Kenneth J. Dayman
Curriculum Vitae

Contact
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Education
Ph.D., Mechanical Engineering, Nuclear Engineering, August 2015
University of Texas at Austin
Austin, TX
> Dissertation: *Determination of Independent and Cumulative Fission Product Yields with Gamma Spectrometry*
> Adviser: Steven Biegalski

M.S.E., Mechanical Engineering, Nuclear Engineering, May 2012
University of Texas at Austin
Austin, TX
> Thesis: *Multivariate Analysis Applied to the Characterization of Spent Nuclear Fuel*
> Adviser: Sheldon Landsberger

B.S., Mathematics, May 2010
University of Texas at Austin
Austin, TX

Research

12/2017–present **Oak Ridge National Laboratory**
Staff Research Associate

- Nuclear Security Modeling group

- Developed methods to assess misclassification probability, known-data library consistency, and allow for "None-of-the-Above" classifications using multivariate quantile comparisons

- Ongoing work to adapt binary probabilistic classification methods to multiclass problems with integrated feature selection to support pattern recognition analysis of multi-detector datasets and nonproliferation applications

11/2015–11/2017 **Oak Ridge National Laboratory**
Postdoctoral Research Associate

- Nuclear Security Modeling group

- Developed multivariate regression and classification methods for three-dimensional inverse depletion problems to support NA-22 Reactor Venture project

- Performed a ground-up analysis of nuclear fallout debris fractionation and implemented a correction method using convex optimization and parametric bootstrapping for uncertainty analysis

9/2011–8/2015   **University of Texas at Austin**
Nuclear Forensics Graduate Fellow

- Developed Matlab tools for semi-automated analysis of complex fission product gamma spectra using optimization and decay-chain modeling
- Irradiated U_3O_8 to produce fission products, collected gamma spectra, and determined empirical activity time series
- Developed a flexible numerical predictive model for the buildup and decay of fission products including neutron reaction coupling terms
- Determined independent and cumulative fission product yields using Bayesian inference and convex optimization
- Quantified uncertainties using a Monte Carlo procedure to estimate the posterior distributions for yields and compared to conventional methods for propagation of error
- Developed into Ph.D. dissertation

8/2010–9/2011   **University of Texas at Austin**
Graduate Research Assistant

- Researched use of multivariate classification and regression models for nuclear nonproliferation and forensics applications

Summer 2010, 2011   **Pacific Northwest National Laboratory**
National Security Intern

- Extended data analysis methods in support of Multi-Isotope Process Monitor
- Developed into Master's thesis
- Supervised by Christopher Orton

1/2009–5/2010   **University of Texas at Austin**
Undergraduate Research Assistant

- Conducted research projects focusing on gamma spectroscopy, Compton suppression, and neutron activation analysis
- Supervised by Sheldon Landsberger

5/2010–8/2015   **Graduate Class Projects**

- **A Thermodynamic Analysis of the Temporal Cycling of the Oklo Reactors**
  A scoping study coupling thermodynamic and neutronic analyses was performed in order to study the feasibility of thermodynamically-driven evaporation and condensation of water driving cyclic operation of the natural reactors in Oklo, Gabon.
- **MCNPX Digital Workshop**
  Collaborated with seven students to develop an example-driven instructional course in radiation transport using MCNPX. The students prepared and delivered lectures and wrote a text for the course. Supervised by Erich Schneider.
- **Changeover to Traveling Wave Reactors: A Comparative Study of Future Nuclear Fuel Cycle Options**
  Collaborated with four students to model a changeover from the current US once-through LWR nuclear fuel cycle to a fuel cycle based on traveling wave reactors.
- **Graph Cuts with k-Discovery: A Hierarchical Approach**
  Developed a hierarchical clustering algorithm based on a spectral clustering understanding of graph cuts.

- **Prospects for the Future Conversion of FRM-II to Low Enriched Uranium**
  Worked on a team of graduate policy and nuclear engineering students to study the current status and outlook of global phase-out of non-weapons-use HEU.

Teaching & Mentoring

2017–present **Oak Ridge National Laboratory**
Adviser
- Mentored University of Texas Ph.D. student, Adam Drescher
- Developed plan of research for Ph.D. dissertation
- Will act as co-adviser

2010–2014 **University of Texas**
Student Adviser
- Advised University of Texas undergraduate student, Raul Palomares (current University of Tennessee Ph.D. student)
- Guided original research with neutron activation analysis
- Helped prepare journal article manuscript and sponsor report

Guest Lecturer
- Gave lectures in a graduate-level reactor theory course
- Discussed analytic and numerical solutions to neutron diffusion problems and criticality-search problems

Laboratory Teaching Assistant
- Taught laboratory sections of a nuclear instrumentation course
- Gave lectures on Geiger counters, gamma spectroscopy, Compton suppression, and neutron activation analysis

Funded Projects

2016 **Basic Science, Counter-WMD Program**,
Defense Threat Reduction Agency
"Novel Methods for Rapid, Reliable, and Rigorous Analysis of Gamma-Ray Spectra using Optimization and Nuclide Modeling," $300k BA/3 years

Honors

Dec 2018 *Supplemental Performance Award*

April 2015 *ANS Isotopes & Radiation Division Research Development & Travel Award*

June 2013 *Innovations in Fuel Cycle Research*
Second Place in Open Competition: Materials Protection, Control, and Accountancy

Nov. 2011 *UT Office of Graduate Studies Professional Development Award*

2011–present *DHS DNDO Nuclear Forensics Graduate Fellowship*
Awarded in 2011

2010 *Meyer Endowed Scholarship in Engineering*
Awarded in 2010

2006 and 2010 *University of Texas Honors List*

Research Interests

Bayesian statistics; inverse problem theory; machine learning and data analytics; applied numerical optimization; material production modeling and inverse depletion; post-detonation fallout debris analysis; uncertainty analysis; metrology; coincidence and anti-coincidence spectroscopy; neutron activation analysis; gamma spectroscopy; measurement and evaluation of nuclear data.

Technical Skills

Experimental

Gamma spectroscopy, Compton suppression, gamma-gamma coincidence spectroscopy, neutron activitation analysis, neutron beam activation, digital data collection and processing

Computation

Python, Matlab, Origen-ARP/S, Origen2.2, MCNPX, LaTeX, NJOY99, Mathematica, Windows and Macintosh operating systems, document, spreadsheet, and presentation preparation software

Technical Training

Scientific Computing in Python Workshops, July 2017
SCALE6.2 Origen, Origami, Couple Training, Feb. 2016
MCNPX Intermediate Training, Sept. 2011
NNSA/NGSI Nuclear Nonproliferation & International Safeguards, June 2010

Professional Service

2012–present   **External Reviewer**
- *Environmental Radioactivity*
- *Journal of Radioanalytical and Nuclear Chemistry*

2011–2014   **President**
American Nuclear Society UT Student Chapter
- Coordinated outreach activities
- Developed new outreach and educational outlets
- Responsible for annual status reports

2011   **Laboratory Teaching Assistant**
University of Texas & Huston Tillotson University
- Assembled Geiger-Mueller counting systems at HTU
- Trained faculty in using new instrumentation for instructing a course on radiation safety and instrumentation

2010–2011   **Treasurer**
American Nuclear Society UT Student Chapter
- Maintained budget
- Aided in outreach and social events

Memberships

2009–present   Member, American Nuclear Society

2010–2015   Member, American Nuclear Society UT Student Chapter

Publications

Refereed Journal Articles

13. S. Stewart, **K. Dayman**, M. Adams, L. Worrall, C. Crawford, and G. Westphal. A decision framework to quantify the applicability of data analytics and machine learning methods in nuclear safeguards (submitted). *Journal of Nuclear Materials Management*, 2020.

12. C. Greulich, N. Rao, S. Satyabrata, J. Hite, **K. Dayman**, A. Nicholson, M. Dion, D. Archer, M. Willis, I. Garishvili, J. Ghawaly, A. Rowe, I. Stewart, R. Hunley, and J. Johnson. Dissolution event classification at a radiochemical processing facility using effluent measurements. *IEEE Trans Nucl Science (submitted)*, 2020.

11. A. Moore, L. Worrall, C. Britton, S. Croft, and **K. Dayman** et al. Development and evaluation of a list mode neutron coincidence collar for spatial response measurements of fresh fuel assemblies. *Nucl Instr and Meth A*, 976:1–14, 2020.

10. S. Biegalski and N. Kane and J. Mann and T. Tipping and **K. Dayman**. Neutron Activation of NIST Surrogate Post-Detonation Urban Debris (SPUD) Candidate SRMs. *J Radioanal Nucl Ch*, 318:187–193, 2018.

9. **K. Dayman** and C. Weber. Flexible Classification with Spatial Quantile Comparison and Novel Statistical Features Applied to Spent Nuclear Fuel Analysis. *J Radioanal Nucl Ch*, 318:605–618, 2018.

8. **K. Dayman**, S. Biegalski, D. Haas, A. Prinke, and S. Stave. Evaluation of Independent and Cumulative Fission Product Yields with Gamma Spectrometry. *J Radioanal Nucl Ch*, 307(3):2239–2245, 2016.

7. **K. Dayman** and S. Biegalski. Automatic Identification and Quantification of Radionuclides in Gamma Spectra using Numerical Optimization. *J Radioanal Nucl Ch*, 307(3):2247–2252, 2016.

6. **K. Dayman**, S. Biegalski, and D. Haas. Determination of Short-Lived Fission Product Yields with Gamma Spectrometry. *J Radioanal Nucl Ch*, 305:213–223, August 2015.

5. R. I. Palomares, **K. Dayman**, S. Landsberger, S. Biegalski, C. Z. Soderquist, A. J. Casella, M. C. Brady Raap, and J. M. Schwantes. Measuring the Noble Metal and Iodine Composition of Extracted Noble Metal Phase from Spent Nuclear Fuel Using Instrumental Neutron Activation Analysis. *Appl Radiat Isotopes*, 98:66–70, 2015.

4. **K. Dayman**, J. B. Coble, C. R. Orton, and J. M. Schwantes. Characterization of Used Nuclear Fuel with Multivariate Analysis for Process Monitoring. *Nucl Instr and Meth*, A 735:624–632, 2013.

3. **K. Dayman** and S. Biegalski. Feasibility of Fuel Cycle Characterization using Multiple Nuclide Signatures. *J Radioanal Nucl Ch*, 296:195–201, 2013.

2. S. Landsberger and **K. Dayman**. Monitoring of Neutron Flux Changes in Short-Lived Neutron Activation Analysis. *J Radioanal Nucl Ch*, 296:329–332, 2013.

1. S. Landsberger, G. George, R. Lara, D. Tamalis, J. Louis-Jean, and **K. Dayman**. Analysis of Naturally Occurring Radioactive Material Using Neutron Activation Analysis and Passive Compton Suppression Gamma-Ray Spectrometry. *Nukleonika*, 57(4):461–465, 2012.

Book Chapters

1. **K. Dayman**. *Nuclear Terrorism and Global Security: The Challenge of Phasing Out Highly Enriched Uranium*, chapter Germany: The FRM-II Reactor, pages 121–135. Routledge Series on Global Security Studies. Routledge, April 2013.

Technical Reports

7. **K. Dayman**, A. Nicholson, and L. Worrall. Updates to the relevance vector machine: Multiclass classification, variable selection, and proof-of-concept application to safeguards fresh fuel verification using list-mode neutron collar data. Technical Report ORNL TM-2018/1079, Oak Ridge National Laboratory, October 2020.

6. A. Hagen, A. Luttman, E. McGarrah, T. Nowak, B. Wilson, and **K. Dayman**. Artificial Intelligence Threats and Protections for Global Material Security. Technical report, Pacific Northwest National Laboratory and Oak Ridge National Laboratory, Richland, Washington 99352, September 2019 (Document is OUO).

5. **K. Dayman** and V. Jodoin. Fractionation of Post-Detonation Debris: Analysis and Correction. Technical Report ORNL/TM-2017/180, Oak Ridge National Laboratory, 2017.

4. B. Ade, **K. Dayman**, N. Luciano, and C. Weber. Inverse Method Testing Framework and Results. Technical Report ORNL/SPR-2017/537, Oak Ridge National Laboratory, 2017.

3. D. Meyer, J. B. Coble, D. V. Jordan, L. Mcdonald, J. Forrester, J. Schwantes, K. Unlu, S. Landsberger, S. Bender, and **K. Dayman**. The Multi-Isotope Process (MIP) Monitor Project: FY13 Final Report. Technical report, Pacific Northwest National Laboratory, 2013.

2. J. B. Coble, C. R. Orton, D. V. Jordan, J. M. Schwantes, S. E. Bender, **K. Dayman**, K. Unlu, and S. Landsberger. The Multi-Isotope Process (MIP) Monitor Project: FY12 Progress and Accomplishments. Technical Report PNNL-21819, Pacific Northwest National Laboratory, Richland, Washington 99352, September 2012.

1. C. R. Orton, C. G. Fraga, J. W. Hayes, J. M. Schwantes, S. E. Bender, K. Unlu, **K. Dayman**, S. S. Schreiber, and S. Landsberger. The Multi-Isotope Process Monitor Project: FY11 Progress and Accomplishments. Technical Report PNNL-20707, Pacific Northwest National Laboratory, Richland, Washington 99352, August 2011.

Refereed Conference Papers

4. **K. Dayman**, Jason Hite, Adam Drescher, and Brian Ade. An Explainable Statistical Learning Algorithm to Support Data Fusion. In 23rd *International Conference on Information Fusion*, June 2020.

3. J. Hite, **K. Dayman**, N. Rao, C. Greulich, S. Sen, D. Chichester, A. Nicholson, D. Archer, M. Willis, I. Garishvili, A. Rowe, J. Ghawaly, and J. Johnson. Automated Vehicle Detection in a Nuclear Facility Using Low-Frequency Acoustic Sensors. In 23rd *International Conference on Information Fusion*, June 2020.

2. N. S. V. Rao, C. Greulich, S. Sen, **K. Dayman**, J. Hite, W. Ray, R. Hale, A. Nicholson, J. Johnson, R. Hunley, M. Maceira, C. Chai, O. Marcillo, T. Karnowski, and R. Wetherington. Reactor Power Level Estimation by Fusing Multi-Modal Sensor Measurements. In 23rd *International Conference on Information Fusion*, June 2020.

1. **K. Dayman**, B. Ade, and C. Weber. Sparse Bayesian Regression with Integrated Feature Selection for Nuclear Reactor Analysis. In *International Conference on Mathematics & Computational Methods Applied to Nuclear Science & Engineering*, April 2017.

Conference Presentations

28. A. Drescher, M. Adams, S. Stewart, **K. Dayman**, L. Worrall, and G. Westphal. Machine learning approaches for nuclear material accounting data from irradiation and reprocessing. In *Proceedings of the Institute of Nuclear Materials Management*, 2020.

27. A. Drescher and **K. Dayman**. Leveraging machine learning capabilities for the characterization of irradiated uranium: A case study of analysis methods for nuclear safeguards and nuclear forensics. In *Proceedings of the Institute of Nuclear Materials Management*, 2020.

26. N. Rao, C. Greulich, S. Satyabrata, J. Hite, **K. Dayman**, A. Nicholson, D. Archer, M. Willis, I. Gar-ishvili, R. Hunley, and J. Johnson. Classification of dissolution events using fusion of effluents measurements and classifiers. In *Proceedings of the Institute of Nuclear Materials Management*, 2020.

25. **K. Dayman**, C. Weber, N. Luciano, B. Ade, Matthew Francis, A. Nicholson, and A. Drescher. Transformative Data Analytic Capabilities for Nuclear Decision Science. In *Proceedings of the Institute of Nuclear Materials Management*, Palm Desert, CA, 2019.

24. N. Rao, S. Sen, **K. Dayman**, M. Chattin, K. Buckley, R. Hunley, H. Hesse, and R. Hale. Classifiers for Dissolution Events in Processing Facility Using Effluents Measurements. In *Proceedings of the Institute of Nuclear Materials Management*, Palm Desert, CA, 2019.

23. C. Weber and **K. Dayman**. Using Quantile Comparisons to Classify Environmental Samples. In *Proceedings of the Institute of Nuclear Materials Management*, Palm Desert, CA, 2019.

22. C. Weber and **K. Dayman**. Classification of Forensic Measurements Using Multivariate Quantile Comparisons. In *INMM Nuclear Materials Science, Processing, and Signature Discovery Workshop*, May 2018.

21. **K. Dayman** and S. Biegalski. Rapid Spectral Analysis for Complex Gamma-ray Spectra. In *Methods and Applications of Radioanalytical Chemistry*, April 2018.

20. **K. Dayman** and C. Weber. Statistical Evaluation of Multivariate Measurements for Material Provenance Assessment. In *Methods and Applications of Radioanalytical Chemistry*, April 2018.

19. L. Worrall, A. Nicholson, S. Croft, **K. Dayman**, B. McElroy, and A. Simone. Development of a List Mode Collar (LMCL) for Fresh Fuel Pattern Recognition. In *Institute of Nuclear Materials Management Annual Meeting*, July 2017.

18. **K. Dayman**, B. Ade, and C. Weber. Sparse Bayesian Regression with Integrated Feature Selection for Nuclear Reactor Analysis. In *International Conference on Mathematics & Computational Methods Applied to Nuclear Science & Engineering*, April 2017.

17. **K. Dayman**, S. Biegalski, D. Haas, A. Prinke, and S. Stave. Evaluation of Independent and Cumulative Fission Product Yields with Gamma Spectrometry. In *Methods and Applications of Radioanalytical Chemistry*, 2015.

16. **K. Dayman**, S. Biegalski, and D. Haas. Determination of Short-Lived Fission Product Yields with Gamma Spectrometry. In 8th *Conference on Isotopes*, August 2015.

14. **K. Dayman**, T. Tipping, and S. Biegalski. A Field Survey Laboratory for a Course in Nuclear Instrumentation. In *Transactions of the American Nuclear Society*, volume 109, pages 243–244, Washington, D.C., November 2013 *(refereed proceedings)*.

13. **K. Dayman**. Measurement of Short-Lived Fission Product Yields. Presented at the NNFEDP Academic-National Laboratory Collaboration Meeting, July 2013.

12. S. Landsberger, S. G. Landsberger, G. Graham, G. Kuzmin, D. Millsap, **K. Dayman**, C. Lu, D. Tamalis, J. Louis-Jean, G. Dort, and T. Dudley. Naturally Occurring Radioactive Material (NORM) Wastes from Oil Exploration. Presented at the 7th Symposium of Naturally Occurring Radioactive Material, April 2013.

11. **K. Dayman**, C. Orton, J. Coble, and J. Schwantes. Characterization of Spent Nuclear Fuel using Multivariate Analysis. In *Transactions of the American Nuclear Society*, volume 107, pages 354–356, San Diego, CA, Nov. 2012 *(refereed proceedings)*.

10. J. Graham, **K. Dayman**, U. Phathanapirom, B. Epping, and K. McConnell. A Comparative Study of CANDLE Reactor Based U.S. Nuclear Fuel Cycles. In *Transactions of the American Nuclear Society*, volume 106, pages 224–225, Chicago, IL, June 2012 *(refereed proceedings)*.

9. **K. Dayman** and S. Landsberger. Characterization of Spent Nuclear Fuel using Multivariate Signatures. Presented at the American Nuclear Society Student Conference, April 2012.

8. **K. Dayman**, C. Orton, and S. Landsberger. Applications of Statistical Learning Techniques to Gamma Spectra: Process Monitoring and the Characterization of Spent Nuclear Fuel. Presented at the Southwest Regional Meeting of the American Chemistry Society, Nov. 2011.

7. S. Landsberger, **K. Dayman**, C. Orton, and J. Schwantes. Automated Measurement of Burnup Credit Using PLS. In *Transactions of the American Nuclear Society*, volume 104, pages 217–218, Hollywood, FL, July 2011 *(refereed proceedings)*.

6. **K. Dayman**. Multivariate Analysis Applied to the Characterization of Spent Nuclear Fuel. Presented at the NNFEDP Academic-National Laboratory Collaboration Meeting, July 2012.

5. **K. Dayman**, S. Landsberger, and C. Orton. Automated Measurement of Burnup Credit Using PLS. Presented at the American Nuclear Society Student Conference, April 2011.

4. C. Orton, C. Fraga, J. Hayes, S. Bender, K. Unlu, **K. Dayman**, S. Landsberger, R. Christensen, and J. Schwantes. The Multi-Isotope Process Monitor: FY 11 Accomplishments. Presented at the FCR&D MPACT Working Group Meeting, 2011.

3. S. Landsberger, S. Fitch, and **K. Dayman**. An Assay of Uranium Ore with Compton-Suppressed Gamma Spectroscopy. In *Transactions of the American Nuclear Society*, volume 102, pages 181–182, June 2010 *(refereed proceedings)*.

2. C. Orton, C. Fraga, S. Bender, **K. Dayman**, R. Christensen, and J. Schwantes. The Multi-Isotope Process Monitor: Nondestructive, Near-Real-Time Nuclear Safeguards Monitoring for Processing Plants. Presented at the FCR&D MPACT Working Group Meeting, 2010.

1. S. Landsberger, **K. Dayman**, and V. Patel. A Demonstration of Self-Shielding for the Analysis of Gold with Neutron Activation Analysis. In *Transactions of the American Nuclear Society*, volume 102, pages 201–202, San Diego, CA, June 2010 *(refereed proceedings)*.

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