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Adjusting physical models within uncertainties as an intermediate step towards eliminating the drive deficit

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Design of indirect drive inertial confinement fusion experiments (ICF) for the National Ignition Facility (NIF) often use laser-power multipliers [1] to match shock speeds, shock merger times, peak implosion velocity, and time of peak neutron production of the capsule ("bangtime"). While this approach has enabled recent progress, the necessary multipliers must be found empirically, resulting in a lot of experimental resources required to optimize a design. Laser-power multipliers also violate conservation of energy and compromise the ability to accurately model physics like laser-plasma interactions. Further, extrapolations to a larger scale facility beyond the National Ignition Facility (NIF) are uncertain because the correct multipliers are unclear a priori. Recently, it has been found that errors in nonlocal thermodynamic equilibrium (NLTE) atomic physics modeling of high Z elements are partially responsible for the need for these multipliers [2,3]. While the long-term approach is to identify and improve NLTE modeling, we explore an intermediate approach of adopting multipliers that modify LTE and NLTE opacities of the high Z wall, heat capacity of the wall, opacity of the ablator, and the cross-beam-energy-transfer saturation clamp. These multipliers are determined through statistical sampling across a suite of integrated shots tuned to match capsule shock timing, bangtimes, and symmetry, and hohlraum x-ray drive measurements. The multipliers are then applied to several focused hohlraum science experiments: a ViewFactor experiment [2,3], a shot from the "Build-A-Hohlraum" campaign [4], a direct measurement of the burn-through of the Marshak wave through a gold foil, and the DT-ion stagnation experiment [5]. In comparing across the broad number of experiments, this approach seeks to account for uncertainties in the underlying models themselves.

[1] O. S. Jones et al., Phys. Plasmas 19, 056315 (2012).
[2] H. Chen et al., Phys. Rev. E 110, L013201 (2024).
[3] H. Chen et al. Phys. Plasmas 32, 042704 (2025).
[4] G. F. Swadling et al., Phys. Plasmas submitted on 22 January 2025.
[5] D. P. Higginson et al., Phys. Rev. Lett. (in press).

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