

How to use Ra-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, as long as the pH is above 4 and the barium concentration below 0.5 mg/l. For a 100 ml sample and when measuring for 1 day a detection limit of around 5 mBq/l can be expected. For samples other than drinking water, adsorption efficiency should be verified by exposing a second disc to the same sample (template exposition) or by repeating the analysis by adding a known amount of ^{226}Ra . Adsorption process is first order so every template exposition will adsorb the same fraction of the radium present in the sample. There is no known restriction for seawater samples. **When using radium standards make sure the barium concentration in the final solution is < 0.5 mg/l.**

A second measurement of the discs, after some months (ingrowth of ^{228}Ra daughter products) allows for a ^{228}Ra determination. ^{228}Th grows in at a rate of about 3% per month.

What the discs are made of and how they work

A 1.5 mm thick polyamide 66 substrate is stained with „ MnO_2 “ by exposing it to a hot KMnO_4 solution. The exact composition of the „ MnO_2 “ layer is not known. In contact with water it works as a highly selective cation exchanger for heavy alkaline-earth ions. Radium is adsorbed very close to the surface, within less than 1 μm . Po and Pb are efficiently adsorbed too. In the absence of CO_2 the uranyl ion will also be adsorbed. In the presence of CO_2 (HCO_3^- -concentration > 100 mg/l) neutral or negatively charged uranyl- CO_2 complexes form, that are not or only slightly adsorbed.

For an adsorption efficiency > 90% the disc's surface should be at least 4 cm^2 / 100 ml sample volume. Standard Ra-NucfilmDiscs are delivered with one side covered with a writable plastic foil. If needed this foil can be removed to expose both sides (clean side with alcohol). This gives maximum adsorption efficiency.

Shelf life of the MnO_2 stained discs is at least 3 years. They can be disposed of as non-toxic waste (domestic waste). One Ra-NucfilmDisc contains approx. 1 g polyamide-66, approx. 10 mg manganese oxide and approx. 50 mg PVC (back foil, can be removed).

Pretreatment of the discs

Prior to use the discs should be rinsed with deionized water and gently wiped with a soft tissue („Kleenex“-type)

Sample pretreatment

In general there is no need for any pretreatment. For highly mineralized samples (> 1 g /l) with a high CO_2 concentration (sparkling mineral waters) an addition of

approx. 200 mg/l $\text{Na}_2\text{-EDTA}$ is recommended to avoid carbonate precipitation. For very low mineralized waters (conductivity < 50 $\mu\text{S/cm}$) at least 100 mg/l NaHCO_3 should be added to complex possibly present uranyl ions.

Exposition

The discs are exposed for 6 h to the stirred (approx. 200 rpm) 100 ml sample (see Fig.1). After 6 h > 90% of the radium activity present in the sample are adsorbed. A longer exposition time does not result in a higher adsorption efficiency.

Post-exposition handling

Drying can be accelerated by blowing warm air from a hair drier over the surface. Don't use hot air.

Measure one (when back side has been covered by foil during exposition) or both sides 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 flat or not perfectly centred. Figure 2 shows a sample spectrum.

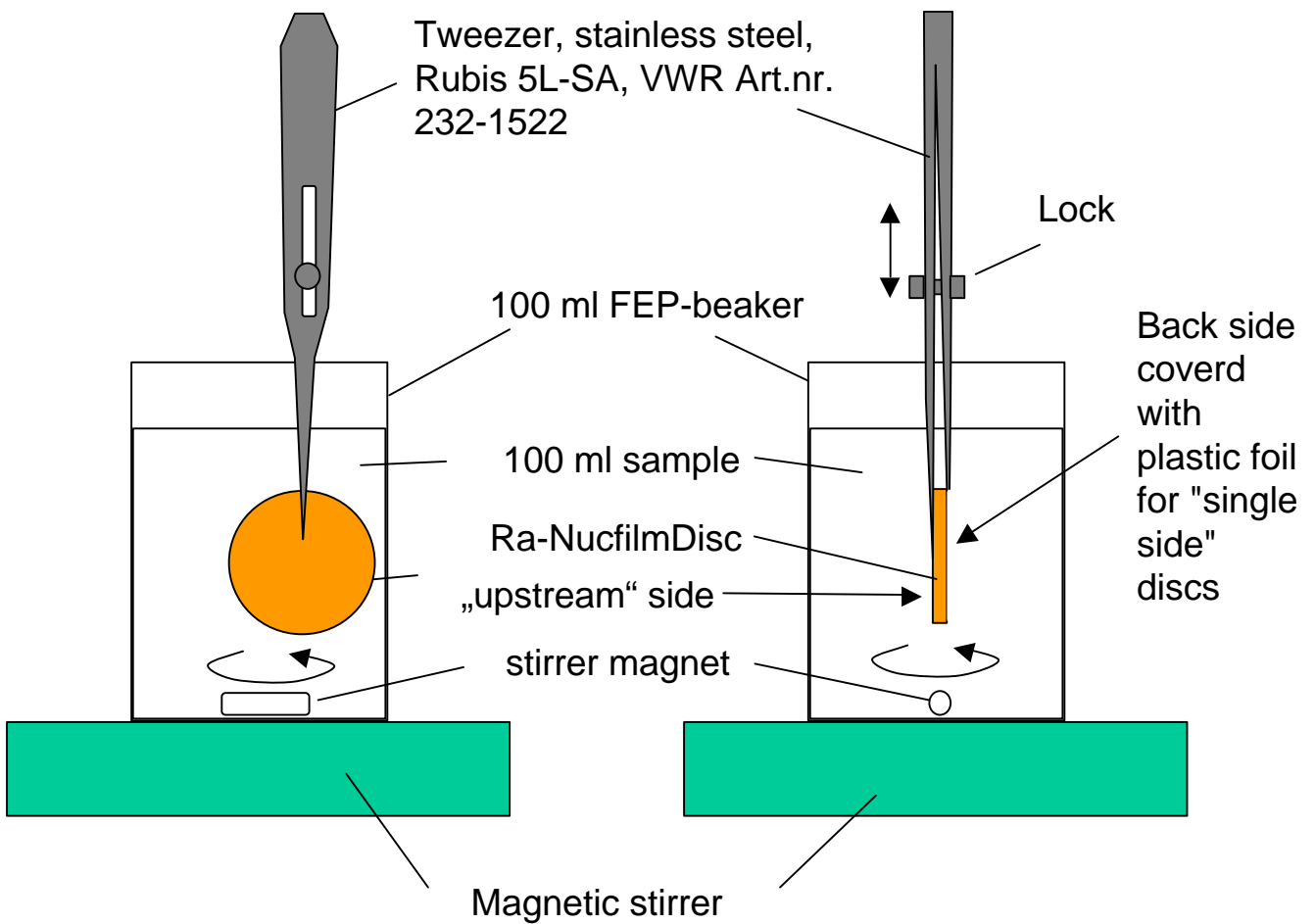


Fig 1 : how to fix the discs

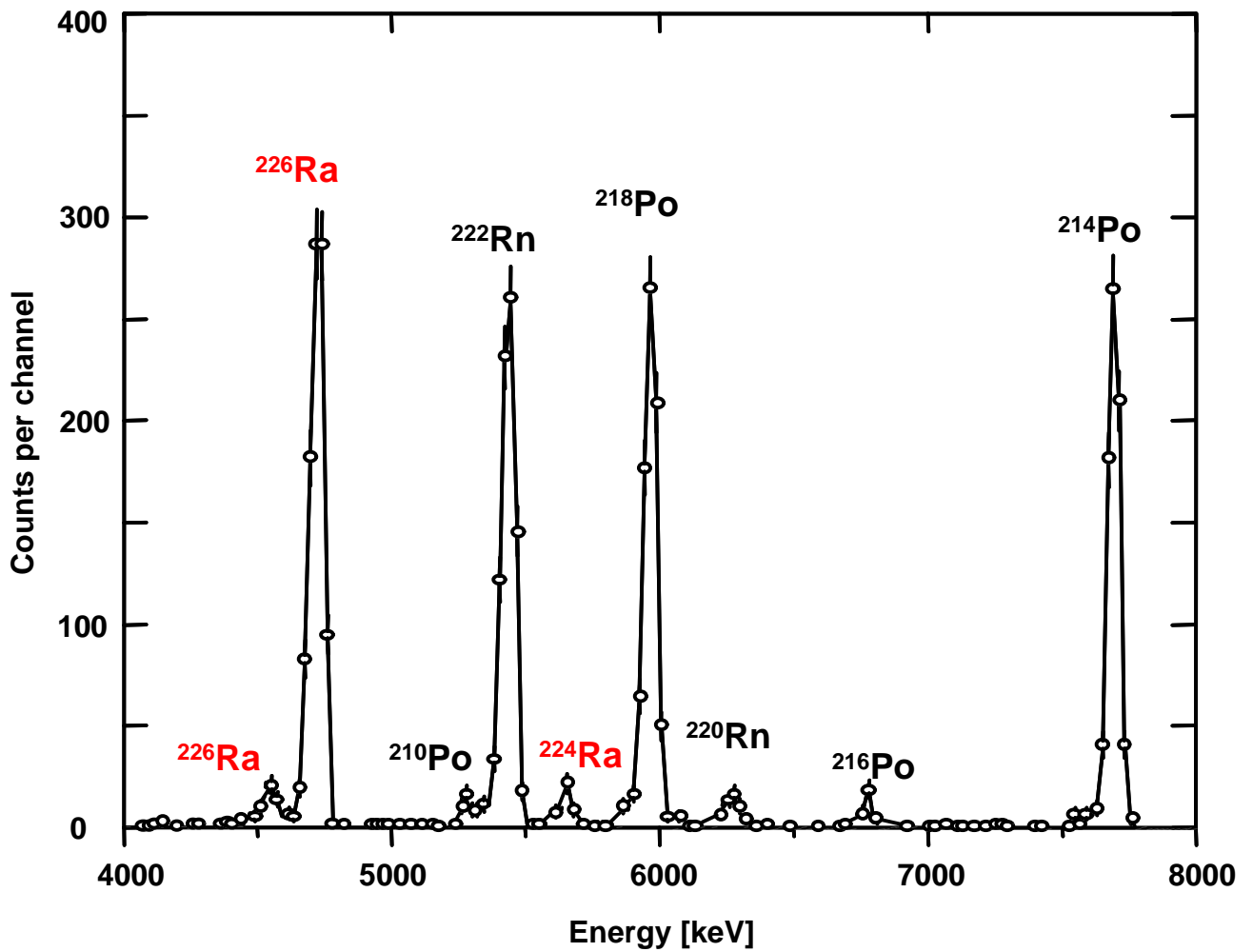


Fig 2 : Alpha spectrum for a mineral water sample („Pedras Salgadas“, Portugal, vintage 1996). Prepared as described above and measured with a 900 mm² Si-detector at a distance of approx. 11 mm. Acquisition time : 80'000 s. The radium activity in the sample is ~ 1'200 mBq/l.