2023 Newsletter

Consortium for Monitoring, Technology, and Verification

Professor Sara A. Pozzi, Director
mtv.engin.umich.edu

Director's Letter

Preventing the further spread of nuclear weapons is one of the central challenges facing our society today. The development of a nuclear weapons program by a state actor, or the acquisition of a nuclear device by a rogue organization, has the potential for creating domestic unrest, political instability, and economic disruption on the national and global scale.

As I read through this annual newsletter, I am amazed by all that the MTV team has accomplished to address the nonproliferation mission. Collaborations between universities and national laboratories continue to grow, as evidenced by joint research papers and collaborative experiments. The MTV continues to develop state-of-the-art technology to support the nation's nuclear nonproliferation. We are actively transitioning these technologies to national laboratories, industry, and the International Atomic Energy Agency.

Ensuring that our trainees have the required skills and commitment to further our nation's nuclear nonproliferation agenda is a top priority of the MTV. We do so by providing a strong pipeline for the future NNSA workforce, launching careers within the national laboratories, government, academia, and industry. Through the MTV consortium, we have supported and trained 308 students and granted 136 degrees: 71 undergraduate, 35 Masters, and 30 Ph.D. Students of all levels conduct research in the three MTV thrust areas: fundamentals of nuclear and particle physics, signals and source terms for nuclear nonproliferation, and nuclear explosion monitoring. The results of this research have been published in 129 peer-reviewed journal articles and 217 conference papers.

The nonproliferation mission requires top talent to address current and emerging challenges. To ensure that we engage a diverse talent pool, we established new initiatives in diversity, equity, and inclusion. We funded a new Diversity and Excellence Fellowship and awarded three graduate fellows, with a new class of fellows being selected. This year we held the first DEI panel discussion at our MTV Workshop bringing members of our community to discuss DEI challenge areas and ideas for improvement. MTV is committed to establishing and maintaining a fair, equitable environment for all people where everyone is included and can do their best work.

I am excited about the work that our team is performing and the relationships and collaborations that have ensued. I am looking forward to what the coming year will bring for MTV.

Sara Pozzi
University of Michigan (UM) Diversity and Social Transformation Professor
Director, Consortium for Monitoring, Technology, and Verification
Director, Diversity, Equity, and Inclusion, U-M College of Engineering

Contents

Our Members

UNIVERSITIES
Columbia University
Georgia Institute of Technology
Massachusetts Institute of Technology
Pennsylvania State University
Princeton University
Texas A&M University
University of California, Berkeley
University of Florida
University of Hawai'i
University of Michigan
University of New Mexico
University of Tennessee, Knoxville
University of Wisconsin
Virginia Polytechnic Institute

NATIONAL LABORATORIES
Argonne National Lab
Brookhaven National Lab
Idaho National Lab
Los Alamos National Lab
Lawrence Berkeley National Lab
Lawrence Livermore National Lab
Nevada Nuclear Security Site
Oak Ridge National Lab
Pacific Northwest National Lab
Princeton Plasma Physics Lab
Sandia National Lab
Savannah River National Lab
Y-12 National Security Complex

MTV Leadership Team

Mission and Motivation

- Preventing the spread of nuclear weapons and related technology is paramount to our national security
- Timely detection of nuclear proliferation requires a deep understanding of the associated signatures and technology to detect them
- The MTV's mission is to develop new technologies that detect and deter nuclear proliferation activities and to train the next generation of nuclear professionals

Executive Leadership

Prof. Sara Pozzi
Director
University of Michigan

Prof. David Wehe
Chief Scientist
University of Michigan

Prof. Igor Jovanovic
Associate Director for National Laboratories
University of Michigan

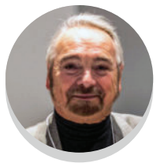
Dr. Shaun Clarke
Associate Director
University of Michigan

Ms. Courtney Wagoner
Project Manager
University of Michigan

External Advisory Board

Dr. Richard Kouzes
Pacific Northwest National Laboratory

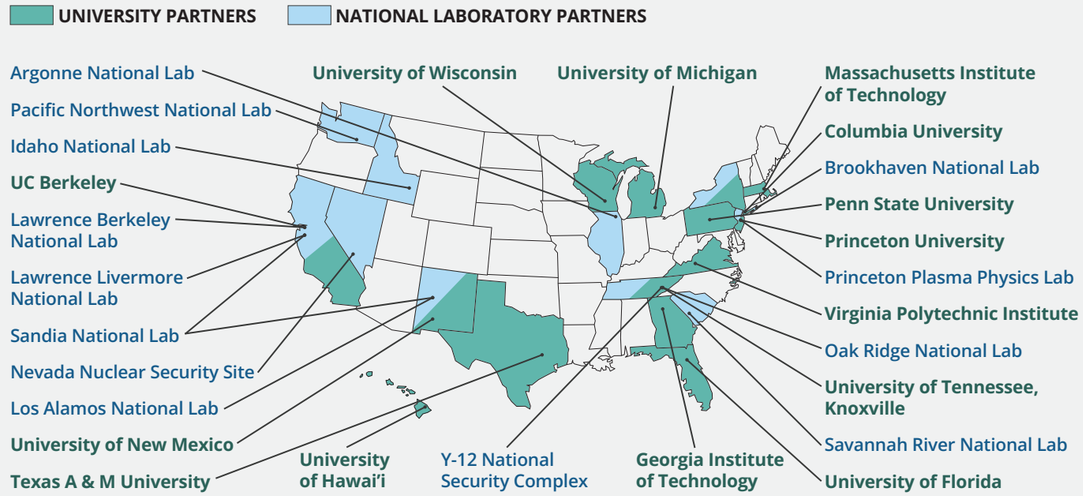
Dr. Nancy Jo Nicholas
Los Alamos National Laboratory



Dr. Vladimir Protopopescu
Oak Ridge National Laboratory

Dr. James Tiedje
Michigan State University

Dr. Amy Waters
Lawrence Livermore National Laboratory



Thrust Areas

THRUST AREA 1
Fundamentals of Nuclear and Particle Physics

LEAD:
Prof. Igor Jovanovic,
University of Michigan

Reaction Theory and Modeling
- S. Pozzi – U. Michigan
- C. Perfetti – U. New Mexico

Novel Imaging Techniques
- Z. He – U. Michigan
- D. Wehe – U. Michigan
- A. Hecht – U. New Mexico

Antineutrino-Based Methods
- A. Erickson – Ga Tech.
- P. Huber – Va Tech.
- J. Learned – U. Hawai'i
- I. Jovanovic – U. Michigan

THRUST AREA 2
Signals and Source Terms for Nuclear Nonproliferation

LEAD:
Prof. Steven Biegalski,
Georgia Institute of Technology

Isotopic Science
- S. Biegalski – Georgia Tech.
- A. Danagoulian – MIT
- M. Flaska – Penn St. U.

Spatial/Temporal Spectroscopic Analysis
- I. Jovanovic – U. Michigan

In Situ Natural Monitoring (biota)
- T. Hazen – UTK
- E. Alm – MIT
- A. Arkin – UC Berkeley
- H. Dulai – U. Hawai'i

Nuclear Fuel Cycle Process Modeling
- P. Wilson – U. Wisconsin
- S. Chirayath – TAMU
- A. Glaser – Princeton U.

Radiation Transport
- B. Kiedrowski – U. Michigan
- A. Prinja – U. New Mexico

THRUST AREA 3
Nuclear Explosion Monitoring

LEAD:
Dr. Milton Garcés,
University of Hawai'i

Infrasound
- M. Garcés – U. Hawai'i

Seismology
- G. Ekstrom – Columbia U.
- P. Richards – Columbia U.
- W-Y. Kim – Columbia U.

Methodologies for Wide Area Environmental Sampling
- K. Hartig – U. Florida

Radiation Background Monitoring
- K. Kearfott – U. Michigan

Environmental Fate and Transport of Radionuclides
- A. Enqvist – U. Florida

Radionuclide
- S. Pozzi – U. Michigan

Cross-Cutting Thrusts

Modeling and Simulation
Prof. Brian Kiedrowski
University of Michigan

Nuclear Policy
Prof. Paul Wilson
University of Wisconsin

Education and Outreach
Prof. Kimberlee Kearfott
University of Michigan

MTV Timeline and Outcomes

PHASE 1: STARTUP

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

YEAR 1/YEAR 2

PHASE 2: DEVELOP

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

YEAR 3

PHASE 3: APPLY (CURRENT PHASE)

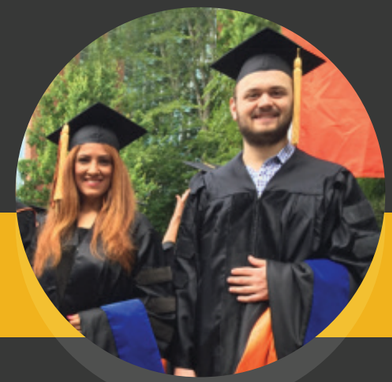
- Conducting experiments and simulations for each thrust area
- Implementing and awarding new fellowships
- Developing new and improving existing courses
- Hosting outreach and recruiting events

YEAR 4

PHASE 4: TRANSITION

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

YEAR 5 AND ON



136 **Degrees Earned**
by MTV students (2019 – March 2023)

30
Ph.D. and Postdoc

35
Master's Degrees

71
Undergraduate Degrees

Launching Careers

GOVERNMENT

William Koch
Massachusetts Institute of Technology

ACADEMIA

David Bernstein
University of California, Berkeley

Lauren Finney
University of Michigan

Abbas Johar Jinia
University of Michigan

Oskari Pakari
University of Michigan

Tamara Patton
Princeton University

Arrielle Opotowsky
University of Wisconsin

Noora Ba Sunbul
University of Michigan

Tingshiuan Wu
University of Michigan

INDUSTRY

Connor Awe
Duke University

Nicholas Grenci
Penn State University

Michael Hua
University of Michigan

Stefano Marin
University of Michigan

Christopher Meert
University of Michigan

Niral Shah
University of Michigan

William Steinberger
University of Michigan

Emily Vu
University of Michigan

Pengyang Xiu
University of Michigan

30 **MTV Ph.D. and Postdoc graduates have moved on to careers in academia, government, industry and national labs**

NATIONAL LABORATORIES

Argonne National Lab

Sean Martinson
Texas A&M University

Lawrence Berkeley National Lab

Jayson Vavrek
Massachusetts Institute of Technology

Lawrence Livermore National Lab

Evan Gonzalez
University of Michigan

Noah McFerran
University of Florida

Felicia Sutanto
University of Michigan

Savanah River National Lab

Valerie Nwadeyi
University of Michigan

Los Alamos National Lab

Ezra Cockram
University of Florida

Taylor Harvey
University of Florida

Kristopher Ogren
University of Michigan

Patrick O'Rourke
University of New Mexico

Patrick Skrodzki
University of Michigan

Daniel Timmons
University of New Mexico

Awards and Accomplishments

MTV Director Professor Sara Pozzi appointed University of Michigan Diversity and Social Transformation Professor

The University of Michigan Board of Regents approved the appointment of Prof. Sara Pozzi as a University Diversity and Social Transformation Professor (UDSPT). This professorship recognizes and rewards senior faculty members for their outstanding contributions to excellence through their commitment to promoting DEI within their scholarship, teaching, service and engagement. The UDSTP program is sponsored by the Provost's Office and jointly administered by NCID and the Office of Diversity, Equity & Inclusion.

Georgia Tech Undergraduate Wins College of Engineering Outstanding Undergraduate Research Award for Nuclear and Radiological Engineering

Ms. Caryanne Wilson, MTV Associate, wins Georgia Tech College of Engineering Outstanding Undergraduate Research award for her work on the development of a PIPS-based coincidence detector project, "Characterization of Passive Implemented Planar Silicon Detector for Radioxenon Detection." Upon her graduation from Georgia Tech this spring, Caryanne will be joining the University of Michigan Ph.D. program in Nuclear Engineering and Radiological Sciences, working with MTV Director Pozzi and Prof. Jovanovic.

Caryanne Wilson

University of Michigan Students Received NPSS Graduate Scholarship Awards

Two University of Michigan Ph.D. students were recognized for their contributions to the fields of Nuclear and Plasma Sciences. Congratulations to Nathan Giha and Ricardo Lopez as they received the NPSS Graduate Scholarship Award. This prestigious award is funded by the IEEE Nuclear and Plasma Sciences Society (NPSS) and the prize includes a certificate, $1,500, and a one-year membership in the NPSS. An award ceremony will take place on the University of Michigan campus later this year.

Nathan joined the Detection for Nuclear Nonproliferation Group (DNNG) as an undergraduate at the University of Michigan, where he developed silicon photomultiplier readout electronics for compact neutron imaging systems. In Fall of 2019, he continued with the group as a Ph.D. student. His graduate research focuses on quantifying the relationship between the energy and angular momentum of fission fragments through correlated measurements of fragment properties and the prompt neutrons and gamma rays they emit.

Ricardo graduated from the University of Michigan in 2020 with a B.S.E in Nuclear Engineering and Radiological Sciences and then joined the DNNG in the Fall of 2020 while pursuing a master's degree. In the Fall of 2021, he continued with the DNNG as a Ph.D. student. His current research interests include organic scintillators and nuclear safeguards. His graduate research focuses on particle imaging for nonproliferation applications.

Nathan Giha

Ricardo Lopez

University of Florida Ph.D. Student/MTV Fellow awarded ANS Graduate Scholarship

Brice Turner

MTV fellow student Brice Turner was awarded an ANS graduate scholarship last summer (2022). The American Nuclear Society (ANS) student members are the future of the society and ANS believes in rewarding those members for their academic, service, and leadership excellence. ANS scholarships are awarded to applicants that have personified the high standards set by the Society and since 1979, over $5 million in scholarships have been distributed.

Brice completed his bachelor's degree in Mechanical Engineering at Embry-Riddle Aeronautical University, Daytona Beach, FL, in May 2022. He came to the University of Florida and Dr. Enqvist's group in August 2022 to pursue his Ph.D. in Nuclear Engineering Sciences. Brice's research is in atmospheric transport of radioxenon for localization and characterization of clandestine underground nuclear tests (UGT).

U-M's Lopez Receives Student Paper Award

MTV Excellence and Diversity Fellow and University of Michigan Ph.D. student, Ricardo Lopez, received the prestigious Third Place Student Paper Award for his poster "Shielded Californium-252 Measurements Using an Organic Glass Dual Particle Imager" at the recent 2022 IEEE Nuclear Science Symposium, Medical Imaging Conference and Room Temperature Semiconductor Detector (IEEE NSS-MIC-RTSD) Conference in Milan, Italy. Ricardo was among over 300 poster presenters at IEEE NSS-MIC-RTSD. The IEEE NSS-MIC-RTSD is a unique meeting in the field of radiation detectors and instrumentation, with a broad range of applications, fields of study and experiences of the thousands of attendees and presenters.

Ricardo Lopez is working on particle imaging with the intent of finding application in nuclear safeguards and nuclear nonproliferation fields. Specifically, his research involves utilizing silicon photomultiplier arrays and organic scintillator detectors. Lopez recently led the development of a new version of the handheld dual particle imager (H2DPI) based on organic glass scintillators.

Princeton Team participates in UNIDIR experiment

In March 2023, MTV Fellow Eric Lepowsky and MTV Faculty Alex Glaser, both from Princeton University, participated in a verification experiment organized by the UN Institute of Disarmament Research (UNIDIR) at a former military facility in Menzingen, Switzerland. The Princeton team oversaw the radiation measurements conducted as part of a mockup onsite inspection and provided the gamma-radiation measurement system used to confirm the absence of nuclear weapons.

Eric Lepowsky is a Ph.D. student and National Science Foundation Graduate Fellow in the Department of Mechanical and Aerospace Engineering at Princeton University, where he is a member of the Program on Science and Global Security (SGS). Eric is researching the application of robotics to nuclear safeguards and arms control, including the development of an autonomous mobile robot equipped with directional neutron detectors. His work was previously recognized with the J. D. Williams Student Paper Award (Divisional Winner in Nonproliferation and Arms Control) at the INMM/ESARDA 2021 Joint Annual Meeting. Prior to joining SGS, Eric graduated from the University of Connecticut with a Bachelor of Science in Engineering degree in Mechanical Engineering with a minor in Mathematics.

University of Michigan Ph.D. student gives colloquium at LANL

Kyle Beyer, Ph.D. student at the University of Michigan, recently gave a colloquium for the Nuclear and Particle Physics, Astrophysics and Cosmology in the Theoretical Division at Los Alamos National Laboratory on his dissertation work, entitled "Extending optical models to the fission fragment region". Kyle will also be presenting this work at the Information and Statistics in Nuclear Experiment and Theory (ISNET-9) workshop in St. Louis in May 2023.

Kyle is working on extending nuclear reaction and structure models away from beta stability and towards the neutron-rich fission fragment region by folding experimental fission observables into the corpus of data that these models are fit to. It is unknown how well current models, which are only fit to stable isotopes, extrapolate to the fission fragment region. Predictive nuclear theory for neutron-rich isotopes has recently been identified as a key goal for the field, and it has implications on nuclear energy, non-proliferation and nuclear forensics, as well as astrophysics.

2023 MTV Excellence and Diversity Fellows

The Consortium for Monitoring, Technology, and Verification (MTV) and Michigan Engineering are proud to announce three recipients of the new MTV Fellowship for Excellence and Diversity. The new fellowship is in alignment with MTV's mission to develop new technologies that detect and deter nuclear proliferation activities and train the next generation of nuclear professionals.

PRABHJOT KAUR
Prabhjot Kaur is working on gamma-ray imaging and characterization with 3-D position sensitive pixelated Cadmium Zinc Telluride, focused on nuclear nonproliferation. Kaur is working on a handheld system that allows for real-time source location, characterization, and 3D gamma-ray imaging.

RICARDO LOPEZ
Ricardo Lopez is working on particle imaging with the intent of finding application in nuclear safeguards and nuclear nonproliferation fields. Specifically, his research involves utilizing silicon photomultiplier arrays and organic scintillator detectors. Lopez recently led the development of a new version of the handheld dual particle imager (H2DPI).

TESSA MAURER
Tessa Maurer is working on artificial neural networks with applications in photon-based active interrogation scenarios and has been aiding in the development/characterization of a new organic glass scintillating material with the potential for radioxenon monitoring.

127
Attendees

18
Universities

11
National Laboratories

2023 MTV Workshop

The Consortium for Monitoring, Technology, and Verification (MTV) held a successful annual workshop March 21–22, 2023 in Ann Arbor, MI. There were 127 attendees in-person from 18 universities, 11 national laboratories, and the government. Workshop activities included presentations consisting of 25 oral talks and 40 posters. The workshop was hosted in-person at the Michigan League on the University of Michigan's campus and on a Zoom webinar.

The consortium held a welcome dinner for workshop attendees Monday, March 20 at the University of Michigan Museum of Art, where Jessica Bufford of the Nuclear Threat Initiative gave a keynote speech, "Curiosity, Connection, and Commitment in Nuclear."

Two panels were held during the two-day event: CVT/MTV Consortium Alumni and DEI Initiatives and Successes. During these panels, 10 panelists from academia and the national laboratories shared their experiences within the MTV consortium and fielded questions from the audience, both virtual and in-person.

- **CVT/MTV Consortium Alumni Panelist:** Angela Di Fulvio, University of Illinois; Michael Hua, Helion; Steven Czyz, Lawrence Livermore National Laboratory; Meghan McGarry, Lawrence Livermore National Laboratory; Tony Shin, Los Alamos National Laboratory

- **DEI Initiatives and Successes Panelist:** Aditi Verma, University of Michigan; J'Tia Hart, Idaho National Laboratory; Christopher Perfetti, University of New Mexico; Mackenzie Warwick, University of Michigan; Nancy Jo Nicholas, Los Alamos National Laboratory

A student-national laboratory meet and greet session was held over lunch March 21st, where students and national lab affiliates were able to network and discuss research and collaboration opportunities. 11 national labs were represented at the informal luncheon.

Eight students won student awards during the workshop and each student award comes with a certificate and $500 prize.

Best Oral Talks:

- **Ethan Klein,** Massachusetts Institute of Technology — "Neutron Resonance Analysis for the Identification and Quantification of Nuclear Material"
- **Ricardo Lopez,** University of Michigan — "Special Nuclear Material Experiments with a Dual-Particle Imager and Visualization in Mixed Reality"

Best Poster Presentations – Graduate:

- **Flynn Darby,** University of Michigan — "Rossi-Alpha Experiments with Highly Enriched Uranium Using Organic Scintillators"
- **Nathan Giha,** University of Michigan — "Correlations Between Fission Fragment Properties and γ-Ray Emission"

Best Poster Presentations – Undergraduate:

- **James Baker, Jr.,** University of Michigan — "Gamma-ray Multiplicity and Spectra from Neutron Induced Fission of 235U"
- **Katie Olivas,** University of Michigan — "The Influence of Time Temperature Profiles on the Minimum Detectable Dose of LiF:Mg,Ti Thermoluminescent Dosimeters"

Best Student Publication:

- **Emily Kwapis,** University of Florida — Kwapis, E.H., Villa-Aleman, E., Hartig, K.C. (2022). "Spectroscopic signatures and oxidation characteristics of nanosecond laser-induced cerium plasmas." *ScienceDirect*, Dec. 2022. **https://doi.org/10.1016/j.sab.2022.106610**
- **Ricardo Lopez,** University of Michigan — Lopez, R., Steinberger, W. M., Giha, N., Marleau, P., Clarke, S. D., & Pozzi, S. A. (2022). "Neutron and gamma imaging using an organic glass scintillator handheld dual particle imager." *Nucl. Instr. Meth. A*, 1042, 167407. **https://doi.org/10.1016/j.nima.2022.167407**

Full meeting details, including an interactive agenda and links to presenter materials, can be found online at: **mtv.engin.umich.edu/2023-mtv-workshop**

Spotlight on Consortium Alumni

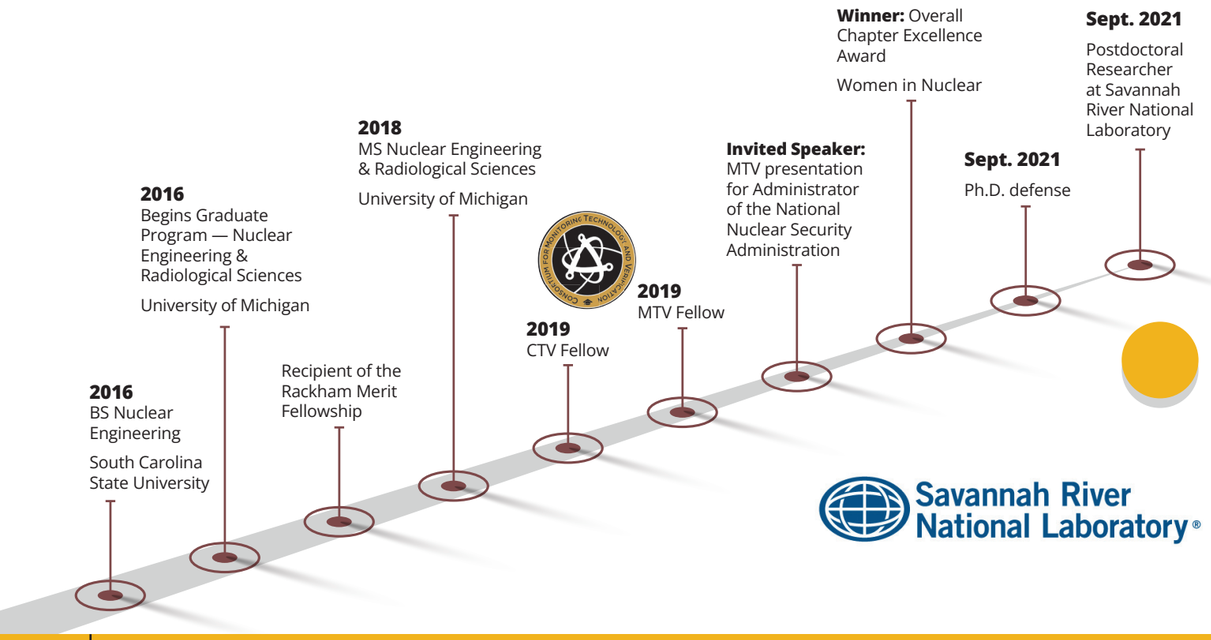
Valerie Nwadeyi

Savannah River National Laboratory

Dr. Nwadeyi received a BS degree in Nuclear Engineering from South Carolina State University and an MS and Ph.D. in Nuclear Engineering and Radiological Sciences from the University of Michigan. Her graduate research focused on gamma-ray imaging techniques for proton beam range verification for cancer therapy. She started her post-doctoral research position at Savannah River National Laboratory in September 2021. Her areas of expertise include radiation detection, imaging, and simulation; specializing in CdZnTe semiconductor detectors, list-mode data analysis, and advanced imaging algorithms and processing. Dr. Nwadeyi currently works on the Strategic Laboratory Agreement, in partnership with ORNL, supporting the Surplus Plutonium Disposition initiative in both imaging techniques for plutonium hold-up analysis and prompt gamma analysis for mass quantification.

As a Post-Doctoral Research Associate in the NDA-Nuclear Measurements Group at Savannah River National Laboratory, Dr. Valerie Nwadeyi's current research projects are all under the plutonium dilute and disposition project where the ultimate goal is to dispose of ~40 tons of plutonium at WIPP. She works on developing imaging algorithms to aid in radiation monitoring and verification of the plutonium throughput in gloveboxes used in the dilution process — specifically Compton and coded-aperture imaging for real time quantification of plutonium and alpha,n oxides hold up material.

Valerie also works on anomaly resolutions which entails developing optimal non-destructive solutions for identifying and quantifying unknown radioactive material that may be present outside of the glovebox operation (i.e. random inspections) unidentified shipments prior to the glovebox process. She also provides support to the tritium extraction facility, monitoring the production of volatile Zn-65 in their extraction process via radiation detection and imaging.



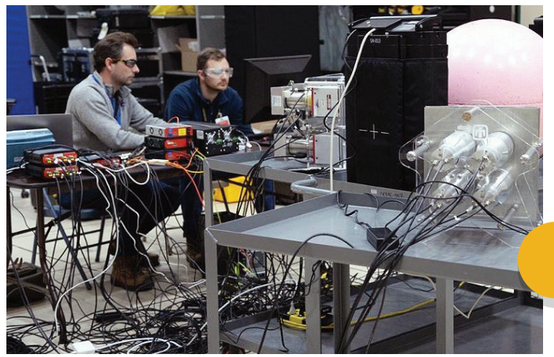
Kyle Polack

Sandia National Laboratory

Kyle Polack received his Ph.D. in Nuclear Engineering and Radiological Sciences (NERS) in 2016 from the University of Michigan where he was an associate member of the Consortium for Verification Technologies (CVT). After graduation, Kyle joined Sandia National Laboratories in Livermore, CA, where he is now a Principal Member of the Technical Staff. At Sandia, Kyle continued his work in radiation detection system and algorithm design. He has worked on the development of several custom measurement systems and has been involved in hardware deployment, data acquisition system development, and data analysis.

Kyle is currently involved in multiple efforts funded by the Office of Defense Nuclear Nonproliferation Research and Development (DNN R&D) that span numerous nonproliferation missions. He is principal investigator for the Modular ReProgrammable Information Barrier project, which aims to develop a general-purpose information barrier in support of potential future arms control agreements. Kyle is also the lead for the Passive Attribute Signatures Suite for Item Verification Experiments sub-task of the PROACTIVE Venture. The goal of this effort is to develop a suite of attributes that can be obtained using passive emissions for the assessment of treaty accountable items across various stages of a hypothetical confirmation and dismantlement regime. A portion of this work will build upon recent success of a Laboratory Directed Research and Development (LDRD) effort to demonstrate the feasibility of using gamma rays created by thermal neutron capture in moderating material surrounding plutonium as neutron surrogates in traditional neutron multiplicity analysis. This effort, which was led by Kyle, included significant contributions of Michael Hamel, who is also a CVT alumni who has been with Sandia since graduating from the University of Michigan NERS program.

In addition to radiation detection applications, Kyle also has led the development of techniques that leverage alternative signatures to complement traditional radiation signatures in support of various nonproliferation mission needs. These efforts have included the development of low-frequency eddy current screening techniques, which show promise for detection and characterization of conductive materials, including uranium, through other intervening materials. Additionally, Kyle is the principal investigator for an ongoing effort investigating the feasibility of quantifying UF_6 enrichment using low-field nuclear magnetic resonance signatures. This project, which supports nuclear safeguards needs, aims to establish the technical basis for a novel technique that could be eventually deployed to complement existing UF_6 enrichment monitoring capabilities.



Kyle Polack and Michael Hamel make measurements at the Device Assembly Facility to experimentally validate the feasibility of neutron capture gamma multiplicity analysis.

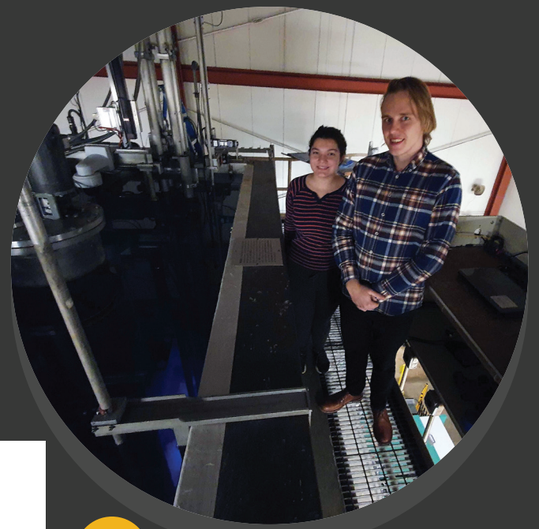
Sandia National Laboratories

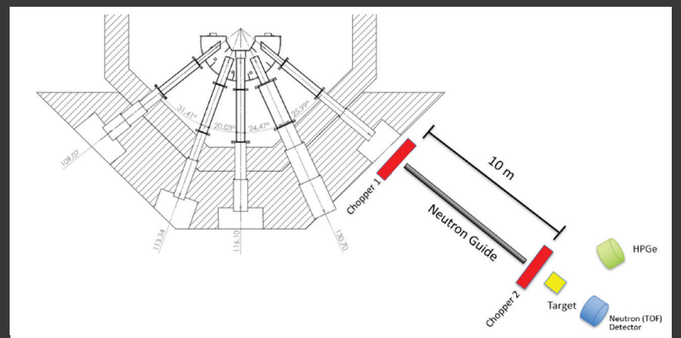
Research Highlights

Reactor Experiments

Penn State University, Texas A&M University, University of Florida, University of Michigan

- 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





PennState

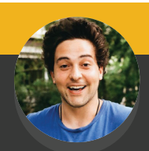
TEXAS A&M UNIVERSITY

UF UNIVERSITY of FLORIDA

UNIVERSITY OF MICHIGAN

The Physics of Nuclear Fission

University of Michigan

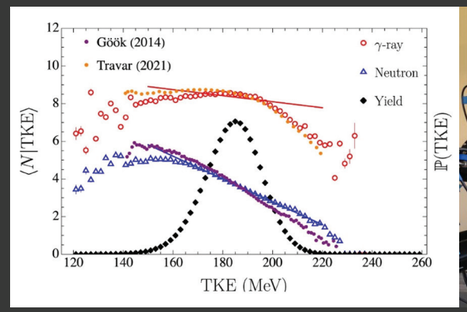


Stefano Marin

Nathan Giha

Sara Pozzi

- We are measuring the dependence of the fragments' angular momenta on the excitation energy of the fissioning system
- Collaboration with Argonne National Laboratory
- The experiments' results will be used to improve models of fission



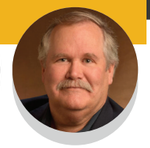
UNIVERSITY OF MICHIGAN

Microbial Biosensors for Detection of Nuclear Proliferation

University of Tennessee, Knoxville

Isis Fukai

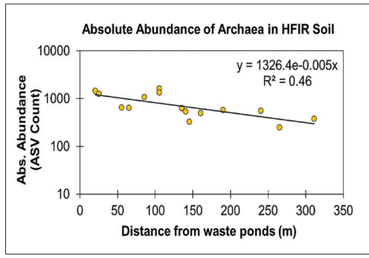
Kurt Ash

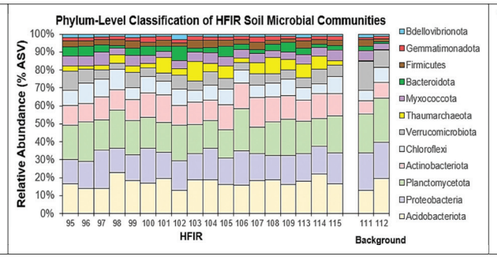


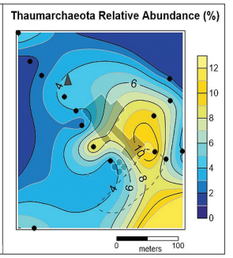
Terry Hazen

- 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

THE UNIVERSITY OF TENNESSEE KNOXVILLE







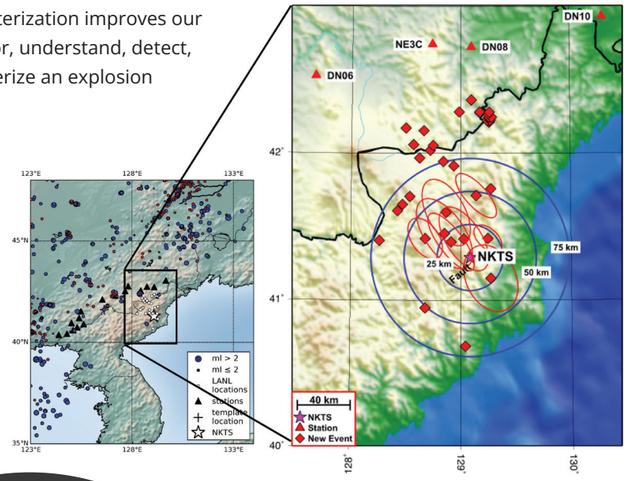
Background Seismicity Near the DPRK Test Site

Columbia University

Won-Young Kim

Paul Richards

- 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



Technology Transition Highlights

Universities to the National Laboratories

MODELING AND ALGORITHMS

- New nuclear data formalism
- Algorithm for stochastic moments
- Algorithm for generating TRISO fuel models
- Fuel cycle modeling code
- Fission process modeling code
- Detector response modeling algorithms

DETECTORS AND TECHNOLOGY

- Muon tomography approach
- Do-it-yourself GM system
- 3D stability system for gamma-spec
- Digital pulse processing approaches for He4 detectors
- Antineutrino detectors and technologies
- Decay energy spectroscopy approach for nuclear material analysis
- Portable gamma-ray spectrometers

Education and Outreach

2023 MCNP®/MCNPX-PoliMi Workshop

The 2023 MCNP®/MCNPX-PoliMi Workshop, supported by MTV, will take place at the University of Michigan July 11–12, 2023. Attendees are required to have individual MCNP® and MCNPX-PoliMi user licenses, which should be obtained from **rsicc.ornl.gov** prior to the Workshop.

University of Michigan Instructors:

Brian Kiedrowski

Shaun D. Clarke

Workshop Topics:

- What is Monte Carlo radiation transport and MCNP®?
- MCNP® Geometry: surface and cell specifications
- MCNP® Material and basic source definitions
- Running MCNP® and tips and tricks
- MCNPX-PoliMi introduction
- Running MCNPX-PoliMi and MPPost
- MCNPX-PoliMi source capabilities
- Organic scintillator response modeling

Applications are due by June 14, 2023:
forms.gle/LChNvzXipZDSaVzZ7

Registration fees are $100/student or $200/standard (non-student) attendees. The payment link will follow registration and license submission.

63 **MCNP®/MCNPX-PoliMi workshop attendees** since 2020

2023 Nuclear Engineering Summer School

The 2023 MTV Nuclear Engineering Summer School is an 8-week program that will cover a range of topics and techniques that benefit student researchers at all academic levels. Students interested in strengthening their research capabilities are invited to register for the upcoming summer school. Classes will be taught in a hybrid format (U-M's campus and via Zoom) by MTV faculty, national lab scientists, and senior Ph.D. students.

Lecture topics include:

- General Nuclear Topics
- Gamma Detection
- Neutron Detection
- Active Interrogation
- Monte Carlo
- Radiation Imaging
- Special Applications
- Fission
- Medical Applications

There is no cost to participate.
A completion certificate will be awarded to participants who attend 80% of lectures.

Registration link:
forms.gle/EREwkqWQ1bqompCd6

Agenda with presentation titles and lecturers can be found on the MTV website at:
mtv.engin.umich.edu/2023-mtv-nuclear-engineering-summer-school

800+ **Summer school attendees** over the last three years

Interactive Graduate School Experience

The Consortium for Monitoring, Technology, and Verification (MTV) and University of Michigan (UM) hosted 4 undergraduate students from the University of New Mexico at the University of Michigan's Ann Arbor campus June 20-24, 2022. During the MTV Summer Experience, UNM undergraduate students engaged in hands-on laboratory experiments, participated in experimental activities/demonstrations, learned about Ph.D. research, and heard lectures by radiation detection and nuclear nonproliferation experts.

This summer, MTV will be hosting its first Interactive Graduate School Program for undergraduate or master's students thinking about graduate school in nuclear science and engineering. This new one-week interactive graduate school experience will be held on the University of Michigan campus June 26-30, 2023.

This program includes:

- Roundtable discussion with current graduate students
- Networking events with faculty and national laboratory scientists
- Hands-on laboratory experiments and demonstrations
- Lectures by radiation detection and nuclear nonproliferation experts

For more information on the participating nuclear engineering laboratories, visit:
ners.engin.umich.edu/research/labs-list

MTV Website and Social Media

The MTV website (**mtv.engin.umich.edu**) provides public information on MTV news, activities, and personnel. MTV team members can find information on opportunities within the research field, national laboratories, and universities. Since its development in 2019, the MTV website has welcomed over 34,000 users.

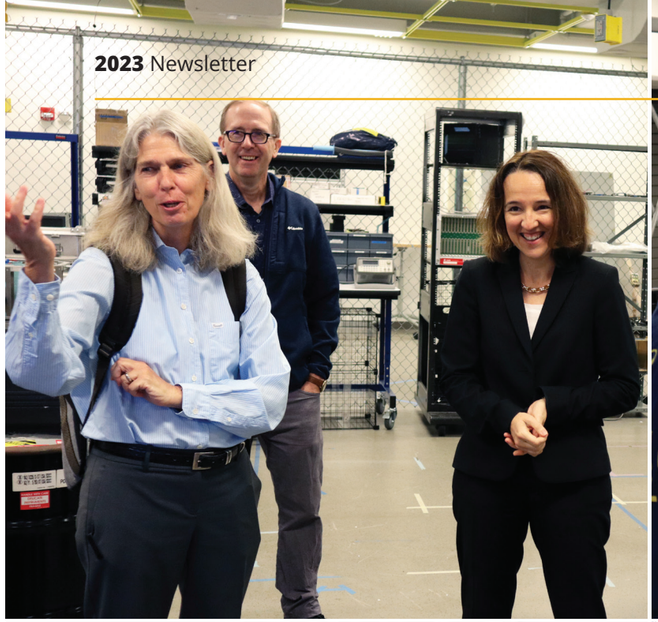
In addition to the website, our social media platforms generate thousands of views.

@NNSA_MTV

@NNSA.MTV

MTV Consortium

linkedin.com/in/sara-pozzi-a98ab813



Lab Tours and Visitors

In September of 2022, MTV welcomed Jill Hruby (top left) , Under Secretary for Nuclear Security and Administrator of the National Nuclear Security Administration, to the University of Michigan. She presented "U.S. Nuclear Security: The Need to be Responsive and Responsible" and was awarded the 2022 Nuclear Lifetime Achievement Award.

Assistant Secretary for Nuclear Energy Dr. Katy Huff (top right) visited the University of Michigan in April 2023. She presented "More Important than Bombs" at the 10th annual Osborn Lecture. While in Ann Arbor, she visited the U-M Nuclear Engineering and Radiological Sciences Labs.

MTV Publications

SEPTEMBER 2019 - MARCH 2023

130 Peer-Reviewed Journals

217 Conference Papers

139 Invited Talks

List of peer-reviewed publications by MTV students, faculty, and national lab collaborators.

1. Pakari, O., Lopez, R., Druckman, I., Meng, E., Zhou, E., Wang, Z., ... & Pozzi, S. A. (2023). Real-time mixed reality display of dual particle radiation detector data. *Scientific Reports*, 13(1), 362. **https://doi.org/10.1038/s41598-023-27632-1**
2. Kwapis, E. H., Hewitt, M., & Hartig, K. C. (2023). Shock physics and shadowgraphic measurements of laser-produced cerium plasmas. *Optics Express, 31*(6), 10694-10708. **https://doi.org/10.1364/OE.483055**
3. Latty, K. S., & Hartig, K. C. (2023). Elemental fractionation in aerosol laser-induced breakdown spectroscopy with nanosecond and femtosecond laser ablation. *Spectrochimica Acta Part B: Atomic Spectroscopy, 202*, 106648. **https://doi.org/10.1016/j.sab.2023.106648**
4. Garcés, M. A. (2023). Quantized Information in Spectral Cyberspace. *Entropy, 25*(3), 419. **https://doi.org/10.3390/e25030419**
5. Martinson, S. P., Garcia, J. R., Haynes, I. W., Saini, S. P., Wagner, E. R., Long, G. R., ... & Chirayath, S. S. (2023). Nondestructive and destructive assay for forensics characterization of weapons-grade plutonium produced in LEU irradiated in a thermal neutron spectrum. *Annals of Nuclear Energy*, *183*, 109645. **https://doi.org/10.1016/j.anucene.2022.109645**
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10. Reza, S. A., Burger, M., Bassène, P., Nutting, T., Jovanovic, I., & N'Gom, M. (2023). Generation of multiple obstruction-free channels for free space optical communication. *Optics Express, 31*(2), 3168-3178. **https://doi.org/10.1364/OE.477204**
11. Bae, J. W., Wu, T. C., & Jovanovic, I. (2023). Reconstruction of fast neutron direction in segmented organic detectors using deep learning. *Nucl. Instr. Meth. A*, 168024. **https://doi.org/10.1016/j.nima.2023.168024**
12. Wilhelm, A. S., Wendel, G., Collins, B., Cowen, D., & Jovanovic, I. (2023). Evaluation of light collection from highly scattering media using wavelength-shifting fibers. *Nucl. Instr. Meth. A, 1049*, 168085. **https://doi.org/10.1016/j.nima.2023.168085**

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21. O'Neal, P. J., Chirayath, S. S., & Cheng, Q. (2022). A Machine Learning Method for the Forensics Attribution of Separated Plutonium. *Nuclear Science and Engineering, 196*(7), 811-823. **https://doi.org/10.1080/00295639.2021.2024037**
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