General Atomics/DIII-D
SULI Participation Highlights
Summer 2016

Microwave Testing a Brewster Angle Diamond Waveguide Window

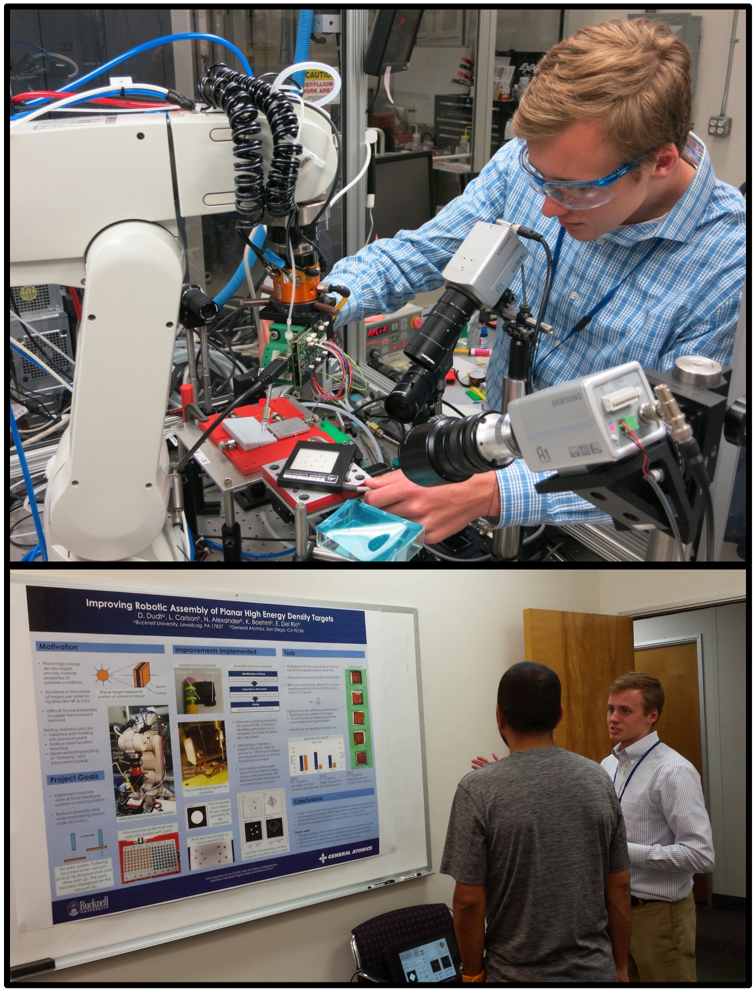
SULI participant from General Atomics

Top: Alexandra LeViness taking transmission data on the diamond Brewster angle window at microwave power levels of 500 kW. Bottom left: LeViness entering the DIII-D vacuum vessel to check on the ECH launcher port. Bottom right: Controlling the gyrotron operation and developing a database for analysis

- An artificially grown diamond vacuum window can pass very high power microwaves with low loss but can normally only be used at one frequency, while if the microwaves are appropriately polarized and the window is mounted at the Brewster angle, the window can be used at any frequency
- Diamond windows cost more than $50K, so using one at the Brewster angle can yield considerable cost savings and increased flexibility
- Alexandra LeViness, a rising senior at the University of Alabama, tested the performance of a Brewster angle diamond window at the DIII-D National Fusion Facility for transmission loss and preservation of beam quality at high power levels
- At low power levels, she checked the polarization performance and sensitivity of the transmission to the angle the rf beam made with the window
- LeViness successfully showed that the innovative window worked as designed at both low and high power levels, and will be presenting her work in the fall at the APS-DPP meeting in San Jose

Robotic Assembly of Planar Targets for High Energy Density Studies

SULI participant from General Atomics

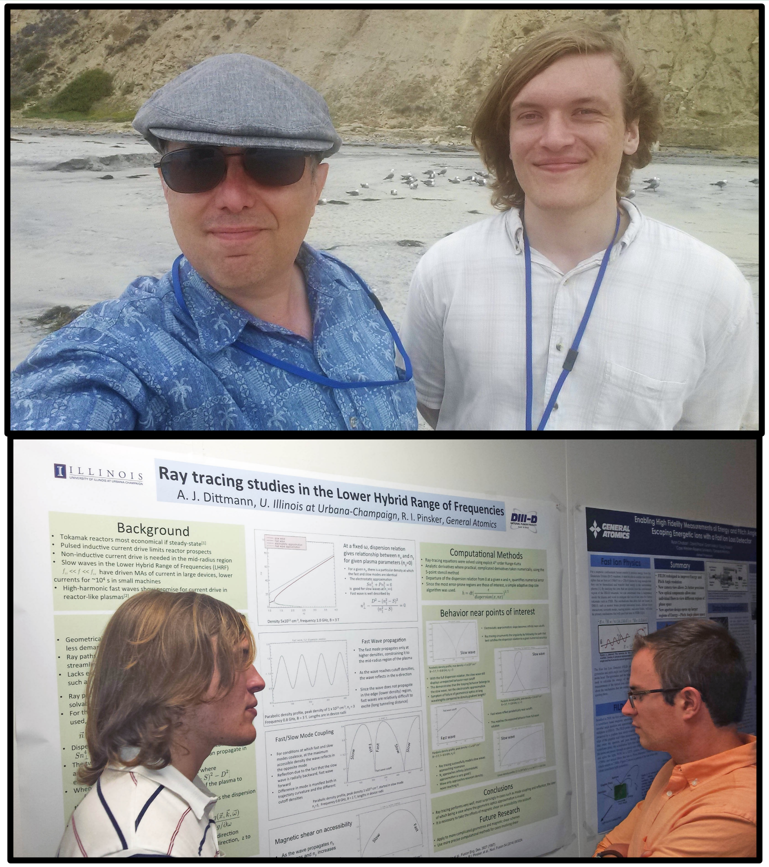


Top: Daniel Dudt loads the robotic planar assembly station with foil components.
Bottom: Dudt presents his poster describing his work at General Atomics.

- Rising senior Daniel Dudt, studying mechanical engineering at Bucknell University, spent nine weeks at General Atomics adding advanced capability to the Inertial Fusion Technology's (IFT) planar assembly robot. Daniel worked to implement micro-cameras and machine-vision algorithms for recognizing, picking and placing planar target components (e.g. 3x3 mm foils, 100 microns thick). Additionally, Daniel programmed and implemented a force-feedback system to enable the robot to gently pick and place the components with a light, non-marring touch. The robot can now pick the parts from a randomly-scattered array and stack them on each other, whereas before the parts had to be inserted into special fixtures and the pickup/placement locations were locked into place by dead-reckoning.
- Daniel's work is directly relevant to current planar target assemblies and the IFT team plans to utilize the advanced features during the next target assembly builds.

Following the Trajectories of Wave Energy in Plasmas

SULI participant from General Atomics



Top: Alex Dittmann (right) and his research advisor Dr. Robert Pinsker observe a hydraulic analog to wave propagation in a plasma during lunch hour in San Diego (at the beach!)
Bottom: Dittmann discusses his poster describing his work at General Atomics with GA staff member Tyler Abrams, who coincidentally had worked with Dr. Pinsker in the summer of 2008 on an undergraduate project of his own.

- Alex Dittmann (U. Illinois Urbana-Champaign) has a wide range of interests, both within physics and astronomy and in other fields of study. He spent the summer between his sophomore and junior years learning about plasma physics and techniques of numerical analysis at General Atomics in San Diego. This provided Alex with an opportunity to learn about plasma physics, which is not a field of study that is available to undergraduates at most universities.

- Dittmann's project was a theoretical study of the propagation of plasma waves in magnetized plasmas using a technique called 'ray tracing' or 'geometrical optics'. Alex and his research advisor, Dr. Robert Pinsker, used ray tracing to study how the waves excited by antennas at the edge of a plasma propagate and carry their energy across the magnetic field, ultimately to transfer their energy into the plasma particles well away from the edge.

Building a Real Time Controller for Laser Beam Positioning

SULI participant from General Atomics

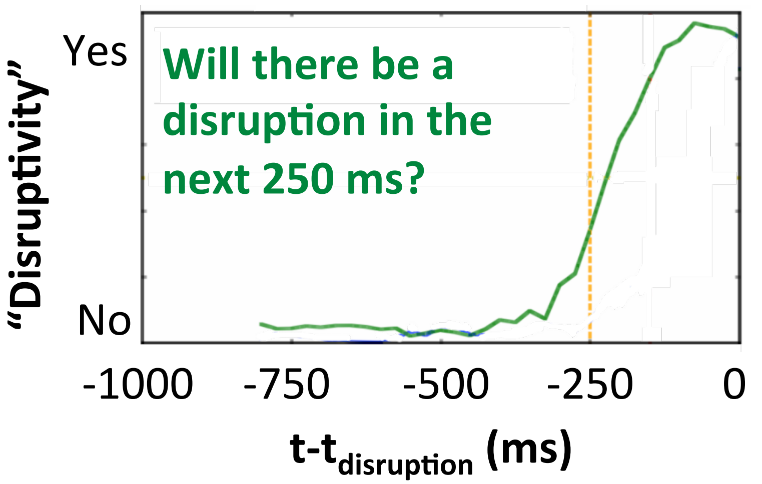
Mickie Hirata explains to a GA staff scientist technical issues encountered while developing the hardware solution for the microcontroller, and how she solved them.

Says Hirata, "What I appreciated the most, besides the specific skills that I learned, was the experience of working independently while still having support from a team and the exposure to experimental physics research."

- Mickie Hirata, a rising junior studying engineering physics at the University of Redlands, initiated the design and construction of a real-time digital controller for beam positioning of the Phase Contrast Imaging system, a density fluctuation diagnostic at the DIII-D National Fusion Facility
- At DIII-D, Hirata worked with MIT research scientists Alessandro Marinoni and Chris Rost, and graduate student Evan Davis
- This hands-on experience required Hirata to understand the functioning of an open-source microcontroller, detect issues related to the hardware and its integrated development environment, and ensure that the controller can meet its physics objectives
- Hirata successfully demonstrated the feasibility of such a system, which is planned to become operational on DIII-D during the next experimental campaign. Mickie will be presenting her work in the autumn at the APS-DPP meeting in San Jose

Collaborating to Teach Computers to Predict Disruptions at DIII-D

SULI participant from General Atomics



Top: Leonard Lupin-Jimenez presenting the results of his disruption detection research to DIII-D scientists. Bottom: Output from Leonard's machine learning algorithm, showing predicted likelihood of disruption as function of time from actual disruption in training set.

- Rising senior physics student Leonard Lupin-Jimenez (Stanford University) developed a machine learning algorithm for predicting disruptions at the DIII-D National Fusion Facility. A disruption is when a large instability causes the plasma to release its stored energy to the surrounding vessel rapidly, with potentially damaging consequences.

- Lupin's work was a true collaboration, requiring remote participation with his primary supervisor Prof. Egemen Kolemen at PPPL, while working onsite at DIII-D with Dr. David Eldon (Princeton University postdoc) and Dr. Nicholas Eidietis (GA scientist).

- This research lays the groundwork for real-time prediction of impending disruptions in the DIII-D control system. When this is implemented, the control system would then be able to take action to avoid the disruption or at least reduce its severity.

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Real-time Diagnosis of a Plasma Coating Process

SULI participant from General Atomics

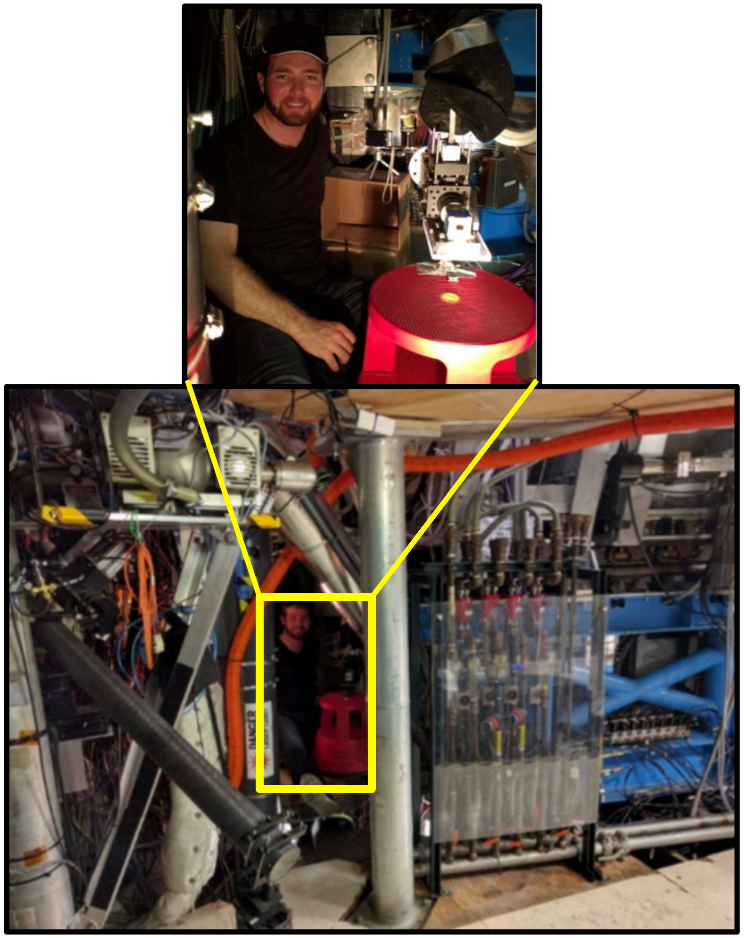
Top: Evan Ostrowski monitors process variables of a glow discharge polymer (GDP) coater inside a clean room at General Atomics. Bottom: Ostrowski presents his findings at the end of the project.

- Evan Ostrowski, a rising senior studying chemical engineering at Case Western Reserve University, Cleveland, Ohio, spent nine weeks in San Diego increasing process knowledge and understanding of glow discharge polymer (GDP) coatings for General Atomics' Inertial Fusion Technologies. These coatings are used as the primary ablator in laser inertial confinement fusion experiments at the National Ignition Facility and at the OMEGA laser facility.

- At General Atomics, Evan qualified a Quartz Crystal Microbalance inside the GDP coater to make in-situ measurements of the effect of process parameters on the coating rate and other properties of the resulting coating. These measurements provide time-resolved feedback that was not previously available. From his experiments, Evan was able to demonstrate increased process control and provide key insights on process variability. His results will have direct impact on increasing the quality and repeatability of GDP coatings used in targets in high energy density laser experiments.

Building a Probe to Catch Particles at DIII-D

SULI participant from General Atomics



Top: Ryan Chaban testing the alignment of his new optical components using a fiber optic bundle installed in the DIII-D machine hall. Bottom: A wide view of the 'comfortable' quarters for Chaban's probe installation.

- Undergraduate physics student Ryan Chaban (Case Western Reserve Univ.) contributed to the design and construction probe that measures particle losses at the DIII-D National Fusion Facility. At DIII-D, Chaban worked with research scientist David Pace (General Atomics) to optimize the probe shape for the 1 – 2 Tesla range of magnetic fields encountered at DIII-D.

- This hands-on experience required Chaban to collaborate with other scientists and engineers to ensure that the probe will be capable of meeting its physics objectives (i.e., capture the expected particle fluxes) while surviving the harsh environment of the DIII-D plasmas that reach temperatures over 150 million degrees.

- *Says Chaban, "I've learned more in seven weeks in this internship than I have in a whole semester of school. And I love school, so I don't say this lightly."*