Liquid DT Layer Approach to ICF Hot Spot Formation

R. E. OLSON, B. M. HAINES, S. A. Yi, A. B. ZYLSTRA, R. R. PETERSON, P. A. BRADLEY, R. C. SHAH, D. C. WILSON, J. L. KLINE, R. J. LEEPER and S. H. BATHA

Los Alamos National Laboratory, USA

E-mail: reolson@lanl.gov

The baseline approach to hot spot ignition involves the implosion of capsules containing a layer of DT ice [1]. DT ice layer designs require a high convergence ratio (CR > 30) implosion, with a hot spot that is dynamically created from DT mass originally residing in a thin layer at the inner DT ice surface. Although high CR is desirable in an idealized 1D sense, it amplifies the deleterious effects of realistic features, including X ray drive asymmetries in the hohlraum, growth of instabilities seeded by capsule surface roughness, capsule defects, and the capsule fill tube and support hardware [2]. In contrast, DT liquid layer designs can operate with low-to-moderate convergence implosions (12 < CR < 25), with a hot spot formed mostly or entirely from DT mass originating within the central, spherical volume of DT vapor [3]. Of course, there are tradeoffs involved in high CR ice layer and reduced CR liquid layer designs, and comparisons of, for example, capsule absorbed energy and hot spot pressure requirements will be discussed in this presentation.

Recent experiments at the National Ignition Facility (NIF) demonstrated cryogenic liquid DT layer Inertial Confinement Fusion (ICF) implosions [4]. Although these initial liquid layer implosions were done as sub-scale experiments, they open up new possibilities for alternative ICF target designs using the central hot spot ignition concept. In our recent experiments, the liquid DT layers were formed using the wetted foam technique. The wetted foam concept has been discussed for many years [5], but it is only within the last few years that a target fabrication process developed for lining the interior of a NIF ICF capsule with an ultralow density CH foam that has the required uniformity and is robust enough to survive wetting with liquid hydrogen [6,7]. Advantages of the wetted foam concept include the ability to strategically place dopants within the foam, hence within the fuel layer, that can be useful for diagnostic experiments. Additionally, experiments involving fuel layers with separated reactants, liquid D_2 layers, and imposed defects or asymmetries imploded with variable CR represent capabilities unique to this new platform.

References

[1] S. W. Haan *et al*., Phys. Plasmas **18**, 051001 (2011).

[2] B. M. Haines *et al.*, “3D simulations of NIF wetted foam experiments to understand the transition from 2D to 3D flow behavior,” these proceedings.

[3] R. E. Olson and R. J. Leeper, Phys. Plasmas **20**, 092705 (2013).

[4] R. E. Olson *et al*., Phys. Rev. Lett. **117**, 245001 (2016).

[5] R. A. Sacks and D. H. Darling, Nucl. Fusion **27**, 447 (1987).

[6] J. Biener et al., Nucl. Fusion **52**, 062001 (2012).

[7] T. Braun et al., ACS Appl. Mater. Interfaces **8**, 2600 (2016).