The Seventh Omega Laser Facility Users Group Workshop

Introduction

The Seventh Omega Laser Facility Users Group (OLUG) Workshop, held on 22–24 April 2015, attracted 110 researchers (capacity limited) from around the world. The purpose of the 2.5-day workshop was to facilitate communications and exchanges among individual OMEGA users and between users and the Laboratory for Laser Energetics (LLE) management; to present ongoing and proposed research; to encourage research opportunities and collaborations that could be undertaken at the Omega Laser Facility and in a complementary fashion at other facilities [such as the National Ignition Facility (NIF) or the Laboratoire pour l'Utilisation des Lasers Intenses (LULI)]; to provide an opportunity for students, postdoctoral fellows, and young researchers to present their research in an informal setting; and to provide feedback from the users to LLE management about ways to improve and keep the facility and future experimental campaigns at the cutting edge. The interactions were wide-ranging and lively, as illustrated in the accompanying photographs.

OLUG consists of over 400 members from 55 universities and 35 research centers and national laboratories from 21 nations from 4 continents. Member affiliations can be found

U1911JR

Figure 144.36
Welcoming remarks were made by LLE Director Robert L. McCrory.

U1908JR

Figure 144.35
The Omega Laser Facility Users Group Workshop attracted 110 researchers from around world.

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Figure 144.37
Additional welcoming remarks were presented by University of Rochester Dean Robert Clark.

at **http://www.lle.rochester.edu/media/about/documents/OLUGMEMBERS.pdf**. OLUG is by far the largest users group in the world in the field of high-energy-density (HED) physics and also one of the most active.

The first two mornings of the workshop comprised six science and facility presentations. The facility talks proved especially useful for those unfamiliar with the art and complexities of performing experiments at the Omega Laser Facility. Since the facility is constantly evolving and improving, even experienced users significantly benefited from these updates. The overview science talks, given by leading world authorities, described the breadth and excitement of HED science either being currently undertaken at the Omega Laser Facility or well within the reach of the facility with improvements or upgrades. Of particular interest was a first-day presentation by Dr. Keith LeChien, Director for Inertial Confinement Fusion (ICF) for the National Nuclear Security Administration (NNSA), who presented the NNSA viewpoint of the users' workshop.

U1919JR

Figure 144.38
Dr. Keith LeChien presented the NNSA perspective.

A total of 63 students and postdoctoral fellows, 46 of whom were supported by travel grants from the NNSA, participated in the workshop. The content of their presentations encompassed the spectrum from target fabrication to simulating aspects of supernovae; the presentations generated spirited discussions, probing questions, and friendly suggestions. In total, there were 70 contributed papers, most of which were presented by students.

An important function of the workshop was to develop a set of **Findings and Recommendations** (p. 204) to help set and define future priorities for the Omega Laser Facility. They were grouped into three broad areas: OMEGA EP, 60-beam

U1920JR

Figure 144.39
Distinguished physicists, such as Professor Stefano Atzeni, presented frontier research within reach of the Omega Laser Facility.

U1922JR

Figure 144.40
Dr. M. S. Wei discussed research in high-energy-density physics at the Omega Laser Facility. Dr. Wei has been a strong advocate for the **Findings and Recommendations** regarding opposing beams on the OMEGA EP laser.

U1921JR

Figure 144.41
LANL'S Dr. Ray Leeper discusses aspects of ignition capsules based on wetted foams.

OMEGA, and general facility improvements and the accessibility and transparency of OMEGA operational information. LLE management uses these recommendations as a guide for making decisions about Omega Laser Facility operations, priorities, and future changes. In addition, the status of these OLUG **Findings and Recommendations** was updated and reviewed at a satellite evening meeting during the fall American Physical Society's Division of Plasma Physics Conference (Savannah, Georgia, 16–20 November 2015). They will also form the grist for the forthcoming workshop.

One highlight of the workshop, as in past workshops, was the panel of students and postdocs who discussed their experiences at the Omega Laser Facility along with their thoughts and recommendations on facility improvements. Engaging discussions sparked by this forum resulted in the student/postdoctoral recommendations for the facility.

The Wednesday evening session featured a tutorial on VISRAD—a program for visualizing the target, laser, and diagnostics configuration on OMEGA, as well as on the NIF.

For the third time, posters were presented by LLE's Summer High School Research Program students. Participants found their work impressive!

Finally, one of the important decisions made at the workshop was the selection of 27–29 April 2016 as the date of the next workshop. Planning for this event has already begun.

Several of the **Findings and Recommendations** of past workshops were either completed or are well underway. Some of the most-recent accomplishments, including improvements in pulse shaping and dynamic bandwidth reductions, energy on target, beam timing, distributed phase plates (DPP's), and diagnostics for the hot-spot pressure measurements. These improvements would benefit all users conducting experiments at the Omega Laser Facility.

The photographs on the following pages provide a representative sampling of the workshop's talks, interactions, and ambience.

Summary of OLUG Findings and Recommendations

1. Findings and Recommendations from the Student/ Postdoc Panel

Each year at the OLUG workshop, a group of students and postdocs lead a discussion with the community on topics rel-

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Figure 144.42
Lois Buitano of NNSA discussed issues with participants. Lois has attended and actively supported all OLUG workshops since they began seven years ago.

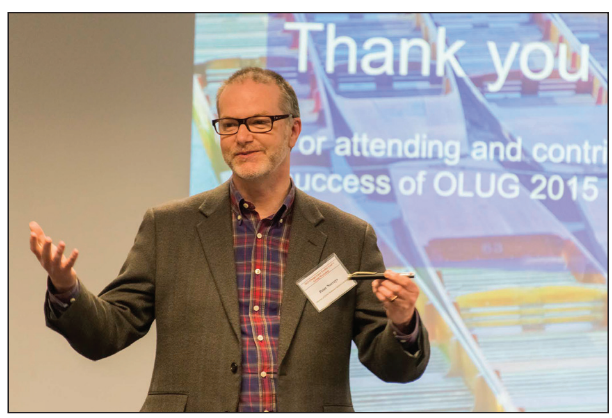

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Figure 144.43
Peter Norreys and Johan Frenje (not shown) led a spirited discussion about the **Findings and Recommendations**.

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Figure 144.44
Sixty-three students and postdoctoral fellows, some of whom are pictured here, participated in the 2015 Omega Laser Facility Users Group Workshop.

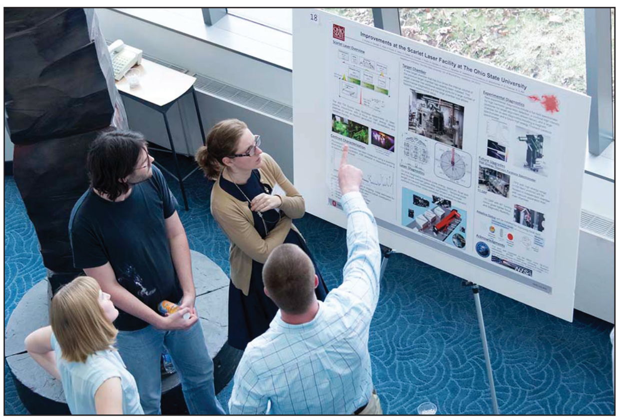

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Figure 144.45
Seventy posters were presented in three different poster sessions—the vast majority by students and postdocs.

evant to young researchers, including the organization of the workshop, recommendations for the facility, and broader topics in the HED community.

This year's workshop was the second one with a Wednesday evening "tutorial" session; the panel strongly recommends that this session continues. We propose that the topic next year covers diagnostic capabilities and techniques relevant to the OLUG community, with a series of round-table discussions led by experts. We also recommend that the workshop reinstate a career session or resources aimed at the students and postdocs, possibly including overview talks from representatives of the national labs plus a job board. The student/postdoc representative will organize these events at the 2016 workshop, in consultation with the rest of the executive committee and OLUG community.

The panel recognizes an effort by LLE to improve and modernize several aspects of the web-based resources available to users. We strongly recommend that this work continue. We also recommend that LLE implement two new capabilities. First, an ability to search upcoming proposals by keywords or configuration parameters, which would help facilitate ride-along experiments. Secondly, we recommend that there be the capability for diagnostic experts to post simple codes that would be available to the community—for example, to parse files or visualize specific types of data.

U1914JR

Figure 144.46
The posters ran the gamut from laboratory astrophysics to high-end simulations to diagnostic development. Here MIT undergrad Emily Armstrong explains the functioning of a low-energy proton spectrometer.

LLE Response: LLE recognizes the value of the student workshop and will provide a speaker for the proposed topic at the 2016 OLUG Annual Meeting. LLE also recognizes the value of improving web-based resources and will continue to improve and expand those capabilities. The LLE effort is being managed within the Omega Informatics Group (R. Kidder). The importance of the specific requests for search criteria, file uploading and parsing, and visualization is recognized; these items are currently being implemented and LLE appreciates the focused specificity of the request.

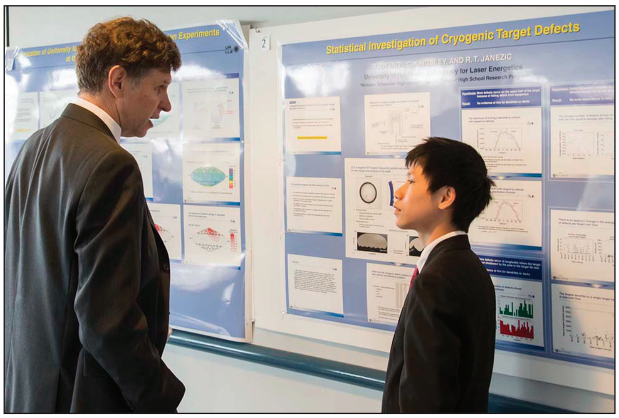

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Figure 144.47
Presentations were given by two of LLE's 2014 Summer High School Researchers.


U1917JR

Figure 144.48
Awards for outstanding posters were presented to ten students and postdocs.


U1916JR

Figure 144.49
The young-researchers panel and town meeting is one of OLUG's most important sessions.

2. Smaller-Diameter Phase Plates (400 to 500 μm) on OMEGA EP

One or more smaller phase plates are requested to be available for use on OMEGA EP. The requested phase-plate profile is eighth-order super-Gaussian with a diameter of 400 to 500 μm (95% energy content). The final spot size requested would be dependent on modeling of the final beam profile, with smaller spot sizes being preferred.

LLE Response: A phase-plate design with a 400-μm spot size was completed at the end of FY15 and a substrate was ordered. The Q2FY16 delivery is possible as of 1 October 2015. Additional substrates will be available in FY16 for DPP imprinting and these will be imprinted as funds allow. As of 1 October 2015 the funding for additional imprinting is not available.

3. Capability to Measure Low-Energy, Low-Yield Charged-Particle Spectra with High Resolution

The added capability to measure charged-particle spectra at low yield (10^5 to 10^8) and low energy (E < 5 MeV) with high resolution is requested. We propose that a ten-inch–manipulator (TIM)-based, compact charged-particle spectrometer be implemented to fulfill this role. Current charged-particle spectrometers at the Omega Laser Facility are capable of measuring high-energy charged particles for yields from ~10^6 upward, and low-energy charged particles for yields from ~10^8 upward (Table 144.X). The new detector would complement the existing charged-particle detector suite by adding a missing capability.

Table 144.X: Current charged-particle spectrometers include the wedge-range filter (WRF) spectrometer, the charged-particle spectrometer (CPS), and the magnetic recoil spectrometer (MRS) run in charged-particle mode.

Diagnostic	Particles	Energy	Yield
MRS	p, D	6 to 30 MeV	$\geq 10^7$
CPS	α, p, D, …	0.1 to 30 MeV	$\geq 10^8$
WRF	p	4 to 20 MeV	$\geq 10^6$

LLE Response: MIT has the lead on the design and construction of the low-energy, low-yield charged-particle spectrometer. The prototype design at MIT is named the "Mini Orange Spectrometer" and is expected to fulfill this request when implemented on OMEGA. LLE will support implementation and has assigned C. J. Forrest for additional LLE scientific support.

4. Improved Capability to Measure the Low-Energy Neutron Spectrum at Omega

This request is to improve the existing capability to measure low-energy neutron spectra in a DT background at Omega. These spectra are currently measured with a neutron time-of-flight (nTOF) scintillator detector on a collimated line of sight in LaCave.[1] Proper operation of this detector requires a clear line of sight in TIM-6, precluding use of TIM-6 for other diagnostics such as neutron imaging, which can also operate only in TIM-6. Requested improvements:

(a) Dedicated, reoccurring x-ray and low-ρR DT and DD neutron-producing shots to determine the response of the detector and track sensitivity changes over time.

(b) An effort to understand the impact of rescattering on a measurement: how much does, e.g., a diagnostic in TIM-4 impact the measurement at low energy in TIM-6?

(c) An effort to validate signal output versus neutron energy, in particular with regard to the simulated correction required for material in the line of sight, which varies more than 25% as a function of energy and is highly structured in the important region below E_n = 2 MeV.

(d) Optimize the capability to measure the neutron spectrum below 2 MeV. This is a very challenging measurement and requires, e.g., MCNP simulations to address where on OMEGA the background is small enough and whether or not an evacuated line of sight is needed. The choice of detector technology should also consider the capability to measure these low-statistics signals at late flight times.

(e) Implementation of a second detector on a non-TIM–based line of sight for complementary measurements, considering the information from point (4).

LLE Response: Item 4(a) has been assigned to J. P. Knauer. Item 4(b) is complete; see C. J. Forrest for results. Item 4(c) is being investigated by C. J. Forrest with SUNY Geneseo; scintillator light output versus neutron deposition is being characterized. Item 4(d) has been assigned to C. J. Forrest; the FY16 project LowEnSpec to install a vacuum tube on the TIM-6 line of sight was deferred due to available resources. Item 4(e) is underway (project 2nTOFrhoR, V. Yu. Glebov).

5. Continue to Allow Spectroscopy of High-*Z*, Open-Geometry, Plasmas

To accomplish their science, OMEGA users have a strong need to be able to continue to make spectroscopic measurements of high-*Z*, open-geometry targets. An extension to closed-geometry targets would enable novel scientific explorations. The User Group encourages the Omega Laser Facility management to advocate for these capabilities on behalf of the users.

LLE Response: LLE concurs with the OLUG finding regarding x-ray spectroscopic measurements of open-geometry targets and their extension to closed geometry. While the management supports less-restrictive guidance in this field, LLE must, of necessity, continue to abide by the classification guidelines.

6. Beam Blocks on OMEGA

This request is to increase the number of beam blocks on OMEGA. For specific experiments (with low-density foam targets, for example), a part of the laser energy could be transmitted and go to the opposite port. Beam blocks are set up on the opposite port to stop the beam light and avoid facility damages.

LLE Response: LLE has budgeted for nine additional beam blocks and will acquire them in FY16. They are expected to be available for the Q4FY16 experiment (J. Kwiatkowski).

7. Optical Diagnostic on OMEGA EP to Characterize Laser–Plasma Instabilities

Implementing optical diagnostics is requested on OMEGA EP to measure reflected- and scattered-light spectra and energy. Specifically, backscatter measurements of one or two UV beams equipped with a full-aperture backscatter station (FABS)[2] are requested to provide time-resolved spectra recorded on several streaked spectrometers covering the wavelength ranges of 353±3 nm for stimulated Brillouin scattering (SBS), ~500 to 700 nm for stimulated Raman scattering (SRS), and 234±4 nm for $3\omega/2$ emission from the two-plasmon–decay (TPD) instability. In addition, measurements of near-backscatter light outside the FABS aperture by a near-backscatter image (NBI)[3] and time-integrated scatter calorimeters (SCAL's) are also desired on OMEGA EP to obtain information on the overall laser energy coupling to targets. The setup of the optical diagnostic system can be identical or similar to those already available on OMEGA or the NIF.

LLE Response: The designs of the OMEGA and NIF backscatter stations do not readily overlay onto the OMEGA EP architecture. A project to build OMEGA EP FABS was proposed but was deferred because the estimated cost was excessively high and the engineering challenges daunting (one to two years). LLE acknowledges the importance of backscatter diagnostics and is working to identify a path for a modest-cost path to deploying time-resolved spectra of SRS and SBS. There are currently no proposed projects that are achievable within resource constraints. LLE is currently reviewing concepts that sample sub-aperture portions of the backscattered light and an alternate scheme that will not require a major engineering effort. Requirements are presently being collected and refined by the LLE Plasma and Ultrafast Physics group led by D. H. Froula.

8. Opposing Beam Configuration on OMEGA EP to Facilitate a Broad Area of HED Experiments

It is requested that one or more OMEGA EP long-pulse UV beams be brought to the opposite side of the chamber to establish the opposing-beam configuration. Currently, all four long-pulse UV beams on OMEGA EP originate from the same front side of the chamber. This fixed-UV-beam configuration limits their use and usually compromises energy coupling to the driven target because of a large incident angle to the sample. A community-wide survey has identified a strong need for the UV beam operation with the opposing-beam configuration from both internal Principal Investigators (PI's) at LLE and external PI's from national labs, academic, and private sectors. OLUG has strongly recommended its implementation since 2011.

LLE Response: This request, pending since 2011, is a straightforward, low-risk engineering project. The cost has been the major hurdle; at approximately $1.8M, it has been proposed and cut from the FY14–FY16 budgets. LLE is seeking additional funding for this project in FY17. It is recognized as a priority item for the user community.

9. Bringing TIM-15 Online for OMEGA EP

This request is to commission TIM-15 and bring it online in the OMEGA EP chamber. The setup would be similar to the existing TIM's.

LLE Response: TIM-15 is desired by LLE as well. Resource limitations restrict starting the project in FY16. It would be helpful for knowledgeable users of OMEGA EP to recommend locations for the TIM so that when funds do become available, the question of optimum location is already determined. LLE will host a web conference in Q2FY16 and present the results at OLUG 2016.

10. Rotating Frame for the X-Ray Spectrometer

A rotating frame is requested to be implemented to the existing x-ray spectrometer (XRS). With a single orientation, experiments using the XRS diagnostic are constrained in how they can be designed. Using a rotating frame, which has been implemented on many other diagnostics, will remove the diagnostic orientation constraint, making it easier to design experiments requiring spatially resolved spectra.

LLE Response: This project (LLE-SXS-RSPCA, C. Sorce) has been funded for FY16 and is being managed within the Experimental Support Group.

11. Target Preheat Capability for Materials Science Experiments

This request is to implement a system capable of preheating a portion of a target prior to firing the main laser and monitoring the preheat temperature. There are a few methods (laser heating, induction heating, resistance heating) to preheat a section of target, such as the 2- to 3-mm-diam physics package of the broadband x-ray diffraction (BBXRD) or powder x-ray diffraction image plate (PXRDIP) diagnostics. The temperature could likely be measured remotely by using a thermal imaging camera.

LLE Response: LLE is looking to develop and implement a system as a joint project with LLNL. The effort is currently being coordinated by T. C. Sangster.

12. CR39 Etching/Scanning Capability

Many experiments use a D^3He-filled capsule as the proton backlighter and CR39 detector. This very powerful diagnostic is used for many projects, and many prominent papers are written from this data (for example, Ref. 4). Many campaigns require this backlighter on OMEGA and OMEGA EP in FY15 and the following years. The CR39 processing, however, takes more than four weeks and sometimes many months. We request allocation of more resources to the LLE CR39 etch/scan laboratory to better support an increasing number of OMEGA/OMEGA EP experiments that will use CR39.

LLE Response: MIT provides strong support and coordination of the Proton Diagnostic Laboratory and the four-week cycle time for this type of data may persist through FY16 or until improved techniques are available. LLE will work to cross-train technicians to support etching and scanning; however, CR39-based diagnostics are still not fully integrated as "Facility Diagnostics." LLE does not have the resources available to independently support all user requests.

13. Gas Jet

The installation of a gas jet on OMEGA and OMEGA EP is requested to create low-density, ambient plasmas for various HED experiments. The low-density ionized plasma environment is ideal to study the plasma interactions relevant to ICF kinetics, laboratory astrophysics, and high-altitude plasma physics. The gas bags can be an option to produce such environment (e.g., the GasCoSphere-14A campaign.) However, they tend to be expensive and, more importantly, very often the membrane mass generates more mass than the required gas density, creating an undesirable condition. Gas jets are used on many other laser facilities such as Janus and Vulcan and produce important scientific results.

LLE Response: LLE implementation of gas jets is constrained by unique high-voltage equipment contained within the vacuum environment on OMEGA EP, specifically the deformable mirrors and tiled grating assemblies within the grating compressor chamber. If a user designs a system such that under fault conditions (i.e., the gas valve fails to close), the pressures does not rise above the Paschen breakdown limit, then LLE would entertain supplying the engineering effort to implement the system.

ACKNOWLEDGMENT

OLUG gratefully acknowledges the financial assistance of NNSA for travel support of students and postdocs to OLUG Workshop 2015; to the Fusion Science Center, OFES, MIT, and especially to LLE and Dr. Robert L. McCrory, Laboratory Director, for sustained support of myriad aspects of the Workshop and activities, including implementation of many of the User Findings and Recommendations. Thank you!

Submitted by R. D. Petrasso, OLUG chair.

U1912JR

Figure 144.50
Tours of the facility are a critical part of the Workshop.

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Figure 144.51
The Workshop banquet at the Meliora offered a wonderful time for socializing.