

NUCLEAR SCIENCE AND SECURITY CONSORTIUM NEWSLETTER

Summer 2018



NSSC HISTORY AND APPROACH

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The Nuclear Science and Security Consortium (NSSC) was originally established by NNSA in 2011 as a five-year award to support research and development in basic and applied nuclear science in collaboration with the national laboratories while developing a pipeline of new talent. In 2016, the NSSC successfully re-competed for an additional five years of support delivering a program that yields new ideas, technology development, and personnel with the integrated capabilities required for the nuclear security mission. The NSSC continues its end-to-end approach to motivate and mentor talented students and postdoctoral scholars in critical NNSA mission areas, from recruitment at all levels to early career phases. At the input end of the pipeline, promising and interested NSSC undergraduate and graduate students are exposed to nuclear security. Undergraduate research assistants, graduate student fellows, and postdoctoral scholars are connected with national laboratory mentors to engage in basic

and applied research and technology development relevant to the nuclear security mission. Through research internships, tailored coursework, and workshops and summer schools, a large and diverse student population is prepared in a broad range of technical areas essential for the nuclear security professional. This educational program includes hands-on training in a wide range of experimental disciplines at unique university and national lab facilities, including nuclear reactors, cyclotrons and other accelerators, and detector development and characterization facilities. Close to 50 faculty have been involved as co-PIs and academic mentors, while more than 150 lab scientists and researchers have been engaged as research mentors and advisors to NSSC-supported students and postdoctoral scholars.

(above) Participants of the NSSC Fall Workshop in September 2017.

LETTER FROM THE NSSC DIRECTOR

In its first five years (2011-2016), the NSSC1 was proven highly successful by all metrics, and the first waves of our students and postdoctoral researchers that completed the program (180) have been transitioning to careers in the DOE laboratories and related national security service (60), academia (37), and in industry or in the field (57). The NSSC1 fellows were mentored by 42 faculty co-PIs and over 120 national laboratory mentors. They presented more than 500 oral presentations and 308 posters, published 164 peer-reviewed publications, and received over 100 awards and honors. NSSC1 co-organized 22 summer schools, serving close to 400 students with participation by more than 22 faculty, 9 researchers and 125 national laboratory scientists.

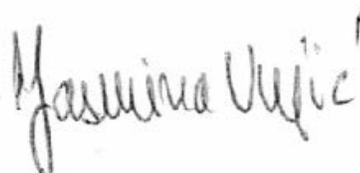
The NSSC2 (2016-2021) primary objectives are to recruit, educate and train top students in relevant nuclear disciplines, to connect students with a core set of disciplines that support the nonproliferation and nuclear security mission, and to expand national laboratory collaboration to provide students the opportunity to engage deeply in research under the guidance of national laboratories staff scientists. All current NSSC Graduate Fellows have a laboratory mentor in addition to an academic mentor. 66 NSSC students and postdocs are conducting in-residence lab research, while additional 34 students are working on lab-led projects. The NSSC2 supported students are also required to participate in the NSSC-LANL Keeping Nonproliferation Summer Science Program (8 weeks), and the NSSC Boot Camp on Nuclear Security Policy (2 weeks) organized by George Washington University that will be held in Washington, D.C., in June 2018.



The NSSC-LANL Keepin Nonproliferation Science Summer Program was offered for the first time in Summer 2017, with the goal of enhancing our connectivity with LANL: to create working relationships between the NSSC students and LANL scientists, to increase number of students performing lab-directed research with LANL, and to turn research and training into careers at LANL and other national laboratories. This Summer Program consisted of a research component (80%, where each student was partnered with a LANL mentor) and enrichment activities (20%, including 20 lectures and 10 tours of facilities at LANL and SNL). The feedback by both the lab mentors and participating students was outstanding.

A total of 79 NSSC Fellows and Affiliates have accepted positions in DOE national laboratories or other government — 38% of students and postdocs completing the program — while an additional 43 were hired into faculty and research positions at U.S. universities. The NSSC has graduated 92 B.S., 45 M.S., and 74 Ph.D. student fellows and affiliates and has supported 24 postdoctoral scholars through program completion. Of these, 62 NSSC Fellows and Affiliates are continuing with graduate education in technical fields, a large fraction of which are expected to accede to positions supporting the NNSA mission in the coming years.

The NSSC has demonstrated scientific excellence in several subject areas through the publication of numerous highly cited manuscripts in influential journals. The consortium has produced 223 peer-reviewed publications and 999 oral and poster presentations on fundamental and applied research within the core set of scientific disciplines supporting the nuclear security mission. 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.



NSSC OVERVIEW

NSSC EXECUTIVE TEAM

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Director
UC Berkeley

DR. BETHANY GOLDBLUM

Executive Director
UC Berkeley

DR. JASON HAYWARD

Deputy Executive Director
UT Knoxville

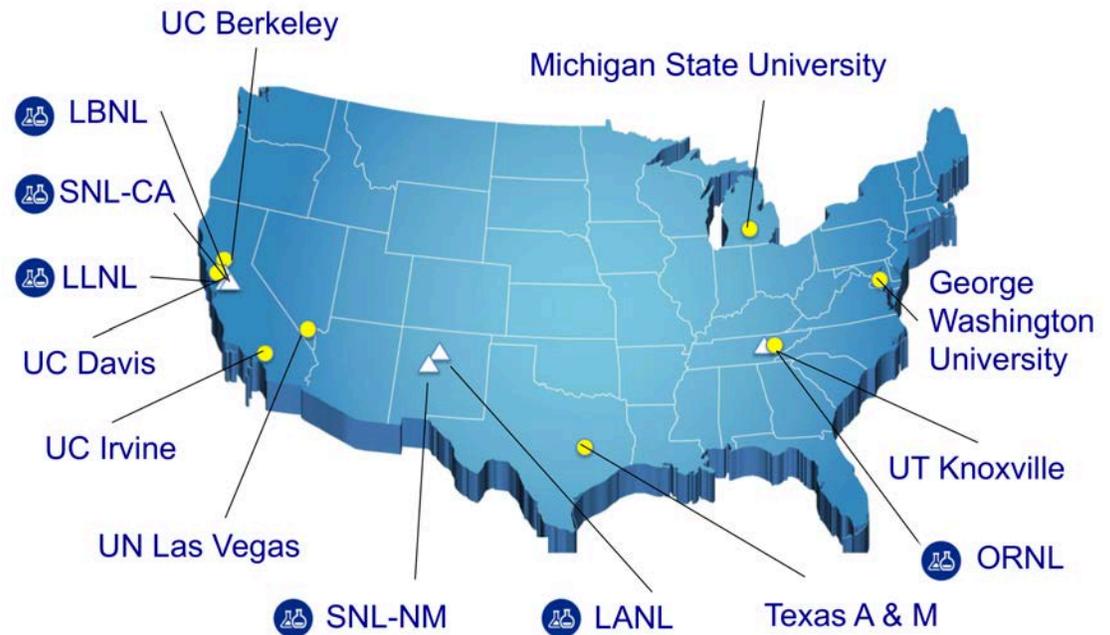
DR. KAI VETTER

NNSA Liaison
UC Berkeley

DR. LEE BERNSTEIN

Director for Laboratories
UC Berkeley

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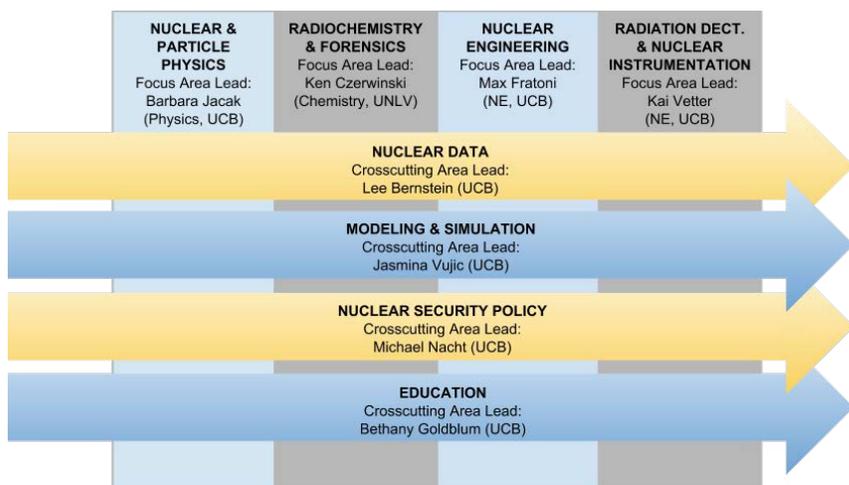
DR. DAVE WILLIAMS

Oak Ridge National Laboratory

DR. ALF MORALES

Sandia National Laboratory

PROFILES of NSSC's Focus and Crosscutting Area Leads



NSSC's Focus and Crosscutting Areas



Professor Ken Czerwinski works with students.
(R. Marsh Starks/UNLV Photo Services)

Barbara Jacak serves as the **Nuclear & Particle Physics Focus Area** Lead. Jacak is the Director of the Nuclear Science Division at Lawrence Berkeley National Lab, as well as a Faculty Senior Scientist, and a Professor of Physics at the University of California, Berkeley.

Ken Czerwinski leads the **Radiochemistry and Forensics Focus Area**. Czerwinski is a Professor of Radiochemistry at the University of Nevada, Las Vegas.

Max Fratoni is the **Nuclear Engineering Focus Area** Lead, and an Assistant Professor of Nuclear Engineering at the University of California, Berkeley.

Kai Vetter leads the **Radiation Detection & Nuclear Instrumentation Focus Area**, and is the NNSA Liaison for NSSC. Vetter is a Professor in the Department of Nuclear Engineering at the University of California, Berkeley and a Faculty Senior Scientist and Head of the Applied Nuclear Physics program at the Lawrence Berkeley National Laboratory. He is the Director of the Institute for Resilient Communities, and serves as a supervising Professor and Professor-in-Residence for Berkeley RadWatch.

Lee Bernstein is the **Nuclear Data Crosscutting Area** Lead, and the Director for Laboratories at NSSC. Bernstein is the Nuclear Data Group Leader at Lawrence Berkeley National Laboratory, and an Adjunct Professor in Nuclear Engineering at UC Berkeley.

Jasmina Vujic, NSSC Director, is the **Modeling and Simulation Crosscutting Area** Lead. Vujic is a Professor in the Department of Nuclear Engineering at the University of California, Berkeley, and is the co-director of the Berkeley Nuclear Research Center.



Dr. Bethany Goldblum and NSSC Graduate Fellow, Adriana Ureche, at LBNL.

Michael Nacht leads the **Nuclear Security Policy Crosscutting Area**, and is a Professor of Public Policy at the Goldman School at the University of California, Berkeley. He served previously as Assistant Secretary of Defense for Global Strategic Affairs and as an Assistant Director of the U.S. Arms Control and Disarmament Agency.

Bethany Goldblum is the Executive Director of NSSC and leads the **Education Crosscutting Area**. Goldblum is also the Founder and Director of the Nuclear Policy Working Group, and the Director of the Public Policy and Nuclear Threats Boot Camp.

NSSC EVENTS

NSSC FALL WORKSHOP AND ADVISORY BOARD MEETING

The annual NSSC Workshop was held on September 11th and 12th, 2017 at Lawrence Berkeley National Laboratory, in Berkeley, CA. NSSC Fellows presented on their work, and the main points of contact from NSSC's academic partners provided updates and research highlights. Technology demonstrations were given by the Canary for Nuclear Security, DoseNet, and RadWatch teams. Students, postdocs, and faculty from all partner schools attended as well as representatives from NSSC's lab partners. Representatives from NNSA, and the NSSC Advisory Board were also in attendance to learn more about NSSC programs and research.



MSU NSSC Fellows, Krystin Stiefel, Daniel Votaw, and Thomas Redpath attending the poster session of the NSSC Fall Workshop.

MONTHLY WEBINARS BRING NUCLEAR SCIENCE AND SECURITY EXPERTS TO CAMPUS

NSSC continued to host monthly webinars. A few highlights from the past year's webinar series included Dr. Mavrik Zavarin (LLNL) discussing Plutonium Contamination of the Environment, Amb. Linton F. Brooks on the Implications of the Trump Nuclear Posture Review, and Dr. Alexis Trahan (LANL) on nondestructive assay for International Safeguards. Webinars were broadcast live to all consortium academic partners. Students were also invited to attend in person, and had the opportunity to connect with invited speakers.



Representatives from NNSA, NSSC Staff, Executive Team, Advisory Board, and Lab Collaborators at the NSSC Fall Workshop.

SPECIAL TOPICS IN NUCLEAR DATA ONLINE COURSE

This course covered the techniques currently applied in nuclear data evaluation. It was co-taught by Prof. Lawrence Heilbronn (UTK) and Vladimir Sobes (ORNL) and broadcast live.

SEVENTH YEAR OF NUCLEAR SECURITY COURSE AT UC BERKELEY

The course "Nuclear Security: The Nexus Between Technology and Policy" was held for the seventh time at UC Berkeley in Spring 2018. This year's course was co-taught by Prof. Michael Nacht of the Goldman School of Public Policy and Prof. Bernstein of the Department of Nuclear Engineering. Guest speakers included Brad Roberts (LLNL), and Sheryl Hingorani (SNL). This class was broadcast live to all academic partners.



NSSC Fellows and Affiliates meeting with Amb. Linton Brooks as part of a NSSC Webinar event.

NSSC SUMMER SCHOOLS 2018



NSSC-LANL Keepin Nonproliferation Science Summer Program Participants, Summer 2017.

NSSC-LANL KEEPINNONPROLIFERATION SCIENCE SUMMER PROGRAM JUNE 18-AUG 10, 2018 | LOS ALAMOS

Thirteen NSSC Fellows or Affiliates will spend summer 2018 learning about how game-changing science, engineering, and technology are applied to reduce the dynamic threats of nuclear nonproliferation. 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. 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 will have broad exposure to LANL, access to mentors from LANL and SNL, and opportunities for lab-directed research.

7/2 NSSC summer program participants from 2017 continued working with LANL after program completion. Many participants will return to LANL for Summer 2018.

Highlight: James Louis-Jean (UNLV) awarded the Seaborg Institute Research Fellowship to continue research at LANL.



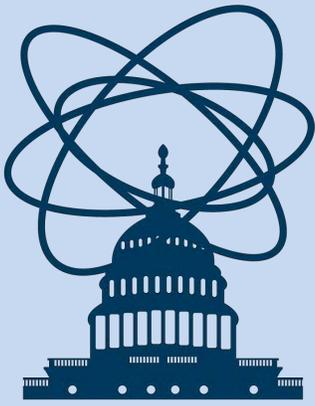
Students touring the Center for Integrated Nanotechnologies (CINT)

FEEDBACK ON 2017 PROGRAM OVERALL

“As far as exposure to the nonproliferation mission and the science supporting it, this program was excellent.”

•16 out of 17 students ranked their overall experience as a 4 or 5 out of 5

•16 out of 17 students were likely or very likely to recommend this program to others



GW Boot Camp on Nuclear Security Policy

GW BOOT CAMP ON NUCLEAR SECURITY POLICY JUNE 11-22, 2018 | WASHINGTON, DC

The boot camp will feature an intensive introduction to nuclear security for the prevention of nuclear weapons proliferation and nuclear terrorism. This course will explore the implications of scientific and technological developments on government function and policy issues as well as international norms, treaties, and diplomacy. Specific topics will 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, the Russian and Chinese situations, and more. The Boot Camp will leverage GW's unique location two blocks from the White House and across the street from the State Department to feature high level personnel from government agencies and nuclear arena NGOs, as well as field trips to NNSA/DOE, Capitol Hill, and other government agencies.

PUBLIC POLICY AND NUCLEAR THREATS BOOT CAMP

JULY 29–AUGUST 7, 2018 | SAN DIEGO, CA

The summer workshop-in-residence at UC San Diego, known as the PPNT boot camp, aims to give participants the knowledge and analytic tools to contribute to the debate on future US nuclear policy. The boot camp features lectures, discussions, debates, and policy simulations. Participants attend talks by distinguished researchers, academics, policy officials, and operational specialists from leading universities, the National Laboratories, international organizations, and government agencies dealing with dealing with nuclear threats, command and control, international safeguards, nonproliferation strategies, and other nuclear issues.



PPNT participants experimenting with a radiation detector.

NUCLEAR ANALYTICAL TECHNIQUES SUMMER SCHOOL

AUGUST 12–18, 2018 | DAVIS, CA

The Nuclear Analytical Techniques Summer School consisted of some lectures, but mostly hands-on activities involving nuclear analytical techniques. Students performed Neutron Activation Analysis using the McClellan Nuclear Research Center, studied proton elastic scattering at the Crocker cyclotron facility, gained experience and skills in counting with NaI and HPGe crystals, and learned about detectors and analysis techniques important across a broad range of science and industry.



Morgan Askins (UCD), Uday Mehta (NSSC Alum at LLNL), and Kyle Bilton (UCB) preparing the samples for the Neutron Activation Analysis in the clean room at UC Davis. Samples are excited by neutrons at UC Davis McClellan Nuclear Research Center, counted using the high purity Germanium detectors and the measured spectra are analyzed offline. This assay process can measure unimaginably low levels of radioactive elements (parts per trillion) in various materials.

2018 RESEARCH HIGHLIGHTS from NSSC Fellows and Affiliates

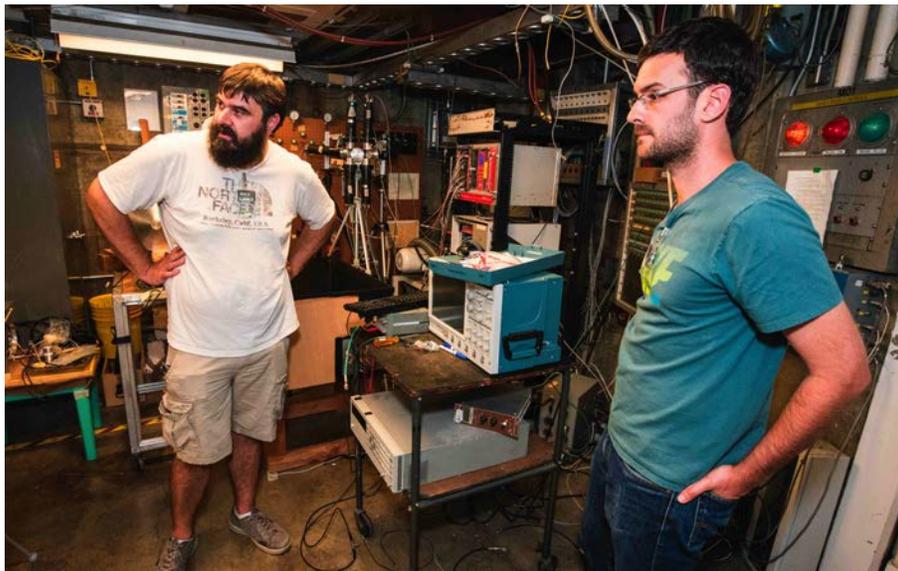
THIBAUT LAPLACE

NSSC POSTDOC AT THE UNIVERSITY OF CALIFORNIA, BERKELEY

Academic Advisor: Bethany Goldblum

Lab Mentors: Patrick Feng (SNL), Erik Brubaker (SNL), Edith Bourret-Courchesne (LBNL)

Thibault Laplace is investigating the response of organic scintillators to neutrons. At the Lawrence Berkeley National Laboratory 88-Inch Cyclotron, using a double time of flight method jointly developed by former NSSC Fellow Josh Brown (now a postdoc at SNL), the proton light yield can be measured over a broad range of energies in a single measurement. To better constrain physics-based light yield models in the energy range relevant for the detection of fission neutrons, the method has been adapted and proton recoil energies down to 10s of keV have been measured. Recent measurements include fast plastic scintillators in collaboration with the Single Volume Scatter Camera venture led by SNL, as well as the trans-stilbene crystal (for energy-dependent light yield anisotropy) and SNL's custom-made organic glass in collaboration with the LBNL-led Advanced Materials for Detection venture.



Thibault Laplace (right) working with Josh Brown at LBNL.



August Ridenour (right) discusses the latest f-element hybrid material research with Dr. Christopher Cahill.

JAMES "AUGUST" RIDENOUR

NSSC GRADUATE FELLOW AT GEORGE WASHINGTON UNIVERSITY

Academic Advisor: Christopher Cahill

Lab Mentor: Robert Rundberg (LANL)

August's research duties and aspirations at The George Washington University are two-fold in pursuit of his Ph.D. in Chemistry. Firstly, his in-lab efforts focus on a fundamental exploration of f-element bearing materials, the determination of their molecular structure through X-ray diffraction, and their characteristic spectroscopic signatures to better understand their properties under environmental and security relevant conditions. Secondly, he serves as the teaching assistant for "The Science of Nuclear Materials" - a course in GW's Elliot School of International Affairs aimed at introducing nuclear science through the lens of nuclear policy and current affairs. August has assisted with both the lecture and lab-practical portions of the course, providing equipment demonstrations for weekly lab practical experiments in radiation detection with lab-based and "in-the-field" analytical techniques. He has also worked to update course material that includes integrating new radioactive sources and radiation detection equipment, from alpha radiation detectors and gamma spectrometers to mobile Geiger-Müller detectors that first responders might utilize in an emergency.

JAMES LOUIS-JEAN

NSSC GRADUATE FELLOW AT THE UNIVERSITY OF NEVADA, LAS VEGAS

Academic Advisor: Frederic Poineau

Lab Mentor: Jeremy Inglis (LANL)

Natural uranium consists of three main isotopes ^{234}U , ^{235}U , ^{238}U with relative isotopic abundance of 0.72%, 0.005%, and 99.275% respectively. After the discovery of nuclear fission by Otto Hahn in 1937, the contemporary uses of uranium rely on the nuclear properties of ^{235}U as it is the only fissile naturally occurring isotope of uranium. However, these applications require enrichment of the fissile ^{235}U isotope before its use for nuclear fuel and nuclear devices. The idea is to prepare uranium compounds that are found throughout the uranium cycle, from mining to storage and reprocessing and measure their isotopic ratios using thermal ionization mass spectrometry (TIMS). These compounds are prepared with 5%, 20%, and 80% ^{235}U to simulate the different percent enrichment for commercial reactor, research reactor, and naval reactor. The need to measure their isotopic ratios along with the chemical form of uranium are crucial in providing accurate measurements for nuclear forensics as well as nuclear material verifications and violations. In addition, the isotopic ratios of samarium are also of concern. Sm is among the rare-earth-elements (REEs) produced in measurable quantities above natural abundances on the high-end-mass of the fission curve during the fission of $^{233,235}\text{U}$ and ^{239}Pu . As a result, the isotopic ratios of Sm using TIMS can provide, in great details, information regarding fissile material, neutron flux, and device yield for nuclear forensic studies.



James Louis-Jean (left) and Dr. Jeremy Inglis at LANL mass spectrometry & clean chemistry lab.

DANIEL RUTSTROM

NSSC GRADUATE FELLOW AT

THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Academic Advisor: Mariya Zhuravleva

Lab Mentor: Bryan Chakoumakos (ORNL)

Daniel Rutstrom conducts research at the Scintillation Materials Research Center (UTK) where he focuses on crystal growth and discovery/development of novel inorganic halide scintillators for gamma spectroscopy. The goal of his work is to develop materials with improved detection capabilities for applications in nuclear security and nonproliferation, which aligns with the NSSC and NNSA's missions to support the nation's nuclear security agenda by preventing nuclear weapons proliferation and reducing the threat of nuclear and radiological terrorism. Part of his work also requires structural characterization of new materials, which is why he works and collaborates with a lab mentor at Oak Ridge National Lab measuring single-crystal X-ray diffraction. The specific project that he has been working on most recently involves optimizing europium concentration in $\text{Cs}_4\text{SrI}_6:\text{Eu}$ and $\text{Cs}_4\text{CaI}_6:\text{Eu}$ scintillators. With energy resolutions as low as 3.2% (at 662 keV) and light yields $>65,000$ ph/MeV, these relatively new scintillator materials are promising for gamma-ray detection and have comparable performance to commercially available scintillators such as $\text{SrI}_2:\text{Eu}$ and $\text{LaBr}_3:\text{Ce}$. Additionally, he has been investigating new activators for Cs_4SrI_6 and Cs_4CaI_6 that could potentially provide faster decay times or might be better suited for incorporation into the host matrices.

**BENJAMIN GODFREY**

NSSC GRADUATE FELLOW AT THE UNIVERSITY OF CALIFORNIA, DAVIS

Academic Advisor: Mani Tripathi

Lab Mentor: Peter Marleau (SNL)



Fast neutron imagers allow for passive, stand-off localization of a special nuclear material (SNM) source even if shielded. They serve to aid everything from treaty verification to stockpile stewardship activities. Much work has already been done developing a compact, fast neutron camera for field deployment. However, mobility, and thus deployment, of the current designs are limited, in part, by the inclusion of large, power-hungry photomultiplier tubes (PMTs). Replacement of PMTs with silicon photomultipliers (SiPMs) promises a reduction in size and power, and, therefore, an increase in mobility, of current systems. To this end, the Davis team is developing a generic SiPM array readout scheme for fast neutron imagers of various topologies. Currently, they have designed and are testing an individualized bias board to combat SiPM-to-SiPM gain variations that degrade energy resolution. Simultaneously, the team is designing a board capable of performing on-board pulse shape discrimination (PSD) without the need of quick ADC's nor the corresponding amount of resource-intensive processing power this entails. They are still in the modeling stage but are planning to have a prototype board designed shortly.

Ben Godfrey (left) with Leo Osornio and Mani Tripathi.

NICOLE APADULA

NSSC POSTDOC AT THE UNIVERSITY OF CALIFORNIA, BERKELEY
Academic Advisor: Barbara Jacak
Lab Mentor: Leo Greiner (LBNL)

In collaboration with Lawrence Berkeley National Lab (LBNL), Nicole's group is working on the construction of a new silicon detector upgrade for the ALICE experiment at CERN. When completed, the new Inner Tracking System (ITS) will be the largest pixel detector in the world and will provide ALICE with improved tracking capability and impact parameter resolution. This is accomplished with seven layers of innovative Monolithic Active Pixel Sensors that can be operated without bias voltage and need minimal cooling, making them a very attractive possibility for satellite-based applications. At LBNL the group is responsible for assembling the two middle layers of the ITS. Using a Coordinate Measuring Machine (CMM), the group can verify the position of the silicon sensors to the sub-micron level. They have coordinated with a large, far-flung team to develop and optimize the assembly procedure, ensuring uniformity over five assembly sites. Over the course of the next year the group will produce 60 staves, corresponding to more than 3 square meters of silicon with 3.5 billion pixels.



Nicole Apadula (right) with NSSC Specialist Jacqueline Garcia and NSSC Fellow Fernando Torales-Acosta at LBNL.

JANETTE ALI HANKS

NSSC SPECIALIST AT THE UNIVERSITY OF CALIFORNIA, BERKELEY
Academic Advisor: Kai Vetter
Lab Mentor: Ren Cooper (LBNL)



Ali Hanks discusses her work at the NSSC Fall Workshop.

Ali supervises a team of undergraduate researchers exploring a range of environmental and radiation data as part of the RadWatch and DoseNet programs. This work includes sample collection and analysis and using data collected through a growing network of radiation and environmental sensors. The groups measure the levels of man-made and naturally occurring radioisotopes in oceanic samples, including fish, seaweed, and kelp, sourced from around the world, with a focus on varieties sourced locally in and around the Bay Area. They also measure the concentration of potentially toxic heavy metals in these samples using neutron activation analysis techniques. Through the DoseNet program, they collect radiation data across their international sensor network of 40 sensors, including 20 in the Bay Area, a location near LA, six in the Fukushima Prefecture in Japan, and additional international locations in Ukraine, S. Korea, Sweden, Germany, and Serbia. At a growing subset of these locations, CO₂ and air particulate (PM 2.5) sensors are now included along with spectroscopic information, allowing for a more in-depth exploration of environmental factors leading to spatial and temporal variations in background radiation levels. As an example, Ali and the students are currently analyzing data collected during the Northern California wildfires last fall looking for the impact on both air quality and radiological signatures.

ROSE PIER

NSSC AFFILIATE AT THE UNIVERSITY OF CALIFORNIA, IRVINE

Academic Advisor: Mikael Nilsson

Lab Mentor: Rebecca Chamberlin (LANL)

Rose Pier's research focuses on the separation of radionuclides from environmental samples for environmental and forensic applications. The work in UC Irvine includes studies on a new cation exchange resin, RSM-25HP to separate radionuclides such as radium-226 from highly saline environmental samples via solid-liquid extraction. Kinetics studies are also performed on RSM-25HP and compared to the well studied Dowex 50W-X8 resin. In addition, work in UC Irvine includes maximizing electrodeposition efficiency for radium and uranium analysis via alpha spectrometry. This summer, Rose will be working at Los Alamos National Laboratory under the NSSC Keepin Nonproliferation Science Summer Program to extend her research project to look at kinetic and thermodynamic studies of actinide separations relative to plutonium process chemistry using anionic exchange resins.



ATHENA GALLARDO

NSSC GRADUATE FELLOW AT THE UNIVERSITY OF NEVADA, LAS VEGAS

Academic Advisor: Frederic Poineau

Lab Mentor: Terry Hamilton (LLNL)

Athena Gallardo is a PhD candidate in the Radiochemistry Program at University of Nevada, Las Vegas (UNLV). She previously received a B.S. as well as a M.S. in Health Physics from UNLV. Her research is conducted under the mentorship of Dr. Terry Hamilton with the Center for Accelerator Mass Spectrometry Group at Lawrence Livermore National Laboratory. Her research focuses on the retrospective analysis of radionuclides in banded corals from the Bikini Atoll which is one of the most contaminated sites in the world due to the high contribution of local fallout from high and low yield nuclear weapons testing. A chronological record of uranium and plutonium within the lagoon will be constructed through chemical analysis of banded coral. Temporal



changes in concentrations and isotopics of uranium and plutonium within the coral and lagoon will be assessed which will indicate source term characteristics while providing an annual nuclear fingerprint of the contamination transported from the lagoon to the Pacific Ocean. This research will provide a basis for understanding and predicting the long-term behavior and consequences of radionuclides from highly contaminated marine environments.

(above) Athena getting ready to board the Air Marshall Islands plane to travel from the Bikini Atoll to the Majuro Atoll at the end of her coral sampling trip in 2016.

MARK QUINT

NSSC GRADUATE AFFILIATE AT THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Academic Advisor: John Auxier

Lab Mentor: Jared Johnson (ORNL)

Diversion of nuclear material is of significant concern, especially during the post-reactor chemical processing of nuclear fuel. In present efforts, diversion has the highest probability of occurrence during the chemical separation phase. Present technology requires that samples are acquired after separation to perform the mass balance to determine diversion. Quint's project seeks to employ real-time monitoring of the process chemistry using the couple video and HPGe gamma-ray spectroscopy to monitor on-line separation setups without having to stop the system to collect samples.

Mark Quint (left) working with the GeGI (Germanium Gamma-ray imager) and taking measurements at ORNL.

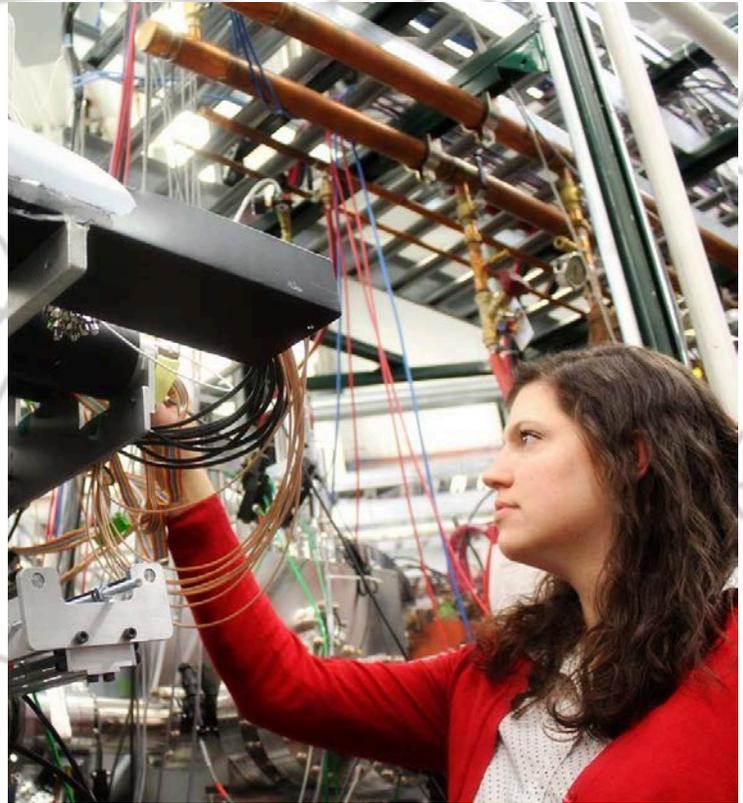


STEPHANIE LYONS

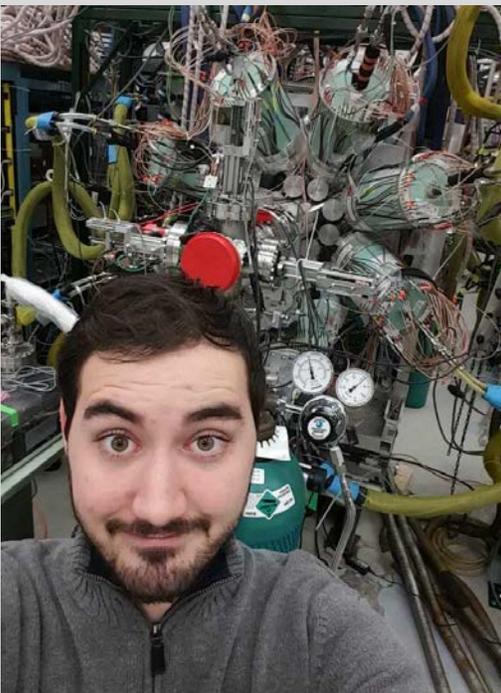
NSSC POSTDOCTORAL FELLOW AT MICHIGAN STATE UNIVERSITY

Academic Advisor: Artemis Spyrou
Lab Mentor: Aaron Couture (LANL)

Stephanie Lyons is an NSSC Postdoctoral Fellow at the National Superconducting Cyclotron Laboratory at Michigan State University. She is currently determining β -decay intensities using the technique of total absorption spectroscopy for rare, neutron-rich isotopes. Accurate β -decay intensities are widely used to extract anti-neutrino spectra from operating reactors and determine the heat produced by β decay following reactor shutdown. Most work uses β decay intensities that are either derived from inaccurate nuclear data on individual isotopes, uncertain theoretical modeling, or bulk measurements on complex multi-isotope samples. β -decay intensities are traditionally determined using high-resolution detectors. However, these detectors often have a low efficiency, which can cause them to miss weak decay branches to high-lying states in the daughter nucleus, which artificially enhances the inferred feeding intensities to lower energy levels. Using the technique of total absorption spectroscopy (TAS), these inaccuracies are avoided by detecting the total energy released in the decay with a high-efficiency detector, improving the underlying nuclear data attributable to a specific nucleus which then is used in other applications. Stephanie has performed a number of experiments at NSCL and results on TAS studies are forthcoming. To expand this work, Stephanie is collaborating with scientists from LLNL to broaden present detection capabilities to avoid radioactive daughter in-growth with the use of a tape station and novel β detector. The newly commissioned system is going to be used this summer for an experiment targeting nuclei in the neutron-rich Sr region.



Stephanie Lyons checks signal cables as she sets up for an experiment to study the properties of rare isotopes at the National Superconducting Cyclotron Laboratory at Michigan State University.



BRENDEN LONGFELLOW

NSSC GRADUATE FELLOW AT MICHIGAN STATE UNIVERSITY

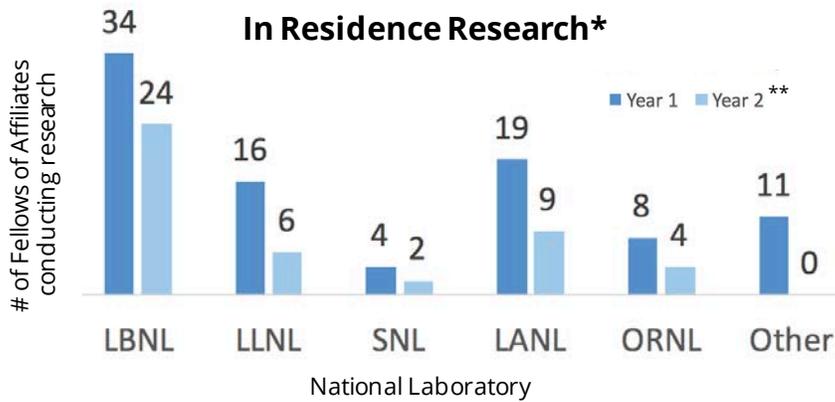
Academic Advisor: Alexandra Gade
Lab Mentors: Ching-Yen Wu (LLNL)

Brenden has been studying nuclear structure near the proton drip line using in-beam gamma-ray spectroscopy at the National Superconducting Cyclotron Laboratory (NSCL). In a recent paper, he reported the first detection of gamma rays from energy levels above the proton separation energy in ^{25}Si , allowing for an improved calculation of the $^{24}\text{Al}(p,\gamma)^{25}\text{Si}$ reaction rate for the astrophysical r -process. Brenden's research helps to inform the late-time neutron-induced destruction cross sections for the interpretation of stockpile radiochemistry on neutron-deficient nuclei. He has also collaborated on a campaign of low-energy Coulomb excitation experiments at the NSCL with Ching-Yen Wu of Lawrence Livermore National Laboratory (LLNL) and is currently working on a project at LLNL with Nicholas Scielzo to study angular correlations in the beta decays of ^8Li and ^8B .

Brenden Longfellow with the segmented germanium array (SeGA) used for gamma-ray detection

NSSC2 METRICS September 2016 – March 2018

NSSC LAB ENGAGEMENT METRICS



*If a student conducted research at more than one lab they are counted towards each lab
 ** Numbers only through March 2018



66 students or postdocs worked on a Lab Directed Project



100% of Graduate Fellows have a Lab Mentor



82 students or postdocs conducted research in a National Laboratory



96 Lab Mentors at National Laboratories worked with NSSC Fellows and Affiliates



METRICS OF SUCCESS



194
Personnel Supported



29
Degrees Earned



30
Awards



59
Peer-Reviewed Publications



71
Posters



111
Oral Presentations

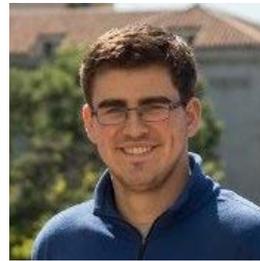
NSSC2 AWARD & HONORS HIGHLIGHTS



Emily Frame (UCB) winner of best poster at the 7th International Symposium of the “Phoenix Leader Education Program for Renaissance from Radiation Disaster” with her presentation: “Radiation & Radiation Detection: From Responding to Radiation Disasters to Saving Rhinos”



Jason Richards (UNLV) First Place Innovations in Nuclear Technology R&D Award, DOE-NE



Austin Wright (UCB) Winner of the 2017 DOE DNN R&D Network Science and Nuclear Nonproliferation Challenge



James Louis Jean (UNLV) Awarded Seaborg Institute Research Fellowship, LANL



Kelly Kmak (UCB) Glen T. Seaborg Award for Outstanding Undergraduate Research in Chemistry



Andrew Reddie (UCB) named NSSC PPNT Nuclear Security Undergraduate Scholar



Scott Parker (UCB) Distinguished Student Performance Award, LANL



NSSC IN THE NEWS

Dr. **Robert Svoboda's** (UCD) work with WATCHMAN (WATER CHerenkov Monitor for Anti-Neutrinos) project featured in the New York Times. Chang, Kenneth. (2018, March 27). How to Spot a Nuclear Bomb Program? Look for Ghostly Particles. *New York Times*.

(left) Dr. Svoboda at the Underground Watchman site, with NSSC Fellows

NSSC Executive Director **Dr. Bethany Goldblum** (UCB) featured in Berkeley Engineer Magazine. Preuss, Paul. (2018, January 22). Keeping watch on Nuclear Weapons. *Berkeley Engineer Magazine*.

NSSC Undergraduate **Lena Korkeila's** work with the UC Davis Neutrino Group featured by the Association of American Universities. Korkeila is testing different plastics and metals that will be used to build the WATCHMAN detector. Yue, Jeanette. (2018, April 18). Undergraduate Students Help Protect the World. *Association of American Universities*.

NSSC Director for Laboratories **Dr. Lee Bernstein's** (UCB) Nuclear Data research highlighted by LBNL News Center. Roberts, G. (2016, December 21). Filling in the Nuclear Gaps. *Berkeley Lab News Center*.

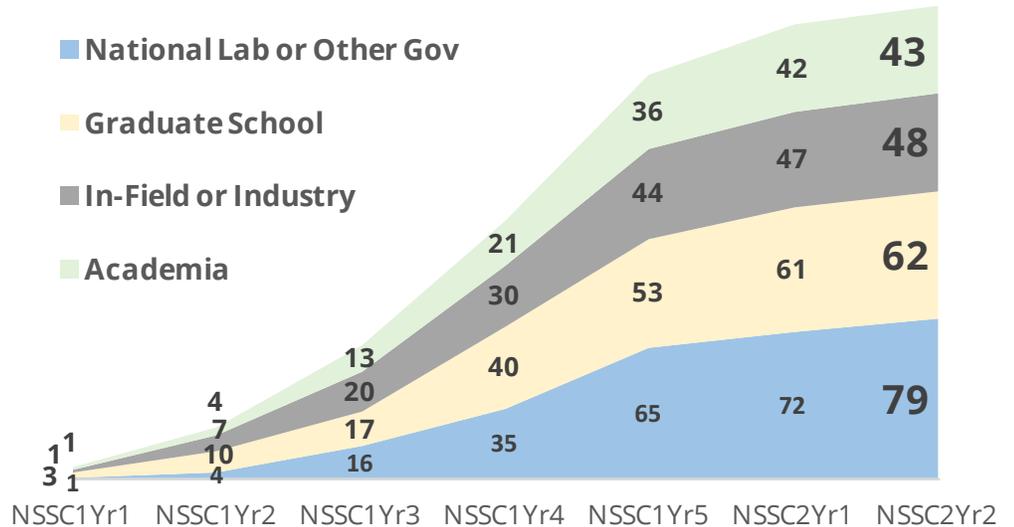
NSSC UNLV Faculty members **Prof. Czerwinski and Prof. Poineau's** work with NSSC featured in the UNLV News Center. Bevel, S. (2016, Feb 16). UNLV to Advance Nuclear Forensics Research as Part of National Consortium. *UNLV News Center*.

NSSC PIPELINE METRICS (2011-2018*)

CUMULATIVE PIPELINE

207 Students and Postdocs have completed the NSSC Program since 2011.

~38% of Fellows and Affiliates go on to positions with the national labs and government!



*As of March 2018

NSSC FELLOWS AND AFFILIATES HIRED AT NATIONAL LABORATORIES & GOVERNMENT



Sherry Faye
PhD UNLV
Postdoc UCB
Postdoc | LLNL
Dec 2015



Joseph Curtis
M.S. UCB
Staff | LBNL
Dec 2014



Ross Barnowski
PhD UCB
Postdoc | LBNL
Spring 2016



Jonathan Plaue
PhD UNLV
Staff | LANL
Fall 2012



Brian Daub
Postdoc UCB
Staff | LLNL
Weapons & Complex
Integration Directorate
Fall 2013



Deepa Khatri
B.S. UCB
Staff Engineer | LLNL
Nuclear Criticality
Safety Division
Summer 2014



Victor Negut
B.A. UCB
Staff, NSD | LBNL
Applied Nuclear
Physics
Spring 2014



Quinn Looker
PhD UCB
Staff | SNL
Fall 2013



Anthony Lubbers
B.Sc. UCB
Staff Engineer | LLNL
Nuclear Criticality
Safety Division
Summer 2014



Ross Meyer
B.Sc. UCB
Staff, NSD | LBNL
Applied Nuclear
Physics
Spring 2015



Andrew Haefner
PhD UCB
Staff, NSD | LBNL
Applied Nuclear
Physics
Spring 2015



Kalee Hammerton
PhD MSU
Staff | Savannah River
Spring 2016



Marc Bergevin
Postdoc UCD
Staff | LLNL
May 2015



Tashi Parsons-Moss
Postdoc UCB
Postdoc | LLNL
Nuclear & Chemical
Sciences Division
Fall 2014



Brian Plimley
PhD UCB
Postdoc | LBNL
May 2014



Christopher Brand
B.S. UCB
Staff | LLNL
May 2015



Perry Chodash
PhD UCB
Postdoc | LLNL
Spring 2015



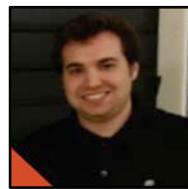
Jeremy Mock
PhD UCD
Postdoc | LBNL
Fall 2014



Caleb Roecker
PhD UCB
Staff | LANL
May 2016



Cameron Bates
PhD UCB
Postdoc | LANL
Fall 2014



Michael Jones
PhD MSU
Postdoc | LBNL
Feb 2016



Keri Campbell
PhD UNLV
Postdoc | LANL
Fall 2014



John Despotopulos
PhD UNLV
Postdoc | LLNL
Nuclear & Chemical
Sciences Division
Spring 2015



Erika Suzuki
B.S. UCB
Staff | LBNL
Dec 2013



Maryline Ferrier
PhD UNLV
Postdoc | LANL
Fall 2014



Tenzing Joshi
PhD UCB
Postdoc, NSD | LBNL
Applied Nuclear Physics
Spring 2015



Tara Mastren
PhD WUSTL
Postdoc | LANL
2014



Timothy Shokair
Postdoc UCB
Postdoc | LLNL
Spring 2015



Sergey Uvarov
Masters UCD
Postdoc | LLNL
Spring 2016



Barbara Wang
PhD UCB
Postdoc UCB
Postdoc | LLNL
Anticipated May 2016



Audrey Roman
PhD UNLV
Postdoc | LANL
Fall 2014



Janelle Droessler
PhD UNLV
Postdoc | LANL
Mar 2016



Daine Danielson
B.S. UCD
Intern | LANL
Summer 2014



Matthew Proveaux
M.Sc. UCB
NNSA Fellow
Pacific Northwest NL
June 2014



Duane Smalley
Postdoc MSU
Staff |
NSTec@LANL
Summer 2014



Jeromy Tompkins
Postdoc MSU
Staff | NSCL
Summer 2014



Steven Ragnar Stroberg
PhD MSU
Postdoc | TRIUMF
2014



Anagha Iyengar
B.S. UCB
Staff | NNSA
May 2014



Keenan Thomas
Masters UCB
Staff | LLNL
Summer 2016



Jenna Smith
PhD MSU
Postdoc | TRIUMF
2014



Scott Suchyta
PhD MSU
Postdoc UCB
Staff | RSL
Apr 2016



Jessica Roche
B.S. UCB
Staff | LLNL
Spring 2016



Tim Aucott
PhD UCB
Staff | SRNL
December 2014



Ligang Bai
Postdoc UNLV
Postdoc | ANL
May 2013



Nicole Larson
B.S. | MSU
Nuclear Ops. Engineer
LLNL
Spring 2016



Paul Davis
Postdoc UCB
Fellow | DoD
Spring 2013



Nick Bricker
Masters UCB
Staff | LBNL
Summer 2016



Andrew Wysong
M.S. UCB
Staff | LANL
Fall 2015



Marissa Ramirez
Zweiger
B.S. UCB
Staff | ORNL
May 2015



David Weisz
PhD UCB
Postdoc | LLNL
Summer 2016



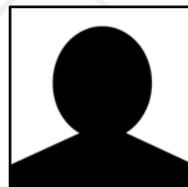
Anthony Juarez
MPP | UCB
Staff | SNL
Spring 2016



Alex Braatz
PhD UCI
Postdoc | ORNL
2015



Uday Mehta
Bachelors UCB
Engineer | LLNL
Spring 2016



Christopher Prokop
PhD MSU
Postdoc | LANL
Spring 2016



David Sweeney
Postdoc UC Berkeley
Postdoc | DTRA
Fall 2015



Quinlan Smith
Masters UNLV
Staff | ORNL
Spring 2016



Justin Munson
PhD UCB
Postdoc | LLNL
Spring 2015



Derek McLain
PhD UNLV
Postdoc | ANL
May 2016



Nick Walsh
Postdoc UCD
Postdoc | LLNL
Summer 2016



James Bevins
PhD UCB
Staff | AFIT
Summer 2017



Adam Rice
Masters UCB
Intelligence
2013



Josh Brown
PhD UCB
SNL | Postdoc
2018



Morgan Askins
PhD UCD
Postdoc | LBNL
2018



Andrew Gillick
Masters UCB
Army
2014



Charles Loelius
Masters MSU
NNSA | PNNL
2016



Brian Champine
PhD UCB
US Army
Spring 2016



Eva Uribe
PhD UCB
Staff | SNL
2016



Mark Quint
M.S. UTK
U.S. Army
2018



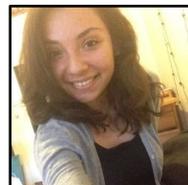
Tomi Akindele
PhD UCB
LLNL | Postdoc
2018



Leo Kirsch
PhD UCB
LBNL | Staff
Spring 2018



Mike Shattan
PhD UTK
AFIT | Staff
2018



Berenice
Garcia
B.S. UCB
LANL | Intern
2018



Joe Belarge
Postdoc MSU
MIT Lincoln Lab
Spring 2017



Steven Gardiner
PhD UCD
Fermi National
Accelerator Lab |
Postdoc
2018



Alexander Dixon
Bachelors UCB
US Navy
Spring 2012



Jeff Rolfes
M.S. UNLV
DTRA | Postdoc
Spring 2017



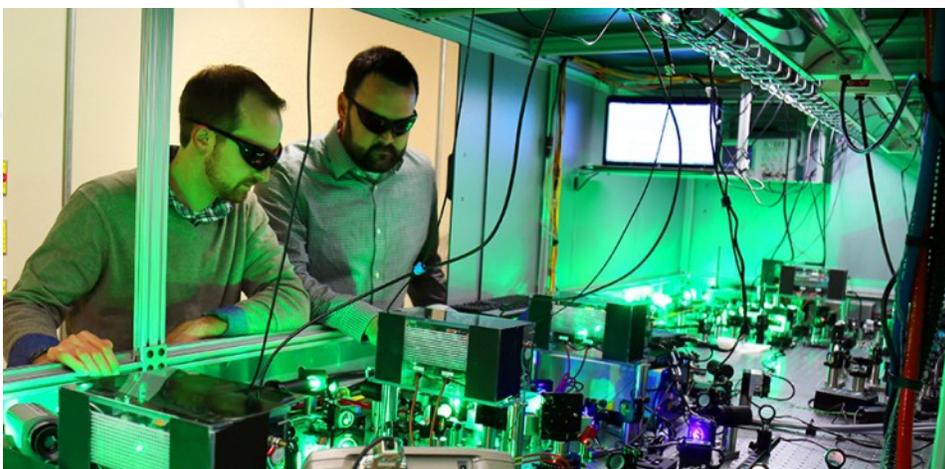
James Kingston
B.S. UCB
LLNL | Intern
2018



Joseph Labrum
B.S. UCB
Intelligence
Spring 2017



Thomas Halverson
Masters UCB
West Point
Spring 2016



David Weisz (left), NSSC Alum, now a chemist in Lawrence Livermore National Laboratory's Chemical and Isotopic Signatures Group. Photo by Carrie Martin/LLNL

NSSC RECENT PIPELINE HIGHLIGHTS



Sarah earned dual graduate degrees in Nuclear Engineering and Public Policy from the University of California, Berkeley in May 2018. During her time as a Fellow with the NSSC Sarah served as the Deputy Director of the Nuclear Policy Working Group, attended the Public Policy and Nuclear Threats Boot Camp, and supported the UC Berkeley course on Nuclear Security.

“ The NSSC has allowed me to continue to blend my intellectual curiosity about both the technical and political sides of the nonproliferation regime, which is a rare quality to find in a graduate program. Using the knowledge I’ve gained over the past 3 years, I am now able to head off to the IAEA for a Safeguards Analyst JPO position.” – Sarah Laderman

SARAH LADERMAN, SAFEGUARDS ANALYST JPO WITH THE INTERNATIONAL ATOMIC ENERGY AGENCY



Josh earned his PhD in Nuclear Engineering from the University of California, Berkeley in December 2017. Josh is now in a postdoctoral position at Sandia National Laboratories.



Jeff earned a PhD in Radiochemistry from the University of Nevada, Las Vegas in 2017. He went on to a position as a Postdoc Program Manager at Defense Threat Reduction Agency at Penn State University.

JOSH BROWN, POSTDOC AT SNL

JEFF ROLFES, POSTDOC AT DTRA



Tomi Akindele recently began as a post-doctoral researcher at Lawrence Livermore National Laboratory working on The WATCHMAN (WATER Cherenkov Monitor for Anti-Neutrinos) Collaboration. She recently received her PhD in Nuclear Engineering from U.C. Berkeley where her dissertation focused on surrogate reactions to determine the prompt fission neutron multiplicity and $(n, 2n)$ cross-section for Pu-241. Tomi attended the Public Policy and Nuclear Threats Boot Camp, and the LANL/SNL Summer Program. Her research interests focus primarily on the application of basic nuclear physics for national security.

TOMI AKINDELE, POSTDOC AT LLNL



Berenice Garcia earned her Bachelors degree in Physics in 2017. After graduation, she continued working with Professor Jacak at LBNL as a NSSC Specialist. Berenice then continued on to a SULI internship at Los Alamos National Laboratory.



Steven graduated from the University of California, Davis. During his time at UCD he contributed to the ANNIE experiment at Fermi Lab. He will begin a postdoctoral position in the Neutrino Division of Fermi National Accelerator Laboratory in Summer 2018.

BERENICE GARCIA, POST-BACHELOR INTERN AT LANL

STEVEN GARDINER, POSTDOC AT FERMI LABS



James Bevins earned his PhD in Nuclear Engineering in 2017 at UC Berkeley. During his time as a NSSC Affiliate he served as the Deputy Director of the Nuclear Policy Working Group. He is now an Assistant Professor of Nuclear Engineering at the Air Force Institute of Technology.



Morgan finished his studies at the University of California, Davis in May 2018 and has accepted a postdoctoral position at UCB as a LBNL affiliate. He will be working with Professor Orebi-Gann on SNO+, Watchman (in collaboration with LLNL, and Theia).

JAMES BEVINS, FACULTY AT AFIT

MORGAN ASKINS, POSTDOC AT UCB/LBNL



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