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October 2023 NS&T Highlights

December 2023

Addison Marie Arave

Changing the World's Energy Future

Idaho National Laboratory

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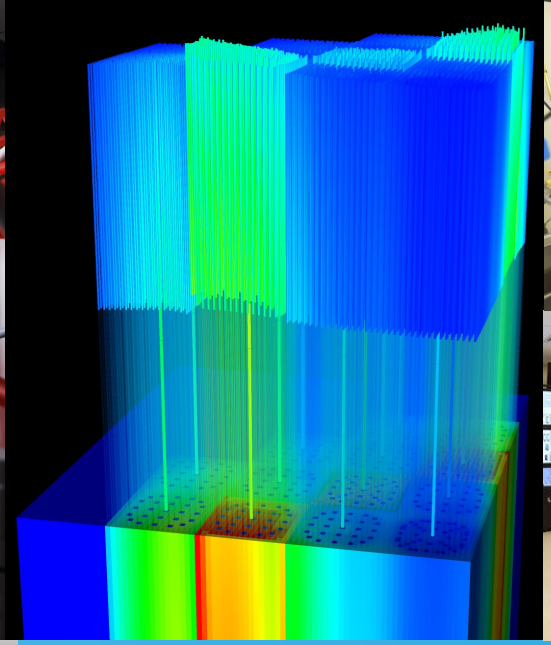


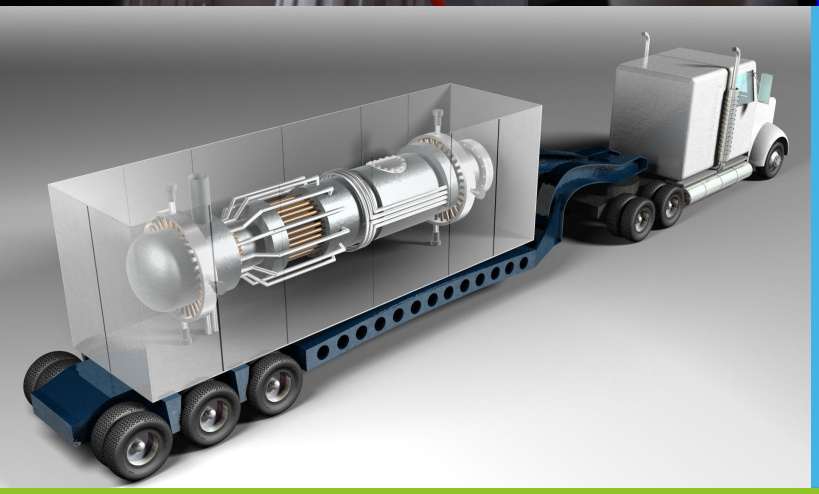

Nuclear Science & Technology

October 2023 Highlights

Idaho National Laboratory

Laboratory Directed Research and Development

Patent Awarded to Prabhat Tripathy for Efficient Manufacturing of Metal Hydride Targets

- Research Scientist Prabhat Tripathy has been awarded a patent for significant improvements to the technology for the manufacture of metal hydrides.
- Current techniques employ high temperatures (~1800°C) and high vacuum. Tripathy's new process requires a much lower temperature (~350°C), and is inexpensive, scalable and effective in producing defect-free thick coatings.
- It has been demonstrated for fabricating materials such as titanium-coated copper targets for portable neutron generators which are used in many industries.

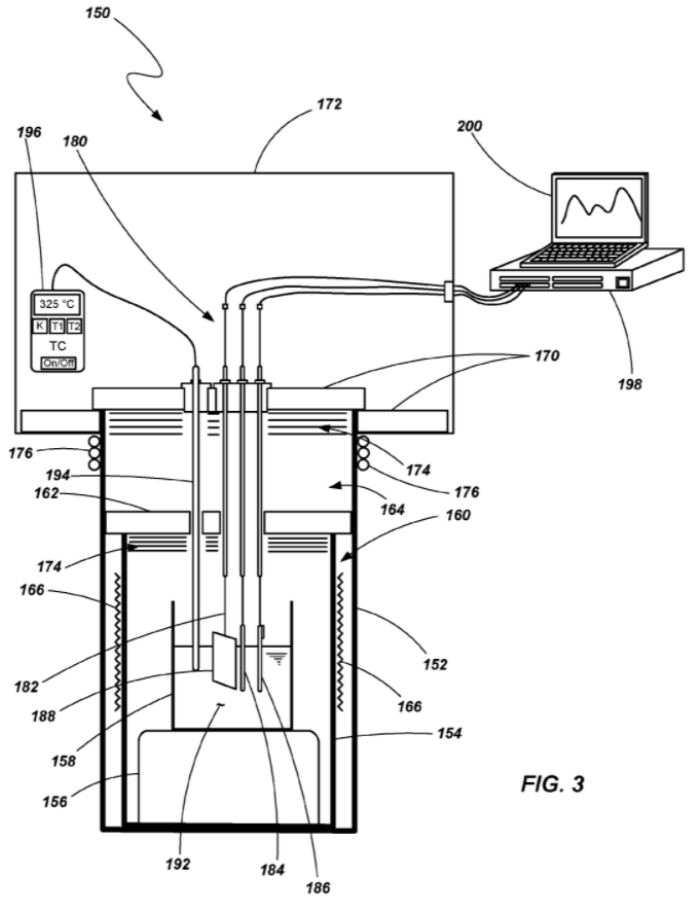

FIG. 3

Schematic illustration showing the fabrication process of the metal hydride target.

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INL/MIT Center for Reactor Instrumentation and Sensor Physics

Electric Power Research Institute and Center for Reactor Instrumentation and Sensor Physics Hold a Joint Workshop on Sensors, Robotics, and Automation

- The Idaho National Laboratory/Massachusetts Institute of Technology MIT) Center for Reactor Instrumentation and Sensor Physics (CRISP) held a two-day workshop jointly with the Electric Power Research Institute (EPRI) on the Massachusetts Institute of Technology (MIT) Campus on October 10–11.
- The "EPRI/CRISP Joint Workshop on Sensors, Robotics, and Automation for Emerging Reactor Applications" was attended by over 80 participants from industry, national laboratories, and academia.
- The program involved keynote speakers, including Robert Okojie of the National Aeronautics and Space Administration (NASA) Glenn Research Center and Craig Dempsey, an Executive Manager from Naval Nuclear Laboratory.
- INL was prominently represented in the program agenda by Joshua Daw, Austin Fleming, and Richard Skifton from the Nuclear Science & Technology directorate, and Kamrynn Schiller from the Materials Fuels Complex.

From top clockwise: Dr. Sacit Cetiner (NS&T); Dr. Robert Okojie (NASA Glenn); Mr. Craig Dempsey (NNL); EPRI Organizers; Dr. Joshua Daw (NS&T); Ms. Kamrynn Schiller (MFC).

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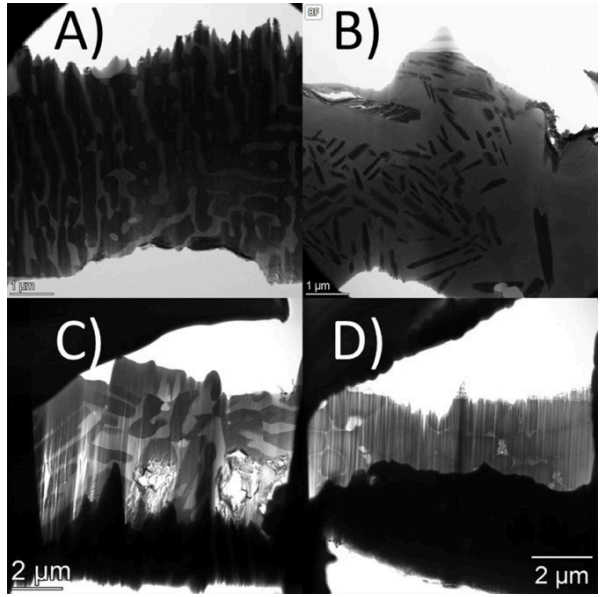
Research Highlight

DOE-NE Nuclear Science User Facilities and Advanced Fuels Campaign Programs

Researchers Capture More Accurate Microstructure Representation of Uranium-Zirconium Specimens

- U-Zr alloys are being pursued as a fuel for sodium-cooled fast reactors.
- This study focuses on two uranium-zirconium (U-Zr) specimens, U-22.5 at.% Zr and U-52.8 at.% Zr, irradiated to <0.001 at.% BU (~4.33E+15 F/cc) at 660°C in the Transient Reactor Test Facility (TREAT).
- Following irradiation, the bulk features of the U-22.5 at.% Zr specimen were retained, even though Zr solubility in the α-U increases to ~18 at.% Zr at 660°C, influencing phase fractions and grain boundary density.
- In contrast, the U-52.8 at.% Zr alloy transformed into an equiaxed granular microstructure implying single phase γ-U-Zr formation.
- This research was possible due to the restart of the TREAT facility and U-Zr alloys made available by the NSUF Disc Irradiation for Separate Effects Testing with Control of Temperature project.



Transmission Electron Microscopy bright field images of specimens pre- and post-irradiation.

Title: Characterization of micro-burnup treat irradiated U-22.5 at.% Zr and U-52.8 at.% Zr foils by transmission electron microscopy and X-ray diffraction
Authors: Walter J. Williams, Tiankai Yao, Xiaofei Pu, Luca Capriotti (INL)
Journal: Journal of Nuclear Materials
Link: doi.org/10.1016/j.jnucmat.2023.154644

NSUF Nuclear Science User Facilities

NUCLEAR FUELS & MATERIALS
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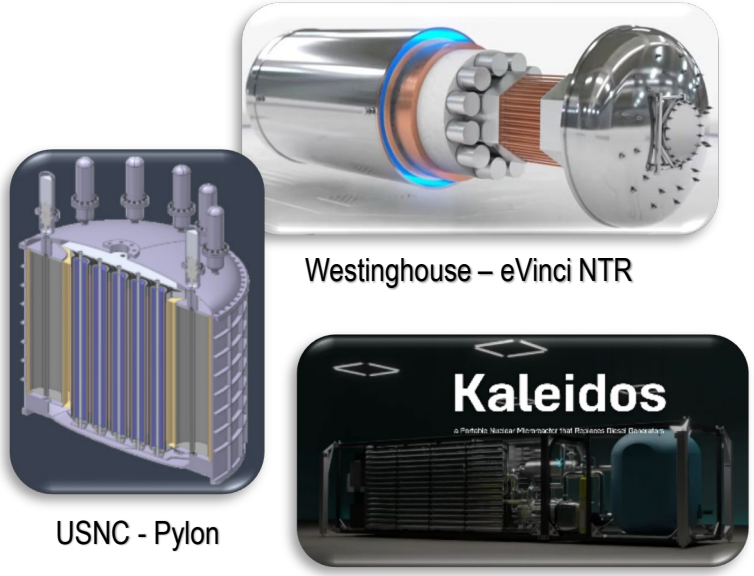
DOE-OECD National Reactor Innovation Center

National Reactor Innovation Center Awards Front-End Engineering and Experiment Design Contracts

- National Reactor Innovation Center (NRIC) distributed $3.9 million to prepare for testing advanced nuclear reactors in the NRIC Demonstration of Microreactor Experiments (DOME) via it's Front-End Engineering and Experiment Design (FEEED) program.
- At the DOME test bed, the race is on to turn visionary designs into reality, with the intent to begin first-of-a-kind nuclear reactor tests in 2026.
- Radiant, Ultra Safe Nuclear, and Westinghouse were awarded FEEED contracts, each aiming to test reactors ranging in size from one-to-three megawatts thermal with a unique blueprint for modernizing how we harness nuclear energy.
- This initiative marks a pivotal step towards a cleaner, more innovative energy future, where nuclear technology solves modern-day challenges.



FEEED award winning projects.

National Reactor Innovation Center Kicks off DOME Construction

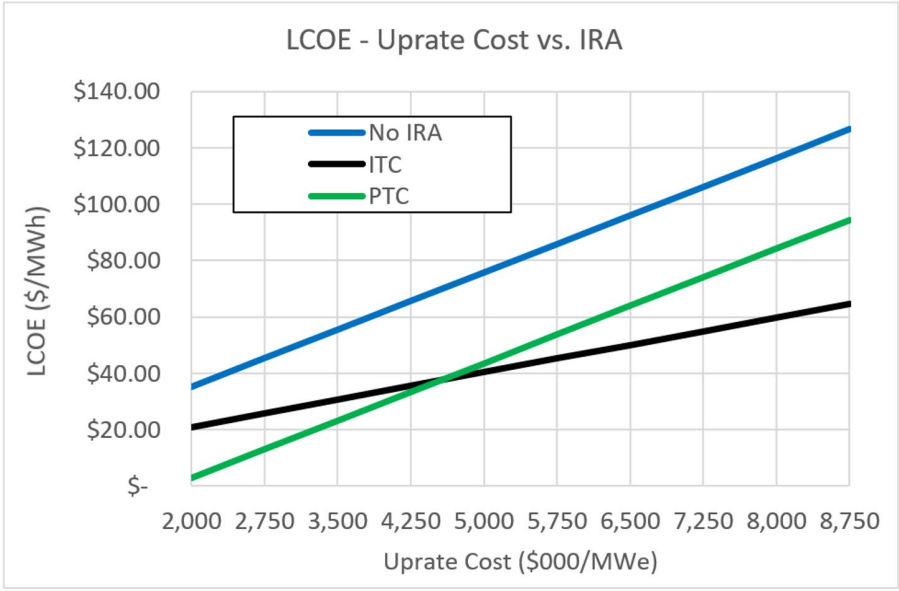
- The National Reactor Innovation Center was joined by Department of Energy, Office of Nuclear Energy (DOE-NE) Assistant Secretary, Dr. Katy Huff, Idaho National Laboratory Director John Wagner, and Department of Energy Idaho Operations Office (DOE-ID) Laboratory Directory Lance LaCroix to mark the beginning of the reestablishment of the EBR-II Dome for advanced reactor testing.
- This facility will help secure the future of fueled microreactor experiments at Idaho National Laboratory.
- The goal is to lead the world in advanced reactor testing, turning today's innovation into tomorrow's reality. The first tests are scheduled to begin in 2026.
- Key features include increased accessibility, new access penetrations, and a state-of-the-art cooling system.

Many important nuclear industry representatives commemorate this milestone.

DOE-NE Light Water Reactor Sustainability Program

Inflation Reduction Act Impacts Power Uprates and Hydrogen Cogeneration

- The Inflation Reduction Act (IRA) offers an unprecedented opportunity for growth of the nuclear industry by increasing plants power output, a process called power uprate.
- The Light Water Reactor Sustainability (LWRS) Program researchers completed power uprate techno-economical assessments for existing nuclear power plants.
  - They assessed market opportunities considering IRA tax credits, evaluated the technical viability and developed a financial model for business case assessments.
  - Scenarios included the use of added power for electricity and hydrogen generation.
- Results show that IRA tax credits support a strong business case for investments in power uprate and for competitive with hydrogen generation.



Levelized cost of electricity (LCOE) with or without consideration of IRA investment tax credits (ITC) and production tax credits (PTC).

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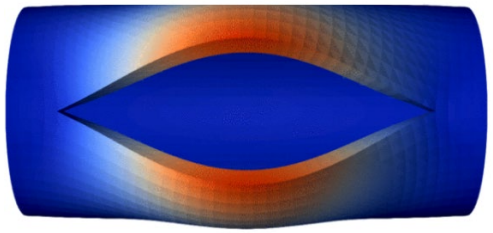
DOE-NE Light Water Reactor Sustainability Program

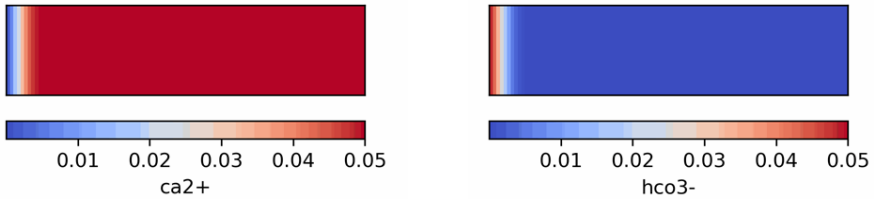
Reducing Nuclear Power Plant Aging Management Costs Through Component Degradation Advanced Modeling

- Nuclear power plants' aging underground pipes are subject to selective leaching. This complex degradation mechanism removes susceptible elements from pipe walls and may cause a loss of structural integrity.
- Light Water Reactor Sustainability Program researchers used the MOOSE (Multiphysics Object-Oriented Simulation Environment) framework to perform physics-based advanced modeling and simulations of degradation mechanisms, crack propagation, and corrosion reactions.
- Results may be used to predict the future condition of underground pipes to support aging management and offer a risk-informed, performance-based approach that supports cost-effective repair and replacement strategies.

Degraded cast iron pipe sample.



Rupture propagation modeling using the MOOSE XFEM Module.



MOOSE modeling of corrosion due to calcium (Ca2+) and bicarbonate (HCO3-) using thermodynamic databases in the MOOSE chemical reactions module.

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LWRS LIGHT WATER REACTOR SUSTAINABILITY

DOE-NE Light Water Reactor Sustainability Program

The Light Water Reactor Sustainability Program Hosts International Atomic Energy Agency Workshop at INL

- The LWRS Program hosted an International Atomic Energy Agency (IAEA) workshop at INL from October 9–13, 2023.
- This workshop aimed to share member states' experiences related to innovative/novel technical solutions to improve performance while minimizing costs at operating nuclear power plants.
- The meeting demonstrated the LWRS Program's worldwide engagement, bringing together 55 attendees representing 37 different companies and spanning 16 countries.

Jess Gehin leading the opening plenary at IAEA Workshop.

INL K-12 Education Programs

Stage Show Provides STEM Education to Children During Nuclear Science Week

- Nuclear Science Week is an annual week-long celebration of nuclear science and innovation.
- Idaho National Laboratory researcher Catherine Riddle and Team (Science, Technology, Engineering, and Mathematics) STEM presented an audience-interactive stage show at the Colonial Theatre in Idaho Falls on October 19.
- Dr. Riddle has participated in K-12 STEM outreach work for the past 15 years and her workshops and stage shows are frequently requested throughout Idaho and Wyoming.
- INL and the Idaho Section of the American Nuclear Society co-hosted the event for eastern Idaho elementary school children. Over 800 students and teachers participated in the event.

Catherine Riddle on stage at the Idaho Falls STEM Event.

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