

Separation of Metal Ions using Tetraphenylborate

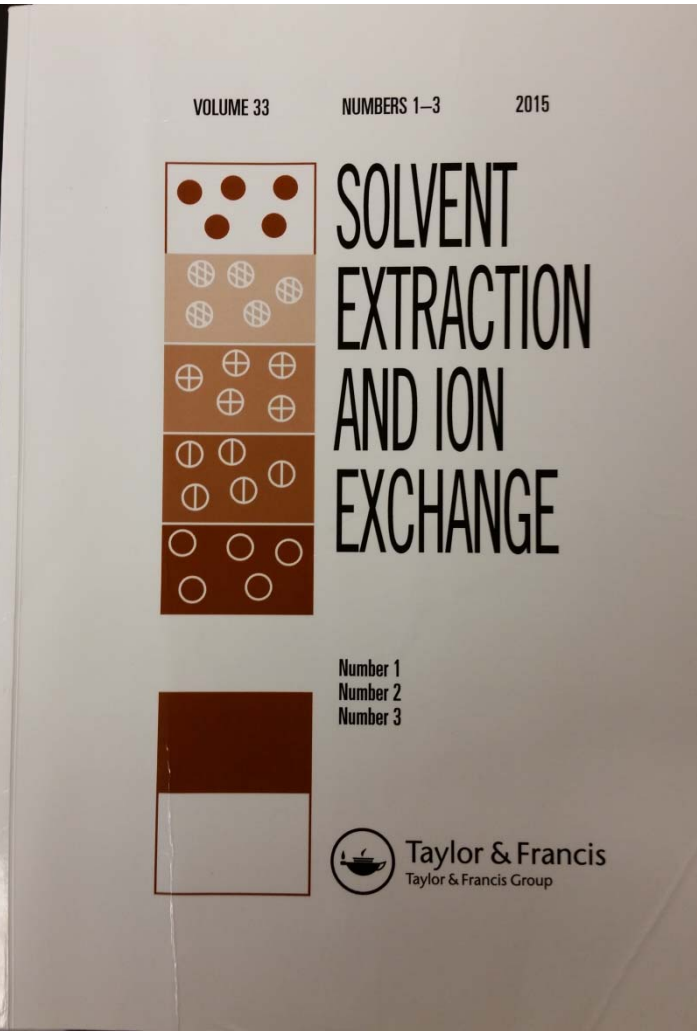
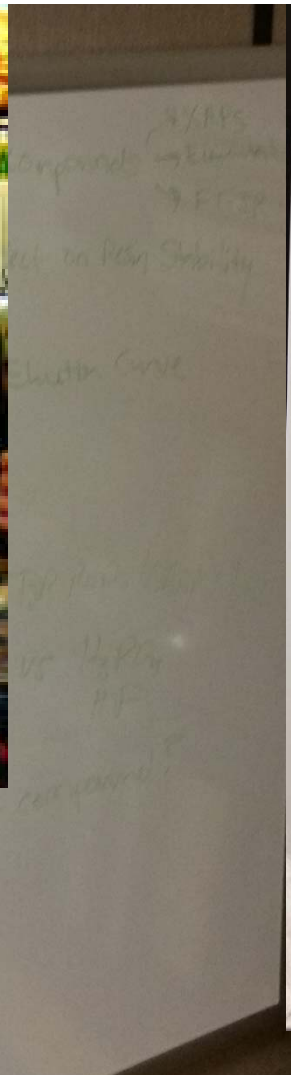
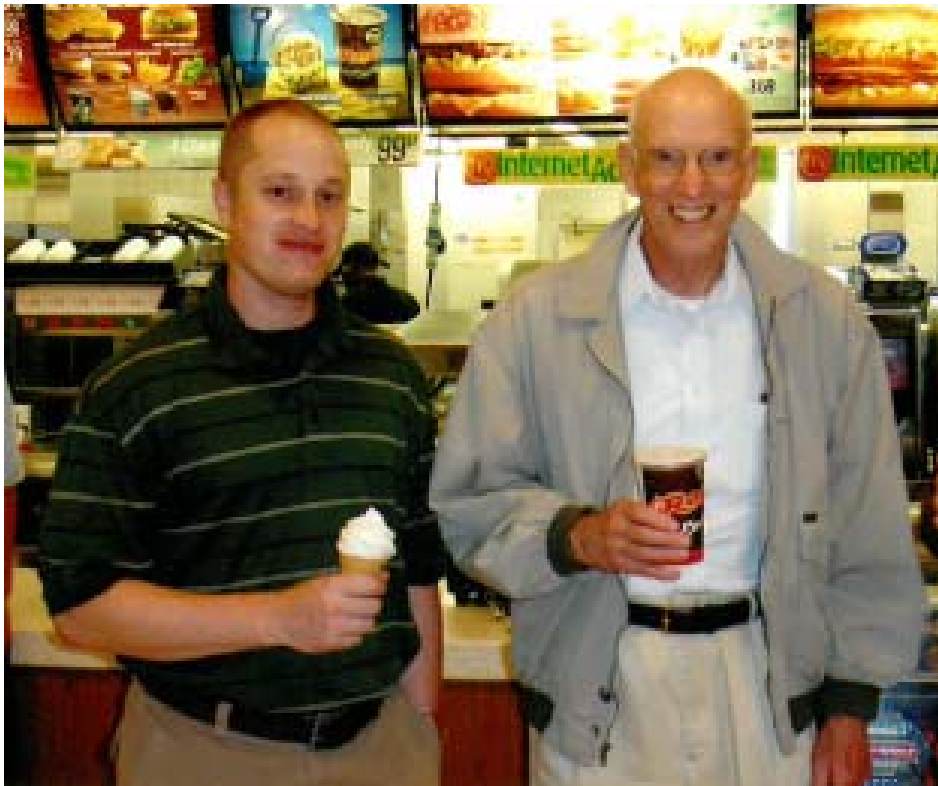
Daniel McAlister, Ph.D.

and

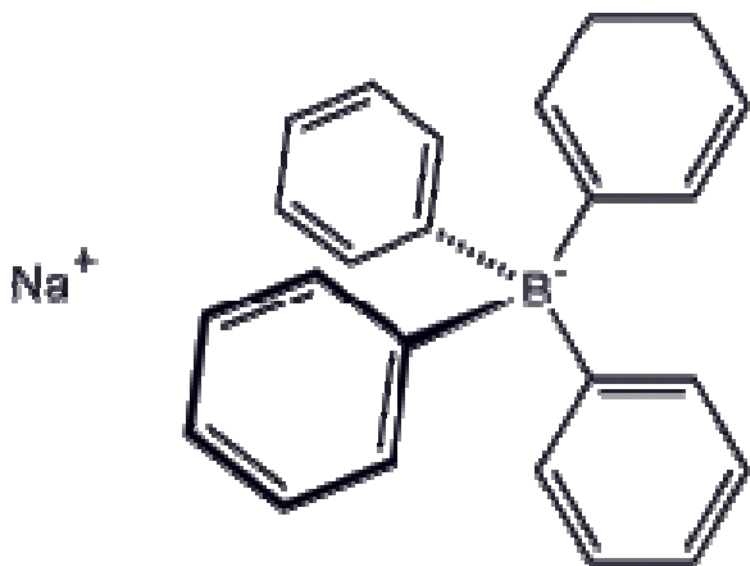
E. Phil Horwitz, Ph.D.

Eichrom Technologies, LLC





Tetraphenyl Borate



50% TBP in toluene

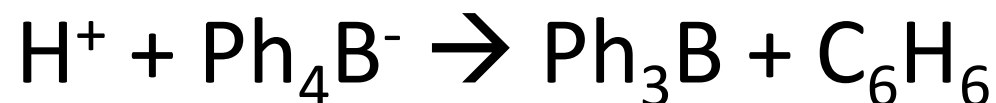
Weakly coordinating
cation exchanger

High Selectivity for Li⁺

Steric Hindrance

NaPh₄B water soluble

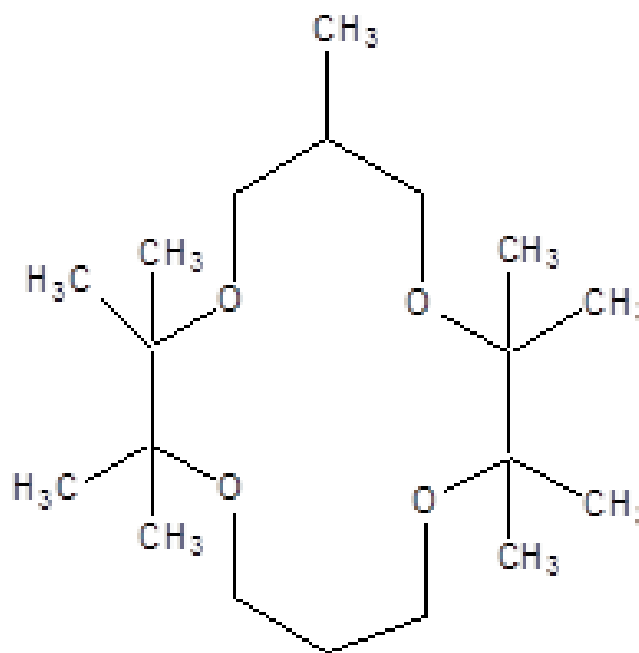
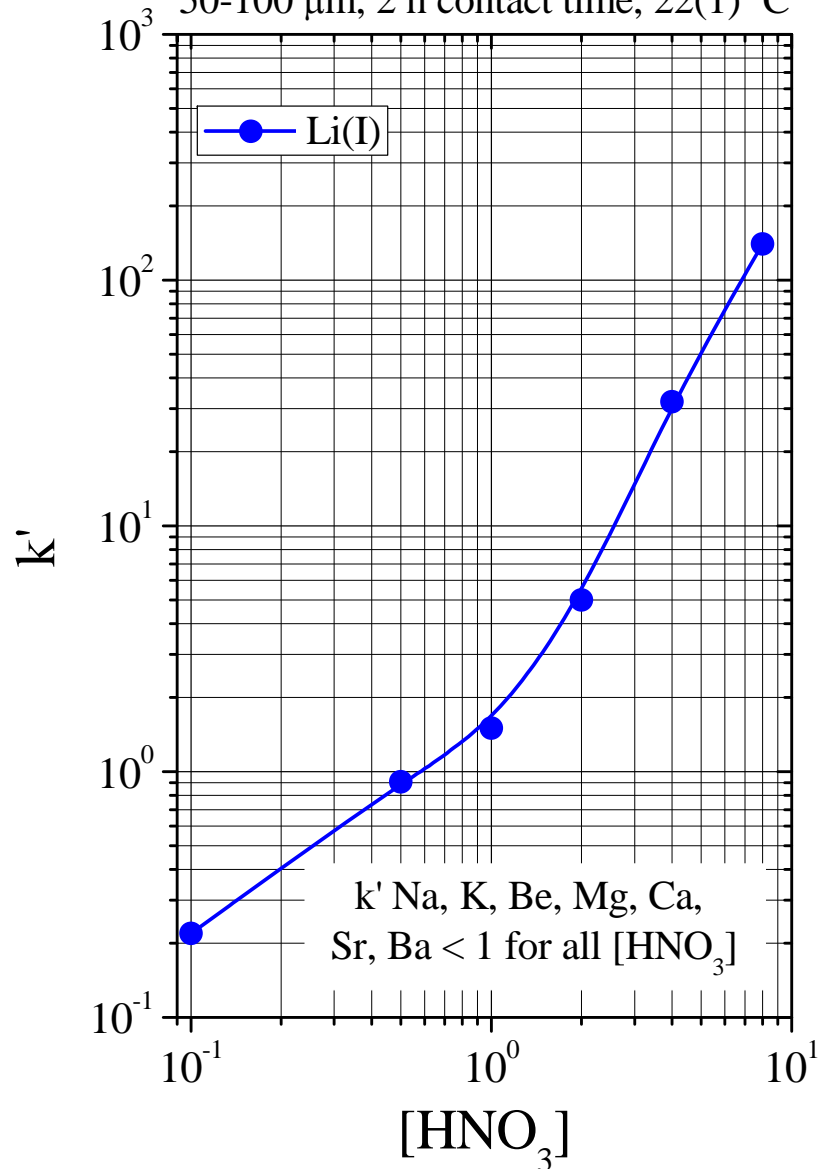
NaPh₄B partitions to
organic diluents



“Extraction of Lithium using TBP and the Noncoordinating Cation Exchanger TetraPhenylBorate: Principles of Selectivity from Sodium and Higher Valent Cations,” V.I. Kuz’min and N. V. Gudkova, *Solv. Extr. Ion Exch.*, 33, 183-195 (2015).

k' vs. HNO_3 for Li Resin

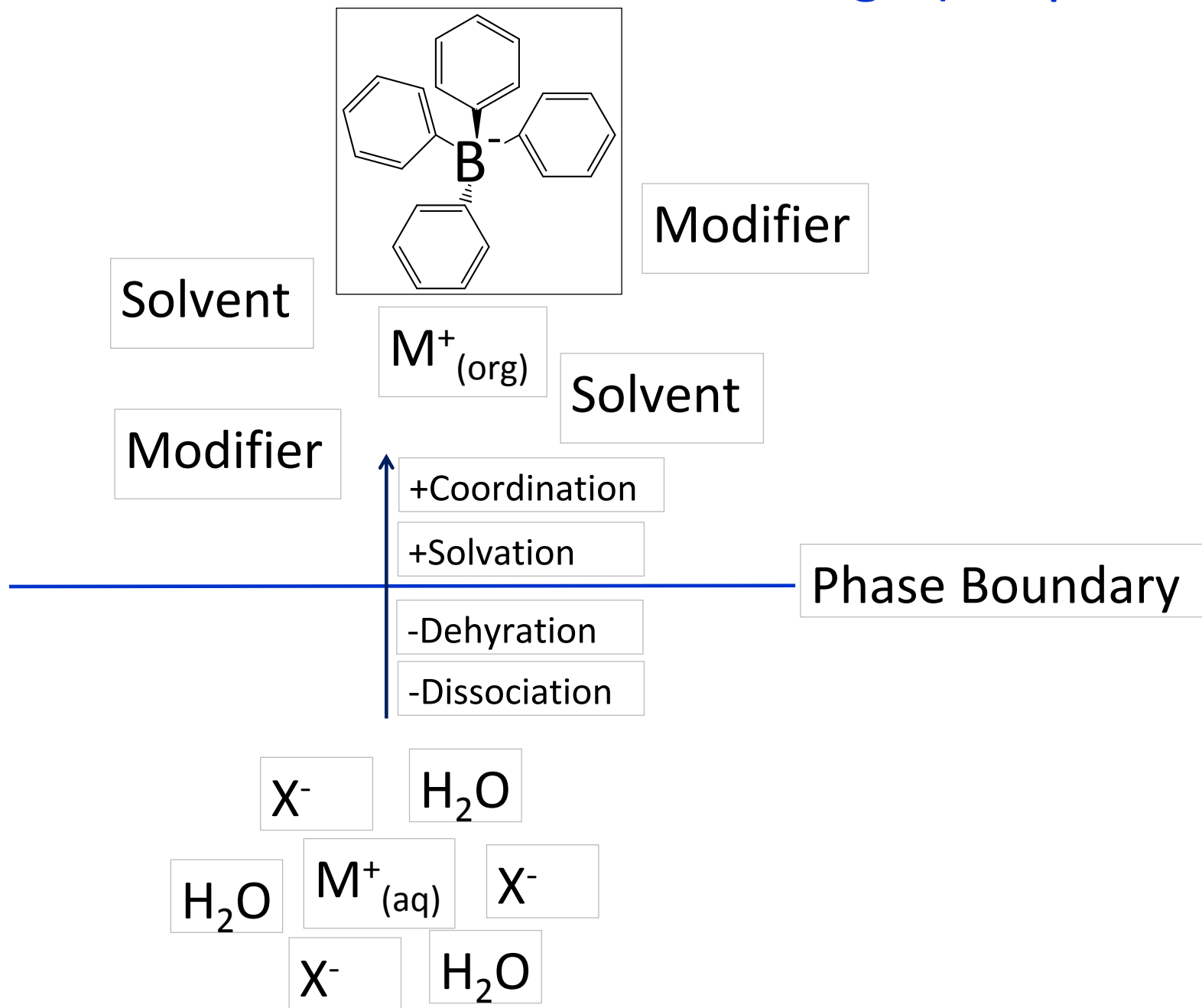
50-100 μm , 2 h contact time, 22(1) $^\circ\text{C}$



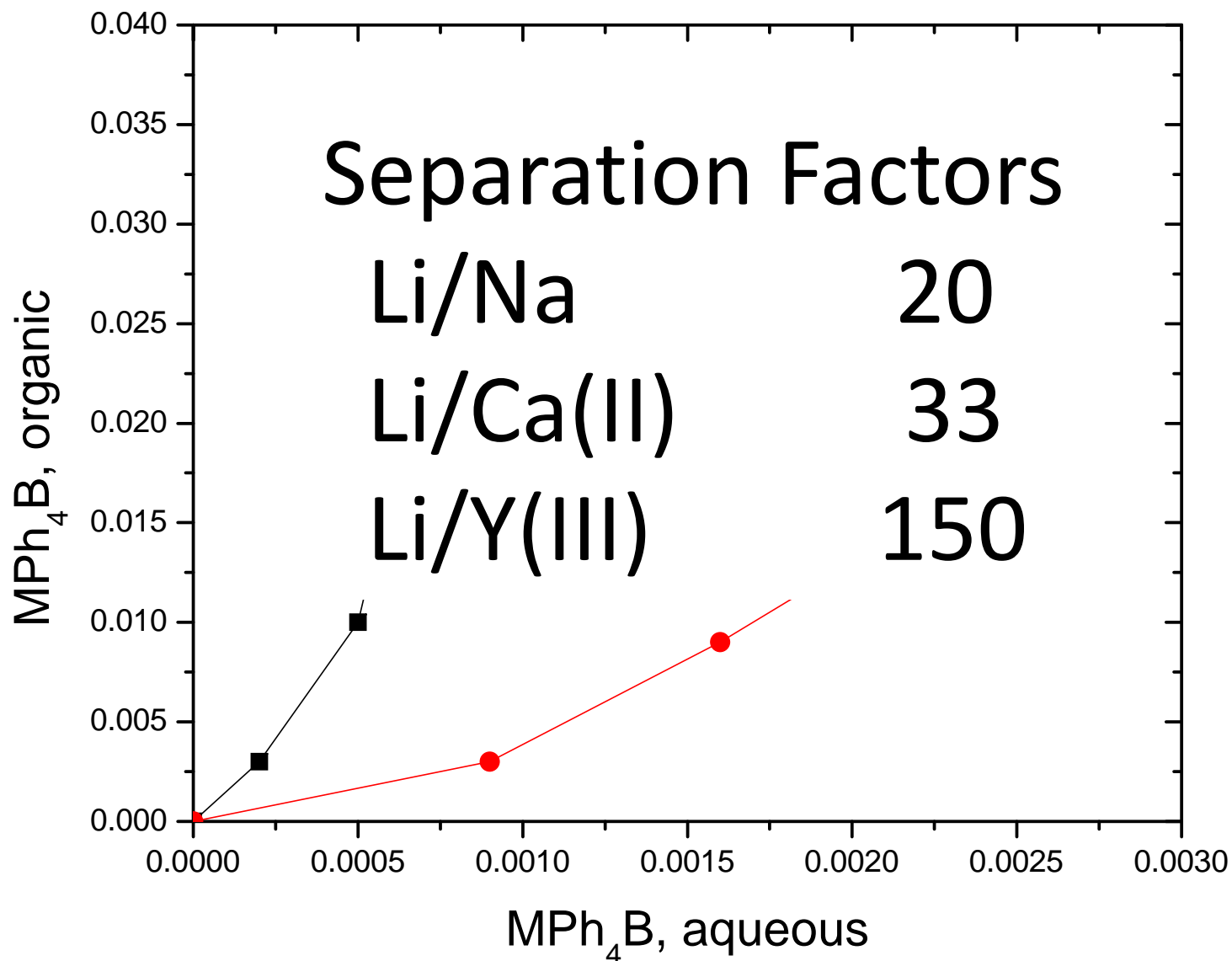
2,2,3,3,6,9,9,10,10-Nonamethyl-14-crown-4

R.A. Sachleben and B.A. Moyer, "Ligand Design for Small Cations: The $\text{Li}^+/\text{14-Crown-4}$ System," In Metal Ion Separation and Preconcentration: Progress and Opportunities. ACS Symposium Series 716, American Chemical Society, Washington D.C., 1999, pp 114-132.

Solvent Extraction with Ion Exchange (Simplified)

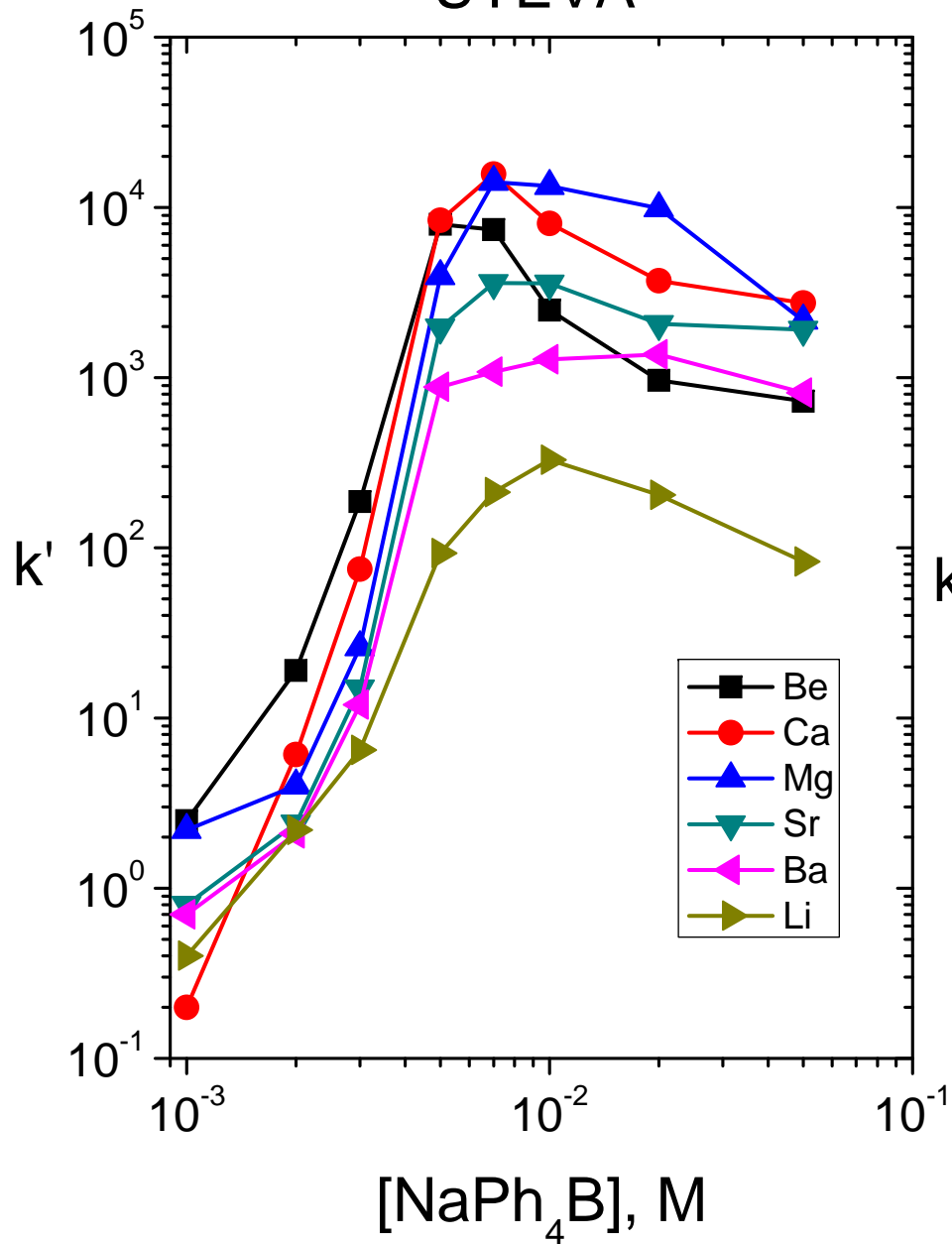


Distribution of Li/Na into 30% TBP in toluene

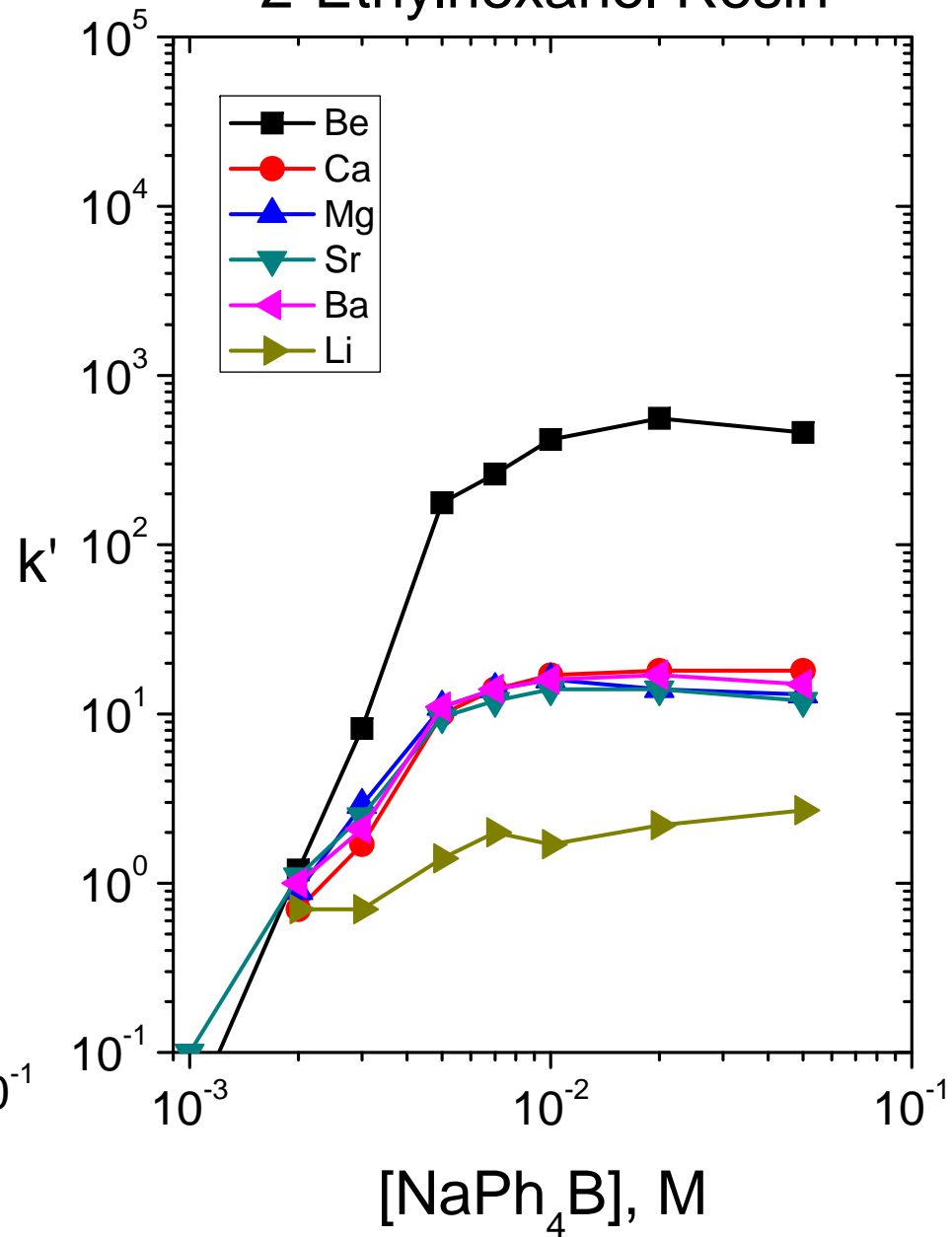


“Extraction of Lithium using TBP and the Noncoordinating Cation Exchanger TetraPhenylBorate: Principles of Selectivity from Sodium and Higher Valent Cations,”
V.I. Kuz’min and N. V. Gudkova, *Solv. Extr. Ion Exch.*, 33, 183-195 (2015).

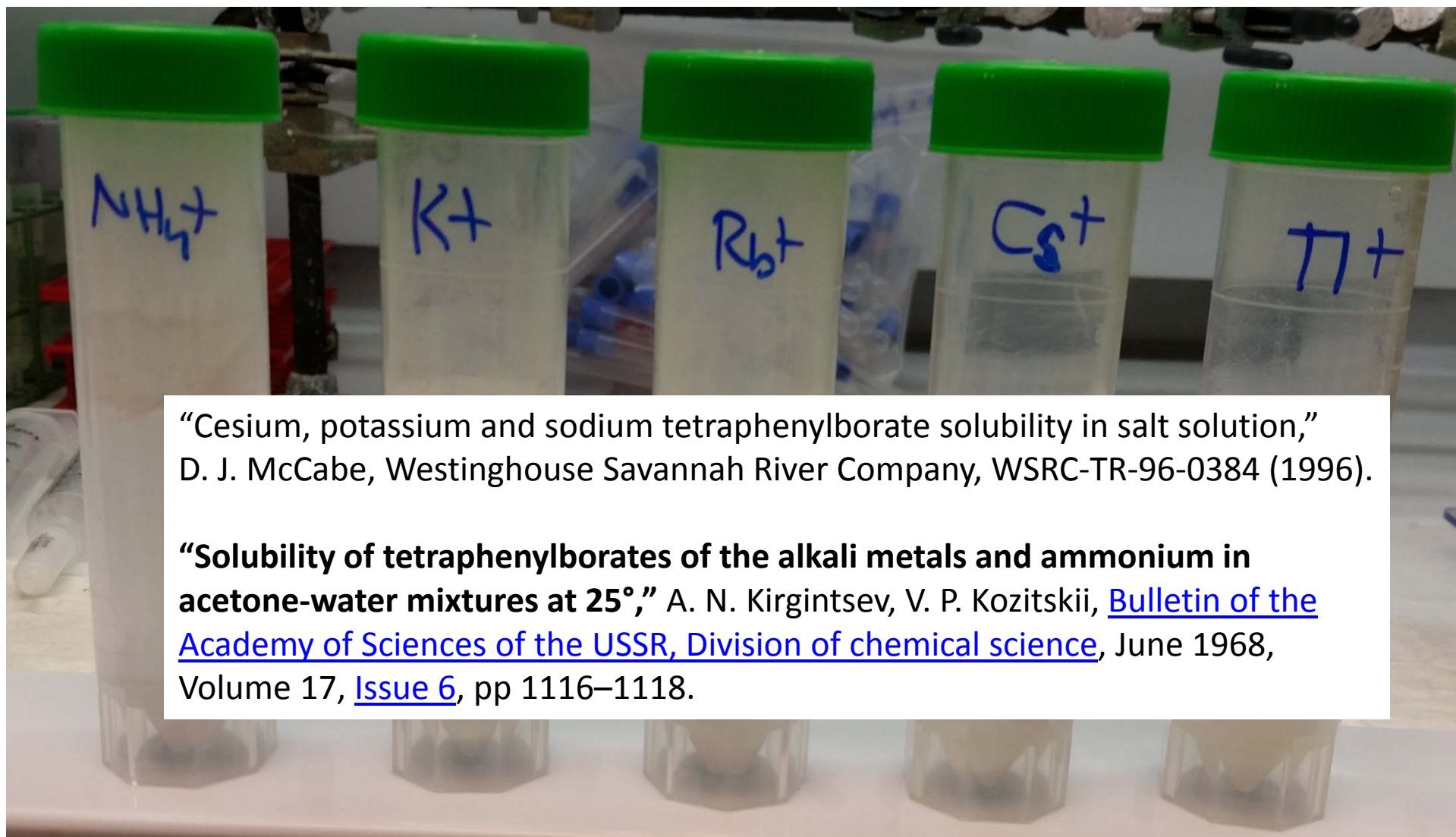
UTEVA



2-Ethylhexanol Resin



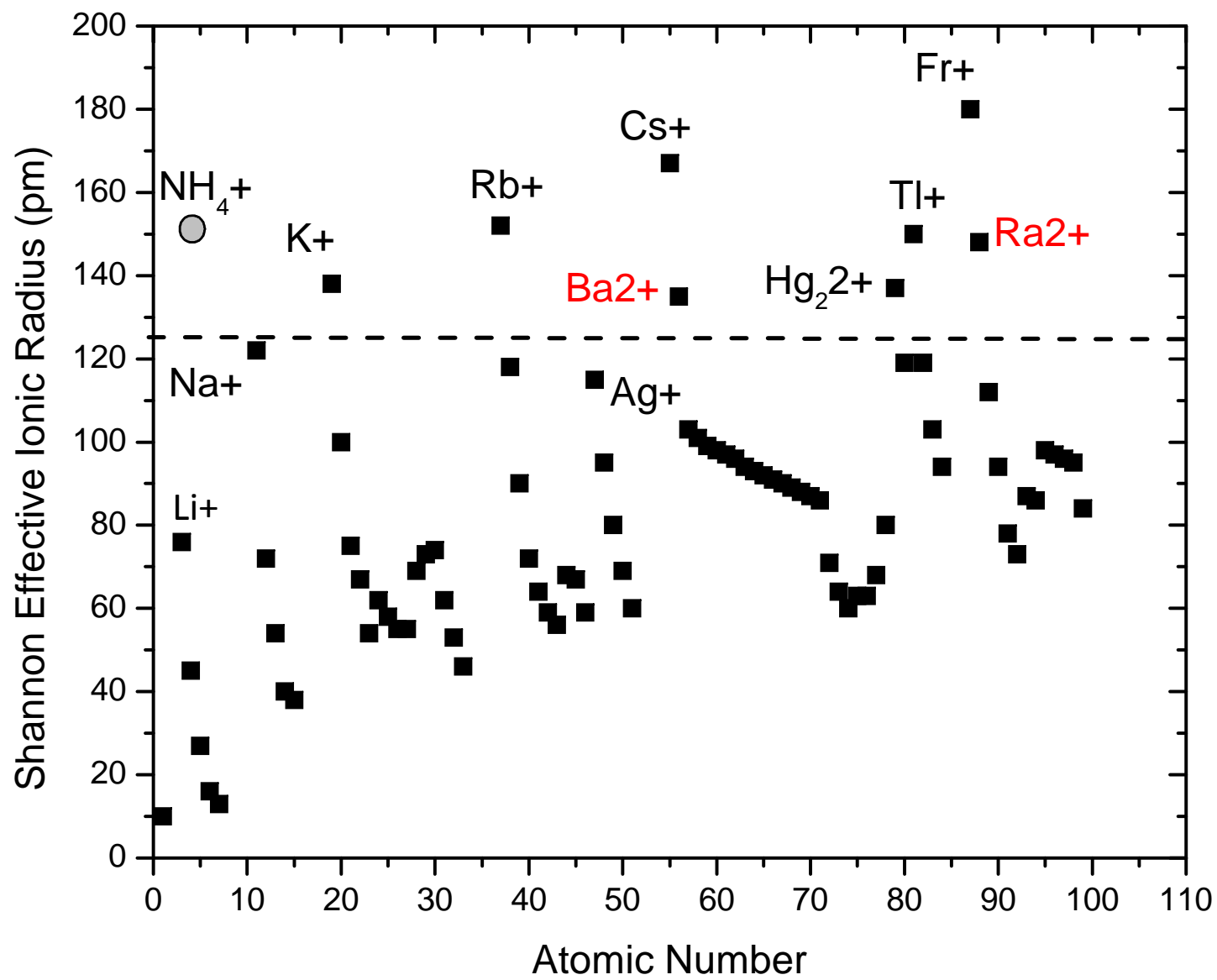
Precipitation from NaPh₄B in Water

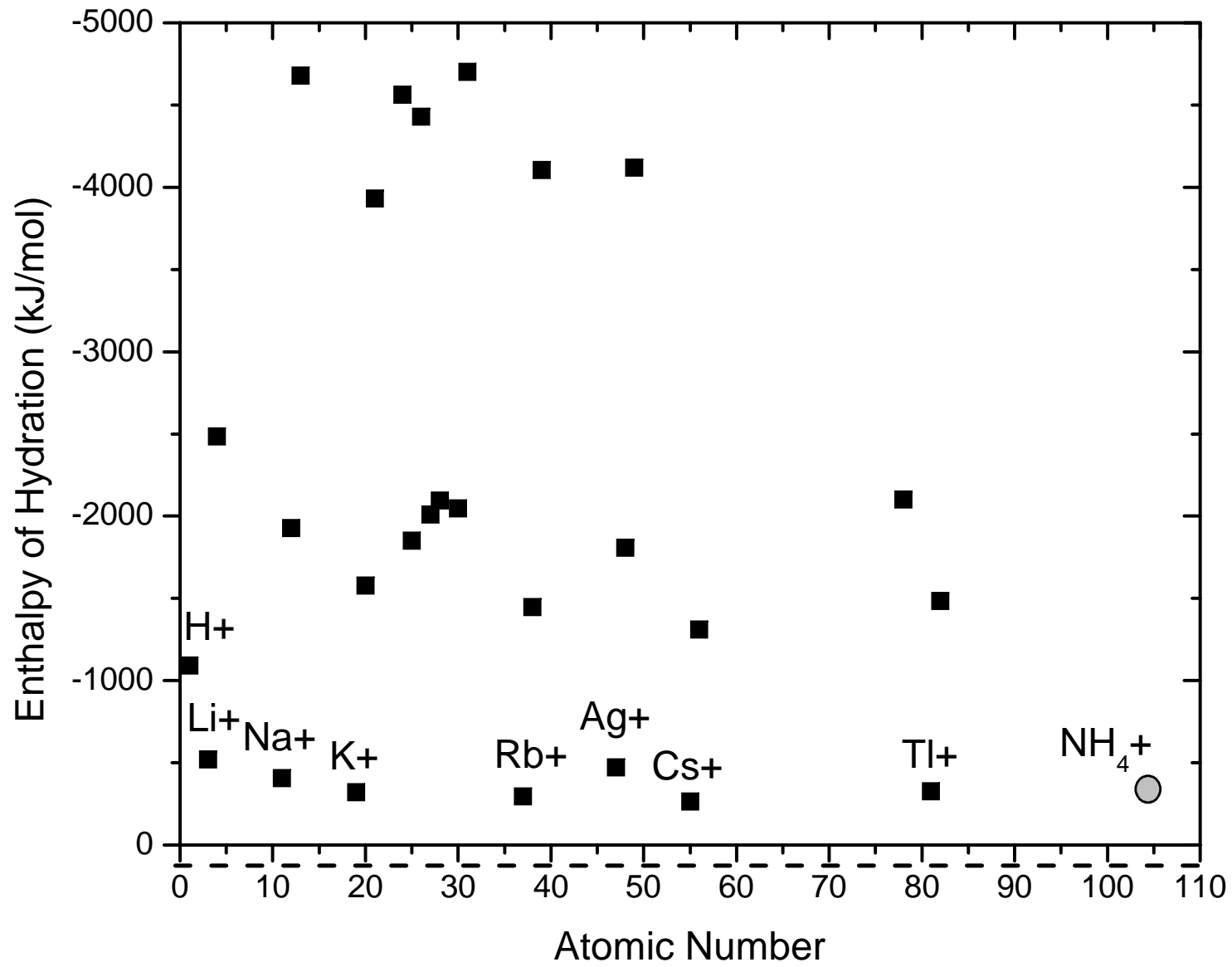


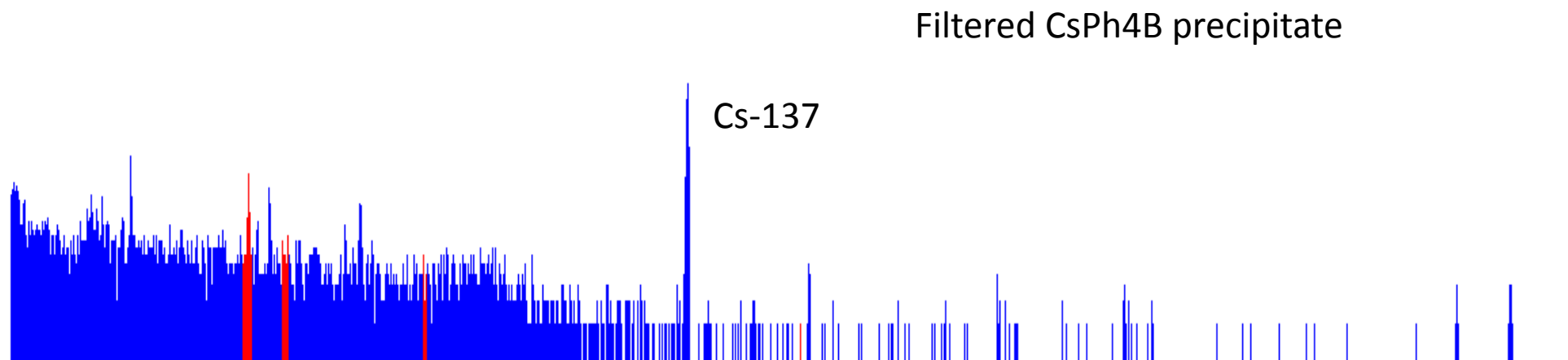
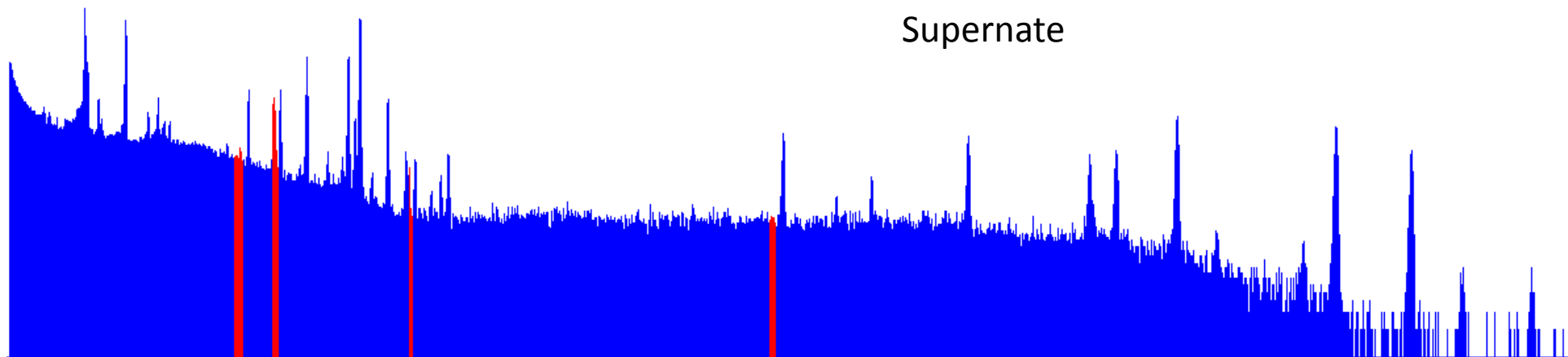
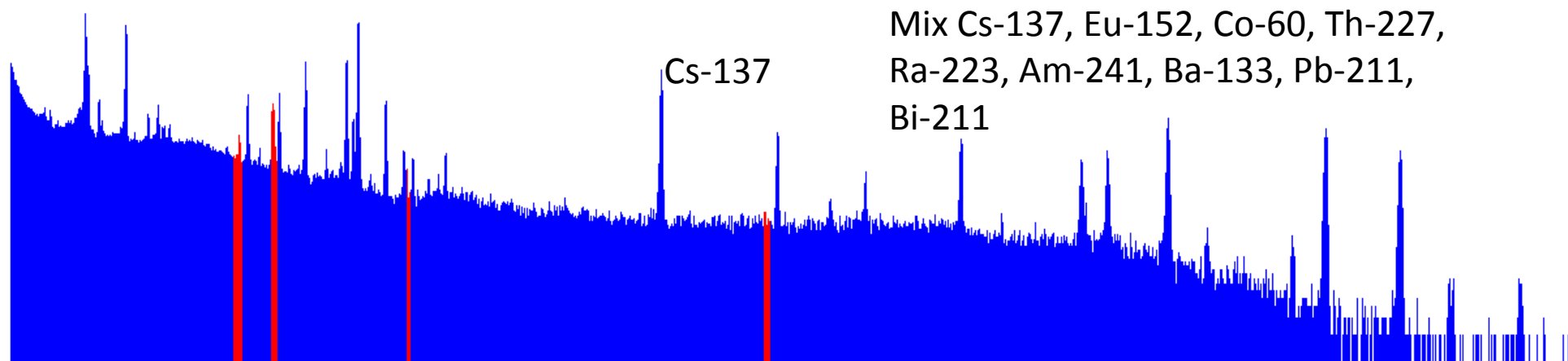
“Cesium, potassium and sodium tetraphenylborate solubility in salt solution,” D. J. McCabe, Westinghouse Savannah River Company, WSRC-TR-96-0384 (1996).

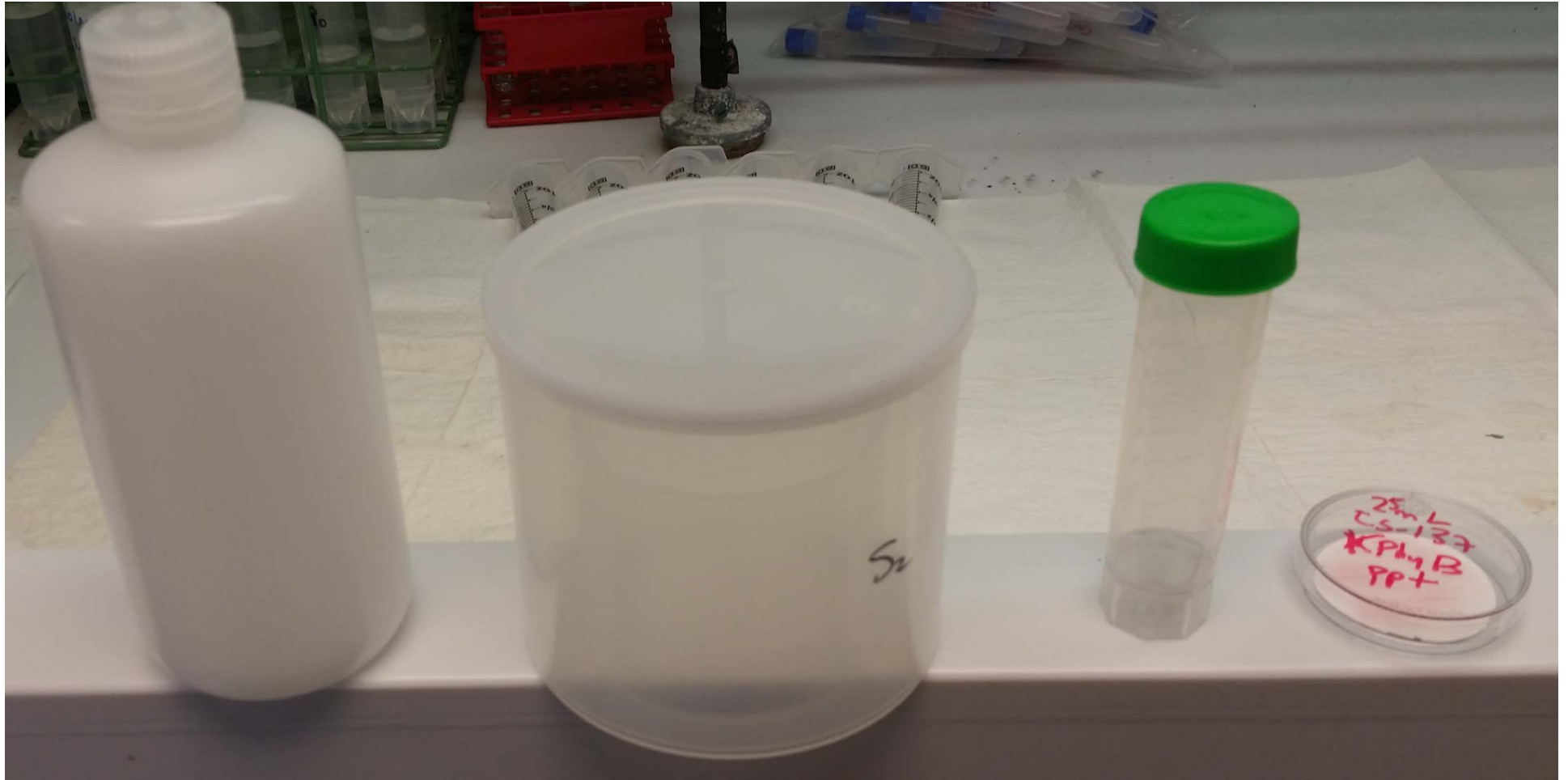
“Solubility of tetraphenylborates of the alkali metals and ammonium in acetone-water mixtures at 25°,” A. N. Kirgintsev, V. P. Kozitskii, [Bulletin of the Academy of Sciences of the USSR, Division of chemical science](#), June 1968, Volume 17, [Issue 6](#), pp 1116–1118.

Ag⁺ and Hg₂²⁺ also precipitate.









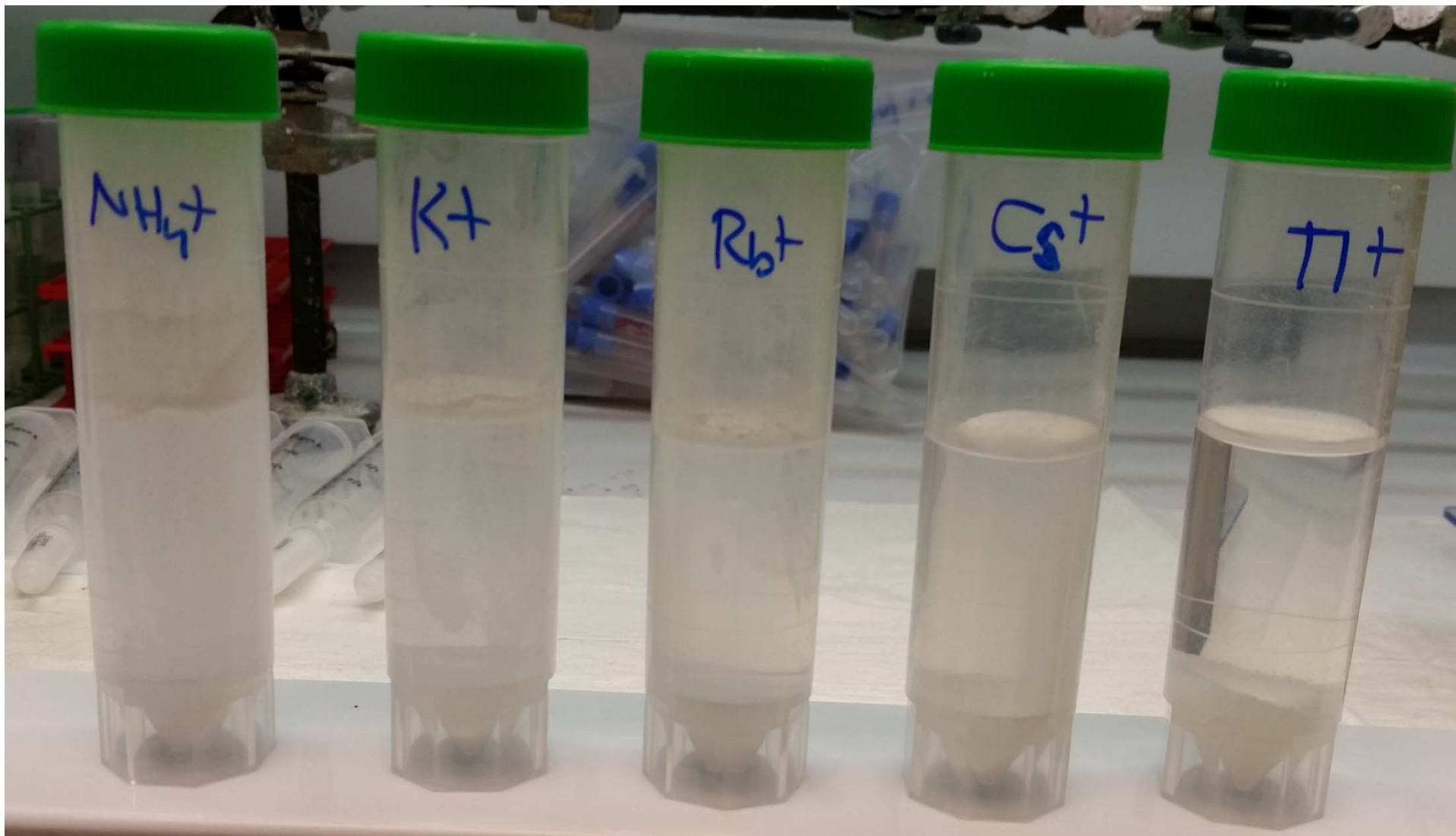
Concentration of Cs-137 from Seawater Simulant

Geometry*	Counts/min
25mL in c-tube	2703 \pm 18
25mL ppt in c-tube	6212 \pm 30
25mL filtered	5843 \pm 28
250mL bottle	1857 \pm 14
250mL Marinelli	3915 \pm 24
250mL ppt. in bottle	7723 \pm 34

Losses on plastic ←

*Endcap type detector, 500 sec count

Precipitation from NaPh4B in Water



Ag^+ and Hg_2^{2+} also precipitate.

高純度NaI(Tl)シンチレータによる 宇宙暗黒物質の探索

High Purity NaI(Tl) Scintillator to Search for Dark Matter



大阪産業大学

Osaka Sangyo Univ.

裕 隆太

R. Hazama

Based on 極低バックグラウンド素粒子原子核研究懇談会@徳島 2016/3/13-15

Workshop on Low BG Technologies@Tokushima 2016/3/13~3/15

<http://www.lowbg.org/ugnd/>

arXiv: 1310.8327[hep-ex]CF1 Summary: WIMP Dark Matter Direct Detection

<http://www.snowmass213.org>

14th Int. Conf. Topics in Astropart. Underground Phys.@Torino, Italy Sep/2015

<http://taup2015.to.infn.it>

PICO-LON Collaboration

- Tokushima University
 - K.Fushimi, G.Kanzaki, R.Orito
- Osaka University
 - H.Ejiri, T.Shima, S.Umehara, S.Yoshida
- Osaka Sangyo University
 - R.Hazama
- Kavli IPMU Tokyo University (WPI)
 - A.Kozlov, Y.Takemoto
- Tohoku University
 - K.Inoue, H.Ikeda, Y.Teraoka
- I.S.C. Lab.
 - K.Imagawa, K.Yasuda

Direct Dark Matter Search in the World

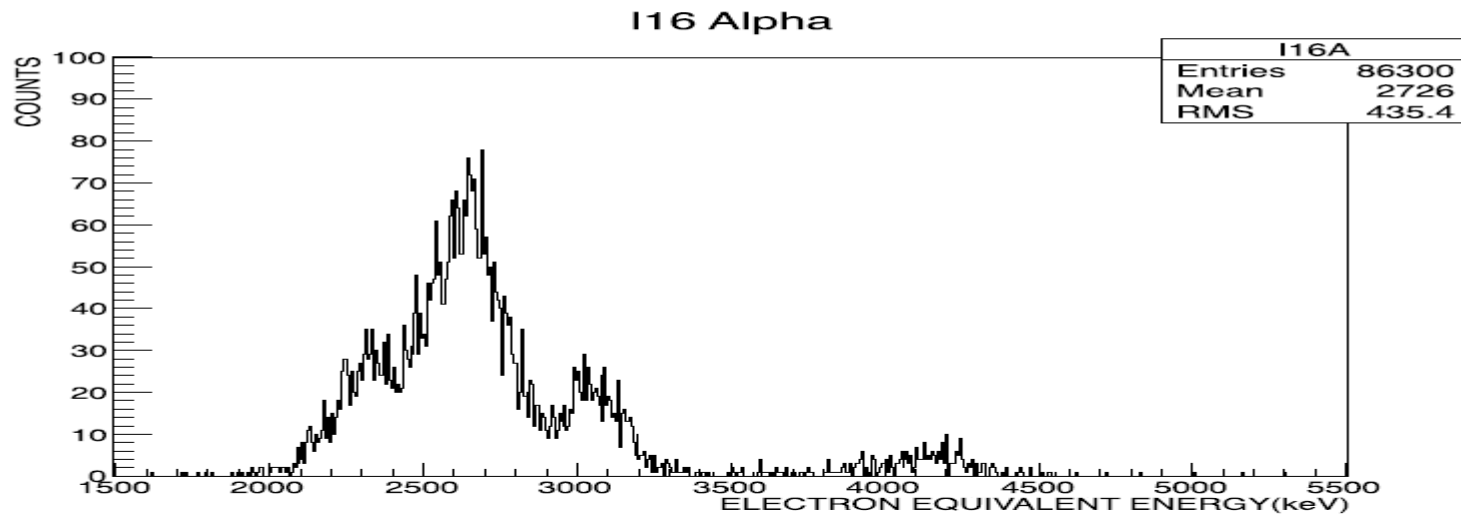
激しい国際競争（実験規模 数億円以下）



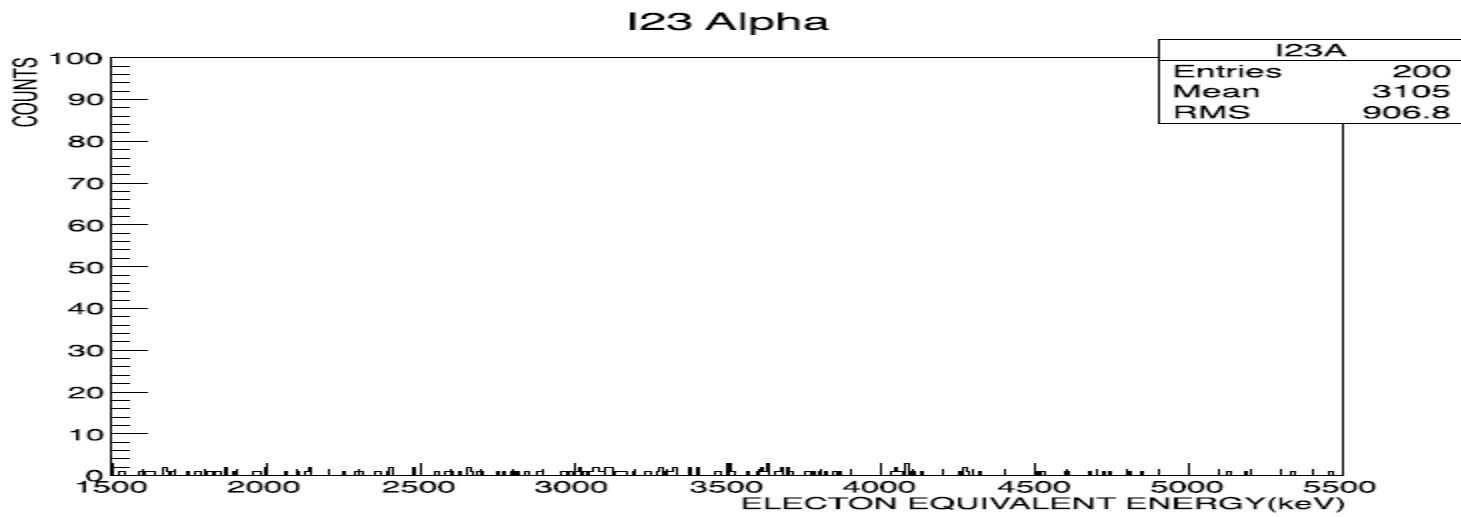
	Goal	Standard	Ingot 26 (2015)
K	<20 ppb	200-3000	2590 \pm 30
²³² Th	<1 ppt	50	0.3 \pm 0.5
²³⁸ U	<1 ppt	7-10	4.7 \pm 0.3
²¹⁰ Pb	<100 uBq/kg	~3000	29 \pm 66

- U-chain: 1ppt= 12.3 μ Bq/kg
- Th-chain: 1ppt= 4.0 μ Bq/kg
- ²¹⁰Pb: 1ppt=2.5kBq/kg

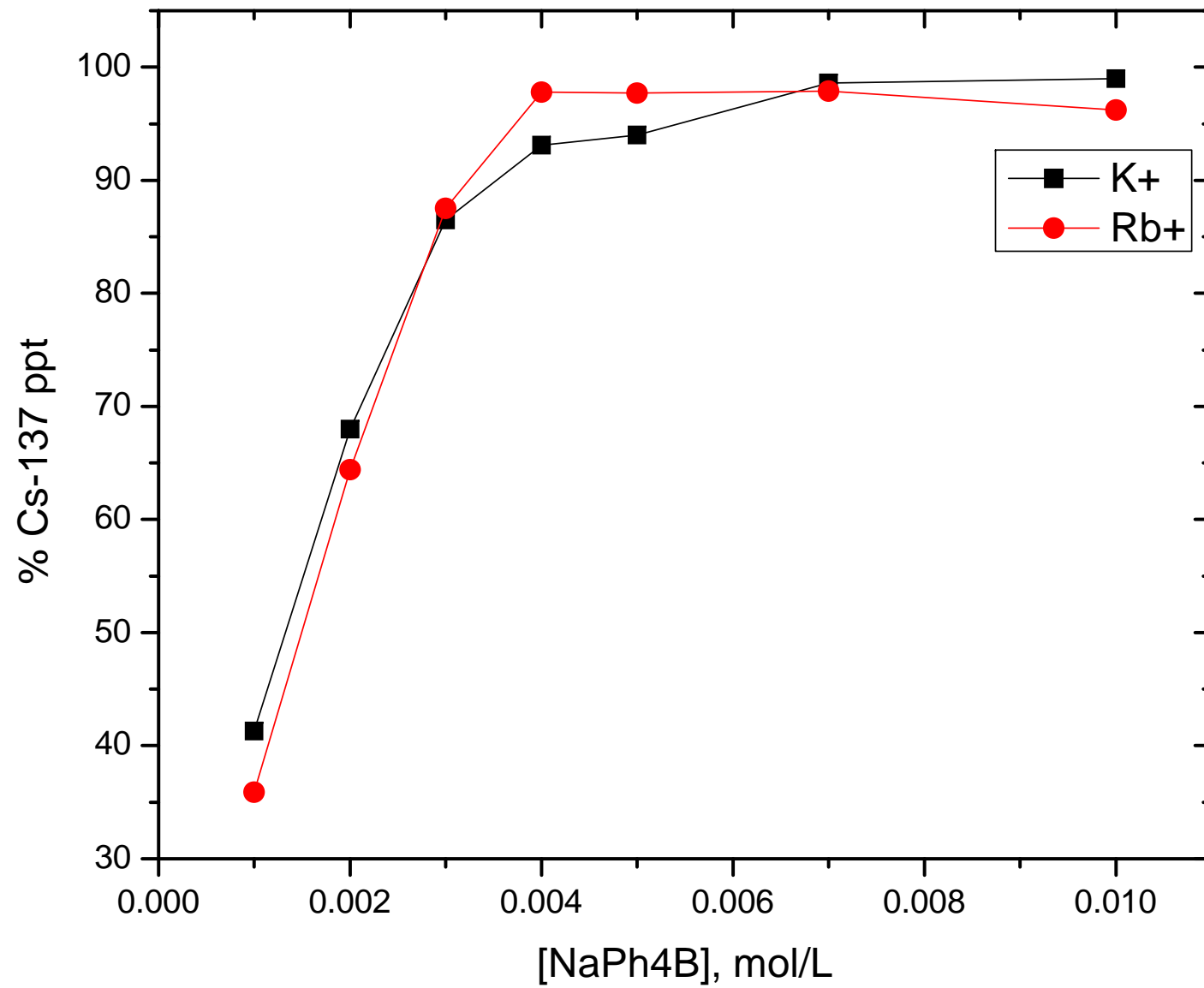
Normal NaI(Tl)



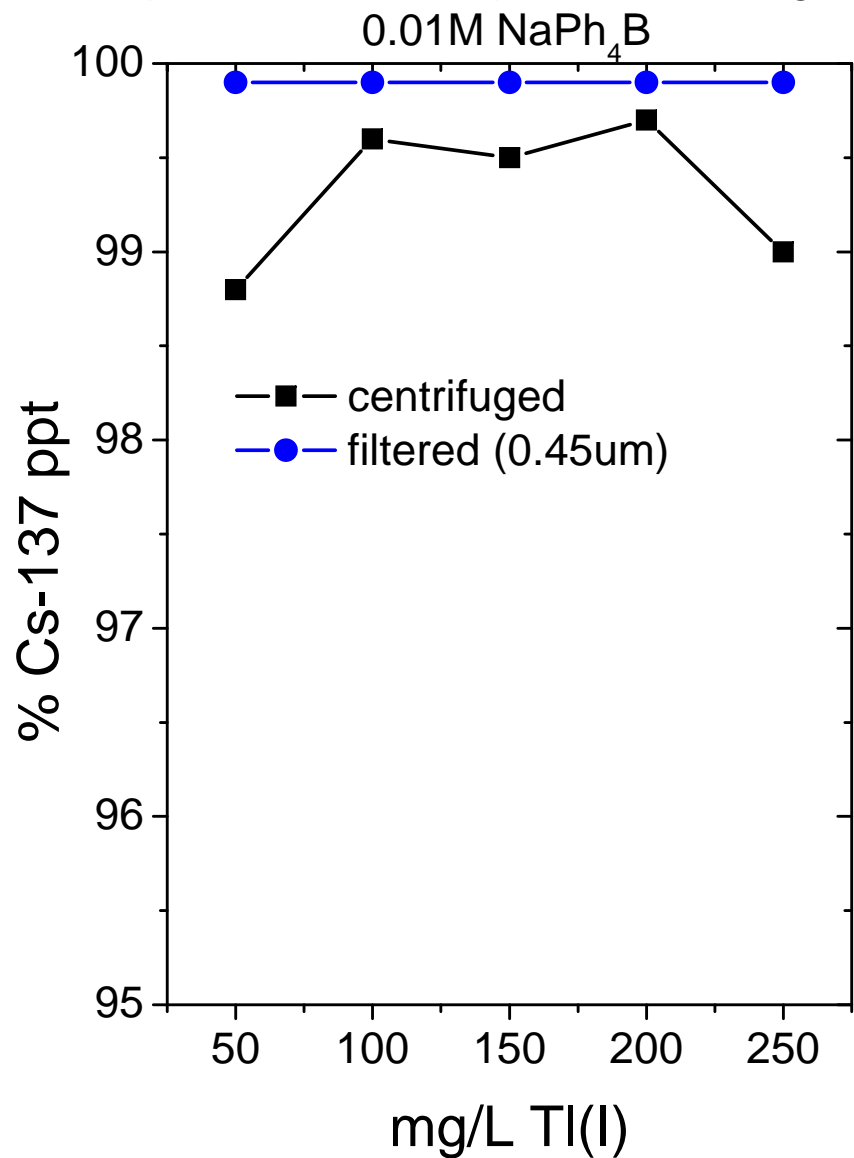
Chemical process



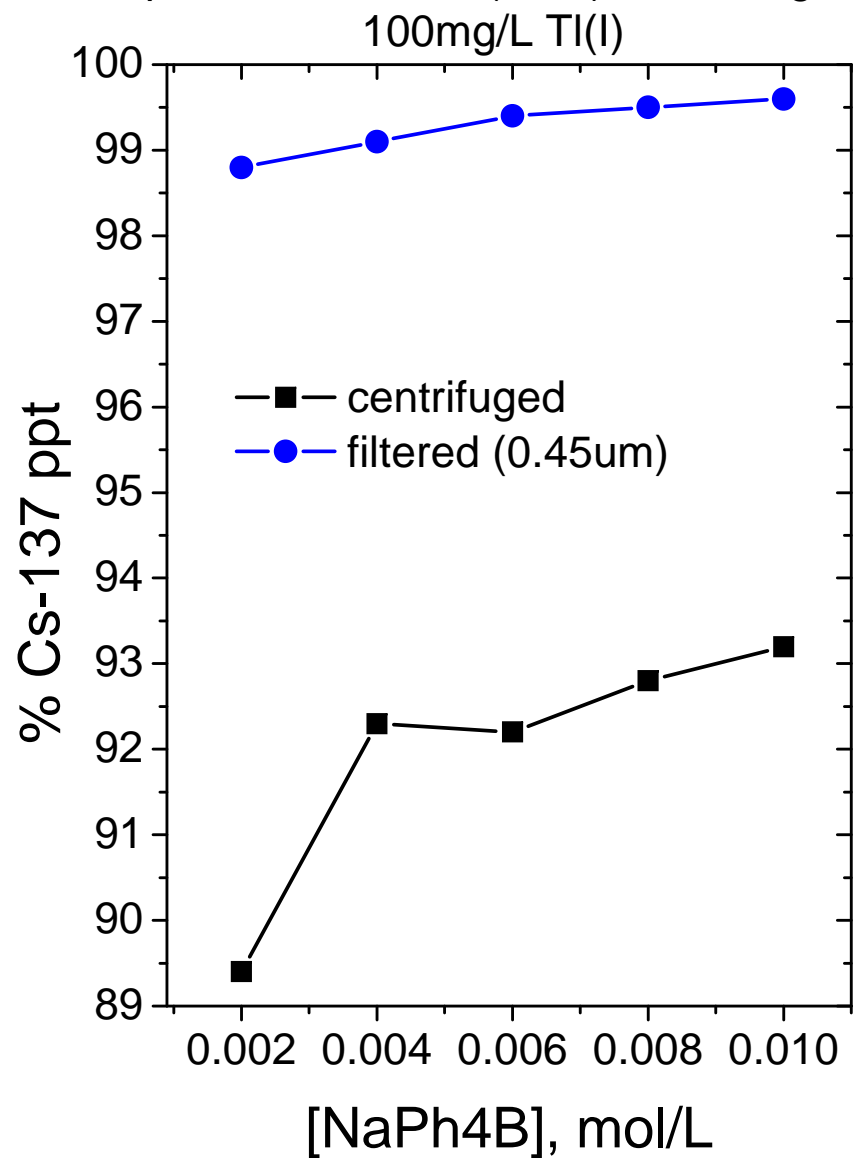
Co-precipitation of Cs-137 from 100mg/L K^+ or Rb^+



Precipitation of Cs-137(K-40) from 200g/L NaI



Precipitation of Cs-137(K-40) from 200g/L NaI



K-40 Removal

200g/L NaI solution

Dissolve 100mg/L Tl(I) as Tl-Iodide (0.0005M)

Add Filtered 0.1M NaPh₄B to make 0.001-0.002 mole/L.

Mix well. Allow Tl(K)Ph₄B to settle

Filter NaI Solution

Repeat to remove residual NaPh₄B

Remove >99% K-40

Future Work

Li Separation resin

- Toluene/Diisopropylbenzene Diluent

Non-Benzene substituents

- cyclohexyl
- *t*-butyl

Thank you !!!

