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Studies of Emittance Growth and Halo Particle Production in Intense Charged Particle Beams Using the Paul Trap Simulator Experiment[1]

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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 spatially-periodic magnetic fields applied in the AG system. The transverse emittance of the charge bunch, which is the area in the transverse phase space that the beam distribution occupies, is an important metric of beam quality. Maintaining low emittance is an important goal when defining AG system tolerances and when designing AG systems to perform beam manipulations such as transverse beam compression. Results will be presented from experiments in which white noise and colored noise of various amplitudes and durations has been applied to the PTSX electrodes. This noise is observed to drive continuous emittance growth over hundreds of lattice periods. Additional results will be presented from experiments that determine the conditions necessary to adiabatically reduce the charge bunch's transverse size. During adiabatic transitions, there is no change in the transverse emittance. The transverse compression can be achieved either by a gradual change in the PTSX voltage waveform amplitude or frequency.

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