

Beam commissioning of the rare-RI ring

Y. Yamaguchi,^{*1} Y. Abe,^{*1} D. Nagae,^{*1} F. Suzaki,^{*1,*2} H. Miura,^{*2} S. Ohmika,^{*2} S. Naimi,^{*1} Z. Ge,^{*2} T. Yamaguchi,^{*2} A. Ozawa,^{*3} S. Suzuki,^{*3} Y. Yanagisawa,^{*1} H. Suzuki,^{*1} H. Baba,^{*1} S. Michimasa,^{*4} S. Ota,^{*4} T. Uesaka,^{*1} M. Wakasugi,^{*1} T. Watanabe,^{*1} Y. Yano,^{*1} and Rare-RI Ring Collaborators

We conducted two test experiments of the rare-RI ring in 2015. The first experiment using a ^{78}Kr primary beam with an energy of 168 MeV/u was performed in June. At that time, we succeeded in injecting a particle, which was randomly produced from a DC beam from cyclotrons, into the ring individually with a fast kicker system¹⁾; we extracted the particle from the ring less than 1 ms after the injection²⁾. We also checked the periodic signals of the circulated particle in the ring by using a carbon-foil with an MCP detector³⁾. We measured the Time-Of-Flight (TOF) of the particles between the entrance and the exit of the ring to check the isochronism. By adjusting the first-order isochronous magnetic field using trim-coils, which were installed into the dipole magnets of the ring, the isochronism of around 10-ppm was achieved for the momentum spread of $\pm 0.2\%$ ⁴⁾. In addition, we confirmed that a resonance-type Schottky pick-up successfully acquired the revolution frequency information of one particle with a resolution of approximately 1.3×10^{-6} in a storage mode⁵⁾.

The second experiment was performed in December by using a secondary beam to verify the principle of mass determination using the following equation.

$$\frac{m_1}{q} = \left(\frac{m_0}{q}\right) \frac{T_1}{T_0} \sqrt{\frac{1 - \beta_1^2}{1 - (\frac{T_1}{T_0} \beta_1)^2}}, \quad (1)$$

where $m_{0,1}/q$ is the mass-to-charge ratio of the reference and interested particles, $T_{0,1}$ is revolution time of these particles, $\beta_1 = v/c$, v is the velocity of the interested particles, and c is the light velocity. The secondary beam was produced via the projectile fragmentation of a 345 MeV/u ^{48}Ca primary beam with a ^9Be target. We identified the isotopes before the F3 achromatic focus of BigRIPS, and we injected particles to the ring individually with the fast kicker system. Figure 1 (a) shows the timing signal of the detected particles using a plastic scintillation counter, which was installed on the central orbit of the ring at the next straight section of the kicker area. We confirmed that these particles are ^{36}Ar and ^{35}Cl by using the ΔE -TOF information eventually, as shown in Fig. 1 (b). After removing the plastic scintillation counter from the central orbit of the ring, we checked the periodic signals of these two types of particles by using the carbon-foil with the MCP detector³⁾. Finally we succeeded

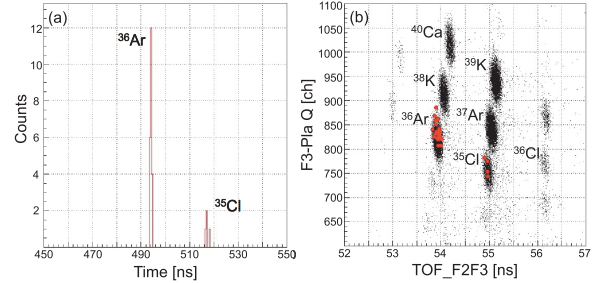


Fig. 1. (a) Timing signal of the detected particles at the plastic scintillation counter after injection by kicker magnets. (b) Two-dimensional for particle identification before the F3 of BigRIPS. The red circle indicates the injected particles.

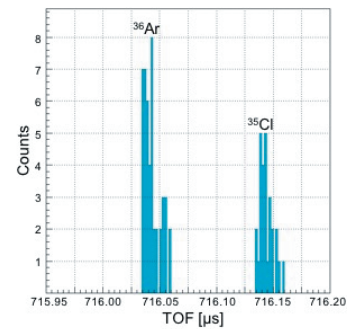


Fig. 2. Spectrum of TOF between the plastic scintillation counter at S0 of SHARAQ and the plastic scintillation counter at the exit area of R3 is shown. The peak on the left side indicates extracted ^{36}Ar , whereas the peak on the right side indicates extracted ^{35}Cl .

in extracting these particles from the ring simultaneously. Figure 2 shows the result of the TOF between the plastic scintillation counter at S0 of SHARAQ and the plastic scintillation counter at the exit area of the ring.

Offline analysis is now in progress to determine the revolution time ($T_{0,1}$) and the β_1 values, which will allow the discussion of mass determination using equation (1).

References

- 1) Y. Yamaguchi et al.: Phys. Scr. T166 (2015) 014056.
- 2) H. Miura et al.: In this report.
- 3) D. Nagae et al.: In this report.
- 4) Y. Abe et al.: In this report.
- 5) F. Suzaki et al.: In this report.

^{*1} RIKEN Nishina Center

^{*2} Department of Physics, Saitama University

^{*3} Institute of Physics, University of Tsukuba

^{*4} Center for Nuclear Study, University of Tokyo