

# Exploratory Research Program

## Investigating Transformational Technology

The Exploratory Research program explores innovative, high-risk, early-stage technologies, concepts, and ideas that can make transformational contributions in support of radiological and nuclear detection and nuclear forensics capability development efforts. Efforts are intended to transform the basic building blocks of detection technology and supporting fields, with research generally culminating in a proof-of-feasibility or proof-of-concept demonstration in a laboratory setting. Specifically, the program researches technology and techniques that:

- Address radiological and nuclear detection capability gaps and weaknesses;
- Provide substantial performance improvement or cost reduction of radiological and nuclear detection capabilities; and
- Improve nuclear forensics capabilities.

### Areas of Emphasis

#### Materials Development and Supporting Technology:

Greatly improved sensing materials fielded in detection systems at low costs in the form of semiconductors and scintillators.

**Radiation Detection Techniques:** Cutting-edge new approaches to threat detection based on intrinsic radiological signature of a material, with emphasis on contextual-aware, multi-modal, and agile detection systems.

**Shielded Threat Detection:** Novel methods and signatures to overcome the challenge of detecting shielded special nuclear material, through advanced non-intrusive inspection for cargo/vehicle scanning, mobile, and human-portable applications.

**Advanced Analytics:** Utilization of advanced signal processing and analyses to enhance the ability to detect, locate, track, and identify threat materials across a range of operational environments.

**Technical Nuclear Forensics:** Development of analytical techniques to improve current methodologies for faster, more precise measurements of physical, chemical, radiological, and morphological properties of sample material.

### Ongoing Projects

Listed below are a number of ongoing projects that the Domestic Nuclear Detection Office is carrying out with national laboratories (NL), industry, and universities.

Materials Development and Supporting Technology	Organization
Low-Cost Industrial Production of Halide Crystals	CapeSym
High Efficiency Solid State Semiconductor Crystal for Neutron Detection	Fisk University

### Grand Challenges

- Cost-effective equipment with sufficient performance to ensure widespread deployment.
- Detection of special nuclear material even when heavily shielded.
- Enhanced wide area search in a variety of scenarios, to include urban and highly cluttered environments.
- Monitoring along challenging pathways, to include general aviation, small vessels, and between ports of entry.
- Forensic determination of origin and/or route of interdicted materials.

### Program Success

The Exploratory Research program has resulted in some of the following accomplishments:

- Emerging scintillator and semiconductor materials for dual gamma/neutron detection.
- Algorithms for discrimination of high-Z material for active interrogation and data fusion

Solicitation information is available at [www.fbo.gov](http://www.fbo.gov). For questions about the Exploratory Research program, please contact [dndoerp@hq.dhs.gov](mailto:dndoerp@hq.dhs.gov).



High Throughput Discovery of Scintillator Materials	LBNL
High Resolution Scintillator Materials and Detectors, Thallium Bromide Cooled Modules and Room Temperature Development, Large-Scale Stilbene Development	LLNL
Chalcohalide Family of Compounds for Gamma Detection	Nious Technologies Inc.
Semiconductor Material Discovery using Informatics Approach	PNNL
Development of Detector Materials for Intra-Pulse Multi-energy X-Ray Radiography	RadiaBeam Technologies
Wide-Bandgap Semiconductor AlGaAs for SSPM; Bandgap Engineered Sensor for Active Interrogation; Ceramic Scintillators for Low Cost Transmission Radiography; Energy Resolution Improvement in NaI and CsI Scintillators; Plastic Scintillators for Delayed Neutron/Gamma Detection; Photonic Crystal Structures Development to Improve Energy Resolution; Tl-based Ternary Semiconductor for Advanced Gamma Detectors	Radiation Monitoring Devices
Boron-Nitride Solid-State Thermal Neutron Detector Fabrication	Rensselaer Polytechnic Institute
Metal Loaded Plastics for High Efficiency Gamma Detection	SNL

Radiation Detection Techniques	Organization
Background Estimation Via Semantic Mapping & Environment Classification	LBNL

Shielded SNM Detection Techniques	Organization
Low Dose Radiography Based on Laser-Driven X-rays	National Strategic Research Institute
High Speed Rail Cargo Scanning with Low Radiation; High-Performance Betatron X-ray Source	RadiaBeam Technologies
Advanced Rail Cargo Inspection System (ARCIS); Modular Active Interrogation and Fast Radiography Optimization Software (MACROS)	Rapiscan Laboratories
Shielding Anomaly Detection Using Magnetic Induction Sensors	SNL
Compact, 3-Axis Gravity Gradiometer Based on Controlled Diamagnetically Levitated Masses	SRI International
High Output, Ultra-Compact Neutron Generator	Starfire Industries

Advanced Analytics	Organization
Radionuclide Analysis Kit Development & Implementation	LLNL
Monte Carlo Neutral-Particle Code Physical Model Interoperability & Validation; Nuclear Inspection Node Event SIMulator (NINESIM) Tool for GNDA Node Simulations	LANL
Software for Optimization of Radiation Detectors Upgrades	Naval Research Laboratory
Robust Network Fusion Algorithms for Detection and Localization of Radiation Sources	ORNL

Forensics Data Collection and Analyses	Organization
Development of mass bias/nonlinearity correction software for ICP-QMS	ANL
Synthesis and characterization and isotope separation of volatile actinide compounds: applied to the production of pure isotopes for isotope dilution reference materials	INL
Bonding and Distribution as a Function of Depth in PU and U Forensics Samples; Chemical Forensic Science of Plutonium Oxides; Quantitative Image Analysis for Nuclear Forensics	LANL

