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Reinforcement Learning for Intensity Tuning at Large FEL Facilities

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One of the key metrics determining the capabilities of Free Electron Laser (FEL) facilities is the intensity of photon beam they can provide to experiments. However, in day-to-day operations, tuning to maximise the FEL intensity is one of the most difficult and time-consuming tasks. Skilled human operators still need large amounts of the available beam time, which are then not available for experiments, to achieve maximum performance. The large number of tuning parameters and high non-linearity of the underlying dynamics have so far made it challenging to develop autonomous FEL tuning solutions. We present a method based on reinforcement learning to train a neural network policy to autonomously tune the FEL intensity at *LCLS* and *European XFEL*. Our method is trained requiring little to no beam time and is appealing for tuning across different FEL setups. In contrast to conventional black box optimisation approaches that do not share information across different tuning sessions and setups, a trained policy can leverage its experience to tune the FEL intensity with minimal online exploration.

Primary Keyword

reinforcement learning

Secondary Keyword

AI-based controls

Tertiary Keyword

ML-based optimization

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