



# Advances in Radiation Instrumentation to Achieve Enhanced Characterization of Source Term Reduction Results

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**Cook Nuclear Plant**

**American Electric Power**

**ISOE International Symposium**

**Rio De Janeiro, Brazil, May 26-28, 2015**

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- ## Background on New ALARA Tool: H3D
- Developed at Un of Michigan 2002-2012
  - Field tested in 2013 at Cook
  - Introduced in 2014 as a new ALARA Tool for RP Analysis of Individual Isotopes in the field
  - Initially used to verify adequacy of temporary shielding

# **NATC CZT Data Analysis Working Group**

NATC was asked to develop CZT data analysis working group to share new applications of the new ALARA Tools  
Monthly conference call in 2015  
32 members from US, Canada, Switzerland and Slovenia

# NATC Group is Highly Engaged

Member share in-plant measurements on NATC MY BOX website

Organized by plant component

NATC working group is excited about the new CZT ALARA Tool and eager to share new capabilities and applications each month

# Purpose of Presentation

Objective of this presentation is to show  
“applied new applications” of the H3D  
Based on the unique ability to detect  
individual isotopes in the field

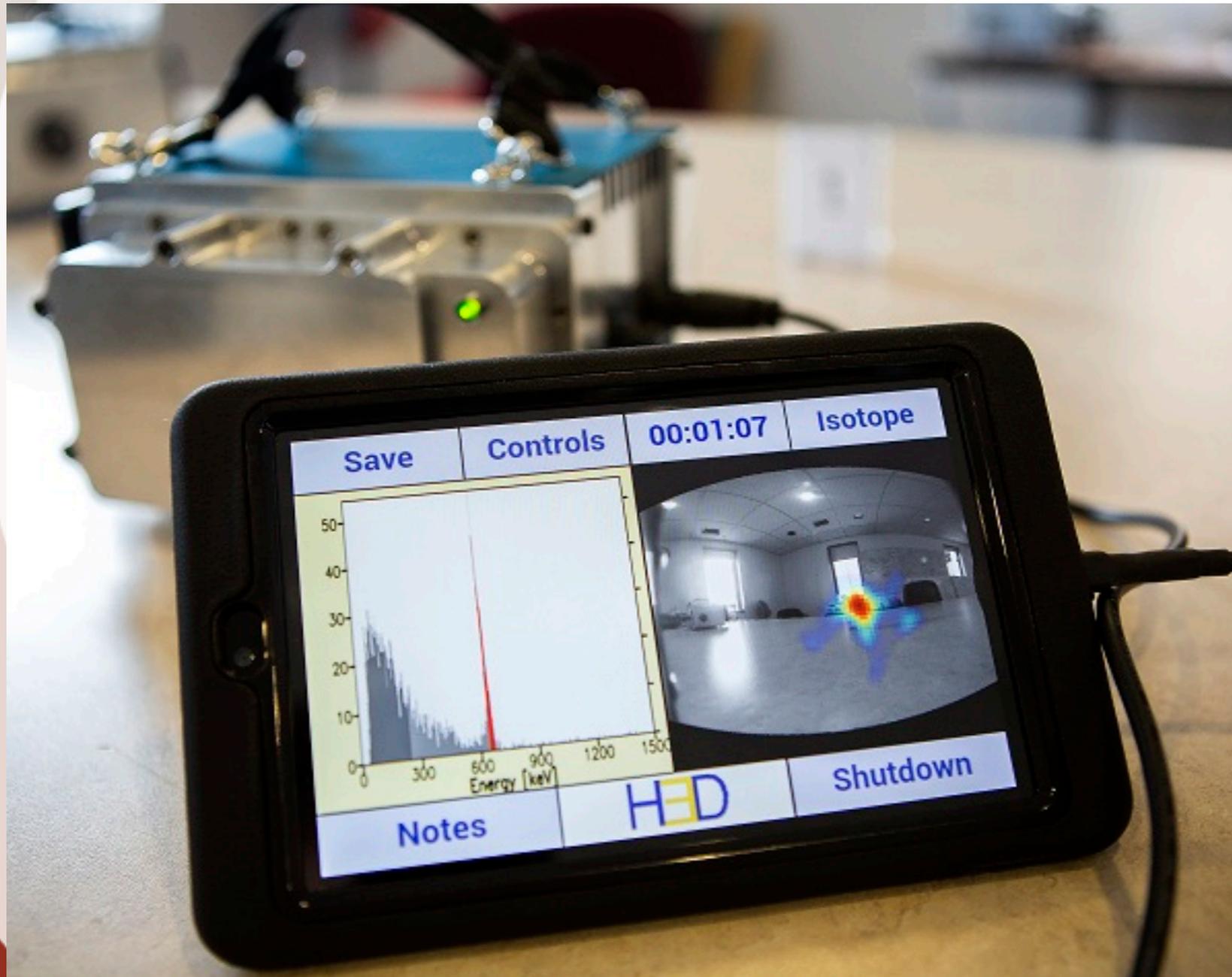
# Presentation Overview

1. System Basics
2. Elevated Dose Rates in HTC
3. U1 W CTS Hx
4. Waste Gas System
5. Turbine Building Contamination Verification
6. Contaminated Scaffold Investigation
7. CRUD Trap Isotopic Analysis
8. Low Level Percon Investigation

# Polaris-H

## Imaging Spectrometer for Nuclear Power Plants

Response to nuclear power plant need for **portable instrument to image in contaminated areas.**

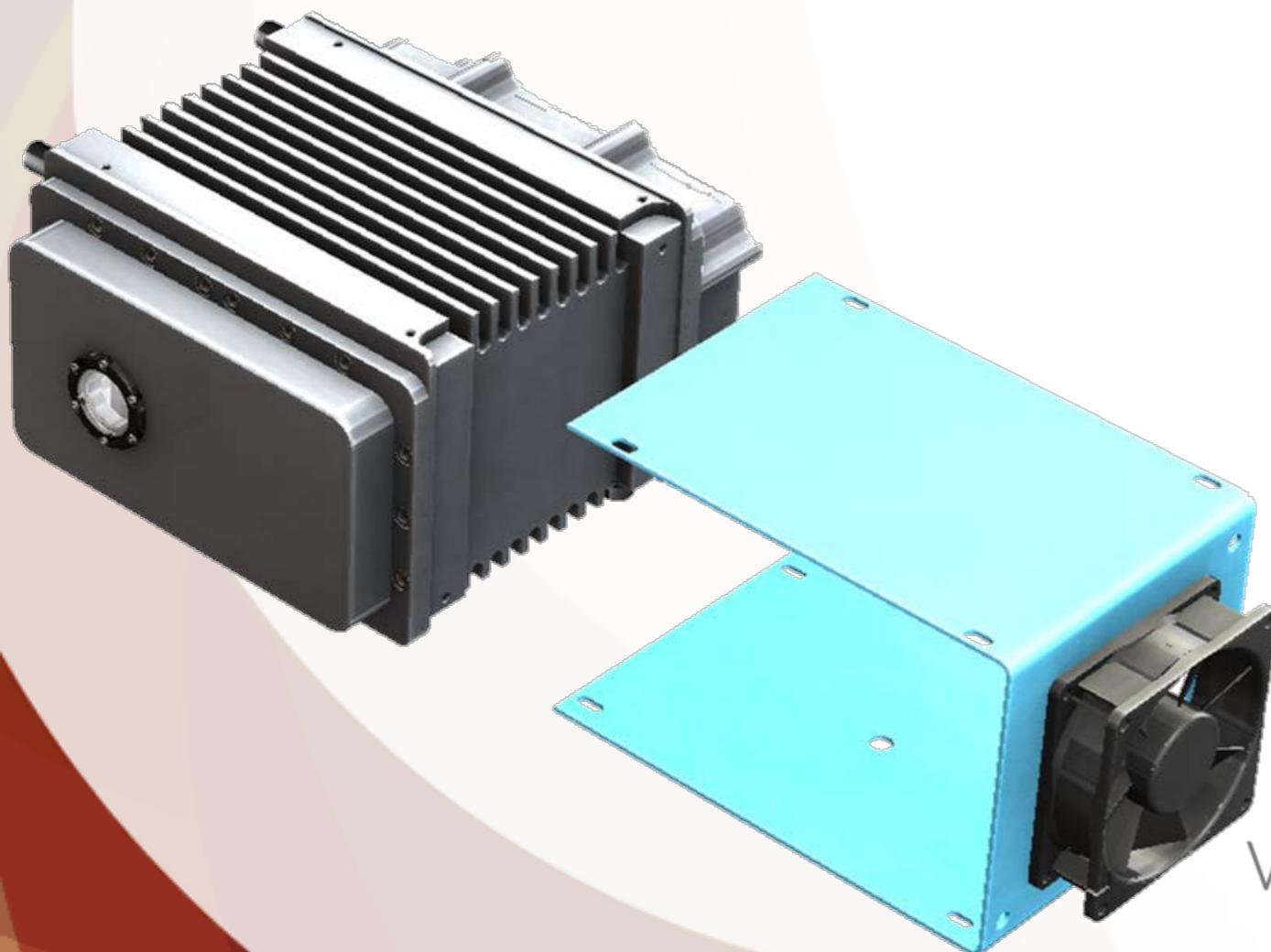
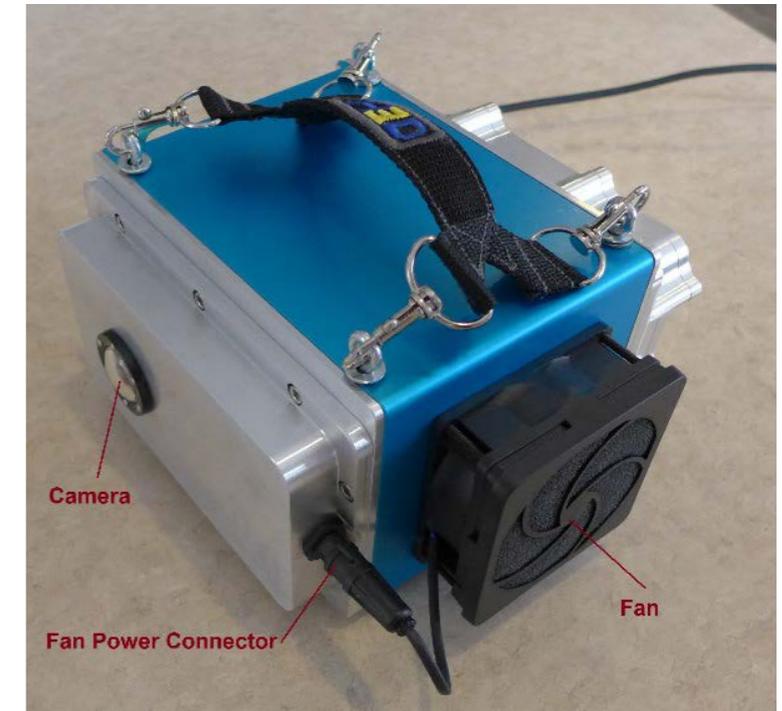


- 8.5 lbs
- Battery operated (5 hr)
- Washable for easy decontamination
- “Simple” user interface
- $\leq 1.1\%$  FWHM energy resolution at 662 keV
- Omnidirectional imaging

# Polaris-H

## Imaging Spectrometer for Nuclear Power Plants

- $\sim 2\pi$  optical camera for overlay of radiation image
- Compton imaging  $\sim 250$  keV to 3 MeV
- Communication with tablet display via Wi-Fi, Bluetooth, USB, or Ethernet to network
- Fan and external fins for temperature regulation



# Polaris-H

## Imaging Spectrometer for Nuclear Power Plants

- Real-time software on embedded CPU for isotope detection/ID, isotope-specific imaging, data logging, control and regulation.

The screenshot displays the real-time software interface with several panels:

- Save** | **Controls** | **00:02:20** | **Isotope**
- Energy [keV]** plot (0-3000) and **Notes** | **16 CPS** | **Shutdown**
- Back** panel: Thu Dec 19 16:04:58 2013, Elapsed Time: 00:05:21, Count Rate: 46 CPS, Storage Space: 11.1GB, On Wall Power, Battery Level: N/A%, High Voltage: OK, Detector Temperature: 86°F. Includes buttons for **Create New Measurement**, **Stop Measurement**, **Notes**, **Preset Live Time** (OFF), **Measurement Repeat** (ON), and **Change Repeat Time (600s)**.
- Cancel** | **None** | **All IDs** | **Submit**
- Isotope detection results table:

<b>Cs-137</b> 480(92%)	<b>Co-60</b> 57(100%)		
Cs-134 (No Peak)	Co-58 (No Peak)	Mn-54 (No Peak)	Fe-59 (No Peak)
511 keV (No Peak)	*Am-241 (No Peak)	K-40 (No Peak)	I-131 (No Peak)
*Ce-141 (No Peak)			

- Post-processing software for time analysis, high-resolution imaging, detailed studies.

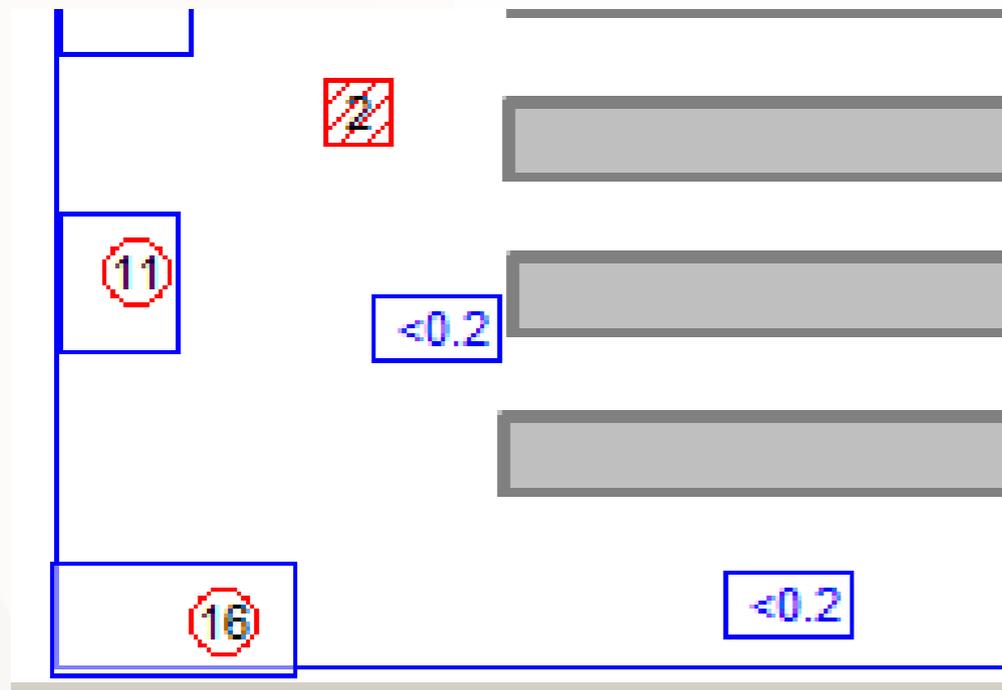
The screenshot shows the HSDVisualizer post-processing software interface with two windows:

- Left Window:** Shows filters (Cs), a table of measurements, and a measurement preview for Cs-137\_Angular\_Resolution. The table includes columns for Name, Date, Time, Duration, and Detector.
- Right Window:** Shows a list of selected measurements, a plot of Counts vs Energy (keV), and a heatmap image of the measurement area. The plot shows a peak at approximately 662 keV.

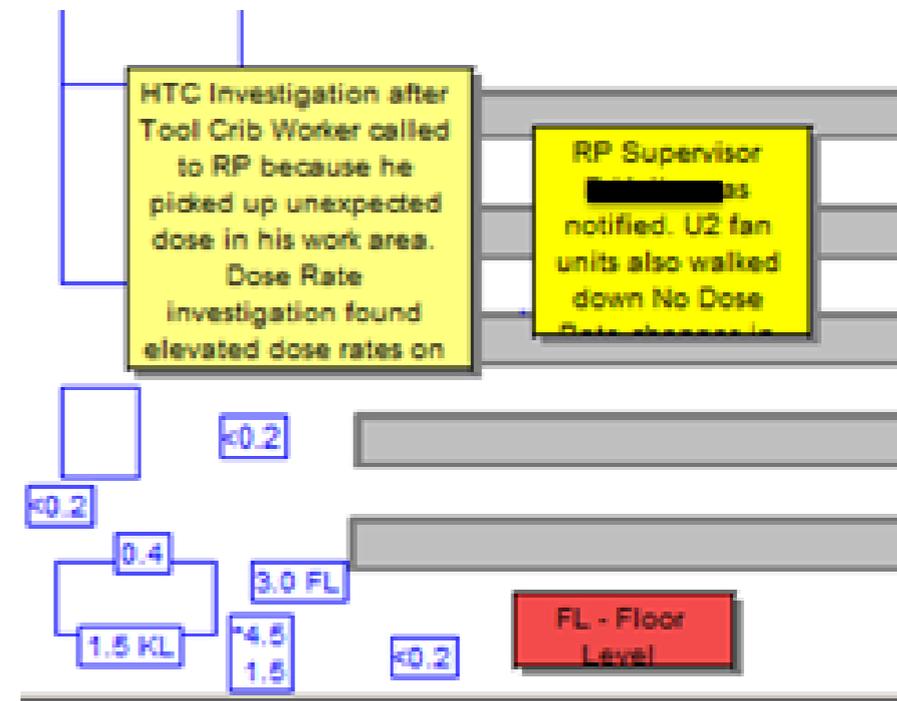
# Elevated Dose Rates in Hot Tool Crib

- On 9/10/14, a tool crib worker received an unexpected dose accumulation of 0.1 mRem while in the Hot Tool Crib (HTC).
- Dose was streaming through the floor plugs from a drained demin vessel.

# Elevated Dose Rates in Hot Tool Crib

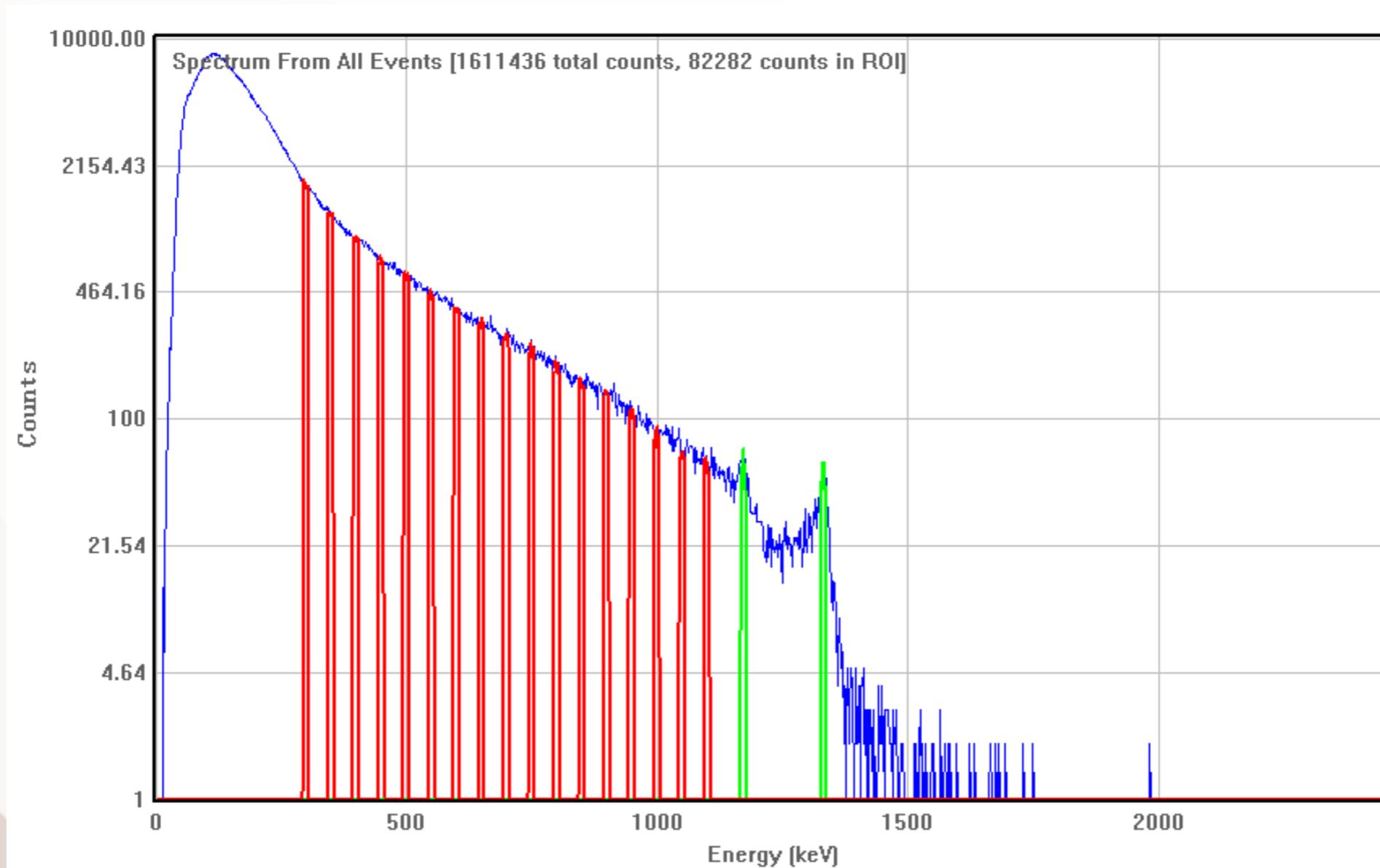


Typical Dose Rates



Elevated Dose Rates (9/10/14)

# Elevated Dose Rates in Hot Tool Crib



# Elevated Dose Rates in Hot Tool Crib

Image of Co-60:

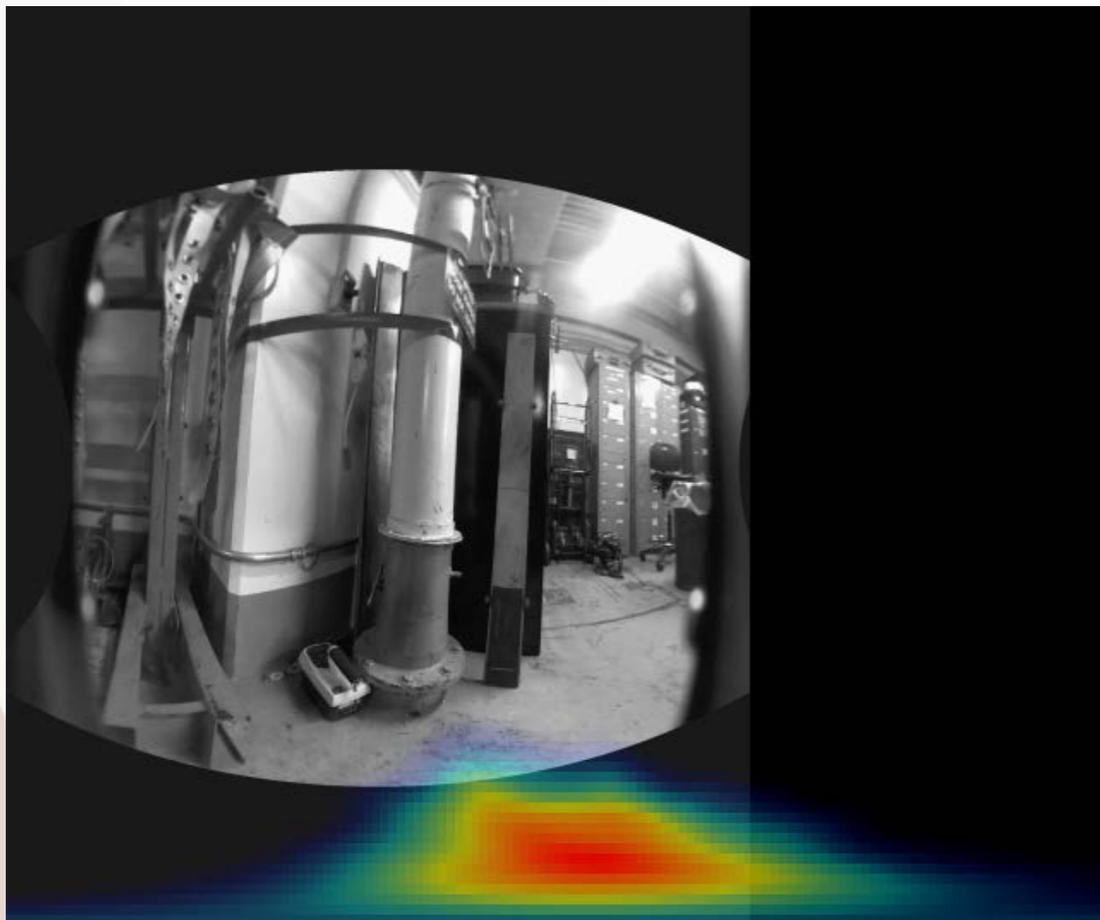
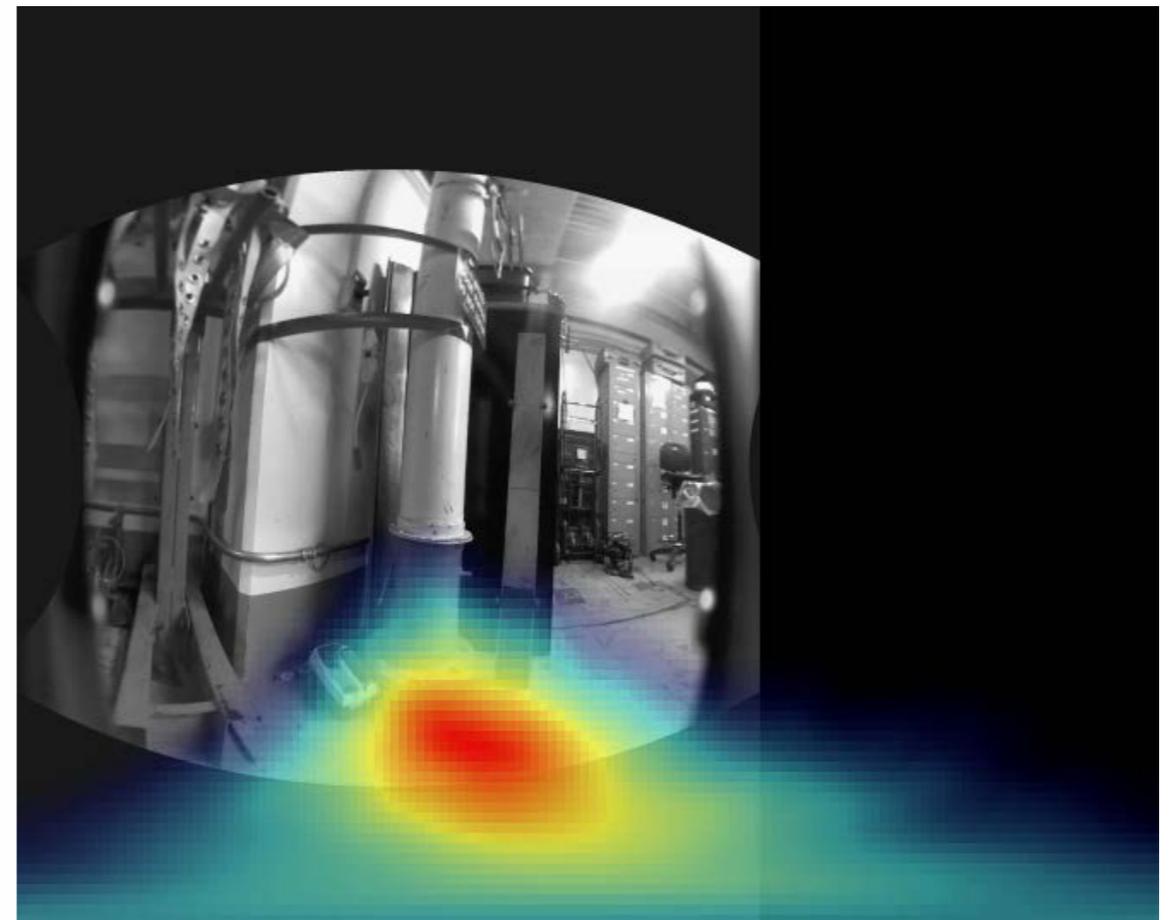


Image of Scatter:



# Elevated Dose Rates in Hot Tool Crib

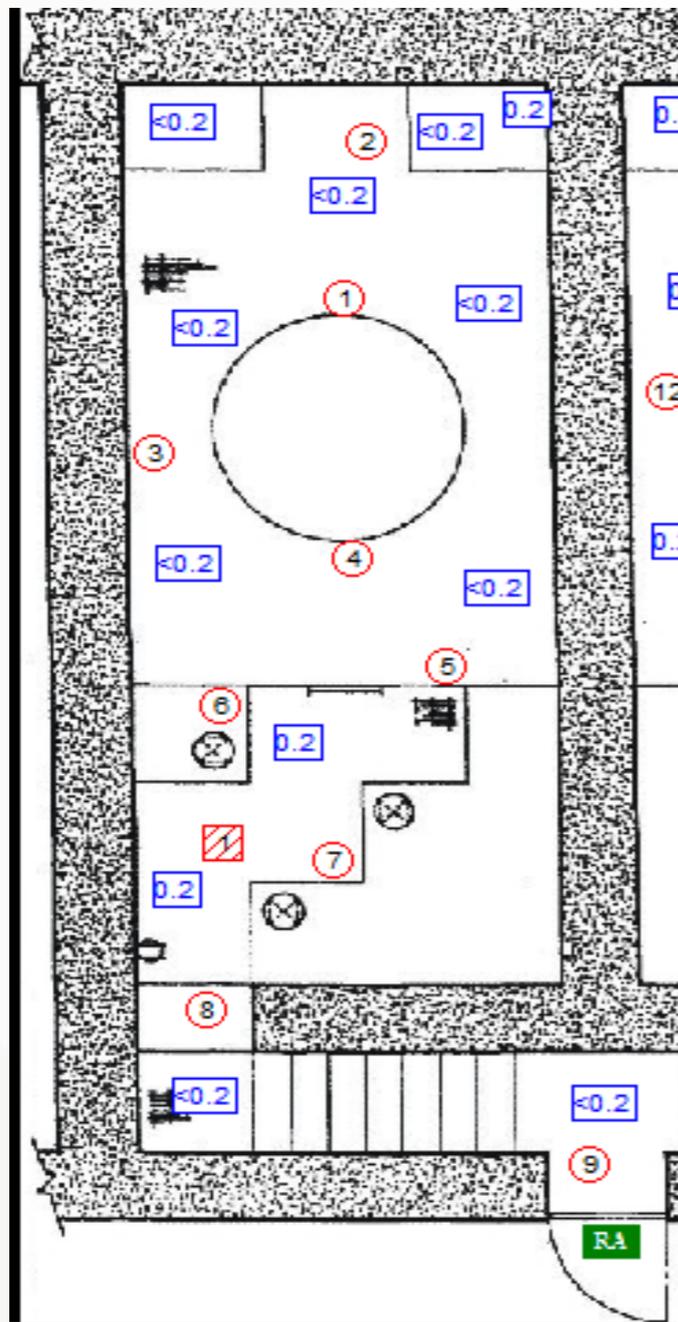
## Results of the Imaging:

- HTC Workers Instructed to avoid whole area near floor cover
- Increased Importance to Refill Demin prior to refueling outage
- Filled Demin decreased Dose Rates

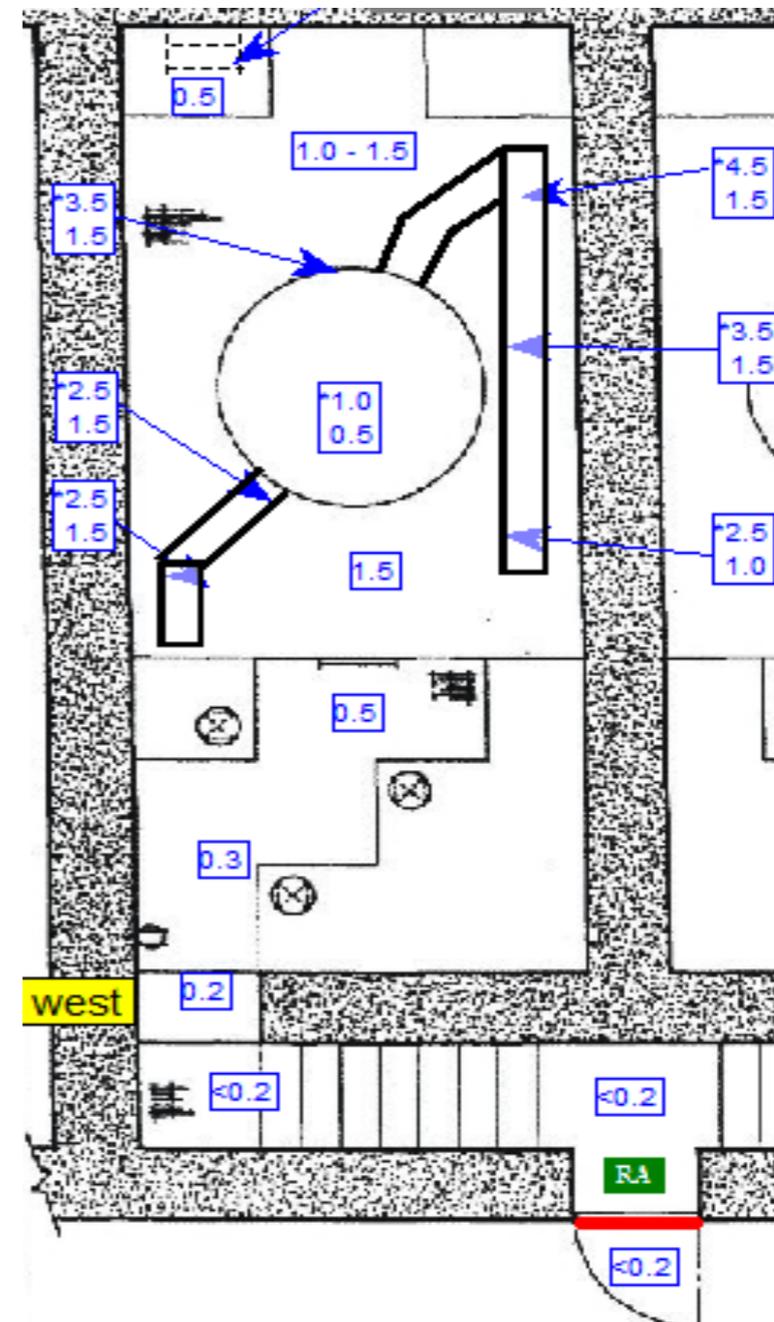
# Elevated Dose Rates in CTS Hx Room

- On 11/6/2014 elevated dose rates were found in the U1 W Containment Spray (CTS) Hx Room
- Room already Radiation Area due to E CTS Hx

# Elevated Dose Rates in CTS Hx Room

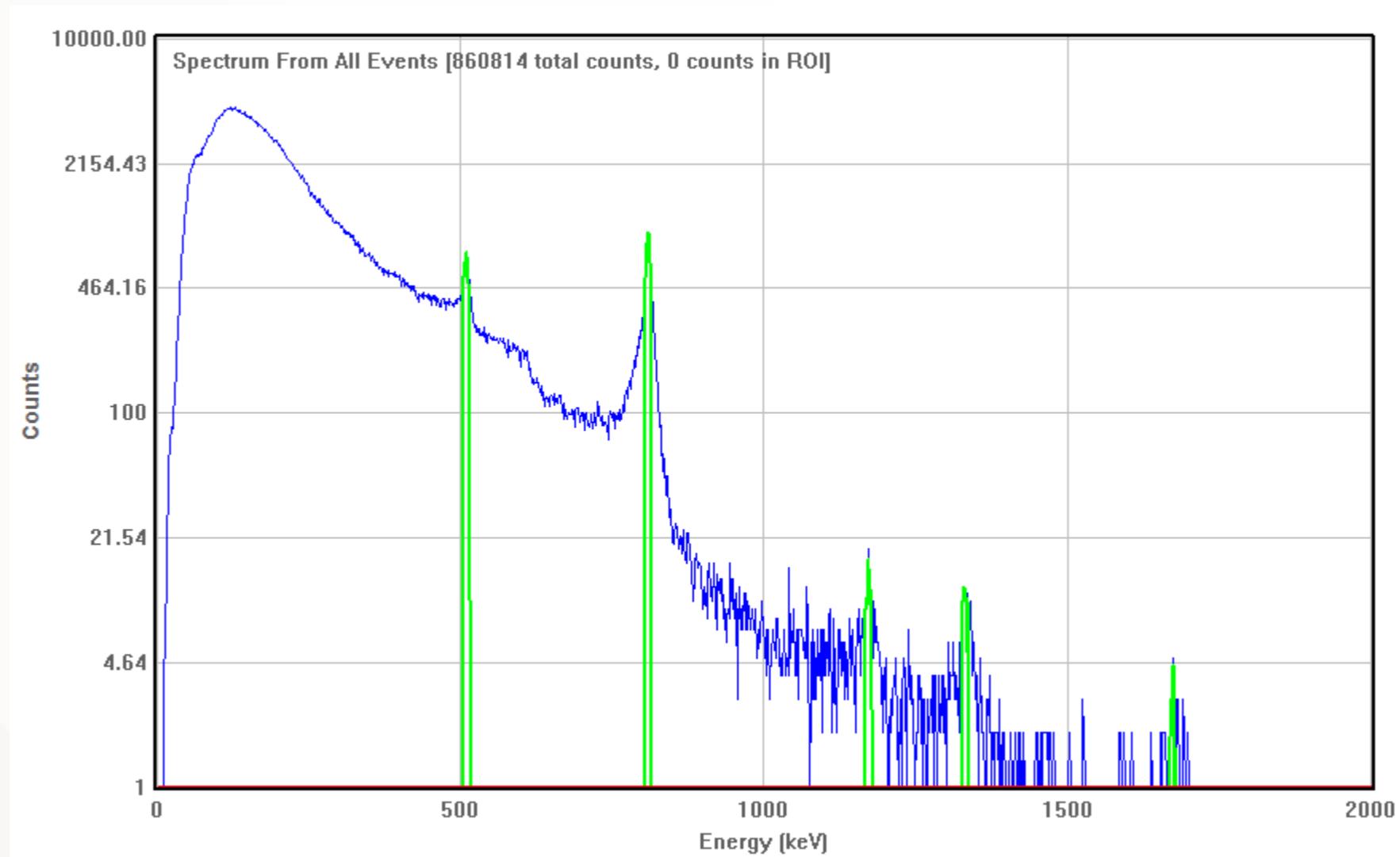


11/3 – Routine Survey

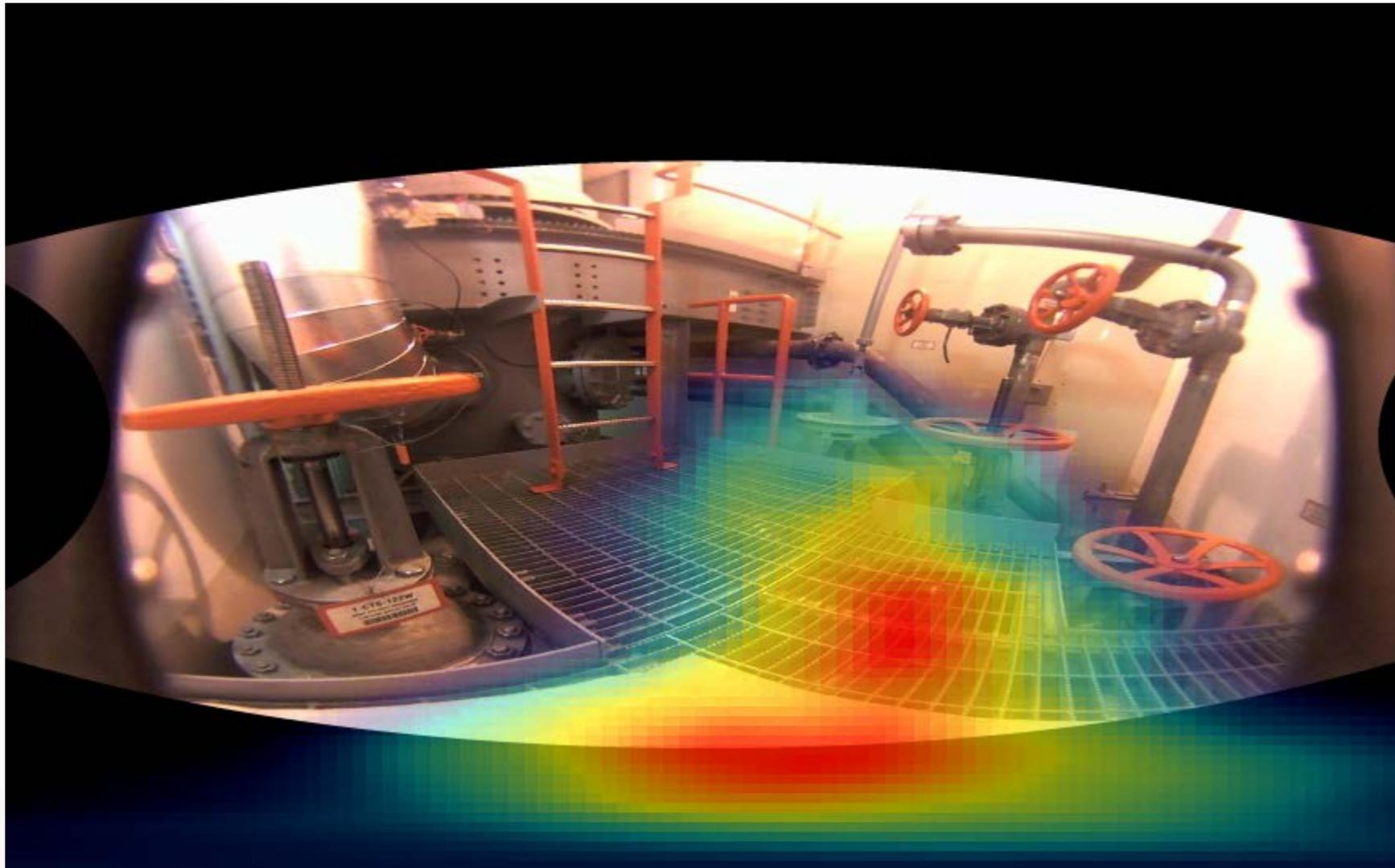


11/6 – Post Leak Testing

# Elevated Dose Rates in CTS Hx Room

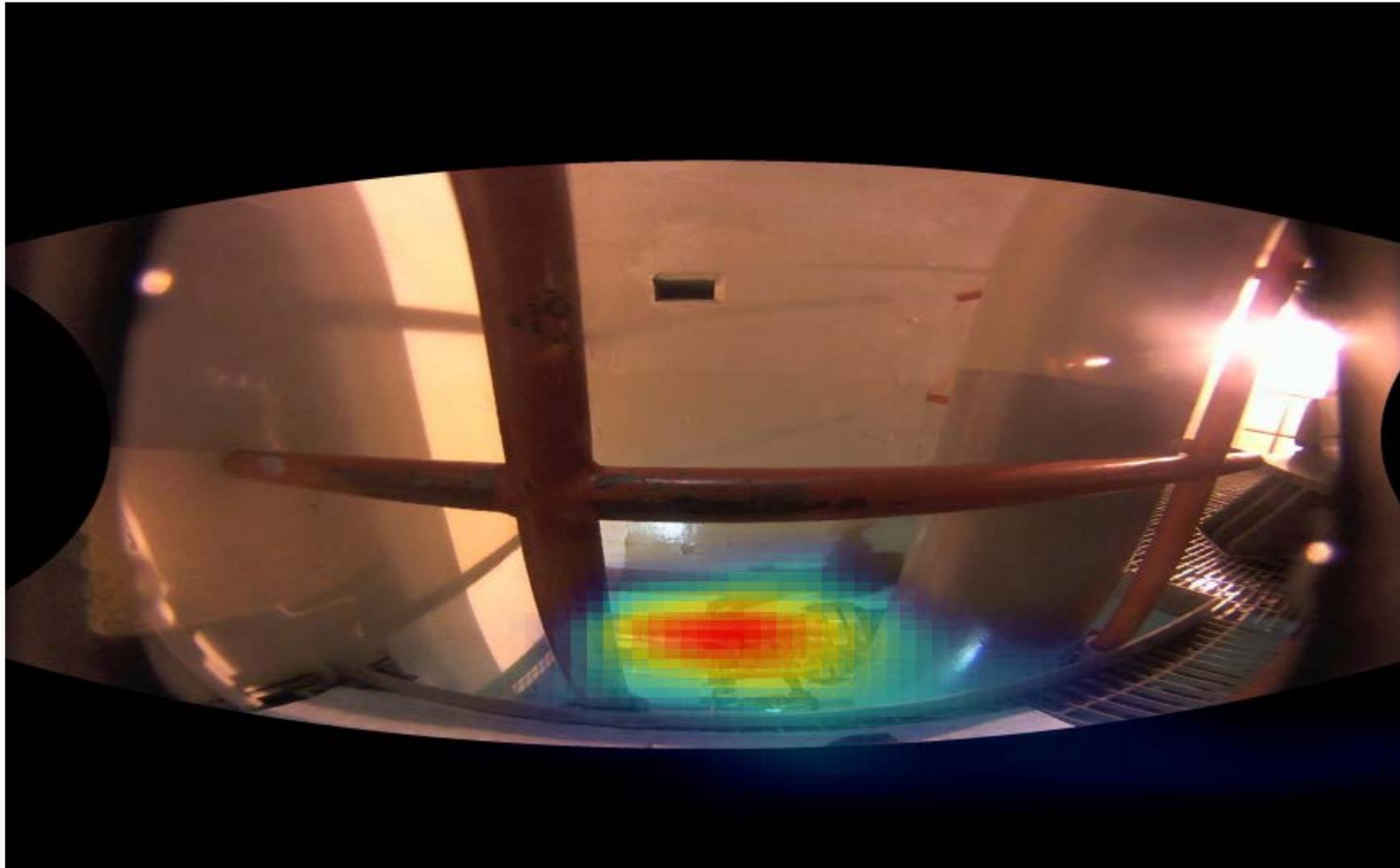


# Elevated Dose Rates in CTS Hx Room



Co-58 – Highest contact DR: 2.1 mR/hr  
– Highest GA DR: 0.5 mR/hr

# Elevated Dose Rates in CTS Hx Room



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# Elevated Dose Rates in CTS Hx Room

- Co-58 was primary contributor to increased dose rates.
- Dose Rates coming from line used for leak test
- Recommendation was made to decay system instead of flush system.

# Elevated Dose Rates in Waste Gas System

- Unposted Radiation Area found on 609' in S. Waste Gas Compressor Room during routine surveys
- The small heat exchanger found reading 30 mR/hr on contact and 8 mR/hr at 30 cm.

# Elevated Dose Rates in Waste Gas System

- No air sample needed to get isotopic on waste gas
- Gamma Spectrum provided on next slide nearly matched composite sample of resin taken for resin characterization.

# Elevated Dose Rates in Waste Gas System

Comments:

0.2604 grams of resin from the SRST sluice performed on 12-10-2014.

Efficiency File: 8\_ResinVial\_1.Clb

Efficiency Desc: RP Detector #8 Resin Vial on Jig

Library: General.lib

Nuclide	Activity uCi/gm	Error %
Be-7	1.298E+00	2.35
Mn-54	1.275E+00	0.57
Co-57	7.185E-02	2.68
Co-58	1.689E+00	0.47
Co-60	5.123E+00	0.19
Zn-65	5.587E-02	16.54
Zr-95	7.471E-02	6.00
Nb-95	1.282E-01	2.53
Ag-110m	4.037E-02	11.78
Sn-113	3.673E-02	11.44
Sb-124	7.499E-03	16.32
Cs-134	3.872E+00	0.25
Cs-137	3.360E+00	0.29
Sb-125	6.310E-01	2.13

*H3 = 1.05 mCi/cc or  
1.311 mCi/g*

Total

1.766E+01

PAGEBREAK

1.766E+01

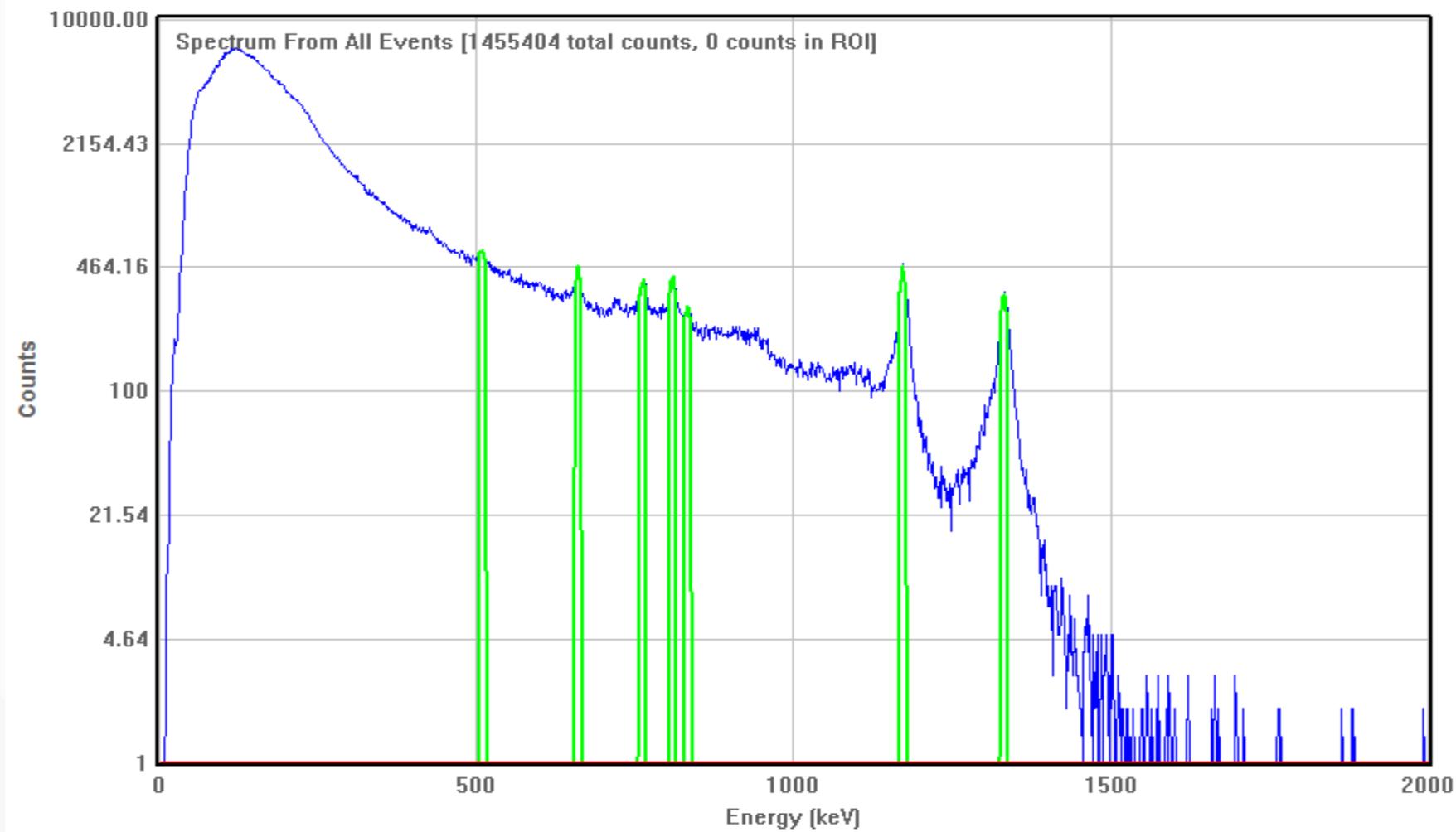
DC Cook Nuclear Power Plant

CHEM/RP/ENV Department

Description: Unit#12 SRST resin sample sluiced on 12-10-14

RWP: 2014-1012

# Elevated Dose Rates in Waste Gas System – S. Waste Gas Compressor

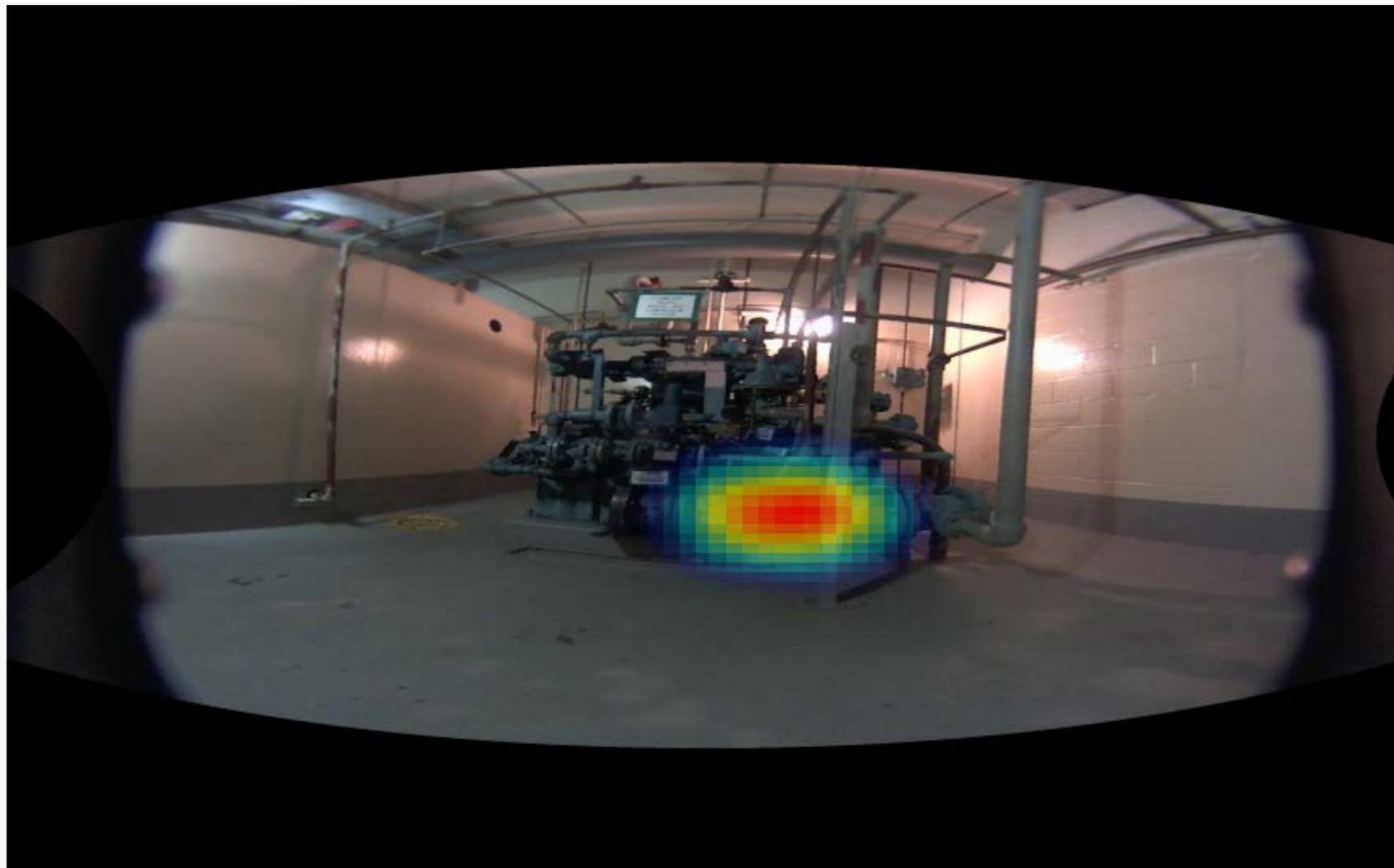


S. Waste Gas Compressor:  
Co-58, Co-60, Cs-137, Mn-54, Nb-95

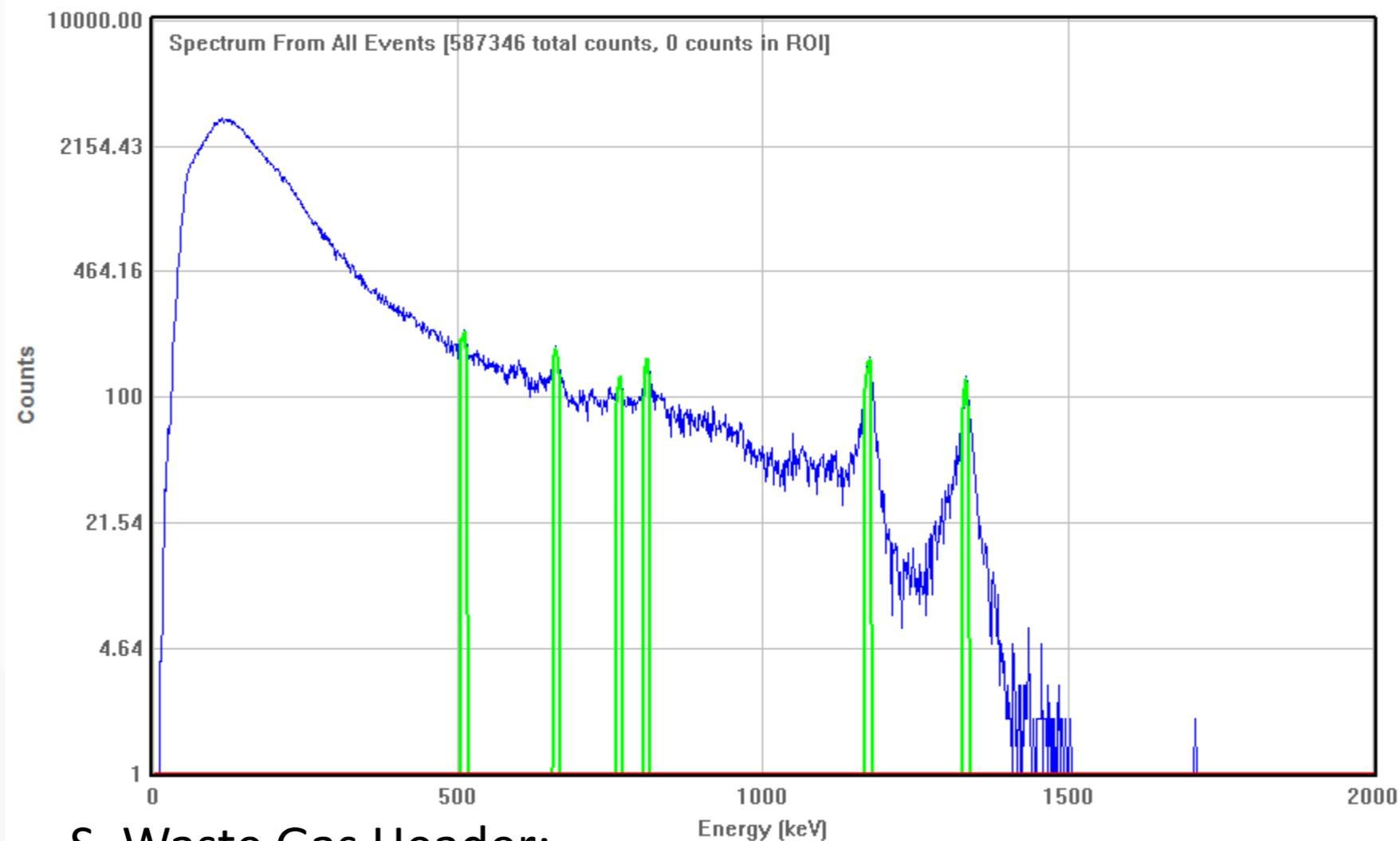
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# Elevated Dose Rates in Waste Gas System – S. Waste Gas Compressor

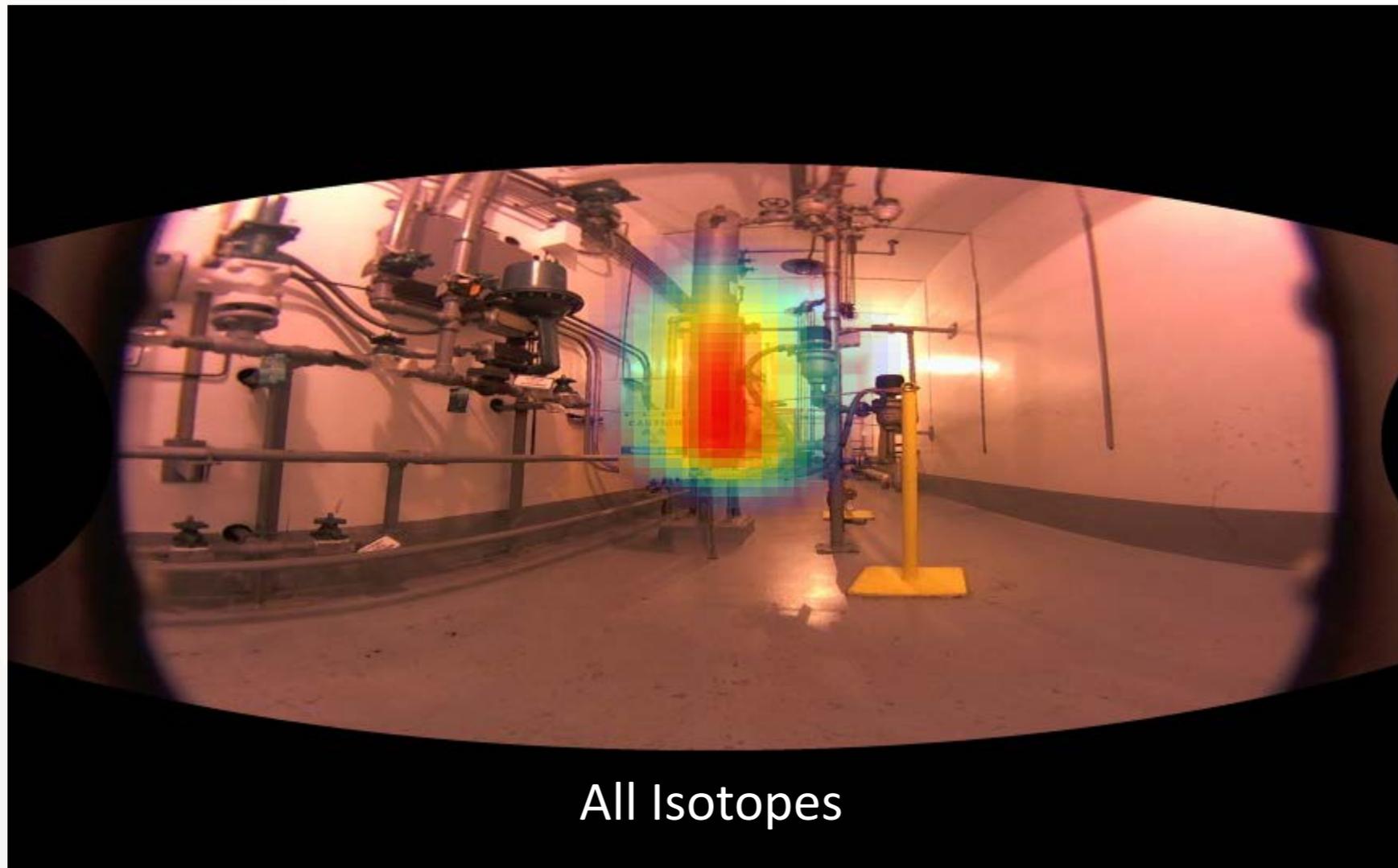


# Elevated Dose Rates in Waste Gas System – S. Waste Gas Header



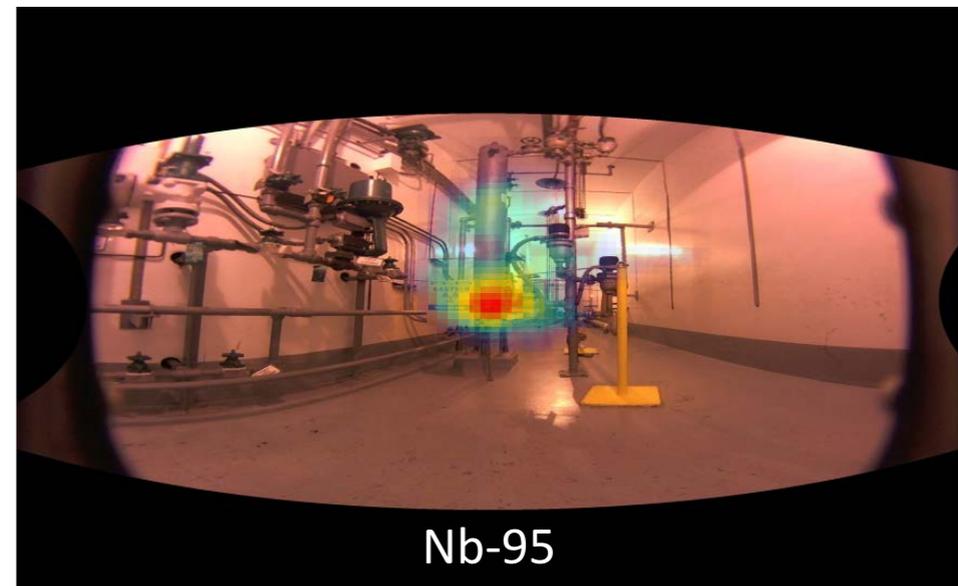
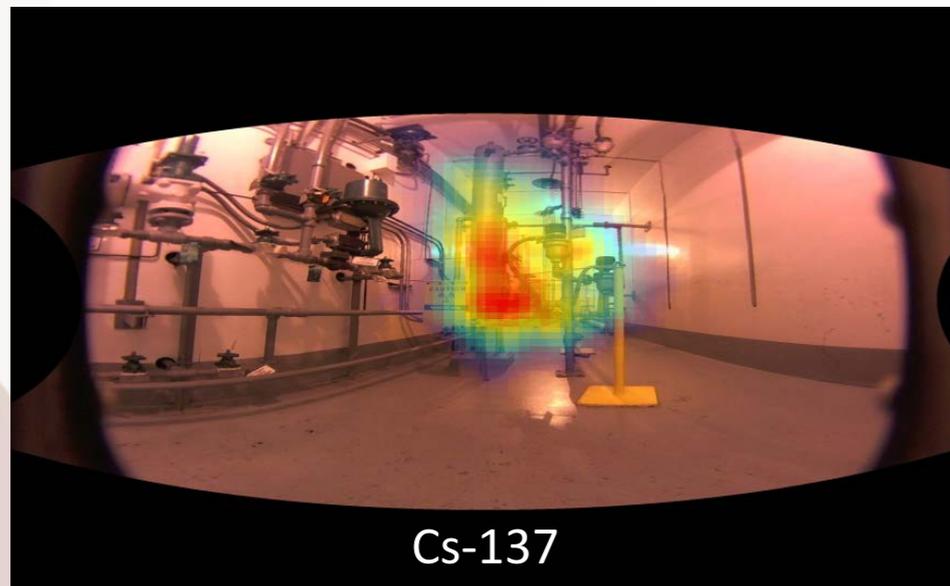
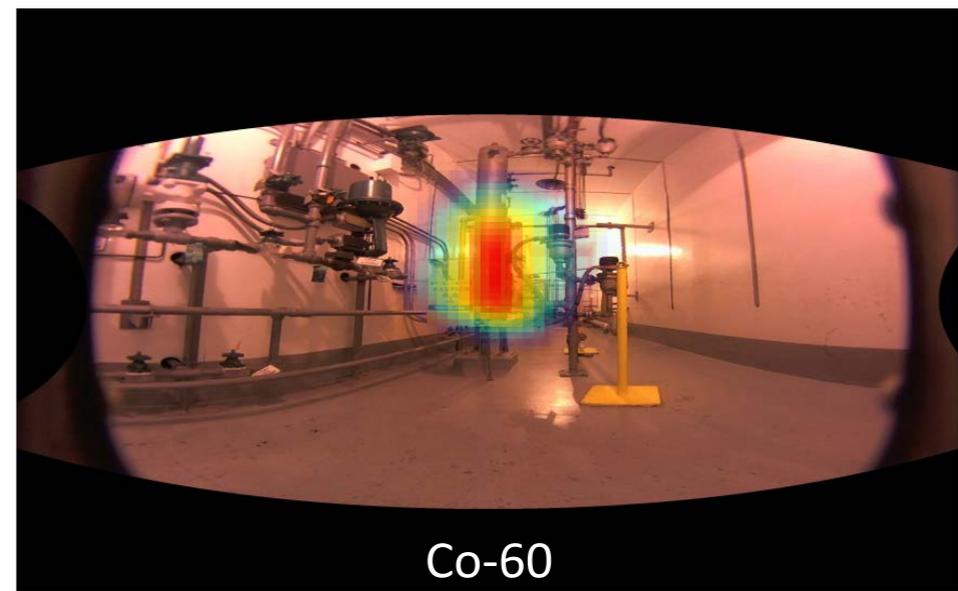
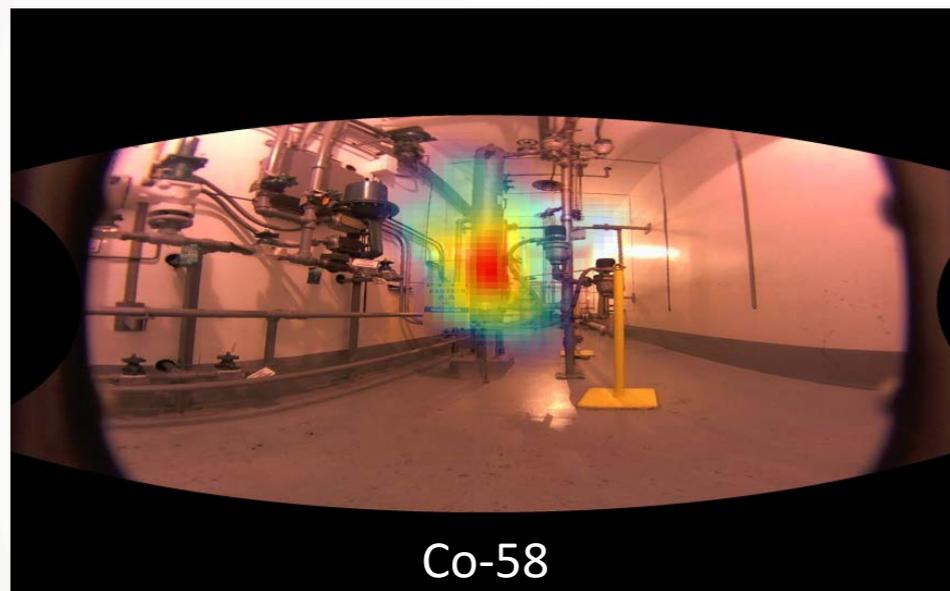
S. Waste Gas Header:  
Co-58, Co-60, Cs-137, Nb-95

# Elevated Dose Rates in Waste Gas System – S. Waste Gas Header



All Isotopes

# Elevated Dose Rates in Waste Gas System – S. Waste Gas Header



# Elevated Dose Rates in Waste Gas System

- When the spent resin storage tank was filled water solid, the vent path allowed water to enter the plant vent header.
- This water cleared out particles entrained in the piping and flowed down to the drain tank.
- The gas / vapor with the radioactive particles was drawn into the south compressor suction.

# Turbine Building Measurements

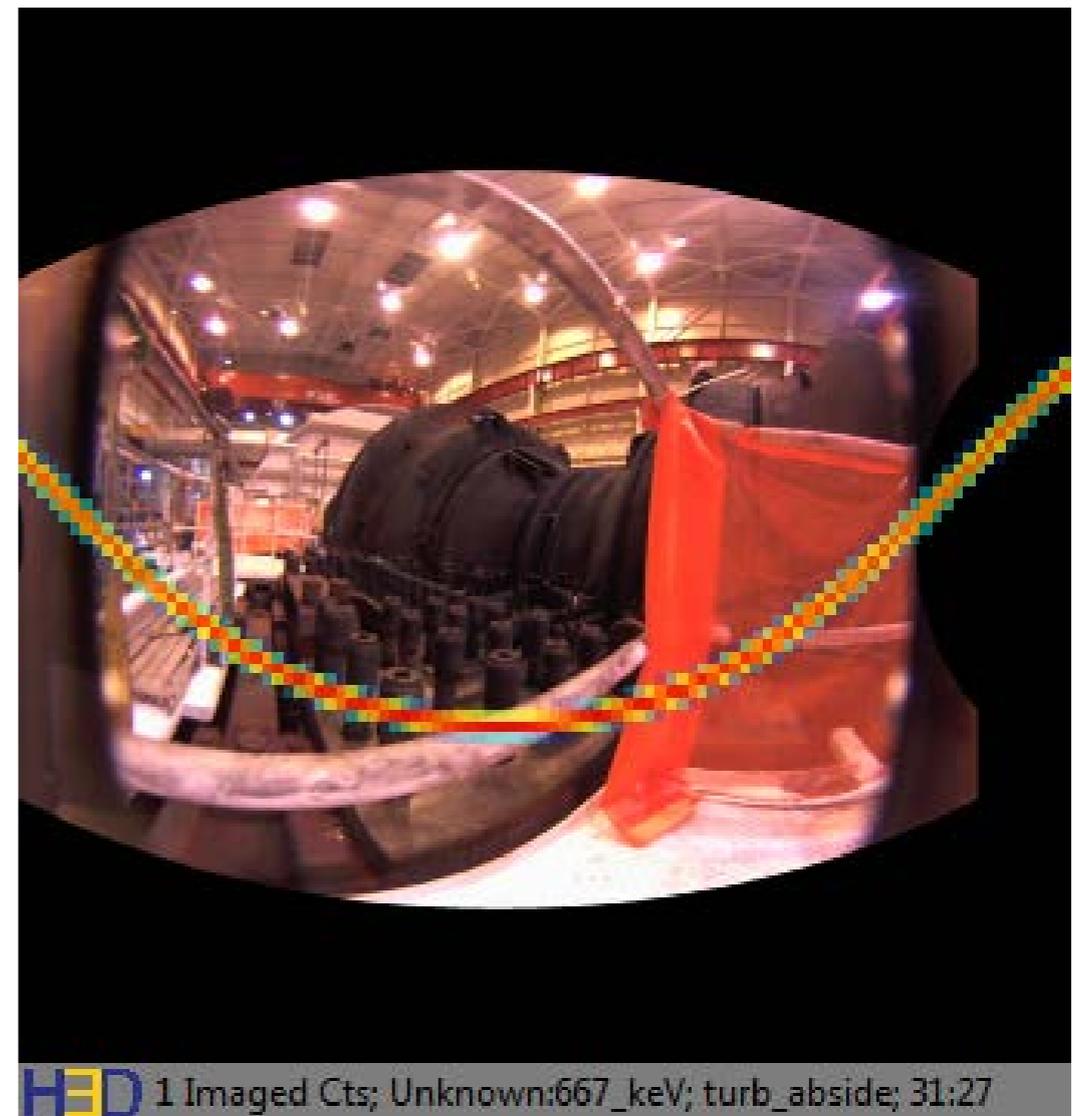
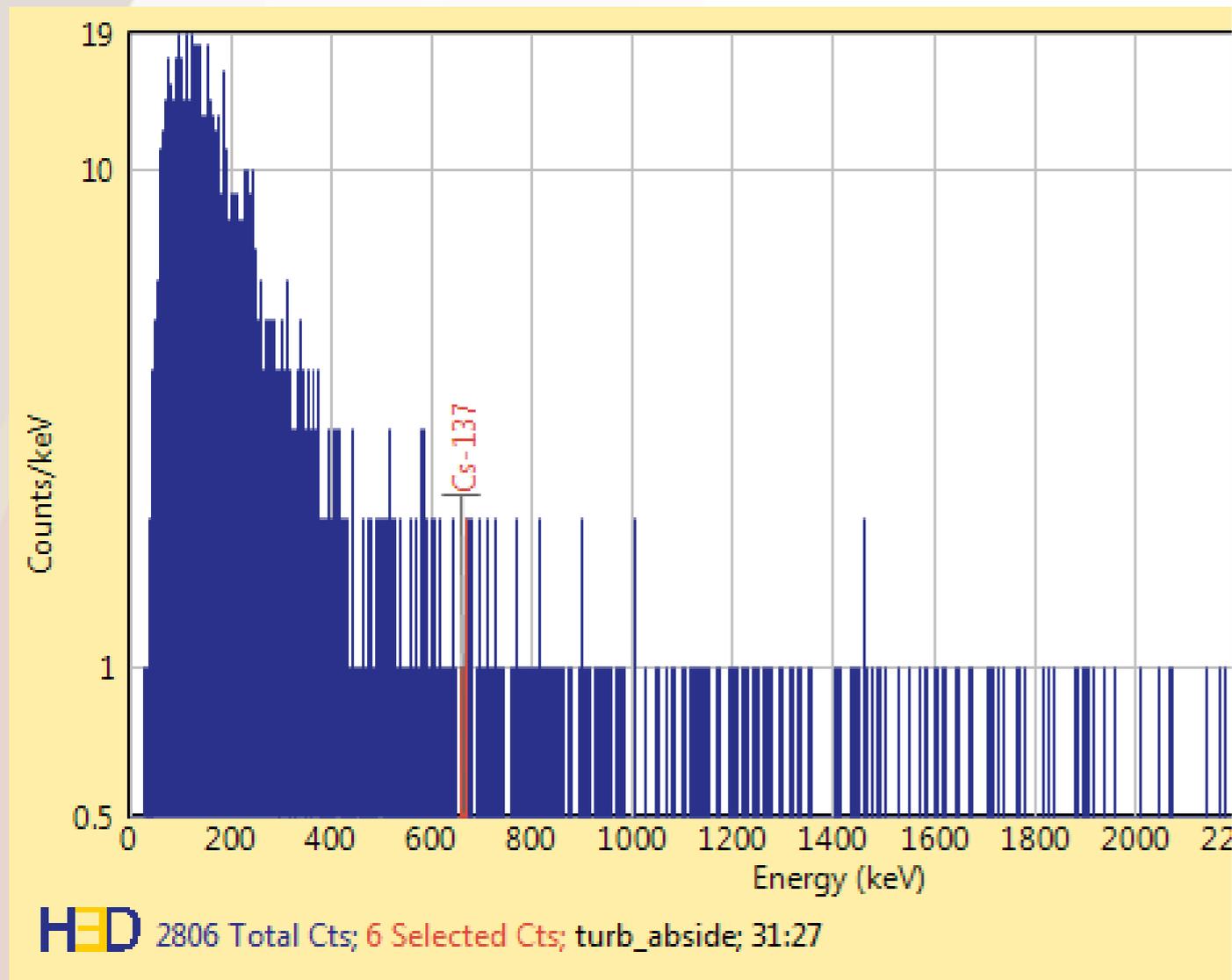
Disassembly of two (2) Low Pressure Turbines (LPTs) with aggressive work scheduled

Historical very low levels of fixed contamination found in localized areas.

Work treated as potentially contaminated until shown otherwise

2 CPS – No noticed contamination. It's a good zero!

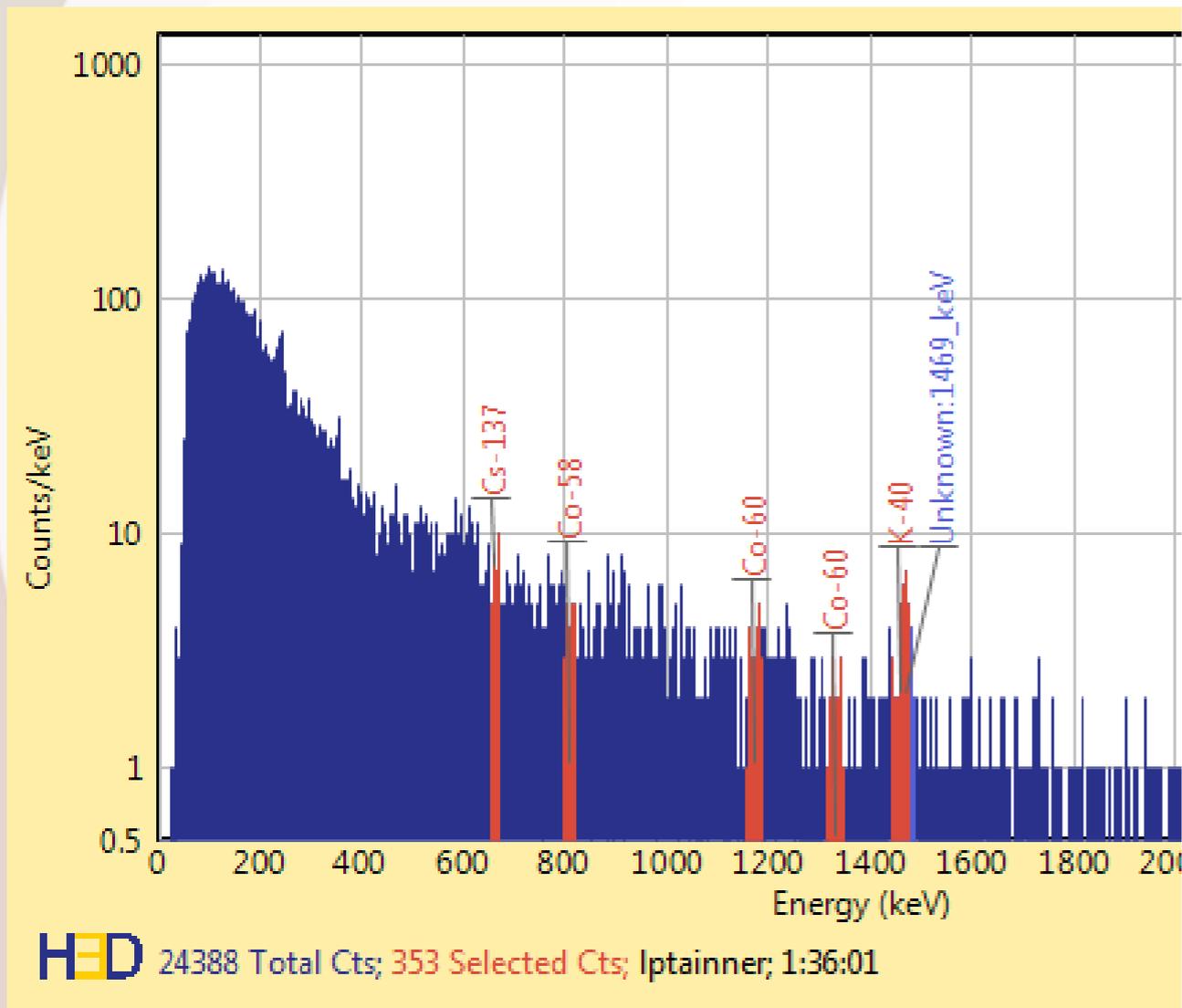
# LPT 'B' O/S of Inner Cover



Something needs to be selected. Cs-137 most probable isotope, nothing above bkgd

# LPT 'A' – I/S Inner Cover (Posted Restricted Area from Survey)

1 hour 30 minute measurement – No plant identified peaks



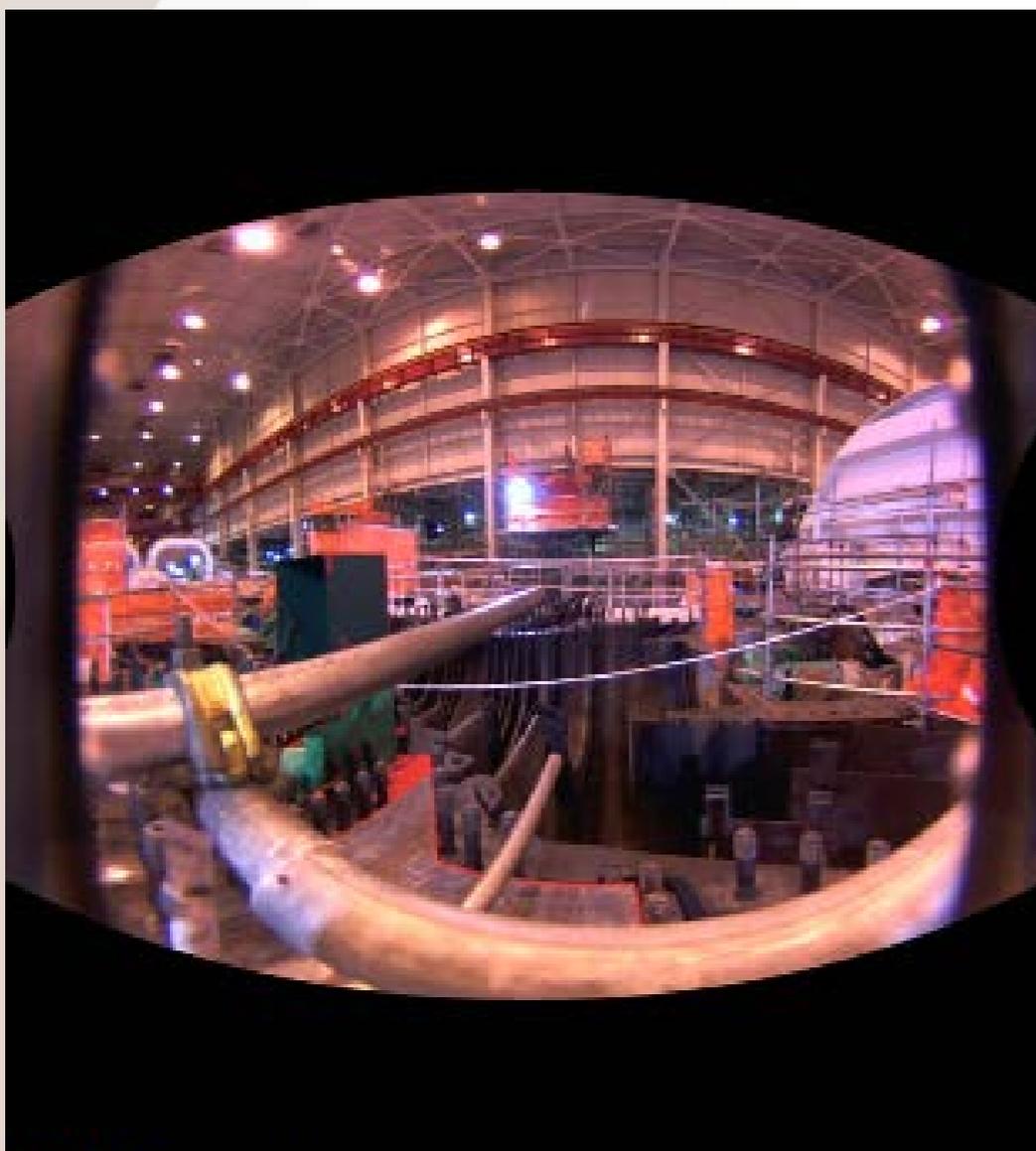
Unknown Peak is K-40 – Software misidentification. Only noted peak on spectrum.  
Other isotopes selected as reference

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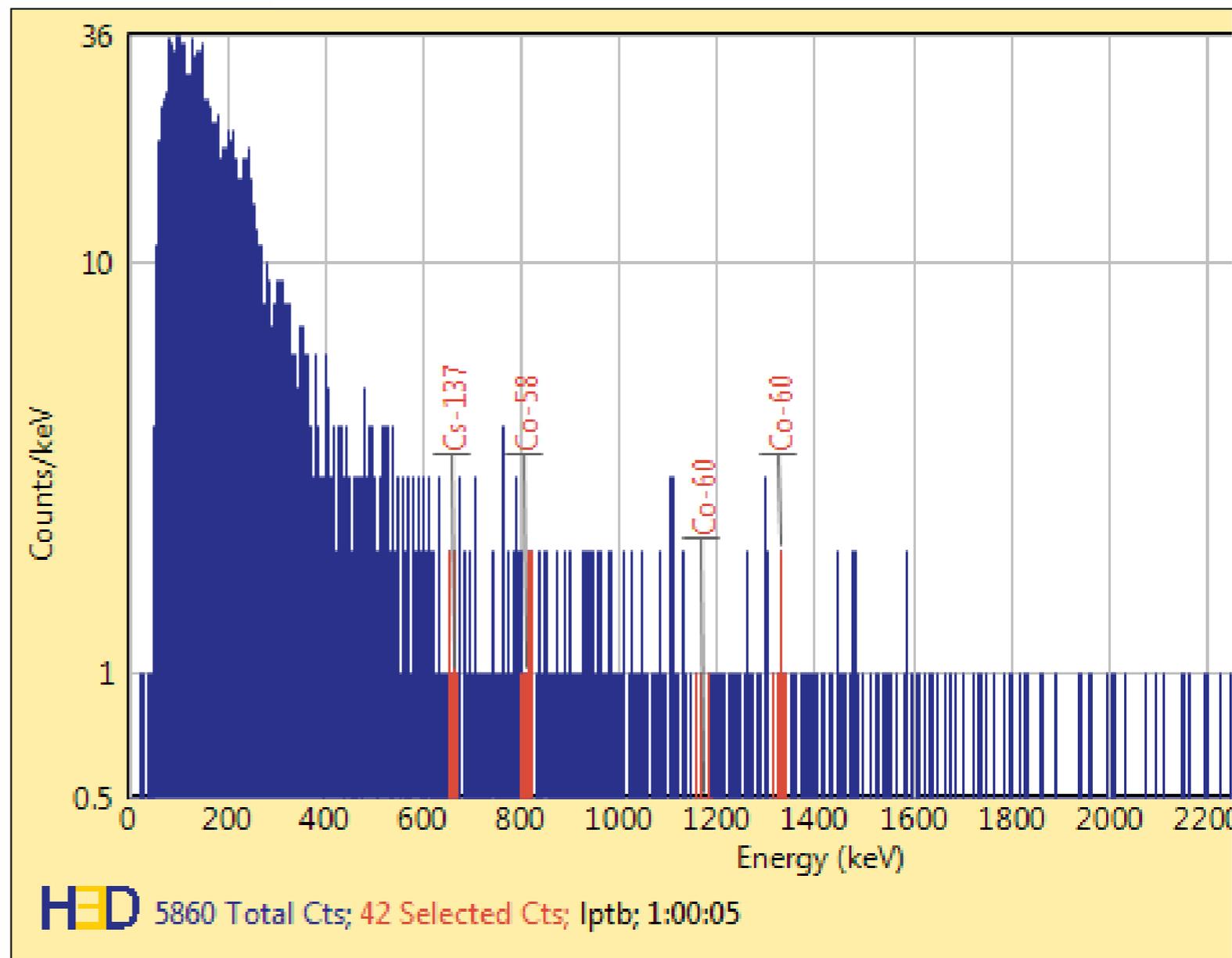


Count Rate 2 CPS!!! – Count Rate in the office buildings 7-8 CPS  
No peak received 10 counts in 1 hour.

# Turbine Building Measurements



HED Iptb; 1:00:05



# “Co-58” – 3 imaged counts

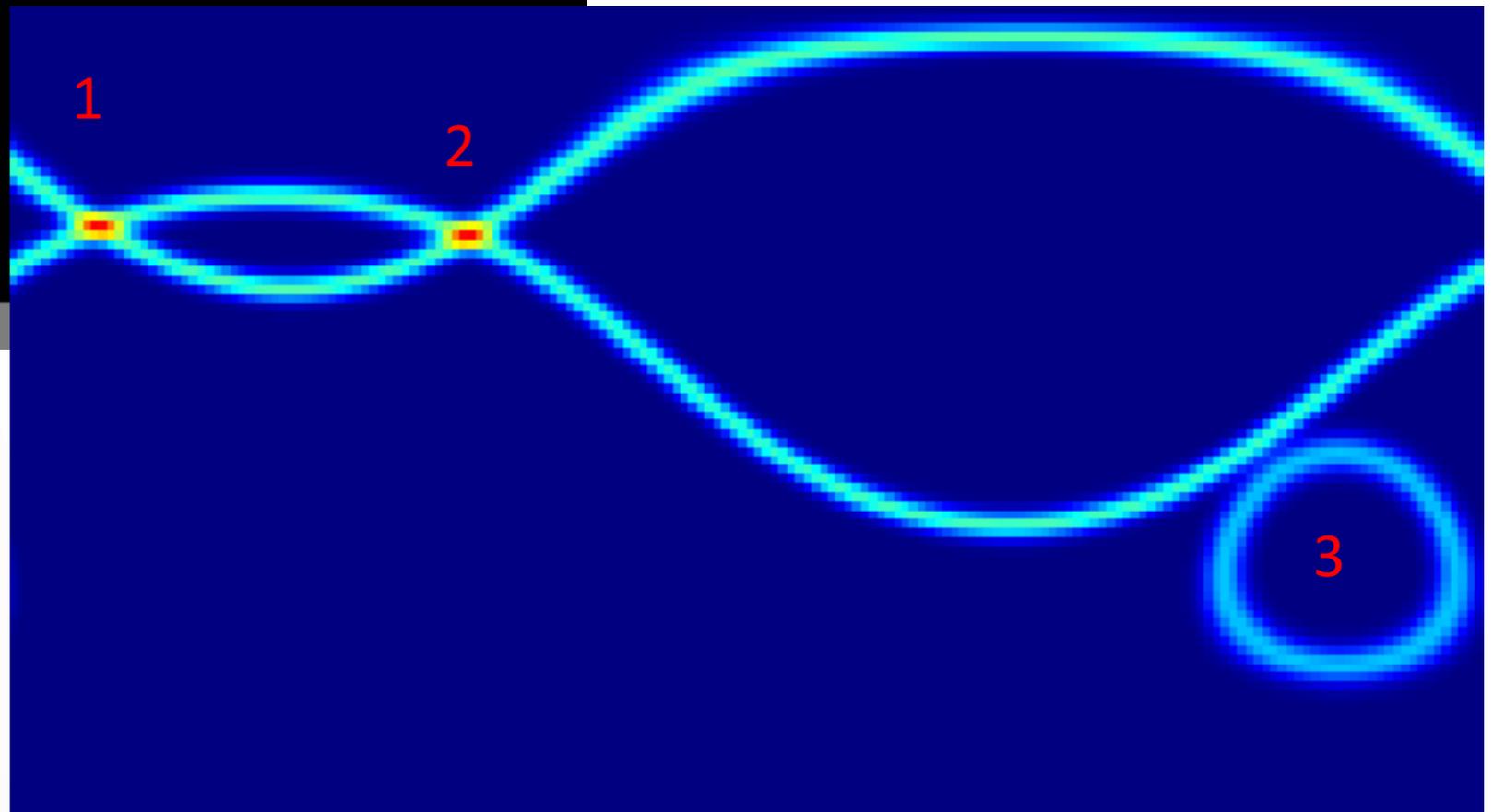
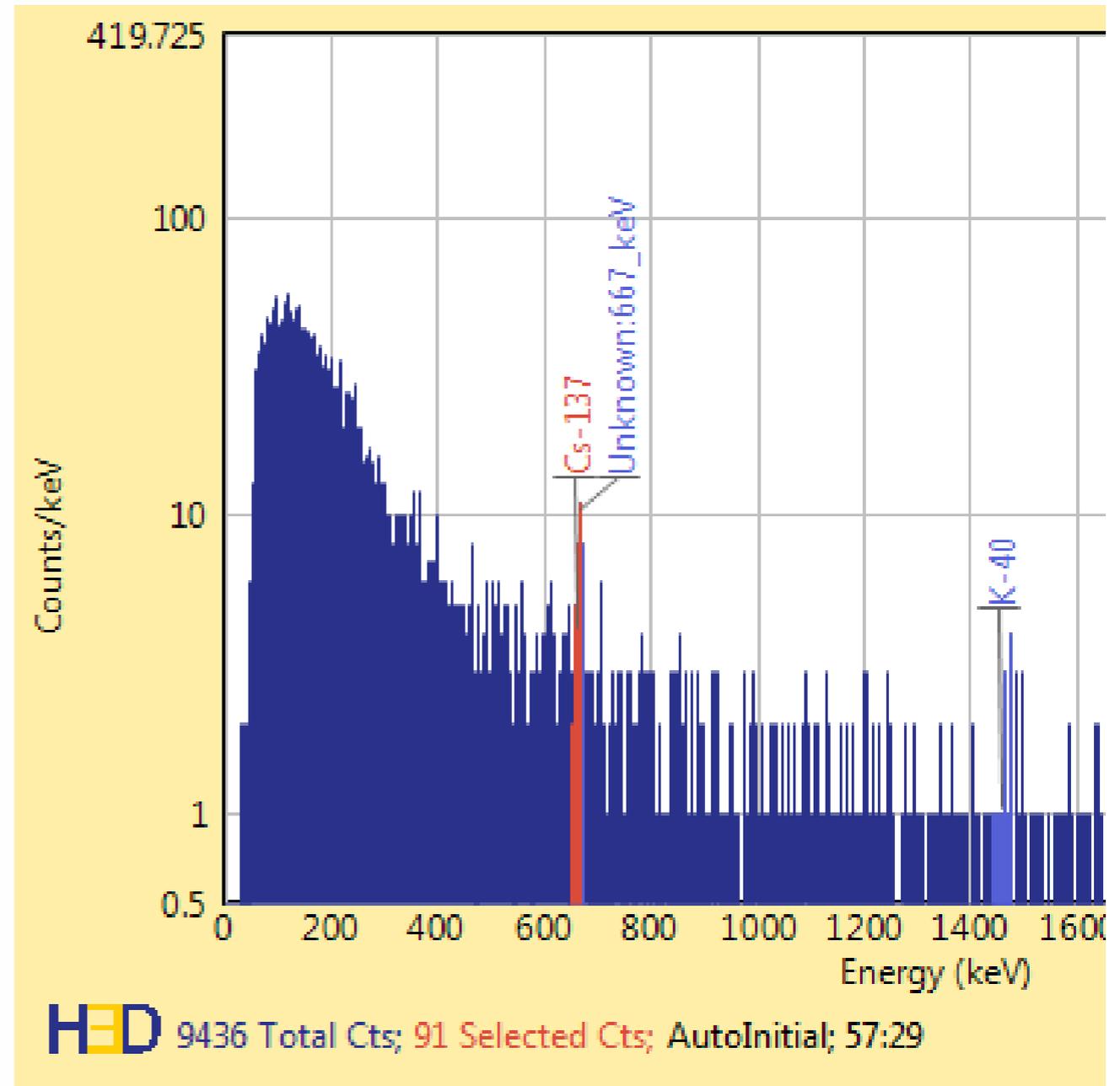
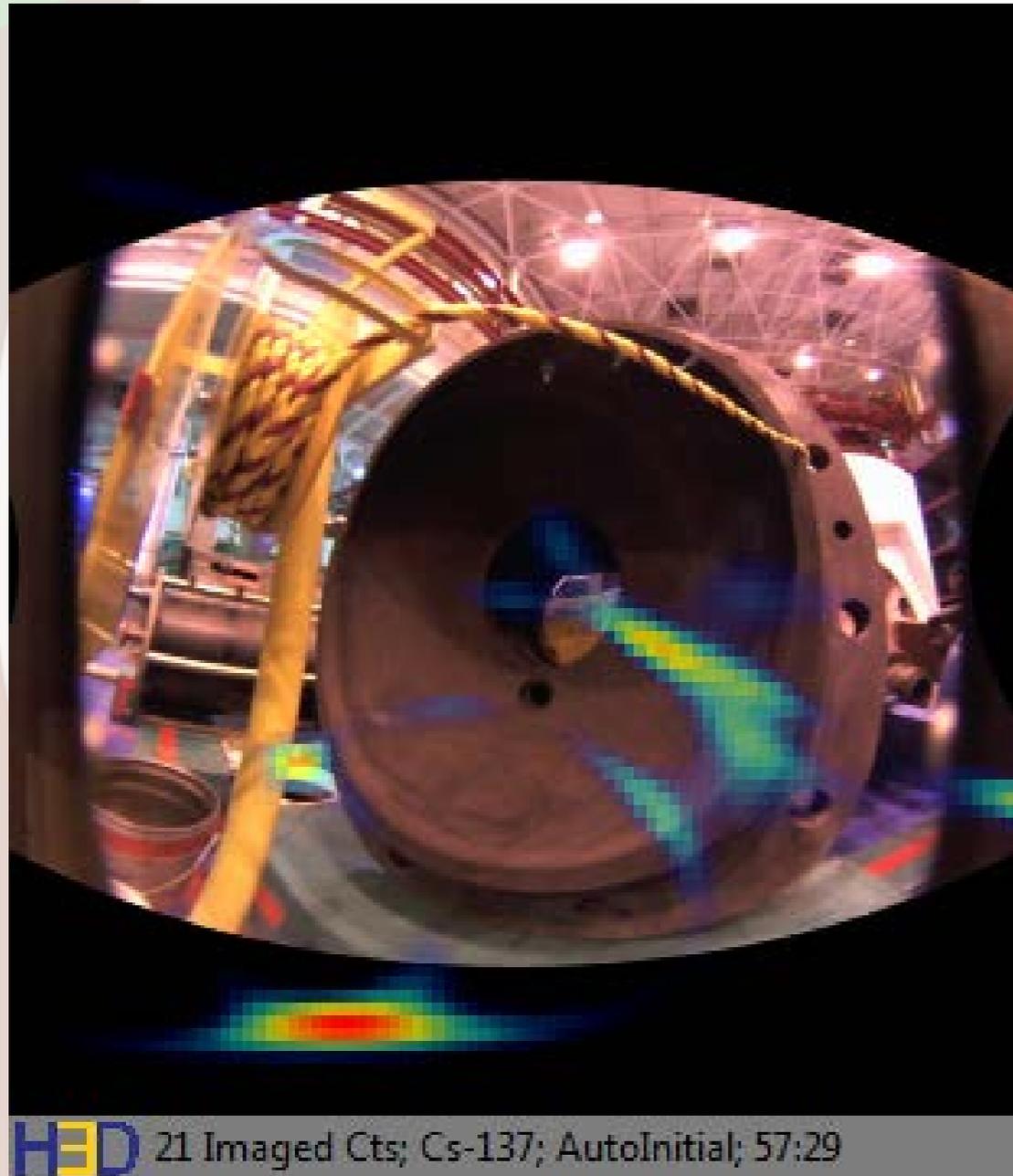


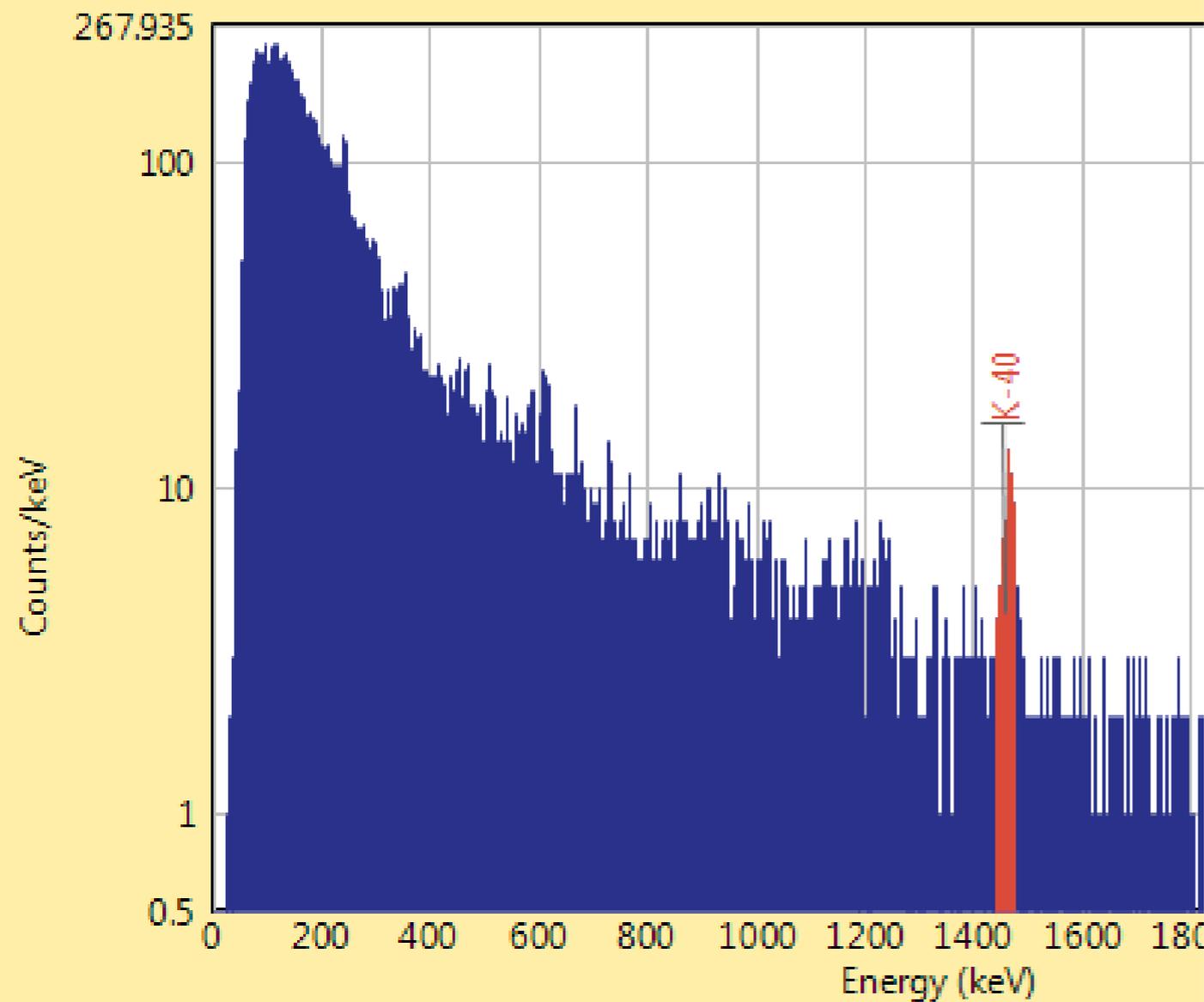
Image is not resolved. The system will image any energy range (>250 keV) programmed regardless of background in the area and whether the isotope is actually present.

# Turbine Stop Valve – Positive Cs-137

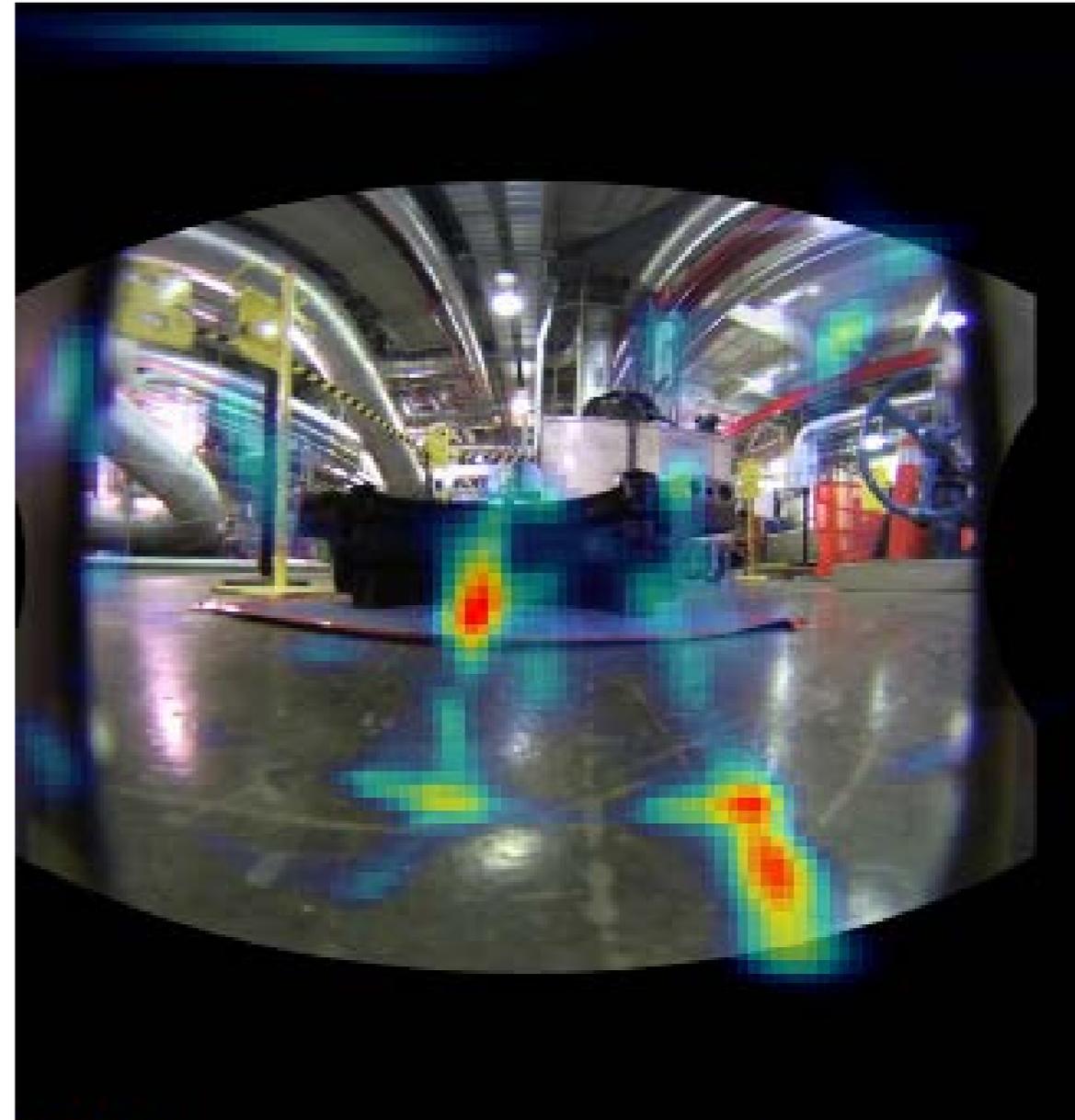


Count Rate of 3 CPS for 58 minutes. Image is not fully resolved to show contamination location. Verification of plant generated isotopes on fixed contamination.

# Auxiliary Feedwater Pump Seal

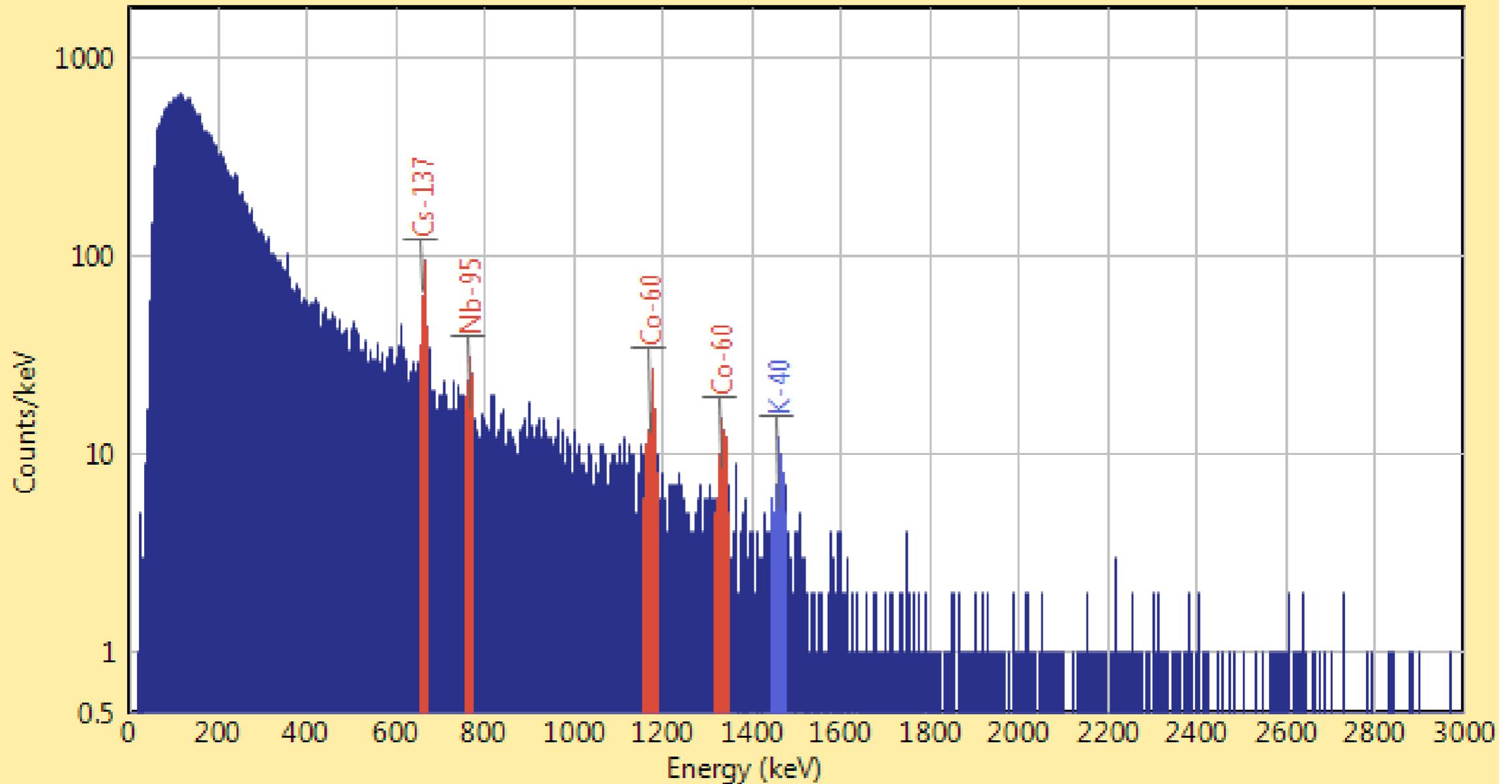


**HED** 44097 Total Cts; 199 Selected Cts; mfp\_parts; 2:43:34



**HED** 83 Imaged Cts; K-40; mfp\_parts; 2:43:34

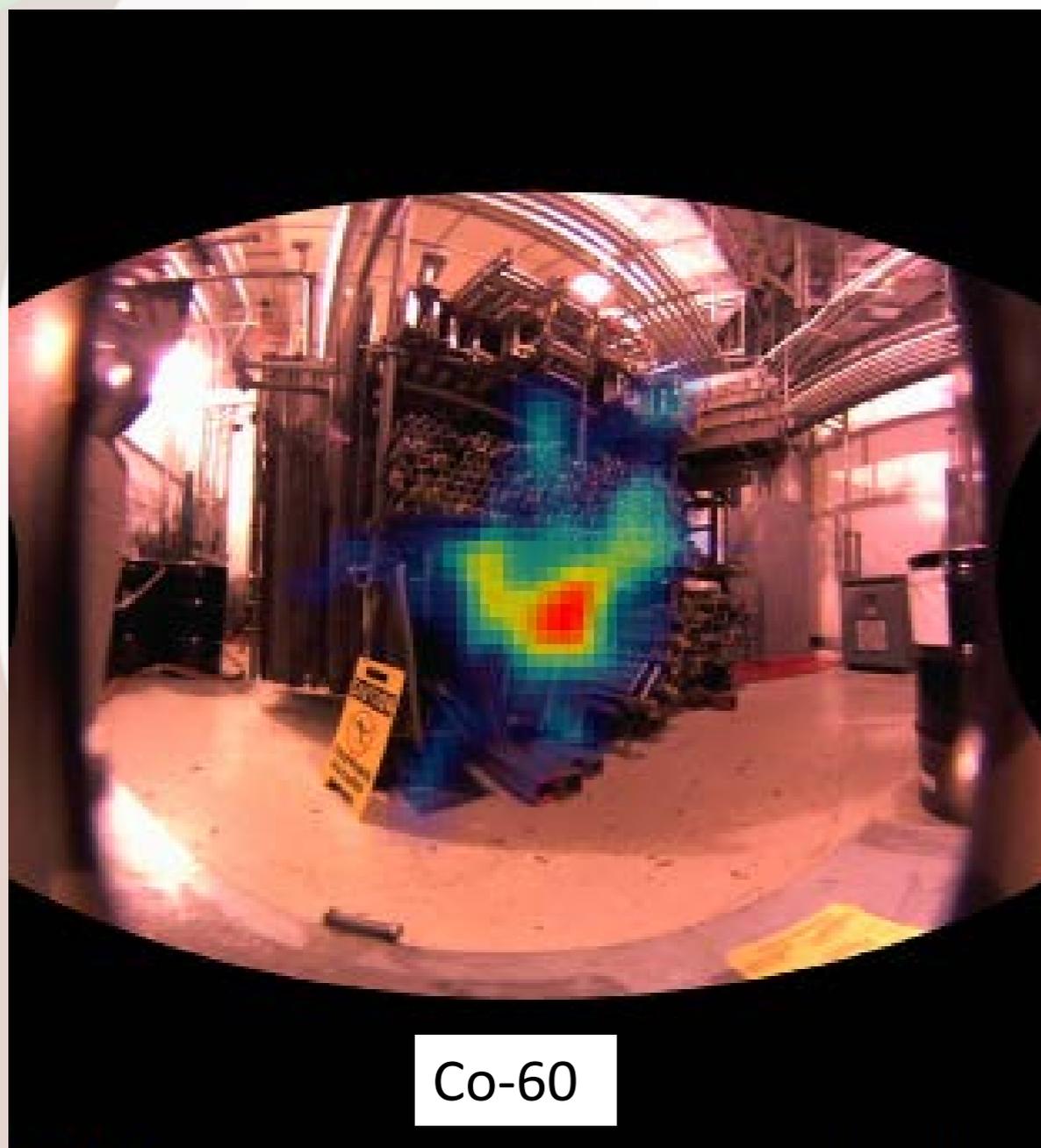
# Scaffold Rack Contamination



HED 116498 Total Cts; 1791 Selected Cts; cook\_unit\_2\_609\_scaffolding\_5; 2:55:00

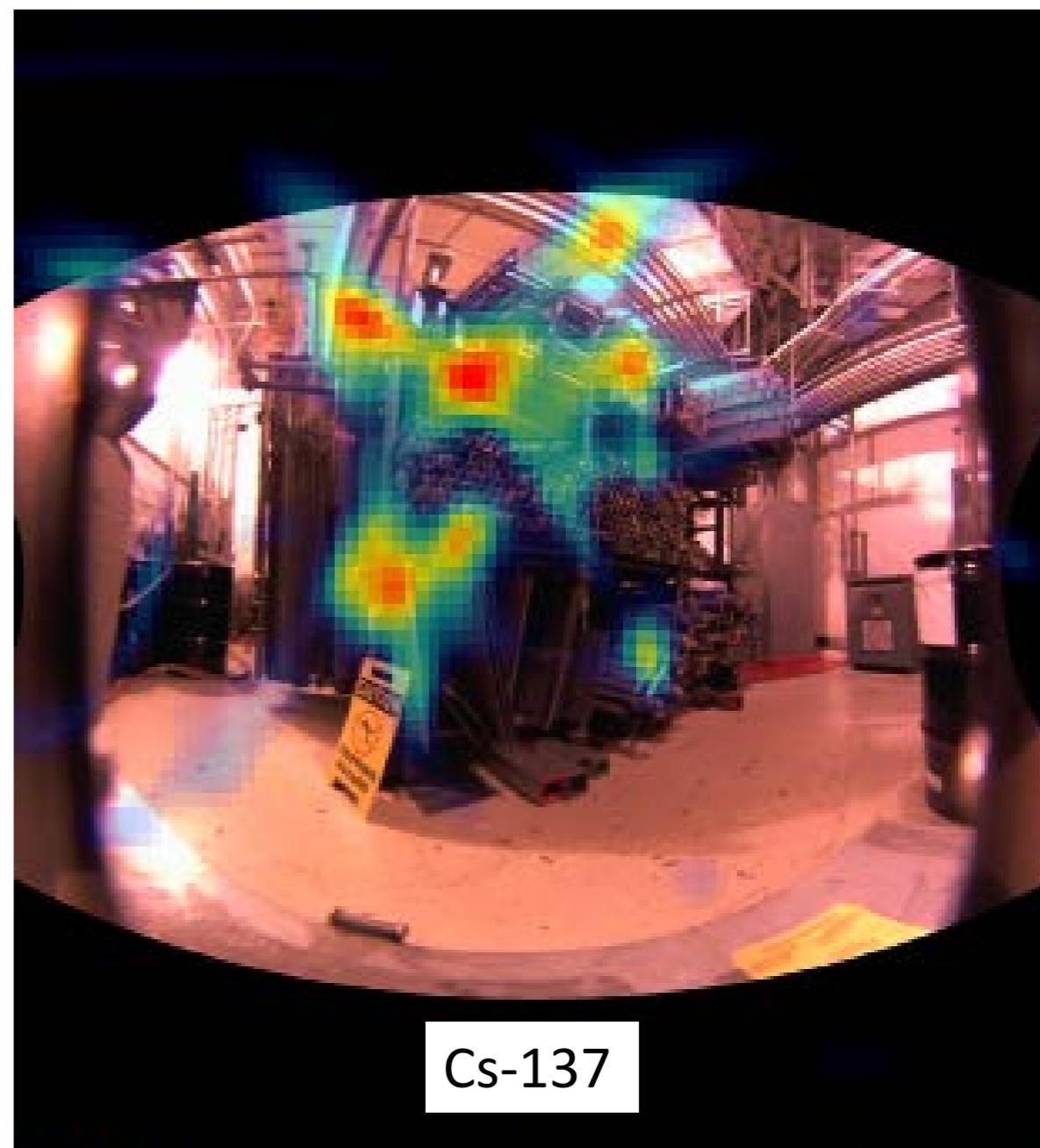
Detected Selected

# Scaffold Rack Contamination



Co-60

HED 209 Imaged Cts; Co-60; cook\_unit\_2\_609\_scaffoldir



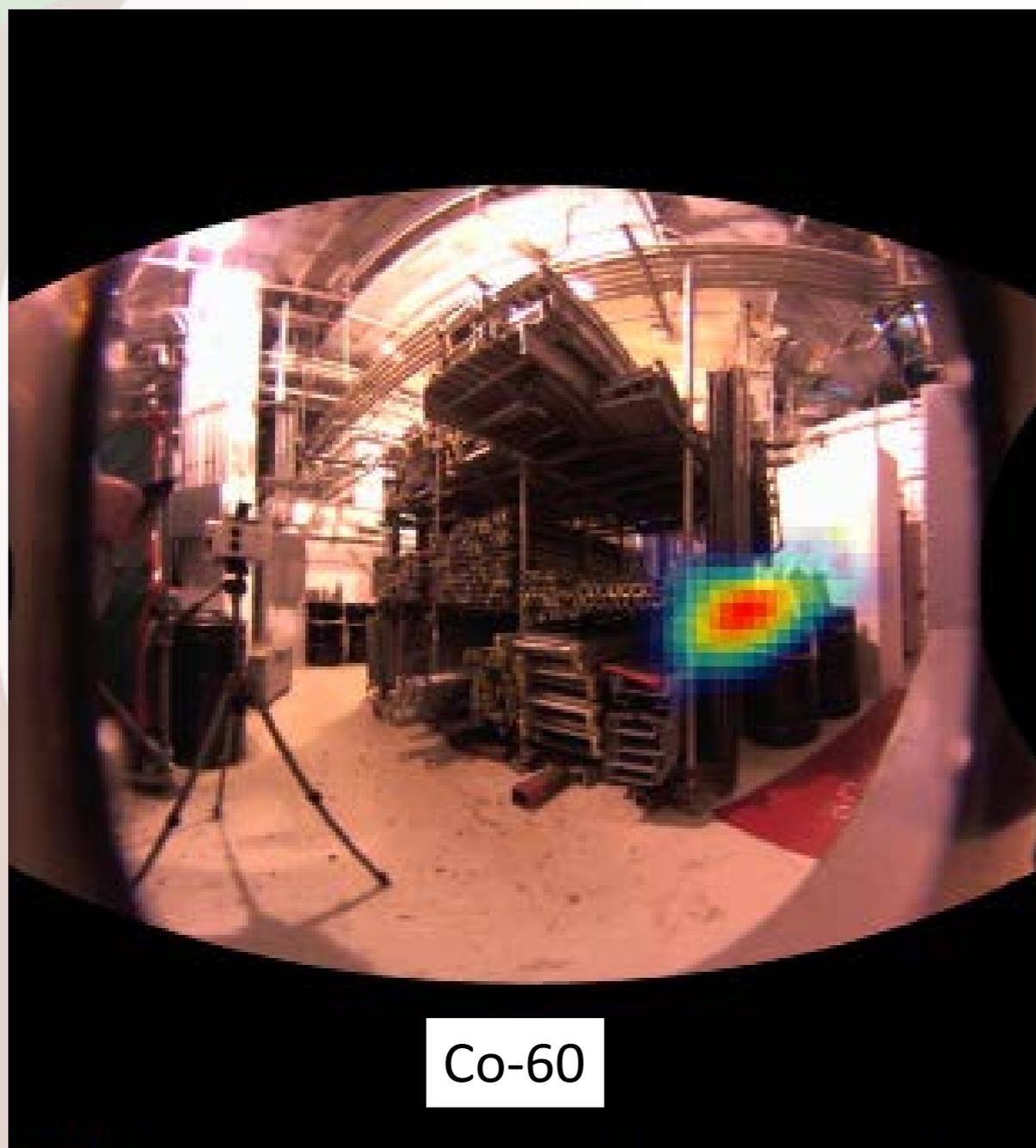
Cs-137

HED 249 Imaged Cts; Cs-137; cook\_unit\_2\_609\_scaffoldir

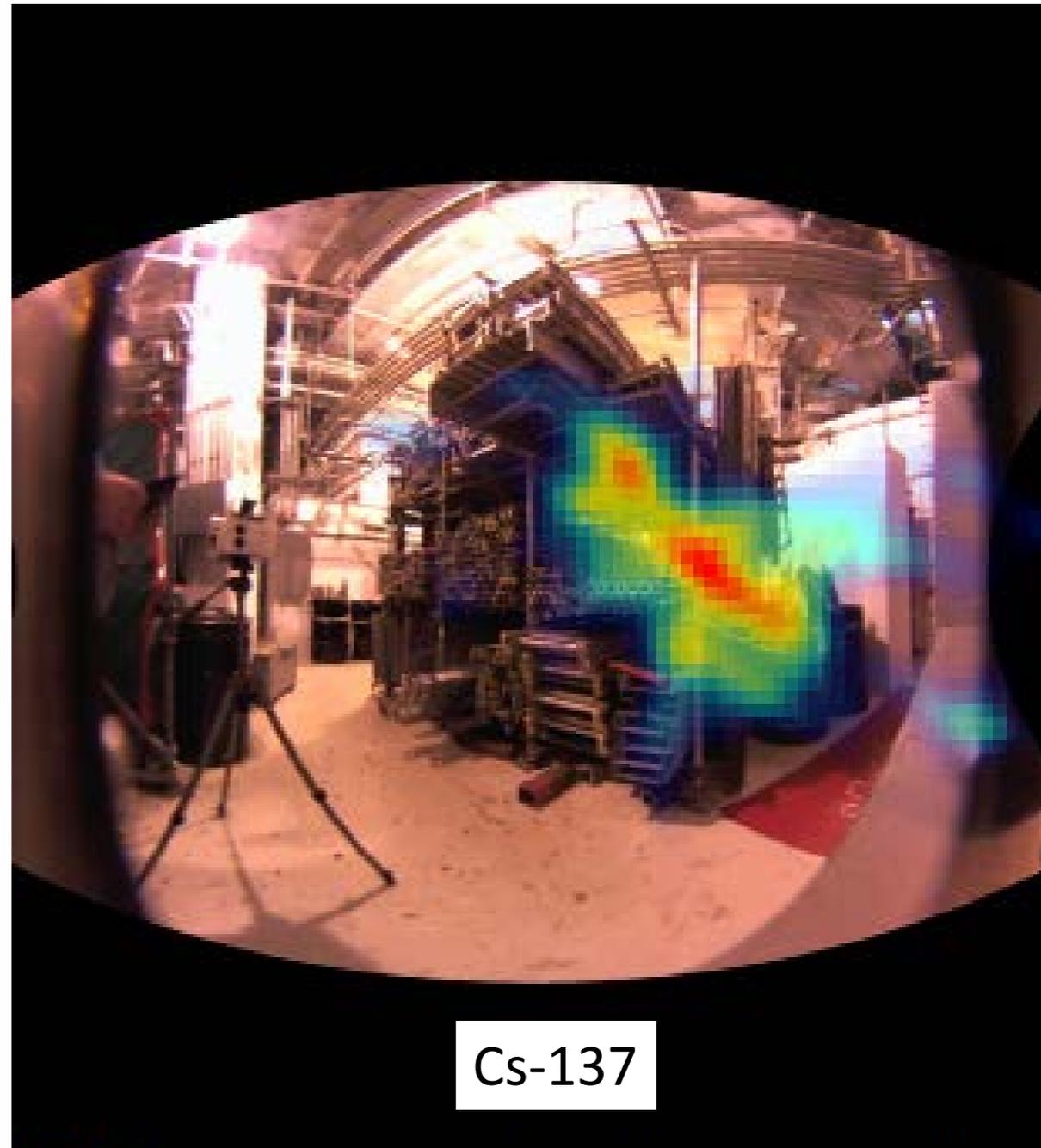
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# Scaffold Rack Contamination



HED 369 Imaged Cts; Co-60; 603\_aux\_unit\_2\_scaffolding

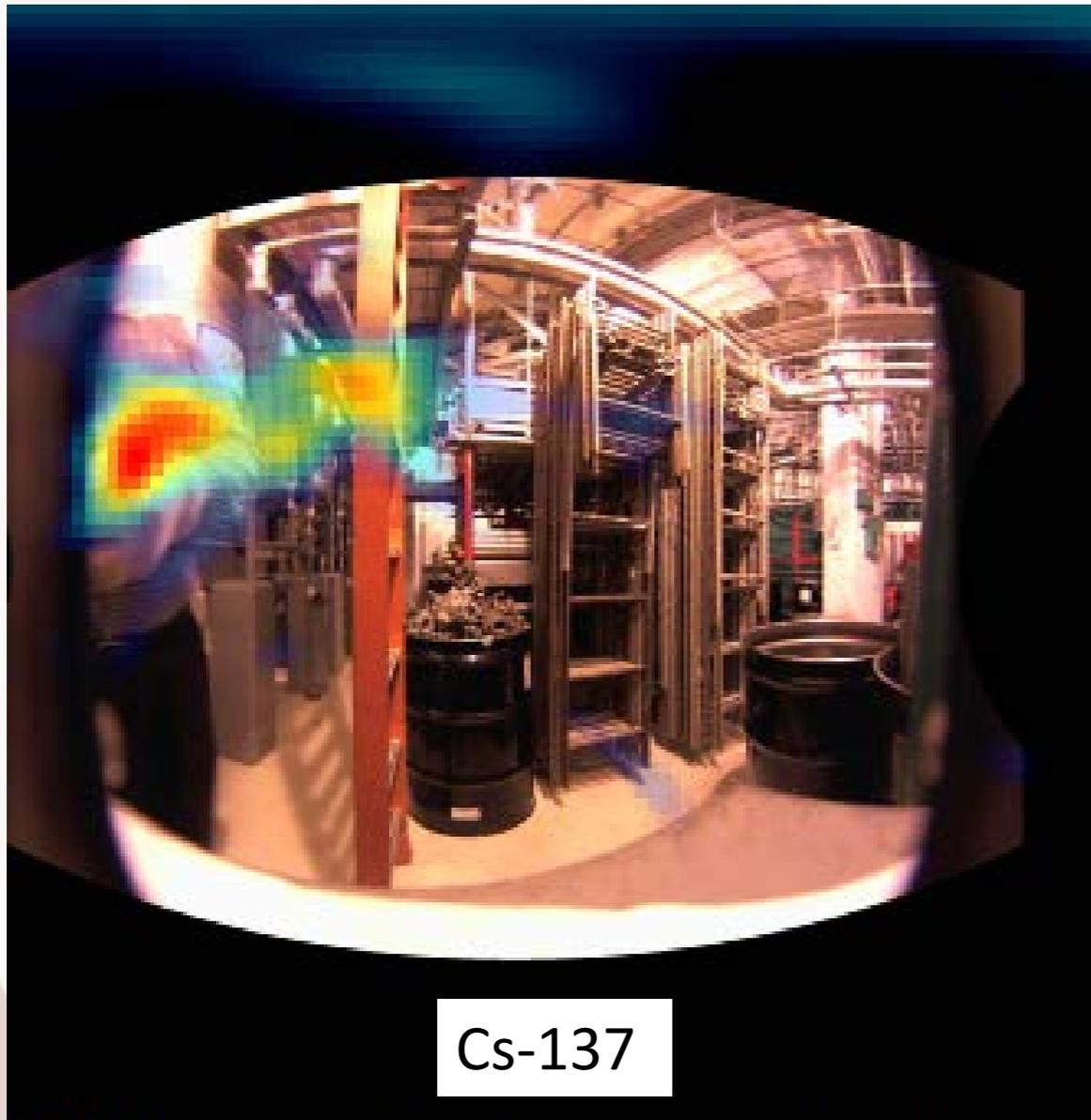


HED 217 Imaged Cts; Cs-137; 603\_aux\_unit\_2\_scaffolding

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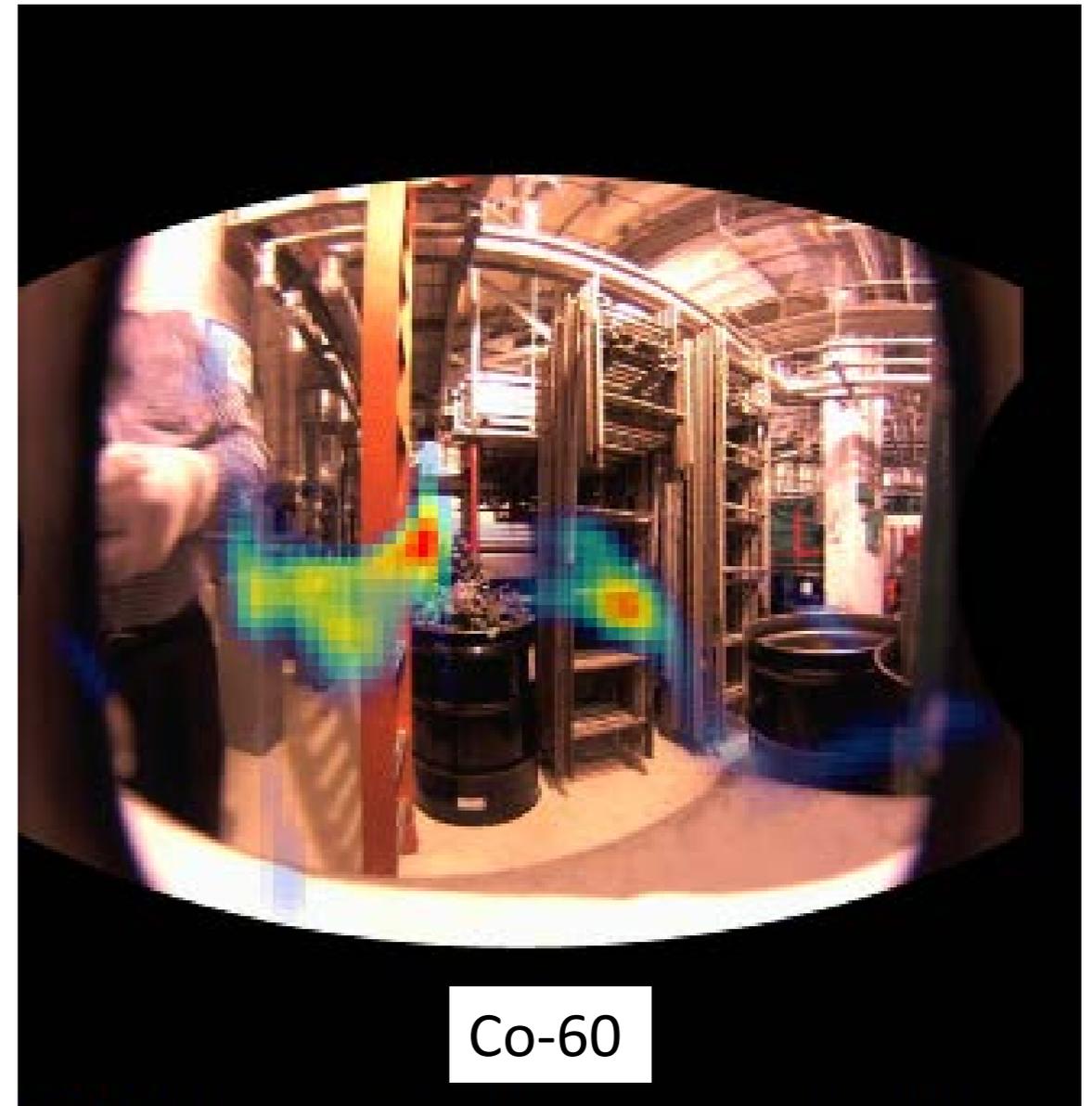


# Scaffold Rack Contamination – Behind Scaffold



Cs-137

HED 90 Imaged Cts; Cs-137; cook\_unit\_2\_609\_scaffolding\_st

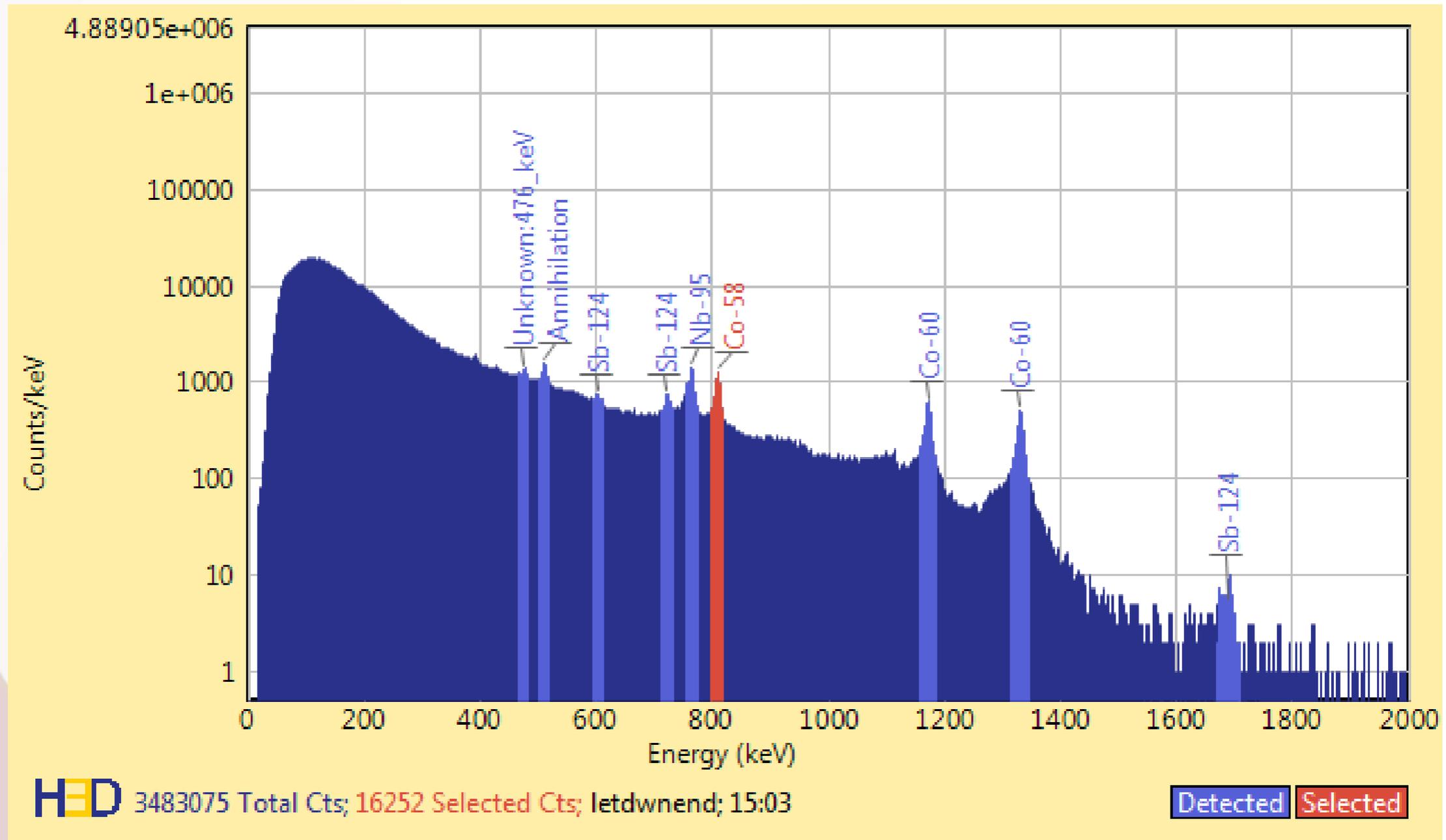


Co-60

HED 51 Imaged Cts; Co-60; cook\_unit\_2\_609\_scaffolding\_st

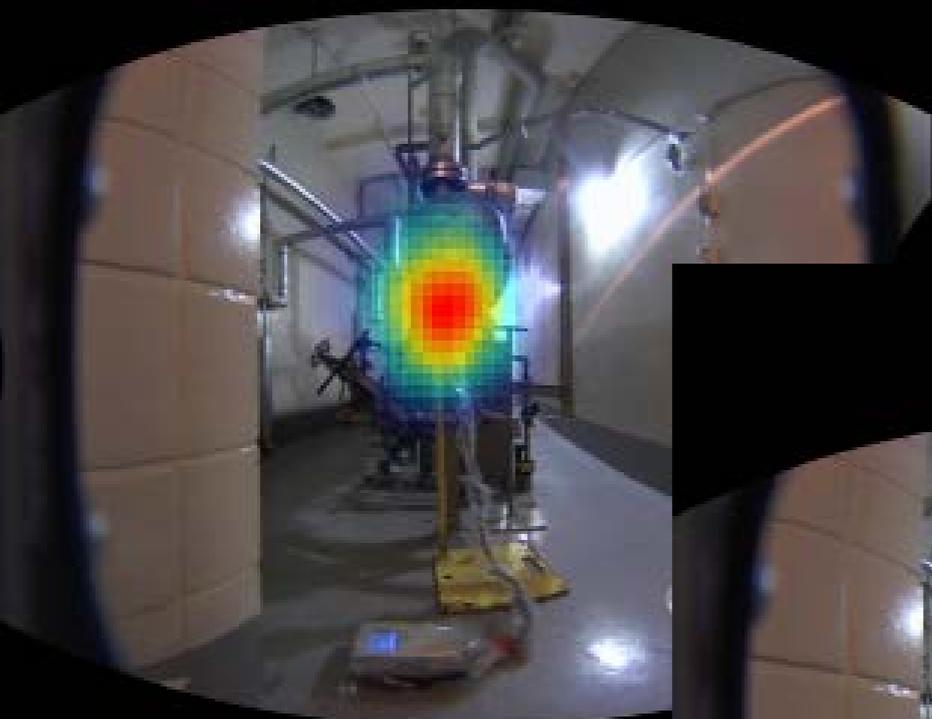
10.4 mR/hr contact w/Ion Chamber –  
Lowest recorded dose rate

# CRUD Location Isotopic – Letdown Hx Endbell

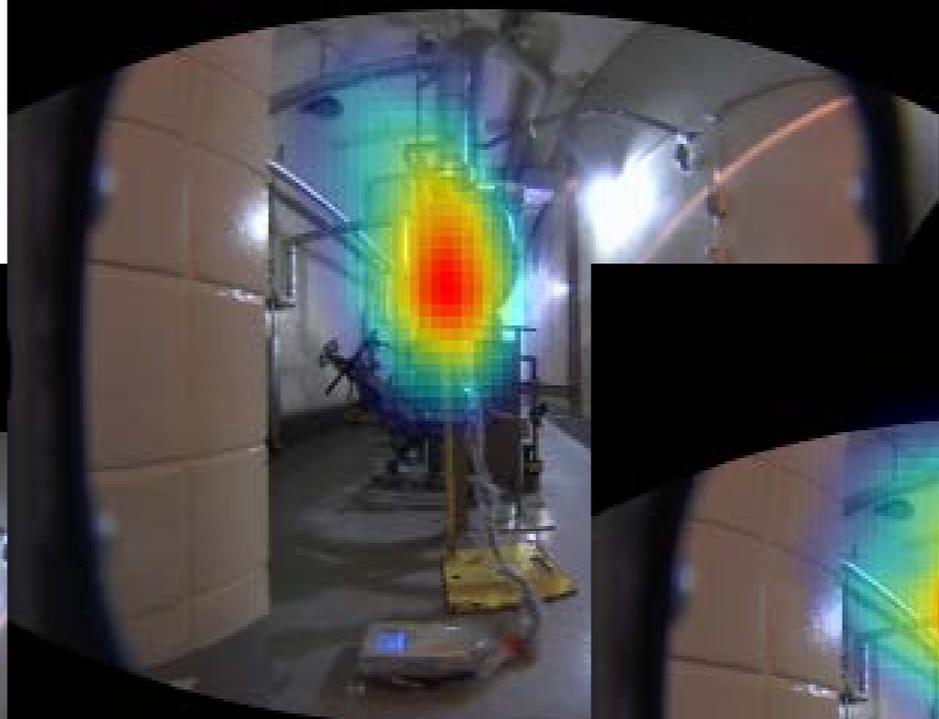


# CRUD Location Isotopic – Letdown Hx Endbell

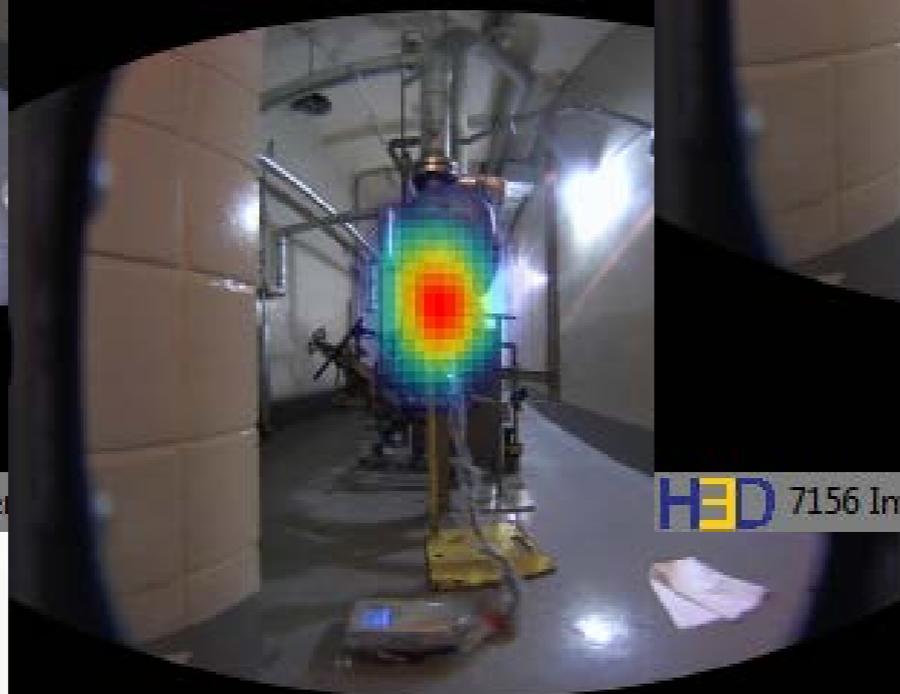
Sb-124



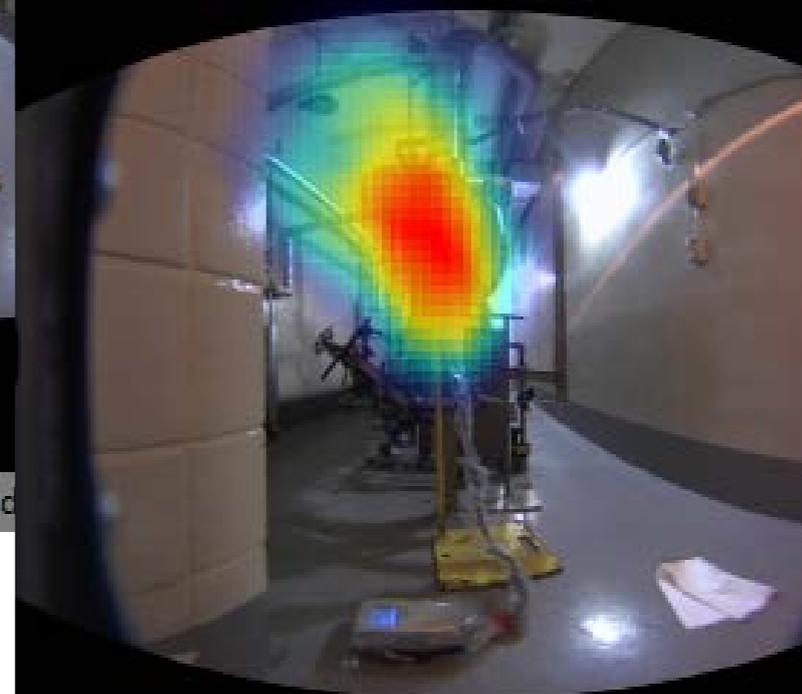
Co-60



Nb-95



Co-58



HED 6181 Imaged Cts; Sb-124; letdwnend

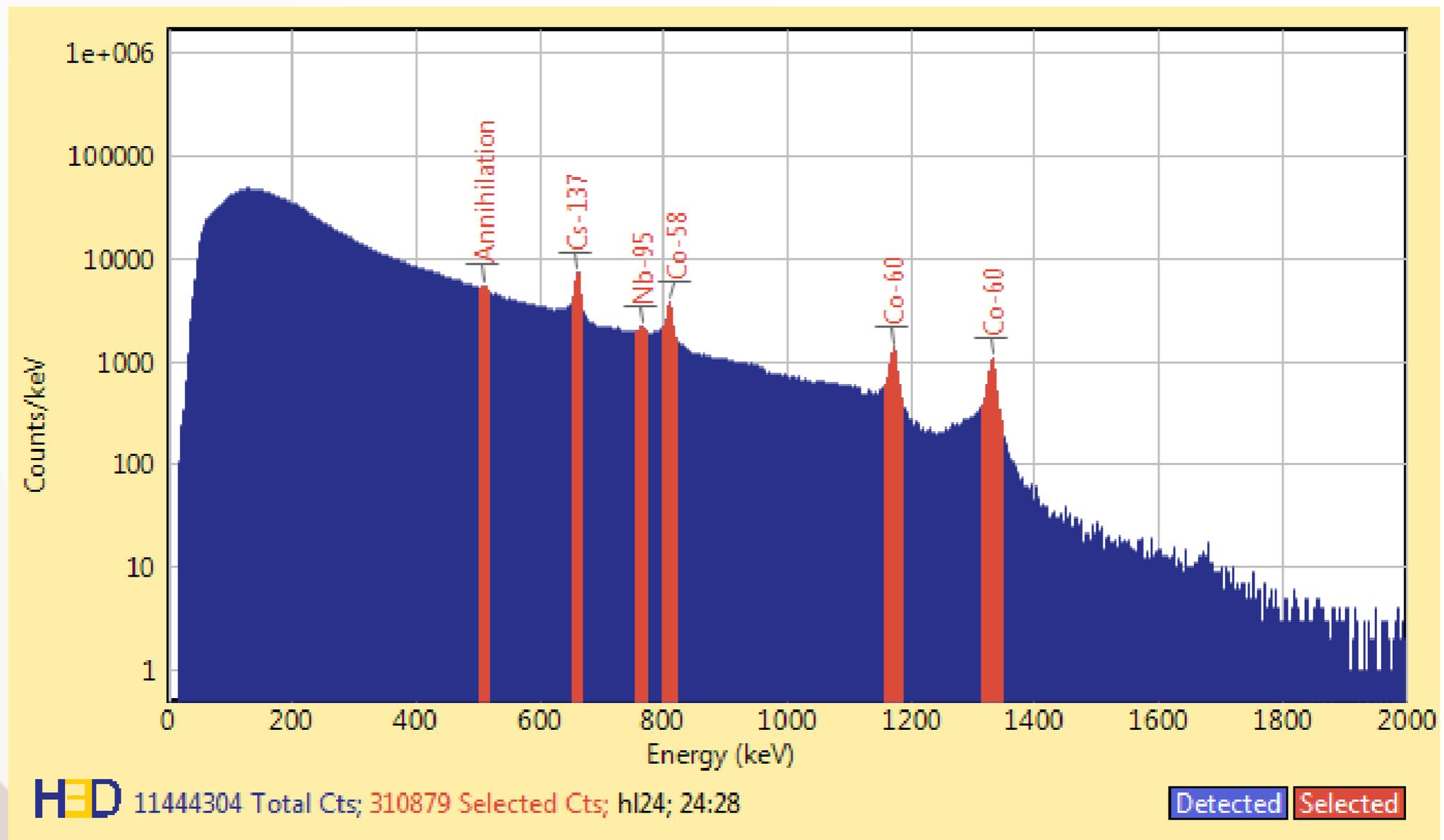
HED 7156 Imaged Cts; Co-60; letdwnend

HED 5998 Imaged Cts; Nb-95; letdwnend; 15:03

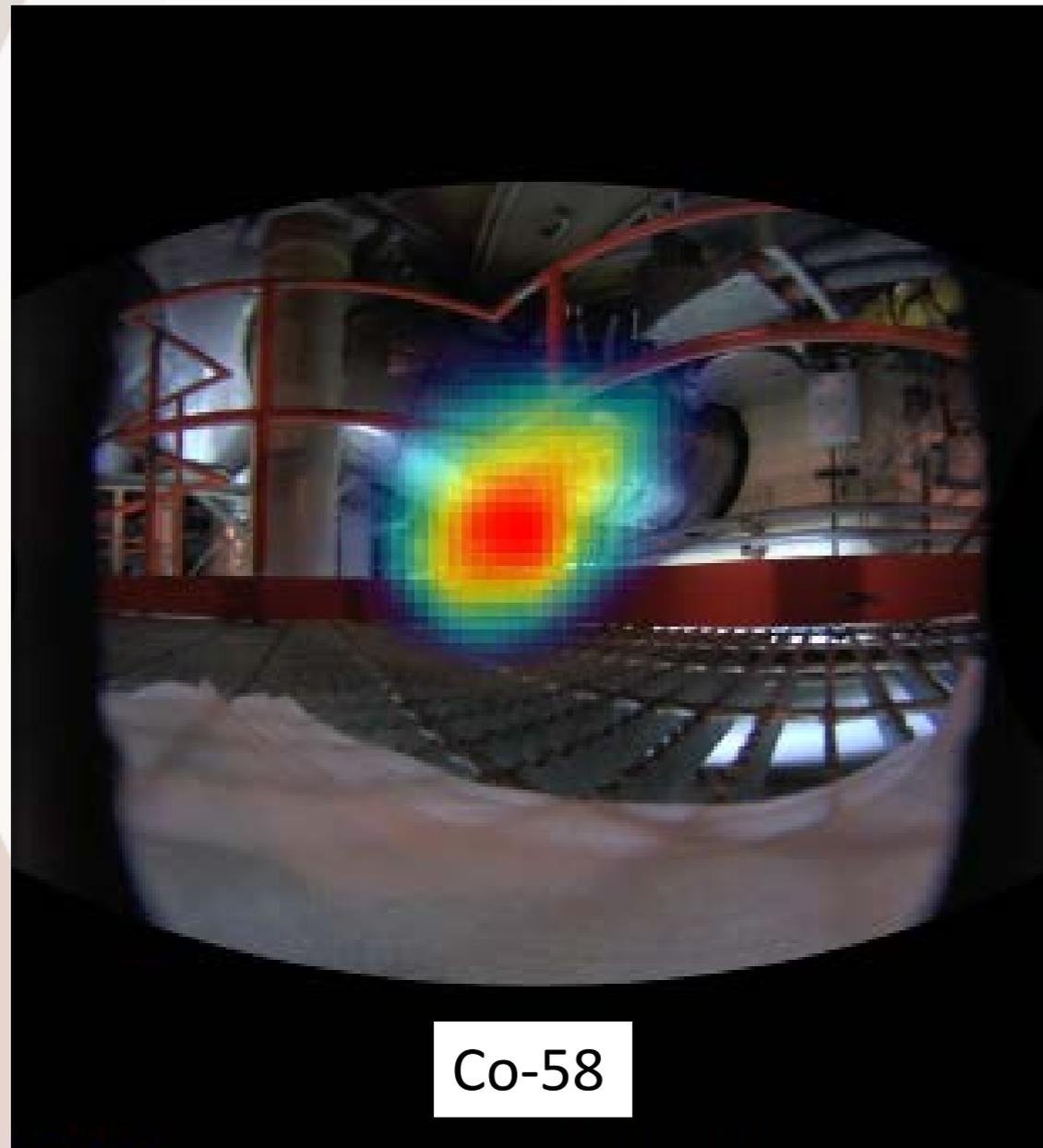
HED 4874 Imaged Cts; Co-58; letdwnend; 15:03

~10 mR/hr on platform, 28 mR/hr contact

# CRUD Location Isotopic – S/G Hot Leg Loop 2

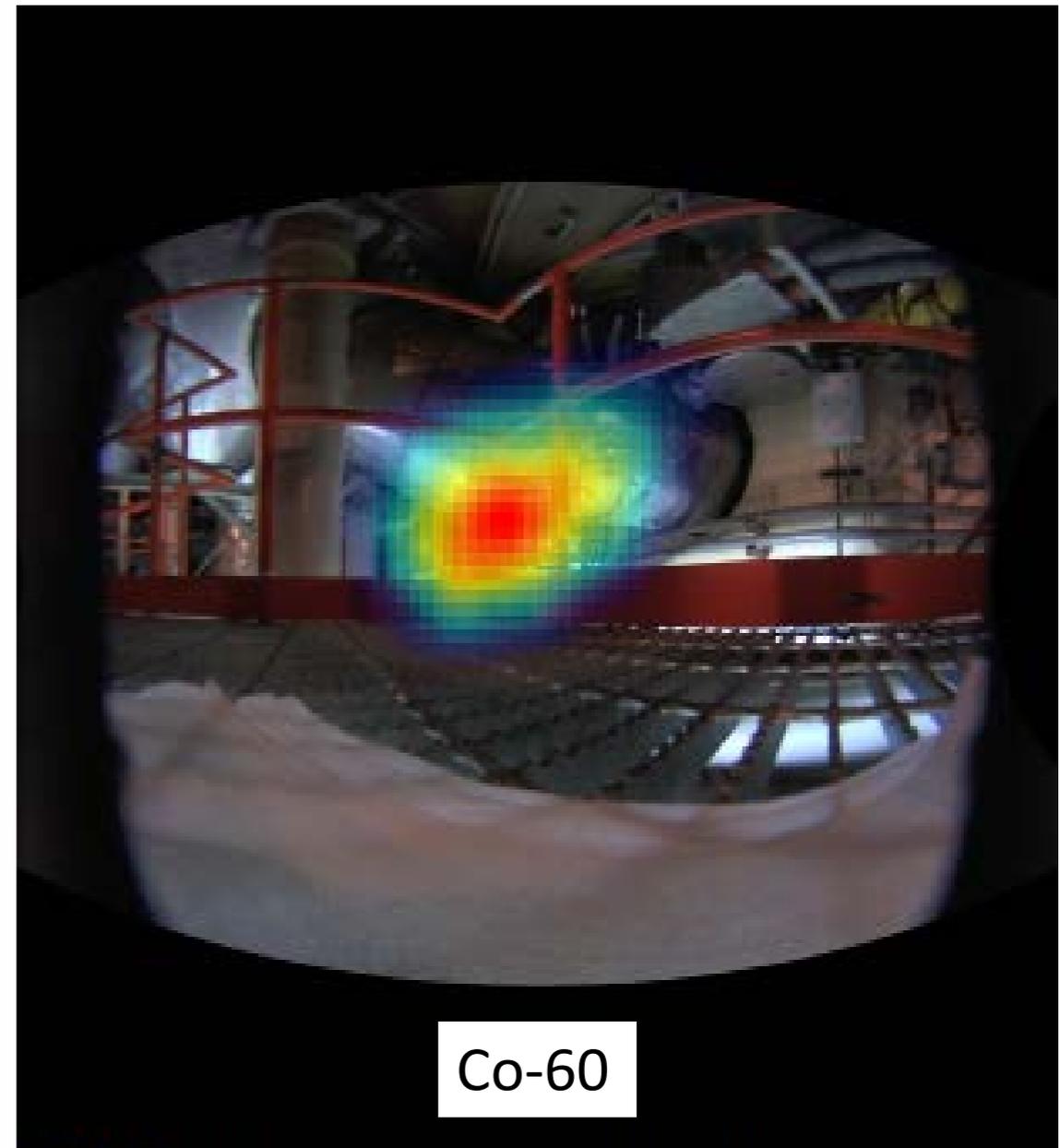


# CRUD Location Isotopic – S/G Hot Leg Loop 2



Co-58

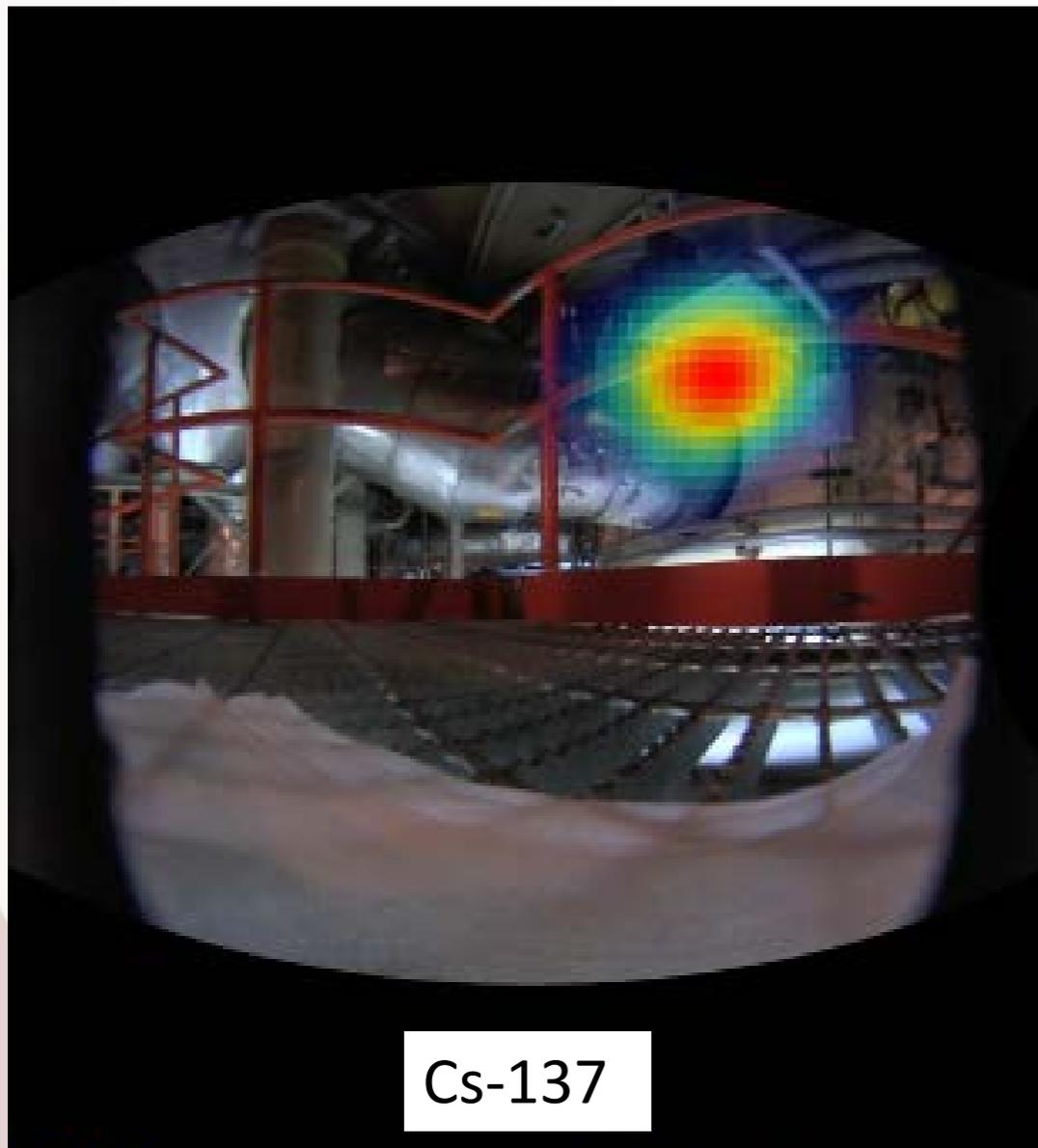
HED 18096 Imaged Cts; Co-58; h124; 24:28



Co-60

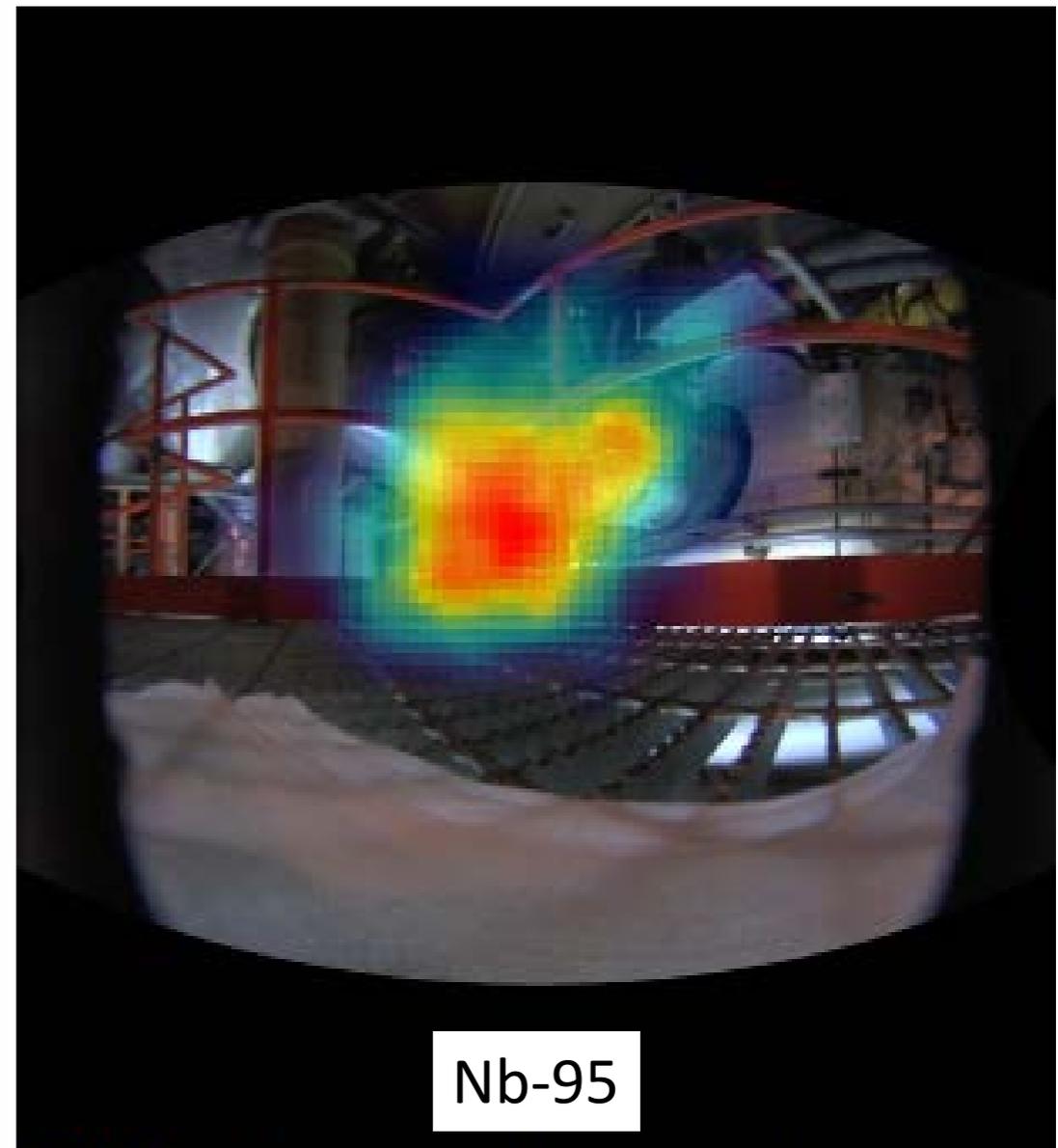
HED 18171 Imaged Cts; Co-60; h124; 24:28

# CRUD Location Isotopic – S/G Hot Leg Loop 2



Cs-137

HED 27870 Imaged Cts; Cs-137; h124; 24:28

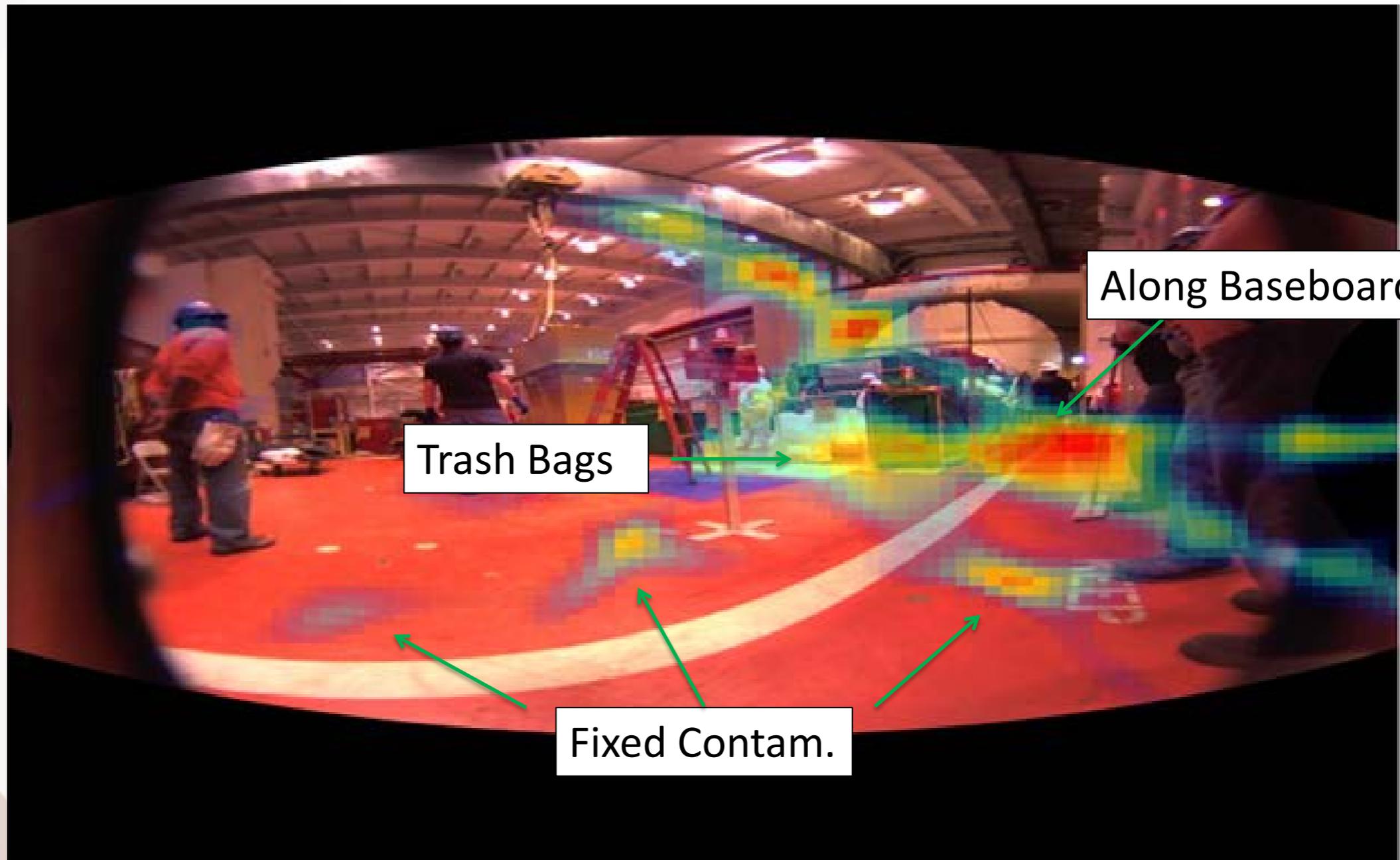


Nb-95

HED 13207 Imaged Cts; Nb-95; h124; 24:28

Note: 30 minute count imaged 100 counts. For good resolution, distributed contamination should have minimum 1000 counts (5 hour image).

# Percon Investigation(s)

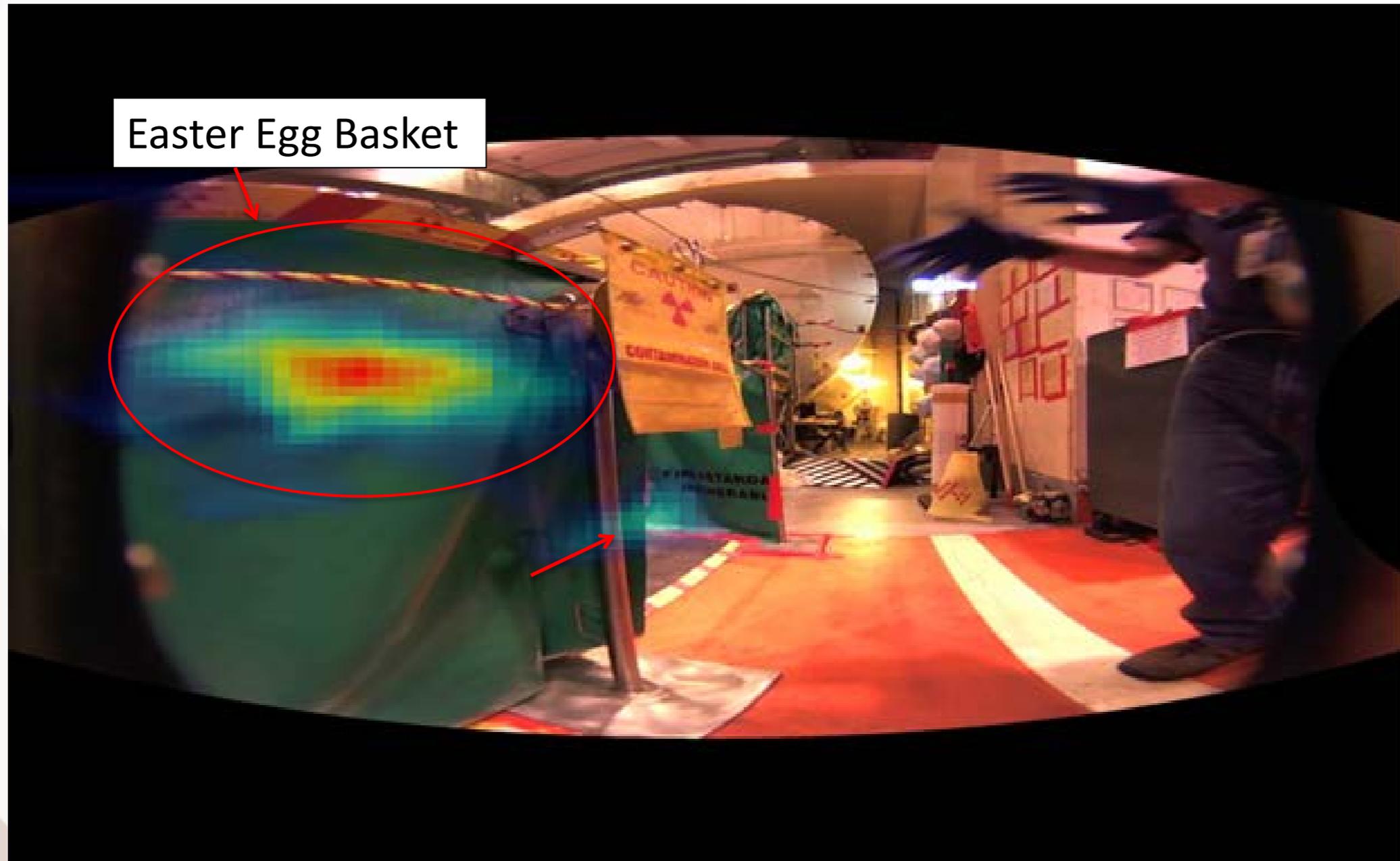


# Percon Investigation(s)



Drained Transfer Canal did not show release of particles

# Percon Investigation(s)



Questions?



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