MATTER AND TECHNOLOGIES

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Simulating laser wakefield acceleration with PIConGPU - from modeling the laser plasma dynamic to in-situ radiation calculation

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We recent simulations of laser wakefield acceleration on recent experiments performed at HZDR. We focus on how to best approximate the experimental setup using newly developed laser-models, as well as particle creation- and ionization-methods. Furthermore, we elaborate on predicting experimentally observable radiation signatures from the simulation.

We discuss in detail the influence of various ionization mechanisms, including BSI, ADK and Keldysh, and how to model the initial gas or plasma distribution. Furthermore, we present recent improvements in the laser implementation, that added Laguerre-Gauss modes, which drastically reduces discrepancies between previous simulations and experiments. On top of simulating plasma dynamics, we present how to predict experimental observables using PIConGPU's in-situ synthetic diagnostics, especially the classical Liénard-Wiechert potential- and QED-based radiation. It allows predicting both coherent and incoherent radiation spectrally from infrared to x-rays and provides the capability to resolve the radiation polarization as well as determine its temporal and spatial origin.

On the examples of a large-scale LWFA simulation, we illustrate how we reduce the gap between simulated plasma dynamics and radiation observed in experiments and discuss valuable spectral signatures which allow conclusions on the micrometer femtosecond electron dynamics during acceleration.

Topic (ARD or DTS)

ARD

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