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Courant-Snyder formalism for modeling, optimizing and simulating broadband THz radiation transport

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In order to exploit the scientific potential of user-oriented accelerator facilities, it is necessary to provide adequate pump sources to enable pump-probe science. The EuXFEL R&D project, STERN, aims to equip X-ray users with an accelerator-based THz source matching the high repetition rate of the XFEL. The proposed THz radiation generation methods involve Cherenkov wakefield structures and diffraction radiation, aiming to produce a spectrum from 300 GHz to 30 THz. To enable experimental characterization, both broadband and narrowband pulses must be transported through a single beamline to a radiation-shielded laboratory. A major challenge has been the simulation, optimization and design of the STERN beamline. The OCELOT accelerator lattice optimizer is adapted for optical transport with mirrors substituting traditional focusing magnets. The performance is corroborated using a THz transport code that considers beam clipping and diffraction. The optimized beamline achieves efficient transport over 10 meters, maintaining over 75% source-to-end efficiency across the frequency range. This development marks a significant step forward in THz beamline design for advanced applications.

Footnotes

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