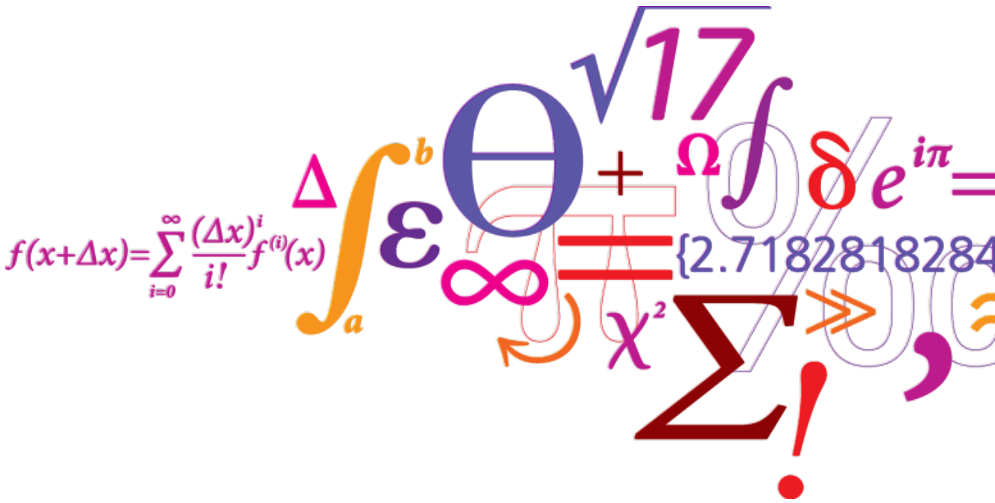
Application of Rapid and Automated Techniques in Emergency Preparedness ---Inspirations from NKS-B Rapid-Tech Project

Jixin Qiao



DTU Nutech
Center for Nuclear Technologies

NKS-B Rapid-tech project [AFT/B(14)7]

- Funded by Nordic Nuclear Safety Research (NKS) for 2014-2016

- **Partners:**

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Project objectives

- To explore the application of different rapid techniques in determination of radionuclides, thus to improve the analytical efficiency of present radioanalytical methods in the areas of E, W and R.

- Specific tasks:
- Identification of current needs and problems in methodology development for rapid determination of ^{90}Sr and actinides.
- Identification of individual processes wherein rapid techniques can be potentially applied to improve the analytical efficiency.

Potential Rapid Techniques in Emergency Preparedness

No.	Rapid techniques
1	Flow injection (FI)/sequential injection (SI)
2	High performance liquid chromatography (HPLC)
3	Vacuum box system
4	other effective sample treatment approaches (microwave assisted digestion, alkaline fusion, co-precipitation)

Rapid radiochemical analysis

Flow/sequential injection chromatographic separation:

Flow injection (FI) system:

- Peristaltic pump
- Continuous flow

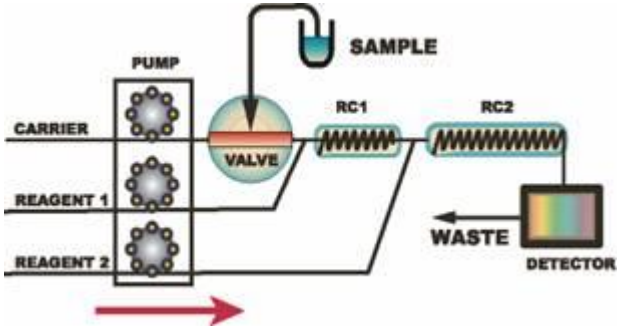

Fig. Scheme of a FI system

Sequential injection (SI) system:

- Syringe pump
- Selection valve

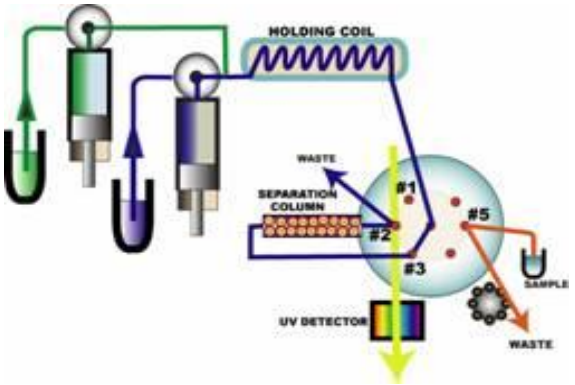

Fig. Scheme of a SI system

Our focus

No.	Rapid techniques
1	Flow injection (FI)/sequential injection (SI)
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3	Vacuum box
4	other effective sample treatment approaches (microwave assisted digestion, alkaline fusion, co-precipitation)

Rapid radiochemical analysis

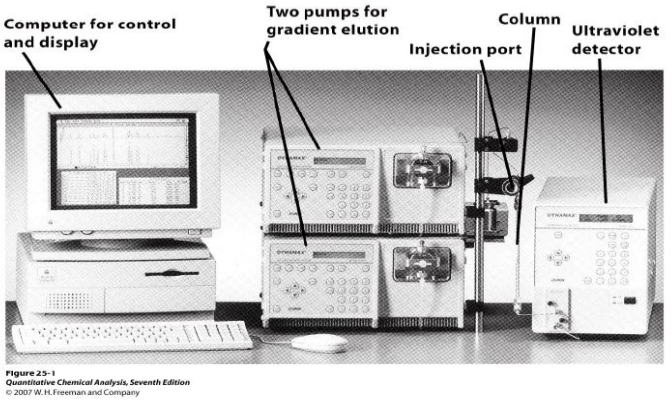
High performance liquid chromatography (HPLC):

Advantages:

- Fully automated
- Can be connected directly with MS

Disadvantages:

- Only handle small samples
- Single sample processing
- High cost



HPLC system

Our focus

No.	Rapid techniques
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Rapid radiochemical analysis

Vaccum box:

Advantages:

- Multi-sample processing
- Easy operation
- Low cost
- Flexible

Eichrom vaccum box

Disadvantages:

- Need human attention

Our focus

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Rapid radiochemical analysis

Alkaline fusion --- Rapid sample pre-treatment techniques for solid samples:

Fluxes can be used for alkaline fusion:

- NaOH
- Na_2O_2
- $NaCO_3$
- $LiBO_2$
- Others

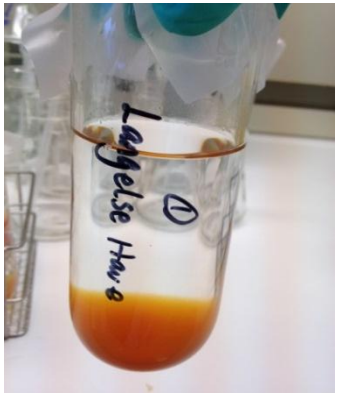
Busen burner

Katanax automatic electric fluxer

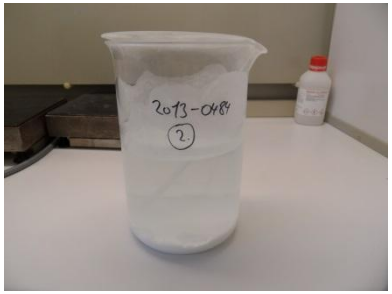
Rapid radiochemical analysis

Co-precipitation --- Rapid sample pre-treatment for liquid samples:

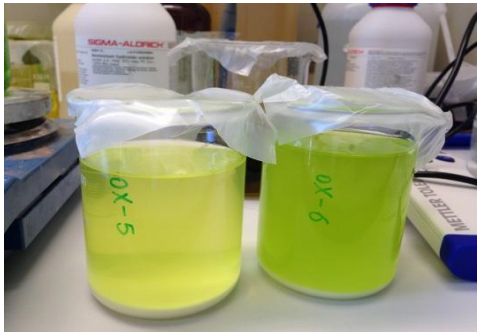
- Carbonates (e.g.,$CaCO_3$)
- Oxalates (e.g., CaC_2O_4)
- Hydroxides (e.g., $Fe(OH)_3$)
- Oxides (e.g., MnO_2)
- Phosphates (e.g., $Ca_3(PO_4)_2$, $BiPO_4$)
- Others (e.g., AMP for Cs)



$Fe(OH)_3$ co-precipitation



$CaCO_3$ co-precipitation



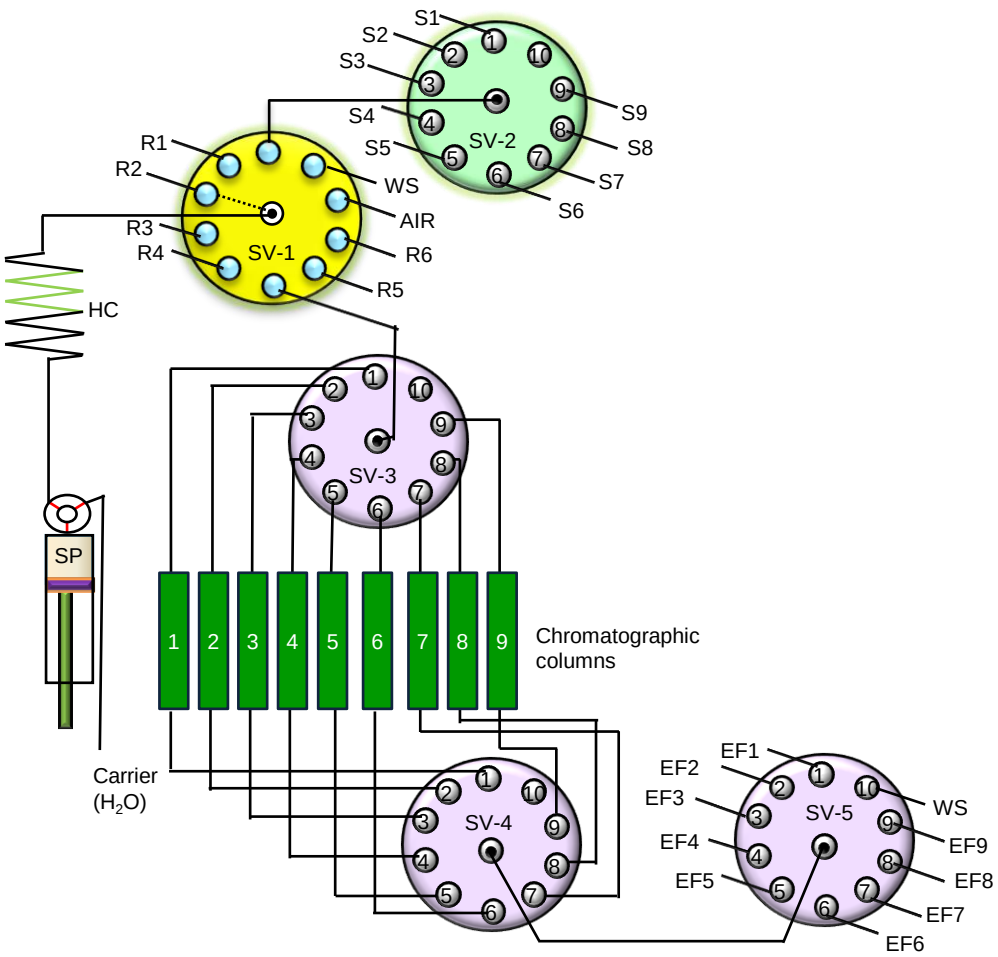
CaC_2O_4 co-precipitation

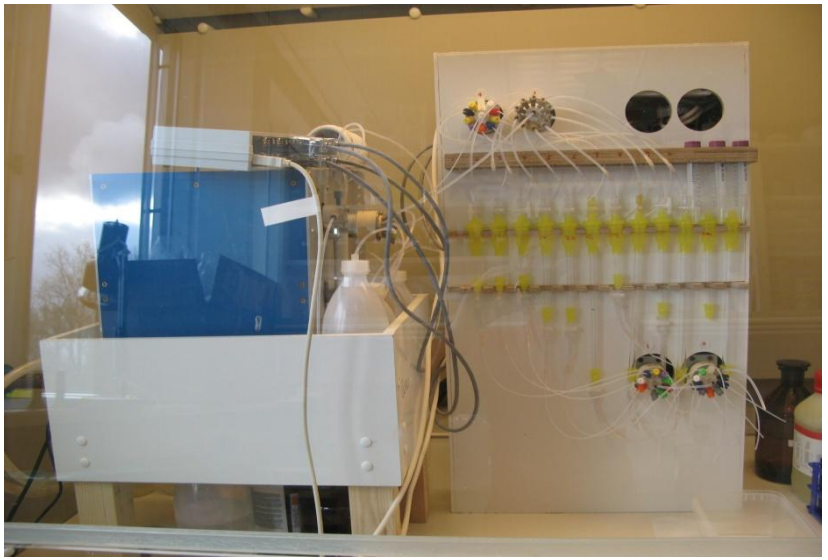
Current application of rapid techniques in Emergency preparedness

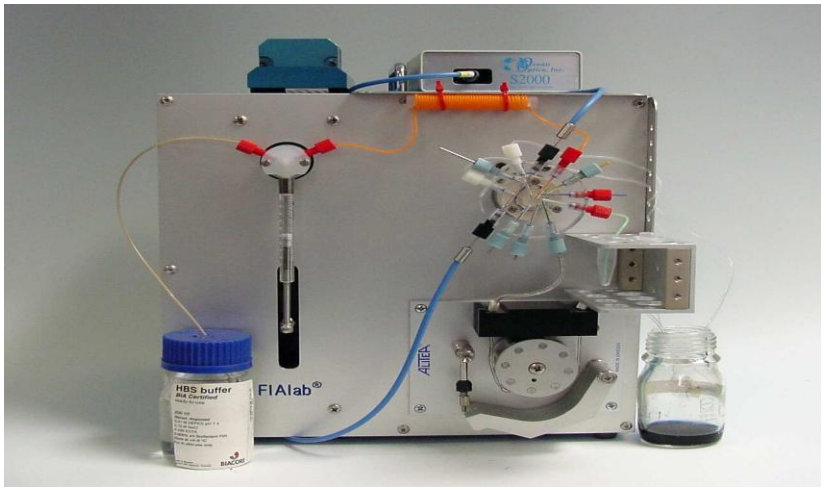
1) Current application of novel automated techniques in Nordic countries is very limited.

2) There is a need for end users to become more aware of the advantages of improved techniques for radiochemical assays.

Development of automated system in DTU Nutech



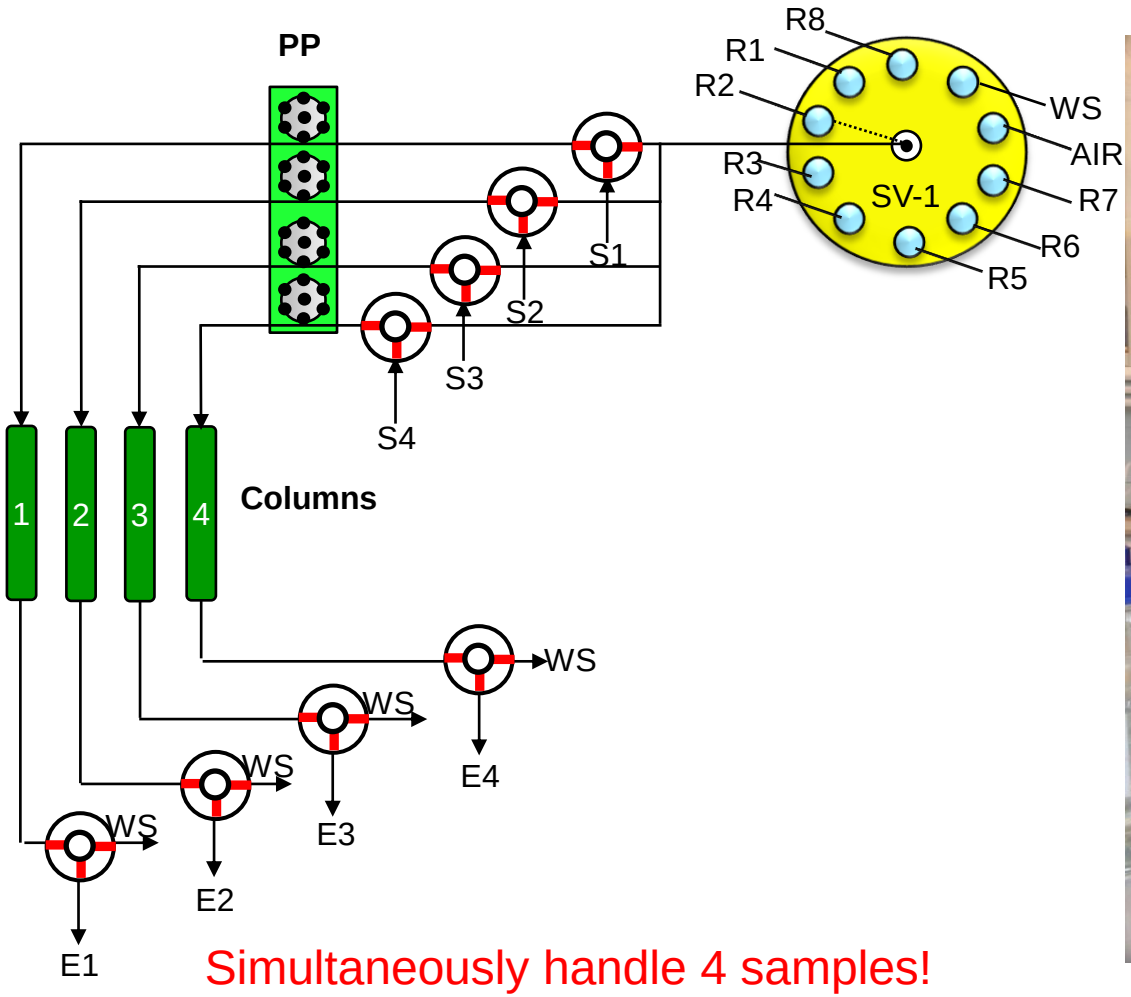


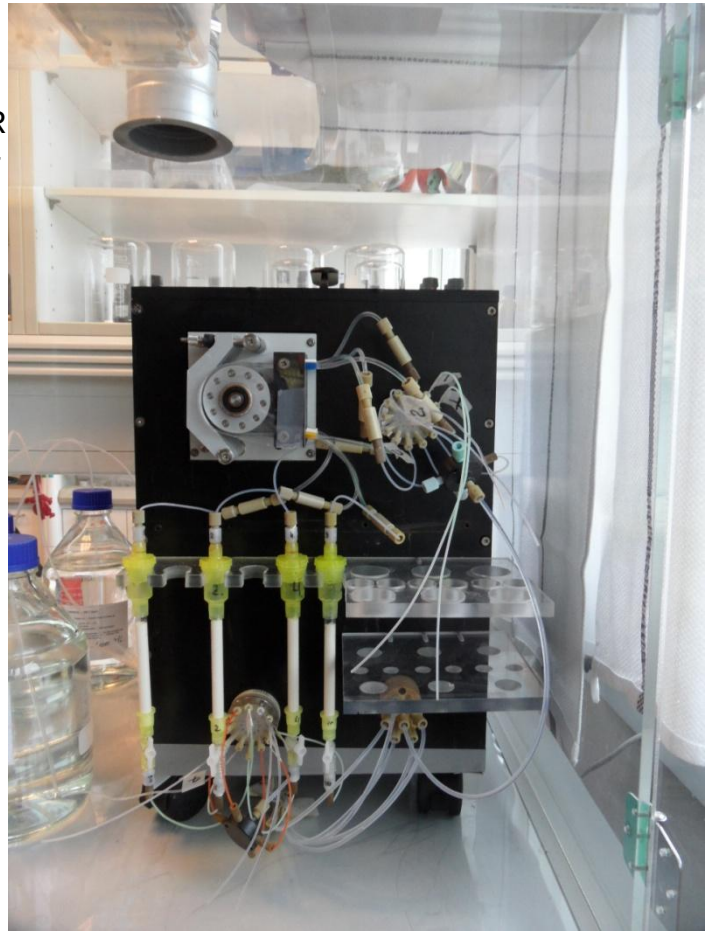


Automatically handle 9 samples!
Work overnight !

Qiao, J. X., Hou, X. L., Roos, P., Miró, M. Analytica Chimic Acta. 2011.

Development of automated system in DTU Nutech





Simultaneously handle 4 samples!

Qiao, J. X., Shi, K. L., Hou, X. L., Nielsen, S., Roos, P. Environmental Science & Technology. 2013.

Conclusions

- More efforts are needed to improve the application of automated and rapid techniques in radiochemical analysis

- More support from NKS or other foundations for future projects

- More communication and collaboration among Nordic and international labs

Thank you!