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Storage test of a table-top electrostatic ion storage ring (μE-ring)

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Synopsis A table-top electrostatic ion storage ring (μE-ring) with the circumference of about 0.8 m was developed. The first storage of ions, about 2 ms storage under vacuum of about 1 × 10^{-5} Pa, was achieved for 4 keV Ar^+ ions.

An electrostatic ion storage ring (E-ring) is a powerful device for investigation of slow reactions, such as metastable decay and radiative cooling of molecular ions. The first table-top E-ring was constructed by Lyon group [1]. We developed a second table-top E-ring (μE-ring), of which the size is reduced ten times from that of the existing ring at Tokyo Metropolitan University (TMU E-ring) [2], keeping the basic idea for beam manipulation unchanged.

The μE-ring consists of two 160 degree deflectors (160Def-1~2), four 10 degree deflectors (10Def-1~4) and four focusing and defocusing electrostatic quadrupole doublets (Q-1~4), as shown in figure 1. The circumference of an ion beam trajectory is about 0.8 m. All the electrodes are made of aluminum, mounted on a single rectangle plate of 480 mm × 200 mm, for precise alignment of the electrodes and efficient bake-out of the ring. Voltages of all the electrodes are provided from high-voltage modules controlled by a personal computer. Presently, the vacuum pressure is about 5 × 10^{-5} Pa with a 400 L/s turbo molecular pump.

Ion storage tests were performed by using Ar^+ ions at an energy of 4 keV extracted from an electron impact ion source. Typical current of the incident ion beam was about 100 nA. A pulsed voltage on 10Def-1 changes from injection to storage mode. Rotation period of the ions in the ring is about 6.3 μs. During ion storage, neutral argon atoms were produced due to collisions of Ar^+ ions with residual gas. When the neutralization occurs in the straight section (SS-2), the neutrals were detected by the secondary electron multiplier (SEM) in the forward direction of the SS-2.

Figure 2 shows neutral argon yield as a function of storage time. Background coming from the SEM was subtracted. The ions were stored for at least a few milliseconds (the ions turned round a few hundred times). In the early stage of storage, a fast decay appeared due to loss of ions with unstable trajectories. Then, a slow exponential decay with a lifetime of about 2 ms is observed, corresponding to collision with the residual gas.

The storage test has so far been conducted rather low vacuum. In near future, operation under better vacuum will be tested to store ions for much longer storage.

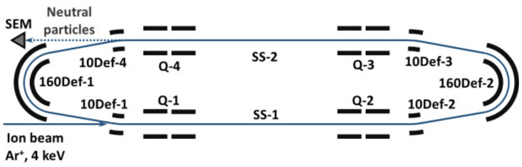

Figure 1. Schematic drawing of μE-ring. All electrodes are mounted on a single rectangle plate of 480 mm × 200 mm. 4 keV Ar^+ ion beam is injected from the lower left and makes a counterclockwise turn.

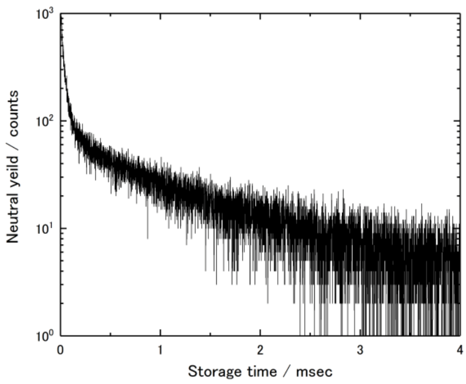

Figure 2. Neutral argon yield as a function of storage time. Background caused by the SEM was subtracted. Vacuum in the ring was about 5 × 10^{-5} Pa.

References

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