WETTED FOAM LIQUID FUEL ICF TARGET EXPERIMENTS

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We are developing a new NIF experimental platform that employs wetted foam liquid fuel layer ICF capsules. We plan to use the liquid fuel layer capsules in a NIF experimental campaign to explore the relationship between hot spot convergence ratio (CR) and the robustness of hot spot formation. Our hypothesis is that the predictive capability of hot spot formation is robust for a relatively low CR hot spot (CR~15), but will become less reliable as hot spot CR is increased to CR>20. Simulations indicate that backing off on hot spot CR is an excellent way to reduce capsule instability growth and to improve robustness to low-mode x-ray flux asymmetries[1].

As explained in Ref. 1, the hot spot formation processes in DT ice layer and DT liquid layer ICF capsule implosions are quite different. In an ice layer capsule, the hot spot is created at a very high CR (CR~35), and must be dynamically formed from material that originates at a very thin layer at the inside of the ice surface. In contrast, the hot spot in a liquid layer capsule can be formed largely from mass originating in the vapor. Because of this, liquid layer capsules allow for significant flexibility in hot spot CR and can have CR's in the range of 12 to 25 via the adjustment of the initial cryogenic capsule temperature and, hence, DT (or DD) vapor density.

High Density Carbon (HDC) is a leading candidate as an ablator material for ICF capsules[2], and a technique has been developed for lining the inner surface of a HDC shell with a ultra-low-density hydrocarbon foam that will survive wetting with liquid hydrogen[3]. Our initial liquid fuel layer HDC capsule experiments utilize near-vacuum hohlraums[2,4] with NIF laser pulse energies of less than 1 MJ. In these initial experiments, we are testing our hypothesis by measuring hot spot size, neutron yield, ion temperature, and burn width to infer hot spot pressure and compare to predictions for implosions with hot spot CR's in the range of 12 to 25. Larger scale experiments are also being designed, with the longer-term objective of developing a liquid fuel layer ICF capsule platform with robust thermonuclear burn, modest CR, and significant α-heating with burn propagation.

Additional impacts of this new NIF experimental platform include 1) the potential to increase NIF shot rate for layered ICF capsules; 2) an improved symcap technique (using liquid DD instead of the current method involving a surrogate fuel mass made of ablator material); 3) the possibility of doping the CH foam to observe cold fuel mix into the hot spot; and 4) the possibility (using foam dopants) for measuring electron temperature and fuel density near the cold fuel / hot spot boundary.

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