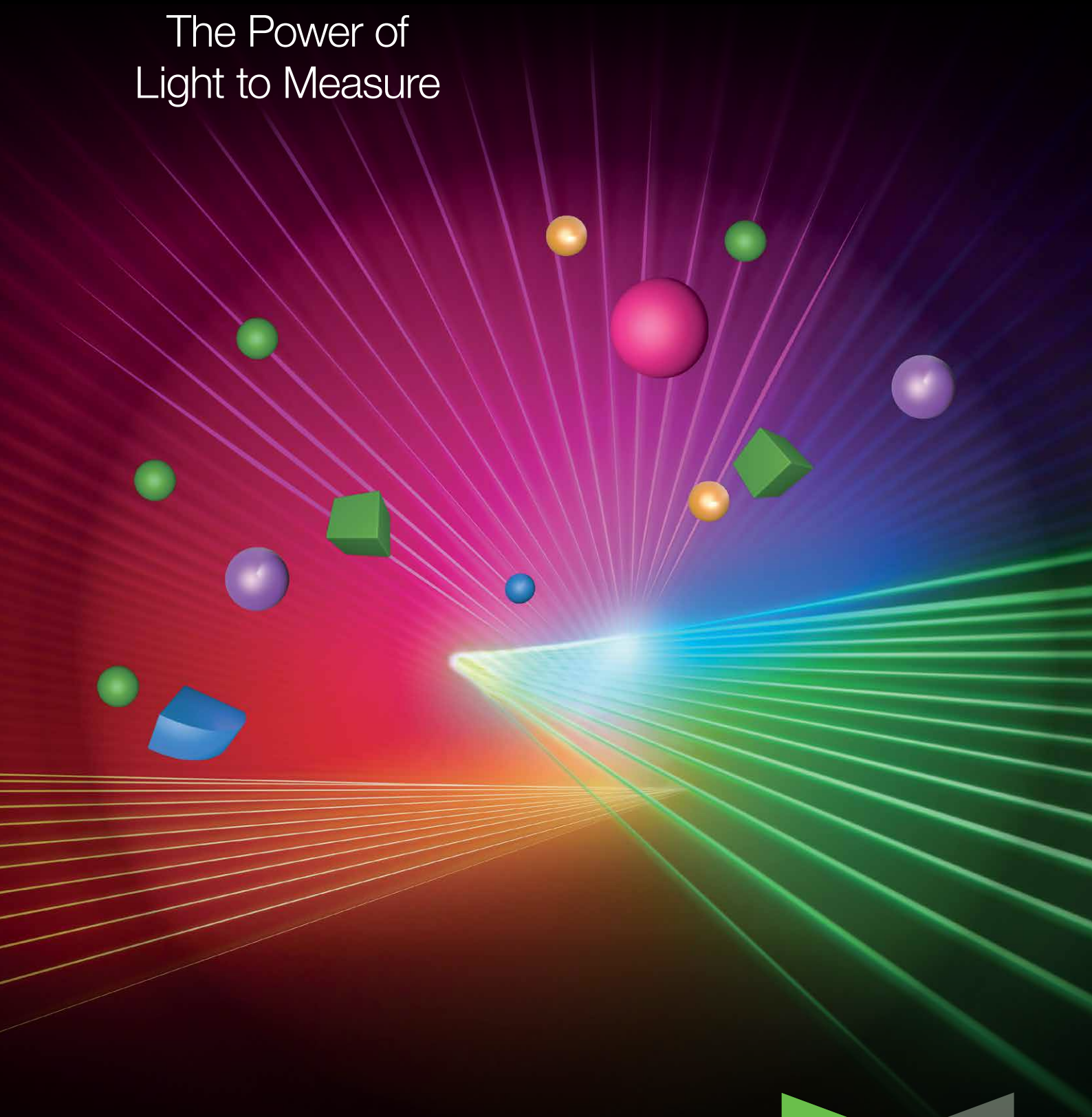




Centre for
**Nanoscale
BioPhotonics**
ARC CENTRE OF EXCELLENCE

The Power of Light to Measure



2017
ANNUAL
REPORT



Australian Government
Australian Research Council



THE UNIVERSITY
of ADELAIDE



MACQUARIE
University
SYDNEY • AUSTRALIA



RMIT
UNIVERSITY

CNBP links Australia's key nanophotonics groups and builds on Global Collaborations with a focus on doing the science required to advance biology.



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CITY UNIVERSITY
LONDON



SAHMRI
South Australian Health &
Medical Research Institute



Government of
South Australia



Trade &
Investment



BIOPLATFORMS
AUSTRALIA

Leibniz | ipht
LEIBNIZ INSTITUTE of
PHOTONIC TECHNOLOGY

UNIVERSITY OF
Southampton



UHN
COURAGE LIVES HERE
Toronto General
Toronto Western
Princess Margaret
Toronto Rehab



University of Colorado
Boulder

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Nanoscale BioPhotonics (CNBP) 2017 Annual Report.

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Centre for
**Nanoscale
BioPhotonics**
ARC CENTRE OF EXCELLENCE



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University
SYDNEY · AUSTRALIA



RMIT
UNIVERSITY

Director's Report

Welcome to the 2017 annual report of the Australian Research Council Centre of Excellence for Nanoscale BioPhotonics (CNBP), a highlights package of our exciting and transformational scientific journey.

In now our fourth year of operation, we have produced some amazing scientific and organisational outcomes. We continue to deliver more ground-breaking 'research firsts' for our Centre—this built on the efforts of our exceptional team as well as our focus on fully embracing and maximising a transdisciplinary scientific approach to our programs.

Within the science program of the CNBP we are continually asking questions at the nanoscale. It is at the nanoscale that we guide light to interact with biology. It is at the nanoscale where we can create light where we need it. It is at the nanoscale that we can observe life begin, watch the triggers of pain be activated, and detect heart disease as it evolves. I am very proud of all of the work conducted in our Centre in 2017 and excited as to what we have in store for the coming years as well.

Organisationally, this year has seen an evolution of the communication of the structure of our Centre's science program which is now focused into three key domains of Imaging, Sensing and Discovery. Underpinning these areas of research are our fundamental motivations to both capture images and to make novel sensing measurements that will have broad application across the biosciences, medical, agriculture, food and manufacturing sectors.



CNBP Director, Prof Mark Hutchinson

The transition of our science program to this new structure has allowed for us to further focus and refine what we are uniquely achieving across all of our targeted research areas.

Our strength of industry engagement across the CNBP has also been pleasing and has translated this year into the creation of five new start-up companies across the Centre. Both Prof Robert McLaughlin's company MiniProbes and Prof Jeremy Thompson's company ART Lab Solutions have been awarded TechInSA funding to accelerate their venture development. Other developments from the South Australian Rapid Commercialisation Initiative (SARCI) have led to the creation of seven industry placed jobs and three more start-ups, Spectral Change, Dairy Explorer and MEQ probe. It is with excitement that we await what 2018 has in store for these early commercial ventures which are able to add real and unique value to businesses, their processes and to their bottom line.

At the CNBP we have hosted a number of major events in 2017 including scientific workshops, a partner launch at the University of Colorado Boulder, industry networking events at SPIE Photonics West and AusBiotech and was a key leader at the 'Science meets Business' event in Sydney. These events saw engagement with many hundreds of people, including representatives of the State Government, Federal Government, industry, members of the University communities and the general public.

These collective activities exemplify our key pillars of Academic Excellence, Commercial Impact, Quality Communication and a Nurturing Environment. Since the beginning of CNBP, these principles have grown from an organisational initiative into meaningful actions. This can be seen in our amazing science programs and has been exemplified in the way that we have conducted this science through open communication channels with industry and government.

ACADEMIC
EXCELLENCE



NURTURING
ENVIRONMENT



QUALITY
COMMUNICATION



COMMERCIAL
IMPACT



In now our fourth year of operation, we have produced some amazing scientific and organisational outcomes. We continue to deliver more ground-breaking 'research firsts' for our Centre—this built on the efforts of our exceptional team as well as our focus on fully embracing and maximising a transdisciplinary scientific approach to our programs.

The fourth CNBP Scientific Conference was a resounding success with nearly 100 Centre scientists, Associate and Partners Investigators in attendance for the three-day event. We were delighted to welcome five members of our International Science Committee to the conference, as well as colleagues from local and International Partner organisations. Once again the annual conference highlighted and strengthened the vibrant culture and environment of nurturing and mentoring of our scientists across all levels and localities.

Additionally, I would like to emphasise how fortunate we are at the CNBP to have such amazing science communicators as part of the research team. Two of our scientists, Dr Hannah Brown and Dr Sanam Mustafa were successful in being selected for the inaugural Science and Technology Australia run 'Superstars of STEM' program. This will see them schooled in all that it takes to maintain an active research program and be a public voice of science across the Australian media and outreach landscape.

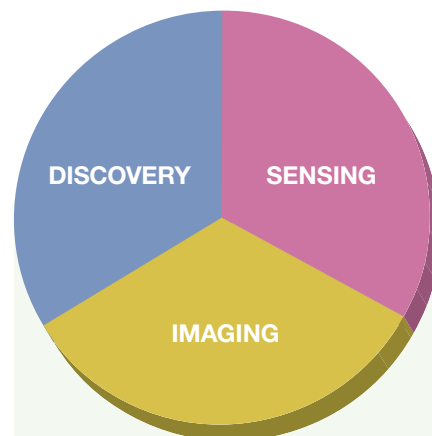
Importantly, our Centre continues to be one in which our scientists can openly share and test new, raw and cutting edge hypotheses, where our scientists are mentored and equipped with the skills to be the next generation of science leaders. This means we have an environment where we are encouraged to practice and to take the big risks that sometimes fail, so that when the once in a lifetime opportunities come around we are already fashioned with the necessary skills to succeed.

Finally, I would like to congratulate all of the Centre's personnel for a highly successful and productive year. Thanks to our wonderful CNBP leadership team for all their hard work in 2017. These are exciting times!



Prof Mark Hutchinson
Director, CNBP

Light to Measure



Our Fundamental Motivations are to Make Imaging and Sensing Measurements

- 1 in ultrasmall volumes;
- 2 in defined spatial compartments;
- 3 *in vitro*, *ex vivo* and *in vivo*, in behaving models;
- 4 at the relevant timescale, including in real-time;
- 5 at new limits of a resolution, sensitivity and specificity level;
- 6 using deployable devices.

Impact Areas

- 7 visualise and sense the working neuroimmune interface;
- 8 quantify and diagnose pain;
- 9 create *in vivo* tools for cardiology;
- 10 detect and monitor cellular responses in atherosclerotic plaques;
- 11 quantify sperm/embryo/oocyte quality;
- 12 visualise and sense the working reproductive tract.

Who We Are

CENTRE DIRECTOR

Prof Mark Hutchinson



JOINT DEPUTY DIRECTORS

Prof Ewa Goldys



JOINT DEPUTY DIRECTORS

A/Prof Brant Gibson
RMIT University
Node Director



PROFESSIONAL TEAM

Dr Kathy Nicholson
Chief Operations
Officer



PROFESSIONAL TEAM

Mrs Melodee Trebilcock
Partnerships, BD
& Events Manager



PROFESSIONAL TEAM

Mr Tony Crawshaw
Comms & Outreach
Co-ordinator



SCIENCE LEADERSHIP TEAM

Prof Andrew Abell
The University
of Adelaide
Node Director



SCIENCE LEADERSHIP TEAM

Prof Jim Piper^{AM}
Macquarie
University
Node Director



SCIENCE LEADERSHIP TEAM

Prof Stephen Nicholls



SCIENCE LEADERSHIP TEAM

Prof Tanya Monro



SCIENCE LEADERSHIP TEAM

Prof Heike Ebendorff-Heidepriem



SCIENCE LEADERSHIP TEAM

Prof Nicolle Packer



SCIENCE LEADERSHIP TEAM

Prof Andrew Greentree



SCIENCE LEADERSHIP TEAM

Prof Jeremy Thompson



SCIENCE LEADERSHIP TEAM

Prof Robert McLaughlin



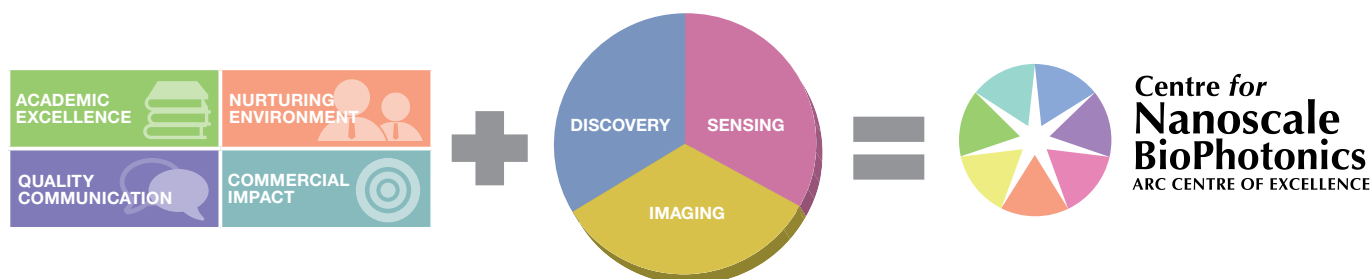
ASSOCIATE INVESTIGATORS AI





PARTNER INVESTIGATORS PI

RESEARCH TEAMS

CNBP Strategy

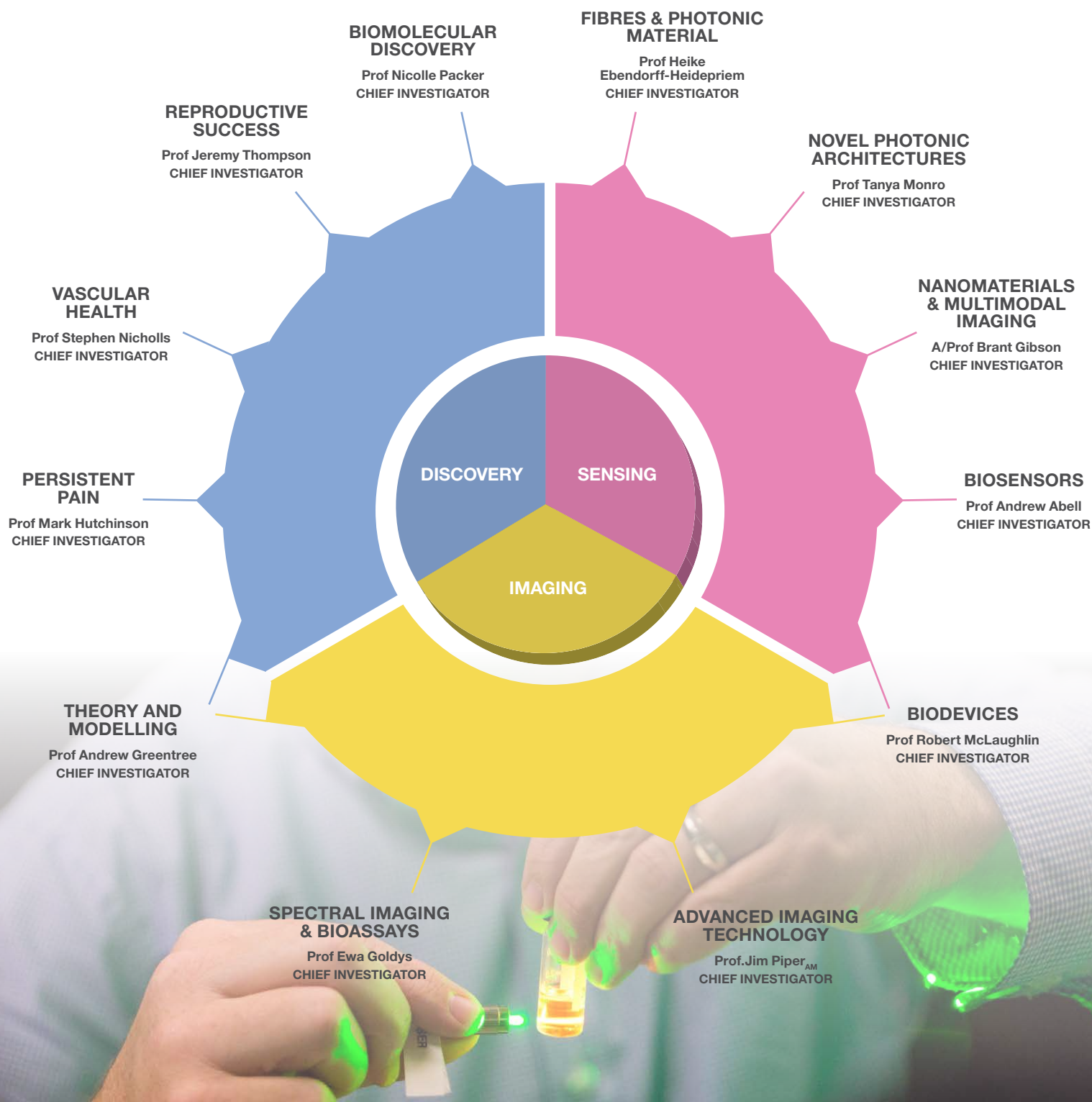
CNBP will drive the development of new devices to measure and sense at the nanoscale level, providing powerful new ways of understanding cellular processes within the human body.



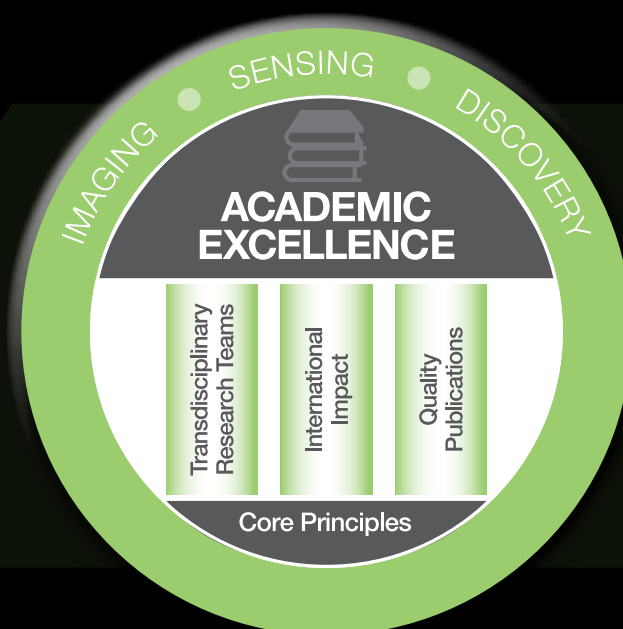
	ACADEMIC EXCELLENCE 	NURTURING ENVIRONMENT 	QUALITY COMMUNICATION 	COMMERCIAL IMPACT 
Strategic	<ul style="list-style-type: none"> • Delivering research excellence in Nanoscale BioPhotonics; • International recognition of the Centre and its researchers as leaders in Nanoscale BioPhotonics; • Focussed research priorities. 	<ul style="list-style-type: none"> • Provide individually tailored career development focusing on traditional and non-traditional pathways; • Encourage children and young adults to pursue careers in research; • Foster resilience; • Growth from positive failure. 	<ul style="list-style-type: none"> • Increase public awareness of value of science; • Engage with stakeholders to demonstrate impact and relevance of CNBP research; • Bridge communication gaps between disciplines and geographic locations; • Increase reputation and collaboration for new opportunities. 	<ul style="list-style-type: none"> • Translate research in a timely manner; • Deliver needs-driven research; • Capture high-value IP portfolio; • 20 Outcomes from 20 ventures by 2020.
Tactical	<ul style="list-style-type: none"> • Attract best people to produce impactful research outcomes; • Set and contribute to International research agenda; • Develop research synergies to address centre flagships. 	<ul style="list-style-type: none"> • Provide supervision and project management opportunities; • Drive transdisciplinary research; • Mentor ECRs and students; • Champion equal opportunity policy. 	<ul style="list-style-type: none"> • Benchmark best practice; • Leverage technology; • Leverage existing and grow new networks with prioritised relationships; • Ensure consistent brand identity; • Develop internal and external 'go to' spokespeople. 	<ul style="list-style-type: none"> • Build collaborative projects with large companies; • Spin out small companies; • Engage with end users throughout projects; • Train ECRs about commercialisation.
Operational	<ul style="list-style-type: none"> • Build large transdisciplinary teams to solve major challenges; • Engage with key international and national stakeholders; • Structure connecting networks of researchers; • Develop research integrity policy and scrutinise research. 	<ul style="list-style-type: none"> • Enable workshops and professional development; • Support 5% time for non-research activities; • Train individuals based on interest, strength and existing capabilities; • Offer awards and travel grants; • Implement gender equity and diversity policy. 	<ul style="list-style-type: none"> • Tailored communications and activities for target audiences; • Build common language; • Develop key messages and consistently branded communications; • Identify and train individuals; • Convene expert advisory committees and workshops including key stakeholders. 	<ul style="list-style-type: none"> • Market CNBP to potential partners; • Attract collaborative funding for new projects; • Build partnerships with end-users; • Develop internships with industry and end users; • Grow technology readiness levels.
Contingency	<ul style="list-style-type: none"> • Grow strategically, rewarding existing organisational support; • Secure expert advisor network from industry, communication, academia and policy to ensure sound governance and maximum impact; • Structure outputs for maximum benefit across multiple domains. 			
Legacy	<ul style="list-style-type: none"> • Setting the agenda for Nanoscale BioPhotonics research with foundational papers in the public domain; • Resource the Australian community with examples of how to deliver bold science successfully; • Disruptive tools using light to measure - allowing biologists to ask new questions / solve hard problems; • Knowledge and tools for work in transdisciplinary and/or translational research; • CNBP alumni are trained to be transdisciplinary science leaders and communicators in and out of Academia; • End Users have an increased awareness about the research / clinical / commercial opportunities created by Nanoscale BioPhotonics; • Job creation through spin-out companies and exposure of scientists to entrepreneurial and Industry practices; • Legacy partners continue CNBP work beyond current funding. 			

CNBP Focus Areas within Discovery, Sensing & Imaging

CNBP carries out fundamental research strategically directed at the **discovery** of molecular-nanomaterial- and optical fibre-based light-responsive tools that **sense** and **image** the molecular origins of health and disease. Our cohesive program is focussed on research challenges in **Persistent Pain, Reproductive Success** and **Vascular Health**. We seek to understand the complexity of the living body, casting new light on how life begins and how our brain works.



Academic Excellence



The Centre for Nanoscale BioPhotonics (CNBP) carries out fundamental research strategically directed at the discovery of molecular-nanomaterial- and optical fibre-based light-responsive tools that sense and image the molecular origins of health and disease.

Our cohesive program is focussed on research challenges in Persistent Pain, Reproductive Success and Vascular Health.

We seek to understand the complexity of the living body, casting new light on how life begins and how our brain works.

Brighter Signals from Nanoparticles

CNBP RESEARCHER

Dr Philipp Reineck



CNBP ASSOCIATE INVESTIGATOR

Dr Yiqing Lu



Photostable Nano-Probes Dr Philipp Reineck

Fluorescent nano-probes are able to provide contrast to specific parts of biological cells. This approach makes it possible to investigate single cells in real time and observe processes such as active transport of cell components along intracellular “highways” called microtubules. This requires fluorescent probes with persistent fluorescence, in contrast to typical probes which rapidly fade during imaging—an effect known as photo-bleaching. To overcome this problem, we developed fluorescent diamond nano-probes that are perfectly photostable. Additionally, they can also sense temperature and magnetic fields.

We have recently discovered a new fundamental phenomenon: an increase of diamond fluorescence caused by a magnetic field. In our interdisciplinary team within the CNBP we also develop diamond probes that can sense important cellular signalling molecules. This way we will be able to not only detect cellular signals, but simultaneously track the movement of these molecules. We also continue to push the boundaries of fundamental science to develop new classes of ever-brighter and smaller diamond probes.

Our probes are not only photostable, but can also sense temperature and magnetic fields.

Nano Laser Crystals Dr Yiqing Lu

The applications of nanoparticles in microscopy imaging offers prospects to investigate dynamic biomolecular processes in ultra-fine sub-micrometre detail. However, this requires high light illumination levels that can damage biological samples. Furthermore, unavoidable background signals in such samples limit the contrast of what can be observed. In our research breakthrough we developed a new generation of bright luminescent nanocrystals, with high concentration of chemical element thulium, extensively used in lasers. This new particle exhibits a unique “photon avalanche” effect, whereby emission photons are generated at higher efficiency, substantially amplifying brightness even for low-power infrared illumination light. This discovery has allowed us to achieve “super resolution” imaging of objects as small as 28 nm. Our approach has with multiple other benefits such as suppression of unwanted background interference as well as reduced complexity and cost of the complete imaging system. Our work shows that ultrasall laser nanocrystals represent new generation luminescent probes for optical microscopy at the nanoscale.

Our breakthrough super-resolution microscopy at low illumination levels builds on our unique laser nanocrystals.

Big Data to Help See Small Cells

CNBP CHIEF
INVESTIGATOR
& CO-DEPUTY
DIRECTOR

Prof Ewa Goldys



New Cell Colour Technology

Prof Ewa Goldys

Our newly developed technology enables colour to be used as a uniquely powerful diagnostic and detection tool for medicine, with additional applications across the life sciences, manufacturing and the food industry.

Our pioneering hyperspectral imaging technique allows us to extract specific biomolecular information, hidden in the fluorescent colour signatures of living cells and tissues.

Using this information, we can non-invasively determine cell biochemistry. We are able to test hypotheses about the similarity (or otherwise) of cells and cell populations and about the effects of chemical interventions in those cells, such as drug treatment.

In our approach, we obtain fluorescence images of live cells and tissues at a number of selected excitation wavelengths, capturing their fluorescence emission at multiple specified, wavelength ranges. This accurately quantifies their fluorescence (colour).

We then analyse micrographs of cell populations using custom-developed software to gather information about hundreds of quantitative features including cell size, shape, brightness and texture.

This dataset provides richly detailed information about living cells, letting us unveil the presence of biomolecules such as NADH, flavins, retinoids, cytochrome C, and many others, and their cellular content.

This next-generation methodology allows our team to non-invasively and

This next-generation methodology allows our team to non-invasively and rapidly detect major health conditions including neurodegeneration, cancer and diabetes.

rapidly detect major health conditions including neurodegeneration, cancer and diabetes. Notably, these cellular and molecular measurements can be done non-invasively, in living organisms. The method offers the potential for healthcare decisions to be based on the health needs of the individual, and their unique biological characteristics.

Using our technique, we will ultimately be able to look at the colour of a patient's cells and tell if the patient is sick or healthy, and how they respond to treatment.

We also see commercial applications for our healthcare, in industrial and environmental monitoring—such as in determining the quality of fresh and processed foods; and in industrial processes to identify microbial contamination.

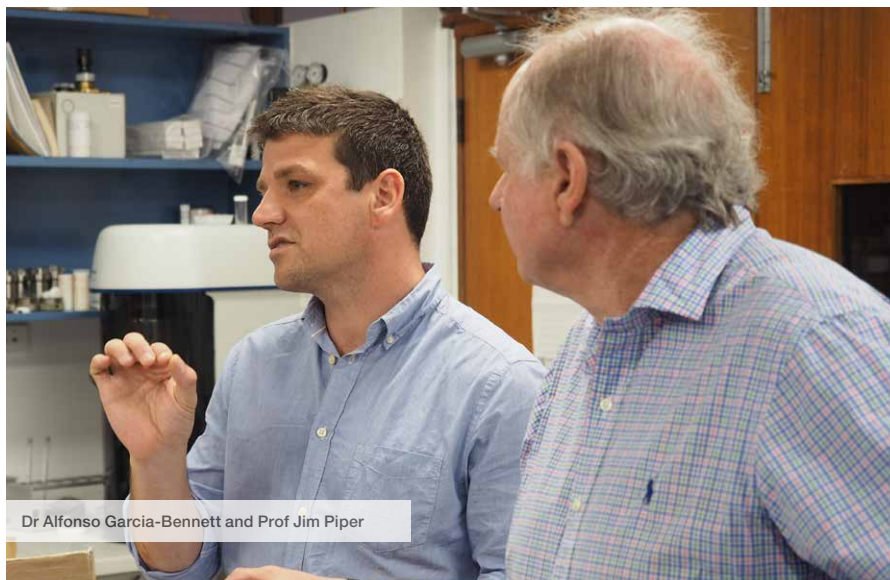


Advanced Imaging Technology Team

IMAGING: Prof James Piper^{AM}, Dr Yiquing Lu, Dr Lianmei Jiang, Dr Denitza Denkova, Mr Tom Lawson, and CNBP students: Mr Alexander Ariola, Dr Xianlin Zheng, MQ, Ms Victoria Wang, Mr Yujia Liu, Mr Yan Wang.

Highlights from 2017

- In collaboration with Zhang group, State Key Laboratory of Molecular Engineering of Polymers, Fudan University, we have demonstrated for the first time lifetime imaging of luminescent nanoparticles in deep-tissue using down-conversion emission from engineered lanthanide nanoparticles in the second infrared window. This has been applied to demonstration of multiplexed *in vivo* lifetime imaging in a mouse model to determine ratios of 3 specific tumour biomarkers for non-invasive tumour identification. (With Yiqing Lu and Xianlin Zheng).
- Substantial progress has been made with automated synthesis of NaYF₄:Yb,Tm upconversion nanocrystals, with excellent batch-to-batch repeatability - crystal size, crystal phase, luminescence intensity and lifetime. This is a critical advance since repeatable fabrication underpins all applications. Nanocrystals from this program have already been used for demonstration of super-resolution of single nanoparticles in biological material as above. (With Xianlin Zheng).
- A high-pressure capillary microdroplet generator has been developed which enables polymer microspheres with diameters as low as 5µm to be fabricated. When loaded with upconversion nanocrystals of specific luminescence lifetimes these can be used for lifetime-multiplexed microbead assays in microfluidic flow. (With Lianmei Jiang, Yan Wang, Yiqing Lu).



Dr Alfonso Garcia-Bennett and Prof Jim Piper

Team Goals & Plans for 2018

- Super-resolution based on UCNPs will be extended to lifetime-multiplexed super-resolution with subsequent application to biological systems
- Lifetime imaging and lifetime-based multiplexing using UCNC probes will be extended to a range of biological systems (note also spin-off application in security labelling)
- We will explore co-doping and related strategies to demonstrate lifetime changes in bio-labelling of UCNPs
- We will progress microfluidic developments to demonstrate integrated target-cell capture, concentration and luminescence-based detection at chip level, including microfluidic flow cytometry
- Alternative biodetection strategies including SERS and SRS nanoprobe will also be explored.



Dr Yiquing Lu

Spectral Imaging and Bioassays Team

IMAGING: Prof Ewa Goldys, Dr Ayad Anwer, Dr Jared Campbell, Dr Biju Cletus, Mr Alexander Arriola, Dr Sandhya Clement, Dr Xiaoteng Jia, Ms Zofia Kautzka, Mr Chrys Maoudis, and CNBP Students: Mr Jason Chen, Mr Kashif Islam, Mr Felix Wang, Mr Meng He, Mr Kaixin Zhang, Mr Abbas Habibalahi, Ms Fang Gao, Mr Fei Deng, Ms Yuan Liu, Mr Aziz Ul Rehman, Mr Saabah Bin Mahbub, Mr Piotr Wargocki.

Highlights from 2017

Goldys' team pursues two distinctive programs within CNBP.

Non-invasive molecular imaging:

- completed a joint project with the Reproductive Success team concerned with non-invasive assessment of embryo quality published in a leading journal in reproduction;
- our world-first label free imaging of connective tissue was employed for the assessment of meat quality;
- our successful hyperspectral analysis of eye biopsies and the identification of cancer margins has led to a funded partnership with an opthalmology company Personal Eyes Ltd;
- in partnership with a clinician Dr Dominic Rowe from Macquarie University Hospital we successfully applied hyperspectral imaging to diagnostic and treatment monitoring in Motor Neuron Disease. This result is being patented; and
- attracted NHMRC funding for hyperspectral diagnostics of diabetic kidney disease with a clinician Dr Carol Pollock from Royal North Shore Hospital.

Cytokine detection:

- we demonstrated world-first *in vivo* measurement of stimulated cytokine release in the living brain, in partnership with Dr Mike Baratta from Colorado University Boulder;
- our cytokine detection fibres have been deployed to the University of Adelaide for the assessment of cytokine release in the spinal cord; and
- we demonstrated an *in vivo* implantable device for cytokine sensing.



Prof Ewa Goldys

Photo: Chris Stacey



Members of the spectral imaging and assays team

Team Goals & Plans for 2018

- the development of real time cytokine sensors; and
- the hyperspectral imaging program will continue engaging with all three CNBP biological challenges.

Biodevices Team

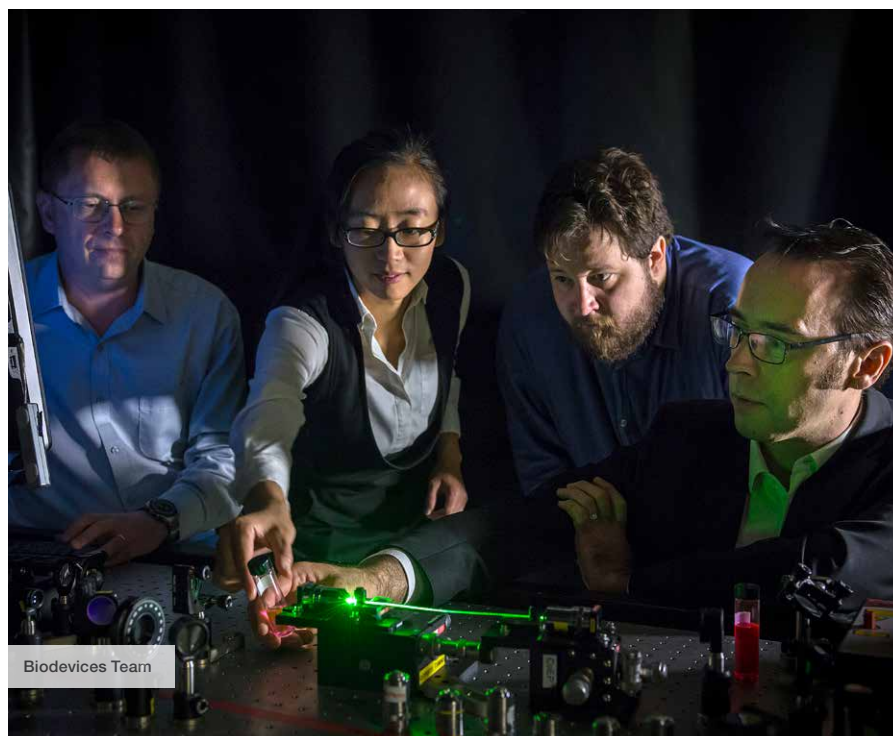
IMAGING & SENSING: Professor Robert McLauglin, Dr Jiawen Li, Mr Bryden Quirk, Mr Rodney Kirk.

The Biodevices team had successes in both research and commercial translation during 2017. Through collaborations with other CNBP researchers, the team have begun to bring new imaging techniques into a range of biological challenges.

In parallel, 2017 saw the launch of Miniprobes Pty Ltd, a spin-out company focused on commercialisation of the team's world-leading imaging needle technology. Attracting seed funding from both the SA State Government and the University of Adelaide, the company launched its first product, resulting in negotiations with a number of potential industry partners.

Highlights from 2017

- Development of optical techniques to measure blood flow in skin to provide new insights into how our bodies regulate temperature.
- Publication of our work describing a new type of optical imaging probe – a flexible imaging needle for use in detecting disease in airways.
- SA State Government seed funding from TechInSA for our spin-out company, Miniprobes Pty Ltd.
- Commercial launch at Photonics West, San Francisco, of Miniprobes' first product – a handheld imaging needle able to acquire high resolution optical images deep within tissue.



Team Goals & Plans for 2018

- Development of a new generation of multi-function imaging needles, combining high resolution imaging with optical fibre sensor technologies to provide a deeper understanding of biological processes.
- Exploring new technologies in 3D printing of tiny microstructures to print a lens onto the end of an optical fibre, the thickness of a human hair.
- Extending Miniprobes' products into new industrial markets.



A handheld imaging needle developed by Miniprobes

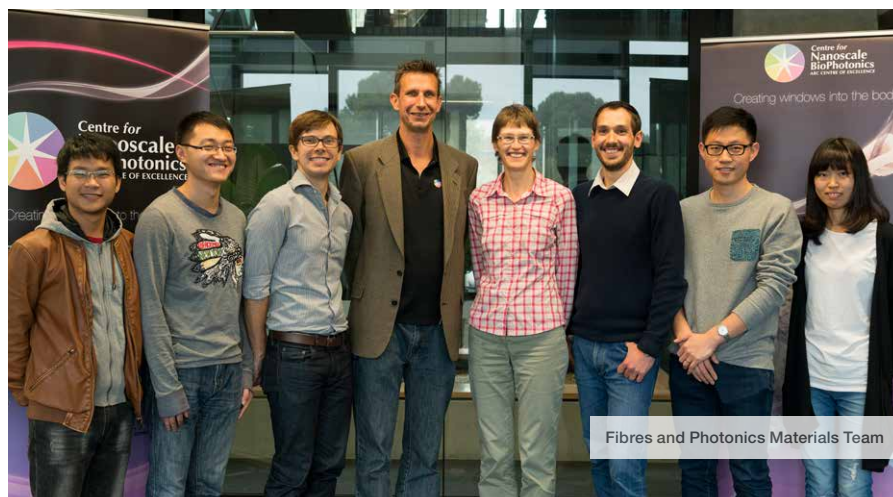
Fibres and Photonics Materials Team

SENSING: Prof Heike Ebendorff-Heidepriem, Dr Erik Schartner, Dr Roman Kostecki, Dr Peipei Jia, Dr Akash Bachhuka, Dr Tim Nguyen, Dr Stephen Warren Smith and CNBP students: Mr Xuanzhao Pan, Mr Yunle Wei, Ms Mengke Han, Mr Mustaf Bekteshi, Mr Weikun Huang.

Highlights from 2017

The Fibres and Photonic Materials Team continued 2017 working together with our colleagues across the Centre to create new materials and fibre sensing concepts as well as to translate these new materials and tools for use by biologists, industry and in an outreach application, for artists.

- Fertilisation sensing: In collaboration with the Reproductive Success and BioSensor teams, Dr Roman Kostecki led the creation of a novel photonics device concept for measurement of fertilisation success during (or immediately after) intracytoplasmic sperm injection (ICSI).
- Cancer margin sensing: In collaboration with clinicians, Dr Erik Schartner advanced the development of the pH fibre sensor as a cancer margin probe through funding from the Commercial Accelerator Scheme of the University of Adelaide.
- Imaging+Sensing probe: Developed by combining our temperature sensing fibre probe with the optical coherence tomography based imaging technique of BioDevices team.
- Index-based sensing platforms: In collaboration with CNBP International Partner IPHT, Dr Stephen Warren-Smith developed label-free fibre-based sensing platforms such as ultra-short Fabry-Perot cavities written into optical micro-fibres.
- Fibre surface functionalisation: Dr Akash Bachhuka established a novel and solvent free coating method employing plasma polymerization for surface functionalization of exposed core optical fibre.
- Exposed core fibre: Dr Erik Schartner fabricated for the first time a small-core exposed core fibre with low loss [paper in Optical Materials Express].



Fibres and Photonics Materials Team

- Gold nanomembranes: In collaboration with the University of Cambridge, UK, Dr Peipei Jia achieved large-scale integration of gold nanomembranes for cryoEM.
- Tellurite sol-gel: By in-depth analysis of the underlying mechanisms of metallic tellurium and crystalline tellurium oxide formation, Master student Xuanzhao Pan successfully prepared for the first time a highly transparent tellurite glass film using the sol-gel technique.
- Plasmonic glass: PhD student Yunle Wei and Dr Tim Zhao discovered a universal method to manipulate the formation of noble metal nanoparticles in any type of glass, including tellurite, silicate, germanate and borate glass (patent pending).
- Demonstrate *in vivo* spinal fluid ion sensing
- Use of temperature fibre probe for a medical study on brain temperature effects from MDMA/minocycline
- Achieve multiplexing in sensing by immobilising different size nanoparticles across the core of exposed core fibre
- Analyse the stability of gold nanomembrane and design the optimum features for single particle cryoEM
- Advance plasmonic glass towards noble metal nanoparticles induced upconversion improvement in glass and potential application for temperature sensing
- Develop fibre sensors for detection of specific biochemicals in food such as almonds.
- Commercialisation: Further commercialisation of our cancer margin probe. Further R&D towards commercialisation of our coloured glass and fertilisation sensor technologies. Explore commercialisation of our gold nanomembrane platform for sensing and/or cryoEM.

Team Goals & Plans for 2018

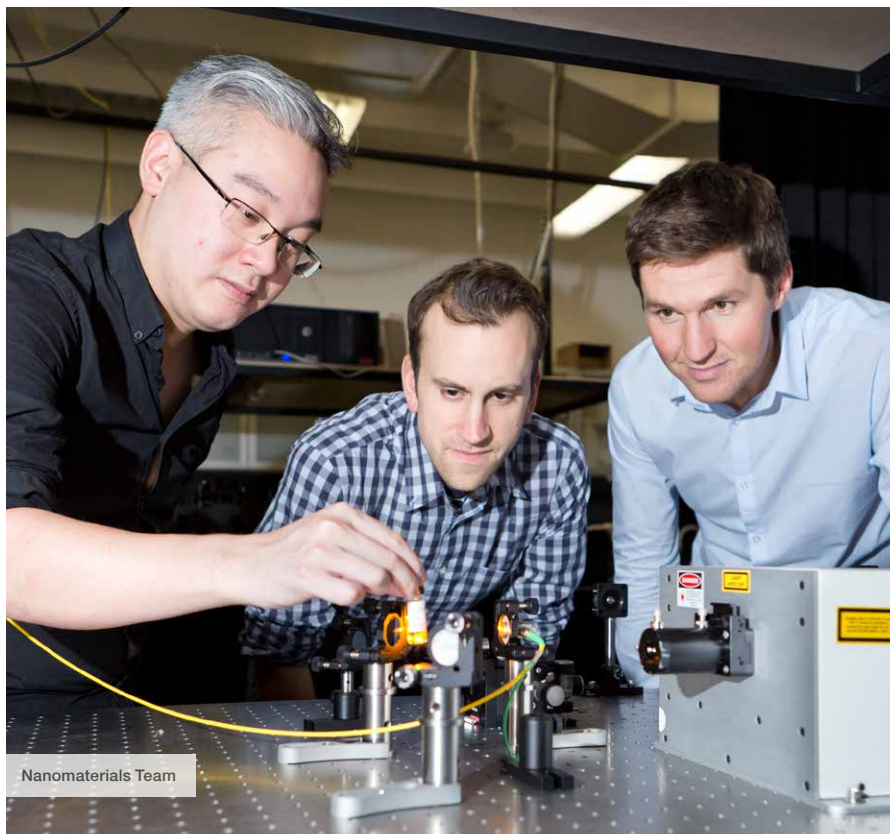
- Further pushing the limits in extruded fibre fabrication, such as demonstration of low-loss hollow core fibre for Raman sensing and multi-core fibre for high-resolution in-vivo imaging
- Demonstrate fertilisation sensing during ICSI using our novel photonic device concept
- Assess silk-coated fibre for sensing

Nanomaterials & Multimodal Imaging Team

SENSING: A/Prof Brant Gibson, Dr Philipp Reineck, Dr Antony Orth, Mr Ashleigh Heffernan, Ms Nafisa Zohara, Mr Marco Capelli, Ms Nuriyah Aloufi, Ms Emma Wilson.

Highlights from 2017

- 4 RMIT-based PhD students have published their first journal papers in 2017 (3 as lead author)
- The nitrogen-vacancy (NV) centre in diamond is a unique optical defect that is used in many applications today and methods to enhance its fluorescence brightness are highly sought after. M. Capelli et al. observed experimentally an enhancement of the NV quantum yield by up to 7% in bulk diamond caused by an external magnetic field relative to the field-free case.
- Bright and photostable NV fluorescence from unprocessed detonation nanodiamond (DND), 4-6 nm in size, has also been observed by P. Reineck et al. This result opens the possibility of applications requiring the crossing of the blood-brain barrier.
- P. Reineck et al. has also demonstrated that DNDs exhibit significant and excitation-wavelength-dependent fluorescence from the visible to the near-infrared spectral region above 800 nm, depending on the surface functionality of the DND particles. This work was published in the prestigious ACS Nano journal.
- A. Heffernan et al. published an approach for depositing nanodiamonds in pre-determined arrays which have applications for hybrid photonic devices and quantum biosensing.
- N. Zohara et al. published a method to study the intrinsic optical characteristics of individual copper (I) oxide (Cu_2O) nanocubes which have applications from photocatalysis to angiogenesis.



Team Goals & Plans for 2018

- Use multicore optical fibers (MOFs) to develop compact microendoscopes which can visualize hard-to-reach regions of the body. We plan to realise a method to digitally adjust the collection aperture and therefore extend the depth of field of lensless MOF imaging probes. The aim is to enable imaging of complex 3D objects without the requirement of lenses, scan units or transmission matrix calibration systems
- Develop 'point-of-care' imaging devices using a mobile phone which is capable of both brightfield, darkfield and 3D imaging modes, enabling microscopic visualization of samples ranging from plants to mammalian cells.



- Explore the sensing potential of DND and examine changes in the photoluminescence (PL) emission from the nanodiamond. It is anticipated that the PL of the DND will change as a function of pH, for example.
- Improve the intrinsic magnetic field sensitivity of hybrid diamond-doped optical fibres from the current value of $11\text{uT}/\sqrt{\text{Hz}}$.

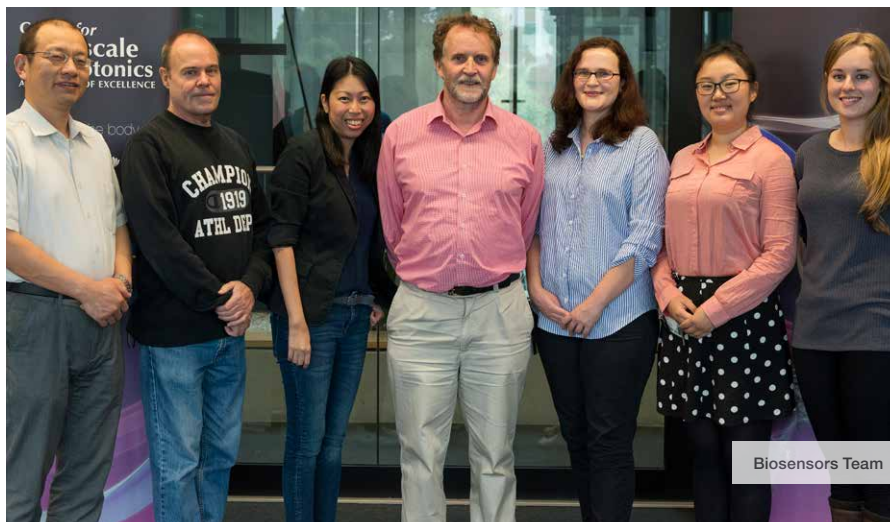
BioSensors Team

SENSING: Prof Andrew Abell, Dr Sabina Heng, Dr Jingxian Yu, Dr Michelle Zhang, Dr Victoria Peddie and CNBP students: Ms Georgina Sylvia, Mr Nicholas Schumann, Mr Yuan Qi Yeoh, Ms Aimee Horsfall, Ms Kathryn Palasis, Mr Patrick Capon.

Highlights from 2017

Scientific and professional achievements include:

- Photopharmacology: A photoswitchable anticancer agent has been developed where a cis-enriched state selectively inhibits both breast and colorectal carcinoma cell lines. The alternative trans-enriched state is not cytotoxic.
- Super-imaging fluorescence microscopy has demonstrated the accumulation of a new antibiotic in the cytoplasm of *S. aureus*, but not *Escherichia coli*. This novel fluorescent probe provides new insights into the mechanism of uptake, efflux and metabolism of BPL inhibitors in *S. aureus*.
- A new spiropyran with enhanced fluorescence has been developed and published as a bright, photostable and red-emitting calcium sensor.
- An organic fluorophore-nanodiamond hybrid sensor has been developed for photostable imaging and orthogonal, on-demand biosensing.
- A reversible, reaction-based 'turn-off' probe has been developed that gives increased fluorescence and absorbance at lower concentrations of GSH.
- A new pragmatic approach for controlling mechanisms responsible for charge transfer in helical peptides through the introduction of a side-bridge. New building blocks for future three-dimensional peptide-based molecular circuitry.
- Cell-permeable fluorescent chemosensors have been incorporated into a liposome to block membrane permeability to allow selective detection of extracellular Zn_2^+ , Ca_2^+ and GSH: A new general sensing platform.



- Success with an ARC DP grant Andrew Abell & Jingxian Yu 'Bio-Inspired Molecular Electronics: From Nanoscience to Nanotechnology' in collaboration with Prof Wenjing Hong (Xiamen University) and Prof David Cahen (Weizmann Institute of Science).
- Patent 'New Antimicrobial Compounds' awarded (ZL2012800549094)
- Andrew Abell spent four weeks at the University of Strasbourg as a visiting Professor to build research links and student exchange programs.
- The development of a new fluorescent peptide constraint that both induces secondary structure and allows imaging.
- Photoswitchable cyclic antimicrobial peptides to minimize resistance and maxiasse therapeutic effect.
- A new three component sensor: Synthesis and optimisation of a cell nuclear targeting nanodiamond based ROS sensor
- Electrochemical detection of ligand/protein interaction using a photoswitchable nNOS β -finger peptidomimetic.

Team Goals & Plans for 2018

- A superbright, cell-trappable sensor with red fluorescence for improved sensitivity for the detection of intracellular HNO.
- A ratiometric sensor for quantification of NO level in cardiovascular system.
- Photoregulation of NOS activity using new azobenzene- and spiropyran-based inhibitors and monitoring downstream changes in RNS levels.
- Lithium 'Hot-spots': Real-time Analysis of Ion Conductance in Aquaporin-1 channels.
- The introduction of sensing capability into IVF holding pipettes, a collaborative approach.
- Photoswitchable cyclic peptides that bind and release Alzheimer disease-causing amyloid peptides 'on demand'.
- Peptide azobenzene dimers as prodrugs for selective inhibition of the proteasome.

Theory and Modelling Team

IMAGING & DISCOVERY: Prof Andrew Greentree, Dr Daniel Drumm, Dr Ivan Makystov, and CNBP students: Mr Josef Worboys, Ms Maria Javaid.

Highlights from 2017

Photoacoustics:

- Development of new techniques to understand the interaction of light and sound in fluids with bubbles.
- Application of that research to the design of ultra-compact low power frequency combs and novel hydrophones
- Prediction of plasmonic effects in liquid metal nanoparticles, and new collaboration with Prof Dickey from North Carolina State University

Search/enhanced microscopy:

- Solved optimal search problem for single emitter with verification
- Analytical results for multi-particle quantum correlations

Ab initio modelling:

- First calculations of MoS₂ nanoflakes (search for novel fluorophores)
- Survey of electric field response of all table TMDCs

1D imaging/plasmonics:

- Simulations showing response of platinum wire to changing carbonaceous content (practical ion beam induced deposition)
- Exploration of Er and rhodamine on fibre searching for nonlinear response.



Theory and Modelling Team

Team Goals & Plans for 2018

Photoacoustics:

- Experimental demonstration of photoacoustics in liquid metal nanoparticles and bubbly water

Search/enhanced microscopy:

- Verification applicability of enhanced search to Olympus microscope
- Proof of concept experiment
- Publish multi-particle solution
- Design of superresolution 'grid' based quantum microscope
- Proof of concept experiment

1D imaging/plasmonics:

- Verification of plasmonic properties of platinum nanowires
- Demonstration of prototype 1D imaging



Prof Andrew Greentree

Biomolecular Discovery Team

DISCOVERY: Prof Nicolle Packer, Dr Andrew Care, Dr Lindsay Parker, Dr Nicole Cordina, Dr Edward Moh, Dr Liisa Kauto, and CNBP Students: Mr Christopher Ashwood, Mr Shathili Abdulrahman, Ms Sameera Iqbal.

Highlights from 2017

Many of the highlights of 2017 revolve around the professional development of the ECRs in the Biomolecular Discovery team (successful Cancer Institute NSW Early Career Researcher Fellowship, ARC DECRA Fellowship and new appointment at Griffith University); as well as significant advances in the understanding of the challenges of translating the properties of nanoparticles to biological applications.

- Combined MQ and CINSW grants have enabled new live cell nanoparticle imaging microscopy to be established. Together with new time-gated microscope modalities we have enabled high-speed screening of biomedical samples with highly fluorescent nanoparticles such as Upconversion Nanoparticles (UCNPs) and Nanodiamonds at high resolution in both fixed and live cells.
- The visualisation of nanoparticles has been further enhanced by the application of the CNBPs Super Resolution microscopic capability and the use of lanthanide chelate tags to reduce cellular background autofluorescence.
- The functionalisation of nanoparticles has been optimised using different approaches: using the silica-binding peptide system to functionalise a range of silica-coated nanoparticles to selectively label cells in biological fluids; hydrophobic UCNPs have successfully been water dispersed and functionalised with specific polymer coatings (currently being patented); direct attachment of antibodies (IgGs) to nanodiamonds via a polyethylene spacer arm has been reproducibly used for targeting specific inflammatory biomarkers.
- Unique protein glycosylation has been found to offer novel molecular targets to visualise changes that



occur in inflammation, neuronal activity, cardiovascular disease and metastasis.

- A novel mechanism of selectively labelling immunoglobulin M (IgM) will allow new mechanisms of visualisation, targeting of interactions and drug delivery (currently being patented) as will the development of new protein self-assembling nanocages.

Team Goals & Plans for 2018

New Research Fellows will be employed to replace and complement postdocs moving to fellowships and AI status, we will focus on completion of the development and biological application of the most promising functionalised nanomaterials.

- Use our collaborations with University of Colorado, University of Tasmania and Harvard University to apply nanodiamond tracers further into live brain tissues.
- Improve our conjugation of lanthanide chelates to antibodies to reduce interference with the binding site as well as increasing and multiplexing the time gated fluorescent labelling of cells.
- Exploit different targeting molecules such as IgMs and lectins on nanodiamonds, mesoporous silica and UCNPs for selective recognition of cell surface molecules in both live and fixed cells.
- Work with commercial partner (Bruker) to move the MALDI-MS imaging of cells in Formalin-Fixed Paraffin Embedded tissues into pathology laboratories.
- Use microfluidics and Surface Enhanced Raman Spectroscopy at the single cell level of molecular visualisation.
- Compare molecular profile of cells grown in two dimensional culture with those grown in model three dimensional matrices for the development of an improved cellular model of the brain.

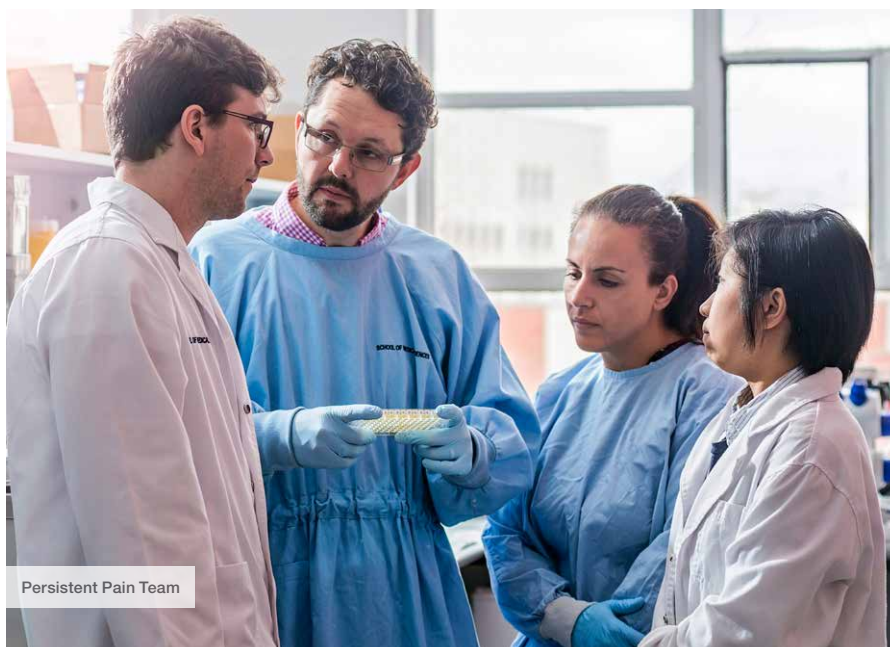
Persistent Pain Team

DISCOVERY: Prof Mark Hutchinson, Dr Sanam Mustafa, Dr Georgios Tsiminis, Mr Jacob Thomas and CNBP Students: Mr Stefan Musolino, Mr Azim Arman, Ms JiaJin Liu, Mr Jonathan Jacobsen, Ms Vicky Staikopoulos, Mr Samuel Evans, Ms Krystal Iacopetta.

Highlights from 2017

The pain and biomarker research team continued 2017 working extensively with our colleagues across the Centre allowing us to make significant breakthroughs in technical methodological approaches and exploration of the basic science of the molecular events at the neuroimmune interface. This year also saw us extend our reach out of the brain and into industry:

- Through ongoing collaborative efforts with scientists across the CNBP we have deployed the first spatially resolvable cytokine sensor into the spinal cord of rats to make repeated measurements of proinflammatory cytokines via an indwelling catheter. This technology will allow us to understand the time course of immune signalling in the spinal cord during states of exaggerated pain and importantly resolve the anatomical location these signals are arising from.
- In partnership with HUST we have generated the first images that capture the time course of neuroimmune changes within the spinal cord and determined how these change across degrees of nerve injury. Importantly, by coupling the dual use of two photon microscopy and photoacoustic imaging we have also gained insights into the brain activity associated with these cellular changes. These data are the first of their kind and implicate neuroimmune processes not only in the creation and maintenance of pain states, but also in modulating their severity.
- We have generated platform working models of receptor signalling employing Bioluminescence



Resonance Energy Transfer (BRET) technology that is affording us the capacity to explore the molecular workings of the neuroimmune interface.

- Industry collaborations have seen our team deploy fibre based sensors onto farms and factory floors, for food and wine quality assessment. These advanced technologies are affording nondestructive assessments in real time and at line speed.

spinal glial cells that have not been visualised previously owing to their scarcity.

- Quantify and spatially resolve specific protein release at the neuroimmune synapse with sensitivity down to single molecules.
- Deploy novel biosensors *in vivo* that allow quantification of short lived reactive chemical species, allowing the exploration of critical reactive signalling events.

Team Goals & Plans for 2018

- Deploy the world's first label free signature of exaggerated pain states paving the way for an objective pain biomarker in livestock.
- Visualise glial reactivity and immune signalling during exaggerated pain states *in vivo* in real time.
- Use bright and long-lived nanoparticles to detect rare cellular events and protein expression within

Vascular Health Team

DISCOVERY: Prof Stephen Nicholls, Dr Christina Bursill, Mr Benjamin Pullen, Dr Nisha Schwarz, Dr Jarrad Goynes.

Highlights from 2017

The vascular health team had a successful 2017 with their first interdisciplinary publications within the Centre and expanding new collaborations across the Centre. We have continued developing novel approaches for sensing and imaging clinically relevant targets.

- Our work on the application of a ruthenium based nitric oxide (NO) sensor has expanded from cell-free media to endothelial cells and *ex vivo* rabbit blood, and demonstrated the capacity to detect changes in intracellular NO in macrophages. A pilot study is underway in human blood samples.
- We have continued our collaborative work with chemists and physicists to develop a ratiometric sensor and on modifications that make sensors compatible with surface functionalization of optic fibres as groundwork for device development for NO or other sensing.
- We have extended the mass spectrometry studies on sialoglycoprotein signals from cholesterol-fed rabbits with the Biomolecular Discovery group.
- Our collaborative work over the last two years with chemists generated two interdisciplinary publications on application of a photo-switchable Zinc sensor in endothelial cells and an organic fluorophore-nanodiamond hybrid sensor for hydrogen peroxide in macrophages.
- We have established new collaborations for developing blood vessel specific biosensors, drug delivery tools and hybrid imaging.



With Dr Guozhen Liu two projects have been initiated including an inflammation targeted drug delivery system for atherosclerosis and an angiogenesis targeted system with microRNA delivery.

Team Goals & Plans for 2018

- Extend the application of the ruthenium based sensor to measure changes in NO in human blood in a clinical setting.
- Expand on the intracellular detection of NO in macrophages in *in vivo* animal studies, administering novel sensors to an atherosclerotic model.
- Continue collaborative work developing a biocompatible platform for nitroxyl (HNO) sensing.
- Complete multispectral analysis of aging endothelial cells to identify therapeutic targets.
- Establish a collaboration with Prof Gang Zheng at University Health Network, Toronto on multimodality imaging inside blood vessels using high-density lipoprotein based nanosensors for imaging/therapeutics.
- Continue collaboration with the BioDevices team to develop a hybrid optical coherence tomography and near-infrared fluorescence catheter for intravascular detection of atherosclerotic plaques.
- Start development of a photoacoustic imaging platform using plasmonic nanoantennas for detection of atherosclerosis in collaboration with the Theory and Modelling team.

Reproductive Success Team

DISCOVERY: Prof Jeremy Thompson, Dr Kylie Dunning and CNBP Students: Ms Hanna McLennan, Ms Megan Lim, Mr Saini Avishkar.

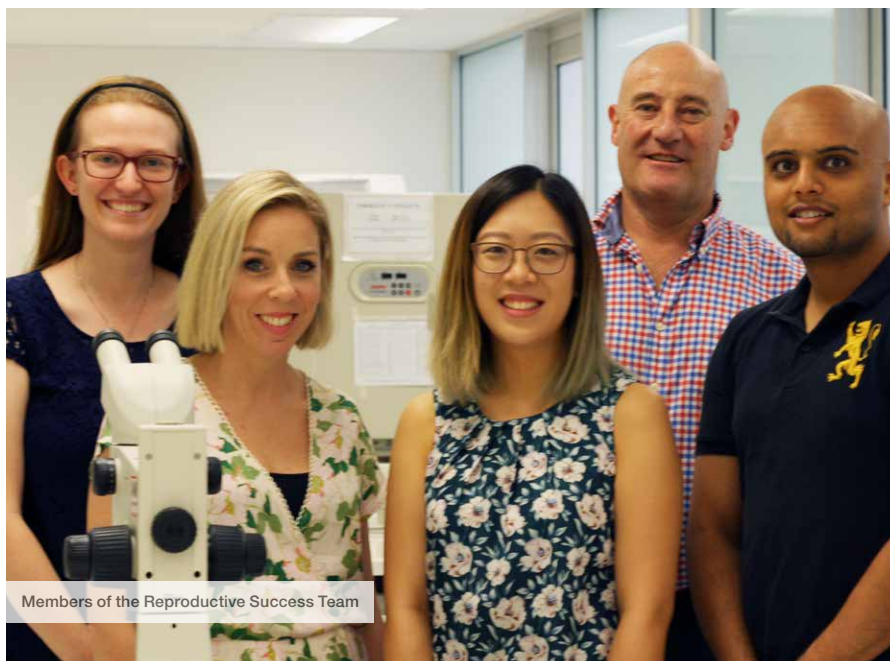
Highlights from 2017

The uniqueness of the Centre's collaborative and cross-nodal research opportunities have been highlighted by CI Jeremy Thompson's 4 month sabbatical to both the RMIT node (CI's Brant Gibson, Andrew Greentree, and Dr Tony Orth) and a Centre AI, Professor David Gardner (University of Melbourne). The four-month study period allowed for some highly innovative projects:

- 'Automation of IVF', including the development of novel 3D-printed devices using the RMIT's micron-scale 2-photon lithographic printer. The devices have been designed to incorporate various sensing modalities in addition to providing a platform for IVF automation.
- Just as innovative is the work beginning with diamond as both a 'vessel' for embryo development and cryo-preservation, which exploits the thermal conductance properties of diamond, but also as a receptacle to study electric and magnetic fields of embryos during their development, which may have predictive quality attributes.

Other 2017 highlights include:

- Further development using Sabrina Heng's zinc spyropyran probe has been advanced between PhD student Hanna McLennan and Dr Roman Kostecki, investigating a new line of tools that can assess when mammalian fertilisation takes place. This is an exciting project, which is drawing commercial interest.
- Dr Kylie Dunning joined the team, bringing a focus to the work investigating the reproductive tract and early pregnancy loss, which will utilize photonic probes to



Members of the Reproductive Success Team

investigate the uterine and oviductal environment. Kylie has also been very active in the CNBP's schools outreach program.

- AI Dr Hannah Brown joined forces with AI Martin Gosnell and clinical IVF programs in SA and WA, to further characterise specific features of human embryos using Grey-Level Co-occurrence Matrices, combined with artificial learning algorithms to identify which embryos have high probability of surviving to term. Hannah has had an outstanding year promoting CNBP research in many different media interactions, including the 'fusion' between glass sculptures and CNBP technologies, and her appointment as a "Superstar of Stem".

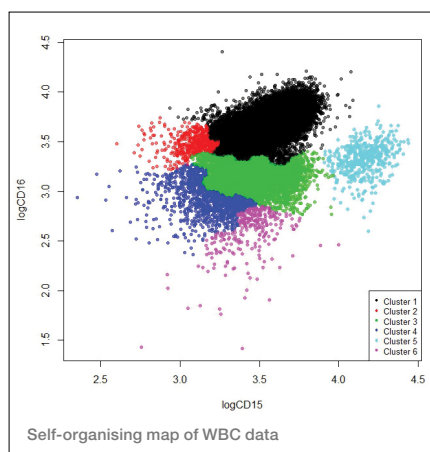
Team Goals & Plans for 2018

- Automation of the IVF process combined with embryo sensing functions will be a major focus moving forward, with further collaborations planned with robotic platform experts as well as CNBP colleagues.
- Clinical and livestock field trialling of several CNBP reproductive technologies.
- Sensing when fertilisation takes place following Intracytoplasmic Sperm Injection using the spyropyran zinc sensors.
- Using photonic fibres in utero as sensors for the uterine environment.

Highlights & Goals

Associate Investigators

Prof Irene Hudson, Prof Kevin Pfleger, Dr Abel Santos



Swinburne Grant with CNBP

Associate Investigator:
Prof Irene Hudson
Swinburne University

The CNBP-focused research of this project is Machine Learning and data driven methods, for microscopy image enhancement for imaging cytometry. Initial work shows promising results. Cytometry, “cell measurement” is the derivation of numbers (quantifiers of features) from the measurement of large populations of single cells. High-throughput single cell imaging is seen as a critical enabling and driving technology in molecular and cellular biology, biotechnology and medicine. However, to date data analytic methods for Imaging cytometry have not been able to gain full leverage of the rich information in digital imagery. This work will involve a unique biological microscopy (WBC) data set of analysed and discussed in Orth, et al., 2017, “Dictionary-enhanced imaging cytometry”. We aim to further develop methods for data-driven image restoration and denoising in the context of biological microscopy, and leverage information in digital imagery using supervised machine learning algorithms and clustering approaches along with further refinements.

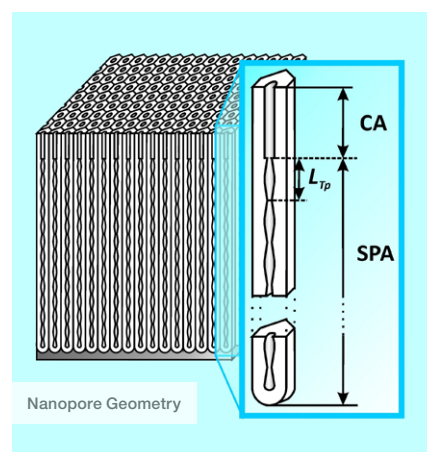


MTP Connect

Associate Investigator:
Prof Kevin Pfleger
Perkins Institute

2017 Highlights have included: working closely with CNBP to engage researchers to encourage entrepreneurial thinking through engagement with Accelerating Australia.

Accelerating Australia is a national consortium of biomedical research institutions, universities, healthcare providers and companies supported by a \$1.15 million commitment from the Medtech and Pharma Industry Growth Centre, MTPConnect, matched dollar for dollar by consortium members. It boosts biomedical entrepreneurship and translation of medical research through experiential entrepreneurial courses, brokerage and early stage commercialisation support services.



Photonics Materials

Associate Investigator:
Dr Abel Santos
The University of Adelaide

Our experimental team explores rationally designed and engineered photonic materials to achieve ultra-sensitive limits of detection of analytes with biological relevance. At the nanoscale, every photon matters and, as such, our objective is to develop photonic materials that can utilise light efficiently for sensing applications. We engineer nanoporous materials with rationally designed effective medium and integrate them into lab-on-a-chip systems to enable user-friendly biosensing nanotools that make it possible to understand molecular interactions at the nanoscale. These nanoporous matrices offer unique opportunities to increase the available area for sensing and implement new functionalisation strategies to endow these photonic platforms with highly selective sensing features for analytes of interest.

Associate Investigators

A/Prof Guozhen Liu, Dr Mike Baratta, Prof Steven Wiederman



Guozhen Liu

Nanophotonic Tools for Cytokine Sensing

Associate Investigator:
A/Prof Guozhen Liu
Macquarie University

Dr Guozhen Liu has been leading a team focusing on developing nanophotonic tools for cytokine sensing. Besides her recent patented technologies of on cell surface ELISA and spatial ELISA, Dr Liu's team has developed a nano-sensor to detect cytokines—a category of small proteins that govern basic activities of cells and coordinate cell actions.

This new generation of nanoscale 'biosensors' are capable of detecting the early signs of inflammatory disorders and even cancer. Further development could mean that the sensor becomes a common tool in precise theranostics, leading to improved health outcomes.

In 2018 Dr Liu will continue as a CNBP AI while commencing a new research role at The University of New South Wales.



Dr Mike Baratta at CNBP Annual Conference

Nanoscale Sensor to Spot Disease

Partner Organisation:
Dr Mike Baratta
University of Colorado, Boulder

It is thought that immune signals in the brain, such as proinflammatory proteins called cytokines, play a central role in normal information processing and in the development of numerous psychiatric disorders (e.g. depression, schizophrenia, autism). A major obstacle to the study of neuroimmune signaling in healthy and disease states is the absence of tools for in vivo detection of brain cytokine release. In collaboration with CNBP Deputy Director Ewa Goldys, our laboratories have designed and characterized a novel immunosensing device for capturing spatially localized cytokine release in discrete brain regions. Furthermore, our approach enables repeated measurements within the same subject such that real-time monitoring of neuroimmune signalling can be assessed in preclinical models of disease. Our development of immunosensing technologies represents a promising opportunity for unlocking the function of immune to brain communication across multiple clinically relevant applications.



Prof Steven Wiederman

Quantum Dots for Biological Labelling

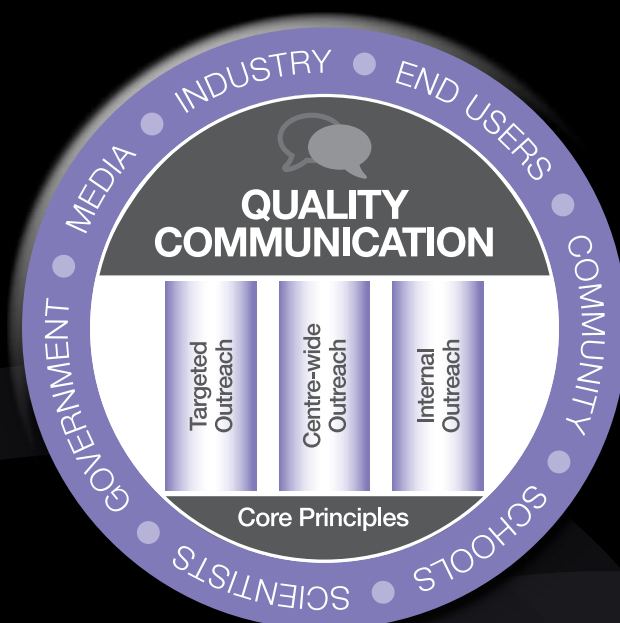
Associate Investigator:
Prof Steven Wiederman
The University of Adelaide

2017 Highlights included completion of PhD student Mengke Han who worked on semiconductive quantum dots (QDs).

QDs have been used as unique luminescent labels in biological staining and diagnostics because of their superior optical properties. An effective delivery of QDs inside of the cellular environment (intracellular) may assist in many biological applications as well as in our understanding of cellular mechanisms. In this project, we investigated the technique of microelectrophoresis to deliver monodispersed QDs into target cells. We used sharp-tipped glass micropipettes and electrical currents, with negligible cell membrane damage and cell distortion. Intracellular QDs have the potential to measure the activity of target cells in real-time.

This project has paved the way for testing several biocompatible nanoparticles for either intracellular or extracellular delivery which has many applications in bioimaging research.

Quality Communication



CNBP's communication and outreach strategy is focused on providing differing audiences with appropriate messaging, content and activities in support of the organisation, its world-leading biophotonic science and other aligned accomplishments.

Our key audiences include the scientific community, general public (including young adults and school students), government & influencers; and end users and industry. Our 'quality communication' strategy also incorporates an internal communications component, supporting the effective transfer of knowledge, as well as operational updates, to researchers across the CNBP community.

Supporting Academic Excellence

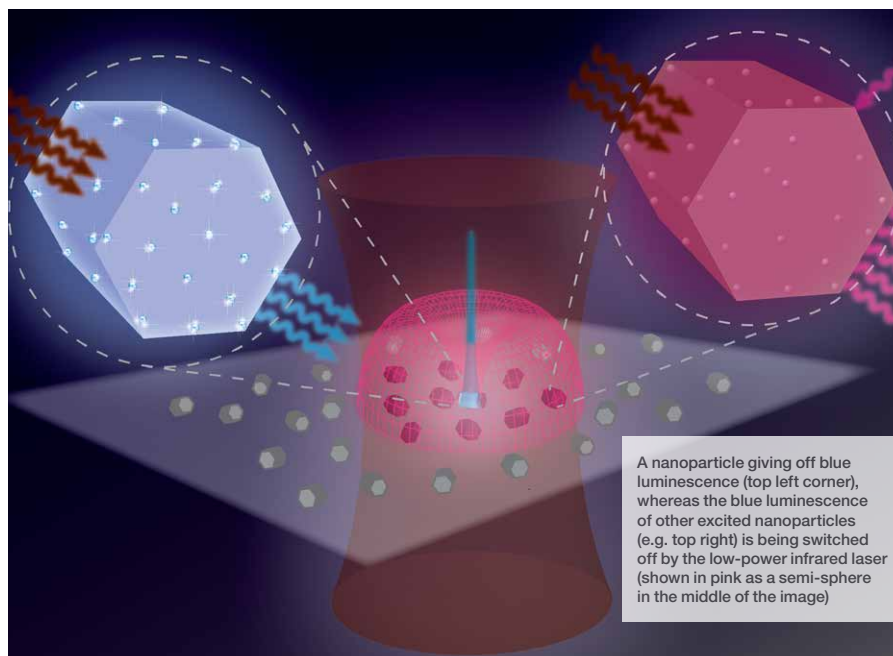
New nanoparticle discovery to aid super-resolution imaging

CNBP communications activity is actively focused on promoting the high quality science that is generated by Centre researchers as well as Partner and Associate Investigators. Awareness and visibility of influential CNBP research aids Centre reputation, opens the door to potential new collaborations and demonstrates impact and relevance of CNBP research to external stakeholders.

Researchers at CNBP, Macquarie University, the University of Technology Sydney (UTS), Peking University and Shanghai Jiao Tong University made a scientific breakthrough in the development of practical super-resolution optical microscopy. This resulted in a paper published in the prestigious journal 'Nature'.

CNBP took the lead in developing and coordinating a media release and associated promotional material for this innovative high impact paper.

Researchers have made a scientific breakthrough in the development of practical super-resolution optical microscopy.



This included liaising with key researchers Prof Jim Piper_{AM} (CNBP node leader at Macquarie University), Prof Dayong Jin (CNBP Associate Investigator at UTS) and Associate Professor Peng Xi (CNBP Partner Investigator at Peking University). Working closely with the media arms of the involved Universities, appropriate quotes were coordinated and materials produced.

This highly technical paper was picked up by six news outlets and also promoted on the CNBP Facebook page resulting in 1,049 views and featured on the @CNBPscience Twitter account gaining a further 1,707 impressions. The paper achieved an Altmetrics score of 104 (In the top 5% of all research outputs scored by Altmetric).

CNBP researchers demonstrated that bright luminescent nanoparticles can be switched on and off using a low-power infrared laser beam, and used to achieve images with a super resolution of 28nm (about 1/36 the wavelength of light).

CASE STUDY

Internal Communication

Slack, GoToMeeting, Zoom and CoLab

CoLab

Created by Centre researchers for Centre researchers, Colab is an online platform inspired by the interdisciplinary, global collaborations at CNBP. Colab facilitates these collaborations by hosting a library which include:

- Tool Box of Resources: equipment, nanoparticles, molecular probes, fibers, etc available to CNBP members
- Database of Capabilities: presented using non-technical language and with focus on potential applications. This facilitates interdisciplinary collaborations, as it eliminates the need for researchers to read highly-specialized, technical papers from other disciplines.
- Challenges Forum: An in built help desk where informal questions can be discussed – from simple everyday lab problems to big questions in the field – which can spark new research collaborations.

CoLab is currently growing and we are looking forward to seeing its effect on the effective communication and collaboration across CNBP and beyond!

The CoLab team: Denitza Denkova, Antony Orth (special thanks for coding the actual software product), Andrew Care, Martin Ploschner, Vicky Staikopoulos, Benjamin Pullen, Brant Gibson.



Communication Tools

CNBP places heavy emphasis on internal communications and team engagement, using a number of industry leading tools to facilitate communications activity, to help bring team members together and to ensure Centre information is easily accessible to all.

This includes use of 'Slack' a wiki type communication and direct messaging channel with project, news and Centre announcement channels in place. CNBP also invests in both 'GoToMeeting' and 'Zoom' video conferencing software to allow the real-time streaming of both seminars and presentations, and to provide a face-to-face element for internal team meetings where participants are located at differing institutions.

CNBP live-streams researcher seminars and presentations across all of its University nodes aiding internal collaboration and discussion.

School Engagement: Concordia College

CNBP researchers have engaged closely with Concordia College (Adelaide) during 2017, building deep and meaningful outreach linkages between the school and Centre researchers.

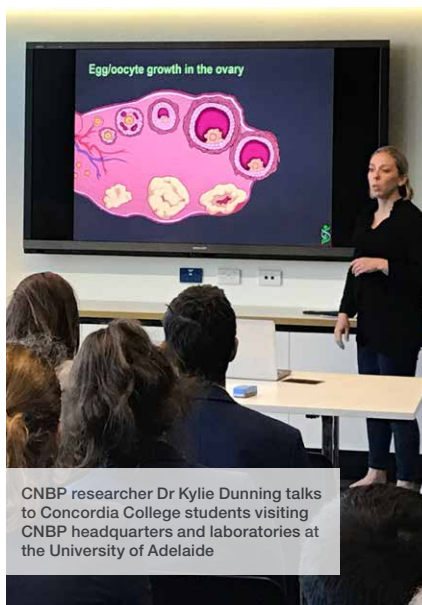
As a part of National Science Week, a team of CNBP scientists and researchers visited Concordia College and presented a variety of talks and light-based science demonstrations to over 150 Year 9 students with an interest in science, technology, engineering and maths (STEM).

This was followed up in September 2017, with 80 Concordia students visiting the CNBP laboratories at the University of Adelaide for a series of educational laboratory tours. This included demonstrations of advanced needle probes and optical imaging systems, hands-on demonstrations of near-infrared light scanners, use of a 3D metal printer and tours of CNBP's glass and optical fibre fabrication facilities.

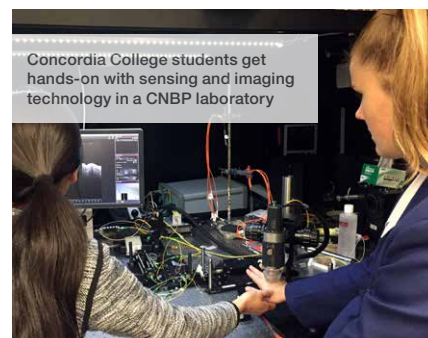
Finally, during November, 2017, 31 Concordia students (all part of the International Baccalaureate Science program), visited CNBP at the University of Adelaide for presentations, laboratory tours, hands on scanning demonstrations and a Q&A session on science, further education and the realities of working as a scientist in a University environment.



CNBP researchers Dr Hannah Brown, Dr Georgios Tsiminis, Mr Patrick Capon and Ms Aimee Horsfall with students, at the conclusion of a successful session of science outreach at Concordia College



CNBP researcher Dr Kylie Dunning talks to Concordia College students visiting CNBP headquarters and laboratories at the University of Adelaide



Concordia College students get hands-on with sensing and imaging technology in a CNBP laboratory

CNBP researchers have organised or participated in 25 school events during 2017, including visits to schools, talks and presentations to students, the undertaking of light-based science demonstrations and hosting school visits at our University based laboratories. At the CNBP, we look to communicate the wonders and opportunities related to our science, to all of our school and student audiences, with an energy and enthusiasm that aims to motivate, educate and inspire.

“All of the students (and teachers) really enjoyed the sessions. They came back quite buzzing and extremely interested in what they saw.”

Emily Johnson
Middle Years Programme Coordinator
Concordia College

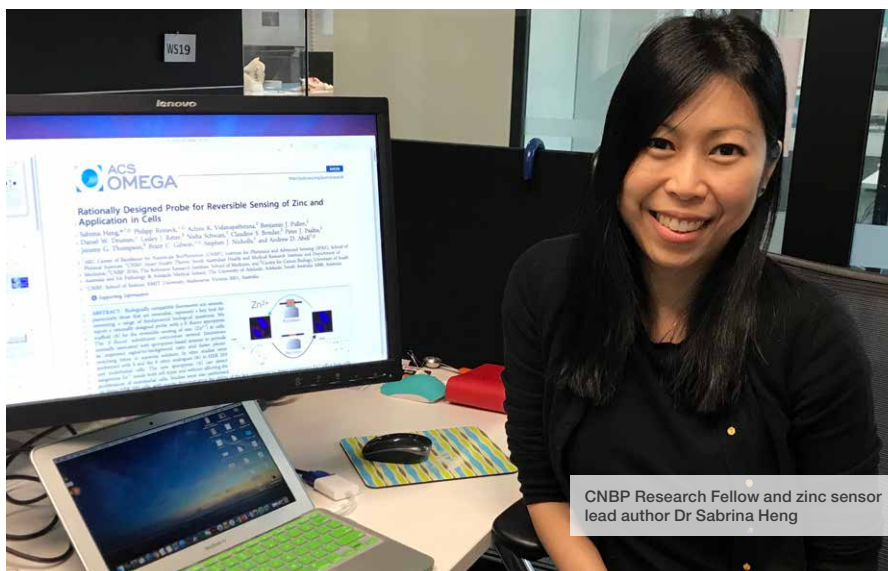
CNBP utilises traditional media, as well as the interactive and connected nature of social media to build up communities of interested audiences to aid promotion of CNBP, its research and activity, and to help build the organisation's reputation and impact.

Rationally Designed Probe for Reversible Sensing of Zinc and Application in Cells

CNBP researchers reported the development of a newly designed chemical sensor that could detect and measure zinc levels in cells. The sensor had the functionality to allow for a deeper understanding of the dynamic roles that metal ions play in regulating health and disease in the living body. Published in the journal 'ACS Omega' the lead author of the paper was CNBP's Dr Sabrina Heng.

In support of this publication, CNBP developed a media release and promotional strategy which achieved the following high-impact communications outputs:

- An Altmetric score of 73 - In the top 5% of all research outputs scored by Altmetric
- 15 mentions across all media
- 6,743 Twitter impressions
- 595 people reached on Facebook
- Posted on the Newswise, EurekAlert! and Science Media Exchange news sites.



CNBP Research Fellow and zinc sensor lead author Dr Sabrina Heng

Fantastic TV talents (and CNBP researchers) Prof Brant Gibson and Dr Philipp Reineck from RMIT University featured on SCOPE TV for kids, November 2017. They discussed the use of diamond nanoparticles in biophotonics to help shed light on cells and to better understand the living body.



at a glance

Media and Social Media Engagement

CNBP Media Releases: 8

CNBP Media Mentions: 71

CNBP Twitter Followers: 545

Most impactful Facebook post:

CNBP's Dr Hannah Brown and Dr Sanam Mustafa, both selected to participate in the inaugural 2017 Superstars of STEM program: 4025 people reached; 228 reactions, comments and shares.

CNBP News Items on the Blog: 122

CNBP LinkedIn Channel Developed

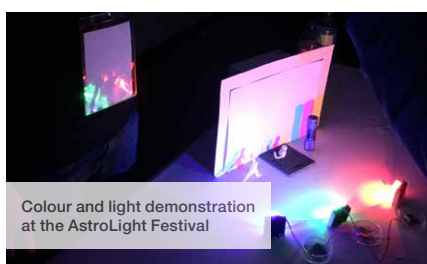
CNBP In The Community

CNBP researchers are focused on communicating their amazing science to the wider community, encouraging the general public to engage with scientific thinking and to better appreciate the benefits that scientific research can provide.

In undertaking this activity, much of CNBP outreach activity is based around National Science Week. In 2017, this included all three CNBP University nodes participating in their respective University Open days, with researchers talking to prospective students and their families about CNBP science, and undertaking demonstrations around light-based science, including use of fully operational Centre microscopes.



Fresh Science Program Team



Colour and light demonstration at the AstroLight Festival

Other significant community outreach activity included CNBP participation at the Melbourne AstroLight Festival where CNBP researchers gave talks and demonstrations on topics ranging from laser combat in movies, to fluorescent proteins found in nature, to being able to better understand how light can help us answer just how life begins.

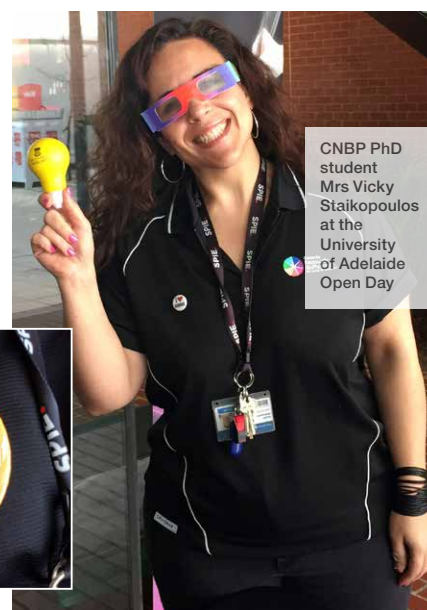
Additional highlights included two CNBP scientists - Dr Jiawen Li and PhD Student Ms Kathryn Palasis - being selected to attend the 'Fresh Science' program. This is a national program helping early-career researchers narrate, and then share, their amazing stories of discovery to the public.

Notably, CNBP had two of its scientists, Dr Hannah Brown and Dr Sanam Mustafa, selected to participate in the inaugural Superstars of STEM program initiated by Science and Technology Australia (STA). The program supports a small number of women employed in STEM to become highly visible public role models and spokespersons.

The program will provide ongoing community outreach opportunities to the two CNBP scientists as their careers develop.



CNBP AI Dr Wei Deng and CNBP Research Fellow Dr Lianmei Jiang prepare for Macquarie University Open Day



CNBP PhD student Mrs Vicky Staikopoulos at the University of Adelaide Open Day



The world's smallest fibre-optic probe that can simultaneously see and sense deeply inside the body (Dr Jiawen Li) and an anti-cancer drug that can be switched 'on' and 'off' inside the body to help reduce chemotherapy side effects (PhD student Ms Kathryn Palasis). These were the research narratives developed by the two CNBP scientists who attended the 'Fresh Science' outreach training program in Adelaide.

CNBP For Government and End-Users

Government and influencers; and end users and industry are key audiences targeted as a part of CNBP's multi-stakeholder and multi-faceted communications strategy. We look to reach out to these groups, to be able to contribute positively to policy, to better understand market needs, to look for commercial opportunities and to co-promote successful commercial collaborations as they take place, showcasing the value of CNBP translational science and research.

Highlights from 2017 include:

CNBP participation at the STA 'Science meets Parliament' (SmP) event in Canberra, with Centre Investigator Prof Heike Ebendorff-Heidepriem and Centre Research Fellow Dr Andrew Care both able to discuss Centre science and success to senior politicians.

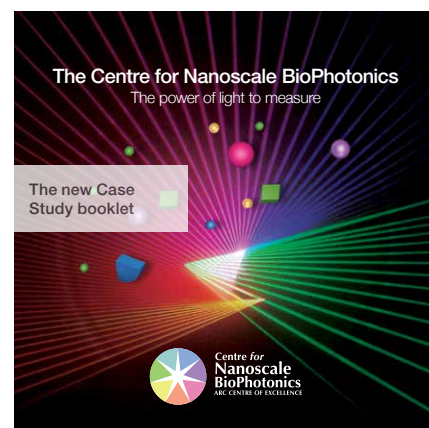
CNBP was also well represented at the STA 'Science meets Policymakers' event held in Canberra, August, 2017, with researchers A/Prof Guozhen Liu, Dr Alf Garcia-Bennett, Dr Sanam Mustafa and Dr Hannah Brown all in attendance. The event brought together researchers and practitioners from a range of science and technology disciplines, with policymakers from across government departments and agencies.



Dr Andrew Care meeting with Mr Adam Bandt - Federal Member for Melbourne at 'Science meets Parliament'

New CNBP Marketing Collateral

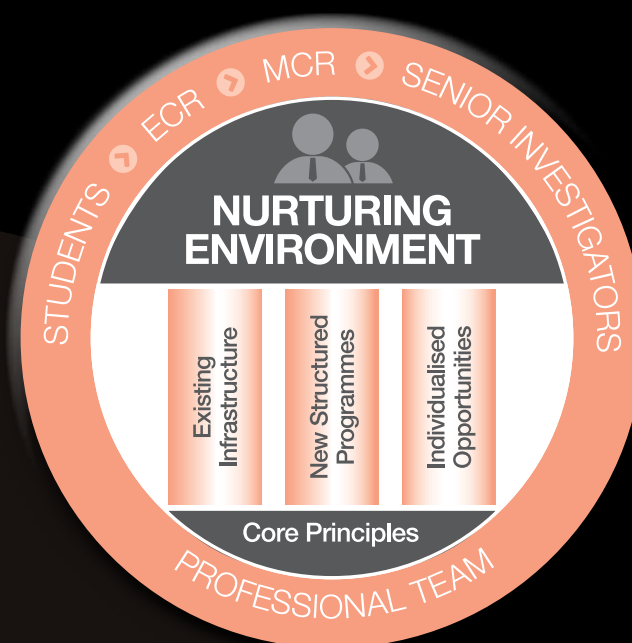
A CNBP booklet targeting the end-user and industry sectors was produced as a part of CNBP's communication and marketing strategy during 2017. The booklet, detailing CNBP's research expertise and including relevant case studies, also featured the Centre's commercialisation and partner focused objectives and is now being used regularly by Executive team members in their new-business and potential partner collaboration interactions.



Improving collaboration between the research community and industry was a hot topic in many of the discussions that I had", said Heike. "Particularly in my meeting with Senator Chris Back. People were also extremely excited about our approach, in using fibres and light to create exciting new windows into the body."



Nurturing Environment



CNBP nurtures next-generation scientific leaders to equip them with high-level skills to succeed in careers inside and outside of academia. CNBP colleagues across our Nodes and Partner Organisations have access to Centre-run workshops and mentoring programs.

Personnel



CENTRE PERSONNEL

Senior Investigators

Prof Mark Hutchinson, Director, UA
A/Prof Brant Gibson, Deputy Director
& RMIT Node Director
Prof Ewa Goldys, Deputy Director, MQ
Prof Andrew Abell, UA Node Director

Prof James Piper^{AM}, MQ Node Director
Prof Heike Ebendorff-Heidepriem, UA
Prof Andrew Greentree, RMIT
Prof Robert McLaughlin, UA
Prof Tanya Monro, UA & UniSA

Prof Stephen Nicholls, SAHMRI
Prof Nicolle Packer, MQ
Prof Jeremy Thompson, UA

Centre Researchers

Dr Ayad Anwer, MQ
Mr Alexander Arriola, MQ
Dr Akash Bachhuka, UA
Dr Jared Campbell, MQ
Dr Andrew Care, MQ
Dr Sandhya Clement, MQ
Dr Biju Cletus, MQ
Dr Nicole Cordina, MQ
Dr Denitza Denkova, MQ
Dr Daniel Drumm, RMIT
Dr Kylie Dunning, UA
Mr Jarrad Goyne, UA & SAHMRI
Dr Sabrina Heng, UA
Dr John Horsley, UA
Dr Peipei Jia, UA

Dr Xiaoteng Jia, MQ
Dr Lianmei Jiang, MQ
Ms Liisa Kautto, MQ
Ms Zofia Kautzka, MQ
Mrs Robyn Kievit, UA
Mr Rodney Kirk, UA & UWA
Dr Roman Kosteck, UA
Mr Desmond Lau, RMIT
Mr Tom Lawson, MQ
Dr Jiawen Li, UA
Ms Liuen (Olivia) Liang, MQ
Dr Saabah Mahbub, MQ
Mr Chrys Maoudis, MQ & Regeneus
Dr Ivan Maksymov, RMIT
Dr Shi Xian (Edward) Moh, MQ

Dr Sanam Mustafa, UA
Dr Antony Orth, RMIT
Dr Lindsay Parker, MQ
Dr Victoria Peddie, UA
Dr Bryden Quirk, UA
Dr Philipp Reineck, RMIT
Mr Benjamin Pullen, UA & SAHMRI
Dr Erik Schartner, UA
Dr Nisha Schwarz, UA & SAHMRI
Mr Jacob Thomas, UA
Dr Georgios Tsiminis, UA
Dr Jinxian (Jin) Yu, UA
Dr Xiaozhou (Michelle) Zhang, UA
Dr Xianlin Zheng, MQ

CENTRE PERSONNEL

PhD Students

Mr Azim Arman, UA
 Mr Chris Ashwood, MQ
 Mr Rachit Bansal, MQ
 Mr Matthew Briggs, UA
 Mr Marco Capelli, RMIT
 Mr Patrick Capon, UA
 Mr Wenjie Chen, MQ
 Ms Minakshi Das, MQ
 Mr Fei Deng, MQ
 Mr Kasun Dissanayake, CUL
 Mr Samuel Evans, UA
 Mr Shilun Feng, CSIRO
 Mr Fang Gao, MQ
 Mr Kalpeshkumar Giri,
 Ms Anna Guller, MQ
 Mr Abbas Habibalahi, MQ
 Dr Jonathan Hall, UA
 Mr Meng He, MQ
 Mr Ashleigh Heffernan, RMIT
 Ms Aimee Horsfall, UA
 Ms Krystal Lee Iacopetta, UA
 Ms Sameera Iqbal, MQ
 Mr Kashif Islam, MQ
 Mr Jonathan Jacobsen, UA
 Ms Hong Ji, UA
 Mr Manoj Kale, MQ

Ms Jagjit Kaur, MQ
 Ms Zahra Khabir, MQ
 Mr Stephen Kirby, UA
 Mr Aniket Kulkarni, UA
 Mr Rahul Kumar, CUL
 Ms Inga Kuschnerus, MQ
 Ms Megan Lim, UA
 Ms Yuan Liu, MQ
 Ms Jiajun (JJ) Liu, UA
 Ms Hanna McLennan, UA
 Ms Nuriyah Aloufi, RMIT
 Ms Lauren Murray, UA
 Mr Stefan Musolino, UA
 Mr Xuanzhao Pan, UA
 Ms Kathryn Palasis, UA
 Ms Lu Peng, MQ
 Ms Layla Pires, UHNT
 Mr Aziz Rehman, MQ
 Ms Vlada Rozova, MQ
 Mr Nicholas Schumann, UA
 Mr Shathili Abdulrahman Mansour, MQ
 Mrs Vasiliki (Vicky) Staikopoulos, UA
 Ms Georgina Sylvia, UA
 Ms Victoria (Yan) Wang, MQ
 Mr Fei (Felix) Wang, MQ
 Mr Piotr Wargocki, MQ

Mr Yunle Wei, UA
 Ms Emma Wilson, RMIT
 Mr Josef Worboys, RMIT
 Ms Yuan Qi Yeoh, UA
 Mr Kaixan Zhang, MQ
 Mr Fuyuan Zhang, MQ
 Ms Nafisa Zohora, RMIT

Masters Students

Mr Mustaf Bekteshi, UA
 Mr Padraig Fyfe, UA
 Ms Mengke Han, UA
 Ms Aimee Horsfall, UA
 Mr Weikun Huang, UA
 Ms Rashmi Pillai, MQ
 Mr Avishkar Saini, UA
 Mr Nicholas Charles Schuman, UA
 Mr Daniel Stavrevski, RMIT
 Mr Wang Quiang, MQ

Honours Students

Mr Thomas Almond, UA
 Mr Adam Francis, RMIT
 Mr Anmol Saini, UA
 Ms Tahlee Stevenson, UA

Professional Team

Dr Kathy Nicholson
 Chief Operating Officer, UA
 Mrs Melodee Trebilcock
 BD and Events Manager, UA
 Mr Tony Crawshaw
 Comms Manager, MQ

Ms Kathleen Zummo
 EA to the Director & UA Node Admin
 Ms Jenny Morcom
 MQ Node Administrator
 Ms Brooke Bacon
 RMIT Node Administrator

Mrs Karen English
 UA Support Officer

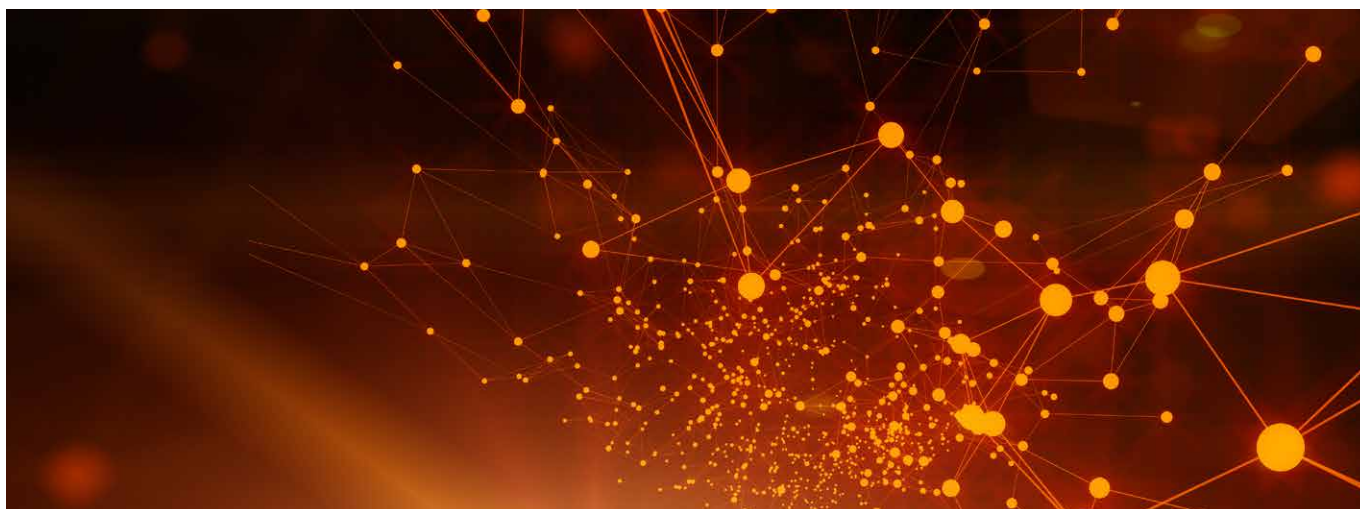
Partner Investigators

Prof Stephen Nicholls, SAHMRI
 Prof Juergen Popp, IPHT
 Prof Qingming Luo, HUST
 Prof Peng Xi, Peking

Prof Yujie Sun, Peking
 Prof Gilberto Brambillo, SOTON
 Prof Tong Sun, CUL
 Prof Brian Wilson, CUL

Prof Gang Zheng, CUL
 Prof Yonggang Zhu, CSIRO
 Prof Steven Maier, Colorado

Personnel (cont'd)



CENTRE PERSONNEL

Associate Investigators

Mr Shahraam Afshar, UniSA	Prof Dayong Jin, UTS	Dr Nima Sayyadi, MQ
A/Prof Igor Aharonovich, UTS	Dr Asma Khalid, RMIT	Dr Bingyang Shi, MQ
Dr Hannah Brown, UA	Dr Woei Ming (Steve) Lee, ANU	Dr Varun Sreenivasan, UNSW
Dr Louise Brown, MQ	Dr Christian Leiterer, MQ	Dr Anwar Sunna, MQ
Dr Christina Bursill, SAHMRI	A/Prof Guozhen Liu, MQ	Dr William Tieu, SAHMRI
A/Prof Jennifer Cornish, MQ	Dr Yiqing Lu, MQ	Dr Johan Verjans, SAHMRI
Dr Arun Dass, Griffith	Dr Sally McArthur, Swinburne	Dr Achini Vidanapathirana, SAHMRI
Dr Wei Deng, MQ	Dr Dougal McCulloch, RMIT	A/Prof Tiffany Walsh, Deakin
Dr MyNgan Duong, SAHMRI	Dr Anne-Marie Nadort, MQ	Dr Yuling Wang, MQ
Dr Alexandre Francois, UA	A/Prof Kevin Pflieger, UWA	Dr Stephen Warren-Smith, UA
Dr Alfonso Garcia-Bennett, MQ	Dr Martin Ploschner, MQ	Prof Steven Wiederman, UA
Dr Jonathan George, UA	Dr Mark Prescott, Monash	Prof Marc Wilkins, UNSW
Prof Bruce Hammock, UC Davis	Dr Peter Psaltis, SAHMRI	Dr Xiaoxue (Helen) Xu, MQ
Prof Stephen Hill, U of Nottingham	Dr Malcolm Purdey, UA/SAHMRI	Mr Run Zhang, Uni of Qld
Dr Peter Hoffman, UniSA	Dr Nicolas Riesen, UA	Dr Tim Zhao, UA
Prof Irene Hudson, U of Newcastle	Dr Yinlan Ruan, UA	A/Prof Andrei Zvyagin, MQ
Dr David Inglis, MQ	Dr Abel Santos, UA	

Legend

UA: The University of Adelaide
 MQ: Macquarie University
 RMIT: RMIT University
 CUL: City University London
 SAHMRI: South Australian Health and Medical Research Institute
 UniSA: The University of South Australia
 UNSW: University of New South Wales
 UTS: University of Technology Sydney
 UWA: University of Western Australia

Researchers / GED Breakdown

	Male	Female	Total
Senior Investigators	66%	33%	12
Research Personnel	59%	41%	44
Students	63%	37%	65
Associate Investigators	68%	32%	50
Partner Investigators	91%	9%	11
Professional team	14%	86%	7
Total	63%	37%	

Awards

Congratulations to Centre Colleagues who received public recognition in 2017 including:

Prof Andrew Abell

- 2017 NHMRC: Ten of the Best Research Projects
- Review Panel: American Australian Association Educational Fellowships
- Channel 7 Research Foundation Grant

Dr Mike Baratta

- Review Panel: American Australian Association Educational Fellowships

Dr Hannah Brown

- Board Position: Your Fertility Advisory Board
- SRB Travel Award: World Congress for Reproductive Biology
- Australia-China Young Researcher Travel Award
- Superstar of STEM

Mr Patrick Capon

- MH Joyner Scholarship in Science

Prof Ewa Goldys

- ATSE Fellow

Prof Andrew Greentree

- ARC College of Experts

Mr Asheigh Heffernan

- SPIE Student Travel Grant

Dr Jonathan Hall

- Life Whisperer : Winner "Best Idea – One to Watch" - global technology awards program

Ms Aimee Horsfall

- Travel Scholarship: 12th Australian Peptide Conference
- Travel scholarship: 6th Modern Solid-Phase Peptide Synthesis Symposium
- Poster Prize: 6th Modern Solid-Phase Peptide Synthesis Symposium

Prof Mark Hutchinson

- Review Panel: American Australian Association Educational Fellowships
- CNBP-Smart Needle: Featured in ARC publication 'Making a difference—Outcomes of ARC supported research'

Dr Peipei Jia

- ANN Overseas Travel Fellowship

Prof Dayong Jin

- Malcolm McIntosh Prize for Physical Scientists of the Year

Dr Jiawen Li

- Women's Research Excellence Award
- PD Program: MAGIC at ANU

Prof Robert McLauhlin

- MiniProbes - South Australian Early Commercialisation Fund Grant
- CNBP-Smart Needle: Featured in ARC publication 'Making a difference—Outcomes of ARC supported research'

Dr Sanam Mustafa

- Superstar of STEM

Dr Ann Marie Nadort

- iMPQRTS Scholarship

Prof Nicolle Packer

- Awarded Distinguished Professor of Macquarie University
- Chair: Glycoproteomics Initiative: International Human Proteome Organisation (HUPO)
- Reference Group Member: Australian Biosciences Data Capability project
- Board Position: NIH Glycoinformatics integration project (GlyGen)

Prof Kevin Pfleger

- 40 Under 40 Award: Entrepreneur Category
- City of Perth Strategic Alliance Award

Mr Benjamin Pullen

- Runner Up: UA Tech eChallenge Wool Innovation

Dr Philipp Reineck

- Best Poster Award: 5th International Conference on Biophotonics
- Travel Grant: France Australia Mobility Program
- ANN Travel Grant

Dr Nima Sayyadi

- Invited Referee: Journal of Analytical and BioAnalytical Chemistry

Dr Stephen Warren-Smith

- Faculty of Sciences Emerging Industry Research Partnerships Award

Mrs Vicky Staikopoulos

- Runner Up: UA Tech eChallenge Wool Innovation
- Winning team-ReMind: Australian-French Entrepreneur Challenge

Prof Jeremy Thompson

- Travel Grant: Global Connections Fund Priming Grants initiative
- ART Lab - Tech In SA Grant

Mrs Melodee Trebilcock

- Scholarship: University of Adelaide Professional Leaders Program (PLP)

Ms Emma Wilson

- RMIT - VC PhD Scholarship

Mr Josef Worboys

- Winner: 3 min thesis, RMIT

Fellowship Success

CNBP are delighted to see a high ratio of CNBP researchers win independent Fellowships.

ARC Future Fellows:

- Dr Alfonso Garcia-Bennett (MQ)
- Dr Guozhen Lu (MQ)
- Dr Jonathan George (UA)

ARC DECRA Fellows:

- Dr Yiqing Lu (MQ)
- Dr Lindsay Parker (MQ)

Beacon Fellowship:

- Dr Hannah Brown (UA)
- Dr Abel Santos (UA)

Cancer Institute of NSW ECR Fellowship:

- Dr Andrew Care (MQ)

Humboldt Fellowship:

- Dr Tim Zhao (UA) to be undertaken at CNBP partner IPHT

NHMRC Early Career Fellowship:

- Dr Annemarie Nadort (MQ)

Ramsay Fellowship:

- Dr Stephen Warren Smith (UA) returning from CNBP partner IPHT

RMIT VC Fellowship:

- Dr Philipp Reineck (RMIT)



Dr Yuling Wang and Prof Andrew Greentree solving the big problems

Grant Writing Workshop

What is the difference between a good grant application and a great application? CNBP researchers joined A/Prof Rob Gilchrest from UNSW to discuss the intricacies of preparing your CV and writing a successful grant application.

Science Workshops

A Centre wide mid-year science workshop was hosted at Macquarie University, with small project based workshops hosted as needed throughout the year.

Alternate Careers Panel

What does a lawyer, consultant, project manager and entrepreneur have in common? A PhD in Science! CNBP students and researchers spent a fascinating afternoon hearing from a collection of individuals who used skills developed from their PhD / postdocs to find satisfying science-related careers outside of Academia.

The How and Why of Networking

Hosted by Professor Peter Grace, MD Anderson Cancer Centre, University of Texas, this session discussed the value of networking including tips for building and maintaining a network of collaborators, contacts, associates and mentors to support future career endeavours.

CNBP Seminar Series

A weekly seminar series streamed live to all Centre nodes provided an opportunity for students and postdocs to present their science to CNBP colleagues, facilitating discussion and the generation of ideas.



Prof Mark Hutchinson giving a lecture at CNBP workshop



CNBP's 2017
Child-Friendly
Conference



Prof Peter Grace
MD Anderson
Cancer Centre



Ms Nafisa Zohora

Mentoring

ISC Mentorship of Senior Investigators

CNBP were excited to welcome five members of the Centres International Science Committee (ISC) at our annual Conference. Similar to previous years ISC members met with each Senior Investigator individually to discuss challenges and successes in their research program. Now in its 4th year this mentoring program provides Senior Investigators with a rare opportunity to be mentored by a team of International experts.

ECR and Student Network

Run by students and ECRs this network provides local support to the student/ ECR community and have responsibility for running the weekly CNBP seminar series.

CNBP Seminar Series

A weekly seminar series streamed live to all Centre nodes provided an opportunity for students and postdocs to present their science to CNBP colleagues, facilitating discussion and the generation of ideas.

GED Support

Caring for the Carer at CNBP Annual Conference

CNBP believes that family commitments should not impact the ability of our researchers to participate in Centre workshops. In 2017 five researchers embraced the Centre's Family Friendly policy by traveling with a child / carer to the 3-day annual Conference.

CNBP Mum's Group

A support network for CNBP Mum's working towards the elusive work-life balance with small children. The GED committee is exploring setting up a similar network for all Carers.

Congratulations to CNBP's 2017 Student Completions:

PhD:

- Dr Sandya Clement, MQ
- Dr Anna Guller, MQ
- Dr Jonathan Hall, UA
- Dr Jonathan Jacobsen
- Dr Xiaoteng Jia, MQ
- Dr Roman Kostecki, UA
- Dr Jiajun Liu, UA
- Dr Saabah Mahbub, MQ
- Dr Jacob Thomas, UA
- Dr Xianlin Zheng, MQ

Masters By Research:

- Ms Aimee Horsfall, UA
- Manoj Kale, MQ
- Xuanzhao Pan, UA
- Rashmi Pillai, MQ
- Mr Nicholas Charles UA

Honours:

- Mr Thomas Almond, UA
- Mr Adam Francis, RMIT
- Mr Anmol Saini, UA
- Ms Tahlee Stevenson, UA



Kaixin Zhang

Kaixin Zhang **Spectral Imaging and Bioassays** **Team, Macquarie University**

Second year PhD student at Macquarie University, Kaixin Zhang had the opportunities to spend a month with Partner Organisation Colorado University. Collaborating with Dr Mike Baratta he collected preliminary in vivo data in rat hippocampi using a newly developed cytokine biosensor device. Since returning to Macquarie University, the research team have continued this exciting project by standardising the fabrication of the sensing devices.

Kaixin says he is looking forward to *'advancing this project by collecting more preliminary data to assist biologists to understand the role of brain neuroimmune signalling.'*



Marco Capelli

Marco Capelli **Nanomaterials Team** **RMIT University**

It has been a big year for 2nd year PhD student Mr Marco Capelli who joined the CNBP in March 2016. With a first big publication under his belt (Capelli, M. et al. 2017, Nanoscale, 9(27)) Marco's work focuses on understanding the ability of diamond to sense the magnetic field with high sensitivity and spatial resolution. Attracted to the CNBP due to the opportunity for transdisciplinary research, Marco hopes to merge his understanding of nanodiamonds with the existing CNBP studies on nanodiamond internalisation. Ultimately this will assist in the cellular mapping of neuronal activities and improve our understanding of pain.

'Since joining the CNBP I have been amazed by the level of interaction with researchers with diverse knowledge and expertise' says Marco. 'Attending the mid-year science workshop and the CNBP annual conference I also had the opportunity to share my own research, receive feedback which initiated new ideas. In addition, the social aspect of the conference lowered the barrier of formality creating the sense of community – people sharing ideas rather than just a workplace – this has been such a positive impact for me as a new researcher, and makes me want to continue to work with CNBP for as long as possible.'



PhD Student Hanna McLennan

Hanna McLennan **Reproductive Success Team** **The University of Adelaide**

Embracing the opportunity that CNBP provides to work across disciplines, 3rd year PhD student Hanna McLennan is working on a project to use CNBPs chemical sensors and functionalise fibres to better understand the oocyte at time of fertilisation. She is excited that these tools enable her to work at nanoscale volumes, thus reducing the risk of damaging the oocyte. The potential future applications in both human and agricultural IVF are exciting.

While finding the variations in scientific languages spoken by biologist, chemists and physicists challenging, Hanna has embraced this transdisciplinary project. She believes that exposure to different ideas, ways of thinking, and a vast network of CNBP mentors and supervisors is unique and valuable.

Another unique experience for Hanna was her participation in an Industry placement at the Rockhampton cattle IVF lab Australian Reproductive Technologies. She believes that *'this was of huge benefit to me as I was exposed to potential future employment opportunities and therefore have different priorities than you do in a research lab.'*

Engaging with Existing PD Programs



Neurophotonics Summer School

This year's Neurophotonics Summer School held in Quebec, Canada, June 11-21, was attended by three CNBP members: PhD student Ms Vicky Staikopoulos (UoA), CNBP Research Associate Dr Antony Orth (RMIT) and CNBP Associate Investigator Dr Varun Sreenivasan (UNSW).

The school focuses on teaching physics and biology and how they can merge, and runs for 10 days and includes 14 lectures from world class speakers and 10 workshops that teach the latest technology in the bio-imaging of the central nervous system.

For the last 4 days of the summer school, students are given a project to participate in for direct hands-on experience which is then presented on the last day, with prizes awarded for the top three presentations.

This year, equal second prize was given to CNBP's Ms Vicky Staikopoulos for her work on Digital Holographic Microscopy in red blood cells.

Super Stars of STEM

CNBP Research Associate Dr Sanam Mustafa and Associate Investigator Dr Hannah Brown, both from the University of Adelaide were selected to participate in the inaugural 2017 Superstars of STEM program.

The program, implemented by 'Science and Technology Australia', supports 30 women employed in science, technology, engineering and mathematics to become highly visible public role models.

With the objective of inspiring and encouraging young women in their STEM related education and study, participants have access to training in public speaking, media, and communicating with influence as well as access to high profile mentors.

"In addition to the formal program, for me the relationships that have formed within the Superstars of STEM group are invaluable. The informal mentorship, insight, support and encouragement from the superstars has been an added bonus to the opportunities provided by the training and access to influential names within the STEM and political arenas," says Dr Sanam Mustafa.



"In addition to the formal program, for me the relationships that have formed within the Superstars of STEM group are invaluable."

Dr Sanam Mustafa
CNBP Research Associate

On Sabbatical

Prof Jeremy Thompson

Embracing the opportunity to take a sabbatical, Prof Jeremy Thompson spent four months in Melbourne working with AI Prof David Gardner at Melbourne University and the CNBP team at RMIT University.

The time was spent primarily on developing crucial elements of a novel system that automates laboratory techniques used in IVF labs, which will include sensing capabilities to monitor embryo health as the embryo grows. With the CNBP's RMIT post-doc Tony Orth, Jeremy designed (using a CAD software program) and then 3D-printed in the micron-scale, a completely new approach to handling and manipulating embryos. The devices were made with the aid of the RMIT's 'Nanoscribe', a unique 3D-printer. Preliminary testing of the devices in David Gardner's lab

revealed they can be loaded with a single embryo in each device, and these support further embryo development when placed in an embryo culture environment. Several designs have been tested, and many of the difficulties of handling such small devices with embryos were fortunately resolved in the last week of the sabbatical.

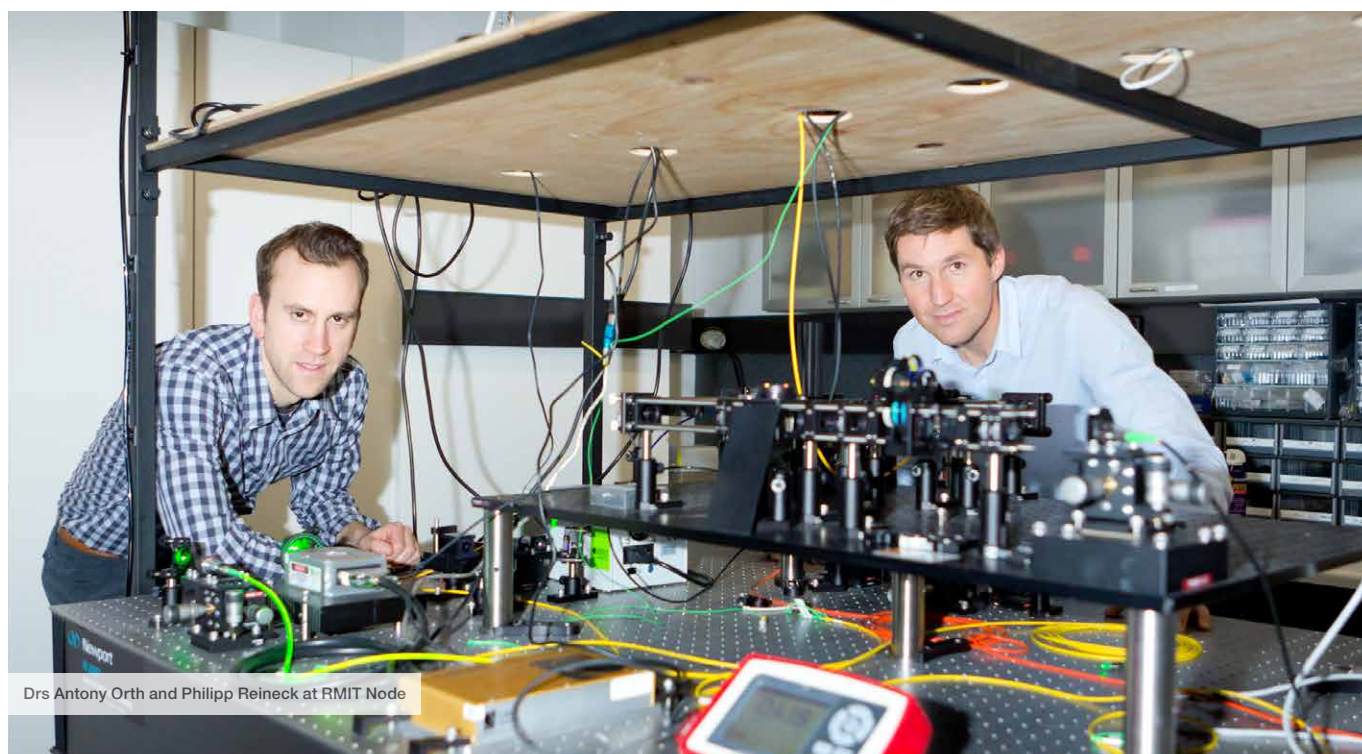
Another novel project initiated with CIs Brant Gibson and Andrew Greentree is focussed on how diamond material could be used to measure electrical and magnetic fields that are predicted to occur as early embryos develop, especially at the time of fertilization and the first cellular divisions. This is another aspect of embryo sensing which we want to explore in the future.

Along with these specific projects, Jeremy's time at RMIT was also of value for bridging knowledge across



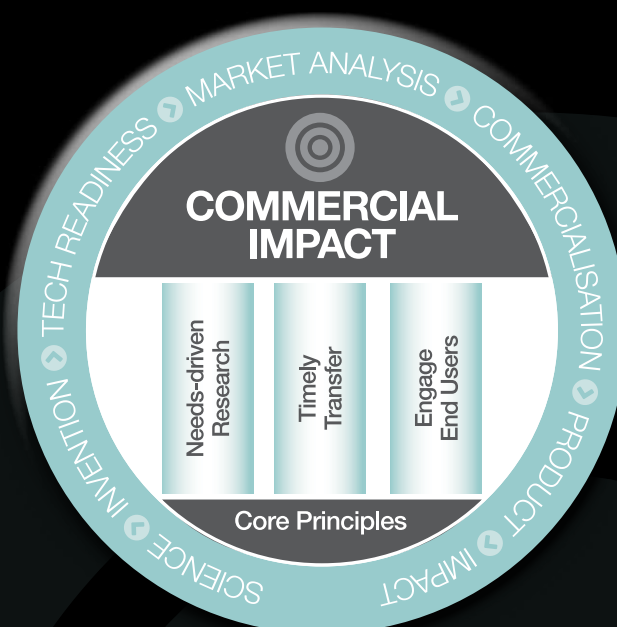
Prof Jeremy Thompson

from the worlds of optical physics and reproductive biology, and gave an opportunity for Jeremy to be mentored and also be a mentor to other CNBP staff.



Drs Antony Orth and Philipp Reineck at RMIT Node

Commercial Impact



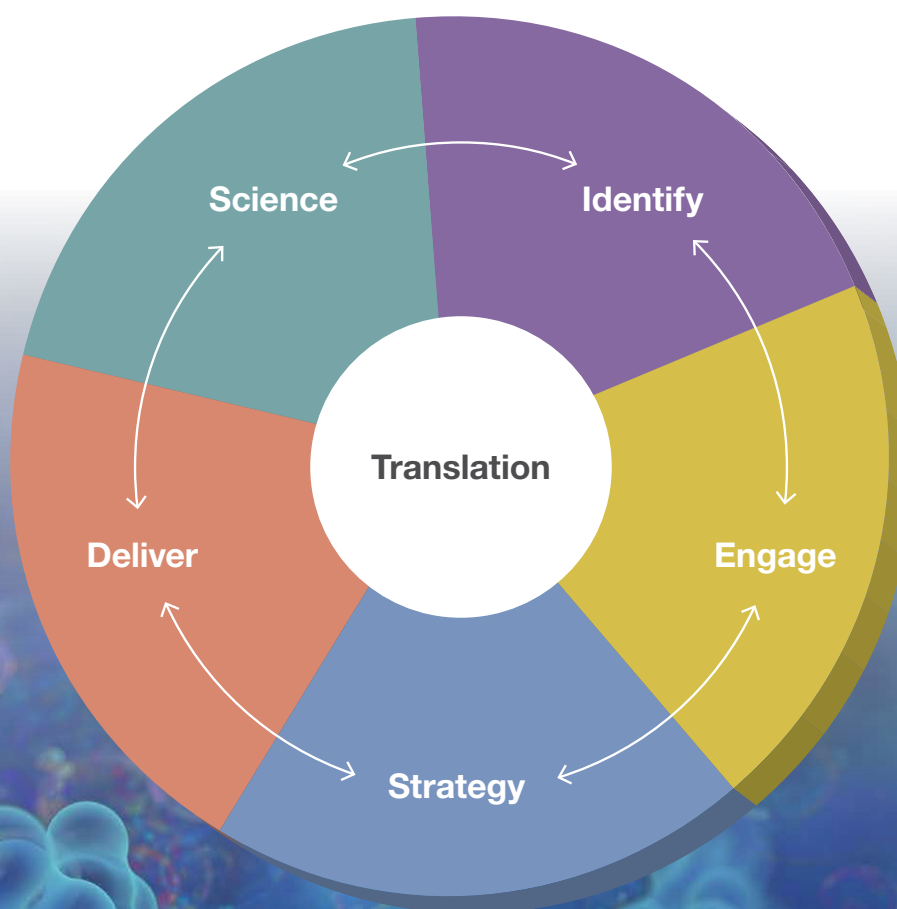
The 23 million dollar ARC investment in CNBP over 7-years of fundamental science discovery, has enabled us to also create a significant legacy through our commercialisation and technology transfer. CNBP successes to date includes nine tangible outcomes, and a goal of 20 outcomes from 20 ventures to be completed by 2020.

Commercialisation Strategy

CNBP Commercialisation strategy is to achieve 20 translational outcomes by 2020. To achieve this goal CNBP researchers are encouraged and supported to review their scientific projects regularly to identify potential translational outcomes.

Where relevant, researcher are encourage to follow a series of steps:

- **Deliver Quality Science**
- **Identify Translational Opportunity**
- **Engage Early with Experts:** End-Users, Partners, Investors and Tech Transfer Office etc
- **Build a Strategy:** Secure IP, Proof of Concept, Business Plan, Regulatory Strategy etc.
- **Deliver Translational Outcome:** Patent, Open Source Software, Spin-Out Company etc



CASE STUDY

Sensors for the Brain

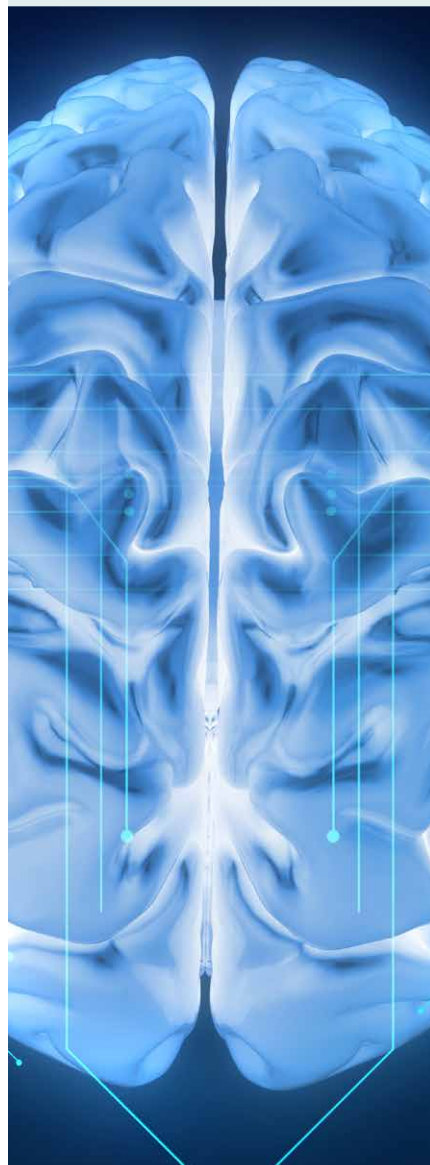
CNBP SENIOR INVESTIGATOR

Prof Robert McLaughlin



CNBP RESEARCHER

Mr Stefan Musolino



A Smart Needle

Prof Robert McLaughlin

A new high-tech medical device to make brain surgery safer is being developed by CNBP researchers at the University of Adelaide.

The tiny imaging probe, encased within a brain biopsy needle, lets surgeons 'see' at-risk blood vessels as they insert the needle, allowing them to avoid causing bleeds that can potentially be fatal. The 'smart needle' contains a tiny fibre-optic camera, the size of a human hair, shining infrared light to see the vessels before the needle can damage them.

Utilising optical coherence tomography (OCT) the imaging needle is able to be connected to a range of OCT scanners, with computer software then able to recognise blood vessels and alert the surgeon in real-time as the probe is being used.

The smart needle has already been used in a pilot trial with 12 patients undergoing neurosurgery at Sir Charles Gairdner Hospital in Western Australia. It will soon be ready for formal clinical trials.

The team are in discussions with a number of international medical device manufacturers and are seeking to manufacture the smart needles in Australia.

This smart needle will soon be ready for formal clinical trials.

Brain Temperature

Prof Stefan Musolino

The brain is the most temperature sensitive organ in the body—even small deviations in brain temperature, as a result of disease, brain injury or drug use are capable of producing behavioural change and neuronal cell death.

In order to measure and understand these temperature changes and how they are influenced by various biochemical pathways in the brain, a transdisciplinary team at the CNBP has developed an optical fibre-based temperature sensor, capable of pinpoint brain temperature measurement in freely-moving animals.

The sensor tip, minimised to only a few microns, provides for precisely localised temperature monitoring where conventional technology would struggle. Due to the small size of the fibre tip it has the possibility to be combined with existing sensors and implanted with identical methods without inducing additional stress or damage.

A fully developed probe could find potential application in human brain temperature monitoring after traumatic brain injury, stroke, or subarachnoid haemorrhage. It could also be utilised for tracking hypothermia in infants with neonatal encephalopathy to aid in neuroprotective therapy efforts during the first 72 hours after delivery.

CNBP has developed an optical fibre-based temperature sensor.

**CNBP
RESEARCHER**Prof Nima
Sayyadi

Sensitive Immunodetection of Prostate Cancer Cells Dr Nima Sayyadi

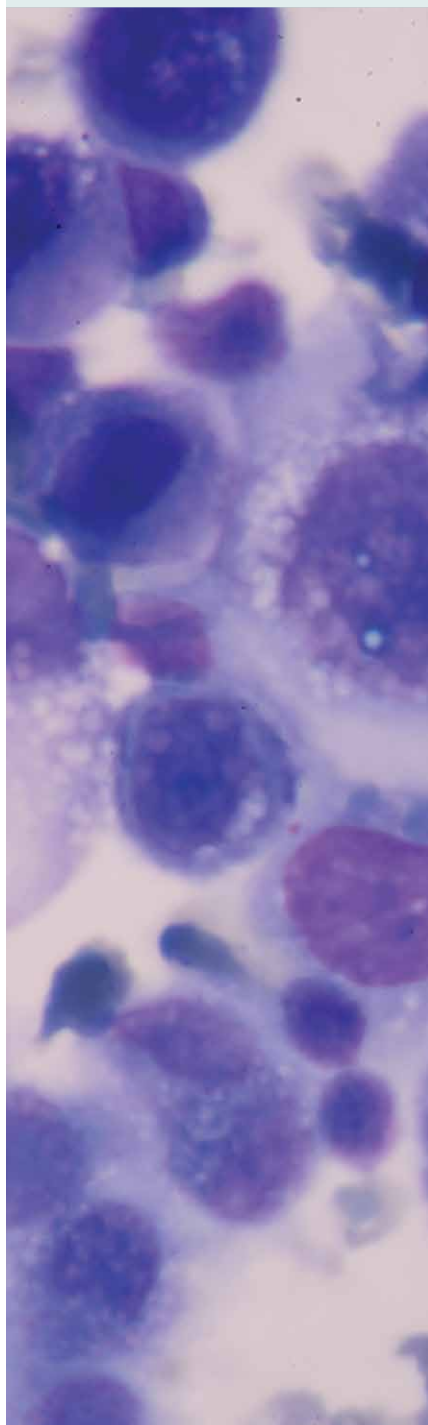
Rapid, sensitive, and non-invasive diagnostic tests for prostate cancer have the potential to lead to better treatment outcomes and lower healthcare costs. However, less than ten cancer cells need to be detected in large volumes of urine for useful diagnosis. Current urine cytology approaches lack required sensitivity at this level.

Detection of prostate cancer cells (PCCs) in urine would be far more preferable than the current approach of invasive needle biopsy. More than 50% of the biopsies are negative for prostate cancer partially because the prostate specific antigen (PSA) biomarker in serum can be elevated for reasons other than prostate cancer. The low sensitivity (33%) widely used PSA have been increasingly recognized.

A highly specific IgG antibody (MIL38) was developed to specifically recognise PCCs by our collaborator Minomic International Ltd. However, at present, immunofluorescence urine cytology detection of PCCs is not sensitive enough as a diagnostic approach.

The capacity to quantify single prostate cancer cells has the potential to revolutionise the diagnostics industry.

The fundamental problem in the detection of these low abundance PCCs in urine is the weak signal-to-noise ratio (SNR) obtained when using common fluorescence probes, such as fluorescein isothiocyanate (FITC), because of the overlapping of the fluorescent signal with the commonly encountered auto-fluorescent molecules within the cells and urine matrices; these factors combine to greatly reduce detection efficacy.





Mr Benjamin Pullen

Innovation and Entrepreneurial Skills

CNBP Research Associate Benjamin Pullen and PhD student Vicky Staikopoulos have been awarded a runner up prize as part of the University of Adelaide's 'Tech eChallenge Wool Innovation' competition.

"We entered the competition to learn about marketing and entrepreneurial thinking and with only two weeks to go before the end of the workshop program we stumbled, by chance onto an idea as to how to help wool growers better manage their flock," says Ben. "We plan to pursue this project and develop the idea into a working product."



Mr Andrew Grant and Prof Mark Hutchinson at Science Meets Business

STA 'Science Meets Business'

CNBP sponsorship of the 2017 STA 'Science meets Business' event was a strategic decision to support engagement and collaboration between the research sector and Australian industry.

CNBP senior personnel spoke and presented in a variety of capacities including CNBP Director Prof Mark Hutchinson and consultant Mr Andrew Grant (Availer) who discussed CNBP's commercialisation success and strategy for taking ideas from 'boom to the showroom.' Deep dive (idea creation), value-add solutions, solving pain points and interesting new jobs were all touched upon in a quick fire exchange of views.



Dr Jacob Thomas

Working With Industry

CNBP Post doc Dr Jacob Thomas has been working on a series of projects to develop light based tools for objective quality assessment of products in the food and agriculture space. "We have taken a more commercially orientated approach with each project requiring integration with at least one industry partner" says Jacob.

Over the next 12 months Jacob and team hope to take these projects from preliminary pilot projects with industry to commercially available products.

Jacob believes "these project give a much greater understanding of research application, commercialisation, and how not all researchers need to take a purely academic path."

Impact: Spin-Out Companies

CNBP has created a significant legacy through our commercialisation and technology transfer, with seven start-up companies to date.

DairyExplorer

Dairy Explorer utilises spectral analysis to determine the fat, protein, and SCC of milk on a cow-by-cow basis. The technology utilises a blend of physics, chemistry and biology coupled with advanced analysis, proprietary algorithms and big-data sets, to provide dairy farmers with information that enables them to optimise the performance of their herd. **2.0 FTE Employees.**

Founded by the South Australian Rapid Commercialisation Initiative (SARCI) in collaboration with Availer in 2017.

dairyexplorer.com

MEQ Probe

MEQ Probe is a new solution that utilises spectral analysis to objectively determine the quality of meat in seconds. The technology utilises a blend of physics, chemistry and biology coupled with advanced proprietary data analysis algorithms and big-data sets to provide meat processors with an objective measure for meat quality. **3.0 FTE Employees.**

Founded by the South Australian Rapid Commercialisation Initiative (SARCI) in collaboration with Availer in 2017.

meqprobe.com

Miniprobos

Imaging Needles for optical coherence tomography. A handheld probe for optical coherence tomography less than 0.7mm in diameter. **1.0 FTE Employees.**

Founded by Prof Rob McLaughlin, 2017.

miniprobos.com



Apple co-founder Steve Wozniak with Life Whisperer co-founder Dr Jonathan Hall at the Global Technology Awards Life Whisperer winner of the 'Best Idea - One to Watch' category

Art Lab Solutions

A core focus of developing and commercialising cattle reproductive technologies that feed into genetic improvement breeding programs **0.5 FTE Employees.**

Founded by A/Prof Jeremy Thompson, 2017.

artlabsolutions.com

SpectralChange

Spectral Change has developed proprietary software, analytics, and food-grade devices. Spectral Change give winemakers a clear insight into the maturity of wine across every barrel, in an unobtrusive model, such that the age-old process of wine making can continue, with a next-generation solution. **1.0 FTE Employees.**

Founded by the South Australian Rapid Commercialisation Initiative (SARCI) in collaboration with Availer in 2017.

spectralchange.com

Lucigem

Based at Macquarie University in Sydney, Lucigem produces a range of nanomaterials including fluorescent nanodiamonds and phosphorescent nanorubies. Nanoparticles developed by Lucigem's researchers exhibit excellent colloidal stability in aqueous solutions, without any coating or functional groups. Lucigem strives to generate nanoparticles with well-characterised physical and chemical properties, which ensure reproducible results.

Founded by Dr Louise Brown, 2016.

lucigem.com.au

Life Whisperer

Life Whisperer uses AI to better select healthy embryos for IVF, and ultimately improve outcomes for couples wanting to have children. **1.0 FTE Employees.**

Co-Founded by Dr Jonathan Hall in 2017

www.lifewhisperer.co

CNBP Partner Organisations

At the CNBP we actively look to develop strong partnerships, building networks with major national and international research centres, as well as with industry to deliver exciting research, translation and commercial outcomes.

We firmly believe that our strength is significantly enhanced by engaging closely with our partners in an active and collaborative manner, with the end-benefit that our research is pushed in new and exciting directions that could not be achieved alone. Working with partners helps CNBP to strengthen research outcomes, drive development activity, achieve global competitiveness, provide exciting new collaboration opportunities for our researchers and communicate our research to the wider Australian community.



CNBP research projects at UHN continue with joint publications in nanoparticle therapy stemming from the work of UHN based CNBP researcher Dr Greg Dmochowski and PhD student Ms Layla Pires.

The introduction of Prof Gang Zheng to CNBP at the 2017 annual conference identified strong synergies for the vascular health team and the opportunity to access animal models for application and testing of new probes/devices.

**Partner Investigator:
Prof Gang Zheng**



Successful outcomes in 2017 include a number of lab visits and active fibre functionalisation and coating projects. CNBP researcher Dr Tim Zhao won a Humboldt fellowship to join the IPHT team. These and other collaborations led to the development of an (unsuccessful) Horizon 2020 application. CNBP were pleased to welcome Dr Volker Dekhert to the 2017 Annual conference.

**Partner Investigator:
Prof Juergen Popp**



**HUST University is a
Top 10 Chinese University**

HUST-CNBP collaborations grow annually with increased interest in growing existing projects using photoacoustic imaging to visualise mouse ovaries. Members of the CNBP Biosensor team (UA) spent time at HUST and CNBP were pleased to welcome Prof Zhang to the 2017 Annual Conference.

**Partner Investigator:
Prof Qingming Luo**

Our strength is significantly enhanced by engaging closely with our partners in an active and collaborative manner.

CNBP Partner Organisations (cont'd)



Engaged discussions about CNBP –SOTON capabilities has opened the door for a new project in the BAM space. It is hoped that a suitable student or postdoc will be available in 2018 to pursue this project.

Partner Investigator:
Prof Gilberto Brambillo



The South Australian Health and Medical Research Institute (SAHRI) is home to more than 600 medical researchers, working together to tackle the biggest health challenges in today's society. The SAHMRI Heart Health Program houses CNBPs Vascular Health team led by PI Prof Stephen Nicholls.

Partner Investigator:
Prof Stephen Nicholls



**CITY UNIVERSITY
LONDON**

On a recent visit to City University London, CNBP Director Prof Mark Hutchinson met with new CNBP PhD Students Mr Kasun Dissanayake and Mr Rahul Kumar and was delighted to see them present their research on CNBP slides and using CNBP terminology. Delighted Prof Hutchinson commented that 'this validates that CNBPs quality communication channels are reaching our remote researchers.'

Prof Tong Sun and Prof Ken Grattan at CUL worked with CNBP individuals to support an International fellowship application and continue to seek new CNBP joint PhD students.

Partner Investigator:
Prof Tong Sun



Our 2017 Nature publication 'Amplified stimulated emission in upconversion nanoparticles for super-resolution nanoscopy,' co-authored with collaborators at Peking was the culmination of a long collaboration between Prof Peng Xi and CNBP researchers.

Partner Investigator(s):
Prof Peng Xi and Prof Yujie Sun



Engagement with CSIRO during 2017 has been limited due to movement of CSIRO staff. However, some collaborations with CSIRO continue, through joint supervision of PhD student Mr Shilun Feng who is working on a microfluidics needle device that can detect cytokines *in situ*.

CNBP Champion:
Dr Cathy Foley



University of Colorado Boulder

After a successful AAA fellowship year, collaborations with Dr Mike Baratta at Colorado University continue to grow with publications, grants and a successful student exchange taking place with Macquarie University PhD student Mr Kaixin Zhang spending a month at Colorado testing the biological capabilities of his cytokine sensor.

Continuing our tradition of hosting a CNBP launch at each Partner institution, Prof Mark Hutchinson officially launched the Colorado collaboration in August with a seminar and the traditional CNBP plaque ceremony.

Partner Investigator:
Prof Steven Maier



Prof Mark Hutchinson presents the CNBP plaque to Prof Steve Maier and Prof Linda Watkins at the University of Colorado partner launch

Heraeus

Heraeus Quarzglas are global leaders in innovating quartz and fused silica solutions. CNBPs partnership with Heraeus continue to provide CNBP researchers with valuable support in the form of custom glass solutions for fibre fabrication.

Key Industry Contact:
Mr Gerhard Schoetz

OLYMPUS®

FOCUS ON LIFE

As world leaders in delivering high quality equipment to the Medical, endoscopy and Industry markets, Olympus partner with CNBP to engage at ground level R&D. Olympus support to CNBP includes regular lab visits, the loan of instruments, problem solving in regard to instrument applications and upgrades as well as system service and training. In addition, two Olympus staff members presented their career journey at CNBP's alternate science careers workshop, and Dr Jian Shen participated in the CNBP Mid Term Review and attended CNBP's 2017 Annual Conference.

Key Industry Contact:
Dr Jian Shen



BIOPLATFORMS AUSTRALIA

Bioplatforms Australia enables Australian life science research by investing in state-of-the-art infrastructure and associated expertise in the specialist fields of genomics, proteomics, metabolomics and bioinformatics. Bioplatforms Australia continue to support CNBP with annual cash support and access to Bioplatforms state-of-the-art facilities to generate 'omics data.

Key Industry Contact:
Dr Andrew Gilbert

Other Partners



**Government of
South Australia**

During 2017 CNBP maintained two active grants from the Premiers Research Infrastructure Fund (PRIF). \$1M PRIF Fellowship (2016- 2020) which supports Chair of BioPhotonics Prof Robert McLaughlin at the University of Adelaide; and \$300K PRIF Grant (2014-2017) to support technical and research salaries in fibre fabrication, and costs associated with local outreach and interstate travel.



**Trade &
Investment**

The CNBP was awarded a \$500K NSW Trade and Investment fund (2014 – 2017) to support industry relevant research at the CNBP. In 2017 this funding continued to support a postdoc salary at the Macquarie University node.



NCI

NATIONAL COMPUTATIONAL INFRASTRUCTURE

The CNBP has been awarded 800,000 core hours per annum of computing time, equating to \$32,000 annually since 2015. In 2017 Prof Andrew Greentree and Dr Daniel Drumm utilised the NCI collaboration to enable the running of complex theoretical state of the art super computer systems.



The CNBP is supported by the state of the art fabrication facilities of the Optofab Node of the ANFF. These enable CNBP researchers to make the optical fibre sensors that have continued to progress the Centre's research in 2017.

We actively look to develop strong partnerships, building networks with major national and international research centres, as well as with industry to deliver exciting research, translation and commercial outcomes.

Legacy Partners



Science and Technology Australia (STA) is Australia's peak body in science and technology - and represents about 70,000 Australian scientists and technologists working across all scientific disciplines. STA membership helps CNBP to maintain strong relationships with politicians, business leaders and the wider community.

Availer

Availer is a rapid commercialisation company based in Adelaide and New York, who won a \$2.4 million state government grant developed under the "South Australian Rapid Commercialisation Initiative" ("SARCI"). In 2017 CNBP engaged with Availer to spin-out CNBP technology into three start-up companies 'MEQ', 'DairyExplorer' and 'SpectralChange.'



The American Australia Association (AAA) has a mission to broaden, strengthen and encourage ties across the Pacific through corporate, educational, economic, artistic and cultural activities and people to people exchange. CNBP sponsor an annual CNBP-AAA Fellowship to bring a US-based scientist to the CNBP laboratories for an extended visit.



The Australian Science Media Centre is an independent, not-for-profit service for the news media, giving journalists direct access to evidence-based science and expertise. AusSMC membership connects CNBP scientists and press releases with active science journalists as well as providing a go-to location for media advice and training.




Concordia College is a co-educational Early Learning Centre to Year 12 International Baccalaureate World School located in Adelaide's eastern suburbs. CNBP have collaborated with staff at Concordia College (2015- 2017) to develop curriculum, facilities and outreach programs to inspire secondary school students to contemplate careers in STEM.

Our strength is significantly enhanced by engaging closely with our partners in an active and collaborative manner.



Governance



A strong governance structure enables CNBP to implement its vision and pursue ambitious science goals.

CNBP core principles of Academic Excellence, Nurturing Environment, Quality Communication and Commercial Impact lie at the foundation of all Centre governance.

Governance Committees



Executive Management Committee (EMC)

The CNBP Executive Management Committee (EMC) is Chaired by the Centre Director and consist of all CNBP Chief Investigators, the Chief Operations Officer (Secretary) and Representation from a student or ECR from each node.

2018 Membership was:

- Prof Mark Hutchinson (Chair)
- Prof Andrew Abell
- Prof Andrew Greentree
- A/Prof Brant Gibson
- Prof Ewa Goldys
- Dr Lianmei Jiang
- Prof Stephen Nicholls
- Dr Kathy Nicholson (Secretary)
- Prof James Piper
- Prof Nicolle Packer
- Dr Philipp Reineck
- Prof Jeremy Thompson
- Dr Michelle Zhang

CNBP Advisory Board

The CNBP Advisory Board work to strengthen CNBP linkages with academic, industry and government by identifying strategic engagement opportunities. The board met three times in 2017 with two in person meetings and the later incorporating a joint session with the CNBP Executive Management Committee.

Advisory Board Membership:

- Ms Catriona Jackson (Chair), Deputy CEO Universities Australia
- Prof Calum Drummond, DVCR RMIT University
- Prof Mark Hutchinson, Director CNBP
- Prof Peter Nelson, PVCR Macquarie University
- Prof Julie Owens, Acting DVCR University of Adelaide
- Prof Goran Roos, Private Consultant
- Prof Elaine Sadler, Director CAASTRO, University of Sydney
- A/Prof Paul Willis, CEO Media Engagement Services
- Dr Kathy Nicholson (Secretary), COO CNBP

Education and Outreach Committee

Chaired by Prof Paul Willis, the Education and Outreach committee guides CNBP researchers towards effective approaches to communicating the wonders of science to the broader community. During 2017 the committee met three times by video conference.

Education and Outreach Committee membership:

- A/Prof Paul Willis, CEO Media Engagement Services
- Mr Nick Besley, Marketing and comms RMIT University
- Mr Tony Crawshaw, CNBP Communications Officer
- Dr Rachel Dunlop, Medical Research and Sceptic
- Prof Mark Hutchinson, CNBP Director
- A/Prof Rod Lamberts, CPAS
- Mr Mike Seyfang, Private Consultant IT & Social Media
- Dr Kathy Nicholson (Secretary), COO, CNBP

Governance Committees (cont'd)

International Science Committee

The CNBP International Science Committee (ISC) advises on the strategic direction of the scientific endeavours of the centre and supports the centre in increasing International visibility. ISC members act as mentors to CNBPs Senior Investigators, an invaluable program that is now in its third year.

In 2017 the ISC met twice in person, at the start of the year in the US coordinating around the International conference SPIE Photonics West, and at the CNBP annual conference in November.

International Science Committee membership:

- Prof Dennis Matthews (Chair), Director Centre of BioPhotonics, Science & Technology, UC Davis
- Prof Kishan Dholakia, University of St. Andrews, UK
- Prof Bob Grubbs, Nobel Laureate, Caltech
- Prof Mark Hutchinson, Director CNBP
- A/Prof Kelly Nash, University of Texas San Antonio
- Prof Katarina Svanberg, Lund University
- Prof Brian Wilson, University Health Network, Canada
- Dr Kathy Nicholson (Secretary), COO CNBP



Prof's Kishan Dholakia, Dennis Matthews, Katarina Svanberg, Brian Wilson and Kelly Nash at the CNBP annual conference.

Centre Commercialisation Committee

Managed by CNBP Business Development Officer Mrs Melodee Trebilcock this committee aims to engage with University and external commercialisation stakeholders to streamline future commercialisation activities. Two preliminary committee meetings were hosted in 2017 bringing together the commercialisation offices from all three CNBP Nodes.

Commencing early 2018, this committee will be chaired by Dr Andrew Gooley, Chief Scientific Officer, Trajan Scientific Medical.

Gender Equity Committee

This committee was formed in 2017 to review the Centres Gender Equity and Diversity policies and to provide a primary point of contact for researchers based at each node.

Gender Equity Committee membership:

- Prof Mark Hutchinson, CNBP Director, The University of Adelaide
- Prof Andrew Greentree, CNBP Chief Investigator, RMIT
- Prof Nicolle Packer, CNBP Chief Investigator, MQ
- Dr Kathy Nicholson, CNBP COO, The University of Adelaide

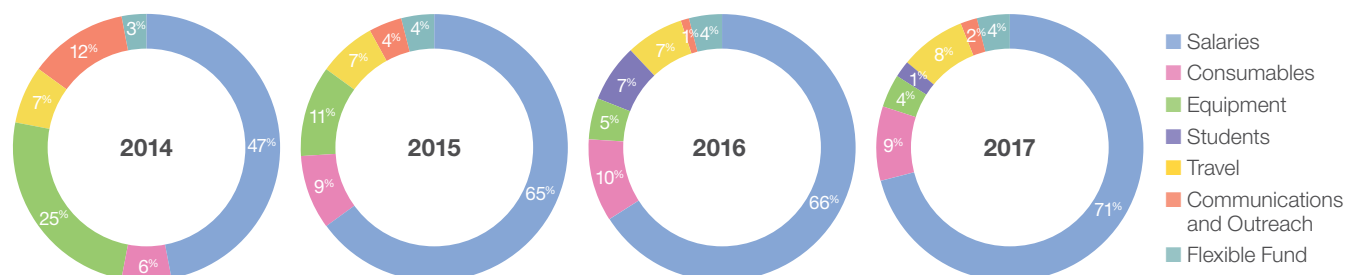
Growth of this committee in 2018 will see the role increase to encompass all elements of the CNBP Nurturing Environment Pillars and include ECR and student representation.

Financials

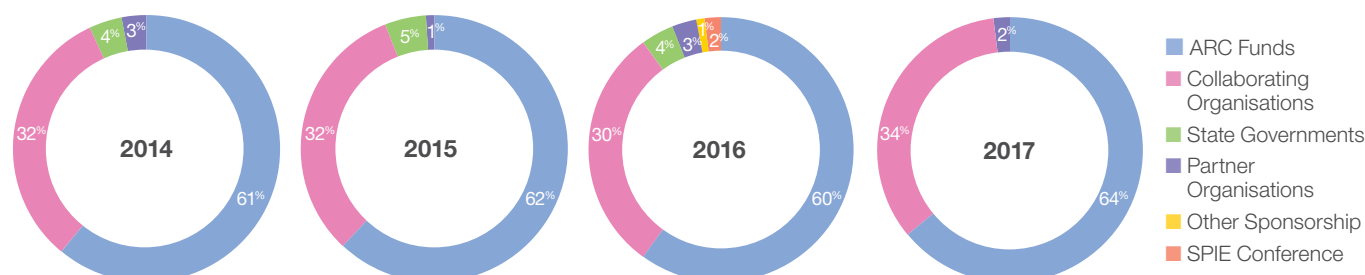
EXPENDITURE	2014 ACTUALS	2015 ACTUALS	2016 ACTUALS	2017 ACTUALS	2018 PROJECTIONS
Salaries	\$ 784,194	\$ 3,789,521	\$ 4,213,276	\$ \$4,150,971	\$ 4,114,287
Consumables	\$ 107,403	\$ 525,034	\$ 620,525	\$ \$556,083	\$ 535,050
Equipment	\$ 414,627	\$ 646,603	\$ 296,793	\$ \$241,777	\$ 215,000
Students	\$ -	\$ 21,326	\$ 420,765	\$ \$62,068	\$ 80,000
Travel	\$ 125,710	\$ 393,599	\$ 428,289	\$ \$486,925	\$ 370,280
Communications & Outreach	\$ 193,176	\$ 222,484	\$ 87,219	\$ \$119,702	\$ 111,000
Flexible Fund	\$ 51,411	\$ 204,558	\$ 280,004	\$ \$244,882	\$ 392,709
Total	\$ 1,676,521	\$ 5,803,125	\$ 6,346,871	\$ 5,862,408	\$ 5,818,325

INCOME	2014	2015	2016	2017
ARC Funds	\$ 3,385,012	\$ 3,445,635	\$ 3,504,212	\$ 3,556,775
Collaborating Organisations	\$ 1,781,724	\$ 1,791,815	\$ 1,782,478	\$ 1,914,459
State Governments	\$ 216,667	\$ 261,000	\$ 266,500	\$ -
Partner Organisations	\$ 140,000	\$ 90,000	\$ 190,000	\$ 90,000
Other Sponsorship	\$ 909	\$ -	\$ 4,545	\$ -
SPIE Conference	\$ -	\$ -	\$ 131,906	\$ -
Total	\$ 5,524,312	\$ 5,588,451	\$ 5,879,641	\$ 5,561,234

2014 - 2017 EXPENDITURE



2014 - 2017 INCOME



KPIs at a Glance



CNBP KPIs

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
1. Research Findings								
Peer reviewed journal publications	30	22	58	40	121	80	124	80
Other publications (conf pub, poster, community news)	48	20	53	40	138	80	92	80
Provisional patent application	3	1	3	1	5	2	3	2
% of journal publications in top 10% of peer reviewed journals	80%	60%	31%	80%	36%	80%	43%	80%
% of journal publications in > 3.5 impact factor journals	55%	30%	44%	40%	63%	50%	64%	50%
Research awards (student prizes, researcher awards, etc)	9	0	38	2	37	4	43	5
Invited talks/papers at major international meetings including int. conf. in Australia	25	12	39	15	89	20	60	20
Articles mentioning achievements	24	5	26	10	77	20	71	20
Media releases about achievements	4	5	8	10	12	10	8	10
Citation data for print publications (Ave for 2014 publications)	n/a		n/a		31	4	21	8
Citation data for print publications (Ave for 2015 publications)	n/a		n/a		n/a		11	n/a

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
2. Research Training and Professional Education								
# PD courses for staff and postgraduate students attended	5	1	6	2	15	2	5	2
# Centre attendees at all PD courses offered by the Centre	45	10	250	50	360	50	300	100
New PhD student commencements	6	6	20	12	13	12	13	12
New Honours/Masters students	1	0	13	6	10	10	14	10
New Postdoctoral researchers recruited to Centre	17	6	14	10	12	8	12	6
# PhD completions (students working on core CNBP research & supervised by Centre staff)	n/a		n/a		5	0	10	5
# Early Career Researchers	14	10	10		24	10	20	15
# students mentored (Centre Students)	25	10	20		45	30	73	30
Mentoring Programs (Centre Run)	3	2	5	4	9	4	5	4
External stakeholder workshops	1	1	10	2	5	2	3	2

CNBP KPIs

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
3. International, national and regional links and networks								
# international visitors to Centre nodes	25	25	26	25	29	25	26	25
# Extended visits from International visitors (>1 week)	7	5	16	10	15	10	12	10
# national and international workshops held/organised by the Centre	3	2	9	2	6	2	4	2
# Visits to overseas labs and facilities	12	10	44	20	45	30	35	30
# Extended visits to overseas Labs and facilities (>1 week)	4	4	9	8	18	8	19	8
Examples of relevant interdisciplinary research supported by the Centre (% publications reporting interdisciplinary research)	45%	35%	44%	35%	44%	35%	52%	35%

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
4. End-user Links								
Industry briefings	8	2	42	3	10	3	31	3
Government briefings	n/a		11	0	6	0	27	0
Community briefings	n/a		41	0	22	0	27	0
CNBP in school events	1	0	36	2	16	4	25	4
Open days / lab tours	3	1	14	1	9	2	10	2
Currency of information on the Centre's website (updated monthly as required)	yes		yes		yes		yes	
# website hits ('000s) - (defined as page views)	28	10	46	10	35	20	30	20
# talks given by Centre staff open to the public	30	6	82	15	28	15	27	15

CNBP KPIs

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
5. Organisational Support								
Annual cash/in-kind contributions from Administering and Collaborating Organisations (\$'000)	See financials on page 58							
Other research income secured by Centre staff (\$'000): Total	\$13,864	\$400	\$32,779	\$800	\$33,666	\$1,000	\$30,137	\$1,000
ARC	\$4,130	\$200	\$5,098	\$300	\$7,031	\$400	\$5,416	\$400
Other Aus. Competitive	\$2,441	\$100	\$11,479	\$200	\$11,130	\$200	\$12,218	\$200
Industry	\$5,239	\$50	\$15,100	\$100	\$14,638	\$200	\$11,018	\$200
Other (including international)	\$1,762	\$50	\$656	\$200	\$867	\$200	\$1,484	\$200
# new organisations collaborating with, or involved in, the Centre	0	0	6	1	5	1	3	1

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
6. Research Training and Professional Education								
Student internships with industry	0	0	0	2	2	2	1	3
Support Fellowship applications to attract researchers	0	2	4	3	21	6	9	6

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
7. End-user Links								
Technologies in pathway to translation: Technology Transfer	0	1	4	0	3	1	8	2
Joint funded projects with industry (e.g. ARC Linkage Projects)	0	1	3	2	11	2	7	3

PERFORMANCE MEASURE	2014		2015		2016		2017	
	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET	OUTCOME	TARGET
8. International, national and regional links and networks								
Secure international funded projects with international collaborators	0	0	8	2	15	4	10	4

Appendix



Appendix 1: 2017 Centre Publications

Ahmed, M. H., J. Jeske and **A. D. Greentree**. "Guided Magnonic Michelson Interferometer." *Scientific Reports* 7, (2017).

Ahmed, T., S. Walia, J. Kim, H. Nili, R. Ramanathan, E. L. H. Mayes, **D. W. M. Lau**, O. Kavehei, V. Bansal, M. Bhaskaran and S. Sriram. "Transparent Amorphous Strontium Titanate Resistive Memories with Transient Photo-Response." *Nanoscale* 9, no. 38 (2017): 14690-14702.

Akison, L. K., P. H. Andraweera, M. J. Bertoldo, **H. M. Brown**, J. S. M. Cuffe, T. Fullston, O. Holland and J. E. Schjenken. "The Current State of Reproductive Biology Research in Australia and New Zealand: Core Themes from the Society for Reproductive Biology Annual Meeting, 2016." *Reproduction, Fertility and Development* 29, no. 10 (2017): 1883-1889.

Alikhani, M., M. Mirzaei, M. Sabbaghian, P. Parsamatin, R. Karamzadeh, S. Adib, N. Sodeifi, M. A. S. Gilani, M. Zabet-Moghaddam, **L. Parker**, Y. Wu, V. Gupta, P. A. Haynes, H. Gourabi, H. Baharvand and G. H. Salekdeh. "Quantitative Proteomic Analysis of Human Testis Reveals System-Wide Molecular and Cellular Pathways Associated with Non-Obstructive Azoospermia." *Journal of Proteomics* 162, (2017): 141-154.

Alsawat, M., T. Altalhi, **A. Santos** and D. Losic. "Carbon Nanotubes-Nanoporous Anodic Alumina Composite Membranes: Influence of Template on Structural, Chemical, and Transport Properties." *Journal of Physical Chemistry C* 121, no. 25 (2017): 13634-13644.

Anugraham, M., F. Jacob, **A. V. Everest-Dass**, **A. Schoetzau**, S. Nixdorf, N. F. Hacker, D. Fink, V. Heinzlmann-Schwarz and **N. H. Packer**. "Tissue Glycomics Distinguish Tumour Sites in Women with Advanced Serous Adenocarcinoma." *Molecular Oncology* 11, no. 11 (2017): 1595-1615.

Arriola, A., S. Gross, M. Ams, T. Gretzinger, D. Le Coq, R. P. Wang, **H. Ebendorff-Heidepriem**, J. Sanghera, S. Bayya, L. B. Shaw, M. Ireland, P. Tuthill and M. J. Withford. "Mid-Infrared Astrophotonics: Study of Ultrafast Laser Induced Index Change in Compatible Materials." *Optical Materials Express* 7, no. 3 (2017): 698-711.

Ashwood, C., J. L. Abrahams, H. Nevalainen and **N. H. Packer**. "Enhancing Structural Characterisation of Glucuronidated O-Linked Glycans Using Negative Mode Ion Trap Higher Energy Collision-Induced Dissociation Mass Spectrometry." *Rapid Communications in Mass Spectrometry* 31, no. 10 (2017): 851-858.

Bachhuka, A., J. D. Hayball, L. E. Smith and K. Vasilev. "The Interplay between Surface Nanotopography and Chemistry Modulates Collagen I and III Deposition by Human Dermal Fibroblasts." *ACS Applied Materials and Interfaces* 9, no. 7 (2017): 5874-5884.

Biktagirov, T. B., A. N. Smirnov, V. Yu Davydov, M. W. Doherty, A. Alkauskas, **B. C. Gibson** and V. A. Soltamov. "Strain Broadening of the 1042-Nm Zero Phonon Line of the Nv- Center in Diamond: A Promising Spectroscopic Tool for Defect Tomography." *Physical Review B* 96, no. 7 (2017).

Blanco, B., **K. A. Palasis**, A. Adwal, D. F. Callen and **A. D. Abell**. "Azobenzene-Containing Photoswitchable Proteasome Inhibitors with Selective Activity and Cellular Toxicity." *Bioorganic and Medicinal Chemistry* 25, no. 19 (2017): 5050-5054.

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Book Chapter:

F. Xie, **W. Deng**, **E.M. Goldys**; "Compatibility of Metal-Induced Fluorescence Enhancement with Applications in Analytical Chemistry and Biosensing; In Surface Plasmon Enhanced, Coupled and Controlled Fluorescence.

G. Arentz P. Mittal, C. Zhang, Y.Y. Ho, **M. Briggs**, L. Winderbaum, M.K. Hoffmann, **P. Hoffmann**; "Applications of Mass Spectrometry Imaging to Cancer"; *Advances in Cancer Research*; Volume 134, 2017, Pages 27-66.

A.D. Pehere and **A.D. Abell**; "The Synthesis of Macrocycles by Huisgen Cycloaddition" *Practical Medicinal Chemistry with Macrocycles: Design, Synthesis, and Case Studies*.

J. Horsley, **J. Yu**, **Y.Q. Yeoh** and **A.D. Abell**; "Peptides as Bio-inspired Molecular Electronic Materials" *Peptides and Peptide-based Biomaterials and their Biomedical Applications*.

A. Care, P.L. Bergquist, **A. Sunna**; "Solid-Binding Peptides in Biomedicine" Part of the *Advances in Experimental Medicine and Biology* book series (AEMB, volume 1030).

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