



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Nuclear Science User Facilities (NSUF) Gateway to Nuclear Research



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Topics

- **NSUF General Overview**
- **NSUF Partnerships**
- **NSUF Capabilities**
- **NSUF Projects**
 - **NSUF Access**
 - **Nuclear Energy Infrastructure Database (NEID)**
 - **NSUF Fuels & Materials Library**



NSUF Purpose



- The research performed to support nuclear energy development requires specialized (expensive) and increasingly rare capabilities
 - High flux reactors
 - Hot cells
 - Ion Beams
 - Support infrastructure (shipping, casks, test fabrication, etc.)
 - State-of-the-Art instrumentation
- But also intellectual capital
 - Universities
 - Nuclear Industry
 - Innovative Small Businesses
 - National Laboratories
- The NSUF aims to merge the national nuclear research infrastructure with intellectual capital to pair the best ideas with needed capability
- The NSUF offers access to capabilities and expertise at no cost to the user. The NSUF can fund experiment design, fabrication, transport, irradiation, and post irradiation examination (PIE) activities.
- The NSUF core purpose is to provide an avenue for innovative ideas that address NE mission needs to be realized.



NSUF Overview



- Established 2007 under INL IFM funding
- DOE Office of Nuclear Energy first and only user facility
- Total of ~\$123M in DOE support (2008-2015)
- 5 types of projects:
 - Irradiation + PIE (\$1.2M - \$4.0M, up to 7 years)
 - PIE only (~\$500K, up to 3 years)
 - Irradiation only (\$500K - \$3.5M)
 - “APS” (beamline at other user facilities, \$100K - \$250K)
 - Rapid Turnaround Experiments (RTE, up to \$50K)
- Total of 26 projects executed (excluding RTEs)
- Total of 10 projects currently ongoing (excluding RTEs)
- Total of 71 RTEs executed
- Total of 26 RTEs ongoing
- Partner Facilities established starting in 2008 (self selection)
 - 8 Universities
 - 2 National Laboratories (4 under consideration)
 - 1 Industrial





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Distribution of NSUF Projects



*Opening new
opportunities to
researchers*



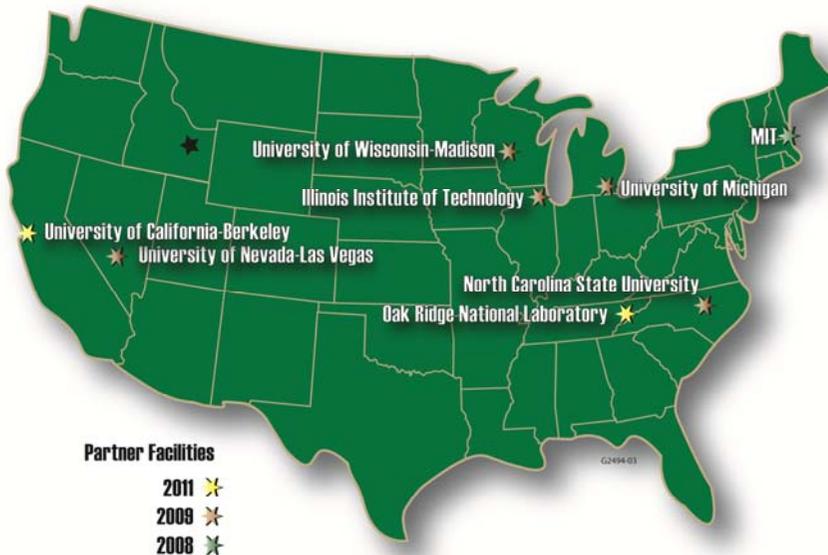
- **133 Projects Awarded**
 - 98 to 27 universities
 - 35 to 4 national and 1 international laboratories
 - 18 states plus UK and Australia



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NSUF Partnerships Distributed Research Capabilities



- **INL – ATR, hot cells, and PIE facilities**
- **ORNL – HFIR, hot cells, and PIE facilities**
- **PNNL – hot cells and PIE facilities**
- **Westinghouse – hot cells and PIE facilities**
- **CAES – MaCS Laboratory (BSU, ISU, IU, INL)**

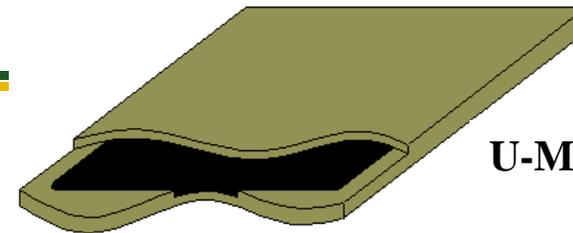
- **Massachusetts Institute of Technology – MITR and hot cell**
- **North Carolina State University – PULSTAR reactor**
- **Illinois Institute of Technology – MRCAT beamline at Advanced Photon Source**
- **University of Michigan – Ion Beam Laboratory and Irradiated Materials Laboratory**
- **University of Wisconsin – Tandem Accelerator Ion Beam, Characterization Laboratory for Irradiated Materials**
- **UC Berkeley – PIE instruments**
- **University of Nevada, Las Vegas – Radiochemistry Laboratory**
- **Purdue University – CMUXE**



What are we studying?

Irradiation Effects & Behavior of Nuclear Fuels and Materials

- Maintaining fleet of current reactors
 - Life extension for commercial reactors
 - Developing accident tolerant nuclear fuels
- Developing the next generation of safer more efficient reactor systems
 - Materials resistant to high levels of radiation damage
 - Reduced enrichment fuels for test reactors
 - High temperature gas reactor fuels and materials
 - Liquid metal cooled fast reactors for transmutation - burning long lived radioisotopes and reduce need for long term used fuel storage
- NSUF does NOT support development program prior to irradiation.

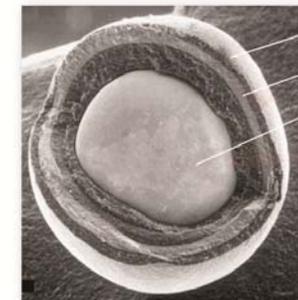


U-Mo Plate Fuel

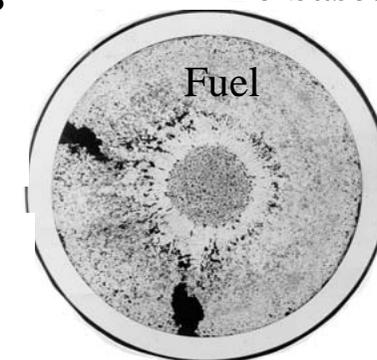
Radiation Damage Effects in Cladding and Structural Materials



Austenitic Stainless Steel Following Irradiation in EBR II Fast Reactor



Gas Reactor Coated Particle Fuel



Fe-based Cladding

Restructuring in U-Pu-Zr Metallic Fuel



■ Neutron Irradiations

- ATR (loop, rabbit) 250MW
- ATRC
- HFIR (rabbit) 85MW
- MITR (loop) 10MW
- PULSTAR 2MW

■ Hot Cells

- INL(HFEF, FCF, AL, IASCC)
- ORNL (IFEL, IMET, REDC)
- PNNL (RPL)
- Westinghouse (MCOE)
- U. Mich (IMC)

■ High radiation level

measurements/instrumentation

- neutron radiography
- elemental & isotopic analyses
- gas sampling and analyses
- metrology, profilometry
- gamma & micro-gamma scanning
- mechanical & tensile testing
- electron and optical microscopy
- thermal analyses
- eddy current
- IASCC
- EPMA
- AES
- XPS
- FIB



■ Low radiation level measurements/instrumentation

- Electron microscopy
- APT
- FIB
- hardness
- micro- & nano-indentation
- tensile
- thermal analyses
- XRD
- XPS
- AES
- SIMS
- NMR
- PAS

■ Ion Irradiations

- Tandem Accelerator Ion Beam (U. Wisc)
- Michigan Ion Beam Lab (U. Mich)

■ Beamlines

- X-ray (ANL APS: MRCAT, IIT)
- Neutron, positron (PULSTAR, NCSU)

- Visit nsuf.inl.gov under Research Capabilities tab for details at individual facilities



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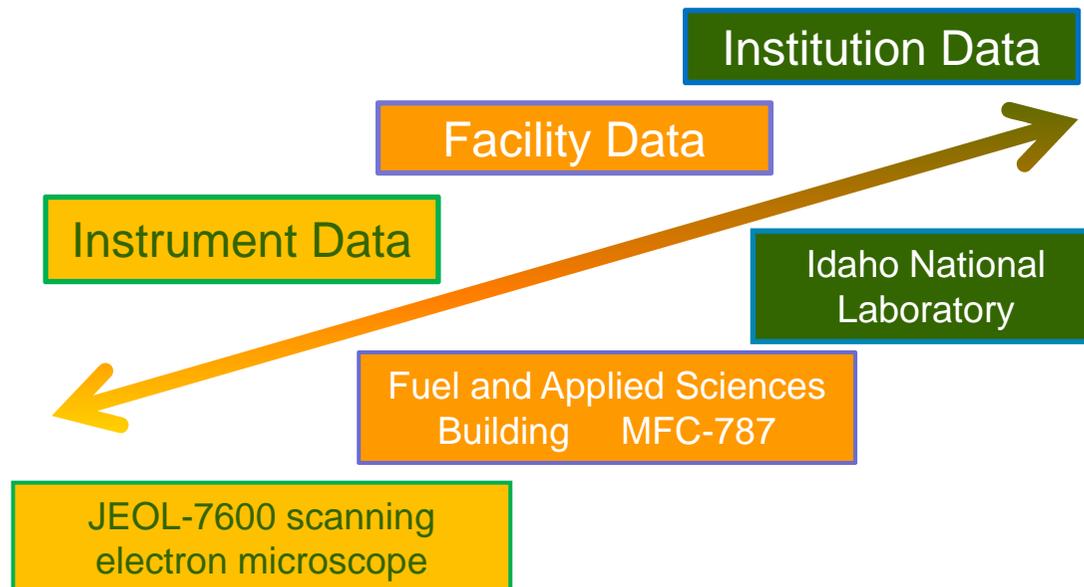
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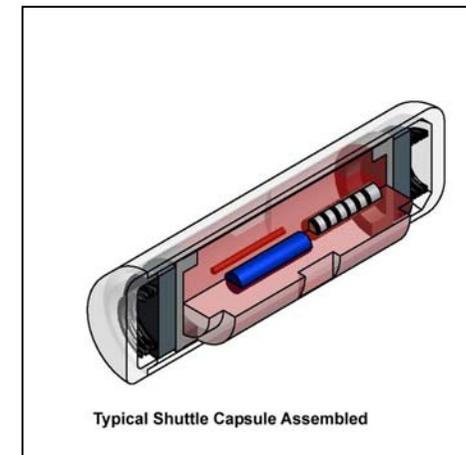
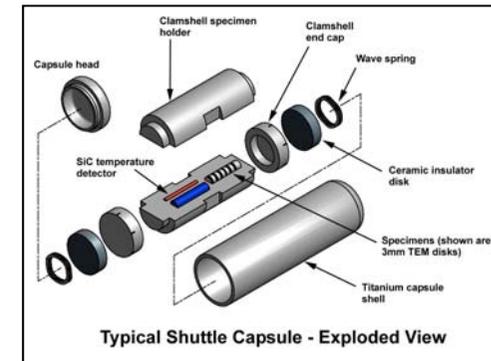
- **Majority awarded through competitive process**
 - **Applications open to university, national laboratory, industry, small business researchers**
 - **Large projects once per year call**
 - **Rapid Turnaround (RTE) and beamline experiments three calls per year**
 - **Fully forward funded**
 - **Requires firm scope of work, cost estimate, and schedule before project awarded – feasibility study**
 - **Better ensure project performance and facility access/priority**
- **Research support funding possible through coupled process**
 - **NSUF only provides access to capabilities and expertise**
 - **Research support provided through NEUP/NEET programs or other**
 - **Single application process (Letter of Intent, Pre-proposal, Full proposal)**
- **Interest is growing and becomes very competitive**
 - **FY2014: 41 LOIs, 31 Pre-proposals, 17 Full proposals, 4 projects awarded**
 - **FY2015: 80 LOIs, 66 Pre-proposals**

- Catalogue, analyze, “manage” DOE-NE infrastructure on continuous basis
 - Establish the Nuclear Energy Infrastructure Database (NEID)
 - NEID used to aide DOE increase efficiency of existing capabilities utilization and guide future investments
 - NEID will be available to nuclear community to help formulate projects and proposals
- To date: 84 institutions, 381 facilities, 802 instruments



- Desire to expand NEID to international capabilities
 - perform feasibility/cost analysis of material transport vs national implementation
- Database available at Infrastructure-NSUF.inl.gov

- Critical to reducing costs and taking advantage of new ideas and future analysis techniques and equipment.
- A detailed inventory of samples currently in the library has been completed in the form of excel spreadsheets available on website (nsuf.inl.gov) that will be used as initial population of a searchable on-line database for users to locate samples of interest (in progress).
- Working to increase inventory of samples and establish pedigree of materials throughout DOE complex for potential incorporation in sample library. Data to be available in database.
- Effort to consolidate materials into easily accessible locations to reduce costs of retrieval.
- Initiated international effort with UK National Nuclear User Facility (NNUF).





Expanded NSUF Vision

