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# MagLIFEP and MagLIFSNL

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The MagLIF campaign operated by Sandia conducted a total of four shot days in FY17 (one on OMEGA and three on OMEGA-EP) aimed at characterizing the laser heating of underdense plasmas ($D_2$, Ar) at parameters that are relevant to the Magnetized Liner Inertial Fusion (MagLIF) ICF scheme being pursued at Sandia National Laboratories [1] [2]. MagLIF combines fuel preheat, magnetization and pulsed power implosion to significantly relax the implosion velocity and ρR required for self-heating. Effective fuel preheat requires coupling several kJ of laser energy into the 10 mm long, underdense (typically $n_e/n_c<0.1$) fusion fuel without introducing significant mix. Barriers to achieving this include the presence laser plasma instabilities (LPI) as laser energy is coupled to the initially cold fuel, and the presence of a thin, polyimide laser entrance hole (LEH) foil that the laser must pass through and that can be a significant perturbation.

Experiments were performed on the OMEGA and OMEGA-EP laser with different goals. The objective of the OMEGA-EP experiments was to develop a spectrometer capable of viewing Ne K-shell emission (hν = 920 – 1100 eV), and to continue to investigate the effects of pulse shaping and LEH foil thickness on energy coupling. Capturing Ne spectra required developing a new spectrometer based on the multi-purpose spectrometer (MSPEC) design that used a KAP or RbAP with a maximized Bragg angle giving an observable energy range of 891-1773 eV. The MSPEC is both temporally and spatially resolved In addition, modifications to the targets were required that allowed soft x-rays to escape while still enabling high pressure (up to 10 atm) gas fills. This was achieved by machining up to 5 slots in the sides of the 115 µm thick CH tube target and covering the slots with a 2 µm thick polyimide foil, as shown in Figure 1a. Capturing Ne spectrum was challenging but was achieved as shown in Figure 1b. The instrument should allow the cooling of the plasma after the laser has turned off to be observed potentially allowing the effect of an applied magnetic field on that cooling to be investigated.

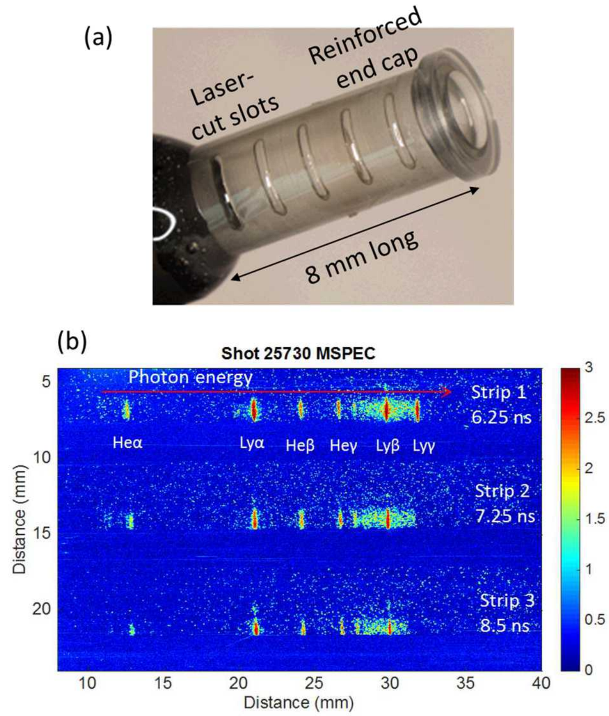


Figure 1a: Photograph of an OMEGA-EP target 5 side-on windows covered with a 2 µm polyimide foil capable of holding 10 atm and b) a spectrum captured with the Ne MSPEC on shot 25730 from MagLIFEP_17B.

The objective of the OMEGA laser experiments was to compare energy coupling into underdense $D_2$ plasma with 2ω and 3ω beams, with and without SSD, and for different beam intensities. This shot series was the first Sandia-led effort to investigate preheat on this laser and as such scaled-down versions of the OMEGA-EP targets were required because of the reduced energies per beam available (~450 J max compared to >3 kJ on OMEGA-EP). Of particular interest in this series was the effect that changing the laser wavelength, intensity and smoothing had on beam propagation and on stimulated Brillouin scattering (SBS) and stimulated Raman scattering (SRS) levels. The results suggest that for similar intensities and similar values of $n_e/n_c$, the laser wavelength has a significant effect on the beam propagation as measured by XRFC imaging (Figure 2a), and on LPI levels as inferred by hard x-ray signal levels (Figure 2b), while SSD has little impact. The results have implications for the future of MagLIF laser preheat which currently uses a 2ω laser and is susceptible to significant LPI at relatively low intensities. The data suggest that a 3ω laser could allow for more preheat at higher intensities for given plasma parameters enabling greater energy coupling over a given propagation distance.

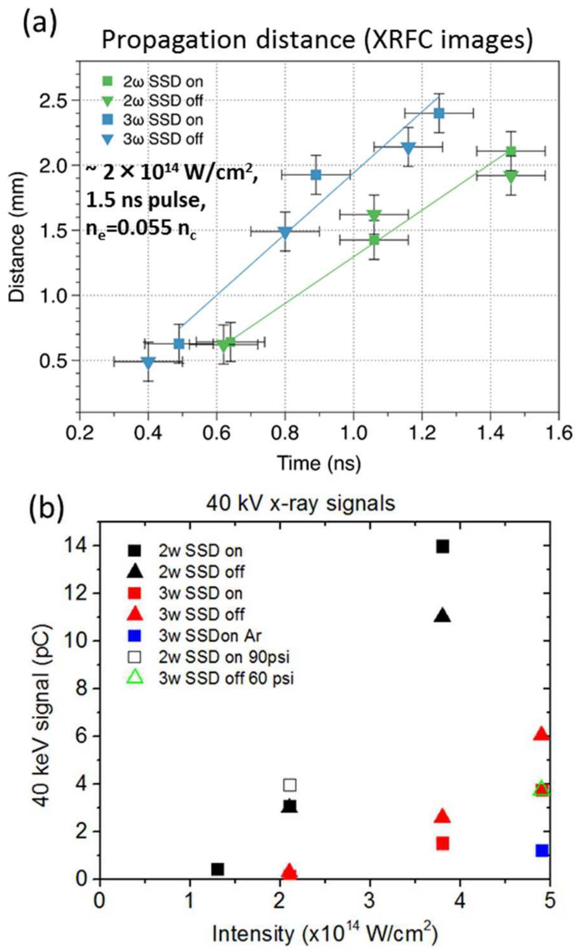


Figure 2a: Emission depth as a function of time measured from time-gated XRFC images for 2ω and 3ω light with SSD on and off and b) hard x-ray signal levels as a function of intensity for the various parameters tested in the experiment.

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