Consortium for Monitoring, Technology, and Verification (MTV) Accomplishments

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University Diversity and Social Transformation Professor
Director, Consortium for Monitoring, Technology, and Verification
Director, Diversity, Equity, and Inclusion, College of Engineering
University of Michigan

2023 MTV Workshop
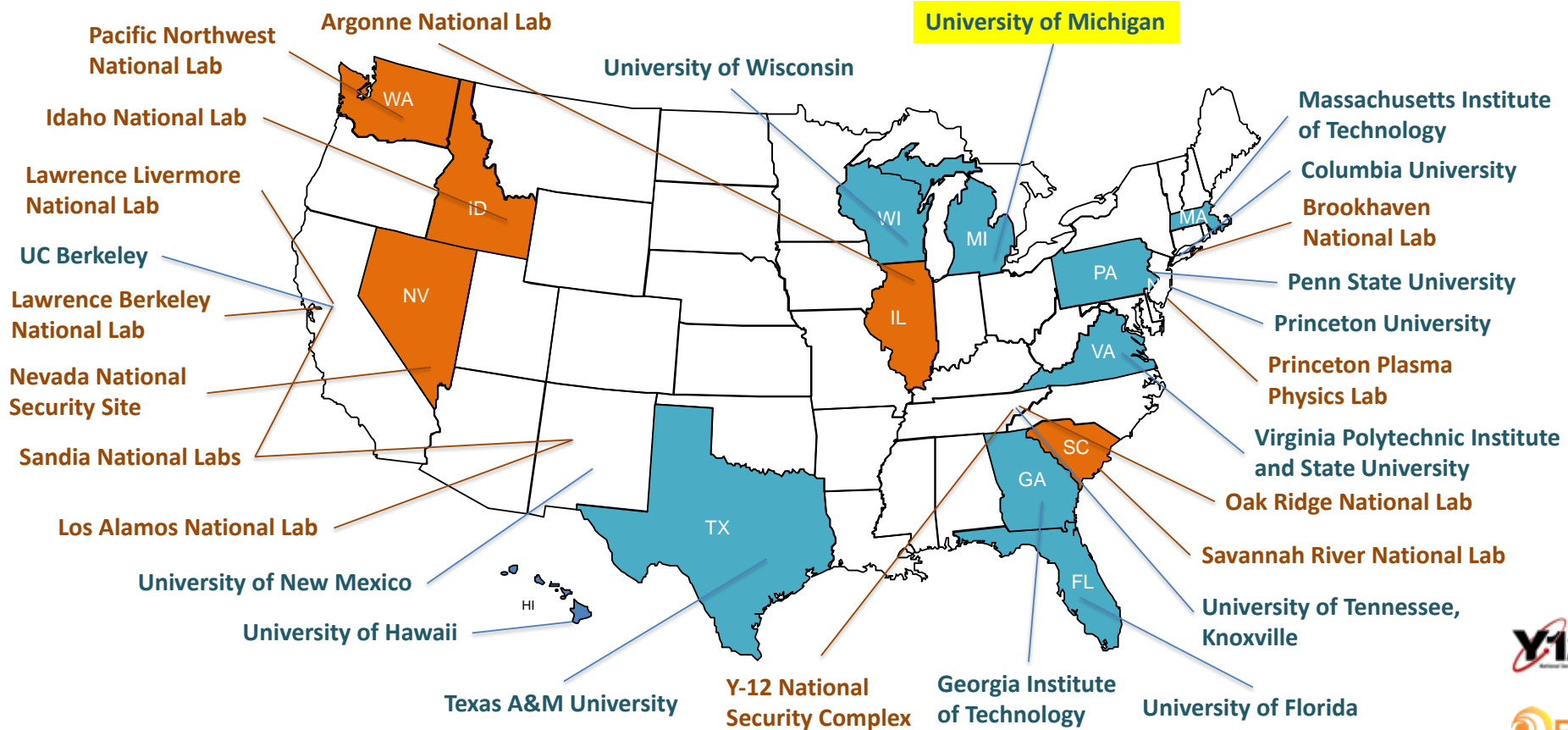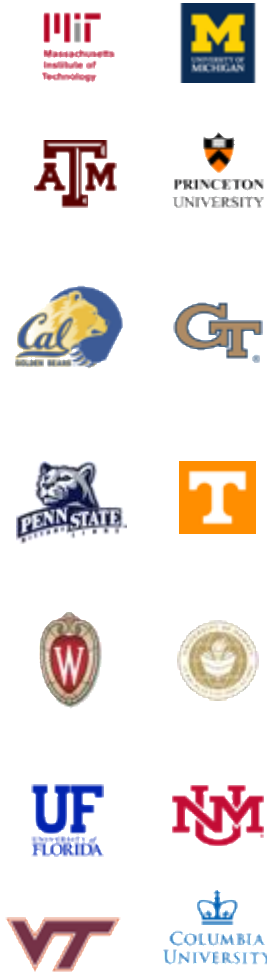March 21, 2023

Motivation and Mission

- Preventing the further spread of nuclear weapons and related technology is paramount to our national security

- Recent world events have significant impact on the nonproliferation landscape

  - North Korea nuclear weapons program and recent rocket tests

  - Possible revival of the Joint Comprehensive Plan of Action with Iran

  - Russia/Ukraine war putting nuclear facilities and nonproliferation at risk

- Timely detection of nuclear proliferation requires a deep understanding of the associated signatures and technology

- The NNSA Consortium mission is to develop new technologies that detect and deter nuclear proliferation activities and to train the next generation of nuclear professionals

The New York Times

ASIA PACIFIC

North Korean Nuclear Test Draws U.S. Warning of 'Massive Military Response'

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By DAVID E. SANGER and CHOE SANG-HUN   SEPT. 2, 2017

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Consortium for Monitoring, Technology, and Verification (MTV)

14 Universities

13 National Labs

Pacific Northwest National Lab
Argonne National Lab
University of Michigan
University of Wisconsin
Idaho National Lab
Massachusetts Institute of Technology
Columbia University
Lawrence Livermore National Lab
Brookhaven National Lab
UC Berkeley
Penn State University
Lawrence Berkeley National Lab
Princeton University
Nevada National Security Site
Princeton Plasma Physics Lab
Sandia National Labs
Virginia Polytechnic Institute and State University
Oak Ridge National Lab
Los Alamos National Lab
Savannah River National Lab
University of New Mexico
University of Tennessee, Knoxville
University of Hawaii
Texas A&M University
Y-12 National Security Complex
Georgia Institute of Technology
University of Florida

WA, iD, NV, WI, MI, MA, PA, IL, VA, SC, GA, TX, FL, HI

MTV Timeline and Outcomes

Phase I: Startup

- Refined research directions
- Recruited talent for MTV fellowships
- Introduced fellows and associates to research activities
- Created collaborations with national laboratories

Phase II: Develop

- Advanced nuclear nonproliferation technologies in 3 thrust areas
- Implemented student and faculty participating in research onsite at national laboratories

Phase III: Apply

- Conducting experiments and simulations for each thrust area
- Implementing and awarding new fellowships
- Developing new and improving existing courses
- Hosting outreach and recruiting events

Phase IV: Transition

- MTV graduates are transitioned into career positions
- Technology is transitioned to national labs, industry, and academia
- Results are published in peer-reviewed journal publications and at conferences

Year 1   Year 2   Year 3   Year 4   Year 5 and on

Research Highlight: Neutrino and Fission Physics

- We are measuring the dependance of the fragments' angular momenta on the excitation energy of the fissioning system

- Collaboration with Argonne National Laboratory

- The results of these experiments will be used to improve models of fission

Stefano Marin, Nathan Giha, Sara Pozzi
University of Michigan

PROSPECT Detector

HFIR Core
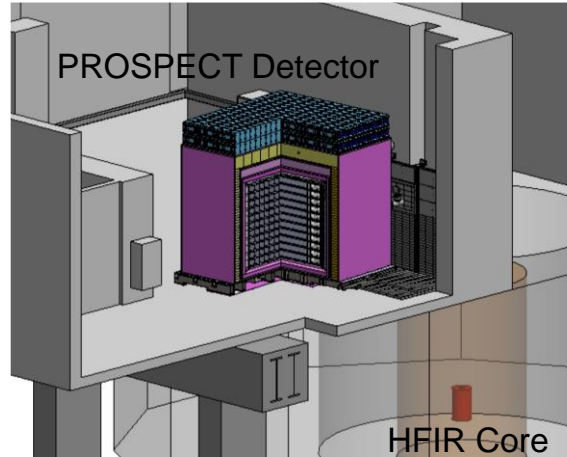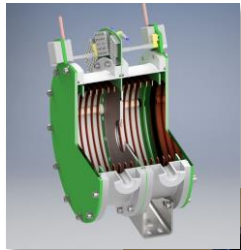
- We are analyzing antineutrino data from the PROSPECT detector at the High Flux Isotope Reactor

- Precise measurement of reactor flux will demonstrate this technology towards commercial reactor monitoring

Paige Kunkle, David Campbell
Boston University

Prompt PSD

n − ^{6}Li

nuclear recoil

proton recoil

prompt/gamma
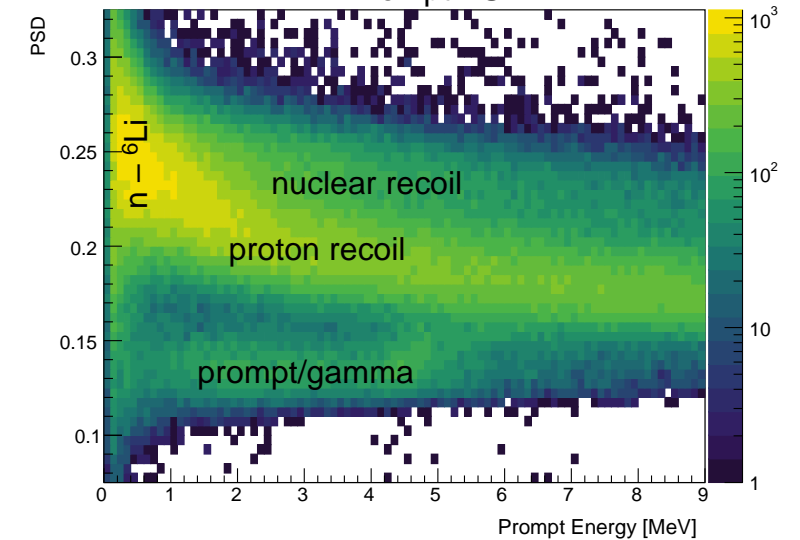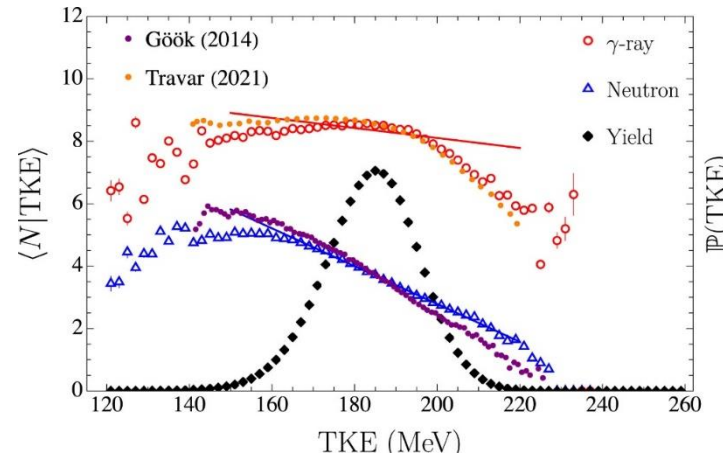
Research Highlight: Reactor Experiments

- Conducted new experiments for nuclear reactor monitoring and forensics signature discovery

  - beam characterization at the OSU Reactor Measurements

  - UM neutron noise measurements at the CROCUS Reactor at EPFL, Switzerland

  - Sample irradiation at Missouri University Research Reactor for MCNP6.2 model validation

  - Epithermal neutron chopper designed for the Breazeale Reactor at PSU to perform neutron activation analysis

- We are developing better ways to monitor the power levels of a nuclear reactor, analyze materials in the fuel cycle, and detect radioactive emissions
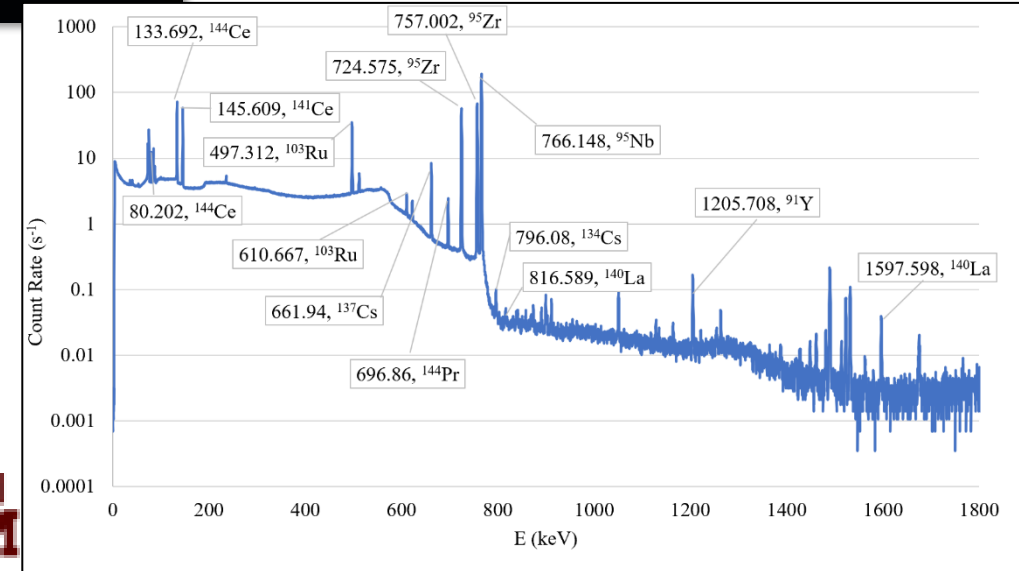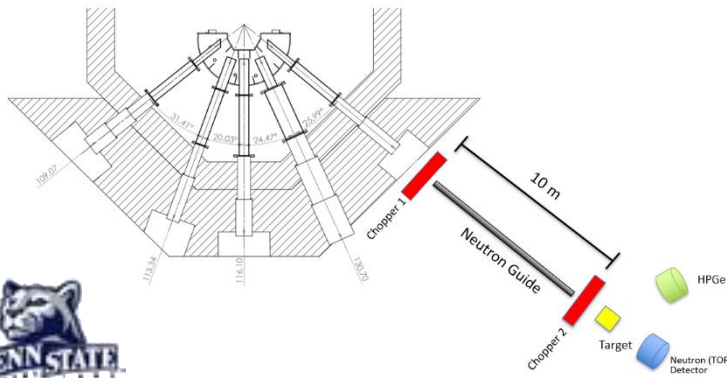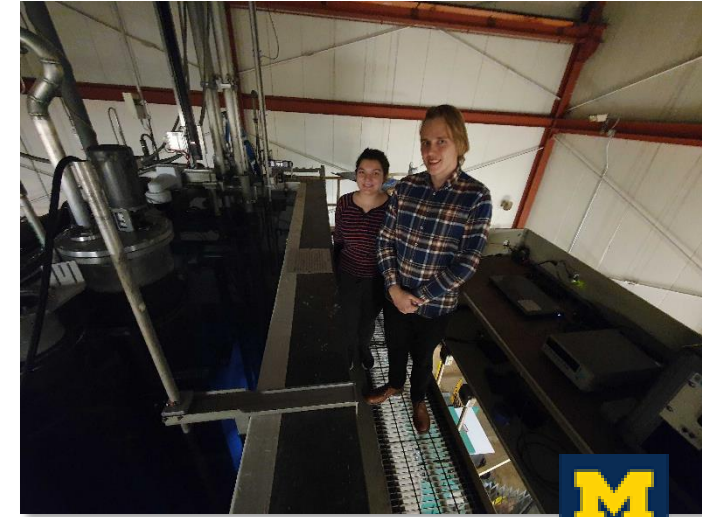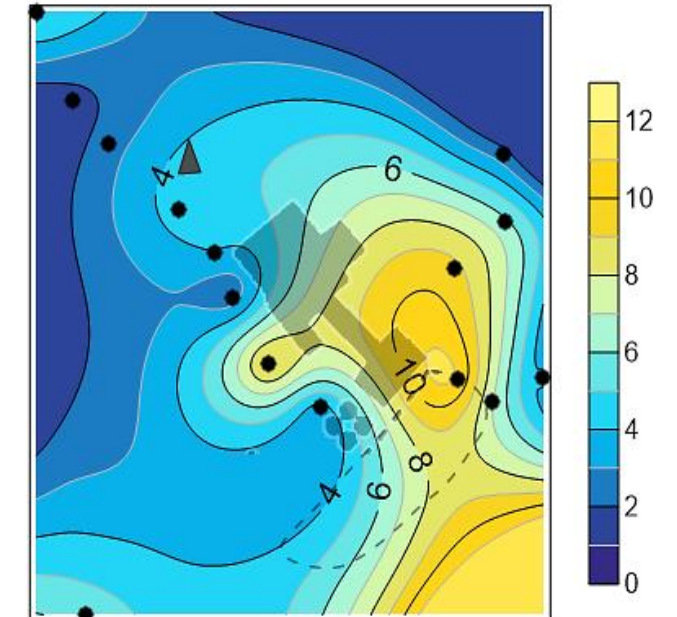
Research Highlight: Microbial biosensors for detection of nuclear proliferation
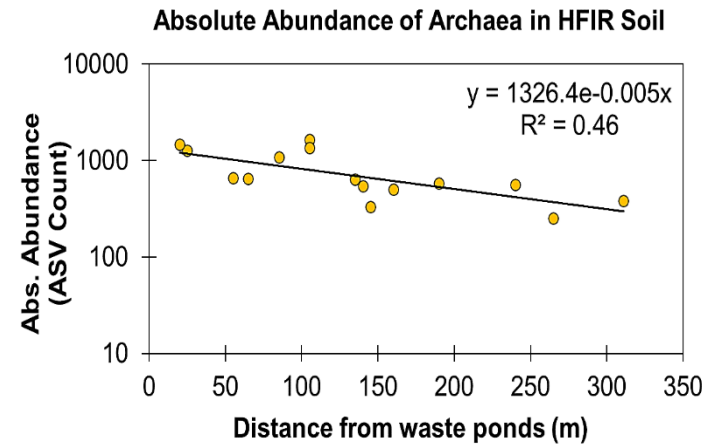
- Environmental sampling is important for monitoring and detecting proliferation-sensitive nuclear activities

- This work explores microbial community dynamics in environments exposed to proliferation-sensitive fuel cycle activities to inform remote detection and monitoring technologies

Phylum-Level Classification of HFIR Soil Microbial Communities
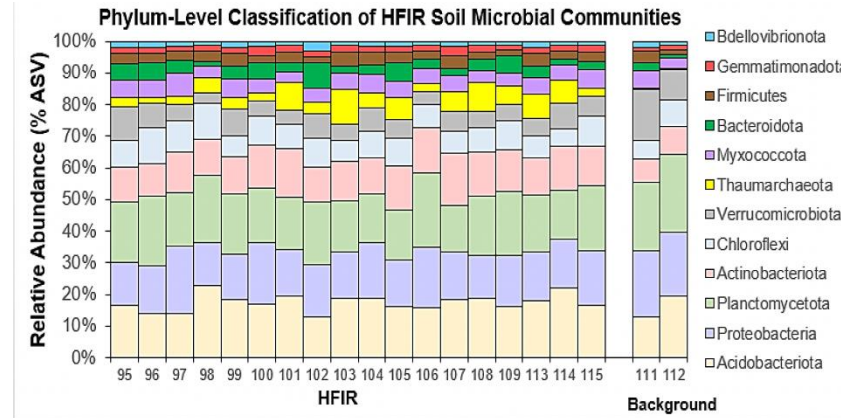
Thaumarchaeota Relative Abundance (%)

Absolute Abundance of Archaea in HFIR Soil

$$y = 1326.4e^{-0.005x}$$
$$R^2 = 0.46$$

Isis Fukai   Kurt Ash

University of Tennessee, Knoxville

HFIR Facility   Sample location

Historical Waste Ponds   Emission Stack

# Research Highlight: Background Seismicity near the DPRK Test Site

- Use of historic Dongbei sensor network data to better understand background seismicity around the North Korea test site

- Background characterization improves our capability to monitor, understand, detect, locate, and characterize an explosion

Won-Young Kim, Paul Richards
Columbia University
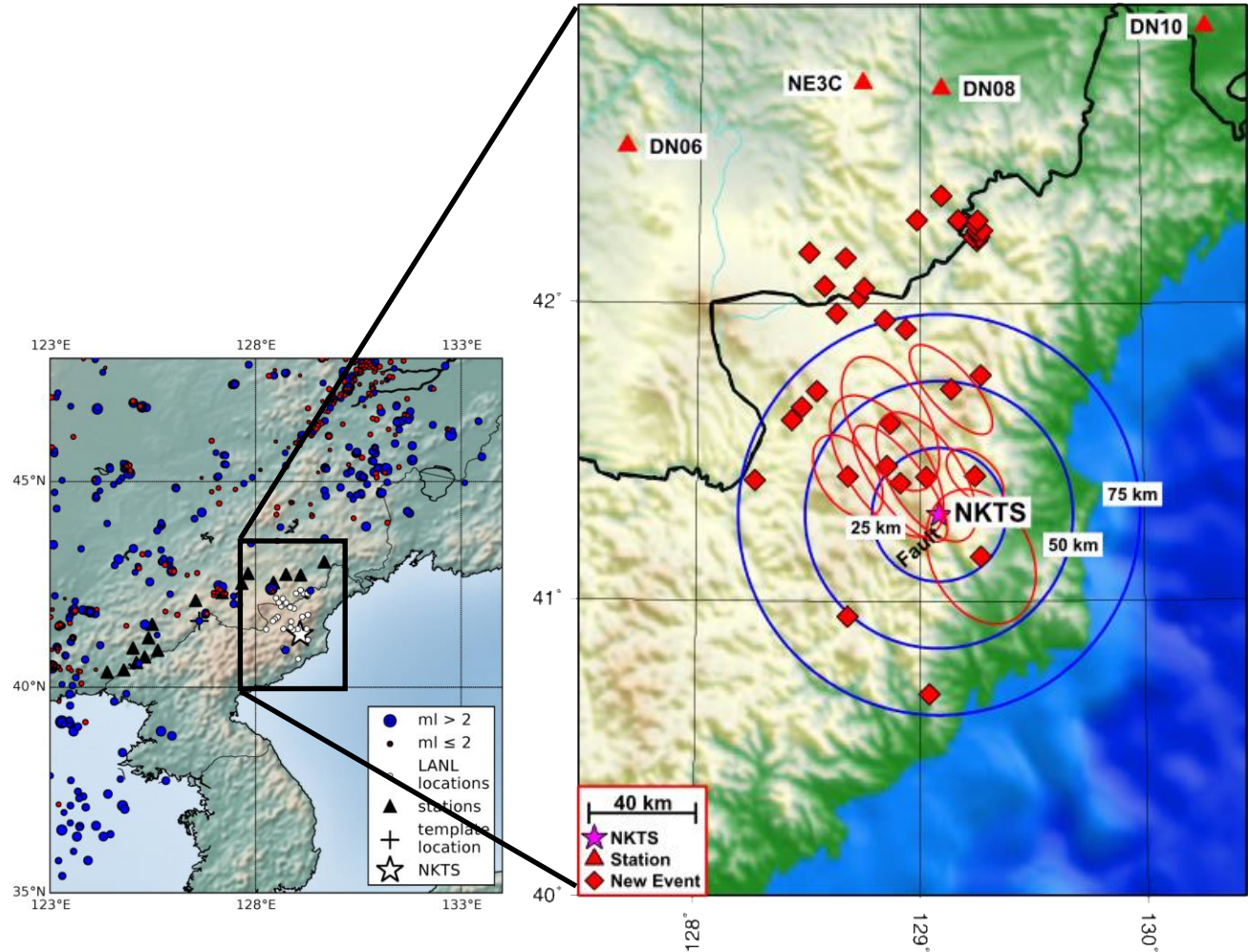
University of Michigan Consortia Student Advancement Models
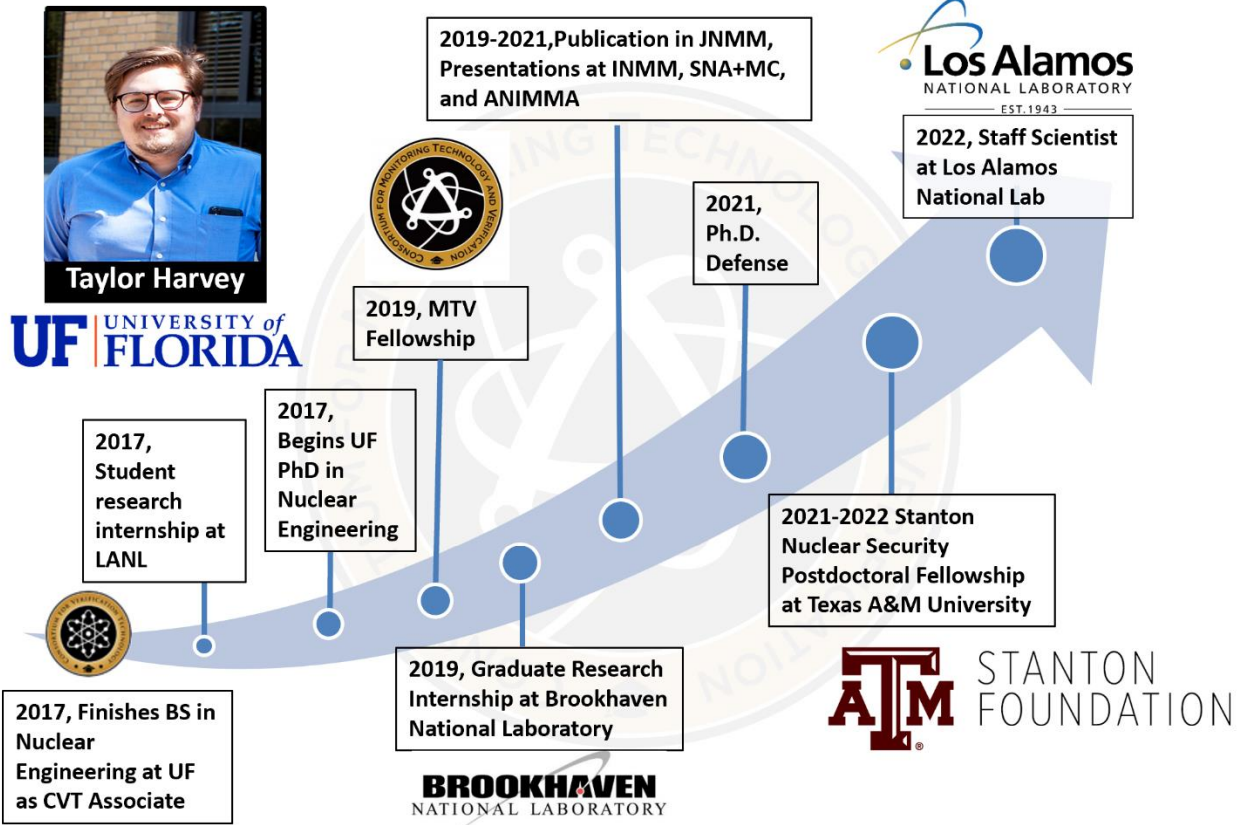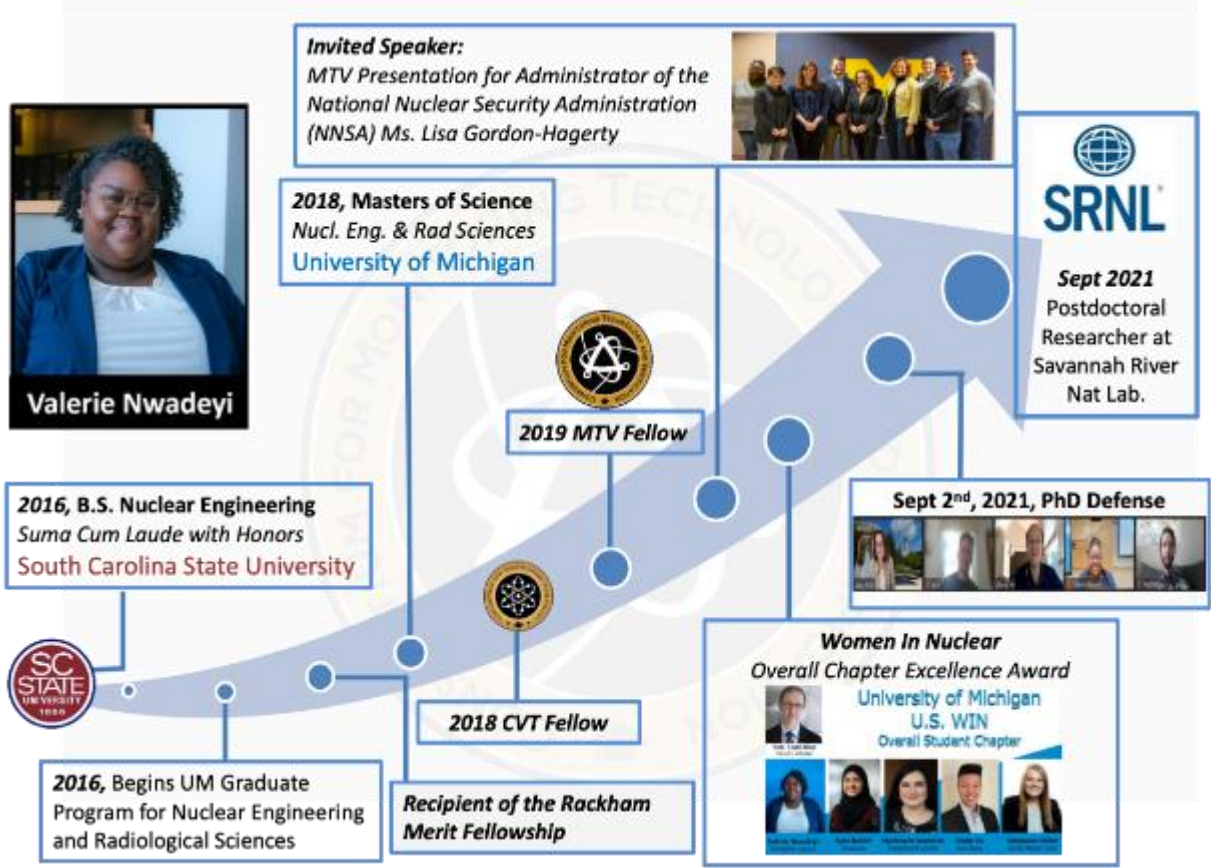
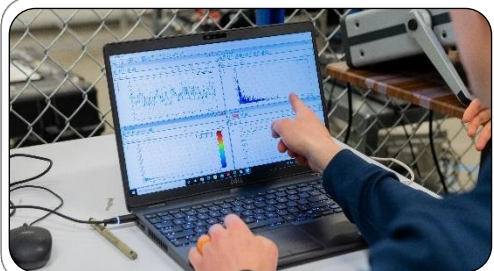# MTV Students: 133 Degrees Earned as of December 2022

 Ph. D. and Postdoc **28**

 Masters Degrees **35**
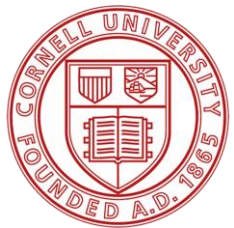
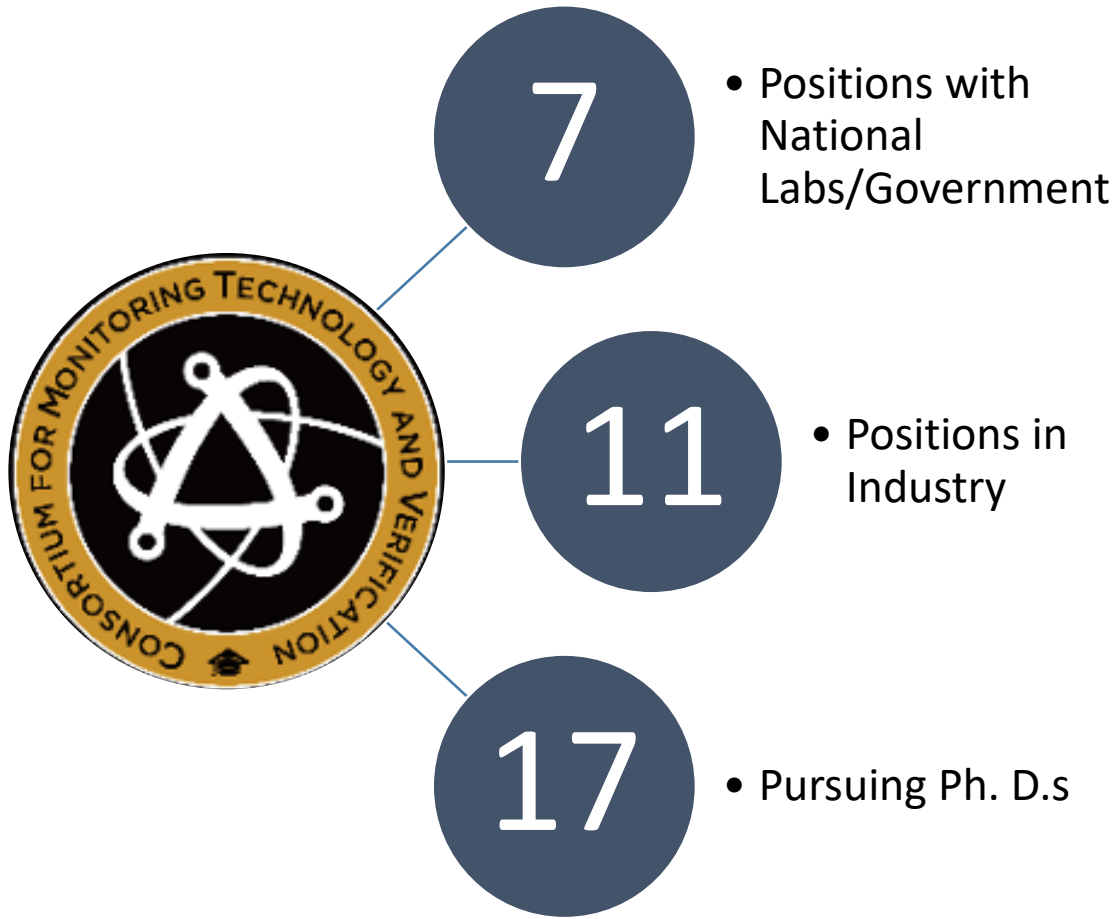 Undergraduate Degrees **71**

Consortium for Monitoring, Technology, and Verification (MTV)
Launching Careers: 28 Ph. D.s and Postdocs Graduated and Transitioned

35 MTV Masters Students: Graduated and Transitioned

7 • Positions with National Labs/Government

11 • Positions in Industry

17 • Pursuing Ph. D.s

MTV-Developed Courses

- Penn State University, Prof. Flaska, NucE450: Radiation Detection and Measurement. Students: 45
- Princeton University, Prof. Glaser, MAE 518: Virtual and Augmented Reality (VR/AR) for Scientists, Engineers, and Architects. Students: 36
- Texas A&M University, Prof. Chirayath, NUEN-651: Nuclear Fuel Cycles and Nuclear Material Safeguards. Students: 22
- University of Michigan, Prof. Pozzi, NERS 532: Nuclear Safeguards (collaboration with Oak Ridge National Laboratory). Students: 13
- University of Michigan, Prof. Pozzi, NERS 590-3: New Scintillators (collaboration with Oak Ridge National Laboratory). Students: 9

Education and Workshops

- MTV Annual Workshops: 525+ attendees since 2020

- MCNP / MCNPX-PoliMi Workshop: 63 participants since 2020

- UK-US Academic Network in Nuclear Security and Nonproliferation Skills Workshop 2021 (virtual): 27 lectures from 3 Consortia

- Nuclear Engineering Summer School (NESS): 700+ Attendees in 3 Years and lecturers from MTV students, faculty, and national lab affiliates

Early Engagement and Outreach

- Lab tours for elementary, junior high, and high school students

- Undergraduate research fellowships

- Do-it-yourself Geiger counter for radiation detection with high-school students
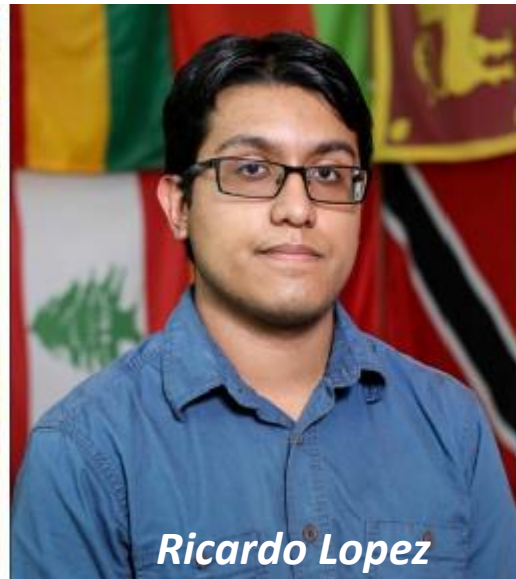
- UM-UNM Summer Research Experience
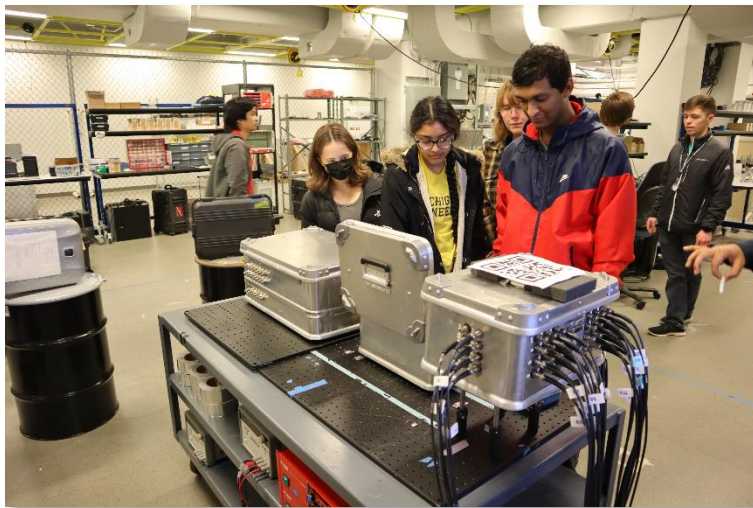
MTV Diversity and Excellence Fellows

The Consortium for Monitoring, Technology, and Verification (MTV) and Michigan Engineering (ME) recently created the MTV-ME Fellowship for Excellence and Diversity for undergraduate and graduate students.

Prabhjot Kaur   *Ricardo Lopez*   *Tessa Maurer*

MTV Diversity and Excellence Fellows awarded in Fall 2022

Current call for MTV Diversity and Excellence Fellows:

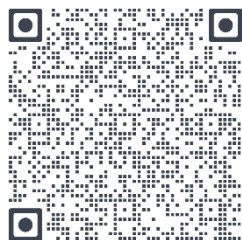# MTV Doctoral Fellows in Applied Antineutrino Physics

Graduated Fellows

Connor Awe
Duke University
2019 Fellow
Experimental Physicist,
SRI International

Kristofer Ogren
University of Michigan
2019 Fellow
Postdoc,
Los Alamos National Lab

Current MTV Doctoral
Fellow in Applied
Antineutrino Physics Call:

Current Fellows

Edward Callaghan
UC, Berkeley
2019 Fellow

Matthew Lee
Texas A&M University
2021 Fellow

Paige Kunkle
Boston University
2022 Fellow

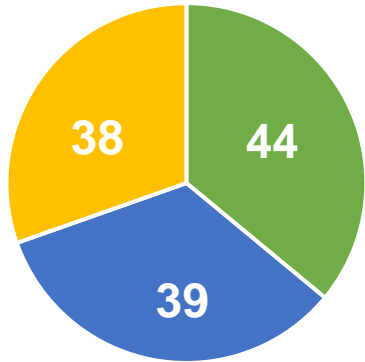Tyler Johnson
Duke University
2019 Fellow

Garrett Wendel
Penn State
University
2021 Fellow

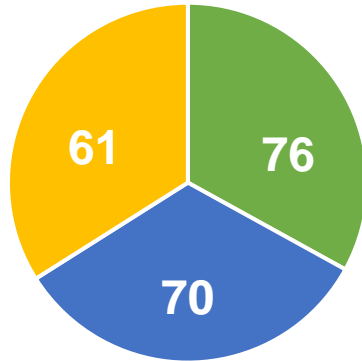Ryan Bouabid
Duke University
2022 Fellow

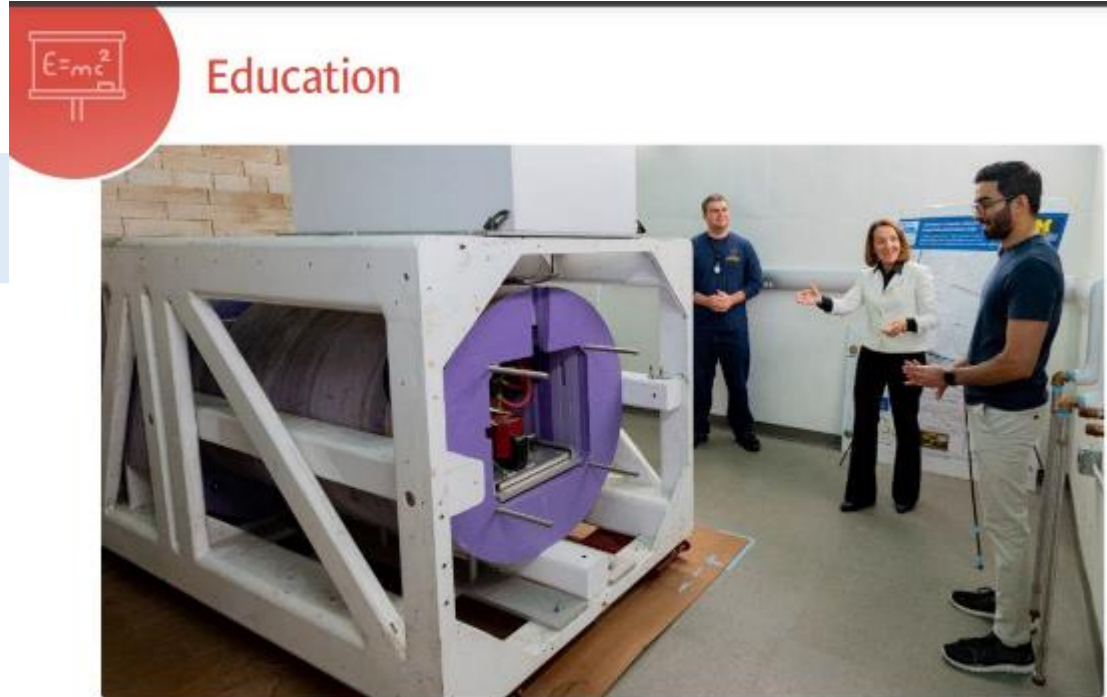# Publications: September 2019 - December 2022

121
Peer-reviewed Journals

- TA1
- TA2
- TA3

207
Conference Papers

- TA1
- TA2
- TA3

Education

Professor Sara Pozzi with students and researchers in the UM Detection for Nuclear Nonproliferation Group lab. (Photo: Daryl Marshke, University of Michigan)

The MTV at the cutting edge of nonproliferation technology

NuclearNews Article, ANS, July 2022:

Website, Social Media, and Engagement with Public

MTV Website:

www.mtv.engin@umich.edu

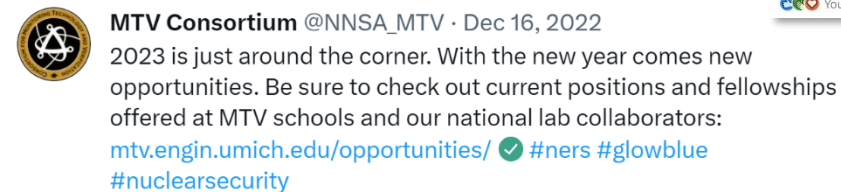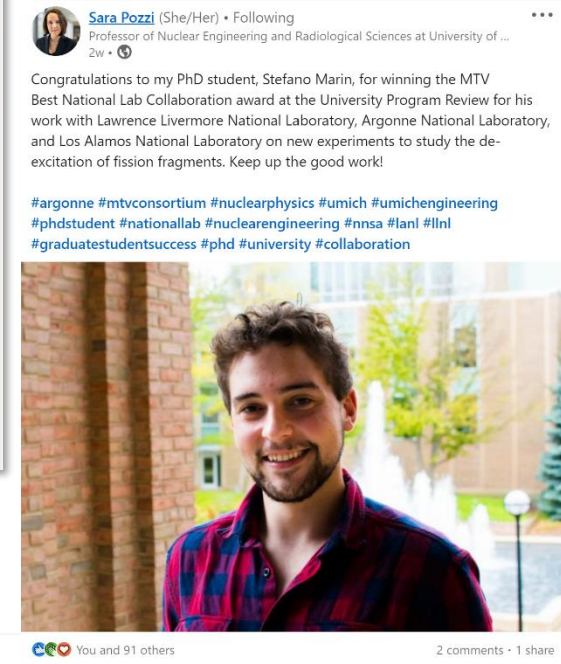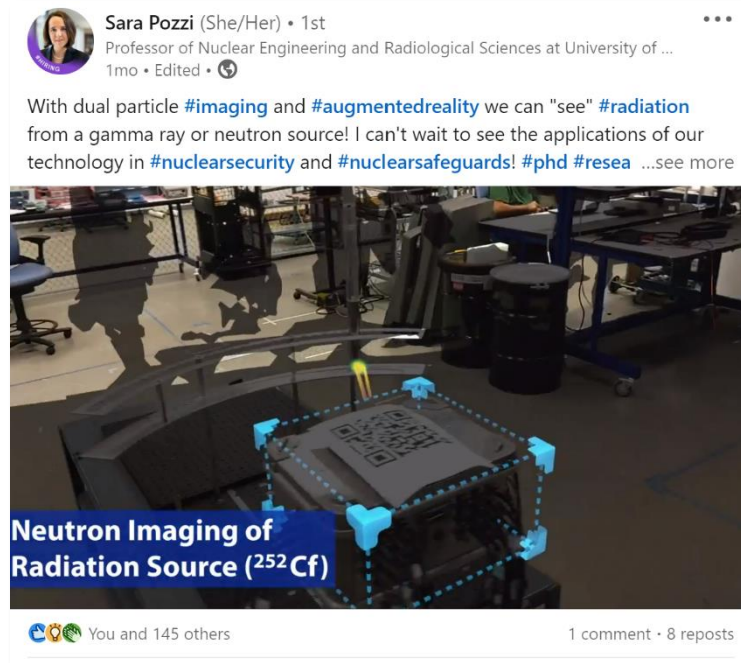a. Website Traffic: over 34,000 sessions by 19,500 users since 2019

Thousands of views generated by social media:

- LinkedIn: https://www.linkedin.com/in/sara-pozzi-a98ab813/
- Twitter: @NNSA_MTV
- Facebook: @NNSA.MTV
- YouTube: MTV Consortium, 133 videos available

Invited talks: 129

Interactions with press: 28

Interactions with public: 118

MTV Hosted University Program Review (UPR) in June 2022

- UPR hosted in-person meeting June 7-9, 2022, in Ann Arbor, MI

- Three DNN R&D-funded consortia welcomed

- 273 participants

- 54 oral research presentations

- 70 posters

- Three MTV students awarded best presentation awards:

  - Best National Lab Collaboration: Stefano Marin, University of Michigan

  - Best Oral Talk: Kelly Truax, University of Hawai'i at Manoa

  - Best Poster Presentation: Eric Lepowsky, Princeton University

MTV Welcomed Administrator Hruby

- Under Secretary for Nuclear Security and NNSA Administrator Jill Hruby visited the University of Michigan (UM) September 2022
- Presented "U.S. Nuclear Security: The Need to be Responsive and Responsible"
- Awarded the Nuclear Science Week 2022 Nuclear Lifetime Achievement Award
- Visited UM Nuclear Engineering and Radiological Sciences Labs

MTV Impact

- Trained next-generation workforce

- Extended the understanding of ^{252}Cf spontaneous fission to improve fission codes

- Improved reliability of nuclear reactor monitoring for existing and proposed reactors through reactor experiments at several sites

- Refined our ability to detect fuel cycles via analysis of biological samples

- Improved our capability to detect, locate, and characterize nuclear explosions through analysis of seismic data from the Dongbei sensor network

The Consortium for Monitoring, Technology, and Verification would like to thank the DOE-NNSA for the continued support of these research activities.