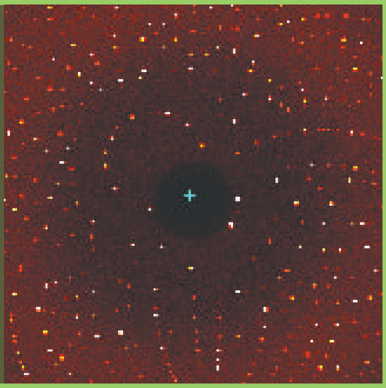
01



Overview

IMAGE: Laue diffraction pattern of a single crystal of the ribotoxin, restrictocin. Image taken at the Advanced Photon Source, Chicago, by Xiao-jing Yang and used with permission.

Chapter 01

Overview

The Australian Synchrotron, which will commence operations in mid 2007, is an essential piece of national science infrastructure needed to keep Australia and its region at the forefront of world class scientific and industrial research in the 21st century.

The machine provides an extremely intense light source covering a broad band of electromagnetic radiation – from deep infrared through to very hard x-rays. It enables a wide range of experiments and measurements to be performed simultaneously and these are done on separate specialised beamlines that run tangentially from the synchrotron ring.

The facility will be the latest 'third generation' design with world class capability, comparable to the new synchrotrons currently under construction in the UK, Canada and the USA.

Benefits to Australian Science and Industry

The Australian Synchrotron will be of immense value to a large section of the scientific community and it has been estimated that once the initial suite of beamlines is fully established it will be used by more than 1,200 members of the scientific research community in the country[1]. This has been the experience in other advanced countries where their scientists enjoy access to a local synchrotron[2,3].

For the life sciences it is an essential tool for the structural and conformational (i.e. shape) analysis of proteins, nucleic acids and viruses. It brings new techniques for the imaging of cells and biological structures, an area where Australia enjoys a first-rate reputation, and for studying cellular interactions in real time.

For the physical and chemical sciences the range of high resolution x-ray, VUV and infrared spectroscopic techniques, together with x-ray diffraction and imaging, plus the ability to follow reactions in real time, will bring new understanding to many areas from basic physics and chemistry through to the science of new advanced materials.

For the emerging area of nanoscience, where materials and chemical processes are controlled and manipulated at the atomic and molecular level, synchrotron techniques are vital not only for characterisation on this scale, but also for the production of the microtextured substrates on which nanoscience is carried out.

For agriculture it opens up new possibilities in understanding the proteomics of plant systems, in imaging cells and plant tissue, and following processes such as the uptake of metal-ion species or toxins into plant cells. It enables high throughput, rapid analysis of soils and can detect extremely low levels of trace elements.

For the minerals industry it is expected to revolutionise the way minerals exploration and processing are done. The extremely high beam intensity enables very high throughput of large quantities of exploration samples and the tunability of the source provides information on the speciation (i.e. the oxidation state) of the elements in minerals. This information is vital in evaluating the ease with which ore bodies can be treated.

For the oil and gas industry the ability to study reactions in real time under high temperature and pressure will assist in developing technologies for extracting additional oil and gas from depleted fields. Synchrotron science can also simulate and study reactions such as the corrosion by carbon dioxide of transmission pipelines.

For advanced materials development, the ability to characterise materials with unprecedented precision and with the unique technique of x-ray absorption spectroscopy that can only be performed with the synchrotron will bring new understanding of the nanostructure of advanced ceramics, the molecular structure and functioning of intelligent polymers and biomaterials, and the electronic and magnetic structures of new semiconductors and opto-electronic materials.

For the microtechnology industry the synchrotron will bring a unique capability for the manufacturing of micro-devices with very high depth to width ratios and ultra smooth surfaces.

1 J.W. Boldeman, 'The Boomerang Proposal, Part IV: Benefits and opportunities for Australian science and industry' ASRP, April 2000.

2 See http://www.aps.anl.gov/aps/frame_science.html

3 See http://www.srs.ac.uk/srs/annual_reports.htm

Conventional lithographic techniques used for the manufacture of microcircuits produce planar devices – components that are essentially a series of two-dimensional layers. Synchrotron based lithography (LIGA) provides access to the third dimension and this is required in many micro-mechanical and micro-fluidic devices.

The synchrotron also enables the measurement of very thin surface layers and extremely low trace elements – important in the latest generation of silicon micro-devices. These techniques enable the manufacture of intelligent integrated sensors and other novel micro-devices for commercialisation in the automotive, aerospace, defence, information and communication technology and biotechnology sectors. The availability of smart integrated micro-devices is expected to impact all aspects of manufacturing in the future.

For the scientific instruments sector, where Australia already has an excellent reputation for innovation, the ability to develop the underlying physics and detector technologies behind new measurement techniques by accessing the high brilliance and tunable synchrotron light will maintain this industry at the forefront of developments.

For the pharmaceutical industry, in addition to the techniques critical to advancing drug design and medical research mentioned previously, x-ray diffraction driven from a synchrotron source is becoming an essential tool for monitoring quality control systems and for trouble shooting in the manufacture of medicines.

Contributions to National Research Priorities

The Australian national synchrotron facility will make contributions to all four of Australia's National Research Priorities:

- an environmentally sustainable Australia
- promoting and maintaining good health
- frontier technologies for building and transforming Australian industries
- safeguarding Australia.

An environmentally sustainable Australia

The Australian Synchrotron will enable the measurement of very small concentrations of toxic materials in soils, streams, seawater or the atmosphere. Such measurements can be performed with sub-micron spatial resolution, so the levels of various elements can be mapped through a sample. For example, the uptake of heavy elements by plants and microorganisms has been investigated in order to develop mine and industrial site remediation strategies[4]. The role of microorganisms in zinc-related processes associated with acid mine drainage have been explored[5,6]. Investigations such as these using the synchrotron address the goals of transforming existing industries and overcoming soil loss, salinity and acidity.

It will be possible to characterise airborne pollutants with discrimination and accuracy hitherto unobtainable, and thus positively identify their sources. Pioneering work by scientists at ANSTO on pollutants in the Sydney Basin has already demonstrated this[7].

The synchrotron is an ideal tool for studying the operation in real time of catalytic systems for emission control and fuel processing, for the operation of fuel cells and developing new technologies for sustainable development. Such work addresses the goal of reducing and capturing emissions in transport, and waste and energy generation.

Fine particulate air pollution

Atmospheric fine particles (< 2.5 microns diameter) are produced by combustion processes, traffic, industrial plants and mining operations, as well as by such natural sources as windblown soils and seaspray.

These atmospheric aerosols can affect health and the environment; they may stay in the atmosphere for weeks and can travel many kilometres from their source.

To assess the potential effects and assist with anti-pollution programs, ANSTO researchers analyse the composition of air samples and try to identify the likely source. They use XRF at the APS to determine whether emissions from Hunter Valley coal combustion for power generation and industry are reaching the Sydney Basin and impacting air quality there. More at www.ansto.gov.au/ansto/environment1/iba/projects/aerosol_studies.htm

Image: Views of Sydney during clear and foggy days. Courtesy D Cohen, ANSTO

4 Studies at the Advanced Photon Source covered by Mark Rivers in his presentation at the workshop, titled 'The Australian Synchrotron: New opportunities for soil and environmental science', 3–4 October 2003.

5 A. Gerson & R. Hill, ATSE Focus, No. 121, Mar/Apr 2002, 'Synchrotron Applications to the Earth Sciences', refer to website http://www.atse.org.au/publications/focus/focus-gerson.htm

6 M. Labrenz, G.K. Druschel, T. Thomsen-Ebert, B. Gilbert, S.A. Welch, K.M. Kemner, G.A. Logan, R.E. Summons, G. De Stasio, P.L. Bond, B. Lai, S.D. Kelly & J.F. Banfield, 'Formation of sphalerite (ZnS) deposits in natural biofilms of sulfate-reducing bacteria', Science, 290 (2000) 1744–1747.

7 D. Cohen, R. Siegele, E. Stelcer, D. Garton, A. Stampfl, Z. Cai, P. Ilinski, W. Rodrigues, D.G. Legnini, W. Yun & B. Lai, 'The complementarity of PIXE and synchrotron induced x-ray methods for the characterisation of combustion sources contributing to urban air pollution', Nucl. Instr and Methods, B189 (2002) 100–104.

Promoting and maintaining good health

Australia has a fine reputation for leading-edge medical research in many areas.

Understanding the structure and shape of the genome and the proteins expressed by the genome is fundamental to understanding the basis of all life. This task is enormous – it is estimated that there are over one million proteins, all with different functions, expressed by the human genome, let alone the much greater number produced by the immune system. The synchrotron is an essential tool for this – not only for protein crystallography, which elucidates molecular structure, but also for envisioning the way protein chains are folded and change during cellular reactions.

Beyond this the synchrotron provides enhanced ability for the structural analysis of viruses, and the imaging of cells and biological structures. It is capable of studying cellular interactions in real time; this will bring new understanding of the processes of disease and be a major factor in rational drug design.

At a more fundamental level, it will be possible to measure the electronic properties and interactions at atomic level of the building blocks that make up biological molecules (for example, amino acids). Understanding these will provide new insights into many of the complex processes observed in biological systems.

The special characteristics of the synchrotron beam enable the imaging of biological tissues with much better contrast and more detail than is possible with conventional technologies[8]. Images of the fine detail of lungs and hearts, which were previously difficult to obtains will be possible with the synchrotron. The fine imaging of small animals, in particular, will have a major impact on Australian medical research – currently this is impossible to do on overseas facilities because of quarantine restrictions.

Highly intriguing research has shown that synchrotron radiation has great potential for development of new types of medical therapy – in particular the treatment of difficult cancers, such as brain tumours[9].

Food science, also, will benefit greatly from access to the Australian Synchrotron. The high beam intensities mean that it will be possible to follow food processing by infrared spectroscopy. It will also be possible to better characterise food pathogens.

Structure determined for critical SARS enzyme

Scientists from California based company Structural GenomiX used x-ray diffraction techniques on their beamline at the Advanced Photon Source, Chicago, to determine the first structure of the main protease from the coronavirus that causes Severe Acute Respiratory Syndrome (SARS). The three-dimensional, high resolution (1.86Å) image will assist in development of a drug to inhibit SARS virus replication. A similar strategy succeeded with the HIV protease for treatment of AIDS. (More at http://www.anl.gov/OPA/whatsnew/030912sars.htm)

Frontier technologies for building and transforming Australian industries

The special characteristics of the extremely intense, tunable, polarised, and pulsed synchrotron light will open up many new avenues for breakthrough science to be performed in Australia.

Breakthrough science

A small selection from examples of breakthrough science are:

- Australian researchers, particularly at La Trobe University and the University of Western Australia, have been at the forefront of the development of new synchrotron-based surface spectrographic techniques that can measure electron spin-dependent phenomena in atoms, clusters, ferromagnetic films and surfaces. This emerging area of 'spin-electronics' will impact technologies such as quantum computing, new artificially structured magnetic materials and transistors and the development of the next generation of hard disc storage systems.
- The operation of high temperature superconductors is not well understood and progress after the initial promising discoveries in the 1980s has been slow. Using synchrotron techniques it has recently been possible to probe the electronic structure of these unusual layered materials and reveal the 'stripe phase' that had been predicted by theorists in 1989. Study of the charge carrying mechanism of the stripe phase is expected to lead to new advances in the field.
- In the earth sciences synchrotron techniques will enable improved understanding of metal complexes and solubilities and the modes of transport of metal ions in molten magmas under high pressure and in hydrothermal systems, leading to better predictive models of ore formation.
- Over the past twenty years scientists at Melbourne and Monash Universities and the CSIRO have made major advances in the fundamental knowledge about x-ray imaging. This work has led to dramatic improvements in the contrast resolution that can be obtained. It has had important spin-offs in medical imaging, as described

8 S.W. Wilkins, T.E. Gureyev, D. Gao, A. Pogany, & A.W. Stevenson, 'Phase-contrast imaging using polychromatic hard x-rays', Nature, 384, (1996) 335–338.

9 P. Suortti & W. Thomlinson, 'Medical applications of synchrotron radiation', Phys. Med. Biol., 48 (2003) R1–R35, online at stacks.iop.org/PMB/48/R1

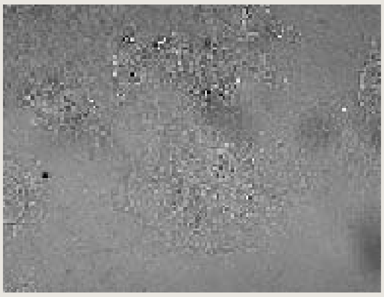
New microscope technology leads to global sales

Just as the study of lasers has opened up the new field of photonics, so ARC Federation Fellow Professor Keith Nugent and colleagues are using synchrotron science to open up the field of coherent x-ray optics.

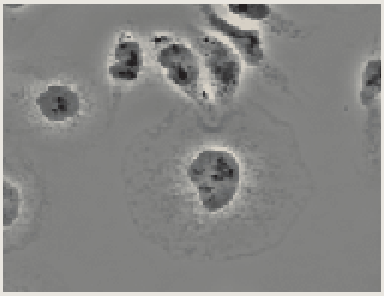
One of the first spin-offs of this work has been quantitative phase imaging which enables new and useful information to be gathered from light microscope images.

A Melbourne company IATIA has been established to develop and market this new technology and is already exporting to Europe, USA and Asia. The global market is estimated as hundreds of millions of dollars a year.

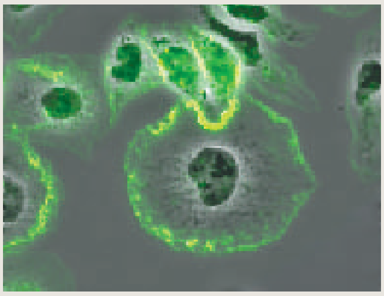
Images of rat mast cells taken three ways



A. Brightfield (conventional) shows no visible cellular contents



B. Quantitative phase image shows protein concentrations, increased density of cell surface and microfilaments, and locations of nucleus and cytoplasm areas.



C. Overlay of the fluorescence and phase image displays the localisation of proteins in the cells (Source: IATIA/Centre of Immunology, St Vincent's Hospital, University of NSW)

above, and the development of specialised new imaging instruments. To date much of the work been performed using overseas synchrotrons, and access to the Australian Synchrotron will enable this work to be continued more rapidly and at a higher level of intensity.

Frontier technologies

The Australian Synchrotron will have major impacts on the frontier technologies of nanotechnology, biotechnology, ultra broad-band communications (especially photonics) and genomics, proteomics and phenomics. An example where nanotechnology, biotechnology and proteomics have converged is research into ordered organic nanostructures or 'soft matter'. Soft matter covers many different types of systems, for example liquid crystals, functional polymers, di-block polymers, protein/lipid composites and organic/inorganic complexes. These have in common the self-assembly of component molecules into complex structures that have unique and different properties to their constituents. Synchrotron techniques enable detailed characterisation of these structures and can monitor in real time the dynamics of the self-assembly processes as well as their response to external environments.

Advanced materials

There are many examples of exciting new developments in advanced materials, and the synchrotron is expected to be an important tool in the development and refinement of most of them. An Australian example is the development of geo-polymers, a class of 'low temperature cements' with an outstanding combination of extremely high fire- and acid-resistance, high abrasion- and scratch-resistance, very low thermal conductivity and high compressive strength. These materials are based on alumino-silicates and can incorporate many other constituents, including waste products such as fly-ash[10]. Characterisation of these materials by conventional laboratory techniques is difficult because of their semi-amorphous nature, but synchrotron-based x-ray diffraction is providing new insights into the structure and method of synthesis.

Another Australian example is the development of materials for photonic devices. While silicon single- or poly-crystals are currently used in commercial devices, new work is seeking lower cost approaches. Highly oriented thin films of zinc oxide are an attractive alternative and these can be produced on novel organometallic precursors. Synchrotron techniques are important in measuring and optimising the properties of these films[11].

Smart information

The synchrotron beamlines will produce vast amounts of information-rich high quality data. Therefore a key supporting feature of the synchrotron is the smart and efficient handling and interpreting of data. Facing up to this challenge will lead to new developments, particularly in bio-informatics for interpreting the outputs of protein crystallography.

10 J.W. Phair & J.S.J. Van Deventer Int. Journal of Mineral Processing, 66 (2002), 121–143.

11 E. Lee, N.H. Tran, J. Russell & R. Lamb, J. Appl. Phys 92 (2002), 2996–2999.

Large scientific infrastructures, such as the synchrotron, have a long history of groundbreaking developments in this area. The World Wide Web had its genesis in 1990 at the European Laboratory for Particle Physics, CERN, when researchers there were seeking a platform-independent method of communicating the large amounts of data generated every day by the facility.

Safeguarding Australia

Synchrotron methods are widely applied in forensic science. For example, the infrared beamlines at the Brookhaven synchrotron are used extensively by the Federal Bureau of Investigation. The intensity and focus of synchrotron light helps to characterise precisely micro-particles of paint, hair, skin or other substances at crime scenes or crash sites. In recent work, the structure of the anthrax lethal factor was solved using synchrotron protein crystallography, and now work is proceeding to develop anti-toxins[12]. Such work relates to the goal of protecting Australia from terrorism and crime.

Personnel at the Defence, Science and Technology Organisation (DSTO) are already synchrotron users. Their work has included the characterisation and development of improved ceramic coating materials for aircraft engine components[13] and the development of sensor technology, as part of automating military hardware.

DSTO users are strong advocates of the Australian Synchrotron and envisage that the new capabilities embodied in the initial suite of beamlines will be of great value in their ongoing programs for monitoring the health of aircraft, ships and land vehicles and their propulsion systems[14].

Synchrotron research helps the Australian Defence Force to extend the life of engine components in jet engines

Jet engines can reach 1,000°C. Engine designers want them to get hotter still – higher temperatures mean more thrust. However, the ceramic coatings in engines wear under stress. DSTO scientists used the Advanced Photon Source, Chicago, to develop improved ceramic coatings and make significant cost savings in maintenance bills. Source: DSTO

Education and Research Training

The Australian Synchrotron will have a major influence on the education and research training of the next generation of Australian and New Zealand graduate students, post-doctoral fellows and other emerging researchers in the physical, chemical, materials and biological sciences.

The wide range of advanced research techniques available in a single location at a synchrotron facility, together with the opportunity to work alongside leading national and international scientists, will broaden the scope and lift the sophistication and breadth of students' and young scientists' research. The variety of scientific disciplines that are simultaneously brought together is likely to open new opportunities for working across boundaries and in innovative clusters that are linked internationally to world-class science.

At most overseas synchrotron facilities research training and the development of the next generation of scientific and medical researchers is an important activity. For example, last year there were 320 PhD students who worked at the Advanced Light Source, Berkeley, USA[15]. The Australian Synchrotron Research Program, funded by the Australian Government, has already supported 68 Australian graduate students to access overseas synchrotron light sources for thesis research during 2002–03, and sixteen PhD theses that depended in part on synchrotron research were submitted in that period.

Managers of overseas synchrotrons have noted that the collegiate atmosphere which generally exists at these facilities provides the opportunity for students to mix and discuss their work with leading researchers from advanced research organisations located around the region, with industrial researchers and with fellow students. To encourage this, special provisions are made to train and induct research students and they are given additional assistance from scientific and technical staff.

A national synchrotron facility will also assist Australia's efforts to attract and retain the most talented people. Indeed this is already starting to happen, with lively interest in scientific opportunities offered by the Australian Synchrotron being expressed by world-ranking international scientists, including a number of expatriate Australians.

Promotion of regional collaboration

Australia has an important role to play in promoting regional collaboration in science and technology and the Australian Synchrotron will be a major new drawcard for this activity.

The Australian Synchrotron, as a medium energy 3 GeV facility, will complement the lower energy synchrotrons in Singapore (0.7 GeV), Thailand (1 GeV) and Taiwan (1.5 GeV), which are better suited to the ultraviolet and soft x-ray part of the spectrum. It is likely that reciprocal access arrangements will be made with these facilities.

12 T.Y. Wong, R. Scharzenbacher & R.C. Liddington, 'Towards understanding anthrax: structural basis of target recognition by anthrax lethal factor', refer to website http://www-ssrl.slac.stanford.edu/research/highlights_archive/anthrax.html.

13 J. Thornton, D. Cookson & E. Pescott, 'The measurement of strains within the bulk of aged and as-sprayed thermal barrier coating using synchrotron radiation', Surface and Coatings Technology, 120–121 (1999) 96–102.

14 C.R. Guy, DSTO, DPSL 643/03, pers.comm.

15 E. Moxon, Technical Communications, ALS, pers. comm.

In addition, the Australian Synchrotron has performance characteristics that can support Japanese researchers while their machines are shut down during their routine maintenance periods or when there are power shortages.

A number of links have already been established. For example, the Photon Factory at Tsukuba in Japan has provided space and support for the Australian National Beamline Facility, and Taiwan's National Synchrotron will be hosting the new soft x-ray end station during its development phase prior to being transferred to the Australian Synchrotron. In addition senior scientists from SPring-8 (the world's largest third generation synchrotron in Japan) and the Singapore Synchrotron Light Source are represented on the Australian Synchrotron International Scientific and Machine Advisory Committees.

Effectively, a 'Pacific Rim' synchrotron community already exists, with close links established with synchrotrons similar to the Australian Synchrotron such as the Advanced Light Source at the Lawrence Livermore Laboratories, Berkeley, USA and the Stanford Synchrotron Radiation Laboratory, San Francisco, USA. A collaborative beamline design project is under way with the Canadian Light Source in Saskatoon, Canada (see chapter 10, beamline 11).

Further opportunities exist to link with the National Synchrotron Research Centre, Thailand, and to provide access to South East Asian scientists from organisations such as the Indonesian Institute of Sciences.

New Zealand has a strong contingent of highly skilled synchrotron scientists. However, like their Australian colleagues, they have to travel to the northern hemisphere for beamtime. The opportunity for the two groups to interact is thus very limited at present. This will change dramatically once the Australian Synchrotron is operational; indeed, New Zealand scientists have been involved in the selection process for the initial suite of beamlines and have already identified a number of opportunities for close collaboration.

Contents of the Proposal

This proposal summarises the current status of the project and the planned capability of the Australian Synchrotron in the context of other synchrotrons around the world, including several of the latest 'third generation' designs that are currently under construction. It outlines the returns to the nation that can confidently be expected from the investment in terms of the new science it enables, the health of the nation, and the new industries and new jobs created.

The proposal gives an introduction to Synchrotron technology and the techniques that it can perform in chapter 2. Then it describes some of the new science that will be enabled by the synchrotron in chapter 3 and the proposed initial suite of beamlines in chapter 4. The process for selection of the initial suite has been guided by both national and international scientific advisory committees, and has involved extensive information sessions, consultation and workshops with experienced and potential synchrotron users in Australia and New Zealand over the past two years (see appendix 3).

Guiding principles for the beamline selection process have been:

- The initial suite of beamlines should cover 95% of the techniques that it is anticipated the Australian and New Zealand scientific community will require
- All beamlines should be of world class standard, and where possible incorporate unique features that will attract a sizeable international group of users.
- The beamlines should be user-friendly, and accessible to scientists who may not be skilled synchrotron experimentalists.
- A number of the beamlines should be designed for flexibility and easy setting up of new instruments (e.g. the Infrared Spectroscopy and the Imaging and Medical Therapy beamlines), provided this does not compromise the overall performance and operational cost of the beamline.

The Australian and New Zealand research communities are geographically broadly spread. Special emphasis will be given to enable remote access to, and operation of, key beamlines. This feature is now possible because of developments in broadband communications, rapid data-processing and specialised robotics.

Chapter 4 also includes the cost estimates for construction of each beamline and for the overall annual operating cost of the facility.

Chapter 5 gives an analysis of the user base for each beamline, based on information from researchers who are either already using synchrotrons overseas or who have registered keen interest in using the techniques. Summary tables of key researchers at senior or 'principal investigator' level are provided and it is notable that many of these have registered interest in using a number of the beamlines. This is reinforced by an analysis of the disciplines that will be enhanced by each beamline, and it can be seen that in most cases access to several – not just one or two – of the beamlines will be required. (A detailed list of names of key research leaders and principal investigators is provided in volume 2, appendix 2.)

Chapter 6 places the Australian Synchrotron in the international and regional context. It can be seen that it will be a world-class facility, comparable with new facilities that are under construction in England, Canada, France, and the USA.

Chapter 7 summarises a number of studies on the national economic benefits of the synchrotron, indicating handsome returns in improved industry competitiveness, job growth and technical status of the country.

Chapter 8 gives the project timetable showing the parallel development of each beamline and the expected timetable for full commissioning of the initial suite.

Chapter 9 discusses possible approaches to the ownership and management of the facility, noting that final details will be decided in discussion with potential funding agencies and organisations. The terms for access to the beamlines are important and a possible model is described, based on best practice of successful synchrotrons overseas.

The function of each beamline is described in detail in Chapter 10.

Scientific Context for the Proposal

More than 350 scientists have been involved over the past two years in the development of this proposal.

Many have had experience of synchrotron research made possible through the federally funded Australian Synchrotron Research Program and the Access to Major Research Facilities Program, where access has been negotiated with synchrotrons in Japan, Taiwan, the USA and Europe. While this so-called 'suitcase science' is extremely valuable, and recently additional access has been arranged at synchrotrons in Chicago and Taiwan, the ASRP expects that opportunities will saturate within the next four years, as the local user communities increase. Currently access to beam time takes 3–6 months to arrange and, of course, involves the expense and inconvenience of international travel. This impacts on the nature and timeliness of the research.

Furthermore, it has sometimes been difficult or impossible to use this program due to the delicate nature of samples (protein crystals, for example, can be fragile and have limited shelf life) or due to quarantine restrictions, which limits the type of samples that can be transported (e.g. soil and tissue samples). The life sciences user community, in particular, has been disadvantaged in this way.

Finally, data gathered at overseas facilities can be subject to intellectual property ownership restrictions. For example, proprietary research at the Advanced Photon Source in the USA can only be carried out subject to restrictions regarding exploitation of the products of the research in the USA.

To date Australian users of synchrotron light have tended to confine their work to one particular technique, because of difficulties of access. Once the initial suite of beamlines is established, which will offer a comprehensive range of techniques, the user will be able to examine samples from a variety of viewpoints. The extra information that can be achieved by using several techniques will add immeasurably to the quality of the research output.

In addition, because there will be many researchers using the facility at the same time, the interaction that will be generated from the inevitable contact and discussion is sure to enhance and advance the research collaboration and output. This interaction is impeded when the Australian users are itinerant visitors to many different facilities.

The advanced experimental techniques which can be performed on the Australian Synchrotron will permeate through and raise the overall level of scientific performance of the Australian and New Zealand scientific community.

The Australian Synchrotron initiative builds on the successful outcomes of the ASRP and AMRFP facilitation. In many cases, the projects that have been carried out under these schemes are directly funded by ARC, NHMRC, CSIRO and to a lesser extent DSTO.

The Australian Synchrotron is a long-overdue piece of national scientific infrastructure and we confidently expect, based on overseas experience, that within five years after operations commence in 2007 it will transform many aspects of Australia's scientific and industrial research capabilities.