Towards Laser Port Designs for Reduced Laser Imprint in Inertial Fusion Facilities

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At Focused Energy, the development of inertial confinement fusion (ICF) power plants relies on robust laser-plasma coupling strategies. A critical requirement for achieving symmetric capsule compression is minimizing laser imprint and associated hydrodynamic instabilities through optical smoothing. While broadband laser beams ($\Delta\nu/\nu$ ~1% bandwidth) and techniques such as smoothing by spectral dispersion and polarization smoothing are being investigated to enhance temporal smoothing, the geometric configuration of the laser ports on the target chamber itself also plays a key role in shaping the illumination profile.

We present ongoing theoretical studies exploring laser port designs aimed at reducing imprint, with a focus on adaptability to various scales of ICF laser facilities. Our approach combines high-mode focal spot modeling with design constraints specific to current and future experimental facilities that are planned by Focused Energy. Preliminary results suggest optimized port geometries can complement optical smoothing strategies by suppressing deleterious modes in the target plane. The designs under development will inform future experimental configurations and help guide the architectural choices of next-generation fusion facilities.