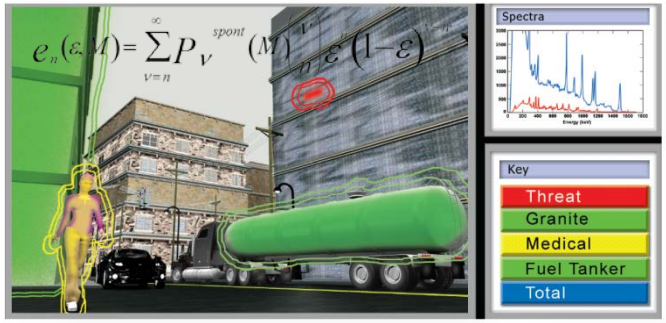
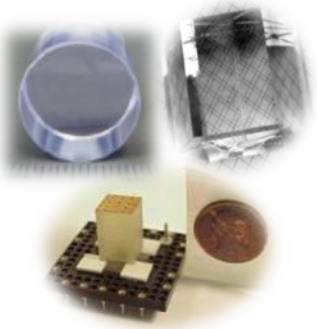
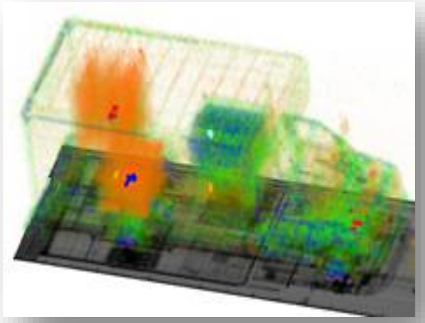
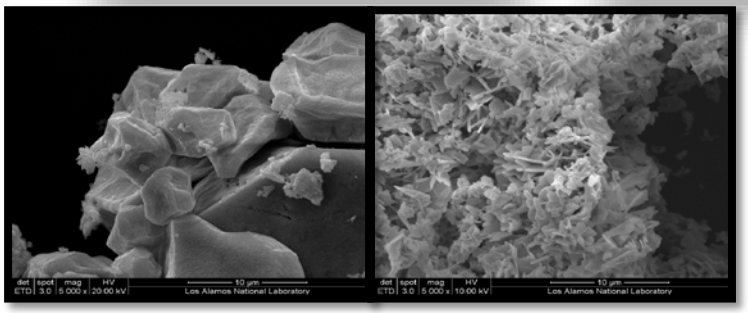
# Domestic Nuclear Detection Office (DNDO)

## *Advancing Technological Capabilities to Prevent Nuclear Terrorism*





*27 October 2016*

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**Assistant Director**
**Transformational and Applied Research**
**Domestic Nuclear Detection Office**

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# *Nuclear Terrorism is a Persistent Threat*

"No threat poses as grave a danger to our security and well-being as the potential use of nuclear weapons and materials by irresponsible states or terrorists." - President's National Security Strategy, February 2015

Materials:

- Nuclear or other radioactive materials out of regulatory control


Devices:

- Improvised Nuclear Device (IND)
- Radiological Dispersal Device (RDD) – "dirty bomb"
- Radiation Exposure Device (RED)

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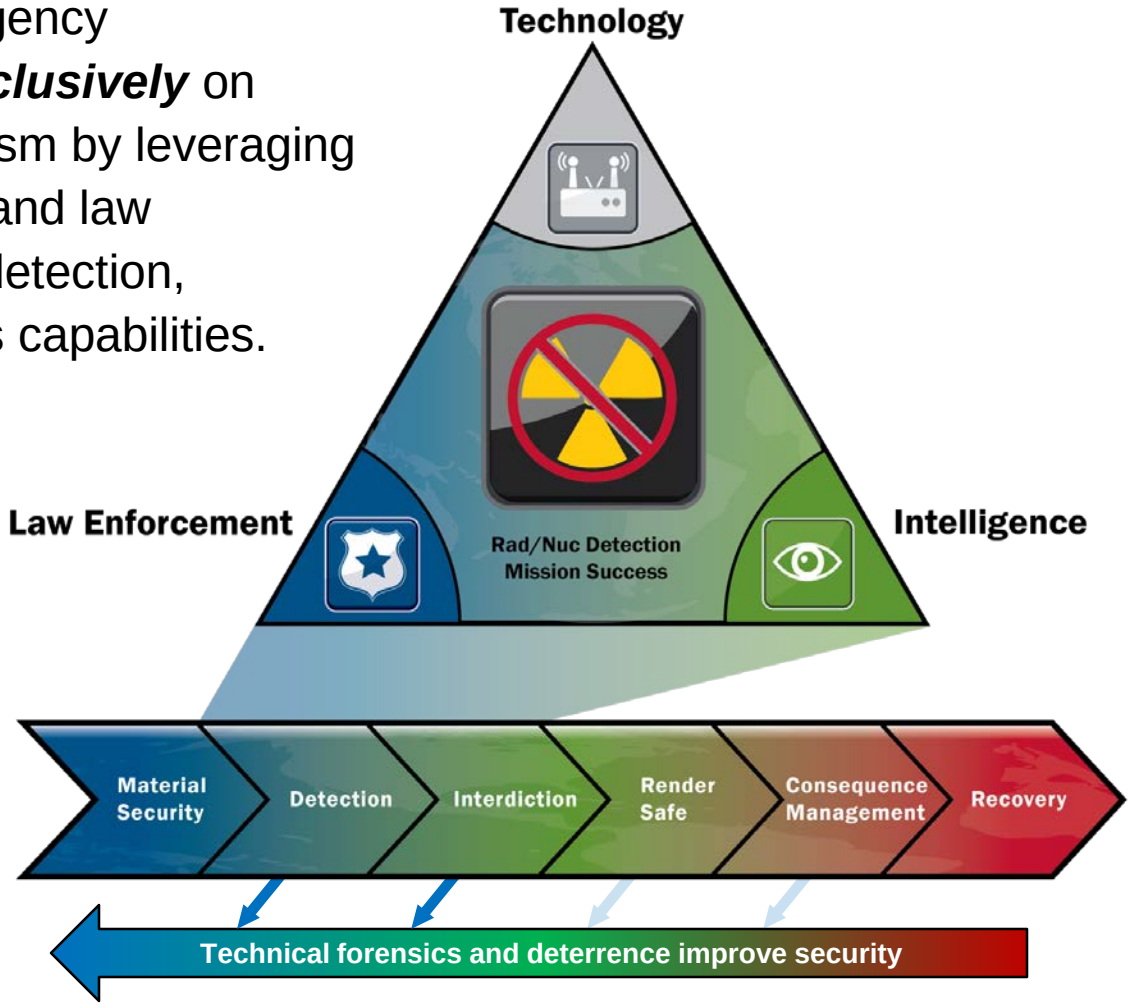
# *DNDO Mission*

- DNDO is a unique interagency organization ***focused exclusively*** on preventing nuclear terrorism by leveraging technology, intelligence, and law enforcement to improve detection, interdiction, and forensics capabilities.




**Nuclear Defense Spectrum**

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# DNDO Functions

## Nuclear Detection

- Develop the Global Nuclear Detection Architecture (GNDA) framework


- Acquire and support the domestic component of the GNDA
- Evaluate technology and operations
- Enhance capabilities over time through aggressive research and development

## Nuclear Forensics

*National Technical Nuclear Forensics Center*

- Lead interagency stewardship and coordination to ensure operational readiness
- Advance the capability for pre-detonation materials nuclear forensics
- Restoration and maintenance of science and expertise


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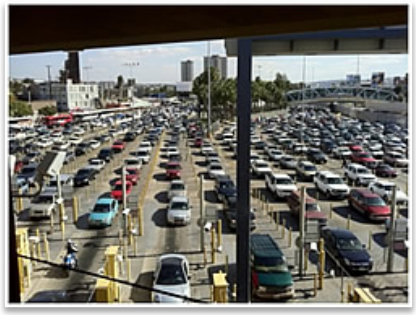
# Operational Realities of the United States

- Land Border Pathway
  - 1.1 million individuals legally cross U.S. borders every day
  - 14,000 trucks cross into the U.S through our Southern Border daily
  - 7,400 miles of border with Canada and Mexico
  - 5,400 loaded rail cars cross into the United States every day



- Aviation Pathway
  - 640 million domestic and international aviation passengers and 1.5 billion checked and carry-on bags are screened annually.
  - 200,000 general aviation aircraft and 19,500 landing facilities are in the U.S.

- Maritime Pathway
  - 32,000 seagoing containers arrive and are offloaded at U.S. seaports each day
  - 13 million registered U.S. recreational vessels, 282,000 fishing vessels, and 100,000 other commercial small vessels

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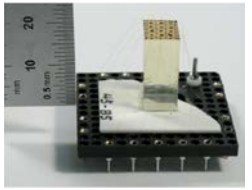
*Approximate numbers

# Grand R&D Challenges

- Cost effective equipment with sufficient performance to ensure wide spread deployment



- Detection of special nuclear material even when heavily shielded

- Enhanced wide area monitoring and search in a variety of scenarios, to include urban and highly cluttered environments

- Monitoring along challenging GNDA pathways, to include general aviation, small vessels, and in between ports of entry

- Linking nuclear forensic signatures of interdicted materials to a specific processing history and origin

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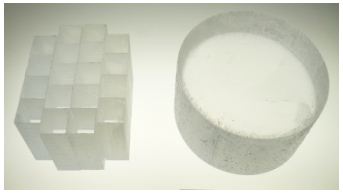
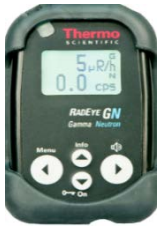
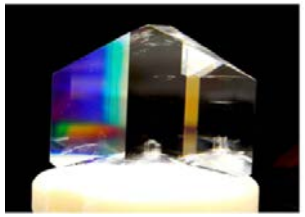
# Cost Effective: Materials

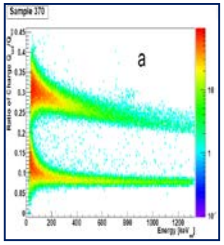
## Recent Successes






Cesium lithium yttrium chloride (CLYC) gamma and neutron detection

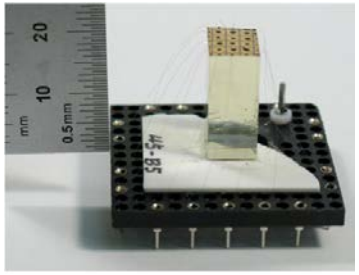


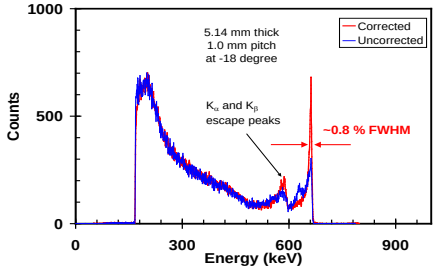



Fast neutron detection with large stilbene

Neutron detectors for radiation portal monitors that do not use He-3

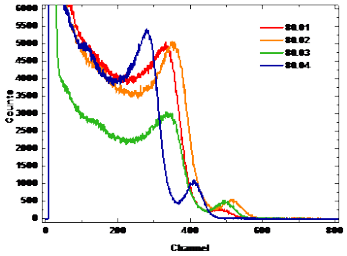
## Up and Coming Materials

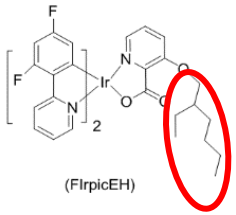




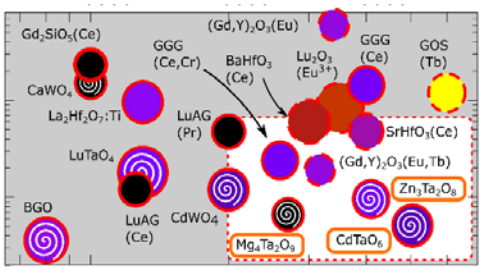


Thallium bromide (TlBr) semiconductor

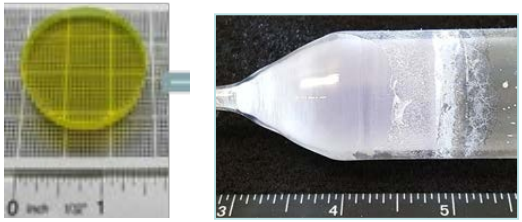





Spectroscopic plastics




Scintillator discovery
http://scintillator.lbl.gov



Scintillators: ceramic GYGAG and driving down the cost of SrI

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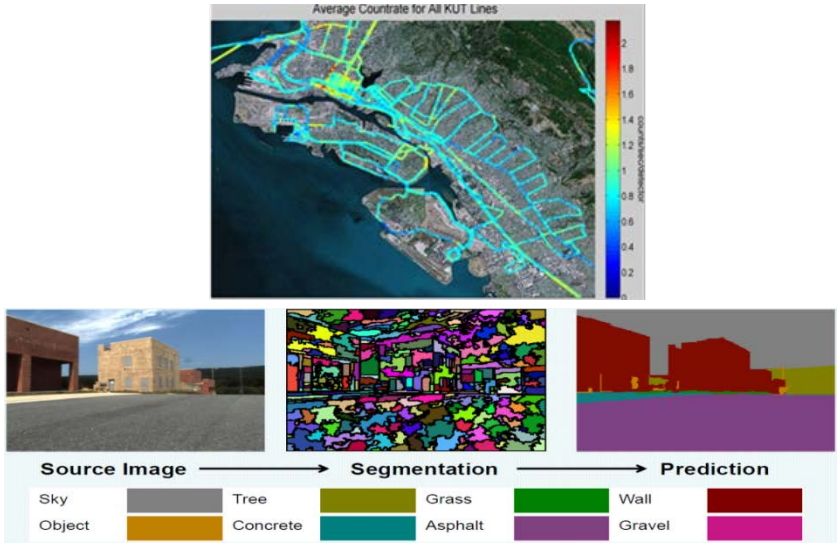
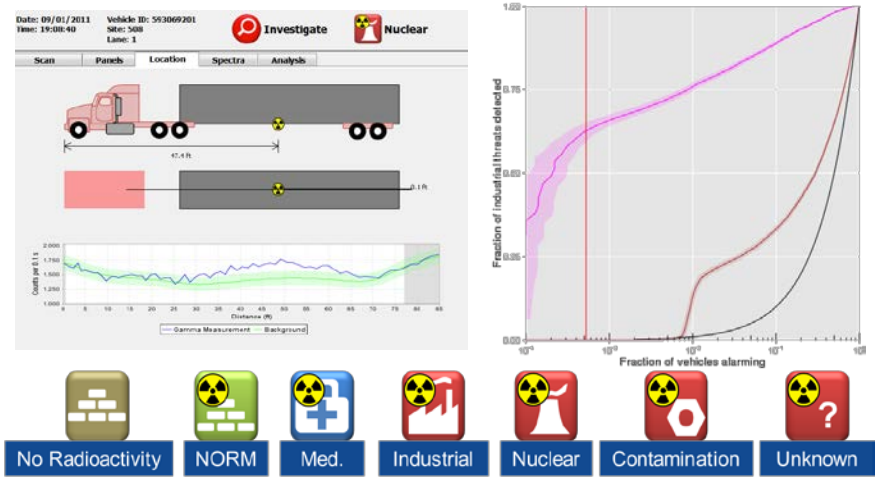
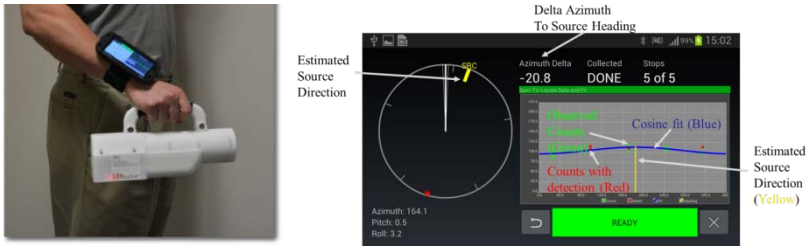
# Cost Effective: Algorithms




Background mapping and modeling




Machine learning algorithms for radiation portal monitors




Embedded algorithms for identification, localization, and tracking


Smartphone and simulated training tools

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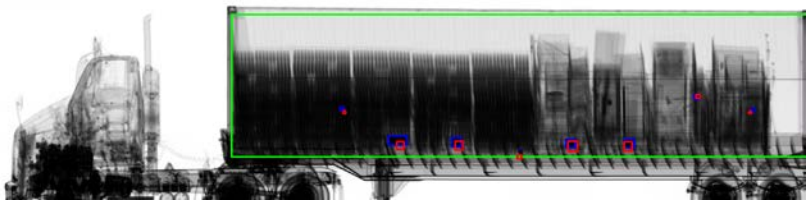
Goal is to reduce nuisance alarms and improve detection while increasing usability.

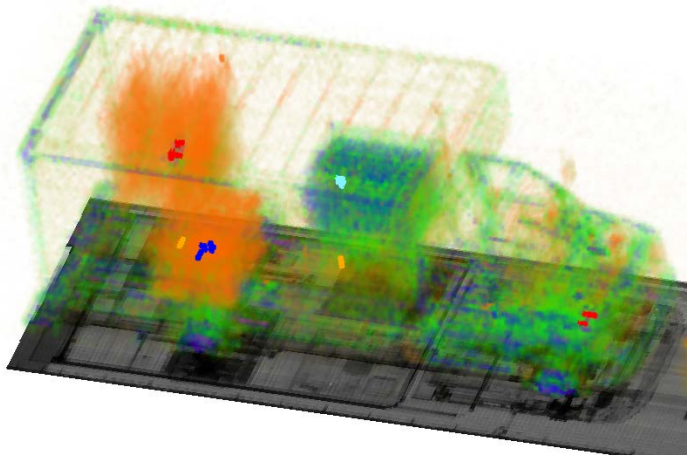
# *Shielded: Cargo Scanning*



Single and dual energy radiography systems with automated detection algorithms

Gamma (*photofission*) and neutron (*differential die away*) induced fission systems

Passive muon tomography integrated with radiation detection



High energy backscatter provides three dimensional elemental map coupled with nuclear resonance fluorescence to give isotopic information

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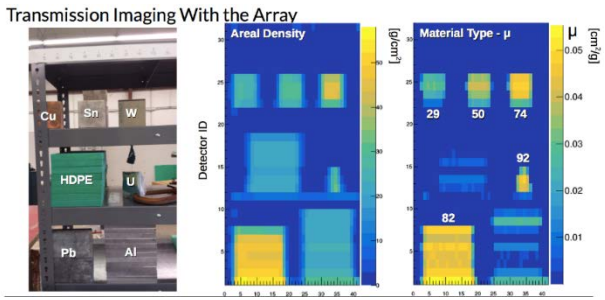
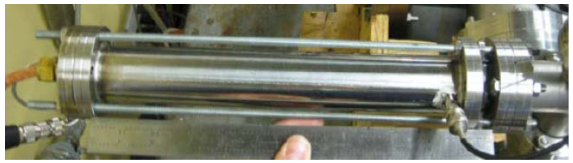
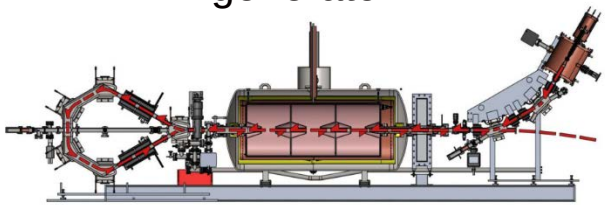
# *Shielded: Enabling Technology*




Low dose reaction based gamma-ray source gives material discrimination

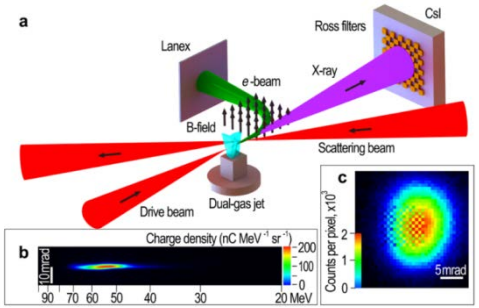


Portable DD neutron generator

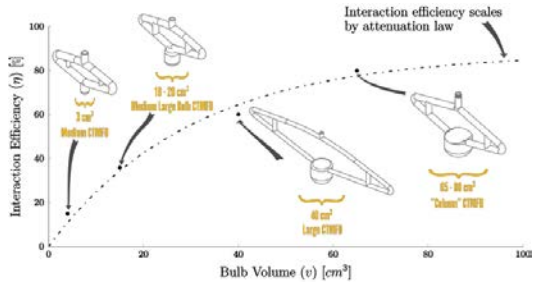


Superconducting near continuous wave x-ray source

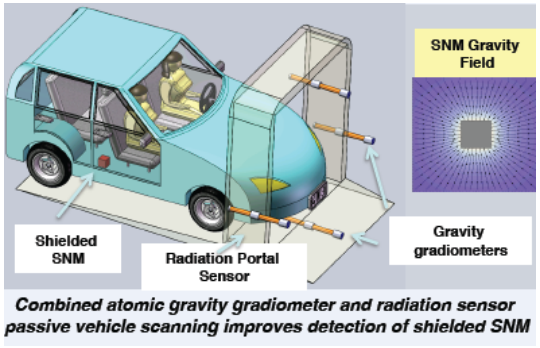
Compact betatron x-ray source for mobile applications




Laser driven sources to produce near-mono energetic and tunable photon beams




Tensioned metastable fluid neutron detector is insensitive to gamma-rays




Gravity imaging utilizing cold-atom gravity sensors

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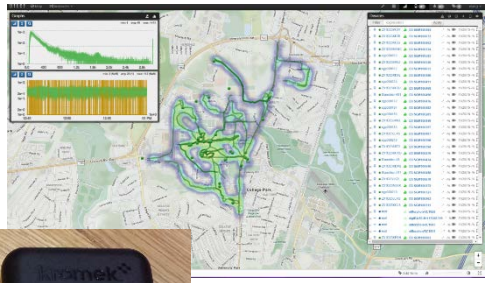
# *Wide Area: Monitoring*

## Radiation Awareness and Interdiction Network (RAIN)

Vehicle scanning at highway speeds to provide actionable information to law enforcement

## SIGMA

***DNDO teaming with the Defense Advanced Research Project Agency (DARPA)***




Massive deployment of inexpensive but effective networked detectors to provide continuous monitoring

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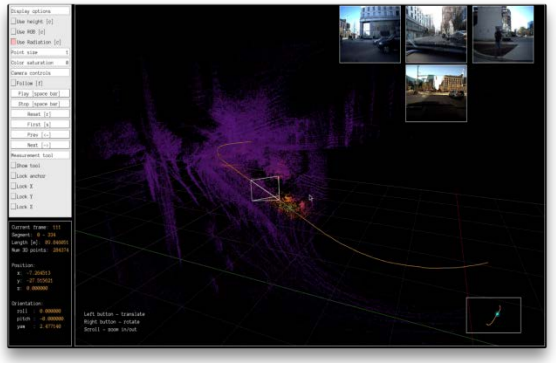
# *Wide Area: Search*

## Wearable Intelligent Nuclear Detection (WIND)

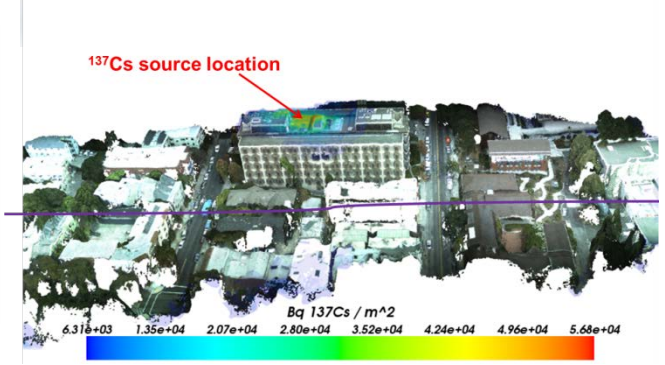
Modular, reconfigurable, and man-portable detection and localization.

## Mobile Urban Radiation Search (MURS)



Hexagonal array of NaI detectors with LIDAR and Google cameras.

## Airborne Radiological Enhanced -sensor System (ARES)




Gamma-ray detectors with multispectral imaging, GPS, and altimetry.

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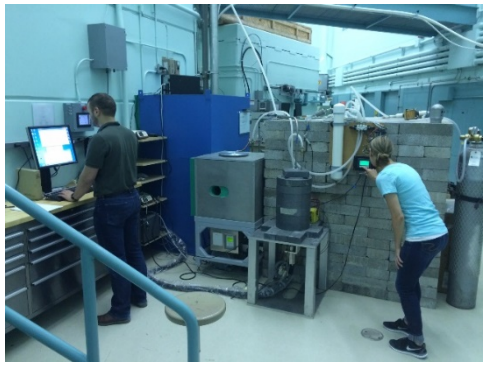
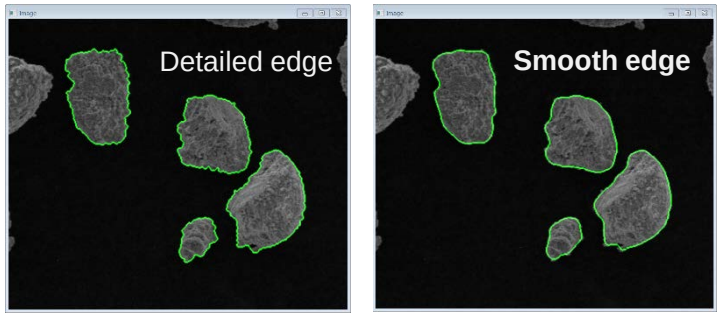
Fusion of radiation detection with other contextual information to enhance awareness and usability.

# Nuclear Forensics

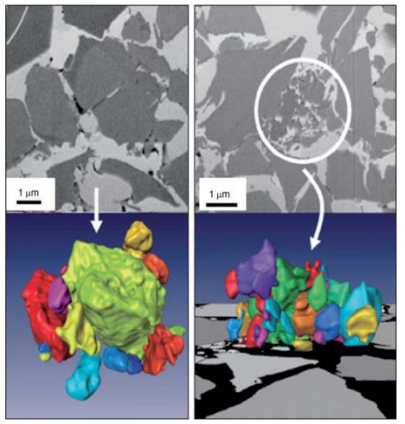


Temporal gamma-ray spectroscopy after neutron induced fission

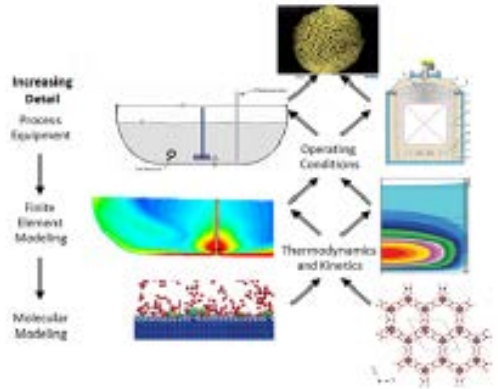
## Analytical Methodologies




Quantitative image analysis for microstructural and morphological properties



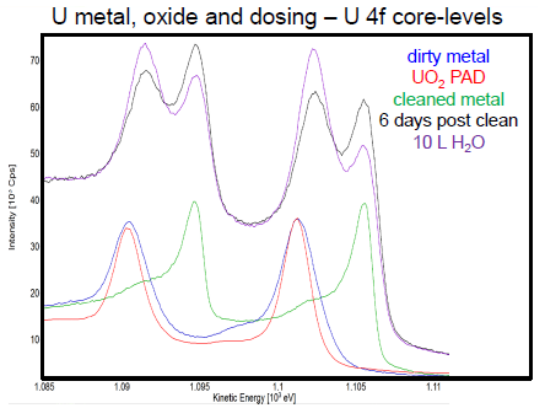

Focused ion beam for 3D morphology




Dynamic simulation of plutonium processing

## Signature Discovery


Chemical forensics science of plutonium and uranium oxides with age and environment




Using x-ray photoemission and laser ablation to determine Pu and U per depth

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# *Questions?*


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