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Application of the Finite-Element MICHELLE to RF Photoemission Modeling[1]

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RF photocathodes are difficult to model but continue to be at the forefront of solutions to many applications, especially as high power FEL sources. Modeling the photoemission process requires a high degree of computational mesh resolution to resolve geometrical and surface finish features, or simply fine spatial scale phenomena. The new Finite-Element (FE) MICHELLE [1] two-dimensional (2D) and three-dimensional (3D) steady-state and time-domain particle-in-cell (PIC) code has been employed successfully by industry, national laboratories, and academia and has been used to design and analyze a wide variety of beam sources and devices. In particular, the MICHELLE code has the ability to resolve small spatial scales, and is a good choice for photoemission modeling. To investigate the application of the Electrostatic time-domain model to emission properties of photocathodes, two code models are needed; an EM frequency-domain code and a PIC code. We use the STAR ANALYST [2] code for the Frequency Domain solutions and the NRL/SAIC MICHELLE code for the PIC solutions. The RF fields from ANALYST are imported into the MICHELLE code and clocked in time. MICHELLE adds the self fields and emits the beam according to an emission rule. For the photoemission process, we employ the NRL photoemission model [3], and can capture detailed spatial and temporal effects of the emission surface finish and beam development. In the talk, we will consider an example that investigates the effects of fine scale surface imperfections on the photoemission process.

[1] John Petillo, et al., “The MICHELLE Three-Dimensional Electron and Collector Modeling Tool: Theory and Design,” IEEE Trans. Plasma Sci., vol. 30, no. 3, June 2002, pp. 1238-1264.
[2] Analyst is a commercial finite-element package for electromagnetic design. www.staarinc.com.
[3]K. Jensen, et al., “The Quantum Efficiency of Dispenser Photocathode: Comparison of Theory to Experiment” Applied Physics Lett. 85, 22, 5448, 2004.

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