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Simulating spectral detectors - synthetic radiation diagnostics with PIConGPU and ClaRa

Summary

We present both the in-situ far field radiation diagnostics in the particle-in-cell code PIConGPU and the offline radiation diagnostic code ClaRa. The first was developed to close the gap between simulated plasma dynamics and radiation observed in laser plasma experiments. The second is used to quantitatively simulate radiation observed in e.g. Thomson scattering experiment. Both methods are based on the far field approximation of the Liénard-Wiechert potential. Their predictive capabilities, both qualitative and quantitative, have been tested against analytical models.

We will discuss the advantages of the in-situ approach of PIConGPU over ClaRa that allows predicting both coherent and incoherent radiation spectrally from infrared to x-rays and provides the capability to resolve the radiation polarization and determine the temporal and spatial origin of the radiation. Furthermore, we explain why the direct integration into the highly-scalable GPU framework of PIConGPU allows computing radiation spectra for thousands of frequencies, hundreds of detector positions and billions of particles efficiently.

We will demonstrate these capabilities on resent simulations of laser wakefield acceleration (LWFA), high harmonics generation during target normal sheath acceleration (TNSA) and Thomson scattering during laser electron interactions.

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