

# ***INL and the Consortium for Enabling Technologies & Innovation***

## **INL Capabilities and Resources for ETI Support**

November 2019

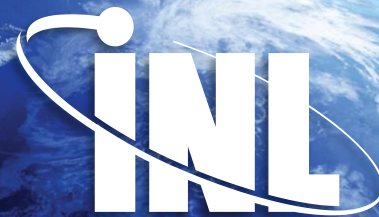
David Chichester, Directorate Fellow  
Nuclear Nonproliferation Division  
National & Homeland Security Science and Technology Directorate





## *Our Mission*

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



Idaho National  
Laboratory

## *Our Vision*

INL will change the world's energy future and secure our critical infrastructure.

# Idaho National Laboratory

- ~4500 employees
- 890 square miles
- 111 miles of electrical distribution lines
- 579 buildings
- 177 miles of paved roads
- 14 miles of railroad lines
- 4 nuclear reactors
- Mass transit system
- Protective security force
- Irradiated-fuel storage pools
- Dry-cask fuel storage research testbed





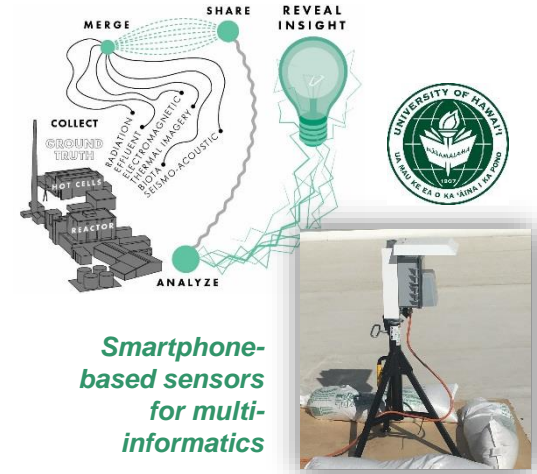
# Artificial Intelligence & Machine Learning at INL



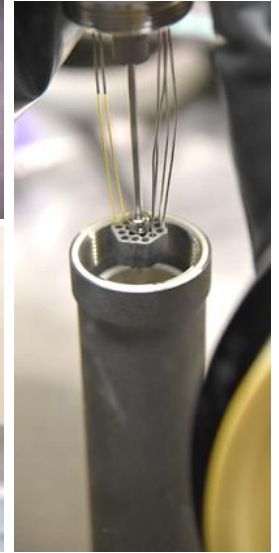
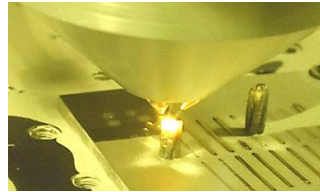
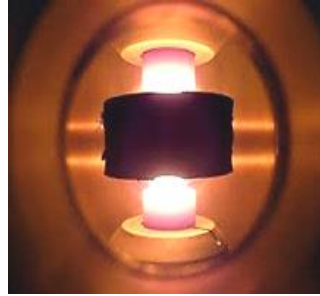
In October INL opened two new research centers with strong ties to AI and ML: Collaborative Computing Center (C3) and Cybercore Integration Center (CIC)



Existing strengths exist related to instrumentation and control systems, telecommunications networks and wireless communications; growing work related to cloud-based real-time data analysis



INL is supporting the Office of Proliferation Detection in Data Analytics and AI research through contributions to MINOS (Multi-Informatics for Nuclear Operations Scenarios) and the Ecosystem for Open Science (eOS)

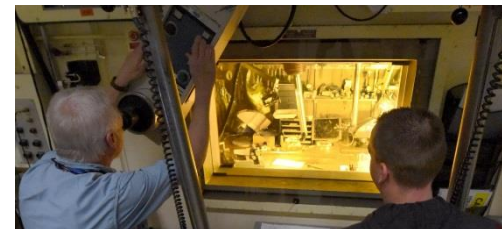
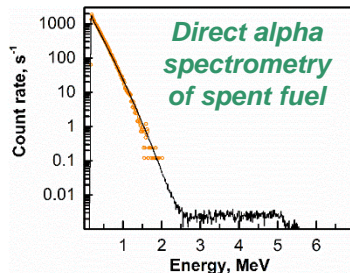
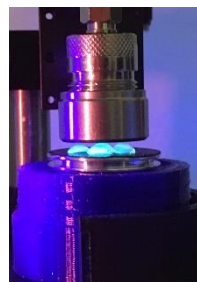
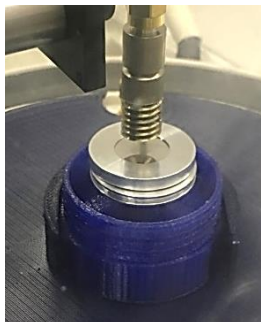
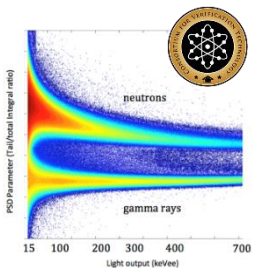


Advanced manufacturing technology is being developed to support all of INL's mission areas; notable focus areas are additive manufacturing, spark plasma sintering, and work with refractory metals

An important aspect of INL ADM work relates to the processing of high melting temperature materials, and work using actinides

ADM work at INL includes developing the methods for fabricating advanced nuclear fuels, and then testing those fuels under harsh conditions.

# Instrumentation for Nuclear Fuel Cycle Monitoring



INL collaborated with the Consortium for Verification Technology to explore how to optimize light collection for enhancing PSD in organic scintillators

INL is working on multiple projects to develop wide band gap single-crystal CVD diamond semiconductor sensors for nuclear energy and nuclear nonproliferation applications

Work within INL's fuel cycle facilities provides a challenging set of extreme environments, these facilities can serve as testing grounds for evaluating advanced microelectronic sensors developed within ETI

# INL Capability Alignment with the ETI Thrust Areas

Thrust Areas	Project Areas	INL Staff	INL Resources
1: Computer & Engineering Sciences for Nonproliferation	<i>Framework for Rapid Evaluation of Algorithms and Data Streams</i>	✓	✓
	<i>Fundamental Advances in Data Science Algorithms</i>	✓	✓
	<i>Machine-Guided Learning and Data Collection</i>	✓	✓
	<i>Incorporation of Novel/Ad-Hoc Data Streams</i>	✓	✓
2: Advanced Manufacturing for Nonproliferation Additive Manufacturing Micro-Manufacturing Maker-Communities Micro-Reactors (?)	<i>Identification of Advanced Manufacturing Techniques and Key Properties</i>	✓	✓
	<i>Physical Signatures</i>	✓	✓
	<i>Digital and Electronic Signatures</i>	✓	✓
	<i>Side-Channel Signatures</i>	✓	✓
3: Novel Instrumentation for Nuclear Fuel Cycle Monitoring	<i>Light Collection and Materials/Methods and Radiation Detection</i>	✓	✓
	<i>Microelectronic Components and SWaP</i>	✓	✓
	<i>Biota and Biological Sensors</i>	✗	??
Consortium-Wide Projects (CWP)	<i>Behavior Inference from Integrated Fuel Cycle Simulations</i>	??	??
	<i>Multi-UAV Gathering and Processing of Biological Samples</i>	??	??
	<i>Online Monitoring of Chemical Separation Processes</i>	✓	??
	<i>Multi-Modal Global Surveillance Using Cube Satellites</i>	✗	✗



# Potential INL Resource Support for the ETI

## U & Pu Processing Facilities

Thrust Areas: 1 & 3



Hot-cell facilities processing irradiated fuel; U and Pu radio-chemistry; engineering-scale solvent extraction pilot plant for non-proliferation R&D

## Explosives Test Range

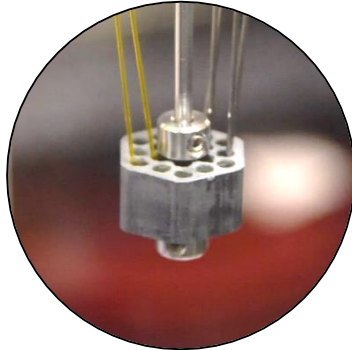
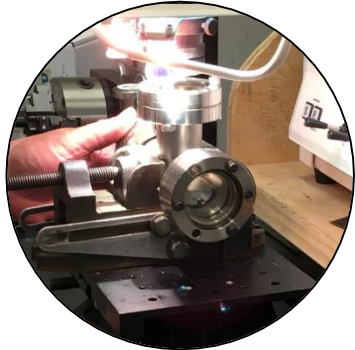
Thrust Areas: 1 & 3



Explosive test ranges with large areas suitable for collecting time-synchronized infrasound data for ML development

## Advanced Manufacturing of Nuclear Fuel

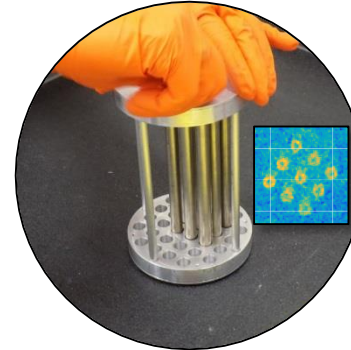
Thrust Area: 2



Equipment and facilities processing special nuclear material for advanced nuclear energy R&D; for example, using laser 3-D printing to produce uranium silicide fuel pellets

## Radiological and Nuclear Material Access

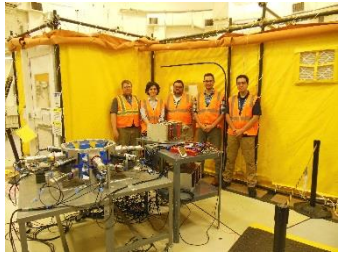
Thrust Areas: 3



Access to nuclear and radiological materials for nonproliferation research, including work to develop advanced imaging systems



# University Student Experiments at INL



# INL Research Staff Interests Aligned with the ETI

- Ecosystem for Open Science (eOS), developing a hosted platform to improve DNN research activities that allows collaboration, data analysis, data archiving, and data analytics

**PI: Tammie Borders TA: 1**

- Infrasound assessment of nuclear facilities to develop automated detection and characterization of status and activities

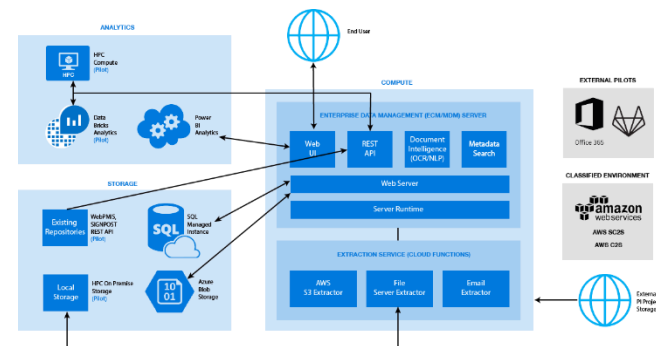
**PI: David Chichester TA: 1**

- Advanced manufacturing to developing advanced nuclear fuels for extreme environments

**PI: Rob O'Brien TA: 2**

- Design and use of scCVD diamond semiconductors for use as radiation sensors in harsh environments

**PI: David Chichester TA: 3**



eOS cloud-hosted architecture to support DNN research projects for both data warehousing and on-line collaboration, data analytics, and machine learning development



Dr. Garcés (U. Hawai'i) visiting INL to take infrasound measurements at INL's Advanced Test Reactor



Idaho National Laboratory