Abstract for an Invited Paper
for the DPP05 Meeting of
The American Physical Society

Experimental Simulations of Intense Beam Propagation Over Large Distances in a Compact Linear Paul Trap[1]

ERIK GILSON, PPPL

The Paul Trap Simulator Experiment (PTSX) is a compact laboratory experiment that places the physicist in the frame-of-reference of a long, charged-particle bunch coasting through a kilometers-long magnetic alternating-gradient (AG) transport system. The transverse dynamics of particles in both systems are described by the same set of equations, including nonlinear space-charge effects. The time-dependent voltages applied to the PTSX quadrupole electrodes are equivalent to the axially-oscillating magnetic fields applied in the AG system. Experiments concerning the quiescent propagation of intense beams over large distances can then be performed in a compact and flexible facility. An understanding and characterization of the conditions required for quiescent beam transport, minimum halo particle generation, and precise beam compression and manipulation techniques, are essential, as accelerators and transport systems demand that ever-increasing amounts of space-charge be transported. Application areas include ion-beam-driven high energy density physics, high energy and nuclear physics accelerator systems, etc. One-component cesium plasmas have been trapped in PTSX that correspond to normalized beam intensities, s, up to 80% of the limit where the self-electric forces would destroy the transverse confinement. Plasmas in PTSX have been trapped with twice the value of s to be employed in the Spallation Neutron Source, corresponding to equivalent beam propagation over 20 km. Results are presented for experiments in which the amplitude of the quadrupole focusing lattice is modified as a function of time. It is found that beams can be transversely compressed by a gradual increase in quadrupole lattice amplitude that takes place over only 15 lattice periods. Instantaneous changes in lattice amplitude are quite detrimental to transverse confinement of the charge bunch.

[1]This research is supported by the U.S. Department of Energy