U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Informational Webinar:
Nuclear Science User Facilities (NSUF) Access
CINR FY 2025 FOA DE-FOA-0003309
May 9, 2024

https://nsuf.inl.gov/Page/cinr

Christopher Barr, Program Manager

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Nuclear Science User Facilities (NSUF)

DOE Office of Nuclear Energy's sole user facility

Focus: Irradiation effects in nuclear fuels and materials

- Awards provide access to capabilities and expertise at no cost to the user
- Access awards support experiment design, fabrication, transport, irradiation, PIE, final disposition of materials

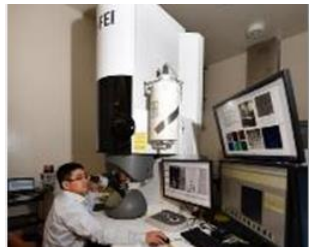
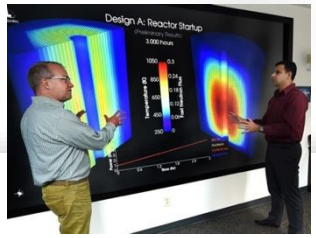
Open and Competitive User Access

- CINR NSUF User Access with and without R&D support
  - User Access Cost: <$4M, up to 7 years*
  - Neutron irradiation and post irradiation examination (PIE)
  - PIE only, including synchrotron or neutron beamline access
  - Neutron irradiation only
  - Ion or gamma irradiation and PIE
  - Ion or gamma irradiation only
- Rapid Turnaround Experiments (RTE) are **not** part of the CINR FOA

Center for Advanced Energy Studies Microscopy Lab – NSUF Partner Facility

Advanced Test Reactor at INL - NSUF Partner Facility

NSUF Website: https://nsuf.inl.gov/

Neutron Reactors		12 reactor facilities at national laboratories and universities including the Advanced Test Reactor at INL
Gamma & Ion Irradiation		7 gamma irradiation facilities and 7 ion beam facilities at national laboratories and universities
Post-Irradiation Examination		Multiple hot cell and broad post-irradiation examination facilities including advanced characterization methods
Beamlines		Synchrotron and neutron beamlines for nuclear fuel and materials studies
Computational Resources		Scientific high-performance computing capabilities for advanced modeling and simulation at INL

NSUF Nuclear Science User Facilities

Cutting-Edge Resources: Access to infrastructure and associated capabilities across 21 partner sites

Open access: Available to industry, academia, and national labs for non-proprietary R&D

Education and training: Workshops and hands-on skill development

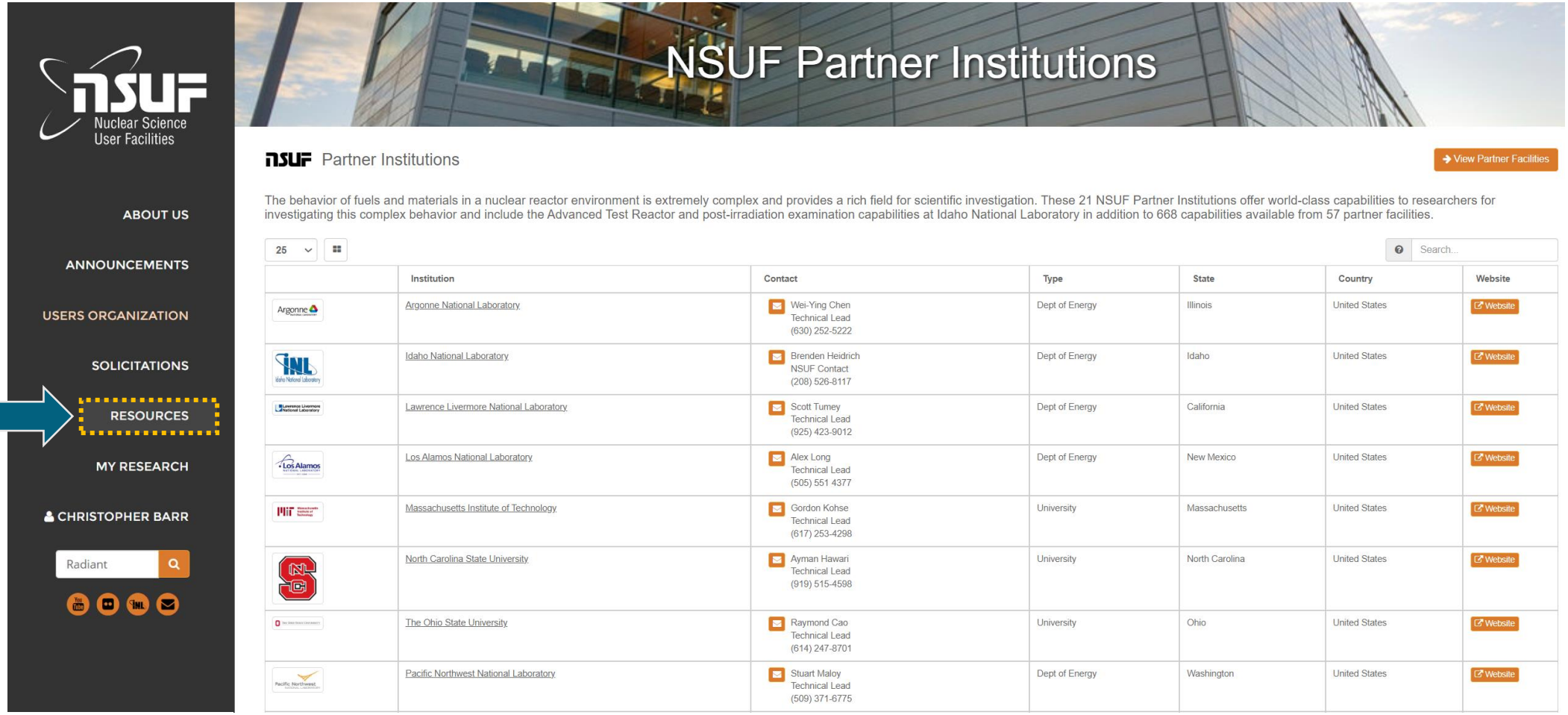
Impact: Increase understanding to drive innovation across nuclear energy technologies

Distributed User Facility Model

*Reflects a subset of existing NSUF partners

Partner sites enable unparalleled facility access and technical expertise to enable innovation and emergent nuclear materials R&D

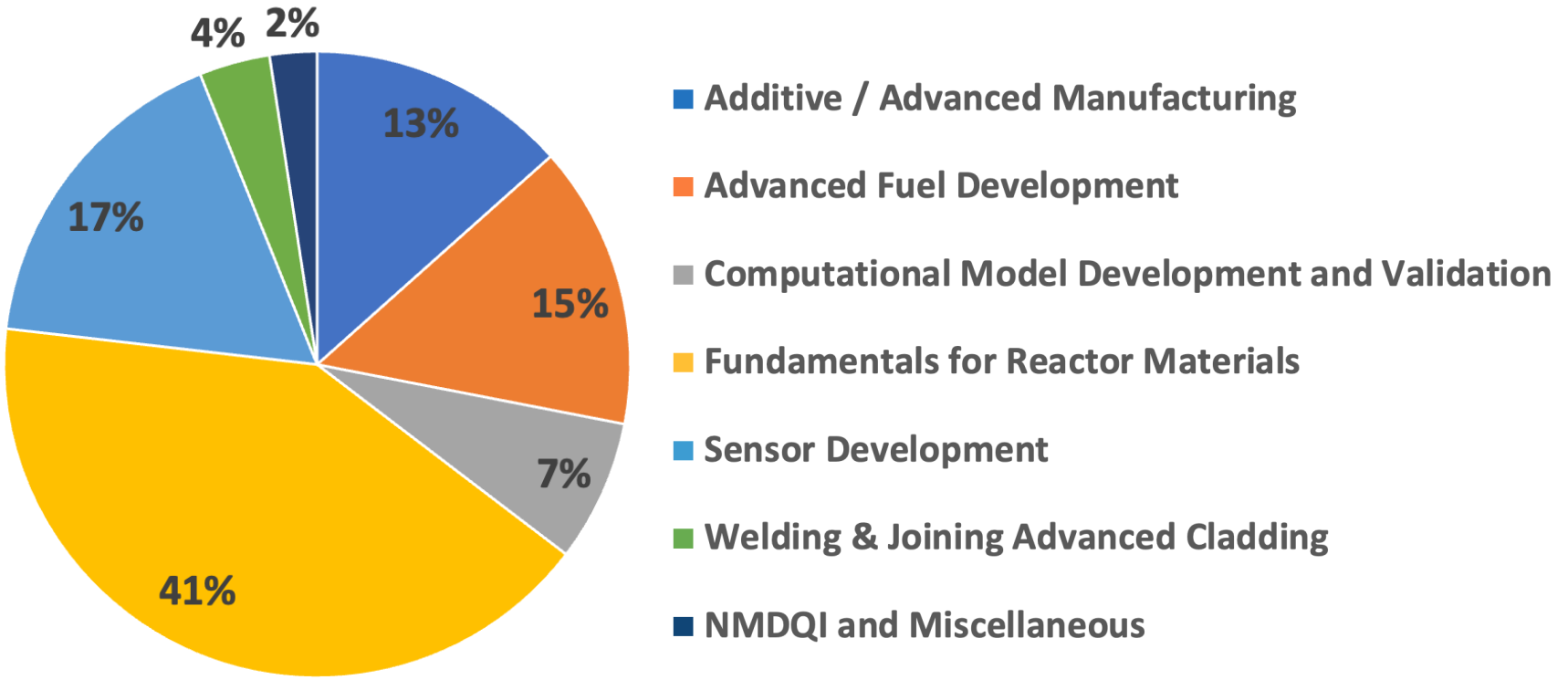
User Resources for Capabilities and Partner Facilities



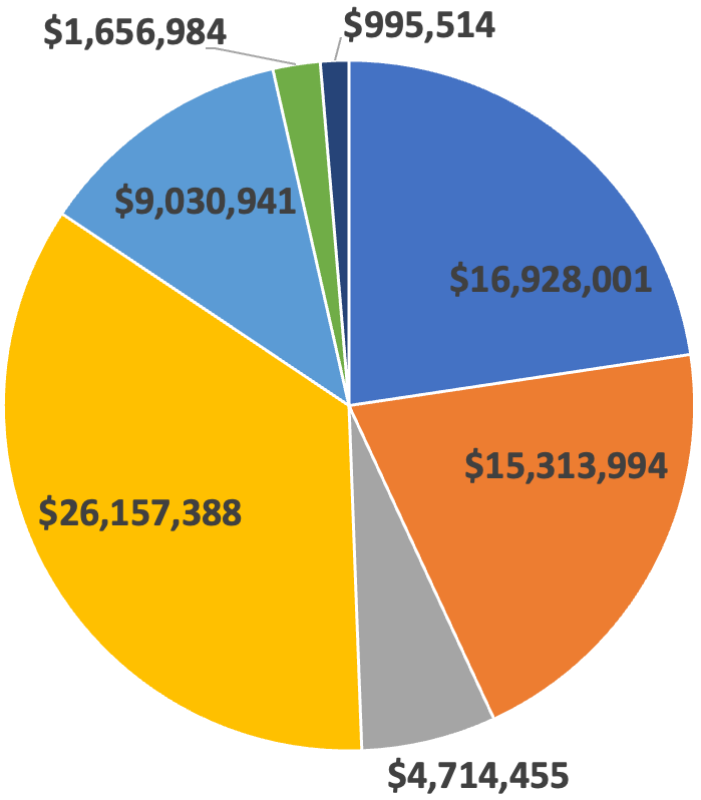
NSUF **Program Office** and **Technical Leads** are available to **help users** identify facilities and capabilities

CINR Awarded Projects FY 2015 – FY 2024

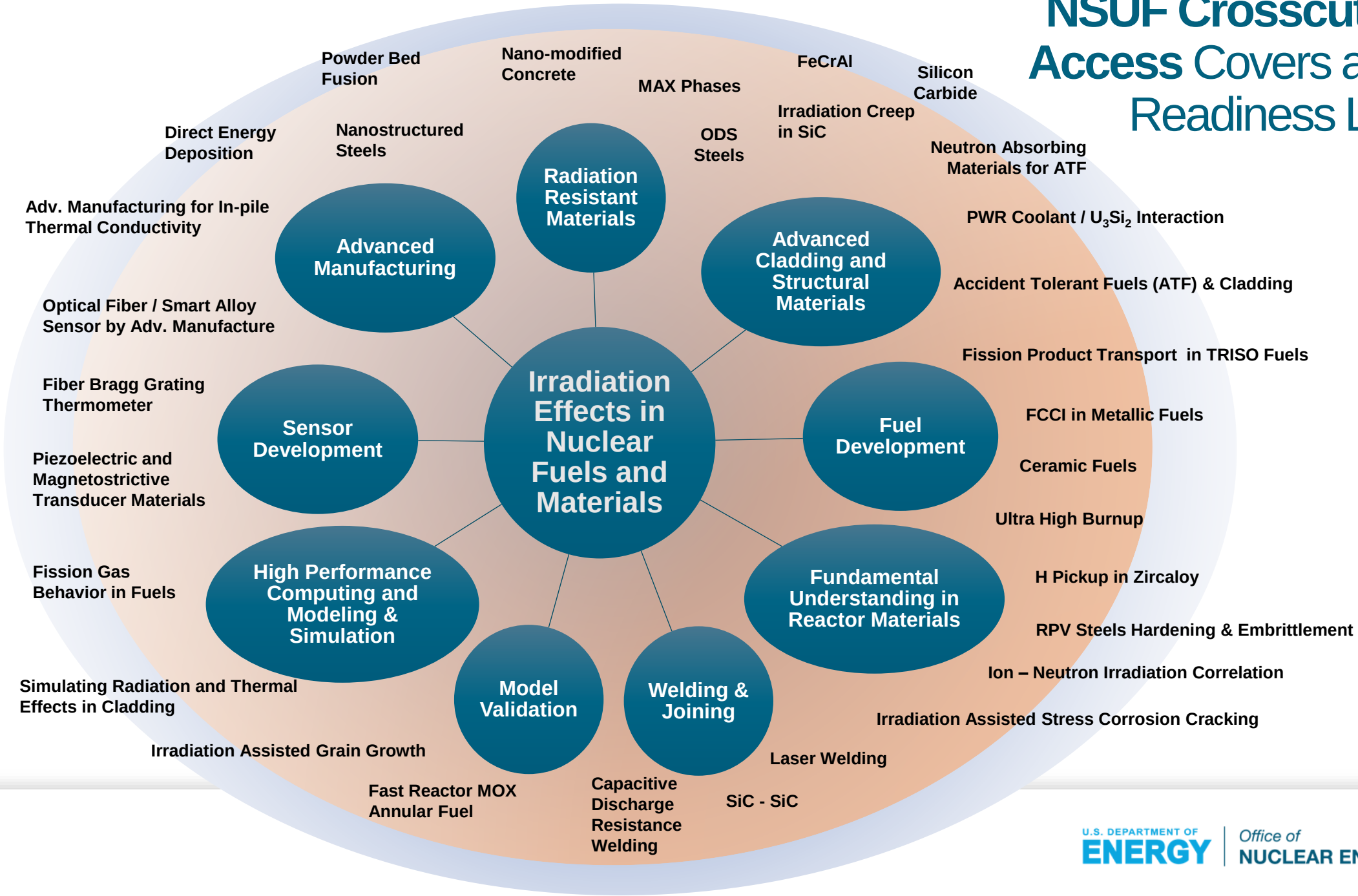
Number of Awards by Field



Value of Awards by Field

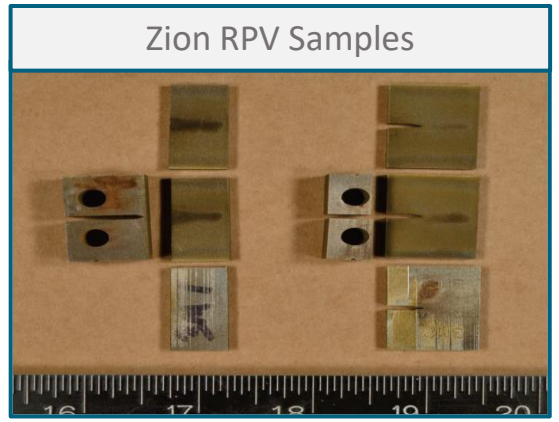


NSUF Crosscutting User Access Covers all Technical Readiness Levels



Nuclear Fuel and Materials Library (NFML)

- Library includes >9000 specimens from NSUF projects, legacy research projects, commercial reactors, and research reactors
- Most specimens are neutron irradiated
- Searchable database through https://nsuf.inl.gov/ by material or fuel composition, specimen configuration, irradiation conditions, and publications
- Legacy samples from EBR-II and FFTF, commercial decommissioned power reactors, donations from other sources
- Recent additions include:
  - 304 stainless steel core shroud from commercial LWR
  - Zion Nuclear Power Plant Reactor Pressure Vessel steels
  - ATR-irradiated fuel plates from Korea Atomic Energy Research Institute
- **Forthcoming additions include:**
  - ATR-irradiated multi-principal component alloys from Tensile Testing Using the Standard Capsule (TTUSC) irradiation
  - TREAT-irradiated U-Zr from the Characterization-scale Instrumented Neutron Dose Irradiation (CINDI) irradiation campaign
  - Yttrium-Hydride samples from the Microreactor Program



Applicants may request NFML specimens for CINR NSUF Access proposals.
Please contact NSUF Office with questions.

NSUF Topic Areas

Nuclear Science User Facilities Joint R&D and Access (NSUF-1)

- Joint R&D and Access
- Eligible to lead: **Universities ONLY**
- R&D Support: Up to 7 years, and up to $1,000,000
- NSUF Access funding: Up to $4,000,000
- Federal POC: Christopher Barr

R&D and Readiness for NSUF-1:

- R&D support is only permitted for tasks associated with the execution of the requested NSUF capabilities. This would include compilation and interpretation of irradiation and post-irradiation examination results, complementary modeling and simulation studies, and related activities.
- R&D support is not for the development of new materials, fuels, or sensors.
- NSUF Readiness: Refer to Part IX Appendix D Accessing Nuclear Science User Facilities. Ensure all actions as they pertain to your proposal are provided. NSUF-1 access proposals need to demonstrate that the material is readily available and sufficient prior R&D has been completed.

Nuclear Science User Facilities Joint R&D and Access (NSUF-1) Topic Area

Objective

- Provide access to highly specialized nuclear research facilities and technical expertise to advance nuclear energy technologies that crosscut the DOE Office of Nuclear Energy mission.
- Provide R&D support for work directly associated with the proposed irradiation and/or post irradiation examination user access project

Types of Projects

- Neutron Irradiation and Post Irradiation Examination (PIE)
- Synchrotron or Neutron Beamline or PIE only
- Ion or Gamma Irradiation only
- Ion or Gamma Irradiation and PIE
- INL High Performance Computing access can be added (free to user) to any of the NSUF topic areas

Restrictions

- Access to NSUF capabilities will require agreement and final signature to the User Agreement
- Project meets NSUF readiness requirements

NSUF Joint R&D and Access (NSUF-1)

Crosscut topic that spans wide range of nuclear energy technologies

Areas of interest may include **but are not limited to**:

Fuel and Core Materials: irradiation performance and combined effects of irradiation and environment on fuels and materials; fundamental and applied aspects to fuel performance. Fuel types include, but are not limited to, oxide, metallic, particle, and/or new innovative fuel types. Core materials include, but are not limited to, accident tolerant fuel cladding systems, zirconium alloys, innovative cladding materials, and neutron-absorbing materials

Advanced Materials and Manufacturing Methods: advanced nuclear materials, novel or cost-effective manufacturing methods, and related topics that leverage NSUF irradiation and post-irradiation examination capabilities.

Sensor Materials, Instrumentation, and Active Component Systems: irradiation testing and post-irradiation examination that support the development of advanced sensor materials, and the development of advanced instrumentation or measurement systems

NSUF Topic Areas

Nuclear Science User Facilities Access Only (NSUF-2)

- Joint R&D and Access
- Eligible to lead: **Universities, National Laboratories, and Industry**
- R&D Support: **None**
- NSUF Access funding: Up to $4,000,000
- Federal POC: Christopher Barr

NSUF Readiness:

- NSUF Readiness: Refer to **Part IX Appendix D Accessing Nuclear Science User Facilities**. Ensure all actions as they pertain to your proposal are provided. NSUF-1 access proposals need to demonstrate that the material is readily available and sufficient prior R&D has been completed.

Nuclear Science User Facilities Access Only (NSUF-2) Topic Area

Objective

- Provide access to highly specialized nuclear research facilities and technical expertise to advance nuclear energy technologies that crosscut the DOE Office of Nuclear Energy mission.
- Provide R&D support for work directly associated with the proposed irradiation and/or post irradiation examination user access project

Types of Projects

- Neutron Irradiation and Post Irradiation Examination (PIE)
- Synchrotron or Neutron Beamline or PIE only
- Ion or Gamma Irradiation only
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- INL High Performance Computing access can be added (free to user) to any of the NSUF topic areas

Restrictions

- Access to NSUF capabilities will require agreement and final signature to the User Agreement
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NSUF Access Only (NSUF-2)

Crosscut topic that spans wide range of nuclear energy technologies

Areas of interest may include **but are not limited to**:

Fuel and Core Materials: irradiation performance and combined effects of irradiation and environment on fuels and materials; fundamental and applied aspects to fuel performance. Fuel types include, but are not limited to, oxide, metallic, particle, and/or new innovative fuel types. Core materials include, but are not limited to, accident tolerant fuel cladding systems, zirconium alloys, innovative cladding materials, and neutron-absorbing materials

Advanced Materials and Manufacturing Methods: advanced nuclear materials, novel or cost-effective manufacturing methods, and related topics that leverage NSUF irradiation and post-irradiation examination capabilities.

Sensor Materials, Instrumentation, and Active Component Systems: irradiation testing and post-irradiation examination that support the development of advanced sensor materials, and the development of advanced instrumentation or measurement systems

Cautions and Requirements

NSUF User Agreement

- Upon award of an NSUF supported project, the NSUF User Agreement must be signed before activities will begin on the project.
- Failure to sign the non-negotiable User Agreement within 30 days of receipt of the User Agreement may result in cancellation of an awarded project.

NSUF Readiness Review

- NSUF Access (both NSUF-1 and NSUF-2) undergo a **readiness review** to evaluate if the proposed work is ready for NSUF access funded irradiation and/or post-irradiation examination. Part IX Appendix D provides NSUF Readiness Review Considerations.
- NSUF readiness should be addressed in both the pre-application and full application.

NSUF Feasibility

- NSUF Access (both NSUF-1 and NSUF-2) undergo a **feasibility review** which evaluates experimental complexity, facility schedule, project schedule, cost, need of shipping or specialized containment.

Duplication of NSUF program activities

- Proposals that completely duplicate previous or on-going NSUF or other DOE-NE supported studies will not be considered. A complete list of NSUF awards can be found under the R&D section on the website NEUP.inl.gov. In addition, please review recent competitive awards, R&D program websites, and documents.

Application Timeline and Information

Please contact NSUF at NSUF@inl.gov and visit NSUF website at http://nsuf.inl.gov

NSUF partner sites and technical leads: https://nsuf.inl.gov/Home/PartnerInstitutions

Key Dates:

Letter of Intent (Mandatory)	June 5, 2024 at 5:00 p.m. ET
R&D/NSUF Pre-application (Mandatory)	June 26, 2024 at 5:00 p.m. ET
NSUF Pre-application SOW (Mandatory)	August 1, 2024 at 5:00 p.m. ET
NSUF Full Application SOW (Mandatory)	October 30, 2024 at 5:00 p.m. ET
Full R&D/NSUF Application (Invited)	November 13, 2024 at 5:00 p.m. ET

Note: Presentation summarizes key aspects to the NSUF access component of the of the FOA. Nothing in this webinar presentation intended to add to, take away from, or contradict any of the requirements of the FOA

Questions and Points of Contact

Federal Program Manager:

Christopher Barr, christopher.barr@nuclear.energy.gov

Technical Point of Contacts:

Brenden Heidrich (NSUF Director), brenden.heidrich@inl.gov

Irradiation Chief Scientist – Keith Jewell, james.jewell@inl.gov

Post-irradiation Chief Scientist – Rongjie Song, rongjie.song@inl.gov

NFML Lead - Kelly Cunningham, kelly.cunningham@inl.gov

All NSUF partner facility PoC are listed at: https://nsuf.inl.gov/Home/PartnerInstitutions


NSUF
Nuclear Science
User Facilities

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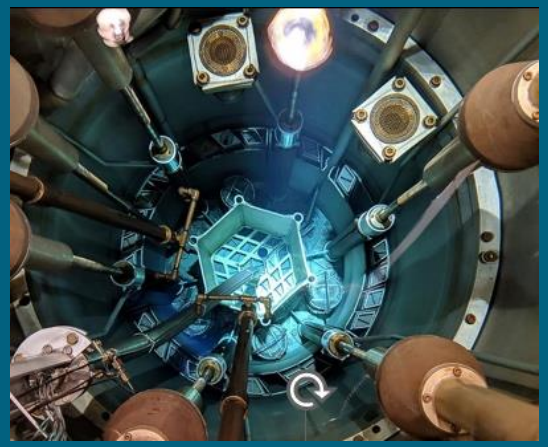
Extra Slides
NSUF – Key Capabilities by Type

Christopher Barr

Neutron Irradiation Facilities



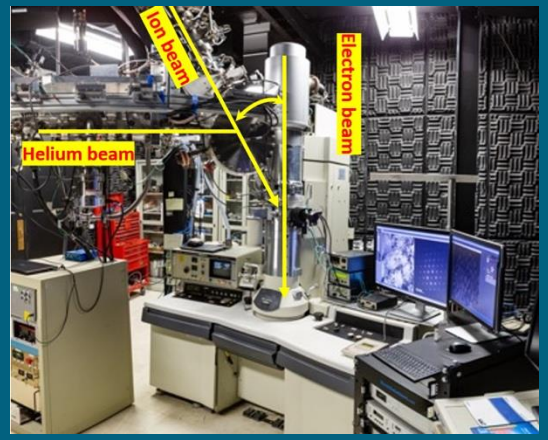
- Highly configurable neutron irradiation testbed capabilities for fuels, materials, and sensors
- Large or small volumes (mm disks to ASTM size Tensile/CT)
- Water loops, corrosion loops, sub-sized specimens, power maneuvers
- ATR, HFIR, TREAT, MITR for CINR
- University reactors accessible for RTEs

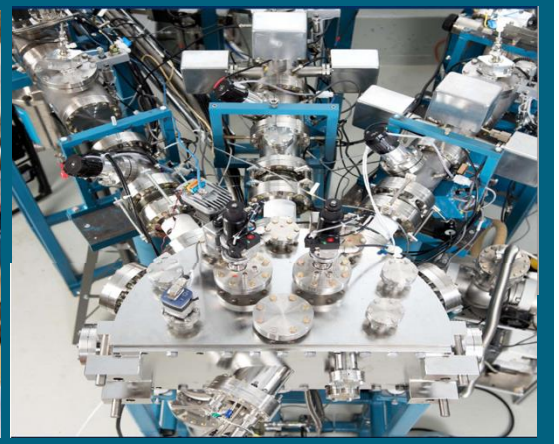
Recent Award Examples:

•**Fuel**: UN multi-design irradiation campaign: a critical assessment of accelerated burnup and main correlations for mechanistic fuel performance modeling; PI: **E. Sooby** (UTSA) – Access Value $2.5M, FY 2023 CINR

•**Structural Material**: Integrated Effects of Irradiation and FLiBe Salt on Fuel Pebble and Structural Graphite for Molten Salt Reactors; PI: **G. Meric** (Kairos Power) – Access Value $833K, FY 2022 CINR

Ion Irradiation Facilities





- Low-energy helium through 10s MeV proton/ions beams
- In-situ ion irradiation in TEM (IVEM-Tandem)
- In-situ mechanical testing + ion irradiation
- All capabilities accessible via RTE and CINR

Recent Award Examples:

•**Structural Material:** The effects of high-temperature creep on irradiation damages of 316H stainless steel made by laser additive manufacturing, **J. Snitzer** (Purdue – **Graduate Student**), FY 2023 RTE

•**Sensor**: Investigation of evolution of defects in β-Ga2O3 under irradiation and high temperature, **G. Yang** (NC State, FY 2023 RTE

•**Fuel**: Elucidating the Effect of Radiation-Induced Defect Accumulation on Swelling in UN using in-situ TEM Irradiation, **C. Taylor** (LANL), FY 2023 RTE

Argonne NATIONAL LABORATORY · WISCONSIN · TEXAS A&M UNIVERSITY · UNIVERSITY OF MICHIGAN · Lawrence Livermore National Laboratory

Hot Cells / Shield Facilities

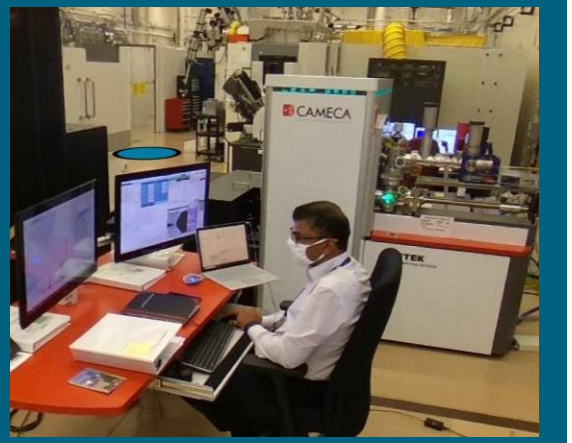



- Radiological material handling, sectioning, characterization, and testing
- In-cell mechanical load frames
- In-cell furnace testing and electron microscopy
- Severe accident testing station

Recent Award Examples:

- **Structural Material:** Investigation of intergranular cracking of highly irradiated austenitic stainless steels – materials of pressurized water reactors – in ambient conditions, M. Gussev (ORNL), FY 2023 CINR
- **Fuel/Cladding**: Mechanical response and chemical effects at the fuel-cladding interface of HT-9 and metallic fuel, M. Okuniewski (Purdue) FY 2022 CINR

Low-Length Scale Characterization Labs



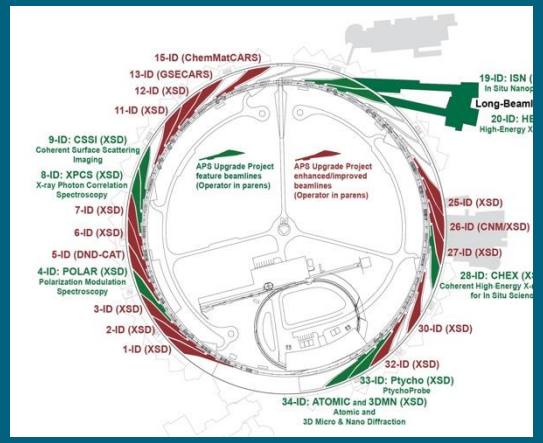
- Low-level irradiation to radiological materials
- SEM, P-FIBs, Ga-FIBs for sample preparation and in-situ testing
- XRD, thermal physical property testing such has thermal conductivity microscope
- Low-length scale characterization, spectroscopy, and tomography via S/TEM-EDS/EELs and APT

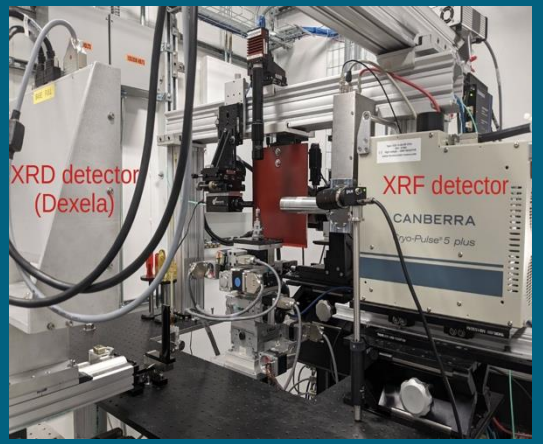
Recent Award Examples:

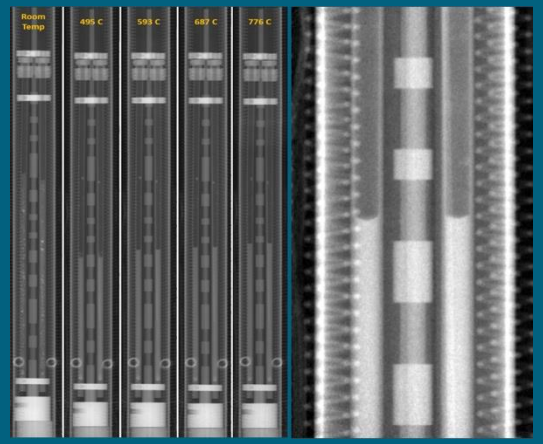
•**Structural Material:** Critical database development of high dose microstructure evolution in irradiated advanced steels, **A. Motta** (PSU), FY 2023

•**Fuel/Cladding**: Mechanical response and chemical effects at the fuel-cladding interface of HT-9 and metallic fuel, **M. Okuniewski** (Purdue) FY 2022 CINR

Beamlines







- Radiological material handling and characterization using synchrotron and neutron-beam lines
- In-situ techniques available including tensile and high-temperature
- Spectroscopy, diffraction, microscopy methods; 3D reconstructions

Recent Award Examples:

•**Cladding Material:** In situ Synchrotron radiation diffraction study of the Effect of Radiation Damage on the Precipitation and Dissolution of Hydrides in Zircaloy, **J. Balog** (PSU-Graduate Student), FY 2023 RTE

•**Fuel/Cladding**: Isotope density mapping using Energy Resolved Neutron Resonance Imaging of a High Burnup UO2 Fuel Fragment, **W. Cureton** (ORNL), FY 2023 RTE

BROOKHAVEN NATIONAL LABORATORY
Argonne NATIONAL LABORATORY
NC STATE UNIVERSITY
Los Alamos NATIONAL LABORATORY

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NSUF Capabilities – CINR Access Opportunities

Neutron Irradiations	Ion Irradiations	Gamma Irradiations	Hot Cells & Shielded Cells	Low Activity Laboratories	Beamlines
INL Idaho National Laboratory	University of Wisconsin-Madison	INL Idaho National Laboratory	INL Idaho National Laboratory	INL Idaho National Laboratory	Brookhaven National Laboratory
ORNL Oak Ridge National Laboratory	University of Michigan	ORNL Oak Ridge National Laboratory	ORNL Oak Ridge National Laboratory	CAES Center for Advanced Energy Studies	Argonne National Laboratory
MIT Massachusetts Institute of Technology	Argonne National Laboratory	Sandia National Laboratories	PNNL	ORNL Oak Ridge National Laboratory	NC State University
NC State University	Sandia National Laboratories		Los Alamos National Laboratory	Cal	Los Alamos National Laboratory
Ohio State	Texas A&M University		Westinghouse	PNNL	
Sandia National Laboratories	Lawrence Livermore National Laboratory		University of Michigan	Los Alamos National Laboratory	
				NC State University	
				University of Michigan	
				Purdue University	
				University of Wisconsin-Madison	
				University of Florida	

Visit nsuf.inl.gov for details of individual facilities and leads