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Overview of the Bigfoot Campaign: A high adiabat, high velocity indirect drive platform to produce an interesting and predictable implosion[1]

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To achieve hotspot ignition, inertial confinement fusion (ICF) implosions must achieve high hotspot internal energy that is inertially confined by a dense shell of DT fuel. To accomplish this, implosions must achieve high peak implosion velocity, good energy coupling between the hotspot and imploding shell, and high areal-density at stagnation.

However, experiments have shown that achieving these simultaneously is extremely challenging, partly because of inherent tradeoffs between these three coupled requirements. For example, the time it takes to carefully maintain a low shell adiabat makes transport of the laser through the hohlraum plasma problematic and therefore implosion symmetry becomes more difficult to predict and control. Additionally, the high gradients and high convergence ratios are subject to increased hydrodynamic instability growth that can destroy the integrity of the shell and inject higher-Z ablator mass into the hotspot radiating hotspot energy away.

The Bigfoot approach [1] is to trade off high convergence, and therefore areal-density, instead for conditions that are favorable for hohlraum symmetry control and predictability (like short pulse shape and pre-colliding shocks) and hydrodynamic instability, while leveraging high velocity to maximize the anticipated hotspot internal energy. This approach potentially enables high yields at high adiabat (~4-5).

The results of this campaign so far will be reviewed and include demonstrated P2 and P4 symmetry control at two different hohlraum geometries (5.75 mm and 5.4 mm diameters) and at two different target scales (5.4 mm or 0.8x and 6.0 mm or 0.9x) spanning 300-430 TW in laser power and 0.8-1.7 MJ in laser energy. Hydrodynamic instability growth from engineering features like the capsule fill tube are currently thought to be a significant perturbation to the target performance and a major factor in reducing its performance compared to calculations. Evidence supporting this hypothesis as well as plans going forward will be presented. Ongoing experiments are attempting to measure the impact on target performance from increase in target scale, and the preliminary results will also be presented.

References

[1] C. A. Thomas et. al., Bull. Am. Phys. Soc. 55th Annu. Meeting APS DPP Vol. 61, 18 (2016).

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