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Measurement of Two-Plasmon–Decay Dependence on Plasma Density Scale Length

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An accurate understanding of the plasma scale-length (L_{q}) conditions near quarter-critical density is important in quantifying the hot electrons generated by the two-plasmon–decay (TPD) instability in long-scale-length plasmas. A novel target platform was developed to vary the density scale length and an innovative diagnostic was implemented to measure the density profiles above 10^{21} cm^{-3} where TPD is expected to have the largest growth. A series of experiments was performed using the four UV (351-nm) beams on OMEGA EP that varied the L_{q} by changing the radius of curvature of the target while maintaining a constant $I_{\mathrm{q}}/T_{\mathrm{q}}$. The fraction of laser energy converted to hot electrons (f_{hot}) was observed to increase rapidly from 0.005% to 1% by increasing the plasma scale length from 130 μm to 300 μm, corresponding to target diameters of 0.4 mm to 8 mm. A new diagnostic was developed based on refractometry using angular spectral filters to overcome the large phase accumulation in standard interferometric techniques. The angular filter refractometer measures the refraction angles of a 10-ps, 263-nm probe laser after propagating through the plasma. An angular spectral filter is used in the Fourier plane of the probe beam, where the refractive angles of the rays are mapped to space. The edges of the filter are present in the image plane and represent contours of constant refraction angle. These contours are used to infer the phase of the probe beam, which are used to calculate the plasma density profile. In long-scale-length plasmas, the diagnostic currently measures plasma densities from $\sim 10^{19}$ cm^{-3} to $\sim 2 \times 10^{21}$ cm^{-3}. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.

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