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Machine learning driven beam emittance optimization at EuXFEL

Thursday 5 June 2025 15:30 (2 hours)

Planned upgrades of the European X-Ray Free Electron Laser (EuXFEL) target higher photon energy and a high duty-cycle operation up to CW operation, critically depending on improvements of the beam slice emittance of the electron gun. We are addressing this challenge by the application of deep learning techniques to create an inverse model that predicts optimal parameter configurations for the photoinjector, enabling targeted control and minimization of beam emittance. This methodology involves sampling synthetic training data through comprehensive beam dynamics simulations and introduces a machine
learning-based strategy for prediction of optimal gun parameters as well as temporal pulse shaping, accommodating a family of pulse distributions including flattop and Gaussian shapes. We present results from trained neural networks with various architectures and outline our research on the invertibility of the forward model by connecting our approach to the theory of inverse problems.

Footnotes

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LaTeX

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Europe

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