High-School Projects at the Laboratory for Laser Energetics (2023)

Mark Atalla (McQuaid) used Raman microscopy to characterize particles that were found inside the OMEGA EP Grating Compressor Chamber with the goal to reveal the source of such contamination. His efforts led to the identification of a few organic species, thus highlighting the usefulness of this method for addressing a critical issue in current and future generation laser systems.

Maxwell Braithwaite (Webster Thomas) built an optical system to characterize targets and coils held by the Magneto Inertial Fusion Electrical Discharge System (MIFEDS), used to create magnetic fields on both OMEGA and OMEGA EP. He used NX CAD software to design parts printed by a FormLabs 3D printer. His system has already been used on OMEGA EP.

Logan Canfield (McQuaid) employed a p-spline analysis technique to extract a model-independent energy spectrum from neutron time-of-flight signals generated in fusion experiments. He used this technique to effectively obtain the DT and DD energy spectra essential to infer experimental metrics including the nuclear yield and thermal temperature of the fusing plasma.

Gregory Demos (Pittsford Mendon) explored gallium-alloy-based liquid-metal mirror designs as an innovative approach for the development of the final optic in future inertial fusion energy systems. His results demonstrated the validity of this approach, exhibiting a fivefold improvement in the laser damage threshold compared with conventional metal mirrors.

Shuwen Ding (Pittsford Sutherland) investigated 1-MHz acoustic (megasonic) cleaning as a method to remove contaminants from optical surfaces. She prepared samples with various particles, and quantified the megasonic cleaning efficiency using fluorescence microscopy. She found that particles of diameter ≥ 1 µm could be removed from diffraction gratings without causing damage.

Maya Gopakumar (Pittsford Mendon) used a computer-controlled microscope and translation stage to metrologize pinhole aperture arrays used for imaging inertial confinement fusion (ICF) implosions on OMEGA. She quantified previously unknown deviations in the apertures from their nominal specifications. Her work will be used in experiments using the apertures.

Marianna Hodgins (Palmyra-Macedon) measured the mode field diameter of single-mode fiber by aligning an optical setup that images the fiber tip and writing software to analyze the images. This method has the advantage of allowing asymmetries in specialty fibers such as polarization-maintaining or polarizing fibers to be identified.

Sophie Khan (Pittsford Mendon) used real-time, time-dependent density functional theory to model the change in the electron-density distribution in liquid crystal molecules when exposed to femtosecond-scale laser pulses. She examined three molecules with widely varying degrees of electron delocalization. Her work will aid the development of improved liquid crystal optics for OMEGA.

Cammarata Mazzacane (Pittsford Mendon) investigated how large language models, a form of generative artificial intelligence (AI) that has knowledge of English language semantics, may be employed to access information in LLE databases such as equipment documentation and experimental procedures. He studied the use of these models in building AI applications.

Aariv Mody (Pittsford Sutherland) analyzed historical data from the operation of LLE's Isotope Separation System to see if the tritium extraction efficiency depends on the total amount of gas in the system, the tritium fraction of the gas, or the number of system cycles. He found that none of these parameters significantly affect the separation efficiency.

Shawn Nordstrom (Hilton) used the one-dimensional hydrodynamics code *LILAC* to optimize the design of direct-drive solid sphere experiments being performed at the National Ignition Facility (NIF). He identified laser pulse shapes that produce clearly distinguishable multiple shocks needed to study the coupling of laser energy into the targets.

Andrew Pitolaj (Gananda) carried out hundreds of simulations using the two-dimensional hydrodynamics code *SAGE* to optimize laser-beam pointings for proposed experiments at the NIF using targets with foam layers containing liquid deuterium and tritium. He found excellent uniformity for three target designs, demonstrating the feasibility of the concept.

Alexander Song (Victor) studied the impact of fluid properties and dip coating parameters on the morphology of polymer films deposited onto textured optics with thick and thin portions, proposed to improve the uniformity of ICF lasers such as OMEGA. He discovered several key conditions that dictate whether the deposited films will conform to or deviate from the surface topography.

Edward Wu (Pittsford Sutherland) adapted an indirect-drive uniformity code written by a former student in the program to investigate a proposal to use 48 of the 60 OMEGA beams to implode fusion targets using indirect drive with cubic symmetry. He demonstrated that the proposal is feasible, promises excellent uniformity, and could be used on a future 60-beam laser system.

Lina Yang (Pittsford Sutherland) measured palladium hydride isotherms between -30°C and -115°C using hydrogen and deuterium. Her measurements improved upon previously reported values and extended the dataset to include isotherms at intermediate temperatures. Her work has applications to hydrogen isotope separation techniques and novel means of pressurizing ICF targets.

Michael Yu (Pittsford Mendon) developed a machine-learning model to predict the laser pulse shape and energy of the OMEGA EP laser system. The model employs a convolutional neural-network architecture to achieve good agreement with a physics-based model using only 1% of the processing time.