National Nuclear Security Administration
Office of Nonproliferation R&D
University Programs

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Office of Proliferation Detection, NA-221

Outline

- Office of Nonproliferation and Verification Research and Development (NA-22) Overview
- Integrated University Program
- NA-22, Safeguards Research and Development

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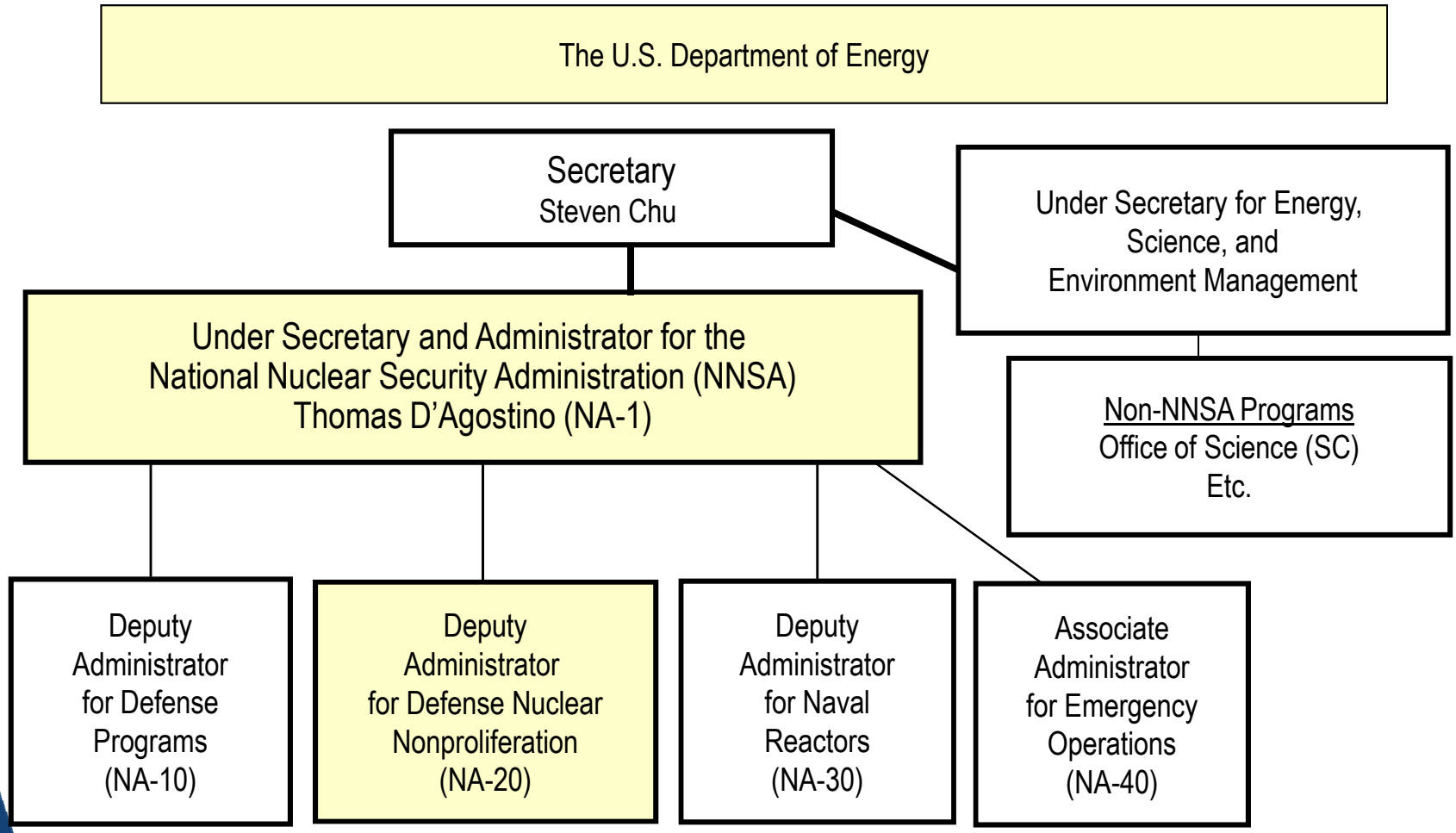
U.S. Department of Energy



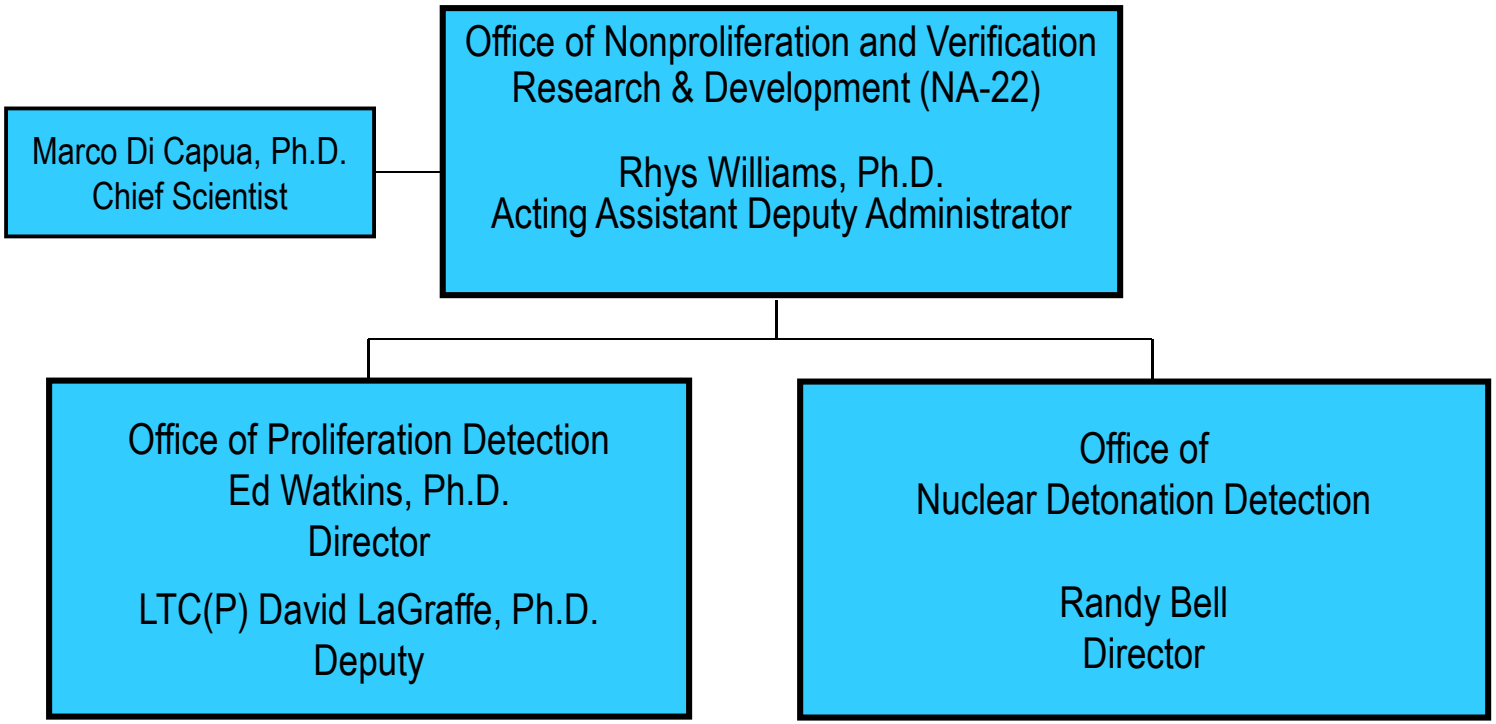
Defense Nuclear Nonproliferation

Office of Defense Nuclear Nonproliferation
NA-20

Anne Harrington (Nominated)

Global Threat Reduction (NA- 21) Andrew Bieniawski	Nonproliferation and Verification R&D (NA-22) Rhys Williams, Ph.D. (acting)	Nuclear Risk Reduction (NA-23) Trisha Dedik
Nonproliferation and International Security (NA-24) Adam Scheinman	International Material Protection and Cooperation (NA-25) David Huizenga	Fissile Materials Disposition (NA-26) Ken Bromberg

Nonproliferation R&D



Mission and Objectives

Mission:

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

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

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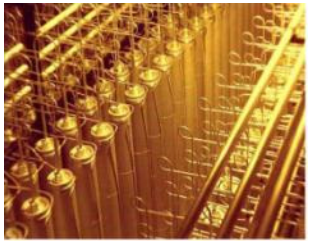
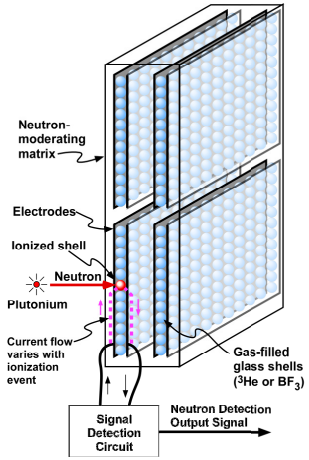
Proliferation Detection

Proliferation Detection

Nonproliferation Mission Areas

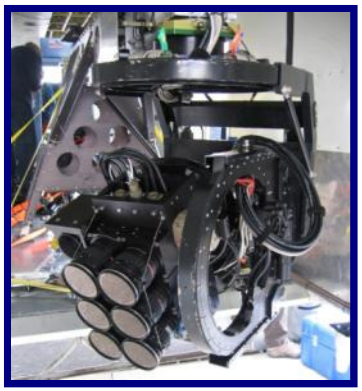
- U-235 Production Detection
- Pu Production Detection
- SNM Movement Detection/Radiation Sensing
- Detection of Nuclear Weapons Production and Testing
- Safeguards R&D and Rad Source Replacement





Nonproliferation Enabling Technologies

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



Signatures &Observables

- Identify & characterize relevant nuclear proliferation signatures and observables

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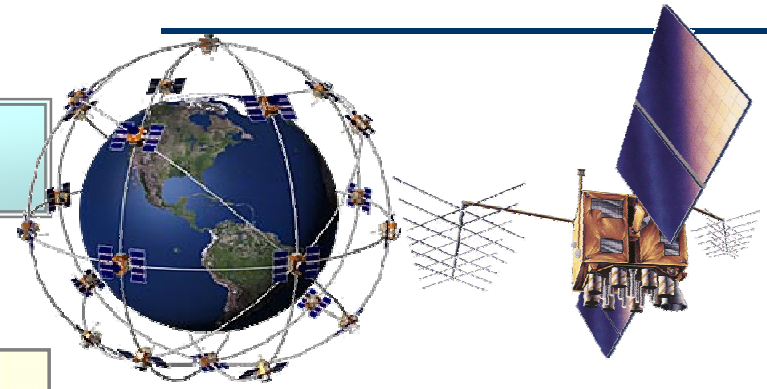
Nuclear Detonation Detection

Nuclear Detonation Detection (NDD)

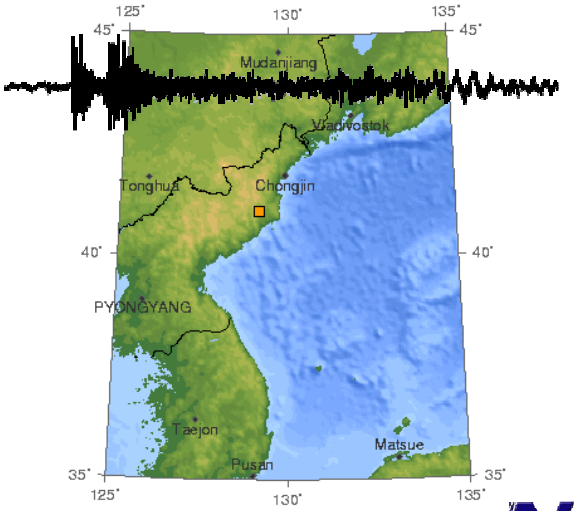


Space-Based Systems

- Surface & Atmospheric Burst Detection
- High Altitude & Space Burst Detection

Ground-Based Systems

- Seismic Detection Methods
- Radionuclide Detection Methods



Detonation Forensics

- Prompt Signatures
- Radionuclide Debris Sampling

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Integrated University Program

- $450M over 10 years
- 3 coordinated sources
  - NRC – focus on trades, industry needs
  - DOE/NE – focus on basic research and education
  - NNSA/NA-22 – focus on applied research and security
- $15M each per year
  - $10M for mission related research
  - $5M for Nuclear Science and Engineering Grant Program

"To be the effective source of innovation and highly trained engineers and scientists that the Nation needs, our nuclear engineering programs must have sustained support for multiyear research projects with modern curricula."

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IUP-NRC

Close Date	Opportunity Title	Funding Number
8/27/2010	U.S. Nuclear Regulatory Commission Funding Opportunity Announcement, Trade School and Community College Scholarship Grant, Fiscal Year 2011	HR-FN-0610-NED03
8/27/2010	U.S. Nuclear Regulatory Commission Funding Opportunity Announcement, Faculty Development Grant, Fiscal Year 2011	HR-FN-0610-NED02
8/27/2010	U.S. Nuclear Regulatory Commission Funding Opportunity Announcement, Scholarship and Fellowship Education Grant, Fiscal Year 2011	HR-FN-0610-NED01
10/1/2010	U.S. Nuclear Regulatory Commission Funding Opportunity Accouncement, Nuclear Education Curricula Development Grant, Fiscal Year 2011	HR-FN-0610-EDU5

See: www.grants.gov

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IUP-NE

- Attracting the brightest students to the nuclear profession and supporting the nation's intellectual capital in nuclear engineering and relevant nuclear science, such as health physics, radiochemistry and applied nuclear physics.
- Integrating research and development (R&D) at universities, national laboratories and industry to revitalize nuclear education.
- Improving university and college infrastructures for conducting R&D and educating students.
- Facilitating the transfer of knowledge from the aging nuclear workforce to the next generation of workers.

See: www.ne-up.org

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IUP-NNSA

- Mission-related research support
  - $10M issued in FY 10
  - Planned $10M in FY 11
- Nuclear Science and Security Consortium

Mission Research Topics

- 2010
  - Radiation Sensing and Advanced Materials
  - Remote Sensing
  - Radiological Replacement Sources
  - Global Safeguards
  - Simulation, Algorithms, and Modeling
- 2011
  - Radiation Sensors and Advanced Materials
  - *Nuclear Forensics*
  - Remote Sensing
  - Radiological Replacement Sources
  - Global Safeguards - *Safeguards measurement and sensor technology*
  - Simulation, Algorithms and Modeling

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NNSA 2010 Awards and Application Titles

Application Title	2010 Award	Grant value	Lead Performing Org
Critical Analysis for Model Selection for Nuclear Proliferation Predictions	298600	898600	North Carolina State University
Solids Identification Using Hyperspectral Imagery: Extracting Reliable Signatures from a Sea of Variability	800000	800000	Brigham Young University
Compact, Highly Sensitive and Selective, Mid-InfraRed (MIR) Chemical Sensors	273500	820000	Clemson University
Ultrafast Large Area ZnO Thermal Neutron Scintillators for a Near Term Replacement of 3He	850000	850000	Georgia Institute of Technology
Global Atmospheric Profiling Techniques for the Improvement and Increased Utility of Atmospheric Compensation Methods	780000	780000	Hampton University
Purification and Growth InI and InIXTl1-X Crystals for Nuclear Detection Applications	300000	900000	Illinois Institute of Technology
Production of Gamma-Ray Spectral Libraries for Nuclear Threat Cargo Monitoring	298600	899446	North Carolina State University
Compressive Sensing and Super-Resolution of Passive Millimeter Wave Images	273500	820000	Northwestern University
Perceptual Data Analysis and Semantic Information Extraction for Geospatial Intelligence	300000	900000	Northwestern University
Super-Resolution in Remote Sensing by Quantum Phase Amplification	260000	780000	Purdue University
Modeling of SNM Fission Signatures and Cosmic-ray Induced Neutron Backgrounds	233500	700000	Purdue University

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NNSA 2010 Awards and Application Titles

Application Title	2010 Award	Grant value	Lead Performing Org
High-Sensitivity Laser-Ablation Inductively-Coupled-Plasma Time-of-Flight Mass-Spectrometry (LA-ICP-TOF-MS) for Nuclear Material Detection	572099	572099	Purdue University
Smart Data Embedding and Inverse Solution Algorithms, Modeling and Simulation for Nonproliferation	900000	900000	Purdue University
Modeling and Radiation Transport for Simulating Input to Remote Sensing Algorithms	162000	618011	University of California, Davis
Digital 3-Dimensional Position-Sensitive Semiconductor Radiation Detectors	900000	900000	University of Michigan
Enhanced Radiometric Scene Simulation Through Incorporation of Process Models	901835	901835	Rochester Institute of Technology
A Particle Accelerator on a Chip for Radionuclide Replacement in Industrial Applications	280000	550388	University of California, Los Angeles
Single-Pixel Testing of Magnetic Microcalorimeters for Gamma-Ray Spectroscopy	250000	750000	University of New Mexico
Development of a Thin-film Boron Phosphide Solid State Neutron Detector	250000	750000	University of Tennessee
Enhancing Energy Migration and Proportionality in Scintillation Materials	250000	750000	University of Tennessee
Multi-Element Polarimetric Millimeter Wave Radiometer Utilizing Optical Up-Conversion	273500	820000	University of Delaware
Strengthening Materials Accountability in Reprocessing Plants: Rapid, In-Line Monitoring of Actinide Isotopes and Species During Reprocessing	592866	592866	Washington State University
Total	**10000000**	**17253245**	

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Nuclear Science and Security Consortium

- Support multiyear research projects which are of a basic or fundamental nature that do not necessarily align with programmatic missions of DOE/NNSA but are critical to maintaining the discipline of nuclear science and security.
- Achieve the congressional goals of the IUP of supporting the continued development of the nuclear engineering and science discipline.
- Enable collaborative research relationships between universities, the National laboratories, and other government agencies.
- Transition technology from universities to National Laboratories.
- Motivate talented researchers toward careers in nuclear security applications.

NA-22 Research and Development Efforts

SAFEGUARDS

Safeguards R&D Mission and Objectives

Mission:

Investigate and develop new and novel safeguards technologies for arms control and safeguards to reduce the threat to global security posed by nuclear weapons

Goals and Objectives:

- Develop, demonstrate, and deliver innovative and transformational technologies for safeguards and arms control
- Provide innovative technologies and support research to strengthen safeguards and arms control systems globally
- Lead an integrated U.S. approach to safeguards R&D
- Facilitate the transition of technology and exchange of information
- Revitalize the safeguards and arms control capability base

Improved Pu Assay Using A Novel Monochromatic Wavelength Dispersive X-ray Fluorescence

- Goals
  - Implement new X-ray optic technology for sensitive detection of Pu for safeguard applications
  - Attain a sensitivity of at least 10 ppm for Pu detection
  - Develop new sampling methodology to reduce sample size, improve safety and accuracy of Pu measurements
- Objective
  - Use novel X-ray optic technology to provide monochromatic excitation of the specimen
  - Use another optic to selectively collect the emitted x-rays of the target elements and direct them to the detector

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Nuclear Resonance Fluorescence Methods for Nuclear Safeguards

- Goals
  - Evaluate feasibility and limitations of NRF-based methods for isotopic assaying in nuclear safeguards.
  - Provide the nuclear data, modeling tools, and concepts needed for the development of NRF-based methods for specific safeguards applications.
- Objectives
  - Model NRF-based methods to study quantitative capabilities.
  - Participate in construction of NRF measurement station at UCB.
  - Experimentally validate modeling tools & results.
  - Measure NRF spectra and cross sections for isotopes of interest.
  - Experimentally test NRF assaying method.

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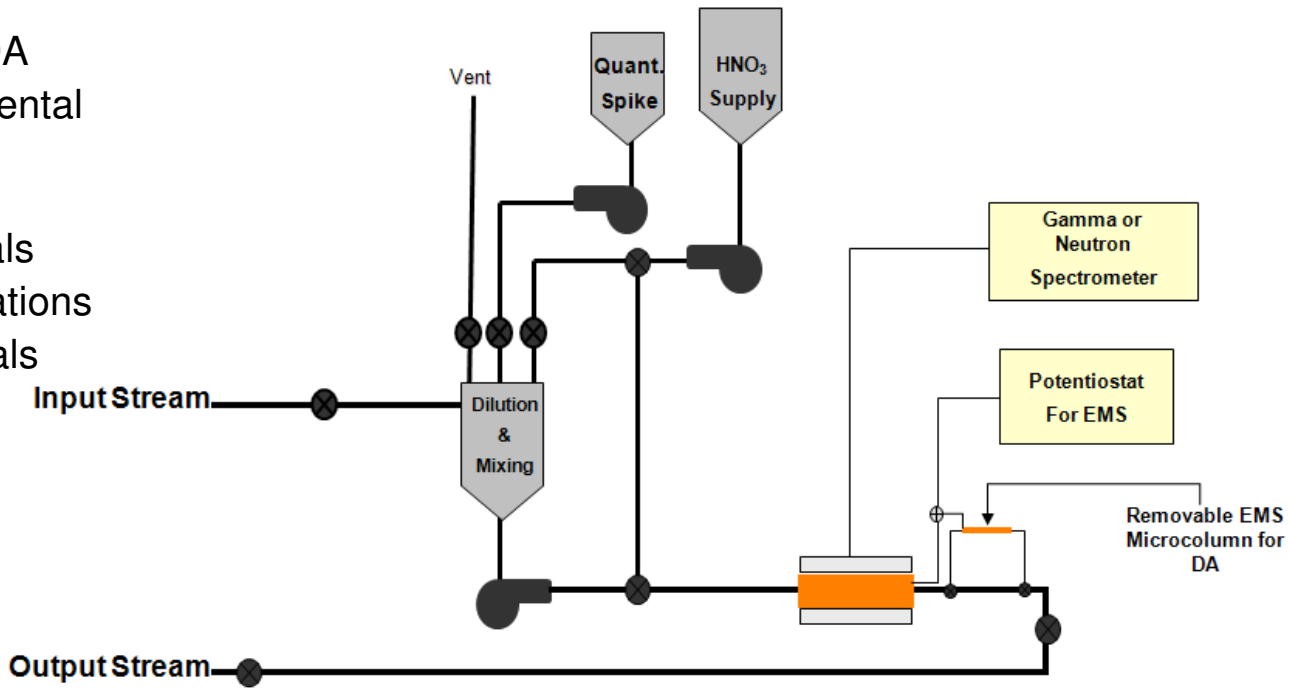
Electrochemically-Modulated Separations for Material Accountability Measurements

Goal

- Development of novel separation and analysis techniques for plutonium measurements during fuel reprocessing

- Simplifies DA
- Near real time NDA
- Isotopic and elemental concentration
- No grab sampling
- No redox chemicals
- No column separations
- Re-usable materials
- High throughput
- Reduced cost

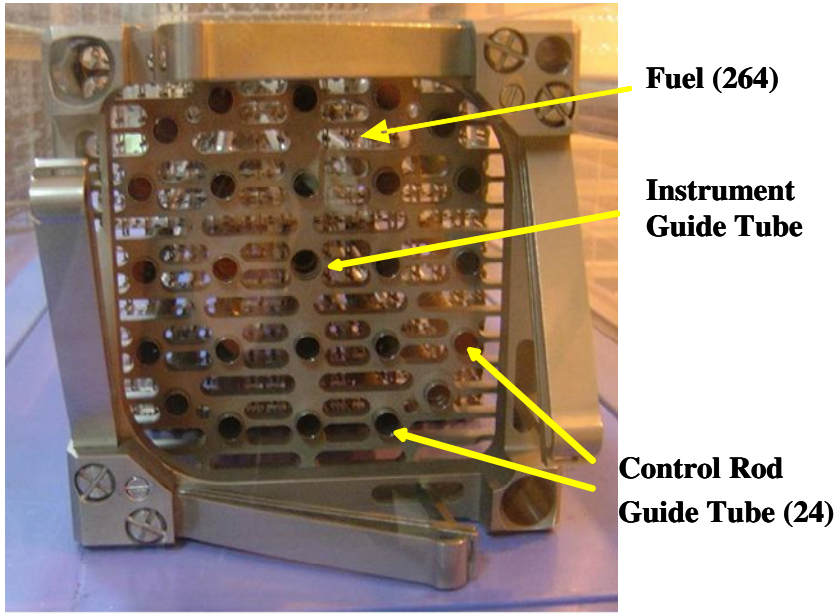


Development of a Safeguards Verification Method and Instrument to Detect Pin Diversion from Pressurized Water Reactor Spent Fuel Assemblies

Goal

➢Develop, build and demonstrate a novel safeguards verification method and instrument that detect pin diversion from PWR spent fuel assemblies

- **Measure neutron and gamma flux profiles inside the PWR spent fuel assembly at multiple locations simultaneously.**
- **In the presence of missing/replaced pins, data profiles would be distinctly different from the profiles obtained without missing pins.**



17 x 17 PWR Westinghouse Type

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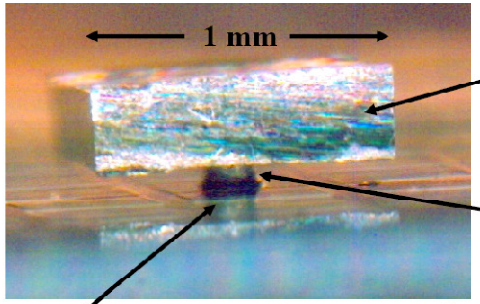
Micro-Calorimetric Radiation Detectors

Develop ultra-high resolution detector arrays based on calorimetric measurement of heat deposited by absorbed radiation.

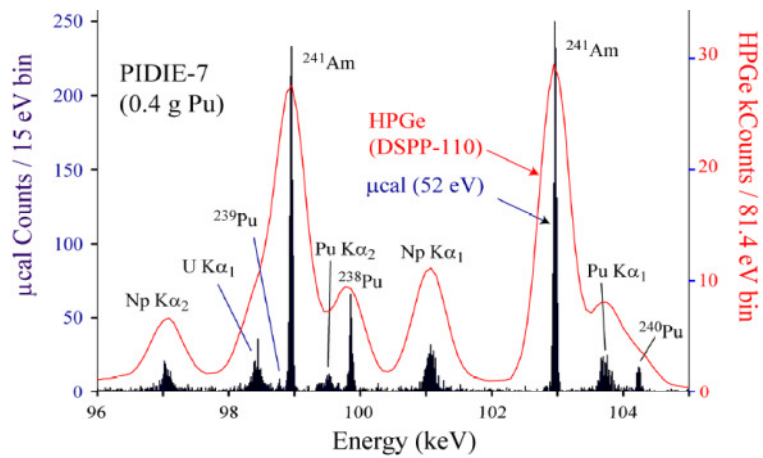
Research Interests

- Demonstrate world record energy resolution, ~25eV @ 100keV
- Improve laboratory spectroscopy
- Enable new analytical techniques



Energy Resolution (FWHM)

52 eV	Pu	94 – 106	keV
25 eV	^{153}Gd	97, 103	keV
46 eV	^{57}Co	122	keV



Technical Challenges

- Fabrication for absorber arrays
- Multiplexed readout of large arrays
- Expanding to alpha and neutron spectroscopy

Questions?