Abstract for an Invited Paper
for the DPP09 Meeting of
The American Physical Society

Multi-laser beams scattering processes in ignition targets[1]

PIERRE MICHEL, Lawrence Livermore National Laboratory

Inertial Confinement Fusion experiments in the indirect drive approach rely on efficient deposition of the energy from many laser beams on the interior walls of a cylindrical cavity (the hohlraum). On the National Ignition Facility, 96 laser beams will overlap at each of the two laser entrance holes (LEH) of the hohlraum. As they propagate further into the hohlraum, they can potentially trigger laser plasma instabilities (LPI) such as stimulated Raman or Brillouin scattering (SRS/SBS) where plasma conditions are favorable for LPI. In this talk, we show that the SRS or SBS light exiting the hohlraum can get collectively amplified by multiple overlapping laser beams as it goes through the LEH. Typically, a SRS or SBS seed will be very weakly amplified by each of the overlapping laser beams; however, the total contribution from all 96 beams can lead to a strong amplification. This was analyzed with a steady-state kinetic model accounting for the collective coupling to all the laser beams. The effects of possible plasma turbulence due to superimposition of multiple plasma waves, as well as nonlinear saturation mechanisms, will also be discussed. The LPI amplification process in a NIF hohlraum is thus similar to a two-stage Raman or Brillouin amplifier, with a first pre-amplifier stage inside the hohlraum followed by a post-amplifier at the LEH. We will show that the process can be controlled by separating the range of frequencies at which the seeds are generated inside the hohlraum, from those that are efficiently amplified at the LEH - i.e. by detuning the pre- and post-amplification stages of the hohlraum. This is achieved by modifying the plasma conditions inside the hohlraum and at the LEH, by appropriately changing the targets designs and compositions. Several targets will be tested on the National Ignition Facility to validate the LPI amplification process as well as its mitigation in the summer of 2009. We will present the experimental data, compare it to our prediction and discuss the results.

[1]This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.