NIDC | NATIONAL ISOTOPE DEVELOPMENT CENTER
MANAGED BY THE U.S. DEPARTMENT OF ENERGY ISOTOPE PROGRAM

Newsletter

Summer/Fall 2019

DOE IP and NIDC at EANM 2019!

Thank you to those who stopped by our booth at the 2019 European Association of Nuclear Medicine Annual Conference (EANM) in Barcelona, Spain!

The U.S. Department of Energy Isotope Program (DOE IP) and the National Isotope Development Center (NIDC) attended the 2019 EANM Annual Congress in Barcelona, Spain from October 12–15. It was wonderful to see so many new and familiar faces, and we look forward to continuing our relationships with each of you.

If you are interested in speaking with the DOE IP/ NIDC during an upcoming event, email Karen Sikes at **sikeskg@ornl.gov** to schedule a meeting.

INSIDE THIS ISSUE

Jasmine Hatcher-Lamarre: Ac-225 Researcher and Rising Star

Growing up in Queens, New York, Jasmine Hatcher-Lamarre never dreamed she would find fulfillment in a career as a chemist. Today her research is bringing the world closer to supplying groundbreaking cancer-fighting therapies to thousands of patients.

Jasmine enrolled at a local college, Queensborough Community College, as a nursing student but soon realized she lacked enthusiasm for her chosen major. At the suggestion of her chemistry professor, she applied for an internship at Brookhaven National Laboratory (BNL) on Long Island.

“I wish I could say I had a strong inclination toward a career in science, but the truth is I was good at chemistry in high school and college, and I thought research was really interesting,” she said. “When the opportunity arose for a position that would pay me to explore my interests while attending school, I couldn’t pass it up.”

Over the next 7 years, Jasmine pursued undergraduate and graduate degrees in inorganic chemistry while researching ionic liquids, the removal of technetium-99 from radioactive waste, and the separation of actinium-225 (Ac-225) using polyoxometalates (POMs), polyatomic ions that consist of three or more transition metal oxyanions linked together by shared oxygen atoms to form closed 3D frameworks. Those experiences prepared her well for her current challenge: researching a new method for producing Ac-225. If proven successful, her work could lead to increased Ac-225 availability in the market—a winning solution for both the cancer therapy community and the DOE IP, which is funding this research.

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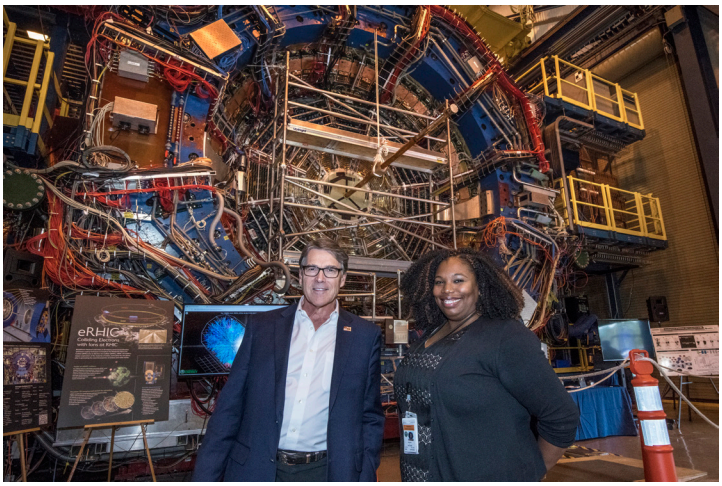
Jasmine's Journey

The internship at BNL proved to be the start of Jasmine's journey toward a career in radiochemistry. After receiving her associate's degree, she enrolled as a chemistry major at nearby Queens College and continued working part-time at BNL as a laboratory technician assisting with ionic liquid synthesis research. Upon completion of her bachelor's degree, she was hired full-time at BNL and spent the next 3 years continuing her research in the synthesis of ionic liquid, exploring liquids use in molten salt reactors. It was during this time Jasmine realized she wanted to pursue a doctoral degree.



Jasmine Hatcher-Lamarre, BNL staff scientist, with Secretary of Energy Rick Perry during his visit to BNL while on his U.S. National Laboratory tour.

"When I graduated from college, I swore I would not go for my PhD," she said. "I was adamant that I would not do it. But after 3 years of working in a related field, I fell in love with radiochemistry. The rest is history.

Jasmine enrolled in the inorganic chemistry PhD program at Hunter College in Manhattan and began researching technetium chemistry in ionic liquids and the separation of Ac-225 using POMs. Over the past 2 years, she and her team have demonstrated that POMs can completely extract thorium from an aqueous solution of thorium, lanthanum, and actinium and, conversely, can extract thorium over lanthanum and Ac-225. For this work, Jasmine and her team were recognized last fall at the BNL Early Career Symposium with an award for best poster.

Although Jasmine ultimately opted for a career in chemistry over nursing, she is, in a way, still caring for patients. Her work with radiopharmaceutical isotopes for cancer therapies has the potential to provide thousands of people with life-saving treatments.

History of Ac-225

Researchers and pharmaceutical companies around the world have studied Ac-225 for its alpha-emitting properties and its precise destruction of cancer cells. Demand for the radioactive isotope is increasing, with new clinical trials starting each year. At the same time, the DOE IP has taken the lead as a global champion of Ac-225 development, creating a suite of production pathways and investigating how to best supply Ac-225 to the medical market and meet increasing demands.

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Isotope Availability News

Newly Available

- Actinium-225 (accel.-produced)
- Actinium-227
- Aluminum-26
- Americium-241
- Astatine-211
- Barium-133
- Copper-67
- Lutetium-177
- Mercury-194
- Ruthenium-96
- Selenium-75
- Strontium-89
- Thorium-228
- Thorium-232
- Titanium-44
- Uranium-234
- Yttrium-86

Coming Soon

- Cadmium-109
- Carbon-14
- Cerium-139
- Iridium-192
- Iron-55
- Iron-59
- Holmium-163
- Zinc-65

Under Investigation

- Argon-39
- Cerium-134
- Gadolinium-153
- Heavy Water (D_2O)
- Lithium-7
- Manganese-52
- Molybdenum-98
- Molybdenum-100
- Niobium-93m
- Platinum-195
- Promethium-147
- Scandium-47
- Silicon-28
- Silver-111
- Tellurium-119
- Uranium-230
- Xenon-129
- Ytterbium-176

Availability Notice: Zinc-65 & Cadmium-109

The DOE IP has plans to replenish its inventory of two isotopes—zinc-65 (Zn-65) and cadmium-109 (Cd-109)—in the coming weeks because of significant demand and interest from the medical community.

With a half-life of 244 days, Zn-65 is most commonly used as a tracer in physical and metabolic studies because of its gamma- and positron-emitting properties.

It is produced via proton irradiation of a gallium metal target using DOE's Brookhaven Linac Isotope Producer. The Zn-65 product has a radionuclidic purity of >99%, and an activity concentration of >1 mCi/mL. It is sold as zinc (II) in 0.05–0.5 N HCl.

Most commonly used as a source for x-ray fluorescence imaging and in environmental research, Cd-109 (half-life of 461.4 days) is produced at the Isotope Production Facility at Los Alamos National Laboratory (LANL) through the proton bombardment of an indium target. Unlike the more conventional reactor-produced Cd-109, the accelerator route offers a no-carrier-added product with a high specific activity expected to be >100 Ci/g. It also possesses a relatively high radionuclidic purity of ≥99.9% (excluding cadmium-113m).

Cadmium-109 can be ordered in mCi quantities as cadmium (II) in 0.1 M HCl.

For further inquiries about Zn-65 or Cd-109, contact the NIDC at **contact@isotopes.gov** or visit **www.isotopes.gov/catalog.**

Accelerator-Produced Ac-225 Update

Achievement of routine and reliable production of Ac-225 was recently presented and discussed with members of the medical community at two events. Members of the DOE Ac-225 Tri-Lab Production Effort (Ac-225 Tri-Lab Effort), discussed new research, findings, and the development of a Drug Master File (DMF) during sessions at the 11th International Symposium on Targeted-Alpha-Therapy conference in April and the Society of Nuclear Medicine & Molecular Imaging Annual Meeting (SNMMI) in June. These interactions provided the team with crucial feedback, ensuring that the focus of the Ac-225 Tri-Lab Effort is aligned with customer needs. In addition, they can communicate the team's enthusiasm and readiness to add to the Ac-225 supply chain—and provide this critical isotope to the growing community of Ac-225/Bimuth-213 researchers and drug developers.

Dr. Cathy Cutler, BNL Isotope Program Manager, moderates the DOE IP Ac-225 session at the 2019 SNMMI Annual Meeting.

Production Scale-Up

Currently, Ac-225 production occurs every 6 weeks with 20 to 40 mCi per batch typically available for distribution. The material is distributed to a variety of end-users for a series of independent labeling, dosimetry, and novel chelation studies. Also, the Ac-225 Tri-Lab Effort team is using some of this material for investigations focused on end-product quality assurance and process scale-up development. The goal is to eventually ramp up to 100 mCi batch sizes with product availability targeted for every 4 weeks—at which point the plan is to support at least one clinical trial.

Drug Master File

A DMF for the Ac-225 accelerator product is in development to support drug manufacturers who are planning to submit Investigational New Drug Applications. The goal is to submit this DMF to the Food & Drug Administration by the end of 2019.

DOE IP Announces University Funding Awards

The DOE IP recently announced the FY19 funding of two awards to enhance the scientific and technical capabilities at existing university accelerator facilities for isotope research and production. Awards to Duke University and the University of California, Davis, will advance research and development in the production of astatine-211 (At-211), a short-lived alpha-emitting isotope for cancer therapy. The funding of these two awards also paves the way for each university to participate in the DOE IP's University Isotope Network (UIN).

The UIN is a DOE IP supported network of university-based isotope production centers capable of providing unique or short-lived radionuclides to the nation. The UIN is a partnership that allows regionalized reliable production and distribution of high-purity radioisotopes for fundamental or preclinical research through the NIDC. It was established in 2016 with accelerator-based production of At-211 at the University of Washington. Shortly after, reactor-based production was added via the University of Missouri Research Reactor, supplying research grade quantities of lutetium-177 and selenium-75.

The DOE IP plans to announce additional funding awards for FY20 in the coming months.

"Jasmine Hatcher-Lamarre: Ac-225 Researcher and Rising Star," continued from page 2

Currently, production of Ac-225 is limited to a few sources around the world. Many years ago, thorium-229 (which decays to Ac-225) was extracted from uranium-233, and long-lived Th-229 stocks—referred to as "cows"—were created. The DOE IP is also producing Ac-225 via proton bombardment of natural thorium targets at the DOE accelerator facilities at BNL and LANL, with post-bombardment chemical processing completed at Oak Ridge National Laboratory (ORNL).

The DOE IP has committed funds and resources to research new techniques to produce Ac-225, such as target development, and production methods using cyclotrons, electron accelerators, and nuclear reactors. Four national laboratories—Brookhaven, Los Alamos, Oak Ridge, and Argonne—are conducting the research.

A New Method and a Sense of Purpose

Jasmine's work centers around developing a new Ac-225 production method that, if successful, will produce very pure, but small, quantities of the isotope. The process involves manufacturing a radium-226 (Ra-226) target and then bombarding it with protons in a cyclotron. Once the new method is proven successful, scientists will then aim to fabricate larger Ra-226 targets until an optimal quantity of Ac-225 can be produced in each batch. If this new approach works, the U.S. potentially could increase the amount of Ac-225 available in the market.

For Jasmine, this research has a deeper meaning than most of her previous projects.

"Knowing this research has the potential to help people in 5 years or less and that people need it, and that people are waiting for it, really gives me a sense of purpose," she said. "The goal of this work is to help people, and that is really what keeps me going."

Leadership Outside the Lab

Jasmine's passion for science extends far beyond her laboratory research. Over the course of her career, she has aligned herself with programs focused on diversity and inclusion, especially those related to science.

She volunteers as a speaker and moderator for career panels with the Long Island STEM Hub (**www.listemhub.org**), which offers opportunities for junior high and high school students and teachers to spend time in science, technology, engineering, and math-related settings.

Jasmine was also recently selected to serve on the advisory board for the Inclusive Graduate Education Network, or IGEN (**www.apsbridgeprogram.org/igen/about.cfm**), which fosters interest in science careers and doctoral study among women and underrepresented racial and ethnic minorities. She hopes to help shape policy and outreach activities for IGEN participants, ultimately resulting in greater diversity among those holding PhDs in science-related fields.

She's grateful to have such opportunities: "It's nice to have a hand working behind the scenes, creating a real impact through programming and education opportunities provided to women and underrepresented minorities."

Jasmine Hatcher-Lamarre, BNL staff scientist, moderating a career panel with the Long Island STEM Hub.

Californium-252 Consortium and DOE IP Sign New 4-Year Contract

The DOE IP has executed a new 4-year contract with a consortium of commercial source manufacturers to produce californium-252 (Cf-252), marking the third consecutive multiyear contract between the two parties. Formed to facilitate a robust and reliable domestic source of Cf-252, the consortium uses bulk material allocations to ensure various market sectors are sufficiently supplied with commercial-grade neutron sources.

The Cf-252 procured through this contract is produced by irradiation of curium targets in ORNL's High Flux Isotope Reactor. Following irradiation, the material undergoes radiochemical processing in the adjacent hot cells at the Radiochemical Engineering Development Center, where the final product is recovered and purified for subsequent bulk californium-palladium cermet wire fabrication and distribution to the consortium.

Californium-252 offers a powerful and cost-effective neutron source that is critical for numerous industrial applications including nuclear reactor start-up, nuclear fuel inspection, coal/mineral analyses, and oil and gas exploration.

Research of Septa Materials & Germanium-68 Results

Kimberly Lopez, a second-year undergraduate student at New Mexico Institute of Mining and Technology in Socorro, New Mexico, joined the LANL isotope program over the 2018 summer. Kim completed two research studies for the program, including researching the availability, chemical stability, and radiological stability of septa materials as well as compiling all results from recent germanium-68 (Ge-68) production campaigns.

During her internship Kim wrote a comprehensive 15-page research summary on rubber septa, a critical component of sealed vials for shipment of purified isotopes. Her report included a literature search, published stability data, and manufacturer information. Future studies in the stability of sealed vials will benefit from Kim's work.

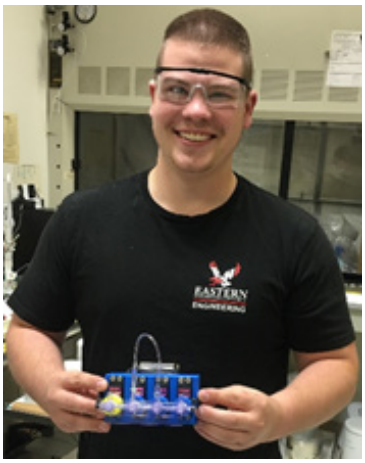
Kim's Ge-68 data included information on target irradiation conditions, chemistry yields, and final product quality. Her work has been valuable in the analysis of target irradiation parameters, chemistry optimization, and future efforts in production. Kim returned to LANL during the 2018–19 winter break and then returned to the program for the summer of 2019.

Kimberly Lopez, LANL student researcher, investigated septa materials and compiled results of Ge-68 production campaigns during her summer with the LANL isotope program.

3D Printing of Automation Systems

Undergraduate mechanical engineering intern Jarith Fry from Eastern Washington State University joined the Pacific Northwest National Laboratory (PNNL) Isotope Program and worked under the direction of Matt O'Hara. Jarith is in his senior year and plans to return to PNNL after graduation and then apply to graduate school, where he plans to study robotics.

During his summer internship, Jarith applied his mechanical engineering expertise to improving command and control software and designing and fabricating components for automated radiochemical processing systems using a 3D printer. The 3D printing process facilitates rapid prototyping and decreases the costs associated with custom machining. The parts are designed for easy assembly and replacement and will eventually be deployed for testing for remote operations in a glovebox or hot cell.



Jarith Fry, PNNL summer intern, with 3D-printed components for automated radiochemical processing systems.

Actinium-227 Production Efforts Prove Successful

Joseph Wright, after completing an undergraduate degree in chemistry from Tennessee Technological University, joined the Nuclear and Radiochemistry Group at ORNL for a 1-year post-bachelor's internship position. During his 2017 internship, Joseph conducted research in support of the Ac-227 production effort. In particular, he researched the chemistry associated with recovery and purification of Ac-227 from an irradiated Ra-226 target, a process that was recently implemented with great success.

Joseph helped pioneer a new approach to target refinement, which ultimately will improve the Ac-227 purification process by reducing processing time, maximizing yields, and most importantly, reducing radioactive waste volumes. Starting on the bench-top, Joseph developed and tested this new approach before optimizing the chemistry in a glovebox using actinium and radium radiotracers. Joseph's new methodology was successfully demonstrated this year in hot cell processing, and the Nuclear and Radiochemistry team is now working with customers to implement the strategy for Ac-227 production.

Joseph Wright, 2017 ORNL intern, worked on the recovery and purification of Ac-227 from an irradiated Ra-226 target.

ISOtopics

RESEARCH EXCELLENCE

Congratulations to **Kevin John**, LANL's Radioactive Isotope Program lead and project manager for the Ac-225 Tri-Lab Effort, who was awarded the laboratory's 2018 Fellows Prize for Leadership. This award acknowledges Kevin for his significant leadership roles nationally and internationally supporting medical isotope production, research, and infrastructure development.

Also, congratulations to ORNL's **Julie Ezold** for earning the "Science Communicator" award at the 2018 UT-Battelle Awards Night, recognizing her leadership in communicating the importance and impact of nuclear science to numerous groups through interactive presentations, program coordination, and community outreach.

STAFF ADDITIONS

The DOE IP welcomed two new employees to the Germantown, Maryland, headquarters office.

Dr. Arne Freyberger joined the program as program manager for Isotope Accelerator Facilities. His new role includes overseeing all accelerator facility operations and associated processing related to isotope production. He will also be responsible for large-scale production of Ac-225 and establishing isotope harvesting capabilities at the Facility for Rare Isotope Beams.

Before joining the program, Arne was with the Thomas Jefferson National Accelerator Facility, where he held the position of director of operations.

Also new to the program is **Dr. Jon Neuhoff**. Jon joined the Isotope Program as the program manager for Isotope Reactor Facilities. In his new role Jon oversees all isotope production and processing at reactor facilities. Jon is also the DOE IP point of contact for isotopes produced for super heavy element research and heavy element chemistry.

Previously Jon worked in the private sector at Zachary Nuclear Engineering as an engineering manager. Before his work in the private sector, he was the New Brunswick Laboratory (NBL) laboratory director for 7 years and an NBL physical scientist prior to that.

FEATURED PUBLICATION

Featured in *Molecules*, Volume 24, Issue 10 is "Optimization of Cation Exchange for the Separation of Actinium-225 from Radioactive Thorium, Radium-223, and Other Metals". Researchers from BNL contributed to the investigation into the optimization of a cation step in the separation of Ac-225.

Their research indicated that HCl removes more isotopes earlier than HNO_3, but some elements, such as barium and radium, could be eluted with ≥2.5 M HNO_3. Also discussed are optimal solutions for maximum recovery of the isotope. **To read the full research article, click here.**

UPCOMING EVENTS

International Conference on Isotopes & Exposition
February 3–7, 2020, Kuala Lumpur, Malaysia.

ACS National Meeting & Exposition
March 22–March 26, 2020, Philadelphia, Pennsylvania.

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