Development of multiple reflection time of flight mass spectrograph at KISS

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KEK Isotope Separation System (KISS) dedicated to the study of the third peak around $A \sim 195$ in the solar abundance can produce pure low-energy beams of neutron-rich isotopes around $N = 126$ using multi-nucleon transfer reaction and in-gas cell laser ionization and spectroscopy technique.[1)]

The KISS facility mainly performing beta-decay life-time study and beta-delayed γ-ray spectroscopy so far, by a multi-reflection time-of-flight (MRTOF-MS), will be able to measure masses of RIs by steering the beam direction toward the MRTOF-MS system while the beta-decay curve is being measured at the decay station. The MRTOF-MS, competitive to the state-of-art Penning trap, features a high mass resolving power of >100000 even in the short measurement time (∼30 ms). Together with its lower yield requirement, remarkable strengths the device has are suitable for the short-lived RIs of low production yield.[2)]

Recently, construction of a new MRTOF-MS has been completed (Fig. 1), and presently in the performance test. It consists of a gas cell to cool down the injected ions, a trap system, and a MRTOF chamber. The trap system thermalizes the ions, and converts a continuous beam into a pulsed beam for further MRTOF operation.

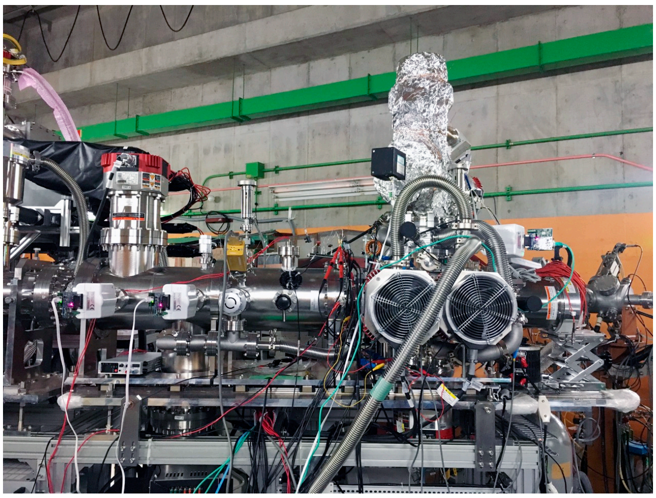

Fig. 1. MRTOF-MS system, constructed and coupled to the KISS beam line.

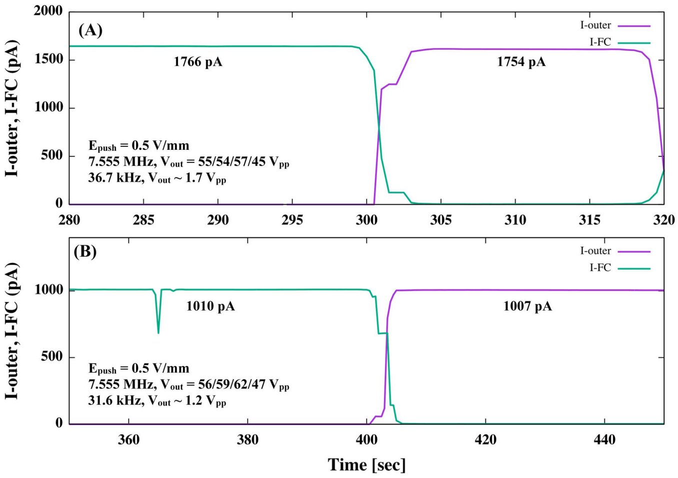

Fig. 2. Ion currents measured at the outer-ring and the faraday cup, respectively for the different pressures – (A) P_{He} = 100 Pa, (B) P_{He} = 174 Pa.

In this report, for the gas cell filled with the helium buffer gas, its ion extraction efficiency experimentally measured has been briefed. The investigation has been performed at two different pressures of $P_{\mathrm{He}} = 100$ and 174 Pa. Using a radio frequency (RF) carpet (ϕ190 mm) with a pitch of 0.64 mm, an exit hole with ϕ1.28 mm and a thermal K^+ ion source. The "ion surfing" mode developed by the combination of a repelling RF potential, a DC potential gradient, and a 4-phase audio frequency (AF) potential has been implemented, by which the ions stopped in the gas cell are quickly transported.[3)] When the ion surfing mode with ion drift direction opposite to the exit hole applied, the current measured at the outermost ring of RF carpet (I_{outer}) showed only small difference of around 1%, compared to that at the carpet surface of no RF applied. A faraday cup was installed near the exit, whose current is I_{FC}. Figure 2 shows the evidence of the ion surfing mode created, in which the relative phase of AF voltages was changed by time from +90° (to exit hole) to −90° (to outer-ring). It has been achieved that most of ions arrived on the carpet were extracted by the "ion surfing" mode, *i.e.* the ratio of the extracted ions to the collected ("extraction efficiency") close to 100%.

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