FY14 Laser Facility Report

During FY14, the Omega Laser Facility conducted 1405 target shots on OMEGA and 699 target shots on OMEGA EP for a total of 2104 target shots (see Tables 140.III and 140.IV). OMEGA averaged 11.1 target shots per operating day with Availability and Experimental Effectiveness averages for FY14 of 95.8% and 93.3%, respectively.

OMEGA EP was operated extensively in FY14 for a variety of internal and external users. A total of 638 target shots were taken into the OMEGA EP target chamber and 61 joint target shots were taken into the OMEGA target chamber. OMEGA EP averaged 7.6 target shots per operating day with Availability and Experimental Effectiveness averages for FY14 of 95.7% and 92.8%, respectively.

Highlights of Achievements in FY14

1. IR Transmission Diagnostic

Hardware was installed to collect final optics transmission data for the short-pulse beams on OMEGA EP. These optics will be characterized after each campaign to understand the resultant degradation of the surfaces from target debris and increase accuracy of on-target energy measurements. The diagnostic will also be used to collect data for debris-shield policy modifications.

Table 140.III: OMEGA Laser System target shot summary for FY14.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	ICF	Shots in Support of ICF	Non-ICF
CEA	61	67	0	0	67
DTRA	22	26	0	0	26
LANL	187	206	33	0	173
LBS	154	165	0	0	165
LLE	495	484	0	455	29
LLNL	253	270	70	0	200
NLUF	165	178	0	0	178
Maintenance	0	9	0	9	0
Total	1337	1405	103	464	838

Table 140.IV: OMEGA EP Laser System target shot summary for FY14.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	ICF	Shots in Support of ICF	Non-ICF
LANL	12	15	7	0	8
LBS	90	133	0	0	133
LLE	168	242	0	128	114
LLNL	60	70	39	0	31
NLUF	84	88	0	0	88
SNL	12	13	13	0	0
Maintenance	0	138	0	138	0
Total	426	699	59	266	374

2. OMEGA Digital Imaging System

The aging laser alignment video system for OMEGA is being replaced with modern digital equipment. The core infrastructure has been installed and many of the cameras have been replaced as part of project work this year. As with the system in OMEGA EP, integration of GigE-based camera diagnostics can be supported in shorter time frames.

3. Short- and Long-Pulse Late-Cycle Wavefront Control

The late-cycle control software has been implemented to optimize focal-spot performance. It coordinates the wavefront control and device motion control during the amplifier charge sequence on OMEGA EP. This capability significantly reduces the amount of time between final wavefront correction and each shot. Results include reduced wavefront error and consistent on-target short-pulse spot sizes of less than 20-μm radius.

4. OMEGA EP ASBO Laser Installation and ASBO/VISAR Diagnostic Tune Up

The OMEGA EP active shock breakout (ASBO) and velocity interferometer system for any reflector (VISAR) diagnostic have been significantly refurbished to ensure optimum measurements. An additional source laser for OMEGA EP was commissioned to reduce dependence on the OMEGA source, mitigate campaign conflicts, and provide a spare resource for OMEGA. With this system operational, both laser systems are able to support campaigns that require ASBO diagnostic measurements on the same day.

5. OMEGA Arbitrary Waveform Generator on the SSD Driver

The OMEGA smoothing by spectral dispersion (SSD) driver pulse-shaping system has been converted from aperture-coupled stripline technology to modern digital arbitrary waveform generator technology. Accuracy and repeatability of pulse-shape generation have been dramatically improved. The facility has also extended available pulse-shaping features by adding a fourth-picket capability. The changing hardware required a redesign of all pulse shapes. The facility used this opportunity to update the pulse nomenclature to improve clarity and correlate the pulse shape name more closely to the design features.

6. 4ω Probe Polarimetry Diagnostic

The 4ω probe polarimetry diagnostic was activated over the past year and is being used to measure the polarization rotation of the probe beam after transmission through plasma formed at the target chamber center (TCC). The primary purpose is to diagnose magnetic fields generated at TCC that induce Faraday rotation of the 4ω probe-beam polarization as it passes through a plasma or dielectric medium. The angular filter refractometry diagnostic is simultaneously used to measure the plasma density profile complementing the plasma characterization and enabling one to calculate the magnetic fields.

7. Co-Propagation Activation

The OMEGA EP beam combiner optic coating has been re-engineered to withstand the fluences present in the beam path. With this advancement, LLE has activated a mode where the short-pulse signal from the upper and lower compressors is co-propagated to the target along the same beam path. The co-propagation option is available for either the backlighter beam path (on OMEGA EP) or the OMEGA target chamber beam path. In addition to simultaneous co-propagation, the ability to alternate shots using a single laser source through the same beam path to target is now available to users to achieve a higher shot rate.

8. 3ω Beam Timing Prototype System

The use of a target-sized scattering sphere enables one to directly measure UV light at the target chamber center. A procedure has been developed to launch a 5-Hz-repetition-rate infrared pencil beam into one of the beamlines such that sufficient energy is present at the frequency-conversion crystals to make several nanojoules of UV light. The signal scattered from the target is captured and characterized relative to a reference beamline, allowing the path-length adjustment to be characterized for co-timing of all 60 beams. The initial data have shown that less-than-10-ps peak-to-peak timing can be achieved with this system.

9. Experimental Operations

Ten qualifications have been completed in FY14 to improve the capabilities of OMEGA and OMEGA EP, including the MIT split nose for the proton temporal diagnostics, the LLNL B-dot probes, and the LANL gas Cherenkov detector #3. As in previous years, many of the new instruments and capabilities were developed by, or in collaboration with, other laboratories.

Several infrastructure projects were completed this year to support target diagnostics: the final two ten-inch manipulators (TIM's) have been retrofitted with modern mechanical and electrical control systems; the magneto-inertial fusion energy delivery system (MIFEDS) has been qualified in two additional TIM locations; and a pressurized gas-handling system has been implemented to support the gas Cherenkov and gamma reaction history diagnostics for LANL.

The National Ignition Facility (NIF) x-ray spectrometer (NXS) has been qualified for use on OMEGA, calibrated on a two-day shot campaign, and then transferred to the NIF. Image plates for NXS were subsequently cross calibrated to those actively used on the NIF.