UCI

Note: CEP Chairman, Dan Stetson discussed the results of the UCI ocean water analysis during the 4Q CEP meeting on October 26, 2023. This presentation by UCI details the analysis and is provided for awareness.

Ocean water analysis at UC Irvine

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Ocean water analysis by gamma spectroscopy

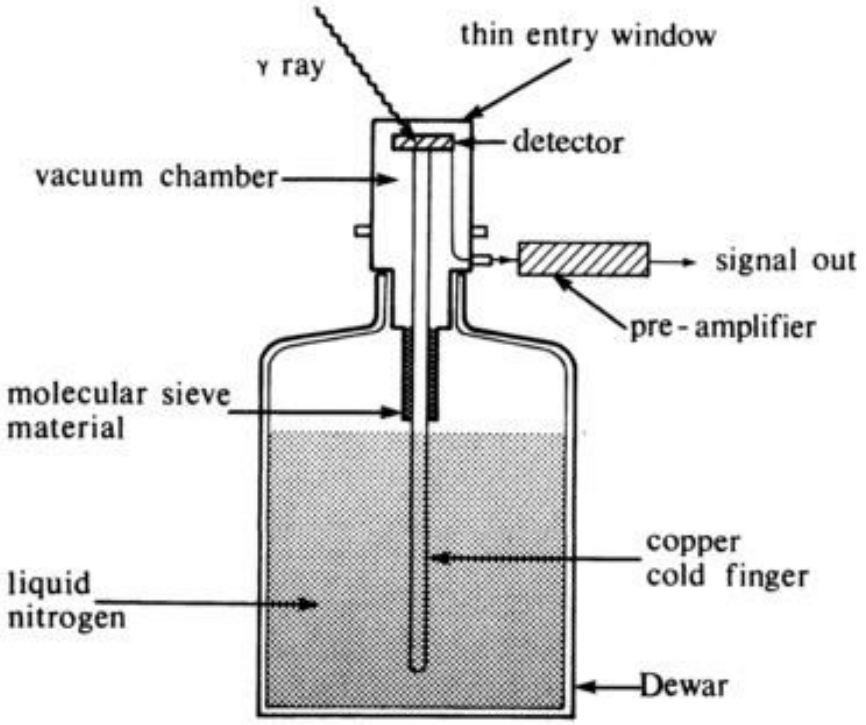
Overview collected samples

- Sample volume ~1 liter, was collected just below ocean's surface
- Samples prior to waste water release, collected 6/7/2023:
  - Sample 1: boat, sample 4: beach
- Samples during waste water release, collected 6/8/2023:
  - Sample 2: boat, sample 5: beach
- Samples after waste water release, collected 6/11/2023:
  - Sample 3: boat, sample 6: beach

➢ **Goal:** measure the water samples with gamma spectrometry to probe if there is measurable activity in the ocean water that would indicate the presence of radionuclides from waste water release

Gamma spectroscopy

- Gamma spectroscopy is the quantitative measurement of gamma rays and their energies, to determine the identity of nuclides in a sample
- Sample is placed onto a sample holder on the detector
- Sample is typically surrounded by lead shielding
- Cooled with liquid nitrogen to avoid thermal noise
- Very high voltage applied:
  - HPGe detector used 4500 V
- Measurements are performed at UCI's Nuclear Reactor Facility (NRF)

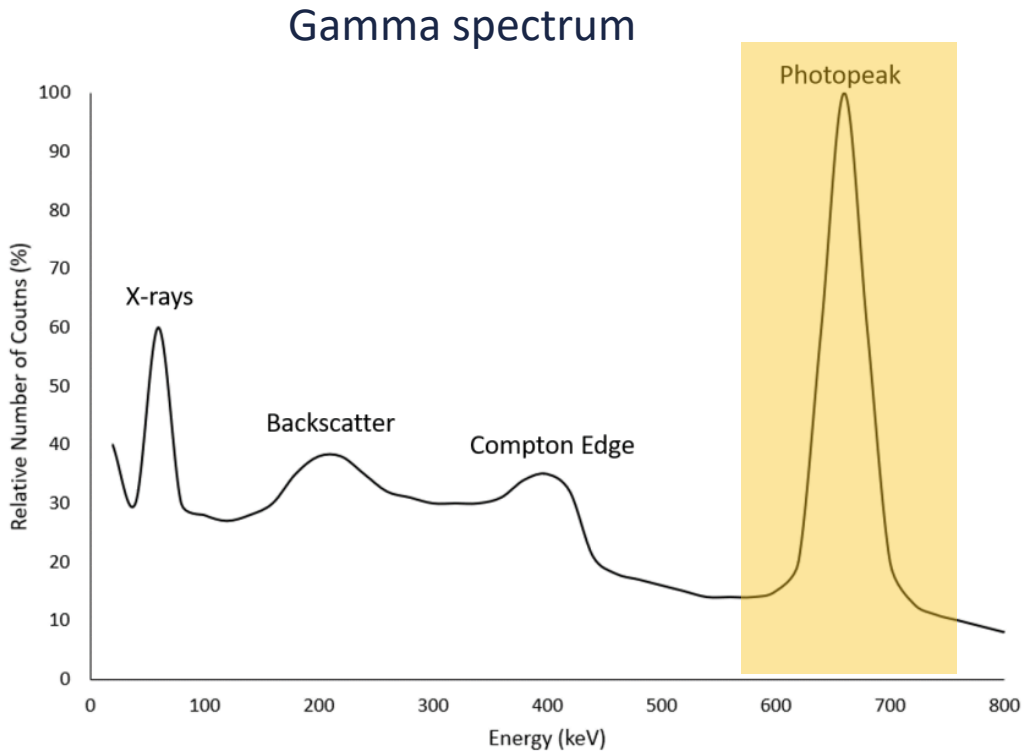


https://www.researchgate.net/figure/HpGe-Detector-Schematic_fig5_264037533

Gamma spectroscopy

- Gamma rays interact with matter in several ways (bold ones can be seen in gamma spectrometry:
- Coherent scattering (no energy loss)
- **Photoelectric effect**
- **Compton scattering**
- **Pair production**
- Nuclear reactions

→ **Photopeak:** corresponds to the energy of the emitted gamma ray and can be used for isotope identification



Two measures of a gamma detector

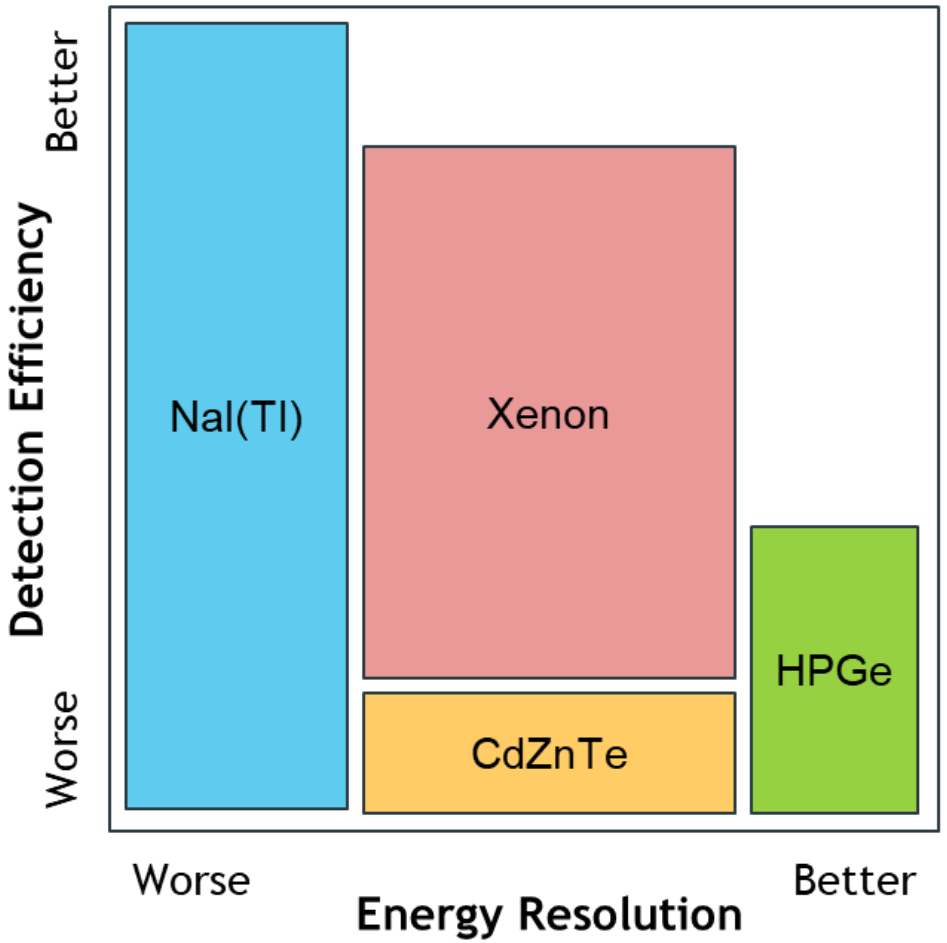
Efficiency

- ε = cps/dps (counts per second/decays per second)

Resolution

- How well a detector resolves a gamma ray of a certain energy
- Resolution = FWHM at energy E (FWHM = Full Width Half Maximum - The width of the peak at half of its full height)

- Detector choice is compromise between Efficiency and Resolution:
- We used a HPGe detector for the water analysis

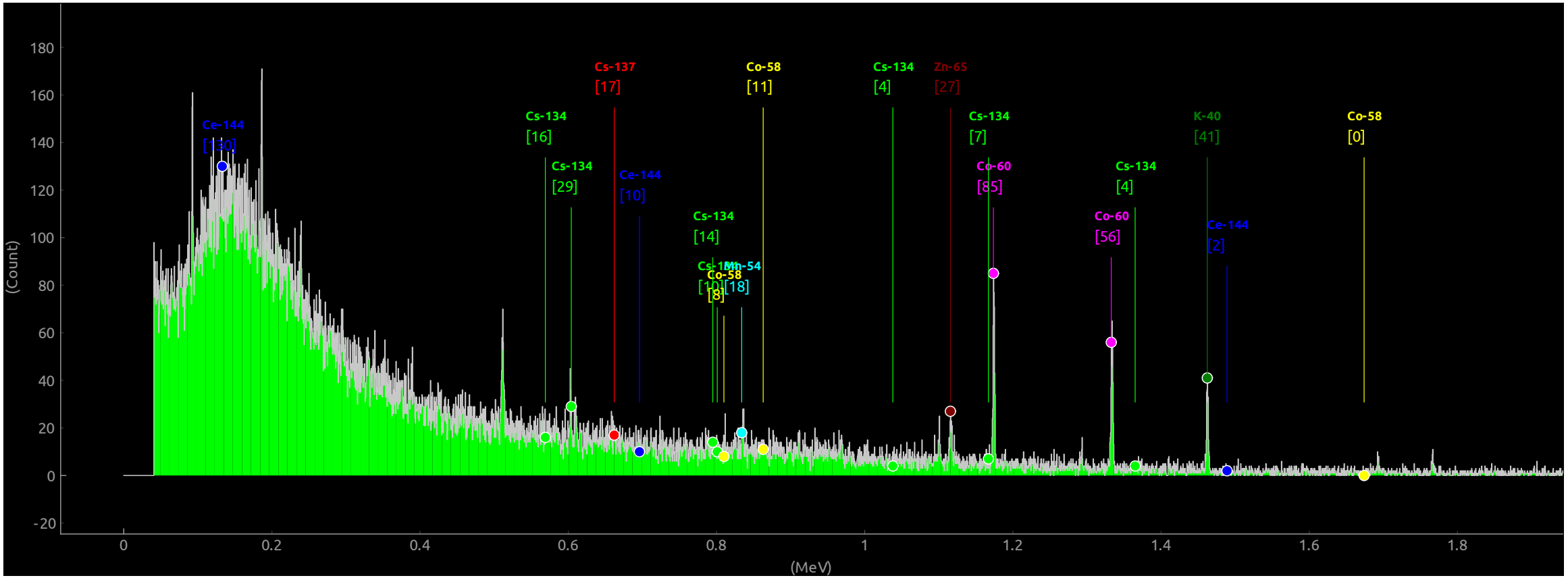


Measurement conditions & data treatment

- Samples were all measured on the 40% HPGe detector for a total counting time of 20,000 seconds (~5.5 hrs)
- Additional measurements for the water samples collected on the boat (#1,2,3) were collected on 30% HPGe to reduce noise in the background
- We used the water samples before the waste water release as background measurements

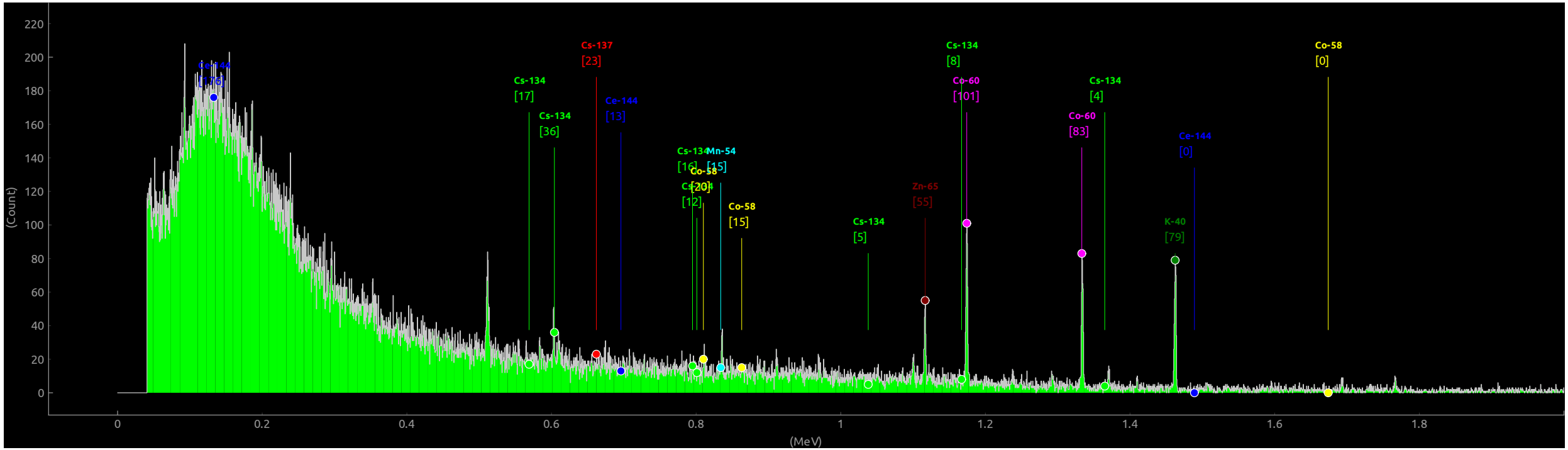
Reference - Empty background measurement

- This is a gamma spectrum recorded, when no sample was inside the detector
- Note the very low count rate, but nonetheless the presence of some very weak signal



Sample prior to waste water release used as background measurement

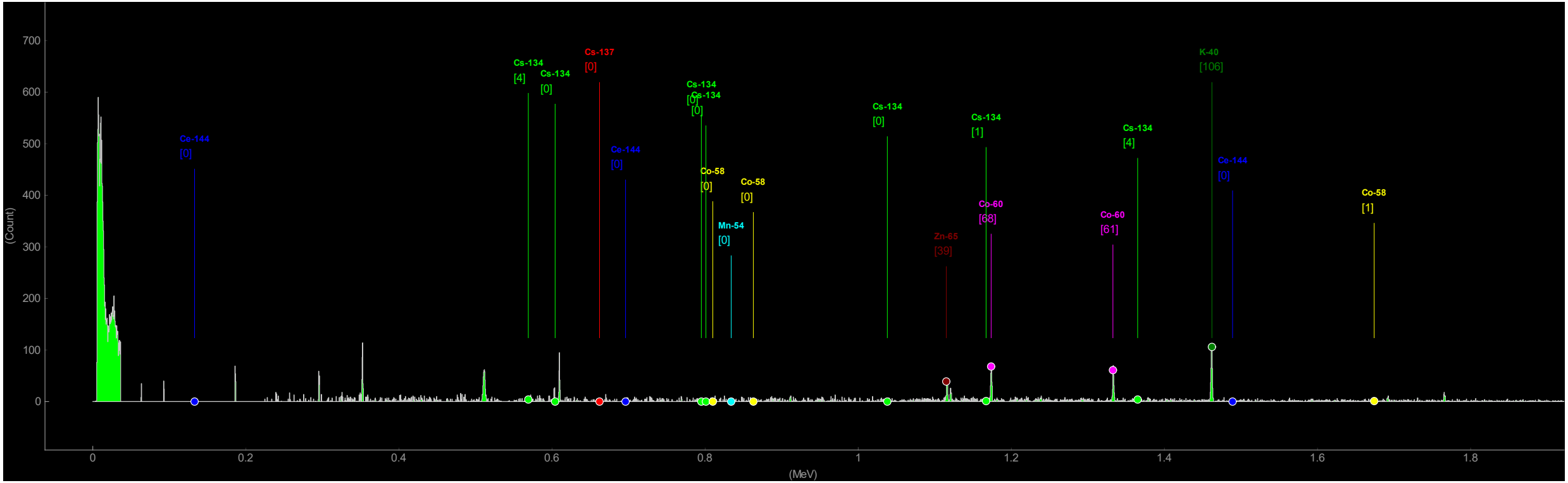
- This is a gamma spectrum recorded for sample #1 (boat, pre waste water release)
- Very low count rate, but nonetheless the presence of some very weak signal
- Any signals below 2x background count rate are considered within the statistical variation of background (also referred to as “noise” level)



Water sample during release @ boat

- Water sample pre waste water release was subtracted as background from water sample during waste water release
- Peaks for isotopes that Surfrider had asked for were identified

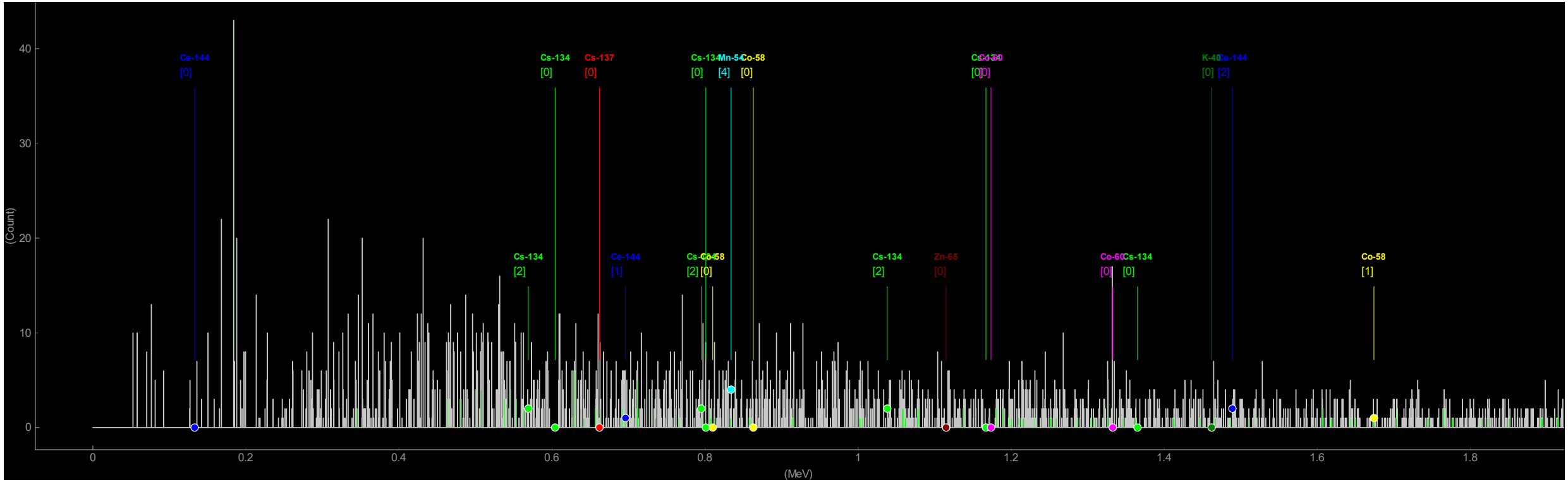
→There are no high count rates in the gamma spectrum, if there was a high activity of an isotope present the count rate would increase above background



Water sample during release @ boat

- Water sample pre waste water release was subtracted as background from water sample post waste water release

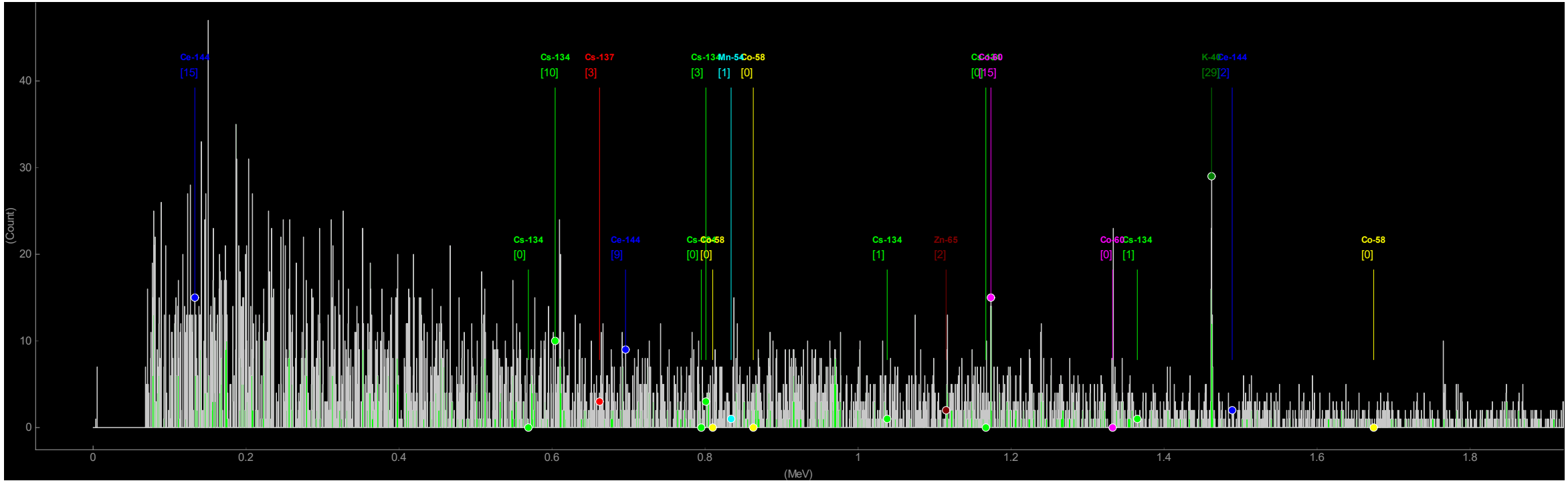
→ No count rates above background level: no contamination of water from the isotopes listed below detectable (note the extreme low count number on the y-axis)



Water sample during release @ beach

- Water sample pre waste water release was subtracted as background from water sample during waste water release

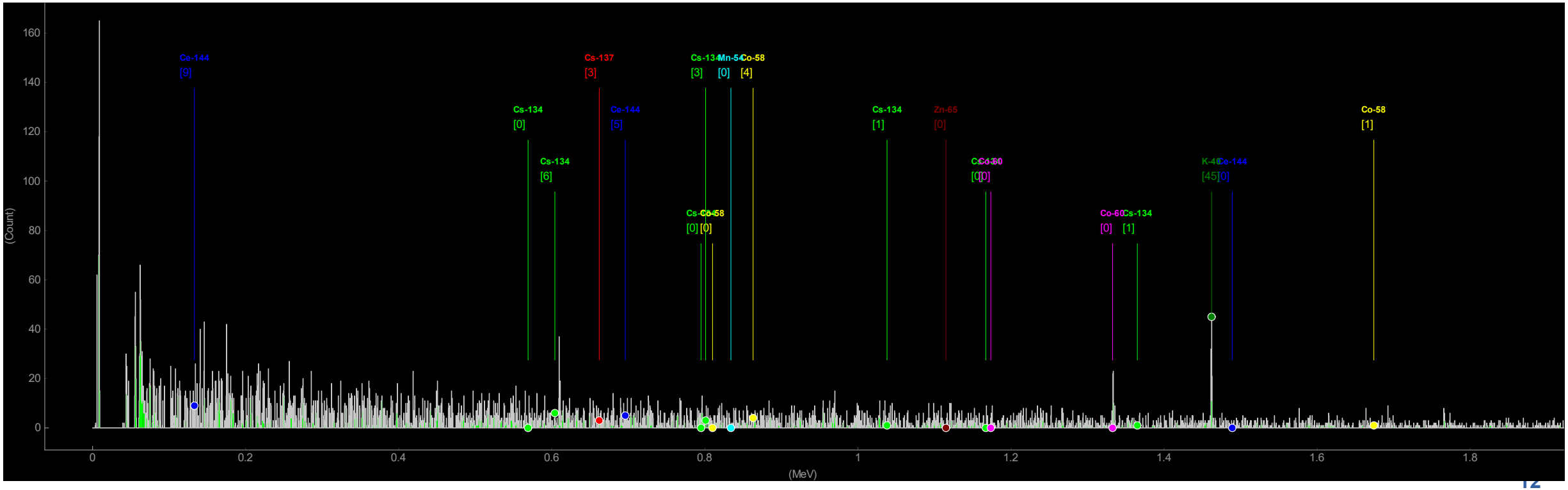
→ again, only very low count rates, barely distinguishable from background → typically signal above 2x background is treated as “real signal”: Cs-134 ~40 counts, K-40 slightly above 40 counts (within 20,000 sec measurement)



Water sample during release @ beach

- Water sample pre waste water release was subtracted as background from water sample post waste water release

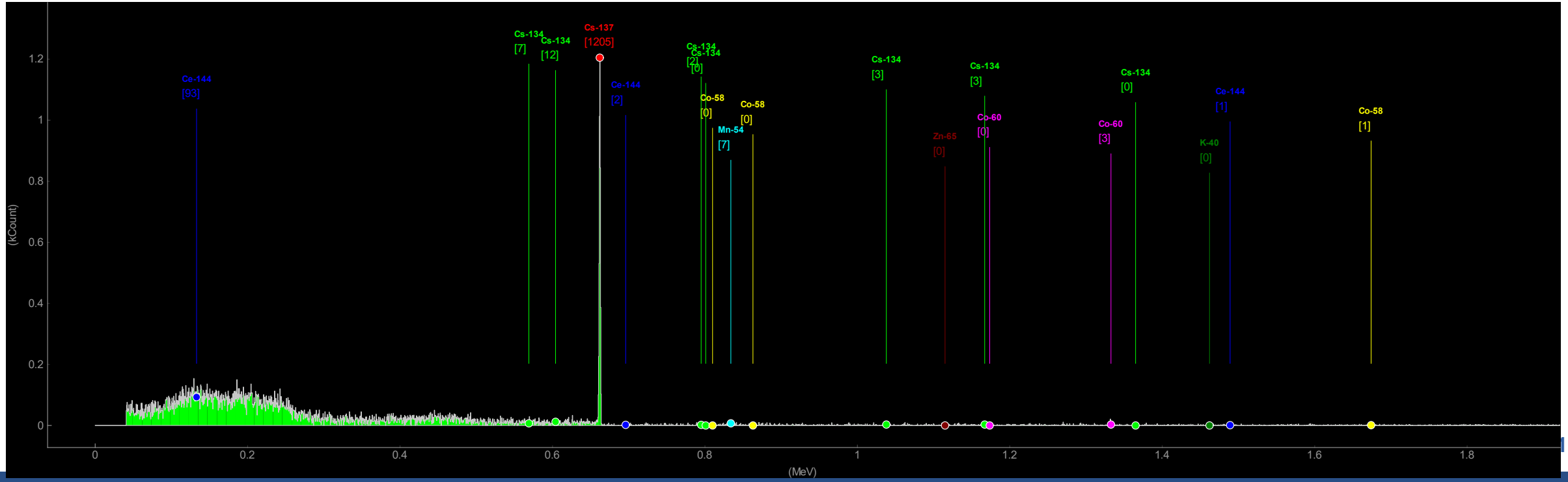
→ again, only very low count rates, barely distinguishable from background → typically signal above 2x background is treated as “real signal”: Cs-134 ~40 counts, K-40 slightly above 40 counts (within 20,000 sec measurement)



Simulated contaminated sea water sample

- Measurement of a simulated contaminated water sample **(not from the sampling, but from UCI!)** with a Cs-137 activity of <0.1 microCi (this is 1/10 the activity of Am-214 in a residential smoke detector)

→ note the count rate for Cs-137 on the y-axis which now has a scale in kCount (X1000 compared to previous plots) shows ~800 counts for a very low activity sample compared to <20 counts for all ocean water samples



Summary

- No absolute activities could be determined due to the absence of calibration standards for each radionuclide (we just don't have them all at UCI)
- Goal was to investigate if there are elevated counts for nuclides of interest/concern
- Identified nuclides have very low count rates, right around 2x background which is considered the "noise" level. While some of the nuclides are present, no elevated concentrations of these nuclides could be determined during the water analysis for the samples collected at the beach and on the boat
- Measurement of a simulated contaminated water sample with a Cs-137 activity of <0.1 microCi was measured for comparison, which reveals much higher count rates (~800 counts) compared to the waste water release samples which showed <20 counts for the same measurement duration and following the same data processing

➢ **Gamma spectroscopy measurements do not reveal increased levels of radionuclides due to the waste water release.**

