Study of cross-beam energy transfer in spherical strong shock polar direct drive experiments at the NIF

D. Viala[1], A. Colaïtis[1], W. Theobald[2], L. Ceurvost[2], I.V. Igumenshchev[2],
P. B. Radha[2], M. J. Rosenberg[2], K. S. Anderson[2], R. Scott[3], D. Batani[1]
[1] *CELIA, Université de Bordeaux, Talence, France*
[2] *LLE, University of Rochester, Rochester, New-York, USA*
[3] *STFC Rutherford Appleton Laboratory, Didcot, UK*

When the interaction parameter $I\lambda_L^2$ crosses the threshold of $\sim 10^{14}$ W µm²/cm², the laser plasma interaction becomes prone to numerous couplings between electromagnetic and plasma waves [1]. Most of these additional processes have non-linear behaviors and are in general harmful to the implosion in inertial confinement fusion. It is notably the case of the cross-beam energy transfer (CBET), a non-linear laser/plasma coupling effect that is paramount in ICF implosions. CBET can lead to a net transfer of energy between incoming and outgoing beams that affects both the symmetry of the implosion and the laser-target coupling [2].

In this talk, I will present 3D simulations of Polar Direct Drive (PDD) experiments [3] carried out on the NIF. These experiments aimed to study the efficiency of the laser energy coupling to a spherical target with beam intensities close to the SI regime. Two series of shots were simulated: N190204 (a 1100 µm CD+CH radius target with 3.0×10^{15} W/cm² peak intensity and 5 *ns* pulse) and N210519 (a 1050 µm radius CH target with 8.0×10^{14} W/cm² peak intensity and 7 *ns* pulse) [4]. These shots are simulated with and without CBET to investigate its influence on compression and coupling efficiency using the IFRIIT + ASTER [5] coupled codes.

We observe that with CBET, there is a large loss of total energy absorbed for both shots. The energy absorption decreases from 85% energy absorption without CBET to 40-60% absorption (and drops at 30% relative absorption during spike) with CBET. These energy losses occur mainly around the equatorial plane, where the overlap between the beams is much more extreme therefore inducing more CBET. This results in an inhomogeneous compression that is much stronger at the poles, leading to the creation of a pancake-shaped shock, and to several *ns* delays regarding the convergence time. We present comparisons of these results to angularly-resolved density profiles extracted from radiography data.

References

[1] K. Tanaka, L.M. Goldman, W. Seka D., and al., Physical Review Letters **48**, 17 (1982)
[2] I.V. Igumenshchev, D.H. Edgell, V.N. Goncharov, and al., Physics of Plasmas **17**, 12 (2010)
[3] M.Hohenberger, P.B. Radha, J.F. Myatt, and al., Physics of Plasmas **22**, 5 (2015)

[4] K. Anderson, and al., APS-DPP, (2020) **and** W. Theobald, and al., APS-DPP, (2021)

[5] A. Colaïtis, I.V. Igumenshchev and al., Journal of Compulational Physics **443**, (2021)