

How to use U-NucfilmDiscs (V301209)

General Remarks

The discs have been developed to analyze drinking water samples. With some precaution they can also be used to analyze other water samples. For samples other than drinking water, adsorption efficiency should be verified by exposing a second disc to the same sample (template exposition, Fig.3) or by spiking with ^{232}U . For a 100 ml sample and when measuring 1 day a detection limit of around 5 mBq/l can be expected. Adsorption process is first order so every template exposition will adsorb the same fraction of the uranium present in the sample. There is no known restriction for seawater samples.

What the discs are made of and how they work

A 1 mm thick polycarbonate (PC) substrate, dia. 24 mm, is covered with epoxy resin fixing a finely ground ion exchange resin (Diphonix®). Uranium is adsorbed very close to the surface, within about a 1 μm . Diphonix®'s active groups (diphosphonic acid) adsorb actinides very selectively. Adsorption works best at a low pH. Lowering pH below 3 also guarantees that uranyl- CO_2 complexes are broken up. For an adsorption efficiency > 90% the disc's surface should be at least 4 cm^2 / 100 ml sample volume.

Shelf live of the discs is at least 1 year. They can be disposed of as non-toxic waste (domestic waste). One U-NucfilmDisc contains approx. 0.6 g polycarbonate, approx. 50 mg fully polymerized epoxy resin and approx. 50 mg Diphonix®.

Pretreatment of the discs

Prior to use the discs should be rinsed with deionized water.

Sample pretreatment

Add 0.5 ml of concentrated (85%) formic acid/100 ml sample to bring the pH to 2 to 3. The sample can be spiked with ^{232}U if there are doubts about adsorption efficiency. Stirr the sample until most of the CO_2 bubbles have disappeared, if there are any.

Diphonix® is a registered brand name of Eichrom, Darien, IL, USA

Exposition

The discs are exposed for 20 h to the stirred (approx. 200 rpm) 100 ml sample (see Fig.1). After 20 h > 90% of the uranium activity present in the sample is adsorbed. A longer exposition time does not result in a higher adsorption efficiency.

Post-exposition handling

Don't rinse the discs, just let them dry. Drying can be accelerated by gently blowing warm air from a hair drier over the surface. Don't use hot air.

Measure by alpha spectrometry for approx. 1 day. Recommended distance to detector surface is 10 mm or more to avoid a too large change in counting efficiency when the disc is not perfectly centered. Figures 2 and 3 show sample spectra. Figure 3 gives an example how adsorption efficiency can be determined by template exposition

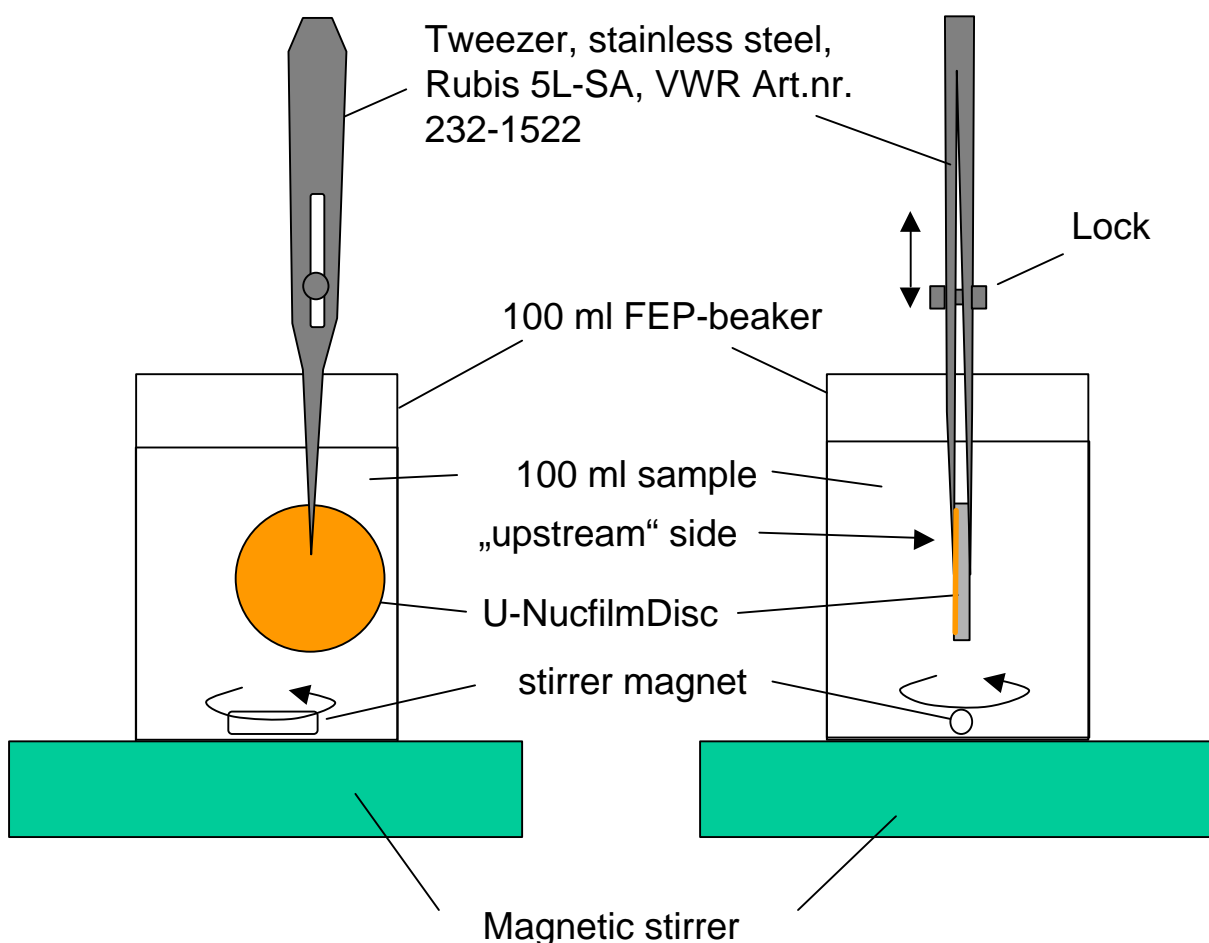


Fig 1 : how to fix the discs

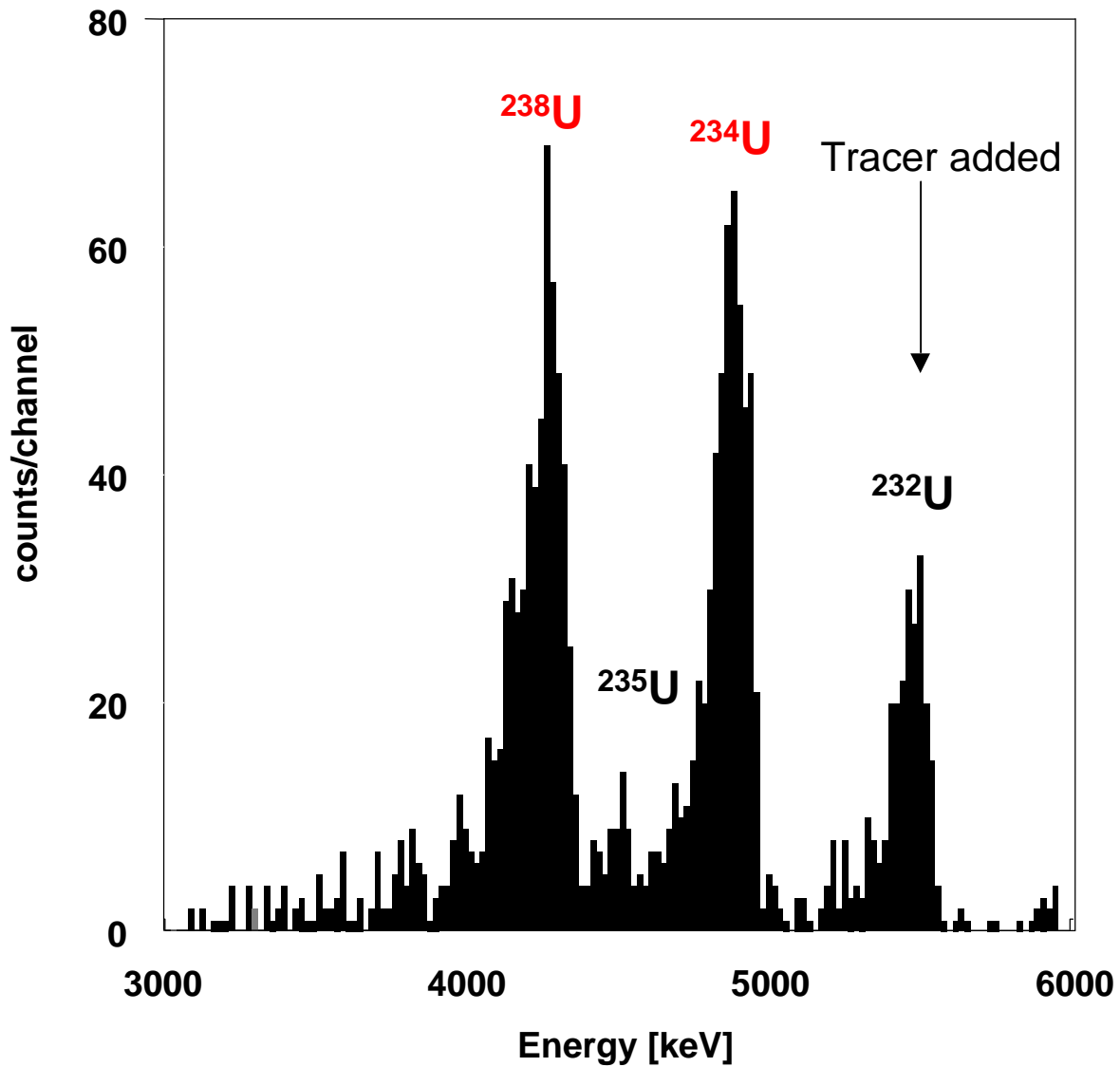


Fig 2 : Alpha spectrum for a mineral water sample („Aproz Ancienne“, Valais, Switzerland). Prepared as discribed above and measured with a 900 mm² Si-detector at a distance of approx. 11 mm, in vacuum. Acquisition time : 80'000 s. The tracer's activity is 200 mBq/l.

**Adsorption efficiency for U-NucfilmDisc, prod. December 2009,
determined by template exposition**

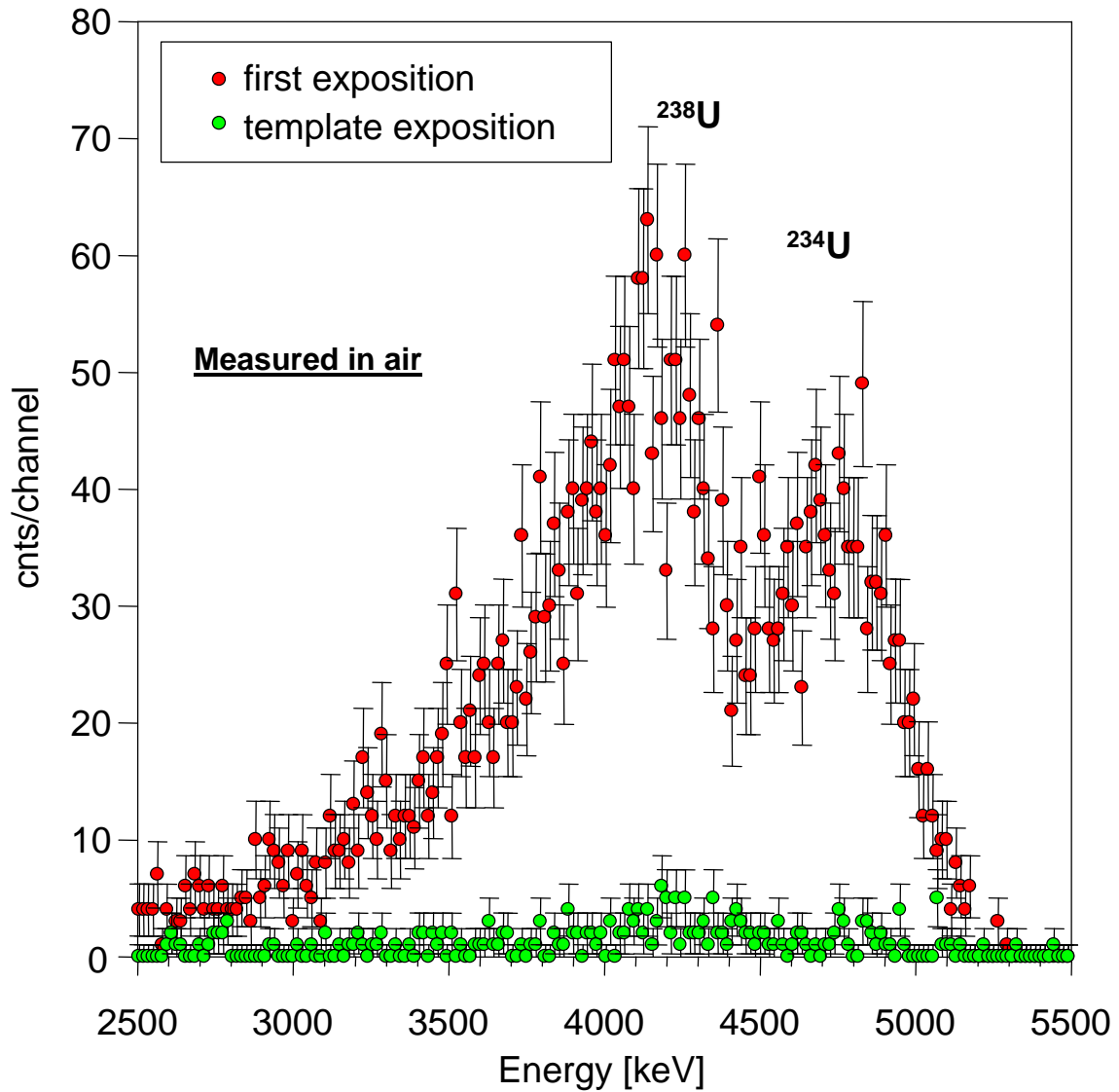


Fig. 3 : Alpha spectra measured in air

Sample : 100 ml spring water "Source Poisson, Saxon" , ²³⁸U + ²³⁴U : ~ 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) %