Polaris-H Measurements and Performance

H3D, Inc.

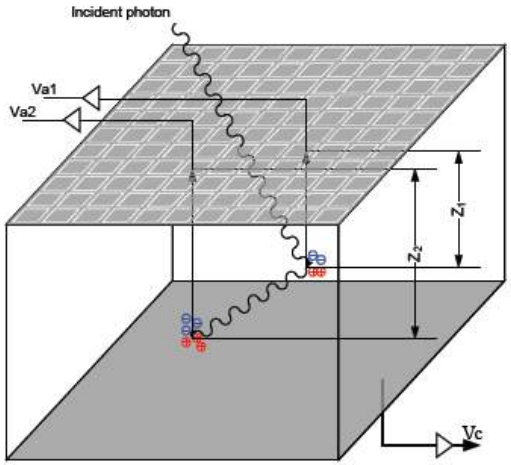
May 2015

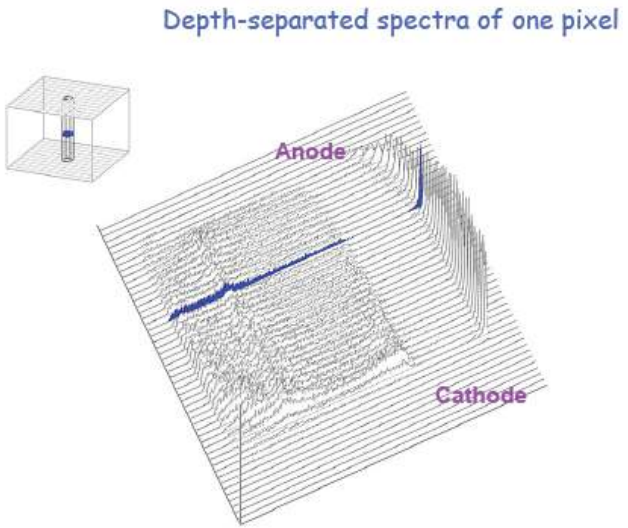
www.h3dgamma.com

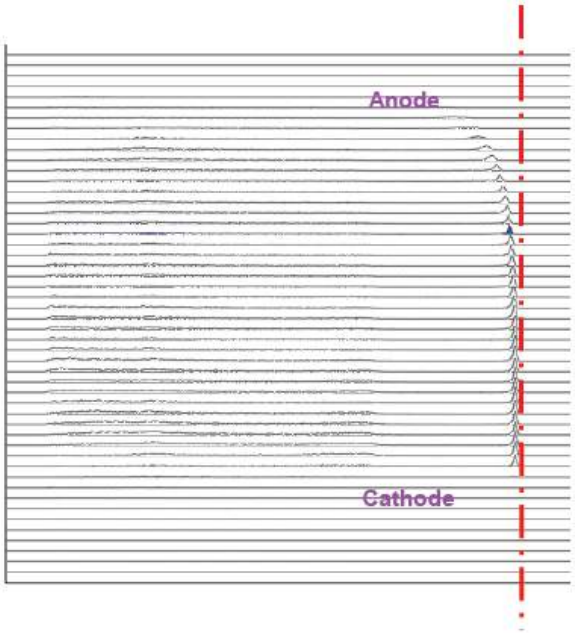
About H3D, Inc.

- Spinoff from University of Michigan, Department of Nuclear Engineering, 2011.
  - Based on over a decade of research in room-temperature position-sensitive semiconductors by Prof. Zhong He and group.
- Currently under several government contracts and have domestic and international commercial sales.
- Released commercial product for nuclear market December 2013 – Polaris-H.
  - Have DoD product with better performance than Polaris-H.

H3D's Technology

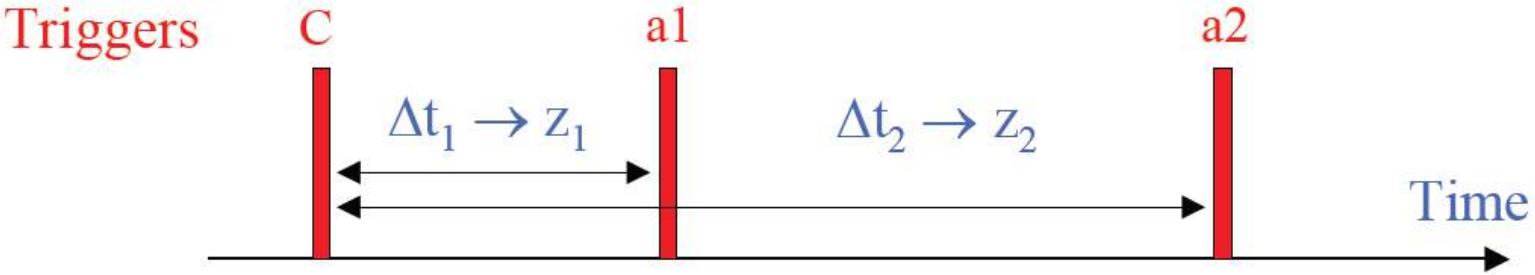






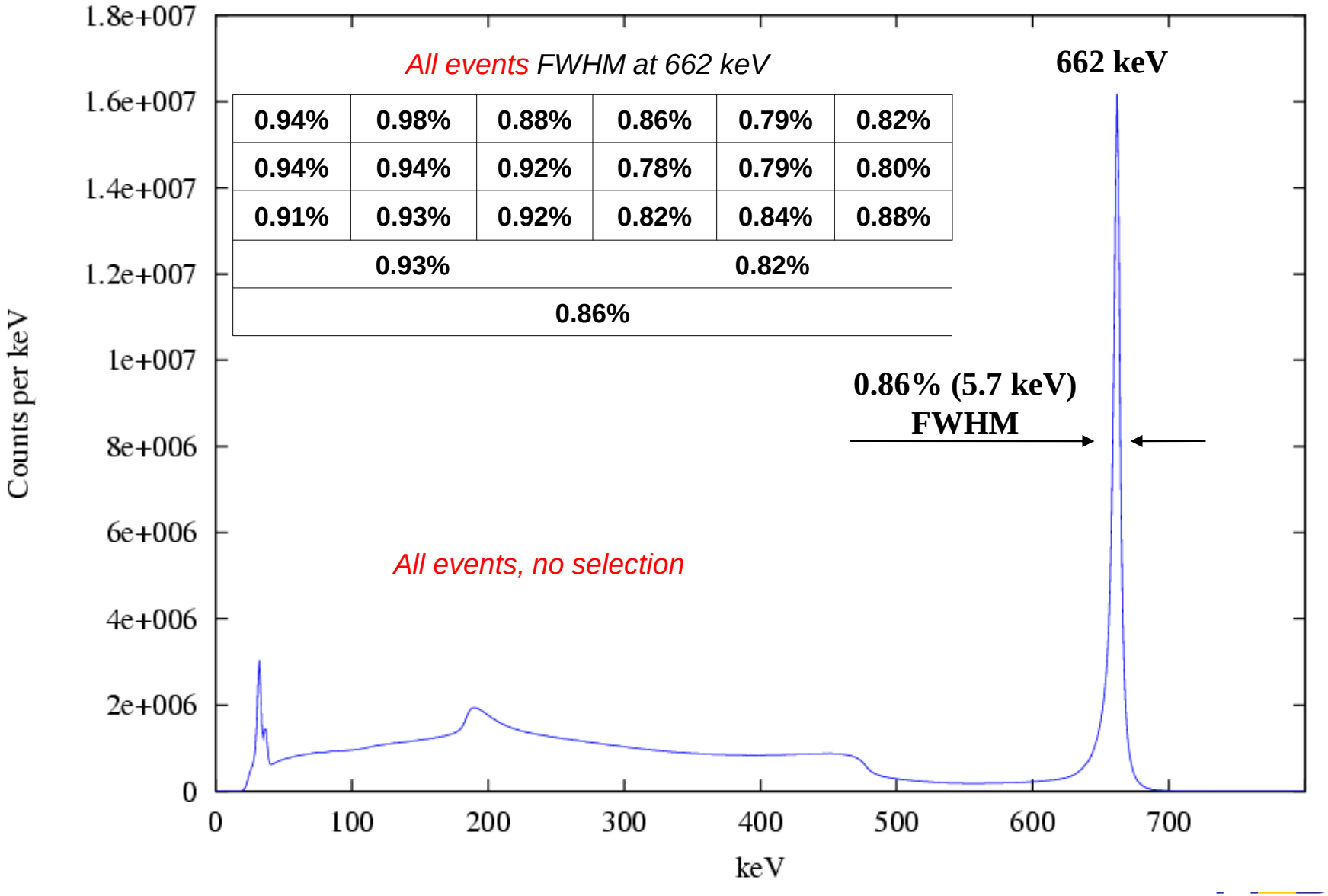
6 cm^3 CZT
At room temperature

(*x*,*y*) found from pixel collecting charge, and *z* found from drift time.



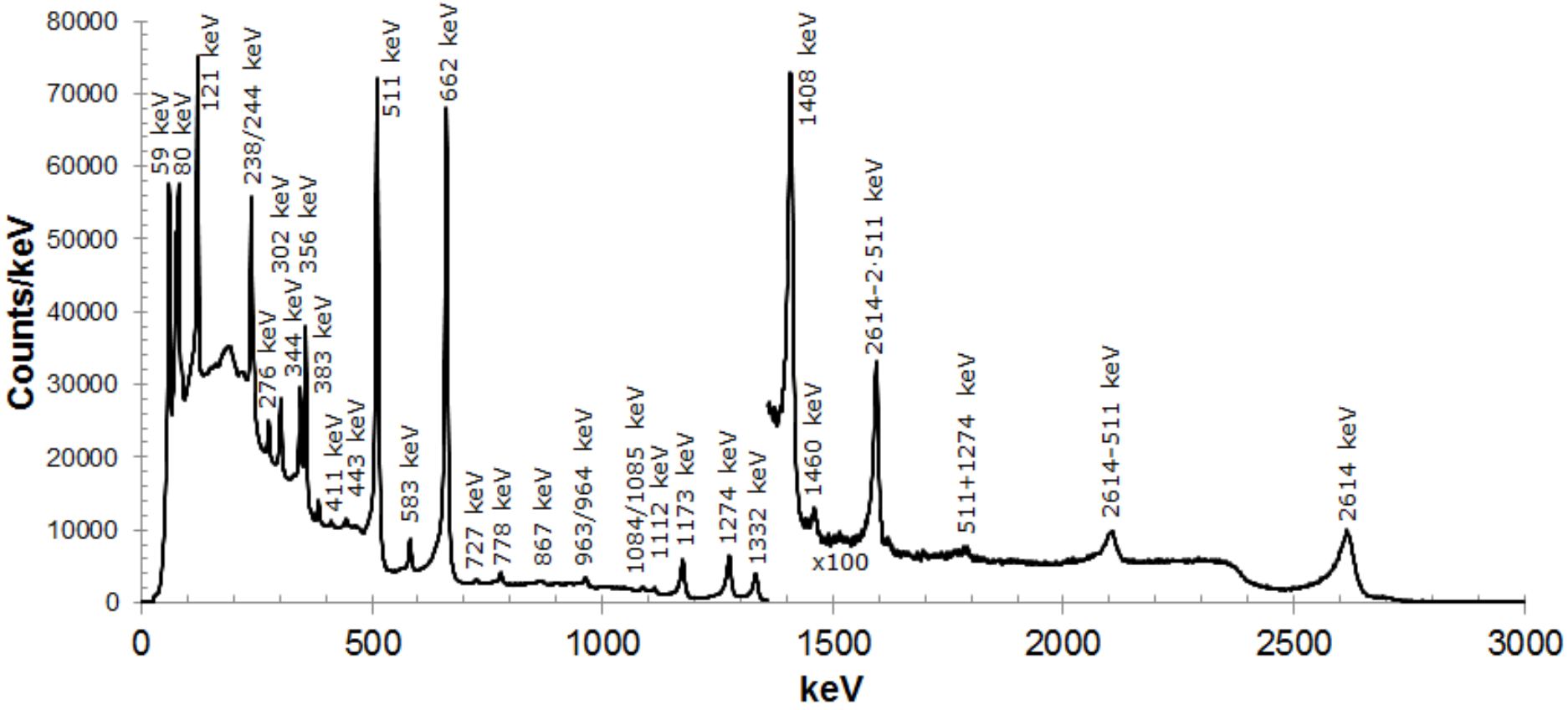
Energy found from charge induced on anode, corrected for interaction position.

Energy Resolution – DoD System

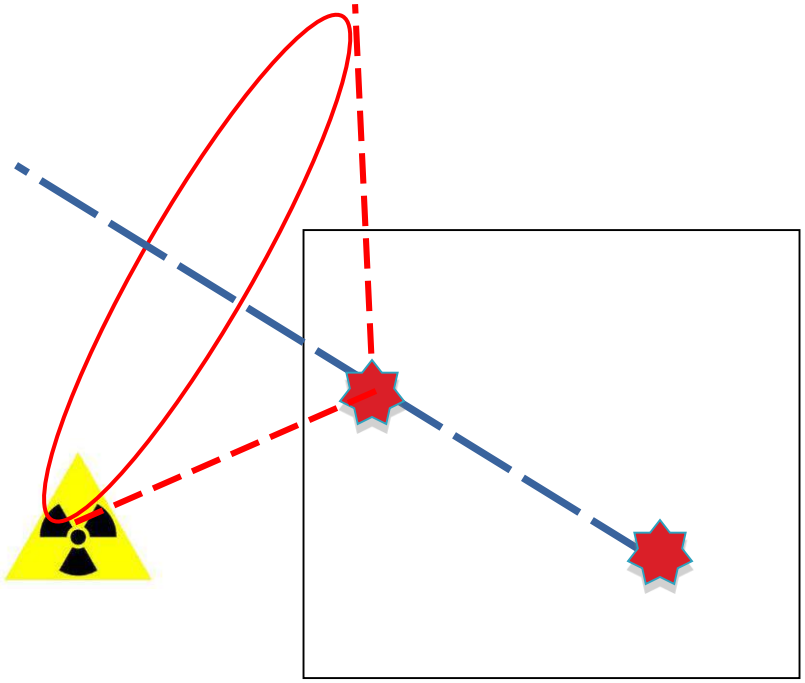


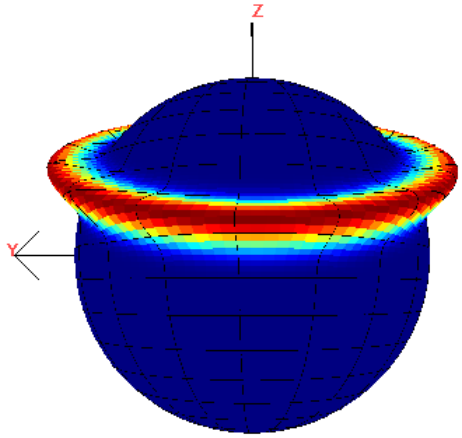
Energy Resolution – Polaris-H

<1.1% FWHM at 662 keV



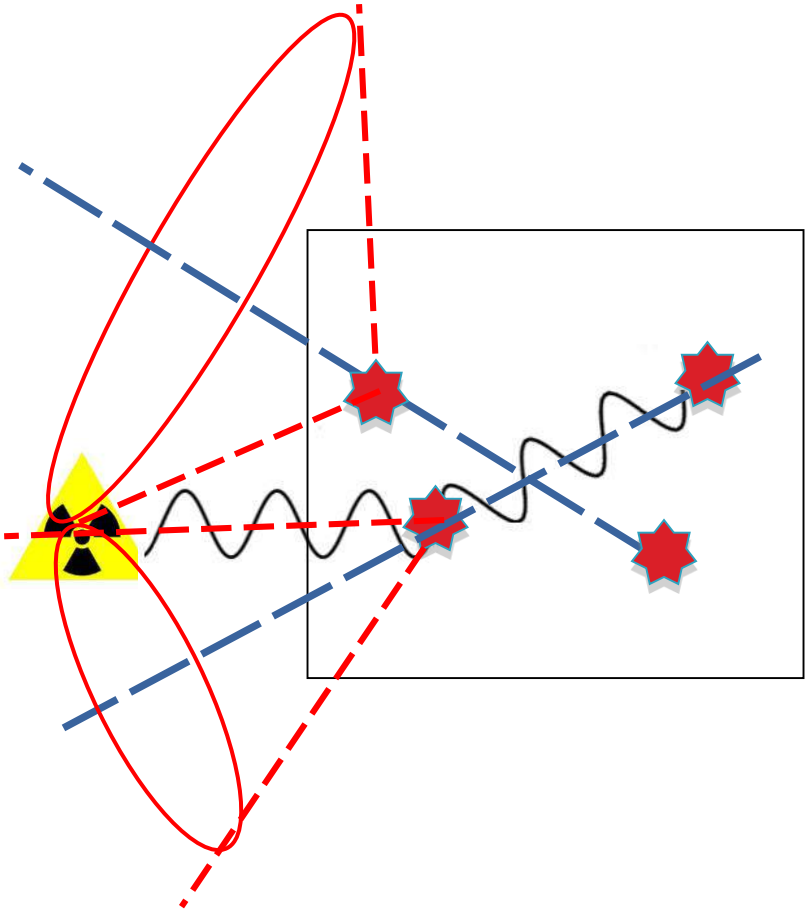
Gamma-Ray Imaging

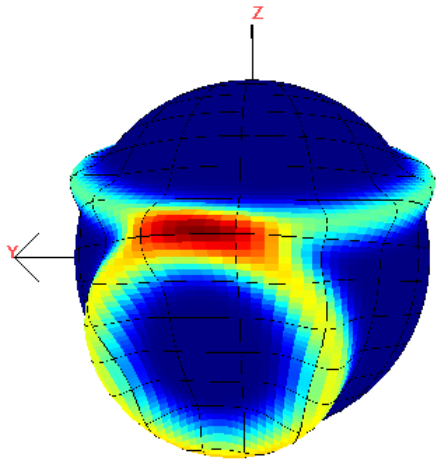


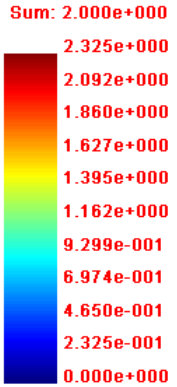


Number of photons: 1

Gamma-Ray Imaging

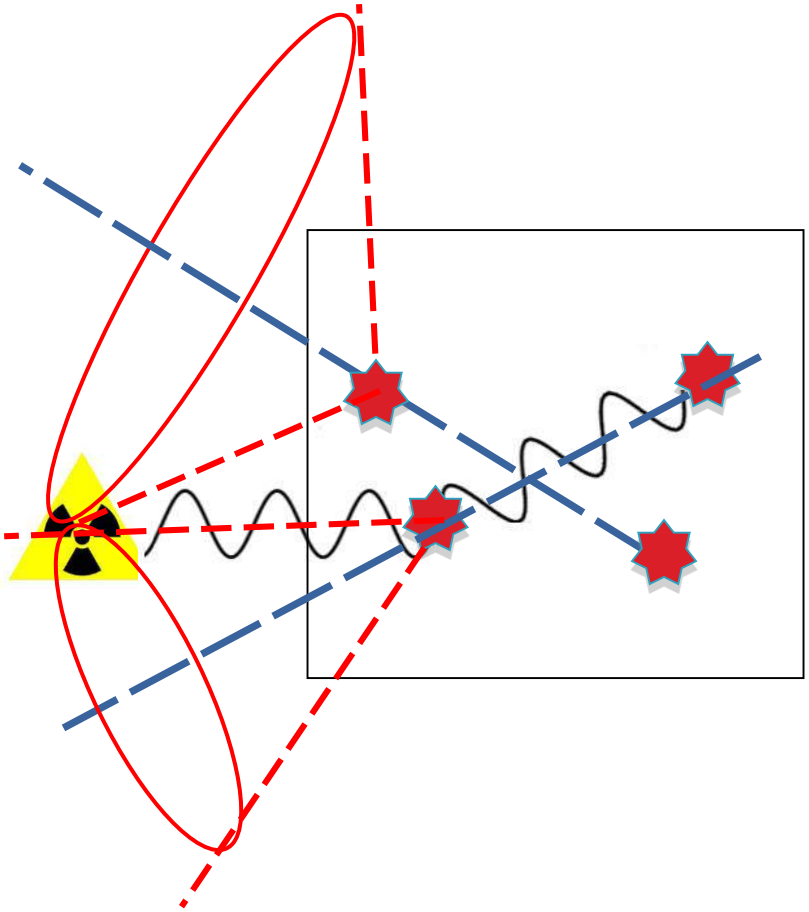


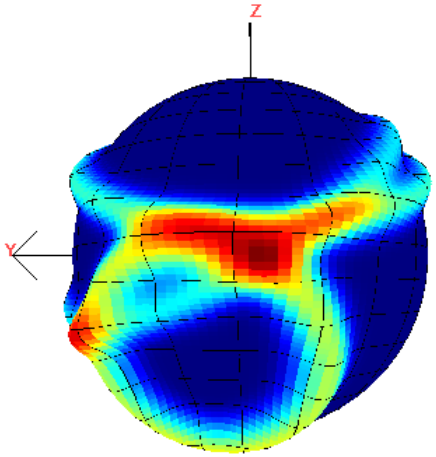




Number of photons: 2

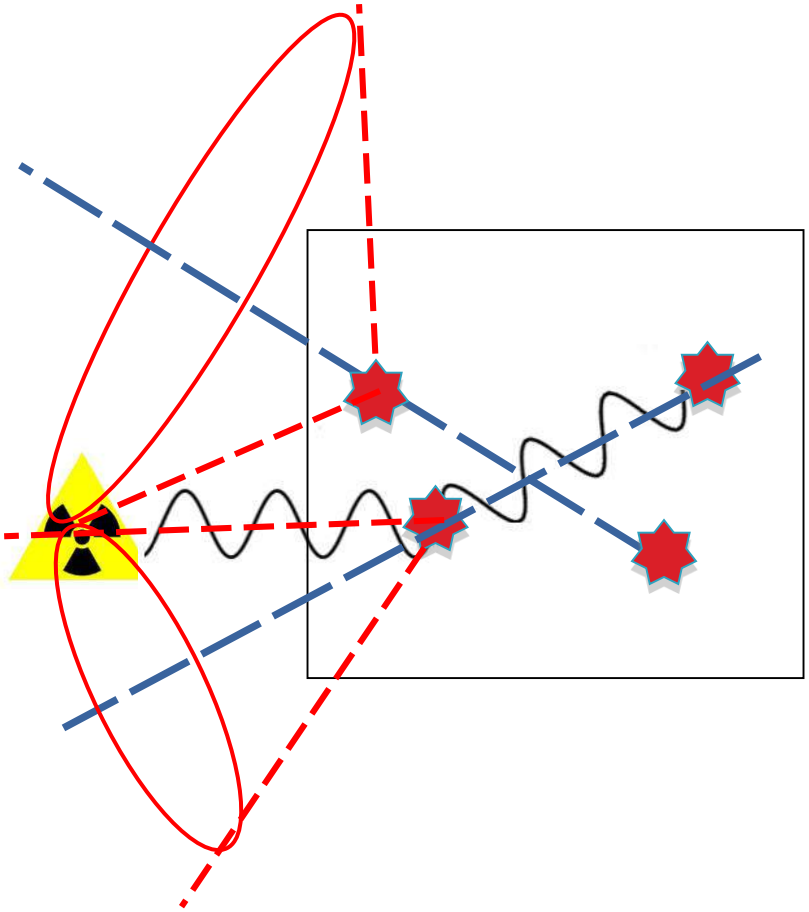
Gamma-Ray Imaging

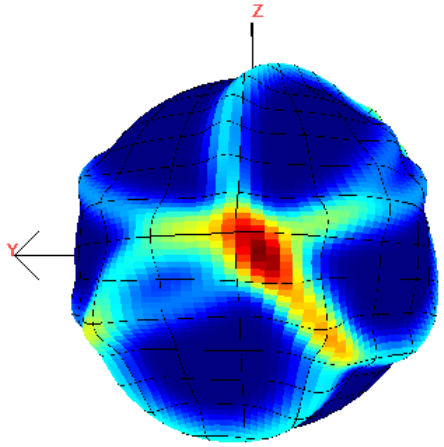


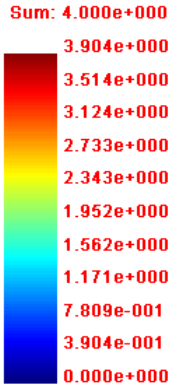


Number of photons: 3

Gamma-Ray Imaging

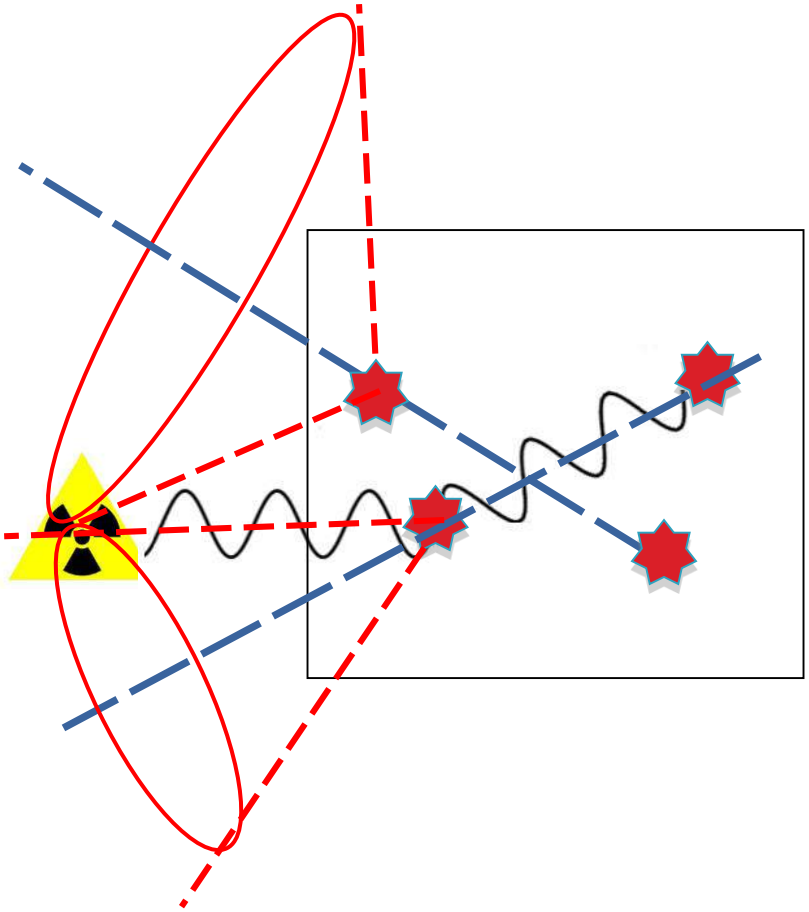


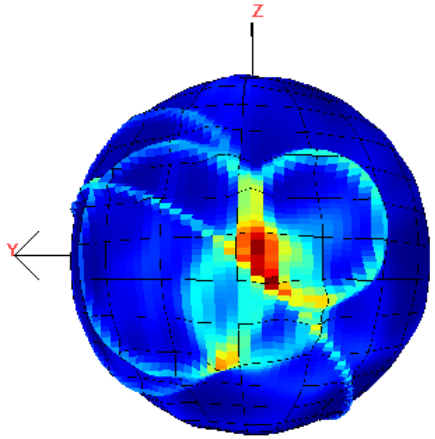


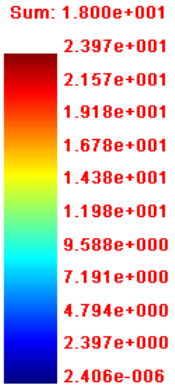


Number of photons: 4

Gamma-Ray Imaging

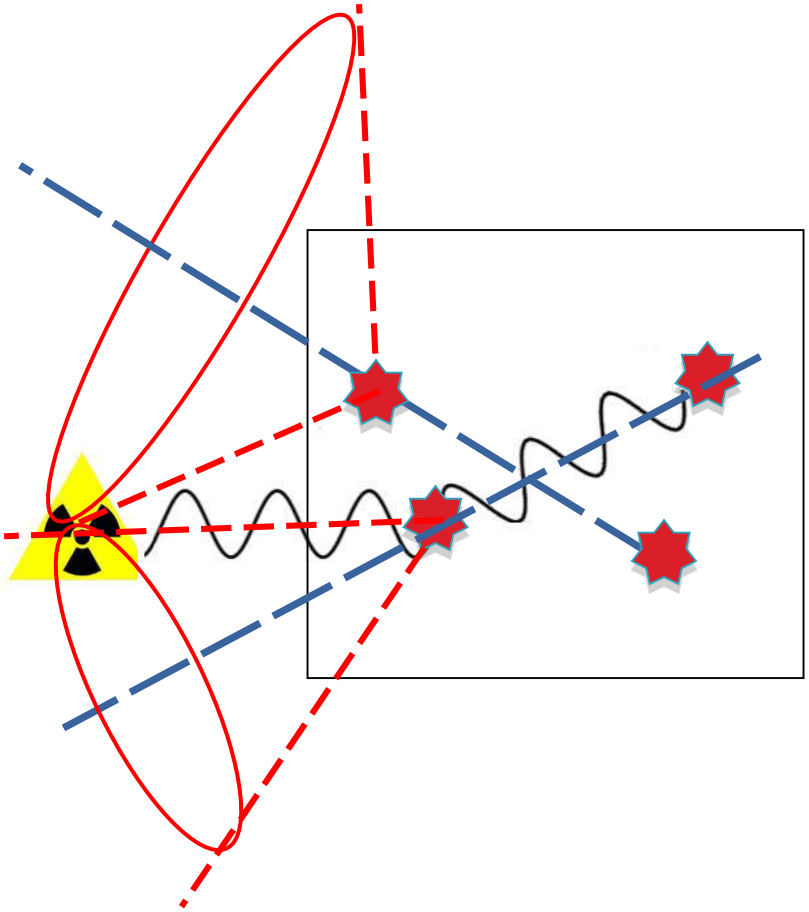


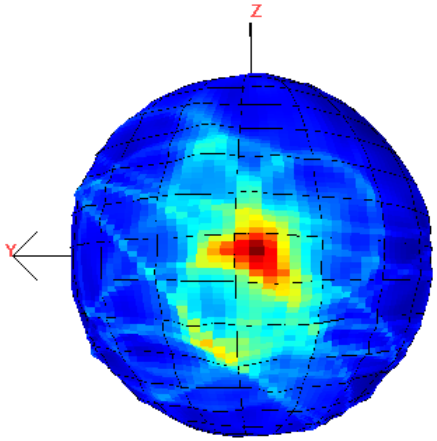


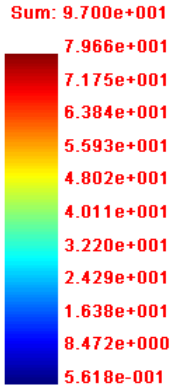


Number of photons: 18

Gamma-Ray Imaging

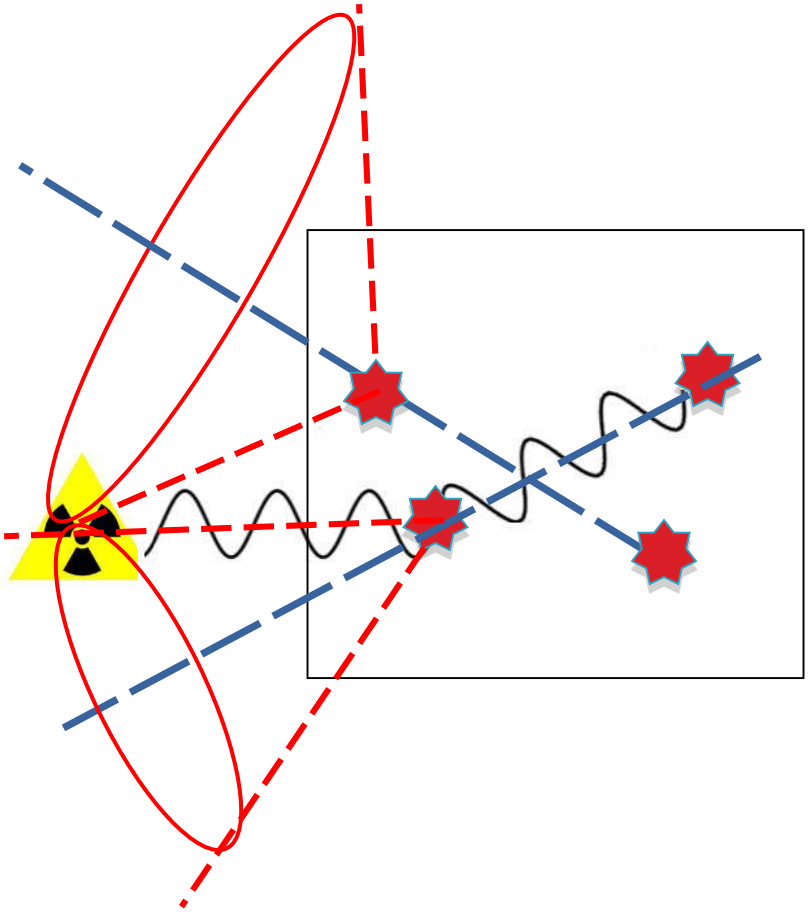


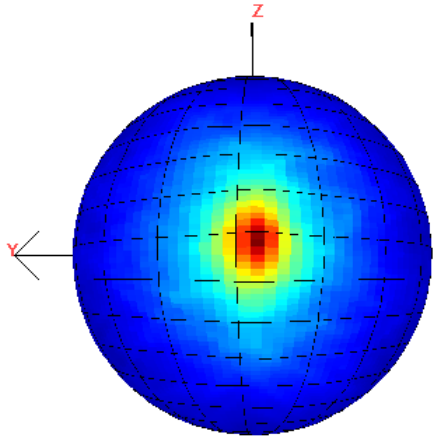


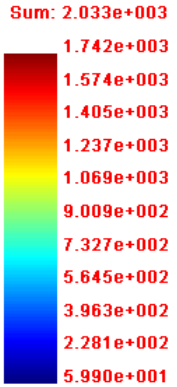


Number of photons: 97

Gamma-Ray Imaging



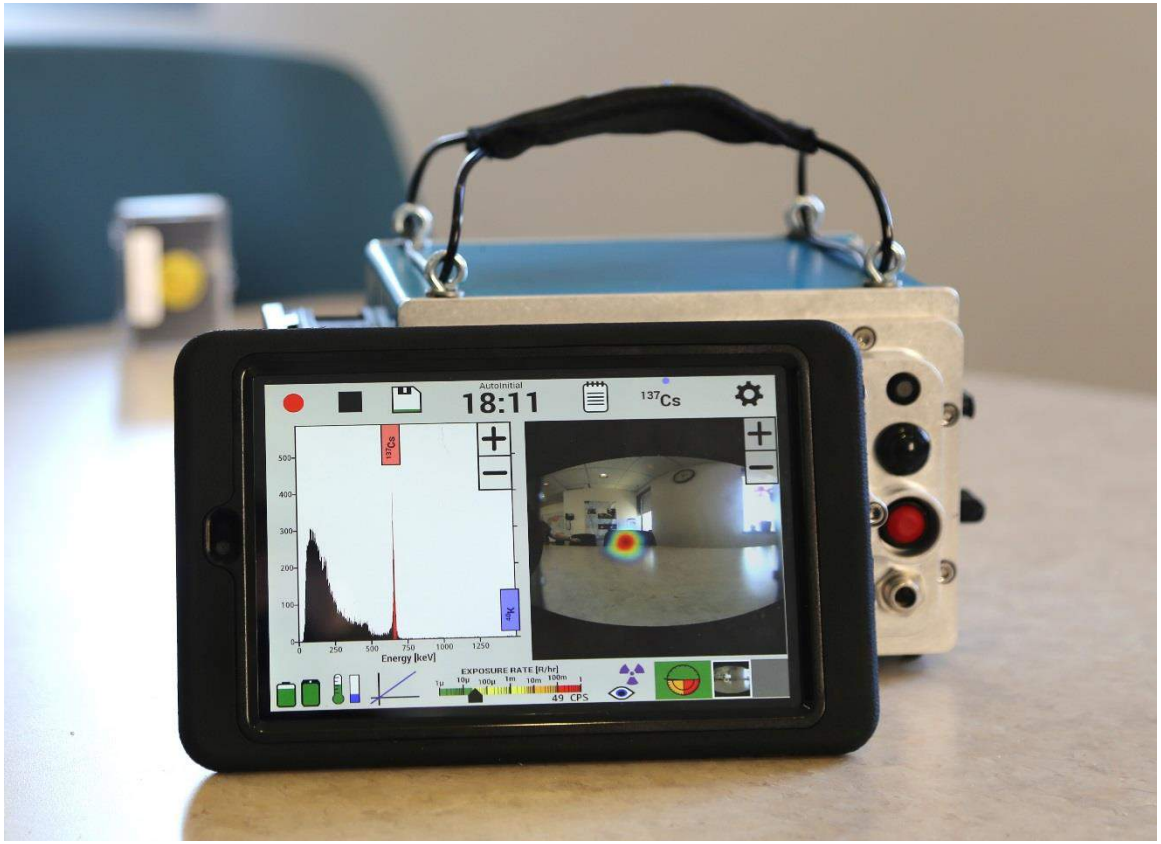




Number of photons: 2033

Polaris-H
Imaging Spectrometer for Nuclear Power Plants

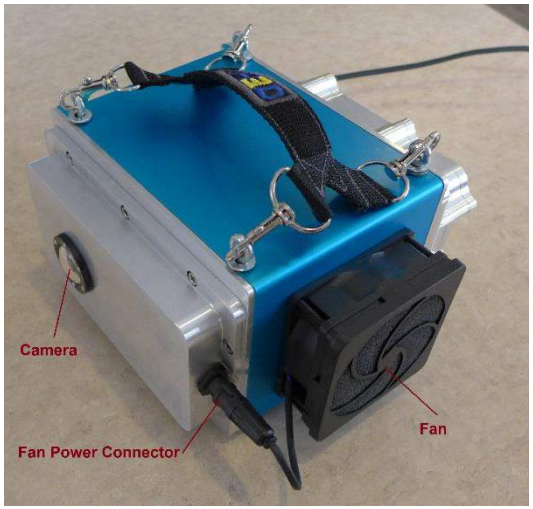
Response to nuclear power plant need for **portable instrument to image in contaminated areas**.

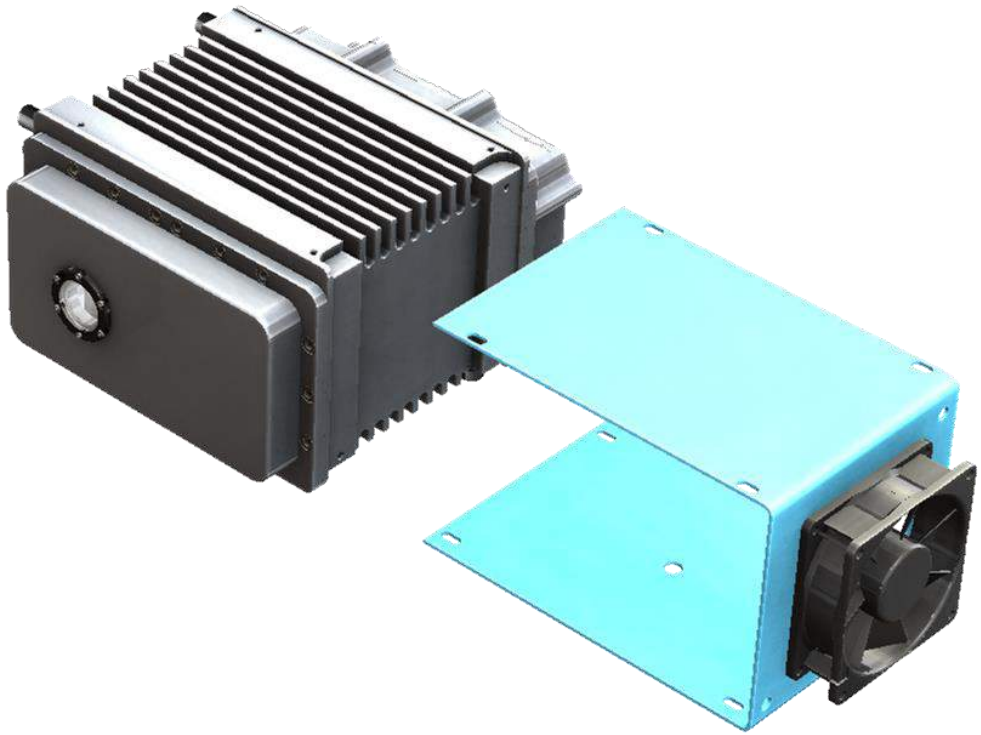


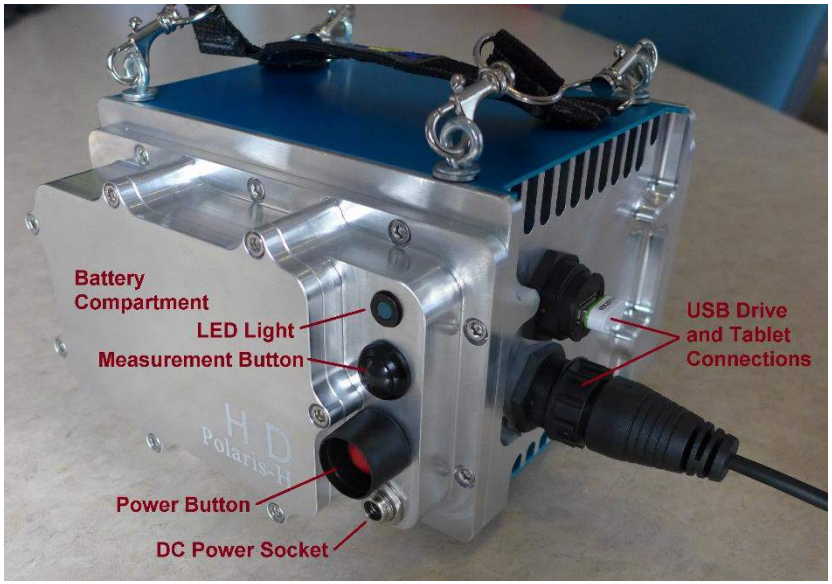
- 8.5 lbs
- Battery operated (5 hr)
- Washable for easy decontamination
- “Simple” user interface
- ≤1.1% FWHM energy resolution at 662 keV
- Omnidirectional imaging

Polaris-H
Imaging Spectrometer for Nuclear Power Plants

- ~2π optical camera for overlay of radiation image
- Compton imaging ~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

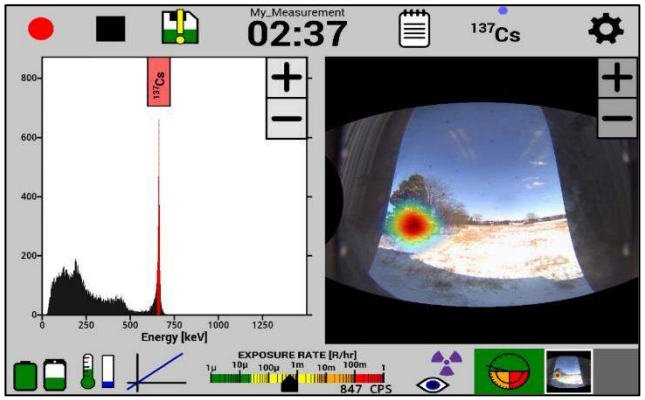


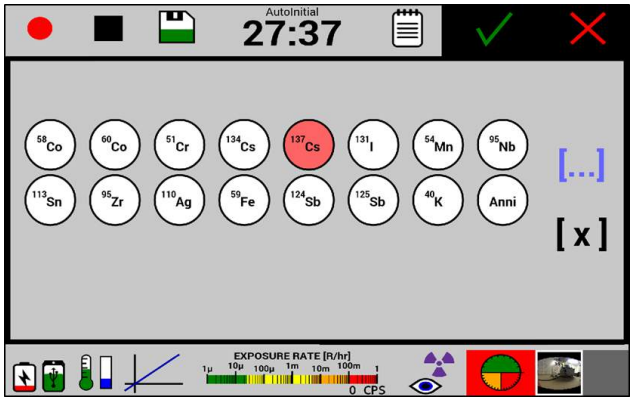




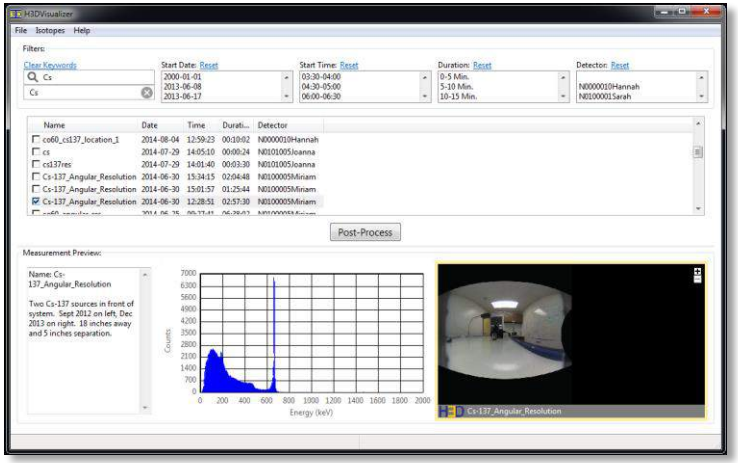
Polaris-H
Imaging Spectrometer for Nuclear Power Plants

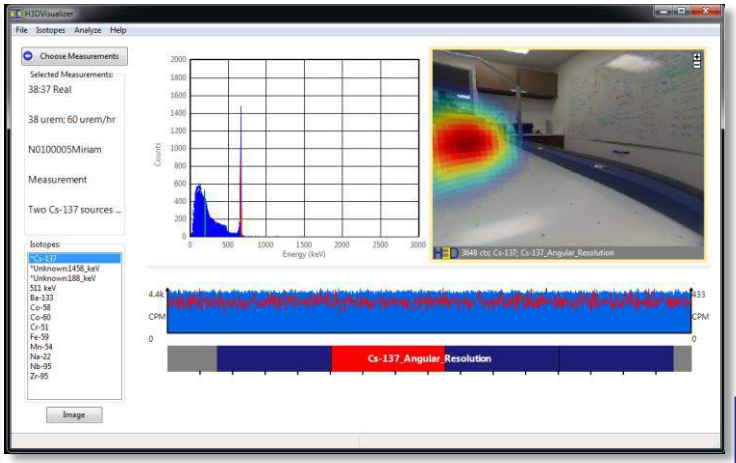
- Real-time software on embedded CPU for isotope detection/ID, isotope-specific imaging, data logging, control and regulation.



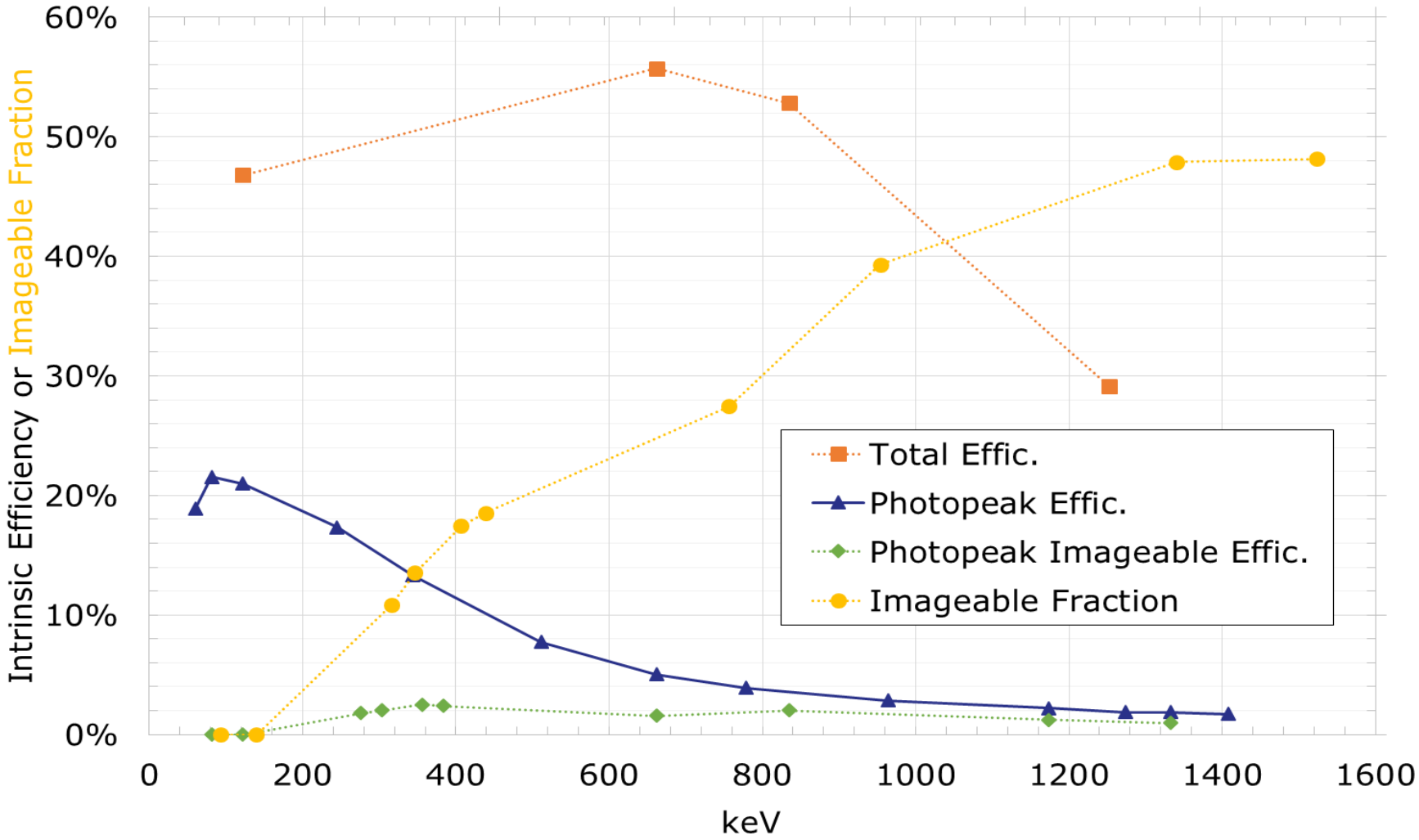


- Post-processing software for time analysis, high-resolution imaging, detailed studies.



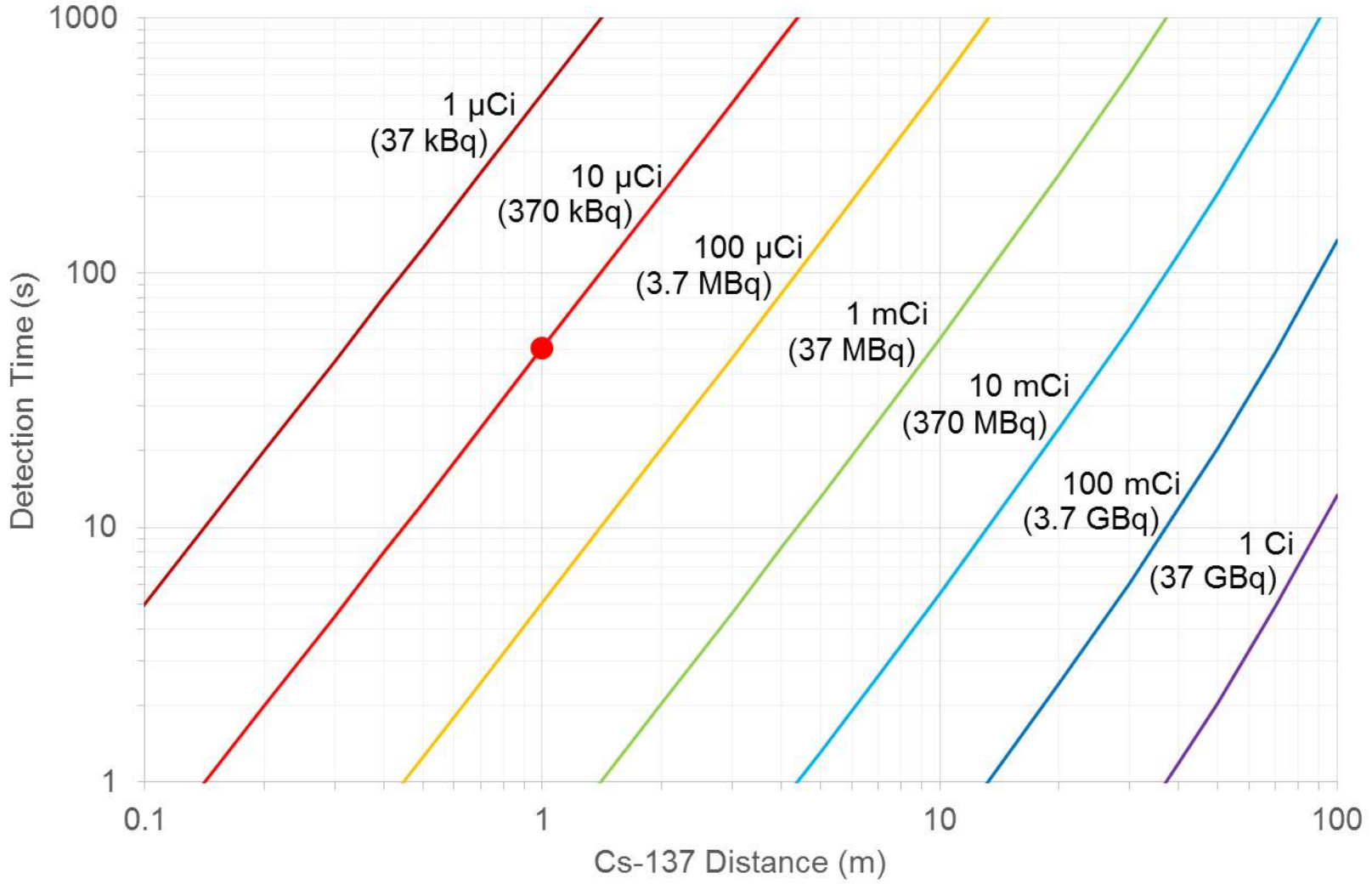


Polaris-H Performance – Efficiency



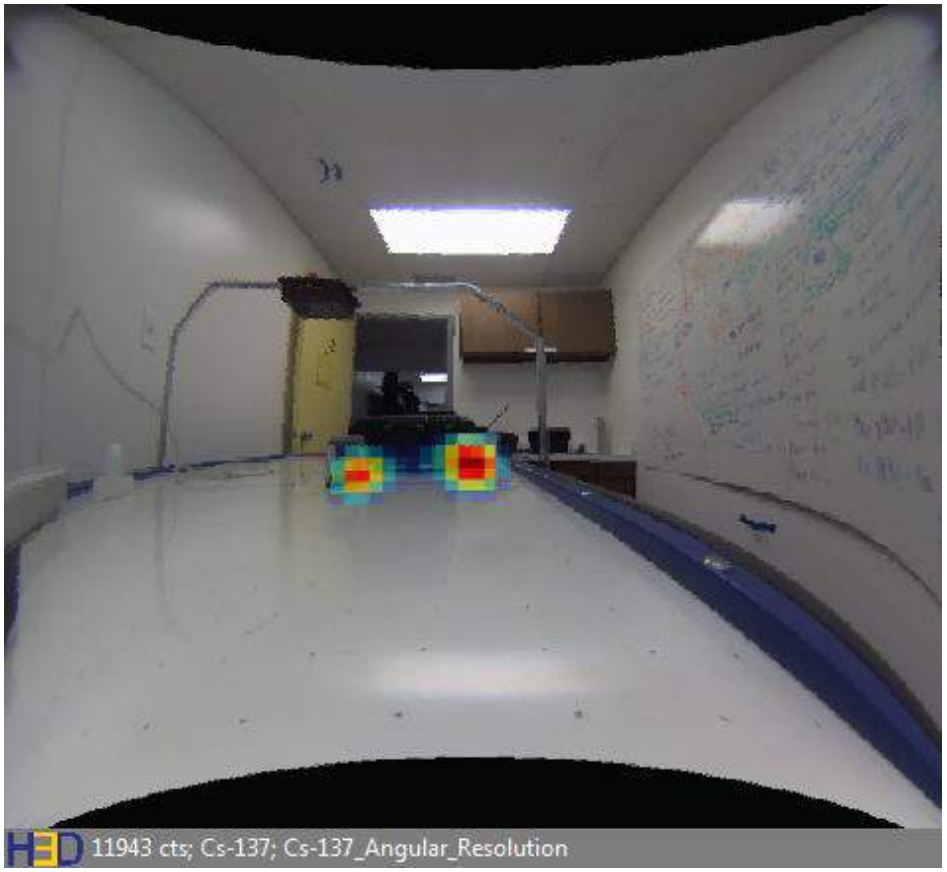
- ~1% relative efficiency (compared to 3”x3” NaI at 1333 keV)
- Almost 50% of events image-able at 1333 keV

Polaris-H Performance – Detection/ID

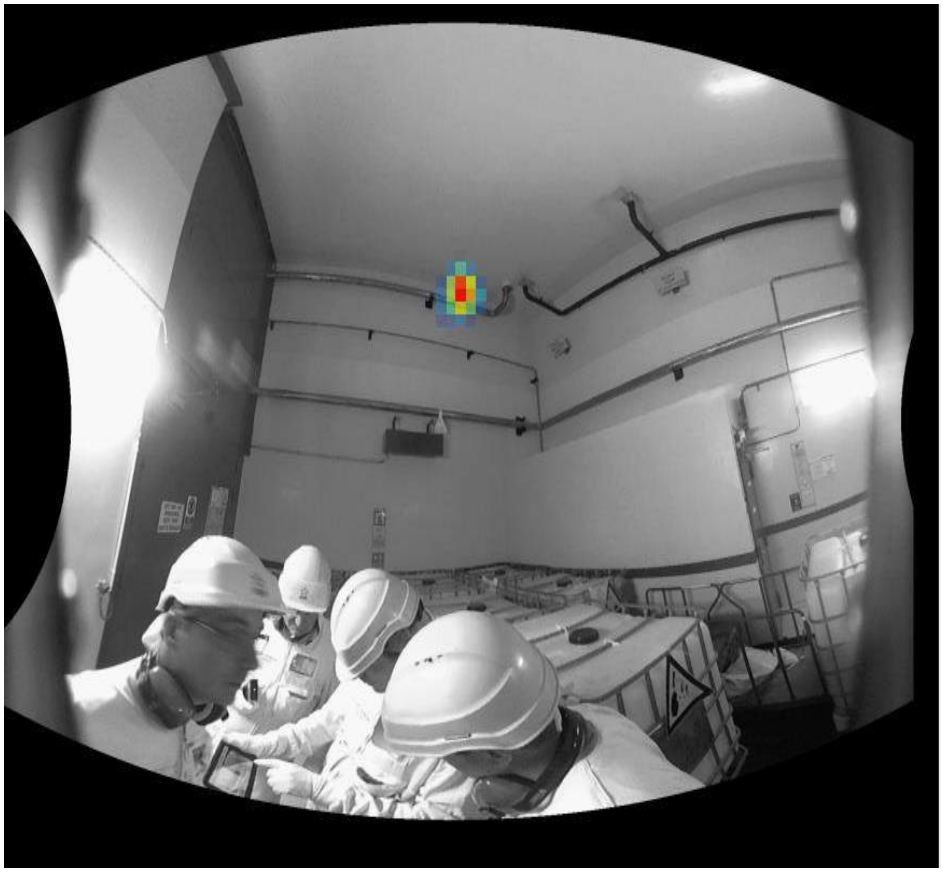


- Detects 3 µR/hr (30 nSv/hr) Cs-137 in <1 minute
  - False alarm rate < 1/hr

Polaris-H Performance – Imaging

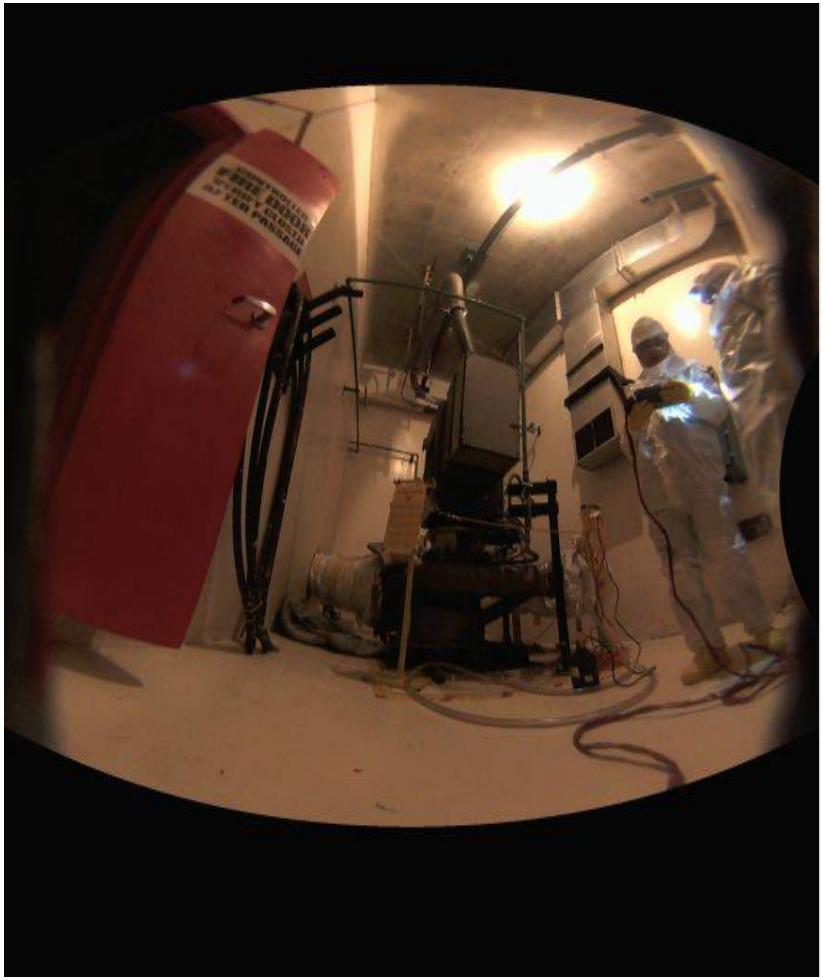


- Can distinguish sources of same energy 20˚ apart

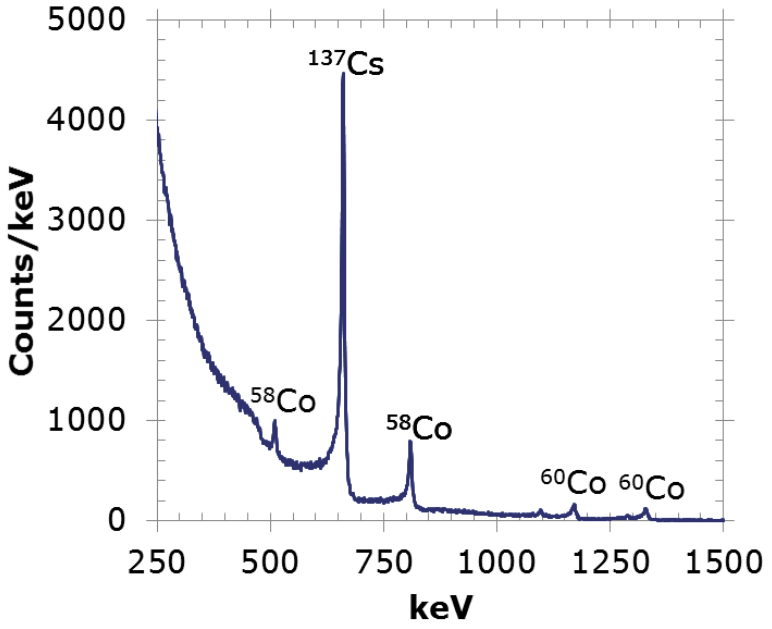


- Can find center of point source to ±1˚ in any direction

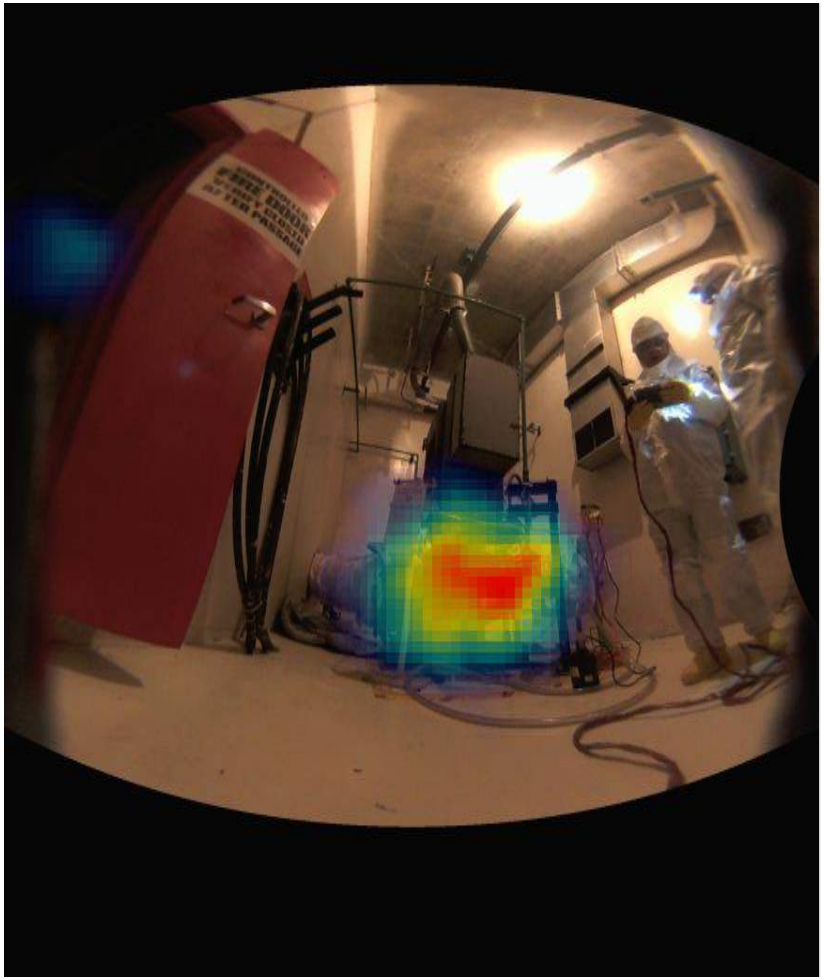
RHR Pump Room



10.2 minutes
2.3 x 10^6 counts
~0.4 mrem/hr

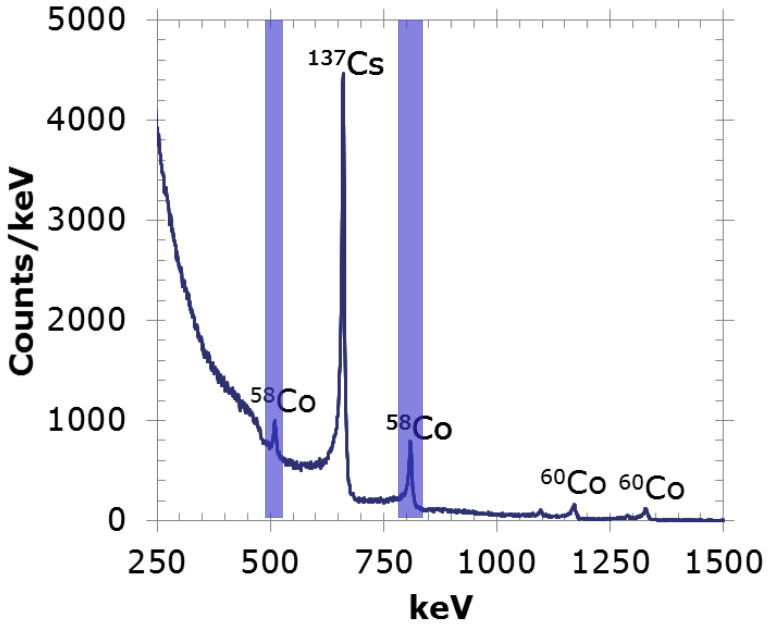


RHR Pump Room – ^{58}Co

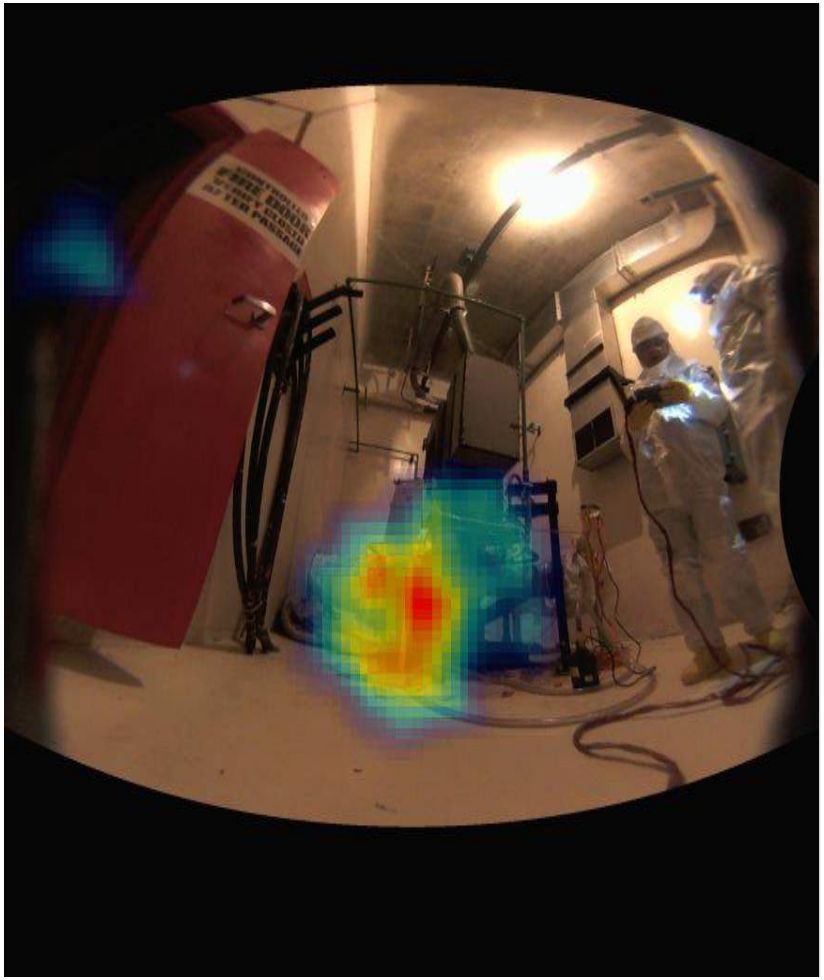


Area source found on pump.

2.1 x 10^4 counts in ROI
(23% of those imageable)

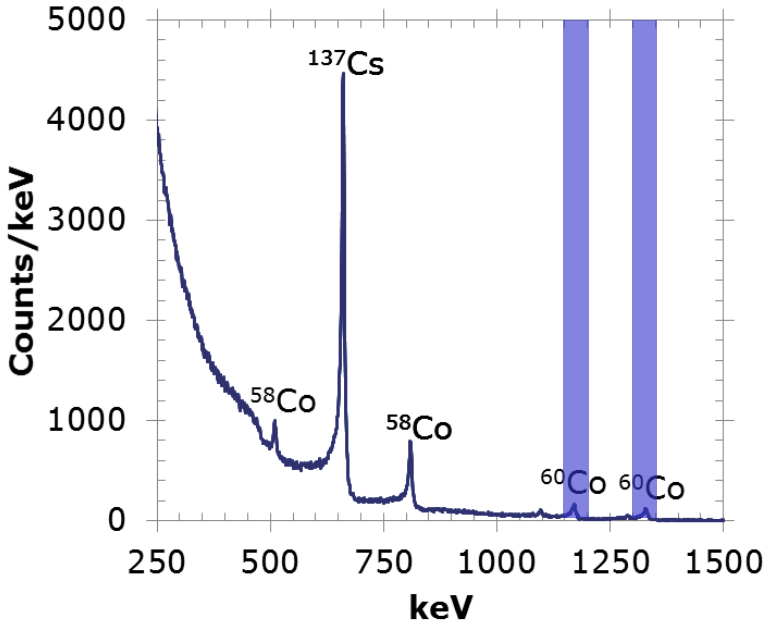


RHR Pump Room – ^{60}Co

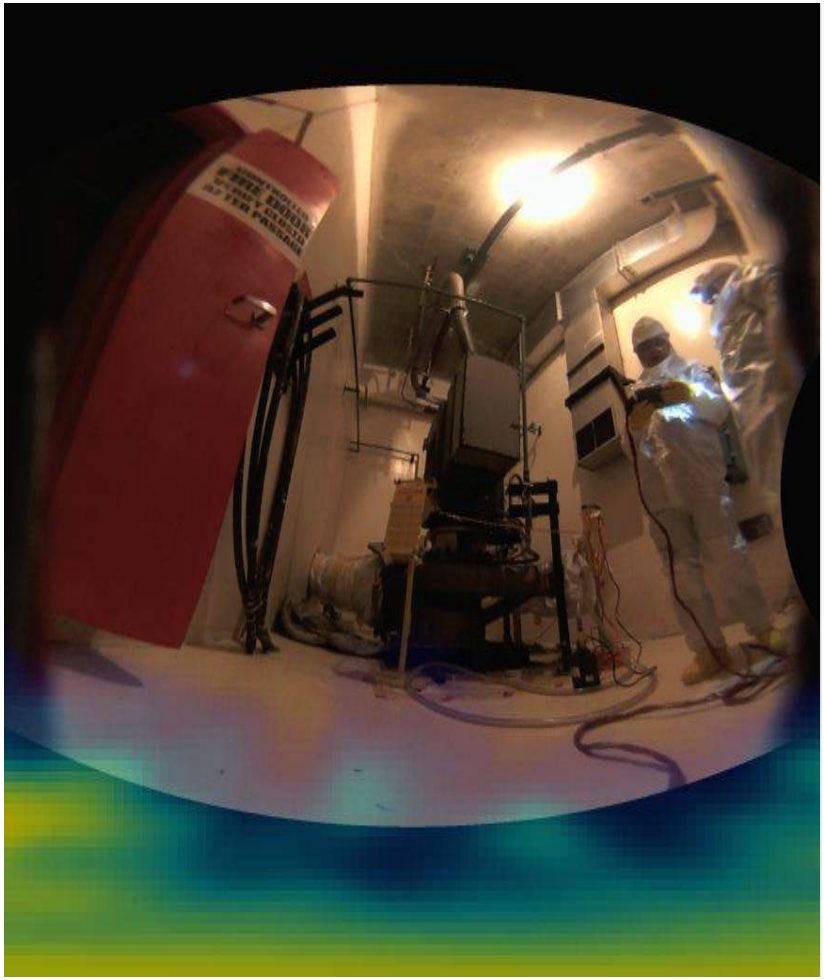


^{60}Co and ^{58}Co are in different regions of pump.

3.7 x 10^3 counts in ROI
(34% of those imageable)

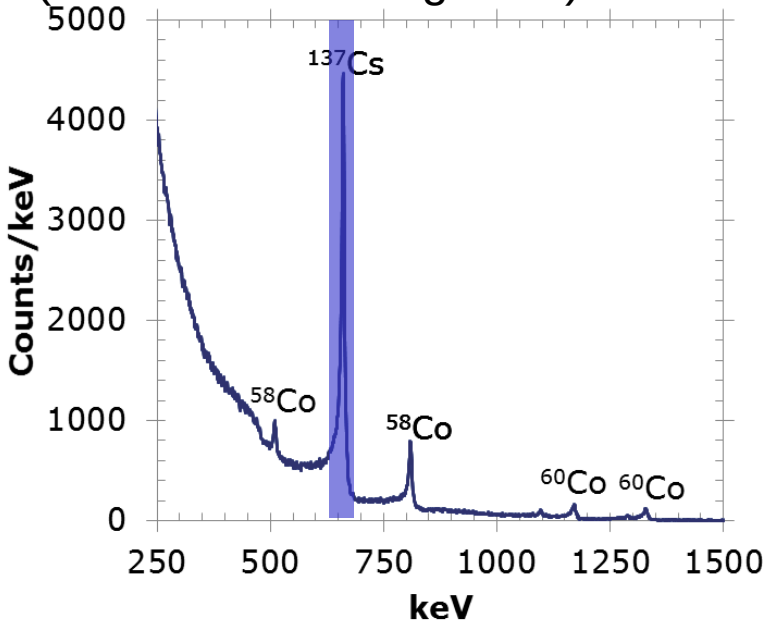


RHR Pump Room – ^{137}Cs

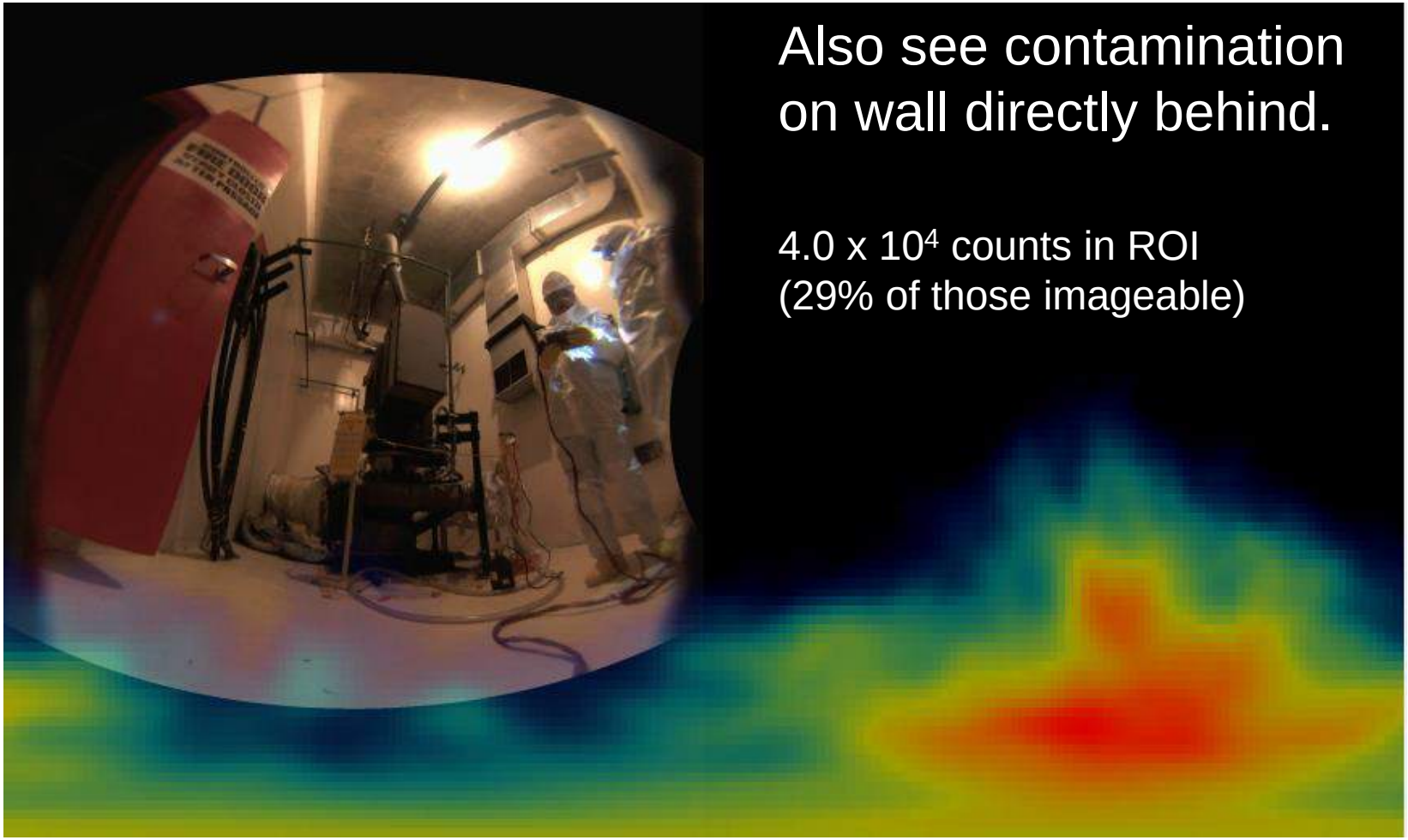


See contamination on floor from prior flood. Nearer areas appear hotter.

4.0×10^4 counts in ROI
(29% of those imageable)



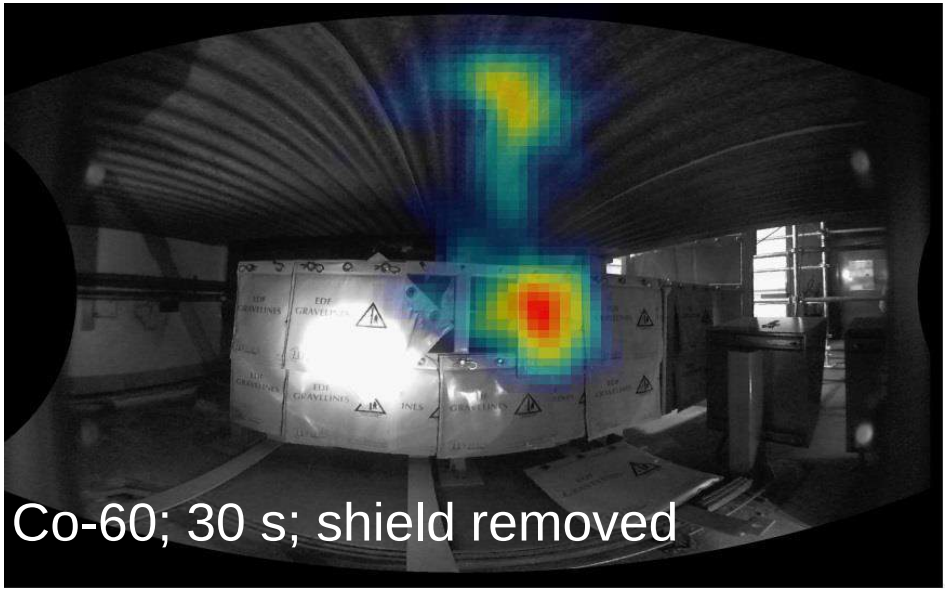
RHR Pump Room – ^{137}Cs

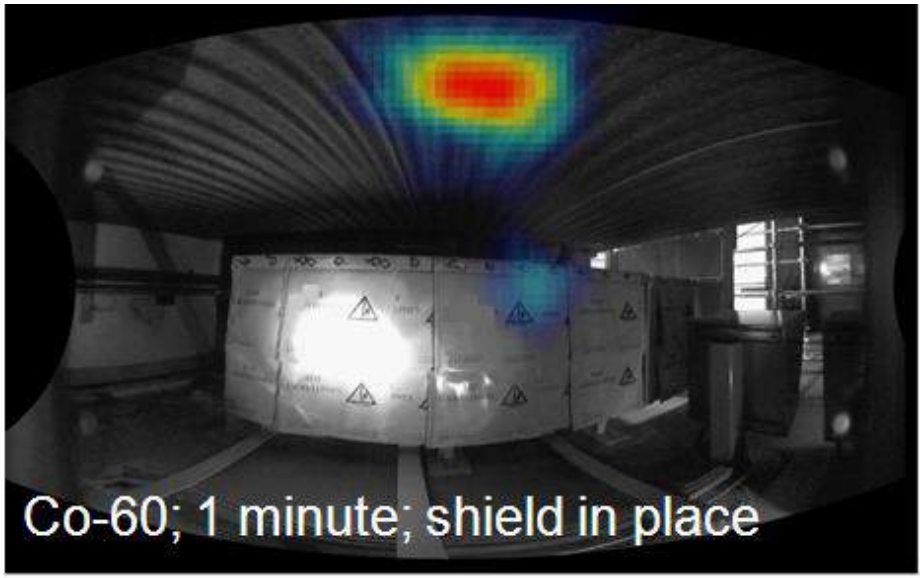


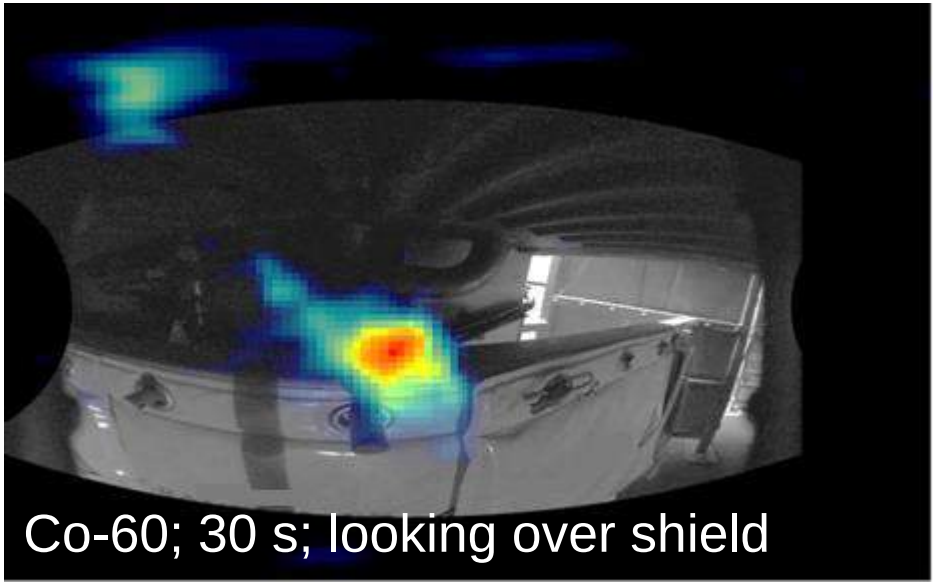
Also see contamination on wall directly behind.

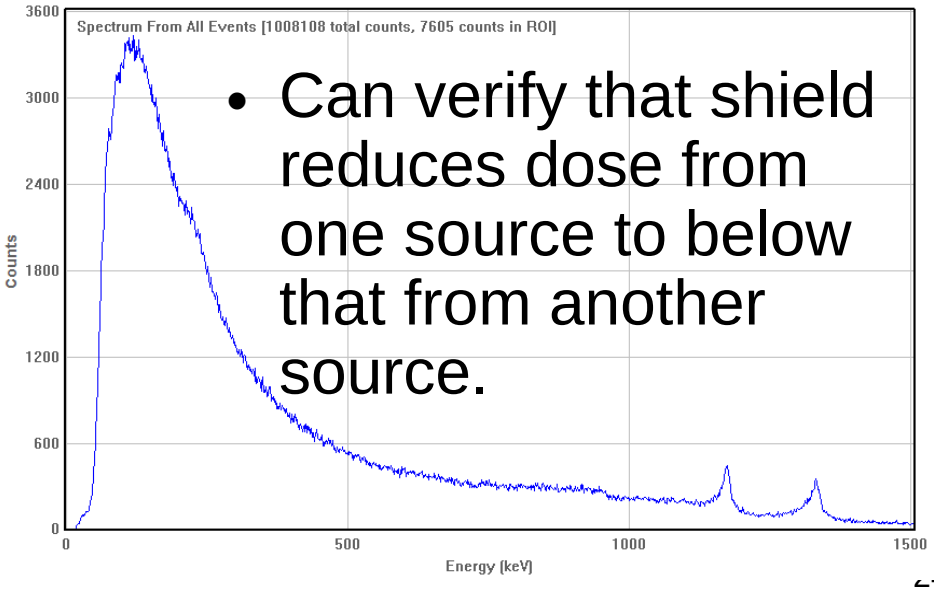
4.0×10^4 counts in ROI
(29% of those imageable)

Shielding Verification









- Can verify that shield reduces dose from one source to below that from another source.

Locating Unknown Source

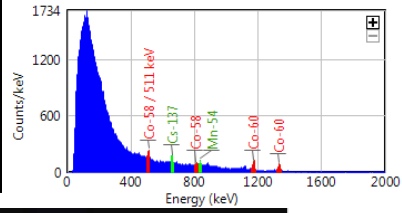
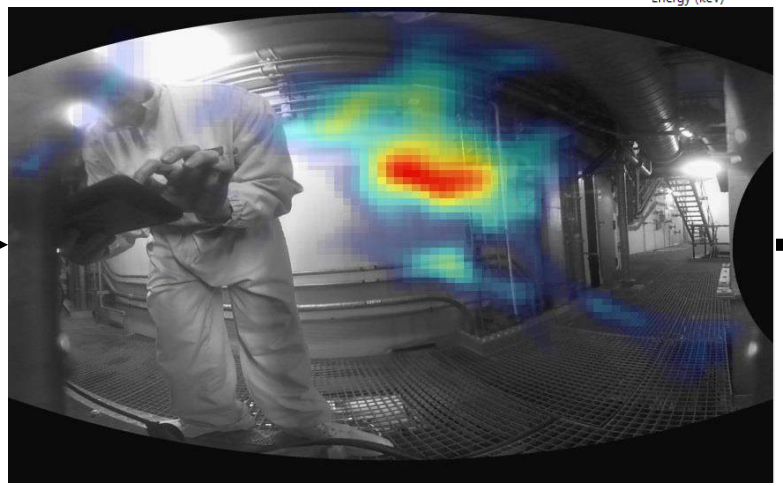
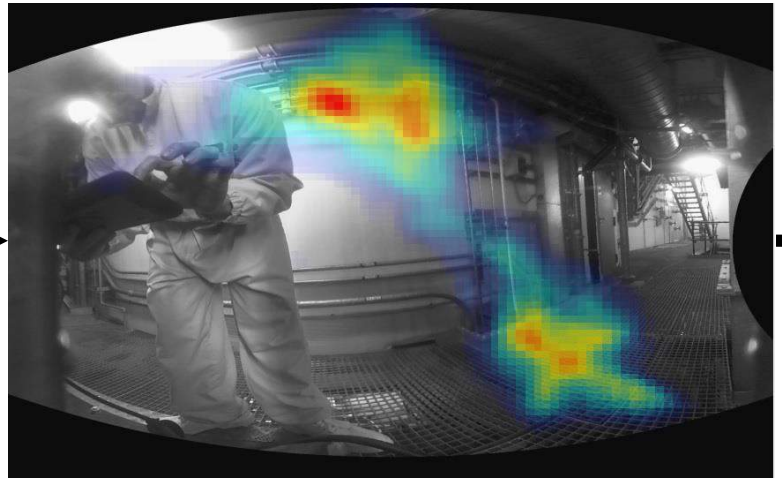


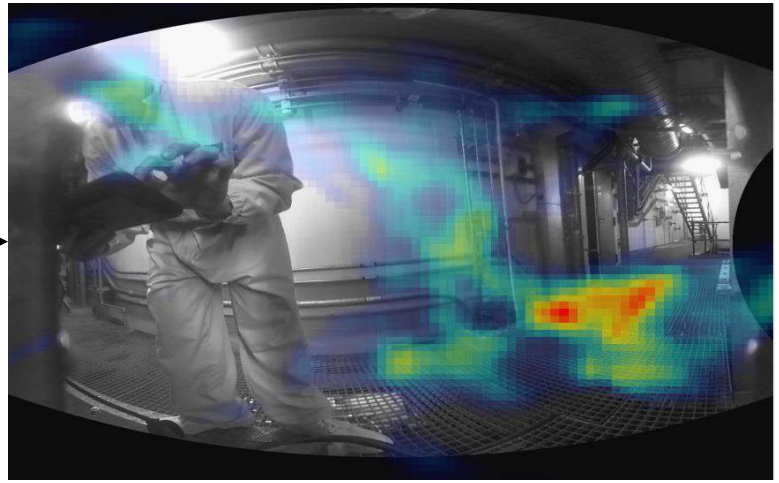
Image known hot spot (red box).



Cs-137 image primarily hot in expected direction.



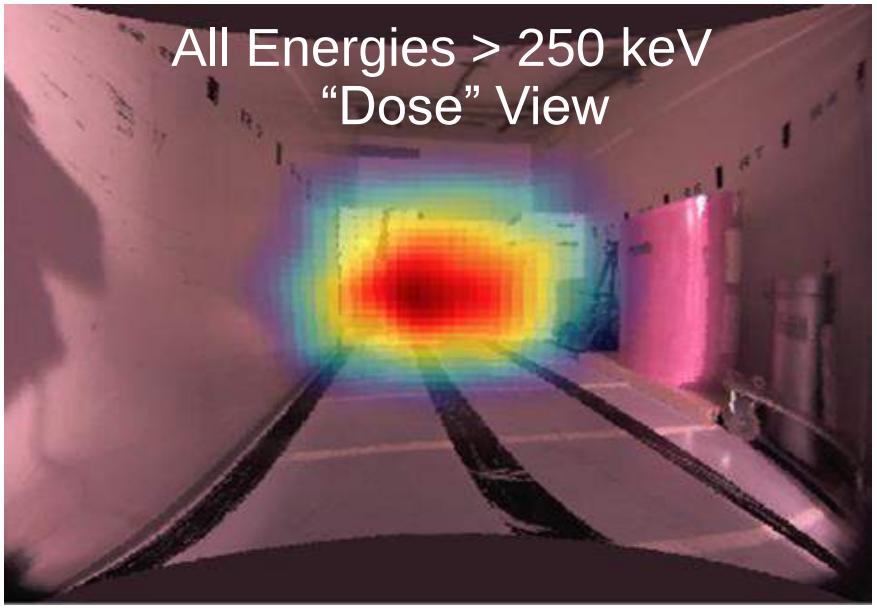
Co-60 image shows another previously unknown source near floor.

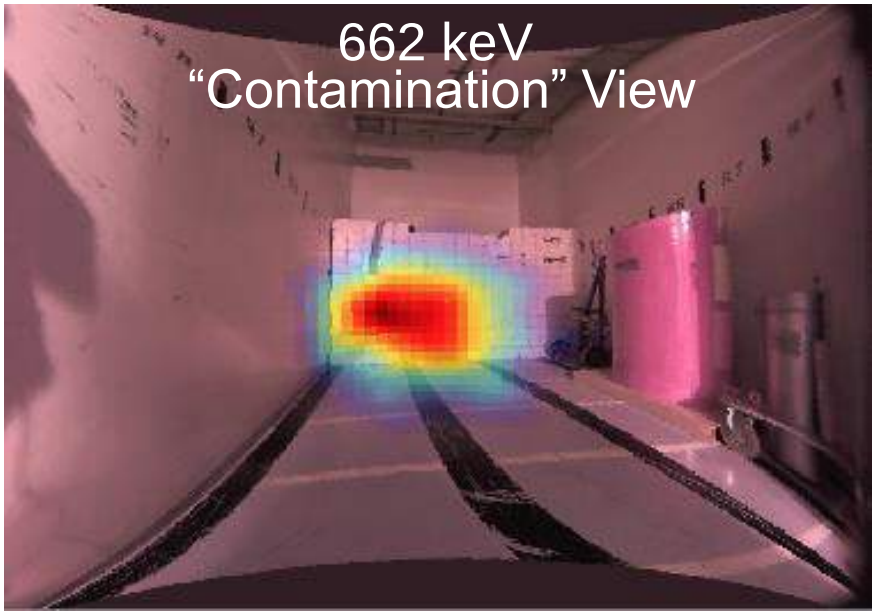


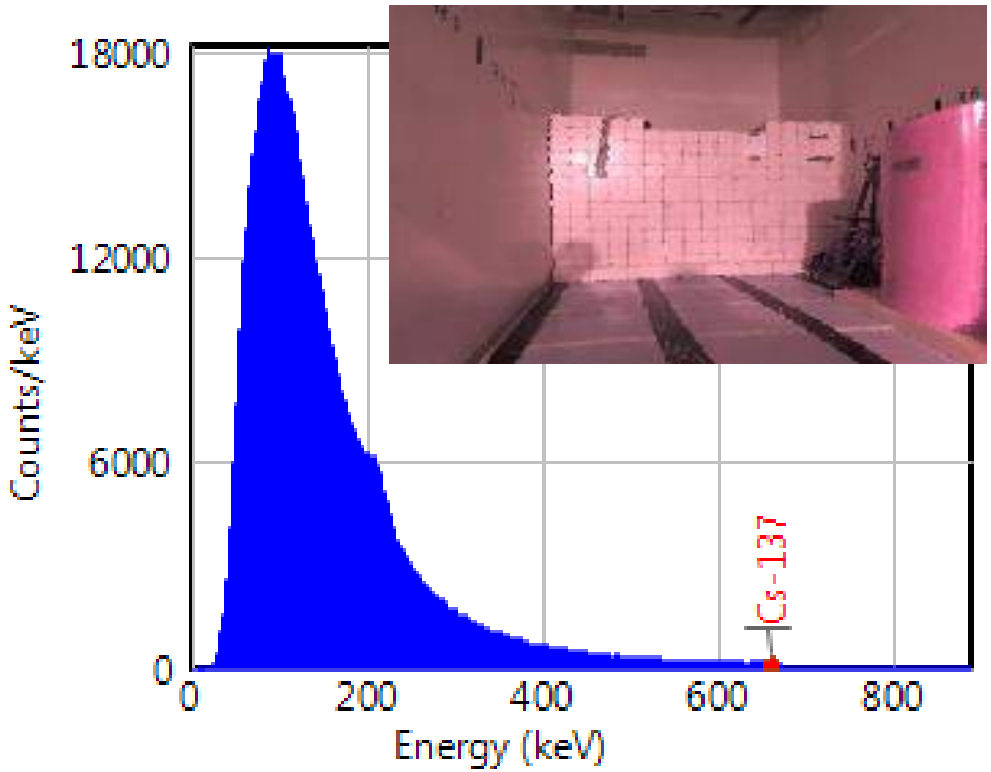
Co-58 primarily near floor.

2.5 minutes, ~4 mR/hr

Source Behind Shield

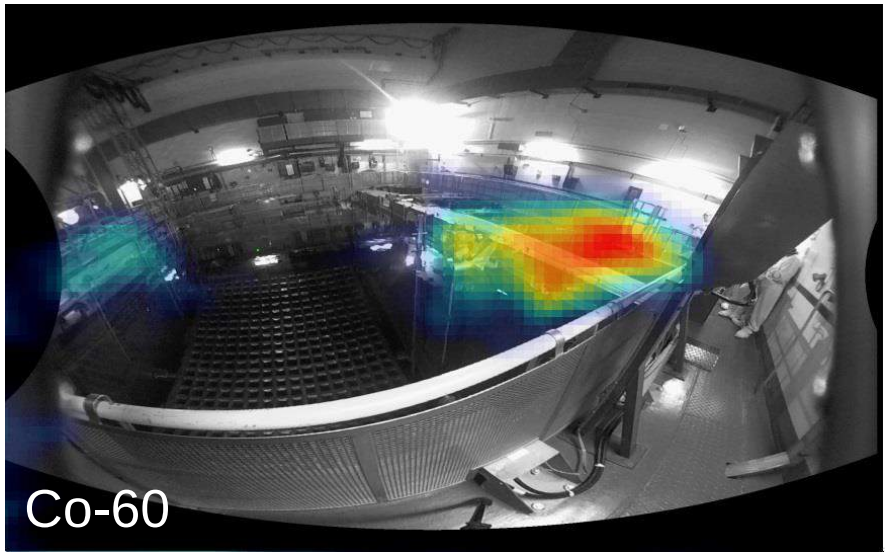


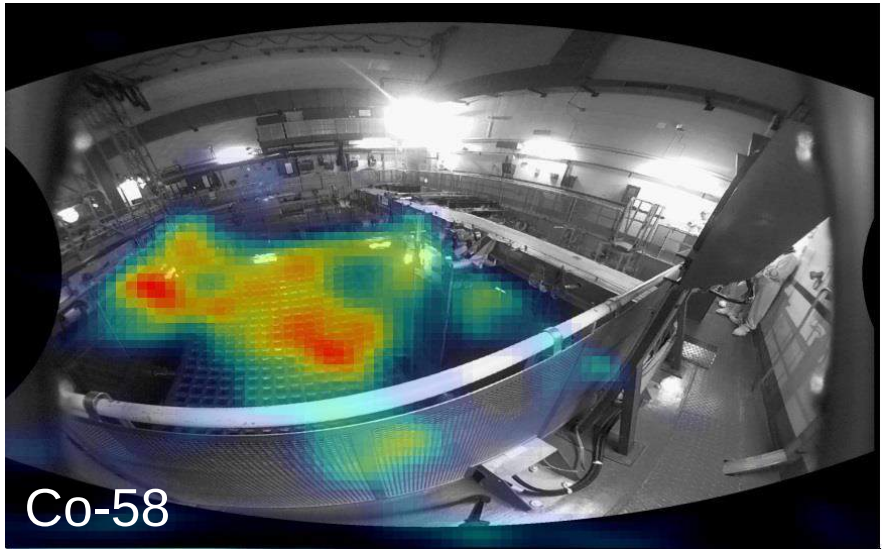


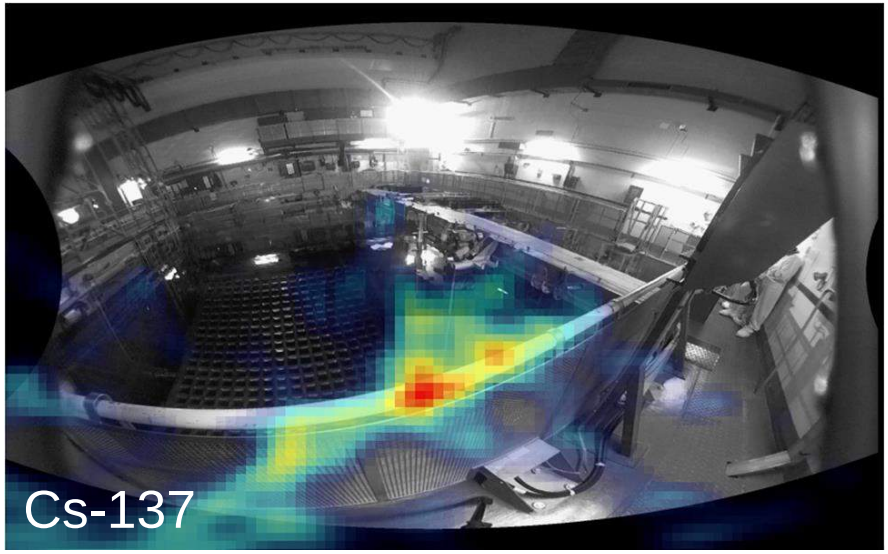


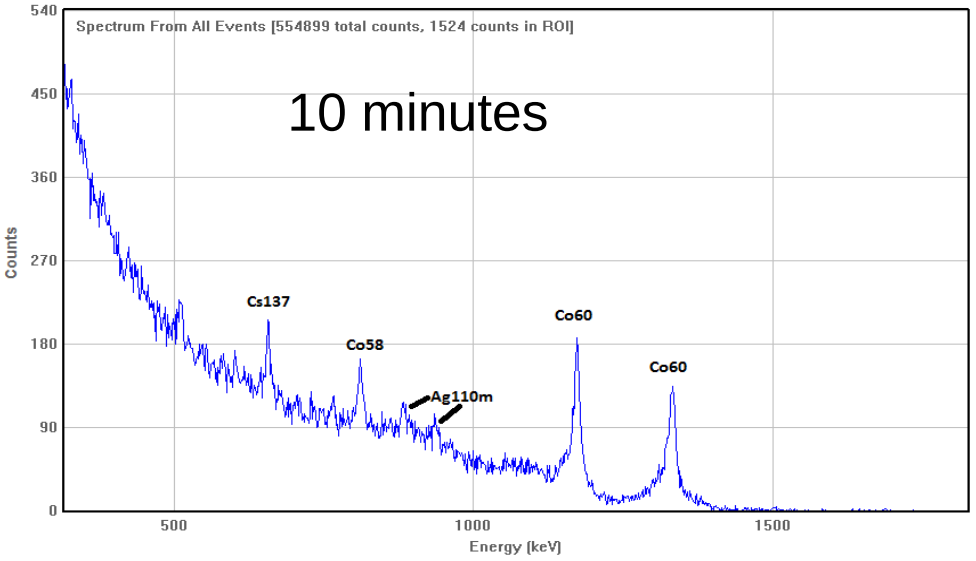
- See buildup from shielding when image all energies, but only see source direction when only image 662-keV peak.

Fuel Pool


Co-60


Co-58


Cs-137


Spectrum From All Events [554899 total counts, 1524 counts in ROI]
10 minutes
Counts
Energy (keV)
Cs137
Co58
Ag110m
Co60
Co60
540
450
360
270
180
90
0
500
1000
1500

Summary

- Polaris-H developed for nuclear power plant applications.
- Provides <1.1% FWHM energy resolution at 662 keV and isotope specific images.
- Efficiency (~1% relative) is sufficient for generally high count-rate environments of nuclear power plants.
  - Paired with energy resolution, detection of 10 μCi check sources at 1 m in 1 min.
- Also, needed other features to make a practical instrument (battery life, water-tight, wireless connection…)

Thank You For Your Time

H3D, Inc.

www.h3dgamma.com

info@h3dgamma.com