VeriTainer Radiation Detector For Intermodal Shipping Containers

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Introduction

- There is a clear and pressing need to prevent clandestine importation of WMD via intermodal shipping containers
- Currently, 2% of the 6 million containers (per year) are monitored
- The goal is 100% monitoring
- How to achieve this without significantly impeding commerce?

House passes $7.4 billion port security bill, Jonathan Weisman, Washington Post, 5 May 06

GreenLane Maritime Cargo Security Act, sponsored by Senators Murray and Collins, Bill S.2008

VeriSpreader™ Concept

- Goal: Scan 100% of containers in the normal flow of commerce
  - No additional processing steps or time
  - Minimize false alarms from NORM

- Approach: Integrate neutron and spectroscopic gamma ray detectors into a container crane spreader bar
  - This is the piece of the container crane that directly engages an intermodal shipping container as it is moved onto and off of a container ship
  - Every container handled by the crane spends 30-60 seconds in close proximity to the spreader bar
  - Makes 100% screening feasible, since implemented during the existing handling interval

VERITAINER corp.
Trust But Verify

AMPTEK®

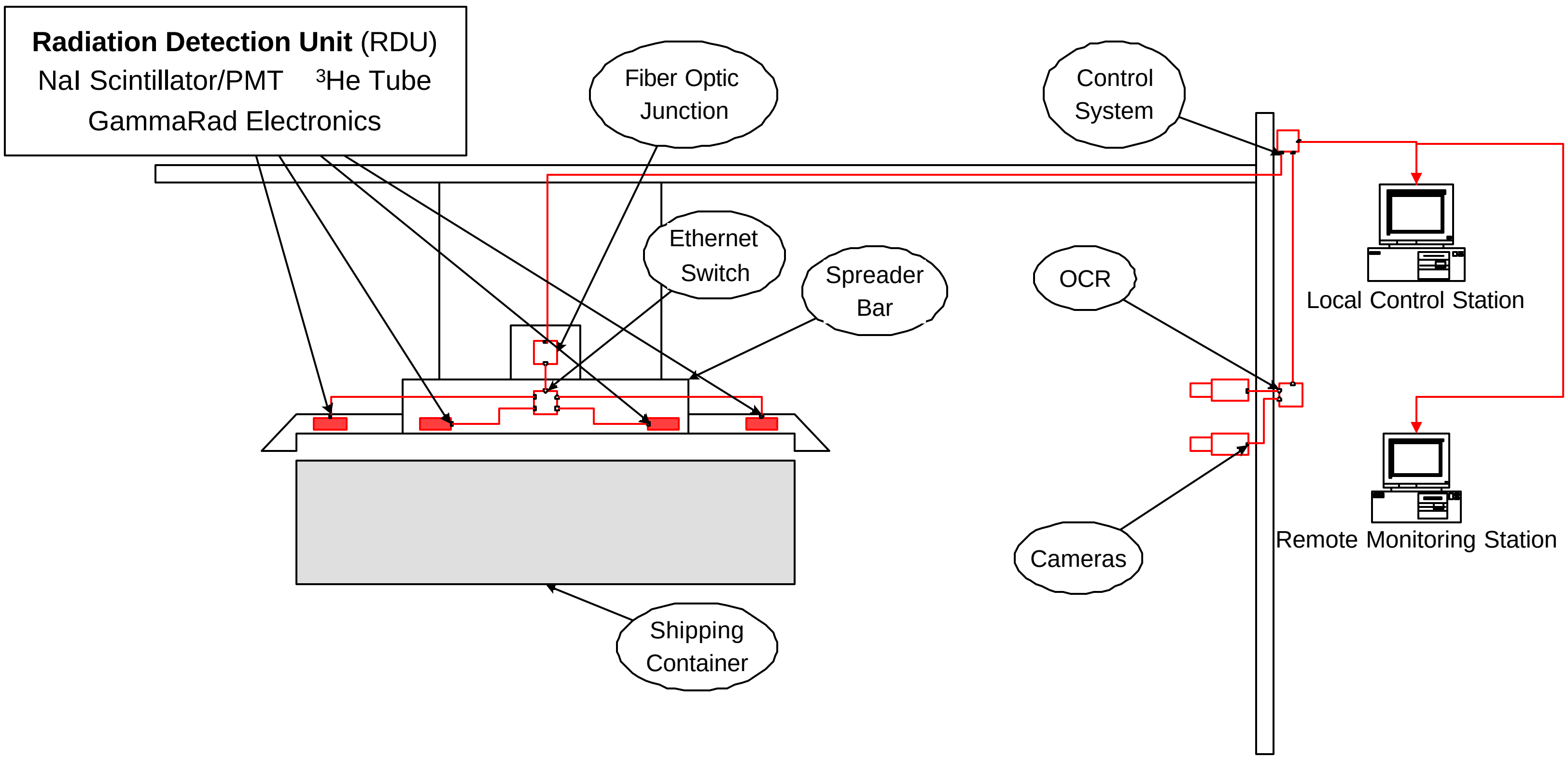
Typical crane at the
Port of Oakland, CA

Container spreader bar
VeriSpreader™

Challenges

- Includes all the challenges of other radiation detection systems
  - Detecting the radiation with adequate sensitivity & resolution
  - Analyzing data to determine threat level
- Additional challenges in packaging & system engineering
  - Mechanical shock when spreader twistlock engages
  - Vibration when spreader bar is moving
  - Thermal fluctuations at end of bar
  - Constant exposure to humid, salty air
  - Robust communications over long distances (hundreds of meters) in noisy environment

VeriSpreader™ Concept



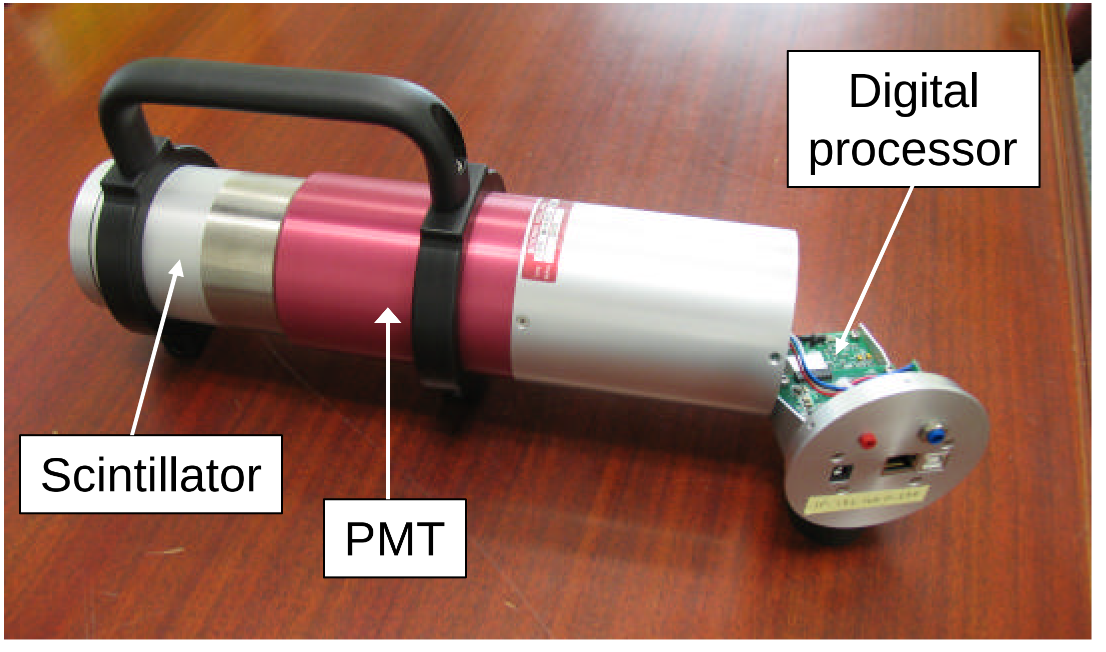
U.S. Patent 6,768,421

Key VeriSpreader™ Components

- Gamma-Rad Spectrometer
  - Ruggedized 76 x 152 mm NaI(Tl) with PMT
  - Digital processor with power supplies
  - Ethernet interface
- ^{3}He Neutron Counter
- Radiation Detector Unit packaging
  - Packaging addresses environmental issues
  - Eight RDUs per spreader
- Optical sensor
  - Identify container and twistlock status to control acquisition
- Communication System
  - Ethernet via fiber optic for robust, long distance communications
- Analysis Software

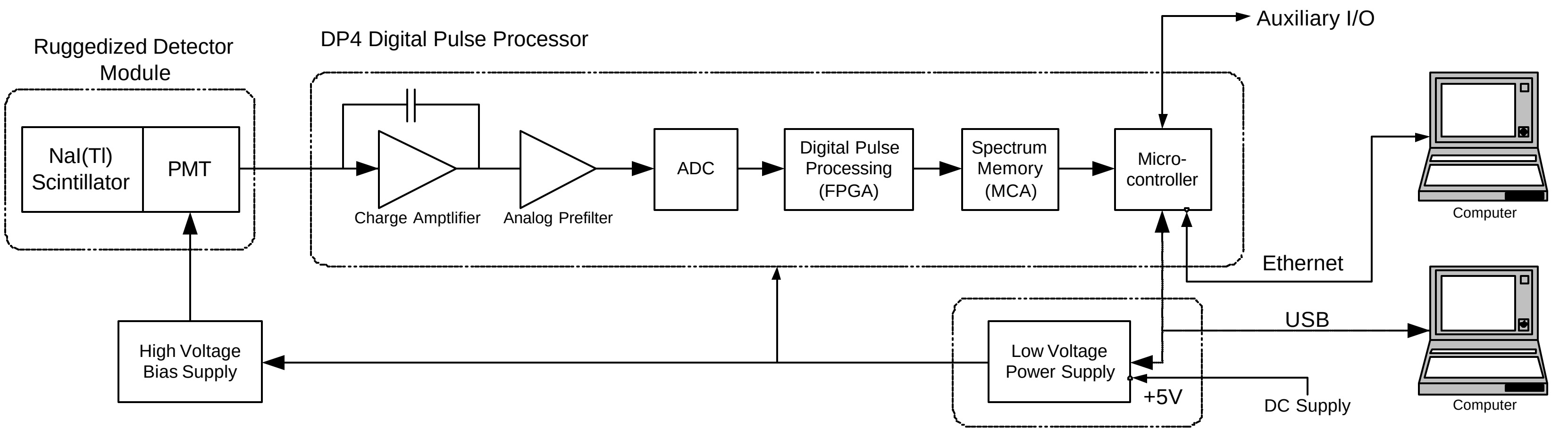
Gamma-Rad Spectrometer

- Ruggedized scintillator & PMT from Scionix, Ltd.
- Amptek's digital pulse processor and power supplies



Gamma-Rad Spectrometer

- Digital processor includes charge amplifier, digital shaping
- Choice of interfaces: USB, Ethernet, and RS232
- Auxiliary I/O includes counter input, timing & control signals

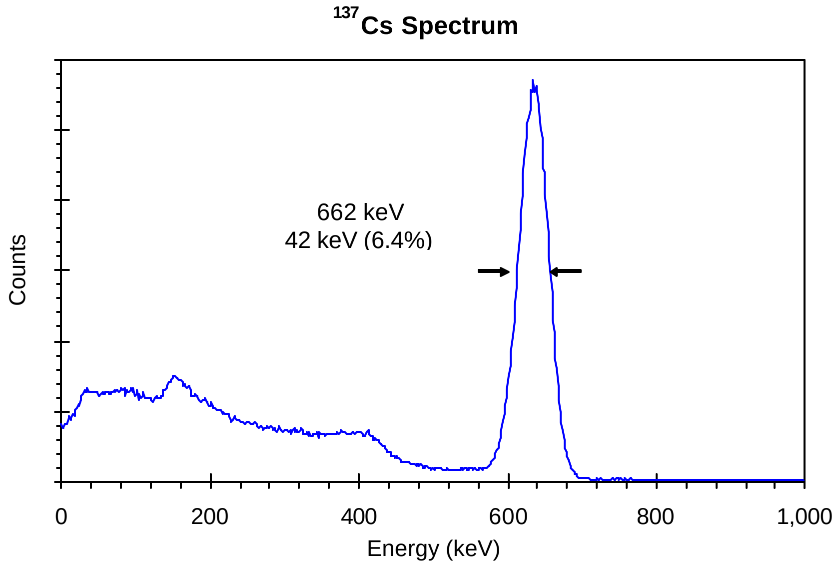


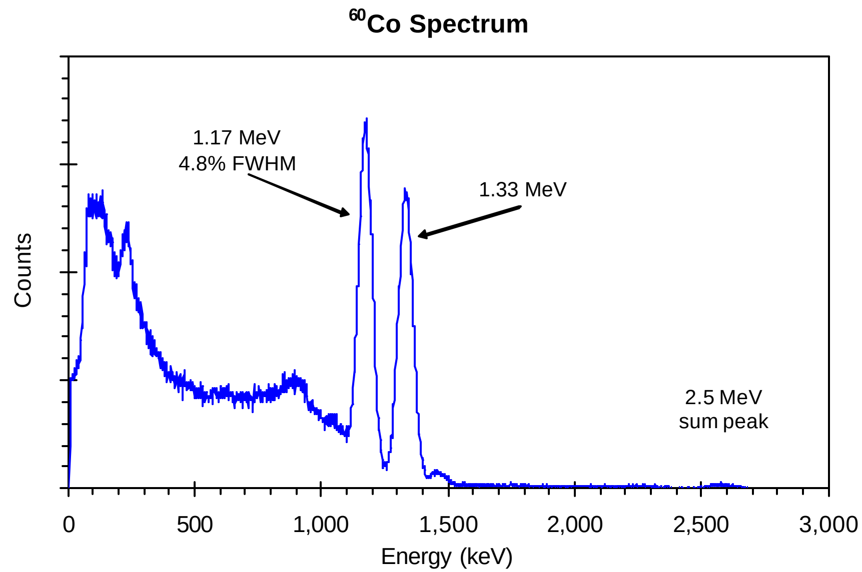
Gamma-Rad Key Features

- Ruggedized scintillator and PMT assembly
- Digital Processor
  - Integrates shaping amp, fast shaper, multichannel analyzer, microprocessor
  - Software configuration yields many options and adjustable parameters, set remotely, to optimize for specific conditions
  - Finite impulse response improves high count rate performance (better throughput, pile-up rejection, operation at 99% dead time)
  - Better stability and repeatability due to digital components
- Ethernet Interface
  - Robust communication over long distances (100 m)
- Gain stabilization algorithm
  - Operates in software using natural ^{40}K background

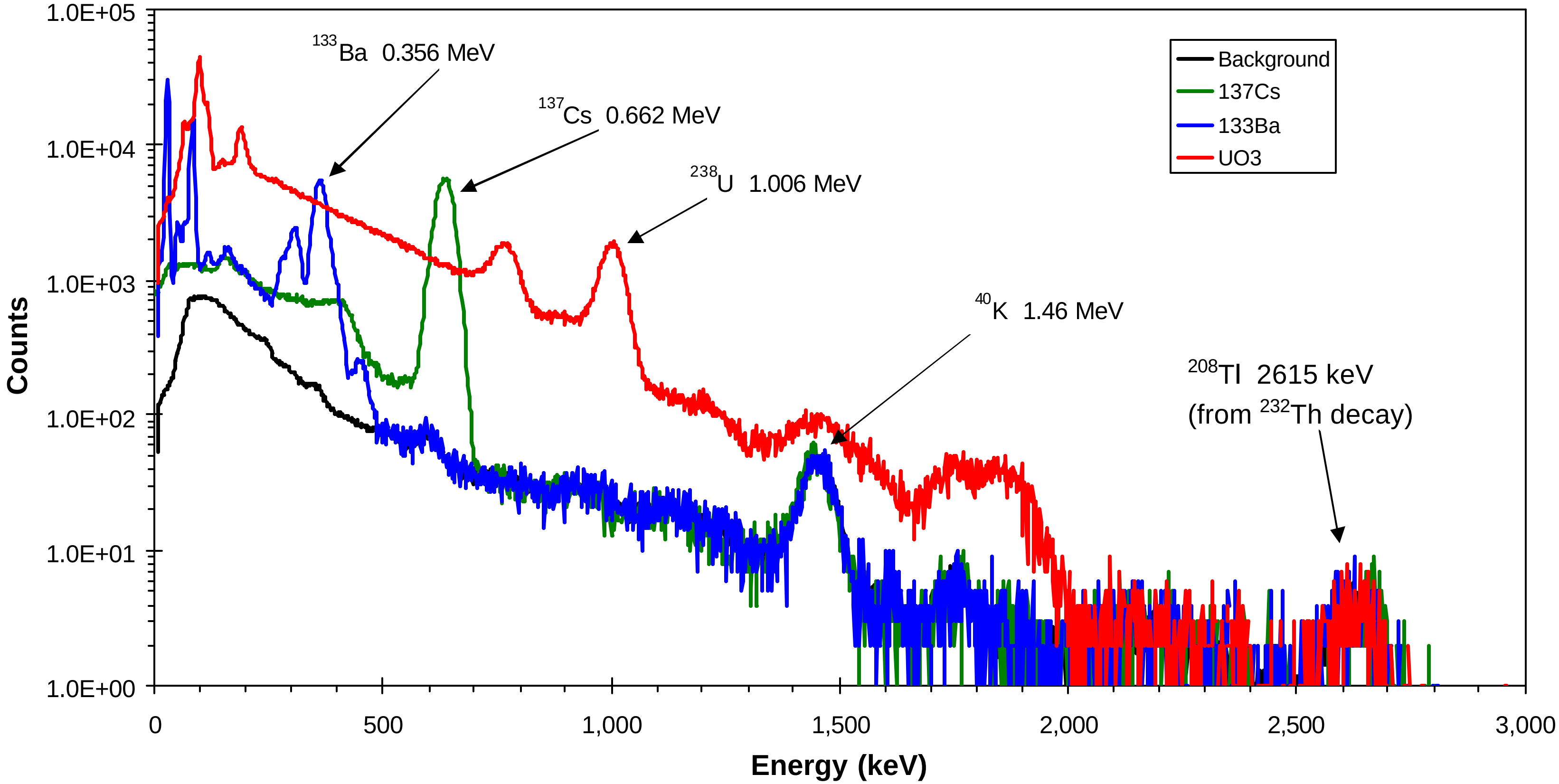
Gamma-Rad Spectra

Spectra typical for 76 x 152 mm NaI(Tl) with PMT





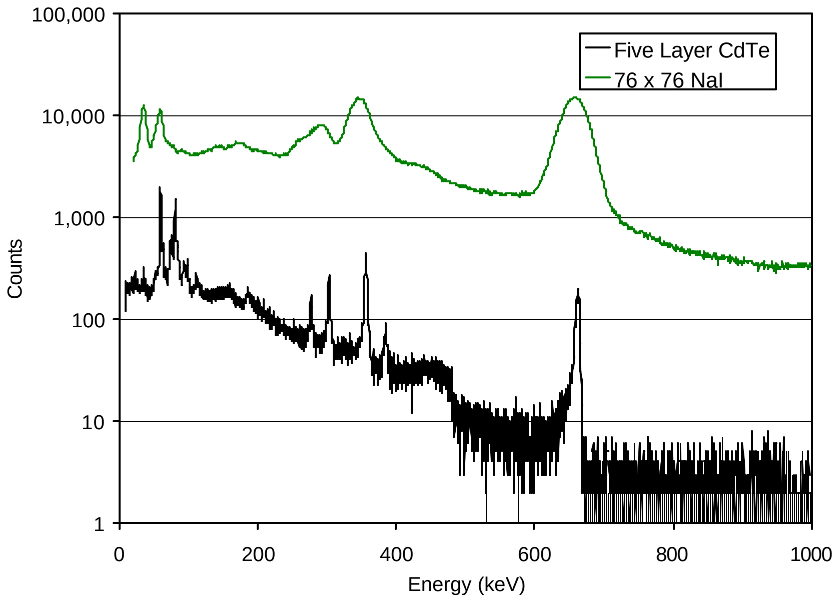
Gamma-Rad Spectra



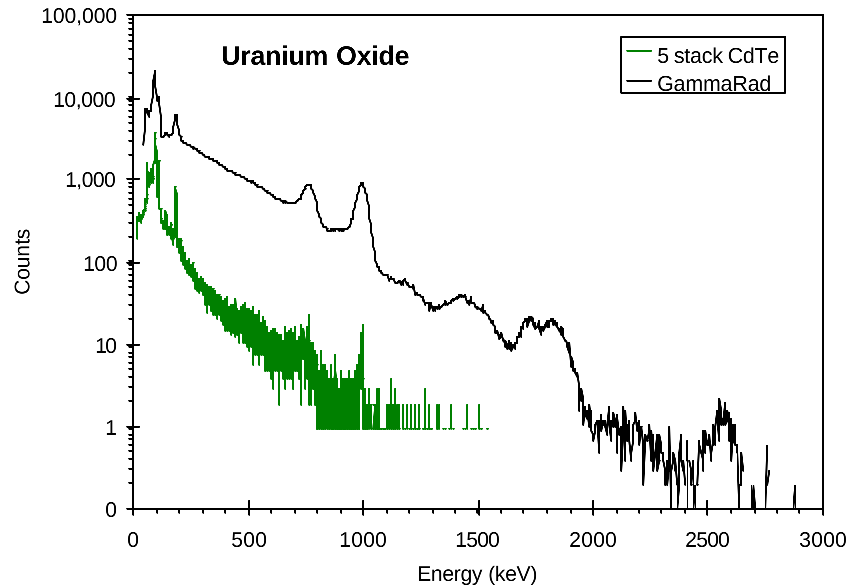
Gamma-Rad Spectra

Sensitivity vs resolution: 76 mm NaI(Tl) vs 5x5x3 mm^3 CdTe stack

CdTe resolves more peaks but must count vastly longer



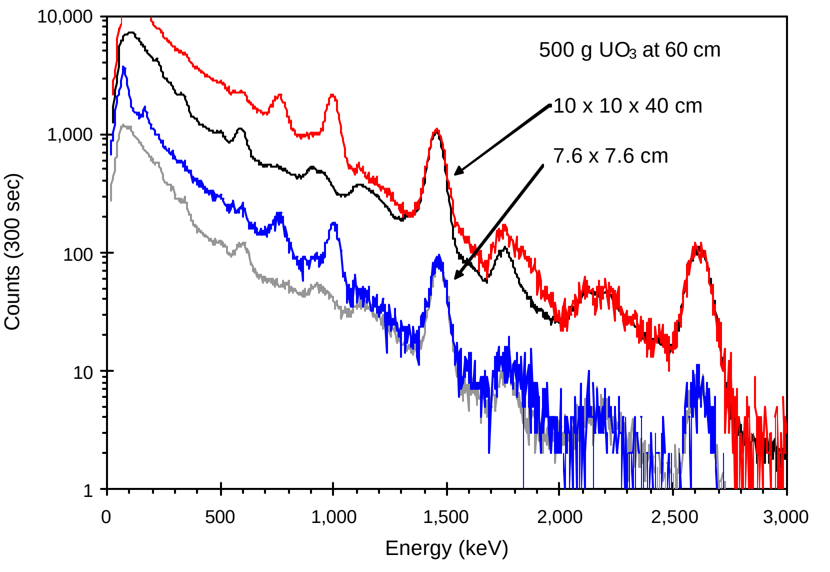
Mixed ^{241}Am, ^{137}Cs, ^{133}Ba, ^{60}Co, UO_3

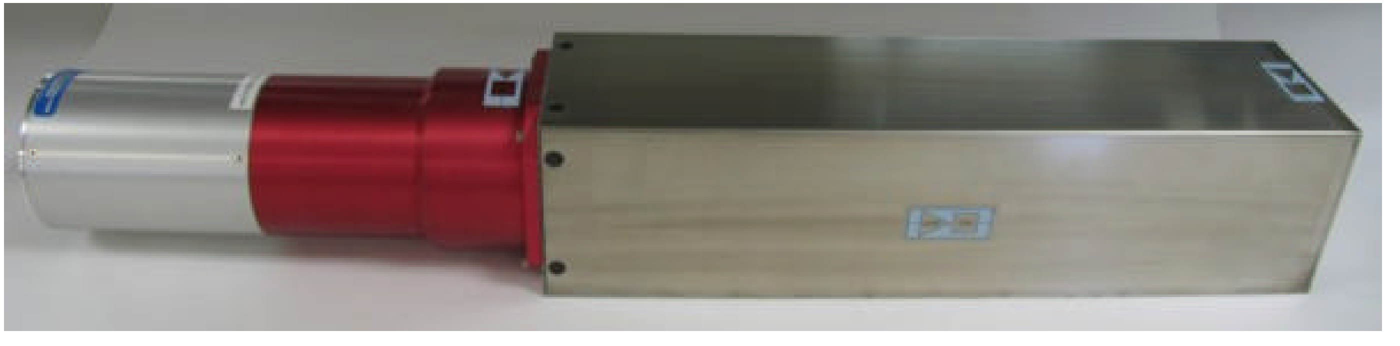


Natural UO_3

Gamma-Rad Options

- 10 X 10 X 40 cm^3 NaI(Tl)
  <7% FWHM at 662 keV
- 2.5 cm $LaCl_3$





Other VeriSpreader^{TM} Components

Neutron Counter

- Moderated ^{3}He detectors with 1 m active length, 50 mm diameter, and 4 atm pressure, supplied by St. Gobain Crystals & Detectors
- Dedicated HV supply and pulser shaper with TTL output

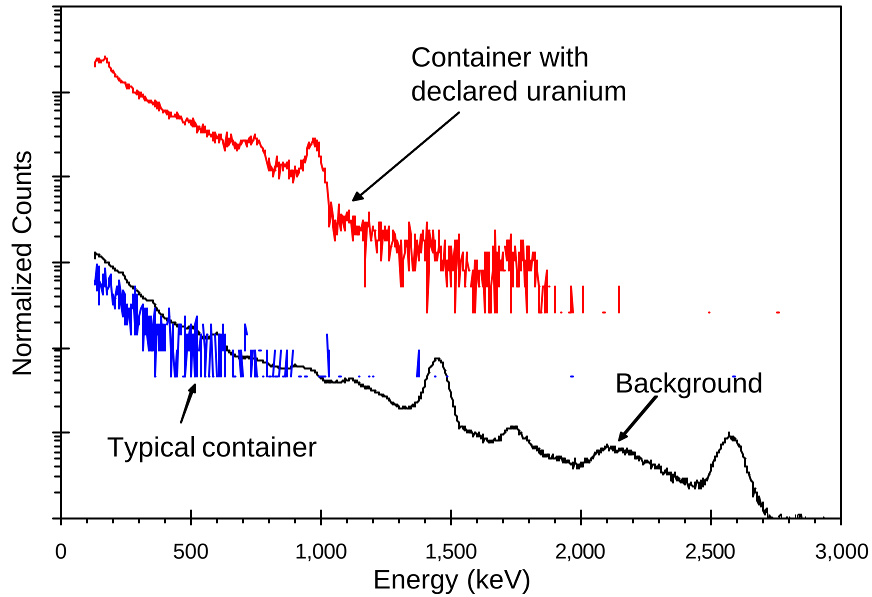
Radiation Detector Unit

- Includes shock mount to reduce shock & vibration levels
- Environmentally sealed to keep out humid, salty air

Software

– Data acquisition and control module
  - Optical system determines twistlock status to control data acquisition
  - Identifies container and associates nuclear data
– Data analysis module
  - Must distinguish NORM from possible threats
    – Background subtraction
    – Isotope identification
    – Threat analysis and reporting
  - Plan to use existing software and algorithms
  - Currently evaluating existing software

Spectra from Oakland Pilot Project

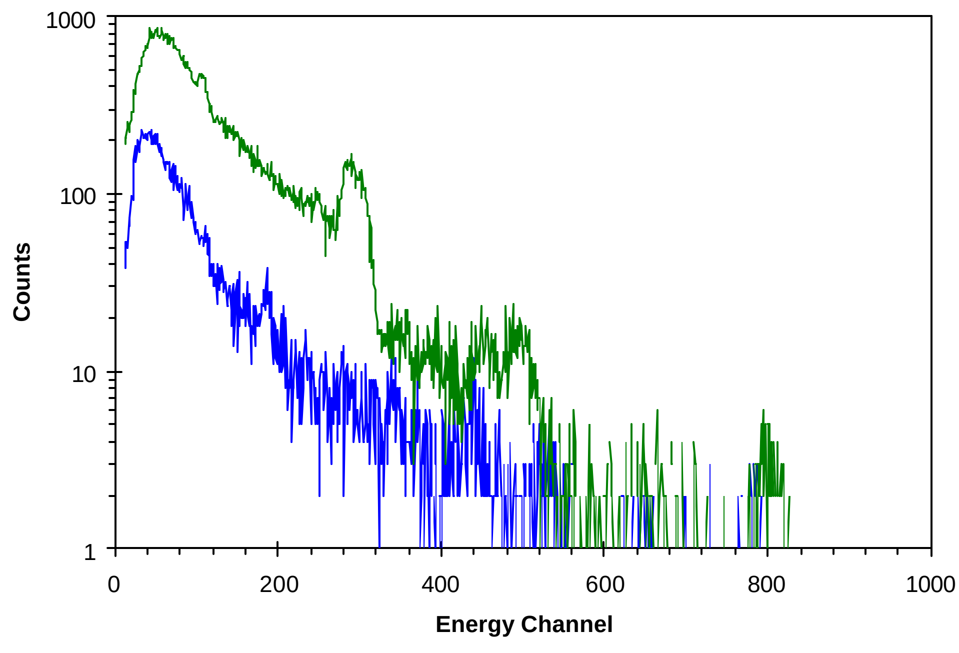


Key result: Good spectra were measured in this environment

- Background integrated for most of a day
- Typical container spectrum (similar to background)
- Chance measurement of declared uranium shipment

Results from Oakland Pilot Project

- Test conducted at Ben E. Nutter Container Terminal at the Port of Oakland
- Monitored 22 ships (6529 containers) from 14 Aug through 25 Oct 2005
- Representative spectra from undeclared containers shown below



Status

- Proof-of-concept prototype was built and tested
- Oakland pilot project demonstrated feasibility of measuring spectra in this environment
- Models and lab data verify sensitivity, spectral quality

Plans for Next Phase

- Build fully functional systems
  - Eight, 76 x 152 mm NaI(Tl) detectors on each spreader
  - Implement spectral analysis software
  - Hardware fabrication and software selection are in progress
- Validate performance in ports