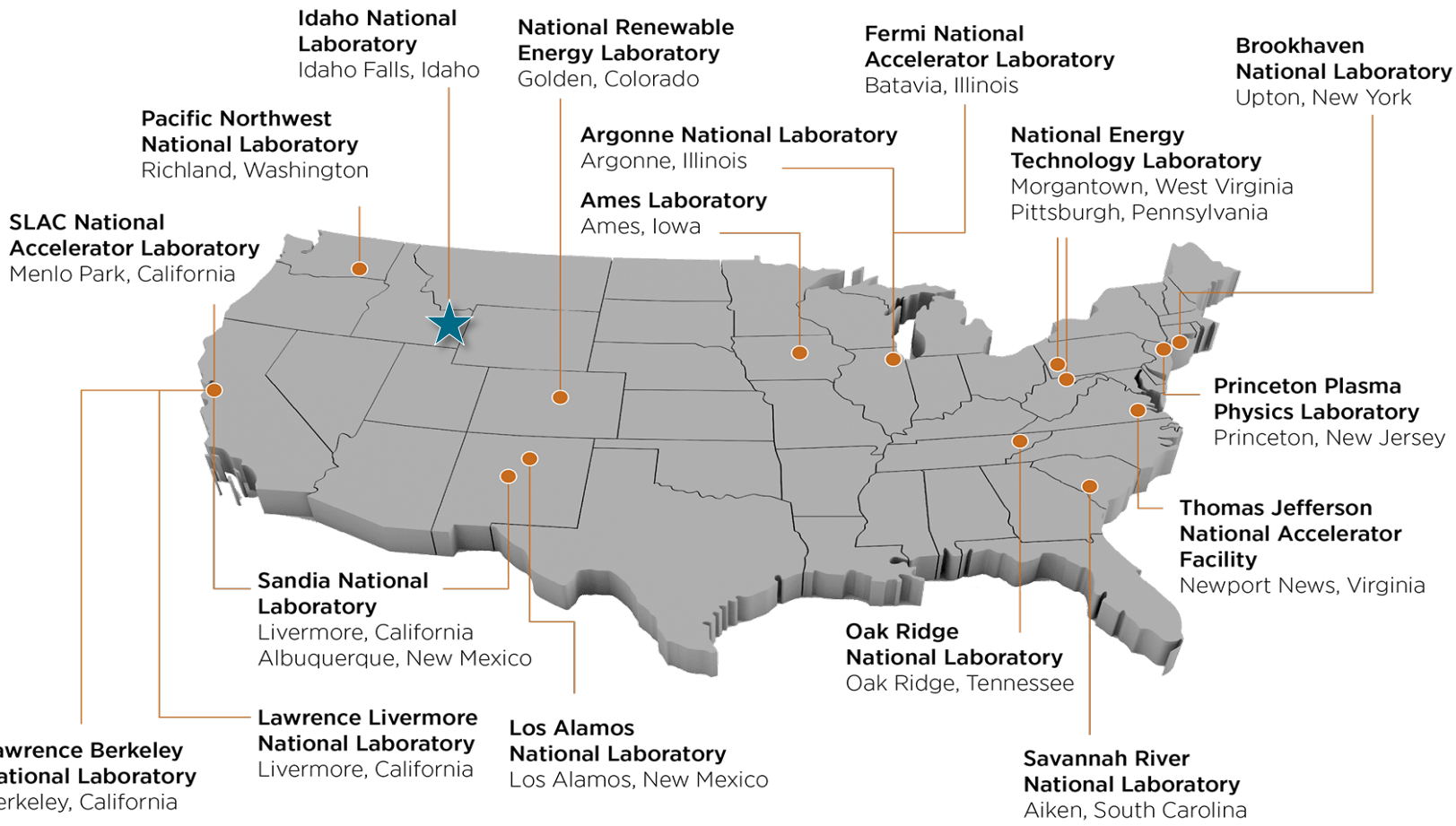
INL support to advancing nuclear technology

www.inl.gov

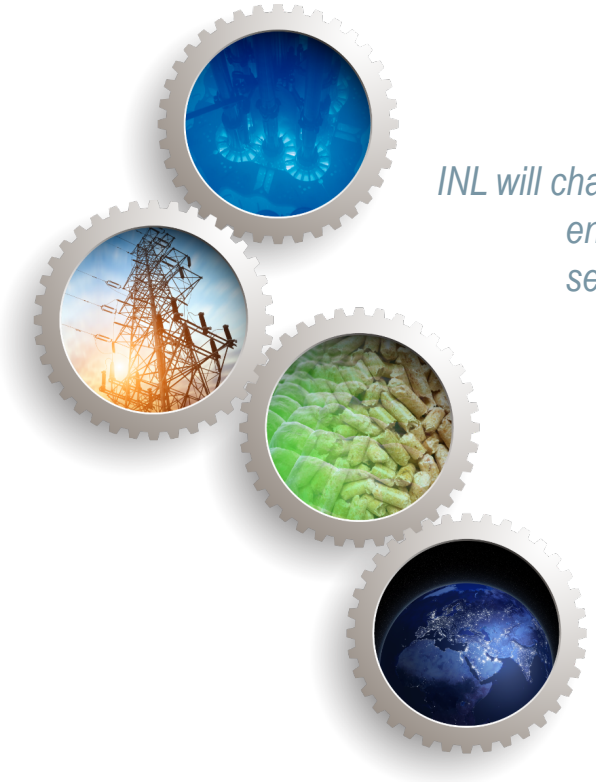
Idaho National Laboratory

Fidelma Giulia Di Lemma, Ph.D.
Instrument Scientist
MFC, U510 Advanced Characterization and Post Irradiation Examination
P.O. Box 1625, MS 6000
Idaho Falls, ID 83415
208-533-8005
FidelmaGiulia.DiLemma@inl.gov

National Laboratories



Our Vision, Mission, and Values Position us as a Vital Resource to Meet the Nation's Energy and Security Future



INL Vision

INL will change the world's energy future and secure our critical infrastructure.

INL Mission

Discover, demonstrate and secure innovative nuclear energy solutions, clean energy options and critical infrastructure.

INL Values

Excellence, Integrity, Ownership, Teamwork, Safety

INL History

The Idaho National Laboratory – 70 Years of Groundbreaking Nuclear Energy R&D

International Intellectual Leadership

Building a Laboratory

1949 — *National Reactor Testing Station*

1974 — INEL (Idaho National Engineering Laboratory)

Energy Mission – Reactor Science, Safety and Sustainability Solutions

1997 — INEEL (Idaho National Engineering and Environmental Laboratory)

Environmental Management Mission

2005 — INL Idaho National Laboratory

INEEL & ANL-W combined to create the new Idaho National Laboratory

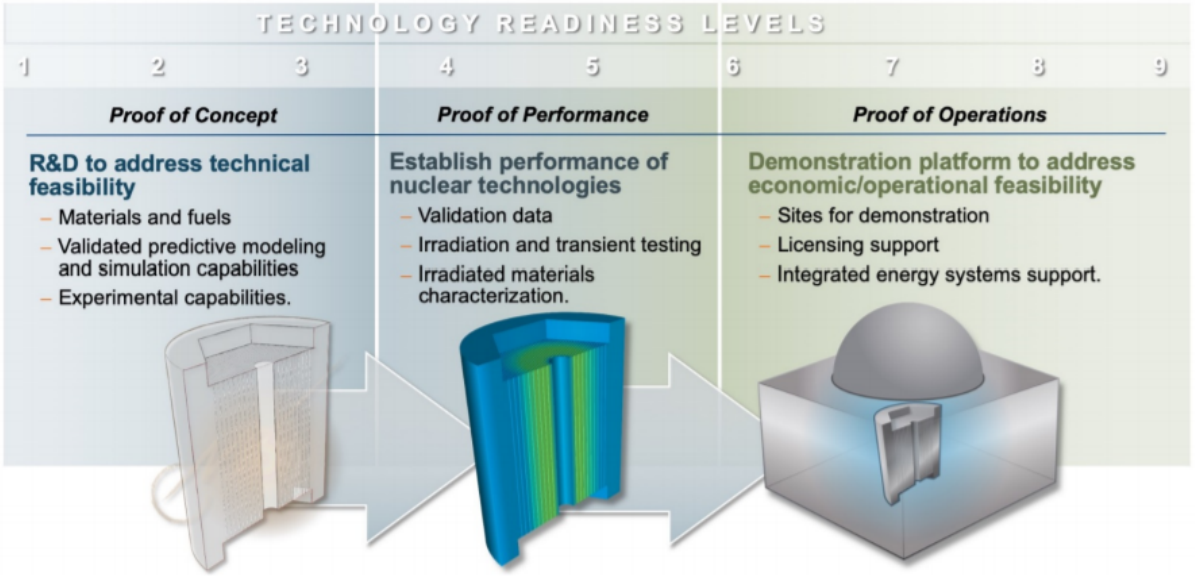
- Nuclear Energy
- National and Homeland Security
- Energy and Environment

Argonne NATIONAL LABORATORY

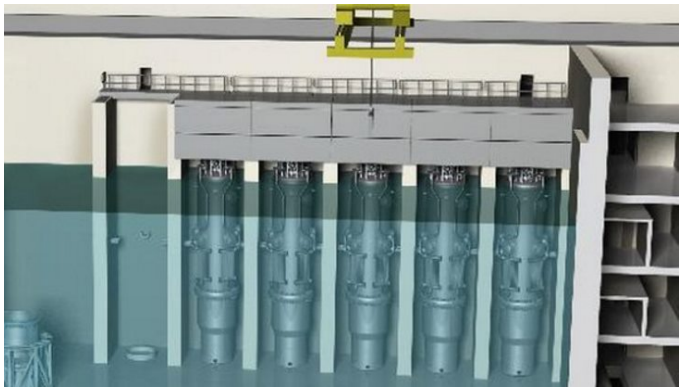
2020

- Advancing Nuclear Energy
- Securing & Modernizing Critical Infrastructure
- Enabling Clean Energy Systems

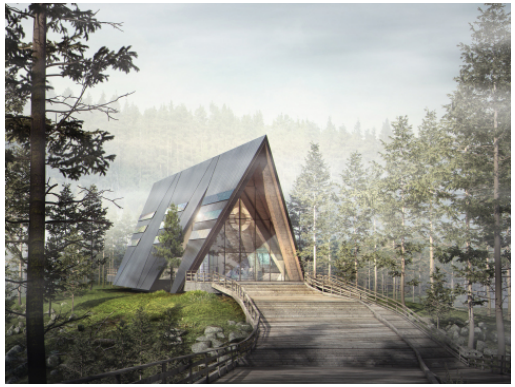
National Reactor Innovation Center



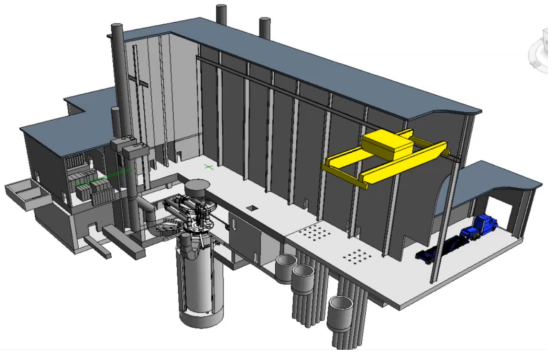
NRIC Provides Capabilities to Accelerate Technology Readiness from Proof of Concept through Proof of Operations.



https://www.nextbigfuture.com/2018/09/nuscale-will-start-manufacturing-its-small-modular-reactor.html



https://uncrate.com/oklo-aurora-energy-plant/



https://inl.gov/trending-topic/versatile-test-reactor/

Sustaining the current LWR fleet:

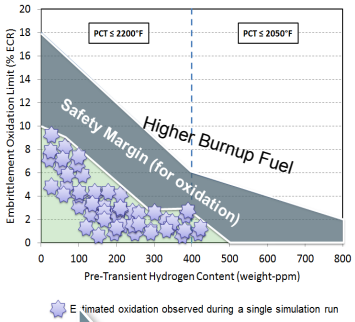
Vision for Protecting the Current Fleet at Idaho National Laboratory

Energy systems and market analyses

- Define attributes of zero-emission baseload energy for market recognition
- Establish vital relationships to other market and grid attributes – resilience, reliability, etc.

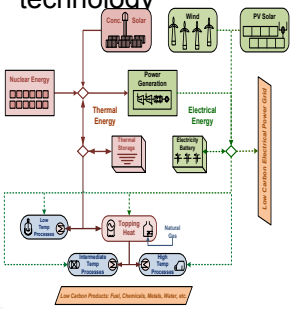
Risk-informed tools and analyses to recover plant margins and reduce cost

- Employ advanced PRA tools and best estimate codes to reduce unnecessary conservatisms that drive costs
- Key to NEI and industry initiatives



Integrated energy system testing

- Revenue and energy supply that addresses grid futures for US fleet
- CRADAs and industry engagement initiated to demonstrate technology

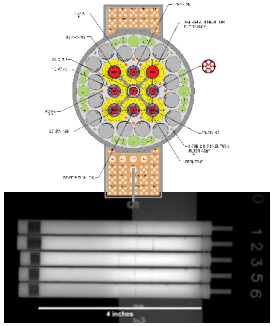


LWR modernization and life extension

- Work with plant operators to implement digital I&C upgrades to modernize plant control rooms
- Provide scientific basis of long-term material performance of SSCs to support license extension
- Develop sensors and more efficient methods and systems for plant health monitoring

Advanced Accident-Tolerant Fuel concepts

- Establish technical basis for licensing and deployment of accident-tolerant fuel concepts



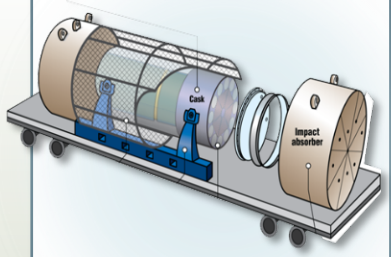
2019 → 2020 → 2021 → 2022

Creating the next-generation National Reactor Testing Station:

Advanced Reactor Pipeline Vision at Idaho National Laboratory

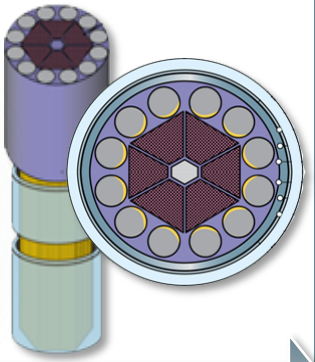
Demonstrate first <10MW micro-reactor by early 2020s

- Resolve key advanced reactor issues
- Open new markets for nuclear energy
- Provide a 'win' to build positive momentum



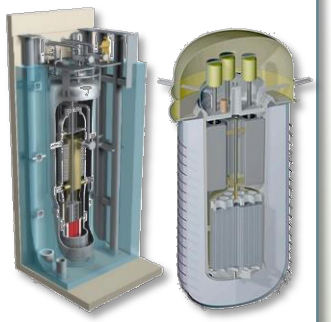
Commercial micro-reactors deployed

- Support deployment of micro-reactors for key remote site power and process heat customers



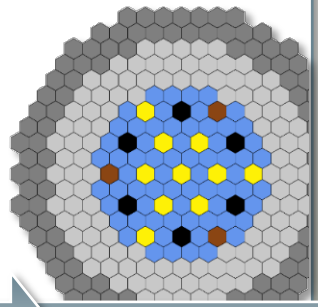
SMR operating by 2026

- Enable deployment through siting and technical support
- Joint Use Modular Plant leased for federal RDD&D



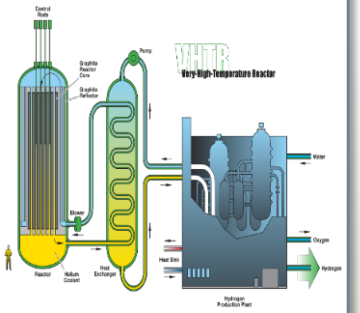
Versatile Test Reactor (VTR) operating by 2026

- Re-establish leadership in fast-spectrum testing and fuel development capability
- Supported by micro-reactor demonstration
- Support non-LWR advanced reactor demonstration



Non-LWR Advanced Demonstration Reactor by 2030

- Demonstrate non-LWR technology replacement of U.S. baseload clean power capacity



2021 → 2025 → 2026 → 2028 → 2030

My small part

1987 Born

2012-2015
Ph.D. in applied Sciences

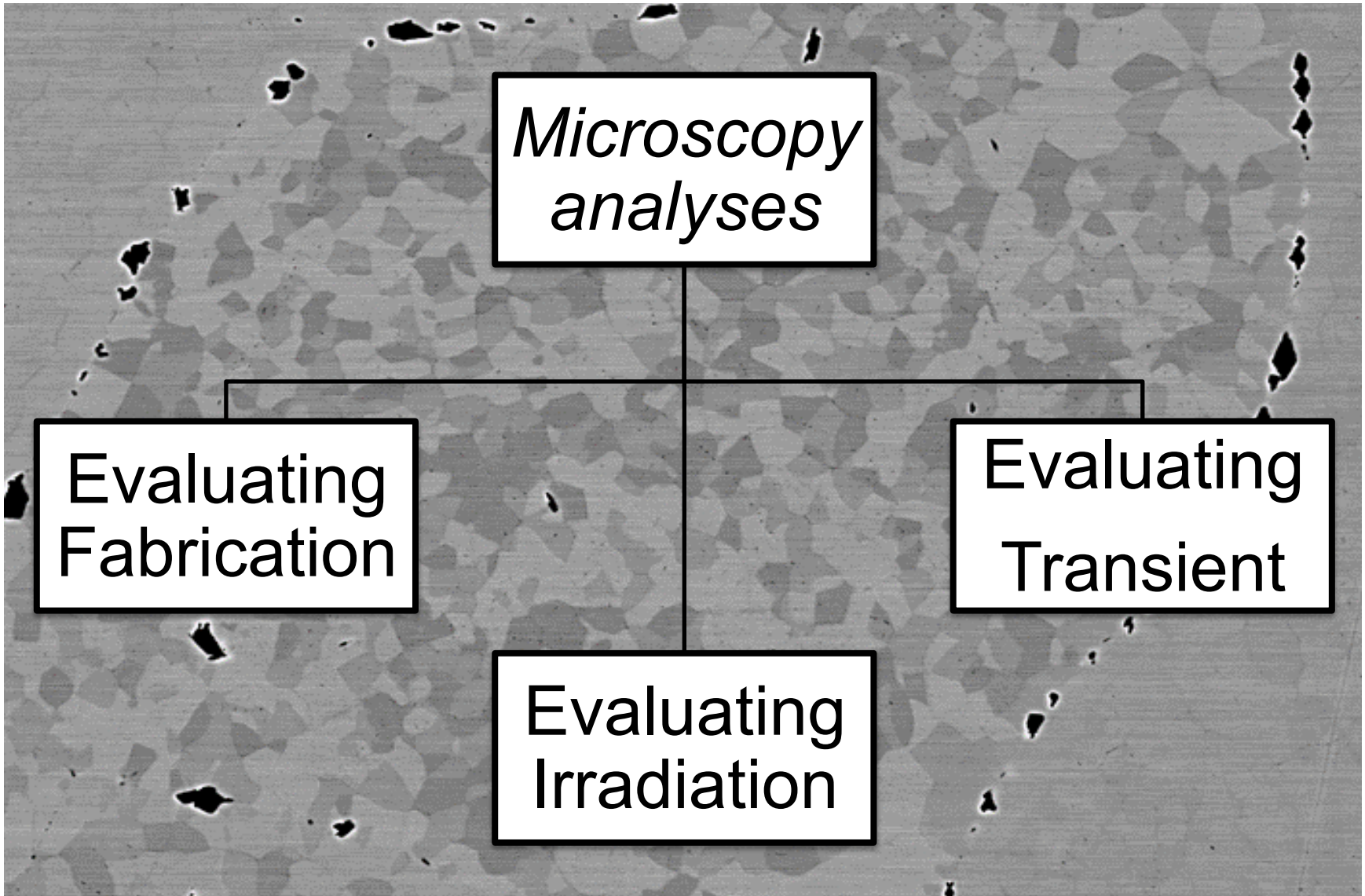
2011-2015
Intern and grant-holder on aerosol behavior from RDD and SA

4/2015-9/2016
Postdoc on FP and structural material behavior during SA

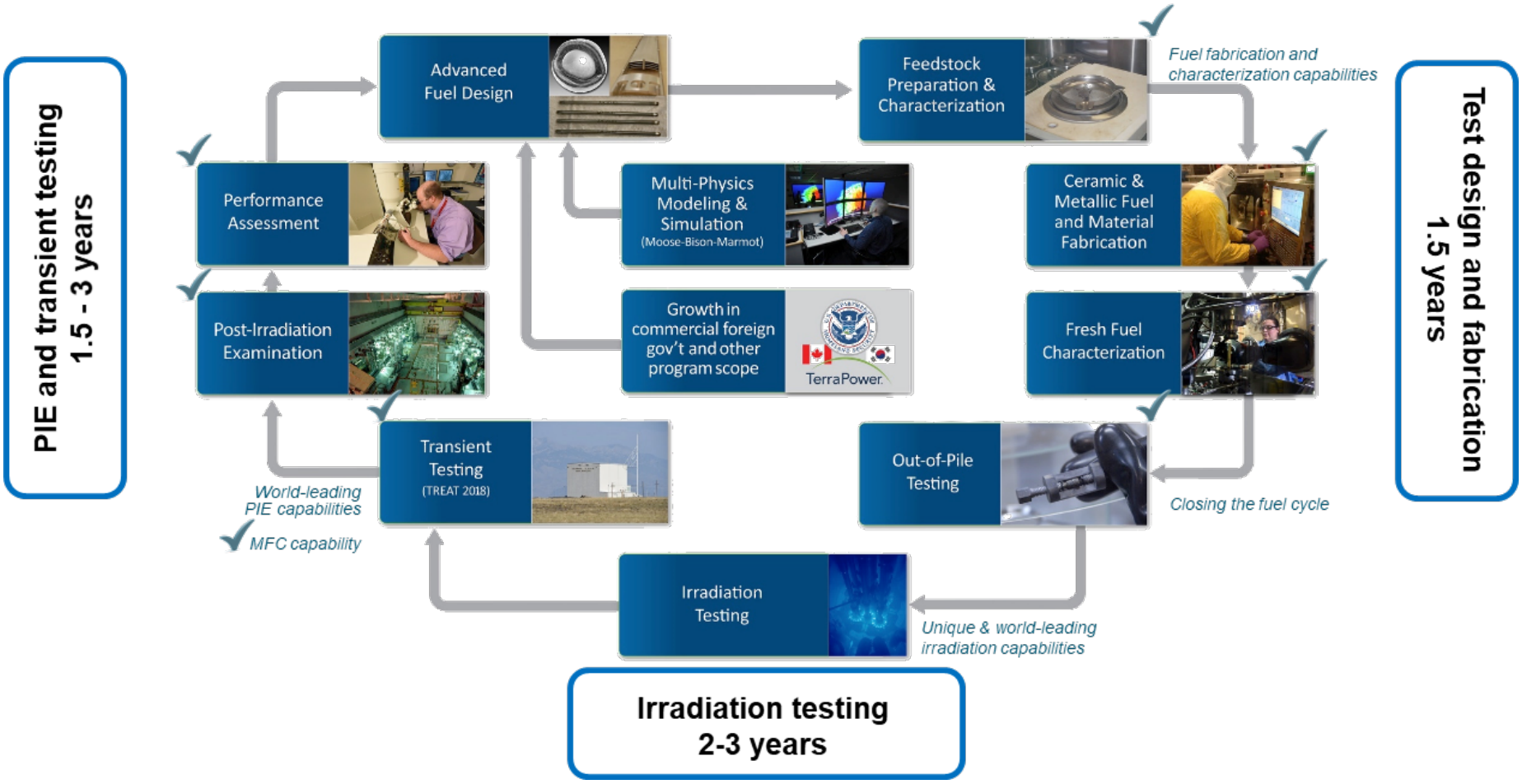
2006-2011
B.Sc.+M.Sc.
Nuclear Engineering

from 11/2016

My small part

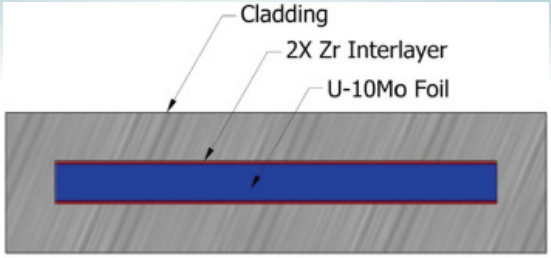


The Future of Post-Irradiation Examination



Understanding fuel fabrication

US-HPRR program aims to convert the HEU fuel of research reactor to High Density LEU (U-10Mo monolithic) in view of increasing proliferation resistance.

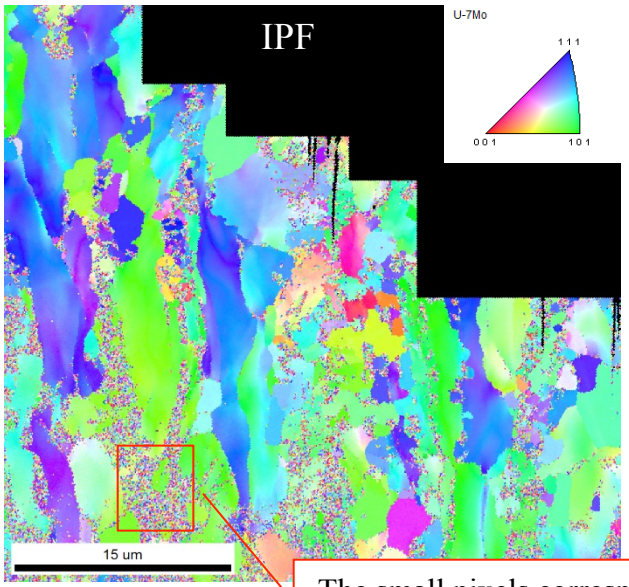


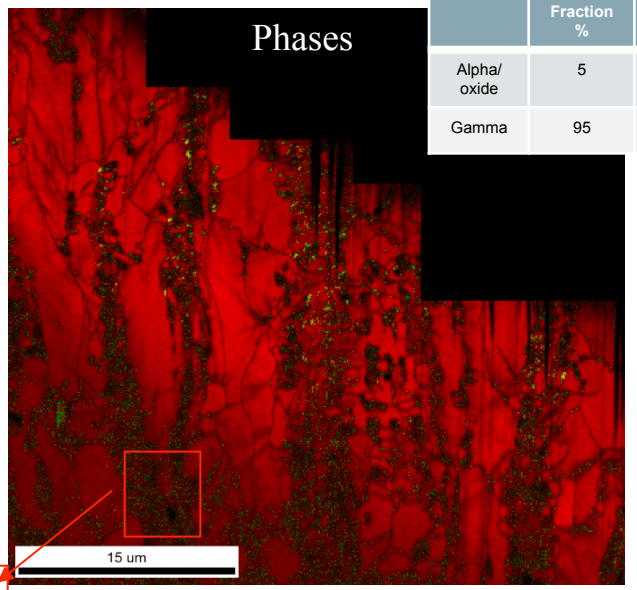
U-Mo Monolithic Base Fuel Design

M.K. Meyer, et al., Nuclear Eng. Techn., (2014)

Our work aims in "understanding of the impact of processing conditions on the final fuel microstructure (using fabrication processes that meet "commercial viability" requirements.)"

1) Identify γ-U phase decomposition



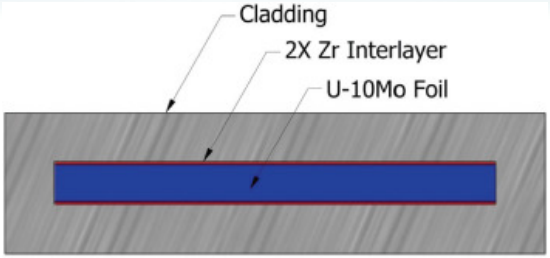


Phases	Area Fraction %	Color
Alpha/ oxide	5	
Gamma	95	

The small pixels correspond to α/oxide phase

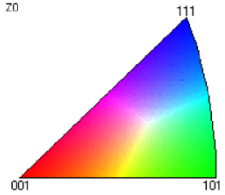
Understanding fuel fabrication

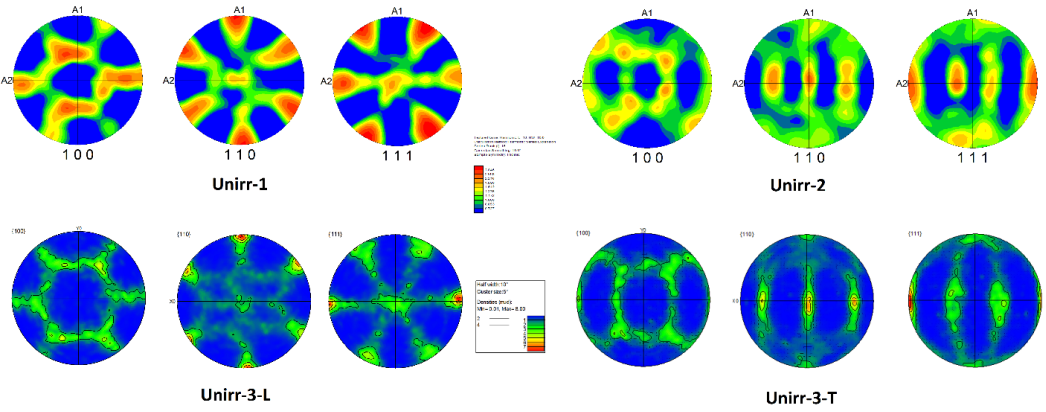
2) Understanding grain size and grain boundary characters.
3) Understanding texture.
4) Understanding interaction with cladding.
5) Understanding bonding in the cladding.



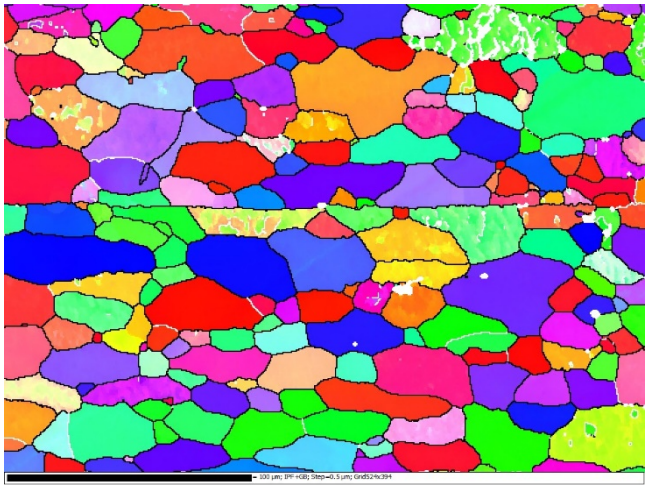
U-Mo Monolithic Base Fuel Design

M.K. Meyer, et al., Nuclear Eng. Techn., (2014)



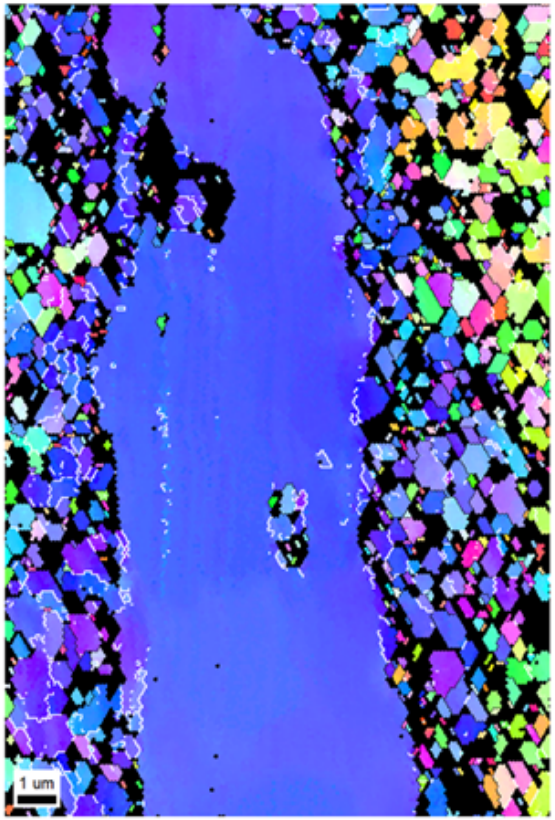


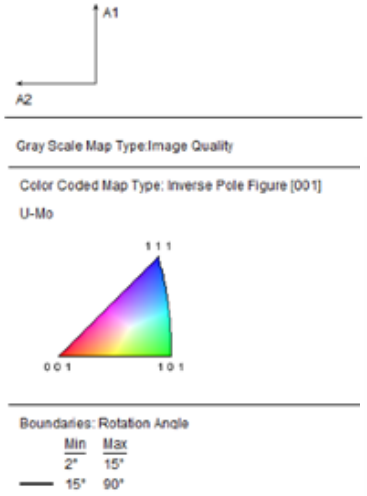
Texture in fuel

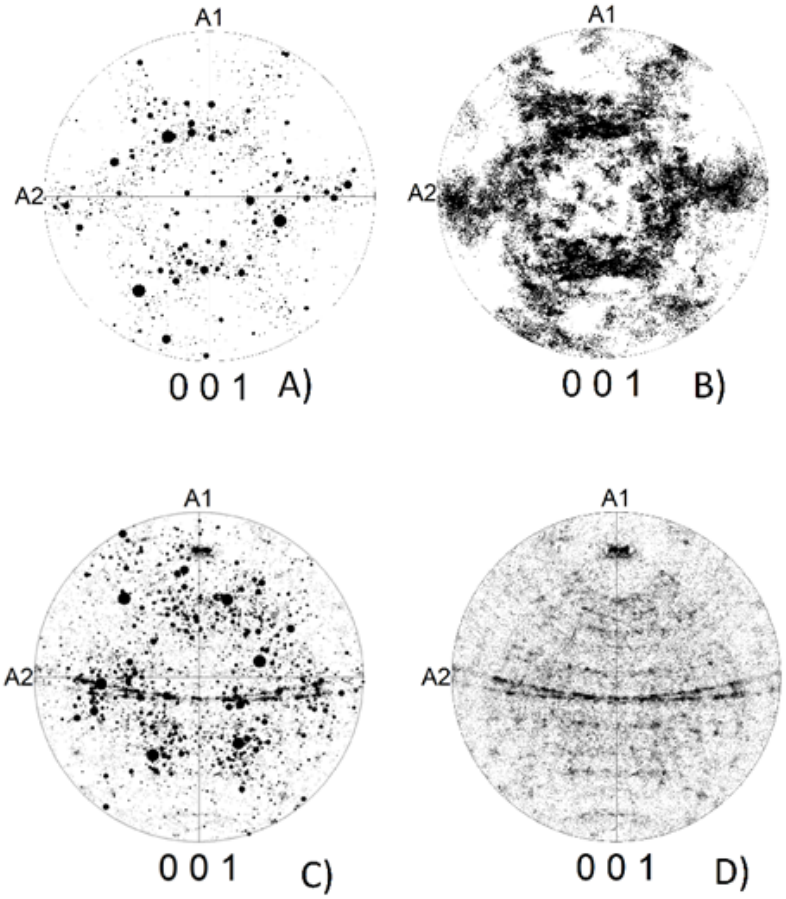


IPF map on cladding bonding

Understanding irradiation effects







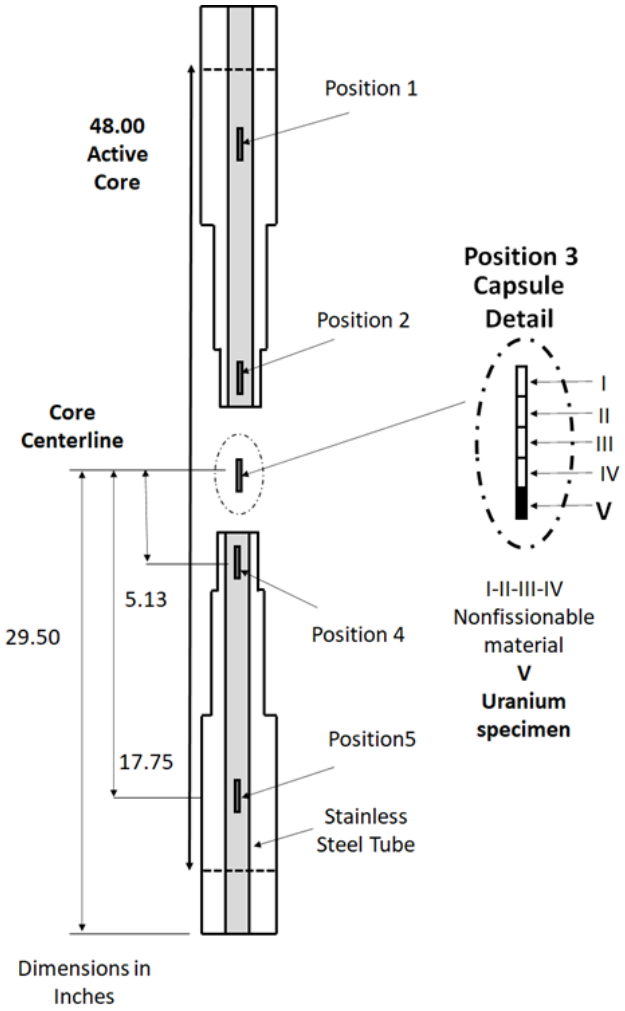
Grain Refinement process

Texture evolution

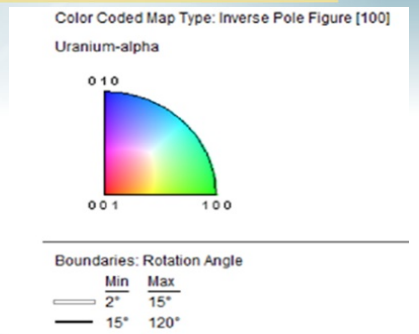
Understanding Transient effect on fuel

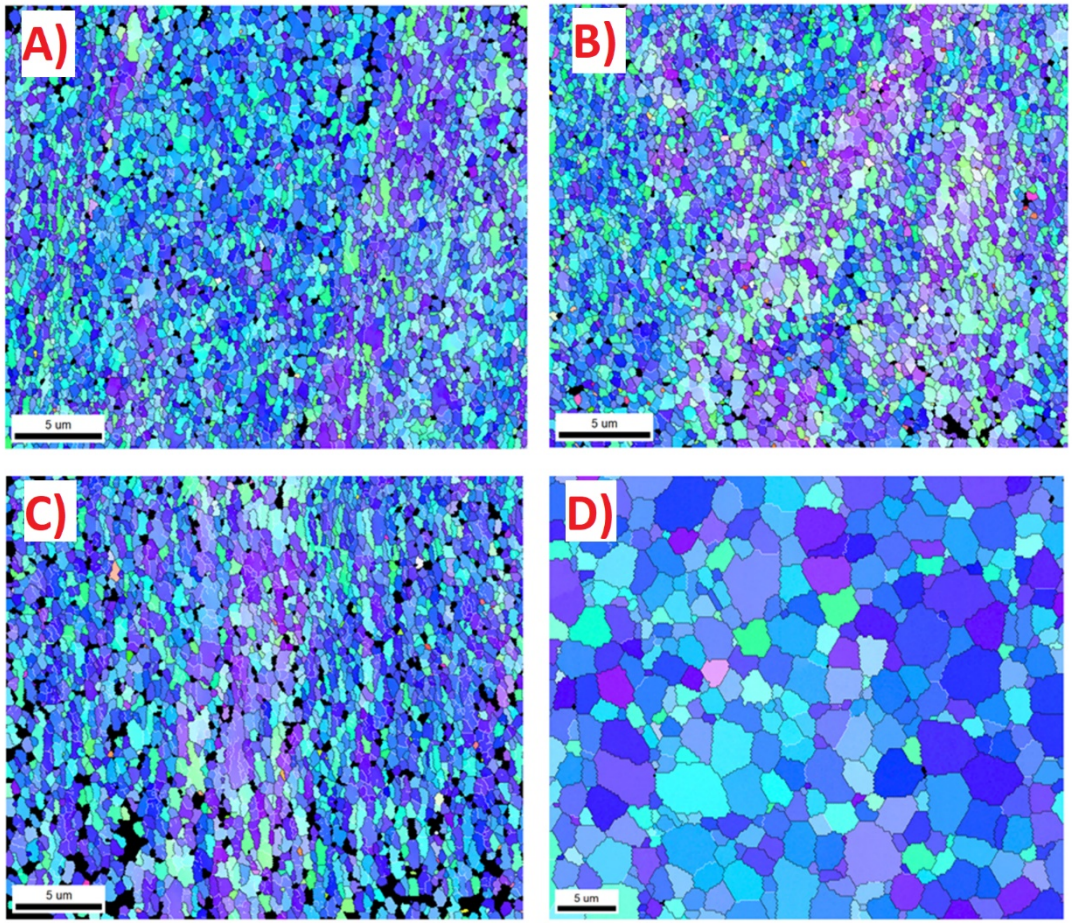
Understanding Transient effect on fuel

Capsule irradiation in TREAT

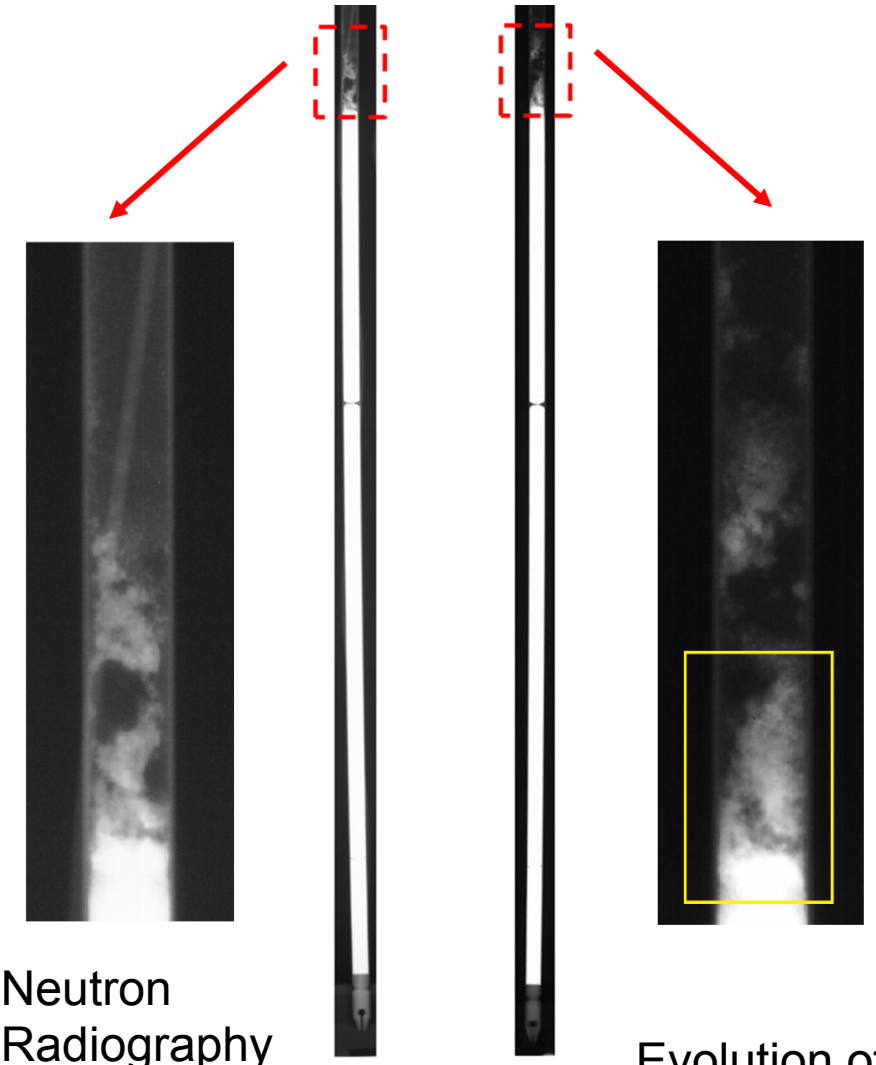


Microstructure evolution:
A) Before transient
B-C-D) After different transients



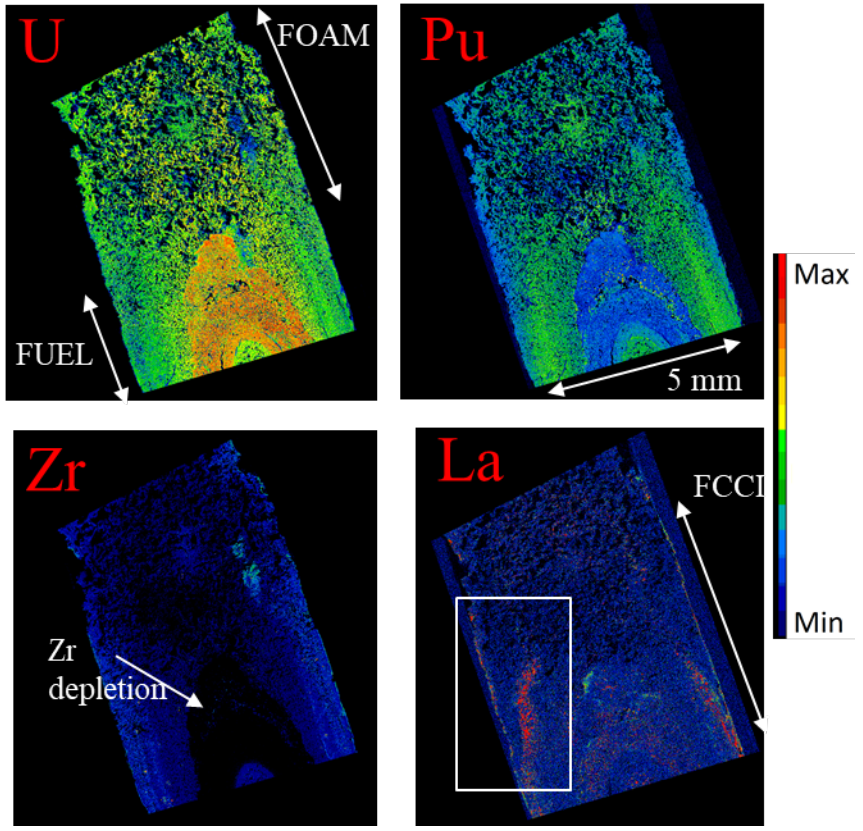


Understanding Transient effect on fuel



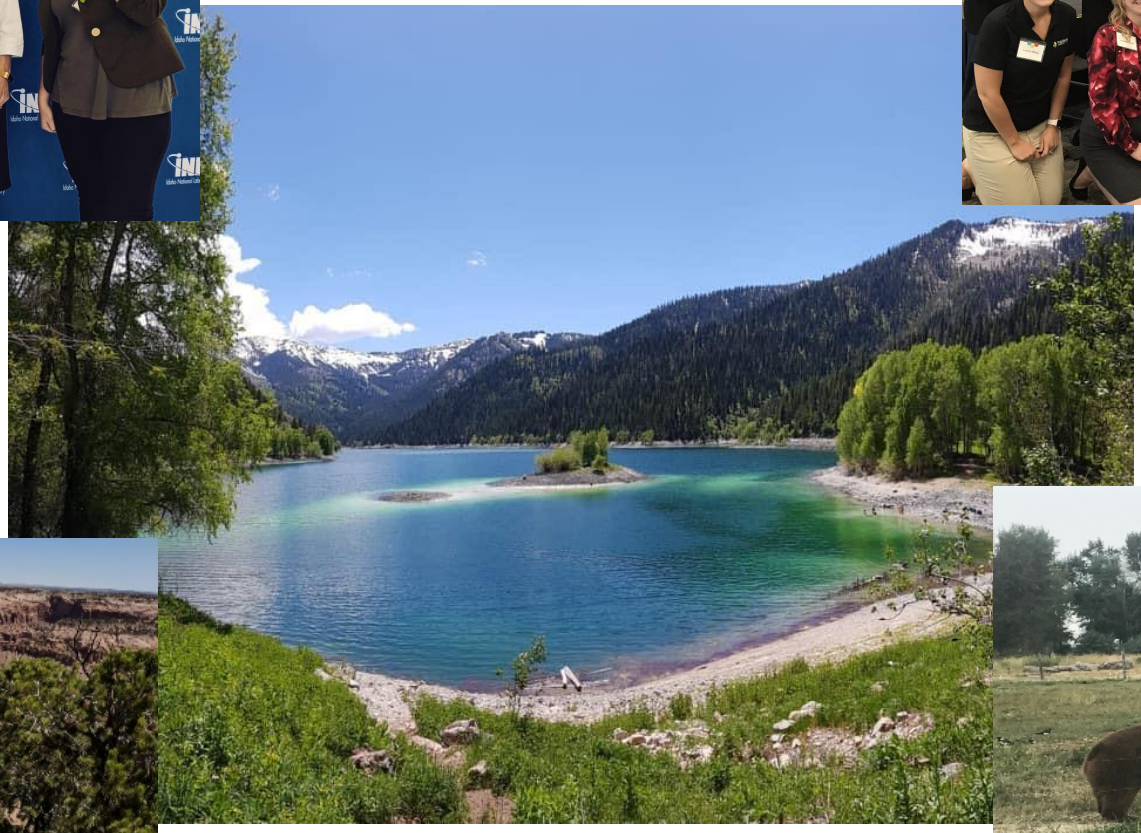
Neutron Radiography

EPMA



Evolution of top of the fuel after a transient

Fidelmagiulia.dilemma@inl.gov



Acknowledgement

- *USHPRR: J. Madden, J. Burns, T. Trowbridge, J. Jue, D. Keiser, J. Cole.*
- *AFC: C. Jensen, D. Wachs, A. Winston, L. Capriotti, K. Wright, A. Zabriskie, X. Liu, D. Murray, F. Teng, T. Holschuh, C. Folsom, C. Adkins.*
- *Presentation Material: P. Xu, C. McDaniel, C. Permann, G. Llevbare.*
- *Management: M. Kerr, M. Meyer, J. Giglio.*

NSUF Nuclear Science User Facilities

All the support staff at MFC.


INL
Idaho National Laboratory