Peformance of a fast kicker magnet for Rare-RI Ring†

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A fast kicker magnet is indispensable for injecting beams into the rare-RI ring individually[1)]. Therefore, we developed a distributed-constant type fast kicker magnet. The kicker magnet is equivalent to an electronic circuit that is a π-type LC circuit.

Based on the detailed simulations of the equivalent electronic circuit of the prototype kicker magnet, we optimized the inductance, capacitance, and mutual inductance. We used these simulation results to develop a new kicker magnet. The new kicker magnet parameters are designed to be $L = 100$ nH and $C = 350$ pF to improve impedance matching, and an additional capacitance of 2600 pF was attached to the entrance of the kicker magnet to prevent reflection.

We applied the search coil method to measure the magnetic field. The result of the magnetic field of the new kicker magnet at 20 kV is shown in Fig.1. The propagation time from a trigger signal input, which corresponds to 0 ns in Fig.1, until the peak of the kicker magnet field, is approximately 545 ns.

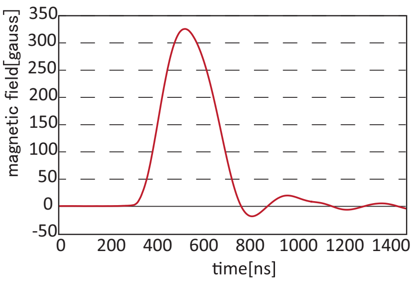

Fig. 1. Typical magnetic field of a new kicker magnet.

In June 2015, we carried out the first commissioning of the rare-RI ring using a $^{78}Kr^{36+}$ beam with an energy of 168 MeV/nucleon. The kick angle of 11.4 mrad is required for injection into the rare-RI ring. For the present beam condition, a magnetic field of 434 G is required. Thus, the kicker power supply should be charged up to 26.6 kV.

We tested an individual injection method using the new kicker magnet. To confirm the injection of the beam, a plastic scintillation counter was placed in the central orbit at the detector chamber after the next straight section of the rare-RI ring. When the beam is kicked correctly, it is counted by the plastic scintillation counter. We measured the number of counts by changing the charging voltage, as shown in Fig. 2. This figure shows the relative injection efficiency because the width of the plastic scintillation counter is smaller than that of the acceptance of the ring.

We tested the ejection of the stored beam using the same kicker magnet after 700 μs storage. A plastic scintillation counter was placed at the exit of the ring. We measured the number of events counted by the plastic scintillator by changing the ejection timing; the charging voltage of the kicker magnet was 26.6 kV. The result is shown in Fig. 3. This plastic scintillation has sufficient width to cover the extractable acceptance of the ring. From this result, the kicker magnet has a flat top of approximately 100 ns because the duration until the extraction efficiency up to 90 % of the peak is approximately $\pm$ 50 ns.

The present result shows that the individual injection method and ejection was successfully performed.

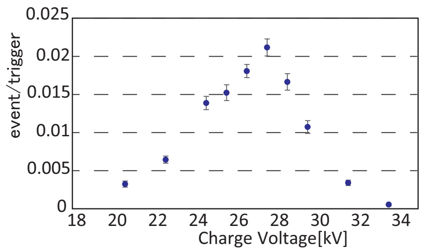

Fig. 2. Number of injected events by the plastic scintillation detector as a function of the charging voltage of the kicker magnet.

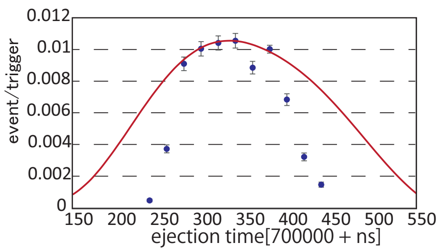

Fig. 3. Number of events counted by the plastic scintillation detector at the exit of the storage ring as a function of ejection delay timing.

Reference

1) Y. Yamaguchi et al., Phys. Scr. T166, 014056 (2015).

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