Preliminary investigations of zirconium behaviour with extraction chromatography and other media

Peter Ivanov, Simon Jerome, Ben Russell

National Physical Laboratory, UK

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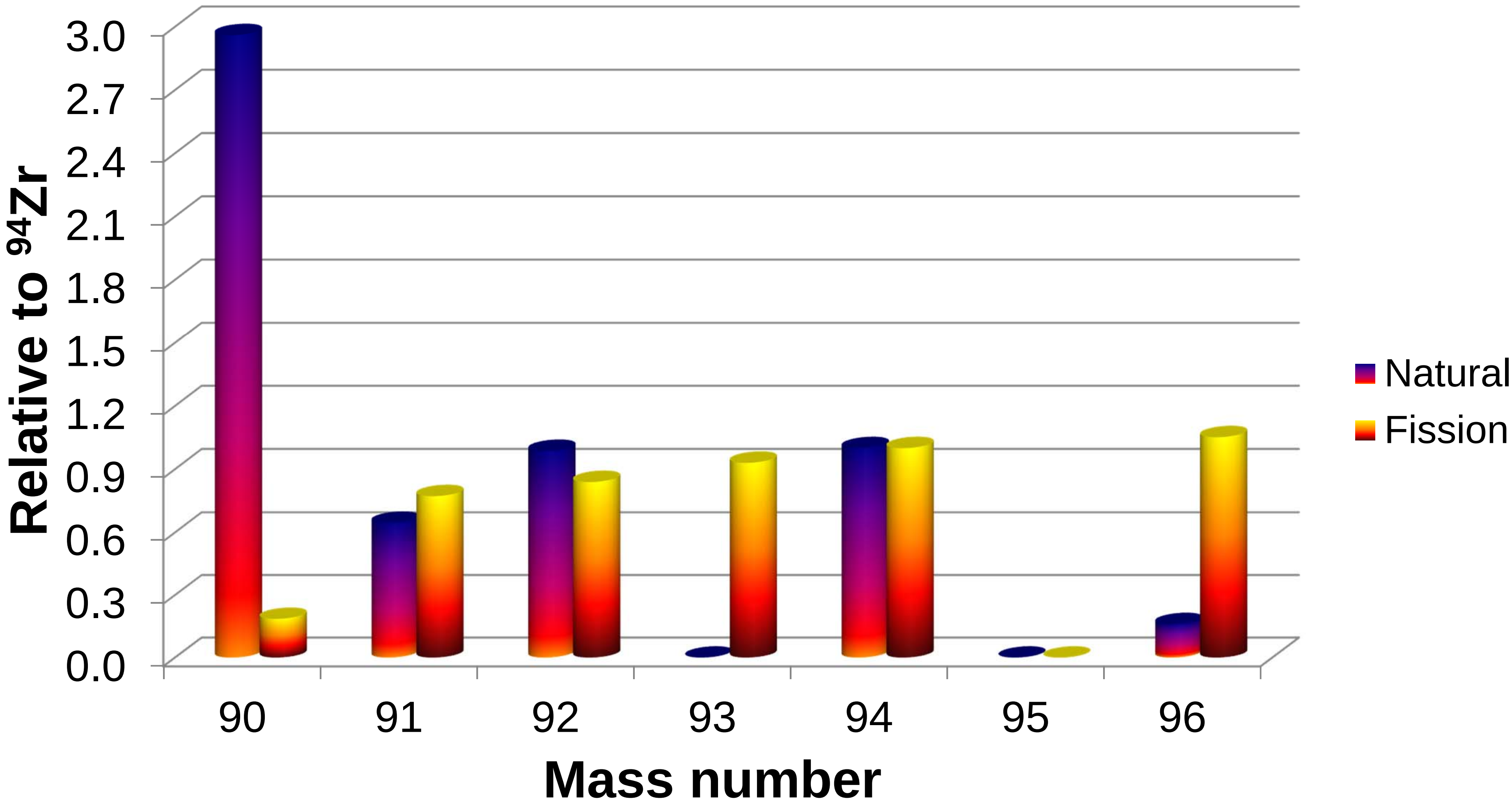
Introduction

- Zirconium as an element
- Production of ^{88}Zr and ^{89}Zr
- Planned standardisation of ^{93}Zr
- Recovery and purification of ^{95}Zr from fission product mixtures

(This work was carried out by Peter Ivanov and Ben Russell)

Zirconium

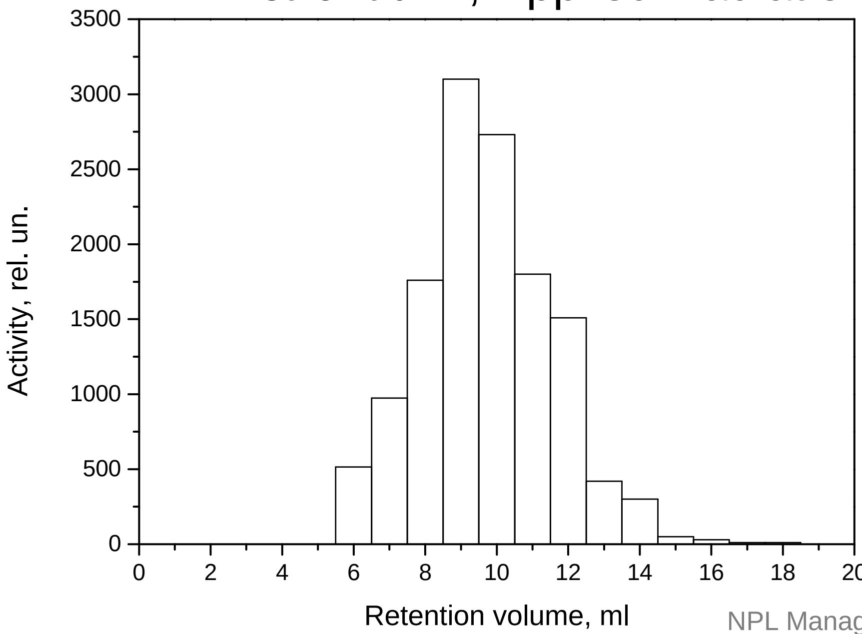
Zirconium mass distribution

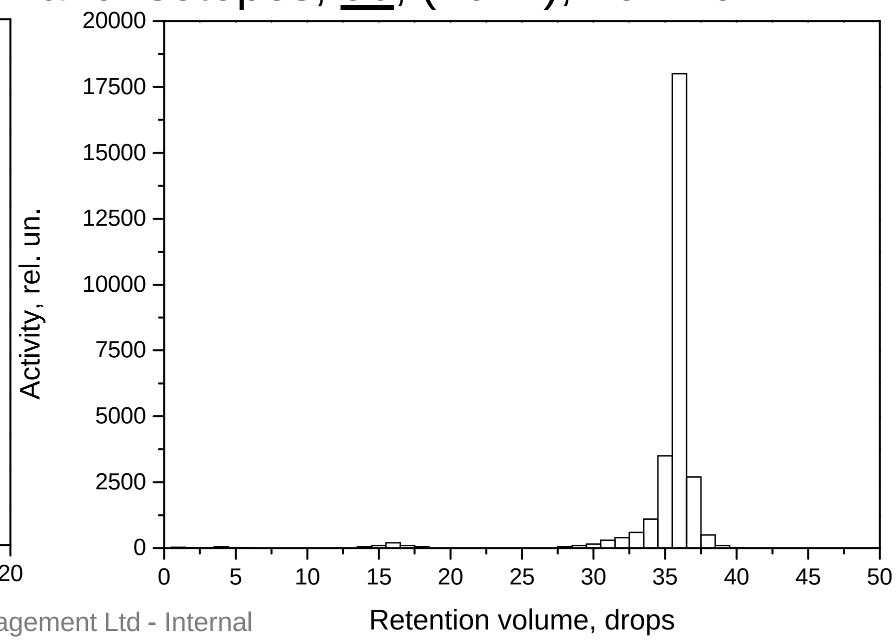


Zirconium-88 and -89

- Used medically
  - Absorption of Zr on anion resin:
  - Load solution: **12M HCl** Elution: **6M HCl**
  - Load solution: **3M HF** Elution: **1M HNO_3**

Ivanov, P.I *et al*, '*Cyclotron production and radiochemical purification of ^{88,89}Zr via α-particle induced reactions on natural strontium*', Applied Radiation and Isotopes, **90**, (2014), 261-264





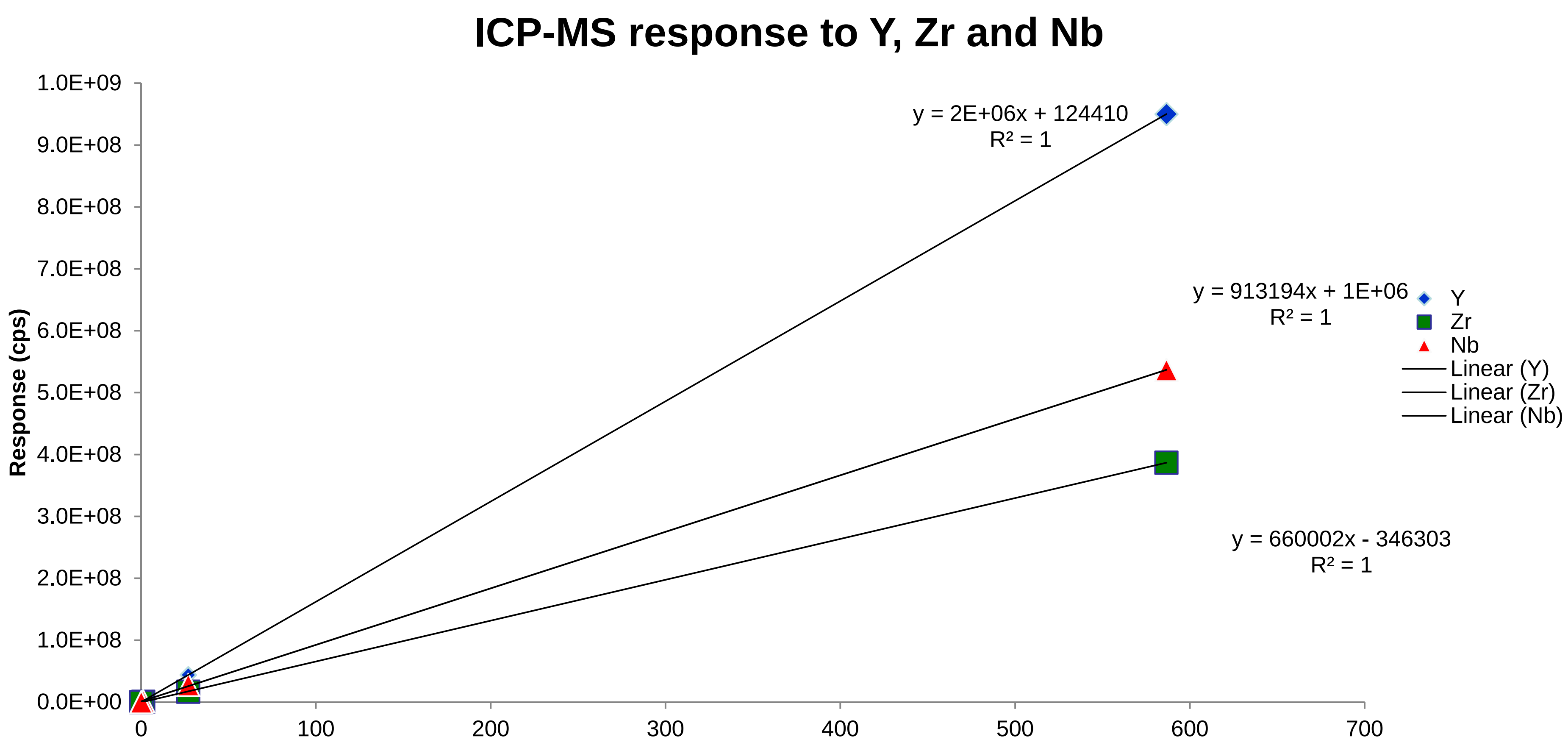
Zirconium-93

- Standardisation of ^{93}Zr
  - High yield (**>6%**), long lived (**$t_{½}$: 1.6×10^{6} y**) fission product
  - Also activation product from irradiation of zircaloy in fuel
  - Dominant nuclide 0.5-5 million years
- Relatively pure
  - Need to separate from residual fission products
  - Have to separate from ^{93m}Nb daughter

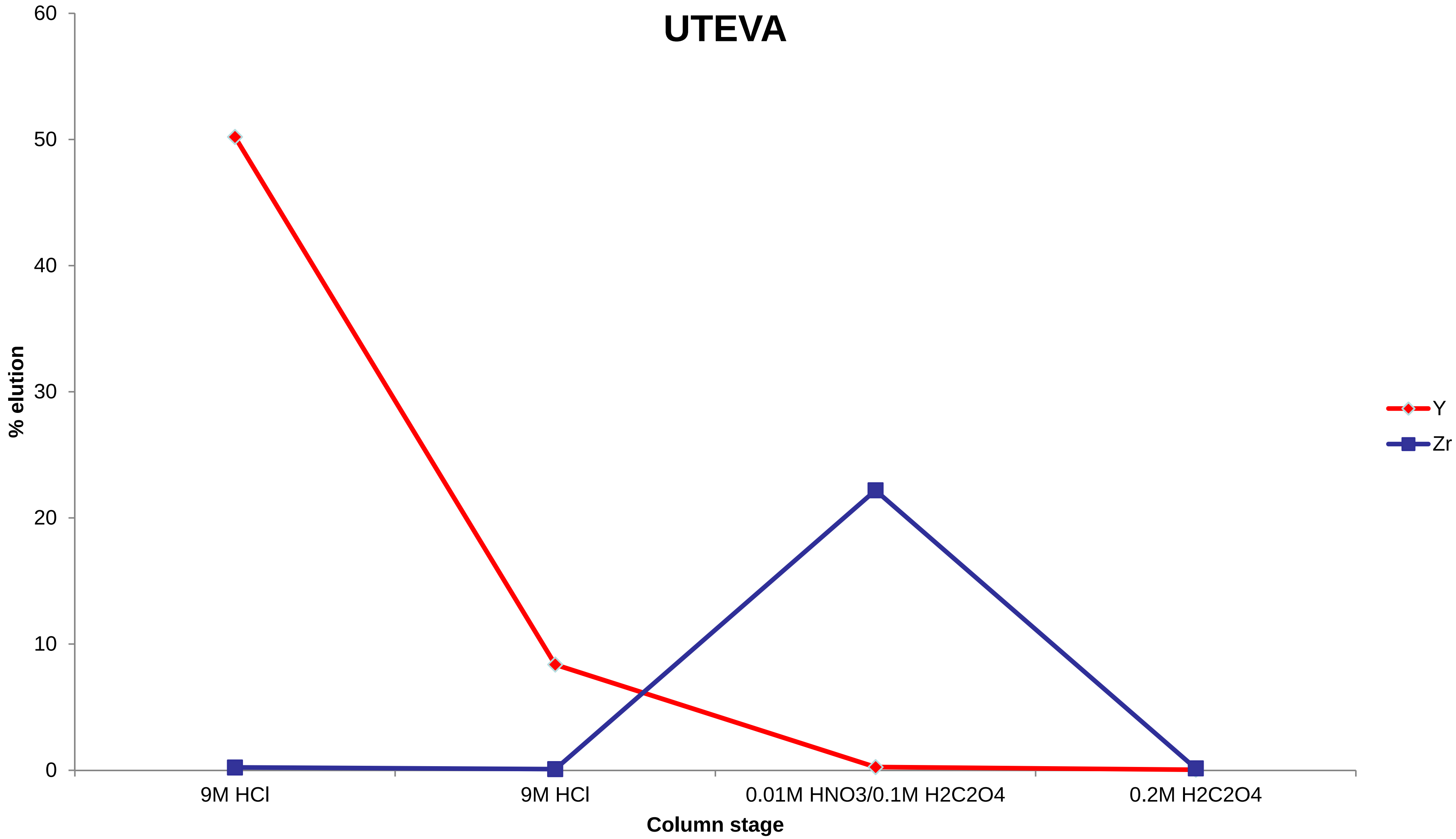
What else do we say here?

Recovery and purification of ^{95}Zr from fission products

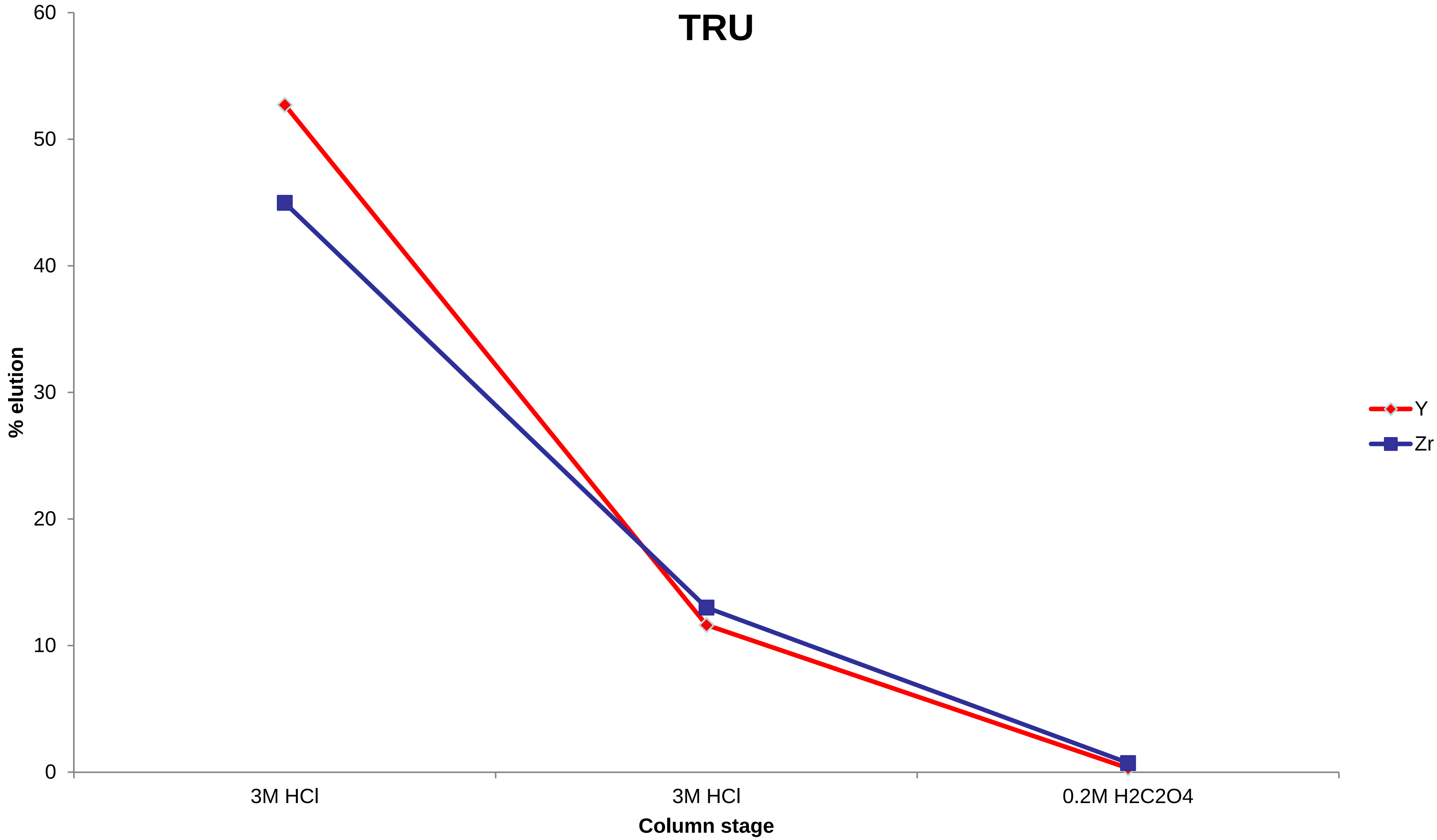
- Recovered as useful radionuclide from irradiated uranium targets



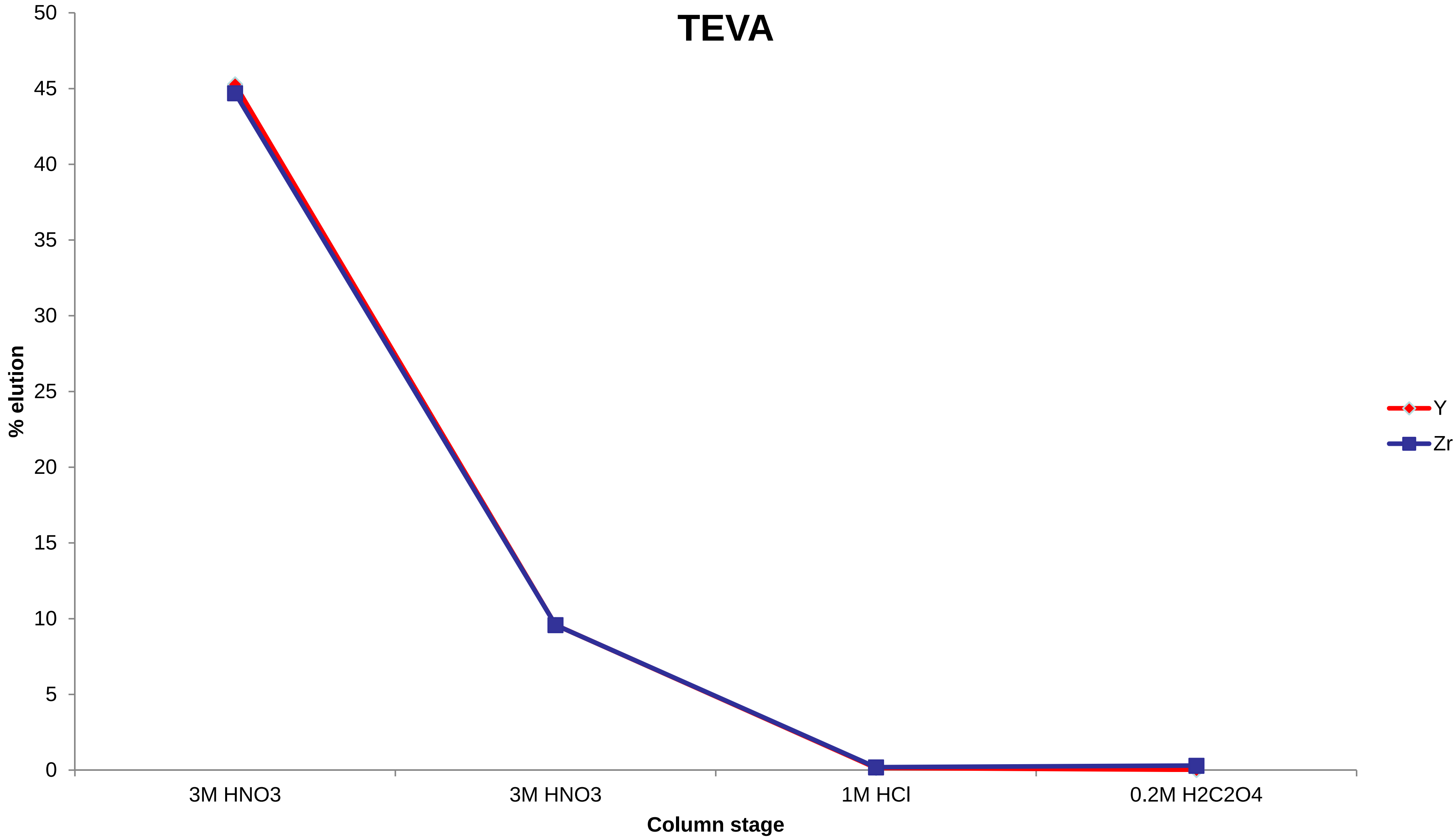
Zr behaviour



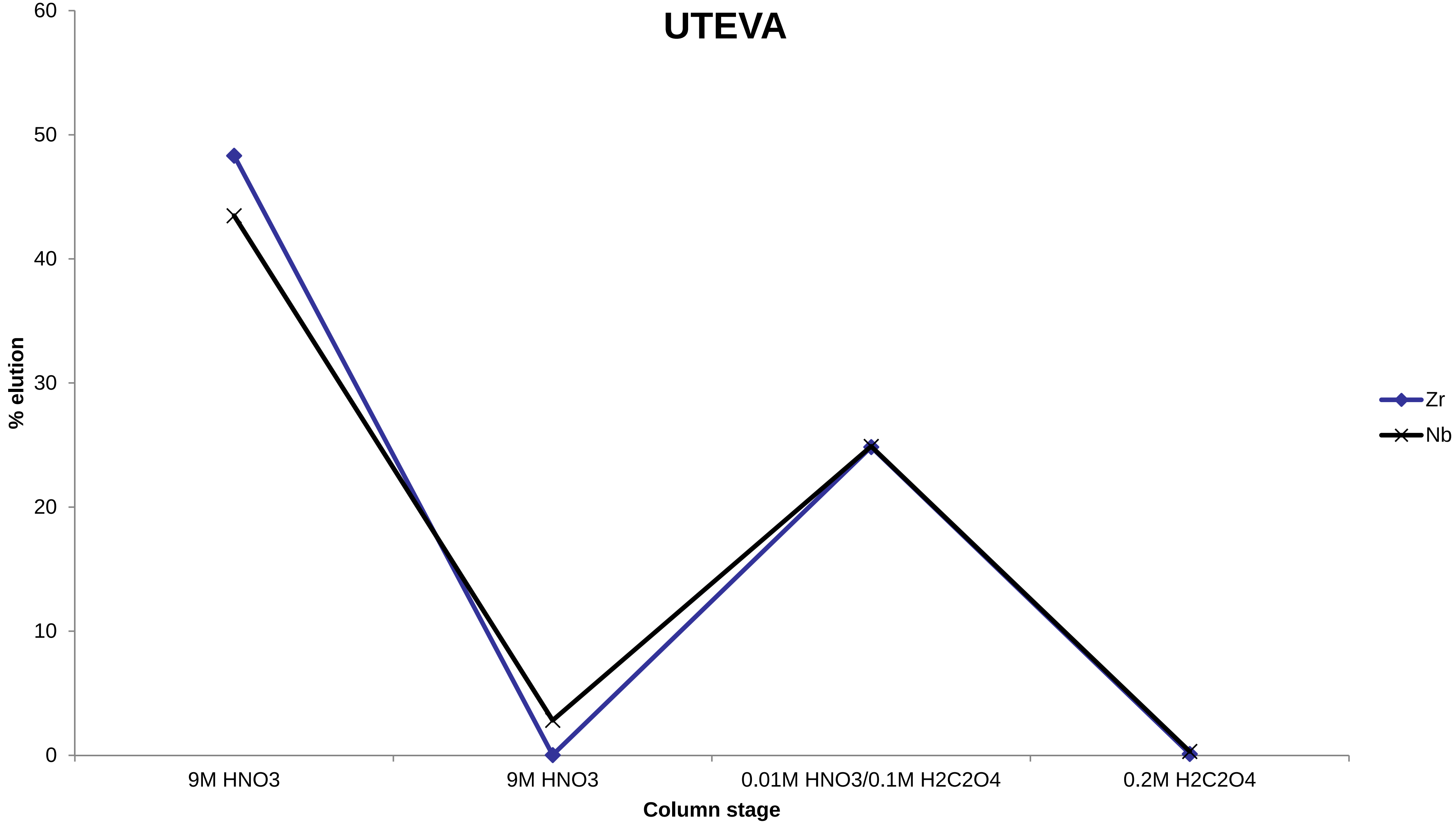
Zr behaviour



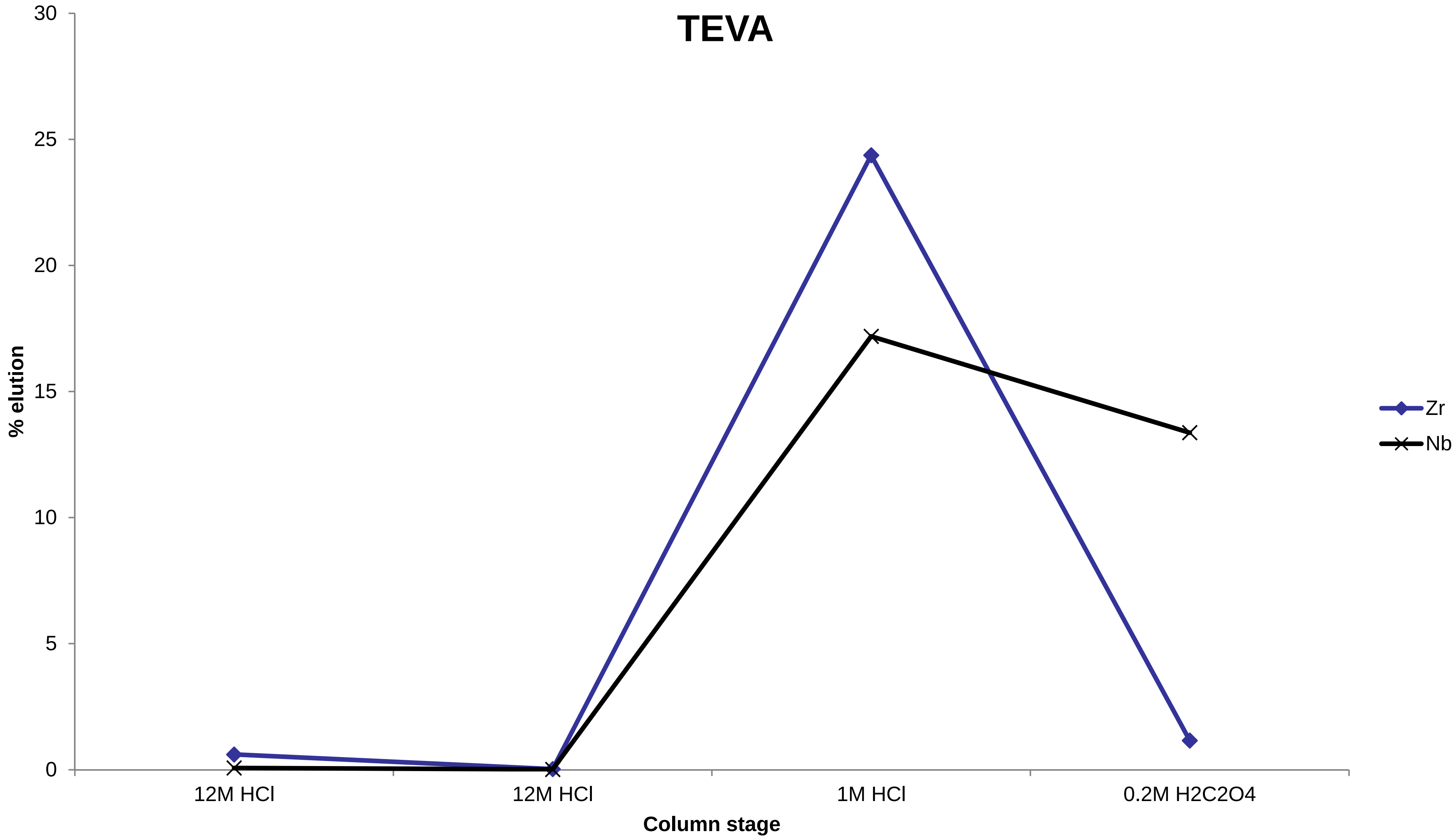
Zr behaviour



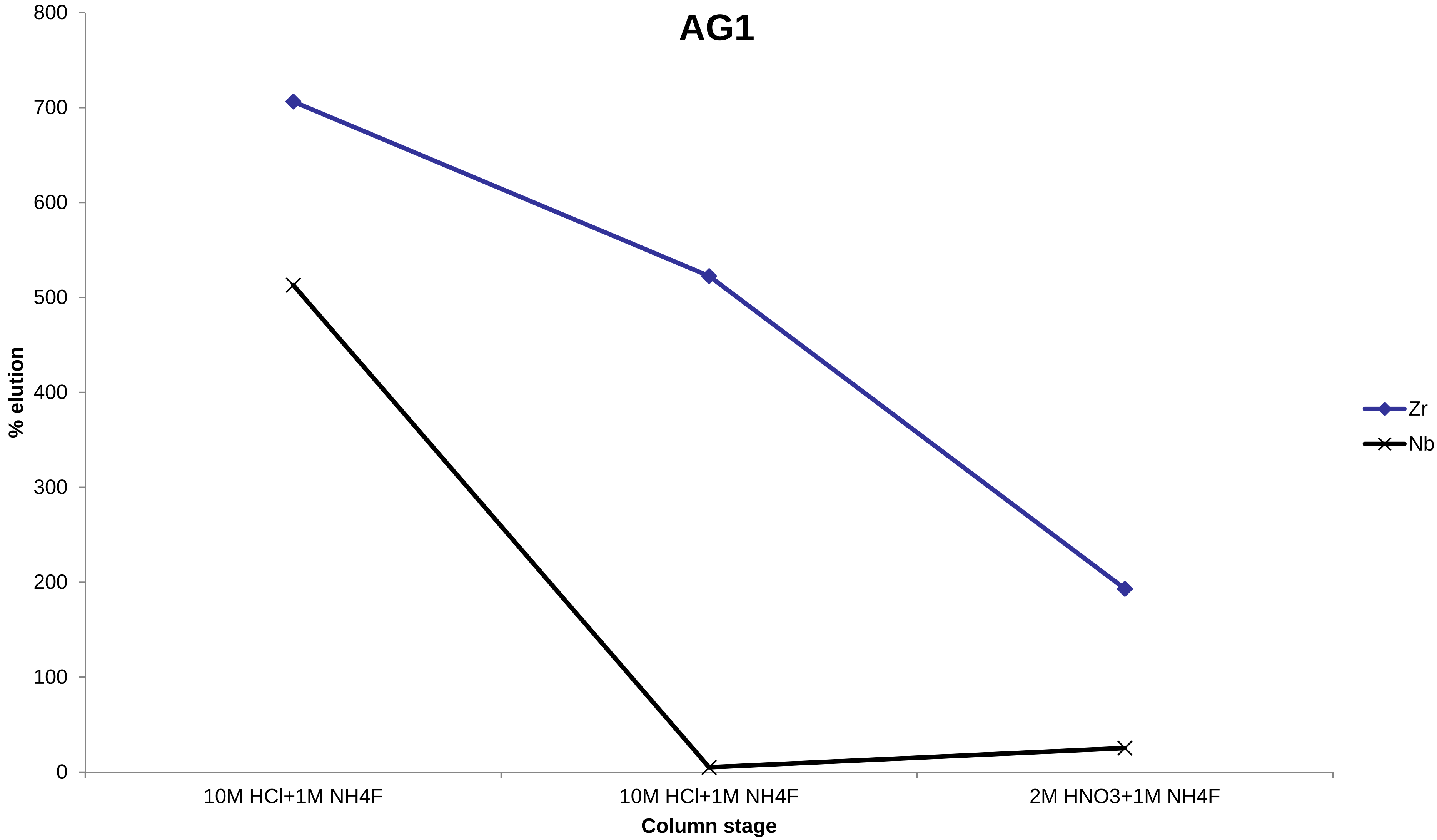
Zr behaviour



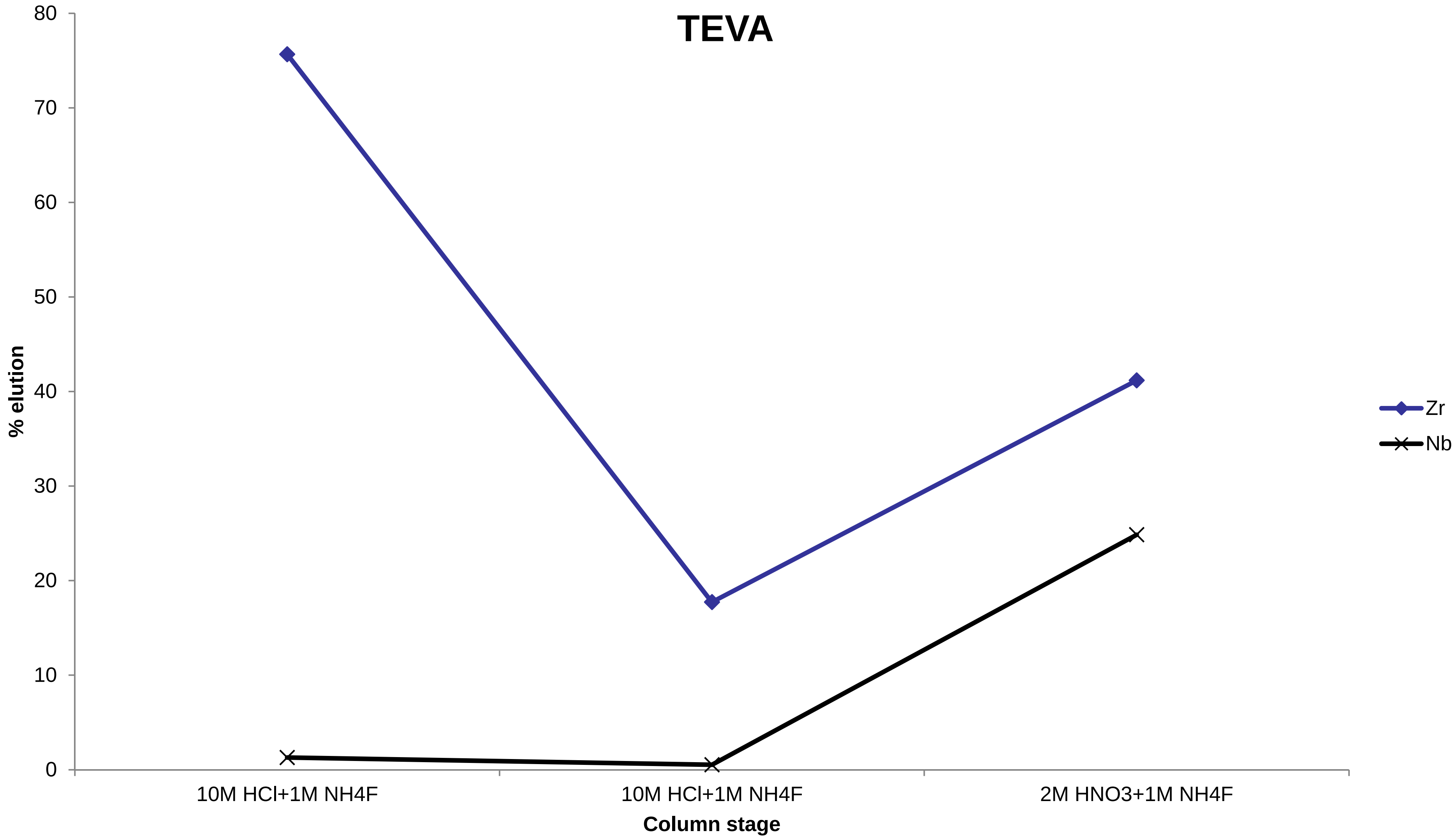
Zr behaviour



Zr behaviour



Zr behaviour



Zr separation

- U-TEVA
  - Yttrium weakly adsorbed in 9M HCl
  - Zirconium strongly adsorbed in 9M HCl
  - Niobium strongly adsorbed in 9M HCl

  - Zirconium weakly adsorbed in 9M HNO_3
  - Niobium weakly adsorbed in 9M HNO_3

- Therefore
  - Load in strong HCl to remove lanthanides
  - Recover with strong nitric acid

Zr separation

- TEVA
  - Zirconium strongly adsorbed in 12M HCl
  - Niobium strongly adsorbed in 12M HCl

  - Zirconium weakly adsorbed in 10M HCl/1M NH_4F
  - Niobium strongly adsorbed in 10M HCl/1M NH_4F

- Therefore
  - Load in strong HCl to adsorb zirconium and niobium
  - Recover zirconium with 10M HCl/1M NH_4F

Zr separation next steps

- Fission products
  - Behavior of antimony and other fission products on U-TEVA and TEVA
- Optimisation
  - Specific isolation of zirconium
  - Use of stacked columns
  - Try and avoid use of HF

Conclusions

- Separation and purification of zirconium
  - Work so far suitable for:
    Separating ^{89}Zr from Y_2O_3 target
    Purifying ^{93}Zr sample – main issue: removal of ^{93m}Nb and ^{152}Eu
  - Extend to spectrum of fission products

- Future
  - Test removal of niobium with ^{92m}Nb/tantalum
  - Stacked columns

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