of post-processing capabilities e.g. surface functionalisation and advanced characterisation. These techniques have been used to produce artefacts for use in telecoms, biotechnology, biomedicine, microelectronics, optical sensing, industrial processing, defence and security applications.

Contact:
Luis Lima-Marques
M: +61 (0)413 339 808
E: luis.lima-marques@adelaide.edu.au
Atmospheric Physics – Buckland Park

Buckland Park is an Atmospheric Physics field station owned by the University of Adelaide. It is located 60km North-West of Adelaide. The facility comprises MF, VHF and UHF radars.

IPAS researchers working in atmospheric and laser physics are setting up a new LIDAR facility at Buckland Park. The aim is to measure atmospheric temperature, wind and dynamical processes with high spatial and temporal resolution from 10 to 110 km altitudes.

Investigating the middle atmosphere by LIDAR is a well-established method and utilised at many sites around the world. However, these sites are predominately in the northern hemisphere and there are very few LIDAR stations in the southern hemisphere. In particular the southern subtropics are important as there is significant demand for measurement with high spatial and temporal resolution. This facility is the first of its kind in Australia and at a unique location in the southern hemisphere, 35° S 138° E.

In addition, IPAS researchers are developing a range of new advanced LIDAR technologies.

First stage:
- LIDAR building finished and power laser under development.
- Implement all parts for LIDAR in building.
- From 2010 on Rayleigh temperatures from 30 to 60 km altitude.

Second stage from 2011 onwards:
- Power laser for resonance measurements.
- Extend altitude range for Rayleigh measurements 15 to 80 km.
- Combined Rayleigh and Resonance measurements.
- Continuous observation from 15 to 100 km on a regular basis.

Scientific aims:
- Study seasonal temperature structure at 36°S.
- Study dynamical processes such as tidal, planetary and gravity waves.
- Validate these local observations with Satellite and Model results.
- Intercomparison of South-North hemisphere and along 36° longitude.

Contact:
David Ottaway
T: +61 8 8313 5165
E: david.ottaway@adelaide.edu.au
Advanced LIGO and the Gingin Facility

LIGO Development and the Gingin Facility

The Laser Interferometer Gravitational-Wave Observatory (LIGO) is dedicated to the detection of cosmic gravitational waves and the measurement of these waves for scientific research. It consists of two widely separated installations within the United States, funded by the National Science Foundation (NSF) and operated in unison as a single observatory. This observatory is available for use by the world scientific community, and is a vital member in a developing global network of gravitational wave observatories.

IPAS researchers actively engage in LIGO and have worked in senior positions in the USA headquarters of the project. They have designed and developed a range of laser systems, architectures and components for LIGO. Current work includes the development of ultra-sensitive optical wavefront sensors for installation on the advanced LIGO detector.

Contact:
Jesper Munch
T : +61 8 8313 3526
E: jesper.munch@adelaide.edu.au
Bragg X-ray Crystallography Facility

Single-crystal X-ray structure determination provides the single most important means of unambiguously characterising molecules in the solid state. Using this technique an experimenter can determine the exact 3-D arrangement of atoms in a structure – this includes the relative positions, bonding and interactions of all atoms in a structure. No single step can provide more information about the way a biological/chemical agent works than its three dimensional structure.

The main capabilities of the Bragg Crystallography Facility include:

- High throughput small molecule structure determination;
- Protein and macromolecule structure determination;
- Screening of large protein samples for subsequent synchrotron data collection;
- Powder diffraction analysis.

Key equipment include two state-of-the-art diffractometers:

- a Mo-target Oxford Diffraction X-Calibur X-ray diffractometer; for small molecule structure determination;
- a Cu-target Rigaku Hiflux Homelab rotating anode X-ray diffractometer for large molecule structure determination.

1. High throughput small molecule structure determination

High throughput small molecule structure determination (SMX) SMX is used to determine the structures of inorganic, organic and mineralogical species (i.e. compounds with a few atoms to those containing a thousand atoms) and to define the absolute structure and configuration of chiral (asymmetric) compounds. SMX can be used to identify and characterise potential drug leads, protein inhibitors/activators and nanoscale/catalytic homogenous systems.

2. Protein and macromolecule structure determination

Protein and macromolecule structure determination (PX) PX structure determination offers industries with a research focus in biotechnology, (stem) cell biology, biochemistry, biomedicine and biotechnology single step access to the 3-D structure of a protein or enzyme. This information can be used to further understand drug targets or biological activity, for example. Our PX capable instrument can also be used for other macromolecular structure determination, e.g. polynucleic acids, polymers and supramolecular extended network materials. The services provided under items 1 and 2 can include:

- Selection and mounting of crystal specimens;
- X-ray data collection;
- Digital movies of crystals;
- Face-indexed numerical absorption corrections (when needed);
- Structure solution and refinement;
- Full crystallographic report with experimental details, figures, files, and tables of crystallographic data.

3. Screening of weakly diffracting protein samples

Screening of weakly diffracting protein samples prior to synchrotron access. Samples that require more intense X-ray sources due to inherently weak X-ray diffraction using conventional sources can only be structurally determined using the intense X-ray beams provided by a synchrotron. Examples of these samples include membrane bound proteins and biomacromolecules.

4. Powder

Powder samples can be run on the Xcalibur (Mo radiation only). However, only homogeneous powder samples with at most two chemical components are appropriate for the CCD diffractometer.

Contact:
Dr Christopher Sumby
T: +61 8 8303 7406
E: christopher.sumby@adelaide.edu.au
Environmental Luminescence

Environmental Luminescence studies a range of applications of luminescence phenomena to diverse problems in Environmental Monitoring, Quaternary Geology, Defence and National Security, Archaeology and Palaeontology. These include the use of luminescence for determination of absorbed radiation dose (Luminescence Dosimetry and Dating), the real-time monitoring of radiation fields in the environment, and the use of luminescence and fluorescence for trace substance detection. Our research interests lie both in the underlying physics and the applications.

The radiation sensing and Luminescence Analysis takes place in our Environmental Luminescence facility.

The Environmental Luminescence facility brings together an apparatus suite, which enables state-of-the-art Geochronology and a great range of research possibilities.

The main facility includes:

- 3D TL Spectrometer – Interferometer-based, 200-720 nm sensitive range for temperatures up to 600°C – the world’s most sensitive TL spectrometer.
- Photon-Counting Imaging System (PCIS) – developed in collaboration with ANU and to be transferred to IPAS on long-term loan. An LN-cooled silicon CCD camera is interfaced with a Risø OSL/TL-DA-15 with fast (f0.9) reflective optics to enable exploitation of the full 200-1050 nm sensitive range of the CCD.
- R1: a Risø TL-DA-8 with cooled red (S20) PMT module optimised for red TL.
- R3: a Risø TL/OSL DA-20 with fast photon timer module for time-resolved OSL (POSL), and Single-Grain Module with green and IR lasers.
- R4: a Risø OSL/TL-DA-12 for blue TL, with blue/UV (bialkali) PMT, and a 470 nm LED pack for optical stimulation.
Sample Preparations:

Well-equipped sample preparation darkrooms include separate areas for field kit, a “saw room” with masonry saw, Buehler diamond wafering slow-saw and water-cooled coring drill, and a preparation lab dedicated to the extraction of mineral grains; apparatus includes 38 mm and 100 mm micromesh sieve stacks, a facility for batch density separation using lithium heteropolytungstate, Franz magnetic separator, centrifuge, ultrasonic baths, hotplates, precision electronic balances, drying ovens, a tube oven and wide range of laboratory glassware.

Irradiations:

Alpha (Am241) and beta (Sr90/Y90) particle irradiations are administered by sources either mounted within the four RisÅfÂ, automated luminescence readers, or in stand-alone automated irradiators. These include two Elsec “6-position” alpha irradiators, an Elsec automated alpha irradiator Type 9010, two Elsec Type 9010 automated beta irradiators, two Daybreak automated beta irradiators, and a Littlemore automated beta irradiator. In addition, a set of free standing Sr90/ Y90 sources with activities ranging from 0.7 MBq to 1.5GBq and a free-standing 14 MBq Am241 alpha source are available for purpose-configured experiments on Elsec readers or within lead castles.

Contact:

Nigel Spooner
E: nigel.spooner@adelaide.edu.au
IPAS Structures and Governance
IPAS Structures

IPAS is one of five University of Adelaide Research Institutes. The organisational chart below illustrates the governance structure for IPAS. Further details on IPAS key governance, scientific and operational committees are provided later in this report.

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IPAS Structures and Governance

- IPAS Executive Committee
- IPAS Scientific Management Committee (SMC)
- IPAS Director
- IPAS Board
- IPAS Senior Advisory Group (SAG)
- IPAS Core Team (Institute Manager, Grants Development, Commercialisation, Admin Support)
- IPAS Student Committee

IPAS Research Themes

- Optical Materials & Structures
- Lasers & Nonlinear Optics
- Surface Science & Synthetic Chemistry
- Chemical & Radiation Sensing
- Medical Diagnostics & Biological Sensing
- Remote Sensing
IPAS Board

IPAS has a Board with the skills to support IPAS in achieving its goals and oversee its activities.

The Board provides strategic advice on external linkages and opportunities and recommendations for shaping IPAS research capabilities.

This advisory board contains representatives from a broad range of sectors, including industry, defence, academia, education and government.

Mr Joe Flynn
IPAS Chairman
CEO, Water Industry Alliance

Mr Joe Flynn has an international infrastructure background with experience at MD and GM levels having run water and electricity utilities. Joe has led some of Australia’s largest infrastructure service businesses and chaired government-industry economic development initiatives. He is currently the CEO of the Water Industry Alliance.

Professor Mike Brooks
Deputy Vice-Chancellor and Vice-President (Research), The University of Adelaide

Professor Mike Brooks was appointed to the position of Deputy Vice-Chancellor and Vice-President (Research) at The University of Adelaide in 2008. He is a leading international researcher in computer vision and image analysis, with wide commercial success in the security and defence industries.

Professor Bob Hill
Executive Dean, Faculty of Sciences, The University of Adelaide

The University of Adelaide Professor Robert Hill is the Executive Dean, Faculty of Sciences at The University of Adelaide. He is a graduate of The University of Adelaide. During his career he has won many awards including the Clarke and Burbidge Medals for his research into the impact of long-term climate change on the evolution of Australian vegetation.

Professor Andrew Holmes
University Laureate Professor and CSIRO Fellow, The University of Melbourne

Professor Andrew Holmes is a distinguished researcher, focussing on applications of synthesis to problems in biology and materials science. He is presently a CSIRO Fellow at the Division of Molecular and Health Technologies, a University Laureate Professor at the University of Melbourne and Distinguished Research Investigator at Imperial College.
Executive Summary

IPAS Structures and Governance

IPAS Research & Facilities

Working with Industry / Commercialisation

2011 Activities

IPAS Board

Dr Warren Harch
Deputy Chief Defence Scientist (Information and Weapon Systems), DSTO

Dr Warren Harch is the Deputy Chief Defence Scientist (Information and Weapon Systems) at DSTO, supporting Australia’s current and future military capability and national security.

Dr Jurgen Michaelis
CEO, BioInnovation SA

Dr Jurgen Michaelis has more than 20 years’ experience as a senior executive in the international life science industry, having worked in Europe, Australia and New Zealand. He has raised more than $120 million in private equity and venture capital for biotechnology companies and has participated in the full life cycle of technology development and commercialisation.

Dr Neil Bryans
Executive Director, Counter Terrorism and Security Technology Centre, DSTO

Dr Neil Bryans has had an association with the University of South Australia’s Institute of Telecommunications Research and its predecessors dating back to the mid-nineties. His interactions with the University have broadened to include assisting the University in a number of initiatives and strategies it has undertaken. Neil is currently the Executive Director of the Counter Terrorism and Security Technology Centre at DSTO, working previously as Deputy Chief Defence Scientist at DSTO.

Professor Tanya Monro
IPAS Institute Director

Professor Tanya Monro is an ARC Federation Fellow at the University of Adelaide. Tanya is a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE), a member of the Future Manufacturing Industry Innovation Council (FMIC), a member of the National Committee for Physics, a member of the SA Premier’s Science & Research Council and an inaugural Bragg Fellow of the Royal Institution of Australia. In 2010 she was named South Australian Scientist of the Year, and Telstra Business Woman of the Year at both National and State levels (in the Community & Government category).
IPAS Scientific Management Committee

This committee has been selected to span the six research themes within IPAS and its role is to:

- Grow research funding and capacity
- Define the research priorities of IPAS
- Define and focus resources on research strengths
- Create a visible front door for external engagement
- Advise on mechanisms to deliver on these priorities
- Support the Director by growing research and delivering the KPIs of the Institute
- Communicate IPAS strategies and initiatives to the broader IPAS community
- Engage their research teams with the activity of IPAS

Each of the six core Scientific Themes within IPAS has two Theme Leaders, and these theme leaders sit on the Scientific Management Committee (SMC).
IPAS Science Themes and Theme Leaders

Optical Materials & Structures
Heike Ebendorff-Heidepriem
Tanya Monro

Lasers & Nonlinear Optic
David Ottaway
David Lancaster

Remote Sensing (including Astrophysics, LIGO, Lidar)
Gavin Rowell
David Ottaway

Medical Diagnostics & Bio Sensing
Peter Hoffmann
Tanya Monro

Surface Science & Synthetic Chemistry
Chris Sumby
Andrew Abell

Chemical & Radiation Sensing
Nigel Spooner
Tanya Monro
IPAS Senior Advisory Group

The IPAS Senior Advisory Group advises the IPAS Director on the strategic and scientific directions for IPAS.

John Carver
Protein Structure, Function and Interactions

Roger Clay
Astronomy, Astrophysics, Cosmic Rays

Alan Cooper
Ancient DNA, Palaeocology, Biogeography

TuckWeng Kok
Virology, Biotechnology, Diagnostics

Shaun McColl
Proteomics, Immunology, Chemokine Biology

Jesper Munch
Solid State Lasers, Lidar Sensors, Gravitational Wave Detection

Iain Reid
Atmospheric Physics, Atmospheric Radar

Bob Vincent
Atmospheric Physics, Atmospheric Radar
IPAS Executive Committee

The IPAS Executive Committee is an operational management committee that meets fortnightly to address high-level operational issues at the juncture between Institute, School and Faculty activities. It comprises staff from IPAS, the Faculty of Sciences and the School of Chemistry & Physics.

Tanya Monro  
IPAS Director

Derek Leinweber  
Head of School, Chemistry & Physics

Carol Maelzer  
Manager School of Chemistry & Physics

Raelene Wildy  
Manager, Faculty of Sciences

Piers Lincoln  
IPAS Institute Manager

Sara Leggatt  
IPAS Executive Assistant Senior Office Administrator
IPAS Professional Team

The professional team manage the operations of the Institute including the development of new grant applications with the research teams, management of laboratories within IPAS, planning of new IPAS facilities, business development, contracts management, executive support to the Director, marketing and events management and financial management.

Piers Lincoln
IPAS Manager
Responsible for helping to define the strategic direction of IPAS and ensuring the smooth operations and Commercialisation activities of the Institute.

Mark Saunders
IPAS Grants Developer
Responsible for supporting the development of new grant applications with IPAS research members.

Elodie Janvier
IPAS Grants Developer Assistant (Part Time)
Responsible for supporting the IPAS Grants Developer.

Luis Lima-Marques
IPAS Laboratory Manager
Responsible for the delivery of the laboratories and offices in the new IPAS headquarters as well as managing current IPAS facilities.

Ashwin Ravikumar
IPAS Commercial Development Manager (Part Time)
Responsible for the development of contract research, confidentiality agreements and commercialisation activities.

Jason Dancer
IPAS Financial Accountant (Part Time)
Financial support and budgeting for the Institute.

Sara Leggatt
IPAS Executive Assistant and Senior Office Administrator
High-level executive support to the Director and office management.

Olivia Towers
IPAS Office Administration
First point of contact for enquiries and provides administrative support to the IPAS team including marketing support.

Danielle Fox
IPAS Office Administration (P/T)
Administrative support to the IPAS team.

Lesley Sparkes
IPAS Office Administration (P/T)
Administrative support to the IPAS team.

Mike Seyfang
New Media Consultant
Responsible for communicating activities of the Institute via social networking.
**IPAS Student Committee**

The Student Committee represents the needs of the students within IPAS and organises science and networking events for the student body. The Chair of the Student Committee sits on the IPAS Scientific Management Committee.

- **Tilanka Munasinghe**
  *IPAS Student Committee Chair*

- **Karina Martin**

- **Courtney Hollis**

- **Herbert Foo**

- **Matthew Henderson**
Working with Industry / Commercialisation
Industry Links

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 research 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:

- AOFR Pty Ltd
- Asahi Glass, Japan
- BAE Systems Australia
- Bruker Daltonics
- Cook Medical
- CPR Pharma Services Pty Ltd
- DSTO
- Diemould Tooling Services Pty Ltd
- IMVS Pathology
- Micromet
- Nomacor SA
- RISE, Denmark
- Schott Glass, Germany
- Treasury Wines Estates
- Yalumba Wines
Commercialisation and Industrial Collaboration

When IPAS was established one of the key aims was 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, contract research and to develop technology licence agreements.

Through their research IPAS members have built a significant portfolio of patents covering the fabrication and use of microstructured optical fibres as ultra low volume/high sensitivity chemical sensors, two novel bio-sensing platforms, a new waveguide laser architecture for generating mid infrared light, a Q switched laser for coherent laser radar applications and a sensor for monitoring browning.

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.

IPAS - VESPR sensing platform for rapid virus, bacteria and protein biomarker detection

3 new patents filed in 2011
IPAS Patented Technologies

**Microstructured Optical fibre sensors**

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

**VESPR & Early Stage Gastric Cancer Diagnostics**

VESPR is a new form of Surface Plasmon Resonance Sensing that has been demonstrated to rapidly detect viruses, bacteria and cancer biomarkers in a label free system. We are using this system to develop a medical diagnostic for early stage gastric cancer using a panel of biomarkers discovered by the Adelaide Proteomics Centre.

**Waveguide 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 1.1um, 1.9um and 2.1um with broad tunability. We anticipate these being 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.

**Whispering Gallery Mode**

Our Whispering Gallery Mode sensors comprise microspheres attached to the end of optical fibres. This architecture allows very sensitive measurements to be made in vivo.

**Browning sensor**

Our low cost browning sensor is able to discriminate between specific shades of browning that occur in cooking and other industrial processes. Work is ongoing to develop prototypes and to seek customers who wish to incorporate this sensor in their next generation products and processes.

**Optical fibre radiation sensor**

We have developed an optical fibre radiation dosimeter capable of instant readout of ionising radiation as well as readout of accumulated radiation dose. We are working with oncologists to understand how to apply this to accurately measure the radiation dose applied to tumours during radiotherapy.

**Q switched laser**

Major applications for this include coherent laser radar (LIDAR) and other remote sensing applications including gas detection.
2011 Activities
A Fine Line – Science Meets Art
Glass Exhibition

At opposite ends of the Adelaide CBD, the researchers at The Institute for Photonics & Advanced Sensing (IPAS) at Adelaide University and the artists at the JamFactory Glass Studio work at the very edge of glass design and manufacture.

Over a series of visits to each others facilities an idea of holding a collaborative exhibition evolved and became ‘A Fine Line’, where glass became the connective line between nature, science, and art, as scientists and artists found their common ground in the alchemical extremes of working with glass.

The exhibition brought glass art and glass science together and visitors were able to see videos of both types of glass-making. The exhibits covered the process of scientific glass making, including some of the scientific failures which often have a beautiful art-like quality to them, to examples of pure glass art from JamFactory glass artists: Nick Mount, Danielle Rickaby, Janice Vitkovsky and Jaan Paldaas.

Visitors were challenged to judge the fine line where science finished and art began.
Trilateral Nanophotonics Workshop

The Trilateral Nanophotonics Workshop held in August, 2011 at Seralino, McLaren Vale, brought together leading nanophotonics researchers and their groups from Australia, Italy and France. The aim of the workshop was to foster and strengthen research collaborations.

In addition to the 23 South Australian participants, there were 18 Italian and French participants and 15 Australian interstate participants. The majority of these were early career researchers or PhD students.

Generous sponsorships were provided by the Italian and French Embassies in Australia, the South Australian State Government, The Department of Innovation, Industry, Science and Research (DIISR), the Australian Nanotechnology Network (ANN) and the Institute for Photonics & Advanced Sensing (IPAS).
IPAS Student Prizes

In January 2011, all IPAS students were invited to present their research in a 5-minute talk. A disciplinary prize (sponsored by IPAS) and a transdisciplinary prize (sponsored by Merry Wickes), each worth $1,000, were on offer to the best presentation in each category.

The IPAS Scientific Management Committee voted on the quality of the project and on the skill of the speaker in communicating the value, scientific approach and possible outcomes of the research.

The winners of these prizes were:

The Merry Wickes Transdisciplinary Student Prize
Erik Schartner

IPAS Disciplinary Prize
Ori Henderson-Sapir and Janette Edson were joint winners.

Many congratulations to Erik, Ori and Janette We would like to thank Merry for her on-going support of the transdisciplinary prize.
South Australia’s Australian of the Year 2011

Physicist Professor Tanya Monro was named South Australia’s Australian of the Year 2011 and was presented with her award by the Governor of South Australia, His Excellency Rear Admiral Kevin Scarce AC CSC RANR.

Tanya was recognised for her work in the field of photonics – technology which allows the generation and control of light using glass optical fibres. Photonics enables the creation of new tools for scientific research and solutions for problems in areas such as information processing, surgery, health monitoring, military technology, agriculture and environmental monitoring.

Professor Monro became the inaugural professor in photonics at the University of Adelaide in 2005 and her PhD research focused on developing new classes of optical fibres, for which she received the Bragg Gold Medal for the best physics PhD in Australia. In 2006, she was named as one of the top 10 brightest young minds in Australia by national science magazine Cosmos and, in 2008, she was awarded the Prime Minister’s Prize for Physical Scientist of the Year. Tanya is a member of the South Australian Premier’s Science & Research Council and regularly serves on a range of key national bodies in the area of science policy and evaluation.
John Prescott 1924–2011

2011 marked the passing of Professor John Prescott who established the world-renowned cosmic ray and luminescence activities at the University of Adelaide.

John Russell Prescott, affectionately known to colleagues and students as “Prof”, was born in Cairo, Egypt on 31 May 1924. Soon after John’s birth, his father was appointed Director of the Waite Agricultural Research Institute and the family moved to Adelaide.

John attended Scotch College, and in 1942 entered the University of Adelaide to study Physics. He graduated in 1945 with the degree of BSc (Honours) and in the same year became engaged to Josephine Elizabeth Wylde. He moved to Melbourne to undertake a PhD on cosmic ray showers and bursts, and he and Jo were married in 1947. John then won a scholarship to Oxford University and received his D.Phil. from Christchurch College in 1953. After 11 years as a lecturer at the University of British Columbia, Canada, he became Professor of Physics at the University of Adelaide and in 1982 was appointed Elder Professor of Physics.

His main research interest was in cosmic rays, and he founded the cosmic ray research group at the University of Adelaide. While helping excavate at Roonka on the Murray, he decided to apply his knowledge of physics to archaeology, using the new technique of thermoluminescence dating. He set up a laboratory and luminescence soon began to dominate his academic research, particularly after his notional retirement in 1990.

His fieldwork included Lake Mungo, the Flinders Ranges and other sites in Australia, China and Thailand. At the same time his interest in cosmic rays did not diminish and his paper on cosmic ray penetration in sediments is one of the most cited in the luminescence literature.

He received many scientific awards, including the 2002 Royal Society of South Australia Verco Medal.

John’s outstanding service to the University of Adelaide included periods as Dean of Science, Chairman of Physics and later Physics and Mathematical Physics, and also Chairman of the Education Committee.

A gifted and caring teacher, mentor and supervisor, he always put his students and their welfare above all else, giving generously of his time, knowledge and expertise. His kindness and generosity, sense of humour, love of jokes, deep love of science, breadth of knowledge and intellectual curiosity were, and will continue to be, an inspiration to us. He will be sorely missed.

He is survived by his wife Jo and children James, Ann and Kate.
**DSTO**

The University of Adelaide and DSTO jointly launched the Centre of Expertise in Photonics (CoEP) in May 2006. The intent behind this initiative was to:

- Build photonics research capacity and capability in South Australia;
- Strengthen the Physics Discipline at the University;
- Deliver photonics research projects and create research capability of relevance to Defence;
- Support collaborations between Defence and University scientists.

In 2011 the scope of the CoEP was enlarged to encompass all research activity within IPAS with defence applications. This includes photonics, optical fibre, laser, optical sensing and luminescence research activities.

IPAS has strong relationships with multiple groups at DSTO and has engaged in projects with researchers in Air Vehicles Division, Weapons Systems Division and Electronic Warfare & Radar Division.

IPAS Scientists collaborate with DSTO Scientists across many research areas:

- Sensors – fibres for sensing and detection e.g. corrosion, fuel degradation, radiation and other applications (Tanya Monro);
- LIDAR – laser radar for water vapour monitoring (Murray Hamilton);
- Luminescence detection techniques for non-proliferation and retrospective dosimetry (Nigel Spooner);
- Development of new classes of mid-infrared optical fibres (Heike Ebendorff-Heidepriem);
- High power laser systems including fibre lasers (David Lancaster, Jesper Munch).

DSTO also provides for annual Scholarships to provide support for high achieving undergraduates in the Photonics areas of study. This has led to visibility of DSTO as an employer for high calibre physics graduates.

DSTO has employed a number of PhD graduates from our laboratories, strengthening the ties between the organisations.
IPAS Global Collaborators

IPAS collaborates with academic teams across the world. We are always seeking complementary skills and teams in order to solve global research challenges.

In 2011 IPAS collaborated with researchers located in the following organisations:

- **USA**
  - University of California Merced
  - University of California, Davis
  - California Institute of Technology
  - CRES (NOAA and U Colorado)
  - US Army Research Labs, Adelphi
  - UC Berkeley
  - Massachusetts Institute of Technology
  - Caltech
  - University of Colorado
  - Georgia Institute of Technology
  - CREOL
  - Syracuse University
  - NorthWest Research Associates, Boulder
  - National Center for Atmospheric Research, Boulder, Colorado

- **CHINA**
  - Yanshan University
  - Beijing University of Technology
  - Huazhong University of Science and Technology
  - Institute of Geology and Geophysics, Chinese Academy of Sciences
  - Peking University
  - Center for Space Science and Applied Research (CSSAR), CAS

- **UNited Kingdom**
  - University of Aberystwyth, UK
  - University of Nottingham, UK
  - University of Southampton, UK

- **Japan**
  - The University of Tokyo / Professor Shinji Yamashita, Japan

- **Singapore**
  - DSO, Singapore

- **New Zealand**
  - University of Otago, New Zealand

- **Europe**
  - University of Trento, Italy
  - Jagiellonian University, Krakow, Poland
  - Institute for Atmospheric Physics on the University of Rostock, Germany
  - Universite Claude Bernard – Lyon, France
  - Institute of Photonic Technology, Jena, Germany
  - VUB, Brussels, Belgium
  - Danish Technical University, Riso, Denmark
  - University of Rennes, France
  - Laboratoire de Meteorologie Dynamique, Ecole Polytechnique, Paris, France

- **Argentina**
  - University Buenos Aires, Argentina

- **Argentina**
  - University Buenos Aires, Argentina
IPAS Australian Collaborators

IPAS members collaborate with universities, Defence, Industry, and Research Organisations across Australia – major collaborations are shown on the adjoining map.

**NATIONAL**
- Australian National University
- Australian Defence Force Academy
- CSIRO
- DSTO

**QUEENSLAND**
- University of Queensland

**SOUTH AUSTRALIA**
- Flinders University
- Monash University
- SARDI
- South Australian Government
- South Australian Museum
- University of South Australia

**NSW**
- Macquarie University

**VICTORIA**
- Swinburne University
- University of Melbourne
## IPAS Members

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<tr>
<th>Title</th>
<th>First Name</th>
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<td>Prof</td>
<td>Andrew</td>
<td>Abell</td>
<td>Professor</td>
<td>School of Chemistry &amp; Physics</td>
<td>Surface Science &amp; Synthetic Chemistry, Medical Diagnostics &amp; Biological Sensing</td>
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<td>Afshar</td>
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<td>Lasers &amp; Nonlinear Optics Remote Sensing</td>
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<td>Ms Rachel</td>
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<td>Prof Iain Reid</td>
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<td>Dr Andrew Richardson</td>
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<td>Dr Gavin Rowell</td>
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<td>Prof Dennis Taylor</td>
<td>Head of Discipline &amp; Professor of Oenology</td>
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<td>Prof Anthony Thomas</td>
<td>Australian Laureate Fellow &amp; Elder Prof of Physics, Director (CSSM)</td>
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<td>A/ Prof Jeremy Thompson</td>
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<td>Ms Vicky Thompson</td>
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2011 Publications

Journal Articles


54. Gilchrist, R. B., De Vos, M., Smitz, J. and Thompson, J. G. IVM media are designed specifically to support immature cumulus-oocyte complexes not denuded oocytes that have failed to respond to hyperstimulation. Fertil Steril. 96 (2), e141-e141, 2011.


132. White, R. T. and Monro, T. M. 'Cascaded Raman shifting of high-peak-power nanosecond pulses in As2S3 and As2Se3 optical fibers', Optics Letters, 36(12), 2351-2353, 2011.


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9th International Meeting of Pacific Rim Ceramic Societies (PacRim 9), Cairns, Australia, 2011.


34. Ruan, Y., Afshar V. S. and Monro, T. M. ‘Trapping forces by radially polarised mode from high index nano fibres’, Frontiers in Optics Conference, San Jose, California, USA, October 2011.


Book Chapters

