



Access to Major Overseas Research Facilities

J W BOLDEMAN, Australian Nuclear Science and Technology Organisation
PMB 1, Menai New South Wales 2234

SUMMARY This paper summarises the details for four programs which provide funding for Australian scientists to access international major research facilities.

1 INTRODUCTION

The cost of constructing large research facilities which now dominate many aspects of scientific activities can exceed several billion dollars. Furthermore as science has become more and more sophisticated the range and scope of such facilities has also increased. Australia at the best could consider funding one or two facilities costing several hundred million dollars. While these facilities could be competitive in some aspects of the related research activities they could not be expected to be the world leaders. Therefore for Australian science to participate in current activities and for the country to benefit from developments in technology it is essential that mechanisms be developed which allow Australian scientists to use these overseas facilities.

This paper will describe four schemes which have been established to permit this access. These include:

- Access to Major Research Facilities Program;
- The Australian National Beamline Facility at the Photon Factory;
- The Australian Synchrotron Research Program; and
- The ISIS Agreement.

The details of each of these programs is discussed below however the statistics on the scientific output have been combined in Section 6. All programs are managed on behalf of DIST by the Australian Nuclear Science and Technology Organisation, ANSTO.

2 ACCESS TO MAJOR RESEARCH FACILITIES PROGRAM

In 1990, the Department of Industry, Technology and Commerce now the Department of Industry Science and Tourism (DIST), on the recommendation of its International Science and Technology Advisory Committee, set up the Access to Major Research Facilities Program with initial funding of \$150,000 per year. The level of funding was increased to \$160,000 for the financial year

1992/93, \$220,000 for the financial year 1993/94, \$270,000 for the financial year 1994/95, \$320,000 for the financial year 1995/96 and \$330,000 for the financial year 1996/97. The objectives of the program are:

1. to facilitate travel to major research facilities overseas by Australian investigators with approved projects; and
2. to encourage the participation of Australian postgraduate students, technicians and other research personnel in approved research projects, to use major research facilities not available in Australia.

The term "**major research facilities**" refers to large facilities not available in Australia such as synchrotron radiation sources, high flux neutron beam sources, high energy physics facilities and astronomical facilities. There are two unique demands which need to be met for major facilities access, and which underlie the current program:

1. access to such facilities is competitive and subject to heavy worldwide demand. Scientists who apply for access to the facilities are often given only short notice that they have been successful in their application. Hence a program with a very short turnaround time is vital to enable the scientist to make use of the access time granted.
2. in many cases the use of these facilities is complex and requires more than one person to operate the equipment. Thus postgraduate students and technicians are often involved in the running of the experiment. This Program makes provision for multiple personnel to visit the facilities.

The selection criteria for funding under this program are as follows:

- The proposed facility must be a major facility with a capital cost greater than \$100m;

- The proposal has to have been submitted to the facility review panel and granted time on the facility or an instrument on the facility;
- The proposal is for a specific experiment and not for a long term collaborative proposal;
- The funding request has to be within the funding guidelines; and
- An experimental team must have submitted all acquittals and a report from previous grants.

The grant details are as follows:

- Maximum funding is limited to \$12,000 for any experiment;
- One application only is permitted per research team for any 6 month period;
- The maximum number of researchers is three per proposal;
- Economy class airfares apply to all;
- The visits are limited to funding for 14 days; and
- There is an obligation to acquit the funds and provide a two page report on each experiment.

3 THE AUSTRALIAN NATIONAL BEAMLINE FACILITY

The recommendations of the ASTEC Review "Small Country - Big Science" (1990) which considered specific aspects of Australian access to international major facilities were:

- Access to the synchrotron light source (the Photon Factory) at Tsukuba, Japan should be provided by the establishment of an Australian beam line and the construction of a special purpose diffractometer;
- Access to a high flux neutron beam should be provided by contributing 1.5% towards the annual operating budget of the Institut Laue Langevin (ILL) at Grenoble, France; and
- Access to the high energy accelerator operated by the European Organisation for Nuclear Research at Geneva, Switzerland, should be facilitated on a project basis by the provision of \$1.98 million over the first three years to the Australian Institute of High energy Physics for the construction of special detector equipment.

In a response to the first recommendation, a consortium comprising DIST, ARC, CSIRO, Australian Defence Force Academy and the Australian National University, under the management of ANSTO was established in 1991 with a three year budget of \$3.3M to build a versatile instrument at the Photon Factory at Tsukuba in Japan. The consortium also allocated travel funds for access to the Australian National Beamline Facility (ANBF) and other instruments at the Photon Factory.

The ANBF is now a multi-capability hard X-ray beamline installed at the 2.5 GeV Photon Factory second generation synchrotron light source. The ANBF is installed on a bending magnet port, beamline 20B, at the Photon Factory. It delivers monochromatic synchrotron X-rays in the energy range 4.5 - 20 keV to two experimental stations in a single hutch. The primary instrument is a multi-configuration vacuum diffractometer which uses image plates as its primary detector system. The diffractometer can be configured as an X-ray camera in Debye-Scherrer and Weissenberg geometries, or as a two circle diffractometer, a triple crystal diffractometer and a Bonse-Hart small angle scattering diffractometer. Its capabilities are:

- High resolution powder diffraction using image plates or conventional detectors;
- Time resolved powder diffraction;
- Grazing incidence (solid surface) X-ray diffraction and reflectometry;
- Triple crystal diffraction; and
- Small angle scattering.

An optical table behind the diffractometer functions as a second experimental station, which is used primarily for X-ray absorption spectroscopy, XAFS and XANES. Instrumentation includes a standard transmission detection system (ion chambers), a Lytle ion chamber fluorescence detector, and a 10 element germanium fluorescence detector. A cryogenic sample environment stage is planned. Other experiments can be performed on the second station. Recent examples include X-ray micro-beam optics and applications and phase contrast imaging.

4 THE AUSTRALIAN SYNCHROTRON RESEARCH PROGRAM (ASRP)

The Australian National Beamline Facility was a great success in attracting Australian researchers to the use of synchrotron radiation. However the access was limited to the Australian beamline and peer review access to the other facilities at the Photon Factory. There were therefore some components of the relevant Australian research effort that could not be served by the Photon Factory connection and in addition a new generation of more powerful facilities began to become available. Consequently, a working party was established under the auspices of the Australian Academy of Science to consider appropriate options to expand the opportunities for Australian scientists. It was agreed that the best option for Australian science was to establish a relationship with groups developing and exploiting instrument stations at the Advanced Photon Source at the Argonne National Laboratory in the United States.

A proposal was submitted to the Major National Research Facilities Program seeking funding of \$12.2M over five years to establish a relationship with three consortia at the Advanced Photon Source (APS). This proposal was one of seven successful submissions and the Australian Synchrotron Research Program was incorporated on the 13th January 1997. The continuation of the relationship with the Photon Factory was included in the ASRP.

At the APS, all experimental beamline facilities are being funded and constructed by Collaborative Access Teams (CATs). A CAT is allocated one or more sectors of the APS, comprising a bending magnet and an insertion device (undulator or wiggler) beamline. Therefore to have appropriate access to this facility it was necessary to join one or more CATs. After a consideration of various options and negotiations with the US counterparts, it was decided to join two such CATs, the Synchrotron Radiation Instrumentation (SRI) CAT and the Consortium for Advanced Radiation Sources (CARS) CAT. These two CATs were chosen because they provided the best and most efficient package of instrument stations.

4.1 The SRI-CAT

The SRI-CAT is developing three sectors of the APS, and will operate 11 experimental stations on 5 insertion device and two bending magnet beamlines. SRI-CAT is the Argonne National Laboratory/APS facility CAT. Its principal goals are:

- To develop and diagnose insertion devices;
- To investigate high heat load optics, and other novel X-ray optical components and to develop innovative techniques that will provide a baseline of operations for the entire community of APS CATs; and
- To develop and implement strategic instrumentation programs that will open up new areas of research at the APS.

The capabilities of the SRI-CAT beamlines are:

- A 1 and 0.1 micron spot size beam for micro-analysis, diffraction and spectroscopy;
- Time-resolved scattering and spectroscopy (XAFS);
- A 1-4 keV radiation source for coherent X-rays;
- High resolution high flux soft X-ray spectroscopy;
- A milli-electron volt resolution beamline;
- A micro-to-nano-electron volt resolution instrument to perform nuclear resonant scattering experiments;

- A selectable polarisation beam (linear and circular) for polarisation dependent scattering, eg magnetic scattering; and
- A high energy beam (up to 200 keV).

The end stations operated by this CAT are mostly operational and the ASRP has recently called for proposals from Australian scientists to use the various facilities.

4.2 The Consortium for Advanced Radiation Sources (CARS)

The consortium CARS is also developing three sectors of the APS, organised along disciplinary lines. CARS is sub-divided into BioCARS, Geo/SoilEnviroCARS and ChemMatCARS, each of which is developing a single sector. Australia, via the ASRP, is an Institutional member of CARS, with guaranteed access to the BioCARS and ChemMatCARS beamline facilities. Other Institutional members are the University of Chicago (the CARS Managing Agent), Northern Illinois University and Southern Illinois University.

4.2.1 BioCARS

The goal of BioCARS is to promote the understanding of basic biological processes in structural terms. To this end, BioCARS will provide state-of-the-art beamline facilities for X-ray crystallographic studies of biological molecules, eg proteins, and viruses on one insertion device and two bending magnet beamlines. The specific BioCARS capabilities include:

- Protein crystallography from micro-crystals and large unit cell proteins/macro-molecules;
- Protein crystallography using Multiple wavelength Anomalous Dispersion (MAD);
- Virus crystallography; and
- Time resolved Laue protein crystallography.

A great deal of equipment is now in place and access is expected to begin in early 1998.

4.2.2 ChemMatCARS

In ChemMatCARS, research will focus on aspects of dynamic and structural condensed matter and materials chemistry research, including surface and interface properties of soft condensed matter and liquids, interfacial and bulk properties of novel polymers and composites and the structure and properties of molecular aggregates and semiconductors in microporous, layered and glassy materials. Initially, ChemMatCARS will construct and operate one insertion device beamline with three

experimental stations. A bending magnet beamline will be built in a second phase.

The Phase I capabilities are:

- Surface X-ray scattering and diffraction;
- Small and ultra-small angle X-ray scattering; and
- High resolution crystallography, including time resolved and multi-wavelength capabilities

The development of these facilities is in the preliminary stage and access is not expected until 1999.

5 THE ISIS AGREEMENT

Recommendation 2 from the ASTEC Review was implemented by establishing an agreement with the Rutherford Appleton Laboratory in the UK. Under the terms of this agreement ANSTO contributed to the operational costs of the ISIS facility and in return Australian scientists were able to access the experimental facilities following peer review. ISIS is the premier spallation neutron source in the world and offers a complementary performance to that of ILL. The funds contributed by ANSTO were used to construct the neutron reflectometer SURF. Travel funds to visit ISIS are provided by the Access to Major Research Facilities Program.

6 SCIENTIFIC OUTPUT FROM THE PROGRAMS

All Programs have been outstandingly successful and have provided comprehensive research opportunities for Australian scientists at very small cost. The buildup of the program is shown in Figure 1 which plots the number of funded proposals per year and the number of Australian scientists that have benefitted from the international access. The number of proposals was slightly smaller in 1996/97 because the Photon Factory was being upgraded. It is scheduled to be back on line in October 1997 and will be running continuously for almost a year. As the APS instruments are also becoming operational, the magnitude of the overall program will double in the next few years.

Each funded experiment is expected to produce a two page report summarising the achievements of the funded research proposals. The various reports are collated and published each year in November for the previous financial year. The reports are available for the last five years from the Facility Director ASRP. The report for 1997 which is the sixth in the series is in production.. One hundred and thirteen senior scientists plus forty one postgraduate students were supported through these schemes for this financial year.

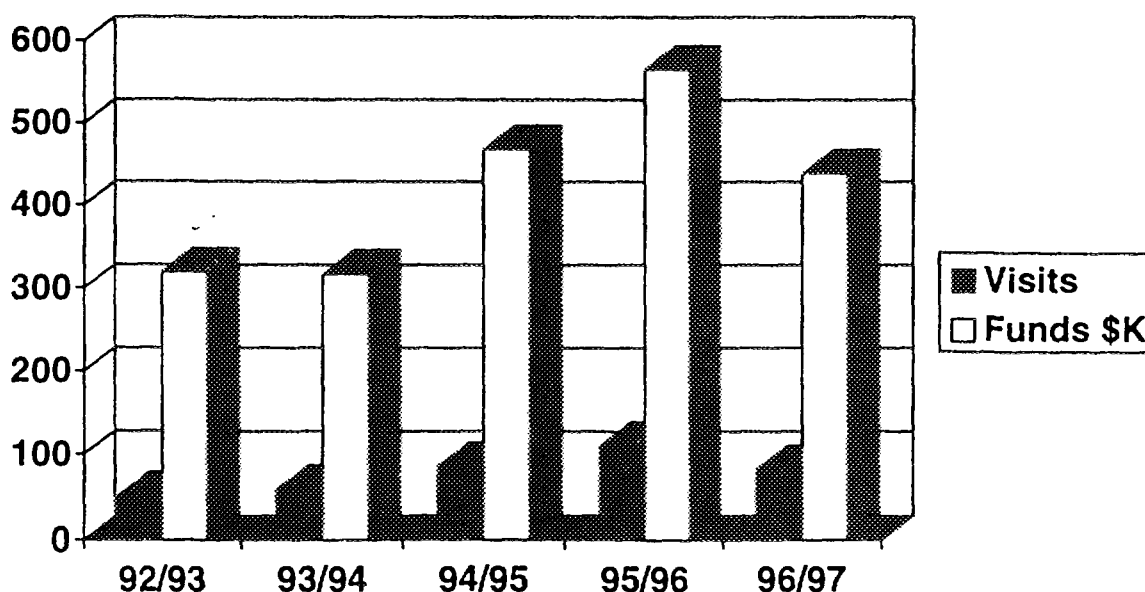


Figure 1. Development of the program