U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

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# DOE Microreactor Program

# Heat Removal and Validation Studies

## Technology Maturation Panel

Microreactor Program Virtual Workshop
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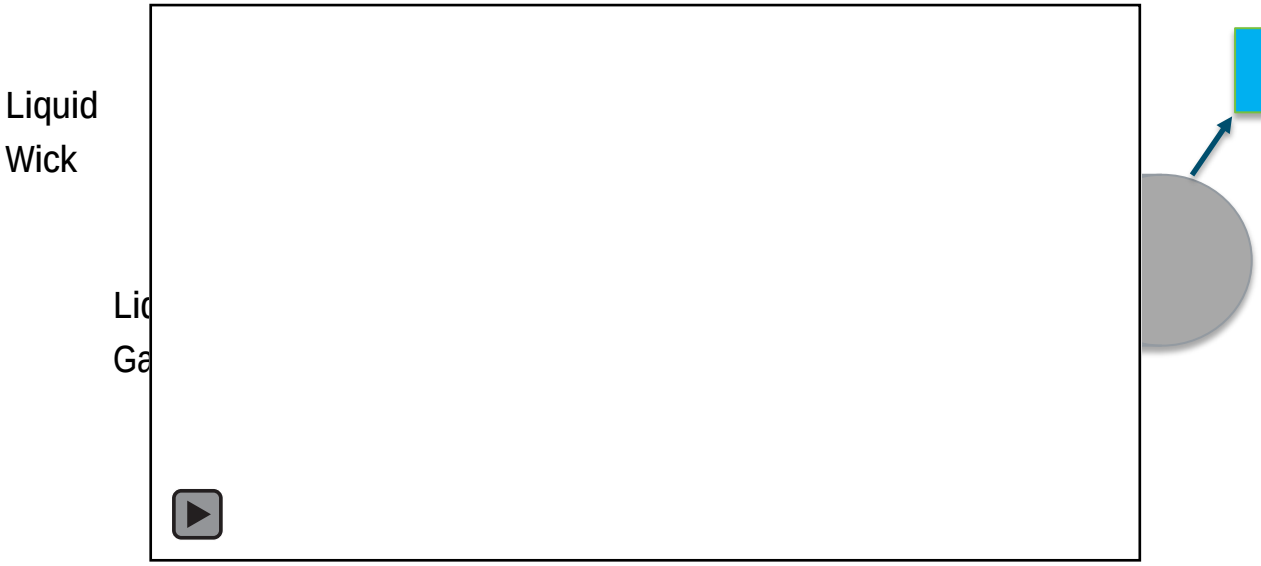
# Advance technology to effectively remove heat from the fuel/core block and convert to electricity

- Advance technology to effectively remove heat from the fuel/core block and convert to electricity.
- Demonstrate heat removal for single and integrated components through high fidelity experiments.
- Generate performance data that supports design and validation of Nuclear Energy Advanced Modeling and Simulation (NEAMS) codes.
- Research more efficient heat exchangers/power conversion units.
- Initial focus is on heat pipe technology (below) as other advanced reactor programs have studied gas and liquid coolant.

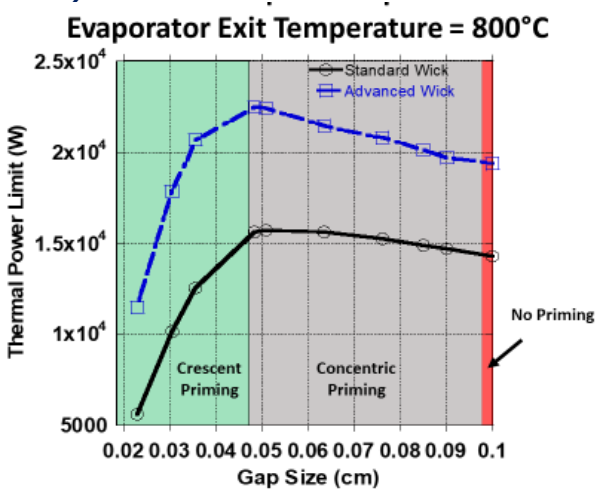



Power Conversion Unit

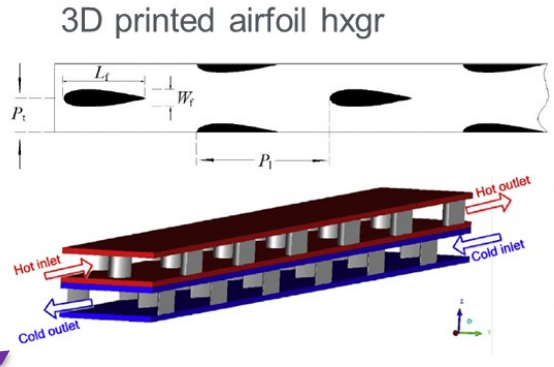
Video Courtesy of Valerie Lawdensky, LANL

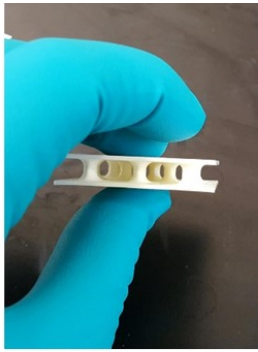
# Current Research

- Enhance heat pipe efficiency:
  1. Increase power production with double-ended heat pipes
  2. Decrease annular pore radius in wick designs (below).


Gas-Cooled Microchannel Heat Exchanger Development



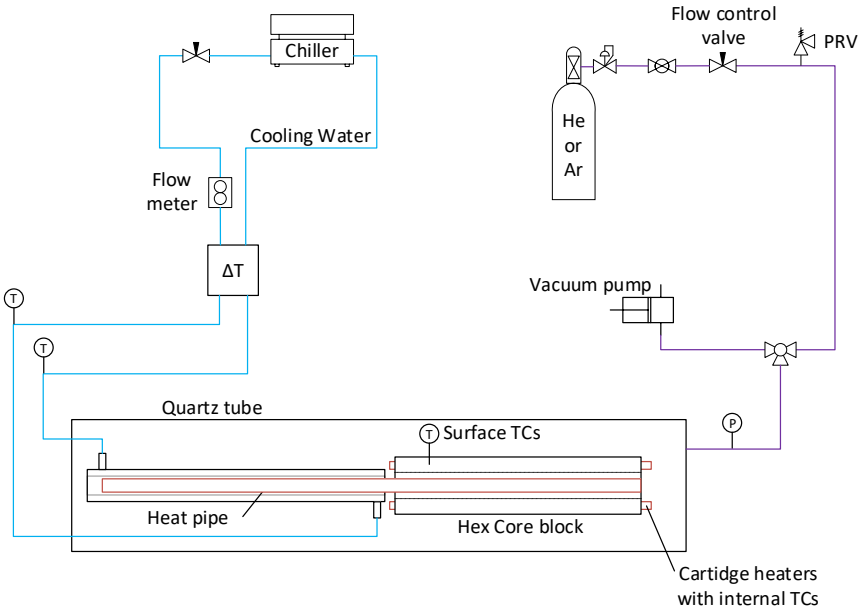



- Evaluate multiple heat exchanger designs:
  - shell and tube,
  - printed circuit,
  - gas-cooled microchannels, and
  - bayonet-type.

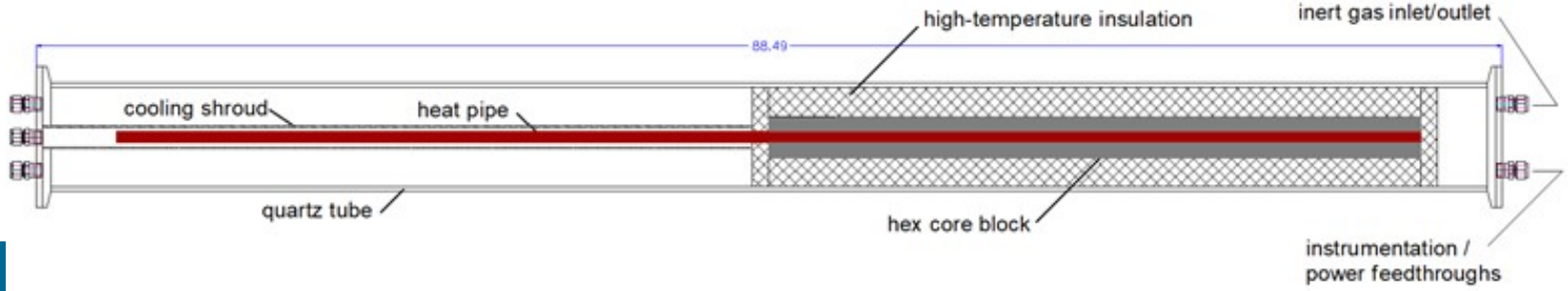
Pictures Courtesy of Bob Reid, LANL, and Donna Guillen, INL

# Single Heat Pipe Nonnuclear Experiments in MAGNET

- 7-hole test articles have a heat pipe in the center and 6 heaters in surrounding holes.
- Heat flux for cartridge heaters is 3.8 W/cm$^2$.
- Characterize high-power heat pipe performance during startup and steady-state conditions.
- Perform calorimetric measurements with water-cooled gas gap calorimeter.
- Determine heat pipe temperatures and other operational limits.
- Advanced manufacturing creates unconventional geometries of structural an heat removal components: determine performance of both additively and traditionally manufactured material.

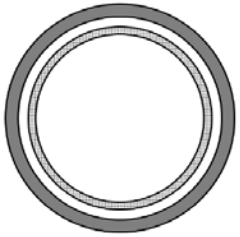


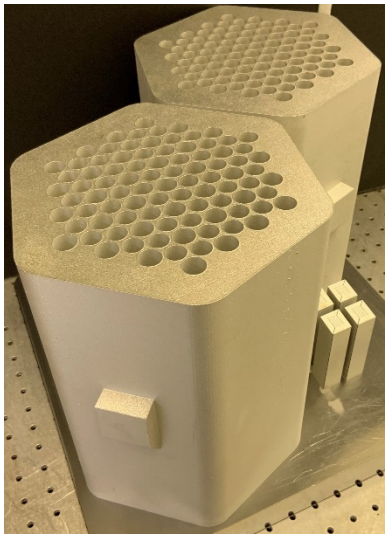

Pictures Courtesy of TJ Morton and Jim O'Brien, INL, and Colt Montgomery, LANL

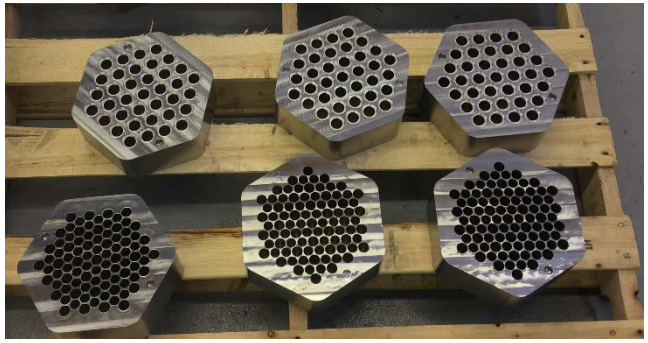



# Larger nonnuclear test article for heat pipe performance/validation

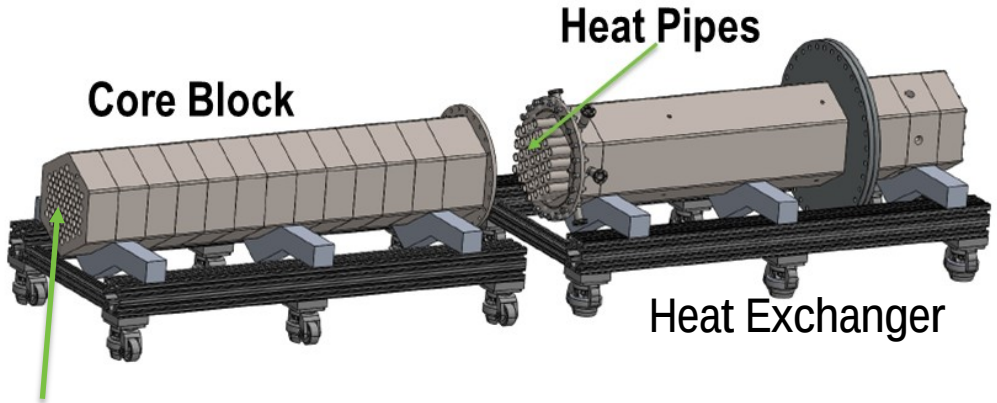
- 37 heat pipes and 54 heaters to simulate fuel rod performance.
- ~75 kWt nonnuclear demonstration is planned.
- Determine benefits of additive manufacturing and joining techniques for fabrication of test articles.
- Demonstrate heat pipe to heat exchanger interface.
- Heat pipes have annular gap design, stainless steel-sodium system.
- Throughput (heat pipe limits)
  - 600 ° C, up to 4 kW/heat-pipe
  - 650 ° C, up to 7.5 kW/heat-pipe
  - 700 ° C, up to10 kW/heat-pipe







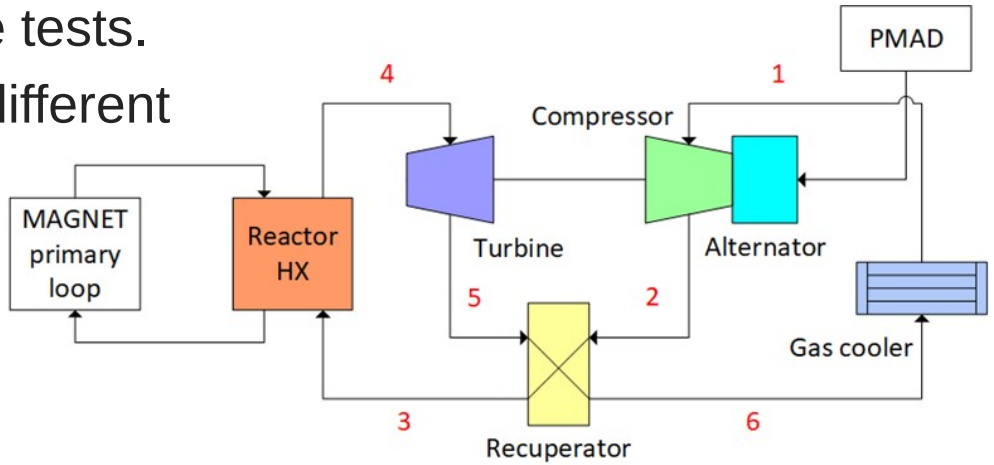
Pictures Courtesy of Bob Reid, Colt Montgom-ery, John Carpenter, LANL



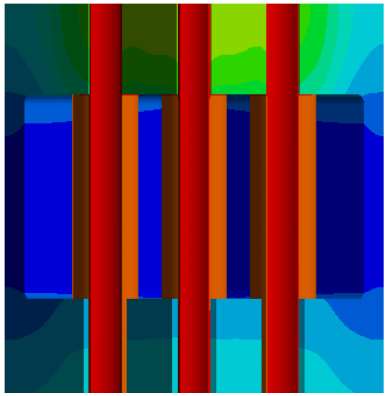

Heaters in Nonnuclear Demo as 'Fuel Rods'

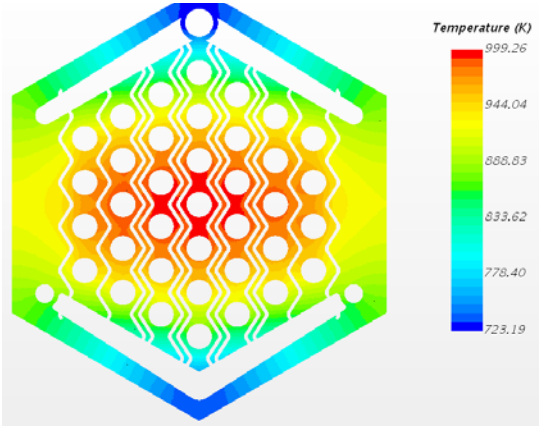
# Upcoming Work

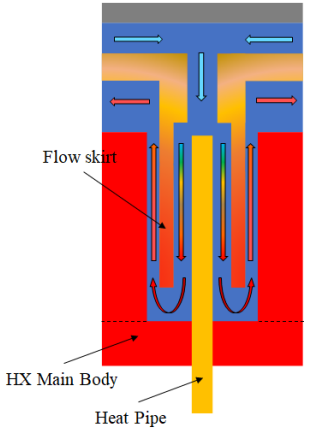
- Perform aforementioned test article experiments.
- Research/develop gas- and/or liquid-cooled test articles.
- Demonstrate integration with a Power Conversion Unit using MAGNET.
- Finish advanced heat pipe tests.
- Evaluate performance of different heat exchangers.

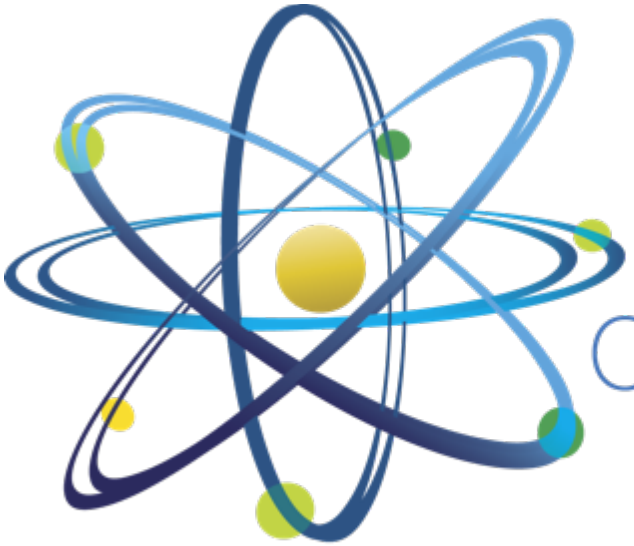



Pictures courtesy of Donna Guillen, Lindsey Gaspar, James O'Brien, Jun Soo Yoo, and SuJong Yoon







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