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Nuclear Science User Facilities (NSUF) Gateway to Nuclear Research

NSUF Nuclear Science User Facilities

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NSUF Nuclear Science User Facilities

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Topics

- NSUF General Overview
- NSUF Partnerships
- NSUF Capabilities
- NSUF Recent Development
  - Applying to NSUF (Integration into CINR)
  - Nuclear Energy Infrastructure Database (NEID)
  - NSUF Sample Library

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NSUF Purpose

NSUF Nuclear Science User Facilities

- 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.

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NSUF Overview

NSUF Nuclear Science User Facilities

- 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
- Open competitive proposal process
  - Non proprietary projects only
- Non competitive projects
  - CRADA or WFO
  - Proprietary or non-proprietary
- University, National Laboratory, Industry, Small Business, International

- 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

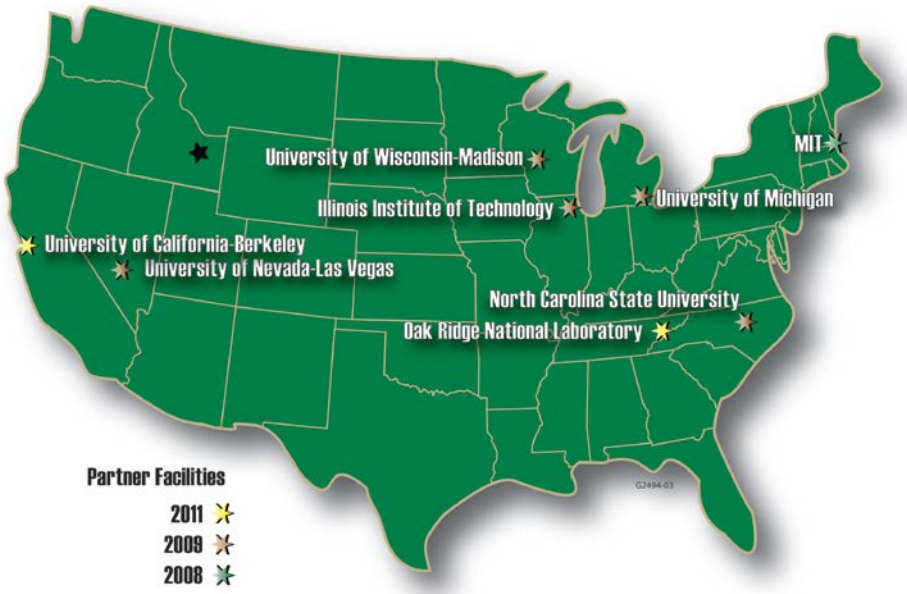
NSUF Nuclear Science User Facilities

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**

6

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*
- *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*

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NSUF General Capabilities

NSUF Nuclear Science User Facilities

- Neutron Irradiations
  - ATR (loop, rabbit), ATRC, HFIR (rabbit), MITR (loop), PULSTAR
- Ion Irradiations
  - Tandem Accelerator Ion Beam (U. Wisc), Michigan Ion Beam Lab (U. Mich)
- 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, 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)
  - Neutron, positron (PULSTAR, NCSU)
- Visit nsuf.inl.gov under Research Capabilities tab for details at individual facilities

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NSUF Recent Developments

NSUF Nuclear Science User Facilities

- Move to only forward funded projects from mortgaged funding profile
  - Mortgaged funding profile created some “confusion” in past (e.g. project is awarded but not yet funded) due to volatility in annual NSUF budgets
  - All back mortgages covered by end of FY15
  - Created some budgetary challenges
  - Requires firm scope of work, cost estimate, and schedule before project awarded
  - Better ensure project performance and facility access/priority
  - Require management reserve account
  - Large “carry-over” budget
- Infrastructure: catalogue, analyze, “manage” NE infrastructure
  - NSUF to help DOE increase efficiency of existing capabilities utilization and guide future investments
  - Nuclear Energy Infrastructure Database (NEID) established
  - NEID will be available to users
- Enhancement of Sample Library
  - Sample “librarian”
  - Set policy
  - Increase sample catalogue and user friendly database

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NSUF Recent Developments

NSUF Nuclear Science User Facilities

- Integration of NSUF into FY14 and FY15 Consolidated Innovative Nuclear Research (CINR – NEUP/NEET) Funding Opportunity Announcements (FOA)
  - Applications open to university, national laboratory, industry, small business researchers
  - NEUP/NEET provides R&D funding
  - Letter of Intent (LOI) and Pre-application stage of proposal process implemented (not for RTE calls)
  - Single evaluation of entire scope of proposal and will include
    - Technical review
    - Relevancy review (according to workscope applied to)
    - Feasibility review
      - Ensure project scope can be performed at cost on schedule
      - May require negotiation between proposer(s) and facilities
      - Will require communication and interaction with NSUF Tech Leads and experimenters at earliest time (starting with LOI)
    - Firm cost estimate in full proposal (forward funded)
  - 41 LOIs, 31 Pre-apps, 17 full apps in FY14 (80 LOIs in FY15
  - 13 R&D + NSUF (7 workscopes), 4 NSUF-only, awarded 3 NSUF-only and 1 R&D + NSUF in FY14 call

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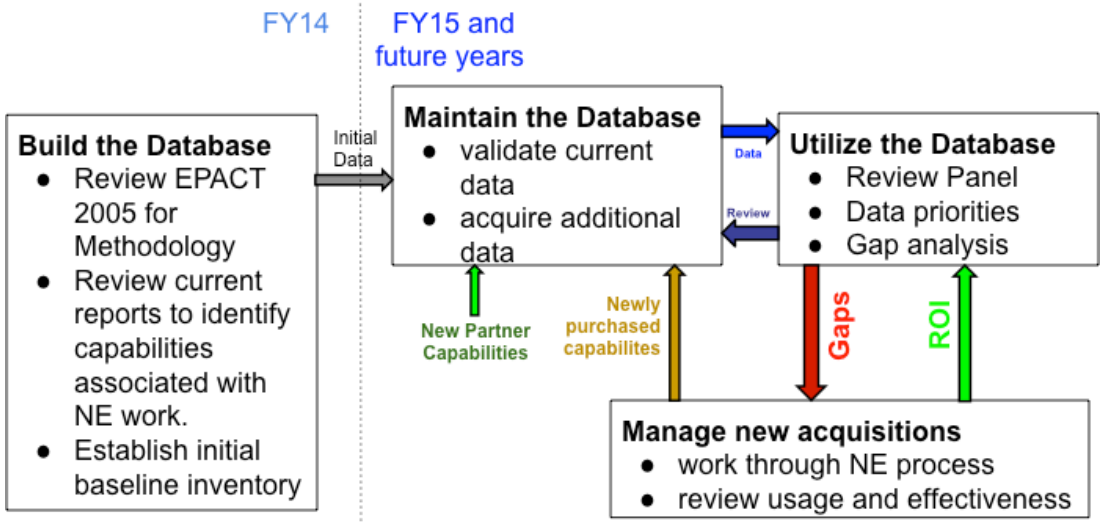
NSUF Management of NE R&D Infrastructure

NSUF Nuclear Science User Facilities

- New directive: catalogue, analyze, "manage" NE infrastructure
- A formal program for managing infrastructure acquisitions with the NEUP/NEET infrastructure calls.
  - Establish the Nuclear Energy Infrastructure Database (NEID)
  - NSUF will lead/manage this program and establish needs/priorities in call.
  - NSUF will continue to monitor acquisitions for effectiveness
- NSUF will use database analysis to establish needs
- NSUF – NEID will be available to users



- NSUF will take input from NE programs, Users Org, SRB, NEAC, ANIAC, RFI for needs
- NSUF will collect and analyze international capabilities and perform feasibility/cost analysis of material transport vs national implementation.

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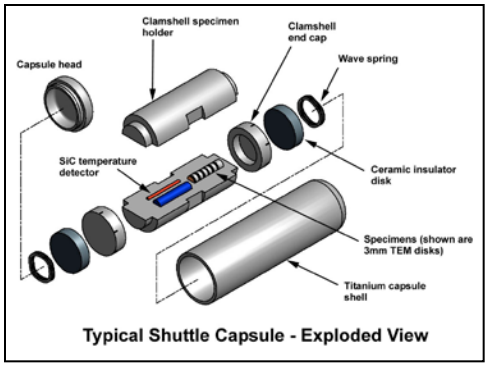
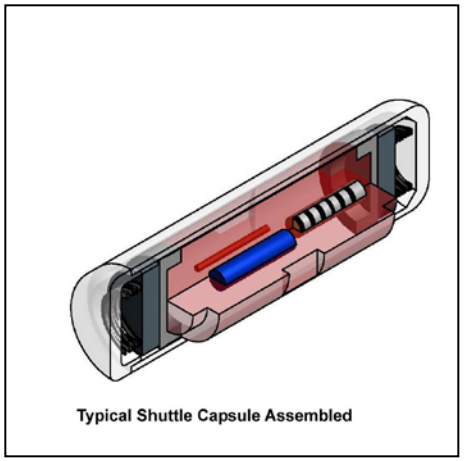
NSUF Sample Library

NSUF Nuclear Science User Facilities

- 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 that will be used to populate a searchable database that can be put on-line for users to locate samples of interest (online searchable database is in progress).
- Hired “librarian”.
- Working to establish pedigree of materials throughout DOE complex for potential incorporation in sample library. Data would be available on website.
- A subset of samples have been removed from the hot-cells and made available to the user community through the NSUF proposal process. Action of relocating larger quantities of samples for easy access will continue.



Typical Shuttle Capsule - Exploded View


Typical Shuttle Capsule Assembled

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NSUF Sample Library

NSUF Nuclear Science User Facilities

- The sample library policy has been refined, incorporating comments and suggestions from the user community and DOE.
  - Specimens moved into library after maximum 3 years actual PIE activities.
  - DOE owns library contents (NSUF manages) but not necessarily intellectual investment
    - If new project proposal not from original PI, NSUF will put proposer in contact with original PI for potential collaboration (original PI can not veto proposal if no interest in collaboration)
    - If program invests in populating library, special consideration must be given to program needs and intentions
  - NSUF reserves right to duplicate specimens in irradiation test for sole purpose of library
- Several entities have contacted the NSUF about contributing samples to the library. In the process of considering these requests and evaluating the mechanism for ownership transfer and storage location (at INL or at the originating facility).
- Initiated international effort with UK National Nuclear User Facility (NNUF).

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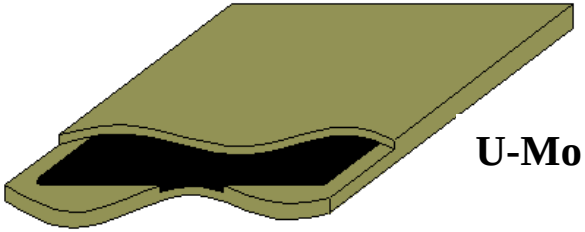
What are we studying?

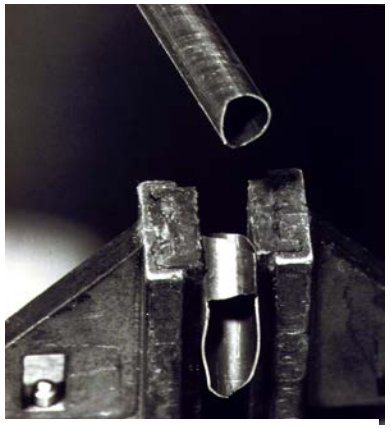
Irradiation Effects & Behavior of Nuclear Fuels and Materials

- 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.

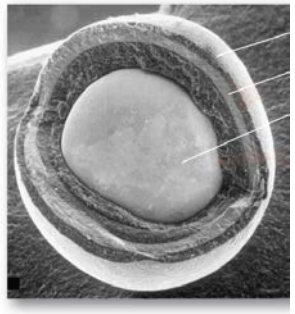


U-Mo Plate Fuel

Radiation Damage Effects in Cladding and Structural Materials

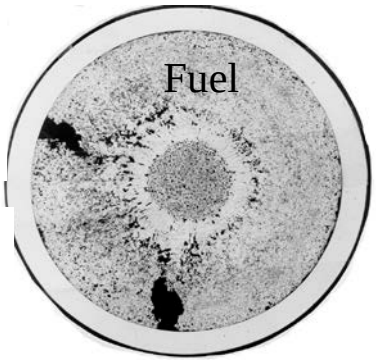


Austentitc Stainless Steel Following Iradiation in EBR II Fast Reactor



Gas Reactor Coated Particle Fuel

Fe-based Cladding



Restructuring in U-Pu-Zr Metallic Fuel

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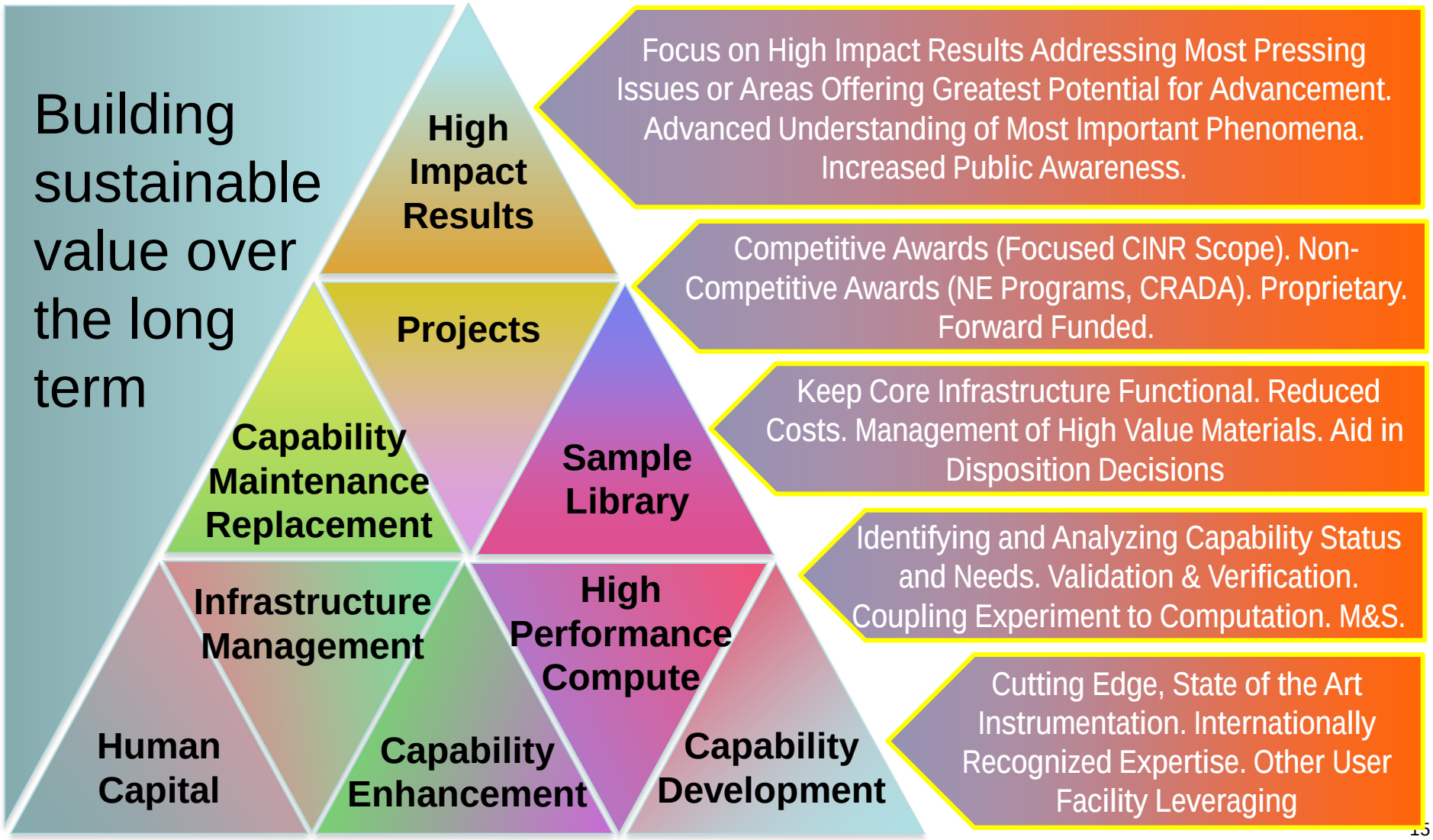
Expanded NSUF Vision

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