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Green's Function-based Methods for Modeling Electromagnetic Interaction Between RF Accelerator Cavity and Electron Bunch

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Accurate and efficient numerical modeling of beam propagation in RF accelerator cavities is inevitable for understanding and optimizing cavity characteristics in electron accelerators. Existing modeling tools are typically based on differential equation-based electromagnetic solvers, such as CST or ACE3P. These solvers require volumetric discretization of the computational domain and can suffer from numerical dispersion, both leading to high computational costs for high-fidelity wide-band modeling. This work investigates several boundary element method (i.e., Green's function)-based algorithms, which do not require volumetric mesh and are free from numerical dispersion. These methods can be further augmented by fast compression-based algorithms and high-order discretization. We demonstrate the efficacy of the proposed algorithm for both time-harmonic and transient modeling beam-cavity interaction. This is joint work with Tianhuan Luo, Ji Qiang, Yikai-Kan, Mustafa Rahman, and Sherry Li from Lawrence Berkeley National Lab.

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