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Development and applications of differentiable coherent optical transition radiation simulations

Monday 11 August 2025 16:00 (2 hours)

Optical transition radiation (OTR) beam profile monitors are widely used to measure the transverse profiles of low-charge electron bunches at advanced linear accelerator facilities such as LCLS-II and FACET-II. However, in scenarios involving strong longitudinal compression or microbunching-induced current spikes, the incoherent OTR signal—proportional to the transverse beam density—is often dominated by coherent OTR (COTR). The resulting COTR patterns exhibit complex dependencies on the full spatiotemporal structure of the beam, rendering conventional profile interpretation ineffective. In this work, we present a novel, backwards-differentiable simulation framework for COTR emission, enabling gradient-based inference of beam characteristics directly from COTR images. We further integrate this framework with the generative phase space reconstruction (GPSR) method to recover high-fidelity 4D transverse phase space distributions of strongly compressed beams. Simulation results demonstrate the ability of this approach to accurately reconstruct detailed beam structure from COTR-based diagnostics, offering a new path toward high-resolution characterization of ultrashort electron bunches.

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No

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

No

Footnotes

Funding Agency

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Yes

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