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JuTrack, a Julia-based auto-differentiable accelerator simulation code for advanced dynamics, scientific machine learning and optimization

Tuesday 12 August 2025 16:00 (2 hours)

JuTrack is a high-performance accelerator modeling and particle tracking package developed in the Julia programming language. With compiler-level automatic differentiation (AD), JuTrack enables fast and precise derivative computations for arbitrary differentiable simulation functions. It supports efficient modeling of complex collective effects such as space-charge forces, wakefields, and beam-beam interactions. Beyond conventional tracking simulations, JuTrack also incorporates a machine learning–based module for self-field modeling and convenience interface that brings data-driven and physics-driven model together. In this paper, we demonstrate the capability and performance of JuTrack through a broad set of beam dynamics applications and optimization across various accelerator types, including a synchrotron light source, a heavy-ion linear accelerator, and the colliders. Built on Julia's high-performance architecture and user-friendly syntax, JuTrack provides a powerful tool for beam dynamics studies and accelerator design optimization.

Please consider my poster for contributed oral presentation

Yes

Would you like to submit this poster in student poster session on Sunday (August 10th)

No

Footnotes

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Yes

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