Simulating Strong-Field QED effects in relativistic plasmas on contemporary supercomputers

L. Fedeli[1], N. Zaïm[1], P. Bartoli[1], A. Sainte-Marie[1], A. Formenti[2], A. Huebl[2], A.Myers[2], W. Zhang[2], R. Lehe[2], J.-L. Vay[2], and H. Vincenti[1]

[1] Université Paris-Saclay, CEA, LIDYL, 91191 Gif-sur-Yvette, France

[2] Lawrence Berkeley National Laboratory, Berkeley, CA 94720, United States of America

contact: luca.fedeli ⊕ cea.fr

Physical scenarios characterized by electromagnetic fields so strong that Strong-Field Quantum Electrodynamics (SF-QED) plays a substantial role are one of the frontiers of contemporary plasma physics research. The modeling of these scenarios often requires massively parallel kinetic plasma simulations. In this contribution, we present WarpX [1, 2], a state-of-the-art, open-source Particle-In-Cell code conceived to address the challenges of computing at the exascale, as well as PICSAR-QED[3], a portable Monte Carlo module providing WarpX with the capability of simulating the SF-QED phenomena that are usually the most relevant (i.e., nonlinear Breit-Wheeler pair production and nonlinear inverse Compton scattering). We will also present examples of production simulations performed using WarpX and PICSAR-QED, in particular of the interaction of ultra-high intensity light beams with solid-density plasmas [4, 5] (see Fig. 1) and of the collision of ultra-high energy electron beams in conventional accelerators [6].

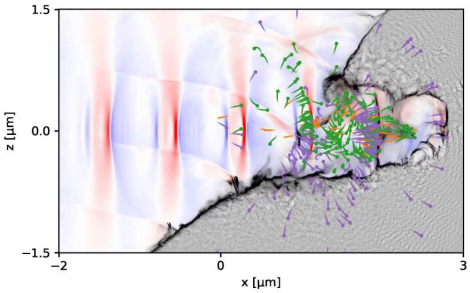

Figure 1: Interaction of an ultra-intense light pulse (blue-red) with a solid density plasma (greyscale). High-energy photons (orange) and e^+/e^- pairs (green and purple) are generated via SF-QED processes.

References

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