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Machine learning to enhance XFEL operation at LCLS-II

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The LCLS-II is a high repetition rate upgrade to the Linac Coherent Light Source (LCLS). LCLS-II will provide up to a million pulses per second to photon science users. The emittance and dark current are both critical parameters to optimize for ideal system performance. The initial commissioning of the LCLS-II injector was substantially aided by detailed online physics modeling linking high performance computing directly to physicists in the control room, along with the use of Bayesian optimization for fine tuning the emittance while balancing against dark current.

Here we summarize the role these tools played in the commissioning period and are playing in the current operational stage of the LCLS-II injector, which provides an example for how other accelerator facilities may benefit from combining online modeling and optimization infrastructure. We also describe current progress on creating a fully deployed digital twin of the LCLS-II injector based on a combination of ML modeling and physics modeling, using the LUME software suite and various ML-based characterization tools. Finally, we will describe current efforts and plans to leverage the online LCLS-II injector model in fast optimization and control schemes.

Primary Keyword

Secondary Keyword

Tertiary Keyword

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