Development of R3-related equipment with ^{124}Xe beam

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The Rare-RI Ring (R3) was developed to precisely measure the masses of nuclei with short lifetimes (<10 ms) and low yields (≈1 particle/day) in regions far from the β-stability line. Lifetime measurements for such exotic nuclei have been planned. Further improvements in the measurement efficiency and the installation of Schottky cavities sensitive to single ions are essential to perform such measurements. This paper briefly summarizes the progress of this development.

The following two measures were implemented to further improve measurement efficiency. The first measure was extending the duration of the kicker magnetic field used to extract circulating particles from R3. We succeeded in achieving an extractable duration equivalent to one revolution, reducing the timing adjustment required for a successful extraction.[1] However, the charging ceramic capacitors of the kicker pulsed power supply repeatedly experienced an insulation breakdown during subsequent mass measurement experiments, which affected measurement efficiency. Repairing this insulation failure was a requirement for resuming experiments at R3, and therefore, resolving this problem was a top priority for the past few years.[2]

Second measure was increasing the transmission efficiency. We have a history of improving the transmission efficiency from BigRIPS-F3 to R3-ELC, which is the area after extraction, by a factor of 10 or more by revising the beam optics.[3] However, the value remained low at ∼1% because of the large deviation of the beam relative to the narrow vertical aperture of 36 mm in R3. We installed vertical steering magnets dedicated to R3 in OEDO-SHARAQ beamline because there was no way to adjust the beam deviation after the F0 focal plane of BigRIPS, as shown in Fig. 1. ST1 is located downstream of the FE11 focal plane and ST2 is located just before the ILC1 focal plane, which adjusts the vertical beam position and angle after ILC1 to be nearly zero. The results of the sixth machine study (MS-EXP24-05) that verified their performance are described in Ref. 4).

A new highly sensitive compact resonant Schottky pick-up cavity was also tested in MS-EXP24-05 to realize the lifetime measurements of short-lived nuclei in the near future. This was installed in an existing vacuum chamber at the straight section of R3, and we observed the Schottky signal of a single $^{124}Xe^{54+}$ ion.[5] The kicker system operated without failures during this experiment, showing that R3 is now ready to resume experiments.

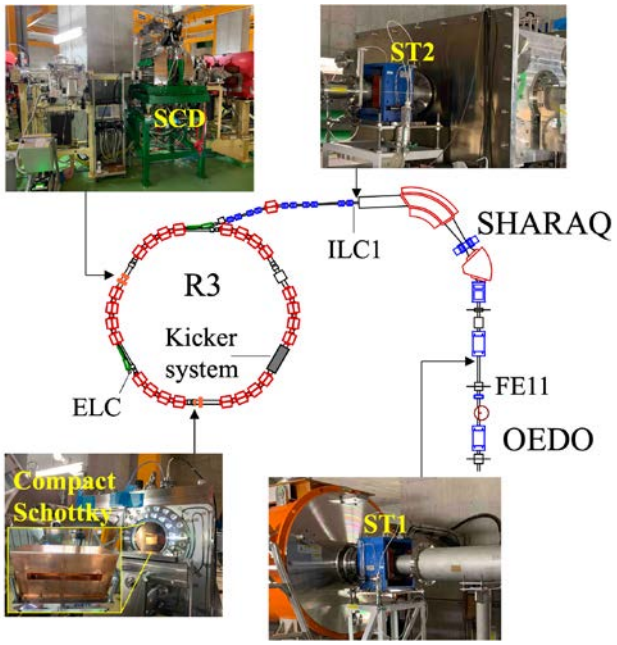

Fig. 1. Photographs of newly installed devices in the OEDO-SHARAQ system and R3.

A position-sensitive Schottky cavity doublet (SCD)[6] has recently been installed as a device for expanding the possibilities of R3. SCD can be determined the magnetic rigidity of each particle inside the ring; therefore, unlike the current time-of-flight method, mass measurements using the SCD do not require a position detector such as PPAC before injection, which can improve measurement efficiency. A pilot experiment on the SCD-based method will be conducted soon.

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