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The Role of Beryllium Ablators in Inertial Confinement Fusion

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Low-mode implosion asymmetry and hydrodynamic instabilities of the capsule are considered the main obstacles for achieving ignition in indirect drive inertial confinement fusion (ICF). Superior ablation properties of beryllium (Be) ablators as compared with plastic and diamond ablators may help overcome these obstacles. In particular, higher Be ablation pressure permits use of either thicker fuel layers and thereby lower ICF capsule convergence; or of lower radiation drive temperatures and thereby larger hohlraums and case-to-capsule ratios. Both effects are predicted to be beneficial for implosion symmetry. Higher ablation velocity can provide enhanced ablation front stabilization and reduce detrimental effects of hydrodynamic instabilities. "High-foot" plastic campaign on the National Ignition Facility (NIF) has demonstrated importance of the suppression of instabilities, in particular by reducing the perturbation induced by the capsule support membranes that hold the capsule in the hohlraum - a major factor degrading earlier implosions. Initial measurements using hydro-growth radiography have shown that Be ablators are even more stable. In addition, high-adiabat Be implosions in 5.75 mm hohlraums with high-density (1.6 mg/cm^3) helium gas fill showed that performances of Be and comparable plastic targets were similar. Difficult-to-model non-linear plasma physics effects strongly degrade X-ray drive properties and the capsule implosion symmetry in such high-fill hohlraums. To fully test the predicted Be ablator advantages, hohlraums where such effects are suppressed need to be used. Beryllium integrated hohlraum experiments that started in the Fall of 2015 have been using larger (6.72 mm) hohlraums with lower (<0.6 mg/cm^3) fill densities and purposely reduced radiation drive temperature, and have demonstrated significantly improved laser-capsule coupling and good Be ablator performance. This suggests a future possibility of using even larger hohlraums to control symmetry if necessary. We will next employ these well-performing hohlraums with the goal of obtaining Be capsule implosions with good in-flight and stagnation symmetry.

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