Nuclear Science User Facilities (NSUF)

Nuclear Fuels and Materials Library Update

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The research performed to support nuclear energy development requires specialized and increasingly rare capabilities:

- Test and research reactors
- Hot cells
- Ion beams
- Support infrastructure (shipping casks, test fabrication, etc.)
- State-of-the-Art instrumentation & Expertise

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.

Focus area of NSUF is irradiation effects in nuclear fuels and materials. Expanded scope is intended.

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.
Established 2007 as DOE Office of Nuclear Energy first and only user facility
  - Idaho National Laboratory is lead institution

Generally select projects through open competitive proposal processes
  - Consolidated Innovative Nuclear Research (CINR FOA, 1 call/year)
    - Irradiation + PIE ($1.0M - $4.0M, up to 7 years)
    - PIE only ($~500K, up to 3 years)
    - Irradiation only ($500K - $3.5M)
    - Beamlines at other user facilities
  - Rapid Turnaround Experiments (RTE, 3 calls/year, limited $$, executed within 9 months)
  - Proposals welcome from University, National Laboratory, Industry, Int’l researchers

Partner Facilities established starting in 2008 (self selection)
  - 8 Universities + 3 universities in CAES (3 expressed interest)
  - 4 National Laboratories (3 expressed interest)
  - 1 Industrial
NSUF – A consortium
A group formed to undertake an enterprise beyond the resources of any one member
Neutron Irradiations
- ATR (loop, rabbit), ATRC, HFIR (rabbit), MITR (loop), PULSTAR, NRAD (Future: BR2 – SCK-CEN Belgium), Halden – Norway ?

Ion Irradiations
- Tandem Accelerator Ion Beam (U. Wisc), Michigan Ion Beam Lab (U. Mich), IVEM (ANL) (Future: TAMU, SNL, LANL)

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

High radiation level measurements/instrumentation
- Neutron radiography, elemental & isotopic analyses, gas sampling and analyses, profilometry, gamma scanning, mechanical testing, electron and optical microscopy, thermal analyses, eddy current, IASCC, EPMA, AES, XPS, SIMS, focused ion beam (FIB)

Low radiation level measurements/instrumentation
- SEM, TEM, APT, FIB, hardness, micro- & nano-indentation, tensile, thermal analyses, XRD, XPS, AES, SIMS, NMR, PAS

Beamlines
- X-ray (ANL APS: MRCAT, IIT; BNL NSLS-II: XPD, NST Dept)
- Neutron, positron (PULSTAR, NCSU)

Visit nsuf.inl.gov under Research Capabilities tab for details at individual facilities
Total of 28 awarded CINR type projects executed
Total of 21 awarded projects currently ongoing (excluding RTEs)
Total of 97 RTEs executed
Total of 30 RTEs ongoing
176 total projects awarded
• 122 projects to 33 US universities
• 49 projects to 5 national laboratories
• 4 projects to 3 international (Oxford U., Manchester U., ANSTO)
• 1 project to industry (GE-Hitachi)
172 total projects across 22 states
Interest and support levels
• FY 2014 – $400K, 8 full proposals, 3 awards
• FY 2015 – $4.1M, 41 LOIs, 31 pre-proposals, 17 full proposals, 5 awards
  (1 R&D coupled, 4 NSUF only)
• FY 2016 – $9.7M, 80 LOIs, 67 pre-proposals, 32 full proposals, 12 awards
  (8 R&D coupled, 4 NSUF only)
• FY 2017 – 124 LOIs, 109 pre-proposals
Project portfolio spans a variety of research objectives that are ultimately focused on both near and long-term technology development goals:

- Understanding atomic level phenomena in fuels that affect thermal transport, elemental migration/diffusion, interface interaction, etc. as complex microstructures develop under irradiation
  - ceramic, metallic, TRISO, ATF
- Understanding fundamental defect evolution in irradiated structural materials across multiple length scales as they affect mechanical properties.
  - RPV, austenitic, F/M, Zr alloys, ATF
- Development of innovative radiation resistant materials for advanced reactor systems
- Development of radiation resistant sensors for collecting high fidelity on-line irradiation test data
- Providing fundamental actinide nuclear data that can help inform advanced reactor and fuel cycle modeling and simulation campaign.

J. Cole contributed to content of slide
1. Gather Data on Nuclear Energy R&D Capabilities

2. Estimate Near, Mid and Long-term R&D Directions

3. Use these to perform gap analyses for Nuclear Energy R&D.

4. Assist funding decisions and incorporate the results into the NEID.
Infrastructure / Capabilities

- Nuclear Energy Infrastructure Database (NEID) public web-based searchable tool launched in November 2015 (nsuf-infrastructure.inl.gov)
- Over 125 institutions operating over 450 facilities housing almost 900 instruments
- Current NEID users include researchers from 75 Federal Government and National Laboratories, 38 Universities and NGOs, and 25 Industry organizations.
- Used to complete initial infrastructure gap analysis
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 web-based searchable database for users to locate samples of interest (public launch Sept 14, 2016).

Working to increase inventory of samples and establish provenance of materials throughout DOE complex for potential incorporation in NFML.

Effort to consolidate materials into easily accessible locations to reduce costs of retrieval.

Interest in collaboration on international efforts.
Provides irradiated samples for users to access and conduct research through a competitively reviewed proposal process.

“Librarian” hired

The library includes over 3500 specimens as part of the NSUF awarded research.

6K – 7K additional specimens by year end.

Most materials in NFML neutron irradiated with small number ion irradiated.

SAM irradiation series to stock library moving forward

Materials Include:
- Steels
- Other alloys
- Ceramics
- Pure materials
- Actinides
- Fission products
Materials from NSUF projects, EBR-II, ATR, FFTF, HFIR, José Cabrera Nuclear Power Station, Zion 1 & 2 NPS (in negotiation).
1. We can connect **facilities and instruments** as parts of a process to accomplish a research method or process, such as:
   - Microstructural characterization of irradiated fuel.
   - Irradiation experiment (through design, fabrication, irradiation, etc.)
2. We can include **fuels and materials**:
   - Nuclear Fuels and Materials Library
   - Link to facilities utilized
   - Link to researchers
3. We can connect **research**:
   - Subject matter
   - Facilities utilized
   - PIs & collaborators
4. We can include **expertise**:
Building sustainable value over the long term

- High Impact Results
- Projects
- Sample Library
- High Performance Compute
- Capability Enhancement
- Capability Development
- Human Capital
- Infrastructure Management
- Capability Maintenance Replacement

Focus on High Impact Results Addressing Most Pressing Issues or Areas Offering Greatest Potential for Advancement.
Advanced Understanding of Most Important Phenomena.
Increased Public Awareness.

- Competitive Awards (Focused CINR Scopes). Non-Competitive Awards (NE Programs, CRADA). Forward Funded.

- Keep Core Infrastructure Functional. Reduced Costs. Management of High Value Materials. Aid in Disposition Decisions


- Cutting Edge, State of the Art Instrumentation. Internationally Recognized Expertise. Other User Facility Leveraging

Expanded NSUF Vision

Sample Library

Projects

High Impact Results

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Capability Maintenance Replacement

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