RF DENSITY-MODULATED ELECTRON SOURCE SIMULATIONS WITH MICHELLE*

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New models have been developed and implemented in the MICHELLE Finite-Element Electrostatic Particle-in-Cell code\(^1\) in support of modeling RF photocathodes and IOTs (inductive output tubes). In the case of photocathodes, low emittance, high current density sources are required to achieve the small beam size needed for high frequency vacuum electronic devices and, in particular, low emittance sources are demanded for high power free electron lasers (FELs). Emission models are of particular importance in the emittance-dominated regime, where emission non-uniformity and surface structure of the cathode can have an impact on beam characteristics and situations that depend on beam quality (e.g., halo). We have been developing comprehensive time-dependent photoemission models that account for laser and cathode material and surface characteristics and adapting them to develop emission models for inclusion into beam simulation codes\(^2\). In addition to the photoemission effects, including the effects of thermal field emission and modeling dark current are key to predicting beam quality and performance degradation due to beam tails and halo.

The input cavity of the IOT is particularly difficult to model due to disparate spatial scales (~1000 to 1) of the electrodes and accelerating gap compared to the grid and cathode-grid gap, and requires an extremely fine mesh to resolve these features. The use of FE ESTD PIC can handle such a mesh, but at a cost: the beam wave interaction with the RF fields is through a circuit model and not a first-principle calculation. We have found that a circuit model coupled to a time-varying electrostatic electric field can simulate the effect of electron Beam Loading and reactive detuning with reasonable accuracy. Our benchmarks and results will be discussed.


* Work supported by ONR, JTO, NAVSEA and SAIC IR&D.