June 2000 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Charged-Particle Diagnostics: Electronic detection of charged particles has been demonstrated using the charged-particle spectrometer (CPS1) at OMEGA. Researchers from SUNY–Geneseo (including several undergraduate students), LLE, Lawrence Livermore National Laboratory, and the Massachusetts Institute of Technology Plasma Science and Fusion Center mounted a 250-μm-thick pin diode in the spectrometer focal plane at the position corresponding to 15-MeV protons. In a series of D-^{3}He-filled target implosions, magnetically selected, high-energy protons passed through a collimator, an aluminum foil, and a CR-39 track detector before stopping in the diode. The resulting voltage signal of the diode was recorded using an oscilloscope (Fig. 1). This project demonstrates proof-of-principle that electron detection of charged particles generated in the ICF environment is possible under appropriate conditions. This work was funded, in part, through a Department of Energy National Laser Users' Facility (NLUF) grant.

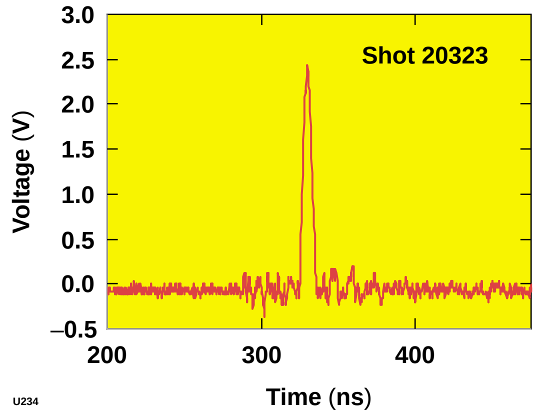

Figure 1. The recorded proton signal for a D-^{3}He target. The proton signal shown was generated by about 8900 protons on the detector, corresponding to a primary yield of 8.3×10^{10}.

Neutron Imaging: Recently, scientists from the Commissariat à l'Énergie Atomique (CEA), France, installed a new 14-MeV neutron imaging system (NIS) on OMEGA. Future experiments on NIF and LMJ will require neutron imaging with resolution better than 10 μm. The prototype system installed on OMEGA uses the technique of prenumbral imaging; it was tested in June and shown to have an ultimate resolution of 30 μm. The aperture consists of a massive cylinder (50 mm thick) made of tungsten alloy. An aperture with a biconical shape is drilled into this cylinder. The aperture is placed 55 cm from the target, and the image is recorded by a detector placed 8 m from the target. The detector consists of 8000 plastic scintillating fibers, a gated microchannel plate, and a CCD camera. The coded image is unfolded by a filtered auto-correlation technique to produce the image shown in Fig. 2. On this shot, a 920-μm-diameter, 2.5-μm-thick glass shell filled with 20 atm of DT was imploded with 30 kJ (UV, 1 ns) and produced 6×10^{13} DT neutrons. The neutron source size is 120 μm in diameter and can be compared with the hard x-ray image (5- to 7-keV energy band) obtained with a Kirkpatrick–Baez (KB) microscope on the same shot (Fig. 3). The microscope image resolution is better than ~10 μm. The microscope image shows the hot region of the glass shell, which is larger in size than the neutron-emitting region.

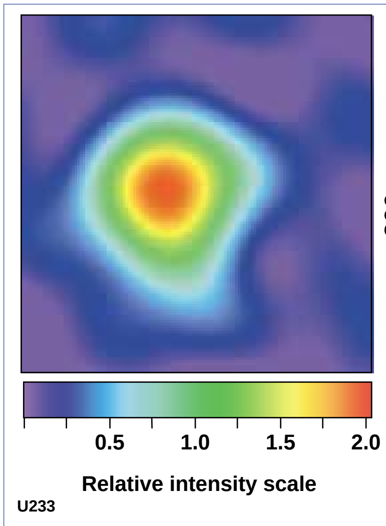

Figure 2. Unfolded neutron image of a DT imploded target (shot 20290).

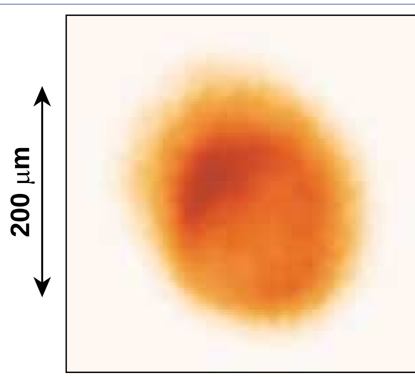

Figure 3. Hard x-ray image (5- to 7-keV energy band) recorded with a KB microscope on shot 20290. The x-ray image and the neutron image have the same spatial scaling. The KB microscope views the target from a direction ~30° above the NIS.

OMEGA Operations Summary: In June, there were 98 target experiments carried out on OMEGA, including 50 shots for various LLNL campaigns (radiation transport, backlit implosion, x-ray diffraction, equation of state, polyimide Rayleigh–Taylor, direct-drive hydro, and NIF symmetry); 5 shots for SNL experiments supporting WBS-3; 15 shots for the LLE integrated spherical experiments (ISE); and 28 shots for NLUF experiments, including campaigns by SUNY Geneseo and General Atomics. Ride-along diagnostics were fielded on some of these shots, including a neutron imaging system (NIS) from CEA and a Cerenkov detector from Los Alamos National Laboratory (LANL). Work on Cryogenic Target Handling System (CTHS) activation continued during the reporting period.

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