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Fast and efficient modeling of structure-based wakefield accelerators

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Structure-based wakefield accelerators (SWFA) have been identified as a candidate technology for future applications ranging from free electron lasers to colliders. However, achieving the desired beam energy and quality requires meter-scale structures with tight tolerances, placing constraints on structure and beam characteristics to minimize emittance growth and combat transverse instabilities. High fidelity and self-consistent simulations over these lengths necessitate enormous computational resources, making parametric studies of novel structures or instability-mitigation schemes unfeasible with standard practices. We present a technique for decomposing high dimensional wakefield systems into a set of lower dimensional components, capable of accurately reconstructing the structure response in a fraction of the time. We discuss the approach and implementation of this technique using Green's Functions for common structure geometries. We demonstrate the potential for significant reduction in computation times and memory footprint using such representations. Finally, we discuss the application of machine learning in generating these representations for novel structure geometries.

Footnotes

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LaTeX

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