Diagnostic Timing Design for NIF: The absolute-timing accuracy requirement for most of the temporally sensitive target diagnostics on the NIF and OMEGA is between 25 and 50 ps. Diagnostics are typically timed relative to laser light on target using a high-*Z* foil target (e.g., gold) and a short-duration 3ω laser pulse—typically 100 ps on OMEGA and 88 ps on the NIF. The short-duration x-ray emission from the foil generates signals in diagnostics that are cross-timed to the laser pulse using a facility-wide fiducial recorded with the diagnostic signals. On OMEGA, the standard time-sensitive diagnostics are the neutron temporal diagnostic (NTD), the particle temporal diagnostic (PTD), all of the neutron time-of-flight (nTOF) diagnostics, the x-ray framing cameras (XRFC), and the TIM-based streak camera (SSCA). A similar set of instruments is absolutely timed on the NIF and include the γ-reaction history (GRH) and the south pole bang time (SPBT) detector. The challenge for these timing experiments is to generate adequate signals in diagnostics that are typically well shielded from lower-energy x-ray emission (e.g., hohlraums).

The initial timing shots on the NIF were scaled directly from their OMEGA counterparts. The first timing shots (e.g., N092210) were performed without phase plates where on-target intensities approached 1×10^{17} W/cm^2 using 100 J/beam. Later timing shots were performed with the laser configured for hohlraum drive where, with 3ω phase plates in all of the beams, the peak intensities on target were limited to the mid-10^{15} W/cm^2 range. In addition, the laser energy of the 88 ps pulses was reduced to 50 J/beam to minimize final optics damage. The combination of lower energy and much lower intensity reduced the diagnostic signal levels below the threshold needed to ensure absolute timing accuracy (shot N110803).

A beam-timing campaign was inserted into the December OMEGA schedule to test a target design that promised to produce larger diagnostic signals at the beam energies and intensities used on shot N110803. The basic premise was that hard x-ray emission (>30 keV) from hot electrons generated by the two-plasmon-decay (TPD) instability could be enhanced by coating the targets with plastic (CH) to create a preplasma for the TPD instability using a suitable low-energy prepulse. The campaign used a mix of uncoated and CH-coated gold and silver targets. Some of the OMEGA nTOF diagnostics were modified to have shielding comparable to their NIF counterparts. As expected, the CH-coated targets with the prepulse produced much larger diagnostic signals than the uncoated targets. Figure 1 shows a summary of the data at comparable intensities. The silver target signal in a well-shielded 10-mm CVD diamond detector was 6 to 8× larger than without the CH-coating. The absolute-timing accuracy was monitored using the NTD, which showed no measurable difference in the x-ray production time between coated and uncoated targets.

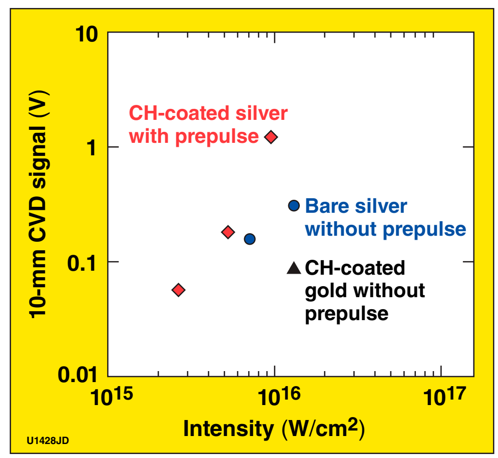

Figure 1. The peak signal in a shielded CVD diamond nTOF detector as a function of target type and pulse intensity. The plastic-coated targets with a low-energy prepulse produced significantly more hard x rays (>30 keV) as a result of TPD instability.

The results of this experiment were used to design a NIF timing experiment based on the standard hohlraum-drive configuration (N120105). A 1-ns prepulse illuminated a CH-coated silver target that was then driven with the 88-ps timing pulse. The preliminary results showed that all of the primary diagnostics obtained good data and that the signal levels in the various nTOF detectors and the GRH increased by a factor of 20 over the earlier shot (N110803). The rapid development and successful execution of the joint LLNL–LLE timing campaign is another example of the value of interlaboratory collaboration within the NIC.

Omega Facility Operations Summary: The Omega Facility conducted 112 target shots in December with an average experimental effectiveness of 98.7%. There were 102 shots conducted on OMEGA with an experimental effectiveness of 98.5% and 10 on OMEGA EP with an experimental effectiveness of 100%. The NIC program accounted for 49 target shots taken by teams from LANL, LLE, and LLNL. Five teams from LLNL conducted 43 shots for the HED program. One NLUF experiment was conducted by a team led by the University of California, Berkeley (12 shots), and one LBS experiment was conducted (8 shots) led by LLNL.