Investigation of transmission efficiency loss at Rare-RI Ring

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We have conducted a test experiment at the Rare-RI Ring (Fig. 1) using Rare Isotopes (RIs) produced from ^{238}U beam on Be target at RIBF.[1)] The aim was to demonstrate the mass measurement principle of Rare Isotopes using the Rare-RI Ring.[1,2)] In this experiment, the total transmission efficiency at the extraction (ELC) was very low (0.14%), which is not suited for mass measurement of RIs with very low yield. To investigate the origin of the efficiency loss, we have conducted simulation using MOCADI. As it can be seen from Fig. 2, the transmission efficiency loss is dominated by loss at the injection (between ILC2 and Kicker) and extraction (between Kicker and ELC). In order to investigate the reason for such large drop in efficiency, we examined the emittance evolution at the injection. Since it was not possible to measure the emittance during the experiment, we deduce the emittance from elements matrix calculated in COSY

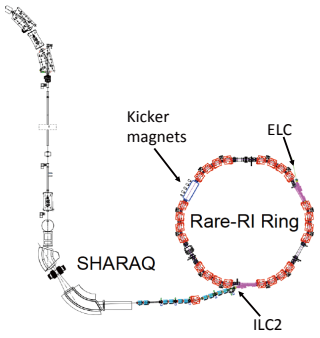

Fig. 1. Overview of the Rare-RI Ring (R3).

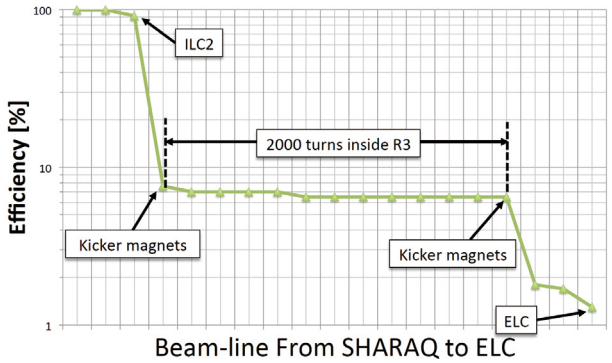

Fig. 2. MOCADI simulation of transmission efficiency.

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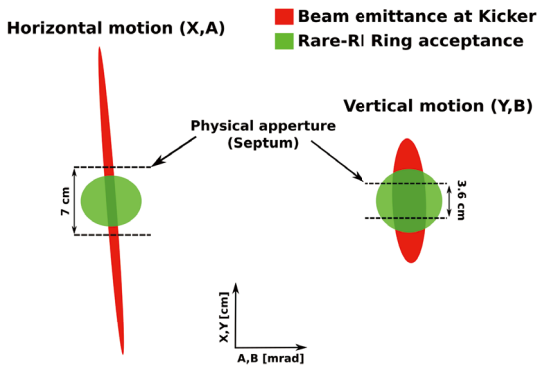

Fig. 3. Horizontal and vertical beam emittance at the Kicker compared to Rare-RI Ring acceptance. Typical beam emittance was around 50 ∼ 80 mm · mrad.

Infinity based on the initial experimental emittance. We compared the emittance at Kicker magnets to the Rare-RI Ring acceptance in Fig. 3. It is clear that there is a mismatch between the beam emittance and the storage ring acceptance, especially in the horizontal direction, since the dispersion matching condition should be also satisfied for a stable particle motion in the ring.[3)] The total transmission in Fig. 2 is overestimated by simulation (experimental value 0.14%). We believe this is due to observed vertical and horizontal shift of the beam, which is still under investigation.

We can also evaluate the efficiency from the intersection of the beam emittance and the storage ring acceptance taking into account the physical aperture of the injection septum located at the ring entrance. The evaluated efficiency after the Kicker is consistent with experimental efficiency of about 2% measured behind the Kicker. From this result, we conclude that the loss in transmission efficiency is mainly due to emittance mismatch between the beam emittance and the Rare-RI Ring acceptance. A compromise between dispersion matching and emittance matching should be found in order to increase the transmission efficiency. For this purpose, we designed a new injection optics, which was tested end of November 2017. We have improved the over all transmission efficiency by 13 times. Details of the simulation and results are discussed in details in Ref. 4).

References

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