Fast-Electron Control with a Magnetic Field in Hohlraums: The primary objective of this project is to demonstrate control of laser–plasma instabilities in gas-filled hohlraums using an applied magnetic field. In current ignition experiments on the National Ignition Facility, laser–plasma instabilities such as stimulated Raman scattering (SRS) reflect a significant fraction of the incident laser light and produce hot electrons. Previous experiments on OMEGA showed the production of hot electrons by two-plasmon–decay (TPD) instability from the laser entrance hole windows.[1] An average magnetic field of 10 T throughout the hohlraum is provided by an upgrade of the magneto-inertial fusion electrical discharge system (MIFEDS) field generator.[2] The magnetic field is expected to inhibit transverse heat flow, increasing the temperature of the gas and reducing the SRS and TPD growth rates, as previously observed in experiments with gas jets using a similar field.[3] In addition, the magnetic field is expected to guide hot electrons along the field lines and control their trajectories.

The experimental setup illustrated in Fig. 1 shows a hohlraum surrounded by two sets of coils—parallel and perpendicular (only one set is used at a time). The magnetic field parallel (axial) to the hohlraum axis acts to prevent fast electrons from reaching the hohlraum walls and generating hard x-rays. It also prevents fast electrons generated off-axis from reaching a target at the center of the hohlraum. The magnetic field perpendicular (transverse) to the hohlraum axis drives fast electrons into the wall close to the axial position where they were generated, which is expected to be close to the entrance holes, thereby preventing fast electrons from reaching the target.

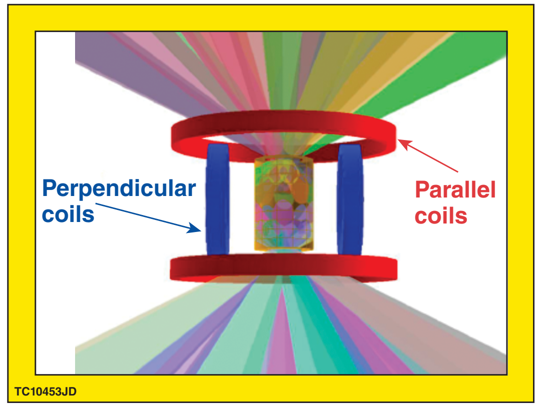

Figure 1: A (VISRAD) model showing the view of the target with both sets of coils present. In practice, only one set is used at a time.

The experiment, conducted on 20 November 2012, featured Au-wall hohlraums with a wall thickness of 5 μm, a length of 2.4 mm, and an inside diameter of 1.6 mm. The hohlraum's 1.2-mm-diam laser entrance hole (LEH) was covered with a 0.6-μm-thick polyimide window. Each LEH was irradiated with 20 laser beams arranged in three axisymmetrical rings. Multiple diagnostics, including x-ray framing cameras, soft and hard x-ray spectrometers (HXRS), calorimeters, and backscattering diagnostics were deployed.

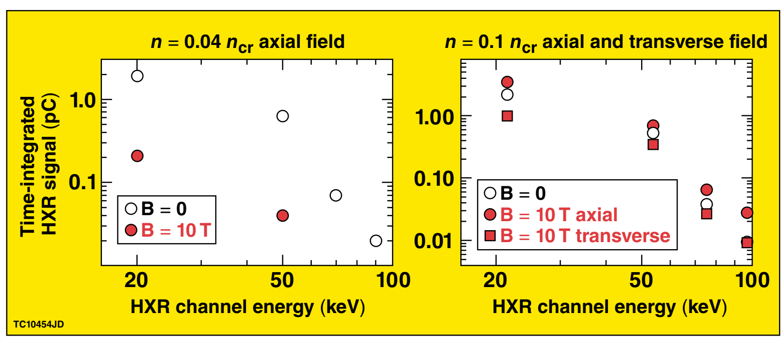

Figure 2: (a) Hard x-ray energy spectra at low density and (b) high density with and without an external magnetic field.

The measurements were taken at plasma densities of 0.04 n_{cr} and 0.1 n_{cr} (n_{cr} = 9 × 10^{21} cm^{-3}). The HXRS spectra shown in Fig. 2 indicate a reduction of hot electrons with the applied magnetic field at the low plasma density. At low plasma densities, the electrons are magnetized ($\omega_{ce}\tau_e > 1$) and the shot with the field exhibits a ~10× lower level of hot electrons. At high densities, the effect is minimal as expected by the reduced magnetization of the electrons ($\omega_{ce}\tau_e \sim 1$). These preliminary results are derived from a single-shot comparison. Further data analysis is ongoing and more shots are needed for definitive conclusions.

Omega Facility Operations Summary: The Omega Facility conducted 158 target shots in November (112 on OMEGA and 46 on OMEGA EP) with an average experimental effectiveness of 98.1% (97.3% for OMEGA and 100% for OMEGA EP). Teams led by LLE and LLNL carried out 58 ICF shots on the facility and LANL and LLNL teams led 35 HED program shots. Two NLUF campaigns led by the University of California, Berkeley, and by General Atomics, respectively, conducted 22 target shots. The LBS program accounted for a total of 43 target shots for experiments led by LLE and LLNL.

1. S. P. Regan *et al*., Phys. Plasmas **17**, 020703 (2010).
2. O. V. Gotchev *et al*., Rev. Sci. Instrum. **80**, 043504 (2009).
3. D. H. Froula *et al*., Phys. Rev. Lett. **98**, 135001 (2007).