

News Triskem International

Raddec-Triskem International Technical Workshop, 18th April 2024



Overview

New Resins

- TK-ELScint: TK-SrScint and TK-TcScint
- TK102
- TK221
- TK225

Under development

- Ra separation
- Extractive membranes – gross alpha discs
- Cs resins
- « Industrial » resins

Other projects



Triskem International



- Based in Rennes (France)
- Independent company since 02/07
 - Formerly part of Eichrom Europe
 - ISO 9001 since 2007
- Main products: extraction chromatographic resins
- Staff : 22
- R&D, QC and TechSupport group:
 - 5 RadChem PhD, 3 Technicians
- R&D: Development of new resins, techniques and applications
- Products used in several domains

Radiopharmacy
and
Nuclear Medicine

Environment and
Bioassay

Geochemistry
and
Metals Separation

Decommissioning



TK-EIscint Resins



UNIVERSITAT DE
BARCELONA

Technology developed by the University of Barcelona (García, Tarancón, Bagán, Gimenez)

« TK-EIscint » product line

TK-TcScint for measurement of Tc-99 but also Cl-36, I-129... => last presentation today by Ines Llopart

The next resin commercially available coming TK-SrScint for Sr-90 => presentation during the LSC meeting and more to be presented by Alex Tarancon during this workshop



TK102 Resin

- Modified version of SR Resin
 - Same crown-ether
 - Solvent, inert support and ratios => different
 - Solvent is a fluorinated alcohol
- Distribution coefficient K_d ~50% higher (Pb, Sr, Ba)
- Higher capacity (Pb and Sr)
- SR resin separation procedure can be transposed on TK102
- Specific separating methods under development



TK102 Resin – K_d values

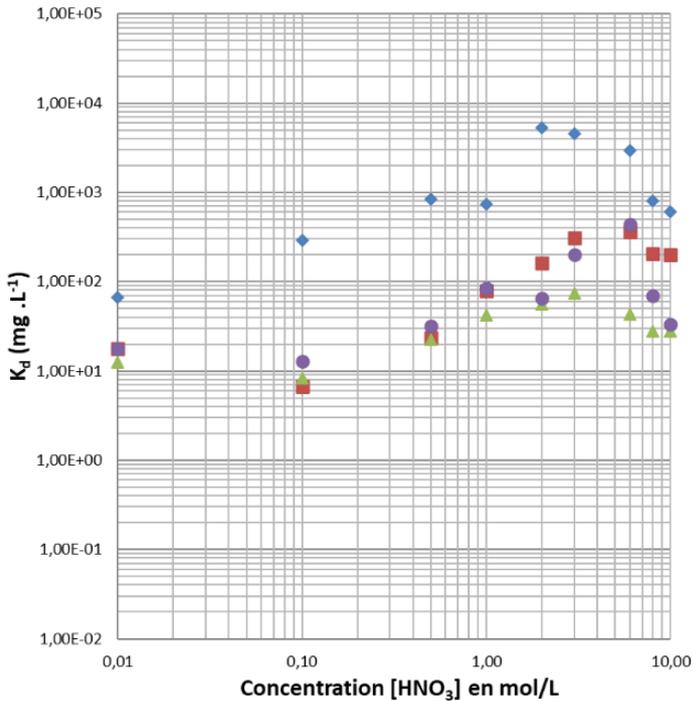


Fig. 1: Distribution coefficients of selected elements on TK102 Resin in HNO₃
 ▶ Sr, Ba, Pb and Tl show high D_w in HNO₃

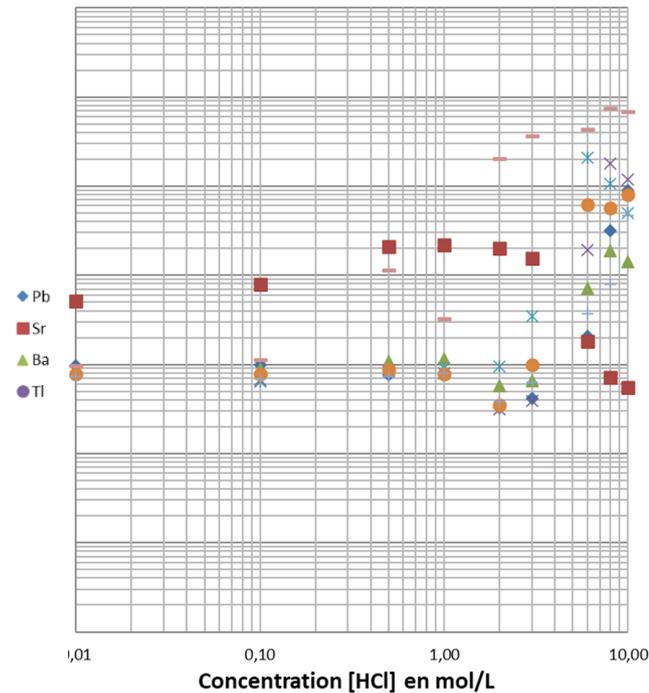


Fig. 2: Distribution coefficients of selected elements on TK102 Resin in HCl
 ▶ Pb, Tl, Sn, Sb, Ga show high D_w in HCl

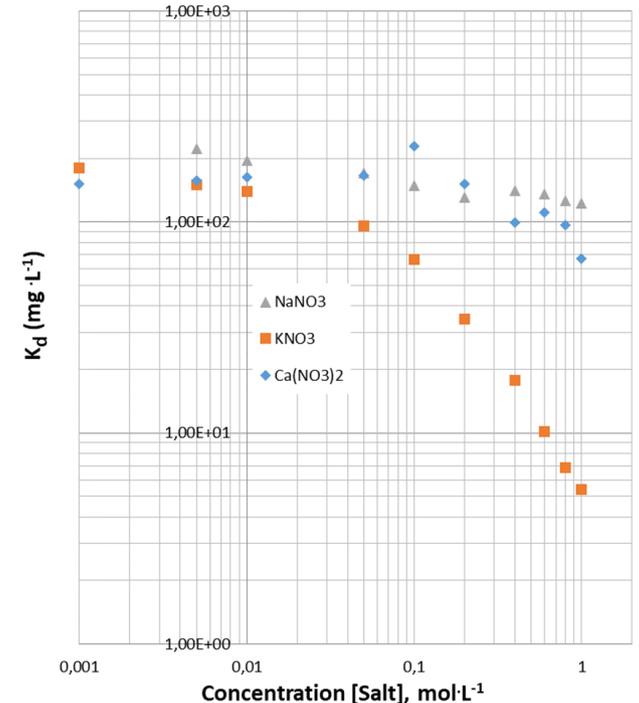
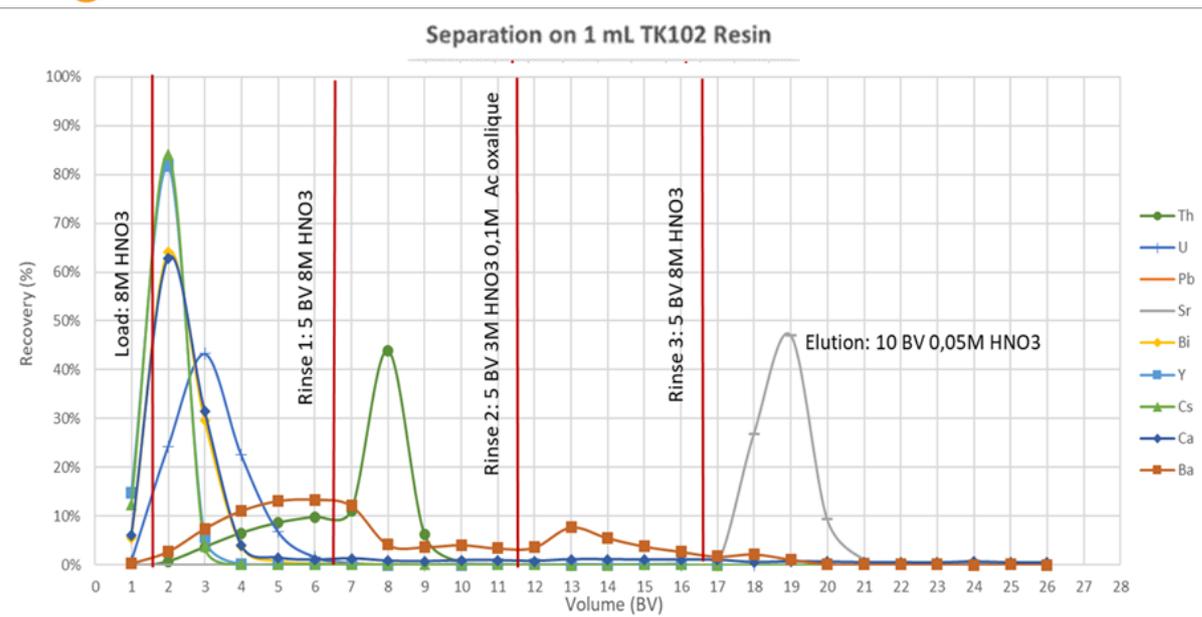


Fig. 3: Distribution coefficients of Sr on TK102 Resin in 3 M HNO₃ in the presence of different salts
 ▶ D_w Sr decreases with KNO₃ starting at 0,05 M,
 ▶ no effect of NaNO₃ and Ca(NO₃)₂ up to 1 M.



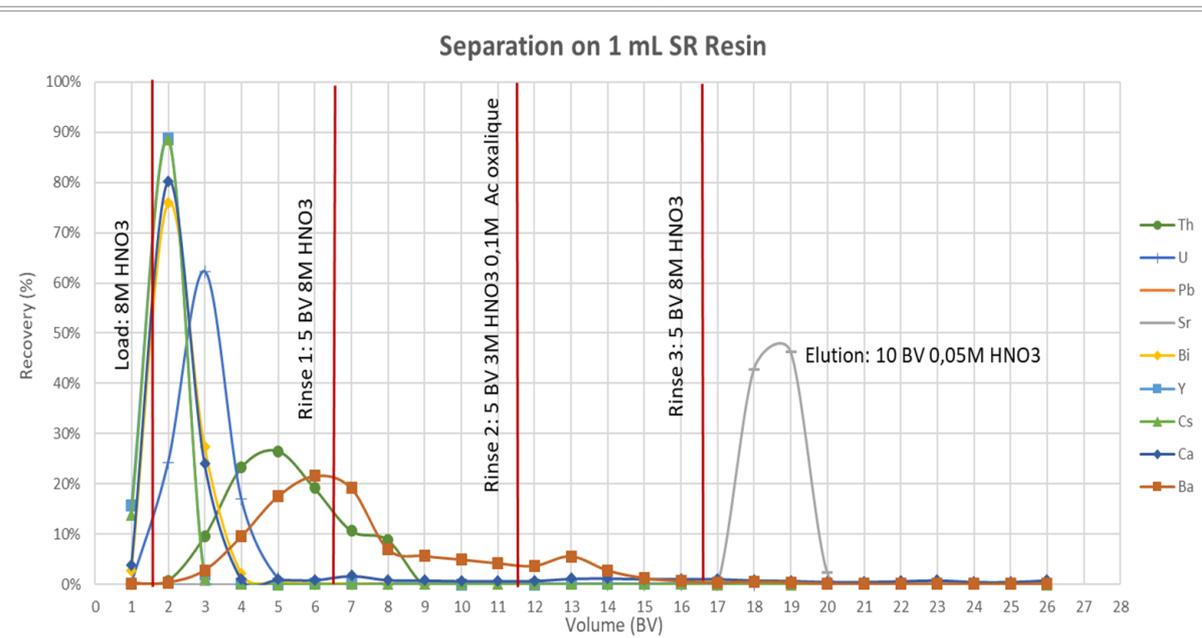
TK102 Resin – Sr separation



Sr elution study in
8M HNO₃ load medium

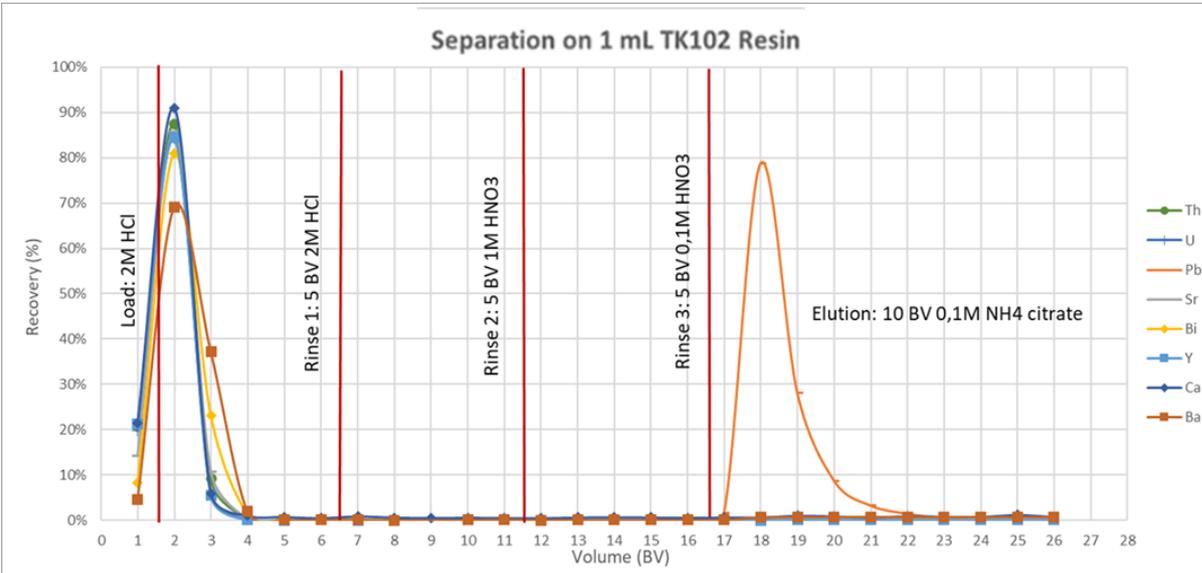
Resins TK102 and SR
similar for the separation
of elements

Th/U/Pb/Sr/Ca/Bi/Y/Ca/Ba



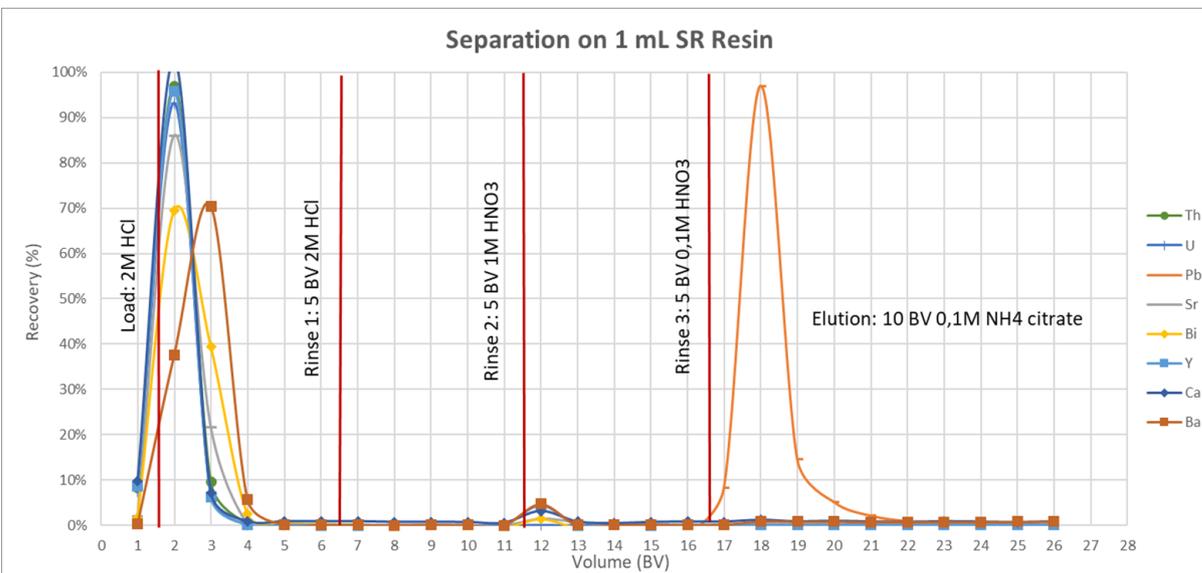


TK102 Resin – Pb separation



Pb elution study with 2M HCl loading medium

Resins TK102 and SR **similar** for the separation of elements Th/U/Pb/Sr/Ca/Bi/Y/Ca/Ba





TK221 Resin

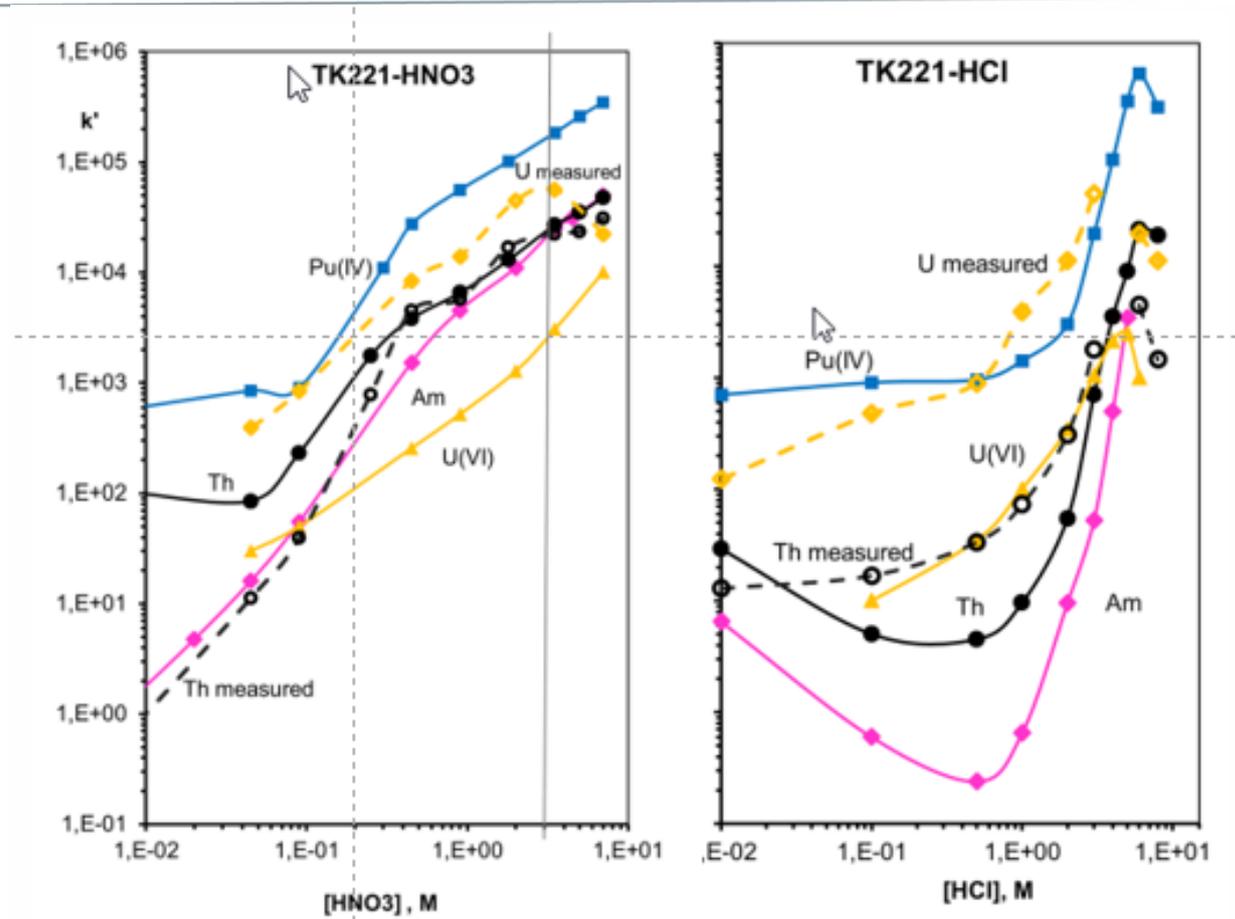
(Papp, I., Vajda, N. & Happel, S.. *J Radioanal Nucl Chem* **331**, 3835–3846 (2022).

<https://doi.org/10.1007/s10967-022-08389-9>)

Resin based on a mixture of diglycolamide and phosphine oxide + traces long chained alcohol on inert support

Main applications in radpharm

Applications for the separation of actinides





TK221 Resin

(Papp, I., Vajda, N. & Happel, S.. *J Radioanal Nucl Chem* **331**, 3835–3846 (2022).
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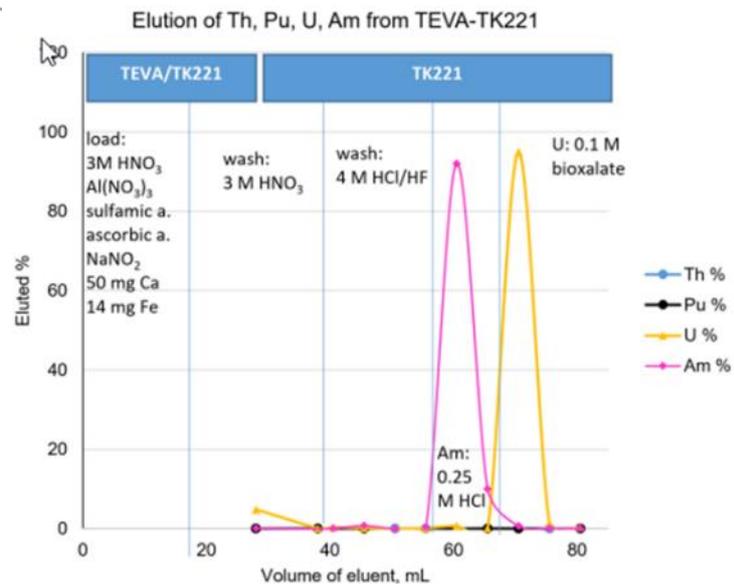
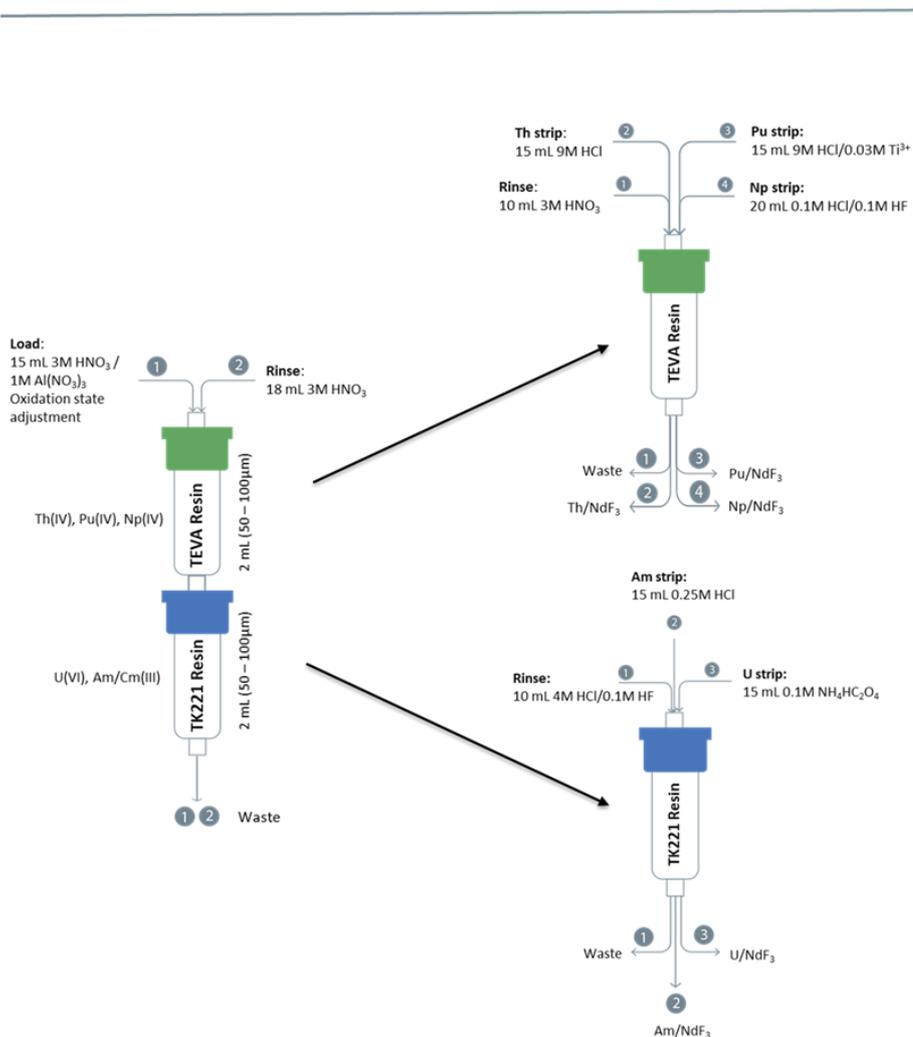


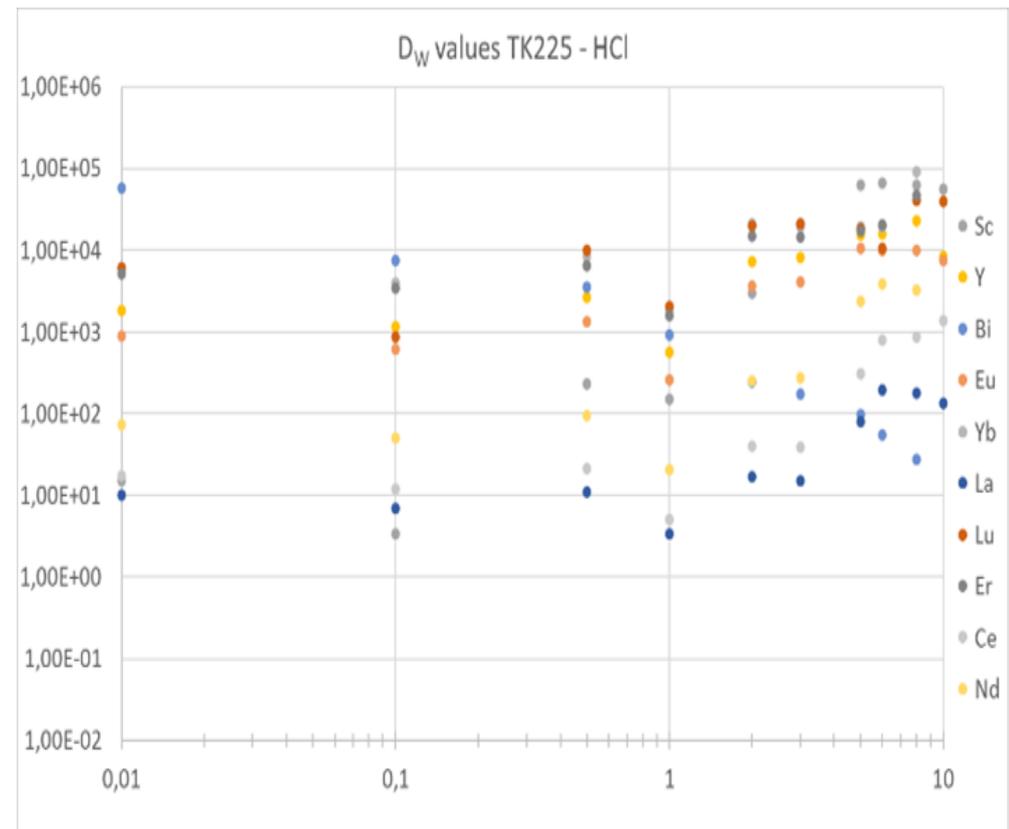
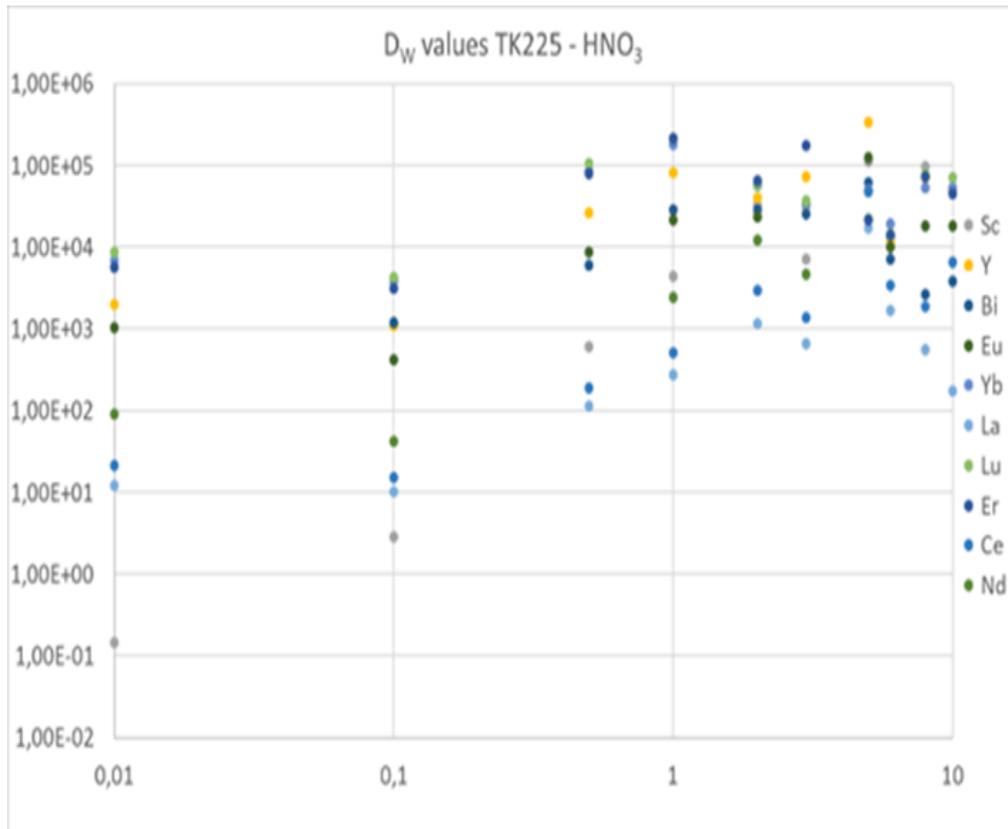
Table 3 Recovery of actinide tracers from spiked water samples

	Actinides determination	
	Without Np separation	With Np separation
	Yield	Yield
	%	%
TAP water		
²³⁰ Th	90 ± 8	86 ± 7
²³⁹ Pu	108 ± 7	95 ± 7
²³⁷ Np	–	91 ± 9
²⁴¹ Am	103 ± 7	97 ± 6
²³³ U	103 ± 7	70 ± 7
SEA water		
²³⁰ Th	71 ± 7	61 ± 6
²³⁹ Pu	91 ± 7	87 ± 6
²³⁷ Np	–	93 ± 8
²⁴¹ Am	89 ± 7	92 ± 6
²³³ U	88 ± 7	59 ± 6



TK225 Resin

- TO-DGA plus ionic liquid
- Very high retention of lanthanides at medium to high acid
- Especially heavy lanthanides also very well retained at low acid concentrations
- **Main application: Removal of radiolanthanides from effluents**





Impregnated TLC – DGA Sheets

TO-DGA (normal DGA) and TEH-DGA (branched DGA) impregnated TLC paper

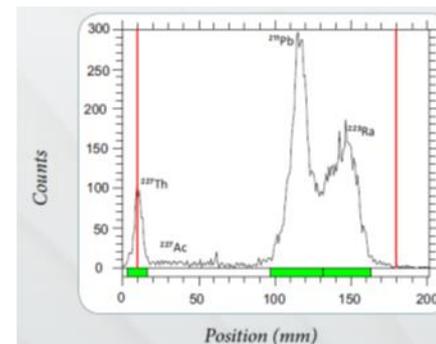
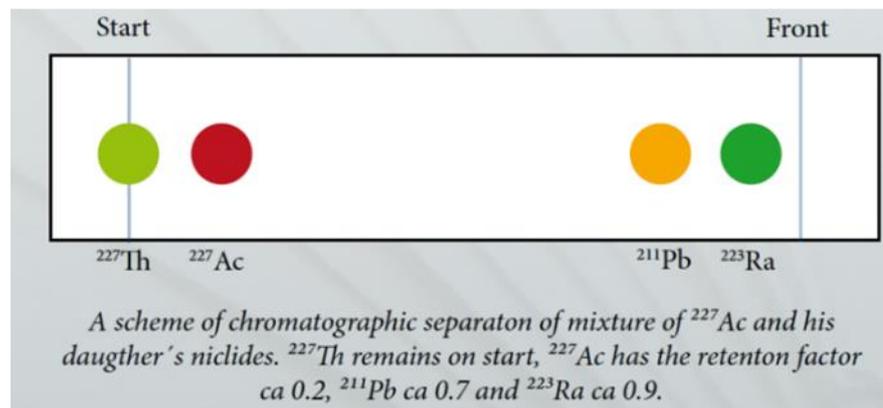
- Developed at CVUT (Kozempel et al.)

QC of radionuclides and generator eluents

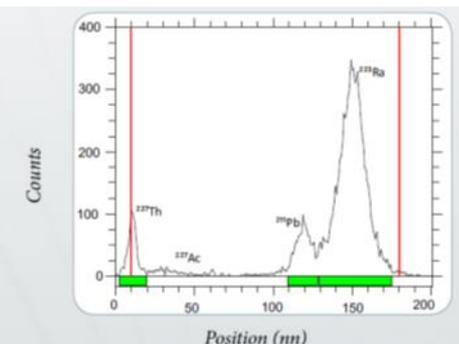
(p.ex. Ra-223, Ac-225/Bi-213, Pb-212, Ge-68/Ga-68 ...)

- TLC scanner or radiometer/LSC or HPGe after cutting

Run under acidic conditions => radionuclidic purity



Radiochromatogram measured immediately after separation. Low abundant radiations of ^{227}Ac were not detected.



Radiochromatogram measured one hour after separation. Decay and ingrowth of ^{211}Pb is clearly visible.

More types of sheets under development (selectivities, geometry, support)

- 2D TLC for radionuclide screening ?



Impregnated TLC – CU Sheets

Poster presented at Terachem 2022
(Svedjehed et al.)

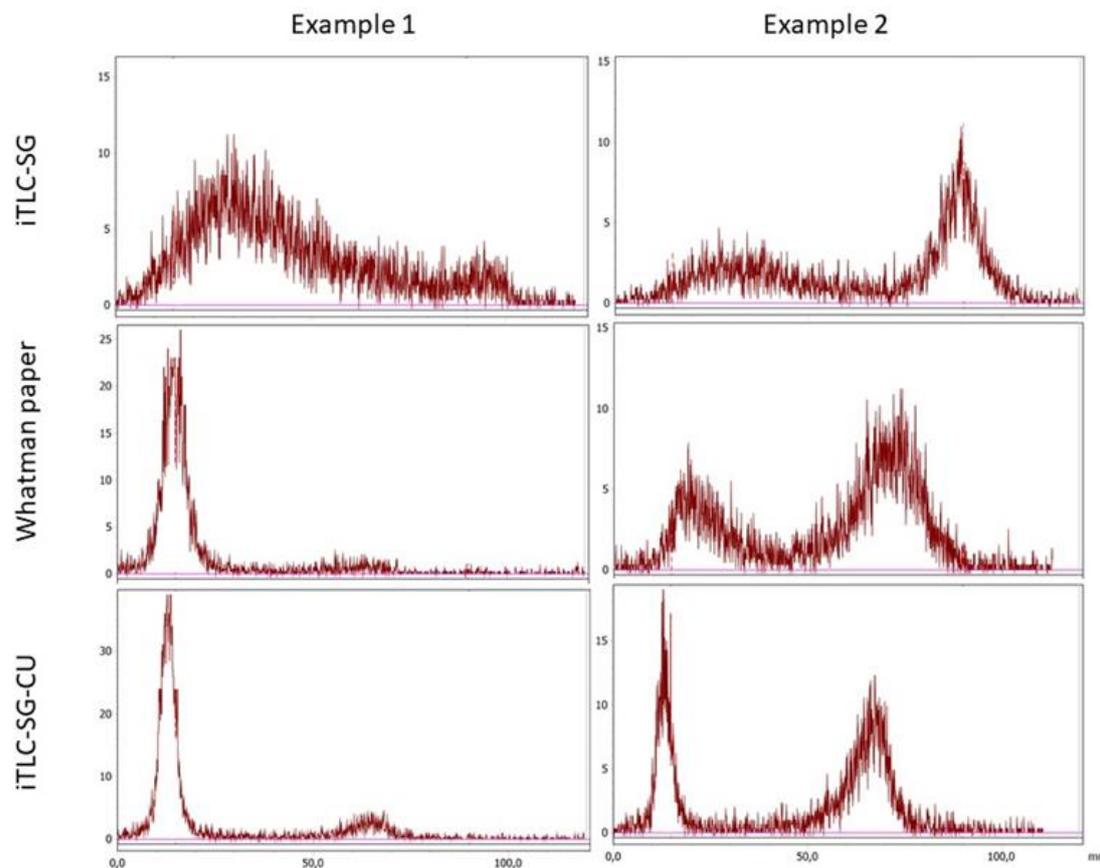
QC of Cu radiolabeled peptides (labeled vs free Cu)

- Shown: [^{61}Cu]Cu-NOTA-octreotide Spotting/run on three different papers after labeling:

- Whatman and iTLC without modification and
- CU extractant impregnated iTLC paper.

Both iTLC paper (impregnated/non-impregnated) developed in less than 10min, Whatman took 25 – 30 min.

CU extractant impregnated iTLC paper showed superior resolution



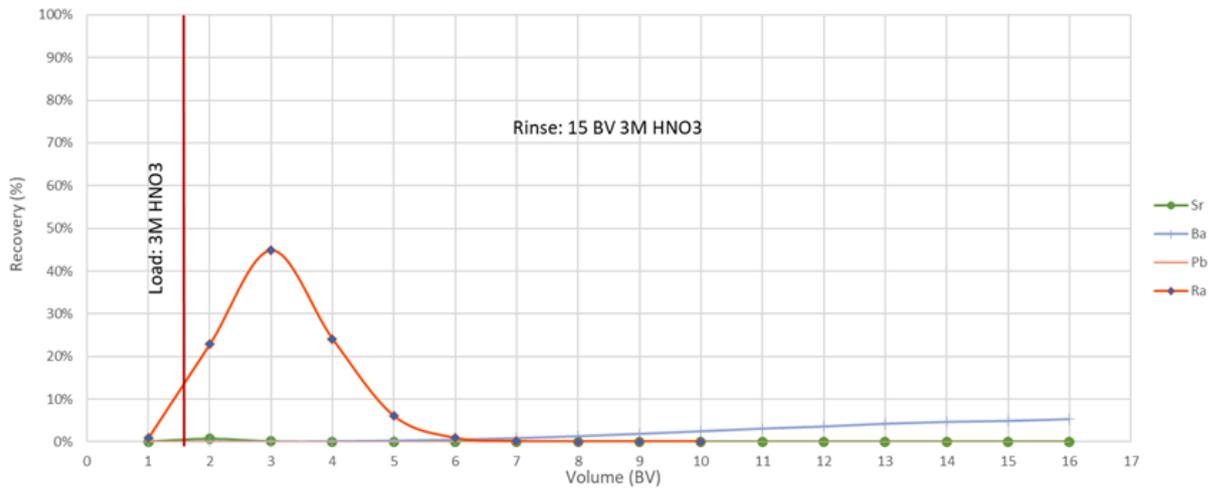
Other systems under development/testing (TK101, ZR,...)



Under development

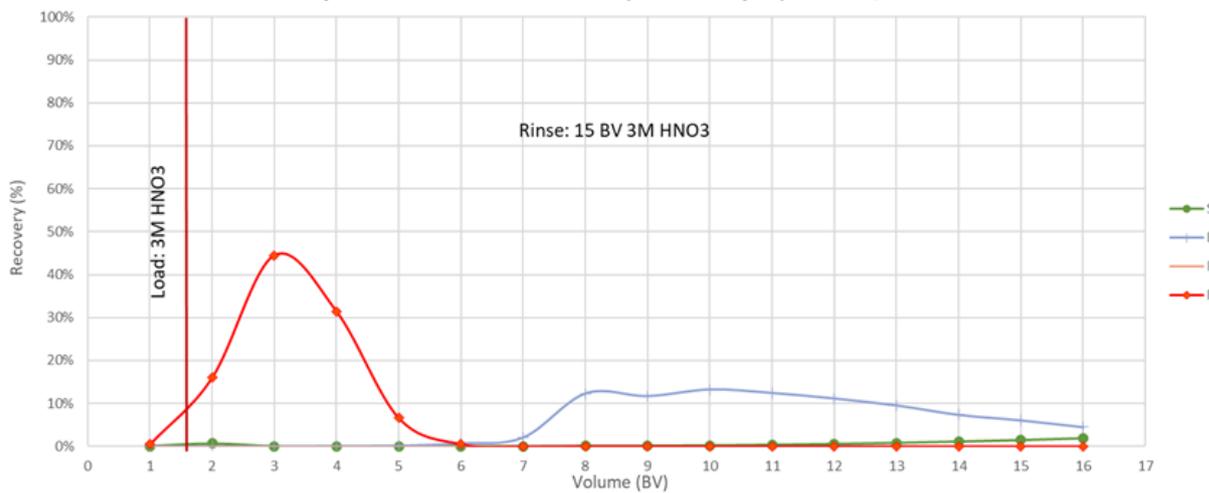
Ra purification/recycling

Separation on 1 mL TK102 Resin (100 - 200 μ m) - ~0.5BV/min



Elution study - Ra separation from Ba on TK102 Resin in 3M HNO₃ - Ra data courtesy of N. Vajda (RadAnal)

Separation on 1 mL SR Resin (100 - 150 μ m) - 0.5BV/min



Elution study - Ra separation from Ba on SR Resin in 3M HNO₃ - Ra data courtesy of N. Vajda (RadAnal)

Work on crown-ether based resin for Ra ongoing

Aim: Ra retention from acidic/high NO₃⁻ matrices, high capacity

Ra initial purification and recycling after irradiation

specific methods depending on impurities present

=> Ideal case: only remove impurities, leave Ra in solution

- TK221 (or DGA) => other alpha emitters et al.
- TK102 for Ba, Pb and Sr removal from 3M HNO₃ (Low organics bleeding (hydrophobic solvent))



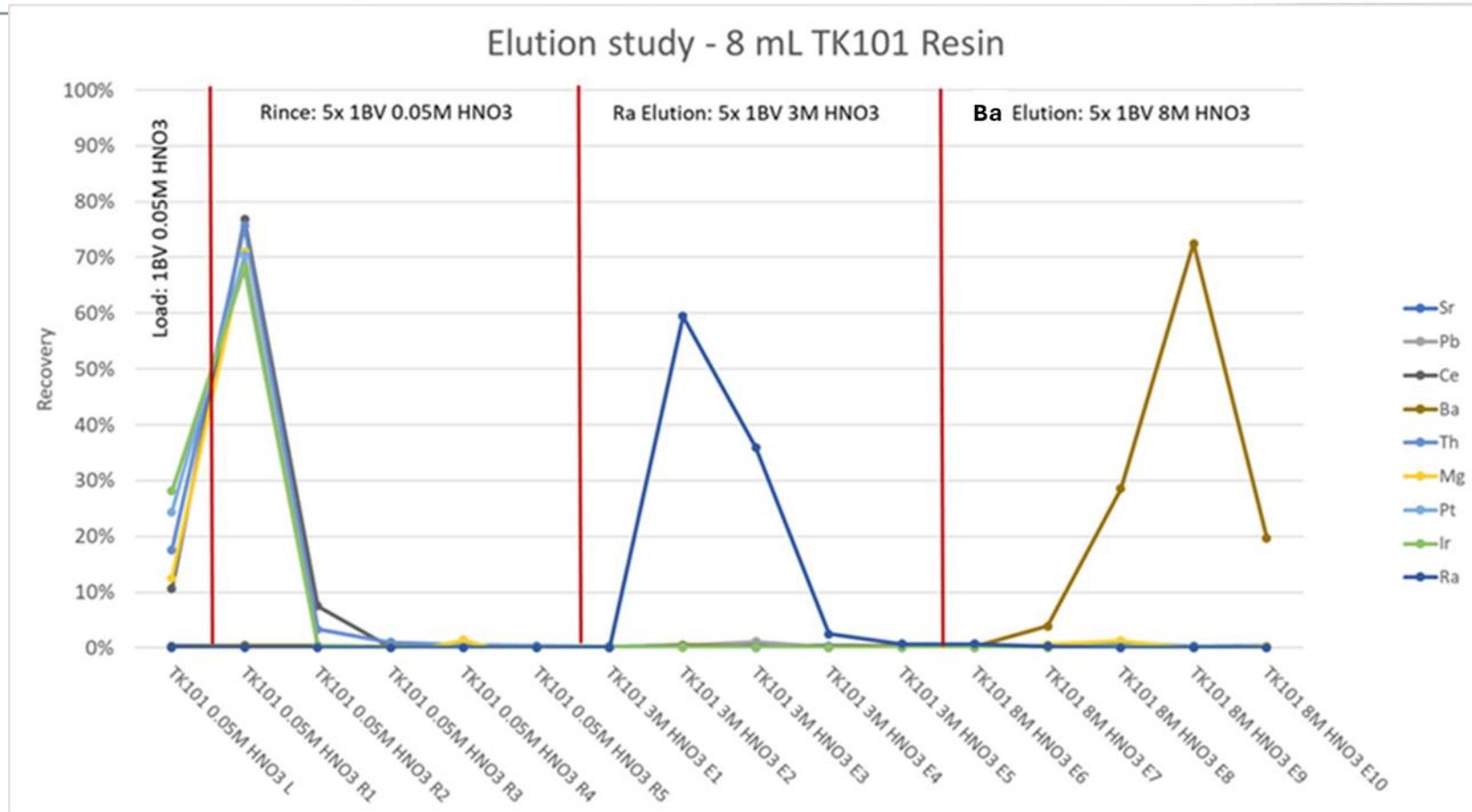
Under development

Ra purification/recycling

- In case Ra needs to be purified on-column (e.g. dissolved Ra needles) => Use of TK101 for Ra retention / purification
 - Test against Chelex, CEX, TK100
- TK101 => similar to TK100 but ionic liquid replaces HDEHP
 - Both based on same crownether as SR Resin
 - TK100 developed for Sr and Pb uptake also between pH ~2 and 7 (DGT)
 - ⇒ Wagner et al. TK100 discs
 - ⇒ Retains wide range of elements
 - Replacing HDEHP by ionic liquid (=> TK101 Resin) allows for retention of Pb, Sr, Ba, Ra,... from pH ~2 – 7 without extensive extraction of other elements



Under development Ra purification/recycling



- Good Ra separation when loading from dilute HNO₃/HCl
- When eluting Ra in 3M HNO₃, Ba, Pb, Sr remain retained
- No retention of U, Th, Pt, Ir,...
- Ra eluted in 3M HNO₃
- Tl and Ba eluted in 8M HNO₃



Under development

Membranes /Gross alpha discs

On-going work: development of impregnated membrane filters

First filters under beta testing:

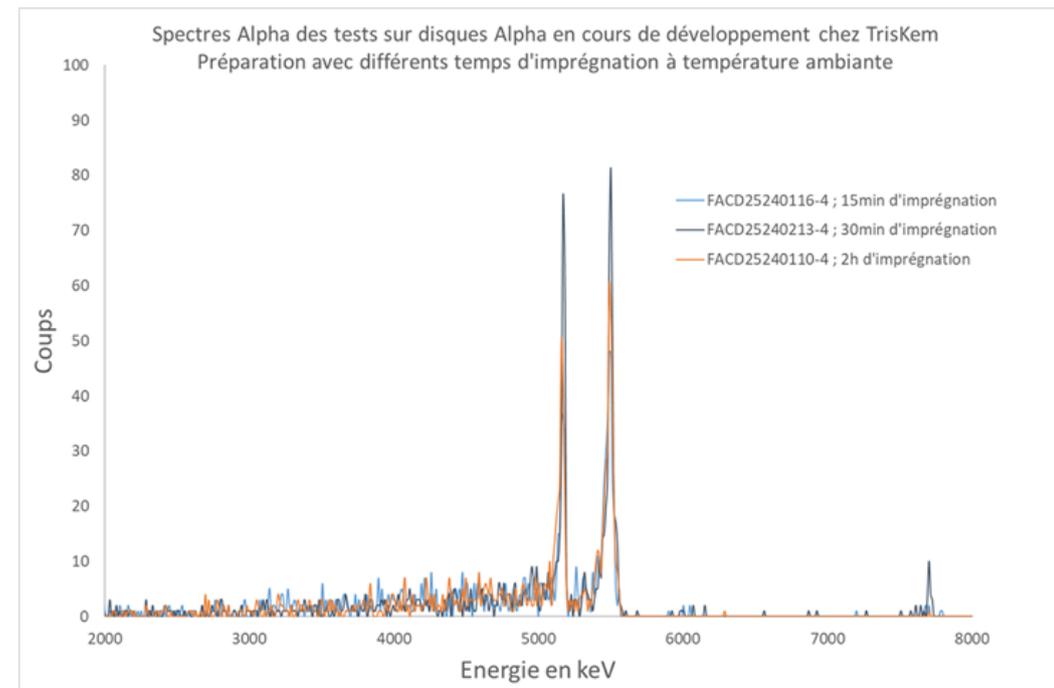
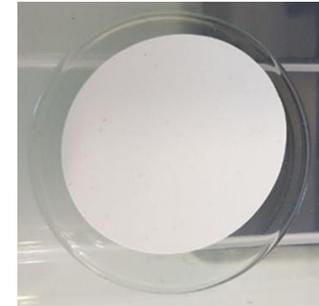
- TK100 (DGT of Sr, Pb, Zn, LN in soil samples)
- TK201 (determination of Tc-99 in aqueous samples)
- 25mm and 47mm

Currently under testing, membrane filter for gross alpha measurement

pH 2, 10mL/min, typically 100mL samples

High retention of actinides

Peak resolution/spectrum still to be improved



Alpha spectrum, Am-241 & Pu-239, ~50mBq each



Under development **Cs Resins**

Calixarene based => presentation by Illarion Dovhyi after morning break



Production of « industrial » extraction chromatographic resins

Requests from hydrometallurgy area

- Possible applications in decontamination and valorisation of effluents or decontaminant (e.g. acid)

Different resins

Bigger particle size support and higher amount of resins requested

- ~400 – 600 μ m
- Challenge: supply of extractant and inert support
 - Extractants: sufficient quality, low costs, high quantities

Increase of production capacity for these resins



Other on-going Projects

➤ Impregnated membrane filters

- Replacement of Nucfilm U discs
- Passive sampling

➤ Impregnated PSm resins

➤ Range of 'Test sticks'

- Suitable impregnated support
- JCU => rapide isotope ratio analysis by MS (metallomics)
- Uni Southampton/NPL
 - Ideally multiple layers of resins for multi RN screening
 - LSC measurement
 - Scintillating supports for non-LSC options
 - Decommissioning/screening

• Separation of DTM

- SE Resin
- Zr-93, Fe, Mo, Nb,...

• Fate' of RN in the environment

- Separation methods
- Mainly longer lived RN (=> therapy)
 - Ac-225/7, Lu-177(m), radioiodine,...
- Quantification

• In-field preconcentration

- Impregnated membranes
- Cartridges

Microfluidics

Other 'geometries' &

'Non-resin' separation materials 20

Thank you for your attention !

