



# DOE Microreactor Program

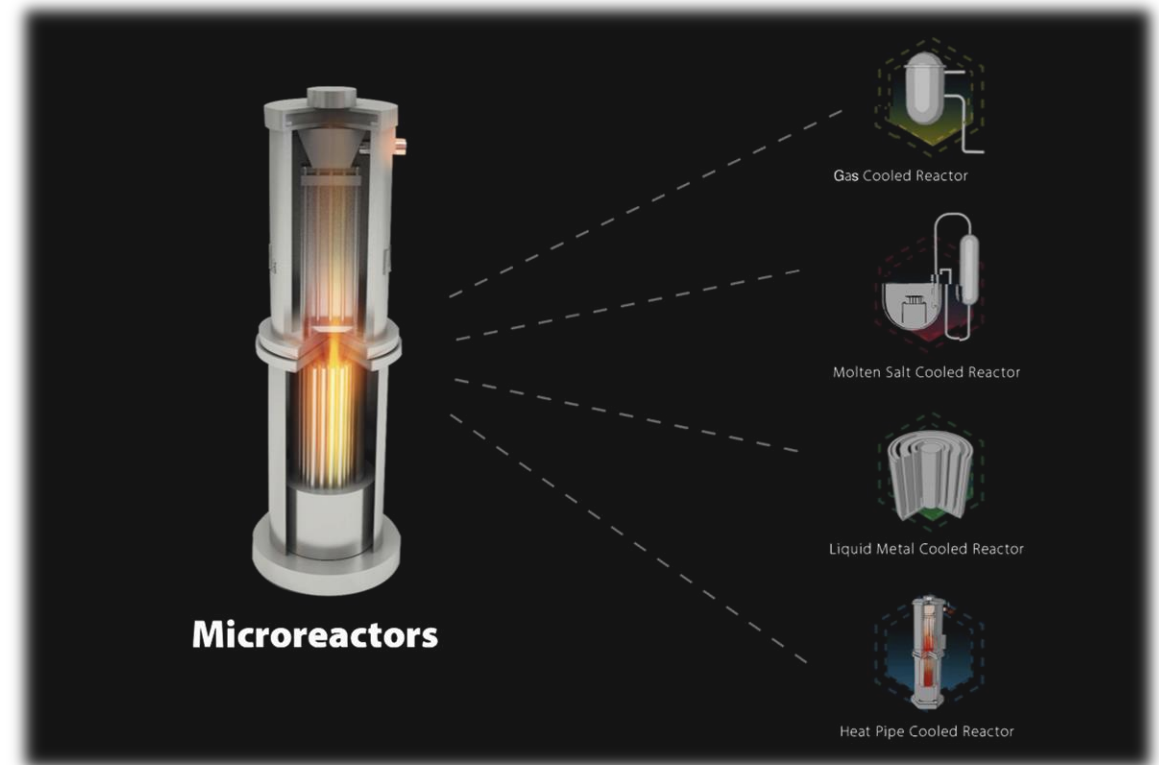
Technology to Enable Microreactor Development,  
Deployment and Commercialization

May 12, 2021

**John H Jackson, Ph.D.** | National Technical Director

# What are Microreactors?

- Small size and power level: ~0.1 – 20 MW<sub>t</sub>
- Factory fabricated
- Easily transportable to and from site
- Minimum site preparation
- Flexible operation
- High-degree of passive safety
- Operational lifetime: 5 – 20 yrs
- Technologies evolving from advances in materials, space reactor technologies, advanced nuclear fuels, and modeling & simulation
- Well suited for remote areas and applications:
  - Remote communities
  - Isolated microgrids
  - Mining sites
  - DOD applications
- Broadly distributed, reliable, energy sources



Microreactors are integrated systems that can be based on a range of reactor technologies

# DOE Micro-Reactor RD&D Program

## Mission, Approach and Objectives

**Mission:** Enable microreactor technology demonstrations at a DOE National Laboratory and subsequent deployment for commercial and/or defense applications

### Approach:

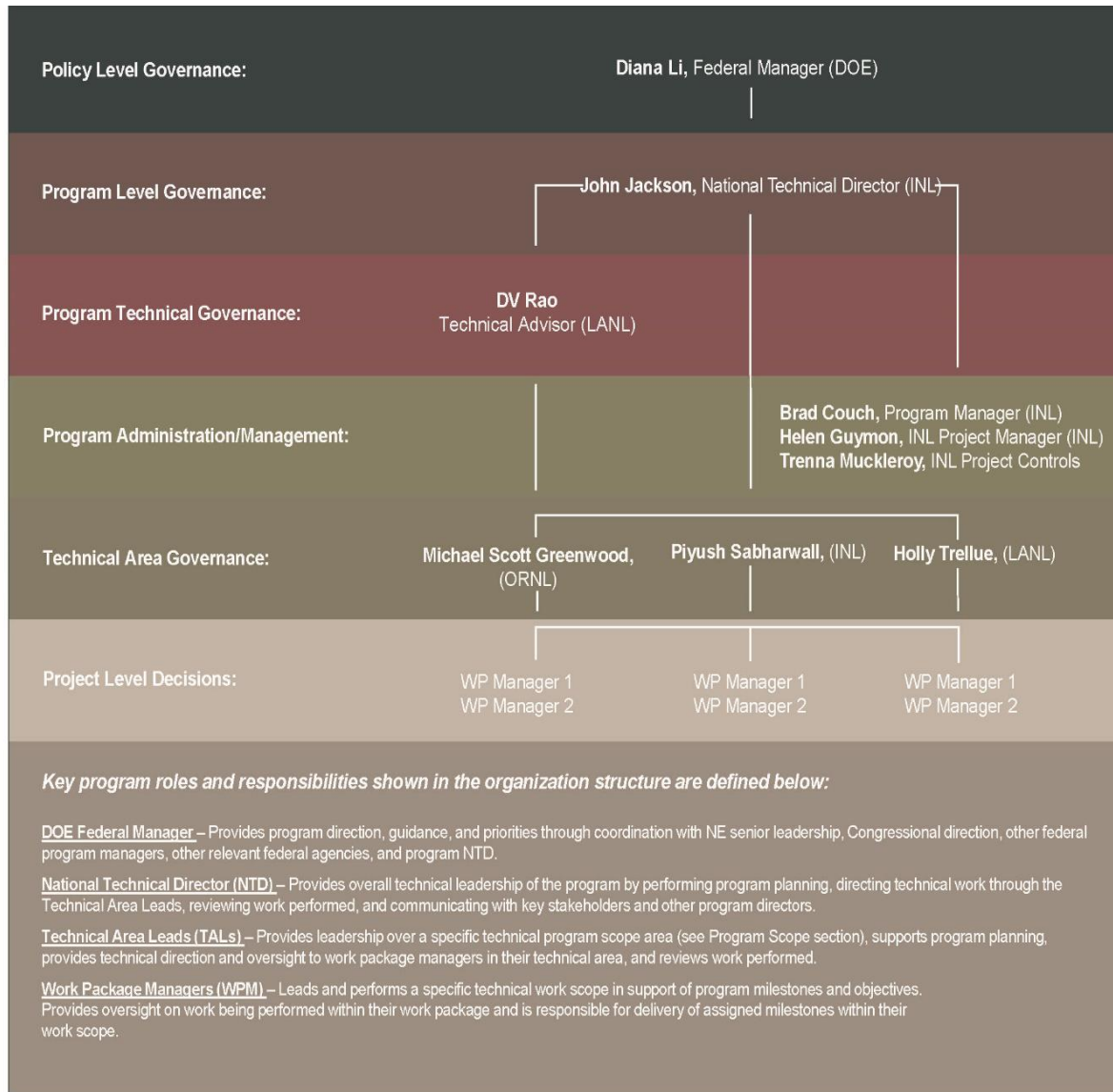
- The DOE-funded program will conduct fundamental R&D to reduce uncertainty and risk in the design and development of microreactors to facilitate rapid technology commercialization
- R&D is selected to support technology maturation that is broadly applicable to multiple reactor cooling/technology options to ensure that concepts can be licensed and deployed to meet specific use-case requirements

### Primary Objectives:

- Meet critical cross-cutting R&D needs of existing developers that require national laboratory or university expertise or capabilities.
- Develop R&D infrastructure to support design, demonstration, regulatory, and safety-related tests and to collect data to validate modeling and simulation (M&S) tools.
- Develop advanced technology and technology concepts that enable improved performance, economics, or integration of microreactors.



# Microreactor Program Organization



# DOE Microreactor Program

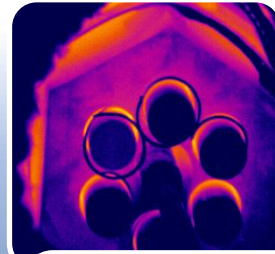
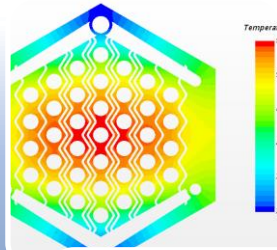
## Program Vision

**Through cross-cutting research and development and technology demonstration support, by 2025 the Microreactor Program will:**

- Achieve technological breakthroughs for key features of microreactors
- Empower initial demonstration of the next advanced reactor in the US
- Enable successful demonstrations of multiple domestic commercial microreactors.

## Program Objectives

- Address critical cross cutting R&D needs that require unique laboratory/university capability or expertise
- Develop R&D infrastructure to support design, demonstration, regulatory issue resolution, and M&S code validation
- Develop advanced technologies that enable improvements in microreactor viability



### System Integration & Analyses

- Economics & Market Analysis
- Integrated Systems Analysis
- Applications of NEAMS computational Tools
- Technoeconomic Analyses
- Regulatory Development

### Technology Maturation

- Advanced Heat Pipes
- Advanced Moderators
- Heat Exchangers
- Instrumentation & Sensors
- Advanced Materials and Material Code cases

### Demonstration Support Capabilities

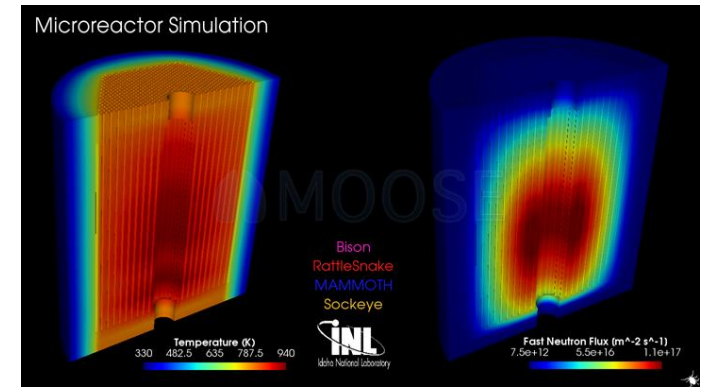
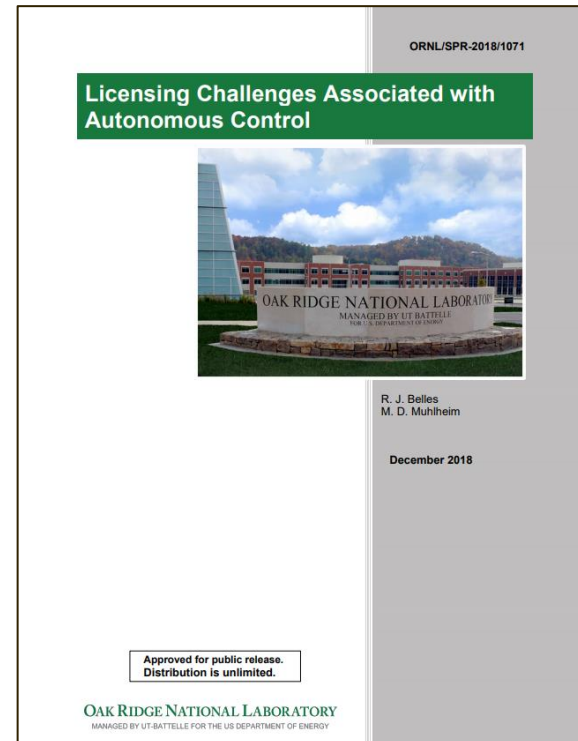
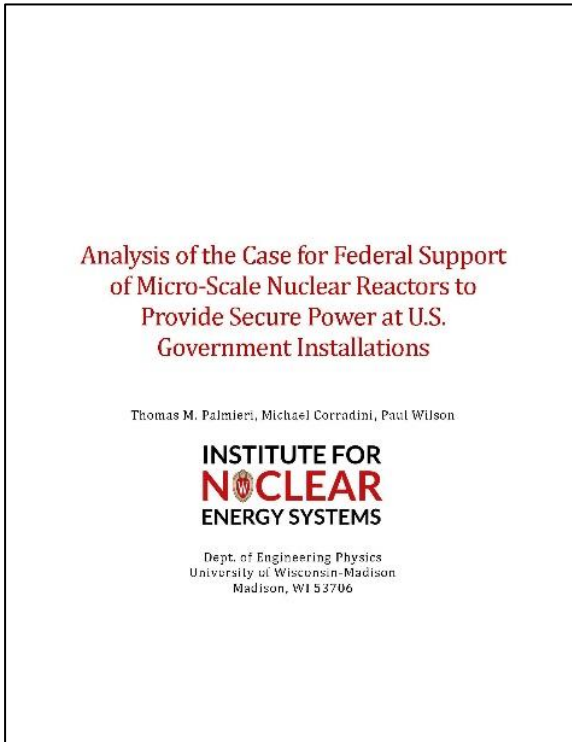
- Non-nuclear thermal and integration testing
- Microreactor Agile Non-nuclear Experimental Testbed (MAGNET)
- Microreactor Applications Research, Validation and Evaluation (MARVEL)

### Microreactor Demonstrations & Applications

- Reactor Demonstrations
- Remote heat & power
- Hydrogen co-generation
- District heating
- Desalination

# Microreactor Program Technical Areas and Leads

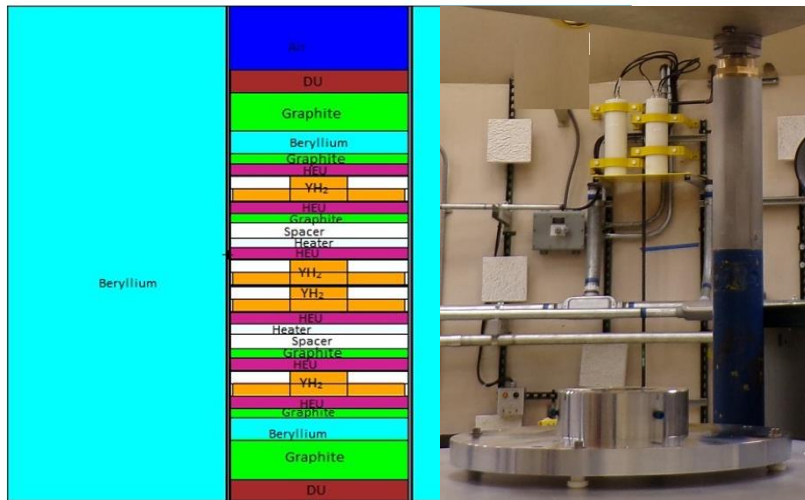
- Systems Integration and Analysis – Scott Greenwood (ORNL)
  - Regulatory support
  - Modeling and Simulation
  - Economic and Market Analysis



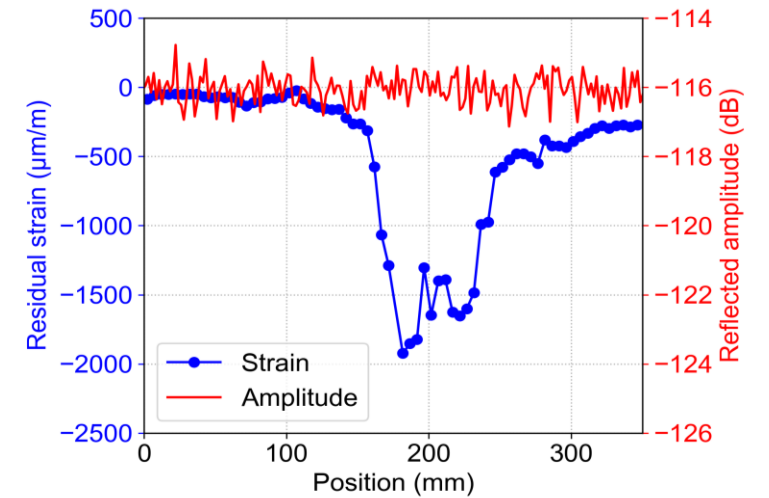
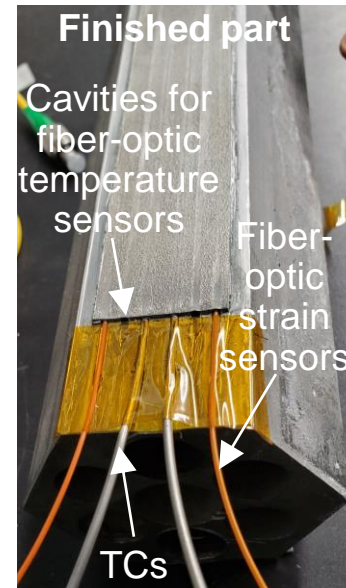
# Microreactor Program Technical Areas and Leads

- Technology Maturation – Holly Trelue (LANL)

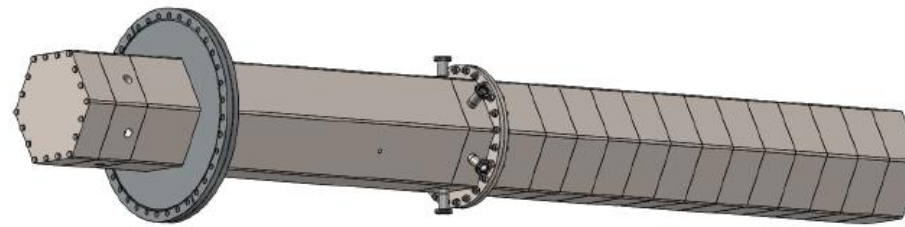
- High temperature moderators
- Structural materials
- Heat removal and power conversion
- Instrumentation and sensors
- Legacy fuel



Hypatia



High fidelity strain

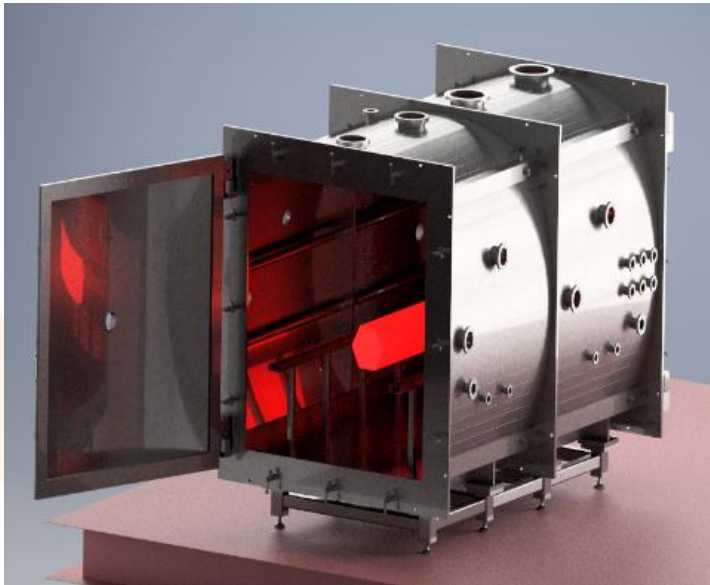


eBlock37 core block

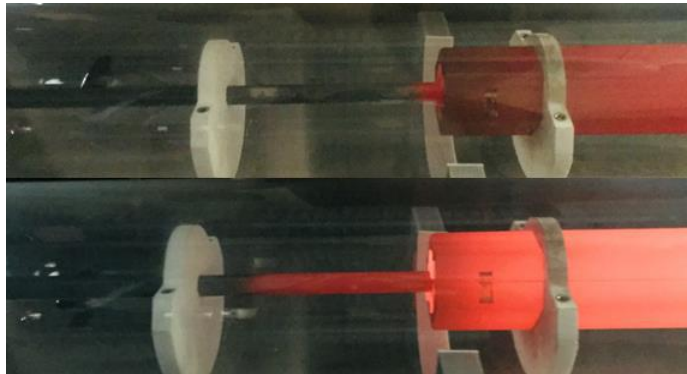


# Microreactor Program Technical Areas and Leads

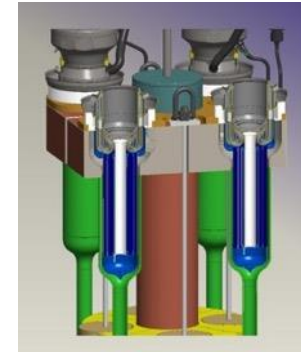
- Demonstration Support Capabilities – Piyush Sabharwall (INL)
  - Non-nuclear testing and demonstration
    - MAGNET, SPHERE
  - Nuclear test bed (MARVEL)
  - Siting support and Analysis (in coordination with NRIC)



MAGNET



SPHERE



MARVEL





# FY21 Program Priorities

- 1) Complete irradiation of an advanced moderator and develop a handbook of material properties for industry use.
- 2) Perform shakedown testing to demonstrate operability of non-nuclear test bed facilities (SPHERE and MAGNET)
- 3) Complete microstructural modeling for an advanced steel material with improved performance over standard steel materials (G91), investigate materials with improved higher temperature performance (316H SS).
- 4) Complete design, safety analysis, fuel fabrication capability and EA for microreactor nuclear applications integration and testing platform to support applications testing to meet the requests and needs of potential end users (MARVEL)

# Workshop purpose and expectations

- Collect feedback on current and future research and development challenges toward enabling demonstration and commercial deployment of microreactors
  - In other words, how do we make operational microreactors a reality?!
  - What is the role of the DOE programs and laboratories and what is the synergy between all the stakeholders?
- Share what we're working on under the DOE-NE Microreactor Program
  - Does it help/have value?
  - Can we expand on it?
  - ***What else should we be doing?***
- Get perspective from additional stakeholders
  - NRC, NEI, EPRI, DOD



# Microreactor Program resources and partner programs

- Microreactor Program website - <https://gain.inl.gov/SitePages/MicroreactorProgram.aspx>
  - Program plan
  - Fact sheets
  - Reports
- Gateway for Accelerated Innovation in Nuclear (GAIN) – <https://gain.inl.gov>
  - Vouchers
  - Workshops and conferences of interest
  - DOE competitive funding
- National Reactor Innovation Center (NRIC) – <https://nric.inl.gov>
  - Siting
  - Demonstration support





# MRP Microreactor Program

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(Technology Maturation) Holly Trelue – [Trelue@lanl.gov](mailto:Trelue@lanl.gov)

(Systems Integration & Analysis) Scott Greenwood – [greenwoodms@ornl.gov](mailto:greenwoodms@ornl.gov)

(MARVEL) Yasir Arafat – [Yasir.Arafat@inl.gov](mailto:Yasir.Arafat@inl.gov)

<https://gain.inl.gov/SitePages/MicroreactorProgram.aspx>