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

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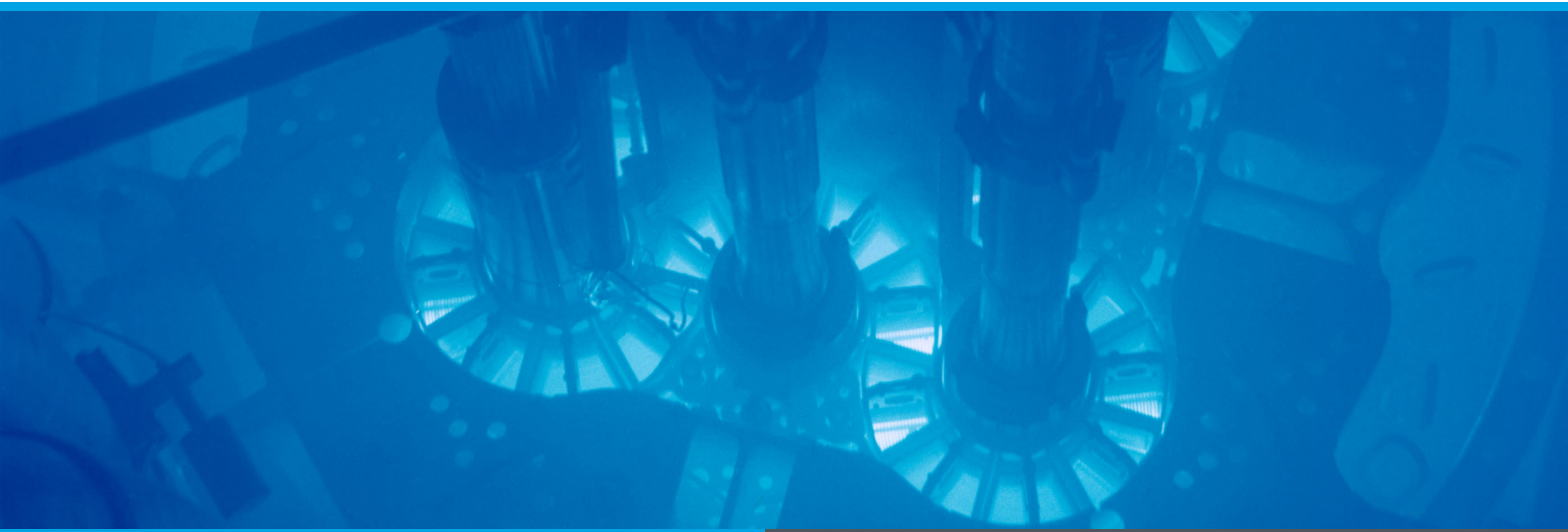


Advanced Sensors and Instrumentation Program Overview

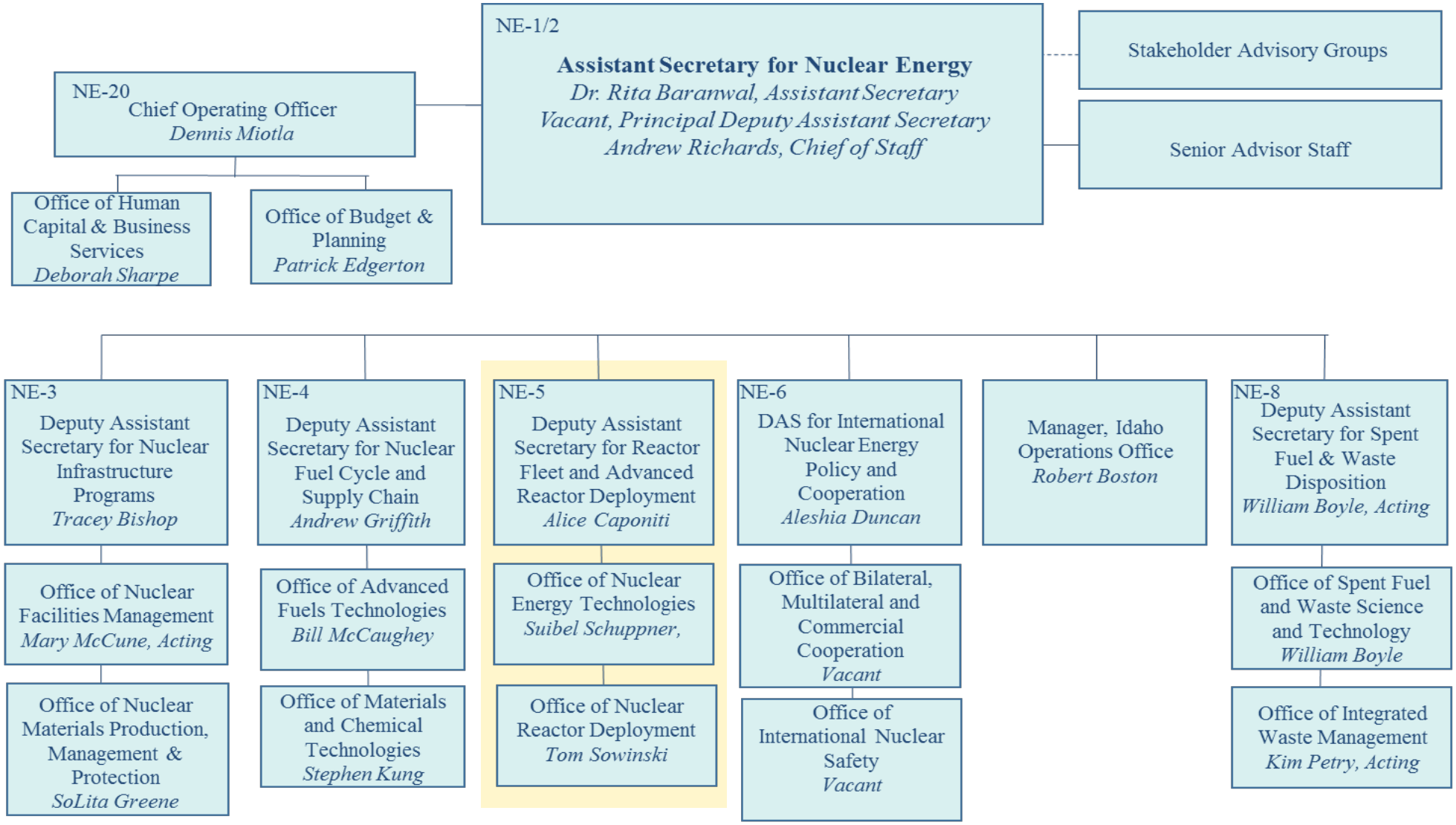
October 29, 2020

Suibel Schuppner

Office of Nuclear Energy

U.S. Department of Energy

Office of Nuclear Energy



Reactor Fleet and Advanced Reactor Deployment (NE-5)

NE-5
DAS for Reactor Fleet and Advanced Reactor Deployment
Alice Caponiti, Deputy Assistant Secretary
Michael Worley, Associate Deputy Assistant Secretary
Tim Beville, Acting ARDP Program (Demos)

NE-51
Office of Nuclear Energy Technologies
Suibel Schuppner, Director

NE-52
Office of Nuclear Reactor Deployment
Thomas Sowinski, Director

NE-51.1
Enabling Technologies Team
Melissa Bates, Acting Team Leader

- Advanced Sensors and Instrumentation (ASI)
- Advanced Methods for Manufacturing (AMM)
- Nuclear Energy Advanced Modeling and Simulation (NEAMS)
- Nuclear Science User Facilities (NSUF)
- Transformational Challenge Reactor (TCR)

NE-51.2
University and Competitive Research Team
Aaron Gravelle, Team Leader

- Nuclear Energy University Program (NEUP)
- Integrated University Program (IUP)
- Research Reactor Infrastructure (RRI)
- Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)
- Gateway for Accelerated Innovation in Nuclear (GAIN)
- Advanced Nuclear Industry Funding Opportunity (Industry FOA)
- Technology Commercialization Fund (TCF)

NE-52.1
Reactor Optimization and Modernization Team
Alison Hahn, Team Leader

- Light Water Reactor Sustainability (LWRS)
- Advanced Small Modular Reactor R&D
- Integrated Energy Systems (IES)
- Nuclear Cybersecurity
- Advanced Reactors Safeguards (ARS)

NE-52.2
Advanced Reactor Development Team
Janelle Eddins, Team Leader

- Sodium-Cooled Fast Reactor
- Gas-Cooled High-Temperature Reactors
- Molten Salt Reactors
- Microreactors
- National Reactor Innovation Center (NRIC)
- Risk Reduction
- Advanced Reactor Regulatory Development

New Advanced Sensors and Instrumentations Management

Federal Program Manager: Melissa Bates

Melissa.bates@nuclear.energy.gov

National Technical Director: Pattrick Calderoni

pattrick.calderoni@inl.gov

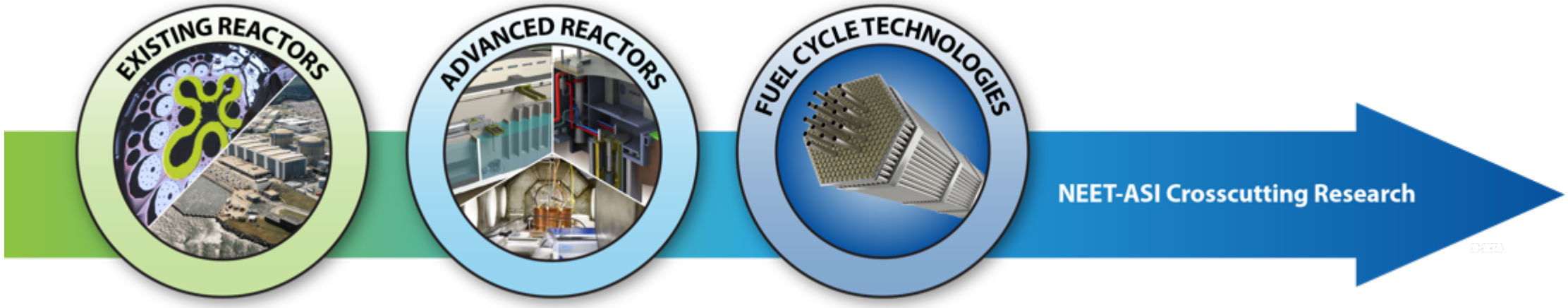
Advanced Sensors and Instrumentation (ASI) Program

Mission

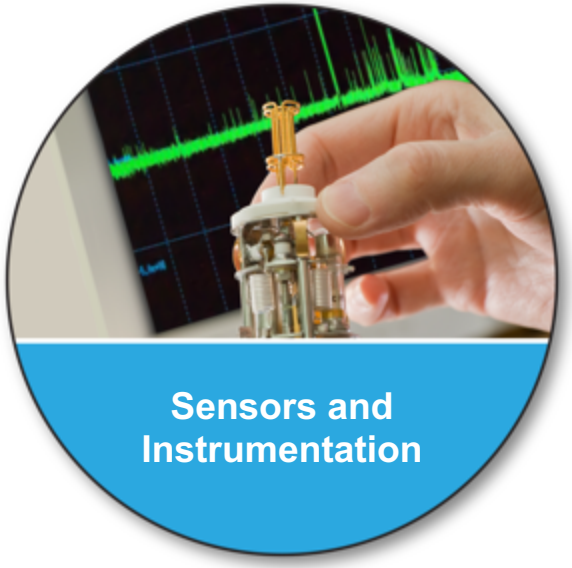
Develop **advanced sensors and I&C** that address **critical technology gaps** for monitoring and controlling existing and advanced **reactors** and supporting **fuel cycle** development

Vision

NEET ASI Research results in advanced sensors and I&C technologies that are **qualified, validated, and ready to be adopted by the nuclear industry**



Strategic ASI R&D Areas



Sensors and Instrumentation

Reliable, cost-effective, real-time, accurate, and high-resolution measurement of the performance of existing and advanced reactors core and plant systems

Communication

Resilient, real-time transmission of sufficient amount of data for online monitoring and advanced data analytics

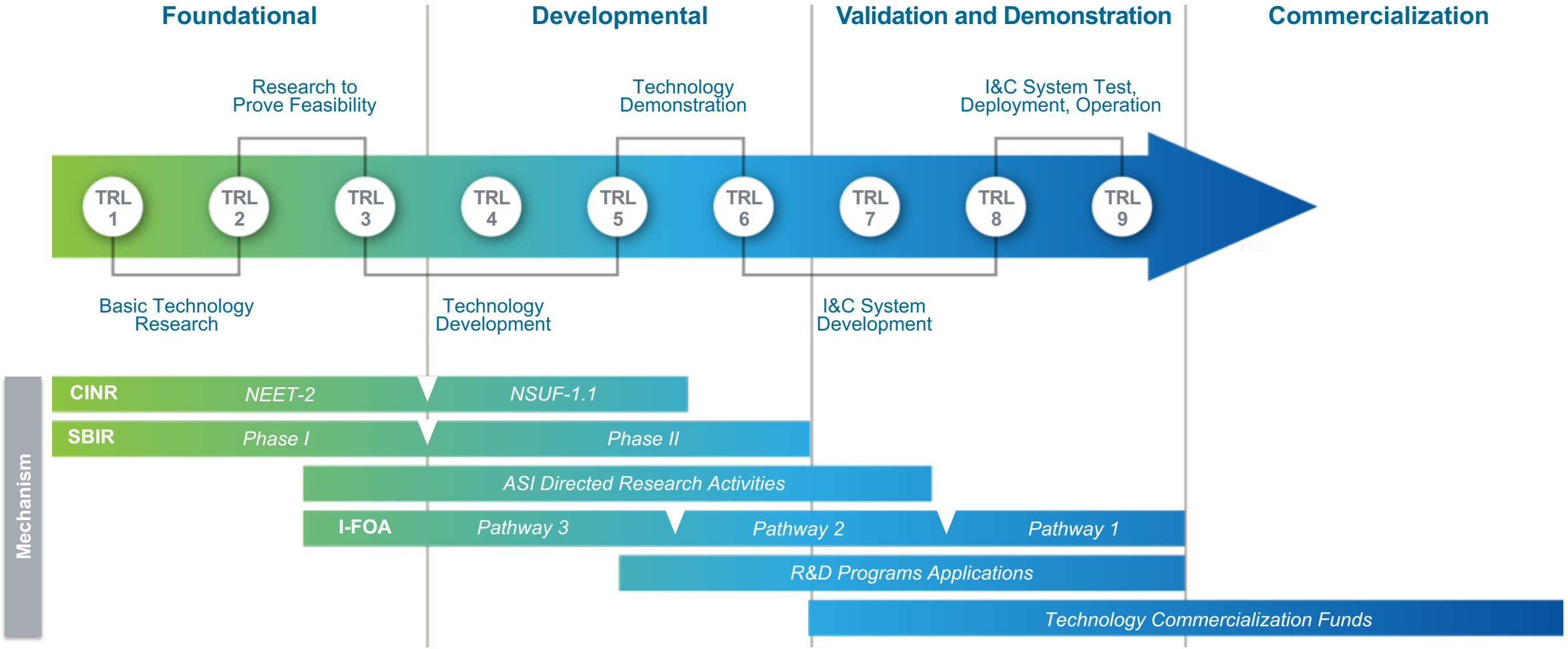
Big Data, Machine Learning, Artificial Intelligence

Machine learning and artificial intelligence processes to enable semi-autonomous operation and maintenance by design

Advanced Control Systems

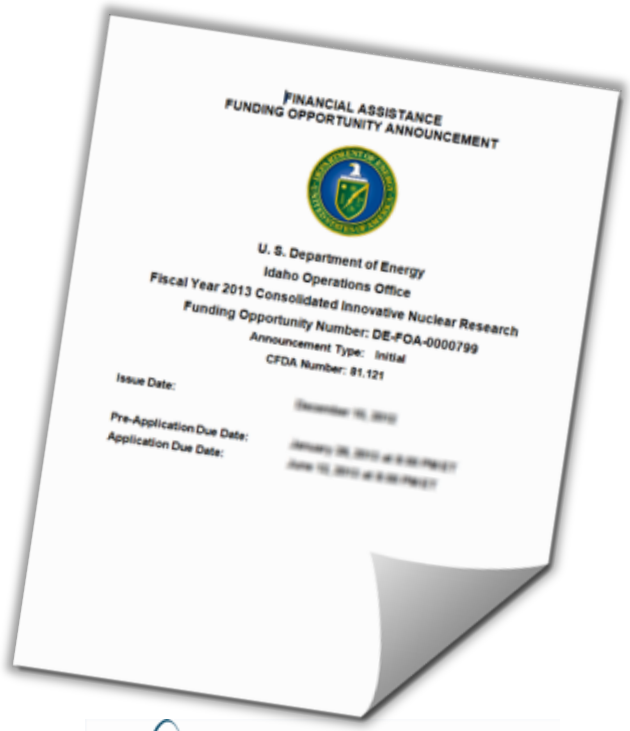
Enable near real-time control of plant or experiments process variables to enhance performance

Metrics: ASI Research Progression



NE Funding Opportunities

- **Consolidated Innovative Nuclear Research (CINR)**
  - Nuclear Energy University Program (NEUP)
  - Nuclear Energy Enabling Technologies (NEET)
  - Nuclear Science User Facilities (NSUF)
- **Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)**
  - Advanced Technologies for Nuclear Energy
  - Phase I Release 2
- **U.S. Industry Opportunities for Advanced Nuclear Technology Development (DE-FOA-0001817)**
- **Gateway for Accelerated Innovation in Nuclear (GAIN) Vouchers**



GAIN
Gateway for Accelerated Innovation in Nuclear

https://gain.inl.gov

FY2020 Consolidated Innovative Nuclear Research (CINR) Funding Opportunity Announcement (FOA)

- **University-led Nuclear Energy University Programs (NEUP) Projects**
  - Program and Mission Supporting
- **University-, or National Laboratory-led Nuclear Energy Enabling Technologies (NEET) Crosscutting Projects**
  - **Advanced Sensors and Instrumentation**
  - Advanced Methods for Manufacturing
- **University-, National Laboratory-, or Industry-led Nuclear Science User Facilities (NSUF)**
  - **NSUF-1.1: Testing of advanced materials for sensors and advanced sensors for Nuclear applications**

- **CINR Due dates:**
  - September 16, 2020: NSUF Letter of Intent
  - September 30, 2020: R&D/NSUF Pre-Applications
  - November 12, 2020: NSUF Preliminary Statement of Work
  - January 22, 2021: NSUF Final Statement of Work
  - February 11, 2021: Full R&D Applications
  - February 11, 2021: IRP Applications

www.neup.gov

NEET-ASI Current CINR Awards

FY	Project Title	Principal Investigator
2017	Integrated silicon/chalcogenide glass hybrid plasmonic sensor for monitoring of temperature in nuclear facilities	Maria Mitkova, Boise State University
2017	High temperature embedded/integrated sensors (HiTEIS) for remote monitoring of reactor and fuel cycle systems	Xiaoning Jiang, North Carolina State University
2017	3-D Chemo-Mechanical Degradation State Monitoring, Diagnostics and Prognostics of Corrosion Processes in Nuclear Power Plant Secondary Piping Structures	Douglas Adams, Vanderbilt University
2017	Versatile Acoustic and Optical Sensing Platforms for Passive Structural System Monitoring	Gary Pickrell, Virginia Polytechnic Institute and State University
2018	Process-Constrained Data Analytics for Sensor Assignment and Calibration	Richard Vilim, Argonne National Laboratory
2018	Development of optical fiber- based gamma thermometer and its demonstration in a University Research Reactor using statistical data analytic methods to infer power distributions from gamma thermometer response	Thomas Blue, The Ohio State
2019	Design of Risk Informed Autonomous Operation for Advanced Reactor	Michael Golay, Massachusetts Institute of Technology
2019	Cost-Benefit Analyses through Integrated Online Monitoring and Diagnostics	David Grabaskas, Argonne National Laboratory
2019	Acousto-optic Smart Multimodal Sensors for Advanced Reactor Monitoring and Control	Michael Larche, Pacific Northwest National Laboratory
2019	Context-Aware Safety Information Display for Nuclear Field Worker	Pingbo Tang, Arizona State University
2019	Advanced Online Monitoring and Diagnostic Technologies for Nuclear Plant Management Operation, and Maintenance	Daniel Cole, University of Pittsburgh
2020	Design and Prototyping of Advanced Control Systems for Advanced Reactors Operating in the Future Electric Grid	Roberto Ponciroli, Argonne National Laboratory
2020	Adaptive Control and Monitoring Platform for Autonomous Operation of Advanced Nuclear Reactors	Athi Varuttamaseni, Brookhaven National Laboratory
2020	Development of Sensor Performance Model of Microwave Cavity Flow Meter for Advanced Reactor High Temperature Fluids	Alexander Heifetz, Argonne National Laboratory

NSUF Current CINR Awards with ASI R&D funds

FY	Project Title	Principal Investigator
2018	Irradiation Behavior of Piezoelectric Materials for Nuclear Reactor Sensors	Marat Khafizov, Ohio State University
2018	High-performance nanostructured thermoelectric materials and generators for in-pile power harvesting	Yianliang Zhang, University of Notre Dame
2019	Irradiation of optical components of in-situ laser spectroscopic sensors	Igor Ivanovic, University of Michigan
2019	High Fluence Active Irradiation and Combined Effects Testing of Sapphire Optical Fiber Distributed Temperature Sensors	Josh Daw, Idaho National Laboratory
2020	Irradiation of Sensors and Adhesive Couplants for Application in LWR Primary Loop Piping and Components	James Wall, EPRI

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STT): Advanced Technologies for Nuclear Energy

- **Competitive awards for small businesses only**
- **Winners keep the rights to any technology developed and are encouraged to commercialize the technology**
- **Funded by federal R&D budgets set aside**

NE funds SBIR and STTR projects

- Office of Nuclear Energy Section

Phase I Release 2

- Topics Issued: November 09, 2020
- Webinar: November 16, 2020
- FOA Issued: December 14, 2020
- LOI Due: January 2, 2021
- Application Due: February 22, 2021

www.science.energy.gov/sbir

Phase II Release 2 (only Phase I awardees are eligible to apply)

- FOA Issued: March 01, 2021
- LOI Due: March 31, 2021
- Application Due: April 20, 2021

SBIR Current Awards

FY	Project Title	Principal Investigator
	PHASE II	
2016	High Temperature Operable, Harsh Environment Tolerant Flow Sensors For Nuclear Reactor Applications	Jon Lubbers, Sporian Microsystems, Inc
2017	A robust wireless communication system for harsh environment including nuclear facilities	Richard Twogood, Dirac Solutions Inc
2018	Distributed Antenna System for Wireless Data Communication in Nuclear Power Plants	Chad Kiger, Analysis & Measurement Serv Corp
2018	Fiber-Optic Sensor for Simultaneous Measurement of Temperature and Pressure	Derek Rountree, Luna Innovations Inc
2019	Metamaterial Void Sensor for Fast Transient Testing	Mark Roberson, Goldfinch Sensor Technologies and Analytics LLC
2019	Health Monitoring of Digital I&C Systems using Online Electromagnetic Measurements	Chad Kiger, Analysis & Measurement Serv Corp
2019	Fault Detection of Digital Instrumentation and Control Systems using Integrated Electromagnetic Compatibility and Automated Functional Testing	Greg Morton, Analysis & Measurement Serv Corp
2020	Development of Radiation Endurance Ultrasonic Transducer for Nuclear Reactors	Uday Singh, X-wave Innovations Inc
2020	A Radiation and Temperature-Tolerant Plasma Contact Microphone for Sensing Ultrasonic Acoustic Emissions in Fatiguing Metal Structures	Johan Carlsson, RadiaSoft LLC
	PHASE I	
2020	Advanced Laser Ultrasonic Sensor for Fuel Rod Characterization	Marvin Kelin, Intelligent Optical Systems, Inc
2020	Printed Sensors for Monitoring Reactor Health	Richard Fink, Applied Nanotech, Inc
2020	Hybrid Diamond Detector for Nuclear Reactor Monitoring	Valerly Konovalov, Applied Diamond, Inc

U.S. Industry Funding Opportunities

U.S. Industry Opportunities for Advanced Nuclear Technology Development (DE-FOA-0001817) Amendment 008 (Sep. 2020)

- The U.S. Department of Energy (DOE) is soliciting proposals for cost-shared projects to develop innovative industry-driven reactor designs and technologies to advance nuclear power in America.
- This funding opportunity is open for a five-year period.
- Applications will be accepted on a year-round basis with selections made twice a year.
  - **Due Date: February 28 at 5:00:00 p.m. ET**
  - **Due Date: August 31 at 5:00:00 p.m. ET**
- Open to U.S. companies with the expectation that resulting products will be manufactured in U.S. after reaching commercialized state.
- Industry cost share will be between 20-50%, depending on the nature of the proposal

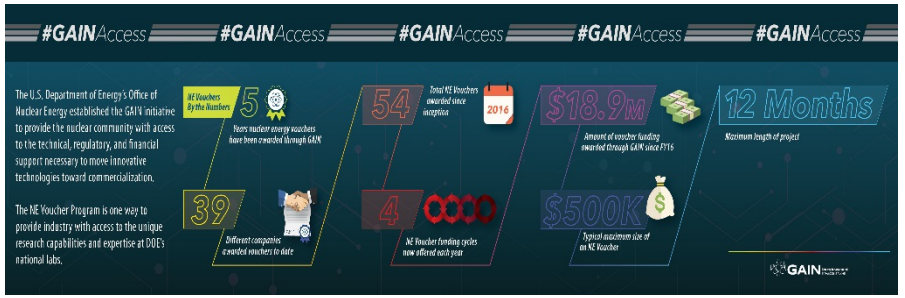
Pathway	DOE Funding Range	Cost Share	Duration
First-of-a-Kind (FOAK) Nuclear Demonstration Readiness Projects	$10M-$40M	50/50	3 years
Advanced Reactor Development Projects	$500K-$10M	80/20	2 years
Regulatory Assistance Grants	$50K-$500K	80/20 or 50/50	1 year

https://www.energy.gov/ne/services/funding-opportunities

https://gain.inl.gov

Gateway for Accelerated Innovation in Nuclear (GAIN) Vouchers

- Provide funds to assist industry applicants seeking access to world class expertise and capabilities available across the U.S. DOE Complex
  - **Due Date: November 2 at 5:00:00 p.m. ET**



Industry I&C Current Awards

FY	Industry-FOA Project Title	Recipient
2018	Resolving the Regulatory Issues with Implementation of Online Monitoring Technologies to Extend the Calibration Intervals of Process Instruments in Nuclear Power Plants	Analysis & Measurement Services Corp. Knoxville, TN
2019	Passive Radio Frequency Tags and Sensors for Process Monitoring in Advanced Reactors	Dirac Solutions Inc. Pleasanton, CA
2019	Application of Machine Learning for Enhanced Diagnostic and Prognostic Capabilities of Nuclear Power Plant Assets	Blue Wave Capital and Consulting, DBA Blue Wave AI Labs, Celebration, FL

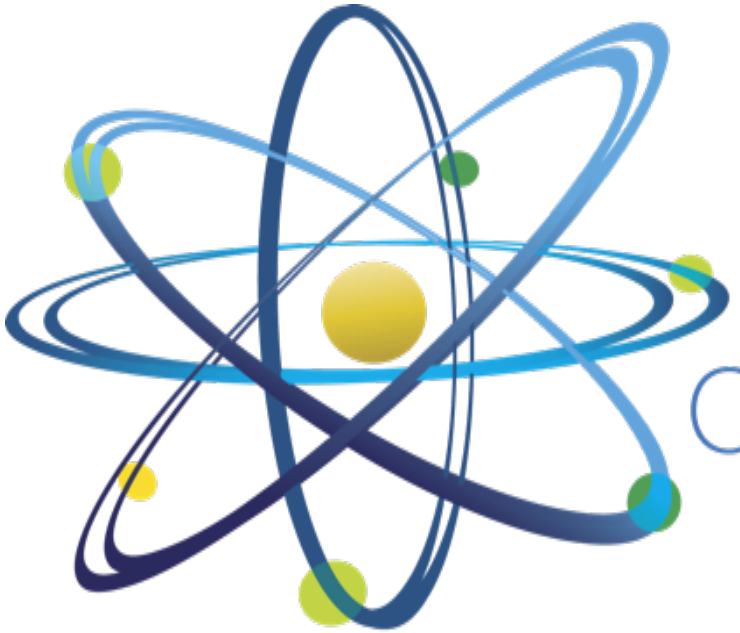
FY	GAIN Voucher Title	Recipient
2017	Radiation Aging of Nuclear Power Plant Components	Analysis & Measurement Services Corp. Knoxville, TN
2017	Human Factors Engineering for the Move to Digital Control Systems – Improved Strategies for Operations	GSE Systems Inc. Sykesville, MD
2018	Advancement of Instrumentation to Monitor IMSR® Core Temperature and Power Level	Terrestrial Energy USA New York, NY
2018	Electroanalytical Sensors for Liquid Fueled Fluoride Molten Salt Reactor	ThorCon, Stevenson, WA
2019	Testing of Instrumentation and Control Sensors and Cables for Small Modular Reactors	Analysis & Measurement Services Corp. Knoxville, TN
2020	On-Line Lead/Water Heat Exchanger Sensor/System Feasibility	Neutroelectric, LLC Williamstown, NJ

Summary

- Improvements and advancements in ASI technologies will
  - enable advances in nuclear reactor and fuel cycle system development
  - enhance economic competitiveness for nuclear power plants, and
  - promote a high level of nuclear safety
- NEET-ASI research produces concepts, techniques, capabilities, and equipment that are or can be demonstrated in simulated or laboratory test bed environments representative of nuclear plant systems or fuel cycle systems
- Innovative and crosscutting research is funded through competitive, peer-reviewed, solicitations and directed work

I&C technologies are a vital key to enabling the expansion of clean, safe, and economical nuclear power

Thank You!



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