THE HIGH DENSITY CARBON ABLATOR IMPLOSION CAMPAIGN ON THE NATIONAL IGNITION FACILITY

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The goal of the high-density carbon (HDC, or diamond) ablator campaign on the National Ignition Facility (NIF) is to assess HDC as an ablator for achieving alpha-heating and ignition [1]. Testing HDC as an ablator requires designing and developing a platform that drives high convergence ($\rho R \approx 1$ g/cm^2) implosions to ignition-relevant velocity ($v_{fuel} \geq$ 350 km/s) while maintaining suitable drive symmetry and hydrodynamic stability. HDC's high density ($\rho \approx 3.5$ g/cm^3) results in a thinner ablator than in plastic (CH) or beryllium designs, resulting in multi-shock laser pulses with durations ≤ 9 ns, compared to ≈15 ns for CH and Be. Short pulses enable the use of near-vacuum ($\rho < 0.1$ mg/cm^3) hohlraums, which are up to 40 % more efficient than hohlraums filled with high density ($\rho \geq 0.9$ mg/cm^3) helium gas. Implosion velocities equivalent to $v_{fuel} \geq 400$ km/s have been demonstrated in these hohlraums [1]. In addition, laser backscatter and hot-electron generation are negligible [2]. Recently, the HDC campaign has driven implosions with thermonuclear yields of 2-3 × 10^{15} neutrons, DT fuel $\rho R \approx 0.5$-0.6 g/cm^2, and no measurable ablator mix in the hot spot.

In this talk, we summarize the campaign's progress in two efforts:

1. Develop a platform (hohlraum + capsule + laser) with suitable symmetry control
2. Find a combination of capsule dopant and hohlraum drive spectrum with suitable stability at the ablation front and the fuel-ablator interface

Symmetry has been difficult: the highest performing implosions have been prolate, with hot-spot shape $P_2/P_0 \approx$ 20-40% [2]. To fix this, the campaign has explored several hohlraum sizes and laser pulse durations. Good control of P_2 asymmetry has been achieved in a 5.75 mm diameter hohlraum with an 844 μm radius capsule and laser energy < 1 MJ. Uranium hohlraums without a thin gold liner have also been tested, demonstrating M-band x-ray intensities ($h\nu > 1.8$ keV) 33 % lower than in gold-lined hohlraums. Future plans include incorporating unlined uranium hohlraums into the promising 5.75 mm platform and testing this platform with cryogenic DT layer implosions.

[1] A. J. MacKinnon et. al., "High-density carbon ablator experiments on the National Ignition Facility," Phys. Plasmas **21**, 056318 (2014).

[2] L. F. Berzak Hopkins et. al., "First high-convergence cryogenic implosion in a near-vacuum hohlraum," Phys. Rev. Letters (forthcoming 2015)

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