RADIONUCLIDE GENERATOR SYSTEMS

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OUTLINE

-Separation Goals/Cautions

- ^{239}Pu

-Systems Developed

-Detailed Examples

- $^{90}Y/^{90}Sr$
- $^{225}Ac/^{225}Ra/^{229}Th$
- $^{223}Ra/^{227}Th/^{227}Ac$
- $^{211}Pb/^{223}Ra$
- $^{239}Np/^{243}Am$

Separation Goals

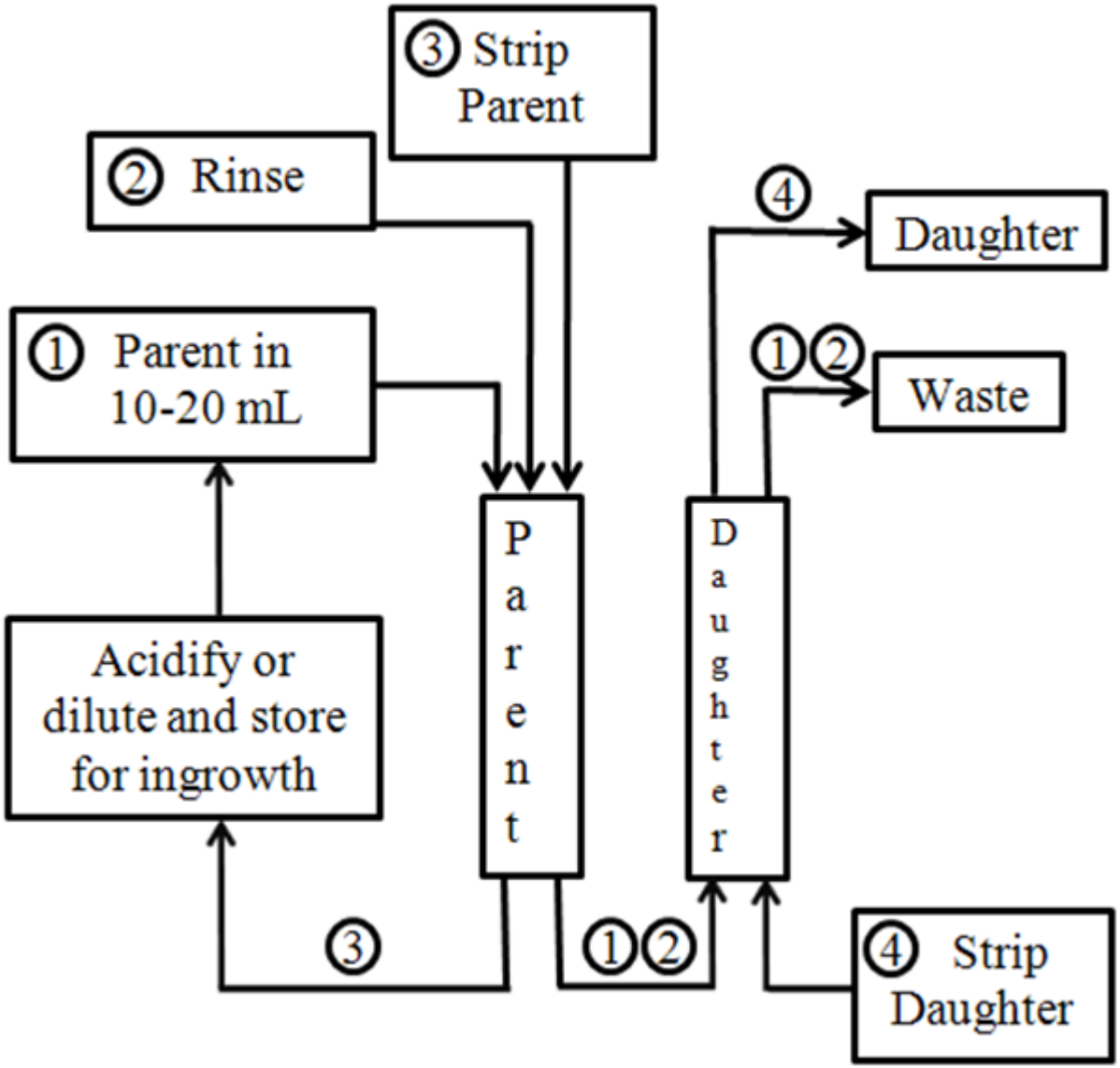
-Parent Nuclide:

- -Recover in High Yield
- -Recover in High Purity
- -Reduce or eliminate need for Evaporation Steps
- -Recover in a suitable matrix for continued processing

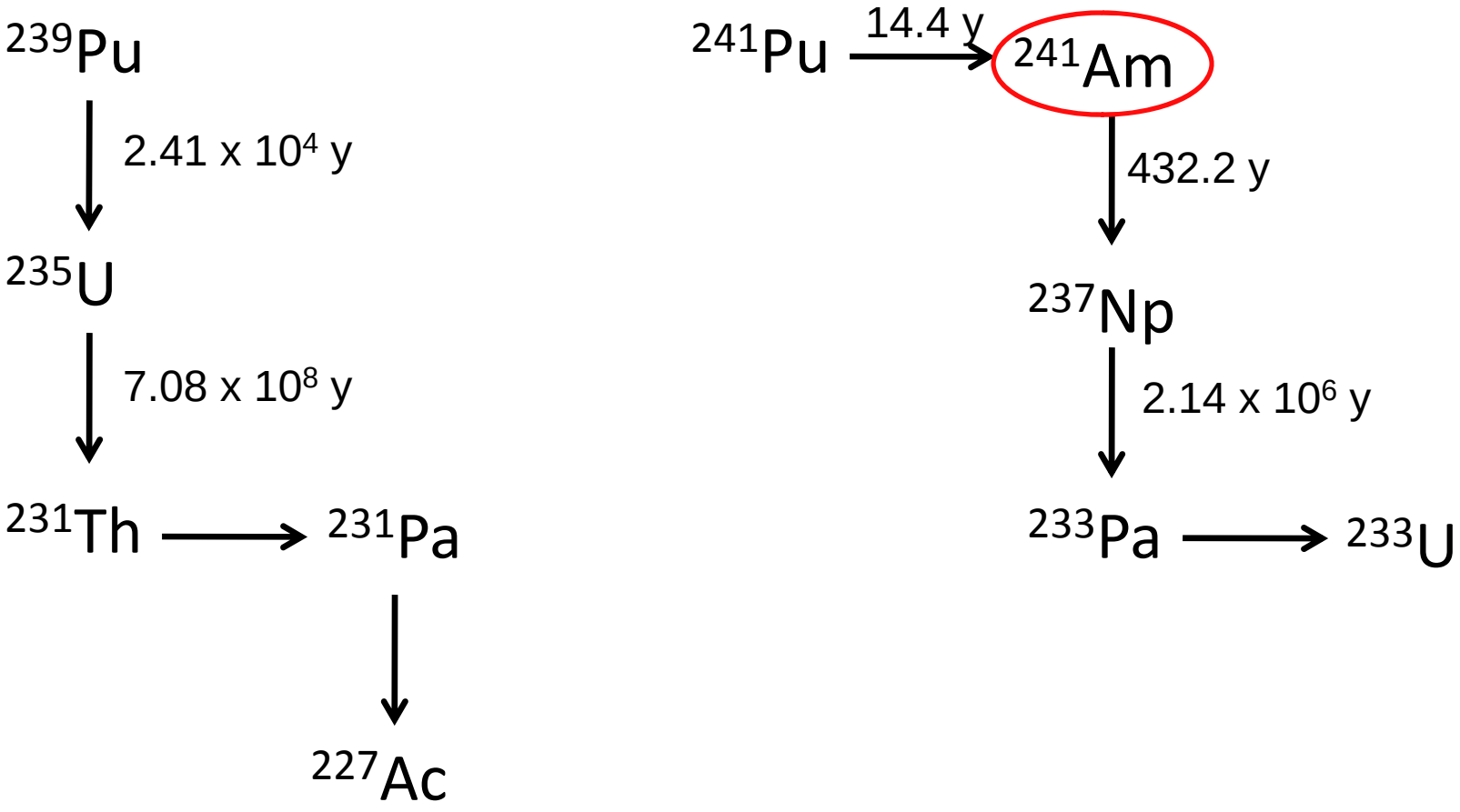
-Daughter Nuclide:

- -Recover in High Yield/Purity
- -Recover in Matrix Suitable for Desired Use
- -Reduce or eliminate need for Evaporation Steps

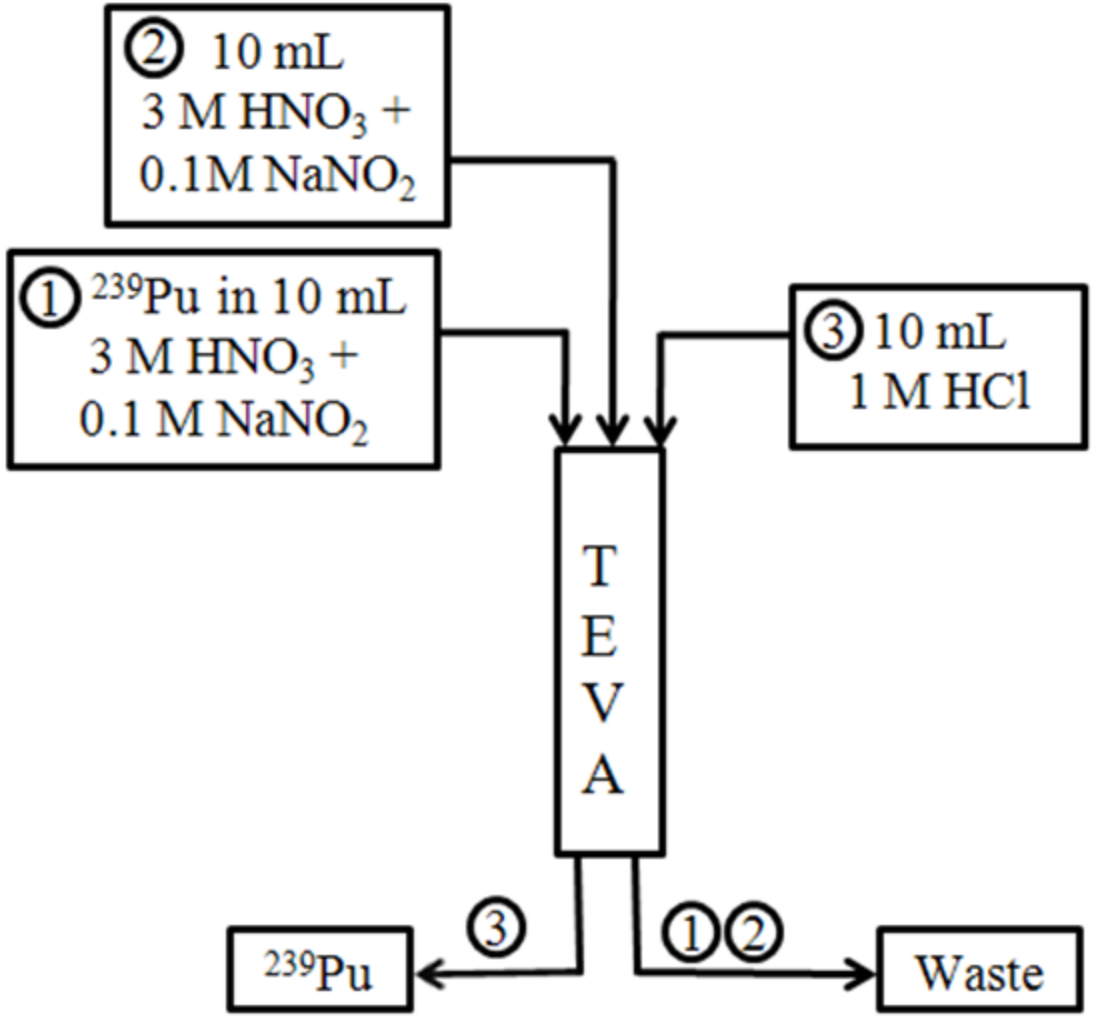
“Ideal” Generator



Purification of ^{239}Pu Tracer



Purification of ^{239}Pu Tracer



Recovered Pu in High Yield and Radiochemical Purity.

Use of Purified Pu suggested extractant bleed causing poor Pu retention on TEVA and TRU.

Impurity not removed by Prefilter, isodecanol wash or HNO3/H2O2 digestion.

Purification of ^{239}Pu Tracer

Pu-239 on TEVA (Repeated runs on Fresh 2mL cartridge)

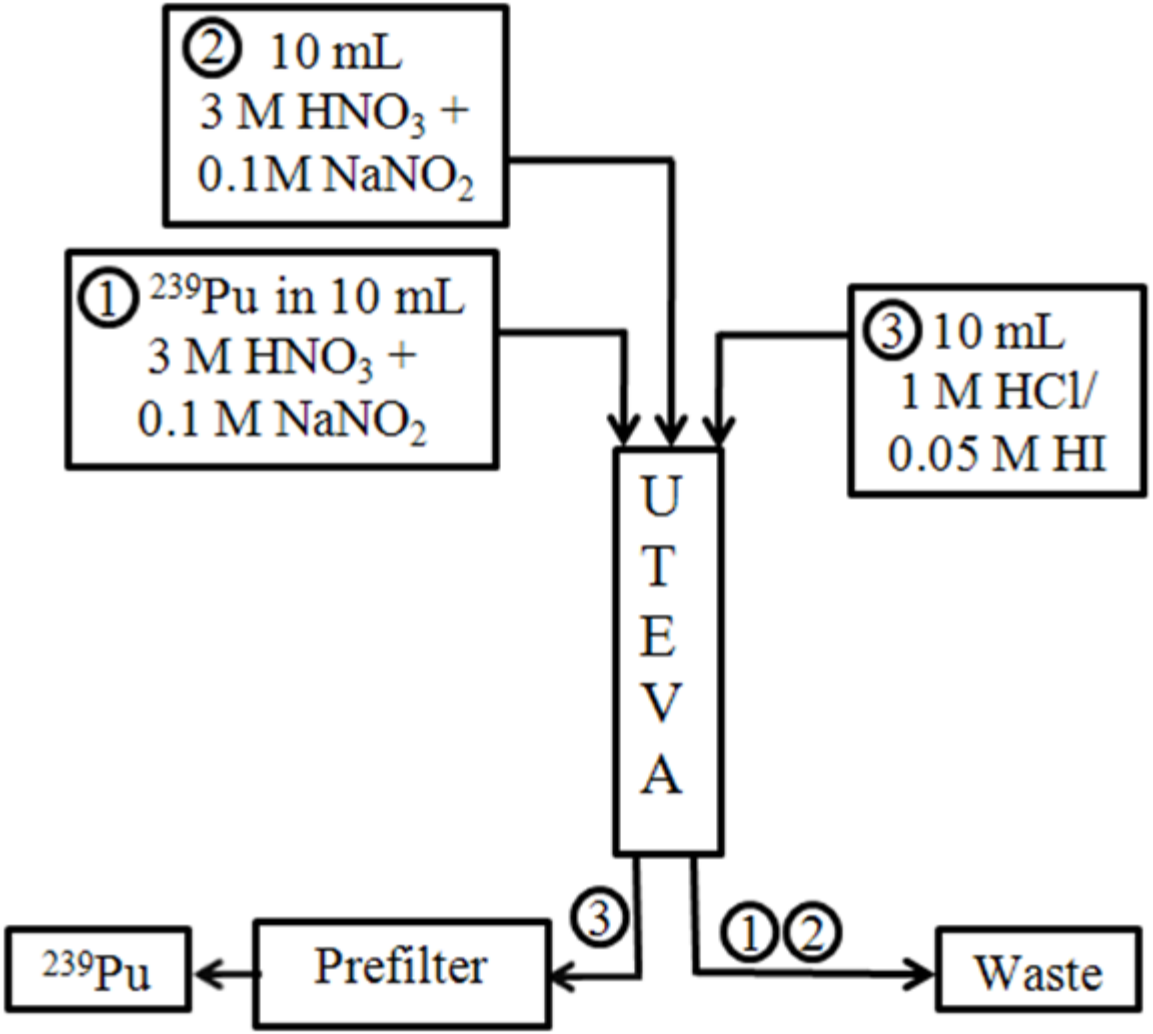
Run	Fraction	total mL	% Pu
1	Load 3M HNO3/0.1M NaNO2	20	0.1
1	Rinse 6M HCl	10	0.0
1	Strip 1M HCl	10	98.3
1	TEVA		1.6
2	Load 3M HNO3/0.1M NaNO2	20	4.9
2	Rinse 6M HCl	10	0.1
2	Strip 1M HCl	10	93.7
2	TEVA		1.3
3	Load 3M HNO3/0.1M NaNO2	20	6.6
3	Rinse 6M HCl	10	0.0
3	Strip 1M HCl	10	92.1
3	TEVA		1.3
4	Load 3M HNO3/0.1M NaNO2	20	2.9
4	Rinse 6M HCl	10	0.0
4	Strip 1M HCl	10	95.7
4	TEVA		1.4
5	Load 3M HNO3/0.1M NaNO2	20	3.4
5	Rinse 6M HCl	10	0.0
5	Strip 1M HCl	10	94.7
5	TEVA		1.8

Increased Pu Breakthrough and

Decreased Yield

with successive purifications

Purification of ^{239}Pu Tracer



Purification of ^{239}Pu Tracer

Pu-239 on UTEVA (Repeated runs on Fresh 2mL cartridge)

Run	Fraction	total mL	% Pu
1	Load 3M HNO3/0.1M NaNO2	20	0.0
1	Rinse 6M HCl	10	0.0
1	Strip 1M HCl + 0.05 M HI	10	98.4
1	UTEVA		1.6
2	Load 3M HNO3/0.1M NaNO2	20	0.0
2	Rinse 6M HCl	10	0.0
2	Strip 1M HCl + 0.05 M HI	10	98.8
2	UTEVA		1.2
3	Load 3M HNO3/0.1M NaNO2	20	0.0
3	Rinse 6M HCl	10	0.0
3	Strip 1M HCl + 0.05 M HI	10	99.3
3	UTEVA		0.8

Systems Developed

- $^{68}Ga/^{68}Ge$
- $^{90}Y/^{90}Sr$
- $^{210}Po/^{210}Bi/^{210}Pb$
- $^{211}Pb/^{223}Ra$
- $^{212}Pb/^{224}Ra/^{228}Th$
- $^{223}Ra/^{227}Th/^{227}Ac$
- $^{225}Ac/^{225}Ra/^{229}Th$
- $^{228}Th/^{232}U$
- $^{231}Th/^{235}U$
- $^{234}Th/^{238}U$
- $^{239}Np/^{243}Am$
- ^{241}Am/Smoke Detectors

Long Lived Tracers:

^{230}Th

^{233}U

^{239}Pu

^{241}Am

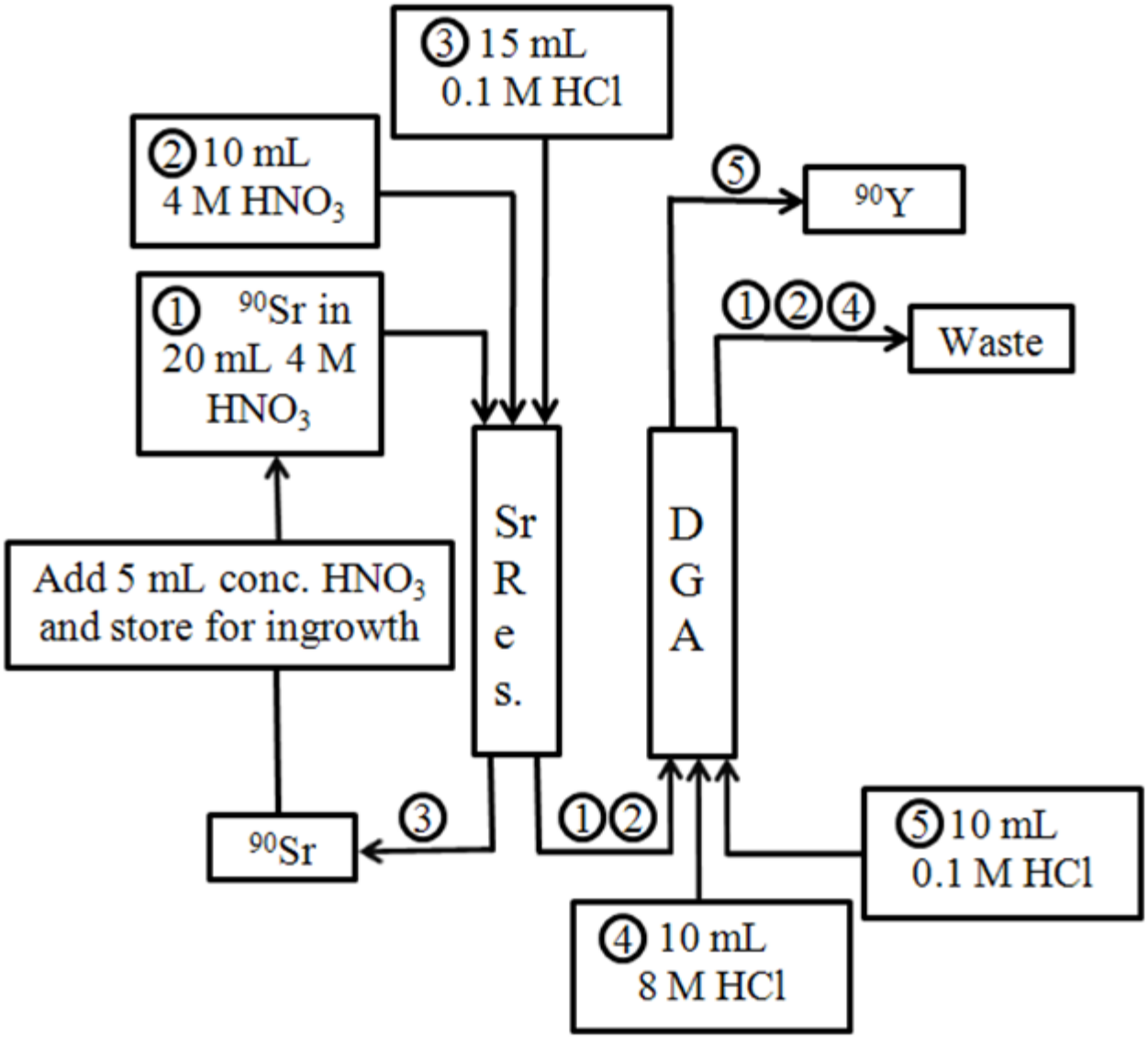
^{90}Y from ^{90}Sr

$$^{90}Sr \xrightarrow{28.6\ y} {}^{90}Y \xrightarrow{2.67\ d} {}^{90}Zr\ (stable)$$

After 14 days of ingrowth
for a 10uCi ^{90}Sr Source:

9.7 uCi ^{90}Y

^{90}Y from ^{90}Sr



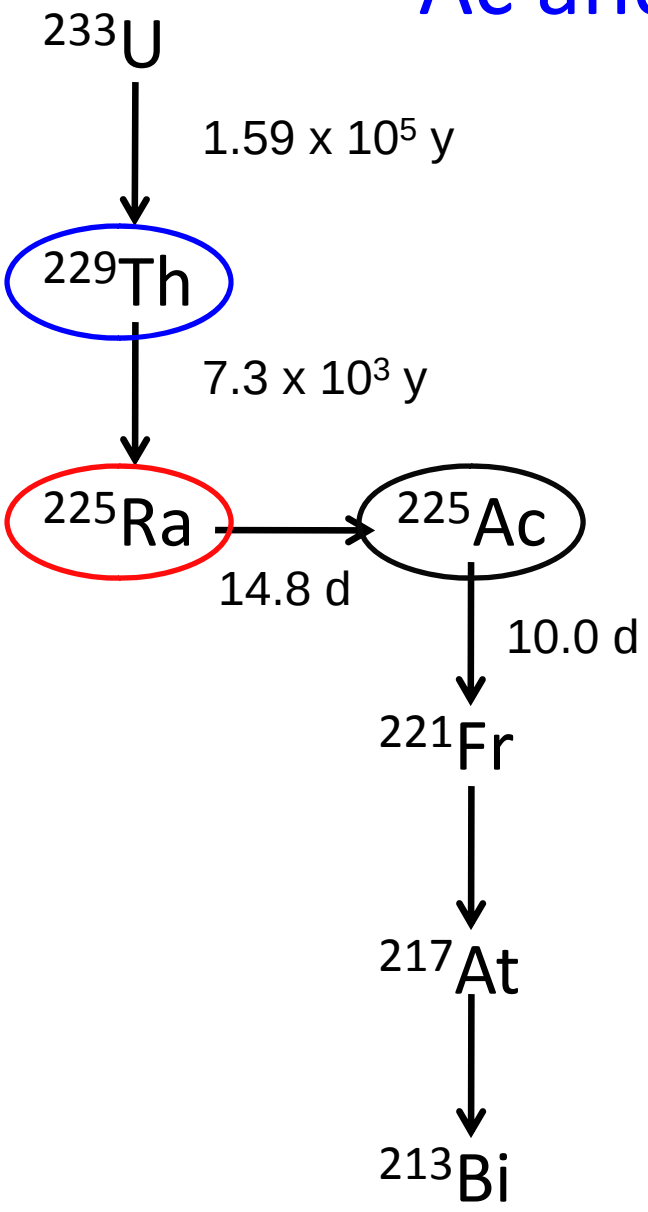
^{90}Y from ^{90}Sr

^{90}Y Yield = 99.3 $\pm$ 0.3%

^{90}Sr Recovery = 98.4 $\pm$ 0.1%

^{90}Y purity < 0.00003% ^{90}Sr

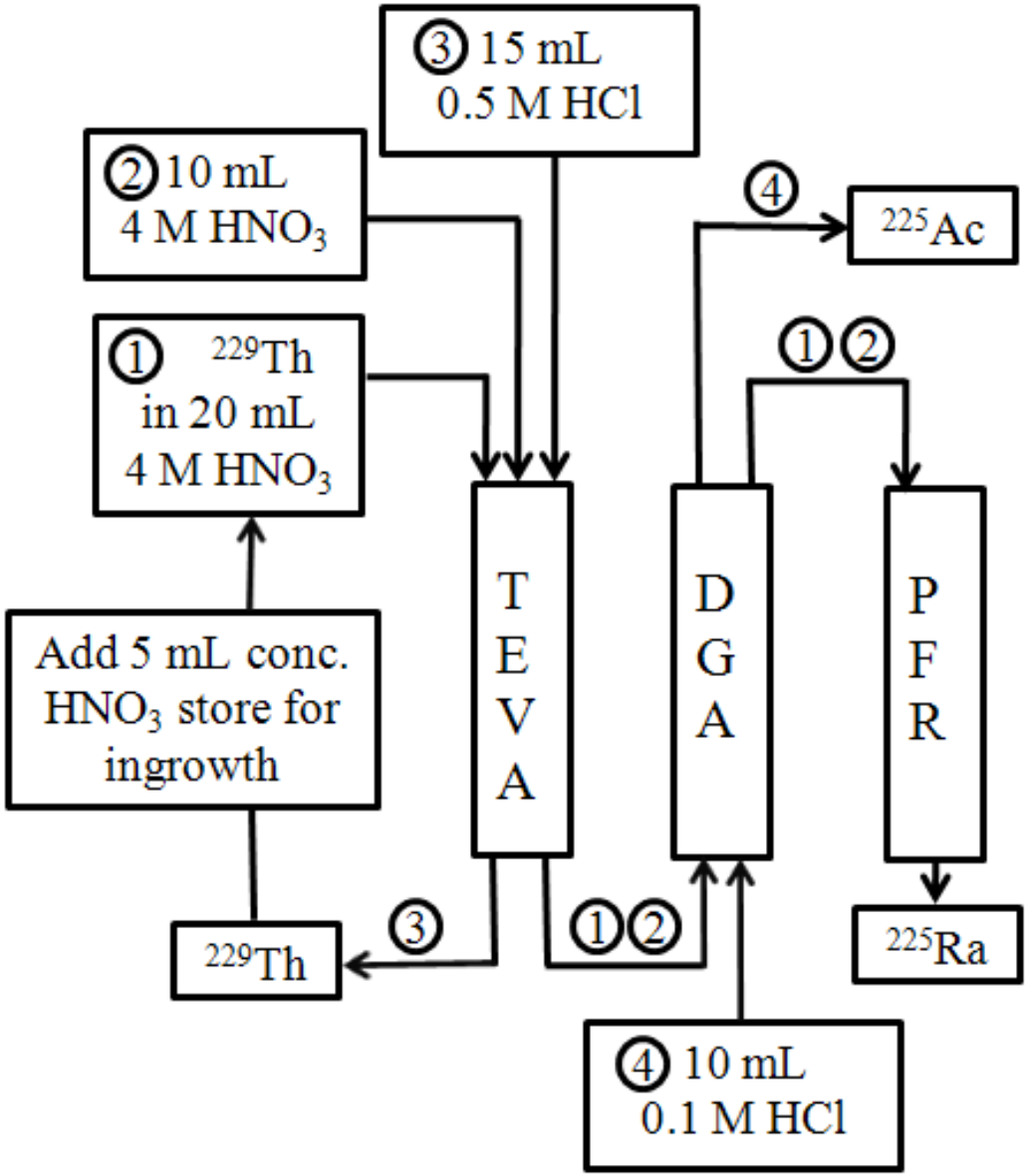
^{225}Ac and ^{225}Ra from ^{229}Th



After 30 days of ingrowth
for a 10uCi ^{229}Th Source:

7.5 uCi ^{225}Ra
5.0 uCi ^{225}Ac

^{225}Ac and ^{225}Ra from ^{229}Th



^{225}Ac and ^{225}Ra from ^{229}Th

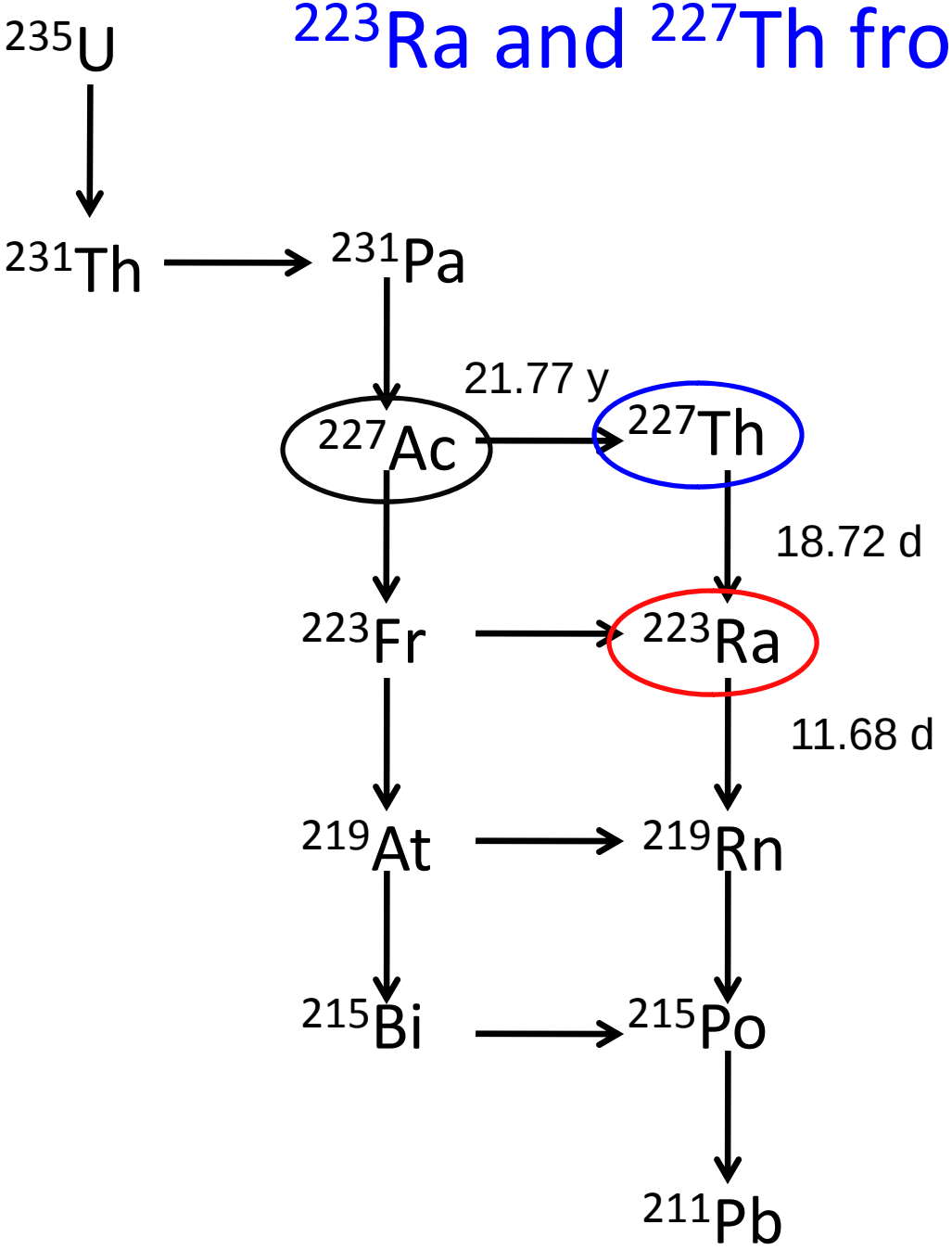
^{225}Ac Yield = 99.2 $\pm$ 0.5%

^{225}Ra Yield = >99%

^{229}Th Recovery = >99%

^{225}Ac purity < 0.0001% ^{229}Th
< 0.0001% ^{225}Ra

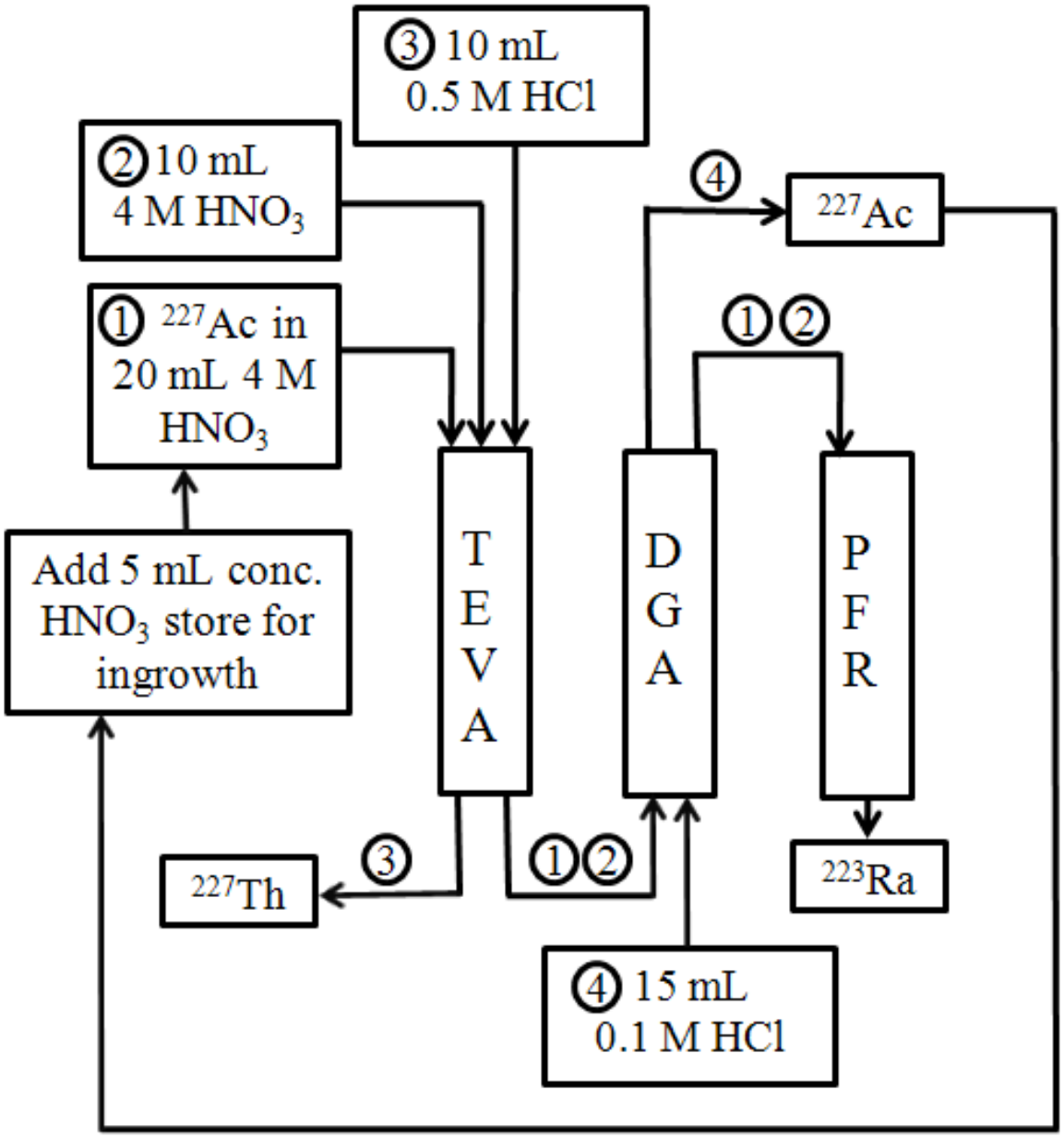
^{223}Ra and ^{227}Th from ^{227}Ac



After 30 days of ingrowth for a 10uCi ^{227}Ac Source:

6.6 uCi ^{227}Th
4.1 uCi ^{223}Ra

^{223}Ra and ^{227}Th from ^{227}Ac



^{223}Ra and ^{227}Th from ^{227}Ac

^{227}Th Yield = >95%

^{223}Ra Yield = >99%

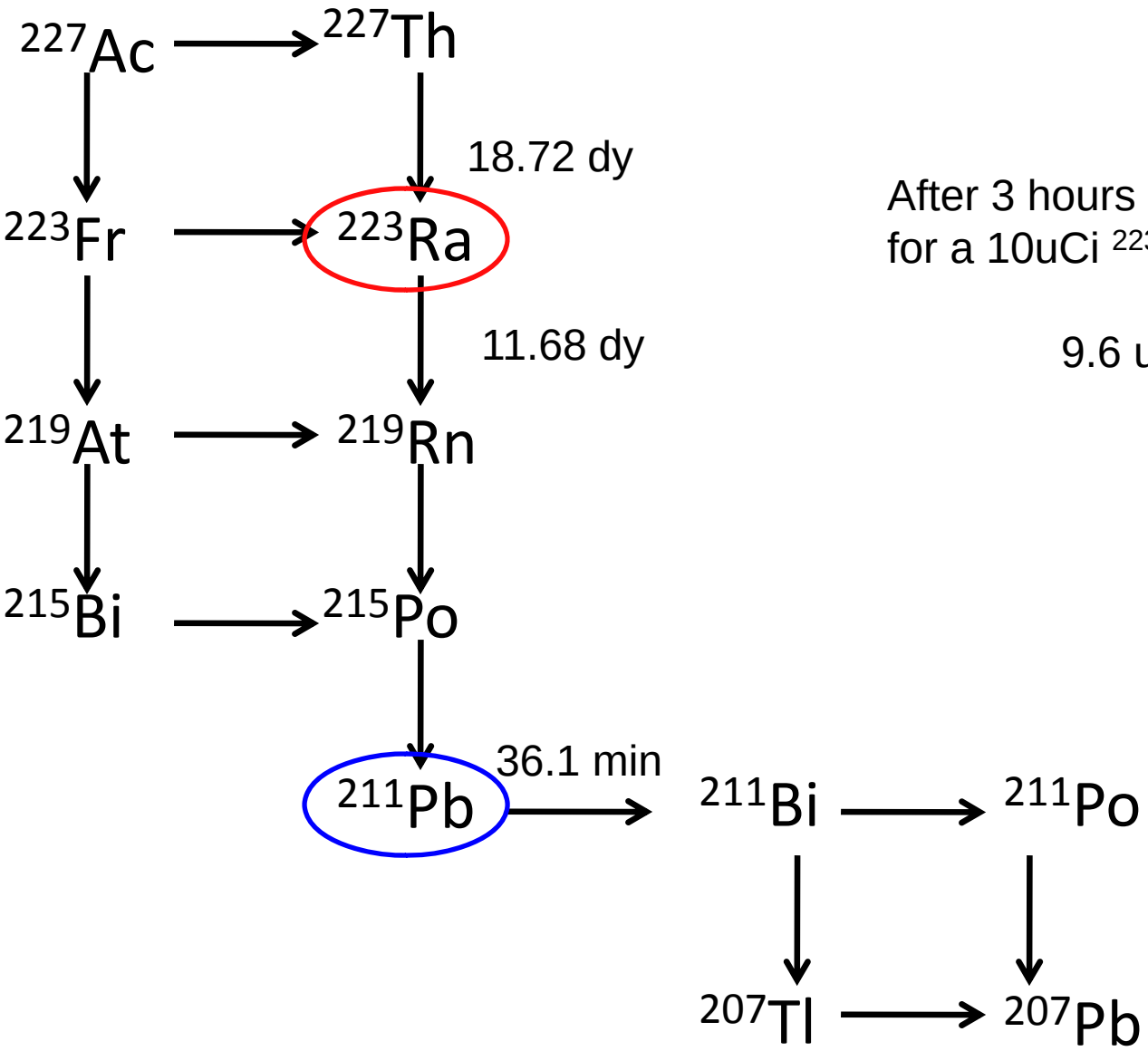
^{227}Ac Recovery = >99.9%

^{227}Th purity < 0.0001% ^{227}Ac

^{223}Ra purity < 0.0001% ^{227}Ac

< 0.0001% ^{227}Th

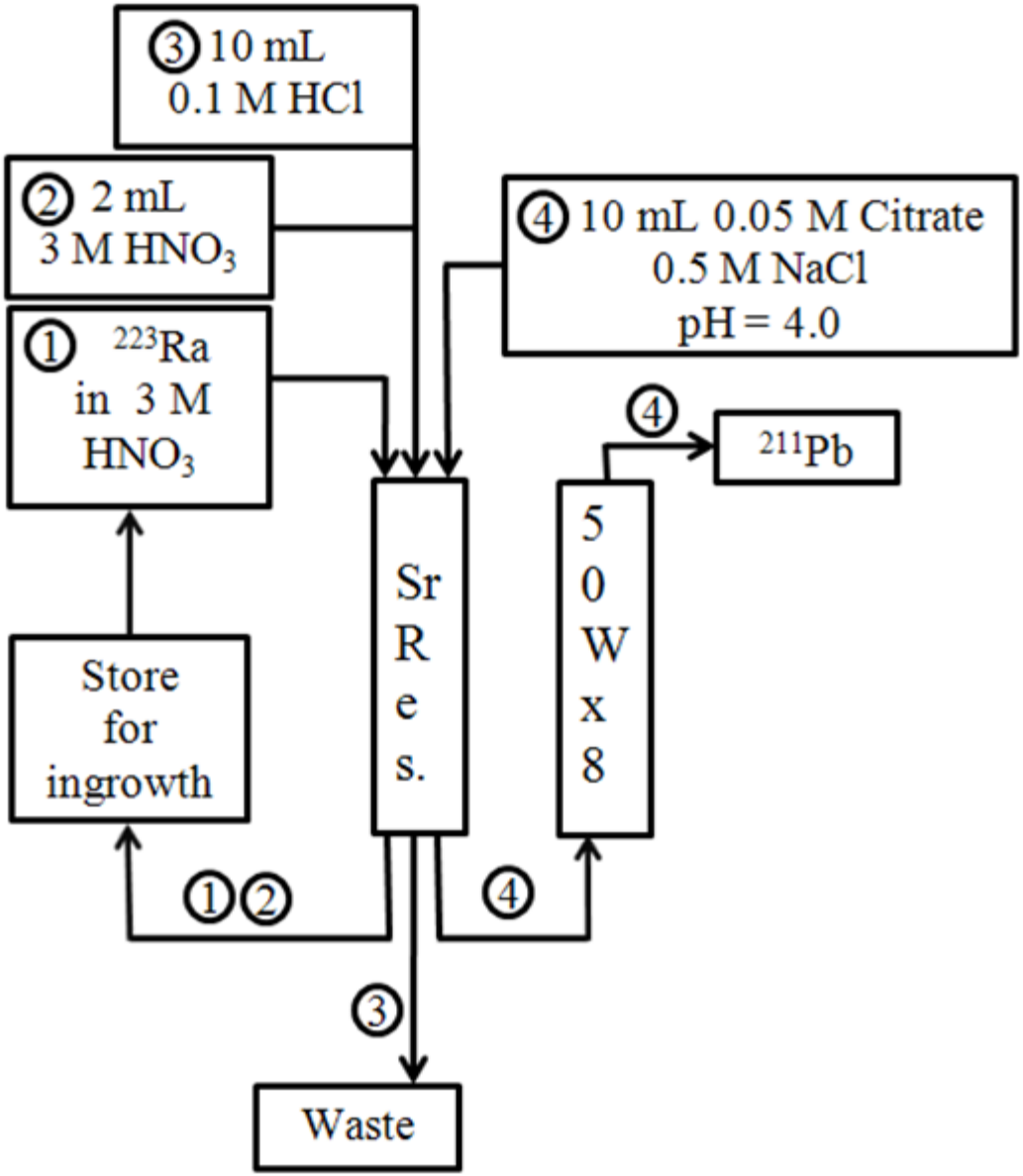
^{211}Pb from ^{223}Ra



After 3 hours of ingrowth
for a 10uCi ^{223}Ra Source:

9.6 uCi ^{211}Pb

^{211}Pb from ^{223}Ra



^{211}Pb from ^{223}Ra

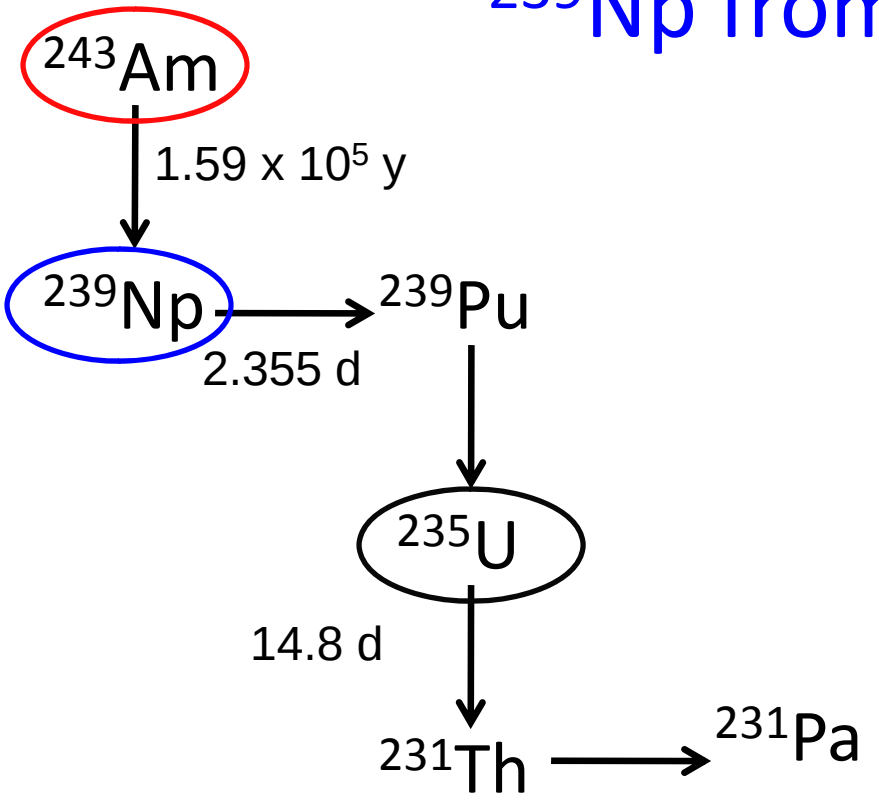
^{211}Pb Yield = ~75%

^{223}Ra Recovery = >99%

^{211}Pb purity < 10^{-8}% ^{227}Ac/^{227}Th

< 0.0001% ^{223}Ra

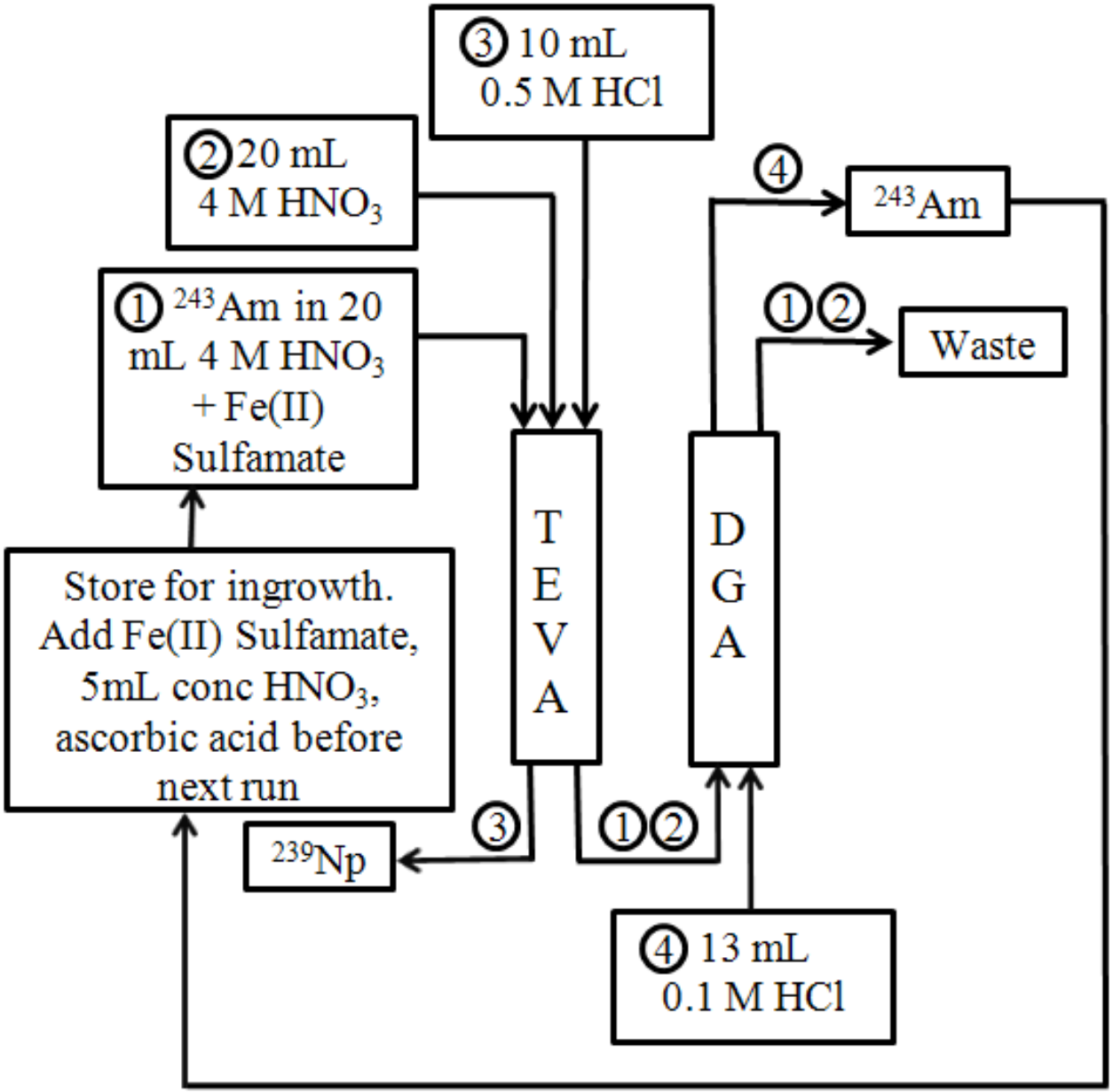
^{239}Np from ^{243}Am



After 10 days of ingrowth
for a 10uCi ^{243}Am Source:

9.5 uCi ^{239}Np

^{239}Np from ^{243}Am



^{239}Np from ^{243}Am

^{239}Np Yield = 88 ± 4%

^{243}Am Recovery = 99.8 ± 0.1%

^{239}Np purity 0.006 ± 0.001% ^{243}Am

Conclusion

Generator Systems for a wide range of useful radioisotopes have been developed:

- Evaporation steps eliminated/minimized
- High recovery of Parent and Daughter
- Fast methods (<1 hr)

Results currently being written for a manuscript to be submitted to Radiochimica Acta