Circulation detector for Rare RI Ring

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A circulation detector consisting of a carbon foil and a multichannel plate (MCP) has been developed for confirming that particles can be stored and for evaluating the revolution time in the Rare RI Ring[1)]. Although the basic concept of the circulation detector is the same as those developed at GARIS and Tsukuba[2)], and GSI[3)], an enlargement of the sensitive area is required to cover a large beam profile in the Rare-RI Ring. A schematic view of the detector is shown in Fig. 1. A large and thin carbon foil (100 × 50 mm^2 and 60 μg/cm^2) was developed at RIKEN[4)]. A stored particle generates secondary electrons when passing through the carbon foil. Secondary electrons are accelerated by an acceleration electric field $E_{\rm acc}$ applied between the carbon foil and an acceleration grid, and they are then deflected at 90 degree towards the MCP by an electrostatic mirror field $E_{\rm mir}$ applied between two parallel grids. These grids are made of gold-plated tungsten wires with a diameter of 40 μm. The acceleration field ($E_{\rm acc}$) and the mirror field ($E_{\rm mir}$) are chosen to satisfy the relation $2E_{\rm acc} = E_{\rm mir}$.

The circulation detector was used in the first commissioning experiment where the ^{78}K primary beam was used. The detector was used in the same manner in the second commissioning experiment using the secondary beam of ^{36}Ar and ^{35}Cl produced by the fragmentation reaction of a primary beam of ^{48}Ca at an energy of 345 MeV/nucleon on a ^{9}Be target with a thickness of 25 mm. A circulation time spectrum of ^{78}Kr is shown in Fig. 2. Particles were successfully stored approximately 60 turns. A revolution frequency was estimated to be 2.639 MHz from the circulation time spectrum. Figures 3(a) and 3(b) are circulation time spectra for ^{36}Ar and ^{35}Cl, respectively. ^{36}Ar ions and ^{35}Cl ions were circulated for approximately 40 turns and 10 turns, respectively. The preliminary revolution times of 378.32(6) ns and 386.3(1) ns were obtained for ^{36}Ar and ^{35}Cl, respectively.

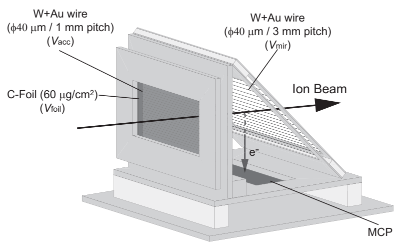

Fig. 1. Schematic view of the circulation detector.

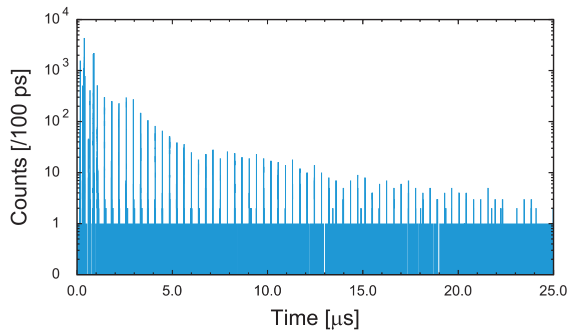

Fig. 2. Circulation time spectrum of ^{78}Kr. Noise generated by the kicker magnet is observed at approximately 0.05 μs.

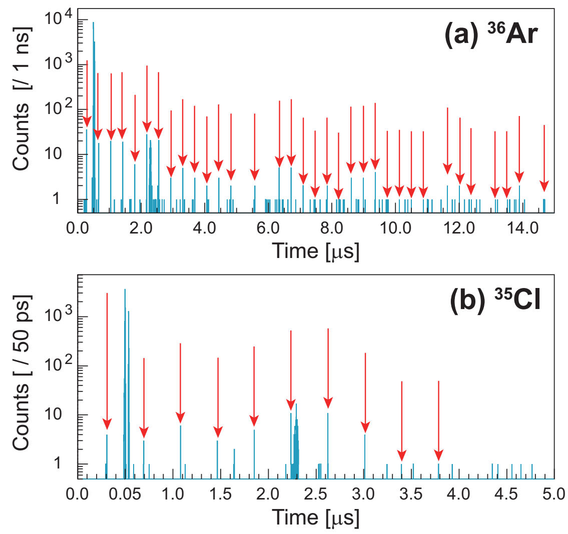

Fig. 3. Circulation time spectra of (a) ^{36}Ar and (b) ^{35}Cl. Arrows indicate signals corresponding to particles.

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