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Synthetic Radiation Diagnostic in Hybrid LPWFA

Monday, 22 September 2025 19:00 (1h 30m)

We present a study of a radiation signal in laser-driven plasma wakefield accelerators (LPWFA) employing photo cathode injection. While experimentally observed and significant for timing calibration, its underlying physics remains elusive. Using a synthetic optical imaging plugin for PIConGPU we reproduce this signal in simulations for the first time, linking it to plasma structures and cavity dynamics. By analyzing the images alongside 3D, time-resolved particle distributions, we trace the formation of distinct scattering patterns, offering new perspectives on plasma dynamics.

Our synthetic diagnostic enables self-consistent imaging of plasma structures in laser-plasma accelerators. By integrating electromagnetic fields from the PIC simulation and propagating them via Fourier optics methods onto a virtual screen, we generate synthetic images that resemble experimental measurements. This approach allows direct comparison with experiments, providing insights into plasma dynamics and laser-plasma interactions.

These results highlight the potential of synthetic optical imaging to improve experimental diagnostics in laser-plasma accelerators, such as shadowgraphy, and to deepen our understanding of scattering processes in wakefield acceleration.

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