FY15 Laser Facility Report

During FY15, the Omega Laser Facility conducted 1380 target shots on OMEGA and 736 target shots on OMEGA EP for a total of 2116 target shots (see Tables 144.XII and 144.XIII). OMEGA averaged 11.5 target shots per operating day with Availability and Experimental Effectiveness averages for FY15 of 94.5% and 95.5%, respectively.

OMEGA EP was operated extensively in FY15 for a variety of internal and external users. A total of 736 target shots were taken in the OMEGA EP target chamber and 43 joint target shots were taken in the OMEGA target chamber. OMEGA EP averaged 7.8 target shots per operating day with Availability

Table 144.XII: OMEGA Laser System target shot summary for FY15.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	ICF	Shots in Support of ICF	Non-ICF
CEA	27.5	26	0	0	26
DTRA	8	10	0	0	10
HED	429	486	0	0	486
LANL	44	47	47	0	0
LBS	126.5	147	0	0	147
LLE	407	400	0	400	0
LLNL	49.5	54	54	0	0
NLUF	132	151	0	0	151
SNL	22	18	18	0	0
Maintenance	0	41	0	41	0
Total	1245.5	1380	119	441	820

Table 144.XIII: OMEGA EP Laser System target shot summary for FY15.

Laboratory	Planned Number of Target Shots	Actual Number of Target Shots	ICF	Shots in Support of ICF	Non-ICF
HED	150	243	0	0	243
LANL	12	15	15	0	0
LBS	54	88	0	0	88
LLE	108	133	0	133	0
LLNL	42	64	64	0	0
NLUF	66	83	0	0	83
NRL	6	7	7	0	0
SNL	12	15	15	0	0
Maintenance	0	88	0	88	0
Total	450	736	101	221	414

and Experimental Effectiveness averages for FY15 of 95.3% and 95.8%, respectively.

Highlights of Achievements in FY15

1. Cross-Beam Energy Transfer Mitigation

The loss of drive energy coupled to the target because of cross-beam energy transfer (CBET) degrades performance of spherical implosions on OMEGA. This past year, several laser upgrades were implemented to continue studying CBET and enable a mitigation strategy where the beam size on target is changed over the course of the pulse shape. The primary upgrade implemented a change to the front-end laser to allow dynamic bandwidth reduction; two pulses, one with smoothing by spectral dispersion (SSD) and one without, were spliced together to form the LLE multiple-pulse driver line. To prevent damaging pulse overlap, a significant change to the fiber seed laser system enabled a single laser and pulse-shaping system to create both pulses and ensure the requisite low jitter (<60 ps peak-to-peak). A new demultiplexer was implemented to direct those pulses into different free-space paths. The SSD regenerative amplifier and SSD modulation system were reused with minor changes to enable co-propagation with a pulse from a new regenerative amplifier. Once combined, these pulses must be carefully characterized to achieve the desired energetic balance between the first pulse (normally pickets) and the second pulse (longer drive pulses). To achieve this, a new diagnostic package was implemented at the output of the driver line ring amplifiers including pre-shot pulse shaping and on-shot energy measurements. The OMEGA Laser System is now activating the ability to allocate different portions of the spatial beam aperture to each pulse to enable greater flexibility.

2. SG5 Phase Plates

A full set of distributed phase plates was procured and activated to improve the overall energy uniformity on target. These have a super-Gaussian, fifth-order, spatial profile on target, and feature reduced energy in the low-intensity wings of the focal spot and a higher degree of symmetry to minimize the CBET seed energy.

3. Neutron Timing Diagnostic on Port P11

The port H5 neutron timing diagnostic suffered from noise based on proximity to the target event. In February 2015, a second neutron timing diagnostic was implemented with the signal image relayed outside the shield wall where noise is dramatically reduced. This enables precise measurement of neutron burnwidth for high hot-spot-pressure cryogenic DT implosions.

4. OMEGA EP Streaked Optical Pyrometer

A streaked optical pyrometer diagnostic was activated in the OMEGA EP target chamber to measure the spatial and temporal optical emission of the target and derive the shock temperature.

5. Precision Trigger System

A low-jitter, small-step-size trigger system has been conceived and implemented for the spherical crystal imager and the Kirkpatrick–Baez framed microscope diagnostic. Information to date indicates that the systems have jitter below 10-ps rms with subpicosecond delay control.

6. Multi-FM Study

In FY15, an LLE–LLNL collaborative team performed propagation experiments of multifrequency-modulated SSD (multi-FM SSD) pulses on the OMEGA EP laser to demonstrate safe use of the technique in support of the National Ignition Facility (NIF) polar-direct-drive and laser–plasma instability missions. New laser diagnostics to measure amplitude modulation noise, pinhole irradiance, and pinhole closure were developed specifically for this activity. The new diagnostics were deployed in a series of experiments that confirmed that the threat of pinhole closure resulting from dispersion of the laser focus was negligible, and that amplitude modulation introduced in a NIF-like beamline caused by multi-FM SSD was acceptable.

7. OMEGA EP IR Transmission Data

Since commissioning the IR transmission diagnostic in FY14, LLE has gathered measurements after each campaign where an off-axis parabola has been deployed and continues to analyze the impact of target materials, mass, and geometry on the transmission of the parabola.

8. Ultrafast Temporal Diagnostics Study

The OMEGA EP short-pulse diagnostic package has been limited in the ability to fully characterize the pulse width between the best compression setting and the 10-ps pulse width. To address this deficiency and provide a replacement for the older streak-camera system, scientists and engineers have successfully prototyped a novel system utilizing pulse replication in fiber with a fast oscilloscope to accurately diagnose the pulse width over the full OMEGA EP range (1 to 100 ps).

9. Backlighter Arbitrary Waveform Generator

The backlighter driver was transitioned from aperture-coupled striplines to an arbitrary waveform generator in FY15. This development greatly improved pulse-shape integrity and repeatability in addition to allowing the Principal Investigator to select picket pulses on the backlighter. With this transition, the 15-year-old aperture-coupled stripline pulse-shaping system was fully retired.

10. FTS #1 Target Inserter

The cryogenic Fill Transfer Station (FTS) target inserter mechanism was significantly upgraded to decrease the generation of particulate during motion and eliminate the contamination observed on cryogenic targets.

11. Cryogenic Cart Viewing System

The cryogenic target carts have been upgraded to include higher-resolution viewing cameras. This upgrade enabled both higher precision layer monitoring and layering activities in the cart before reaching the characterization station.