Developing the next generation of hohlraums for indirectly-driven implosions*

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In the Indirect Drive (ID) scheme, lasers striking the inner wall of a hohlraum are converted into x-rays to ablatively drive a fusion capsule. The hohlraum designer's challenge is to specify a hohlraum geometry and laser configuration that symmetrically drives an implosion with the necessary velocity, compressibility, and hydrodynamic stability. Symmetric implosions have been driven on the National Ignition Facility (NIF) in cylindrical hohlraums filled with low density helium gas ($\rho \leq 0.6$ mg/cm^3, or $n_e \leq 0.02\ n_c$). Recently, a hohlraum platform with a high-density carbon (HDC, or diamond) ablator demonstrated symmetry control at all measurable times [1]. Similar platforms have been developed for other drive pulses and ablators and are now the standard for driving implosions on NIF; however, current designs are limited in capsule size and pulse duration. Further improvements in design, underpinned by improved understanding of hohlraum plasma dynamics, are needed to drive larger capsules with lower adiabat and/or lower coast time.

This talk discusses our current understanding of how hohlraum plasma dynamics limit symmetry control and how this can be mitigated. Measurements of laser propagation and wall expansion are analyzed with the help of 2D and 3D radiation-hydrodynamics codes. Laser propagation to the equator is limited by the expansion of high-Z "bubbles" formed where the outer-cone lasers strike the hohlraum wall. This can be mitigated in part by reducing the laser spot intensity on the wall. The bubbles can be tamped by increasing the hohlraum gas fill or by lining the hohlraum with low-density foam. The hohlraum shape can be changed, statically or dynamically, to reduce bubble expansion. The capsule ablator also absorbs the laser and squeezes the surrounding plasma to higher densities. Absorption of the inner lasers in the ablator can be reduced by increasing the gas fill, by reducing the laser spot size, or by locally increasing the volume available for ablator expansion, e.g., "rugby" hohlraums [2]. Alternatively, smaller hohlraums can be driven without inner-cone beams. We present design simulations of these mitigation techniques (comparing to data where possible) and a plan to experimentally test these next generation designs.

References

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