Abstract Submitted
for the DPP14 Meeting of
The American Physical Society

Gyrokinetic description of high intensity beams in cyclotrons

JOSEPH GUADAGNI, ANTOINE CERFON, Courant Institute, NYU — Continuum kinetic and fluid theories are a useful complement to Particle-in-Cell simulations to study the dynamics of intense beams in cyclotrons. We recently derived a reduced fluid model for cyclotron beams in the regime in which 1) the ratio of the self-electric field force to the externally imposed magnetic force is small; 2) the amplitude of the mismatch oscillations is small compared to the characteristic size of the beam. The fluid equations in this model are formally identical to the vorticity-streamfunction form of the incompressible 2D-Euler equations. Based on this analogy, we were able to use well-known results of fluid dynamics to offer intuitive explanations for beam spiraling and breakup. In our present work, we relax assumption 2) to include the effects of large mismatch oscillations in our model. We still assume that the beam is strongly magnetized, corresponding to a large scale separation between the betatron time scale and the space charge time scale. Averaging over the betatron time scale, we show that the evolution of the beam on the space charge time scale is determined by the gyrokinetic Vlasov-Poisson system. We describe the numerical scheme we developed to solve these equations and present initial results.

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Date submitted: 11 Jul 2014

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