On the separation of Sc, Zr and Ga

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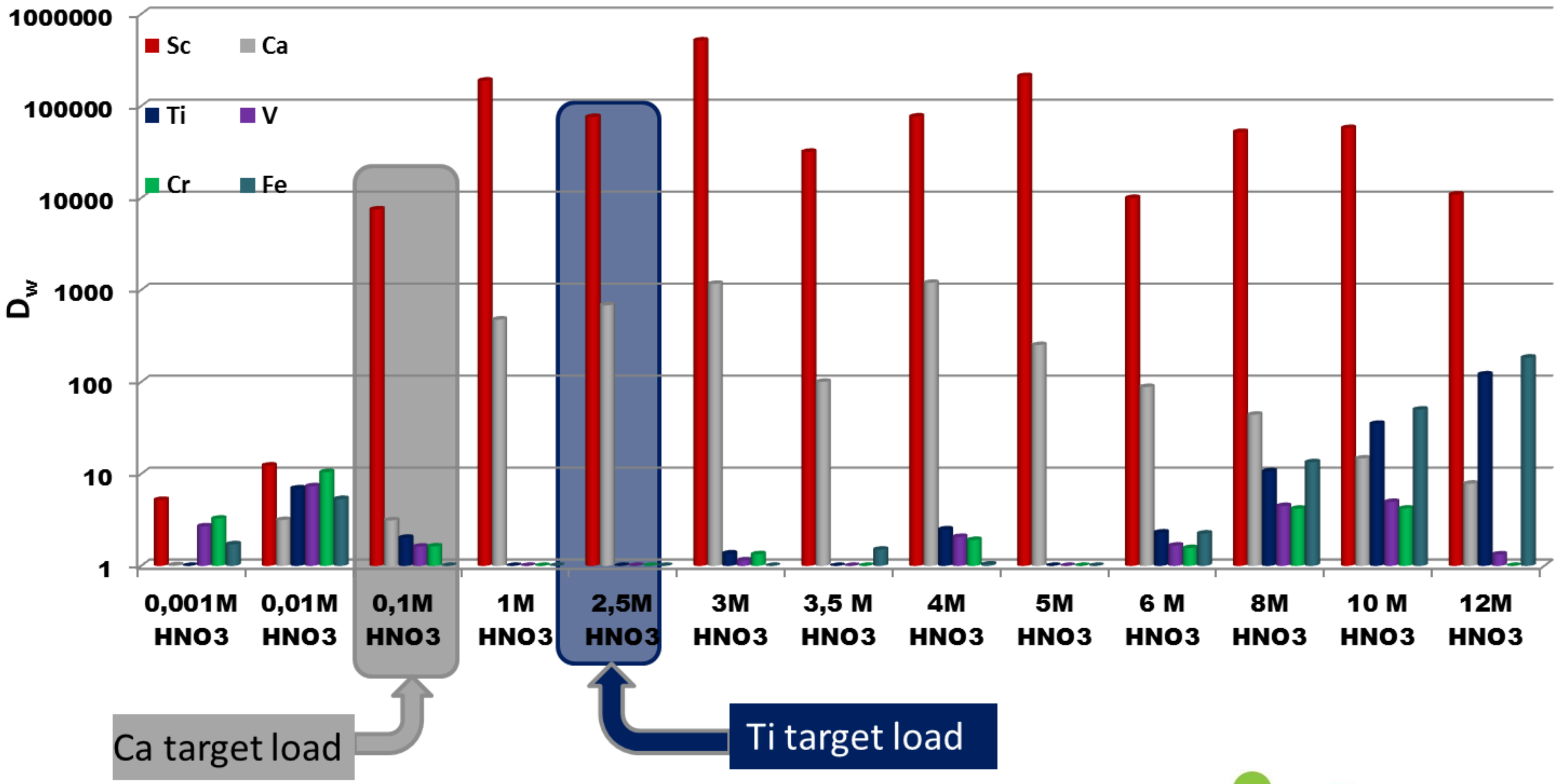
TRISKEM INTERNATIONAL

Scandium - general

- Radiopharmaceutical applications:
  - PET imaging (i.e. ^{44}Sc, β^{+})
  - Therapy (i.e. ^{47}Sc, β^{-})
  - "matched pair" -> theranostics
- Production:
  - Irradiation of Ca or Ti targets
    - Excellent Sc/Ca-Ti separation needed
  - $^{44}Ti/^{44}Sc$ generator
- Tests on TRU and DGA Resins

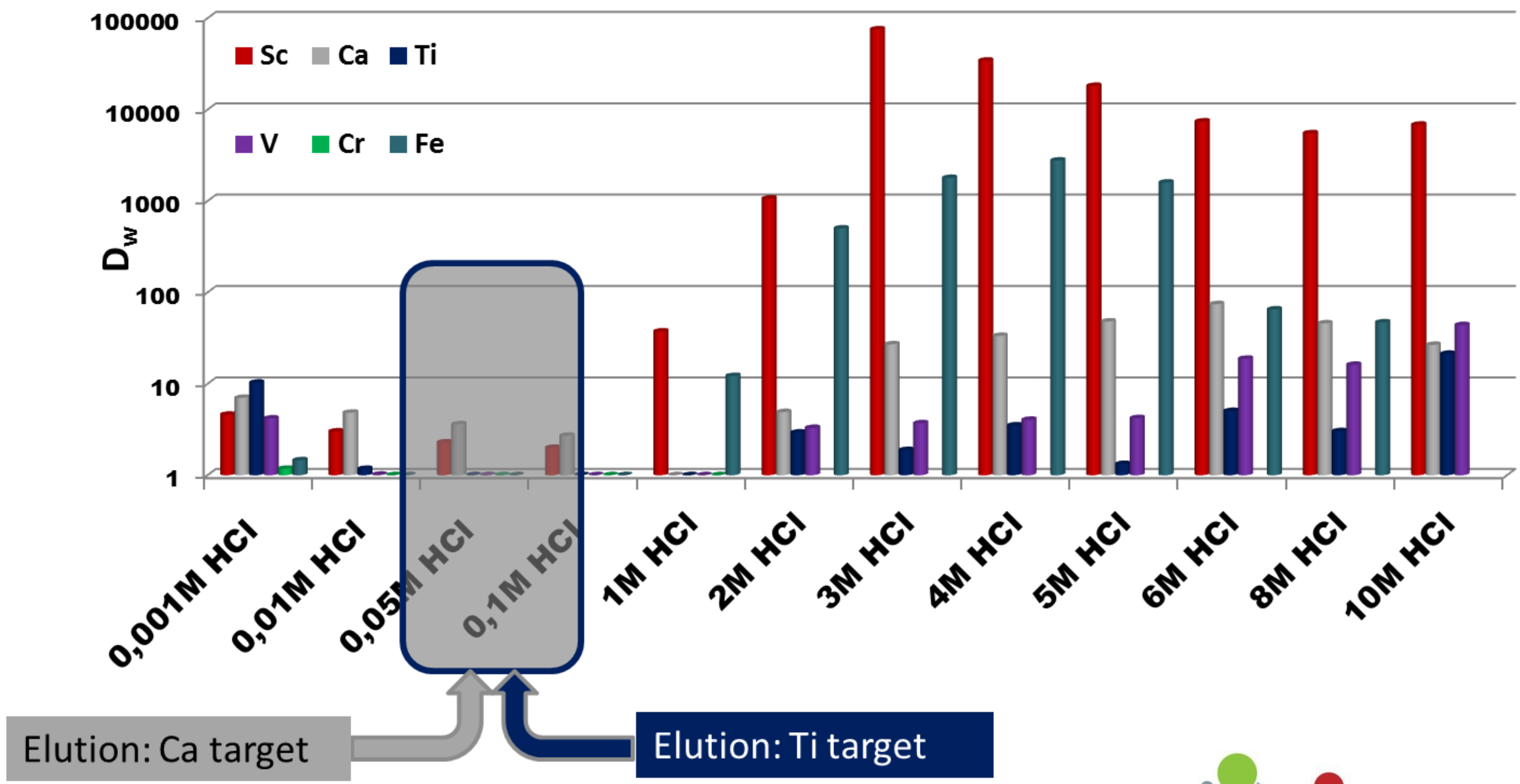
Scandium

- D_W values on DGA Resin – HNO_3



Scandium

- D_W values on DGA Resin – HCl



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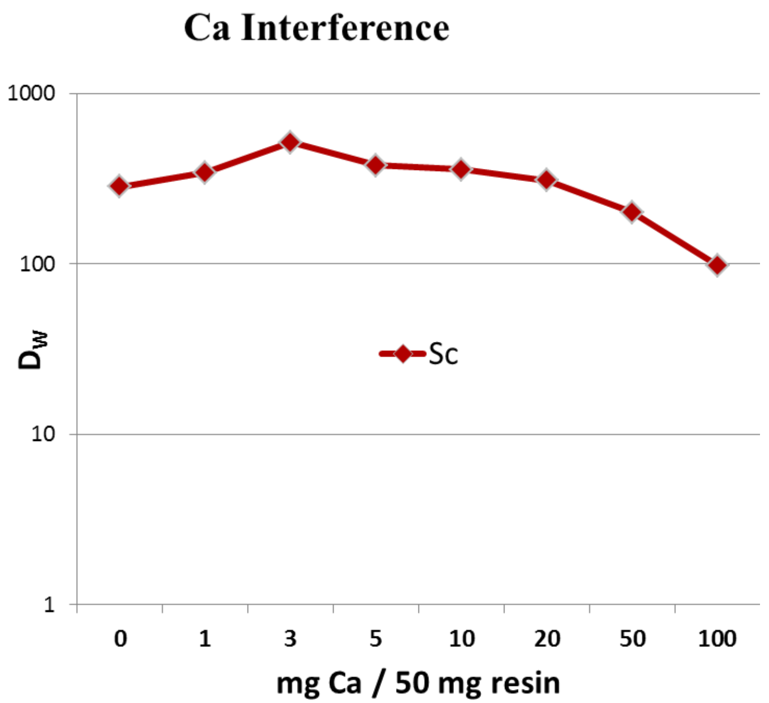
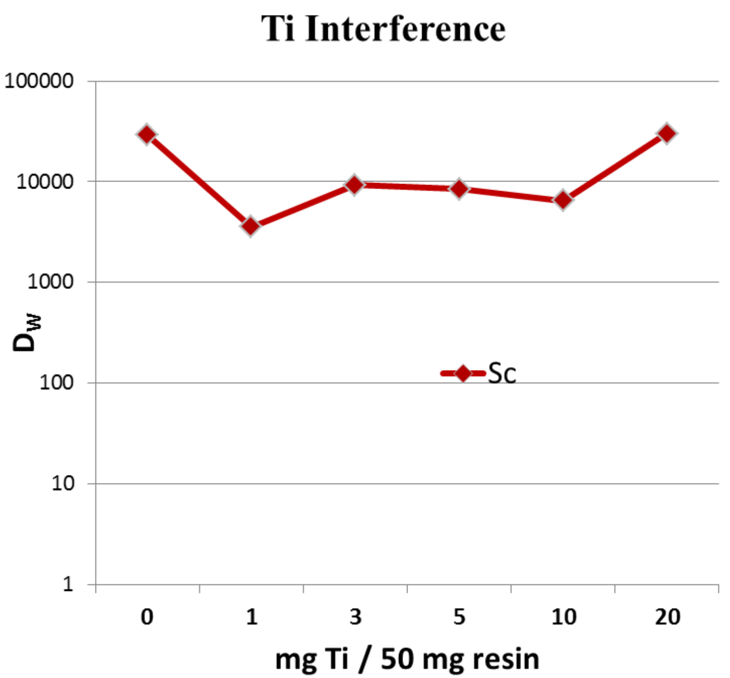
Scandium

- Interference from target materials - DGA Resin - 0.1M HNO_3

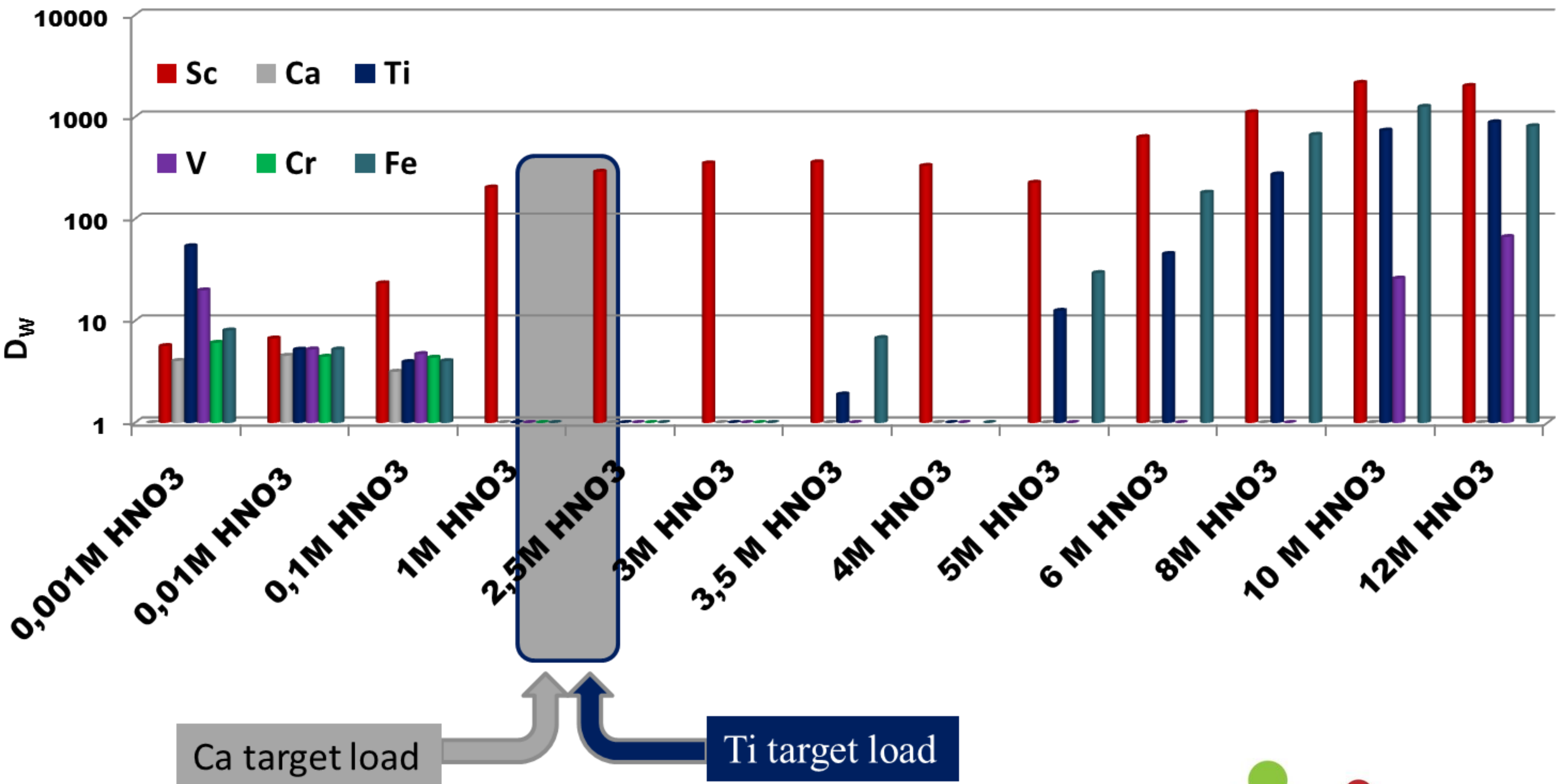




➢Stable, high D_w Sc in HNO_3
➢No impact on Sc uptake from Ca or Ti even when present in high amounts
➢**Interferences are negligeable**

Scandium

- Tests on TRU Resin :



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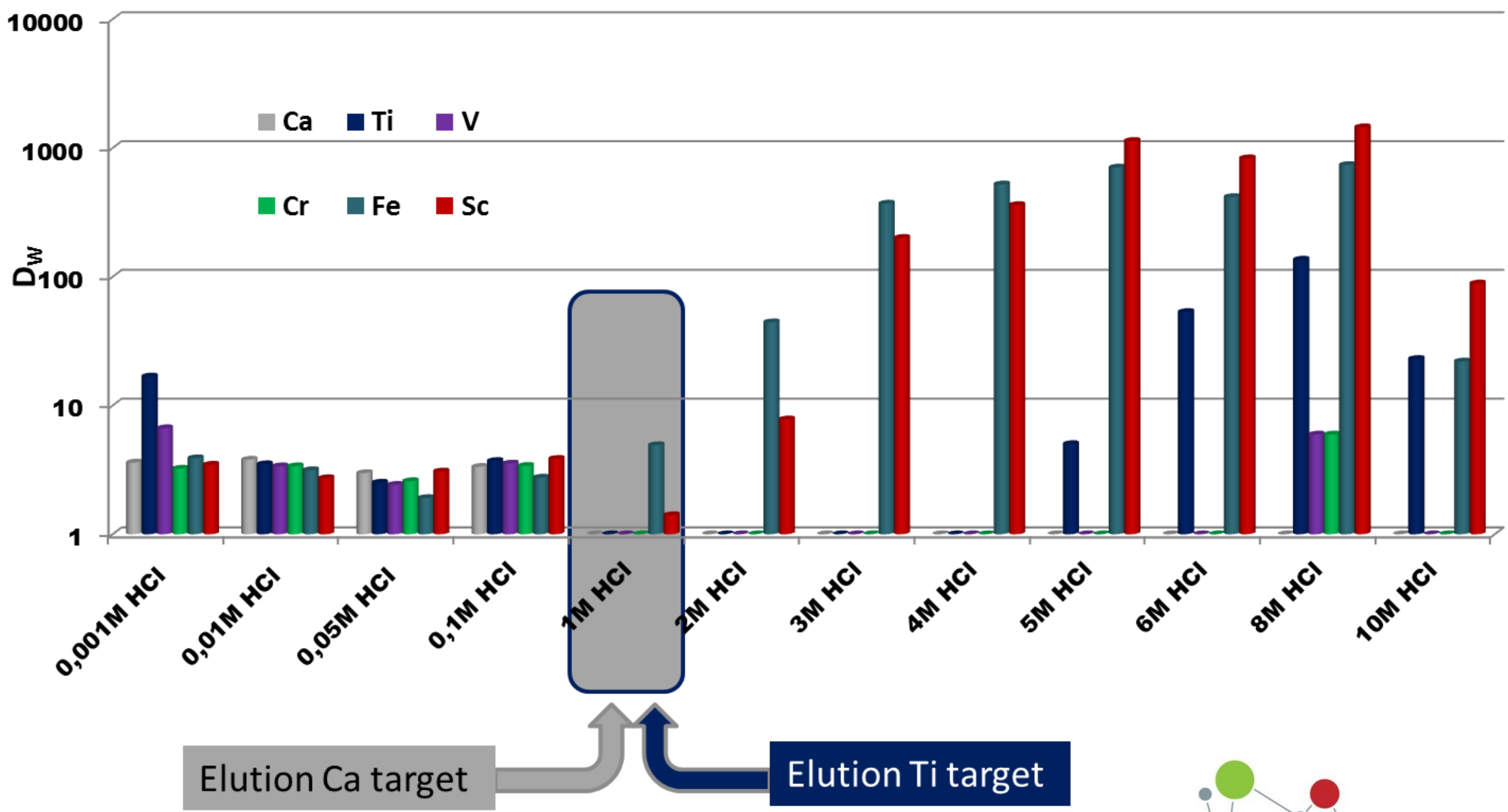
Scandium

- Tests on TRU Resin :



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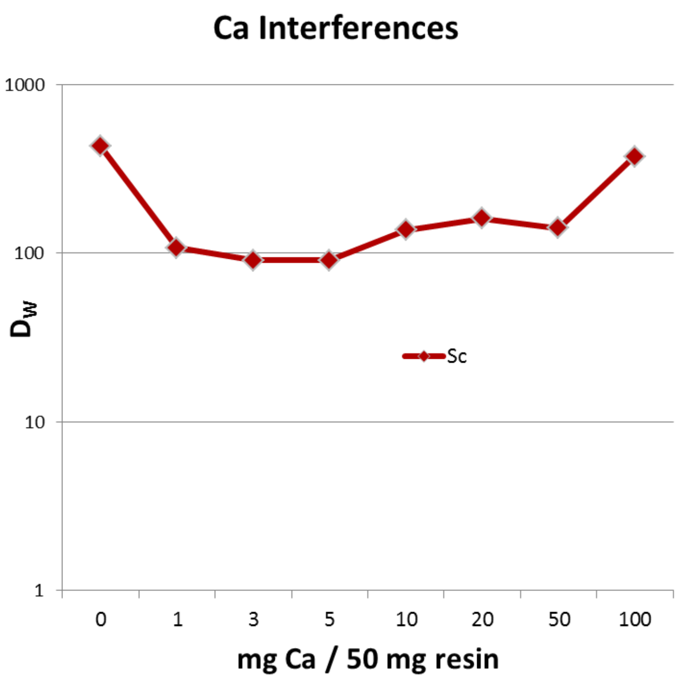
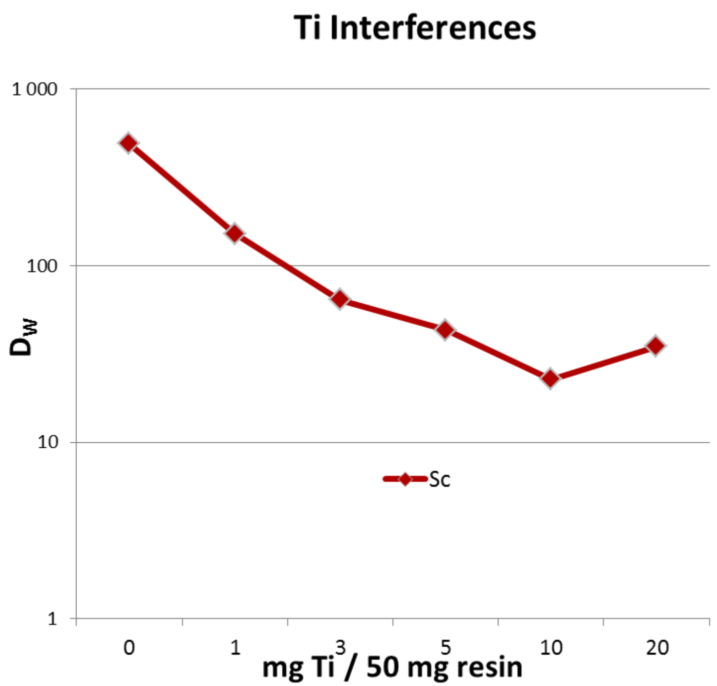
Scandium

- Tests on TRU Resin (2,5M HNO_3):





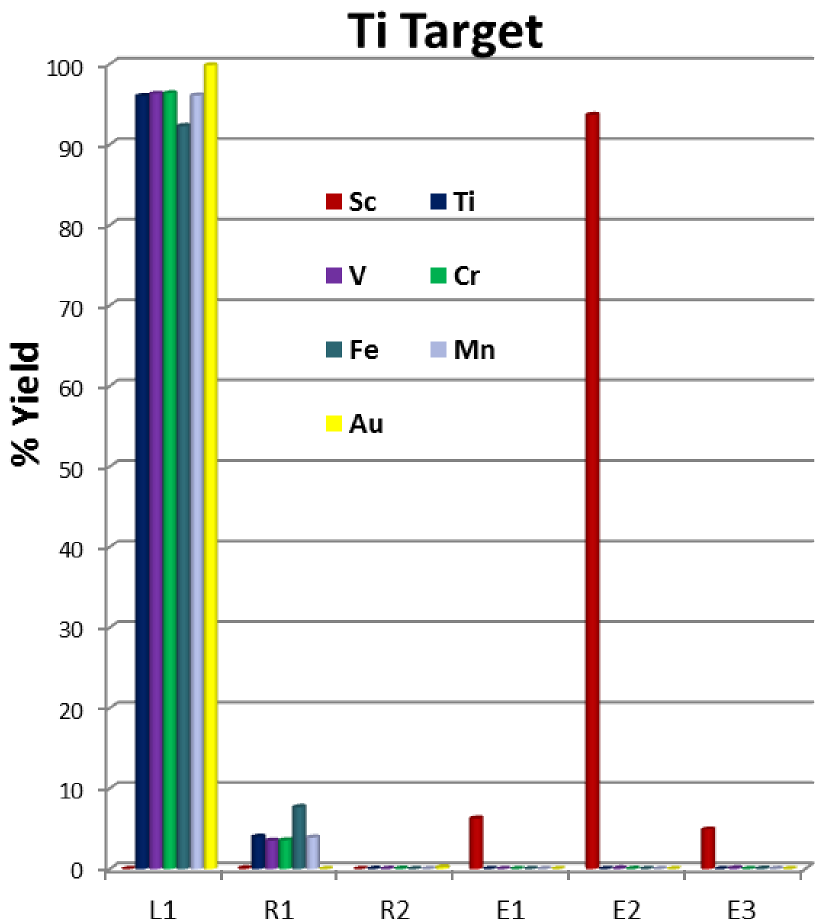
- Stable, D_w Sc high in 2.5M HNO_3
- High selectivity for Sc, no selectivity for Ca or Ti
- Fast kinetics
  - sample load: 2,5M HNO_3; for both Ca- and Ti- targets
- Elution with 1 M HCl for both Ca- and Ti- targets
- Interferences are negligeable for Ca;

Ti interferences for 2mg Ti /50mg resin

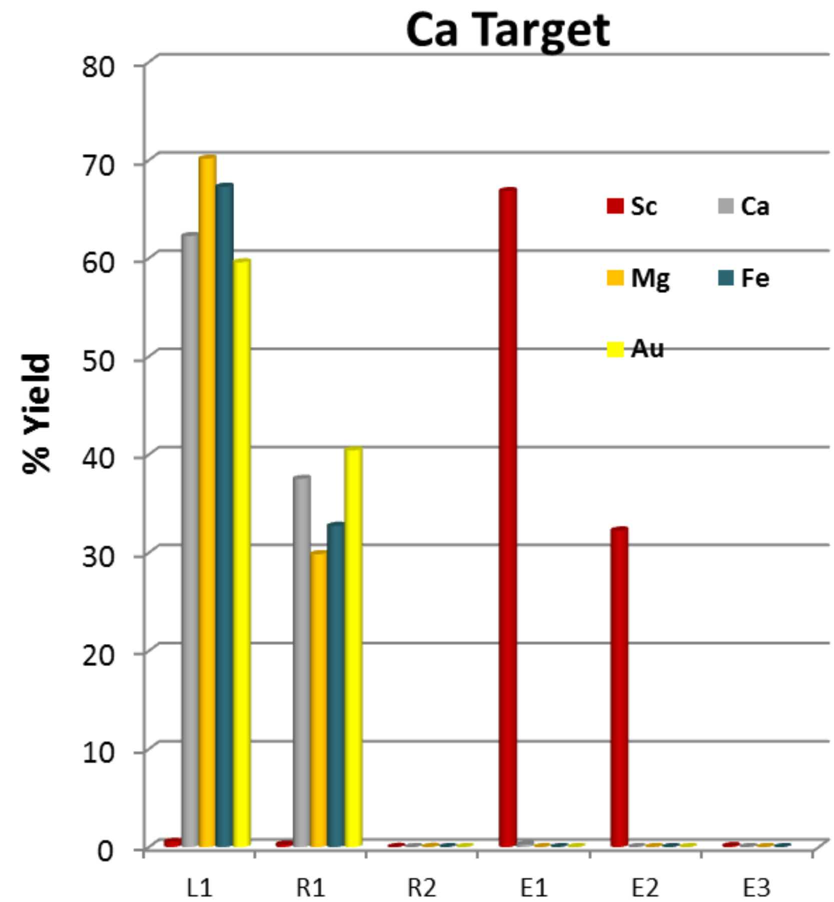
TRISKEM INTERNATIONAL

Selective separation of Scandium

Separation scheme on DGA Resin



L1: 5 mL 2.5 M HNO_3
R1 / R2 : 2 x 5 mL 2,5 HNO_3
E1 / E2 / E3 : 3 x 5 mL 0.1 M HCl

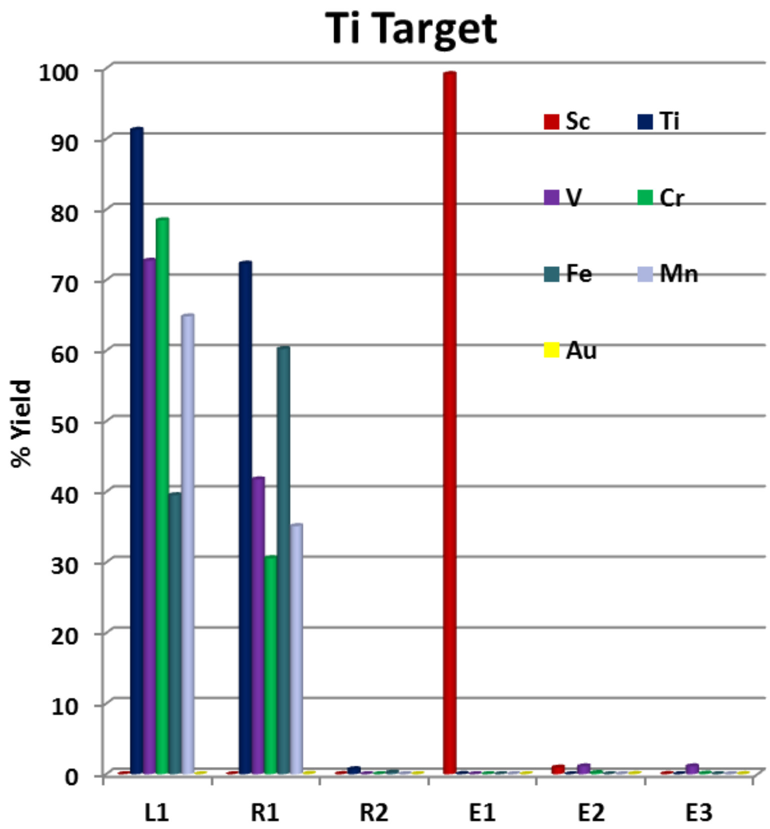


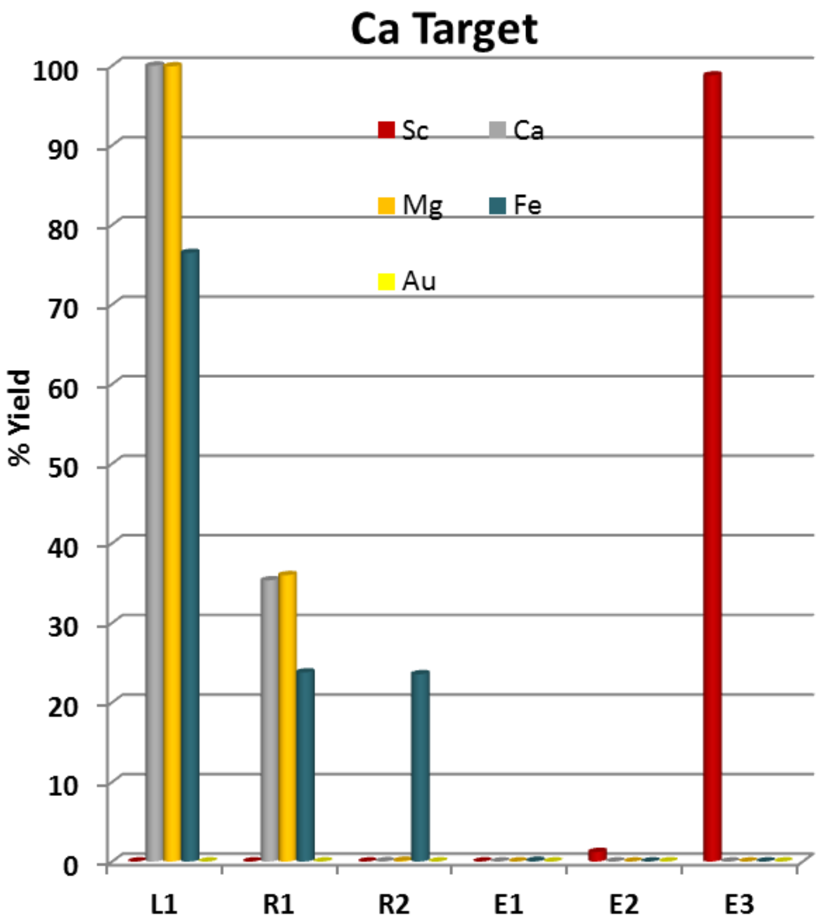
L1: 5 mL 0.1 M HNO_3
R1 / R2 : 2 x 5 mL 0.1 M HNO_3
E1 / E2 / E3 : 3 x 5 mL 0.1 M HCl

TRISKEM INTERNATIONAL

Selective separation of Scandium

Separation scheme on TRU Resin





L1: 5 mL 2.5 M HNO_3

R1 / R2 : 2 x 5 mL 2.5 M HNO_3

E1 / E2 / E3 : 3 x 5 mL 1 M HCl

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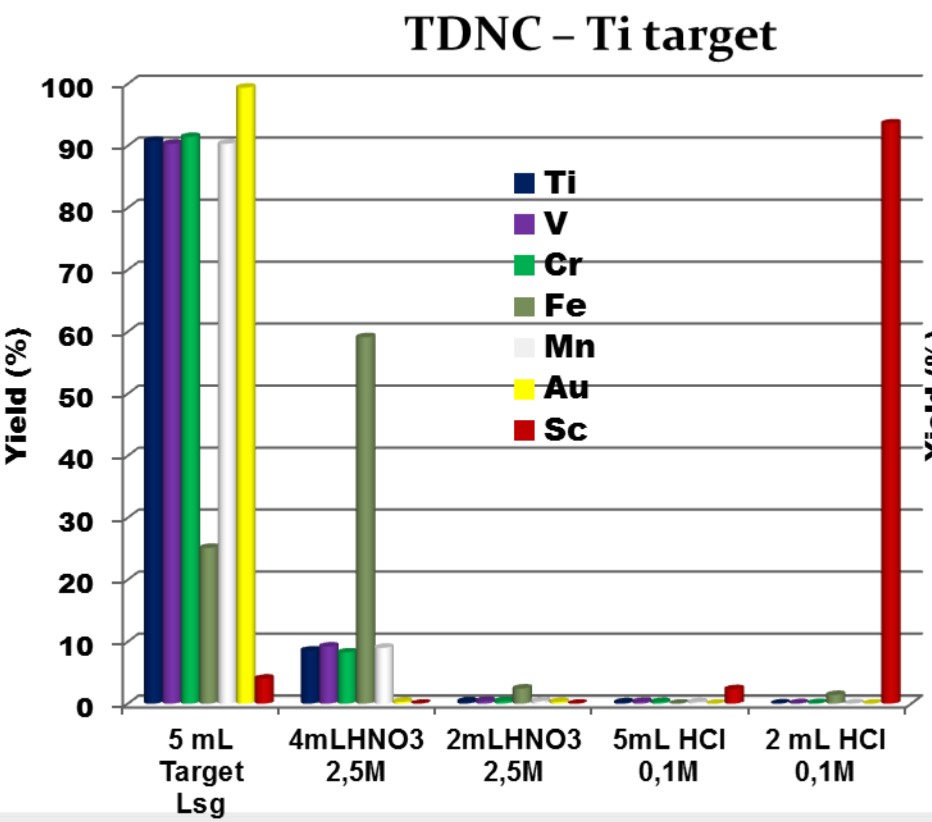
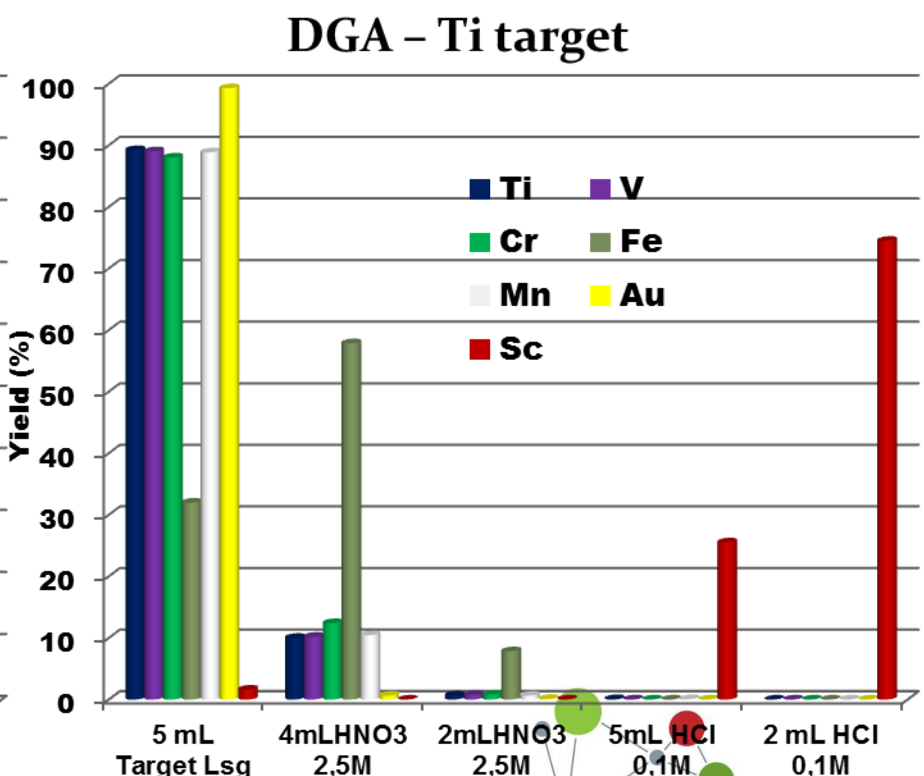
Selective separation of Scandium

tests on nanotubes

- Same experiments done on DGA-nanotube Resin (TDNC) to compare impact of the support
- TDNC vs. DGA on Ti Target:





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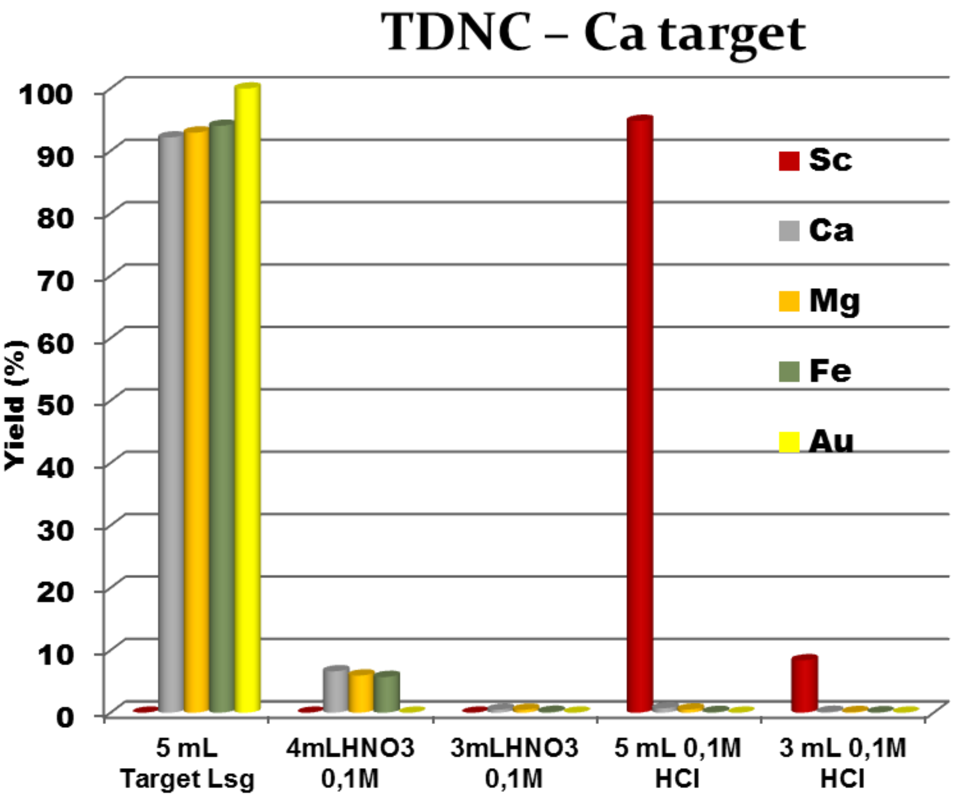
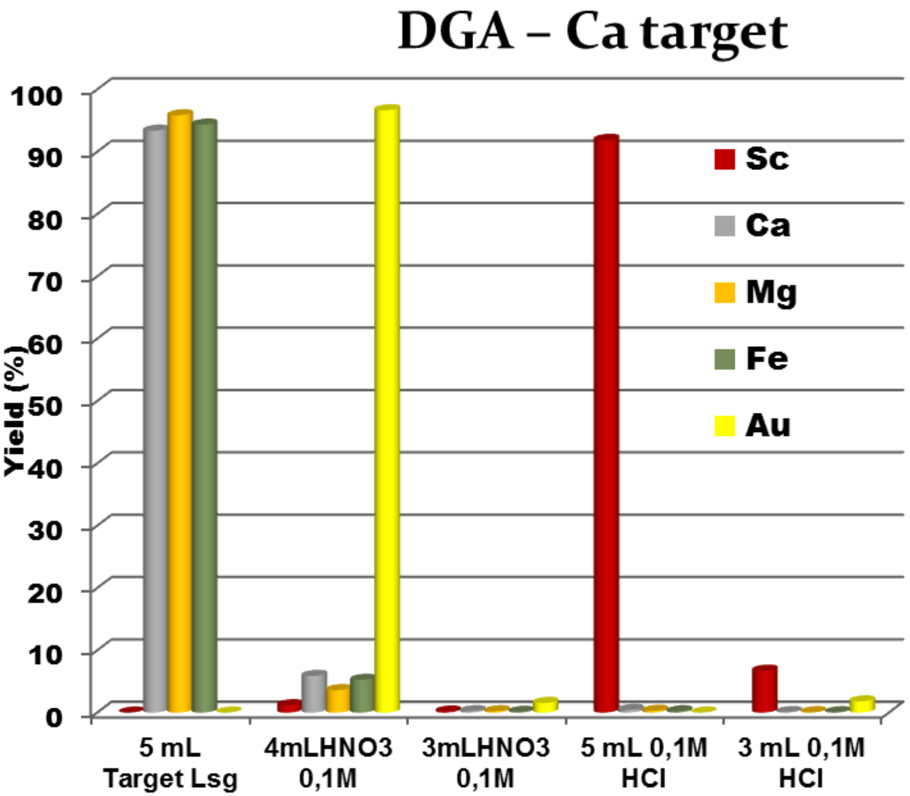
Selective separation of Scandium
tests on nanotubes

➢ TDNC vs. DGA on Ca Target:





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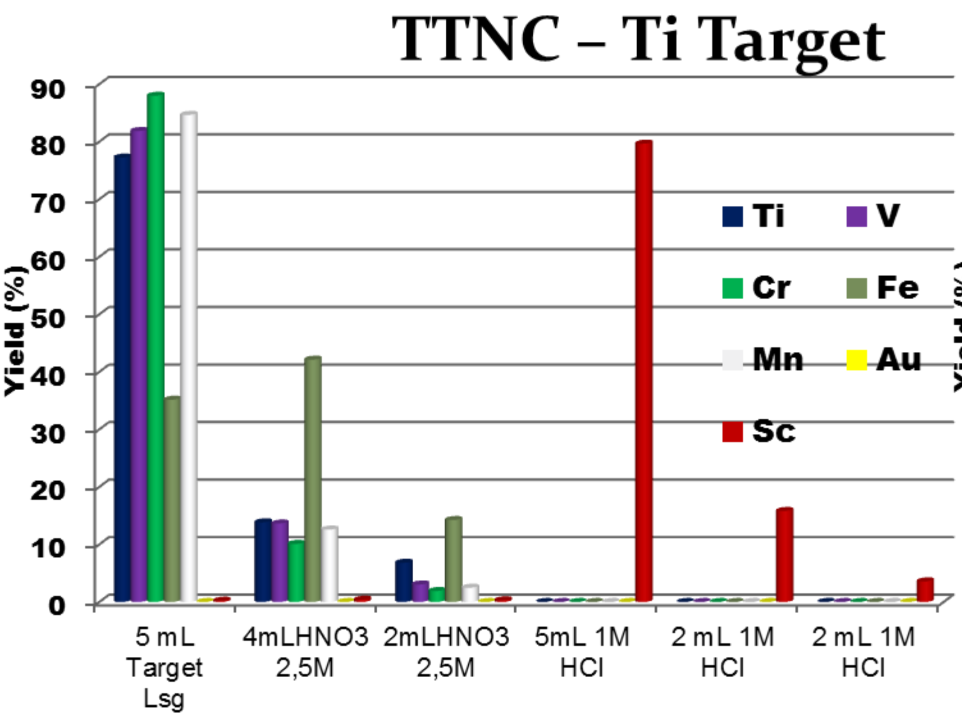
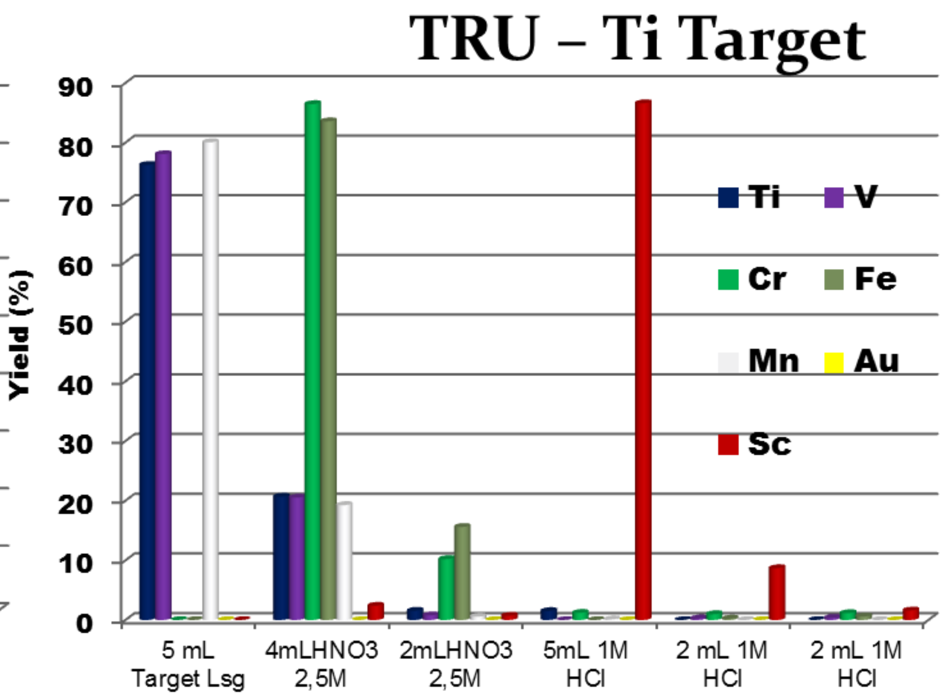
Selective separation of Scandium

tests on nanotubes

- TTNC vs. TRU on Ti Target:

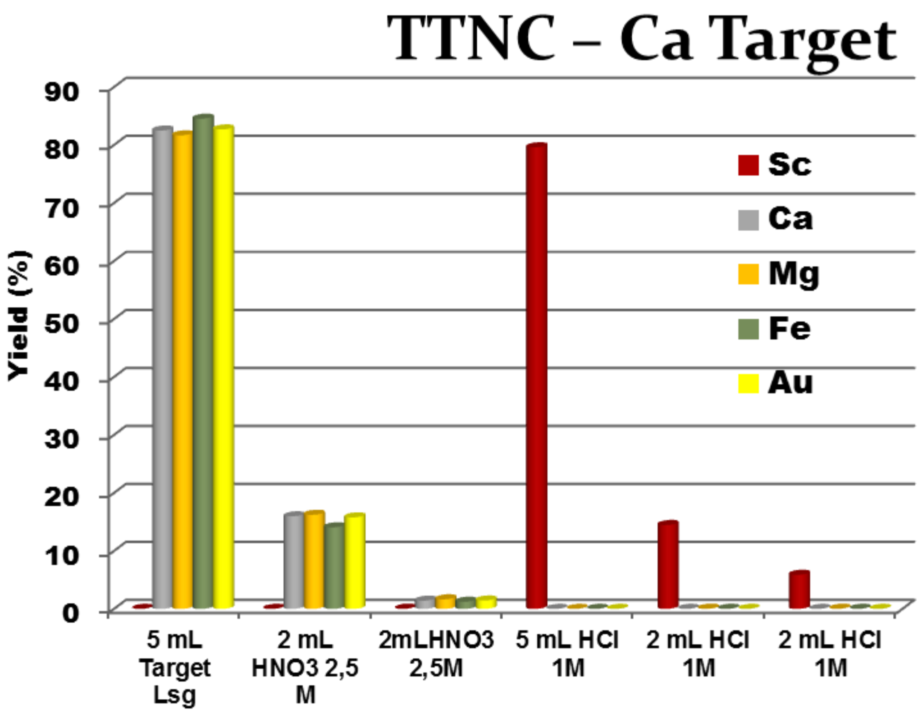


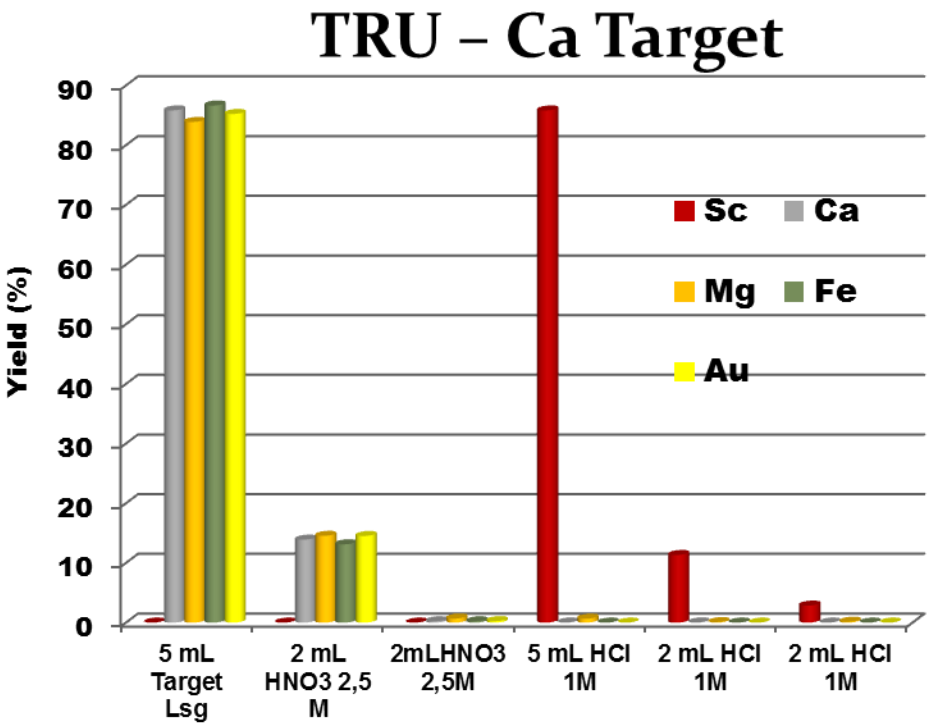


Selective separation of Scandium

tests on nanotubes

- TTNC vs. TRU on Ca Target





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Selective separation of Scandium

Conclusions

- High selectivity for Sc on both DGA and TRU Resins
- Interferences are negligeable for Ca and Ti
  - TRU Resin: **strong Ti interferences for 2mg Ti /50mg**
  - DGA more robust
- Clean separation
- Fast kinetics
- Quantitative elution of Sc: chemical yield Sc >98%
- High purity of Sc fraction
- Ca and Ti can be quantitatively recovered small volumes (5-10mL)
- Use of nanotubes gives comparable results to standard resins

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Selective separation of Scandium

Future works

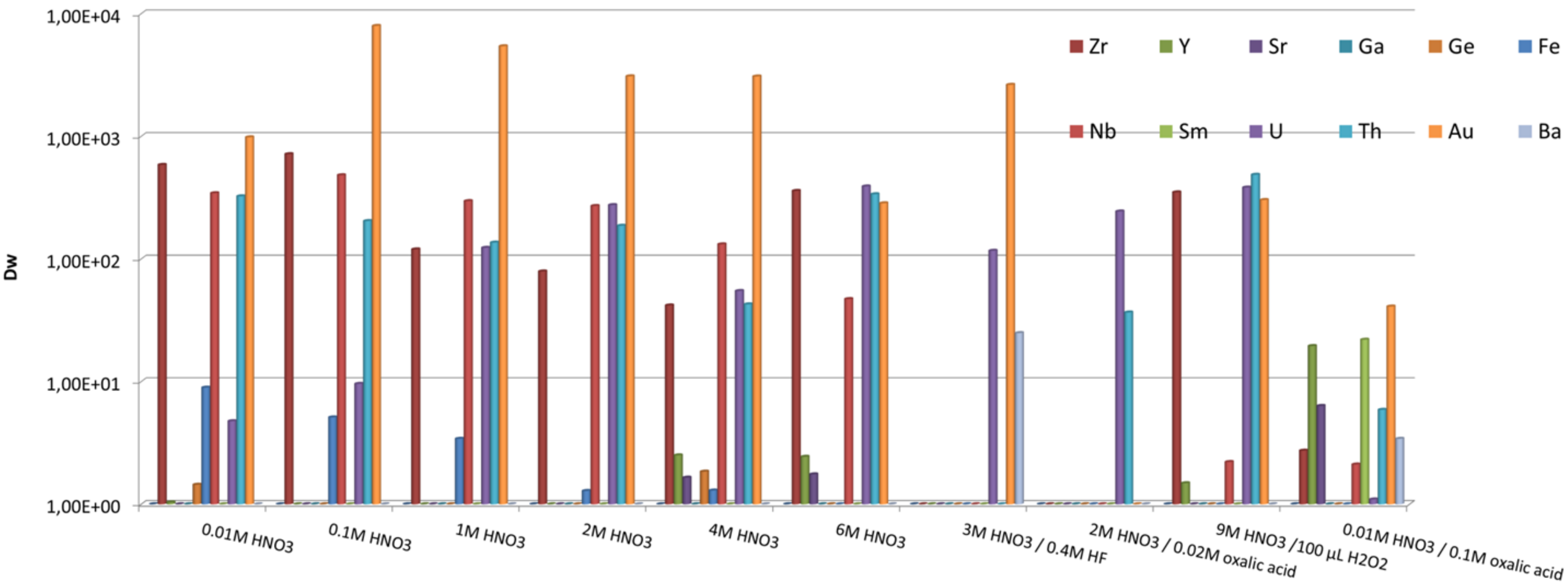
- COT analysis of Sc fraction
- Recovery and purification of Ca/Ti for preparation of new targets
- Flow rate optimisation
- Radiolysis stability of DGA

Zirconium-89

- Half-life: 78,4h
- β^+(22.7%), ε(73.3%) et γ(~100%)
- Production *via* irradiation of Y targets
- Application e.g. in immuno-PET
  - monoclonal antibodies, mAbs
- Several resins tested, UTEVA Resin best suited

Zirconium-89

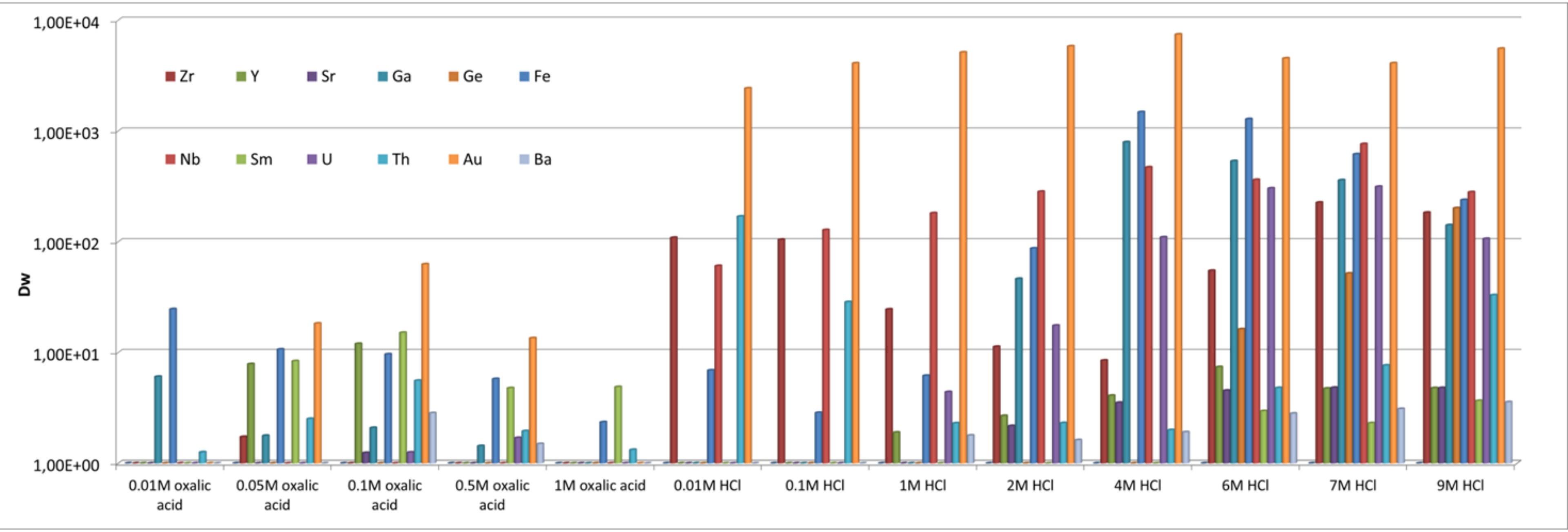
- D_w values on UTEVA Resin - HNO_3



- Zr uptake generally high in HNO_3
- Oxalate and fluoride interfere with Zr uptake

Zirconium-89

- D_w values on UTEVA Resin – HCl and oxalic acid



- ➢ Zr uptake high for high HCl
- ➢ Oxalate well suited for elution

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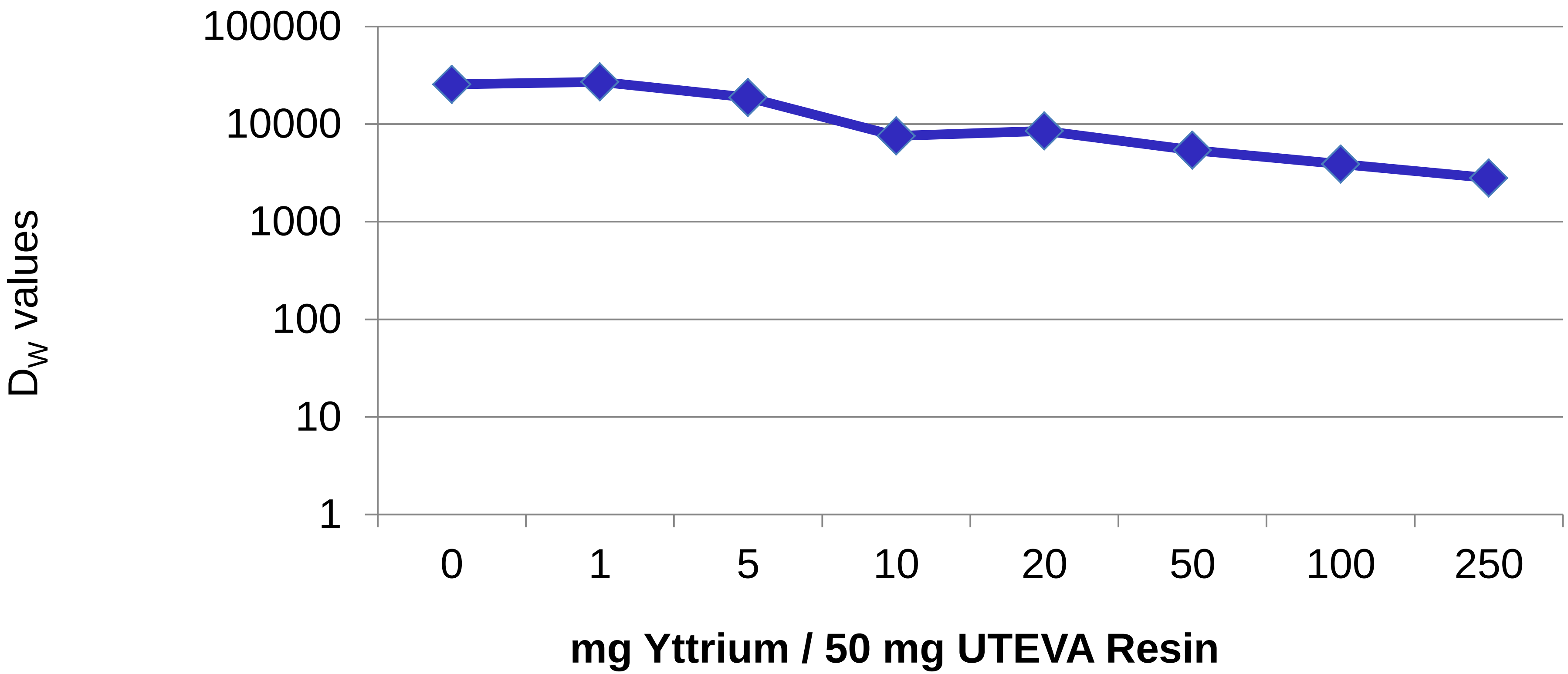
Zirconium-89

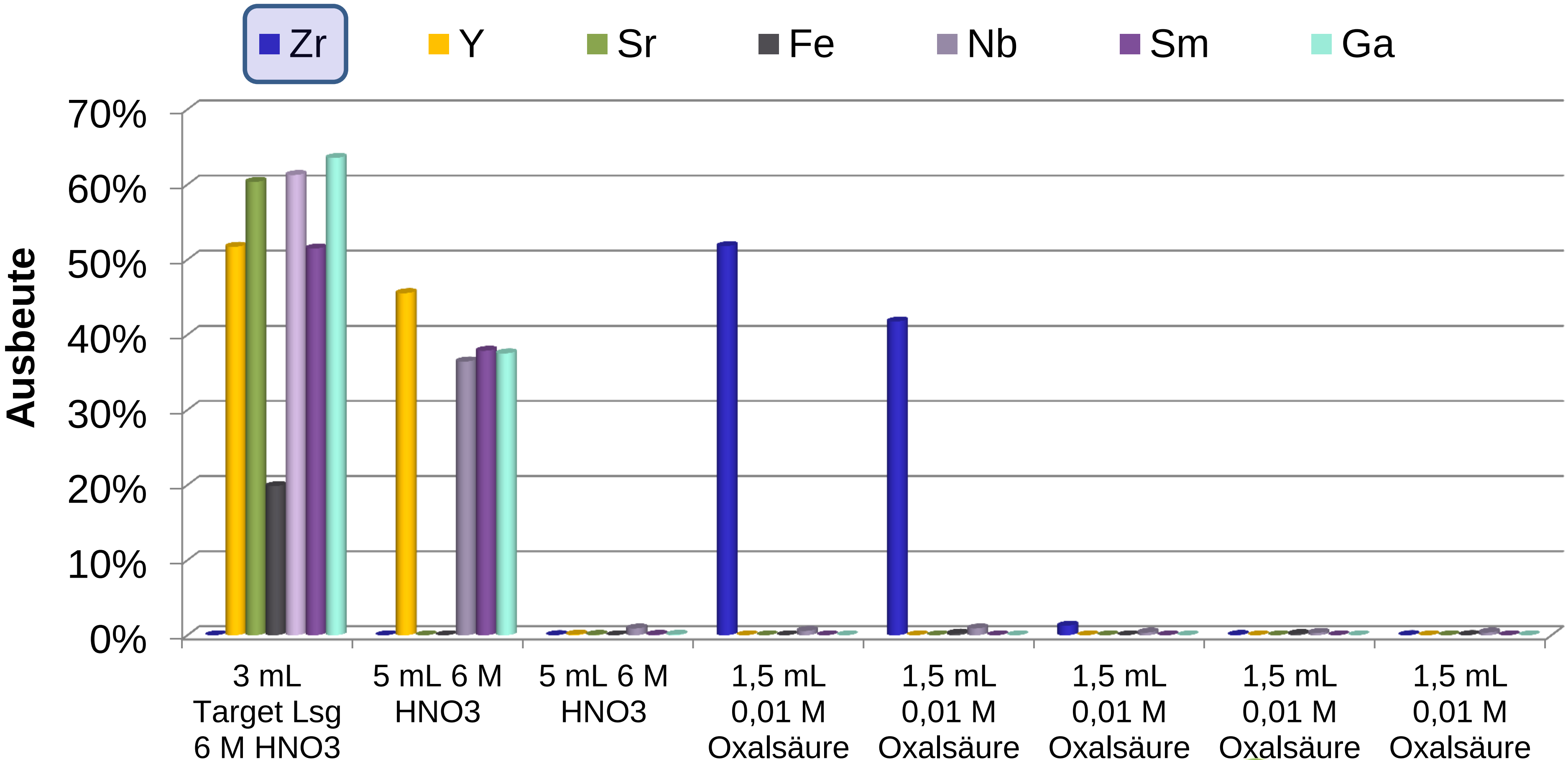
Y interference on Zr uptake by UTEVA in 6 M HNO_3



- Y shows slight intferference on Zr uptake in 6M HNO_3
- D_W remains > 1000 even for elevated amounts of Y
- High HCl to be evaluated

Zirconium-89

Elution study on 2 mL UTEVA column



- Zr elution in dil. oxalic acid ->Clean Zr fraction
- Alternatively load/rinse in high HCl

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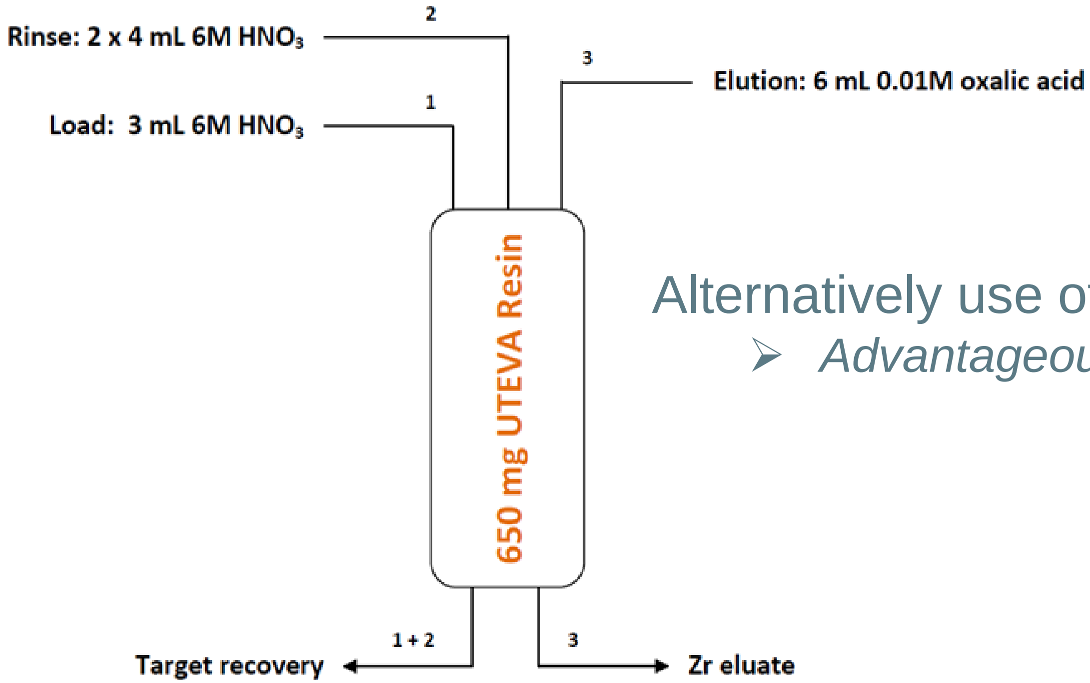
Zirconium-89

- Results:



Alternatively use of high HCl concentrations

- *Advantageous for some matrices*

- Method optimisation *via* elution study
- Zr chemical yield (6 mL 0.01M oxalic acid): ≥ 93%
- High decontamination factors: > 100 000 for Y, Sr, Fe, Ba
- UTEVA also used for ^{90}Nb (Radchenko, Filosofov et al.)

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Gallium separation

- **Ga-68** and **Ga-67** frequently used in **radiopharmacy**
  - Ga-68: β^+: 88.88(41)%, ε:11.11(41), $T_{1/2}$: 67.83(20) min; PET
  - Ga-67: ε: 100%, γ, $T_{1/2}$: 3.2613(5) d; SPECT
- **Ga-68** obtained from **Ge-68/Ga-68 generator**
  - Elution typically with 0.1M HCl, rarely 5M HCl
  - Removal of Ge, Zn and Fe from generator eluates necessary
- **Ga-67** obtained from **irradiated Zn targets**
  - Rapid method for Ga/Zn separation
  - Robust against Zn interference
- Several resins tested
  - Determination of D_W values
  - Elution studies
- Best results obtained with LN resin

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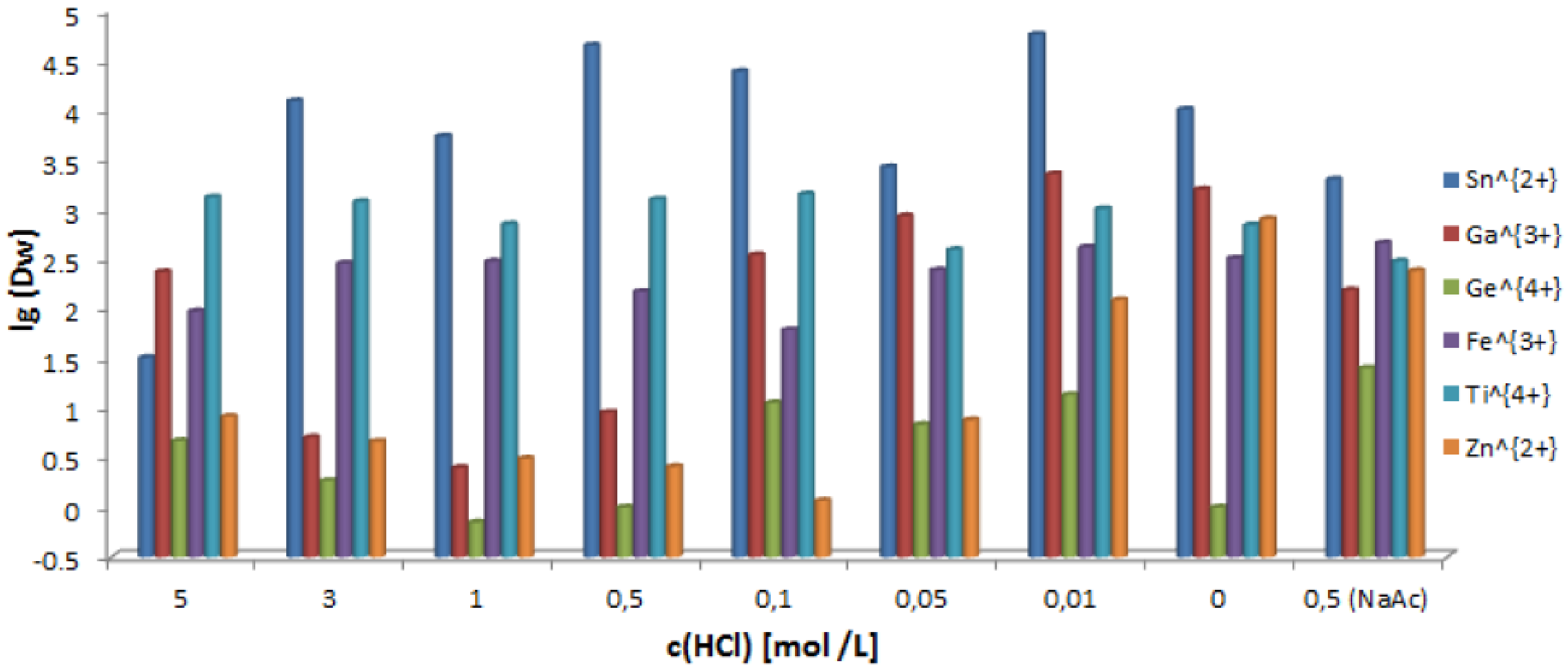
Gallium separation

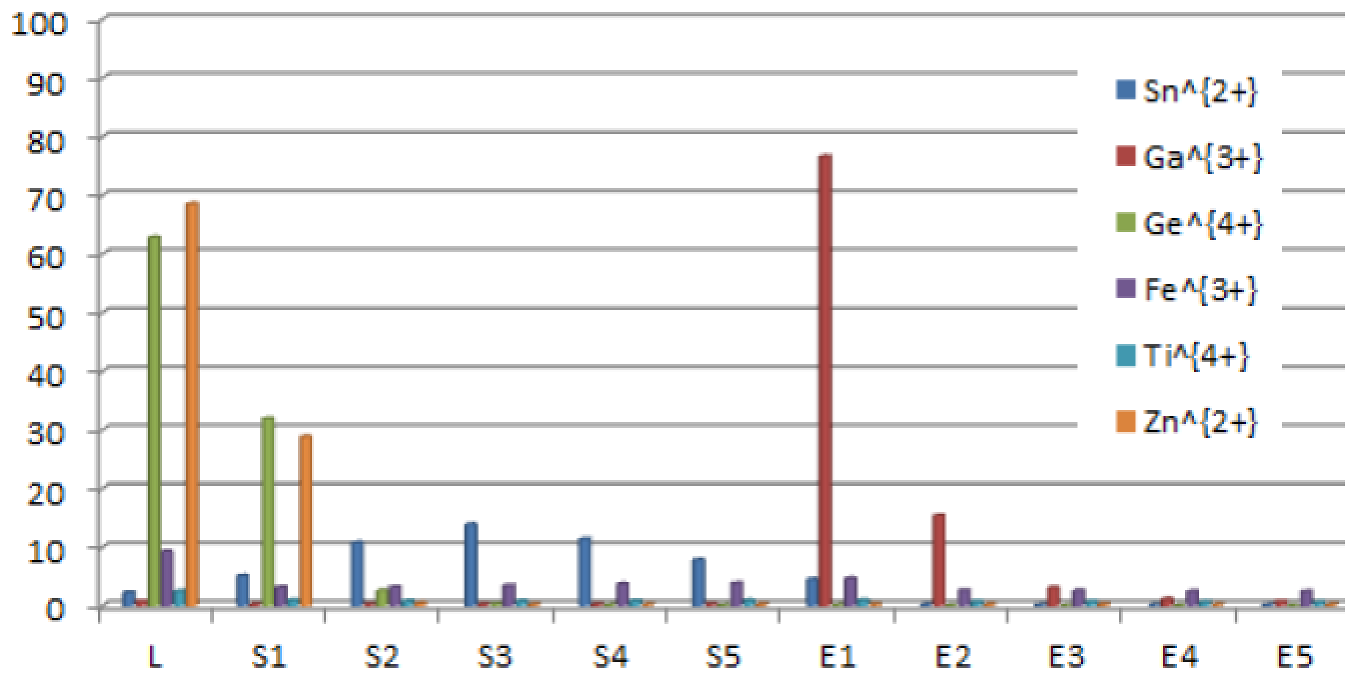
D_W values of selected elements on LN resin



- High D_W values for Ga at high (5M) and low (≤ 0.1M) HCl concentrations
- Low selectivity for Ge and Zn, selectivity generally high for Fe
- **Ga elution possible with 0.5M or 1M HCl**
- **Low selectivity for Zn in high HCl – interesting for Ga-67 production**

Gallium separation

1st elution studies – LN resin – Load from 5M HCl



- Load: 5 mL 5M HCl; S_N: 2 mL 5M HCl; E_N: 2 mL 1M HCl
- All fractions collected and analysed by ICP-MS
- Suitable selectivity, **Ga elution in 4 mL 1M HCl**

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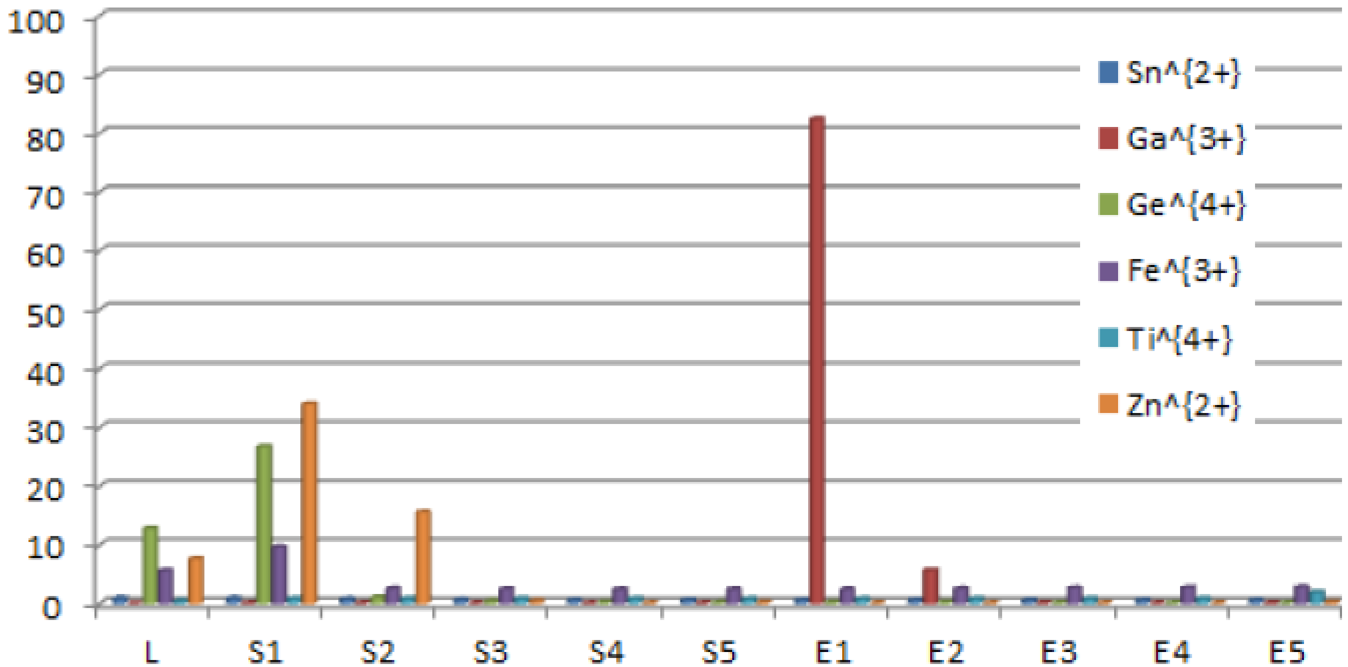
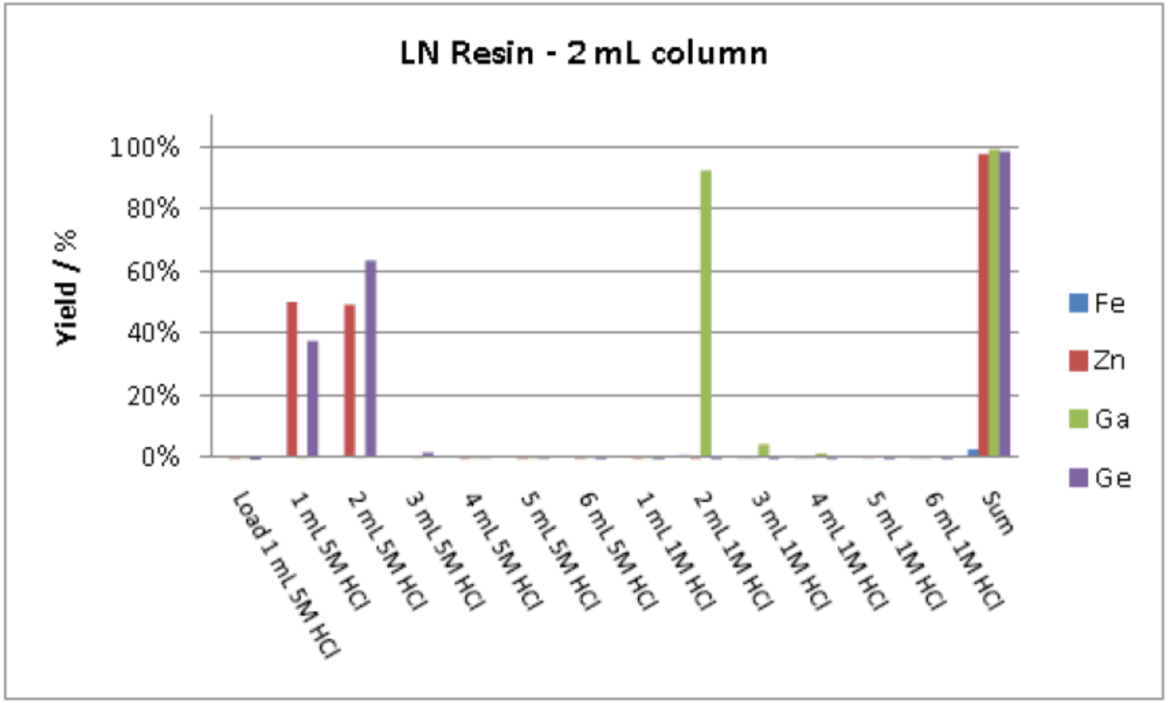
Gallium separation

1st elution studies – LN resin – Load from 0.1M HCl

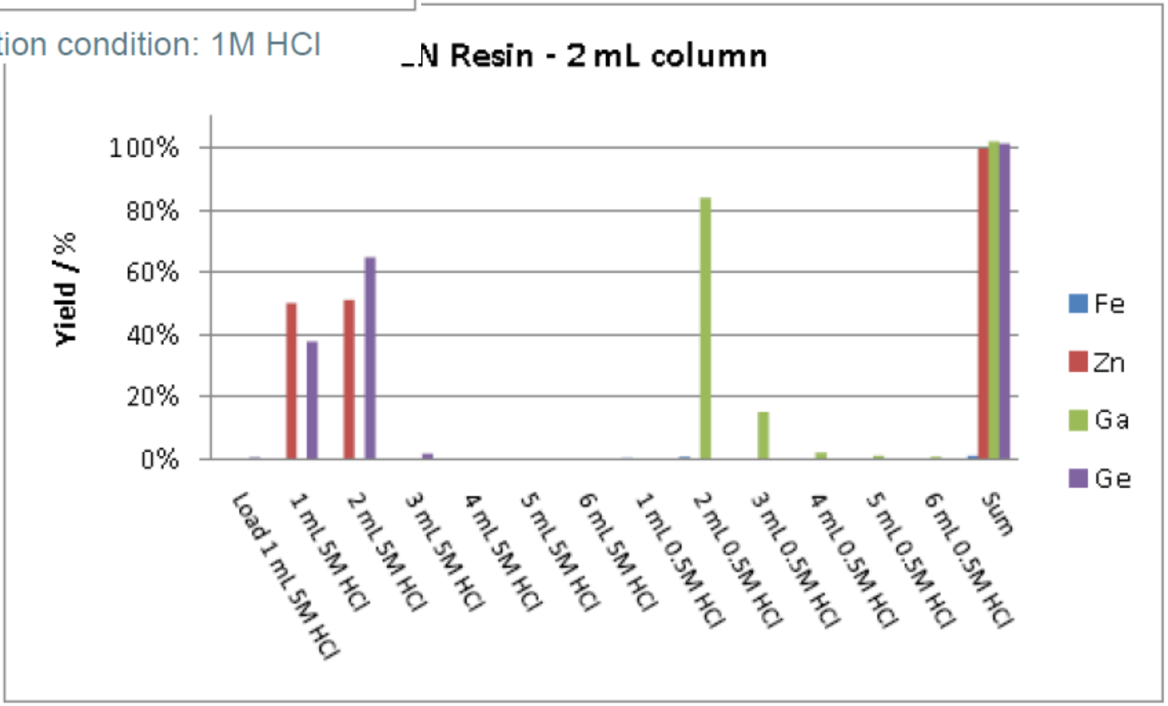


- Load: 5 mL 0.1M HCl; S_N: 2 mL 0.1M HCl; E_N: 2 mL 1M HCl
- All fractions collected and analysed by ICP-MS
- Suitable selectivity, near **quantitative Ga elution in 2 mL 1M HCl**



Elution study 2 mL LN column; 5M HCl, Elution condition: 1M HCl

- 1M HCl slighly lower elution volume than 0.5M HCl



Elution study 2 mL LN column; 5M HCl, Elution condition: 0.5M HCl

Thank you for your attention!

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