Influence of laser smoothing techniques on Stimulated Brillouin Scattering in the context of LMJ ICF experiments

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One of the most important difficulties standing in the way of achieving Inertial Confinement Fusion is the presence of parametric instabilities [1], growing during laser propagation in plasma. In order to limit these effects, it is essential to get a focal spot as homogeneous as possible. Various optical smoothing schemes have then been developed [2]. These schemes consist in generating speckles patterns featuring many hot and cold spots, and adding them up incoherently as fast as possible. This addition can be instantaneous using polarization (polarization smoothing, PS) or be done over time, by expanding the pulse spectrum and using a dispersing element in order to spatially separate frequencies (smoothing by spectral dispersion, SSD). SSD has been selected on LMJ, PS being an option. The disperser used for SSD is a focusing grating, which allows obtaining either a purely longitudinal or a longitudinal and transverse smoothing. Because of the spatial and temporal scales of the problem, we are especially concerned with an instability involving ion acoustic waves, namely Stimulated Brillouin Scattering (SBS). Our aim is to compare various smoothing schemes regarding their effectiveness to reduce SBS in order to choose their best parameters. Our approach is first to consider a set of ideal cases to simulate the Brillouin backscattering rate: perfect transverse smoothing (applied to a square beam) and perfect longitudinal smoothing (applied to a circular beam with the same surface area). In order to achieve this, we use sequentially two 3D simulation codes: the first one describes the laser beam propagation in vacuum [3], while the second models the laser-plasma interaction [4]. We will show compromises that need to be made when choosing the simulation parameters (see first results in the Figure below). As expected, simulations have shown great similarities between longitudinal and transversal smoothing with comparable saturation level of the Brillouin backscattering rate. However, as opposed to the common belief, the growth rate for short time scales is different as we will explain during the presentation.

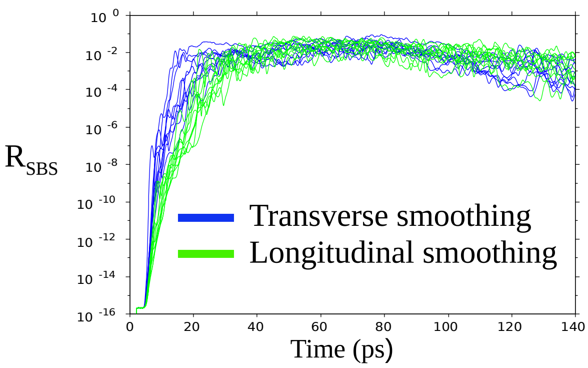

Figure 1 : Temporal evolution of the Brillouin backscattering rate

References

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