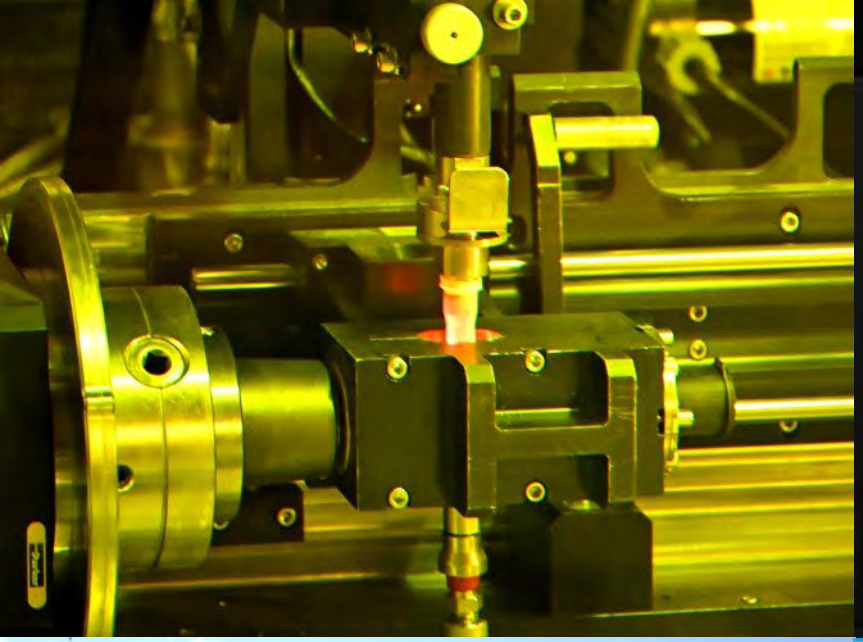


Simon M. Pimblott

Chief Scientist, Nuclear Science & Technology Directorate

Simon.Pimblott@INL.Gov

Idaho National Laboratory –

Creating a Secure, Resilient, Competitive Energy Future

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy

Idaho National Laboratory

Our Heritage: *The National Reactor Testing Station drove nuclear innovation in the U.S. and around the world*

1st

- Nuclear power plant
- U.S. city to be powered by nuclear energy
- Submarine reactor tested; training of nearly 40,000 reactor operators until mid-1990s
- Mobile nuclear power plant for the army

Demonstration of self-sustaining fuel cycle	Basis for LWR reactor safety	Aircraft and aerospace reactor testing	Materials testing reactors

Enabling energy dominance and security through research, development, and demonstration

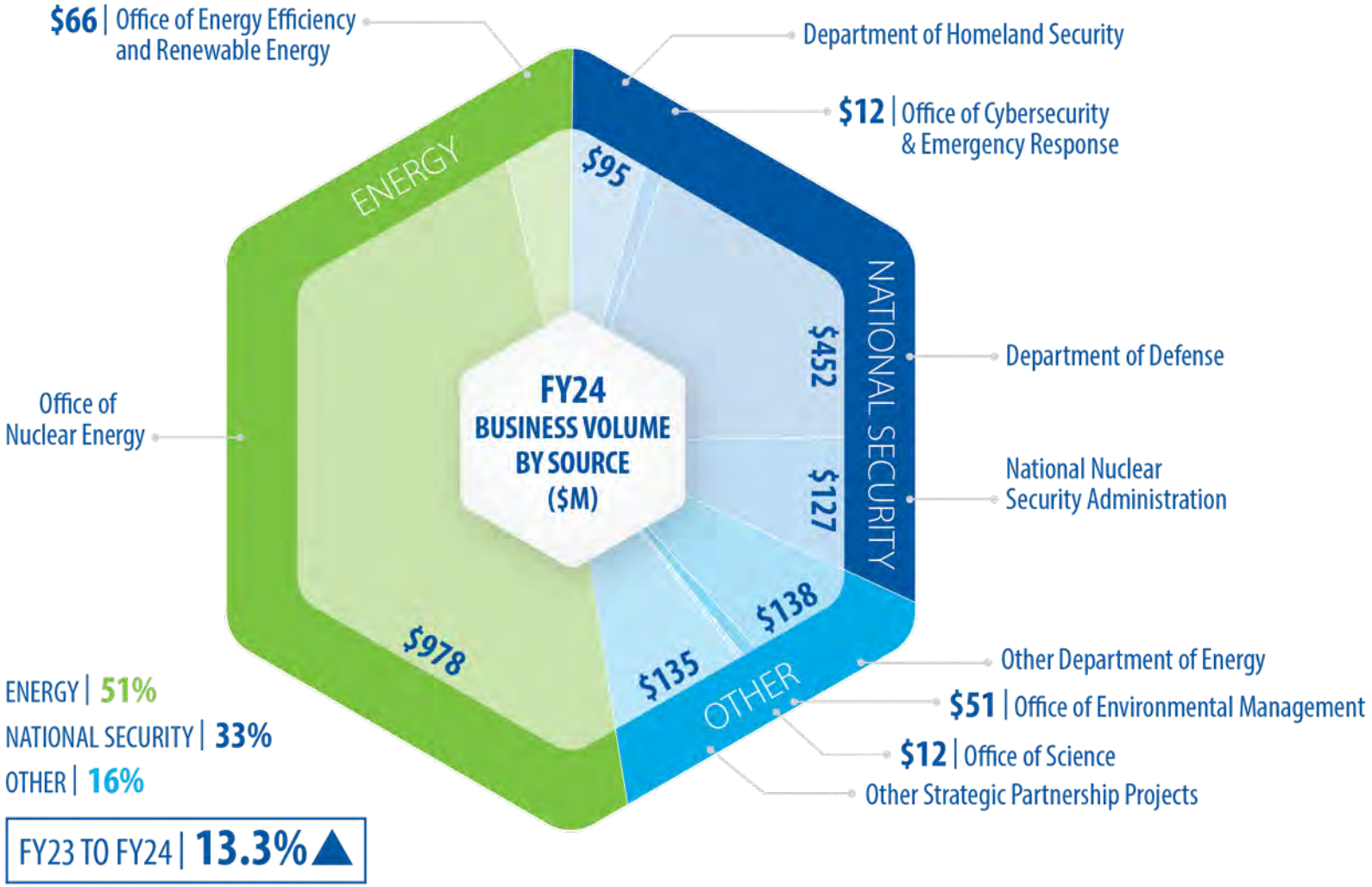
VISION

To change the world's energy future and secure our nation's critical infrastructure.

MISSION

To discover, demonstrate and secure innovative nuclear energy solutions, other clean energy options and critical infrastructure.

Exceeded $2B in business volume, 53% increase in past 5 years



FY24 OPERATING COST

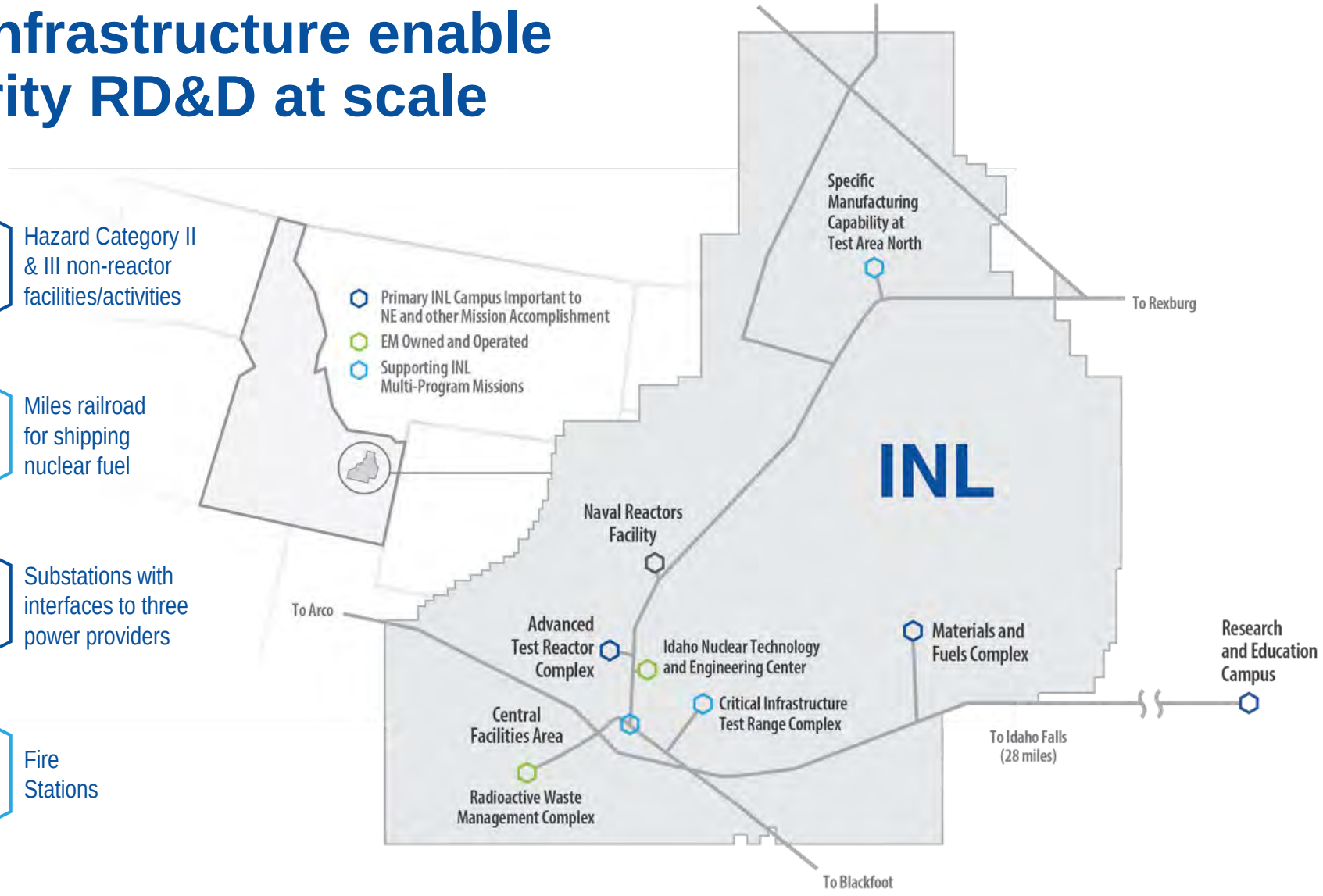
DOE/NNSA Costs: $1,372M
SPP (Non-DOE/Non-DHS): $581M
CRADA: $6M
DHS Costs: $107M
Total: $2,066M ($1.823M FY23)

FY24 HUMAN CAPITAL

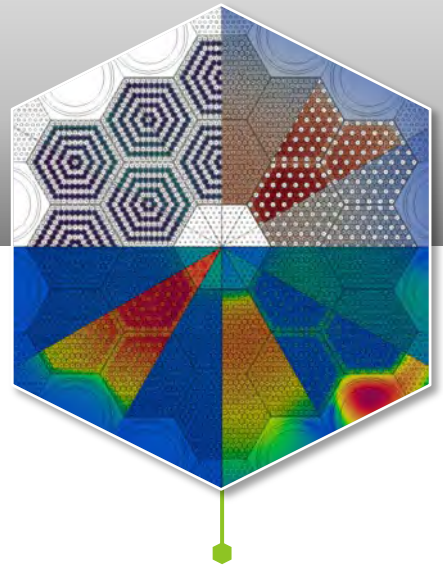
6,475	Full-time equivalent employees
112	Postdoctoral researchers
69	Joint appointments
687	Interns
19	Graduate fellows
52	Visiting scientists
996	Facility users

Unique site and infrastructure enable energy and security RD&D at scale

- **4** Operating reactors
- **49** Radiological facilities/activities
- **144** Miles high-voltage transmission & distribution lines
- **44** Miles primary roads (125 miles total)
- **22** Hazard Category II & III non-reactor facilities/activities
- **17.5** Miles railroad for shipping nuclear fuel
- **11** Substations with interfaces to three power providers
- **3** Fire Stations



Enabling American Energy Dominance & Security



Nuclear Science
& Technology

Advanced Test
Reactor Complex

Materials &
Fuels Complex

Energy &
Environment Science
& Technology

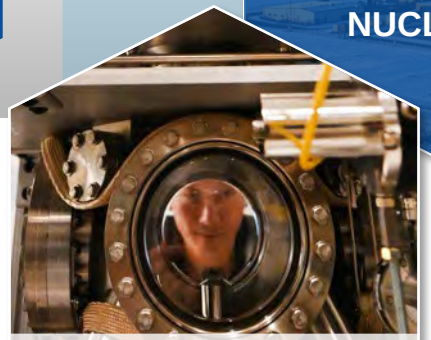
National & Homeland
Security Science
& Technology

Foundational Science & Technology Initiatives Advance Our Mission & Strategic Thrusts Accelerate Innovation


NUCLEAR

INTEGRATED ENERGY


NATIONAL SECURITY

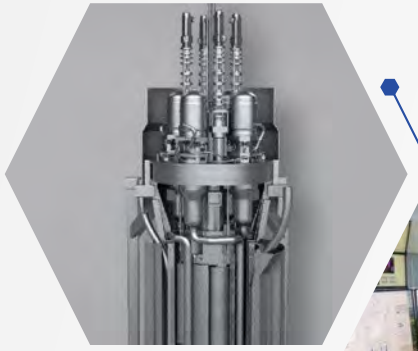

Fusion


Space & Defense

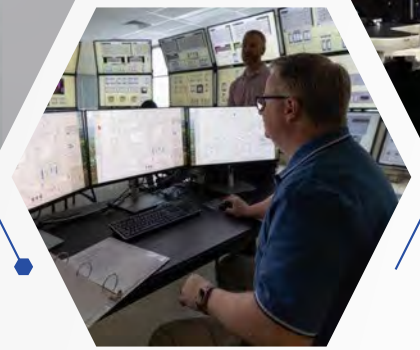

Critical Materials


AI

Sustaining the existing commercial reactor fleet and expanding deployment of nuclear energy

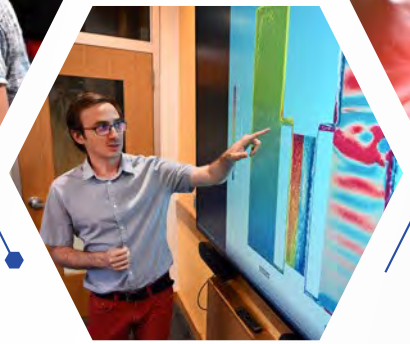


Advanced reactor technologies



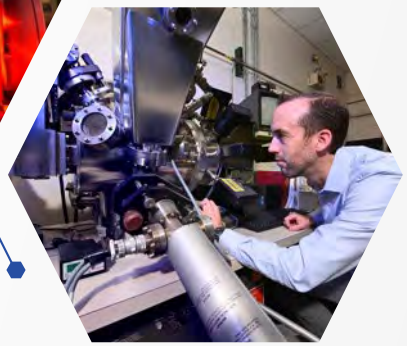
Regulatory and safety research

Fuel cycle and separations



Advanced modeling and simulation

Nuclear fuels and materials



Fusion Energy

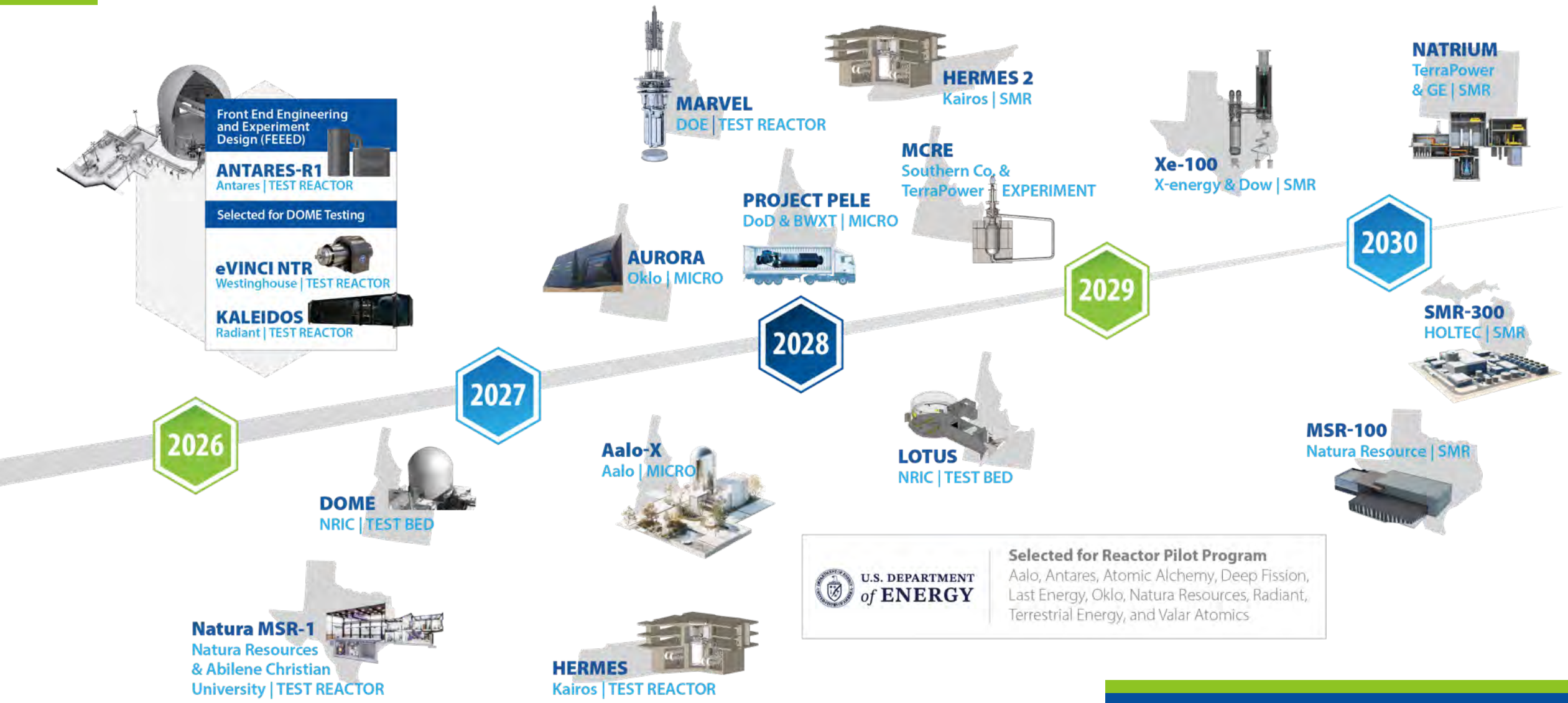
NSUF Nuclear Science User Facilities | GAIN Gateway for Accelerated Innovation in Nuclear | NRIC National Reactor Innovation Center

Nuclear Energy Executive Orders

- Reinvigorate the Nuclear Industrial Base
- Reform Nuclear Reactor Testing at DOE
- Deploy Advanced Nuclear Reactor Technologies for National Security
- Reform the Nuclear Regulatory Commission

President Donald Trump holds up a signed executive order in the Oval Office of the White House May 23, 2025 in Washington, DC. Win McNamee/Getty Images

Accelerating advanced reactor demonstration and deployment



Nuclear Energy Launch Pad

- Responds to executive orders.
- Builds on INL’s unique role and capabilities to enable the commercial nuclear industry and
rapidly innovate reactor technology.
- Designed to accelerate private-sector nuclear technology development through an innovative public-private partnership model.
- Idea modeled on NASA's successful approach to enabling commercial space innovation.
- A transformative expansion of the National Reactor Innovation Center.

INL Technical Capabilities Contribute to Regulatory Reforms

INL REPORTS

- Recommendations to Improve Nuclear Licensing
- Reevaluation of Radiation-Protection Standards for Workers and the Public Based on Current Scientific Evidence

Discovering new technologies for economically competitive energy integration for electricity, transportation, and industry

Critical materials recovery

High-efficiency thermal energy use

Integrated energy systems solutions

Nuclear H_2

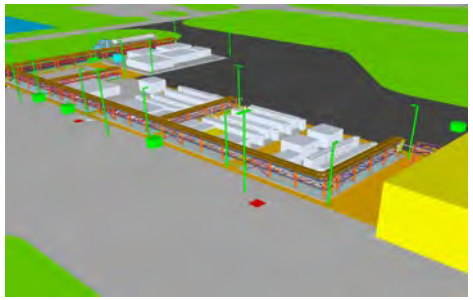
Sustainable fuels through waste recycling

Secure vehicle charging

Scaling up to the Energy Technology Proving Ground

Industrial-Scale Demonstration and Testing Complex That Will:

- Validate industrial technology at demonstration-relevant scale
- Design and control integrated energy systems
- Leverage contributions from nuclear energy
- Integrate with other test beds across the DOE laboratory complex



High Temperature Test Facility

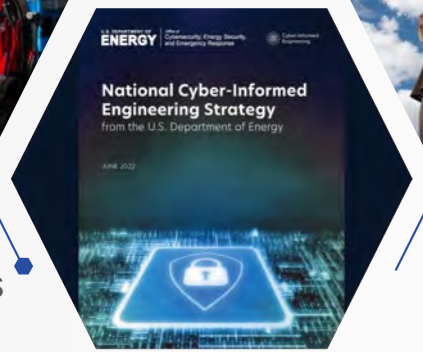
Biomass & Waste Carbon Processing

Microreactor Testing & Operations Facilities

Thermal Energy & Carbon Management Facility

Solving urgent national security challenges

Industrial Control Systems Security



Secure and Resilient Grid

Wireless Security

First Responder Training

Nuclear Safety and Security

National Defense Support

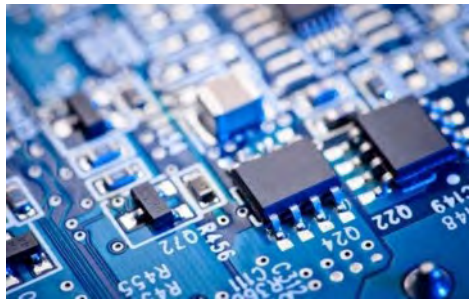
Deploying our cyber-physical capabilities

Current Programs and Tools

Cyber-Informed Engineering (CIE) - "engineer out" cyber risk throughout the design and operation lifecycle, rather than add cybersecurity controls later

Cybersecurity for the Operational Technology Environment (CyOTE™) - asset owners improve identification of adversarial techniques within operational technology (OT) environments

CyTRICS™ - cyber vulnerability testing, forensics, and digital subcomponent enumeration



Improves cybersecurity supply chain for ICS

Uses expert testing

Identifies common-mode vulnerabilities

Partners with vendors and asset owners

Relationships & Continuing Engagement

NS&T Leads Significant DOE-NE programs for the Department of Energy

NSUF Nuclear Science User Facilities

NRIC National Reactor Innovation Center

LWRS LIGHT WATER REACTOR SUSTAINABILITY

AFC Advanced Fuels Campaign

GAIN Gateway for Accelerated Innovation in Nuclear

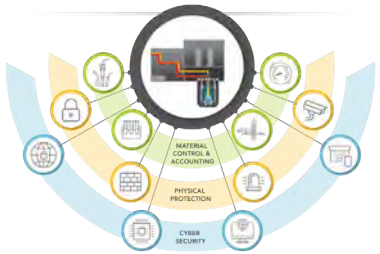
MRP Microreactor Program

ARDP

ART Advanced Reactor Technologies GAS-COOLED REACTORS

AMMT ADVANCED MATERIALS AND MANUFACTURING TECHNOLOGIES

ADVANCED REACTOR SAFEGUARDS & SECURITY



NEAMS NUCLEAR ENERGY ADVANCED MODELING & SIMULATION PROGRAM

ASI Advanced Sensors and Instrumentation

U.S. DEPARTMENT OF ENERGY | OFFICE OF ENVIRONMENTAL MANAGEMENT

U.S. DEPARTMENT OF ENERGY Office of Science

Material Recovery and Waste Form Development

COLLABORATION BASED SITING (NE-83)

URANIUM FUEL SUPPLY (NE-41)

Private-Sector Partners provide key collaborations and support of our RD&D

Idaho National Laboratory

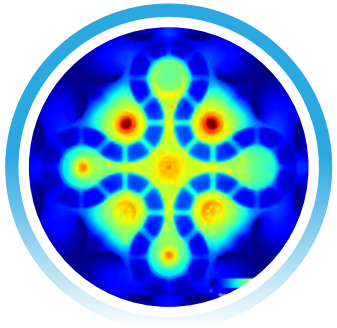
Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy. INL is the nation's center for nuclear energy research and development, and also performs research in each of DOE's strategic goal areas: energy, national security, science and the environment.

Nuclear Reactor Technology

Division Director: Justin Coleman

Pioneering the future of advanced nuclear energy by delivering next-generation reactors and closing technology gaps through mission-focused research and development (R&D)

Capabilities

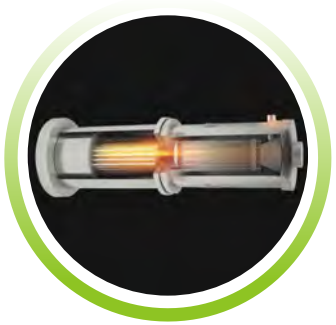


Reactor physics, core analysis, design and modeling

Thermal experiments, design and analysis

Microreactor design, development and testing

Advanced reactor remote and autonomous control



Space and Defense

STAFF: 92

KEY PROGRAMS:

- DOE-NE Microreactor Program,
- Microreactor Applications Research Validation and Evaluation (MARVEL)
- Molten Chloride Reactor Experiment (MCRE)
- PELE (DoD-SCO)
- Versatile Autonomous Kilowatt Reactor Experiment (VALKRE)
- Advanced Reactor Technologies – Gas-Cooled Reactor (ART-GCR)
- Fission Surface Power (NASA)
- Space and Defense Programs

TOOLS:

- Griffin
- Pronghorn
- RAVEN
- RELAP

KEY COLLABORATIONS:

- BWXT
- NASA
- DoD-SCO
- General Atomics
- Southern Company
- TerraPower
- Orano
- EPRI
- Core-Power
- 3M
- Holtec International
- Westinghouse

Regulatory Research & Plant Optimization

Division Director: Katya Le Blanc

Enable advanced nuclear energy and optimize current fleet by developing and demonstrating technologies to improve operations, maintenance, and regulatory processes

Capabilities

Manage and analyze nuclear data

Develop and demonstrate AI for nuclear operations

Perform analysis and training to support regulatory process

Improve technology effectiveness with human factors testing and analysis

Develop risk analysis methods and tools

Modernization of regulatory processes

STAFF: 79

FACILITIES:

- Human Systems Simulation Lab (HSSL)
- Advanced HSSL
- Monitoring and Diagnostics Lab
- Digital Instrumentation and Control Lab

KEY PROGRAMS:

- Light Water Reactor Sustainability (LWRS) program (DOE NE-5)
- Regulatory Development Program (DOE NE-5)
- Nuclear Regulatory Commission
- Advanced Reactor Safeguards and Security (ARSS) program (DOE NE-5)

KEY COLLABORATIONS:

- NRC, Nuclear Energy Institute
- Institute for Energy Technology
- Utilities Service Alliance
- Constellation

National Reactor Innovation Center (NRIC)

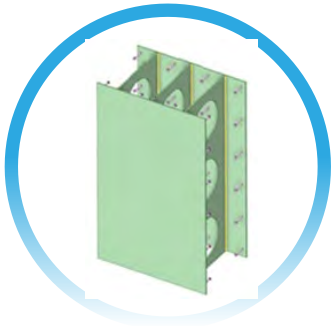
Division Director: Brad Tomer

Partnering with industry and national labs to bridge the gap between research, development, and technology deployment; a national program located at INL

Capabilities

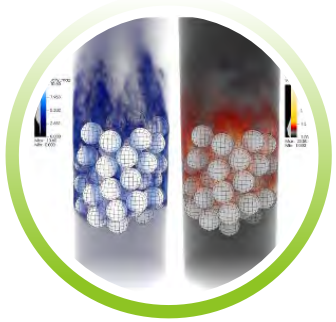
Reactor test beds

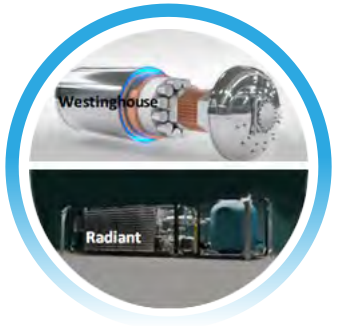
Experimental facilities



Advanced Construction Technologies Initiative

Digital engineering and virtual test bed





Engineering and experiment expertise for demonstrations

STAFF: 20 (and 100+ dedicated experts)

FACILITIES & CAPABILITIES:

- DOME
- LOTUS
- MSTEC
- HeCTF
- Creep Frames
- Virtual Test Bed
- METL

KEY PROGRAMS:

- NRIC Program (NE-5)
- Privately Funded Partnerships (SPP/CRADA)

KEY COLLABORATIONS:

- Westinghouse
- Radiant
- Oklo
- Aalo
- Nano
- Antares
- TerraPower
- X-energy
- BWXT
- Mobile Nuclear
- Zeta Joule
- Deployable Energy
- Blue Energy
- GE-Hitachi
- American Bureau of Shipping
- Alpha Tech
- Valor Atomics
- Atomic Alchemy

Fuel Cycle Science and Technology

Division Director: Josh Jarrell

Delivering nuclear fuel cycle solutions with innovative separations development and demonstration, material and isotope recovery, used fuel management, and proliferation risk reduction.

Capabilities

Radiochemistry and radiation science

HALEU generation

Pyrochemical processing of oxide/metal fuel

Isotope recovery and separation

Molten salt thermophysical properties & chemistry

Used nuclear fuel storage, transportation, and disposition

STAFF: 84

FACILITIES & CAPABILITIES:

- Gamma Irradiators
- Radiochemistry Lab
- Moran
- Material Recovery Pilot Plant
- Molten Salt Thermophysical Examination Capability
- Molten Salt Test Loop Lab
- Rad and Non-rad Aqueous Separations Labs
- Fuel Cycle and Pyro-chemistry Gloveboxes
- Molten Salt / Electrochemistry Furnaces
- Remote Work Mockup and Prototype Lab
- Solvent Extraction Laboratory

KEY PROGRAMS:

- Center for Radiation Chemistry Research (CR2)
- Material Recovery and Waste Form Development (NE-43)
- Uranium Fuel Supply (NE-41)
- Collaboration Based Siting (NE-83)
- MCRE Fuel Salt Synthesis
- Environmental Management Tech-nology Development

KEY COLLABORATIONS:

- Oklo
- Curio
- General Matter, TerraPower
- Southern
- Quadrant
- Simplot
- BWXT

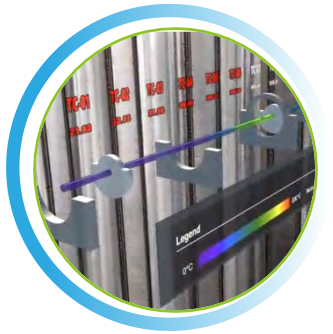
Scientific Computing & AI

Division Director: Chris Ritter

Advancing AI, data, and computation to accelerate energy science and deployment

Capabilities

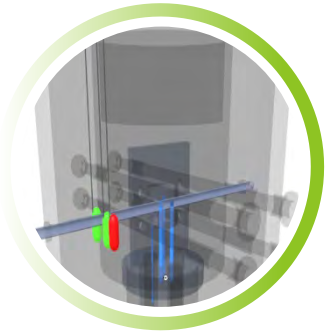
MOOSE framework for evaluation of energy systems



Autonomous nuclear reactor control

Supercomputing for modeling and simulation

Digital twin of Reactors



Data and digital thread technology

Digital twin of nuclear facilities

STAFF: 96

FACILITIES:

- Collaborative Computing Center (C3)
- High Performance Computing (HPC)
- Scientific Visualization Laboratories (AVL and XRL)

TOOLS:

- DeepLynx
- MOOSE Framework
- Project Alexandria

KEY PARTNERS:

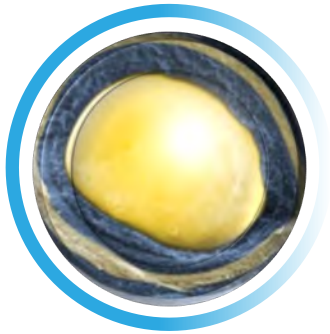
- Amazon
- BWXT
- Microsoft
- Westinghouse
- X-energy

Nuclear Fuels and Materials

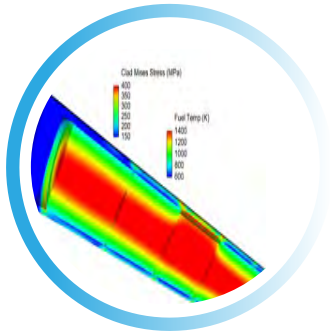
Division Director: Steven Hayes

Accelerating the development and qualification of nuclear fuels and materials, multi-scale materials modeling, and advanced sensors and instrumentation.

Capabilities



Nuclear fuels and materials development and qualification



Mechanistic, multiscale modeling of fuels and materials under irradiation

Irradiation testing and experiments in ATR

Advanced sensors & instrumentation for in-core applications

Transient testing and accident simulations in TREAT

Tritium transport and interaction with materials at STAR

STAFF: 165

FACILITIES:

- Measurement Science Laboratories(MSL)
- Safety and Tritium Applied Research (STAR)

PROGRAMS:

- Accident Tolerant & High Burnup Fuels
- TRISO Fuel & Graphite Qualification
- HPRR Fuel Qualification
- NSUF
- Advanced Materials & Manufacturing Technologies
- NEAMS (Fuels)
- Advanced Sensors & Instrumentation
- Fusion Safety Program

KEY PARTNERS:

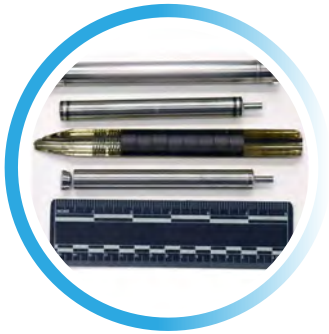
- TerraPower
- X-energy
- Westinghouse
- General Electric
- Framatome
- General Atomics
- Lightbridge

Applied Engineering

Division Director: Bryce Kelly

Enabling world-class nuclear R&D through applied engineering principles, national codes and standards, innovative designs, and advanced manufacturing methods.

Capabilities



Irradiation experiment design

Research quality engineering

Drafting and CAD modeling

Facility component design and fabrication

Research engineering and material acquisition

Codes and standards committee leadership and expertise

STAFF: 59

FACILITIES:

- Test Train Assembly Facility (TTAF)
- NHL machine shop

CODES AND STANDARDS:

- ASME
- ANS
- IEEE

DESIGN COLLABORATIONS:

- NCSU
- BYU-I
- NASA
- DARPA

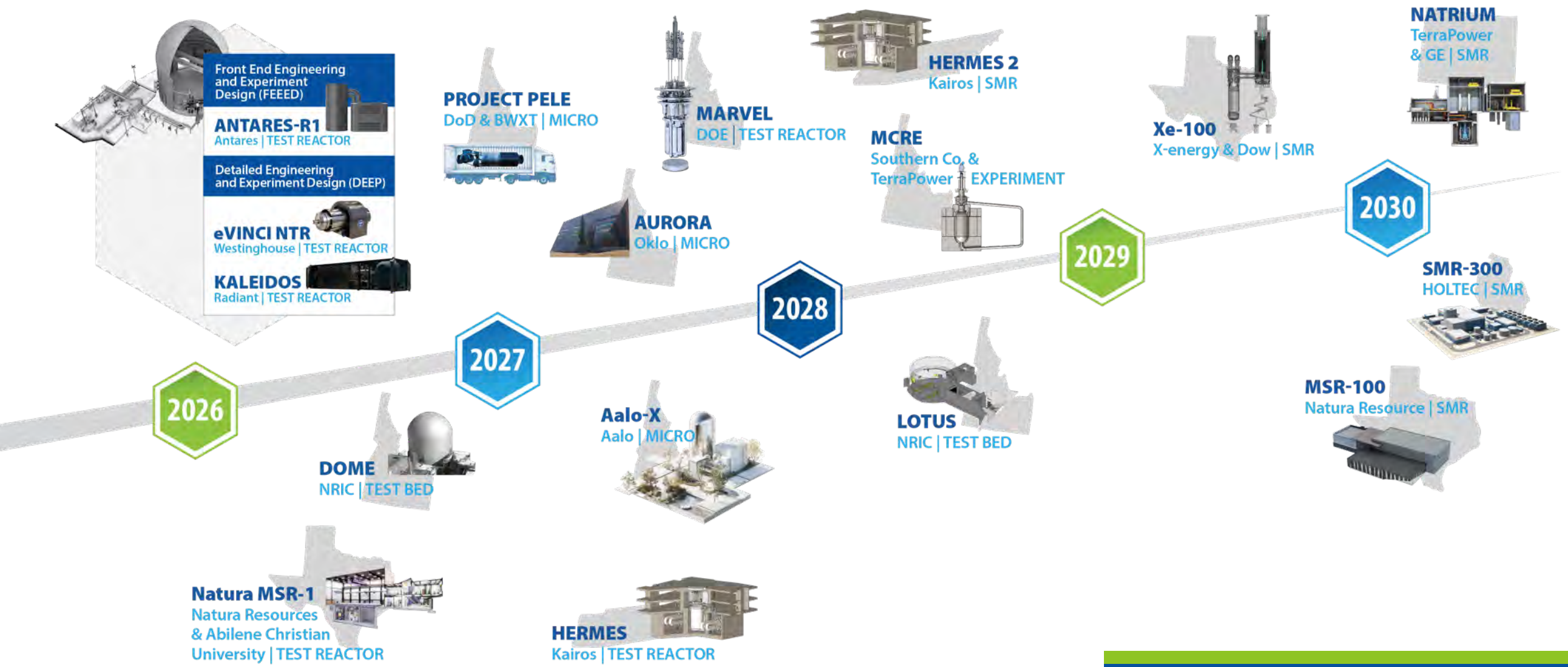
KEY PARTNERS:

- Naval Nuclear Laboratory (NNL)
- GE Vernova

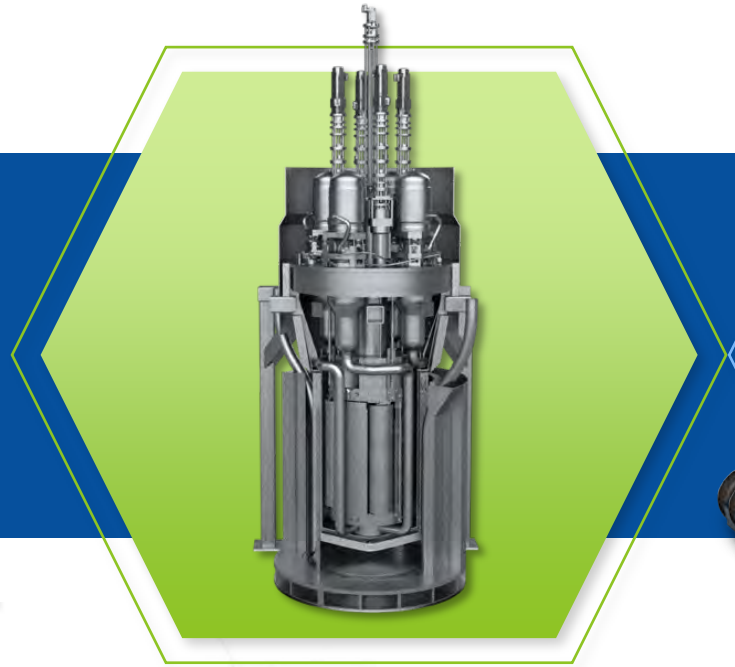
NOTABLE DESIGNS:

- AGR Lead-out experiments
- ATR iLoop and Infrastructure
- ATR TMIST Experiments
- ATR Top Head Closure Plate and Transition Shield
- TREAT TWIST Experiments
- TREAT Graphite Moderator Assemblies and Big BUSTER
- TREAT Sodium Loop and Electromagnetic Pump
- TREAT HENRI Helium-3 Infrastructure

Accelerating advanced reactor demonstration and deployment

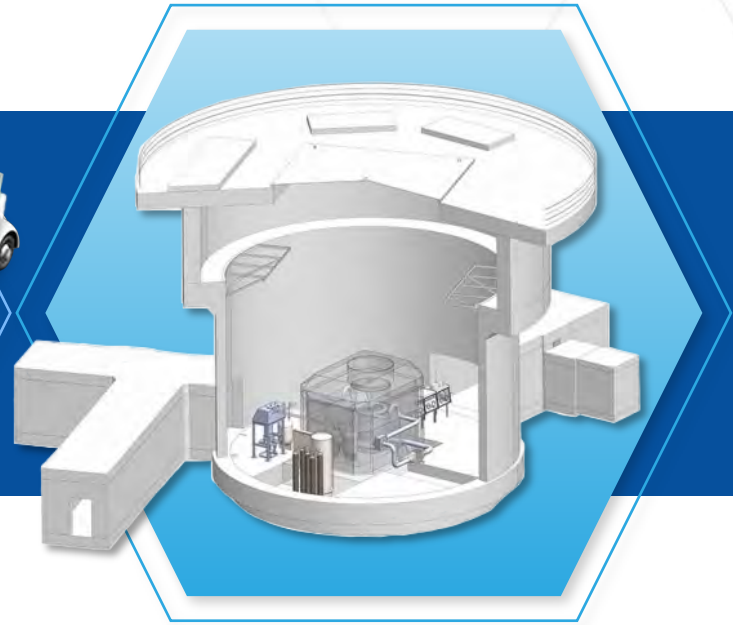


We will demonstrate the first new reactors on the INL site in over 40 years.



Microreactor Application Research, Validation and EvaLuation Project *(MARVEL)*

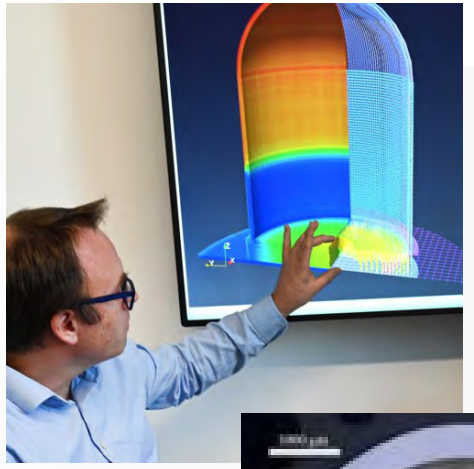
Department of Defense Strategic Capabilities Office Project Pele



Molten Chloride Reactor Experiment *(MCRE)*

Unleashing Nuclear Energy Abundance

Lead: Simon Pimblott



Mission

Quadruple U.S. commercial deployment of nuclear power by 2050 ensuring energy security.

Goals

- Increase Nuclear Capacity to Ensure Energy Abundance
- Realize Sustainable and Flexible Fuel Cycle Solutions
- Develop and Demonstrate Advanced Technology Fuels
- Change the Build Paradigm for Nuclear Energy Systems
- Predict Nuclear Energy Systems Performance

Challenges

- Finance - upfront costs, budget overruns.
- Generation - base-load vs load following, electrons and beyond
- Delivery - project delays, supply chain limitations and regulation.
- Sustainability - fuel supply, waste management, addressing proliferation concerns

Enabling future fusion energy systems

Lead: Pattrick Calderoni

Experimental capabilities

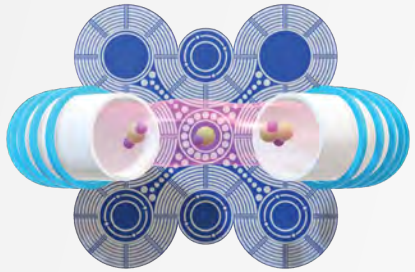
- Understand Tritium Interaction with Fusion Materials
- Test Fusion-Blanket Materials in Fission Reactors
- Demonstrate Technologies for Tritium Processing

Modeling and simulation

- Develop MOOSE-based Modeling Tools for Fusion Power Plants
- Assess Fusion Power Plant Safety and Reliability

Fire Collaborative

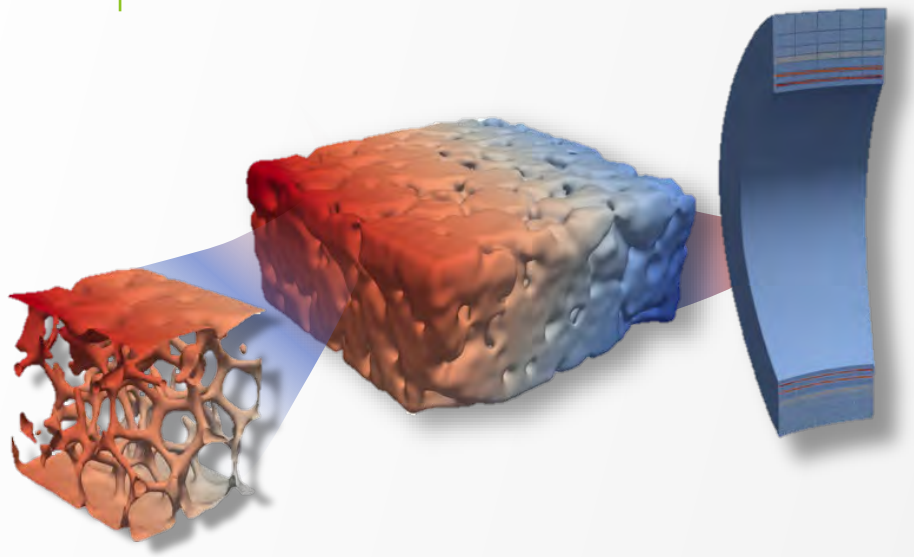
Blanket Nuclear Testing



- INL leads the blanket FIRE collaborative to accelerate the demonstration of fusion technology

SRNL Savannah River National Laboratory · Oak Ridge National Laboratory · Massachusetts Institute of Technology · General Atomics · PPPL

- Private-public industry partnership projects



Commonwealth Fusion Systems · Tokamak Energy · generalfusion · Kyoto Fusioneering · Type One Energy · Xcimer Energy Corporation · EX-Fusion · Blue Laser Fusion · Thea Energy

Innovating Defense and Space Nuclear-Fission Systems

Lead: Justin Coleman

Capabilities

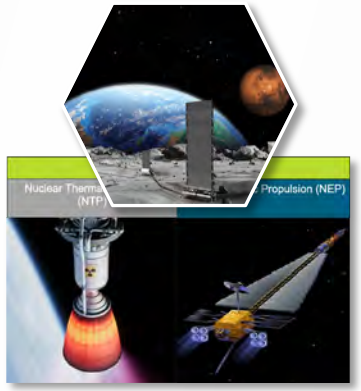
- Demonstrate reactor prototypes
- Develop and demonstrate autonomous defense and space reactor systems
- Provide testbeds for space and defense reactor demonstrations to accelerate advancements

Strategic Partnerships

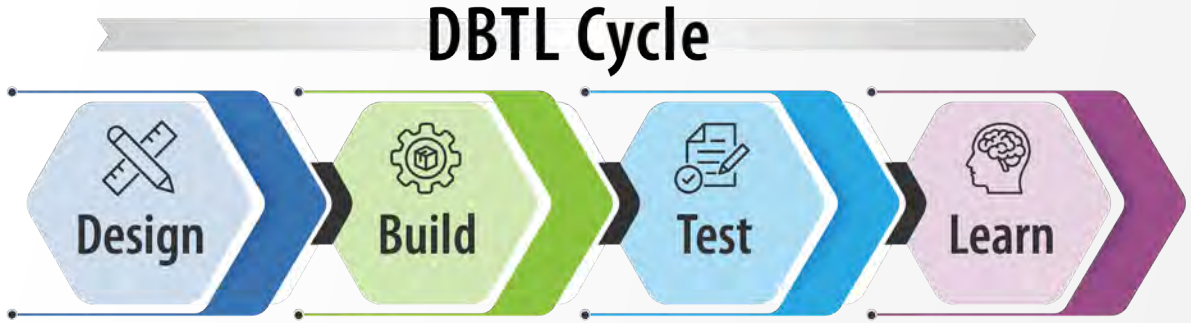
- Private-public industry partnership projects

U.S. Department of Defense NASA

Advance Engineering Excellence



- Accelerate innovation with Design, Build, Test, Learn (DBTL) cycle
- Pioneer engineering methods enabling nuclear energy resilience for defense and space
- Deliver reactor prototypes for defense and space (Pele, VALKRE)



BWXT BWX Technologies, Inc.

IDAHO NATIONAL LABORATORY

Harnessing AI to unlock nuclear energy innovation

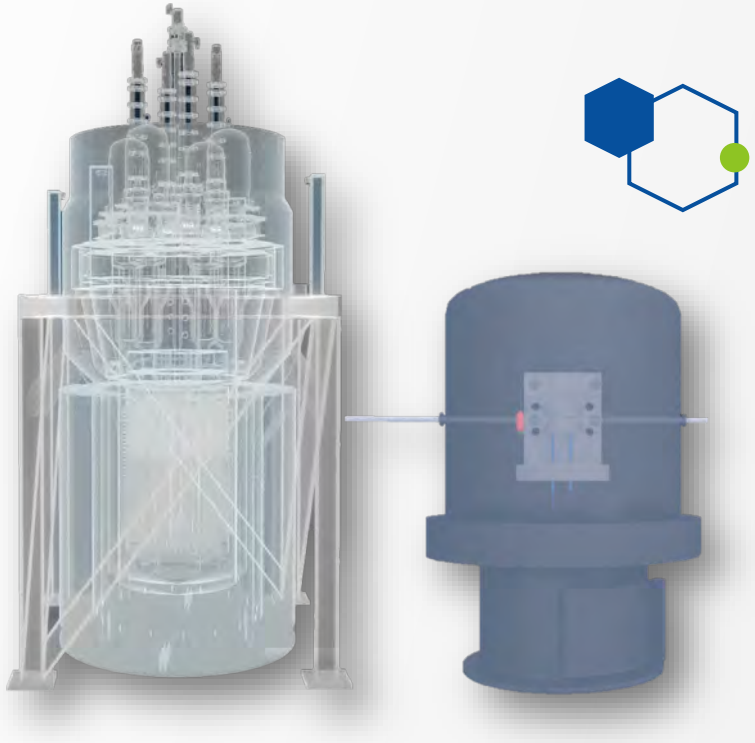
Lead: Chris Ritter

Opportunity

- Lead AI research for applied energy applications
- Provide singular tools, people, and infrastructure to advance energy security and accelerate nuclear energy innovation

Modeling and simulation

- MOOSE Framework
- DeepLynx
- Project Alexandria



SMART USA Institute

Semiconductor Manufacturing and Advanced Research with Twins

A Manufacturing USA® Institute

Project Alexandria

PROJECT ALEXANDRIA

- INL leads technical digital twin integration for SMART USA
- Data centers for custom computing power for Nuclear Multi-Physics

Massachusetts Institute of Technology · UMASS LOWELL · WISCONSIN UNIVERSITY OF WISCONSIN–MADISON · THE UNIVERSITY OF TENNESSEE KNOXVILLE · Los Alamos NATIONAL LABORATORY

- Private-public industry partnership projects

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