Subscale HDC implosions driven at high radiation temperature using advanced hohlraums

Darwin Ho, Peter Amendt, Ogden Jones, Laura Berzak Hopkins, and Sebastien Le Pape
Lawrence Livermore National Laboratory, USA

Implosions using high-density carbon HDC ablators have received increased attention in recent years because HDC ablators require considerably shorter pulse length and can access higher implosion velocity than CH ablators. [1-3] Recent HDC subscale (i.e., outer radius ~ 0.9 mm or about 0.8 of full scale) implosion experiments showed very promising results with improved DT neutron yields (~6.6e15) and fuel compression. [4] Our 2D radiation-hydrodynamic simulations show that 0.8 subscale HDC capsules can achieve robust high-yield performance if driven at high enough radiation temperature because the penalty for less fuel mass can be offset by higher implosion velocity (provided by higher T_R). Simulations suggest that if the peak T_R ~ 330 eV, then the robustness of the subscale implosions should be similar to those of full-scale implosions (with peak T_R of 305 eV) with similar fuel adiabat. Yield cliffs in both 1D and 2D, which are indicators of implosion robustness, for full vs subscale implosions and for various peak T_R can be explained in terms of the Generalized Lawson Criterion GLC formalism [3]. To achieve a peak T_R of 330 eV will likely require the use of innovative hohlraum concepts, e.g., integrated simulations in 2D using a rugby-shaped hohlraum [5] at 0.8 subscale and 330 eV using ~1.3 MJ of laser energy should be able to provide the required radiation symmetry without incurring a risk of high laser backscatter. Confidence in our modeling of HDC implosions is high in part because our 2D modeling of recent HDC implosions experiments show good agreement with data. The yield and DSR from our simulations are within 20% percent and a few percent, respectively, to the data from shots N161023 and N170226 (with a 2× reduction in fill tube diameter) which gave neutron yields of 4.7e15 and 6.6e15, respectively. [4] The simulations are sensitive to the mix entrained by the fill tube, the amount of high-*Z* dopant (W) in the ablator for control of perturbation growth, and accurately modeled a clear performance cliff when the delivered dopant level was lower than requested (N161113). The experimental data points will be shown on the GLC contours [3] to assess the implosion performance and the directions one may take to access higher yields.

References

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