High-School Projects at the Laboratory for Laser Energetics (2025)

Mathew Atalla (McQuaid) developed software for processing microscope images collected at different objective heights, intended to extract information about the 3-D structures in and underneath optical surfaces. He used Matlab to implement edge detection algorithms and Laplacian filters, and used their output along with input from the user to generate 3-D plots of microscopic surfaces.

Rebecca Camilleri (Fairport) measured bulk etch velocities of the particle recording medium CR-39, a detector used on charged particle experiments on OMEGA. She identified the role of process variables such as the initial detector temperature and the use of a stirrer in the etching bath. The new understanding can be used to provide more consistent and uniform processing.

Leixi Chen (Pittsford Mendon) used analytical modeling and Monte Carlo simulations to investigate the feasibility of measuring the neutron-neutron scattering length with ultra-intense laser-driven high-density neutron beams. She identified optimal experimental parameters for neutron-neutron elastic collisions. The proposed experiments probe charge symmetry breaking in nuclear physics.

Sean Della-Torre (McQuaid Jesuit) evaluated adhesive formulations proposed to bond KDP substrates to a base substrate prior to milling to ~150 µm thick for second harmonic generation in the proposed NSF-*OPAL* laser system. He developed a technique using a motorized blade coating machine to deposit uniform, defect-free thin adhesive films onto test substrates of various sizes.

Elias Gray (Brighton) developed a Python script to optimize laser pulse shapes for inertial fusion energy target designs. In these designs, a sequence of short laser pulses (“pickets”) launches shock waves whose timing must be carefully controlled. Elias’s program determines the timing, positions, and energies of the pickets to achieve this optimization.

Karthik Jaligama (Pittsford Mendon) developed a framework for the *RIGEL* simulation database to train a convolution neural network model for 3D reconstructions of the hot spot in fusion implosions. He integrated additional neutronic data into the model to improve its physics constraints. He also encoded 3D data to reduce the high demand of memory for training the model on 3D data.

Caleb Krenzer (Churchville-Chili) conducted experimental tests using the Magneto-Inertial Fusion Electrical Discharge System (MIFEDS) to determine characteristics of debris generation and mitigation when using MIFEDS. He found two distinct types of debris, with different impacts on optics, and identified a wire type that could be used to mitigate much of the debris for future coils.

Malena Leastman (Churchville-Chili) measured the efficiency of a palladium catalyst for separating hydrogen isotopes. She performed initial measurements on a new system, testing a commercially available catalyst at various gas flow rates and catalyst temperatures. Her work highlighting several important parameters will greatly enhance the ability to test future palladium catalysts.

John Luger (Brighton) used computational chemistry modeling to predict the frequency-dependent change in sign of the dielectric anisotropy in liquid crystal (LC) materials for fast switching LC electro-optical devices. His modeling predicted the dielectric anisotropy crossover frequency in several model systems from the literature to within 6% of experimentally determined values.

Emmanuel Nyibule (Rush Henrietta) characterized sub-micron features on polystyrene targets used in DT fusion experiments utilizing a cryogenic microscope and Matlab analysis software developed in-house. He first improved the analysis code and then calculated a full set of feature statistics needed to improve simulation models of hydrodynamic instability in target implosions.

Ella Rogala (Mercy) modeled a proposed “zooming” experiment at the National Ignition Facility using the two-dimensional hydrodynamics code SAGE. She optimized the laser-beam pointings for the first half of the beams, focused on the initial target surface, and for the second half, which follow with a tighter focus for higher intensity. Both designs give excellent uniformity.

Michael Shi (Pittsford Sutherland) developed analysis tools to use Cherenkov neutron detectors to measure the temperature of the fusing ions in OMEGA target implosions. He found that these detectors can, in principle, provide a more precise measure of the plasma temperature, supporting their use as the next-generation neutron detectors for high-performance cryogenic experiments.

Manveer Singh (Webster) performed classical molecular dynamics simulations of the liquid-to-solid phase transition in a Coulomb one component plasma, which approximates the material at the core of a white dwarf star. He wrote python scripts to analyze the simulations and extract the rate of crystal growth as a function of temperature.

Stefanos Tedla (Eastridge) developed numerical methods for calculating the optical and radiation transport properties of materials over large ranges of photon energies. He implemented his methods in a MATLAB code that processes fundamental atomic cross-section data into tables of refractive index, opacity, and emissivity needed for computer simulations of laser fusion experiments.

Hailey Wardell (Mercy) used atomic force microscopy, data analysis with Python, and scanning electron microscopy to optimize a hard-bake process used in the manufacturing of diffraction gratings. The process is required to produce smooth photoresist side walls without compromising the wall dimensions. Hailey found that the hard baking should ideally be done at ~148°C for 60 s.

Caleb Youngblut (Honeoye Falls) investigated 1-MHz acoustic (megasonic) cleaning for removal of particles ≥ 0.5 µm from flat optical surfaces. He quantified cleaning efficiency using optical microscopy and image analysis software, measured before and after executing different cleaning procedures, and found that >99% efficiency could be obtained for copper and silica particles.