STAR 🔆 FIRE 2025 Summer Workshop

MONDAY

8:00 AM Introductions and Logistics Jackson Harter, INL

8:15 AM INL's Role in Advancing Space Fission: An Overview of Capabilities and Innovations | Jess Gehin, INL

Gehin will present an overview of the Idaho National Laboratory's R&D capabilities, highlighting the lab's innovative work and contributions to advancing space fission technology for future space exploration missions.

8:45 AM **A Brief History of Space Nuclear Power** *Chris Stanek, Los Alamos National Laboratory*

To provide context for the presentations that will follow at the STAR★FIRE workshop, Stanek will present a brief summary of the history of space nuclear power. Given the location of STAR★FIRE, special attention will be given to the Rover Project space reactor tests that occurred at the Nevada Test Site and the technological advances associated with those tests.

9:15 AM Advanced Nuclear Fuels for Nuclear Thermal Propulsion Applications | Patrick Warren, UTSA

Nuclear thermal propulsion (NTP), an attractive alternative to chemical propulsion, can achieve higher engine efficiency, reduced mass and shorter transit times in space but degradation of NTP fuel under harsh conditions presents a major challenge. The Extreme Environments Materials Laboratory at UTSA aims to investigate the degradation of NTP fuels.

9:45 AM Lessons Learned from the Last 20 Years of Space Reactor Power System Development | Lee Mason, NASA

Mason, from NASA Glenn Research Center in Cleveland, will summarize the progress made and challenges encountered during the last three major space reactor development projects including Prometheus/Jupiter Icy Moons Orbiter, Constellation/Fission Surface Power, and Game Changing Development/Kilopower. All the projects included strong teaming arrangements between NASA centers and Department of Energy (DOE) national labs. The presentation will emphasize the concepts that were developed and the hardware that was built and tested. We will provide a full bibliography of technical papers with publicly accessible links.

10:15 AM Break All

10:30 AM Space Nuclear I&C Gaps | Dianne Ezell, Oak Ridge National Laboratory

Even with the near-term goals of deploying reactors in space, there are significant technology gaps within instrumentation and controls that require development. The DOE national laboratory system is working with NASA to ensure sensors and controls are mature enough for deployment on both space nuclear propulsion and fission surface power. Ezell will discuss some of the technology gaps identified by the programs and how ORNL and INL are supporting these missions.

11:00 AM XE-Prime Engine Test Program: The Culminating Test Campaign for NERVA Nuclear Rocket Engine Development | Jonathan Witter, BWXT

Witter will review the NERVA Program XE-Prime Integrated Reactor Engine Test Plan from SPEAR Test Reports that supported the XE-Prime Engine Final Report (RN-S-0510) for each phase of the Experimental Plan. Witter will explain how the operation and control performance was verified/validated, with explanations of some of the state point data traces for transitioning through the operational phases of a thrust burn.

11:30 AM SP-100: Lessons from Design to Future Space Fission Applications in Earth Orbit | Jordan Bramble, Antares

Bramble will explore the SP-100 space reactor's design, challenges, and lessons learned, and examine how these insights can guide future space fission power systems in earth orbit.

12:00 PM Working Lunch: High or Low? Challenges to the Use of Low Enrichment Uranium in Space Nuclear Reactors | Jeff King, Tennesse Tech

Until recently, it was nearly universally assumed that space nuclear reactors would be fueled with uranium enriched to 95 wt% or more (i.e. highly enriched uranium, or HEU). The use of HEU allowed for compact reactor designs with relatively simple reactor physics and feedback mechanisms. Starting with Space Directive 6, signed in 2019, U.S. policy shifted space reactor design to the use of uranium enriched to less than 20 wt% (i.e. high-assay low enriched uranium, or HALEU). Space reactors using HALEU have been computationally shown to be feasible; however, the shift from HEU to HALEU poses several design challenges. This talk will address some of those issues, with a focus on the areas where additional research is most urgently needed.

12:45 PM Planetary Detectives: Using Neutron and Gamma Fingerprints to Reveal What Lies Beneath the Surface | Suzanne Nowicki, Los Alamos National Laboratory

Sending instruments to space is like designing a laboratory bench experiment that can fit in a backpack, go through a rocket launch, operate in Antarctica, run on a flashlight battery, and still do groundbreaking science without ever getting touched again. Nowicki will review neutron and gamma-ray instruments that have been used in planetary science to uncover what lies beneath planetary surfaces.

1:15 PM **Space Reactors Moving Beyond Paper** | *AJ Fallgren, X-energy*

Fallgren has observed the development of multiple reactor concepts as a member of teams at Los Alamos National Laboratory as well as at IX (Intuitive Machines and X-energy Joint Venture). Fallgren will discuss various aspects that were not expected in translating a reactor concept into a more mature system design.

1:45 PM A Fast Track to Orbit: Nuclear Thermal Operations in Three Steps | Fred Kennedy, Dark Fission

Dark Fission has embarked on a demonstrationfocused development program for a lightweight, compact nuclear thermal rocket engine. We are planning three flight demonstrations: DARK SCOUT, DARK RANGER, and the culminating test, DARKFORCE, a full-scale nuclear orbital transfer vehicle.

2:45 PM Managing Risk at 17,500 mph Mike Fossum, TAMU-Galveston

This presentation will feature Mike Fossum, a veteran of three space missions during which he accumulated 194 days in space and over 48 hours in seven space walks. He will share the experience of launching into space propelled by 4 million pounds of rocket fuel, serving as commander of the International Space Station, then coming home in a 5,000-degree fireball. He will discuss the two catastrophic space shuttle accidents and how NASA works to manage risk through rigorous system design, intense training and excellent teamwork.

3:45 PM Break All

4:00 PM KRUSTY: Advancing Space Nuclear Power for Future Missions | Theresa Cutler, Los Alamos National Laboratory

Cutler will discuss the Kilopower Reactor Using Stirling Technology (KRUSTY) experiment's role in demonstrating compact nuclear reactor technology for space applications, its significance in the evolution of space nuclear power, and its potential impact on future deep space exploration missions.

4:30 PM Current Status for the Modular Assembled Radiators for NEP Vehicles (MARVL) Project | Amanada Stark, NASA

Stark will provide the progress on developing a high-temperature modular radiator array for nuclear electric propulsion (NEP) that takes in-space assembly into consideration.

5:00 PM Shielding Designs for Space Nuclear Reactors: Challenges and Solutions | Alex Levinsky, Los Alamos National Laboratory

Levinsky will address the complexities of designing effective radiation shielding for space reactors by examining technical challenges, innovative solutions, and the importance of ensuring personnel safety and mission success in the harsh space environment.

5:30 PM Wrap Up and Adjourn Jackson Harter, INL

TUESDAY

8:00 AM Welcome and Review Jackson Harter, INL

8:15 AM **Overview of Current Space Reactor Programs** | Sebastian Corbisiero, INL

> Corbisiero will cover recent advancements and ongoing projects in space nuclear power and propulsion. He will discuss specific reactor technologies, key programs by NASA and other agencies, and their potential applications for deep space missions and lunar or Martian habitats.

8:45 AM Thermal-hydraulic Design of NTP Reactors: A Demonstration of the Various Analysis Scales Required for Complete System Characterization | *Bryan Zilka, BWXT*

Zilka will explore how BWXT designers characterize thermal environments in nuclear thermal propulsion reactors. Zilka will cover the macro-scale approach for rocket requirements, microscopic-scale assessments for nuclear and structural configurations, and atomicscale interactions affecting transport properties. The presentation includes examples of analyses at each scale and discusses information transfer across models, concluding with a demonstration of Mixcoatl, BWXT's multi-scale transient analysis tool.

9:15 AM **Powering the Final Frontier: Unraveling the Nuclear Paradox in Space Exploration** | *Bhavya Lal, RAND School of Public Policy*

Nuclear propulsion and power systems offer significant advantages for space exploration, yet remain underutilized. Lal will analyze the historical, technical, and policy challenges impeding their adoption, and discusses steps needed to overcome these obstacles and realize the potential of space nuclear technologies.

10:15 AM Break All

10:30 AM Testing and Evaluation Needs for Space Nuclear Propulsion Systems | *Kurt Polzin, NASA*

Polzin will discuss the test and evaluation needs to field nuclear thermal propulsion and nuclear electric propulsion systems. Testing must be robust and performed in relevant environments to quantify performance, reliability, and develop data for modeling and simulation validation needs.

11:15 AM **Thoughts on Space Nuclear Culture** | *Andrew Presby, NASA*

Presby will explore the motivation, potential, and essential mindset for conducting effective and safe nuclear-powered space missions. Presby will emphasize fostering a culture of safety, innovation and commitment to advancing space exploration technology.

11:45 AM Working Lunch: An Overview of the National Criticality Experiments Research Center (NCERC) | Cole Kostelac, Los Alamos National Laboratory

Recognizing that a number of participants will not be available to join the Wednesday tour, Kostelac will provide an overview of the National Criticality Experiments Research Center (NCERC). Kostelac will cover NCERC's facilities, unique experimental capabilities, and key research areas, such as criticality safety evaluations and nuclear data validation. Attendees will gain insights into NCERC's role in advancing nuclear safety and research, its collaborative efforts, and contributions to the scientific community, ensuring that everyone has a comprehensive understanding of the center's operations and significance.

- 12:30 PM Wrap Up of Lectures, Intro to Lightning Talks | Jackson Harter, INL
- 12:40 PM Lightning Talks Students
- 2:40 PM Break All
- 2:55 PM Lightning Talks Continue | Students
- 4:25 PM Closing Comments and Adjourn | Jackson Harter, INL

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy



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