Improvement of the Rare-RI Ring beam transport using vertical steering magnets

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To improve beam transport from the focal plane F3, at BigRIPS to the Rare-RI Ring (R3), we developed two vertical steering magnets.[1)] Since there were no vertical steering magnets in the beam line, a displaced beam both in position and angle at F3 propagates to R3 resulting in the deterioration of beam transport.

In June 2024, we tested the steering magnets to check the beam correction ability and the degree of improvement on the extraction yield from R3 using a primary beam of ^{124}Xe. To measure the vertical beam position and angular distribution at F3, we used two Parallel Plate Avalanche Counters (PPACs). Another two PPACs were also installed inside R3's kicker chamber to verify the beam position and angle. To measure the extraction yield, a plastic scintillator was placed at the exit of R3. The used detectors are illustrated in Fig. 1.

In this experiment, we observed a mean vertical beam position of −2.0 mm and a mean vertical angular distribution of −2.7 mrad at F3. Figures 2(a) and 2(b) illustrate the vertical beam position and angular distribution at the kicker magnet before beam correction. The vertical beam position was shifted and broadened due to beam optics in this time. For the angular distribution, it was sharp due to the narrow acceptance of R3, and the mean value was −1.7 mrad. We investigated the optimal deflection angle of the steering magnets by checking the vertical beam profile at the kicker. As a result, the vertical beam position and angular distribution were adjusted as shown in Figs. 2(c) and 2(d). Under those conditions, we applied a current of −7 A and +7 A to the upstream and the downstream steering magnets which correspond to deflection angles of −1.5 mrad and +1.7 mrad, respectively. Using the steering magnets, we obtained a higher extraction yield by a factor of 7 in total. This includes a 2-fold improvement of the yield at the kicker and a 3.5-fold improvement at the end of R3.

This experiment demonstrated that the steering magnets improved the beam transport from F3 to the ring. Higher extraction yield enables more efficient experiments and opens opportunities to study nuclei far from stability. To provide further insight into the beam transport inside the ring, a 3D beam trajectory simulation using the Runge-Kutta method is under development.

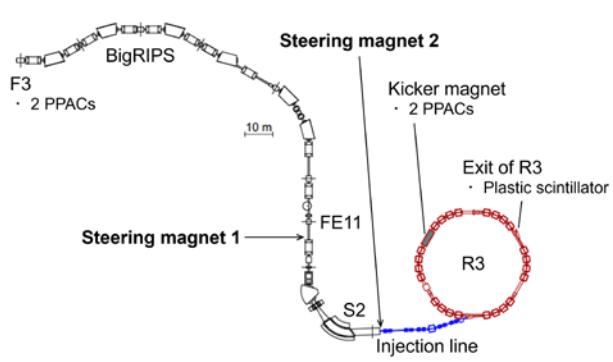

Fig. 1. The schematic view of the beam line.

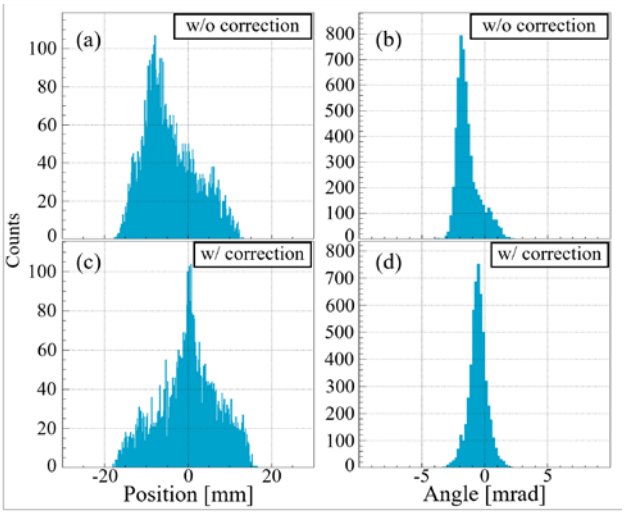

Fig. 2. (a) and (b): The vertical beam position and angular distribution at kicker magnet without the correction. (c) and (d): The vertical beam position and angular distribution at kicker magnet with the correction.

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Reference
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