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Coherent synchrotron radiation simulation methods using cavity Green's functions

The characterization and mitigation of collective beam effects, particular coherent synchrotron radiation (CSR), represents an important challenge in facilitating the development of particle accelerators with higher beam brightness. Among the mitigation strategies proposed in the literature, the use of appropriately configured shielding walls to curb CSR remains an promising area of research with several open problems. In this work, we consider the construction of a simulation method based on the use of an effective Green's function for such systems. Utilizing such an approach would allow for characterizing the emitted radiation in a manner that (1) is mesh independent, therefore eliminating the numerical dispersion errors present in traditional PIC methods and (2) accounts for the effects of shielding walls. We will discuss the theoretical components involved in constructing the Green's function, along with an analysis of the computational cost compared to existing image current methods in the literature. This work is part of a broader project that involves a planned sequence experiments at the Argonne Wakefield Accelerator (AWA) that aims to probe CSR effects (including shielding) over a wide range of parameters. The results of these experiments will eventually be used to benchmark the proposed simulation tools for complex bunch shapes and shielding configurations.

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