Construction of a Faraday cup for high intensity beams from the SRC

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The beam intensity supplied to RIBF users is evaluated based on the measurement of the Faraday cup (FC-G01) installed in the beamline at the exit of the SRC. The FC-G01 also plays an important role in adjusting the entire RIBF accelerator system using the high-intensity beam. However, the FC-G01 could not handle the recent increase in beam intensity, because it was manufactured and installed in 2007 when the RIBF beam intensity was low. Originally, it was assumed that high intensity beams would be stopped by the beam dump of the RI fragment separator BigRIPS, but this caused an operational problem in that the accelerators could not adjusted with high intensity beams until the BigRIPS team completed the preparation of the beam dump. Therefore, the design and fabrication of the new FC-G01, which can handle beam intensities of several tens of kW, were gradually performed, and the installation was finally completed in FY2023 and operation started in FY2024.

The most difficult challenge in the realization of the new FC-G01 was the limited space for installation. As shown in a left panel of Fig. 1, the old FC-G01 was installed in a chamber that fit into an opening 1.5 m long, 1.5 m wide, and less than 1 m deep in the wall. To enhance cooling of the Faraday cup for high intensity beams, the chamber needed to be as long as possible; therefore, it was designed to fit in the 1.5 m space from the downstream of the quadrupole magnets to the inner wall of the opening. A external view of the new FC-G01 is shown in right panel of Fig. 1.

The main body of the new FC-G01 is about 1.2 m long and created from copper, and the beam irradiation part is wedge-shaped, about 80 cm long, and is suspended from a rectangular flange fabricated from alminum, as shown in Fig. 2. An aluminum rectangular chamber is installed at the opening to hold the new FC-G01. The rectangular flange is placed upstream of the crane's reach, and a mechanism is provided to remotely slide the flange to just above the chamber in the opening and then lower the flange down to store it in the rectangular chamber. Because the distance between the top of the quadrupole magnet and the top wall of the opening is small, the new FC-G01 is moved horizontally perpendicular to the beam axis by a stepping motor to the measurement and standby positions.

A cooling water system dedicated to the new FC-G01 was also installed as shown in Fig. 3. Although the total heat load is not large, the system can circulate pure water at 2.0 MPa for a total of

Fig. 1. External view of the old Faraday cup at the exit of the SRC (left panel) and new high-intensity Faraday cup (right panel).

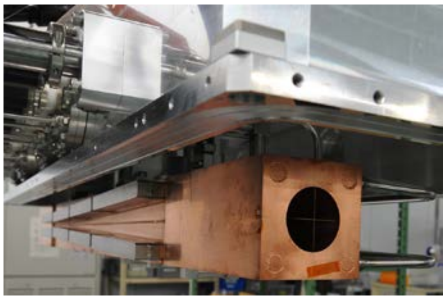

Fig. 2. Main body of the new FC-G01.

Fig. 3. Entire view of the high pressure cooling water system.

660 L/min to increase the flow velocity. Because the electronic circuits of flow meters and pressure gauges are easily damaged by radiation during accelerator operation, old-fashioned pneumatic transmitters and pneumatic/electro-pneumatic converters are used. A program logic controller was also implemented to automatically perform pump operation, circulation operation to the FC main body, water draining, and water filling sequences.

The new FC-G01 was successfully constructed and began operation in the RIBF experiment from April 2024, stopping and measuring beams up to 12 kW. During operation, a motor stall occurred owing to lack of lubrication in the drive mechanism as an initial failure, but this problem was resolved by applying grease.

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DOI:10.34448/RIKEN.APR.58-237