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Virtual Photon Diagnostics at SwissFEL for Real-Time Spectral Analysis Using Convolutional Neural Networks

Friday, 8 November 2024 12:00 (30 minutes)

The analysis of SASE X-ray FEL spectra plays a critical role in supporting user experiments and advancing machine development. The number and width of SASE spikes in a spectrum serve as key indicators of FEL pulse duration and electron beam energy chirp. In this study, we present a method for real-time spectral analysis using convolutional neural networks (CNNs). A significant aspect of this work involves training the model to detect the number of SASE spikes, even when individual spike widths fall below the spectrometer's resolution. We trained the CNNs on extensive experimental datasets (N>50000) from the hard and soft X-ray beamlines at SwissFEL, as well as on synthetically generated data. The results of our spectral analysis are compared with time-domain measurements based on electron streaking. This approach provides a practical solution for enhancing photon spectra diagnostics at SwissFEL.

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