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Low Level ^{140}Ba Measurements on High Volume Air Filters using Gamma Coincidence Systems

Judah Friese[†], Jon Burnett[†], Brandy Gartman[†], Ashley Davies[‡], Matt Goodwin[‡]
[†]Pacific Northwest National Laboratory, U.S. [‡]AWE, UK

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POSTER

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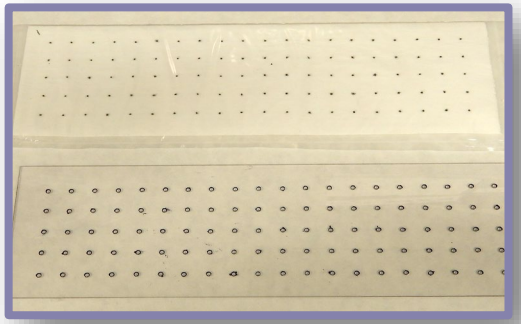
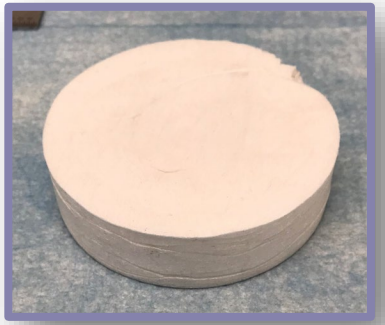
Objective

- Experimentally measure ^{140}Ba using gamma coincidence and singles at low levels for detection limit comparisons.
- Use exposed RASA filters with 24 hour and 1 week decay times to simulate measurements at a station versus counting at a laboratory.



RASA spiked with ^{140}Ba



RASA compressed into a puck for counting

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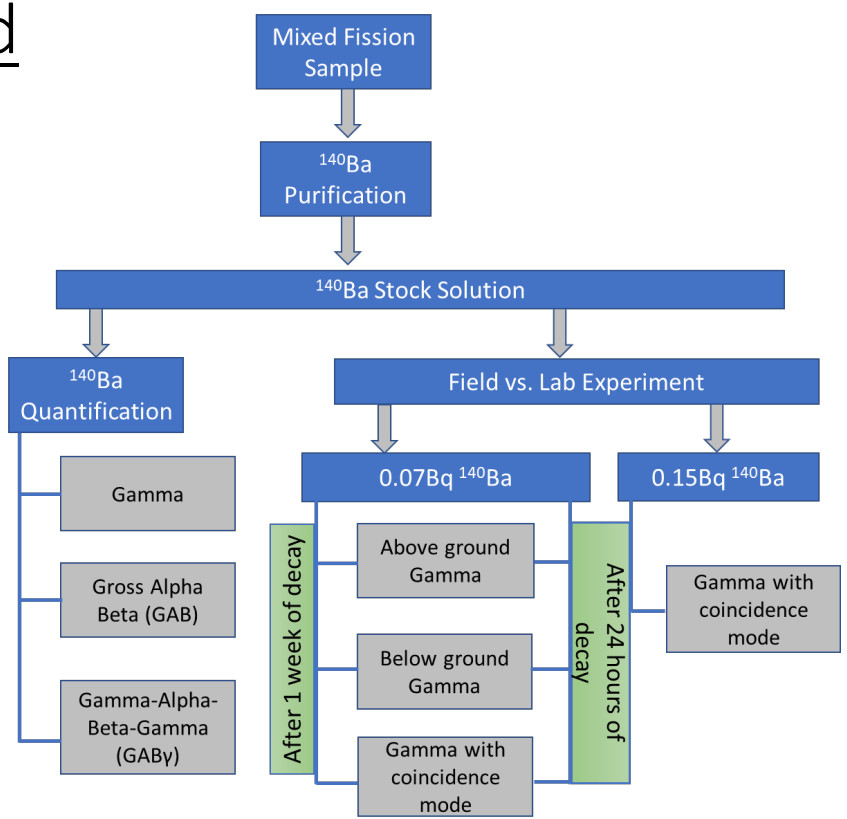
Method

- ^{140}Ba was purified from a thermal irradiation of uranium
- Purification followed a series of ionic exchange and precipitation steps
- Stock solutions of ^{140}Ba were quantified at high level using standard gamma spectroscopy.
- Dilutions were made to spike filters at roughly 0.07 and 0.15 Bq of ^{140}Ba rapidly to minimize the ingrowth of ^{140}La
- Spiked filters included 24 hour of aerosol collection followed by either 24 hour or 7 days of decay prior to measurement.



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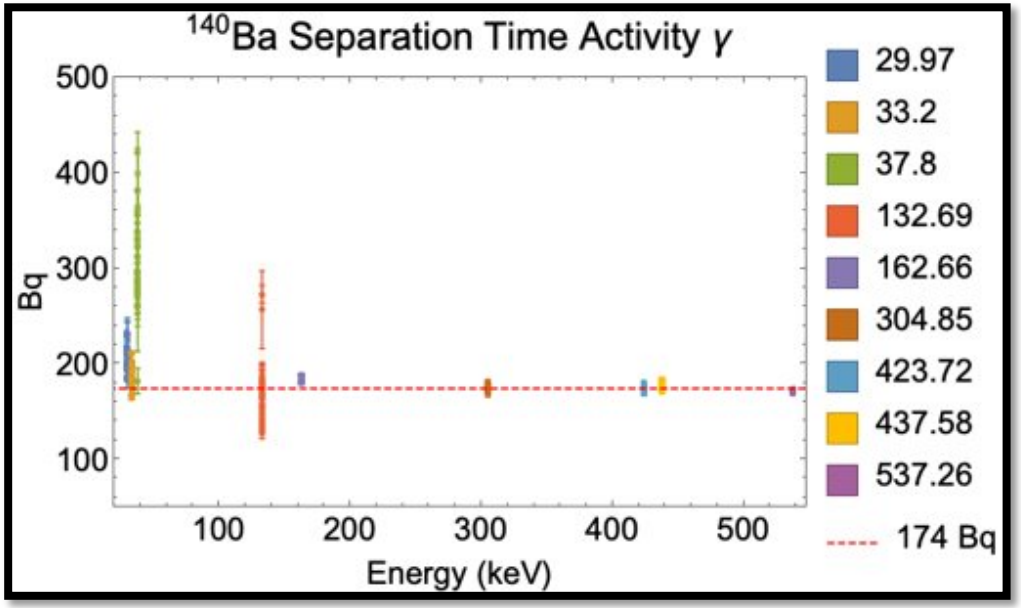
Quantification and Characterization

- Stock ^{140}Ba quantified by high level gamma spectroscopy at 174 Bq
- Gamma-Gamma coincidence at high level indicate which gamma pairs result in good data.
  - X-ray data less reliable



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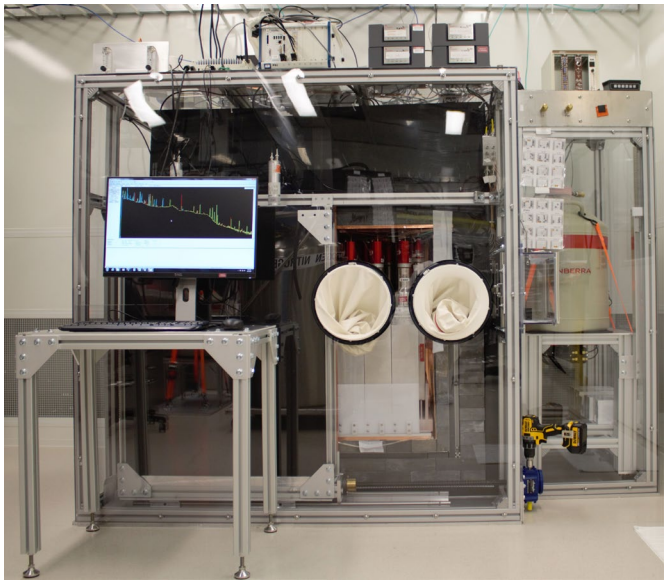
Measurements

Low Background HPGe detectors in underground Laboratory

- P-type detector, 112% relative efficiency, copper housing with carbon fiber window



Advanced Radionuclide Gamma Spectrometer (ARGO)

- Coincidence BEGe detectors
- ^{140}Ba coincidence energy lines 162.7 and 304.8 keV.

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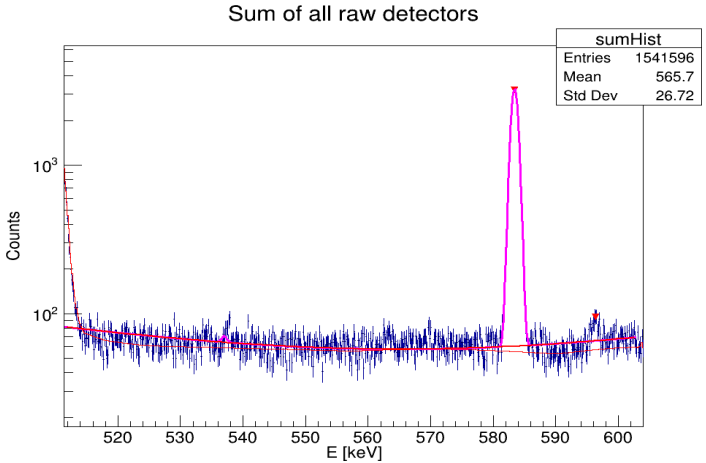
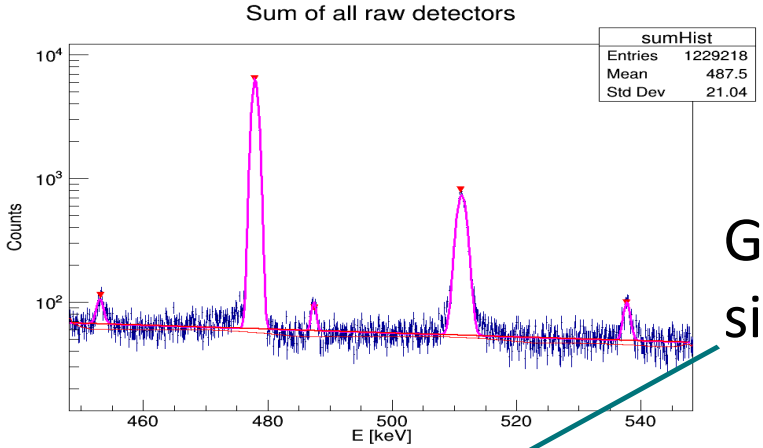
Singles at 0.07 Bq ^{140}Ba and 0.15Bq ^{140}Ba

- First experiment measurement (0.07 Bq)
- Start Acquisition 11-MAR-2020 14:00
- Count time 80k s



No information

- Second experiment measurement (0.15 Bq)
- Start Acquisition 19-MAR-2020 12:54
- Count time 86k s



G2K singles

	Energy	GEP	Activity	+/-	Csf	Area
Ba-140	537.26*	24.39	2.16E-01	4.50E-02	0.954	335

No Zero Time Information

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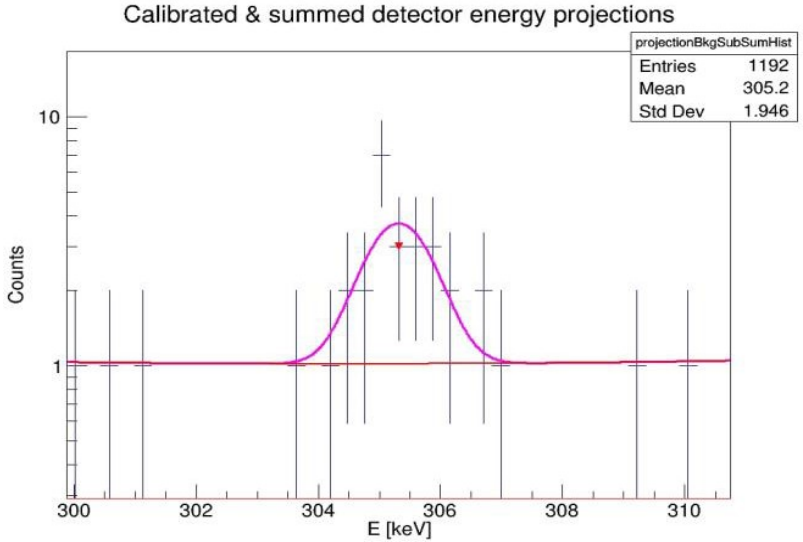
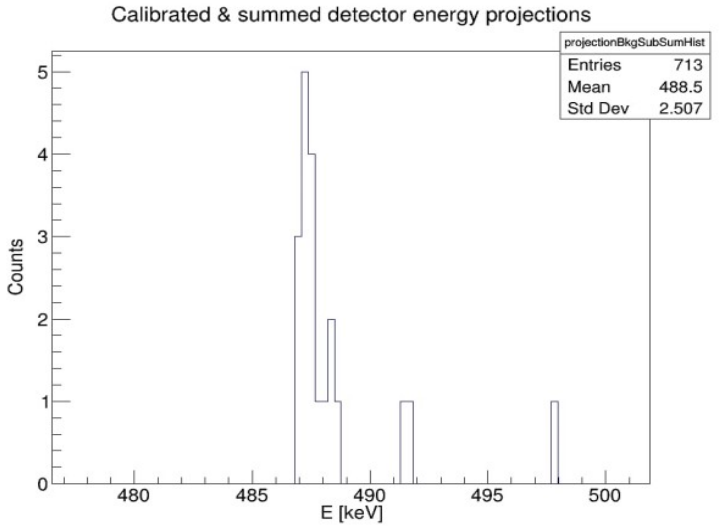
Coincidence at 0.15 Bq ^{140}Ba/La

- Using gamma coincidence measurements, both ^{140}Ba and ^{140}La are observable due to the reduction in background.





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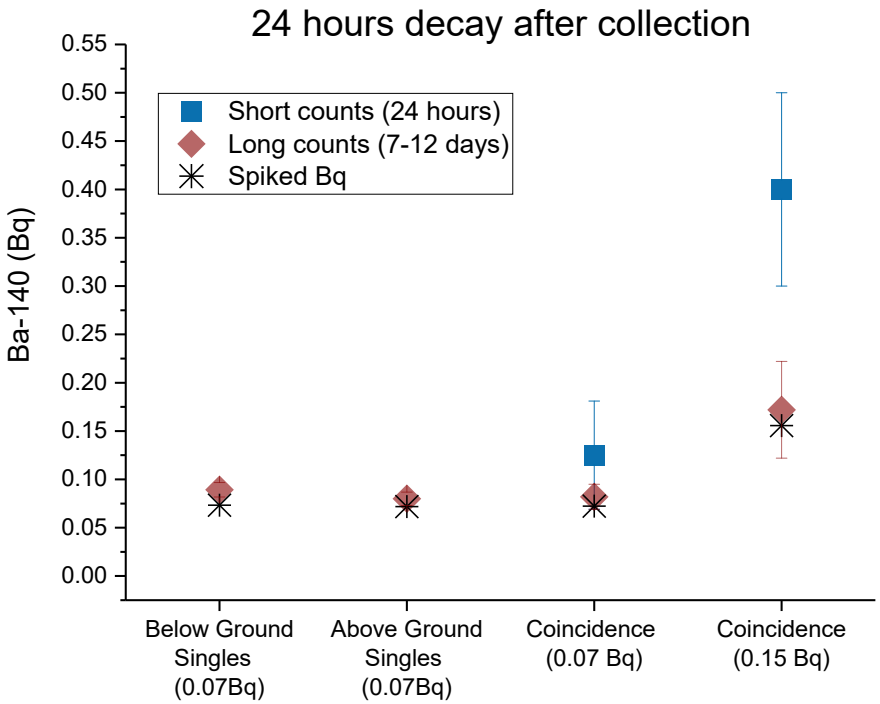
24-hour Results Summary (IMS Station)

- RASA filters spiked with ^{140}Ba
- 24-hour collection
- 24-hour decay delay
- 24-hour count (Blue squares)
- Week-long count (Red squares)

Key Observation

^{140}Ba is **only** observable using coincidence methods during a 24-hour count at ~0.07 Bq.



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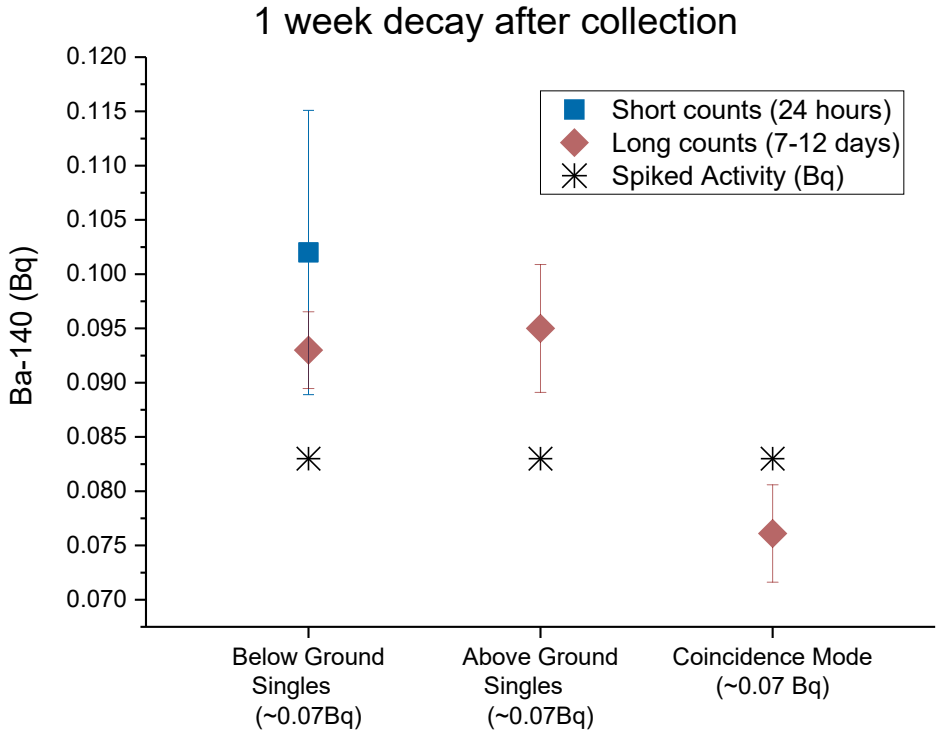
One Week Results Summary (IMS Lab)

- RASA Filter spiked with ^{140}Ba
- 24-hour collection
- 1 week decay delay
- 24-hour count (Blue Squares)
- 1 week count (Red Squares)

Key Observation

^{140}Ba is observable using both coincidence and singles methods at ~0.07 Bq.



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Gains from Gamma- Gamma Coincidence

Coincidence measurements at IMS stations would detect ^{140}Ba/La at levels that would otherwise be missed.

Lower detection limits afforded by coincidence methods likely extends to many radionuclides that decay with coincidence signatures.

Isotopes with a lower energy than ^{7}Be would gain in detection.

Gamma singles measurements for IMS Laboratory scenarios are equivalent gamma- gamma coincidence measurements when the gamma energies are higher than ^{7}Be.

Due to long radon decay times typical for IMS laboratory measurements- gains in coincidence background reduction are not as critical in station measurements.