

NucfilmDisc

Heinz Surbeck

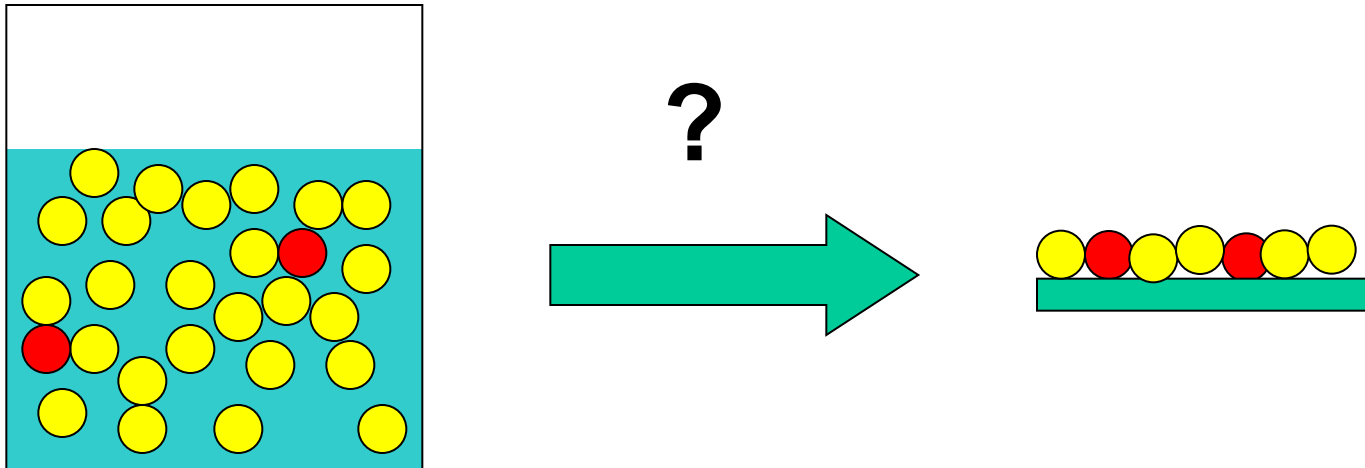
Nucfilm GmbH, Cordast, Switzerland

Steffen Happel

Triskem International



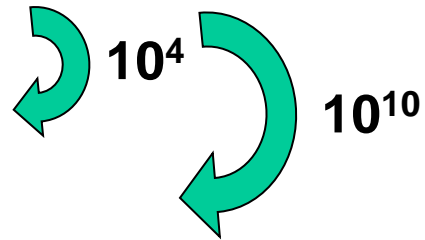
Main problem with alpha spectrometry : sample preparation

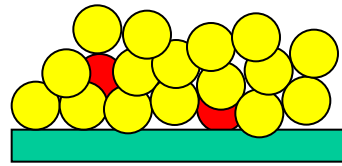
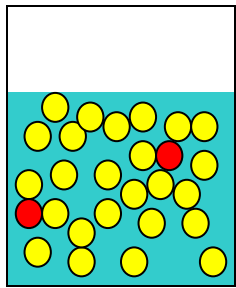


100 mg Ca : $N = 1.5 \times 10^{21}$

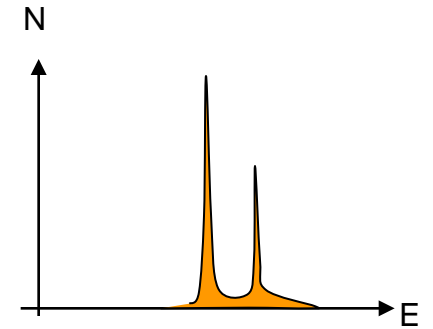
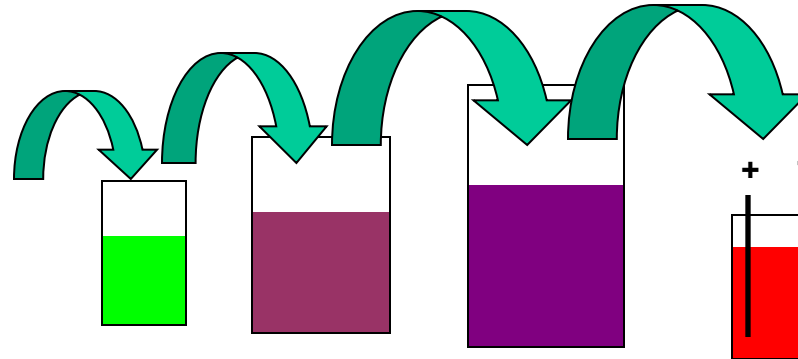
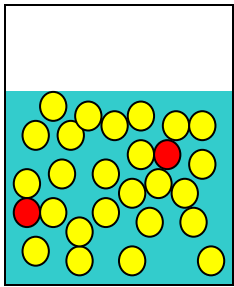
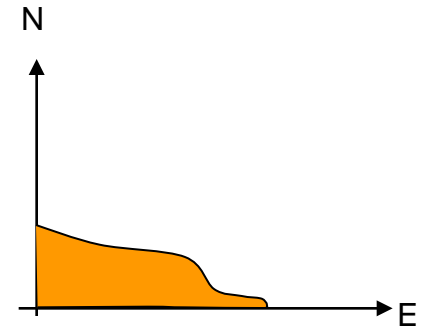
1 Bq ^{238}U : $N = 2.1 \times 10^{17}$

1 Bq ^{226}Ra : $N = 7.2 \times 10^{10}$

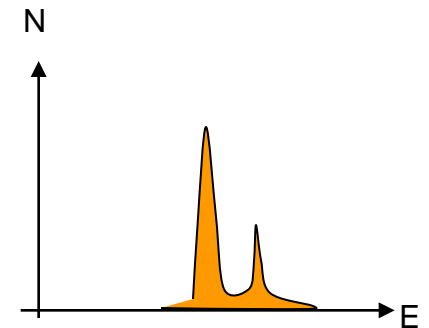
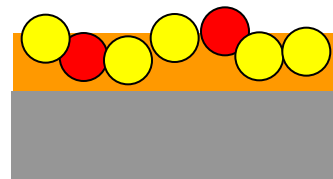
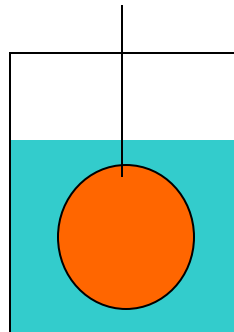
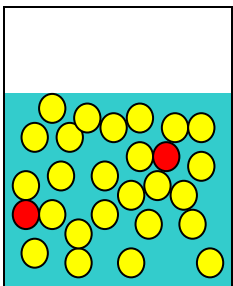




evaporation



Selective extraction and electrolytic deposition



Selective adsorption on thin film

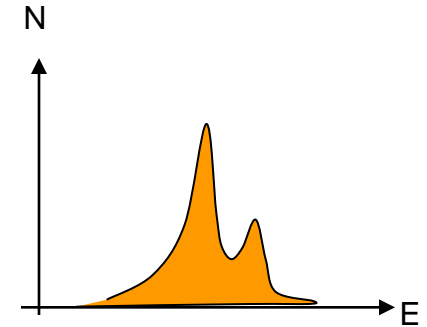
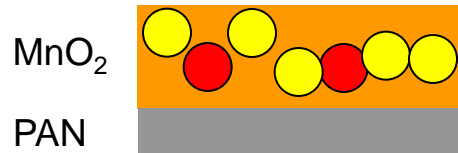
Moore and Reid, 1973

„... impregnation of acrylic fibres with Mn...“

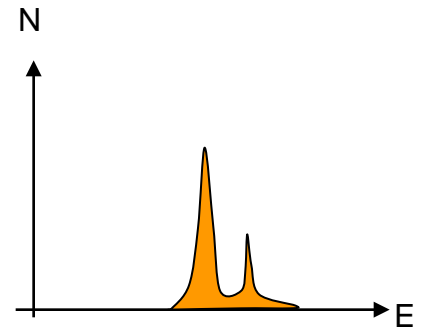
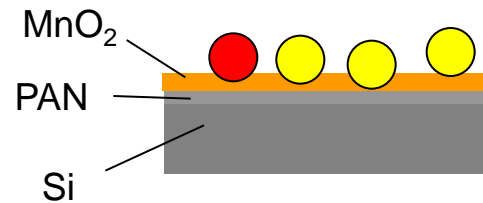
Bland 1979

„... nylon sheet can be treated with hot KMnO_4 solution...“

Glöbel and Berlich, 1983

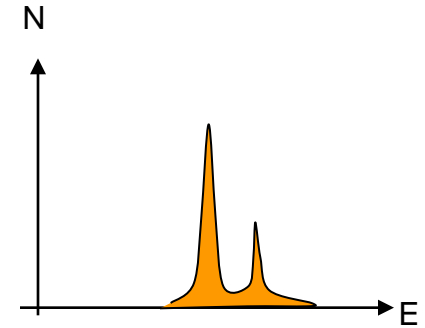
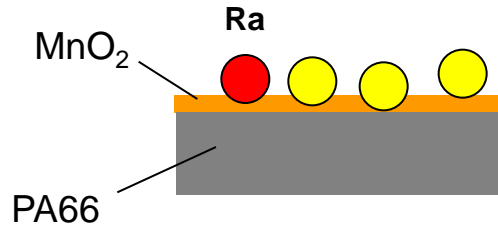


Deillon 1987

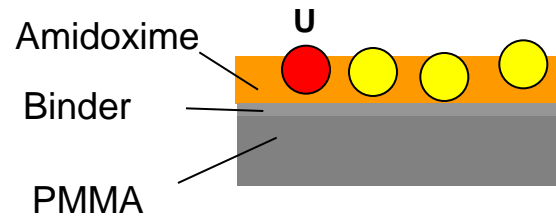
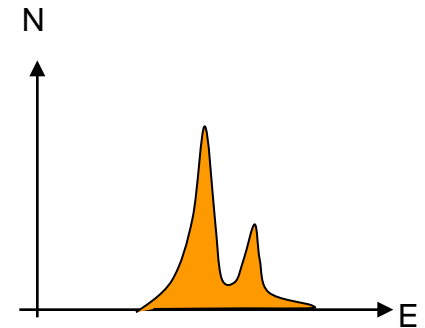
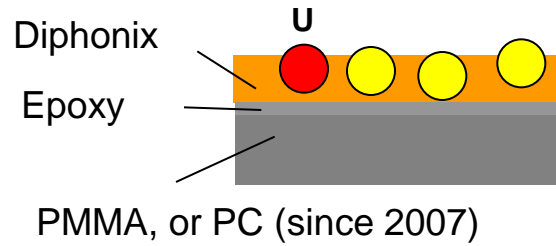


Surbeck et al., 1989

Surbeck 1995, 2000 ff

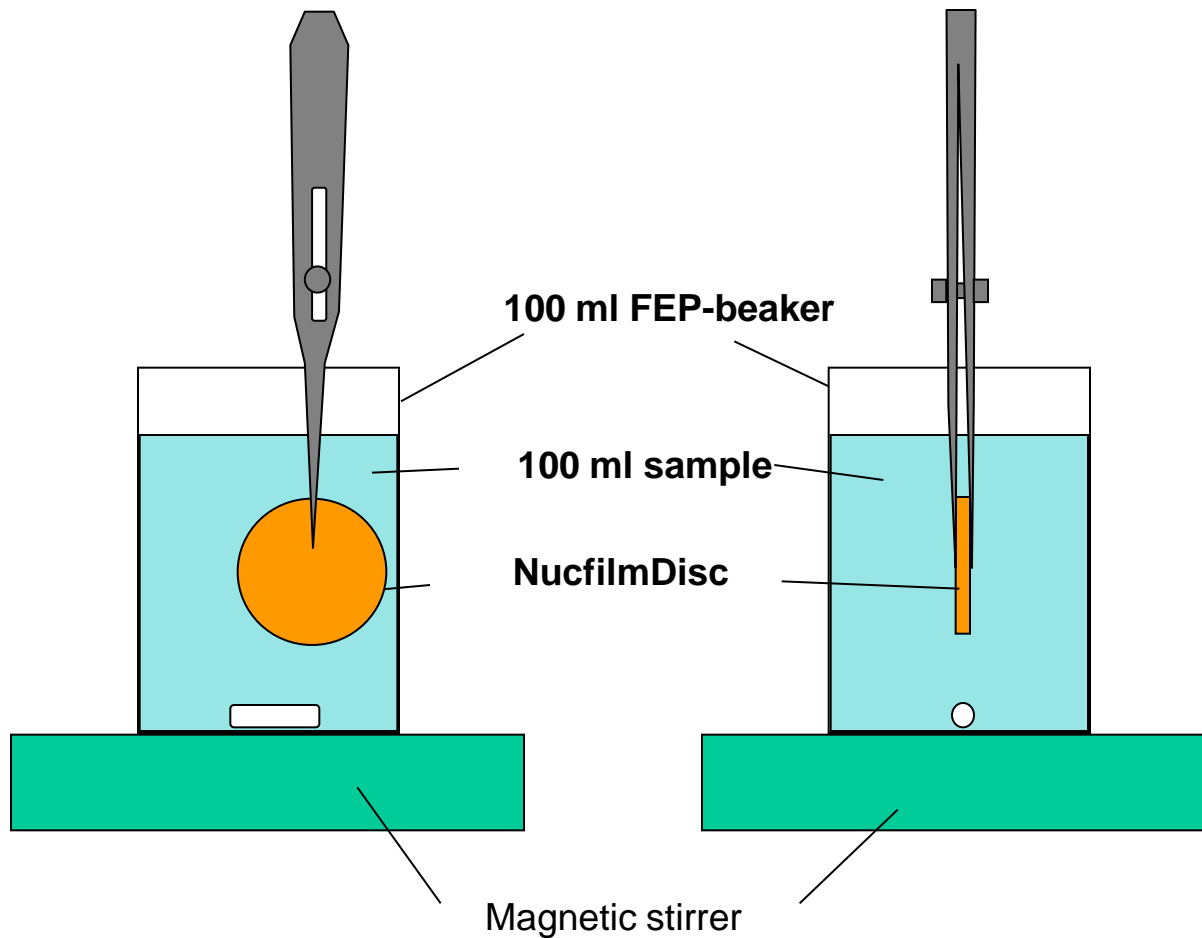


**CTI-Projekt, 1999-2001
(Tecost, EPFL, Surbeck)**

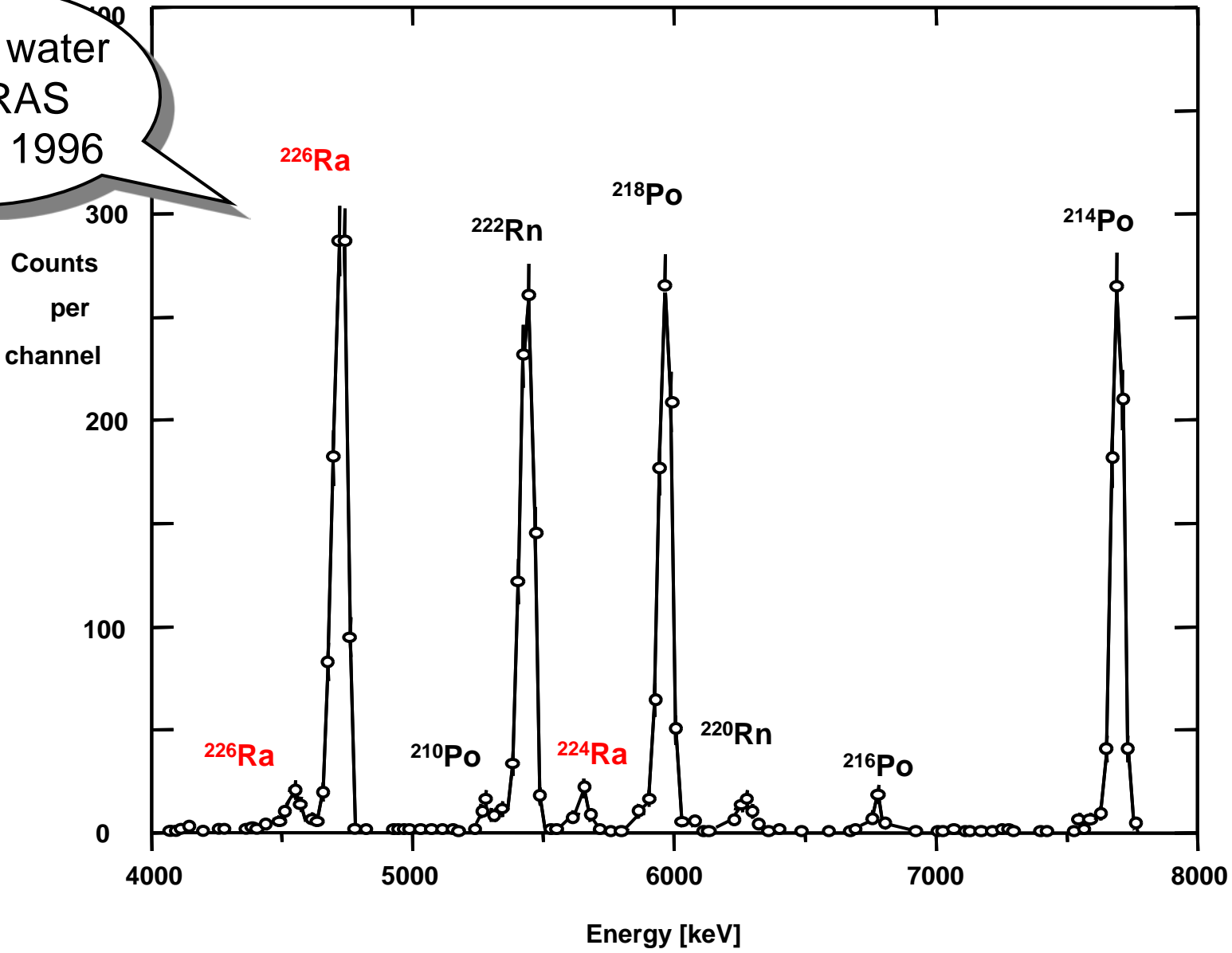


Ra : 6 h exp. @ pH 4-8 → 75 to > 90 % adsorbed, **depending on surface exposed** (single side / double side, diam 24 /26 mm)

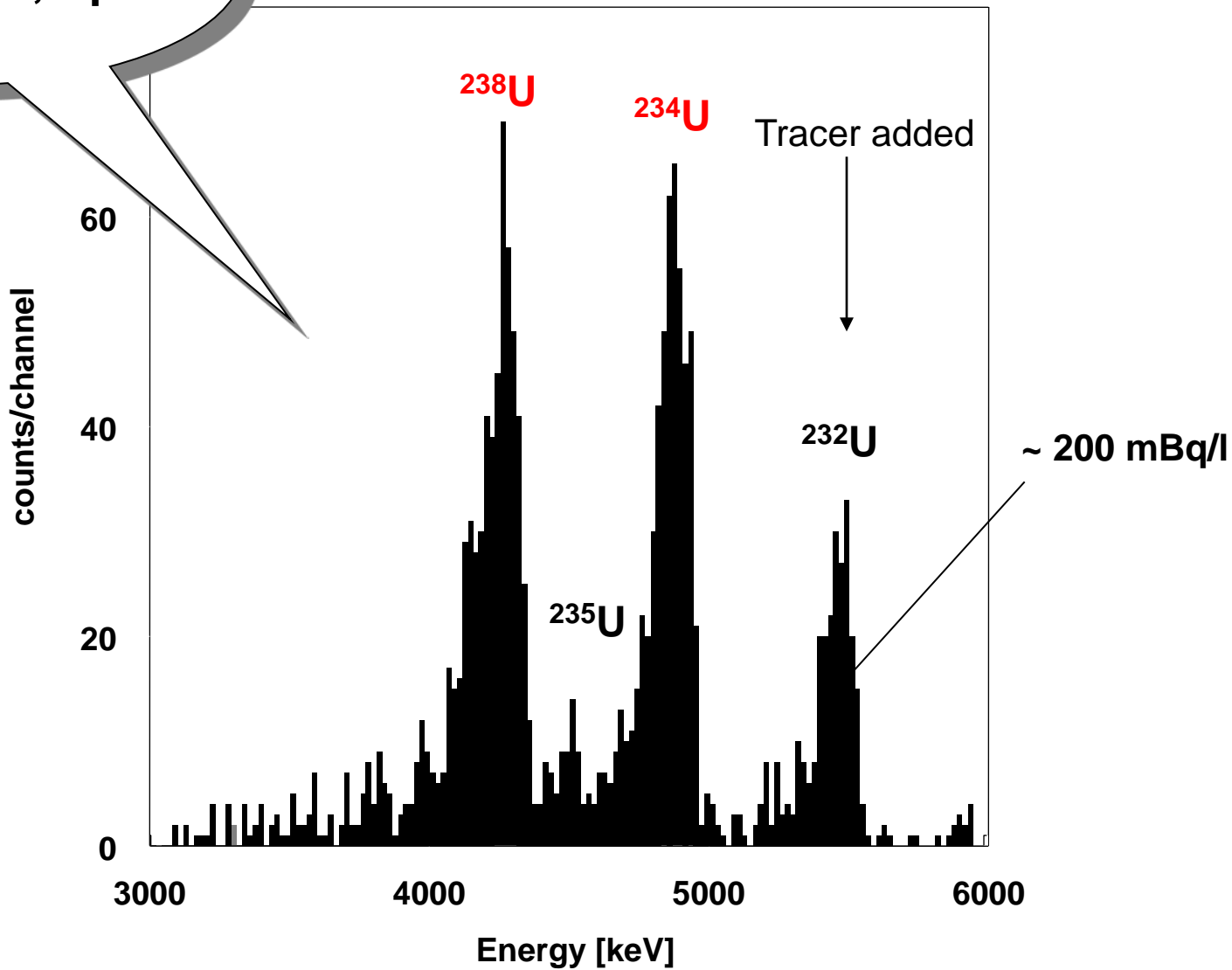
U : 20 h exp @ pH 2-3 → (90 +/- 10) % adsorbed



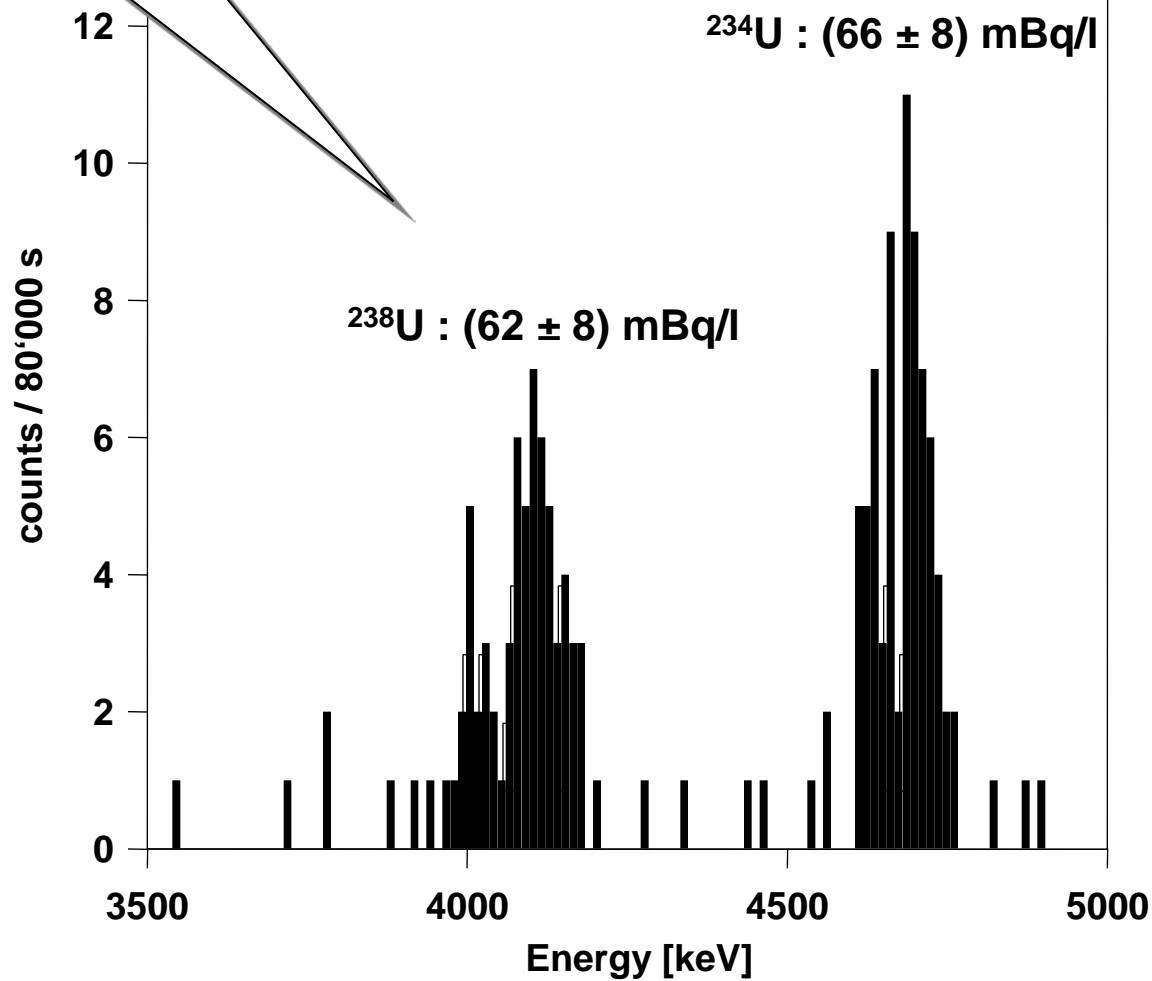
Mineral water
PEDRAS
vintage 1996



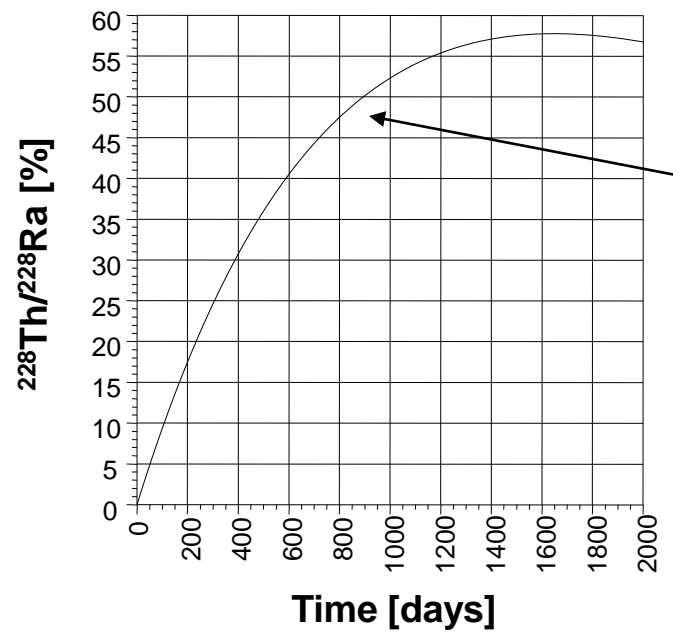
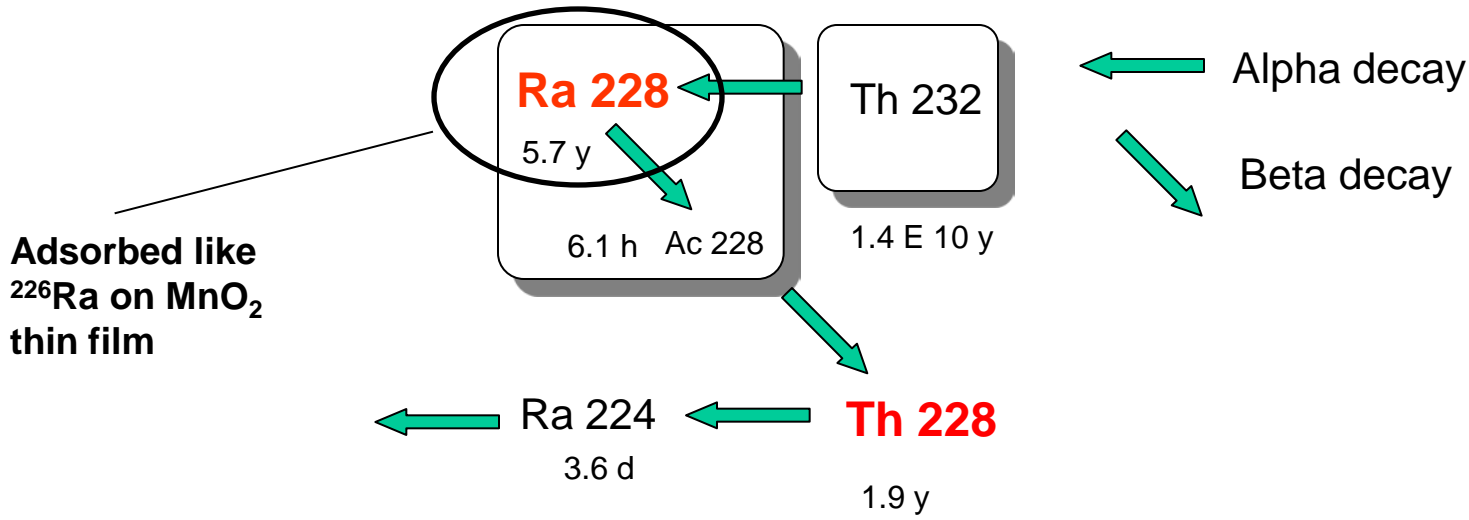
**Mineral water
« Ancienne », Aproz**



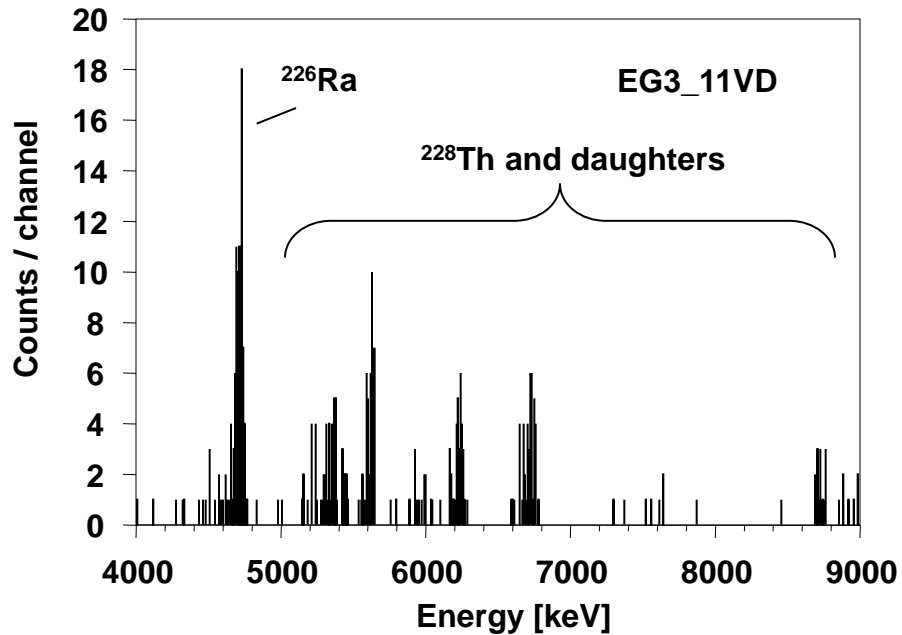
Seawater Cyprus



Second measurement of exposed Ra-NucfilmDisc to determine ^{228}Ra



^{228}Th buildup from ^{228}Ra , ~ 3 % / month
 Eikenberg et al. 2001

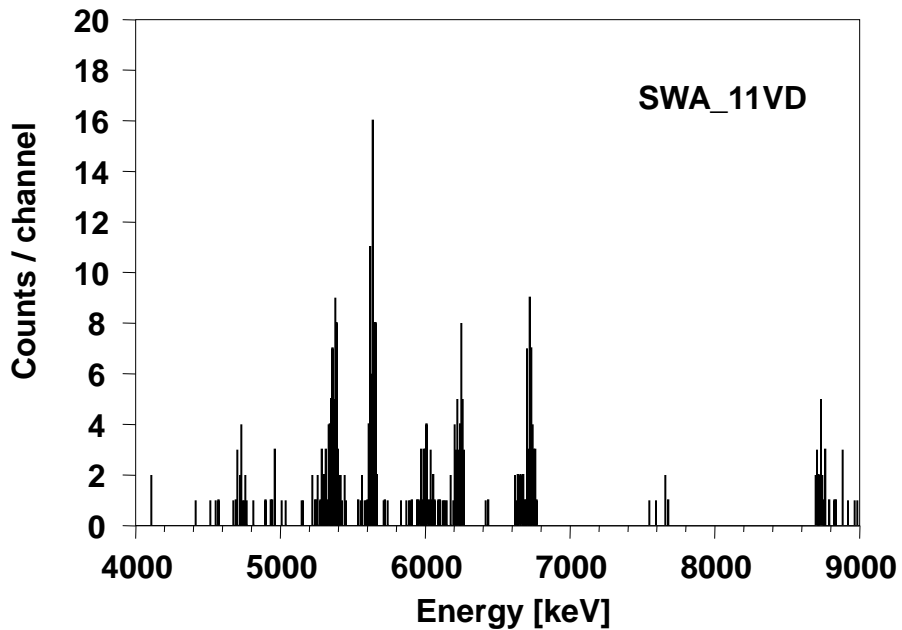


Alpha spectra for Ra-NucfilmDisc, measured approx. 2 years after exposition to radium rich mineral waters

EG3_11VD :

^{226}Ra : (90 ± 10) mBq/l,

^{228}Ra : (100 ± 10) mBq/l



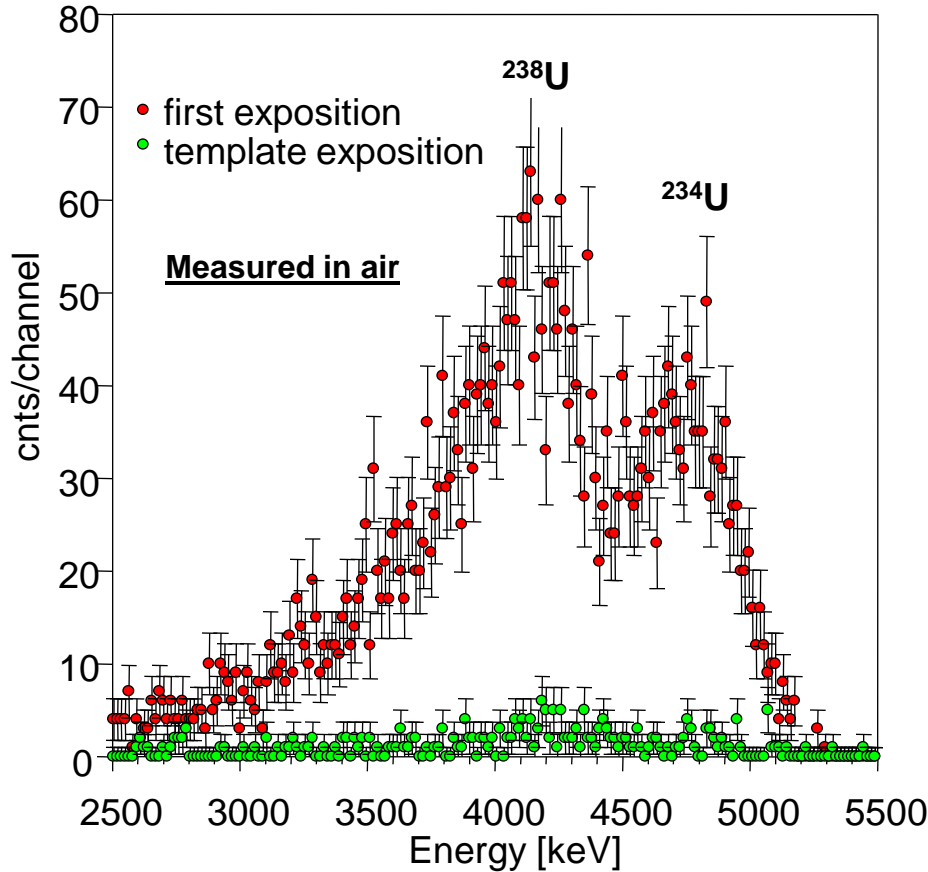
SWA_11VD :

^{226}Ra : (30 ± 10) mBq/l,

^{228}Ra : (160 ± 20) mBq/l

- **Ra-NucfilmDisc and U-NucfilmDisc have been developed and tested for water samples having drinking water quality, including mineral waters.**
- **For other samples like seawater and waste water it is highly recommended to determine adsorption efficiency individually.**
- **Spiked solutions, like intercomparison samples or standard solutions frequently contain high concentrations of inactive carriers that may saturate adsorption sites on the NucfilmDiscs.**
- **The worst case is barium blocking radium adsorption on the Ra-NucfilmDisc. Thus **avoid barium concentrations above 0.1 mg /l** in the final solution to be measured.**
- **The most reliable method to determine adsorption efficiency is by template exposition. The adsorption process is first order so every NucfilmDisc exposed will adsorb the same fraction of the activity remaining in the sample.**

Adsorption efficiency for U-NucfilmDisc, determined by template exposition



Alpha spectra measured in air

Sample : 100 ml spring water "Source Poisson, Saxon" ,
 $^{238}\text{U} + ^{234}\text{U}$: ~ 3.8 Bq/l,
+ 0.5 ml formic acid conc. (85%) --> pH ~ 2

Adsorbing discs used :
U-NucfilmDisc, prod. December 09, diam. 24 mm

Exposition time : 20 h per disc

Measured with 400 mm² Si-detector at sample detector
distance of 7.5 mm

Acquisition time : 80'000 s per disc

First exposition : 53.65 cnts/ks (ROI 2'500 keV to 5'500 keV)
Template exposition : 2.72 cnts/ks (ROI 2'500 keV to 5'500 keV)
Background : 0.13 cnts/ks (ROI 2'500 keV to 5'500 keV)

--> adsorption efficiency : (95 +/- 1) %

Ra-226 determination via MnO₂ discs

project french norm (Ra-226 in water), COFRAC accredited

- Sample volume 50 to 100 mL (filtered water, acidified to pH = 0,5 – 2)
- Addition of Ba-133 (10 to 100 Bq) as internal standard
 - **Problem: Ba content of the sample has to remain below 10µg!**
- Addition of EDTA to complex potential interferents



- Adjustment of pH to 7 - 8,5 with NaOH and addition of NaHCO₃ as buffer
- Measurement of the initial Ba-133 activity in the solution via gamma spec



- Place MnO₂ disque in sample container
- Stir sample for 10 h



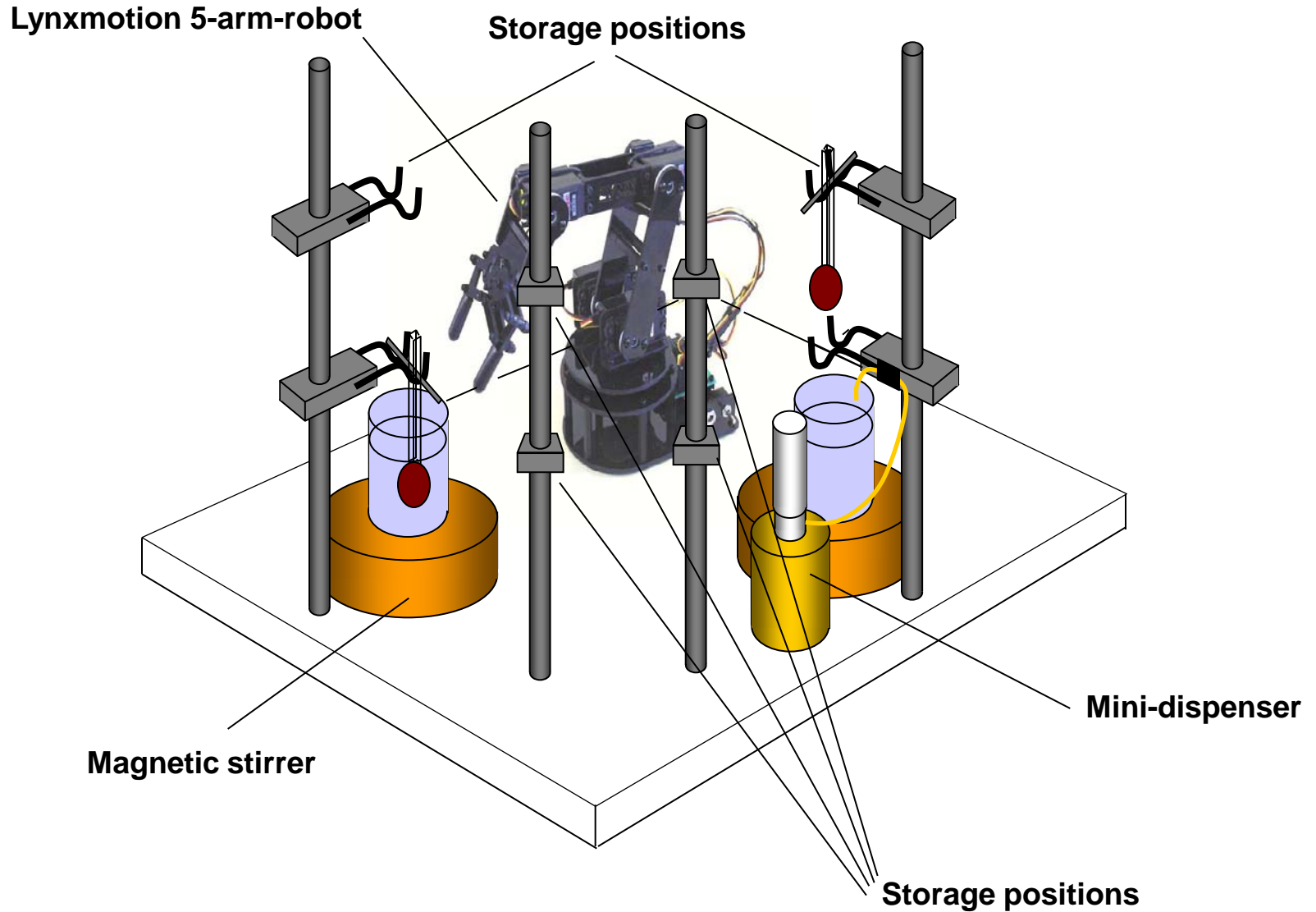
- Remove MnO₂ disque from the sample, rinse and dry
- Measure Ba-133 activity in the solution after extraction via gamma spec



- Count disque on alpha spectrometer

➤ LDs obtained in the order of 5 - 10 mBq/L for 50 to 100 mL samples and counting times between 24 and 48 hours

Automation is easy, even a small robot can do the whole exposition process





Lax, Valais,
Switzerland

1 Bq/l ($^{238}\text{U} + ^{234}\text{U}$)

- Publications from Belgian and Norwegian groups (oil industry and phosphogypsum monitoring) on use of RaNucFilm disc based DGT
- U NucFilm discs?