The Energetic Neutrons Campaign led by Sandia National Laboratories (SNL) had a successful year testing electronic devices and printed circuit boards (PCB’s) under 14-MeV neutron irradiation at the Omega Laser Facility. During FY21, Sandia’s neutron effects diagnostics (NED’s) and data acquisition systems were upgraded to test novel commercial off-the-shelf and Sandia-fabricated electronic components that support SNL’s National Security mission. The upgrades to the Sandia platform consisted of new cable chains, sample mount fixtures, and a new fiber optics platform for testing optoelectronic devices.

The new cable chains improved data quality and reduced the time required by LLE and Sandia to identify and solve issues with the electronic circuits under test. A variety of sample fixtures were designed and fabricated to mount new shapes and sizes of PCB’s closer to the neutron source without interfering with other components fielded simultaneously. PCB’s fielded in FY21

![Figure 1](image)

(a) A PCB mounted in one of the Sandia NED’s used to study single-event effects; (b) an example of the setup used to test optoelectronic devices in the Sandia NED’s; and (c) an example of the light output data measured after each shot during one of the Energetic Neutrons Campaigns.
contained a variety of components ranging from low to high voltage and from discrete devices to small integrated circuits as shown in Figs. 1(a) and 1(b).

The new fiber optics platform consisted of fiber optic cables, sample mount fixtures, and data acquisition systems that allowed Sandia to measure high-quality optical signals for the first time on OMEGA. Optical data will be used to calculate carrier lifetime degradation in semiconductor devices exposed to 14-MeV neutron irradiation using light output decay and frequency response measurements as shown in Fig. 1(c).

A SNL graduate student intern participated for the first time in one of the experiments on OMEGA performing in-situ testing of optoelectronic devices. The student developed software, connected hardware, acquired data, and performed data analysis during one of the energetic neutrons campaign in FY21; he will be participating again in FY22.

This work was performed at Sandia National Laboratories, a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy’s National Nuclear Security Administration under contract DE-NA0003525. The views expressed in the article do not necessarily represent the views of the U.S. Department of Energy or the United States Government. SAND2021-14522 R.

Investigating the Effects of Magnetization on Laser–Plasma Instability Backscatter in MagLIF Preheat
Principal Investigators: J. R. Fein and A. J. Harvey-Thompson

The magnetized liner inertial fusion1 (MagLIF) concept requires coupling energy from a multikilojoule laser to preheat magnetized D2 before compression with a pulsed-power generator. The laser preheat process is sensitive to laser–plasma instabilities (LPI’s) and filamentation, which affect energy coupling and can lead to beam spray that introduces mix into the target. The LPI processes are affected by magnetic fields that affect plasma temperatures by suppressing thermal conduction but can exacerbate thermal self-focusing and filamentation and breakup of the beam. These effects have not been studied at conditions relevant to MagLIF.

To address the effect of magnetic fields on LPI in MagLIF preheat, magnetized D2-filled gas tube experiments were conducted on OMEGA as part of the MiniMagLIF-21a shot day. Figure 2(a) shows the target geometry, wherein a single OMEGA beam (B30) heated a 650-nm polyimide window and D2 gas inside a polyimide tube. The heating beam delivered a total of ~450 J in a 1-ns
pulse with 300-μm spot, resulting in intensities $\sim 6 \times 10^{14}$ W/cm$^2$. Dual MIFEDS (magneto-inertial fusion electrical discharge system) coils imposed an $\sim 40$-T magnetic field oriented along the tube axis. Five shots were conducted in total, including one calibration shot for the full-aperture backscatter system (FABS) and four target shots: two with and two without a magnetic field.

FABS systems monitored direct backscattered and sidescattered light from stimulated Raman (SRS) and stimulated Brillouin scattering (SBS), and an x-ray framing camera diagnosed time-gated emission to evaluate beam propagation. Preliminary data collected by the FABS calorimeters are shown in Fig. 2(b). SBS levels increased nearly 5× when the magnetic field was increased from 0 to 40 T, whereas virtually no change in the amount of SRS was observed. SBS streaked spectra from magnetized targets showed an additional feature at the laser wavelength not present in the spectra from the unmagnetized targets. Hard x rays, as recorded by the HERIE, decreased by a factor of $\sim 2$ in the magnetized targets compared to unmagnetized targets. While the increased SBS levels and decreased hard x rays in magnetized targets may have resulted from magnetization effects in the pre-heated gas and laser entrance hole (LEH) window, additional experiments are needed to rule out other causes. The preliminary data set from these experiments is helping to inform target modifications and diagnostic configurations for similar experiments set for January 2022.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy’s National Nuclear Security Administration under contract DE-NA0003525.