SLOW EXTRACTION SYSTEM OF STRETCHER RING, KSR

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Abstract

A beam extraction channel of 100 MeV electron injected into a stretcher ring, KSR from a disc-load type s-band linac has been constructed. An electrostatic septum (ESS) with the field strength of 70 kV/cm utilizing a Ti foil 0.1 mm in thickness has been fabricated as the first septum. A septum magnet with the field strength of 5kG utilizing septum coil 14 mm in thickness is to be utilized to deflect the extracted beam further as large as 46 °.

1 INTRODUCTION

A race-track ring, KSR, 25.7 m in circumference was originally designed as an electron storage ring for synchrotron radiation. The needs of the 100 MeV electron beam from the injector linac has been increasing more and more in these years[1,2]. The very small duty factor as $2x10^{-5}$ of the output beam from the linac, however, limits the statistics and resolution of the experiments. In order to improve this situation, KSR is decided also to be used as a pulse stretcher. The injected beam into KSR will be extracted in 100 msec with use of a combination of the third order resonance and RFKO method, which has already been successfully applied to ion beams[3,4,5].

The extraction channel is to be installed at the upstream of the inflector as shown in Fig. 1. With this configuration, the same beam dump can be commonly used both for the direct output beam from the linac and the extracted beam from KSR. As the beam dynamical points have been already reported[6], the hardware system of the extraction channel under construction is to be presented here.

2 EXTRACTION CHANNEL OF KSR STRETCHER MODE

The 100 MeV electron beam injected into the KSR ring is increased in its betatron oscillation amplitude by the third order resonance ($\nu_H = 2\frac{1}{3}$) with a sextupole magnet of the strength of 9.5 $1/m^2$ ($B''l/B\rho$) and a transverse RF electric field which resonates with the betatron oscillation. As the aperture of the normal parts of the KSR ring is rather limited to be ±55mm, septum position of the first septum is set to be at 0.45mm as shown in Fig. 2. As is known from the figure, the turn separation at the septum position is not so large as 3.2 mm. In order to attain tolerable extraction efficiency, the septum thickness of the first septum should be as small as possible and the electrostatic

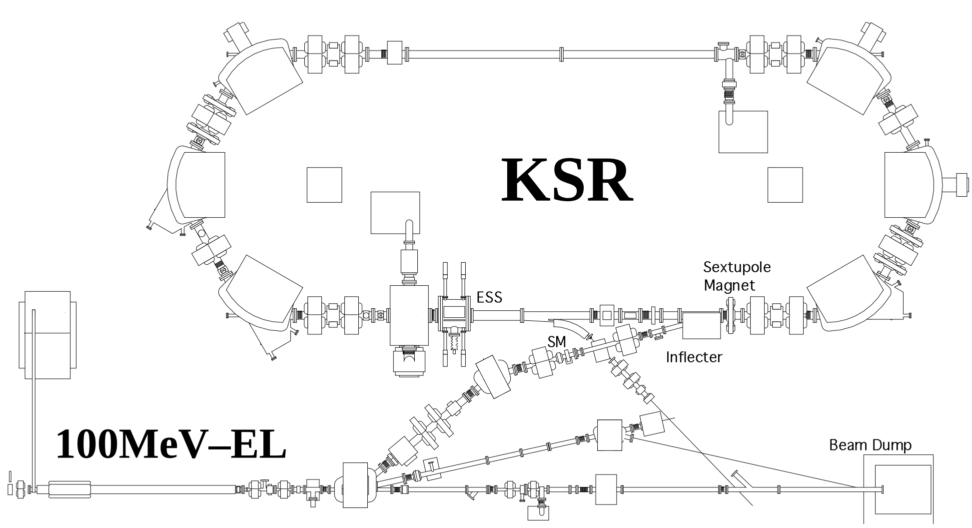

Figure 1: Beam extraction channel of the KSR stretcher mode and the injection line.

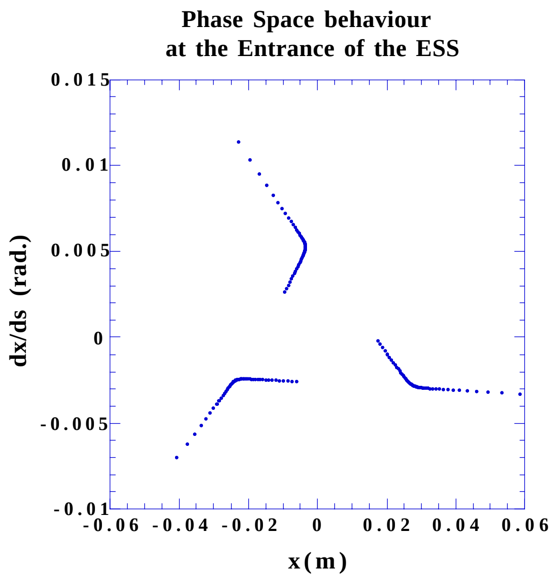

Figure 2: Beam behavior in the horizontal transverse phase space at the entrance of the ESS.

type is necessarily adopted.

Here we use the Ti foil, 0.1mm in thickness as the septum, which is expected to result in the extraction efficiency of more than 95%. The electric field of 70 kV/cm will deflect the 100 MeV electron beam by 21mrad, which realizes coil space of 14 mm for the second septum magnet, SM. The SM will deflect the beam as large as 46° by the magnetic field of 5kG with core length of 0.565m along the central orbit.

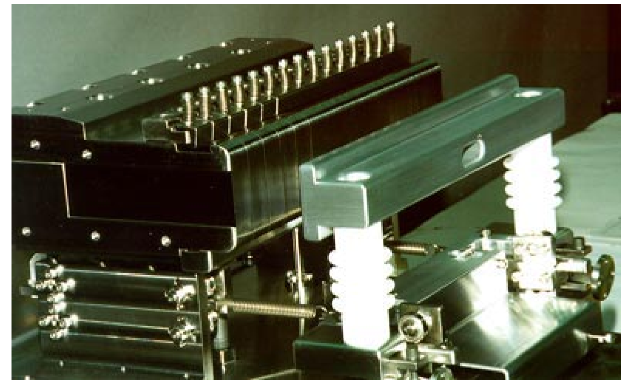

Figure 4: Fabricated electrostatic septum (ESS).

3 ELECTROSTATIC SEPTUM

The electrostatic septum is composed of a high voltage electrode made of Al and the septum foil made of Ti 0.1 mm in thickness, which is attached to the stainless steel yoke as shown in the cross-sectional view of Fig. 3. The foil is pulled from up and down by applying tensions with use of bolts as is seen in Fig. 4. As we are so much afraid of wrinkles of the foil when electron beam hits the uppermost part of the foil, we have divided the one third of the foil into 5 stripes each 2 cm in width in order to apply enough tension to each stripe.

The special feature of the extraction system of KSR is the fact that it must be compatible with the operation as a synchrotron light source without beam extraction. So the ESS should be movable to the position where the ESS does not limit the beam aperture. From this condition, the septum position is made to be varied in the region of 20

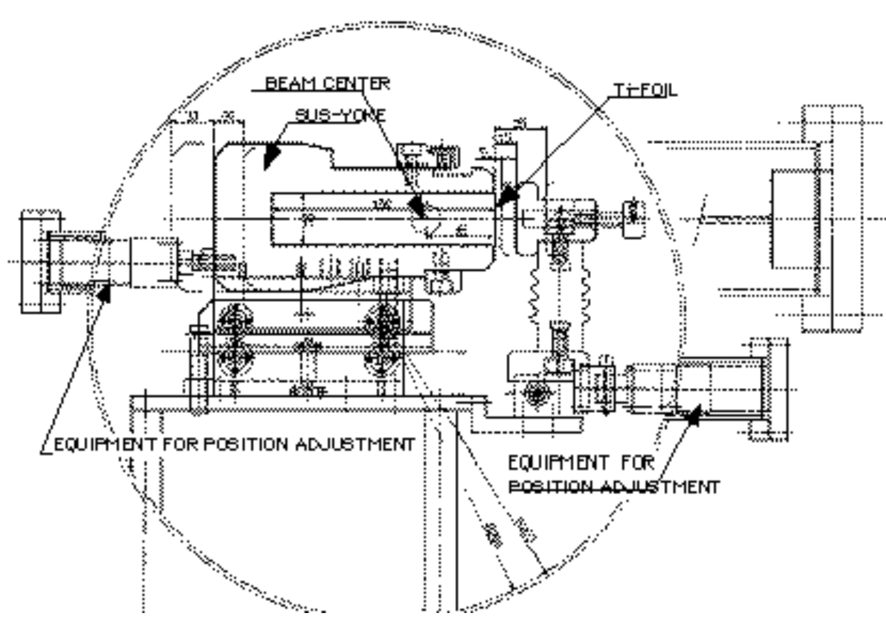

Figure 3: Cross-sectional view of the ESS.

mm to 65 mm outside from the beam center. The inner side of the Al electrode can be varied in the region of 50 mm to 80 mm outside from the beam center in order to make it possible to give a various gap size between 5 mm to 35 mm according to turn separation. The positions of Yoke and electrode are adjusted by linear feedthroughs drived with pulse motors from outside of the radiation controlled experimental area. Their positions are monitored by measuring the voltages at the potentiometers attached to the linear feedthroughs. In Fig. 5, completed ESS set into a vacuum vessel is shown.

As the material of the high voltage electrode, we have adopted Aluminum because a positive high voltage is to be applied and heavy emission of secondary electrons is anticipated once sparking has been triggered for metals with high resistance as stainless steel[2].

4 SEPTUM MAGNET

In order to kick out the 100 MeV electron beam entirely outside of the ring as shown in Fig. 1, a septum magnet with field strength of 5kG of the septum thickness of 14mm is now being studied. The septum coil is to be set outside of the vacuum, because KSR requires ultra-high vacuum for the case of utilization as a synchrotron light source. So additional spaces for vacuum chamber wall is needed in addition to the septum coil space of 14 mm. In the present configuration given in Fig. 1, the separation between the deflected beam by the ESS and the circulating beam in the KSR ring is expected to be 27 mm at the entrance of the SM, which seems to provide enough spaces for the septum coil and chamber wall and their clearance. In Fig. 6, the septum magnet (SM) under design is shown. By putting a thin iron plate, 1mm in thickness outside of the septum coil at the position 1.5 mm apart from the septum surface with use of non magnetic spacer, the leakage field level is reduced to be less than 0.1 % of the field strength in the gap at the center of the extracted beam orbit, which seems to be well in the torelance for real usage.

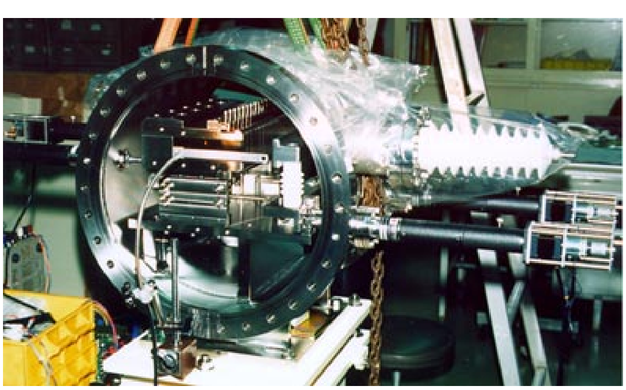

Figure 5: view of the ESS installed in the vacuum vessel.

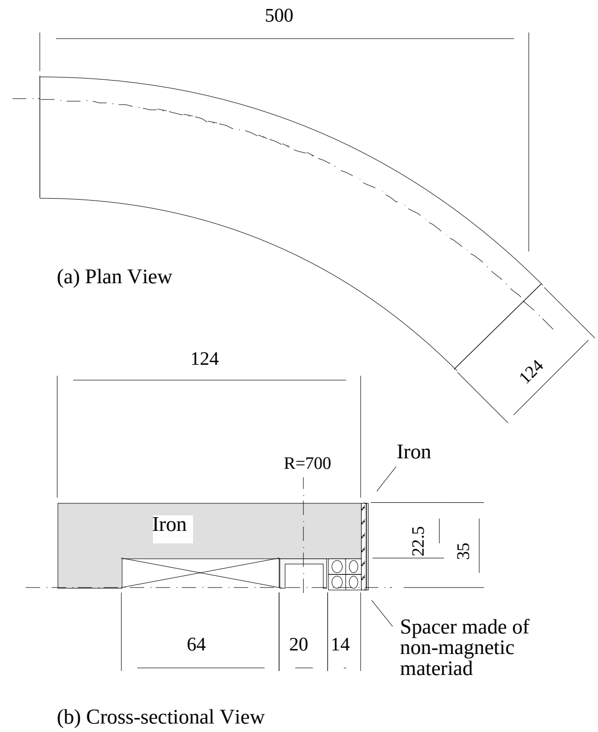

Figure 6: The septum magnet under design for KSR stretcher mode.

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