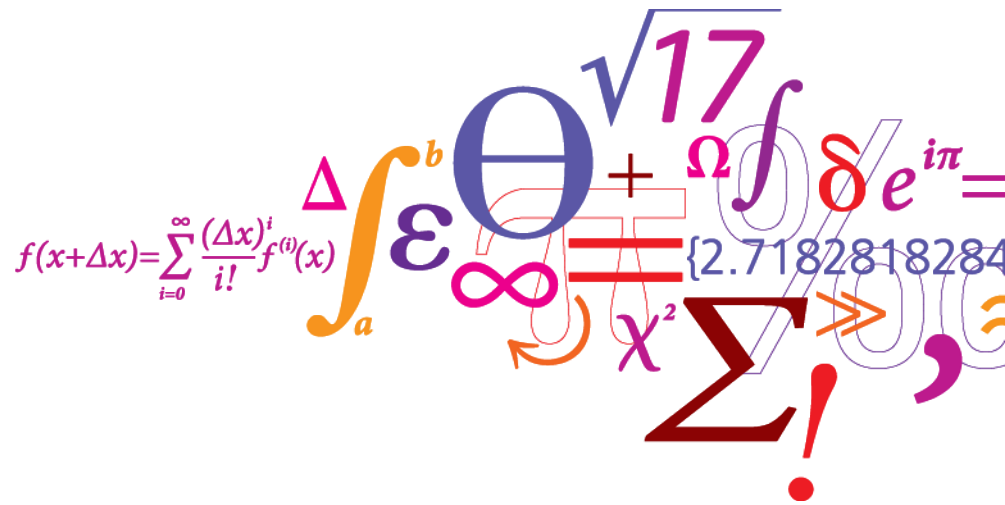


# Comprehensive radiochemical method development at DTU Nutech

Jixin Qiao



# Facilities at DTU Nutech

- 6 x Radiochemistry lab (24 fume hoods)
- 32 x low-level alpha spectrometers
- 18 x low-level gamma spectrometers
- 35 x low-level gas flow beta counters
- 2 x LSC (Quantulus, Tricap)
- 2 x ICP-MS (ICP-QQQ, Quadrupole)
- 1 x ICP-OES





- These measurement techniques are well established at DTU Nutech

# Environmental monitoring and Tracer studies

## Comprehensive monitoring programme for alpha, beta and gamma emitters

- Air, water, soil, plants and foodstuff
- In the vicinity of nuclear installations

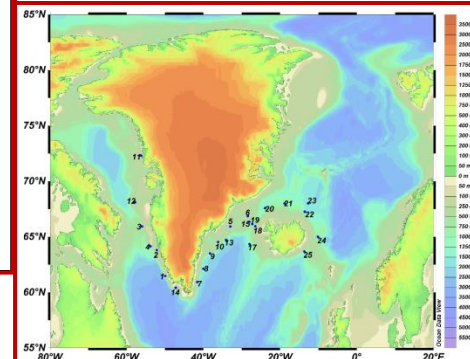
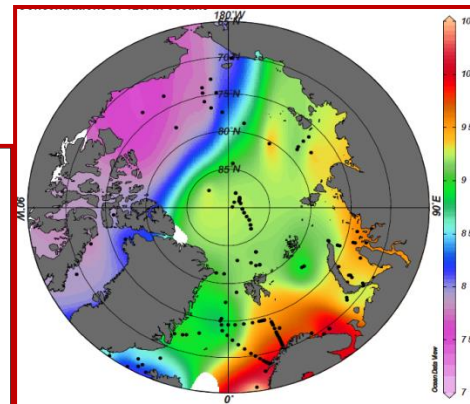
## Tracer studies

- Oceanographic studies
- Soil erosion
- Geological dating

Total diet samples

Seaweed sampling

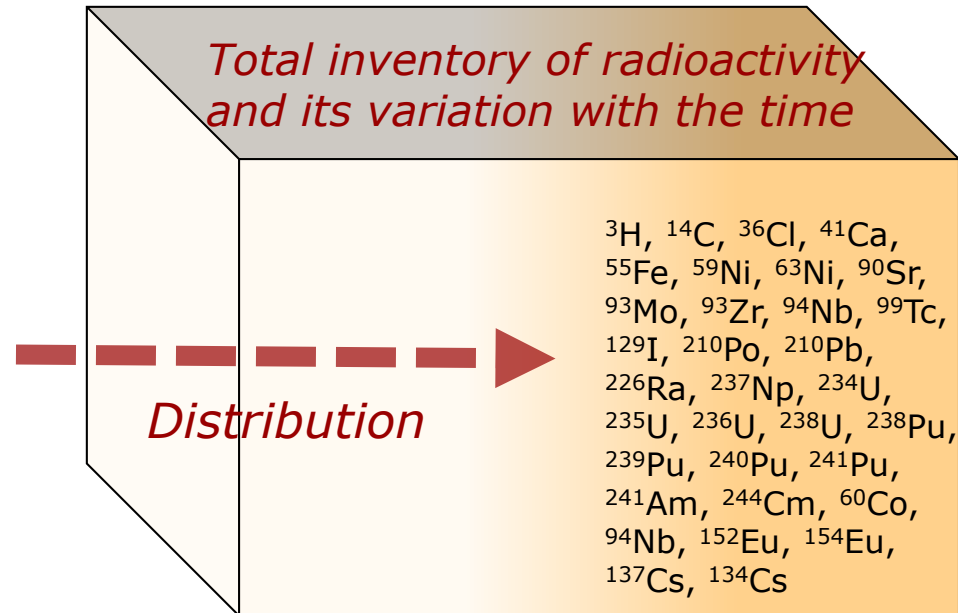
Water sampling



# Characterization of decommissioning materials



- Various sample types, e.g. metals, graphite, concrete, plastic, soil, sludge, water, ion-exchange resin, urine...
- Most nuclides require **complete chemical separation**



1. Rapid determination of Pu, Np, U and Tc
2. Automation of the analytical procedure

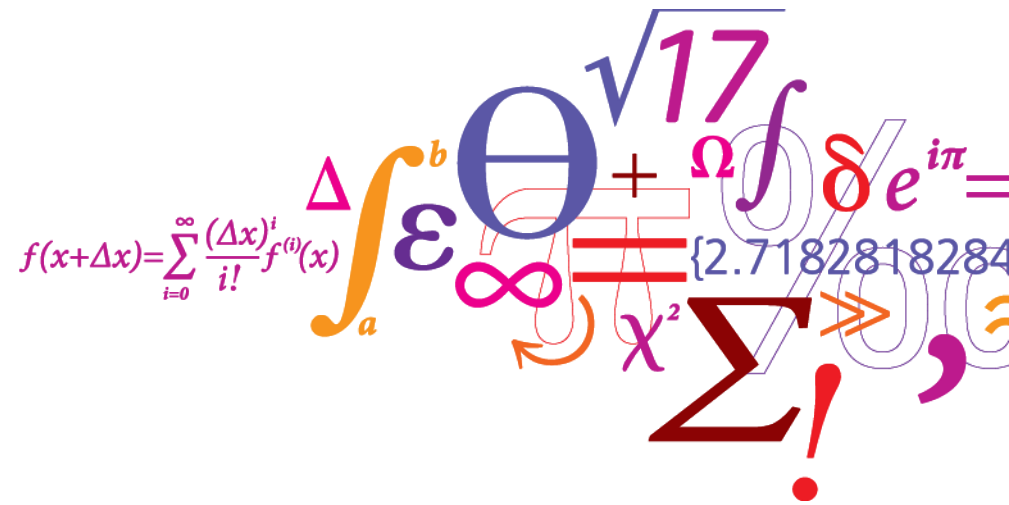
## Specific focuses:

### i. Chemical purification

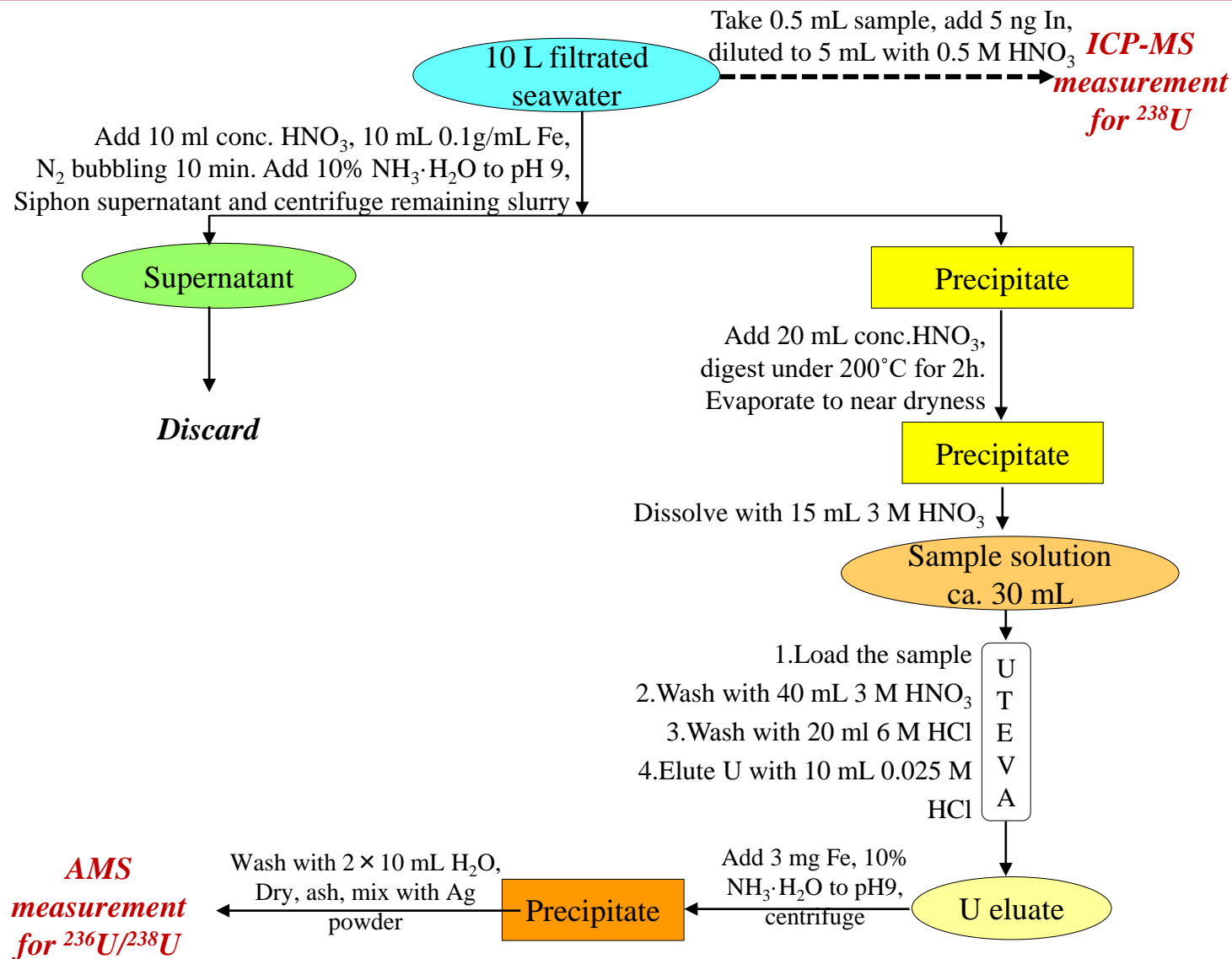
- Protocol simplification and optimization
- Automation

### ii. Detection

- Mass spectrometry (ICP-MS, AMS)

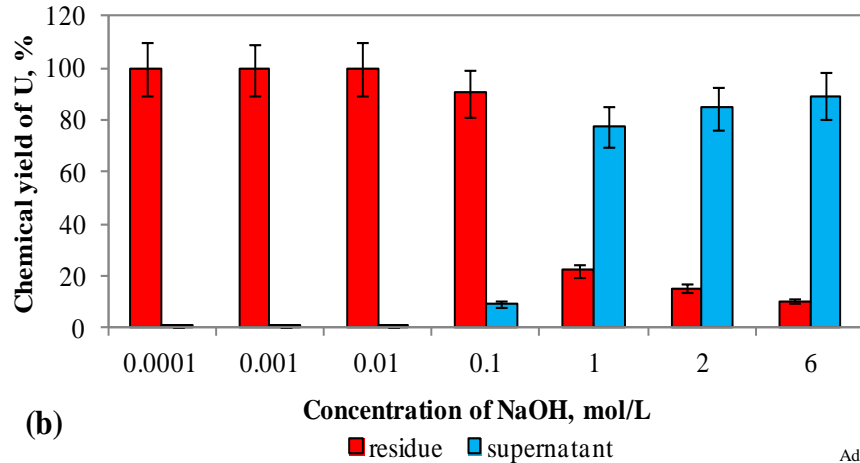


# Determination of $^{236}\text{U}$ in seawater

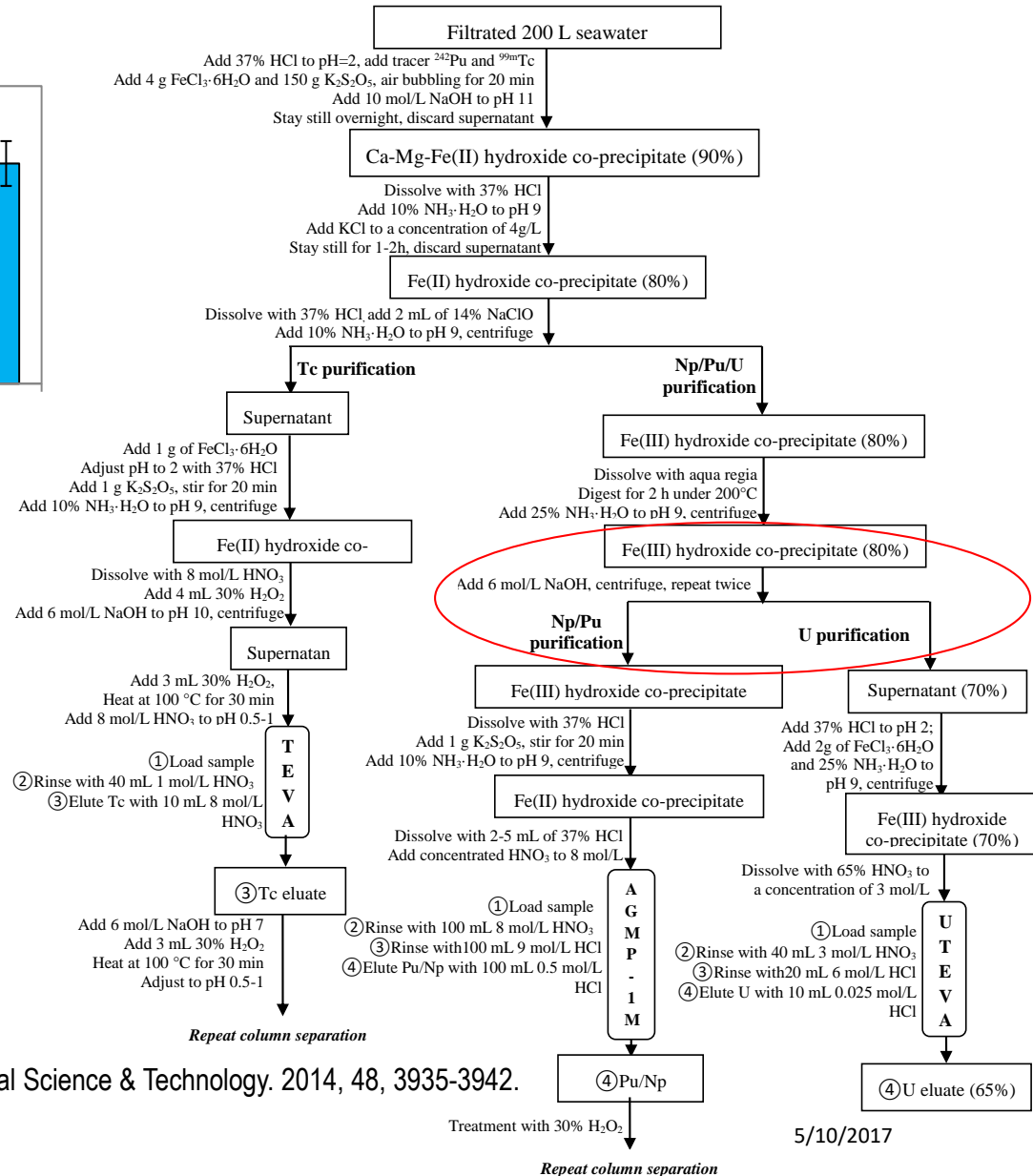




# Pu, Np, U and Tc simultaneous determination

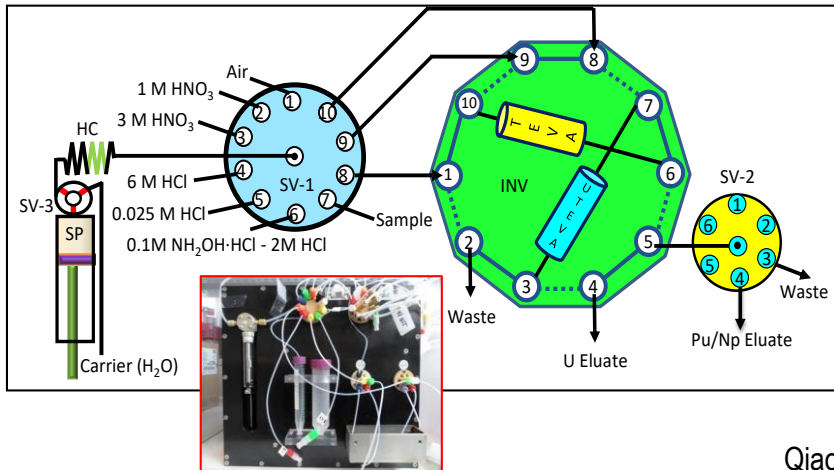
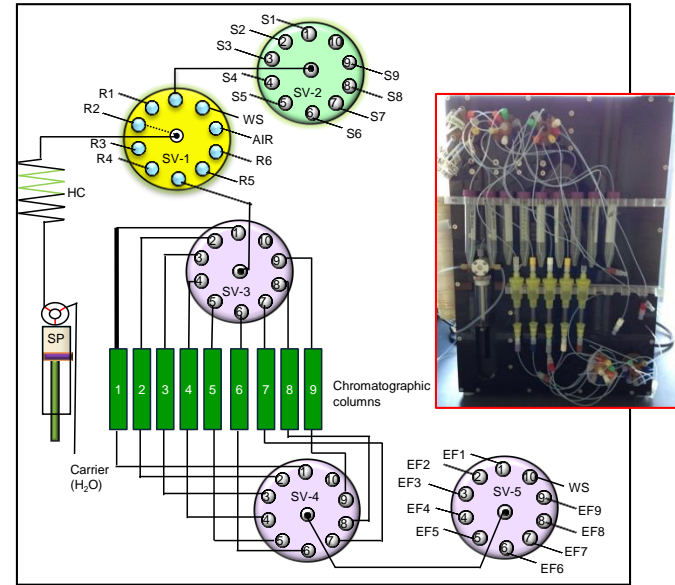
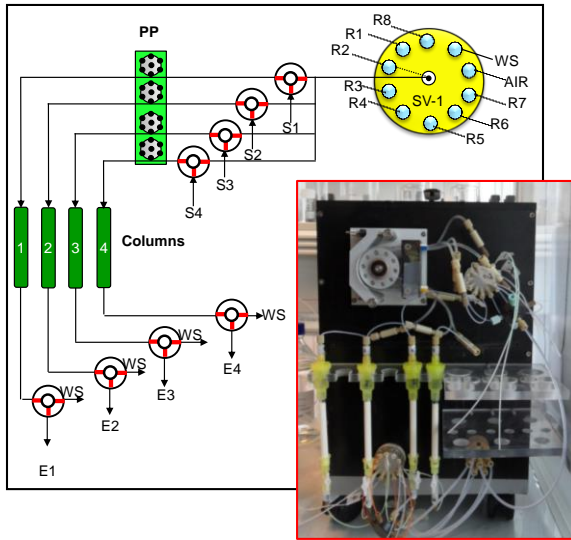


(b) Improvement on U decontamination



Qiao, J. X., Shi, K. L., Hou, X. L., Nielsen, S., Roos, P. Environmental Science & Technology. 2014, 48, 3935-3942.

# Automated Radiochemical Separation System (Auto-Rass)



JQ-1 Model

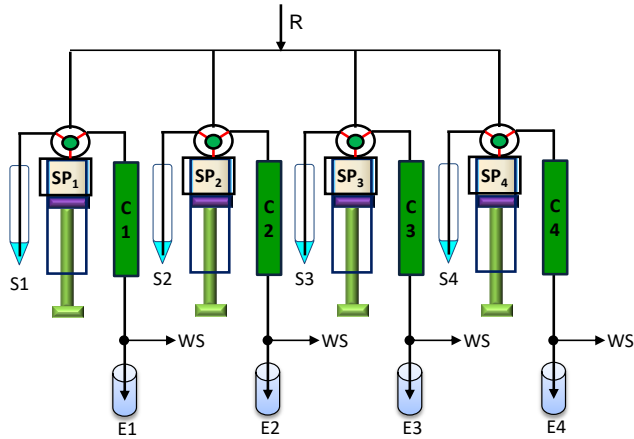
Qiao, J. X., Hou, X. L., Roos, P., Miró, M. *Analytica Chimica Acta*. 2011, 685, 111-119.

Qiao, J. X., Hou, X. L., Steier, P., Golser, R. *Analytical Chemistry*. 2013, 85, 11026-11030.

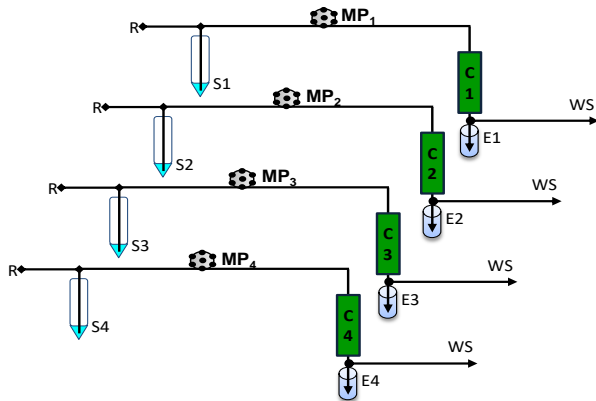
Qiao, J. X., Shi, K. L., Hou, X. L., Nielsen, S., Roos, P. *Environmental Science & Technology*. 2014, 48, 3935-3942.

# Automated Radiochemical Separation System (Auto-Rass)

Radiochemical Automated Analysis System (RAAS) with four syringe pump (SP-4)



Radiochemical Automated Analysis System (RAAS) with four milligat pump (MP-4)



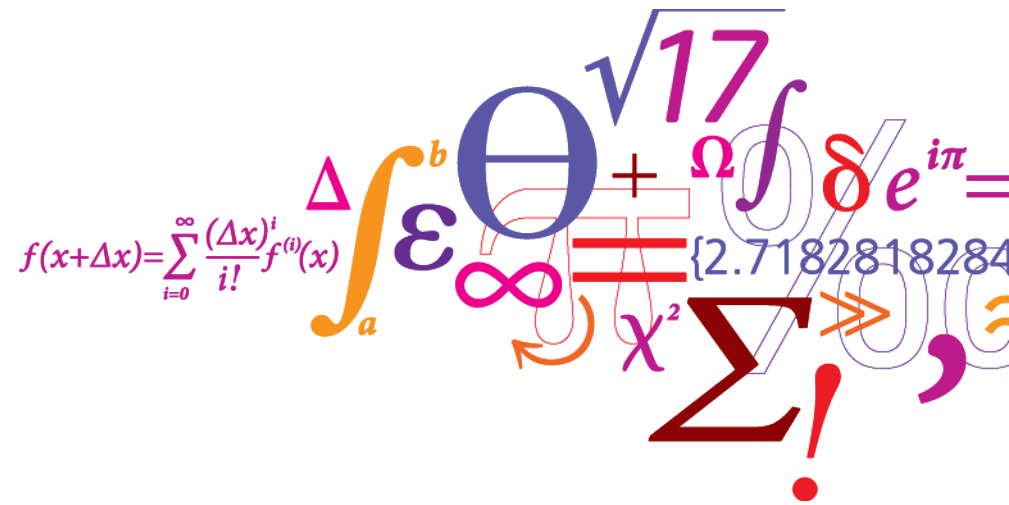
- Research
- Routine analysis
- Commercialization
- Collaboration

Model JQ-2

➤  $^3\text{H}$  and  $^{14}\text{C}$

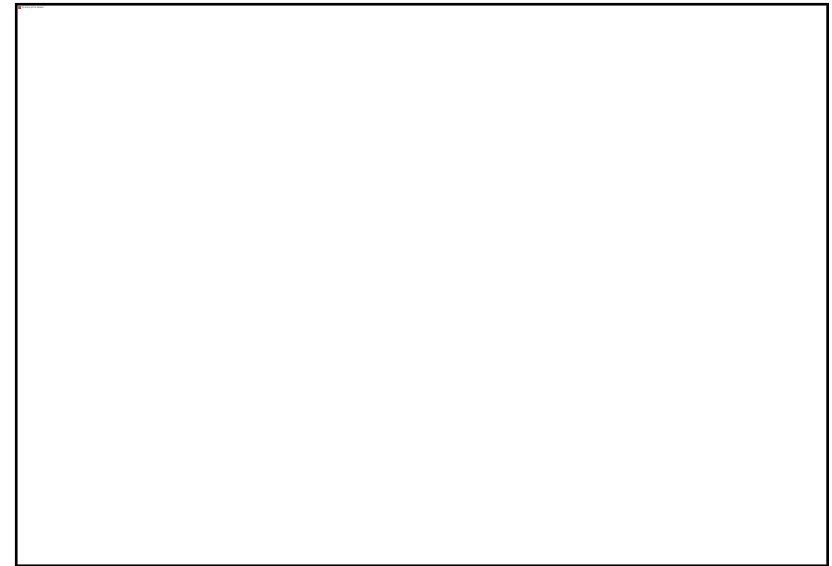
➤  $^{41}\text{Ca}$

➤  $^{55}\text{Fe}$  and  $^{63}\text{Ni}$



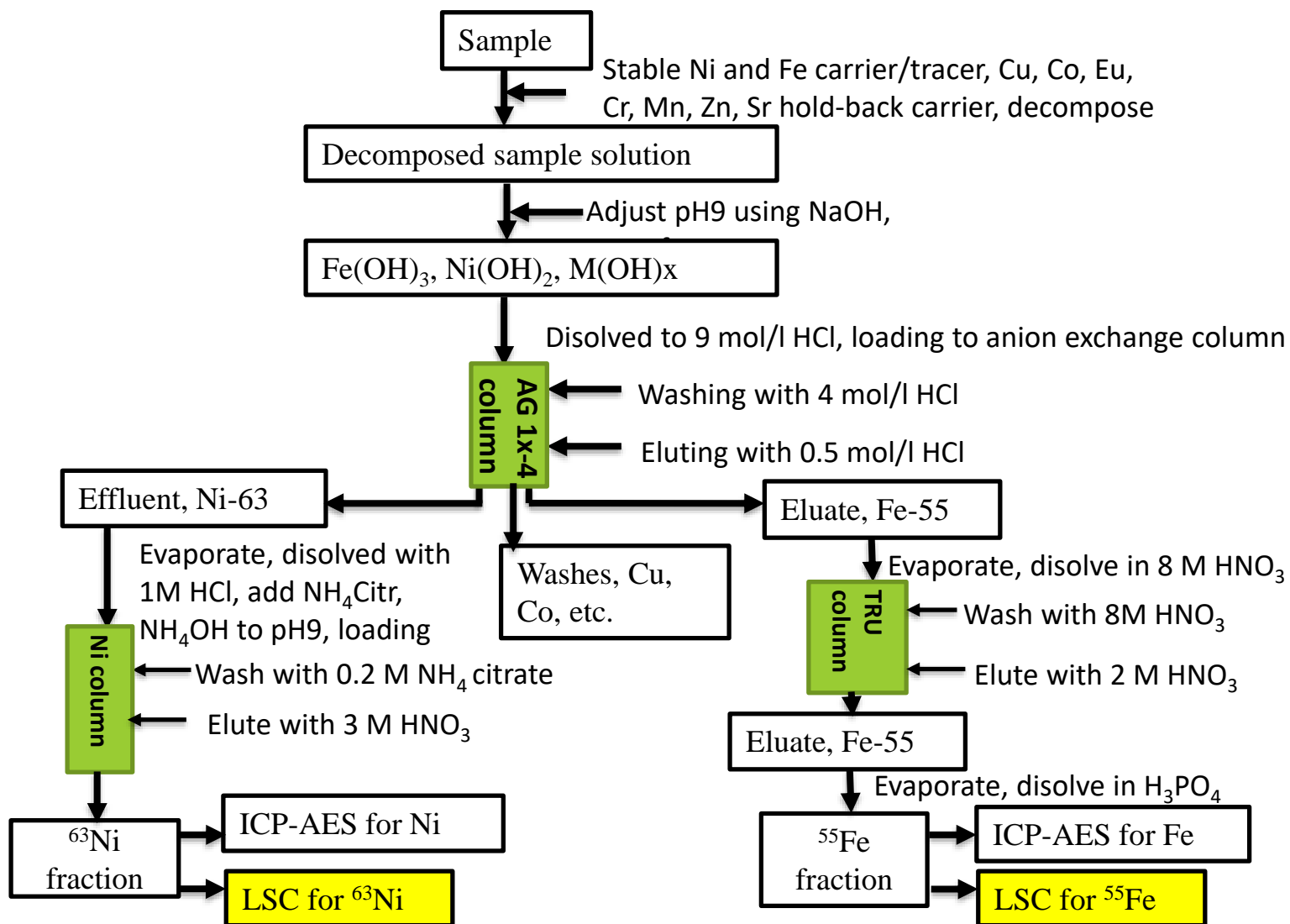
# Determination $^{41}\text{Ca}$ in concrete

- **Separation fro matrix**
  - Decomposition of heavy concrete by alkali fussion
  - Leaching Ca by acids
- **Separation from active metals such as  $^{60}\text{Co}$ ,  $^{152}\text{Eu}$ ,  $^{55}\text{Fe}$ ,  $^{63}\text{Ni}$ ,  $^{65}\text{Zn}$ ,  $^{54}\text{Mn}$ ,  $^{51}\text{Cr}$ , etc.**
  - Precipitation with  $\text{Fe}(\text{OH})_3$  by hydroxides at pH9
- **Separation from other alkaline metals, such as  $^{133}\text{Ba}$ ,  $^{226}\text{Ra}$  and  $^{90}\text{Sr}$ .**
  - $\text{Ca}(\text{OH})_2$  precipitation in NaOH solution



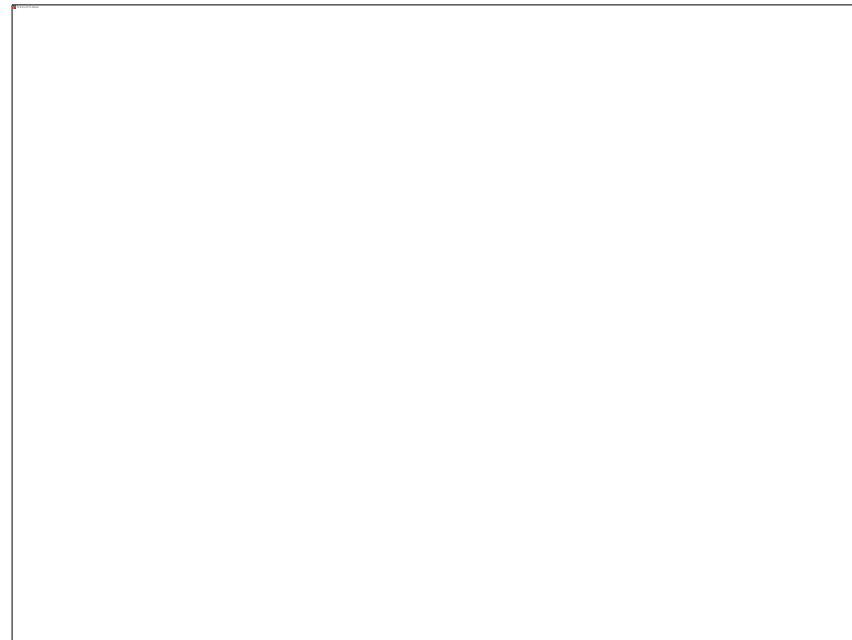
Element	Recovery, %	redionuclide	Decontamination factor
Ca	97.7±3.9	$^{137}\text{Cs}$	$(4.5\pm0.3)\times 10^5$
$^{85}\text{Sr}$	97.9±2.1	$^{60}\text{Co}$	$(1.2\pm0.4)\times 10^5$
$^{133}\text{Ba}$	97.3±2.8	$^{152}\text{Eu}$	$(8.5\pm0.5)\times 10^5$
		$^{59}\text{Fe}$	$(2.5\pm0.1)\times 10^5$
		$^{63}\text{Ni}$	$(2.5\pm0.2)\times 10^5$

# Determination $^{41}\text{Ca}$ in concrete



## DTU Nutech:

- Radiochemical analyses of various radionuclides
- Automation development and commercialization
- Analytical work performed under accreditation (ISO/IEC 17025:2005)
- Trainings and consultancy
- Scientific collaboration



## Contact:

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# Thank you!

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