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Dark current in the LCLS-II-HE superconducting injector

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In high-gradient accelerator structures, field emission produces dark current that behaves much differently than the main photobeam current. This dark current can damage accelerator components and increase the radiation dose in the surrounding area. Thus it is important to analyze its behavior when designing a new accelerator or subsystem, such as the superconducting low-emittance injector (LEI) currently under development for the LCLS-II high-energy upgrade (LCLS-II-HE). In principle, the emission of dark current is governed by the Fowler-Nordheim (FN) equation. *In practice, variations in surface quality result in localized emission sites at locations that are not predictable a priori. Since the superconducting gun for the LEI does not exist yet, particles must be tracked from a dense array of initial positions and times on all likely emission surfaces and assigned weights according to the FN equation in the early design phases to inform the placement of collimators. We present the results of tracking studies using BMAD** and Python to analyze dark current in the LEI.

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Footnotes

*R. H. Fowler and L. Nordheim, "The effect of the image force on the emission and reflexion of electrons by metals," Proc. R. Soc. Lond., vol. 119, pp. 173–181, 781 1928.*L.W. Nordheim, "The effect of the image force on the emission and reflexion of electrons by metals,"Proc. R. Soc. Lond. A, vol. 121, pp. 626–639, 788 1928.
**D. Sagan, "Bmad: A relativistic charged particle simulation library,"Nucl. Instrum. Meth., vol. A558, no. 1, pp. 356–359, 2006.

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