Current status of a gas-cell system for precision experiments with GARIS-II

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We constructed a gas cell for precision experiments on fusion-evaporation residues coupled with GARIS-II. In the last report[1)], we presented the commissioning results. In this report, we present the current status of the whole system, from the gas cell to the multi-reflection time-of-flight mass spectrograph (MRTOF) (Fig. 1).

For precision mass measurement with MRTOF[2)], we installed an upstairs radio-frequency ion trap system after extraction from the gas cell. The ion trap system comprises a flat trap[3)] (FT) and a pair of resistive ion traps (RT). The RT stores and pre-cools ions before transferring them to the FT. For this function, we adopted four silicon electrodes with electrical contacts at both edges and 30 mm from the FT side. The electrodes have 6 mm width and 145 mm length which corresponds to the resistance of 330(10) Ω and an inter-strip gap of 8.4 mm. Ions extracted from the gas cell were first stored in the RT for several milliseconds, and then, they were transfered to the FT and bunched in the FT (3 ms). The ion bunch was ejected to the experimental room located downstairs through a 3-m beam transport line (BTL). To accelerate the ion bunch, we used pulsed drift tubes (PDT) that hace a 15 mm inner diameter and 150 mm length. The PDT was switched from -1.5 kV to a GND potential of the BTL with 200 ns rise time when the ions are traveling in the tube. As a result, the ions gain 1.5 keV and are transported in the grounded BTL. In the middle of the BTL, we installed a Bradbury-Nielsen (BN) gate that has a 50 μm gold-coated tungsten wire with a 0.5 mm pitch and is capable of eliminating unwanted ions by fast voltage switching. After the BN gate, we placed another PDT that is switched oppositely to the one upstairs. The ions are decelerated to be ∼50 eV from the PDT by focusing lenses toward a downstairs trap system identical to the one upstairs. The decelerated ions were re-bunched in the same manner as those upstairs and ejected toward the MRTOF at the TDC start time to measure time-of-flight.

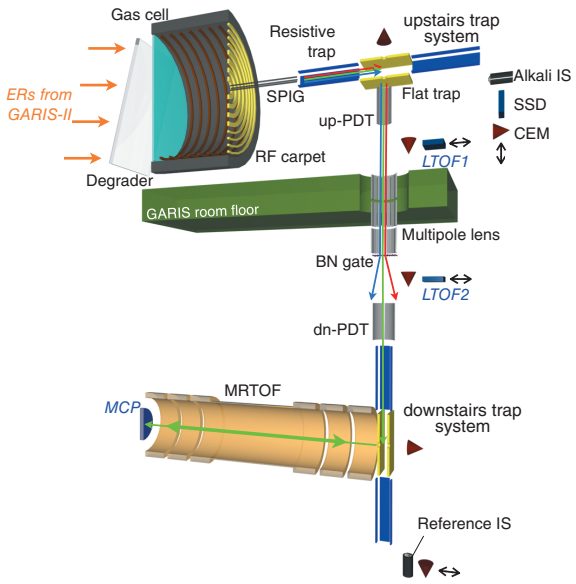

Fig. 1. Schematic view of the gas cell setup with MRTOF.

Using several diagnostics, SSD and channeltron (CEM) detectors, we evaluated efficiencies. First, we counted the ^{205}Fr rate by SSD in front of the gas cell; then we counted the ^{205}Fr^{+} rate by SSD at LTOF2 located after the BN gate. The efficiency to LTOF2 compared to the incoming ^{205}Fr was given as 19%. Second, we measured the BTL transmission efficiency using SSDs at LTOF1 and LTOF2, and obtained the efficiency of 70%. By using the pre-measured gas-cell efficiency of 29%[1)], we could obtain the efficiency of 94% for the upstairs trap system. Finally, the re-trapping efficiency for the downstairs trap system was measured to be 1.6% using the ^{205}Fr^{+} rate at MCP after the MRTOF and ^{205}Fr^{+} rate at LTOF2. In total, the overall efficiency of 0.3% was obtained.

The bottleneck was after re-trapping efficiency that was expected to be more than 20%. We recently found mis-wiring to apply DC voltages for the downstairs trap system. The potential created with this wiring resulted in an unreasonable potential configuration for transferring ions to the FT. We fixed the problem and will check the efficiencies in next beam time.

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