XXIX International Conference on Photonic, Electronic, and Atomic Collisions (ICPEAC2015) IOP Publishing
Journal of Physics: Conference Series **635** (2015) 112113 doi:10.1088/1742-6596/635/11/112113

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

Jun Matsumoto[1], Kodai Gouda, Natsumi Kondo, and Haruo Shiromaru

Department of Chemistry, Tokyo Metropolitan University, Hachioji, Tokyo 192-0397, Japan

Synopsis A table-top electrostatic ion storage ring (μE-ring) is being developed. All the electrodes of the ring were mounted on a single rectangle plate of 480 mm × 200 mm, and 4 keV Ar^+ ions were injected for a test of the ring. In the presentation, we will show the detailed design and the status of the μE-ring.

An electrostatic ion storage ring is a powerful device for investigation of slow reactions such as metastable decay and radiative cooling of molecular ions including clusters and biomolecules. We are developing a table-top electrostatic ion storage ring (μE-ring), of which the size is reduced ten times from that of the existing ring at Tokyo Metropolitan University (TMU E-ring) [1], keeping the basic idea for beam manipulation unchanged. That is, the μE-ring consists of two 160 degree deflectors, four 10 degree deflectors and four focusing and defocusing electrostatic quadrupole doublets (Q-lens). It is designed for storage of either positive or negative ions with the energy range from several to 20 keV with the storage time up to several seconds under ultra-high vacuum. Compact size of the ring has a great advantage in the time resolution of the measurements detecting neutral particles, which is limited to the residence time of the ion beam in the straight section. The portability enables us to bring it to various ion beam facilities. For example, use of the ring in a synchrotron radiation facility will definitely expand the field explored by the ion-storage ring.

First, we reconsidered transport property of an ion beam in order to check the effect of the miniaturization. Based on the equation of motion of ions in the ring, transfer matrices were produced, and the Twiss parameters were calculated. Then the stable conditions of betatron oscillations were derived by changing voltages of the quadrupole doublets. Second, actual electric fields generated by the electrodes were calculated by a simulation code, SIMION. The simulated ion beam trajectories show considerable deviation from those expected from the transport property. Therefore, the ion optics was refined with field clamps recursively. The dimensions of each electrode were determined with considering accuracies of machining and assemblage due to the miniaturization. In the final design, 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, as shown in figure 1. Voltages of all the electrodes, the deflectors and the Q-lenses, are provided from high-voltage modules controlled by PC. Presently, the vacuum pressure is ≈ 1 × 10^{-5} Pa with a 400 L/s turbo molecular pump.

Ion storage tests were carried out by injection of Ar^+ ions at an energy of 4 keV extracted from an electron impact ion source. On the basis of the ion currents measured at various places in the ring, we confirmed that the ion beam was properly controlled on the whole, in the first revolution by the steady voltages close to the designed values. For further revolutions, optimization of all the voltages including the pulse profile of the voltage applied to the switching electrodes is under way.

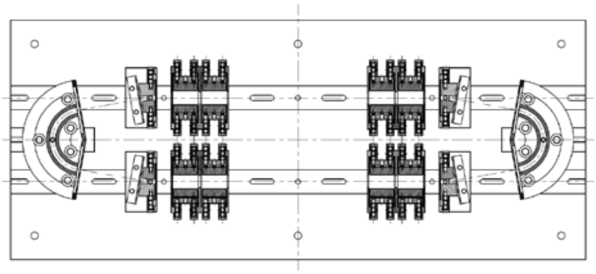

Figure 1. Schematic drawing of μE-ring . All electrodes are mounted on a single rectangle plate of 480 mm x 200 mm

References

[1] S. Jinno *et al* 2007 *Nucl. Instrum. Meth. A* **572** 568

[1] E-mail: junmatsu@tmu.ac.jp