Status of SOR-RING in 1978

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1. Status of the Accelerator

SOR-RING is the 0.4 GeV electron storage ring completed in 1974 at the Institute for Nuclear Study, University of Tokyo, and is presently being operated by the Institute for Solid State Physics. Electrons for injection are supplied by the 1.3 GeV electron synchrotron of INS at the energy of 0.3 GeV.

Currently more than 10 electron storage rings are used as the light sources in the world, and five of them are operated exclusively for the radiation users. Further seven or more dedicated synchrotron radiation sources are under construction or being planned in Europe, America and Japan, but the SOR-RING is still the only one operating machine of this kind designed from the start as such.[1)]

As a result of a series of efforts toward improvements from 1975 through 1976, the machine reached and went over the design goal, which was the maximum storage of 100 mA with a life of one hour at 300 MeV.(2～5) It is now capable of accumulating more than 300 mA at that energy, and operating at 400 MeV has turned out feasible.(6) It is injected three or four times daily, each injection taking about 5 minutes for accumulating 200～250 mA. Table 1 gives main parameters of the SOR-RING under the normal mode of operation currently being used.

The current stored in the ring is determined by measuring the total photoemission current of an irradiated metal plate which subtends an effective horizontal angle of 20 mrad outside the orbit and yields 3.4 μA per 1 mA ring current. This value is a result of calibration by observing the photon flux emitted by a single electron in the orbit with a photomultiplier as the transfer standard.

2. Status of the Beam Lines for Radiation Users

There are four beam lines for providing synchrotron radiation for users, and the fifth is being prepared. The first one (BL-1) is led upstairs by a mirror with an angle of 110° to be coupled with a 1m vertical Seya-Namiokamonochromator and will be used in the ultraviolet region of spectrum, mainly from 300 to 2000Å (40～6 eV). BL-2 is equipped with a 2m vertical modified Rowland to be used between 100 and 400 A (120～30 eV). A photoelectron spectrometer of double cylindrical mirror type is also incorporated. BL-3 has no staying instrument and is open to the users who don't need spectrometers or want to bring their own instruments. So far experiments on modulation spectroscopy, radiation chemistry and biology, and micro-lithography were performed in this line. BL-4 is assigned for the range of highest photon energies (20～200 A, or 600～60 eV) with a 2m modified Vodar.

Common to all these beam lines are connected the diffential pumping systems separating the ring and spectrometers. To cope with the technical difficulties in spectroscopy arising from that the spectrum is a continuum, developments in filter technique are the stringent requirement for all the regions. Stability of the beam position is often required by users and the operating conditions of the ring must be carefully determined so that they cause minimum instabilities. A change of the beam profile or source parameters due to the changing coupling of vertical and horizontal betatron oscillations depending upon the beam current and operating point may give rise to the similar trouble. Therefore, the amount of radiation entering the monochromator must be monitored behind the entrance slit, or preferably behind the exit slit.

References

1) For instance, see "An Assessment of the National Need for Facilities Dedicated to the Production of Synchrotron Radiation", National Academy of Sciences, Washington, D.C., 1976, or SLAC Beam Line, Febr. 1977.
2) T.Miyahara et al, INS-TH-107, June 1976.
3) H.Kitamura et al, INS-TH-108, June 1976.
4) T.Miyahara et al, Particle Accelerators 7 (1976) 163.
5) H.Kitamura et al, Japan. J. Appl. Phys. 15 (1976) 1349.
6) T.Sasaki et al, Proc. Xth Intern. Conf. High Energy Accelerators, Serpukhov, July 1977.

Table 1
Parameters of the SOR-RING (Status December 1977)

Energy of stored electrons		$250 \sim 400$ MeV
Highest current stored at 307 MeV		330 mA(10^{11} el.)
Initial current in normal operation		$200 \sim 300$ mA
Typical beam life at 307 MeV for	200mA	47 min.
(τ in $\exp[-t/\tau]$)	100mA	71 min.
Radius of a bending magnet (BM)		1.10 m
Field strength of BM		$7.6 \sim 11.5$ kG
Field index of BM		n = 0.4
Total orbit length		17.4 m
Revolution frequency		17.26 MHz
Resonant frequency of the RF cavity		120.82 MHz
Operating RF voltage		15 kV
Radiation loss of an electron per turn		0.65 keV
Number of betatron oscillations*		$\nu_x = 1.28$, $\nu_z = 1.21$
Values of field gradient of a QM*		$K_F = 6.3$m , $K_D = 6.1$m
Source parameters*	σ_x, σ_x'	$\simeq 0.8$mm, 0.27mrad
	σ_z, σ_z'	< 0.2mm, 0.08mrad
Dilation factor		$\alpha_c \simeq 0.58$
Damping time of betatron oscillations		$\tau_x, \tau_z \simeq 54$msec.
Average pressure in vacuum chambers	without beam	$< 7 \times 10^{-10}$ Torr
	with 100mA beam	$< 5 \times 10^{-9}$ Torr
Total design pumping speed		> 4500 l/sec
Frequency of injection		1 Hz
Typical filling time		5 min.
Useful range of photon energy	300 MeV	< 0.44 keV
	400 MeV	< 1.0 keV

* Under the normal mode of operation