Australian Synchrotron

LIGHTSPEED December 2010

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Background image: Artificially rendered image of data from a sample of lanthanum hexaboride captured on the 2D x-ray detector at the powder diffraction beamline at the Australian Synchrotron

From the Acting Director - Congratulations to all

Several recent events have highlighted the quality of the science that takes place at the Australian Synchrotron – and the value of research collaborations.

I would firstly like to congratulate two of our beamline scientists, Nathan Cowieson and Tom Caradoc-Davies, recently listed as co-authors on two articles in the prestigious publication Nature. Further information about this work and Nathan's and Tom's contributions appears later in this Lightspeed.

Further evidence of our high quality research is the significant increase in the number of scientific articles that draw on the results of experiments conducted by users at the Australian Synchrotron. More than half the 226 scientific articles published since the opening of the synchrotron in July 2007 have occurred in 2010.

I am proud to acknowledge that yet another of our users has received an award that recognises their individual achievements. Darren Goossens from the Australian National University has received the ACT Young Tall Poppy Scientist of the Year award for 2010.

Those of you who attended the Australian Synchrotron User Meeting in Melbourne in November 2010 would have seen many more examples of achievement by individuals and research teams. The animated discussions that took place during question times and session breaks are a good indication of further achievements to come.

On behalf of synchrotron management, I congratulate users and staff for their contributions to a very productive 2010.

Looking ahead, 2011 also promises to be a very active period for the Australian Synchrotron. The imaging and medical beamline extension is proceeding well and work has also commenced on the construction of the new National Centre for Synchrotron Science and other associated buildings that will provide additional room for staff, users and visitors to the synchrotron.

I'm sorry to say that Professor Ian Gentle, our Head of Science since October 2008, will leave us at the end of 2010 to return to his position of Professor of Chemistry at the University of Queensland. On behalf of Board members and synchrotron staff, I thank Ian for his great achievements and science leadership at the Australian Synchrotron. He will be greatly missed and we wish him well with his future career plans. Dr Andrew Peele from La Trobe University has been appointed as our new Head of Science and will work closely with Ian to ensure a smooth hand-over.

We have also appointed a new Head of External Relations, Dr Shirley Lanning, a microbiologist by training who has considerable experience in public relations and stakeholder management.

I would like to thank our stakeholders, committee members and valued friends of the Australian Synchrotron for their ongoing support and assistance throughout the year.

Best wishes to you all for a safe and enjoyable holiday season, and we look forward to a productive start to 2011.

George Borg

Chief Operating Officer, Australian Synchrotron

Up to speed: Daniel Hausermann

This month our short interview features Daniel Häusermann, who heads the Australian Synchrotron's imaging and medical beamline team. The beamline is currently being extended to provide advanced high-resolution imaging capabilities in preparation for clinical research with patients.

Describe your job in 25 words or less.
Designing, building and running the Imaging and Medical Beamline – the longest beamline in the southern hemisphere.

Best aspect of your job?
Moving from high pressure physics to medical research has opened my eyes to the profound impact synchrotron-based research can have in increasing our understanding of a wide range of medical conditions and finding new treatments for illnesses such as cancer and cardio-vascular diseases.

Hardest aspect of your job?
Building something as world-unique and technically complex as the IMBL takes a collective leap of faith on the part of scientists, funders and administrators. Maintaining a cohesive vision over the years it takes to develop a project of this scale is challenging. But on most days this is one of the best things about my job.

Apart from the Australian Synchrotron, what's the coolest job you've ever had?
Working at the European Synchrotron Radiation Facility (ESRF) in France from 1992 to 1999. It is a multi-cultural, multi-lingual laboratory which had the first high-brilliance beamlines in the world and rapidly built up the most outstanding research programs and achievements in the synchrotron world. I was given the opportunity to work with young, dynamic and outstanding hands-on users to establish a high-pressure research program that is still world-leading today. But being a 'house mother' in an ashram in the early 70s was pretty 'cool' too.

Best things about living in Melbourne and why?
Living on an acre of Australian bush, where echidnas, kookaburras, cockatoos and parrots visit daily. Yet I'm only 40 minutes drive from the city or the beach. You don't get that in Switzerland.

Your favourite overseas destination and why?
With family in Switzerland, London, France and the USA there is always much desire to go there, but recently discovering South East Asia is hard to beat.

A little-known fact about the Australian Synchrotron?
Worrell Louden is the best and most helpful store manager of all synchrotrons in the world, and he brings breakfast to his wife in bed every morning!

What's the most unusual or interesting sample you've seen on the IMBL?
As part of a developmental biology research program, we recently studied a 380-million-year-old fossilised bone from an extinct armoured fish.

What is the biggest achievement or discovery so far for your beamline?
That a Swiss, an Englishman, a Greek and a Russian can share a 4m x 4m office and build a world-leading beamline.

What is the biggest challenge facing your beamline?
To build a facility that can receive patients for clinical research in a few years from now. It is only through strong collaboration with our international colleagues and the support of the Australian biomedical community that we can navigate the uncharted territories and manage the risks required to get there.

What is the best piece of advice you would like to offer users and potential users?
If you think you are thinking big, think bigger.

The nature of science

It's double celebration time at the Australian Synchrotron, with Nathan Cowieson and Tom Caradoc-Davies recently listed as co-authors on separate research papers published in Nature, arguably the world's most prestigious and widely read scientific journal.

The nature of science

Congratulations to Australian Synchrotron scientist Nathan Cowieson, who is co-author of a paper just published in Nature, along with colleagues at Monash University.

Nature is arguably the world's most prestigious and widely read scientific journal. It is also considered to be one of the most highly cited interdisciplinary science journals of its kind.

In simple terms, the work revealed details of the 'quality control' process that immature T cells, a kind of white blood cell that plays an important part in the body's immune system, must undergo before they can mature. The 'T' in T cell stands for thymus, which is where the T cells mature.

The study (Nature 467: 844-8, 14 October 2010) from Jamie Rossjohn's laboratory at Monash University describes the underlying molecular mechanism of T cell selection and maturation. A breakthrough in the field of cellular immunity, the finding relied on the Australian Synchrotron's protein crystallography and small-angle x-ray scattering beamlines. Nathan collaborated with Jamie Rossjohn's research group while working at Monash University in Matthew Wilce's laboratory before joining the Australian Synchrotron in 2009.

T cells are a population of cells that play a key role in cell-mediated immunity. On the surface of each T cell is a T cell receptor (TCR) composed of two polypeptide chains that bind together when an antigen is present leading to T cell activation and an immune response. Random recombination or shuffling within the TCR genes gives rise to variations in the receptor from T cell to T cell that allows populations of T cells to recognise a wide range of pathogenic organisms.

While gene shuffling and variation are key features of the TCR the process also inevitably gives rise to variations that are no longer able to perform the dimerisation and signalling functions of the TCR. For this reason T cells go through a quality checkpoint during their maturation. In this process an invariant pre-T cell TCR chain binds to the variant T cell receptor chains in the absence of an antigen and in this context the binding and signalling allow the immature cells to become mature T cells.

The Nature paper describes the atomic resolution structure of a pre-T cell dimeric complex solved by protein x-ray crystallography at the macromolecular crystallography beamlines at the Australian Synchrotron. The structure reveals the molecular mechanism by which these proteins dimerise and how the pre-T cell chain 'samples' the variant chain to test for integrity. The mode of dimerisation seen in the crystal structure is validated in solution by experiments conducted at the small angle x-ray scattering (SAXS) beamline at the Australian Synchrotron.

Click here to read the paper, entitled 'The structural basis for autonomous dimerisation of the pre-T-cell antigen receptor', as an abstract or in full.

http://www.nature.com/nature/journal/v467/n7317/full/nature09448.html

Nathan said he was "privileged to play a small part in this research and felt strongly that science like this reflected the hard work of both users and staff".

"The work described in the Nature paper could not have happened without significant input from other scientists, including the work of major contributor and PhD student Siew Siew Pang, and the important work of Nicole La Gruta, Zhenjun Chen and Matthew Wilce on the MX and SAXS beamlines," Nathan said. He noted the contribution of Professor Jamie Rossjohn, who heads the laboratory where much of the work was done.

"The research described in this paper is also a real testament to the great instrument that the synchrotron is."

The nature of science (cont.)

How perforin packs its punch

An international research collaboration has revealed how a protein called perforin punches holes in cancer cells and cells hijacked by viruses, enabling toxic enzymes to enter and destroy the rogue cells.

Dubbed the 'assassin protein', perforin is a key part of the body's defence mechanisms. If perforin isn't working properly, the body cannot fight infected cells. Defective perforin activity can also cause problems, such as when the wrong cells are marked for elimination, for example in autoimmune disease conditions such as early onset diabetes, or in tissue rejection following bone marrow transplantation.

The perforin findings were published online in the prestigious journal Nature on 31 October 2010.

Tom Caradoc-Davies, who heads the Australian Synchrotron's macromolecular crystallography team, is one of the paper's co-authors. The work was co-led by James Whisstock from Monash University, Joe Trapani from the Peter McCallum Cancer Centre and Helen Saibil from Birkbeck College in London. This is the second Nature paper to list a synchrotron staff member as a co-author.

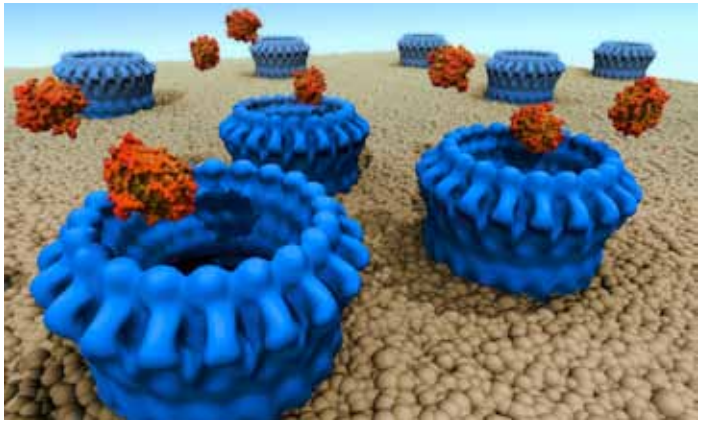
The 10-year perforin study drew on structural information from the Australian Synchrotron's microcrystallography (MX2) beamline and high-powered electron microscopy images from Birkbeck College. Perforin is a thin, key-shaped molecule that works by joining forces with other perforin molecules to penetrate cell membranes and form pores in the cell surface that allow granzyme proteases (enzymes that break down other proteins) into the target cells.

The new research confirmed that the important parts of the perforin molecule are quite similar to those in toxins deployed by bacteria such as anthrax, listeria and streptococcus, demonstrating their common ancestry. However, an unexpected finding was that the perforin docks with the rogue cell surface in the opposite orientation to its bacterial counterparts, suggesting that the two groups of proteins must have undergone some extraordinary structural adaptations. These data reveal remarkable flexibility in the common mechanisms of action noted in the two groups and provide new insights into how related immune defence molecules such as complement proteins assemble into pores.

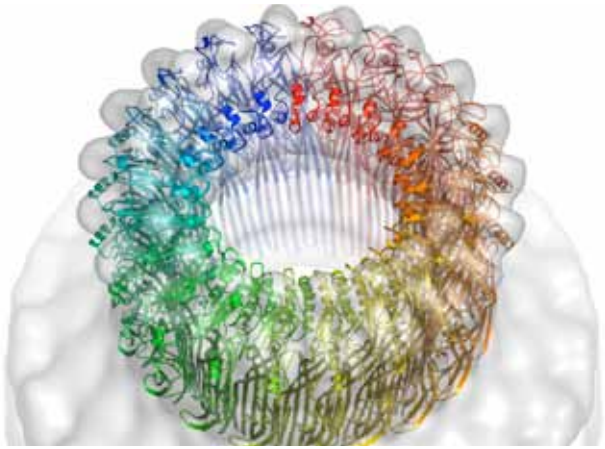
"Our crystals diffracted poorly, so the highly-focused, intense beam on the MX2 beamline was absolutely essential for obtaining high-resolution diffraction data," James Whisstock said.

"We needed a lot of synchrotron time to solve the perforin structure. Without the Australian Synchrotron we'd probably still be flying back and forth to overseas facilities – and we might well have been scooped by our rivals in this highly-competitive field." Click the line below to read the paper, entitled 'The structural basis for membrane binding and pore formation by lymphocyte perforin', as an abstract or in full.

http://www.nature.com/nature/journal/vaop/ncurrent/full/nature09518.html



Perforin molecules (blue) create pores in a cell membrane, allowing granzyme toxins to enter and destroy the cell. Image: Mike Kuiper, VPAC



Perforin pore model (rainbow colours) created from crystal structure and electron microscopy (semi-transparent surface). Image: Helen Saibil, Birkbeck College

Student experiments with IR beamline

Perth teenager Darren Ng, a year 11 student at All Saints College in Bull Creek, recently became one of Australia's youngest synchrotron users when he used synchrotron infrared microspectroscopy to help examine a series of fingermarks.

Darren shared the excitement with his classmates back in Perth through a live videolink set up by Chris Myers and Michael D'Silva from VERSI at the synchrotron end and Darryl Watson at the college in Bull Creek.

After being trained to use the infrared beamline and microscope equipment, Darren started work under the guidance of Simon Lewis from Perth's Curtin University of Technology, and Danielle Martin from the synchrotron's IR beamline team.

"I wanted to make sure that Darren was able to run as much of the experiment as possible so I taught him to use the IR microscope as I would any other user at the beamline," Danielle said. "He picked it up fantastically.

"The students were enthusiastic and the questions from students and teachers were varied and interesting. We all really enjoyed the day."

Darren examined fingermarks from his school principal, Geoffrey Shaw, using these to explain the concepts involved in the analysis to his classmates and teachers in Perth, who were then able to ask questions. Simon and Darren also supplied and examined two other types of fingermark: 'charged' fingerprints, taken after the subject has rubbed their fingertips over oily areas of their skin to create thicker, oilier prints; and another called 'groomed' fingerprints, where the prints are taken from a clean but sweaty hand.

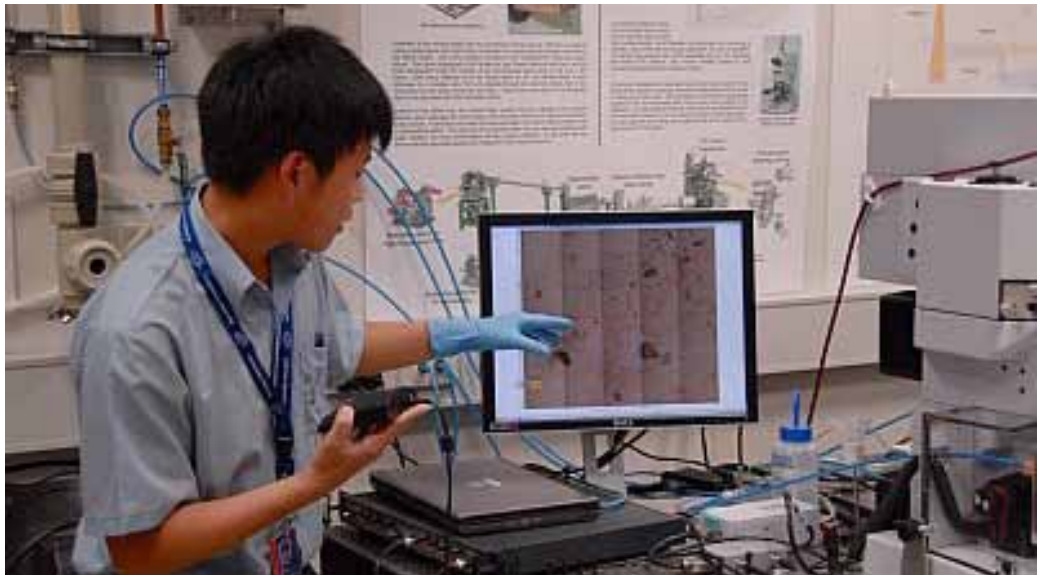
Darren's synchrotron project was undertaken as part of his and Simon's involvement in the International BioGENEius Challenge. The winners of the Western Australia BioGENEius Challenge will compete in the International BioGENEius Challenge held in Washington, DC, in June 2011. The fingermark experiments form part of an ongoing national research investigation led by Simon Lewis in association with Kieran Lim from Deakin University in Melbourne.

Darren's teacher Lyndon Smith, who also attended the experiments, said on his return to Perth that: "the school is quite excited about what we did. All the teachers are abuzz about it and the kids are too."

Danielle said that the project was a good way to give young students a small glimpse of the world-class scientific developments occurring within Australia and around the world.

"In this way we can reach out to and enthuse students in distant locations, and give young students an improved understanding of 'the bigger picture'. Synchrotron science is a relevant part of current school curricula in physics and chemistry, and secondary and primary schools are able to arrange visits to the facility to see it in operation. However, distance and other factors can mean that this option is not readily available.

"This exercise enabled us to expose these students to the concept of IR spectroscopy and its application across many fields of science, in this case specifically forensic science. We really enjoyed the opportunity to demonstrate the beamline to such enthusiastic students, particularly those who may not otherwise have a chance to visit the synchrotron. We are keen to run similar sessions again.



Speaking from the Australian Synchrotron, Darren Ng explains to his year 11 classmates back in Perth how fingermarks are examined by synchrotron infrared microspectroscopy. Darren is wearing a glove on one hand to make that hand sweaty so he can collect a 'groomed' fingerprint for analysis. Photo: Mark Tobin

Beamtime applications December 2010

Beamtime submissions for round 2011/2 (June-September 2011) will open on 8 February 2011. Applications for round 2011/1 (January-May 2011) closed on 6 October and applicants will be notified from mid-December 2010.

Key dates for beamtime submissions are listed on the synchrotron website at:

http://www.synchrotron.org.au/index.php/features/applying-for-beamtime/proposal-deadlines

If you would like to discuss your ideas for future beamline proposals with the beamline scientists at the Australian Synchrotron, please allow plenty of time.

For more information about applying for beamtime at the Australian Synchrotron, contact the User Office:
user.office@synchrotron.org.au

Synchrotrons in the news December 2010

Could aliens live on arsenic?

NASA astrobiologists recently reported the first microorganism on Earth able to live and thrive on arsenic instead of phosphorus. Phosphorus was previously considered essential for life, while arsenic is noted for its toxicity to living beings. A US synchrotron played a crucial role in the work.

http://www.nasa.gov/home/hqnews/2010/dec/HQ_10-320_Toxic_Life.html

Read the authors' response to criticisms:
http://content.usatoday.com/communities/sciencefair/post/2010/12/arsenic-bacteria-study-authors-respond-to-critics-/1?csp=34

Neanderthals grew up fast

Synchrotron studies of the teeth of Neanderthal children have added weight to the theory that Neanderthals reached adulthood faster than Homo sapiens.

http://www.washingtonpost.com/wp-dyn/content/article/2010/11/22/AR2010112204883.html

http://www.pnas.org/content/early/2010/11/08/1010906107

Behind the scenes

Photographers have captured the backroom life and sights at CERN and other accelerator facilities around the world as part of a global competition

http://www.zdnet.co.uk/news/after-hours/2010/10/20/behind-the-scenes-at-particle-physics-labs-40090551/?s_cid=938

Egg meets sperm

Swedish researchers used synchrotron data to determine the 3D structure of a complete egg receptor that binds sperm at the beginning of fertilisation. The results, published in the journal Cell, will lead to a better understanding of infertility and may enable entirely new types of contraceptives.

http://ki.se/ki/jsp/polopoly.jsp?l=en&d=130&a=109057&newsdep=130

This is NO killer revelation

Nitric oxide (NO) is a toxic pollutant, but the human body also creates it and uses it to attack invading microbes and parasites. A new synchrotron study by US and Japanese researchers shows how nitric oxide attacks an important group of proteins critical to cell survival.

http://www.news.ucdavis.edu/search/news_detail.lasso?id=9705

Open for business

Representatives from large and small businesses in south-east Melbourne visited the synchrotron in October 2010 for the first in a series of workshops designed to make publicly-funded research organisations more accessible to the business community. A similar workshop was held at CSIRO Clayton in November 2010.

Organised by the South East Melbourne Innovation Precinct (SEMIP), the workshops aim to foster relationships between people in business and research and encourage collaboration and innovation. The synchrotron workshop attracted 35 participants, including local council representatives. Participants toured the Australian Synchrotron, discussed how the synchrotron's capabilities can assist industry, and heard about some successful commercial partnerships between the synchrotron and industry.

Suzanne Ferguson, Manager Economic Development for the City of Kingston, said "It was great to actually be on the technical floor and learn about the capabilities of this incredible machine".

Jürgen W. Schneider, Regional General Manager for Siemens Ltd Australia in Victoria/South Australia, said: "I found the experience of being introduced to the Australian Synchrotron thought provoking from the perspective of innovation and collaboration. I am delighted to reference the synchrotron in conversations with Siemens customers across Industry, Energy and Healthcare".

Click here to go to SEMIP webpages.

L-R: Shaun Smith (Executive Director, SEMIP) and George Borg (Acting Director, Australian Synchrotron) discuss how the synchrotron can assist industry

Tardis to store synchrotron data

The Australian Synchrotron and ANSTO have both selected an all-Australian software solution to assist with storing and managing the reams of scientific data generated by their experiments. They will use TARDIS/MyTARDIS, a software system developed by computer scientists at Monash University, to make data more accessible, easier to interpret and easier to verify and report.

The decision means scientists from the two organisations, which support some of Australia's most sophisticated scientific instruments, can cooperate more effectively, and better organise the information gathered from their experiments, ultimately making data easier to retrieve and use.

The TARDIS project is supported by the Australian National Data Service (ANDS). ANDS itself is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy Program and the Education Investment Fund (EIF) Super Science Initiative.

Tall poppy award for synchrotron user

Darren Goossens from the Australian National University was recently judged one of two ACT Young Tall Poppy Scientists of the Year for 2010. He received the ANU medal for the ACT Young Tall Poppy Scientist of the Year 2010.

An Australian Synchrotron user, Darren's field of research is materials science. His ANU research group combines experimental techniques such as neutron, x-ray and electron diffraction with computational modelling to explore the structures of materials, and relate these structures to their physical and magnetic properties. Darren is also a member of the powder diffraction program advisory committee (PAC) at the synchrotron.

4th Cheiron School

Cheiron School 2010 Report

Six PhD students from Australian universities attended the 4th AOFSRR Cheiron School in Japan in October 2010.

Ye Wu and Connie Liu from the University of Sydney, Mark Edmonds from La Trobe University and Josephine Yin Tse Chong from Monash University were funded by the Cheiron School. The Australian Synchrotron supported two additional students: Wei Kong Pang from Curtin University of Technology and Zhiqiang Liu from the University of New South Wales.

The school is an intensive, two-week, hands-on course on synchrotron radiation science and technology for graduate students, postdoctoral fellows, young scientists and engineers who want to pursue careers in a field requiring synchrotron radiation and join a synchrotron radiation facility in the Asia Oceania region. An annual event, the Cheiron School is organised by the Asia-Oceania Forum for Synchrotron Radiation Research (AOFSRR), RIKEN, JASRI and KEK and held at the SPring-8 facility in Hyogo, Japan.

Momentous Movember

In Mo-vember 2010, Australian Synchrotron staff again mo-thballed their shaving gear and grew mo-ustaches to raise awareness of – and funds for – prostate cancer, which kills around 3300 men a year in Australia, and beyondblue, Australia's national depression initiative.

Events diary

Synchrotron-related events in Australia and overseas. Read more

Space for your event

To submit your synchrotron-related event for listing in Lightspeed and on the Australian Synchrotron website, click here.

Reader feedback

Lightspeed welcomes your comments and suggestions. Please send these to: info@synchrotron.org.au with 'Lightspeed comments' in the subject line.

Use of Lightspeed material

Careers at the Australian Synchrotron

The Australian Synchrotron offers a unique working environment for a wide range of specialists. For information on job postings, go to:

http://www.synchrotron.org.au/index.php/about-us/working-at-the-synchrotron/employment-opportunities

Staff list

http://www.synchrotron.org.au/index.php/about-us/working-at-the-synchrotron/staff-contact