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STATUS OF THE TRISTAN ACCUMULATION RING AS A SYNCHROTRON RADIATION SOURCE

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Abstract The TRISTAN Accumulation Ring (AR) is a 8 GeV storage accelerator ring which accelerates electrons or positrons from the 2.5 GeV linac and transfers them to the TRISTAN main colliding beam ring (MR). During the interval of beam filling in the MR the AR is mainly used as a synchrotron radiation (SR) source. In this paper the SR facility in the AR, the operation in the normal emittance lattice in which the AR is regularly operated and the accelerator studies of the low emittance lattice are described.

SR FACILITY OF THE AR

The SR facility of the AR is shown in Figure 1. At present three beam lines, BL-NE1, BL-NE5 and BL-NE9 are available.

The BL-NE5 is the oldest beam line with which the utilization of SR started in the AR at FY 1986. It accepts SR which is emitted from a bending magnet of the normal cell in the north-east arc of the AR. The critical energy of SR emitted from the bending magnet is 26.4 keV at the beam energy of 6.5 GeV. This beam line is used for high pressure X ray diffraction experiment and coronary angiography. In the next summer the BL-NE5 will be made into two branches to make the experiments simultaneously.

The BL-NE9 is another beam line which accepts SR from a bending magnet and delivers SR light to picosecond pulse radiolysis, generation and storage of multiple-charged ions and research and development works by the TRISTAN vacuum group.

The BL-NE1 is illuminated by a multipole wiggler which is installed

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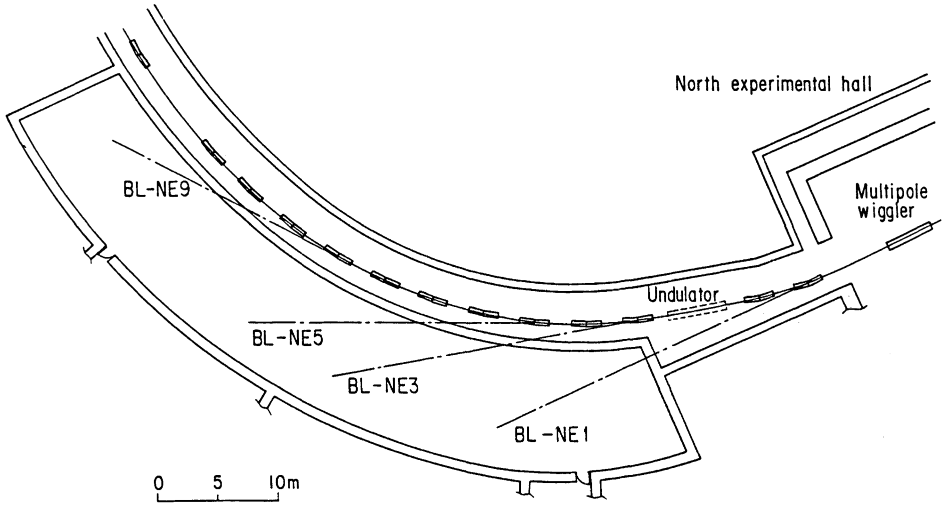

FIGURE 1 Synchrotron radiation facility of the TRISTA AR.

in the north long straight section of the AR. This wiggler, which has horizontal and vertical pairs of permanent magnet arrays whose number of periods and periodicity are 21 and 16 cm respectively, produces a deformed-helix motion of an electron which generates circularly polarized X ray at the energy range of 100 eV ~ 70 keV. The maximum magnetic fields of horizontal direction is 0.2 T and that of vertical direction is 1.0 T. This beam line was successfully commissioned in the autumn of 1988[1] and has been used for experiments of magnetic Compton scattering from the beginning of 1989.

A new beam line BL-NE3 is under construction and will begin the operation in the next autumn. It will be equipped with a X ray undulator in a missing bend section for dispersion suppression.

OPERATION IN THE NORMAL EMITTANCE LATTICE

The AR consists of two beam lines which are connected mirror-symmetrically. It has two long straight sections in the north and south symmetry points. The circumference and the harmonic number is 377 m and 640, respectively.

Optics parameters in the normal emittance lattice is listed in Table I. The beam energy is 6.5 GeV for the experiments of magnetic Compton scattering and high pressure X ray diffraction and is 5.8 GeV for the experiments of coronary angiography. Betatron tunes are fixed at appropriate values so as to meet the demand of the experiments. For the experiment of coronary angiography the horizontal tune is selected identical to the vertical one to obtain the round beam. For the experiments of magnetic Compton scattering and high pressure X ray diffraction the tunes were selected through the tune survey to minimize the width of the angular distribution of the SR light emitted from the multipole wiggler.

TABLE I Optics parameters of the normal and low emittance lattices.

	Normal emittance lattice	Low emittance lattice
Energy (GeV)	6.5	6.5
Emittance (10^{-7} m-rad)	2.95	1.65
ν_x	10.15	12.15
ν_y	10.28	8.28
ψ_x in normal cell (°)	90	145
ψ_y in normal cell (°)	90	60
max. β_x in normal cell (m)	14.8	24.0
max. β_y in normal cell (m)	14.7	19.6
max. η_x in normal cell (m)	1.33	0.70
β_x at north N. S. P. (m)	4.01	7.99
β_y at north N. S. P. (m)	4.00	3.84
η_x at north N. S. P. (m)	0	0
ξ_x	-14.3	-22.2
ξ_y	-13.1	-13.0
Momentum compaction	0.0127	0.0072
Bunch length (cm)	1.8	1.6
RF voltage* (MV)	13.6	11.1

$\nu_{x,y}$:tune
$\psi_{x,y}$:phase advance/cell
$\beta_{x,y}$:beta function
η_x :dispersion function
$\xi_{x,y}$:natural chromaticity
(x:horizontal, y:vertical)

N. S. P.:north symmetry point.
*: RF voltage which gives quantum life time of 24 hours.

Fluctuations of a SR beam position was observed in the BL-NE5 with a split photoemittion chamber which was located at 5 m apart from the source point of SR[2]. The SR beam position drifted by 300 to 500 μm for about 30 minutes after acceleration from 2.5 to 5.8 or 6.0 GeV. Ripples of 20 to 30 μm were also observed. The cause of this position drift is understood roughly by the fact that the SR beam position and the temperature of the cooling water show a similar time dependence. To stabilize the SR beam position an orbit-bump feedback system was tested. With the feedback system the variation of the SR beam position was maintained within ±50 μm at the position monitor.

A beam current and a lifetime recorded through 24 hours are shown in Figure 2. The notched patten of the current indicates that the AR works at the beam transfer to the MR. The SR operation starts with single bunch of the electrons of 30 mA. As seen in the figure shortening of the lifetime of the electron beam is sometimes observed. In the test operation with the positron beam through 3.3 hours this phenomena was not observed, so we are thinking about ion and/or macro particle trapping as the source.

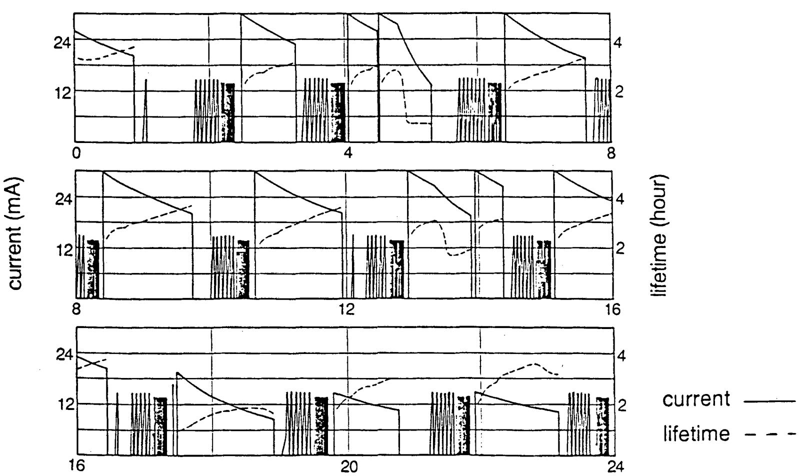

FIGURE 2 Total current and lifetime of the AR recorded through 24 hours.

STUDIES OF THE LOW EMITTANCE LATTICE

The studies of the low emittance lattice were performed several times since 1987. The parameters for the low emittance lattice are listed in Table I and lattice functions for half of the ring are shown in Figure 3. The low emittance is achieved by reducing the dispersion function in the normal cells by increasing the horizontal tune. To obtain the optimum phase advances we calculated the emittance as the function of

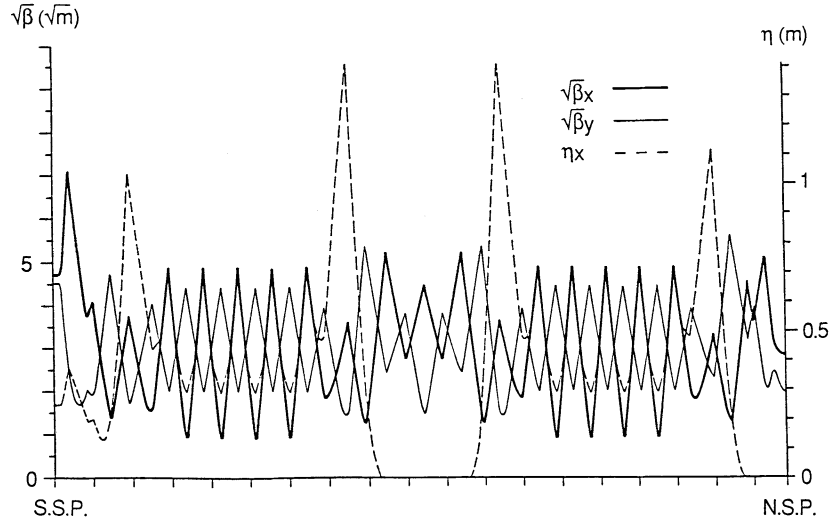

FIGURE 3 Lattice functions in the low emittance lattice.

the horizontal phase advance in a hypothetical ring which consists of the normal cells only and fixed it at 145° where the emittance has the minimum value. The similar calculation for the vertical phase advance shows that the emittance slowly decreases with it. We selected the vertical phase advance of 60° so as to keep the beta functions moderate. The emittance of this lattice is reduced by half compared with that in the regular operation at the same energy.

As shown in Table I the horizontal chromaticity of the low emittance lattice is 1.6 times larger than that of the normal emittance lattice. To study the effect of sextupoles on the dynamic aperture, particle tracking was performed by the computer code PATRICIA[3] for the various working points[4]. In the calculations the chromaticities are corrected by the sextupoles of two families. The results for the particle with no momentum deviation are shown in Figure 4. A figure at a working point in the tune diagram represents the maximum initial amplitude of betatron oscillation at which a particle makes 800 turns successfully at its working point. The amplitudes are normalized by the

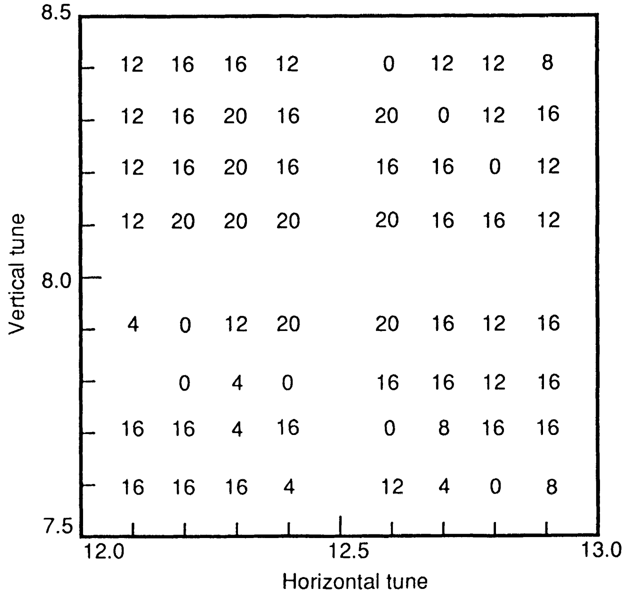

FIGURE 4 Tracking results of the low emittance lattice.

beam size at 6 GeV, assuming the zero coupling for the horizontal plane and the full coupling for the vertical plane. The horizontal and vertical initial amplitude were set to the same value.

The results of the accelerator studies after the installation of the multipole wiggler are summarized below.

1) The stored current was limited to 20 mA. The reason is not clarified yet. With the beam of two bunches the current of 26 mA was achieved by detuning the half of RF cavities.

2) The beam of 20 mA was accelerated to 6.5 GeV without beam loss.

3) The beam lifetime at the current of 18 mA was 4 hours which is comparable to the lifetime of the regular operation at the same current.

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