

Consortium for Monitoring, Technology, and Verification Newsletter, 2021



PROF. SARA A. POZZI

Director, Consortium for Monitoring, Technology, and Verification
MTV.engin.umich.edu



MTV Leadership

MTV Motivation and Mission

- 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
Assoc. Dir. for Natl. Labs
University of Michigan



Dr. Shaun Clarke
Associate Director
University of Michigan



Mr. John Rodriguez
Project Manager
University of Michigan

External Advisory Board



Dr. Mona Dreicer
Lawrence Livermore
National Laboratory



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National Laboratory



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Oak Ridge
National Laboratory



Dr. James Tiedje
Michigan State University

■ University Partners
 ■ National Laboratory Partners



THRUST AREA 1
FUNDAMENTALS OF NUCLEAR AND PARTICLE PHYSICS



Prof. Igor Jovanovic
Thrust Area 1 Lead
University of Michigan

Reaction Theory and Modeling

S. Pozzi, U Michigan
 C. Perfetti, New Mexico

Novel Imaging Techniques

Z. He, U Michigan
 D. Wehe, U Michigan
 A. Hecht, New Mexico

Antineutrino-Based Methods

A. Erickson, Ga Tech
 P. Huber, Va Tech.
 J. Learned, Hawaii
 I. Jovanovic, U Michigan

THRUST AREA 2
SIGNALS AND SOURCE TERMS FOR NUCLEAR NONPROLIFERATION



Prof. Steven Biegalski
Thrust Area 2 Lead
Georgia Institute of Technology

Isotopic Science

S. Biegalski, Ga 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, Berkeley
 H. Dulai, Hawaii

Nuclear Fuel Cycle Process Modeling

P. Wilson, Wisconsin
 S. Chirayath, TAMU
 A. Glaser, Princeton

Radiation Transport

B. Kiedrowski, U Michigan
 A Prinja, UNM

THRUST AREA 3
NUCLEAR EXPLOSION MONITORING



Dr. Milton Garces
Thrust Area 3 Lead
University of Hawaii

Infrasound

M. Garces, Hawaii

Seismology

G. Ekstrom, Columbia
 P. Richards, Columbia
 W-Y. Kim, Columbia

Methodologies for Wide Area Environmental Sampling

K. Hartig, Florida

Radiation Background Monitoring

K. Kearfott, U Michigan

Environmental Fate and Transport of Radionuclides

A. Enqvist, 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

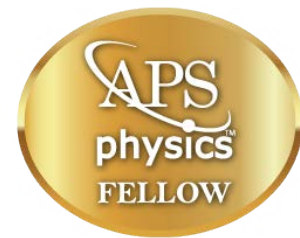
Awards & Accomplishments

Prof. Terry Hazen receives the 2021 ASM award for Environmental Research in Microbiology!

Prof. Terry Hazen, the University of Tennessee at Knoxville, who is recognized with the American Society for Microbiology (ASM) Award for Environmental Research, which honors an outstanding scientist with distinguished research achievements that have improved our understanding of microbes in the environment, including aquatic, terrestrial, and atmospheric settings.



Alex Glaser elected Fellow of the American Physical Society!



Alexander Glaser has been elected a Fellow of the American Physical Society. Glaser has been recognized “for major contributions to advancing the scientific and technical basis for nuclear arms control, nonproliferation, and disarmament verification.”

AWARDS

Recognitions and awards have been given to faculty and students for outstanding performance over the second year of the Consortium for Monitoring, Technology, and Verification



Katie Mummah, University of Wisconsin, wins first place in the J. D. Williams Student Paper Award at INMM 2020!

Katie's paper titled, "Integrating Acquisition Pathway Analysis Into The Cyclus Fuel Cycle Simulator" can be found online at the INMM website.

<https://resources.inmm.org/annual-meeting-proceedings/integrating-acquisition-pathway-analysis-cyclus-fuel-cycle-simulator>

Oskar Searfus, University of Michigan, receives NNSA's Nuclear Nonproliferation International Safeguards Fellowship!

The Fellowship is awarded to exceptional students pursuing doctoral research in the field of international safeguards and provides up to four years of appointment and at least one summer of practicum at one of thirteen laboratories around the world, including the NNSA national laboratories and several European Commission Joint Research Centres.



Lauren Nagel, University of Michigan, receives an inaugural Marie Skłodowska-Curie Fellowship!

The International Atomic Energy Agency (IAEA) has announced the first group of 100 female students from around the globe to receive a Marie Skłodowska-Curie Fellowship. Among them is U-M Nuclear Engineering and Radiological Sciences Ph.D. Student Lauren Nagel. According to IAEA, out of over 550 applicants from more than 90 countries, the first 100 fellows represent geographic diversity, coming from 71 different countries.

Awards & Accomplishments

MTV Annual Workshop, March 29 - 31, 2021

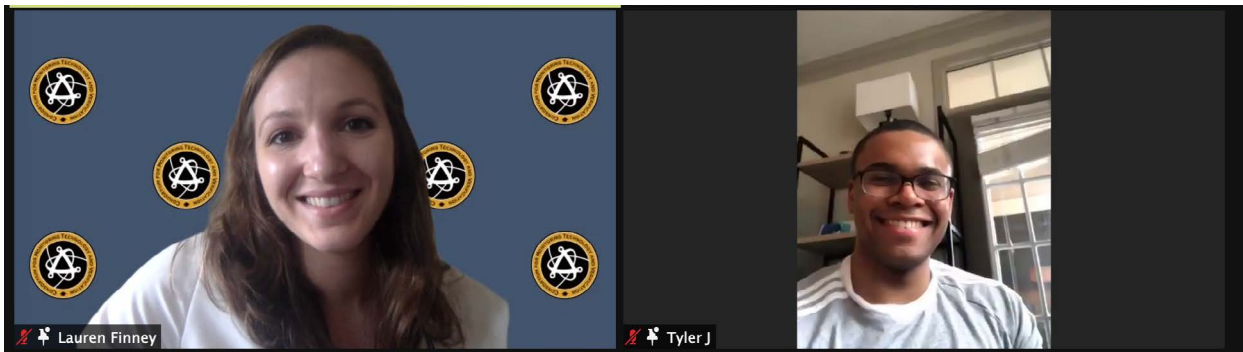
The Consortium for Monitoring, Technology, and Verification (MTV) held a successful virtual annual workshop on March 29 – 31, 2021. Activities included 54 presentations consisting of 24 talks and 30 posters. Additionally, we hosted three national laboratory roundtables, three poster sessions, and one alumni panel.

The workshop was hosted as a fully virtual experience. The MTV Website (mtv.engin.umich.edu) and Zoom meeting platforms served as the primary forms of audience engagement. This format made it possible for the MTV to host its most highly attended workshop with over 200 participants consisting of university faculty (25%), students (35%), national laboratories and government representatives (35%), and industry professionals (5%).

Four students won best presentation awards:

Best Talk:

- **Lauren Finney**, University of Michigan, “Identification of Stress in Plants via Femtosecond Laser-Induced Fluorescence and Steady-State Absorption Spectroscopy”
- **Tyler Johnson**, Duke University, “Neutrino-Induced Nuclear Fissions”



Best Poster:

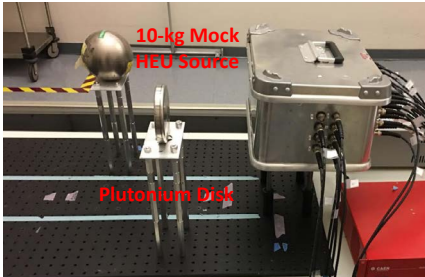
- **Eric Lepowski**, Princeton University, “No Access, No Data, No Problem: Toward Autonomous Robotic Inspections of Nuclear Facilities”
- **Samuel Takazawa**, University of Hawaii, “Explosion Yield Estimation using Machine Learning Methods”



RESEARCH

Research Highlights

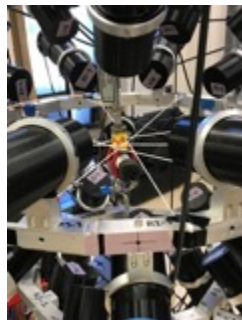
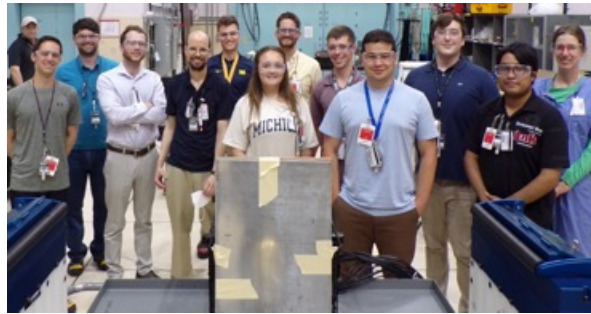
Experimental Activities During the Pandemic



Experiments with Special Nuclear Material samples at Savannah River National Lab
November 2020



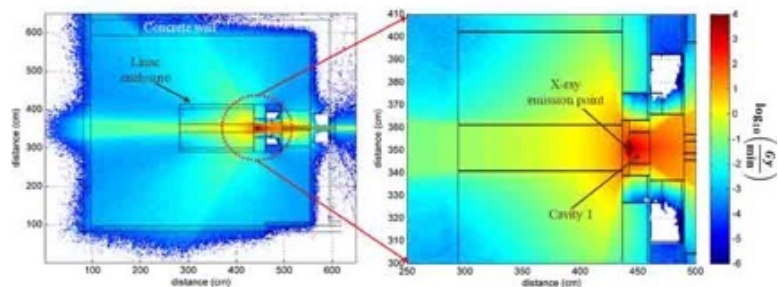
Device Assembly Facility
Jul 19 – 22, 2021



^{252}Cf fission studies with a chamber from ORNL at the University of Michigan
November 2020



Top-down cross section of the shielded Varian M9 electron linear accelerator at the University of Michigan that can be used for sterilization of personal protective equipment.



A. J. Jinia et al., "Review of Sterilization Techniques for Medical and Personal Protective Equipment Contaminated With SARS-CoV-2," in IEEE Access, vol. 8, pp. 111347-111354, 2020, doi: 10.1109/ACCESS.2020.3002886.

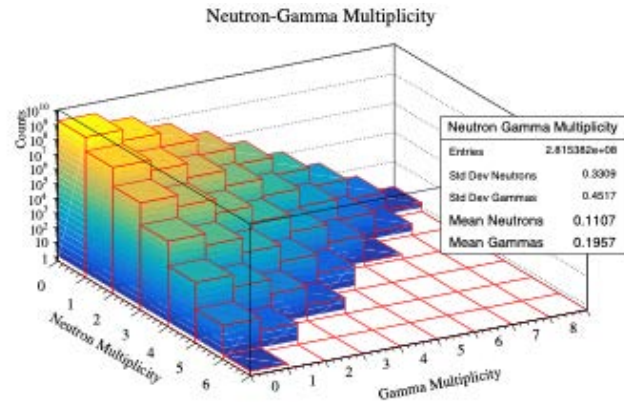
RESEARCH

Research Highlights

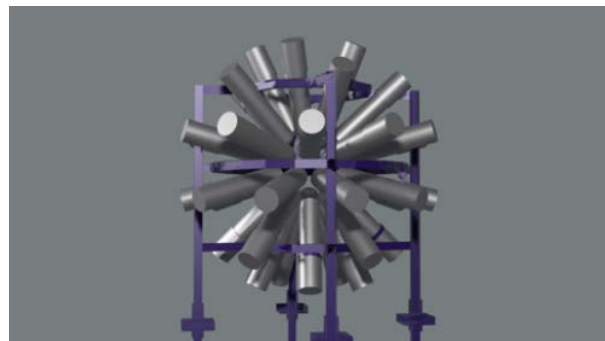
Correlated Neutron and Gamma-Ray Emissions from Fission



Stefano Marin
Ph.D. Student
University of Michigan



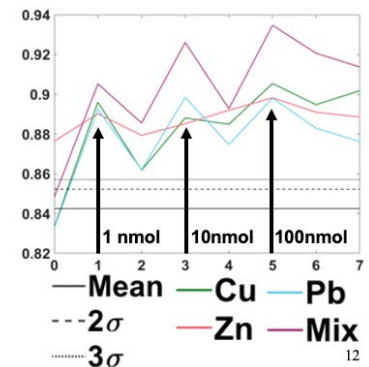
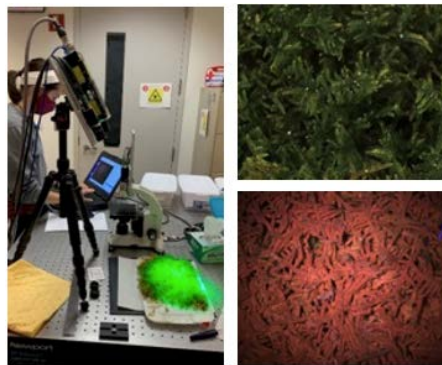
- Nuclear fission produces correlated neutrons and gamma rays from fission fragments
- We have designed and tested an array of 40 stilbene detectors dedicated to the study of fission reactions and the correlations in the neutron-photon emission, the Fission Sphere 3 (FS-3)
- The excellent timing resolution and PSD capabilities of stilbene enable differential measurements of neutron-photon correlations



Laser-Induced Fluorescence in Moss



Kelly Traux
Ph.D. Student
University of Hawaii



- The research is driven by the need for a development of remote sensing technology and methodology to detect contamination in biota from nuclear fallout, mining waste, and nuclear waste.
- The project goal is to develop a non-invasive, non-destructive, remote, laser induced fluorescence (LIF) technique to detect metal contamination in moss and other plants. So far we have treated moss with various levels of different metals and exposed samples to LIF. We analyzed the captured images to detect changes in the plant's fluorescence in response to the metal exposure.
- Laboratory testing revealed the methods ability to detect and identify multiple metals at the nmol/cm2.

HIGHLIGHTS

MTV research activities began September 2019

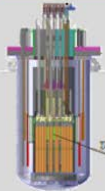
Machine Learning for Antineutrino-Based Safeguards



Matthew Dunbrack
Ph.D. Student
Georgia Tech.

RETINA System

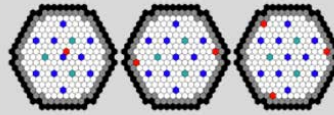
- Reactor Evaluation Through Near-field Antineutrinos system



- Compare monitored antineutrino spectra to previously simulated reactor cores for inventory deviation

Approach

- Utilize machine learning models to detect 12 simulated core diversion scenarios



- Individually train models for well-prepared diversion scenarios
- Group train models for unexpected diversion scenarios

Results

- Could detect sensitive variations in most antineutrino spectra

Model	Average Detection Probability
Individually Trained	1.44%
Group Trained	1.06%

Consortium Pandemic Response



University of Tennessee, Knoxville and Massachusetts Institute of Technology

Terry Hazen, UTK, chaired an expert committee on this best course of action for SARS CoV-2 testing for the Fall 2020 semester and beyond. Activities include waste-water monitoring.

Eric Alm and his team at MIT have been engaged in wastewater-based monitoring of COVID-19.



Education and Outreach

“Overall terrific workshop. I learned a substantial amount of material that will definitely help with future research projects.”

- MCNP/MCNPX PoliMi Workshop survey



Prof. Brian Kiedrowski
Associate Professor
U. Michigan



Dr. Shaun Clarke
Associate Research Scientist
U. Michigan

MCNP/MCNPX-PoliMi Training Workshop

Prof. Brian Kiedrowski (top) and Dr. Shaun Clarke (bottom) at the University of Michigan, Nuclear Engineering and Radiological Sciences department, served as instructors at the 2021 MCNP/MCNPX-PoliMi Training Workshop.

This year’s 4-day virtual workshop, held from May 10 to May 14, 2021, welcomed 10 participants interested in learning and developing their skill with this unique code.

MTV Launches a YouTube channel!



The **MTV Consortium** YouTube channel currently hosts 186 videos! Viewers can find videos from the Nuclear Engineering Summer school, summaries of student research experiments, and presentations by our distinguished MTV faculty.



NNSA leads national collaboration to drive next-generation in AI for nonproliferation

DNN R&D sponsored the second workshop in a series on “Next-Generation AI for Proliferation Detection,” focused on domain-aware methods: computational techniques to combine domain information with data-driven AI models. The workshop spanned four challenge areas specific to this mission: complex and noisy environments; sparse data and rare events; robust deployment and decision support; and early proliferation detection and signature discovery.

MTV Student Abbas Jahor Jinia (photo right) was one of the four projects represented at this workshop.

[click here to read more.](#)



“The MTV Summer School allows me to see my individual work in the greater scheme of things by providing a strong foundation of theoretical nuclear engineering and physics.”

- Isabel Hernandez, University of Michigan, Undergraduate Student

MTV Nuclear Engineering Summer School!

8
Weeks

23
Lectures

8
Guests

244
Students

Classes are taught virtually by MTV faculty, national lab collaborators, and senior PhD students.

Lectures are designed to benefit students interested in strengthening their research capabilities. This 12-week program covers a range of topics and techniques that benefit student researchers at all academic levels.

Course details, topics, and recorded presentations can be found online here:

<https://mtv.engin.umich.edu/2021-mtv-ness/>

Course topics include:

- Nuclear Engineering basics
- Gamma Rays
- Detector Characterization
- Monte Carlo
- Fission
- Active Interrogation
- Imaging / Radioxenon

Virtual Courses, June 1 - July 29, 2021

Host Lecturers



Dr. Shaun Clarke
Associate Research Scientist
U. Michigan



Leah Clark
Ph.D. Student
U. Michigan



Nathan Giha
Ph.D. Student
U. Michigan



Ricardo Lopez
Ph.D. Student
U. Michigan



Noora Ba Sunbul
Ph.D. Student
U. Michigan



Abbas Jinia
Ph.D. Student
U. Michigan



Julianne Lamproe
Ph.D. Student
U. Michigan



Stefano Marin
Ph.D. Student
U. Michigan



Christopher Meert
Ph.D. Student
U. Michigan

Guest Lecturers

- **Cameron Geddes**, Lawrence Berkeley National Laboratory
- **Bethany Goldblum**, Lawrence Berkeley National Laboratory
- **Igor Jovanovic**, University of Michigan
- **Christopher Perfetti**, University of New Mexico
- **Jorgen Randrup**, Lawrence Berkeley National Laboratory
- **Melinda Sweany**, Sandia National Laboratories
- **Alexis Trahan**, Los Alamos National Laboratory
- **Ramona Vogt**, Lawrence Livermore National Laboratory

Training and Development

198

198 Students and Postdocs engaged in MTV Research

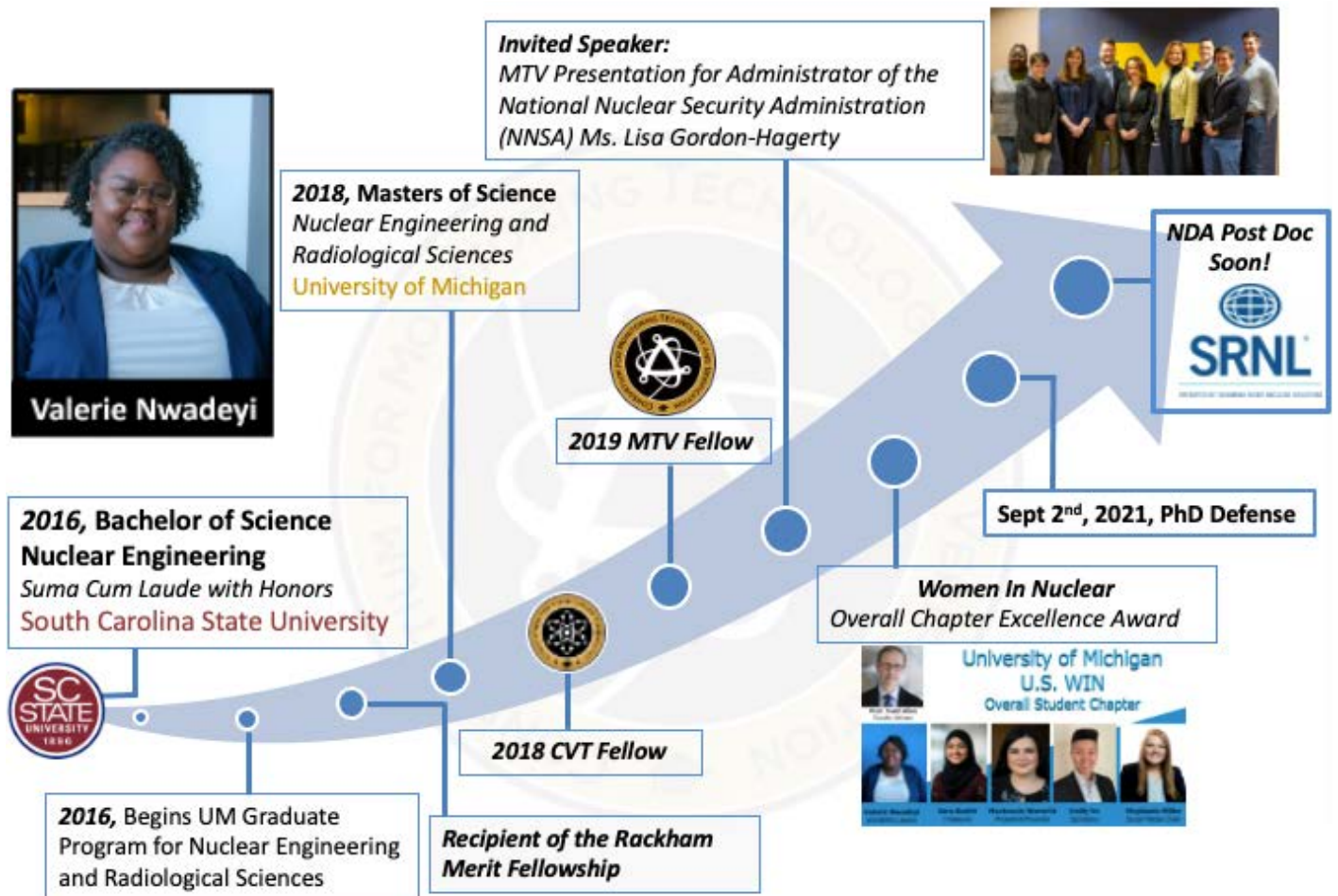
MTV Fellows

Postdocs.....3
 Graduate Students.....46
 Undergraduate Students.....23

MTV Associates

Postdocs.....3
 Graduate Students.....57
 Undergraduate Students.....66

Student Advancement Model



MTV Publications

1. A. Bernstein, N. Bowden, B. L. Goldblum, P. Huber, I. Jovanovic, and J. Mattingly, "Colloquium: Neutrino Detectors as Tools for Nuclear Security", *Reviews of Modern Physics*, <https://doi.org/10.1103/RevModPhys.92.011003>
2. Moritz Kütt and Alexander Glaser, "Vintage Electronics for Trusted Radiation Measurements and Verified Dismantlement of Nuclear Weapons," *PLOS ONE*, October 30, 2019. <https://doi.org/10.1371/journal.pone.0224149>
3. Noah McFerran, Bonnie Canon, Benjamin McDonald, Jonathan Kulisek, Jonathan Dreyer, Simon Labov, Andreas Enqvist, "Gamma-ray spectrum variations for surface measurements of uranium hexafluoride cylinders", *Nuclear Instruments and Methods A*, Vol. 961, p. 163675, 2020, <https://doi.org/10.1016/j.nima.2020.163675>
4. S. Marin, V. A. Protopopescu, R. Vogt, M. J. Marcat, S. Okar, M. Y. Hua, P. Talou, P. F. Schuster, S. D. Clarke, and S. A. Pozzi, "Event-by-Event Neutron-Photon Multiplicity Correlations in $^{252}\text{Cf}(sf)$," *Nuclear Instruments and Methods A*, Volume 968, 163907 - 2020. <https://doi.org/10.1016/j.nima.2020.163907>
5. Alexander Glaser and Moritz Kütt, "Verifying Deep Reductions in the Nuclear Arsenals: Development and Demonstration of a Motion-detection Subsystem for a "Buddy Tag" Using Non-export Controlled Accelerometers," *IEEE Sensors Journal*, 2020. DOI: 10.1109/JSEN.2020.2978540"
6. A. Haghghat, P. Huber, S. Li, J.M. Link, C. Mariani, Observation of Reactor Antineutrinos with a Rapidly-deployable Surface-level Detector, *Phys. Rev. Appl.* 13 (2020) 034028. DOI:<https://doi.org/10.1103/PhysRevApplied.13.034028>
7. Noey, J. D., Xiao, J. B., DiFulvio, A., Sulieman, N. A., Carmona, M. A., Chung, L.K., El-Amir, I. N., Frank, S. J., Liu, K., Schiefer, K., Seekamp, J. M., Sosa, C. S., Trimas, D. J., Vyas, A. P., Kearfott, K. J., "The Effects of Radiation and Emitted Light Transport on the Positional Response of 11 cm x 42.5 cm x 5.5 cm NaI(Tl) Detectors", *Health Phys*, 117(4): 362-377, 2019. doi: 10.1097/HP.0000000000001051
8. Champion RJ, Golduber RM, Kearfott KJ, "Use of an Imaging Spectrometer for Characterization of a Cesium Dosimeter Calibration Facility", *Health Phys*,118(4):462-469, 2020. doi: 10.1097/HP.0000000000001150
9. Seekamp JM, Noey JD, Kwapis EH, Chung LK, Shubayr NA, Smith T, Trimas DJ, Kearfott KJ, "Design and Characterization of an Extremely-Sensitive, Large-Volume Gamma-Ray Spectrometer for Environmental Samples", *Health Phys*, submitted June 20, 2019, accepted January 7, 2020. (Winner 2019 Department of Energy Innovations in Nuclear Technology R&D Award) doi: 10.1097/HP.0000000000001271
10. Rafique M, Tareen ADK, Mir AA, Nadeem MSA, Asim KM, Kearfott, KJ. "Delegated regressor, a robust approach for automated anomaly detection in the soil radon time series data", *Scientific Reports*, 10: article 3004, 1-11 (open access), accepted January 27, 2020 <https://doi.org/10.1038/s41598-020-59881-9>
11. Ezra M. Engel, Ethan A. Klein, A. Danagoulian, "Feasibility study of a compact Neutron Resonance Transmission Analysis instrument," *AIP Advances* 10, 015051 (2020) <https://doi.org/10.1063/1.5129961>
12. Areg Danagoulian, "Verification of Arms Control Treaties with Resonance Phenomena," *Nuclear Physics News* (2020) invited review article, <https://doi.org/10.1080/10619127.2020.1717271>
13. F. Sutanto, O. A. Akindede, M. Askins, M. Bergevin, A. Bernstein, N. S. Bowden, S. Dazeley, P. Jaffe, I. Jovanovic, S. Quillin, C. Rocker, and S. D. Rountree, "Measurement of Muon-induced High-energy Neutrons from Rock in an Underground Gd-doped Water Detector", *Physical Review C* 102, 034616 (2020). DOI:<https://doi.org/10.1103/PhysRevC.102.034616>
14. Garcés, M. A. Quantized constant-Q Gabor atoms for sparse binary representations of cyber-physical signatures, *Entropy*, 2020, 22, 936; doi:10.3390/e22090936
15. Julien de Troilloud de Lanversin, Moritz Kütt, and Alexander Glaser, "ONIX: An Open-source Depletion Code," *Annals of Nuclear Energy*, forthcoming. <https://doi.org/10.1016/j.anucene.2020.107903>
16. M. Bowen, P. Huber, "Reactor neutrino applications and coherent elastic neutrino scattering", *Phys. Rev. D* 102 (2020) 5, 053008; DOI:10.1103/PhysRevD.102.053008
17. K. Ogren, J. Nattress, and I. Jovanovic, "Discriminating Uranium Isotopes Based on Fission Signatures Induced by Delayed Neutrons", *Physical Review Applied* 14, 014033 (2020). DOI:<https://doi.org/10.1103/PhysRevApplied.14.014033>
18. J. Nattress, F. Sutanto, P.-W. Fang, Y.-Z. Chen, A. Cheng, K.-Y. Chu, T.-S. Duh, H.-Y. Tsai, M.-W. Lin, and I. Jovanovic, "Characterization of the $^{12}\text{C}(p,p')^{12}\text{C}$ Reaction ($E_p=19.5\text{--}30$ MeV) for Active Interrogation", *Physical Review Applied* 14, 034043 (2020). DOI: 10.1103/PhysRevApplied.14.034043
19. M.Y. Hua, F.B. Darby, J.D. Hutchinson, G.E. McKenzie, S.D. Clarke, and S.A. Pozzi, "Validation of the two-region Rossi-alpha model for reflected assemblies," *Nuclear Instruments and Methods in Physics Research Section A*, 981,164535, November 2020. <https://doi.org/10.1016/j.nima.2020.164535>
20. Hin Y. Lee,1 Brian S. Henderson,1, a) Roberts G. Nelson,1 and Areg Danagoulian1, "Multiple Monoenergetic Gamma Radiography (MMGR) with a compact superconducting cyclotron" b)Department of Nuclear Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA, arXiv:1911.12276v2; <https://doi.org/10.1063/5.0002201>
21. Y. Altmann, A. Di Fulvio, M. G. Paff, S. D. Clarke, M. E. Davies, S. McLaughlin, A. O. Hero, and S. A. Pozzi, "Expectation propagation for weak radionuclide identification at radiation portal monitors," *Nature Scientific Reports*, vol. 10, 6811, 2020. <https://doi.org/10.1038/s41598-020-62947-3>
22. Burger, M.; Skrodzki, P.J.; Finney, L.A.; Nees, J.; Jovanovic, I. Remote Detection of Uranium Using Self-Focusing Intense Femtosecond Laser Pulses. *Remote Sens.* 2020, 12, 1281. <https://doi.org/10.3390/rs12081281>
23. T.C. Wu, T.Shi, I.Jovanovic, "Compound pulse characteristics of a heterogeneous composite scintillator in a gamma-ray field", *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* Volume 976, 1 October 2020, 164265, <https://doi.org/10.1016/j.nima.2020.164265>
24. Chung LK, Mata LA, Carmona MA, Shubayr NAM, Zhou Q, Ye Y, Kearfott KJ. "Radon kinetics in a natural indoor radon chamber." *Sci Total Environ* 734(2020):139167, available online May 6, 2020. DOI: 10.1016/j.scitotenv.2020.139167
25. A. J. Jinia, N. B. Sunbul, C. A. Meert, C. A. Miller, S. D. Clarke, K. J. Kearfott, M. M. Matuszak, S. A. Pozzi, "Review of Sterilization Techniques for Medical and Personal Protective Equipment Contaminated With SARS-CoV-2" *IEEE Access*, vol. 8, pp. 111347-111354, 2020, DOI: 10.1109/ACCESS.2020.3002886.
26. M.Y. Hua, J.D. Hutchinson, G.E. McKenzie, B.C. Kiedrowski, M.W. Liemohn, S.D. Clarke, S.A. Pozzi, "Measurement Uncertainty of Rossi-alpha Neutron Experiments," *Annals of Nuclear Energy*, vol. 147, 107672, 2020. <https://doi.org/10.1016/j.anucene.2020.107672>

PUBLICATIONS

27. M. Y. Hua, J. D. Hutchinson, G. E. McKenzie, T. H. Shin, S. D. Clarke, and S. A. Pozzi, "Derivation of the Two-Exponential Probability Density Function for Rossi-alpha Measurements of Reflected Assemblies and Validation for the Special Case of Shielded Measurements," *Nuclear Science and Engineering*, vol. 194, pp. 56-68, 2020; <https://doi.org/10.1080/00295639.2019.1654327>
28. M. Y. Hua, B. Goddard, C. Lloyd, E. C. Leppink, S. A. Abraham, J. D. Noey, S. D. Clarke, and S. A. Pozzi, "Simulation of the Nondestructive Assay of ²³⁷Np using Active Neutron Multiplicity Counting," *Nuclear Science and Engineering*, vol. 194, pp. 154-162, 2020. <https://doi.org/10.1080/00295639.2019.1654329>
29. M. Y. Hua, C.A. Bravo, A.T. MacDonald, J.D. Hutchinson, G.E. McKenzie, B.C. Kiedrowski, S.D. Clarke, S.A. Pozzi, "Rossi-alpha measurements of fast plutonium metal assemblies using organic scintillators," *Nuclear Instruments and Methods in Physics Research Section A*, vol. 959, 163507, 2020. <https://doi.org/10.1016/j.nima.2020.163507>
30. C. A. Miller, B. Ludewigt, C. Geddes, S. A. Pozzi "Verification of dry storage cask loading using monoenergetic photon sources", *Annals of Nuclear Energy*, vol. 137, 2020. <https://doi.org/10.1016/j.anucene.2019.107091>
31. C. A. Miller, C.G.R. Geddes, S.D. Clarke, S.A. Pozzi "Shielding a monoenergetic photon source for nonproliferation applications analysis," *Nuclear Instruments and Methods in Physics Research Section A*, vol. 954, 161849, 2020. <https://doi.org/10.1016/j.nima.2019.01.075>
32. C. A. Miller, F. Odeh, M. Mamtimin, W. Peters, S.D. Clarke, S.A. Pozzi "Actively Interrogated Dieaway Measurements of a Subcritical Assembly," *Nuclear Instruments and Methods in Physics Research Section A*, vol. 959, 163598, 2020. <https://doi.org/10.1016/j.nima.2020.163598>
33. D. Shy, Z. Chen, J. A. Fessler and Z. He, ""Filtered Backprojection in Compton Imaging using a Spherical Harmonic Wiener Filter with Pixelated CdZnTe,"" in *IEEE Transactions on Nuclear Science*, doi: 10.1109/TNS.2020.3045878"
34. M. Burger, P. Polynkin, and I. Jovanovic, "Filament-induced Breakdown Spectroscopy with Structured Beams", *Optics Express* 28, 36812-36821 (2020). <https://doi.org/10.1364/OE.412480>
35. Eric Lepowsky, Jihye Jeon, and Alexander Glaser, "Confirming the Absence of Nuclear Warheads via Passive Gamma-Ray Measurements," *Nuclear Instruments and Methods in Physics Research A*, 990, 2021, authors.elsevier.com/a/1cMrdcPqbec3A. <https://doi.org/10.1016/j.nima.2020.164983>
36. J.R. Moussa and A.K. Prinja, "SSA Monte Carlo and Master Equation Modeling of Neutron Leakage Distributions," *Transactions of the American Nuclear Society*, vol. 123, pp. 866-869, 2020. <https://dx.doi.org/10.13182/T123-33356>
37. M.Y. Hua, J.D. Hutchinson, G.E. McKenzie, S.D. Clarke, and S.A. Pozzi, "On the Feynman-alpha method for reflected fissile assemblies," *Annals of Nuclear Energy*, 155, 108082, 2021. <https://doi.org/10.1016/j.anucene.2020.108082>
38. N.A. Kleedtke, M.Y. Hua, S.A. Pozzi, "Genetic Algorithm Optimization of Tin-Copper Graded Shielding for Improved Plutonium Safeguards Measurements," *Nuclear Instruments and Methods in Physics Research Section A*, 988, 164877, February 2021. <https://doi.org/10.1016/j.nima.2020.164877>
39. L. A. Finney, J. Lin, P. J. Skrodzki, M. Burger, J. Nees, K. Krushelnick, and I. Jovanovic, "Filament-induced breakdown spectroscopy signal enhancement using optical wavefront control," *Optics Communications*, . <https://doi.org/10.1016/j.optcom.2021.126902>
40. M. Burger, L. A. Finney, L. Garrett, S. S. Harilal, K. C. Hartig, J. Nees, P. J. Skrodzki, X. Xiao, and I. Jovanovic, "Laser Ablation Spectrometry in Nuclear Security and Safety", *Spectrochimica Acta, Part B* 179, 106095 (2021). <https://doi.org/10.1016/j.sab.2021.106095>
41. Liu T, DiFulvio A, Chung LK, Kearfott KJ. Radiation mapping for unmanned aerial vehicle: Development and simulated testing of algorithms for source mapping and navigation path generation. *Health Phys* 120(3):321-338; 2021. DOI: 10.1097/HP.0000000000001334
42. Noey JD, Golduber RM, Kearfott KJ. Analysis of long-term quality control data for a ¹³⁷Cs dosimetry calibration source. *Health Phys* 120(3):227-242; 2021. (cover article) DOI: 10.1097/HP.0000000000001355
43. Chung Long Kiu, Kent AJE, Cooney MA, Noey JD, Liebler KJ, Kearfott KJ. Simulations and experimental verifications of an algorithm for radiation source mapping and navigational path generation. *Health Phys* 120(?):???-???; 2021. DOI: 10.1097/HP.0000000000001392
44. Chung Long Kiu, Piersma NP, Kearfott KJ. Radon kinetics in a basement space measured with different devices. *Health Phys* 120(5):582-588; 2021. [Cover Article, May 2021 Issue] DOI: 10.1097/HP.0000000000001402
45. Thiesen JH, Hepker JM, Yu W, Pombier KD, Kearfott KJ. Preliminary thermoluminescent dosimeter glow curve analysis with automated glow peak identification for LiF:Mg,Ti, accepted February 9; 2021; doi: 10.1097/HP.0000000000001426
46. Kuchta JR, Thiesen JH, Noey JD, Chung Long Kiu, Kearfott KJ. Preliminary experiences with the REXON UL-320-FDR: An automated thermoluminescent dosimeter reader with removable contact heating planchets and an infrared temperature feedback system. *Health Phys* 120(4):467-471; 2021. DOI: 10.1097/HP.0000000000001386
47. N. Ba Sunbul, I. Oraiqat, B. Rosen, C. Miller, C. Meert, M. Matuszak, S. Clark, S. Pozzi, J. Moran, I. El Naqa, "Application of Radiochromic Gel Dosimetry to Commissioning of a Megavoltage Research Linear Accelerator for Small-Field Animal Irradiation Studies", *Medical Physics*, vol. 48, 3, pp. 1404-1416, 2021, <https://doi.org/10.1002/mp.14685>
48. Rafique M, Iqbal J, Lone KJ, Kearfott KJ, Rahman SU, Hussain L. Multifractal detrended fluctuation analysis of soil radon (²²²Rn) and thoron (²²⁰Rn) time series. *J Radioanal Nucl Chem*:10 pp; 2021. DOI: 10.1007/s10967-021-07650-x
49. Niral P. Shah, Member, IEEE, Peter Marleau, Jeffrey A. Fessler, Fellow, IEEE, David L. Chichester, Senior Member, IEEE, and David K. Wehe, Member, IEEE, Improved Localization Precision and Angular Resolution of a Cylindrical, Time-Encoded Imaging System from Adaptive Detector Movements, DOI: 10.1109/TNS.2021.3060071
50. Fred N. Buhler, David K. Wehe, and Michael P. Flynn, A Secure Measurement Unit for an Inspection System Used in Nuclear Arms-control Verification, <https://doi.org/10.1016/j.nima.2020.164577>
51. Ethan A. Klein, Farheen Naqvi, Jacob E. Bickus, Hin Y. Lee, Robert J. Goldston, Areg Danagoulian, ""Neutron Resonance Transmission Analysis with a Compact Deuterium-Tritium Neutron Generator"" , *Phys. Rev. arXiv:2012.03937; 10.1103/PhysRevApplied.15.054026*"
52. W. M. Steinberger, M. L. Ruch, N. P. Giha, A. Di Fulvio, P. Marleau, S. D. Clarke, S. A. Pozzi, "Imaging of Special Nuclear Material Using a Handheld Dual Particle Imager," *Sci Rep* 10, 1855 (2020). <https://doi.org/10.1038/s41598-020-58857-z>. (open access)
53. U. Shirwadkar, E. van Loef, G. Markosyan, J. Tower, M. Spens, C. Ji, L. S. Pandian, A. Gueorguiev, J. Glodo, K. Shah, S. A. Pozzi, S. D. Clarke, W. Langeveld, D. Strellis, J. Garcia, "Low-cost, multi-mode detector solutions", *Nuclear Instruments and Methods in Physics Research Section A*, vol. 954, 161289, 2020. <https://doi.org/10.1016/j.nima.2018.09.124>

MTV Publications

54. Zelaya, A.J., A.E. Parker, K.L. Bailey, P. Zhang, J. Van Nostrand, N. Daliang, D.A. Elias, J. Zhou, T.C. Hazen, A.P. Arkin, and M.W. Fields, "High spatiotemporal variability of bacterial diversity over short time scales with unique hydrochemical associations within a shallow aquifer", *Water Research*, vol. 164 (114917), November, 2019. <https://doi.org/10.1016/j.watres.2019.114917>
55. Zhou Q, Shubayr N, Carmona M, Standen TM, Kearfott KJ, "Experimental Study of Dependence on Humidity and Flow Rate for a Modified Flowthrough Radon Source", *J Radioanalytical and Nuclear Chemistry*, published online, March 4, 2020. <https://link.springer.com/article/10.1007/s10967-020-07081-0>
56. Taylor Harvey, Andreas Enqvist, and Katherine Bachner, "Applications and Deployment of Neutron Scatter Cameras in Nuclear Safeguards Scenarios", *Journal of Nuclear Materials Management*, Volume XLVIII, Number 2, p. 4, 2020
57. Michael A. Ford, Buckley E. O'Day, John W. McClory, Areg Danagoulian, "Development of a Neutron Spectrometer Utilizing Rubberized Eu:LiCAF Wafers," *Nuclear Instruments and Methods in Physics Research A*, vol. 954 (2020) 161685. <https://doi.org/10.1016/j.nima.2018.11.144>
58. Sean Martinson and Sunil Chirayath, Monte Carlo neutronics benchmarks on nuclear fuel depletion: A review, *Annals of Nuclear Energy*, 161, Article No. 108441, 2021. <https://doi.org/10.1016/j.anucene.2021.108441>
59. Klein, Ethan A, Farheen Naqvi, Jacob E Bickus, Hin Y Lee, Areg Danagoulian, and Robert J Goldston. 2021. "Neutron-Resonance Transmission Analysis with a Compact Deuterium-Tritium Neutron Generator." *Phys. Rev. Applied* 15 (5): 54026. <https://doi.org/10.1103/PhysRevApplied.15.054026>. Y Rob Goldston
60. Surafel Woldegiorgis, Andreas Enqvist, James Baciak, "ResNet and CycleGAN for pulse shape discrimination of He-4 detector pulses: Recovering pulses conventional algorithms fail to label unanimously", *Applied Radiation and Isotopes*, 176, 109819, (2021), <https://doi.org/10.1016/j.apradiso.2021.109819>
61. P. J. Skrodzki, M. Burger, L. A. Finney, R. Nawara, J. Nees, and I. Jovanovic, "Millisecond-long suppression of spectroscopic optical signals using laser filamentation," *Optics Letters*, <https://doi.org/10.1364/OL.430809>
62. Morishita Y, Ye Y, Mata L, Pozzi SA, Kearfott KJ. Radon measurements with a compact, organic-scintillator-based alpha/beta spectrometer. with a compact, organic-scintillator-based alpha/beta spectrometer. *Radiation Measurements* 137:106428, 2020. DOI: 10.1016/j.radmeas.2020.106428
63. Kim, K, A. R. Rodgers, M. A. Garces, and S. C. Myers (2021). Empirical Acoustic Source Model for Chemical Explosions in Air. *Bulletin of the Seismological Society of America* 2021; doi: <https://doi.org/10.1785/0120210030>
64. Malte Götttsche and Alexander Glaser (eds.), *Toward Nuclear Disarmament: Building Up Transparency and Verification*, German Federal Foreign Office, Berlin, May 2021.
65. Alexander Glaser, "Monitoring Regimes for All-Warhead Agreements," in M. Götttsche and A. Glaser (eds.), *Toward Nuclear Disarmament: Building Up Transparency and Verification*, German Federal Foreign Office, Berlin, May 2021.
66. Alexander Glaser and I. Niemeyer, "Nuclear Monitoring and Verification Without Onsite Access," in M. Götttsche and A. Glaser (eds.), *Toward Nuclear Disarmament: Building Up Transparency and Verification*, German Federal Foreign Office, Berlin, May 2021.
67. F. Sutanto, T. Classen, S. Dazeley, M. Duvall, I. Jovanovic, V. Li, A. Mabe, E. Reedy, and T. Wu, "SANDD: A directional antineutrino detector with segmented 6Li-doped pulse-shape-sensitive plastic scintillator," *Nuclear Instruments and Methods in Physics Research A* 1006, 165409 (2021). <https://doi.org/10.1016/j.nima.2021.165409>
68. J.A. Kulesza, C.J. Solomon, B.C. Kiedrowski, "Discrete Ordinates Analysis of the Forced-flight Variance Reduction Technique in Monte Carlo Neutral Particle Transport Simulations," *J. Comp. Phys.* 429 (2021) <https://doi.org/10.1016/j.jcp.2020.109997>
69. Stefano Marin, M. Stephan Okar, Eoin P. Sansevero, Isabel E. Hernandez, Catherine A. Ballard, Ramona Vogt, Jørgen Randrup, Patrick Talou, Amy E. Lovell, Ionel Stetcu, Olivier Serot, Olivier Litaize, Abdelhazze Chebboubi, Shaun D. Clarke, Vladimir A. Protopopescu, and Sara A. Pozzi "Energy-Dependent Event-by-Event Correlations in Neutron Emission of 252Cf(sf)", *Physical Review C*, Vol 104, 024602. (2021) <https://doi.org/10.1103/PhysRevC.104.024602>
70. A. J. Jinia, T. E. Maurer, C. A. Meert, M. Y. Hua, S. D. Clarke, H. S. Kim, D. D. Wentzloff, S. A. Pozzi, "An Artificial Neural Network System for Active Interrogation Applications", (Accepted 8/23/2021)
71. N. Ba Sunbul, W. Zhang, I. Oraiqtat, D. Litzenberg, K. Lam, K. Cuneo, J. Moran, P. Carson, X. Wang, S. Clarke, M. Matuszak, S. Pozzi, I. El Naqa, "Feasibility of Ionizing Radiation Acoustic Imaging (iRAI) as a Real-Time Dosimetric Technique for FLASH Radiotherapy: A simulation Analysis" (Accepted 8/6/2021)