Australian Synchrotron

LIGHTSPEED April 2011

TOP STORIES

page 2:
From the Acting Director

page 3:
Up to speed

page 4:
Researchers go with the grain

IN THIS ISSUE

Background image: MASSIVE computer at the Australian Synchrotron

From the Acting Director - Under new management

I am pleased to announce that the Australian Synchrotron Board has appointed a new Director, Professor Keith Nugent. I have stepped down as Acting Director to take on the newly created position of Chief Operating Officer, which means I am responsible for day-to-day management of the facility. I am also Chief Executive Officer for the synchrotron holding company, ASHCo.

Keith Nugent is well known to the Australian and international synchrotron communities. He has been a member of our Board and senior management committees and was the main driving force behind the Australian and New Zealand Synchrotron-based Science Strategic Plan 2007-2017.

As Director Australian Synchrotron, Keith will focus on scientific leadership and strategic development. His main priorities will be to help ensure that the synchrotron continues to produce great science – and to work with the Board, our new Head of Science, Andrew Peele, staff, stakeholders, Science Advisory Committee and National Science Colloquium to promote the case for the synchrotron's future expansion and development.

We also welcome Michael Tonroe as our new Chief Financial Officer. Michael has previously been CFO and company secretary for companies in Australia, the UK and Hong Kong.

And finally, as this is my last column as Acting Director, I would like to express my sincere thanks to all staff and stakeholders who have supported me in this role over the last 16 months. During this period we have collectively faced – and triumphed over – some major challenges and achieved some significant milestones. Highlights have included:

- Operating a safe working environment for our staff and maintaining a world-class facility
- Preparation and submission of the Business Case and Science Case 2
- Establishing good relationships with stakeholders
- Achieving compliance and operation within budget
- The commencement of various construction works
- The joint launch of the MASSIVE high-performance computing facility
- The visit of the new Victorian Minister for Technology, the Hon. Gordon Rich-Phillips.
- I feel privileged to have had the opportunity to make a contribution at this level to the future of the Australian Synchrotron.

We are very fortunate to have someone of Keith Nugent's scientific standing to lead us into the next phase of the Australian Synchrotron's development and we will all work together to ensure the success of this leadership transition.

George Borg

Chief Operating Officer, Australian Synchrotron

Up to speed: Samantha Chan

This month our short interview features Samantha Chan, the Australian Synchrotron's receptionist.

Describe your job in 25 words or less.
In general, my job is to be friendly and professional, to meet and greet visitors with a smile! :-)

Best thing about your position here?
I get the best view in the office.

Worst thing about your position?
Having to brave the cold winds at the front desk.

Biggest challenge facing you in your position?
The phone system is the most complicated machine I have ever dealt with. Impatient callers hung up on me during my first week of work.

Apart from the Australian Synchrotron, what's the coolest job you've ever had?
When I worked as a contracts administrator with SIA Engineering Company, I got to travel for free on Singapore Airlines to meet people working in the aviation industry in the SE Asian region.

Best things about living in Melbourne and why?
You get to experience both urban and suburban living.

Your favourite overseas destination and why?
Singapore – that's where home is and where I get my pretty clothes and shoes from.

What's the funniest question anyone has ever asked you about the AS?
"Who is Ron?" (Hint: The 'ELECT RON' slogan on some of our t-shirts.)

Beamtime applications April 2011

Applications for round 2011/2 (June-September 2011) closed on 9 March 2011. Applicants will be notified from early May 2011.

Beamtime submissions for September-December 2011 (round 2011/3) will open on 25 May 2011.

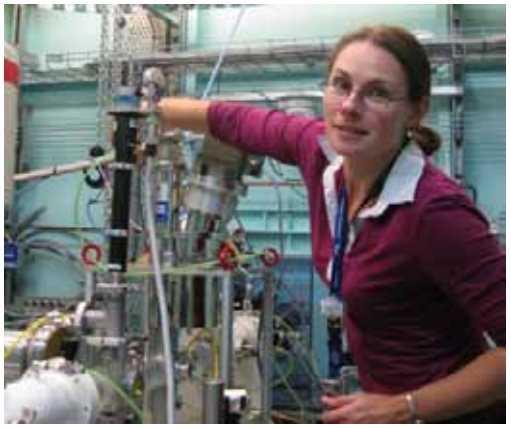
Key dates for beamtime submissions are listed on the synchrotron website at:

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

Researchers go with the grain



Erica Donner spent her birthday this year working on the XAS beamline at the Australian Synchrotron. Photo: Enzo Lombi.

Rice, barley and other cereal grains are important energy sources for many millions of people around the world. Unfortunately, diets that rely too heavily on these relatively poor sources of nutrition are often low in important micronutrients such as iron. In response to increasing global concern about dietary deficiencies, Australian researchers are using synchrotron techniques to investigate various strategies to improve the levels of iron and other important micronutrients in these staple food grains.

One third of the world's population suffers from iron deficiency, mainly women and children. Up to one billion people may be deficient in selenium, which helps prevent tissue degeneration by acting as an antioxidant. Because access to food types and supplements to combat these problems is often limited by location, dietary habits and costs, there is considerable interest in biotechnology and cereal crop biofortification. However, we first need to know more about the locations and chemical forms of micronutrients in cereal grains. The chemical form is important because it determines the extent to which our bodies can actually absorb and use the micronutrients. For example, minerals that are bound up in complexes with phytic acid are virtually unavailable to humans.

Enzo Lombi and Erica Donner from the Centre for Environmental Risk Assessment and Remediation at the University of South Australia are using synchrotron techniques to find out exactly where minerals such as iron, selenium and zinc are located in rice, barley and other cereal grains. These findings will assist the development of improved processing methods and breeding programs to increase the nutritional value of cereal grains.

Enzo and his research collaborators have been using the x-ray fluorescence microscopy (XFM) beamline and the new Maia detector at the Australian Synchrotron to examine the chemical form and locations of a range of micronutrients in barley grains. This technique offers micrometre-scale lateral resolution, high sensitivity and collection times that make it possible to map whole grains.

The XFM findings show that there is considerable variation in micronutrient distribution in barley grains, and that micronutrient transport is highly regulated, i.e. different micronutrients may be transported to different parts of the grain, or even different locations within the same part.

Enzo and researchers from the Australian Centre for Plant Functional Genomics, Flinders University and University of Melbourne have also investigated iron speciation and transport in polished (white) and unpolished (brown) samples of transgenic rice with enhanced ability to move iron further into the grain. This research used the XFM and the x-ray absorption spectroscopy (XAS) beamlines at the Australian Synchrotron. In rice, more than three-quarters of the iron in rice is lost when the outer layers of the grain are removed during milling. Copper and zinc are better able to diffuse into the endosperm (white rice) than iron is. The transgenic rice has multiple copies of the rice gene responsible for synthesis of nicotianamine, a compound that is involved in long distance transport of ferrous (Fe2+) ions.

XAS is virtually the only technique capable of determining the chemical form of these elements at the low levels found in cereal grains – without the need for extraction processes that could alter the chemical form.

Enzo has used a similar technique on the Australian National Beamline Facility (ANBF) at the Photon Factory in Japan in collaboration with colleagues in China and the UK to determine the most effective fertiliser regimes for improving selenium levels in rice. The ANBF is operated by the Australian Synchrotron.

Further research in this area is expected to provide additional essential information to assist the development of strategies that aim to alleviate malnutrition – strategies ranging from fertilisation to conventional breeding and biotechnologies.

Magnetic attraction

Researchers are using powder diffraction to find out how heat influences the properties of a new generation of strong permanent magnets. A three-centimetre-long glass capillary contains an amorphous precursor that is gradually transformed into a magnetic material when heat is applied.

A subject of fascination for thousands of years, magnets are an essential part of modern electronic devices such as computers, microphones, electric motors and cars. Australian researchers are using synchrotron techniques to understand the formation of the key magnetic phase in a new generation of magnets with improved cost effectiveness.

The strongest permanent magnets currently known are made from iron, boron and rare earth elements. The world market for permanent magnets is worth around US$11 billion, with neodymium- iron-boron (Nd2Fe14B) magnets accounting for 62 per cent of this total. Permanent magnets are typically made from 'hard' magnetic materials, which have a high resistance to becoming demagnetised; 'soft' magnets have much lower resistance to becoming demagnetised. These characteristics are measured in terms of properties called coercivity (resistance to demagnetisation) and remanence (ability to retain magnetisation).

PhD student Vanalysa Ly and her Monash University supervisors Christopher Hutchinson and Kiyonori Suzuki are developing computer models of crucial stages in the production of nanocomposite Fe-Nd-B magnets. These magnets consist of a magnetically-hard Nd2Fe14B phase and a neodymium-free soft phase, significantly reducing the total amount of costly Nd. They are produced by applying heat to transform an amorphous precursor (a 'melt-spun' Fe77.5B18Nd4.5 metal alloy ribbon created by rapidly cooling a molten stream of the metal) into a crystalline material with the optimum arrangement of phases. The challenge is to select the right precursor from an infinite range of compositions and then subject it to a suitable heat treatment.

Vanalysa used the powder diffraction beamline at the Australian Synchrotron in February 2011 to examine the in situ crystallisation at varying temperatures of a series of amorphous precursors for nanocomposite Fe-Nd-B materials. Vanalysa acquired a continuous series of five-second 'snapshots' of her materials over the course of the heat treatment in order to obtain time-resolved measurements of the different phases as they formed and disappeared. The beamline setup enabled her to capture both the thermodynamic and kinetic aspects of the crystallisation of the amorphous melt-spun ribbon as heat was applied.

Vanalysa's powder diffraction results will help her to modify and validate a phenomenological phase transformation model she has developed to quantitatively capture the nucleation and growth of competing phases as a function of alloy composition and thermal treatment. The next step will be to perform desktop experiments that simulate heat treatments with the aim of identifying promising heat treatment schedules that could potentially enhance the magnetic properties of the resulting material.

Synchrotrons in the news April 2011

How snakes lost their legs

A novel x-ray imaging technology called synchrotron laminography is helping scientists better understand how snakes lost their legs in the course of evolution.

http://www.esrf.eu/news/general/Snake-with-leg/

Step towards early detection of Alzheimer's

CSIRO's Jose Varghese and University of Melbourne collaborators used x-ray crystalllography at the Australian Synchrotron to reveal the structure of a key protein involved in Alzheimer's disease. The researchers fused the protein to a shark antibody to stop the protein from self-assembling.

http://www.csiro.au/news/Alzheimers-diseases-research-inroads.html

Fade to brown

The reason why the bright yellows in some of Vincent van Gogh's paintings have turned brown is a complex chemical reaction involving the reduction of chromium VI to chromium III. The finding could help identify ways to stop some of the artist's most famous paintings from fading..

http://www.bbc.co.uk/news/science-environment-12453610

http://pubs.acs.org/doi/abs/10.1021/ac102424h

Metal work ahead

Scientists are using the Canadian Light Source to help them develop new magnetic resonance imaging (MRI) techniques for accurately mapping metals such as iron, copper, manganese and zinc in the living brain.

http://www.theglobeandmail.com/life/health/dementia/scientists-look-to-new-imaging-techniques-to-map-and-measure-metals-in-the-brain/article1914809/

Protein residues found in ancient reptile skin

UK researchers have combined synchrotron x-ray and laboratory infrared techniques to map trace metals and organic compounds in a 50-million-year-old fossilised reptile skin, revealing the presence of protein residues.

http://www.manchester.ac.uk/aboutus/news/display/?id=6850

Researchers mind the gap

A puzzling gap in the electronic structures of some high-temperature superconductors could indicate a new phase of matter.

http://home.slac.stanford.edu/pressreleases/2011/20110324.htm

Keith Nugent appointed Director

http://www.theaustralian.com.au/higher-education/australias-synchrotron-appoints-new-director/story-e6frgcjx-1226013719836

http://news.ninemsn.com.au/technology/8217652/nugent-appointed-head-of-synchrotron

X marks the spot

Ted Baker, Chairman of the Australian Synchrotron's Science Advisory Committee, and Andrew Peele, the new Head of Science, were recently interviewed by The Age newspaper.

http://www.theage.com.au/national/education/x-marks-spot-for-new-images-to-boost-cancer-research-20110404-1cyef.html

http://www.theage.com.au/national/education/high-beams-light-way-to-the-future-20110404-1cyee.html

Head of Science speaks out

Head of Science Andrew Peele spoke to Australian Life Scientist about how the synchrotron aims to work with life scientists to produce world-class research.

http://www.lifescientist.com.au/article/376222/new_head_science_australian_synchrotron_talks_life_science_research/?fp=4&fpid=1013

Other AS staff who have recently featured in the media include accelerator physicist Mark Boland, who was interviewed on Channel 10's Scope science show on 24 March 2011.

AS physicists achieve new low

Hidden behind white concrete walls, the electron storage ring of the Australian Synchrotron light source might easily be forgotten as simply a device for generating light. To the accelerator physics team, however, it is a state-of-the-art experimental apparatus that is rich in both physics and fascination – and many times more interesting than any beamline.

While the team's first responsibility is to ensure the delivery of high quality photon beams to the beamlines, the smooth operation of the Australian Synchrotron accelerator systems allows the team to conduct research into acceleration techniques that will improve current accelerators as well as paving the way for future machines.

One area of recent study has pushed the performance of the Australian Synchrotron storage ring into the international accelerator community 'spotlight'. Accelerator physicist Rohan Dowd and his colleagues have achieved a world-record low vertical emittance of only 1.2 picometre radians, significantly lower than the previous record for an electron beam. The research is described in the Physical Review Special Topics : Accelerators and Beams journal (R. Dowd, et al., "Achievement of ultralow emittance coupling in the Australian Synchrotron storage ring" http://link.aps.org/doi/10.1103/PhysRevSTAB.14.012804).

Emittance is a quantity that describes the spread of position and angle of the individual particles in the beam, in this case electrons. A beam with a small emittance is small in size and well collimated. The magnitude of the beam's emittance in an electron storage ring is determined by the equilibrium between processes that cause it to grow, such as passage through bending magnets, and those that damp it, such as emission of synchrotron radiation. Since most bending happens in the horizontal plane, the horizontal emittance is much higher than the vertical emittance. In fact, the vertical beam emittance is almost completely dominated by coupling of the horizontal emittance into the vertical plane through small magnet misalignments.

The record low vertical emittance was achieved by employing a novel beam analysis technique to determine the best configuration of magnet settings to minimise coupling in the storage ring. Because of the extremely low vertical beam size resulting from this emittance (only a few micrometres high in places) it was not possible to use our current diagnostic equipment to directly measure the beam emittance using optical techniques. Instead we had to use indirect measurements, inferring emittance by measuring other characteristics such as beam lifetime. Indirect measurements are often complicated by assumptions and uncertainties not present in a direct measurement. To prove the validity of our indirect measurements, we conducted a painstaking series of independent measurements under differing conditions and cross-checked these against each other.

As well as demonstrating great achievements in accelerator alignment and beam control at the Australian synchrotron, the result has implications for future accelerator design. Researchers involved in the proposed International Linear Collider (ILC) and Compact Linear Collider (CLIC) projects are keenly interested because this is the first demonstration of a vertical emittance of the magnitude that they require in the damping rings of these colliders. The Australian Collaboration for Accelerator Science (www.accelerators.org.au), of which the Australian Synchrotron is part, recently signed a memorandum of understanding with CERN to participate in design work for the CLIC project, concentrating on damping ring design and RF (radiofrequency) structure analysis. Emittance tuning techniques will be a key area of this design work, drawing on experience gained on the Australian Synchrotron storage ring.

Accelerator physicist Rohan Dowd shares his fascination with synchrotron storage ring physics at a recent Open Day.

Construction update

Watch those spaces!

Three of the new buildings being constructed around the Australian Synchrotron are now in use: the technical support laboratories building, the office extension pod and the switchroom extension. External construction of the user accommodation building is complete, and the building is being fitted with furniture in readiness for users.

The biggest construction project, the National Centre for Synchrotron Science building, is nearing completion, with installation of windows and Rodeca panelling on all exterior walls. Inside the building, auditorium seating and lighting are in place, and interior walls and office fittings are quickly taking shape.

Commenced in late 2010, these projects are an initiative of the Australian Government being financed from the Education Investment Fund.

Click here to download a map (pdf, 140kb) with information about new parking arrangements for visitors to the synchrotron.

National Centre for Synchrotron Science (NCSS)

- Two-storey building with a 400-seat auditorium, seminar rooms, exhibition space, User Office, staff offices, cafeteria and underground parking.
- Building construction is ahead of schedule. Installation of the translucent Rodeca panelling facade is almost complete and most of the exterior windows have been fitted. Kitchen equipment has been installed and joinery items are being fitted out throughout the building. Auditorium lighting comprises an impressive array of 120 circular fluorescent luminaries.
- The NCSS building has a five-star rating under the Green Star system, which is a comprehensive, national, voluntary environmental rating system that evaluates the environmental design and construction of buildings. To achieve this rating, the building includes features such as 20 kilolitre water tanks for recycling water, high-efficiency heating and cooling systems, and 100 photo-voltaic panels on the roof to offset the power needed for the facade lighting, which is a key feature of the building's exterior. Click here to read more about the NCSS building and its green credentials.
- Several elements of the NCSS building, such as landscaping, fittings, and audiovisual equipment, are being managed separately from the main construction works.
- Investigations into the operation of the cafeteria are continuing.
- Following several feasibility studies in late 2011, a detailed landscaping design is being developed from the landscaping masterplan to address aspects such as tree types and locations, irrigation pipes, concreted areas, parking, benches and seating. The design calls for many new trees to be planted, particularly around parking areas and the user accommodation building. A vegetable garden will be established near the existing barbecue area. The entrance roadway and lighting for the main synchrotron building will be redesigned. The landscaping work is expected to be put out for tender in March 2012.
- See overleaf for photos of construction work on NCSS building.

User accommodation building

- Two-storey building with 50 self-contained rooms, communal kitchens, lounges, laundry and reception. The ground floor includes disabled facilities.
- Construction is complete. Following successful assessment of the prototype bedroom, all bedrooms are being fitted out with furniture. The kitchen, laundry and lounge areas are also being equipped with furniture, fittings and equipment.
- "The user accommodation building is so nice, particularly the lounge area, that synchrotron staff are already joking about occupying the building themselves," says Alexis Kouts from the Synchrotron's Major Projects and Technical Services Group.
- "Provided the new furniture is delivered on schedule, we hope to begin making the accommodation available to users in April 2012."
- Processes are being developed for carrying out the necessary cleaning, scheduling, security, repair and maintenance tasks.

Click here to go to user accommodation building photo page.

Construction update (cont.)

Modular office extension (office extension pod)

The modular extension 'pod' connected to the main synchrotron building is complete. It has been fitted out with workstations and office furniture and is now occupied by staff from several groups, including Major Projects. The building provides a simple but functional open office area with plenty of natural light. Spare desks are available for visitors to use.

Click here to go to office extension 'pod' building photo page.

Technical support laboratories building

This building is occupied and fully operational with four laboratories, an open plan office, meeting rooms, mechanical workshop and stockroom. The large spaces within this building have enabled the engineering group to be consolidated into one area, supported by tools and equipment located downstairs.

Click here to go to technical support laboratories building photo page.

Switchroom extension

Extension to the existing low voltage switch room, which had reached capacity. The uninterrupted power supply (UPS) system is now operational. A cooling system is being installed for days of extreme heat.

Thanks to three brand-new 'uninterruptable power supply' (UPS) systems, the AS storage ring can continue operating for up to 15 seconds without any power, enabling synchrotron operators and users to continue working through any short-term power supply disruption.

Click here to go to switchroom extension building photo page.

We will post regular updates on our website to keep you informed of progress.

(17 March 2011): construction work for NCSS building.

(14 April 2011): pouring concrete in the rain for the NCSS building.

(21 April 2011): progress with construction work for NCSS building.

Imaging and medical beamline

The imaging and medical therapy beamline will offer high-resolution, phase-contrast x-ray imaging of biomedical samples and a wide range of engineering materials. It will also enable research into new cancer treatments.

The beamline will be 150 metres long, with a satellite building that will later include a medical suite for clinical research as well as extensive support facilities for biomedical and clinical research programs. All experiment enclosures will eventually have near-beam surgery facilities for fast preparation-to-measurement transfers.

The first phase of this 'long beamline' program was commissioned in 2009. It will cater for high-resolution phase contrast imaging of medium-sized samples.

Click here to go to the IMBL construction update webpage.

A discussion forum has been established for users. Click here to go to the forum.

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