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Direct-Drive Inertial Confinement Fusion Implosion Physics[1]

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The direct-drive approach to inertial confinement fusion ignition and high gain will be reviewed, including results from recent experiments on the OMEGA Laser System, a general theory of target design and implosion hydrodynamics, and a discussion of future directions. Target design theory leads to optimized designs for conventional isobaric ignition [including polar direct drive (PDD)] and fast ignition. PDD is a concept that allows direct-drive ignition experiments, while the National Ignition Facility (NIF) is configured for indirect drive. The target design review will include the theory of adiabat shaping to suppress the Rayleigh–Taylor instability, hydrodynamic scaling from current to ignition-size implosions, and the latest ignition designs for conventional and fast-ignition targets. The Lawson criterion for ICF is presented in a form that can be experimentally determined. The experimental review will cover linear and nonlinear, single and multimode ablative Rayleigh–Taylor instability experiments; adiabat shaping; and low-velocity, low-adiabat implosions to achieve high areal densities for fast-ignition fuel assembly, shock ignition, PDD, and cryogenic implosion experiments. This intense activity has culminated in OMEGA experiments producing the highest compression (i.e., highest value of the areal densities) ever achieved in cryogenic implosions. Results from the OMEGA implosion campaigns provide an important physics validation for the nation's direct- and indirect-drive-ignition campaigns and increasing confidence that direct-drive ignition will be achieved on the NIF.

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