MULTISCALE MODELS OF LASER-PLASMA INTERACTION FOR THE SHOCK IGNITION SCHEME

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Laser-plasma interactions (LPI) in the context of Inertial Confinement Fusion (ICF) are prone to numerous nonlinear and kinetic processes. Although routinely studied at miscroscopic and mesoscopic scales with Particle-in-Cell and Paraxial Electromagnetic codes, these processes are hardly accounted for in the radiative hydrodynamics codes, which are usually limited to collisional absorption modeling. The direct drive advanced ICF schemes such as shock ignition, and laser plasma experiments at a nanosecond time scale require a more detailed description of LPI at hydrodynamic scales including the cross-beam energy transfer, parametric instabilities, high energy electron and ion transport and their effect on the ablation pressure and fusion ignition conditions.

In this talk we present a novel macroscopic LPI model specially adopted for using in hydrocodes and its application to the shock ignition scheme. The model is based on the Paraxial Complex Geometrical Optics for stochastically distributed Gaussian optical beamlets[1]. It is describing the laser beam refraction and diffraction in the plasma, laser energy absorption due to the collisional and resonant processes, energy exchange between the laser beams[2] and hot electron generation due to the resonance absorption, the Stimulated Raman Scattering (SRS) and Two-Plasmon Decay (TPD). The hot electron transport is described in the multi-group continuous slowing down approximation, adapted to transversally Gaussian electron beams. The LPI model is validated against several experiments conducted on the PALS and OMEGA facilities, showing an extremely good agreement, simultaneously matching observables from hydrodynamic, hot electrons and reflectivity measurements. The role of hot electrons in the shock formation and preheat of the upstream plasma is demonstrated.

The conditions of hot spot ignition with a strong shock are analyzed using the LPI model. The hot electrons modify the criterion of the central hot spot ignition with a laser spike, the shock pressure formation process and the shock strength amplification in the converging shell. The SRS driven hot electrons are permitting to increase the shock pressure by 30% but they are requiring a longer shock formation length, decreasing the shock strength and the time of shock convergence by preheating of the cold shell. The requirements on the shock ignition target design related to hot electrons will be discussed.

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