



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Nuclear Science User Facilities

Overview of Irradiation and PIE Activities

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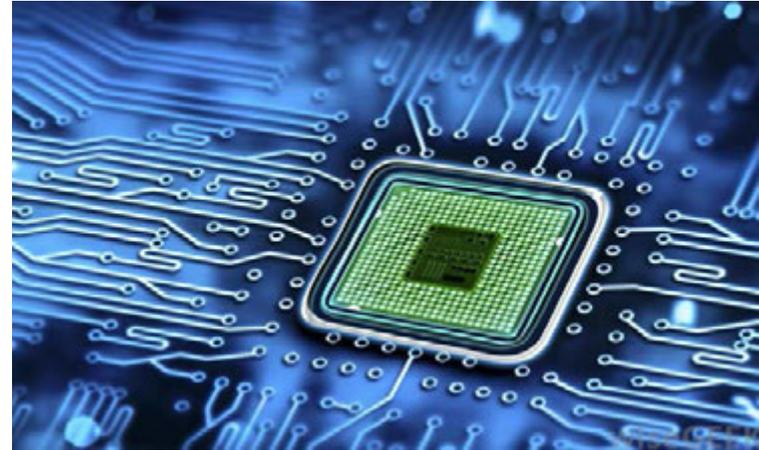
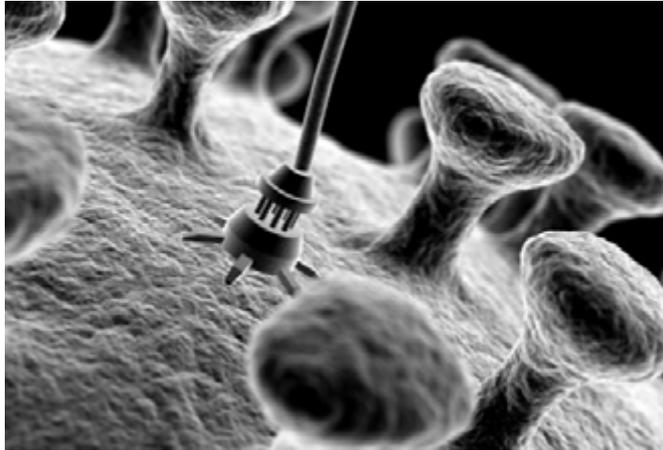
FY 2015 NSUF Annual Program Review

DOE Germantown Office

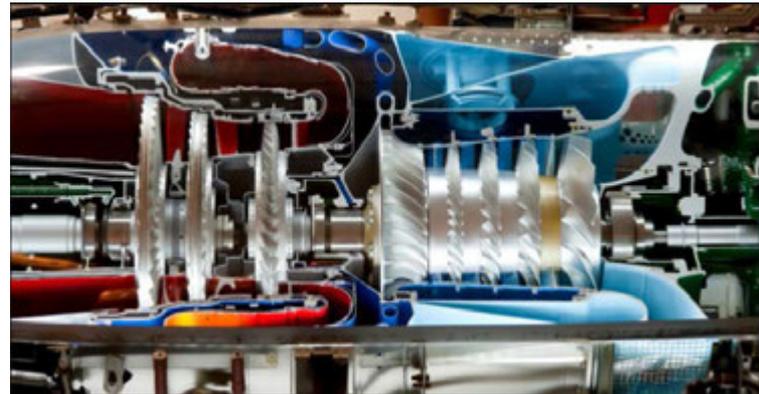
March 1 and 2, 2016



Why Use Micro- and Nano- Analysis Tools in Advancing Nuclear Energy?



- Advance nuclear fuels and materials research and applications using the analysis tools and instruments that provided game changing results in the nano-technology, computers and aerospace industries
- Benefits: Lengthen life spans of existing reactors; develop accident tolerant fuels; reduce costs for new reactors; and safe / long-term disposal of waste



Scale of Characterization Techniques

- The Earth – 12,742,000 m (diameter)
- Vermont – 127,420 m (10^{-2}) (width)
- Football field – 127.4 m (10^{-5}) (with end zone)
- Ruler – 12.7 cm (10^{-8}) (close enough)
- Nickel – 1.27 mm (10^{-10}) (thickness)



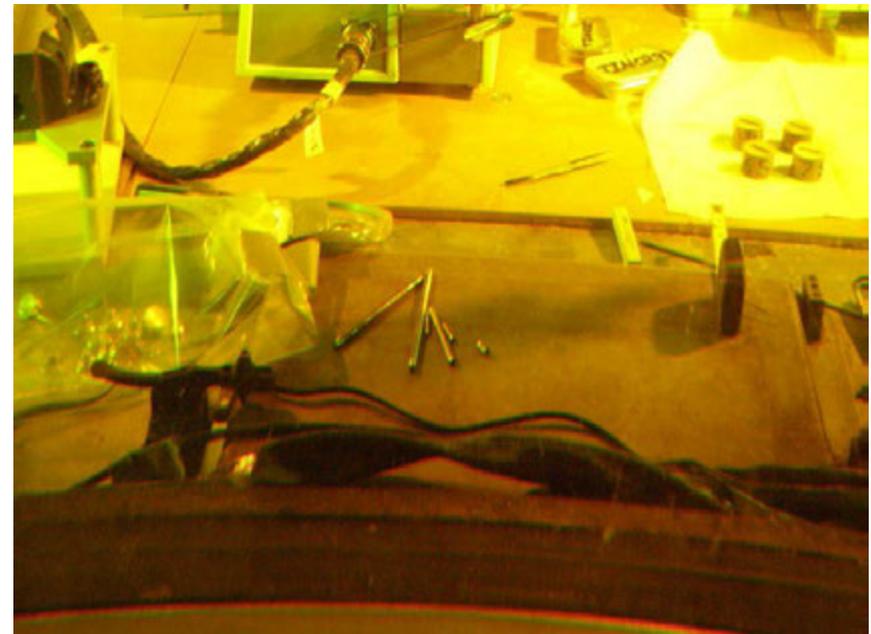
Static Capsule Irradiation Experiments

- **Completed irradiations:**
 - Penn State (MITR) (Evaluating Materials for In-Pile Ultrasonic Transducers)
 - Material to be sent to MFC to be included in NSUF library
- **On-going experiments:**
 - EPRI-ZG-C (Held Out – Temperature Selection)
 - EPRI-ZG-D (Current Being Irradiated)
- **Future experiments:**
 - SAM-2 (SiC Materials)
 - UCF-3 (Metallic Fuels)
 - Boise State University (BSU) (Accident Tolerant Fuels)

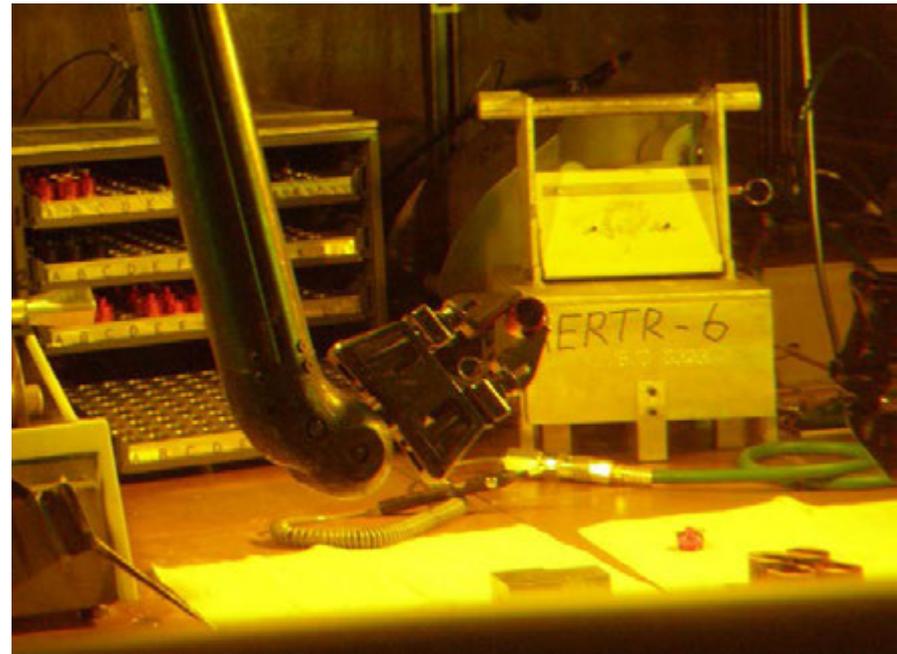


■ Completed irradiations:

- University of California-Santa Barbara (UCSB) (-2) (High Fluence Embrittlement Library for LWR Vessel Life Extension)
 - Cropped in ATR canal
 - Sized in ATR dry cubical
 - Sizing was challenging due to hardened condition of test capsule
 - Shipped to MFC

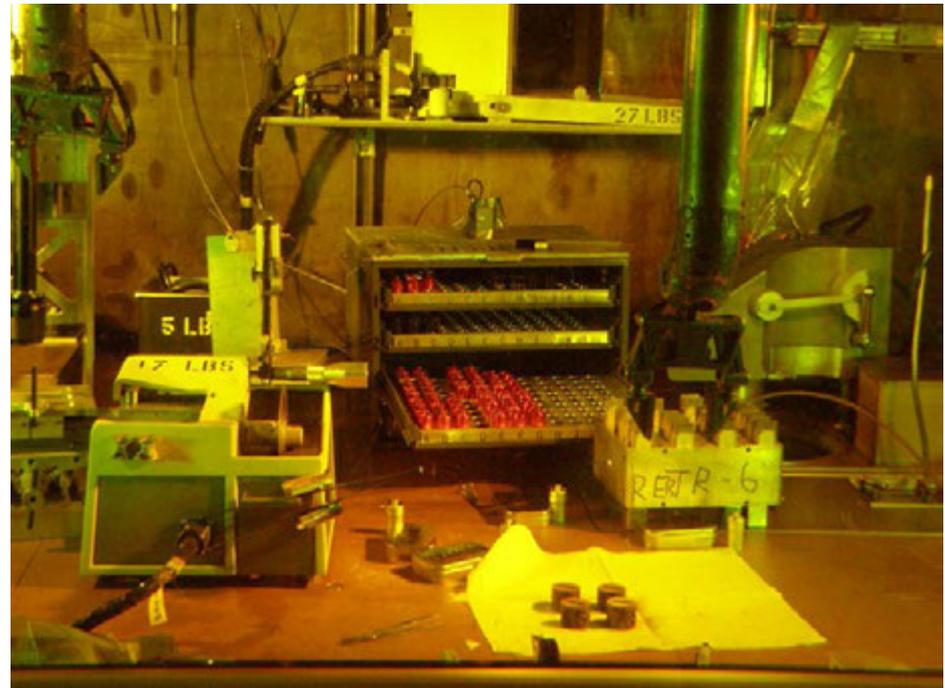


- **Completed irradiations:**
 - EPRI-1 (Stress Corrosion Cracking Studies for LWR Reactor Materials)
 - Stored in ATR canal ready to ship to MFC
- **On-going experiments:**
 - EPRI-3 (Stress Corrosion Cracking Studies for LWR Reactor Materials)
 - Located in ATR loop 2



Hydraulic Shuttle Irradiation Experiments

- **On-going experiments:**
 - University of Central Florida-2 (Low Fluence Behavior of Metallic Fuels)
 - SAM-1 (Fiber Optic Temperature Sensors and Graphite Materials)



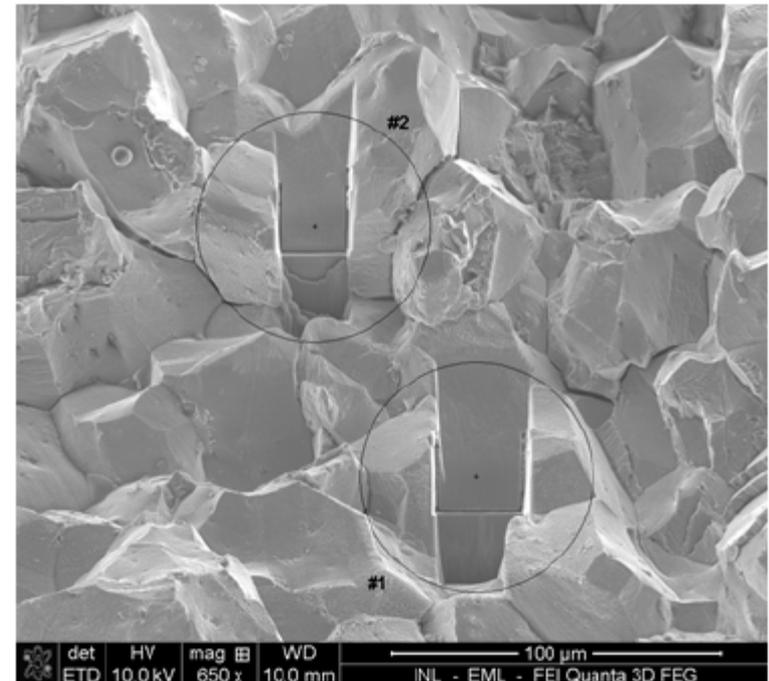
■ Experiments completed:

- Atomic Energy of Canada (Canada National Laboratory) (CANDU Reactor Spacer Springs)
 - FIB lamellae preparation and TEM analysis (CAES and McMaster University (Ontario))
- University of California-Santa Barbara (UCSB) (-2) (High Fluence Embrittlement Library for LWR Vessel Life Extension)
 - Disassembled and shipped to LANL (13 packets and 3 flux wires)
 - Micro-hardness testing and TEM analysis on-going under LWR Extension Program

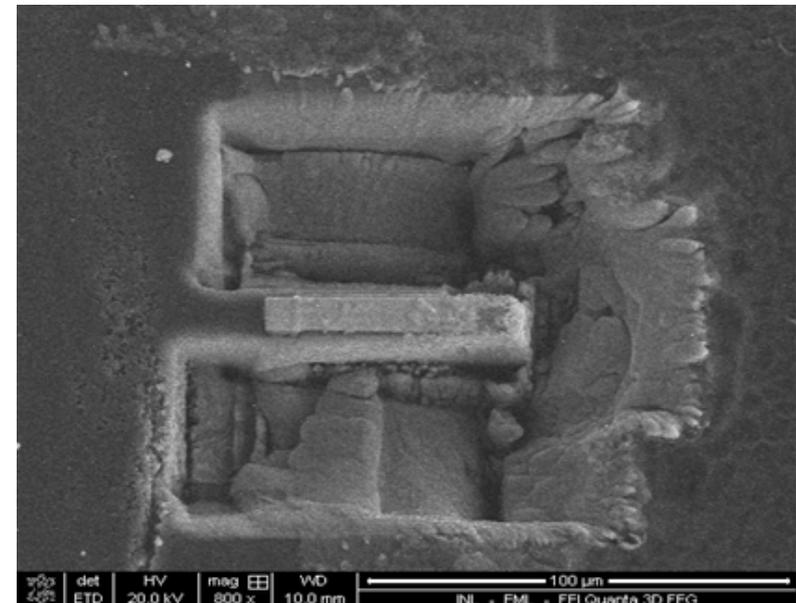


■ Experiments completed (cont.):

- Drexel MAX (MAX Phase Ceramics)
 - XRD, TEM and resistivity measurements for TiSiC and TiAlC specimens
 - Sample prep complicated due to brittle nature of samples
 - Researchers gained valuable experience in sample prep and decontamination techniques
- Idaho State MANTRA (-1, -2 and -3) (Actinide Nuclear Data)
 - ICP-MS
 - Target specimens prepared and shipped to ATLAS for accelerator mass spectrometry (AMS)

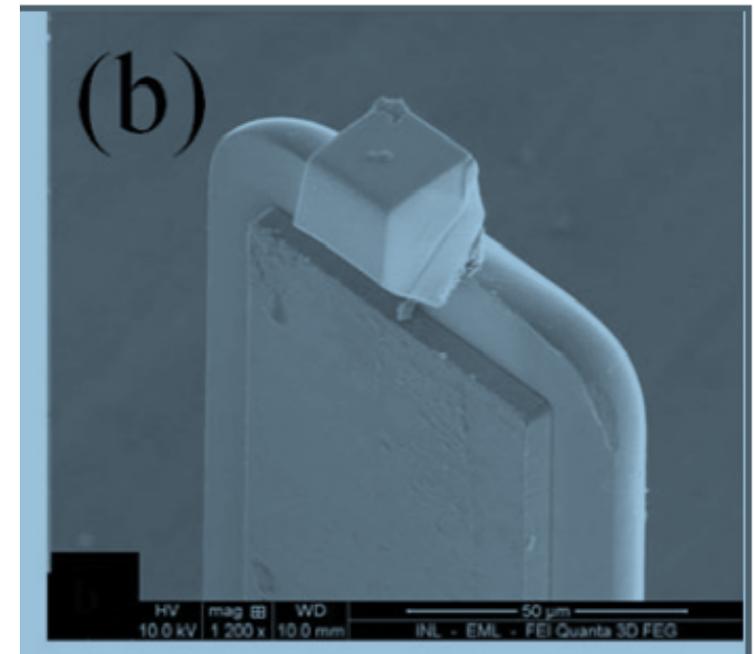


- **Experiments currently on-going:**
 - Utah State University (USU) (Thermal Neutron Filter)
 - Extensive Laser flash, Dilatometry and Differential Scanning Calorimetry (DSC) analysis
 - Tensile hardness testing planned
 - University of Illinois-355 (Reactor Material Studies for LWR Life Extension)
 - 13 tensile specimens have been shipped to ANL
 - Beam time is expected in late 2016



■ Experiments currently on-going (cont.):

- EPRI (Reactor Structural and Cladding Materials)
 - IASCC
 - testing on-going (load frame and TEM)
 - Zirconium growth
 - TEM analysis
- UC Berkeley at PNNL (Accident Tolerant LWR Fuel)
 - Analysis of capsule on-going
 - Analysis includes optical and microscopy
 - Two remaining capsules to be returned to INL to be included in NSUF library



- **Experiments currently on-going (cont):**
 - Central Florida-1 (Low Fluence Behavior of Metallic Fuels)
 - Sample prep for beam line testing at Brookhaven (NSLS-2) and APS
 - 38 samples to be sent to NSLS-2
 - Samples to be analyzed using high-energy XRD and small angle X-ray scattering (SAXS)

