FROM THE DIRECTOR: OUR TOP 110 FOR 2008

We're proud of what we've achieved at the Australian Synchrotron as a relatively small team, but with more than 100 people now employed onsite, we don't always know what everyone else does.

Prof. Robert Lamb

Some years ago I saw a web photo of the assembled staff at a US synchrotron. When you zoomed in on the photo, you discovered that everyone was faceless. I was reminded of that photo the other day when I realised that visitors to the Australian Synchrotron – and even some of our own staff – don't have the opportunity to get to know the whole team.

For the record, our official tally is 110 staff, including contractors. As well as the beamline scientists, who are the largest group here, we have electrical, mechanical and electronics engineers, accelerator physicists, control systems operators, IT specialists, electrical and mechanical technicians and landscape contractors. We also have human resources, finance, administration, external relations, marketing, and occupational health and safety staff. I'm indebted to every one of them for their contribution to making this place really work.

Rob Lamb and the staff of the Australian Synchrotron wish all readers of Lightspeed a Merry Christmas and a relaxing holiday break.

In this issue:

NEW DATES FOR BEAMTIME APPLICATIONS

Beamtime submissions will open for the 2009/2 round on **28 January 2009** (not 11 February 2009 as previously advised) for beamtime between May and August 2009.

This call for proposals will close on 24 February 2009 and users will be notified from 1 April 2009 (or mid-March for ANBF proposals).

Key dates for 2009 beamtime submissions are listed at http://www.synchrotron.org.au/content.asp?Document_ID=5305.

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

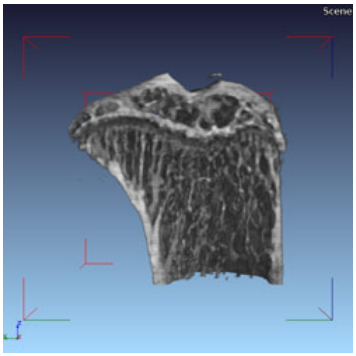
BEAM ME UP, SCOTTY

The imaging and medical therapy (IMT) beamline has produced its first images within days of achieving first light.

A flurry of activity over the last few weeks has seen engineers and technicians join forces with beamline staff to assemble sample and detector tables and deliver beam through a helium-filled tube. Within one week of successfully completing the radiation tightness tests of the beamline enclosures, we had 'beam on sample'.

After this important milestone, there was no stopping progress and we immediately began a week of near round the clock operation with samples ranging from Queensland ambers to Melbourne rat brains brought in from the University of New South Wales, the National Stroke Research Institute (Austin Health), the University of Melbourne, CSIRO and Monash University. Hundreds of images were collected, including some to characterise the source in preparation for early 2009 user experiments. Most importantly, several tomography experiments were successfully carried out.

The enthusiasm that took over the IMT beamline is best summed up by mentioning that our last user, Andrew Stevenson from CSIRO (Clayton), had to request a 15 minute extension to the 2008 user beamtime to complete his night work! Well done Andrew, and all those involved, both here and at a distance.



The figure shows a mouse tibia (knee) studied for its relevance to understanding the endocrine mechanisms that affect bone turnover.

People who contributed to the production of this image include Andrew Stevenson, Sherry Mayo and Steve Wilkins from CSIRO, Damien Myers from the University of Melbourne, Rob Lewis and Chris Hall from Monash University, and the Australian Synchrotron IMT beamline team and support staff.

To view a YouTube video illustrating some of the early IMT tomography, go to http://www.youtube.com/watch?v=vnBTsVlQLAY

Daniel Häusermann, Principal Scientist, Imaging and Medical Therapy

AO WEEK

Around 300 scientists, students and research managers from Australia, New Zealand, Italy, UK, France, Japan, China, Korea, Taiwan, Germany, Singapore, Canada and the USA attended A-O Week 2008 in Melbourne, Australia.

The week's activities began with a meeting of the Australian Synchrotron Science Advisory Committee on 1 December, followed by the Australian Synchrotron Annual Users Meeting on 2-3 December. The remainder of the week was devoted to the third Asia Oceania Forum on Synchrotron Radiation Research (AOFSRR) 4-5 December.

The event attracted seven directors of synchrotrons in the Asia Oceania region as well as two directors from North American synchrotrons. The week's events were organised by the Australian Synchrotron with a total of 111 presentations

for beamtime at the Australian Synchrotron, contact the User Office: user.office@synchrotron.org.au

EVENTS DIARY

EVENTS IN AUSTRALIA

CRYSTAL 26

26th Meeting of the Society of Crystallographers in Australia and New Zealand.
14-17 April 2009
Barossa Valley Novotel Resort, Rowland's Flat, South Australia

The conference will cover all aspects of crystallography and will feature

distinguished invited speakers from overseas and around Australia.

More:
http://xrsi.cmit.csiro.au/SCANZ26/

11th International Symposium on Radiation Physics (ISRP-11)

21-25 September 2009
The University of Melbourne, Australia

ISRP-11 is organised by the International Radiation Physics Society (IRPS) and is supported by DEST, the Australian Synchrotron and the Victorian Government. The meeting is devoted to current trends in radiation physics research.
More:
http://mcmconferences.com/isrp11

10th International Conference on Synchrotron Radiation and Instrumentation 2009 (SRI2009)

Melbourne Convention & Exhibition Centre
28 September – 2 October 2009

including 35 invited speakers covering the entire spectrum of synchrotron science in the region.

Highlights included presentations from keynote speakers Prof Peter Colman (Walter and Eliza Hall Institute), Dr Anton Barty (Lawrence Livermore National Laboratory, California) and Prof Ian Gentle (Australian Synchrotron). Barty is a former student of Keith Nugent at the ARC Centre of Excellence for Coherent X-ray Imaging.

Photos taken during AO Week, including the dinner, are available at: http://www.digital-image.com.au/photographs/Aus_synchrotron/

Relenza revisited - designed drugs and drug resistance

Prof. Colman from the Walter and Eliza Hall Institute in Melbourne gave a fascinating first-hand account of the development of anti-influenza drug Relenza™, an early example of structure-based drug discovery.

Detailed protein crystallographic studies of neuraminidase from all known human and animal flu viruses revealed that one section of the protein did not change when the virus mutated – the active site that binds sialic acid on the host cell surface. Colman and his associates then identified a compound, Relenza (also known as zanamivir), which could plug this 'pocket'.

Relenza's main competitor, Tamiflu (oseltamivir carboxylate), has a similar structure, with modifications that bypass the Relenza patents – and enable Tamiflu to be delivered by mouth. Relenza can only be delivered by nasal inhalation, as oral delivery substantially reduces its effectiveness. Both are being stockpiled by governments keen to arm themselves against the possibility of a major outbreak of avian influenza (bird flu).

However, Tamiflu has been linked to the development of drug-resistant flu viruses, including one recent death in Vietnam from the H5N1 strain of avian influenza. The drug-resistant viruses cannot bind the drug, but can still bind to sialic acid. Colman believes that the reason why Tamiflu has been linked to drug resistance – but not Relenza – is because Relenza mimics the structure of sialic acid much more closely. Colman and his colleagues, including Jose Varghese, published a paper in 1998 outlining their view that the best strategy for designing drugs against a moving target is to optimise the drug's similarity to the natural ligand so that loss of drug-binding ability is also loss of function.

Colman discussed how the principle of optimising similarity might be applied to the development of anti-HIV drugs. He noted that other researchers appear to be moving towards similar ideas, such as the idea of 'substrate envelope'. However, Colman believes that physical shape is not enough on its own and that chemical similarity is also important.

The world's largest and most important forum for synchrotron radiation science and technology communities, SRI is expected to attract 800 international and Australian delegates in 2009. The conference promotes international exchange and collaboration among scientists and engineers involved in developing new concepts, techniques and instruments related to the production and utilisation of synchrotron radiation. More details are available at http://www.sri09.org/

EVENTS OUTSIDE AUSTRALIA

For additional information and listings, see http://www.lightsources.org/cms/?pid=1000068

XAFS 14 Conference

26-31 July 2009
University of Camerino, Italy

The International Conference on X-ray Absorption Fine Structure (XAFS) is a triennial event. XAFS 14 will cover a wide range of topics, including EXAFS, NEXAFS, XANES, DAFS, SEXAFS, EELFS, XMCD and Auger spectroscopies, microspectroscopy and spectro-microscopy, resonant photoemission, resonant and non-resonant inelastic x-ray scattering, time-resolved XAFS and diffraction. Specific symposiums are planned on hot topics such as ultra-fast time-resolved spectroscopy, slicing schemes and free electron lasers in the x-ray and UV/XUV domains.

Early registration and student discounts available. Early registration deadline is 15 May 2009.

More: http://www.xafs14.it/

Femtosecond dynamic diffraction imaging with free electron lasers: X-ray snapshots of ultra-fast nanoscale phenomena

Free electron lasers will deliver femtosecond x-ray pulses of unprecedented intensity, opening up new frontiers of science. Anton Barty from the Lawrence Livermore National Laboratory in California and his colleagues are developing experimental methods for x-ray FEL diffractive imaging, initially at FLASH (Free-electron LASer in Hamburg), the world's first operational x-ray FEL. FLASH provides pulses of less than 30 femtoseconds each with 1013 photons per pulse with a spot size of 20 micrometres. Other FELs will come online around the world in the next few years.

FELs produce very brief, very intense bursts of radiation with transverse coherence and a high degree of monochromaticity. They will have many applications in fundamental atomic physics, ultrafast chemistry and materials science. Examples include inner shell ionisation studies, experimental astrophysics (temperature and pressure similar to conditions at Jupiter's core), non-equilibrium dynamics, and femtosecond pump-probe studies for imaging chemical reaction processes. Of particular interest is the potential to study transient material dynamics, and ultimately determine the structures of proteins, viruses and macromolecules that cannot be crystallised.

Barty's main area is ultrafast lensless coherent x-ray diffraction imaging (CXI). FEL x-rays are so intense that they can yield detailed structural information from just one pulse, and potentially from a single molecule, but the specimen is destroyed in the process. Barty and his colleagues are using a 'diffract and destroy' approach to beat the radiation damage limit.

The grand challenge for Barty is whether he and his colleagues can revolutionise molecular biology by imaging isolated molecules. X-ray crystallography is a powerful technique, but growing the crystals is often difficult. Barty's aim is to use the FEL beam to analyse molecules one at a time. Challenges that lie along the way include developing methods for injecting aerosol samples into the path of the beam, and overcoming the additional complications posed by molecular vibrations and the random orientation of molecules from aerosol injection.

Probing liquid surfaces with synchrotron radiation

Prof Ian Gentle from the University of Queensland, who has been appointed Head of Science at the Australian Synchrotron, gave a presentation about his work, which focuses on using interfaces between liquids or between liquids and solids as a means of controlling the assembly of organic materials in thin films. Examples of applications include photovoltaic devices and optoelectronics. Thin films are typically less than 10 molecular layers thick and their behaviour is determined by interactions that occur in the first few molecular layers. Prof Gentle has used synchrotron x-ray techniques to tackle the challenges involved in measuring subtle structural

X-RAY SCIENCE, GORDON RESEARCH CONFERENCE MEETING

2-7 August 2009
Colby College, Waterville, Maine, USA

Topics currently under consideration for this meeting include:

- science frontiers using new x-ray sources
- x-ray scattering /spectroscopy under extreme conditions
- use of coherent x-rays for imaging and studies of dynamics
- x-rays in biology, life, energy and environment science
- dynamics by pump and probe technique
- inelastic x-ray scattering
- new techniques / optics, detectors and others.

The Conference Chairman is Jun'ichiro Mizuki (mizuki@spring8.or.jp), Deputy Director General, Quantum Beam Science Directorate, Japan Atomic Energy Agency (JAEA).
The Vice Chair is Brian Stephenson (stephenson@anl.gov), ANL.

SYNCHROTRON SCIENTIST LOSES HIS HAIR

Beamline scientist Daniel Hausermann got the chop last Friday, but it was all in a good cause.

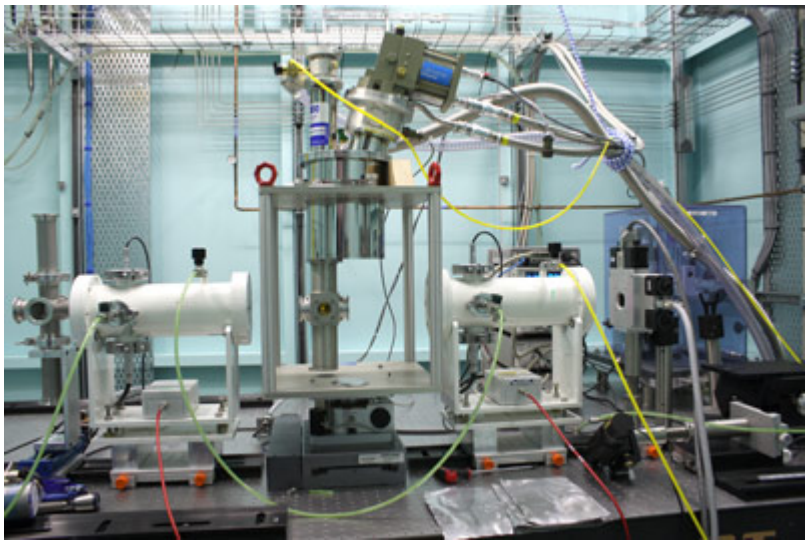
Daniel agreed to have his hair cut off at around $100 per inch ($40 per centimetre for those of you who prefer metric) to help raise funds for mechanical engineer Julian Price, who will spend 2009 working for a Christian volunteer organisation in the Middle East.

features of thin films such as highly ordered porphyrin films on liquids and on solid surfaces, and liquid films in biological systems. His objectives are to control thickness and structure. This means he needs to determine the structure of very thin films at very high resolution

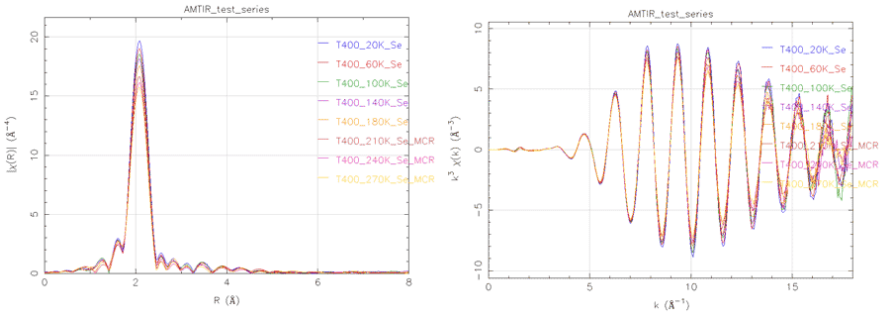
BEAMLINE FOCUS

X-ray Absorption Spectroscopy Beamline

The XAS beamline closed-cycle helium cryostat has been successfully utilised for several user experiments this year. Measurements at temperatures from 20 - 300 K are possible with full computer control.



Shown below are the raw Se edge EXAFS spectra and corresponding Fourier transforms of an amorphous GeAsSe alloy measured as a function of temperature by Mark Ridgway from the Australian National University (plots courtesy of Leandro Araujo and Mark Ridgway). The effect of increasing thermal disorder with increased measurement temperature can be observed as a reduction in the amplitude of the EXAFS oscillations and magnitude of the Fourier transform. Such measurements can shed light on the acoustic and dynamic properties of a material.



Chris Glover, Principal Scientist, X-ray Absorption Spectroscopy

Julian, who also recently lost his hair for the cause, will be stationed at a tuberculosis hospital in Jordan, working among Iraqi refugees in the outer suburbs of Amman and "generally putting a positive face on westerners to our Arab brothers and sisters". He has to raise around $20,000 to pay the cost of his participation in the project.

Fortunately for Daniel, who lost his prized ponytail ($200), no-one took up the offer to shave one of his eyebrows – a snip at just $100.

Julian raised $1545, including the $100 Daniel paid to keep an inch of his hair.

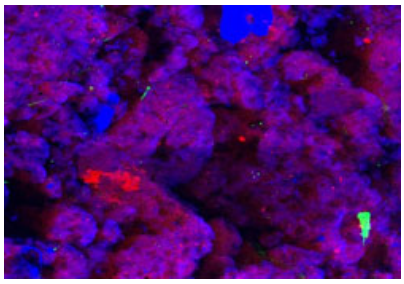
NOBUGS

The 8th biennial meeting of the NOBUGS group with the embarrassingly manufactured acronym 'New Opportunities for Better User Group Software' was held in November 2008 in Sydney. The Australian Synchrotron's head of controls and IT, Richard Farnsworth, is an active member of NOBUGS, which aims to improve and inspire software collaborations between synchrotrons, neutron sources and similar large facilities such as radio telescopes.

Several NOBUGS participants from Diamond in the UK, ANL in Chicago, CELLS (Alba in Spain) and ESRF/EMBL in Grenoble, France also visited the Australian Synchrotron to give presentations to the controls group, VERSI and other interested staff. Discussions focused on developments in DLS software platforms on all beamlines (GDA), developments in data storage and curation

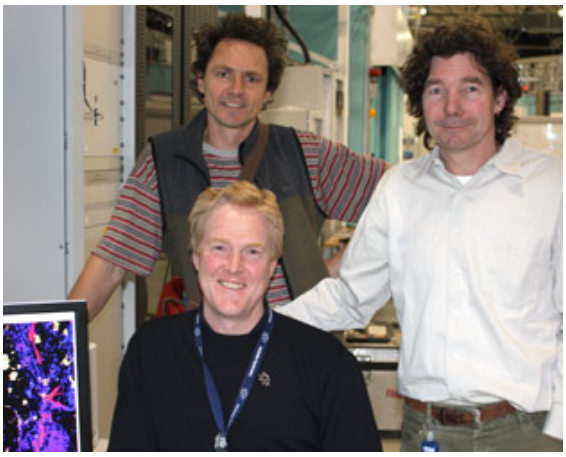
X-ray Fluorescence Microprobe (Microspectroscopy) Beamline

Recent months have seen rapid commissioning, with the first real sample scans acquired on the microspectroscopy beamline within weeks of achieving a one-micron focus in September 2008. The prototype advanced detector (Maia) being developed by CSIRO and BNL has demonstrated 64 megapixel elemental maps in 20 hours (msec/pixel dwell). The final version of the Maia detector with annular geometry and 384-elements will be installed early in 2009.



Synchrotron image (8000 x 5000 one-micron pixels) showing trace gold (green), rubidium (red) and iron (blue) in a regolith sample.

Image: Rob Hough, Mel Lintern, Chris Ryan, CSIRO.



L to R: Beamline user Chris Ryan from CSIRO (seated) with beamline scientists Martin de Jonge and David Paterson.

David Paterson, Principal Scientist, Microspectroscopy

Infrared beamline

Users of the IR beamline's microscopy branch are making the most of the FPA (focal plane array) microscope for mapping large areas of samples off-line and the grazing angle objective for studying thin films (tens of nanometres range) on the reflective surface.

The beamline team has implemented a range of measures to improve the IR microscopy branchline's capabilities for studying live cells. These include placing the live cells between two thin (0.5 mm) calcium fluoride windows with a spacer (approximately 7, 10 or 12 microns) fabricated onto one of the windows and kept in position in the compression cell. Further improvements are planned.

Recent developments on the IR beamline's high-resolution far IR branch include the achievement of coherent far IR light and the new enclosive flow cell for sample measurements at liquid nitrogen temperatures.

Steven Best from Melbourne University is using the ATR objective on the IR microscope branch to assist the analysis and conservation of artworks. For example, he is using FTIR to examine cross-sections of paint chips from the Commercial Hotel in Fitzroy to reveal details of

techniques (ICAT) and goniometer control for crystallographers.

Both the Australian Synchrotron controls group and VERSI (the Victorian eResearch Strategic Initiative) are now looking at further potential opportunities for future collaboration and enhancements to existing systems. VERSI has two full-time staff members, Chris Myers and Michael d'Silva, located at the Australian Synchrotron to assist with a range of IT-related developments, including the virtual beamline and remote access and rapid data transfer capabilities.

SYNCHROTRON INFLUENCES EPICS DECISION

The Australian Square Kilometre Array (AuSKA) radiotelescope project proposed for Western Australia plans to use EPICS as its control system. The decision was influenced by Australian Synchrotron staff who last year trained the AuSKA head of controls (Juan Carlos-Guzman) in EPICS and inspired his confidence in the suitability and stability of the system as used at the Australian Synchrotron.

Artist's impression of the square kilometre radiotelescope array
(Image: Chris Fluke,
Swinburne University of Technology)

pigment, binder and filler distribution.

Users of the high-resolution far IR branch include Chris Thompson from Monash University, who is conducting atmospheric and astrophysical studies of gases at high spectral resolution.

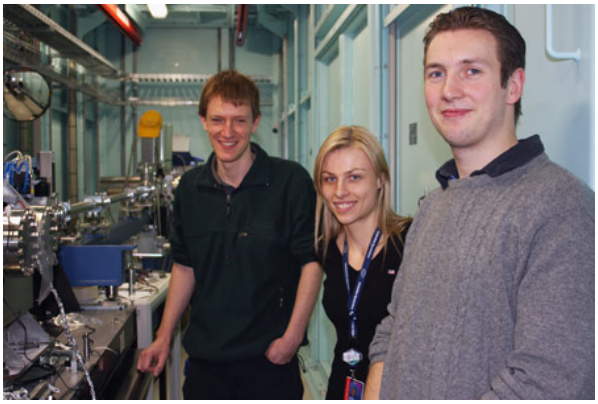
Mark Tobin, Principal Scientist, Infrared

Small angle and wide angle x-ray scattering beamline
The SAXS/WAXS beamline made major progress in November and December 2008, completing the final stages of optics commissioning and conducting an expert user program on the endstation.

We have accurately mapped the complete range of undulator harmonics and aligned the monochromator so that users can choose any wavelength and easily vary it during an experiment. The bimorph mirrors are producing a very clean, well focussed beam needing very little guarding for SAXS analysis, and the slit systems are working well. The optics are delivering a low instrument background; we have already been taking excellent data down to 0.003 Å-1 and we will push for lower q early in 2009. The beamline is delivering a full flux of 1013 photons/s/200mA at 10 keV, drastically reducing acquisition times and enabling a much broader range of experiments.

To date we have conducted seven expert user experiments covering in-situ time resolved analysis of gold nanoparticle formation, cellulose analysis, x-ray detector development, bio-membranes and the structures of collagens, nerve cell proteins, and protein solution scattering. Despite most samples being relatively weak scatterers, acquisition times have been typically been only a couple of seconds, and so far only very dilute protein solutions have drawn on the full flux of the beamline. These experiments have been invaluable in testing the capability of the beamline and preparing for the full user program next year. For example, we have designed and implemented a new shutter control system, tightly integrated the CCD detector into the control system, implemented highly automated data acquisition software functions, and deployed a sophisticated digital video system for precise sample alignment and monitoring developed entirely in house. A major program of implementing and developing the IDL-based software for beamline control, data presentation and processing is underway.

The SAXS/WAXS camera is no longer just plastic pipe, and while the stainless steel tubes we are currently using are providing high quality data, the full SAXS capabilities of the system will come on stream when the two remaining vacuum vessels and the custom-designed nose cones arrive.



Beamline staff Adrian Hawley (R) and Stephen Mudie (L) with beamline user Leanne Dyksterhuis from CSIRO.

RAPID PX ACCESS TO CONTINUE

Following the rapid access trial on the high-throughput protein crystallography beamline at the Australian Synchrotron in October, November and December 2008, rapid access applications will be sought again in 2009.

The main aim of the new system is to provide rapid beamline access for experienced users with high profile, highly competitive projects.

CAREERS AT THE AUSTRALIAN SYNCHROTRON

The Australian Synchrotron offers a unique working environment for a wide range of specialists.
More information on job postings: http://www.synchrotron.org.au/content.asp?Document_ID=14.

READER FEEDBACK

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

The beamline team has been boosted by the commencement of our newest staff member, Adrian Hawley, as the scientific support officer for SAXS/WAXS. Adrian completed his PhD at the University of Bath in England before starting at the synchrotron, and his experience in scattering and chemistry is a real asset to the beamline and its users.

The beamline was heavily oversubscribed with quality applications for its first cycle of operations, the 2009/1 cycle, and we are looking forward to really getting started in January.

Nigel Kirby, Principal Scientist, SAXS/WAXS

LIGHT SOURCE UPDATE

Since the initial design of the Australian Synchrotron storage ring, improvements have been made in the machine working point through extensive studies involving theoretical models and detailed measurements. The Accelerator Physics Group has implemented various measures to improve the quality of the beam, including optimising the linear optics, tuning the RF, measuring and controlling instabilities, insertion device compensation, fast bunch-by-bunch feedback and top-up injection studies.

Future development plans include specialised beamline source points, non-linear optics measurements, coherent radiation production, a precision beam energy measurement and time resolved measurements.

Mark Boland in the storage ring tunnel with two of the four RF cavities

Mark Boland, Principal Scientist, Accelerator Science

MORE INFORMATION

A list of Australian Synchrotron personnel can be found here: http://www.synchrotron.org.au/content.asp?Document_ID=129.

Email: info@synchrotron.org.au

Facility office
800 Blackburn Road,
Clayton, Vic 3168

Within Australia:
03 8540 4100

International:
+61 3 8540 4100