Design of a cryogenic electrostatic storage ring at RIKEN

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A new electrostatic ion storage ring for atomic and molecular physics experiments will be constructed in AMO Physics Laboratory, RIKEN [1]. The vacuum chamber and all electrostatic components of the new ring will be cooled down below 10K. Combined with a 4K ion trap at the injection beam line, this cryogenic ring allows the storage of cold molecular ions, which will be used for merging experiments with tunable lasers and neutral atomic and molecular beams.

Following the existing electrostatic storage rings in operation in Denmark [2] and Japan [3,4], we adopted the race-track shape for the ion beam trajectory in the new ring, however, the circumference of the track is reduced to ~3 m. The small-sized ring has an advantage for effective cooling of the chamber and merging with a neutral beam. The geometrical layout of the electrostatic components is shown in Fig. 1(a). The ion beam is bent by two 160° deflectors and four 10° deflectors, and focused by four sets of quadrupole doublet lenses. The stable storage conditions for the beam energies from 20 keV to 30 keV were calculated by a transfer matrix calculation. In addition, the actual beam trajectories were simulated using SIMION 8, which are also shown in Fig. 1(a). Figure 1(b) shows the schematic structure of the twofold vacuum chamber of the storage ring. All electrostatic components will be attached onto the inner vacuum chamber, which is cooled down by 4K cryocoolers. For the thermal isolation from the atmosphere, the cold chamber will be installed in a large vacuum chamber with a thermal shield. A neutral beam source for merging experiments is also under development based on a photodetachment of a negative ion beam using a Q-switched YAG laser.

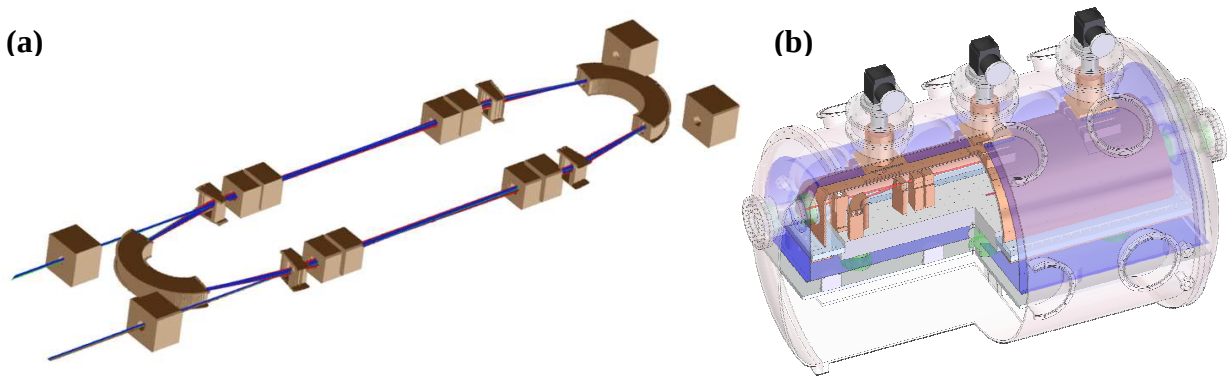

Figure 1. (a) The layout of electrostatic components and the result of ion trajectory simulation by Simion 8. **(b)** The thermal shielding and vacuum sealing structure planned for the new ion storage ring at RIKEN.

References

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