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Machine Learning based optimization of beam emittance in Free-Electron Lasers

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The European XFEL at DESY is a world-leading research infrastructure in Hamburg (Germany), enabling scientists to observe and investigate microstructural processes and phenomena with spatial and temporal resolutions on the atomic and femtosecond scale. To improve the performance of the accelerator and also to ensure its competitiveness with other facilities, it is essential to optimize the European XFEL for operation in continuous-wave (CW) mode in near future. Despite its advantages, an operation in CW mode requires a reduction of the beam energy and is associated with an increase in the geometric beam emittance though.
To still ensure the delivery of high quality beams, we develop and
apply machine learning methods to the modeling the photoinjectors and pulse shaping within a novel approach,
resulting in the improvement of crucial beam properties such as the beam emittance.
Based on both simulated and experimental data, we will implement a Digital Twin of the EU XFEL, enabling us to optimize the generated emittance in an online control while also considering nonlinear space-charge effects near the photocathode while outperfoming classing optimization methods.

Footnotes

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