First transport of unstable nuclei into SCRIT system

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The electron-beam-driven RI separator for the SCRIT (ERIS)[1)] at the SCRIT electron scattering facility[2)] is an online isotope separator system. It is used to produce low-energy RI beams via photofission of uranium. This year, we transported a pulsed ^{137}Cs beam, which was produced by a surface-ionization ion source and using ion-stacking and pulse-extraction systems,[3,4)] into the SCRIT system. We report the results obtained from the experiments.

Details of the RI production method and the surface-ionization ion source of the ERIS are reported in Refs. 4) and 5). In the measurements, self-made 43 uranium carbide disks[6)] were used as production targets. The total amount of uranium was approximately 28 g. We measured the production rate of Cs isotopes using a particle identification (PID) system[1)] located at the exit of the FRAC[3)] to estimate the rate of ^{137}Cs, because the life of ^{137}Cs is extremely long to measure γ-rays. In the measurements, the electron beam power was adjusted to approximately 1 W to reduce background events. The target and the ionization chamber were heated to 1500–2000°C by resistive heating. The electric currents applied to the ionization chamber and the target heater were 120 A and 750 A, respectively. Ionized RIs were extracted by the exit grid of the ionization chamber, accelerated to 10 keV, and transported to the PID system. PID was performed by measuring specific γ-rays corresponding to the decay of the RIs using a Ge detector. The measurement process is reported in Ref. 7). Figure 1 shows the isotope dependence of the rate of Cs obtained from the experiments. The mass dependence is similar to the trend reported from the ALTO[8)], which is expected to become flat for masses lower than 139. From this result, the rate of ^{137}Cs ion is estimated as approximately 1×10^5 atoms/s with an electron beam power of 1 W under the ionization chamber and target condition.

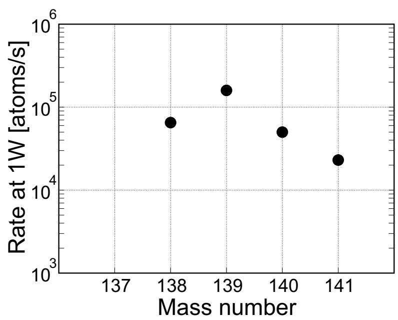

Fig. 1. Isotope dependence of rate of Cs. Electron beam power is approximately 1 W. Total amount of uranium is 28 g.

After adjusting the electric currents of the ionization chamber and target heater to 150 A and 900 A, respectively, the rate of the RIs increased by approximately one order, and we transported the ^{137}Cs beam to the SCRIT system by monitoring it using Faraday cups in the beamline. To produce ^{137}Cs ions, an electron beam was irradiated was at a power of approximately 15 W. The produced ^{137}Cs ions were stacked in the ERIS with a 50 ms stacking time. The pre-pulsed ^{137}Cs ions were injected into the FRAC and subsequently stacked and extracted from the FRAC as a pulsed beam in a cycle of 1 s. The pulsed ^{137}Cs beam was successfully transported from the FRAC to the SCRIT system with approximately 100% transmission efficiency by carefully adjusting the optical parameters. Figure 2 shows the signal of the ^{137}Cs beam at the position monitor located at entrance of the SCRIT device. The number of ^{137}Cs ions transported to the SCRIT system was 9.8×10^6 atoms/pulse. The yield of ^{137}Cs may be improved by optimizing the optical parameters from the ERIS to the FRAC and the stacking conditions of the FRAC. It can also be increased by optimizing the temperature of the ionization chamber and the target heater.

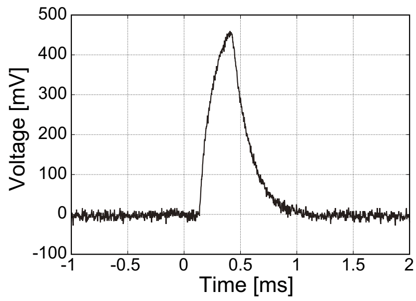

Fig. 2. Signal of ^{137}Cs beam at position monitor located at entrance of SCRIT device.

The ERIS is almost ready for the world's first electron scattering experiment with unstable nuclei, which will be conducted in the future.

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