

## Extraction system of the electron storage and stretcher ring, KSR

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### Abstract

The electron ring KSR has two operation modes. One is a storage mode of maximum energy 300 MeV and the other is a stretcher mode with energy 100MeV. In stretcher mode, we will use slow extraction method with RF knock-out. This method will keep an emittance of the extracted beam low. We newly built an electrostatic septum (ESS) with the field strength of 70 kV/cm and a magnetic septum with the field strength of 0.5 T for the beam extraction. A steering magnet, which makes a bump orbit for the extraction will be installed.

### 1.Introduction

An electron storage ring, KSR, is under construction at the Nuclear Science Research Facility, Institute for Chemical Research, Kyoto University. This ring will be used for the research using the synchrotron radiation from bending magnets and an insertion device. It will be also used as a pulse stretcher of the electron beam from the linac[1] [2]. The operating energy is 100 MeV in stretcher mode. The electron beam from the S-band linac is injected into the ring at the inflector and extracted from the ring through the electrostatic septum with the repetition of 1 Hz[3]. For the extraction, a sextupole magnet is used as a resonance exciter, and the third order resonance,  $3\nu_H=7$ , is excited. The electron, whose betatron oscillation amplitude exceeds the separatrix, is taken out along the outgoing separatrix. Betatron oscillations increase when there is a transverse electric field that resonates with the betatron

oscillation (RF-KO). An RF-KO is used to take an electron to the separatrix. The beam in the unstable region is captured by electric field of electrostatic septum and taken out of the ring. Septum magnet bends an electron beam orbit further more and then the beam is transported to beam dump. The merit of this method is the small variation of beam extraction angle. The separatrix does not change its size throughout the whole extraction process in this method though the tune shift method brings about shrinkage of separatrix. The reduction of separatrix means the change of extraction angel. The total layout of KSR and positions of major devices for injection and extraction are shown in Figure 1.

### 2.Extraction channel of KSR

The electrostatic septum, which is the first septum, consists of the electrode of Aluminum and foil of Titanium. The septum magnet is the second septum that is located 0.86 m down stream of the electrostatic septum.

#### 2.1 ESS

Figure 2 shows the cross sectional view of electrostatic septum. A power supply of maximum voltage 100 kV is connected to an Al electrode. The main parameters of electrostatic septum are shown in Table 1. We succeeded in applying electric field up to 65 kV/cm with the gap of 0.8 cm, which well covers the turn separation. To attain the field of 70kV/cm we need further aging process.

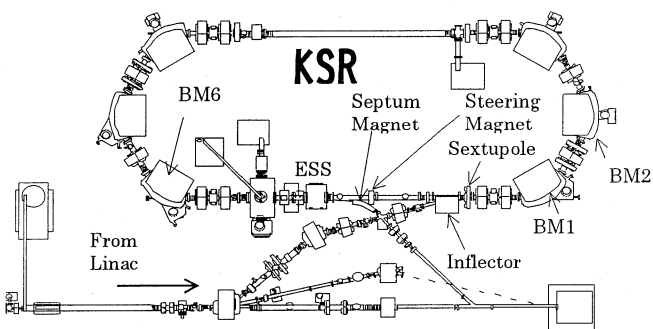


Figure 1 The layout of the KSR. It shows the places of the main devices for the injection and the extraction of the beam.

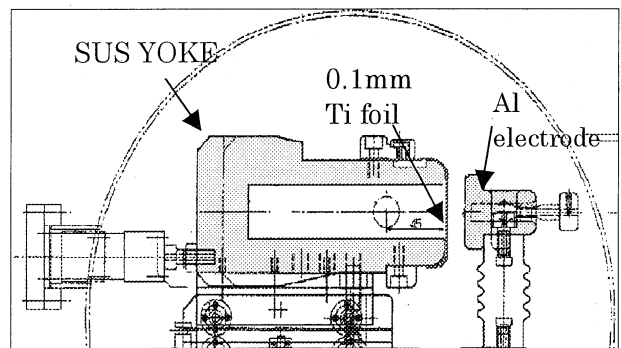


Figure 2 Cross sectional view of ESS. The circulating beam passes through in the yoke, and the extracted beam goes through between the Ti foil and Al electrode. Both the yoke and the electrode can move in horizontal direction independently.

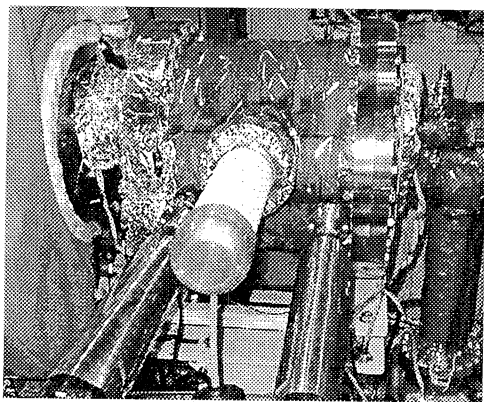


Figure 3 ESS installed in the KSR. The corona ball attached to the ceramic insulator is seen at the center. The linear feedthroughs covered with copper sheets, which are utilized for the position adjustment of the Al electrode, can be seen below.

Table 1 Main parameters of the electrostatic septum

Deflection angle	20.5 mrad
Gap electric field	70 kV/cm
Electrode length	0.3 m
Septum thickness	0.1 mm
Maximum power supply voltage	100 kV

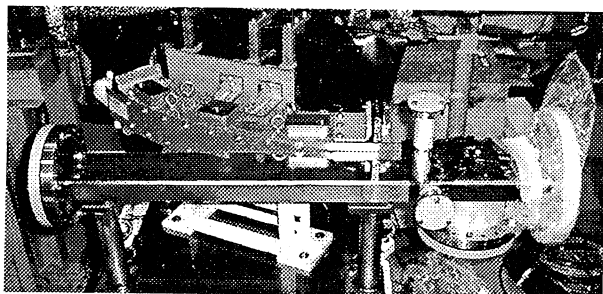


Figure 4 Septum magnet. The circulating beam goes through the inside of the vacuum duct which can be seen this side. Extracting beam passes a duct surrounded by septum coil of the other side.

### 2.2 Septum Magnet

Figure 4 shows the whole view of the septum magnet. This device will be installed in the ring after the magnetic field measurement. Table 2 shows main parameters of this element. The septum coil is placed out of a vacuum duct to achieve ultra-high vacuum in storage mode. So the septum thickness of 22.6 mm is required. (See figure5) The

specification of electrostatic septum and the distance of the first and the second septum meet this condition.

Table 2 Main parameters of the septum magnet

Deflection angle	45 °
Gap	29 mm
Magnetic field	0.5 T
Pole length	550 mm
Maximum current	1460 A
Septum thickness	22.6 mm
Turn of coil	8 turn

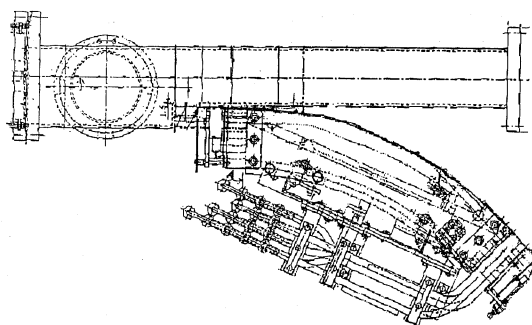


Figure 5 The septum magnet and the duct. The septum coil surrounds the curved duct.

### 3. Steering magnet for the bumped orbit

As described earlier, injection and extraction are done in the same straight section. So the electrostatic septum and the inflector are close to each other. This causes a problem that the circulating beam near the electrostatic septum foil might hit the inflector. Because the horizontal aperture is 33 mm at the inflector while the distance between the orbit center and the septum foil is 45 mm. A steering magnet (shown in figure 6) is used to resolve this difficult situation. The steering magnet and three correction coils of bending magnets (BM1, 2,6) make an orbit bump to avoid the beam loss and put out this effect in other section. Figure 7 shows concept of the beam slalom. A beam travels avoiding the wall and comes back to an original orbit after this section. We find out the kick-angles suitable for this orbit bump by calculation.

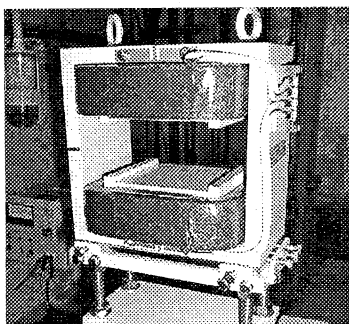


Figure 6 Photograph of a steering magnet. Maximum magnetic field is 400 gauss, and pole length is 10 cm. This magnet kicks the circulating beam by 5 mrad.

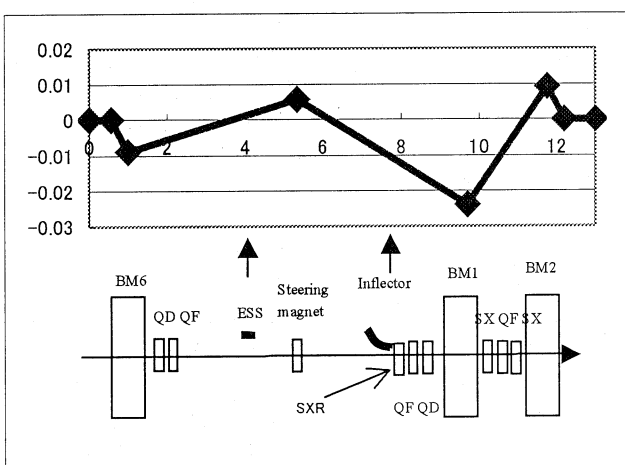


Figure 7 The bump of the beam orbit. Orbit distortion from the center orbit is shown in upper graph. Horizontal axis corresponds to the elements below. The correction coil of BM6 kicks the circulating beam toward the electrostatic septum foil. The steering magnet kicks back the beam toward the center orbit. The correction coils of BM1 and BM2 compensate the orbit distortion. And the distortion is disappeared after the BM2.

#### 4. Conclusion

We produced some devices for slow-extraction by the third order resonance with RF-KO method in order to extract the beam whose change of extraction angle is fairly small. And we made a steering magnet to be consistent with storage and stretcher modes. The electrostatic septum was installed in the KSR. After the field measurement of septum magnet, the steering magnet and the septum magnet will be

installed in the KSR. The beam test of these equipments will start soon.

#### Acknowledgement

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