

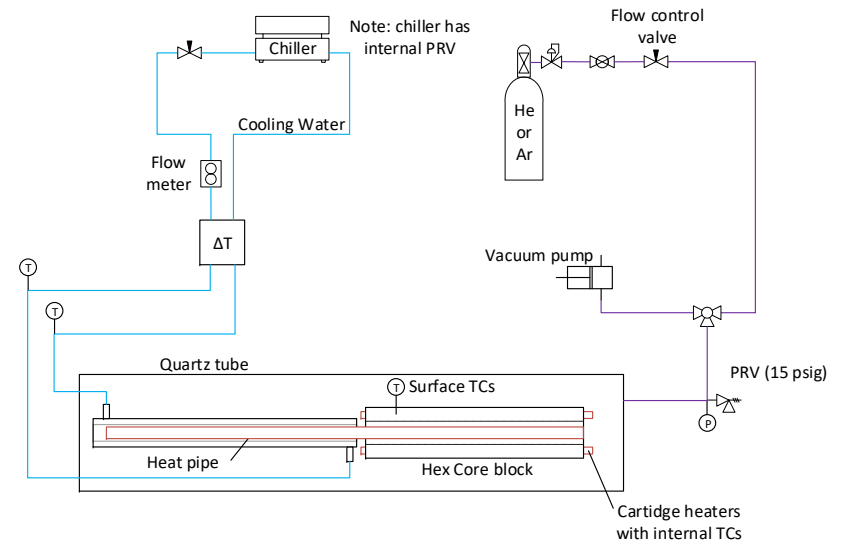
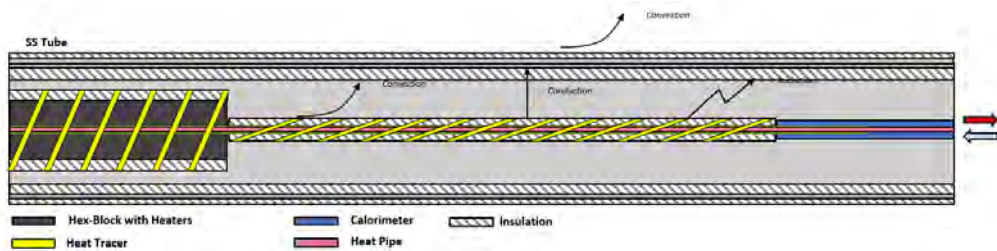


# Microreactor Program Review: Demonstration Support Area -SPHERE

Jeremy Hartvigsen, Zack Sellers, Sunming Qin, Piyush Sabharwall



# Single Primary Heat Extraction and Removal Emulator



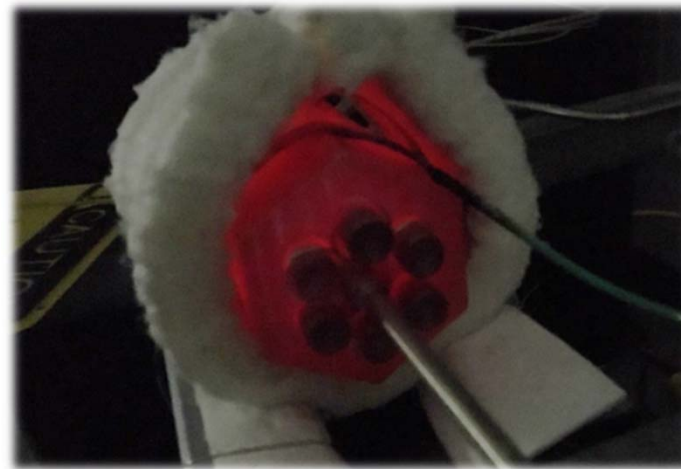
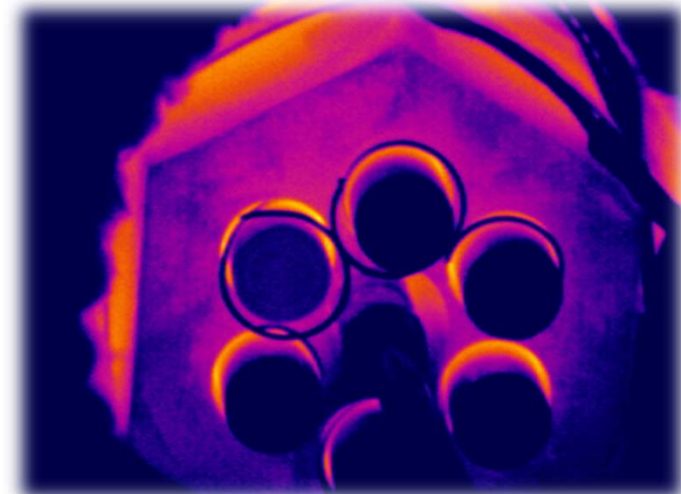
# Overview

## FY22 Accomplishments

- Gap Conductance Test Completed
- Procurement of high-performance heat pipes.
- Discussion of current SPHERE testing capabilities
  - Recent Results

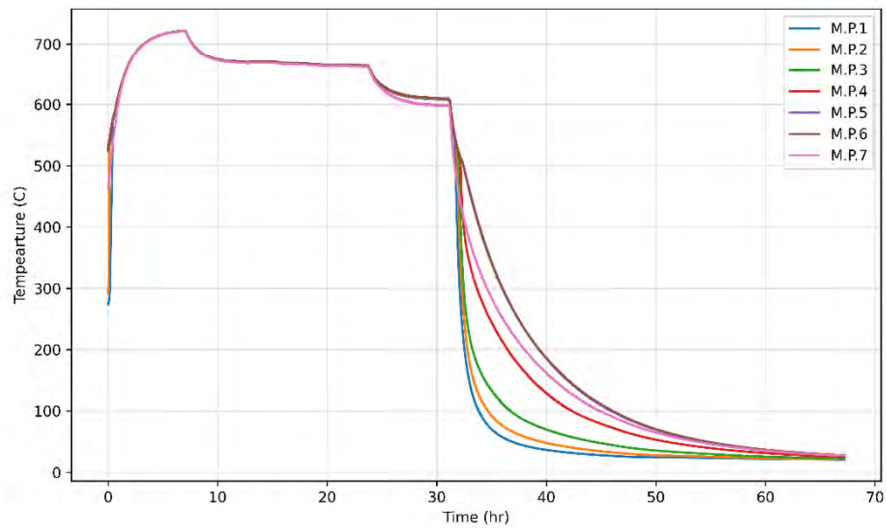
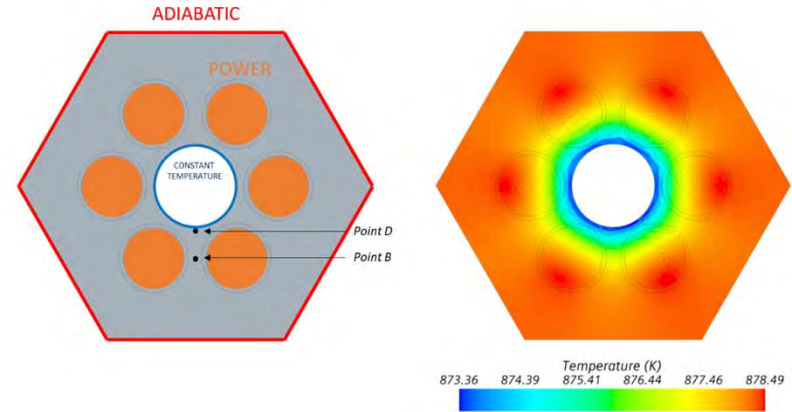
## FY23 Current and Upcoming

- In-Operando x-ray imaging
  - Test Stand modification
  - Open test measurements
- SOCKEYE V&V Status
- Summary



# Gap Conductance

- Experimental Data Validating limiting heat transfer case
- Thermal model of heat transfer in stainless steel block



# High Performance Heat Pipes

Heat Pipe Performance and Design Characteristics

Greater than 3.5 kW at conditions representative of microreactors in development

Vendor #1: Anonymous data release. Currently being tested Internally usable for SOCKEYE V&V

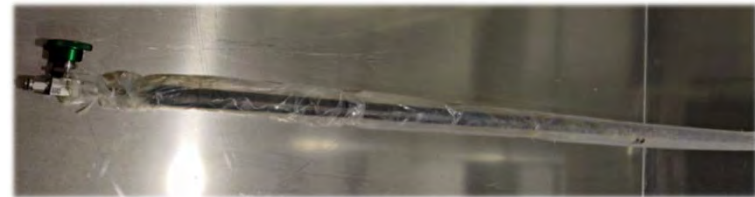
LANL: High performance heat pipe. Next in queue for testing

Vendor #2: Currently in design and Manufacturing

External Vendor #1



LANL



External Vendor #2

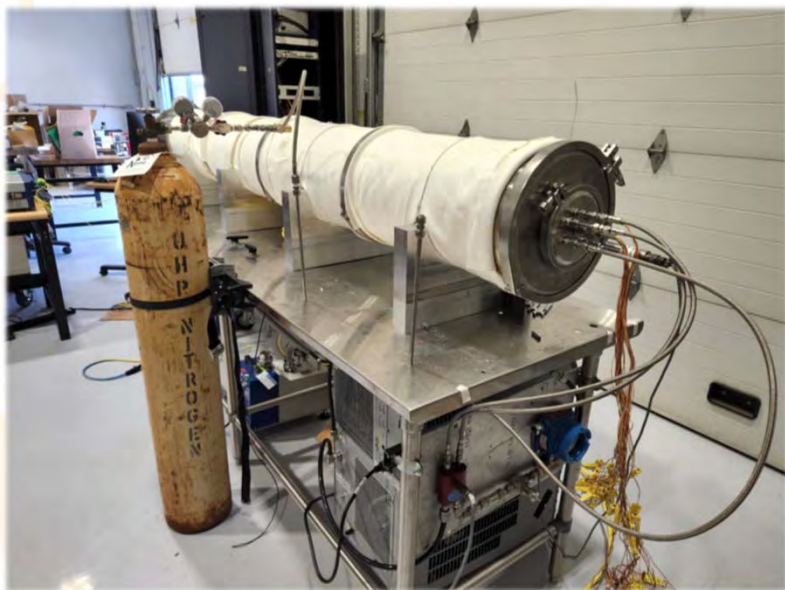




# Horizontal Test Fixture

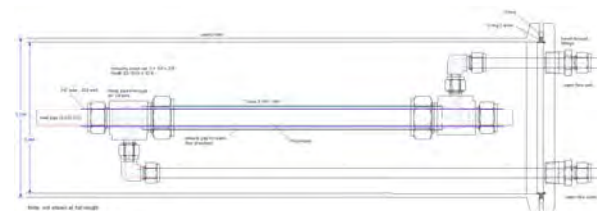
Heat input methods:

Ceramic Fiber Heater,  
Cartridge Heater with Hexagonal Block  
Induction Heating up to 15 kW

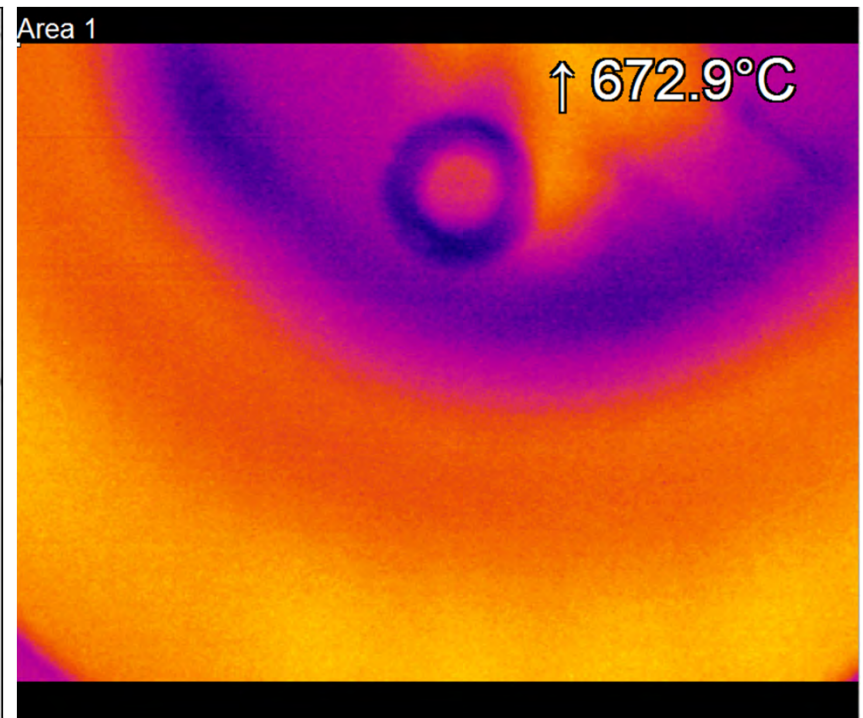
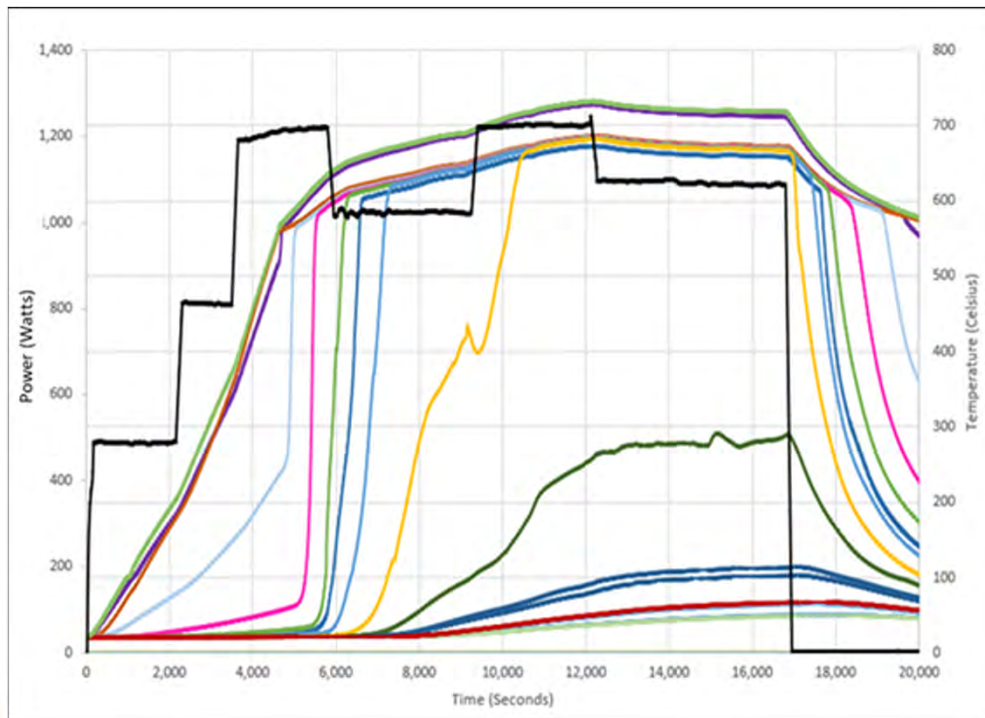


Ceramic Fiber Heaters

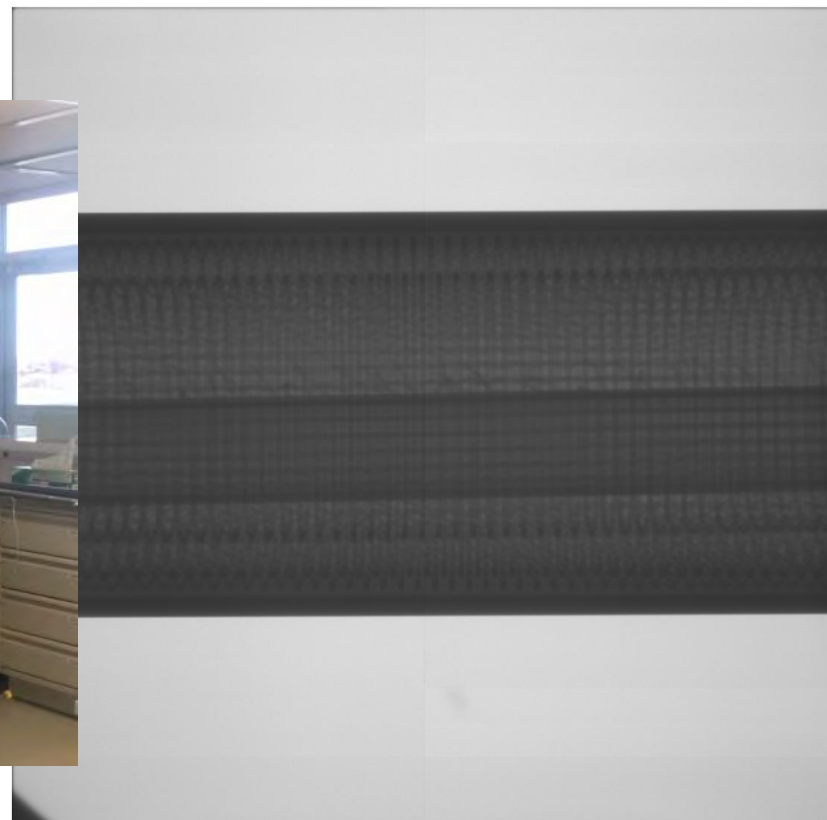
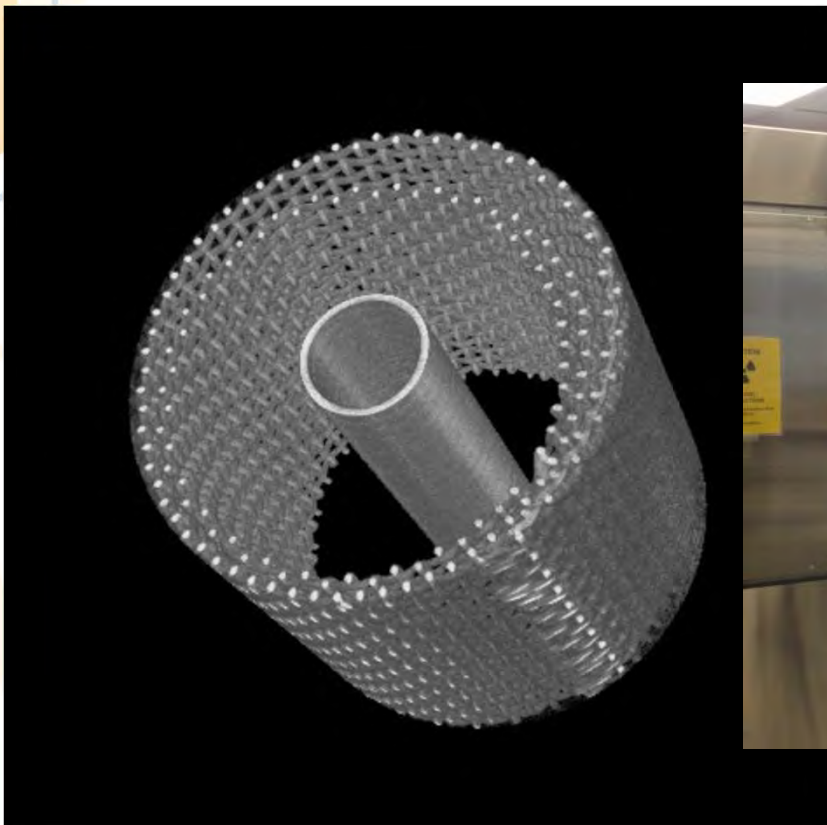
- Instrumentation
  - TCs
  - Heat Pipe Temperature Boundary
  - Quartz Window with IR camera
- Heater Input
  - Ceramic Fiber Heater
- Condenser
  - Coupling and cold end temperature
- Ramp Rates
  - 5 C/min nominal
- Operating targets
  - (power vs temperature)



# Heat Pipe IR imaging

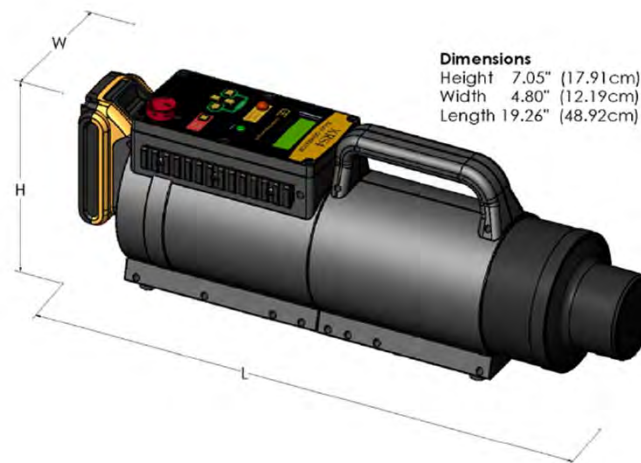


# Micro-CT





# Upcoming Capability--In-Operando Radiography



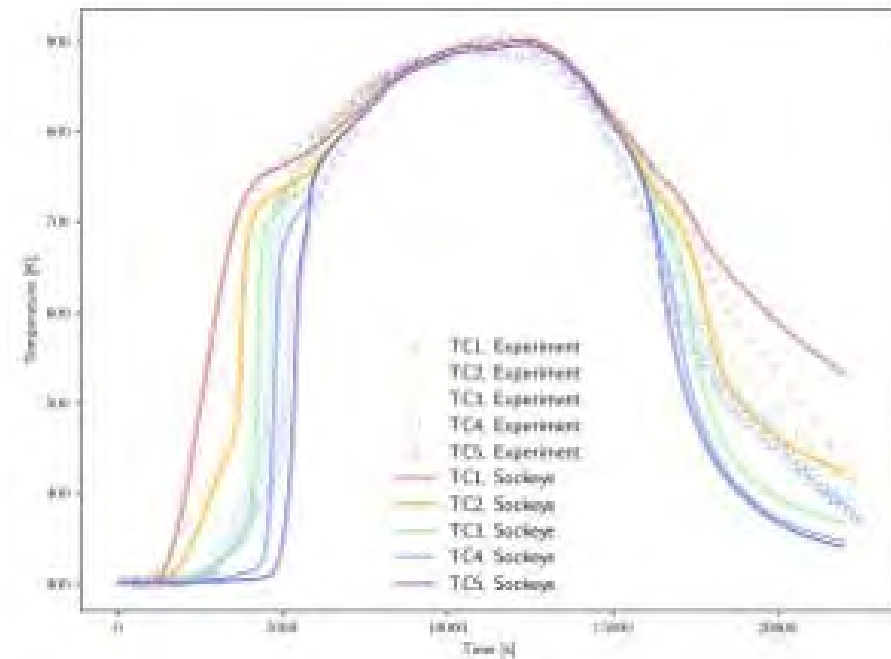
<b>Power</b>	<b>DeWalt® 20V (18EU) Battery</b>
<b>Weight</b>	18.3 lbs / 8.3 kg (including battery)
<b>Output dose</b>	4.5 to 7 mR/pulse measured 12" from source
<b>Pulse rate</b>	9 pulses per second
<b>Source size</b>	1/8" (3mm)
<b>Max. photon energy</b>	370 kVp
<b>Pulse width</b>	10 nanoseconds
<b>Beam angle</b>	40 degree standard / 60 degree available
<b>Current draw</b>	17 amp
<b>Max. duty cycle</b>	200 pulse per 4 minutes
<b>Warm up</b>	None Required

# SOCKEYE V&V



- Data provided to SOCKEYE V&V efforts
  - Variable conductance heat pipes under test
  - SOCKEYE simplified non-condensable gas model
  - Focus on capillary limit validation

Data Set	Notes
SAFE-30	External TCs
SPHERE – Feb. 2021	ACT heat pipe, central thermowell, unknown NCG mass
SPHERE – Gap Conductance	ACT heat pipe (Same as previous), central thermowell
SPHERE – High Performance Heat Pipe	
Texas A&M University	Water heat pipe, DTS at various radii
University of Michigan	
Miscellaneous Literature (Need to document)	



## Summary of Milestones

Activity	Status	Date
Complete shakedown testing to demonstrate operability of the in operando heat pipe characterization system	In Progress: On Schedule	9/29/2023
Compile preliminary design needs for imaging system	Complete	11/7/2022
Complete Design and Instrumentation Needs for in operando heat pipe characterization	In Progress: On Schedule	4/27/2023
Complete Sockeye modeling of variable conductance heat pipe	In Progress: On-Schedule	8/30/2023



**MRP** Microreactor  
Program