



Single Primary Heat Extraction and Removal Emulator (SPHERE)

Jeremy Hartvigsen, PhD | Research Engineer

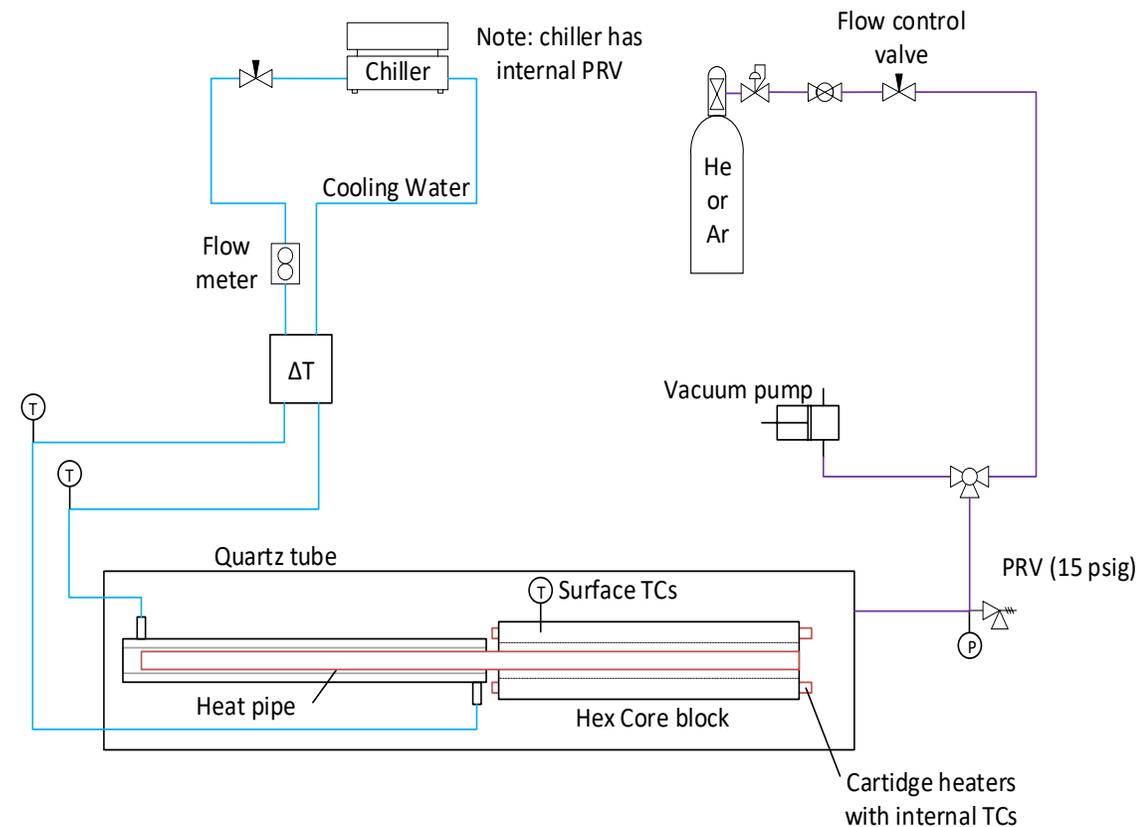
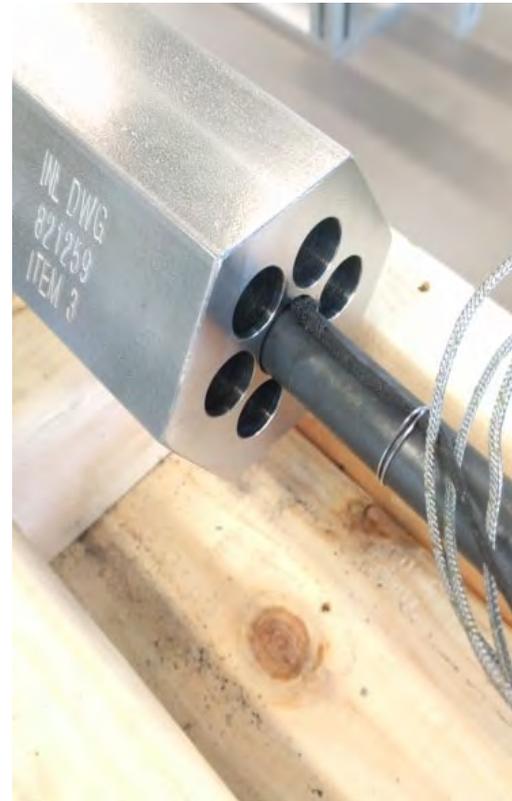


SPHERE Purpose

- Validation and Verification activities for microreactor programs
- Initially supporting heat pipe testing
- Preliminary testing of instrumentation and controls to be deployed in MAGNET

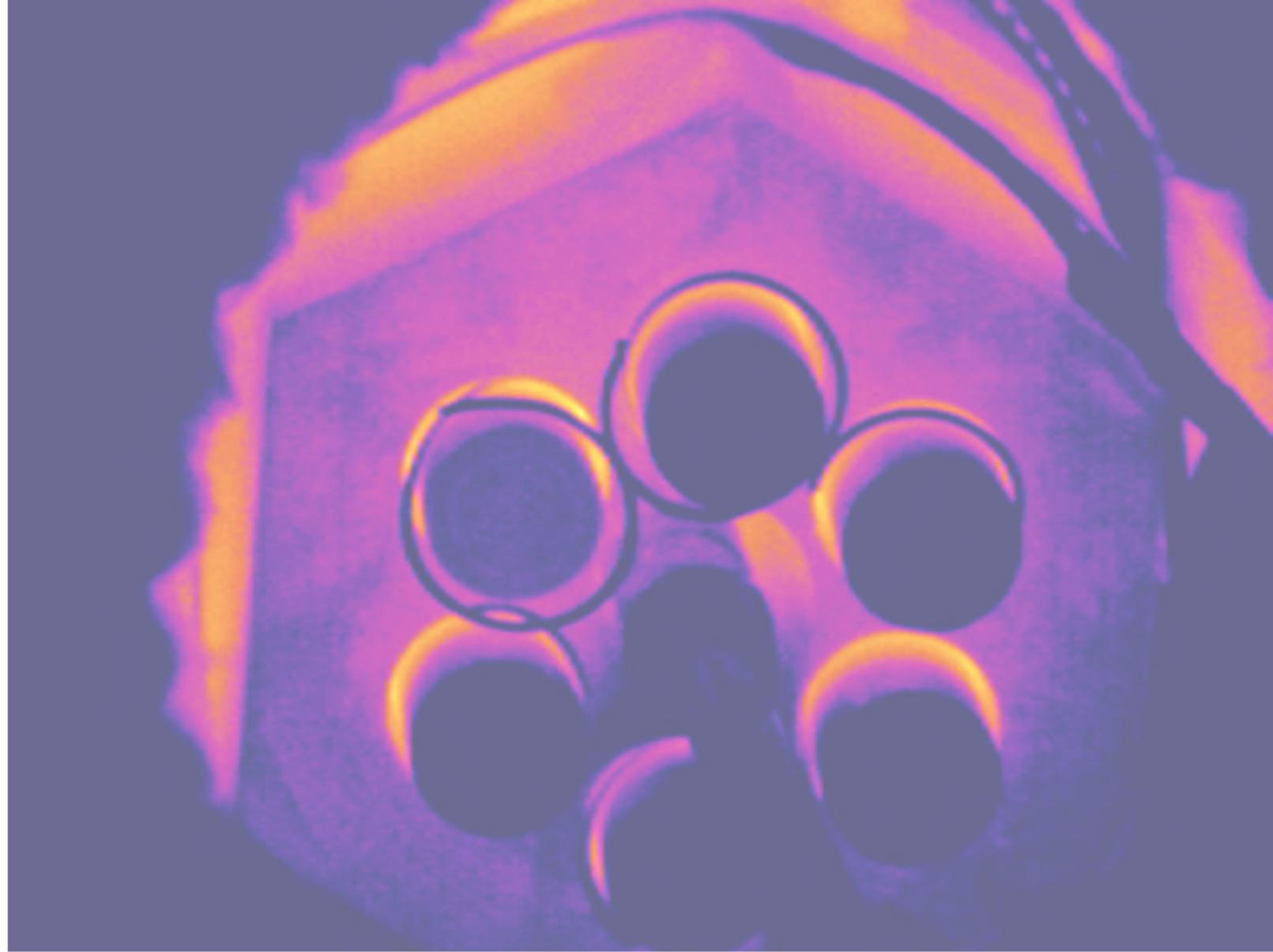
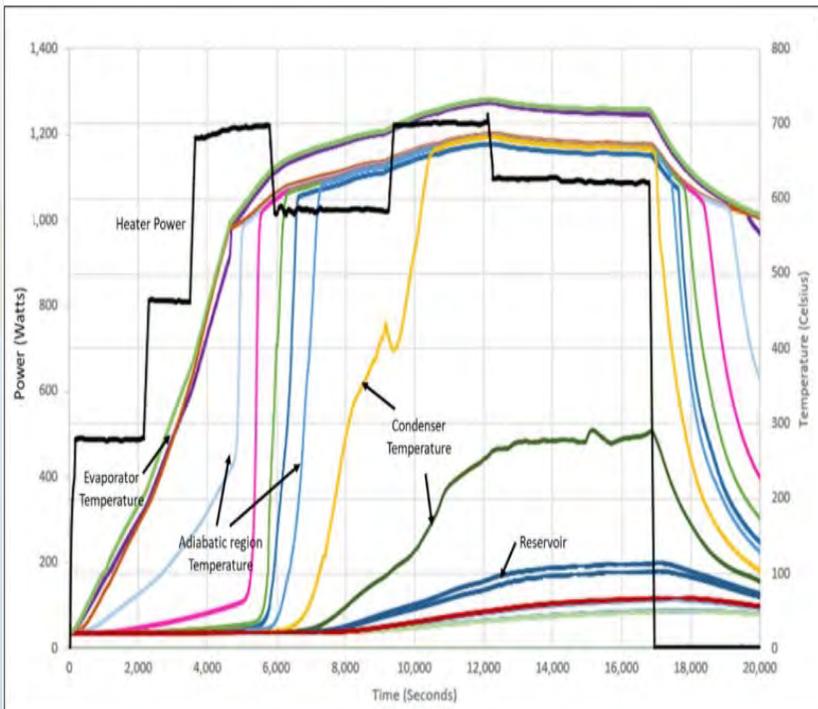
SPHERE—Primary Measurements

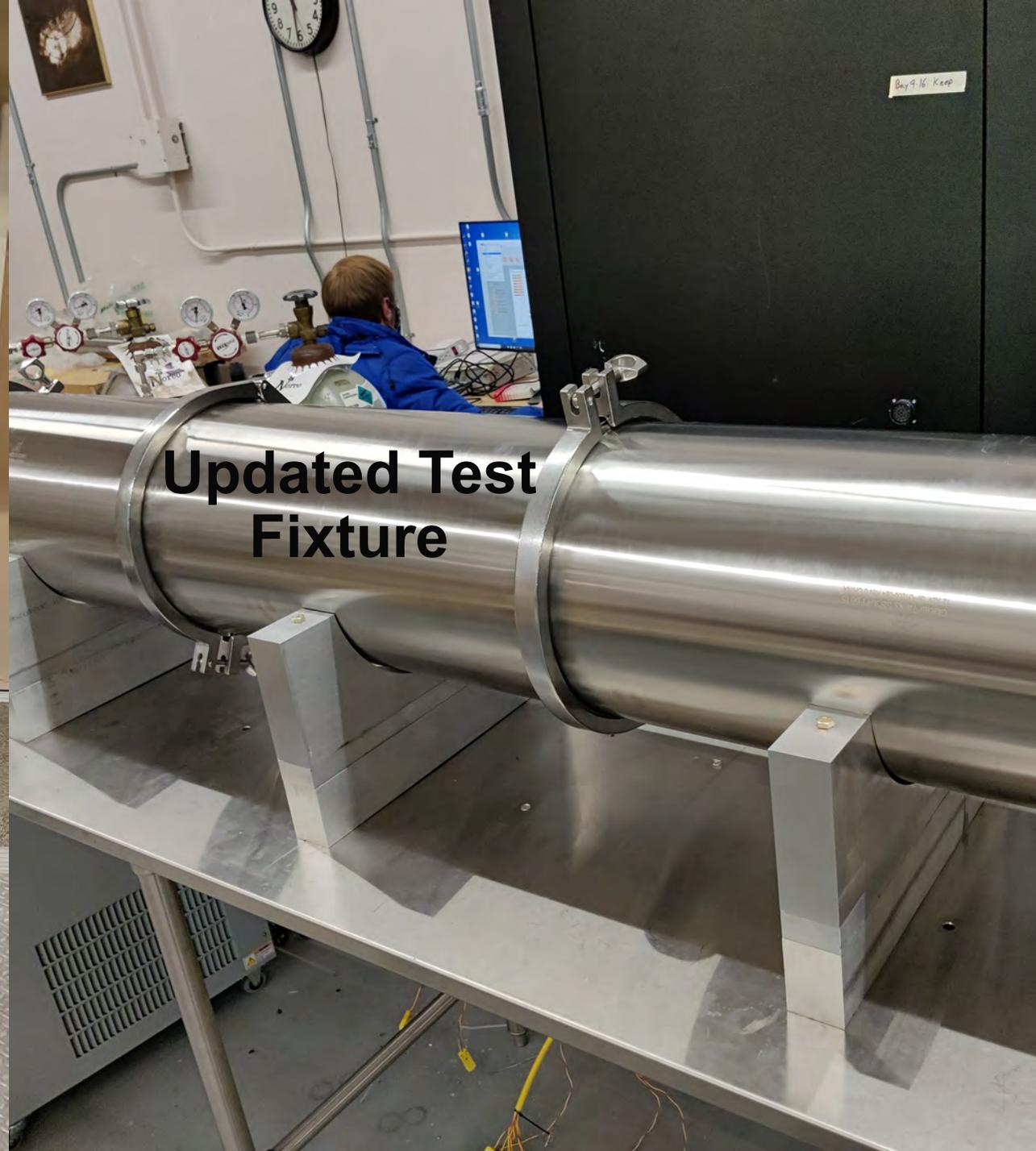
- Power In
- Heat Out
- Temperature
- Gas Environment
 - Pressure
 - Oxygen Content
- Strain Gauges



Outline

- Rebuilt System
 - New Testbed
- Lessons Learned
 - Gap Conductance
- Ongoing and Future work

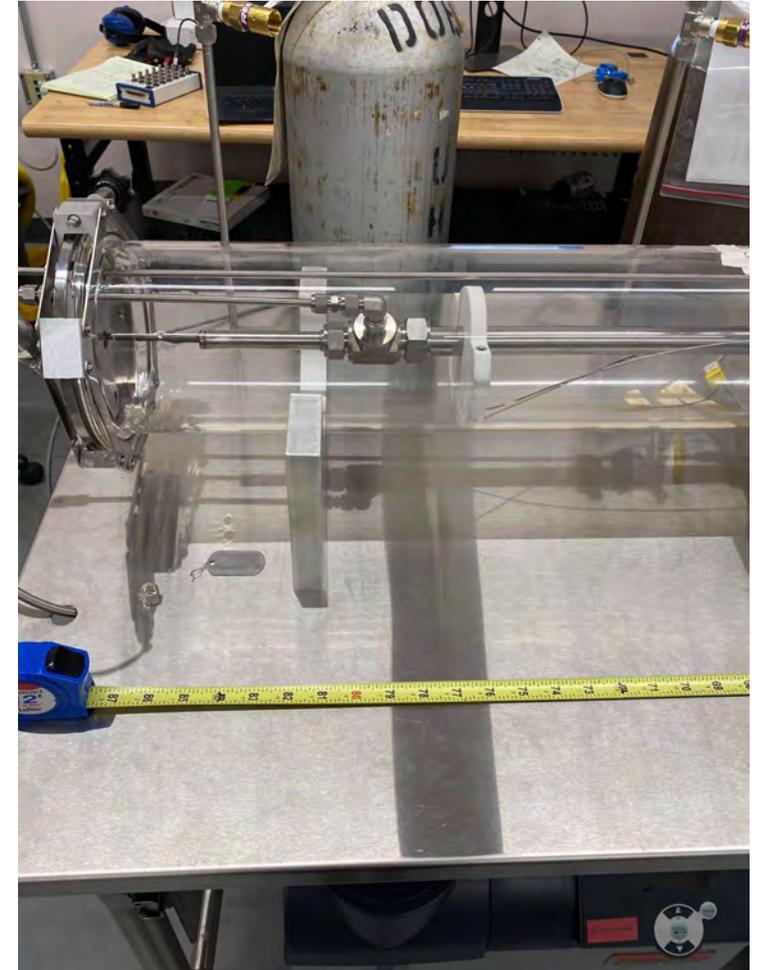
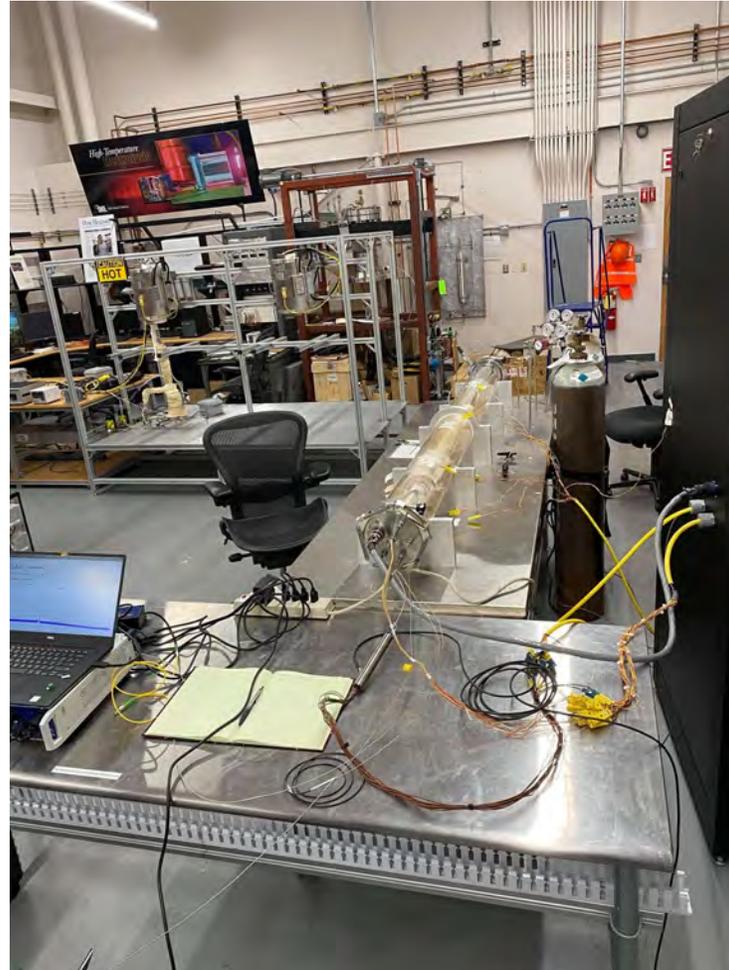




**Updated Test
Fixture**

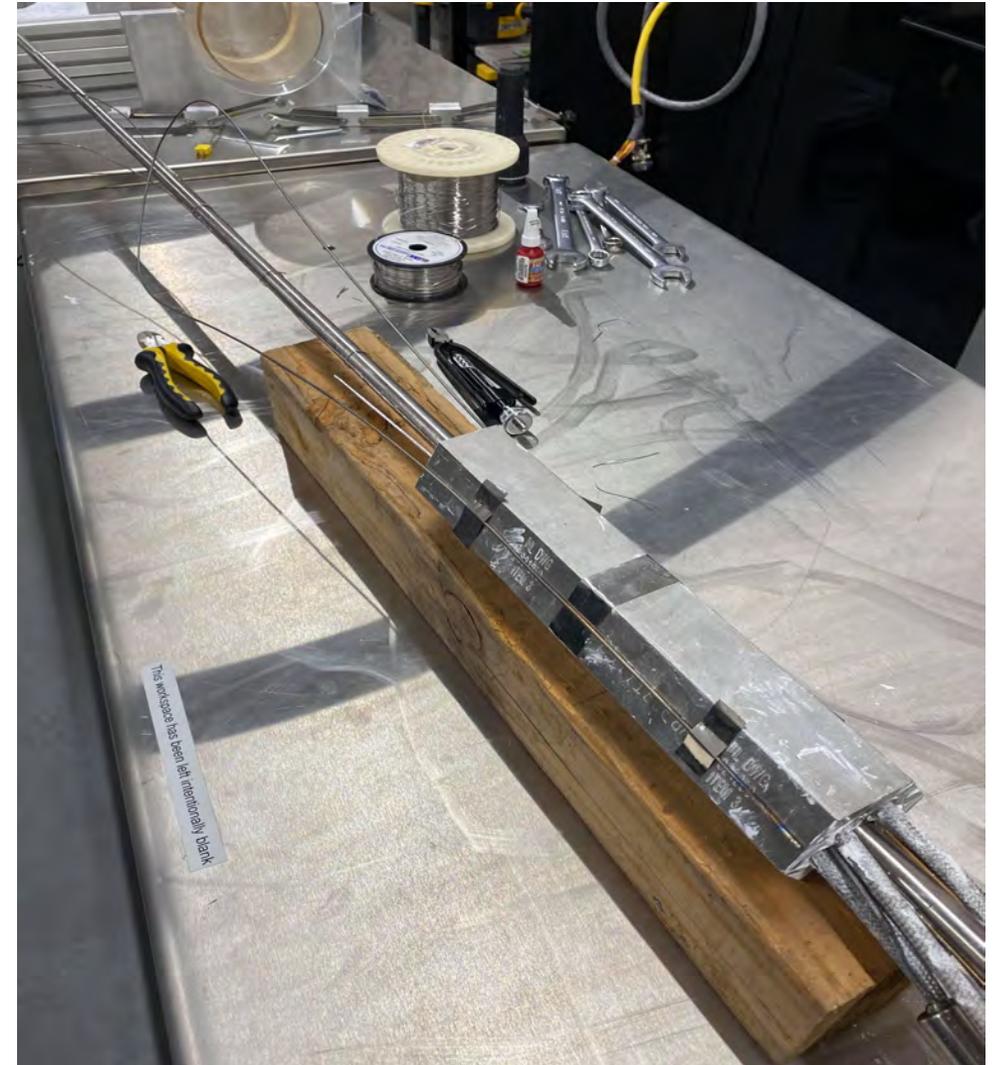
Lessons Learned

- Challenges encountered with quartz tube
 - Difficult assembly procedure
 - Length
 - Heat loss



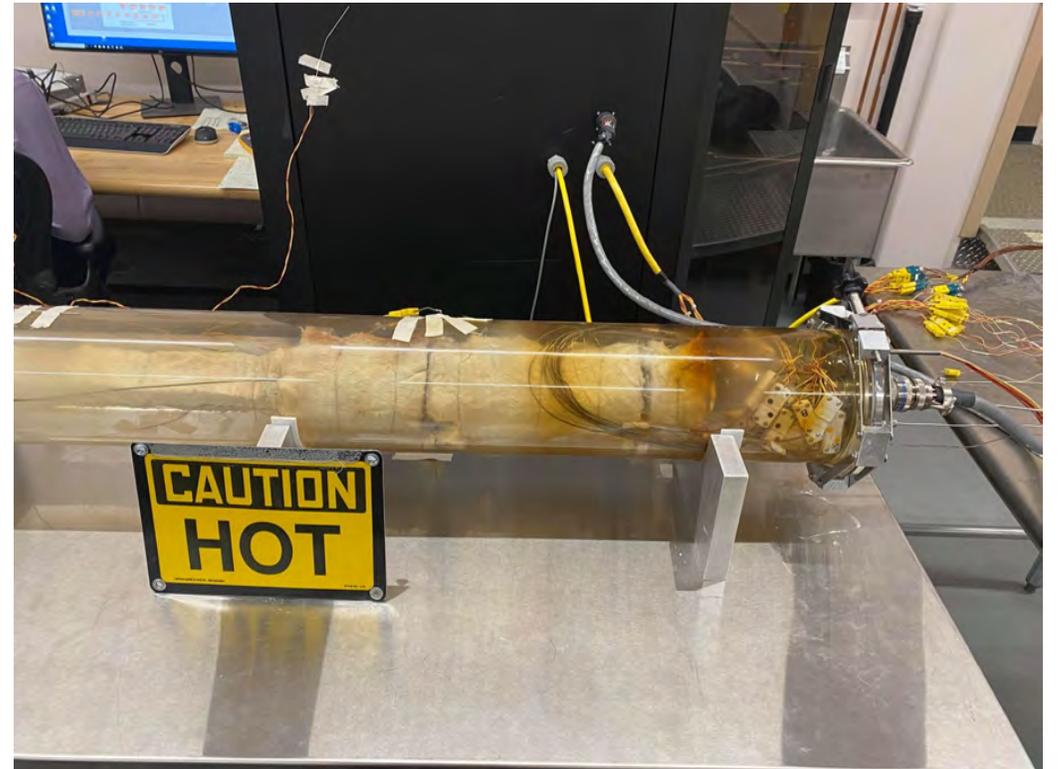
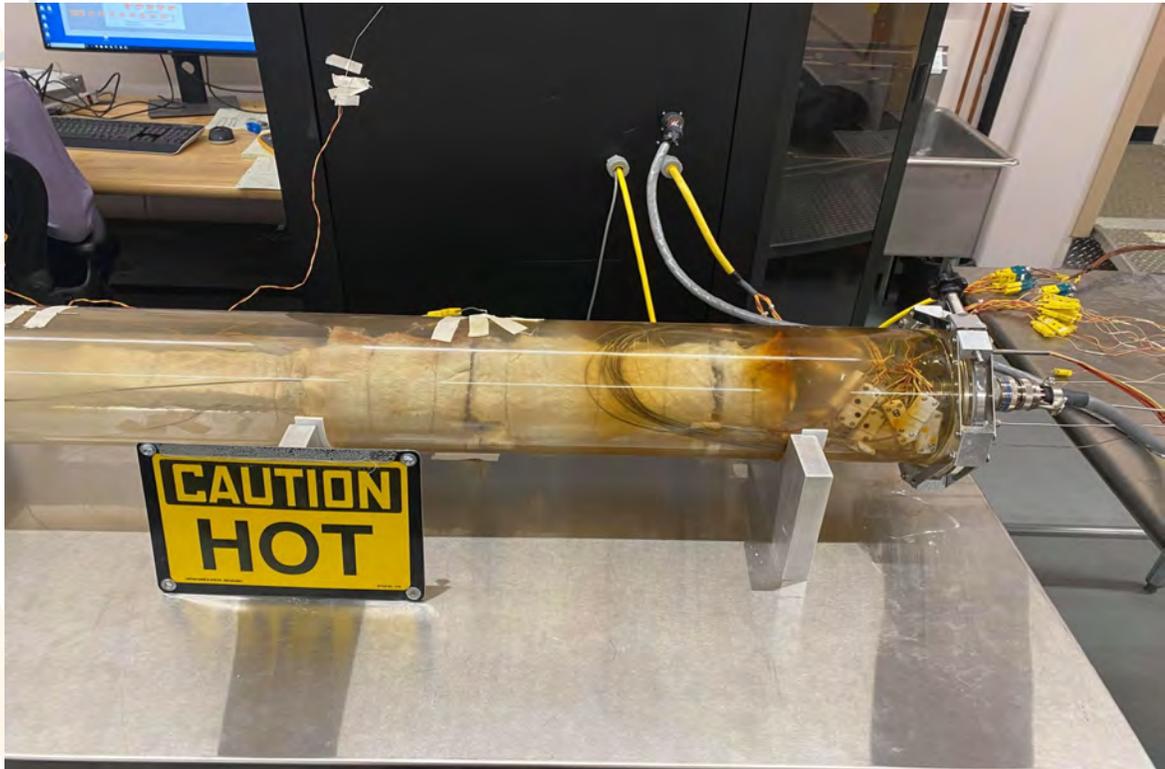
Lessons Learned

- Fiberoptic sensor issues
 - First sensor broke
- Ultrasonic sensor data collection



Lessons Learned

- Thermocouple junction burnouts



Root Causes

1. Testbed chamber is inadequate for accessibility and assembly
2. TC routing too tight
3. Secondary test article creates additional complexity
4. Contact resistances are significant source of model error

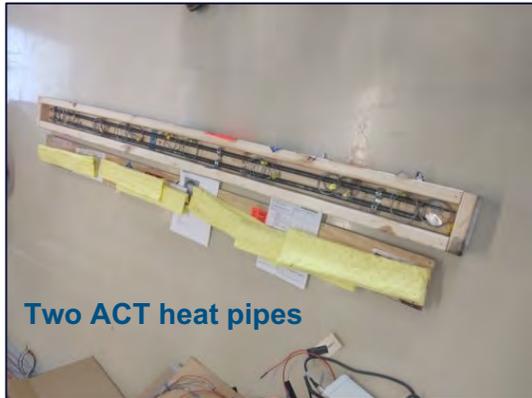
Rebuilt SPHERE Test Stand

- 12 inch diameter sanitary tubing replaced the quartz tube
- Full length wire EDM machined hex block has been completed
- Installed fiber optic and ultrasonic sensor to fit within the machined hex block
- Extra multipoint thermocouple redundancies.
- Integral junction thermocouples on the exterior



Internal heat pipe temperature measurements for sensor demonstration

- Two commercial 78.75" long 0.625" OD sodium-filled heat pipes available
 - Include 78.5" long, 0.125" ID thermowell for instrument and sensor demonstration



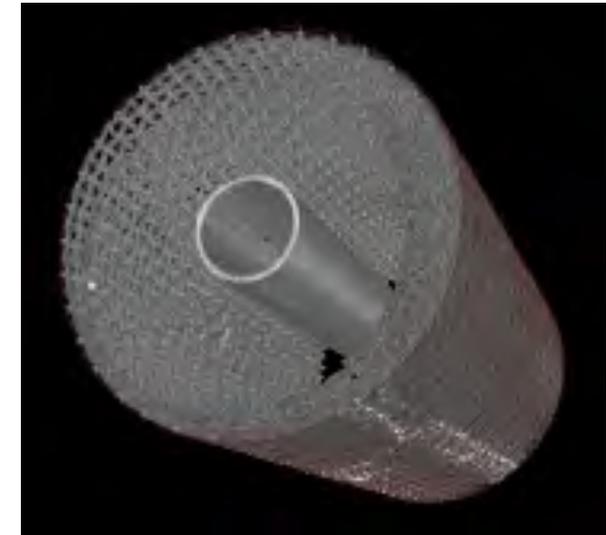
Two ACT heat pipes



Thermowell (0.125" ID) in sodium filled heat pipe (0.625" OD) for distributed temperature sensor deployment



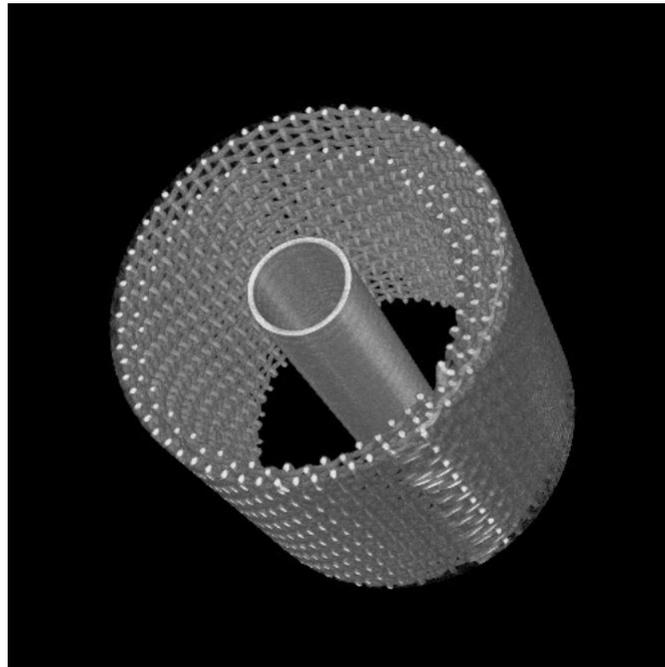
Specialized 3-D system with 1" through ports for long specimens



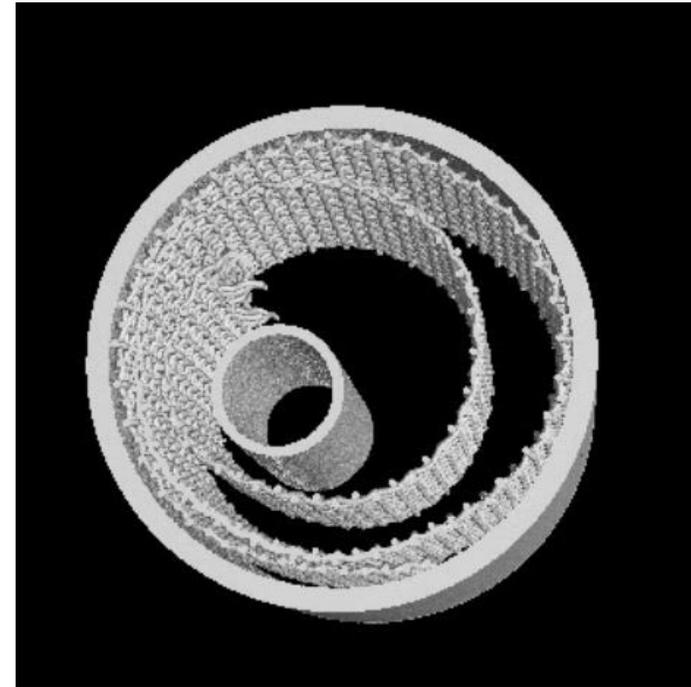
3D CT scan of sodium filled heat pipes with (above) thermowells for instrument testing

3-D CT scan of ACT heat pipe before/after heating

- Can confirm radiographs were NOT taken at the same location



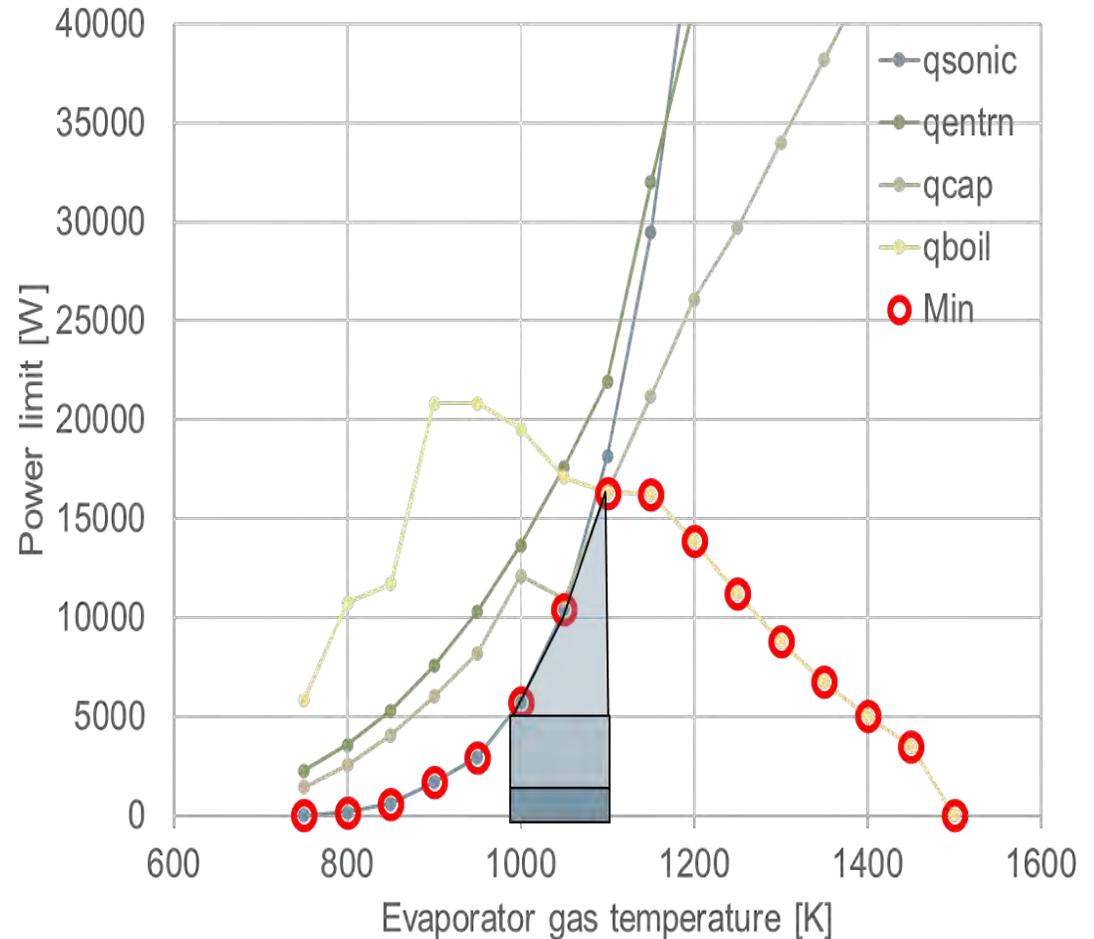
Before heating (central location)



After heating (worst location)

SPHERE Activities—External Vendor

- Evaluation of heat pipe performance for external microreactor vendor
 - Lower Power Testing
 - Vertical performance tests
 - Heat pipe limit testing
 - High power temperature control loop
 - Compare vertical and horizontal performance
 - Low Power
 - High Power



Ongoing and Future SPHERE Work

- Run embedded sensor test article
 - ORNL
- Gap-conductance test
- LANL heat pipe
- Run 15kW test article once the induction heater arrives
 - Continue testing external vendor heat pipe
- Support NEAMS tools