Advanced Test Reactor Experiment Research Program

Frances M. Marshall
S. Blaine Grover

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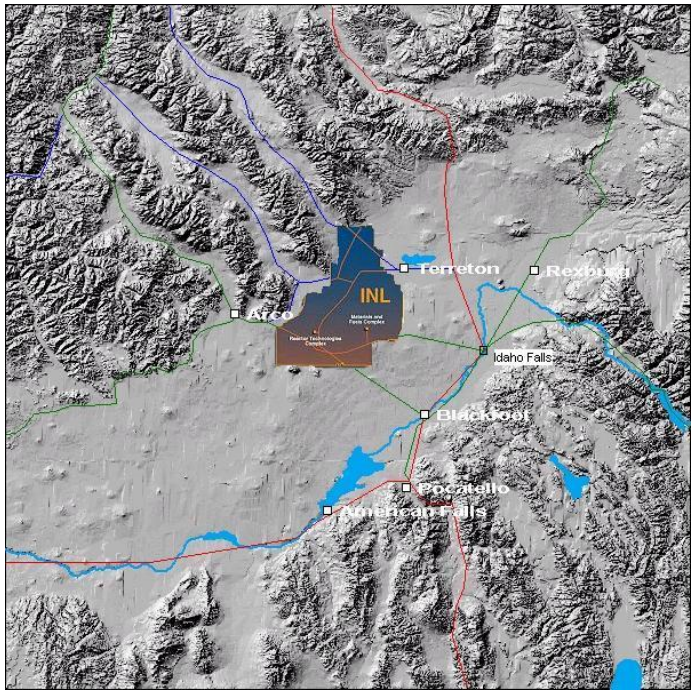

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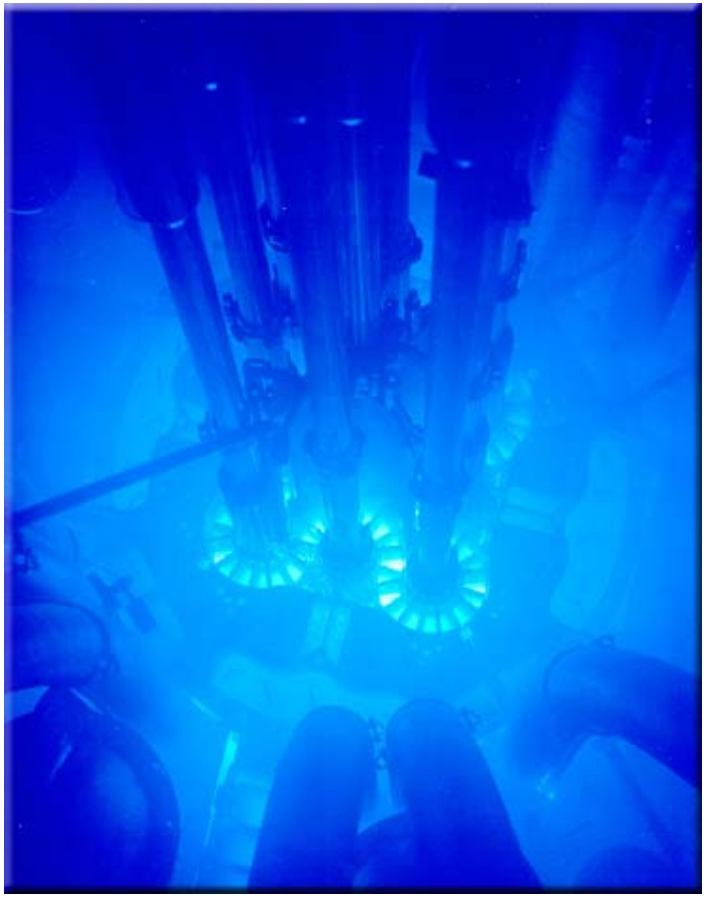
Presentation Outline

- Advanced Test Reactor (ATR) Description Summary
- Experiment Configurations and Capabilities
- Current Research
- Proposed Research
- Planned Enhancements
- Summary



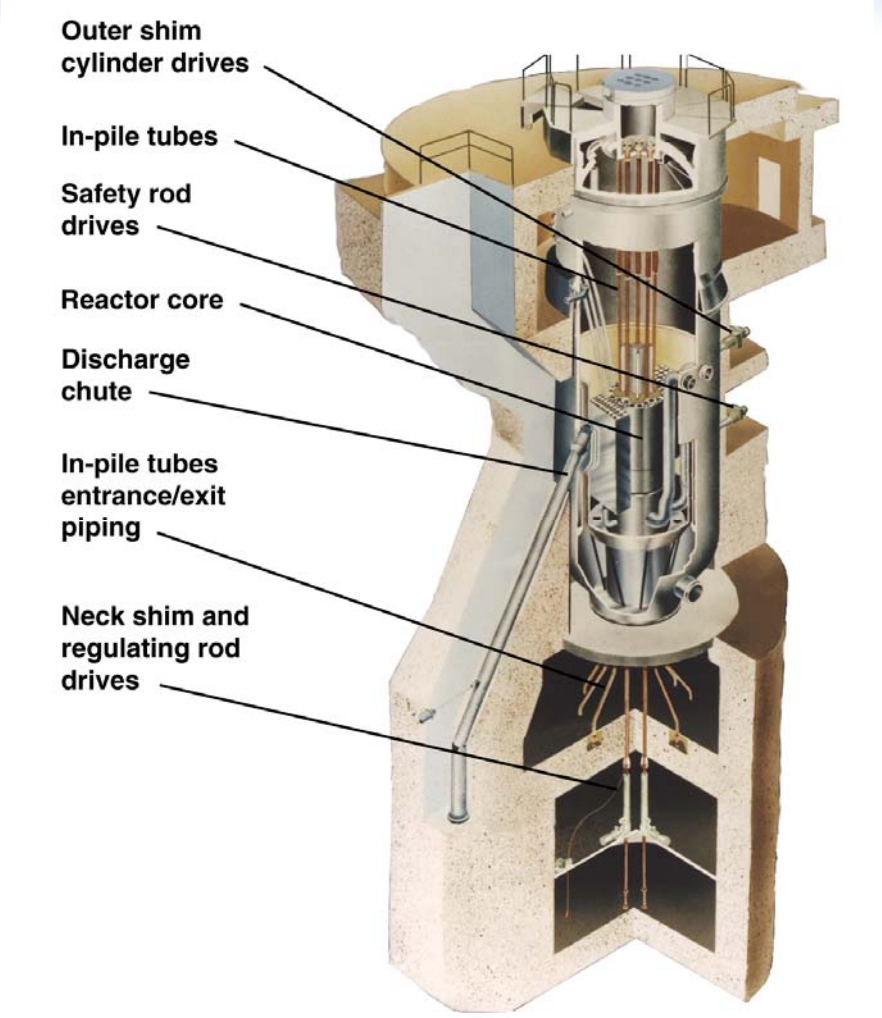
ATR Description

Reactor Type
Pressurized, light-water moderated and cooled; beryllium reflector
250 MWt design

Reactor Vessel
12 ft (3.65 m) diameter cylinder,
36 ft (10.67 m) high stainless steel

Maximum Flux, at 250 MW
1×10^{15} n/cm^2-sec thermal
5×10^{14} n/cm^2-sec fast

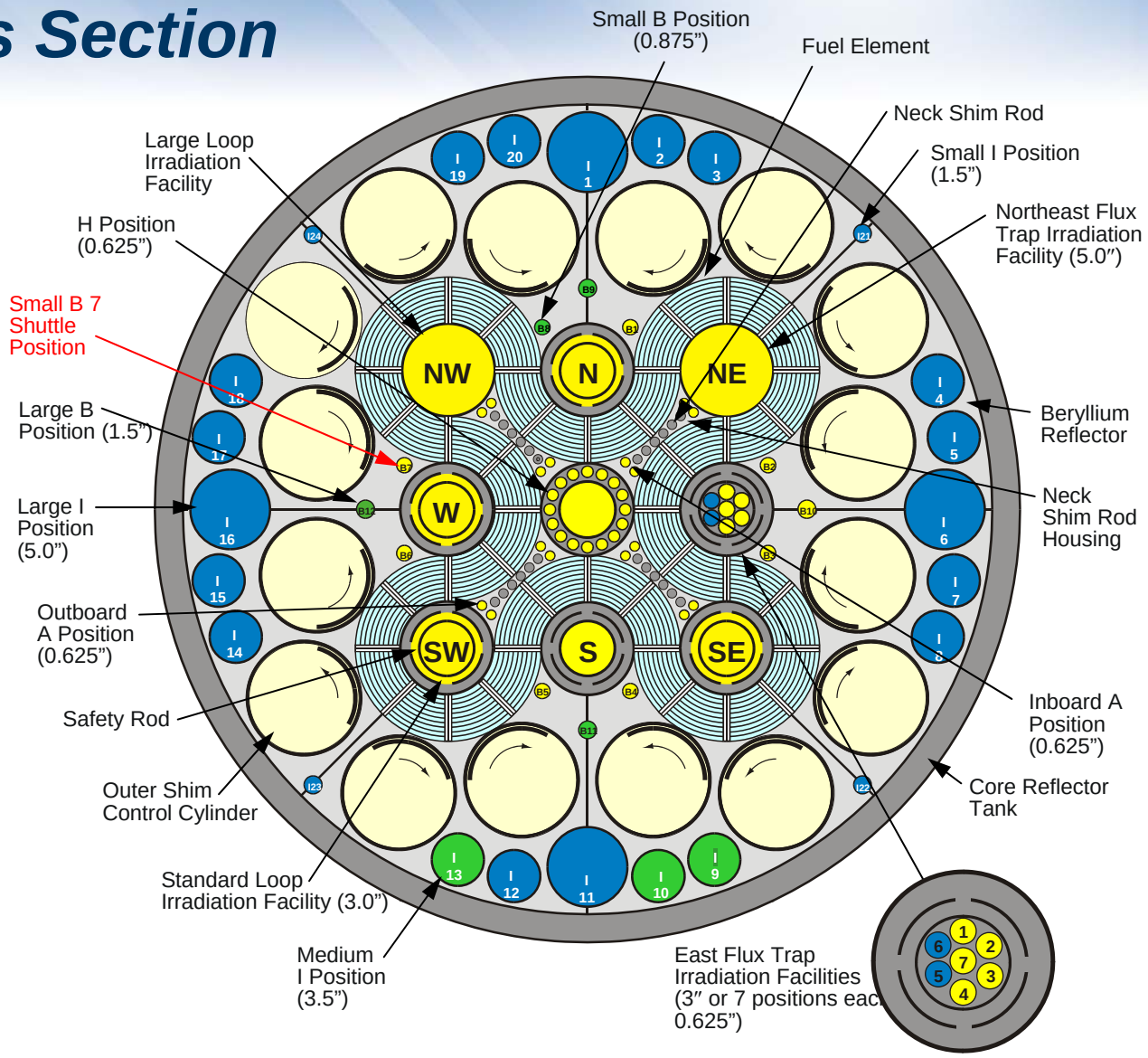
Reactor Core
Fuel length – 48” (122 cm)
U-Al plates – 19/assembly



ATR Core Cross Section

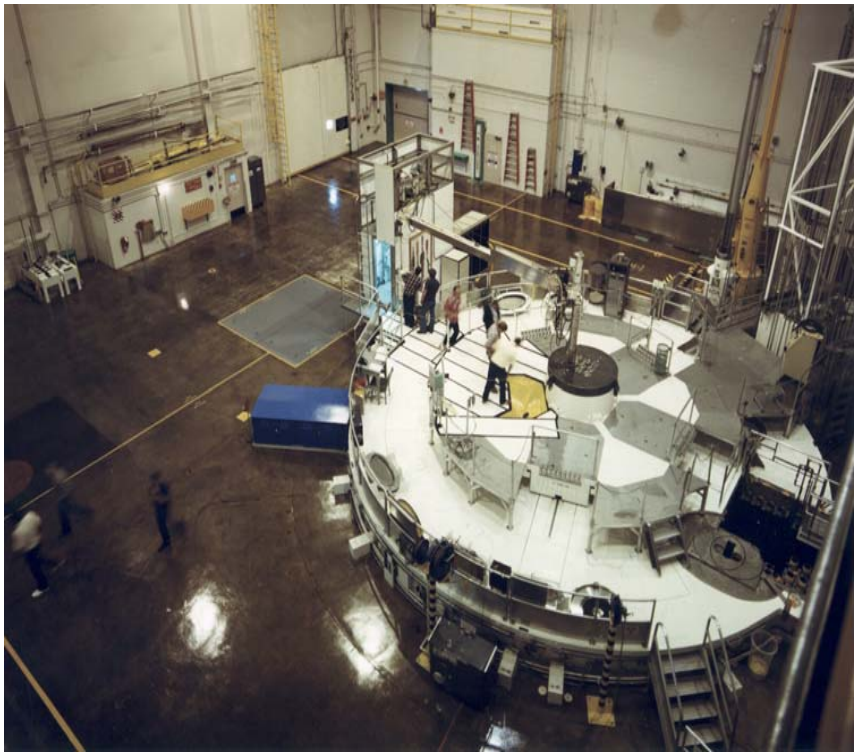
77 irradiation positions
- 4 flux traps
- 5 in-pile tubes
- 68 in reflector

Currently in use
Planned future use (within 18 months)
Currently unplanned for 2010



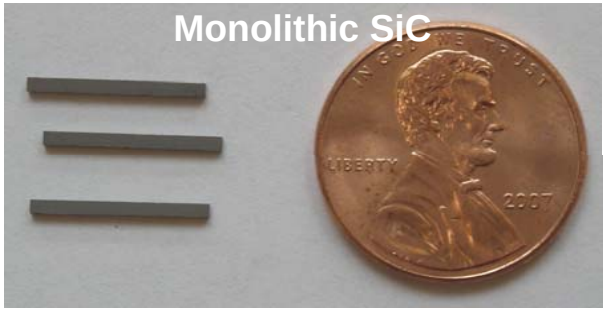
ATR Operations

- Operating Cycles
  - Standard operating cycle is 6 to 8 weeks
  - Occasionally short high power cycles of 2 weeks
  - Standard reactor outages are 1 or 2 weeks
  - Operations for ~ 240 days per year
- Core Internals Changeout (CIC), every 7 to 10 years
- ATR Critical Facility – used for reactivity measurements
- Manual Fuel and Experiment Handling



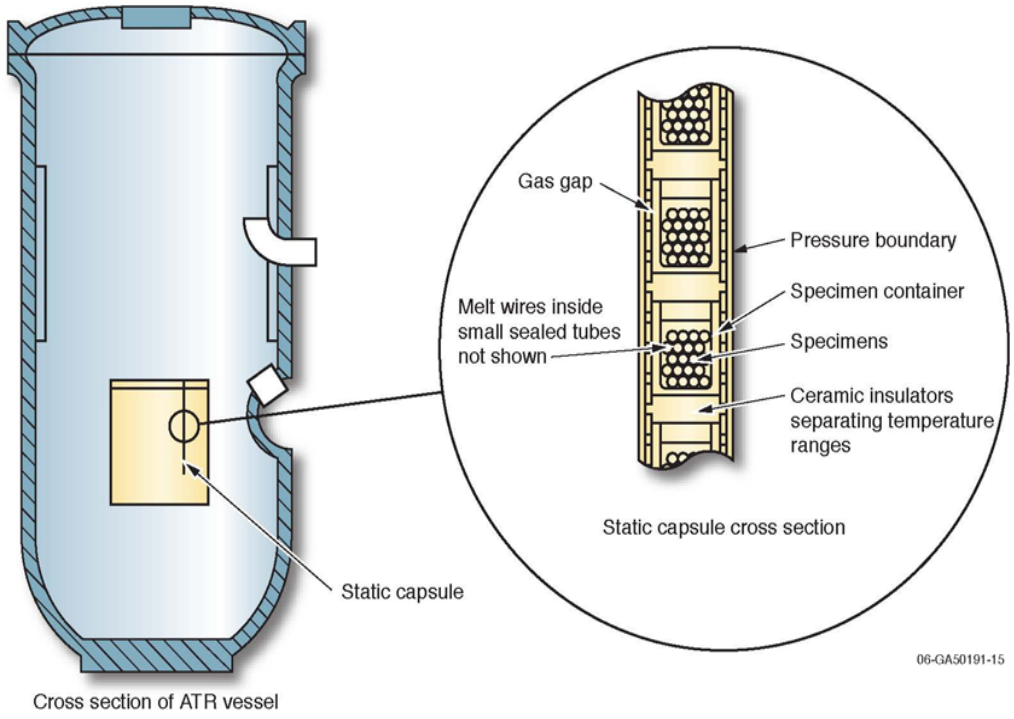
Current ATR Irradiation Projects

- Naval Reactors Materials
- Advanced Fuel Cycle Initiative (AFCI)
- NGNP, Particle Fuel and Graphite
- National Scientific User Facility (NSUF) Materials
- Tritium Barrier Material
- RERTR Fuel
- Cobalt-60
- Zirconium



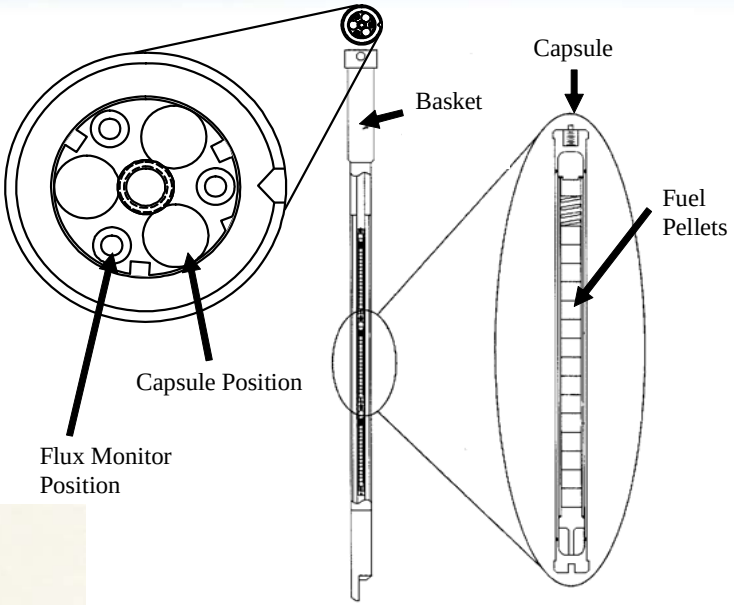
Simple Static Capsule Experiments

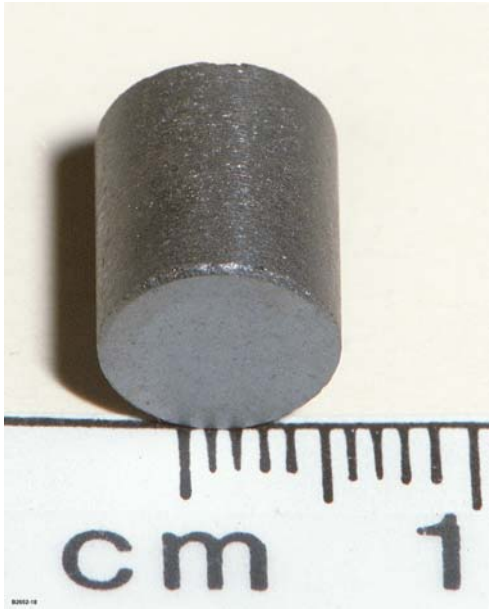
- Passive instrumentation (flux wires, melt wires)
- Enclosed in sealed tube, or fuel plates
- Temperature target controlled by varying gas mixture in conduction gap and with material selection
- Lengths up to 122 cm; diameter 1.27 – 12.7 cm
- Co-60, AFCI, NSUF, RERTR, MOX



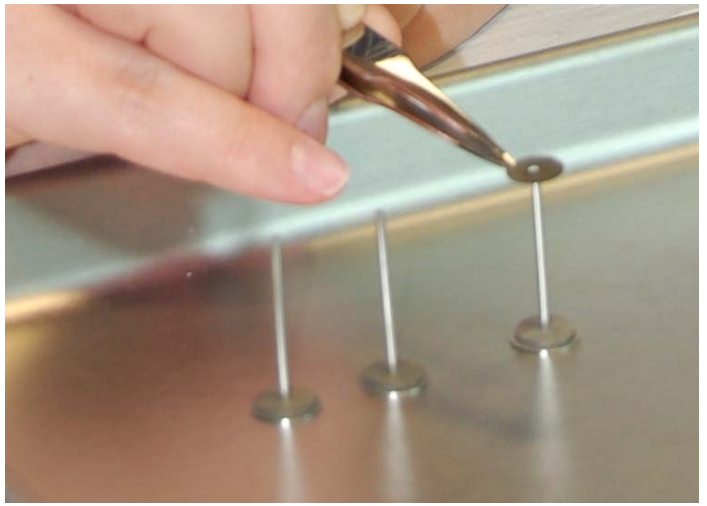
Mixed Oxide Fuel Test

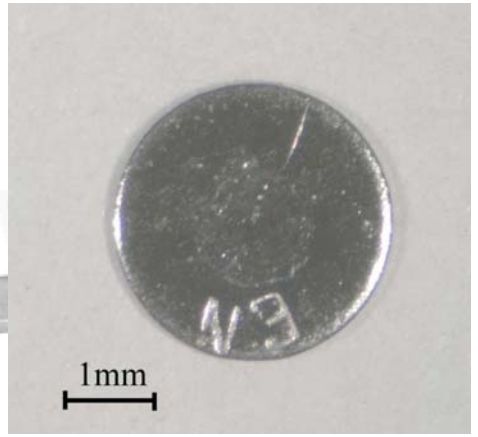
- PWR temperature at surface of fuel pin cladding
- Linear heat rate requirements
  - 6 KW/ft minimum
  - 10 KW/ft maximum
- Fuel burn-up levels
  - 8 GWd/t minimum
  - 50 GWd/t maximum





NSUF Experiment Fabrication – Sample Loading

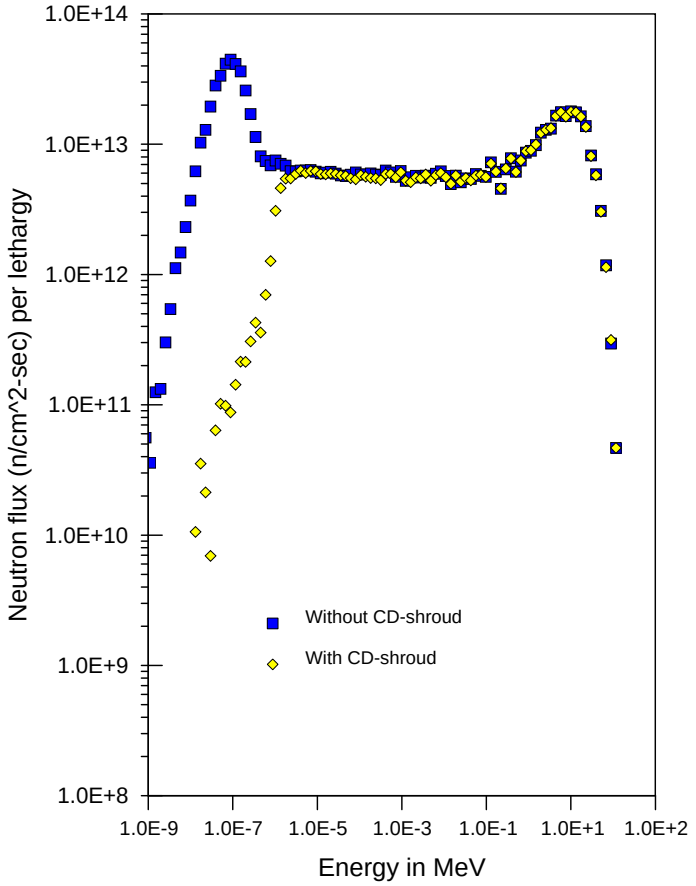




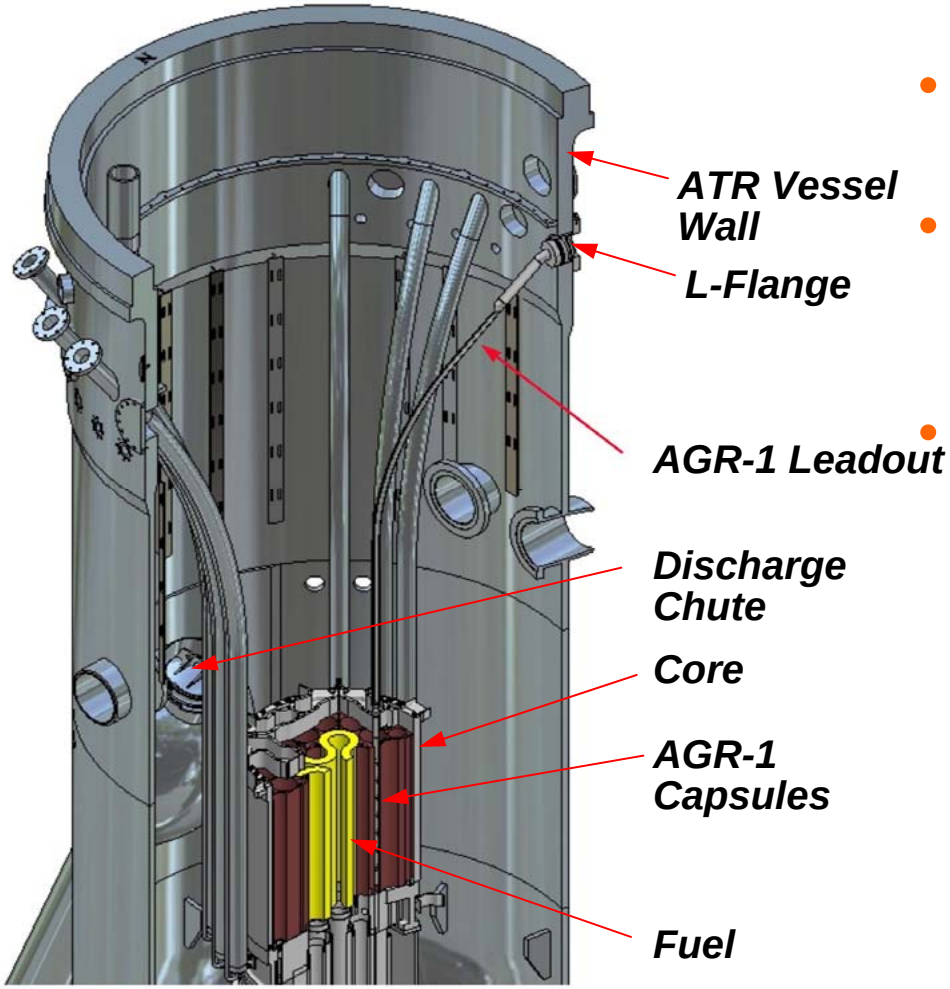
AFCI Flux Spectra with Cadmium Sleeved Basket

- Hard Spectrum Achieved in ATR by Use Of .045 inch Thick Cadmium
- > 97% of Thermal Flux is Removed

	Thermal neutron flux (E < 0.625 eV) n/cm^2-sec	Fast neutron flux (E > 1.0 MeV) n/cm^2-sec
With CD-shroud	8.46E+12	9.31E+13
Without CD-shroud	3.71E+14	9.39E+13
Ratio	2.28%	99.14%
Note: the flux tallies are normalized to a E-lobe power of 22 MW.		



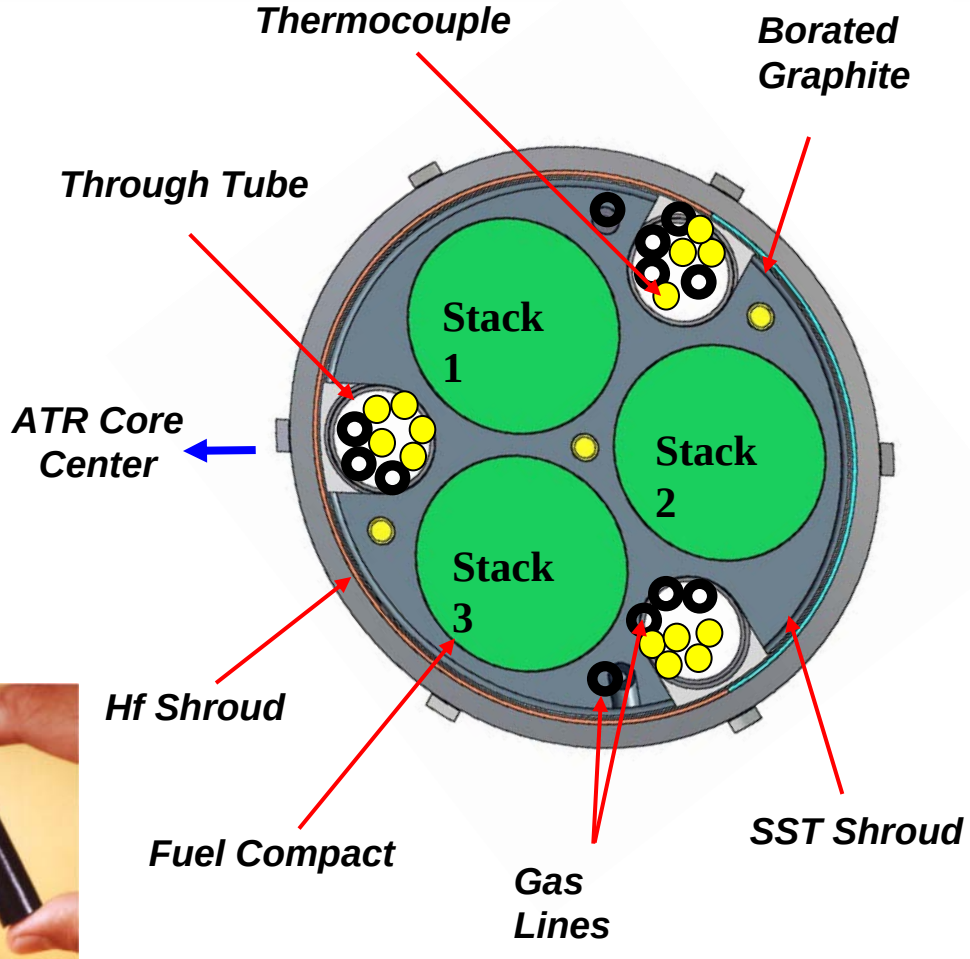
Instrumented Lead Experiments



- On-line experiment measurements
- Temperature control range 250-1200° C, within +/- 5° C
- Gas Control and Monitoring Options
  - Tritium Monitors
  - Moisture Monitors
  - Fission Product Monitors
  - Compression Creep
  - Oxidation Measurements on Graphite Experiment
- AGR, AGC, TTP, Magnox

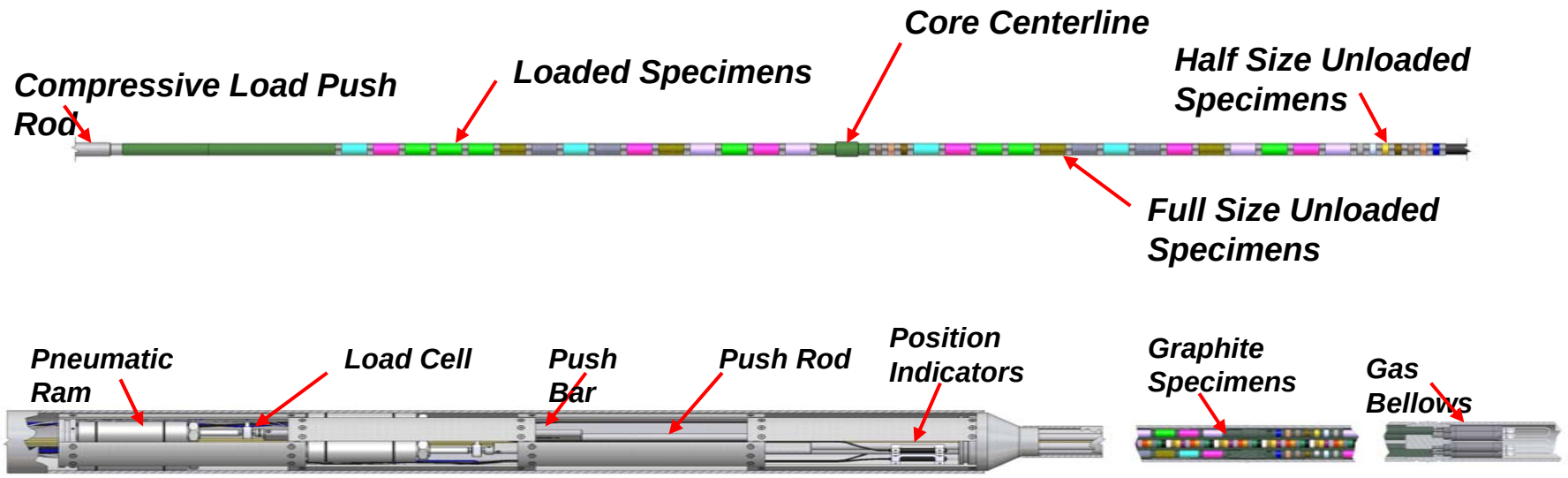
Advanced Gas Reactor (AGR) Fuel Program

- Development of Fuel for the Next Generation Nuclear Plant
- AGR-1 Experiment
  - TRISO-coated, Uranium Oxycarbide (UCO)
  - Low Enriched Uranium (LEU), <20% enrichment



Advanced Graphite Capsule (AGC) Experiments

- Experiments will be conducted at:
  - 600, 900 and 1200ºC
  - 4 to 7 dpa fast neutron damage levels (5.5 and 9.6 x 10^{21} n/cm^2 for E > 0.1 MeV)
  - Compressive loads of 2 to 3 ksi (14 to 21 MPa)
- Total of Eight Tests



Test Train Assembly

- Induction brazing of instrument leads (e.g. thermocouples) to penetrate capsule boundaries
- Electro-plating, typically in support of induction brazes
- Heat treatment and (specimen) vacuum drying ovens
- Welding - Standard GTAW and MIG, tube welder
- Pressure and helium leak testing

Pressurized Water Loop Tests

- Five Flux Trap Positions Currently have Pressurized Water In-pile Loop Tests (1 large diameter, 4 small diameter)
- Separate from ATR Primary Coolant System - can meet current PWR operating conditions (2235 psig, 650F)
  - Temperature
  - Pressure
  - Flow
  - Chemistry control systems
  - Transient testing capabilities (cycle/seconds)
- Potentially feasible to simulate boiling water reactor void conditions

ATR Standard Loop Layout

Proposed Irradiation Tests

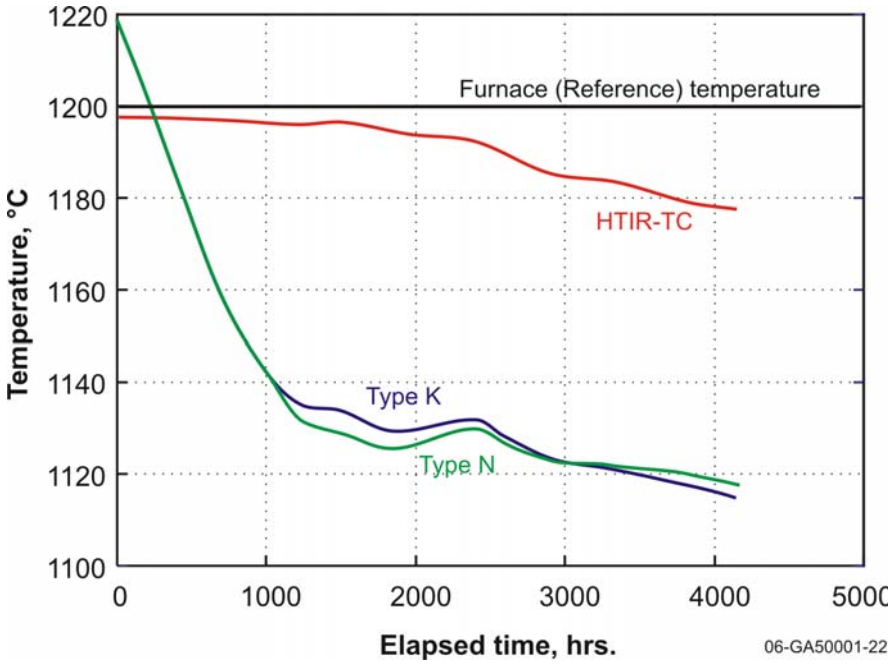
- Isotopes, Industrial and Medical Applications
- Light Water Reactor (LWR) Material in PWR Loop - Cladding, Fuel, Control Rod Material
- Simulation of BWR Conditions for Current and New Reactors
- Advanced Fuels for Fuel Cycle
- Optical Fibers for Instruments
- Zircaloy Material for LWR Applications
- Beryllium Samples (Research Reactor Reflector Applications)
- Treated Stainless Steel
- Control Blade Material, Commercial LWR Applications
- Aqueous Reactor Structural Material

ATR Experiment Capability Enhancements

- Test Train Assembly Facility - Three assembly tables for simultaneous instrumented or loop test train assembly
- Instrumentation Development
- PWR Loop Reactivation
- Hydraulic Shuttle Irradiation System
- Post Irradiation Examination
  - 2009 Focus in Irradiation Assisted Stress Corrosion Cracking
  - Collaboration with other NE programs (NGNP, RERTR) on Metallography Containment Box in HFEF

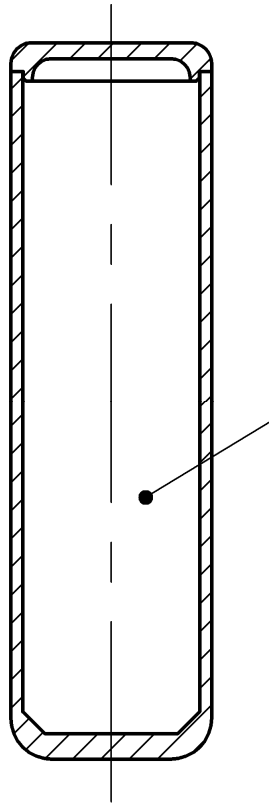
Experiment Measurement Capabilities

- Flux Wires
  - Co-Al
  - Fe-Ni
  - Others
- Tritium Monitors
- Moisture Monitors
- Thermocouples
  - High Temperature
  - SiC Thermal Resistivity
- Fission Product Monitors
- Specimen Creep
  - Tension (in development)
  - Compression
- Oxidation Measurements on Graphite Experiment



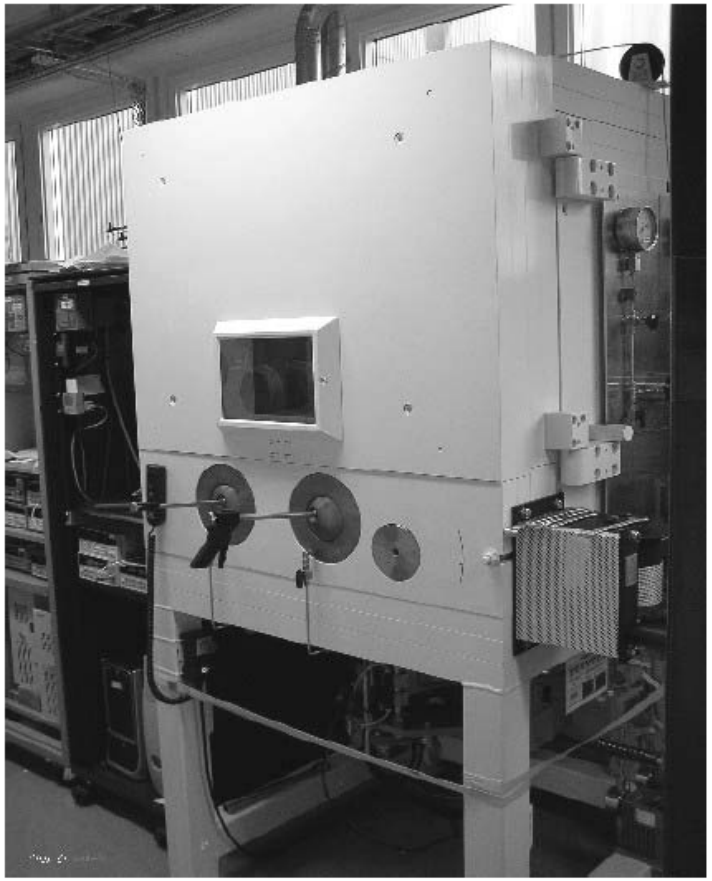
Hydraulic Shuttle Irradiation System

- 14 – 18 shuttle capsules
- Simultaneously irradiated
- Dimensions:
  - ~ 0.55” ID, ~2.1” IL
  - ~ 7 cc useable volume
- ~35 gm Content Limit
- Shuttle Wall Temp:
  - ~ 180 F to 240 F
- Max. Internal Pressure
  - < 215 psig



Experimental Infrastructure for LWR Materials R&D

- PWR Loop Reactivation
- Assembly/Disassembly station in ATR canal
- Crack Growth Testing, pre-irradiation and post-irradiation
- AFCI PIE equipment
- HFEF equipment upgrades (sample preparation, gamma scanner, visual exam machine)



Summary

- Many DOE Programs Plan to Continue to Utilize ATR, with addition of new DOE programs
- Increase in ATR Interest from Other Sources
  - Isotopes
  - LWR industry
  - Private companies
- Multiple Programs Continue to Invest in Capability Enhancements and Personnel Skills
- DOE Commitment for Long Term Utilization of ATR