



Educating the Next Generation of Nuclear Experts: the Nuclear Science and Security Consortium 10-Year Experience

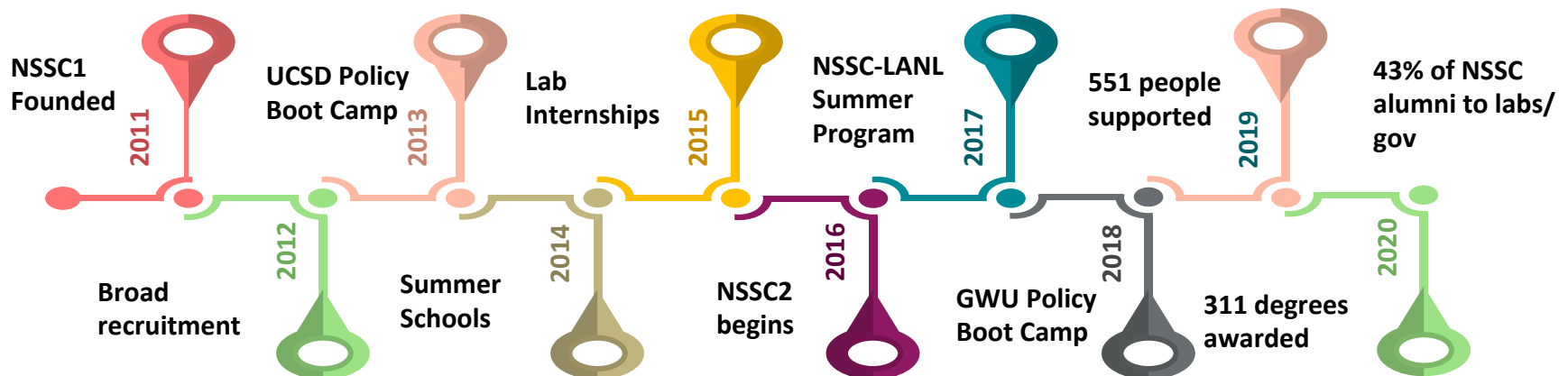
February 1, 2021

Jasmina Vujic and Bethany Goldblum
University of California, Berkeley
Lawrence Livermore National Laboratory

With an urgent goal to develop well rounded professionals with a working knowledge across all disciplines of nuclear science and security needed to meet its nuclear security mission, DOE/NSA NA-22 established the Nuclear Science and Security Consortium (NSSC) in 2011 and provided provided \$50 M over the 10-year period for E&R&D.

The NSSC's primary objectives are to:

- **recruit and train top students** in relevant nuclear disciplines,
- connect students with a **core set of disciplines** that support the nonproliferation and nuclear security mission, and
- **expand national laboratory collaboration** to provide students the opportunity to **engage deeply in research** under the guidance of lab staff scientists.



SUCCESS PIPELINE MODEL

- **Seven Universities Coordinating Coursework and Experience from Student to Scientist in a Partnership for Identifying and Preparing Educated Laboratory-Integrated Nuclear Experts**
- Start with a multidisciplinary team of experts from academia and national labs. Develop effective management and organizational structure. Utilize the Lab researchers expertise by creating joint appointments and adjunct positions at universities.
- “End-to-end approach” – broad recruitment of best undergrads and grads, focusing on those who combine (i) broad perspective, (ii) solid science & engineering foundation, (iii) highly developed specialization.
- Develop advanced E&R&D programs, enriched with summer schools, workshops, webinars, internships at the labs. Expose students to the lab environment and work on their retention. Develop effective reporting and metrics of success.

Program and
Curriculum
Development

Workshops
and Summer
Schools

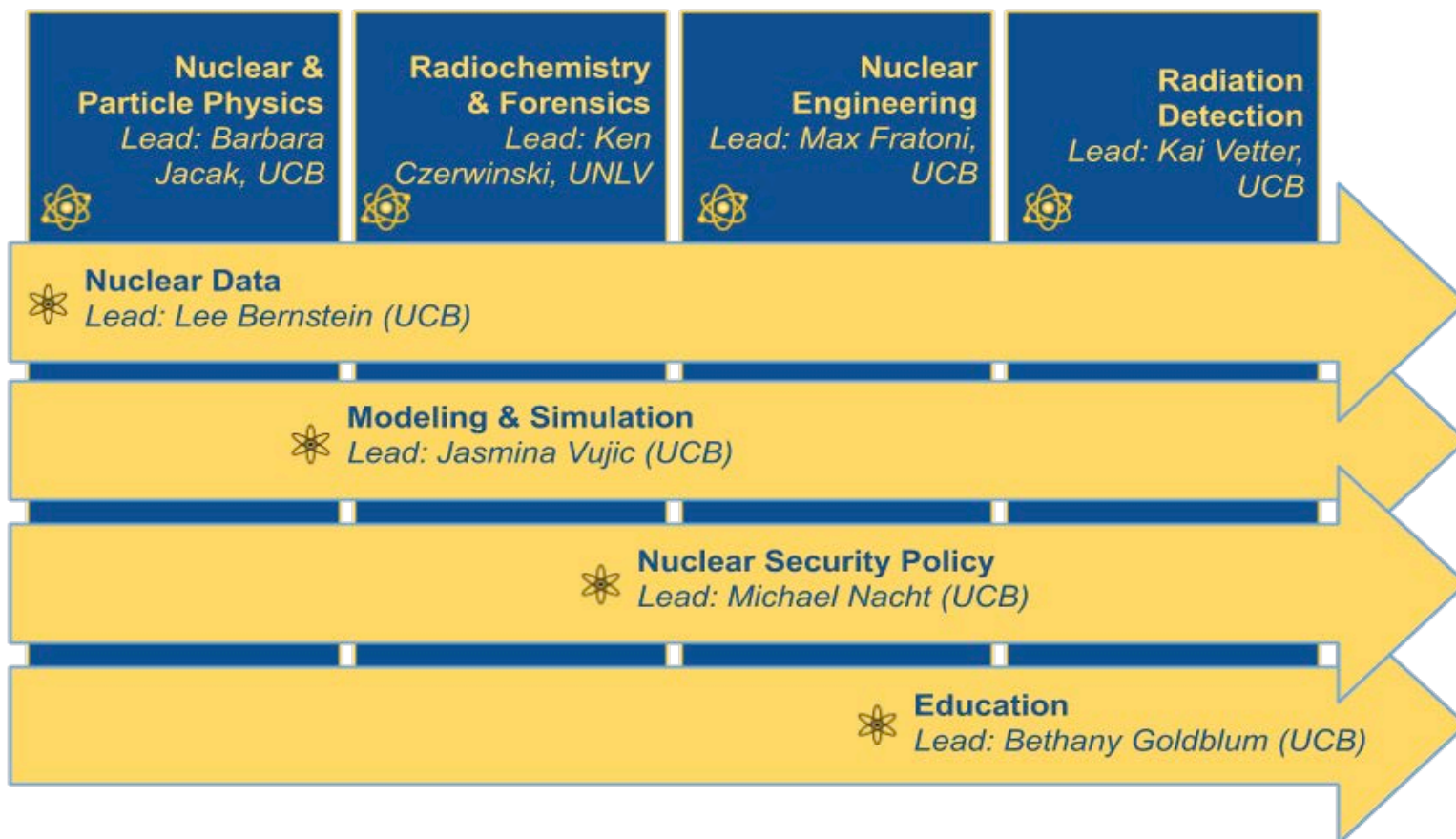
Broad and
Diverse
Outreach

Adjunct
Faculty
Positions

Careers in
the Nuclear
Security
Arena

SUCCESS PIPELINE MODEL Science-Technology-Policy

- NSSC draws students and scholars together in unconventional ways, replacing the boundaries that separate disciplines with more inclusive SCIENCE-TECHNOLOGY-POLICY interface.



SUCCESS PIPELINE MODEL

Strong Teams of Experts

- NSSC partner universities currently include UC Berkeley as the lead, with MSU, UCD, GWU, TAMU, UTK, and UNLV .
- Involvement of 63 faculty and 17 specialists in NSSC's E&R&D.
- NSSC partner laboratories: LBNL, LLNL, LANL, ORNL, and SNL with close to 200 lab scientist involved in mentorship and summer programs.

NSSC2
Inauguration



May 23, 2016



NSSC1 inauguration: June 10, 2011



2017 NSSC Annual Workshop at LBNL

SUCCESS PIPELINE MODEL

Effective Management and Oversight

NNSA DNN

NSSC EXECUTIVE TEAM

PI/Director: Jasmina Vujic - UCB
Executive Director: Bethany Goldblum - UCB/LBNL
Deputy Executive Director: Jason Hayward - UTK
NNSA Liaison: Kai Vetter - UCB
Director for Laboratories: Lee Bernstein - UCB/LBNL

ADVISORY BOARD

Chair - Carol Burns - LANL
 Roger Falcone - UCB
 Miriam John - SNL (retired)
 David McCallen - UN Reno
 Benn Tannenbaum - SNL
 Catherine Romano - ORNL
 Mavrik Zavarin - LLNL

POINT OF CONTACT COUNCIL

UNIVERSITY

Chris Cahill - GWU
 Sean Liddick - MSU
 Cody Folden - TAMU
 Mani Tripathi - UCD
 Frederic Poineau - UNLV
 Jason Hayward - UTK

LABORATORY

Margie Root - LANL
 John Valentine - LBNL
 Vladimir Mozin - LLNL
 Dave Williams - ORNL
 David Peters - SNL

NSSC SUPPORT STAFF

Program Manager: Charlotte Carr
Financial Analyst: Derek Johnson

SUCCESS PIPELINE MODEL

Effective Management and Oversight

- **Effective NSSC management:**
 - The Executive Team meets every week.
 - The Leadership Team (the university and lab POCs) meets every month.
 - The Advisory Board meets once a year.
- **Effective NSSC student oversight:**
 - Daily communication with academic advisors and lab mentors.
 - Weekly meetings of research groups.
 - Monthly participation in seminars.
 - One Working Session per semester – the NSSC students connect and learn about the research that other NSSC students are conducting.
 - One NSSC Annual Workshop – held in one of the partner national laboratories – providing an opportunity for NSSC students to present their work, and to meet with lab scientists.
 - Each student required to attend one summer program at the labs and one policy boot camp.
- **Effective NNSA oversight:**
 - UPR annual showcase.
 - Schubert Reviews.

SUCCESS PIPELINE MODEL

Performance Metrics

Performance Metrics

➤ Number of People Supported

- Undergraduate students
- Graduate students
- Postdocs
- Faculty (Jr./Senior)
- Lab-based Adjuncts



➤ Degrees awarded

➤ Students conducting research in-residence at National Labs

➤ Students working on Lab-directed projects

➤ Number of peer-reviewed publications

➤ Number of presentations

➤ Number of honors and awards

Metrics of Effectiveness

➤ Pipeline of Graduating Students

- Continuing to Graduate School
- Position at a National Lab
- In the Nuclear Security Industry
- In Nuclear Security Related Academia
- In Nuclear Security Related Other Government



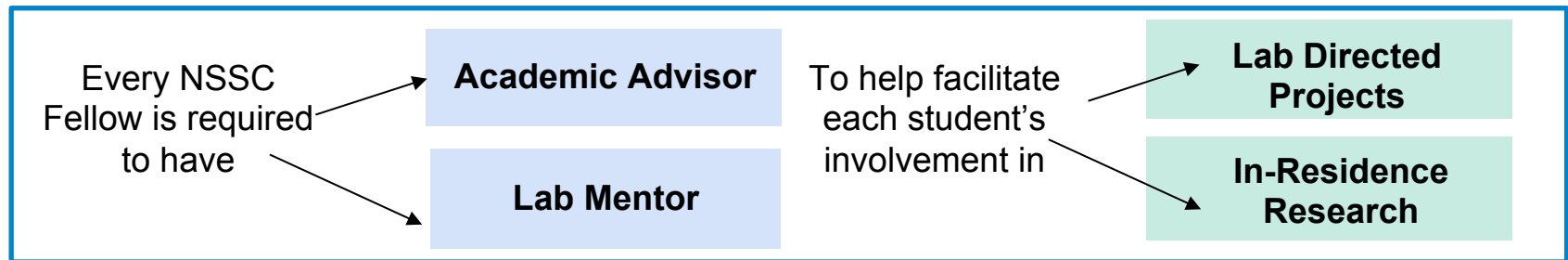
SUCCESS PIPELINE MODEL

Research and Educational Model

We attract the **best** and **brightest** students from our 7 partner institutions



Match their interests to our **research** focus areas

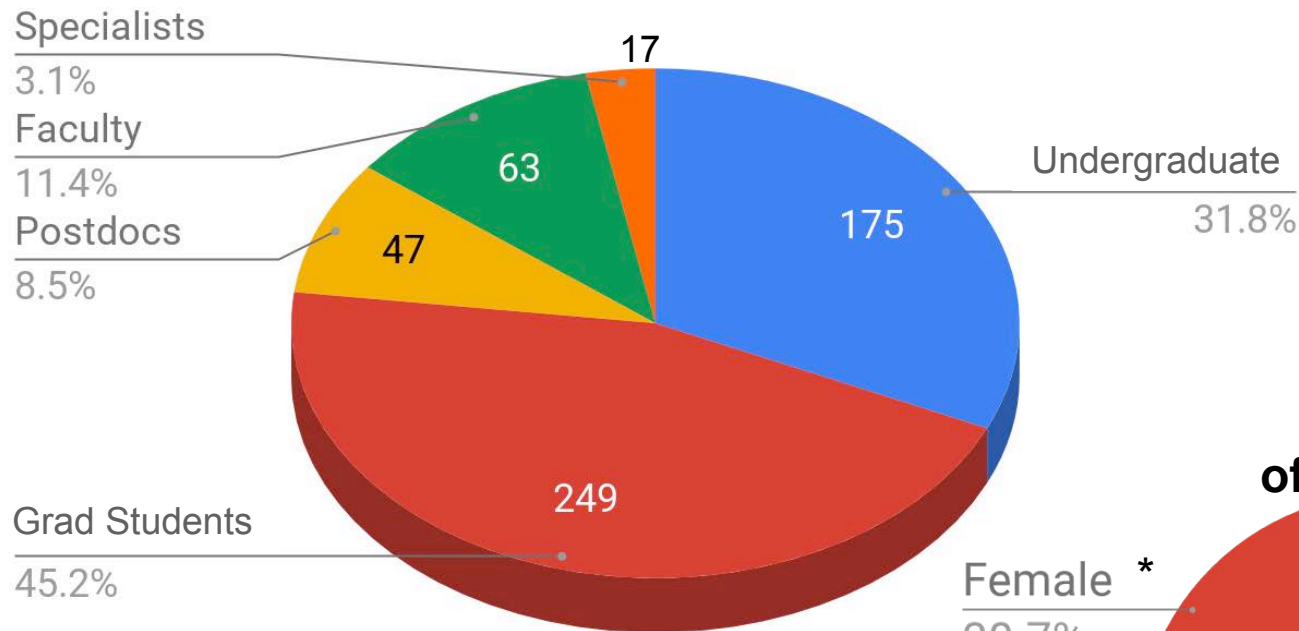


In collaboration with 5 **National Lab** Partners



Transition students into **careers** at the national labs supporting the
NNSA National Security Agenda!

NSSC Personnel 2011 - Present



**Completed
311 degrees:**

**114 Ph.D. degrees
81 M.S. Degrees
116 B.S. Degrees**

**Gender ratio
of NSSC scholars**

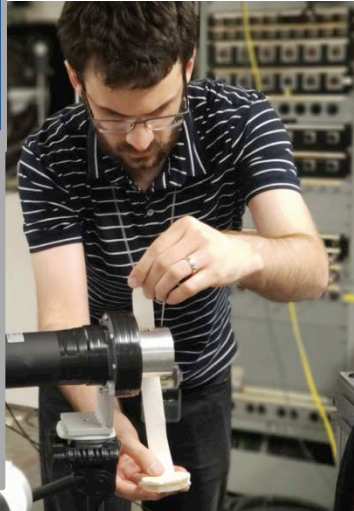


**551 people have been
supported by NSSC**

NSSC Metrics Overview 2011 - Present

364 Peer Reviewed Publications

Thibault Laplace (UCB/LBNL) “Low energy light yield of fast plastic scintillators,” in *Nuclear Instruments and Methods* (2020).



188 Awards

Daine Danielson (UCD) and Travis Smith (UTK) won 2019 Innovations in Nuclear Technology R&D Awards



520 Poster Presentations

Kevin Glennon (TAMU/LLNL) presented “A Forensic Investigation of Legacy Separated Pu” at LANL. Kevin also won Outstanding Presentation in Chemistry at LANL



801 Oral Presentations

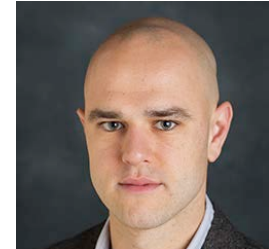
Stephanie Lyons (MSU/PNNL) “ β -decay of neutron-rich Co with Total Absorption Spectroscopy” Nuclear Seminar, Technical University Darmstadt, Germany.



NSSC Sponsored Courses

NSSC has sponsored 10 courses held at four partner institutions

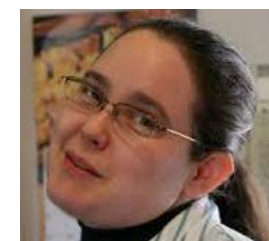
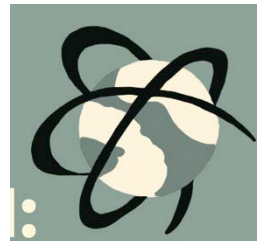
Course	Institution
Nuclear Security: The Nexus Between Policy and Technology	UC Berkeley
A Hands-On Introduction to Radiation Detection	UC Berkeley
Special Topics: Nuclear Data	UT Knoxville
Radiochemical Methods in Nuclear Technology and Forensics	UC Berkeley
Radiation Detection and Nuclear Instrumentation Lab Course	UC Berkeley
Advanced Concept for Radiation Detection & Measurements	UC Berkeley
Special Topics: Nuclear Data	UC Berkeley
Nuclear Criticality Safety	UC Berkeley
Nuclear and Radiochemistry	UC Irvine
Designed Emphasis in Nuclear Science (DENS)	UC Davis



Special Topics: Nuclear Data
with Prof. Heilbronn and Prof. Sobes

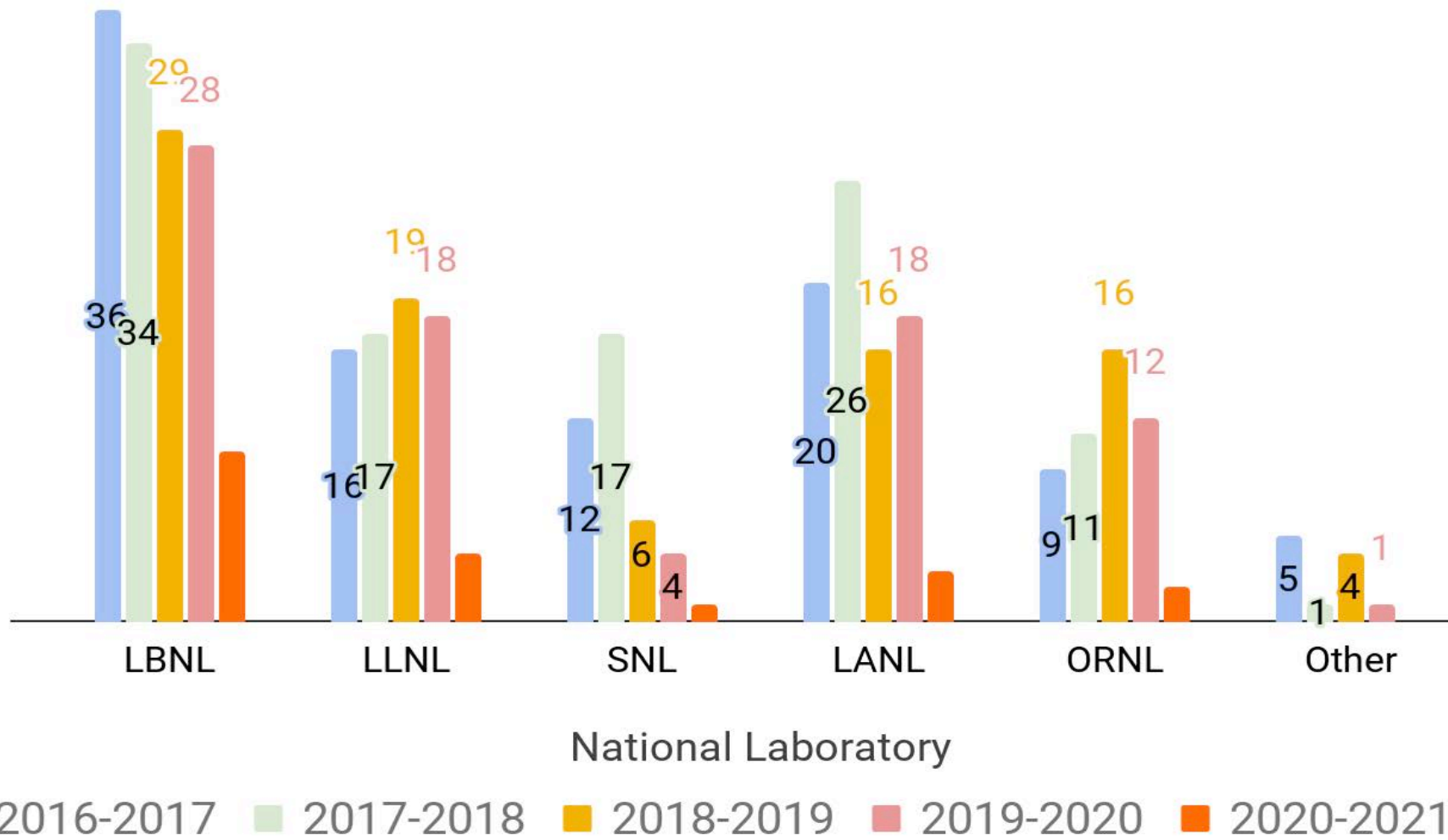


Nuclear Security: The Nexus Between Policy and Technology
with Prof. van Bibber and Prof. Nacht



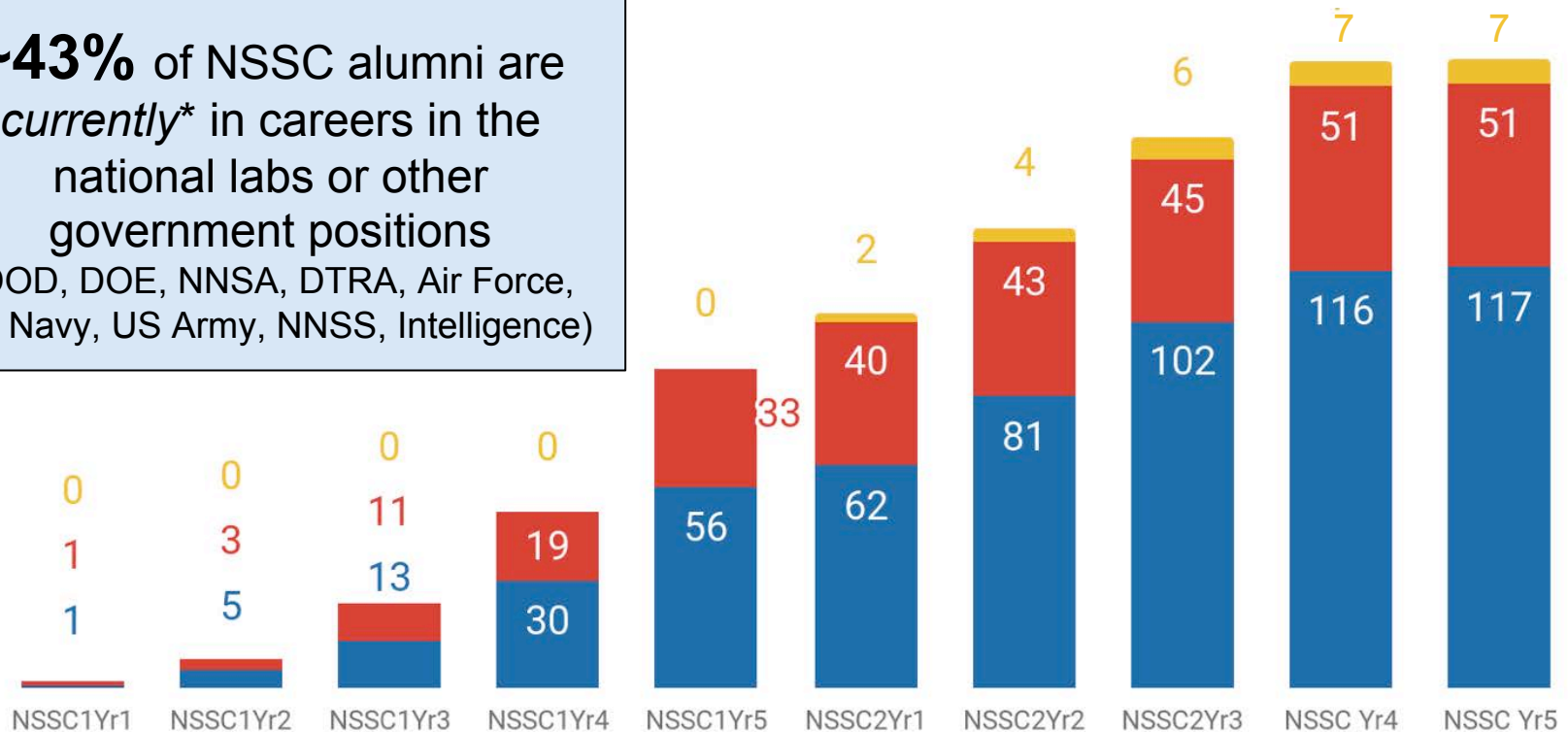
A Hands-On Introduction to Radiation Detection
with NSSC Specialist Dr. Ali Hanks

NSSC Fellows and Affiliates Conducting In-Residence Lab Research



NSSC Cumulative Pipeline 2011 - Present

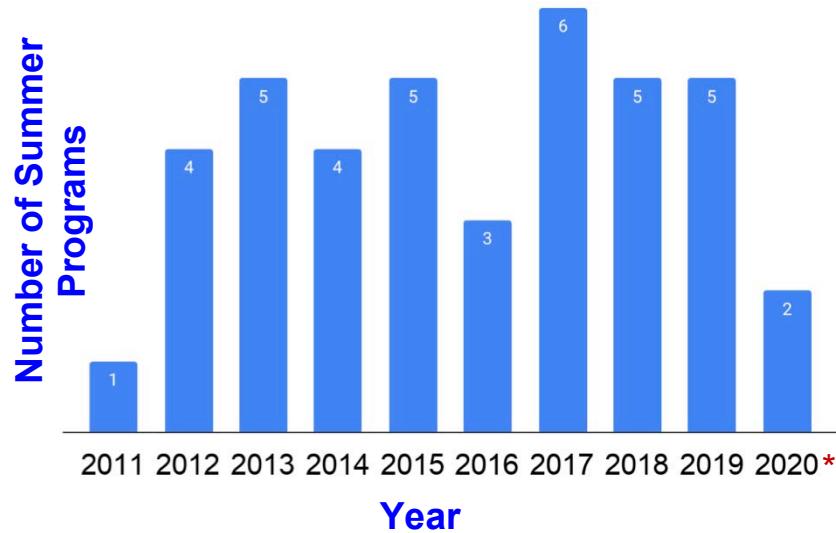
~43% of NSSC alumni are *currently** in careers in the national labs or other government positions
(DOD, DOE, NNSA, DTRA, Air Force, US Navy, US Army, NNSS, Intelligence)



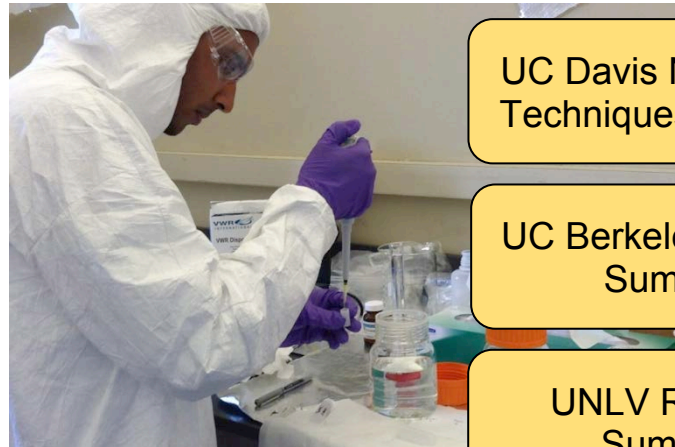
NSSC Cumulative Pipeline

■ In-Field or Industry ■ Academia ■ National Lab or Other Gov.

*These data reflect current appointments. A total of **131** NSSC alumni have been employed in positions in the National Labs or Other Government, with some then moving on to other fields.



NSSC has supported 40 Summer Schools



UC Davis Nuclear Analytical Techniques Summer School

UC Berkeley Radiation D&M Summer School

UNLV Radiochemistry Summer School



GW Boot Camp on Nuclear Security Policy



NSSC LANL Keepin Nonproliferation Science Summer Program

*Many Summer 2020 programs were cancelled due to COVID-19

NSSC-LANL Keepin Nonproliferation Science Summer Program

Dates	NSSC Participants	Other Participants	Total
June 22 - Aug 14, 2020	2	12	14
June 17 - Aug 9, 2019	5	11	16
June 18 - Aug 8, 2018	14	13	27
June 19 - Aug 1, 2017	12	8	20

**2020 program
held virtually**

Goals:

- Create **working relationships** between NSSC students and LANL scientists
- Increase number of students performing **programmatic research** with LANL
- Turn research and training into **careers at the national laboratories**

At the end of the summer program all participants present oral **“lightning presentations”** for LANL personnel on their summer research project

Post-program survey of 2020 participants:

90% of students found this program to be beneficial or very beneficial to their professional development.

100% of students are likely or very likely to recommend this program to others.

Public Policy & Nuclear Threats Boot Camp (PPNT&GW)

Dates	NSSC Students	Other Students	Total
GW 2019 (6/9-6/21)	20	6	26
GW 2018 (6/11-6/22)	11	9	20
PPNT 2020 (7/26-8/15)	13	255	268
PPNT 2019 (7/18-8/7)	1	26	27
PPNT 2018 (7/29-8/7)	1	18	19
PPNT 2017 (7/16-7/25)	1	16	17
PPNT 2016 (6/19-6/29)	15	11	26
PPNT 2015 (6/21-7/11)	23	7	30
PPNT 2014 (7/6-7/16)	15	8	23
PPNT 2013 (8/4-8/18)	1	17	18
PPNT 2012 (8/5-8/25)	0	12	12

Goals:

- Establish a foundation for understanding the **national security mission**
- Provide participants with a foundation on the historical, legal, ethical, and technical aspects of **nuclear weapons policy** issues
- Facilitate collaboration between scholars from **the technical and social sciences**
- Provide **networking opportunities** with nuclear policy professionals



NSSC Fellows from UCB, MSU, and UTK participate in a **mock congressional hearing**

Objectives:

- Support the educational process
- Provide data from laboratory demonstrations
- Benefit university research projects

*Evaluation of prompt
gamma-ray emissions
from neutron interrogation
of meteorites*



Instrumentation:

- **Neutron generators:** DT, DD, Cf, Cm, (α ,n)
- **Gamma-ray detectors:** HPGe, LaBr₃, CZT, NaI(Tl), etc.
- **Neutron detectors:** ³He, EJ-301, EJ-309, Stilbene
- **Imaging:** X-Ray and Neutron transmission

Materials:

- Gamma-ray and neutron sources
- Low- and high-Z shielding
- Pu material samples
- U mass and enrichment standards
- Containers and enclosures



Monthly webinars featuring nuclear science and policy as well as numerous workshops, panels, and special events



Assisted the organization of **Workshop on Nuclear Data Needs and Capabilities for Applications 2015**



Dr. Nicholas Scielzo, LLNL presented webinar on “Improving beta-decay studies for fundamental science and applications” in 2017



NSSC Fellows touring the NIF as part of the **NSSC 2019 Fall Engagement Workshop**

Provided support **22nd technical meeting of the Nuclear Structure and Decay Data Network** of the International Atomic Energy Agency in 2017



Barbara Jacak (lead)
Lee Bernstein
Bethany Goldblum



Research Areas Include:

- Cross section measurements
- Neutrino physics
- Detectors for charged particles, photons, and neutrons
- Structure of bound and unbound nuclear states



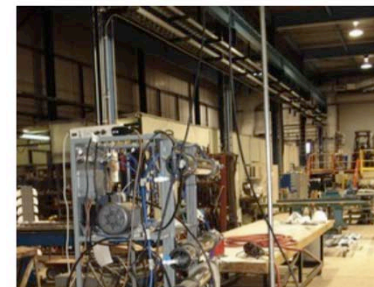
Sean Liddick (co-lead)
Alexandra Gade
Artemis Spyrou
Hiro Iwasaki



Crosscutting with Nuclear Data, Modeling and Simulation



Mani Tripathi
Robert Svoboda



Vincent Fischer, UCD
ANNIE Phase II construction
Lab Mentor: Steven Dazeley



ANNIE Phase I filtration system



Berkeley
UNIVERSITY OF CALIFORNIA

Lee Bernstein (Lead)
Bethany Goldblum



MICHIGAN STATE
UNIVERSITY

Sean Liddick (Co-Lead)

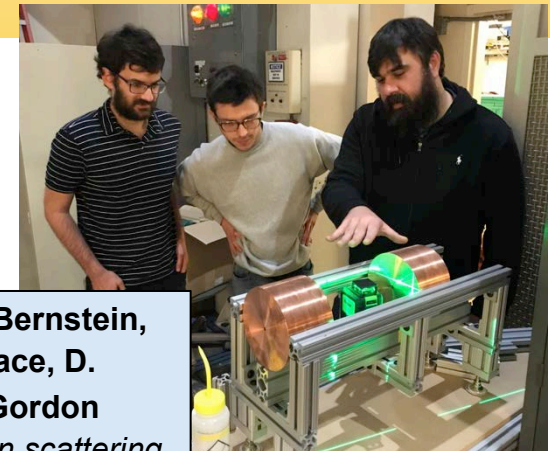


UCDAVIS
UNIVERSITY OF CALIFORNIA

Mani Tripathi
Robert Svoboda
Eric Prebys

Research Areas Include:

- Fission fragment distribution and beta-decay studies
- Forensics/delayed gamma-ray measurements
- Statistical nuclear properties for nuclear reaction modeling
- Topical evaluations for nonproliferation
- Nuclear data architecture development
- (n,f) , (n,n') and (n,γ) experiments
- “Baghdad Atlas” $(n,n'\gamma)$



UCB/LLNL team: L. Bernstein, B. Goldblum, T. Laplace, D. Bleuel, J. Brown, J. Gordon
 $(n,xn\gamma)$ data for neutron scattering and active interrogation

Recent Graduates Highlights



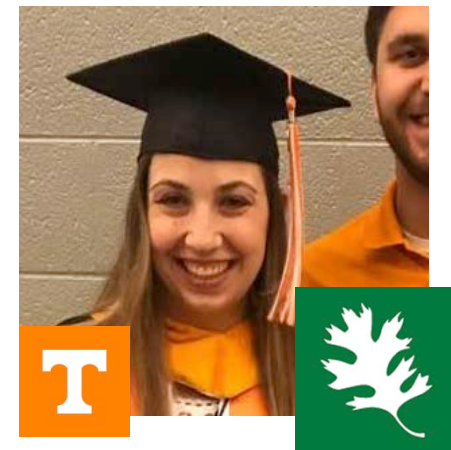
Stephanie Lyons



Daniel Hellfeld



Madhuri Kumari



Rachel Mersch



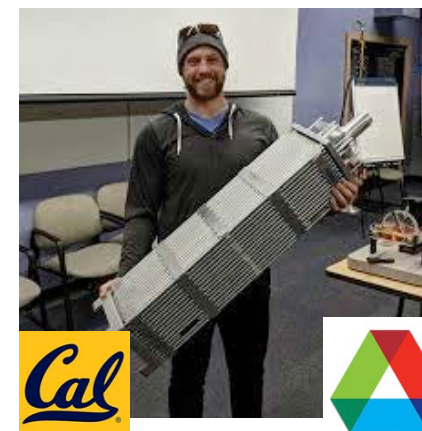
Matthew Tweardy



Aaron Manalaysay



August Ridenour



Milos Atz

Acknowledgements



2019 NSSC Fall Workshop at LLNL

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Additional Slides

UNLV

Ken Czerwinski (lead)
Frederic Poineau



Research Areas Include:

- Molecular nuclear forensics
- Mass spectrometry for forensics applications
- Synthesis and characterization
- Chemical separations and innovative solvents

Berkeley
UNIVERSITY OF CALIFORNIA

John Arnold (co-lead)
Peter Hosemann



ATM | **TEXAS A&M**
UNIVERSITY

Cody Folden

T THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

Howard Hall



Athena Gallardo, UNLV
Now at LANL.
*Analyzing coral from the
Bikini Atoll*
Lab Mentor: Terry Hamilton,
LLNL

THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON, DC

Chris Cahill



Prof. Massimiliano Fratoni (lead)
Prof. Peter Hosemann
Prof. Jasmina Vujic



Research Areas Include:

- Proliferation resistance of advanced fuel cycles
- Materials science
- Advanced tools for safeguards measurements

GW

Prof. Philippe Bardet (co-lead)



Prof. Howard Hall
Prof. Jason Hayward
Prof. Eric Lukosi
Prof. Charles Melcher



Matthieu Andre, GWU
Modeling of nuclear plumes
Lab Mentor: Marianne Francois (LANL)



Kai Vetter (lead)
Bethany Goldblum

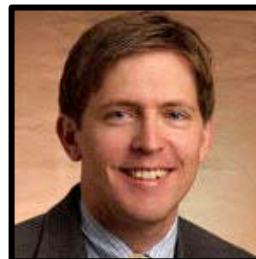


Research Areas Include:

- Detector materials
- Detector development and characterization
- Radiation imaging and advanced concepts



Jason Hayward (co-lead)
Eric Lukosi
Chuck Melcher
Mariya Zhuraleva

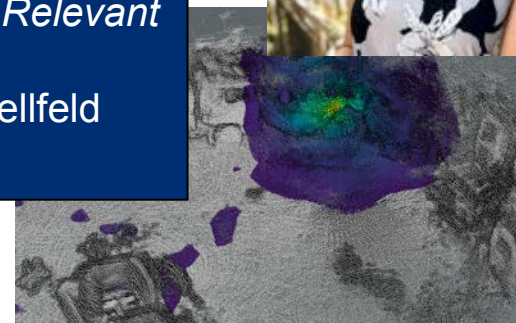


Sean Liddick



Mani Tripathi
Robert Svoboda
Eric Prebys
Emilija Pantic

Kalie Knecht, UCB
*3D Compton Imaging with
Scene Data Fusion in Relevant
Environments*
LBNL mentor: Dan Hellfeld
(former NSSC fellow)



Modeling & Simulation Overview



Jasmina Vujic (Lead)
Max Fratoni
Lee Bernstein
Barbara Jacak



Research Areas Include:

- Neutral particle transport on advanced architectures
- Methods development for forensics applications
- Physics-specific code development and verification
- Nuclear data benchmarking
- Reactor disaster monitoring through antineutrino detection



Mani Tripathi
Robert Svoboda



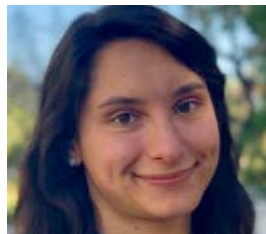
Sean Liddick



Jason Hayward

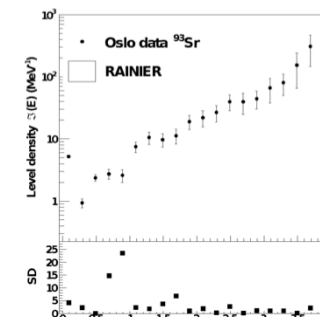
Adriana Sweet, UCB
Statistical Nuclear Properties of ^{93}Sr for National Security Applications

Lab Mentor: Darren Bleuel, LLNL

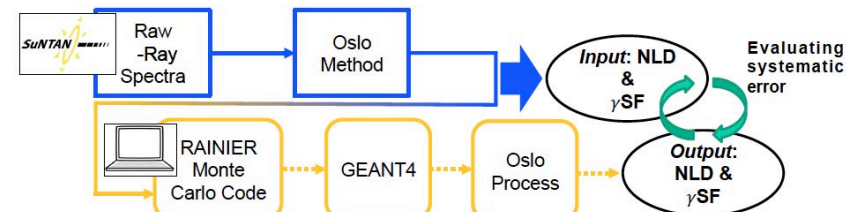
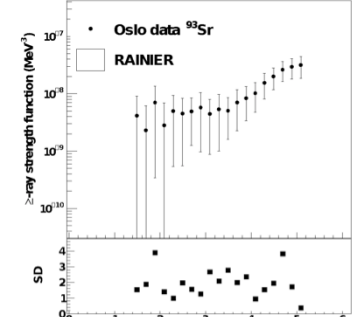


Nuclear Properties

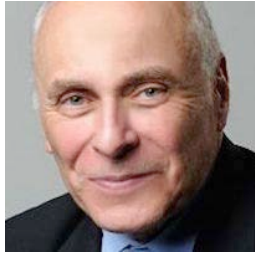
Nuclear Level Density (NLD)



γ -Ray Strength Function (γSF)



Philippe Bardet



**GW Boot Camp on
Nuclear Security Policy**

Crosscutting Area Lead:
Michael Nacht (UCB)

Partner Institutions



**Nuclear Security: The Nexus Between
Technology and Policy**
Grad-Level Course at UC Berkeley (with
LANL Partnerships and Pipeline Office)



**2018 GW Boot Camp on Nuclear
Security Policy**

