# 2015 SULI participant Brandon Lee develops research skills while investigating fast ion transport in fusion reactors

Brandon Lee reconnects a camera transmitter in order to send signals from the reactor to the control room.

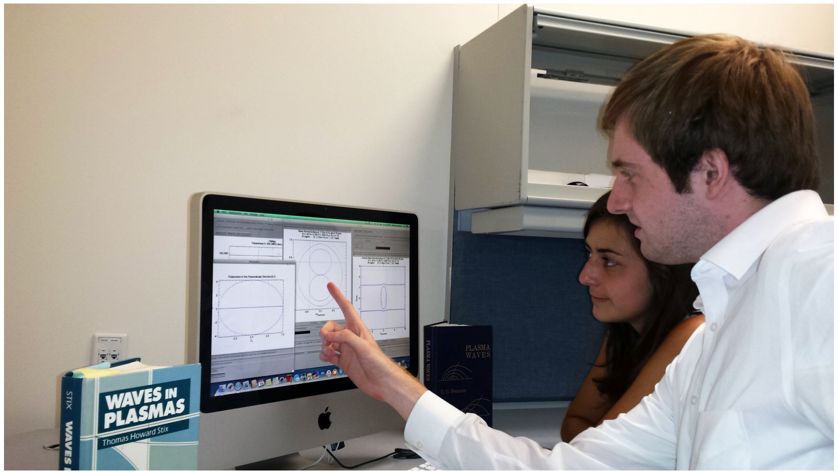
Brandon Lee adjusts the positions of fiber optic cables as part of the alignment procedure for the Fast Ion Loss Detector diagnostic.

- Undergraduate Brandon Lee (U. Illinois, Urbana-Champaign) participated in a ten week SULI program to gain experience in both theoretical and experimental plasma physics and fusion. Following a one week lecture series at the Princeton Plasma Physics Laboratory, Lee spent nine weeks working with research scientist David Pace (General Atomics) studying the ways in which highly energetic ions ("fast ions") are ejected from the reactor during large amplitude edge perturbations.

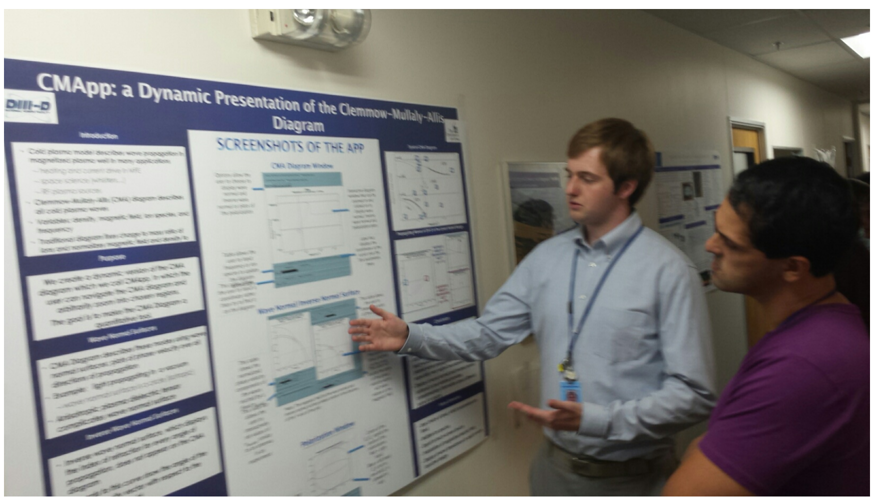
- As a double major in Physics and Nuclear Engineering, Lee sought to further develop his data analysis skills before deciding on a particular graduate study path. In addition to participating in new experiments and collecting unique measurements, he also worked with a large set of previously obtained measurement data of energetic ion losses in DIII-D. The computer programming methods necessary to process this data set will continue to be valuable in his future path.

- Lee will also present a poster of his results during the APS-DPP in November, and this will provide an opportunity to enhance his ability to communicate results, which is an important skill in any career.

# Patrick Adrian (U. Iowa) brings the “CMA diagram” to life as “CMApp” during his summer 2015 SULI appointment at General Atomics




Patrick Adrian demonstrates the CMApp to fellow SULI participant Hannah Hoffmann, and points out some of the properties of the plasma waves described therein.



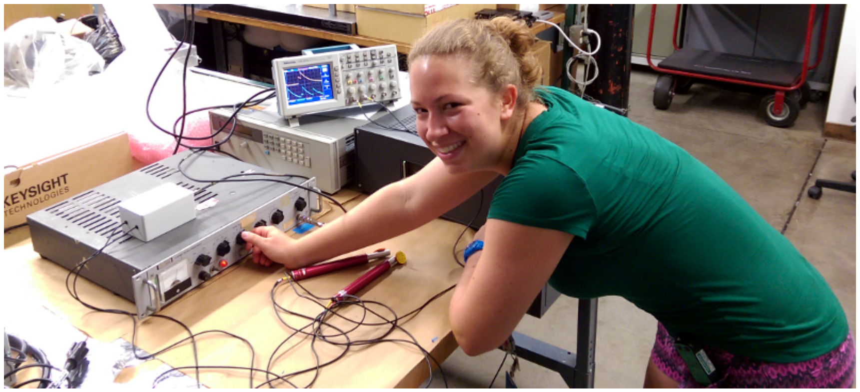

Patrick Adrian explains his final poster presentation to PPPL scientist Wayne Solomon. Adrian’s presentation was awarded the First Prize after the poster session at General Atomics.

- Patrick Adrian, of the University of Iowa, developed a dynamic version of the traditional “CMA diagram” as part of his ten-week SULI appointment at General Atomics in San Diego in the summer of 2015. The computer program, or ‘app’, was dubbed “CMApp”. Adrian worked with General Atomics research scientist Bob Pinsker on this project in the area of the theory of waves in a magnetized plasma.

- Although Adrian has completed only the first two years of his university program, he has already been working in the field of plasma physics for a year. Back at Iowa, he has worked on analysis of data from a probe orbiting Mars to tease out information on the nature of the Martian ionosphere. In performance of his work, Patrick became intrigued by the plasma wave physics that provides the foundation of these measurements, and so was uniquely well-matched to study of the ‘cold-plasma wave model’ described by the CMA diagram. Furthermore, Adrian’s coursework in computer science provided an excellent base from which to work in the creation of a dynamic graphical user interface for the CMApp.

- Patrick’s final poster presentation was awarded the First Prize in the poster session at the end of the 2015 SULI term at General Atomics, and he hopes to present the work at the American Physical Society Division of Plasma Physics meeting this November.

# 2015 SULI participant Victoria Riso characterizes gamma radiation at DIII-D National Fusion Facility en route to career as nuclear engineer



Victoria Riso calibrates the energy sensitivity of gamma ray scintillators using a well understood cobalt-60 source.

Victoria Riso worked with postdoctoral scholar Christopher Cooper to commission the new Gamma Ray Imager diagnostic at DIII-D.

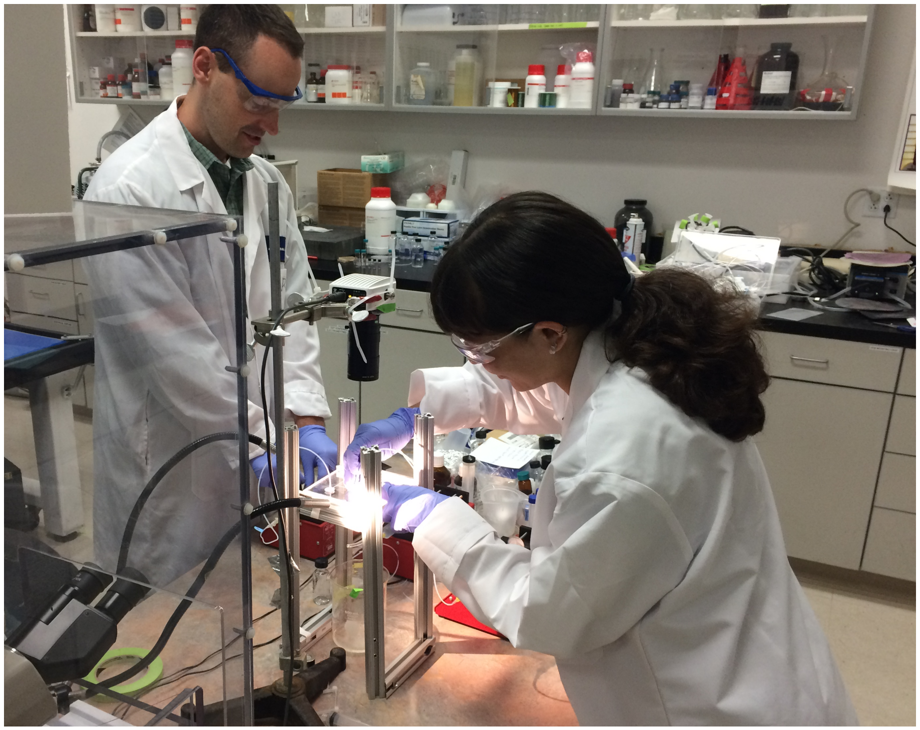
- Undergraduate nuclear engineering student Victoria Riso (SUNY-Buffalo) spent ten weeks gaining hands-on experience with plasma physics and magnetic confinement fusion through one week of lectures at the Princeton Plasma Physics Laboratory and nine weeks of experimental work at the DIII-D National Fusion Facility. At DIII-D, she worked with research scientist David Pace (General Atomics) and postdoctoral researcher Christopher Cooper (Oak Ridge Associated Universities) to measure the gamma radiation spectrum of the reactor hall.

- Riso, who intends to pursue a Master's degree in nuclear engineering next Fall, made full use of her SULI opportunity to learn about magnetic fusion facilities and their possible role as a future energy source.

- Riso's thorough measurements provide a gamma ray energy spectrum of relevance to the background level encountered by the new Gamma Ray Imager diagnostic at DIII-D.

- By presenting these results at the APS-DPP meeting in November, Riso will gain valuable experience in communicating her work to other professional scientists and engineers.

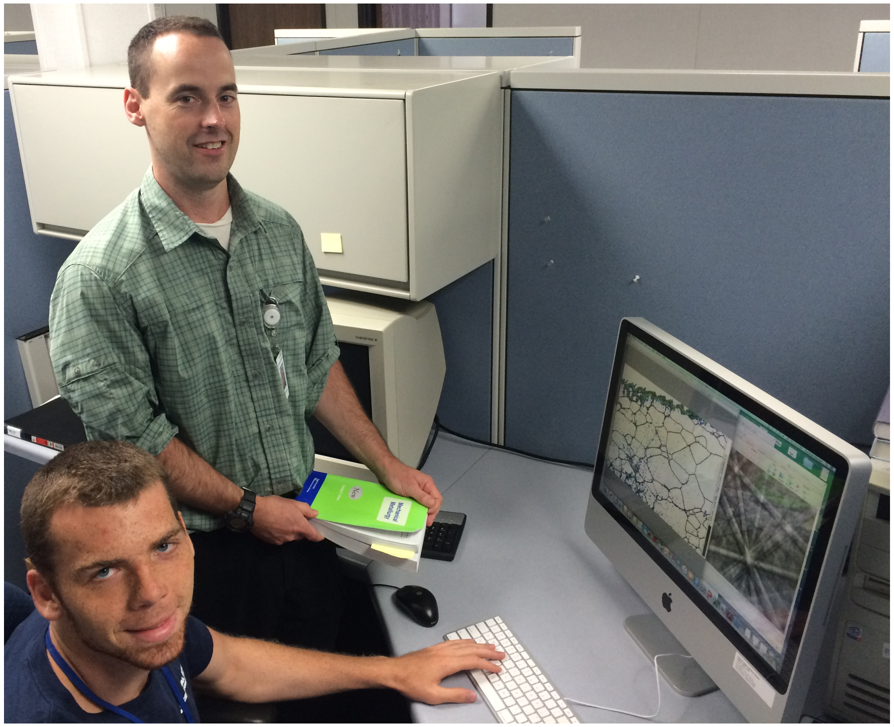
# 2015 SULI student Emma Willard using fluids to help engineer inertial confinement fusion shells at General Atomics



Intern Emma Willard helped troubleshoot a new process to create inertial confinement fusion shells while working with mentor Greg Randall. Here she is connecting tubing to a hand-sized fluidic chip designed to cut fluid streams into droplets-within-droplets.

- Undergraduate Emma Willard (University of California Davis) worked with General Atomics scientist Greg Randall to adapt a microfluidic droplet generation method to a process designed to make polymeric inertial confinement fusion shells. The process is designed to produce custom shells where every one is spherical with a uniform wall thickness.
- Willard helped troubleshoot processing problems using COMSOL Multiphysics to model forces on the droplets, pendant drop interfacial characterization, and microfluidic experiments.
- The focus on polymers, interfacial physics, and microfluidics applies directly to her Chemical Engineering major. She was able to encapsulate an interesting multi-core droplet using knowledge of interfacial properties and the effect of sharp corners on fluid-fluid interfaces.

# 2015 SULI student intern Kameron Hansen helps with the complexities of metal characterization



Kameron Hansen (front) and Greg Randall analyzing electron backscatter data at a General Atomics workstation. Coincidently, Kameron shares a name with one of the methods. He constructed “KAM maps” (Kernel Average Misorientation) to show regions of high dislocation density.

- Kameron Hansen, a physics major at Brigham Young University, worked with General Atomics scientist Greg Randall to apply electron backscatter diffraction (EBSD) to characterize line defects known as “dislocations” in metal.
- Recent simulations and experiments from Lawrence Livermore National Laboratory point to dislocation density as a very important parameter in predicting a metal’s strength at extremely high pressure and strain-rate.
- This work relies on careful computer-based analysis of experimental EBSD scans conducted on different metal samples on an electron microscope. Kameron was able to research the method in literature, determine the system resolution, and set up the framework for low-and high-resolution EBSD characterization

# 2015 SULI student Evan Peters characterizes the in/out asymmetry in the ELM heat flux energy deposition at DIII-D

Evan Peters explains his findings regarding the in/out asymmetry in the ELM heat flux deposition to DIII-D scientists John Lohr and Adam McLean.

- Oregon State University physics student Evan Peters worked with Lawrence Livermore scientist Mike Makowski on analysis of a database on Edge Localized Modes (ELMs) as part of an effort to quantify the 'in/out asymmetry' in the ELM energy deposition.
- Evan used the SQL query computer language to interrogate several databases to study the asymmetry under a wide variety of plasma conditions. He also used the PYTHON scripting language to graphically display the results for the complex data sets
- This work has important implications for the next step fusion device, ITER. Working on such topical research provided a great incentive for Evan to continue his pursuits in the area of plasma physics.

# 2015 SULI student Hannah Hoffmann finds project at DIII-D helps bring a fusion research future into focus

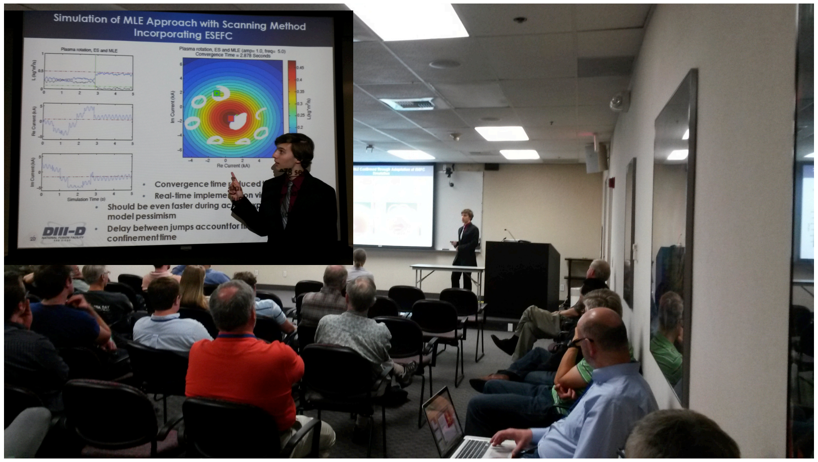
MIT undergraduate Hannah Hoffmann at General Atomics in the summer of 2015

- Before applying to the SULI program, MIT undergraduate Hannah Hoffmann had developed a keen interest and deep curiosity about diagnostic instrumentation, from medical to astrophysical applications, and the way advanced technology aids in the visualization of complex scientific problems. But she wasn't sure if fusion was the right field for her.

- During her SULI assignment at General Atomics' DIII-D facility, she found herself immersed in the scientific process, overcoming technical challenges and generating new solutions for visualizing and understanding highly nonlinear instabilities using microwave imaging diagnostics. Hannah quickly came to appreciate both the challenges and rewards of fusion energy research.

- After enjoying a stimulating scientific environment and the collaborative atmosphere at General Atomics, Hannah is set on pursuing a higher degree in a fusion-relevant field. She has already been accepted to a Master's program at MIT in the Nuclear Science department, and "can't wait to make further contributions to the fusion endeavor."

# 2015 SULI participant Matthew Capella develops candidate solution to correct ITER magnetic field imperfections



Matthew Capella presents his work on real-time error field correction to colleagues at the DIII-D Science Group Meeting

Matthew Capella participates in remote experiment with EAST long pulse tokamak (Hefei, China) from GA Remote Control Room

- Undergraduate Matthew Capella (U. Cal. San Diego) spent ten weeks at General Atomics in the 2015 SULI program, developing a new control algorithm to correct tokamak magnetic field irregularities in real-time. The algorithm avoids the need to expend multiple plasma discharges to identify optimal coil currents that minimize the field irregularities. The approach has high potential for long-pulse devices such as ITER, which have limited discharge availability for commissioning.

- Applying his background in electrical engineering, physics, and computational modeling, Capella worked with research scientist Matthew Lanctot of General Atomics to design the algorithm. Capella's SULI experience included participation in remote experiments performed with the EAST tokamak in China, and culminated with implementation of the algorithm in the DIII-D Plasma Control System in preparation for use in upcoming experimental campaigns. An experimental demonstration of the technique would motivate implementation in existing superconducting tokamaks (such as EAST and KSTAR), which already use GA control software.

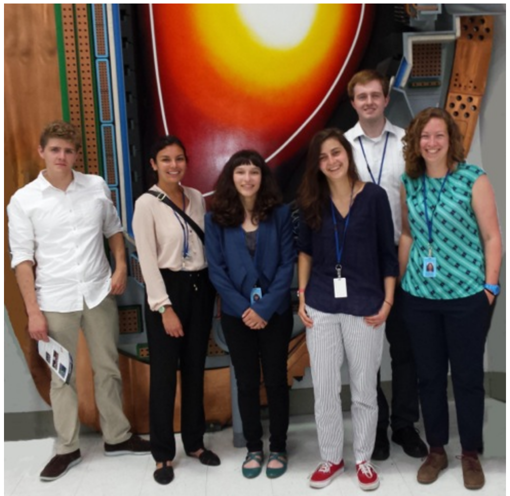
- Capella hopes to present this work at the 57th APS Division of Plasma Physics conference in November, both to help him further develop his communication skills and to share his important new results with the international fusion community.

# 2015 SULI student Joe Milliano quantifies magnetic symmetry-breaking at General Atomics/DIII-D

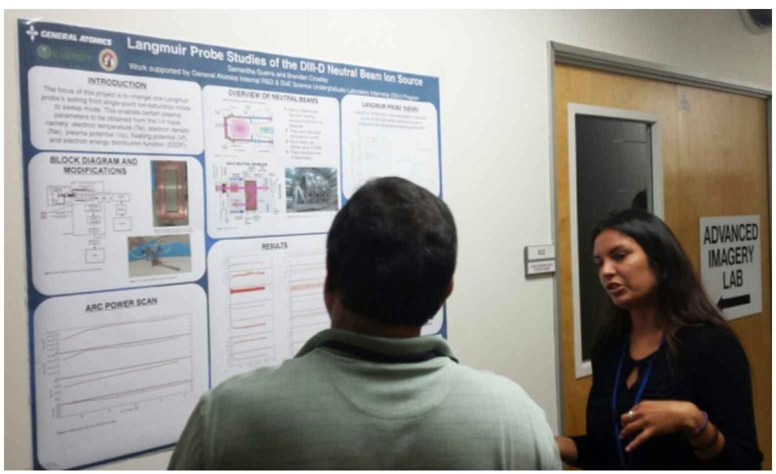

SULI intern Joe Milliano presents the results of his work at a poster session at General Atomics

- Undergraduate student Joe Milliano (Truman State University, MO) conducted plasma physics research with Dr. Carlos Paz-Soldan at General Atomics in San Diego, CA through the Science Undergraduate Laboratory Internship (SULI) program.
- The goal of the General Atomics group where Milliano contributed is to develop the tokamak approach to fusion energy production.
- Experiments at the DIII-D tokamak were conducted to investigate the effects of breaking toroidal symmetry with magnetic perturbation fields. Milliano developed robust data analysis tools in MatLab to determine how asymmetric the plasma became as a result of the intentionally applied 3D magnetic fields and how different plasma conditions affected the asymmetry.
- Milliano intends to pursue a career path focused on science, technology, engineering, and mathematics education, and his future students will benefit from his first-hand experience in how scientific research is conducted in a large laboratory setting.

# 2015 SULI student intern Samantha Guerra helps measure the DIII-D neutral beam ion source plasma parameters



Samantha Guerra (2nd from left) with five of her fellow SULI students at the DIII-D National Fusion Facility at General Atomics




Samantha Guerra explains her work on the Langmuir probe studies to a DIII-D researcher at the poster session

- Samantha Guerra, an engineering major at San Diego State University, worked with General Atomics scientist Brendan Crowley studying the ion source of the DIII-D neutral beam system.
- Neutral beams play a major role in magnetically confined thermonuclear fusion technology. Understanding the physics of the neutral beam ion source is key to improving the reliability and quality of the neutral beam system.
- Guerra's role during her internship involved developing new control and data analysis software for the ion source Langmuir probe system. The aim of the project was to acquire plasma parameters in the source that were not measured previously: the electron temperature, plasma potential, and the Electron Energy Distribution Function (EEDF).
- At the completion of the program Samantha presented a poster to the scientific staff at the DIII-D National Fusion Facility and she is preparing a poster to be presented at the American Physical Society Division of Plasma Physics conference to be held in Savannah, Georgia in November.