



Agenzia nazionale per le nuove tecnologie,  
l'energia e lo sviluppo economico sostenibile

## Triskem Users Meeting 2022

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# Application of TEVA and DGA cartridges in radiological characterization of concrete, paint and resin deriving from the decommissioning of Italian nuclear power plant

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# Tasks of the Laboratory IRP-MIR

IRP – Radiation Protection Institute

MIR – Integrated Monitoring and measurements of the Radioactivity

- Physical surveillance of the internal contamination of employees exposed to ionizing radiation
- Technical advanced service for radiological characterization

Biological samples

Environmental samples

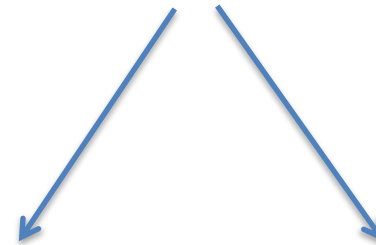


# Italian nuclear power plant

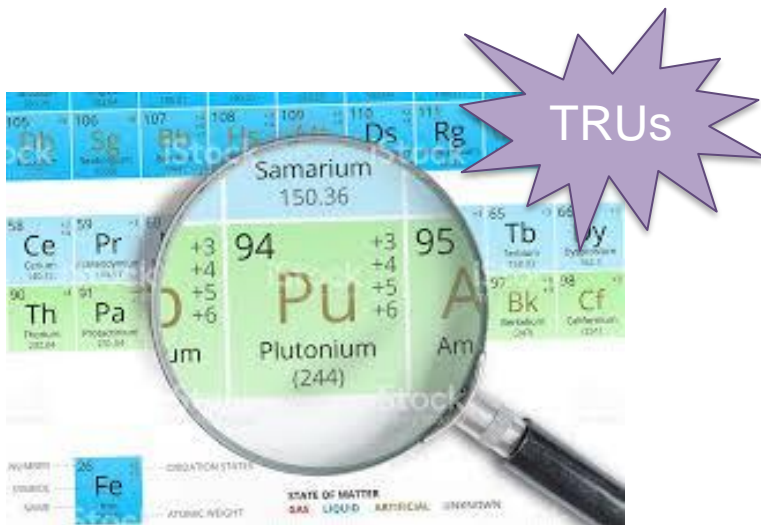


# Decommissioning and waste management

Dismantling the structures and removing contaminated materials



# Waste characterization



$^{239+240}\text{Pu}$ ,  $^{238}\text{Pu}$

$^{241}\text{Am}$

$^{242}\text{Cm}$ ,  $^{244}\text{Cm}$



Sequential separation

Concrete

Paint

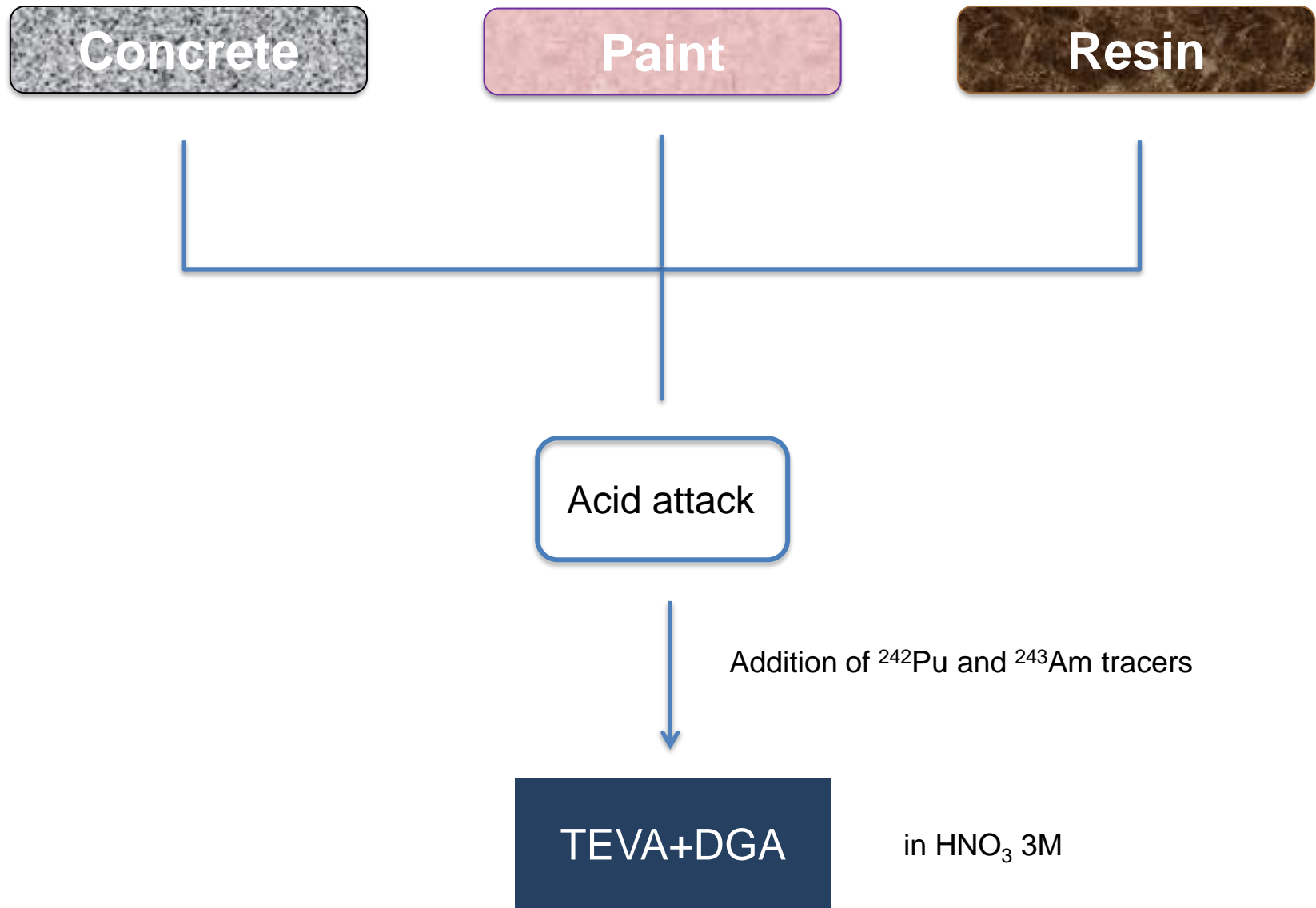
Resin



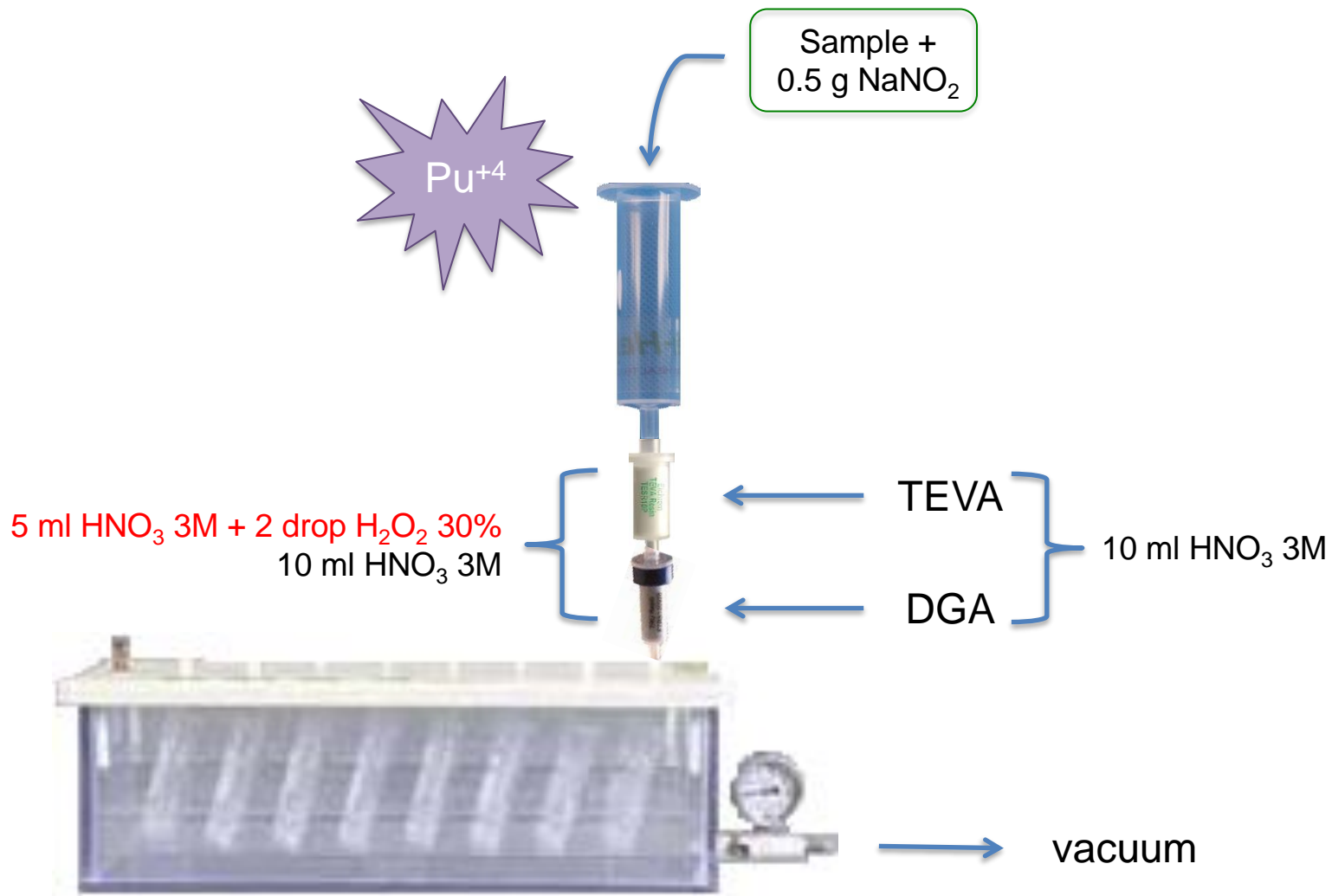
# Procedure

## Bibliography

- Maxwell et al., Rapid radiochemical method for determination of actinides in emergency concrete and brick samples (2011) *Analytica Chimica Acta* 701:112-118
- Horwitz et al., Separation and preconcentration of actinides by extraction chromatography using a supported liquid anion exchanger: application to the characterization of high-level nuclear waste solutions (1995) *Analytica Chimica Acta* 310: 63-78
- Eichrom Technologies Inc. Analytical Procedure ACU02 VBS (2005)

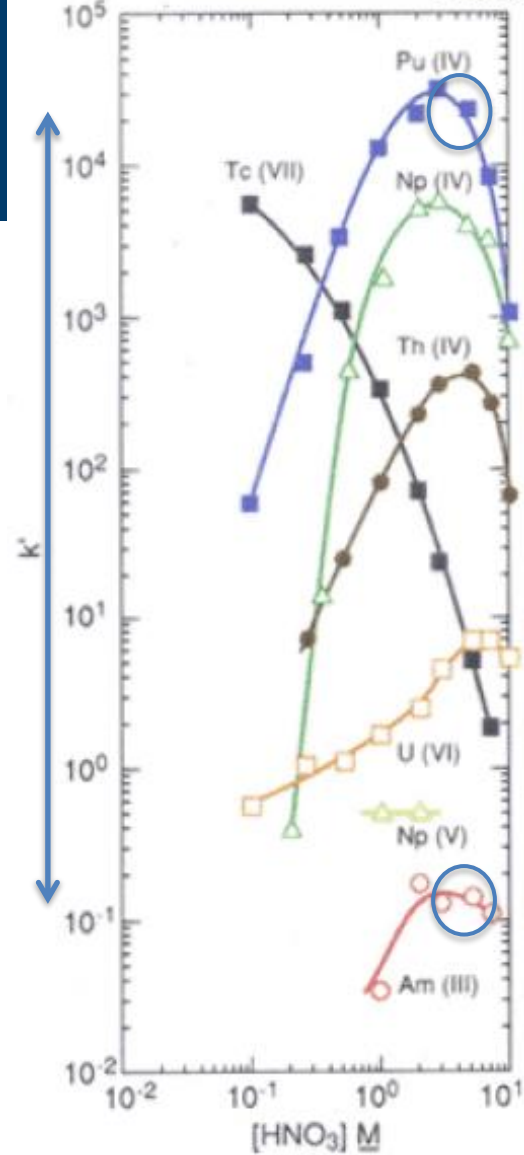
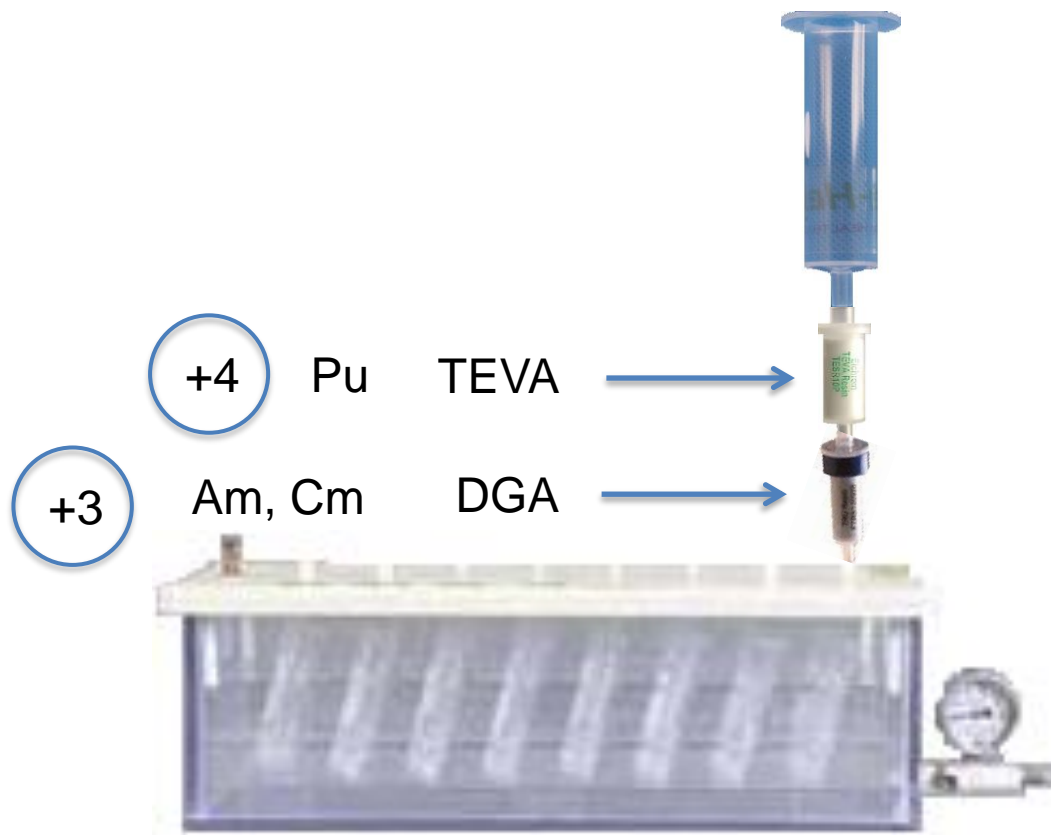


# TEVA+DGA

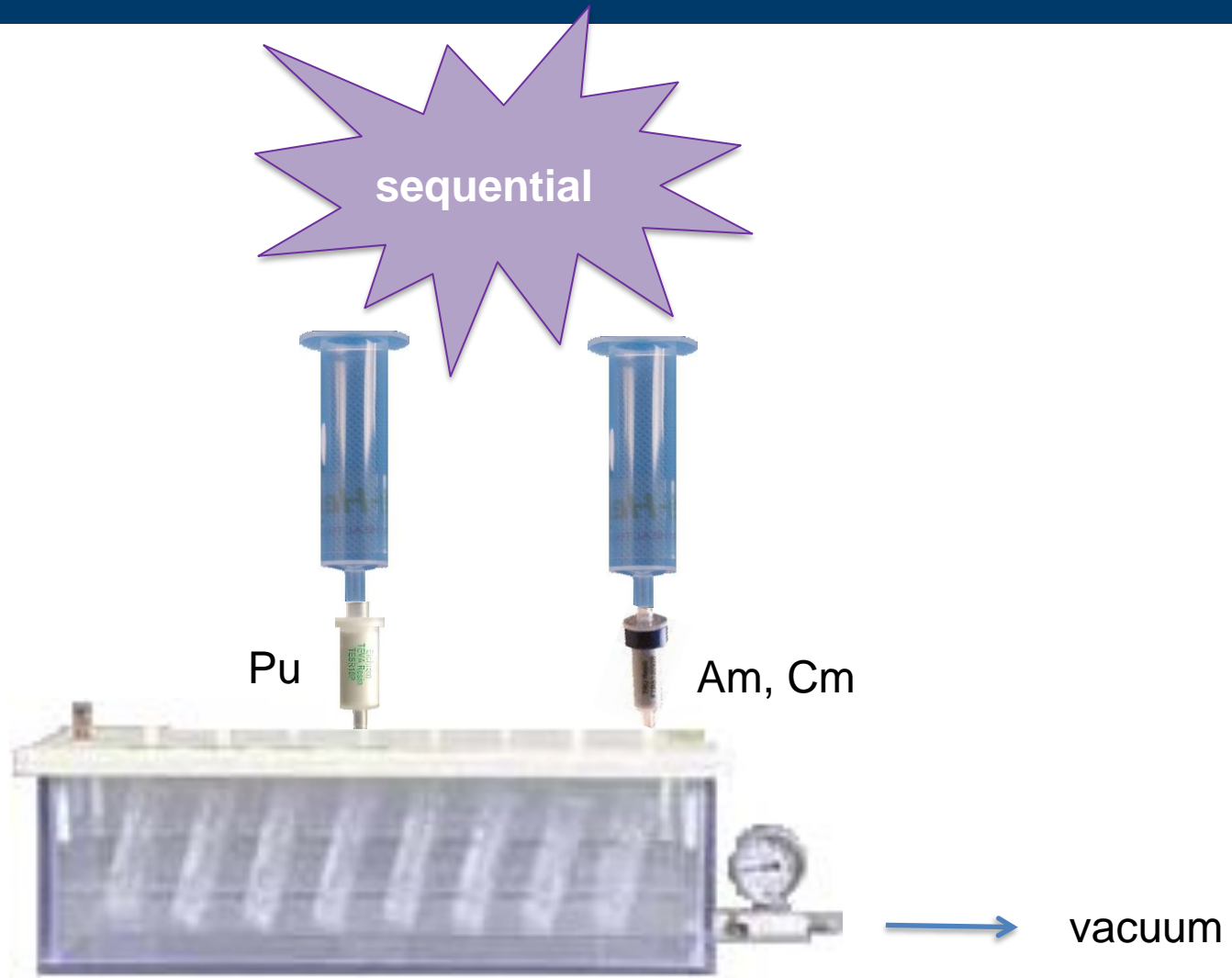




# TEVA+DGA



# TEVA+DGA



# TEVA+DGA

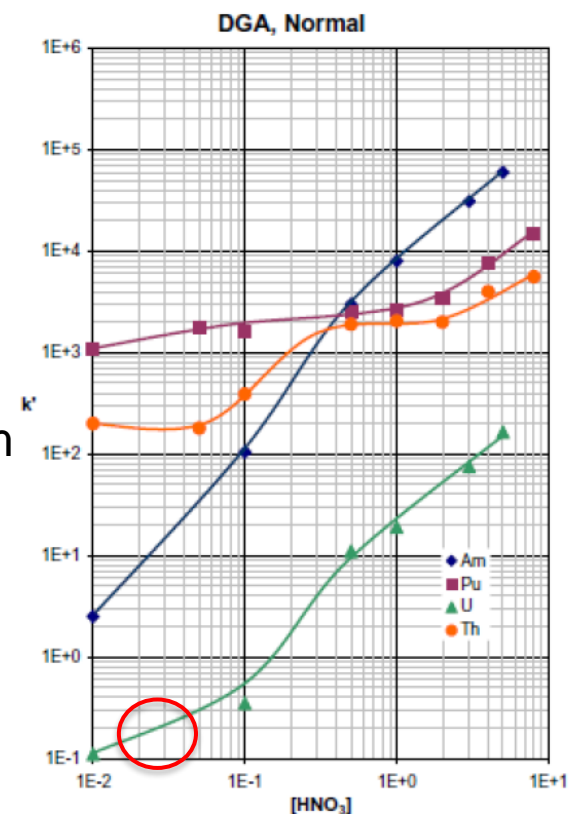
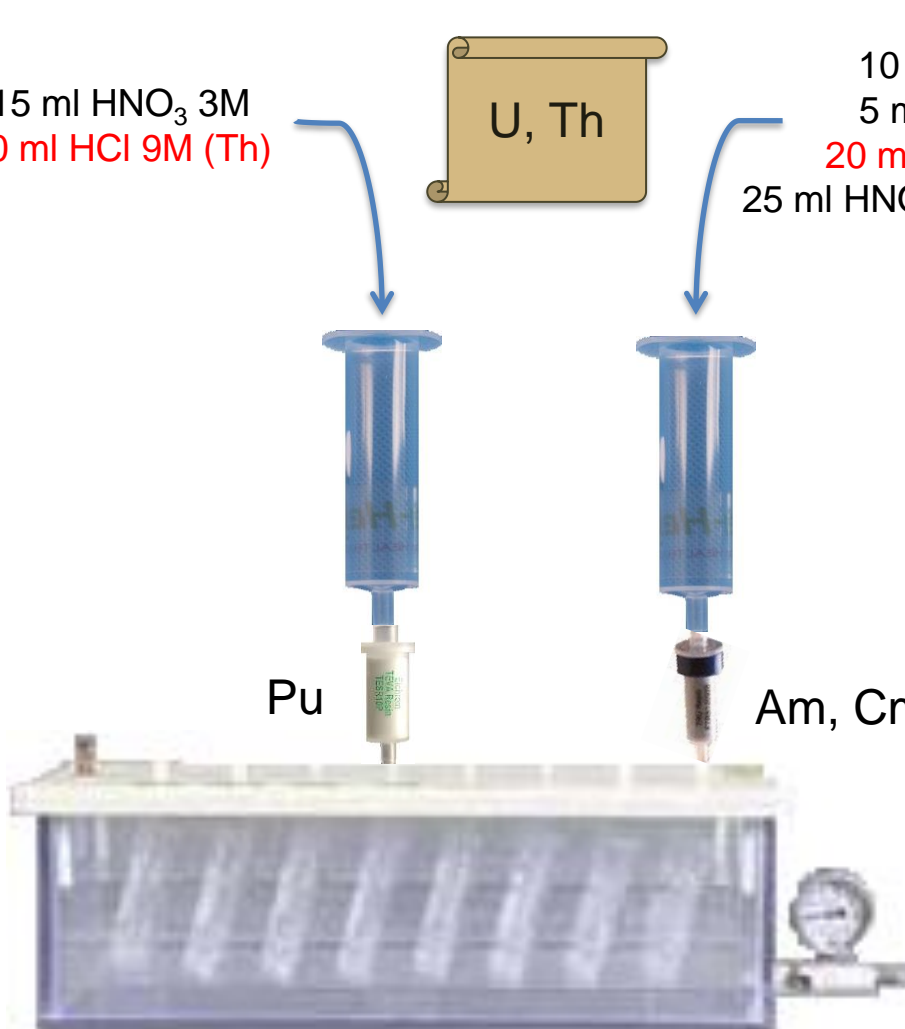
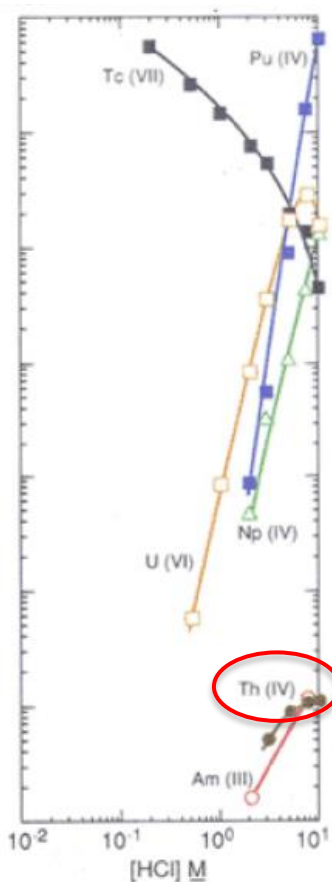
35 mL

15 ml HNO<sub>3</sub> 3M  
20 ml HCl 9M (Th)

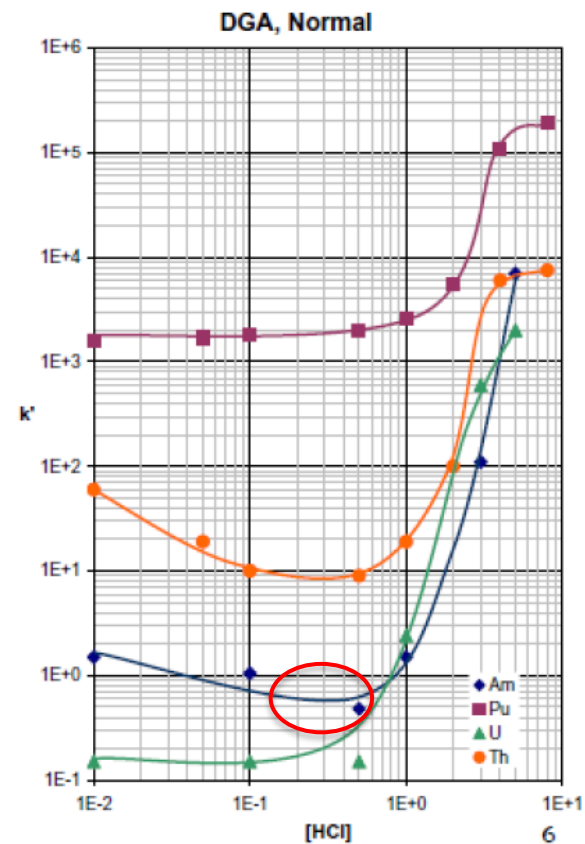
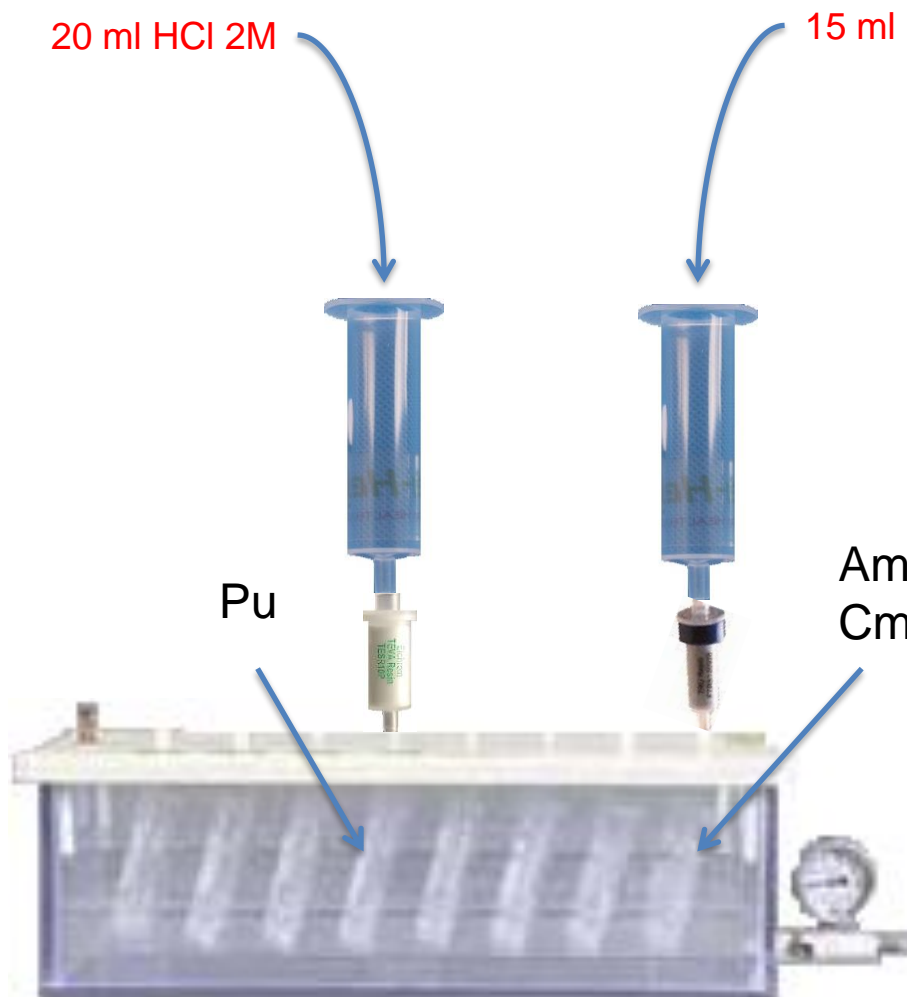
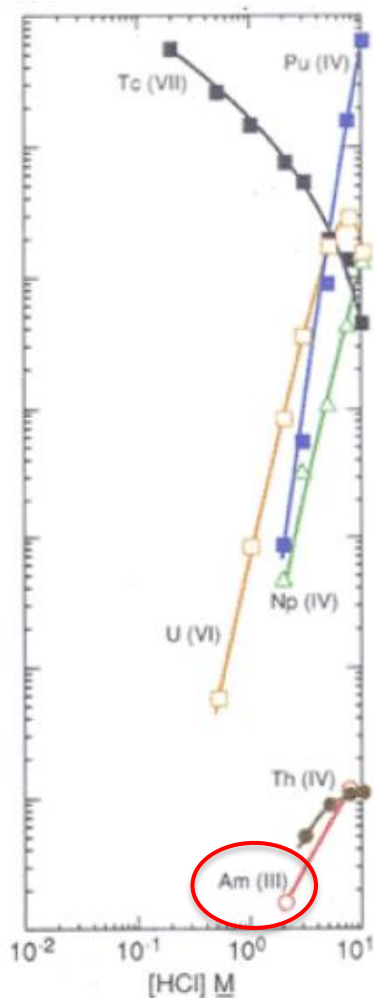
U, Th

10 ml HCl 3M (Ca)  
5 ml HNO<sub>3</sub> 1M (La)  
20 ml HNO<sub>3</sub> 0.05M (U)  
25 ml HNO<sub>3</sub> 3M – HF 0.25M (Th)

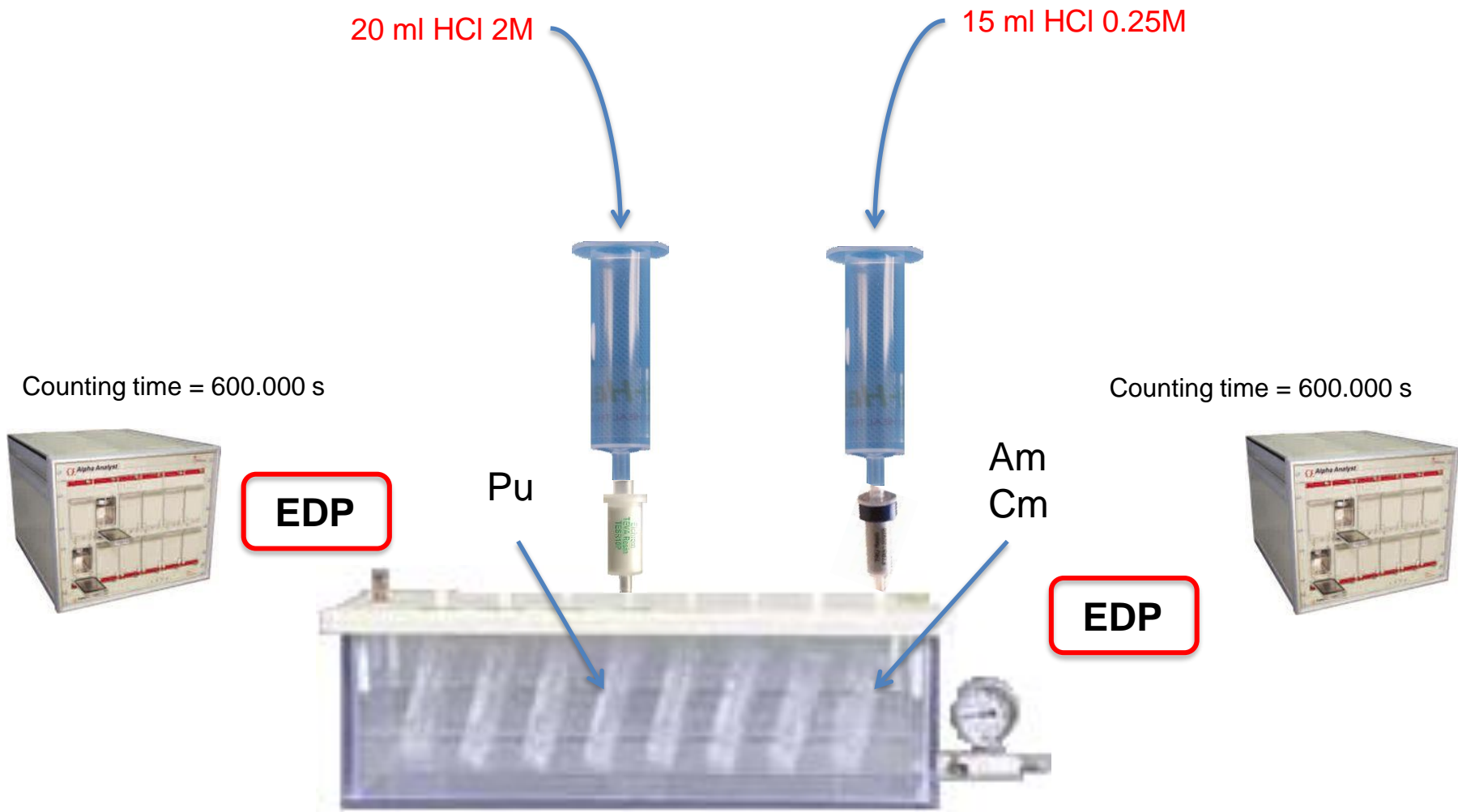
60 mL



# TEVA+DGA

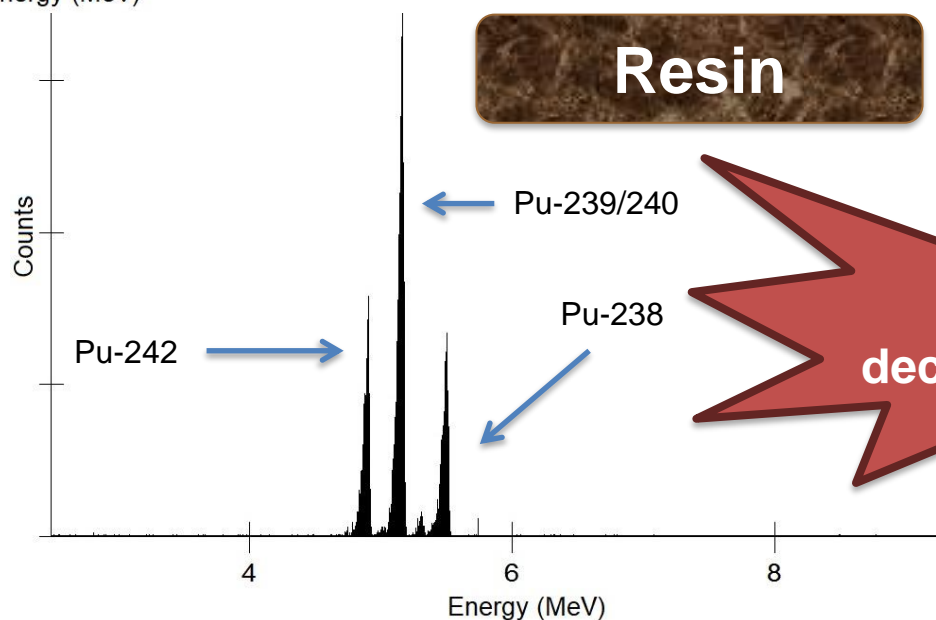
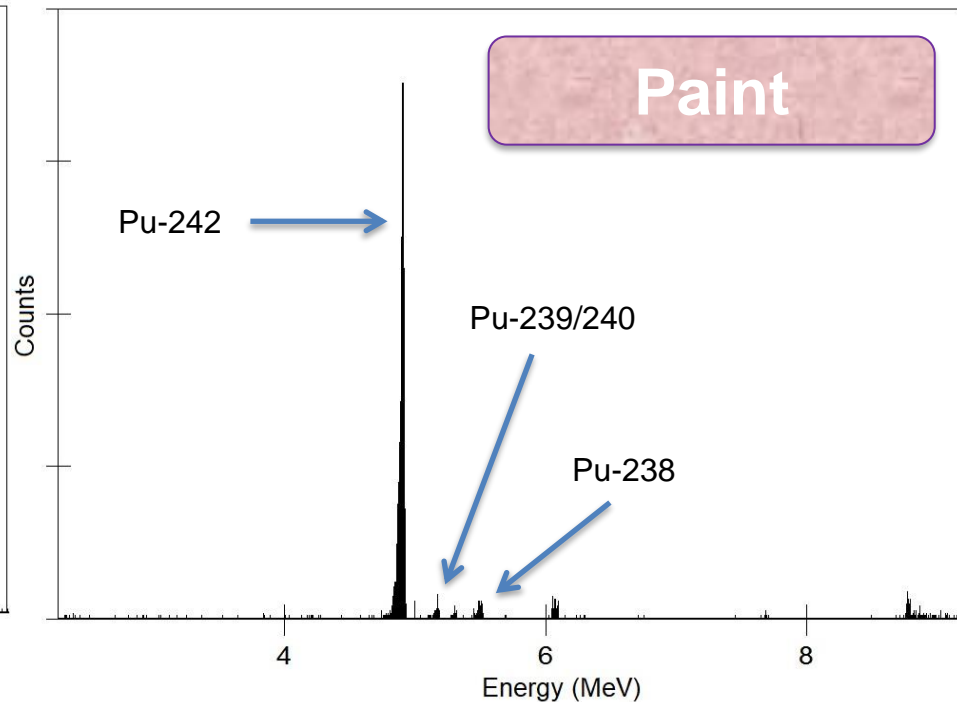
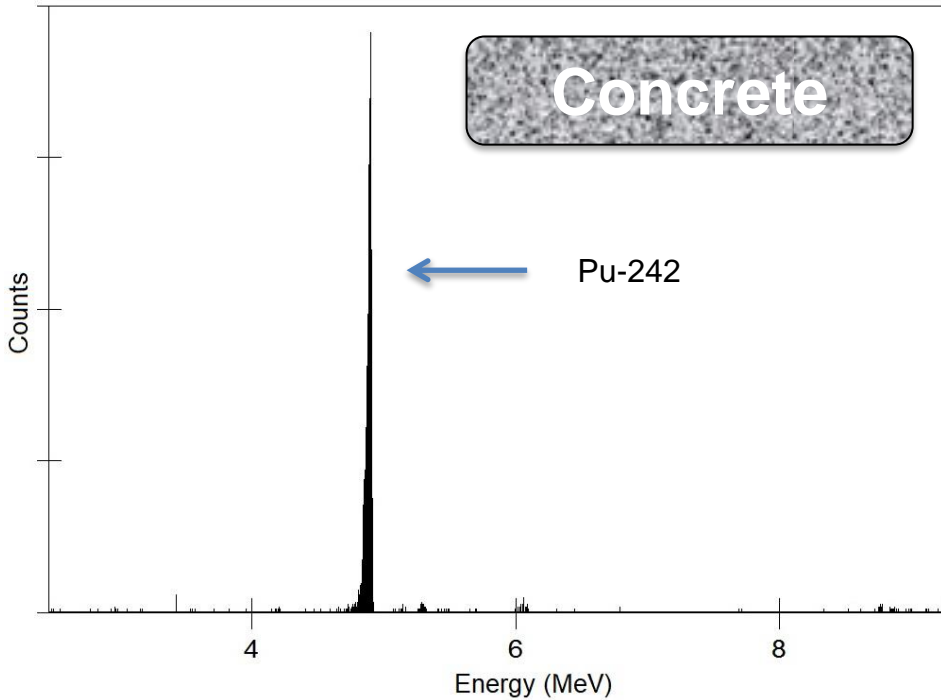


# TEVA+DGA



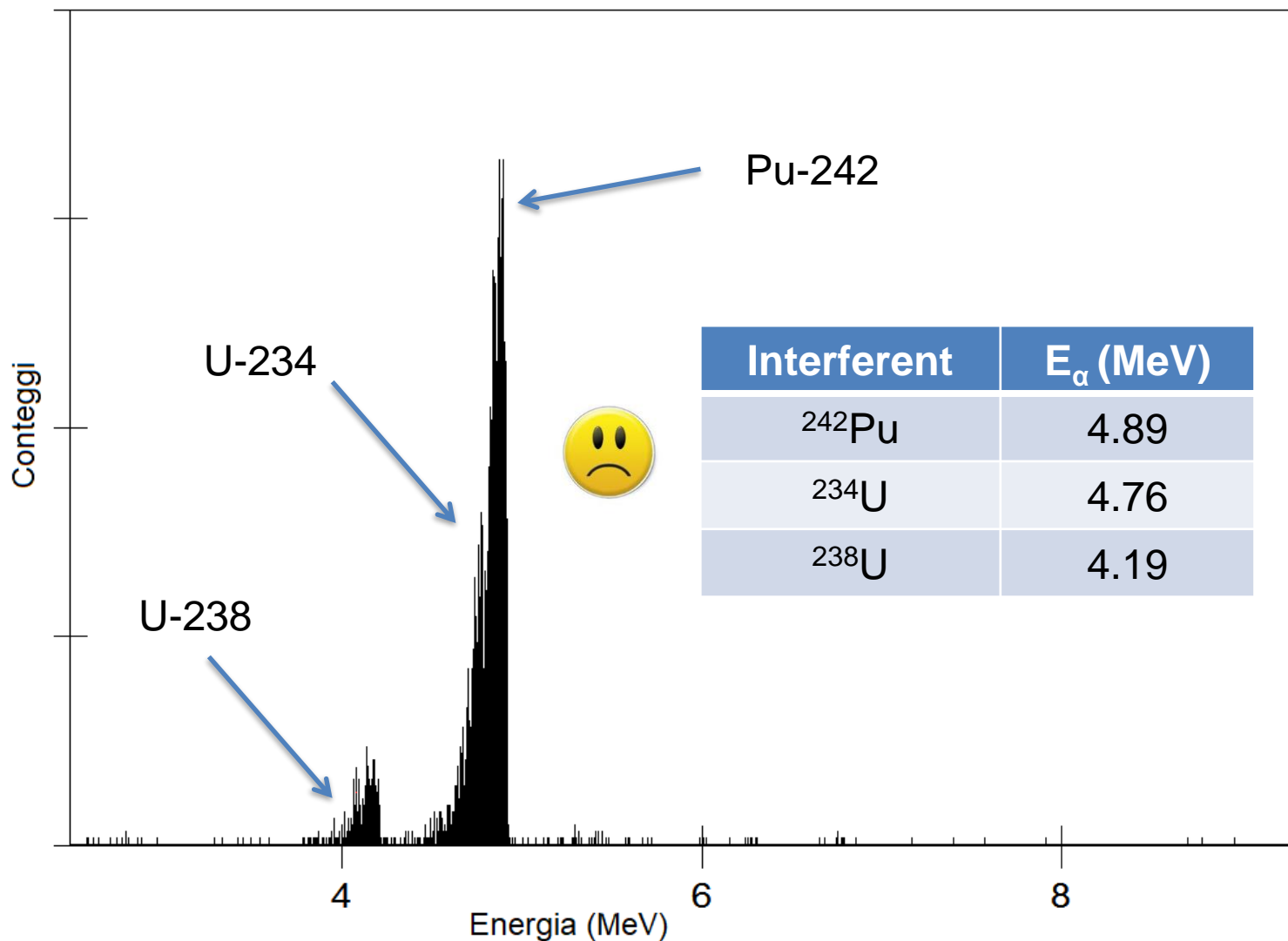


# Results and discussion



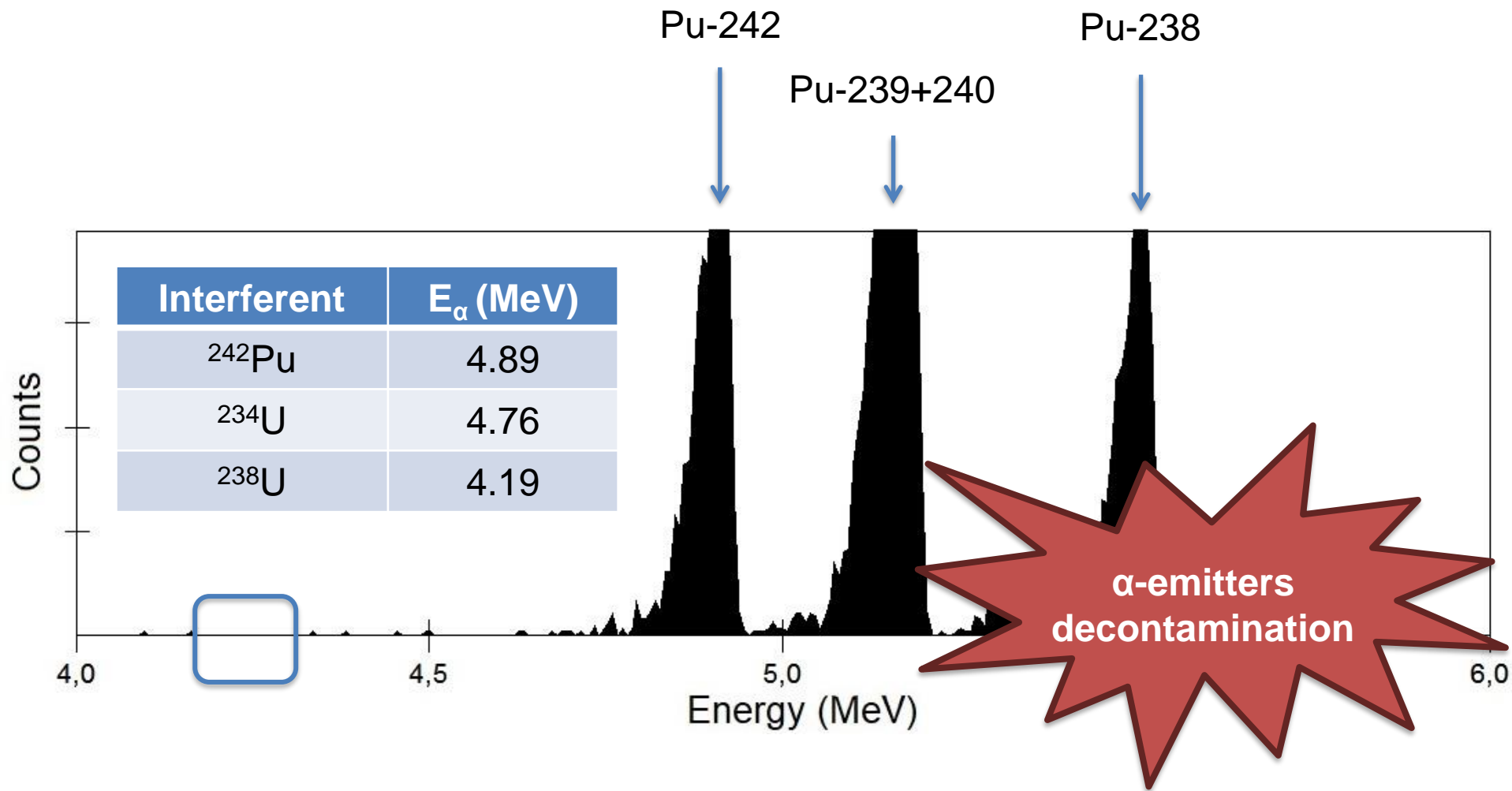
**α-emitters  
decontamination**

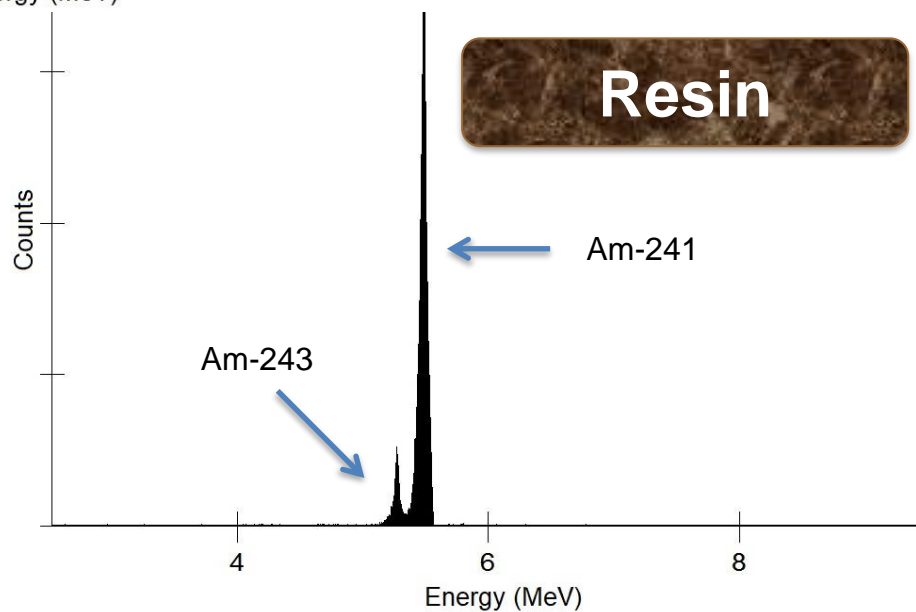
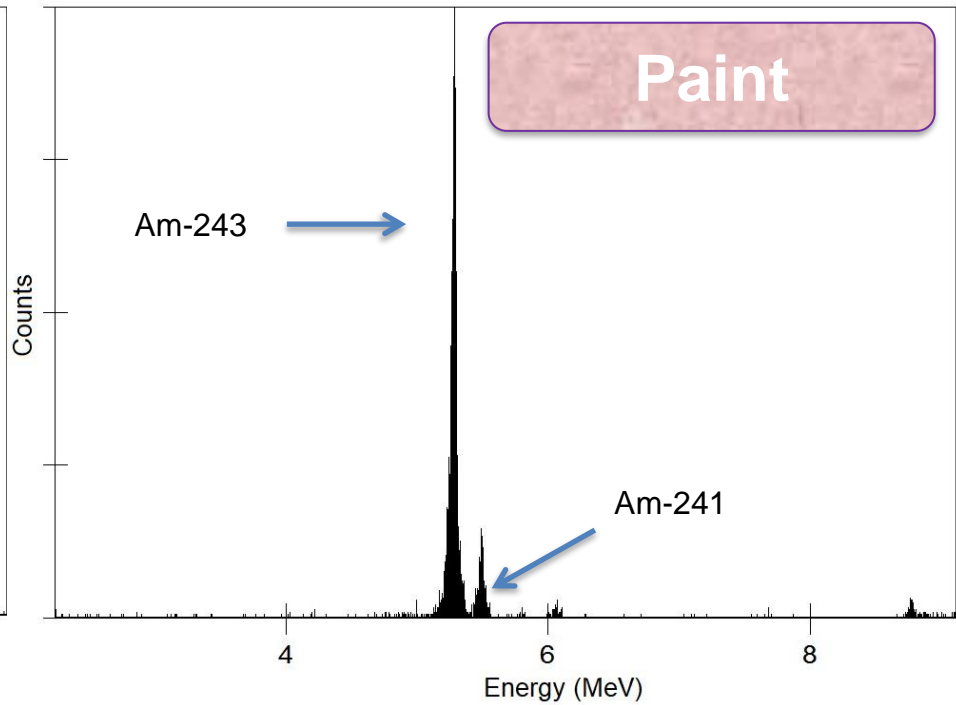
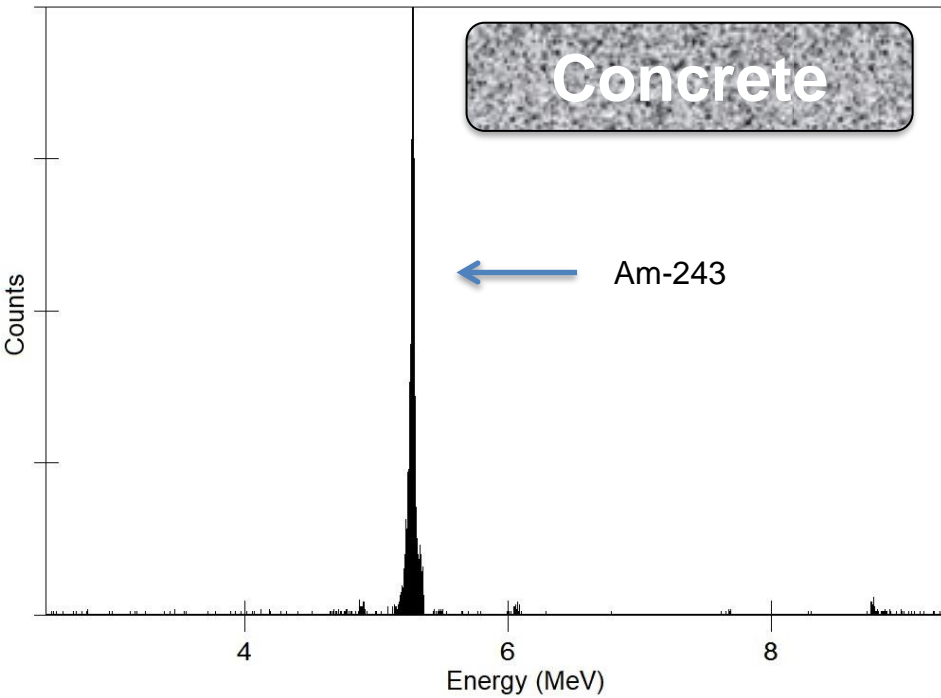
# Interference in Pu spectra



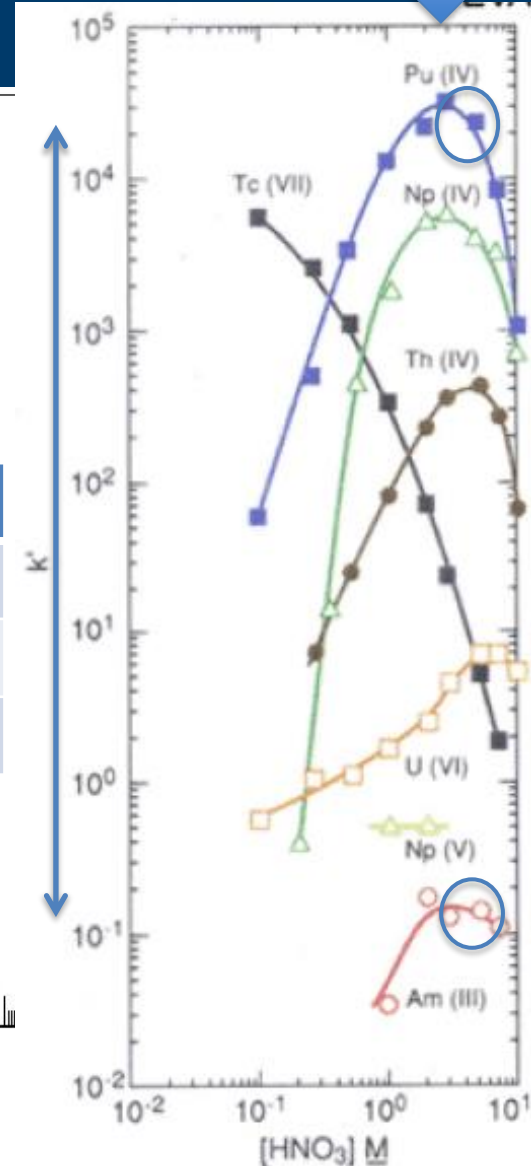
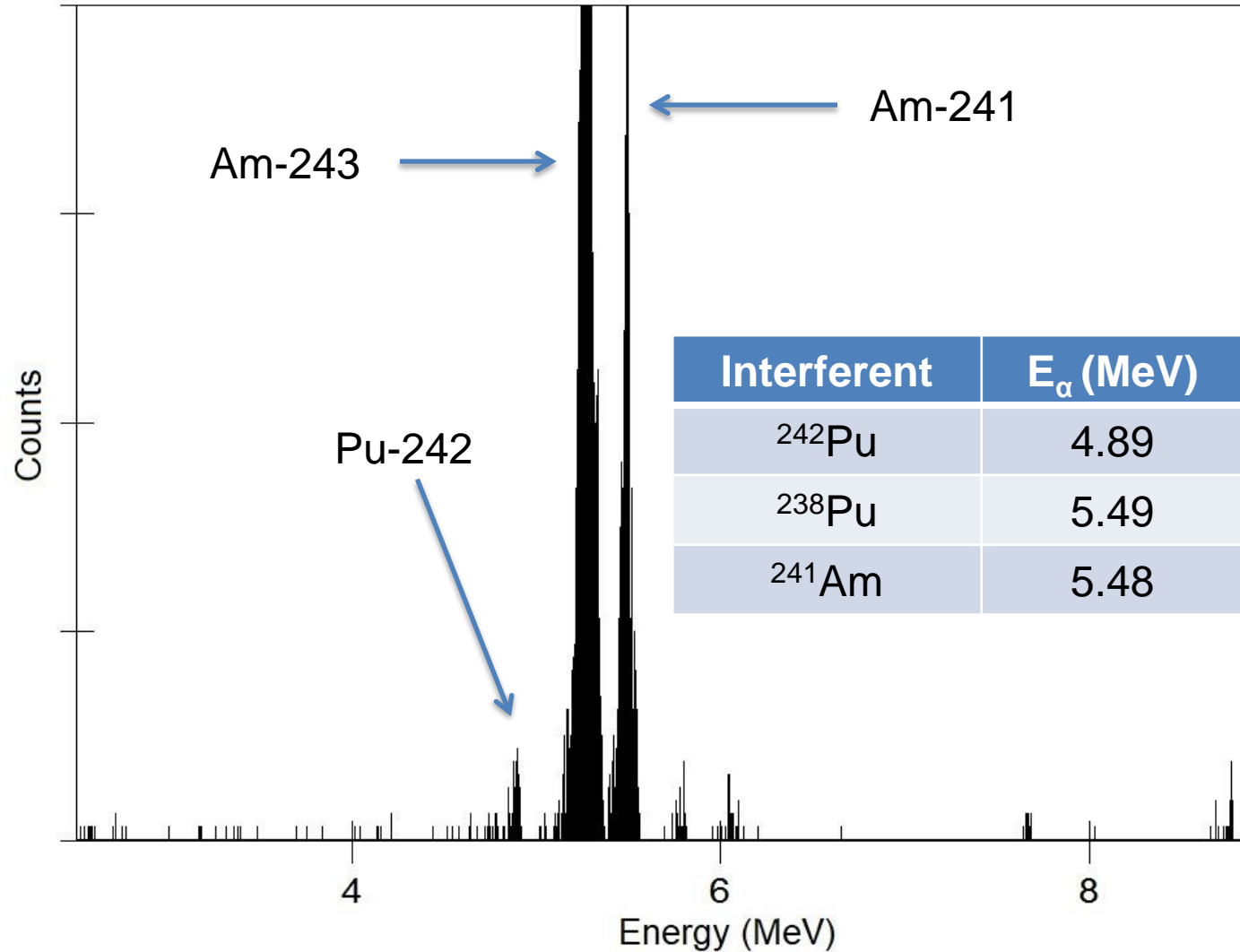


# Interference in Pu spectra





# Interference in Am spectra



# Results - Performance

## Concrete

Sample amount analyzed (g)	Pu Yield (%)	Am/Cm Yield (%)
< 0.3	99 ± 3	90 ± 3
0.5	62 ± 18	96 ± 4
1	50 ± 7	91 ± 8

## Paint

Sample amount analyzed (g)	Pu Yield (%)	Am/Cm Yield (%)
0.5	68 ± 8	99 ± 3
1	64 ± 3	100 ± 1

Matrix effect



← TEVA

# Results - Performance

## Concrete

Sample amount analyzed (g)	Pu Yield (%)	Am/Cm Yield (%)
< 0.3	99 ± 3	90 ± 3
0.5	62 ± 18	96 ± 4
1	50 ± 7	91 ± 8



## Paint

Sample amount analyzed (g)	Pu Yield (%)	Am/Cm Yield (%)
0.5	68 ± 8	99 ± 3
1	64 ± 3	100 ± 1

## Resin

Sample amount analyzed (g)	Pu Yield (%)	Am/Cm Yield (%)
1	70 ± 19	90 ± 12

# Minimum Detectable Activity (MDA)


$$\text{MDA (Bq/g)} = \frac{L_D}{t \cdot \epsilon \cdot Y \cdot m}$$


$L_D$  = detection limit

$t$  = counting time

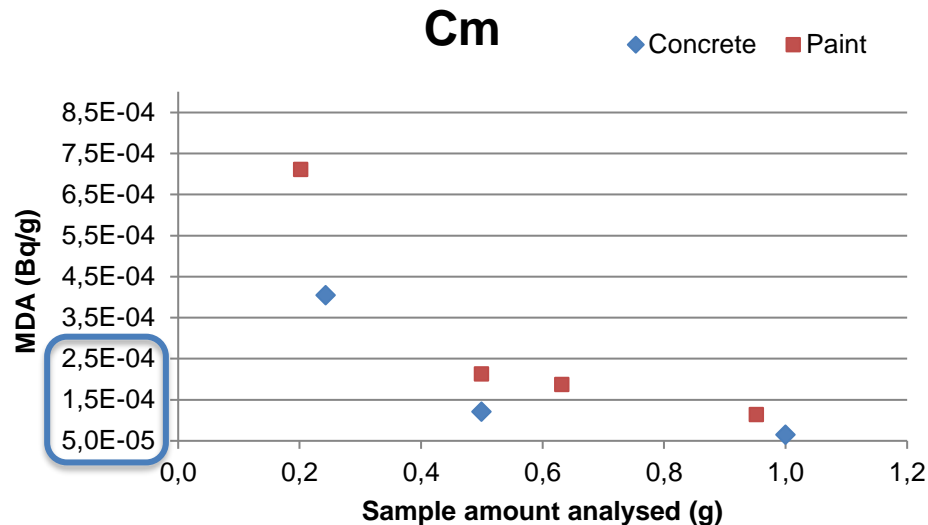
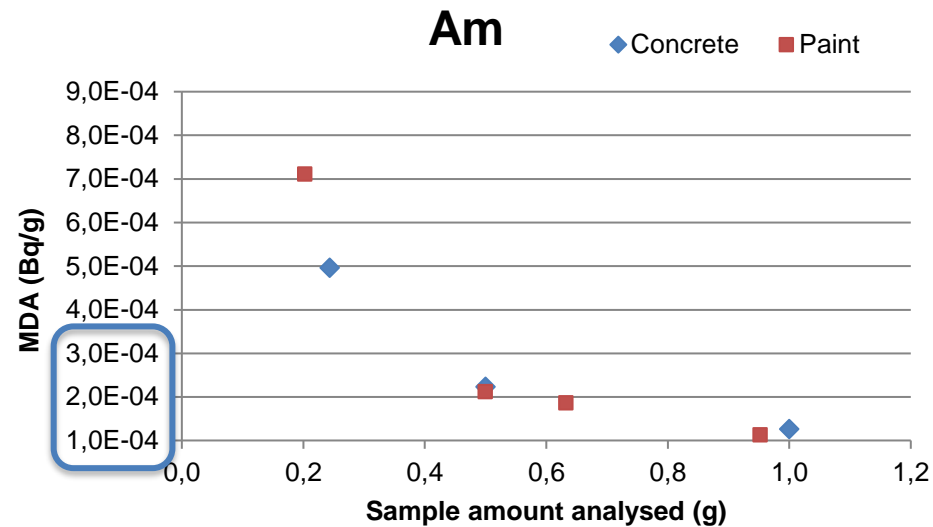
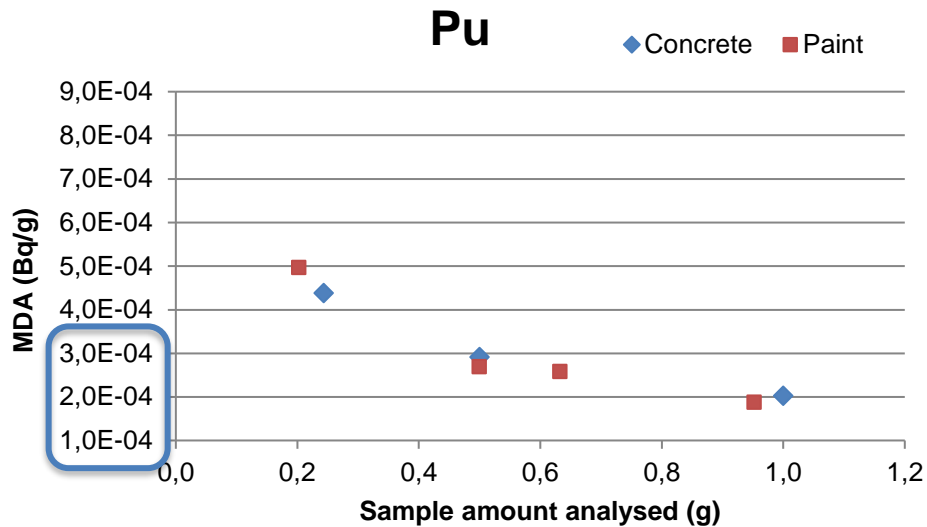
$\epsilon$  = efficiency

$Y$  = chemical yield

$m$  = sample amount

**Reliable quantification**

# Minimum Detectable Activity (MDA)



# Results – Sample amount optimization

## Concrete

< 0.3 g

Pu Yield  
(%)

99 ± 3

Am/Cm Yield  
(%)

90 ± 3

MDA  
(Bq/g)

4.06E-04 ± 1.1E-04

## Paint

0.5 g

Pu Yield  
(%)

68 ± 8

Am/Cm Yield  
(%)

99 ± 3

MDA  
(Bq/g)

2.17E-04 ± 9.8E-05

## Resin

1 g

Pu Yield  
(%)

70 ± 19

Am/Cm Yield  
(%)

90 ± 12

MDA  
(Bq/g)

1.37E-04 ± 5.8E-05

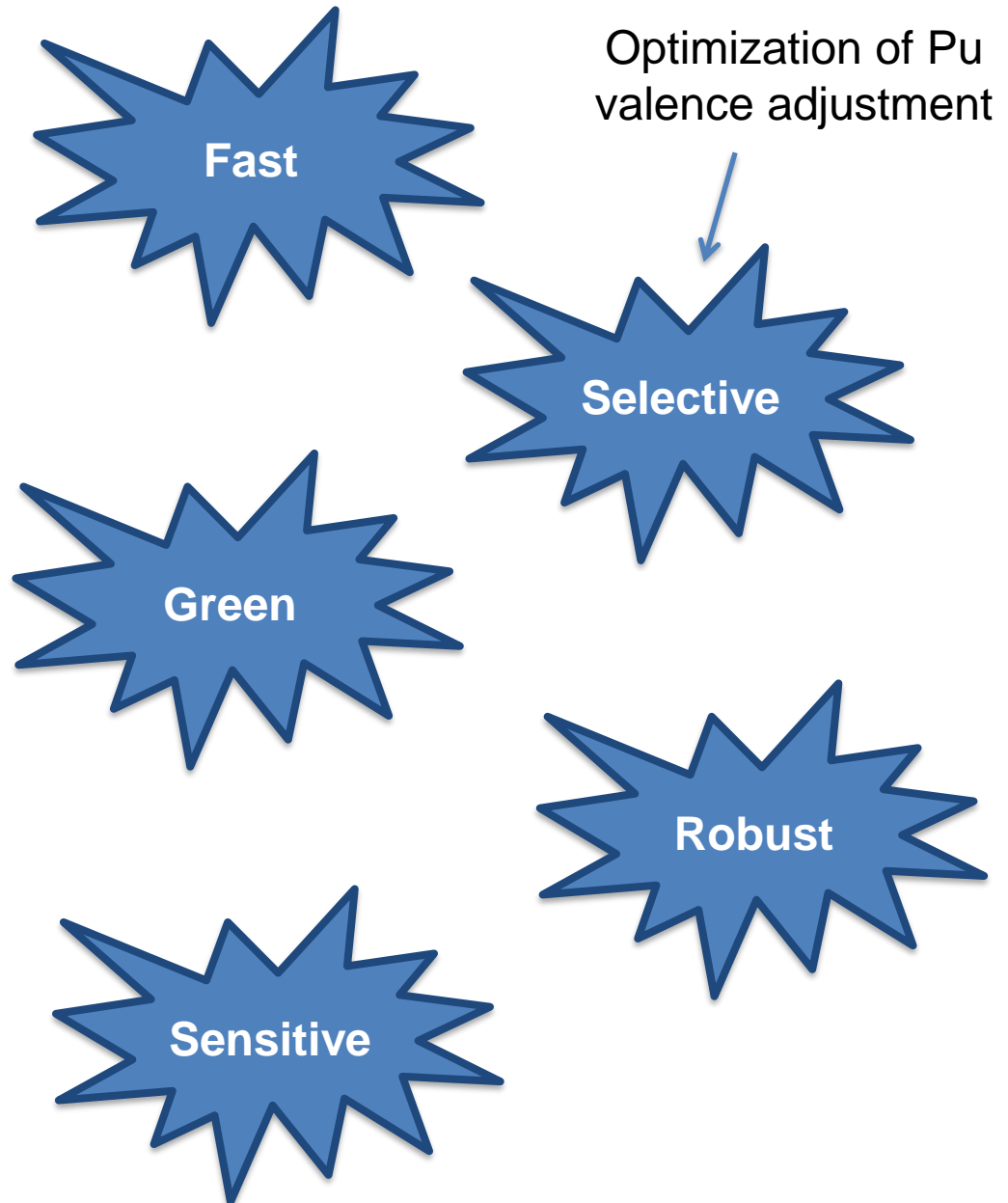


## Conclusions:

TEVA and DGA cartridges were successfully applied in sequence for the determination of Actinides in concrete, paint and resin samples deriving from the decommissioning of the Italian nuclear power plants.

## Conclusions:

- **Sequential separation**
- **Decontamination capacity**
- **Low volume of liquid waste**
- **Satisfactory performance up to 1 g of sample**
- **Reach very low MDA value**



Merci de votre attention

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