THE AUSTRALIAN SYNCHROTRON LIGHT SOURCE

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Abstract

A third generation synchrotron light source is to be constructed on a site adjacent to Monash University in Melbourne Australia. The chosen facility will be a 3 GeV third generation compact facility. Two variants of a DBA lattice are under consideration and a decision on the final design is expected in July 2002 and construction of the building is scheduled to commence in March 2003 following establishment on the site in late 2002. This paper provides a summary of the performance of the two storage rings and preliminary details concerning the overall project.

1 BACKGROUND

Following the construction of a National Beamline Facility at the Photon Factory, Japan in 1991 and the establishment of the Australian Synchrotron Research Program (1995) (ASRP), which provided additional access to three Collaborative Access Teams at the Advanced Photon Source (SRI-CAT, BioCARS and ChemMatCARS), the Australian research community has grown rapidly and presently exceeds 300 different researchers who have been involved with experiments on international facilities. As a consequence proposals were prepared to construct a national facility. The Victorian State Government has agree to provide $A100 M towards the cost of the facility. The facility is to be constructed on a 12 hectare site adjacent to Monash University in Melbourne, Australia. Much of the preliminary planning has now been completed. An International Machine Advisory Committee has been established to review proposed designs and has met already and will meet for a second time in June this year. In addition an International Scientific Advisory Committee has been established in addition to a National Synchrotron Advisory Committee to consider the appropriate mix of initial beamline and experimental facilities.

2 DESIGN OBJECTIVES

Following a Feasibility Study under the auspices of the ASRP and wide-scale community consultation, both nationally and internationally, the following design objectives were derived for the proposed facility. These are:-

Beam Energy	3 GeV
Beam Current	at least 200 mA in Phase I
Emittance	better than 12 nm rad for a dispersion of less than 0.3 m
Long Straights	more than 9
Life Time	greater than 20 hrs
Circumference	approximately 200m
Instrument Stations	9 in Phase I.

3 PROPOSED DESIGNS

Several options were studied. For all, a Double Bend Achromat (DBA) was adopted, similar to the recent designs of the CLS and ANKA facilities. Preliminary versions of designs considered here have been presented to SRI-2000, the 2nd Asian Forum[1)], SSILS[2)], the 1st Meeting of the IMAC[3)]. Following considerable input from many sources, the design has now been refined for consideration by the 2nd IMAC meeting where a decision is hopefully to be made. Essentially two variants of a specific lattice design have been evaluated in detail. In both, each cell comprises two dipoles, six quadrupoles (Q), and six sextupoles (S) separated by appropriate drift spaces (D). It differs from the ANKA facility in that all straight sections are of equal length. In addition, the dipoles have a gradient magnet field as in the CLS and thus function as quadrupole elements as well as bending the electron beam. The new lattice differs from the Canadian lattice in that the gradient field of the dipole is more modest. Additional vertical focussing is provided by two small vertically focussing dipoles in each cell. Each lattice also incorporates additional sextupoles to allow the lattice to operate at a higher distributed dispersion. The sextupoles are also double function elements as they incorporate correctors thereby minimising space requirements. The principal difference between the two options is the number of superperiods. The lattice designated Boomerang 18232 has 12 superperiods while Boomerang 20232 has 14. There are slight differences in some of the drift lengths to account for specific harmonic numbers of the selected RF frequency.

The configuration of the smaller lattice (18232) is shown in Figure 1. As indicated previously the larger lattice is almost identical but of course the curvature is slightly different and the length of the long straight sections is fractionally shorter.

To calculate the performance of the storage ring, three different codes have been used. These are

- Beta Code developed at the ESRF
- WinAgile from CERN
- Beam Optics from Stanford.

The optical functions calculated for the 18232 lattice with the Beta Code are shown in Figure 2. The optical functions for the 20232 lattice are very similar and are not reproduced here. In figure 3, the dynamic aperture calculated with the Beta Code for the design energy is shown.

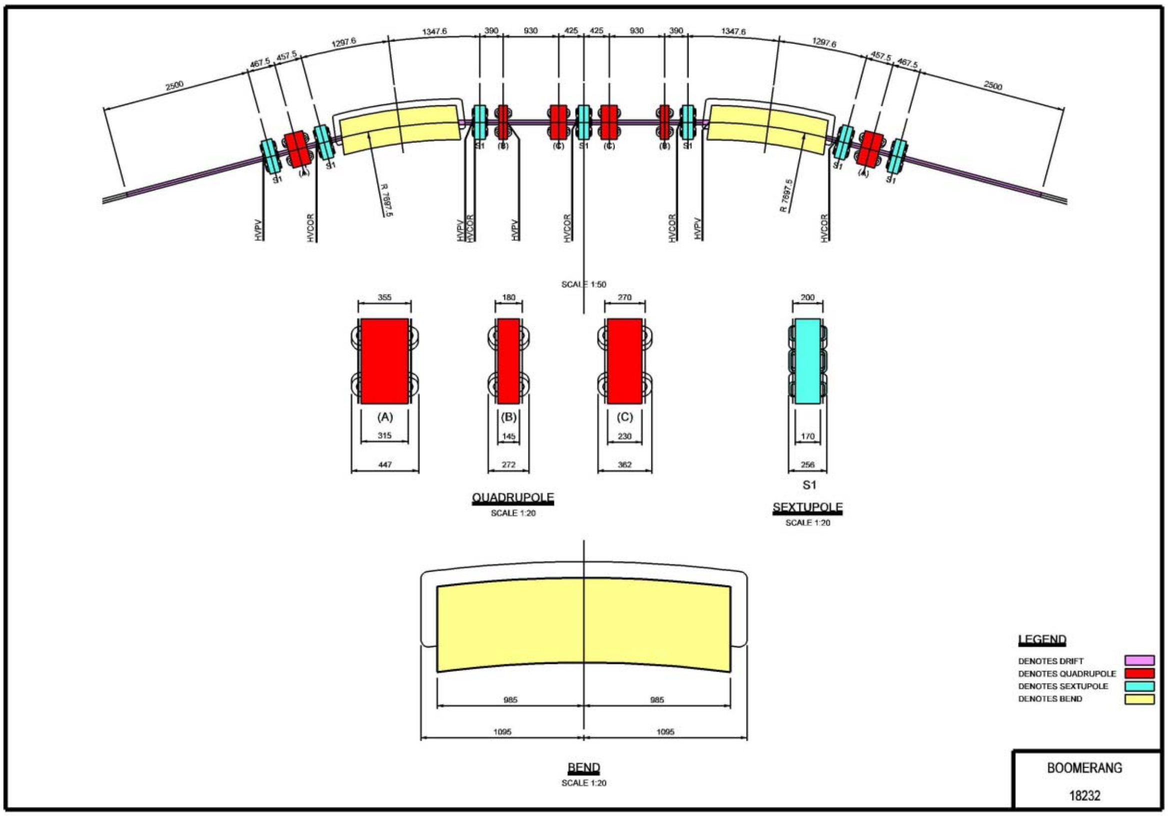

Figure 1: The Boomerang 18232 Lattice

The dynamic aperture (Figure 3) as calculated by the Beta Code + 38 mm, -65 mm horizontally and 25 mm vertically. A detailed study of misalignment errors has been carried out for each lattice and they are both robust to normal alignment errors. In Figure 1, a preliminary version of the proposed correction scheme is also shown. A detailed study of the environmental vibrations encounted at the site is in progress.

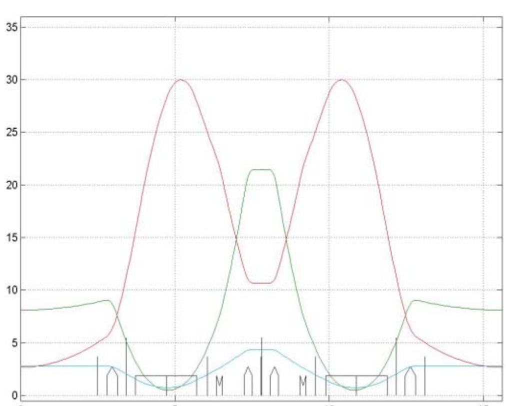

Figure 2: Optical Parameters (m) for Boomerang 18232 calculated with the Beta Code

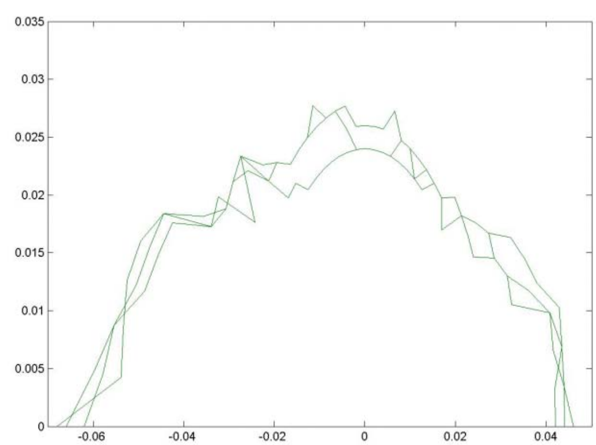

Figure 3: Dynamic Aperture for Boomerang 18232

4 COMPARISON - THE TWO LATTICES

The principal difference between the two lattices is the number of superperiods with 12 for Boomerang 18232 and 14 for Boomerang 20232. The emittance for the smaller lattice is 11.36 nmrad with distributed dispersion of 0.287 m. This becomes 7.36 nmrad with 14 superperiods. A comparison is made of the properties of the two lattices in Table 1

Table 1 : Comparison of the two lattices.

Parameter	Boomerang 18232	Boomerang 20232a
Energy	3 GeV	3 GeV
Circumference	187.202 m	215.866 m
Harmonic Number	316	360
Periodiocity	12	14
Emittance	11.36 nmrad	7.39 nmrad
Horizontal Tune	11.2	13.18
Vertical Tune	4.3	4.3
Hor Nat Chromaticity	-24.0	-32.44
Vert Nat Chromaticity	-17.3	-17.89
Horizontal Chromaticity*	6	6
Vertical Chromaticity*	2	2
Length of Straights	4.8 m	4.62 m
Betax	8.9 m	8.1 m
Betay	3.6 m	2.7 m
Dispersion	0.287 m	0.244
Dipole Field	1.31 T	1.12 T
Momentum Com	0.0033	0.0024
Energy Loss per Turn	939 keV	805 keV
Total Rad Power	188 kW	160 kW
Dynamic Ap Hor	+46, -66 mm	+38, -68mm
Dynamic Ap Vert	27 mm	20 mm
Energy Acceptance H	+6, -6%	+6, -5%
Energy Acceptance V	+6, -6%	+4, -4%
No Usable Straights	10	12
Beam size x, y	403, 17.3 microns	351, 16 microns
Brightness Se Edge**	$2.4 * 10^{18}$	$4.6 * 10^{18}$

5 BRIGHTNESS OF THE LATTICES

It is intended that whichever lattice is selected that many of the beamline stations will be positioned on Insertion Devices. The brightness of the 20232 lattice has been calculated for three notional undulators as listed in Table 2. In the current plans for the storage ring provision has been made for an initial complement of 3 undulators and 1 wiggler.

Table 2 Notional Undulators

Undulator	1.4 cm period	2.5 cm period	8 cm period
No. of periods	100	100	40
K_{max}	2	1.5	4.4
Minimum gap	~5mm	10mm	25mm
Total Power K_{max}	3.8 kW	1.3 kW	1.26 kW

Table 3 Wiggler Parameters

Period	6.1 cm
Length	2 m
Critical Energy	11.35 keV
Total Power	8.1 kW
Magnetic gap	7.5 mm

The properties of the most likely wiggler are listed in Table 3. This is similar to an ID that has recently been supplied to the SLS. The brightness of the 20232 lattice has been calculated for each of the three undulators in Figure 4.

6 REFERENCES

1. J. W. Boldeman, "Boomerang – The Australian Light Source", 4th Asian Forum on Synchrotron Light Sources, Hiroshima, January 2001.
2. J. W. Boldeman and D Einfeld, Shanghai Symposium on Synchrotron Light Sources, Shanghai, September 2001, page 32.
3. J. W. Boldeman, E Huttel and R.F. Garrett (2002) – ASP Report SN10/10.

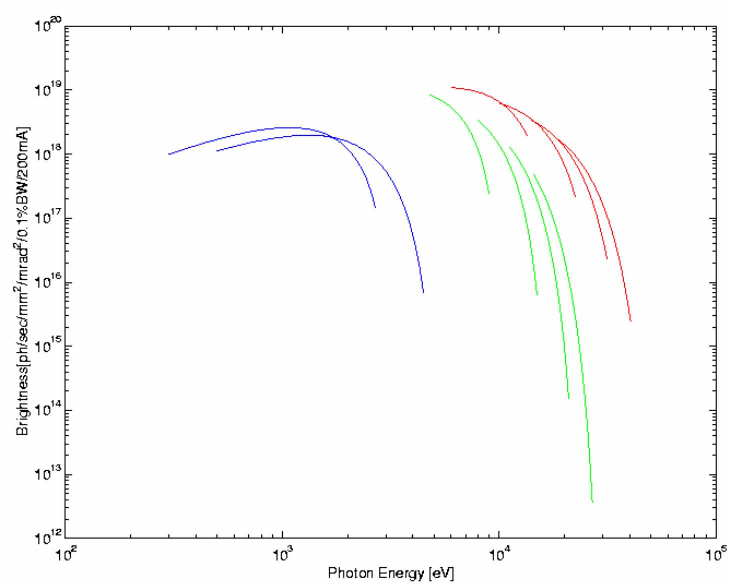

Figure 4 Brightness for Three Undulators