Commissioning of the Electron Ring, KSR

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KSR (Kaken Storage Ring) is a compact electron ring in Kyoto University. The circumference of KSR is 25.7 m and the maximum beam energy is 300 MeV. It is designed for the synchrotron light source and the electron pulse stretcher ring. The beam commissioning of KSR had started in September, 1999. In last October, the beam current of 3 mA was stored successfully. The beam parameter measurements and the machine parameter adjustments were carried out. At the end of 1999, the beam current is 10 mA. The typical beam lifetime is 1000 second.

Keywords : electron ring/ KSR/synchrotron radiation

A compact electron ring (Kaken Storage Ring, KSR) is now under construction at Institute for Chemical Research, Kyoto University. KSR has two operation modes, one is a beam storage mode and the other is a pulse stretcher mode. In the storage mode, the beam energy is 300 MeV and the design current is 100 mA. The critical wave length of the synchrotron radiation is 17 nm from the bending magnets. The design issue of the ring is to make 5 m straight sections where the dispersion is zero. One of the straight section is used for a beam injection, an extraction and an RF cavity. An electrostatic septum and a septum magnet for the stretcher mode are installed in this section. At the other section, an insertion device will be installed for the storage mode.

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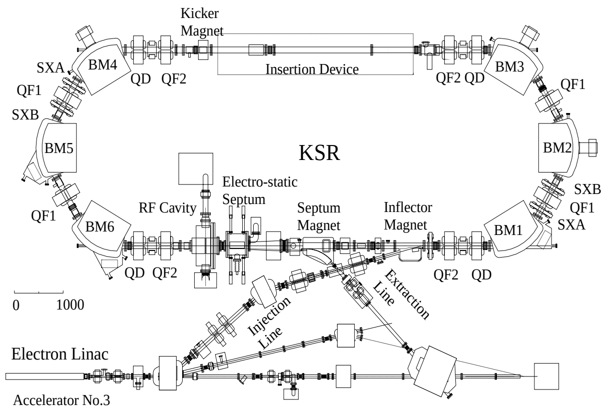

Figure 1. Layout of KSR, the injection and the extraction beam line.

NUCLEAR SCIENCE RESEARCH FACILITY — Particle and Photon Beams —

Scope of research

Particle and photon beams generated with accelerators and their instrumentations both for fundamental research and practical applications are studied. The following subjects are being studied: Beam dynamics related to space charge force in accelerators: Beam handling during the injection and extraction processes of the accelerator ring:radiation mechanism of photon by electrons in the magnetic field: R&D to realize a compact proton synchrotron dedicated for cancer therapy: Control of the shape of beam distribution with use of nonlinear magnetic field: and Irradiation of materials with particle and photon beams.

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KSR were carried out using the stored beam. Table 1 shows the comparison between the simulation and the measurement results. The tune value is an important parameter to show the beam stability. It was measured using the RF electric field. The beam is perturbed strongly when the electric force of the RF field resonates with the transverse motion of the beam. The beam perturbation was measured from the deformation of the synchrotron radiation profile. Figure 2 shows the tune value at the operation point and the resonance line. The present tune is far from the resonance lines up to 6th order. At the injection time, the tune spreads due to the energy spread. It is compensated to be smaller than +/- 0.01 by the sextupole magnet correction not to cross the resonance line up to 4th order. The higher order resonance is not effective for the injection.

The β function agrees well to the simulation results within the measurement error. The natural chromaticity in the vertical direction is different from the design value. It is due to the effect of the sextupole components in the field of the bending magnet, especially in the fringe field. Including this effects, the chromaticity was corrected using 2 sets of sextupole magnets.

At the end of 1999, the beam stacking and the beam acceleration up to 300 MeV succeeded. Figure 3 shows the circulation beam current at the injection. The beam current is measured by a DC current transformer. The beam pulse is injected every 3.3 seconds from the linac. It corresponds to the horizontal dumping time. The beam are stacked about 20 times and the final storage current becomes 10 mA. It is limited by the scattering beam loss with the residual gas, especially, the gas induced by the synchrotron radiation. The conditioning process is going on now. The beam life also depends on the beam current strongly because of the same reason. The typical beam life is 1000 second with zero current and 400 sec with 3 mA.

References

[1] A.Noda, et al., "Electron Storage and Stretcher Ring, KSR", Proc. of the 5th European Particle Accelerator Conference, Sitges (Barcelona), Spain, 451-453 (1996)

Table 1. Comparison between the simulation and the measurement results of the beam parameters.

	Design	*Measurement*
Tune	*(2.300, 1.275)*	*(2.309, 1.270)*
Storage Current	*100 mA*	*10 mA*
Beam Life	*---*	*400 sec (at 3 mA)* *1000 sec (at 0 mA)*
β function at QF	*(7.1, 10.2)*	*(6.5, 10.3)*
Natural Chromaticity	*(2.4, -8.2)*	*(-2.6, -6.1)*
Chromaticity with Correction	*(0.0, 0.0)*	*(-0.1, -0.3)*
Dispersion at straight section	*0.0 m*	*< 0.05 m*

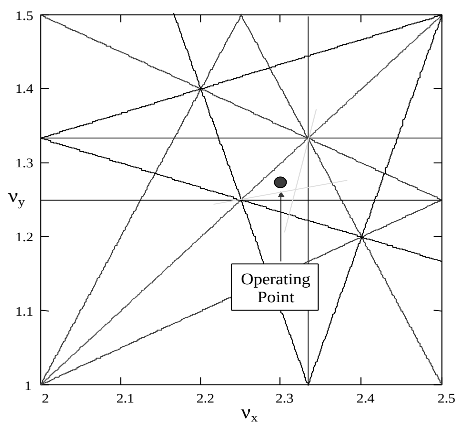

Figure 2. Operation point in the tune diagram. The lines show the resonance up to 6th order.

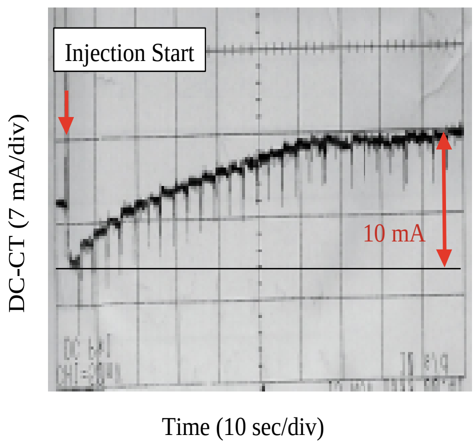

Figure 3. Stacking beam current at the injection. It is measured by the DC current transformer.