Australian Synchrotron

Turning bright ideas into brilliant outcomes

2015 ANNUAL REPORT

VICTORIA State Government

Australian Government

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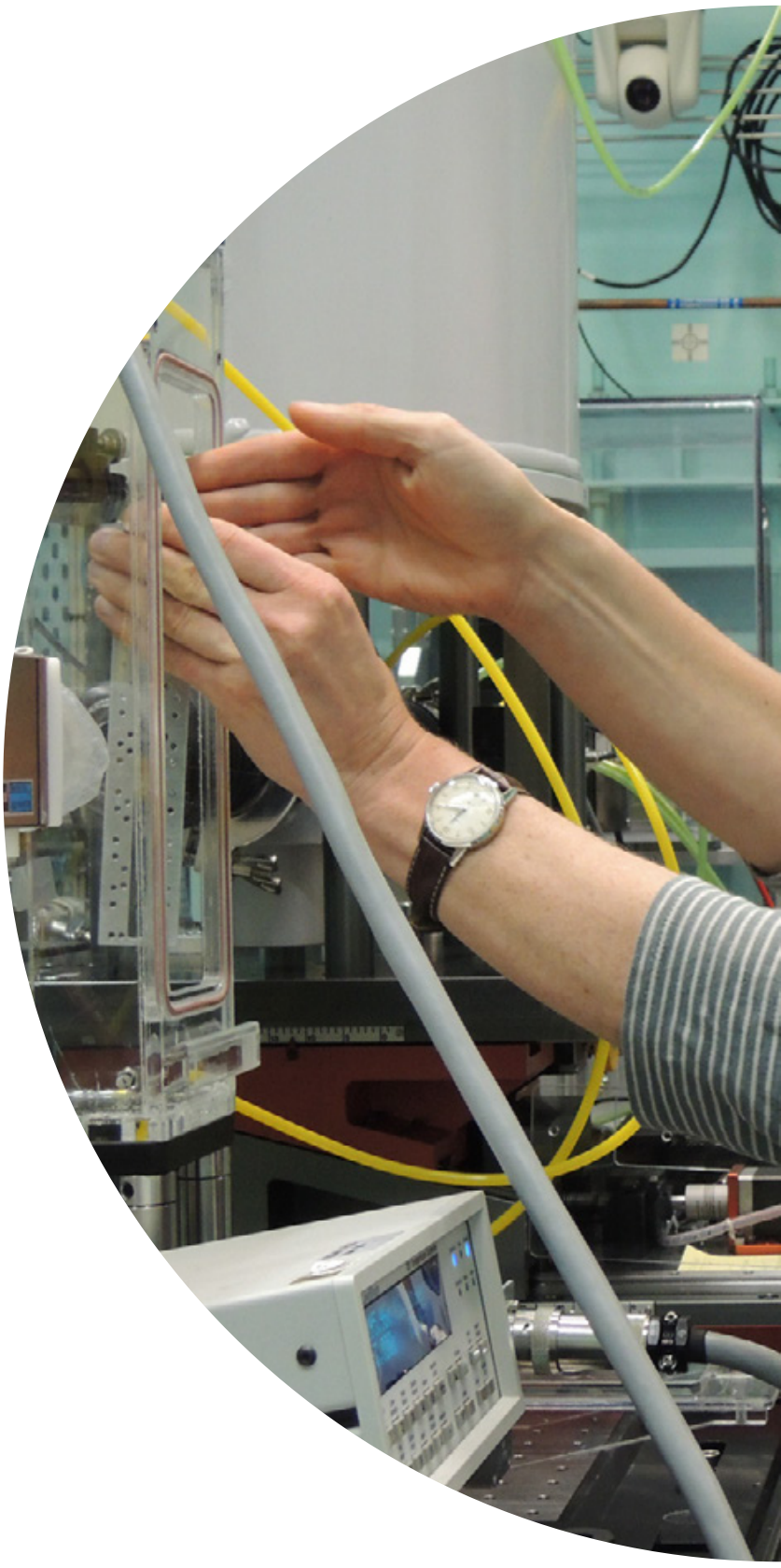

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CHAIR'S REPORT

In a pivotal year in the history of the Australian Synchrotron, the Australian Government committed funding of $20.5 million for the ANSTO-operated facility to continue operations from June 2016.

The Australian Synchrotron remains one of the most important research infrastructure elements in the country. The strong vote of confidence shown by the Australian Government in allocating funding as part of Budget 2015 for operations through to 30 June 2017 was warmly welcomed. The funding will support the operation of this landmark facility over the 2016-2017 financial year while long term ownership and operations are finalised with all stakeholders.

As work continued to realign the Australian Synchrotron under the auspices of ANSTO, the two organisations jointly held a series of integration workshops in 2014-2015, with representatives from key departments in attendance, aimed at ensuring work practices and procedures merge effortlessly when the transfer takes place after 1 July 2016.

With more than 5,000 registered users, the security of the facility into the future is essential to ensure Australian and New Zealand academic researchers and industry can continue to progress new ideas and solve problems as diverse as developing drugs that more effectively target disease including for people with Alzheimer's and cancers, ensuring greater crop security and stronger yields for our farmers, and helping mining companies to improve the processing of minerals.

On behalf of the Synchrotron Light Source Australia (SLSA) Board I thank Director, Professor Andrew Peele, and the broader management and employees of the Australian Synchrotron for their work, in partnership with representatives from ANSTO and the Victorian and Commonwealth governments, in building a model of operational sustainability and ongoing growth and success. These tireless efforts pay enormous dividends, contributing to our collective prosperity by facilitating truly innovative research.

Dr Greg Storr
Chair, Board of Directors
Synchrotron Light Source Australia Pty Ltd

ANSTO OPERATIONS UPDATE

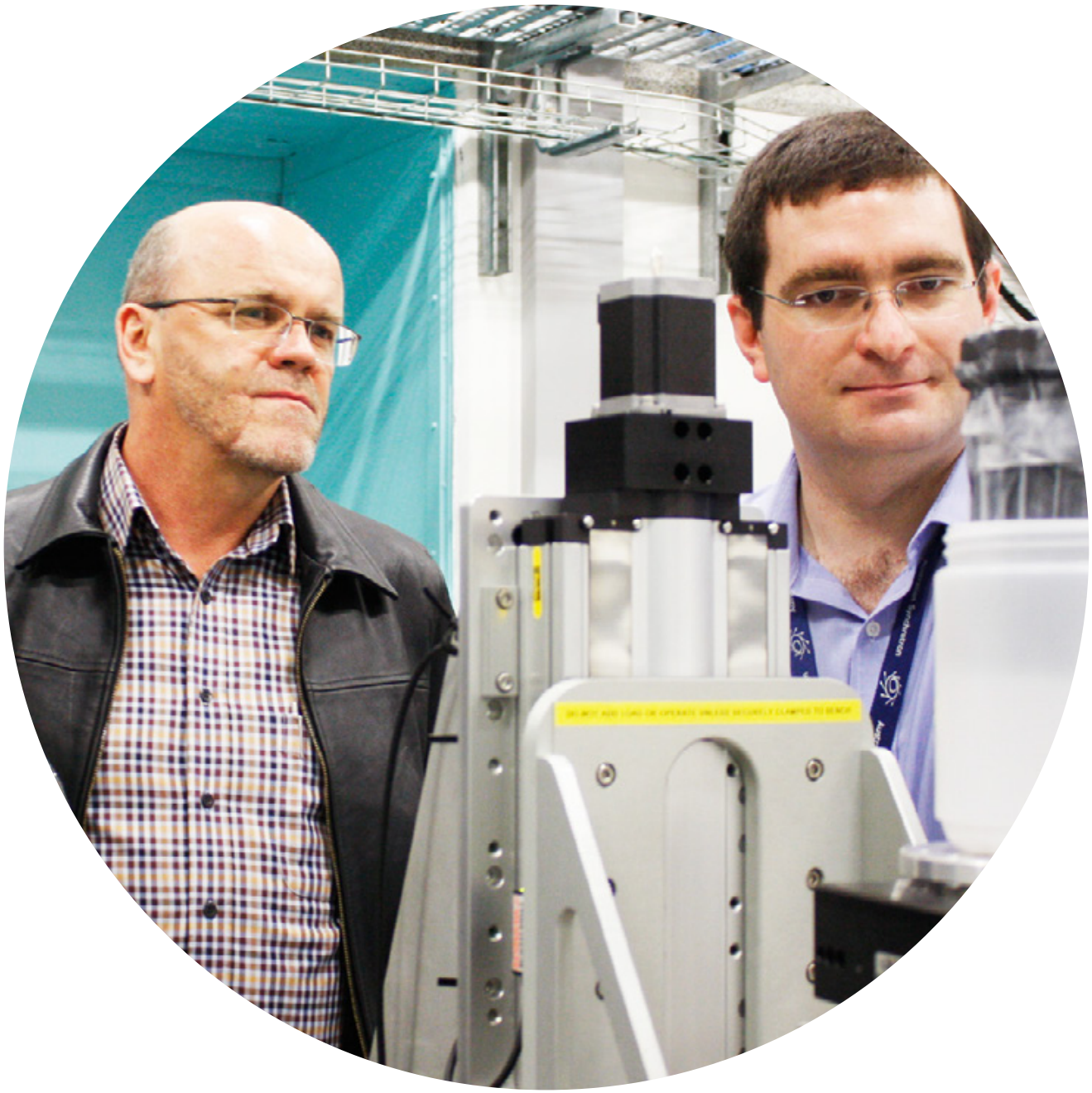
The support the Australian Synchrotron provides to the research community and industry was evident in 2014-2015, with outcomes showcased in high-impact academic publications and through demonstrable and impactful case studies with industrial and societal benefit.

With yet another year of growing demand, including oversubscription on each of the facility's beamlines, the value of the Synchrotron as landmark national research infrastructure was reflected not only by the continued advocacy of leaders from across the scientific community, but by ongoing support from across all areas of government.

On the ground, close cooperative work continued between the Australian Synchrotron and ANSTO in preparation for the transfer of the Synchrotron's assets to the Commonwealth, and the inclusion of the Synchrotron within ANSTO's governance structure, when the current funding arrangements cease.

On behalf of ANSTO, I thank the many Australian Synchrotron employees for delivering another 12 months of growing success in the quality and output excellence of synchrotron science, to the benefit of the Australian and New Zealand communities.

Dr Adi Paterson
Chief Executive Officer
Australian Nuclear Science Technology Organisation (ANSTO)



An industry support scientist from the Australian Synchrotron trains an industry user on the Imaging and Medical beamline (IMBL).

DIRECTOR'S REPORT

The excellence and breadth of research supported by the facility has again been exceptional.

Use of the Australian Synchrotron to solve problems and to make important and innovative advances across industry and academic research continued to grow in 2014-2015. In 12 months, the Australian Synchrotron supported more than 4,300 researcher visits and 888 experiments in areas as diverse as medicine, pharmaceuticals, biotechnology, agriculture, environment, technology, manufacturing and mining. This year, the total number of publications using data captured on the Australian Synchrotron's beamlines since it opened in 2007 exceeded 2,000; remarkably, while the first 1,000 papers were published over a six year period, the second 1,000 took only two.

Reflecting this strong output, subscription across the facility remains consistently high with the number of eight-hour access shifts requested at 1.6 times that available, due to both a steady influx of new users, and continuing demand from current users. Some beamlines, such as Powder Diffraction (PD) and X-ray Fluorescence Microscopy (XFM), showed subscription rates as high as 230 per cent in 2014-2015, demonstrating strong and consistent demand, and a need to further develop instrumentation as well as new beamline capabilities at the Australian Synchrotron. With 38 ports available for experimental stations, the facility has capacity for many more than the current ten that are simultaneously supported. As such, over the coming 12 months, a plan aimed at seeking support for an additional seven beamlines will be prosecuted to ensure Australian and New Zealand discovery and innovation are supported and strengthened into the future.

The Federal Government's commitment to provide $20.5 million, as part of Budget 2015, to the Australian Synchrotron for the 2016-2017 financial year was received positively by the research community and secures another year of operation for one of Australia's most important pieces of research infrastructure. Since the announcement, activity to secure a Commonwealth decision to provide long-term operating funding has continued. In particular, the Department of Industry, Innovation and Science has continued to mediate a process with all stakeholders designed to culminate in sustainable funding for the facility and the transfer of ownership to ANSTO.

The Australian Synchrotron continued its efforts to reach out and engage with its communities in 2014-2015. To celebrate the International Year of Crystallography (2014) and the International Year of Light (2015), the Australian Synchrotron hosted a public lecture series at the National Centre for Synchrotron Science, which attracted audience members of all ages and backgrounds keen to learn more about synchrotron light and its applications. The Speaker Series covered topics as diverse as: 'There's science in your food', 'Crystallography: making matters crystal clear', 'Science at the speed of light', and 'An advanced introduction to synchrotron light'. A highly successful breakfast held at Parliament House in Canberra attracted more than 20 members of parliament as well as senators and luminaries from the national science community, who learnt more about how the Australian Synchrotron is underpinning the competitiveness of Australian and New Zealand industry and, importantly, helping to drive collaborations between research groups and between researchers and industry.

Excellence at the Australian Synchrotron is not only a product of the ingenuity of Australia's broader scientific community and the capabilities of this unique research facility but of its expert team of scientists, engineering, computing, user office and other support staff, whose passionate approach and drive continue to enable truly innovative, world-class research.

I commend this report to you and thank you for your continued support.

Professor Andrew Peele
Director
Australian Synchrotron

AUSTRALIAN SYNCHROTRON: NATIONAL LANDMARK INFRASTRUCTURE

Professor Ben Boyd using Australian Synchrotron's SAXS/WAXS beamline for research into new drug delivery.

The Australian Synchrotron is a world-class research facility that uses accelerator technology to produce a powerful source of light – X-rays and infrared radiation – a million times brighter than the sun. This national scientific infrastructure facility harnesses that light, feeding it down 'beamlines' replete with various apparatus and technologies so academic researchers and industry from across Australia and New Zealand can use it to understand the fundamental structure, composition and behaviour of materials, on scales ranging from the atomic to the macroscopic – with a level of detail and accuracy not possible using conventional laboratory-based equipment.

The facility, which is operated by the Australian Nuclear Science Technology Organisation (ANSTO), has more than 5,000 researchers registered as users. In 2014-2015, researchers visited on more than 4,300 occasions; at June 2015, the Australian Synchrotron had recorded more than 26,000 visits since opening its doors in 2007, welcoming and supporting researchers from research institutions, universities and industry around the country, the region and the world, reflecting its standing as a landmark research facility.

The Australian Synchrotron supports a broad range of high-quality research, with applications in sectors from medicine and nanotechnology to manufacturing and mineral exploration. Our highly advanced techniques and passionate staff contribute to scientific advances and industrial innovations with societal and economic benefits for all Australians.

VISION

The Australian Synchrotron's vision is to be the catalyst for the best research and innovation in Australia and New Zealand. The focus for the facility is to provide a thriving environment that is conducive to creating, inspiring and nurturing the best outcomes, enabled by scientific excellence, for users and staff of the facility.

MISSION

The Australian Synchrotron's mission is to enable science for the benefit of the community, by providing world-class synchrotron expertise and facilities.

VALUES

Our staff are driven by the core values of passion, respect, innovation, collaboration, and excellence.

OUR RESEARCH CAPABILITIES

The Australian Synchrotron's sophisticated scientific techniques provide benefits for diverse academic research and industrial fields and purposes, including:

Biomedicine: offering world-class diagnostic, imaging and therapeutic techniques and investigation of biomimetic materials (such as artificial skin and organs) as well as conducting cell imaging, and high-throughput structural biology capabilities.

Defence: enabling study of the atomic structure of materials, sensors and specialty alloys.

Environmental technologies and services: supporting environmental remediation work and analysing soil samples, the quality and composition of fresh and salt water, air and atmospheric samples, pollutants, toxins and contaminants.

Food technology: analysing the composition of ingredients, assessing the effectiveness of food processing and determining the nutritional impact of foods.

Forensics: refining or developing new forensic processes, techniques and applications, revealing secrets of artefacts.

Life sciences and pharmaceuticals: analysing proteins, nucleic acids, bacteria and viruses that are fundamental to healthy biological function or disease; quality control monitoring, identification and assessment of the effectiveness of drug targets; developing detector technologies, measurement techniques, medical implants and delivery systems.

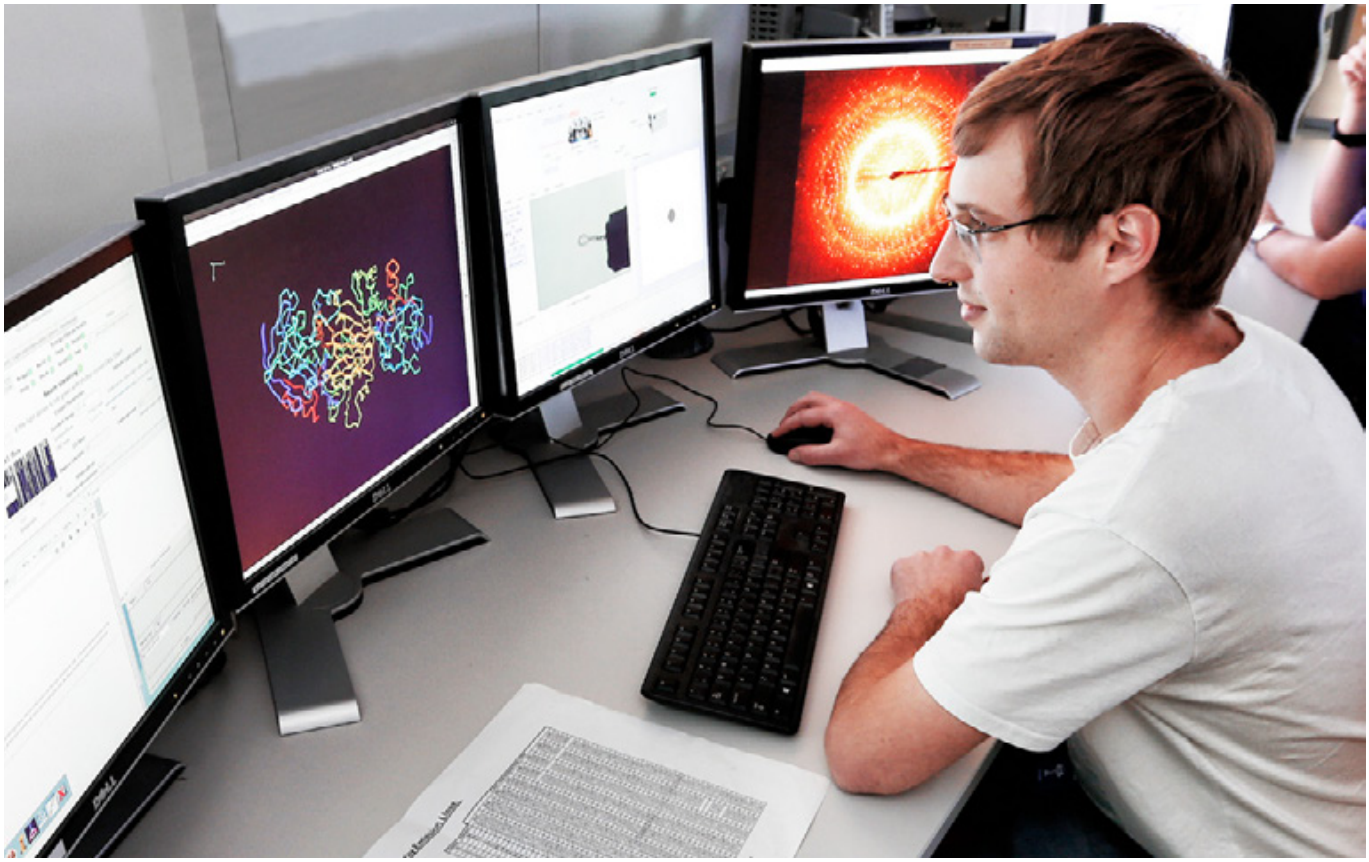
Manufacturing: investigating the structure and characterisation of alloys, catalysts, fibres, textiles, adhesives, polymers, plastics, surfaces, interfaces and coatings; analysing stresses in engineered components.

Minerals: supporting all aspects of mineral exploration and mineral processing; environmental remediation.

Natural resources: supporting the development of exploration and processing, fuel processes, and fuel cell innovations.

IN 2014-2015, RESEARCHERS VISITED ON MORE THAN 4,300 OCCASIONS; AT JUNE 2015, THE AUSTRALIAN SYNCHROTRON HAD RECORDED MORE THAN 26,000 VISITS SINCE OPENING ITS DOORS IN 2007.

IN FOCUS: THE POWER OF 1000 AS AUSTRALIAN RESEARCH REACHES MOLECULAR MILESTONE



One of the major areas of expertise at the Australian Synchrotron is the ability to determine protein structures which, using techniques at the Macromolecular and Micro Crystallography (MX1 and MX2) beamline, can be done in only minutes, rather than hours or even days, using regular laboratory X-ray research. In 2014-2015 depositions of protein structures in the worldwide Protein Data Bank, determined using data from the Australian Synchrotron since opening in 2007, reached 1,000; more than doubling the regional deposition rate achieved prior to the advent of the facility.

Detailed imagery of the Bax protein, determined by scientists from the Walter and Eliza Hall Institute of Medical Research in Melbourne using the Australian Synchrotron, was the 1000th structure submitted to the Protein Data Bank, a free and open-access central repository for crucial molecular information that supports global biological research.

Professor Peter Colman, head of the Walter and Eliza Hall Institute's Structural Biology division said Bax will now be analysed to understand key steps involved in programmed cell death in diseases.

'Through our experiments at the Australian Synchrotron, we can now picture the molecular structure of Bax and, by analysing its surface, shape and interactions, we can now work toward treatments that support, or block, its activity, depending on its role in different diseases, including cancer.'

Scientists from Australia and New Zealand used the Australian Synchrotron to solve 1,000 protein structures in less than eight years, using only two of the facility's ten experiment stations, a rate on par with other, larger synchrotrons in North America, Europe and Asia.

Dr Tom Caradoc-Davies, Principal Scientist of the Macromolecular and Micro Crystallography (MX1 and MX2) beamline at the Synchrotron, said the facility is crucial to understanding the structure of proteins, at a molecular level, which cannot be visualised in any other laboratory setting.

'To reveal a protein's structure, which may hold the key to better understanding its role in diseases, treatments or industrial products, researchers must purify the protein and turn it into a crystal – the right crystal can take months to make and may be too small or weak to subject to regular laboratory X-ray research.

'The Australian Synchrotron's X-ray light is a million times brighter than the sun, enabling light to diffract off crystals smaller than one-tenth the thickness of a human hair, leading to high definition data sets that can be produced in a matter of minutes, rather than days.'

Dr Caradoc-Davies said structures discovered using the Australian Synchrotron have unlocked innovation across a range of scientific fields including medical research, electronics and mining.

'New appreciation of how proteins are shaped enables scientists to understand their role in the onset and progression of diseases, design novel drugs that target proteins for new medicines, or rationally engineer new medical products.'

RESEARCH HIGHLIGHTS

SUPPORTING ACADEMIA AND INDUSTRY TO INNOVATE

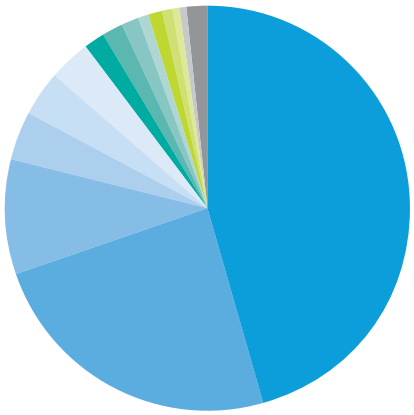
By visualising unprecedented detail of the structure, composition and behaviour of materials at the macro and nanoscale, the Australian Synchrotron enables academia and industry from across Australia and New Zealand, to make discoveries that improve the way we eat, work and live.

Competitively awarded research at the Australian Synchrotron comprised over 32,000 hours of delivered beamtime in 2014-2015.

The majority of these experiments supported world-class research into health and wellbeing, with 46 per cent of total usage focused on biological sciences. The powerful light and advanced data and imagery of the Australian Synchrotron armed researchers with new information and extraordinary insights, which were detailed in 485 articles published in peer-reviewed international science journals.

The following pages shed light on just some of the year's findings among the many advances enabled through the merit access program, as well as outcomes and advances achieved by industry through the Australian Synchrotron's commercial access program, which is dedicated to assisting small and medium enterprises and large corporations alike to problem-solve and innovate.

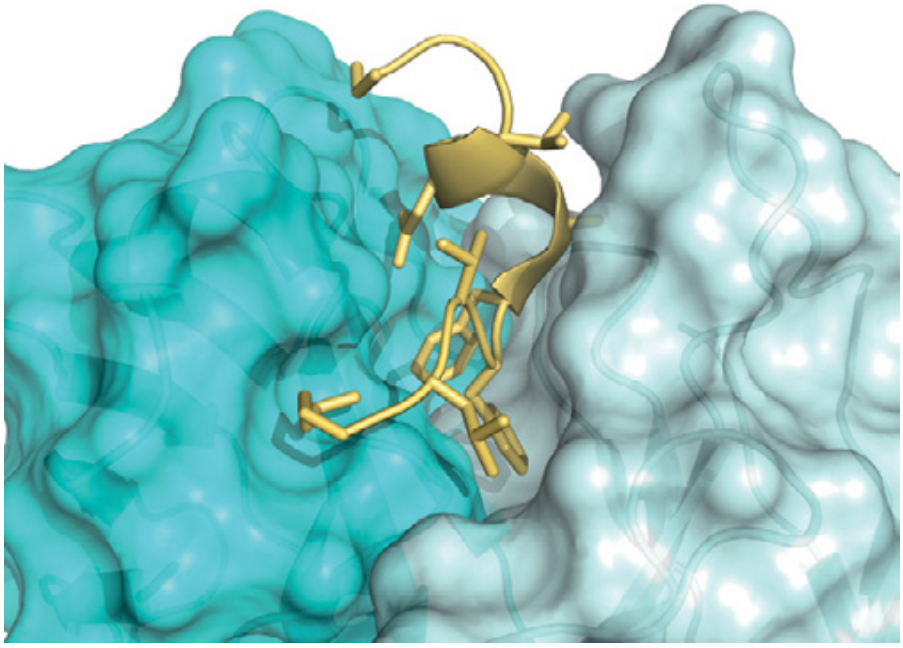
AUSTRALIAN SYNCHROTRON EXPERIMENTS BY FIELD OF RESEARCH: DEMONSTRATING THE BROAD APPLICATIONS OF SYNCHROTRON-RELATED RESEARCH TO CRITICAL SECTORS



- Biological sciences 46%
- Chemical sciences 24%
- Medical and health sciences 9%
- Engineering 4%
- Earth sciences 4%
- Physical sciences 3%
- Technology 2%
- Energy 2%
- Environmental sciences 1%
- Mineral Resources (excl. energy resources) 1%
- Agricultural and veterinary sciences 1%
- Manufacturing 1%
- Environment 1%
- Health 0%
- Other 1%

X-RAYS REVEAL THE KEY TO THE EFFECTIVENESS OF NEW ALZHEIMER'S DRUGS

Researchers from St Vincent's Institute of Medical Research used the Australian Synchrotron to reveal important new detail of the structure of a drug currently in advanced clinical trials to combat Alzheimer's disease.



In April, Professor Michael Parker and his research team revealed how the drug, Solanezumab, interacts with brain proteins associated with the development of Alzheimer's disease; the findings highlight what makes current therapies for the disease effective, and show how these therapies can be improved.

Professor Parker's team used the high-intensity X-ray beams from the Macromolecular Crystallography (MX) beamline at the Australian Synchrotron to visualise the structure at a resolution powerful enough to see how Solanezumab, an antibody, interacts with a toxic peptide thought by many to cause the disease.

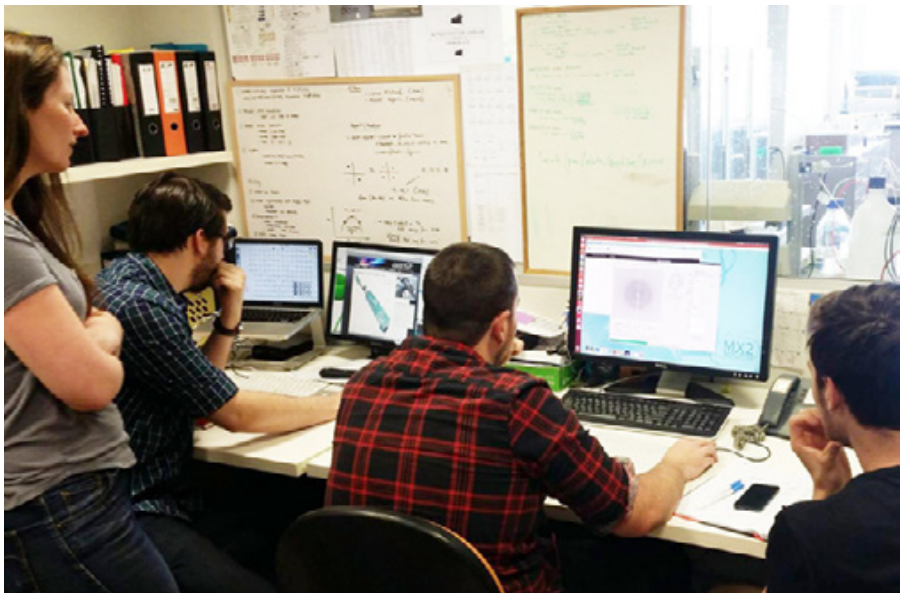
The research revealed how the drug interacts with a peptide that forms plaques in the brain, which are symptomatic of Alzheimer's; these peptides are otherwise difficult for the body's immune system to clear. Solanezumab works by identifying foreign molecules and 'escorting' them to other parts of the immune system that destroy them.

The findings, which were published in *Science Reports*, show Solanezumab appears to behave in a similar way to a second Alzheimer's drug, called Crenezumab, which is also in clinical trials, enabling the research team with a basis to understand how both drugs recognise the toxic peptide and, in doing so, laying the foundation for approaches to improve both therapies.

Alzheimer's disease is the most common form of dementia, affecting 34 million sufferers worldwide. It is expected to become three times as common in the next 40 years as life expectancy increases. There is no cure for the disease, which damages the brain and affects memory, thinking and behaviour. Out of every ten people with dementia, as many as seven have Alzheimer's.

SAYING NONO TO NEUROBLASTOMA

Nucleic acids, proteins and carbohydrates constitute the three major macromolecules essential for all known forms of life.

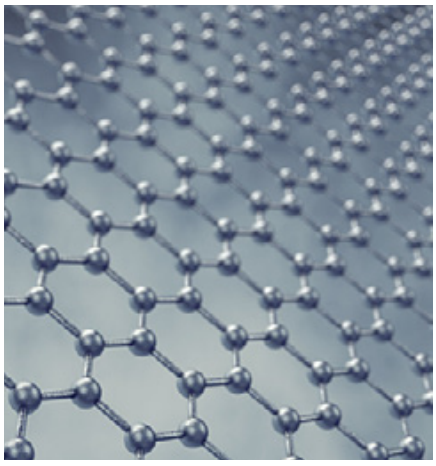


How ribonucleic acid (RNA) is shaped, usually as a folded single-strand chain of molecules, is crucial to conveying genetic information that directs the production of proteins; variance in protein-RNA interactions in the cell nucleus has been implicated in the growth and progression of the childhood cancer neuroblastoma, and prostate cancer.

Professor Charles Bond from The University of Western Australia is leading a research team, partnering with scientists from the Australian Synchrotron's Macromolecular and Micro Crystallography (MX1 and MX2) and Small-angle X-ray Scattering (SAXS) beamlines to understand the structure and function of a key protein active in these interactions, called NONO, with a view to exploring small molecule inhibitors of the protein as a potential neuroblastoma therapy.

‘ATOMIC CHICKEN-WIRE’ IS KEY TO FASTER DNA SEQUENCING

An unusual and very exciting form of carbon – that can be created by drawing on paper – looks to hold the key to real-time, high-throughput DNA sequencing, a technique that could revolutionise medical research and testing.



Led by Dr Jiri Cervenka and PhD candidate Nikolai Dontschuk from The University of Melbourne, the study, published in *Nature Communications*, also included scientists from the Australian Synchrotron and La Trobe University.

The research team showed that graphene – a one-atom thick sheet of hexagonally arranged carbon, shaped like chicken wire – can detect the four nucleobases that make up DNA (cytosine, guanine, adenine and thymine); a unique combination of the four nucleobases makes up the individual DNA sequence of a gene. Currently, DNA sequencing is a fundamental tool for medical diagnostics, forensic testing and medical and biological research.

Nikola Dontschuk said the use of graphene to electrically sequence DNA promises to improve the speed, throughput, reliability and accuracy while reducing the price compared to current techniques.

‘We found that each nucleobase influenced the electronic structure of graphene in a measurably different way.

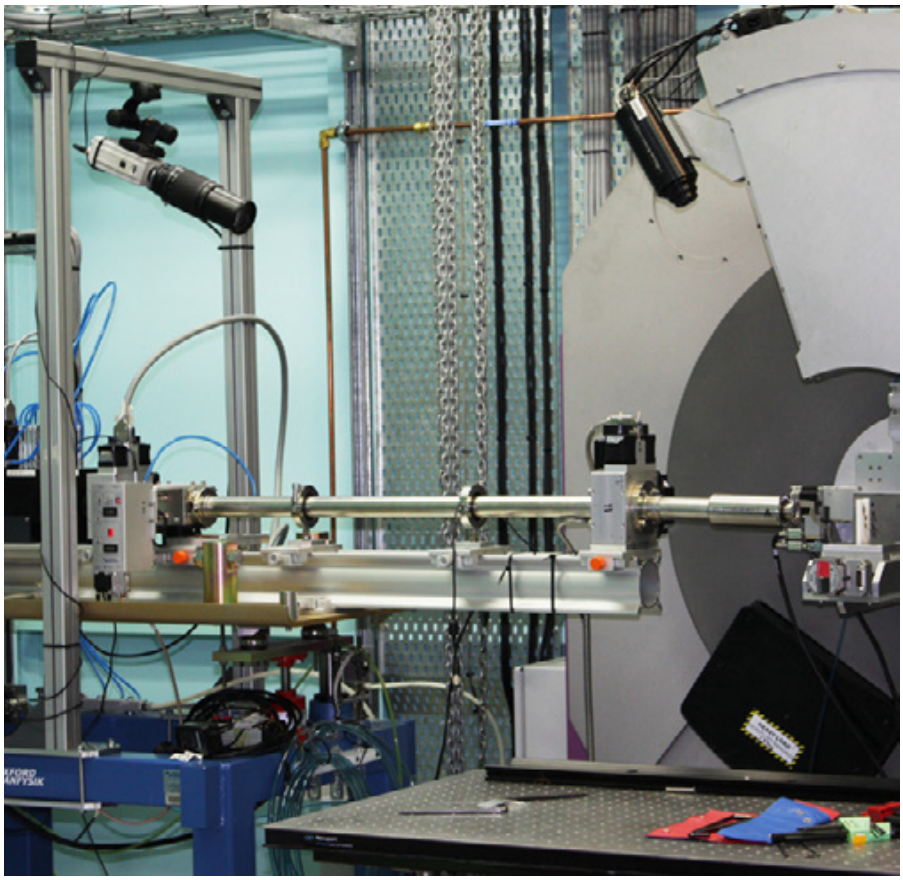
‘When used in conjunction with a nanopore (a tiny hole), a single DNA molecule would pass through the graphene-based electrical sensor – like a single string of beads passing through one section of tiny chicken wire – enabling real-time, high-throughput sequencing of a single DNA molecule,’ he said.

The research team conducted the first experiments to combine in situ electrical measurements of graphene-based field effect transistors (GFET) with photoemission spectroscopy at the Soft X-ray Spectroscopy (SXR) beamline at the Synchrotron.

After comparing the experimental and synchrotron results, the team predicted that single-molecule sensing of the four DNA nucleobases: adenine; guanine; cytosine; and thymine, by bulk graphene devices could be achieved.

ADDING VALUE TO HYDROGEN THROUGH CONTROLLED STORAGE SOLUTIONS

Hydrogen is the lightest and most abundant element in the universe.



In its common form, hydrogen has many important uses in energy and scientific research, however, there are efficiency and safety challenges in the transport and storage of large volumes of the gas.

Associate Professor Kazuhiro Nogita from the University of Queensland, who previously discovered a processing route that allows magnesium-nickel based alloys to safely and efficiently store hydrogen, has partnered with scientists at the Australian Synchrotron's Powder Diffraction (PD) beamline to further develop these alloys and understand the fundamental mechanisms by which they operate.

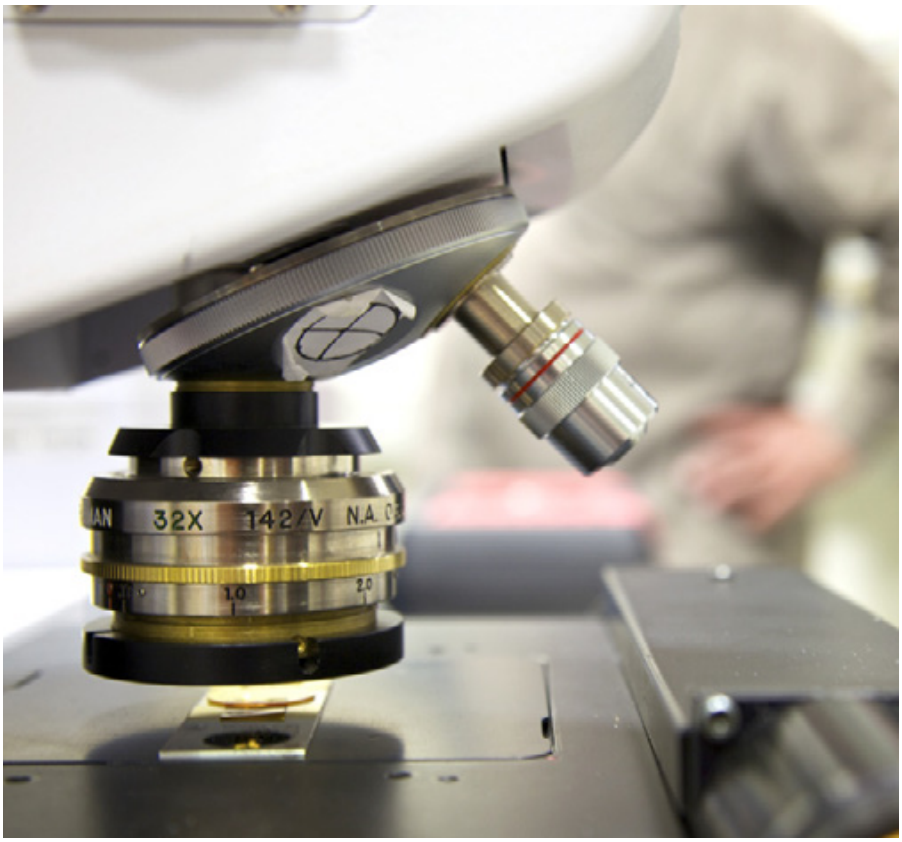
Through Synchrotron experiments at different temperatures and pressures, the research team identified important new attributes of magnesium nickel alloys. These include the potential for gas composition to affect the compound, altering the hydrogen absorption and desorption properties. This new understanding will inform improvements in alloy chemistry and processing conditions, contributing to new on-board vehicle hydrogen storage systems and the development of regenerative, renewable off-grid power sources.

ANALYSING THE AIR ABOVE US

Dichlorodifluoromethane, also known as CFC-12, was one of a suite of gas-molecules widely used as refrigerants in the 20th century. Unfortunately, the chemical stability that made it so appealing for industrial application turned out to be something of a curse in the context of environmental impact, having an atmospheric lifetime of more than 100 years.

To better understand the impact of the lingering presence of CFC-12 and other greenhouse gases on our fragile atmosphere, researchers from La Trobe and Monash universities drew on the specialised infrastructure of the Terahertz/Far Infrared (THz/Far-IR) beamline at the Australian Synchrotron. The beamline combines a specialised vacuum chamber that can replicate atmospheric temperature conditions, the bright light of the synchrotron beam and a high precision spectrometer to provide a capability that is unique in the world.

New analysis of the molecular properties of CFC-12, published in *Journal of Physical Chemistry A*, informs better approaches to atmospheric monitoring of gases by ground, airborne, or satellite based spectrometer systems which, in turn, enables more accurate climate models as scientists continue to assess and predict the effects of greenhouse gas interactions and depletion of the Earth's ozone layer.

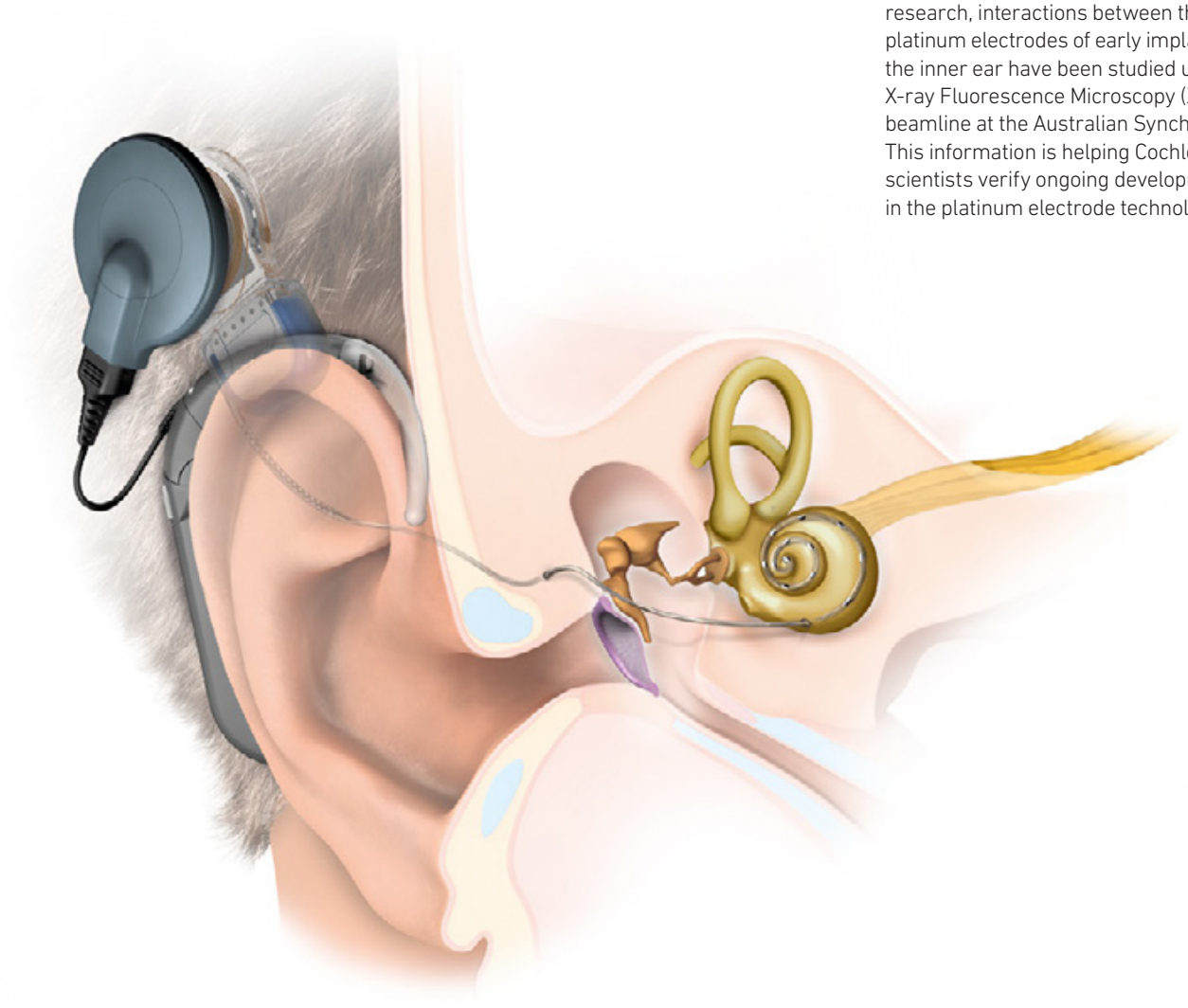


MAINTAINING A COMPETITIVE EDGE IN BIOTECHNOLOGY

Cochlear Limited is a global biotechnology company based in Sydney. It was formed in 1981 to commercialise the implants pioneered by Professor Graeme Clark in 1967, with initial research performed at the University of Sydney and The University of Melbourne.

The Australian device has been the world-leader for more than 30 years, and was the first to utilise a flexible implant that could curl around inside the cochlea of the human ear with platinum electrodes contained within the implant passing signals from a computer processor directly into the inner ear.

Research by Cochlear Limited and Professor Graeme Clark continues to refine the Cochlear implant. In recent research, interactions between the platinum electrodes of early implants and the inner ear have been studied using the X-ray Fluorescence Microscopy (XFM) beamline at the Australian Synchrotron. This information is helping Cochlear scientists verify ongoing developments in the platinum electrode technology.

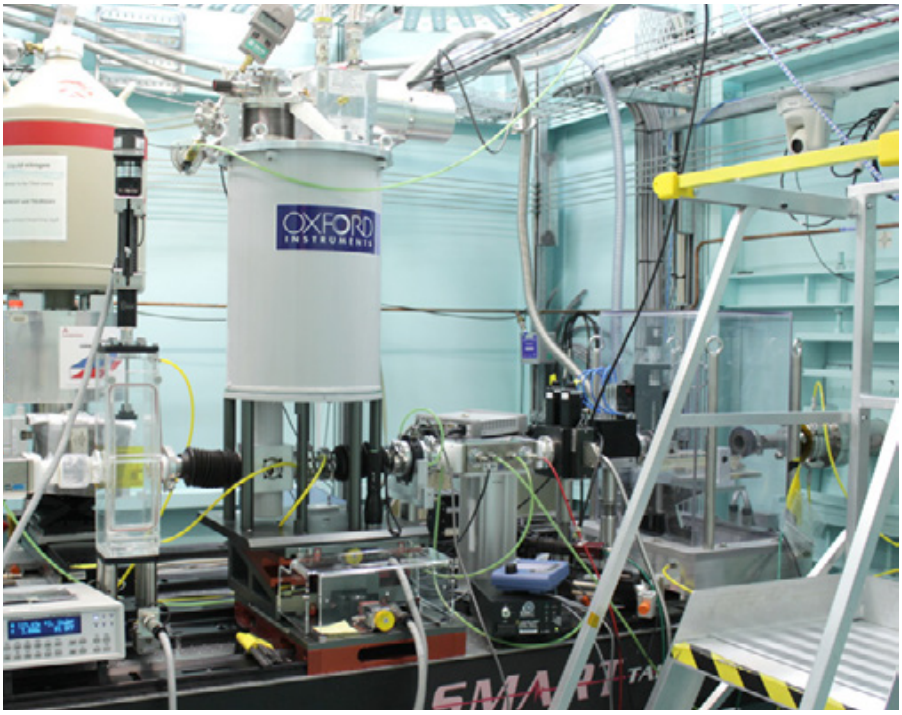


UNDERSTANDING THE FATE OF VANADIUM-BASED ANTI-DIABETIC DRUGS

The anti-diabetic activities of vanadium compounds have been known for over a century. Oral vandium-based anti-diabetic drugs have been shown to have clinical effects, however, interactions within the gastrointestinal environment can affect their biological activity.

Researchers from The University of Sydney completed the first detailed study of the reactivity of typical vanadium-based anti-diabetic drugs in the presence or absence of food components by simulating interactions in the gastrointestinal tract, before measurement and analysis of samples using the X-ray Absorption Spectroscopy (XAS) beamline at the Australian Synchrotron.

The studies revealed the presence and composition of food components in the gut changes the compound and form of vanadium, enabling researchers to predict how readily various types of vanadium-based anti-diabetic drugs will be metabolised when taken orally and the effects of taking such drugs with food.



DESIGNER COKE TO IMPROVE BLAST FURNACE EFFICIENCY

Coke is an essential input for iron production, acting as a carbon source and as a fuel that burns at the high temperatures required for ironmaking, however, there are many chemical and thermal processes that degrade coke in the blast furnace.

Scientists are investigating how the blast furnace environment affects coke structure and microporosity to design stronger coke.

BlueScope Steel Australia, in partnership with the University of Newcastle, is using the Imaging and Medical beamline (IMBL) at the Australian Synchrotron to examine detailed pore structure and the behaviour of mineral inclusions in coke samples from a blast furnace and laboratory experiments simulating the furnace environment.

A better understanding of coke's structural characteristics will benefit the design of coking coal blends for improved furnace efficiency and reduced costs.

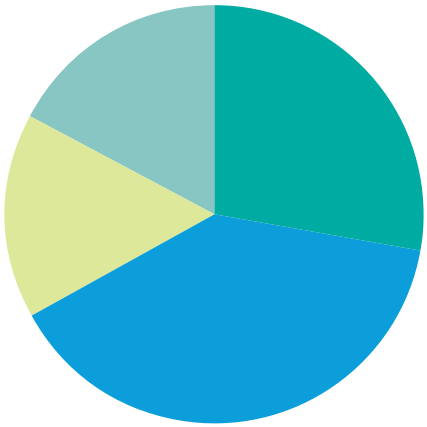
IN FOCUS: ADVANCING NEW SOUTH WALES

From supporting the refinement and innovation of the well-known Australian medical invention – the Cochlear implant, to providing deeper understanding of the possible causes for failures in our iconic gemstone, the opal, the Australian Synchrotron continues to contribute to the advancement of NSW industry.

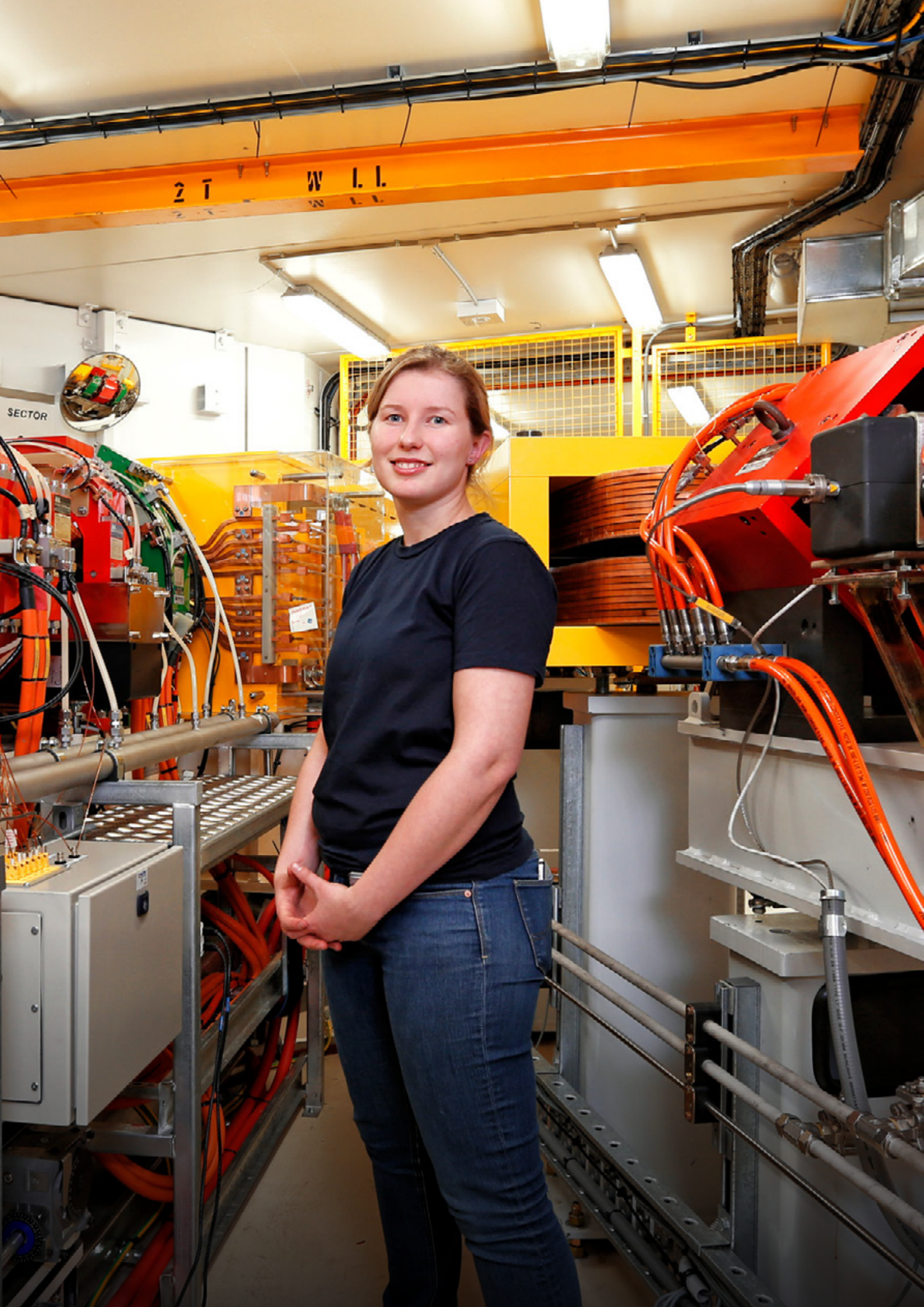
Funded by the New South Wales (NSW) Government, the NSW Industry Synchrotron Access (NISA) scheme was established to encourage NSW-based companies, regional universities, and NSW institutions not associated with a Synchrotron funding party to actively engage with the Australian Synchrotron, supporting NSW innovation and reducing the cost to business of utilising science and technology.

In the second year of the NISA scheme, 18 experiments were performed for 14 different NSW-based companies from across the agricultural, biotechnology, manufacturing and minerals processing sectors.

SECTORS ACCESSING THE AUSTRALIAN SYNCHROTRON THROUGH THE NISA SCHEME IN 2014-2015



SCIENCE OVERVIEW


SECTOR

FACILITY PERFORMANCE

This year the Australian Synchrotron's scientific output set a new pace of growth, while activities to advance the facility's investigative capabilities continued apace.

Considerable developments have not only maintained but improved the facility's performance and capabilities.

More than 4,300 researcher visits from all over Australia, New Zealand and further afield internationally took place in 2014-2015, with particular areas of strength in medical and life sciences, advanced materials and engineering science and earth and environmental sciences.

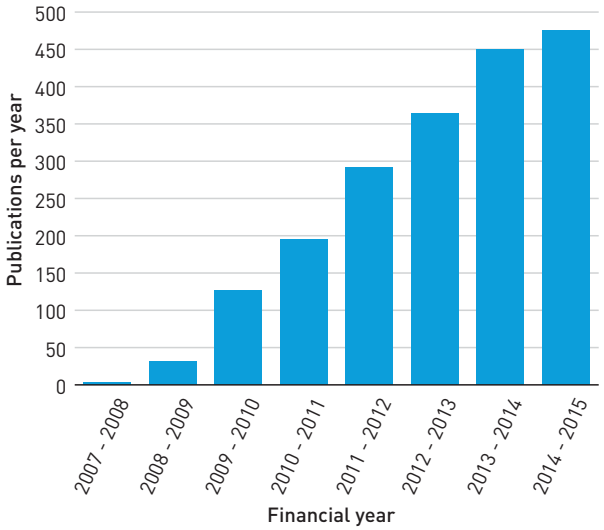
Other areas of focus, including new capability in radiation treatment of cancer, biomedical and nanoscale imaging, and the study of the electronic properties of material, broadened the scope, quality and volume of research produced by scientists and industry using the Australian Synchrotron.

One measure of productivity at the Australian Synchrotron is the number of research papers that have been published in international, peer-reviewed scientific journals containing data from the facility. Strong performance in this area is a good predictor of innovation and societal and industry impact, which when coupled with the Australian Synchrotron's mandate for industry engagement makes the facility an effective focus for translation between discovery research and applied outcomes. Publication output in 2014-2015 was again outstanding, with the publication of 485 peer-reviewed scientific articles – an increase of eight per cent on the previous financial year. The quality of these publications was also very high in 2014-2015 with 16 per cent of all articles published appearing in scientific journals with a high or very high level of global citation, or impact factor (of seven or more); the average facility impact factor also remained strong at 4.8.

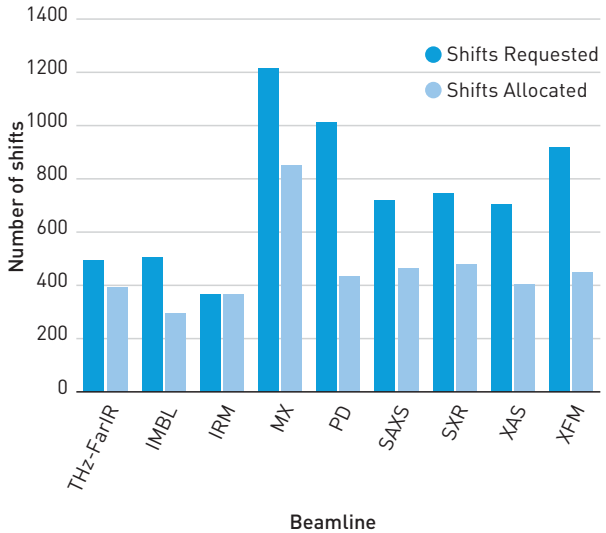
A further 62 publications were produced by Australian Synchrotron staff or other Australian researchers accessing international synchrotron facilities, supported by funding administered by the Australian Synchrotron through the International Synchrotron Access Program. Demand for access to international facilities is further evidence of the sophistication of the Australian user community and provides a way to grow expertise and demonstrate need for instrumentation that is not yet available at the Australian Synchrotron – instrumentation that we hope to deliver under our plan for new investment.

The high quality output from the Australian Synchrotron reflects not only the expertise and effort of our research community and scientific staff but also, importantly, on that of our engineering, computing, user officer and other support staff in providing advanced technical capability and reliability of this research facility. In practical terms, the past 12 months have delivered: better beam quality; improvements in beamline optics, detectors and sample environments; advances in data analysis tools and high-performance computing.

PUBLICATIONS PER YEAR INCLUDING DATA FROM THE AUSTRALIAN SYNCHROTRON



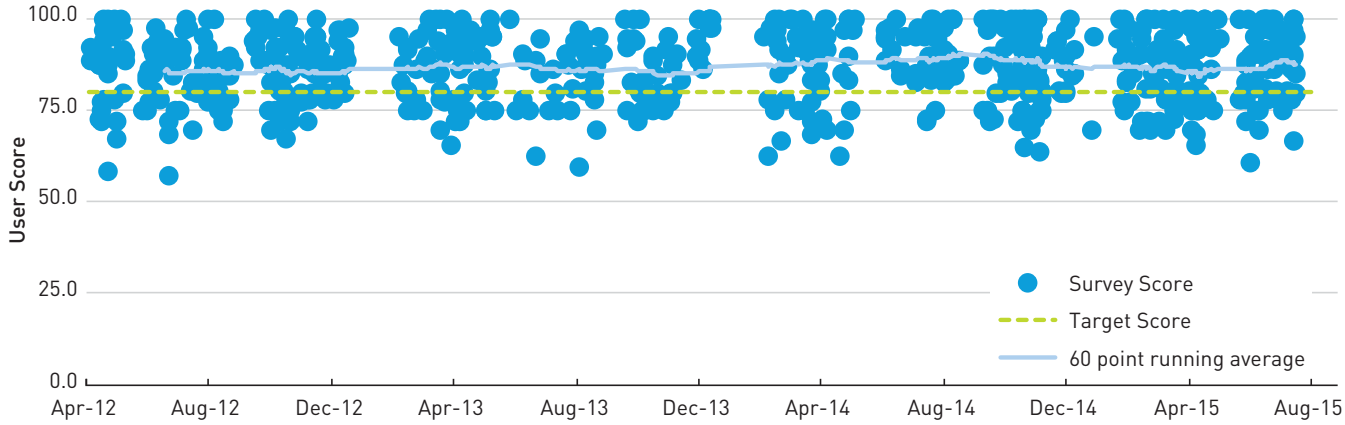
SUBSCRIPTION RATES PER BEAMLINE



OUR COMMUNITY

The number of registered Australian Synchrotron users has climbed to more than 5,000 since opening in 2007 with 547 new researchers registering this year.

USER SURVEY RESULTS



Year-on-year, the number of new users to the facility remains consistent, demonstrating the continued engagement and vitality of the research community.

The experience our users have of the facility is tracked through a survey and by representations made by users to the User Advisory Committee. Users are invited to submit a user satisfaction survey upon completion of their beam time; the averaged data from this survey are shown above with overall user satisfaction sitting above our target of 80 per cent.

IN 2014-2015 THE AUSTRALIAN SYNCHROTRON GUESTHOUSE TOOK MORE THAN 1,150 BOOKINGS FROM MORE THAN 800 UNIQUE GUESTS; 74 PER CENT OF BOOKINGS WERE FOR USERS ATTENDING BEAM TIME, WITH THE REMAINING 26 PER CENT FOR GUESTS ATTENDING MEETINGS, CONFERENCES AND WORKSHOPS.

USER MEETING 2014: HIGHLIGHTING THE TALENT OF THE NEXT GENERATION OF SYNCHROTRON SCIENTISTS

Young researchers played a prominent role in the facility's premier event for the year, the Australian Synchrotron User Meeting 2014, held in November at the National Centre for Synchrotron Science.

In an exciting new feature, the Student Poster Slam, student poster presenters vied to promote their posters in one slide and 60 seconds. The highly competitive and entertaining session was won by Roxanne Smith from La Trobe University for her presentation on 'Targeting DsbD from *Neisseria meningitidis* for the development of new anti-Neisserial agents'.

The User Meeting, which showcases the latest research developments, was for the first time held in conjunction with the New User Symposium, giving prospective users the opportunity to not only learn about the Australian Synchrotron, but also the neutron and accelerator facilities available under the ANSTO umbrella.

In addition to the Poster Slam, the 200 delegates enjoyed plenary presentations from Professor Harald Ade from North Carolina State University in the United States who spoke about organic photovoltaic device performance, while Dr Bruce Ravel of the US National Institute of Standards and Technology discussed X-ray absorption spectroscopy in the age of insertion devices. The Victor Chang Cardiac Research Institute's Dr Daniela Stock spoke with the audience about molecular power converters.

Other national and international conferences and workshops hosted by the Australian Synchrotron in 2014-2015 included:

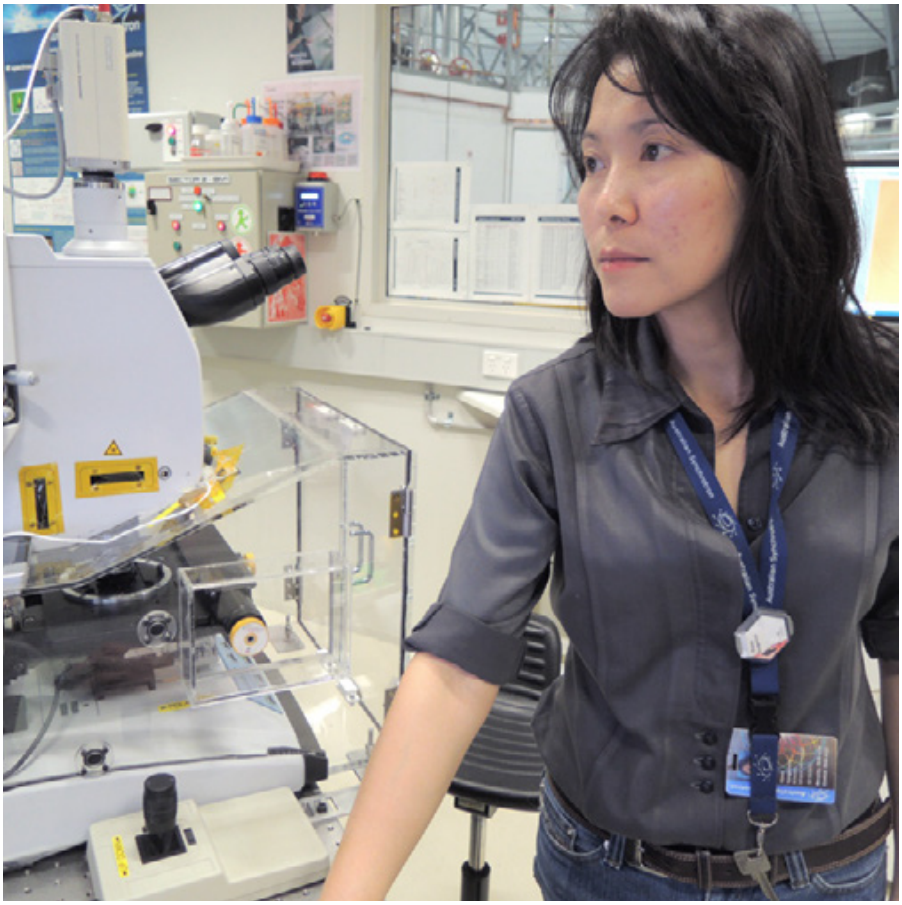
- *Mechanical Engineering Design of Synchrotron Radiation Equipment and Instrumentation 2014*
- *International Conference on X-ray Microscopy 2014*
- A workshop on *Coherent X-ray Scattering* with senior attendees from Taiwan's National Synchrotron Radiation Research Centre.

RESEARCH TRENDS BY BEAMLINE

Of this year's 485 publications, 32 contained data from more than one instrument, with the most common pairings between the Macromolecular and Micro Crystallography (MX1 and MX2) and Small-angle X-ray Scattering (SAXS) beamlines, and the Powder Diffraction (PD) and Soft X-ray Spectroscopy (SXR) beamlines.

The MX/SAXS combination allows researchers to examine protein structure with atomic resolution when packed into crystals, while scattering provides an understanding of their native conformation in solution. The PD/SXR combination allows researchers to examine both the long-range atomic structure of advanced crystalline materials, as well as the nature of local charge ordering due to variation in elemental oxidation states. Twenty-eight publications also contained neutron scattering data from ANSTO's OPAL Research Reactor in Sydney.

Increasingly we are seeing Australian researchers turn to these complementary techniques to solve sophisticated problems or better understand the nature of complex materials, especially in relation to powder diffraction where 22 per cent of all publications from the PD beamline used both X-ray and neutron techniques.



BEAMLINE AND MACHINE UPDATES

BEAMLINE DEVELOPMENTS: SHINING LIGHT ON IMBL

In June, the finishing touches were placed on the Australian Synchrotron's $26 million Imaging and Medical beamline (IMBL) with a $16.1 million extension.

Funded by the National Health and Medical Research Council, Foundation Investors, and the Victorian Government, the upgrade included completion of the current beam delivery and instrumentation programs and unique research infrastructure, including laboratories, holding and preparation facilities and clinical suites for patients.

The upgrade also involved the procurement of a patient positioning system for imaging, to enable the translation of pre-clinical outcomes, informing new approaches to understanding and treating human disease.

The Imaging and Medical beamline is the largest piece of medical research infrastructure at any synchrotron facility worldwide and is a flagship project of the Australian Synchrotron. The IMBL facilitates cutting-edge medical research in many fields using high sensitivity X-ray imaging and dynamic dose delivery.

UPGRADES

Upgrades to the synchrotron machine are constantly being planned and implemented. Projects recently completed or currently in hand include:

- the upgrade of all cooling water systems and electrical infrastructure, support of beamline control systems
- initiating a more proactive approach to the reliability of the accelerator and beamlines; this has involved identifying possible failures and using this to prioritise required maintenance, upgrade projects and spares procurement.

MACHINE RELIABILITY

The machine's reliability continues to be outstanding, with availability of 99.2 per cent, above the target figure of 97 per cent for the 2014-2015 financial year. Faults due to aging equipment and the corresponding increase in time to diagnose and rectify have seen an increase in the mean down time accompanying each fault. Continuing our high level of performance will only be possible with a well-resourced and proactive program of maintenance and repair.

AWARDS AND ACHIEVEMENTS

The Australian Synchrotron provides users from research and commercial backgrounds with a uniquely powerful combination of cutting-edge technology and internationally renowned expertise. At our facility, it is the commitment, passion and expertise of all of our staff that enables the maximum possible productivity from highly specialised equipment. Our people are a diverse group who represent a wealth of expert skills in such diverse areas as science and research, electrical and mechanical engineering, computing, software, control systems, user liaison, occupational health and safety, business development and industry liaison, finance, accounting, human resource management, communication and stakeholder management.

Here we celebrate some of the achievements and successes enjoyed by our employees, former and current, and by our users.

THE WORLD STAGE: SYNCHROTRON STAFF HELP TO SECURE GLOBAL CONFERENCES

Around 1,000 delegates will visit Melbourne as part of the International Particle Accelerator Conference 2019 (IPAC 2019) in May 2019.

The bid for the six day conference, which will bring with it an estimated economic contribution of approximately $5 million to the State of Victoria, was supported by Dr Dean Morris, Head of Corporate Services, at the Australian Synchrotron with the winning bid presented in Korea by the Synchrotron's Principal Scientist, Accelerator Physics, Associate Professor Mark Boland.

In partnership with the Melbourne Convention and Visitors Bureau, Australian Synchrotron employees, as leaders in their respective fields, developed successful bid proposals, delivering in the past financial year:

- 12th International Conference on X-ray Microscopy: Dr David Paterson, Principal Scientist, X-Ray Fluorescence Microscopy
- 8th International Conference on Mechanical Engineering Design of Synchrotron Radiation Equipment: Brad Mountford, Group Leader, Mechanical Engineering.

EARLY SYNCHROTRON SUPPORTER GIVEN QUEEN'S BIRTHDAY HONOUR

Professor John Boldeman, former Director of the Australian Synchrotron Research Program, became an Officer of the Order of Australia (AO), for his distinguished service to nuclear science and technology, particularly for his work in the designing and construction of the Australian Synchrotron, as part of the Queen's Birthday Honours.

Professor Boldeman also played an important role in proposing and promoting the Australian Synchrotron within government and the research community.

2014 L'ORÉAL FOR WOMEN IN SCIENCE FELLOWSHIP FOR CLEAN WATER WITH CRYSTALS

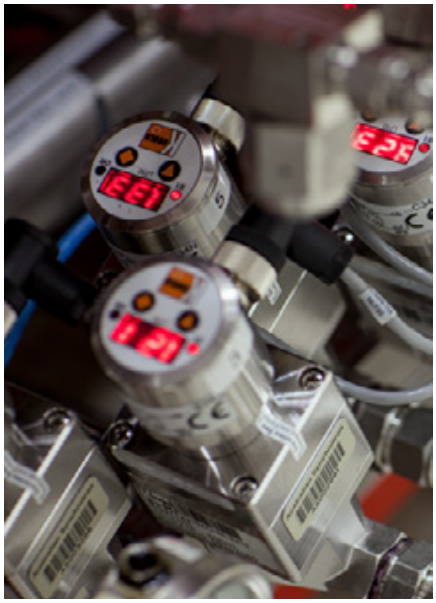
A young scientist who is using the Australian Synchrotron to help her pursue a vision for a new manufacturing industry was awarded a $25,000 L'Oréal For Women in Science Fellowship.

CSIRO materials scientist and Synchrotron user Dr Cara Doherty is developing new technologies that could transform water filters, batteries and medical sensors, and clean up carbon emissions.

Dr Doherty works with crystals that are packed with nothing. They're highly porous sponges – down to a molecular level – and can be customised to absorb almost any molecule. The crystals are metal-organic frameworks (MOFs), which consist of an array of metal ions linked by organic molecules in a vast, open structure. MOFs can be tailored by varying the metal ions or organic molecules, but there are major challenges in creating the 3D devices required for practical, commercial applications.

At CSIRO, Dr Doherty works in the Materials for Energy, Water and Environment group. She uses antimatter (positrons) and synchrotron X-rays to measure the crystals and their properties before using her patented technique to imprint useful shapes for devices. She combines data from positron annihilation lifetime spectroscopy (PALS) with information from synchrotron techniques such as small angle X-ray scattering and X-ray powder diffraction.

Dr Doherty plans to use her Fellowship to investigate developing 3D structures for a smart water filter that uses MOFs to trap and remove chemical and biological pollutants from non-potable water.



GOVERNANCE

Synchrotron Light Source Australia Pty Ltd (SLSA), trading as the Australian Synchrotron, assumed operations of the facility on 1 January 2013, while the assets are owned by the Australian Synchrotron Holding Company Pty Ltd (ASHCo). SLSA is a wholly-owned subsidiary of the Australian Nuclear Science and Technology Organisation (ANSTO), which operates the Synchrotron under an operations services agreement with ASHCo.

SLSA BOARD OF DIRECTORS

Members of the SLSA Board of Directors for the period 1 July 2014 to 30 June 2015 were as follows:

Dr Greg Storr
(Chair) Group Executive, ANSTO

Mr Peter Arambatzis
Chief Financial Officer, ANSTO

Ms Nadia Levin
General Manager, Government, International and External Relations, ANSTO

Professor Liz Sonenberg
Pro Vice-Chancellor (Research Collaboration), The University of Melbourne

Professor Jill Trewhella
Deputy Vice-Chancellor (Research), The University of Sydney

Further detail of the Directors and activities of SLSA are contained in the Australian Synchrotron Financial Reports, 30 June 2015.

FUNDERS' COMMITTEE

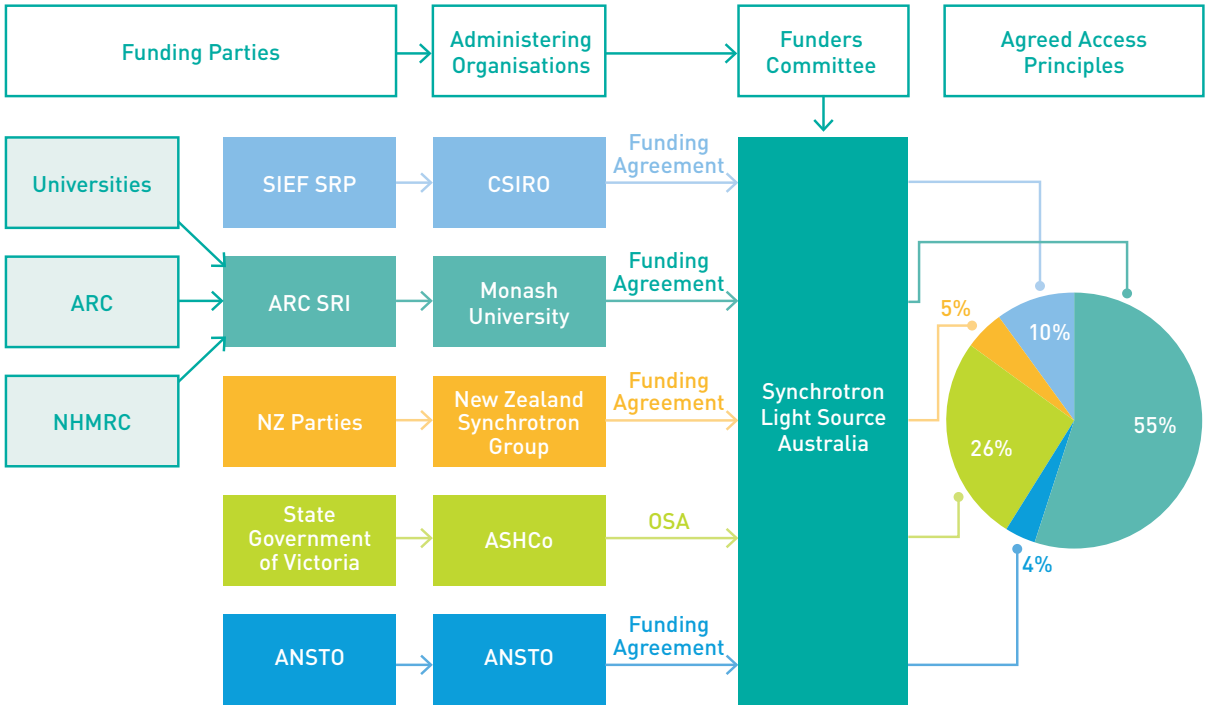
A representative committee of the Funding Parties (see Funding Framework), the Funders' Committee has oversight of facility operations and its endorsement is required before matters, such as the operating plan and budget for SLSA, can be approved.

COMMITTEES

Several bodies continue to support the development and effective operation of the Australian Synchrotron:

- Scientific Advisory Committee
- Animal Ethics Committee
- Industry Advisory Committee
- International Program Advisory Committee
- Machine Advisory Group
- Program Advisory Committees
- User Advisory Committee.

FUNDING



In March 2012, Commonwealth and Victorian government parties signed a Memorandum of Understanding, providing the framework to deliver $100 million to support operating and research costs at the Australian Synchrotron for the four years to 30 June 2016.

The funding parties and relevant funding schemes are:

- Australian Research Council Strategic Research Initiative (ARC SRI), National Health and Medical Research Council (NHMRC), and Australian universities: $55 million
- State Government of Victoria (managed through the Department of Economic Development, Jobs, Transport and Resources): $26 million
- Science and Industry Endowment Fund Special Research Program (SIEF SRP): $10 million
- The New Zealand Synchrotron Group Ltd representing a consortium of the federal government, universities and research institutes: $5 million
- ANSTO: $4 million.

The funding parties are granted synchrotron beamtime in proportion to their funding contributions. The relationship between the funding parties, their administering organisations, the Funders' Commitee and the share of beamtime is set out above.

FINANCIAL STATEMENTS

The Australian Synchrotron continued to deliver strong scientific achievements to funding parties and the wider scientific and commercial communities during the 2014-2015 financial year. The year saw an increase in other revenue above budget of $438,172, $346,524 of which was income relating to two international conferences (MEDSI & XRM), which were not included in the budget. Including the conference expenditure of $371,020 there was an overspend on budgeted operating expenditure of $218,829. This means an additional $219,343 is available for operations in the 2015-2016 financal year. The full consolidated result was a small surplus of $48,172 due to timing of revenue received for operation of a grant program.

This year's result is on total revenue of $27,543,260 and total expenditure of $27,495,089, which includes $1,835,709 of assets transferred to Australian Synchrotron Holding Company Pty Ltd (ASHCo) for zero consideration. The main source of revenue was from the funding parties comprising $25,121,911. In addition, $15,418,058 of revenue was also received in advance and allocated into the statement of financial position as a contribution in advance. Commercial revenue of $663,569 includes $436,232 for the NSW Industry Synchrotron Access scheme.

Other revenue of $1,209,229 consists mainly of income from international conferences held, grant funding towards the International Synchrotron Access Program, office rental, guesthouse revenue, other conference and workshop registrations and postdoctoral contributions. Operating expenditure during the year was made up of $16,732,428 for salaries and employee benefits and $224,822 for occupational, health and safety expenditure. An amount of $5,223,676 was spent on operating and maintaining the facility at a world-class standard, including $2,758,595 for building and technical expenditure and $2,465,081 on utilities. A total of $1,835,709 was spent on essential operating upgrades and spare parts, while an additional $1,688,307 was committed to support local and international user access, scientific development, external relations activity and business development. Administrative costs of the facility were $1,790,147 including staff travel, information technology and general administration. Further financial information is available in the 2015 annual financial statements for Synchrotron Light Source Australia (SLSA).

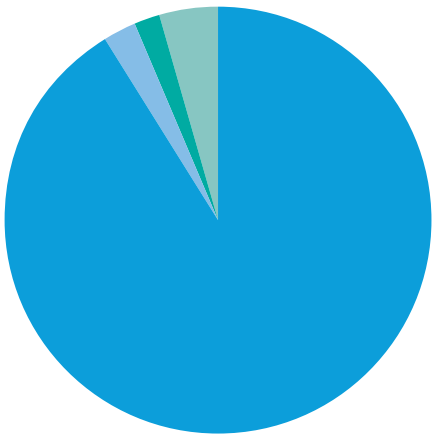
EXPENSES

Payroll and consulting	16,732,428	60.86%
Occupational health, safety and environment	224,822	0.82%
Building and engineering	5,223,676	19.00%
User support and business development	1,688,307	6.14%
Administration	1,790,147	6.51%
Transfer of assets at nil consideration	1,835,709	6.68%
Total expenses	**27,495,089**	

REVENUE

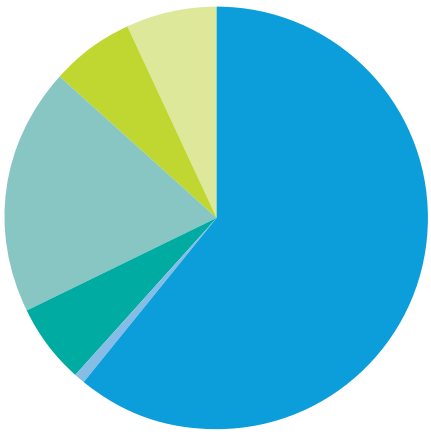
Funding parties	25,121,911	91.21%
Interest	548,551	1.99%
Commercial revenue	663,569	2.41%
Other revenue	1,209,229	4.39%
Total revenue	**27,543,260**	

INCOME



- Funding parties 91.21%
- Commercial revenue 2.41%
- Interest revenue 1.99%
- Other revenue 4.39%

EXPENDITURE



- Salaries and employee benefits 60.86%
- OHS&E 0.82%
- User support and business development 6.14%
- Building and technical expenses 19.00%
- Administration expenses 6.51%
- Spares and essential operating upgrades 6.68%


NATIONAL
CENTRE FOR
SYNCHROTRON
SCIENCE
Australian
Victoria
AUSTRALIA

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