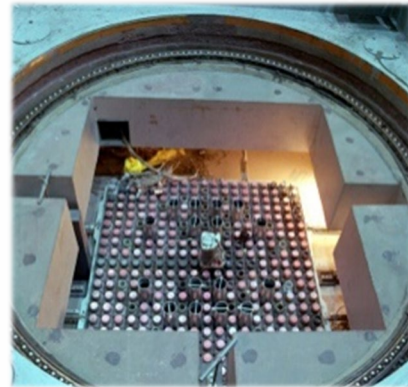


The Transient Reactor Test Facility (TREAT)

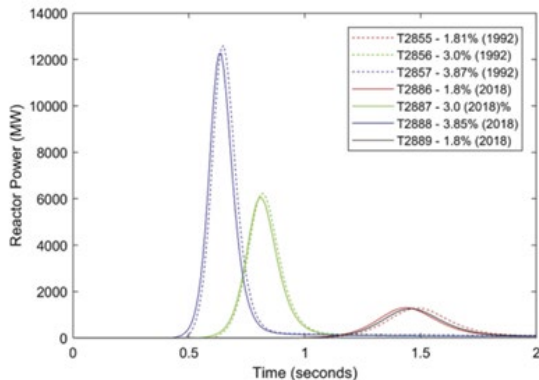
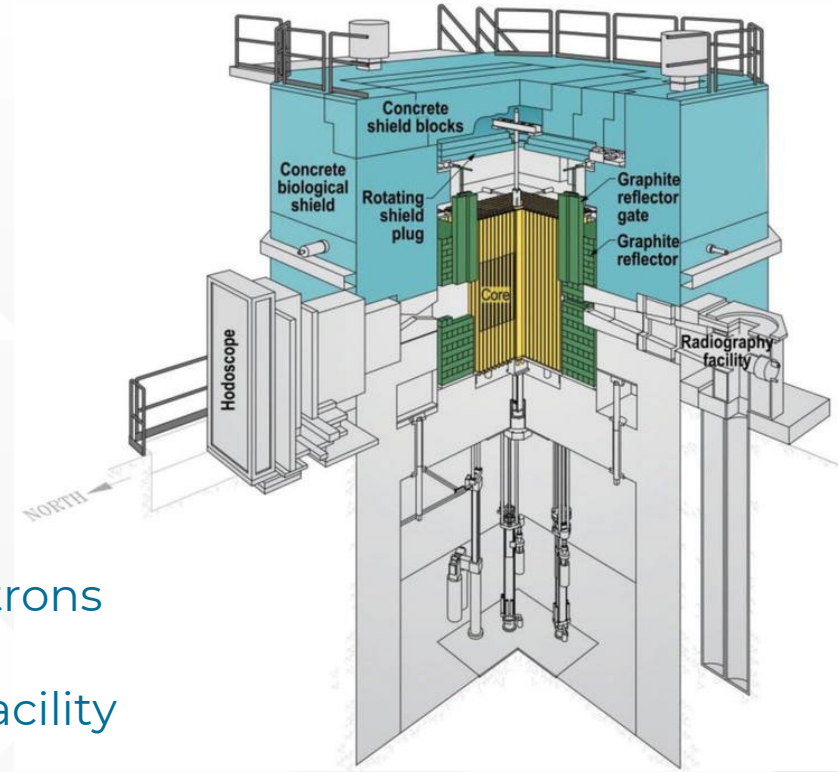
N. Woolstenhulme, D. Crawford

7/9/2024

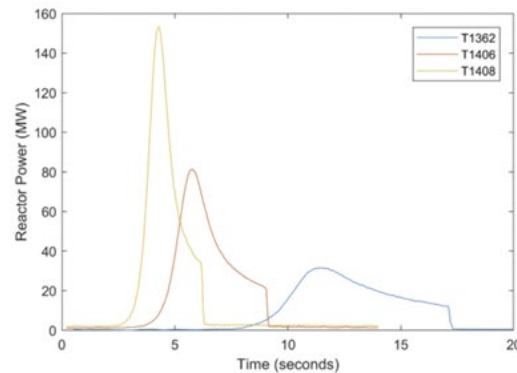


Background on TREAT

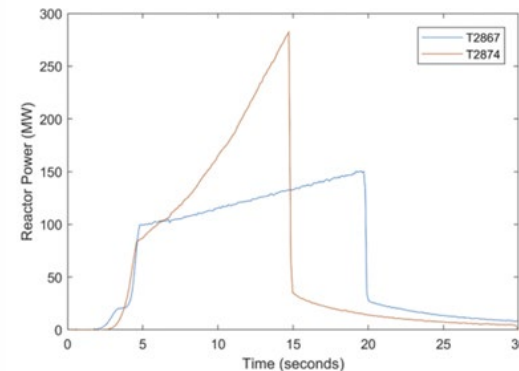
- TREAT operated from 1959-1994, later refurbished & resumed operation in 2017 to support fuel safety testing
- Zircaloy-clad graphite/fuel blocks comprise core
 - Virtually any power history possible within ~2000 MJ core transient energy capacity
 - From milliseconds to minutes: Pulses, Ramps, LOCA
- Fuel motion monitoring system “hodoscope” observes fast neutrons emitted from specimens to track fuel relocation in real time
- Reactor also can be a neutron source to adjacent radiography facility
- Experiment vehicle does everything else
 - Safety containment, specimen environment, and instrumentation



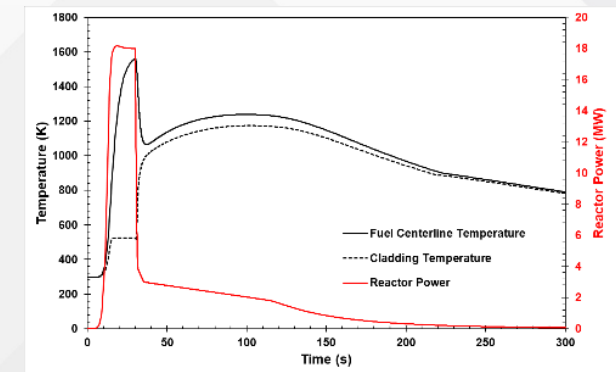
GW-Class Fast Pulses



MW-Class “Slow” Pulses



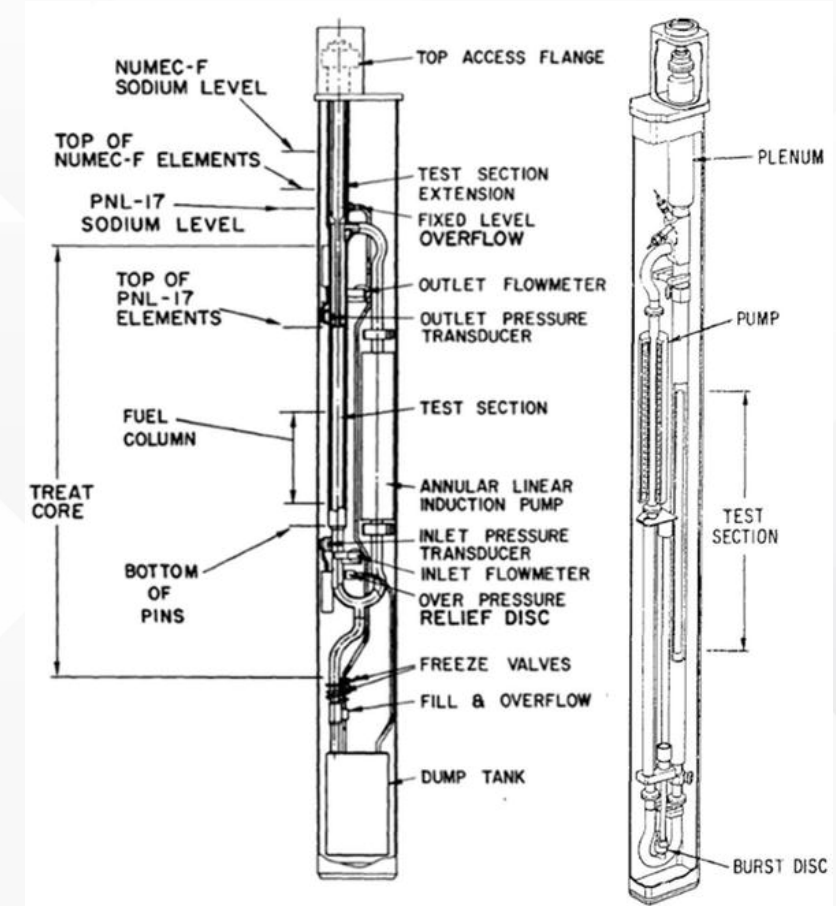
Overpower Ramps



LOCA Shaped Transient

Experiment Design

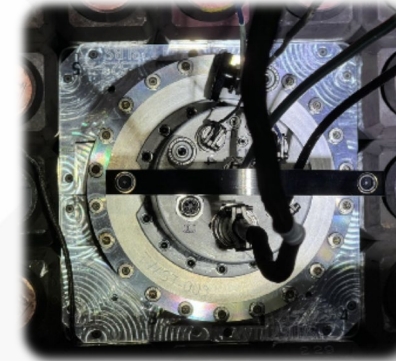
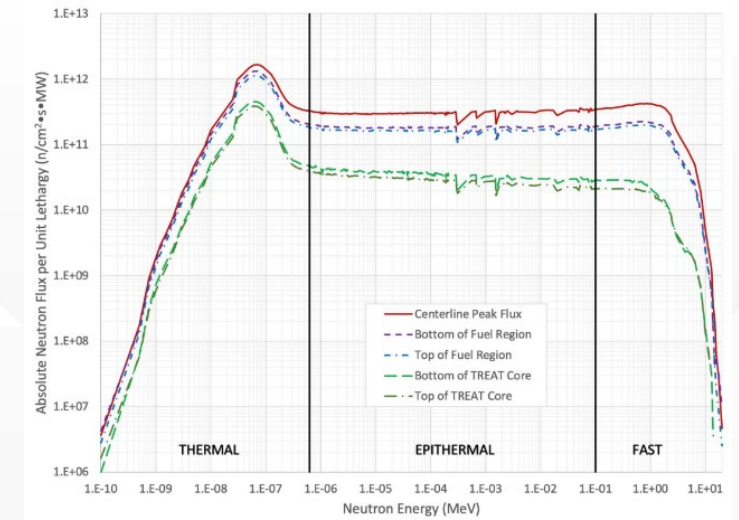
- TREAT: A concrete-shielded block of graphite with a uranium “impurity”
 - No shielded cubicles or reactor pressure vessel
 - Cooled by air blowers during 80 kW steady state runs, and to cool core down after transients
- Supports one primary experiment at a time, and pivots between missions frequently
 - LWR tests one week, SFR tests the next
- Double-contained package type experiments most successful layout
 - Pre-irradiated specimens assembled into casks at HFEF, transported in casks
 - Electrical service and instrumentation leads connections on top of experiment rig
 - Fresh fuel experiments can be usually be irradiated and examined without using hot cells



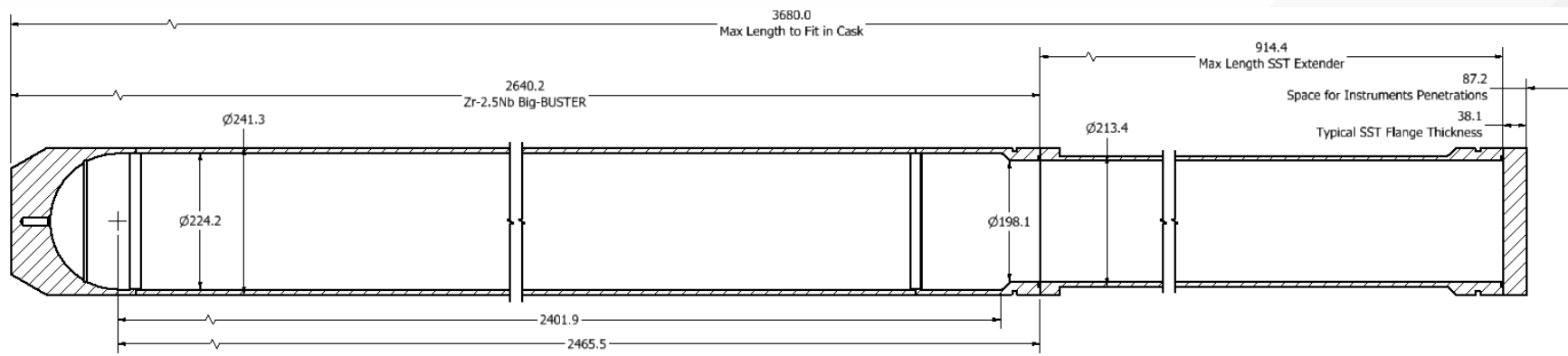
TREAT's Historic “Loop in a box” workhorse sodium loop, the inspiration for most modern TREAT tests

Big-BUSTER

- Enlarged version of the Broad Use Specimen Transient Experiment Rig (Big-BUSTER) developed for modern experiments
 - Reusable nuclear grade outer safety containment, commercial grade inner capsules/loops
 - Large as possible within existing transport casks (shipment between TREAT & HFEF)
 - Graphite moderators and all Zry hardware delivers more, better-thermalized flux to test
 - Max transient fluence $\sim 2.2E16$ n/cm² (pulse)
 - Maximizes nuclear heating capability in specimens

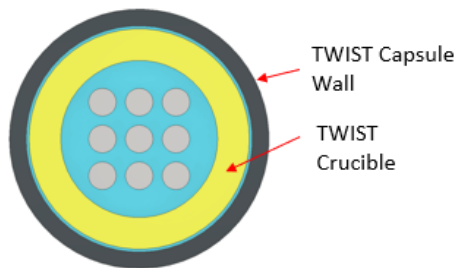


Big-BUSTER in TREAT core

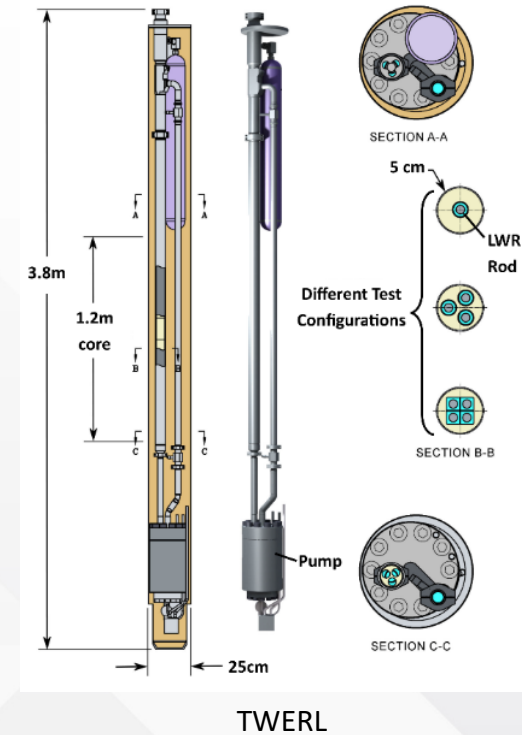
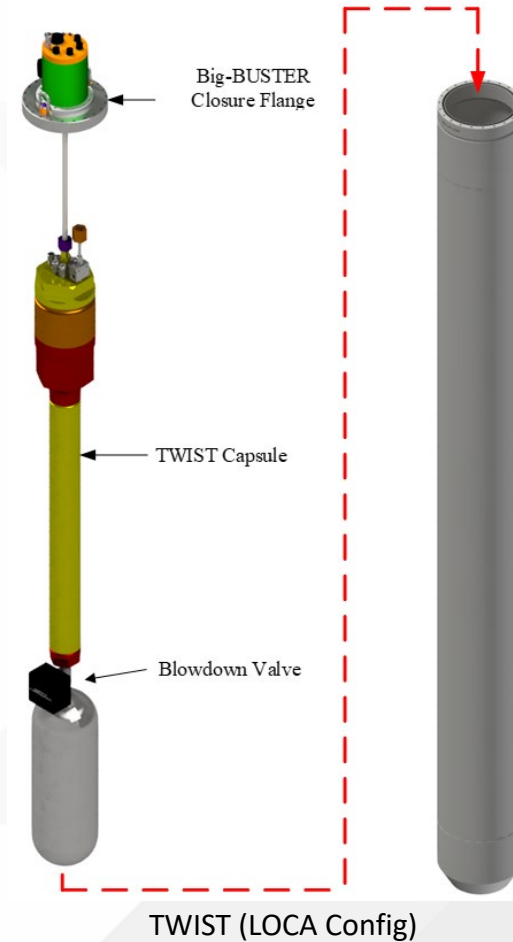
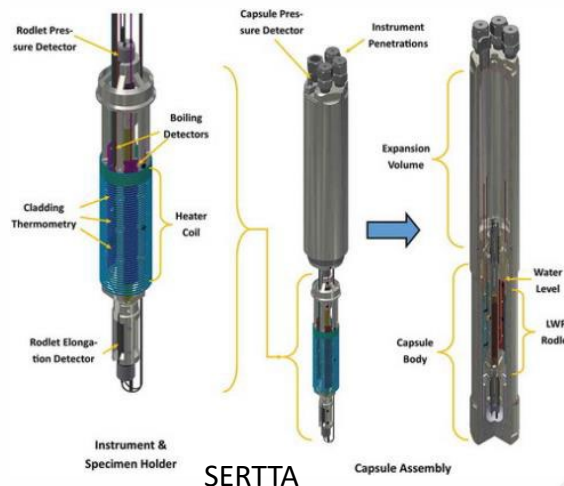


LWR Test Capabilities

- Existing SERTTA capsule available now for low-cost irradiations
 - Capable of RIA pulses on 10 cm specimens
- Larger TWIST capsule currently undergoing in-reactor commissioning tests
 - Capable of RIA & LOCA, up to 60 cm rods or small bundles
- TWERL water loop (Development underway)
 - Full forced convection for multi-specimen assemblies
- Sensors available to measure temperature, pressure, boiling fraction, & acoustic emission

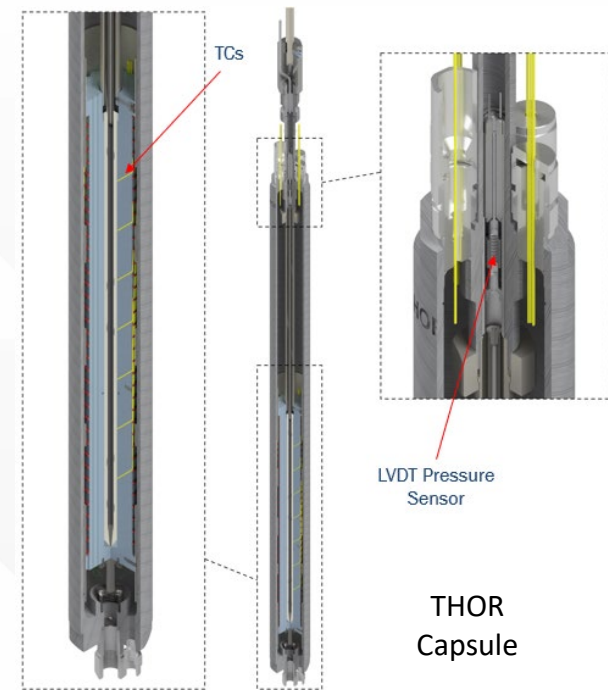


Sketch illustrating 9-rods in TWIST



SFR Test Capabilities

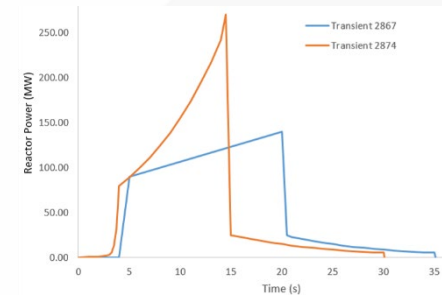
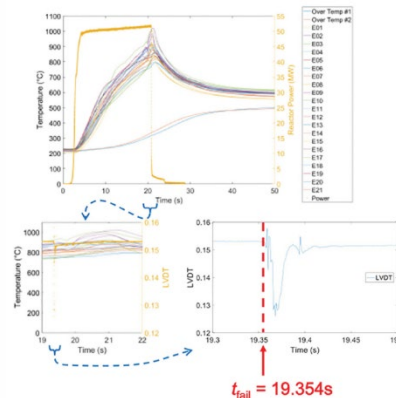
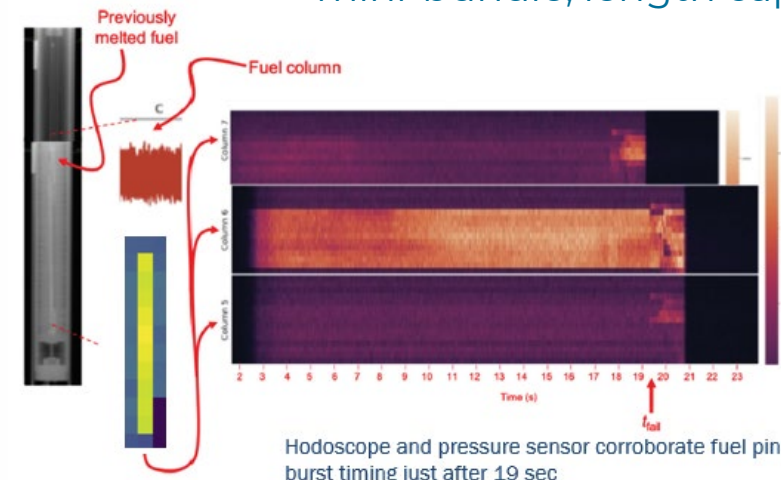
- THOR heat sink sodium capsule
 - Capsule sensors: TC's, LVDT for pressure/elongation, acoustic emission sensor for cladding rupture detection
 - THOR tests have been through a few HFEF-TREAT campaigns, glitches have been worked out, a workhouse capsule for testing single-pin, EBR-II length specimens
- Sodium loop (Mk-IIIR, first deployment late 2025)
 - Forced convection loop provides prototypic thermal hydraulic conditions
 - Loop equipped with coolant temperature, pressure, and flowrate instrumentation
 - Options for 2 or 3 pins in individual flow tubes, or single 7-pin mini-bundle, length capacity for FFTF length pins



Modernized Induction Pump



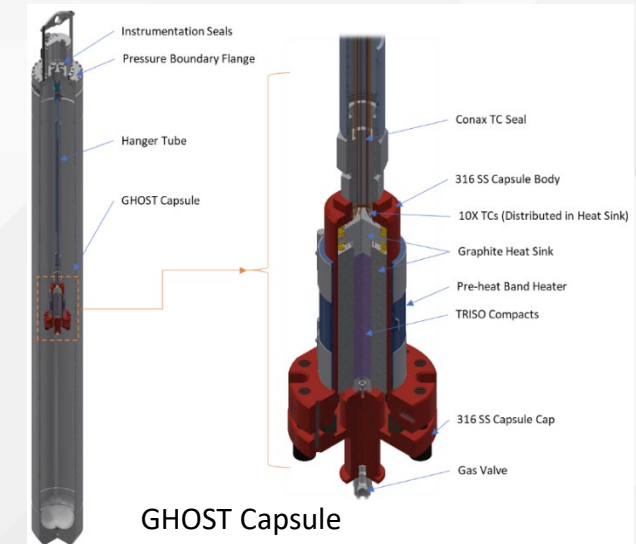
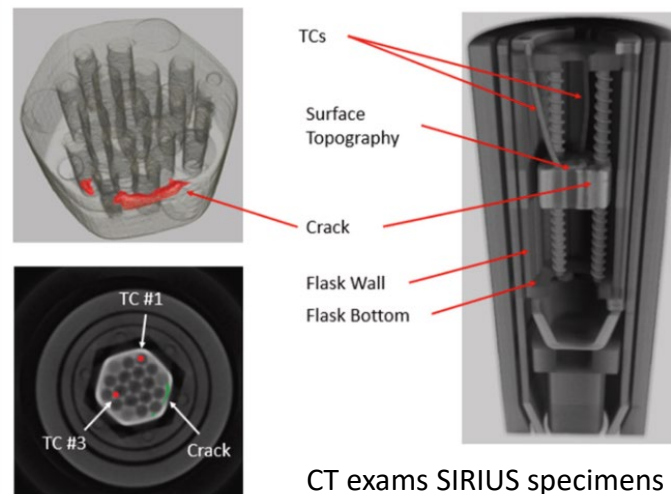
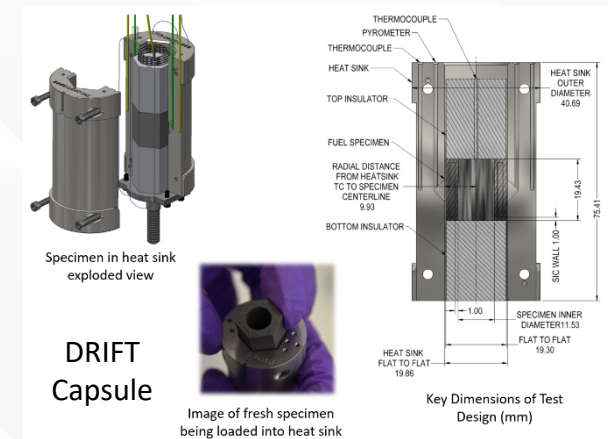
Sodium Loop



Overpower Ramp Transients

HTGR and Other Capabilities

- Existing DRIFT Capsule
 - Used for AM SiC TRISO testing under TCR program
- GHOST Capsule (first test early 2025)
 - Helium environment, graphite heat sink, designed for testing TRISO compacts
 - High temperature pre-transient electrical heater
- Existing SIRIUS capsule
 - High temperature capsule with corresponding instrumentation
 - Used for space nuclear propulsion fuels testing to simulate engine startup ramp to power
 - Flowing hydrogen loop to be installed in future
- Molten salt (as coolant or fuel)
 - Loop concepts have been brainstormed, seems feasible
- Other ideas or needs
 - Let us know, there's probably a way to make it work in TREAT





NRIC

National Reactor
Innovation Center

7/9/2024

www.nric.inl.gov