Cross-Beam Energy Transfer Platform on OMEGA

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A more-comprehensive understanding of laser–plasma interactions is expected to expand the design space for inertial confinement fusion and high-energy-density–physics research. To isolate the hydrodynamic physics from cross-beam energy transfer (CBET) physics, a platform is being built at the University of Rochester that will facilitate focused experiments between up to five resonant 351-nm laser beams in well-characterized uniform plasmas. The platform will enable experiments to explore the effects of beam smoothing (phase plates, smoothing by spectral dispersion, and polarization smoothing) on CBET and test the linear CBET theories used in hydrodynamic modeling. The thresholds for a nonlinear ion-acoustic response will be measured for two-beam, and up to six-beam, interactions to understand if these deviations from linear theory could be limiting the predictive capabilities of current CBET models. The CBET platform will introduce a tunable 61st beam, a millimeter-diameter supersonic gas jet, and a full-aperture transmitted beam diagnostic to the OMEGA Laser System. To generate the 61st beam, a narrowband tunable fiber front end will seed the existing optical parametric amplifiers on the OMEGA EP Laser System. The high-power (0.5-TW) laser pulses will be delivered to the target through Port 9 in the OMEGA target chamber and will be tunable between 350.2 nm and 353.4 nm. The uniform gas will be heated by thirty 0.1-TW, 351-nm OMEGA beams that will be defocused to generate a plasma with a 1-mm-long density plateau at $n_e = 5 \times 10^{20}$ cm^{-3}. Hydrodynamic simulations suggest uniform 1.5-keV plasma conditions along the path of the 61st beam and these conditions will be well characterized by collective Thomson scattering. A transmitted beam diagnostic will be installed to collect nearly 2× the aperture of the transmitted 61st beam through the port (P4) opposing the 61st beam. The diagnostic will measure the transmitted spectrum, power, polarization, and near field. The light will be coupled to a 1-m streaked spectrometer to provide a 0.005-nm spectral resolution and 40-ps temporal resolution. A third-generation ultrabroad-band, long-pulse laser beam is being considered as a phase-two option that would demonstrate laser–plasma instability mitigation using this platform.

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