FY18 Laser Facility Report

Introduction

During FY18, the Omega Facility conducted 1441 target shots on OMEGA and 878 target shots on OMEGA EP for a total of 2319 target shots (see Tables 156.V and 156.VI). OMEGA averaged 12 target shots per operating day with 95.0% Availability and 96.5% Experimental Effectiveness.

OMEGA EP was operated extensively in FY18 for a variety of user experiments. A total of 833 target shots were taken into the OMEGA EP target chamber and 45 joint target shots were taken into the OMEGA target chamber. OMEGA EP averaged 8.3 target shots per operating day with 95.8% Availability and 96.3% Experimental Effectiveness.

Table 156.V: OMEGA Laser System target shot summary for FY18.

Laboratory/ Program	Planned Number of Target Shots	Actual Number of Target Shots	ICF	Shots in Support of ICF	Non-ICF
CEA	49.5	59	—	—	59
HED	440	510	—	—	510
LBS	132	150	—	—	150
LLE	385	369	—	369	—
LLNL	60.5	61	61	—	—
LANL	22	17	17	—	—
NLUF	170.5	186	—	—	186
ARPA-E	22	19	—	—	19
Rutherford	11	12	—	—	12
Calibration	0	58	—	58	—
Total	1292.5	1441	78	427	936

Table 156.VI: OMEGA EP Laser System target shot summary for FY18.

Laboratory/ Program	Planned Number of Target Shots	Actual Number of Target Shots	ICF	Shots in Support of ICF	Non-ICF
CELIA	7	8	—	—	8
HED	203	279	—	—	279
LBS	63	81	—	—	81
LLE	140	209	—	209	—
LLNL	42	71	71	—	—
NLUF	91	107	—	—	107
NRL	14	14	14	—	—
Calibration	0	109	—	109	—
Total	560	878	85	318	475

Highlights of Achievements in FY18

1. 100-Gbar Campaign

The OMEGA 60 Laser System performs high-energy-density experiments with a symmetric direct-drive laser design. In FY16, the laboratory embarked on a campaign to seek higher implosion pressures through improved laser power balance and uniformity on target while also pursuing a cryogenic fill-tube target system for improved fuel quality at the time of shot.

The power-balance effort included improvements to system diagnostics and laser components to achieve the maximum beam-to-beam uniformity of spot size and energy balance over 100-ps portions of the pulse shape. The first-generation full-beam in tank (FBIT) diagnostic was deployed on the system with the ability to measure the UV spot size, shape, and the total energy of a single beam on a full-power laser shot. It is capable of accessing 31 of the 60 beams in the current configuration. Over the coming months, this diagnostic will be used to acquire measurements on multiple beams and compare on-target conditions with the primary on-line diagnostics located upstream of the target chamber.

In FY17, the infrared portion of the laser system was energy balanced using roving calorimeters with substantial improvement to the energy balance, but at a significant cost of system time in shot campaigns to acquire the data. These laser campaigns continued in FY18, but a simultaneous effort has been underway to measure the passive losses in the system using a retroreflector and ratiometer system. A number of initial shortcomings with this concept have been eliminated and a prototype measurement system has been demonstrated, paving the way for an FY19 project to mount the retroreflector in each of the 60 beamlines. This will allow the beams to be measured quickly by a small staff of technicians during normal maintenance hours to achieve equal or better results. Additionally, a prototype lens-damage measurement tool has been used on the Stage-E spatial filters to quantitatively measure beam obscurations and allow the System Scientists to track losses. This project is also proceeding to expand measurements into the Stage-D and -F lenses.

In FY18, new distributed phase plates were acquired to optimize the laser coupling of the implosion by controlling the beam spot size. Theoretical calculations indicated that the ideal ratio between target radius and the spot size is 0.75; a set of plates with a super-Gaussian fifth-order profile and 650-μm spot diameter were designed. These plates have been acquired and are qualified for use on the OMEGA laser starting on experiments in Q1 of FY19.

The Cryo Fill-Tube Project continued with designs to implement a new DT-capable cryo system on OMEGA. The Fill-Tube System is projected to be ready for use on OMEGA in FY21.

2. Cross-Beam Energy Transfer Mitigation Study

Experiments at the Omega Laser Facility have been conducted for the characterization of cross-beam energy transfer (CBET). CBET is a nonlinear process in the coronal plasma of an implosion that causes significant laser energy to be diverted away from the implosion capsule. Understanding this phenomena is critical to the fundamental design of next-generation systems. The OMEGA EP laser was modified with a tunable front end to utilize the existing amplifier system. The output beam is now available both on the OMEGA EP target chamber and as an optional Port P9 beam on the OMEGA-60 target chamber. These experiments use the gas jet to form a plasma. Initial experiments clearly measured and characterized two-beam CBET interactions over a number of tunable wavelengths, with more campaigns planned to increase the parameter space of interest to inertial confinement fusion (ICF).

3. Other Improvements to the Facility

A new shielded line-of-sight neutron time-of-flight diagnostic has been built and is ready for measurements in Q1 of FY19. The remote diagnostic is being supported by a full suite of control software since it resides on the far side of the shield wall in a newly constructed room at the roof level.

The OMEGA EP 4ω probe system received two important upgrades this year. The source laser was replaced with an in-house design and fabricated unit for higher reliability and improved repairability. On the diagnostic table, a Wollaston prism interferometry arm was added to characterize plasma density.

Several systems have received an incremental improvement to capabilities. The streaked optical pyrometer telescope was upgraded with an improved telescope for the wavelength bands being measured. The distribution for the OMEGA fiducial laser system has been updated to better balance the energy launchers and provide additional signal fibers for future use. The Gas-Jet Target System has been qualified for use with the OMEGA EP short-pulse beams through an extensive testing program.