Present status of ERIS at the SCRIT electron scattering facility

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The Electron-beam-driven RI separator for SCRIT (ERIS)[1)] at the SCRIT electron scattering facility[2)] is an online isotope separator system used to produce low-energy RI beams for electron scattering experiments of unstable nuclei. Recently, ion stacking and pulse extraction were performed at ERIS in order to inject RI beams into a dc-to-pulse converter named fringing-RF-field activated dc-to-pulse converter (FRAC).[3)] The results were reported in Ref. 4). In the present year, we modified the ionization chamber to increase the intensity of ion beams. In this paper, we report the results and present status of ERIS.

Figure 1 shows a schematic of the new ionization chamber of ERIS. The new ionization chamber consists of a curved cathode, an ionization chamber (anode), and entrance and exit grids. The entrance grid is a curved tungsten-wire mesh. The wire diameter of the mesh is 30 μm, and the mesh pitch is 0.85 mm. The entrance and exit grids are connected to the ionization chamber through an insulator. Ion stacking and extraction are controlled by switching the voltage of the exit grid. Neutral atoms enter the ionization chamber, passing through the cathode. They are ionized by collision with thermionic electrons emitted from the cathode, which is maintained at approximately 2000°C.

Though ionization occurs everywhere inside the ionization chamber, ions located near the exit hole are mainly extracted, because the potential is low enough for ion extraction only around the exit hole owing to its small diameter of 2.5 mm. To increase the number of ions near the exit hole, the focusing of electron beams on the exit hole is proposed using a new curved cathode and a curved entrance grid, as shown in Fig. 1. The bending of the cathode and entrance grid was determined based on the electron track simulation using the SIMION code.[5)]

The properties of the new ionization chamber were studied using 10-keV ^{132}Xe ion beams. The voltages of the cathode and anode were set to 0 and 180 V, respectively. The exit-grid voltages at the stacking and extraction points were 185 and 0 V, respectively. The entrance-grid voltage needed to prevent the escape of ions from the entrance grid was 200 V. This voltage is higher than the voltage in the case of the non-curved entrance grid, 182 V,[4)] which indicates the large difference of potential distribution between the curved and non-curved electrodes. Under the same condition for the anode current, ~20 mA, the ion beam currents with the curved and non-curved electrodes were approximately 2 and 6 nA, respectively. Pulse shapes measured at the exit of ERIS with the curved and non-curved electrodes are shown in Fig. 2. The stacking time was 10 ms, and the extraction period was 300 μs. These pulse shapes are plotted as the ratio of the pulse beam current to the continuous beam current. With the curved electrodes, it takes almost 1.5 ms to extract all of the stacked ions. In the case of the non-curved electrodes, the stacked ions are extracted within 0.5 ms. These results show that the ionization with the curved electrodes occurs mainly far from the exit hole contrary to the calculated results. More detailed calculation including the effect of the space charge and other effects is needed in order to understand the obtained results.

In summary, we tested the new ionization chamber with the curved electrodes at ERIS. The expected improvement of the ion beam intensity was not observed. More detailed study and developments are in process.

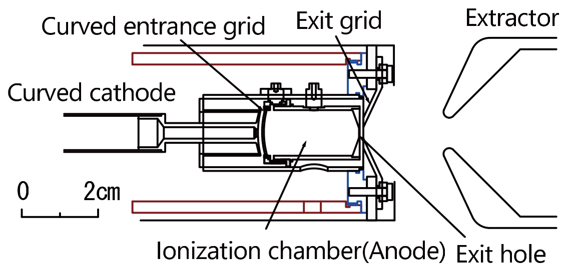

Fig. 1. Schematic of the new ionization chamber of ERIS.

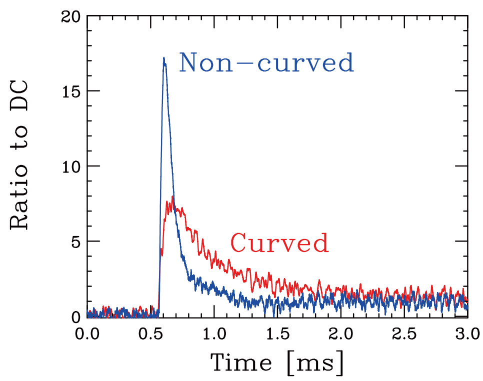

Fig. 2. Pulse shapes extracted from ERIS after the stacking. The pulse shape is plotted as the ratio of the pulse beam current to the continuous beam current. The red and blue shapes are measured with the curved and non-curved electrodes, respectively.

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References
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4) T. Ohnishi *et al.*, Accel. Prog. Rep. **50**, 192 (2017).
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