The two-plasmon-decay (TPD) instability can be detrimental for direct-drive inertial confinement fusion because it generates high-energy electrons that can preheat the target, reducing target performance. Extensive simulations to create a new experimental platform have been made to investigate plasma and interaction conditions relevant to direct-drive–ignition implosions at the National Ignition Facility (NIF). The simulations are compared with recent experiments at the NIF.

The radiation–hydrodynamic code DRACO has been used to design planar target experiments that are predicted to generate plasma conditions that approach those expected in ignition-relevant polar-direct-drive (PDD) designs. The extreme plasma conditions generated in these targets ($I_L \sim 8 \times 10^{14} \text{ W/cm}^2$, $T_e > 3 \text{ keV}$, and density gradient scale lengths of $L_n > 550 \mu\text{m}$) are not achievable in current NIF PDD implosion experiments in which cross-beam energy transfer (CBET) reduces the laser absorption [1]. The use of planar targets makes it possible to decouple TPD from CBET, enabling a first look at the effect of TPD in NIF PDD implosions when CBET has been mitigated [2]. Two separate planar geometries have been designed: (1) irradiation by the NIF inner-cone beams only (20° to 30° incidence angle with respect to target normal) and (2) irradiation by the outer-cone beams (40° to 50°). The higher-angle cones approximate irradiation conditions near the equator of a PDD implosion, while the lower-angle cones correspond to those near the poles.

The laser–plasma interaction code LPSE [3] has been used to investigate TPD using the predicted plasma profiles and laser irradiation geometry in three dimensions. The energetic electrons generated by LPSE are propagated into the planar target using the electron–photon Monte Carlo transport code EGSnrc. This enables a direct comparison between the simulated and experimentally observed Mo Kα fluorescence and hard x-ray bremsstrahlung emission. The plasma profiles have been further post-processed for backscattered stimulated Raman and Brillouin scattering gains using the Lawrence Livermore National Laboratory gain postprocessor “newlip” [4]. Comparisons of these results with recent experiments and the implications for ignition-scale PDD experiments will be presented.

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