



# Advances in Homeland Security Instrumentation Detection of Special Nuclear Material

John Smalling

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# The Nuclear Threat is Real

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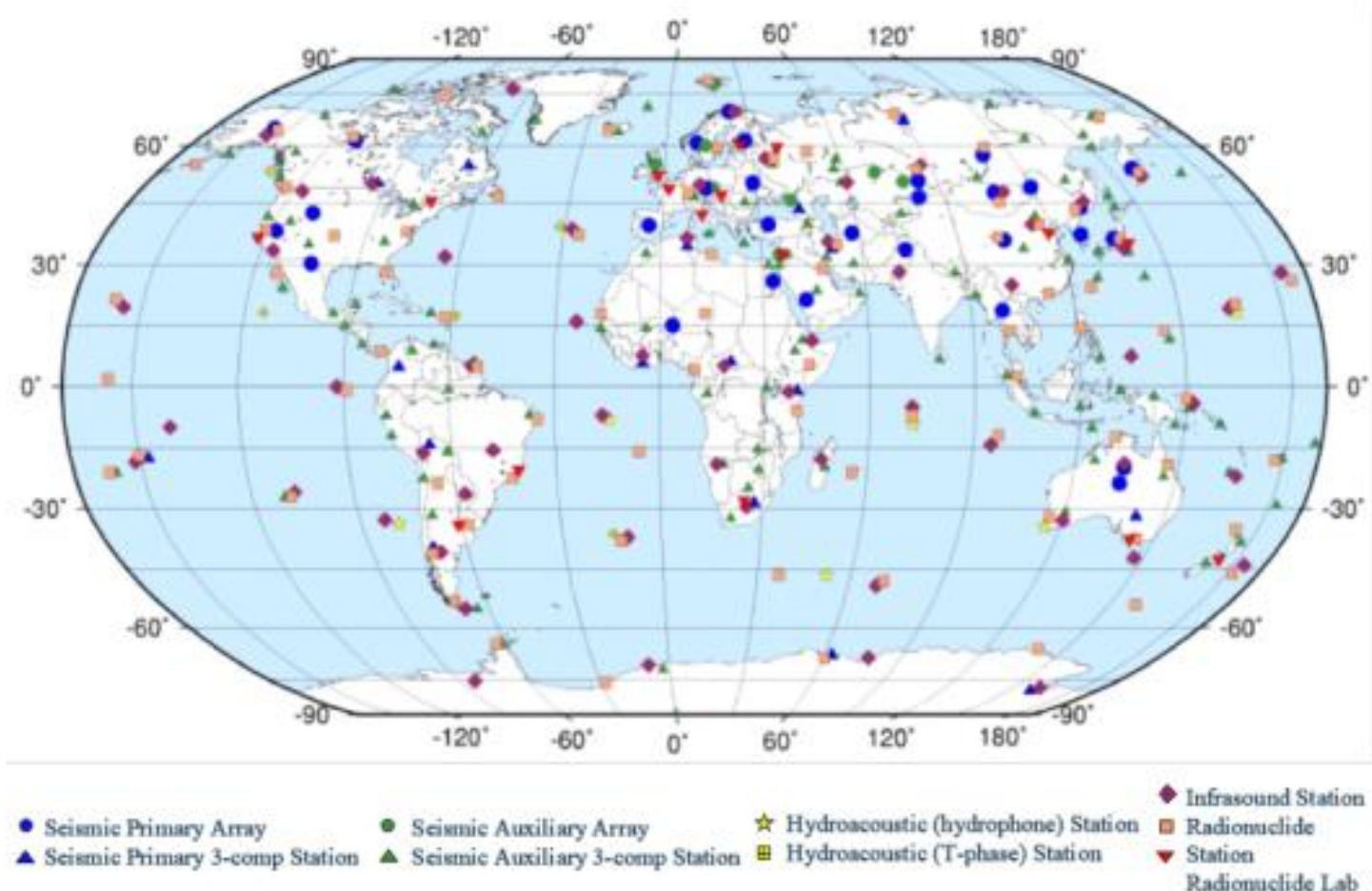
- ▀ N. Korea has conducted six underground nuclear tests since 2007 ranging from about 1 kt to about ~ 100kt.
- ▀ Radical terrorists only need enough SNM to create an asymmetric nuclear threat

# Nuclear Weapon Signatures

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- Weapons Grade Plutonium (WGPu)
  - 94%  $^{239}\text{Pu} \rightarrow 414 \text{ keV gamma ray}$
  - 6%  $^{240}\text{Pu} \rightarrow \text{spontaneous fission neutrons}$
  - $^{241}\text{Am} \rightarrow 60 \text{ keV gamma rays}$ 
    - Grows in as  $^{241}\text{Pu}$  decays with 14.4 yr half life
  - IAEA “significant quantity” = 8 kg
- Highly Enriched Uranium (HEU)
  - 93%  $^{235}\text{U} \rightarrow 186 \text{ keV gamma ray}$
  - 7%  $^{238}\text{U} \rightarrow 1001 \text{ keV gamma ray from } ^{234\text{m}}\text{Pa}$
  - IAEA “significant quantity” = 25 kg
- Density of material – X-ray or transmission image
  - U 18.95 gm/cc                      Pu 19.84 gm/cc
  - Pb 11.35 gm/cc                      W 19.3 gm/cc
  - Cargo 0.4 gm/cc                      Fe 7.87 gm/cc
  - Sand 1.6 gm/cc
  - Metallic – Metal detection

# CTBTO International Monitoring Stations



International Monitoring System: 337 Facilities – 90%+ complete. Source: CTBTO.

# The Nuclear Threat - What has changed?

## Potential Points of Entry

- Traditional Threats –The Nuclear Triad
  - *Sea-Based Missiles*
  - *Land-Based Missiles (ICBM's)*
  - *Bombers*
- Defense Systems in place to counter traditional threats
- Very few defense systems in place to counter asymmetric terrorist nuclear threats
- Non-Traditional Asymmetric Nuclear Threats (points of entry)
  - *Sea Cargo*
  - *Air Cargo*
  - *Package shippers (FedEx, UPS, USPS)*
  - *Border Crossings into US*
    - Private Auto
    - Trucks
    - Rail
  - *Passengers & Luggage*
    - Commercial Aviation
    - General Aviation
    - Cruise Ships
  - *Other*
    - Fishing Boats
    - Private Yachts

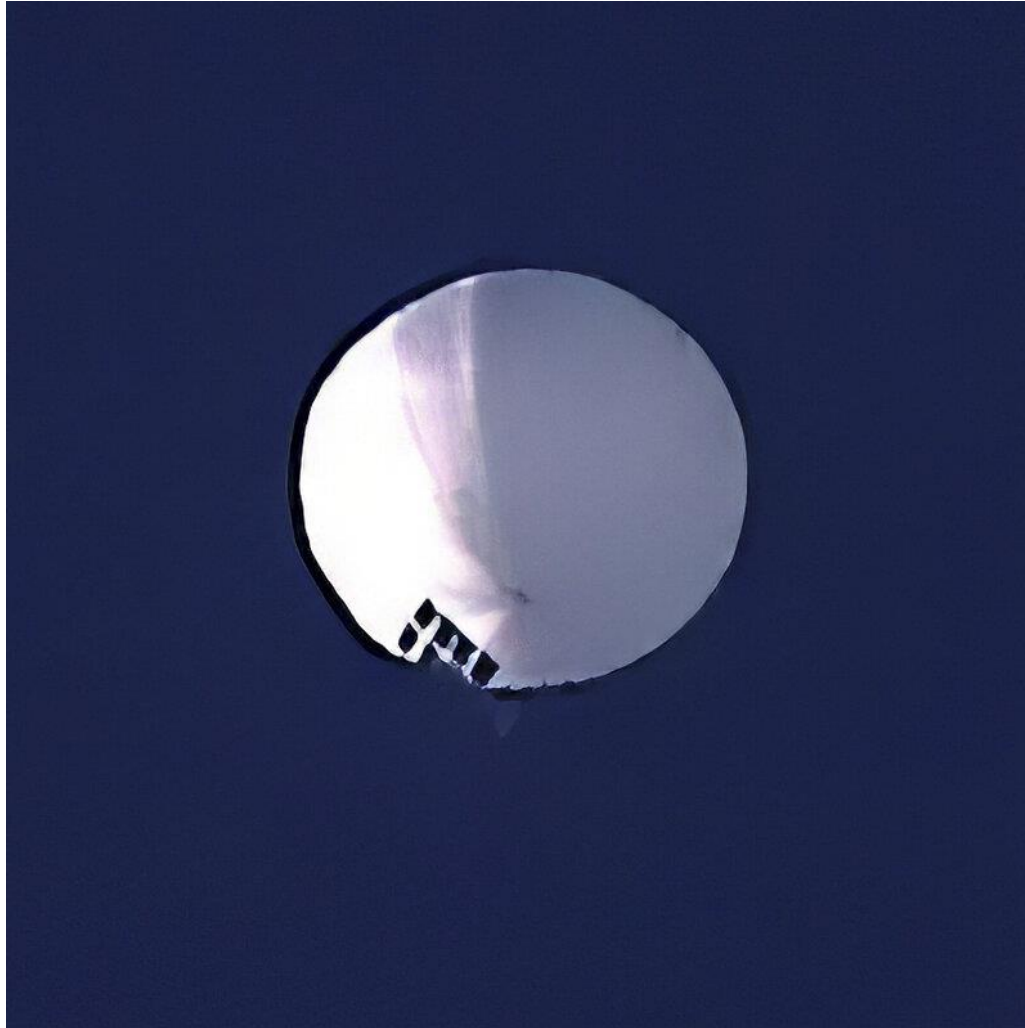


# Potential Points of Entry



# Potential New Way to Deploy??

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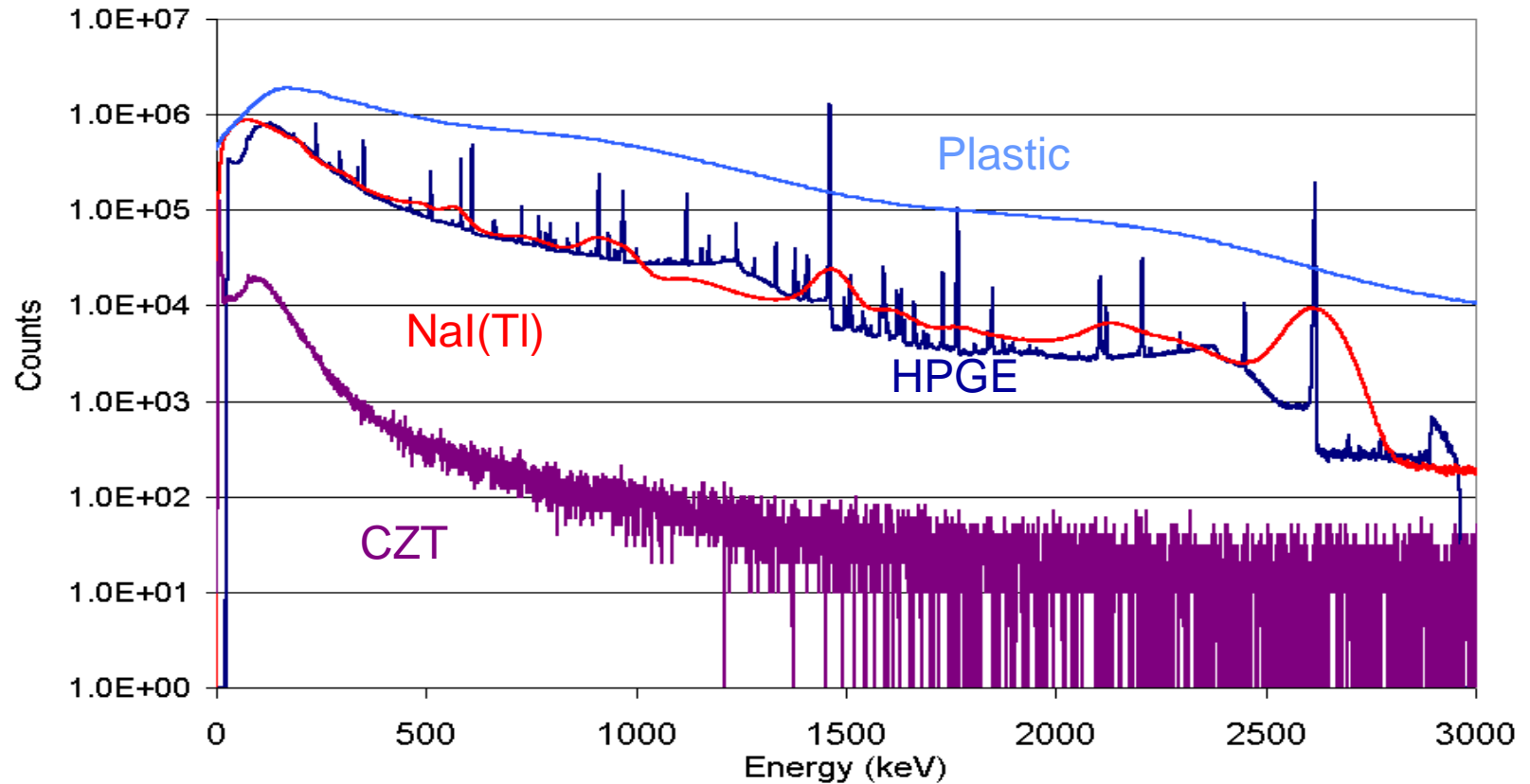
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# Types of Detectors used in Homeland Security



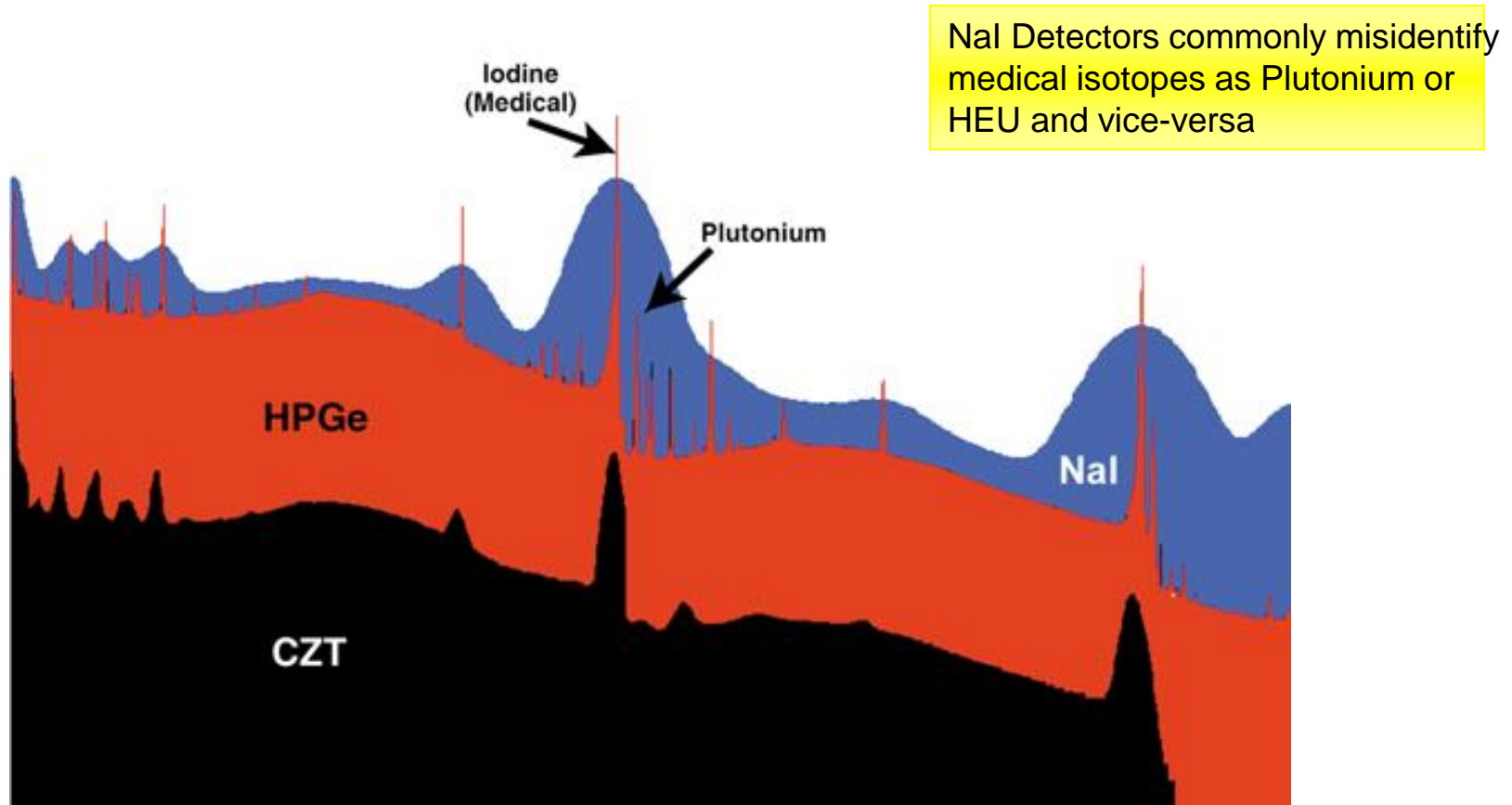
# Different Types of Radiation Detectors

Gamma-Ray Spectra of Natural Background

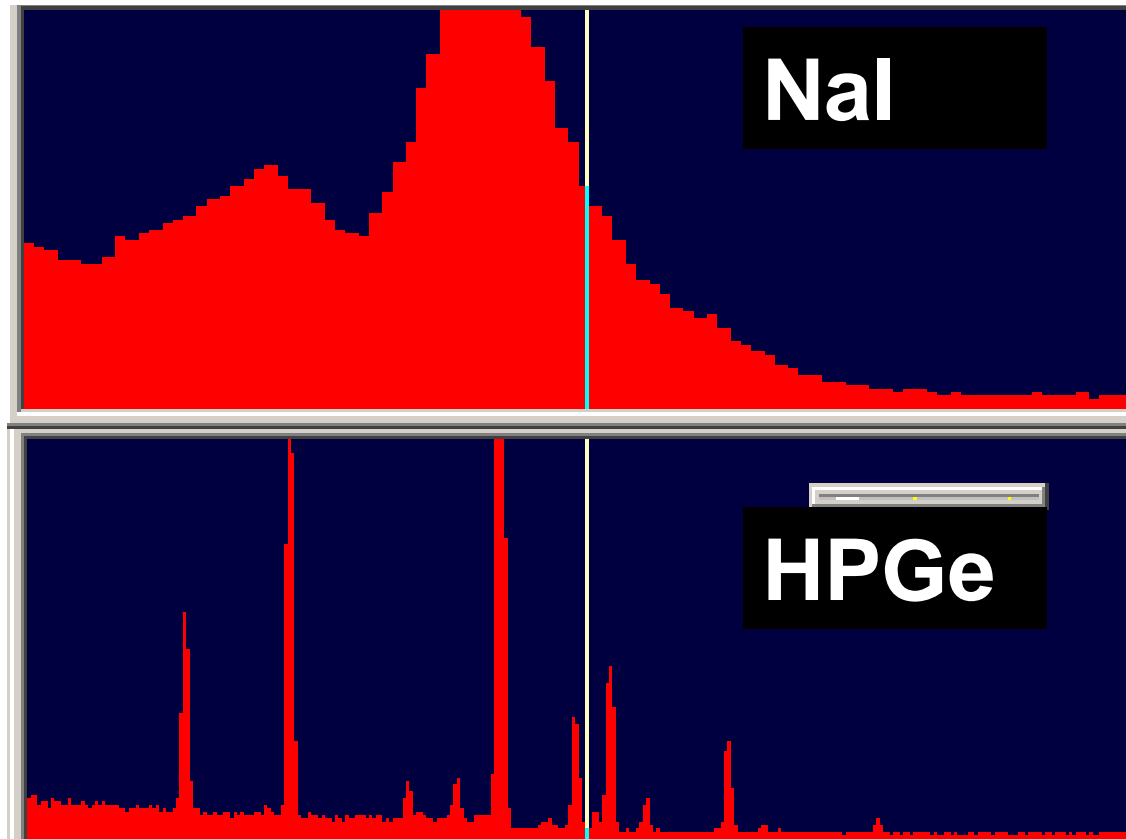


# Comparison of Germanium vs Other Radiation Detectors

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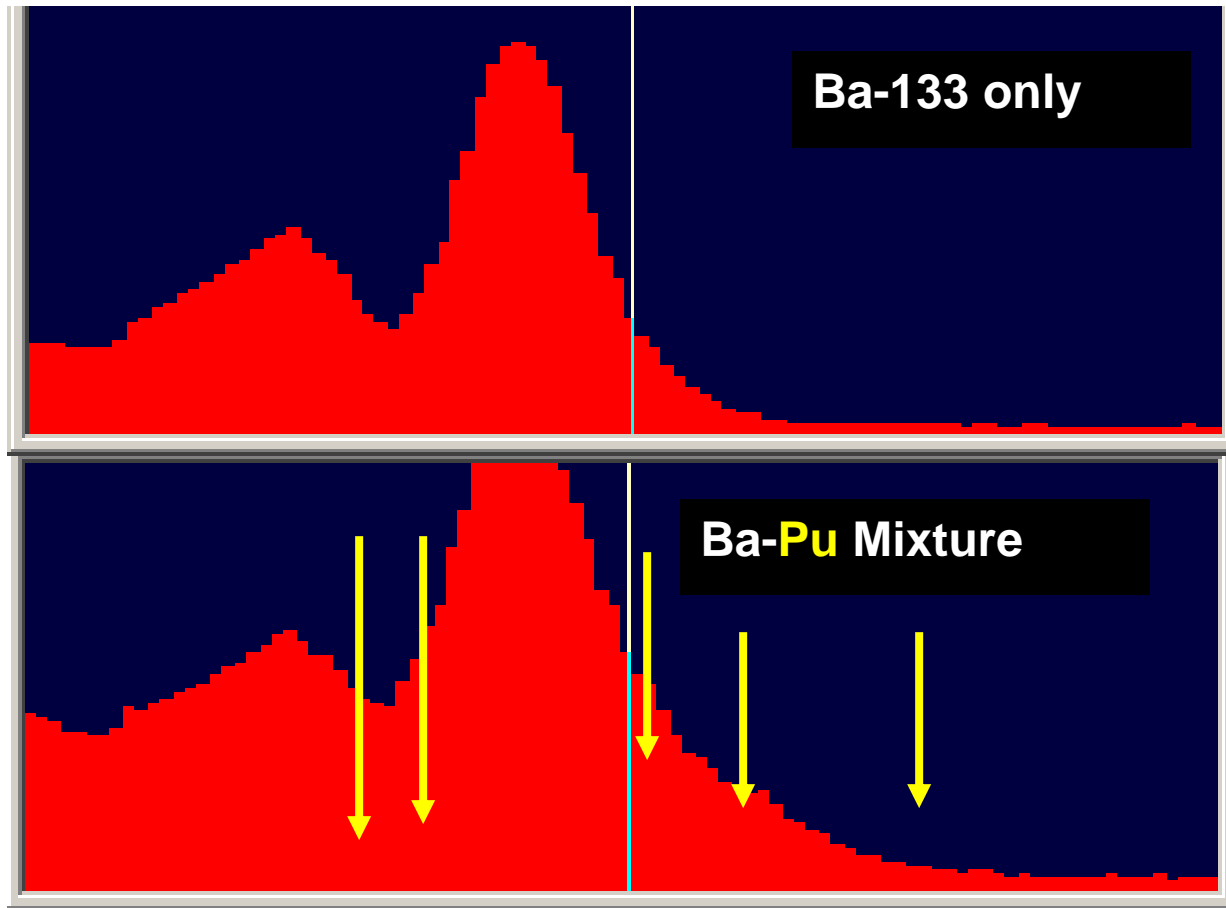


# Weapons Grade Pu and Ba133 mixture



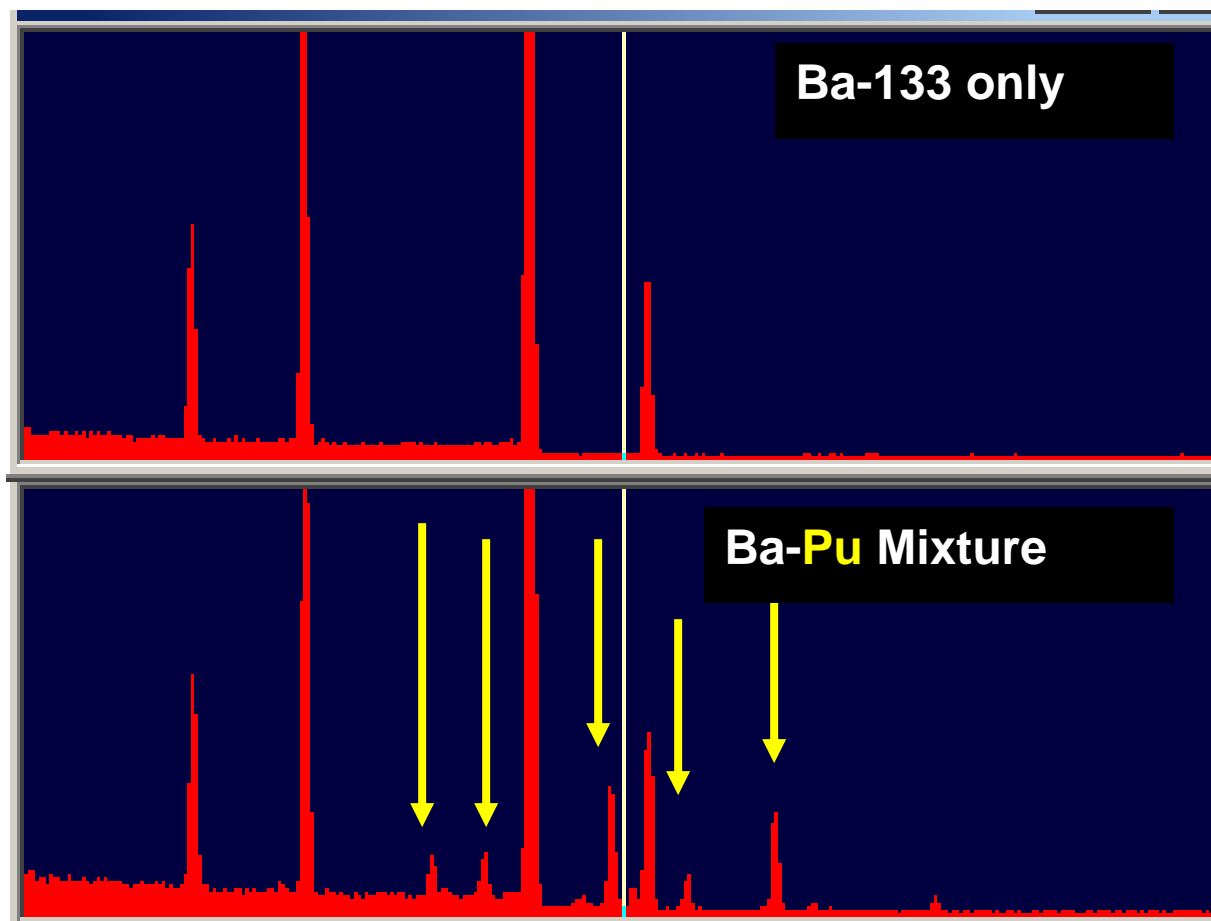
Energy range Approx 220-480KeV

# Nal Detector (arrows indicate Pu peaks)



Energy range Approx 220-480KeV

# DETECTIVE HPGe Detector



Energy range Approx 220-480KeV



# Alexander Litvinenko & Po-210

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Alexander Litvinenko (former KGB agent)  
was Poisoned with Po-210

# Alexander Litvinenko & Po-210

- Polonium 210 was used to kill former KGB officer and Russian dissident, Alexander Valterovich Litvinenko
- Believed to have been poisoned on 1 November after meeting with two fellow former KGB agents and later that afternoon with an Italian acquaintance.
- After suddenly falling ill, Litvinenko, a critic of the Putin Administration, claimed he was poisoned by the Russian security service (FSB) before he died on 23 November



2002

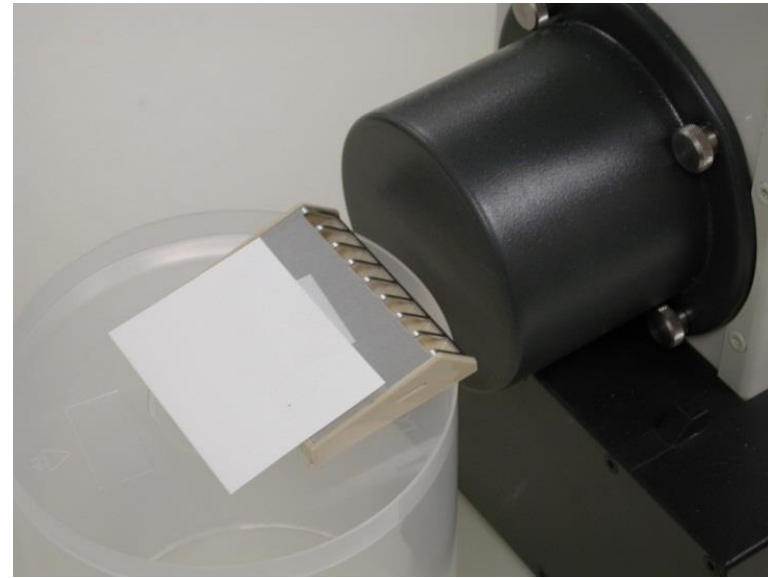


November 2006

# ORTEC Tests for Po-210 using Detective-EX

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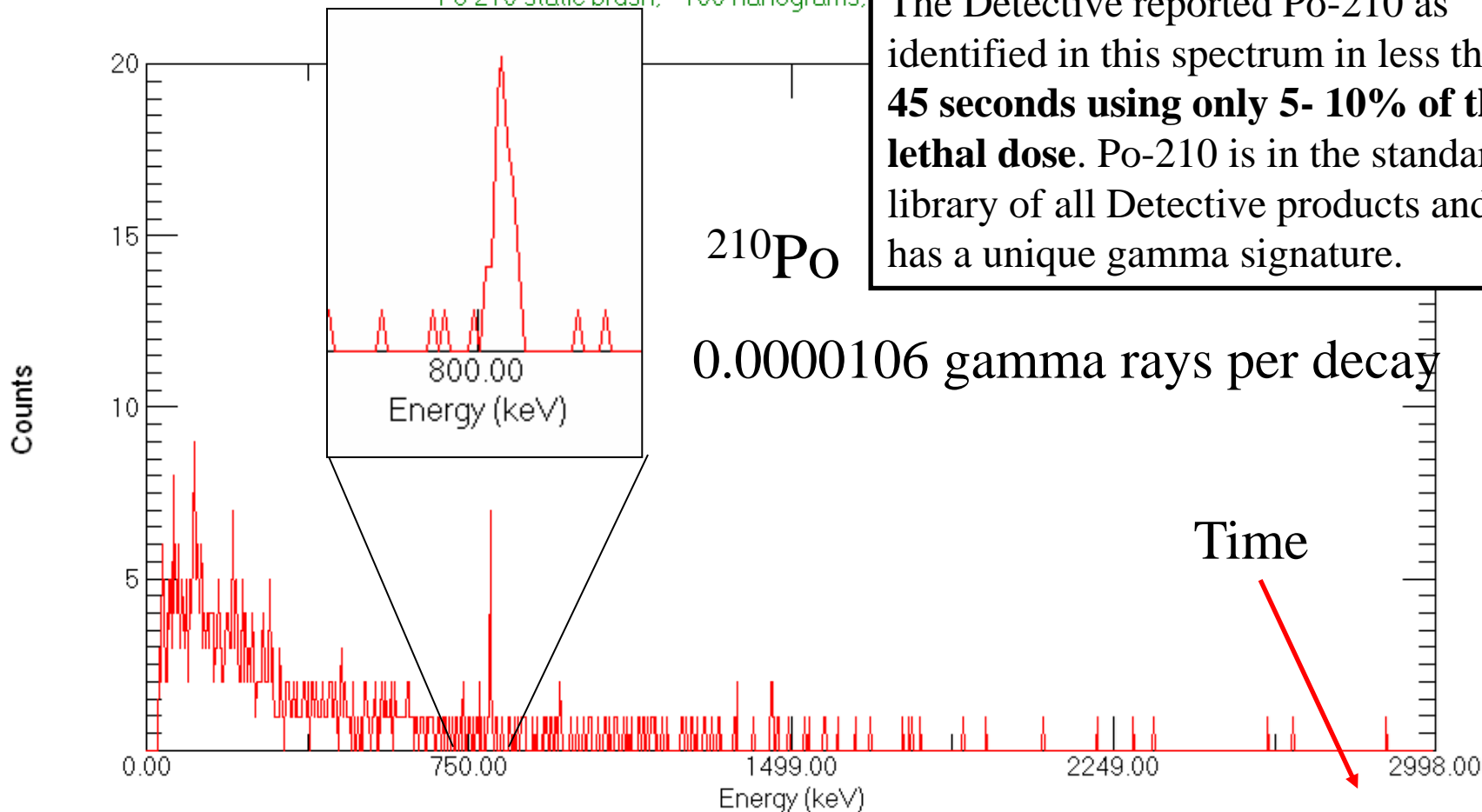
- “Static Master Brush” sample
  - *~100 nanograms of  $^{210}\text{Po}$*
  - *Electroplated on metal*
- Testing was done without special shielding
- Results show easy identification in less than 45 seconds



# **$^{210}\text{Po}$ Gamma Spectrum Identified 803 keV Peak**

2006\_12\_07\_13\_29\_300

Po 210 static brush, ~100 nanograms.



Acquired: 07-Dec-06 1:28:47 PM

File: C:\user\Detective\Po210 spectra\2006\_12\_07\_13\_29\_300.spc

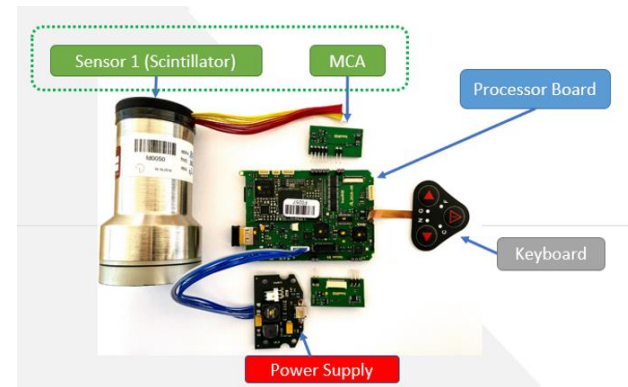
Detector: #1 DETECTIVE-EX

Real Time: 43.64 s. Live Time: 43.52 s.

Channels: 8192

# ORTEC's RadEAGLET-R Summary

- **Proven and Tested Algorithm** - Thoroughly tested by independent test labs and government test organizations. Fewer false positives and false negatives
- **Most Rugged instrument on the market**
- **Modular Design** – Allows electronics technicians to repair and support the product internally (don't have to send the instrument back to the vendor)
- **State-of-the-art connection capabilities** Wi-Fi Dongle, Bluetooth Dongle, USB to Ethernet Adapter, USB Flash Drive, USB-RNDIS\* connection to Web-Interface, Android and Apple App available for remote connection
- **Better Cyber Security (both hardware and software disabled)**
- **Better, higher resolution display**
- **New battery-pack philosophy** (available options include Li-Ion, NMH and AA). Li-Ion Battery lasts 15 hours.
- **Hot swappable battery capability** (internal battery provides power for 30 minutes)
- **Ergonomic rubberized handle** with larger diameter
- **Easier access to USB and SD-Card**
- **Ultra reliable and proven He-3 neutron detection technology** (alternative Li6/ZnS polymer available)





# ANSI N42.34 Testing for SNM Isotopes at PNNL

PNNL-ACT-10

Table 5: Results from ANSI N42.34 section 6.9 evaluation

	Complete and correct identifications per total trials						
	<sup>137</sup> Cs + DU	<sup>67</sup> Ga + HEU	<sup>99m</sup> Tc + HEU	<sup>201</sup> Tl + HEU	<sup>131</sup> I + WGPu	NORM + HEU	NORM + WGPu
RadEAGLE 17127	10/10	10/10	10/10	10/10	10/10	10/10	10/10
RadEAGLE 15021	10/10	10/10	10/10	10/10	9/10	10/10	10/10
RadEAGLET-R 18321	10/10	10/10	9/10	10/10	9/10	10/10	10/10
RadEAGLET-R 18319	10/10	10/10	9/10	10/10	10/10	10/10	10/10

## Abstract

In February of 2021, two ORTEC RadEAGLE and two RadEAGLET-R units were evaluated at Pacific Northwest National Laboratory (PNNL) per the test methods laid out in ANSI N42.34. Only the requirements involving special nuclear material (SNM) in Sections 6.8 and 6.9 were evaluated. Section 6.8 assessed identification against only SNM, while Section 6.9 assessed combinations of SNM and medical isotopes or naturally occurring radioactive material (NORM). No discrepancies were observed between the ANSI N42.34 requirements and the performance of the RadEAGLE or RadEAGLET-R instruments. Table 1 provides the summary of identification performance from the units that were evaluated.

Table 1: Summary of identification results among all ANSI N42.34 Section 6.8 and 6.9 tests.

Radioisotope(s)	Complete and correct results per total number of trials			
	RadEAGLE 17127	RadEAGLE 15021	RadEAGLET-R 18321	RadEAGLET-R 18319
HEU	10/10	10/10	10/10	10/10
WGPu	10/10	10/10	10/10	10/10
DU	10/10	10/10	10/10	10/10
<sup>137</sup> Cs + DU	10/10	10/10	10/10	10/10
<sup>67</sup> Ga + HEU	10/10	10/10	10/10	10/10
<sup>99m</sup> Tc + HEU	10/10	10/10	9/10	9/10
<sup>201</sup> Tl + HEU	10/10	10/10	10/10	10/10
<sup>131</sup> I + WGPu	10/10	9/10	9/10	10/10
NORM + HEU	10/10	10/10	10/10	10/10
NORM + WGPu	10/10	10/10	10/10	10/10



# RadEAGLET-R Testing

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## IAEA Testing of RadEAGLE/RadEAGLET Algorithm

- IAEA Laboratory, Vienna & at Hans Blix Complex
- Basic nuclides including:  $^{60}\text{Co}$ ,  $^{137}\text{Cs}$ ,  $^{133}\text{Ba}$ ,  $^{241}\text{Am}$ ,  $^{137}\text{Cs}$ ,  $^{232}\text{Th}$ ,  $^{235}\text{U}$ ,  $^{226}\text{Ra}$ ,  $^{152}\text{Eu}$
- SNM nuclides including: WGPu93, RGPu61, DU0031, U071, U2000, U0294, RGPu70, WGPu84
- Excellent ID speed and accuracy, even with mixed sources and weapons grade nuclides

## RASE Testing at ORNL TTAC and INL ZPPR (RadEAGLE and RadEAGLET)

## Independent 3<sup>rd</sup> Party Testing of ANSI N42.34 criteria at IB3 Global Solutions (Oak Ridge)\*

## US Dept. of Energy Pacific Northwest Nuclear Laboratory (PNNL) – Response to Special Nuclear Material per ANSI N32.34\*

\* - Copies of reports provided

ORTEC CONFIDENTIAL and PROPRIETARY INFORMATION

## Recent RadEAGLET-R Customers

- UK DSTL
- Danish Ministry of Defense
- UK London Metropolitan Police
- Lawrence Livermore National Labs
- UK AWE
- Atlanta Georgia Secure the Cities Program
- Italian Fire Brigades
- Boston Secure the Cities

20

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WGPu	10/10	10/10	10/10	10/10
DU	10/10	10/10	10/10	10/10
<sup>137</sup> Cs + DU	10/10	10/10	10/10	10/10
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NORM + HEU	10/10	10/10	10/10	10/10
NORM + WGPu	10/10	10/10	10/10	10/10



# Detective-X HPGe RIID

## The Gold Standard for Nuclear Interdiction



# ORTEC's Detective Family Deployments

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## ■ DoD Deployments

- *DTRA*
  - NTD
  - International Counterproliferation Program
  - Contingency Operations
- *20<sup>th</sup> CBRNE Command*
- *Nuclear Disablement Teams*
- *US SOCOM*
- *Defense Intelligence Agency*
- *National Guard WMD Civil Support Teams*
- *DIA*
- *Pentagon Force Protection Agency*
- *AFRAT*
- *DISA*

## ■ DOE Deployments

- *NSDD*
- *DOE RAP Teams*
- *National Labs (LLNL, LANL, SNL, INL, ORNL, SRNL, ANL, BNL, etc.)*

## ■ DHS/CWMD Deployments

- *CBP*
- *CWMD – HPRDS*

## ■ Misc. Other

- *FBI Field Offices*
- *FBI Stabilization Teams (Bomb Techs)*
- *Capitol Police Bomb Squad*
- *Swiss Army*
- *UK MoD*
- *Australia MoD*
- *Canada Dept. National Defense*



# What Makes ORTEC's New Detective X Better?

## ■ Detection and Identification Features

- *Larger HPGe crystal, 45-50% efficient compared to 13% Micro-Detective-HX.*
- *Improved Algorithm that increases detection probability.*
- *Comprehensive library of over 175 radionuclides including new radiopharmaceuticals.*
- *Better standoff detection and ID capability.*



# What Makes ORTEC's New Detective X Better?

## Operational Improvements

- *Rugged Instrument designed for harsh environments (IP65 compliant).*
- *Weight Significantly Reduced (about half of Detective-EX-100T).*
- *Battery life doubled and batteries are hot swappable.*
- *New Li6/ZnS Neutron Detector Module (NDM), no He-3 required.*
- *Bigger display screen, easily readable in sunlight.*



# ~2500 Detectives across over 60 Countries



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