

The Multiple Ambipolar Recirculating Beam Line Experiment: MARBLE-1

Alexander J. Klein

The MARBLE-1 is a linear electrostatic ion-beam trap which is designed to stably contain up to five overlapping (yet largely independent) beam populations. It incorporates an axial magnetic field, electron injection schemes, high vacuum ($P < 1 \times 10^{-9}$ Torr), and other features which are all interfaced with a compact PXI LabView data acquisition and control system. This machine was hastily constructed and started operations only six weeks after conception! Although very simple and relatively inexpensive in design, the quick pump-down and configurability make the MARBLE-1 a very versatile device to explore the physics of the MARBLE concept. This poster describes the experimental apparatus, associated hardware/software and diagnostics systems.

MARBLE concept: Conventional ion beam storage devices provide stable containment for only a small volume in phase space (p, E). We have recently discovered that multiple, separate volumes in stable phase space can be effectively realized in a single linear trap with simple arrangements of electrodes. In addition, it is possible to confine both ions and electrons on stable orbits together and at the same time – purely electrostatically. Finally, the addition of an axial magnetic field produces an extraordinary effect: all electrons in the system are constrained to travel axially, regardless of energy. With a single externally located electron source, virtual cathodes are easily established along an ion trap device, such cathodes being located near the (negative) valleys of the free space vacuum potential. At the same time, the (positive) peaks of the vacuum potential are transformed into classical Penning traps, where cold electrons are extremely well confined and may be used to ionize a rarefied population of neutrals (acting as ion sources).