NUCLEAR SCIENCE AND SECURITY CONSORTIUM NEWSLETTER

September 2017

IN THIS ISSUE

THE HISTORY OF NSSC AND LOOKING AHEAD

The National Nuclear Security Administration (NNSA) established the Nuclear Science and Security Consortium (NSSC) beginning in 2011, as a five-year program to develop a new generation of laboratory-integrated nuclear experts. Since then, the NSSC has supported over 300 students and postdoctoral scholars through a multidisciplinary program that provided education and hands-on training in nuclear science, technology, and policy.

NSSC1 concluded in 2016, with 179 students and postdocs completing the program and the remaining 128 continuing their education with the NSSC. Between 2011 and 2016 a total of 59 NSSC Fellows and Affiliates accepted positions in DOE national laboratories—~33% of students and postdocs completing the program— while an additional 37 were hired into faculty and research positions in universities. Of those earning a degree, 57 NSSC Fellows and Affiliates continued with graduate education in technical fields.

In 2016, after a re-competition, the NNSA announced an additional grant award of $25 million to a new consortium of eight universities to continue research and development in nuclear science and security through the NSSC. The NSSC enables a rich collaborative research environment between universities and the national laboratories, and fosters the development of science and technology underlying the nuclear security mission.

NSSC will continue to build on the partnerships and programs developed during the first five years of the consortium. NSSC welcomes our new partners and new students to the NSSC community, and look forward to achieving our mission together.

(Left) Visiting NSSC Research Engineer Aaron Hurst (middle) and NSSC Fellow Eric Matthews (right) conduct research at the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory.

(Below) Members of the NSSC Community attending NSSC's Workshop in September 2016 at Lawrence Livermore National Laboratory.
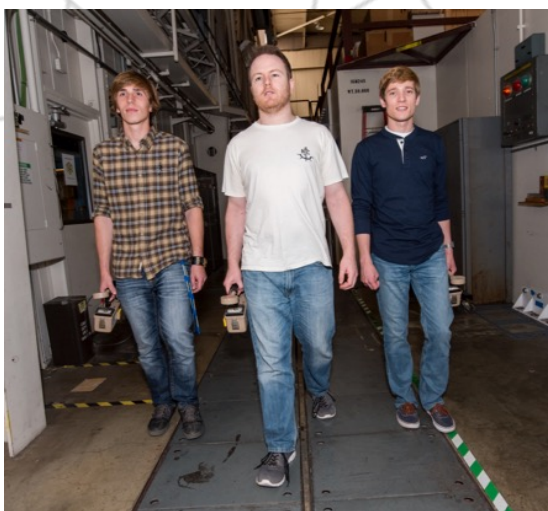
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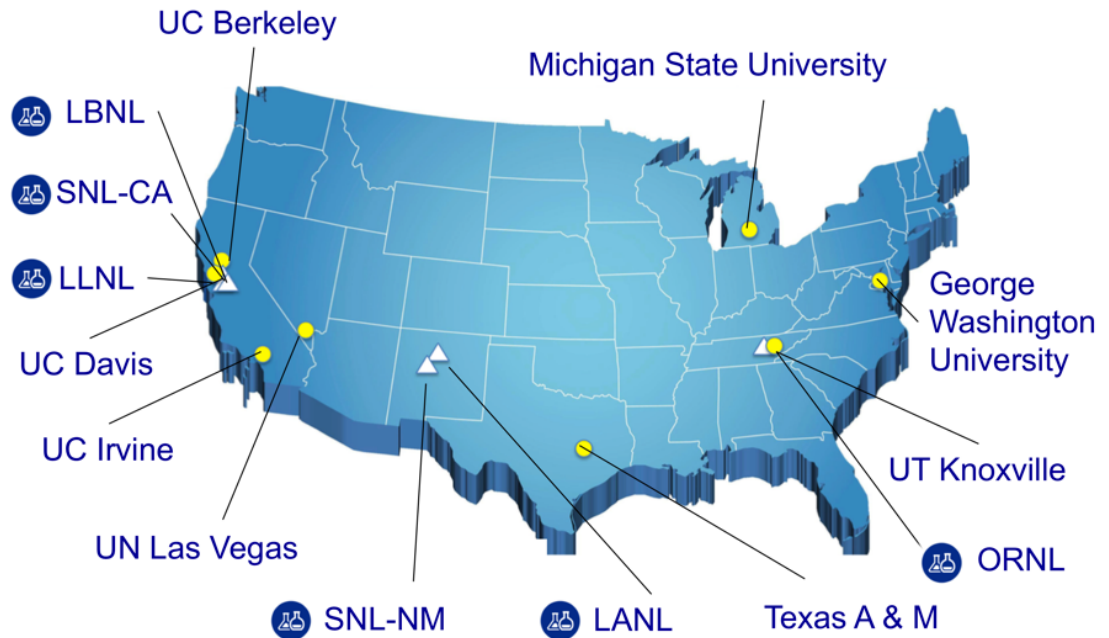Deputy Executive Director
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UC Berkeley

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LETTER FROM THE NSSC PROGRAM DIRECTOR

In its first five years (2011-2016), the NSSC1 has proven highly successful by all metrics, and the first waves of our students and postdoctoral researchers that completed the program (179) have been transitioning to careers in the DOE laboratories and related national security service (59), academia (37), and industry or in the field (49). The NSSC1 fellows were mentored by 42 faculty co-PIs and over 120 national laboratory mentors. They presented more than 500 oral presentations and 315 posters, published 164 peer-reviewed publications, and received over 100 awards and honors. NSSC1 co-organized 22 summer schools, serving over 400 students with participation by more than 22 faculty, 9 researchers and over 180 national laboratory scientists.

Our team won again! A new $25 million grant from the DOE National Nuclear Security Administration was awarded in 2016 to UC Berkeley-lead consortium including eight universities (UCB, MSU, UTK, UNLV, UCD, UCI, GWU, and TAMU), and five national laboratories (LBNL, LLNL, LANL, SNL and ORNL).
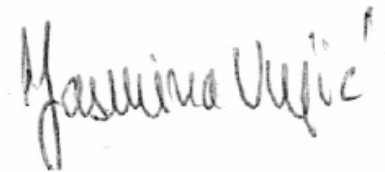
The NSSC2 (2016-2021) will carry out R&D in four technical areas: nuclear and particle physics, radiochemistry and forensics, nuclear engineering, and nuclear instrumentation and radiation detection. Linking these R&D areas are four crosscutting disciplines: nuclear data, modeling and simulation, nuclear security policy, and education and training. Together they provide a framework that yields new ideas, technology development, and personnel with the integrated capabilities required for the nuclear security mission. NSSC2 leverages significant resources from the previous consortium (NSSC1) and other past federal funding by building upon existing administrative processes, academic-lab relationships, and experience that enables effective management of a large multi-institutional collaboration.

The new NSSC continues our end-to-end approach to motivate and mentor talented women and men in critical NNSA mission areas, from recruitment at all levels to early career phases. At the input end of the pipeline, promising and interested undergraduate and graduate students are exposed to nuclear security. Undergraduate research assistants, graduate student fellows, and postdoctoral scholars engage in basic science research and technology development relevant to the nuclear security mission. Through research internships, scholarships and fellowships, workshops and summer schools, a broad and diverse student population is trained in a wide range of technical areas essential for the nuclear security professional. The 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. To round out the experience of our NSSC students, education in nuclear security policy complements the scientific and technical training, providing students with the tools to contribute to the nonproliferation mission immediately upon graduation and accede to leadership positions while still early in their careers.

In order to enhance our connectivity with the labs, with an emphasis on LANL, during Summer 2017 NSSC2 co-organized the 8-week NSSC-LANL Keepin Nonproliferation Science Summer program. It provided students with the opportunity to engage deeply in research, under the guidance of lab staff scientists, on projects supporting the NNSA mission.

At the end of its first year, NSSC2 supports 22 undergraduate students, 58 graduate fellows, 10 postdocs, 29 affiliates and 4 specialists. The NSSC2 fellows are advised by 38 faculty members and 75 laboratory mentors. All NSSC2 graduate fellows are required to have national laboratory mentors. Currently 66 students and postdocs are conducting research in one of the collaborating national laboratories, and 52 students and postdocs are working on laboratory directed projects.

Jasmina Vujic
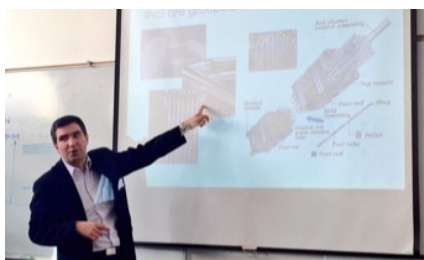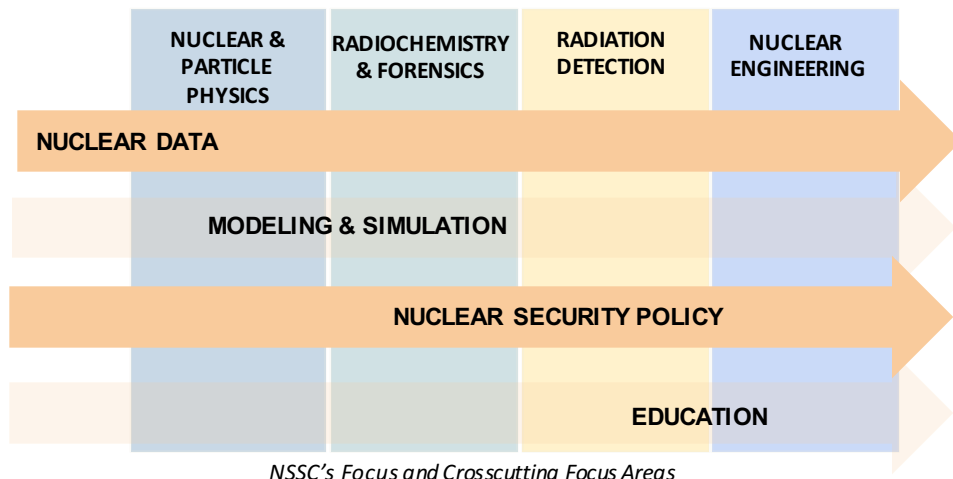
Prof. Jasmina Vujic, NSSC Program Director

PROFILES
of NSSC's Focus and Crosscutting Focus Area Leads

Barbara Jacak serves as the **Nuclear & Particle Physics Focus Area** Lead of the Nuclear Science and Security Consortium. Jacak is also the Director of the New Science Division at Lawrence Berkeley National Lab, as well as a Faculty Senior Scientist, and a Professor of Physics at UC Berkeley. Her research focus is on the experimental study of quark gluon plasma.

Ken Czerwinski leads the **Radiochemistry and Forensics Focus Area**. Czerwinski is a Professor of Radiochemistry at the University of Nevada, Las Vegas. His research focus is chemistry and properties of actinides and technetium compounds, as well as routes for radioelement compound synthesis and characterization techniques to identify forensics signatures.

Max Fratoni is **the Nuclear Engineering Focus Area** Lead, and an Assistant Professor of Nuclear Engineering at the University of California, Berkeley. Fratoni's research interests are advanced fuel cycles that maximize natural resource utilization and minimize nuclear waste enabling sustainable nuclear energy. His main focus is on the design and analysis of advanced reactors such as molten salt reactors, fast spectrum reactors, reduced-moderation boiling water reactors, and fluoride-cooled high-temperature reactors. Prof. Fratoni's group also develops computational methods to support reactor analysis, and in particular multi-physics modeling and uncertainty quantification.

Kai Vetter leads the **Radiation Detection Focus Area.** Vetter is a Professor of Nuclear Engineering at the University of California, Berkeley, who also serves as the NNSA Liaison for NSSC. Professor Vetter's research interests include fundamental physics, biomedical imaging and homeland security. He also heads the Applied Nuclear Physics program at Lawrence Berkeley National Laboratory. This program involves many aspects of radiation detection including the detector fabrication, readout, integration and signal processing. Professor Vetter is the Director of the Institute for Resilient Communities. He also serves as a supervising Professor and Professor-in-Residence for Berkeley RadWatch.

NUCLEAR & PARTICLE PHYSICS	RADIOCHEMISTRY & FORENSICS	RADIATION DETECTION	NUCLEAR ENGINEERING
NUCLEAR DATA			
MODELING & SIMULATION			
NUCLEAR SECURITY POLICY			
		EDUCATION	

NSSC's Focus and Crosscutting Focus Areas

Professor Fratoni introduces the nuclear fuel cycle.

Professor Vetter discussing aerial radiation detection system with NSSC Students, Tenzing Joshi and Andrew Haefner. (Photo by LBNL)

Lee Bernstein is the **Nuclear Data Focus Area** Lead, the Nuclear Data Group Leader at Lawrence Berkeley National Laboratory, and an Adjunct Professor in Nuclear Engineering at UC Berkeley. His group performs nuclear data evaluation and measurements in support of basic and applied nuclear science as a part of the US Nuclear Data Program and the Nuclear Structure and Decay Data Network of the IAEA. The group is working on topics including neutron capture and inelastic scattering, the measurement of medical isotope production cross sections, and measuring the properties of excited nuclear states including level densities and radiative strength functions

Jasmina Vujic, NSSC Program Director, now serves as the acting **Modeling and Simulation Crosscutting Focus Area** Lead. Professor Vujic also serves as the co-director of the Berkeley Nuclear Research Center. Her research interests include development of advanced numerical methods for the neutronic analysis of nuclear reactors, radiation shielding, and medical applications of radiation; neutron and photon transport theory; reactor core design and analysis; optimization technique for vector and parallel computing systems.

Michael Nacht leads **the Nuclear Security Policy Crosscutting Focus Area**, and is a Professor of Public Policy at the Goldman School at UC 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. His research is on the future of strategic nuclear forces and nuclear security initiatives, the future of INF Treaty, China's nuclear weapons as part of its regional strategy, cyber security and cross domain deterrence, and economic sanctions as a counter-proliferation tool.

Bethany Goldblum leads the **Education Crosscutting Focus Area** and serves as the NSSC's Scientific Director. Dr. 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. Her research interests include the interface between nuclear science and policy, and developing policy solutions to strengthen global nuclear security.

2017 RESEARCH HIGHLIGHTS
from NSSC Fellows
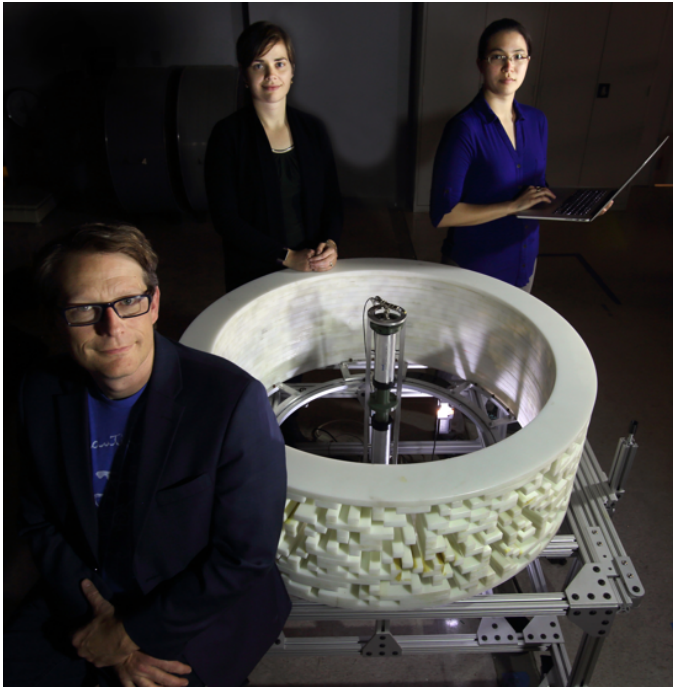
REBECCA KRENTZ-WEE
NSSC GRADUATE FELLOW
AT THE UNIVERSITY OF CALIFORNIA, BERKELEY
Academic Advisor: Kai Vetter
Lab Mentors: Peter Marleau (SNL)

Rebecca Krentz-Wee (UCB) is working with Peter Marleau (Sandia National Labs) and Patricia Schuster (University of Michigan) on a new method for verifying warheads. Commonly procedures for warhead verification include confirming key technical attributes, but this procedure may reveal critical, and secret, design information. Krentz-Wee's new method, called CONFIDANTE, for CONfirmation using a Fast-neutron Imaging Detector with Anti-image Null-positive Time Encoding, could help address the problem of conducting verification measurements while simultaneously protecting sensitive design information. CONFIDANTE allows the monitoring party to conduct the measurement in real time without accessing sensitive design data.

(left) Sandia National Laboratories researchers, left to right, Peter Marleau, Patricia Schuster (NSSC Alum) and Rebecca Krentz-Wee (NSSC Fellow) have developed a new method for verifying warhead attributes (Photo by Dino Vournas)

CORDELL DELZER
NSSC GRADUATE FELLOW
AT THE UNIVERSITY OF TENNESSEE, KNOXVILLE
Academic Advisor: Jason Hayward
Lab Mentor: Steve Payne (LLNL)

Cordell Delzer is investigating the non-proportionality of scintillation crystals and ceramics. This includes growing and pressing ceramics and also characterizing these and other scintillators with the goal of developing a better understanding of non-proportionality and its effect on improving the energy resolution of scintillation detectors. As part of this work, he has spent time working at both Oak Ridge National Lab and Lawrence Livermore National Lab. During his time at ORNL, he worked on developing methods for producing transparent ceramic scintillators from both Cesium Iodide and Strontium Iodide. During Delzer's time at LLNL he worked with the Scintillation Light Yield Characterization Instrument (SLYNCI), both testing the crystals grown at the University of Tennessee and working on the analysis code in order to obtain better data for crystals at low energies even if these scintillators have low light yield.

(right) Cordell Delzer loads a compaction die in preparation for hot gamma pressing a ceramic scintillator at Oak Ridge National Laboratory.
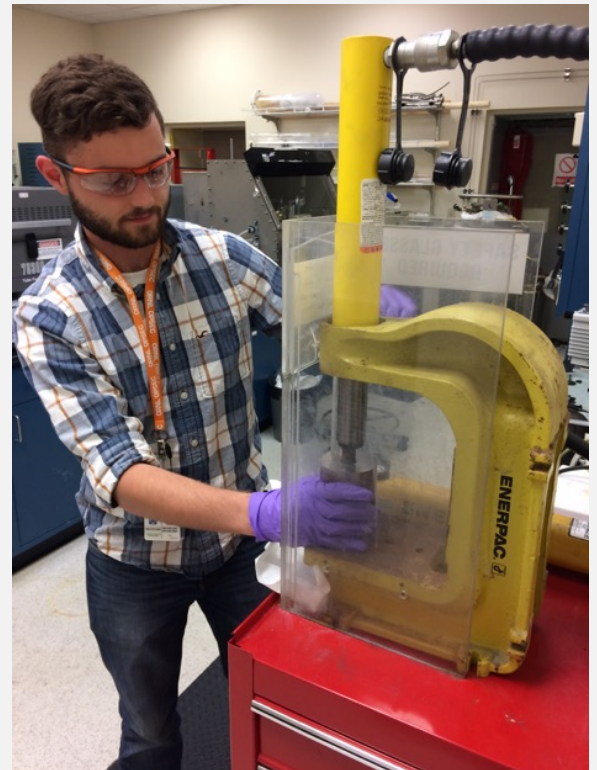
AMBER HENNESSEY
NSSC GRADUATE FELLOW AT THE UNIVERSITY OF CALIFORNIA, IRVINE
Academic Advisor: A.J. Shaka
Lab Mentor: Nicholas Scielzo (LLNL)

The goal of Amber Hennessey's Ph.D. research is to develop and test a new approach to precisely determine the γ-ray branching ratios (to about ~1% uncertainty) of long-lived radioactive nuclei that are of importance in fission environments. The measurements will take advantage of recent advances in radioactive ion beam facilities such as CARIBU (at Argonne National Laboratory) to collect isotopically pure samples on ultra-thin carbon foils. The beta particles, internal conversion electrons, and γ-rays from each sample are simulated in GEANT4 and detected using a specialized 4π beta-particle detector and a high precision high-purity germanium detector (HPGe). This research effort is in collaboration with the University of California Irvine, Lawrence Livermore National Laboratory, Texas A&M, and Argonne National Laboratory.

DANIEL HELLFELD
NSSC GRADUATE FELLOW AT THE UNIVERSITY OF CALIFORNIA, BERKELEY
Academic Advisor: Kai Vetter
Lab Mentors: Paul Barton (LBNL), Lucian Mihailescu (LBNL), Don Gunter (LBNL), Steven Dazeley (LLNL)

Daniel is working with Lawrence Berkeley National Laboratory on the development of a hand-held omnidirectional CdZnTe-based spherical active coded aperture gamma-ray imaging system. With contextual sensors and computer vision techniques, the system can simultaneously map the surrounding environment in 3D and track its path through the scene. The 3D scene model can be fused with the 3D gamma-ray image to provide visual context to the user as well as to constrain the image reconstruction. Hellfeld's work focuses on the coded aperture modality, specifically investigating the capability of free-moving 3D imaging in real-time. This centers around algorithm and software development as well as system design, integration, and testing.

KRYSTIN STIEFEL
NSSC GRADUATE FELLOW AT MICHIGAN STATE UNIVERSITY
Academic Advisor: Dave Morrissey and Sean Liddick
Lab Mentor: Shea Mosby (LANL)

Projectile fragmentation reactions have been described as a two-step process in which the fast collision creates an excited precursor fragment, which then undergoes a slower de-excitation process to result in a final fragment. Though measurements have been made of the production of the final projectile fragments, the specifics of the production mechanism are not well understood. New coincident measurements of the fragment and neutron distributions can provide insight into the projectile fragmentation process. From another standpoint, calculations using the Constrained Molecular Dynamics (CoMD) model have shown that the N/Z ratio of residue fragments and neutron emission from projectile fragmentation reactions are sensitive to the form of the symmetry energy, a term within the nuclear equation of state. Determining the form of the symmetry energy remains a major objective in understanding properties of neutron-rich nuclear matter. In order to understand the projectile fragmentation process and constrain the symmetry energy using the N/Z ratio observable, an experiment was performed at the NSCL. Beams of ^{30}S and ^{40}S impinged on ^{9}Be targets. Resulting heavy residue fragments were measured in coincidence with fast neutrons using the MoNA-LISA and Sweeper magnet detectors. The multiplicity of neutrons in coincidence with fragments from carbon (Z = 6) to sodium (Z = 11) were obtained and will be compared to theoretical models to probe the fragmentation production mechanism and constrain the symmetry energy term.

*(above) Krystin Stiefel with the MoNA detector*

This work is done with the help of the MoNA Collaboration, a group of faculty, staff, and student scientists. The collaboration draws on the knowledge and skills of members and former members to perform and analyze experiments run with the MoNA-LISA and Sweeper set-up. Shea Mosby, a former MoNA graduate student and current staff scientist at Los Alamos National Laboratory, has provided his expertise on performing fragment separation and identification on this project

ALEX DOMBOS
NSSC GRADUATE FELLOW
AT MICHIGAN STATE UNIVERSITY
Academic Advisor: Artemis Spyrou
Lab Mentors: Toshihiko Kawano, Matthew Mumpower (LANL)
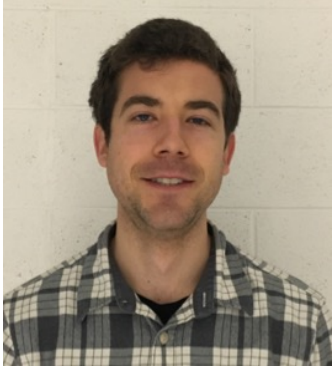
Accurate modelling of the astrophysical r-process requires knowledge of properties related to fission, including fission rates and fragment mass distributions. The fission fragment mass distribution and prompt neutron emission of the excited, nascent fragments are difficult to explore experimentally for the neutron-rich nuclei relevant to the r-process, and therefore accurate modelling of these physical quantities is crucial. Alex Dombos worked with Matthew Mumpower at Los Alamos National Laboratory (LANL) over the
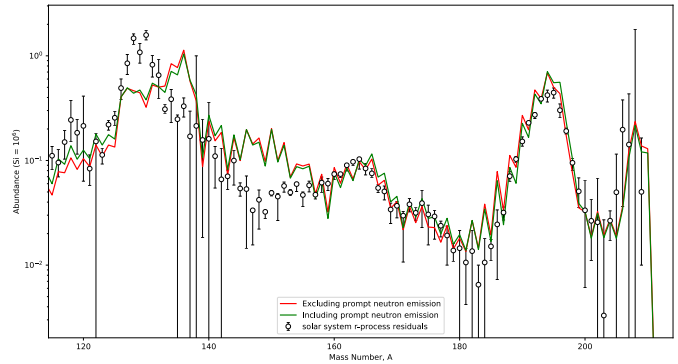
(Above) plot showing solar system r-process residuals and two theory calculations using the reaction network PRISM.

summer as part of the NSSC-LANL Nonproliferation Science Summer Program. Dombos performed research in the area of fission, specifically studying how fission impacts the final abundance pattern of the r-process. After studying different models that describe the fragment mass distribution and prompt neutron emission from the fragments, he implemented these models into the r-process reaction network PRISM (portable routines for integrated nucleosynthesis modeling) to investigate what impact they have on the final abundance pattern. This project will be continued and expanded upon by the FIRE (fission in r-process elements) collaboration, which uses state-of-the-art theory to explore the role of fission in the r-process, and includes scientists from the University of Notre Dame, North Carolina State University, Los Alamos National Laboratory, Brookhaven National Laboratory, and Lawrence Livermore National Laboratory.

(Above) Kevin Glennon working on plutonium separations in the glovebox.
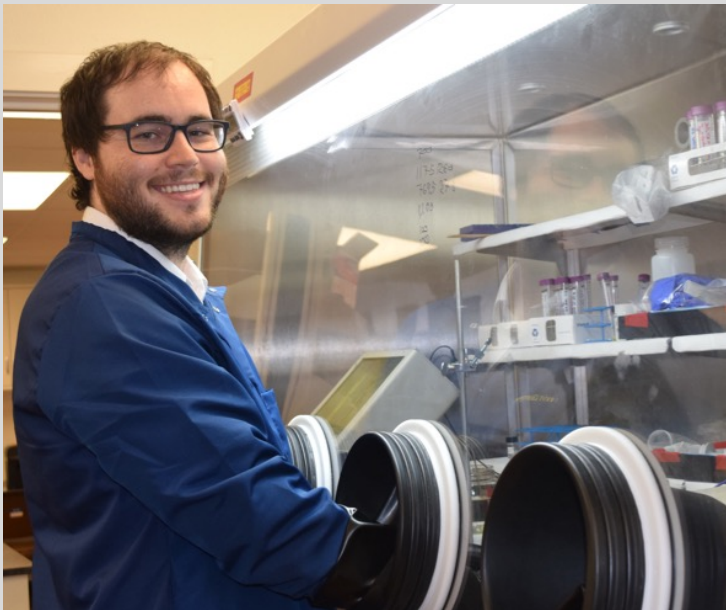
KEVIN GLENNON
NSSC GRADUATE FELLOW
AT TEXAS A&M UNIVERSITY
Academic Advisor: Charles Folden
Lab Mentor: Ken Moody (LLNL)

^{239}Pu is a fissile nucleus which may be used to make a nuclear weapon. It is produced as a byproduct of uranium irradiation inside a nuclear reactor alongside many other actinides and fission products (FPs). The distribution of these FPs depends upon multiple variables, including the burnup of the fuel, the neutron spectrum within the reactor, and the time since irradiation. Because of this dependency, measuring the FP:^{239}Pu ratios within a sample of intercepted weapons grade plutonium can teach us about the history of its irradiation. It is possible that any intercepted weapons grade plutonium may already be purified. If the decontamination factor (DF) of each FP was known, the original FP: ^{239}Pu ratios before purification could be determined. Unfortunately, this information is only available for very few FPs. Glennon's research investigates the most commonly used plutonium purification scheme, known as the PUREX process, to quantify the DFs of several key FPs. So far DFs for various radionuclides such as

^{241}Am, ^{144}Ce, ^{154,155}Eu, ^{125}Sb, ^{106}Ru, and ^{134,137}Cs have been measured by gamma spectrometry for some of the early steps of purification; ^{239}Pu extraction is monitored via alpha spectrometry and the DFs of various stable nuclei will be measured by mass spectrometry. This work is done using a sample of UO_2 that was irradiated in the High Flux Isotope Reactor at Oak Ridge National Laboratory.
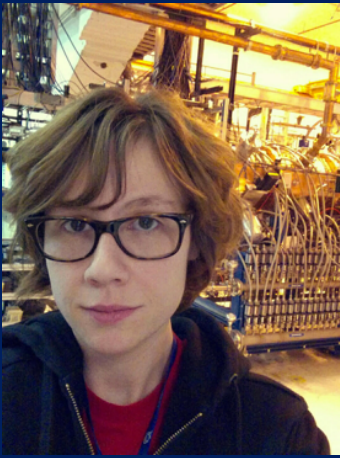
ELIZABETH HECKMAIER
NSSC AFFILIATE AT THE UNIVERSITY OF CALIFORNIA, IRVINE
Academic Advisor: A.J. Shaka
Lab Mentor: Nicholas Scielzo (LLNL)

Elizabeth Heckmaier's research focus is beta spectrum analysis of short-lived fission products to probe the reactor antineutrino anomaly, detector simulations, and calibration/construction of a new beta spectroscopy detector array at Argonne National Laboratory's CARIBU facility. Improved nuclear data and a better understanding of antineutrino spectra can be applied to reactor fuel composition monitoring for non-proliferation and treaty verification purposes. Elizabeth is mentored by Dr. Nicholas Scielzo at Lawrence Livermore National Laboratory and collaborates with affiliated research groups at Argonne National Laboratory.

(left) Elizabeth with a ATLAS accelerator Radio Frequency Quadrupoles at Argonne National Laboratory

KATHERINE THORNOCK
NSSC GRADUATE FELLOW AT THE UNIVERSITY OF NEVADA, LAS VEGAS
Academic Advisor: Ken Czerwinski
Lab Mentor: Robert Rundberg (LANL)

Katherine Thornock researched the Application of Silicon Drift Detector to Nuclear Forensics as part of the NSSC-LANL Keepin Nonproliferation Summer Program. Silicon drift detectors are an emerging category of semiconductor detectors capable of measuring x-ray photons. They are uniquely capable of measuring x-rays in the fingerprint region below 18 keV. Silicon Drift Detectors measure gamma radiation and x-ray emission from nuclear and electron de-excitation. Thornock measured primarily x-rays emitted below 18 keV, a region inaccessible except for specialized detectors. Photons are emitted as x-rays when an excited electron returns to a lower energy state. Each transition emits an x-ray with characteristic energy. By analyzing the spectrum of x-ray peaks, it it possible to identify the element being measured. For some elements, including uranium, the relative frequency of each transition can indicate which isotopes are present in the sample because the transitions are representative of daughter products. This work was performed in residence at Los Alamos National Laboratory, under the direction of lab mentor Dr. Robert Rundberg. In addition to being able to work with an emerging instrument and make progress in nuclear forensics data, Katherine enjoyed meeting and working with the scientists in her group. She looks forward to continuing work on this project. [LA-UR- 17-27123]
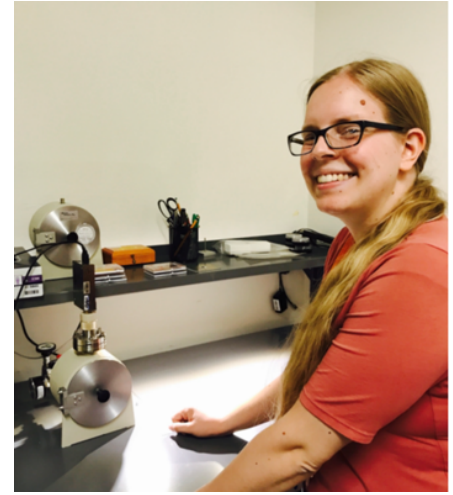
(above) Katherine Thornock using a silicon drift detector for X-ray spectroscopy at Los Alamos National Laboratory.
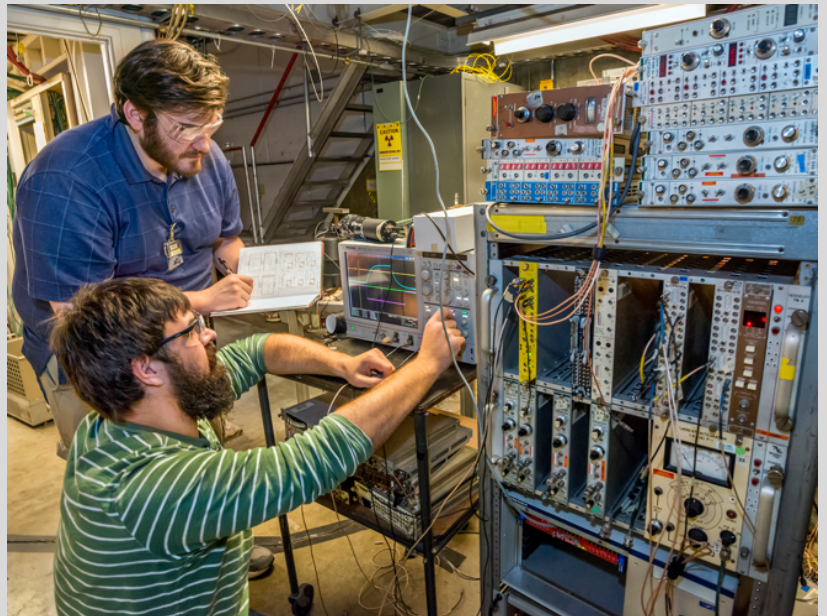
JOSH BROWN
NSSC GRADUATE FELLOW AT THE UNIVERSITY OF CALIFORNIA, BERKELEY
Academic Advisor: Jasmina Vujic
Lab Mentor: Erik Brubaker (SNL), David Reyna (SNL), Walid Younes (LLNL), Lee Bernstein (LBNL)

Josh Brown's dissertation research focuses on the development of a hardware and software platform for scintillator materials characterization. The work was initially motived by characterization of the scintillators used for neutron time-of-flight diagnostics at the National Ignition Facility, and has been conducted in collaboration with the Radiation and Nuclear Detection Systems Group based at Sandia National Lab's California site. Josh's primary focus is on the development of a double time of flight method for measuring proton light yield in organic scintillators. By exploiting a pulsed broad spectrum neutron source and a coincident detector array, Josh has demonstrated the ability to measure the proton light yield over a broad range of energies in a single setup. This quantity is of fundamental importance in considering neutron detection systems in simulation space, and in imaging reconstruction algorithms for scatter camera systems.

(Above) Josh Brown works with Brian Daub, a former NSSC Postdoc who is now a staff scientists at LLNL.

ROBERT FORCHA
NSSC FELLOW AT GEORGE WASHINGTON UNIVERSITY
ACADEMIC ADVISOR: Philippe Bardet
LAB MENTOR: Marianne M Francois (LANL)

Robert Forcha is an NSSC Fellow pursuing his PhD in Mechanical Engineering in the Thermo-Fluids Laboratory at The George Washington University under the advisement of Professor Philippe Bardet. He is working in collaboration with his National Laboratory Mentor, Dr. Marianne Francois, to experimentally validate new multi-physics fluid flow models being developed at Los Alamos National Laboratory (LANL). Robert's research is currently focused on the flow properties of buoyant turbulent jets in a linearly stratified density environment routinely encountered in nuclear reactors. While much literature exists on turbulent jets in uniform environments, very little is known about the behavior of buoyant jets in varying density fields. Using state of the art optical diagnostic instrumentation, both velocimetry and densitometry are simultaneously performed on a large cubic test section via particle image velocimetry (PIV) and planar laser induced fluorescence (PLIF). Flow behavior is recorded on multiple spatial and temporal scales spanning from hundreds of microns to meters and from tenths of Hertz to kilohertz, allowing for resolution of turbulent phenomena from the largest (integral) to the smallest (Kolmogorov) scales. The data gathered is then processed and analyzed in order to glean information about the flow physics and develop validation metrics for the LANL models.
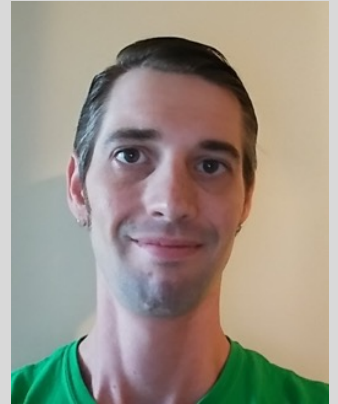
JAMES BEVINS
NSSC AFFILIATE AT THE UNIVERSITY OF CALIFORNIA, BERKELEY
ACADEMIC ADVSOR: Rachel Slaybaugh
LAB MENTOR: Lee Bernstein (LBNL), Bill Dunlop (LLNL)

James Bevins received his PhD from the Department of Nuclear Engineering at the University of California, Berkeley in August 2017. A Captain in the U.S. Air Force, James held a National Science Foundation Graduate Research Fellowship and was an NSSC Affiliate advised by Prof. Rachel Slaybaugh. His dissertation research focused on the design and fabrication of an energy tuning assembly for modification of the neutron spectrum at the National Ignition Facility at Lawrence Livermore National Laboratory for technical nuclear forensics applications. As a part of his thesis work, James also performed a proof of concept demonstration experiment at the 88-Inch Cyclotron at Lawrence Berkeley National Lab. As a graduate student, James minored in public policy and served as the Deputy Director of the Nuclear Policy Working Group. He accepted a professorship at the Air Force Institute of Technology upon completion of his degree.

TEAL PERSHING
NSSC AFFILIATE AT THE UNIVERSITY OF CALIFORNIA, DAVIS
ACADEMIC ADVISOR: Robert Svoboda
LAB MENTOR: Adam Bernstein (LLNL), Marc Bergevin (LLNL), Steven Dazeley (LLNL)

Teal Pershing is a Ph.D. candidate in Physics at University of California, Davis. Teal is a member of the SNO+ and the WATCHMAN experimental collaborations. The SNO+ experiment is a liquid scintillator detector that will attempt to measure the neutrinoless double-beta decay of Tellurium-130. For SNO+, Teal maintains the slow control monitoring systems, contributes to data cleaning cut optimization, and performs neutron activation analysis for the scintillator cocktail R&D group. The WATCHMAN demonstration is a proposed kiloton scale gadolinium-doped water Cherenkov detector. WATCHMAN would be capable of monitoring operational power reactors from remote standoffs. The state of an operational reactor can be determined from a distance by measuring the reactor's emitted antineutrino flux. Teal works with the WATCHMAN collaborators at LLNL to study the detector's sensitivity to reactor antineutrino signals at currently proposed deployment location

(above) Teal replacing PMTs in the SNO+ detector during commissioning

NSSC EVENTS

NSSC KICKS OFF SECOND ROUND OF FUNDING WITH ENGAGEMENT WORKSHOP

In early September 2016 representatives from the Nuclear Science and Security Consortium's partner schools and labs as well as the NNSA convened in Berkeley, California to delve into NSSC's research focus areas, and discuss plans for collaboration among partners in the next phase of the consortium. The workshop concluded at LLNL with presentations on lab research and projects, a reception and poster session, where workshop attendees were joined by lab personnel and NSSC students from UC Berkeley and UC Davis.

22ND TECHNICAL MEETING OF THE NSDD

The meeting of the Nuclear Structure and Decay Data Network of the International Atomic Energy Agency was held at the Lawrence Berkeley National Laboratory from May 22nd – 26, 2017. Professor Lee Bernstein, NSSC's Director for Laboratories, was the host for this event. The meeting featured reporting from data centers, committee sessions, and demos of codes. NSSC Fellows, Affiliates, and Collaborators were able to participate in the technical meeting.

ALL TIME HIGHEST ENROLLMENT FOR NUCLEAR SECURITY COURSE

Nuclear Security: The Nexus Between Policy and Technology was held in the Spring 2017 semester for the sixth year. The course was co-taught by Professor van Bibber of the UC Berkeley Nuclear Engineering Department, and Professor Michael Nacht, of the UC Berkeley Public Policy Department. A record high number of students completed the course, 40 in total. Students came from both technical and policy backgrounds.

The course included topics such as Origins of Nuclear Energy, Nuclear Weapons and the Cold War, types of Nuclear Reactions and Basics of Reactor Physics and Design. Guest lecturers included Brad Roberts of LLNL, Sheryl Hingorani of SNL, and George Moore of James Martin Center for Nonproliferation Studies.

Each class was broadcast live to all consortium partners, and videos are hosted on the NSSC's website.

A textbook covering course content, co-authored by Michael Nacht, Michael Frank, and Stanley Prussin is planned to be published, with a first draft anticipated by the end of 2017.

WEBINAR SERIES BROADCAST CONSORTIUM-WIDE

NSSC continued its series of webinars presented to NSSC Fellows by National Laboratory Scientists. Representatives from SNL, LLNL, and LBNL all presented during the first year of NSSC2. Webinars were attended by local students, and broadcast live to all consortium partners.
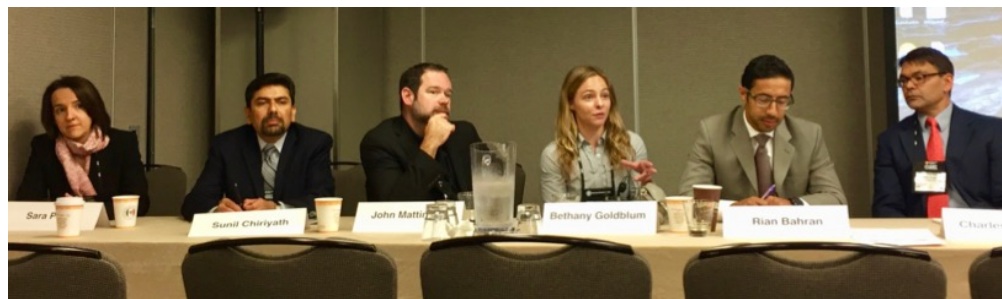
(above) NSSC Fellow, Eric Matthews prepares to lead a crisis simulation as part of the Nuclear Security: The Nexus between Policy and Technology course. The simulation dealt with the negotiation of the JCPOA.

One highlight of this year's webinar series was Dr. Cameron Geddes talk on "Compact quasi-monoenergetic photon applications and sources for nuclear applications". A student in attendance was hired on by Dr. Geddes at LBNL to support this project as a NSSC Undergraduate.

NSSC PERSONNEL ON PANEL DURING AMERICAN NUCLEAR SOCIETY MEETING 2017

NSSC Faculty and Staff were in attendance for this year's American Nuclear Society Meeting, held in San Francisco. Bethany Goldblum, the Scientific Director of the NSSC, and Rian Bahran, the main point of contact between LANL and NSSC, were part of a panel discussion on "Establishing and Advancing Nonproliferation and Nuclear Policy Education at U.S. Nuclear Science and Engineering Programs". NSSC programming was discussed, with the NSSC-LANL Keepin Nonproliferation Science Summer Program highlighted. This panel was featured in the August 2017 edition of the ANS Nuclear News.

Stephan Friedrich presenting on LLNL Research in Nuclear Physics & Radiation Detection during the September 2016 Workshop.

Bethany Goldblum and Rian Bahran speaking on a panel during the American Nuclear Society 2017 meeting on "Establishing and Advancing Nonproliferation and Nuclear Policy Education at U.S. Nuclear Science and Engineering Programs".

NSSC SUMMER SCHOOLS 2017

NSSC-LANL Keepin Nonproliferation Science Summer Program Participant, UCB student Emily Frame performing neutron measurements with special nuclear material as part of an active interrogation project funded by NA-22 [LA-UR-17-26292]

NSSC-LANL KEEPIN NONPROLIFERATION SCIENCE SUMMER PROGRAM
June 20 – August 11, 2017 | Los Alamos, NM

During Summer 2017 NSSC held the first ever NSSC-LANL Keepin Nonproliferation Science Summer Program. This program was a fellowship requirement for all NSSC Fellows who had not yet attended any of the NSSC Summer Programs. Twelve NSSC Fellows were matched with lab mentors and research projects at Los Alamos National Laboratory. The mentor matching process involved NSSC and LANL staff as well as the student's academic advisors to ensure the research project would complement the student's interests. The program lasted eight weeks, with an additional optional week on non-destructive assay (NDA) measurement techniques that are used for nuclear material accountancy by the International Atomic Energy Agency (IAEA). Students spent 80% of their time conducting research in the lab, and the remaining 20% of their time in enrichment activities such as lectures from experts in the field, and tours of the facilities at LANL and SNL.

> "I really enjoyed the breadth of the program. It was very clear to me that a lot of effort was put into choosing speakers, facilitating tours, and orchestrating the whole program. As far as exposure to the nonproliferation mission and the science supporting it, this program was excellent."
> - NSSC-LANL Summer Program Participant

16 OUT OF 17 STUDENTS SURVEYED PLAN TO CONTINUE WORKING WITH LOS ALAMOS NATIONAL LABORATORY.

(Above) Dr. Alexis Trahan (NEN-1) LANL Staff Scientist and UCB graduate presenting a lecture on Fuel Cycle and Verification.

(Left) Students participating in an outdoor source search exercise at Sandia National Laboratory.

PUBLIC POLICY AND NUCLEAR THREATS BOOT CAMP
July 13–25, 2017 | San Diego, CA

The summer workshop-in-residence at UC San Diego, known as the PPNT boot camp, was held at UC San Diego. This boot camp was designed to give participants the knowledge and analytic tools to contribute to the debate on future US nuclear policy.

This year's boot camp featured lectures, discussions, debates, and policy simulations. Participants attended 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.

(Top Right) NSSC Affiliate, UCB student Andrew Reddie, at PPNT 2017.
(Bottom Right) PPNT Director, Bethany Goldblum talking with Major General Robert Wheeler.

SHORT COURSE ON NUCLEAR WEAPONS AND RELATED SECURITY ISSUES
April 21-22, 2017 | Washington, DC

Technical workshop co-hosted by NSSC at George Washington University. Topics included strategic nuclear weapons, multilateral arms control, nuclear proliferation, and terrorism.

NUCLEAR INNOVATION BOOT CAMP
July 16 – 29, 2017 | Berkeley, CA

The Nuclear Innovation Boot Camp, now in it's second year at UC Berkeley, focuses around the idea that to expand the ability to improve the environment and global health, a new level of innovation in Nuclear Energy is needed. The Bootcamp trains the next generation of students in developing and executing ideas that work in the world by providing them the tools to make a real impact.

(Above) NSSC Affiliate, Mitch Negus, presenting at the conclusion of the Nuclear Innovation Bootcamp.

NUCLEAR ANALYTICAL TECHNIQUES SUMMER SCHOOL
August 13–19, 2017 | Davis, CA

The NAT 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.

BASICS OF NUCLEAR REACTOR OPERATIONS
July 10-21, 2017 | Irvine, CA

The Basics of Nuclear Reactor Operations Summer Program provides participants with the theoretical and practical training needed to obtain a Nuclear Regulatory Commission (NRC) Reactor Operator's license. This summer a 2-day crash course in nuclear basics held on July 6-7 for those participants who had no previous training or courses.

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NSSC AWARDS AND HONORS

Daniel Hellfeld (UCB) awarded "Best Oral Presentation"

Cordell Delzer (UTK) awarded "Best Poster"

Josh Brown (UCB) awarded "Best National Laboratory Collaboration"

UNIVERSITY & INDUSTRY TECHNICAL INTERCHANGE PROGRAM & TECHNICAL REVIEW MEETING 2016

Ross Barnowski (UCB) awarded "Best Oral Presentation"

James Bevins (UCB) awarded "Best Oral Presentation"

Nick Walsh (UCD) awarded "Best Poster Presentation"

AWARD HIGHIGHTS FROM NSSC2 STUDENTS AND POSTDOCS

Austin Wright	UCB	2017 DOE DNN R&D Network Science and Nuclear Nonproliferation Challenge
Eric Matthews	UCB	Christopher Wootton Award, May 2017.
Kelly Kmak	UCB	Glen T. Seaborg Award for Outstanding Undergraduate Research in Chemistry, May 2017.
Issac Meyer	UCB	Podium Presentation: Best in Fusion Energy Track at 2017 ANS Student Conference.
Michael Martin	UCB	Innovation in Nuclear Technology R&D 2017
Natalie Johns	UNLV	UNLV Office of Undergraduate Research Award, August 2017.
Robyn Collette, Daniel Rutstrom	UTK	Awarded 1st Place in the AACG-SE Graduate Student poster contest. November 2016.
Jason Richards	UNLV	First Place Innovations in Nuclear Technology R&D Award, DOE-NE, May 2017.
Jason Matheny	UTK	Top Junior Academic Award, UTK, April 2017

(Above) Dr. Marco Dicapua, DOE/NNSA/DNN Chief Scientist presenting Josh Brown with the award for Best National Laboratory Collaboration at the University Program Review, 2017.

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THE NSSC2 COMMUNITY

22 Undergraduate Students
58 Graduate Fellows
38 Faculty Members
10 Postdocs
29 Affiliates
4 Specialists
And 75 Lab Mentors
From **Eight** Universities and
Five National Laboratories

NSSC2 METRICS
Year 1 of the NSSC2
September 2016 – August 2017

THE FELLOWSHIP EXPERIENCE
EVERY NSSC GRADUATE FELLOW HAS
- AN ACADEMIC ADVISOR
- A LAB MENTOR
- A FOCUS AREA THEY CONDUCT RESEARCH UNDER

TO SUPPORT FUTURE CAREERS AT
THE NATIONAL LABORATORIES

FELLOWS PER FOCUS AREA

- ■ Radiation Detection & Instrumentation
- ■ Nuclear & Particle Physics
- ■ Nuclear Chemistry & Forensics
- ■ Nuclear Engineering

8%
18%
31%
43%
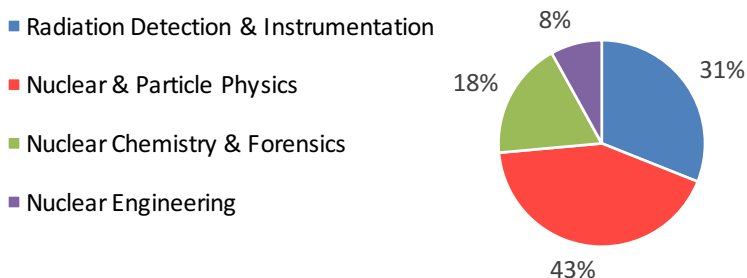
September 2016 – August 2017

100% of Graduate Fellows have a Lab Mentor

66 students or postdocs are conducting research in a National Laboratory

52 students or postdocs are working on a Lab Directed Project

NSSC FELLOWS & AFFILIATES CONDUCTING IN-RESIDENCE RESEARCH*

	LBNL	LLNL	SNL	LANL	ORNL	Other
UCB	27	9	2	7	1	1
UCD	0	4	1	0	0	1
UCI	0	2	1	0	0	1
UNLV	0	1	0	3	0	1
MSU	0	0	0	3	0	6
TAMU	0	0	0	0	0	0
GWU	0	0	0	0	0	0
UTK	0	0	0	3	7	0
Total	27	16	4	16	8	10

*In-Residence is defined as being physically present at a partner national laboratory for research related purposes
(If a student is conducting research at more than one lab, they are counted for each lab.)

(above) Mark Quint, NSSC Fellow from UTK, working with the GeGI (Germanium Gamma-ray Imager) and taking measurements at ORNL.

16 Awards	36 Peer-Reviewed Publications	46 Posters	62 Oral Presentations

THE NSSC2 PIPELINE

WHERE DO NSSC FELLOWS GO AFTER COMPLETING THE PROGRAM? HOW DID NSSC HELP THEM GET THERE?

The second phase of the consortium began in September 2016. Over the past year 13 degrees have been earned by NSSC Fellows. These Fellows have continued with their studies in graduate school, or found work in the national labs, national security related industry, or academia.

PIPELINE HIGHLIGHT: ERIC MATTHEWS
NSSC UNDERGRADUATE TO NSSC GRADUATE FELLOW AT UC BERKELEY

"During my time as an undergraduate, both my research and academic careers benefitted from the experiences and opportunities the NSSC provided to me. Not only did the NSSC help strengthen my résumé, but my fellowship also trained me to be a better academic and researcher.

My research on delayed gamma rays through the development of the Fission Induced Electromagnetic Response (FIER) code was substantially augmented by my relationship with the NSSC. With the mentorship of advisors at LBNL, I worked to produce a code that will serve as a useful tool to the nuclear science community. Then through an NSSC-facilitated collaboration with LLNL and PNNL I was able to compare FIER output to experimentally measured delayed gamma-ray spectra. These collaborations will produce a peer-review journal article with co-authors from all three of these national laboratories.

Because of the very positive influence the NSSC had on my undergraduate and post-graduate experiences, I'm very excited to continue with the NSSC as a graduate fellow. I look forward to the collaborations with national laboratories that the NSSC will be able to provide to me."

PIPELINE HIGHLIGHT: CHARLES LOELIUS
NSSC ALUMNUS FROM MICHIGAN STATE UNIVERSITY TO NNSA GRADUATE STUDENT FELLOWSHIP PROGRAM

" Being a part of the NSSC gave me the opportunity as a scientist to learn more about the history and policy that informs our nuclear deterrence and nuclear non-proliferation regime. I am glad to be able to put that education and support to use as I continue as an NGFP fellow in NA-143."

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NSSC

NSSC1 PIPELINE METRICS (2011-2016)

During the first phase of NSSC (2011-2016) 179 students and postdocs completed the program. Of these students 37 were hired for academic positions, 49 found work in industry or in the field, and 57 continued to Graduate School. 59 Fellows and Affiliates were hired at the National Laboratories. These students are highlighted below.

~33% of students and postdocs completing the NSSC program went on to positions at national labs and government!

NSSC1 FELLOWS AND AFFILIATES HIRED AT NATIONAL LABORATORIES & GOVERNMENT

UCB	9	2	3	13**	6***	33
UCD	1	0	1	3	0	5
UCI	0	0	0	0	1	1
UNLV	0	0	5	2	2	9
MSU	1	0	1	0	7	9
WUSTL	0	0	1	0	0	1
MSIs	0	0	0	0	1	1
Total*	11	2	11	18	17	59*

*Includes both postdoctoral and staff positions at the labs for NSSC fellows and affiliates; 13 affiliates
** Sherry Faye completed her postdoc at UCB, but is only counted towards UNLV in chart
*** Scott Suchyta completed his postdoc at UCB, but is only counted towards MSU in chart

NSSC1 FELLOWS AND AFFILIATES HIRED AT NATIONAL LABORATORIES & GOVERNMENT

Sherry Faye
PhD UNLV
Postdoc UCB
Postdoc | LLNL
Dec 2015
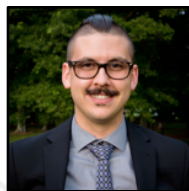
Joseph Curtis
M.S. UC Berkeley
Staff | LBNL
Dec 2014

Ross Barnowski
Masters NE | UCB
Postdoc | LBNL
Spring 2016

Jonathan Plaue*
PhD UNLV
Staff | LANL
Fall 2012

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

Deepa Khatri
B.Sc. UC Berkeley
Staff Engineer | LLNL
Nuclear Criticality Safety Division
Summer 2014

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

Quinn Looker
PhD UC Berkeley
Staff | SNL
Fall 2013

Anthony Lubbers
B.Sc. UC Berkeley
Staff Engineer | LLNL
Nuclear Criticality Safety Division
Summer 2014
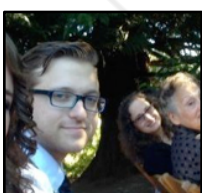
Ross Meyer
B.Sc. UC Berkeley
Staff, NSD | LBNL
Applied Nuclear Physics
Spring 2015

Andrew Haefner*
PhD UC Berkeley
Staff, NSD | LBNL
Applied Nuclear Physics
Spring 2015
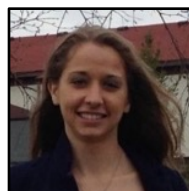
Kalee Hammerton
PhD | MSU
Staff | Savannah River
Spring 2016

NSSC

Marc Bergevin*
Postdoc UCD
Staff | LLNL
May 2015
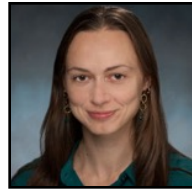
Tashi Parsons-Moss*
Postdoc UC Berkeley
Postdoc | LLNL
Nuclear & Chemical
Sciences Division
Fall 2014

Brian Plimley*
PhD UC Berkeley
Postdoc | LBNL
May 2014

Christopher Brand
B.S. UC Berkeley
Staff | LLNL
May 2015
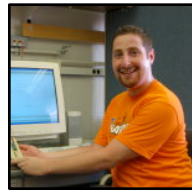
Perry Chodash*
PhD UC Berkeley
Postdoc | LLNL
Spring 2015

Jeremy Mock
PhD UC Davis
Postdoc | LBNL
Fall 2014

Caleb Roecker
PhD UC Berkeley
Staff | LANL
May 2016

Cameron Bates
PhD UC Berkeley
Postdoc | LANL
Fall 2014
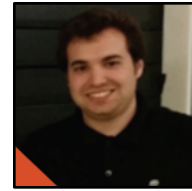
Michael Jones
PhD MSU
Postdoc | LBNL
Feb 2016

Keri Campbell
PhD UNLV
Postdoc | LANL
Fall 2014

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

Erika Suzuki
B.S. Political Science
Staff | LBNL
Dec 2013

Maryline Ferrier*
PhD UNLV
Postdoc | LANL
Fall 2014
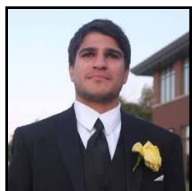
Tenzing Joshi*
PhD UC Berkeley
Postdoc, NSD | LBNL
Applied Nuclear Physics
Spring 2015

Tara Mastren
PhD WUSTL
Postdoc | LANL
2014

Timothy Shokair
Postdoc UC Berkeley
Postdoc | LLNL
Spring 2015

Sergey Uvarov
Masters | UCD
Postdoc | LLNL
Spring 2016

Barbara Wang
PhD UC Berkeley
Postdoc UC Berkeley
Postdoc | LLNL
Anticipated May 2016

Audrey Roman
PhD UNLV
Postdoc | LANL
Fall 2014
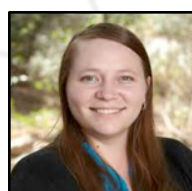
Janelle Droessler
PhD UNLV
Postdoc | LANL
Mar 2016

Daine Danielson
B.S. UC Davis
Intern | LANL
Summer 2014
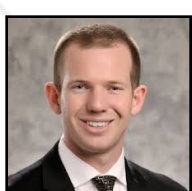
Matthew Proveaux
M.Sc. Nuclear Engr.
NNSA Fellow
Pacific Northwest NL
June 2014

Duane Smalley
Postdoc MSU
Staff | NSTec@LANL
Summer 2014
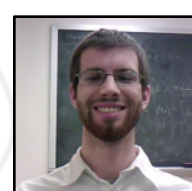
Jeromy Tompkins
Postdoc MSU
Staff | NSCL
Summer 2014

NSSC

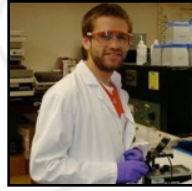Steven Ragnar Stroberg
PhD Michigan State
Postdoc | TRIUMF
2014

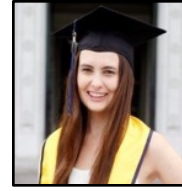Anagha Iyengar
B.S. UC Berkeley
May 2014
Staff | NNSA
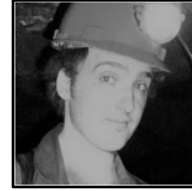
Keenan Thomas
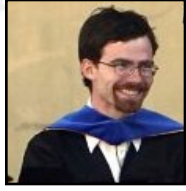Masters UCB
Staff | LLNL
Summer 2016

Jenna Smith
PhD Michigan State
Postdoc | TRIUMF
2014

Scott Suchyta
PhD MSU
Postdoc UCB
Staff | RSL
Apr 2016

Jessica Roche
B.S. Nuclear Engineering
Nuclear Ops. Engineer LLNL
Spring 2016

Tim Aucott*
PhD UC Berkeley
Staff | SRNL
December 2014

Ligang Bai*
Postdoc UNLV
Postdoc | ANL
May 2013

Nicole Larson
B.S. Nuclear Engineering
Nuclear Ops. Engineer
LLNL
Spring 2016

Paul Davis
Postdoc UC Berkeley
Fellow | DoD
Spring 2013

Nick Bricker
Masters UCB
Staff | LBNL
Summer 2016

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

Marissa Ramirez Zweiger*
B.S. UC Berkeley
Staff | ORNL
May 2015

David Weisz
PhD UCB
Postdoc LLNL
Summer 2016
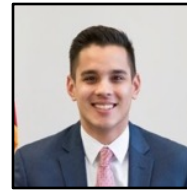
Anthony Juarez*
MPP | UCB
Staff | SNL
Spring 2016
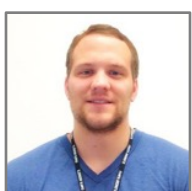
Alex Braatz*
PhD UCI
Postdoc | ORNL
2015

Uday Mehta
B.S. Nuclear Engineering
Nuclear Ops.
Engineer LLNL
Spring 2016
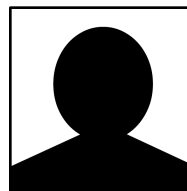
Christopher Prokop
PhD | MSU
Postdoc | LANL
Spring 2016

David Sweeney
Postdoc UC Berkeley
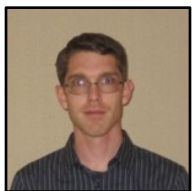Postdoc | DTRA
Fall 2015

Quinlan Smith
M.S. Physics
Research Associate
| 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
**NSSC2

*Affiliate

NSSC

MICHAEL JONES
Earned a Ph.D. in Nuclear Physics from Michigan State University in 2015. Michael now works as a Postdoctoral Research Associate at Lawrence Berkeley National Laboratory in the Nuclear Science Division.

ALEXANDER BRAATZ
Earned a Ph.D. in Chemical Engineering in 2015 from the University of California, Irvine. He then worked as a Postdoctoral Researcher at Oak Ridge National Laboratory, until February 2017 when he was hired by ORNL as a Radiochemist/Radiochemical Engineer.

KERI CAMPBELL
Earned a Ph.D. in Radiochemistry in 2015 from the University of Nevada, Las Vegas. Keri went on to work as a Postdoctoral Researcher at Los Alamos National Laboratory, where she works on LA-ICP-MS and LIBS analysis on a variety of materials.
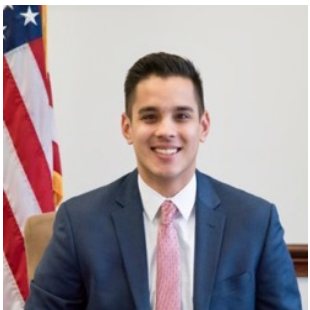
ANTHONY JUAREZ
Earned a Master of Public Policy from the University of California, Berkeley in 2016. While at Berkeley, Anthony worked as a student researcher at the Center for Global Security Research at LLNL, and as the Graduate Student Instructor for the NSSC Course, Nuclear Security: The Nexus between Policy and Technology. After graduation Anthony spent time as a NNSA Graduate Fellow. Anthony currently works at Sandia National Laboratories as a Systems Research Analyst.
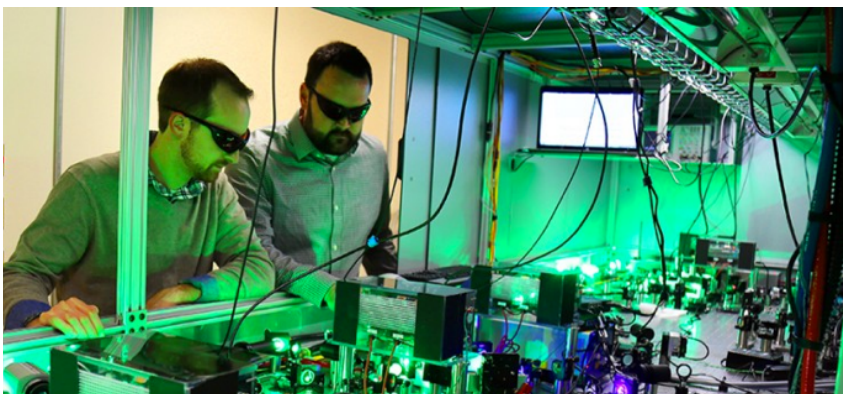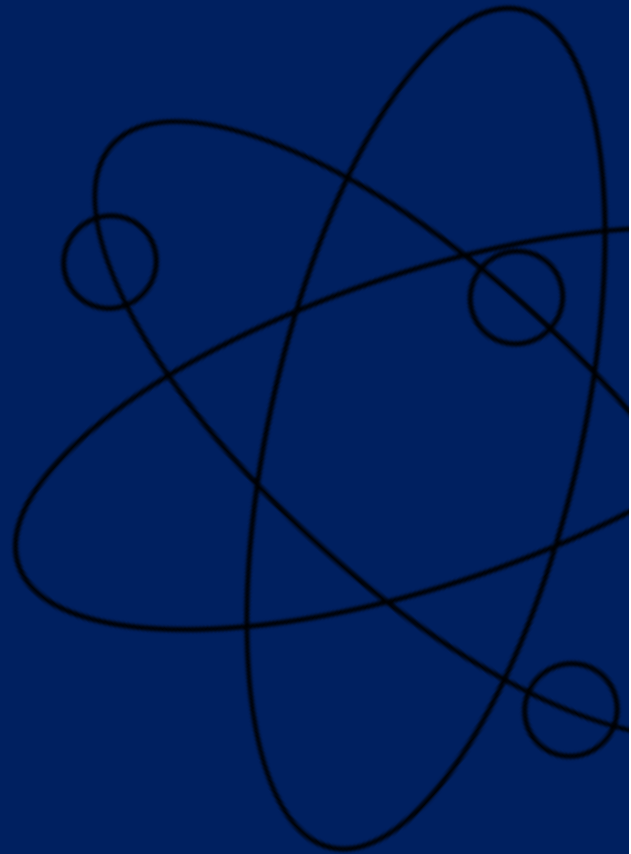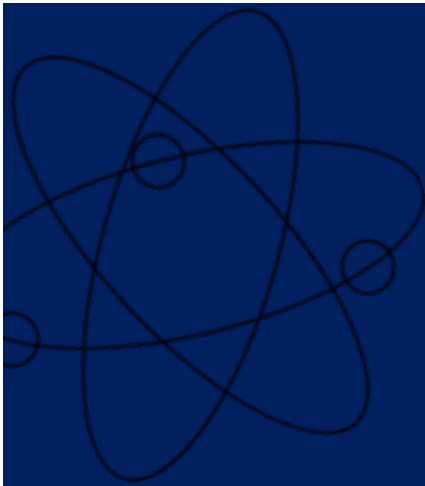
DAVID WEISZ
Earned a Ph.D. in Nuclear Engineering in 2016 from the University of California, Berkeley. David was hired in a post-doctoral position at Lawrence Livermore National Laboratory. David was the first recipient of the the Hutcheon Fellowship, awarded by the Department of Homeland Security, and named in honor of David's mentor, Dr. Ian Hutcheon.

Weisz on left. Photo by Carrie Martin/LLNL.

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GET IN TOUCH

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