ATR NSUF Industry Program

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ATR Industry Program

- ATR has historically been focused on Naval and DOE advanced fuel and material testing
- LWR life extension requires new research capability
- Building a program to meet LWR industry needs requires a step-by-step approach over several years
  - Understand industry needs
  - Build a cooperative working relationship
  - Build necessary research capability
    - Irradiation
    - Post-irradiation examination and testing
    - Collaborations
  - Supply supporting infrastructure

1. Understanding Industry Priorities

- ATR NSUF Industry Advisory Committee (ANIAC)
- Industry experts
  - ATR NSUF Summer Session/Workshop
  - Consultation with EPRI
- LWR Sustainability Program (new DOE program)
- Documents such as:
  - EPRI Materials Degradation Matrix
  - NRC PMDA (Proactive Material Degradation Assessment)

ANIAC (ATR NSUF Industry Advisory Committee)

- An advisory group whose objectives are to:
  - Prioritize industry research needs for the ATR and associated PIE facilities
  - Identify needs for irradiation testing, post-irradiation examination, and transportation capability
  - Provide an effective interface between the ATR NSUF and industry
  - Provide advice on making the ATR NSUF a sustainable asset for industry
- Representation from AREVA, GE, Westinghouse, EPRI, NRC, FirstEnergy, Exelon, Duke, EdF, Dominion Engineering

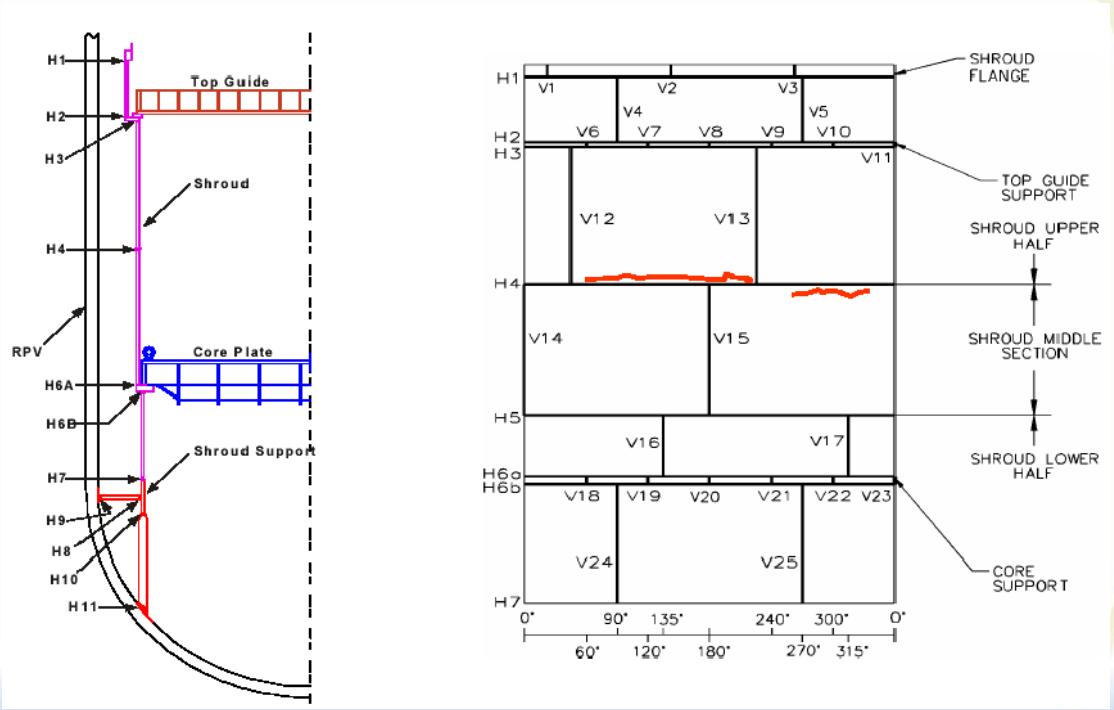
2. Building Good Working Relationships

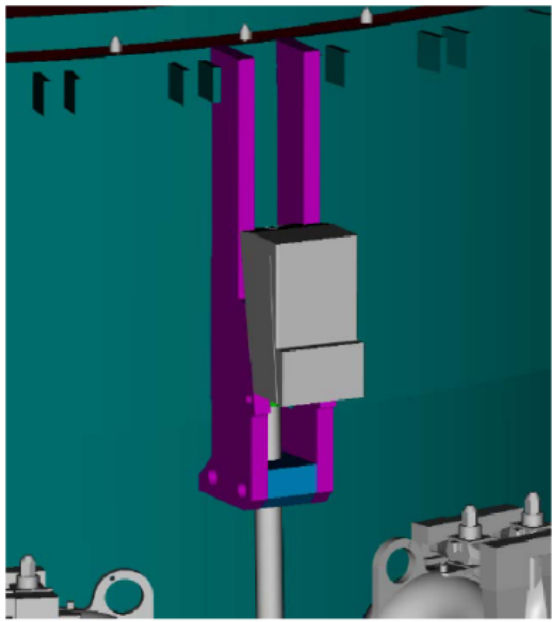
Execute ‘Pilot Programs’ designed to:

- Develop the administrative protocols for cooperative research, such as cooperative agreements and funding
- Allow the ATR NSUF to adapt to industry needs for timely conduct of research and cost control
- Develop portions of the research capability and staffing required to address future research and development needs
- Develop protocols for validation of data

Example: X750 Pilot Program

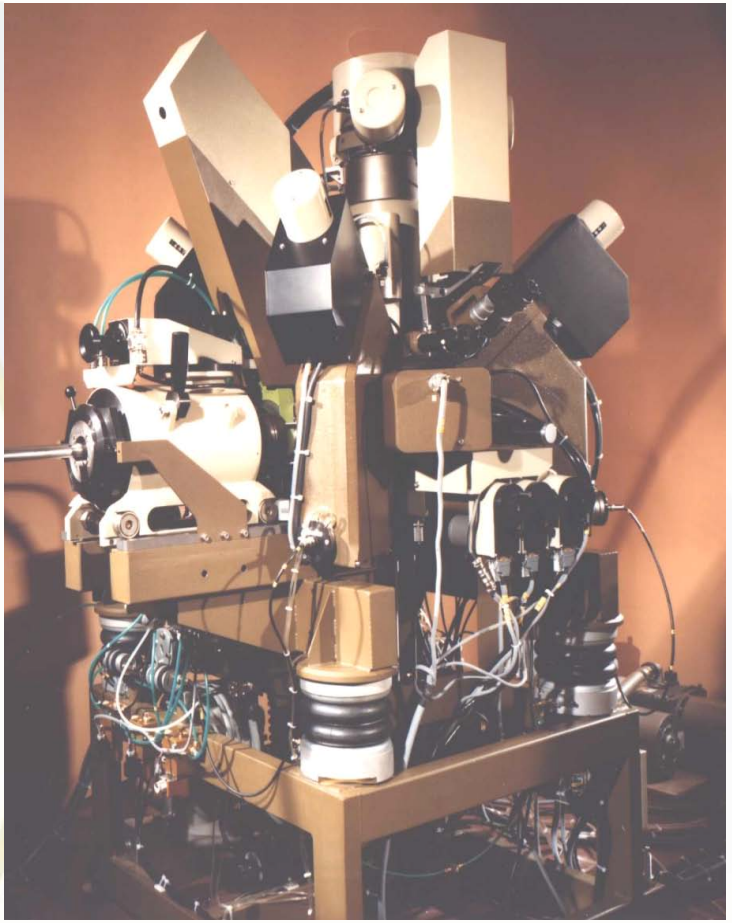
- Joint program with EPRI
- Objective: Measure crack growth rates and fracture toughness of irradiated alloy X750 and XM19 used in BWR core shroud repair brackets





3. Building Research Capability

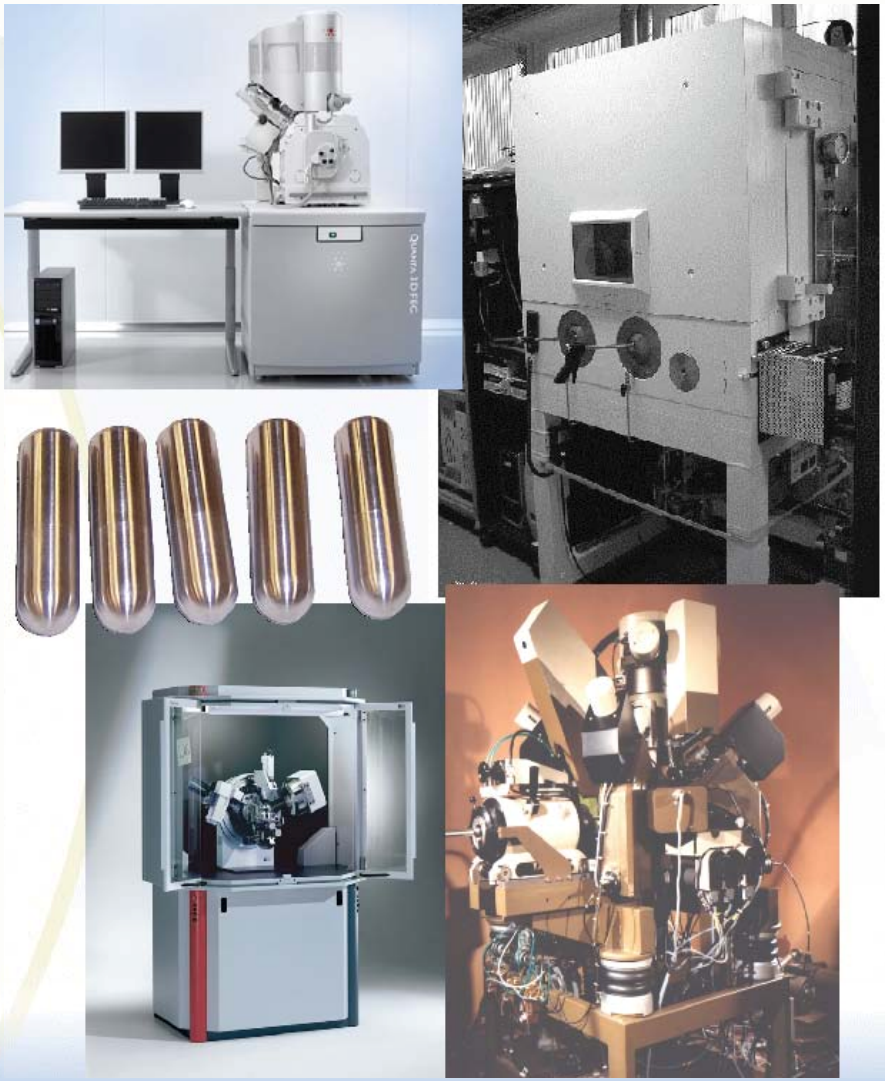
- ATR NSUF provides capability that industry needs to reduce front end cost and risk, and reduce experiment turnaround time
- Investments in R&D capability are based on industry priorities for R&D
- Industry capability mostly synergistic with DOE-NE programs and university needs, although there are some special LWR needs



Current Capability Projects

- New reactor capabilities
  - Hydraulic shuttle irradiation system (2009)
  - Pressurized water loop (2011)
  - Test Train Assembly Facility (2009)
  - In-reactor experiment instrumentation
- New PIE capabilities
  - Focused Ion Beam (2009)
  - Micro x-ray diffraction (2009)
  - In-cell mechanical testing (2009)
  - Scanning thermal diffusivity (2009)
  - Electron probe micro-analyzer (EPMA, 2010)
  - Environmental crack growth rate testing (2011)

Need for capability validated through industry advisory committee (ANIAC), user workshops and surveys, and Scientific Review Board (SRB)



In-reactor Instrumentation

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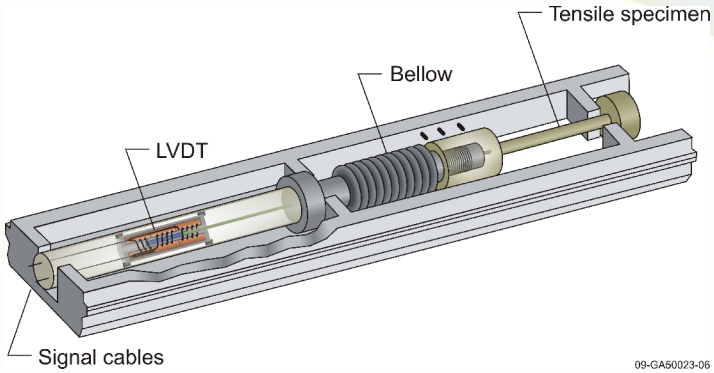

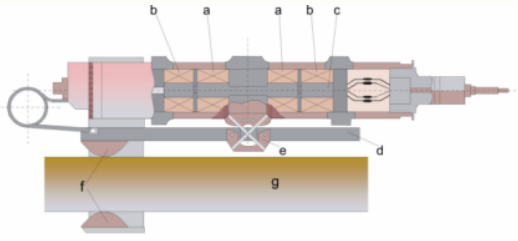

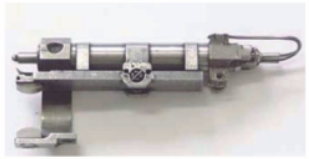

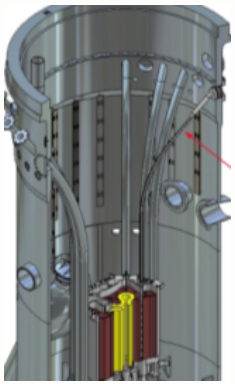

- In-core methods currently available or being developed
  - Dimensions (LVDT)
  - Thermal Conductivity (TCs)
  - Temperatures (TCs)
  - Creep testing (bellows & LVDT)
  - On-line flux monitors
- Potential New Technologies
  - Ultrasonic techniques
  - Fiber optics
- Potential future testing capability
  - Tensile testing
  - Pressure measurements
  - Crack growth rate
  - Etc…

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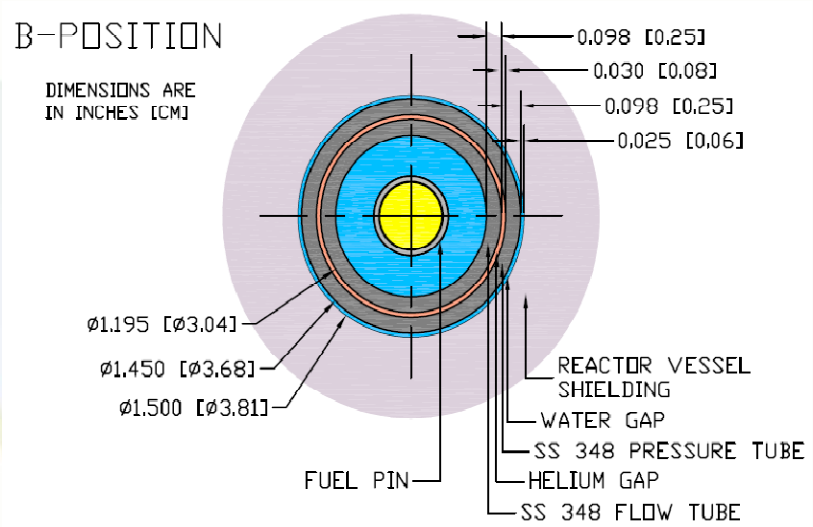
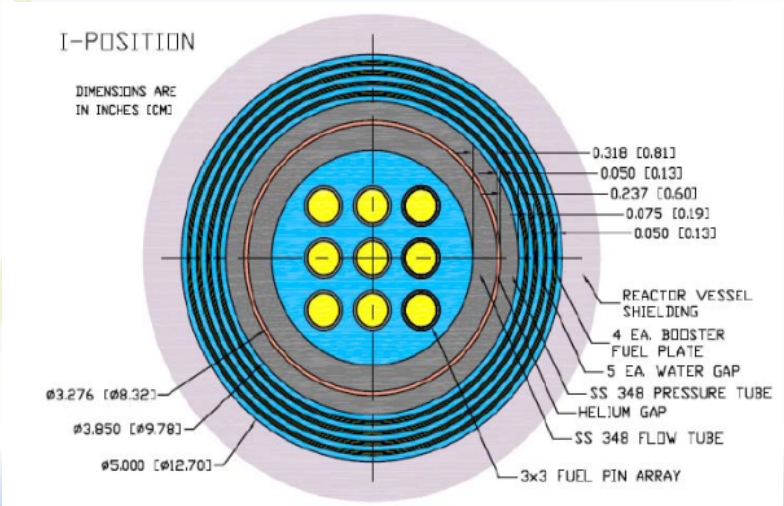
BWR Loop Development

- Currently one loop (2A) for testing both fuels and materials
- Testing to failure results in α/β contaminated loop and potential issues handling/testing specimens
- Main loops may not be suitable for testing under boiling water conditions due to reactor safety implications
- Need additional dedicated capability for fuel testing
  - PWR and BWR conditions
  - Ramp testing
  - Instrumentation for temperature, pressure, elongation, flow
- Reflector positions may offer a workable alternative





IASCC Infrastructure

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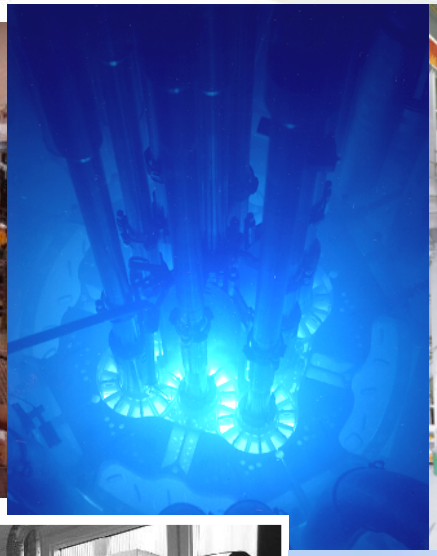

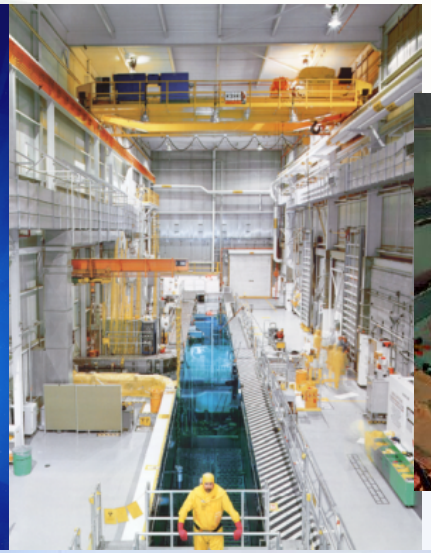

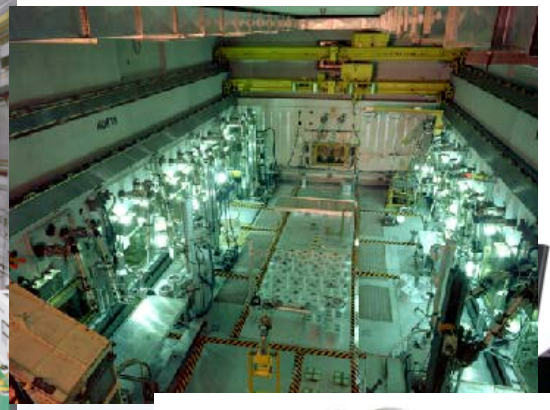

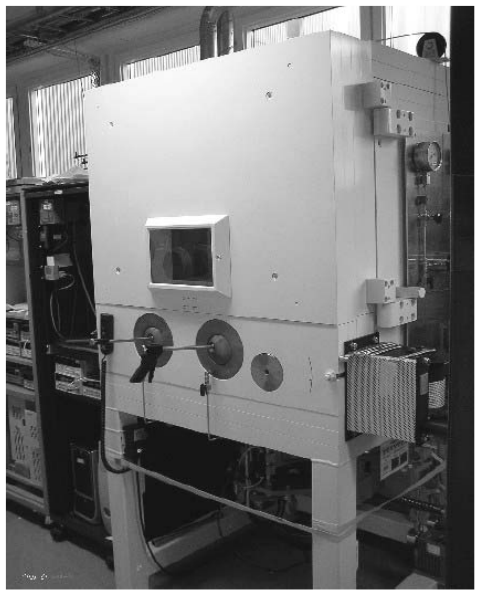

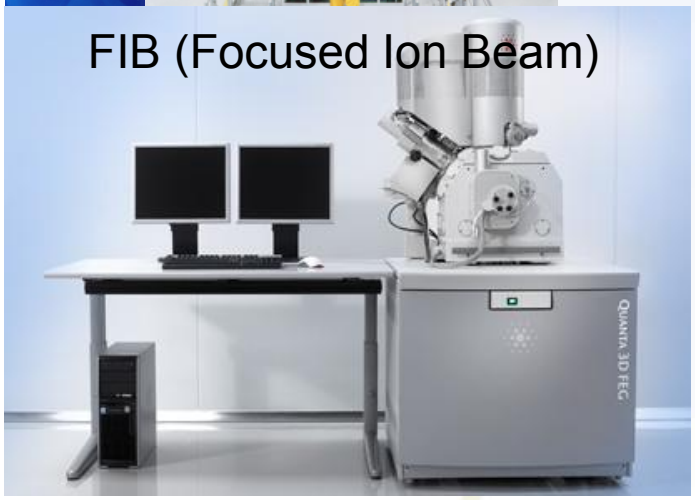

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Crack Growth Rate and Fracture Toughness Testing

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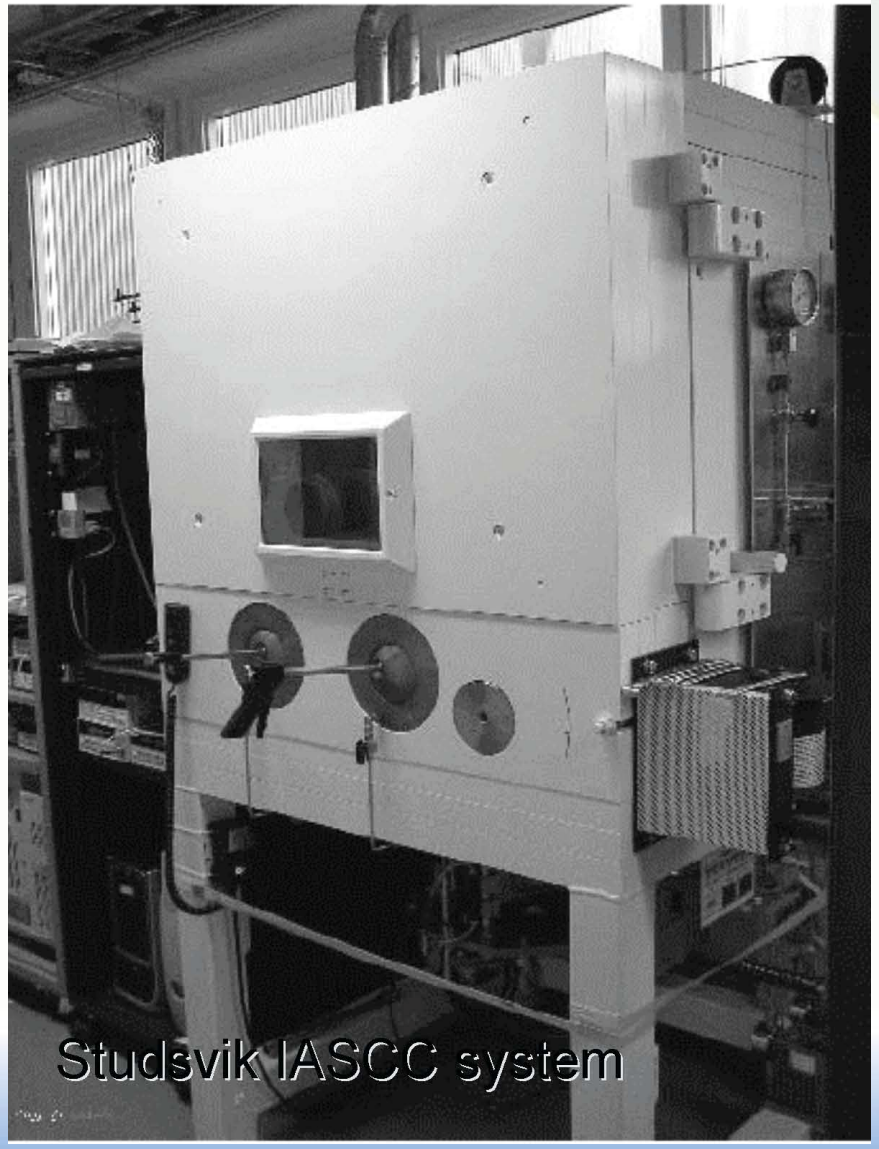

- Currently building heavily shielded system based on Studsvik design
- 20 cm lead shielding (0.4T-CT Ni alloy specimens)
- GE/PNNL/ANL/MIT involvement in design/build/validation

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IASCC Collaborations

- Massachusetts Institute of Technology (MIT)
  - Ph.D. student project related to baseline testing of nickel alloys
  - Software development
- Studsvik Nuclear AB
  - Design layout of shielded systems used for CGR testing
- GE Global Research Company
  - Assistance in system design, construction and validation
  - Water chemistry control system design
- Argonne National Laboratory (ANL)
  - Expertise on regulatory issues related to LWR material degradation
- Pacific Northwest National Laboratory (PNNL)
  - Assistance in system design, construction and validation

ATR NSUF Partnerships

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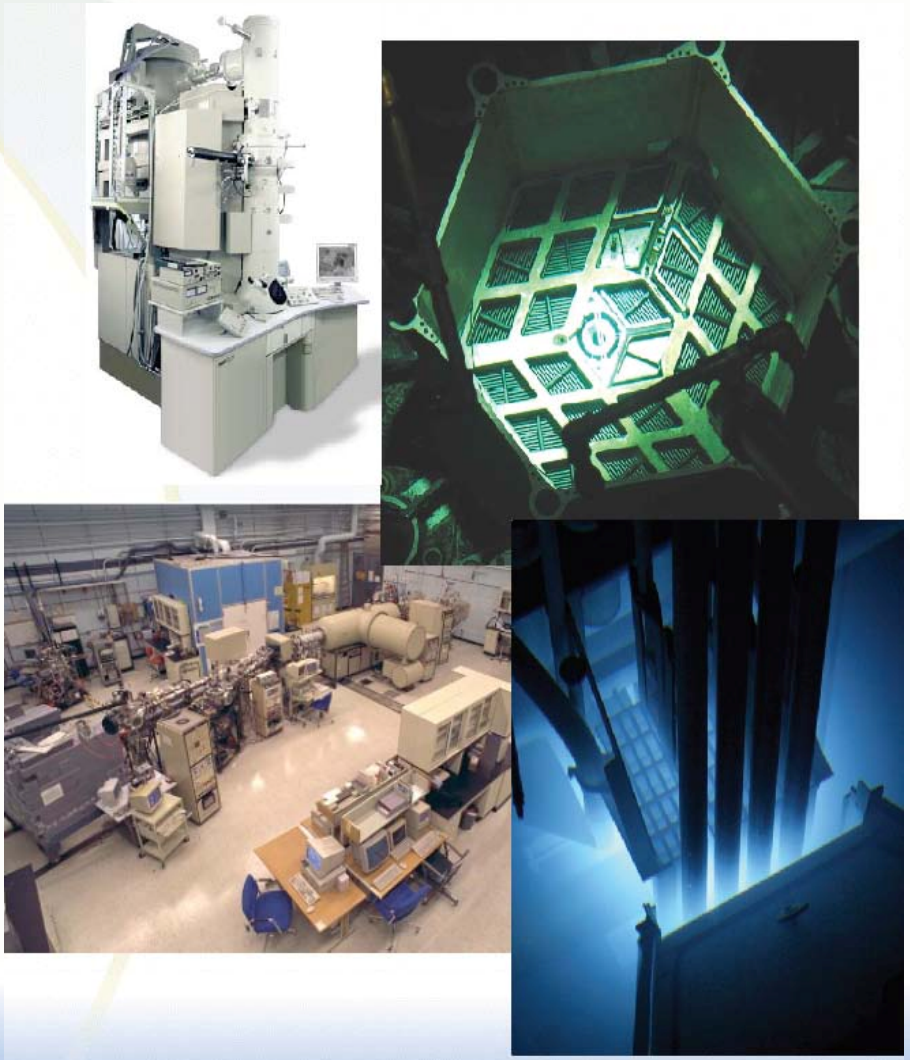
- ATR NSUF aims to meet customer needs
- ATR NSUF includes additional (non-INL) capability that benefits users
  - University research reactors (MITR, Pulstar)
  - Hot cells or hot laboratories (UM, UW)
  - Accelerator facilities (UW, UM)
  - Analytical capability (UNLV)
- Process
  - Potential university partners self-nominate
  - Expert group evaluates nominations
  - Capabilities added to next proposal solicitation



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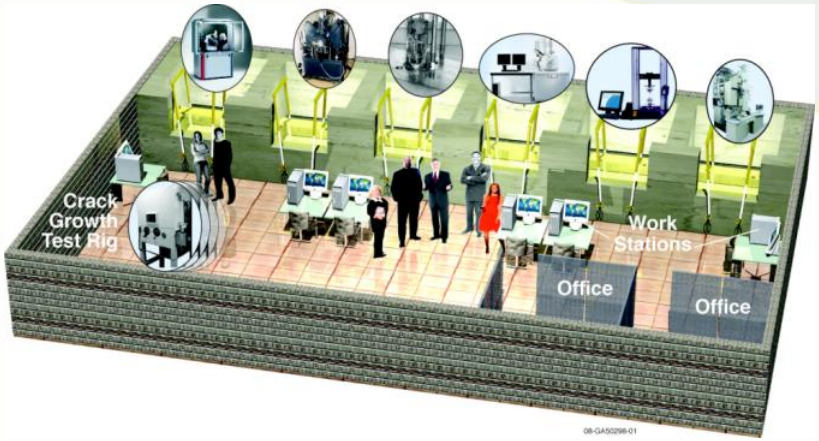
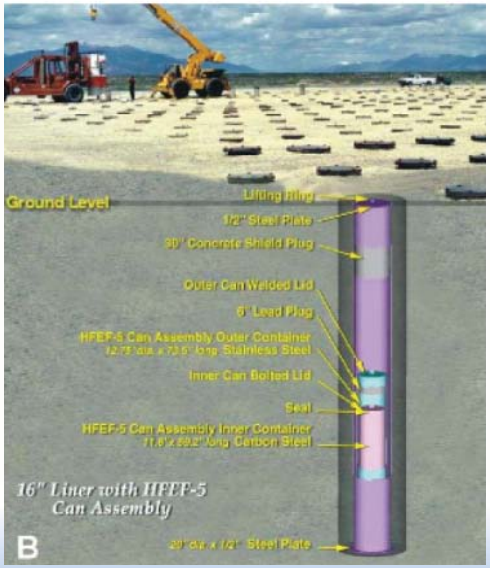
Future Research Capability

- In-reactor instrumentation capability that is world-class
- Develop capability to routinely conduct commercial fuel testing
- Wide range of post-irradiation mechanical testing capabilities for materials and fuels
- Advanced characterization tools uniquely applied to post irradiation analysis of fuel and material performance
- Expand university/industry/national lab/small business collaborations and partnerships that maximize research dollars spent
- Long-term irradiation and testing programs for core internal materials and RPV steels

4. Supporting Infrastructure





- Transportation
- Efficient safety analysis processes
- More effective/efficient PIE by locating major analytical equipment in the same facility (IMCL)
- Waste management

Transportation Capabilities

- Currently handle NAC-LWT, FSV, GE-100, GE-2000, T-2, T-3, HFEF-X, numerous other site specific casks
- Fort St. Vrain Cask
  - Certificate of conformance modification submitted to NRC
  - New inner shielded cask insert – LWR fuel
- Currently defining requirements for acquiring a flexible, mid-size cask

GE-2000 in HFEF

Core Safety and Experiment Modeling

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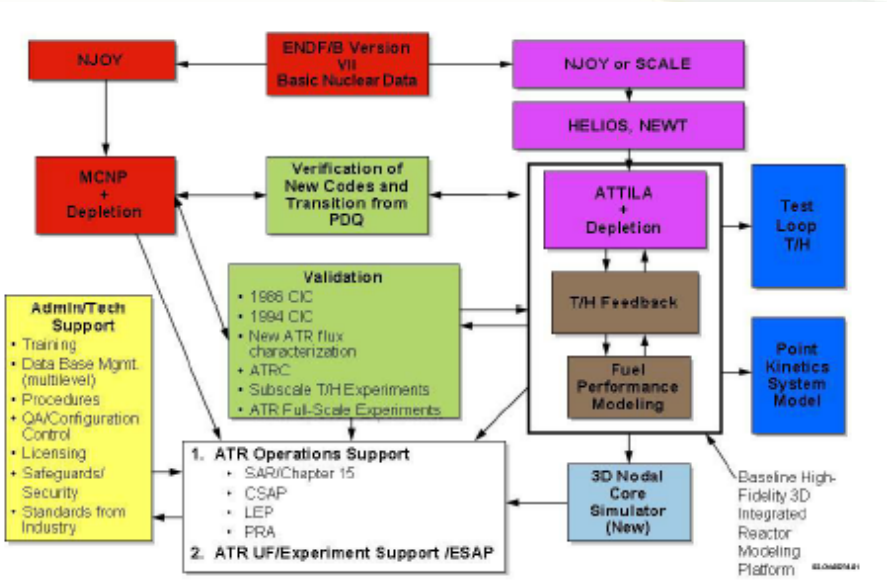

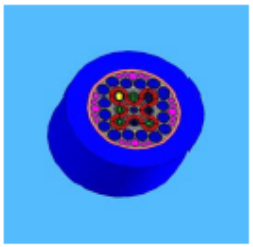

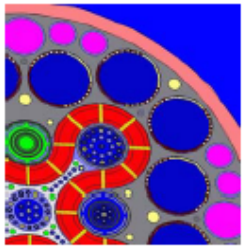

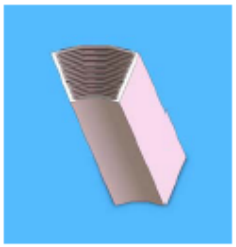

- Current core safety modeling process leads to:
  - High experiment cost
  - Overly conservative, arbitrary ‘safety’ decisions
  - Lack of experimental flexibility
- Core safety analysis process currently being upgraded using Attila as a tool for full core 3-D analysis
- Experiment analysis process projects coupling CAD models to MCNP funded as an FSRT (Faculty Student Research Team)

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