Purification of slowed-down RI beam

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The purity of a slowed-down RI beam at the second stage of the BigRIPS separator[1)] is important for particle identification (PID) under the condition of a total rate of 10^5 pps or higher.[2)] High-purity slowed-down RI beams are desirable for experiments at BigRIPS and the OEDO beamline.[3)] A high-intensity purified slowed-down exotic RI beam (HIPSER) concept is proposed to obtain high-intensity and high-purity RI beams using two-stage separation with two thick wedge degraders before measurement using beamline detectors for PID. The HISPER concept consists of three technical components:

(1) purification of the RI beam using the two-stage separation,
(2) two-step momentum compression, and
(3) transport of three charge states coupled with PID using a time-of-flight (TOF) measurement after the purification.

In this report, we focus on the RI-beam purification.

An experiment to verify the HIPSER concept was performed using a ^{107}Pd beam produced with the BigRIPS separator at RIKEN RIBF. The ^{107}Pd beams were separated at the first stage of BigRIPS using a wedge degrader with a thickness of 4.5 mm at F1 and the F2 slit with a ±5-mm setting. The thickness-to-range ratio (d/R) was 0.47. The energy was slowed down from 254 to 174 MeV/nucleon. The contaminants at F2 were isotones of ^{107}Pd, since the horizontal position x_{F2} of ^{107}Pd at F2 were the same as those of the isotones. Figure 1 shows x_{F3} distributions of ^{105}Ru, ^{106}Rh, ^{107}Pd, ^{108}Ag, and ^{109}Cd beams measured at F3. The positions at F2 and F3 show the relation, $x_{\mathrm{F3}} = -x_{\mathrm{F2}}$. The central values of the x_{F3} distribution for these RI beams were the same.

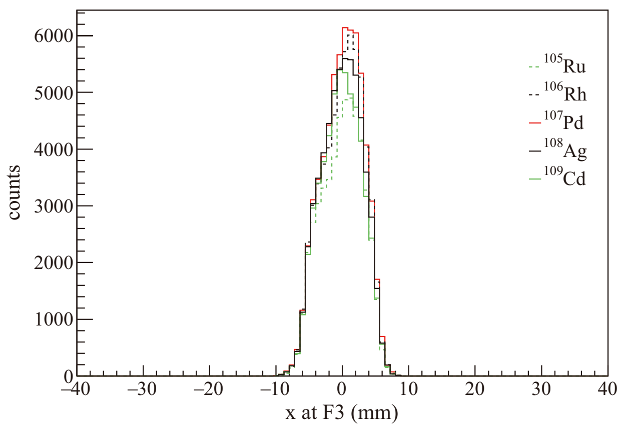

Fig. 1. Horizontal-position distributions of ^{107}Pd and its isotones at F3. The results of ^{105}Ru, ^{106}Rh, ^{107}Pd, ^{108}Ag, and ^{109}Cd are shown by the green-dashed, black-dashed, red-solid, black-solid, and green-solid lines, respectively.

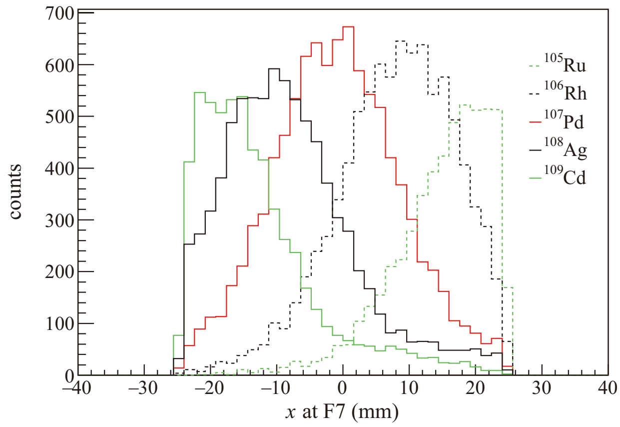

Fig. 2. Same as Fig. 1 but for the positions at F7.

With a thicker wedge degrader at F5, the ^{107}Pd beam could be separated from its isotones.[1,2)] The second wedge degrader at F5 had a thickness of 3.5 mm ($d/R = 0.69$). The F7 position x_{F7} of the ^{107}Pd beam was separated from the isotones, as shown in Fig. 2. By setting the F7 slit as -10 mm $< x_{\mathrm{F7}} < +5$ mm, the purity of ^{107}Pd was obtained as 32%. The beam energy between F5 and F7 was 78 MeV/nucleon. The TOF measurement for the three charge states was performed at the ZeroDegree spectrometer. The charge-state separation at the ZeroDegree spectrometer, influence of higher-order aberration, and beam-energy broadening due to energy-loss straggling will be investigated in a future analysis.

References
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