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Integrated Kinetic Simulation of Laser-Plasma Interactions, Fast-electron Generation and Transport in Fast Ignition[1]

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We present new results on the physics of short-pulse laser-matter interaction of kilojoule-picosecond pulses at full spatial and temporal scale, using a new 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. In addition to yielding orders of magnitude in speed-up while avoiding numerical instabilities, this allows us to model the whole 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. Key questions such as the multi-picosecond temporal evolution of the laser energy conversion into hot electrons, the impact of return currents on the laser-plasma interaction, and the effect of self-generated electric and magnetic fields on electron transport will be addressed. We will report applications to current experiments at LLNL's Titan laser and Omega EP, and to a Fast-Ignition point design for forthcoming experiments on NIF-ARC.

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