NSSC Virtual Scholar Showcase

Nuclear Science and Security Consortium Research Overview

June 3, 2020

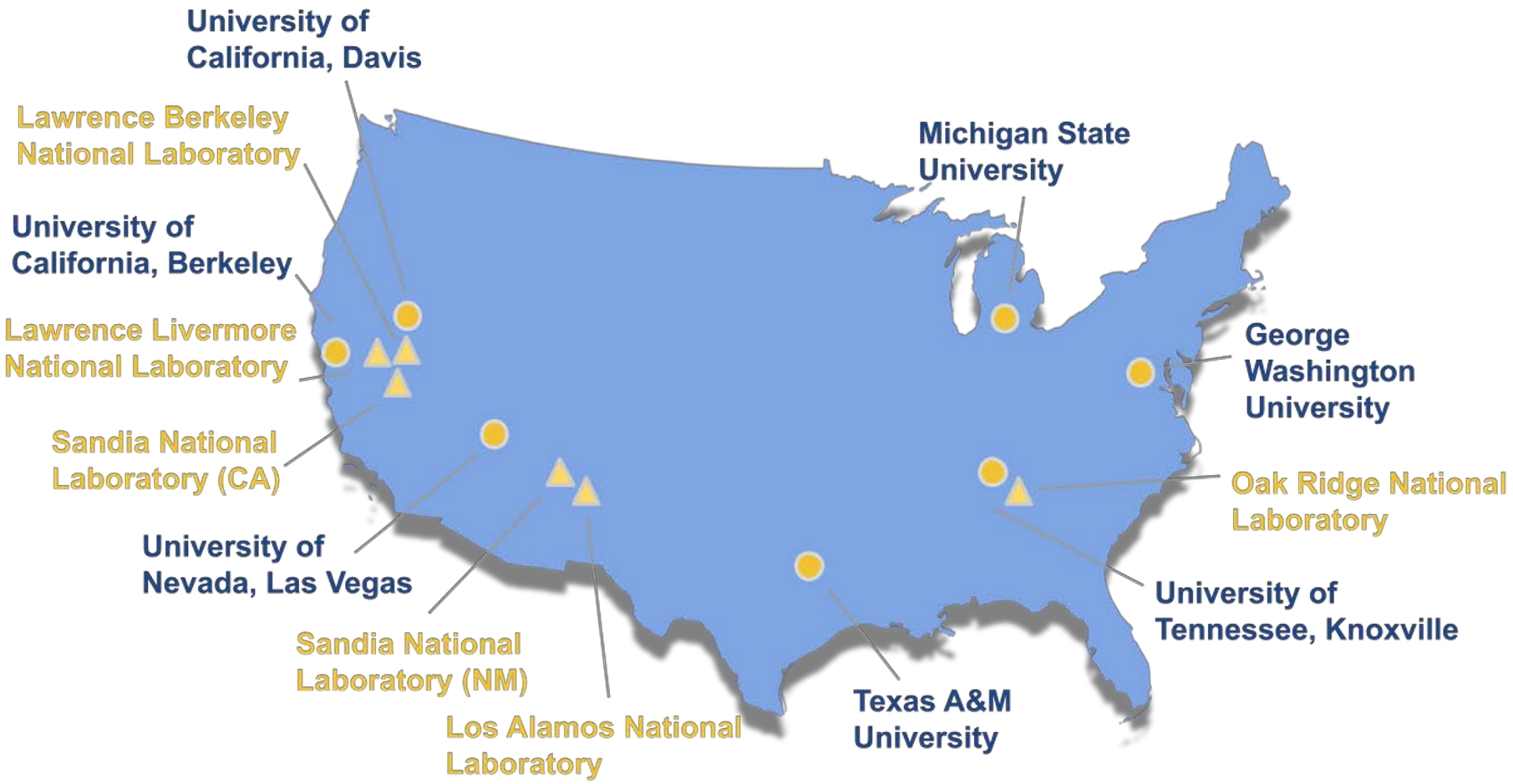
Dr. Jasmina Vujic
University of California, Berkeley

History and Mission

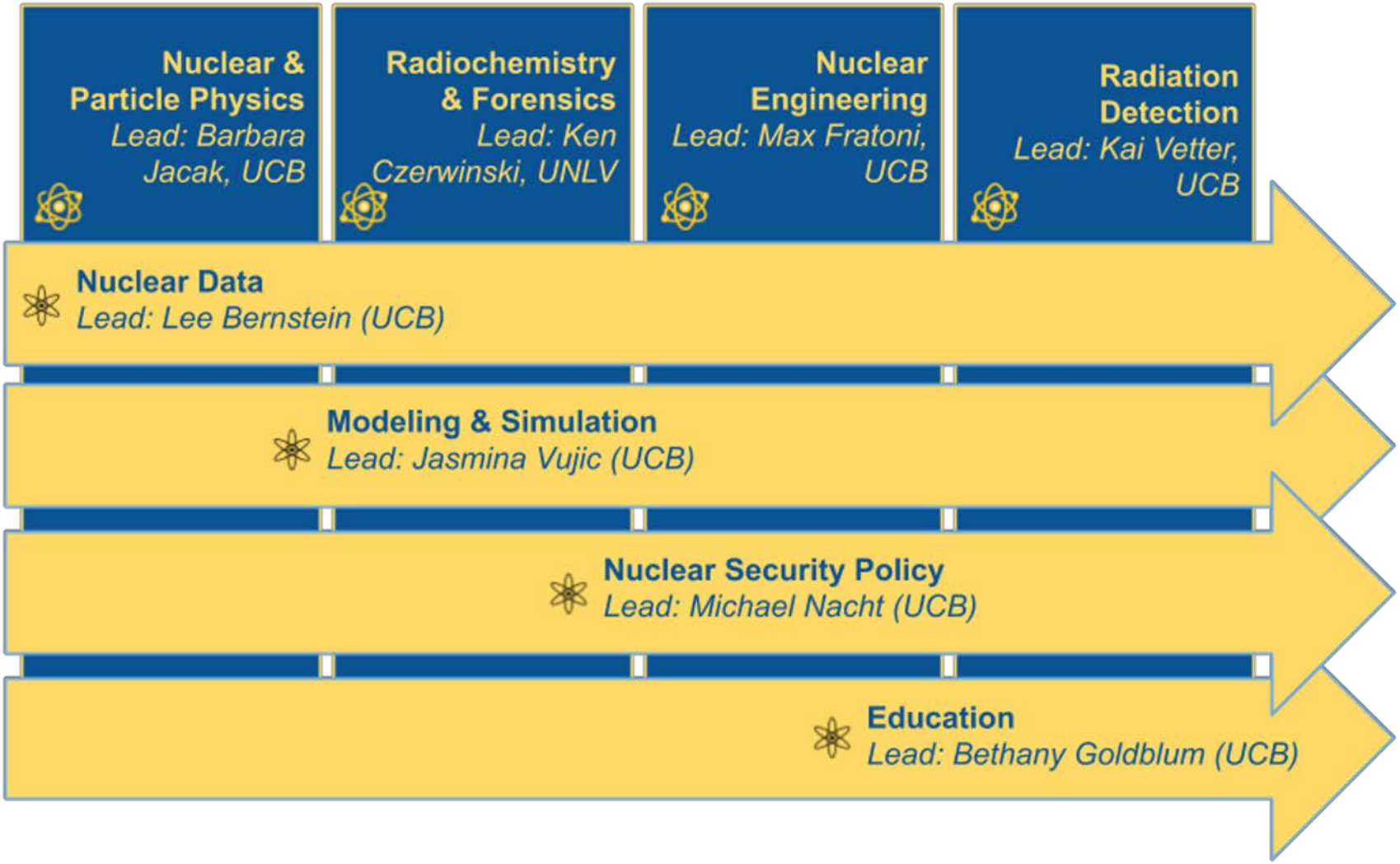
The Nuclear Science and Security Consortium's primary objectives are to **recruit and train top students** in relevant nuclear disciplines, connect students with a **core set of disciplines** that support the nonproliferation and nuclear security mission, and **expand national laboratory collaboration** to provide students the opportunity to **engage deeply in research** under the guidance of lab staff scientists.

NSSC1 was originally established in 2011. The NSSC2 began its performance period in 2016 and started its fourth year in October 2019.

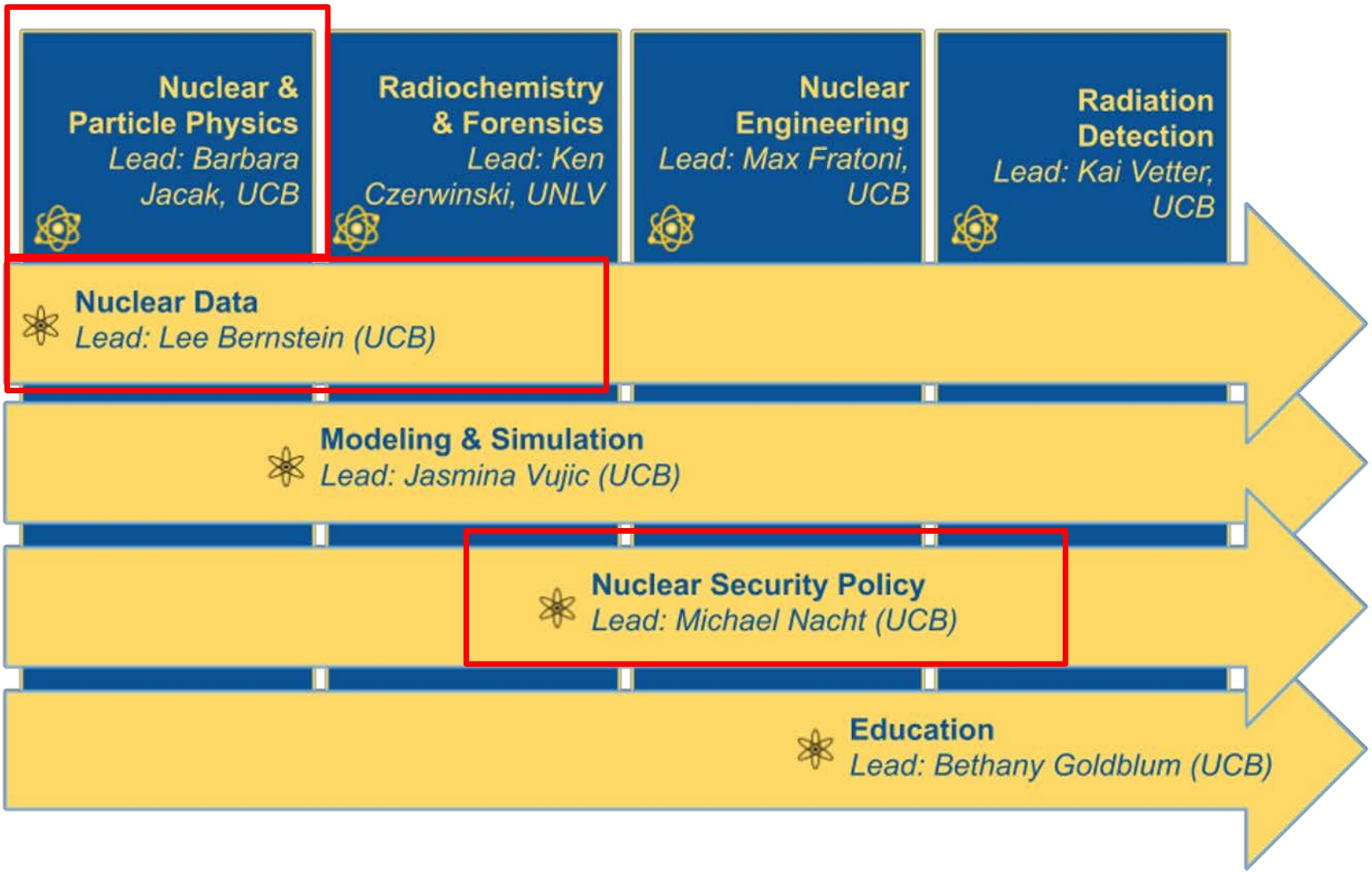
NSSC2 Partner Institutions



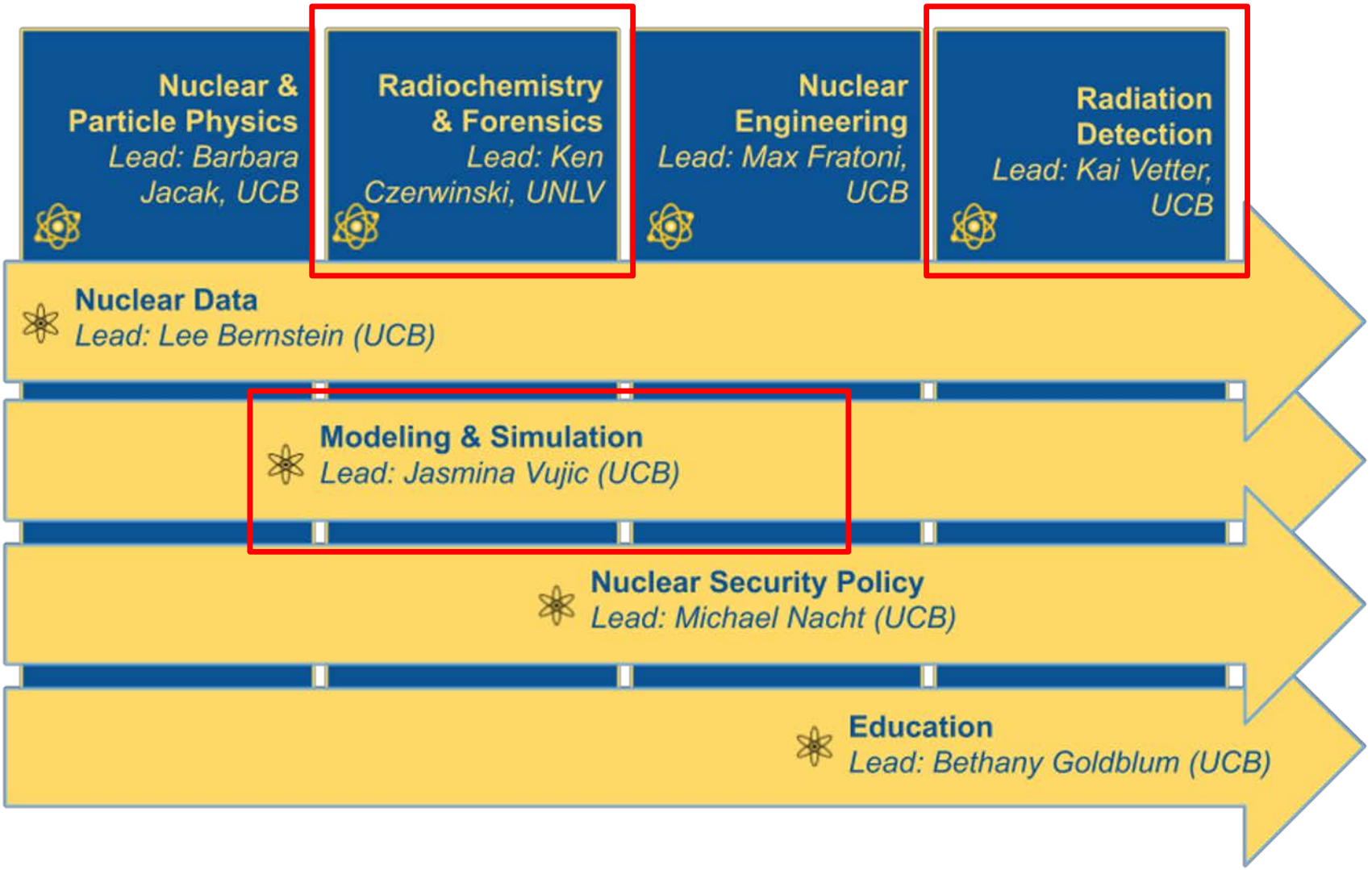
NSSC2 Research Focus Areas and Crosscutting Areas



Virtual Scholar Showcase: Day 1 Focus



Virtual Scholar Showcase: Day 2 Focus



The NSSC Research and Education Model

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

Match their interests to 1 of our 4 Research Focus Areas and at least one Crosscutting Area

NUCLEAR & PARTICLE PHYSICS	RADIOCHEMISTRY & FORENSICS	NUCLEAR ENGINEERING	NUCLEAR INSTRUMENTATION

Every NSSC Fellow is required to have

- **Academic Advisor**
- **Lab Mentor**

To help facilitate each student's involvement in

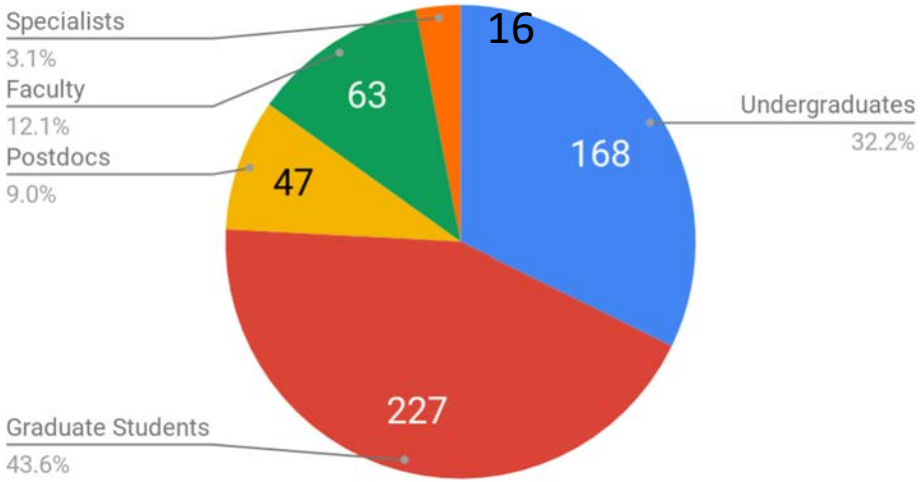
- **Lab Directed Projects**
- **In-Residence Research**

In collaboration with our 5 National Lab Partners

Los Alamos NATIONAL LABORATORY EST. 1943 · OAK RIDGE National Laboratory · BERKELEY LAB

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

NSSC Personnel 2011 - Present

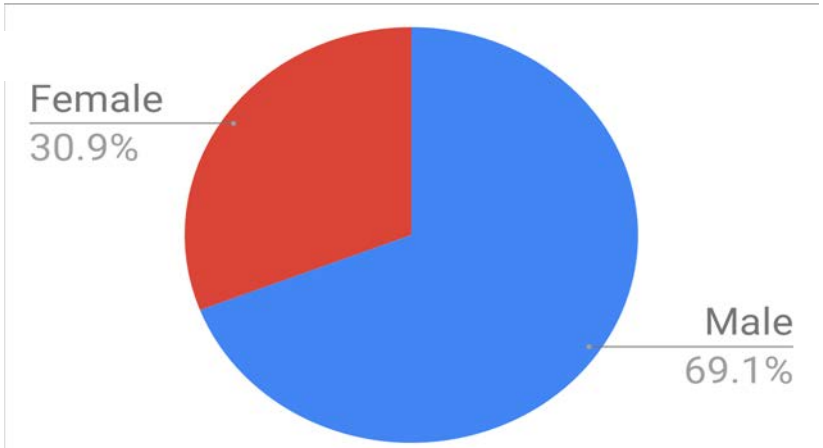


521 people have been supported by NSSC

Completed (286):
108 Ph.D. degrees
67 M.S. Degrees
111 B.S. Degrees

333 Peer Reviewed Publications
508 Poster Presentations
756 Oral Presentations
176 Awards

Gender ratio of NSSC scholars*



112 (42%) to the national labs or other gov (DoD, DoE, NNSA, DTRA, AirForce, US Navy, US Army, NsTec, Intelligence)
50 to Academia;
55 In-Field or Industry.

*The student body of the College of Engineering at UC Berkeley is 28.6% female.

Nuclear & Particle Physics Focus Area

Berkeley
UNIVERSITY OF CALIFORNIA

Barbara Jacak (lead)
Lee Bernstein
Bethany Goldblum

MICHIGAN STATE UNIVERSITY

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

UCDAVIS
UNIVERSITY OF CALIFORNIA

Mani Tripathi
Robert Svoboda

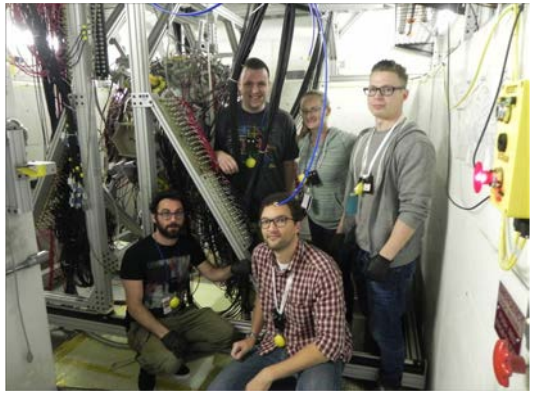
Research Areas Include:

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

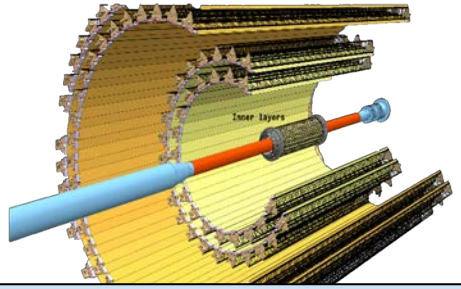
Crosscutting with Nuclear Data, Modeling and Simulation

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

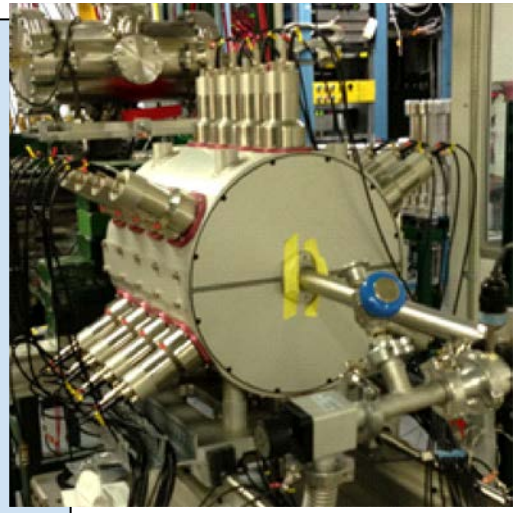
Nuclear & Particle Physics Highlights



UCD NSSC Team: Luca Pagani, Leon Pickard, Steven Gardiner, and Julie He
Argon Capture Experiment at DANCE (ACED)
LANL Team: A.Couture, C.Prokop, J.Ullmann



MSU NSSC Team: Stephanie Lyons, Prof. Sean Liddick, Alex Dombos
Nuclear properties of neutron-rich isotopes
LANL Team: Aaron Couture, Shea Mosby



UCB Team: Fernando Torales Acosta, Jose Soria
Tracking for dense QCD matter studies using active pixel sensors. Experiments: ALICE, sPHENIX, future Electron-Ion Collider
LBNL Team: Barbara Jacak

Radiochemistry & Forensics Focus Area

UNLV

Ken Czerwinski (lead)
Frederic Poineau

Berkeley UNIVERSITY OF CALIFORNIA

John Arnold (co – lead)
Peter Hosemann

TEXAS A&M UNIVERSITY

Cody Folden

THE UNIVERSITY OF TENNESSEE KNOXVILLE

Howard Hall

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

Chris Cahill

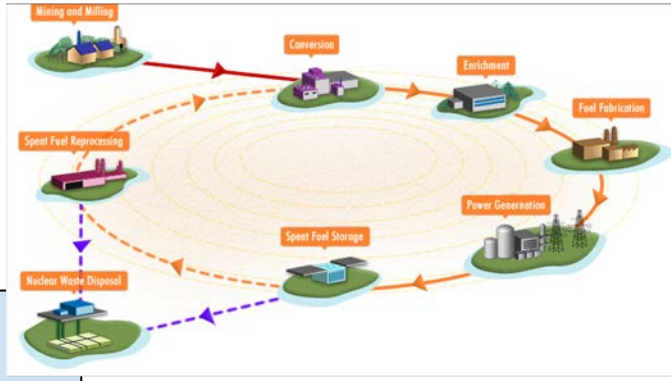
Research Areas Include:

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

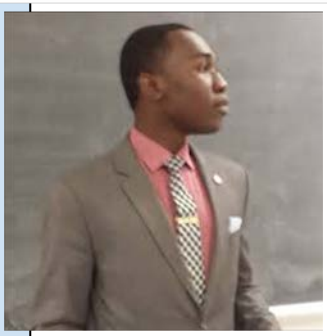
Athena Gallardo, UNLV
Now at LANL.
Analyzing coral from the Bikini Atoll
Lab Mentor: Terry Hamilton, LLNL

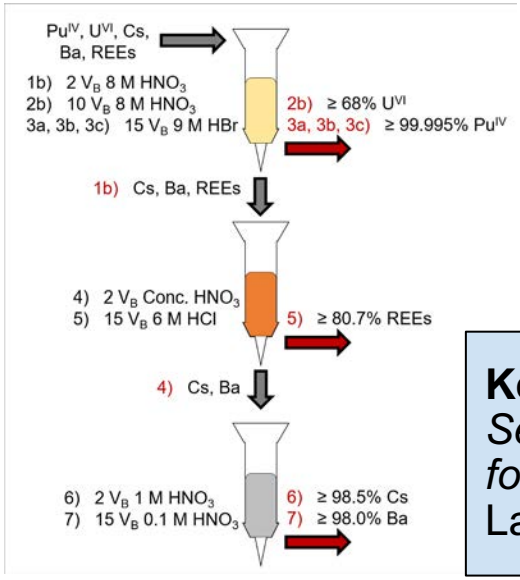
Radiochemistry & Forensics Highlights

Ben Jordan, UTK
Laser Spectroscopy of Uranium Hexafluoride
Lab Mentors: George Chan (LBNL), Larry Cutlip (Centrus)



James Louis-Jean, UNLV
Analysis of Uranium and Samarium Isotopic Ratios by Thermal Ionization Mass Spectrometry (TIMS) for Nuclear Forensic Analysis
Lab Mentor: Jeremy Inglis (LANL)





Kevin Glennon, TAMU
Separation of 4 – 60 mg super-grade Pu as part of a forensic analysis
Lab Mentor: Evelyn Bond (LANL)

Nuclear Engineering Focus Area

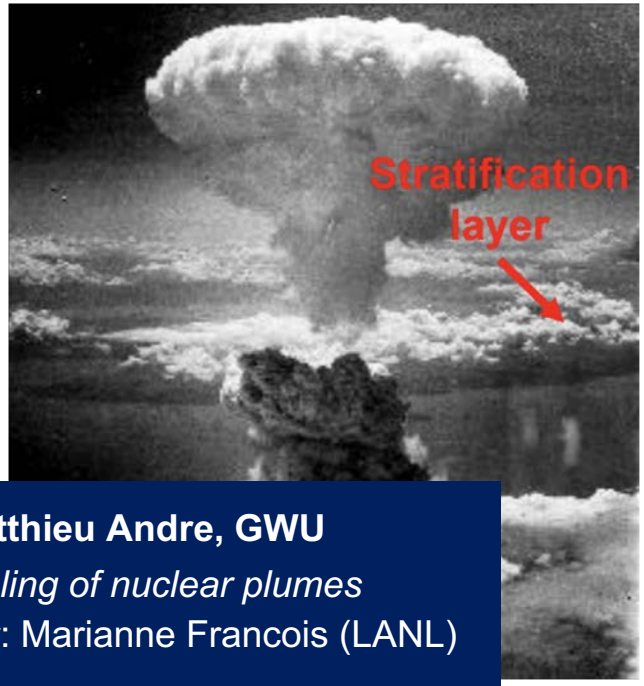
Prof. Massimiliano Fratoni (lead)
Prof. Peter Hosemann
Prof. Jasmina Vujic

Research Areas Include:

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

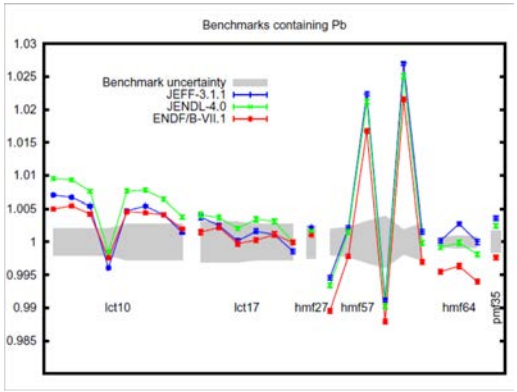
Prof. Philippe Bardet (co-lead)

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

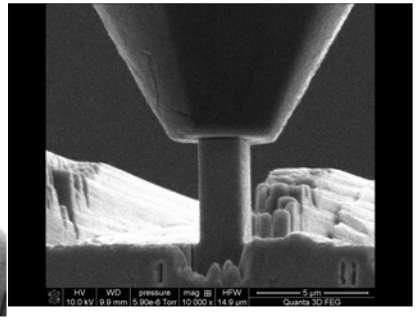


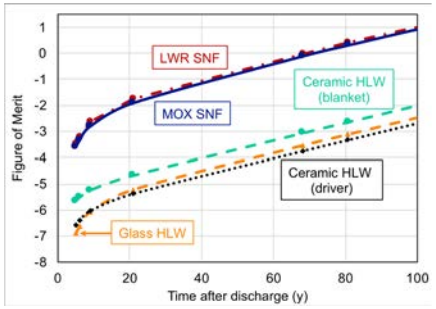
Matthieu Andre, GWU
Modeling of nuclear plumes
Lab Mentor: Marianne Francois (LANL)

Nuclear Engineering Highlights



Kelsey Amundson, UCB, now at LANL
Measuring mechanical properties of micrometer size particles to gain insights into material history
Lab mentors: Jesson Hutchinson, Joetta Goda, Theresa Cutler (LANL)





Hi Vo, UCB
Measuring mechanical properties of micrometer size particles to gain insights into material history
Lab Mentor: Stuart Maloy (LANL)

Milos Atz, UCB, now at Argonne NL
Methodologies for the evaluation of nuclear waste management strategies and applications to advanced fuel cycles
Lab Mentor: Andy Worrall (ORNL)

Radiation Detection & Nuclear Instrumentation Focus Area

Berkeley UNIVERSITY OF CALIFORNIA

Kai Vetter (lead)
Bethany Goldblum

THE UNIVERSITY OF TENNESSEE KNOXVILLE

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

MICHIGAN STATE UNIVERSITY

Sean Liddick

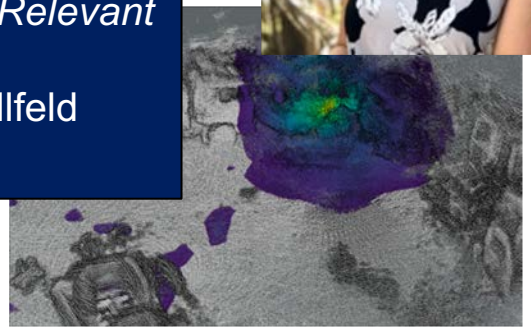
UCDAVIS UNIVERSITY OF CALIFORNIA

Mani Tripathi
Robert Svoboda
Eric Prebys
Emilija Pantic

Research Areas Include:

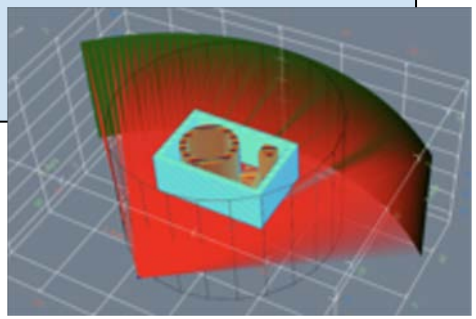
- Detector materials
- Detector development and characterization
- Radiation imaging and advanced concepts

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

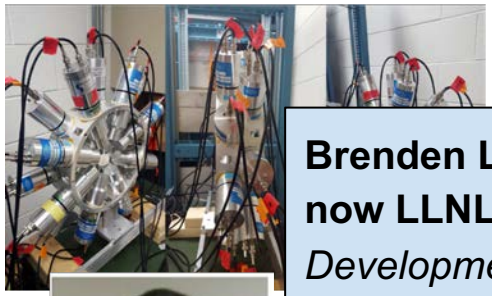


Radiation Detection & Nuclear Instrumentation Highlights

Aaron Nowack, UTK
Enrichment and Multiplication Estimation of Shielded Uranium Assemblies Under Active Interrogation
Lab Mentors: Seth McConchie, Paul Hausladen (ORNL)

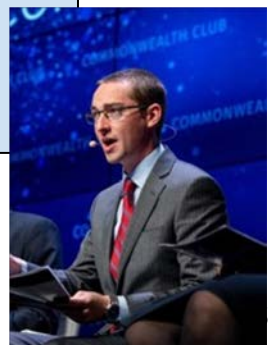


Emily Frame, UCB
High-Resolution Multi-Modality Gamma Ray Imaging
Lab Mentors: Lucian Milhailescu and Don Gunter (LBNL)



Brenden Longfellow, MSU, now LLNL
Development of nuclear instrumentation arrays for spectroscopy of rare isotopes.
Lab Mentor: Nicholas Scielzo (LLNL)

Jake Hecla, UCB
Optical Properties of Water-Based Liquid Scintillators for Large-Scale (Anti-) Neutrino Detection
Lab Mentor: Adam Bernstein (LLNL)



Nuclear Data Crosscutting Area

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

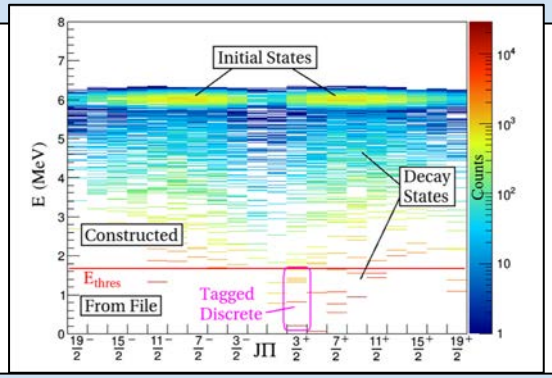
Research Areas Include:

- 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'*γ)*

Aaron Hurst, UCB
Baghdad Atlas
Lab Mentor: Lee Bernstein

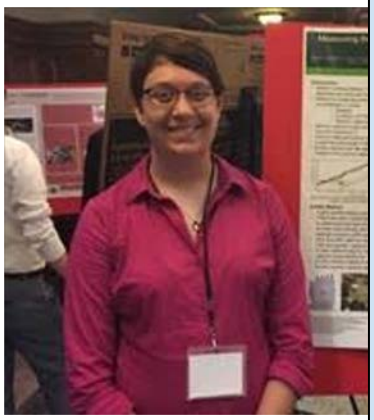
Nuclear Data Highlights

Eric Matthews, UCB
Interpreting short-lived high Q-value fission product yields (β-pandemonium)
Lab mentor: Lee Bernstein



- γ-decay from short-lived, high-Q fission products is poorly-known due to the population of highly-excited states.
- We are modeling the decay of these states using RAINIER and existing data to improve FPY data.

UCB/LLNL team: L. Bernstein, B. Goldblum, T. Laplace, D. Bleuel, J. Brown, J. Gordon
(n,xnγ) data for neutron scattering and active interrogation - The Gamma-Energy Neutron-Energy Spectrometer for Inelastic Scattering (GENESIS)



Katie Childers, MSU
Validation of an Indirect Method for Constraining Neutron-Capture Cross Sections
Lab Mentor: Aaron Couture (LANL)

Modeling & Simulation Overview

Jasmina Vujic (Lead)
Max Fratoni
Lee Bernstein
Barbara Jacak

Mani Tripathi
Robert Svoboda

Sean Liddick

Jason Howard

Philippe Bardet

Research Areas Include:

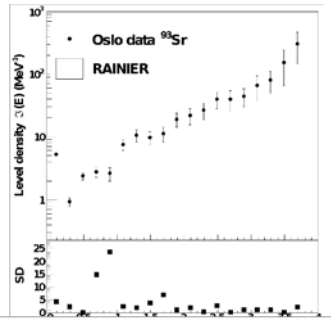
- Neutral particle transport on advanced architectures
- Methods development for forensics applications
- Physics-specific code development and verification
- Nuclear data benchmarking
- Reactor disaster monitoring through antineutrino detection

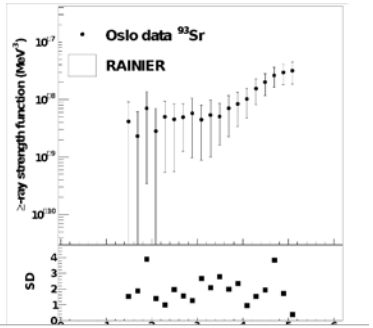
Adriana Sweet, UCB
Statistical Nuclear Properties of ^{93}Sr for National Security Applications

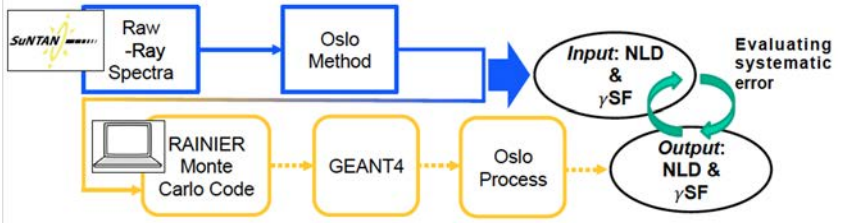
Lab Mentor: Darren Bleuel, LLNL

Nuclear Properties

Nuclear Level Density (NLD) γ-Ray Strength Function (γSF)





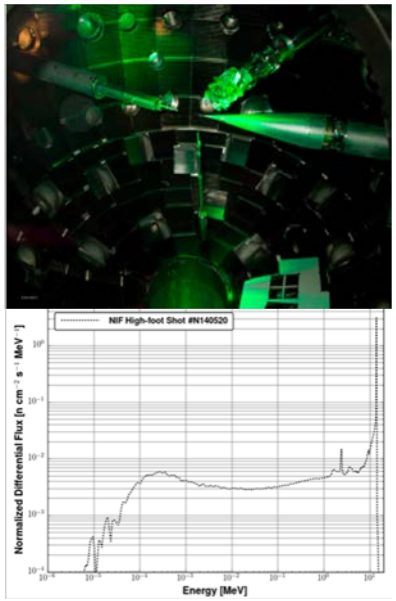


Modeling & Simulation Highlights

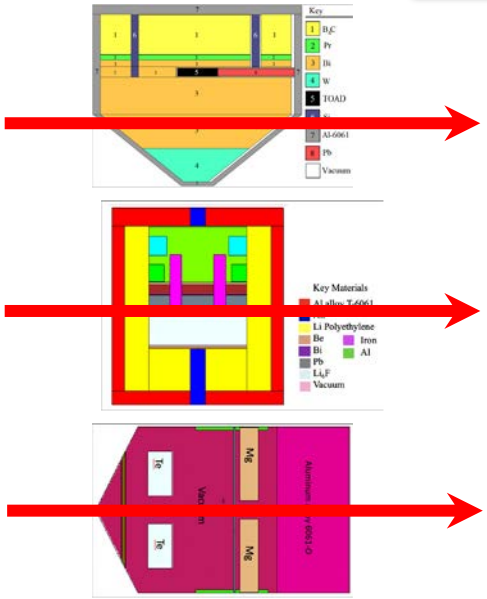
UCB Team: Prof. Vujic, Sandra Bogetic (now a postdoc at LLNL) Prof. Bernstein, Prof. Slaybaugh, James Bevins (now AFIT)
LLNL Team: L. Dauffy, D. Shaughnessy

Development, Validation and Applications of a Metaheuristic Optimization Method for Neutron Spectra Tailoring

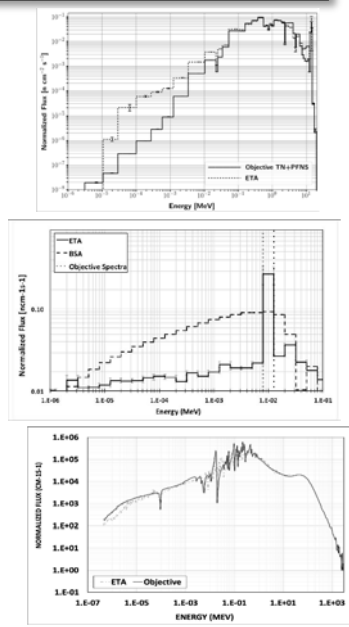
Available Neutron Sources (ex. NIF)

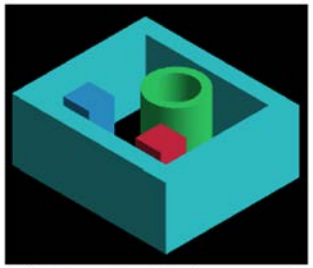


Energy Tuning Assembly (ETA)

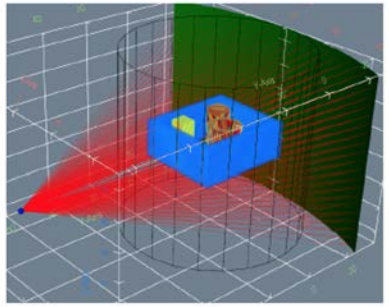


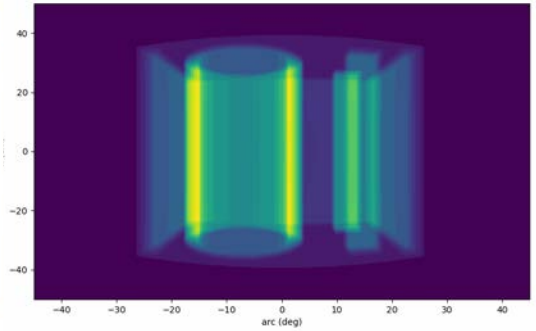
Tailored Spectra to match Objective Spectrum





An enriched uranium 161 storage casting (green) surrounded by HDPE box (teal) with steel (blue) and DU (red) blocks





UTK Team: Prof. J. Hayward, A. Nowack,
ORNL: S. McConchie, P. Hausladen

Enrichment and Multiplication Estimation of Shielded Uranium Assemblies Under Active Interrogation (UTK/ORNL)

Nuclear Security Policy Crosscutting Area

Crosscutting Area Lead:
Michael Nacht (UCB)

GW Boot Camp on Nuclear Security Policy

Partner Institutions

Nuclear Security: The Nexus Between Technology and Policy
Graduate Level Course held at UC Berkeley.

Alumni Highlights

Micah Folsom
Member of the original 2011 NSSC co-hort at UCB. Recently earned PhD at UTK and will soon be starting a position at **ORNL**.

Sarah Laderman
Earned a dual masters in Public Policy and Nuclear Engineering at UCB, now at the **IAEA**.

Andrew Reddie
earned a PhD in Political Science at UCB, Deputy Director of NPWG, now senior staff at **SNL**.

Athena Gallardo
earned a PhD at UNLV, now at **LANL.**

Daine Danielson UCD graduate, recently named a 2020 recipient of the **Hertz Fellowship**.

Stephanie Lyons
completed a postdoc at MSU, now at **PNNL**.

Acknowledgements

NSSC Fall Workshop at LLNL

This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0003180.