INERTIAL CONFINEMENT FUSION USING THE OMEGA LASER

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The OMEGA/OMEGA EP Laser System is being used to study a variety of approaches to direct-drive inertial confinement fusion—the traditional central hot-spot (CHS) approach, fast ignition (FI), and shock ignition (SI). To achieve ignition, CHS requires the highly uniform compression of a solid deuterium–tritium (DT) layered target on a low-adiabat (defined as the ratio of the pressure to the Fermi-degenerate pressure) and with an implosion velocity, $v > 3.5 \times 10^7$ cm/s. A laser-pulse shape with multiple pickets produces this low adiabat. The timing of multiple shocks launched by the pickets and the main laser pulse is optimized in experiments using cone-in-shell geometry. Cryogenic targets imploded with optimally timed, low-adiabat multiple-picket pulses have demonstrated near 1-D compression with an areal density, $\rho R = 290$ mg/cm^2, at $v = 3.1 \times 10^7$ cm/s. These are by far the highest DT areal densities demonstrated in the laboratory. FI and SI relax energy and uniformity requirements on the compression laser by separating fuel assembly from ignition. Integrated FI experiments have been performed on the OMEGA/OMEGA EP Laser System. A 10-ps, 1-kJ OMEGA EP beam is pointed into the tip of a gold cone inserted into a thick plastic converging and compressing shell. The neutron yield increased by more than a factor of 2 when the OMEGA EP beam was optimally delayed, indicating ~10% conversion efficiency from laser energy to core heating. Shock-ignition experiments, where a shock is launched by a picket at the end of the laser pulse into the compressing capsule, have been performed on low-adiabat warm plastic targets. Both yield and areal density improve significantly when a spike is used at the end of the laser pulse, indicating that energy from the shock is coupled into the compressing target. This talk will discuss these results, compare them to simulations, and identify future work necessary to demonstrate ignition relevance for all these schemes.

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