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TAT13 INTERNATIONAL SYMPOSIUM ALPHA THERAPY
19 EDWALDO CAMARGO SYMPOSIUM BETA THERAPY

Rapid Detection of Thorium, Radium, and Actinium Impurities in ^{224}Ra and ^{212}Pb by Alpha Spectrometry

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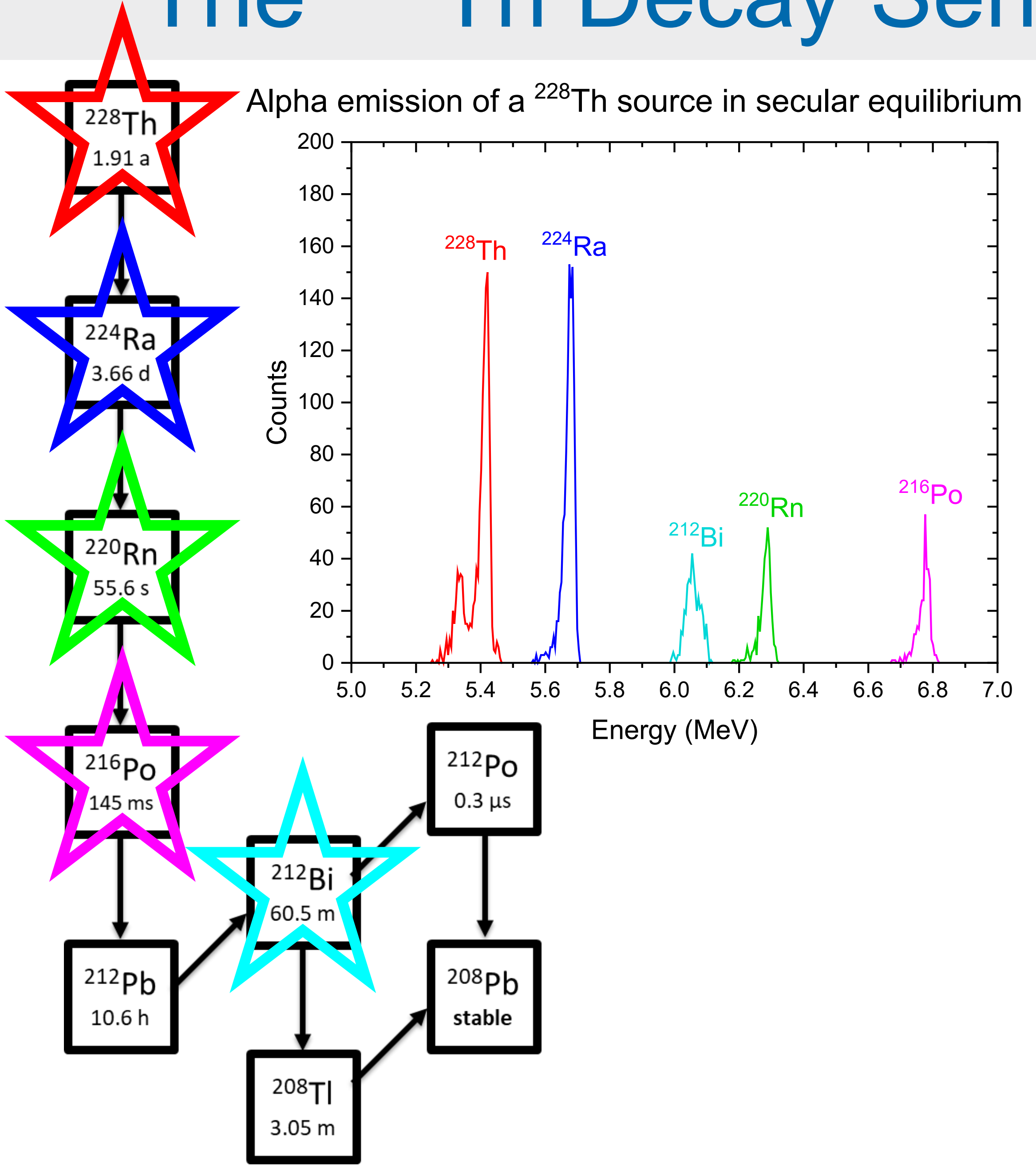
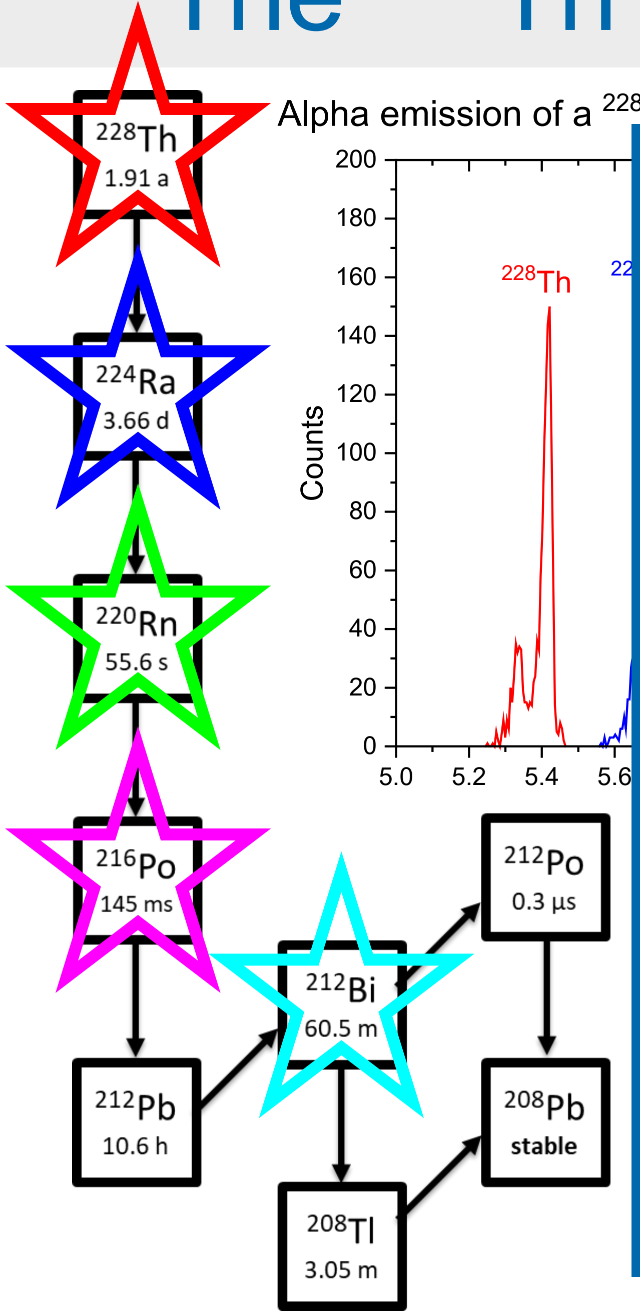
The ^{228}Th Decay Series



- ^{224}Ra or ^{212}Pb isotope products are usually highly pure, **99.999+%**
- Still need to quantify long-lived radionuclide impurities
  - Parent isotopes ^{228}Th and ^{224}Ra
  - Other Th isotopes and daughters
- Difficult to find impurities of <0.001%
  - Highly radioactive sample
  - Complex decay chain
  - Peak overlap / tailing
    - Worse for HPGe

The ^{228}Th Decay Series



Some additional steps are required for proper QC

Chromatographic separation

- Isolate impurities from bulk of radioactivity

Microprecipitation for source prep

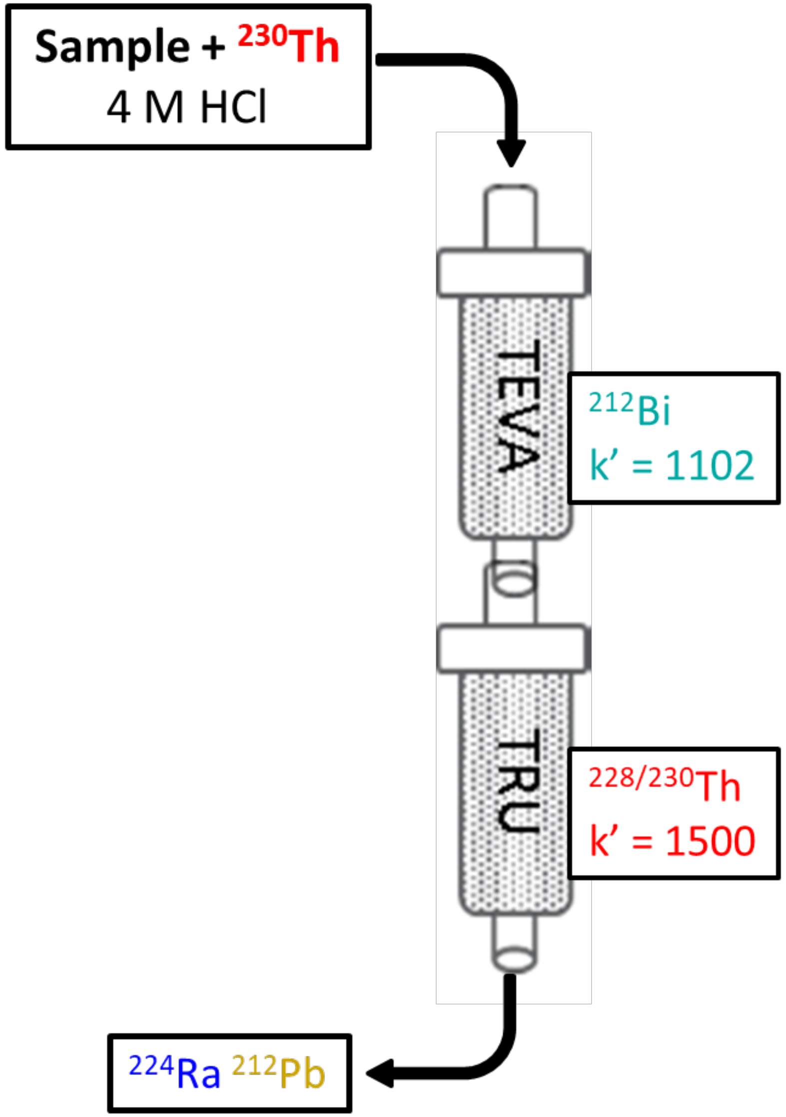
- Rapid, adequate resolution, user-friendly

Alpha spectrometry analysis

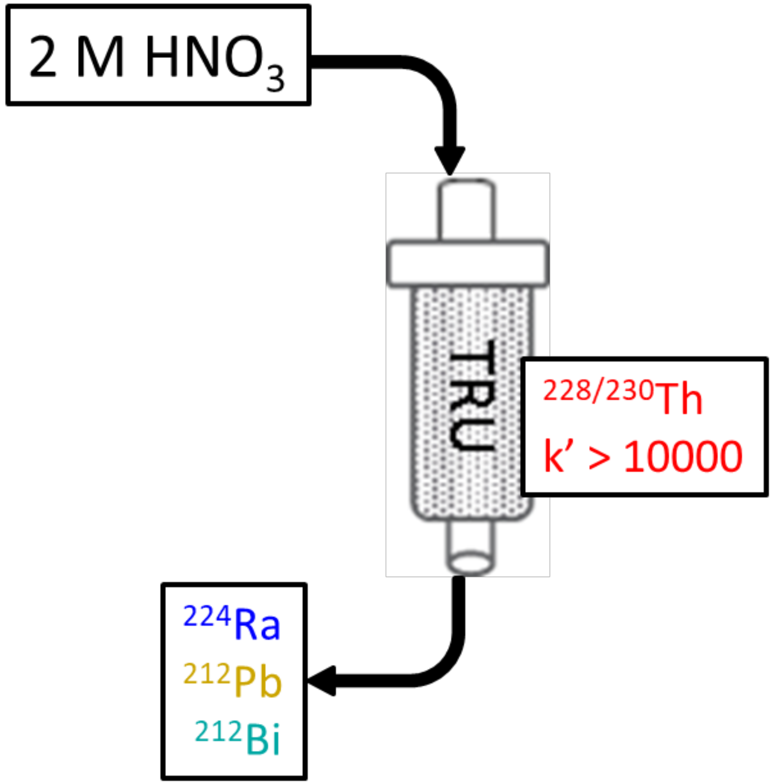
- Low background, high efficiency, traceable*

^{228}Th in ^{224}Ra

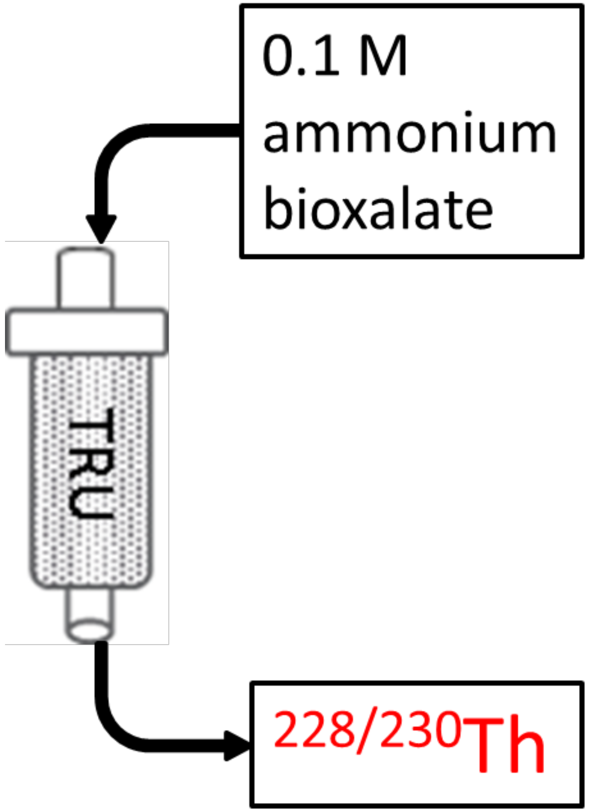
Load



Rinse

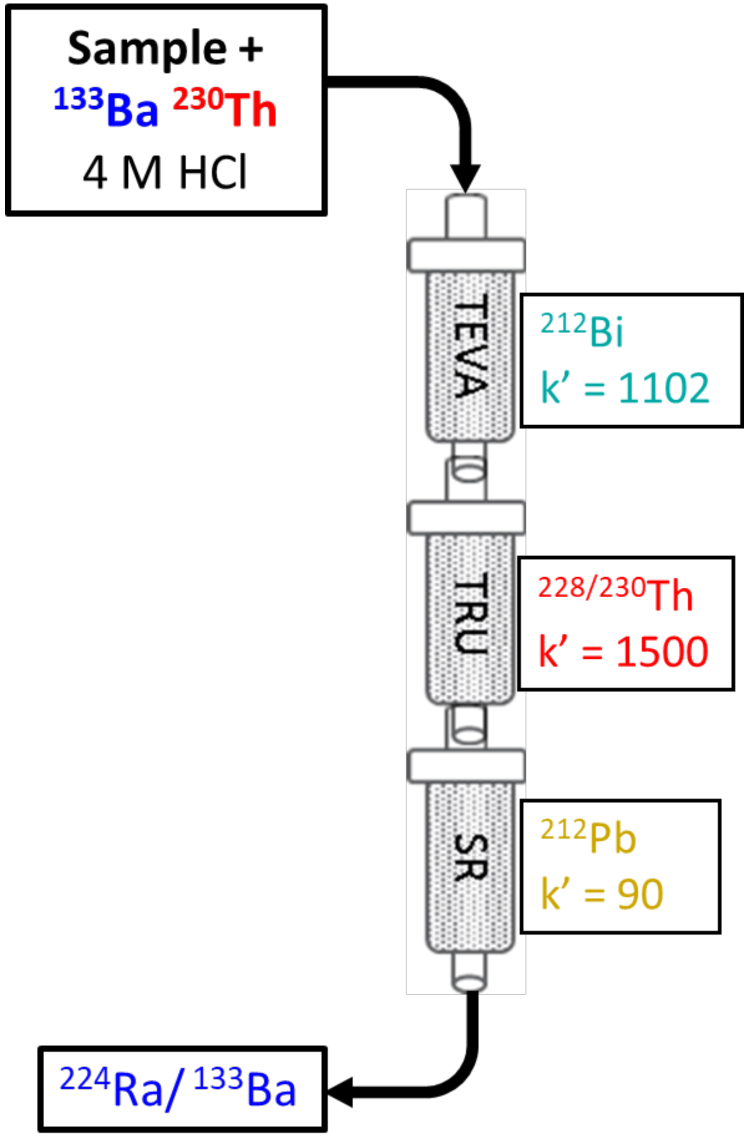


Strip (^{228}Th)

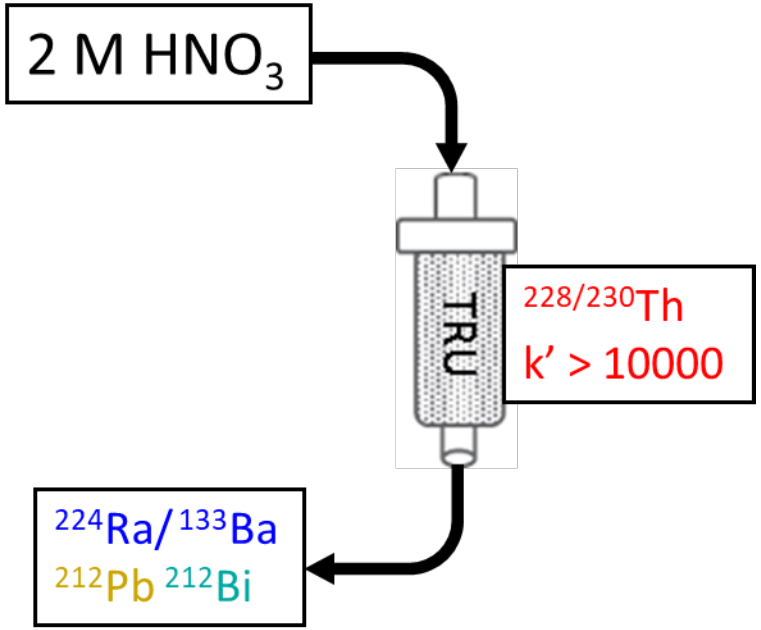


^{228}Th and ^{224}Ra in ^{212}Pb

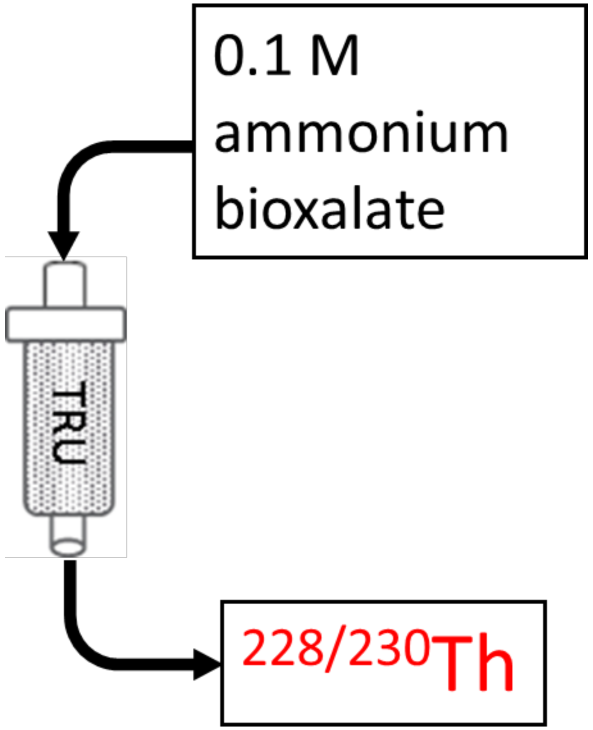
Load (^{224}Ra)



Rinse



Strip (^{228}Th)



Alpha Source Recipes

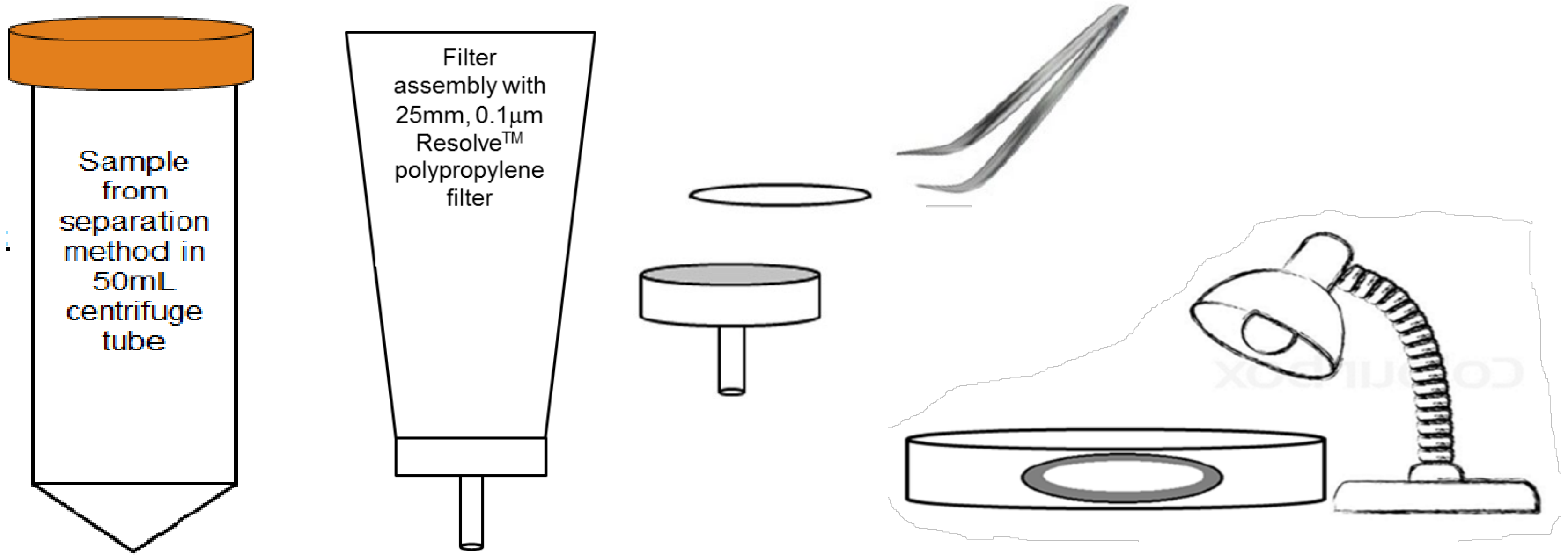
CeF_3 for ^{228}Th

- 40-50 µg Ce carrier
- 1 mL conc. HF
  - – Substitute 1.5 mL 8 M NH_4HF_2

$BaSO_4$ for ^{224}Ra

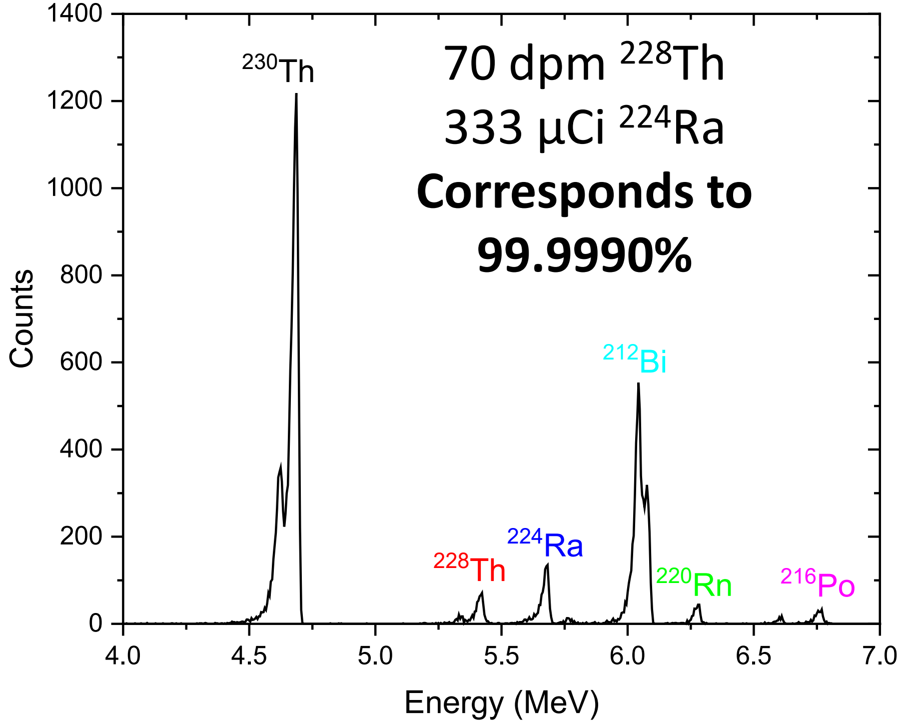
- 50 µg Ba carrier
- 3 g $(NH_4)_2SO_4$
- 5 mL isopropanol
- Ice bath

- Wait 20-30 min
- Filter over Eichrom's Resolve® Filter
- Mount on adhesive planchet
- Dry under heat lamp
- Analyze using a calibrated alpha spectrometer



QC of ^{224}Ra Isotope Products

^{228}Th in ^{224}Ra by Alpha Spec.			
% yield ^{230}Th	dpm ^{228}Th (1%)	µCi ^{224}Ra	% Purity
93.2	69.79	333	99.9990
102.9	12.27	246	99.9998
91.2	22.64	233	99.9996
95.6	224.6	256	99.996
102.9	47.62	205	99.9990
91.2	45.9	226	99.9991
99.3	1110	2260	99.998



QC of ^{212}Pb Isotope Products

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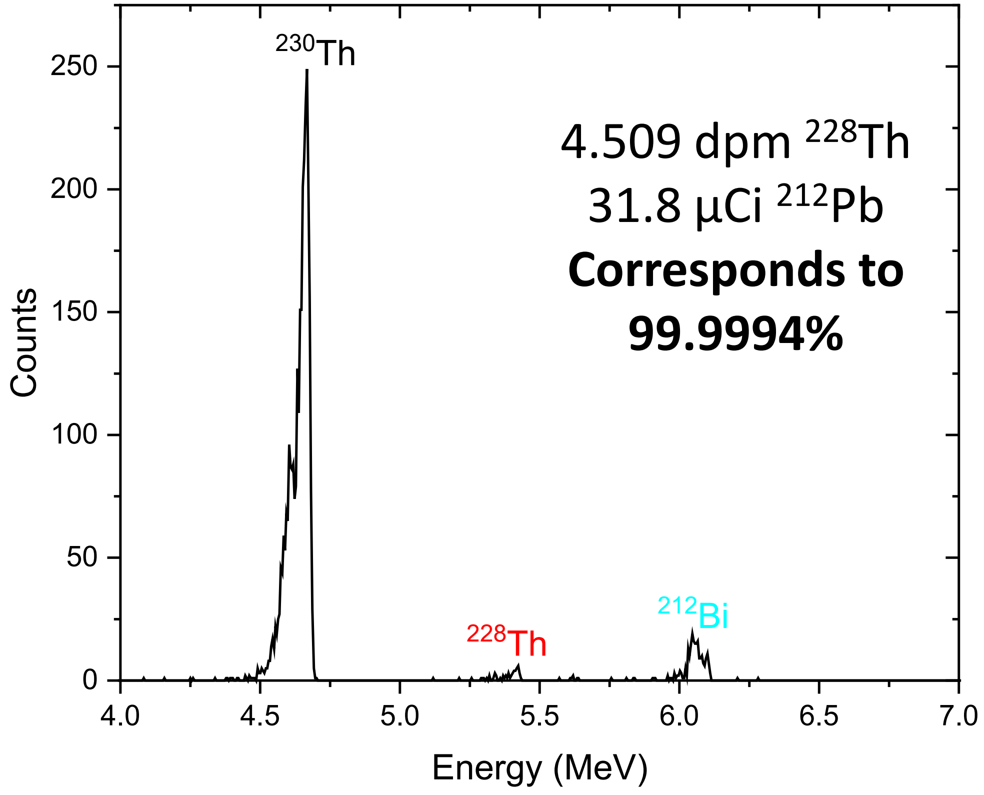
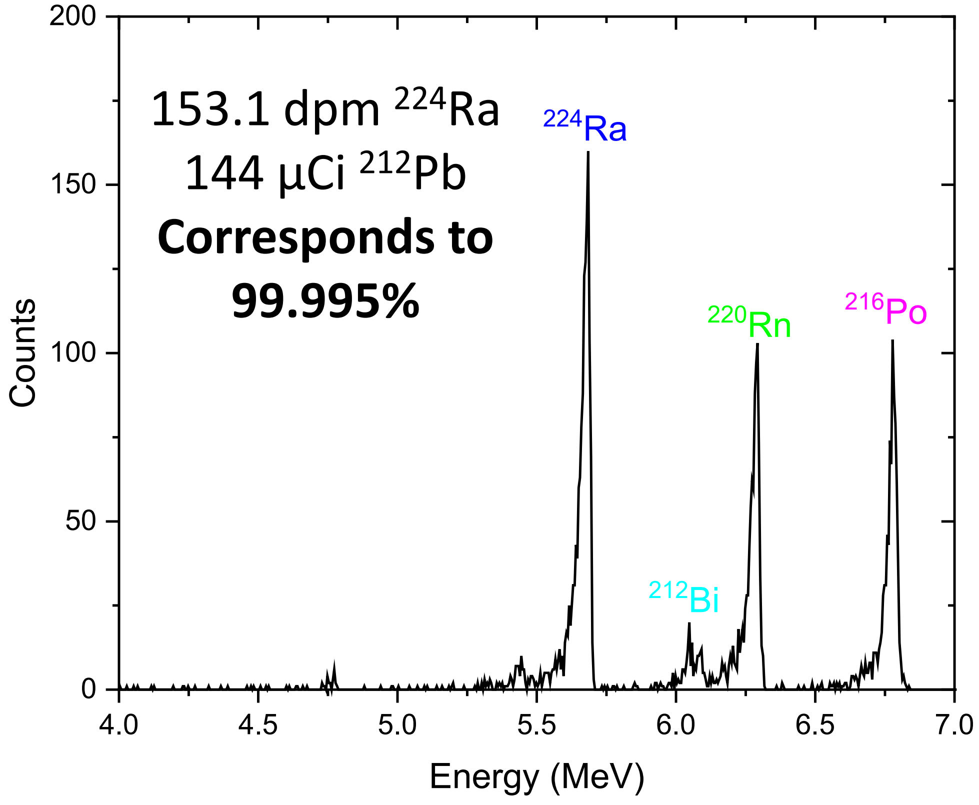
^{228}Th in ^{212}Pb by Alpha Spec.			
% yield ^{230}Th	dpm ^{228}Th (1%)	µCi ^{212}Pb	% Purity
103.3	6.358	144	99.9998
96.3	2.369	96.5	99.9999
98.9	3.603	46.3	99.9997
97.9	4.509	31.8	99.9994

Combined % Purity
99.995
99.9996
99.9991
99.998

^{224}Ra in ^{212}Pb by Alpha Spec.			
% yield ^{133}Ba	dpm ^{224}Ra (1%)	µCi ^{212}Pb	% Purity
101.3	153.1	144	99.995
103.0	5.755	96.5	99.9997
89.5	4.624	46.3	99.9995
100.8	7.428	31.8	99.999





Conclusions and Future Work

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Conclusions:

- ^{228}Th in ^{224}Ra method works well
  - Routine use for 1 mCi samples
- The Th + Ra in Pb method builds off the success of Th in Ra
  - Th is pushing LOD
  - Ra is traced by ^{133}Ba via HPGe
- The methods agree well with delayed measurements of decayed samples (LSC)

Future Work:

- Optimize sample aliquot size for high-activity samples
- Test methods on different types of ^{228}Th samples
- Adjust methods for applications to the ^{229}Th / ^{225}Ac decay chain

Thank you!

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