FY12 Laser Facility Report

During FY12, the Omega Laser Facility conducted 1494 target shots on OMEGA and 426 target shots on OMEGA EP for a total of 1920 target shots (see Tables 132.V and 132.VI). OMEGA averaged 11.2 target shots per operating day with Availability and Experimental Effectiveness averages for FY12 of 94.2% and 96.7%, respectively.

OMEGA EP was operated extensively in FY12 for a variety of internal and external users. A total of 356 target shots were taken in the OMEGA EP target chamber and 70 joint target shots were taken in the OMEGA target chamber. OMEGA EP averaged 6.1 target shots per operating day with Availability and Experimental Effectiveness averages for FY12 of 88.0% and 95.5%, respectively.

Table 132.V: OMEGA Laser System target shot summary for FY12.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	NIC	Shots in Support of NIC	Non-NIC
AWE	10	12	0	0	12
CEA	35	43	0	0	43
CRASH	20	18	0	0	18
LANL	200	244	361	0	183
LBS	170	202	0	0	202
LLE	347	411	13	398	0
LLNL	300	335	116	8	211
NLUF	172	215	0	0	215
SNL	10	14	14	0	0
Total	1264	1494	204	406	884

Table 132.VI: OMEGA EP Laser System target shot summary for FY12.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	NIC	Shots in Support of NIC	Non-NIC
LBS	45	71	0	0	71
LLE	120	172	0	172	0
LLNL	105	121	39	0	82
NLUF	55	62	0	0	62
Total	325	426	39	172	215

Highlights of achievements in FY12 include the following:

Multi-FM Beam Smoothing on OMEGA EP

A one-dimensional smoothing by spectral dispersion (SSD) demonstration system using multiple modulation frequencies (multi-FM 1-D SSD) was commissioned on one long-pulse beamline of OMEGA EP. The modified OMEGA EP beamline has supported experiments to validate this novel beam-smoothing capability prior to implementation at the National Ignition Facility (NIF) to enable polar-drive ignition. The fiber-laser–based seed-pulse system design greatly increases the laser pulse–shaping flexibility and is compatible with the NIF front-end laser design. Multi-FM SSD modulation is selectively applied to portions of the laser pulse required for polar-drive ignition on the NIF. The output seed pulse is injected into the NIF preamplifier module (PAM) with a custom SSD grating inserted into the PAM's multipass amplifier section. The dispersion of the SSD grating was selected to cleanly propagate the dispersed SSD bandwidth through the spatial-filter pinholes in the system while providing the required focal-spot smoothing performance. A series of equivalent-target-plane measurements was conducted that confirmed the expected time-integrated smoothing of the focal spot when combined with a distributed phase plate (DPP).

Equivalent-Target-Plane Diagnostics on OMEGA EP

An equivalent-target-plane (ETP) diagnostic has been activated on Beamline 4 to characterize the UV laser pulse spot on target through DPP's. The UV diagnostic package receives a sample of the laser pulse after frequency conversion. A mount has been added to install a DPP into this diagnostic arm. A far-field camera is configured to observe the entire intensity profile in low-resolution mode with 1-μrad/pixel resolution and also features a fine-resolution mode to study details of the speckle pattern with 0.3 μrad/pixel.

OMEGA EP Short-Pulse Contrast Improvement

The primary source for prepulse in the OMEGA EP short-pulse laser has historically been the amplified stimulated emission (ASE) in the optical parametric amplifiers. In FY12, the seed oscillators were upgraded to include an ultrafast optical parametric amplifier (UOPA) prior to the pulse stretcher. With this equipment, the seed energy into the next stage of amplification is increased, allowing a redistribution of the system gain to realize reduced ASE. This upgrade resulted in an improvement in the short-pulse (SP) contrast of over two orders of magnitude. (See Fig. 132.46 for representative short-pulse contrast measurements before and after this upgrade.)

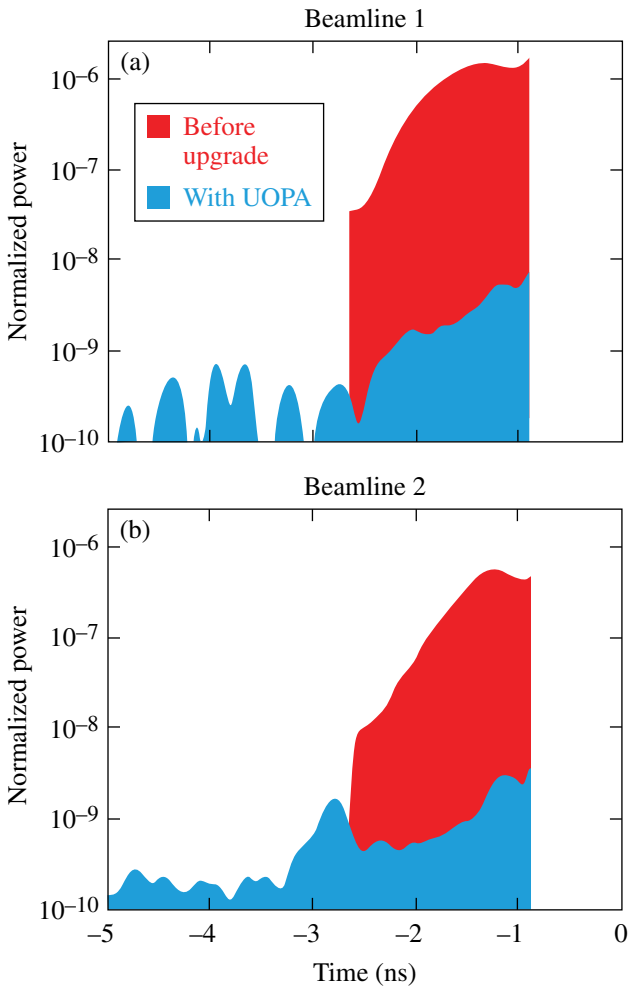

Figure 132.46
Short-pulse contrast measurements from Beamlines 1 and 2. The red curves show previously normal contrast results. The blue curves are characteristic of contrast measurements after the UOPA upgrade. On-shot power contrasts higher than 10^9 at best compression have been measured, translating into intensity contrasts higher than 10^{10}.

OMEGA EP Spatial Profile Improvements on Beamlines 3 and 4

Programmable spatial light modulators (PSLIM's) have been installed and activated in the front ends of Beamlines 3 and 4. The PSLIM system consists of a spatial light modulator installed at an image plane. The spatial light modulator applies a phase term in a 2-D array to the beam such that a prescribed amount of energy is removed at the next spatial filter in the system. A dedicated wavefront sensor (employing a novel routine for calculating the spatial profile) is used to provide feedback and achieve the desired near field without adversely affecting the wavefront.

OMEGA Ultraviolet Pulse-Shape-Measurement Capabilities

A precision ultraviolet pulse (PUVP) shape measurement diagnostic has been commissioned on the OMEGA laser to improve the resolution of pulse-shape measurements. The PUVP is a streak camera with 6-ps resolution that is free-space coupled to Beamlines 47, 57, and 67. This is twice the resolution offered by the fastest sweep speed of the P-510 streak cameras. This diagnostic also offers longer sweep speeds to ensure data collection when the beamline timings are requested to be within 13-ns separation.

A 33-ns sweep speed was added to complement existing 6-ns and 20-ns options on the P-510 timing diagnostic for all six clusters. The extended acquisition duration gives new capability to capture reference fiducials when large timing offsets are employed on individual beams or between multiple drivers. The longer sweep speed was specifically tailored to provide improved timing analysis for several campaigns that routinely employ such offsets. Standard automated analysis gives a reported timing accuracy of 350 ps and a precision of 100 ps. Additional manual processing can be performed to further improve these results when necessary.

4ω Probe Laser System

The source laser for the 4ω probe diagnostic has been installed and activated in the OMEGA EP Target Bay. This system produces a 10-ps pulse of 263-nm light, which will be used to investigate laser–plasma interactions in the OMEGA EP target chamber. The seed laser is a mode-locked oscillator that is synchronized to the short-pulse lasers by the hardware timing system to less than 5 ps. The pulse is stretched to a length of 10 ps and amplified by two stages of regenerative amplifiers before being frequency quadrupled. The energy at the target interaction (currently >20 mJ available) will exceed the background UV in the diagnostic systems. A shadowgraphy and schlieren diagnostic package is under construction to accurately

characterize the plasma densities based on the refracted light from the source.

Thomson-Scattering Spectrometer System on OMEGA

The Thomson-scattering spectrometer diagnostic has proven to be a valuable resource for characterizing the electron and ion temperatures during a target interaction. During FY12, the Thomson-scattering spectrometer system was upgraded to improve the resolution, increase the signal to noise, and add functionality. In this diagnostic, the scattered light from a probe beam is collected by an improved optical system in TIM-6 and relayed to diagnostic tables where an ion-acoustic wave spectrometer, electron plasma wave spectrometer, and the new two-plasmon-decay imager reside. Both of the spectrometers have a resolution of 20 lp/mm (increased from 7 lp/mm).

Experimental Operations and Diagnostics

In FY12, 26 new target diagnostics were commissioned on OMEGA and 8 on OMEGA EP. These included a suite of TIM-based scattered-energy calorimeters, the SXS crystal spectrometer for x-ray streak cameras, the first of the new PJX-2 streak cameras, a new high-speed video target viewing system, and an additional x-ray pinhole camera. The streaked optical pyrometer diagnostic measures the time-resolved laser-driven shocks on OMEGA. This system has been upgraded with a ROSS streak camera system and improved optical relay for higher resolution in increased signal strength. As in previous years, many of the new instruments were developed by or in collaboration with other laboratories, including LLNL, LANL, CEA, and General Atomics.

Experimental facility improvements included the introduction of an image plate scanning capability on OMEGA, the addition of a second image plate scanner on OMEGA EP, and the commissioning of a set of fully integrated TIM-based target positioning systems on both OMEGA and OMEGA EP. Two of the OMEGA TIM's were retrofit with new EMI-resistant, OMEGA EP–type control systems, and updated TIM vacuum system operating software was installed on both OMEGA and OMEGA EP.