TIME EVOLUTION OF AREAL-DENSITY IN SUBSCALE NEAR-VACUUM-HOHLRAUM IMPLOSIONS AT THE NIF

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Recent experiments at the National Ignition Facility have demonstrated for the first time measurements of the time evolution of areal-density (ρR) in implosions using the subscale near-vacuum hohlraum platform.[ab] In particular, the evolution of ρR from the time of peak implosion velocity to peak compression has been probed using this platform, which provides new constraints on the modeling of implosion dynamics from peak velocity through peak compression.

Protons are produced by D-^{3}He fusion reactions when the initial shock rebounds from the center of the implosion ('shock-bang time'), which occurs near the time of peak shell velocity, and when the implosion reaches peak compression ('compression-bang time') approximately 600 ps later. The energy downshift of the emitted protons from their birth energy of 14.7 MeV depends on ρR of the implosion. The spectrum of these emitted protons is measured using the Wedge Range Filter (WRF) spectrometers [1,2], from which the ρR at shock- and compression-bang time are inferred [3]. The shock- and compression-bang time are measured with the Particle Time of Flight diagnostic [4]. Using these data, the time evolution of ρR asymmetries from peak velocity to peak compression, and time difference between shock- and compression-bang time (ΔBT) in a single implosion are determined.

On several experiments in 2014 and 2015, the evolution of ρR and the ΔBT were measured to be consistent with simulations: ρR increased from ~75 mg/cm^2 at shock-bang to ~250 mg/cm^2 at peak compression, while ΔBT was approximately 0.6 ns. However, the ρR at shock-bang was more symmetric than predicted by nominal radiation-hydrodynamics simulations. The consistency of ΔBT with simulations contrasts with the results from full-scale surrogate implosions [3], in which an experimentally inferred ΔBT differed from simulations by up to a factor of 2. Detailed comparison between experimental and simulated data will be presented. Future applications will be discussed, including upcoming direct measurements of the time difference between shock- and compression-bang time in full-scale experiments using the upgraded MagPTOF diagnostic [5].

[1] F.H. Séguin, et al. Rev. Sci. Instrum. 83, 10D908 (2012)
[2] A. B. Zylstra, et al. Rev. Sci. Instrum. 83, 10D901 (2012)
[3] A.B. Zylstra, et al. Phys. Plasmas 21, 112701 (2014)
[4] H.G. Rinderknecht, et al. Rev. Sci. Instrum. 83, 10D902 (2012)
[5] H.G. Rinderknecht, et al. Rev. Sci. Instrum. 85, 11D901 (2014)

[a] Related abstracts presented at this conference include those by L.F. Berzak-Hopkins and S.F. Khan
[b] Work performed as part of the first author's PhD thesis