Fourth report on offline tests for RF carpet transportation in RF ion guide gas cell at the SLOWRI facility

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A new gutter structure RF ion guide gas cell[1] was developed at the SLOWRI facility. The gas cell comprises two RF carpet (RFC) stages. We previously reported on the transportation efficiencies of the 1st stage RFC for various gas pressures and various RF frequencies.[2,3] In this report, the transport efficiency including the 2nd stage RFC is presented.

The 2nd RFC comprises concentric ring electrodes with a pitch of 0.26 mm (electrode width of 0.1 mm and inter-electrode spacing of 0.16 mm); there is a ϕ0.65 mm exit hole at the center of the 2nd RFC. Ions are collected onto the 1st carpet and transported to the inner edges of the pair of the 1st RFCs. After they are pulled over the edge to the 2nd RFC by a DC field, they are delivered to the exit hole by the "ion surfing" transport technique that uses the combination of two-phases RF and four-phases audio-frequency (AF) fields[4] (Fig. 1). A segmented quadrupole ion beam guide (smQPIG) is placed behind the exit hole. The ions are transported to a high vacuum region by the smQPIG through differential pumping stages.

We recently investigated the transport efficiency including the 2nd RFC in offline tests. Cesium ions were produced from a surface ionization ion source at the inner wall of the gas cell. The entire setup has been described in Ref. 1). We measured the ion currents on the RFCs and subsequently on the smQPIG. The RFC transport efficiency was defined as the ratio of the two currents.

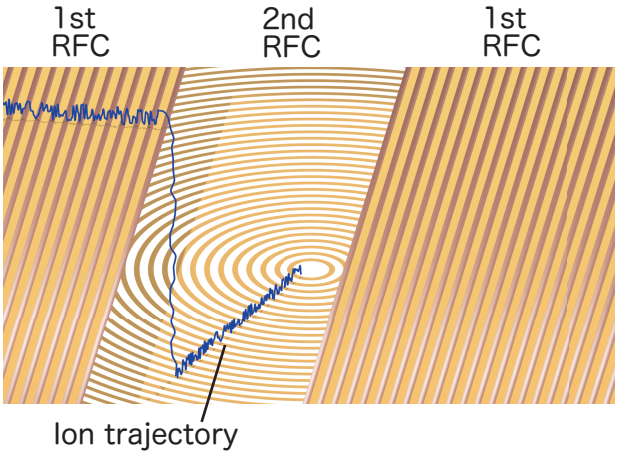

Fig. 1. Sketch of 1st RFC and 2nd RFCs around the exit hole with an ion trajectory in blue.

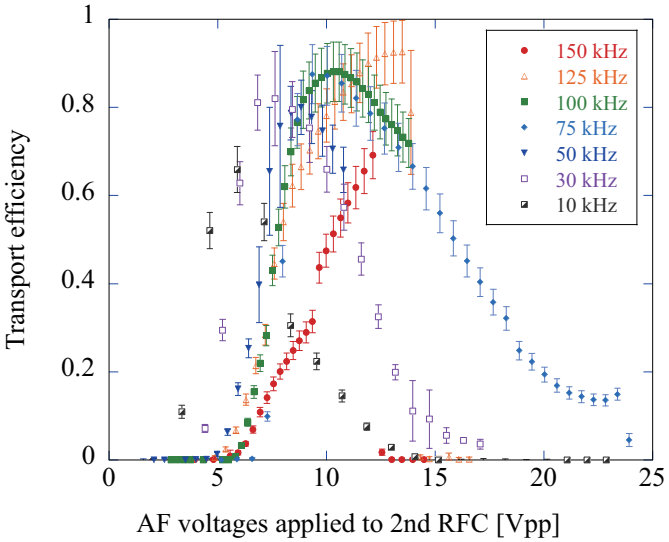

Fig. 2. Offline test results on the transport efficiency for Cs^+ as a function of AF voltages at various AF frequencies.

Figure 2 shows the test results in 133 mbar of room temeperature He gas as a function of the AF voltages for various AF frequencies. The RF voltages applied to the 1st and 2nd RFCs were 103 V_{pp} at 8.15 MHz and 111 V_{pp} at 10.06 MHz, respectively. The push DC field between the 1st and 2nd RFCs was ~40 V/cm. We achieved ~90% transport efficiency with an AF frequency of 125 kHz in this measurement. The plots show a sudden drop at 12–15 V_{pp} for AF frequencies $\geq$125 kHz, because the AF signals became highly distorted by the AF/RF coupling circuitry. An attempt to improve the circuit characteristics is afoot.

This gas cell was coupled to an MRTOF mass spectrograph for a parasitic experiment during the HiCARI campaign in 2020. The online experiment results about this gas cell are reported in other articles by S. Iimura and D. Hou in this issue.

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