Full-Scale Integrated Kinetic Simulations of Laser-Plasma Interactions on the multi-picosecond scale

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We present new results on the modeling of short-pulse laser-matter interaction of picosecond pulses at full spatial and temporal scale, using an approach that combines a 3D collisional electromagnetic Particle-in-Cell code with an MHD-hybrid model of high-density plasma. In the latter, collisions damp out plasma waves so the displacement current can be neglected; and an Ohm's law with electron inertia effects neglected determines the electric field [Cohen, Kemp, Divol, J.Comp.Phys. 229 (2010)]. In addition to yielding orders of magnitude in speed-up while avoiding numerical instabilities, this allows us to model the whole short pulse laser plasma interaction problem in a single unified framework: the laser-plasma interaction at sub-critical densities, energy deposition at relativistic critical densities, and fast-electron transport in solid densities. We address key questions such as characterizing the multi-picosecond evolution of the laser energy conversion into hot electrons, i.e., conversion efficiency as well as angular- and energy distribution; the impact of return currents on the laser-plasma interaction; and the effect of self-generated electric and magnetic fields on electron transport. We will report applications to current experiments at LLNL's Titan laser and Omega EP, and to a Fast-Ignition point design.

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