Properties of speckle pattern in the zone where all the beams overlap in the LMJ configuration

Gilles Riazuelo [1] and Denis Penninckx [2]
1/ CEA, DAM, DIF, F-91297, ARPAJON Cédex
E-mail: gilles.riazuelo@cea.fr
2/ CEA, DAM, CESTA, F-33116 Le Barp Cedex

The control of Laser–Plasma Instabilities (LPI) is of crucial importance for the success of ICF projects carried on multiple laser beam facilities such as National Ignition Facility (NIF) or Laser MégaJoule (LMJ) in France The propagation of intense laser beams in an under-critical plasma can generate LPI such as filamentation, stimulated Brillouin scattering or stimulated Raman scattering. Moreover, recent experiments carried on multiple laser beams facilities such as NIF or OMEGA laser in Rochester suggested that important laser beam energy transfer can occur in the zone where many laser beams overlap. By breaking both spatial and temporal coherences, the use of optical smoothing techniques, such as smoothing by Spectral Dispersion (SSD), often dramatically reduces LPI and also ensures the reproducibility of laser conditions from one shot to another. An accurate description of the speckle pattern in the hohlraum is thus of great interest in FCI context. If the characteristics of the speckle pattern is well known when it is generated by a single laser beam [1], the statistical properties of multiple beams speckle pattern has so far not been deeply studied.

In this work, we investigate the description of speckle pattern generated from numerous spatially shaped laser beams (with a phase plate but without SSD) in the zone where all the beams overlap in the LMJ configuration. We focus our attention on the size of the speckles and on the values of the contrast. Numerical simulations of the propagation of multiple laser beams in vacuum have been performed with a code which solves the propagation of electromagnetic field by using paraxial approximation for each beam in its local frame and then transposing all of them in the main frame [2]. A specific numerical tool has been developed in order to numerically analyze statistical properties of speckles in a 3D focal volume. Excellent agreement is found between simulation results and previous analytical works [3] for the size of the speckles and for the values of the contrast in different configurations. As a matter of fact, the contrast may decrease below $1/\sqrt{2}$ because of the geometrical configuration even without polarization smoothing. Influence of the polarization of the beams and the choice of the phase plates are also investigated.

References

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