

National Nuclear Security Administration Defense Nuclear Nonproliferation (DNN) R&D

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**National Nuclear Security Administration
Defense Nuclear Nonproliferation R&D**

Defense Nuclear Nonproliferation

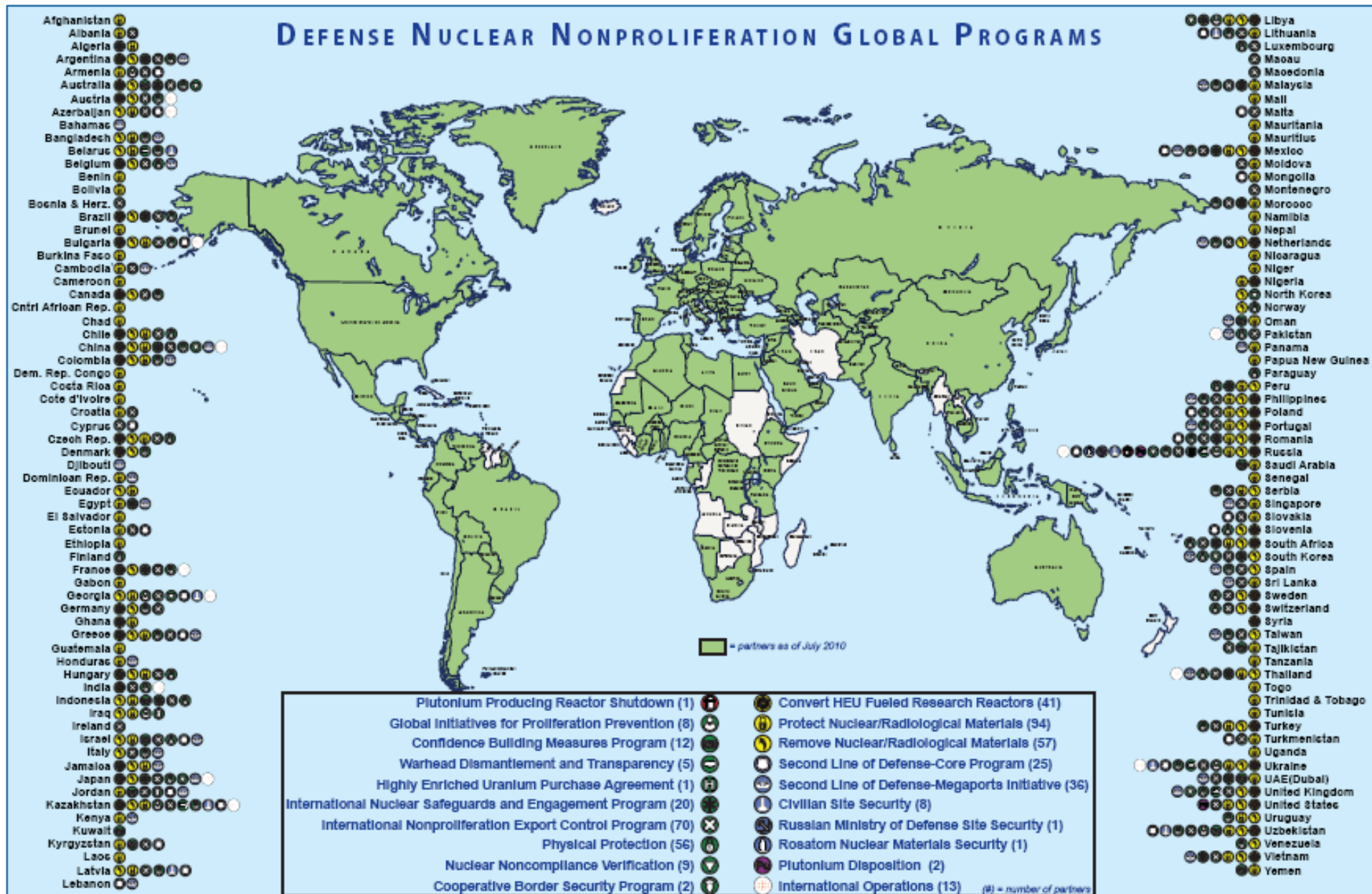
Vision: *We are committed to making the world a safer place by reducing nuclear and radiological dangers.*

Mission: *To develop and implement policy and technical solutions to eliminate proliferation-sensitive materials and limit or prevent the spread of materials, technology, and expertise related to nuclear and radiological weapons and programs around the world.*

Core Competencies:

1. Remove, eliminate, and minimize the use of proliferation-sensitive materials.
2. Safeguard and secure materials, technologies, and facilities.
3. Detect and prevent the illicit trafficking of nuclear/radiological materials, technology, information and expertise.
4. Provide R&D technology solutions for treaty monitoring, minimizing the use of proliferation-sensitive materials, and the application of safeguards and security.
5. Provide unique technical/policy solutions and develop programs/strategies to reduce nuclear/radiological dangers.

DNN's Global Reach



DNN Nuclear Security and Arms Control Regime Mission

DNN seeks to prevent the proliferation of WMD by strengthening the nonproliferation, nuclear security, and arms control regime.



Safeguard and Secure nuclear material and facilities to prevent diversion, theft, and sabotage.



Control the spread of WMD-related material, equipment, technology, and expertise.



Negotiate, Monitor and Verify compliance with international arms control and nonproliferation treaties and agreements.



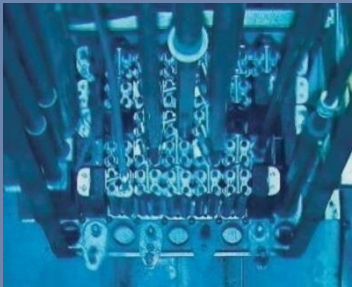
Develop and implement DOE/NNSA nonproliferation and arms control **policy** to reduce the risk of weapons of mass destruction.

DNN Nuclear Security Program Activities



DNN seeks to reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide.

Convert



Convert research reactors and isotope production facilities from the use of highly enriched uranium (HEU) to low enriched uranium (LEU)

Permanent threat reduction by minimizing and, when possible, eliminating HEU in civilian applications.

Remove



Remove and dispose of excess nuclear and radiological materials;

Permanent threat reduction by eliminating HEU or Pu material at civilian sites

Protect



Protect high priority nuclear and radiological materials from theft

Threat reduction by improving security on the bomb material remaining at civilian sites – reduces the risk until a permanent threat reduction solution can be implemented

DNN Nuclear Security Program Activities

DNN seeks to enhance the security of vulnerable stockpiles of nuclear weapons and weapons-usable nuclear material in partner countries and improve the ability to detect the illicit trafficking of SNM.

Material Protection, Control & Accounting



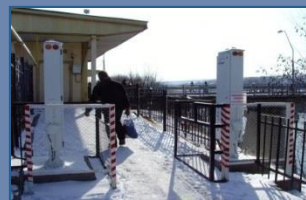
Assist countries to secure and reduce stocks of vulnerable nuclear weapons and weapons-usable material by:

- Enhancing Material Protection Control and Accounting (MPC&A) at nuclear sites
- Enhancing national level infrastructure (e.g., regulations, inspections, nuclear security culture) required to support an effective MPC&A Program
- Enhancing transportation security
- Supporting consolidation of material to fewer and more defensible locations
- Supporting conversion of excess HEU to LEU
- Supporting sustainability of MPC&A Programs
- Providing training in nuclear security best practices

Second Line of Defense

Strengthens capability of foreign governments to deter, detect, and interdict illicit trafficking in nuclear and other radioactive materials across international borders and through global maritime shipping system as well as at choke points throughout the country.

Implementation



- Equip points of entry: airports, border crossings, and seaports
- Provide mobile detection technology (vans) to law enforcement agencies for green/blue borders
- Install national communications network joining all detection equipment to central partner country location

Sustainability



- Ensure long-term operation of SLD systems by Partner Countries
- Build Partner Countries' indigenous capabilities to fully support SLD systems
- Provide transition support and services including help desk, data analysis, and other technical expertise

DNN Fissile Material Disposition Activities

DNN seeks to reduce inventories of surplus fissile materials including HEU and plutonium which are excess to U.S. national to security needs, in a safe, secure, and irreversible manner.

U.S. Plutonium

- Current plans call for at least 34 MT of plutonium to be fabricated into MOX fuel and irradiated in existing commercial reactors
- Key infrastructure needs: MOX Fuel Fabrication Facility, Waste Solidification Building and pit disassembly capability
- Infrastructure projects far more costly than anticipated

U.S. HEU

- ~180MT Designated for Down-blending
- 142 MT completed for peaceful use as nuclear reactor fuel.



U.S.-Russia Plutonium Management and Disposition Agreement (PMDA)

- Protocol Amending the PMDA signed at the 2010 Nuclear Security Summit
- Reaffirms commitment to dispose of at least 34 MT of plutonium in the U.S. and Russia and verification by the IAEA

Global Plutonium Management and Disposition

- Work with DOE/NE and other interagency and international partners

MOX Fuel Fabrication Facility , Dec. 2012

DNN R&D Program Activities

DNN seeks to reduce the threat to national security posed by the proliferation of nuclear weapons or materials by developing the U.S. capabilities to monitor nuclear treaties, weapons development activities, and nuclear detonations worldwide.

Nonproliferation



- SNM production capabilities
- Weapons development detection
- Operationally focused technical nuclear forensics

Verification and Monitoring



- SNM Movement Detection
- Warhead monitoring
- Nuclear Safeguards
- Warhead Chain-of-Custody



- Produce and improve U.S. operational satellite nuclear detonation sensors in support of both treaty monitoring and military missions.
- Advance US capability for seismic and radionuclide detection of nuclear tests.

DNN R&D is a Program Office

- DNN R&D executes Executive Branch responsibilities to manage, provide Federal oversight and set strategic direction and requirements for nonproliferation R&D funding.
- DNN R&D funds NNSA/DOE national laboratories through Management & Operations (M&O) contract arrangements (Los Alamos or Oak Ridge National Labs as an example).
- DNN R&D also awards grants to Universities or small businesses.

DNN R&D Key Requirements and Drivers

- National Strategy Documents
 - National Security Strategy
 - Nuclear Posture Review - *“a comprehensive national R&D program to support continued progress toward a world free of nuclear weapons, including expanded work on verification technologies and the development of transparency measures.”*
- DOE and NNSA Strategic Plans
- Public Law (NDAA for 2008, 2011) related to production of space-based nuclear detonation assets.
- Needs-driven research and requirements-driven production
 - DNN R&D engages with user community
 - DNN R&D outlook is long-term
 - DNN R&D plans in advance of formal requirements
 - DNN R&D supplies nuclear detonation detection payloads on US satellites

Policy Impacts DNN R&D Activities

Proliferation Detection:

Nuclear nonproliferation community R&D leader in advancing unilateral capabilities for detecting foreign nuclear material production activity and weapons development programs; supporting Administration policies and priorities, and strategic guidance (e.g. NPR) by developing the technical basis for meeting future multi-lateral nuclear arms control treaty verification and monitoring requirements; detecting the movement and diversion of special nuclear materials, including for nuclear safeguards; and for supporting a broad set of national nuclear security technical needs, including radiological source replacement and those complementary to counter-proliferation and counter-terrorism missions.

Nuclear Detonation Detection:

Maintains the nation's space based global nuclear detonation detection capability per Public Law 110-181; Sec 1065 & Public Law 111-383; Sec 913 (NDAA FY 2010); provides the underlying science and technology behind the nation's operational nuclear test treaty monitoring and Integrated Threat Warning/Attack Assessment capabilities; supports detection of underground detonations through development of improved seismic and radioxenon measurement methods; and improves pre- and post-detonation technical nuclear forensic capabilities.

DNN R&D Program Stakeholders

- **NNSA**
 - Other Defense Nuclear Nonproliferation offices – Technology provider
 - Emergency Operations – Technology provider
 - Counter Nuclear Terrorism – Fundamental R&D, collaboration
 - Defense Programs – Collaboration
- **Department of Defense**
 - Leverage DNN R&D investments, collaboration
- **Department of Homeland Security**
 - Leverage DNN R&D investments, collaboration
- **Department of State**
 - Treaty Verification Needs document
- **Intelligence Community**

DNN R&D Proliferation Detection: Teams

- **Nuclear Weapons Development and Material Production Detection (MPD)** – develops in situ, near-field, and remote capabilities for detecting signatures and observables of weapons development/fuel cycle processes, including detection capabilities for uranium and plutonium production and for weapons development and non-nuclear testing detection. This component's particular emphasis is with unilateral capabilities or those applied in a non-cooperative environment.
- **Nuclear Weapons and Material Security (WMS)** – develops radiation sources and sensors for detecting material diversion, movement, and life-cycle continuity-of-knowledge of warheads and material, such as for interdiction, arms control and safeguards applications. This component's particular emphasis is with multi-lateral capabilities or those applied in a cooperative environment.
- **Nonproliferation Enabling Capabilities (EC)** – develops cross-cutting, supportive technologies, such as modeling, simulation, the Integrated University Program, and field test bed experiments that are critical for meeting PD metrics for demonstrating broader capability advancements in MPD and WMS. These enabling capabilities can be applied in both unilateral and multi-lateral environments.

DNN R&D Proliferation Detection: Staff

7 Fed
3 Military
9 M&O
1 Contractor

David LaGrafte
Director
Vacant (Army COL)
Deputy Director

Kloey Waller (Cont)
Admin Support

Nonproliferation
Enabling Capabilities (EC)

Victoria Franques
James Peltz
Bryan Broadhead (M&O)

Weapons and Material
Security (WMS)

David Beach
Arden Dougan
Allen Bakel (M&O)
Kristin Hertz (M&O)
Cathy Romano (M&O)

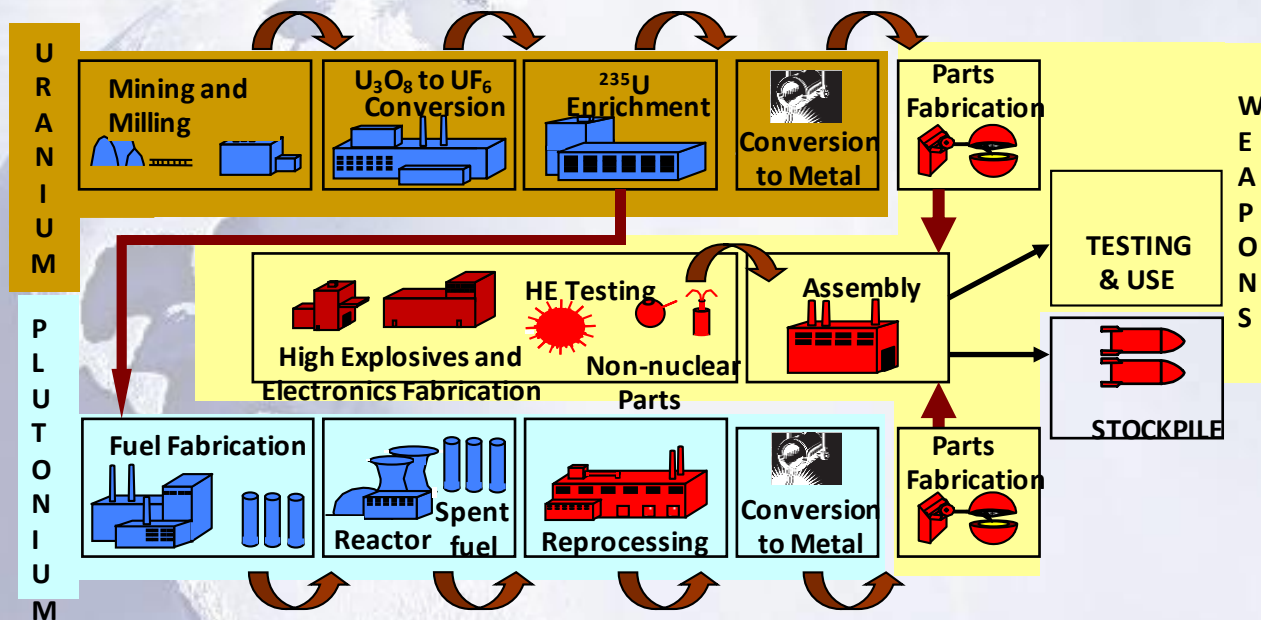
Weapons Development and
Material Production
Detection (MPD)

Vacant
Eleanor Dixon
Victoria Franques
LTC Steve Frederiksen
LTC Won Kim
Darcie Dennis-Koller (M&O)
Jared Johnson (M&O)
Gordon Jarvinen (M&O)
Wade Williams (M&O)

DNN R&D Material Production Detection: Objectives

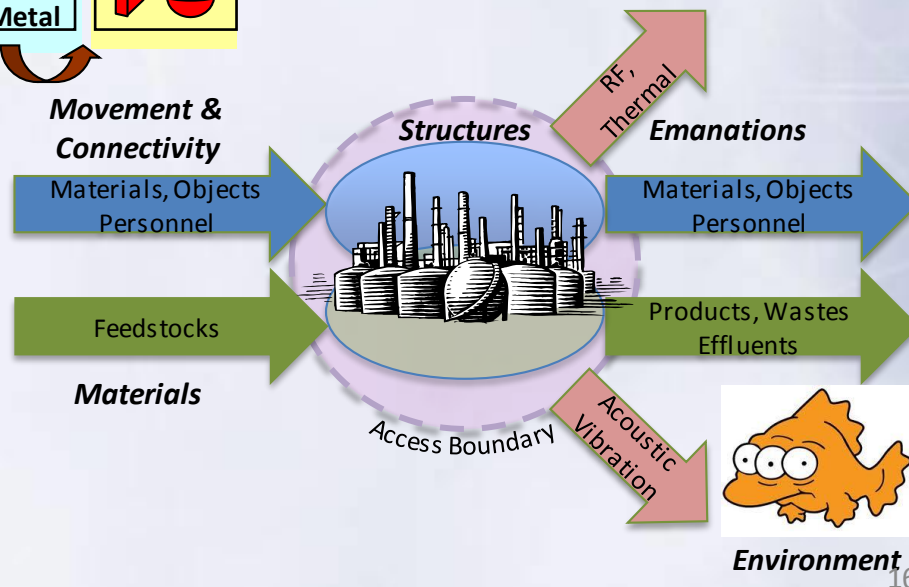
- **Uranium Production Detection:** develop advanced methods and technologies to detect, locate, and characterize Uranium conversion, enrichment, and metal production processes.
- **Plutonium Production Detection:** develop advanced methods and technologies to detect, locate, and characterize Plutonium production processes, including fuel and target fabrication and irradiation, reprocessing and metal production.
- **Weapons Development Detection:** develop advanced methods and technologies to detect, locate, and characterize Weapons activities, including high-explosive and hydrodynamic testing, metal shaping, and weapons component manufacturing.
- **Other Processes Detection:** develop advance methods and techniques to detect, locate, and characterize other nuclear processes.
- **Sustaining Technology:** sustain technical capability in areas that require long-term support and that are critical to meeting DNN R&D future mission requirements.

DNN R&D Materials Production Detection: Technical Focus



Focused on the fuel cycle pathways to produce SNM and weapons development.

Multi-source fusion of remote sensing, particulate, thermal, optical, EM, imagery, and process modeling.



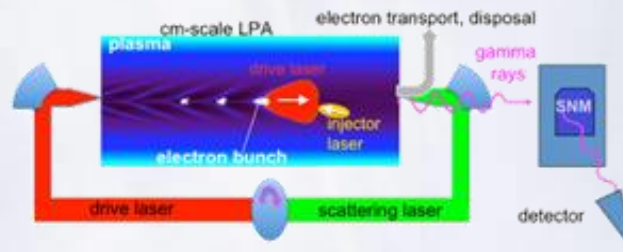
DNN R&D Weapons and Material Security: Objectives

- **Detection:** increase our confidence in our ability to detect nuclear weapons and nuclear material not under regulatory control.
- **Nuclear Emergency Response and Interdiction:** develop and demonstrate advanced detectors, active interrogation sources, and algorithms for enhanced search, detection and identification in signal-starved environments.
- **Safeguards:** cooperatively quantify and track special nuclear materials in the nuclear fuel cycle and detect any diversion of these materials for illicit purposes.
- **Radiological Source Replacement:** replace radiological sources with alternatives that minimize the risk of diversion for malicious use.
- **Arms Control and Treaty Verification:** characterize nuclear weapons and nuclear materials for treaty verification.

DNN R&D Weapons and Materials Security: Technical Focus

Arms Control

Warhead Measurement Campaign, confirmation and dismantlement methods, Information Barrier



International Safeguards

Tags and Seals, Improving nuclear measurements



Detectors & Sources

Radiation Materials, detectors, photon sources
CZT, 3He replacements, detectors & N Sources; for scintillators & semiconductors, Laser Wakefield



Interdiction & Emergency Response

Maritime detector test, 3D-GADRAS

Radiological Source Replacement

AmBe replacement for well logging; Tags; 99.9% SBIR

DNN R&D Enabling Capabilities: Objectives

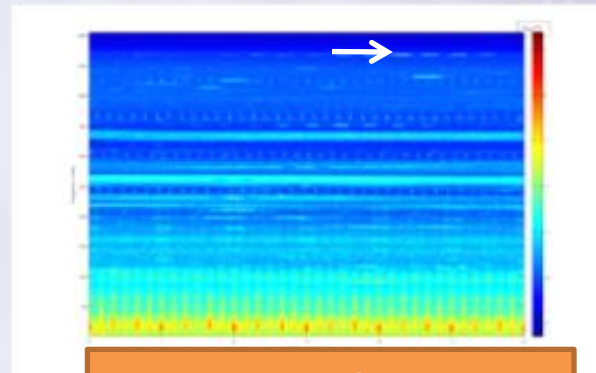
- **Innovative ideas:** explore new innovations in nonproliferation detection that lie outside of current technology roadmaps
- **Data Science:** Novel methodologies and techniques to explore and analyze data. Data Science addresses the development of techniques which efficiently employ large data sets, utilize data fusion to incorporate multiple avenues of information, and support automated techniques for analysis of complex data.
- **Remote Sensing:** Advanced capabilities to target activities and materials of interest remotely (typically at kilometer scales). Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed.
- **Signature Physics:** Novel theoretical and predictive capabilities to enable signature discovery across the DNN R&D mission space. Signature physics R&D evaluate signatures associated with nonproliferation issues with modeling and simulations of processes and detectors, or of the signatures themselves.

DNN R&D Enabling Capabilities: Technical Focus



Remote Sensing

Advanced capabilities to target activities and materials of interest remotely

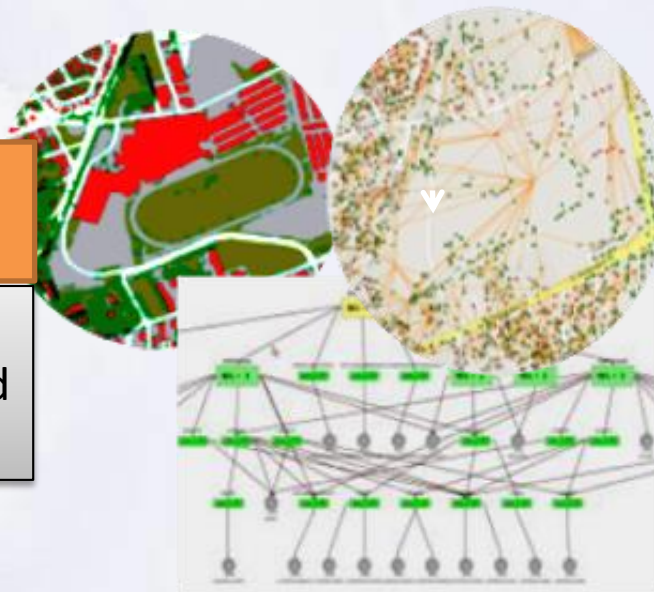


Signature Physics

Novel theoretical and predictive capabilities to enable signature discovery across the PD mission space

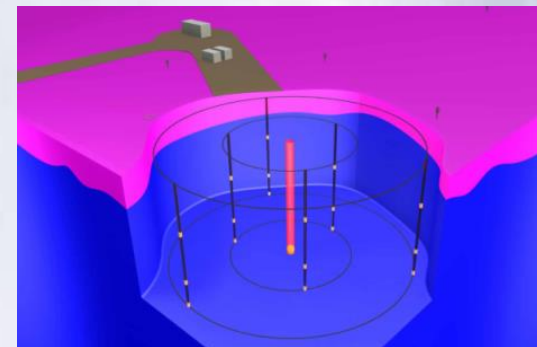
Data Analytics, Modeling, and Simulation

Novel methodologies and techniques to explore and analyze data



DNN Treaty Monitoring & Verification R&D Requires a Unique Approach

- **Spiral development of new technology**
 - Proliferation Monitoring
 - Weapons & Material Monitoring
 - Test Monitoring
- **High Explosive Test series**
- **National Test beds**
 - Nonproliferation Test Bed
 - End-to-End Demonstration
 - Source Physics Experiment
 - Underground Nuclear Event Signatures Experiment
 - Most activities take place at the Nevada National Nuclear Security Site



DNN R&D University Grant Program

- **Purpose**
 - Create a “pipeline” to deliver the next generation of national security technical experts
 - Bridge the knowledge bases of academia and DOE/NNSA national laboratories
 - Low TRL (technology readiness level) contributions
 - Peer review
 - Build broader support for nonproliferation funding
 - Complement the NRC and DOE/NE Integrated University Program
- **Creating a pipeline requires a consortia model to complement and leverage strengths of diverse academic institutions.**
- **DOE / NNSA Laboratories are key participants in the consortia.**
- **DNN R&D consortia approach is now fully implemented**
 - Nuclear Science and Security Consortium (Lead - UC Berkeley)
 - Consortium for Verification Technology (Lead - U of Michigan)
 - Consortium for Enabling Capabilities (Lead - NC State)

DNN R&D Business Innovation and Technology Transfer Programs

- **Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)**
 - U.S. Government programs in which federal agencies with large research and development (R&D) budgets set aside some fraction of their funding for competition among small businesses only.
- **The SBIR and STTR have four program goals:**
 - Stimulate technological innovation
 - Use small business to meet Federal R/R&D needs
 - Foster and encourage participation by the socially and economically disadvantaged small businesses, and those that are 51 percent owned and controlled by women, in technological innovation
 - Increase private sector commercialization of innovations derived from Federal R/R&D, thereby increasing competition, productivity, and economic growth

Summary: What DNN R&D is All About

- **DNN R&D supplies broad nuclear security technology options for proliferation monitoring, nuclear test monitoring and materials monitoring production and movement applications.**
- **Universities contribute cutting-edge, basic science for the next generation of technology and create the nuclear security talent pool of the future**
- **The DOE/NNSA national laboratories are key participants in these activities.**

BACKUP SLIDES

PD Management Model

