Slowed-down RI beams of ^{93}Zr and ^{107}Pd at 50 MeV/u produced for spallation reaction

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The spallation-reaction cross sections of long-lived fission products (LLFPs) on proton and deuteron were measured at ∼100 and 200 MeV/u at RIKEN RIBF to search for a method to transmute LLFPs in nuclear waste[1–3]. In the present study, RI beams of ^{93}Zr and ^{107}Pd were provided for the measurement at an energy of 50 MeV/u. The control method of the RI beam energy was established in a previous experiment[4]. This report gives an outline of RI beam production and new developments, and approaches.

Figure 1 shows a schematic view of the experimental setup. The RI beams of ^{93}Zr and ^{107}Pd were produced and separated in the BigRIPS separator using a ^{238}U primary beam and a 7-mm Be target. The thickness of the aluminum degraders at F1 and F5 were 5 mm and 0.5 mm, respectively. The maximum intensity of the primary beam was used to make the emittance of the RI beams small. Under the standard operation, the acceptance of the momentum and position distributions can be changed by the slits at the momentum dispersive and achromatic foci, respectively, but the angle distribution is retained. Two new methods were developed to control the angle distributions in the horizontal (X) and vertical (Y) directions. For the X direction, a narrow second slit (Joker slit) at F1 was used as shown in Fig. 2. The RI beams with a large angle were stopped in the Joker slit by the use of narrow slit widths. For the Y direction, the focus position of Y at F2 was changed from the F2 slit position. Because the defocus beam on the slit has a correlation between the angle and position, RI beams with a large angle were stopped in the F2 Y slits with a narrow width of ±2 mm. The position and distribution for ^{107}Pd are shown in Fig. 3.

Fragments measured in the ZeroDegree spectrometer are produced not only in a secondary target but also in the detectors at F7 and F8. Although the contribution from the detectors is subtracted by using the data without the secondary target, a thinner detector combination can increase the sensitivity of the measurement. The ionization chamber (140 mg/cm^2) at F7 for the atomic number Z determination of the RI beam was removed, because Z was determined from the energy loss in the F5 degrader instead[5].

The momentum dispersive mode in the ZeroDegree spectrometer was used to avoid the charge-state change in F9 detectors that was necessary for the achromatic mode. A wide plastic scintillator and ionization chamber at F11 were developed[6]. An analysis of the particle identification in the ZeroDegree spectrometer is in progress.

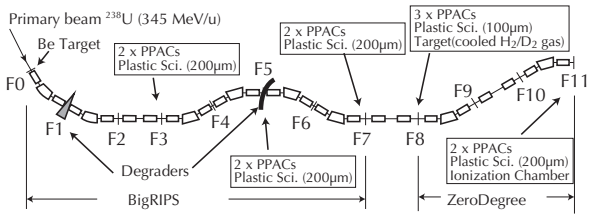

Fig. 1. Configuration of target, degrader, and detectors in the BigRIPS and ZeroDegree spectrometer.

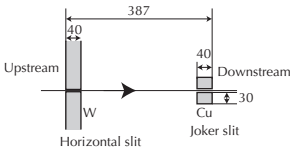

Fig. 2. Schematic top view of two sets of slits at F1. The position and angle were restricted by the narrow slit widths for both sets of slits. The widths of the upstream and downstream slits were ±2 mm and ±10 mm, respectively.

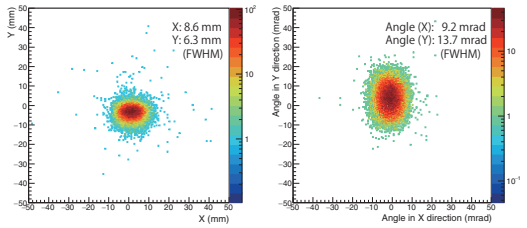

Fig. 3. Position (left) and angle (right) distributions on the secondary target at F8 for ^{107}Pd with 50 MeV/u.

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References

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