Current status of RI beam production at electron-beam-driven RI separator for SCRIT (ERIS)

T. Ohnishi,[*1] S. Ichikawa,[*1] M. Togasaki,[*1,*2] K. Kurita,[*1,*2] and M. Wakasugi[*1]

The ERIS[1] (electron-beam-driven RI separator for SCRIT) 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. Recent developments of the ERIS were reported in Ref. 3. In this year, we performed an operation for a long period of time using stable ions to evaluate the stability of the ERIS. In addition, improvements were made to increase rate of unstable nuclei. In this paper, we report the results and the present status of the ERIS.

The operation of the ERIS started on May 8, 2015. Beams of stable xenon ions were used for the optimization of the ion transport line and the commissioning of the new electron spectrometer, WiSES[4]. In this operation, the ionization chamber and the transfer tube equipped with the cathode head were the same as in the case of the production of unstable nuclei. These parts were heated using self-resistance heating with a large current, about 325 A, and the temperature was maintained at about 2273 K. The maximum current of ^{132}Xe was about 400 nA. After seven months of operation, the cathode head was broken on December 2, 2015.

Figure 1 shows the long-term trend of the cathode voltage and the vacuum degree of the acceleration chamber, which is one order higher than that of the ion source. For constant current operation, the cathode voltage affects the condition of the electrodes. When the cathode voltage decreased and became constant, the connection between the cathode head and the transfer tube improved. Finally, the cathode voltage increased rapidly, because the cathode head became thinner and it broke.

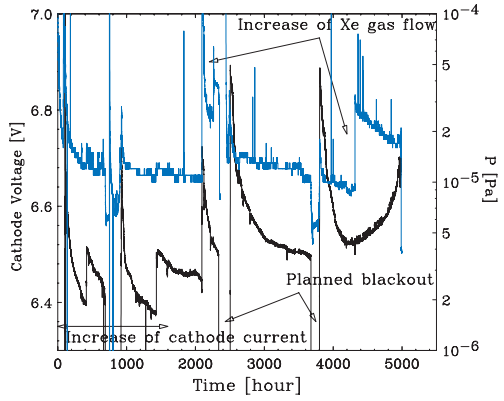

Fig. 1. Long-term trends of cathode voltage (black) and pressure of the acceleration chamber (blue). The period is from May 8 to December 2, 2015. During the operation, there were two planned blackouts.

This operation period was much longer than in 2013, about 2 months. One of the key points was a high vacuum degree because of the minor damage to electrodes caused by a small amount of residual gas. The other key point was considered as small thermal stress. The cathode current was continuously applied during the operation period except for during the planned blackout. Therefore, damage from the thermal stress caused by the variation of the temperature was estimated to be very small.

In order to increase the extraction rate of unstable nuclei, a new ionization chamber of the ERIS is considered. Figure 2 shows a schematic of the new ionization chamber. By applying a voltage higher than the anode voltage to the entrance and exit grid electrodes, stacking of ions is expected to occur inside the ionization chamber. For positive ion extraction, voltage lower than the anode voltage is applied only to the exit grid. The optimization of the exit grid voltage improves the extraction using the extractor. This new chamber is still being manufactured.

In summary, we performed a stability test of the ERIS with the long-term operation. This gives us very useful information about the stable operation with high temperature conditions. Plans to improve the efficiency of the ERIS, mainly the extraction efficiency, are underway.

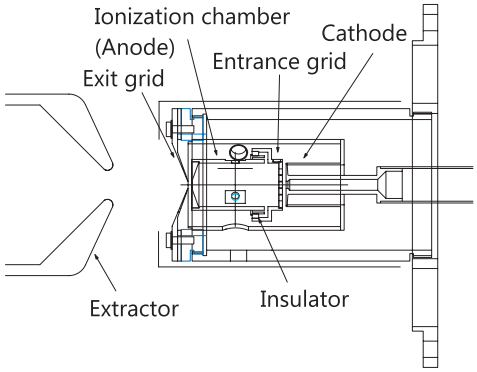

Fig. 2. Schematic of new ionization chamber of ERIS. The entrance and exit grid electrodes are connected to the ionization chamber through an insulator.

*1 RIKEN Nishina Center
*2 Department of Physics, Rikkyo University

References

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