



U.S. DEPARTMENT OF
ENERGY

PNNL-22527

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Summary of the Graduate Mentoring Assistance Program for PNNL

PNNL.12.006
(April 2012 – May 31, 2013)

JM Schwantes

May 2013



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service
5301 Shawnee Rd., Alexandria, VA 22312
ph: (800) 553-NTIS (6847)
email: orders@ntis.gov <<http://www.ntis.gov/about/form.aspx>>
Online ordering: <http://www.ntis.gov>

Summary of the Graduate Mentoring Assistance Program for PNNL

**PNNL.12.006
(April 2012 – May 2013)**

JM Schwantes

May 2013

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Summary of Students and Projects

Sarah Bender

The possible improvement of the Multi-Isotope Process (MIP) Monitor by the addition of Compton suppression is investigated for this study. The Compton continuum from the dominant 661.7 keV Cs-137 fission product peak obscures lower energy lines which could be used for spectral and multivariate analysis. A novel Compton suppression system which uses fast, room-temperature materials will be developed using simulation. As opposed to the standard high purity germanium (HPGe) detector suppressed using a thallium-doped sodium iodide (NaI(Tl)) guard detector array, cerium-doped lanthanum bromide (LaBr₃) will be used as the primary spectroscopic detector. For Sarah's Master's degree, she constructed and validated the unsuppressed detector response of the Pennsylvania State University (PSU)-Compton suppression system. For Sarah's PhD, she is completing that simulation by including the suppressed operation which will be validated with spent fuel samples. She is also going to use the validation of suppressed operation to predict the detector response of a LaBr₃ based Compton suppression system.

Richard Clark

Richard Clark completed his study this FY of a new technique known as Intrinsic Dosimetry. Intrinsic Dosimetry is the method of measuring total absorbed dose received by the walls of a container holding radioactive material. By considering the total absorbed dose received by a container in tandem with the physical characteristics of the radioactive material housed within that container, this method has the potential to provide enhanced pathway information regarding the history of the container and its radioactive contents. The latest in a series of experiments designed to validate and demonstrate this newly developed tool are reported.

Kenneth Dayman

The MIP Monitor is an online, non-destructive approach to process monitoring in a nuclear fuel reprocessing facility using gamma spectra taken of process streams and multivariate data analysis to detect anomalies in operation. Last year, Mr. Dayman investigated methods to classify spent nuclear fuel according to both reactor type and burn up based on the constituent nuclide activities, which may be used to more accurately calibrate other models in an analysis scheme in order to improve the accuracy and precision of predictions. He is currently writing up his results for publication and has transitioned to another project with Dr. Derrick Haas at PNNL.

Student Research Contributions

Below is a complete description of references which were supported by the Graduate Mentoring Assistance Program (GMAP).

Publications (1)

Dayman K, CR Orton, JB Coble, and JM Schwantes. 2012. "Characterization of Spent Nuclear Fuel using Multivariate Analysis." In 2012 ANS Winter Meeting and Nuclear Technology Expo. PNNL-SA-88880, Pacific Northwest National Laboratory, Richland, WA.

Journal Article (1)

2013. PNNL-SA-93329 [Limited Distribution, Unpublished]

Formal Reports (3)

Orton CR, CG Fraga, JW Hayes, JM Schwantes, SE Bender, K Unlu, KJ Dayman, SS Schreiber, and S Landsberger. 2012. *The Multi-Isotope Process Monitor Project: FY11 Progress and Accomplishments*. PNNL -20707, Pacific Northwest National Laboratory, Richland, WA.

Coble, JB, CR Orton, and JM Schwantes. 2012. *Automated Characterization of Spent Fuel through the Multi-Isotope Process (MIP) Monitor*. PNNL-21599, Pacific Northwest National Laboratory, Richland, WA.

Coble JB, CR Orton, DV Jordan, JM Schwantes, SE Bender, K Unlu, KJ Dayman, and S Landsberger. 2012. *The Multi-Isotope Process Monitor Project: FY12 Progress and Accomplishments*. PNNL -21819, Pacific Northwest National Laboratory, Richland, WA.

Presentations (4)

Dayman KJ, CR Orton, JB Coble, and JM Schwantes. 2012. "Characterization of Spent Nuclear Fuel using Multivariate Analysis." Presented by Kenneth Dayman at 2012 ANS Winter Meeting and Nuclear Technology Expo, San Diego, CA on November 12, 2012. PNNL-SA-91726.

Schwantes, JM, SA Bryan, DC Duckworth, TG Levitskaia, SH Pratt, JB Coble, M Liezers, GL Hart, and CR Orton. 2012. "Advanced process monitoring safeguards technologies at Pacific Northwest National Laboratory." Presented by Jon Schwantes at ATALANTE 2012 International Conference, Montpellier, France on August 30, 2012. PNNL-SA-90454.

Coble JB, DV Jordan, DE Meier, CR Orton, CG Fraga, S Bender, K Unlu, KJ Dayman, S Landsberger, and JM Schwantes. 2013. "The Multi-Isotope Process Monitor: FY13 Progress." Presented by Jamie Coble at MPACT Working Group Meeting, College Station, TX on March 14, 2013. PNNL-SA-94228.

2012. PNNL-SA-90319 [Limited Distribution].

Coble, JB, JM Schwantes, CR Orton, and DV Jordan. 2013. “Online Process Verification with the Multi-Isotope Process Monitor.” Presented by Jon Schwantes at 245th American Chemical Society (ACS) National Meeting & Exposition, New Orleans, LA on April 8, 2013. PNNL-SA-94646.

Abstracts (1)

Coble JB, JM Schwantes, and CR Orton. 2012. “Online Process Verification with the Multi-Isotope Process Monitor .” Abstract submitted to 245th American Chemical Society (ACS) National Meeting & Exposition, New Orleans, LA. PNNL-SA-91983.

Conference Papers (3)

Dayman, K, CR Orton, JB Coble, and JM Schwantes. 2012. “*Characterization of Spent Nuclear Fuel using Multivariate Analysis.*” In 2012 ANS Winter Meeting and Nuclear Technology Expo. PNNL-SA-88880, Pacific Northwest National Laboratory, Richland, WA.

Coble, JB, CR Orton, and JM Schwantes. 2013. “*Spent Fuel Characterization with the Multi-Isotope Process Monitor.*” In American Nuclear Society Annual Meeting. PNNL-SA-92968, Pacific Northwest National Laboratory, Richland, WA. [Unpublished]

Schwantes, JM, SA Bryan, CR Orton, TG Levitskaia, SH Pratt, CG Fraga, and JB Coble. 2013. “Advanced process monitoring safeguards technologies at Pacific Northwest National Laboratory.” In *ATALANTE 2012 INTERNATIONAL CONFERENCE ON NUCLEAR CHEMISTRY FOR SUSTAINABLE FUEL CYCLES.* PNNL-SA-93285, Pacific Northwest National Laboratory, Richland, WA. [Unpublished]

Other Publications (1)

Coble, JB. 2013. “M3 Deliverable for MPACT Project, “Multi-Isotope Process Monitor.” PNNL-SA-94098, Pacific Northwest National Laboratory, Richland, WA.

Kenny Dayman has submitted a manuscript titled “Characterization of Used Nuclear Fuel with Multivariate Analysis for Process Monitoring,” describing his Master’s work to *Nuclear Inst. and Methods in Physics Research, A*. Revisions based on journal reviewer feedback are currently underway.

A manuscript is being drafted by Sarah Bender and Kenny Dayman titled “Nondestructive Determination of Burnup of Spent Nuclear Fuel from Gamma Ray Spectra using Partial Least Squares Analysis,” describing their joint work on comparison of burnup methods. This article will be submitted to *Applied Radiation and Isotopes* when complete.

Benefits (to the laboratory, the mentors, and the students)

GMAP has provided a number of important benefits to our laboratory, our staff and our mentees. First and foremost, GMAP supported quality National Laboratory mentoring of university graduate students. Mentoring is a necessary part of the education of all in-coming staff to the National Laboratory system due to the particular nature of the research being conducted at these institutions.

Secondly, this Program provided support to staff for activities that are often unfunded. To an extent, mentoring is a normal part of many staff members' days. The mentoring staff has active and ongoing relationships with academia and as such, often hosts students from these institutions for extended periods of time at the Laboratory. However, funding to support activities specific to mentoring are almost never captured within scope that is inherently "research and development" in nature. This leaves staff to often volunteer their time to interact with and mentor students from academia. GMAP has supported these often overlooked activities.

Third, GMAP has provided a small but important source of gap funding for National Laboratory research that has ended ahead of a student's thesis or dissertation. National Laboratory research and development (R&D) is funded on a yearly basis, while graduate student research projects last on the order of two to five years. For projects that tie graduate students to National Laboratory research funding discrepancies can and do ensue. Pacific Northwest National Laboratory (PNNL) has in the past been able to support gap funding for graduate student research activities associated with a no longer funded National Laboratory project through GMAP.

Challenges

After completing his Master's thesis, Kenny Dayman transitioned to a different research area and is only peripherally engaged with the NTNFC research program. We continue to engage with him to publish a journal article covering his work on the MIP Monitor. Jamie Coble, who has been working with Kenny Dayman and Sarah Bender on work related to the MIP Monitor, will be leaving PNNL at the end of July to join the faculty at the University of Tennessee.

A significant challenge that continues to plague Nuclear Forensics Undergraduate Summer School (NTNFC) graduate fellowship student activities at PNNL is our inability to sponsor security clearances for these students. These issues stem from the fact that PNNL must have a formal financial connection with personnel they sponsor for a security clearance. For instance, graduate students that are hired directly by PNNL through the Laboratory's "National Security Internship Program" or indirectly through a subcontract with their home institution do not suffer from this problem. The inability to obtain a security clearance for NTNFC fellows limits their access to many research and development activities at the Laboratory. While it is not typical practice for graduate students to conduct classified research for their graduate work, some of the research activities going on at the laboratory can be connected to certain sensitivities. As a

result, graduate students without a security clearance would not be allowed to work on any research activities having sensitive aspects associated with them.

Summary of Laboratory Mentor Interactions with Students' Home Universities & Significant Events

April 2012

- Jon Schwantes traveled to ANS Student Meeting, Las Vegas, NV, as an invited panel speaker regarding future employment at the National Laboratories.
- Jon Schwantes – Traveled to Pennsylvania State University to participate in Sarah Bender's Master's Defense. Also, presented to the Student Chapter of INMM, Pennsylvania State University.

May 2012

- Kenneth Dayman graduated with his MS degree in May.

June 2012

- Richard Clark presented an overview of his work at the Collaboration Meeting, Oak Ridge, TN.

July 2012

- Kenneth Dayman spent a week at PNNL wrapping up his master's research and working on a journal submission covering that work. The target journal is the Institute of Electrical and Electronics Engineers transactions on Nuclear Science; submission is planned for the end of July.
- Jon Schwantes – traveled to Columbia, MO, to participate as an expert instructor for the NTNFC.

August 2012

- Dr. Richard Clark successfully defended his dissertation. Jon Schwantes participated in this defense as an Outside Committee Member.

November 2012

- Kenny Dayman attended and presented the results of his Master's research at the 2012 ANS Winter Meeting.
- Dilute spent fuel samples were set to PSU to support Sarah Bender's Ph.D. research.

January 2013

- NEUP pre-applications for work related to the MIP Monitor were submitted by PSU and University of Tennessee-Knoxville. Full proposals will be submitted in June.

April 2013

- Kenny Dayman submitted his journal manuscript to NIM-A. Reviewer comments were received in May, and revisions are underway.



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99352
1-888-375-PNNL (7665)

www.pnl.gov



U.S. DEPARTMENT OF
ENERGY