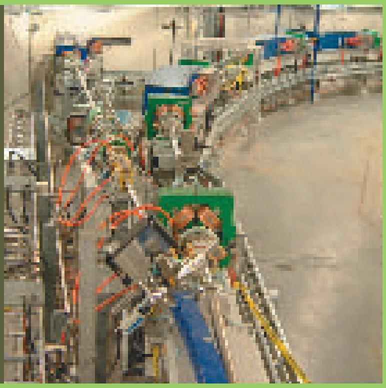


06

The Australian Synchrotron in the international context

IMAGE: Canadian Light Source booster ring, showing extraction region.
Printed with permission from Canadian Light Source.

Photographer: Sandra Ribiero, CLS

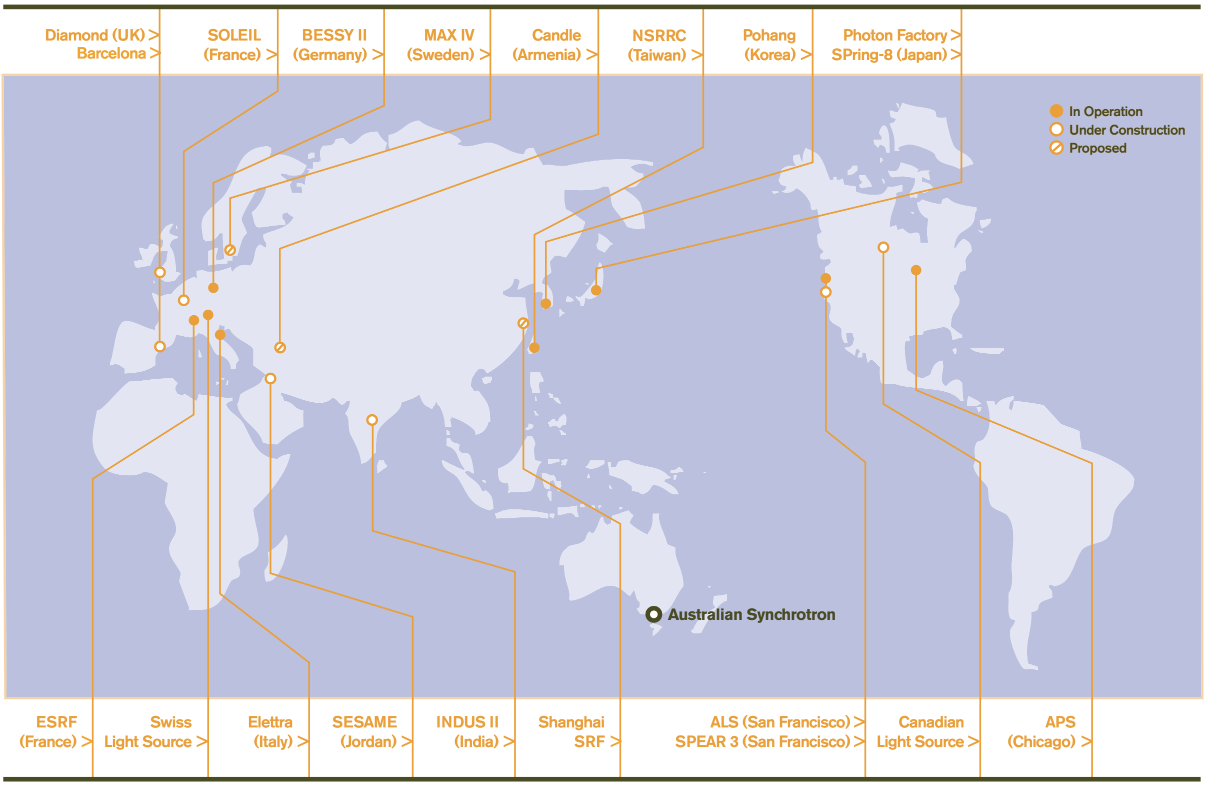
Chapter 06

The Australian Synchrotron in the international context

Synchrotrons originated in the 1940s and have evolved progressively; the first serious exploitation of synchrotron light was in the 1960s. As scientists became aware of its great potential as a tool for conducting a wide variety of leading edge experiments, development accelerated dramatically – particularly over the past fifteen years – with the building of a number of second generation and, from the mid 1990s, third generation facilities. At present there are about 50 facilities worldwide[1]. Most scientifically developed countries have a local facility, including countries such as Brazil and India. Japan has eight major installations (with a number of others privately operated), Germany seven and Sweden two.

The design objectives for the Australian Synchrotron, which were established in early 1999 following a feasibility study[2] and widespread community consultation both in Australia and overseas, were:

- an energy of 3 GeV to provide the best balance between energy range and cost
- a performance competitive with other third generation facilities currently under construction
- adequate beamline and experimental stations to satisfy 95% of the research requirements of an expected Australian community of 1,200 different scientists



GLOBAL PERSPECTIVE Third Generation Synchrotrons with Energies > 1.5 GeV

Figure 6.1. *Showing the installation of third generation synchrotrons around the world. Those already operating are solid and those under construction are open.*

1 Lists of world's synchrotron facilities at http://spring8.or.jp/ENGLISH/other_sr and at http://www-ssrl.slac.stanford.edu/SR_SOURCES.html

2 Prepared for the Australian Government by J.W. Boldeman, 1998.

- provision of facilities and an environment to cater for all demands of Australian industry for synchrotron analytical requirements
- a sufficiently competitive performance to attract a potential international research community of at least 300 researchers
- a robust design to allow relatively easy construction and commissioning.

With these design objectives a full proposal[3] for an Australian synchrotron was prepared and submitted to the Australian Government in December 1999 by the ASRP.

The design of the Australian Synchrotron ring (known as the ‘lattice’) is the result of four years of intensive effort led by Prof. John Boldeman in collaboration with Prof. Dieter Einfeld of the Forschungszentrum Kahlsruhe[4]. The lattice has been evaluated in detail at two meetings of the International Machine Advisory Committee and by independent specialists at a design workshop in October 2002 at the Lawrence Berkeley Laboratory. During the period 2000 to 2003, the proposed design was also submitted to international scrutiny at many international conferences and workshops. The conclusion of all of these meetings is that the lattice is a particularly robust design with a very high performance satisfying the requirements of the Australian research and industrial community. The design specification has been confirmed at numerous workshops in Australia over the past two years as being optimal for Australian scientific needs. Details of the lattice design are included in appendix 2.

The medium energy 3 GeV capability adopted for the Australian synchrotron is widely regarded as providing the best value-for-money design of synchrotron. It covers the energy range needed for most experiments and has the flexibility to accommodate most foreseeable developments in synchrotron science.

The 6.1 shows the extended performance characteristics compared with three world class third generation 3 GeV synchrotrons currently under construction in the UK (Diamond), Canada (Canadian Light Source) and the USA (SPEAR III).

In the regional context, the Australian Synchrotron will complement low energy synchrotrons in Singapore (0.7 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.

3 J.W. Boldeman, The Boomerang Proposal Parts I–VII, prepared for the Australian Synchrotron Research Program, December 1999.

4 J.W. Boldeman et al., The Australian Synchrotron: A Progress Report, paper presented at the ANA Conference, November 2003; J.W. Boldeman & D. Einfeld ‘The Physics Design of The Australian Synchrotron Storage Ring – Boomerang’, NIM, 2003, in press.

Table 6.1. Comparison of the Australian Synchrotron with others currently under construction in the UK, Canada and the USA

Parameter	Australian Synchrotron[2]	Diamond (Chilton, UK)[3]	Canadian Light Source	SPEAR III (Stanford, USA)
Lattice energy	3.0 GeV	3.0 GeV	2.9 GeV	3.0 GeV
Useable straights[1]	12	22	10	14
Circumference	216.0 m	561.6 m	170 m	234 m
Current[4]	200 mA	300 mA	200 mA	500 mA
Emittance[5]	7 nmrad	2.7 nmrad	18.1 nmrad	18 nmrad
Lifetime at max. current	~ 17 h	10–20 h	N/A	~50 h
Beam size in straights (height × width)	340, 13 μm	123, 6.4 μm (5 m str.) 178, 12.7 μm (8 m str.)	420, 29 μm	510, 40 μm

Notes:

1. The number of useable straights determines how many high performance insertion devices can be installed on the facility.
2. Australian Synchrotron has a dispersion level of 0.2 m.
3. Diamond has straights of two different lengths – 5 m and 8 m.
4. Most facilities will start up with 200 mA but some have plans to increase the current after several years of operation. This option is also available for the Australian Synchrotron.
5. The emittance specifies the size of the electron beam in the straight sections. The smaller the number the higher the brightness of the photon beams. The emittance of the Australian Synchrotron is smaller than that for the CLS and SPEAR III but not as small as Diamond.