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Quantitative electron and gas cloud experiments*

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Electrons can accumulate in and degrade the quality of positively charged beams. This is a well-known problem in proton storage rings. Heavy-ion rings are more frequently limited by gas pressure-rise effects. Both effects may limit how closely the beam radius can approach the beam-tube radius in a heavy-ion linac. We study beams of 1 MeV K^+ with currents of up to 180 mA in the High-Current Experiment (HCX), and compare our work with simulations [1]. The simulation results are discussed in a companion paper [2].

We have developed the first diagnostics that quantitatively measure the accumulation of electrons in a beam [3]. This is compared with separate measurements of the three sources of electrons in a linac: ionization of gas, emission from walls surrounding the beam, and emission from an end wall coupled with electron drifts upstream through quadrupole magnets. These will enable the particle balance to be measured for each source, and electron-trapping efficiencies determined. We, along with colleagues from GSI and CERN, have also measured the scaling of gas desorption with beam energy and dE/dx [4].

Experiments where the heavy-ion beam is transported with solenoid magnetic fields, rather than with quadrupole magnetic or electrostatic fields, are being initiated. We will discuss initial results from experiments using electrode sets (in the middle and at the ends of magnets) to either expel or to trap electrons within the magnets.

We observe electron oscillations in the last quadrupole magnet when we flood the beam with electrons from an end wall. These oscillations, of order 10 MHz, are observed to grow from the center of the magnet while drifting upstream against the beam, in good agreement with simulations.

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[1] J-L. Vay, Proc. of the 2005 Particle Accelerator Conference.

[2] J-L. Vay, this conference.

[3] M. Kireeff Covo, et al., to be submitted to Phys. Rev. Lett.

[4] A. W. Molvik, et al, to be submitted to Phys. Rev. Lett.