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# Radioanalytical determination of $^{225}\text{Ac}/^{227}\text{Ac}$ and radiochemical separation of $^{225}\text{Ra}/^{225}\text{Ac}$

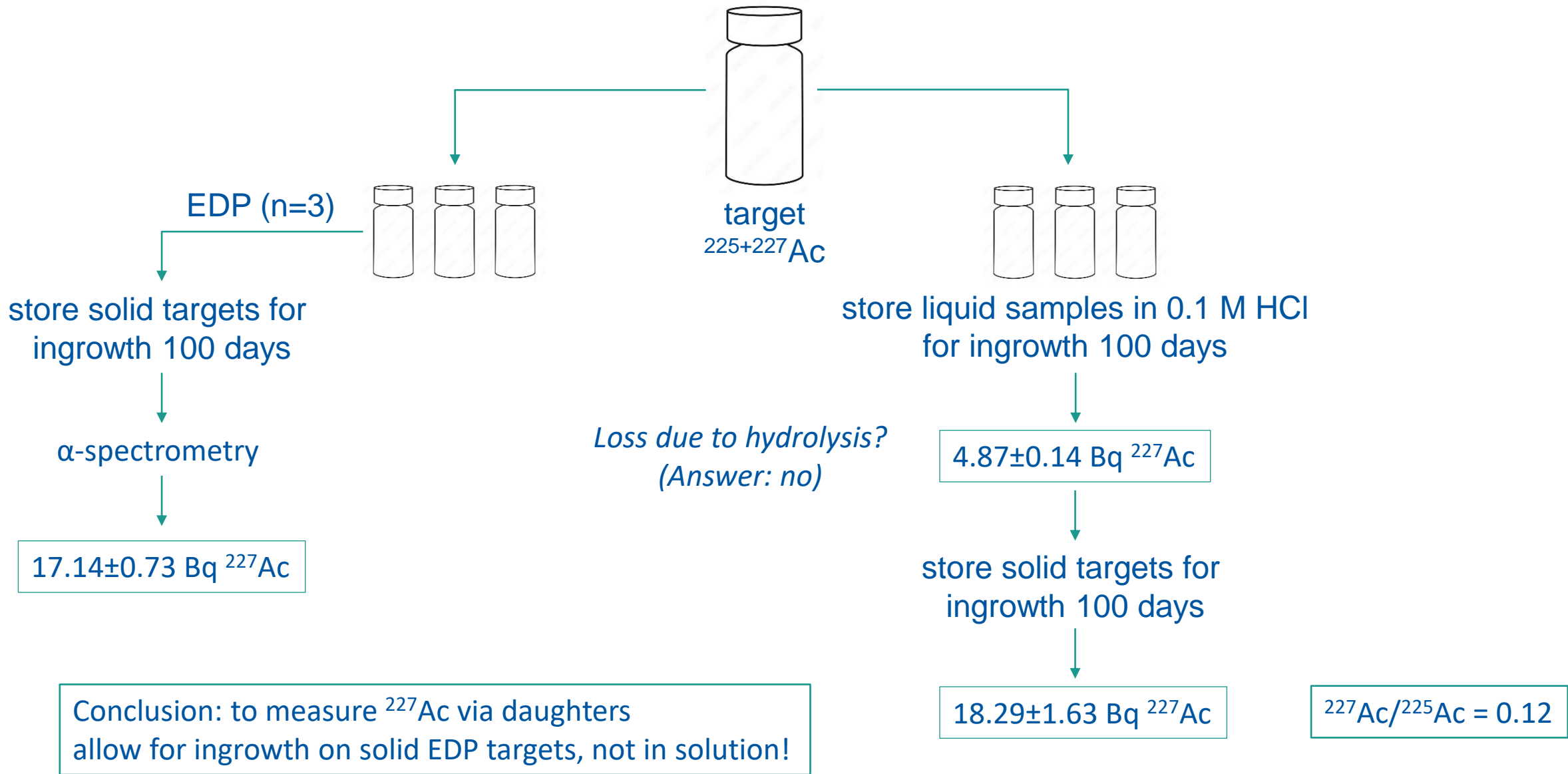
Ruslan Cusnir, Institut de Radiophysique, Rue du Grand-Pré 1,  
1007 Lausanne



02/07/2024

MEDICIS Collaboration Meeting

1



# Determination of $^{227}\text{Ac}$ impurity in $^{225}\text{Ac}$

Three  $^{225}\text{Ac}$  productions (May, June, September 2023) characterised

- **Method:**

$^{225}\text{Ac}$  provided after collection solubilised with 0.1 M HCl

aliquots (n=3) electrodeposited in the presence of  $^{243}\text{Am}$  tracer

samples stored for at least 100 days to allow for the decay of  $^{225}\text{Ac}$  (*and for the ingrowth of eventual  $^{227}\text{Ac}$  decay products*)

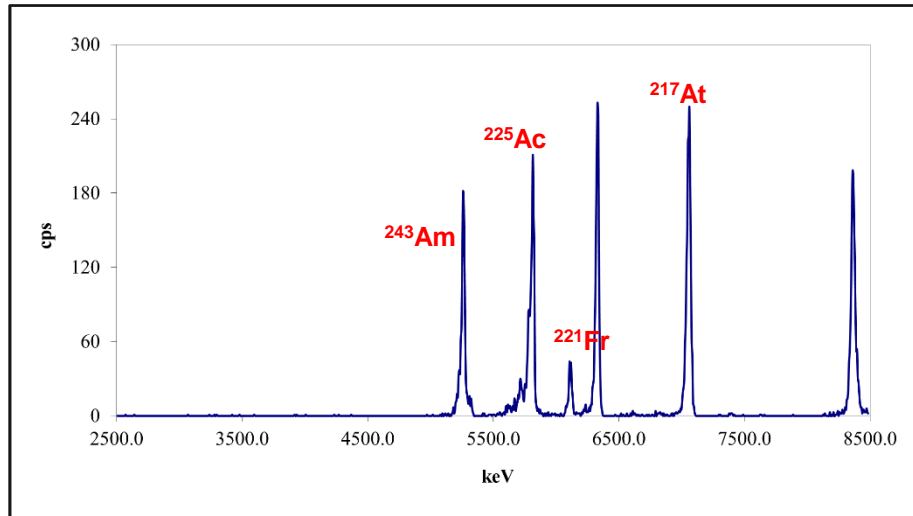
samples measured using alpha spectrometry

- **Outcome:**

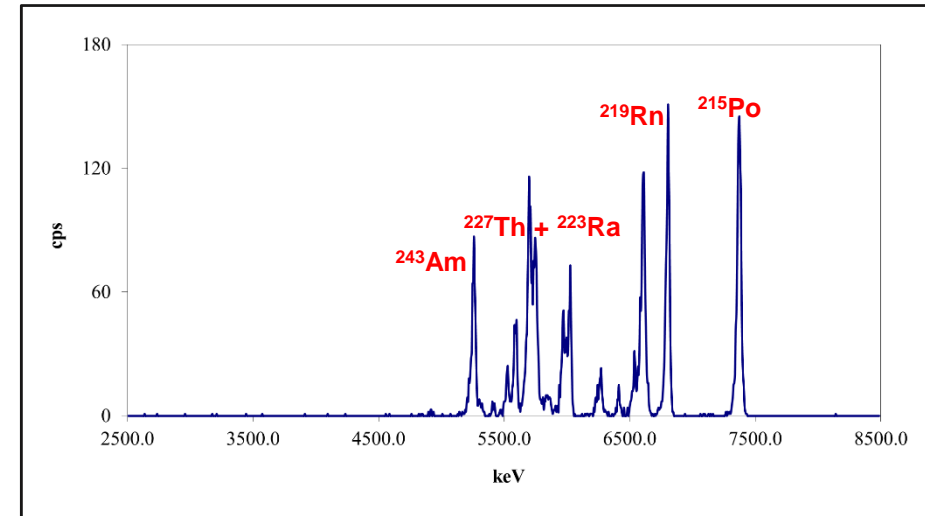
no  $^{227}\text{Ac}$  impurity was identified in either  $^{225}\text{Ac}$  samples

minimal detectable activity (MDA)  $0.12 \text{ mBq mL}^{-1}$

# Determination of $^{227}\text{Ac}$ impurity in $^{225}\text{Ac}$



**Figure 1.** Alpha spectrum of a  $^{225}\text{Ac}$  aliquot from a June 2023 production.



**Figure 2.** Alpha spectrum of a model aliquot  $^{225}\text{Ac} + ^{227}\text{Ac}$  after the decay of  $^{225}\text{Ac}$ .

# Generator $^{225}\text{Ra}$ / $^{225}\text{Ac}$

A 1 MBq  $^{225}\text{Ra}$  /  $^{225}\text{Ac}$  generator received in September 2023:

used to test an ion-imprinted resin for preparative chemical separation of  $^{225}\text{Ra}$  and  $^{225}\text{Ac}$   
(it is known that 2+ ions like  $\text{Ra}^{2+}$  are not retained by the resin, unlike 3+ ions including  $\text{Ac}^{3+}$ )

*[Reference: Analytica Chimica Acta 1194 (2022) 339421]*

$^{225}\text{Ac}$  will be used for further development of incorporation measurements and internal dosimetry,  
namely for the development of a method that employs commercially available DGA resin cartridges

# Generator $^{225}\text{Ra}$ / $^{225}\text{Ac}$

A  $^{225}\text{Ra}$  /  $^{225}\text{Ac}$  generator received in September 2023:

1.17 MBq activity declared for  $^{225}\text{Ra}/^{206}\text{Po}$ ...

$\gamma$ -spectrometry on 26.10.2023:

$$1.082 \cdot 10^5 \pm 1.129 \cdot 10^4 \text{ Bq } ^{221}\text{Fr (eq. } ^{225}\text{Ac)}$$

$$1.250 \cdot 10^2 \pm 6.906 \cdot 10^1 \text{ Bq } ^{206}\text{Po}$$

$$2.074 \cdot 10^2 \pm 6.931 \cdot 10^0 \text{ Bq } ^{206}\text{Bi}$$

eluted x 2 with 20 mL 0.1 M HCl



Isotope	Activity (Bq)	Incertainty ( $\pm$ )
$^{221}\text{Fr}$	<b>1.873E+05</b>	2.004E+04
$^{213}\text{Bi}$	1.787E+05	1.389E+04
$^{209}\text{Tl}$	1.748E+05	1.766E+04
$^{206}\text{Bi}$	1.858E+02	6.818E+00
( $^{225}\text{Ac}$ )	(3.011E+05)	(3.631E+04)

Fraction 1: 19.84 g

Isotope	Activity (Bq)	Incertainty ( $\pm$ )
$^{221}\text{Fr}$	<b>1.316E+03</b>	1.372E+02
$^{213}\text{Bi}$	1.232E+03	1.003E+02
$^{209}\text{Tl}$	1.225E+03	1.260E+02
$^{206}\text{Bi}$	3.073E+00	2.185E+01
( $^{225}\text{Ac}$ )	(2.070E+03)	(2.431E+02)

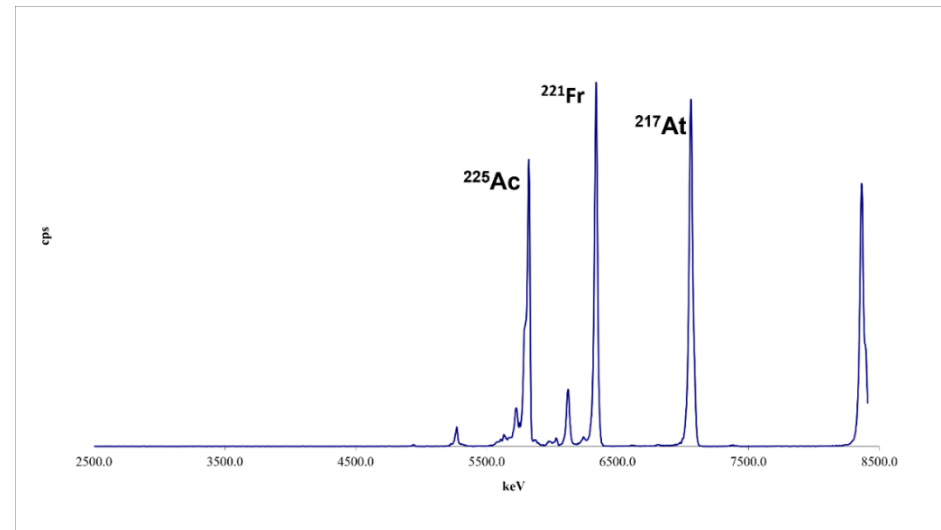
Fraction 2: 18.01 g

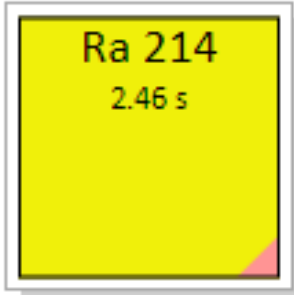
# Generator $^{225}\text{Ra} / ^{225}\text{Ac}$

A  $^{225}\text{Ra} / ^{225}\text{Ac}$  generator received in September 2023:

1.17 MBq activity declared for  $^{225}\text{Ra}/^{206}\text{Po}$ ...

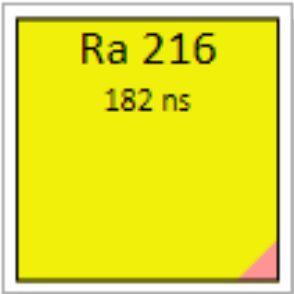
$\alpha$ -spectrometry on 26.10.2023:  $1.79 \cdot 10^5 \pm 9.16 \cdot 10^3 \text{ Bq } ^{221}\text{Fr}$  (eq.  $^{225}\text{Ac}$ )





- 88 Ra214: 2.46 s, 3.47E+03 atoms, 3.55E+06 disintegrations
  - 86 Rn210: 2.4 h, 3.54E+06 atoms, 5.99E+03 disintegrations; BR: 9.99E-01
    - 84 Po206: 8.8 d, 5.75E+03 atoms, 5.67E-02 disintegrations; BR: 9.60E-01
      - 83 Bi206: 6.243 d, 5.36E-02 atoms, 5.07E-07 disintegrations; BR: 9.46E-01
      - 85 At210: 8.1 h, 2.39E+02 atoms, 6.16E-02 disintegrations; BR: 4.00E-02
        - 83 Bi206: 6.243 d, 1.08E-04 atoms, 1.02E-09 disintegrations; BR: 1.75E-03

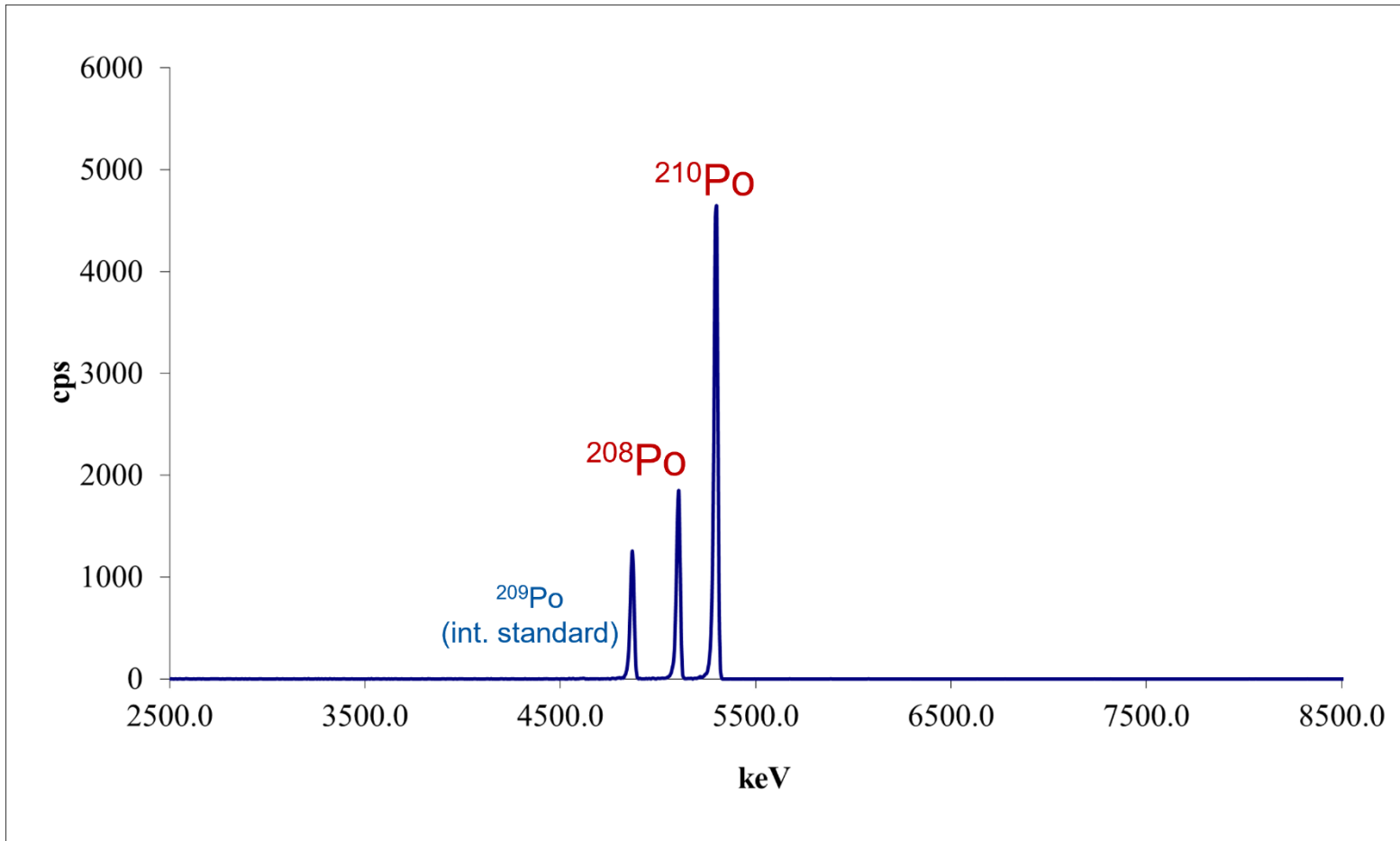
- 88 Ra214: 2.46 s, 3.47E+03 atoms, 3.55E+06 disintegrations
  - 86 Rn210: 2.4 h, 3.54E+06 atoms, 5.99E+03 disintegrations; BR: 9.99E-01
    - 85 At210: 8.1 h, 2.39E+02 atoms, 6.16E-02 disintegrations; BR: 4.00E-02
      - 84 Po210: 138.388 d, 6.15E-02 atoms, 2.62E-08 disintegrations; BR: 9.98E-01
    - 87 Fr214 m: 3.35 ms, 2.79E-03 atoms, 2.09E+03 disintegrations; BR: 5.90E-04
      - 85 At210: 8.1 h, 2.09E+03 atoms, 1.05E+00 disintegrations; BR: 1.00E+00
        - 84 Po210: 138.388 d, 1.05E+00 atoms, 6.56E-07 disintegrations; BR: 9.98E-01



- 88 Ra216: 182 ns, 2.56E-04 atoms, 2.62E-01 disintegrations
  - 86 Rn212: 23.9 m, 2.62E-01 atoms, 1.98E-10 disintegrations; BR: 1.00E+00
    - 84 Po208: 2.93 y, 1.98E-10 atoms, 0.00E+00 disintegrations; BR: 1.00E+00







1 mL of the 20 mL  $^{225}\text{Ra}/^{225}\text{Ac}$   
deposited on  $\text{Ag}^0$  disc with  $^{209}\text{Po}$

measured with  $\alpha$ -spectrometry

decay-corrected for 21.09.2023

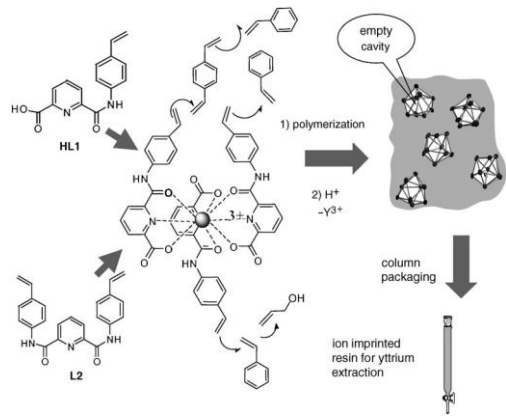
$^{208}\text{Po}$  0.88 Bq

$^{210}\text{Po}$  7.61 Bq

LL ORaP  $^{208}\text{Po}$  1 Bq  $\text{g}^{-1}$

LL ORaP  $^{210}\text{Po}$  1 Bq  $\text{g}^{-1}$

# $^{225}\text{Ra}$ / $^{225}\text{Ac}$ separation on Y-imp resin



1. Load 200 mBq  $^{225}\text{Ra}/^{225}\text{Ac}$  on Y-imp column (n=3)
2. Wash  $\text{H}_2\text{O}(\text{H}^+)$  pH 3
3. Elute with 1 M HCl

$\alpha$ -emission measured by liquis scintillation counting

Y-imprinted resin did not retain  $^{225}\text{Ra}$  → potential application for the chemical separation of  $^{225}\text{Ra}/^{225}\text{Ac}$

