Opportunities with NSUF for Nuclear Energy R&D

Advanced Sensors and Instrumentation Annual Webinar

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Nuclear Science User Facilities
Nuclear Science User Facilities (NSUF)

- Established 2007 as US DOE Office of Nuclear Energy first & only user facility.
- Founded at Idaho National Laboratory initially intended as a single institution user facility. INL remains lead and primary institution.
- NSUF operates as typical US user facility (no cost to user, competitive proposal processes, no funding to users) but also some unique aspects.

Unique aspects of NSUF

- Consortium of facilities/capabilities, not single institution (currently 11 Universities + 4 Universities in CAES, 7 National Laboratories, 1 industry)
- NSUF offers multiple capabilities to a single scientific area:
  - irradiation effects in nuclear fuels and materials.
- Projects can last many years or be short duration.
  - Largest projects include design, fabrication, transport, irradiation, PIE, and final disposition.
- No base funding to facilities.
  - Funding to facility is for project cost and is fully forward funded.
  - Excess capacity is generally utilized.
NSUF Experiment Pathways
NSUF Capabilities Offer Research Opportunities

<table>
<thead>
<tr>
<th>Neutron Irradiations</th>
<th>Ion Irradiations</th>
<th>Gamma Irradiations</th>
<th>Hot Cells &amp; Shielded Cells</th>
<th>Low Activity Laboratories</th>
<th>Beamlines</th>
<th>High Performance Computing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idaho National Laboratory</td>
<td>University of Wisconsin</td>
<td>Idaho National Laboratory</td>
<td>Idaho National Laboratory</td>
<td>Idaho National Laboratory</td>
<td>Argonne National Laboratory</td>
<td>Idaho National Laboratory</td>
</tr>
<tr>
<td>Oak Ridge National Laboratory</td>
<td>MIT</td>
<td>Oak Ridge National Laboratory</td>
<td>Argonne National Laboratory</td>
<td>Oak Ridge National Laboratory</td>
<td>PNNL</td>
<td>Brookhaven National Laboratory</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>NC State University</td>
<td>Sandia National Laboratories</td>
<td>Los Alamos National Laboratory</td>
<td>Sandia National Laboratories</td>
<td>Westinghouse</td>
<td>SCK·CEN</td>
</tr>
<tr>
<td>Ohio State University</td>
<td>Texas A&amp;M University</td>
<td>Lawrence Livermore National Laboratory</td>
<td>Argonne National Laboratory</td>
<td>Lawrence Livermore National Laboratory</td>
<td>Purdue University</td>
<td>SCK·CEN</td>
</tr>
</tbody>
</table>

Visit nsuf.inl.gov for details at individual facilities

11 Universities
CAES (4 Unis)
7 National Labs
1 Industry
Simple Static Capsule Experiments

- Passive instrumentation (flux wires, melt wires)
- Enclosed in sealed tube, or fuel plates
- Temperature target controlled by varying gas mixture in conduction gap and with material selection
- Lengths up to 48”; diameter 0.5” – 5.0”
- Used for isotope production, fuel and material testing
Instrumented Lead Experiments

- On-line experiment measurements
- Temperature control range 250-1200°C, within +/- 5°C
- Monitoring of temperature control exhaust gases for experiment performance (e.g., fission products, leaking materials, etc.)
- Specialized gas environments (oxidizing, inert, etc.)
NSUF – Ion Beam Irradiation Facilities

University of Michigan
Ion Beam Laboratory

University of Wisconsin
Tandem Accelerator Ion Beam

Additional Partner Facilities:
• IVEM at the Argonne National Laboratory
• CMUXE at the Purdue University (surface science)
• Ion Beam Laboratory at the Texas A&M University
• I³TEM Facility at the Sandia National Laboratory
Gamma Irradiations

Idaho National Laboratory
- **ATR Gamma Facility** is an aluminum dry tube projecting from the spent fuel rack to the top of the ATR canal.
  - Used fuel irradiation
  - 25kGy/hr
- **Gamma Irradiator Test Loop**, located in the Fuels and Applied Science Building.
  - $^{60}$Co – Nordion Gammacell 220
  - 3kGy/hr

Oak Ridge National Laboratory
- **Gamma Irradiation Facility** located in the HFIR pool.
  - Used fuel irradiation
  - 1MGy/hr

Sandia National Laboratories
- **Gamma Irradiation Facility**
  - Pool and hot cell irradiators
  - $^{60}$Co sources (repositionable)
  - 36kGy/hr
Database of nuclear energy R&D resources (NEID)
The NSUF Nuclear Fuels and Materials Library

- Owned by DOE-NE and curated by the NSUF
- Includes nuclear fuel and material samples from past and ongoing irradiation test campaigns, decommissioned power reactors, and donations from other sources.
- Contains >6000 searchable samples and corresponding information
  - Irradiation Conditions
  - Experiment information
  - Project reports

- Mostly neutron irradiated specimens:
  - EBR-II (Idaho National Laboratory)
  - ATR (Idaho National Laboratory)
  - HFIR (Oak Ridge National Laboratory)
  - FFTF (Hanford Site)
  - José Cabrera Nuclear Power Station

Nuclear Power Plant harvested materials (in negotiation)
1. **Consolidated Innovative Nuclear Research FOA**
   - Kickoff in August, awarded the following June
   - R&D support funding can be requested
   - Irradiation + PIE ($500K - $4.0M, up to 7 years)
   - PIE only ($50K to $750K, up to 3 years)
   - Irradiation only ($500K - $1.5M)

2. **Rapid Turnaround Experiment calls**
   - For small examination or beam-line projects
   - Three calls per year
   - No R&D support funding
   - XPD at NSLS-II, IVEM and MRCAT at APS are available

3. **DOE-NE Infrastructure Programs**
   - Reactor Upgrades
   - General Scientific Infrastructure
NSUF Workscopes

University Led
- **NEAMS-2:** SEPARATE EFFECTS IRRADIATION TESTING FOR VALIDATION OF MICROSTRUCTURAL MODELS IN MARMOT
- **FC-2.5:** SEPARATE EFFECTS TESTING IN TREAT USING STANDARD TEST CAPSULES

University, National Laboratory, Industry Led
- **NSUF 1.1:** TESTING OF ADVANCED MATERIALS OR ADVANCED SENSORS FOR NUCLEAR APPLICATIONS
- **NSUF 1.2:** IRRADIATION TESTING OF MATERIALS PRODUCED BY INNOVATIVE MANUFACTURING TECHNIQUES

Industry Led
- **NSUF-2.1:** CORE AND STRUCTURAL MATERIALS
- **NSUF-2.2:** NUCLEAR FUEL BEHAVIOR AND ADVANCED NUCLEAR FUEL DEVELOPMENT
- **NSUF-2.3:** ADVANCED IN-REACTOR INSTRUMENTATION
High-performance nanostructured thermoelectric materials and generators for in-pile power harvesting

- NSUF-1.1 (Sensors)
- MITR and MIBL
  - In-Core Sample Assembly (ICSA)
  - 2 cycles (~6 months in reactor)
  - $0.3-0.5 \times 10^{21}$ n/cm$^2$, E$>1.0$ MeV
Irradiation Behavior of Piezoelectric Materials for Nuclear Reactor Sensors

- NSUF-1.1 (Sensors)
- Determine piezoelectric, elastic and dielectric properties of AlN material under nuclear reactor environmental conditions.
- OSURR and Wisconsin IBL
  - instrumented-lead experiment
  - Starting 2019
    - 300 hours
    - $8.1 \times 10^{17}$ nvt fast fluence
    - surface acoustic wave radiofrequency filter
    - RT, 350°C & 650°C
  - will use the 7” high-temp furnace irradiation facility
DOE-NE Requests for Information

- **Capabilities RFI (DE-SOL-0008318)**
  - seeking information regarding capabilities needed by researchers to accomplish nuclear energy R&D

- **CINR Workscope RFI (DE-SOL-0008246)**
  - seeking ideas in the areas of research, information, comments, feedback, and recommendations from interested parties for future work scopes for the major NE-funded research programs.

- **NFML RFI (DE-SOL-0010995)**
  - seeking information regarding:
    - existing nuclear energy research materials and specimens that can, potentially, be added to the NFML, and
    - future needs for nuclear energy-related material to support ongoing nuclear energy challenges as well as future research advancements in nuclear energy.