STRETCHER MODE OPERATION OF 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 100 MeV. In stretcher mode, we use slow extraction utilizing the RF knock out method with the third order resonance. This method has a merit of realizing a low extracted beam emittance. In this paper the first beam extraction from KSR is reported.

1 INTRODUCTION

There is an electron storage ring, KSR 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. There is a S-band linac whose maximum duration, maximum repetitions and typical beam current are 1μsec, 21Hz and 100mA, respectively. The electron beam from the linac is injected into the ring through an inflector and extracted from the ring through an electrostatic septum and a magnetic 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, ν_H=7/3, is excited. The electron, whose betatron oscillation amplitude reaches 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 knock out). An RF knock out is used to drive 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. The magnetic septum 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 a 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 angle. Therefore we can extract a small emittance beam by RF knock out method. This method achieved a remarkable success in ion accelerators such as TARN II and HIMAC. But it has the effect of the radiation damping in the case of the electron beam. The possibility that a beam can't be taken out from the ring exists especially with the high-energy machine. But in the case of KSR stretcher mode of the highest energy 100 MeV, the dumping time is about 3.5 seconds and the effect of the radiation damping can be ignored when injection and extraction is performed with the repetition rate of 1Hz then the RF Knock Out method is adopted.

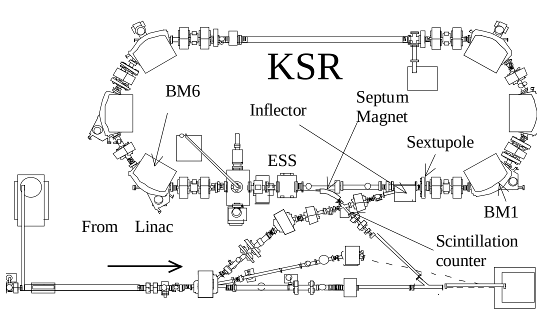

Figure 1: The layout of the KSR. It shows the places of the main devices for the injection and the extraction of the beam.

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 Aluminium and foil of Titanium. The magnetic septum is the second septum that is located 0.86 m down stream of the electrostatic septum. The beam, whose betatron oscillation amplitude is increased rapidly by the third order resonance enters into the aperture of the electrostatic septum and kicked toward the outside of the ring by the electric field of the electrostatic septum. And then it departs from the circulating orbit further with a magnetic septum, and it is led outside the ring to the beam dump.

2.1Eelectrostatic Septum

Figure 2 shows the cross sectional view of electrostatic septum. A power supply of maximum voltage 100 kV is connected to an Al electrode and attains the electric field of 70 kV/cm between an electrode and a yoke. The main parameters of electrostatic septum are shown in Table 1.

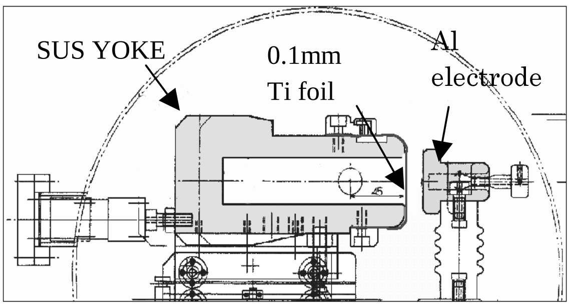

Figure 2: Cross sectional view of ESS. The circulating beam passes through inside the yoke, and the extracted beam goes through between the Ti foil and Al electrode. Both the yoke and the electrode can move in horizontal direction independently.

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

2.2 Septum Magnet

Figure 3 shows the whole view of the magnetic septum. The extracting beam is bent at 45° by this septum.

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. 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 degree
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

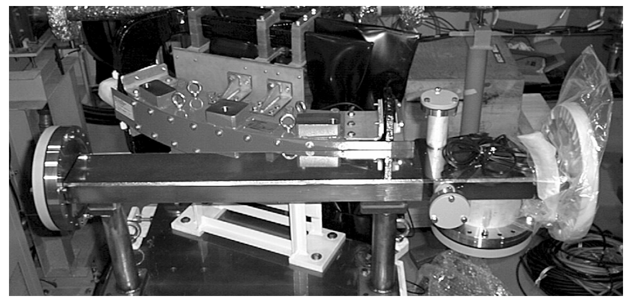

Figure 3: Magnetic septum. The circulating beam goes through the inside of the vacuum duct which can be seen this side. Extracting beam passes a duct surrounded by septum coil of the other side.

3 BEAM EXTRACTION EXPERIMENT

We set scintillation counter to a position shown in figure 1 already, and detected extraction beam. Figure 4 shows a block diagram of the measurement system. We did this experiment on the beam energy of 80 MeV. Figure 5 shows the output signal of the DCCT installed in KSR. From this figure it is clear that the beam current decreases slowly from after 50 msec. A difference of the output signal from scintillation counter between the two conditions of the electric field of electrostatic septum 55.3kV/cm and 8.4kV/cm is shown in figure 6. Because

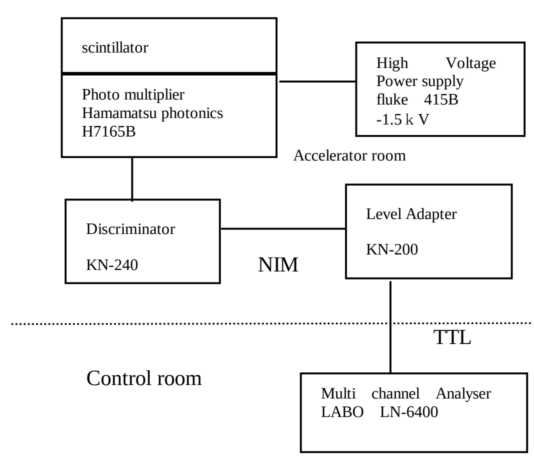

Figure 4: Block diagram of the measurement system

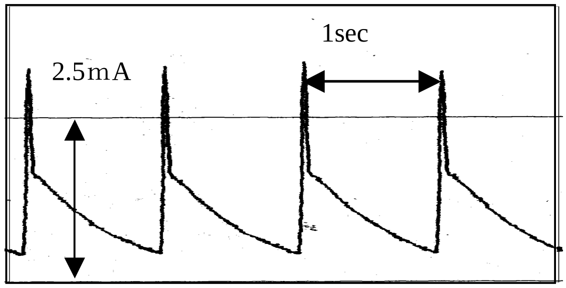

Figure 5: Output signal of DCCT X-axis shows time. Y-axis shows the beam current of KSR

the kick to the beam by the electric field of 8.4kV/cm is negligible, we can consider this output signal of scintillation counter as background noise. So it can be said that figure 6 shows a signal by the extracted beam. This indicates that slow extraction is completed slowly at least from 50 msec to 800 msec after the injection. Figure 7 shows a change of the sum of the signal that entered within 100 μ sec duration when the current of septum magnet coil is changed. Because a signal varies with a change of a magnetic field, this signal wasn't brought about by noise of radioactive rays but by the extracted electrons.

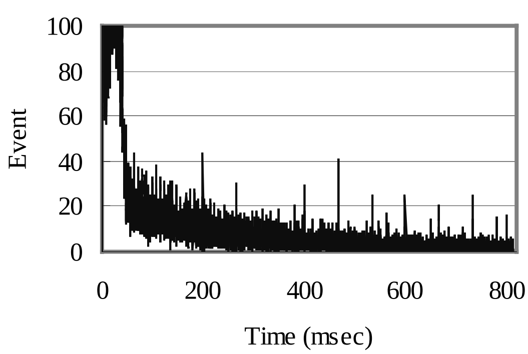

Figure 6: Signal of extracted beam There are some sharp noise caused by thyratrons for linac.

4 CONCLUSION

The first beam extraction experiment to extract the electron beam from the stretcher ring KSR utilizing the RF-knock out method with the third order resonance is accomplished. From this preliminary experiment, it is found that our slow extraction system works as is designed. More quantitative measurement is scheduled in the near future.

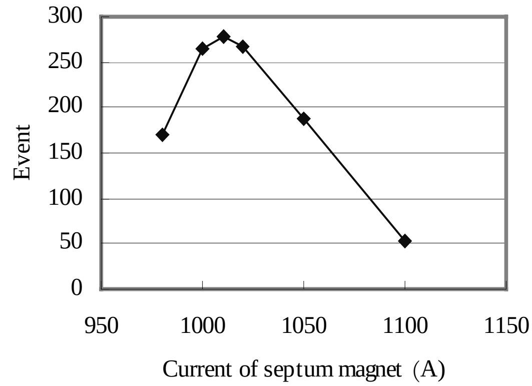

Figure 7: Output signals of scintillation counter versus current of septum magnet.

ACKNOWLEDGEMENT

The work presented here is supported by Grant-in-Aid for Scientific Research (A) from Ministry of Education, Science, Sports and Culture of Japan with contact No. of 09304042.

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