Present operation status of ERIS at the SCRIT electron scattering facility

T. Ohnishi,[*1] Y. Abe,[*1] D. Abe,[*2] R. Danjyo,[*2] A. Enokizono,[*1,*3] T. Goke,[*2] M. Hara,[*1] Y. Honda,[*1,*2] T. Hori,[*1] S. Ichikawa,[*1] S. Iimura,[*1,*3] Y. Ishikura,[*2] Y. Ito,[*4] K. Kurita,[*3] C. Legris,[*2] Y. Maehara,[*4] Y. Nagano,[*5] R. Ogawara,[*1,*4] R. Ohara,[*2] T. Suda,[*1,*2] K. Tsukada,[*1,*4] M. Wakasugi,[*1,*4] M. Watanabe,[*1] H. Wauke,[*1,*2] and S. Yoshida[*4]

The electron-beam-driven radioactive isotope separator for SCRIT (ERIS)[1)] at the SCRIT electron scattering facility[2)] is an online isotope-separator system used to produce low-energy radioactive isotope (RI) beams using the photofission of uranium. The RI beam production at ERIS began in 2013 and has been vigorously developed. This year, two full-scale ion beam operations were conducted for physics experiments. The first was the ^{137}Cs ion-beam production for electron scattering experiment with RI. The second was the ion beam supply of Xe isotopes for the systematic study of nuclear structure using electron scattering. In this paper, we report details of both these operations.

The ^{137}Cs ion-beam production was performed in the spring of 2022. ^{137}Cs nuclei were produced via photofission of uranium, and they were ionized and extracted with the surface ionization technique. Details of the ^{137}Cs beam production are reported in Ref. 3). In this operation, self-made 48 uranium carbide disks, with thickness and diameter of 0.8 and 18 mm, respectively, were used as production targets and the total amount of uranium was approximately 28 g. A 150-MeV electron beam with beam power of approximately 15 W irradiated to the production target heated to around 2000°C using the resistive heating method. Ionized RIs were stacked in the ionization chamber for 25 ms, extracted as a pulsed beam by the exit grid of the ionization chamber, and then accelerated to 6 keV. Following mass selection, the pulsed ^{137}Cs ion beam was injected into a RFQ cooler and buncher, FRAC.[4)] Approximately 10^7 ions/pulse for ^{137}Cs, accumulated for 4 s inside FRAC, were transported to the SCRIT system for the electron scattering experiment. During the measurement, which was approximately one month operation, the ERIS operation was very stable. Although there were concerns regarding the lifetime of the production target, the amount of produced RI remained almost constant because of the good quality of the target. It is important to establish a target-production method that guarantees the quality.

The ion beams of Xe isotopes have been supplied since this summver. The FEBIAD type ion source was used for the ionization of Xe, and natural Xe gas was injected directly into the ionization chamber. Details of the FEBIAD type ion source at ERIS are reported in Ref. 5). The overall efficiency, estimated as 5%, was lower than the previous result of 14%.[5)] This is because no magnetic field of the FEBIAD type ion source was used to reduce the ion-beam emittance. With the optimized magnetic field, the overall efficiency became the same as the previous value. Finally, stable xenon ion beams over a wide mass range, from ^{124}Xe to ^{136}Xe, were supplied. For the supply of ^{124}Xe and ^{126}Xe, the gas supply volume was increased because the existing supply volume was insufficient owing to their low natural abundance ratio. An ion beam current, almost 1 nA, was achieved in case of ^{124}Xe, while maintaining the pressure inside the ion source in the order of 10^{-4} Pa with careful control of the gas supply. Figure 1 shows the mass spectrum. ^{124}Xe and ^{126}Xe were clearly separated and measured. After cooling and stacking inside FRAC, 10^8 ions/pulse of each Xe isotopes, including ^{124,126}Xe, were transported to the SCRIT system.

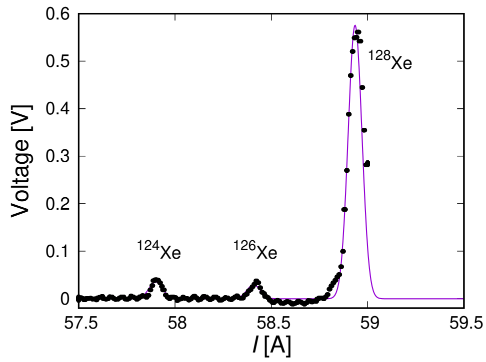

Fig. 1. Mass spectrum around ^{124}Xe and ^{126}Xe plotted with the current value of the analyzing magnet.

Currently, the experiments with Xe isotopes are still ongoing. As the next research objective, further development of ERIS is planned to accommodate the upgrade of the electron beam power to a few kW. For example, the radiation shield and the remote handling system are being considered for updates.

*1 RIKEN Nishina Center
*2 Research Center for Electron-Photon Science, Tohoku University
*3 Department of Physics, Rikkyo University
*4 Institute of Chemical Research, Kyoto University
*5 Department of Physics, Yamagata University

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