Interplay between Crossed-Beam Energy Transfer and Beam Propagation in Plasmas

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The interaction with multiple beams in plasmas naturally occurs in the context of laser fusion. In the direct-drive scheme, beams are crossing when they superimpose on the target and when they are refracted by the critical density of the plasma. In the indirect-drive scheme, all the beams are crossing at the entrance holes of the cavity. Now, when two beams are crossing in a plasma, the density perturbation driven by their ponderomotive beating can scatter energy of one of the beam in the direction of the other by induced stimulated Brillouin scattering, also called crossed-beam energy transfer (CBET). It can redistribute the beam irradiation and modify the symmetry of the implosion. Simulations struggle to reproduce experimental observations. They need to increase the coupling coefficient or to saturate the density-perturbation amplitude.

An experimental platform was designed on the LULI2000 facility, at Ecole Polytechnique (Palaiseau, France), to study CBET. A first kilojoule nanosecond beam, later called the heating beam, preformed a plasma by irradiating a CH foil. A second nanosecond beam, later called the nanosecond beam, and a picosecond beam were crossed in the preformed plasma after or before the end of the heating beam in order to study CBET in conditions of crossing two or three beams. A high resolution 2D spatial imaging diagnostic was used to measure the focal spot of the picosecond beam after the crossing region and to quantify energy transfer from the nanosecond beam to the picosecond beam [C. Neuville *et al.*, Phys. Rev. Lett. **117**, 145001 (2016)]. Additionally, time-resolved measurements of the transmitted power of the nanosecond beam were performed, characterizing the energy transfer from the heating beam to the nanosecond beam.

We will present these experiments and results from the two-beams and three-beams configurations. In the two-beams experiments, the CBET coupling coefficient highly depended on the intensity of the picosecond beam. It could be the proof of an interplay between CBET, self-focusing and plasma-induced smoothing of the picosecond beam. In the three-beams experiments, we observed the inhibition of the energy transfer from the heating beam to the nanosecond beam during hundreds of picoseconds because of the propagation of the picosecond beam (12ps duration) in the crossing volume. This inhibition could be induced by the production of long-wavelength hydrodynamical fluctuations in the crossing volume because of the propagation of the picosecond beam. In both cases, CBET appears to be highly affected by the propagation of the beams in the plasmas.