



Reactor Simulator Testing Overview

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Background



Nuclear Systems Team

- Focuses on technology development for a variety of space nuclear systems (fission reactor and radioisotope systems).
- Utilize state-of-the-art capability for non-nuclear testing (electric heaters to closely mimic the static and dynamic thermal performance of nuclear fuels)
- Applications in:
 - surface and spacecraft power
 - nuclear propulsion (thermal, electric, advanced concepts like fusion, plasma, etc.)

Program/Project

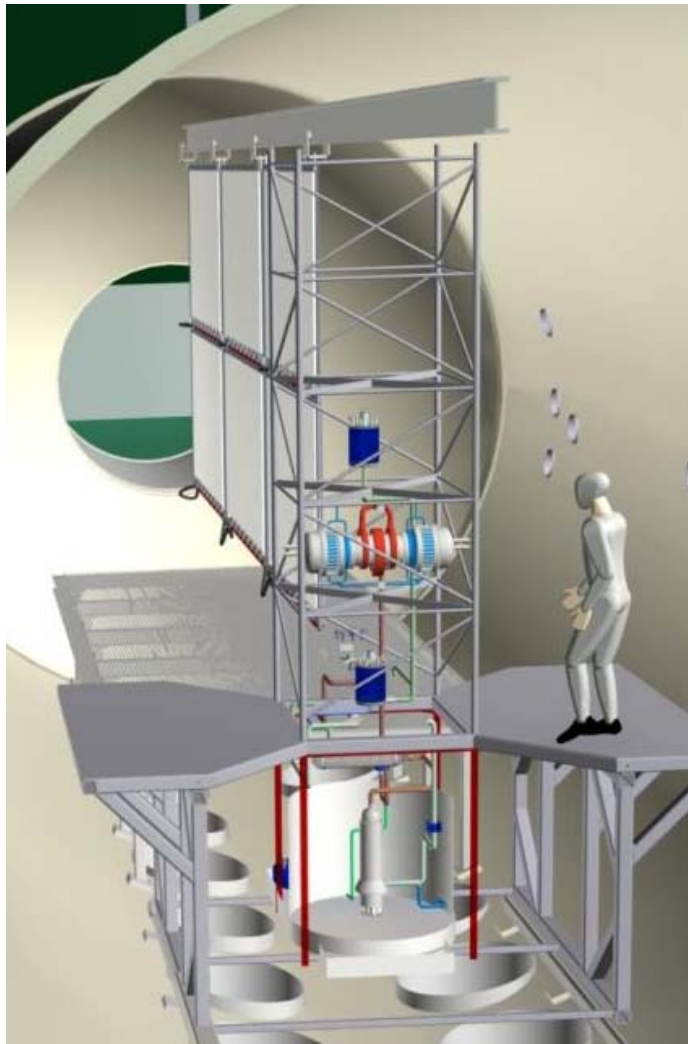
- Nuclear Systems Project efforts supported by NASA HQ Game Changing Division. The MSFC Nuclear Systems Office project lead is Mike Houts/VP33.
- TDU is intended to demonstrate the major element of a notional FSPS. TDU is an end-to-end system test of a core simulator, Power Conversion Unit, and Heat Rejection System in a thermal vacuum.
- RxSim perform integrated testing of the TDU components.



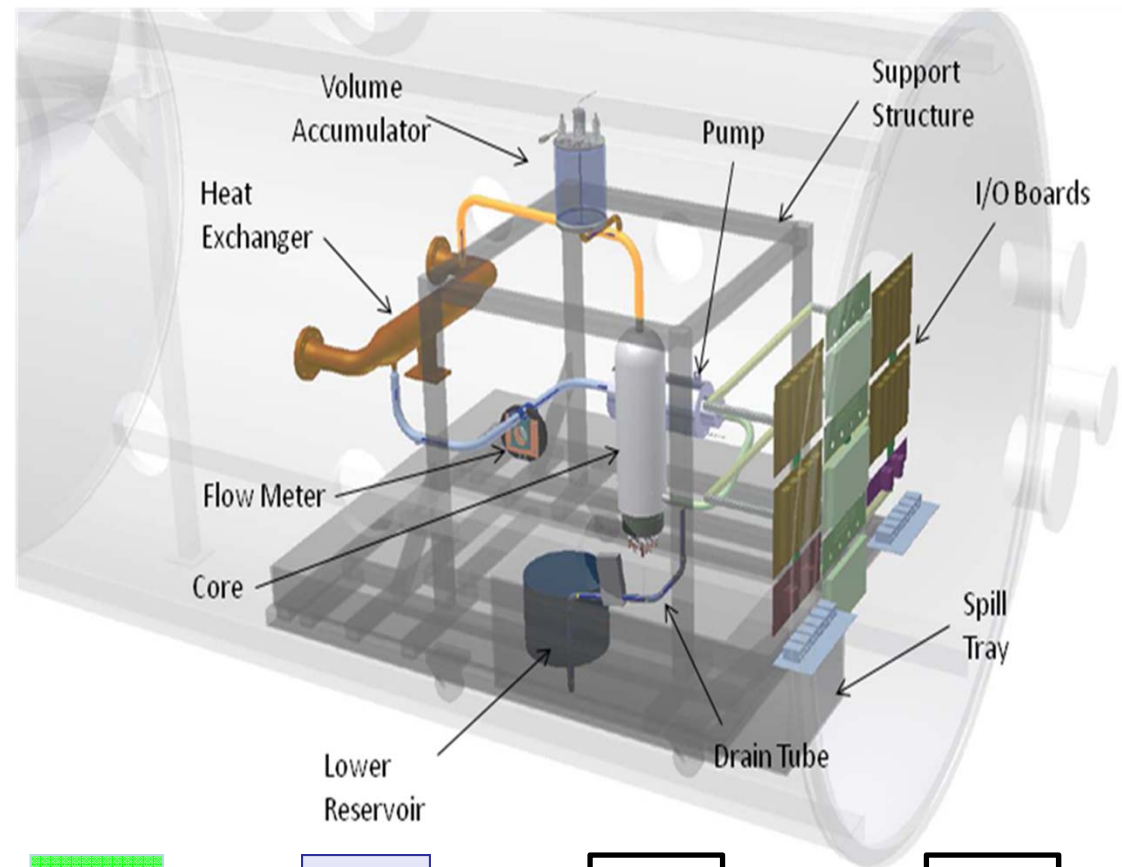
Scope Reactor Simulator



Technology Demonstration Unit



Reactor Simulator



Gas
and
Vacuum
Racks

Facility
Gas,
Vacuum,
& Power
Panels

Power
Rack

Data
and
Control
Rack



Reactor Simulator Testing Overview



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Test Objectives Summary

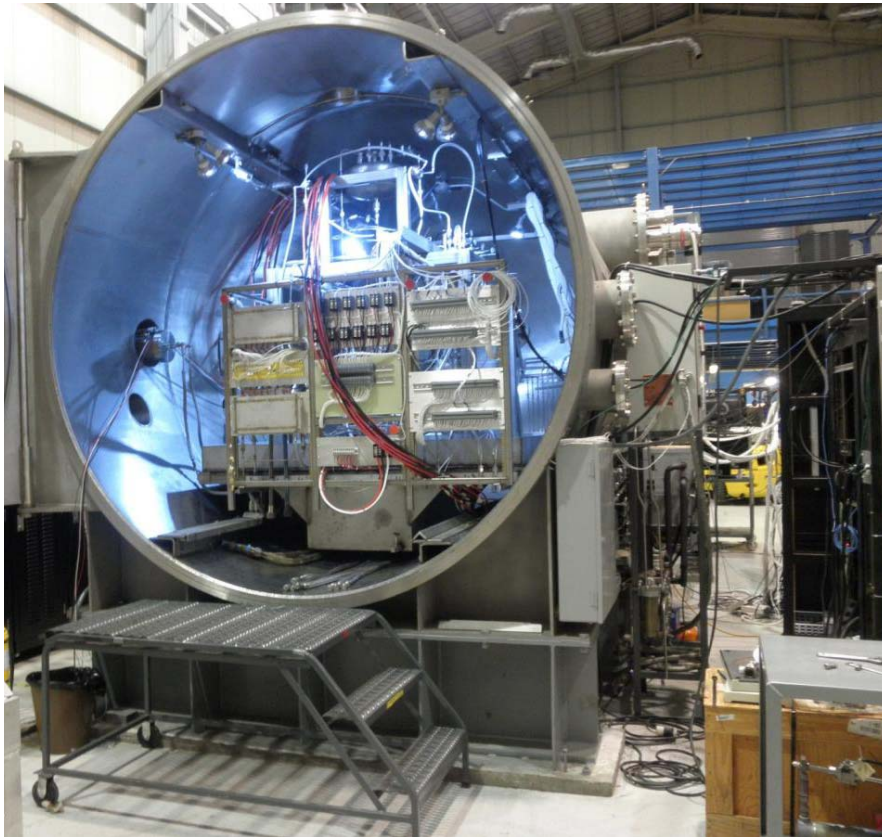
- Verify operation of the core simulator, the instrumentation & control system, and the ground support gas and vacuum test equipment.
- Examine cooling & heat regeneration performance of the cold trap purification.
- Test the ALIP pump at voltages beyond 120V to see if the targeted mass flow rate of 1.75 kg/s can be obtained in the RxSim.

Testing Highlights

- Gas and vacuum ground support test equipment performed effectively for operations (NaK fill, loop pressurization, and NaK drain).
- Instrumentation & Control system effectively controlled loop temperature and flow rates or pump voltage to targeted settings and ramped within prescribed constraints. It effectively interacted with reactor simulator control model and defaulted back to temperature control mode if the transient fluctuations didn't dampen.
- Cold trap design was able to obtain the targeted cold temperature of 480 K. An outlet temperature of 636 K was obtained which was lower than the predicted 750 K but 156 K higher than the minimum temperature indicating the design provided some heat regeneration.
- ALIP produce a maximum flow rate of 1.53 kg/s at 800 K when operated at 150 V and 53 Hz.



Reactor Simulator Integrated Setup



Reactor Simulator in Chamber



User Interface Controls & Gas & Vacuum Panels



Core & Pump Power Panels



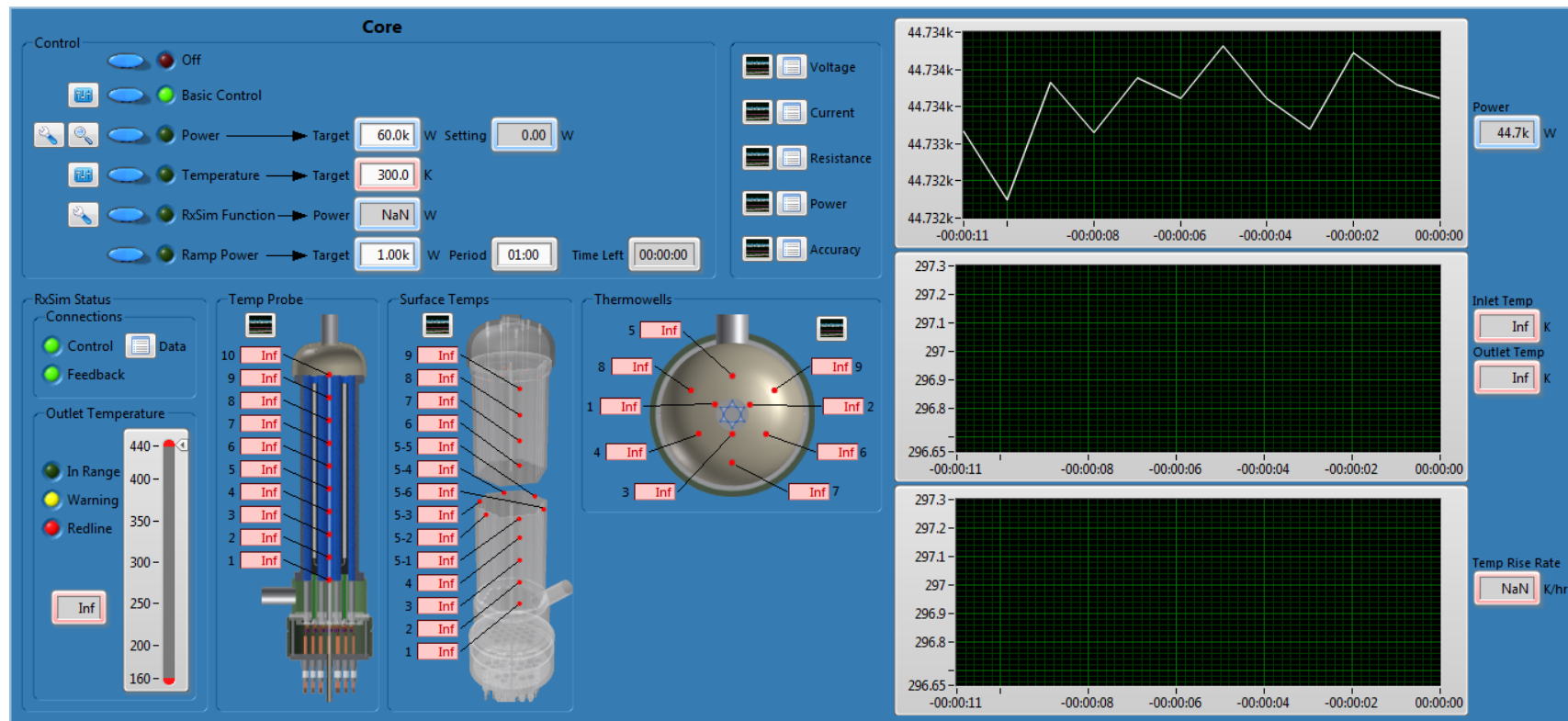
Core Simulator Control System Modes



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1. Basic: Control current (I) and voltage (V) settings of each heater zone in the core simulator
2. Power: Control total power setting for the core simulator
3. Power Ramp: Control total power from starting point to new set point over period of time.
4. Temperature: Control the NaK outlet temperature of the core simulator.
5. Reactor Simulator Function: Remotely control core power by an external Labview real time controller that runs a Simulink model simulating the feedback response of a nuclear reactor.





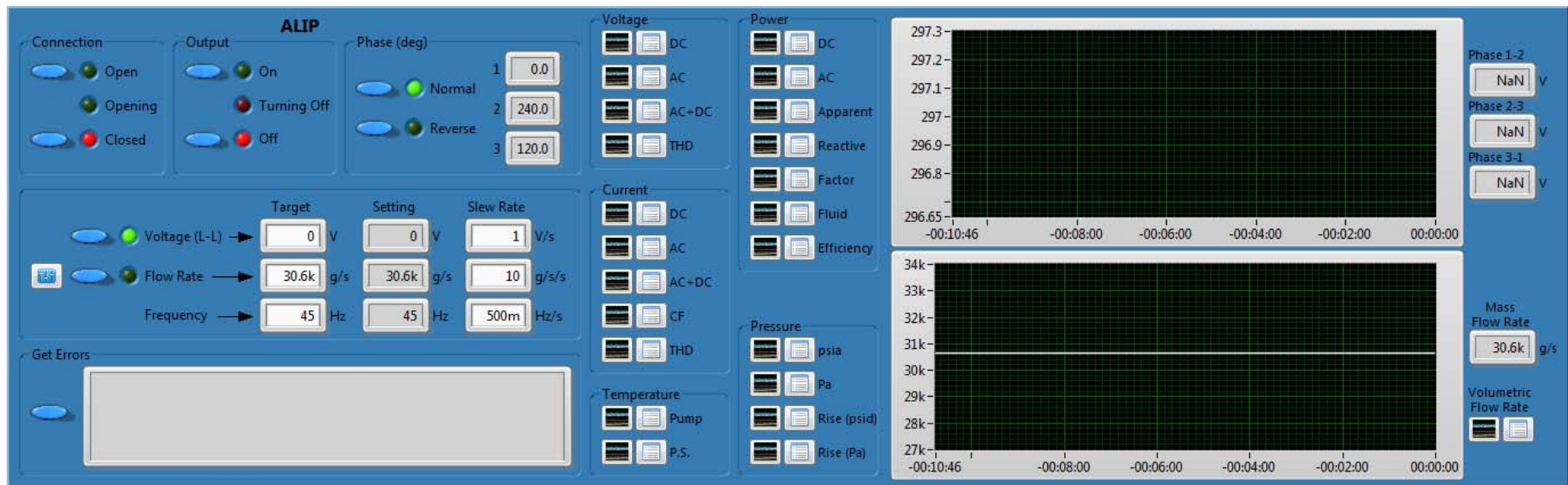
ALIP Control System Modes



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1. Voltage: control the line-line voltage setting of the ALIP power supply
2. Flow Rate: control the NaK mass flow rate



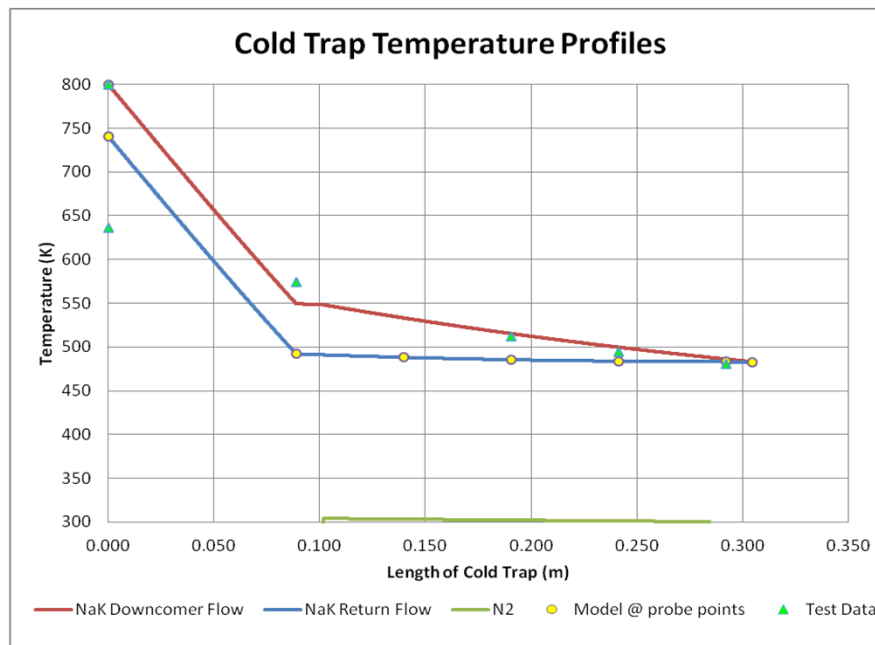
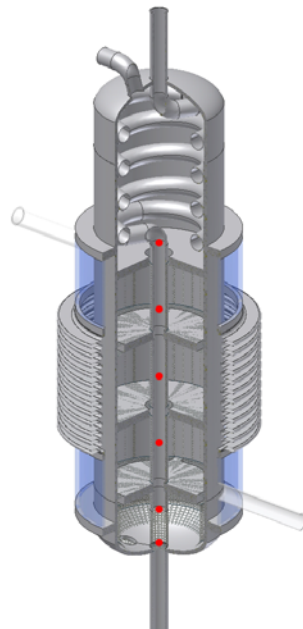
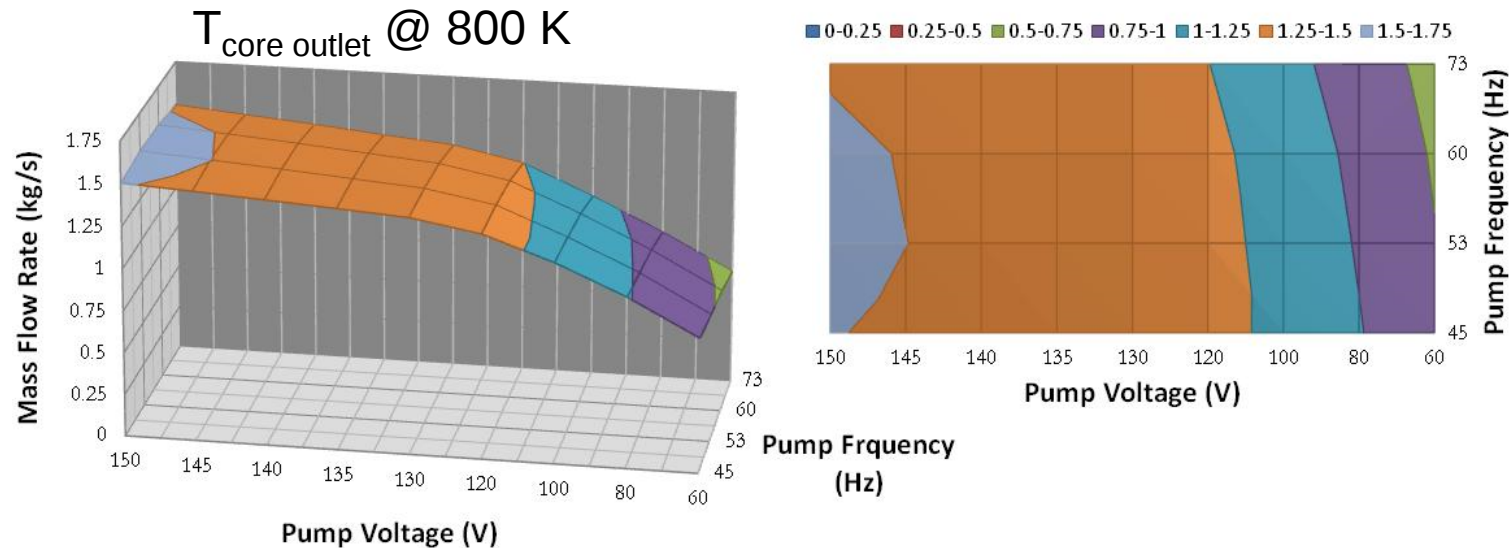


Outcomes



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Questions?

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