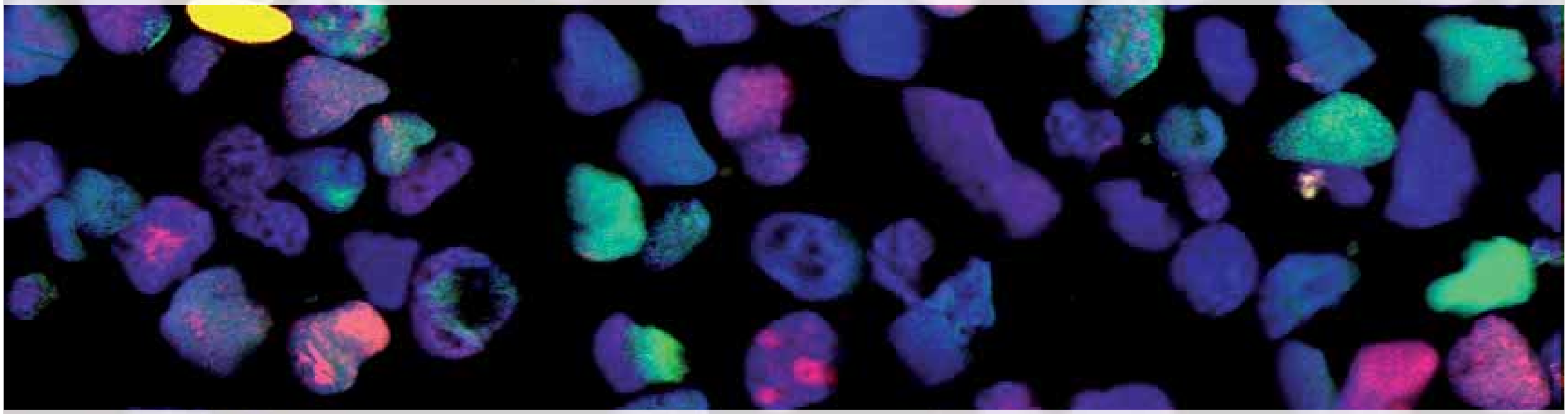
AUSTRALIAN SYNCHROTRON



ANNUAL REPORT 2009

Contents

VISION:

To be the catalyst for the best scientific research and innovation in Australasia. The key focus of the facility is on providing a thriving scientific research environment that is conducive to creating and nurturing the best scientific outcomes for the users and employees of the facility.

MISSION:

Develop a world-class synchrotron facility, maximising the quality, breadth and impact of scientific output.

CORE VALUES:

Passion, respect, collaboration, innovation and continuous improvement. We are committed to supporting leading edge research that will advance:

An environmentally sustainable Australia.

Promoting and maintaining good health.

Frontier technologies for building and transforming Australian industries.

Safeguarding Australia.

About the Australian Synchrotron

A synchrotron is a very large, circular piece of electrical equipment - an electron accelerator - that is housed within a structure about the size of an Australian Rules football field. From the outside, the Australian Synchrotron looks very much like a roofed football stadium. But on the inside, it's very different. Instead of spectator seating and a grass playing surface, there is a vast, circular network of interconnecting tunnels and high tech apparatus.

The synchrotron uses electricity to produce and accelerate charged particles called electrons. The synchrotron's light is produced when the electrons are bent by powerful magnets and forced to travel in a circular orbit inside the tunnels. As they are being bent, the electrons produce light that is about a million times brighter than the sun. Much of this light is outside the visible spectrum, such as infrared and X-rays.

As the electrons are being forced to travel along a circular path, their emissions of light reduce their energy. To maintain their energy, the circulating electrons receive an energy boost at particular intervals within Radio Frequency cavities. The onward travel of the electrons and the delivery of their energy boost is "synchronised."

As the electrons race around the outer storage ring, the light generated is captured by detectors in the experimental end stations. At these points, various samples are interrogated by the intense light, revealing the innermost secrets of the sample materials.

With the new data and knowledge generated by the investigative process, scientists and other experts can invent ways to tackle diseases, make plants more productive and metals more resilient – among many other beneficial applications.

By generating new information about a vast array of materials, the synchrotron can help to make life better for everyone.

To learn more about the Australian Synchrotron, visit www.synchrotron.org.au.

The Australian Synchrotron's Research Capability Areas

Our facilities enable a vast range of new research and development possibilities across a wide range of sciences. These include:

Biosciences: protein crystallography and cell biology

Medical research: microbiology, disease mechanisms, high-resolution imaging and cancer radiation therapy

Environmental sciences: toxicology, atmospheric research, clean combustion and cleaner industrial production technologies

Agriculture: plant genomics, soil studies, animal and plant imaging

Minerals exploration: rapid analysis of drill core samples, comprehensive characterisation of ores for efficient mineral processing

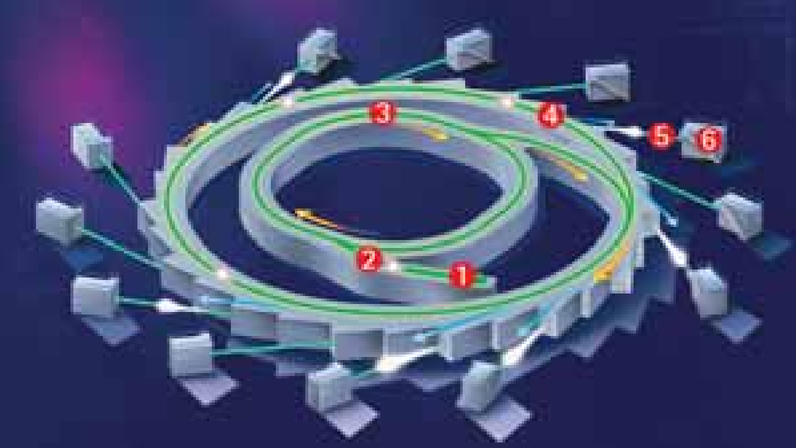
Advanced materials: nano-structured materials, intelligent polymers, ceramics, light metals and alloys, electronic and magnetic materials

Engineering: imaging of industrial processes in real time, high-resolution imaging of cracks and defects in structures, operation of catalysts in large chemical engineering processes

Defence industries: metal and ceramic fatigue and resilience in jet engine components, new materials, sensors

Forensics: the identification or elimination of suspects from extremely small and dilute samples

Pharmaceuticals: analysis of proteins, nucleic acids and viruses, cell imaging, quality control, bio-mimetic materials



1. An electron gun generates a stream of electrons.
2. A linear accelerator speeds up the electron beam.
3. The booster ring further increases the energy of the electron beam.
4. The beam is focused and directed by powerful magnets in the storage ring.
5. Individual beamlines capture the light from the storage ring.
6. Experiments are conducted in the end stations, using synchrotron light.

The Year in Review

Reflections from the Chairman

Although it is a very young organisation, the Australian Synchrotron is rapidly creating a reputation as the most significant scientific facility in the Southern Hemisphere. As Chairman of the Board, it is my responsibility, along with my fellow Board members, to help ensure that the Australian Synchrotron continues to develop and fulfils its potential to deliver maximum benefit to key stakeholders throughout Australasia, the scientific community and the public. I want to pay special tribute to the hardworking members of my Board and the dedicated professionals and scientists for all that we have achieved this year.

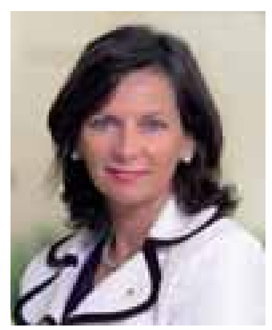
While thanks to the foresight of the Victorian state government the synchrotron is situated in Melbourne, the facility is nevertheless truly national and trans-national in focus, drawing in pioneering scientific research from across the region. The Australian Synchrotron is dependent on and grateful to the Commonwealth and Victorian governments for funding its ongoing operating activities.

To ensure future national prosperity, we must direct more of our energies to research and development and to high value added pursuits. As Chairman, I derive some reassurance from seeing that so much time and talent on the synchrotron's beamlines is devoted to scientific research that may well deliver the secure future that we all seek. For instance, good health at all ages is a fundamental aspiration across communities. Working with researchers from universities, medical research institutes and the private and public sectors, significant advances in understanding the processes of diseases such as cancer and malaria have been made at the Australian Synchrotron. As a prominent structural biologist from Melbourne recently remarked, the synchrotron helped him to solve within a few hours a seemingly intractable problem that had frustrated him in his laboratory for a year. Using the synchrotron to identify drug targets, develop lead compounds and, hopefully, to devise new therapeutics, will deliver not only great health benefits, but will generate important intellectual property, patents and products.

Industry engagement to assist Australian manufacturing to innovate and to add maximum value is a central objective of the Australian Synchrotron. The applications of synchrotron science to industrial processes are vast, ranging from "sunrise" nano, computer and solar energy technologies through to quality assurance and stress testing for metal and ceramic products.

The Australian Synchrotron also has an important role to play in helping this nation's commodity based industries to generate maximum income and benefits, by assisting with scientific solutions that can, among other things, help to identify viable mineral deposits, assist with improving upstream refining processes and minimise environmental impacts. The Australian Synchrotron is deeply committed to assisting Australasia's commodity producers and exporters – including, of course, the agricultural sector – to lead the world in process efficiency and innovation.

Vital and central as it is, the responsibilities of the Australian Synchrotron do not begin and end with scientific research. We must do more to encourage and inspire young people to pursue the study of science in their senior secondary school years and beyond. If we succeed in this endeavour, we will build a future of fulfilling employment and high value added outcomes. The Australian Synchrotron already has a program of active community engagement - and with the prospective development of new educational facilities on site, the way is open for us to cultivate the next generation of scientists who will help to lead this nation on a prosperous course of innovation and achievement.



Mrs Catherine Walter AM

Chairman
The Australian Synchrotron

Building Momentum

This is the second Annual Report of the Australian Synchrotron. The 2008-09 year has been one in which the facility has firmly established scientific operations with nine beamlines available for general scientific user access. This, coupled with outstanding machine operation, including 98% beam availability, has resulted in the Australian Synchrotron being overwhelmingly embraced by the national and international scientific community. Importantly, the Australian Synchrotron reached two milestones this year, with the third anniversary of "first light" from the storage ring and clocking up 10,000 user beam hours.

Scientific user numbers have doubled every six months. Over the past year, there have been 2,003 scientific visits from 46 institutions both here and overseas; and many more potential users have registered their interest. As a gauge of the synchrotron's enthusiastic acceptance by the scientific community, our beamlines are generally oversubscribed two to three times over, while one beamline has registered an astonishing five times as many scientific requests as can be accommodated. The national user meeting held in conjunction with the Third Asia Oceania Synchrotron Forum in December 2008 signalled consolidation of the Australian Synchrotron's position, attracting over 300 participants from across and beyond the region.

With outcomes including 60 published papers in the first half of 2009, some notably in journals such as Science and Nature, the Australian Synchrotron is fulfilling its remit for enabling high quality research spanning the scientific community. Interestingly, some of the scientific papers' co-authors are Australian Synchrotron scientific staff, who are developing their own scientific careers accordingly. The results are all the more impressive when we consider that only half of the available beamlines were in operation just over a year ago.

Nevertheless, we have not forgotten where is all started. Access to overseas synchrotrons continues, with the Australian Synchrotron managing a beamline at the Photon Factory in Japan. The Australian Synchrotron Research Programme (ASRP) has been replaced by the International Synchrotron Access Programme (ISAP), albeit with a much broader responsibility. It accommodates those experiments that are not available locally.

The new ISAP also acts as a pointer to potential new beamlines to be built at the Australian Synchrotron. With so many different types of science being undertaken through the home and away programs, and with the option to build another 29 beamlines around the ring, the big question is: "Which ones?"

Already, a recent boost of $14.7 million from the NHMRC and the Victorian state government will see the construction of a 150 metre long Imaging and Medical beamline. Along with other activities, this will form the basis of a clinical programme that at completion will utilise the largest X-ray beam in the world.

The Australian Synchrotron has grown to meet this and other challenges. A 40% increase in staff numbers over the past year, an enviable safety record and the recent awarding of the Quality Management Standard ISO 9001:2008 have demonstrated the commitment of the Australian Synchrotron to optimising the scientific user experience.

Add to this a burgeoning outreach programme of regular tours and classes that cater for over 600 secondary school and other visitors monthly. The latest in this programme was the inaugural science Winter School for 46 students from universities across Australia and New Zealand.

Another issue addressed this year is funding for the completion of ancillary facilities at the Australian Synchrotron. A successful Education Infrastructure Fund (EIF) proposal for $37 million was confirmed in the May 2009 Federal budget. This money will be used to construct enhanced user facilities – accommodation block, user lounge and restaurant; improved technical facilities – engineering wing and additional laboratories; and a National Centre for Synchrotron Science to house, among other things, a community outreach facility, lecture theatre and exhibition space.

With all this in mind, we can be confident that the Australian Synchrotron is now established as a key centre for national and, increasingly, international multidisciplinary scientific research.

Professor Robert Lamb

Facility Director
The Australian Synchrotron

Highlights of the Past Year

Confronting the malaria pandemic: The development of a new class of anti-malarial drugs is in prospect, thanks to research at the Australian Synchrotron performed by scientists from Monash University, the University of Technology Sydney and the University of Queensland. The high throughput protein crystallography (PX1) beamline at the Australian Synchrotron has produced superbly detailed crystal structures of a key malarial enzyme in its natural state and bound to potential inhibitors. This new, three dimensional information provides pathways for identifying potential drug targets. Malaria is an ongoing global catastrophe that kills up to three million people every year and infects and debilitates around 600 million people – an astonishing 10% of humanity. The few drugs that remain effective against malaria are steadily diminishing in their capabilities, owing to increasing parasite resistance.

Revealing the secrets of cell death: Scientists from the Walter and Eliza Hall Institute of Medical Research in Parkville were the first to solve a protein structure on the Micro Crystallography (PX2) beamline. The scientific team used the beamline to solve in half an hour a problem that had frustrated their lab-based investigative efforts for a year. The WEHI scientists knew the structure of the vaccinia virus on its own, but they needed to determine the structure of one of the peptides to which it binds. The F1L protein enables the vaccinia virus to hijack a crucial mechanism in the cells it invades, repressing the normal and healthy cell suicide program that destroys infected cells. This discovery about the crucial role of F1L in the mechanics of cell suicide (or apoptosis) will have major implications for the downstream development of more effective virus and cancer therapeutics.

Budget boost for synchrotron capabilities: In the 2009 Federal Budget, the government announced an Education Infrastructure Fund grant of $36.78 million to enhance the research and educational capabilities of the Australian Synchrotron. The new facilities to be constructed with the grant includes fifty self-contained rooms to accommodate visiting scientists; an education centre including an exhibition space, 400 seat auditorium, seminar rooms and cafeteria; a technical support laboratories building, which will release space in the main synchrotron building for scientific user laboratories; and a much-needed extension to the synchrotron's electrical power plant.

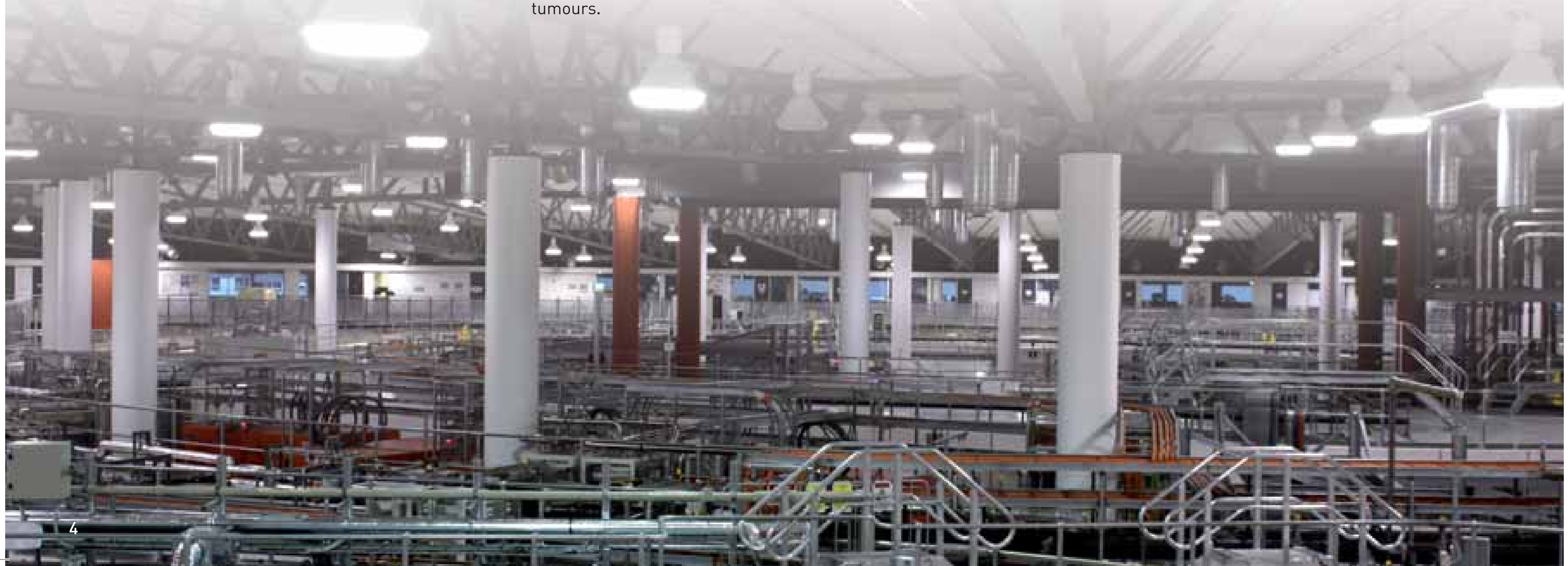
A leap in medical imaging resolution: More rapid detection of cancer will ultimately be possible on a newly-upgraded Imaging and Medical beamline, thanks to a $13.2 million grant from the NHMRC, supplemented by $1.5 million from the Victorian state government. Scientists will exploit the vastly increased imaging capabilities for the high resolution imaging of tissue, which will reveal the existence of hitherto undetectable tumours. In fact, the IM beamline will be able to detect abnormalities that are up to 50 times smaller than those currently detected by conventional X-ray and CT techniques. As the Director of the Australian Synchrotron, Prof Rob Lamb puts it, the effect will be "like going from a grainy black and white 1950s television to a 3D, high resolution flat screen."

Predicting breast cancer: Researchers from Fermiscan Holdings Ltd (ASX:FER) have used the technique of X-ray diffraction at the Australian Synchrotron to develop a potentially revolutionary way to detect the presence of breast cancer. Research suggests that certain discernable changes in the structure of hair may be a simple, non-invasive and reliable indicator of cancer. The "Fermiscan Test" has the potential to provide a fast and accurate adjunct to existing technologies for the detection of breast tumours.

First light: Over the course of three days in August 2008, three beamlines at the Australian Synchrotron received "first light": Small Angle and Wide Angle X-ray Scattering (SAXS/WAXS); Micro Crystallography (PX2); and X-ray Fluorescence Microscopy (XFM). These milestone moments indicate that the synchrotron beam has travelled all the way along the beamline from the storage ring to the experimental station. The achievement of first light demonstrates that all the beamline components are properly installed and aligned. The beamlines are thereby deemed ready to undertake their various investigative and analytical tasks.

Remote control crystallography: The Victorian Premier, John Brumby, has demonstrated the capabilities of remote access, high throughput crystallography. From a laptop computer at the Walter and Eliza Hall Institute in Parkville, the Premier guided a robot at the Australian Syncrotron in Clayton to mount and centre a sample, take a test shot and collect a full data set about trypsin, a pancreatic enzyme. Now, scientists from all over the world are able to take advantage of remote access crystallography to conduct their experiments at the Australian Synchrotron.

1000 unique users: The Australian Synchrotron reached a landmark in May 2009 by hosting the 1,000th researcher to conduct experiments in the facility. This achievement underlines the increasing awareness of the capabilities and benefits of the Australian Synchrotron among the broad scientific community, both in this country and overseas.



The User Office

Scientists and researchers who use the facilities of the synchrotron are referred to as "the user community." The Australian Synchrotron's User Office is committed to making it simple for the scientific community to gain access to and use the synchrotron.

The office is the initial point of contact for anyone who might wish to gain access to the services of the synchrotron. The User Office advises prospective users of beamline availability, provides safety training once a date is confirmed and liaises with scientists until such time their use of the beam is complete. The office funds the travel and accommodation costs of visiting scientists from around Australia and New Zealand – a service that is greatly valued by the user community.

Users are well supported during their time at the Australian Synchrotron by: comprehensive beamline induction training upon arrival; practical support during the day shift, Monday to Friday; some direct support during evening shifts and during the day at weekends; support from machine operators out of hours, when no beamline staff are onsite; and on-call support from beamline staff at all other times. In addition to direct support when taking data, users also have access to support laboratories for tissue culture and the preparation and analysis of samples.

On a more relaxed note, a User Lounge is provided for visiting scientists. The lounge provides daily newspapers, tea and coffee, simple kitchen facilities, local cuisine guide, computers with internet access and printers, cable television and personal lockers. Pool cars are also available for use by visiting scientists.

More than a thousand unique users have passed through the User Office since the Australian Synchrotron started operations. According to Dr David Cookson, Head of Beamline Science and Operations, "This is a huge number, considering the facility has only been open for two years. "

Dr Cathy Harland, Group Leader of the User Office, coordinates the reviewing process that ensures beam time priority is given to the best science from Australasia. Merit-based proposal submissions now exceed 600 per year – all requiring the scrutiny of many proposal advisory committees and expert referees.

The allocation of user access to the beamlines is based upon the following schedule:

Merit Based (50%): Each year, there are three open Calls for Proposals relating to three beamline periods. The proposals are subject to peer review.

Foundation Investors (30%): Foundation Investor Proposals are not subject to peer review and each Foundation Investor takes responsibility for allocating beam time to its member institutions, subject to safety and technical feasibility provisions.

Facility and Commercial Access (20%): This category includes access for projects of the Australian Synchrotron's own scientists; and a program of subcontracted commercial projects.

High Throughput Protein Crystallography – PX1

PX1 is an excellent means by which to identify the otherwise mysterious three-dimensional structures of proteins. This is achieved by computer-based modelling of the structures using X-ray diffraction data derived from the crystal.

One of the main benefits to scientists of "high throughput" PX1 is that within just a few hours it can produce great amounts of data about a large number of samples. Though the beamline is physically based in Clayton, the computer-controlled process can be driven remotely by scientists anywhere in the world.

The three dimensional structures produced from all the newly-generated data will sometimes suggest potential drug targets. The hunt is then on for a molecular compound that will tightly bind to the drug target area. If a compound can devised to bind to the target, it might eventually proceed to be developed and released as a new drug – if it can be proven to be both safe and effective over an exhaustive course of trials.

We can explore the nature of PX1 and its capabilities by resorting to a gesture that is familiar to all of us. A handshake is generally a sign of friendship and cooperation, but for Dr Tom Caradoc-Davies, Protein Crystallography group leader, it can represent something quite different. In the world of structural biology and drug design, the handshake is a simple metaphor sometimes used to illustrate a pivotal move in a complex biomedical process. PX1 is vital in creating the conditions for understanding this biomedical "handshake."

Before any new drug can be developed, a target for the drug needs to be identified. That target might be an invasive "non-self" agent, such as a bacterium, a virus or a parasite. A particular virus, for example, might have upon its surface a protein that enables the virus to bind itself to the host cell. That protein, like all others, will have on its own surface characteristic shapes with lumps, bumps and gaps. We might liken one of those shapes to the first offered hand of a handshake. It is important to know the exact size and shape of that protein's "hand", because scientists will want to find and introduce a molecular "hand" that will clasp tightly to the other – and in the process, prevent the protein's "hand" from doing what it normally does. In this example, being tightly bound or inhibited, the protein would no longer be able to assist the invading virus to replicate itself. Thus, for the virus, the molecular "handshake" signals not friendship and cooperation, but the end of the virus's multiplication within the body.

Essentially, proteins drive the operations of all organisms, so understanding the shape and functionality of a protein is a necessary prelude to altering its behaviour. Because proteins are so universally spread across all forms of organisms, including disease-causing agents, molecular therapeutic intervention is possible in a wide range of diseases and conditions, including cancer; HIV; parasitic diseases, such as malaria and leishmaniasis; autoimmune diseases, such as diabetes and coeliac disease; tuberculosis; cardiac conditions; undesirable immune system responses to transplants – and more.

Micro Protein Crystallography – PX2

As a particular refinement of PX1, PX2 is ideally suited to extracting information from very small or weakly diffracting crystals to determine the three dimensional structures of biological samples.

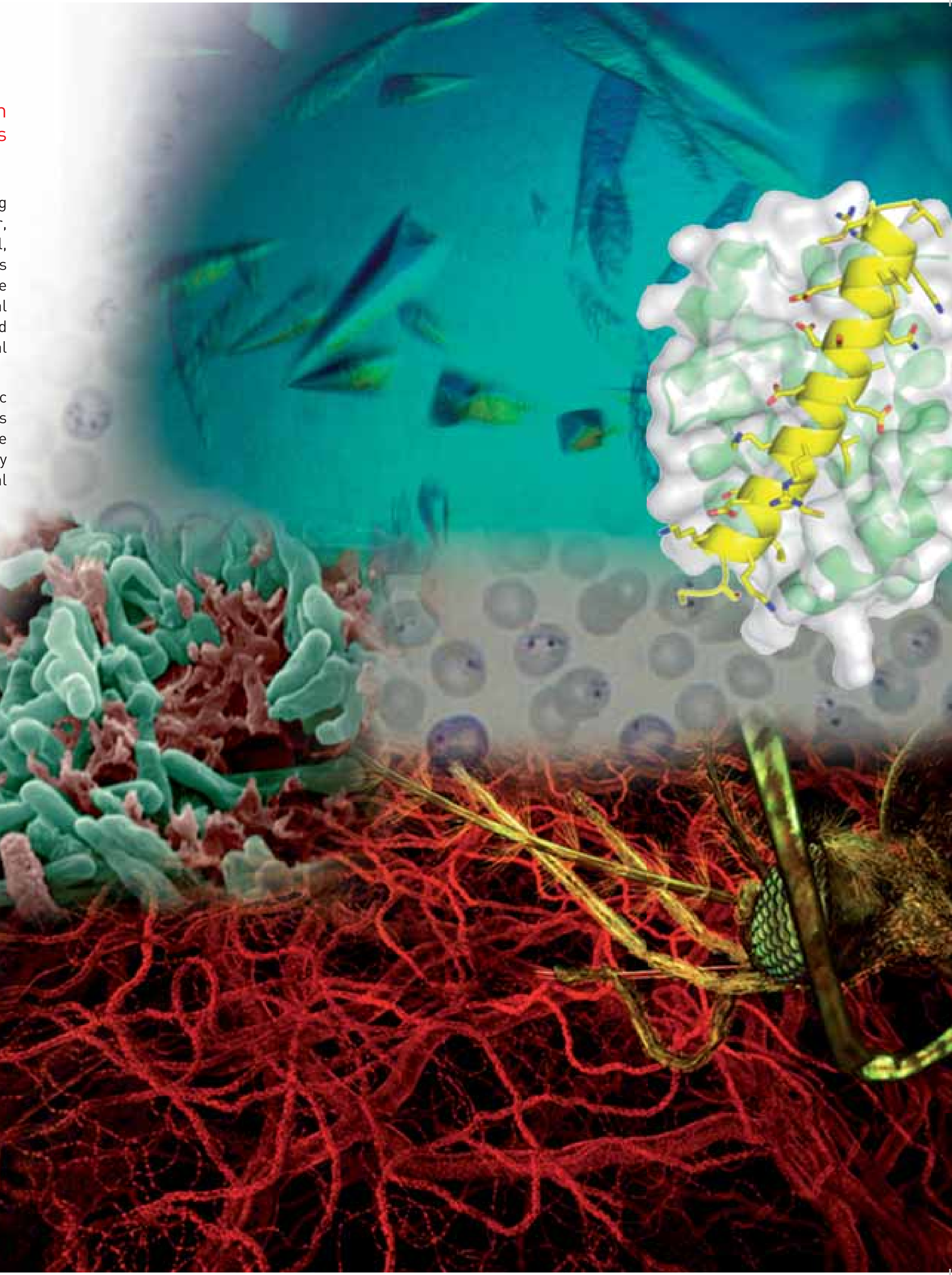
Dr Tom Caradoc-Davies, who is the group leader for both of the related beamlines, reflects upon the respective characteristics of PX1 and PX2 by beginning with a simple metaphor. "Let's say that you have in your garage a big family sedan and parked next to it is a high performance sports car. You can't really say that one is intrinsically superior to the other, because they are built with different features to provide different benefits. The sedan may transport five adults in superb comfort, whereas the sports car will most likely give some of them a hard ride in cramped conditions. Conversely, the high end performance and handling of the sports car is likely to be superior on a race track. Broadly speaking, it's probably fair to say that PX1 is more like a large sedan, while PX2 is closer to being a high performance sports car."

Dr Caradoc-Davies continues, "To extend the metaphor, imagine that our big sedan, called PX1, has standard headlights. Those broad beams are very good for illuminating fairly well defined elements on the road under normal conditions. With our high performance sports car, called PX2, we need to extend our imagination further, because the headlights of PX2 are actually 4,000 times brighter than those of PX1. The intense lights of PX2 are also very tightly focused into amazingly narrow beams. You can focus those lights on something on the road that is very small, weakly reflective (or diffracting) or quite fragmentary, yet still receive a great deal of useful visual information about it."

The tight and highly intense beam of PX2 is very good for avoiding the undesirable visual "noise" that can spill from a crystal that is illuminated by a broader beam, such as that of PX1. But, again, it is an issue of selecting the right beam to illuminate the particular crystal sample, because the extraordinarily bright light of PX2 can damage a highly sensitive crystal. A further issue is that different parts of some crystal samples can vary in quality. PX2 can cope very well with this, owing to its ability to focus closely on selected small sections of a crystal, allowing the user to collect data from the best part of the crystal.

PX2 has proven to be extraordinarily useful in defining molecular structures for research into cancer, malaria, HIV, tuberculosis and a range of other viral, bacterial and parasitic agents. Medical researchers from across Australia, New Zealand and Singapore have taken advantage of the extraordinary analytical and visualisation capabilities of PX2, with a key and ultimate objective being the identification of potential drug targets.

For medical researchers in the Western Pacific region, the location of the beamline in Melbourne has rendered unnecessary the use of PX beamlines in the United States and Europe, thus saving time and money in travel, while building intellectual, developmental and institutional capabilities in our region.



Imaging and Medical – IM

"From human cells to turbine blades and more" is the way that IM Principal Scientist, Dr Daniel Häusermann, describes the investigative capabilities of the Imaging and Medical beamline.

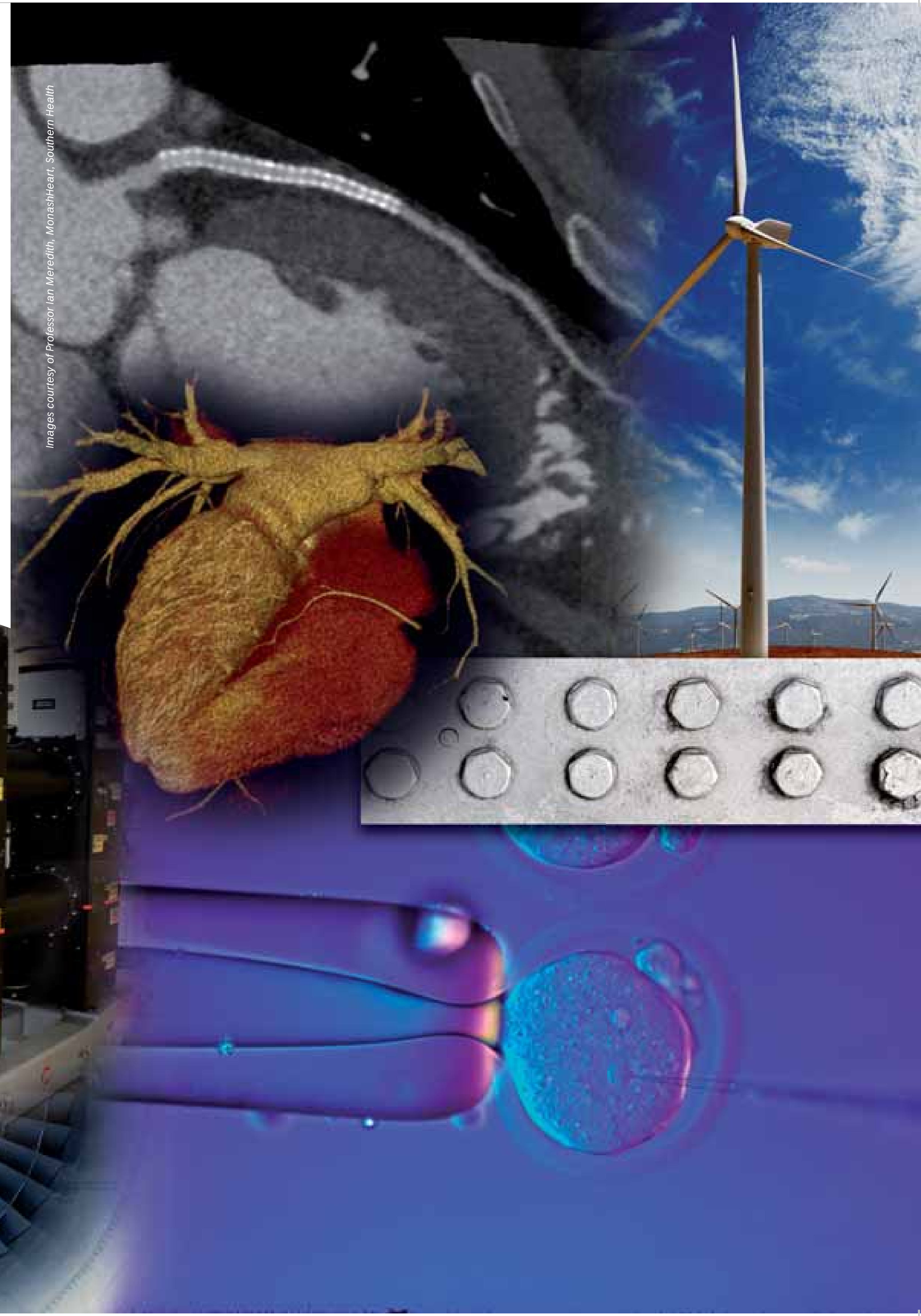
A distinctive feature of IM is its use of phase contrast imaging, which is an extraordinarily sensitive imaging technique. If offers far greater fidelity than conventional absorption imaging, with an astonishing sharpness in tonal contrast and photo-realistic detail.

In the sphere of biology and medical research, a particularly striking feature of IM is its ability to very accurately represent soft tissue. In breast disease, for example, this technique has demonstrated its capability to image a clinical precursor of breast cancer, micro-calcification, which is invisible in conventional mammography. Since early detection is a major determinant of a patient's survival of breast cancer, such fine grained imaging will have a positive impact on diagnostic processes in the future.

The imaging capability of IM at the Australian Synchrotron is so potent that it can visualise cells in hitherto unimaginable detail. It can also be used to accurately track in vivo the behaviour of cells that have been bio-injected with nano-particles of gold. In addition, the IM beamline has the ability to be fine tuned to suit the nature of the material under investigation, by altering the wavelength of the beam. For instance, the intensity of the beam could be varied to better suit the investigation of relatively high density young breast tissue as compared to lower density older breast tissue.

The potential confluence of medical research theories with the astounding imaging capabilities of the IM beamline therefore offers the prospect of accelerated discovery and clinical therapy development. At the Australian Synchrotron, the IM beamline itself will not become a routine clinical treatment tool, but it will be used extensively to help develop better imaging and radiation therapy techniques for use in clinical settings around the world. In clinical research, it will make important contributions to the understanding of diseases in many fields such as regenerative medicine, cancer and cardiology.

A world away from medical research, IM also has remarkable industrial imaging applications. Signs of stress and potential failure that are otherwise invisible within vital components and materials such as turbine blades, propellers, ceramics, structural steel and even large bolts can be detected by the IM beamline. Cracks and faults down to a width of a single micron – a millionth of a metre - can be revealed. Bearing in mind that the width of a single grain of table salt is 70 microns, that kind of detective capability stands to be of enormous assistance to industrial processes, with all manner of consequent benefits: more resilient products, more reliable performance, realistic maintenance scheduling, accurate replacement programming and, ultimately, better lives for entire communities in Australia and around the world.




Images courtesy of Professor Ian Meredith, MonashHeart, Southern Health

Small and Wide Angle X-ray Scattering – SAXS/WAXS

Small and Wide Angle X-ray Scattering (SAXS/WAXS) hosts a beam of extraordinary intensity. SAXS/WAXS has the capability to investigate the structure of a wide range of materials at the scale of particles, molecules and atoms from areas including chemistry, biology and environmental science.

In fact, explains Principal Scientist, Dr Nigel Kirby, SAXS/WAXS is able to analyse the internal geometry of almost any liquid or solid, including solutions, particles suspended in solutions, emulsions (soft materials suspended in solutions), polymers, films, fibres, metals and ceramics. All this is able to be done in air, without resorting to a vacuum.

SAXS/WAXS also has the capability to analyse samples that are otherwise unpromising, owing to their poor condition or very weak signal profile. In addition, SAXS/WAXS has the ability to investigate the structure of surfaces, with very shallow depths of analysis.

Whereas SAXS/WAXS can provide information about the structure of surfaces, another beamline at the Australian Synchrotron, Soft X-ray Spectroscopy (SXR), provides information about the chemistry of surfaces.

In the sphere of medical research, SAXS/WAXS has an important role to play in the development of a potentially improved drug delivery system. Currently, the injection into the human body of a therapeutic drug results in an immediate “flooding” of the local area. This sometimes has adverse effects, such as local inflammation and discomfort. The therapeutic effect of the drug can also be compromised to some degree, owing in part to the body’s undesirably rapid absorption of the drug.

Medical researchers are working on a new drug delivery system based not on the injection of a homogenous liquid drug, but of nano-scale pellets of varying density that contain the drug. The drugs from the variously sized pellets would be released in a regulated way as the body’s own natural systems, including body heat, cause the various pellets to dissolve and to deliver the drug over a desired period of time. Medical researchers can use SAXS/WAXS to closely monitor the progress of their investigations into this potentially better drug delivery system.

For a host of practical and therapeutic reasons, some drugs would be better and more conveniently delivered by swallowing a capsule than by injection or infusion. However, the chemistry of the human stomach has often presented a problem to the oral administration of drugs, since drugs can be degraded by interaction with potent stomach fluids. SAXS/WAXS offers a new way to see this process at work. Knowing what actually happens in the stomach may provide the key to designing drugs and delivery systems that are customised to cope with this difficult biological environment.

Moving from a living system to an inert system, SAXS/WAXS has significant capability to assist with the characterisation of minerals and the improvement of downstream processing. The beamline can interrogate tiny mineral samples and particles, identifying them with a high degree of accuracy. Among other things, this may help to indicate whether a particular region contains minerals in commercially viable concentrations and quantities. Further along the developmental pathway, the underlying bases of some mineral and metal processing activities are not well understood. SAXS has the ability to reveal what is actually happening and what could be done to improve efficiencies.

Soft X-ray Spectroscopy - SXR

Soft X-ray Spectroscopy (SXR) beamline at the Australian Synchrotron has a speciality in determining the surface characteristics of non-biological, solid materials. Using finely-tuned "soft" or low energy X-rays that penetrate to the depth of only a micron or two, SXR can determine surface chemistry of materials with astonishing accuracy.

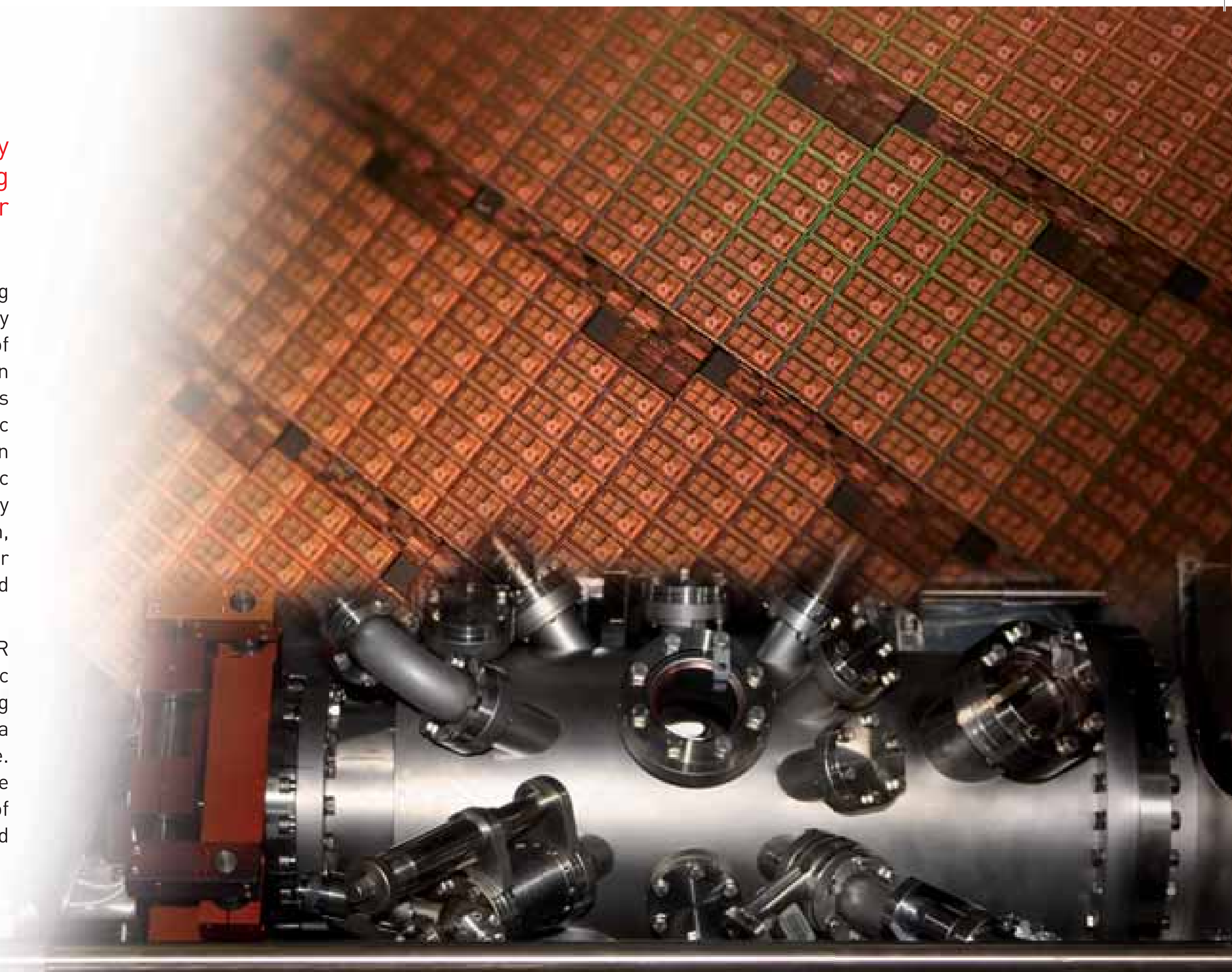
Principal Scientist, Dr Bruce Cowie, says that the techniques of SXR are particularly suitable for assisting in the development of new nanotechnologies. To understand the scale of such undertakings, bear in mind that nanotechnology deals with the control of matter at the atomic or molecular scale - generally under 100 nanometres. A nanometre itself is a billionth of a metre or a millionth of a millimetre. Thinking on this scale, the thickness of a sheet of paper is a comparatively massive 100,000 nanometres.

Nanotechnology is basically concerned with modifications to material properties when small numbers of atoms join. Often, it is found that nanoscale objects will have properties between those of the individual atoms and the commonly understood properties of the bulk material. By tailoring the size of the nano object, it is possible to tailor the desired properties. In this regard, SXR is able to contribute to the improvement of semi-conductors and computer chips. There is a relentless pressure to make computer chips smaller. Generally speaking, the number of transistors on a chip doubles every two years. The new generations of chips, which are heading towards producing structures with a minimum separation of 13 nanometres compared to 45 nanometres, present new manufacturing problems.

In basic terms, the light source hitherto used to manufacture chips is at the limits of its capabilities, since the wavelength of the light source is approaching that of the smallest features on the chips it is meant to manufacture. The series of controlled chemical reactions required on the chip will therefore depend upon a light source with a shorter wavelength. These shorter wavelength sources are being developed, but the wavelength of these sources can also be found on the Soft X-ray beamline. Different chemicals and processes must also be developed to accompany the new light sources. SXR is helping technologists to develop the key polymers that are a vital part of the process of producing the next generation of computer chips.

The science of surface reactivity is far from being restricted to the nanoworld. It is around us constantly and in fact travels with us frequently, in the form of the catalytic converter that is fitted to every modern motor vehicle. In this case, the solid elements platinum, palladium and rhodium within the catalytic converter react with passing hydrocarbons, carbon monoxide and nitrogen oxides to produce less toxic vehicle exhaust compounds. SXR has the capability to closely examine every element except lithium, hydrogen and helium, making it a natural choice for investigating a vast range of surface reactions and downstream practical applications.

In the sphere of metals and minerals, too, SXR has application capabilities with major economic implications. It may be that the process of separating ores from soil could be made more efficient, with a consequent increase in purity and economic value. The basic technique of an investigation of this type involves external users bringing in samples of naturally occurring crystals that are then sliced and studied by soft X-rays within an ultra-high vacuum.



X-ray Fluorescence Microscopy - XFM

XFM has astonishing versatility as an investigative and diagnostic tool. It is extraordinarily useful in four broad categories: biology; geology and mining; environmental studies and forensics. As Dr David Paterson, XFM Principal Scientist puts it, "We can investigate samples ranging from single biological cells right up to big lumps of rock – and much else besides, thanks to highly focused X-ray beams and their beautiful penetrating power."

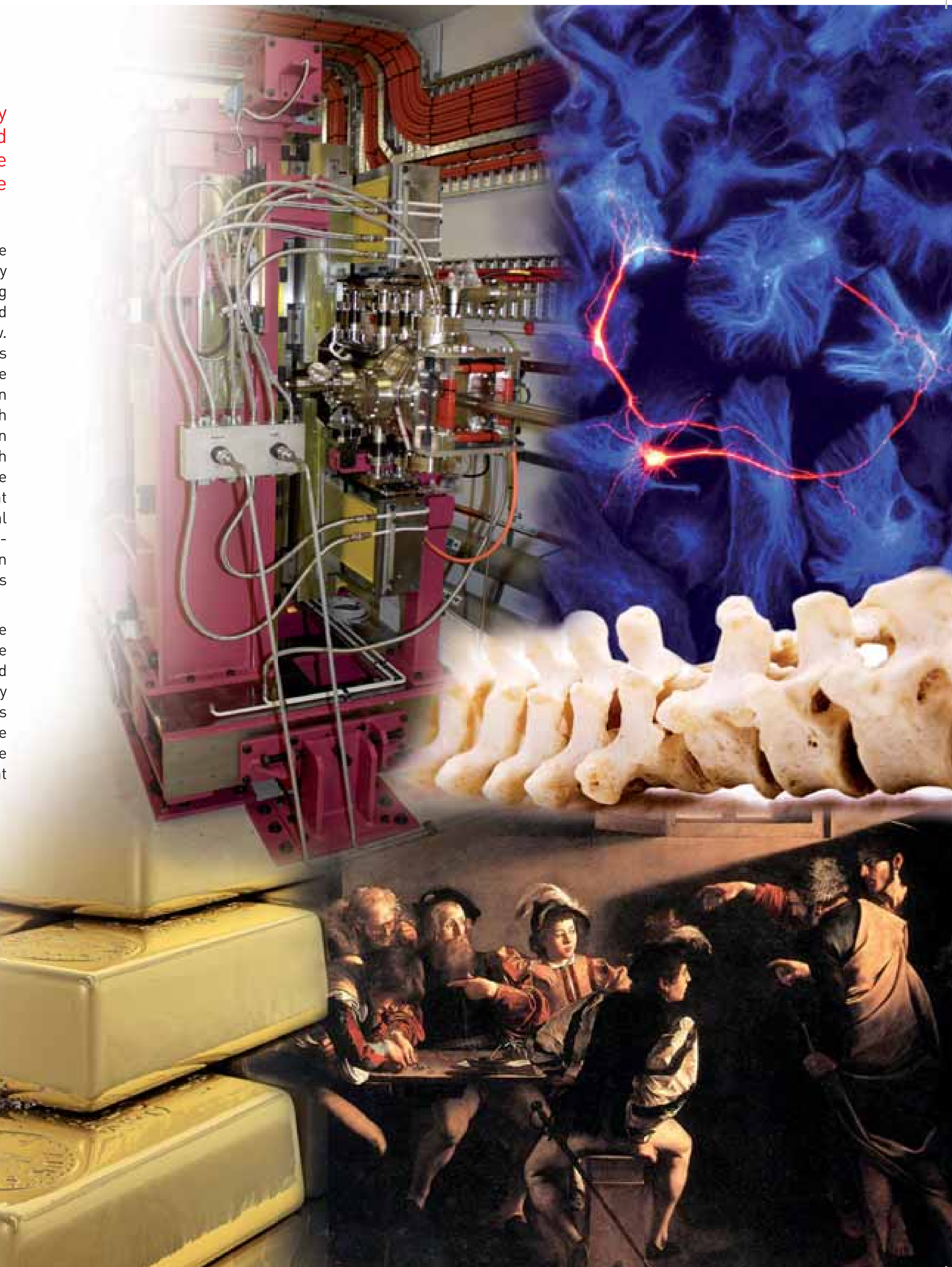
In biology, XFM proves amazingly potent, thanks to its ability to deliver true X-ray images rather than abstract patterns that require additional layers of processing and interpretation. XFM creates its images by scanning the sample under investigation in small steps, steadily building an accurate profile piece by piece. While this capability of XFM is highly beneficial in all its four broad applications, it is particularly useful, for instance, in providing a true image of bone and muscle tissue and determining the levels of essential trace metals such as magnesium, zinc and copper – all of which can be detected simultaneously.

As medical research progresses, such analytical capabilities will assume ever growing importance. In degenerative diseases such as Alzheimer's and Parkinson's, for example, research strongly suggests a vital role for trace metals, their location in the brain and their appropriate regulation. XFM provides an ideal mechanism for testing various theories about trace metals and their roles in both the preservation of good health and the development of disease. Trace metal distribution can be probed from within a single neuron cell to across the entire brain. In cancer research, too, XFM is proving its worth, providing otherwise inaccessible evidence about the possible faulty regulation of trace metals in the creation of malignant cells.

In the sphere of geology and mining, XFM has the ability to analyse rock samples extracted from areas that might hold mineral riches. In a process known as elemental mapping, the beamline can determine simultaneously the presence and qualities of any number of metals, including gold, copper and iron. This information is crucial in enabling governments, companies, investors and other interested parties to ascertain the likely commercial viability and impact of proposed mining developments.

With growing community demands for the maintenance of healthy environments, the capability of XFM to analyse soils and plant matter is becoming increasingly important. Plants typically absorb and impart characteristics of the soil in which they grow. On the positive side, this is perhaps most obvious with varieties of wine grapes, which will produce wines with subtle flavour variations when grown in different soils in the same region. Other plants, which manage to grow in contaminated soils, will contain evidence of contaminants within their foliage. Such toxins may include arsenic, cadmium or lead. Where contamination is suspected, samples of soil or plant material can be analysed by XFM with minimal disturbance to the sample from its natural environment. Precise readings of various contaminants can be obtained and remedial environmental strategies can be devised by the responsible authorities.

Among a variety of forensic applications, XFM can see deep within the fabric of an artwork to help determine its history. Upon investigation, a painting ascribed to an "Old Master" might reveal some distinctly inconsistent characteristics, such as paints or canvas that were not in use at the time or place that the artwork was supposedly produced. Intriguingly, the beamline might also reveal an earlier artwork that was painted over at a later date.



X-ray Absorption Spectroscopy - XAS

While some synchrotron beamlines infer detail by working backwards from the whole sample, a distinctive feature of XAS is that it reveals the detailed local structure and chemistry of individual elements from within the heart of the sample. The technique that enables this to happen is called X-ray absorption spectroscopy. This operates by measuring the absorption of light by the sample.

The information generated by this process is interpreted to produce a spectrum that corresponds to different elements within the sample – what XAS Principal Scientist, Dr Chris Glover, refers to as the "chemical fingerprint" of the sample under analysis. This is possible because every element has a known and distinctive absorption profile, but with subtly differing chemical species.

XAS is very versatile and can be used in a variety of scientific areas including biology, environmental studies, materials analysis, earth sciences, chemistry, physics and engineering.

In biology, for example, XAS has been used to investigate the role of cadmium in the efficacy of anti-inflammatory drugs that are used to treat animals. This can be done by using a "knock out" method, which basically involves removing cadmium from the drug and then observing the effect that its removal has upon the performance of the drug.

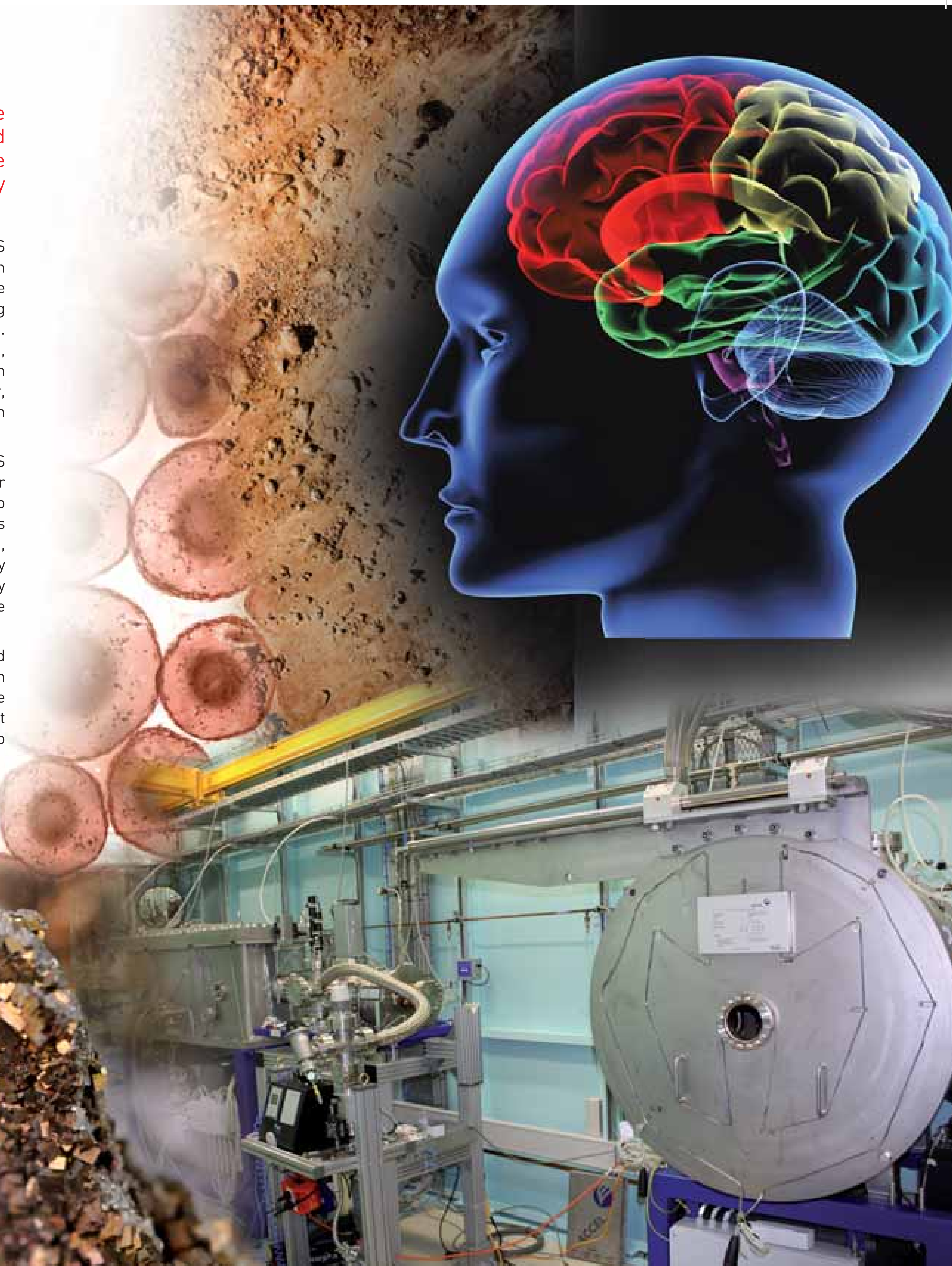
In human biology, XAS can be used to analyse tissue samples to identify drug target sites. The brain, for instance, requires a fine balance of essential elements to maintain its full operating capacity. The failure of the brain's mechanisms to absorb certain metals may lead to the onset of degenerative diseases, such as Alzheimer's. XAS can be used to determine the molecular sites in the brain most likely to be receptive to novel molecules (or drugs) that are structured to inhibit the progress of degenerative diseases. Using that information, drug designers can set about formulating "lead compounds" that may eventually be developed into therapeutic drugs.

In the field of environmental science, XAS has a wide variety of applications, including soil characterisation. For instance, a parcel of former industrial land may be suspected of harbouring toxic elements. Examining a small sample, XAS can readily identify a potentially troublesome contaminant – say, chromium. But detecting chromium is not the end of the investigative story, because chromium has both toxic and non-toxic forms.

Fortunately, both forms can be recognised by XAS and suitable policies for environmental remediation can be devised and implemented by the responsible authorities. Likewise, tailings from uranium mining may prove to be either water soluble or non-soluble. If, using XAS, the former is proven to be the case, action will need to be taken to prevent the uranium tailings seeping into the water table. Significantly, XAS is one of the very few investigative techniques in existence that is able to deliver such results.

What happens deep within the earth's crust? XAS can help to answer that intriguing question. Familiar natural materials that have been subjected to immense pressure and heat can be extracted as samples for XAS interrogation. Among other things, detailed analysis may reveal the processes by which mineral and ore deposits are formed, thereby suggesting the likely location of economically viable mineral and ore fields.

The effectiveness of XAS has been further enhanced by the recent acquisition of a 100 pixel Germanium detector, which is one of only four operating in the world. This innovation has provided high throughput capability for biological samples and the ability to detect metals in very low concentrations.



Powder Diffraction - PD

PD is an ideal means for gaining detailed insights into the atomic structure of materials that form as polycrystalline powders. Principal Scientist, Dr Kia Wallwork, explains that PD uses interrogation techniques that work effectively with samples that are provided "in bulk" – though such "bulk" samples can still be infinitesimally tiny, with the individual constituents being on the micron scale. Nevertheless, the samples analysed by PD are, generally speaking, somewhat larger in volume than the single crystals that can be analysed by other synchrotron beamlines.

In simple terms, PD is able to extract a great deal of information from powdered materials that cannot be rendered into single crystals of adequate quality or size. With these special characteristics, PD is a particularly potent way of analysing a broad range of materials, including pharmaceuticals, minerals, functional materials, fibres and metals.

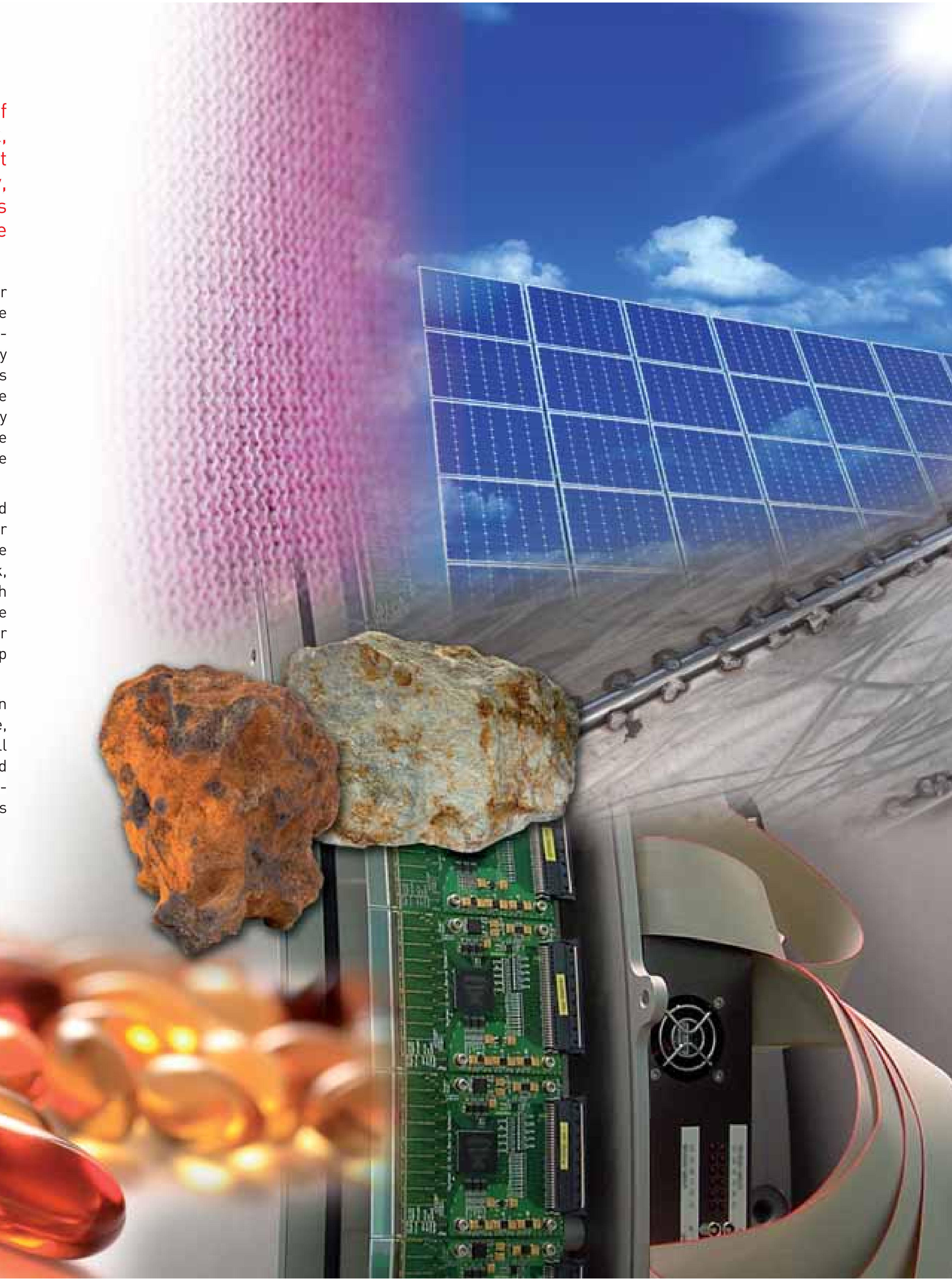
Prospective pharmaceuticals go through an extensive testing and developmental process. Once certain combinations of organic and synthesized molecular ingredients display some promise as possible therapeutics, they may progress to being "lead compounds." In order to investigate the character of the lead compounds for safety and efficacy, every molecular constituent needs to be investigated individually and in combination with the other molecular constituents. Given the nature of this molecular cocktail, which may contain powders and components of varying structure and crystalline quality, PD is an effective means for determining the identity of the constituent components.

In the area of minerals processing, the bulk handling capabilities of PD offer particular investigative advantages. With PD, ores and minerals provided for analysis at a synchrotron can presented in their natural forms. PD allows investigation of the processing of such minerals under conditions that mimic those implemented in the field. But at the Australian Synchrotron, processing is scaled down to a capillary only 1 millimetre in diameter. With the chemistry of the sample determined by PD, the custodians of the sample are much better placed to devise the best way to efficiently process the minerals – maximising purity and economic value, while minimising environmental impact.

Large panels of solar cells are now a familiar and welcome feature of daily life. However, the considerable size of the panels might suggest a sub-optimal level of efficiency in converting solar energy into electrical energy. The particular characteristics of PD analysis of electronic materials offers the opportunity for significant efficiency gains, either by optimising current technologies or by assisting in the creation of the next generation of higher performance solar cells.

Natural and artificial fibres can be micro-coated with materials such as metals to improve their performance in a variety of situations. While we know from experience that this process does work, our knowledge of exactly how it works is much more scant. Could the process be carried out more effectively? Will the micro-coating process endure or will the materials degrade or separate? PD can help to provide the answers to such questions.

PD is also useful in the detection of stress and strain in materials such as finished metals. For instance, a critical weld in a component in an aircraft will produce a typically polycrystalline profile, as revealed at a molecular level. PD can determine the micro-structural details of the weld, with clear implications for maintenance and safety.



Infrared Spectroscopy – IR

Principal Scientist, Dr Mark Tobin, explains that IR is unique at the Australian Synchrotron for two reasons: it uses infrared light rather than X-rays to analyse samples; and it divides a wide fan of synchrotron infrared light into two separate beamlines, so that it can conduct two independent experiments simultaneously.

Broadly speaking, each infrared beamline branch has a different purpose and capabilities. The microscope branch analyses a wide range of solid materials, including biological samples and minerals. The far infrared branch is designed mainly to analyse molecules in the gas phase, but is also used to study biomolecules and nano materials. Both branches conduct their analyses using infrared spectroscopy to reveal information about the chemical composition of the materials under interrogation.

Both instruments are designed to measure the quantities of different wavelengths or frequencies of infrared light that are absorbed by the samples. When a molecule in sample material absorbs infrared light, the molecule is excited to a higher vibrational level. That additional energy absorbed by the molecule corresponds to the energy of a particular frequency of infrared light.

The microscope branch is very versatile and the range of samples that can be examined is extensive. As long as infrared light can be passed through the sample or is able to be reflected off the surface, then significant information can be collected. The microscope takes the light beam and focuses it down sharply for infrared analysis – at approximately 10 x 10 microns.

In terms of practical application, the microscope has proven to be very useful in the analysis of biological tissue and cellular material. In degenerative and autoimmune diseases of the brain, such as Alzheimer's and MS respectively, the microscope can study in very fine detail the chemical nature of the changes associated with these diseases. As well as being used to determine the causes and progression of disease, the information gleaned from the microscope can be used to devise new therapeutic treatments and preventative strategies.

In the field of IVF, the microscope's monitoring of the lipid contents and distribution within individual egg cells has helped to assess the maturity of cells and could in future determine whether such cells are at a suitable stage for fertilisation prior to implantation. The application of this new knowledge may contribute to a higher rate of success with IVF procedures.

In the field of forensics, the microscope has proven to be useful in complex fingerprint analysis and in the development of new fingerprint revealing agents.

The microscope also has significant materials and mineralogical applications. For example, a micro-droplet of oil contained in a shale deposit can be analysed to reveal the chemical composition of the sample, from which commercial viability may be inferred. In the sphere of materials, the microscope can reveal the characteristics of corrosion products on the surfaces of metals and the detailed qualities of surface coatings.

The far infrared branch of the beamline has high spectral resolution capability, which is necessary for studying gases. One particular application is the determination of the behaviour of refrigeration gases, from which their potential impact upon the upper atmosphere may be estimated.

Accelerator Science and Operations

At the heart of scientific achievement at the Australian Synchrotron is the efficient functioning of the complex equipment that generates and regulates the synchrotron's light. At the most fundamental level, this means that the accelerator equipment needs to be operating at optimum stability for as long as possible, so that scheduled experiments can be carried out on the various beamlines.

As Dean Morris, Head of Operations, notes, "In the case of the Australian Synchrotron, beam availability over the past year has exceeded 98.1%, providing 4,511 hours of user time. This compares very favourably to international benchmarks for beam availability of around 95-97%."

What can go wrong with a synchrotron? The question raises a wry smile from Greg LeBlanc, Head of Accelerator Science and Operations, and elicits the laconic response, "Quite a few things, actually." As Greg points out, "The bunches of electrons that race around the ring produce light when they are bent away from their straight path by powerful magnets. That light is channelled into and captured by the various beamline end-stations. There is a current flowing in the vacuum chamber that is equal to the electron beam current. This is called the image current. It can act back on the electron bunches and cause them to become unstable. This is known as the restive wall instability. The effect on the light ranges from a smearing out of the intensity to total loss. A feedback system that can measure and damp the motion of the individual bunches is under development. This is called a bunch by bunch feedback system. In the interim, we have other measures that can effectively manage instability."

Greg continues, "There is nothing particularly unusual about that kind of problem. It's common to many advanced third generation synchrotrons around the world. The important thing is to have on hand an expert team that has the experience to detect, analyse and respond to problems like this as they emerge. That's a capability we are progressively developing at the Australian Synchrotron."

"We have also made some interesting and useful discoveries about the dynamics of the synchrotron. We have found that by changing the storage ring magnet settings, we can change the electron beam size in the straight sections where the insertion devices are situated. Studies are being carried out to see how far the horizontal beam size can be reduced in the straight sections where the in-vacuum undulators are located. We have also found that the length of the electron bunches can be reduced by changing the storage ring settings. When the bunch length gets small enough, the bunches can start to emit coherent synchrotron radiation in the infrared range. Measurements have been performed on the IR beamline demonstrating a dramatic increase in the intensity of the infrared when it becomes coherent. "

Accelerator science and operation activities at the Australian Synchrotron are aimed at:

- Delivering the target number of hours of machine operation time per year
- Providing the maximum availability of beam to users in the scheduled periods
- Continuing improvement in the performance of the machine
- Developing the field of accelerator science

Storage ring diagnostic straight section

Scientific Engagement

As a nationally and internationally-focused organisation, the Australian Synchrotron devotes significant energy to ensuring that its capabilities are appreciated by potential users – especially by practising scientists. In addition, the Australian Synchrotron is involved in promoting and sharing the knowledge and benefits of synchrotron science on a broader plane.

A case in point is the Asia Oceania Forum on Synchrotron Radiation Research, hosted in Melbourne by the Australian Synchrotron in December 2008. Among the 300 international attendees were seven directors of synchrotrons in the Asia Oceania region and two directors from North American synchrotrons. They enjoyed 111 presentations and 35 invited speakers, covering the entire spectrum of synchrotron science in the region.

Prominent among the scientific seminars held over the past year at the Australian Synchrotron were "THz spectroscopy of biomolecules" by Dr Bernd M Fischer from the University of Adelaide; "New insights into biomedicine enabled by the IR microscopy beamline at the Australian Synchrotron" by Dr Philip Heraud from Monash Immunology and Stem Cell laboratories; and "MAX IV: Our future light source" by Prof Mikael Eriksson from MAX-lab, Lund University, Sweden.

Prof Ian Gentle, Head of Science at the Australian Synchrotron, is keen to cultivate further knowledge about the features and benefits of the synchrotron among the scientific community. He speaks with enthusiasm about the upcoming "road show", which will see him, accompanied by Dr Garry Foran, blitz universities and organisations to entice potential users to make the scientific journey south to Melbourne. "The feedback we get from the scientific community will also assist in our deliberations about future beamlines to be commissioned at the Australian Synchrotron," adds Prof Gentle.

Another prominent Melbourne-based project to come to fruition in late 2009 is SRI2009: the 10th International Conference on Synchrotron Radiation and Instrumentation. 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. Being the most important conference of its kind in the world, Prof Gentle describes the snaring of the triennial, 800-delegate event as "a real coup for this city."

Scientific Training and Education

Scientific education provided by the Australian Synchrotron offers tertiary students experiences that are rare and highly prized.

In July 2009, forty-six of Australia's and New Zealand's brightest Honours and early PhD students gathered to learn about many aspects of the pioneering world of synchrotron light at the inaugural ANZAAS Australian Synchrotron Winter School. The students had the opportunity to mix with the nation's leading experts in both formal and more relaxed environments, learning about investigative areas including small and wide X-ray scattering, powder diffraction, protein crystallography, imaging and medical therapies, infrared spectroscopy, soft X-ray spectroscopy, X-ray absorption spectroscopy and microspectroscopy. Later in the four-day program, students on the synchrotron's beamlines had the rare experience of using a light source a million times brighter than the sun to analyse biological and mineral samples smaller than the point of a needle.

Participation in the Winter School was open to all universities on the basis of one nominated student per institution. All travel, accommodation and catering expenses were paid for by the Australian Synchrotron.

Earlier in the year, undergraduate physics students from La Trobe University enjoyed a real life experience of using the PX1 beamline – without leaving their classroom in Bundoora.

Ten students and staff were connected to the PX1 beamline at the Australian Synchrotron via a video link and remote desktop software. In collaboration with three other La Trobe students at the beamline, powder samples were loaded for identification and analysis, with students at the La Trobe end remotely controlling the beamline operations. The outputs from the beamline were duly interpreted by the students, who inferred the nature of the various materials by assessing the powder diffraction patterns and by conferring remotely about the physical nature of the materials.

While the class activities introduced some of tomorrow's scientists to the remote and onsite capabilities of the synchrotron in general and the PX1 beamline in particular, it also formed a part of the students' assessed coursework.

Importantly, the capabilities of the synchrotron's beamlines are also conveyed to potential users by scientific liaison officers who convene seminars within each of the Australian Synchrotron's foundation investor institutions throughout Australasia.

There have been fifteen students engaged with the Accelerator Science Group over the past year. These include two PhD students, two Honours students and the first summer scholarship students. The students come from the University of Melbourne Schools of Physics and Computer Science, Monash University School of Physics and RMIT University.

Controls Group

"In basic terms, it's our job to create and deliver the real-time and remotely-controlled operating systems for the accelerator and all the beamlines," says Richard Farnsworth, Head of the Controls Group for most of 2008-09. "And while doing that we need to accommodate the 40 thousand-odd variables that affect the magnets, power supplies, vacuum pumps, and the timing of processes that monitor and control the electrons as they are injected from one area into another."

The beams of light that emanate from the accelerator are always identical. But by the time they get to the nine beamline end-stations, they can be radically different from each other. How does that happen? How does an undifferentiated beam become an infrared beam or a hard X-ray beam? The answer is that each beamline contains a unique set of mechanisms that transforms the qualities of the light as it passes through. It's the task of the Controls Group, a team of nine dedicated hardware and software engineers, to ensure that the hardware and software for the different beamlines are finely controlled. It's also their role to collect from the detectors the masses of raw data generated after the light has struck the samples under investigation. That data is stored in computers, where it awaits interrogation and interpretation – or conversion into knowledge.

In brief, the Controls Group has under its custodianship those thousands of operating variables, along with the gargantuan volumes of experimental data that are generated every hour of every working day.

Finally, the Controls Group ensures that processes are as safe as possible, regarding humans and equipment. Highly reliable electronic and software protection systems work by interlocking and shutting off equipment – thereby ensuring that people cannot accidentally enter areas that could harm them; and that valuable equipment is protected from overload and other damage.

Computing Group

The Australian Synchrotron is a scientific environment in which an enormous range of samples are interrogated by synchrotron light, yielding ever-increasing volumes of data. Such data must be accurately recorded, transported and stored, ready to be retrieved instantly and reproduced faithfully, so that analyses can be conducted and conclusions drawn.

For all of that to happen as it should, a highly efficient computer network is essential. At the Australian Synchrotron, that responsibility resides with the Computing Group.

A particular challenge for the Computing Group is the exponential growth of data generated and the computer systems and processes required to manage it. Currently, more than 500 Linux machines are dotted around the organisation, maintaining data flow. On top of this are the 150 PCs, essential for the effective operation and governance of the Australian Synchrotron.

Of course, even the best designed and managed systems have their problems from time to time, and the organisation is in the fortunate position of having dedicated staff who are conversant with the sometimes esoteric characteristics and the complexities of a sophisticated and mature system.

Another challenge on the horizon is the growth in e-Research, which is being driven in part by the desire of scientists to conduct experiments from bases off site. Already, scientific users have taken advantage of these new possibilities in the area of protein crystallography – using their computers at remote sites to operate robotics and manage their experiments in the end-station, assisted by Australian Synchrotron staff.

The Computing Group is also exploring the potential of high performance computing, which is based on the power of clusters of computers. Such an approach presents the opportunity to provide real-time processing of high-resolution images as experiments are actually in progress. This initiative is being supported by grants from Multi Media Victoria and the National Computing Initiative.

Major Projects

From the expansive window of the office of Dr George Borg, Head of Major Projects, the view is of a recently landscaped and gently sloping Australian garden. Express your admiration for that bucolic view and George will guide you back into reality. Looking out that same window, George will tell you, "That's not only a garden, but a landscape that will soon also complement the facility's new National Centre for Synchrotron Science building. I should know. I organised the landscaping last year and now I'm going to put some $40 million worth of new buildings around it. On and on it goes."

George's eyes return to the office and settle upon a vast collection of rolled up architectural drawings. Some of the drawings are dog-eared, creased and abstractly tinted by the orange clay of the synchrotron site. Others are crisp and white. "That's the 'done' pile," says George, indicating with a nod the loose pyramid of rolled plans, elevations and specifications. "And that," continues George, with a grand sweeping gesture towards the stacked, crisp collection, "is the 'to do' pile. It's pretty big. And it will get bigger."

The 'done' pile includes not only the main synchrotron facility, but also the more recent expansion of infrastructure to support the Imaging and Medical beamline. That infrastructure development included the installation of thirty giant concrete culverts, each weighing over 22 tonnes, to create a 150 metre tunnel from the synchrotron outwards and far beyond the main circular facility. That tunnel will, within a fairly short time, host the pipeline that carries X-rays to the experimental end-station and laboratories in a satellite building.

We wander out to the tunnel. Inside, it's cold and bare, with crudely fashioned, large, circular holes punched through the thick sectioned walls. "Don't be fooled by how rough it all looks now. The beamline engineering and installation tolerances are infinitesimally small. Keeping within them is one of the great challenges of a project like this." As we walk outside, George turns and points back to the roof of the satellite building. "That's coming off and another storey of laboratories is being added on top." A tricky job? "It'll work out alright. I just need to keep my eye on every aspect of the job from start to finish."

Back in the office, George again contemplates those pristine, rolled up drawings. "In that lot, there's a visitors' centre with a 400 seat auditorium, café, seminar rooms and an exhibition space. Then there's a separate fifty room user accommodation block, engineering and laboratory technical support building, an additional staff building and an extension to the synchrotron's power plant. All due for completion within three years - and we haven't turned a shovel full of dirt yet. That'll be interesting."

On a shelf above the drawings stands a row of files, all with their contents delineated: Safety, Maintenance, Minor Projects, Stores and Logistics, Contracts, ISO Accreditation, Energy, Water, Radiation Regulator... and more. George's gaze moves up to the files and flicks along their titles. "I do that in my spare time," he says.

Occupational Health, Safety and Environment

The health and safety of the staff, contractors, users and visitors is essential for building and maintaining the strong relationships that underpin the successful conduct and delivery of scientific research at this facility. Accordingly, the management and maintenance of an effective and robust safety culture is the number one priority of OHSE. During 2008-09, there were no lost time injury cases and the lost time injury frequency rate (LTIFR) was reduced from 2.65 in 2007-08 to 0. The investment in the delivery of safety inductions has underlined this strong performance in reducing workplace incident and injuries. During 2008-09, we achieved 100% safety induction of users and contractors and 99% induction of staff.

The Australian Synchrotron has strong occupational health and safety (OHS) consultative arrangement with its OHS Committee made up of Health and Safety Representatives (representing the five designated work groups) and management representatives. During a visit in September 2008, a WorkSafe Victoria's inspector stated in his Entry Report, "I observed that a list of each health and safety representative for each designated work group of employees of Australian Synchrotron is displayed on the notice board. I confirmed that consultative mechanism is in place."

High priority has been given to radiation safety at this facility. As part of this, bi-monthly meetings are held with the Victorian Radiation Regulator, the Department of Human Services. These meetings provide an update to the Regulator on new developments, operational performance and the area and personal radiation monitoring results. To date, recorded personal radiation doses have all been significantly less than the organisation's dose constraint of 1 mSv per year (which is equivalent to the legislated dose limit for public exposure). These results validate our approach of operating to the 'ALARA' principle, whereby radiation doses are kept "As Low As Reasonably Achievable".

The Australian Synchrotron recognises its obligation to manage the impacts that it has on the environment and community in which it operates. The organisation participated in the Victorian State Government's cooling tower water efficiency audit program. The auditor rated two systems as "Excellent" and the other two systems as "Good". Arising from this, our water supplier, Yarra Valley Water, has invited the facility to feature as one of the case studies for this audit program. The Australian Synchrotron has successfully documented, submitted and established its waterMAP as required by the EPA Victoria's Water Management Action Plans (waterMAP) Program. As a large user of electricity, the organisation has increased it use of "green" electricity from 10% in 2007-08 to 15% in 2008-09. The Australian Synchrotron has engaged Storm Sustainability to undertake a feasibility study to assist in developing the project parameters and conception options for harvesting stormwater at this facility.

Human Resources

Sir Gustav Nossal once observed that the notorious Australian "brain drain" is not necessarily the one-way exodus that it is feared to be. As Sir Gustav noted, some talented Australian scientists do relocate permanently or semi-permanently overseas, but many return to Australia, creating not a "brain drain" but a "brain circulation", which Sir Gustav calls "the life blood of international science."

The Head of HR at the Australian Synchrotron, Anne Ridgway, is acutely aware of the need to provide the best possible working environment for employees. The cosmopolitan blend of people working at the Australian Synchrotron is indeed a microcosm of the "circulating" international science community.

In many respects, employees at the Australian Synchrotron enjoy superior employment conditions. Such conditions include ongoing permanent employment, varied training and development opportunities, flexible working hours, a popular employee wellbeing program, an Employee Assistance Program (EAP) and flexible leave options including paid parental leave. All this contributes to the much-valued community atmosphere that imbues the organisation and enhances the engagement of people with the culture and operations of the Australian Synchrotron.

In other facets of HR management, the department has taken a leading role is shaping the operational design of the organisation, attracting and retaining employees, supporting organisational changes, facilitating performance planning and review, assuming the responsibility for remuneration systems, and ensuring legal compliance with the many relevant legislative obligations. In a nutshell, HR has assisted the organisation to achieve a variety of strategic goals through its commitment to people.

In the near future, HR will continue the process of negotiation with employees that will culminate in a new collective agreement. Looking outwards, HR is considering a voluntary community engagement program, which would provide opportunities for teams of employees to select a charitable or community-based project to which they could contribute a full day's work, supported by the Australian Synchrotron.

Engineering

Reflecting on the year's work, the Head of Engineering, David Tokell, states that he is immensely proud of the team's "massive achievement" in contributing to the stellar performance of the Australian Synchrotron.

The synchrotron is the grand piano of scientific equipment. In both cases, the construction materials are superb, the craftsmanship sublime and the performance dynamics are astonishing. A grand piano requires careful and frequent tuning as does the synchrotron, in its own way. It is the task of Engineering, in collaboration with others, to keep the synchrotron "instrument" in tune.

If a grand piano breaks a hammer or a string, it can be replaced by a part from the supplier. The objective is to make the instrument perform in exactly the same perfect way as the day it was completed. Up to a point, that's also true of a synchrotron. If a fundamental part fails, it can be replaced with one exactly the same. But at this point, the elements of the analogy start to diverge. Scientists, being the inquisitive people they are, will not be satisfied with the synchrotron performing next year in the same way that it did last year. They will want the synchrotron to perform in different ways to achieve new research objectives, which necessitates altering or supplementing the physical characteristics of the instrument. In a particular sense, the scientists may wish to add sixteen more keys to the eighty-eight already on the grand piano keyboard, along with a titanium harmonica mounted on top. Hardly surprisingly, such innovations would not available off the shelf for your grand piano and the same applies to a synchrotron.

The team in Engineering has the challenge of designing – and sometimes of fabricating onsite – what we call "bespoke" innovations to the synchrotron. In simple terms, the Engineering team helps to supplement the capabilities of the synchrotron by applying in very practical ways their deep knowledge of engineering – while always respecting the boundaries of health and safety for all concerned.

An intriguing challenge that will emerge in the near future is on the Imaging and Medical (IM) beamline. A big question is: How can an experimental system be transformed into a potentially therapeutic device? In addition, how do engineers precisely align the components of the beamline over a distance of 150 metres?

Controlling beam-generated heat load is a big issue in a synchrotron, so cooling processes need to be carefully managed. In addition, the Engineering team needs to monitor and maintain a range of software-controlled electro-mechanical devices that keep the science program running. Then there's hardware engineering on timing systems, beam diagnostics systems, cabling maintenance and the radio frequency systems that keep the all-important beam circulating.

External Relations

The key objective of the External Relations department is to enhance the reputation of the Australian Synchrotron for scientific excellence in the broad public domain. This is achieved by a number of means, including the hosting of visits and tours; educational outreach programs; special events and conferences; liaison with the news media; relationships with stakeholder and interest groups; the organisation's newly renovated website; and the production and distribution of a range of publications and scientific support materials.

The External Relations department hosts visits by individuals and groups ranging from national and international official delegations through to local community service organisations. Over a recent four month period, over 900 such guests were provided with guided tours of the facility, with comprehensive explanations of the capabilities and scientific achievements of the Australian Synchrotron.

Secondary school groups, too, are frequent visitors. The Australian Synchrotron takes very seriously its responsibility to assist in cultivating the next generation of home-grown scientists - by doing so, helping to ensure the future advancement and prosperity of our nation. Accordingly, External Relations provides a range of structured activities to enthuse and inspire secondary school students to maintain their interest in science in their final years of schooling and into their years of tertiary education and beyond. Thanks to a recent Australian government grant, education of all sectors of the community will be greatly enhanced within the next few years with the construction of a new onsite visitors' centre, which will include a 400 seat auditorium, an exhibition space, seminar rooms and a cafeteria.

In October each year we host an Open Day, when the general public en masse is invited to visit the facility. In 2008, over 3,000 people enjoyed self-paced, self-guided general tours and specialist-guided technical tours. Offsite, we collaborated with the scientists and organisers of National Science Week to explain to a very interested public how synchrotron light can be used to improve the flavour and smoothness of chocolate. In a more specialist vein, External Relations organised AO Week – more formally, the Asia Oceania Forum on Synchrotron Radiation Research, which attracted over 300 scientists and students from all over the world.

External Relations has responsibility for the production of a variety of online and hard copy resources and publications, including the organisation's website and electronic newsletter, Lightspeed; regular features in the journal Australasian Science; special purpose booklets and brochures; the Annual Report; posters, banners and a variety of support materials.

The appointment of Kerry Hayes to lead External Relations as Business Development Manager signals an increasing emphasis on engagement with potential commercial, academic, cultural, industrial and agricultural users of the vast capabilities of the synchrotron's existing and prospective beamlines.

Finance

Australian Synchrotron Chief Financial Officer, Peter Dawson, knows a challenge when he sees one. In the coming year, he and his team face the demanding task of financially managing some new and complex capital projects.

This includes the group of facilities financed by the Federal Government's Education Infrastructure Fund grant and the massive extension to the Imaging and Medical beamline. Crucial to the successful management of the projects will be rigorous cost control and continuous budget monitoring.

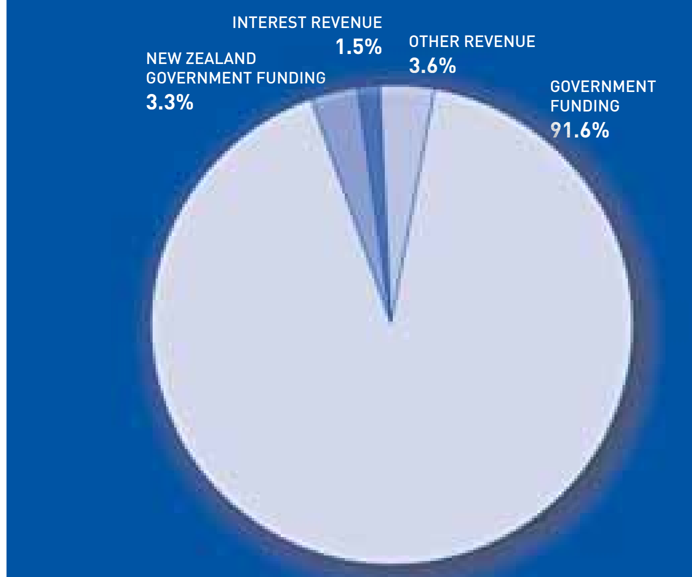
This approaching challenge supplements the existing and ongoing responsibilities of the Finance department, including forecasting, managing costs to budget across all sectors of the organisation, generating and monitoring cost centre reports, providing the Board with accurate and timely advice, ensuring that policies and procedures are up-to-date, implementing comprehensive risk management procedures, overseeing governance structures, supervising funding and shareholding agreements, tending procurement and contracting systems, and ensuring that all statutory and compliance matters are properly addressed.

The Australian Synchrotron is a young organisation that has in recent years made the transition from an entity managed by government to one that has a more recognisably corporate structure.

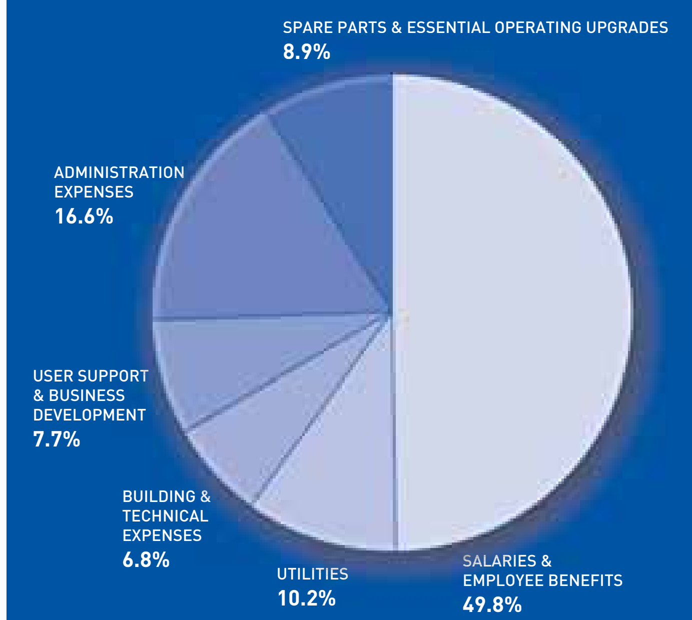
The Australian Synchrotron's Finance department has been at the heart of this successful transition, ensuring that the operational protocols and structures of the organisation deliver optimum levels of financial accountability and performance.

The Year at a Glance

INCOME



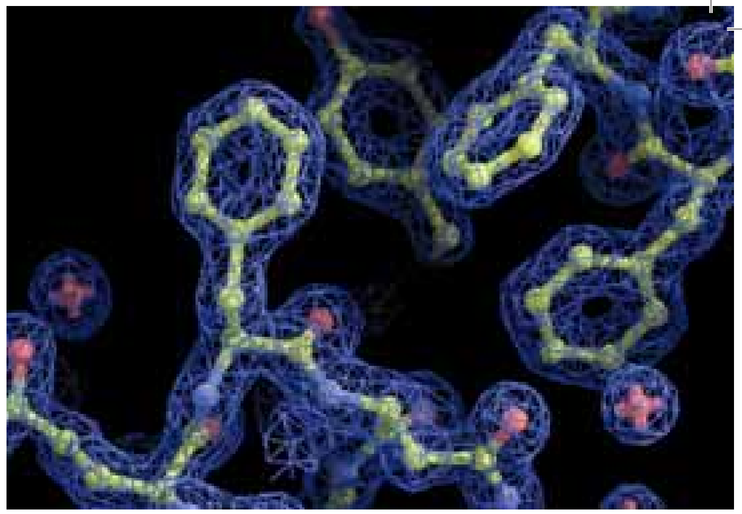
EXPENDITURE



Risk Management Statement

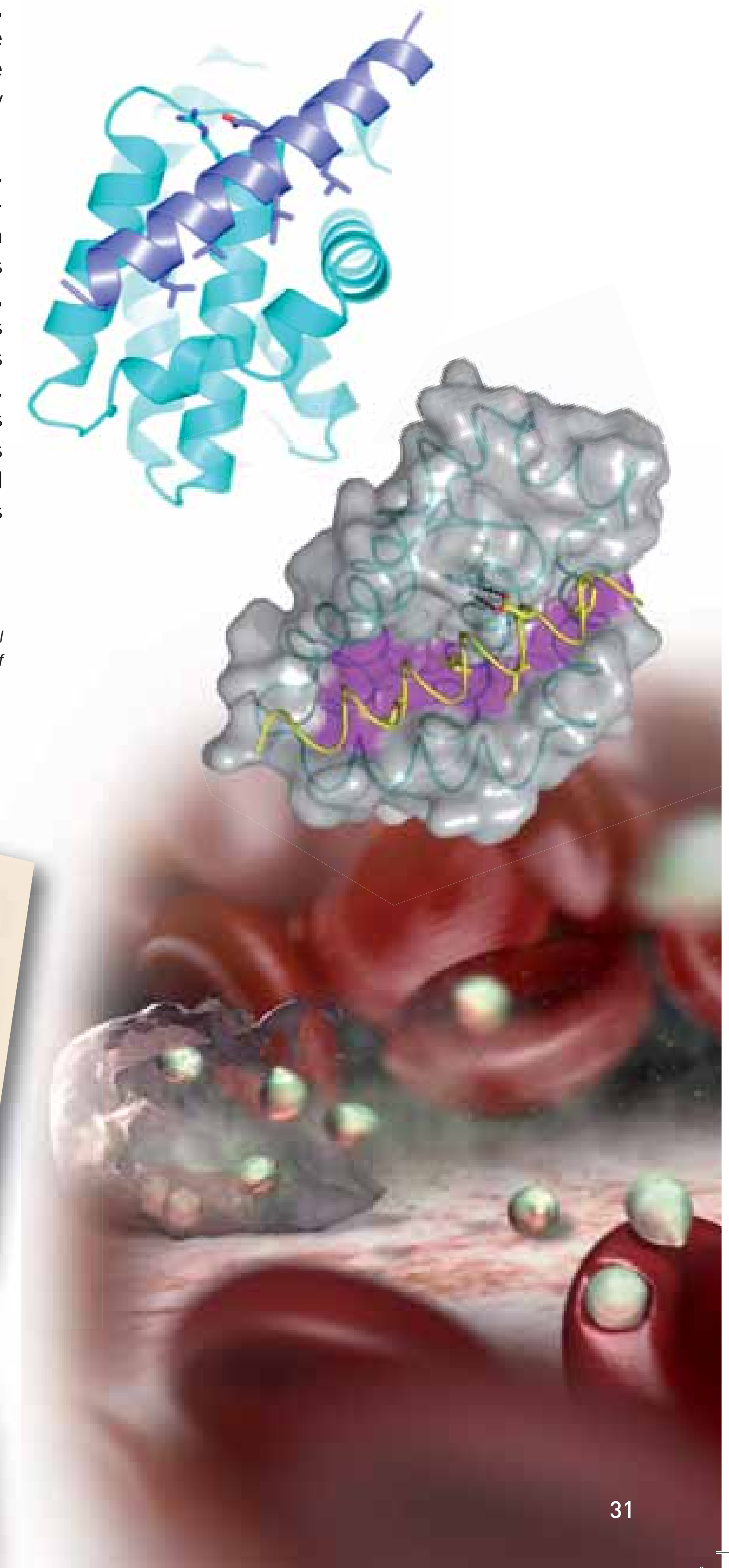
Over the past year, the Australian Synchrotron continued to develop and refine its risk management systems and policies for the operation and management of the facility. The Australian Synchrotron has received a gold star pass from the Victorian government's Victorian Managed Insurance Authority for the results of its site risk survey and a commendation that it had an "excellent attitude to risk management." The Board of Directors and the Audit and Risk Committee fully support the development of world class standards of risk mitigation and processes to the requirement of current Australian Standard AS/NZS 4360 Risk Management. The Australian Synchrotron has developed policies, plans and procedures to achieve compliance and management of this important function.

The Art of Science

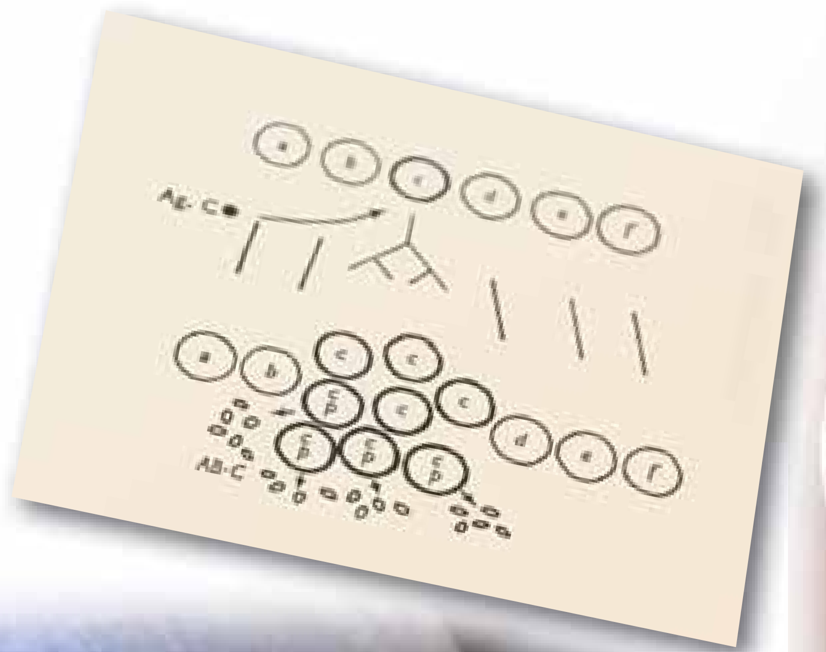


A quick look through the scientific journals of decades past can be instructive in many ways. From today's perspective it's remarkable how many prominent papers were authored by just one or two researchers. The illustrations used to support the papers' contentions were often little more than pencilled stick figures, drawn (quite literally) from the imagination. A case in point is Macfarlane Burnet's famous immunological paper on clonal selection from 1957. Burnet sat down by himself and wrote the paper over a weekend at his home in the Melbourne suburb of Kew, presenting the finished document to his young protégé, Gustav Nossal, during the following week. As you can see from Burnet's figure reproduced on this page, one of the most revolutionary ideas in immunology was illustrated by what appears to be an occasionally wobbly HB pencil.

In today's research world, life is somewhat different. Papers are routinely authored by more than a dozen multi-disciplinary collaborators, who quite often live and work in countries spread around the world. Their research areas and discoveries are often illustrated by sophisticated, computer-generated graphics. Some of the vivid graphics presented on this page began life as scatters of light and dots derived from the beamlines of the Australian Synchrotron. Their transformation into (sometimes 3D) artwork, in this case representing various protein structures, enables detailed visualisation and understanding by scientists and students all around the globe – with consequent benefits for research and, ultimately, community wellbeing.

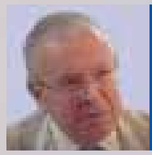


Below: Macfarlane Burnet's figure, as originally published in the Australian Journal of Science, Vol 20, No 3, 21 October 1957, is reproduced with kind permission of Australasian Science.



Leadership Structure

1 July 2008 - 30 June 2009



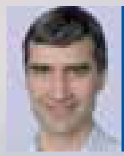
Lyndon Goulding
Company Secretary

ASCo
BOARD OF DIRECTORS

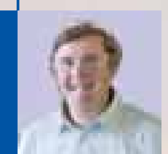
Catherine Walter AM
Board Chairman

Robert Lamb
Facility Director

- **Melissa Moyle**, **Lauren Green** – Exec Assistants
- **Steve Gower** – Senior Executive Officer
- **Kerry Hayes** – Business Development Manager
  - **Jennifer Cook** – Group Leader - Marketing, Media & Comms



- **Ian Gentle** – Head of Science
  - **David Cookson** – Head of Beamline Science & Operations
    - **Cathy Harland** – Group Leader - User Support
  - **David Paterson** – Principal Scientist (XFM)
  - **Bruce Cowie** – Principal Scientist (SXR)
  - **Nigel Kirby** – Principal Scientist (SAXS / WAXS)
  - **Kia Wallwork** – Principal Scientist (PD)
  - **Daniel Häusermann** – Principal Scientist (IM)
  - **Chris Glover** – Principal Scientist (XAS)
  - **Tom Caradoc-Davies** – Group Leader (PX1 & PX2)
  - **Mark Tobin** – Principal Scientist (IR)



- **Dean Morris** – Head of Operations
  - **Greg LeBlanc** – Head of Accelerator Science & Operations
    - **Mark Boland** – Principal Scientist
    - **Don McGilvery** – Group Leader Accelerator Operators
  - **David Tokell** – Head of Engineering
    - **Paul Leonard** – Group Leader Mechanical Techs
    - **Craig Millen** – Group Leader Electrical Techs
    - **Brad Mountford** – Group Leader Mechanical Eng. (from 08/09)
    - **Lou Corvetti** – Group Leader Controls Eng. (from 08/09)
    - **Neil Meadowcroft** – Group Leader Electronics & Electrical Eng.
  - **Richard Farnsworth** – Head of Computing
  - **Ian Graham** – Operations Support Manager

- **George Borg** – Head of Major Projects
  - **Hock Ch'ng** – Head of Safety
  - **Mario Messina** – Facilities Manager

- **Peter Dawson** – Chief Financial Officer
  - **Anne Ridgway** – Head of Human Resources
  - **Suzanne Thursky** – Financial Controller

Corporate Structure and Governance

The Australian Synchrotron is managed under a dual entity structure comprising two companies: the Australian Synchrotron Holding Company Pty Ltd (ASHCo) and the Australian Synchrotron Ltd (ASCo)

ASHCo: Owner of all property and equipment comprising the Australian Synchrotron

Australian Synchrotron Holding Company ASHCo

- Directors
  - Mrs Catherine Walter AM (Chairman)
  - Dr Garth Carnaby
  - Dr Sean Gallagher
  - Dr Rod Hill (Chair, Audit & Risk Committee)
  - Prof David Siddle
- Company Sec
  - Mr Lyndon Goulding
- Shareholders
  - Australian Association of Medical Research Institutes (AAMRI)
  - Australian Science & Nuclear Technology Organisation (ANSTO)
  - Commonwealth Scientific & Industrial Research Organisation (CSIRO)
  - Curtin University of Technology
  - Monash Investment Holdings Pty Ltd
  - New Zealand Synchrotron Group Limited
  - The University of Adelaide
  - The University of Queensland
  - The University of Sydney
  - UMEE Ltd
  - The Secretary, Dept of Innovation, Industry & Regional Development (DIIRD)

ASCo: The management entity that has the exclusive right to operate, manage and develop the Australian Synchrotron assets under a lease with ASHCo

Australian Synchrotron Company ASCo

- Directors
  - Mrs Catherine Walter AM (Chairman)
  - Dr Garth Carnaby
  - Dr Sean Gallagher
  - Dr Rod Hill (Chair, Audit & Risk Committee)
  - Prof David Siddle
  - Prof Linda Kristjanson
- Company Sec
  - Mr Lyndon Goulding
- Foundation Investors (Members)
  - AAMRI
  - ANSTO
  - CSIRO
  - University of Melbourne
  - Monash University
  - New South Wales Consortium
  - New Zealand Synchrotron Group Ltd
  - South Australian / La Trobe University Consortium
  - Queensland Consortium
  - Western Australian Consortium
- Other Contributors
  - Commonwealth Government
  - Victorian State Government
  - New Zealand Synchrotron Pty Ltd

Mrs Catherine Walter AM (Chairman)

Dr Garth Carnaby

Dr Sean Gallagher

Dr Rod Hill

Prof David Siddle

Prof Linda Kristjanson

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Advisory Committees and Councils

The Council of Members

The Council of Members is a representative committee of foundation investors. Its role is to advise the Board of ASCo on issues related to science policy committee appointments and terms of reference and overall facility development.

Affiliation of Council of Members

Foundation investor:	Representative:
Victorian Government	**Dr Amanda Caples**
Monash University	**Mr David Pitt**
Association of Australian Medical Research Institutes	**Professor Garry Jennings**
Australian Nuclear Science and Technology Organisation	**Mr Doug Cubbin**
Commonwealth Scientific & Industrial Research Organisation	**Ms Jan Bingley**
Western Australian Consortium	**Mr Charles Thorn**
New Zealand Synchrotron Group	**Dr Don Smith**
University of Melbourne	**Mr Allan Tait**
South Australian and La Trobe University Consortium	**Professor Richard Russell**
Queensland Consortium	**Professor David Siddle**
AUSyn14 Consortium	**Dr Chris Ling**

Foundation Investor Liaison Committee

The Foundation Investor Liaison Committee meets quarterly to coordinate foundation investor access to the synchrotron. Its members are the conduit for communication with the foundation investors.

Foundation Investor:	Representative:
Victorian Government	**Dr Cassandra Schefe**
Australian Nuclear Science and Technology Organisation	**Dr Richard Garrett**
Commonwealth Scientific & Industrial Research Organisation	**Dr Jose Varghese**
University of Melbourne	**Dr Frances Skrezenek**
Monash University	**Dr Karen Siu**
AUSyn14 Consortium	**Dr Joseph Bevitt**
Queensland Consortium	**Professor Jenny Martin**
Western Australian Consortium	**Professor Roland De Marco**
South Australian and La Trobe University Consortium	**Dr Hugh Harris**
Associate Professor Andrew Peele	
New Zealand Synchrotron Group	**Dr Bridget Ingham**
Association of Australian Medical Research Institutes	**Dr Mike Lawrence**

Science Advisory Committee

Reporting directly to the Board, the Science Advisory Committee (SAC) provides strategic advice on current and proposed scientific programs, ensuring they are aligned with world's best practice and of continuing relevance to the requirements of the Australian scientific community.

The SAC Terms of Reference are to:

- Monitor international developments in synchrotron science and provide input to the Board on optimising the scientific and technical capability of the Australian Synchrotron
- Advise on the preferred mix of beamlines and skill set of operators and the ancillary laboratories and equipment required, having regard to the direction of leading edge scientific enquiry and national research and development priorities
- Develop procedures for the evaluation of proposals for the establishment of new experimental and support facilities and to recommend mechanisms for monitoring progress towards the introduction of theses facilities
- Respond to the Board's requirements for advice.

Membership of the Science Advisory Committee

Australia/New Zealand:

Professor Frank Larkins, Chair, Deputy Vice Chancellor International,
University of Melbourne; Chief Scientist, Energy, Victorian Department of Primary Industry.

Professor Ted Baker, Professor of Biological Sciences, University of Auckland

Professor Jenny Martin, Institute of Molecular Bioscience, University of Queensland

Professor Tony Burgess, Director of the Ludwig Institute for Cancer Research and Professor of Surgery at the Royal Melbourne Hospital

Professor Peter Lay, School of Chemistry, University of Sydney

International:

Dr Bill Thomlinson, former Foundation Executive Director of the Canadian Light Source, Saskatoon, Saskatchewan, Canada.

Professor Michael Grunze, Professor of Applied Chemistry, University of Heidelberg, Germany

Dr Kevin Prince, Head of Spectroscopy, ELETTRA Synchrotron, Trieste, Italy

Professor Xu Hongjie, Director of the Shanghai Synchrotron Radiation Facility, Shanghai, China

Professor Soichi Wakatsuki, Director of the Photon Factory Synchrotron Radiation Facility, Tsukuba, Japan

Professor Janet Smith, University of Michigan Medical School, Life Sciences Institute, Michigan, USA

Ex officio:

Professor Robert Lamb, Facility Director of the Australian Synchrotron

The Australian Synchrotron has established partnerships with leading light sources worldwide:

Advanced Photon Source - Chicago, USA
Beijing Synchrotron Radiation Facility – China
Canadian Light Source – Canada
Conseil Européen pour la Recherche Nucléaire (CERN) – Switzerland
Diamond Light Source – UK
Elettra (Synchrotrone Trieste) – Italy
European Synchrotron Radiation Facility (ESRF) – Grenoble, France
National Synchrotron Radiation Research Centre – Taiwan
Photon Factory (The Institute of Materials Structure Science of the High Energy Accelerator Research Organization) – Japan
Pohang Accelerator Laboratory – South Korea
Shanghai Synchrotron Radiation Facility – China
SPring-8 (Japan Synchrotron Radiation Research Institute) – Japan
Swiss Light Source (Paul Scherrer Institute) – Switzerland

Additional Advisory Committees

Proposal Advisory Committees

Proposal Advisory Committees (PACs) comprise senior researchers who have an understanding of the latest developments in synchrotron science. PACs meet to discuss proposals submitted for access to the Australian Synchrotron; and make recommendations to the Director about which proposals should be scheduled. This process is consistent with the established peer review system of the Australian Synchrotron Research Program (ASRP). (Members below: July 2008 – June 2009).

Members of the Structural Biology and Chemistry PAC

Professor Charlie Bond University of Western Australia

Dr Paul Carr Australian National University

Professor Geoff Jameson
Massey University, New Zealand

Dr Mike Lawrence
The Walter and Eliza Hall Institute (Chair)

Professor Michael Parker St Vincent's Institute

Dr Peter Turner University of Sydney

Members of the Powder Diffraction PAC

Professor Brendan Kennedy
University of Sydney (Chair)

Mr Ian Madsen CSIRO

Professor Alan Pring Flinders University

Dr Michael James ANSTO

Dr Bridget Ingham Industrial Research Ltd, New Zealand

Members of the Infrared PAC

Professor Don McNaughton
Monash University (Chair)

Assoc Professor Peter Fredericks
Queensland University of Technology

Assoc Professor Bill van Bronswijk
Curtin University of Technology

Dr Phil Heraud Monash University

Dr Liz Carter University of Sydney

Professor Peter Lay University of Sydney

Members of the Soft X-ray PAC

Professor Alan Buckley University of New South Wales

Professor Paul Dastoor University of Newcastle

Assoc Professor William Skinner
University of South Australia (Chair)

Professor Jim Metson University of Auckland

Dr Will Gates Monash University

Members of the Small and Wide Angle X-ray Scattering PAC

Professor John White
Australian National University (Chair)

Dr Robert Knott ANSTO

Professor Gregory Warr University of Sydney

Professor Craig Buckley Curtin University

Dr Kevin Jack University of Queensland

Members of the X-Ray Fluorescence Microscopy PAC

Dr Hugh Harris University of Adelaide (Chair)

Assoc Professor Andrew Peele La Trobe University

Dr Chris Ryan CSIRO

Dr Rob Hough CSIRO

Dr David Cohen ANSTO

Dr Cassandra Schefe Dept of Primary Industries

Members of the X-ray Absorption Spectroscopy PAC

Dr Mark Ridgway Australian National University (Chair)

Assoc Professor Stephen Best University of Melbourne

Profeesor Peter Lay University of Sydney

Dr Weihua Liu CSIRO

Assoc Professor Mark Riley University of Queensland

International Proposal Advisory Committee

The International Proposal Advisory Committee (IPAC) has responsibility for the International Synchrotron Access Programme (ISAP).

Professor Paul Dastoor University of Newcastle

Professor Lyndon Edwards ANSTO

Professor Andrea Gerson University of South Australia

Professor Keith Nugent University of Melbourne (Chair)

Dr Mark Ridgway Australian National University

Dr Chris Ryan CSIRO

Independent Review Panel

Proposals for time on the beamlines undergo independent review prior to being assessed by the Proposal Advisory Committees (PACs). The Chair of the pertinent PAC assigns two expert reviewers to assess each proposal.

Machine Advisory Group

Independent monitoring and review of machine operations is vital to the continued development of the Australian Synchrotron. Membership of the Machine Advisory Group (MAG) comprises machine experts from synchrotrons in the United States and Europe:

Dr Jeff Corbett
Stanford Linear Accelerator Center, United States

Professor Mikael Eriksson
MAX Lab, Sweden

Dr Erhard Huttel
Forschungszentrum Karlsruhe, Germany.

Synchrotron Stakeholders

The Australian Synchrotron owes its existence to the development of a strategic partnership instituted by the Victorian state government, ultimately involving the Australian government, state governments, the New Zealand government, research institutes and universities.

The Victorian state government made an initial commitment of $157 million in development funds to build the national synchrotron facility. Subsequently, the Foundation Investors funded the beamlines program, with each contributing a minimum of $5 million.

The Australian government committed $14 million through the National Collaborative Research Infrastructure Strategy and committed a further $50 million for the operating expenses of the Australian Synchrotron for the period 1 July 2007 – 30 June 2012. The Victorian government likewise committed $50 million to support operating expenses.

The New Zealand Synchrotron Group Limited agreed to contribute $375,000 in 2007-2008 and $750,000 per year until 2011-2012.

In further developments, in April 2009 the NHMRC granted $13.2 million and the Victorian state government granted $1.5 million to fund major extensions to the Imaging and Medical (IM) beamline; while in May the Australian government announced a grant of $36.78 million to significantly enhance the capabilities of the Australian Synchrotron.

Foundation Investors

AAMRI
ANSTO
Victorian Government
CSIRO
Monash University
University of Melbourne

New Zealand Consortium

New Zealand Government
Victoria University of Wellington
University of Auckland
University of Otago
University of Canterbury
Crop Grains Science Limited
University of Waikato
Massey University
Lincoln University
IRL (Industrial Research Limited)
Agresearch

Queensland Consortium

Queensland Government
Griffith University
James Cook University
Queensland University of Technology
University of Queensland

AUSyn14 Consortium

New South Wales Government
University of Western Sydney
University of New England
Southern Cross University
Charles Darwin University NT
Charles Stuart University
University of Technology Sydney
University of Canberra
University of New South Wales
University of Newcastle
University of Wollongong
University of Sydney
University of Tasmania
Macquarie University

South Australian and La Trobe University Consortium

Government of South Australia
Flinders University
University of Adelaide
La Trobe University
University of South Australia

Western Australian Consortium

Government of Western Australia
University of Western Australia
Curtin University

Location of the Australian Synchrotron

AUSTRALIAN SYNCHROTRON
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Clayton, Victoria 3168, Australia
t. +61 3 8540 4100
f. +61 3 8540 4200
www.synchrotron.org.au

Quite simply, virtually every material in, on and above the earth can be usefully interrogated by synchrotron light.

In fact, the Australian Synchrotron is among the most powerful investigative tools on the planet, being capable of delivering hitherto inaccessible information at great speed and in unimaginable detail.

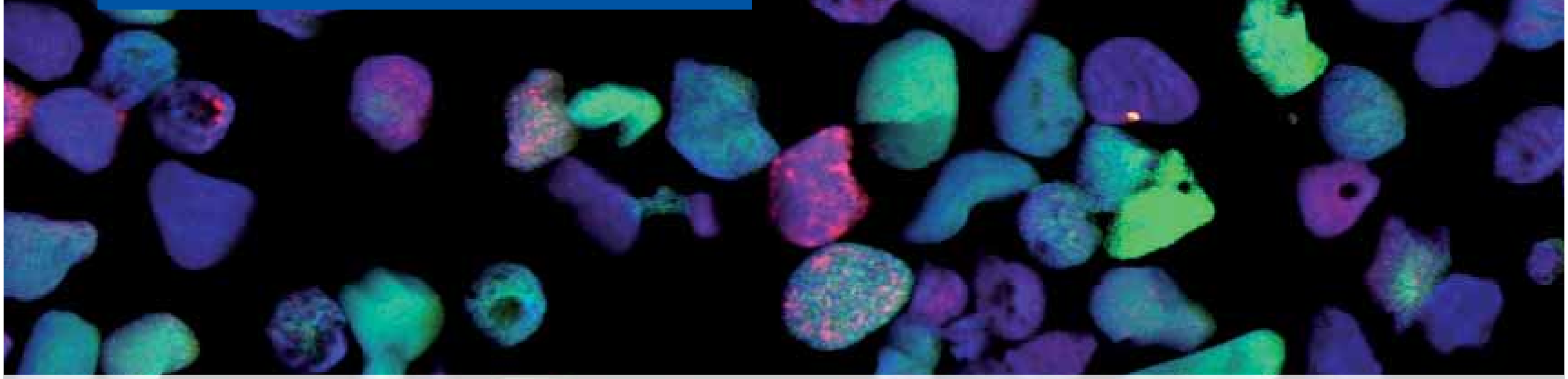
ACKNOWLEDGEMENTS:

Project Manager and Editor:
Brad Allan, External Relations Department, Australian Synchrotron.

Biological images, pp 6-31:
Courtesy of the Walter and Eliza Hall Institute of Medical Research (except as indicated).
Thanks to Drew Berry, Marc Kvansakul, Peter Czabotar, Cameron Wells and Simon Taplin.

Design and Printing:
Pinnacle Print Group.

The image featured on the cover of this Annual Report shows the distribution of titanium (blue), niobium (green) and thorium (red) in ilmenite, an iron titanate ore. Other colours indicate a combination of elements in the same location. For example, shades of purple are combinations of titanium (blue) and thorium (red). The ilmenite sample was provided by Peter Kappen (La Trobe University) and Jules Dubrawski (Iluka Resources Ltd). The image was collected by the Australian Synchrotron's XFM team and CSIRO collaborators Chris Ryan, Robin Kirkham and Gareth Moorehead as part of testing and demonstrating the beamline's fast detector (Maia) capabilities.



AUSTRALIAN SYNCHROTRON

800 BLACKBURN ROAD, CLAYTON, VICTORIA, AUSTRALIA 3168

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COMPANY LIMITED
ACN 126 531 271

AUSTRALIAN SYNCHROTRON
HOLDING COMPANY PTY LIMITED
ACN 126 506 205

Australian Synchrotron