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Detection of Collective Beam Modes in the Paul Trap Simulator Experiment[1] E.P. GILSON, M. CHUNG, R.C. DAVIDSON, M. DORF, P.C. EFTHIMION, R. MAJESKI, E.A. STARTSEV, Princeton Plasma Physics Laboratory, A.B. GODBEHERE, Cornell University — Experiments have been performed to excite and detect collective transverse symmetric and quadrupole modes ($m = 0, 2$) in the Paul Trap Simulator Experiment (PTSX). PTSX is a compact laboratory Paul trap that simulates a long, thin charged-particle bunch coasting through a kilometers-long magnetic alternating-gradient transport system by putting the physicist in the frame-of-reference of the beam. The transverse dynamics of particles in both systems are described by the same sets of equations – including nonlinear space-charge effects. The frequency spectrum of collective mode oscillations depends on the details of the distribution function, the focusing field strength, the self-field intensity parameter, and geometric effects such as the proximity of the conducting wall. These oscillations typically involve various combinations of the frequencies $\hat{\omega}_q$, $\hat{\omega}_p$, and $(\hat{\omega}_q^2 - \hat{\omega}_p^2/2)^{1/2}$ (where $\hat{\omega}_q$ is the average transverse focusing frequency and $\hat{\omega}_p$ is the plasma frequency) modified by geometric effects (r_p/r_w). Initial experiments focus on identifying collective modes whose signature will serve as a robust diagnostic for key properties of the beam, such as line density and transverse emittance. The experimental results are compared with the output of particle-in-cell simulations performed using the WARP code.

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Erik Gilson
Princeton Plasma Physics Laboratory

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