



Defense Nuclear Nonproliferation's Nonproliferation Research and Development (NA-22)

Program and R&D Overview

Rhys Williams, Ph.D. Deputy Director

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Mission:

Reduce the threat to national security posed by nuclear weapons proliferation/detonation or the illicit trafficking of nuclear materials through the long-term development of new and novel technology

Vision/Objectives:

- Develop and demonstrate technologies for detecting the stages of a foreign nuclear weapons program
- Develop, demonstrate, and deliver technologies to detect, report, locate, and identify worldwide nuclear detonations
- Conduct the highest quality, most innovative research and development





Office of Defense Nuclear Nonproliferation (NA-20)

Ken Baker (Acting)

Nonproliferation and International Security (NA-24) Adam Scheinman International Material Protection and Cooperation (NA-25) David Huizenga Fissile Materials Disposition (NA-26) Ken Bromberg

Global Threat Reduction (NA- 21) Andrew Bieniawski Nonproliferation Research and Development (NA-22) T. Jan Cerveny Nuclear Risk Reduction (NA-23) Trisha Dedik











FY2009 \$199.7M

(6 Feds, 3 Military, 8 M&Os, 2 Technical Support Contractors)

- Directly tied to R&D mission for detecting foreign
 - HEU production
 - Pu production
 - Movement of SNM
 - Violation of International Safeguards
- Drives long-term research agenda across USG for nuclear nonproliferation R&D







Office of Proliferation Detection

Nonproliferation Mission Areas

- > U-235 Production Detection
- > Pu Production Detection
- SNM Movement Detection/Radiation Sensing
- > Detection of Nuclear Weapons Production and Testing
- Safeguards and Alternate Radiation Sources

Nonproliferation Enabling Technologies

- Advanced Materials (radiation detection focus)
- > Simulation, Algorithms and Modeling
- > Nuclear Fuel Cycle Remote Sensing
- > Tools, Techniques, Infrastructure and Demonstrations

Signatures & Observables

 Identify & characterize relevant proliferation signatures and observables in support of PD mission areas





Uranium gas centrifuge detection



Neutron detection: gas-filled glass beads



Fuel cycle production signature collection





Example: Characterization of SNM







Advanced Laboratory Techniques: Radiochemistry Automation





Radiochemistry

Automation







Stand-off Sensors: Hyperspectral Remote Sensing

QUAHSI - Quantifying Uranium Conversion Activities by Hyperspectral Imaging



Portable Hyperspectral

Sensor

Gas detection image



- Data collection in relevant time frame and spectral range
- Selection of most effective instrument, sensing location, and image area.
- Unique identification of effluents from complex real-world HSI images





Collectors / Sampling







Improved Accuracy of Pu Assay

Challenge: Correct NDA signal for presence of Cm in spent fuel. Goal: Improve Cm/Pu ratio by a factor of 10 in a reprocessing sample. Approach: Monochromatic Wavelength Dispersive X-ray Fluorescence (MWDXF)



MWDXF experimental breadboard



Spectrum of 1 mL deposit of 10 ppm Y (100 second measurement)

Preliminary measurements of Y demonstrate the feasibility of measuring curium with a sub-ppm detection limit.





E(p)

60

Advanced Enrichment Monitoring

Challenge: Gas centrifuge enrichment plant (GCEP) enrichment monitoring Goal: Improvements beyond existing Continuous Enrichment Monitor (CEMO) Approach: Quantitative enrichment measurements using x-ray generators



Experimental Enrichment Results for UF₆ Gas

40

UF₆ Pressure [torr]

20

R&D efforts focused on x-ray tube characterization and stabilization, optimization of notch filters, and background suppression of 186 keV peak.

80





Novel Pin Diversion Method

Challenge: Detect diversion of spent fuel from Pressurized Water Reactors (PWR) Goal: Exceed current IAEA detection threshold of 50% missing pins Approach: Explore neutron and gamma measurements inside the guide tubes, with assemblies in spent fuel pond



PWR Fuel Assembly

Example of a MCNP modeled

assembly with Missing Pins

(shown in blue)



Blue profile shows a 4.5% diversion case, while the pink profile shows the reference profile for a PWR spent fuel assembly

Monte Carlo simulations show that ratios of neutron and gamma measurements may be a useful indicator of partial defect. Experimental validation are needed. Operator acceptance is still an issue.

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Uranyl Fluoride Studies

UF_6 Environmental Effects UF_6 + 2 H₂O \rightarrow UO₂F₂ + 4 HF









Focus on Signatures from Operational Facilities

Measurements are being made in weapon-complex facilities (LANL) Measurements are being made in Reactor Fuel Fabrication Facility (INL)









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Example: Reactor Monitoring

Reactor Safeguards and Monitoring with Antineutrino Detectors





Nuclear Detonation Detection (NDD)









FY 2009 (\$145.6M)

(4 Feds, 2 Military, 4 M&Os, 2 Tech Contractors)

- Bulk of program driven by product delivery schedule to meet interagency requirements
- R&D crucial to enable design, production, and delivery of Nuclear Detonation Detection systems



Nuclear Detonation (NUDET) Signatures



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GPS Instruments









New Seismic Monitoring Challenge for Low Yield Events



- > New stations installed by DoD as funds and international agreements allow
- > Each new station requires about 3 years to select and install (DOE labs)
- > Station calibration requires 3–5 years of data gathering and mathematical analysis

ENERGY Computational Modeling





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ENERGY Nuclear Detonation Detection – Forensics



Prompt & Debris weapons outputs

Modeling to understand source term & propagation

- to guide/focus research
- for pre-event planning (CONOPS development & site sensors)
- support to post-event evaluation, reconstruction

Collection & Measuring research

- how to best collect and rapidly measure quantities that add value to attribution
- looking for significant advances in radioisotopic measurements, not simply slight improvements in traditional radiochemistry practices (e.g., direct sampling by laser ablation, high-resolution alpha-spec)

Evaluation

- reconstruct pre-detonation device design information
- reconstruct pre-detonation material information



High fidelity model of an evolving nuclear fireball in an urban setting



Installed forensics sensors





Advancing Nuclear Security Capability

- R&D/S&T focused on a specific missions
- Connection to user/operators is a given
- Seeking to solve the toughest technical problems