

Introduction to NEAMS

David Andersson, NEAMS National Technical Director, Los Alamos National Laboratory

Tanju Sofu, NEAMS Deputy National Technical Director, Argonne National Laboratory

David Henderson, Federal Program Manager, U.S. Department of Energy

NEAMS Annual Review Meeting, February 10-12, Idaho National Laboratory



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Nuclear Energy Advanced Modeling and Simulation (NEAMS)

- Why advanced modeling simulation of nuclear reactors?
 - Predictive M&S enable innovation in the development, licensing, deployment, and operation of nuclear reactors by delivering high-fidelity results and increasing the value of often limited experimental data.
 - Supports DOE's NE mission to advance nuclear energy science and technology to meet U.S. needs.
- The NEAMS program captures this opportunity by:
 - Developing advanced modeling and simulation codes and methods in reactor physics, thermal hydraulics, fuels, materials, chemistry, and multiphysics to improve simulation of current and advanced reactors.
 - Utilizing and advancing new and evolving science and technology such as multi-scale simulations, AI/ML, in-line sensor data and digital twins, and advanced computing platforms.
 - Supporting development, licensing, deployment and operation of nuclear reactors by stakeholders through software deployment, maintenance, baseline support, validation and verification.
 - Engaging in collaborations and partnerships to enable use of NEAMS tools for advances in reactor technology by stakeholders (industry, NRC, universities, other DOE programs, etc.).



NEAMS Program Structure



David Henderson
DOE NE-5 Federal Program Manager



David Andersson
National Technical Director



Tanju Sofu
NEAMS Deputy Director



Stephen Novascione
Lead, Fuel Performance



Matthew Jessee
Lead, Reactor Physics



Elia Merzari
Lead, Thermal-Hydraulics



Benjamin Spencer
Lead, Structural Materials & Chemistry



Emily Shemon
Lead, Multiphysics Applications



Michael Cooper
Deputy Lead, Fuel Performance



Joshua Hanophy
Deputy Lead, Reactor Physics



Rui Hu
Deputy Lead, Thermal Fluids



Ted Besmann
Deputy Lead, Structural Materials & Chemistry



Cody Permann
Deputy Lead, Multiphysics Applications

DOE NE-72
Federal Program Manager:
David Henderson

Director: David Andersson (LANL)
Deputy Director: Tanju Sofu (ANL)

Senior Leadership

Fuel Performance

Lead: Steve Novascione (INL), *Deputy:* Mike Cooper (LANL)

Reactor Physics

Lead: Matt Jessee (ORNL), *Deputy:* Joshua Hanophy (INL)

Thermal Fluids

Lead: Elia Merzari (PSU, JFA ANL), *Deputy:* Rui Hu (ANL)

Structural Materials and Chemistry

Lead: Ben Spencer (INL), *Deputy:* Ted Besmann (USC, JFA ORNL)

Multiphysics Applications

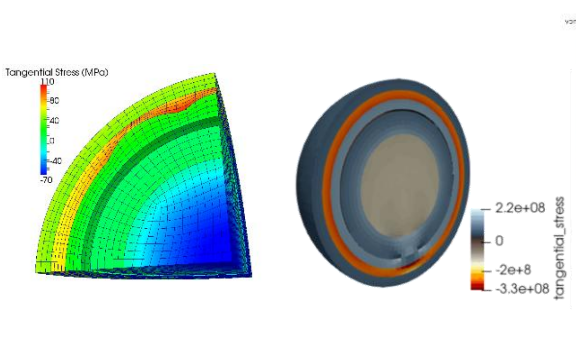
Lead: Emily Shemon (ANL), *Deputy:* Cody Permann (INL)

Extended Leadership



NEAMS Technical Areas and Code Support

Fuel Performance

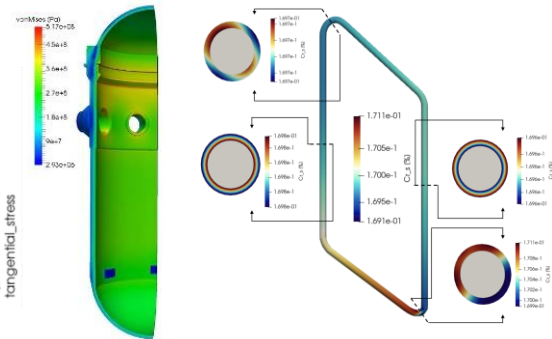


Competencies: Multi-scale fuel and cladding performance

Codes: BISON, MAMBA

Lower-length-scale capabilities: DFT, MD, phase field (MARMOT), crystal plasticity (LAPx), cluster dynamics (Centipede)

Structural Materials and Chemistry

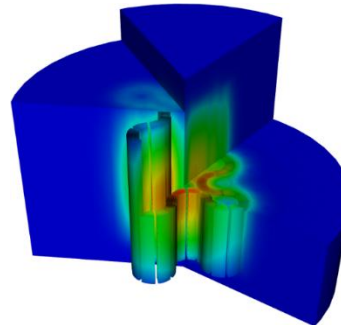


Competencies: Multi-scale modeling of materials degradation and chemistry (molten salts)

Codes: Grizzly/BlackBear, MSTDB-TC/TP, Mole, Saline, SWIFT, MOSCATO

Lower-length-scale capabilities: DFT, MD, phase field, crystal plasticity (LAPx), dislocation dynamics, cluster dynamics

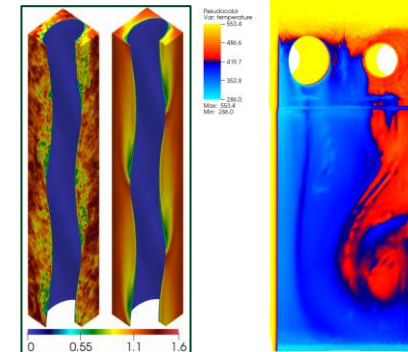
Reactor Physics



Competencies: Deterministic and stochastic methods for simulating neutron transport and nuclide depletion/decay

Codes: GRIFFIN, Shift, MPACT

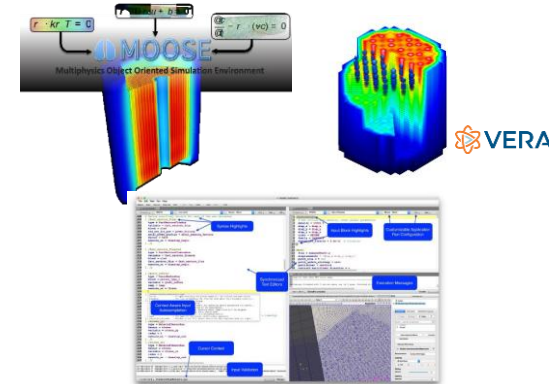
Thermal Fluids



Competencies: Multi-scale simulations of thermal fluids and heat transfer in reactor systems

Codes: CTF, SAM, PRONGHORN, Sockeye, Nek5000/NekRS, Cardinal

Multiphysics Applications



Competencies: Computational framework and methods, multiphysics simulations, reactor specific applications, user interfaces and workflows.

Codes and frameworks: MOOSE, VERA, Workbench

Capabilities are developed for all major reactor types – Light Water Reactors, Gas-Cooled Reactors, Molten Salt Reactors, Metal Cooled Fast Reactors and Microreactors. The reactor specific applications cross-cut the technical areas.

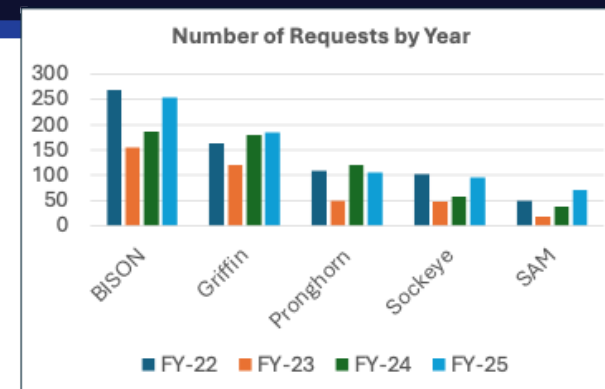
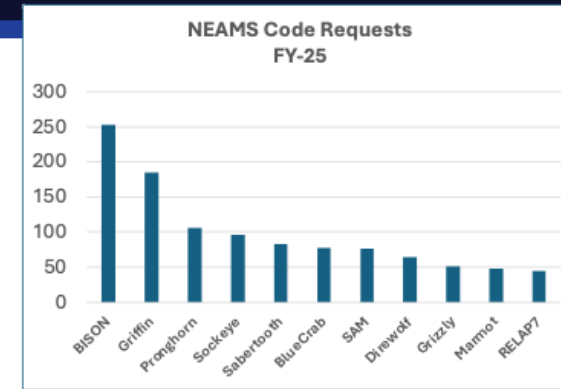
Key success metric: Use of NEAMS technology (either software or R&D) by stakeholder to improve how they “do business.”



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Access to NEAMS codes (NCRC) and additional resources

- Access to most NEAMS codes can be requested through Nuclear Computational Resource Center (NCRC) at INL - <https://inl.gov/ncrc/>.
- NRIC-NEAMS collaboration on the Virtual Test Bed (VTB) - https://mooseframework.inl.gov/virtual_test_bed/ - where open models can be accessed.
- <https://neams.inl.gov/> contains additional information, including OSTI links to key milestone reports (coming soon), presentations from last year's review meeting and the NEAMS newsletter.



NEAMS Argonne INL

NRIC – Virtual Test Bed (VTB)

Reactor Demonstrations

- Accurate Licensing Evaluation (NRC)
- Accurate Authorization Evaluation (DOE)
- Accurate Design, Construction, and Operation (Industry)

What is it?

- Central location for reactor developers/stakeholders to access & leverage state-of-the-art ModSim models of advanced reactors to evaluate performance & safety
- Cross-laboratory and cross-program collaboration between NRIC and DOE Nuclear Energy Advanced Modeling and Simulation (NEAMS) program
- Repository/library of simulations for sodium, gas, lead, micro, and molten salt reactors (continuously tested)
- Continuous Software QA: linking repository to software development to avoid legacy issues while enabling rapid code development

VTB So Far

- Currently hosting 35+ distinct models with 12 NEAMS codes showcases. More coming soon!
- Averaging ~250 visits/month (period between July-Sep 2023) – representation from Industry/Regulatory/Academia

NEAMS

Nuclear Energy Advanced Modeling and Simulation

What does the NEAMS program do?

The Nuclear Energy Advanced Modeling and Simulation (NEAMS) program is a U.S. Department of Energy Office of Nuclear Energy (DOE-NE) program developing advanced modeling and simulation tools and capabilities to accelerate the development of advanced nuclear energy technologies, including light water reactors (LWRs), non-light water reactors (non-LWRs), and advanced fuels.

Learn More

What codes are available?

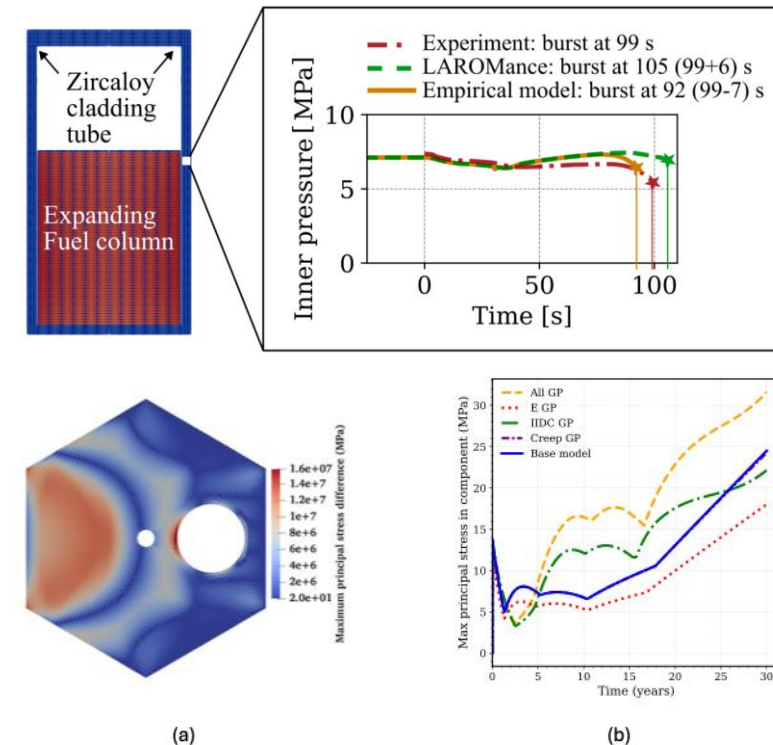


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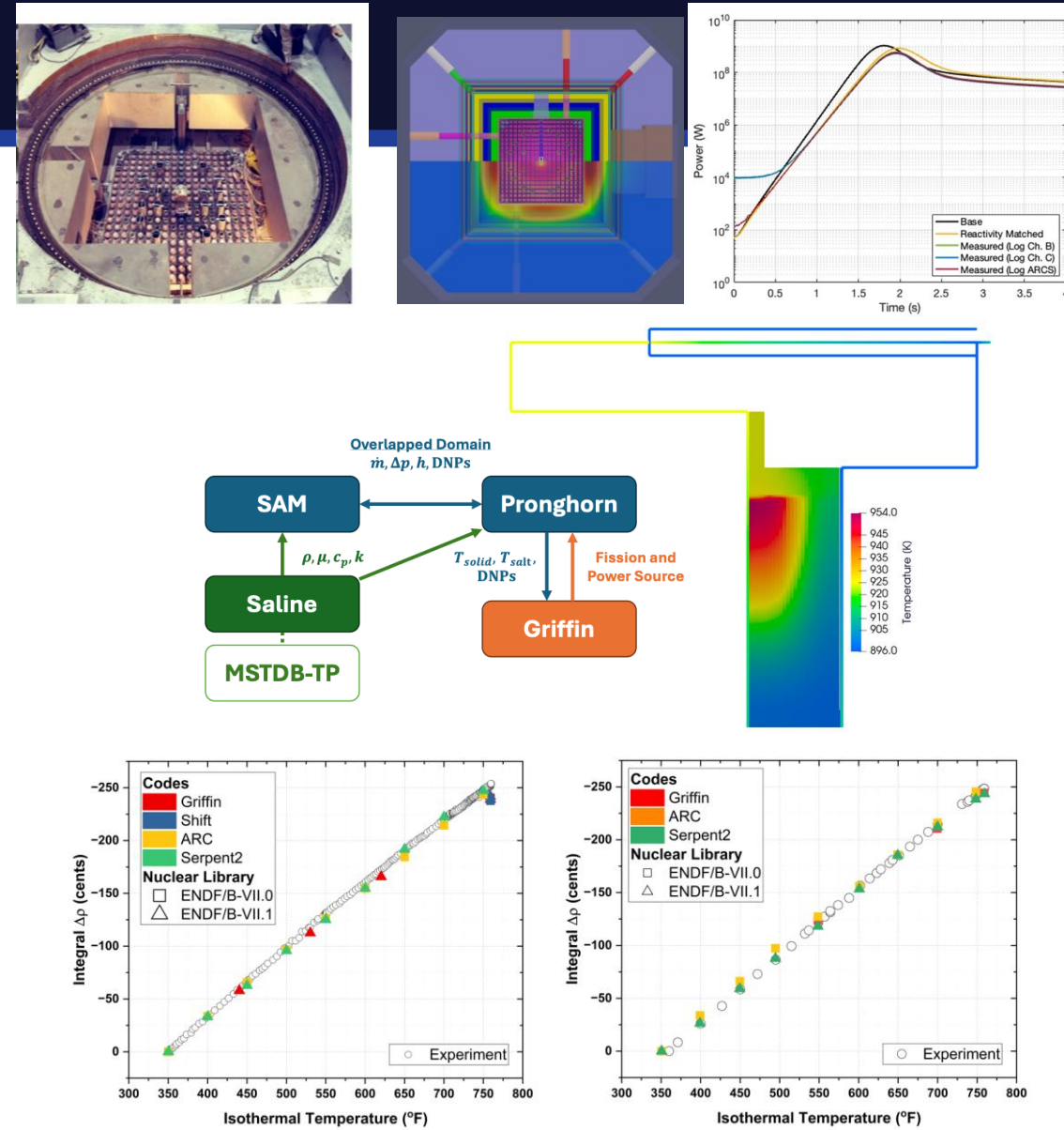
FY25 Accomplishments

- NEAMS contributors were recognized with several ANS awards:
 - ANS Untermeyer & Cisler Reactor Technology Medal: Rui Hu and Elia Merzari
 - ANS 40 Under 40: Mauricio Tano and Dillon Shaver
 - ANS Landis Young Member Engineering Award: Nathan Capps
 - ANS Fellow: Former National Technical Director, Chris Stanek
 - ANS THD Best Paper Award: Joshua Hansel and Elia Merzari
- **Fuel performance:** Demonstration of LOCA simulations using a new micromechanical modeling capability for Zircaloy in BISON utilizing a LAROMance surrogate.
- **Structural Materials and Chemistry:** Bayesian calibration of models for graphite grades demonstrated on component modeling for advanced reactors.



FY25 Accomplishments

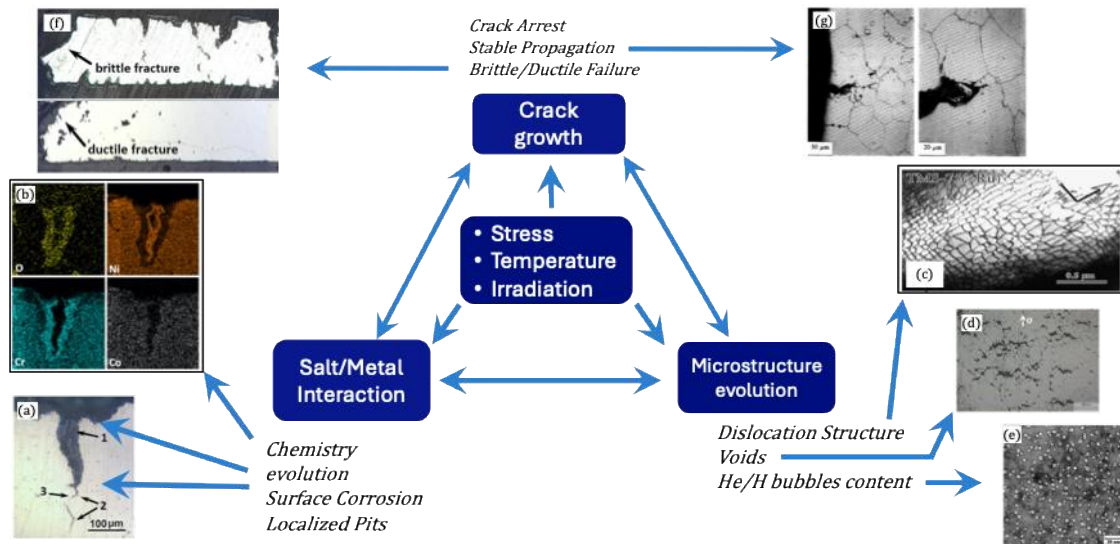
- **Reactor Physics:** Demonstration of enhanced neutron deep-penetration reactor modeling in Griffin on high-fidelity simulations of the TREAT reactor.
- **Thermal Fluids:** Established integrated molten salt reactor modeling capabilities in NEAMS thermal hydraulics tools, including coupling to reactor physics and MSTDP-TP.
- **Multiphysics and Applications:** Validation of fast reactor modeling tools using SEFOR experimental results (FRP collaboration).



Simulation of the Response of Structural Metals in Molten Salt Environment

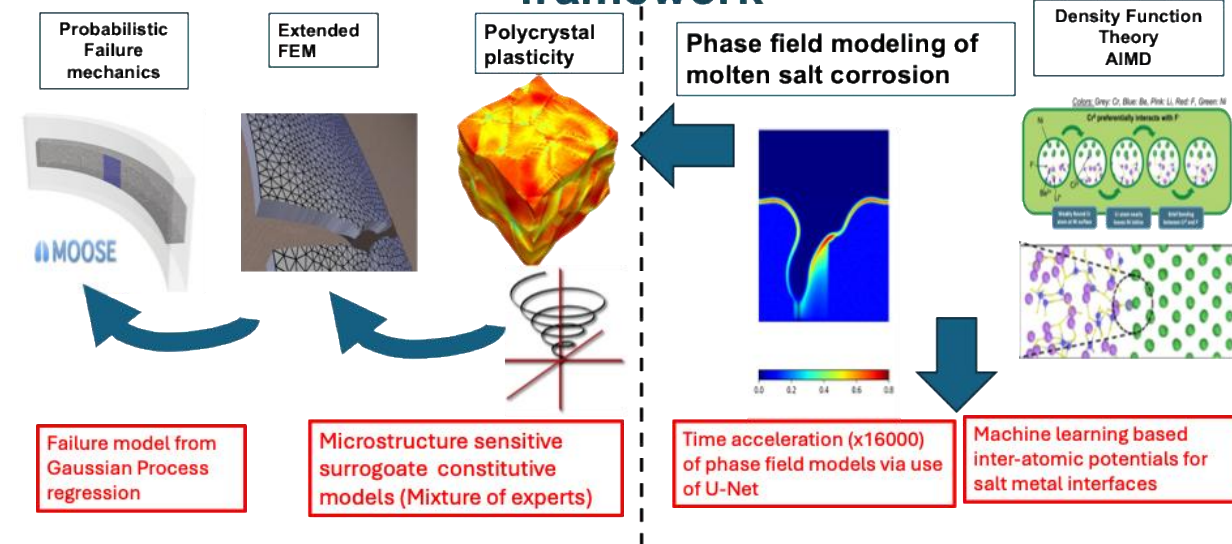
- Collaboration with Office of Science under the Science Scientific Discovery through Advanced Computing (SciDAC) program.
- Interface of molten salt and structural materials lead by L. Capolungo (LANL).

ASCR-NE Scidac: Multimodal Failure of structural metals for molten salt reactor applications



Goals: develop a modeling architecture enabling then study of multi-model failure in molten salt reactors (salt composition, irradiation effects, etc.)

AI/ML powered multiscale/physics framework



AI/ML components of the project in red



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NEAMS Annual Review Meeting Objectives and Structure

- Review research conducted by NEAMS in FY25, learn about our plans, and discuss next steps.
- Accomplished through five interactive panels, with time for open Q&A, organized by reactor type:
 - Light Water Reactors - Moderator: David Andersson (LANL)
 - Fast Reactors – Moderator - Tanju Sofu (ANL)
 - High Temperature Gas-cooled and Fluoride Salt-Cooled Reactors - Moderator: Ling Zou (ANL)
 - Micro-Reactors - Moderator: Jan Vermaak (INL)
 - Molten Salt Reactors - Moderator: Mauricio Tano (INL)
- There will also be a session on Multiphysics Frameworks and Workflows, as well as lunch presentations on how NEAMS is leveraging AI/ML to achieve its goals.
- We welcome stakeholder input during or immediately after the meeting to ensure alignment with industry, regulatory, and R&D needs.
- The second half of the meeting will be an internal NEAMS session to translate feedback into research plans and refine our technical approach.



Agenda

NEAMS Annual Review 2026

February 10-12, 2026

Idaho National Laboratory, Energy Innovation Laboratory (EIL) Room A102 775 MK
Simpson Blvd. Idaho Falls, Idaho 83415

Tuesday, February 10th, 2026

Time	Topic	Presenter
8:00	Welcome to INL	Jess Gehin (INL)
8:15	Introduction to NEAMS	David Andersson (LANL)
8:30	Panel: Light water Reactor Research Capabilities and Needs • Members: Bob Salko (ORNL), Matt Jessee (ORNL), Ben Spencer (INL), PC Simon (INL), Laurent Capolungo (LANL), Nathan Capps (ORNL)	Moderator: David Andersson (LANL)
10:15	Break	
10:30	Panel: Fast Reactor Research Capabilities and Needs • Members: Emily Shemon (ANL), Changho Lee (ANL), Dillon Shaver (ANL), Gary Hu (ANL), Steve Novascone (INL), Bo Feng (ANL)	Moderator: Tanju Sofu (ANL)
12:15	Working Lunch: AI/ML Applications in NEAMS I • Multiphysics Applications: MOOSEngier Development - a Domain-Specific AI Agent for MOOSE Ecosystem • Reactor Physics: Application of Machine Learning in Modeling Multigroup Cross Sections as Neural Networks • Fuel Performance: AI/ML applied to fuel performance modeling • Thermal Fluids: Transformer-Based Deep-Learning for Turbulence Modeling and Reactor System Simulations • Structural Materials & Chemistry: Molten salt thermo-physical property prediction using machine learning interatomic potentials	Mengnan Li (INL) Olin Calvin (INL) Som Dhulipala (INL) Eric Cervi (ANL) Chao Jiang (INL)
13:15	Panel: High Temperature Gas- Cooled Reactors and Fluoride High Temperature Reactor Research Capabilities and Needs • Members: David Reger (INL), Josh Hanophy (INL), Laurent Capolungo (LANL), Jake Hirschhorn (INL), Robby Kile (INL)	Moderator: Ling Zou (ANL)
15:00	Break	

15:15	Panel: Microreactor Research Capabilities and Needs • Members: Yinbin Miao (ANL), Tara Pandya (ORNL), Joshua Hansel (INL), Lynn Munday (INL), Abdalla Abou-Jaoude (INL)	Moderator: Jan Vermaak (INL)
17:00	Adjourn Day 1	

Wednesday, February 11th, 2026

Time	Topic	Presenter
8:00	Panel: Molten Salt Reactor Research Capabilities and Needs • Members: Ting Fei (ANL), Yaqi Wang (INL), Travis Mui (ANL), Tony Birri (ORNL), Daniel Schwen (INL), Patricia Paviet (PNNL)	Moderator: Mauricio Tano (INL)
9:45	Break	
10:00	Multiphysics Framework & Workflows • Usability-Driven Progress in Multiphysics Tools • GPU Acceleration in MOOSE, Chapter 2 - Parallel Development of Parallel Work • Implementation of a Constructive Solid Geometry Framework in MOOSE for improved Monte Carlo integration • User Oriented Advancements in MOOSE-Workbench	Cody Permann (INL) Alex Lindsay (INL) Kalin Kiesling (ANL) Rob Lefebvre (ORNL)
11:00	Discussion and Feedback	
11:30	Working Lunch: AI/ML Applications in NEAMS II • Multiphysics Applications: MOOSE Stochastic Tools Module: Stochastic Sampling, Surrogate modeling, and Optimization for MOOSE-Based Modeling and Simulation • Fuel Performance: Machine Learning Enabled Multiscale Uncertainty Propagation for Fission Gas Swelling in UN • Thermal Fluids: Advances in the multi-scale bridging within NEAMS for thermal-hydraulics applications: leveraging high-fidelity data • Structural Materials & Chemistry: Use of ML in Surrogate Models to Efficiently Bridge Between Mesoscale and Continuum Scale	Zach Prince (INL) Anton Schneider (LANL) Dillon Shaver (ANL) Laurent Capolungo (LANL)
12:30	Adjourn External Meeting	
NEAMS Internal Meeting		

Meeting logistics:

- This is a hybrid meeting.
- Please keep yourself muted when you are not speaking.
- Each panel and session have dedicated time for open Q&A.
- For in-person attendees, please raise your hand and wait for the moderator to call on you before asking your question.
- For the online audience, you can make comments in the chat or raise your virtual hand and wait for the moderator to to call on you before asking your question.
- For general question or requests, please reach out to David Andersson, andersson@lanl.gov.
- Thank you to INL for hosting the meeting and Kim Felde and Maighen Paskett for help with all logistics.





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