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Simulation of the Interaction of Intense Laser Pulses with Dense Plasma

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For some time now the interaction of intense laser beams with dense plasma has generated interest not only because of its relevance for the Fast Ignition concept in the field of Inertial Confinement Fusion (ICF) [1], but also due to the many fundamental physics problems related to it like laser energy deposition in plasma, the transport of the deposited energy via fast electrons or the propagation of ultra-high electric currents through plasma and many more. Of great interest at present are the details of the deposition and the transport of the energy of intense laser pulses in plasma. Of great importance in this context are collisions and collective effects. The proper equations are a set of classical relativistic Maxwell-Vlasov-Boltzmann equations. They are solved numerically with a Monte-Carlo Particle-In-Cell (MCPIC) [2] approach in three spatial dimensions. This quasi-particle method is capable of calculating effects as diverse as the degree of laser absorption in plasma, the generation of fast electrons, the relaxation of laser-generated non-Maxwellian electron and ion distribution functions due to collective effects and binary collisions, the propagation of electron driven heat waves into the plasma, or the generation of vast quasi-steady electric and magnetic fields. Details of the MCPIC-method applicable to systems of intense laser radiation interacting with plasma are presented. The application of the method to the acceleration of protons with intense lasers featuring collisional transport of fast electrons through solid density plasma and the excitation of teravolt electric fields is demonstrated [3].

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