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Shedding light on LWFA plasma dynamics - in-situ radiation diagnostics in PIConGPU

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We present recent results from the in-situ radiation diagnostics available in the particle-in-cell code PIConGPU and illustrate its power to provide insight into LWFA experiments when linked to experimental measurements.

PIConGPU is currently one of the fastest 3D3V PIC codes. Its speed allows including an in-situ radiation diagnostic based on Liénard-Wiechert potentials. This synthetic diagnostic is capable of computing the spectrally resolved far field radiation of billions of macro-particles for numerous observation directions. It allows resolving the intensity and polarization of the emitted radiation both temporally and spatially for frequencies extending from infrared to x-rays. Its use of form-factors and its capability of phase tracking each individual macro-particle enable quantitative predictions in both the coherent and incoherent regime. Applications for this synthetic radiation diagnostics have already been demonstrated in astrophysical simulations to identify and quantify the Kelvin-Helmholtz instability.

After a brief introduction of the techniques for computing the radiation in-situ, we focus on the characteristic radiation of LWFA, which allows identifying the various stages of the laser-plasma dynamics. We demonstrate the correlation between emitted radiation and particle dynamics and discuss application of these signatures in laboratory experiments

Primary author: Mr PAUSCH, Richard (Helmholtz-Zentrum Dresden - Rossendorf)

Co-authors: Dr DEBUS, Alexander (Helmholtz-Zentrum Dresden-Rossendorf); Mr HUEBL, Axel (HZDR, TU Dresden); Mr STEINIGER, Klaus (Helmholtz-Zentrum Dresden-Rossendorf); Mr GARTEN, Marco (HZDR); Dr BUSSMANN, Michael (Forschungszentrum Dresden-Rossendorf e.V.); Mr WIDERA, René (HZDR); Prof. SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: Mr PAUSCH, Richard (Helmholtz-Zentrum Dresden - Rossendorf)

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