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

Clean. Reliable. Nuclear.

Opportunities with NSUF for Nuclear Energy R&D

Advanced Sensors and Instrumentation Annual Webinar

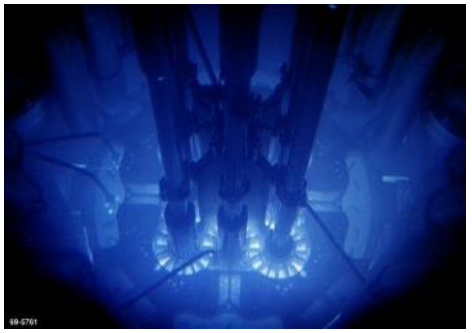
October 31 – November 1, 2018

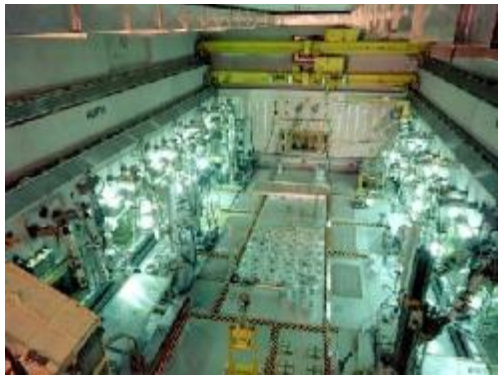
Brenden Heidrich

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.

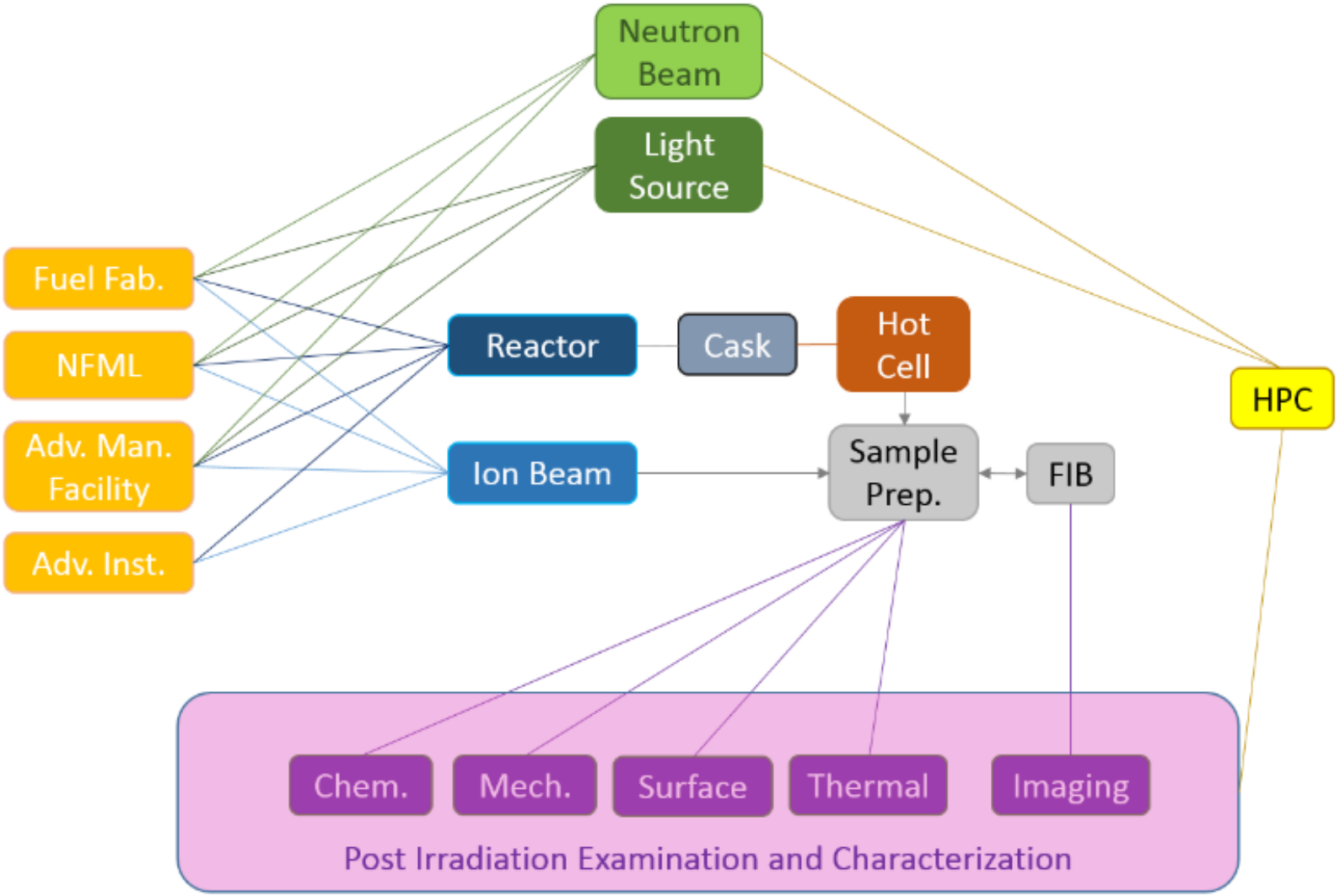




Unique aspects of NSUF

- **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

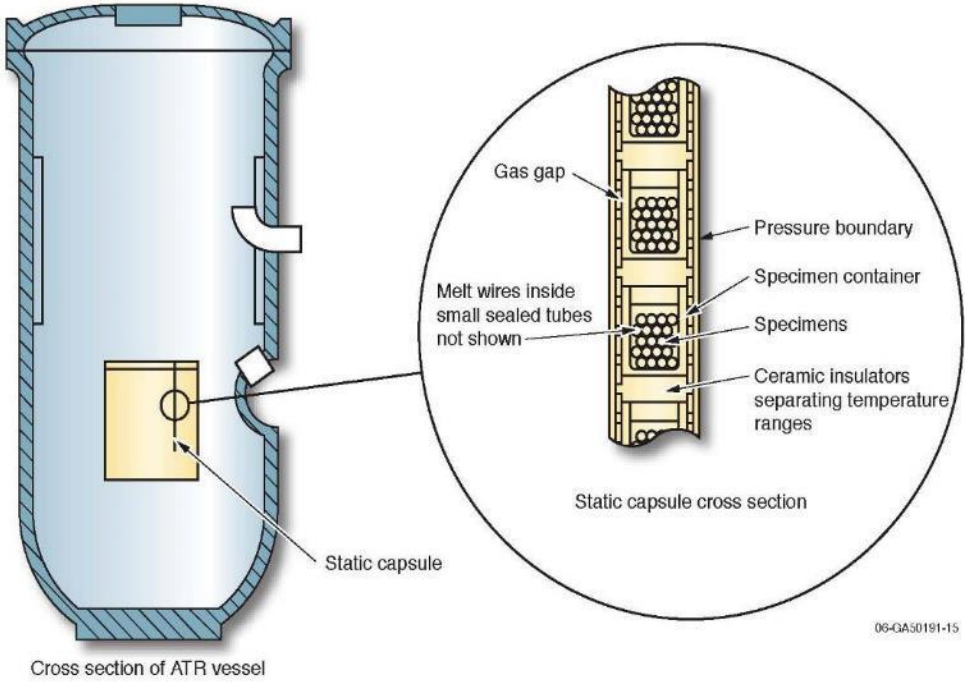
Neutron Irradiations	Ion Irradiations	Gamma Irradiations	Hot Cells & Shielded Cells	Low Activity Laboratories	Beamlines	High Performance Computing
INL Idaho National Laboratory	University of Wisconsin-Madison	INL Idaho National Laboratory	INL Idaho National Laboratory	INL Idaho National Laboratory	125 Illinois Tech Since 1890	INL Idaho National Laboratory
Oak Ridge National Laboratory	University of Michigan	Oak Ridge National Laboratory	Oak Ridge National Laboratory	CAES Center for Advanced Energy Studies	Brookhaven National Laboratory	
Massachusetts Institute of Technology	Argonne National Laboratory	Sandia National Laboratories	PNNL	Oak Ridge National Laboratory		
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		
SCK•CEN Studiecentrum voor Kernenergie Centre d'Etude de l'Energie Nucleaire			SCK•CEN Studiecentrum voor Kernenergie Centre d'Etude de l'Energie Nucleaire	Purdue University; University of Michigan; UNLV; University of Florida; SCK•CEN Studiecentrum voor Kernenergie Centre d'Etude de l'Energie Nucleaire		

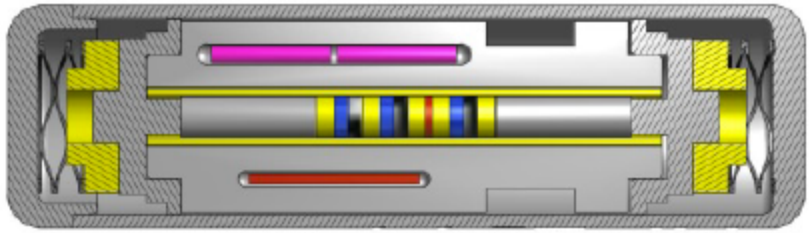
Visit nsuf.inl.gov for details at individual facilities

- 11 Universities
- CAES (4 Unis)
- 7 National Labs
- 1 Industry

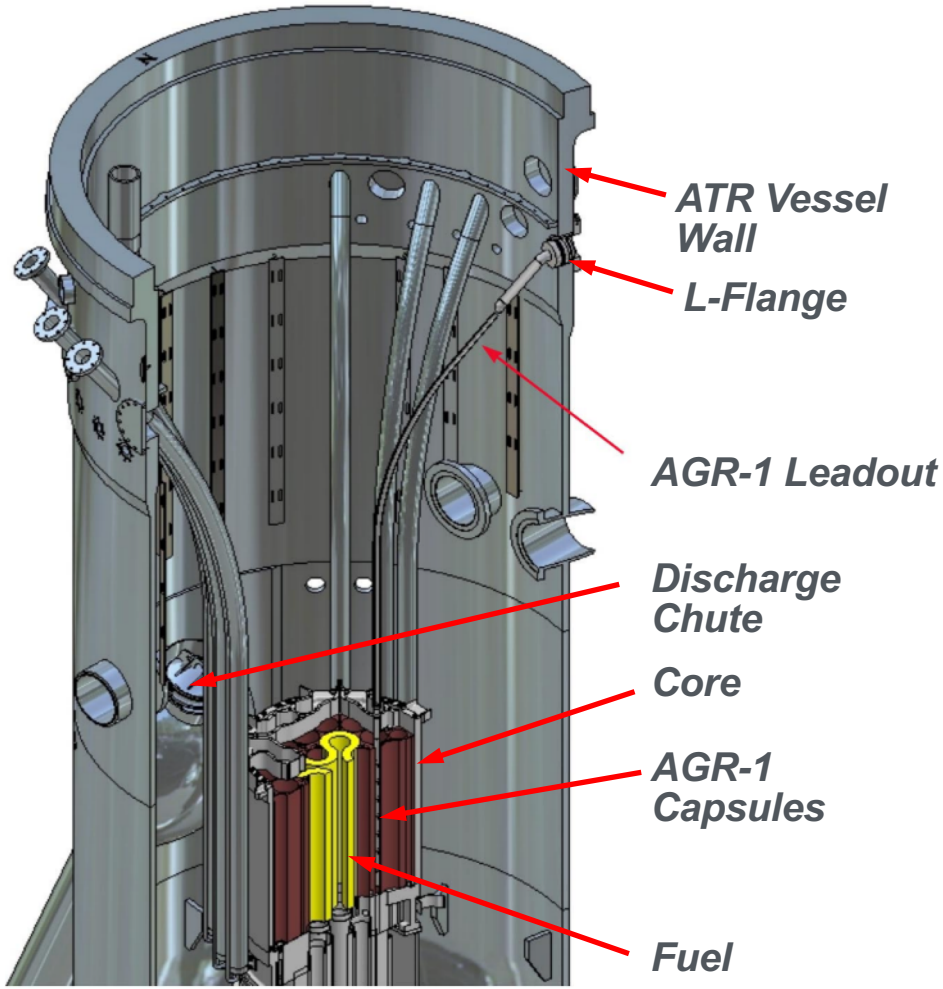
Simple Static Capsule Experiments

- 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.)

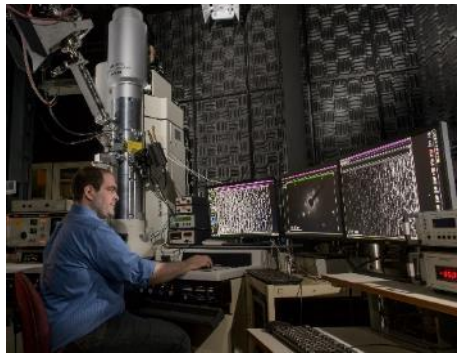
NSUF – Ion Beam Irradiation Facilities

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
- I^{3}TEM Facility at the Sandia National Laboratory



Gamma Irradiations

Idaho National Laboratory

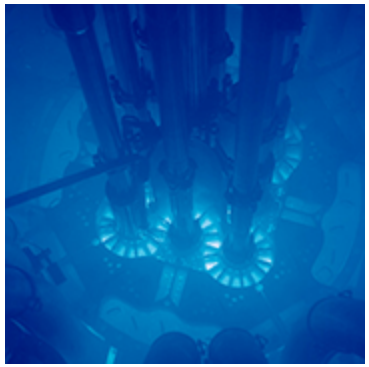
- ATR Gamma Facility is an aluminum dry tube projecting from the spent fuel rack to the top of the ATR canal.
  - Used fuel irradiation
  - 25kGy/hr
- Gamma Irradiator Test Loop, located in the Fuels and Applied Science Building.
  - ^{60}Co – Nordion Gammacell 220
  - 3kGy/hr

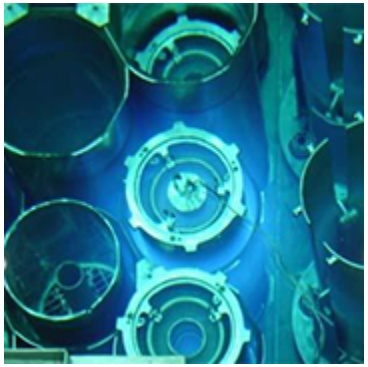
Oak Ridge National Laboratory

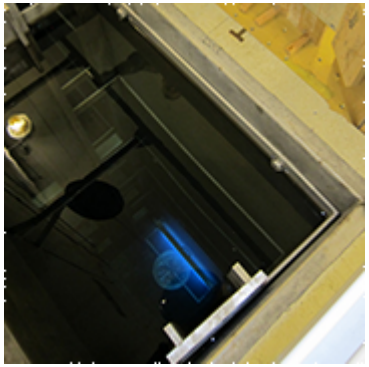
- Gamma Irradiation Facility located in the HFIR pool.
  - Used fuel irradiation
  - 1MGy/hr

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)

Nuclear Fuels and Materials Library

- **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)

Accessing the NSUF

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

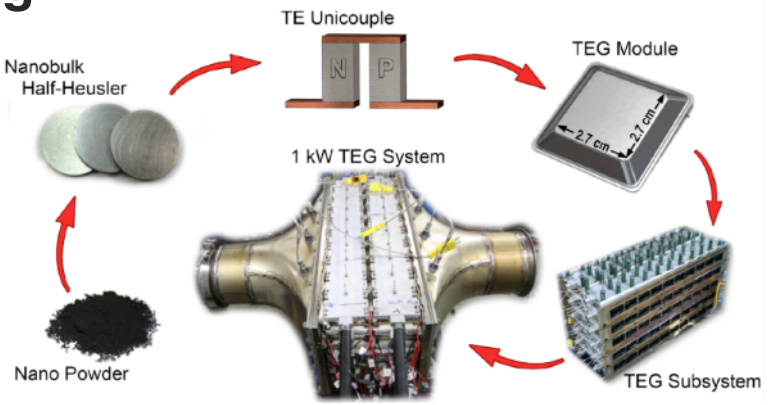
Industry Led

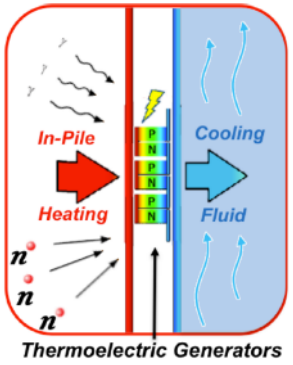
- NSUF-2.1: Core and Structural Materials
- NSUF-2.2: Nuclear Fuel Behavior and Advanced Nuclear Fuel Development
- NSUF-2.3: Advanced In-reactor Instrumentation

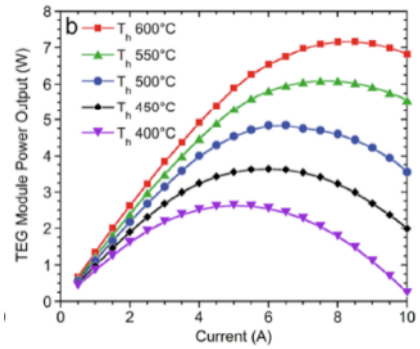
ND-14730: Yanliang Zhang

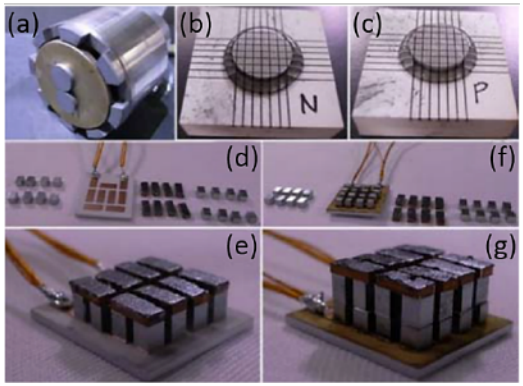
High-performance nanostructured thermoelectric materials and generators for in-pile power harvesting

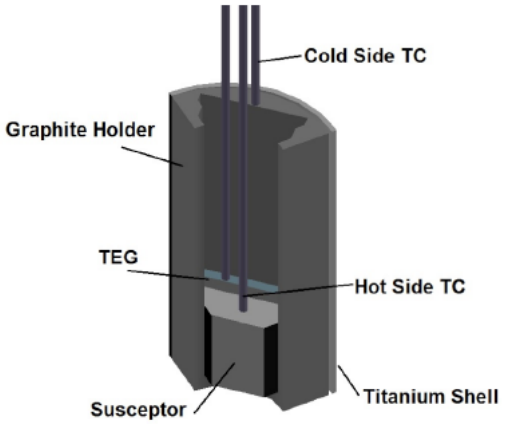
- NSUF-1.1 (Sensors)
- MITR and MIBL
  - In-Core Sample Assembly (ICSA)
  - 2 cycles (~6 months in reactor)
  - 0.3-0.5×10^{21} n/cm2, E>1.0 MeV







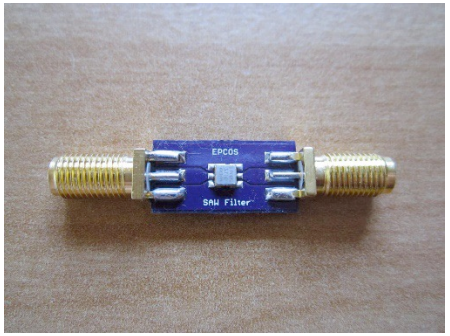




OSU-14749: Marat Khafizov

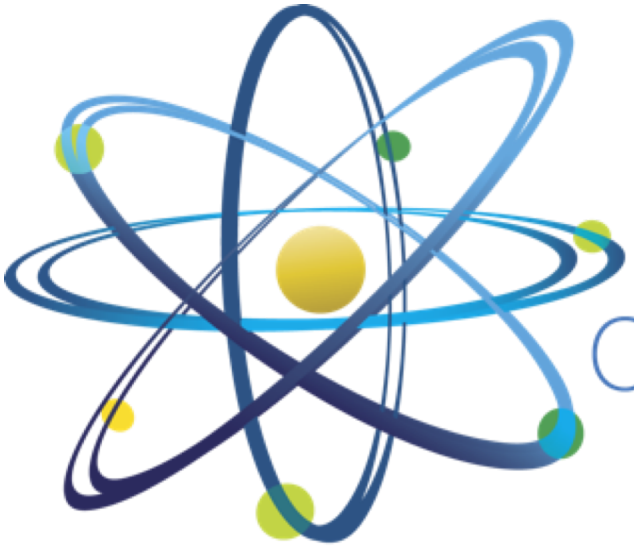
Irradiation Behavior of Piezoelectric Materials for Nuclear Reactor Sensors

- 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
    - 8.1×10^{17}nvt fast fluence
    - surface acoustic wave radiofrequency filter
    - RT, 350ºC & 650ºC
  - 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.



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