# *ELECTRON STORAGE RING, KSR FOR LIGHT SOURCE WITH SYNCHROTRON RADIATION*


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A small electron storage ring (KSR) in a race track shape with the triple bend doubly achromatic lattice and the circumference of 25.7 m is now under construction. Its maximum energy and radius of curvature in the bending section is 300 MeV and 0.835 m, respectively. The critical wave length of the radiation from the dipoles is 17nm. In order to enable future installation of a insertion device for much shorter wave length, two long straight sections, 5.62 m in length are provided. The magnet system consisting of dipole, quadrupole and sextupole magnets are already aligned with precision of a few tenth mm.

## I. INTRODUCTION

At Institute for Chemical Research, Kyoto University, a small electron storage ring (KSR) is under construction. Its injector linac with the energy of ~100 MeV has been almost completed[1] and the magnet system of the KSR ring consisting of six dipole, twelve quadrupole and four sextupole magnets has also been aligned precisely. Its layout is shown in Fig. 1. The critical wave length of the light from the dipole section is 17 nm. So as to provide the light with much shorter wave length, possibility to install a superconducting wiggler is being studied. The main parameters of KSR are listed up in Table 1.

Table 1 Main Parameters of the KSR

| | |
|---|---|
| Maximum Energy | 300 MeV |
| Injection Energy | 100 MeV |
| Circumference | 25.689 m |
| Lattice Structure | Triple Bend Doubly Achromatic |
| Superperiodicity | 2 |
| Bending Angle | 60° |
| Radius of Curvature | 0.835 m |
| n-value | 0 |
| Edge Angle | 0° |
| Length of the Long Straight Section | 5.619 m |
| RF Frequency | 116.7 MHz |
| Harmonic Number | 10 |
| Number of Betatron Oscillations: | |
| Horizontal Direction | 2.75 |
| Vertical Direction | 1.25 |
| Critical Wave Length of the Light from Dipole | 17 nm |

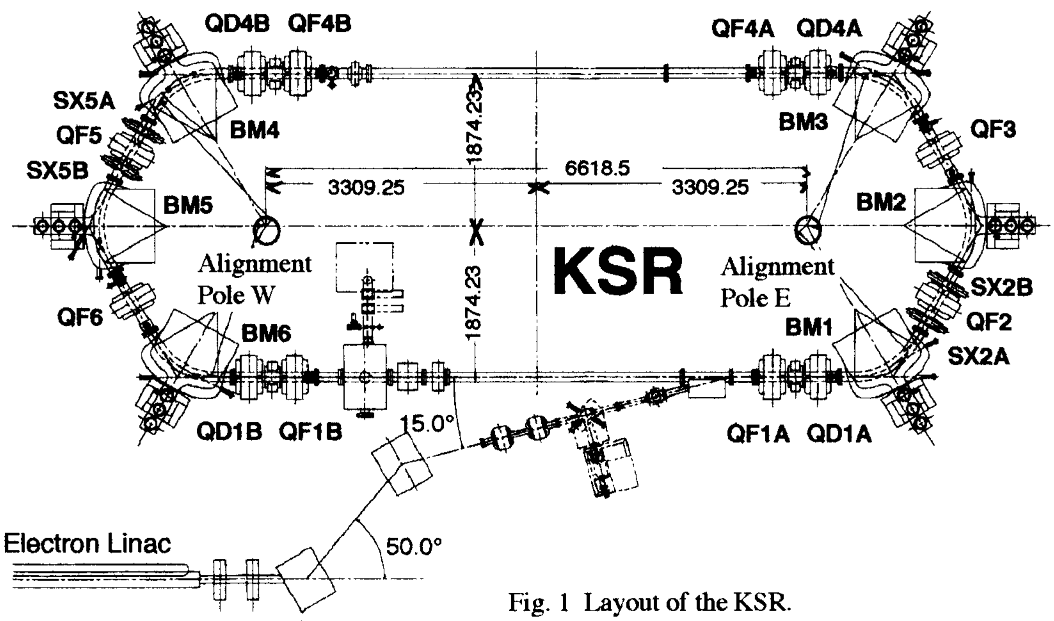


Fig. 1 Layout of the KSR.

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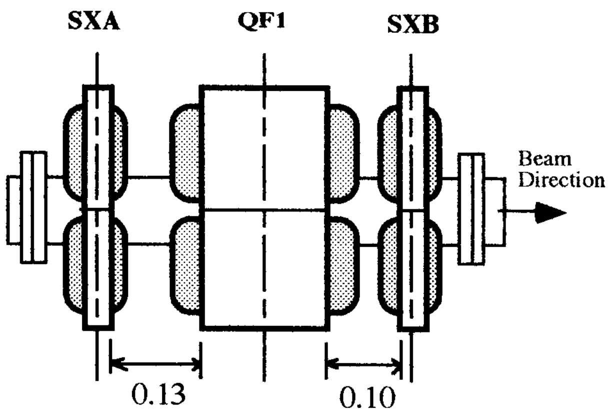


Fig. 2 Positions of the sextupole magnets relative to the quadrupole magnet, QF1. Scales in the figure are given in m.

## II. LATTICE DESIGN

The triple bend doubly achromatic lattice with a race track shape including two long straight sections, 5.62 m in length, has already been decided [2]. As the dispersion function is zero in the long straight sections, sextupole magnets for chromaticity correction should be located at the short straight sections between dipole magnets. Keeping the superperiodicity of two, real installation has been made as shown in Fig. 1 taking the spaces needed for vacuum ports and beam monitors into account. Two sets of sextupole magnets are installed at the two short straight sections located at the diagonal positions in the ring. In Fig. 2, detailed positions of the sextupole magnets relative to the quadrupole magnet (QF1) are shown. The operating point with higher vertical tune of (2.75, 1.25) is newly adopted from the point of view of installing an insertion devices as described later. The momentum dependence of the betatron tune is shown in Fig. 3 for the cases of without sextupole correction (a) and with sextupole correction(b). The excitation strength of the sextupole magnet ($B''l/B\rho$) assumed in Fig. 3(b) is -2.34 $m^{-2}$ and 2.05 $m^{-2}$ for SXA and SXB sextupole families, respectively, where the length of the sextupole magnet is 0.065 m.

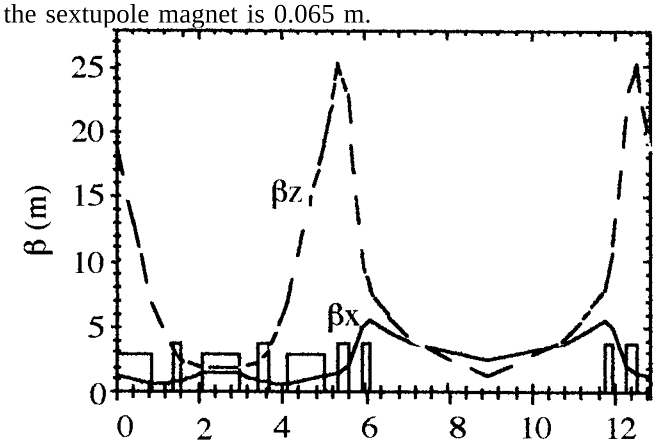


Fig.4(a) Betafunctions without an insertion device.

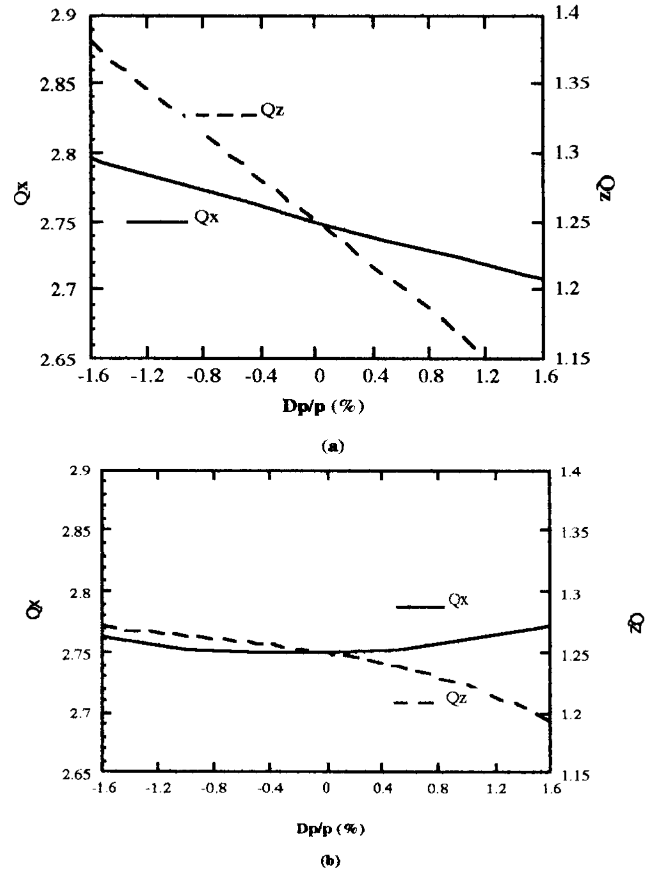


Fig. 3 Momentum dependence of betatron tunes without (a) and with (b) sextupole correction.

The insertion device such as a superconducting wiggler is anticipated to cause undesirable perturbation on beam dynamics[3]. From this point of view, the higher vertical tune might be preferable. The vertical tune is optimal at the value of 0.75 or 1.25 from the point of view of small vertical beam size. The tune value of 1.25 is found more stable against the perturbation from the wiggler. Compared with the case without any insertion device (Fig. 4(a)), the betafunction in vertical direction becomes to have

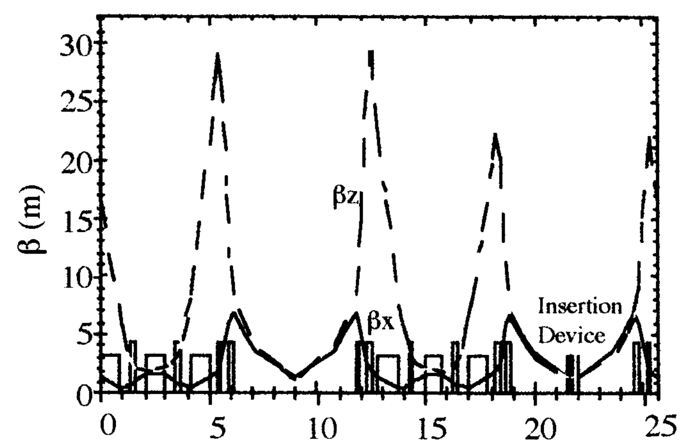


Fig.4(b) Betafunctions perturbed by the three pole wiggler with the strength of 2.5 T.

a beat as shown in Fig. 4(b) due to the wiggler field of 2.5 T,which correspond to the critical wave length of 8 nm. The size of $\beta z$ beat is ~17% which seems to be comparable with that reported for ELETTRA[4]. The vertical tune shift for this case is 0.03. Further careful studies on beam dynamics are needed.

## III. ALIGNMENT OF THE MAGNETS

The procedure of alignment of the magnets has been performed in the following way. (1)Two alignment poles E and W are precisely set at the positions indicated in Fig. 1 with use of optical devices. The pole has a cylinder, the diameter and surface of which are well controlled in precision during fabrication process and the cylinder is set upright with good precision. Further it is possible to attach the positioning table for optical device on the cylinder with good precision. (2)Three dipole magnets in each arc are positioned with measurement of the distances from each alignment pole. Each dipole magnets has three positioning holes whose positions are precisely controlled. The distance between the rods inserted in these holes and the cylinder on the alignment pole is measured with use of an inside-micrometer. Thus the positions of the dipoles are known. The spacing between the adjacent dipoles is adjusted with use of the theodolite which automatically attitude corrected (made by Wild Co. Ltd.) (3) The axes of the quadrupole magnets are adjusted with use of the theodolite set on the line which connects the aperture centers of the two adjacent dipole magnets. Then the distance from the nearest dipole is measured by an inside-micrometer. Thus the positioning of the quadrupole magnets is made relative to the dipole magnets. (4) The sextupole magnets are positioned with the same method as above but relative to the quadrupole magnets. At all stages from (2) to (4), the vertical positions of all the magnets are adjusted with use of an auto-level with optical micrometer.

In order to confirm the precision of this positioning, we measured the distances between positioning rods attached to the adjacent dipoles. The deviations of the measured values from ideal one are less than 60 μm for the distance of 1200 mm. Further the distance between the beam center at the long straight section and the line which connects the centers of the two alignment poles, E and W, is measured to be 1874.17 mm while the designed one is 1874.23 mm (Fig. 1). From these results, we are quite confident of good alignment precision better than a few tenth mm. In Fig. 5, the recent overall view of the KSR after alignment is shown.

Fig. 5 Recent View of the KSR.

## IV. SUMMARY

Up to now, the magnets system has already been aligned and some of vacuum chambers have already been also installed into the magnets after their alignment. However, much careful studies about the effects on beam dynamics due to the insertion device is needed. The possible future application of the radiation from the insertion device should also be considered carefully, which requires some more time. Thus, separate evacuating systems for the arc portions will be prepared for the purpose of vacuum aging during such study about insertion devices. The possibility to use the KSR ring as the stretcher of the electron beam from the linac before the completion of the insertion device is also being considered.


## V. ACKNOWLEDGEMENT

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