

3D-CZT Gamma-Ray Spectrometers and Imaging Spectrometers for Source Term Characterization at Nuclear Power Plants

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# About H3D

## Spectrometers and Imaging Spectrometers

- CZT Expertise, a room-temperature semiconductor detector
- Capable of better than 0.8% FWHM at 662 keV
- Isotope-specific imaging capability
- Isotopic trending

## • H Series Sales Record:

- Sold over 200 units world-wide
- Used at over 75% of US NPPs

## Applications:

- Nuclear Power
- Homeland Security
- CBRNE
- Safeguards
- Medical
- Waste







## Introduction to 3D CZT

- CZT is a semiconductor radiation detector
- H3D's CZT is pixelated to know the 3D position of each interaction
- Similar spectroscopic performance to HPGe but operates at room temperature



## CZT versus HPGe and Scintillators



H<mark>-</mark>D° 4

# Gamma-Ray Imaging

#### Compton Imaging: > 250 keV





Number of photons: 9933



# **Isotopic Imaging Analysis**



<sup>60</sup>Co

137**CS** 

**HD** 6

# Gamma-Ray Imaging





H-D 7

## **Coded Aperture Example**

 This is an example of someone who took a Tc-99m stress test and then we shot them with our camera (the H420 dual mode imager)



Capable of tracking organ-by-organ and locating waste



# Product Summary – H & P

- Up to >19 cm<sup>3</sup> CZT
  - <10 lbs
  - Battery operated (6+ hr)



- Control with tablet, phone, or computer
- Washable for easy decon
- 0.8% FWHM @662 keV
- Omnidirectional imaging
- Imaging from 50 3000 keV



- Collimated with 1" W except for 90° FOV
- >6 cm<sup>3</sup> of CZT
- Battery operated (7 hr)
- Washable for easy decon
- 0.8% FWHM @662 keV
- 25 lbs
- Plug for background subtraction





P SERIES Shielded Imaging Spectrometer

SERIES Spectromete

maging



# H Series Applications at NPPs

- Contamination Control
- Verifying Adequacy of Temporary Shielding
- Shipping
- Outage Projects and Pre-Job Surveys
- Characterization of HRA and LHRA
- Crud-Burst Measurements
- Site-Wide Contamination Surveys











10

# Locating and Tracking Crud in Pipes





Using the S100 and P100S to monitor pipes during an outage



# Remote Monitoring Software



# **Isotopic Trend Analysis**

Watch CRUD Bursts

 Detect unexpected trends

13



\* Data from outage at US NPP

## Waste Characterization

• Characterize Boxes, Drums, or Systems







- Use H3D's Visualizer software to model geometries and calculate activities
- Results validated by third party against HPGe





## Nuclear Industry Proficiency Test Exercise 2019

- 200L drums sent to 14 labs (36 participants)
  - 15 kg vermiculite, 1 kg ion-exchange resin
    - 4 layers of 48 bottles
    - <sup>241</sup>Am/<sup>60</sup>Co/<sup>137</sup>Cs









## **Drum Measurements**

- Measured using H420 by customer
- Four-views, total dwell of 20.5 hours





## Quantification: CZT vs HPGe

- All CZT results agree within  $1\sigma$ 
  - Customer uncertainty (31%) greater than reported by Visualizer
- <sup>241</sup>Am is a difficult isotope to analyze
  - W K $\alpha$  x-ray = 60 keV, <sup>241</sup>Am also emits at 60 keV!
  - Measure W K $\beta$  amplitude and estimate K $\alpha$





# Skyshine





## H3D, Inc.

## Questions?

