Yield analysis using target sliding system at KISS

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We are developing KEK Isotope Separation System (KISS)[1] to perform the β-γ spectroscopy of neutron-rich nuclei around the neutron-closed shell $N = 126$, relevant to the r-process nucleosynthesis. The neutron-rich nuclei are produced by multinucleon transfer (MNT) reactions between the ^{136}Xe beam and ^{198}Pt target,[2] and collected by a gas cell filled with argon placed at the downstream of the target. Because the dense plasma in the argon gas induced by the primary beam would reduce the extraction efficiency for the ions of interest, the gas cell has a beam pipe through which the primary beam passes without entering the gas cell.[3] Thus the target-like fragments (TLFs) ejected from the target at finite angles can enter the gas cell through the doughnut-shaped 5 µm Kapton window with the inner and outer diameters of 20 and 90 mm, respectively. To optimize the distance between the target and window, which is important for the efficient collection of TLFs, a target sliding system was introduced that can move the target along the beam axis and extraction yields were studied by changing the distance.

In this work, the TLFs of interest were ^{199}Pt isotopes, which were produced in the MNT reactions of ^{136}Xe and ^{198}Pt. The beam was provided by RILAC2 + RRC with an energy of 9.4 MeV/nucleon on the target and the target thickness was 12.5 mg/cm^2. ^{199}Pt isotopes entering the gas cell were thermalized and neutralized in the argon gas and transported to the exit of the gas cell by a laminar gas flow. They were irradiated by lasers to be element-selectively ionized and accelerated by a high voltage of 20 kV. After mass-separated by an dipole magnet, they were implanted into an aluminized Mylar tape, where their β-rays were detected to evaluate the implantation rate by fitting the decay curves.

The dots in Fig. 1 show the measured extraction yields by changing the distance between the target and the window. Figure 2 shows the correlation between energies and angles of the ^{199}Pt TLFs by the GRAZING calculations.[4] The yields show a wide distribution with a maximum at the energy around zero and angle around 70°. The red line in Fig. 1 indicates the ^{199}Pt yields considering the calculated correlation in Fig. 2 with the beam spot size (ϕ6 mm) on the target. It is normalized in the experimental data at a distance of 10 mm. These calculations were found to be significantly consistent with the experimental data and they provide a good reference for the optimization of target position.

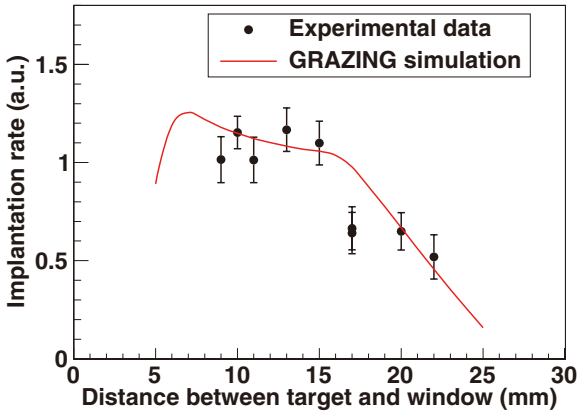

Fig. 1. Yields of ^{199}Pt by changing the distance between the target and the window.

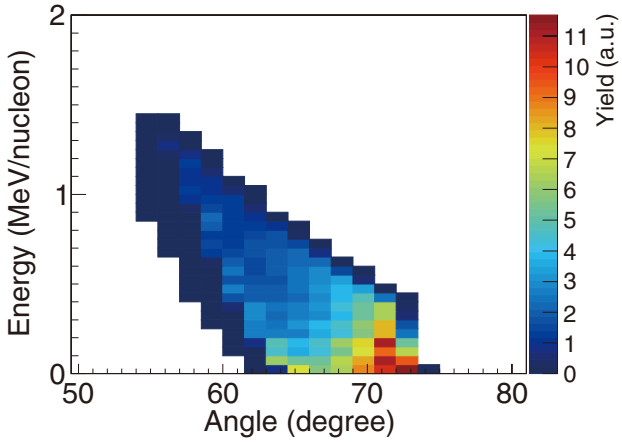

Fig. 2. Correlation between energies and angles of ^{199}Pt nuclei ejected from the target in MNT reactions of ^{136}Xe (9.4 MeV/nucleon) + ^{198}Pt (12.5 mg/cm^2) by GRAZING calculations.

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