Laser–Plasma Interaction Experiments on OMEGA EP: The LPIonEP-19A shot day on OMEGA EP (18 October 2018) explored the effect of density scale length and electron temperature on laser–plasma interaction (LPI) mechanisms. These experiments used planar thick CH slabs, irradiated by between one and four OMEGA EP beams in either 4-ns linear ramp or 2-ns square laser pulses, with different size phase plates (400 or 750 μm) used on the single-beam shots. The purpose of changing the phase plate was to alter the density scale length at the quarter-critical region, with the expectation based on OMEGA[1] and the National Ignition Facility[2,3] results that longer scale lengths will favor stimulated Raman scattering (SRS), while shorter scale lengths favor two-plasmon decay (TPD). The objective of this campaign is to probe the boundary between SRS- and TPD-dominated regimes. Previous OMEGA EP planar experiments, which used a large phase plate, showed predominantly SRS.

The experiments (Fig. 1) were diagnosed using time-resolved optical spectrometry and again showed signatures of SRS via scattered light at wavelengths of ~450 to 650 nm as well as a singlet feature at the half-harmonic (ω/2) wavelength of ~702 nm. The typical TPD ω/2 feature was not observed, even with the small phase plate, indicating that conditions were still not favorable for TPD relative to SRS. In addition, multibeam experiments demonstrated that SRS is not merely a single-beam process, given that single-beam shots produced 15 to 20× fewer hard x rays than four-beam shots at the same per-beam power. Furthermore, SRS scattered light was found to be highly directional. While most experiments used a single beam coming from the direction of the optical spectrometer, one experiment that used two different beams (at twice the total power) produced significantly less SRS signal. Another experiment used a different orientation of the planar target relative to the spectrometer in order to infer SRS sidescatter.

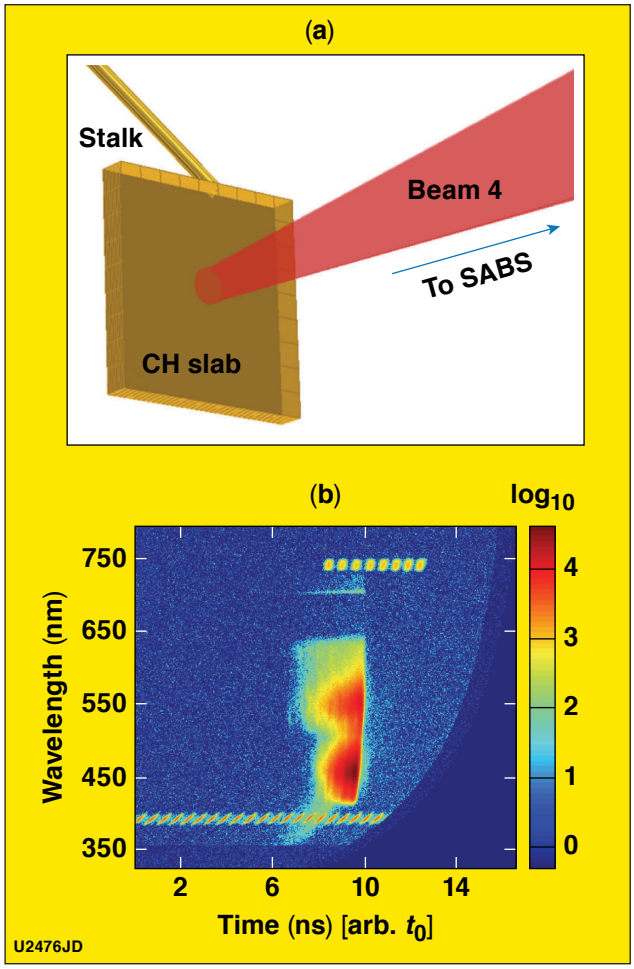

Figure 1. (a) Experimental setup and (b) time-resolved optical spectra from OMEGA EP shot 29234, which used a single beam (Beam 4) incident normally on a CH slab with a 400-μm-diam phase plate. The spectrum was obtained using the sub-aperture backscatter station (SABS) located within Beam 4 and shows signatures of SRS at ~450 to 650 nm and in the singlet feature around 702 nm.

Follow-up experiments will use spherical targets to further reduce the scale length and ideally eliminate SRS while allowing for TPD to be observed. This will make it possible for the boundary of LPI regimes to be determined.

Omega Facility Operations Summary: The Omega Laser Facility conducted a total of 188 target shots in October 2018 with an average experimental effectiveness (EE) of 95.7%. The OMEGA laser had 115 shots with an EE of 98.7% and OMEGA EP had 73 shots with an EE of 91.1%. The ICF program carried out 86 shots for experiments and calibrations led by LLE and NRL, while the HED program accounted for 49 target shots led by LLNL, LANL, SNL, and LLE. Thirty-five target shots were taken for three NLUF experiments led by Princeton University, the University of Michigan, and the University of California, Berkeley/LLNL, respectively. Two campaigns led by CEA accounted for 18 shots.

1. W. Seka *et al.*, Phys. Plasmas **16**, 052701 (2009); 2. M. J. Rosenberg *et al.*, Phys. Rev. Lett. **120**, 055001 (2018); 3. M. J. Rosenberg *et al.*, Phys. Plasma **26**, 012703 (2019).

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