MODELING OF CROSSED LASER BEAM ENERGY TRANSFER (CBET): COMPARISON BETWEEN A PARAXIAL GEOMETRICAL OPTICS APPROACH AND A PARAXIAL DESCRIPTION WITH SMOOTHED LASER BEAMS

A. Colaitis, S. Hüller, G. Duchateau, D. Pesme, and V. Tikhonchuk

1Centre Lasers Intenses et Applications, Université de Bordeaux, CNRS, CEA, 351 Cours de la Libération, 33400 Talence, France
2Centre de Physique Théorique, CNRS, Ecole Polytechnique, Palaiseau, France
hueller@cpht.polytechnique.fr

For both Direct Drive and Indirect Drive concepts of laser fusion, a reliable modeling of laser propagation is of crucial importance. Such a modeling has to take into account the potential energy exchange between laser beams, and between groups of laser beams.

A new approach based on paraxial complex geometrical optics, “PCGO” [1,2], coupled to a hydrodynamics code, allows to compute the laser propagation in large mm- to cm-size plasma volumes with less computational expense than with conventional paraxial modeling. The PCGO approach is based on Gaussian-shaped thick rays, and has been conceived to take into account crossed beam energy transfer (CBET) within the limit of a steady state model of exchange between crossing beams [2].

We examine here the validity of this approach by comparing simulation results of the PCGO code and of the code HARMONY [3,4] based on paraxial light propagation. Both codes are coupled to non linear hydrodynamics codes; the PCGO code, in particular, is implemented as a module in the radiation hydrodynamics code CHIC [5]. For the comparison we apply a well-defined geometry with density- and velocity- profiles corresponding to an inhomogeneous plasma, including a resonance zone in which the matching conditions for the frequencies and the wave vectors between the laser beams and the plasma wave corresponding to stimulated Brillouin scattering are fulfilled. For the simulations with HARMONY we use both laser beams generated with a random phase plate (RPP) and “regular beams” of the same size and the same average intensity, but without laser speckles. For simplicity we restrict ourselves to 2D geometry.

We find, in general, a very good agreement between the PCGO simulations and the fully time-dependent simulations with HARMONY, which is corroborated by the following observations: (i) for the majority of the cases considered, the energy transfer converges – past a transient period on the ps time scale – to values very close to the steady state value computed in the PCGO code; (ii) a simple model based on wave coupling underlines the results from the numerical simulations, and it indicates where a non-stationary exchange has to be expected; (iii) after the transient phase, the spatial intensity distributions obtained with the PCGO code and with HARMONY (for both beam types, RPP and “regular”) are very similar, in particular concerning the pump-depleted zones.

Our comparison shows that the code based on the PCGO approach correctly describes, past a transient phase (~picoseconds), the Crossed Beam Energy Transport in situations where resonant exchange occurs. This result is very promising for the numerical modeling of a complex geometry.