Crossed Beam Energy Transfer (CBET): the role of laser speckles in presence of self-focusing and beam deflection

Stefan Hüller [1], Gaurav Raj [1,2] and Denis Pesme [1]

1) *Centre de Physique Théorique, CNRS, Ecole Polytechnique, Palaiseau, France*

E-mail: hueller@cpht.polytechnique.fr

2) *currently: FEMTO-ST, CNRS U. de Bourgnogne Franche-Comté, Besançon, France*

We investigate the role of laser speckles (hot spots) and their self-focusing in crossed beam energy transfer (CBET) of smoothed laser beams in an inhomogeneous expanding plasma. The configurations we have studied are typical for indirect-drive laser fusion hohlraums where laser beams cross in the vicinity of laser entrance holes. For this purpose we have performed numerical simulations with the code HARMONY in two spatial dimensions (2d).

It is demonstrated how self-focusing of laser hot spots in crossed beams can significantly affect the transfer of energy from one beam to the other in addition to the transfer between the global beams due to stimulated Brillouin scattering (SBS).

In previous work [1,2] it has been shown that for sufficiently intense laser beams, the criterion for the onset of self-focusing in laser hot spots is altered for a plasma with flow, leading also to beam bending in the vicinty of sonic flow [3,4].

It is shown that for CBET the contribution of the laser speckle structure substantially matters due to self-focusing hot spots, in particular what concerns the angular distribution of the transmitted light: the angular spread of both light beams, taken behind the zone of beam crossing, increases considerably with the overall beam intensity for $I\,\lambda^2 > 10^{14}$ W cm^{-2} µm^2 (with I standing for the average laser beam intensity and λ for the wavelength). We also observe the onset of shock-like ion density perturbations that arise in particular in expanding plasma where significant beam deflection occurs.

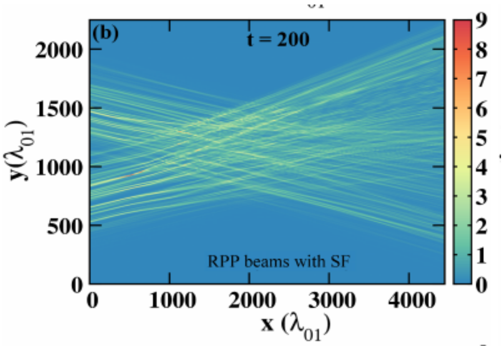

Figure 1: Crossed Beam Energy Transfer of two crossing laser beams with speckle structure: shown is the snapshot of the intensity pattern of two crossing laser beams having the same average intensity and entering from the left. Contour values are normalized to the average intensity of a single beam, here $I\,\lambda^2 = 6\cdot 10^{14}$ W cm^{-2} µm^2. Ref.: G. Raj, S. Hüller, Phys. Rev. Lett. 118, 055002 (2017).

References

[1] A. J. Schmitt, Physics of Fluids B 1, 1287 (1989).

[2] R. W. Short, R. Bingham, and E. A. Williams, Phys. Fluids 25, 2302 (1982).

[3] B. Bezzerides, Physics of Plasmas 5, 2712 (1998).

[4] D. E. Hinkel, E. A. Williams, and C. H. Still, Phys. Rev. Lett. 77, 1298 (1996).