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Qualifying Nuclear Components for Experiment Containment in the Transient Reactor Test (TREAT) Facility

September 2019

Devin D Imholte, Clint Baker, Nicolas E Woolstenhulme

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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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Qualifying Nuclear Components for Experiment Containment in the Transient Reactor Test (TREAT) Facility

D.D. Imholte, N.E. Woolstenhulme, C.C. Baker

DEVICE-MTR Workshop

Session B – Quality Standards and Qualification

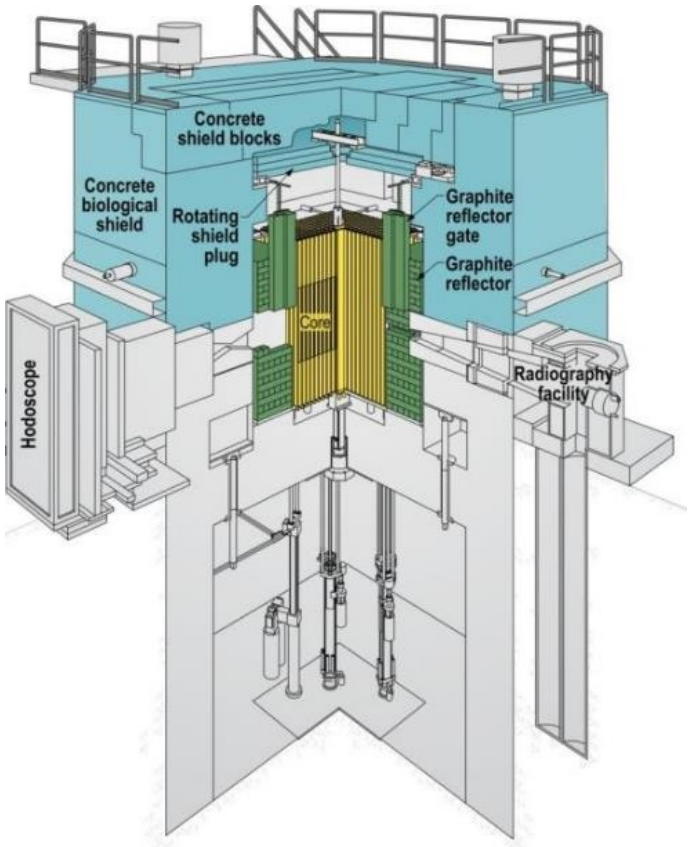
Wednesday September 25th, 2019

Outline

- TREAT Review
- Minimal Activation Retrievable Capsule Holder (MARCH) Concept
- Experiment Containment and Code-Compliance
- Experiment Capsules

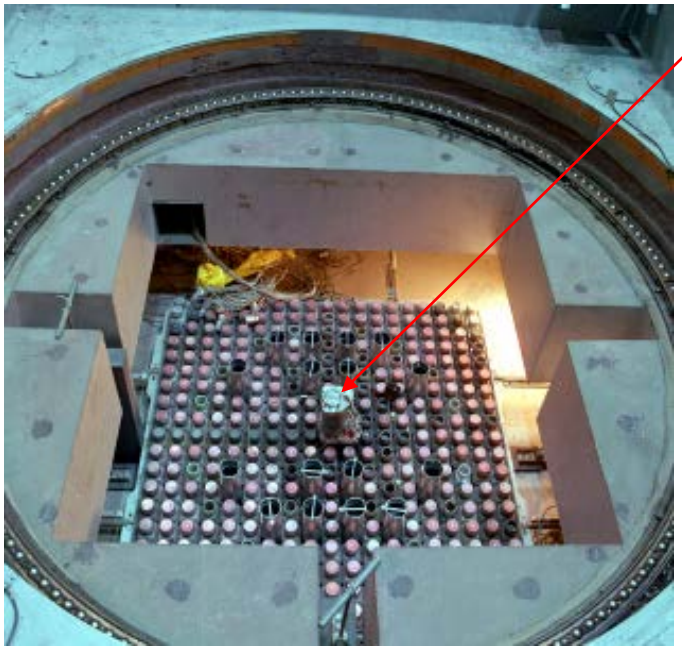
Transient REAactor Test (TREAT) Facility

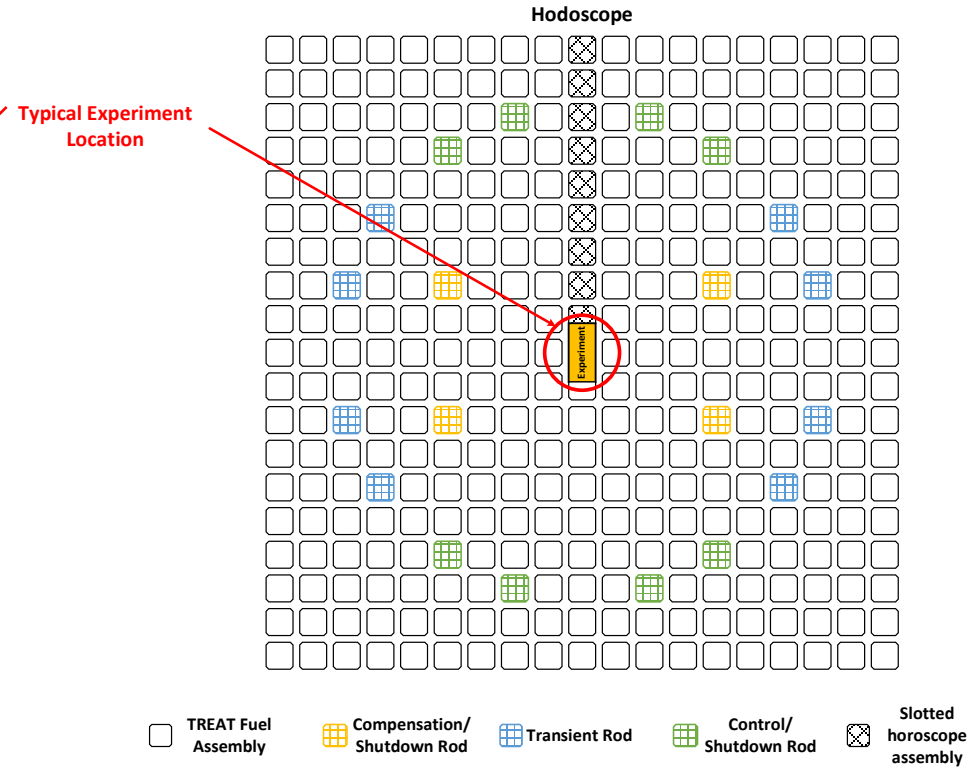
- Graphite-based transient reactor started in 1959
- Pulse transients, shaped transients and steady state irradiation
- TREAT research history
  - Light water reactor – 1960-1970
  - Sodium fast reactor – 1970-1990
  - Suspended operation in 1994
- Restarted 2018 with initial focus on LWR research



Transient REAactor Test (TREAT) Facility

- No reactor pressure vessel/containment → easy access for in-core instrumentation
- Experiments provide their own containment





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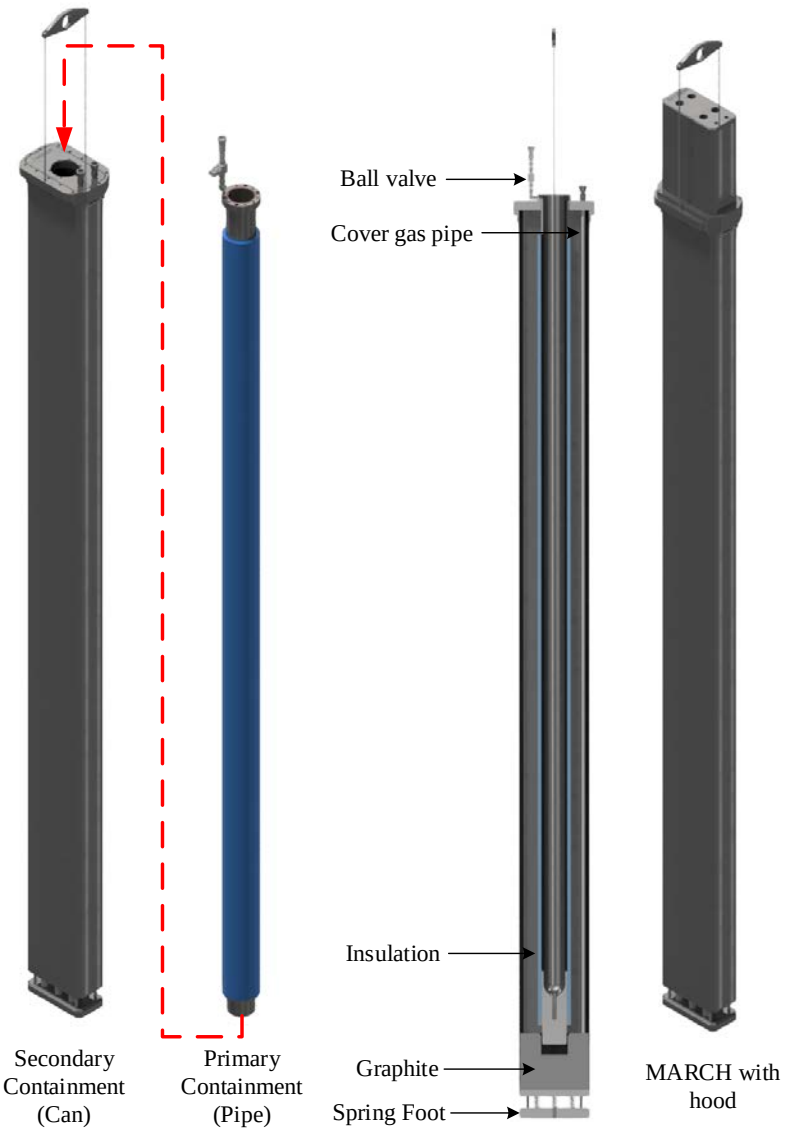
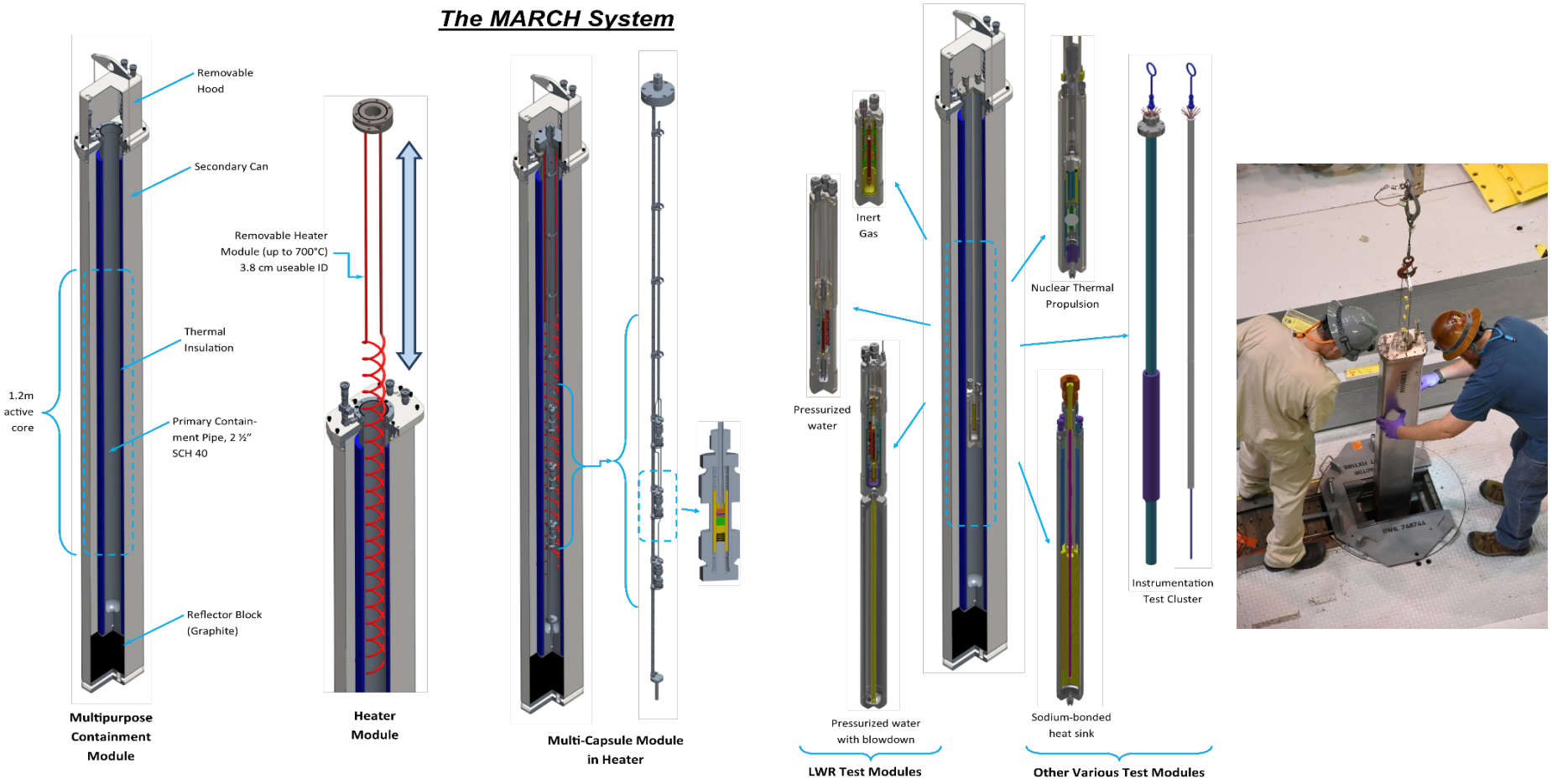
- ✓ TREAT Review
- ❑ Minimal Activation Retrievable Capsule Holder (MARCH) Concept
- ❑ Experiment Containment and Code-Compliance
- ❑ Experiment Capsules

Minimal Activation Retrievable Capsule Holder (MARCH) System

- TREAT safety requirements mandate an experiment primary containment protects against ruptures
- Secondary containment is required for certain experiments to protect against leaks (e.g., Pu-bearing, pre-irradiated fuel)
- MARCH is comprised of a primary containment (pipe) and secondary containment (can)
- TREAT mandates American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME-BPVC) containment
- MARCH allows minimal ASME BPVC rigor and cost to the experiment program



Minimal Activation Retrievable Capsule Holder (MARCH) System



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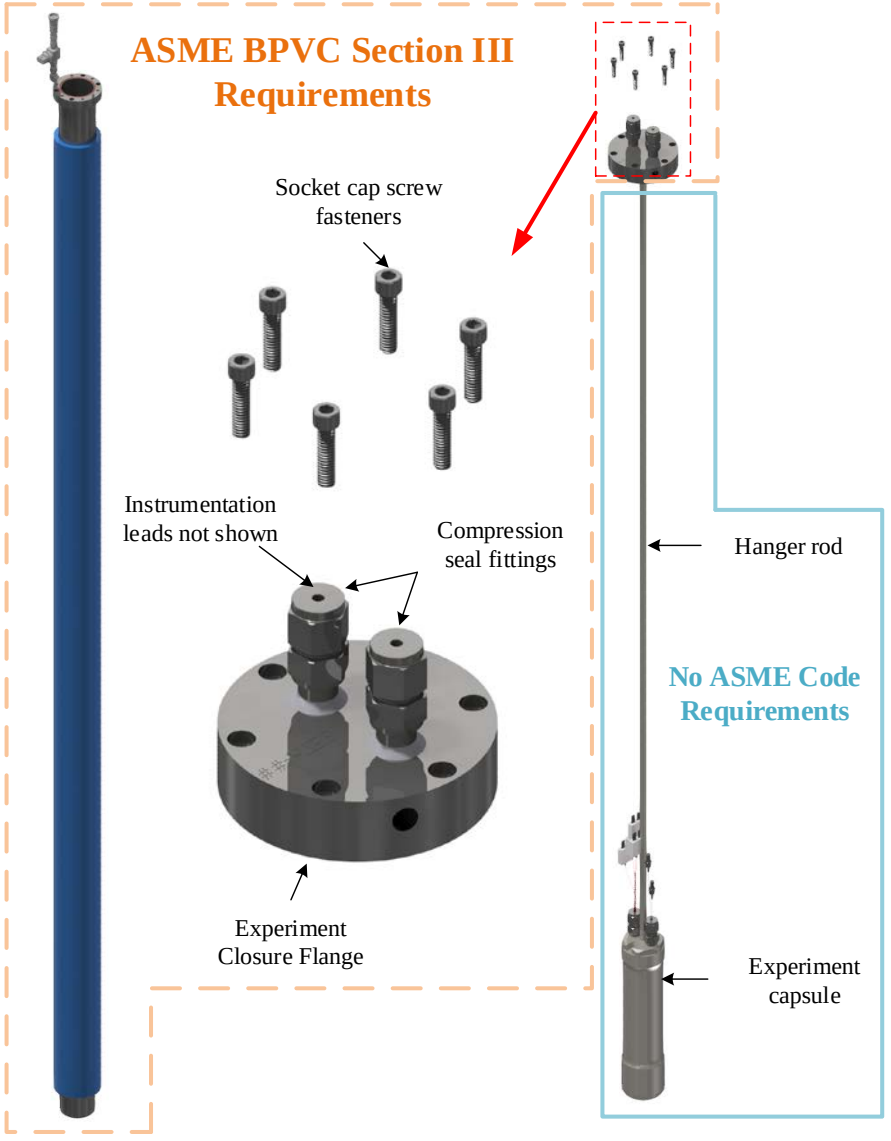
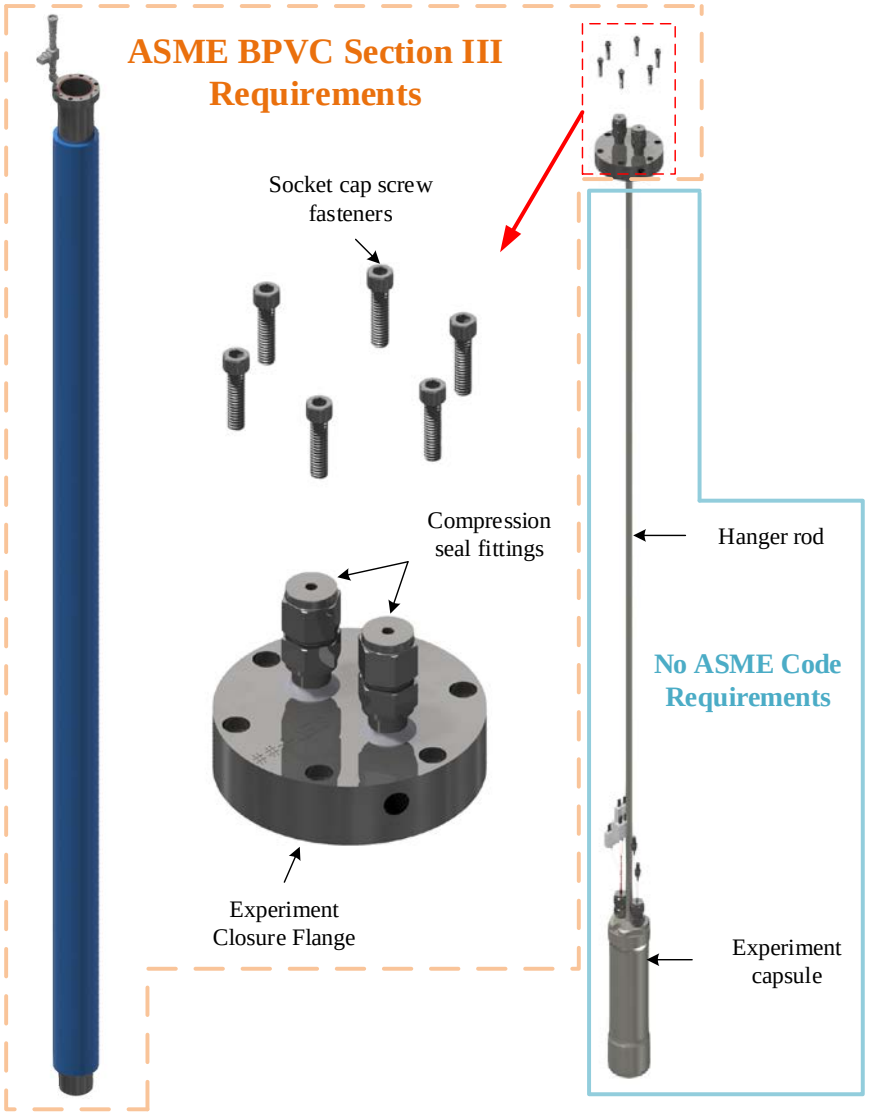
Experiment Containment Strategy

- Primary pipe + Closure Flange → Experiment Containment
- Full ASME BPVC rigor applied to flange and pipe
  - Pressure test (flange, pipe, ball valve)
  - Weld examination (radiography, visual, dye penetrant)
  - Material
- He leak test also conducted on primary containment and secondary containment (if used)
- No ASME-BPVC rigor applied to components inside pipe or instrument leads



Experiment Containment Strategy

- Compression fittings are manufactured by a non-nuclear supplier
- Fittings are commercially dedicated for nuclear use per ASME Quality Assurance Requirements for Nuclear Facility Applications (NQA-1)
- Dedication has occurred both at INL (NQA-1 certified in 2019) and by NQA-1 suppliers
- Vendor dedication has led to difficulty with long lead times and incompletion of dedication



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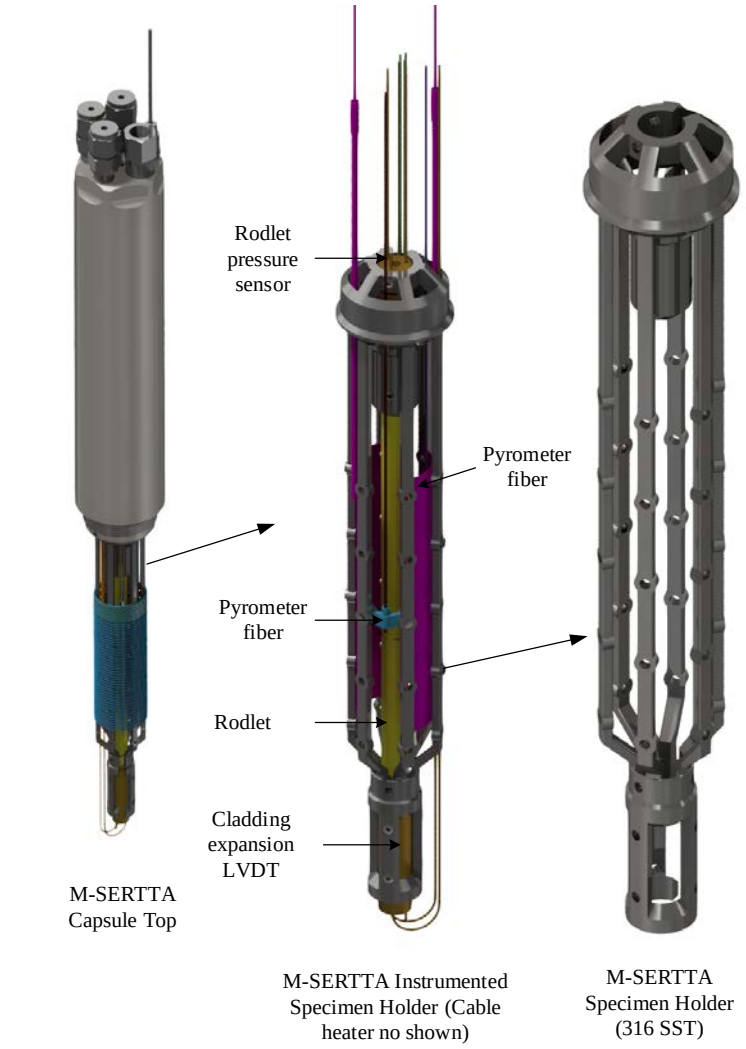
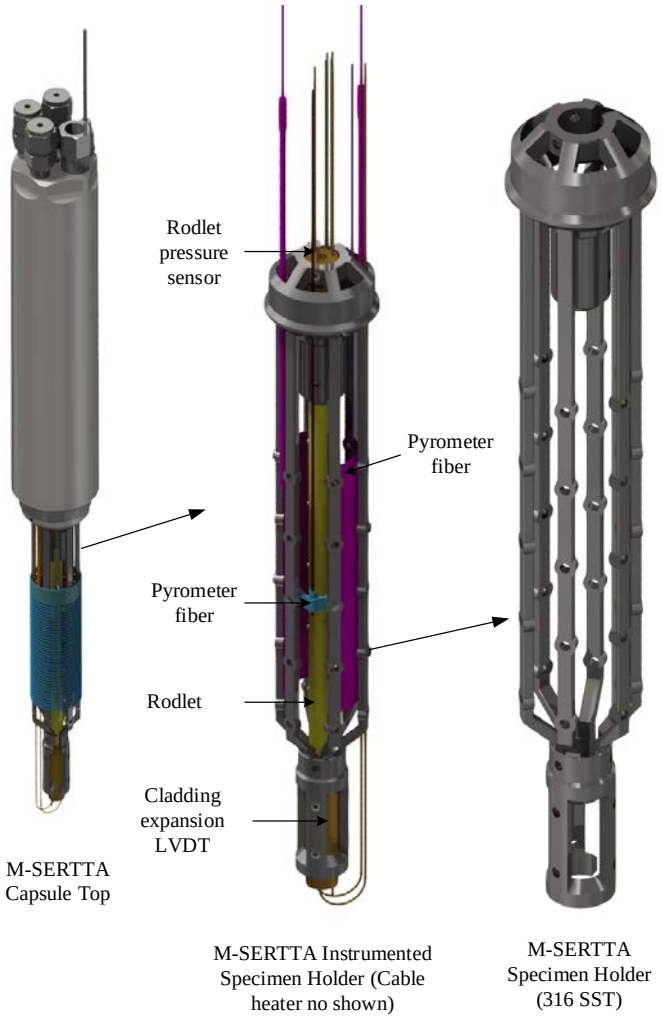
Experiment Capsules

- Experiments need only credit the primary containment, but other containment boundaries often exist:
  - Capsule
  - In-capsule specimen holder
  - Cladding
- This allows TREAT experiment designs to take advantage of additive manufacturing of complex geometries (e.g., M-SERTTA)



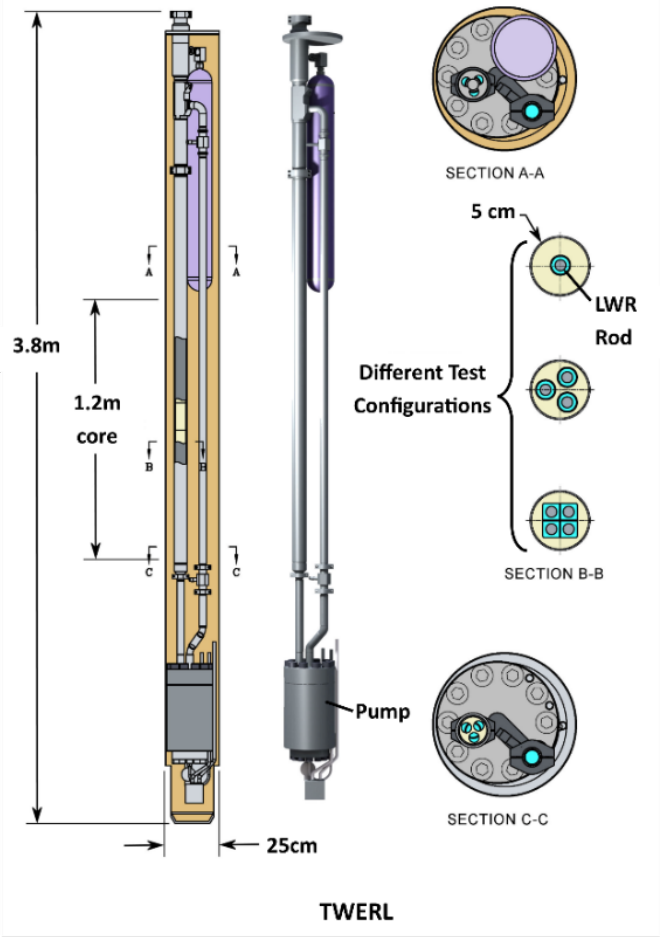
Experiment Capsules

- Capsules are leak tested, not pressure tested
- Capsules and components are printed according to appropriate standards when possible:
  - ASTM F2924 – Ti64
  - ASTM F1472 – Ti64
  - ASTM F3184 – SST
- Mechanical testing to date shows equivalent properties to cast material
- Chemical analysis was conducted for Ta impurity
- Mechanical testing is underway for tensile specimens printed by different vendors



Summary

- Programmatic efforts are focused on optimizing experiment components for data objectives
- Primary containment is tasked with serving the safety function
- Larger experiments (e.g., loops) will require a different containment system
- Water loop and Na loop system designs are under development



Self-contained water loop concept

Thank you!

Questions?

Devin.Imholte@inl.gov