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Super-resolution Reconstruction Algorithm Applied to the Reconstruction of Electron Beam Transverse Phase Space Based on the Scanning Slit Method

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Electron beam injectors, critical to light sources and ultrafast diffraction systems, need precise transverse phase space diagnostics for optimizing beam quality. The slit-scanning method, often combined with computed tomography (CT), is common for non-presumptive phase space reconstruction but has resolution limits due to sparse sampling and constraints of devices/experimental conditions. This study proposes a deep learning-based super-resolution framework to address these issues. Integrating beam transport physics with neural networks, it effectively recovers phase space details from limited slit-scanning data, overcoming resolution degradation in low-data regimes. Compared with traditional methods, it significantly improves reconstructed transverse phase space resolution, better reflecting electron beam transverse performance. Coupled with beam dynamics simulations, it offers systematic engineering solutions for high-fidelity diagnostics, boosting characterization efficiency and reducing accelerator commissioning costs. This research provides an approach to enhance beam transverse phase space reconstruction accuracy, contributing notably to modern particle accelerator technology.

Footnotes

Funding Agency

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Yes

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