DOE/NA-0150

2024
Academic Programs Annual

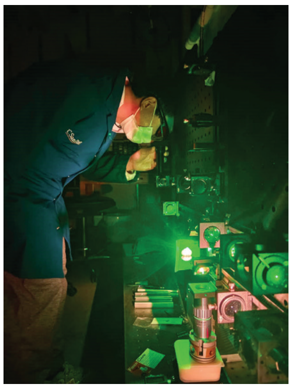
NNSA Defense Programs, Technology and Partnerships Office

- Stewardship Science Academic Alliances
- High Energy Density Laboratory Plasmas
- Predictive Science Academic Alliance Program III
- Minority Serving Institution Partnership Program
- Fellowship Programs

NNSA
National Nuclear Security Administration

U.S. DEPARTMENT OF
ENERGY

On the Cover



Postdoctoral research physicist Yuhang Deng observing a diamond anvil cell under green laser irradiation. The optical system can be used to determine pressure in the megabar range by measuring the Raman spectrum of diamond.

— Image courtesy of Dr. M. Brian Maple, University of California, San Diego

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        - ✦ Fellowship Programs

National Nuclear Security Administration

U.S. DEPARTMENT OF ENERGY

2024 Academic Programs Annual
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The Academic Programs Annual is produced by the NNSA Office of Defense Programs, Technology and Partnerships Office. It features select research conducted by the following NNSA-supported research programs: Stewardship Science Academic Alliances, High Energy Density Laboratory Plasmas, Predictive Science Academic Alliance Program, Minority Serving Institution Partnership Program, and fellowship programs.

Please submit comments to:

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Published February 2024

NNSA will recruit, invest in, and nourish a high-performing, diverse, and flexible workforce that can meet the unique policy, technical, and leadership needs of our mission today and well into the future. We champion all aspects of diversity, equity, inclusion, and accessibility so that NNSA and its enterprise benefit from the full range of America's talent. Efforts to minimize personnel attrition are a high priority, as is investing in university programs to support our future workforce.

2022 NNSA Strategic Vision

Welcome from the NNSA Defense Programs Technology and Partnerships Office

The National Nuclear Security Administration (NNSA) is tasked with ensuring a safe, secure, and effective nuclear deterrent. Since the end of nuclear testing in 1992, we have accomplished this mission through the expert use of experimental science, engineering, and computational capabilities that are strengthened by the NNSA's mission to support the United States' leadership in science and technology. This expertise allows us to model the performance of nuclear weapons and to evaluate changes that may occur to weapon performance as the life of a weapon system is extended beyond its original design lifetime, materials age, or changes are made in material components or manufacturing processes that cause the weapon to differ from its original design. The NNSA directs these experimental science, engineering, and computational activities that make it possible to evaluate weapon performance without testing.

To accomplish this mission requires world-class, state-of-the-art computing power, experimental facilities, and the best minds in the Nation trained in science and engineering disciplines. The Stockpile Stewardship Academic Programs (SSAP), managed by the Technology and Partnerships Office, enable the NNSA to seed the academic pipeline of talent and provide access to world-class computing power and experimental facilities to train the next generation of stockpile stewards. The return on investment in the Academic Programs has been significant for NNSA with much of the best talent choosing to join the NNSA national laboratories as permanent staff or remaining in academia to foster the development of future generations of stewards.

Having such a strong, well-developed base of talent at both the national laboratories and in academia is a key component of the U.S. nuclear deterrent, and expertise in academia provides peer review for the cutting-edge science and technologies that are developed at the national laboratories in support of stockpile stewardship. This work is exciting and ground-breaking! It includes properties of materials under extreme conditions, high energy density science, low energy nuclear science, radiochemistry, high explosives' science, high performance computing, and modeling. These are some of the research areas and there are more areas of fascinating science that you will read about in the pages to follow. We also feature students and alumni of the Academic Programs who write in their own words about their research and about their perspective on the programs that support them and the opportunities provided.

NNSA continues to lean-in to diversity programs and believes strongly that better science and better solutions to the challenges faced in stockpile stewardship come from an interdisciplinary approach and from engaging the talents and expertise from a diverse group of talented researchers from a wide range of backgrounds and with a wide range of experiences. The Minority Serving Institutions Partnership Program (MSIPP), managed out of the NNSA Office of Management and Budget (NA-MB), is a successful powerhouse program that focuses on finding and supporting talent at Minority Serving Institutions and introducing that talent to experiences and opportunities at the national laboratories, plants, and sites of the NNSA. This year's annual features a greater number of MSIPP students and alumni who share their research and their perspective and experiences with the program. The continued success of the MSIPP will provide a richer base from which we can seed the pipeline of talent that will become the next generation of stockpile stewards, and we look forward to continuing to feature MSIPP talent.

I extend my congratulations to all involved on a job well done in being part of this community and in sharing your research and perspectives. All of us at NNSA wish you continued future successes.

Jahleel Hudson
Acting Director
Technology and Partnerships Office
NNSA Defense Programs

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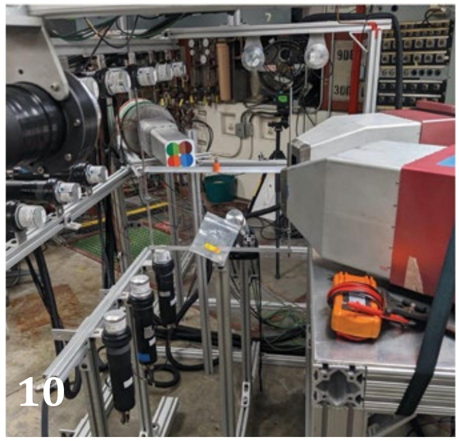

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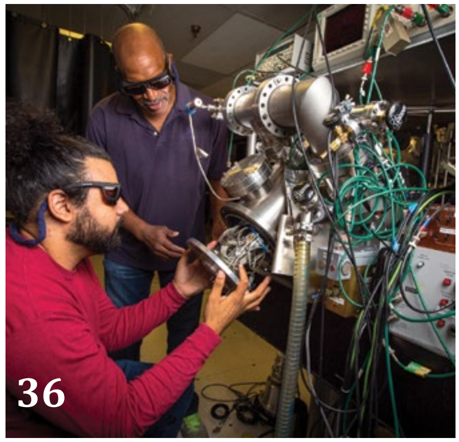

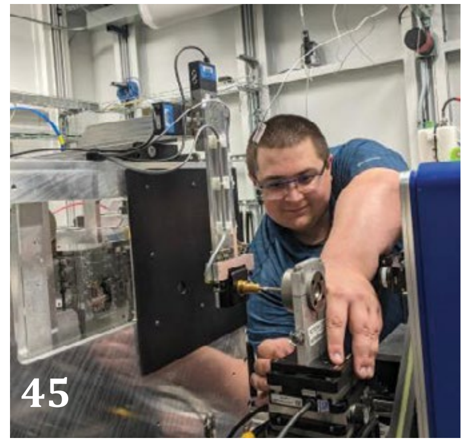

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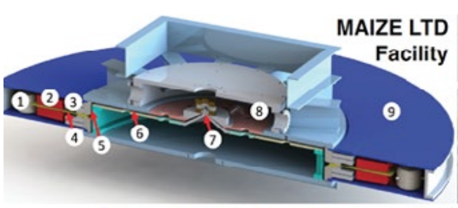

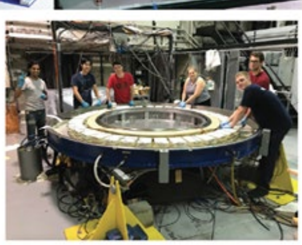

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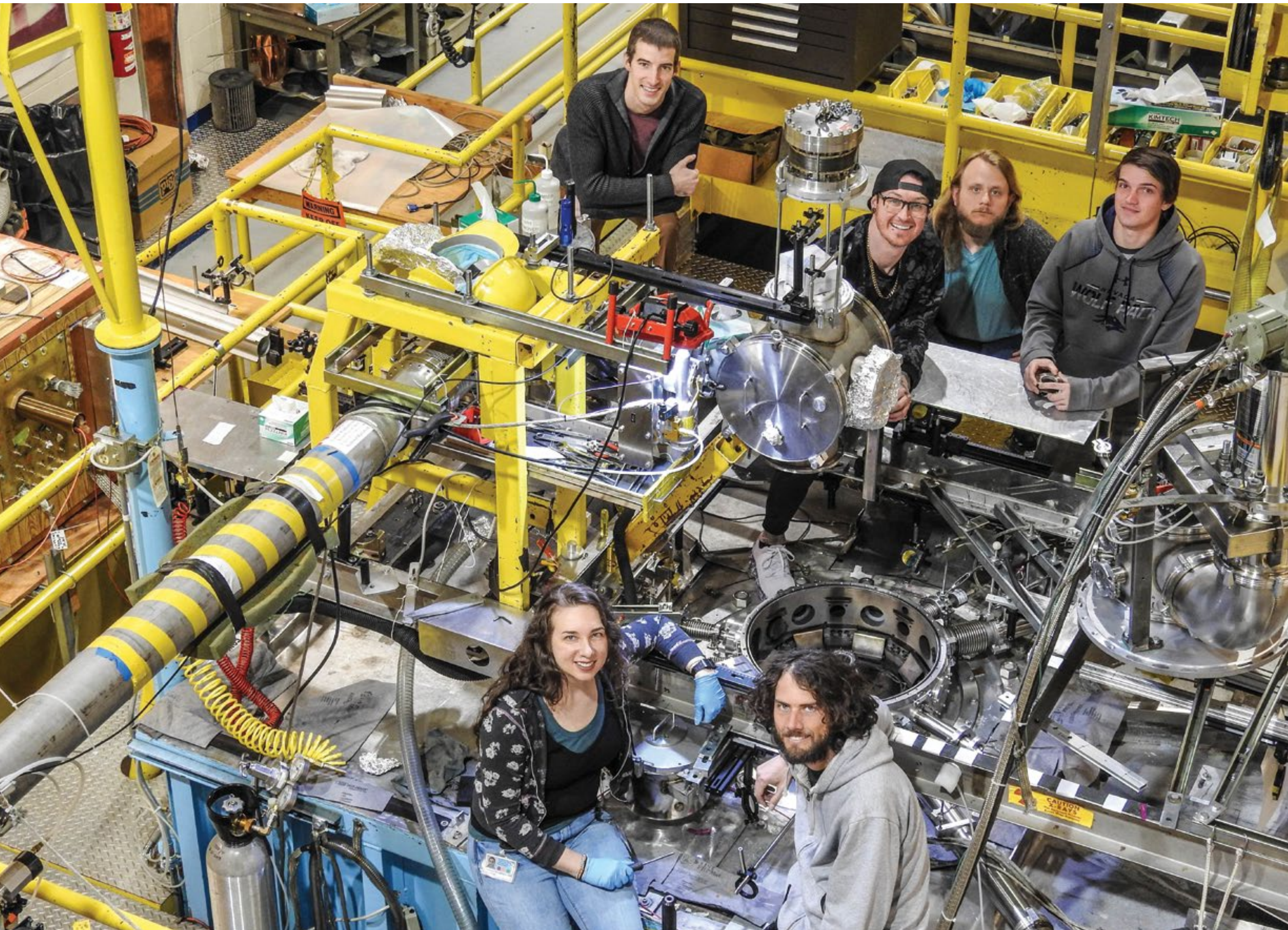
Academic Programs

Training the Next Generation of Stockpile Stewards

The challenges of modernizing our nuclear stockpile demand a strong and diverse base of national expertise and educational opportunities in specialized technical areas that uniquely contribute to nuclear stockpile stewardship. The Academic Programs of the Department of Energy/National Nuclear Security Administration (DOE/NNSA) Office of Defense Programs are designed to support academic programs in science and engineering disciplines of critical importance to the Nuclear Security Enterprise (NSE) such as nuclear science, radiochemistry, materials at extreme conditions, high energy density science, advanced manufacturing, and high-performance computing. In addition, building a diverse workforce will strengthen our stewardship of the future. The role of the Academic Programs is three-fold:

- Develop the next generation of highly trained, technical workers able to support its core mission
- Maintain technical peer expertise external to the NSE for providing valuable oversight, cross-check, and review
- Enable scientific innovation to enhance the NSE missions to strengthen the basic fields of research relevant to the NNSA mission.



The Academic Programs enable a robust and diverse research and science, technology, engineering, and mathematics (STEM) educational community through a variety of methods of support. Investments in consortia and centers of excellence provide collaborative groups to tackle large questions through multi-disciplinary approaches and leverage preeminent scientists in the field. Research grants and Focused Investigatory Centers support individual principal investigators to foster a vibrant community responsive to new breakthroughs by providing flexibility for new ideas, diversity, and career growth. Specific support to minority and tribal serving institutions prepares a diverse workforce of world-class talent through strategic partnerships. Fellowships provide graduate students with key opportunities to connect with the DOE/NNSA mission and to provide direct experiences at the national security enterprise (NSE) sites. NNSA user facilities open opportunities for academic partners to use NNSA's cutting-edge research facilities and to push frontiers of current scientific understanding. Several underlying features of all Academic Programs include the focus on quality science through competitive award, connection with DOE/NNSA mission laboratory/site work, and a view to future needs and opportunities of the NSE.

The Academic Programs is comprised of six subprograms:

- Stewardship Science Academic Alliances
- High Energy Density Laboratory Plasmas
- Predictive Science Academic Alliance Program
- Minority Serving Institution Partnership Program
- Tribal Education Partnership Program
- Fellowship Programs.

Stewardship Science Academic Alliances

The Stewardship Science Academic Alliances (SSAA) Program supports scientific academic research programs to develop the next generation of highly trained, technical workers able to support its core mission and to ensure there is a strong community of technical peers, external to the NNSA national laboratories, capable of providing peer review and scientific competition to strengthen the basic fields of research relevant to the NSE.

The SSAA Program funds both collaborative centers of excellence and smaller individual investigator research projects to conduct fundamental science and technology research of relevance to stockpile stewardship. Current technical areas include properties of materials under extreme conditions; low-energy nuclear science; high energy density physics; and radiochemistry. SSAA funding supports research at U.S. universities, training hundreds of undergraduate students, graduate students, and postdoctoral researchers each year. A key element of both centers of excellence and individual investigator awards is the connection of students with the NSE. These opportunities are focused in technical fields critical to stewardship science and build a field of talented researchers and committed doctoral students sharing a common desire to advance science while impacting national security

High Energy Density Laboratory Plasmas

High energy density (HED) science is central to many aspects of nuclear weapons and maintaining a strong HED academic community in this unique field is critical for the future needs of a modern nuclear stockpile. The High Energy Density Laboratory Plasmas (HEDLP) program is designed to steward the study of laboratory HED plasma physics by funding academic research of ionized matter in laboratory experiments where the stored energy reaches approximately 100 billion joules per cubic meter (i.e., pressures of approximately 1 million atmospheres). The program supports individual investigator research grants, centers of excellence, and the Facility Access and Community Development Program.

Individual Investigator Grants

NNSA's Technology and Partnerships Office partners with the DOE's Office of Fusion Energy Sciences to issue an annual joint solicitation for high energy density laboratory plasmas research. The coordination across agencies enables the support of a strong and broad academic presence in HED science, leveraging common interests and assuring NNSA-specific interests in this area remain vibrant. Competitively awarded research grants are selected through the joint solicitation conducted in coordination with the Office of Science.

Centers of Excellence

The HEDLP program provides funding support toward the HED Centers of Excellence selected under the competitive SSAA Centers process. Centers of Excellence are an integrated, multi-institutional, collaborative effort focused on a central problem or theme. These Centers work closely with NSE scientists and maintain a core set of academic expertise in key technical areas.

Facility Access and Community Development Programs

The Facility Access Program provides travel support for researchers who have been granted experimental time at NNSA user facilities. The HEDLP program's community development effort provides funding for student and postdoctoral researchers' travel to attend the High Energy Density Science summer school and various facility workshops.

Predictive Science Academic Alliance Program

The Predictive Science Academic Alliance Program (PSAAP) consists of participation by leading U.S. universities, focusing on the development and demonstration of technologies and methodologies to support effective, high-performance computing in the context of science and engineering applications. The research performed by the universities in this program is discipline-focused to further predictive science and is enabled by effective, extreme-scale computing. The predictive science that is a highlight of this program is based on verification and validation and uncertainty quantification for large-scale simulations.

PSAAP currently consists of the following types of centers: Multi-disciplinary Simulation Centers (MSCs), Single-Discipline Centers (SDCs), and Focused Investigatory Centers (FICs). MSCs focus on scalable application simulations, targeting large-scale,

Kyle Swanson and Jeff Rolands (University of Nevada, Reno) study results from an OMEGA EP experiment.

Heather Garland (Rutgers University graduate student) working on electronics for a nuclear experiment for stewardship science.

integrated, multidisciplinary problems, whereas SDCs focus on scalable application simulation for targeting a broad single science or engineering discipline. FICs are tightly focused on a specific research topic of interest to NNSA's mission in either a science/engineering discipline or an exascale-enabling technology.

PSAAP has a long-term goal to cultivate the next generation of scientists and engineers to support the Advanced Simulation and Computing and Stockpile Modernization missions. These efforts establish academic programs for multidisciplinary simulation science and provide students the relevant experience for weapons code development through open science applications.

Minority Serving Institution Partnership Program

The Minority-Serving Institution Partnership Program (MSIPP) and the Tribal Education Partnership Program (TEPP) develop and enhance workforce and educational capacities, sustaining a diverse network of students prepared for career pathways into the NSE.

Through MSI-NSE partnerships, the programs align investments in educational capacities and workforce development, supporting a diverse student population ready to meet the needs of the NNSA's STEM workforce. The MSI-NSE collaborations provide opportunities for students and faculty to participate in research activities and internships, strengthening skills and talents in their relevant fields to make immediate contributions to the NSE.

MSIPP and TEPP support MSIs across the nation, including Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs), investing in a diverse portfolio of student enrichment programs, curriculum development, and STEM outreach programs. The mission of the programs to build a diverse workforce and enhance educational capabilities is met through four main objectives:

1. Strengthen and expand minority serving institutions' and Tribal colleges and universities' educational and/or research capacity in NNSA mission areas of interest.
2. Target collaborations and increase interactions between minority serving institutions and Tribal colleges and universities, NNSA laboratories, plants, and sites, and Management & Operating (M&O) partners to increase direct access to NSE resources.
3. Increase the number of MSI/TCU students who have exposure to cutting edge research and career opportunities within the NSE and who graduate with STEM degrees relevant to NNSA mission areas.
4. Increase the number of minority graduate and postdoctoral students hired into the NSE's technical and scientific workforce

DOE/NNSA Fellowship Programs

The Academic Programs also include the Stewardship Science Graduate Fellowship (SSGF), Laboratory Residency Graduate Fellowship (LRGF), and Computational Science Graduate Fellowship (CSGF is jointly sponsored with the DOE's Office of Science). These three programs support PhD students in areas of interest to stockpile stewardship. SSGF and CSGF provide a yearly stipend, tuition, fees, lab practicums, and an academic allowance. The LRGF program extends those benefits to at least two longer practicums and encourages fellows to pursue their thesis research in collaboration with laboratory scientists. This Annual highlights a select few alumni and students from each fellowship. For more information about these programs, please visit http://www.krellinst.org/fellowships.

Stewardship Science Academic Alliances

Centers of Excellence

Stewardship Science Academic Alliances

Launched in 2002, the Stewardship Science Academic Alliances (SSAA) Program supports areas of fundamental research and development relevant to NNSA's stockpile stewardship mission and works to recruit the next generation of highly trained technical scientists and engineers for careers with the Nuclear Security Enterprise. The SSAA program supports both research grants and cooperative agreements (Centers of Excellence).

A SSAA Centers of Excellence notice of funding opportunity announcement (NOFO) is posted every five years. The proposals submitted in response to the NOFO published in 2022 were for Centers of Excellence in the research areas of advanced characterization of materials properties under extreme conditions, low energy nuclear science, radiochemistry, and high energy density physics. Nine proposals were selected for award, and most began in the fourth quarter of fiscal year 2023. The SSAA Centers of Excellence that were selected under this solicitation are presented in the Table 1.

Following is an article outlining recent accomplishments from the renewed Center of Excellence at The Center for Matter Under Extreme Conditions at the University of California, San Diego.

University	Center of Excellence	Principal Investigator
Colorado School of Mines	Advanced Characterization of Metals under Extreme Environments (ACME2)	Dr. Amy Clarke
Georgia Institute of Technology	Transuranic Chemistry Center of Excellence	Dr. Henry La Pierre
Texas A&M University	CENTAUR: Nuclear Science in Service to the Nation	Dr. Sherry Yennello
University of Alabama at Birmingham	Center for Additively Manufactured Complex Systems under Extremes (CAMCSE)	Dr. Yogesh Vohra
University of California, San Diego	The Center for Matter Under Extreme Conditions	Dr. Farhat Beg
University of Illinois Chicago	Chicago/DOE Alliance Center – A Center of Excellence for Materials at Extremes	Dr. Russell Hemley
University of Michigan	The Center for Magnetic Acceleration, Compression, and Heating (MACH)	Dr. Ryan McBride
University of Michigan	Center for High Energy Density Laboratory Astrophysics Research	Dr. Carolyn Kuranz
University of Texas at Austin	The Wootton Center for Astrophysical Plasma Properties	Dr. Don Winget

Table 1. SSAA Centers of Excellence selected from the 2022 NOFO.

At the University of Illinois Chicago, Fatemeh Safari uses an inert atmosphere glove box to load an air sensitive sample into a diamond anvil cell for high pressure studies. A digital microscope provides for high magnification while allowing a wide field of view to aid in the loading process.

James Lamb, a Ph.D. student at the University of California at Santa Barbara and member of the Center for Research Excellence on Dynamically Deformed Solids, is studying the shock resistance of additively manufactured high-strength metals via the 3D TriBeam technology.

Center for Matter Under Extreme Conditions | University of California, San Diego

PI: Dr. Farhat Beg (fbeg@ucsd.edu); Authors: Jessica Pilgram, University of California Los Angeles (jpilgram@ucla.edu), Petros Tzeferacos, University of Rochester (p.tzeferacos@rochester.edu), Simon Bolaños, University of California, San Diego (UCSD) (sbolanos@ucsd.edu), and Mathieu Bailly-Grandvaux, UCSD (mbaillygrandvaux@ucsd.edu)

The Center for Matter Under Extreme Conditions (CMEC) has a mission to lead research and technological breakthroughs in high energy density (HED) science with an emphasis on the creation and diagnosis of extreme states of matter, both magnetized and un-magnetized, exploiting novel combinations of HED drivers to train future scientists, utilizing both modeling and experiments to develop a physics-based understanding of HED systems. During five years, nine PhD and four Master program alumni have graduated and now work at the NNSA national laboratories and in industry. In addition, five research scientists/postdoctoral scholars work at the DOE/NNSA national laboratories or industry. Since its inception, CMEC has published over 80 articles in refereed journals. Two recent projects are highlighted below:

Structure and evolution of laser-driven, Biermann-battery-generated fields.

The creation of magnetic fields in astrophysical and plasma physics experiments are of particular interest to both the high energy density physics and astrophysics communities. One known source of magnetic-field generation in plasmas is the Biermann battery mechanism. This mechanism results in the spontaneous generation of magnetic fields when electron-temperature and electron-density gradients are misaligned in a plasma.

A graduate-student collaboration within CMEC, led by University of California Los Angeles (UCLA) graduate student J. Pilgram and University of Rochester graduate student M.B. Adams conducted an integrated study involving high repetition-rate experiments at UCLA and FLASH simulations of the experiments to examine and understand the spatial structure and evolution of Biermann-battery-generated magnetic fields in laser-produced plasmas. Their efforts[1] extended the work of prior experiments by spatially measuring magnetic fields in multiple planes, on centimeter scales, over thousands of laser shots (Figure 1a). Azimuthally symmetric, Biermann-battery-generated magnetic

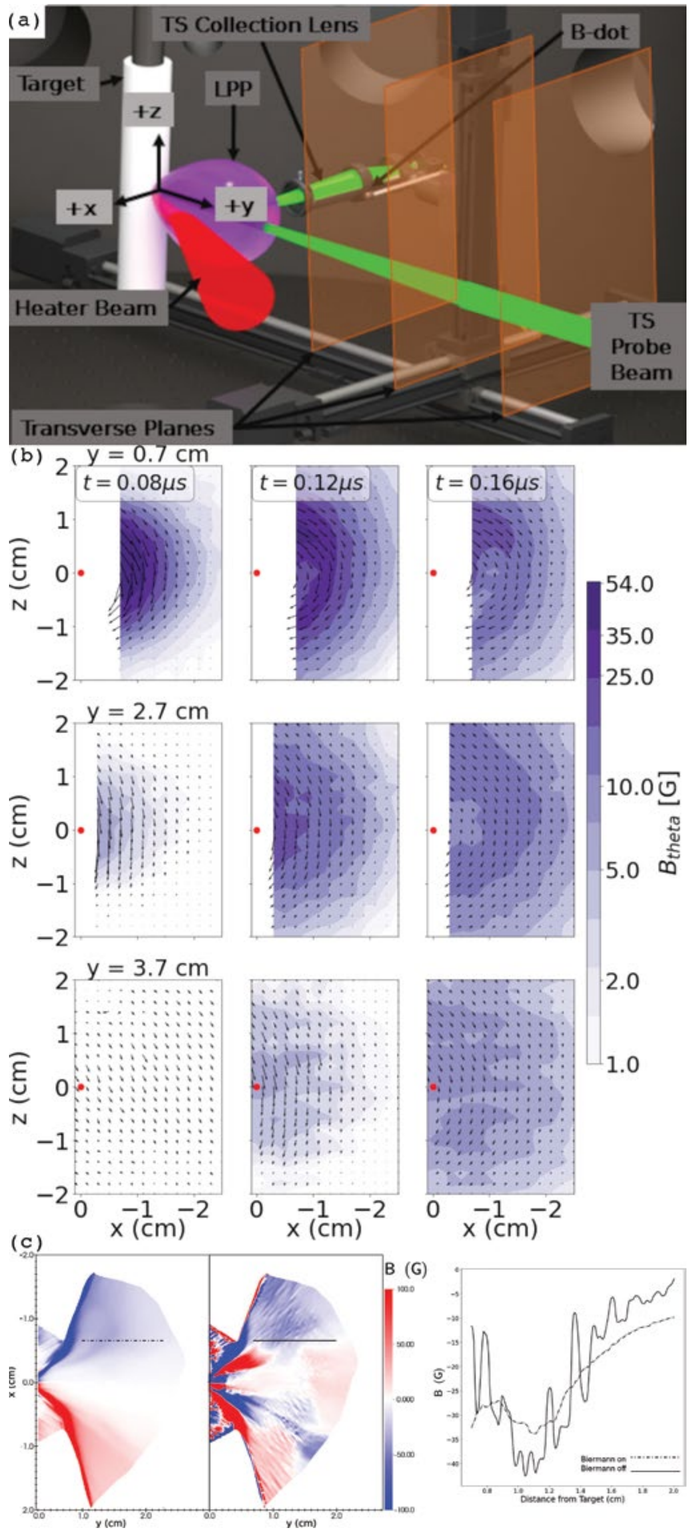


Figure 1. (a) Schematic of the high repetition-rate experiments at UCLA to measure the magnetic field generation in the plasma plume expansion. (b) Spatially-resolved experimental measurements of the magnetic field magnitude from B-dot probes, scanning different planes at different distances from the target. (c) FLASH simulations of the experiments showing the effect of in situ Biermann-battery magnetic-field generation in the expanding plasma plume. The magnitude variability seen in the experimental data is consistent with Biermann battery acting for the duration of the plasma expansion.

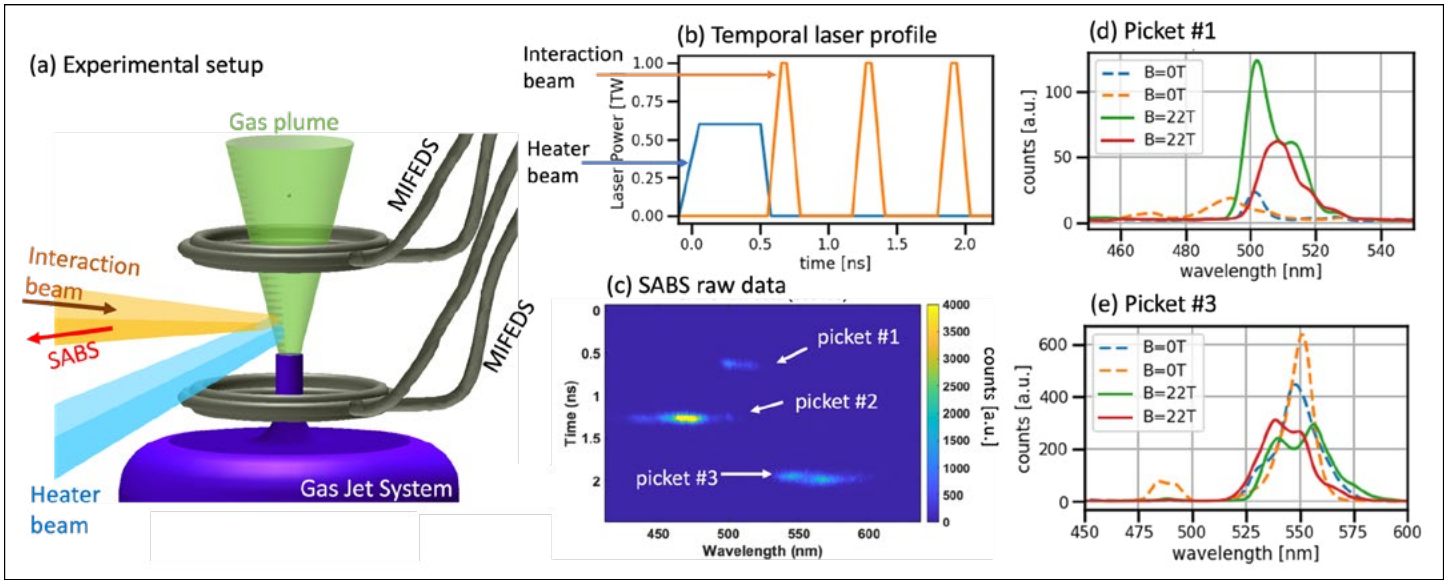


Figure 2. (a) Experimental setup with magnetized gas-jet targets. (b) Pulse shape for the heater beam and interaction beam. The back-scattered light from the interaction beam is collected by the SABS diagnostic. An example of raw data from SABS is shown in (c), where the BSRS emitted during each picket of the interaction beam is observed. The enhancement/mitigation of BSRS respectively during picket#1 (d) and picket#3 (e) are discussed in text. Note that for the picket#2, the backscattered light spectra correspond to lower densities of n_e ~ 5% n_{cr}, though the data was not reproducible for repeated shots.

fields that range from 60 G at 0.7 cm from the target to 7 G at 4.2 cm from the target were measured (Figure 1b). The combination of experimental plasma diagnostics and high-fidelity FLASH simulations (Figure 1c) showed how the magnetic fields generated by the laser-target interaction are advected outwards, whilst in situ generation of Biermann-battery fields due to the asymmetry of the plasma plume continues to augment them.

Laser-plasma instabilities in the presence of an external magnetic field

Laser-plasma instabilities (LPIs) play a detrimental role in energy coupling to the target in inertial confinement fusion (ICF). The recent development of applied strong magnetic fields for use in ICF and laboratory astrophysics experiments has opened new opportunities to investigate the role of external magnetic fields on LPIs. Recent numerical studies have shown that Stimulated Raman Scattering (SRS) can be mitigated by external magnetic fields in the kinetic regime of the instability,[2] warranting systematic experimental studies to validate modeling.

The CMEC team designed experiments on OMEGA EP to investigate the effect of an external magnetic field on SRS. They first successfully demonstrated the feasibility of investigating B-field effects on Backward-SRS (BSRS) in the kinetic regime of instability.[3] The experiment relied on the ability to measure the BSRS light scattered off short laser picket pulses propagating through a magnetized gas-jet target (Figure 2a-b). To measure the backscattered light, the Sub-Aperture Back-Scatter (SABS) diagnostic, which collects the light propagating back from the interaction beam and provides spectrally- and temporally-resolved measurements, was used (Figure 2c). The gas jet was embedded in a quasi-perpendicular and uniform magnetic field of ~20 T using a pair of pulsed-power coils. X-ray emission spectroscopy and 4ω-probe interferometry were fielded to infer plasma conditions and compare them with radiation magneto-hydrodynamic simulations using the FLASH and GORGON codes. In a recent experiment, researchers observed an opposite behavior of how BSRS reflectivity was modified in the presence of the applied B-field. At an electron density ne ~ 10% n_{cr}, where n_{cr} is the critical density for 351 nm light, researchers observed a mitigation of BSRS with B-field (Figure 2e). However, at n_e ~ 8% n_{cr}, the BSRS reflectivity increased with the B-field (Figure 2d). Particle-in-cell simulations using the OSIRIS code show a qualitative agreement with these observables. This is the first experimental evidence of BSRS mitigation with an applied B-field; a paper is in preparation. The platform validation was published earlier this year in the Journal of Plasma Physics.[3]

References

[1]J.J. Pilgram et al., "High Repetition Rate Exploration of the Biermann Battery Effect in Laser Produced Plasmas Over Large Spatial Regions," *High Power Laser Science and Engineering* 10, e13 (2022).

[2]B. J. Winjum et al., "Mitigation of Stimulated Raman Scattering in the Kinetic Regime by External Magnetic Fields," Phys. Rev. E 98, 043208 (2018).

[3]M. Bailly-Grandvaux et al., "Validation of Magnetized Gas-jet Experiments to Investigate the Effects of an External Magnetic Field on Laser-plasma Instabilities," *Journal of Plasma Physics* 89, 175890201 (2023).

Combined Field and Laboratory Studies of Plutonium Aging and Environmental Transport | Clemson University

PI: Dr. Brian Powell (bpowell@clemson.edu)

The goal of this project is to identify the key processes controlling the migration of plutonium (Pu) and other radionuclides in a wetland/pond watershed with the primary objectives of demonstrating novel techniques to monitor Pu speciation, producing a generalized model of major biogeochemical factors controlling Pu migration and identifying plants known to either hyperaccumulate Pu or other radionuclides. Over the past year, researchers have 1) utilized a liquid-sampling, atmospheric-pressure-glow discharge ion source coupled to an orbitrap mass spectrometer (LS-APGD-MS) to evaluate the potential of the instrument to measure Pu-organic ligand complexes; 2) determined cesium (Cs)-137 concentrations in multiple plant samples collected from Pond B at the Savannah River Site (SRS); and 3) monitored trace element cycling within Pond B surface waters. Overall, the LS-APGD-MS system did show multiple peaks which may have corresponded to Pu-citrate complexes. However, there was not a definitive assignment. A new approach of using a liquid chromatography mass spectrometry (LC-MS) system also equipped with an orbitrap detector currently is underway. Details for the other two ongoing projects are provided below.

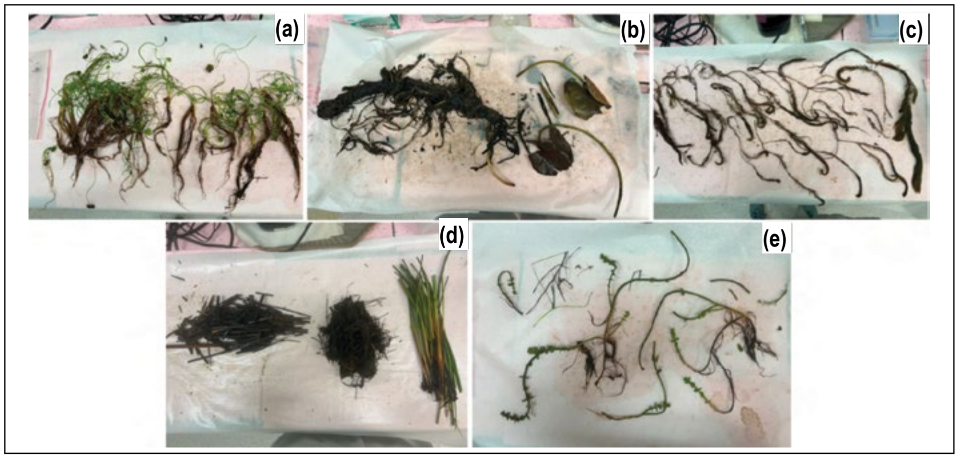


Figure 1. Initial separation and processing of plant specimens. (a) juvenile lily pads; (b) large lily pad and tuber root; (c) watermilfoil; (d) Marsh grass divided into brown shoots, roots, and green shoots; (e) common waterweed.

Radionuclide Uptake in Aquatic Plants at Pond B

An initial survey of prevalent aquatic and riparian plant species was conducted at Pond B on the SRS to compare radionuclide (e.g., Pu, Cs, etc.) uptake in several different classifications and species of plants. Both emergent and submerged plant types were collected. Plant specimens were rinsed, separated by plant part (e.g., root, shoot) when possible or when available, and dried to a constant mass. Most plants exhibited similar cesium uptake, with the common waterweed (Figure 1E) having the highest cesium activity concentration per dry mass and the brown (senescing) grass shoots having the lowest concentration (Figure 2). The juvenile lily shoots also showed somewhat greater uptake than other plant shoots and roots per dry mass, but activity concentrations were similar to other samples on a fresh mass basis (data not shown) owing to the higher water content of this particular plant part. These preliminary results indicate that the common waterweed may be useful as a target species to monitor radionuclide presence in freshwater environments, at least for Cs. However, other species, particularly the water lily, are far more abundant at this site and exhibit similar uptake. This should be considered, as plant sampling is sometimes opportune in nature.

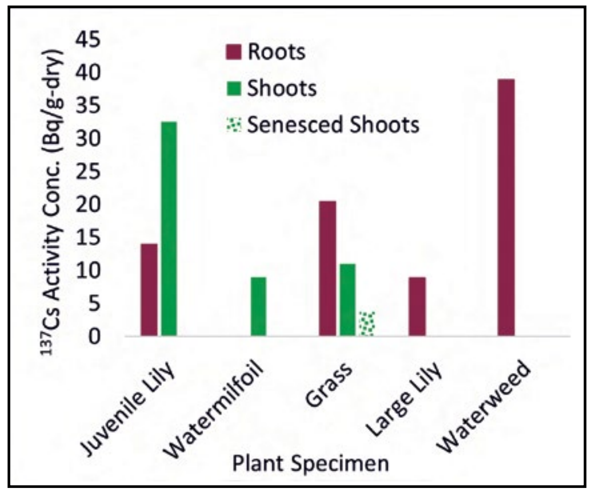


Figure 2. Activity concentrations of Cs-137 (Bq per g of dry plant mass) in the sampled SRS Pond B plant specimens, by plant part, when available.

Pu Colloidal Fraction in Pond Water Column

The seasonal variation of aqueous Pu and iron (Fe) partitioning between particulate size fractions in surface waters is evaluated. Surface water temperature and dissolved oxygen levels were measured using in situ sonde probes, and particulate fractions of column water were collected using a series of filters (1.2µm for debris, 0.45 µm for colloidal fraction, 0.22 µm for truly dissolved fraction, and 0.1 µm for a nanocolloidal fraction). A thermocline routinely forms with an anoxic zone at the bottom which exhibits higher Fe and Pu content associated with particulate and colloid-size solids. Generally, under winter, well-mixed conditions, the highly oxic water column was characterized by low concentrations of Fe and Pu. During the Spring stratification period, the Fe concentration increases to 7 ppm (total) with a large proportion of particulate (<1.2 µm). During the Summer-Autumn stratified period, the concentration of colloidal and nanocolloidal Fe increased towards the bottom of the lake, which coincided with a higher concentration nanoparticle fraction (F4).

Correlated Neutron-gamma Data for Stewardship Science | University of California, Berkeley | PI: Dr. Lee Bernstein (labernstein@berkeley.edu); Co-PIs: Bethany Goldblum (bethany@nuc.berkeley.edu), Josh Brown (brown.ja@berkeley.edu)

The advanced computational capabilities developed since the cessation of nuclear testing offer the opportunity to better exploit archival, post-detonation radiochemical data to improve the safety and reliability of the nuclear stockpile, provided that the relevant neutron-induced reaction cross sections are well known. Funded through the National Nuclear Security Administration's (NNSA's) Stockpile Stewardship Academic Alliances (SSAA) program, a team of researchers at the University of California, Berkeley (UCB), Lawrence Berkeley National Laboratory (LBNL), and Lawrence Livermore National Laboratory (LLNL) have embarked on an integrated measurement and modeling program to improve evaluated neutron, nonelastic scattering cross section data and associated particle emission spectra. During the first year of the program, the award provided support for a graduate, Keenan Myers, and undergraduate, Charles Henderson, student. Myers is taking the lead in analyzing the data from the first experiment, and Henderson helped develop a Monte Carlo particle simulation of neutron air scatter. Henderson's work augmented his undergraduate education and was instrumental in helping him secure a job at LLNL.

"This award allows our team to pursue fundamental nuclear data important for stockpile stewardship, nuclear energy, and space exploration while training the next generation of nuclear scientists with expertise in fundamental research relevant for stockpile stewardship goals," said Principal Investigator Lee Bernstein.

This project is training students using the Gamma Energy Neutron Energy Spectrometer for Inelastic Scattering (GENESIS), a modular array of high-purity germanium detectors and organic scintillators. The GENESIS array leverages the LBNL 88-Inch Cyclotron's tunable, high-flux neutron beam to study neutron scattering data over a wide range of energies. GENESIS is the first spectrometer that allows for the simultaneous measurement of both outgoing neutron and high-resolution gamma-ray spectroscopy from neutron-induced reactions on target nuclides of interest. The pulsed beam allows for time-of-flight determination of incident neutron energies for the observed outgoing particles. The neutron beam current is monitored continuously using a kinematic neutron spectrometer allowing measurement of absolute cross sections.

Figure 1. GENESIS array in a runtime configuration at the 88-Inch Cyclotron at LBNL showing neutron detectors above, below and to the left and the HPGe gamma-ray detectors on the right.

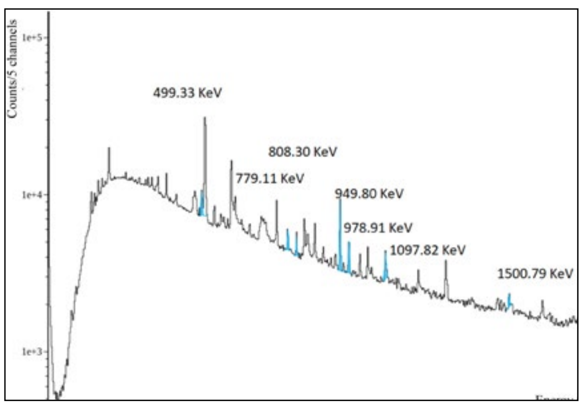


Figure 2. Gamma spectrum with the following transitions in niobium highlighted in blue: 11/2+ ⟶ 9/2-499.33 keV (502.4 keV), 5/2- ⟶ 1/2- 779 keV, 9/2+ ⟶ 7/2- 808 keV,13/2+ ⟶ 9/2+ (ground) 949.8 keV, 11/2+ ⟶9/2+ (ground) 978.9 keV, 5/2- ⟶ 3/2- 1097.82 keV (1092.4 keV), 9/2- ⟶ 9/2+ (ground) 1500 keV.

During the first year, Myers and Henderson were engaged in the deployment of GENESIS for an experiment with a niobium target. The experiment included 25 pulse shape discriminating liquid scintillators and 3 high-purity germanium clover detectors. Figure 1 shows the deployed configuration. In addition to its use as a radiochemical tracer during nuclear testing, niobium also is a key component of the superconducting magnets in the planned International Thermonuclear Experimental Reactor (ITER). GENESIS data for niobium will fill crucial gaps in current experimental information, improving the modeling capabilities of a range of activities in stewardship science, space exploration, and aiding in the development of commercial fusion energy. The niobium measurement was completed in June 2023, and Myers currently is actively engaged with the data analysis. Figure 2 shows a preliminary gamma-ray spectrum highlighting observed inelastic gamma rays. This dataset will form the basis of his doctoral dissertation work. Additionally, the team completed a preliminary analysis of an existing dataset on an ^{27}Al target in cooperation with researchers at the Air Force Institute of Technology.

By harnessing the power of GENESIS, the collective effort of researchers at UCB, LBNL, and LLNL marks a significant stride in improving neutron inelastic scattering data and associated particle emission spectra for nuclides of interest for stockpile stewardship applications. The experience and expertise gained by students like Myers and Henderson through their involvement in the SSAA program will help provide the next generation of nuclear researchers needed to maintain the US nuclear deterrent for years to come while also helping to provide the nuclear data needed for the development of carbon-free energy generation.

Revealing the Invisible | Washington State University

PI: Dr. Hergen Eilers (eilers@wsu.edu); Author: Benjamin R. Anderson, Ph.D. (branderson@wsu.edu)

Plastic bonded explosives (PBXs) are heterogeneous materials containing high-explosive crystals and other additives (e.g., plasticizers, antioxidants, grit) mixed into a polymer binder. The heterogeneity of these materials makes it difficult to optically probe any subsurface chemical interactions, which is of interest in both the study of chemical reactions leading to detonation and in monitoring the degradation of PBXs during long-term storage. To overcome the challenge of performing subsurface optical measurements in heterogeneous materials, the Institute for Shock Physics, Applied Sciences Laboratory (ASL) at Washington State University has been developing novel optical techniques to see inside heterogeneous materials and to study chemical reactions that may occur at subsurface locations. Over the past year, the NNSA has been providing SSAA funding for research into two approaches, feedback-assisted wavefront shaping and self-healing laser beams, to overcome the negative effects of optical scattering inside heterogeneous materials.

Figure 1. Undergraduate students Chester Pollock, Grant McDonald, and Emily Evers.

Figure 2. Bessel beam profile, an example of a self-healing laser beam.

This project has provided an excellent opportunity for undergraduate students to conduct hands-on research in the laboratory. In the past year, three undergraduate students (Figure 1), contributed to the development of hardware, software, and sample preparation for this project. Chester Pollock (Physics, Cornell University) designed and constructed a section of the experimental setup and then measured fluorescence spectra using different size pinhole apertures in an effort to minimize the background signal. He confirmed that smaller pinholes work much better than larger ones for the suppression of higher order modes. Grant McDonald (Engineering, Whitworth University) wrote code to generate phase masks for the formation of self-healing laser beam profiles, including Airy and Bessel beam profiles. The profiles generated using these phase masks then were compared with theoretical profiles. Emily Evers (Chemistry, Gonzaga University) prepared scattering samples using different size particles embedded in a polymer matrix. These samples then were used to test the scattering setup.

The first approach, feedback-assisted wavefront shaping (FAWS), is an optical technique in which the phase profile of a laser beam is modified by a spatial light modulator to focus light inside a heterogeneous material. The modification of the phase profile is controlled by an optimization algorithm that uses optical feedback (e.g., fluorescence, Raman scattering, nonlinear responses) from a target particle embedded inside the material.[1] The second approach is based on self-healing laser beams. These beams are a class of beam intensity profiles that can recover after an optical scattering event. Self-healing beam profiles differ from Gaussian intensity profiles which are used by most lasers and which are destroyed by optical scattering events, preventing any focusing of the laser light. Figure 2 shows an example of a self-healing laser beam profile, a Bessel beam. These self-healing beams are proposed to have deeper penetration depths into heterogeneous materials than traditional Gaussian profiles, which will enable optical monitoring of sub-surface chemistry.

Optical diagnostic approaches based on FAWS and self-healing laser beams promise to provide new experimental means to gain insights into detonation chemistry and aging chemistry of PBXs, as they allow researchers to study the chemical reactions occurring inside of heterogeneous PBXs. These techniques also promise to provide non-invasive viability testing of conventional PBXs by characterizing the internal chemical signatures of aging PBXs.

References

[1]B.R. Anderson, N. Gese, and H. Eilers, Optics Letters 47, 2036 (2022)

Computational Modeling of Hypersonic Flow and Material Response in a Free-jet Test Facility

University of Colorado, Boulder | PIs: Drs. Iain D. Boyd (iain.boyd@colorado.edu) and James Nichols

The Stewardship Science Academic Alliances supports research ongoing at the University of Colorado (CU) at Boulder to investigate and model high-temperature flows and resulting interactions and effects of such flows on materials. This research has application to hypersonic vehicle design, construction, and maintenance including those within the nuclear stockpile. For the past year, this work has supported the work of a graduate student, James Nichols, and facilitated collaboration between CU and Lawrence Livermore National Laboratory (LLNL).

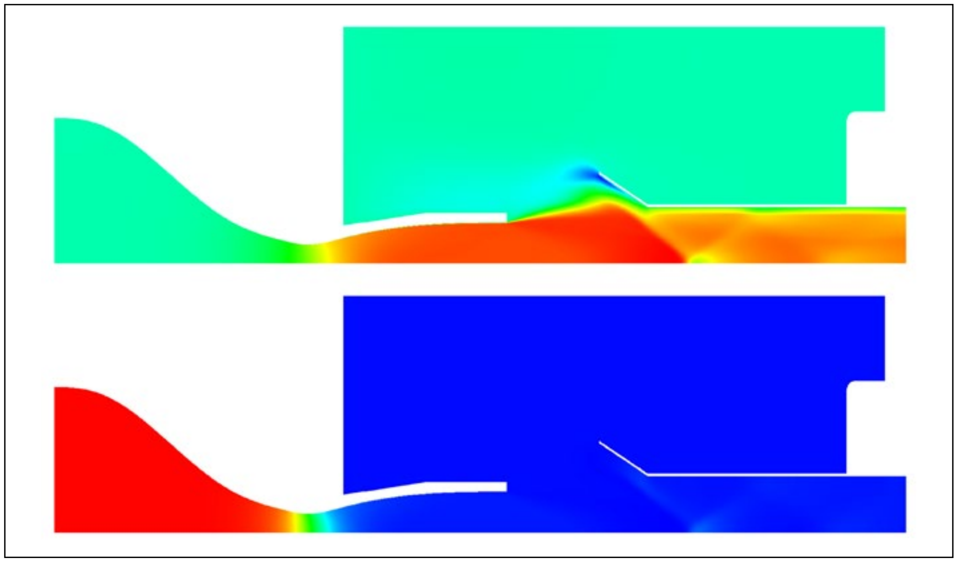


Figure 1. Velocity (top) and pressure (bottom) structures predicted within the EMIT facility.

A key technical challenge in the design of hypersonic vehicles is ensuring they will survive the extreme heating and oxidation environment created in the surrounding flow. Several numerical models have been developed in recent years to predict these conditions and inform designs. However, because of gaps in the understanding of these flows and materials, it is important to closely couple and evaluate these models using experimental and flight data. Due to the uniqueness of hypersonic environments, test and flight campaigns are technically challenging, time consuming, and expensive. Thus, there is immense value in establishing smaller, lower-cost facilities to increase access to testing. The Energy and Material Interaction Tunnel (EMIT) is a small scale, low enthalpy, free jet facility being established at LLNL. The goal of this research is to quantify how closely the flows produced within the facility and resulting material phenomena represent actual hypersonic flight. Success of this tunnel would result in the growth of small format facilities with much greater availability and lower costs, lessening the strain on larger, existing facilities while enabling more rapid development in the field.

Existing hypersonic tunnel facilities often heat the flow prior to acceleration in order to achieve true-enthalpy conditions. This approach is taken in order to allow more accurate reproduction of the phenomena occurring due to the hot gases. These processes include heating of the material surface, ablation, and chemical reactions in the flow. Flow heating is accomplished in many ways typically through some combustion process. Therefore, such facilities are often very complex resulting in high costs, long turnaround times, and shorter test campaigns. In addition, many of these facilities are large in format further contributing to cost, wait times, and shorter runs. EMIT is attempting to reproduce aspects of hypersonic flow and material phenomena by combining a low enthalpy flow with heating directly to the material surface via lasers within the test section. The purpose of this approach is to reduce cost and turnaround time while allowing for longer test times.

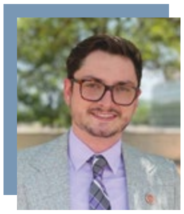
Current work has focused on obtaining and verifying predictions of the flow for the various conditions expected to be produced within the EMIT facility. These simulations are performed utilizing the hypersonic flow code, LeMANS, developed by Professor Boyd's research group.[1] Figure 1 shows the velocity and pressure structures predicted within the tunnel for a relevant flow condition. These results are important in characterizing the flow to inform experimental design and derived conclusions. Future modeling will incorporate flow response to the material geometry as well as material response to the flow and heating scheme.

Data measured in EMIT will be compared to computational results to enable evaluation of newly developed models. In-situ probes along with non-intrusive methods will be used to measure material response and flow phenomena. By facilitating collaboration between LLNL and CU, the graduate student, James Nichols, will have support to travel to LLNL to assist in the design, execution, and analysis of various experiments to be performed. This experience will be invaluable for James, allowing for a solid understanding of experimentation related to hypersonics while providing critical data for completion of his computational modeling thesis.

Reference

[1]A. Martin, L.C. Scalabrin, and I.D. Boyd, I.D., "High Performance Modeling of Atmospheric Re-entry Vehicles," Journal of Physics: Conference Series, Vol. 341, 2012, Article 012002.

Eric Aboud (aboud3@llnl.gov) | Lawrence Livermore National Laboratory
Years at LLNL: 2022 - Present ✦ **Degree:** PhD, Nuclear Physics ✦ **SSAA:** 2017 - 2021, Texas A&M University



I am a criticality scientist at Lawrence Livermore National Laboratory (LLNL). I design and conduct novel critical experiments to test the boundaries of nuclear data, providing essential validation for the nuclear data libraries that are used by all in the nuclear sciences. I am the lead for multiple, high-profile experiments that require interdisciplinary support, which is readily available as the lab contains world experts in a vast array of fields. High-fidelity Monte Carlo simulations are essential to the characterization of my experiments and often are feasible only through the supercomputers available at LLNL. I perform my work at multiple NNSA sites and routinely collaborate with other DOE laboratories, a unique perk of working at a national laboratory.

My research portfolio includes the first low-temperature critical experiments, providing novel nuclear data validation at temperatures below freezing. The low temperature experiments probe the absorption behavior of polyethylene to understand the thermal scattering laws (TSLs) at those temperatures. TSLs, which are fundamental to accurately characterizing the behavior of thermal neutrons within a medium, never have been tested below room temperature. Additionally, no critical benchmarks exist below room temperature, making this experiment the first of its kind. This will open an entirely new subfield of critical experiments at low temperatures, allowing for numerous absorber and reflector materials to be tested.

Other experiments that I have designed and executed include high-priority validation necessary for many international and DOE complex facilities to perform their operations. This includes the validation of chlorine absorbers, which has been a complicated feat that requires expertise in nuclear physics, chemistry, and materials science.

I completed my PhD in December of 2021 at the Cyclotron Institute at

Figure 1. Placing thermocouples on a natural uranium plate to perform surrogate testing for the low-temperature experiments. The plate was cooled to -40°C to test the thermal effects of the material.

Texas A&M University, a Center of Excellence in Nuclear Training and University-based Research (CENTAUR), and began my career at LLNL in early January 2022. At Texas A&M I had the opportunity to conduct research in multiple subfields of nuclear physics including nuclear astrophysics and nuclear security applications. My primary SSAA-supported research was a multi-university collaboration to develop fast neutron detectors for security and fundamental science applications. My experiences in graduate school, specifically my expertise in Monte Carlo simulations, experimental design and fabrication, and detector systems has provided the necessary foundation to be successful in my current work.

During graduate school we had exposure to national laboratories regularly, from conferences to laboratory visits. Any SSAA-funded conference was sure to have an allotted discussion between the students and national laboratory staff members. While never visiting LLNL, I had the opportunity to visit Los Alamos National Laboratory and Oak Ridge National Laboratory (virtually) which really put into perspective the vast scope of research that is conducted and the opportunity to grow as a scientist into unique roles that are only available through the DOE complex.

Many factors played into my desire to work at LLNL, but the exposure that I received during my graduate education, through the SSAA, provided invaluable experiences and knowledge that pushed me into my career path. Coming from an SSAA-supported university brings a huge advantage to students and forms the necessary relationships to pursue a career at a national laboratory, the NNSA, or other SSAA-supported universities.

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Christopher Perreault (perreault@llnl.gov) | Lawrence Livermore National Laboratory
Years at LLNL: 2022 - Present ✦ **Degree:** PhD, Physics ✦ **SSAA:** 2016 - 2022, University of Alabama at Birmingham

As a graduate student at the University of Alabama at Birmingham (UAB) working with Dr. Yogesh Vohra, I was part of the established SSAA program in our group. The SSAA program gave me the opportunity to perform experiments at synchrotron facilities and to make contacts with postdocs and scientists at various national labs while working on my MS and PhD. I had the opportunity to conduct research at Argonne National Laboratory (ANL) at the Advanced Photon Source (APS) as well as at Oak Ridge National Laboratory. The bulk of my graduate research involved studying the high-pressure phases of rare earth elements up to megabar pressures, requiring me to learn and use diamond anvil cell (DAC) techniques coupled with X-ray diffraction (XRD). The annual SSAA symposium allowed me to network with peers and scientists at the national laboratories, learn about the research being conducted, and identify the right fit for me. While I was a PhD candidate at UAB, I was a graduate student guest with Dr. Blake Sturtevant's group at Los Alamos National Laboratory performing analysis of high-pressure radial diffraction data. This experience allowed me to establish contacts and to understand workflow at a typical national lab. By the end of my graduate studies, I had established contacts with individuals at most of the national laboratories which was very valuable for furthering my career goals to find a postdoctoral position.

Currently, I am a postdoctoral researcher at Lawrence Livermore National Laboratory (LLNL) in the Materials Science Division. My research focuses on studying the properties of energetic materials (EM) and their reaction products at high pressure using DACs. These materials typically have low-symmetry (e.g., triclinic, monoclinic) crystal structures or contain mixed or amorphous phases. I utilize several techniques to study the behaviors of these materials including synchrotron powder and single-crystal XRD, optical microscopy and interferometry (OMI), and Raman spectroscopy. Raman spectroscopy and XRD techniques typically are adequate for studying the behavior of many materials. However, obtaining the equation of state (EOS) of mixed and amorphous phases is difficult with conventional XRD techniques, and, as such, OMI is used. OMI is a technique that allows direct measurement of relative changes in volume via white light interferometry to determine the height of the sample. The sample must have a flat, reflective surface to form etalons with the diamond culet above the sample (Figure 1a). Our samples are compressed pellets sputtered with gold to make them reflective (Figure 1a). The sample height is determined by fitting sine functions to interferometric spectra (Figure 1b) to obtain the distance between diamonds and the distance from diamond to sample. The difference between these distances, corrected by the index of refraction of the pressure transmitting media, is the height. The height and area of the sample, measured with a calibrated microscope image, are then multiplied to calculate the sample volume. This direct volume measurement allows the EOS of an amorphous or inhomogeneous sample to be determined. I also regularly perform high-pressure and high-temperature EOS measurements using single-crystal and powder XRD on EMs at ANL APS and the Advanced Light Source at Lawrence Berkeley National Laboratory.

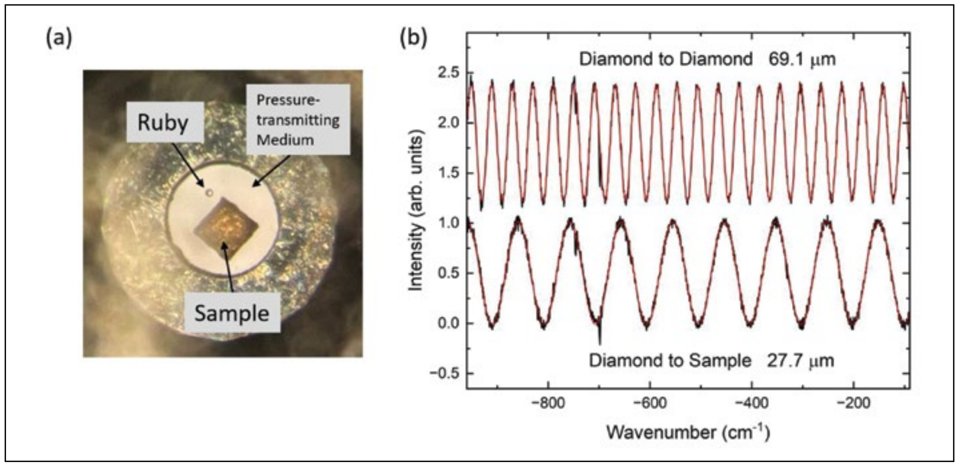
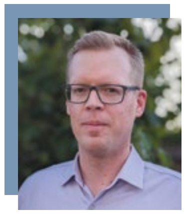


Figure 1. (a) Image of the sample chamber for a typical OMI measurement. The gold sputtered sample is placed in the sample chamber along with ruby for pressure measurement and surrounded by a pressure-transmitting medium. (b) White light interferometry spectra with sine fits and calculated diamond-to-diamond and diamond-to-sample distances.

I sought employment at an NNSA laboratory, because I am very interested in the types of research at the laboratories and the missions they support. LLNL is a diverse work environment, where I can apply my DAC skills and knowledge of condensed matter physics while also constantly learning new skills. There constantly are new problems to be solved allowing for creativity. The ability to work on several different projects at once allows for variety. The national laboratories also have world-class facilities which enable in-house research and the ability to work with the experts who operate the facilities.

Marc-Andre Schaeuble (mschaeu@sandia.gov) | Sandia National Laboratories
Years at SNL: 2018 - Present ✦ **Degree:** PhD, Astronomy ✦ **SSAA:** 2017 - 2018, University of Texas at Austin



I am an experimental physicist at Sandia National Laboratories' (SNL) Z-machine, currently the most powerful pulsed power accelerator on Earth. My research focuses mainly on developing laboratory X-ray sources that can be used to perform stockpile stewardship qualification tests. I perform experiments that enable other researchers to use fully-developed X-ray sources for material assessments. Additionally, I lead inertial confinement fusion (ICF) experiments that provide validation data for high energy density physics codes used at NNSA laboratories. The data collected for each experiment includes X-ray spectra, imaging, and timing, as well as neutron signals for the ICF shots. To analyze all these data, I use traditional analysis methods as well as Bayesian statistics, data science, and machine learning techniques. Accurate experimental analysis is particularly important, since I work closely with modelers to understand how well my results compare to their predictions. This comparison process highlights essential physics in the experiment and potential weaknesses in the simulation codes. Investigating each aspect is important, since we actively are developing new stockpile stewardship experimental platforms and are trying to predict the behavior of current experimental platforms on a future pulsed power facility.

I first was exposed to the Stewardship Science Academic Alliances (SSAA) program in 2017, when my PhD advisors at University of Texas at Austin received funding for a SSAA Center of Excellence. At that time, we were performing experiments at the Z-machine that aimed to validate hydrogen and helium line shape models used by the astrophysical community to infer masses of White Dwarf (WD) stars. WDs are the oldest known stars, and their masses are critical for independently deriving the age of the universe. Our experiments found that hydrogen line shape models predict different masses for different lines, making these models unsuitable to use in age determination studies (Figure 1). Helium experiments revealed that these

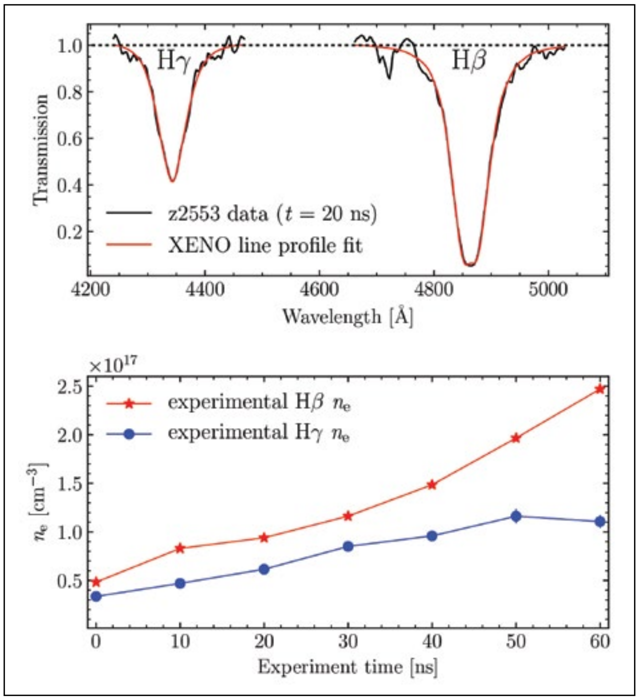
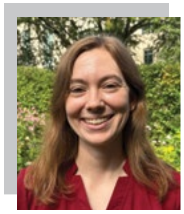


Figure 1. Top: hydrogen line-shape model fits to Hβ and Hy lines recorded during Z experiment z2553. Bottom: electron density (ne) measurements resulting from line shape fits depicted in top panel. When applied to WDs, the Hβ and Hy ne disagreement would result in different stellar masses obtained from the Hβ and Hy lines. Such mass trends are unphysical and highlight potential weaknesses in hydrogen line-shape models. From Schaeuble et al. (2019), ApJ.

line shape models are more reliable and should result in accurate age measurements. We initially only shared our results with the WD community, but being part of a SSAA center resulted in much greater access and connection to the NNSA laboratory community. Attending the yearly SSAP symposia gave me a detailed overview of all the work being done by other students and how our efforts fit into the larger NNSA mission. Through SSAA, I was also able to foster professional contacts with staff members at multiple NNSA laboratories that later translated to postdoc and staff job opportunities. Further, I had the opportunity to explore postdocs at NNSA partner labs in France by attending an SSAA-sponsored postdoc exchange workshop in Paris. NNSA Center of Excellence funding generally persists on much longer time scales compared to regular grant funding. I, therefore, could fully focus on my PhD research without having to worry about funding cycles.

My decision to pursue a career at a NNSA national laboratory was shaped largely by all the positive experiences I had with SSAA during graduate school. I learned that each NNSA laboratory has distinct scientific capabilities that allows for the investigation of physics that cannot be probed anywhere else. Coupled with those extraordinary capabilities are world-class scientists at each laboratory that are highly knowledgeable and provide great mentorship to their early-career colleagues. After having been a SNL staff member for nearly five years, I have come to enjoy the culture of scientific freedom and discovery fostered at NNSA laboratories. I have had the opportunity to explore several different areas of science, including, most recently, machine learning and data science. As my career progresses at SNL, I am confident that I will continue to grow as a scientist and meaningfully contribute to the stockpile stewardship endeavor.

Hannah Bausch (hannah@earth.northwestern.edu) | Northwestern University
Degree in Progress: PhD, Earth and Planetary Sciences ✦ **Advisor:** Dr. Steve Jacobsen ✦ **SSAA:** 2018 - Present



Research Topic

Shock-ramp Compression of (Mg,Fe)O up to Earth's Core Conditions

Research Responsibilities

Where Earth's iron core and silicate mantle meet is a region that is integral to the thermal evolution and dynamics of the mantle, yet the core-mantle boundary (CMB) still is poorly understood. Seismological results suggest the presence of ultra-low velocity zones sitting directly atop the core. One possible explanation for these features is that they are regions of highly iron-enriched ferropericlase (Mg,Fe)O. I am using Sandia National Laboratories' (SNL) Z machine to shock-ramp (Mg,Fe)O containing 0, 25, and 50 mol% Fe in order to determine the influence of iron enrichment in (Mg,Fe)O on sound velocities at P-T conditions following isentropic paths similar to the geotherm. I am responsible for synthesizing and characterizing polycrystalline (Mg,Fe)O samples used in the Z experiments. In advance of experiments, I use density functional theory molecular dynamics (DFT-MD) in order to predict how (Mg,Fe)O behaves during a shock-ramp experiment. DFT-MD results also fill in the gaps left by the limited number of Z experiments we can perform, so that we maximize our return on the data we collect. Sound speeds and other thermodynamic results from experiments and theory will allow us to interpret the origin of ultra-low velocity zones on the CMB.

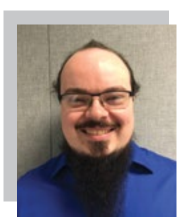
Benefits of SSAA

The SSAA has been an integral part of my PhD educational experience. For me, one of the best things about being involved with the SSAA is the level of collaboration I can access within the national labs. I meet with an SNL scientist weekly through video conference calls and have been able to visit and perform experiments at SNL in Albuquerque several times. Through the SSAA, I have been given the opportunity to travel to several conferences, where I've been able to meet with colleagues are learn about opportunities available throughout the NNSA.

What Students Considering SSAA Should Know

Being involved with SSAA is a great way to learn what it is like to work in a national lab environment and what kinds of problems DOE/NNSA national labs are trying to solve. The SSAA has provided me with numerous opportunities to collaborate with national laboratory scientists and has exposed me to different career paths within and beyond the DOE.

Daniel Lay (lay@frib.msu.edu) | Michigan State University
Degree in Progress: PhD, Physics ✦ **Advisor:** Dr. Witek Nazarewicz ✦ **SSAA:** 2019 - Present



Research Topic

Emulator Development for Theoretical Nuclear Fission Calculations

Research Responsibilities

Nuclear fission is a complicated process that still is not well understood from a microscopic point of view. Nevertheless, it is critically important to understand, due both to the role of nuclear fission in physical processes such as r process nucleosynthesis and the national security concerns surrounding fission. Many nuclei under consideration are not accessible in a laboratory setting, and, thus, theoretical models are required. We use nuclear density functional theory (DFT), because it is based on a microscopic model of the nucleon-nucleon interaction. However, DFT is computationally expensive, prohibiting both large-scale calculations and uncertainty quantification. As such, my research focus is on the development of model emulators for DFT theory. Even relatively simple machine learning techniques are capable of reproducing the DFT calculations, enabling fast calculations of nuclear fission observables across the chart of nuclides. Further methods are under development for even greater speed-ups, to help put trustworthy error bars on our predictions, via Bayesian uncertainty quantification.

Benefits of SSAA

First and foremost, the support I have received from the Stewardship Science Academic Alliances (SSAA) has given me the opportunity to study nuclear fission during my PhD. In studying fission, I have developed a number of technical skills, from traditional high-performance computing to frontier approaches to machine learning and model emulation, that are not present in many other research fields.

Next, the annual Stewardship Science Academic Programs Symposium has given me opportunities to both present my work to, and attend presentations by, an incredibly diverse audience of scientists, including those that are not nuclear physicists. And, the SSAA has highlighted the large number of job opportunities that are available at national laboratories, which is helpful as I consider my future career options.

What Students Considering SSAA Should Know

The SSAA enables collaborations with scientists at top-tier national laboratories. These collaborations lead to incredible scientific results, and the connections that are made with both the scientists and the laboratories are incredibly helpful when deciding on a future career.

Ashton Morelock (amorelock@fsu.edu) | Florida State University
Degree in Progress: PhD, Nuclear Physics ✦ **Advisor:** Sergio Almaraz-Calderon ✦ **SSAA:** 2021 - Present

Research Topic

Neutron Spectroscopy Studies using (d,n) and (^{3}He,n) Reactions

Research Responsibilities

My research delves into the advancement of nuclear instrumentation and its application in investigating the nuclear structure of 18-neon (^{18}Ne). Nuclear properties of the neutron-deficient nucleus ^{18}Ne are needed to reduce uncertainties in the reaction rate calculations of the sequence ^{14}O(α,p) ^{17}F(p,γ) ^{18}Ne, which leads to breakout from the hydrogen-carbon-nitrogen-oxygen cycle. Reaction rates are critical in understanding the nuclear evolution of stellar environments such as Classical Novae and Type I X-ray Bursts. Branching ratio measurements of resonance states in ^{18}Ne through the SiO(^{3}He,n) reaction were performed at the John D. Fox Laboratory at Florida State University using the CATRiNA neutron detector array in conjunction with the CHARON silicon detector array for coincidences between neutrons and charged particles. Additionally, a full characterization of the CATRiNA neutron detector array was performed through reactions ^{9}Be(d,n), ^{27}Al(d,n), and ^{12}C(d,n) at the Edwards Accelerator Laboratory at Ohio University. A method for extracting neutron energies without relying on time-of-flight information, called ``spectrum unfolding", was developed and tested against time-of-flight (ToF) neutron energies with the ^{12}C(d,n) ^{13}N reaction.

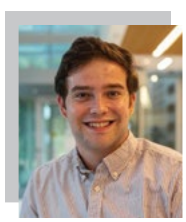
Benefits of SSAA

The Center for Excellence in Nuclear Training and University-Based Research (CENTAUR) has greatly benefitted me throughout my graduate career. Being a CENTAUR student provided me with multiple opportunities to visit national laboratories, collaborate with other institutions, and network with my peers. These experiences have proved invaluable to my growth as an experimental nuclear physicist.

What Students Considering SSAA Should Know

Students are afforded multiple opportunities that can enhance their academic career through joining a collaboration such as CENTAUR. By traveling to the various conferences held throughout the year, you are exposed to a broad array of topics in nuclear physics, and you get the chance to meet new people in the field. Not only that, but you also can present your own research and gain valuable feedback from the various experts within the collaboration. Being a CENTAUR student has truly been one of the most positive and influential experiences in my graduate career.

Daniel Rubio-Ejchel (danrubio@umich.edu) | University of Michigan
Degree in Progress: PhD, Mechanical Engineering ✦ **Advisor:** Dr. Jerard Gordon ✦ **SSAA:** 2021 - Present



Research Topic

Additive Manufacturing of Complex Concentrated Alloys

Research Responsibilities

My research responsibilities include intelligently designing and additively fabricating samples of new alloys. I also metallographically characterize and mechanically test these samples to understand their unique characteristics.

Benefits of SSAA

I have benefitted from the SSAA by having the opportunity to develop not only my technical skills but also by getting to present and explain my work to a large Center. This extra practice of communication and team collaboration has been extremely useful and is probably the biggest advantage of SSAA.

What Students Considering SSAA Should Know

As a member of the SSAA through the Center for Research Excellence on Dynamically Deformed Solids (CREDDS), I have had many opportunities that would have been otherwise unattainable. Being in a multi-university center has facilitated collaborations that make my research possible. For example, I have visited fellow CREDDS PhD candidate Lauren Poole at the University of California Santa Barbara, where we tested samples that I created in compressive and tensile split-Hopkinson pressure bar experiments. I also attended the annual Stewardship Science Academic Programs Symposium for the past two years, where I practiced my scientific communication skills for audiences outside of my narrow fields of additive manufacturing and dynamic deformation. Through this I was able to tour Los Alamos National Laboratory and learn about the exciting work being done under the National Nuclear Security Administration umbrella.

National Laboratory Experience

In the Fall of 2022, I was able to visit Lawrence Livermore National Laboratory (LLNL) as an academic cooperation program participant for six weeks, where I was hosted and mentored by John Roehling, Thomas Voisin, Nick Calta, and Joe Mckeown. Through my scientific collaboration with them, I was able to leverage the lab facilities to advance my own research and academic career. I witnessed first-hand how scientific work is accomplished at the highest level and was even able to sit in on an interview of a prospective postdoctoral fellow. I toured the National Ignition Facility (NIF) where, just days after my tour, the first ever successful fusion experiment occurred fifteen feet from where I was standing. I then returned to LLNL during the Summer of 2023 through the Materials and Chemistry Institute internship program, where I used my experience in additive manufacturing and design to revamp the same custom additive manufacturing machine I employed in my previous stay at the lab.

Students

For me, one of the best things about being involved with the SSAA is the level of collaboration I can access within the national labs. I meet with an SNL scientist weekly through video conference calls and have been able to visit and perform experiments at SNL in Albuquerque several times. Through the SSAA, I have been given the opportunity to travel to several conferences, where I've been able to meet with colleagues are learn about opportunities available throughout the NNSA.

Hannah Bausch
Northwestern University

Students are afforded multiple opportunities that can enhance their academic career through joining a collaboration such as CENTAUR. By traveling to the various conferences held throughout the year, you are exposed to a broad array of topics in nuclear physics, and you get the chance to meet new people in the field. Not only that, but you also can present your own research and gain valuable feedback from the various experts within the collaboration.

Ashton Morelock
Florida State University

The SSAA enables collaborations with scientists at top-tier national laboratories. These collaborations lead to incredible scientific results, and the connections that are made with both the scientists and the laboratories are incredibly helpful when deciding on a future career.

Daniel Lay
Michigan State University

Through my scientific collaboration with them [LLNL], I was able to leverage the lab facilities to advance my own research and academic career. I witnessed first-hand how scientific work is accomplished at the highest level and was even able to sit in on an interview of a prospective postdoctoral fellow. I toured the National Ignition Facility (NIF) where, just days after my tour, the first ever successful fusion experiment occurred fifteen feet from where I was standing.

Daniel Rubio-Ejchel
University of Michigan

High Energy Density Laboratory Plasmas

High-Power Photonics Using Adaptively-Controlled Plasmas as Diffractive Optical Elements | Stanford University

PI: Dr. Matthew R. Edwards (mredwards@stanford.edu)

High-power and high-energy lasers are key tools for creating and probing high energy density (HED) conditions in the laboratory. However, delicate optics limit the power that these lasers can deliver and the environments in which they can be used. This project has been supported over the past year by the National Nuclear Security Administration (NNSA) High Energy Density Laboratory Plasmas (HEDLP) program to study plasma optics as resilient replacements for solid-state optics, with the goal of developing optics suitable for high-power and high-repetition-rate laser systems. Three graduate students and an undergraduate student currently are contributing to this research. Members of the team are shown working on an experiment in Figure 1.

Figure 1. Students working on experiment. From left, Princeton PhD students Michelle Wang and Nicholas Fasano and Stanford PhD students Victor Perez-Ramirez and Ke Ou.

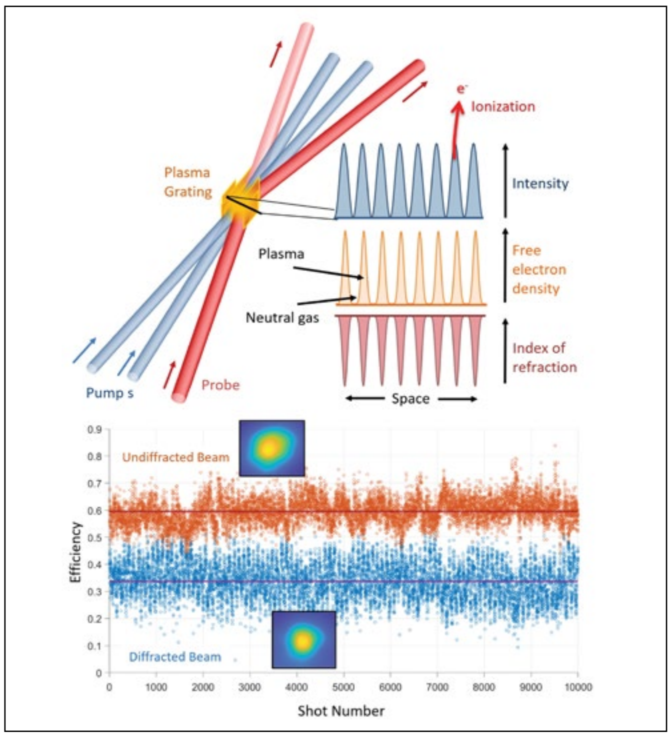


Figure 2. Schematic of plasma optic creation showing how pump and probe beams are arranged to use interference to produce an ionization grating. Below, measured diffraction efficiency over an hour of operation..

Experiments for stockpile stewardship and HED science rely on high-energy pulsed lasers (e.g., the National Ignition Facility (NIF) and the Omega Laser Facility) to create extreme high-pressure and high-temperature states and shorter-pulse, high-power systems to probe these conditions with intense optical and X-ray light. Although the experimental volumes driven to HED conditions are small microns to millimeters—the lasers required to reach these states are enormous: Omega is the size of a building, and NIF covers the area of three football fields. This difference in scales—fifteen orders of magnitude between the laser facility and the active volume of the experiment—arises, because, although a goal of HED science is to understand the behavior of light in HED environments, we rely on matter under very normal conditions to both generate and to control high-power lasers beams.

Plasma is uniquely robust to damage from high intensity light, so optics based on plasma can be much smaller than optics built with solid materials. Figure 2 shows the creation of an ionization grating, a type of plasma made by pump lasers interfering in gas. Ionization in the constructive interference fringes produces a pattern of plasma and neutral gas that acts as a diffraction grating for a high-intensity probe laser due to the difference in index of refraction between gas and plasma. The probe laser then can be turned, compressed,[1] or focused[2] using an optic operating at an intensity far beyond the damage threshold of any solid material.

Experimental measurements of the optical properties and the efficiency of the ionization gratings and the behavior of the plasma are used to validate computational and theoretical models of the system and guide optimization of these optics towards higher efficiency, stability, and energy capacity. Additionally, these experiments are used to develop and test control systems and to integrate diagnostics and actuators for high-repetition-rate laser plasma experiments. As shown in Figure 2, these efforts are leading to substantial improvements in diffraction quality and repeatability, despite the extreme nonlinearity of the grating formation and the fundamental instabilities of plasmas. The stability plot shows a 35% diffraction efficiency of a plasma grating system maintained over an hour of operation, and the beam profiles indicate that the grating maintains the spatial quality of the beam.

The experiments are performed by students on student-run, terawatt-scale laser systems, providing regular interactions with a hands-on training platform for high-repetition-rate, high-power laser science and experimental plasma physics. In addition to experiments, students supported by this project run both simple computational models and large-scale simulations, and practice both validating computational models against experimental results.

References

[1]M.R. Edwards and P. Michel, Phys. Rev. Appl. 18, 024026 (2022).

[2]M. R. Edwards, et al., Phys. Rev. Lett. 128, 065003 (2022).

Probing Transport Mechanisms in High Energy Density Flows | University of Rochester

PI: Dr. Jessica K. Shang (j.k.shang@rochester.edu)

Measuring transport properties is critical to accurately modeling the mixing and instabilities found in processes such as in inertial confinement fusion. Whereas estimates for transport coefficients exist using various theoretical and computational methods, these values can differ by several orders of magnitude.[1] A collaboration between the University of Rochester (UR) and the Stanford Linear Accelerator Center focuses on experimental measurements of shear viscosity of materials at high energy density (HED) conditions, funded by the High Energy Density Laboratory Plasmas (HEDLP) program. Since 2018, the National Nuclear Security Administration (NNSA) has supported this collaboration to probe fundamental hydrodynamic properties. The grant supports three graduate students, one of whom is also a Frank Horton Graduate Research Fellow at the Laboratory for Laser Energetics (LLE), and two undergraduate students.

Shear viscosity is the resistance of a fluid to shear stress. For conventional fluids, this property can be measured readily with a tabletop experiment. However, these methods cannot be applied to HED plasmas that are at high pressures and temperatures. One of the objectives of this effort is to develop platforms to implicitly measure viscosity at user facilities that are capable of generating HED conditions by shock-compressing the material and simultaneously forcing the material to flow in a way where viscous effects are quantifiable. Two approaches are being developed. In the first approach, tracer particles that are embedded in the material of interest are forced to move with the flow, and so the viscous force contribution can be inferred from the acceleration of the tracer particles. In the second approach, the amplitude and oscillation of a propagating rippled shock is modulated by the viscosity which can be determined by comparing the dynamics of shocks of different wavelengths.

In the past year, the graduate students with this project have analyzed experimental data to extract the viscosity and quantify uncertainties, while also planning additional experiments that will advance these methods. Graduate students have been Principal Investigators (PIs) or co-PIs on experimental campaigns on the OMEGA and OMEGA-EP laser facilities at LLE, facilitated by the LLE Laboratory Basic Sciences program and the National Science Foundation Physics Frontier Center for Matter at Atomic Pressures program. This means that the students are critical in planning and executing these experiments, from simulations, to target design, to configuring the diagnostic parameters. In the particle acceleration experiment, for example, students, Afreen Syeda and Kelin Kurzer-Ogul, have partnered up, using Kelin's simulations to understand the detailed flow field around the particle (Figure 1) and how that might contribute to the distribution of viscosity that Afreen has calculated for epoxy from the experimental data (Figure 2). Since the choice of particle material likely affects its trajectory, Afreen conducted an additional experiment using different particles. To accurately simulate this problem and related ones, Kelin spent the summer at Los Alamos National Laboratory (LANL) to hone his skills with xRAGE, a LANL code. Meanwhile, for the rippled shock experiment, the student, Nitish Acharya, has refined the experimental configuration to increase the resolution of a rippled shock propagating in fused silica from the velocity interferometry diagnostic (Figure 3) compared to the pilot experiment conducted the previous year. He is collaborating on other rippled shock experiments on other laser facilities, such as Janus at Lawrence Livermore National Laboratory.

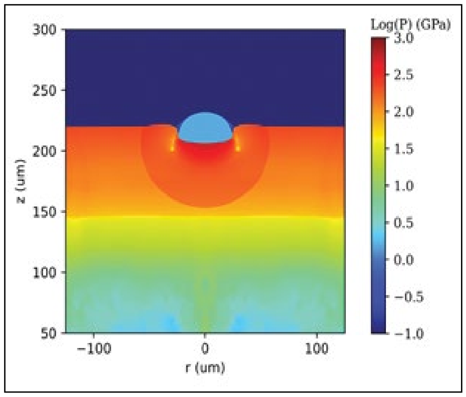


Figure 1. Pressure distribution in the epoxy during a shock-particle interaction, simulated with xRAGE.

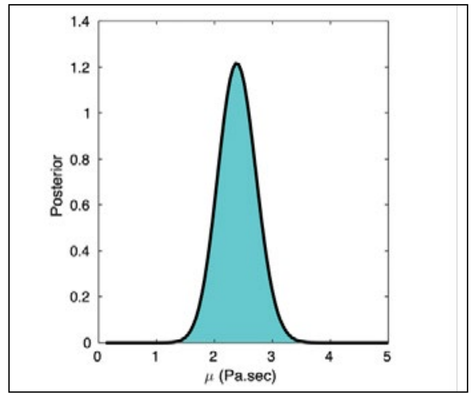


Figure 2. Posterior probability distribution of the shear viscosity of epoxy, determined from the acceleration of tracer particles.

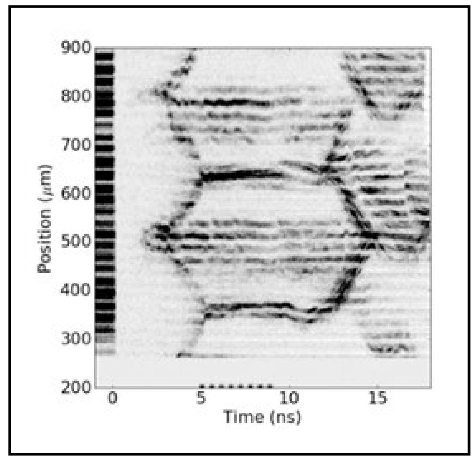


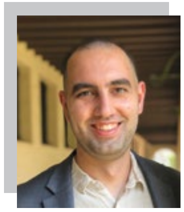
Figure 3. Velocity interferometry image for a rippled shock propagating through fused silica.

Reference

[1]Grabowski, P. E., et al., "Review of the first charged-particle transport coefficient comparison workshop." High Energy Density Physics 37 (2020): 100905.

Matthew Carrier (carrierm@vt.edu) | Virginia Polytechnic Institute and State University
Degree in Progress: PhD, Applied Physics, Aerospace and Ocean Engineering ✦ **Advisor:** Dr. Bhuvana Srinivasan ✦ **HEDLP:** 2019 - Present

Research Topic



Characterization of the Electrothermal Instability to the Magneto–Rayleigh-Taylor Instability Transition and Growth in Megaampere-Scale, Pulsed-Power–Driven Conductors

Research Responsibilities

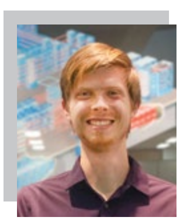
Early experimental studies into magneto- inertial fusion concepts like magnetized liner inertial fusion (MagLIF) have indicated the presence of azimuthally-correlated magneto–Rayleigh-Taylor instability (MRTI) structures when no external, axial magnetic field was applied to the imploded target. Helical structures have been observed when an external, axial magnetic field is applied to the target. The electrothermal instability (ETI) has been suggested as a seeding mechanism for both of these observed macroscale instabilities, motivating research into early-time evolution of the ETI, subsequent ETI to MRT evolution, and whether the ETI plays a role in the development of these helical structures. My computational research has used the multi-physics code, ARES, developed at Lawrence Livermore National Laboratory (LLNL) to perform resistive magnetohydrodynamic simulations of how the ETI grows from microscale surface roughness imparted onto the conductor during machining. I have postdictively validated these arbitrary Lagrangian-Eulerian simulation models using experimental data collected by University of Nevada, Reno (UNR) colleagues working with the Mykonos linear transformer driver facility at Sandia National Laboratories (SNL). To aid in studying the evolution of the ETI to MRTI, I am running simulations of the ETI to MRTI transition in MagLIF-like liners and am developing a neural network that uses Koopman theory to characterize the nonlinear dynamics of the system.

Benefits of HEDLP

The HEDLP program has provided me with opportunities to collaborate with students, faculty, and staff at three other universities and three national laboratories: UNR, the University of New Mexico, the University of Washington, LLNL, SNL, and Los Alamos National Laboratory. This has led to a collaborative, supportive environment among the university teams resulting in joint publications. Additionally, it has led to me joining the Academic Cooperation Program at LLNL, through which I've been the recipient of outstanding mentorship from Dr. Will Farmer. This collaboration, in turn, led me to intern at LLNL during the summer of 2022 through a Defense Science and Technology Internship. These opportunities have enabled me to engage with staff members, including computational physicists, plasma design physicists, and many others, at LLNL. Discussions with these staff members and others have increased my knowledge of high energy density (HED) physics, led to new research directions, and set me up for a promising future in HED physics.

Timothy Mark Johnson (tmarkj@mit.edu) | Massachusetts Institute of Technology
Degree in Progress: PhD, Physics ✦ **Advisor:** Dr. Chikang Li ✦ **SSAA:** 2018 - Present

Research Topic



Biermann Battery-Driven, Collisionless Shocks in Laser-Driven Plasmas

Research Responsibilities

I have designed and performed two experiments at the Omega Laser Facility. These experiments generate and probe the collisionless interaction between a supersonic plasma flow and a hydrogen plasma produced by the gas jet. Spontaneous Biermann battery magnetic fields, generated by the laser drive, are frozen into the plasma flow. These fields are compressed in the interaction with the gas jet and result in the formation of a magnetized, collisionless shock precursor.

It was my job to design the experiment to utilize the gas jet system at OMEGA. The addition of using the gas jet allowed for much better diagnostic access to the experiment. As a result, I was able to collect some really interesting Thomson scattering and proton radiography data. These data showed a strong density jump from the forming shock moving at around 1000 km/s.

In addition to performing experiments and analyzing experimental data, I am responsible for conducting large scale simulations to study the physics of the experiment. Running both magnetohydrodynamics and particle-in-cell simulations has been a good learning experience for me. With both of these types of simulations, I was able to explain the physics of the experiment and show agreement between simulation and experimental data.

Benefits of HEDLP

The HEDLP program has been essential to my studies of laboratory astrophysics. In addition to providing the hands-on opportunities for experiments and numerical simulations, it has helped my work by enabling me to attend different conference like the American Physical Society Division of Plasma Physics meeting and the Stewardship Science Academic Program symposium. Hearing feedback from others and seeing how other people think about problems has helped me elevate the quality of my work. Attending these conferences also has let me meet many scientists who work at the national laboratories and expand my professional network.

What Students Considering HEDLP Should Know

I first learned about laboratory astrophysics and high energy density physics (HEDP) during an internship at Lawrence Livermore National Laboratory, while I was an undergraduate. It was directly because of this experience that I decided to go to graduate school and stay in the field of HEDP.

The HEDLP program has enabled my time in graduate school to bring me closer to my goal of having a career at a NNSA national lab.

Facility Access and Community Development Programs

Facility Access

The Facility Access Program supports travel for researchers who are granted experimental time at the Omega Laser Facility, Discovery Science at the National Ignition Facility (NIF), and other National Nuclear Security Administration (NNSA) user facilities. This provides hand-on research experience to academic and industrial researchers using NNSA user facilities as tools for conducting basic research experiments. In the pursuit of fundamental science advances, the innovative development of diagnostics and platforms by user facility partners often has proven to benefit NNSA experimental needs.

Experiments on the Omega-60 laser facility at the Laboratory for Laser Energetics (LLE) explore radiative shocks in strongly-coupled plasmas (Figure 1). This work under Dr. Carolyn Kuranz, funded through the Stewardship Science Academic Alliances (SSAA) program, provides information about an interesting regime of radiation hydrodynamics that is relevant to neutron star envelopes using laser-driven capsule implosions with a metal lining on the interior surface. The facility access program supported the travel to LLE of two graduate students and a postdoc, which was very helpful for the overall success of the shot day and in improving the students' understanding of the experiments.

– Heath LeFevre, University of Michigan

The High Energy Density Laboratory Plasmas (HEDLP) facility access program supported University of South Florida (USF) researchers to travel to Lawrence Livermore National Laboratory (LLNL) to perform Discovery Science experiments at NIF. Ivan Oleynik and his postdoctoral associates from USF, Jonathan Willman and Kien Nguen Cong, traveled to the NIF in February 2023 to perform the first experiment of the Discovery Science campaign, Defeating Slow Kinetics of Diamond to BC8 Post-diamond Phase Transition (Figure 2). The goal of this collaborative project led by principal investigators (PIs), Ivan Oleynik (USF) and Marius Millot (LLNL), is to synthesize the long-sought BC8 high pressure post-diamond phase of carbon by employing NIF's unique capabilities including precise pulse shaping, the in-situ target diffraction platform (TARDIS), and the velocity interferometry for any reflector (VISAR) and streaked optical pyrometry (SOP) diagnostics. The experiments are guided by large-scale, billion atom molecular dynamics simulations performed on the first Frontier exascale supercomputer at the Department of Energy's Oak Ridge National Laboratory. The campaign consists of four experiments.

– Ivan Oleynik, University of South Florida

Community Development

Community Development provides specialized educational opportunities that both train and attract students to high energy density science. The High Energy Density Laboratory Plasmas (HEDLP) program provides travel support for students and postdocs to attend the High Energy Density Science summer school and various facility workshops.

High Energy Density Science Summer School

This two-week summer school promotes scholastic development through technical lectures given by field experts and professional development sessions aimed at early-career researchers in high energy density science fields of study. The summer school is held annually at either the University of California San Diego (UCSD) or the University of Michigan. In 2023, the summer school was held at UCSD and had more than 125 attendees (Figure 3). The HEDLP's community development effort provided travel funds for 30 participants.

– Farhat Beg, UCSD

The National Ignition Facility & Jupiter Laser Facility User Groups Meeting

The National Ignition Facility (NIF) & Jupiter Laser Facility (JLF) User Groups Meeting took place in Livermore, CA on February 21-23, 2023. The meeting was held at the Garré Winery near Lawrence Livermore National Laboratory (LLNL). Nearly

Figure 1. These experiments on the Omega-60 laser facility at the Laboratory for Laser Energetics explore radiative shocks in strongly coupled plasmas. This work, funded through the SSAA program, provides information about an interesting regime of radiation hydrodynamics that is relevant to neutron star envelopes using laser-driven capsule implosions with a metal lining on the interior surface. The facility access program supported the travel of two graduate students and myself, a postdoc, to the shots, which was very helpful for the overall success of the shot day and in improving the students' understanding of the experiments.

Figure 2. Members of the carbon BC8 collaborative Discovery Science team after the February 28, 2023 experiment (from left): Andy Krygier, Montu Sharma, Neal Bhandarkar, Kien Nguyen Cong (USF), Raymond Smith, Ivan Oleynik (PI, USF), Jonathan Willman (USF), Sebastien Hamel, Federica Coppari, and Marius Millot (PI, LLNL). At right is NIF Facility Manager Bruno Van Wonterghem.

Figure 3. High Energy Density Summer School.

200 registered attendees gathered (Figure 4) to hear presentations on big questions in high energy density (HED) science, current NIF Discovery Science experimental campaigns, recent JLF results, the status of capability development and refurbishment at both the NIF and the JLF, updates on the nation's basic research needs for inertial fusion energy, and the National Academies of Science recommendations for the future of HED science in the U.S. Nearly 80 posters were presented by students and post-docs. 35 graduate students received travel support from HEDLP's community support effort.

– Kevin Fournier, LLNL

2023 Z Fundamental Science Workshop

The Z Fundamental Science Workshop is a key aspect of the Z Fundamental Science Program. This workshop, which has been held annually since 2010, consists of both Plenary and Breakout sessions. The Plenary sessions are meant for the external Z user community to hear about the Z accelerator facility status and future plans, receive an update on Z diagnostics capabilities, and for collaborative users to present the status of their research. The Breakout sessions provide opportunities for current and prospective future collaborators to discuss research directions and ideas for new work on Z; many of these discussions are the genesis of Z Fundamental Science Proposals. The 14th Z Fundamental Science Workshop was successful, with 130 in-person attendees (78 external to Sandia National Laboratories) from 32 institutions and 4 countries, including 32 students and 12 postdoctoral fellows (Figure 5). Many of the students and post docs (21 total) were able to attend through the generous support of the HEDLP's Community Support effort. This group was very engaged during the workshop and many enthusiastically participated in the poster session. Student and postdoctoral fellow involvement in the workshop is critical to growing the user base for Z and attracting the next-generation of talent to the Pulsed Power Sciences Center at Sandia.

– Marcus Knudson, SNL

Figure 4. NIF & Jupiter.

Omega Laser Users' Group Workshop

On April 26-28, 2023, 162 researchers from more than 40 Universities and laboratories gathered at the Laboratory for Laser Energetics (LLE) for the 14th Omega Laser Facility Users Group (OLUG) Workshop (Figure 6).

Figure 5. Z Fundamental Workshop.

Figure 6. Omega Laser User's Group (OLUG Workshop

The meeting is a unique instance at which researchers from all over the world can gather and present their research and establish collaborations. These interactions bring new and exciting research to the facility and help advance the high energy density science field. The main goal of the three-day workshop is to facilitate a continuing dialog between the Omega users, the users and LLE management, and the users and the broader scientific community and to provide an opportunity for students and postdoctoral fellows to present their research at LLE in an interactive and informal atmosphere. Of the 162 participants, one third of those attended virtually. Almost half of the workshop participants were young researchers. Travel grants were awarded to 41 participants in this category thanks to NNSA sponsorship, which enabled their participation in an evening tutorial and poster presentation session, among other activities.

Notably, of the 81 research posters, 64 were presented by high school, undergraduate, and graduate students as well as postdoctoral researchers. The experience enabled a dialog about student experiences running experiments at Omega with other researchers.

– Maria Pia Leiva Valdivia, UCSD

Predictive Science Academic Alliance Program III

Overview

Multidisciplinary Simulation Centers (MSCs)

Exascale Predictive Simulation of Inductively Coupled Plasma Torches | **University of Texas at Austin | Robert Moser (rmoser@oden.utexas.edu)**

In simulating an inductively-coupled plasma torch, representing non-Maxwellian electron energy distribution requires solving the Boltzmann equation. A state-of-the-art solver has been developed, advancing capabilities supporting arbitrary anisotropic distributions, high-order accuracy, and transient solutions. Key developments include a velocity space representation using radial B-splines and spherical harmonic basis functions, formulation of electron-electron Coulomb interactions, and a transient solver with fully implicit time integration. The solver has been cross-verified with BOLSIG+ and a direct simulation Monte Carlo (DSMC) particle-in-cell (PIC) code. Ongoing work involves performance optimization using Parla and integration with the plasma torch simulator in MFEM. Led by Dr. Milinda Fernando, a Research Associate at the University of Texas PSAAP III Center, this Boltzmann solver enhances simulations of inductively-coupled plasma torch operations.

Center for Micromorphic Multiphysics Porous and Particulate Materials Simulations with Exascale Computing Workflows | **University of Colorado at Boulder | Rich Regueiro (richard.regueiro@colorado.edu)**

Recent achievements include:
(i) Calibrating parameters for LAMMPS-granular compression simulations on single sand grains to failure, extending to IDOX and Kel-F binder (Year 4: Estane binder) with quasi-static press and unconfined compression simulations; (ii) Verifying Tardigrade-micromorphic-filter upscaling and parameter calibration against classical continuum uniaxial strain elastic boundary value problem and initiating a multi-domain filter for heterogeneous grain-resolving direct numerical simulation (DNS); (iii) Establishing a procedure for collecting computerized tomography images of IDOX-Estane composite cylinders, segmenting grains, binder, and voids using Segment flow for grain-resolving DNS microstructural discretizations; (iv) Supporting the open-source release of GEOS-MPM on GitHub, with active GPU-acceleration development on Tioga; (v) Demonstrating the implementation of gradient-enhanced damage with Tardigrade-MOOSE micromorphic elasto-plastic model.

Integrated Simulations using Exascale Multiphysics Ensembles | **Stanford University | Gianluca Iaccarino (jops@stanford.edu)**

The PSAAP Center at Stanford University aims to investigate laser-induced ignition reliability in a model rocket combustor, creating probability maps for ignition successes/failures. Leveraging exascale computing and innovations in various domains, the team enhances simulation codes with subgrid-scale models, a four-equation diffuse interface model, and multi-block mesh implementation for propellant injection fidelity. Accomplishments include experimentally demonstrating ignition with liquid propellants. In data science, efforts yielded a machine learning model for fuel atomization, online training of machine learning models for uncertainty quantification, and unsupervised ignition learning from experimental and computational data using autoencoders. The Center combines computational advancements with experimental validation to comprehensively understand laser-induced ignition dynamics.

Center for Exascale-Enabled Scramjet Design | **University of Illinois at Urbana-Champaign | Jonathan Freund (jbfreund@illinois.edu)**

The Center for Exascale-Enabled Scramjet Design (CEESD) presents MIRGE, a platform-portable approach for massive-scale multi-physics simulation. In MIRGE, intuitive Python drivers express the math (M) of governing physics equations, linking to numerical discretization. Demonstrated with discontinuous Galerkin, it solves compressible flow equations coupled with thermal heating, carbon oxidation, surface radiation, and porous media transport in a scramjet combustor wall lining. Computational kernels transform into an intermediate representation (IR), enabling lazy evaluation. OpenCL code is generated (G) and executed (E) on CPUs or GPUs, showcased on various systems, including laptops, LLNL Quartz, Lassen, Tioga, and NCSA Delta, reaching up to 2048 V100 GPUs on 512 Lassen nodes. Physics-targeted experiments interactively guide the supersonic combustion and wall material response model within a uncertainty quanitification (UQ) description.

Single-Discipline Centers (SDCs)

Center for Hybrid Rocket Exascale Simulation Technology | **University at Buffalo | Paul DesJardin (ped3@buffalo.edu)**

The Center for Hybrid Rocket Exascale Simulation Technology (CHREST) explores turbulent reacting flow physics in hybrid rocket motors using exascale computing and machine learning-based model reduction for optimization and uncertainty quantification. The recent focus involved analyzing a small-scale slab burner through direct numerical simulation (DNS), incorporating detailed chemistry, heat/mass transfer, and radiation solvers. CHREST automated an ensemble of DNS simulations, training surrogate models (GPR/multiscale). The Center has shifted towards applying insights and software to real-world applications, such as modeling the NASA Ames Peregrine hybrid rocket motor. CHREST developed a detailed reaction mechanism for $C_{16}H_{34}$ paraffin combustion, validated for ignition delay time predictions. New near-wall modeling for turbulent flows with surface blowing enhances understanding. These efforts culminate in an integrated simulation tool to study fuel atomization and combustion in high-regressing fuels in hybrid rocket motors.

Center for Exascale Simulation of Material Interfaces in Extreme Environments | **Massachusetts Institute of Technology | Youssef Marzouk (ymarz@mit.edu)**

The overarching goal of CESMIX is to predictively simulate the degradation of complex materials, from first principles. As an exemplar, we consider materials used for thermal protection of hypersonic vehicles, exposed to extreme temperatures, heat fluxes, and oxidative environments. CESMIX is developing an automated multiscale workflow to predict materials degradation, with chemical accuracy; and a composable high performance computing workflow that makes central use of the Julia language.

Key accomplishments this year include developing and validating new interatomic potentials for hafnium oxidation, based on proper orthogonal descriptors (POD). POD potentials are now integrated with the LAMMPS molecular dynamics simulator and with the Halide domain-specific language. CESMIX has expanded capabilities of the Julia molecular simulation ecosystem, demonstrating composable workflows for active learning and automated potential fitting, and introduced a new multi-task learning framework for combining multiple density functional theory predictions. The Center has also emphasized compiler technologies for parallel performance/portability, expanding the OpenCilk compiler to handle new languages, runtimes, and hardware.

Focused Investigatory Centers (FICs)

Center for Exascale Monte Carlo Neutron Transport | **University of New Mexico** | **Patrick Bridges (patrickb@unm.edu)**

The Center for Understandable, Performant Exascale Communication Systems (CUP-ECS) focused its recent research on enhancing support for irregular and GPU-based communications in NNSA applications and performance portability frameworks. Notably, they integrated Kokkos with ExaMPI to develop new communication abstractions and incorporated optimized irregular neighborhood collectives into HYPRE and Trilinos via the MPI Advance library. CUP-ECS also examined the performance of existing communication primitives on modern systems, introducing the Beatnik benchmark for DOE application challenges and Pulse, a framework for GPU communication tradeoffs. Additionally, four CUP-ECS personnel joined NNSA national laboratories in full-time roles or as postdoctoral fellows. This work aims to advance communication systems for exascale computing, emphasizing performance and productivity in contemporary programming languages and systems.

Solution-Verification, Grid-Adaptation and Uncertainty Quantification for Chaotic Turbulent Flow Problems | **University of Maryland** | **Johan Larsson (jola@umd.edu)**

The UMD/MIT/USC Focused Investigatory Center, focused on turbulent flow problems, applied the "space-split sensitivity" (S3) method to turbulent channel flow, a first for the Navier-Stokes equations. The team now assesses how algorithm approximations impact accuracy and computational cost, exploring connections between S3 method approximations and other sensitivity algorithms based on information theory and turbulence modeling. Upcoming plans include comparing sensitivity algorithms on an accelerated/decelerated turbulent boundary layer. The Center aims to produce a combined estimated sensitivity, considering parametric uncertainties and grid resolution limitations. In the final project years, efforts will concentrate on integrating various developments for a comprehensive approach to sensitivity estimation in turbulent boundary layer problems.

Center for Exascale Monte Carlo Neutron Transport | **Oregon State University** | **Todd Palmer (todd.palmer@oregonstate.edu)**

In its first year, the Center for Exascale Monte Carlo Neutron Transport (CEMeNT) concentrated on developing two time-dependent Monte Carlo neutron transport codes. Based on Oak Ridge National Laboratory's (ORNL) Shift compiled code, one demonstrated high performance on CPUs and GPUs. The other, written in Python from scratch (MC/DC), was a sandbox for advanced algorithm exploration. Year 2 saw these research efforts mature into standalone projects as proofs of principle. Year 3, termed the "Year of Integration," aimed to incorporate new algorithms and capabilities into MC/DC. The integrated MC/DC now features time-dependent weight windows, variance deconvolution, Monte Carlo sensitivity calculations, iterated Quasi-Monte Carlo, domain decomposition, and asynchronous task scheduling for GPU execution. Year 4 focuses on assessing these features in the context of a small modular reactor transient challenge problem.

Oscar Diaz-Ibarra (odiazib@sandia.gov) | Sandia National Laboratories
Years at SNL: 2020 - Present ✦ **Degree:** PhD, Chemical Engineering ✦ **PSAAP:** 2013 - 2020, University of Utah

I was part of the Carbon-Capture Multidisciplinary Simulation Center (CCMSC PSAAP II) at the University of Utah as a PhD student, postdoctoral fellow, and research staff member. CCMSC aimed to develop and demonstrate exascale computing strategies with validation and uncertainty quantification (V&UQ) methodologies for solving large, practical problems. During my time at CCMSC, I performed various research tasks that shaped my skills to become a potential candidate for a position at a national laboratory. As a PhD student, I applied V&UQ methodologies to analyze and improve the prediction of a multi-physics, large-eddy simulations code and the quality of the experimental data collected by coal-fired devices. The results of these analyses were used to enhance laboratory equipment and models. I obtained experience in high-performance computing, Bayesian calibration, and numerical verification as a postdoctoral fellow. Finally, as a research staff member, I was responsible for the high-fidelity simulations of a biomass, thermal, power generation boiler, a pivotal component in building the Atikokan digital twin, the capstone project of CCMSC (https://chpc.utah.edu/~DigitalTwin).

I visited two national laboratories as a member of CCMSC. First, I visited Sandia National Laboratories in Livermore, California (SNL-CA), where I spent ten weeks as a PSAAP student and worked with staff members who significantly helped me to advance my research on surface reactions of coal particles. I interacted with exceptional personnel who later helped me to find a postdoctoral position at SNL-CA. Then, I joined Sandia National Laboratories in Albuquerque, New Mexico (SNL-NM) as a research staff member. During this visit, I presented a seminar about my work on digital twins. I met several researchers from the Computer Science Research Institute (CSRI), where now I work as a staff member. Finally, I visited Los Alamos National Laboratory (LANL), where I gave two seminars on digital twins for power systems. All these visits were possible because of the PSAAP program, with a notable collaboration between the SNL and LANL research staff who were part of the CCSCM's technical steering committee. I am grateful to have been part of a PSAAP Center because it allowed me to interact with staff members of three national laboratories (SNL, LANL, and Lawrence Livermore National Laboratory) during our Center meetings and my visits to their facilities. This led me to the conclusion that I wanted to pursue a career working at a national laboratory.

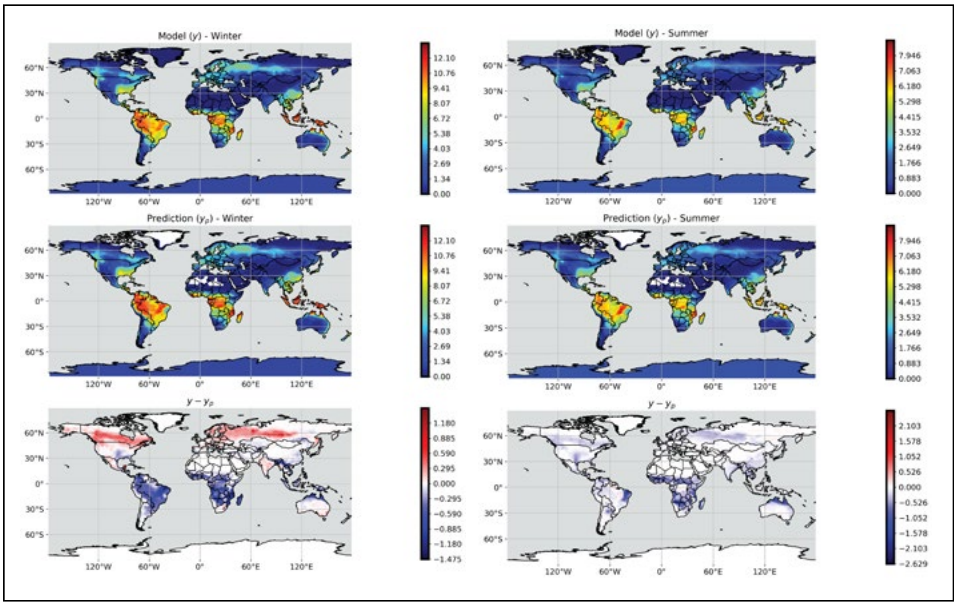


Figure 1. Residual Neural Network (ResNet)'s prediction for the gross primary productivity (GPP), a quantity of interest computed by the Energy Exascale Earth System Model (E3SM). The first row corresponds to the original E3SM outputs. In the second row are predictions from ResNet. The third row is the difference between the model and ResNet predictions. The left and right column corresponds to the winter and summer seasons, respectively.

I started working at SNL-CA as a postdoctoral appointee for the exascale catalytic chemistry (ECC) project (https://www.ecc-project.org), aiming to build predictive models for gas/solid heterogeneous catalytic systems. Specifically, I was responsible for developing software toolkits to analyze complex kinetic models (i.e., TChem (https://github.com/sandialabs/TChem), Tines (https://github.com/sandialabs/Tines), and CSPlib (https://github.com/sandialabs/CSPlib). This project gave me experience developing software tools for modern computing platforms for which performance portable libraries are required. I was interested in improving my expertise in machine learning, and SNL offers the advantage of a wide variety of research projects in which researchers can learn and improve new topics. I was involved in an Laboratory Directed Research and Development project analyzing neural networks as random dynamical systems. For this project, we employed the connection between neural networks and ordinary differential equations to build surrogate models for climate applications (Figure 1). Because I enjoyed my work during my postdoctoral position, I continued my career as a staff member at SNL. I was hired to develop software tools for the atmospheric component of the Energy Exascale Earth System Model (E3SM), mam4 (https://github.com/eagles-project/mam4xx).

My involvement in the PSAAP II, without a doubt, was the bridge to becoming part of SNL, where I enjoy interacting collaboratively with bright scientists in cutting-edge areas such as software development, high-performance computing, machine learning, climate science, and numerical methods.

Thomas Allard (thomas.allard@colorado.edu) | University of Colorado Boulder
Degree in Progress: PhD, Civil Engineering ✦ **Advisor:** Dr. Richard Regueiron ✦ **PSAAP:** 2020 - Present

Research Topic

Micromorphic Upscaling of Bonded Granular Materials

Research Responsibilities

My research responsibilities include developing workflows and methods for upscaling large, direct numerical simulations (DNS) of bonded granular materials to inform macro-scale simulations. Predicting the mechanical response and failure of heterogeneous materials has proven difficult. Multiscale numerical methods based on higher order continuum theories attempt to bridge the gap between micro- and macro-structural behavior of which micromorphic continuum theories show promise. I am using the Tardigrade software package which has capabilities to support upscaling workflows, including higher-order homogenization through the Micromorphic Filter, calibration of micromorphic material models, and macro-scale simulation in Tardigrade-MOOSE. DNS can resolve the grain-scale physics of various materials which our PSAAP multi-disciplinary simulation Center are developing to model the mechanical behavior and failure of a mock high-explosive material. DNS geometry may be generated from X-ray Computed Tomography images of this material, so the computations are very large. My role is to upscale this DNS output with Tardigrade. Macro-scale simulations run faster and with fewer computational degrees of freedom than the micro-scale DNS that inform them.

Benefits of PSAAP

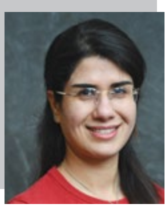
PSAAP has given me an opportunity to work on a large, multi-disciplinary team and has exposed me to many national lab researchers. It would be impossible to feed our upscaling workflow without the efforts of our experimental and DNS teams and the support of our university and national lab colleagues!

National Laboratory Experience

I have been an employee of Los Alamos National Laboratory (LANL) in the advanced engineering analysis group since January 2019. One of my primary research interests is multiscale modeling for understanding the response and failure of structures. Since I first came to LANL, I knew I wanted to continue my education in the field of multiscale modeling and how it relates to the lab's mission and systems. While searching for university funding opportunities, a coworker introduced me to my current advisor, Rich Regueiro, and I had the opportunity to visit University of Colorado Boulder (CU Boulder) while the PSAAP III proposal process was underway in the Fall of 2019. After being accepted into CU Boulder's Civil Engineering PhD program and the PSAAP III funding was awarded, my group agreed to support my PhD through LANL's graduate fellowship program starting in fall of 2020. I can't imagine finding a better opportunity to combine my own research interests with LANL's on such a multi-disciplinary project!

Venus Amiri (venoosam@buffalo.edu) | University of Buffalo (SUNY)
Degree in Progress: PhD, Chemical Engineering ✦ **Advisor:** Dr. Mark T. Swihart ✦ **PSAAP:** 2020 - Present

Research Topic



Automated Generation of Chemical Reaction Mechanisms for Large N-alkane Combustion

Research Responsibilities

My research focus is on developing chemical reaction mechanisms for combustion of n-alkanes as a fuel for hybrid rockets. We have employed automated mechanism generation tools to construct a detailed chemical kinetic model for combustion of n-pentane (C_5H_{12}) and n-hexadecane ($C_{16}H_{34}$) as a step towards the generation of compact kinetic models for larger alkanes (around 30 carbon atoms per molecule). We used a bottom-up method to start from smaller molecules and are building our way towards larger paraffins.

Benefits of PSAAP

Lawrence Livermore National Laboratory (LLNL) is one of the pioneers in the area of constructing detailed chemical kinetic mechanisms, and I had an opportunity to work with great scientists during my time as an intern. My access to the supercomputer cluster at LLNL has allowed me to speed up my calculations. As part of PSAAP, I continue to use this resource which has tremendously helped the mechanism generations process.

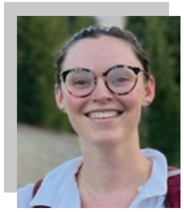
New Contacts, New Opportunities

The PSAAP Center at the University at Buffalo consists of many students and principal investigators working together to develop predictive capabilities for hybrid rocket behavior and performance. They work across broad length and time scales from both a modeling and an experimental point of view, and from varied disciplinary perspectives. This gave me an opportunity to interact with people from other departments and learn about other areas. The PSAAP internship was a remarkable experience for my graduate studies. I connected with scientists at the national laboratories and benefited from their guidance while working towards finishing my PhD.

National Laboratory Experience

I completed an internship with LLNL in the area of chemical kinetic modeling, working on the automated generation of chemical reaction mechanisms. This opportunity improved my understanding of both thermochemistry and chemical kinetics by allowing me to learn from the experts in the field. As LLNL is one of the pioneers in this area, this internship broadened my critical view on the mechanism generation for paraffins, which will be employed for larger scale modeling of paraffin wax as a hybrid rocket fuel. When I first joined the program, I switched from a BS in electronics engineering to chemical engineering for my MS/PhD. Thus, I had plenty of learning ahead of me. However, with the help of my advisor and PSAAP, I interacted with many great scientists in the field who helped me build a fundamental understanding of detailed chemical kinetics mechanisms for my successful transition into this new field.

Kayla Clements (clemekay@oregonstate.edu) | Oregon State University
Degree in Progress: PhD,Nuclear Engineering ✦ **Advisor:** Dr. Todd Palmer ✦ **PSAAP:** 2020 - Present



Research Topic

Uncertainty Quantification and Global Sensitivity Analysis for Monte Carlo Solvers

Research Responsibilities

My responsibilities as a member of the Center for Exascale Monte Carlo Neutron Transport (CEMeNT) include the development of uncertainty quantification (UQ) and global sensitivity analysis (GSA) methods for stochastic solvers, specifically the development of theory and practical estimators for the variance induced by uncertain input parameters without over-resolving the Monte Carlo simulation. As both a CEMeNT student and a Sandia National Laboratories (SNL) intern, I have presented on the development, analysis, and optimization of these UQ and GSA methods at conferences by the American Nuclear Society and the Society for Industrial and Applied Mathematics.

In tandem with researching UQ and GSA methods, I work to implement them as features of MC/DC, CEMeNT's performant and machine-portable Python-based Monte Carlo neutron transport software. Center members collaborate on the software's development and continuous performance, verification, and validation testing, including on Lawrence Livermore National Laboratory's (LLNL's) high performance computers. Some of my future responsibilities will include taking advantage of MC/DC's scalability and LLNL's robust systems to explore UQ performance on increasingly complex simulations.

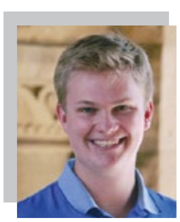
Benefits of PSAAP

Whereas the benefits of PSAAP have been many, I am thankful first and foremost for the fantastic and brilliant group of researchers it has introduced me to. As a PSAAP student, I have the chance to work with faculty from four universities across multiple disciplines and scientists from a number of national laboratories, all of whom have proven happy to provide guidance and support. Collaborating so regularly has led to great relationships among the graduate students on the project, and because of these interactions, I am continually inspired to be a better scientist. Being a member of an interdisciplinary Center on a long-term project has left me feeling well-prepared for work as a researcher beyond graduate school.

National Laboratory Experience

As a student in CEMeNT, I had the chance to intern at SNL for the summer of 2021. I extended my internship to a year-round status and continue to work there as an intern. The project I began as a summer intern under my mentors, Aaron Olson and Gianluca Geraci, has expanded into my ongoing research topic and PhD work. Through my mentors and all of the Sandians with whom they have connected me, I've had the invaluable opportunity to see projects across all stages of development and to learn what a career as a national laboratory researcher can be.

Henry Collis (hcollis@standford.edu) | Stanford University
Degree in Progress: PhD, Mechanical Engineering ✦ **Advisor:** Drs. Ali Mani and Gianluca Iaccarino ✦ **PSAAP:** 2020 - Present



Research Topic

Compressible Multiphase Flow

Research Responsibilities

The PSAAP Center at Stanford is tasked with running simulations of a laser-induced, two-phase rocket combustor. My responsibilities are centered around the development and implementation of the multi-phase models that are required for robust and accurate simulations of the two-phase rocket. My current research has been focused on developing numerical schemes that can handle the interactions of large-density ratios in the presence of strong shocks. I have extended the standard essentially non-oscillatory (ENO)-type schemes to have positivity-preserving guarantees as well as a specific interpolation for handing material interfaces. Furthermore, the interface treatments have been extended to generalized curvilinear coordinate systems in a way that preserves the fundamental interfacial properties associated with cartesian grids (i.e., stability and phase boundedness). These schemes are part of the Hypersonic Task-based Research (HTR) solver which is based on the task-based language, Legion, to run highly parallel and scalable simulations on heterogenous architectures. The multi-phase schemes have been successfully run on the Lawrence Livermore National Laboratory (LLNL) clusters, Quartz and Lassen. In the future, I will extend the multi-phase physics to include surface tension, phase change, and reactions.

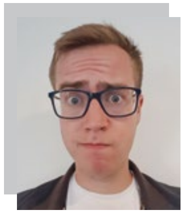
Benefits of PSAAP

Being part of a multi-disciplinary Center has been an excellent learning experience. I am regularly attending meetings focused on topics in computer science, fluid mechanics, machine learning, and experimental techniques that I would not have been exposed to if it weren't for the PSAAP program. Furthermore, I have been able to present many times to the full Center which has helped my communication skills. Additionally, having access to the national laboratory computing clusters has provided an avenue for running much larger problems than otherwise would be possible. I have gained experience in fluid mechanics, computer science, and parallel programing/high performance computing which will be invaluable throughout my career.

National Laboratory Experience

I was fortunate to have an internship at LLNL last summer. I worked with a group conducting design optimization and was exposed to many new ideas that are useful in many computational settings. This included learning and designing Convolutional Neural Networks (CNNs) to learn fluid flow. Additionally, I was able to meet many fantastic researchers at LLNL who gave me invaluable career advice and an outlook on careers at the national labs.

Benjamin Dalman (dalman@usc.edu) | University of Southern California
Degree in Progress: PhD, Aerospace Engineering ✦ **Advisor:** Dr. Ivan Bermejo-Moreno ✦ **PSAAP:** 2022 - Present



Research Topic

Performance Portable Software Development

Research Responsibilities

Our group's project is focused on the development of methods for computing the sensitivity of chaotic systems. As part of that, my work has revolved around developing the software stack that runs the simulations and will eventually include sensitivity predictions. These simulations and predictions can both require an immense amount of computing power, and it's important that we are able to fully utilize the tools available to us. I develop fluid dynamics codes that are performance portable and efficient so that we can run large simulations and take full advantage of all the computing power provided through the PSAAP program.

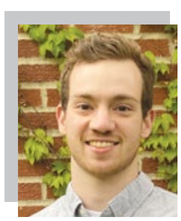
Benefits of PSAAP

Joining a PSAAP project has given me an opportunity to explore an area that I've always been interested in—software development for large-scale scientific applications. As a part of that, the PSAAP program has given me access to computational time on large modern clusters. Without access to PSAAP, I would never have dreamed of such resources. The other major benefit of joining a PSAAP project is getting to be a part of a larger team, across several universities, of diverse students and experts. I highly value being able to get feedback from many people on my research ideas, as I'm developing them. The PSAAP framework enables this.

National Laboratory Experience

I spent this summer completing an internship at Sandia National Laboratories. While there, I worked on a project trying to improve machine learning methods for automatically categorizing fluids data. Though the project isn't directly related to my current PhD research, I still found the internship valuable for other reasons. I was given a great deal of freedom in deciding where to take the research which helped me to grow as a researcher. I also took advantage of the larger research environment at the lab, attending many seminars on a wide variety of topics (fluids, material science, environmental modeling, and many others), meeting with any researcher who would talk to me (about my PhD work and my summer work), and participating in the Computer Science Research Institute intern program events (which included networking, presentations, and writing).

Casey Lauer (clauer@illinois.edu) | University of Illinois at Urbana-Champaign
Degree in Progress: PhD, Aerospace Engineering ✦ **Advisor:** Dr. Jonathan Freund ✦ **PSAAP:** 2021 - Present



Research Topic

Scientific Machine Learning Applied to Scramjet Simulations

Research Responsibilities

I am a research assistant in the Predictive Science Academic Alliance Program (PSAAP) Center for Exascale-enabled Scramjet Design (CEESD) at the University of Illinois Urbana-Champaign (UIUC), working in two main areas. In one, I am developing simulations to study unstart processes in scramjets. These are scientific simulations using the Center's principal simulations tool (MIRGE-Com) to study specific questions about the mechanisms that govern this catastrophic failure of the supersonic flow that maintains the combustion and thrust. These simulations run mostly on the graphics processing units (GPUs) of the Lawrence Livermore National Laboratory (LLNL) Lassen system and are done in close concert with corresponding gas dynamics experiments. My other main task is to seek ways of raising red flags when a machine learning model is becoming unreliable. This involves developing additional training procedures, based in physical facts, that should signal the production of unreliable results.

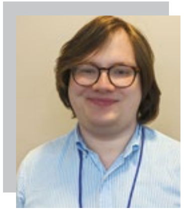
Benefits of PSAAP

PSAAP has given me access to work with and learn from a diverse group of students, faculty, and researchers at Illinois and at the NNSA laboratories. I am excited to continue my PhD research knowing that I have such a strong support system in the PSAAP program. It also facilitated an internship at Los Alamos National Laboratory, and I hope to do another internship at another lab in the future.

National Laboratory Experience

The PSAAP program, and specifically CEESD, has provided me with incredible opportunities to work with researchers outside of my field and develop interaction skills that will prove invaluable to my career. I am a Physics BS student working toward my PhD in Aerospace Engineering. CEESD has provided an environment in which my own research links strongly into a broader ecosystem of collaboration with faculty and students ranging from computer scientist to experts in experiments and diagnostics. I work closely with a fellow student who has been running an experiment that corresponds closely to the simulations I am designing. While I was not expecting to help run an experiment as part of my computational research, I could not be happier that I had the opportunity to do so. I know that my research will be stronger because of it. I have similarly benefited from the efforts of the computer science team. With their help, I can leverage the computational power of GPU systems like LLNL's Lassen for my work.

Evan Drake Suggs (evandsuggs@gmail.edu) | University of Tennessee at Chattanooga
Degree in Progress: MS, Data Science ✦ **Advisor:** Dr. Anthony Skjellum ✦ **PSAAP:** 2021 - Present



Research Topic

Integrating Kokkos Functionality with C++-based MPI Implementations

Research Responsibilities

My current research responsibilities are working on an efficient integration of two programming models; nominally, an interface that ties together Kokkos (on-node) and our Modern C++ implementation of ExaMPI (off-node).

Benefits of PSAAP

PSAAP has afforded me the opportunity to work directly with Sandia National Laboratories (SNL) and get feedback from others via the PSAAP hackathons. I've learned a lot from the hackathons.

My research project has grown over the past two years from a small idea of adding just a few Kokkos-related features to ExaMPI in order to get it to work better for other research that my team is conducting to implementing it for a EuroMPI poster. Getting it to a poster level required learning substantial Modern C++ and templating due to the complexity of Kokkos templating.

The poster at EuroMPI generated a large amount of interest, and it was there that I met several researchers from the Kokkos team at SNL, namely Drs. Stephen Olivier and Jan Ciesko, who are co-authors on the majority of my papers. We worked together to flesh out this effort to a full and successful Masters thesis.

Thanks to PSAAP, I was able to travel to Albuquerque for a PSAAP hackathon that occurred just a month and a half before my thesis defense. During the trip, I was able to meet several times with the Kokkos team and get instant feedback on my thesis document and my thesis presentation. This input was invaluable to the project's completion. My collaboration with the Kokkos team continues to this day, and further features are being added, such as non-contiguous and graphics processing unit support.

Recently, I was able to travel to EuroMPI 2023. I presented a paper on my research and was able to meet again with a member of the Kokkos team. The Kokkos team and I now have planned around three sprints for the next year to further develop the MPI+Kokkos interface.

My work has grown to a full project and has evolved alongside work with MPI_0, another innovative interface for message passing. My work has become significant enough to be part of the committed out-year goals of our PSAAP Center. The PSAAP has not just given me time to further my research. It has given me additional research opportunities, the ability to interact and befriend peers, and, most of all, showed me what a career in research looks like. Learning how former graduate students became full researchers and professors has helped me conceptualize my own future career.

Minority Serving Institution Partnership Program

Overview

The Minority-Serving Institution Partnership Program (MSIPP) develops and enhances workforce and educational capacities, supporting and sustaining a diverse network of students prepared for career pathways into the Nuclear Security Enterprise (NSE) laboratories, plants, and sites.

Through MSI-NSE partnerships, the programs align investments in educational capacities and workforce development, supporting a diverse student population ready to meet the needs of the NNSA's science, technology, engineering, and mathematics (STEM) workforce. The MSI-NSE collaborations provide opportunities for students and faculty to participate in research activities and internships, strengthening skills and talents in their relevant fields to make immediate contributions to the NSE.

MSIPP supports MSIs across the nation, including Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs), investing in a diverse portfolio of student enrichment programs, curriculum development, and STEM outreach programs. The mission of the programs to build a diverse workforce and enhance educational capabilities is met through four main objectives....

MSIPP supports MSIs across the nation, including Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs), investing in a diverse portfolio of student enrichment programs, curriculum development, and STEM outreach programs. The mission of the programs to build a diverse workforce and enhance educational capabilities is met through four main objectives:

1. Strengthen and expand minority serving institutions' and Tribal colleges and universities' educational and/or research capacity in NNSA mission areas of interest.

2. Target collaborations and increase interactions between minority serving institutions and Tribal colleges and universities, NNSA laboratories, plants, and sites, and Management & Operating (M&O) partners to increase direct access to NSE resources.

3. Increase the number of MSI/TCU students who have exposure to cutting edge research and career opportunities within the NSE and who graduate with STEM degrees relevant to NNSA mission areas.

4. Increase the number of minority graduate and postdoctoral students hired into the NSE's technical and scientific workforce.

MSIPP currently partners with 35 consortia consisting of 54 MSIs, including 20 Historically Black Colleges and Universities (HBCUs), 26 Hispanic Serving Institutions (HSIs), and 8 TCUs. Consortia projects commonly extend over a 3- to 5-year performance period, encompassing a broad portfolio of research projects. Students enrolled in consortia MSIs may participate in an internship suited to their academic programs, ensuring they are supported and well-prepared to contribute to the NSE upon graduation. MSIPP's multifaceted consortia model strengthens university capabilities and aligns with NNSA's workforce development objectives while advancing research and educational capacity at underrepresented colleges and universities.

MSIPP plays a pivotal role in fostering diversity and excellence within the NSE. By forging strategic alliances, empowering students, and aligning investments with NNSA mission areas, MSIPP is instrumental in shaping the future of STEM professionals.

2023 MSIPP Annual Technical Meeting, University of New Mexico, Albuquerque, New Mexico

New in 2024: Community and Junior College Trade Occupation Program (CJCTOP)

Recently, MSIPP introduced the Community and Junior College Trade Occupation Program (CJCTOP) addressing a critical need to fill skilled and technical labor gaps within the Nuclear Security Enterprise (NSE). By fostering collaborations between community and junior jolleges and individual NSE facilities, CJCTOP's goal is to recruit and train a diverse, highly skilled workforce. This initiative not only enhances the educational and training environment at these institutions but also directly meets the immediate and ongoing demands for both traditional and emerging technician positions within the NSE. Moreover, CJCTOP strives to improve recruitment from minority and underrepresented populations, ultimately bolstering the Nation's capability to safeguard its nuclear stockpile.

The program's focus is on supporting diverse student and faculty populations refining training programs in trade and skilled labor disciplines and amplifying the overall capacity of the NSE workforce. CJCTOP successfully aligns projects with the overarching mission of MSIPP, contributing to the effective building of trade and skilled labor workforce capacity withing the NSE.

Enhancing the National Security Enterprise Workforce Pipeline
Lead: Augusta Technical College
Partner: Savannah River National Laboratory
Augusta Technical College will enhance their curricula in radiation control and protection, support and engage students enrolled in the programs, and develop an apprenticeship program to support the NSE workforce.

Native Education Excellence in Trades
Lead: Turtle Mountain Community College
Partner: Sandia National Laboratories
Turtle Mountain Community College will enhance the educational curriculum for building construction and electrical trades. This collaboration will recruit and train a skilled workforce of American Indian/Alaska Native students ready to fill traditional and emerging positions in the NSE.

Rapid Education and Placement
Lead: Las Positas College
Partner: Lawrence Livermore National Laboratory
Las Positas College will establish teams for curriculum development and implementation within the community college education program. Laboratory experts will collaborate with Las Positas College to enhance student skills and provide opportunities to benefit the future workforce.

... CJCTOP strives to improve recruitment from minority and underrepresented populations, ultimately bolstering the Nation's capability to safeguard its nuclear stockpile.

NNSS FastStart
Lead: College of Southern Nevada
Partner: Nevada National Security Site
The College of Southern Nevada will increase the number of community college students earning industry-recognized credentials and create a sustainable and scalable model of partnerships that lead to talent pathways, meeting regional and NNSA industry workforce needs.

Developing Next Generation Radiation Safety Professionals
Lead: Queensborough Community College
Partner: Brookhaven National Laboratory
Queensborough Community College will develop the next generation workforce in nuclear safety, radiation safety, and health physics. This collaboration will create a certificate program in radiation protection and support a pathway to a bachelor's degree program.

Consortium Highlight: Consortium on National Critical Infrastructure Security (CONCISE)

Lead: University of Texas at San Antonio (UTSA), HSI | **Sub-Recipients:** North Carolina A&T State University (NCAT), HBCU | Savannah State University (SSU), HBCU), University of Nevada-Las Vegas (UNLV), HSI | **National Security Enterprise Collaborators:** Idaho National Laboratory (INL), Nevada National Security Site (NNSS), Sandia National Laboratories (SNL)

The Consortium on National Critical Infrastructure Security (CONCISE) attracts, educates, and trains minority students in the science, technology, engineering, and mathematics (STEM) fields, especially cybersecurity, with an aim to create and ensure a sustainable workforce recruitment pathway at four Minority Serving Institutions (MSIs)—UTSA, UNLV, NCAT, and SSU—and three Department of Energy/National Nuclear Security Administration (DOE/NNSA) sites/laboratories, SNL, NNSS, and INL. The project has three primary objectives:

1. Enhancing Industrial Internet of Things (IIOT) cybersecurity education capacity by increasing the number of minority students pursuing bachelors, masters, and PhD degrees in the IIoT cybersecurity field.

2. Broadening the IIoT cyber security research capacity by increasing the number of minority undergraduate and graduate students participating in cyber-security research projects. Students apply fundamental knowledge learned from cybersecurity certificate program courses to research projects designed by Principal Investigators. Masters and PhD students conduct cutting-edge cybersecurity research, further preparing them for the DOE/NNSA laboratory workforce.

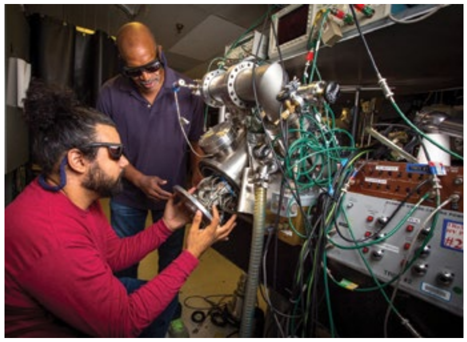
3. Creating and sustaining a DOE/NNSA cybersecurity workforce recruitment pathway. During the project period, enrolled students will participate in

summer internships at the three DOE/NNSA national sites/laboratories.

Jerry Clark (clark235@llnl.gov) | Lawrence Livermore National Laboratory
Years at LLNL: 2023 - Present | **Degree:** PhD, Physics | **MSIPP:** 2018 - 2022, Florida A&M University

I am an experimental physicist at Lawrence Livermore National Laboratory (LLNL) in the diagnostic development group under the umbrella of Strategic Deterrence (formerly Weapons Complex Integration (WCI)). This involves the development of diagnostics to investigate high explosives (HE) experiments and support Weapons Physics and Design (WPD). For me, the highlight of working at a NNSA national laboratory is the opportunity to work on experiments at the forefront of physics with the best resources (people/equipment/facilities) available to you. Before my involvement in the MSIPP, I never had considered a career at a national laboratory, yet I could not imagine a better place to work.

Without MSIPP, I would not have been introduced to the field of high energy density science (HED), nor would I have had the opportunity to connect with individuals such as Dr. Ronnie Shepherd

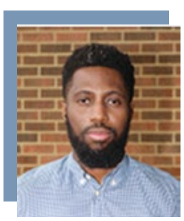


and Dr. Frank Graziani who have provided mentorship throughout my PhD and into my career. Through Florida A&M University's (FAMU's) MSIPP Consortium for High Energy Density Science (CfHEDS), I was supported in-residency at LLNL, meaning I was a year-long intern. Through the MSIPP program, I completed my dissertation research at LLNL under the guidance of Dr. Ronnie Shepherd (LLNL) and Dr. Ronald Williams (FAMU). Initially, I was supposed to be only a summer intern at LLNL funded through CfHEDS. However, at the conclusion of the summer, I was presented with the offer to continue through the completion of my PhD.

My dissertation research topic was electron-ion equilibration in HED plasmas. I was responsible for collecting and analyzing X-ray spectral data. This involved designing and alignment of crystal spectrometers, operation of the LLNL Time-Resolved X-ray (TReX) ultrafast streak camera, an experimental campaign at Colorado State University's Advanced Beam Laboratory, and radiative-hydrodynamic (rad-hydro) simulations in Cretin for comparison to experimental data.

This experience, enabled by MSIPP, helped me develop the skills and knowledge that allowed me to secure a staff position at LLNL, including experience with equipment unique to LLNL (TReX), introduction to a domain of physics initially unavailable at my university (HED science), generally applicable skills (high-voltage and laser systems, X-ray spectroscopy, rad-hydro simulation), and proposal writing experience (two successful LaserNetUS campaigns).

Samuel C. Uba (samuel.uba@srnl.doe.gov) | Savannah River National Laboratory
Years at SRNL: 6/2023 - Present | **Degree:** PhD, Applied Physics | **MSIPP:** 2013 - 2016, Alabama A&M University



Research Topic

Electrospinning Nanofibers for Specific Analyze Detection and Adsorption

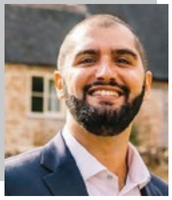
Through the MSIPP University, Laboratory Consortium for Radioisotope Detection and Analysis (UL-CORDA) from 2013 to 2016, I obtained a financial assistantship as an undergraduate student which helped me to complete my required course work. Afterwards in 2014, I received an internship offer at Brookhaven National Laboratory (BNL) as a summer intern with Dr. Ralph James, currently Deputy Laboratory Directory for Science & Technology, Savannah River National Laboratory (SRNL). The internship was influential, as it provided exposure to working at a Department of Energy (DOE) laboratory as a scientist. I was trained in understanding scientific topics, developing experimental methodologies, and presenting solutions.

I completed my undergraduate degree in 2014 and continued with my thesis objective, developed from my summer research experience at BNL and UL-CORDA, to develop crystals for radioisotope detection. Through collaboration with Fisk University as part of the consortium, I received training on crystal growth and material characterization. This was significant in completing my thesis program. As a graduate student, I was a recipient in 2019 of the MSIPP graduate internship offer from Pacific Northwest Nuclear Laboratory with Dr. Jonathan Burnett's group. He referred me to the National Nuclear Security Administration Graduate Fellowship Program. I applied and was accepted as a fellow in 2021 in the NA-22 program office. Through my involvement as a fellow in NA-22, I was able to cultivate networking skills and build professional relationships. Upon completion of the fellowship, I received an offer to become a senior scientist at SRNL.

> *"In high school, I aspired to work at a DOE national laboratory as a scientist. Through the MSIPP consortium with A&M, I was able to get the requisite exposure and training with a partner laboratory and currently am realizing my goal."*

The MSIPP has been very influential in realizing my goals, and I'm enormously grateful. My goal is to assist other underrepresented minority groups to achieve their goals.

Sahar Berlinerblaw (sberl010@fiu.edu) | Florida International University
Degree in Progress: BS, Electrical Engineering ✦ **Advisor:** Dr. Sumit Paudyal ✦ **MSIPP:** 2020 - Present



Research Topic
Power Systems

Research Responsibilities
As an undergraduate student my aim is to assist and help drive the research being done by PhD candidates, including data collection, running simulations, and conducting experiments setup by the PhD candidates.

Benefits of MSIPP
PSAAP has given me an opportunity to work on a large, multi-disciplinary team and has exposed me to many national lab researchers. It would be impossible to feed our upscaling workflow without the efforts of our experimental and DNS teams and the support of our university and national lab colleagues!

What Students Considering MSIPP Should Know
The MSIPP offers the opportunity to apply the theoretical knowledge of the classroom to solving real-world challenges. For example, after studying circuit design and power systems in class, I successfully designed a centralized power bus system that was used to power a model of a city's electrical grid. Further, the foundational skills I learned in embedded systems proved instrumental when connecting the power distribution to the city's loads using a system of relays, all managed by a microcontroller. Additionally, MSIPP introduced me to fields with which I previously was unfamiliar, such as cybersecurity and networking. This exposure not only enriched my academic journey but expanded the potential pathways for my future endeavors.

New Contacts, New Opportunities
One of the things that I've come to value most from MSIPP is the collaboration with mentors. The mentors provided me with a wealth of knowledge and practical experience that helped me learn new approaches to problem solving that only years of hands-on experience can teach. Learning from seasoned experts helped foster a mindset of continuous learning and has shaped my approach to challenges. Working closely with mentors from different areas of research, I was introduced to new fields, some of which I had no previous experience in. This opportunity allowed me to gain new skills and apply them to further the goals of a project.

National Laboratory Experience
I was accepted into a summer internship with the Lawrence Livermore National Laboratory and was immediately presented with a dynamic environment and exposed to real-world challenges. The hands-on projects bridged the gap between theory and practice while learning from experienced professionals.

The research conducted at the laboratory has actual impacts on real-world challenges, many times needing to work collaboratively with different teams to meet a projects goal. The inherent collaborative nature of the projects at the laboratory emphasized more than just technical skills. It highlighted the significance of teamwork, the need for adaptability in meeting deadlines, and the importance of always being prepared to tackle new and unexpected challenges. Working through the summer, I not only gained practical skills but also gained a sense of confidence and direction for future research.

Edwina Leslie (edwina.leslie@student.navajotech.edu) | Navajo Technical University
Degree in Progress: BS, Electrical Engineering ✦ **Advisor:** Dr. Todd Palmer ✦ **MSIPP:** 2020 - Present

Background
I am an enrolled member of the Navajo Nation. I'm currently pursuing a bachelor's degree in electrical engineering at Navajo Technical University (NTU) located in Crownpoint, New Mexico.

I grew up in Churchrock, New Mexico herding sheep with my grandmother on the Navajo reservation. My brother became an electrician and encouraged me to do the same. I investigated this option but decided electrical engineering would be a better match for my life journey. My father chose Navajo Technical University (NTU), because it is close to home and inexpensive—since he would be paying my tuition.

Benefits of MSIPP
My experience here at NTU has been amazing. The faculty are very understanding and helpful. During my two years at NTU, Dr. Stan Atcitty gave presentations about Sandia National Laboratories (SNL) internship opportunities. Then, NTU hosted an American Indian Higher Education Consortium (AIHEC) event where representatives from many different companies, including SNL, came to talk to the students about internship opportunities. Dr. Attcity was there too and offered me an opportunity to become an SNL summer intern.

National Laboratory Experience
Being a summer intern at Sandia was a major milestone in my educational journey. During my internship, I learned a lot about data analytics and renewable energy systems. At the end of my internship, I presented my work to the Future of Research in Climate, Earth, and Energy (FORCEE) Program at Sandia and to the Office of Indian Energy. Wrapping up, I had a great experience, and I highly recommend other students take a chance and come work as an intern at SNL.

Jalyn-Rose Clark (jclar189@jh.edu) | Johns Hopkins University
Degree in Progress: MS, Materials Science and Engineering ✦ **Advisor:** Dr. Tim Weihs ✦ **MSIPP:** 2022 - Present

Research Topic

Electrospinning Nanofibers for Specific Analyze Detection and Adsorption

Research Responsibilities

I joined Lawrence Livermore National Laboratory (LLNL) in the summer of 2022. I worked under the Materials Science Division in the polymer and ceramics group to assist in understanding more about electrospun nanofiber capabilities and whether they can be used to detect certain analyses when incorporated with biological and inorganic ligands. I was responsible for formulating and electrospinning polymer-based nanofibers for specific analyze adsorption and detection. I also was responsible for analyzing the data and decoding which polymer chemistries were best for each analyte. I was able to complete research in the Summers of 2022 and 2023 which allowed me to see my project from the ground up.

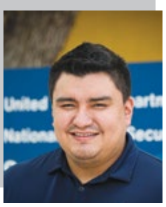
Benefits of MSIPP

MSIPP allowed me to intern at an amazing research facility and have hands on experience with cutting-edge research. As a chemistry major, I wanted more research experience in materials science, and MSIPP allowed me to have that. MSIPP allowed me to prosper as a young researcher, and I quickly became passionate about the topics. Interning at Lawrence Livermore National Laboratory (LLNL) gave me the opportunity to learn considerable technical skills important to Materials Science and Engineering that I would not have learned in a purely academic setting.

National Laboratory Experience

I was honored to complete two summer internships at LLNL. In my time at the lab, I was exposed to amazing research, people, and new ideas. The national labs have a prestigious reputation, which they certainly have earned. Whereas I completed research under the Materials Engineering division, I was exposed to research in Physical and Life Sciences, Bioengineering, and Forensics. Being able to talk to other researchers about their research not only gave me new ideas to implement in my own research, but I was able to see how diverse the research is that goes on at national laboratories. I was able to complete research that I never would have been able to complete at my academic institution or at most other scientific-centered companies. LLNL ensures that their student interns are provided with all the resources needed to have a successful summer internship and that students understand that they truly belong at the lab because of their potential as researchers.

Gordon North Piegan III (gnorthpiegan@gmail.com) | Salish Kootenai College
Degree in Progress: BA, Engineering ✦ **Advisor:** Dr. Tom Trickle ✦ **MSIPP:** 2019 - Present



Oki Nitsiska'sim (hello my name is) Gordon North Piegan, and I am from the Blackfeet tribe in northwestern Montana. The reservation community is tight-knit, since everyone is your "cousin" one way or another. The biggest past time on the reservation is basketball, which provides an outlet for all ages from the many reservation struggles like drug abuse, poverty, and suicide—and I played a lot of basketball. My other outlet is education, and I became interested in engineering when I read that my tribal college, Salish Kootenai College (SKC), had started a B.S. program in engineering. I had no idea what engineering was about but started reading about people like Nikola Tesla, which caused me to become completely fascinated with electrical engineering. From SKC I got an internship at Southwestern Indian Polytechnic Institute, which is when I toured Sandia National Laboratories (SNL) and met Stan Atcitty. I was completely taken aback by the large number of minorities and Native American professionals at SNL. In 2017, I got an MSIPP internship at SNL. Then in 2021 while in the middle of my master's degree, I started another MSIPP internship in SNL's Wind Turbine Data Sciences department, during which I modeled wind turbine performance and published my first professional paper in an Institute for Electrical and Electronics Engineers' (IEEE) journal. MSIPP's funding helped support my family and me through the rest of my master's studies and now into my PhD. I love working for SNL. It's been the best job I've ever had. Even as an intern I was able to advance renewable energy to mitigate climate change. Studying engineering and participating in the MSIPP internship has brought me a long way from my humble beginnings. My goal is to help my tribal community through research contributions and to teach the next generation of Native American students to equip themselves to continue this work. I would not be where I am today without the generous support of the NNSA and its MSIPP program. I highly encourage other Native students to take a chance, study science, technology, engineering, and mathematics fields and apply for SNL's summer intern positions.

Robert Cody Wings of Prayer Sam (robertsam49@hotmail.com) | North Dakota State University
Degree in Progress: PhD, Natural Resource Management, Soil Science ✦ **Advisor:** Dr. Thomas DeSutter ✦ **MSIPP:** 2022 - Present

Research Topic

Geophysics

Research Responsibilities

My research responsibilities included building a readily accessible tool for the project team that provided data to help model simulations.

Background

My name is Robert Cody Wings of Prayer Sam, and I am a proud member of the Shoshone-Paiute Tribe of the Duck Valley Indian Reservation. I grew up in Owyhee, Nevada on the reservation with a population of about 1,000 people. Growing up, I was surrounded by my two older brothers, both parents, grandmother, and numerous cousins, aunts, and uncles. When I was around eight years old, my family moved from the reservation to Bismarck North Dakota so that my mother could earn a nursing degree at United Tribes Technical College (UTTC). In North Dakota, we lived off the reservation, which I really enjoyed. Once my mother graduated, we moved back to the reservation. My father couldn't find work locally, so he ended up working in Boise. I moved to Boise too and graduated from high school with a 2.8 GPA. Because my grades were low, my next step was general studies at the community college. After my first semester, I transferred to UTTC to pursue a four-year degree in environmental sciences. Initially, I wasn't excited about my degree choice. However, I shortly found a passion for sciences.

Benefits of MSIPP

The UTTC instructors strongly advised completing a Research Experience for Undergrads (REU) and Internships.

In 2019, I applied for an internship at Sandia National Laboratories (SNL) which did not work out due to COVID restrictions.

The following year, I applied again and worked on a project where I learned about data management and used a software tool that allows the user to manipulate and visualize the data according to their needs. At SNL, the management and advisors were very supportive, and the work-life balance was good. My time at SNL was funded through the MSIPP. Additionally, my SNL advisors encouraged me to continue my education, so I'm currently in the doctoral program at North Dakota State University. When I graduate, I would like to teach at a tribal college or university and push my students to venture out to get experience at places such as SNL.

Jessica Tucker (jessica2.tucker@famu.edu) | Florida A&M University
Degree in Progress: PhD, Physics ✦ **Advisor:** Dr. Charles A. Weatherford ✦ **MSIPP:** 2020 - Present

Research Topic

Optimal Control in Quantum Computing

Research Responsibilities

My responsibilities involve researching and employing optimal control techniques to improve the performance of superconducting quantum hardware.

Benefits of MSIPP

The Minority Serving Institutions Partnership Program (MSIPP) provides funding that allows access to state-of-the-art computing infrastructure in the field of quantum computing that is not readily available to me through my home academic institution.

National Laboratory Experience

MSIPP provided me with access to computing infrastructure and the opportunity to learn from and collaborate with researchers from various institutions, ranging from academia to the private sector. These opportunities have served as a springboard toward developing transferrable skills in a highly interdisciplinary and immersive environment that will serve me beyond the doctoral degree.

Currently, I am a 7th year graduate student attending FAMU's Physics doctoral program. At the beginning of my studies in FAMU's Physics Department, I decided to utilize their collaborative research pipeline with Lawrence Livermore National Laboratory (LLNL) to conduct off-campus research. With the support of MSIPP, I am completing my dissertation activities onsite at LLNL's Physical Life Science Division. Specifically, I conduct my research in LLNL's Quantum Coherent Device Physics (QCDP) group, where I developed a focus in quantum optimal control of superconducting quantum hardware.

In particular, my research goal involves employing optimal control techniques using algorithms and computational heuristics to improve the performance of superconducting quantum bits. After completing several research rotations over the course of 5 years, I cultivated computational, data analysis, and experimental design skills on state-of-the-art quantum computation infrastructure. Additionally, given my exposure to this multi-collaborative research environment at LLNL within the QCDP group, I developed an acumen for the direction of research and development in the field of quantum computing among the government, private, and academic sectors.

With this experience, I now have an invaluable knowledge-base built to sharpen my hard- and soft-skill set to remain up-to-date and contribute toward impactful advancements in quantum computing and quantum information science at large. Given my timely anticipated graduation date of Spring 2024, I am very eager to graduate and begin my career as a quantum information scientist. Given my robust training at LLNL, I believe my time working in the national laboratory is highly informative and well spent. In total, this experience provided me with a basis for beginning a great career in the new field of quantum computing, and the funding from MSIPP made this opportunity possible.

Minority Serving Institutions Internship Program

The Minority Serving Institutions Internship Program (MSIIP) is administered for the National Nuclear Security Administration (NNSA) by the Oak Ridge Institute for Science and Education (ORISE). MSIIP is designed to promote the education and development of the next generation of scientists and other professionals to meet the current and future mission needs of the NNSA by providing an enhanced training environment that exposes participants to challenges unique to the NNSA mission.

The inaugural Class of 2022-2023 came to an end on June 2, 2023, as 41 year-long interns successfully completed their appointments. Eleven participants returned to MSIIP's Class of 2023-2024, and three were selected for the NNSA Graduate Fellowship Program (NGFP). Two interns from the inaugural cohort, Bennett McEllis and Felicie Trebien, were selected to be featured in the ORISE success stories series. We wish our interns the best of luck in their future endeavors, be that continuing their education, entering the workforce, or whatever else they choose!

On June 5, NNSA-MSIIP welcomed 96 students (6 Associate, 67 Bachelors, 13 Masters, 10 PhD) into the Class of 2023-2024. The students came from different walks-of-life and cultures and represent 50 minority serving institutions (MSIs) from various educational majors, including cyber, engineering, social sciences, law, computer science, and community health. They support projects across the Nuclear Security Enterprise (NSE) and our national laboratories, plants, and sites.

The program has grown since the previous cohort, Class of 2022-2023. The number of participants increased from 86 to 96 (11%). During the summer, of the 96 interns, 32 were virtual, 19 were hybrid, and the remaining 45 were in-person. Thirty-two of the 96 appointments were at NNSA Headquarters, and the remaining 64 were housed at our national laboratories, plants, and site offices. At the beginning of August 2023, the program announced that 52 of the summer-long appointments were able to extend their internship appointments to a full year.

The MSIIP team concluded its recruitment for the Class of 2024-2025, with a goal of 120 interns who are expected to begin in June 2024. Applications opened on August 1, 2023, and closed on October 22, 2023. The candidate pool had 359 eligible candidates, a 50% increase from last year.

As program participants, interns will develop the experience needed to "jump-start" their careers and explore future opportunities within the NSE. Interns are mentored by leading scientists, engineers, and other top professionals to develop their skills and enhance leadership capabilities.

Internship benefits include weekly stipends and supplements to offset the cost of housing, local transportation, and remote participation; inbound/ outbound transportation reimbursement; travel and training allowances; and participation in professional development activities.

Learn more about the NNSA Minority Serving Institutions Internship Program (NNSA-MSIIP) at https://orise.orau.gov/NNSA-MSIIP/.

Class of 2023-2024 with keynote speaker, Mr. Marcus Lea, NNSA's Deputy Associate Administrator for Management.

Fellowships

Britton Olson (olson45@llnl.gov) | Lawrence Livermore National Laboratory
Years at LLNL: 2012 - Present ✦ **Degree:** PhD, Aeronautics and Aeronautics Engineering, Stanford University ✦ **CSGF:** 2008 - 2012

At Lawrence Livermore National Laboratory (LLNL) we're on the verge of switching on the fastest computer humanity has ever seen. El Capitan will be able to compute at a rate of more than 2 Exa-FLOPS ($2e^{18}$ floating point operations per second). To give a sense of scale, it would take roughly 650 million new iPhones (enough phones to wrap around the earth 2.4 times!) to reach the computing power of El Capitan. The power of this new machine is based on graphics processing units (GPUs) that were designed to drive the intensive computational operations of video games. For over a decade, scientists and researchers have been preparing algorithms and software to scale and perform on these massive machines.

As a CSGF Fellow from 2008-2012, I heard many talks predicting the future that exascale computing would lay in the hands of video gamers. As a fellow I attended workshops across the globe on GPU computing, spoke at an Nvidia booth at the Super Computing Conference, and took classes on CUDA (Nvidia's GPU programming model) in graduate school. CSGF gave me opportunities to invest in my training and to get early exposure to this emergent technology that is now transforming what we do with scientific computing.

As a computational physicist at LLNL, I work on a next-generation simulation suite that was built with GPUs in mind. My prior and early experience with GPUs prepared me to be an early adopter of the technology and to help find performance portable software solutions, solutions where one source code can run efficiently on both central processing units (CPUs) and GPUs, for our more difficult libraries and algorithms.

Making our codes performance portable has paid off in huge ways! We now can perform calculations 10-20x faster on these machines, relative to their CPU equivalents, which means that the once massive/three-dimensional (3D)/"hero"-scale/month-long calculations now can be routinely run overnight or over a weekend. It also means that instead of 10s of calculations used to explore uncertainty and parameter space, we now can run 100s. Simply put, this jump in speed is changing the way we do science in scale, in fidelity, and in throughput.

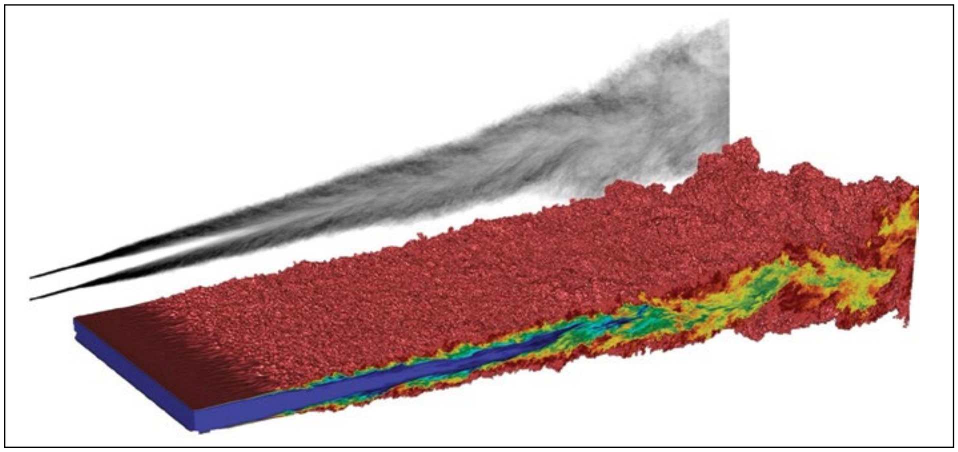


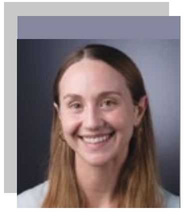
Figure 1. Iso-volume of species mass fraction of a spatially evolving turbulent jet (transformed from a temporal jet) at high Reynolds number (color) with a simulated schlieren image (black/white) in the back plane. This simulation was run on 4k Sierra GPUs with over $8e^9$ grid points and ran over the weekend. High-fidelity datasets like these are used to study turbulence and to inform lower-fidelity models.

Another BIG science project at LLNL is the National Ignition Facility (NIF). Last December, for the first time in human history, we achieved laboratory-controlled fusion ignition. Ignition occurs when the fusion reaction becomes self-sustained to the point at which it generates more energy than was required to start the reaction. Given the abundance of fusion fuel (deuterium and tritium) and the fact that it produces zero emissions, the implications for clean energy for humanity is world-changing, but we're a long way away. Suffice it to say, that we have many years of more research ahead before fusion energy technology matures to the point at which it is powering our homes.

At the intersection of these two massively-scaled science endeavors, there lays a ton of unanswered questions with a tool to start to answer them. When I'm not writing code, my physics research focuses on the turbulent mixing process and its importance in high energy density physics applications, like those found in NIF research. Mixing is the primary physical mechanism that cools the fires of fusion before it can really take off. My group is using high-order numerical methods, advanced models, and massive machines to study the immense cascade of turbulent motion and its interactions with various physical systems.

I'm proud to be part of the CSGF family that continues to prepare the rising generation of scientists to make a big impact in the world and to be part of the DOE and LLNL family that is changing the world today.

Ariel Kellison (arieleileen@gmail.com) | Cornell University
Degree in Progress: PhD, Computer Science ✦ **Advisor:** Dr. David Bindel ✦ **CSGF:** 2020 - Present



Research Topic

Formal Methods for Numerical Software

Research Responsibilities

I design methods to verify that software is correct, especially software that relies on floating-point computations. This type of software is used in medical devices that people rely on for their everyday health and well-being. It also is increasingly used in settings where safety is paramount, like self-driving cars. In addition to the intellectual challenge, I enjoy my research because it aims to keep people safe and ultimately enhances public trust in science.

Benefits of CSGF

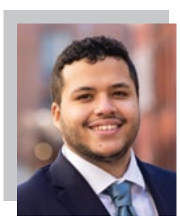
For practical reasons, my area of research doesn't receive significant public attention: software that always behaves correctly and never fails catastrophically doesn't make news! Unfortunately, less public interest in a field usually means fewer funding opportunities for graduate students and new scientists. As a result, without the financial support provided by the Computational Sciences Graduate Fellowship (CSGF), I may have been inclined to choose a different area of research for my PhD.

New Contacts, New Opportunities

In addition to allowing me to focus on a research topic of my choosing, the CSGF has allowed me to pursue research collaborations outside my university, both at national labs and other universities and research institutions. These collaborations have been vital to my progress as a scientist. Collaborating with senior scientists from different institutions has given me a broader understanding of the core problems in my research area. Through these collaborations, I have gained valuable insight into a diverse set of research methods I can use in the future.

In my experience, actively pursuing new collaboration opportunities requires considerable confidence, especially for new scientists. The CSGF practicum that I completed at Sandia National Laboratories in Livermore, California, helped me build this confidence. The group I worked with during my practicum at Sandia was incredibly supportive, dynamic, and interdisciplinary. Group members always encouraged me to share my perspectives and ideas during meetings and technical conversations, which helped me develop my scientific voice. Fortunately, I have continued working with this same group after my practicum as a year-round graduate student intern. This continued collaboration has given me valuable insight into how research is conducted at the labs and how a career at a national lab compares to a career in academia.

Danilo Trinidad Pérez-Rivera (dp2650@nyu.edu) | New York University
Degree in Progress: PhD, Neural Science ✦ **Advisor:** Drs. Christine Constantinople and Cristina Savin ✦ **CSGF:** 2020 - Present



Research Topic

Latent Dynamic Systems for Neural Data Analysis

Research Responsibilities

I am actively involved in the development of computational models aimed at advancing our comprehension of subjective value assessments that underlie animal behavior in value-based decision-making paradigms. Specifically, I have worked on a Hierarchical Kalman Filtering approach enabling the separable extraction of low-dimensional latent dynamics occurring at different timescales: rapid within-trial dynamics and gradual across-trial dynamics. This is pivotal for gaining deeper insights into cognition, as the integration of these disparate timescale dynamics is fundamental in effective decision-making.

Benefits of CSGF

The CSGF program has proven to be an invaluable pillar of support throughout my journey in graduate school, empowering me to remain steadfast in my commitment to contributing to my academic community and beyond. Having become a part of this fellowship amidst the global COVID-19 pandemic, I sought an opportunity to leverage my expertise in furthering our understanding of unfolding events. Through my practicum experience with the Ramanathan group at Argonne National Laboratory, I was granted this opportunity with access to the immense resources at our disposal to conduct impactful scientific research.

My pursuit of an enriched program of study with a focus on intense math courses at NYU's Courant Institute has profoundly influenced my research interests. For example, formalizing my understanding of stochastic processes has deepened my appreciation for their impact on modeling neural variability and noise, crucial factors in comprehending how the brain processes information and makes decisions.

New Contacts, New Opportunities

During my practicum with the Ramanathan Group, I delved into a realm beyond neuroscience, employing Machine Learning approaches to contribute to our understanding of the evolutionary trajectory of COVID-19 genomics. This experience has been immensely beneficial to my research, reinforcing my perspective that computational training is inherently interdisciplinary. It keeps me enthusiastic about pursuing a future career for which the versatility of computational approaches allows me to make significant contributions to questions of interest.

Gabriel Shipley (gashipl@sandia.gov) | Sandia National Laboratories
Years at SNL: 2021 - Present ✦ **Degree:** PhD, Engineering, University of New Mexico ✦ **SSGF:** 2017 - 2021

My research during graduate school was supported by the Stewardship Science Graduate Fellowship (SSGF). Primarily, my work focused on the development of a novel pulsed power inertial confinement fusion (ICF) concept, a variation of the Magnetized Liner Inertial Fusion (MagLIF)[1] target pioneered by Sandia National Laboratories (SNL) known as AutoMag. AutoMag[2,3,4] targets are designed to automatically magnetize a cylindrical column of deuterium fusion fuel without the need for the external magnetic field coils typically used in MagLIF. This is accomplished by enforcing helical electrical current in the target. Helical cuts are made in the metallic liner (cylindrical tube) and filled with electrically insulating epoxy, ensuring the production of a strong internal axial magnetic field when current from the pulsed power accelerator initially flows helically through the target. Then, once the current rise rate increases, the epoxy undergoes dielectric breakdown, and the helical current switches to axial, ceasing internal axial magnetic field production and radially imploding the target. Elimination of the external field coils and use of an AutoMag target could enable (a) magnetic fields in the 30-50 T range thought to be optimum for MagLIF, (b) improved diagnostic access to the imploding MagLIF target, and (c) enhanced coupling of energy from the pulsed power accelerator to the target.

The SSGF enabled me to complete a research practicum at Los Alamos National Laboratory (LANL) in 2018 which was instrumental in shaping the remainder of my graduate studies and which heavily influenced my post-graduate pursuits. Prior to my practicum at LANL, I was primarily focused on experimental physics. My practicum was dedicated to cultivating expertise in running radiation-hydrodynamic computational physics tools, an entirely unfamiliar skillset at that time. Much to my surprise, I developed an enduring interest in using the simulation codes to explore pulsed power ICF and high energy density physics target design. In fact, my work subsequently transitioned away from experimental physics towards computational design physics. Indeed, I used my newfound computational physics skills to simulate AutoMag targets, improving design and analysis of AutoMag experiments that formed the basis for my doctoral work.

Since graduating with my PhD in 2021, I have been appointed to the Truman Fellowship in National Security Science and Engineering at SNL. My current research involves using three-dimensional (3D) magnetohydrodynamic simulations to study the origins and evolution of 3D implosion instabilities in MagLIF implosions. On the Z accelerator at SNL as well as on proposed higher energy accelerators in the future, the performance of MagLIF experiments depends crucially on implosion stability; instabilities degrade fuel compression and confinement, ultimately reducing thermonuclear fusion yield. I am hard at work exploring instability mitigation techniques, particularly methods that utilize magnetic field line tension provided by dynamic, magnetic drive field polarization in magnetically-driven, cylindrical implosions. My research indicates that this dynamic screw pinch stabilization mechanism[5,6] (Figure 1) offers the ability to reduce instabilities during implosion and, therefore, may represent an important tool for improving target performance in MagLIF.

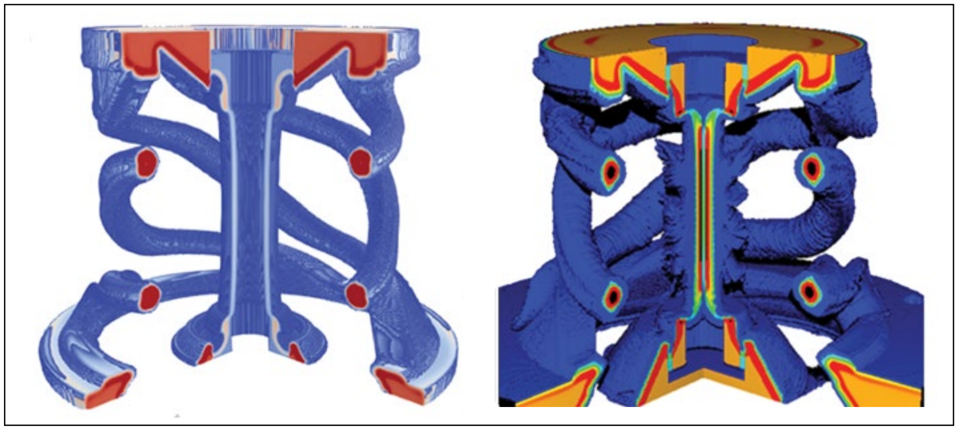


Figure 1. (Left) Cutaway view of a 3D ALEGRA simulation of a dynamic screw pinch implosion on the Z accelerator. (Right) Cutaway view of a 3D GORGON simulation of a dynamic screw pinch implosion on the Z accelerator.

References

[1]S.A. Slutz et al., Phys. Plasmas 17, 056303 (2010).

[2]S.A. Slutz et al., Phys. Plasmas 24, 012704 (2017).

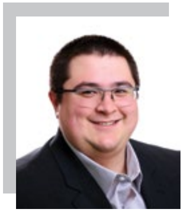
[3]G.A. Shipley et al., Phys. Plasmas 26, 052705 (2019).

[4]G.A. Shipley et al., Phys. Plasmas 29, 032701 (2022).

[5]P.F. Schmit et al., Physical Review Letters 117, 205001 (2016).

[6]G.A. Shipley et al., Phys. Plasmas 26, 102702 (2019).

John Copley (jcopley@princeton.edu) | Princeton University
Degree in Progress: PhD, Geoscience and Materials Science ✦ **Advisor:** Dr. Thomas Duffy ✦ **SSGF:** 2021 - Present



Research Topic

Kinetics of Pressure-Induced Phase Transformations

Research Responsibilities

My research requires the generation of high-pressure environments—subjecting samples to pressures hundreds of thousands of times greater than atmospheric pressure. To generate these extreme conditions, I utilize a piezo-electrically-driven dynamic diamond anvil cell (dDAC) that rapidly squeezes small samples between two diamonds at rates up to 100 TPa/s. Under extreme conditions of pressure, many materials change their crystalline structure to produce denser structures. Combining the rapid compression of a dDAC with synchrotron X-ray diffraction at Argonne National Laboratory's Advanced Photon Source, I perform time-resolved diffraction to track the evolution of structural phase changes as a function of compression rate, stress state, and initial microstructure. These experiments are important in informing our understanding of kinetics at high-pressure and serve to determine if kinetic laws utilized under ambient-pressure conditions are appropriate for use in extreme conditions.

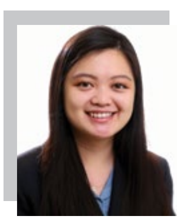
Benefits of SSGF

The SSGF program has allowed me the freedom to design a research problem I find both challenging and interesting. From the application process, where I had to develop an idea for an interesting research topic, to opening doors at the national labs and enabling me to perform experiments and technique development that simply would not be possible in a university lab, the fellowship has allowed me significantly more freedom to focus on a research project that I find engaging. In addition, the SSGF/LRGF community has introduced me to others, both students and national lab staff, who are similarly interested in the results of my work, which has allowed for productive and professionally gratifying interactions.

What Students Considering SSGF Should Know

The opportunity inherent to the practicum experience is hard to overstate. This is a rare chance to spend 12 weeks working with experts in the field and serves as a wonderful time to expand your research interests. I am primarily an experimentalist but decided to do a practicum that focused on molecular dynamics simulations, far outside my normal repertoire. I significantly expanded my understanding of and appreciation for simulations. I cannot think of many other times where a student has the chance to go to a national lab and, for 12 weeks, make use of the unrivaled resources of the national labs. When considering practicums, I would strongly recommend taking a broader look at the possible benefits. If there has ever been something you wanted to learn how to do, the practicum is a wonderful chance to do so.

Yoni Xiong (yoni.xiong@vanderbilt.edu) | Vanderbilt University
Degree in Progress: PhD, Electrical Engineering ✦ **Advisor:** Dr. Bharat Bhuva ✦ **SSGF:** 2021 - Present



Research Topic

Radiation Effects and Reliability on Advanced Bulk FinFET Technology Nodes

Research Responsibilities

As semiconductor technology rapidly advances, the shrinking dimensions of transistors present new challenges related to their susceptibility to radiation-induced effects. Electronic systems, exposed to ionizing radiation in space and terrestrial environments, often experience malfunctions due to single-event effects. The demand for performance improvements in these systems requires hardware upgrades with the most advanced technologies. My research is centered on understanding the impact of radiation on the performance and reliability of cutting-edge fin field-effect transistor (FinFET) technologies. My responsibilities involve experimentation at irradiation facilities and thorough data analysis and simulation work to characterize and model the response of advanced bulk FinFET technology nodes to various types of radiation exposures.

Benefits of SSGF

The SSGF has enabled me to concentrate on my research without the burden of funding concerns and has provided invaluable experience in expanding my skillset. During my SSGF-sponsored practicum at Sandia National Laboratories (SNL), I delved into the investigation of displacement damage effects on memory circuits fabricated with the most advanced commercially-available technology node (5-nm bulk FinFET node). This pivot from my thesis research allowed me to understand and evaluate the effects of destructive irradiations. The success of this project has fostered continued collaboration with SNL, and I plan to characterize multiple technologies for destructive irradiations. The opportunity to initiate and complete such a comprehensive project at a national lab would not have been possible without the fellowship. I am deeply grateful for the mentorship and support received from my colleagues at SNL. The SSGF includes an annual program review, where I have forged friendships and professional connections with both past and current fellows.

What Students Considering SSGF Should Know

The SSGF offers a unique opportunity to immerse oneself in the national laboratory environment through a practicum. Undertaking a completely new project in the midst of graduate studies may seem daunting, but the experience is immensely worthwhile. It allows for the development of technical skills and networking opportunities while offering a chance to bring a fresh perspective to research. My time away from my main dissertation research was refreshing and a fantastic opportunity to collaborate with experts and leverage the resources and facilities available at a national laboratory.

Travis Voorhees (tjvoorh@sandia.gov) | Sandia National Laboratories, California
Years at SNL: 2020 - Present ✦ **Degree:** PhD, Materials Science & Engineering, Georgia Institute of Technology ✦ **LRGF:** 2018 - 2020

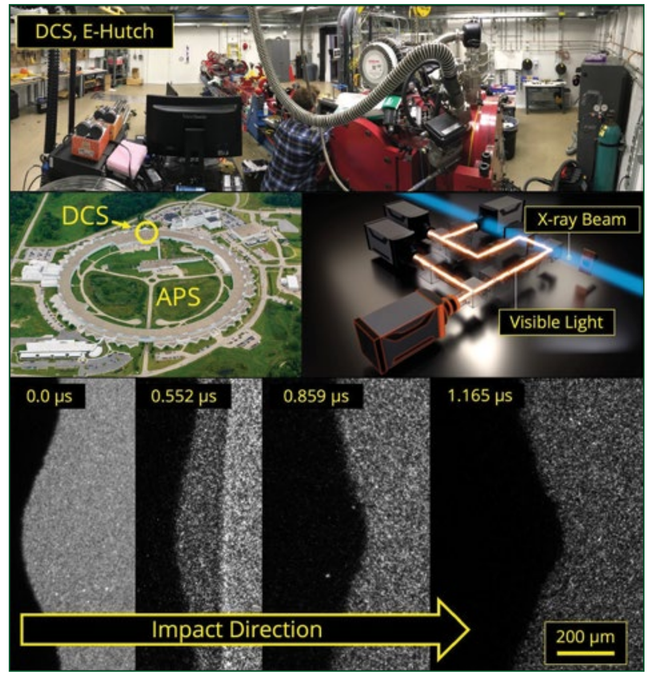


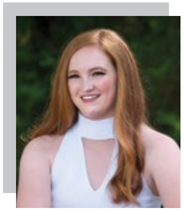
Figure 1. The DCS facility and example radiographs: (top) the two stage gas gun, (middle-left) an overhead view of the APS synchrotron with labeled DCS location, (middle-right) a diagram of how the X-ray beam goes through the sample and generates visible light for imaging, image credit to Chris Garasi, (bottom) four cropped X-ray phase contrast images from a tamped Richtmyer-Meshkov instability experiment, dark material is molybdenum while light material is perfluorooctane.

I am an inaugural fellow of the Laboratory Residency Graduate Fellowship (LRGF). Following graduation, I began working at Sandia National Laboratories (SNL) as a staff scientist, where I design, execute, and analyze shock physics experiments to build predictive computational models for how materials respond to the extreme conditions of shock compression (e.g., hyper velocity impact, explosive loading, etc). This research is my dream job. I work in highly collaborative teams of scientists on coupled computational and experimental efforts. I run simulations on SNL high performance computers (HPC) to design experiments and help interpret diagnostics, then I perform experiments to calibrate and validate the material models controlling those simulations. The majority of my experiments are diagnosed with particle-accelerator-based radiography: the Advanced Photon Source's Dynamic Compression Sector (DCS) at Argonne National Laboratory (operated by Washington State University), Proton Radiography (pRad) at Los Alamos National Laboratory (LANL), and Flash X-ray at Lawrence Livermore National Laboratory's (LLNL) Site 300. Figure 1 shows the DCS facility, where I conduct my experiments, an overhead view of the synchrotron, a model of how the X-ray beam goes through my samples, and four example radiographs from a tamped Richtmyer-Meshkov instability experiment. The ability to perform combined experimental and computational work while collaborating across laboratory borders is one of the key features that drew me to SNL – a laboratory that consistently collaborates across borders and leads the coupled approach to experimental and computational research.

My LRGF residencies guided me towards a career in coupled experimental and computational research. I conducted my PhD research in materials science at Georgia Institute of Technology (GT) from 2015-2020 under the advisement of Dr. Naresh Thadhani and mentorship of Dr. Greg Kennedy. My initial research involved short-term experimental projects using gas guns and a pulsed laser: blast and penetration testing of prototype tank armors, supporting development of laser-based, intracellular cancer therapy delivery, and helping develop new experimental diagnostics. These early projects helped build my familiarity and passion for gas gun operations, high speed cameras, laser-based interferometry, precision machining, and drafting. In 2016, I began my thesis research studying the shock compaction behavior of brittle granular materials (e.g., sands, soils, and asteroids) under the co-advisement of Dr. Anthony Fredenburg at LANL. In 2018, I was accepted into the inaugural LRGF class and conducted my residencies in the X-Theoretical Design division of LANL with Dr. Fredenburg, using the HPC systems to run simulations and the PHELIX pulsed power driver coupled to pRad for validation experiments. During my LRGF residencies, I had the opportunity to meet and network with many of the scientists that I continue to work alongside today. The LRGF gave me the ability to move freely between GT and LANL for extended residencies, provided funds to build a high performance Linux server on which I developed new diagnostic analysis software, and helped connect me with leading researchers in the shock physics field.

I am incredibly grateful to all my mentors and the LRGF for guiding me towards my current career. Of the many benefits of the LRGF, I believe the most beneficial is its consistent effort to promote communication between fellows and NNSA laboratory scientists. Beyond residencies, a key component of the fellowship is the annual program review, where I had the opportunity to meet with and present my work to many leading NNSA scientists, including my current mentor, Tracy Vogler. The Krell Institute, who manage the fellowship for NNSA, makes an avid effort to build community, and I highly recommend that current fellows take advantage of every opportunity provided to promote their research and themselves. I look forward to seeing the LRGF community grow and plan to be a residency mentor in the future.

Taylor Sloop (tasloop@gatech.edu) | Georgia Institute of Technology
Degree in Progress: PhD, Materials Science and Engineering ✦ **Advisor:** Dr. Josh Kacher and Dr. Naresh Thadhani ✦ **LRGF:** 2023 - Present



Research Topic

Dynamic Compression and Tensile Failure of Additively-Manufactured 316L SS with Controlled Porosity

Research Responsibilities

My research responsibilities include designing and executing gas gun experiments to isolate the effects of porosity on shock wave motion in additively-manufactured 316L stainless steel (SS) as well as post-experimental analysis using standard microstructural characterization, including scanning electron microscopy and electron backscatter diffraction.

Benefits of LRGF

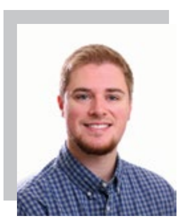
The LRGF program provided funding for my research, so I could pursue the project that interested me. I also have access to mentors in my field at the national labs who are providing valuable insights throughout my PhD process.

National Laboratory Experience

The LRGF is a great fellowship that provides valuable resources. The ability to collaborate with scientists at the national labs during residencies can be invaluable for your PhD work and beyond. The resources that you can access can alter your PhD research and most likely deepen it. When I connected with my residency advisor to discuss the LRGF and began investigating the resources I could utilize during my residency, I knew the fellowship would improve my PhD research and allow me to investigate areas of my research that would not be possible at my university alone. For anyone considering these fellowships, I would recommend determining what resources the national labs may have or research they are currently doing that tie into your own PhD research.

Although I already selected my university before receiving my fellowship, I did adjust my PhD research plans with the additional resources that would be available at Los Alamos National Laboratory (LANL) during my two residencies. Georgia Tech has a gas gun for my research, but since it takes months of preparation per experiment, I place as many samples in one experiment as possible. This limits me to one impact speed for most of my experiments. At LANL, they have a smaller gun that can perform multiple experiments in a day but with fewer samples. With access to this gas gun, I can expand my experiments into multiple impact speeds and delve into interactions and failure mechanisms I couldn't have otherwise investigated.

Brendan Sporer (bsporer@umich.edu) | University of Michigan
Degree: PhD, Plasma Physics ✦ **Advisor:** Dr. Ryan McBride ✦ **LRGF:** 2020 - Present



Research Topic

Pulsed-power, Magnetized Target Fusion and High Energy Density Field-reversed Configurations

Research Responsibilities

Producing multi-MJ nuclear fusion yield in the laboratory is a primary goal of the NNSA Stockpile Stewardship Program. Understanding and properly simulating the physics of inertial and magneto-inertial confinement fusion experiments can inform thermonuclear weapons integrity and advance efforts for controlled fusion energy. The magnetized liner inertial fusion (MagLIF) program on the Z-machine (Z) at Sandia National Laboratories has robustly proved the principles of magneto-inertial fusion, but ultimately is limited to about 0.1 MJ DT-equivalent yield with the maximum capabilities of Z.

My dissertation research concerns an alternative embodiment of magnetized liner fusion on Z, utilizing a magnetized plasma configuration known as a field-reversed configuration (FRC). An FRC has closed field lines, which allows for greater plasma compression, longer burn time, and potentially higher fusion yield than that of standard MagLIF. I have been exploring the applied physics of these novel, high-energy-density FRCs in experiments on a MA-class pulsed-power machine at the University of Michigan, as well as in simulation using the Kraken magnetohydrodynamics (MHD) code developed at Sandia.

Benefits of LRGF

Without support from the LRGF program, it would have been harder to pursue this novel research. FRCs notoriously are difficult to form experimentally and to simulate, so there was the potential for a lot of work to result in little success. I am grateful to the program for taking a chance on me and this unique effort. Furthermore, access to Sandia personnel and resources, primarily through my residencies, was invaluable to my research and my growth as a professional scientist. I always will aspire to achieve the high scientific standards that I experienced at the national laboratories. Finally, I am grateful to the program and to the Krell Institute for the friends and fun experiences from the annual program reviews!

What Students Considering LRGF Should Know

First, students should be excited for their residencies/practicums. I know I, at least, was a bit intimidated as the time approached to pause my experiments and move across the country to a new climate for several months, but it ended up being such a fun experience filled with unique memories that it was almost like an extended vacation! Second, students shouldn't be afraid to apply even if they are not sure they want to work at a national laboratory. There is no pressure or expectation from anyone to do so, and I, ultimately, have chosen a different path. However, the experiences you will have with the national labs are very effective recruiting tools!

Students

The CSGF program has proven to be an invaluable pillar of support throughout my journey in graduate school, empowering me to remain steadfast in my commitment to contributing to my academic community and beyond. Having become a part of this fellowship amidst the global COVID-19 pandemic, I sought an opportunity to leverage my expertise in furthering our understanding of unfolding events. Through my practicum experience with the Ramanathan group at Argonne National Lab, I was granted this opportunity with access to the immense resources at our disposal to conduct impactful scientific research.

Danilo Trinidad Pérez-Rivera
New York University

The SSGF program has allowed me the freedom to design a research problem I find both challenging and interesting. From the application process, where I had to develop an idea for an interesting research topic, to opening doors at the national labs and enabling me to perform experiments and technique development that simply would not be possible in a university lab, the fellowship has allowed me significantly more freedom to focus on a research project that I find engaging.

John Copley
Princeton University

At LANL, I was able to expand the breadth of my experiments with their additional equipment and delve into parts of my PhD that I otherwise wouldn't have been able to explore. Due to these additional experiments, I will be able to publish an extra paper as well as strengthen my PhD dissertation.

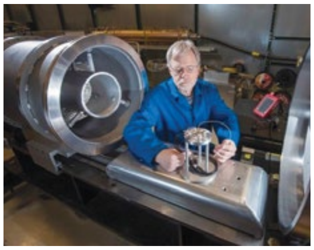
Through the LRGF, I have spent three months at LANL working with leaders in my field. The ability to work closely with and be mentored by the research scientists there has helped me develop a more comprehensive and in-depth PhD dissertation and has allowed me to grow my network and establish a more concrete notion of what I want to do after my PhD.

Taylor Sloop
Georgia Institute of Technology

User Facilities

User Facility Summaries

Dynamic Integrated Compression Experimental Facility



The Dynamic Integrated Compression Experimental (DICE) facility at Sandia National Laboratories provides multiple platforms for material property study utilizing both gun-launched projectiles and pulsed power accelerators with pulse shaping abilities. Unique to DICE is the ability to perform not only shock, or isotropic, compression but also ramped, or isentropic, compression of materials. This allows direct comparison of sample response under different loading conditions. Primary diagnostics include laser-based velocimetry (PDV, VISAR) and high-speed videography. For more information visit https://www.sandia.gov/pulsed-power/research-facilities/dice/. Interested users may contact Scott Alexander (calexa@sandia.gov) for more information.

Dynamic Compression Sector

The DOE/NNSA-sponsored Dynamic Compression Sector (DCS) is a first-of-its-kind experimental capability dedicated to understanding the dynamic compression/deformation response of materials through real-time, multiscale measurements. Managed and operated by Washington State University and located at the Advanced Photon Source (APS) at Argonne National Laboratory, the DCS uniquely integrates state-of-the-art dynamic compression facilities and high energy, synchrotron x-ray capabilities to provide *in-situ* time-resolved, microscopic measurements under high stress impulsive loading. User experiments utilizing x-ray (diffraction, phase contrast imaging, absorption, and scattering) and continuum (laser interferometry) measurements are conducted in each of the experimental stations (Impact Facilities, Laser-Shock, and Special Purpose). Significant enhancements to the DCS experimental capabilities are underway during the APS-Upgrade. Post APS-U, measurements using x-ray energies to 60 plus keV will be routinely available providing unprecedented opportunities for novel scientific studies under dynamic compression. For more details, visit dcs-aps.wsu.edu or contact Dr. Paulo Rigg (dcs.admin@wsu.edu).

High Pressure Collaborative Access Team

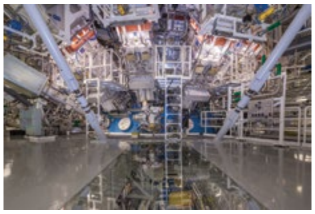
The NNSA-sponsored High Pressure Collaborative Access Team (HPCAT) at sector 16 of the Advanced Photon Source (APS), Argonne National Laboratory, is a synchrotron x-ray facility dedicated for experimental research on materials under extreme pressure-temperature (P-T) and strain rate conditions. The primary experimental focus at HPCAT is on research and development of synchrotron X-ray techniques and coupling these with diamond anvil cell and large volume press, P-T platforms. With four, simultaneously operational, experimental beamline stations, our users are provided X-ray experimental probes, covering an array of diffraction, imaging, and spectroscopy techniques. For more information, visit https://hpcat.aps.anl.gov/ or contact Nenad Velisavljevic (HPCAT-Director@anl.gov). The operational schedule at HPCAT, along with the host APS facility, is divided into three cycles per year – the calendar time-frame of each cycle and any updates can be found on the APS home website. For those interested in performing work at HPCAT the experimental time can be obtained via the General User Proposal (GUP) peer review system or internal partner time allocation request. If interested in GUP additional information can be found at https://www.aps.anl.gov/Users-Information/About-Proposals/Proposal-Types/General-User-Proposals. For partners (including LLNL/ LANL/ SNL and NNSA-SSAA PIs) please email HPCAT-Director@anl.gov to discuss dedicated beamtime allocation, experimental scope/ requirements, etc.

Los Alamos Neutron Science Center

For more than 50 years, the Los Alamos Neutron Science Center (LANSCE) has provided the nuclear physics and material science data needed to ensure the safety and surety of the nuclear stockpile. User time is available at the proton radiography (pRad) facility for dynamic radiography, the Lujan Center for neutron scattering, neutron radiography, and radiography nuclear physics, and the Weapons Neutron Research Facility for nuclear physics, neutron radiography, and electronics testing. In addition to national security research, LANSCE provides the scientific community with intense sources of neutrons and protons for experiments supporting the production of medical and research isotopes, neutron irradiation for industrial application, and research in fundamental physics.

Proposal call dates for the various LANSCE experimental areas vary, but they generally open in December/January and run through January/March. For more information, visit https://lansce.lanl.gov or contact lansce-user-office@lanl.gov.

National Ignition Facility



The National Ignition Facility (NIF) is the world's most energetic laser and is available for user experiments investigating the properties of high energy density matter. The NIF provides up to 2.05 MJ of laser energy to targets, with pulse durations that range from sub-ns to 10s of ns. The NIF main laser can be used in conjunction with the kJ-class, ps-pulse ARC laser. The NIF's 10-meter-diameter target chamber has multiple lines of sight for optical, x-ray, gamma and neutron, and charged-particle diagnostics. Proposals for user experiments are solicited several times each year. A call for proposals for Discovery Science users is issued annually. For details, visit https://lasers.llnl.gov/for-users/call-for-proposals and https://lasers.llnl.gov or contact Kevin Fournier, NIF User Office Director, nifuseroffice@llnl.gov.

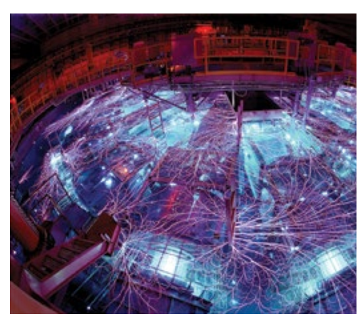
Omega Laser Facility

The Omega Laser Facility at the University of Rochester's Laboratory for Laser Energetics (LLE) includes the 60-beam OMEGA and the 4-beam high-energy, high-intensity OMEGA EP Laser Systems. The OMEGA EP short pulse beam (up to 2) or the tunable-wavelength long-pulse beam can also be transported to the OMEGA chamber for joint operations. The facilities have been adapted to operate experiments for remote users. The two lasers share over 100 facility-supported diagnostics and perform over 2000 highly diagnosed experiments annually. LLE staff work closely with the User Community via the Omega Laser Facility Users Group (OLUG) to improve and add new capabilities every year. Nearly one-third of the experiments at the Omega Laser Facility support basic high energy density science. Three programs provide general user access with beam time granted through a peer-reviewed proposal process (National Laser Users' Facility and Laboratory Basic Science funded by NNSA, and LaserNetUS funded by DOE's Office of Fusion Energy Sciences). Application details are available on the LLE website for the NLUF and LBS programs, on the LaserNetUS website for additional beamtime on OMEGA EP. For more information, visit https://www.lle.rochester.edu/ or contact Dr. Mingsheng Wei, NLUF Manager, mingsheng@lle.rochester.edu.

Shock Thermodynamic Applied Research

The Shock Thermodynamics Applied Research (STAR) Facility at Sandia National Laboratories is specifically designed, staffed, and used by professionals in the technical disciplines of High Temperature/High Pressure Condensed Matter Physics, Shock Physics, and Dynamic Material Properties. STAR houses a collection of five laboratory test launchers (guns) used for dynamic material property and ballistic impact studies. It is unique in the world in that the collection of launchers can achieve a wide range of sample pressure (bars to multi-Mbar) for material property study. The facility is also equipped to perform ballistics studies with a diverse range of projectile shapes, sizes, and materials. Primary diagnostics include laser-based velocimetry (PDV, VISAR), high-speed videography, and flash X-radiography. For more information visit https://www.sandia.gov/pulsed-power/research-facilities/star/. Interested users may contact Scott Alexander (calexa@sandia.gov) for more information.

Z Pulsed Power Facility



The Z Pulsed Power Facility (Z) is a megajoule-class pulsed power accelerator and multifaceted experimental resource at Sandia National Laboratories that produces intense X-rays and magnetic fields useful for experiments in fundamental high energy density (HED) science. Approximately 10% of the Z shots allocated—around 14 shots/year— are designated for the Z Fundamental Science Program. These shots are competitively-awarded to academic, industrial, and national laboratory research interests through a yearly proposal process for state-of-the-art fundamental research in HED physics, including hydrodynamics, properties of materials under extreme conditions, laboratory astrophysics, advanced ignition concepts, fundamental HED physics, biology, and chemistry. The Call for Proposals is typically issued in mid-June and closes in mid-September. The Z Fundamental Science Workshop is held in early August. Award notifications are provided in mid-December for a two-year award period that begins the following July. For more information, visit https://www.sandia.gov/pulsed-power/ or contact Marcus Knudson, mdknuds@sandia.gov.

ZNetUS: Consortium for Advancement in Pulsed Magnetic Science and Technology ✦ ZNetUS Chair: Dr. Keith LeChien

(https://znetus.eng.ucsd.edu)

ZNetUS is a consortium of researchers from academia, the national laboratories, and private industry dedicated to advancing pulsed magnetic science, technology, and high energy density (HED) physics for energy and national security applications with a special focus on creating a pathway for the next-generation scientific leaders. The key objectives of ZNetUS are:

1. Advancing Pulsed Magnetic Science and Technology: The program aims to push the boundaries in areas such as magneto-driven high energy density experimental science, pulsed power technology development, and magneto-hydrodynamic simulation.

2. Access and Collaboration: ZNetUS provides broad access to unique facilities and technologies, fostering collaboration among pulsed magnetic science and technology (PMS&T) researchers and networks.

3. Workforce Development: ZNetUS aims to develop a skilled workforce for advancing pulsed magnetic science and technology, with applications in national security and energy.

Program Objectives and Facilities

The National Nuclear Security Administration (NNSA) recently established a pilot User Facilities program through ZNetUS. This initiative is a significant stride in fostering academic-led collaborations aimed at enhancing the field of PMS&T. The program's Participating User Facilities include:

1. CESZAR (University of California San Diego): This facility features a 20-brick Linear Transformer Driver (LTD) capable of producing approximately 0.8 megaampere current with a rise time of 200 nanoseconds. It includes multiple diagnostics, such as four-frame X-ray/ultraviolet (XUV) cameras and high-resolution spectrometers.

2. COBRA (Cornell University): A low impedance (0.5 ohm) Marx bank generator designed to drive 10 nanohenry loads at 1 megaampere with pulses ranging from 95-230 nanoseconds. COBRA is versatile, having been used in a variety of HED experiments, including conical wire arrays and laboratory plasma jets.

3. MAIZE (University of Michigan): This 3-m-diameter, single-cavity LTD cavity with 40 spark gap switches, 80 capacitors, and a 1-m-diameter vacuum chamber, making it an ideal testbed for experimental and educational purposes.

4. MYKONOS (Sandia National Laboratories, Albuquerque, NM): A 5-cavity LTD operating at 0.85 megampere output current and 400 kilovolt output voltage. Mykonos is used for studying magnetically-driven load physics, power flow plasma physics, and plasma diagnostic development.

5. ZEBRA (University of Nevada, Reno): Zebra delivers up to 1.6 megaampere peak current producing magnetic fields in the 1 megagauss to 4 megagauss range and is suitable for a range of experiments, including wire array implosions and coupled shots with the 50 terawatts Leopard laser beam.

Figure 1. Student researchers install a target at the CESZAR facility.

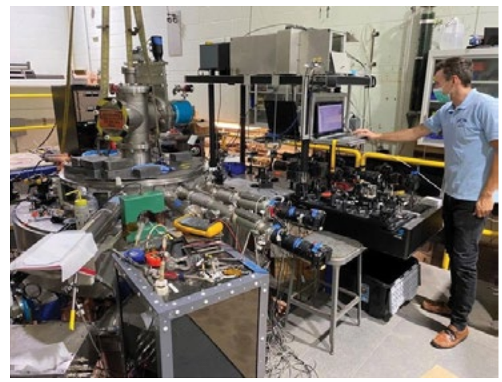


Figure 2. A student researcher configures an experiment at the COBRA facility.

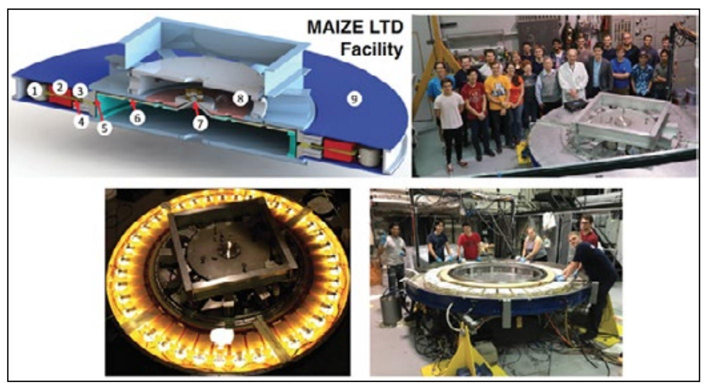


Figure 3. Lower right: Researchers at MAIZE preparing for an experiment

Next Steps for ZNetUS

ZNetUS successfully launched its User Facilities program in 2024 awarding 12 research groups experimental time on the User Facilities. Looking ahead and pending funding, ZNetUS is poised to possibly expand in several key areas:

1. Providing access to more users and broadening facility participation: To address high demand from the pilot User Facility Call for Proposals, ZNetUS will expand the User Program from 12 to 24 Users, adding more User Facilities and opening the call to national laboratory and private industry principal investigators.

2. Launching a transformational technologies joint development effort: ZNetUS will launch an academic-led, multi-institution program focused on the development of multi-user diagnostics and advanced pulsed power technologies. This program will propagate new technologies to each of the User Facilities.

3. Focusing code development for Pulsed Magnetic Science and Technology: An effort will be launched to establish a set of validated codes for simulating pulsed magnetic systems. This effort will close the gap in the availability of mature, publicly accessible, simulation codes, enhancing the utility of the User Facility program.

For more information, visit https://znetus.eng.ucsd.edu.

FY 2024 List of Grants and Cooperative Agreements

Fellowships

Krell Institute
Computational Science Graduate Fellowship
Laboratory Residency Graduate Fellowship
Stewardship Science Graduate Fellowship

High Energy Density Laboratory Plasmas

Colorado State University
Jorge Rocca
Resonant Excitation and Multistage Amplification of Electron Plasma Waves in High Energy Density Plasmas

Cornell University
David Hammer
X-Ray Spectroscopic Studies of Radiative Collapse in X-Pinch Plasmas

Cornell University
Gennady Shvets
Super-Ponderomotive Effects in Ultra-Intense Laser-Plasma Interactions: Towards Novel X-ray and Current Sources

Georgia Tech Research Corporation
Phanish Suryanarayana
Density Functional Theory at Extreme Conditions —Warm Dense Matter from First Principles

Massachusetts Institute of Technology
Johan Frenje
Development of New Advanced X-ray and γ-ray Diagnostics for Inertial-Confinement-Fusion and Discovery-Science Programs at OMEGA and the NIF

Massachusetts Institute of Technology
Chikang Li
Study of Magnetized, High-Energy-Density Hydrodynamics at OMEGA

Princeton University
Nathaniel Fisch
Fundamental Issues in the Interaction of Intense Lasers with Plasma

Princeton University
William Fox
Particle Heating by High-Mach-Number Collisionless Shocks in Magnetized Laboratory Plasmas

Princeton University
William Fox
Magnetic Reconnection in High-Energy-Density Plasmas

Stanford University
Matthew Edwards
High-Power Photonics Using Adaptively Controlled Plasmas as Diffractive Optical Elements

University of California, Los Angeles
Warren Mori
Controlling the Nonlinear Optics of Plasmas Using Spatially and Temporally Structured Light

University of California, San Diego
Maria Pia Valdivia Leiva
Development of Talbot-Lau Phase-Contrast X-ray Diagnostics for High Energy Density Laboratory Plasmas

University of California, San Diego
Farhat Beg
Study of Magnetic Field Distribution and Thermal Conduction in Structured, Magnetized Gas Puff Z-pinches

University of Michigan
Louise Willingale
Direct Laser Acceleration of Electrons for Bright, Directional Radiation Sources

University of Nevada, Reno
Alla Safronova
Understanding Atomic Properties in HED Plasmas by Studying Line and Continuum Emission from High Z Ions

University of Nevada, Reno
Bruno Bauer
Exploring the Connection of Magnetohydrodynamic Instabilities to Earlier Electrothermal Instability from Controlled Surface Perturbations on Metal Driven by Intense Current

University of Nevada, Reno
Roberto Mancini
X-ray Heating, Temperature and Ionization of Photoionized Plasmas

University of Nevada, Reno
Thomas White
Electron-Ion Equilibration in Dense and Quantum Plasmas

University of New Mexico
Mark Gilmore
Exploring the Connection of Magnetohydrodynamic Instabilities to Earlier Electrothermal Instability from Controlled Surface Perturbations on Metal Driven by Intense Current

University of Rochester
Jessica Shang
Probing Transport Mechanisms in HED Flows

Minority Serving Institutions Partnership Program

Advanced Sensors Technologies for Applications in Electrical Engineering – Research and Innovation Excellence Consortium (ASTERIX)
Florida International University, Lead Recipient
Shekhar Bhansali

Advanced Synergistic Program for Indigenous Research in Engineering (ASPIRE)
Turtle Mountain Community College, Lead Recipient
Austin Allard

Application of Artificial Intelligence to Cybersecurity for Protecting National Critical Infrastructure (CONCISE)
University of Texas at San Antonio, Lead Recipient
Guen Chen

Attract, Educate, Train, and Retain Native American and Minority Students in Nuclear & Related Sciences (AETRNAMS)
Nueta Hidatsa Sahnish College, Lead Recipient
Kerry Hartman

Consortium of Advanced Additive Manufacturing Research and Education for Energy Related Systems (CA2REERs)
The University of Texas – Rio Grande Valley, Lead Recipient
Jianzhi (James) Li

Consortium enabling In- and Ex-Situ-Quality Control of Additive Manufacturing (QCAM)
New Mexico State University, Lead Recipient
Borys Drach

Consortium for High Energy Density Science 2.0 (CfHEDS-2)
Florida A&M University, Lead Recipient
Charles Weatherford

Consortium for Laser-based Analysis of Nuclear and Environmental Materials (LANEM)
Florida A&M University, Lead Recipient
Lewis Johnson

Consortium for Research and Education in Materials Science and Photonics Engineering (NoVel)
Norfolk State University, Lead Recipient
Mikhail A. Noginov

Consortium for Research and Education in Power and Energy Systems (CREPES)
Florida International University, Lead Recipient
Sumit Paudyal

Consortium for Nuclear Security Advanced Manufacturing Enhanced by Machine Learning (NSAM-ML-2)
Elizabeth City State University, Lead Recipient
Abdennaceur Karoui

Consortium Hybrid Resilient Energy Systems (CHRES)
Universidad Ana G. Méndez-Gurabo, Lead Recipient
Amaury Malavé

Consortium on Nuclear Security Technologies (CONNECT 2.0)
University of Texas at San Antonio, Lead Recipient
Elizabeth Sooby

Consortium on Sensing, Energy-efficient Electronics and Photonics with 2D Materials and Integrated Systems for Training the Next-Generation DOE-NNSA STEM Workforce (SEEP-IT)
University of North Texas, Lead Recipient
Anupama Kaul

Consortium for Education and Research in Electronics for Extreme Environments (E3C)
University of Texas at El Paso, Lead Recipient
Miguel Velez-Reyes

Consortium for Research and Education in Cyber Manufacturing (CMA-MNuR)
Florida International University, Lead Recipient
Ibrahim Tansel

Developing Next Generation Radiation Safety Professionals (DNGRSP)
Queensborough Community College
Sharon Lall-Ramnarine

Enabling Native Researchers and Graduate Engineering (ENRGE)
Navajo Technical University, Lead Recipient
Peter Romine

Enhancing the National Security Enterprise Workforce Pipeline (ENSEWP)
Augusta Technical College
John Tucciarone

Growing STEMs Consortium: Training the Next Generation of Engineers for the DOE/NNSA Workforce (GSC)
Texas Tech University, Lead Recipient
Michelle Pantoya

Integrated Additive Manufacturing – Establishing Minority Pathways: Opportunities for Workforce-development in Energy Research and Education (IAM-EMPOWEREd)
Florida A&M University, Lead Recipient
Tarik Dickens

Indigenous Mutual Partnership to Advance Cybersecurity Technology (IMPACT)
Turtle Mountain Community College, Lead Recipient
Chad Davis

Microelectronics & Materials Engineering Education for Nuclear and Cyber Security (MEMENCYS)
University of California, Riverside, Lead Recipient
Shane Cybart

MSIPP Gulf Coast A&M Consortium: Materials-at-the-Extreme (MATE) – Material Science for Extreme Environments
Florida A&M University, Lead Recipient
Tarik Dickens

Native Education Excellence in Trades (NEXT)
Turtle Mountain Community College
Sheila Trottier

Nevada National Security Site (NNSS) FastStart Program (FastStart)
The College of Southern Nevada
Michael Spangler

Nuclear Security Science and Technology Consortium (NSSTC)
University of Nevada, Las Vegas, Lead Recipient
Alexander Barzilov

Partnership for Advanced Manufacturing Education and Research (PAMER)
Navajo Technical University, Lead Recipient
Monsuru Ramoni

Partnership for Proactive Cybersecurity Training (PACT)
University of Arizona, Lead Recipient
Salim Hariri

Partnership for Radiation Studies (PaRS)
Alabama A&M University, Lead Recipient
Stephen Babalola

Partnership for Research and Education Consortium in Ceramics and Polymers 2.0 (PRE-CCAP-2)
University of Texas at El Paso, Lead Recipient
Jack Chessa

The Rio Grande Consortium for Advanced Research on Exascale Simulation (Grande CARES)
University of New Mexico, Lead Recipient
Peter Vorobieff

Rapid Education and Placement (REAP)
Las Positas College
Scott Minor

Scholarly Partnership in Nuclear Security (SPINS)
Alabama A&M University, Lead Recipient
Mebougna Drabo

Successful Training and Effective Pipelines to National Laboratories with STEM Core (STEP2NLs)
North Carolina A&T State University, Lead Recipient
Ray Tesiero

Predictive Science Academic Alliance Program III

Massachusetts Institute of Technology
Youssef Marzouk
Center for the Exascale Simulation of Material Interfaces in Extreme Environments

Oregon State University
Todd Palmer
Center for Exascale Monte Carlo Neutron Transport

Stanford University
Gianluca Iaccarino
Integrated Simulations Using Exascale Multiphysics Ensembles

University of Buffalo
Paul DesJardin
Center for Exascale Simulation of Hybrid Rocket Motors

University of Colorado
Richard Regueiro
Center for Micromorphic Multiphysics Porous and Particulate Materials Simulations with Exascale Computing Workflows

University of Illinois
Jonathan Freund
Center for Exascale-Enabled Scramjet Design

University of Maryland
Johan Larsson
Solution-Verification, Grid-Adaption and Uncertainty Quantification for Chaotic Turbulent Flow Problems

University of New Mexico
Patrick Bridges
Center for Understandable, Performant Exascale Communication Systems

University of Texas
Robert Moser
Exascale Predictive Simulation of Inductively Coupled Plasma Torches

Stewardship Science Academic Alliances

High Energy Density Physics

Massachusetts Institute of Technology
Chikang Li
Center for Advanced Nuclear Diagnostics and Platforms for ICF and HED Physics at OMEGA, NIF, and Z

University of California, San Diego
Farhat Beg
Center for Matter Under Extreme Conditions

University of Michigan
Carolyn Kuranz
Center for Laboratory Astrophysics Research

University of Michigan
Ryan McBride
The Center for Magnetic Acceleration, Compression, and Heating

University of Texas at Austin
Donald Winget
Center for Astrophysical Plasma Properties

Hydrodynamics, Instabilities, and Hypersonics

Georgia Institute of Technology
Devesh Ranjan
Detailed Measurements of Turbulent Rayleigh-Taylor and Richtmyer-Meshkov Mixing at Extreme Conditions

University of Arizona
Jeffrey Jacobs
An Experimental Study of Rayleigh-Taylor and Richtmyer-Meshkov Instabilities at Large Reynolds Numbers

University of Colorado
Iain Boyd
Computational Modeling of Hypersonic Flow and Material Response in a Free-jet Test Facility

University of Florida, Gainsville
S. Balachandar
Understanding Hydrodynamic Instabilities of Explosively-Driven Multiphase Fronts for Accurate Prediction of Their Complex Structures

University of Michigan
Carolyn Kuranz
Radiation Transport in Strongly Coupled Plasmas

University of Wisconsin, Madison
Riccardo Bonazza
Experimental Investigation of the Richtmyer-Meshkov Instability Coupled with a Chemical Reaction

Low Energy Nuclear Science

Duke University
Alex Crowell
High-precision neutron-induced cross-section measurements on 191,193Ir

Duke University
Sean Finch
Measurements of Precise Fission Cross-section Ratios and Correlations in Fission Observables

Duke University
Calvin Howell
Measurements of Prompt Neutron Differential Multiplicity in Photofission of ^{235}U, ^{238}U and ^{239}Pu

Duke University
Werner Tornow
Measurement and Analysis of Selected Neutron-induced Fission Product Yields for ^{235}U, ^{238}U and ^{239}Pu

Michigan State University
Sean Liddick
Neutron Capture Cross Section Measurements on Short-Lived Isotopes

Michigan State University
Witold Nazarewicz
Microscopic Description of the Fission Process

Ohio University
Carl Brune
Nuclear Reactions and Scattering

Ohio University
Alexander Voinov
Statistical Nuclear Physics and (a,n) Reactions for Applications

Oregon State University
Walter Loveland
The Energy Release in the Fission of Actinide Nuclei

Rutgers University
Jolie Cizewski
Nuclear Reaction Studies with Rare Isotope Beams for Stewardship Science

San Diego State University
Kenneth Nollett
Scattering and Direct Reactions in a Shell Model Framework

Texas A&M University
Sherry Yennello
CENTAUR: Nuclear Science in Service to the Nation

University of California, Berkeley
Lee Bernstein
Correlated Neutron-Gamma Data for Stewardship Science

University of Notre Dame
Anna Simon-Robertson
Constraining Neutron-Capture Cross Sections via Direct and Indirect Experimental Methods

University of Tennessee, Knoxville
Robert Gryzwacz
Beta-Delayed Neutron Spectroscopy of Exotic Nuclei

Properties of Materials under Extreme Conditions and Energetic Environments

Carnegie Institution of Washington
Sally Tracy
Dynamic Compression of Iron Carbide at Exoplanetary Core Conditions

Colorado School of Mines
Amy Clarke
Advanced Characterization of Metals under Extreme Environments

Colorado School of Mines
Amy Clarke
Microstructure Control of Additively Manufactured Metals of Interest to the NNSA Weapons Complex

Harvard University
Stein Jacobsen
From Z to Planets - Phase IV

Harvard University
Isaac Silvera
Metallic Hydrogen: Reflectance, Metastability, and Superconductivity

Research Foundation for the State University of New York
Baosheng Li
Thermodynamic and Mechanical Properties of SSP Materials from Simultaneous Ultrasonic and X-ray Studies at High Pressure and Temperature

Stanford University
Leora Dresselhaus-Marais
New Operando X-ray Microscope for Movies Resolving the Nanoscale Origins of Defects in Metal Additive Manufacturing

University of Alabama at Birmingham
Yogesh Vohra
Center for Additively Manufactured Complex Systems under Extremes

University of Alabama at Birmingham
Yogesh Vohra
Studies on Rare Earth Metals and Alloys under Terapascal Pressures in Support of the Stockpile Stewardship Program

University of California, San Diego
Brian Maple
Novel d- & f- Electron Materials Under Extreme Conditions of Pressure, Temperature, and Magnetic Field

University of Florida
Douglas Spearot
Understanding the Role of Elastodynamic Effects on Shock Induced Plasticity via Discrete Dislocation Dynamics Simulations

University of Illinois Chicago
Russell Hemley
Chicago/DOE Alliance Center – A Center of Excellence for High Pressure Science and Technology

University of Nevada, Las Vegas
Pamela Burnley
Deformation of Polycrystalline Materials under Extreme Conditions: Stress Percolation, Shear Localization and Grain Boundary Rheology

University of Rochester
Niaz Abdolrahim
Time-Resolved Classification of X-ray Diffraction Data Using Deep-Learning-Powered Computer Vision Techniques

University of Texas at Austin
Michael Downer
Radiography of High Energy Density Phenomena Using X-rays from Laser Plasma Accelerators

Washington State University
Hergen Eilers
Real-time Monitoring of Chemical Reactions at Subsurface Locations in Optically Opaque and Highly Scattering Samples

Washington State University
Choong-Shik Yoo
Chemistry of Dense Planetary Mixtures at Extreme Conditions

Radiochemistry

Clemson University
Brian Powell
Combined Field and Laboratory Studies of Plutonium Aging and Environmental Transport

Clemson University
Scott Husson
Improving the Sensitivity and Precision for Plutonium Isotope Ratio Measurements by Thermal Ionization Mass Spectrometry Using a Novel Polymer Fiber Platform

Duke University
Jason Amsden
Virtual-Slit Cycloidal Mass Spectrometer for Portable Rapid Ultra-Trace Isotope Ratio Analysis of Actinides

Georgia Institute of Technology
Henry La Pierre
Transuranic Chemistry Center of Excellence

University of Notre Dame
Ani Aprahamian
Novel Techniques for the Production of Robust Actinide Targets

Washington University in St. Louis
Rita Parai
Seeing Through the Fission Phase 2: Multi-Modal Analysis of Actinides and Noble Gas Isotopes in Geological Samples

NNSA

National Nuclear Security Administration

DEFENSE PROGRAMS