Transverse Beam Structure Formation in Crossed Beam Energy Transfer

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Crossed Beam Energy Transfer (CBET) plays a large role in both direct drive as well as indirect drive inertial confinement fusion. CBET is responsible for redirecting energy from one beam into another and reshaping the profiles of the laser beams. For this reason CBET has been at the focus of research activities for a number of years. Despite this, the details of the energy transfer and beam reshaping are not yet fully understood.

Usually it is assumed that transverse beam reshaping is due to the effect that the matching conditions for Brillouin or Raman scattering are only met at certain locations in the non-uniform flowing plasma around the target. In order to interact the beams and the plasma wave must meet matching conditions for the frequency and wave vector, corresponding to energy and momentum conservation. However, for the case of Brillouin scattering the bandwidth of the laser beams can be larger than the frequency of the ion acoustic oscillation. For finite bandwidths the matching conditions are relaxed and don't have to be fulfilled exactly at the beams' central frequency and wave vector. As an example of this case, two beams with identical frequency can exchange energy through an ion acoustic wave in a uniform plasma at rest.

We present 2D, direct numerical simulation of Brillouin Scattering using a hydrodynamic code coupled to a full Maxwell solver. In this way we avoid the expense of full PIC simulations while, on the other hand, not restricting the model to a single frequency envelope approximation. The simulations show transverse structuring of the outgoing beams caused by the depletion of the incoming beam energy. For these conditions beam reshaping can not be explained by local fulfilment of the matching conditions and an alternative explanation must be found. In order to investigate the cause of the structure formation a theoretical model is developed. The model shows that the beam reshaping is caused by the same effects as pulse compression in Brillouin backscattering.