3-D Simulations of NIF Capsules with an Applied Magnetic Field

Chris WALSH, Jeremy CHITTENDEN, Kris MCGLINCHEY, Brian APPELBE, Jon TONG, Aidan CRILLY
Imperial College, London
E-mail: c.walsh14@imperial.ac.uk

Magnetic fields have been applied to ICF capsules at the OMEGA Laser Facility, increasing the inferred ion temperatures and neutron yields by 15% and 30% respectively [1], demonstrating improvements in hot-spot energy containment through magnetization of the electron thermal transport. Here we look at the potential for applying magnetic fields to NIF experiments, using the 3-D extended-MHD code Gorgon [2]. In addition to reduced thermal conductivities, the magnetization of fusion-produced α-particles is investigated and estimates for yield improvements are obtained for targets on the edge of the ignition cliff.

3-D MHD effects are presented, such as the effect of magnetic fields on the hot-spot shape. Unrestricted heat flow along the magnetic field lines results in a stretched hot-spot, while reduced thermal conduction perpendicular to the field lowers the ablative stabilization of perturbations. The Righi-Leduc heat flow is also found to cool the hot-spot for low initial applied magnetic fields.

Validation of simulations against OMEGA pre-magnetized experiments [1, 3] using proton deflectometry and integrated fusion performance is also presented.

References

[1] P. Y. Chang, G. Fiksel, M. Hohenberger, J. P. Knauer, R. Betti, F. J. Marshall, D. D. Meyerhofer, Physical Review Letters **035006**, 2 (2011)
[2] C. A. Walsh, J. P. Chittenden, K. McGlinchey, N. P. L. Niasse, B. D. Appelbe, Physical Review Letters **155001**, 15 (2017)
[3] J. P. Knauer, O. V. Gotchev, P. Y. Chang, D. D. Meyerhofer, O. Polomarov, R. Betti, J. A. Frenje, C. K. Li, M. J. E. Manuel, R. D. Petrasso, J. R. Rygg, F. H. Seguin, Physics of Plasmas **056318**, 17 (2010)