NONLINEAR RF AND SPACE-CHARGE INDUCED EMITTANCE GROWTH IN A THERMIONIC INJECTOR ACCELERATING CAVITY*

C. Mitchell
National Research Council Fellow

P. Sprangle, J. Penano, S. Gold and
D. Gordon and A. Ting
Plasma Physics Division, Naval Research Laboratory
Washington, DC 20375

B. Hafizi
Icarus Research, Inc., Bethesda, MD 20824

The performance of a high-power free-electron laser depends crucially on the attainment of low beam emittances and short pulse lengths from the injector. One potential injector design involves generating a beam from an rf-gated thermionic cathode[1] that is located within a 700 MHz accelerating cavity. The proposed RF cavity design is modeled using the field-solver Poisson Superfish. Particle energies in the cavity range from a few hundred eV at the cathode up to 1 MeV at the cavity exit. At these low energies, space-charge effects play a crucial role in determining the phase-space evolution and emittance growth of the beam. To examine these effects, the accelerating cavity region is modeled using the 3-d particle-in-cell code PARMELA. We explore the use of an additional 3rd-harmonic 2.1 GHz accelerating structure to minimize RF-induced curvature in the longitudinal phase space and to improve the longitudinal bunching of the beam.

1. "High Average Current Injectors for High-Power FELs", NRL Memo. Report (2009), NRL/MR/6790—09-9230.

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