
The Second Omega Laser Facility Users Group Workshop 28 April–1 May 2010

Overview

More than 115 researchers from 44 universities and laboratories and 9 countries gathered at the Laboratory for Laser Energetics (LLE) for the second Omega Laser Facility Users Group (OLUG) Workshop (see Fig. 124.46). The purpose of the three-day workshop was to facilitate communications and exchanges among individual OMEGA users and between users and LLE; 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 and postdoctoral fellows to present their research at LLE in an interactive and informal atmosphere; and to provide feedback to LLE about ways to improve the facility and future experimental campaigns. The interactions were stimulating and lively, as can be seen in photographs shown in this document. There are 180 members in the OMEGA Users Group; their names and affiliations can be found at www.lle.rochester.edu/about/omega_laser_users_group.php.



U1092JR

Figure 124.46

More than 115 researchers from around the world and from 44 universities and laboratories participated in this year's OMEGA Laser Users Workshop. Plans for the next workshop, on 27–29 April 2011, are well underway, with significant NNSA support already allocated for student/postdoctoral travel expenses.

During the first two mornings of the workshop, 17 science and facility talks were presented. The facility talks proved especially useful for those not familiar with the art and complexities of performing experiments on OMEGA. The overview science talks, given by leading world authorities, described the breadth and excitement of high-energy-density (HED) science undertaken at the Omega Laser Facility. The next section of this document contains a summary of the presentations.

A total of 45 students and postdoctoral fellows, 37 of whom were supported by travel grants from the National Nuclear Security Administration (NNSA), attended the workshop and presented 31 of the 59 contributed poster and oral presentations. The presentations ranged from target fabrication to simulating important aspects of supernovae, all of which generated spirited discussions, probing questions, and many suggestions. In total there were 76 presentations, including both invited and contributed.

An important function of the workshop was to develop a set of recommendations and findings to help set future priorities for the Omega Laser Facility. These findings were grouped into three areas—60-beam OMEGA, OMEGA EP, and broader facility-improvement issues—and comprise a report given to the management of the Omega Facility. The report, along with management's response, can be found at the end of this document. LLE management is using these recommendations as a guide for making decisions about the Omega Laser Facility operations, priorities, and future changes.

One highlight of the workshop was a panel of students and postdoctoral fellows who discussed their experiences at the facility and their thoughts and recommendations on facility improvements. Wide-ranging and engaging discussions were sparked by this forum, which resulted in the student/postdoctoral report reproduced at the end of this document.

Another important event was a job fair designed to bring students together with potential future employers. This fair will be expanded at the next workshop.

Finally, one of the important decisions made at the workshop was to schedule the next one, which will be held at LLE on 27–29 April 2011. During their meetings, the Users Group and interested members of the HED community are formulating plans for this third workshop and reviewing progress on the **Findings and Recommendations** (p. 208) of the second workshop. In the future, a semiannual meeting will always take place at a satellite meeting during the fall American Physical Society's Division of Plasma Physics Conference.

The Presentations

A wide-ranging series of 76 talks and posters were presented over a two-day period. In the morning sessions, invited talks covered the facility and science. The invited science talks focused on several important topics, including high-energy-density plasmas, laboratory astrophysics, ignition in inertial confinement fusion (ICF), the physics of fast ignition, and future experiments on OMEGA and the NIF.

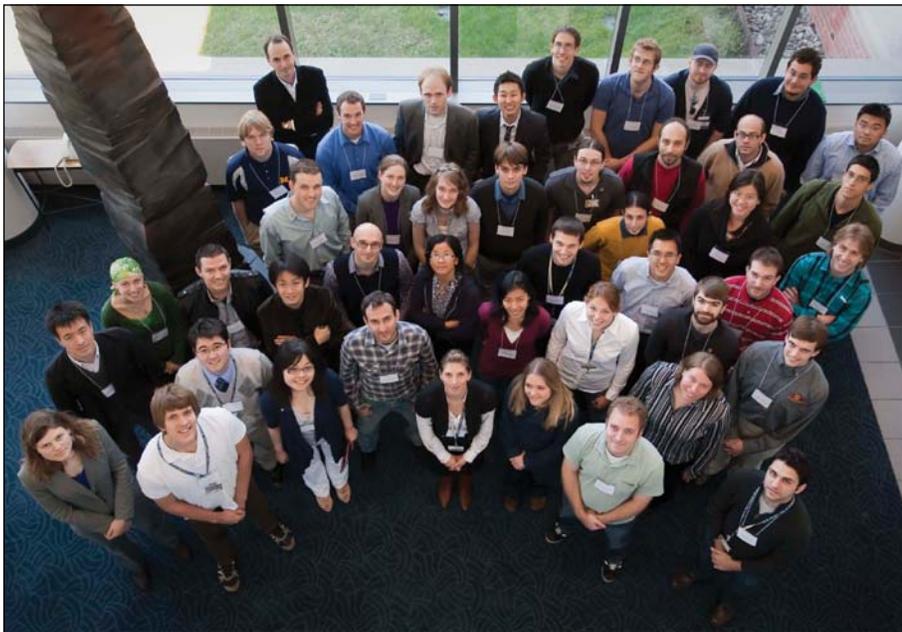


Figure 124.47
A total of 45 students and postdoctoral fellows attended and made 31 engaging presentations.

U1093JR



U1094JR

Figure 124.48

In the plenary sessions, 17 authorities spoke about the science and opportunities of high-energy-density physics and described the evolving capabilities of the Omega Laser Facility needed to reach new science frontiers.

The facility talks presented important details and developments on the status and performance of OMEGA/OMEGA EP from pulse shaping and duration to beam smoothing; the qualification process for interfacing new experiments; the present, and soon-to-be operating, set of diagnostics; and the critical role of targets, from design to procurement, full characterization, fielding, and, finally, shooting.

In addition to the 17 invited presentations, 59 contributed posters and talks covered a wide spectrum of work on OMEGA from target fabrication to fast-ignition experiments to basic and novel nuclear physics experiments. Additional presentations covered opportunities for taking physics platforms developed at OMEGA to larger (the NIF) and smaller (e.g., Jupiter, Trident, and LULI) facilities. The invited, contributed, and poster presentations formed much of the basis for wide-ranging lively discussions resulting in the **Findings and Recommendations** (p. 208) for the Omega Facilities and future capabilities, found at the end of this document.

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



U1095JR

Figure 124.49

Professor Robert Rosner of the University of Chicago kicked off the workshop with an astrophysicist's perspective on high-energy-density physics.

Findings and Recommendations of the Executive Committee

Executive Committee:

Richard Petrasso, Committee Chair,
Massachusetts Institute of Technology
Hector Baldis, University of California–Davis
James Cobble, Los Alamos National Laboratory
Paul Drake, University of Michigan
James Knauer, LLE, University of Rochester (designated)
Roberto Mancini, University of Nevada–Reno
Peter Norreys, Rutherford Appleton Laboratory

1. Introduction

The OMEGA Laser Users Group warmly thanks LLE’s management for taking actions on the recommendations from our last report and for expeditiously addressing the issues identified therein. It is a strong testament to the professionalism of the facility staff that the tasks were executed with good speed and due diligence. The activities undertaken are a great credit to the Laboratory and to the University of Rochester. They are certainly highly appreciated by the academic and research user community.



Figure 124.50
The challenges and science of fast ignition were the focus of Professor Peter Norreys of Rutherford Appleton Laboratory (RAL). Professor Norreys is a member of the Users Executive Committee.



Figure 124.51
Dr. Guy Dimonte of Los Alamos National Laboratory (LANL) discussed the role of particle interactions in the equilibration of high-energy-density plasmas.

The OMEGA and OMEGA EP lasers are world-class facilities that provide academic access to cutting-edge energies and intensities on target. As with any high-performance device, however, critical enhancements are needed to continue to see progress in forefront science. This document describes the academic and research user community’s observations, distilled from its April 2010 workshop, of those elements and components that can maintain LLE’s leading position at the forefront of high-energy-density physics (HEDP). The OLUG looks forward to hearing progress on these recommendations at the semiannual satellite meeting in November (at the APS Conference) and at its next annual workshop (27–29 April 2011).



Figure 124.52
Dr. Brent Blue from General Atomics discussed the science and technology of developing and fielding complex targets for OMEGA experiments.

2. OMEGA (60 beams)

a. Three independent legs will add substantial improvement and flexibility to future experiments. Greatly expanded experimental design options would develop if it were possible to use all three of the existing drivers, with each driving one of the OMEGA legs. Ideally, each driver would be able to drive any leg to accommodate the constraints imposed by diagnostic configurations. Improved experiments and new classes of experiments would then become possible. The OLUG considers this a high priority.

Request: Present a plan to the Executive Committee on the implementation of three independent legs. In addition, include this and additional options for discussion at next year's workshop.

LLE Response: Preliminary concepts for this project have been developed and will be advanced further in FY11. Pending the availability of LLE resources, the implementation will commence in FY11. At a minimum, LLE will complete a plan for the implementation.

b. Request: Compile a list of qualified diagnostics that can be fielded for joint operations.



U1100JR

Figure 124.54

(a) Professor Roberto Mancini from the University of Nevada and (b) Dr. Carolyn Kuranz from the University of Michigan posed questions in a plenary session. Prof. Mancini is a member of the Users Executive Committee.

LLE Response: The requested information will be made more readily accessible, and the OLUG Executive Committee will be notified as soon as the data are published on the Website.

c. It is common to drive experiments with ten OMEGA beams and very common to conduct two separate experiments in one day. The workhorse distributed phase plates (DPP's) are the SG8's. Many users have found that the limited number of these specific DPP's has compromised the quality or productivity of their experiments, especially when they had shots on the second half-day of a shared day. In the area of chamber optics, OLUG would prioritize this item second behind the provision of four 750- μm phase plates for OMEGA EP.

Request: Acquire enough SG8's to make 20 available to the user community (if this will not jeopardize the higher-priority 750- μm phase plate purchase needed for OMEGA EP).

LLE Response: The acquisition of additional SG8 DPP's is included in LLE's FY11 budget. The implementation date is contingent on vendor availability. There are currently 12 SG8



U1099JR

Figure 124.53

Moving physics platforms and experiments from OMEGA to the NIF was the focus of remarks by General Atomics' Joe Kilkenny. Dr. Kilkenny gave many concrete examples of this migration including x-ray, neutron, and charged-particle diagnostics.

DPP's available, and these can continue to be shifted to accommodate campaign transitions as required in the interim period.

d. Request: Acquire a high-resolution neutron spectrometer to measure neutrons with energies in the 2- to 3-MeV range.

LLE Response: LLE is working with users to develop the requirements for this diagnostic and will then determine if it is feasible. If so, LLE will initiate a project to implement it.

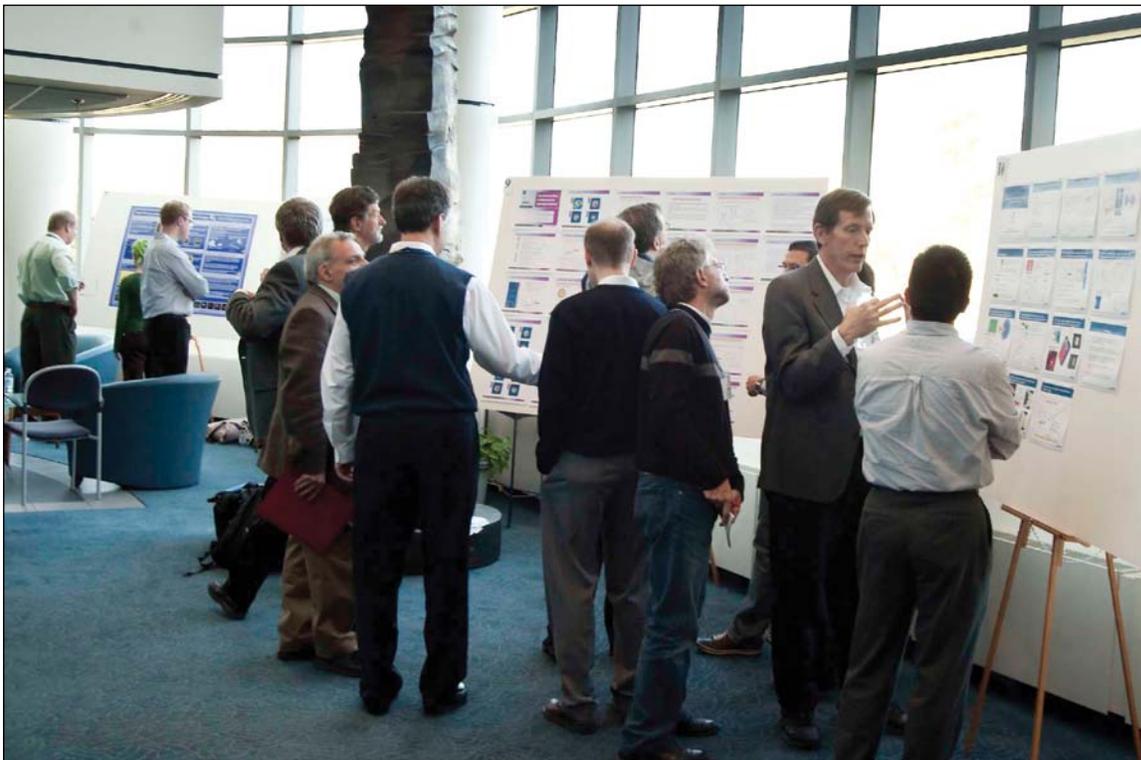
e. Upgrade the backlighter driver to operate at the nominal specified performance. The existing backlighter driver is unable to support the full energy that OMEGA's 60 beams are capable of producing. Because most backlighting and x-ray-probing experiments are photon limited, this is a significant shortfall for some experiments.

Recommendation: Improve the backlighter driver in order to support full-energy operation of the beams that it drives.

LLE Response: The backlighter source will be reworked in FY11 to increase the available operating envelope to match the other laser drivers.

f. OMEGA EP petawatt (PW) beam delivering two foci onto target. There is a need for simultaneous pump/probe experiments on OMEGA using the OMEGA EP PW beam. The availability of this feature would greatly increase the capability of the facility and would lead to the undertaking of many new experiments. Examples include hard x-ray radiography of integrated fast-ignition experiments. The OLUG recognizes, however, that space limitations impose a restriction on the provision of a single off-axis focusing parabolic mirror. The OLUG considered the possibility of splitting the PW beam into two beamlets at the final turning mirror to generate two focal spots.

Request: The OLUG requests that LLE investigate the possibility of splitting the petawatt beam and report back to the Executive Committee.



U1101JR

Figure 124.55

Two poster sessions, during which 43 posters were presented, offered ample opportunities for informal discussion about OMEGA experiments and their connections to important work at other HED facilities.

LLE Response: In FY11 the beam-combiner optic in the grating compressor chamber will be reinstalled. With this optic, the two short-pulse beams can be independently directed to two foci with a small separation. This capability will be developed and demonstrated on the OMEGA EP target chamber initially in FY11 and may be available on OMEGA in late FY11. The requirements for focal-spot separation, quality, and timing need to be refined to determine if this flexibility will meet user requirements. LLE will provide status updates on this effort to the OLUG Executive Committee. Should a “split mirror” be required, the design, fabrication, and integration effort will likely take of the order of 18 to 24 months. LLE recommends that users who need this feature refine their requirements so that this assessment can be made as soon as practical.

g. Integrated experiments require smaller focal spots for the petawatt beam. This is the same problem as Issue (g) (p. 216) in the section devoted to **OMEGA EP**.

Endorsement: OLUG strongly endorses the development and implementation of the new phase-front corrector as a matter of high priority.

LLE Response: The FY11 phase-front-correction effort will initially concentrate on a proof-of-principle experiment. If this demonstration is successful, a second-generation device will be fabricated at large aperture to refine the technique. Concurrent with this work is LLE’s effort to operate the existing adaptive-optic, closed-loop system as close as practical to shot



U1102JR

Figure 124.56
University of Michigan student Elisio Gamboa discussed his work on x-ray Thomson-scattering imaging with National Nuclear Security Agency’s (NNSA) Allan Hauer. Dr. Hauer presented a talk on the importance to NNSA of high-energy-density laboratory physics.



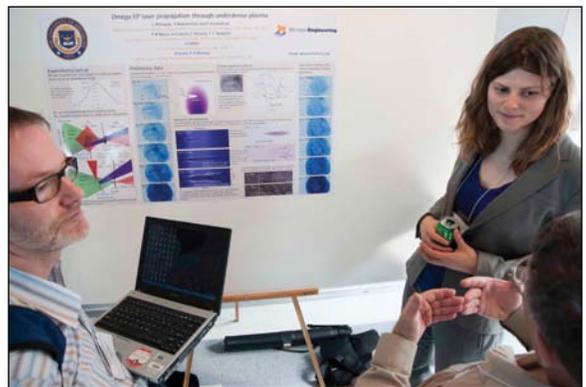
U1104JR

Figure 124.58
Frank Phillipe (left), from France (Commissariat à l’énergie atomique), chatted with Chikang Li of MIT. Drs. Phillipe and Li recently collaborated on OMEGA experiments involving rugby-shaped hohlraums.



U1103JR

Figure 124.57
Dr. Tony Caillaud, from France (Commissariat à l’énergie atomique), showed Professor Linn Van Woerkom (Ohio State University) neutron images of OMEGA DD and DT implosions.



U1105JR

Figure 124.59
Postdoctoral fellow Louise Willingale, from Prof. Karl Krushelnick’s group at the University of Michigan, and Peter Norreys of RAL listen to comments about her OMEGA EP research on proton backlighting of laser channeling.

time to improve repeatability. Finally, high-spatial-resolution phase-front control will be investigated using the active device presented to the OLUG community on 29 April 2010. Note that the implementation of dynamic control may not be complete until FY12.

h. OMEGA 60-beam timing measurement accuracy. At present, for delays or advances (offsets) of beams beyond about 10 ns from time zero, the accuracy with which one knows the beam timing drops to ± 0.5 ns. This often becomes the largest uncertainty in experiments with offsets in the 10-ns to 30-ns range.



U1106JR

Figure 124.60
Dr. Kazuo Tanaka (Osaka University) and Dr. Wolf Seka (LLE) conversed during the poster session. Dr. Tanaka presented work on the self-focusing of relativistic electrons.



U1107JR

Figure 124.61
Dr. Jim Cobble (left, from LANL), a Users Executive Committee member, spoke with Professor David Meyerhofer (LLE) about the Recommendation and Findings report for the LLE management. This report is used to help prioritize LLE facility upgrades and directions.

Request: Develop the means to determine the beam’s temporal offsets actually achieved on each shot, with an accuracy on the order of ± 0.1 ns. Such a capability would significantly improve the quality of experimental results from certain experiments.

LLE Response: The P510 streak camera system has an option currently available for a 40-ns sweep speed that is calibrated to give timing to < 0.1 ns over the requested 10- to 30-ns window. LLE recommends consulting with the Laser Facility Manager during the proposal phase (~2 months prior to shot day) to optimize configuration of the laser streak system to yield satisfactory pulse-shape measurement and precision timing simultaneously.

i. Photographic documentation of some diagnostic and related systems. To understand complex mechanical systems, it is often helpful to have photographic (and/or CAD) images to complement sets of mechanical drawings. This is definitely true of the ten-inch manipulators (TIM’s). We suggest that such images be made available online for the TIM’s. Users and the facility should both consider whether there are other systems that would also merit photographic and/or CAD documentation.

LLE Response: LLE concurs with the request to make a photograph-enhanced diagnostic glossary and will develop a standardized “cut sheet” for each diagnostic. The OLUG Executive Committee will be notified as soon as the data are published on the Website.



U1108JR

Figure 124.62
Dr. Frederick Séguin (MIT) gave a contributed talk about observations of the electromagnetic fields associated with coronal filamentation in direct-drive ICF implosions.

3. OMEGA EP

a. Bring OMEGA EP performance up to its full specification. We fully appreciate that the OMEGA EP IR and UV beam energy must be limited to ensure minimum damage to expensive and difficult-to-obtain optical components during operations with the existing gratings and UV optics. On the other hand, it is OLUG's duty to note that the user community needs access to the full performance of the laser facility to ultimately allow one to explore the exciting new regimes in high-energy-density physics. The constraints, while essential, limit the experiments that have been conducted as well as the results that have been obtained so far. Although it should be pointed out that outstanding results have been obtained with the present operating parameters of OMEGA EP, it is still the desire of the user community to have the facility operating at its specified performance at the earliest practical opportunity.

Endorsement: OLUG endorses LLE's plan to develop and acquire high-laser-damage-threshold IR and UV optics that

will make it possible for OMEGA EP to routinely operate at its design performance. OLUG requests that facility management keep the OLUG Executive Committee apprised of the research and development plans that will make it possible for OMEGA EP to reach design performance.

LLE Response: LLE is aggressively working to expand the operational envelope limits of OMEGA EP. The IR and UV energies on target are currently limited by laser-induced damage. The constraints are due to the laser-damage-threshold limits of gratings (short-pulse IR) and transmission optics (long-pulse UV). LLE will continue to share progress and plans on this item with the OLUG Executive Committee.

b. Bring design options forward to next OLUG workshop for 2 ω and 3 ω conversion of the PW beam. There are some preliminary and tentative indications, from experiments performed in France, that the fast electron energy transfer and heating of background plasma is enhanced with frequency-converted



U1109JR

Figure 124.63
Productive discussions among researchers from around the world occurred in several informal settings.



U1110JR

Figure 124.64
Benchmarks for achieving ignition were the subject of Professor Riccardo Betti's presentation.

light. This past summer at the TITAN facility, more evidence was gathered that added to the knowledge base. Certainly, much greater control over the energy content of the amplified spontaneous emission pedestal associated with petawatt laser pulses is ensured with conversion to 2ω and 3ω . This has been established as an important factor in cone-guided experiments. It is prudent to have available engineering plans for frequency conversion of the PW beam if required for future experiments by the user community.

Recommendation: The OLUG requests that facility management provide options for discussion at the next OLUG Workshop for frequency conversion of the PW beam.

LLE Response: LLE will commence a scope study to identify viable concepts for implementation of short-pulse frequency conversion. There is a high likelihood that conversion crystals, mounts, diagnostics, beam transport, and focusing systems will constitute a significant investment of LLE resources and require an NNSA-approved construction project. A case study representing the need for this item would be beneficial in garnering NNSA support for a capital project.

c. Two Cu K_{α} imaging crystal spectrometers are needed for both OMEGA 60 and OMEGA EP. Understanding the physics of fast electron energy transport from petawatt-power laser-plasma interactions with solid targets requires the deployment of sophisticated x-ray diagnostics. Cu K_{α} imaging spectrom-

eters have been developed in the United States over the past decade and have proven to be powerful tools in diagnosing the heating of dense matter using intense laser pulses. These instruments are required on both chambers so that independent experiments can be carried out simultaneously. In each target chamber, they need to be deployed in orthogonal directions so that spatial nonuniformities can be identified and characterized.

Recommendation: The OLUG requests that LLE management validate and deploy these imaging spectrometers as a matter of high priority in the coming year. The OLUG recognizes that the deployment of orthogonal instruments may pose difficulties, but the requirement for these instruments for each chamber is vital to the user program. We request that OMEGA provide a deployment plan to the Executive Committee for their consideration and report to the workshop next year on arising issues.

LLE Response: A prototype crystal imager is being developed for the Multi-Terawatt laser with plans to install a complete system on OMEGA EP in FY11. In the interim a “fast-track” crystal imager was installed on OMEGA EP in FY10. In FY11, LLE will initiate projects to add a second crystal imager on OMEGA EP and two on OMEGA. Depending on resources available and other priorities, these projects may be carried out in FY11.

d. Two electron spectrometers are needed for both target chambers. Electron spectrometers are important tools for char-



U1111JR

Figure 124.65
Dr. Al Trivelpiece (left) and Jim Decker brought some unique experience and valuable insights to the workshop.

acterizing the behavior of intense laser–plasma interactions. They have applications in many areas, including wakefield acceleration, betatron x-ray source characterization, channel formation, and positron generation, among many others. The development of a university-based program requires the deployment of spectrometers with electromagnets that provide a wide window up to GeV of particle energies. OLUG understands that Lawrence Livermore National Laboratory (LLNL) colleagues have validated and deployed low-energy electron spectrometers in their experiments; these instruments should be made available to the wider community.

Recommendation: The OLUG requests that LLE management initiate a design and validation program for an electromagnet-based electron spectrometer for wakefield acceleration studies up to GeV particle energies. They request that electron spectrometers based on the LLNL design be made available to the wider academic community.

LLE Response: In FY11, LLE will initiate projects to ensure that there are two electron spectrometers on OMEGA EP and two on OMEGA. Depending on resources available and other priorities, these projects may be carried out in FY11.

e. LLE’s contrast-ratio improvement program. The OLUG was impressed with the presentation of Christophe Dorrer relating to the intensity contrast issues of the petawatt beam. The audience appreciated the identification of all the different components in the laser chain that contribute to the pedestal over its full range—some nanoseconds ahead of the pulse, some on its leading edge. The enhancement program was warmly received by the audience.

Endorsement: The OLUG strongly endorses LLE’s contrast-ratio improvement program. They fully endorse the time frame outlined and want to be updated on progress at the next OLUG Workshop.



U1112JR

Figure 124.66

Professor Paul Drake (University of Michigan), a Users Executive Committee member, presented a talk about the opportunities for doing laboratory astrophysics on OMEGA and OMEGA EP.

LLE Response: The OLUG Executive Committee will be kept abreast of all developments in the short-pulse laser's contrast enhancement.

f. Status of the 4 ω probe. The OLUG was impressed with the presentation of Wolfgang Theobald on the fourth-harmonic probe status. The probe commissioning is proceeding with good speed and the audience was delighted with progress so far. Nevertheless, concern was raised that the seeds are not from the same source and much closer attention to minimizing and measuring timing jitter is needed. In addition, the pulse energy is marginal and needs to be increased by an order of magnitude.

Recommendation: The OLUG requests that the timing-jitter issue be addressed and an additional amplifier stage be added so that the probe energy can be increased when required. These changes should be reported to the Executive Committee.

LLE Response: The concerns of the OLUG have been communicated to the development team and will be closely monitored through the initial implementation of the 4 ω probe

laser at its baseline performance level. Any requirements analysis for specific experiments that users can provide to the team would be helpful in motivating changes to the baseline requirements for this system. LLE will work to include design features for operation of the probe with maximum precision timing and as much energy as practical.

g. OMEGA EP focal-spot size of the PW beam. The community welcomed Brian Kruschwitz's characterization of the OMEGA EP focal-spot quality. They were satisfied that the encircled energy measurements he reported were consistent with other plasma diagnostics. Concern was raised, however, that the focus of the OMEGA EP was insufficient for many future experiments and that effort is needed to reduce the 80% encircled energy radius by a least a factor of 2 (from 40 μm to 20 μm). They were delighted to hear about the new phase-front-corrector technology that will make this development possible.

Endorsement: OLUG strongly endorses the development and implementation of the new phase-front corrector as a matter of high priority.



U1113JR

Figure 124.67
From far left, Alberto Marochinno (University of Rome), Tazio Levato (INFN Frascati), Patrizio Antici (INFN Frascati), Rich Petrasso (MIT), Riccardo Betti (LLE), Lois Buitano (NNSA), Orlando Ciricosta (University of Pisa), and Angelo Schiavi (University of Rome) are captured together during the poster session.

LLE Response: See response to **OMEGA** Item (g) (p. 211).

h. Polarization smoothing on all four UV beams. The community was very impressed by the quality of the presentation from Samuel Morse. They received with great pleasure the news of the concerted effort to address issues raised at the last workshop. They were particularly struck by the quality of his argument that the polarization-smoothing technology had reached sufficient maturity to implement on OMEGA EP and that the advantages over smoothing by spectral dispersion were apparent.

Endorsement: OLUG unanimously accepted LLE's recommendation for polarization smoothing on all beams. They look forward to rapid implementation of the proposal and to receiving an updated progress report at next year's meeting.

LLE Response: User need for this feature remains unclear. If there is any specific analysis of an experiment that would benefit from this capability, please communicate to LLE since it will aid in justification of the cost. LLE is pursuing this item with no guarantee that the acquisition will be selected for funding in FY11. The time frame for implementation of polarization smoothing is 18 to 24 months after optics are ordered. Every effort will be made to expedite this acquisition as well as the

mounts that will support the optics, once the funding commitment is secured.

i. The planar cryogenic target handler should be implemented on OMEGA EP for users. A number of academics in the community raised the issue of fielding planar cryogenic-deuterium targets for the OMEGA EP chamber. They expressed concern that this technology was not available for cutting-edge transport and hydrodynamic experiments.

Recommendation: OLUG strongly endorsed the implementation of planar cryogenic target-handling technology as a high priority. The community wants to see this target-handling technology made available at the earliest opportunity.

LLE Response: LLE will consider the OLUG endorsement of this project in prioritizing laboratory resources in FY11. It is likely to take 12 to 18 months from project inception to initial capability deployment. LLE will keep the OLUG Executive Committee informed of the project status.

j. A full set (4) of 750- μ m phase plates is needed. The community expressed great pleasure that a number of phase plates had been acquired in response to their requests at last year's workshop. After considerable debate over different phase-plate



U1114JR

Figure 124.68

The student/postdoctoral panel presented important insights from young researchers working at the Omega Facility. Left to right: Dr. Maria Barrios (University of Rochester, LLE), Dr. Tammy Ma (University of California, San Diego), Dr. Hiroshi Sawada (University of California, San Diego), Dr. Ryan Rygg (LLNL), Dan Casey (MIT), Dr. Andrea Kritcher (LLNL), and Dr. Louise Willingale (University of Michigan).

sizes, it was felt that a full set (4) of 750- μm phase plates is needed. These would be useful in the context of the long-duration hydrodynamics and laboratory astrophysics experiments that OMEGA EP uniquely makes possible by stacking beams in time. By running the specified maximum of 6 kJ in a 10-ns pulse, a 750- μm phase plate produces an average intensity of $1.4 \times 10^{14} \text{ W/cm}^2$. Using an 1100- μm phase plate reduces the intensity to below $7 \times 10^{13} \text{ W/cm}^2$. This is an important difference. One definitely wants to be above 10^{14} W/cm^2 for most experiments. In solid plastics, shocks will be driven not much more than 1 mm in 40 ns; therefore, 2-D expansion is a smaller concern than having adequate intensity.

Endorsement: A full set (4) of 750- μm phase plates should be purchased and made available to the community.

LLE Response: LLE appreciates the aggregation of OLUG requirements and distillation to a well-defined recommendation. The acquisition of additional 750- μm distributed phase plates to obtain a full set of four operational optics is in the FY11 acquisition plan.

k. Requirement for a limited-reservoir gas-jet target. Some academics expressed the view that gas-jet targets should be implemented on OMEGA EP. They accepted the facility

management’s argument that an unlimited reservoir gas line might put the OMEGA EP compressor grating actuators at risk. They recognized, however, that many experiments would benefit from a gas-jet arrangement. It was felt that the burden of commissioning this technology should not fall on a single institution but should be shared as a common resource. They agreed that a limited reservoir would add capability to a wide range of experiments.

Recommendation: The facility should design, validate, and implement a limited-reservoir gas-jet target and make it available to the user community.

LLE Response: Development of equipment to provide a gas jet in the Omega Facility will require significant resources. Users interested in this capability should contact John Soures, who will facilitate formation of a subcommittee to investigate the development of this capability. LLE resource allocation to this project is subject to balancing laboratory priorities. Project selection depends on developing a set of requirements that can be met within the system’s safety constraints.

l. Requirement for added flexibility for long-pulse operation. The community was delighted by the performance of the long-pulse beams in their current configuration. The arrangement



U1115JR

Figure 124.69
A “town hall” meeting on the importance and role of high-energy-density physics, from the DOE perspective, was led by Mark Koepke (left; Office of Fusion Energy Science), Kim Budil (Office of the Under Secretary for Science), and Lois Buitano (National Nuclear Security Agency).



U1116JR

Figure 124.70
Kim Budil (Office of the Under Secretary for Science) discussed her office’s perspective on high-energy-density physics.



U1117JR

Figure 124.71

Facility presentations, like this one by Samuel Morse (LLE), related new and ongoing developments on OMEGA and briefed younger researchers on the effective use of the facility. Mr. Morse's extensive knowledge of the facility is invaluable to those planning OMEGA experiments.

had produced some outstanding results that were received by the audience with acclaim. After much debate, the community felt that if different ports, originally earmarked for long-pulse operation, were made available, it would add substantial flexibility to experiment design and effectiveness. They endorsed the option of irradiation from opposite sides as one example.

Recommendation: The OLUG recommends that all ports originally earmarked for long-pulse operation be brought into facility capability. The OLUG welcomes a report at next year's meeting on progress with options.

LLE Response: The 48°-cone-angle ports were proposed as an option in the OMEGA EP project, but it was not supported by the users or NNSA at that time. It would be very expensive to fit out with UV-beam-transport paths, which would take significant facility time and would require capital project support from NNSA. A potential smaller-scale, higher-payoff alternative, suggested at the OLUG meeting in April 2010, was to bring one or more beams to the back side of the target chamber. A feasibility study will be conducted to assess potential UV-beam routing to the opposite side of the target chamber from the existing 23° UV-beam ports.

m. Equivalent-plane monitors for all UV beams. The community felt that while the focal-spot monitor was adequate for

some experiments, all experiments were complicated by a lack of knowledge of the quality of all beams away from their foci.

Recommendation: Equivalent-plane monitors should be implemented for all beams. The OLUG welcomes a report on this issue at next year's meeting and trusts that this can be implemented with little disruption to operations.

LLE Response: The request for UV far-field measurements on all beams will be carefully considered. It would be helpful if the experimentalists requesting this feature would provide a range of spot sizes of interest for measurement. The UV diagnostic package has provision for locating a far-field monitor, and the LLE plan is to implement a phase-plate holder in the diagnostic path for at least one beam. LLE will keep OLUG apprised of the progress in meeting this recommendation.

n. A new gamma-ray spectrometer diagnostic is required. The community felt that a new gamma-ray spectrometer needs to be designed, validated, and commissioned for the facility. Users requested that the spectrometer have a spectral range up to 20 MeV.

Recommendation: The OLUG requests that management consult the Executive Committee on the design, validation, and implementation of this new instrument for the community.



U1118JR

Figure 124.72

Brian Kruschwitz (LLE) discussed the latest techniques for characterizing the OMEGA EP laser's focal spot. Such information is essential for planning experiments.

LLE Response: OLUG scientists interested in this spectrometer should contact John Soures, who will facilitate formation of a subcommittee on high-energy photon spectroscopy. Once a consensus of requirements for sensitivity, spectral range, resolution, and other features is generated, the subcommittee and OLUG Executive Committee can provide LLE with more definition of what is desired. LLE resource allocation to this project is subject to balancing laboratory priorities.

o. See also Items (f) and (g) (pp. 210,211) of OMEGA (60 beams).

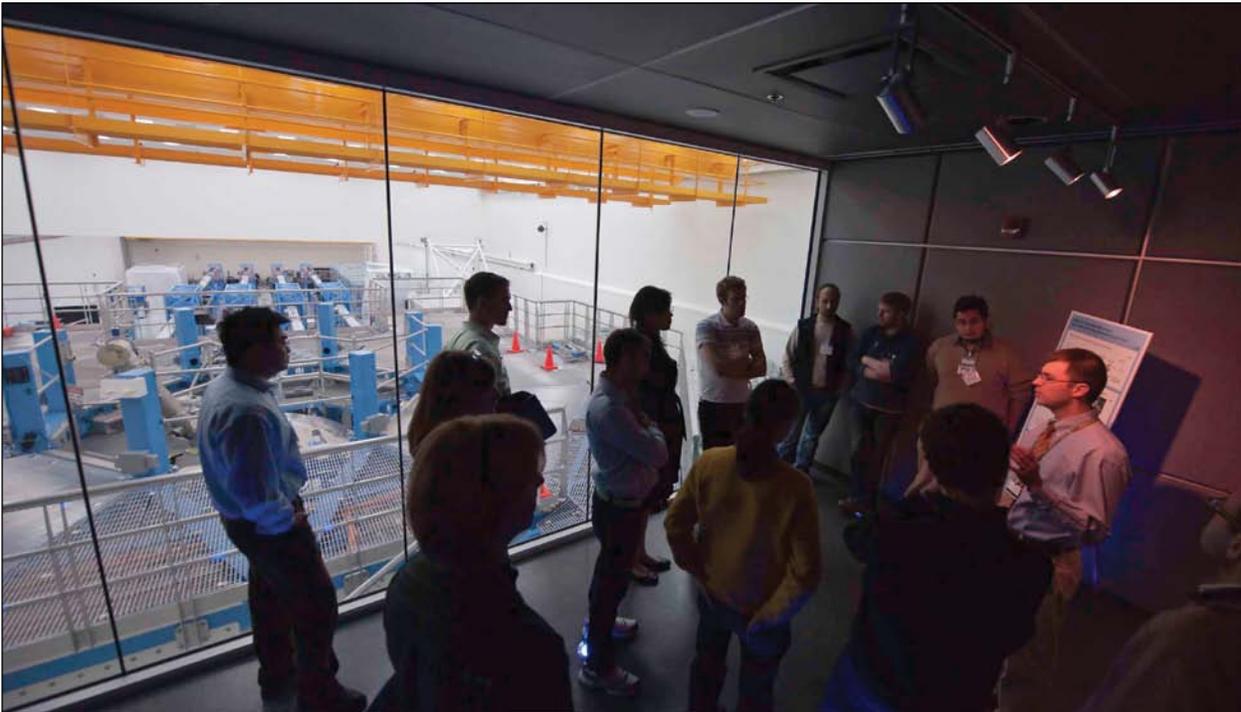
4. Other Facility Improvements

a. Dedicated user support for experiment design and theoretical modeling. To maximize the productivity of both OMEGA (60 beams) and OMEGA EP, it is important to have access to theoretical and computational support for both experiment design and data interpretation for university-based academics. Individual academics, who are motivated by curiosity-driven research in high-energy-density science, often find that they do not have access to the necessary sophisticated computational models at all stages in the training cycle. The

very nature of university life, where there is a high turnover of doctoral and postdoctoral research fellows, means that modeling skills nurtured by the teams and applied to specific problems can suddenly evaporate, leaving them without vital tools at critical stages in the research effort.

Ideally, the theoretical support team must be located within the larger-scale facilities. It must be of critical size to provide the facility users with a wide range of modeling capability (e.g., one- and two-dimensional magnetohydrodynamic simulations, implicit and explicit particle-in-cell and hybrid models for high-intensity laser-matter interactions, quantum molecular dynamics for warm dense matter studies, etc.) and have dedicated access to large-scale, high-performance computing resources. Here are some desirable characteristics of the support team:

- Team members should be involved at all stages in the experiment cycle, obviously requiring a collaborative approach by all parties.
- The team must be university focused and highly responsive to user demands. The team should assist with interpretation



U1119JR

Figure 124.73

David Canning (LLE) led a tour of the OMEGA EP laser and discussed its capabilities. For many new researchers, this was an ideal opportunity to learn about the facility.

of smaller-scale experiments undertaken on university-scale facilities. This is particularly important to the reduction in cost and size of intense laser systems and the proliferation within academic institutions.

- The team must be of sufficient size so that members have enough time to develop their own research interests, in addition to their support duties. This should allow team members time to devote to the development of new codes, algorithms, and possibly visualization routines.
- The team must be involved in training students and post-doctoral fellows in high-energy-density science, e.g., by co-supervision of Ph.D. students, etc.

Clearly, a balance must be struck between supporting experiments themselves and maintaining a critical size in the modeling support team.

Recommendation: The OLUG requests that LLE management establish a university-focused support team, ideally comprising four staff members, with academics from other programs at LLE and/or other institutions. The team will make a huge difference in the quality and depth of publications arising from the facility.

LLE Response: After the 2010 OLUG report is completed, LLE will request additional funding from NNSA and the Office

of Science to support this request. LLE may request a letter from the Executive Committee endorsing this request.

b. Increased support from DOE to the National Laser Users' Facility (NLUF) Program. The OLUG recognizes and applauds the increased funding to the NLUF Program in FY11/12 from the DOE (\$1.3M to \$1.6M). This has allowed facility management to increase access under the NLUF Program for the university community. The OLUG is also highly appreciative of the efforts of DOE officials to achieve this increase. The OLUG firmly believes that the establishment of new academic positions for young researchers in high-energy-density physics, working in partnership with the established academics and consortia (e.g., the Fusion Science Center), is a high priority for the growth of the field.

Recommendation: The OLUG strongly urges DOE to maintain the percentage increase in funding to the NLUF.

Recommendation: The OLUG urges DOE to develop and fund a program to accelerate the career progression for the brightest young dynamic researchers working in experimental high-energy-density physics by sharing the cost of their appointment with universities while they are at the assistant-professor level.

LLE Response: LLE recognizes the value of these requests, but clearly it is an issue for OLUG to communicate directly with DOE.



U1120JR

Figure 124.74

Members of the OMEGA Users Executive Committee. Back row (left to right): Paul Drake (University of Michigan), Jim Knauer (LLE), Jim Cobble (LANL), and Peter Norreys (RAL). Front row (left to right): Ryan Rygg (LLNL), Rich Petrasso (MIT), Roberto Mancini (University of Nevada).

Findings and Recommendations of the Student/Postdoctoral Panel

Student/Postdoctoral Panel

Ryan Rygg (LLNL), Chair

Maria Barrios (LLE)

Dan Casey (MIT)

Andrea Kritcher (LLNL)

Tammy Ma (University of San Diego)

Hiroshi Sawada (University of San Diego)

Louise Willingale (University of Michigan)

1. Interest continued in having extensive diagnostic information available online, such as reference papers and sample/calibration data linked from the Shot Request Form. The OMEGA staff has created a diagnostics forum, with threads for individual diagnostics. It is up to the users, however, to take the discussion there and populate it with useful information, such as optimal setup or analysis techniques.

2. Published papers typically include descriptions of the basic experimental setup, results, and conclusions, but rarely include the full nitty-gritty details necessary to run experiments at OMEGA, or to analyze the raw data produced. Completed theses of prior students were identified as often including many of the useful details left out of published articles. University of Rochester theses containing work done at the Omega Facility are available on the LLE Website. It would be useful if theses from other institutions performed using OMEGA diagnostics were also collected and made available. It was also pointed out that the LLE Review has many articles that include such useful details not contained in published articles. Although back issues of the LLE Review are available on the LLE Website, the content is not easily searchable.

3. Since HEDP is still a growing field, most academic institutions do not have enough interested students to hold dedicated classes on topics relevant to HEDP. It was suggested



U1121JR

Figure 124.75

The OMEGA Users banquet offered another opportunity for attendees to interact informally, reinforce old friendships, and create new working relationships.

that experts in the field may be able to offer lecture series or entire courses online. Roberto Mancini's recent spectroscopy class was held up as an excellent example, and additional topics would also be of interest. The MIT open courseware site was recommended as a model to enable instructors and students to share lecture notes and assignments.

4. The forum concluded with a discussion of the availability and acquisition of jobs in the field, including those in academia, government laboratories, publishing, and government administration.

Conclusions and Future Workshops

This OLUG workshop, with over 115 attendees, was part of a process that will keep members of the inertial confinement fusion and high-energy-density physics communities involved in conversations and collaborations with each other and with the Omega Facility. In addition, OLUG Executive Committee members and the LLE management have been meeting on a bi-monthly basis to assess progress, compatibility with facility resources, and impact toward the implementation of the Findings and Recommendations. Progress will be presented at a

satellite meeting at the Chicago APS Meeting (9 November 2010) and in depth at the next Users Workshop.

The next OMEGA Laser Users Workshop will be held at LLE on 27–29 April 2011; plans for it are already well underway. To this end, significant financial support from NNSA has already been procured to help defray the cost of student and postdoctoral travel. We anticipate that this next workshop will be as exciting and memorable as the first two. Come join us!

ACKNOWLEDGMENT

For capturing the ambience and spirit of the workshop through his camera lens, we thank Eugene Kowaluk. To NNSA, we gratefully acknowledge the financial assistance for student/postdoctoral travel expenses. We thank the University of Rochester Fusion Science Center, and the Office of Fusion Energy Science, for co-sponsoring the OMEGA Users Group Workshops. We thank LLE for supporting this workshop in numerous ways and for their responsiveness in addressing the Findings and Recommendations of the Users.

This synopsis was compiled and edited by R. D. Petrasso (petrasso@psfc.mit.edu) of the MIT Plasma Science and Fusion Center, with critical input and contributions from workshop attendees, the Executive and Student/Postdoctoral Workshop Committees, and the LLE management. Please send corrections to R. Petrasso. The final synopsis will be posted at www.lle.rochester.edu/about/omega_laser_users_group.php.