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THE AUSTRALIAN SYNCHROTRON PROJECT

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Abstract

This paper will give an overview of the Australian Synchrotron Project (ASP) storage ring[1]. The ASP storage ring is a 3 GeV machine with 14 identical cells and a circumference of 216 m. The injection system is commissioned and the storage ring is currently being commissioned. The facility is expected to be in operation by March 2007[2].

STORAGE RING

A single cell of the ASP lattice is shown below in **Figure 1**. The two bending magnets are identical and are gradient dipoles with a focusing strength of $k = -0.335\ \mathrm{m}^{-2}$. There are three families of quadrupoles and four families of sextupoles. Horizontal and vertical corrector and skew quadrupole coils are wound into the sextupole magnets to make the lattice more compact[3]. The design of the vacuum system is detailed in Ref. 4). The storage ring RF system uses HOM damped cavities developed for the Australian Synchrotron project detailed in Ref. 5).

The nominal lattice tunes are $\nu_x = 13.3$ and $\nu_y = 5.2$, but the machine can be tuned over a large range by using the outer two of the quadrupole families. The inner quadrupoles are used to distribute the dispersion to allow it to leak into the straight sections. Two of the straight sections are used for RF cavities, one for the injection septum, and the remaining eleven will be available for full length insertion devices. Splitting the cavities between two straight sections leaves 2.5 m available for insertion devices in those straight sections. The machine functions for one cell in the lattice are shown in **Figure 2** and the design specifications are shown in **Table 1**.

The injection system is a 100 MeV linac feeding a 0.1–3 GeV booster. The injection system runs at 1 Hz and can deliver up to 3 mA per shot into the storage ring. The layout for the injection system and storage ring can be seen in **Figure 3**.

BEAMLINES

Diagnostic Beamlines

There are two diagnostic beamlines to monitor the synchrotron light from dipoles in the storage ring; one

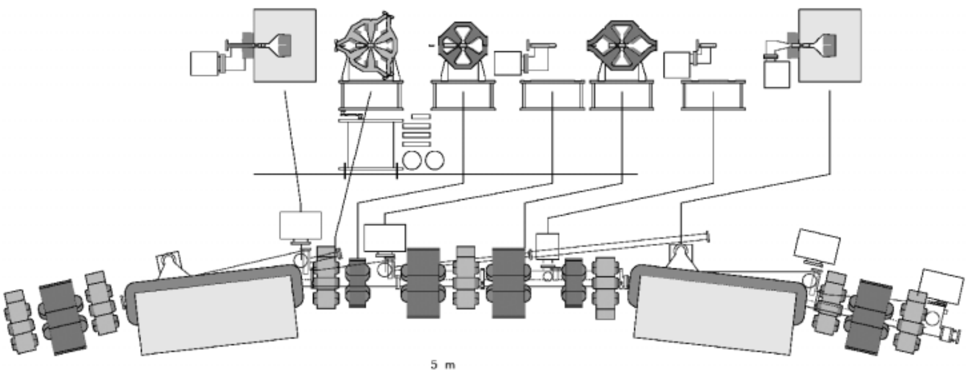

Fig. 1　A unit cell of the 14 cell double bend achromat ASP storage ring lattice.

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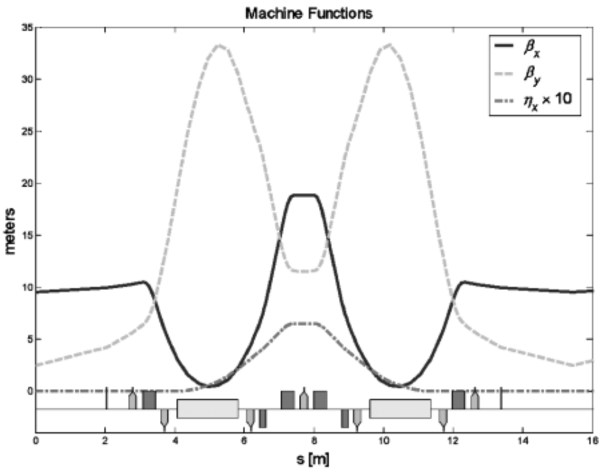

Fig. 2 Machine functions for one cell of the ASP storage ring with zero dispersion in the straight sections.

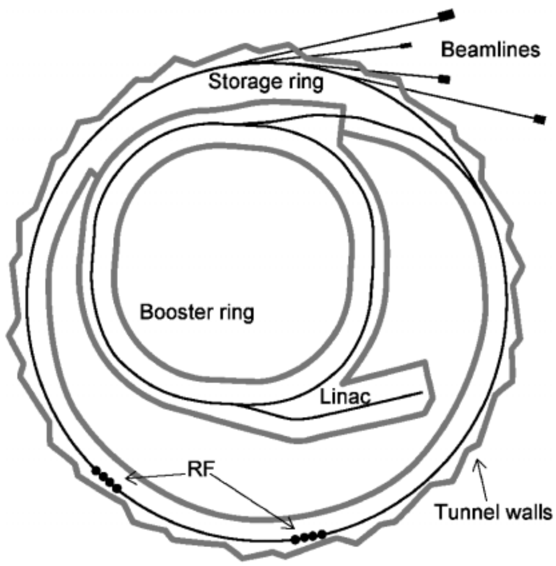

Fig. 3 The storage ring and injector floor plan

Table 1 ASP storage ring specifications.

Energy	3	[Gev]
Circumference	216	[m]
RF Frequency	499.654	[MHz]
Harmonic Number	360	
Peak RF Voltage	3.0	[MV]
Current	200	[mA]
Critical Photon Energy	7.8	[keV]
Betatron Tune (h/v)	13.3/5.2	
Momentum Compaction	0.002	
Natural Chromaticity (h/v)	−28/−27	
Radiation Damping (h/v/l)	3/5/3	[ms]
Energy Spread	0.1	[%]
Radiation Loss	932	[keV]
Horizontal Emittance	16	[nm·rad]

for X-rays and one for optical light. The X-ray beamline has been designed to fit entirely within the shielding walls of the storage ring to simplify the design and remove the need for a hutch. An X-ray pinhole camera, a YAG screen and a CCD camera are used to measure the beam size from a dipole source to determine the beam stability and the emittance.

The optical diagnostic beamline is used to measure the bunch length and study longitudinal beam dynamics. This design consists of an optical chicane to bring the visible light out through the shielding wall and absorb the unwanted X-rays. A hutch containing an optical bench houses a streak camera and a high speed CCD to measure the longitudinal beam characteristics. A fill pattern monitor is also implemented and will be used to target individual bunches in top-up mode.

Experimental Beamlines

An initial suite of nine beamlines is included in the design of the ASP. Four of these are expected to be under commissioning at the completion of the storage ring in 2007. Two beamlines will be from bend magnet sources and two from insertion devices[2].

COMMISSIONING RESULTS

First Light

The first electrons were stored and the synchrotron light observed on the X-ray diagnostic beamline on July 14, 2006. This was according to the project schedule set out in 2002. The next commissioning shift after that saw stacking up to 10 mA.

Matlab Tools

The Accelerator Toolbox[6] tools have been used extensively during commissioning. The control system is based on EPICS and the process variables are available to the Matlab tools. These include orbit control, response matrix measurements and analyses, as well as the ability to easily script up experiments in the Matlab environment and treat the data with all of the standard Matlab tools.

Beam Position Monitor System

The Libera[7] beam position monitor system was chosen for all of the beam position monitors. This gave turn-by-turn, and averaged orbit data simultaneously from the start of commissioning. The orbit interlock to protect the vacuum chamber from a miss-steered insertion device beam is also being implemented using the hardware on the Libera units.

Storage Ring Performance

All of the electron beam performance criteria set out for the project that can be demonstrated at present have been met or exceeded. As of 27 November 2006, the beam orbit has been corrected to 26 μm RMS in the horizontal plane and 17 μm RMS in the vertical plane. Injection from 0–160 mA (highest current achieved so far with the design current of 200 mA) takes ~3 min. The lifetime at 100 mA is 11 hours after a total integrated current of 17 Ahrs. The emittance has been measured at 18.7 nmrad with an emittance coupling to the vertical of 0.5%. The beam stability is less than 6% of the beam size at the source point for the x-ray diagnostic beamline.

CONCLUSIONS

The storage ring is performing as expected and the commissioning has gone very smoothly. With most of the final performance criteria already demonstrated, the time remaining until the March 2007 start of operations will be spent continuing to optimize the performance and work will begin on characterizing and correcting for the effects of insertion devices on the electron beam.

REFERENCES

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