Nuclear Fuels and Materials Library (NFML) and Irradiated Materials Harvesting with the Nuclear Science User Facilities (NSUF)

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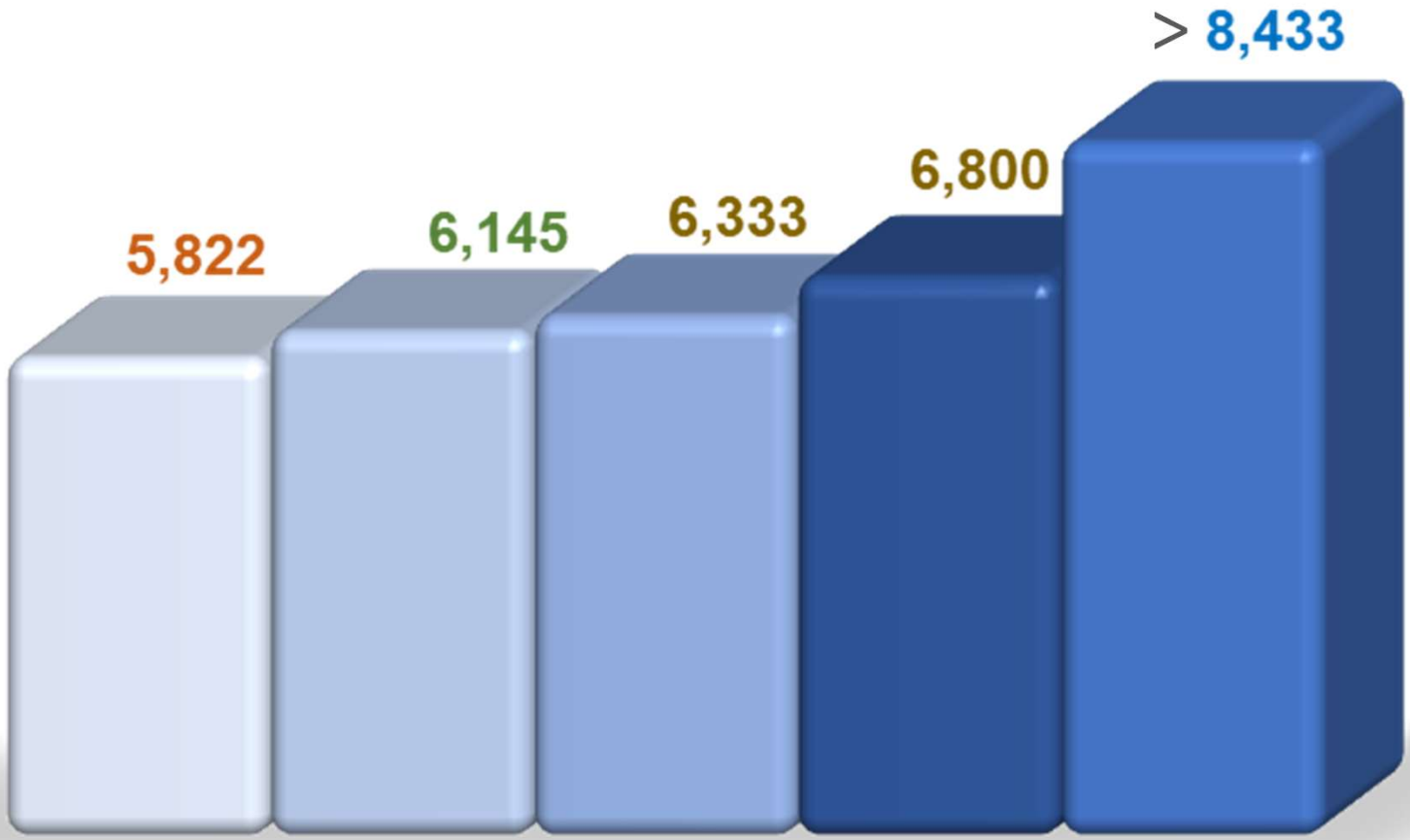
Overview of Nuclear Science User Facilities (NSUF) Program

- NSUF supports Department of Energy-Office of Nuclear Energy missions. Most of the research looks at either understanding the mechanisms of radiation on materials and fuels to address the challenges of the current fleet of reactors or looks at materials and fuels for the next generation.
- The Nuclear Fuels and Materials Library (NFML), owned by the DOE-NE and curated by the NSUF, offers the potential to harvest valuable reactor components during reactor decommissioning activities, without the requirements for a pre-determined test program to be in place.
- Through competitive proposal processes, researchers from universities, government laboratories and agencies, industry, and small businesses can obtain access to these harvested materials for use in DOE funded projects like CINRs and RTE's.
- NSUF provides state-of-art world class PIE facilities for testing and characterizing harvested materials.

The NUCLEAR FUELS AND MATERIALS LIBRARY
Inventory Growth



Reactor Position	B-2
Sample Id Code	09-157-011
Capsule	A1
Packet	N/A
Material Code	Hafnium aluminide/aluminu
Material Name	Hafnium Aluminide
Material Description	28.4% AL3Hf composite
KGT Num	1404
Specimen Type	tensile
Dimensions (mm)	76 mm x 4 mm x 1
Number Of Samples	5
Available for Research	Yes
Anticipated Availability	February 11, 2015

The NFML is the largest global open archive of high-value irradiated fuels and material from test, commercial, and decommissioned power reactors, and valuable donations from other sources. The library includes associated information such as compositions, irradiation conditions and publications.

NSUF Harvesting Activities Overview

- Currently there are 24 commercial power reactors undergoing decommissioning.
- Harvesting real world, irradiated components for research is important toward understanding the irradiation behavior of core structural materials, especially for LWR sustainability and lifetime extension.
- The harvesting process is time consuming and costly and must be “inserted” into the Dismantlement and Decommissioning (D&D) critical path .

https://www.nrc.gov/info-finder/decommissioning/power-reactor/index.html

- The NSUF participates in the Harvesting workgroup that includes individuals from DOE, NRC, EPRI, national and commercial power plants, and decommissioning organizations to develop a strategic approach to harvesting aged materials from U.S. NPPs and to identify areas of common interest.
- Recent and on-going major harvesting initiatives

Donated Samples from a Commercial LWR

- 304 SS core shroud samples from a commercial nuclear power plant
  - Harvested and donated by EPRI, owned by Southern Nuclear, and in the possession of BWXT
  - The title for the samples was transferred to DOE-NE to be added to the NFML and curated by the NSUF
  - Obstacles in the title transfer process made the endeavor long and arduous
  - A total of 133 samples have been added to NFML and are in the process of being transferred to NSUF facilities
    - 304 SS base metals
    - Welds and Heat Affected Zones
    - Cracked samples

Other Harvesting Efforts

Halden Reactor Project (Norway)

- NSUF is currently working with Halden staff to bring samples to the US to be added to the NFML.

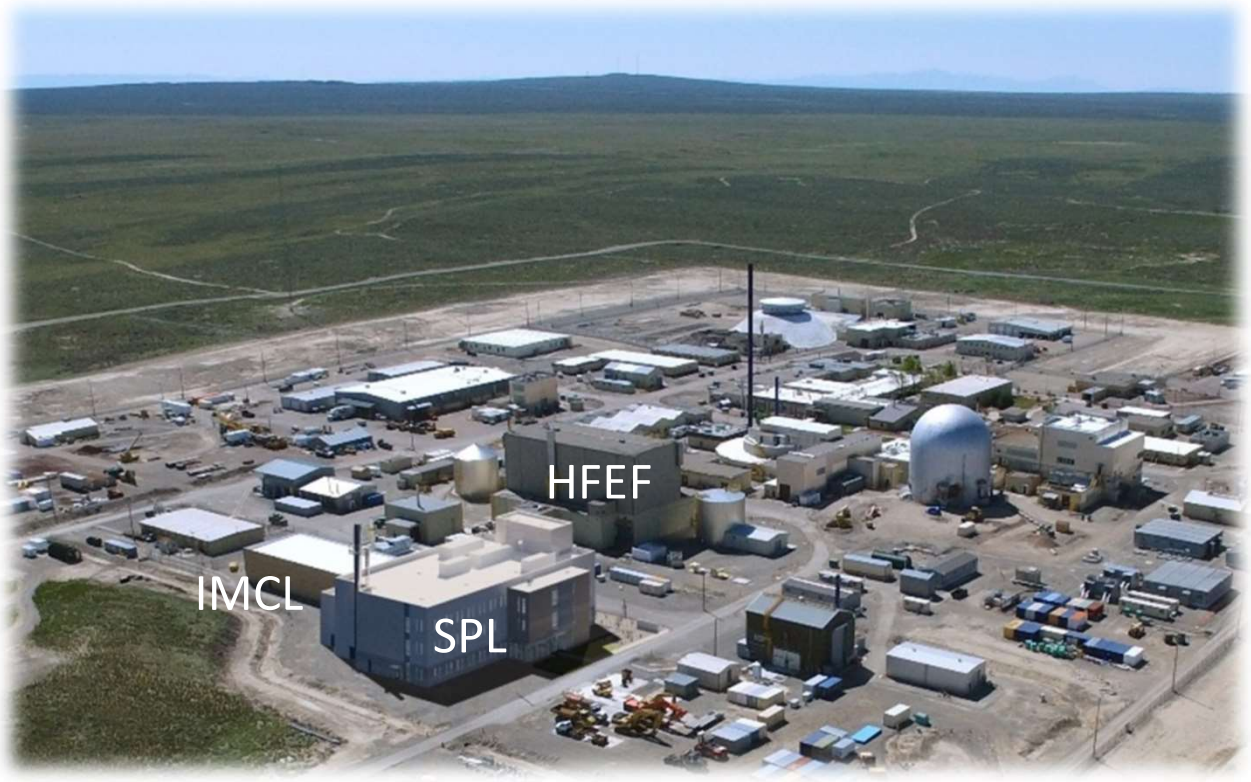
Crystal River (Florida)

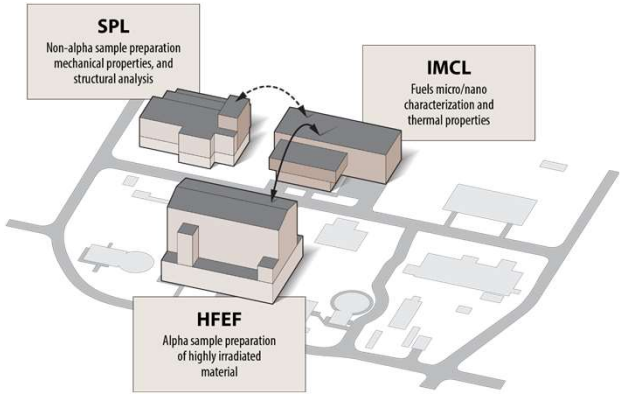
- NSUF completed phase I of harvesting project planning and cost estimate, but didn't move forward with actual harvesting activity due to funding constraint.

Zion Nuclear Power Station (Illinois) – Decommissioned 1998

- LWRS Program currently testing harvested material
- Process of transferring the Zion materials to the NSUF when testing is complete ~ FY 2022 year-end

Post Irradiation Examination Facilities at INL



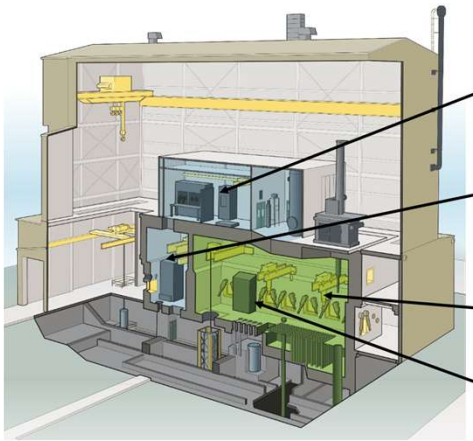


HFEF: Hot Fuel Examination Facility (Fuel Engineering PIE)

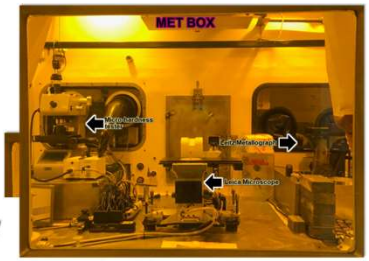
IMCL: Irradiated Materials Characterization Laboratory (Advanced Characterization)

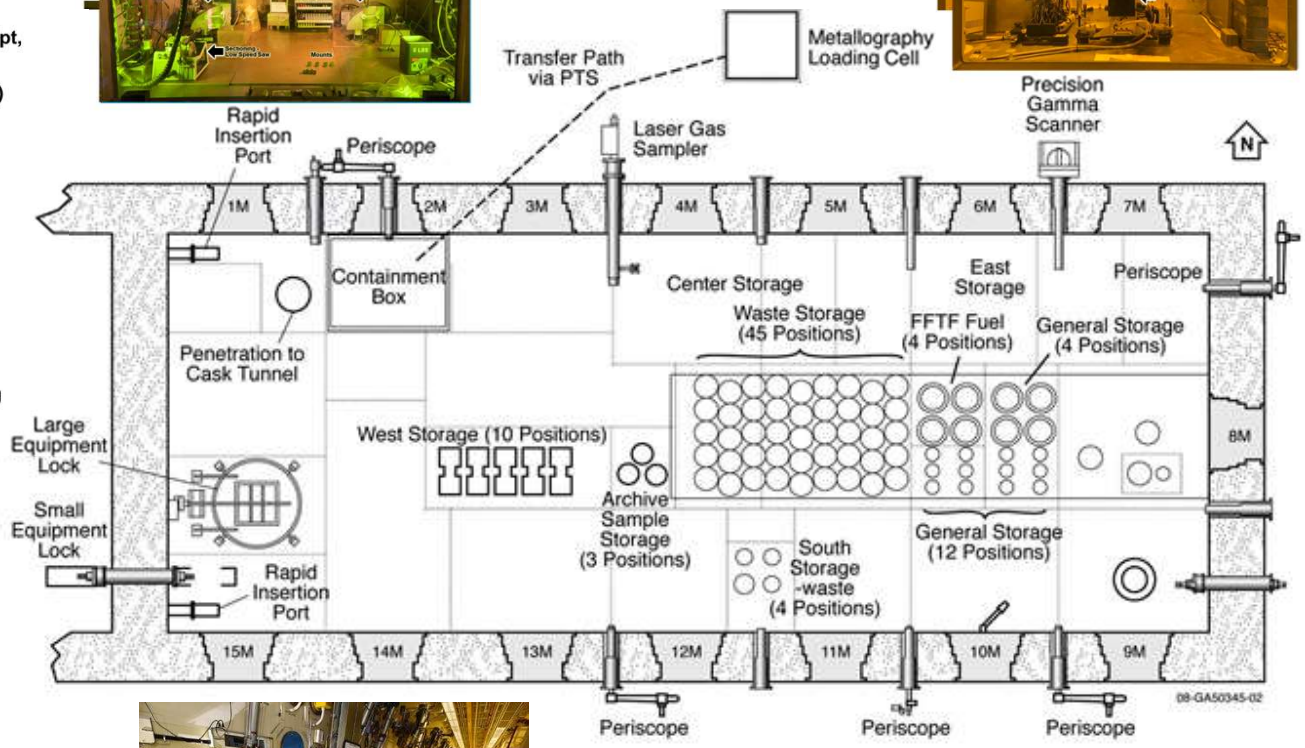
SPL: Sample Preparation Laboratory (Structural Materials PIE)

Hot Fuel Examination Facility (HFEF)



40’x30’ Ar cell, largest in the world





Irradiated Materials Characterization Laboratory (IMCL)

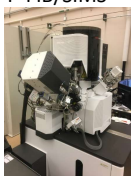
- 15000 ft^2 facility with 15 high end instruments for highly irradiated nuclear fuel and materials testing and characterization

Shielded Sample Preparation Area, SSPA

JEOL-7600 SEM

Shielded EPMA

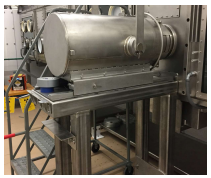
P-FIB/SIMS

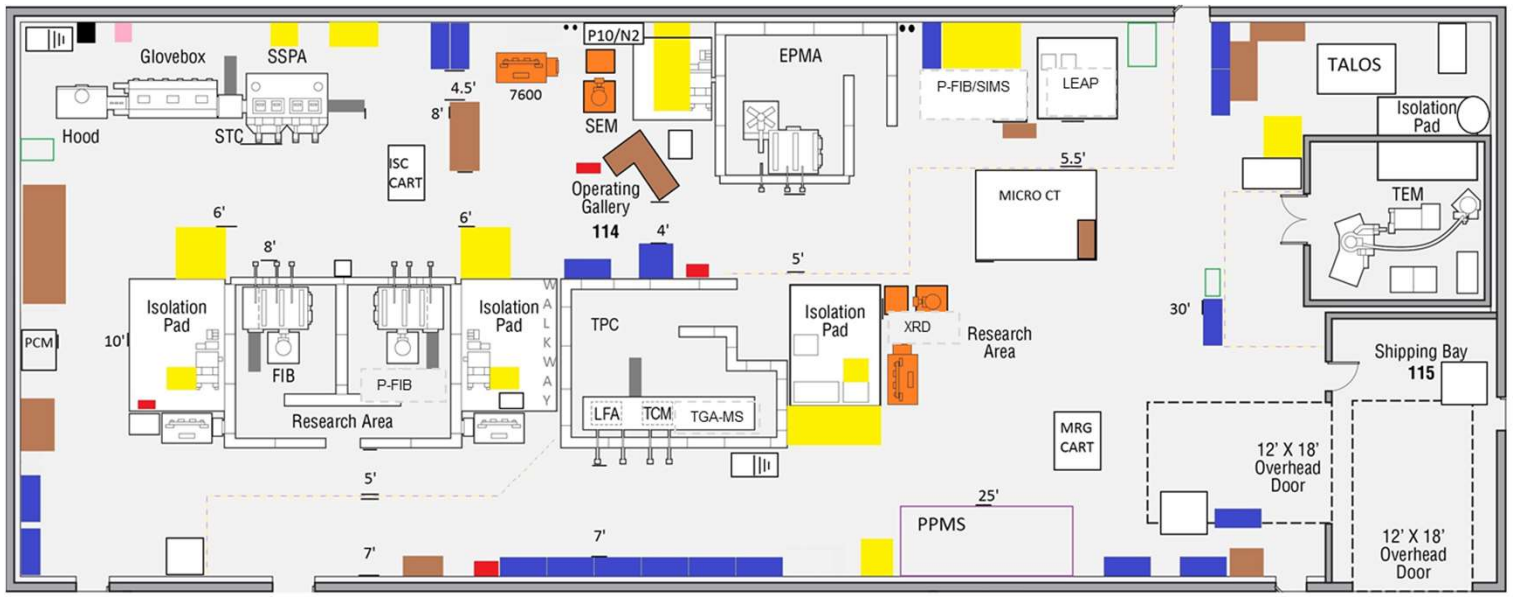


LEAP-5000

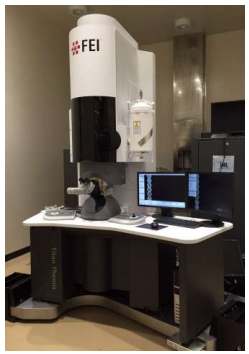
Xradia 520 Versa

Sample transfer casket



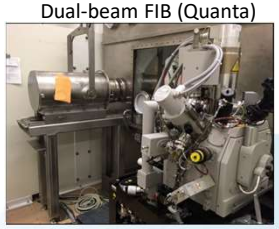


Titan TEM (Thmis-200) With Probe corrector

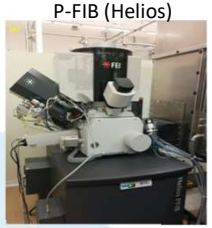


For shielded confinement:
8.5” thick steel wall shielding: 2 Curie Co-60

Dual-beam FIB (Quanta)

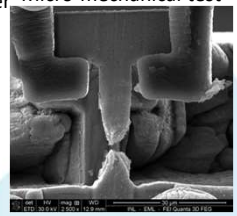


P-FIB (Helios)



PI-88 Pico-Indenter

Micro-mechanical test



LFA

PPMS

Panalytical XRD

Thermal Conductivity Microscope

Sample Preparation Laboratory (SPL)

- Once constructed, the Sample Preparation Laboratory (SPL) will be the most modern reactor structural materials testing and analysis facility in the world.
  - Hazard Category 3 non-reactor nuclear facility
  - 3 story, 49,000 sq. ft facility
- A non-alpha facility dedicated to the investigation of reactor structural materials in support of the deployment of new nuclear innovations, life extension and long-term operation of both the existing fleet and new reactor concepts.
- The SPL will have improved sample preparation processes to enable greater industry and university collaboration, providing access to state-of-the art mechanical testing and failure analysis characterization tools

Renderings of the Sample Preparation Laboratory

Summary

- NSUF manages the nuclear fuel and materials library (NFML), and is engaging with all stakeholders and actively pursuing harvesting activities to bring valuable irradiated materials from decommissioned commerical reactors to NFML, and makes them available for non-proprietary research to serve the general public

- Idaho National Laboratory operates state-of-art post irradiation examination (PIE) facilities and provide access to the nuclear community and general public to meet research and development needs for nuclear fuel and materials