Toward a burning plasma state using diamond ablator inertially confined fusion (ICF) implosions on the National Ignition Facility (NIF)

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Producing a burning plasma in the laboratory has been a long-standing milestone for the plasma physics community. A burning plasma is a state where alpha particle deposition from deuterium-tritium (DT) fusion reactions is the leading source of energy input to the DT plasma. Achieving these high thermonuclear yields in an inertial confinement fusion (ICF) implosion requires an efficient transfer of energy from the driving source, e.g., lasers, to the DT fuel. In indirect-drive ICF, the fuel is loaded into a spherical capsule which is placed at the center of a cylindrical radiation enclosure, the hohlraum. Lasers enter through each end of the hohlraum, depositing their energy in the walls where it is converted to X-rays that drive the capsule implosion. Maintaining a spherically symmetric, stable, and efficient drive is a critical challenge and focused ICF research effort. Our program at the National Ignition Facility (NIF)* has steadily resolved challenges that began with controlling ablative Rayleigh-Taylor (RT) instability in implosions, followed by improving hohlraum-capsule x-ray coupling using low gas-fill hohlraums, improving control of time-dependent implosion symmetry, and reducing target engineering feature-generated perturbations. As a result of this program of work, our team is now poised to enter the burning plasma regime.

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