ORNL Nuclear Hot Cell Complex

Presentation to
TRTR/IGORR 2010 Convention

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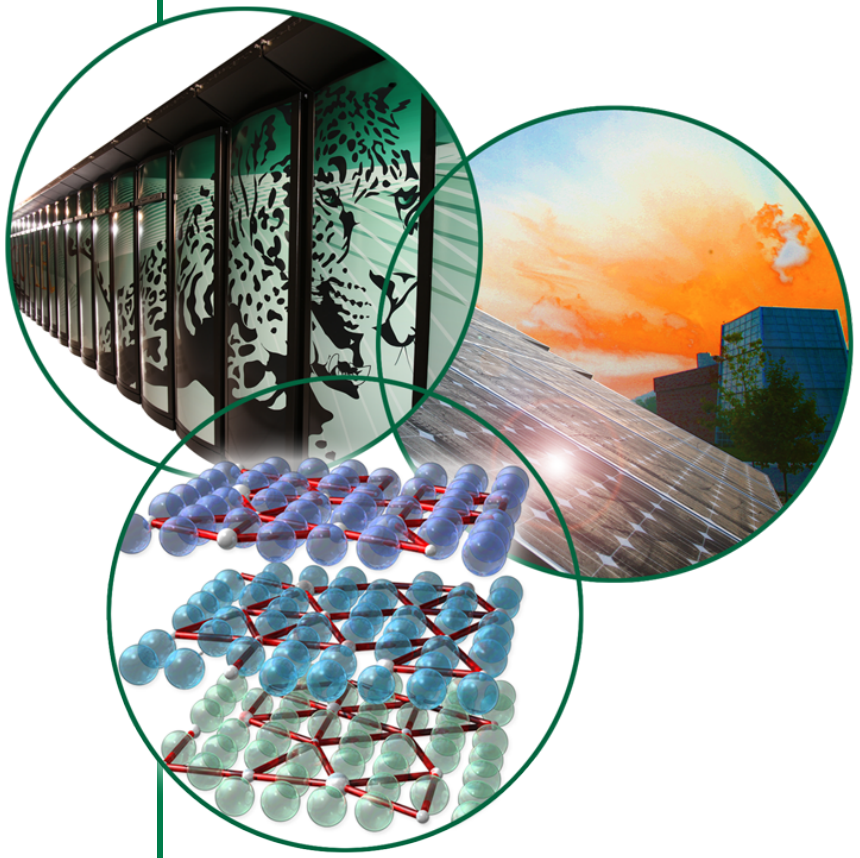


U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Discussion Points

- History/Nuclear Footprint Consolidation and its Benefits
- Nonreactor Nuclear Facilities Division and its Hot Cell Capabilities
- Recent Noteworthy Achievements

Hot Cell Consolidation Has Reduced the Cost and Improved the Quality of Nuclear Facility Operations

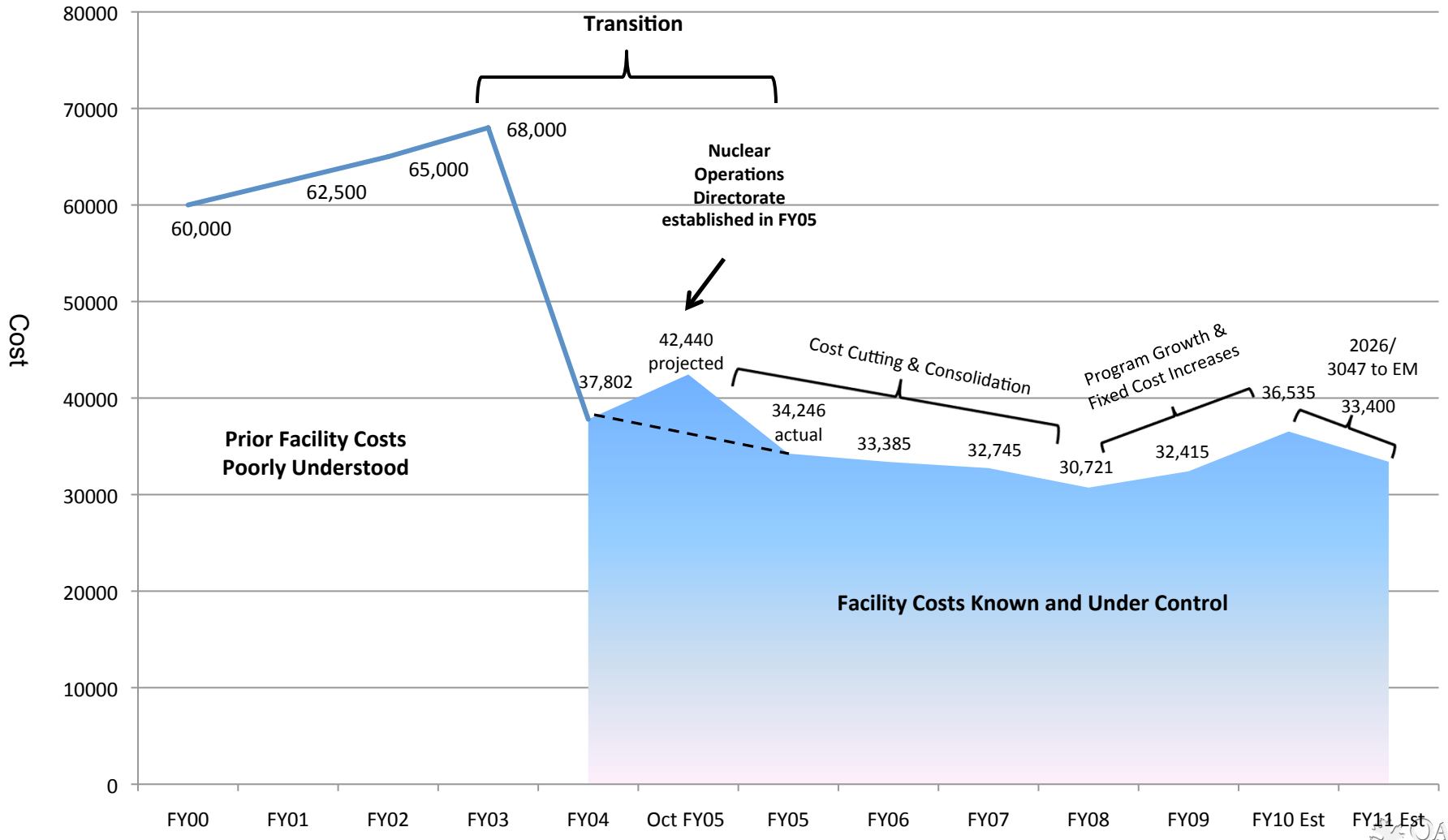
In 2001, ORNL operated 10 hot cell facilities

2001 → 2010

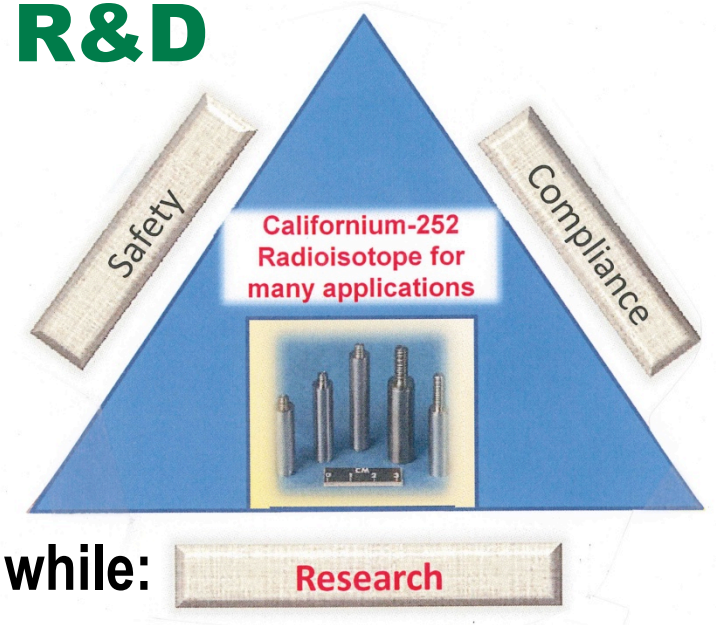
Today, ORNL operates 4 active hot cell facilities:

- 7920
- 7930
- 3525
- 3025E

Consolidation and Establishing a Single Nuclear Facility Operating Organization Has Been a Key to Success



NNFD's Job is to Facilitate R&D



- **Mission:**
  - **The mission of the NNFD is to serve as a stable platform for conducting nuclear programs by providing facilities ready to accomplish programmatic work while:**
    - **Maintaining compliance**
    - **Meeting or exceeding customer expectations**
    - **Being cost-competitive**
    - **Leveraging limited resources to accomplish needed upgrades**
    - **Teaming with science to respond to expanding, multifaceted nuclear program needs**
    - **Maintaining personnel and environmental safety**
- **Research is the mission, and condition of employment is to safely and compliantly implement this mission**

ORNL's Nuclear Hot Cell Capabilities are Significant

ORNL has significant hot cell capabilities to facilitate the science and technology that support many R&D programs

IMET: Nuclear Category 3

IFEL: Nuclear Category 2

REDC 7920: Nuclear Category 2

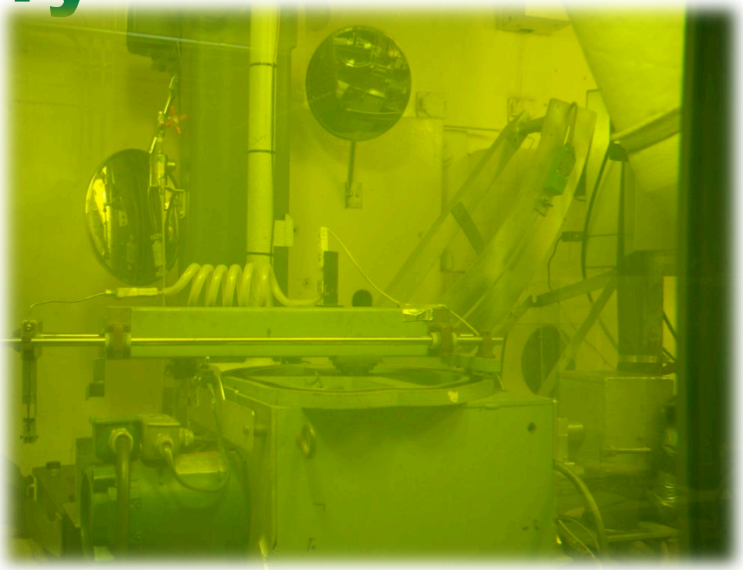
REDC 7930: Nuclear Category 2

The IMET is a World-class Radioactive Materials Testing Laboratory

- Contains a comprehensive suite of equipment to perform physical testing on radioactive materials

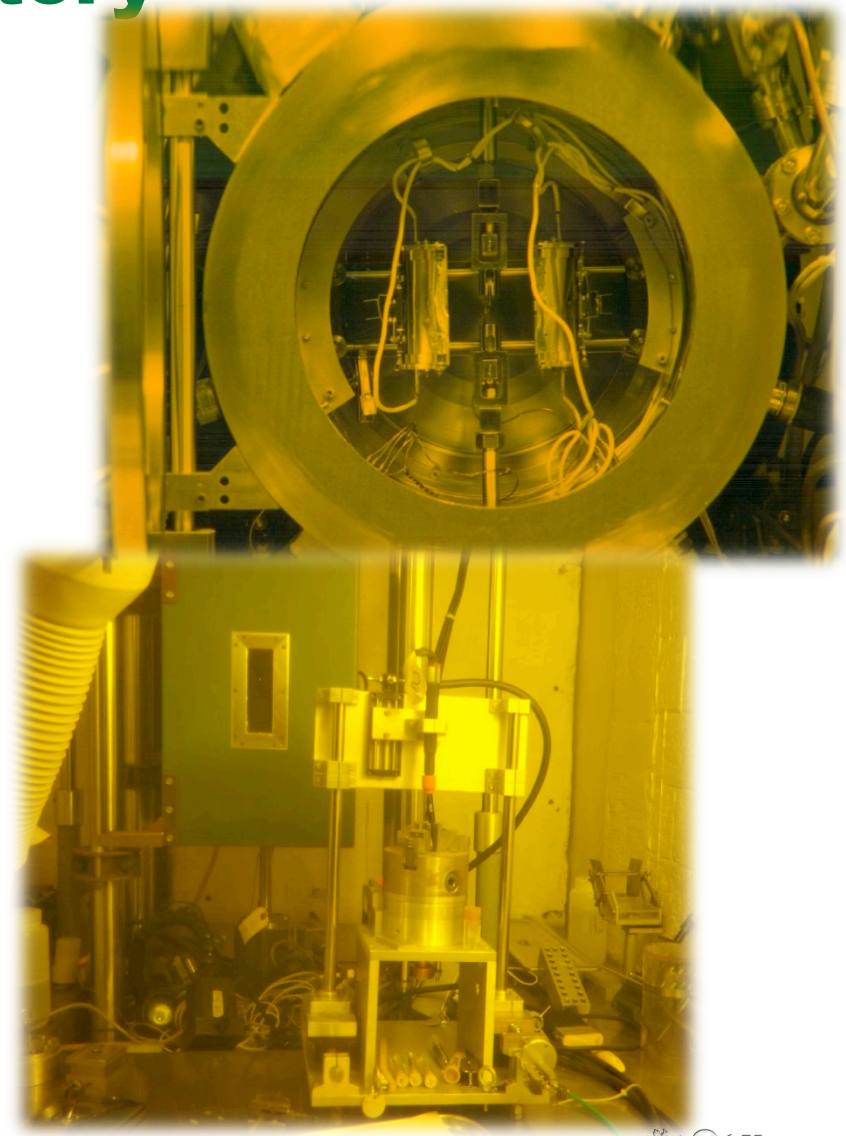
The IMET is a World-class Radioactive Materials Testing Laboratory

- In-cell Charpy Impact System – determines a material's toughness. Brittle to ductile transition studies.
- In-cell CNC milling machine
- Lazer Profilometer – use of a lazer to determine out of roundness or deformity of a material. Looks for surface defects.
- In-cell scanning electron microscope (SEM)



The IMET is a World-class Radioactive Materials Testing Laboratory

- Lathe
- Tensile Testing System – allows testing at elevated temperatures
- Ball Indention System – presses a ball into material, deformation is inspected under SEM
- Microhardness Determination – similar to Ball Indention System but allows real-time inspection of deformation
- Isotope Processing – Se processing from HFIR target rods (used for gamma radiography)

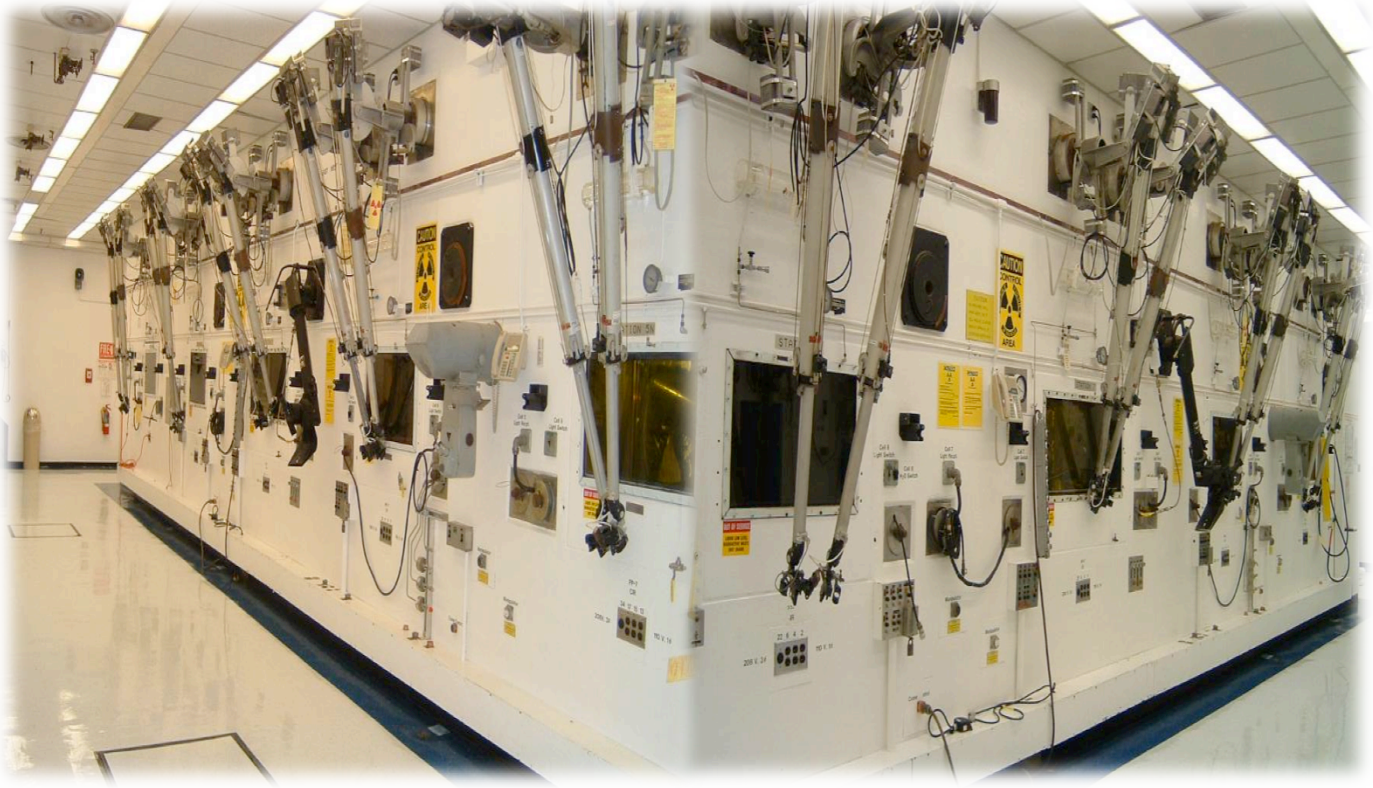


The IMET supports important programs

- Programs ongoing
  - Naval Reactors PIE
  - Fusion materials development
  - HFIR structural support
  - NRC RPV testing
  - Isotope processing
  - AFCI materials testing
  - Nuclear testing

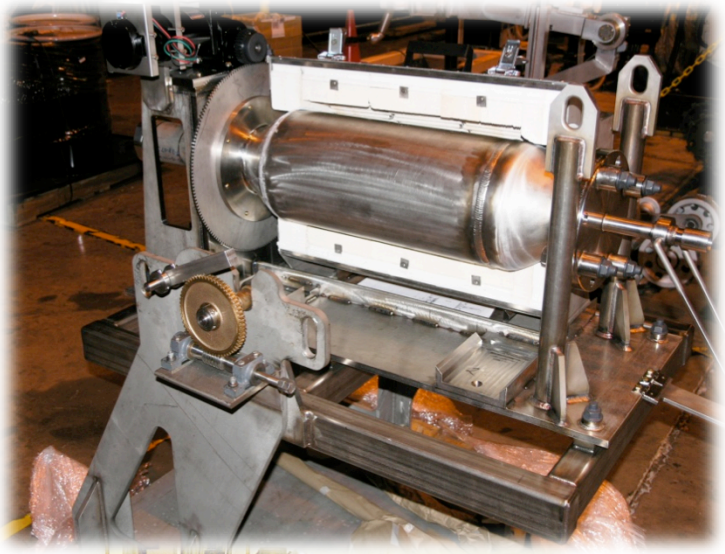
The IFEL is a world-class fuels examination laboratory

- **Post Irradiation Examination of spent nuclear fuel**
  - Used for determination of fuel reliability and to extend fuel burnup

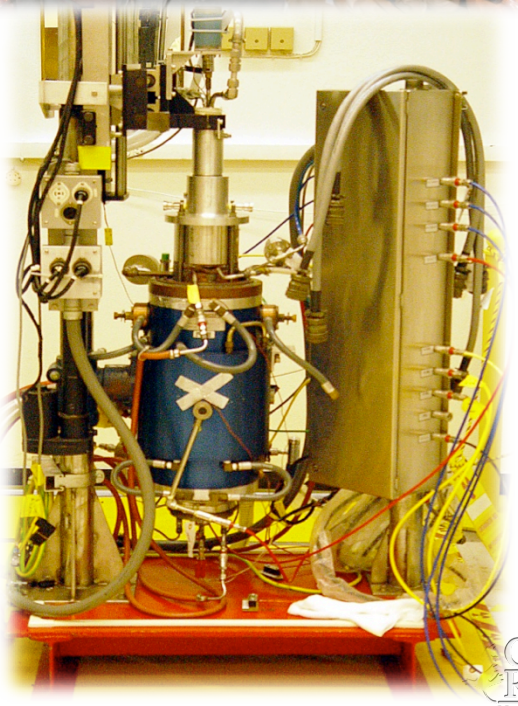


The IFEL is a world-class fuels examination laboratory

- CETE Front End – Voloxidation: Oxidizes spent nuclear fuel creating a fine powder while releasing fission products and unwanted volatile gasses (tritium, carbon, Xe, Kr, etc.)

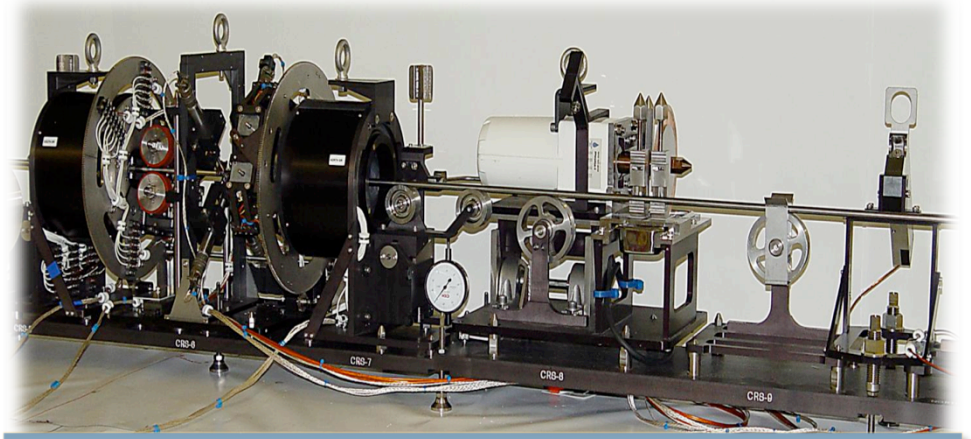


- Core Conduction Cool-down Test Facility (CCCTF) – CCCTF is used to test fuels at extreme temperatures; up to 2000°C (Navy, HTGR, AGR)



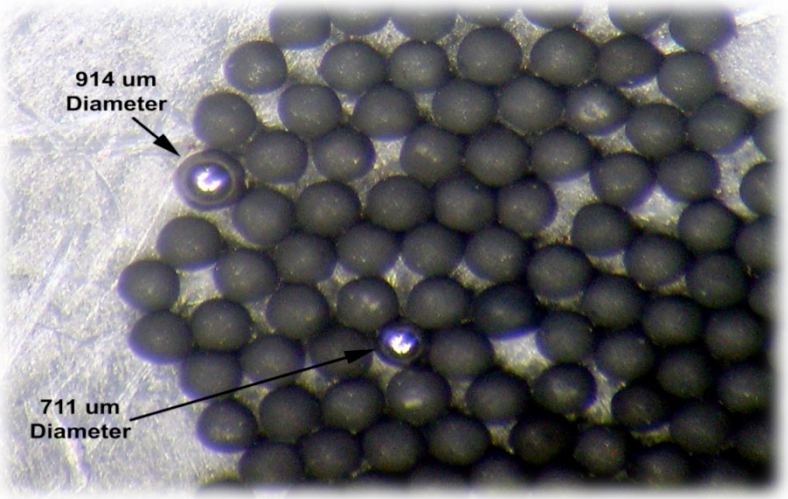
The IFEL is a world-class fuels examination laboratory

- ADEPT is used for long fuel rod testing:
  - Precision segmentation
  - Temperature Determination
  - Rod puncture and gas sampling
  - EDDY current
  - Gamma ray scanning
  - Thermal imaging
  - Metrology



Advanced Diagnostic Evaluation Platform (ADEPT)

- Irradiated Micro-Sphere Gamma Analyzer – perform non-destructive gamma spectrometry on particle fuel
  - Extremely sensitive; measures isotopic inventories in individual fuel particles



The IFEL is a world-class fuels examination laboratory

- Large cask handling
  - Supports AFCI R&D as well as MOX and commercial nuclear power PIE

The IFEL supports important programs

- Programs ongoing
  - Naval Reactor PIE
  - Fusion Program Materials Inspection
  - Legacy waste cleanup
  - SNF Disposition
  - NRC Inspection Program
  - AFCI R &D (head end & voloxidation)
  - NRC LOCA Testing
  - MOX Fuel PIE
  - NGNP/AGR PIE/Deep Burn
  - Etc.

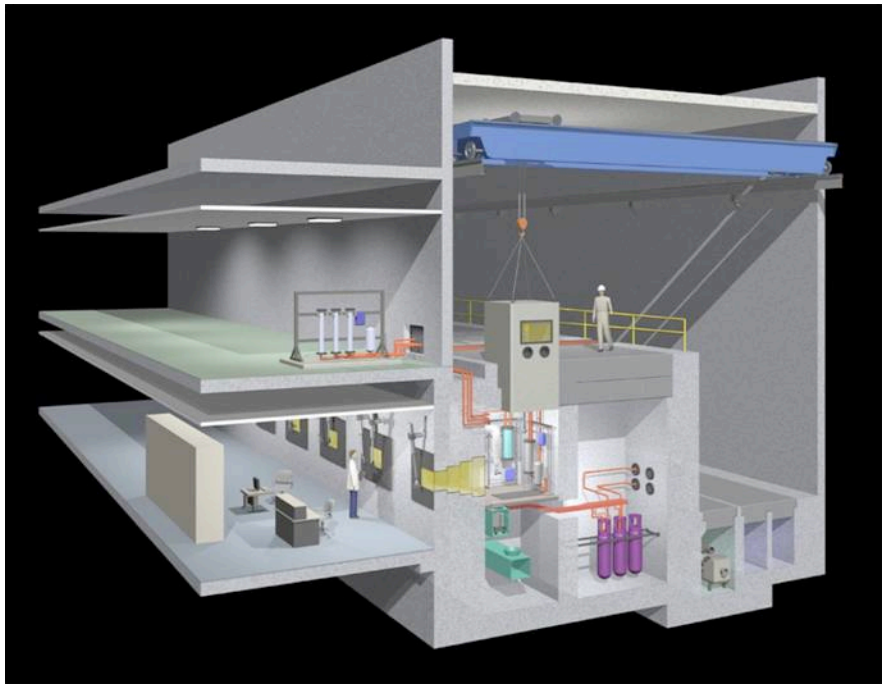
REDC is Key to the Success of the Actinide Chemistry and Isotope Missions

- Building 7920 – Realization of Glenn Seaborg's vision for actinide chemistry and isotope processing

7920 Control Room

REDC is Key to the Success of the Actinide Chemistry and Isotope Missions

- Nuclear category 2 glove box and hot cell facility:
  - Two non-radiological labs
  - Six radiological labs
  - Nine heavily shielded cells designed to shield gamma, neutron, beta radiation and contain alpha contamination
  - Several smaller shielded caves

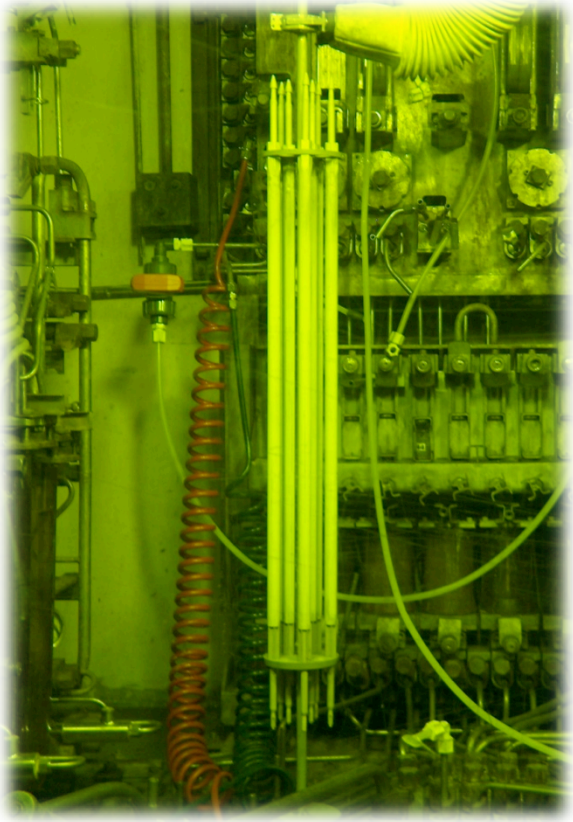


Cutaway View of 7920

7920: A Unique Facility for Isotope Research and Production

- Maintains the feed stock for heavy element production program
- Planning to process
  - Pu-238
  - U-234

Vials Containing Ac-225

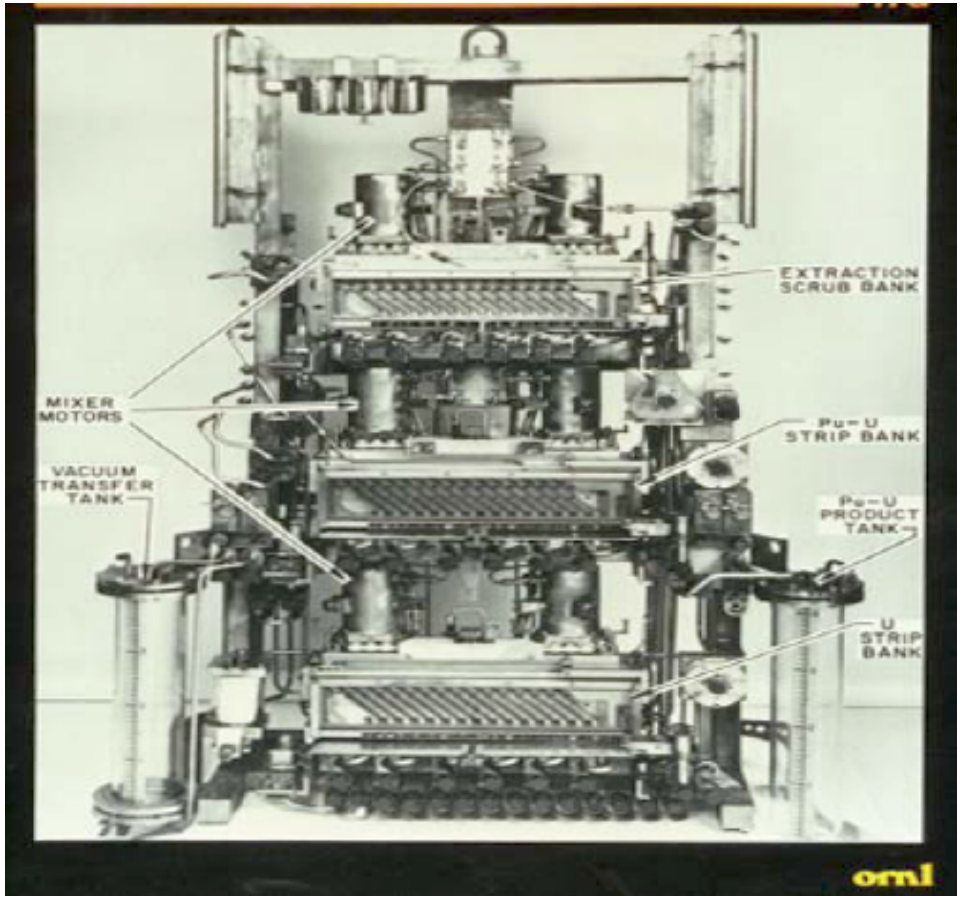


Targets after Irradiation in Cell 7

- Target fabrication for HFIR irradiation
- Processing to produce:
  - Cf-252
  - Ac-225
  - Ni-63
  - Bk-249

Actinide chemistry and isotope production

- Solvent Extraction Test Facility (SETF)
  - Heart of separations chemistry; uses reagents and counter flow mixing to change the valence of the process material to strip out desired components



SETF Mixer-Settler

Actinide chemisty and isotope production

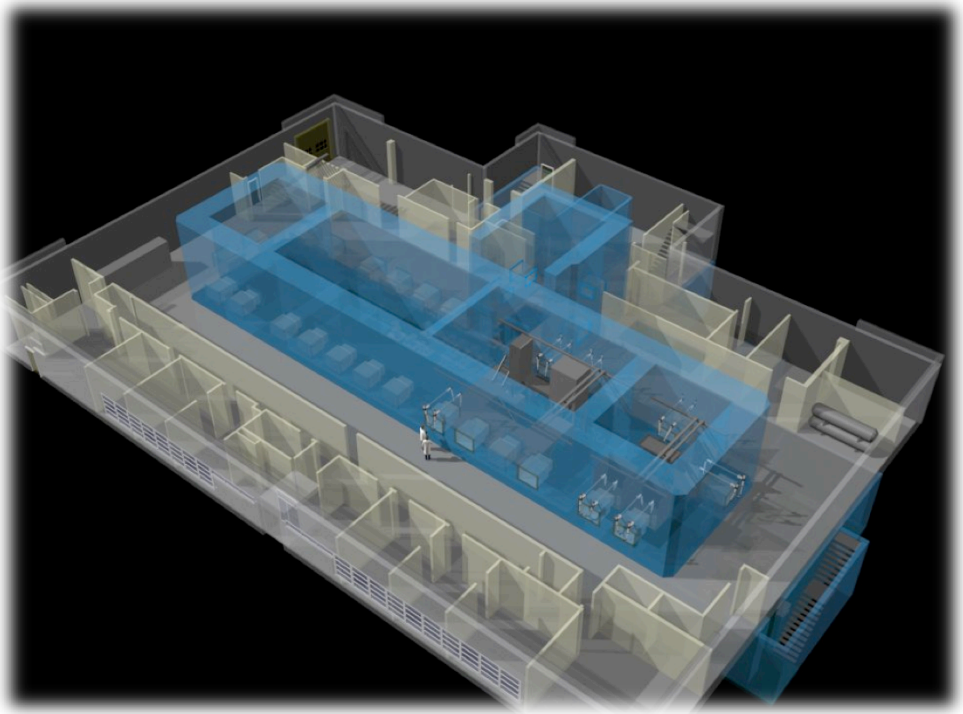
- Modified Direct Denitrator – Process of taking uranyl nitrate (uranium in acid solution) and converting to an oxide powder by thermal decomposition

7920 supports many programs

- Programs ongoing
  - MK 42
  - CETE
  - Legacy waste stabilization
  - Storage and monitoring
  - Isotope generation, processing, and distribution
  - Special projects
    - DOD
    - DHS
    - NSA
- Future programs
  - Bettis neutron source disposition project
  - RTG devices
  - New DOD, DHS, NSA activities
  - Pu-238 (perhaps)

7930 is the Nation's Cf-252 Repository

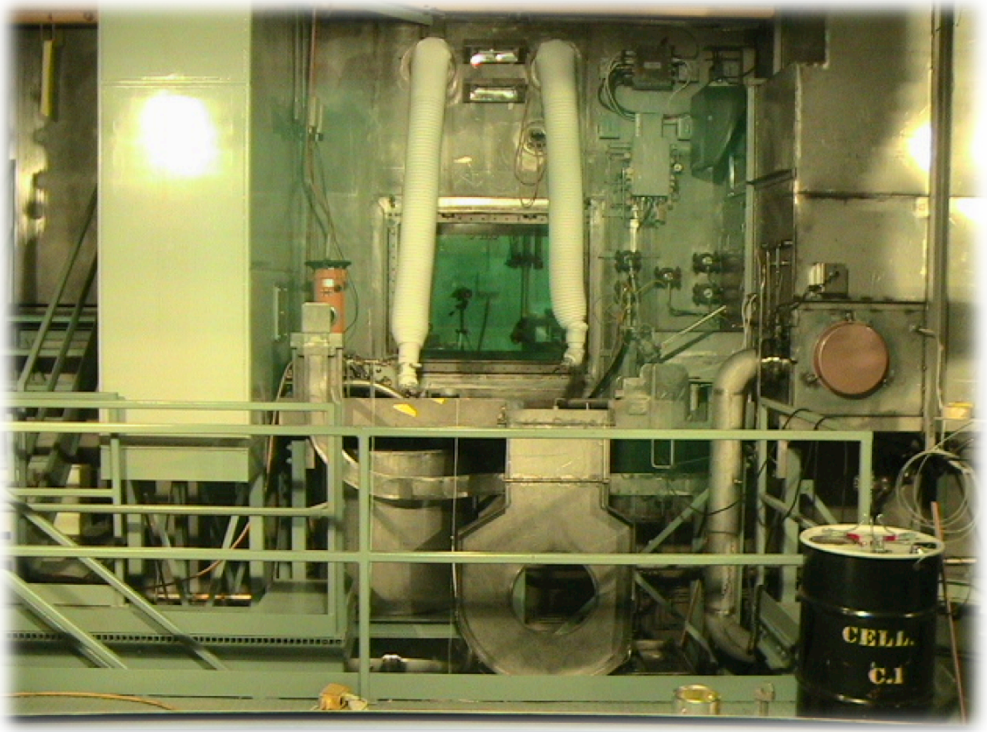
- Contains five heavily shielded hot cells and one unshielded hot cell
  - Cell G is used for purification of Cf for fabrication into wire
  - Cell C is used for final encapsulation, decontamination, leak checking, and loading/ unloading of shipping casks
  - Cells A&B are used for loading/unloading of various shipping casks



Cut-away of 7930 1st floor

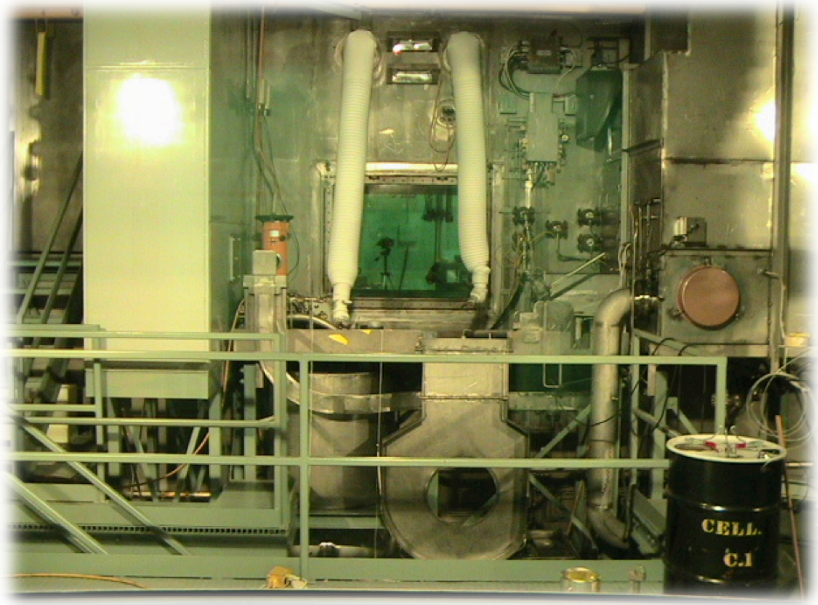
7930 – Country's Cf-252 repository

- Hundreds of sources per year delivered to industry
  - Cancer treatments (inoperable brain tumors)
  - Reactor startup
  - Bioresearch
  - Petroleum research
  - Coal/concrete industry
  - Neutron radiography
  - NAA
  - Failure effect analysis
  - Unexplained ordinance detection



- Demand is growing each year

7930 is the Workhorse Production Facility for Cf-252 Wire Encapsulation



Cf-252 final assay station

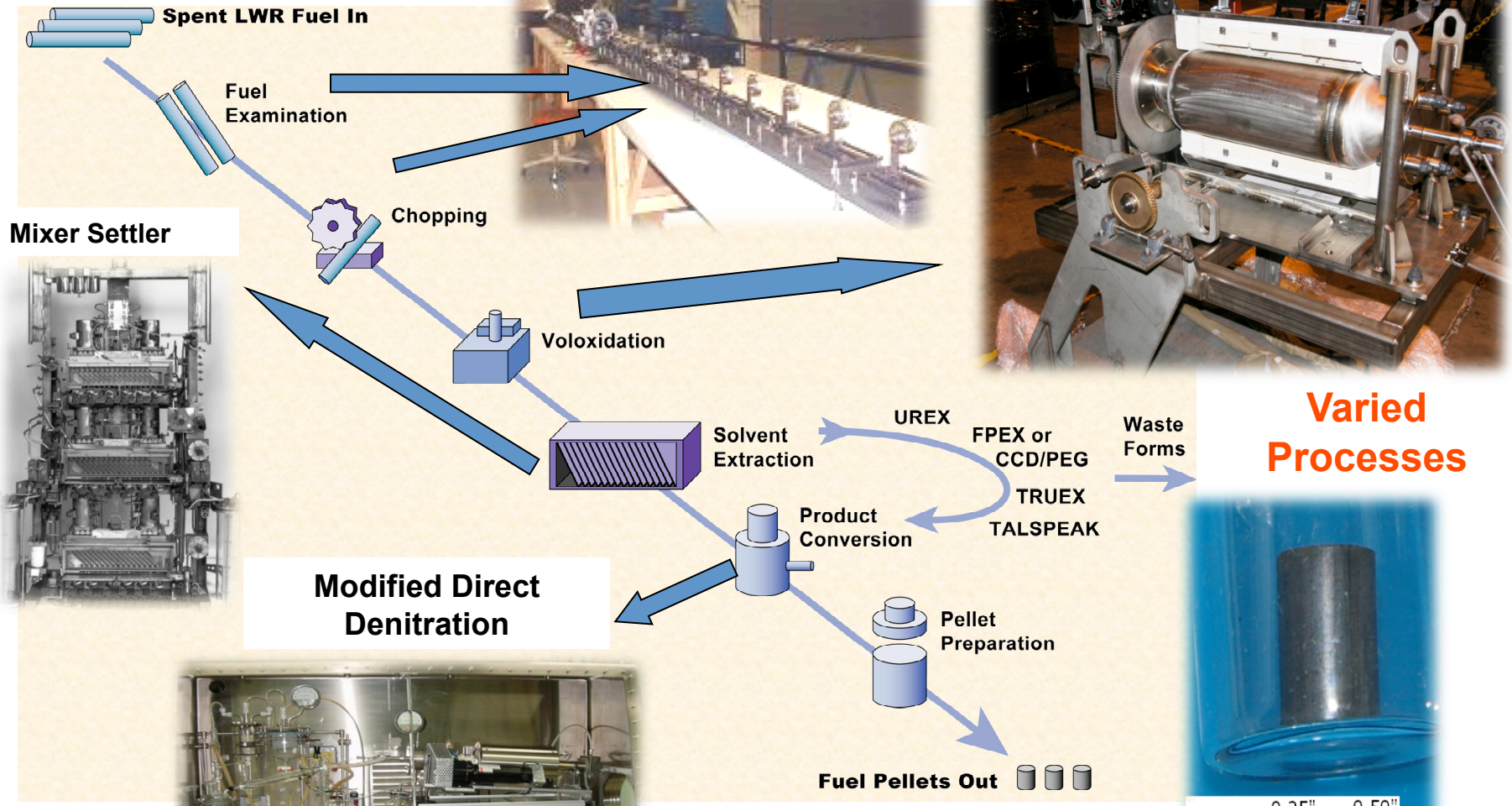
- Hundreds of encapsulations are produced every year

Rolling wire through groove number 12. Wire is ~ 0.05 inches across the flats

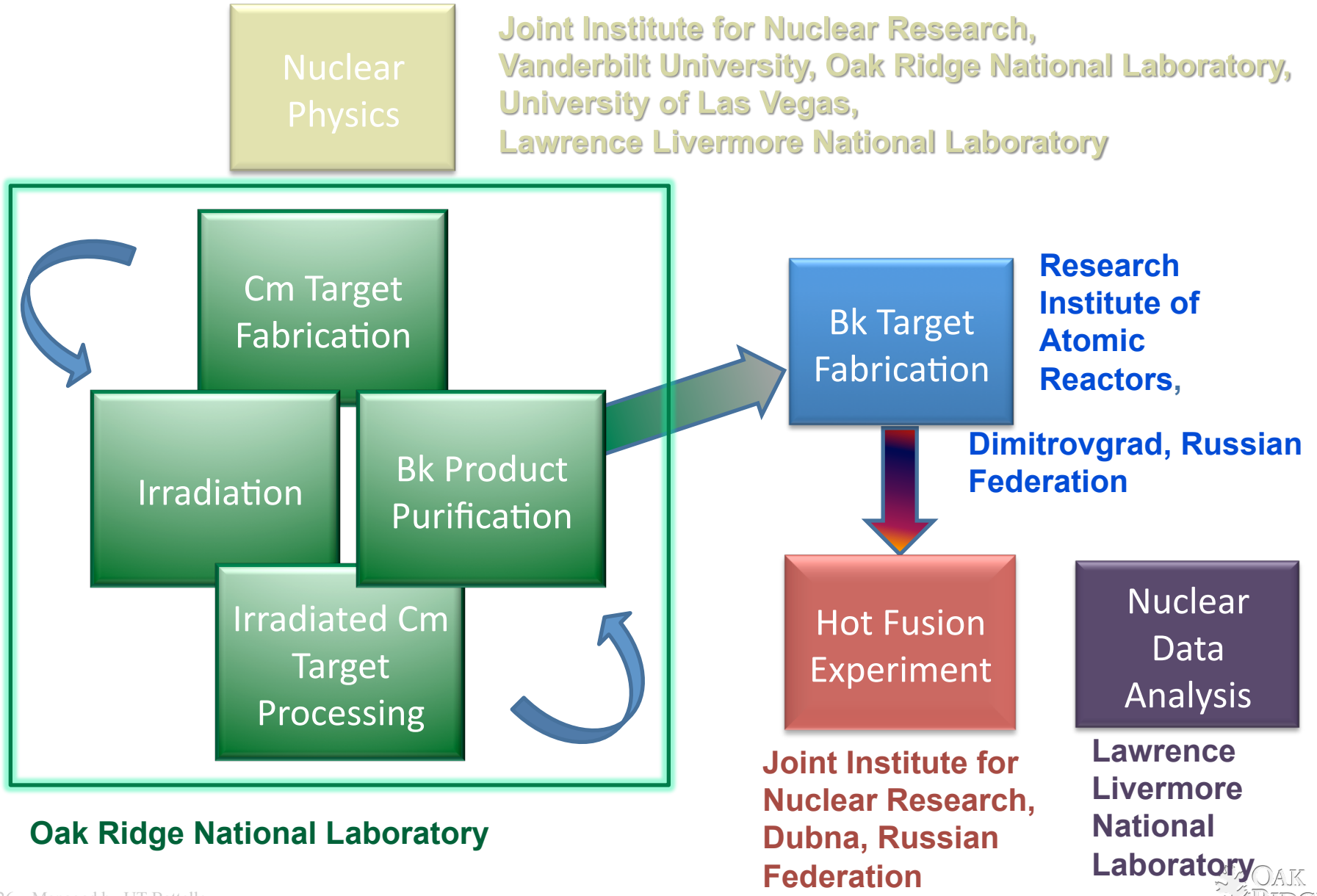
- Targets irradiated at HFIR
- Processed at 7920
- Delivered to 7930 for wire fabrication and encapsulation

Walk-through

Coupled-End-to-End Demonstration (CETE)



Super Heavy Element 117 Experiment



DOE Regulators Acknowledge Significant Nuclear Hot Cell Improvements in Compliance and Conduct of Operations

- Hot Cell facilities received high praises during recent independent oversight review by HS-64:
  - " In the Nuclear Safety area, noteworthy improvement is evident in all areas reviewed…the facilities have established a strong Nuclear Safety culture…"
- Our attitudes, willingness to continually improve and continually ask questions have helped us tremendously
  - Always a "Work in Progress"

ORNL's Nuclear Facilities Work Together to Meet Varied Mission Needs for Benefit of All