# Matthew Durbin, Ph.D. Candidate

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## Education

2017 – 2022 **Ph.D. Nuclear Engineering, The Pennsylvania State University**.
*Ken and Mary Alice Lindquist Department of Nuclear Engineering*
Advisor: Professor Azaree Lintereur
GPA: 4.00/4.00
Fellow: Nuclear Regulatory Commission Graduate Fellowship Program (2019-· · ·)

2013 – 2017 **B.S. Physics, The University of Texas at Austin**.
*Department of Physics*
GPA: 3.48/4.00
Track: Radiation Physics

## Work Experience

2017 – · · · · **Graduate Research Assistant, The Pennsylvania State University**
*Ken and Mary Alice Lindquist Department of Nuclear Engineering*

2021 – · · · · **Student Intern, Lawrence Livermore National Laboratory**
*Nuclear Threat Reduction Program, Global Security*

Summer 2021 **Glenn T. Seaborg Institute Summer Intern, Lawrence Livermore National Laboratory**
*Glenn T. Seaborg Institute*

Spring 2019 **Graduate Teaching Assistant, The Pennsylvania State University**
*Ken and Mary Alice Lindquist Department of Nuclear Engineering*
NucE 450: Radiation Detection and Measurements Laboratory

Summer 2017 **Teaching Assistant, The University of Texas at Austin**
*Walker Department of Mechanical Engineering*
ME 361F: Radiation and Radiation Protection Laboratory

Summer 2016 **Medical Physics Intern, The University of Texas Medical Branch**
*Department of Radiation Oncology, Physics Division*

2015 – 2017 **Undergraduate Research Assistant, The University of Texas at Austin**
*Nuclear Engineering Teaching Laboratory*

2014 – 2015 **Substitute Teacher, Austin Independent School District, Austin, Texas**
Secondary level STEM classes

## Research

### Ken and Mary Alice Lindquist Department of Nuclear Engineering, Penn State University

2018 – · · · ·
**Gamma-Ray Source Localization** - *Dissertation Topic*
*PI: Prof. Azaree Lintereur*
○ Designed NaI-based directional detection system of 4 and 8 detectors
○ Implemented and optimized various machine learning and conventional algorithms to predict source location
○ Developed large simulated and experimentally-obtained datasets of system response to various source locations

2019 – · · · ·
**Pulse Shape Discrimination of Gamma Rays and Neutrons**
*PIs: Profs. Marek Flaska & Azaree Lintereur*
○ Developed python code to process and clean raw waveforms sets from a variety of photosensor-organic scintillator combinations
○ Developed and optimized a novel machine learning regression-based approach that gives a "modified" pulse shape parameter based on extracted waveform features, leading to better particle separation

2019 – · · · ·
**Detection of Missing Radioactive materials**
*PI: Prof. Azaree Lintereur*
○ Designed multiple simulated models of simple spent fuel assemblies
○ Developed simulated datasets of gamma ray detector responses for various diversion scenarios
○ Trained multiple machine learning models to detect diversion and pinpoint array positions from which rods or sources are missing
○ Tested models on an experimentally acquired dataset with 99% accuracy

2017 – 2018
**Radiation Damage in Gallium-Nitride (GaN)**
*PI: Prof. Azaree Lintereur*
○ Simulated gamma ray interactions from various sources in GaN samples
○ Correlated interactions to atom displacements and device damage
○ Prepared samples and assisted in irradiations at the Pacific Northwest National Laboratory High Exposure Facility

### Nuclear Threat Reduction Program, Lawrence Livermore National Laboratory

2021 – ...
**SIGMA/Cognitive Sensor Network**
*PI: Dr. Simon Labov*
○ Developed python code to simulate detection scenarios with injection capabilities into real detector/GPS data
○ Developed back projection and machine learning algorithm codes to predict source location in static and dynamic scenarios

### Nuclear Engineering Teaching Laboratory, University of Texas

2015 – 2017
**Gamma-Gamma Coincidence Detection**
*PI: Prof. Sheldon Landsberger*
○ Performed experiments to determine the optimal coincidence timing window of LaBr3 and HPGe coincidence systems
○ Assisted in experiments characterising signal-to-noise performance of the two systems as a function of count-rate

## Research (continued)

2017 **Rotational Neutron Localization**
*PI: Prof. Sheldon Landsberger*
- Characterized a B-10 based neutron detector
- Quantified angular response of the detector to a neutron source with various shielding

## Honors and Awards

### Fellowships and Scholarships

2019 – · · · · **Graduate Fellow** *Nuclear Regulatory Commission Graduate Fellowship Program*

2015 – 2017 **Scholarship** *Nuclear Regulatory Commission Undergraduate Scholarship*

### Awards

2021 **Division Finalist - Student Intern Research Slam**
*Lawrence Livermore National Laboratory, Physical and Life Sciences*

2021 **Innovations in Nuclear Technology R&D Award: Material Protection, Control, and Accountancy - First Place**
*U.S. Department of Energy, Office of Nuclear Energy, Office of Nuclear Fuel Cycle and Supply Chain*
For the Paper: K-Nearest Neighbors Regression for the Discrimination of Gamma Rays and Neutrons in Organic Scintillators

2021 **IEEE Nuclear and Plasma Science Society Graduate Scholarship Award**

2020 **J. D. Williams Student Paper Award: Best Student Poster**
*Institute of Nuclear Materials Management, Annual Meeting*
For the Paper: Optimization of a K-Nearest Neighbors Regression Algorithm for Improved Pulse Shape Discrimination of Gamma Rays and Neutrons in Organic Scintillators

2019 **J. D. Williams Student Paper Award: Division Finalist: Nuclear Security and Physical Protection**
*Institute of Nuclear Materials Management, Annual Meeting*
For the Paper: Development of Machine Learning Algorithms for Directional Gamma Ray Detector

2019 **J. D. Williams Student Paper Award: Education & Training Student Research Initiative Winner**
*Institute of Nuclear Materials Management, Annual Meeting*
For the Paper: Future Technical and Policy Challenges in Nuclear Security and Physical Protection

### Grants

2020 **IEEE NSS-MIC Trainee Grant**

2019 **Valentin T. Jordanov Radiation Instrumentation Travel Grant**

2019 **IEEE NSS-MIC Trainee Grant**

2019 **PSU Global Programs Graduate Student Travel Grant** (Two time recipient)

### Honor Societies

2018 – · · · · **Alpha Nu Sigma** *Nuclear Engineering Honor Society*

2016 – · · · · **Sigma Pi Sigma** *Physics Honor Society*

## Service and Involvement

### Leadership Positions

2019 – 2021 **President** *Penn State Student Chapter - Institute of Nuclear Materials Management*

2017 – 2019 **Treasurer** *Penn State Student Chapter - Institute of Nuclear Materials Management*

2018 – 2019 **Secretary** *Penn State Student Chapter - Alpha Nu Sigma*

2015 – 2016 **Outreach Chair** *University of Texas Student Chapter - Society of Physics Students*

### Reviewer

2021 – · · · · **Nuclear Instruments and Methods Section A**

2021 – · · · · **Nuclear Engineering and Design**

### Organizing Committees

2021 **Nuclear Engineering Graduate Seminar Series** State College, PA
*Ken and Mary Alice Lindquist Department of Nuclear Engineering*

2021 **Next-Gen AI for Proliferation Detection Workshop: AI-Enabled Information Fusion for Discovery and Decision Intelligence** Virtual
*National Nuclear Security Administration*

2020 **Quantification of the Likelihood of an Attack Workshop** Virtual
*Institute of Nuclear Materials Management*

### Conference Session Chair

2020 **Institute of Nuclear Materials Management Annual Meeting** Virtual
*Detection - Nuclear Protection and Physical Security*

2019 **IEEE Nuclear Science Symposium** Manchester, UK
*Neutron Detectors and Gamma Imaging II*

2019 **International Conference on the Applications of Nuclear Techniques** Crete, Greece
*Poster Session*

### Memberships

2017 – · · · · **Institute of Nuclear Materials Management**

2019 – · · · · **IEEE Nuclear & Plasma Sciences Society**

2017 – 2019 **American Nuclear Society**

### Miscellaneous

2018 – · · · · **Ken and Mary Alice Lindquist Department of Nuclear Engineering**
○ Organized and hosted series of seminars in which national laboratory and university faculty discussed elements of a research career not typically discussed in the normal graduate school experience
○ Interfaced with and provided feedback about many faculty candidates, including the recent department head search
○ Met with department head and student leadership to discuss various student affairs within the department, including providing input on the new "Nuclear Innovation Commons" space
○ Interfaced with the Penn State Nuclear Engineering Society (Alumni) to discuss student affairs and collaboration

## Service and Involvement (continued)

2018 – · · · · **Institute of Nuclear Materials Management**
- Worked with fellow officers to grow on-campus student membership to a sustainable number
- Organized and secured funds for multiple activities including visits to Brookhaven National Laboratory, Pacific Northwest National Laboratory, and multiple Annual Meetings of the parent organization
- Acquired thousands of dollars of chapter funds through a successful fundraiser and workshop
- Coordinated regular chapter meetings with student and external speakers, started a successful Book Club that has been sustained for going on three semesters

2017 **Texas Nuclear Engineering Student Delegation**
- Met with state level congress persons and their staff to promote nuclear energy and STEM education

2015 – · · · · **Outreach**
- Guided students, Boy Scouts, and community members through tours, activities, and demonstrations for various outreach events at Penn State's Breazeale Reactor facility
- Organized nuclear science and engineering demonstrations for Penn State's annual "Haunted U" outreach science event (2 years)
- Guided students and community members through activities and demonstrations for various outreach events though the Nuclear Engineering program and Physics Department at the University of Texas

## Skills

Coding — Python (NumPy, pandas, SciPy, matplotlib, SQLite, scikit-learn, TensorFlow), Matlab, MS Excel, LaTeX, MCNP (PTRAC, VisEd), Arduino

Technical — Gamma ray spectroscopy, data acquisition/analysis/visualization, machine learning, typesetting, teaching

## Publications, Presentations, Proceedings

– Journal – Proceedings – Summary – Oral – Poster – Paper Award

### Peer-Reviewed Journal Publications

R. Sheatsley, **M. Durbin**, A. Lintereur, P. McDaniel. *Improving Radioactive Material Localization by Leveraging Cyber-Security Model Optimizations*, IEEE Sensors, 21, 8, 2021.

**M. Durbin**, M. Wonders, M. Flaska, A. Lintereur. *K-Nearest Neighbors Regression for the Discrimination of Gamma Rays and Neutrons in Organic Scintillators*, Nucl. Inst. Meth. A., 987, 2021.

**M. Durbin**, C. Balbier, A. Lintereur. *Development of a Fully Connected Residual Neural Network for Directional Gamma Ray Detection*, Int. J. Mod. Phys: Conf. Ser. 50, 2020

**M. Durbin**, A. Lintereur. *Implementation of Machine Learning Algorithms for Detecting Missing Radioactive Material*, J. Radioanal Nucl. Chem., 324, 2020.

A. Drescher, M. Yoho, S. Landsberger, **M. Durbin**, *et. al. Gamma-gamma Coincidence Performance of LaBr3:Ce Scintillation Detectors vs HPGe Detectors in High Count-Rate Scenarios*, App. Rad. and Isot. 112, 2017.

## Presentations with Full Length Proceedings

**M. Durbin**, *et. al. Feature Engineering: A Case Study for Radiation Source Localization in Complicated Environments*, Inst. of Nucl. Mat. Mang. Annual Meeting, Virtual, 2021.

**M. Durbin**, *et. al. Quantification of the Likelihood of an Attack Workshop: Lessons Learned from a Virtual Format*, Inst. of Nucl. Mat. Mang. Annual Meeting, Virtual, 2021.

J. Rivers, A. Lintereur, **M. Durbin**. *INMM Workshop on the Quantification of the Likelihood of an Attack* ,Inst. of Nucl. Mat. Mang. Annual Meeting, Virtual, 2021

**M. Durbin**, A. Lintereur. *Machine Learning Approaches to Determine Missing Material from Nuclear Fuel Assemblies*, Inst. of Nucl. Mat. Mang. Annual Meeting, Virtual, 2020.

**M. Durbin**, M. Wonders, M. Flaska, A. Lintereur. *Optimization of a K-Nearest Neighbors Regression Algorithm for Improved Pulse Shape Discrimination of Gamma Rays and Neutrons in Organic Scintillators*, Inst. of Nucl. Mat. Mang. Annual Meeting, Virtual, 2020.

M. Wonders, **M. Durbin**, *et. al. Nuclear Security & Physical Protection Challenges from 2020-2040: Security in the Virtual Realm*, Inst. of Nucl. Mat. Mang. Annual Meeting, Palm Desert, California, USA, 2019.

**M. Durbin**, *et. al. Development of Machine Learning Algorithms for Directional Gamma Ray Detection*, Inst. of Nucl. Mat. Mang. Annual Meeting, Palm Desert, California, USA, 2019.

## Additional Presentations

**M. Durbin**, M. Flaska, A. Lintereur. *A Machine Learning Regression Approach for Pulse Shape Discrimination in Organic Scintillators*, American Nuclear Society Winter Meeting, Virtual, 2021. *Invited*

**M. Durbin**. *Applied Machine Learning Techniques for Radioactive Material Localization with an Array of NaI Detectors*, American Nuclear Society Winter Meeting, Virtual, 2021.

**M. Durbin**. *Machine Learning in Radiation Detection*, IEEE Nuclear Science Symposium, Virtual, 2021. *Invited*

**M. Durbin** *Was That a Threat? Estimating Radiological Source Activity for Detectors on the Move*, Physical and Life Sciences Summer Student SLAM, Lawrence Livermore National Laboratory, Virtual, 2021 and SLAM Special Addition, Livermore Lab Foundation, Virtual, 2021

**M. Durbin**, A Lintereur. *Feature Engineering for Stationary Directional Gamma Ray Detection*, IEEE SORMA West, Virtual, 2021.

**M. Durbin**, M. Wonders, M. Flaska, A. Lintereur. *Application of a Novel Machine Learning Approach to SiPM-Based Neutron/Gamma Detection and Discrimination*, IEEE Nuclear Science Symposium, Manchester, UK, 2019.

**M. Durbin**, A. Lintereur. *Machine Learning Applications for the Detection of Missing Radioactive Sources*, IEEE Nuclear Science Symposium, Manchester, UK, 2019.

**M. Durbin**, C. Balbier, A. Lintereur. *Development of a Fully Connected Residual Neural Network for Directional Gamma Ray Detection*, Int. Conf. App. Nucl. Tech., Crete, Greece, 2019

P-C. Simon, P. Bouhaddane, **M. Durbin**, *et. al. Who's Who? Energy Sources*, Research to Action: The Science of (Project) Drawdown, University Park, Pennsylvania, USA, 2019

M. Wonders, P-C. Simon, **M. Durbin**, *et. al. The Future of Nuclear Energy: Small Modular Reactors and Generation IV, A New Hope*, Research to Action: The Science of (Project) Drawdown, University Park, Pennsylvania, USA, 2019

**M. Durbin**, *et. al. Machine Learning Applications in Directional Gamma Ray Detection*, PSU Inst. Comp. Data Sci. Symp., University Park, Pennsylvania, USA, 2019

**M. Durbin**, *et. al. Comparative Gamma-Gamma Coincidence Perfomrance of LaBr3 and HPGe Detectors in High Count-Rate Scenarios*, American Nuclear Society Student Conference, Gainesville, Florida, USA, 2018