FY11 Laser Facility Report

During FY11, the Omega Laser Facility conducted 1348 target shots on OMEGA and 457 target shots on OMEGA EP for a total of 1805 target shots (see Tables 128.V and 128.VI). OMEGA averaged 10.3 target shots per operating day with availability and experimental effectiveness averages for FY11 were 93.3% and 96.1%, respectively.

OMEGA EP was operated extensively in FY11 for a variety of internal and external users. Of the 457 target shots, 401 were shot in the OMEGA EP target chamber and 56 were joint shots in the OMEGA target chamber. OMEGA EP averaged 5.5 target shots per operating day with availability and experimental effectiveness averages for FY11 of 85.6% and 95.2%, respectively.

Table 128.V: Omega Facility target shot summary for FY11.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	NIC	Shots in Support of NIC	Non-NIC
LLE	335	389	0	375	14
LLNL	260	301	131	0	170
NLUF	155	203	0	0	203
LANL	170	195	45	0	150
LBS	155	170	0	0	170
CEA	40	50	0	0	50
AWE	20	23	0	0	23
U. Mich	20	17	0	0	17
Total	1155	1348	176	375	797

Table 128.VI: Omega EP Facility target shot summary for FY11.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	NIC	Shots in Support of NIC	Non-NIC
LLE	174	192	0	192	0
LLNL	65	79	10	5	64
AWE	10	21	0	0	21
NLUF	60	57	0	0	57
LBS	65	74	0	0	74
LANL	25	28	0	0	28
CEA	5	6	0	0	6
Total	404	457	10	197	250

OMEGA EP Improved Energy Capabilities

Short-pulse (IR) and long-pulse (UV) energy on target has been increased. The UV energy was increased after the acquisition of improved optics. Lithographic-quality fused-silica substrates were finished using LLNL-developed protocols, LLNL-supported production controls, and the latest LLNL post-processing techniques for enhanced damage threshold (Acid Mitigation Process II). The extended UV energy operational envelope was made available after completion of a damage-testing laser shot campaign with the previous optics. UV energy on target was increased from 2.3 kJ per beam to 6.6 kJ at 10 ns, exceeding the 6.5-kJ system-design goal. Short-pulse IR energy was increased following the installation of improved damage-threshold gratings in the grating-compressor vessel. Additionally, a comprehensive short-pulse small-beam damage-testing program was conducted on multilayer dielectric coatings. The combination of new gratings and coating performance analysis resulted in an increase to the IR energy operational envelope for the short-pulse laser beams. IR energy on target for beamline 2 at 10 ps was increased from 1.0 kJ to 1.6 kJ, 60% of the 2.6 kJ design goal. Up-to-date limits to the energy on target are now summarized and available to all users through the Operations Website.

OMEGA EP 100-ps UV Temporal Pulse Shapes

At the request of users, the shortest UV pulse durations have been extended from the previous limit of 1 ns to 100 ps. Users are now able to request pulse shapes between 100 ps and 10 ns. The 100-ps pulse shapes have been utilized to produce short-duration x-ray pulses useful for a variety of target-physics campaigns, including backlighter platform development for the NIF. With this new functionality, the temporal co-timing of all four beamlines has been calibrated to <50 ps.

OMEGA EP Short-Pulse Focal-Spot Improvement Using a Static Wavefront Corrector

Static wavefront correction has been developed for OMEGA EP to correct high-order residual wavefront that is beyond the spatial resolution of the existing adaptive optics. A small-aperture phase corrector, manufactured by QED Technologies, using the magnetorheological finishing (MRF) process, has been added to the injection system to precompensate for repeatable high-order wavefront errors that arise in the beamlines. Following successful proof-of-principle demonstrations, these optics were implemented on both of the OMEGA EP short-pulse beamlines, providing an ~2× reduction in focal-spot extent at the output of the beamline during active wavefront correction. On amplified shots, target-plane focal-spots have met the specification of 80% of the energy in less than a 20-μm radius ($R_{80} < 20\ \mu$m). The ~25% improvement is realized on the first shots, although thermal distortion of the amplifier disks has led to focal-spot degradation after multiple shots have been taken on a day. Future revisions of the phase-corrector design will partially compensate for this effect. See Fig. 128.18 for representative focal-spot results. This work follows on the successful implementation of advanced phase-retrieval techniques developed in FY10 that allow for accurate characterization of the focal spot.

OMEGA EP Infrared Alignment Table and Beamline Injection Table Enhancement

The daily operation of the OMEGA EP laser has been improved with enhancements to the OMEGA EP infrared alignment table (IRAT). This work improved the imaging accuracy from the laser source apodizer plane to the beamline input image plane. This improvement reduces modulation on critical optics in the OMEGA EP Laser System. Additional diagnostics were added to improve the injection energy measurements and centering of beams. All of these improvements have increased system operability and are primary contributors to an increase in shots per day from FY10 to FY11.

Improved OMEGA UV On-Target Predictions

Target implosions have been shown to slowly degrade the UV transmission, primarily on the final debris shield, causing a decrease in on-target energy relative to the diagnostic prediction. During FY11, the study of UV transmission has resulted in a better understanding of the loss mechanisms. The study found that the losses are dependent on target type, target composition, target quantity, number of beams used for each shot, and beam location in the tank. The results of this study and daily measurements of transmission on representative UV optics have been incorporated into a new on-target energy prediction that is reported to the principal investigator. The system average loss is predicted within ±1% accuracy, and the rms error is <2%.

Experimental Diagnostics

Diagnostic capabilities continue to evolve with the commissioning of 24 new diagnostic instruments on OMEGA and 9 new diagnostic instruments on OMEGA EP. These include a new spherical crystal x-ray imager, upgraded hard x-ray diode arrays, B-dot magnetic field probes, an electron spectrometer,

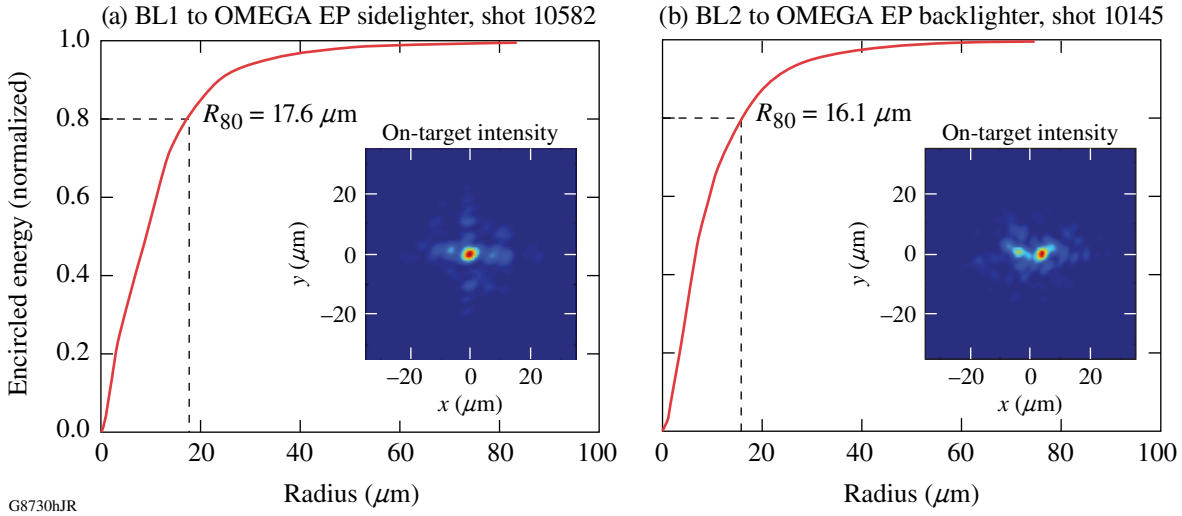

Figure 128.18
(a) Beam 1 (BL1) and (b) Beam 2 (BL2) focal-spot images from target shots with the static wavefront correctors installed.

and a new test platform for CVD-diamond neutron detectors. Many of these new instruments were developed by or in cooperation with other laboratories (including LLNL, LANL, CEA, Oxford University, Osaka University, and SNL).

Improvements to the online information systems available to our scientific users include availability of specification sheets and operating procedures for diagnostic instruments, as well as target chamber port assignment tables. Other facility improvements include commissioning of an additional image plate scanner and electromagnetic interference hardening of the target positioners on both OMEGA and OMEGA EP.

A number of safety improvements were implemented in the experimental area. These include the commissioning of filtered air flow hoods for servicing equipment that contains or is contaminated with beryllium, higher-resolution beryllium monitoring capability; and review and certification of heavy equipment lift procedures. Additionally, tracking beryllium survey data and radioactive material inventory has improved visibility to the operators and other stakeholders.