Understanding and reducing the impact of the fill-tube in ICF implosions on the NIF†

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Inertial Confinement Fusion (ICF) capsules on the National Ignition Facility (NIF) are filled with thermonuclear fuel through a fill-tube, but this engineering feature can have a damaging effect on the spherical compression of the capsule. The fill-tube impacts the implosion in two ways. First, the higher opacity of the glass tube can shadow a portion of the capsule, leading to more mass accumulation below the shadow. Second, the through-hole sends a jet of ablator material into the interior that can radiatively cool the hot-spot. Evidence from experiments and radiation-hydrodynamics modeling suggests that the fill-tube is the dominant yield degradation source in some cryogenic-layered DT implosions.

Both integrated performance experiments and dedicated physics experiments provide evidence to help develop and validate the simulation model, shown in Figure 1. Improvements are being explored to reduce the impact of this feature. These improvements include reducing the dimensions of the fill-tube, inserting the fill-tube at an angle from capsule-normal, and ablating away the fill-tube before the main drive. This paper compares the fill-tube model to the experimental data and discusses these mitigation alternatives.

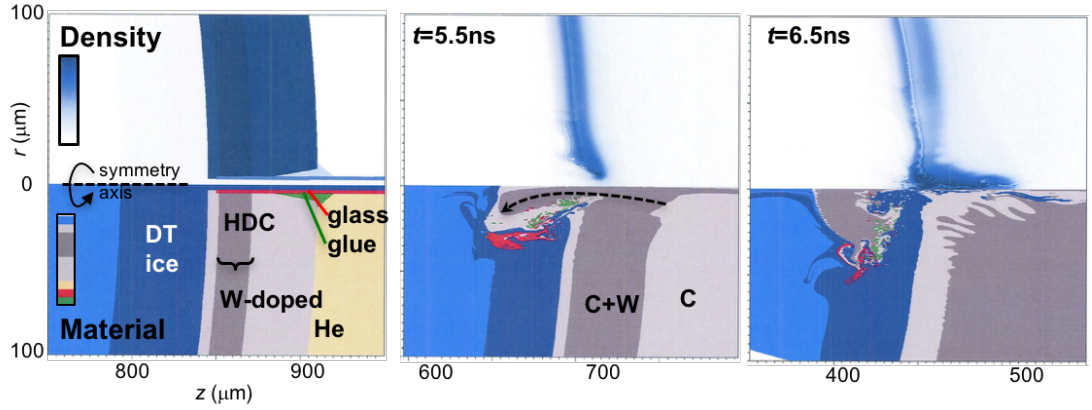

Figure 1: Evolution of the fill-tube perturbation on a DT-layered HDC capsule, showing the initial setup, ablator material entering the interior of the capsule, and a large ρR bump forming.

†This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.