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Role of Nuclear Science User Facilities (NSUF) in Nuclear Energy Materials Research

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Brenden J Heidrich, Rongjie Song

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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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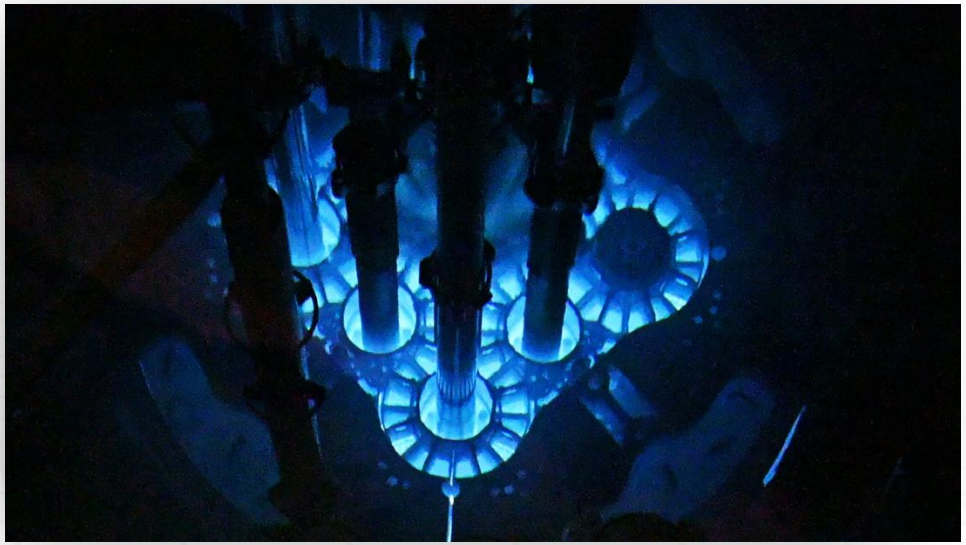
Brenden Heidrich
Director

Role of Nuclear Science User Facilities (NSUF) in Nuclear Energy Materials Research

Nuclear Science User Facilities

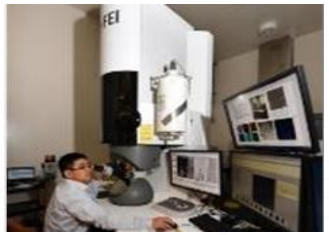
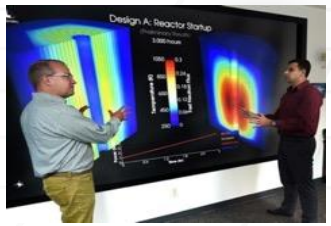
The Nuclear Science User Facilities (NSUF)

- Established in 2007 as U.S. Department of Energy Office of Nuclear Energy's first and only user facility
- Founded at Idaho National Laboratory
  - INL remains lead and primary institution
- NSUF operates similarly to other U.S. user facilities
  - No cost to user, competitive proposal processes, no travel funding to users, etc.
  - Has some unique aspects…



Unique aspects of NSUF

- **Consortium of facilities/capabilities**
  - 21 institutions across the U.S.
- **Offers multiple capabilities to a single scientific area**
  - Irradiation effects in nuclear fuels and materials
- **No base funding to facilities**
  - Funding to facility is for project cost and is fully forward-funded
- **Projects can last many years or be short in duration**
  - Largest projects include design, fabrication, transport, irradiation, PIE and final disposition

Neutron Reactors		12 reactor facilities at national laboratories and universities including the Advanced Test Reactor at INL
Gamma & Ion Irradiation		7 gamma irradiation facilities and 7 ion beam facilities at national laboratories and universities
Post-Irradiation Examination		Multiple hot cell and broad post-irradiation examination facilities including advanced characterization methods
Beamlines		Synchrotron and neutron beamlines for nuclear fuel and materials studies
Computational Resources		Scientific high-performance computing capabilities for advanced modeling and simulation at INL

NSUF offers the best capabilities across the nation

Cutting-Edge Resources: Access to infrastructure and associated capabilities across 21 partner sites

Open access: Available to **industry, academia and national labs** for non-proprietary R&D

Education and training: Workshops and hands-on skill development

Impact: Increase understanding to drive innovation across nuclear energy technologies

Simulated reactor environments | Neutron irradiation





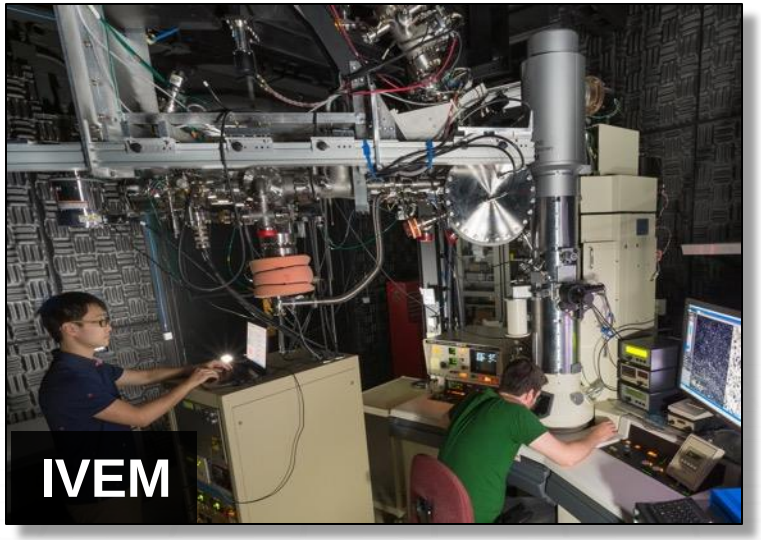


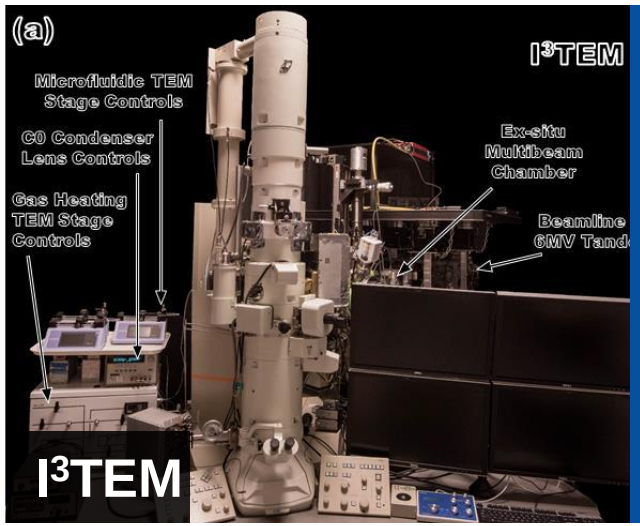


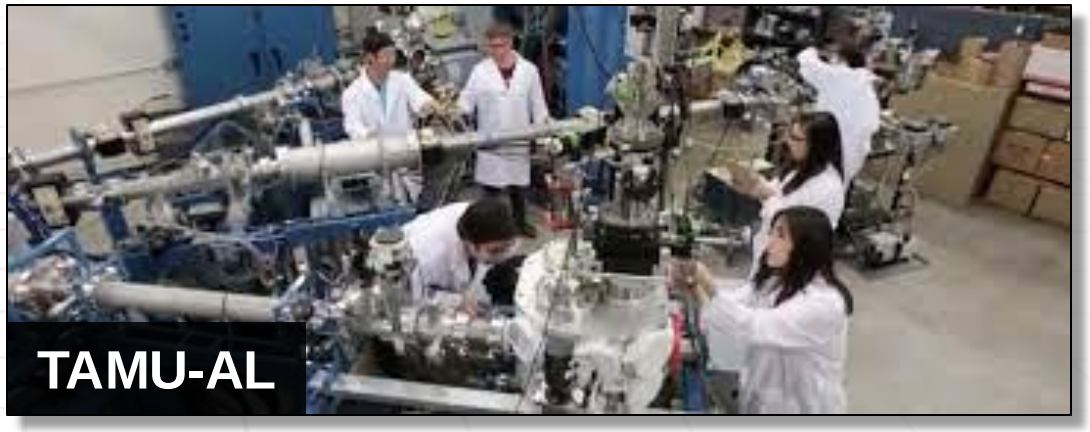




Simulated reactor environments | Ion irradiation



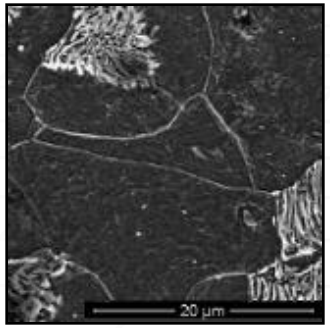


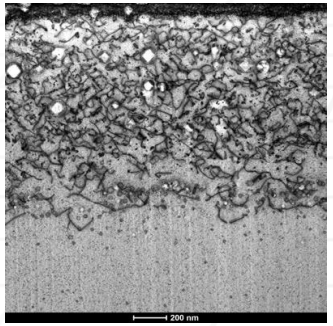


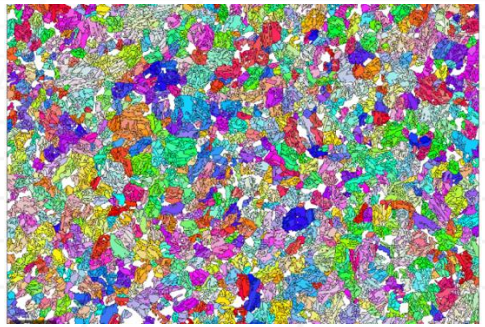
Advanced microstructure characterization capabilities

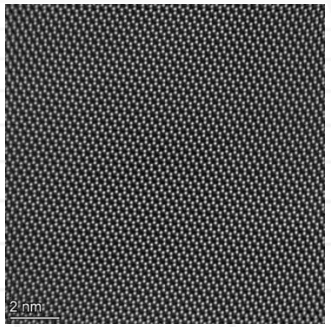
- Optical metallography
- Scanning electron microscopy (SEM)
  - BSE/EBSD/FIB
- Transmission electron microscopy (TEM)

Spectra 300 STEM
STEM resolution 50 pm (125 pm at 30kV)



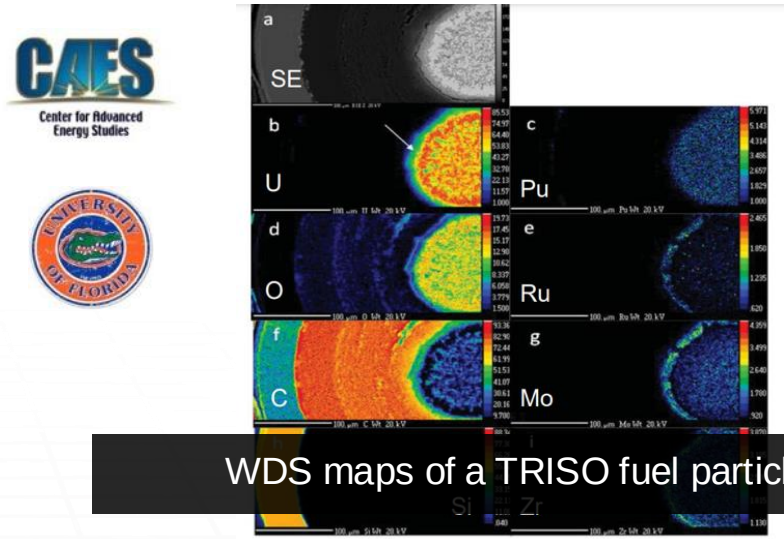






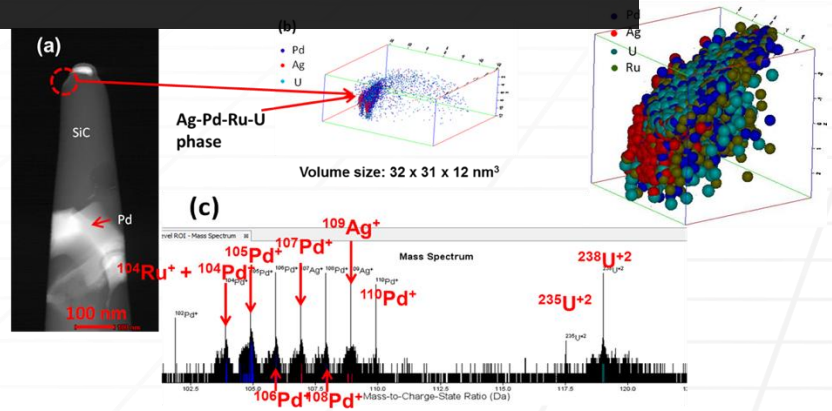
Advanced microstructure characterization capabilities

- Atom probe tomography (APT)
- Electron probe microanalysis (EPMA)
- Energy dispersive spectroscopy (EDS)
- Electron energy loss spectroscopy (EELS)

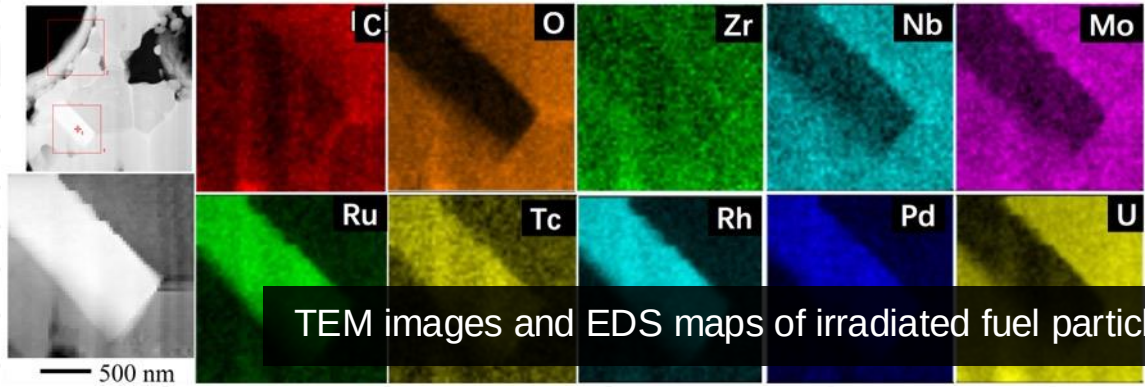


WDS maps of a TRISO fuel particle

Combination of TEM and APT



STEM HAADF image of an irradiated TRISO APT sample tip (a), corresponding reconstructed three-dimensional APT maps showing a Ag-Pd-Ru-U - rich phase in a volume size of 32 nm x 31 nm x 12 nm (b) and mass spectrum showing detected isotopes of Ag, Pd, Ru and U (c).

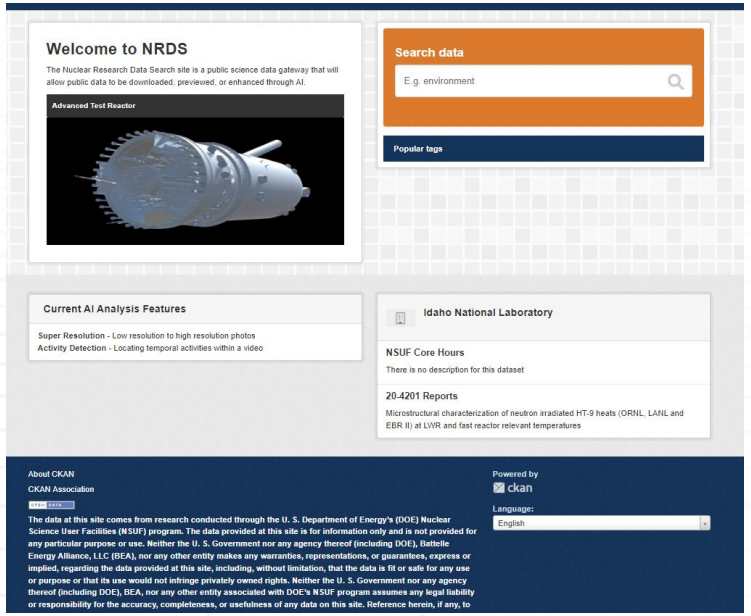


TEM images and EDS maps of irradiated fuel particle

Computation and modeling support | High Performance Computing (HPC) resources

NSUF HPC systems support a wide range of users and programs as a shared-use resource for national laboratories, universities, and industry

- **Bitterroot (2024)** + Windriver (just arrived deploying now, ~2.5x Bitterroot)
  - 374 nodes, 41,888 cores
  - Available to users July 2024
- **Hoodoo (2021)**
  - Machine Learning Cluster
  - 108 A100 GPUs
- **Sawtooth (2020)**
  - 6 Petaflops performance
  - 2,079 compute nodes, 99,972 compute cores
  - #37 on November 2019 TOP500 list
- **Lemhi (2018)**
  - 1 Petaflop performance
  - 504 compute nodes, 20,160 compute cores
  - #427 on November 2018 TOP500 list

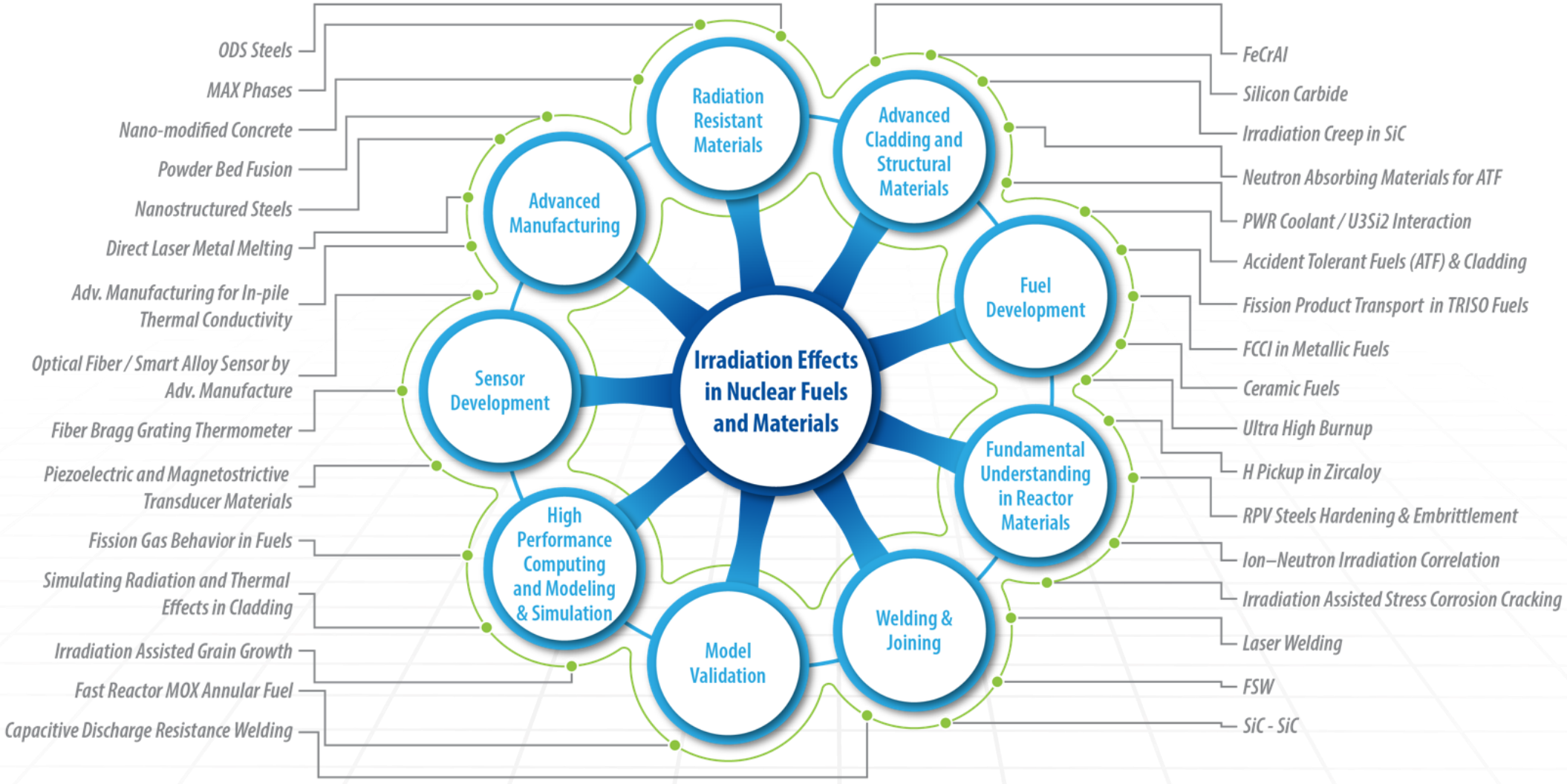


NSUF funding calls

- **Consolidated Innovative Nuclear Research (CINR FOA, 1 call/year)**
  - Projects include design, analyses, fabrication, transport, irradiation, disassembly, PIE, disposition
  - Possibility to also receive user R&D funding on limited number of work scopes
- **Rapid Turnaround Experiments (RTE, 3 calls/year +1 special call)**
  - Limited funding, executed within 9 months

- **NSUF Project Characteristics**
  - Projects are selected through open competitive proposal processes
  - Proposals welcome from university, government laboratory, industry, and small business researchers
  - Only non-proprietary projects accepted.
  - All awarded projects are fully forward funded

NSUF research covers all readiness levels




NSUF
Nuclear Science
User Facilities
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