



Polaris-H Measurements and Performance

H3D, Inc.

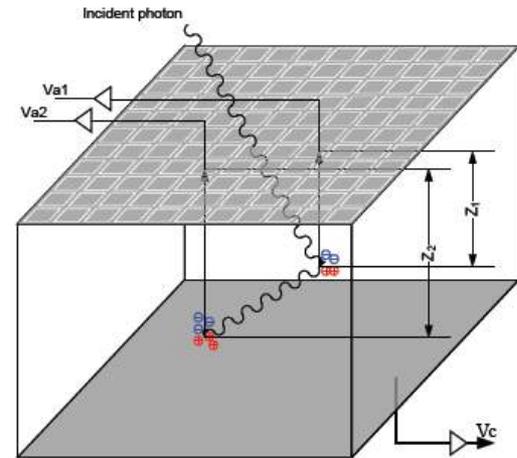
May 2015

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.

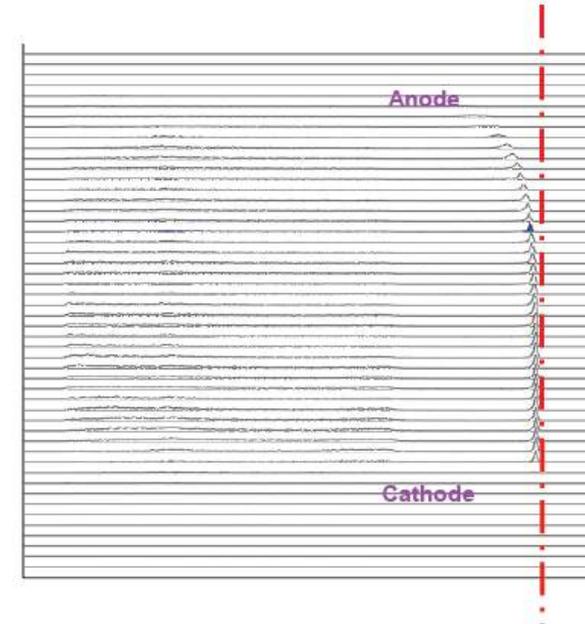
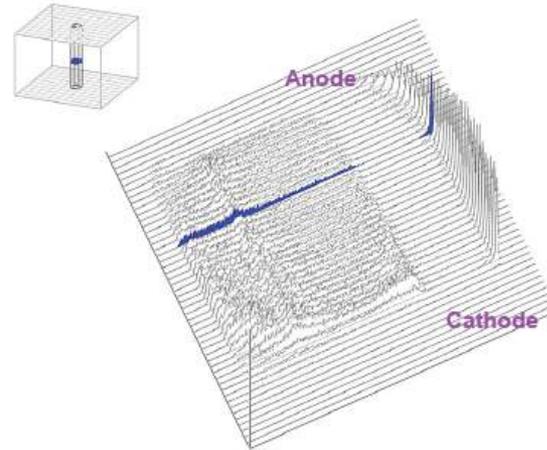
H3D's Technology



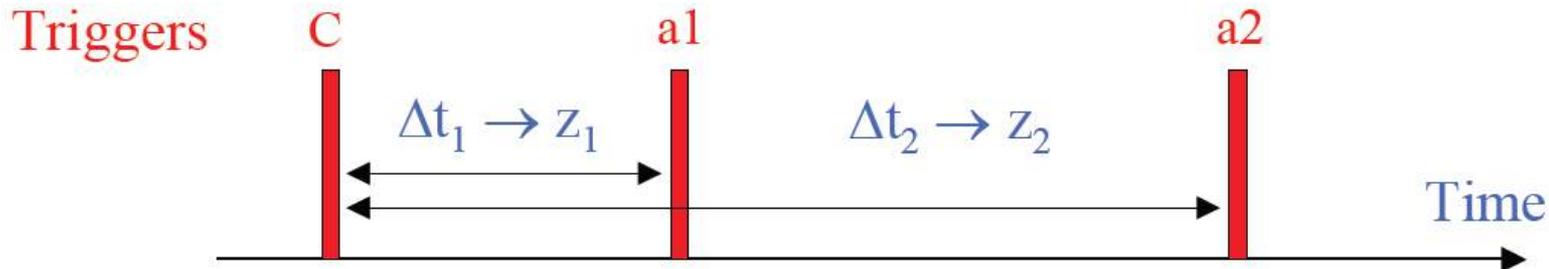
6 cm³ CZT

At room temperature

Depth-separated spectra of one pixel

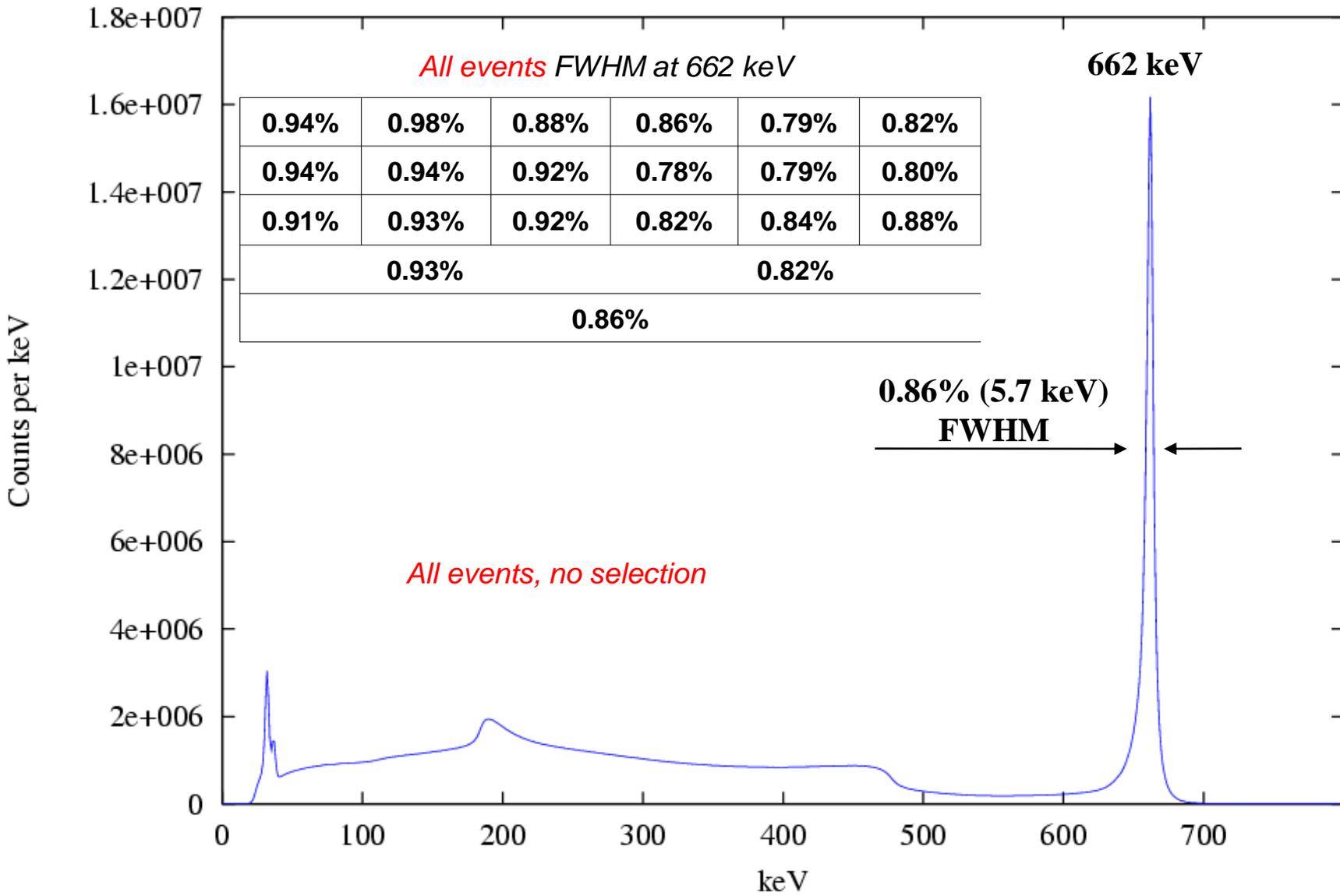


(x,y) found from pixel collecting charge, and z found from drift time.



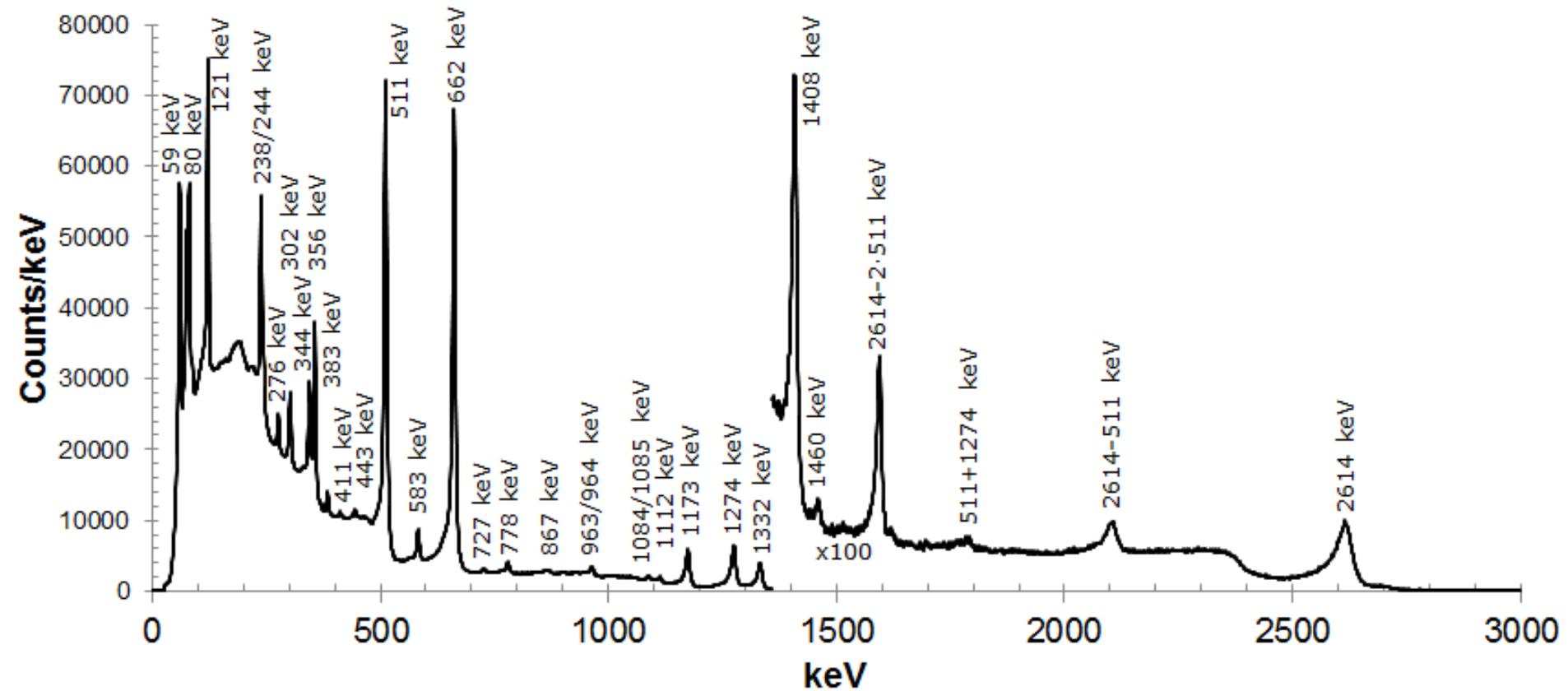
Energy found from charge induced on anode, corrected for interaction position.

Energy Resolution – DoD System

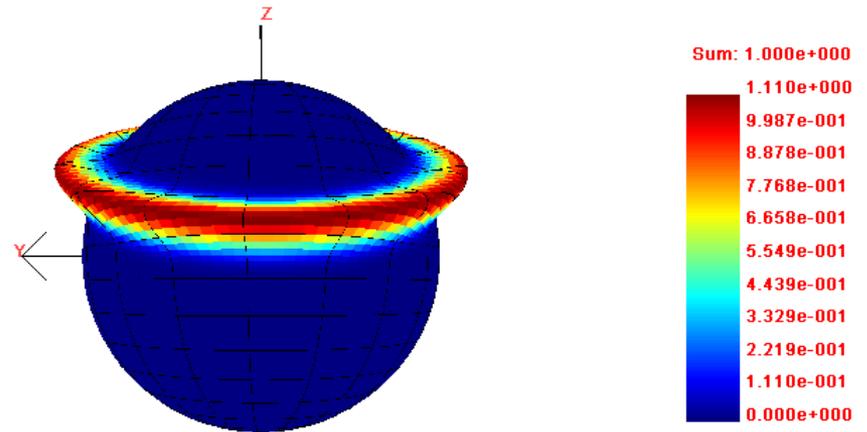
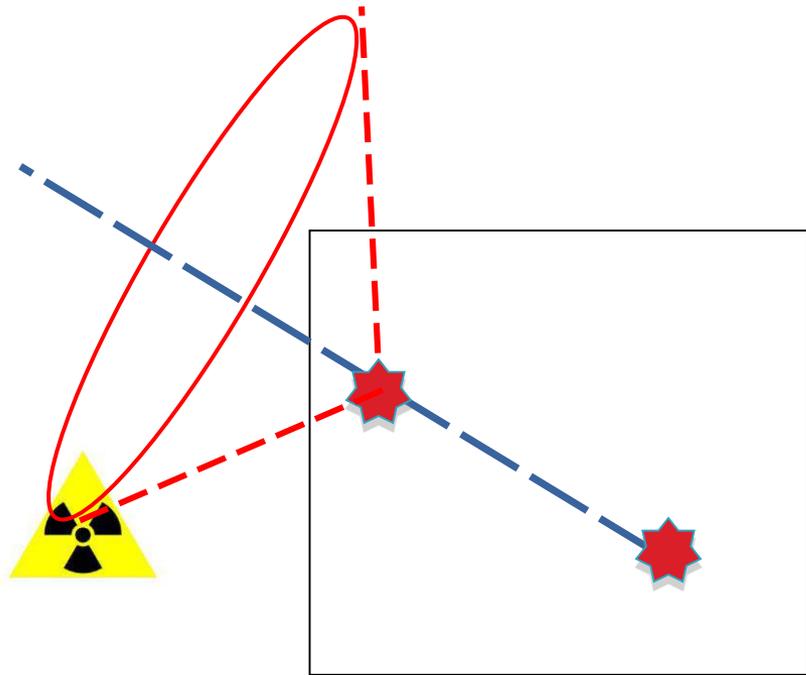


Energy Resolution – Polaris-H

<1.1% FWHM at 662 keV

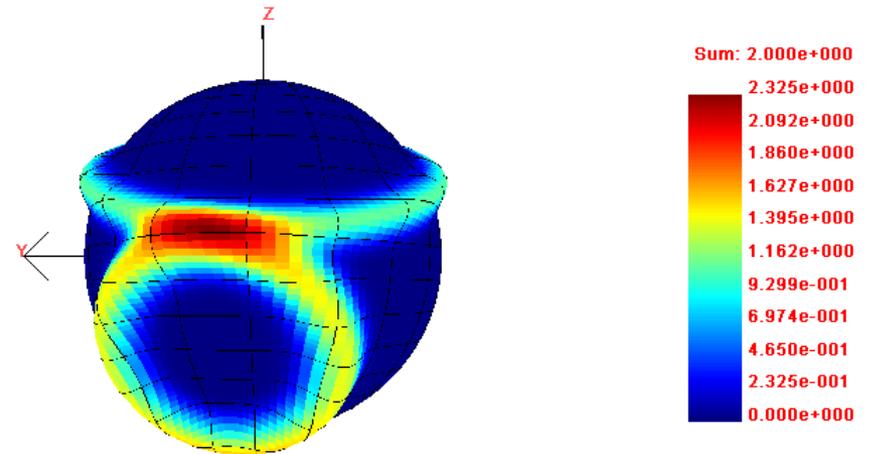
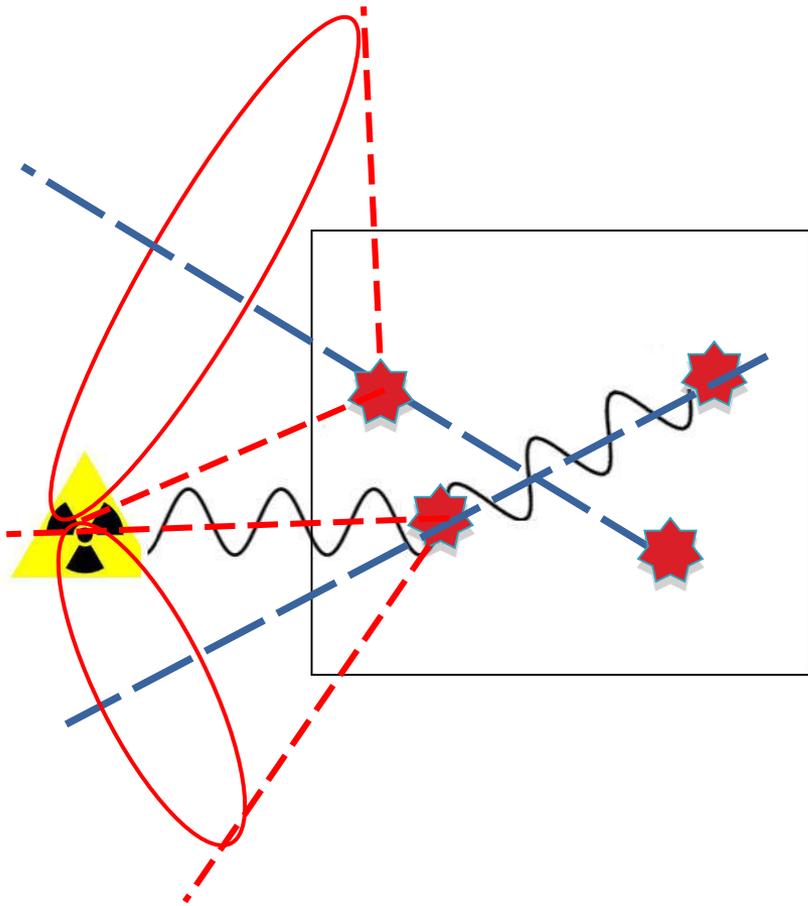


Gamma-Ray Imaging



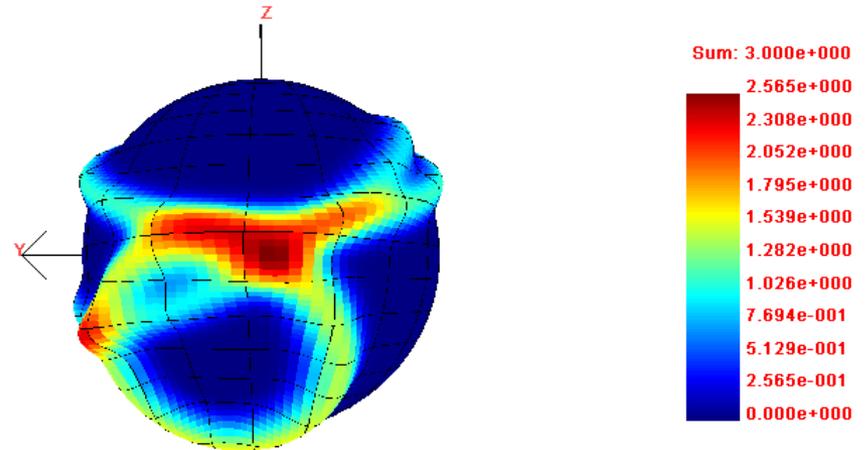
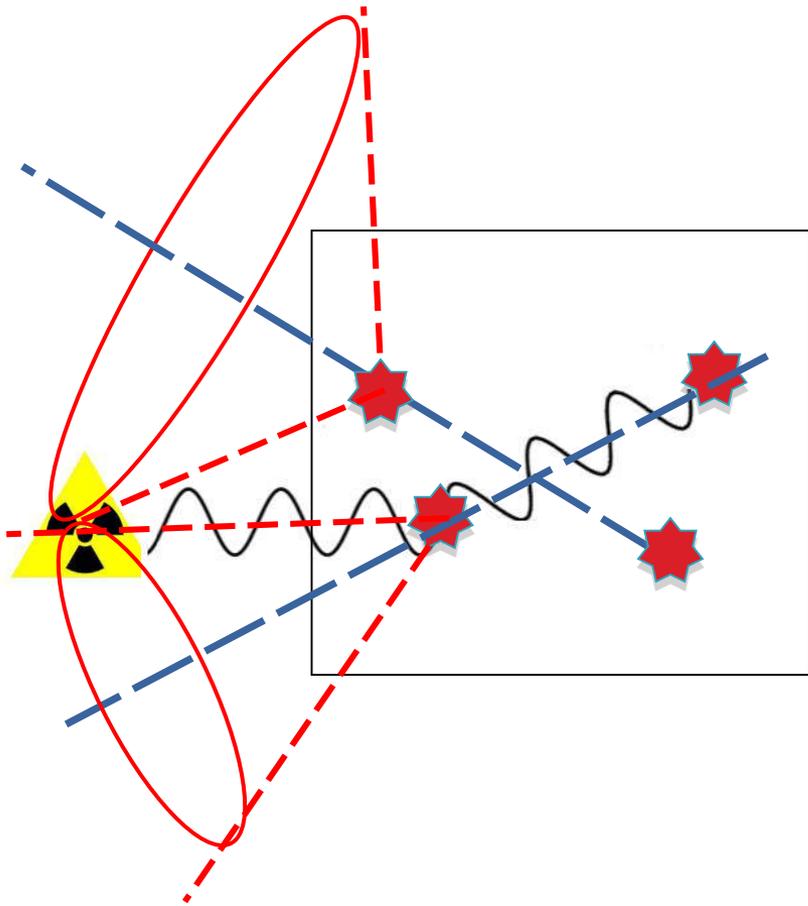
Number of photons: 1

Gamma-Ray Imaging



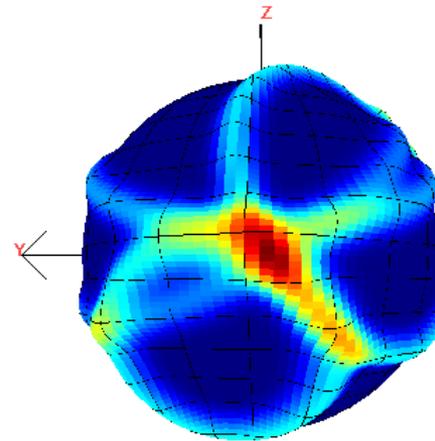
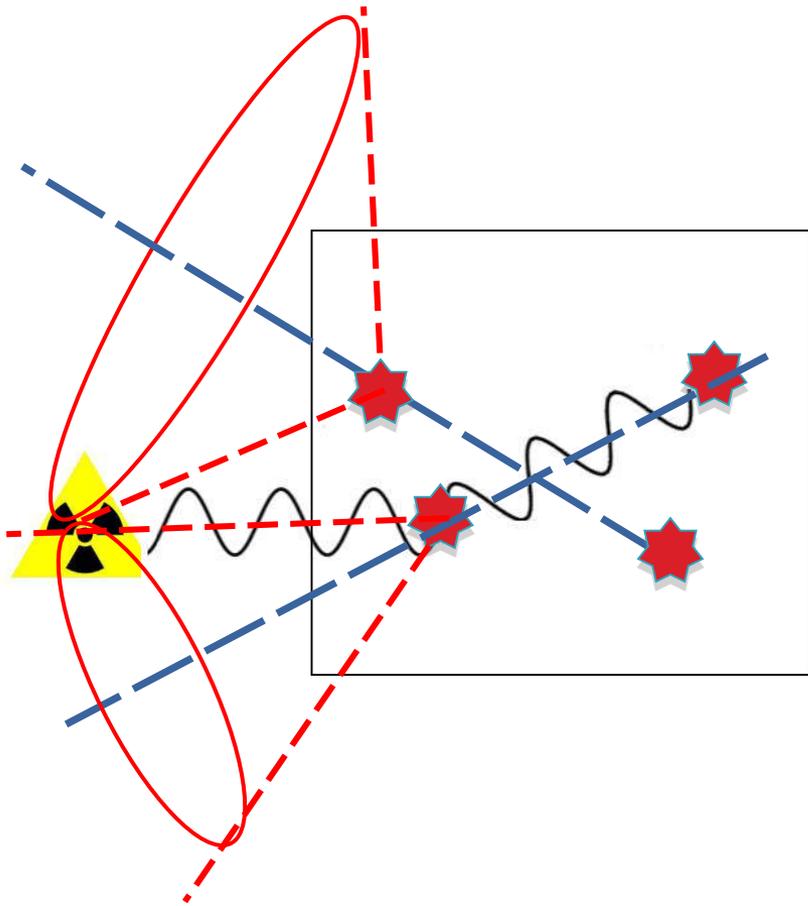
Number of photons: 2

Gamma-Ray Imaging



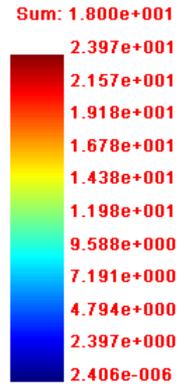
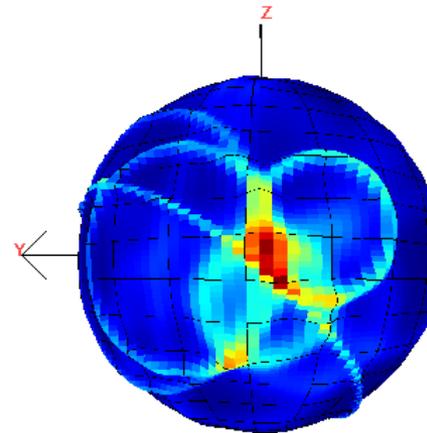
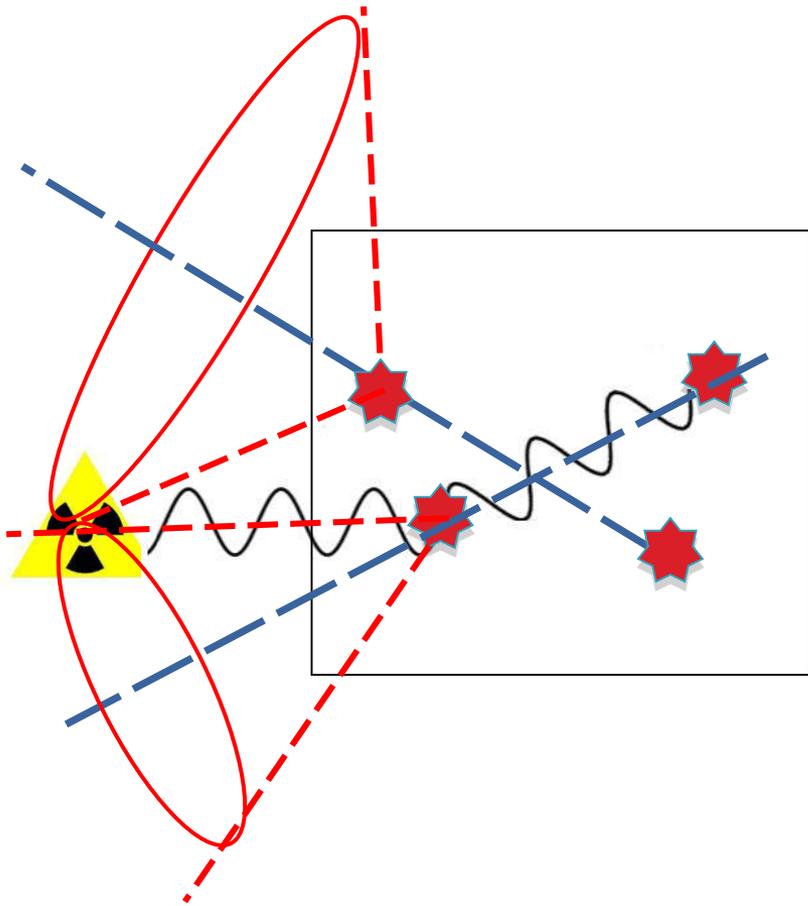
Number of photons: 3

Gamma-Ray Imaging



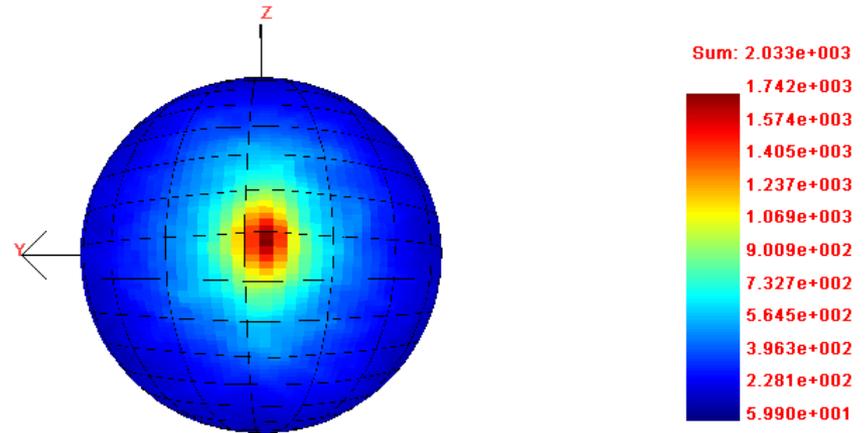
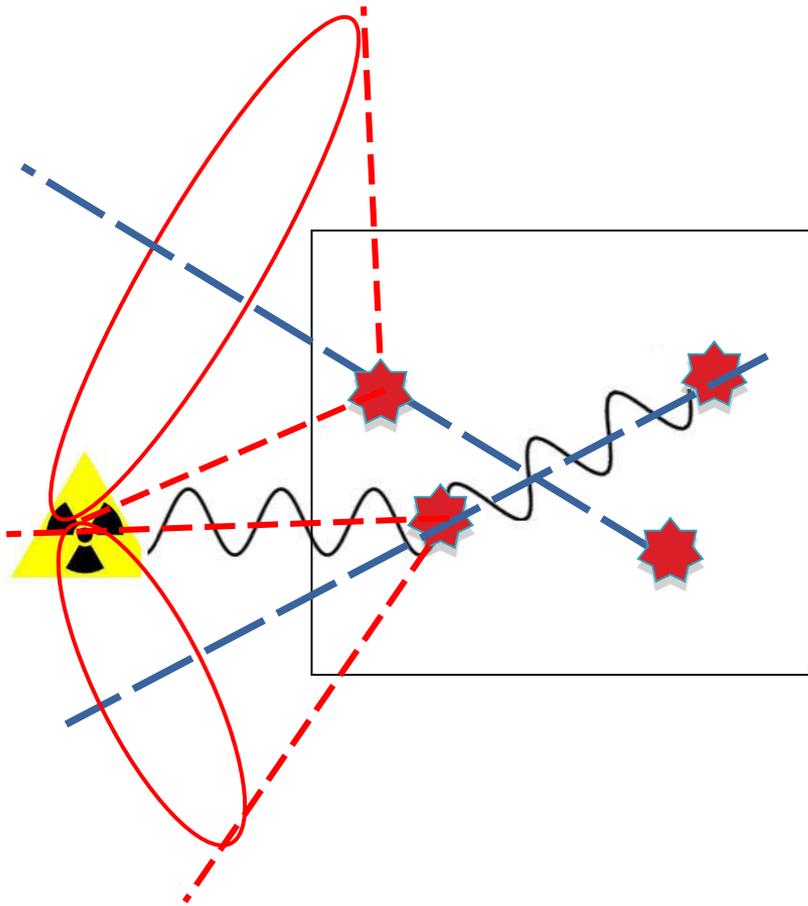
Number of photons: 4

Gamma-Ray Imaging



Number of photons: 18

Gamma-Ray Imaging

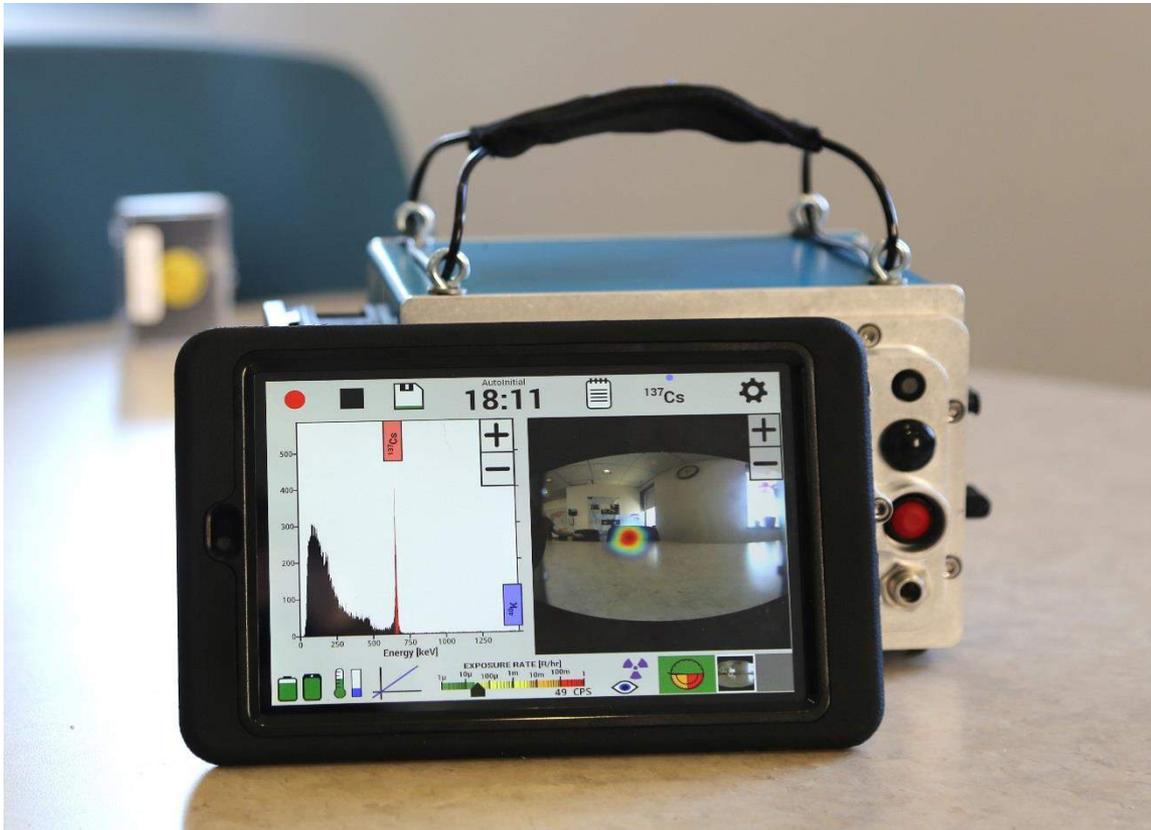


Number of photons: 2033

Polaris-H

Imaging Spectrometer for Nuclear Power Plants

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

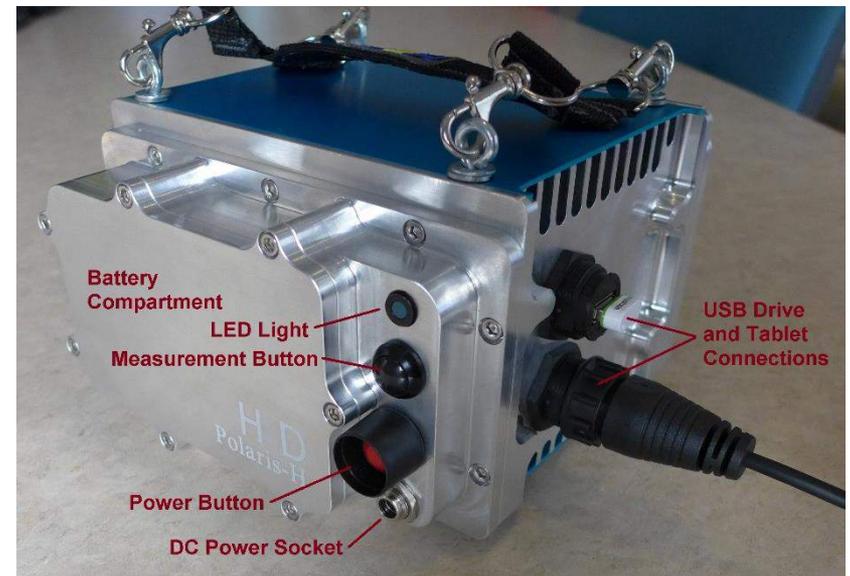
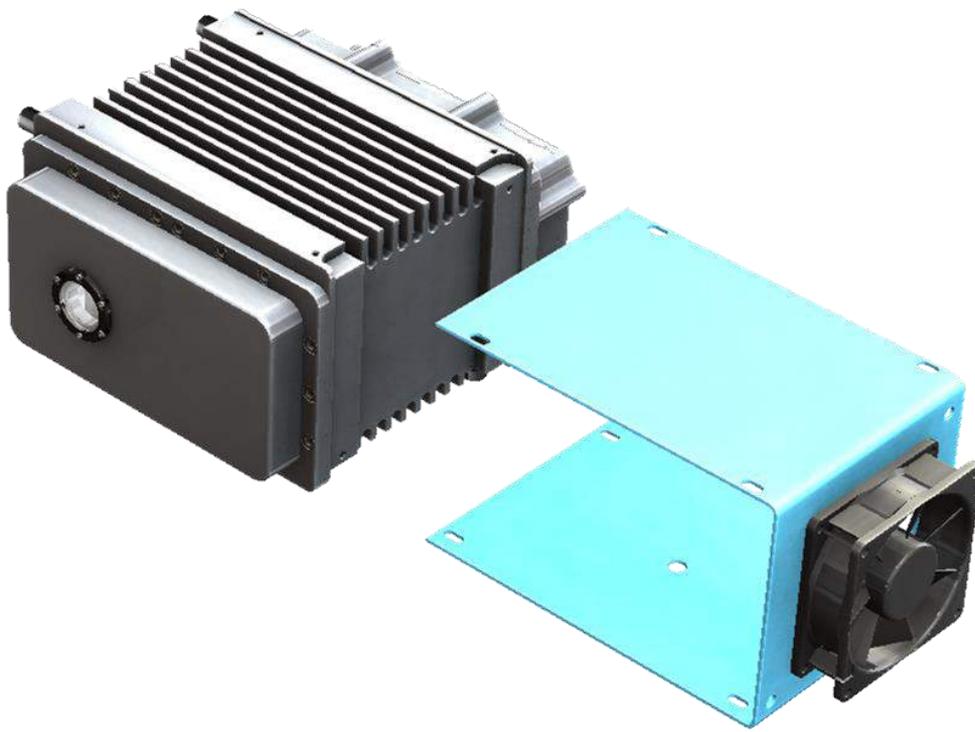


- 8.5 lbs
- Battery operated (5 hr)
- Washable for easy decontamination
- “Simple” user interface
- $\leq 1.1\%$ FWHM energy resolution at 662 keV
- Omnidirectional imaging

Polaris-H

Imaging Spectrometer for Nuclear Power Plants

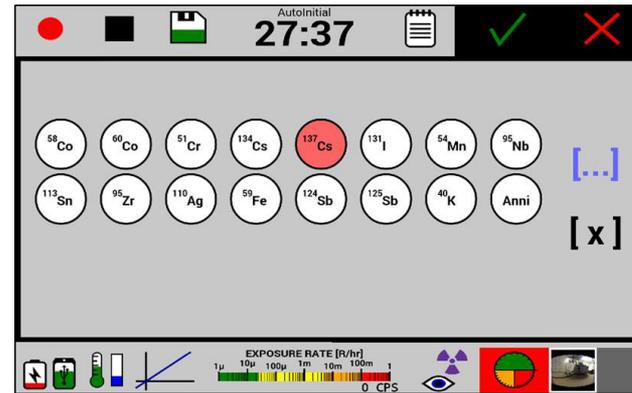
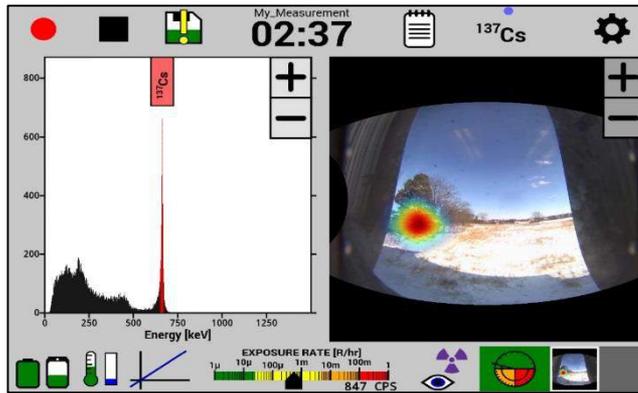
- $\sim 2\pi$ optical camera for overlay of radiation image
- Compton imaging ~ 250 keV to 3 MeV
- Communication with tablet display via Wi-fi, Bluetooth, USB, or Ethernet to network
- Fan and external fins for temperature regulation



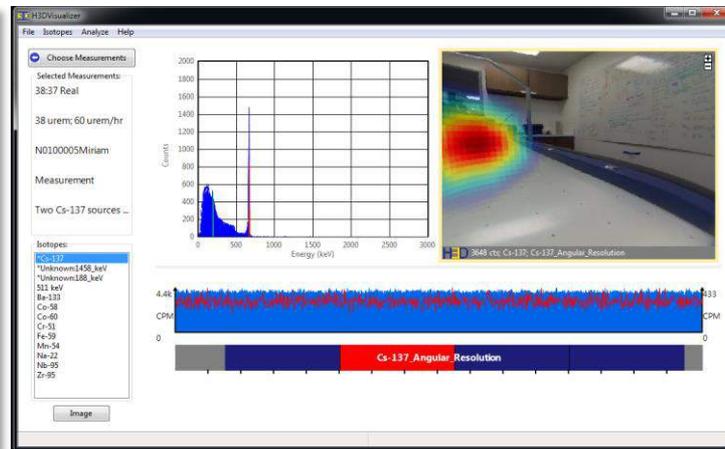
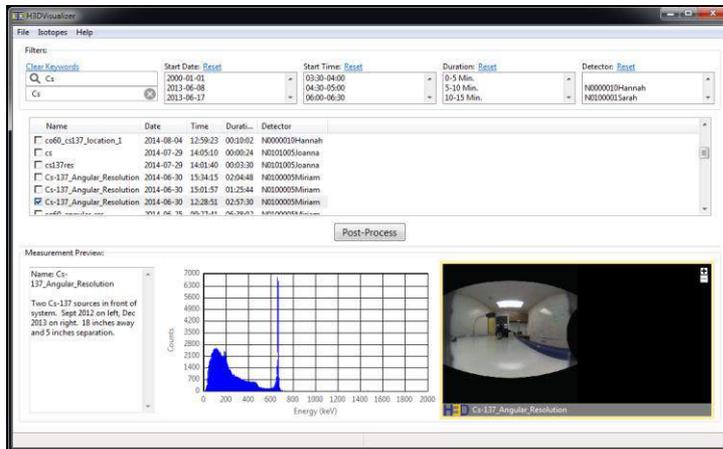
Polaris-H

Imaging Spectrometer for Nuclear Power Plants

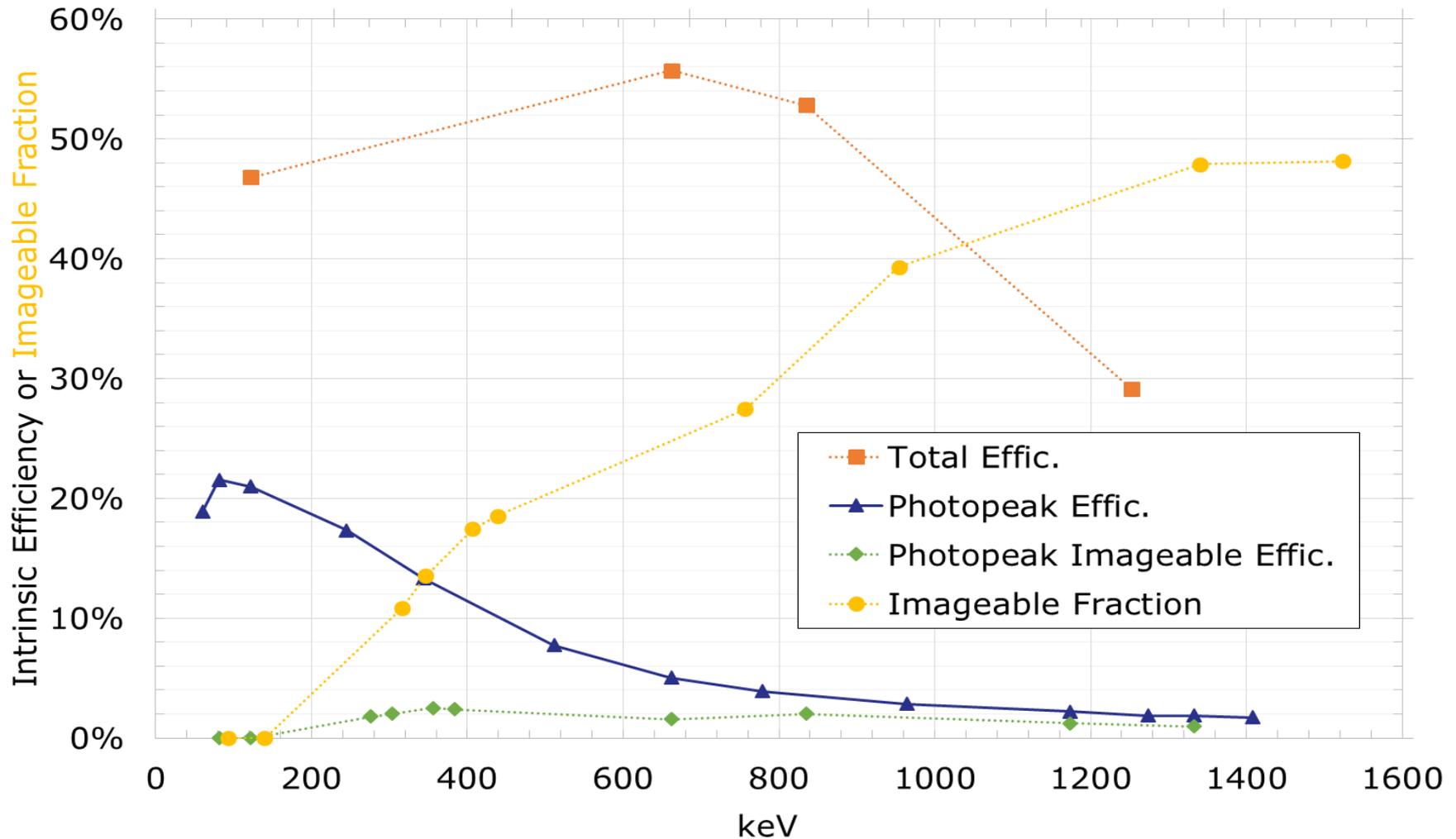
- Real-time software on embedded CPU for isotope detection/ID, isotope-specific imaging, data logging, control and regulation.



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

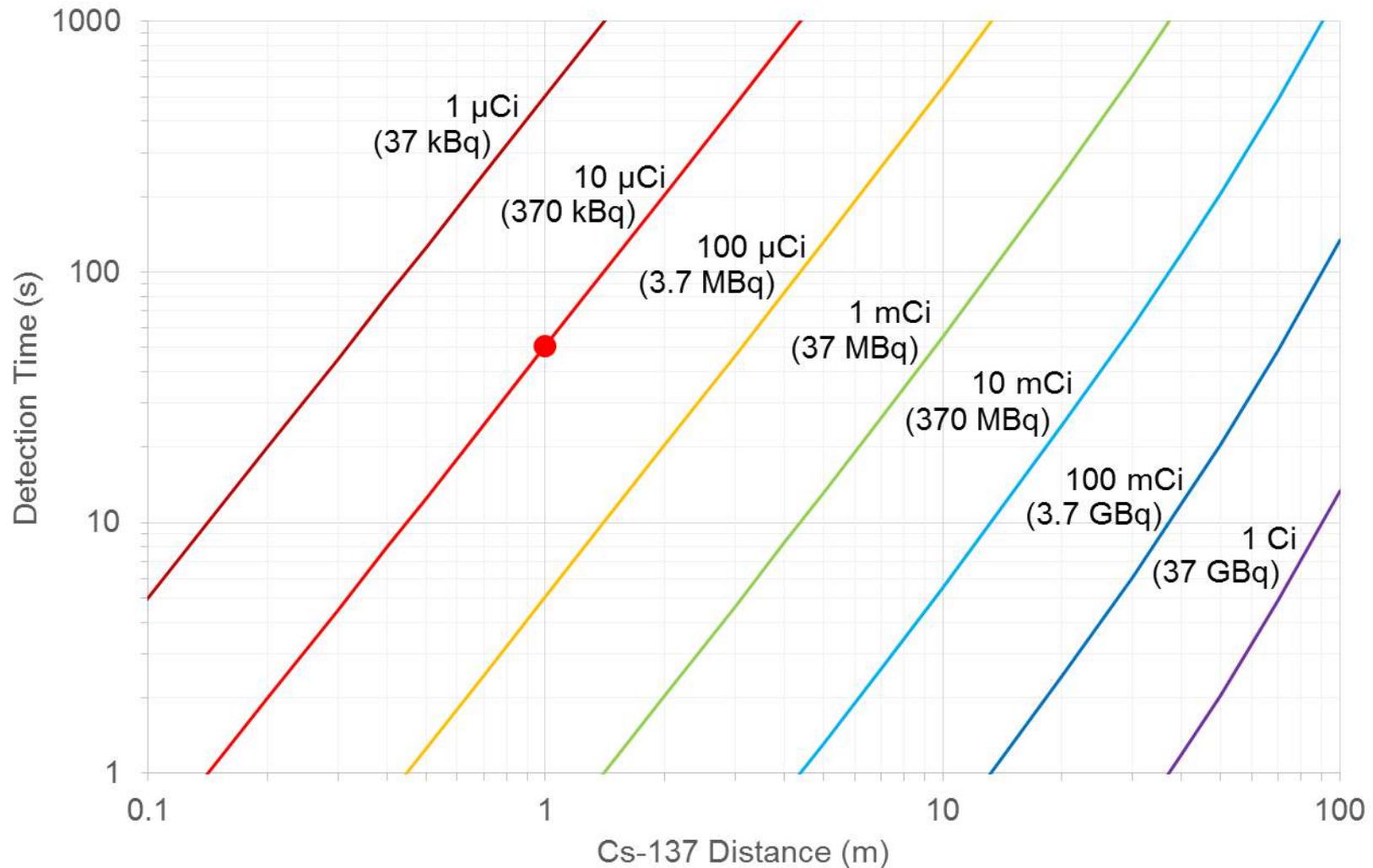


Polaris-H Performance – Efficiency



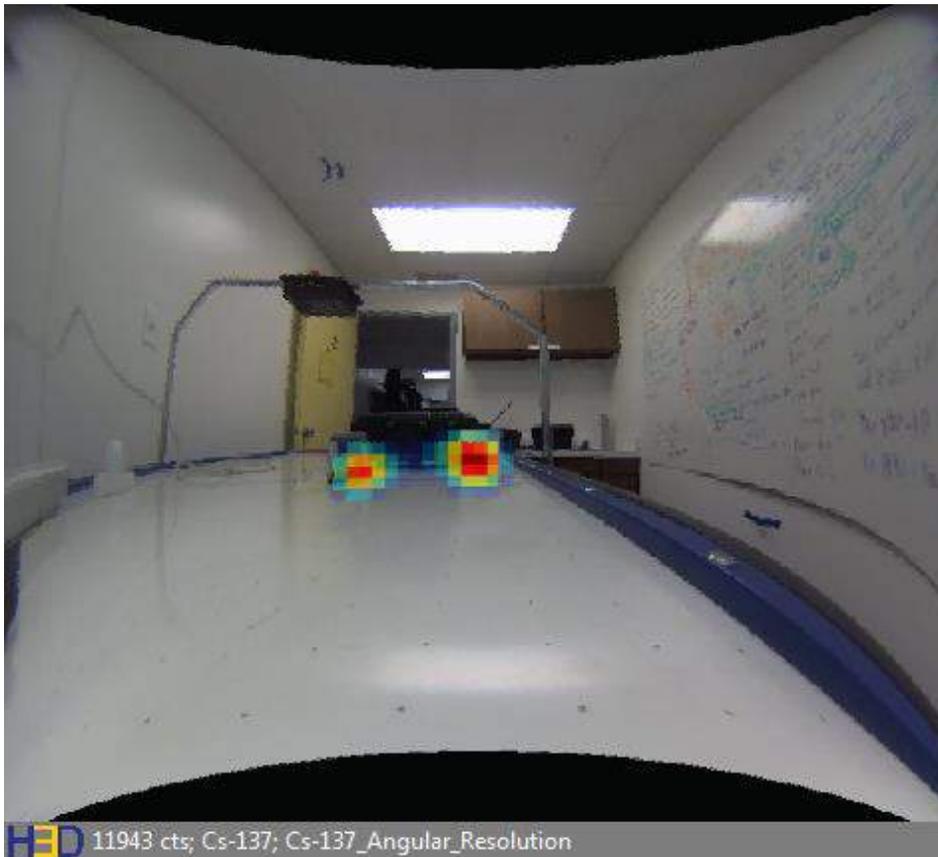
- ~1% relative efficiency (compared to 3"x3" NaI at 1333 keV)
- Almost 50% of events image-able at 1333 keV

Polaris-H Performance – Detection/ID

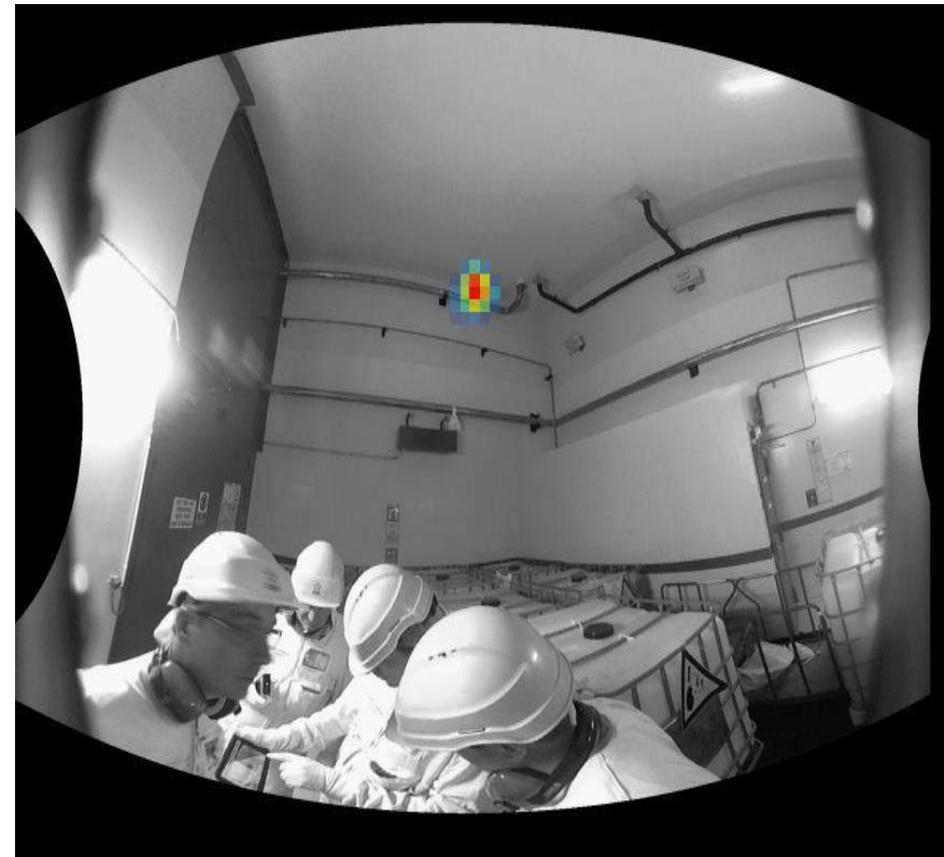


- Detects 3 μR/hr (30 nSv/hr) Cs-137 in <1 minute
 - False alarm rate < 1/hr

Polaris-H Performance – Imaging

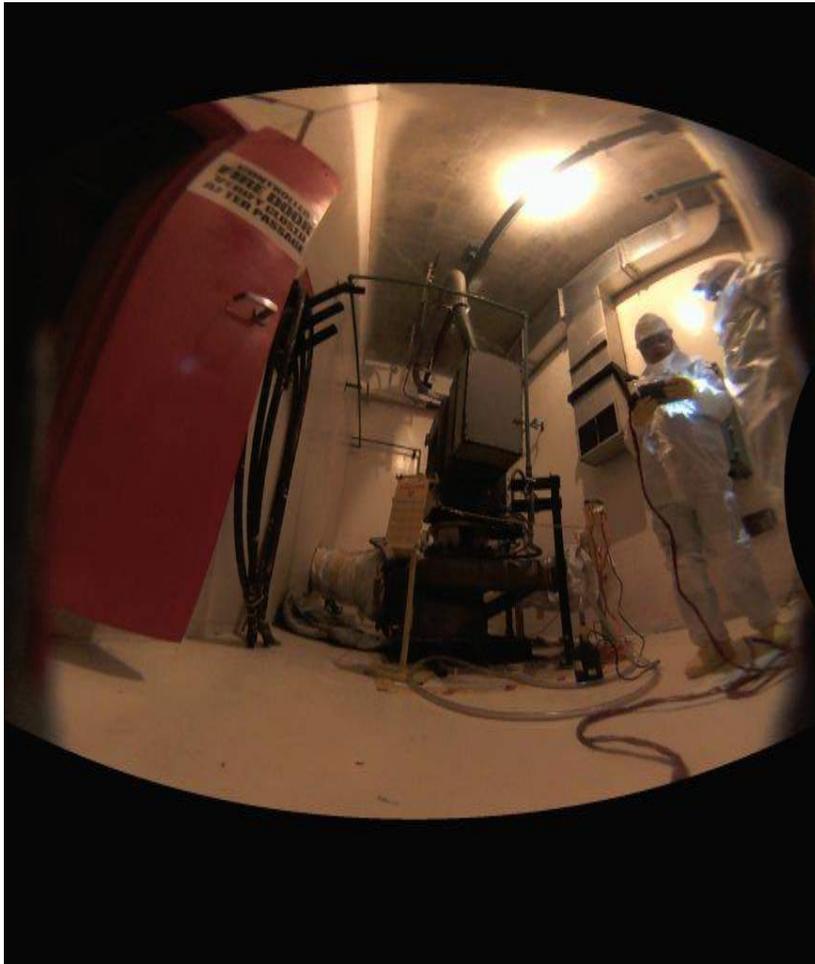


- Can distinguish sources of same energy 20° apart

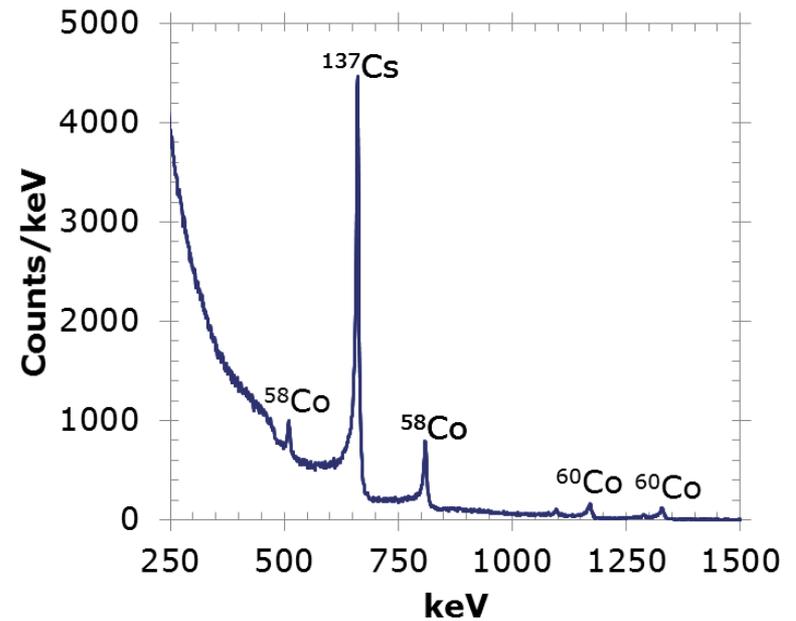


- Can find center of point source to $\pm 1^\circ$ in any direction

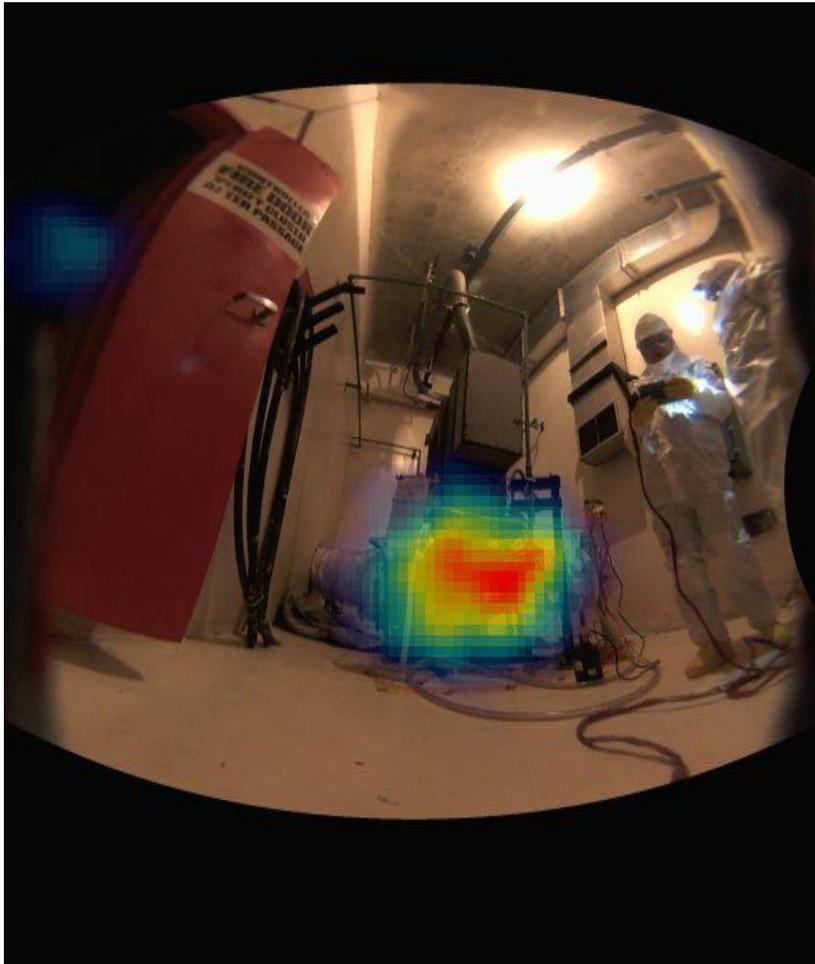
RHR Pump Room



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

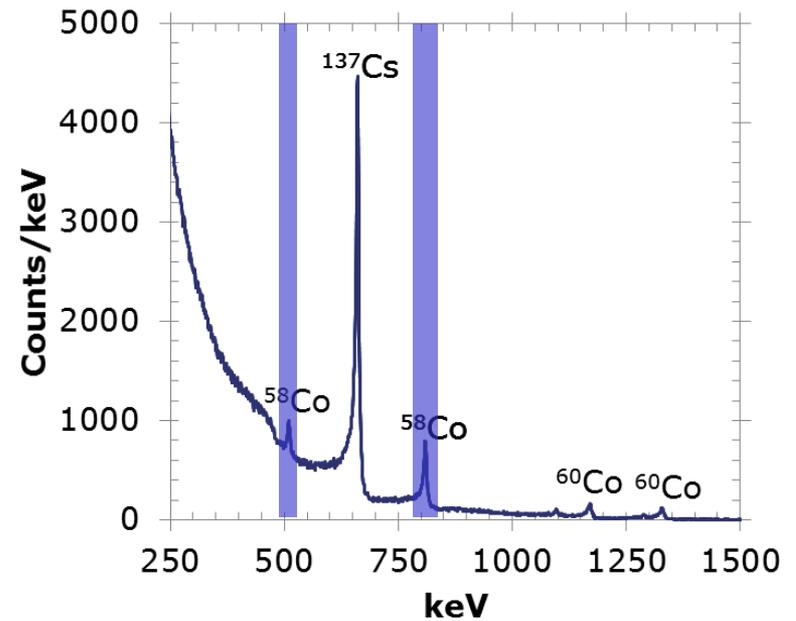


RHR Pump Room – ^{58}Co



Area source found on pump.

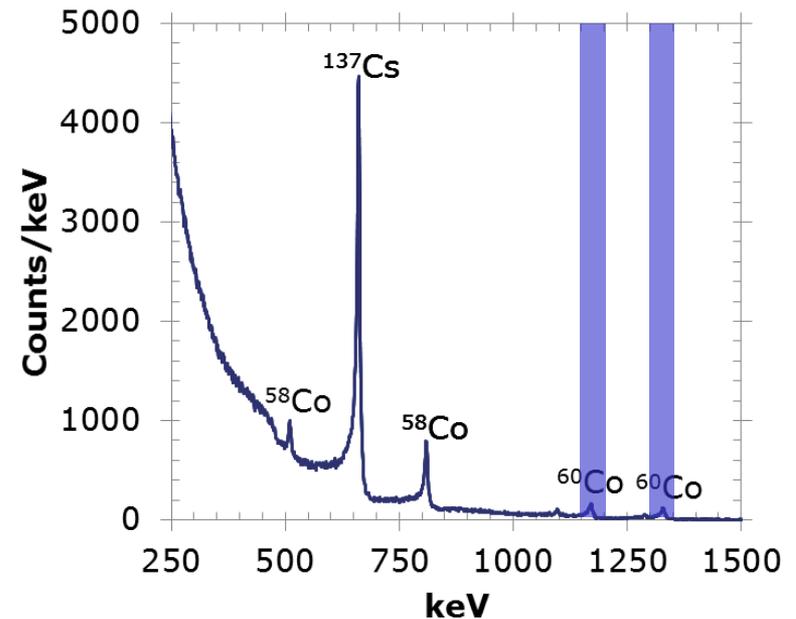
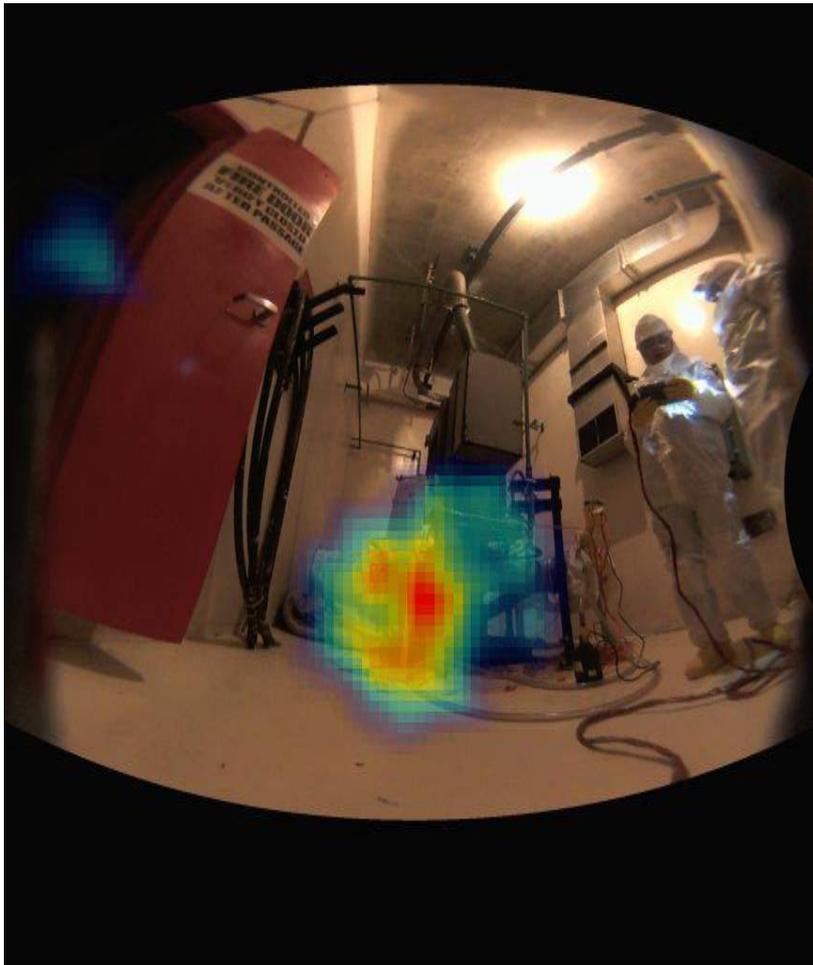
2.1×10^4 counts in ROI
(23% of those imageable)



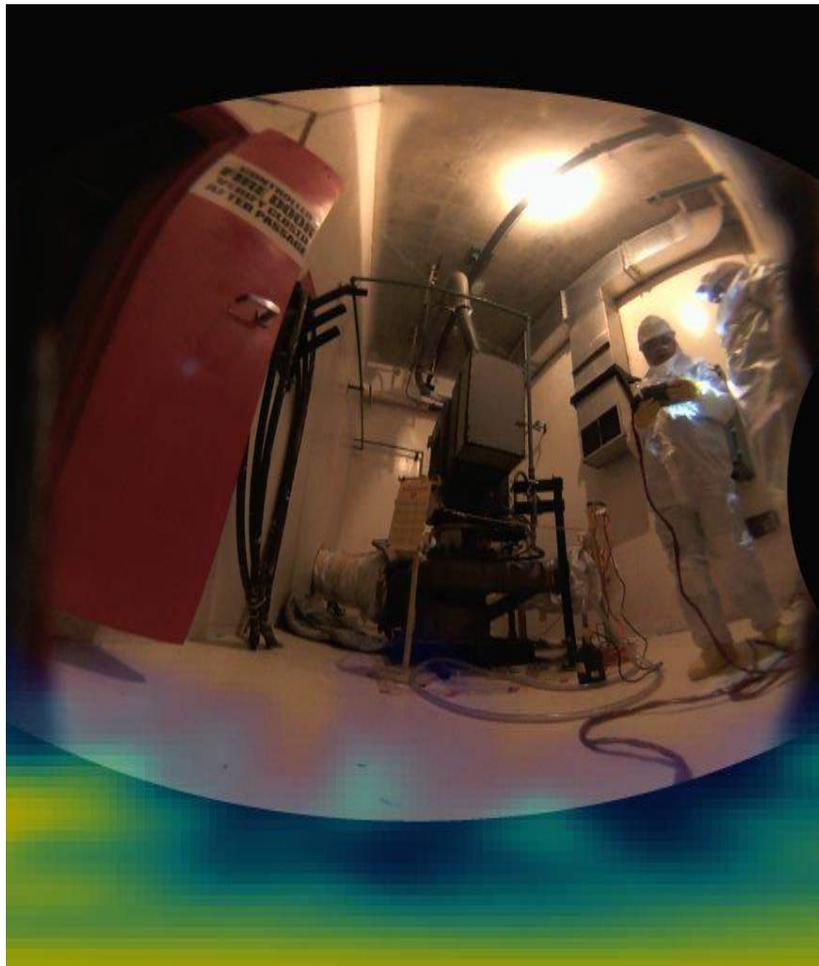
RHR Pump Room – ^{60}Co

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

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

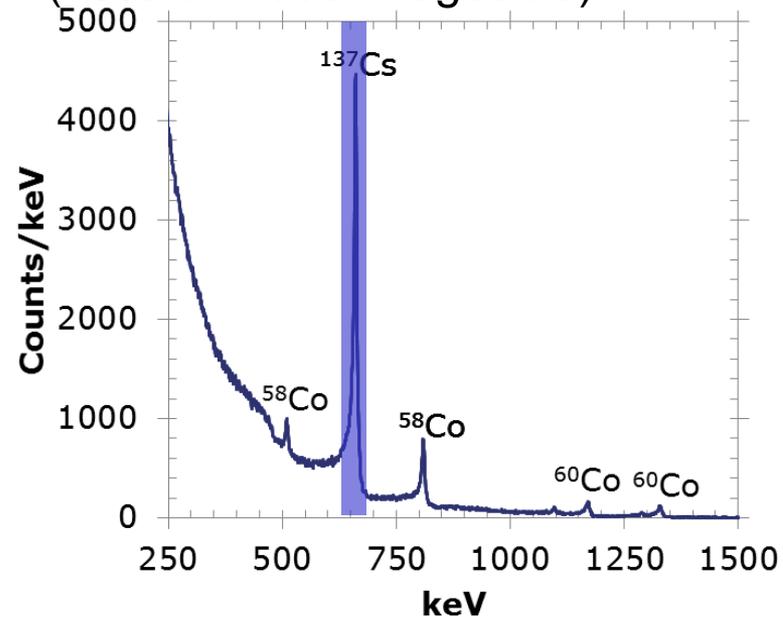


RHR Pump Room – ^{137}Cs

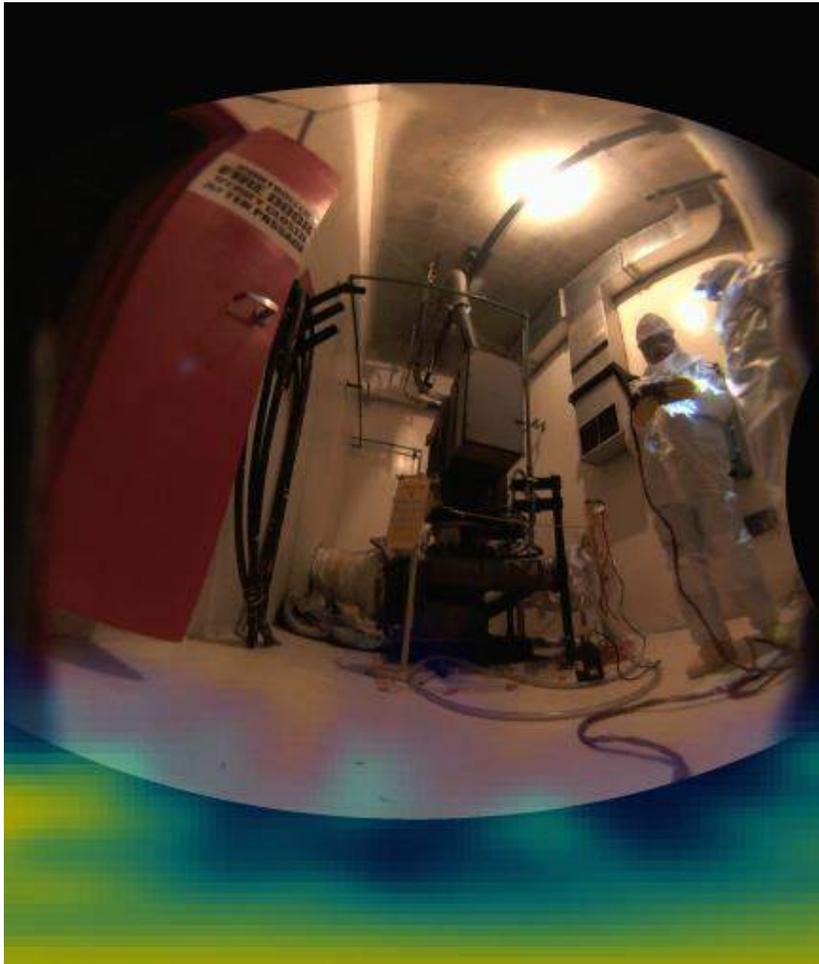


See contamination on floor from prior flood. Nearer areas appear hotter.

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



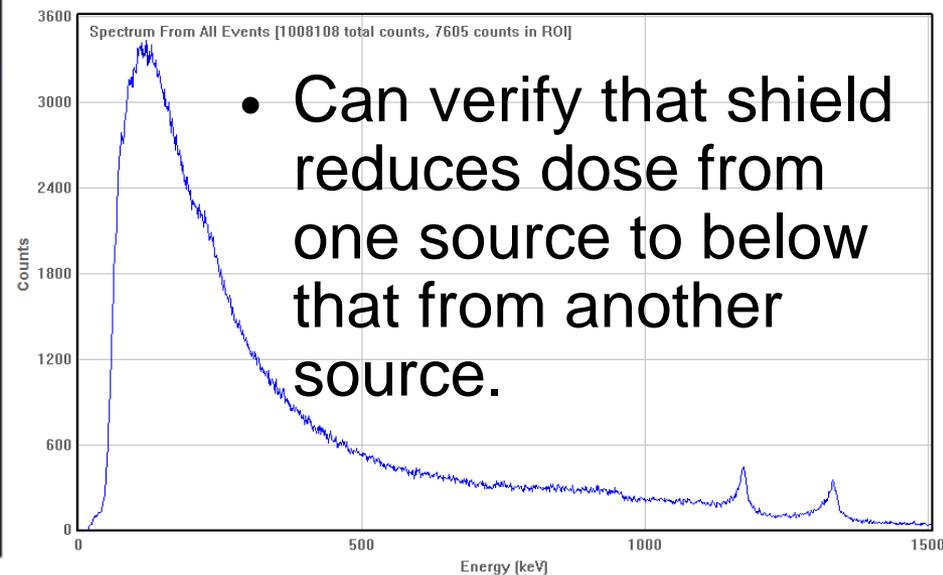
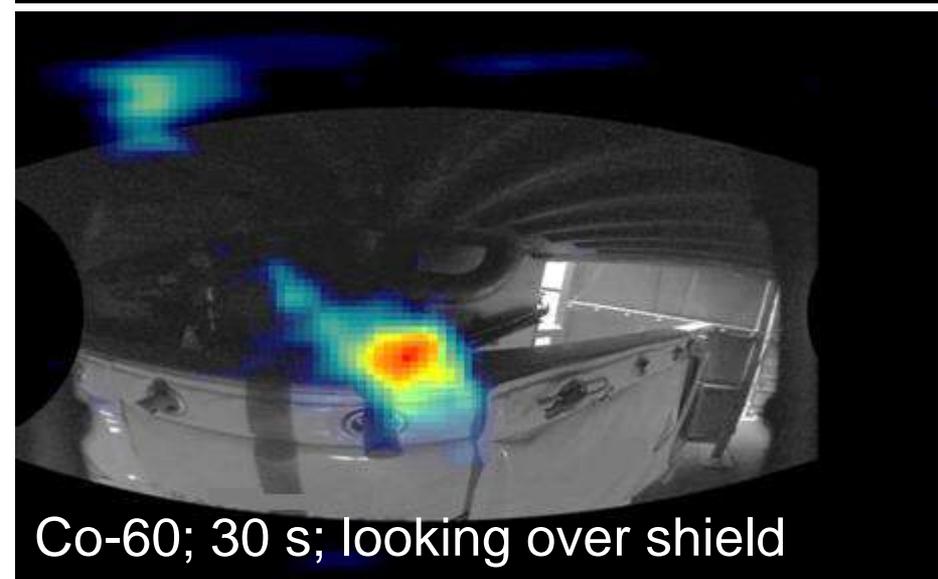
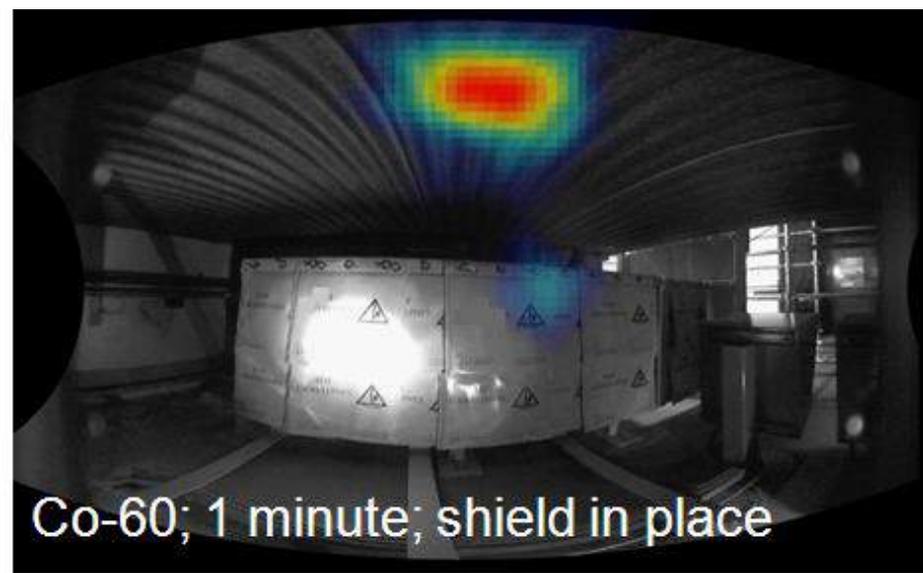
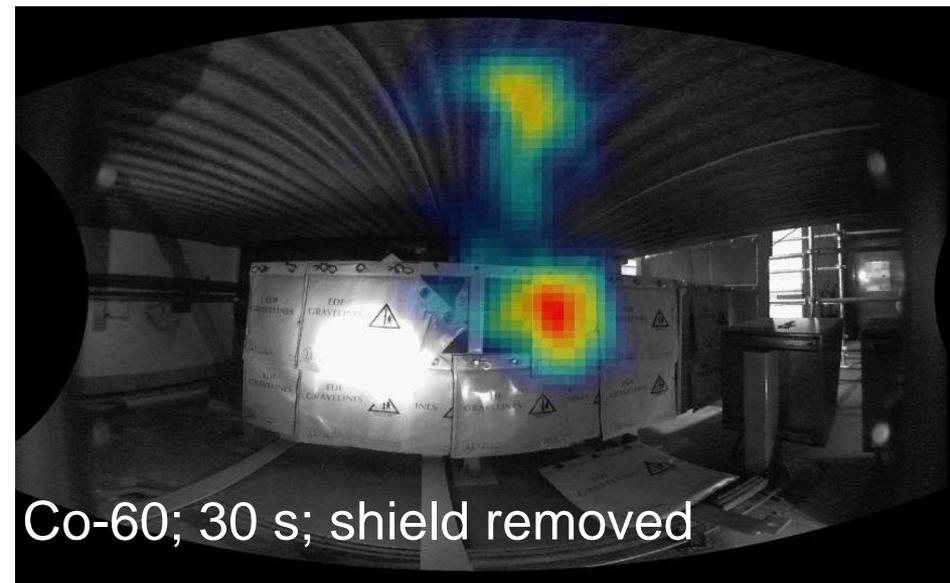
RHR Pump Room – ^{137}Cs



Also see contamination
on wall directly behind.

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

Shielding Verification



Locating Unknown Source

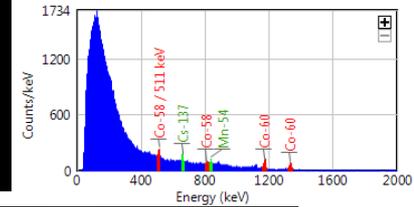
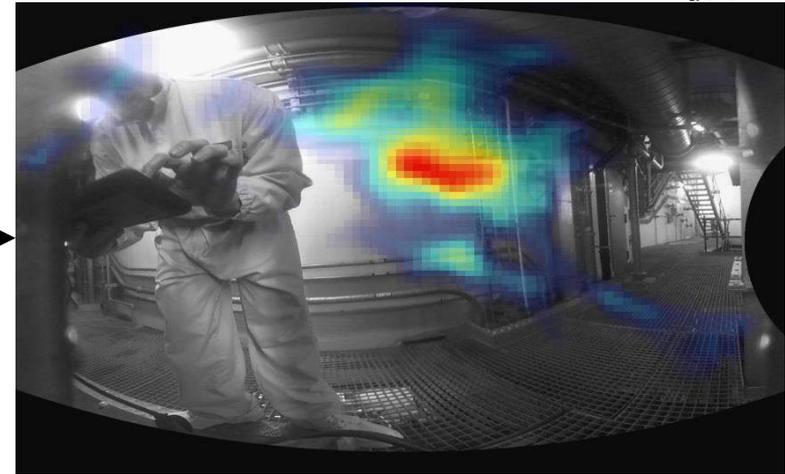
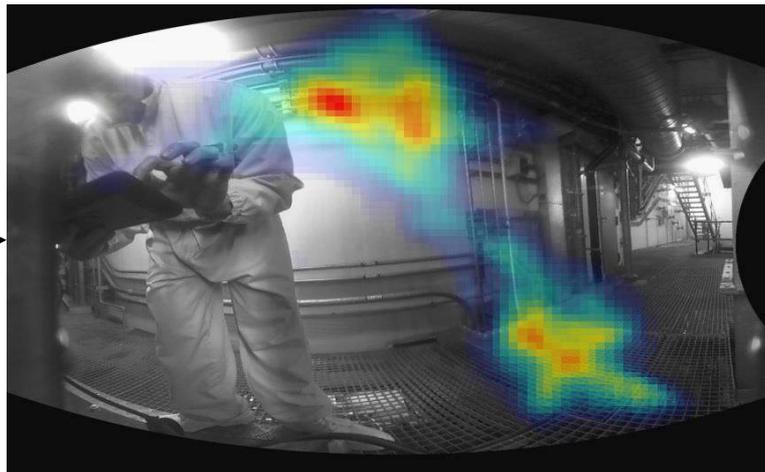


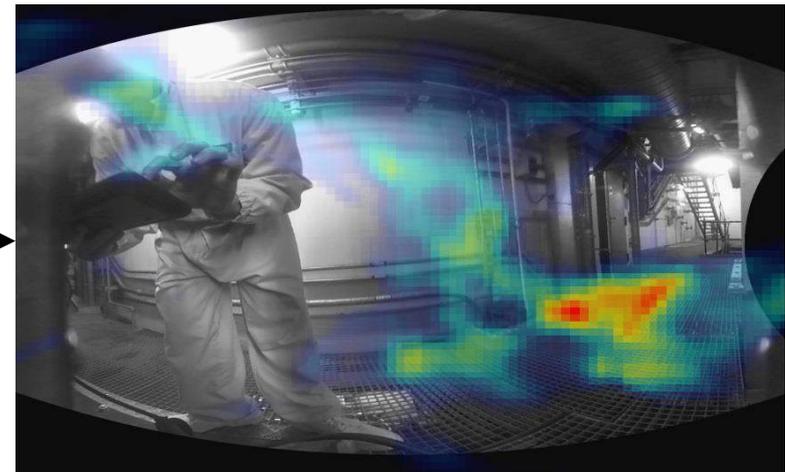
Image known hot spot (red box).



Cs-137 image primarily hot in expected direction.



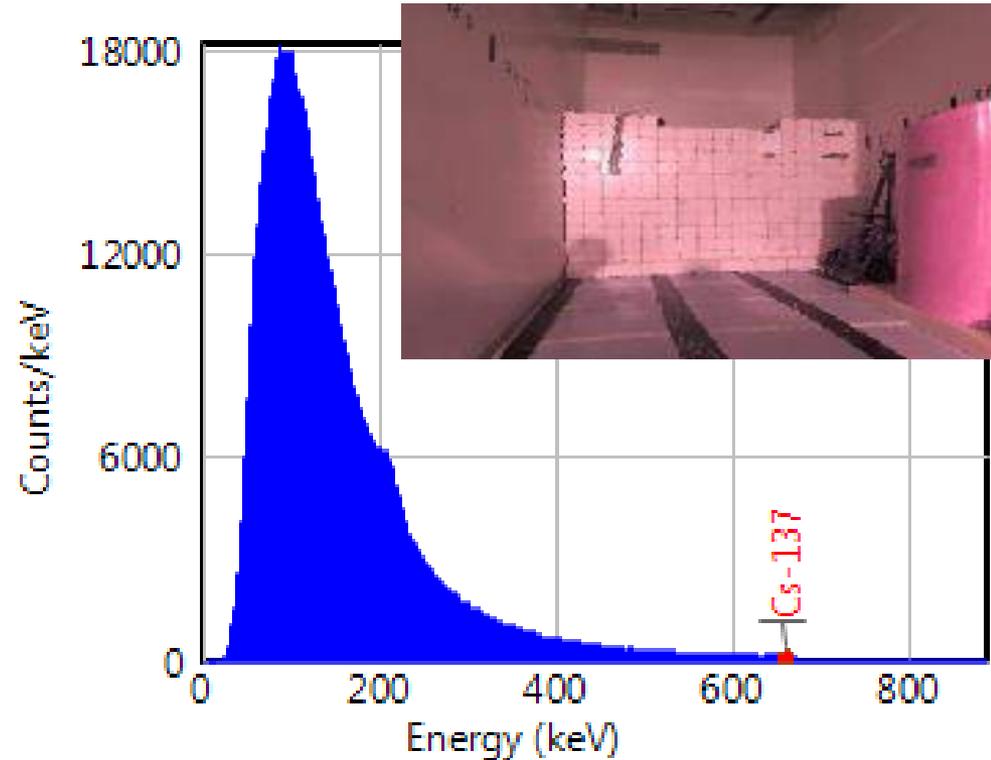
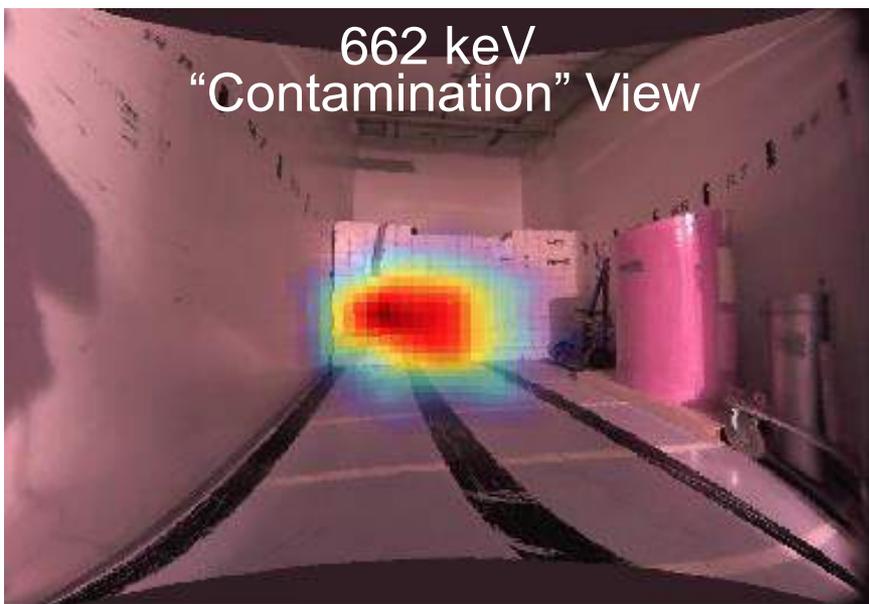
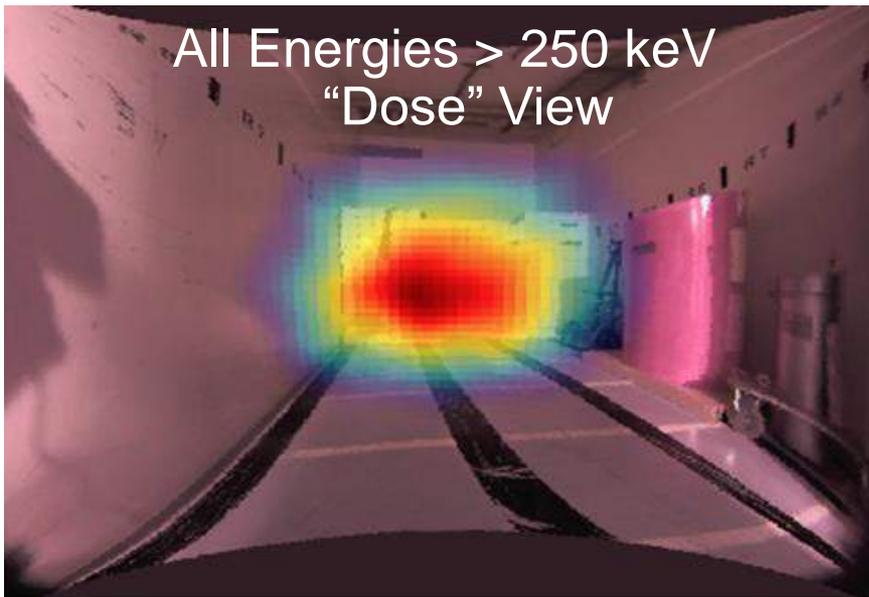
Co-60 image shows another previously unknown source near floor.



Co-58 primarily near floor.

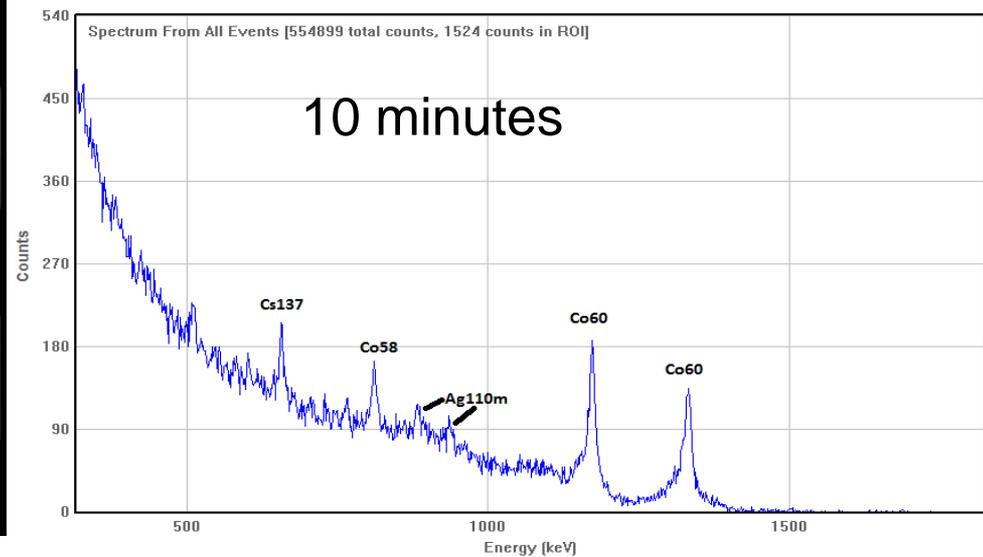
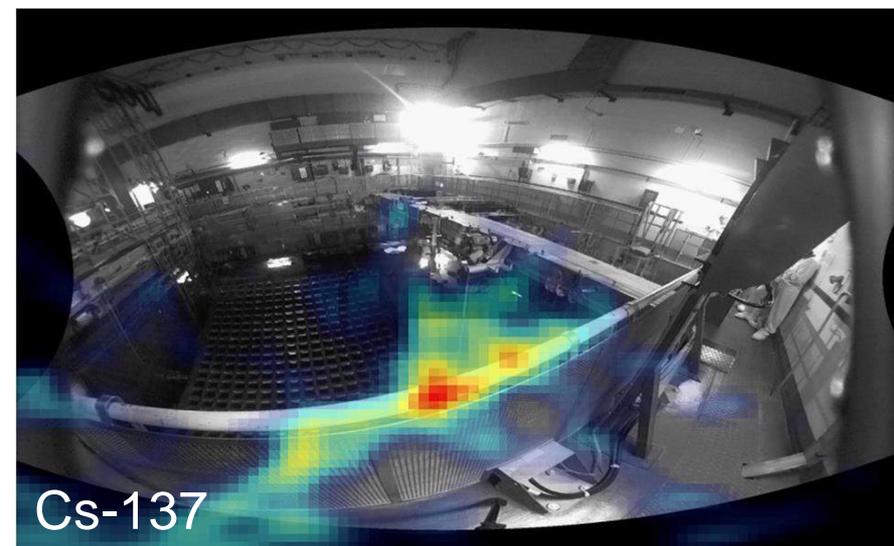
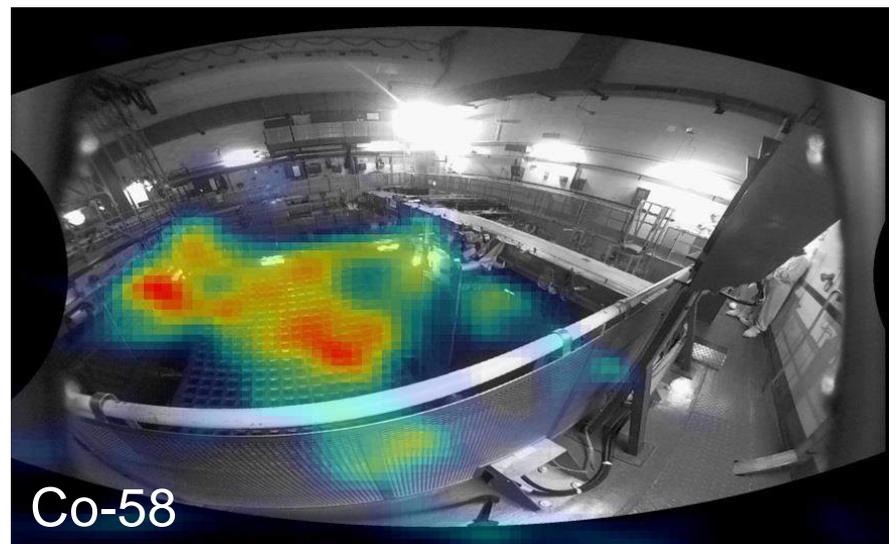
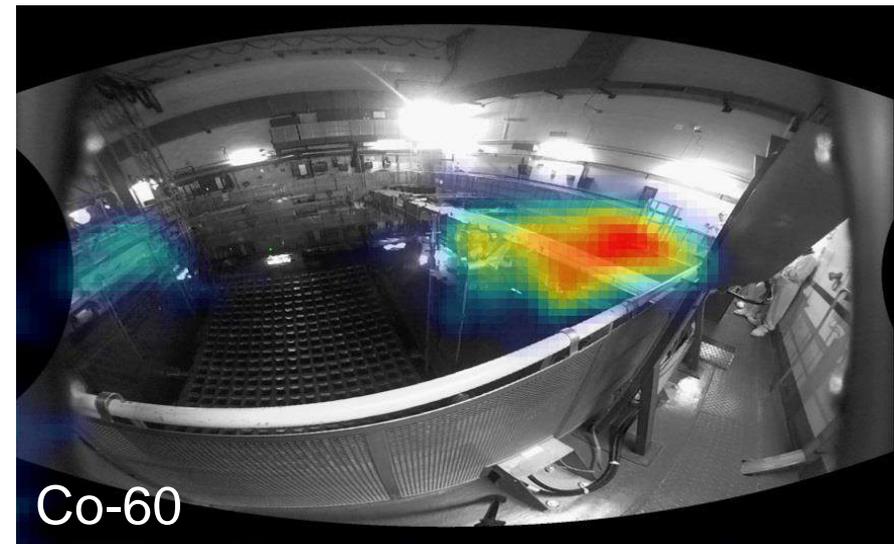
2.5 minutes, ~4 mR/hr

Source Behind Shield



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

Fuel Pool



Summary

- Polaris-H developed for nuclear power plant applications.
- Provides $<1.1\%$ FWHM energy resolution at 662 keV and **isotope specific images**.
- Efficiency ($\sim 1\%$ 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



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