Measurements of the Dependence of the Two-Plasmon–Decay Instability on the Plasma Scale Length: An accurate understanding of the plasma conditions near quarter-critical density is important in quantifying the hot electrons generated by the two-plasmon–decay (TPD) instability in the long-scale-length plasmas expected in direct-drive–ignition experiments. The TPD intensity threshold is predicted to depend on T_q/L_q, where T_q is the plasma electron temperature and L_q is the plasma density scale length at the quarter-critical density. A novel target platform was developed (see Fig. 1) to isolate the dependence of hot-electron production on L_q by varying the density scale length while maintaining a nearly constant I_q/T_q (where I_q is the laser intensity at the quarter-critical density). A series of experiments was performed using 9 kJ of UV (351-nm) energy delivered over 2 ns by the four beams on OMEGA EP. The density scale length L_q was varied by changing the radius of curvature of a CH target.

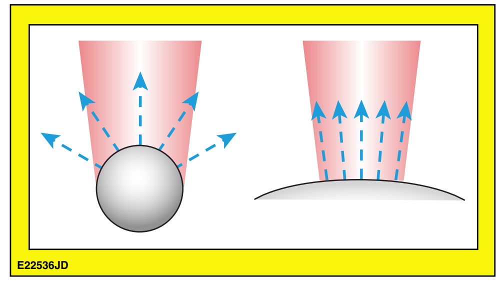

Figure 1. A schematic illustrating the scale length control in this experiment. As the radius of the target decreases, the plasma expansion becomes more divergent and shorter density scale lengths are produced at the quarter-critical surface.

Figure 2 shows the measured scale-length dependence on the target diameter measured using a refractometry-based diagnostic.[1,2] The diagnostic uses angular spectral filters to overcome the large phase accumulation in standard interferometric techniques. It measures the refraction angles of a 10-ps, 263-nm probe laser after propagating through the plasma. The *f*/4 collection system limits the maximum measureable density to 10^{21} cm^{-3}. The measurements show that the density scale length increases with the radius of curvature of the target.

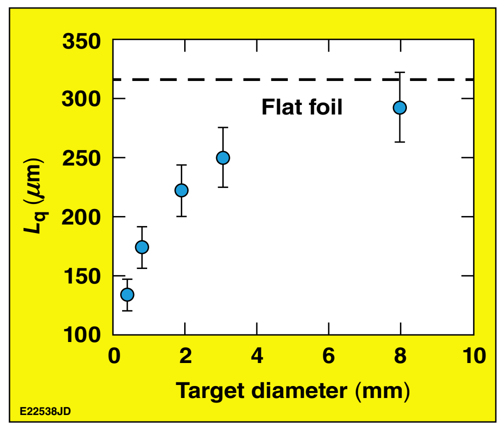

Figure 2. The density scale length at a density of 10^{21} cm^{-3} was measured using the angular filter refractometer.

Figure 3 shows the dependence of the hot-electron fraction on the density scale length. Despite keeping a relatively constant I_q/T_q, the fraction of hot electrons was observed to increase from 0.005% to 1% by increasing the scale length from ~100 μm to ~450 μm. These results will be compared to predictions by the *ZAK3D* code. *ZAK3D* is a plasma-fluid model that incorporates saturation nonlinearities to calculate the hot-electron generation in ignition plasmas.

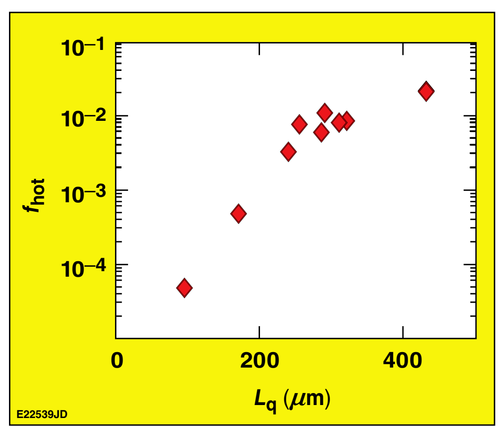

Figure 3. The fraction of laser energy converted to hot electrons at an intensity of 7×10^{14} W/cm^2 was measured using the hard x-ray diagnostic.

Omega Facility Operations Summary: During October, the Omega Laser Facility conducted 137 target shots with an average experimental effectiveness of 96.7%. One hundred ten of the target shots were carried out on the OMEGA laser with an average experimental effectiveness of 96.8%; while the OMEGA EP facility conducted 27 target shots with an average experimental effectiveness of 96.3%. The ICF campaign accounted for 98 of the shots for experiments led by LLE and LLNL scientists; while 27 target shots were carried out for the HED campaign by LLNL and LLE scientists. A collaborative team led by Princeton University carried out 12 NLUF program target shots. In addition to these target shots, 17 shots were carried out on the OMEGA EP laser for beam co-propagation activation.

1. D. H. Froula *et al*., Rev. Sci. Instrum. **83**, 10E523 (2012).
2. D. Haberberger *et al*., in *CLEO: Applications and Technology*, CLEO 2013: Technical Digest (Optical Society America, Washington, DC, 2013), Paper ATu3M.3.