5. Charge strippers

Charge strippers are planned to be used at four stripper sections in the RIBF. Charge strippers increase the variety of acceleration schemes and decrease the construction costs of accelerators. However, their lifetime problem often limits the performance of the accelerator complex. Therefore, we should solve the lifetime problem while maintaining the beam quality. Three kinds of carbon strippers are selected after some examinations of, for example, a liquid film stripper [1]. They are mainly characterized by the thicknesses that are determined by the required charge states.

The first kind of stripper is planned to use at the first section placed between the accelerator and decelerator of the CSM [2]. The stripper is a 14-mm-diameter carbon foil produced at RIKEN, whose thickness range is from 20 to 100 $\mu g/cm^2$. A long-life carbon foil whose lifetime is more than 100 times longer than the foils on the market has been developed at RIKEN [3]. However, when a 90 pμA uranium beam is bombarded on a 25 $\mu g/cm^2$ thick carbon foil, the lifetime of the foil is expected to be approximately one minute. Therefore, in the uranium beam case, the first stripper is planned to be applied only at the commissioning stage of the RIBF, at which the beam intensity is expected to be approximately 1/100 of the target intensity.

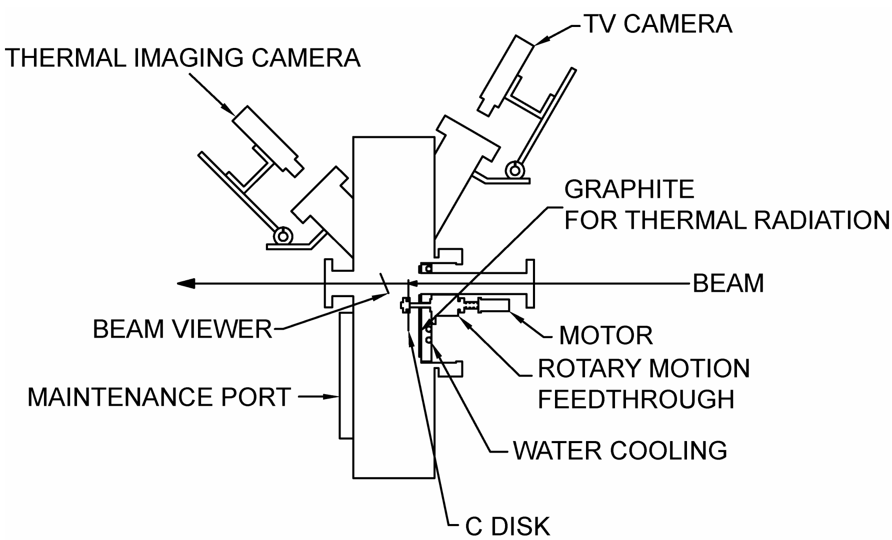

Figure 1. Schematic view of the rotating carbon disk stripper.

Figure 2. Photograph of the rotating carbon disk stripper.

In the typical acceleration scheme, the second and third kinds of strippers expected to receive 1 and 3 kW power, respectively, from uranium beam, so rotating carbon strippers are planned to be used as the second and third strippers enlarging the area from which thermal radiation is emitted. The thickness ranges of the second and third strippers are from 0.1 to 0.5 mg/cm^2 and from 14 to 20 mg/cm^2, respectively. Figure 1 and 2 show a schematic view and a photograph of the third stripper, a rotating carbon disk stripper already constructed, respectively [4]. A 120-mm-diameter carbon disk is rotated by an AC servo motor placed outside the vacuum chamber through a ferrofluid sealed rotary motion feedthrough. The maximum rotation frequency is 3000 rpm. An array of graphite plates is soldered to a water-cooled copper plate close to the carbon disk to absorb the thermal radiation emitted from the beam spot on the carbon disk. The maximum temperature caused by a 3 pμA uranium beam was calculated by ANSYS to be 1549°C, which was sufficiently lower than the evaporating temperature of carbon. The geometrical thickness distribution of the disk was measured with a micrometer, and found that the thickness was uniform within 0.9%. A beam test was performed by a 0.1 pμA krypton beam at 46 MeV/nucleon, and no visible damage of the carbon disk was observed. The second stripper is under construction essentially with the same concept as the third stripper.

Estimation

Cost:	---
Manpower:	3 persons
Period:	2005 -

References

[1] H. Ryuto et al., “Liquid Film Stripper for Intense Heavy-Ion Beams”, the attached document “Collected papers on the accelerators for the RIKEN RI beam factory (2003-2005)”, pp. 168-170.

[2] O. Kamigaito et al., “Construction of a booster linac for the RIKEN heavy-ion linac”, ibid., pp. 148-158.

[3] H. Hasebe et al., ”Long-lived Carbon Stripper Foils for Intense Heavy-ion Beams”, ibid., pp. 69-71.

[4] H. Ryuto et al., ”Rotating Carbon Disk Stripper for Intense Heavy-ion Beams”, ibid., pp. 75-76.