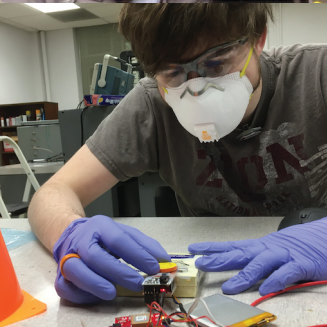
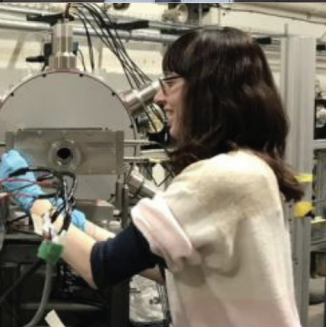
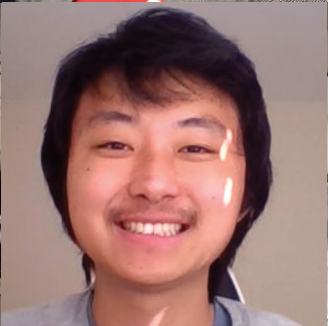


NUCLEAR SCIENCE & SECURITY CONSORTIUM

10 Year Anniversary
Summer 2021 Newsletter



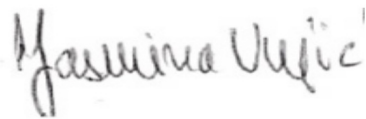
Letter from the NSSC Director

This year, the Nuclear Science and Security Consortium (NSSC) is celebrating 10 years of success—with a thriving pipeline from recruitment and mentorship of top students to a large pool of skilled talent transferred to careers at the national labs. At the same time, the NSSC has demonstrated scientific excellence in innovative basic and applied research in nuclear security science and engineering. At the end of its 10th year, the NSSC is proud for supporting 573 people (undergraduate and graduate students, postdocs, specialists, and faculty) and for placing 135 (46%) of students and postdocs that completed the program into positions in the DOE National Laboratories or other government agencies with over 90% retention rate in national and nuclear security careers.

From the beginning, the primary objective of the NSSC has been to recruit and train top students, connect students with a core set of disciplines that support the nonproliferation and nuclear security mission, and expand national laboratory collaboration to provide students the opportunity to engage deeply in basic and applied research under the guidance of academic advisors and national laboratories staff scientists. The NSSC has graduated 120 B.S., 85 M.S., and 126 Ph.D. student fellows and affiliates, and has supported 50 postdoctoral scholars through program completion. In addition to the 135 NSSC scholars hired by national laboratories and government agencies, 57 NSSC scholars were hired into positions at U.S. universities as leaders in nuclear-related fields. Scientific excellence of the NSSC teams has been demonstrated through the publication of over 400 peer-reviewed manuscripts, close to 1,400 oral and poster presentations, and over 200 excellence and innovation awards.

The wide reach of the NSSC provides a unique infrastructure for recruitment, education and training, as well as human capital development, formidable for the quantity, quality, and diversity of fellows, and a rich collaborative research environment between the university members, their student and faculty researchers, and the DOE National Laboratory scientists and staff. These stellar NSSC Fellows and Affiliates represent the next generation of scientists and researchers, with skill sets and expertise required to support critical nuclear science and engineering disciplines needed in nuclear nonproliferation, nuclear arms control, nuclear incident response, nuclear intelligence activities, nuclear energy, and other nuclear-related fields.

We are also proud that the Department of Energy’s National Nuclear Security Agency has tapped UC Berkeley for the third time to lead the Nuclear Science and Security Consortium (2021-2026), which now brings together nuclear scientists and engineers from eleven universities and five national labs. The R&D agenda in the new consortium is organized by two main themes: fundamental nuclear sciences, which includes nuclear physics and nuclear data, nuclear chemistry and radiochemistry, and nuclear materials science; and applied nuclear science and engineering, which includes radiation detection, nuclear chemical engineering and nuclear engineering. Linking these are two crosscutting activities: computing and optimization for nuclear applications, and education in nuclear science, technology, and policy. The total number of faculty in the new NSSC team is 40, including 13 Assistant Professors. Among the junior faculty co-PIs, we are proud to have the second generation of NSSC fellows that will now engage in mentoring and preparation of the top students using the skills and knowledge that they acquired through their NSSC engagement! Our new team pools some of the nation’s leading educational and research resources in physics, chemistry, materials science, nuclear engineering, and computation to attract highly qualified students and advance them to be leaders in the nation’s future nuclear security workforce.



Dr. Jasmina Vujic
NSSC Director



Attendees of the NSSC Fall Workshop and
Advisory Board Meeting in 2019

Contents

Mission and History of NSSC	page 4
NSSC Leadership, Focus Areas, and Partners	page 6
10 Years of Success	page 8
NSSC in the Pandemic Era	page 10
NSSC Summer Programs	page 12
Winners of the 2021 NSSC Awards	page 14
Student and Alumni Success	page 16
Research Highlights	page 22
The NSSC Pipeline	page 21
NSSC to the National Laboratories	page 22

The Mission of the NSSC

Train the next generation of nuclear scientists and engineers while engaging in research and development spanning basic aspects of new technology and methods to programmatic work directly supporting the nuclear security and nonproliferation mission.



History of the NSSC

The Nuclear Science and Security Consortium was established in **2011** as the first NNSA academic consortium. The NSSC1 (2011-2016) nickname was **SUCCESS PIPELINE** which stands for *Seven Universities Coordinating Coursework and Experience from Student to Scientist in a Partnership for Identifying and Preparing Educated Laboratory-Integrated Nuclear Experts*, and it included more than 100 researchers from Michigan State University, UC Davis, UC Irvine, the UC San Diego Institute on Global Conflict and Cooperation (IGCC), the University of Nevada, Las Vegas; and Washington University in St. Louis, led by UC Berkeley. Four national laboratories (LANL, LBNL, LLNL, and SNL) were NSSC1 partners. NSSC1 carried R&D in four focus areas (nuclear physics, nuclear instrumentation and detection technology, nuclear and radiochemistry, and nuclear engineering), with cross-cutting area of nuclear security policy. In **2016**, the NSSC2 successfully recompeted for an additional five years of support (2016-2021). The UC Berkeley as the lead institution was joined by the George Washington University, Michigan State University, Texas A&M University, UC Davis, UC Irvine, University of Nevada Las Vegas, and University of Tennessee Knoxville. With five national laboratory partners (LANL, LBNL, LLNL, ORNL, and SNL), the NSSC carried out R&D in four technical areas: nuclear and particle physics, radiochemistry and forensics, nuclear engineering, and nuclear instrumentation and radiation detection. Linking these R&D areas were four crosscutting fields: nuclear data, modeling and simulation, nuclear security policy, and education and training. Together they provided a framework that yields new ideas, technology development, and personnel with the integrated capabilities required for the nuclear security mission.

The Department of Energy's National Nuclear Security Administration has tapped UC Berkeley for the third time to lead the Nuclear Science and Security Consortium (**2021-2026**), which now brings together nuclear scientists and engineers from eleven universities and five national labs: UC Berkeley (lead); Air Force Institute of Technology; George Washington University; Michigan State University; North Carolina State University; Texas A&M University; UC Davis; University of Illinois Urbana-Champaign; University of Nevada, Las Vegas; University of New Mexico; and University of Tennessee, Knoxville in cooperation with the same laboratory partners: LANL, LBNL, LLNL, SNL, ORNL. The R&D agenda in the new consortium is organized by two main themes: fundamental nuclear sciences, which includes nuclear physics and nuclear data, nuclear chemistry and radiochemistry, and nuclear materials science; and applied nuclear science and engineering, which includes radiation detection, nuclear chemical engineering and nuclear engineering. Linking these are two crosscutting activities: computing and optimization for nuclear applications, and education in nuclear science, technology, and policy.

After a decade in R&D and education, the NSSC is proud of supporting 573 people (undergraduate and graduate students, postdocs, specialists and faculty). These stellar NSSC Fellows and Affiliates represent the next generation of young scientists and researchers. Research highlight and success stories of the NSSC fellows are provided in this Newsletter.



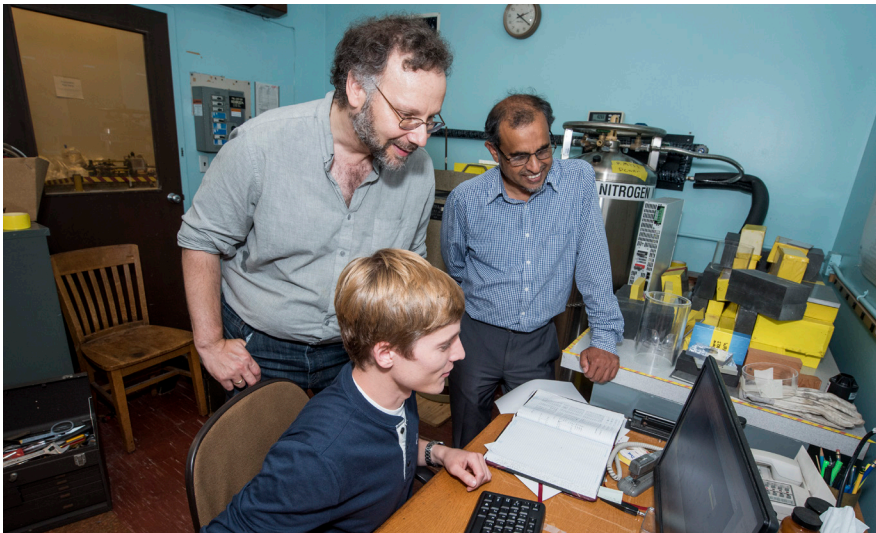
NSSC1 Kick-Off meeting in Berkeley in June 2011. In the photo from the left: from UCB - Chancellor Robert Birgeneau, Prof. Jasmina Vujic, Professor James Siegrist and Prof. Kai Vetter; from the NNSA/DNN R&D (from the left) - Dr. Edward Watkins, Dr. David LaGraffe and Dr. Marco di Capua.

(Left) Tyler Erjavec with Prof. Robert Svoboda (of UC Davis) at Los Alamos running the Argon Resonant Transport Interaction Experiment (ARTIE) in the LANSCE neutron beam line.

NSSC₃ Leadership

EXECUTIVE TEAM
DR. JASMINA VUJIC
Director
UC Berkeley
DR. BETHANY GOLDBLUM
Executive Director
UC Berkeley/LBNL
DR. JASON HAYWARD
Deputy Executive Director
UT Knoxville
DR. KAI VETTER
NNSA Liaison
UC Berkeley/LBNL
DR. LEE BERNSTEIN
Director for Laboratories
UC Berkeley/LBNL

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UC Berkeley
DR. MIRIAM JOHN
former SNL
DR. BRAD ROBERTS
CGSR, LLNL
DR. BENN TANNENBAUM
SNL



Prof. Lee Bernstein, LBNL Mentor Shamsu Basunia, and NSSC Fellow Eric Matthews.

ACADEMIC POINTS OF CONTACT
PROF. MANI TRIPATHI
UC Davis
PROF. FREDERIC POINEAU
UN Las Vegas
PROF. CODY FOLDEN
Texas A&M University
PROF. CHRIS CAHILL
George Washington University
PROF. JASON HAYWARD
UT Knoxville
PROF. SEAN LIDDICK
Michigan State University
PROF. DJAMEL KAOUMI
NC State University
PROF. JIM STUBBINS
Illinois State
PROF. ANIL PRINJA
U New Mexico
PROF. JUAN MANFREDI
AFIT

LAB POINTS OF CONTACT
DR. JOHN VALENTINE
LBNL
DR. VLADIMIR MOZIN
LLNL
MARGARET ROOT
LANL
DR. JENNIFER LADD-LIVELY
ORNL
DR. DAVID PETERS
SNL

NSSC STAFF
CHARLOTTE CARR
Program Manager
DEREK JOHNSON
Financial Analyst

NSSC₃ Research Focus & Crosscutting Areas

Nuclear Physics & Nuclear Data
B. Jacak (UCB)
L. Bernstein (UCB)
S. Liddick (MSU)

Radiochemistry & Nuclear Chemistry
R. Abergel (UCB)
K. Czerwinski (UNLV)

Nuclear Material Science
P. Hosemann (UCB)
J. Stubbins (UIUC)

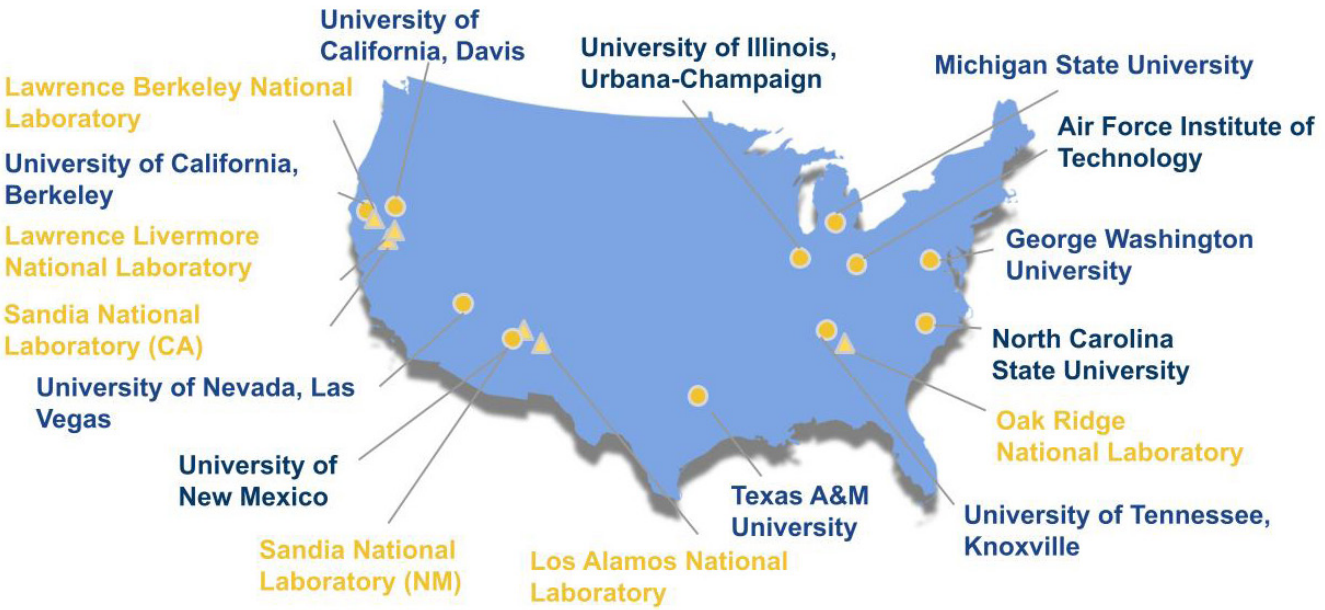
Nucl. Chem. Eng. & Nuclear Engineering
M. Fratoni (UCB)
R. Scarlat (UCB)

Radiation Detection
K. Vetter (UCB)
J. Hayward (UTK)

Computing & Optimization in Nuclear Applications
V. Sobes (UTK)

Education in Nuclear Science, Technology & Policy
B. Goldblum (UCB)

NSSC₃ Partners



10 years of success

Since 2011, **573** people have been supported by NSSC

178	Undergraduate Students
262	Graduate Students
50	Postdoctoral Scholars
17	Research Specialists
66	Faculty Members



Kim Pestovich, UTK; Josh Smith, UTK; Nicholas Cicchetti, UNLV

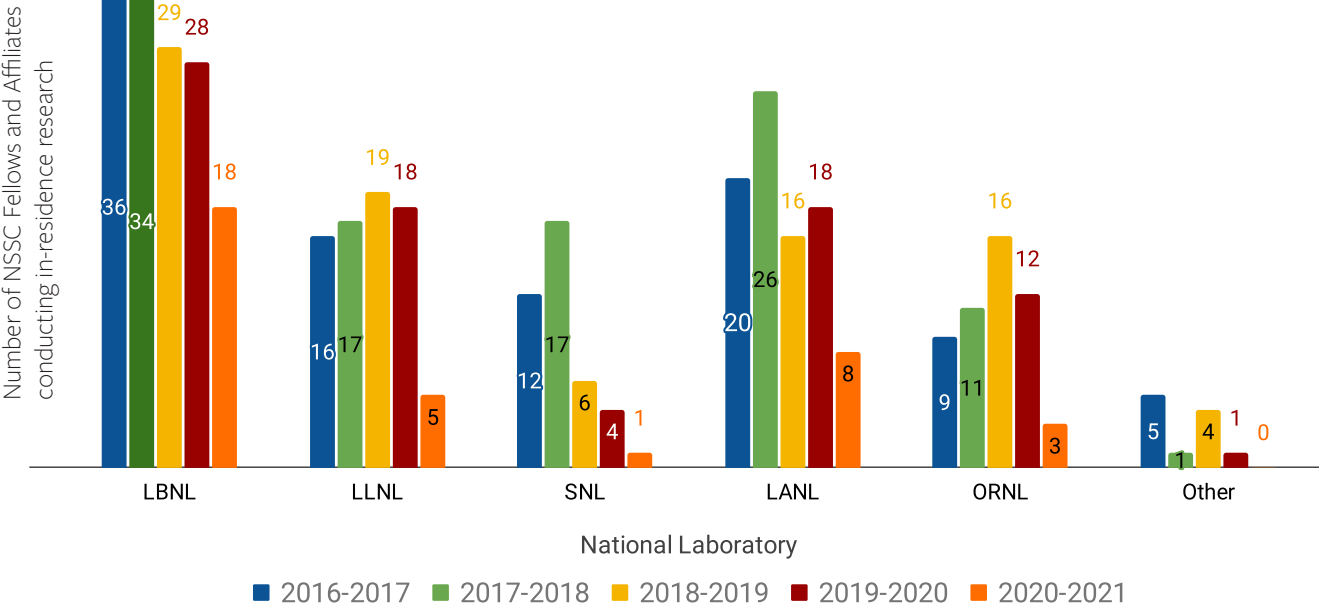
The NSSC Community has earned

120	Bachelors Degrees
85	Masters Degrees
126	PhDs

The NSSC Community has produced

401	Peer Reviewed Publications
842	Oral Presentations
533	Poster Prestations
209	Awards

NSSC Fellows are actively conducting research at the National Laboratories

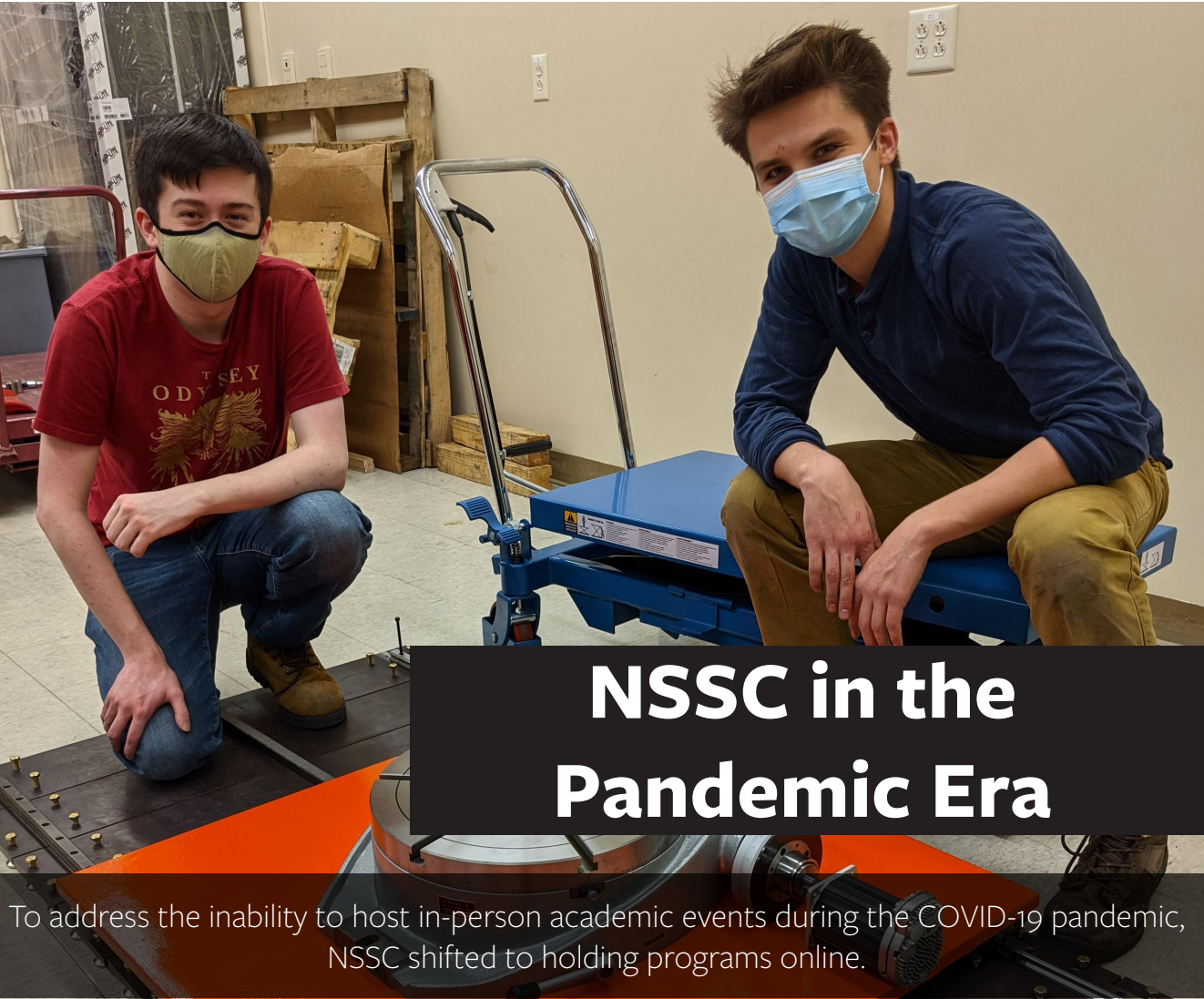


150 Fellows and Affiliates have worked on Lab Directed Projects since 2016

157 Lab Mentors have worked with NSSC Fellows and Affiliates since 2016



Julie He, UCD; Mariah Ramirez, TAMU; Emily Frame, UCB

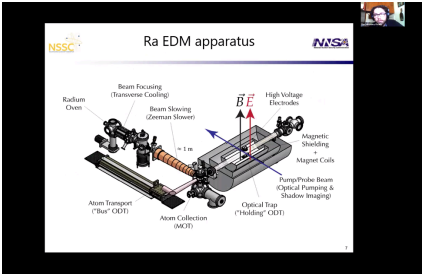


To address the inability to host in-person academic events during the COVID-19 pandemic, NSSC shifted to holding programs online.

UTK Students Cameron Durham and Tolliver Justice.

NSSC Virtual Scholar Showcase

In June 2020, the NSSC hosted a Virtual Scholar Showcase. The online event featured research presentations from NSSC graduate students and postdoctoral fellows. All presenters were recent or upcoming graduates who would be soon transitioning to the workforce and aimed to pursue careers in the US DOE National Laboratories. An audience of over one hundred students, postdocs, lab personnel, and faculty across the NSSC partner institutions tuned in virtually to learn more about students' research and support them as they embark on their careers.



Roy Ready, of MSU, now at the Naval Research Laboratory, presenting online as part of the NSSC Virtual Scholars Showcase.

NSSC Alumni Speaker Series

During Spring 2021, the NSSC hosted a speaker series featuring recent program alumni. Invited alumni had gone on to critical and exciting careers working in the US DOE National Laboratories or in other government organizations that are supporting national and international nuclear security. The current NSSC student community attended the series to learn more about the work of these individuals and hear directly from them how current students can work towards similar careers. Speakers included: **Sarah Laderman**, former UC Berkeley graduate student and now an Associate Safeguards Information Analyst at the International Atomic Energy Agency in Vienna, Austria; **Dr. Daniel Hellfeld**, former UC Berkeley graduate student now a Senior Scientific Engineering Associate at LBNL; **Dr. David Weisz**, former UC Berkeley graduate student now a Staff Scientist, Nuclear and Chemical Sciences Division at LLNL; **Dr. Caleb Roecker**, former UC Berkeley graduate student now at ISR-1 Space Science and Applications at LANL; **Dr. Eva Uribe**, former UC Berkeley graduate student now a Systems Research Analyst at SNL; and **Dr. Krystin Stiefel**, former Michigan State University graduate student now an Experiment Safety Engineer at ORNL.



NSSC LANL Speaker Series

Over Summer 2021, the NSSC and LANL teamed up to host the NSSC LANL Speaker Series, featuring scientists from SNL and LANL. The nuclear security academic and lab community was invited to attend online. Speakers included: **Dr. Alexis Trahan**, R&D Engineer with the Safeguards Science and Technology group and the Senior Project Lead for NA-241 International Nuclear Safeguards at LANL, **Dr. Tony Shin**, staff scientist with the Space Science and Applications Group (ISR-1) in the Intelligence and Space Research Division at LANL, **Dr. Heidi A. Smartt**, Distinguished Member of the Technical Staff in the International Safeguards and Engagements department at SNL, and **Dr. Paul Mendoza**, Texas A&M PhD nuclear engineer who works in the nonproliferation division at LANL.

Nuclear Security: The Nexus Between Technology and Policy Course

For the tenth year, the only nuclear security policy focused course held at UC Berkeley was co-taught by **Prof. Michael Nacht** of the Goldman School of Public Policy and **Prof. Karl van Bibber** of the Department of Nuclear Engineering during the Spring 2021 semester. The course is now streamed live to all three UC labs while engaging a cohort of UC Berkeley graduate students. The purpose of the course is to educate students on the policy roots and technological foundations of nuclear energy and nuclear weapons so that they are in a position to make original contributions to the field in their scholarly and professional careers. The course reviews the evolution of nuclear energy, how it has been applied for both peaceful and military purposes, and the current and prospective challenges it presents.

NSSC Summer Programs

NSSC LANL Keepin Nonproliferation Science Summer Program

The NSSC LANL Summer Program is an eight-week extended research internship hosted by the Nuclear Science and Security Consortium and Los Alamos National Laboratory. Graduate Fellows attend the summer program to learn how game-changing science, engineering, and technology are applied to reduce the dynamic threats of nuclear nonproliferation. During Summer 2021 in response to pandemic-related travel restrictions, students were able to attend the program in person or online. The program provides a survey of the national laboratory activities and mission space, focused research projects with a strong connection to nonproliferation science and technology, and a companion symposium series linking nuclear security science, technology, and policy. Students in the program have broad exposure to LANL, access to mentors from LANL and SNL, and opportunities for lab-directed research.

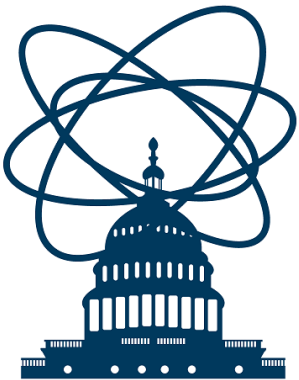
NSSC GW Boot Camp on Nuclear Security Policy

The GW Boot Camp on Nuclear Security Policy features an intensive introduction to nuclear security for the prevention of nuclear weapons proliferation and nuclear terrorism. This course explores the implications of scientific and technological developments on government function and policy issues as well as international norms, treaties, and diplomacy. Specific topics include technical policy issues associated with nuclear weapons, nuclear energy, forensics, and missile defense, as well as regional issues such as the Iran Nuclear Deal, the North Korean nuclear situation, Russian and Chinese arsenals, and more. The Boot Camp leverages GW's unique location two blocks from the White House and across the street from the State Department featuring high level personnel from government agencies and nuclear arena NGOs, as well as field trips to NNSA/DOE, Capitol Hill, and other government agencies.

NSSC has supported **43** Summer Programs since 2011



Daniel Rutstrom of UTK in New Mexico. Daniel participated in the 2021 Keepin program and worked with lab mentor Ken McClellan.



GW Boot Camp on Nuclear Security Policy

Public Policy and Nuclear Threats Boot Camp

The Public Policy and Nuclear Threats (PPNT) Boot Camp, run by **NSSC Executive Director Bethany Goldblum**, is a summer workshop hosted by the Institute on Global Conflict and Cooperation at UC San Diego that aims to give participants the knowledge and analytic tools needed to contribute to the debate on future U.S. nuclear policy. The event features lectures, discussions, debates, and policy simulations.



PPNT Summer 2021 participants attending the lectures virtually.

New Upcoming Programs for NSSC3

NSSC Investigators Laboratory Rotation: NSSC postdoctoral scholars and Assistant Professors will participate in assignments at partner laboratories for a period of 6-8 weeks with the goal of establishing new research collaborations, facilitating existing ones, and deepening University-Lab connections.

NSSC-LLNL Summer Experience: A ten-week research internship will bring advanced undergraduate and graduate students to LLNL to engage in collaborative research advancing innovative concepts developed at NSSC Universities as well as contributing to established projects and programs at the laboratory with strong connection to nonproliferation science and technology.

Nuclear Data Summer School: Available to students from nuclear science and engineering programs across the U.S. Leveraging battle-tested software engineering and data management curricula in The Carpentries, the School will provide an overview of all functions that make up the nuclear data pipeline, from measuring and modeling through compilation, evaluation, validation, and uncertainty quantification. This curriculum will be used to establish the first-ever course in nuclear data for nuclear engineering programs across the nation.

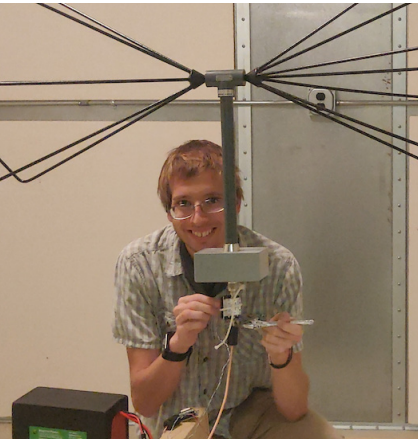
Radiochemistry Summer School: To address the urgent need to train the next generation radiochemistry and nuclear chemistry workforce, the NSSC will be fielding a new 6-week summer school at UC Berkeley and local laboratories to prepare students from DNN R&D consortia for hands-on research experiences in radiological and nuclear facilities.

Winners of the 2021 NSSC Awards

These highly competitive awards honor NSSC Fellows and Affiliates for their excellent contributions to nuclear security science.

Mark Straub, University of California, Berkeley
Winner of Best Review Article

“[Recent Advances in Nuclear Forensic Chemistry](#)”
was featured as the cover article in a special issue of
Analytical Chemistry.

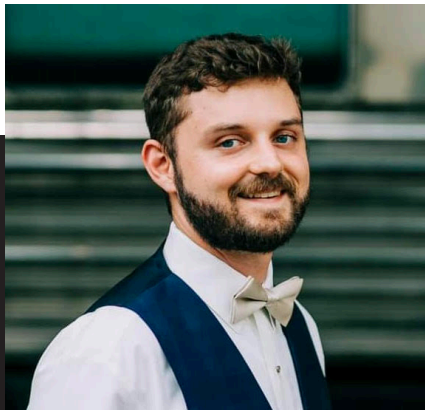


Benjamin Godfrey, University of California, Davis
Winner of Best Original Research Publication

Godfrey was the lead author on the highly regarded
publication, “[Search for Dark Photon Dark Matter: Dark
E-Field Radio Pilot Experiment](#)”, published in Phys. Rev. D.

Cordell Delzer, University of Tennessee, Knoxville
Winner of Outstanding Thesis for Radiation Detection

“Fabrication of Specialized Scintillators
for Nuclear Security Applications”



Teal Pershing, University of California, Davis
Winner of Outstanding Thesis for Nuclear and
Particle Physics

“The Accelerator Neutrino-Neutron
Interaction Experiment”



Kelly Kmak, University of California, Berkeley
Winner of Outstanding Thesis for Radiochemistry and
Forensics

“Investigation of the $^{230}\text{Th}(p,2n)^{229}\text{Pa}$ Reaction
as a Route to ^{225}Ac ”

Hi Vo, University of California, Berkeley
Winner of Outstanding Thesis for Nuclear Engineering

“Influence of Defects’ Mechanical Stability
on Microscale Plasticity and Failure”



Student and Alumni Success

Current and former NSSC Fellows are working together on single fuel pin imaging in partnership with Oak Ridge National Laboratory. **Dr. Anagha Iyengar** earned her Bachelor's degree in Nuclear Engineering from the University of California, Berkeley, where she was one of the first NSSC Fellows! Dr. Iyengar went on to earn a PhD from the University of Tennessee, Knoxville where her advisor was **Prof. Jason Hayward**. Dr. Iyengar's work on the single fuel pin imaging project concentrated on the physics design of the imager. She conducted radiation transport simulations for hundreds of collimator configurations to identify the configurations that have the best neutron performance at a given gamma dose rate. Dr. Iyengar also performed the testing of prototype neutron detectors at high radiation fields to determine sensitivity to gamma rays. Dr. Iyengar is currently a Program Manager for the Office of Nonproliferation and Arms Control at NNSA.

Mairead Montague also earned her Bachelor's Degree in Nuclear Engineering as a NSSC Fellow at the University of California, Berkeley. She is now working towards a PhD in Nuclear Engineering at the University of Tennessee, Knoxville, where her Fellowship with NSSC continues. With the imaging project she has been involved in updating the MCNP simulation to reflect the as-built geometry with 72 slits, better tune the analytics response used by the imager to properly reconstruct at the edges of the field of view, and more recently, assembly and first measurements with the prototype imager. Going forward, Mairead will perform characterization measurements of many fuel pin positions with and without steel shielding rods in place. Mairead's academic advisor is **Jason Hayward** at UTK and her lab mentor is **Paul Hausladen** at ORNL.



Dr. Kathryn Huff currently serves as the Acting Assistant Secretary and Principal Deputy Assistant Secretary of the DOE Office of Nuclear Energy. She received her Ph.D. in August 2013, from University of Wisconsin – Madison, with the dissertation on *An Integral Used Fuel Disposition and Generic Repository Model for Fuel Cycle Analysis*.

Professor Vujic recruited Katy to come to Berkeley and work as a postdoctoral fellow in the Nuclear Science and Security Consortium. From September 2013 to July 2016, Katy was supported jointly by the Fluoride-Salt-Cooled High-Temperature Reactor project and NSSC, and later also through the BIDS Data Science Fellowship at UC Berkeley. Katy led a group of graduate and undergraduate students at UC Berkeley in the development of application-driven numerical simulation methods and codes, and incorporation of sophisticated computational tools, including CYCLUS, MOOSE from INL and the Python for Nuclear Engineering (PyNE) toolkit. She organized numerous computational literacy workshops, PyNE and MOOSE tutorials, the Software Carpentry Python Workshops, GitHub Town Hall meetings. During this time, she developed a o-D accident transient modeling package PyRK, based on Python, to conduct transient analysis in nuclear reactors, which was validated on SFR systems. She took upon herself to work on the development of a multi-physics simulation platform based on the advanced reactor design, T-H and fuel cycle tools based on Python, to conduct transient analysis in nuclear reactors, which was applicable to SFR and FHR nuclear reactor systems. In August 2016 she accepted an Assistant Professor position at UIUC Department of Nuclear Plasma and Radiological Engineering. Katy received many awards including the most recent Mary Jane Oestmann Professional Women's Achievement award from ANS. Katy was a Co-PI for the recently awarded NNSA DNN R&D for the UC Berkeley-lead Nuclear Science and Security Consortium (2021 – 2026), but had to resign due to accepting DOE NE position.



Jenna Garcia at Texas A&M University studies the nuclear forensics of a radium pigment sample from the early 1900s. Radium pigments and paints were used for many household and military applications in this time period because of their attractive, self-luminescent properties. Modern day, radium pigment and paints are no longer used because of known biological and environmental hazards they pose. The IAEA has identified Ra-226 as a potential danger in the event of a nuclear terrorism attack. While no such events have been reported, the detonation of a RDD is concerning for national security. A radium pigment sample will be analyzed using a nuclear forensic approach to establish a signature database for ²²⁶Ra-containing samples to aid national security as there are none in the literature today. Jenna's academic advisor is **Prof. Cody Folden** at TAMU and her lab mentor is **Evelyn Bond** at LANL.

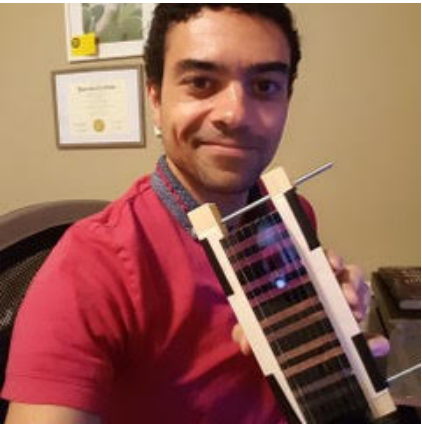
Ava Hill of Michigan State University is currently working on a sub-barrier Coulomb excitation measurement of the 2_1^+ and 4_1^+ transition strengths and quadrupole moments in $^{112,116,120}\text{Sn}$, which will serve to test the predictive power of existing nuclear models. The experiment was completed in October 2020 at the National Superconducting Cyclotron Laboratory's ReA3 facility. Ava is developing and implementing a machine learning framework for the existing GOSIA2 analysis code to improve and automate portions of the analysis for Coulomb excitation experiments. She also had the opportunity to attend the Data Science Summer Institute at Lawrence Livermore National Laboratory, where she worked on improving the predictive power of a model trained on gamma-ray spectra. Ava's academic advisor at MSU is **Alexandra Gade**, and her lab mentor is **Ching-Yen Wu** of LLNL.

Jake Tibbetts was an NSSC Fellow at UC Berkeley from 2018 to 2021 during which time he received undergraduate degrees in computer science and global studies and a graduate degree in computer science. During his time as an NSSC Fellow, Jake worked on the Project on Nuclear Gaming, a partner project between UC Berkeley, SNL, and LLNL. The group focused on non-strategic nuclear weapons, deterrence, and wargaming. For his graduate work, Jake was a part of the SNITCHES team whose work focused on applying machine learning techniques to data collected by an array of low-sensitivity sensors deployed at the High Flux Isotope Reactor at ORNL to characterize reactor operations. Jake is currently a TechCongress Fellow working for Congressman Seth Moulton, a member of the House Armed Services Committee, as a part of his national security and foreign policy team. Jake's academic advisor was **Dr. Bethany Goldblum** at UC Berkeley and his lab mentor was **Jon Whetzel** at SNL.



Billy Boxer at the University of California, Davis, works on the modelling of and development of the analysis framework for a neutron camera which utilizes scintillators coupled to SiPMs. The camera is being developed in conjunction with LBNL and ARC. Billy has developed first order simulations of a single scintillation coupled to a SiPMs using the GODDeSS Geant4 package. From this he made an analysis framework to study the optical model of the system. These simulations were then expanded to a full 8 by 8 array to allow for the study of single and multiple scatter events. It was noted that Geant4 is limited to only 3 components in the emission spectra for a scintillator, which limits its use for energy response studies with materials such as EJ-276 (requiring 4 components to accurately model). For this reason Billy has begun to look at modifying existing software (NEST) from the dark matter community which was developed to improve the modelling of scintillation from interactions with liquid Nobles processes in Geant4. Billy works with academic advisor **Dr. Mani Tripathi**, and lab mentor **Carl Grace** at LBNL.

Dr. Sandra Bogetic is rejoining the NSSC as an affiliate Faculty Member at the University of Tennessee, Knoxville. Sandra joined the Department of Nuclear Engineering as an Assistant Professor in 2021. Sandra was a part of the NSSC Community as an Affiliate at UC Berkeley while earning her PhD. While at UC Berkeley her thesis research was performed within the Nuclear Science and Radiochemistry group at the National Ignition Facility (NIF) at LLNL. The Ph.D. thesis was performed under the mentorship of **Professor Jasmina Vujic**, and lab mentorship of **Dr. Lucile Dauffy** and **Dr. Dawn Shaughnessy**. Sandra's Ph.D. work dealt with the further development, validation, and applications of a novel, cross-cutting modeling capability for tailoring neutron energy for nuclear security and nonproliferation related applications. The specific focus was initially on the generalization of a metaheuristic optimization software package (Gnowee/COEUS), as a part of ongoing collaboration between Berkeley, NIF/LLNL and the Airforce Institute of Technology, where Sandra worked with former NSSC Affiliate **Dr. James Bevins**. This new capability enables the development of optimal designs of neutron spectra tuning assemblies at a fraction of the cost in terms of manpower and research effort, thereby greatly accelerating efforts in many areas of nuclear science and engineering that need neutron spectra with specific desired characteristics.



Dr. Micah Folsom was a member of the first cohort of NSSC Fellows in 2011 while he was an undergraduate at UC Berkeley working with **Professor Kai Vetter**. Micah went on to continue his studies and research at UT Knoxville (academic advisor **Prof. Jason Hayward**) and ORNL. While at UTK, Micah worked on the development of a portable fast neutron camera for use in nuclear security applications such as emergency response or arms control treaty verification. This included modeling new designs, optimizing the geometry and components, building a prototype, and performing experimental measurements to demonstrate that the design worked. Micah now works as a scientist in the Applied Nuclear Physics group at LBNL, where he continues to develop portable radiation imaging systems for nuclear security applications. These systems use contextual information (such as laser scans) to perform Scene Data Fusion, where the radiation image data is incorporated into a 3D representation of the surrounding environment. To help make radiation transport modeling more accessible, he's teaching a course at UTK this semester on the open-source software Geant4, which is available for audit to NSSC students.

Juan Manfredi enjoyed his experience as an NSSC Postdoctoral Fellow at the University of California, Berkeley and recently joined NSSC3 as an NSSC faculty member through his role as Assistant Professor at the Air Force Institution of Technology. At UC Berkeley, Dr. Manfredi worked with **Dr. Bethany Goldblum** on organic scintillator characterization and kinematic neutron imaging projects while also collaborating actively with scientists at LBNL, SNL, and ORNL through the Single Volume Scatter Camera collaboration led by **Dr. Erik Brubaker** (SNL). While at Berkeley, Juan measured the proton light yield of a number of fast plastic organic scintillators of interest of fast neutron detection. Juan also worked closely with other NSSC Fellows and alumni including **Dr. Thibault Laplace** (UC Berkeley), **Dr. Josh Brown** (UC Berkeley), and **Dr. Micah Folsom** (UT Knoxville). As an NSSC faculty member, Juan is currently mentoring NSSC undergraduate **James McGreivy** in machine learning applications for neutron spectrum unfolding in collaboration with **Mark Mitchell** at LLNL.



Erin Good, of Michigan State University, focuses on nuclear properties that can be studied via beta decay using the Summing NaI (SuN) detector. SuN is a segmented, highly efficient NaI detector that allows the performance of total absorption gamma-ray spectroscopy, to measure both individual gamma-ray decays and the excitation energy of the nuclei we study. Good analyzes data from the beta decays of $^{76,77}\text{Cu}$, which will yield information on the nuclear level densities and gamma-ray strength functions of $^{76,77}\text{Zn}$.



Erin Good (right) with members of the SuN group at Argonne National Laboratory

These experimentally-determined properties can be used to reduce uncertainties in the $^{76,77}\text{Zn}$ neutron capture cross-sections via the β -Oslo method. These cross-sections are important for both stewardship science applications and nuclear astrophysics calculations, where they are particularly impactful in network calculations of the astrophysical weak rapid neutron capture process, or r-process, where the neutron-rich heavy elements are created. Erin's academic advisor is **Artemis Spyrou** and her lab mentor is **Nick Scielzo** of LLNL.

Benjamin Walusiak is beginning his 4th year as a Chemistry graduate student **Professor Cahill's** research group at George Washington University. As an inorganic chemist, Ben currently performs synthesis and characterization of tellurium halide compounds. These materials are made via hydrothermal synthesis or room temperature slow evaporation of acidic aqueous media. Crystal structures are determined in-house via single crystal X-ray diffraction. The aforementioned tellurium halide compounds fall into the category of low dimensional halide perovskites, which have established applications in solar cells and scintillators. Of particular interest are the non-covalent interactions that hold these materials together (i.e. hydrogen bonding, halogen bonding) due to their influence on the physical properties of the material itself, such as optical band gap. This fundamental science involving tellurium and iodine, both potential fission products, can also serve to better inform us about the chemistry of molten salt nuclear reactors. As a part of his involvement in the NSSC, Ben was able to attend the GW Boot Camp on Nuclear Security Policy. This week-long course was held virtually this year, and enabled students from various background to engage with experts from all areas in nuclear security, from detection to diplomacy. Starting in mid-June, Ben also attended the 8 week Dr. G. Robert Keepin Nonproliferation Science Summer Program at Los Alamos National Laboratory. There he worked with **Dr. Alice Smith** on analysis of plutonium alloys via X-ray and neutron diffraction powder diffraction. As a result of this unique opportunity through the



Harry Jang of University of Nevada, Las Vegas, is working with LANL on EXAFS and XANES techniques. He helped collect data from various plutonium dioxide samples that originate from the ARIES program to investigate their structural and electronic behavior. Spectra for plutonium, gallium, and iron were collected. Gallium is a prevalent impurity due to the gallium-stabilized plutonium metal starting material, and its contributions and signatures are of high interest for nuclear forensics analysis. Harry's academic advisor is **Prof. Frederic Poineau** at UNLV and his lab mentor is **Sarah Hickam** at LANL.

Zachary McGuire is a graduate student in nuclear engineering at UC Berkeley working on explainable, transferable classification of nuclear reactor power levels using multi-class clustering. Machine learning applied to multi-sensor network data can provide an integrated picture of difficult-to-detect phenomena, where composite signals are used as indicators of proliferation-relevant activity. Transferability, the application of models generated for one setting to another, is critical to the use of multimodal informatics in proliferation detection scenarios, as differences in facility layout, equipment, and operations cycles will greatly impact the signals obtained. Zack's work focuses on identifying non-radiological indicators of nuclear reactor operations through the development and demonstration of transferable, unsupervised machine learning methods. Zack's academic advisor is **Dr. Bethany Goldblum** at UC Berkeley and his lab mentor is **Jon Whetzel** at SNL.



Research Highlights

Rare Event Detection

The UC Davis group has been actively working in collaboration with the Rare Event Detection (RED) group at LLNL and also with the Neutron Physics group at LANL. The work with the RED group was centered around the WATCHMAN and AIT/NEO design projects, but also included collaboration on the ANNIE experiment at FNAL, where we worked together on radioactive source calibrations, simulations, data analysis, and detector operations. This ongoing effort has thus far yielded two PhD theses (**Steven Gardiner** and **Teal Pershing**) and one refereed publication, with more papers and theses to come. Two NSSC postdoctoral researchers are also involved. At LANL two small experiments (ACED and ARTIE) were completed at the LANSCE facility, which so far has resulted in two refereed publications with another expected this year. The LANSCE work involved four NSSC postdoctoral researchers (**Vincent Fischer**, **Jyothiraj Johnson**, **Leon Pickard**, **Luca Pagani**, and **Leon Pickard**) and three NSSC graduate student fellows (**Tyler Erjavec**, **Steven Gardiner**, and **Julie He**).



Julie He, UC Davis, in a dark room built for LAPPD development and testing

Radiochemistry

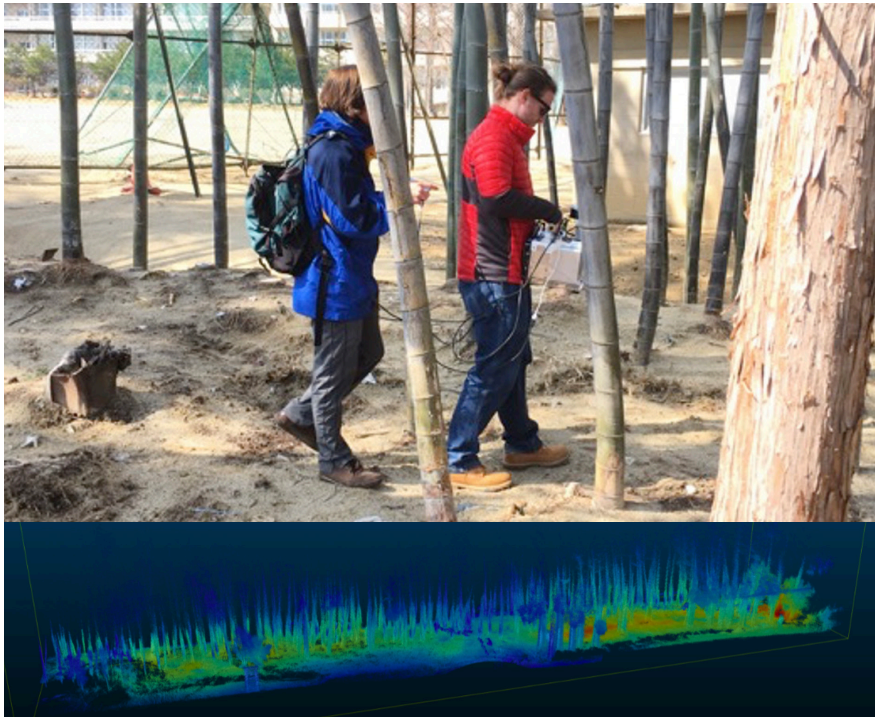
The NSSC fellows and affiliates of the UNLV Radiochemistry Program are performing research to advance the science of radioelements for nuclear security and nuclear energy applications. **Robert March** investigates radiochemical separations to isolate ^{232}Th , ^{238}U , and ^{239}Pu in three separate streams. Rob has isolated ^{232}Th as a proof of concept for the future application with ^{229}Th to build a generator for ^{225}Ac , a promising radioisotope for nuclear medicine. This information can also provide signature development of ion exchange separations of uranium and thorium. **Josephine Libero** is preparing new actinide-transition metal alloys in order to understand the nature



James Louis-Jean, UNLV, photo courtesy UNLV College of Sciences.

and properties of these alloys in metallic spent fuels. Her work provides data that can help to monitor burn-up for safeguard applications, simplify reprocessing and develop new metallic waste forms. Using an arc welder, she has prepared uranium-ruthenium alloys. **Liuba Pauline Williams** is using arc welder techniques to simulate a nuclear fireball and prepare realistic urban melt glass for detonation characterization. Liuba performed SEM analysis on urban melt glass and provided insight into how different materials behave during the rapid heating and cooling process. This technique will be expanded to include sample preparation with Trinitite as the melt glass. **Nicholas Cicchetti** is investigating the behavior of neptunium and plutonium in concentrated base using electrochemical and spectroscopic methods. His research supports efforts to treat and dispose the alkaline tank waste at Hanford and Savannah River, which presents a significant long-term issue to national security and the environment. **Harry Jang** has prepared uranium fluoride microspheres that could be used as targets for medical isotopes production and alternative nuclear fuels for energy production (TRISO fuel). In 2021, Harry performed an internship at LANL where he studied the characterization and behavior of gallium in PuO_2 oxidized from gallium-stabilized δ -plutonium using x-ray absorption spectroscopy. **James Louis-Jean** prepared $^{238}\text{U}/^{235}\text{U}$ oxide and fluoride compounds and measured their isotopic ratios using thermal ionization mass spectrometry (TIMS) for nuclear forensics applications. James has performed several internships at LANL where he studied the development of new methods for isotopic analysis of Sm by TIMS. James was the recipient of the 2020 DOE innovations in nuclear technology R&D award. **Katherine Luebke** is working in nuclear forensics and radiation detection. She studies the solubility and electrochemical recovery of uranium oxides from room temperature ionic liquids for nuclear fuel cycle separation and target preparation. She has worked two summer internships at LANL, where she attended the School of Nukes in addition to her work on silicon drift and gamma detectors. An internship was supported by the LANL Seaborg Fellowship for graduate students. Finally, in 2019, as a part of a collaborative effort with George Washington University, the first transplutonium molecular organic framework material (i.e., $[\text{Am}_2(\text{C}_6\text{H}_8\text{O}_4)_3(\text{H}_2\text{O})_2][(\text{C}_{10}\text{H}_8\text{N}_2)]$) was prepared in the UNLV radiochemistry laboratories. This provides a unique platform for examining the coordination chemistry of transuranic elements, which can result in enhanced understanding for separations and spectroscopic signatures.

3D Scence Data Fusion

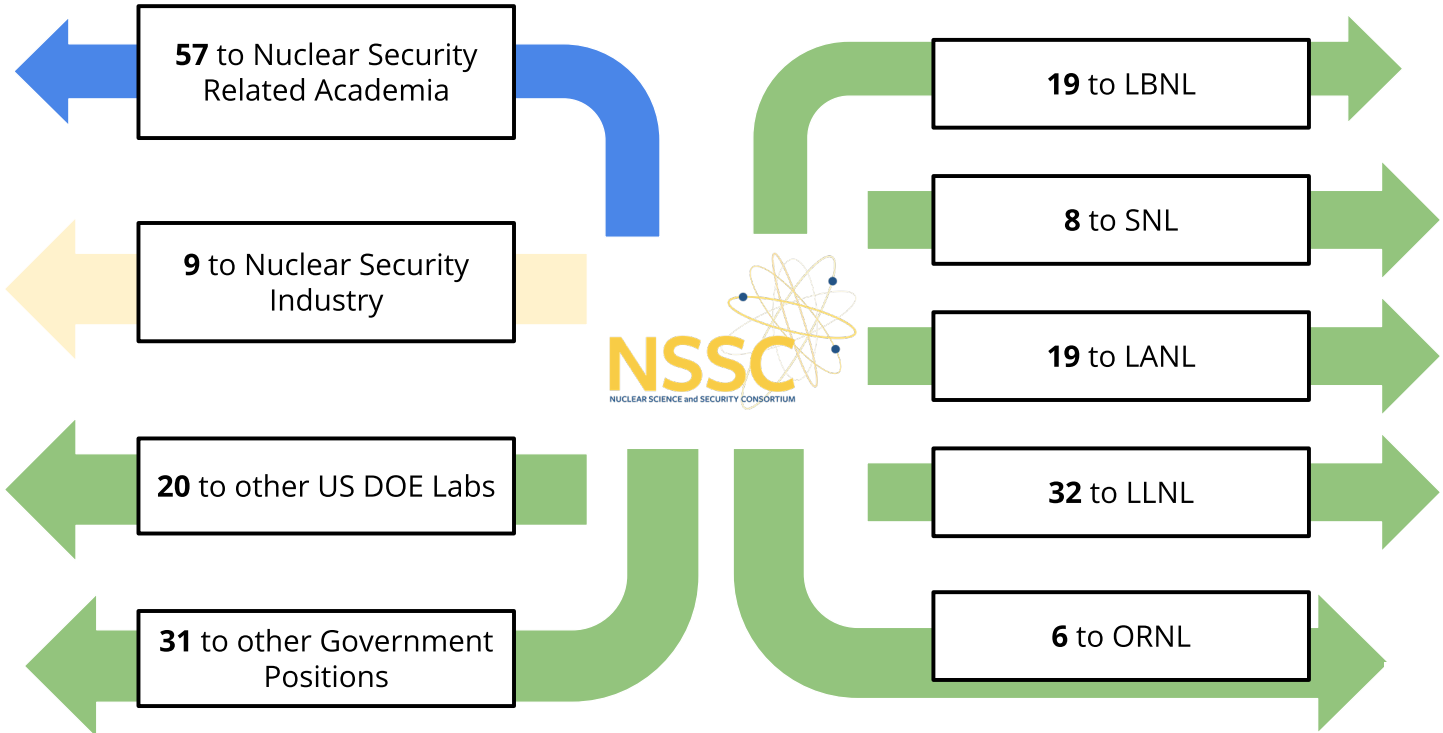
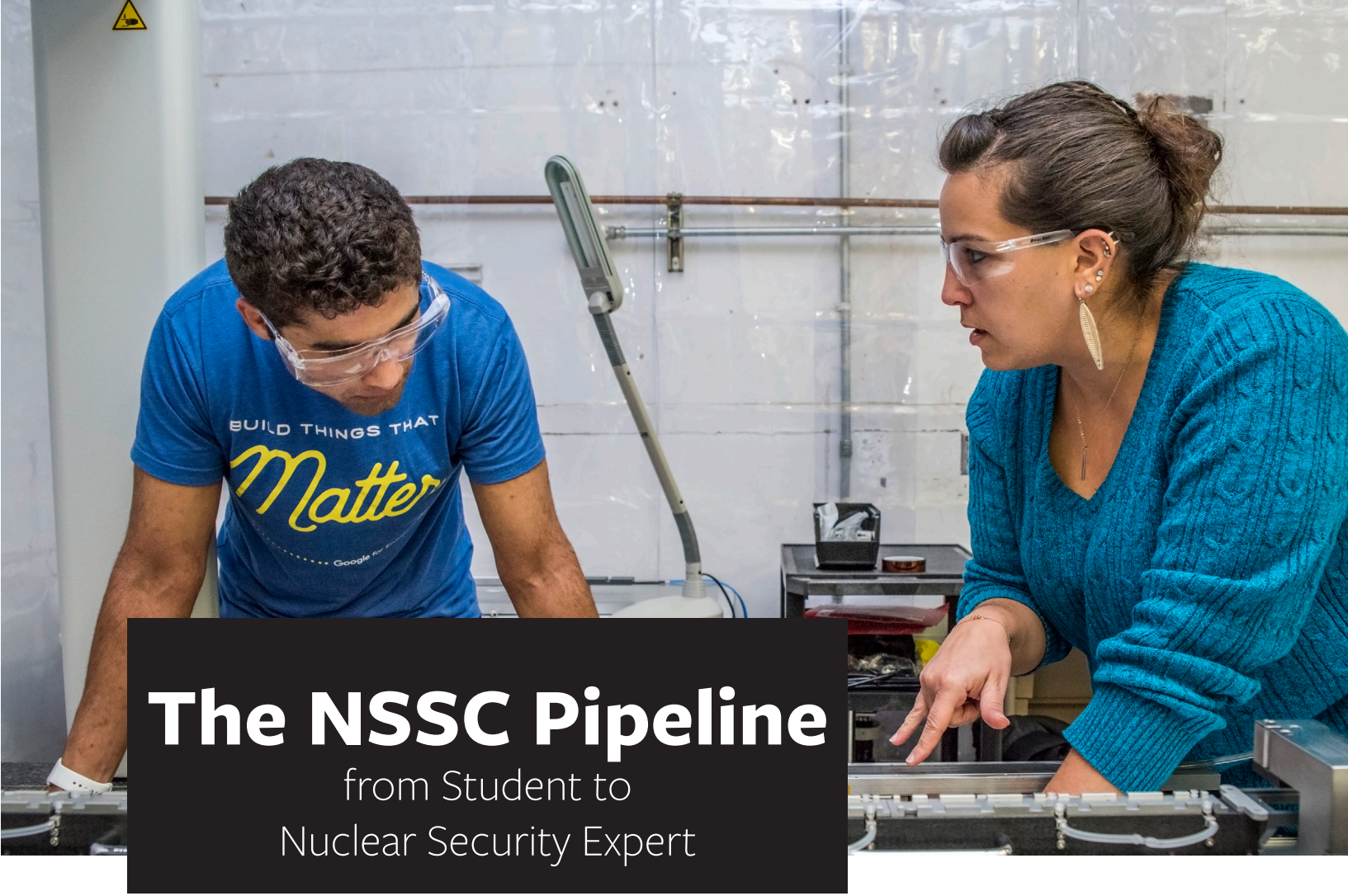


Ross Barnowski, former NSSC Fellow at UC Berkeley, contributes to the development of the new concept of 3D Scene Data Fusion which provides new means in the detection, mapping, and visualization of radioactive materials, relevant for the mission of proliferation detection, nuclear safeguards, and emergency response. Ross came with a B.S. from Univ. Michigan to UC Berkeley to obtain his PhD in Nuclear Engineering, engaged as postdoc in the Applied Nuclear Physics Program at LBNL, and is now a scientist at the Berkeley Institute for Data Sciences at UC Berkeley. While at UCB, Ross worked with academic advisor **Kai Vetter**.

Top: Ross Barnowski and Andy Haefner during the mapping measurements in a bamboo forest in the evacuated area using an early implementation of a Scene-Data Fusion enabled 96-CdZnTe detector element High-Efficiency Multimode Imager HEMI. Bottom: 3-D map of Cs-137 contamination in a bamboo forest in an evacuated area in the Fukushima Prefecture.

Uranium and Plutonium at 200 miles per hour


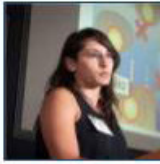








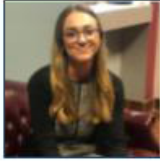

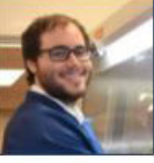


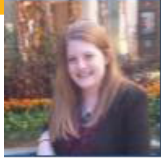





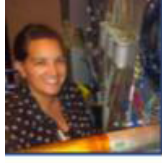


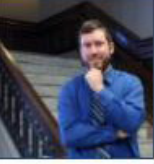
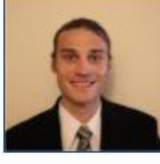
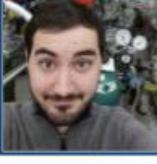












Eric Matthews recently completed his Ph.D. at UC Berkeley with a thesis titled “Advancements in the Nuclear Data of Fission Yields.” This thesis covered three projects that seek to improve the state of fission yield nuclear data. These projects included collaboration with LANLs, LBNL, and PNNL. The Fast Loading User Facility for Fission Yields (FLUFFY) is a pneumatic system that has been constructed at LBNL’s 88-inch cyclotron. This device allows the rapid transport (in less than one second) of a capsule containing target samples between a neutron beam and an HPGe clover array. The rapidity of this transport allows for the measurement of short-lived fission product yields when an actinide sample is loaded in the capsule. Recent results for the fission yields in the A = 86, 98, and 136 mass chains have been reported in Matthews’s thesis. A new method for determining fission yields using the [FIER](#) code was employed in the analysis, offering a new capability to the nuclear science community. In addition to these new fission yield measurements, Matthews’s thesis presented a new method for estimating [fission yield covariance](#) matrices. These covariance matrices are absent in the current evaluations of fission yields, yet are a critical need for several applications. The results of this method were published in Atomic Data and Nuclear Data Tables in May of this year. Eric’s academic advisor is **Lee Bernstein**.



Above: Fernando Torales-Acosta and Nicole Apadula at LBNL.

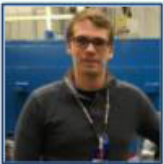
NSSC to the National Laboratories

135 (46%) of NSSC alumni are in careers in the National Laboratories or in Other Government Organizations

 <div>Andrea Richard Postdoc MSU LLNL 2021</div>	 <div>Adriana Sweet PhD UCB LLNL 2020</div>	 <div>Rebecca Krentz-Wee PhD UCB IAEA 2020</div>	 <div>Andrew Reddie Postdoc UCB SNL 2020</div>	 <div>August Ridenour PhD GWU NRL 2020</div>	 <div>Nicole Larson Bachelors MSU INL 2016</div>
 <div>Kelly Kmak PhD UCB LLNL 2021</div>	 <div>Jason Matheny Masters UCB LANL 2021</div>	 <div>Micah Folsom PhD UTK LBNL 2020</div>	 <div>Jon Balajthy PhD UCD SNL 2020</div>	 <div>Eleanor Comer Master UTK Y-12 National Security Complex 2020</div>	 <div>Travis Smith Masters UTK State of Nebraska 2020</div>
 <div>Kevin Glennon PhD TAMU LLNL 2021</div>	 <div>Roy Ready PhD MSU US Naval Research Lab 2021</div>	 <div>Max Wallace Bachelors UCB LLNL 2020</div>	 <div>Kelsey Ammundon Masters UCB LANL 2019</div>	 <div>J.R. Powers-Luhn PhD UTK PNNL 2020</div>	 <div>Maryline Ferrier PhD UNLV LANL 2014</div>
 <div>Joshua Smith PhD UTK LLNL 2021</div>	 <div>Jake Tibbetts Masters UCB Armed Services Committee 2021</div>	 <div>Teal Pershing PhD UCD LLNL 2020</div>	 <div>Nicole Apadula Postdoc UCB LBNL 2018</div>	 <div>Daniel Hellfeld PhD UCB LBNL 2019</div>	 <div>Hi Vo PhD UCB LANL 2021</div>
 <div>Caleb Redding PhD UTK ORNL 2021</div>	 <div>Eric Nelius Masters UTK SNL 2021</div>	 <div>Brenden Longfellow PhD MSU LLNL 2020</div>	 <div>Aaron Manalaysay Postdoc UCD LBNL 2019</div>	 <div>William Kerlin PhD UNLV LLNL 2019</div>	 <div>Christian Bustillos PhD UCI LLNL 2019</div>
			 <div>Bradley Childs PhD UNLV LLNL 2019</div>	 <div>Marc Fitzgerald PhD UNLV LLNL 2017</div>	 <div>Jessica Roche Bachelors UCB LLNL 2016</div>
			 <div>Rachel Mersch PhD UTK ORNL 2019</div>	 <div>Deepa Khatri Bachelors UCB NNSA/LFO 2014</div>	 <div>Milos Atz PhD UCB ANL 2019</div>
			 <div>Caroline Hughes Masters UCB PNNL 2019</div>	 <div>Ardelia Clarke PhD Fisk PNNL 2019</div>	 <div>Lucas Boron-Brenner PhD UNLV PNNL 2019</div>



Angela Simone Moore
PhD UTK
PNNL
2019



Michael Moore
PhD UTK
PNNL
2019



Stephanie Lyons
Postdoc MSU
PNNL
2020



Jaclynn Unangst
PhD UCI
SNL
2019



Madhuri Kumari
PhD UCD
SNL
2019



Cordell Delzer
PhD UTK
LANL
2021



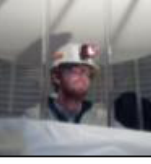
Scott Parker
PhD UCB
LANL
2018



Chris Morse
PhD MSU
LBNL
2016



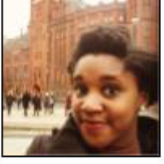
Winston Degraw
Bachelors UCB
LBNL
2018



Morgan Askins
PhD UCD
LBNL
2018



Elizabeth Heckmaier
PhD UCI
LLNL
2018



Tomi Akindele
PhD UCB
LLNL
2018



Krystin Stiefel
PhD MSU
ORNL
2018



Jason Richards
PhD UNLV
ORNL
2018



Mike Shattan
PhD UTK
AFIT
2018



Mark Quint
Masters UTK
U.S. Army
2018



Sarah Laderman
Masters UCB
IAEA
2018



Daniel Harding
PhD UTK
Norfolk Naval
Shipyard
2018



Matthew Tweardy
PhD UTK
NNSA at PNNL
2018



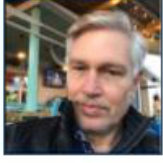
Steven Gardiner
PhD UCD
Fermi National
Accelerator Lab
2018



Gian Surbella
PhD GWU
PNNL
Spring 2017



Justin Munson
PhD UCB
LLNL
2015



Maxwell Sherrod
PhD UNLV
SRNL
2018



James Bevins
PhD UCB
LANL
2021



Charles Loelius
Masters MSU
NNSA | PNNL
2016



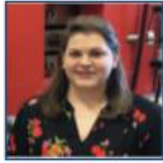
Joseph Labrum
Bachelors UCB
Intelligence
2017



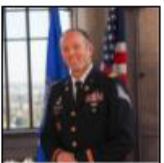
Keenan Thomas
Masters UCB
LLNL
2016



Joe Belarge
Postdoc MSU
MIT Lincoln Lab
2017



Rebecca Lewis
PhD MSU
DNN NNSA
2019



Keith McManus
PhD UCB
NNSA
2019



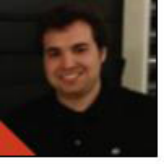
Christopher Prokop
PhD MSU
LANL
2016



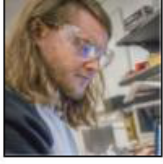
Caleb Roecker
PhD UCB
LANL
2016



Janelle Droessler
PhD UNLV
LANL
2016



Michael Jones
PhD MSU
LBNL
2016



Ross Barnowski
PhD UCB
LBNL
2016



Nick Bricker
Masters UCB
LBNL
2016



Joseph Curtis
Masters UCB
LBNL
2014



Erika Suzuki
Bachelors UCB
LBNL
2013



Sergey Uvarov
Masters UCD
LLNL
2016



Nick Walsh
Postdoc UCD
LLNL
2016



Barbara Wang
Postdoc UCB
LLNL
2016



David Weisz
PhD UCB
LLNL
2016



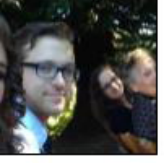
Andrew Wysong
Masters UCB
LLNL
2015



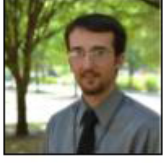
Christopher Brand
Bachelors UCB
LLNL
2015



Uday Mehta
Bachelors UCB
LLNL
2016



Ross Meyer
Bachelors UCB
LBNL
2015



Alex Braatz
PhD UCI
ORNL
2015



Brian Champine
PhD UCB
US Army
2016



Derek McLain
PhD UNLV
ANL
2016



Scott Suchyta
PhD MSU
Postdoc UCB
RSL
2016



Eva Uribe
PhD UCB
SNL
2016



Victor Negut
Bachelors UCB
LBNL
2014



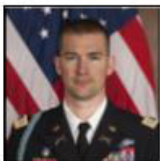
Audrey Roman
PhD UNLV
LANL
2014



Anthony Lubbers
Bachelors UCB
LLNL
2014



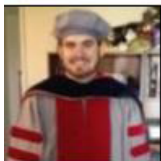
Kalee Hammerton
PhD MSU
Savannah River
2016



Thomas Halverson
Masters UCB
West Point
2016



Kathryn Huff
Postdoc UCB
DOE Office of Nuclear
Energy
2021



Brian Daub
Postdoc UCB
LLNL
2013



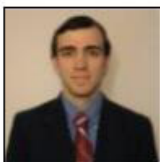
Duane Smalley
Postdoc MSU
LANL
2014



Adam Rice
Masters UCB
Intelligence
2013



Anthony Juarez
UCB
SNL
2016



Cameron Bates
PhD UCB
LANL
2014



Keri Campbell
PhD UNLV
LANL
2014



Jeromy Tompkins
Postdoc MSU
NSCL
2014



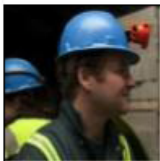
Quinn Looker
PhD UCB
SNL
2013



Noah Fischer
Bachelors UCB
LANL
2012



Brian Plimley
PhD UCB
LBNL
May 2014



Jeremy Mock
PhD UCD
LBNL
2014



Andrew Haefner
PhD UCB
LBNL
2015



Jonathan Plae
PhD UNLV
LANL
2012



Paul Davis
Postdoc UCB
NNSA
Spring 2013



Ligang Bai
Postdoc UNLV
ANL
2013



Tenzing Joshi
PhD UCB
LBNL
2015



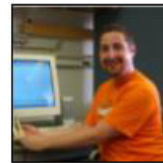
Joshua Meyers
PhD UCB
LLNL
2012



John Despotopoulos
PhD UNLV
LLNL
2015



Alexander Dixon
Bachelors UCB
US Navy
2012



Perry Chodash
PhD UCB
LLNL
2015



Andrew Gillick
Masters UCB
Army
2014



Tashi Parsons-Moss
Postdoc UCB
LLNL
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Timothy Shokair
Postdoc UCB
LLNL
2015



Marc Bergevin
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