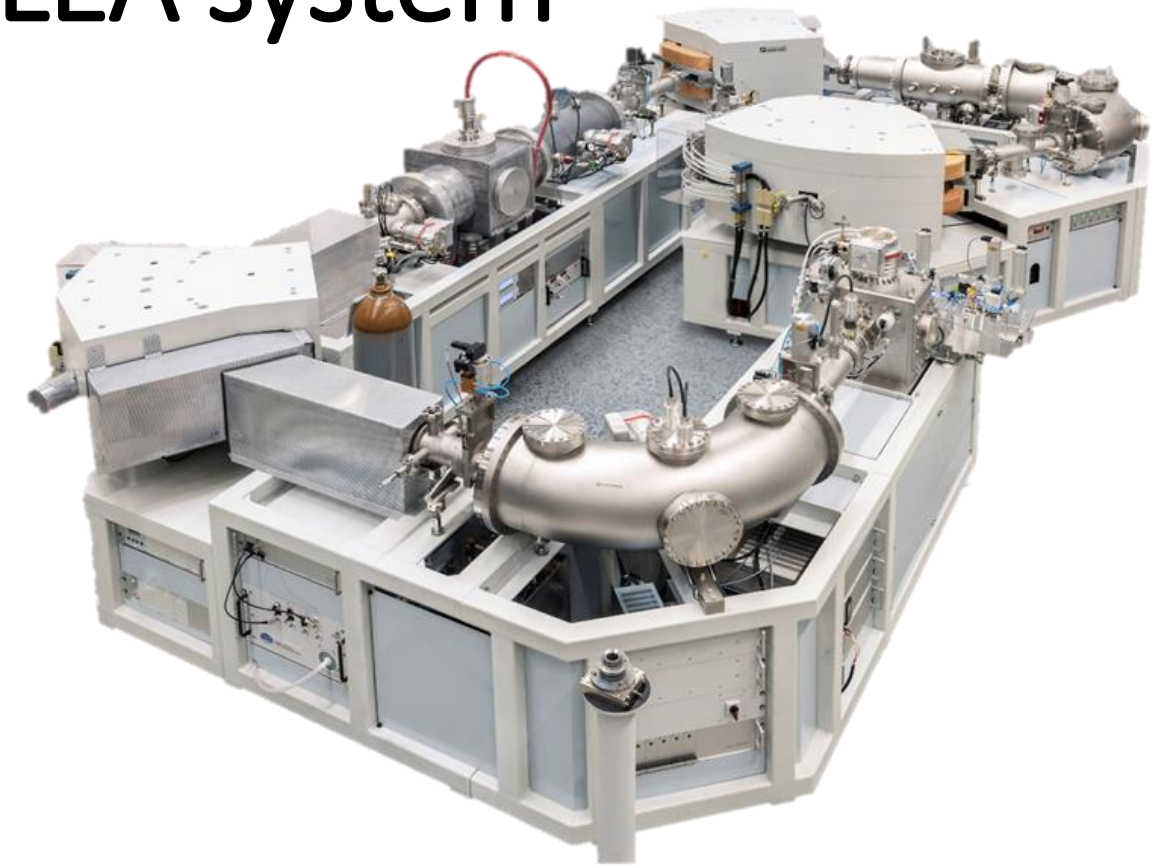
Sample detection efficiency and detection limits for the determination of actinides at the ETH Zürich MILEA system



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Little intro about me…

- I am an oceanographer
- Trace metal analytical chemistry applied to polar regions.
- Started at LIP end of 2022.
- Now I am responsible for actinide measurements

MetroPOEM

Main objective: To extend and harmonise mass spectrometry measurement methods for the measurement of pollutants in the environment.

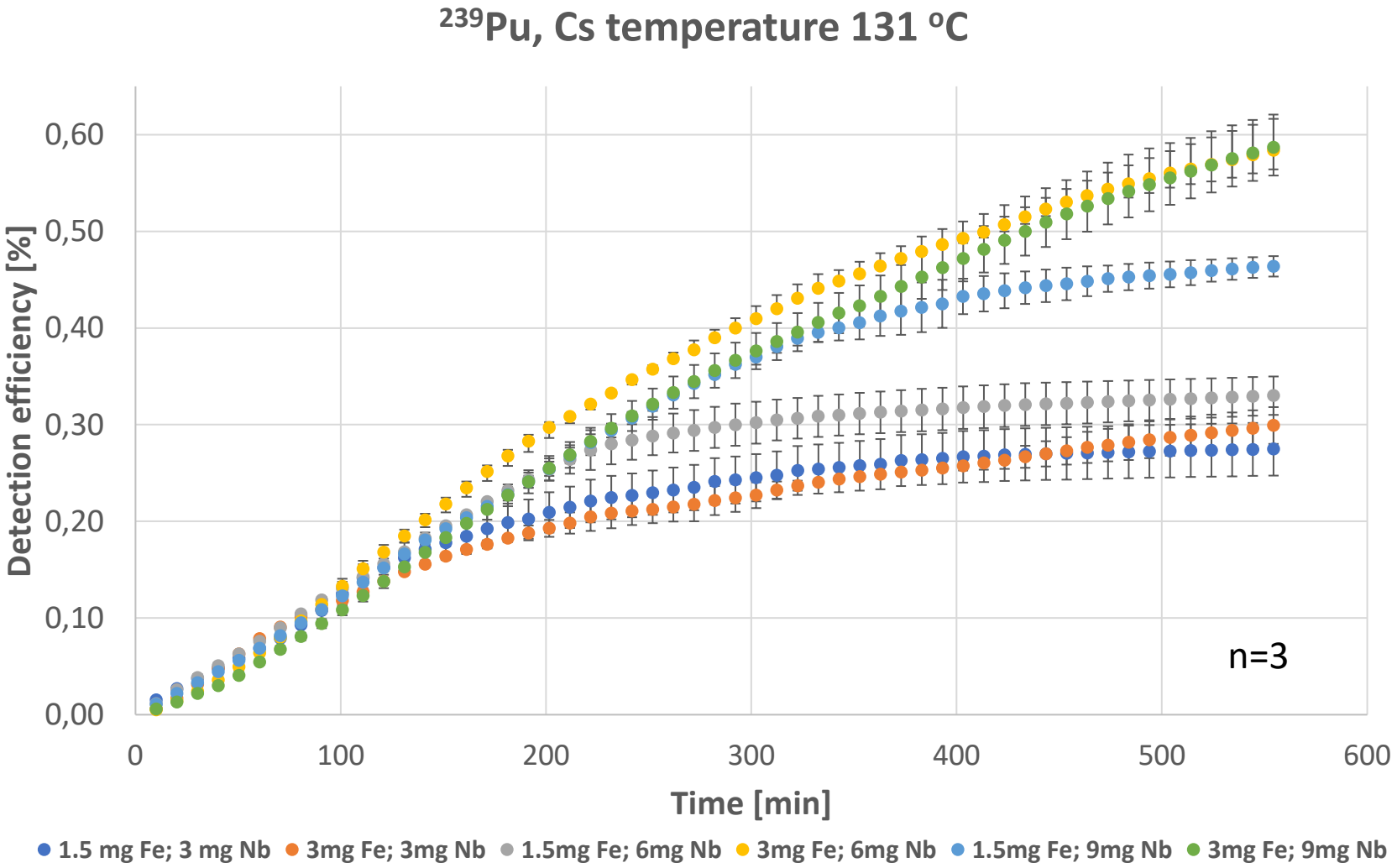
Involvement of ETH on MetroPOEM

Provide measurements of the lowest levels found in environmental samples that other MS techniques can not achieve

- WP1: To establish and compare the selectivity and detection limits of different types of mass spectrometers for the radioactive pollutants U, Np, Pu, Am.

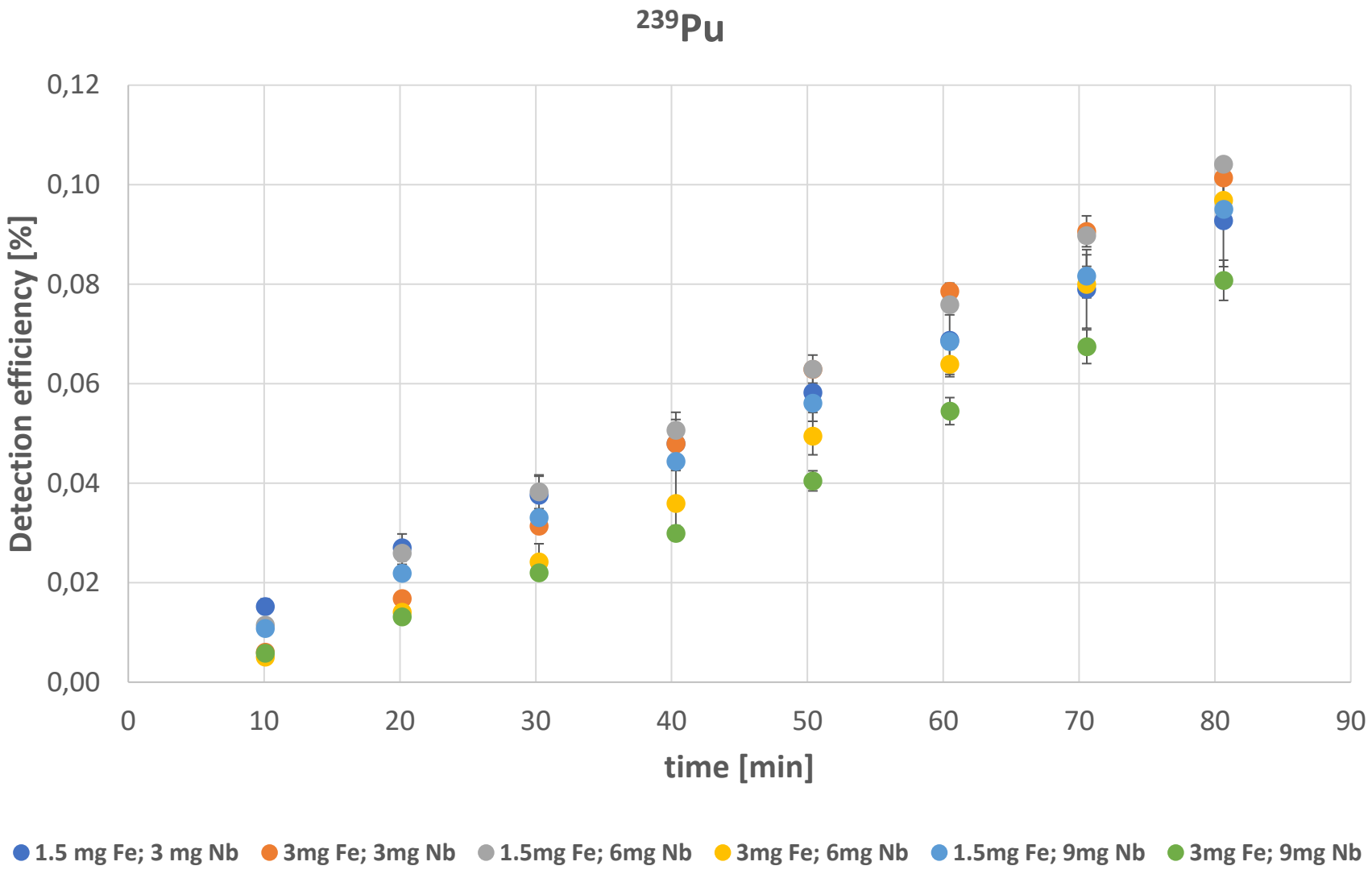
- WP3: To develop two radioactive reference material with the sample matrix containing radioactive pollutants (e.g. U, Np, Pu, Am) for use in an inter-laboratory comparison.

Optimal matrix composition



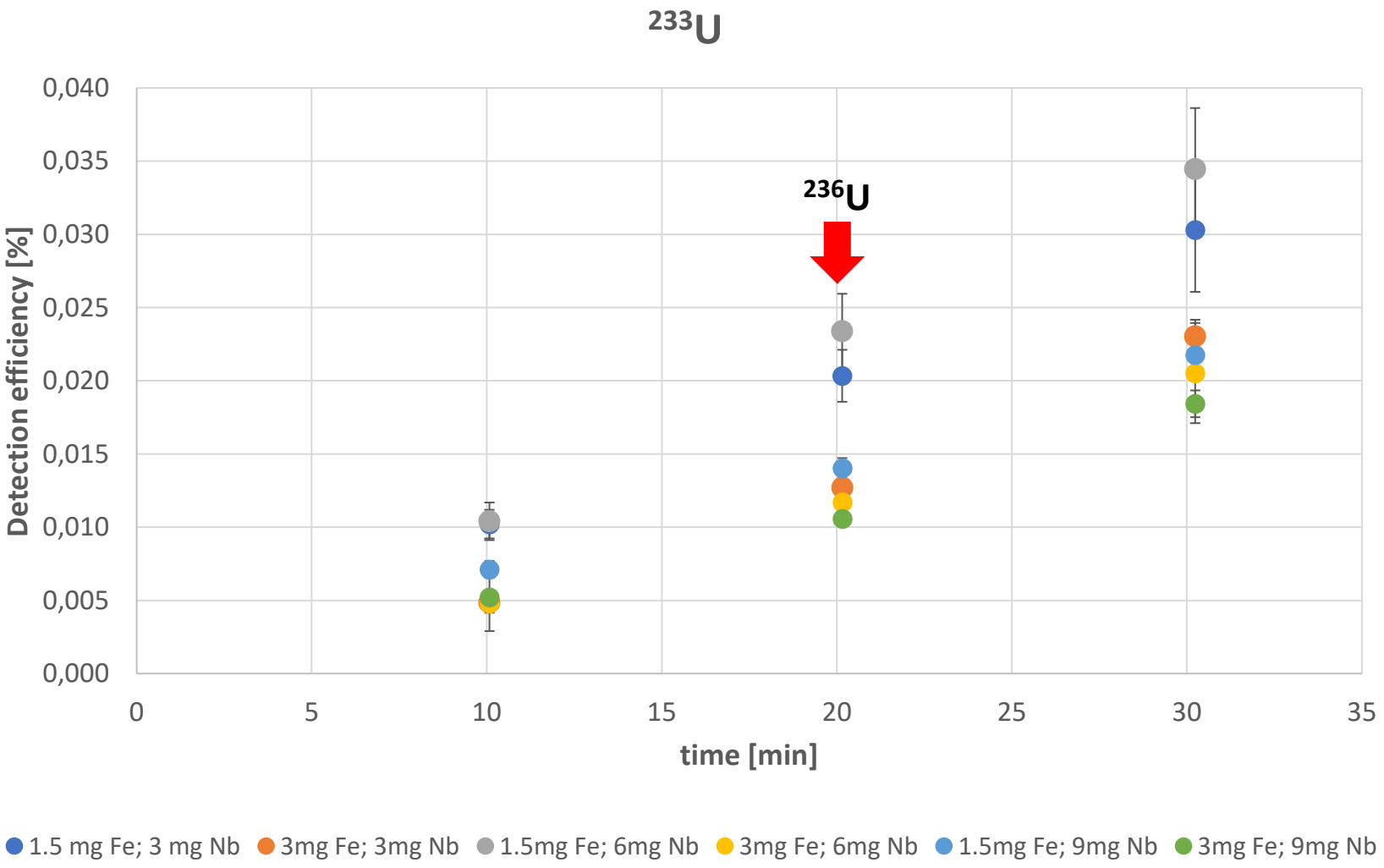
- ‘’heavier’’ matrix produce higher efficiencies.
- Same is the case for Am and U (not shown)

Applied to more realistic analysis time…



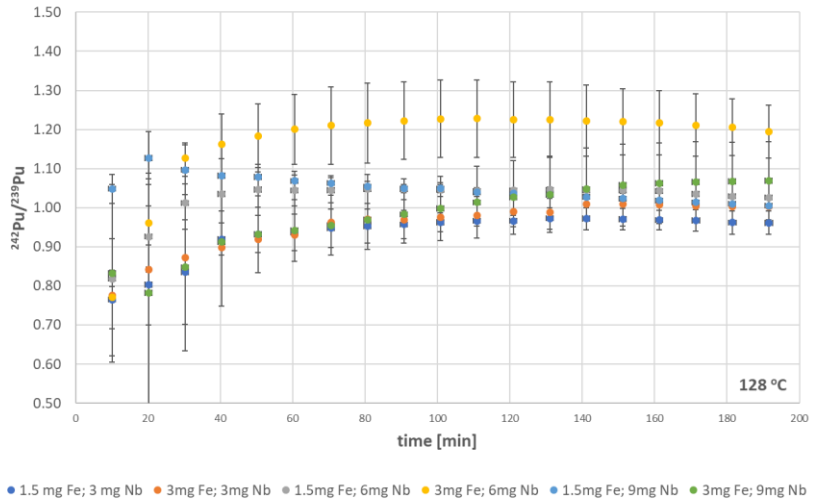
- ‘’lighter’’ matrix produce higher efficiencies.
- Same is the case for Am and U (not shown).

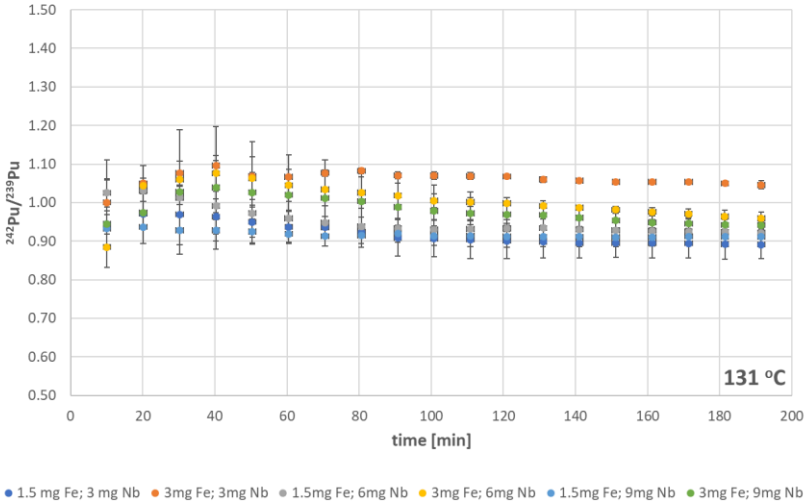
Effect to our dearest actinide U

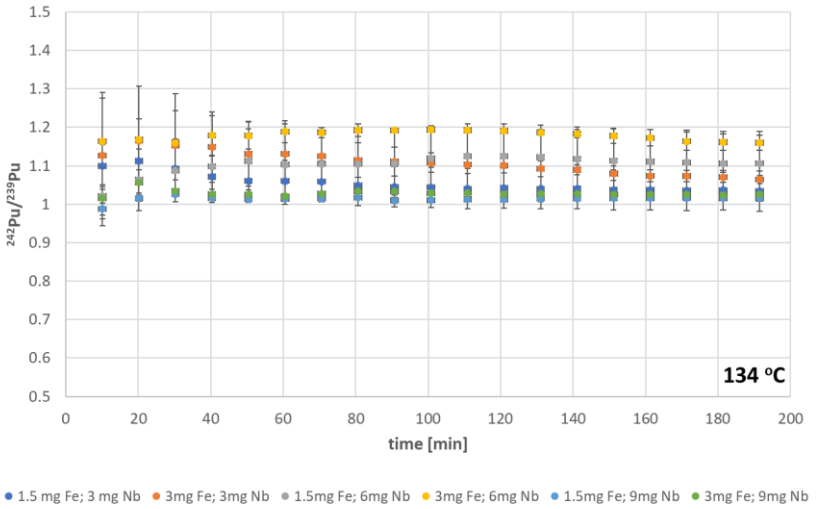


- Efficiency almost double.
- Each samples is sputtered for ~7 mins for U-233 and ~20 mins for U-236
- Over 1000 samples targeting ^{236}U analyzed in 2023.

Effect of Cs temperature on Pu measurement stability

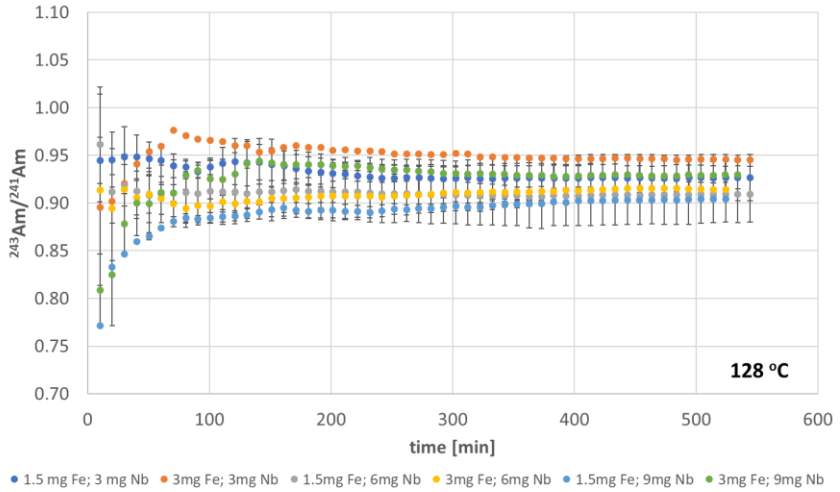


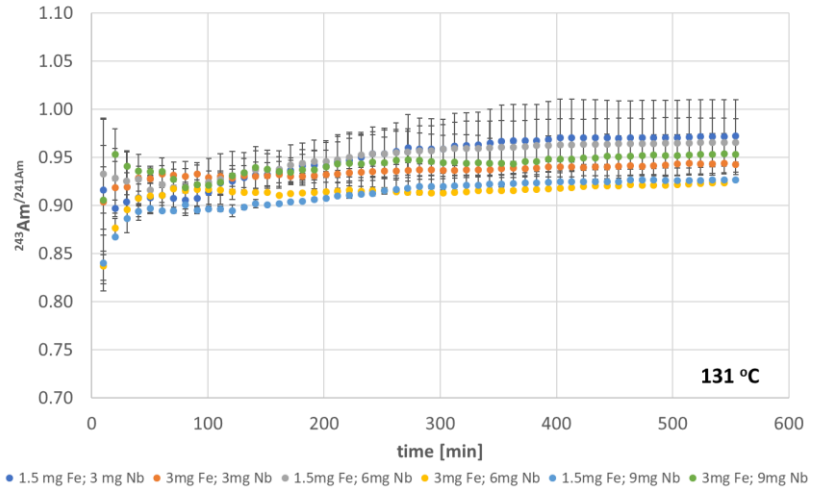


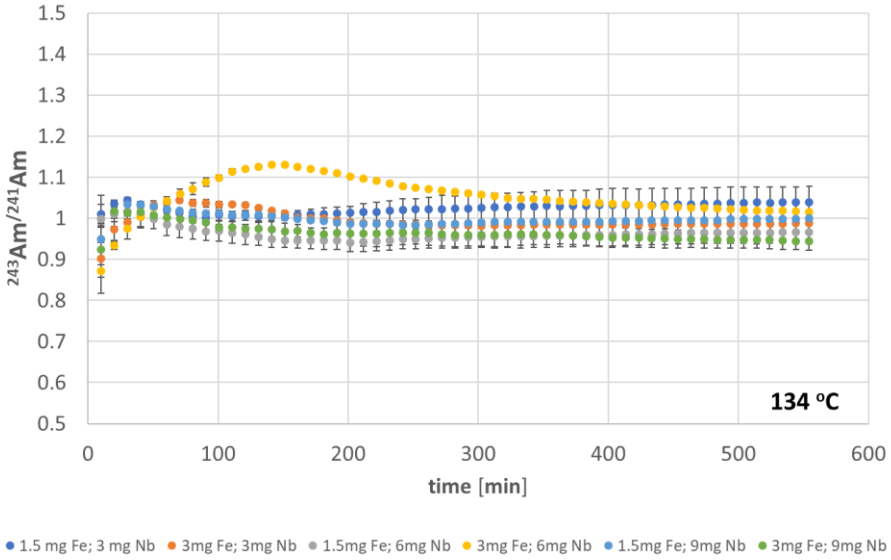


It is easy to see that Pu ratios behave better at higher Cs temperatures.

What about americium?



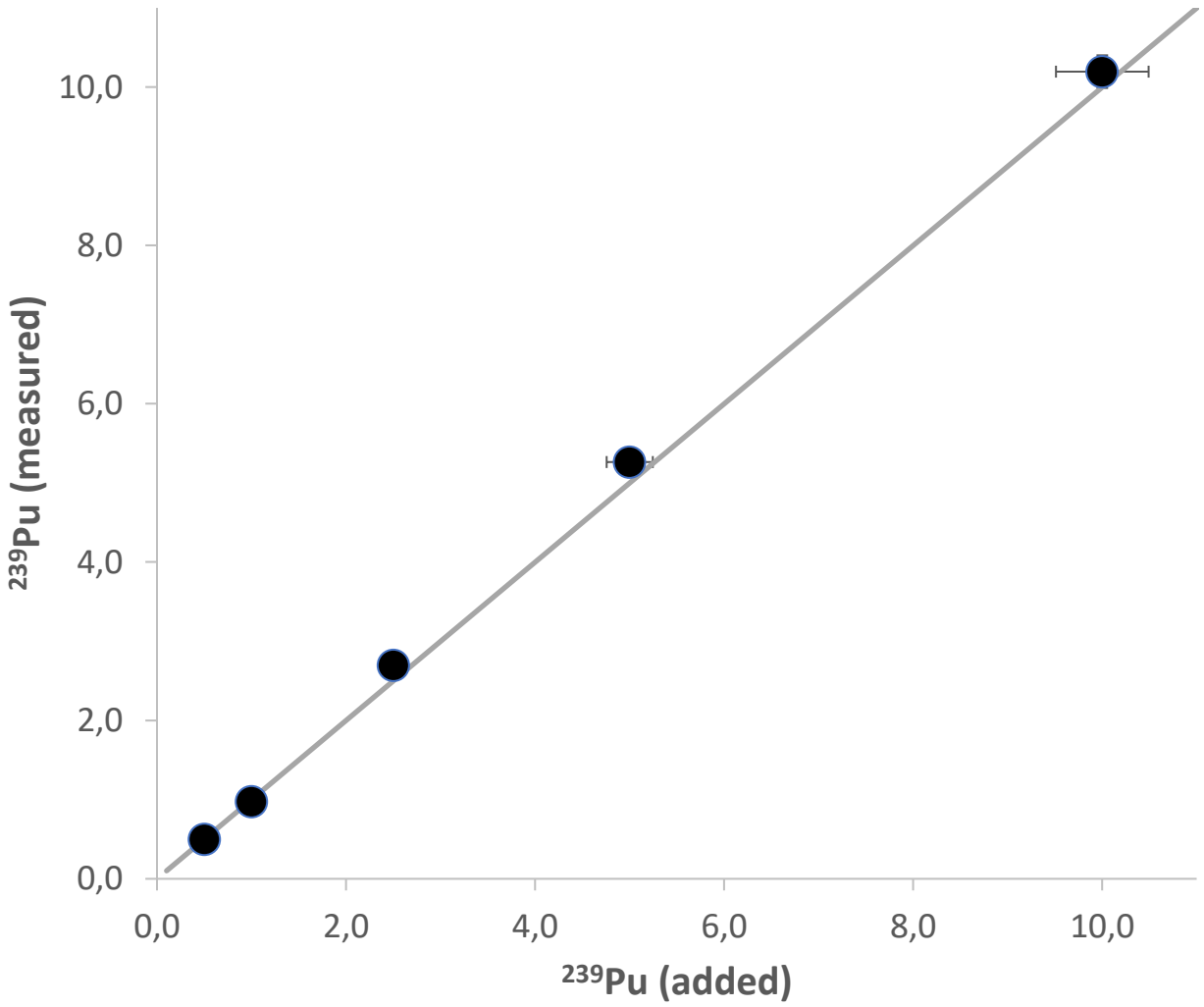




Am ionization also seems to benefit from higher temperatures.

In general this might be more relevant for non isotopic carrier studies…

Detection limits and implications for samples



Detection limits:

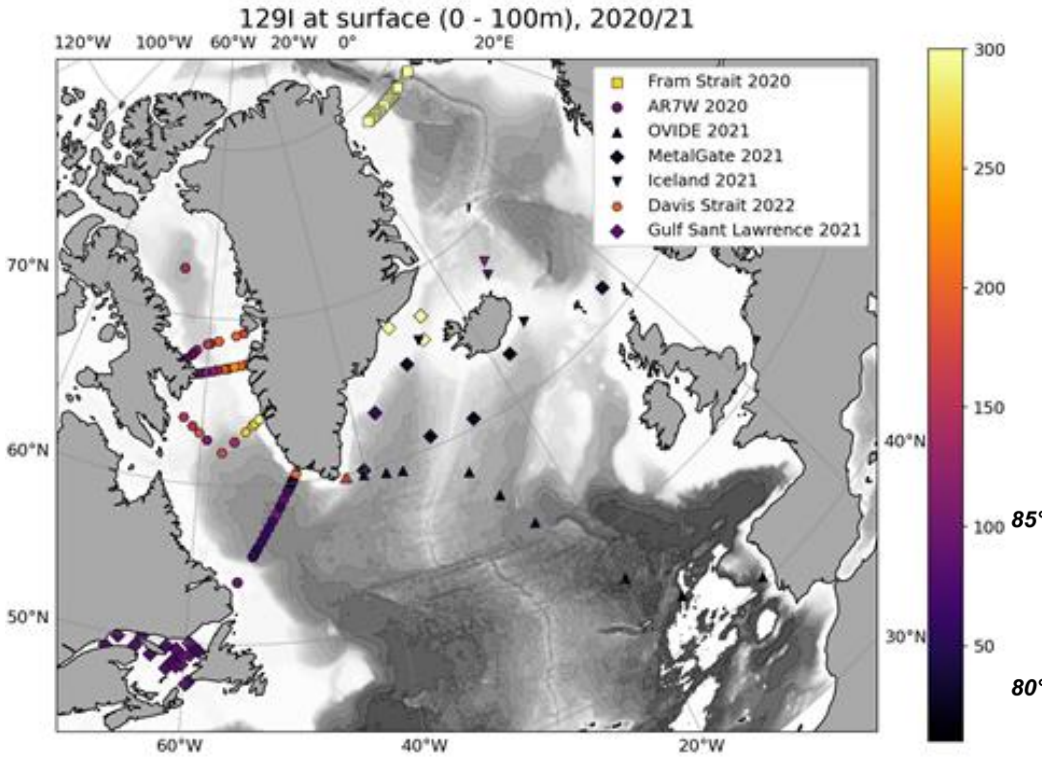
^{239}Pu → 45 attograms
^{240}Pu → 10 attograms
^{236}U → 85 attograms

This represents less than 2% of the total amounts in 1 L of seawater from the North Sea.

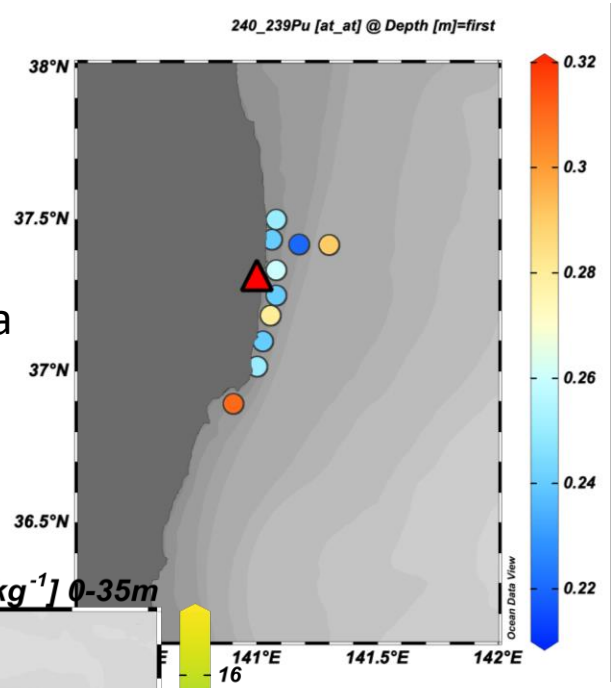
Currently we can analyze Pu isotopes with 1 L of seawater from the N. Atlantic/Arctic and ^{236}U with 0.5 L

Det. Lim. = [blank] + ($3*SD_{blk}$)

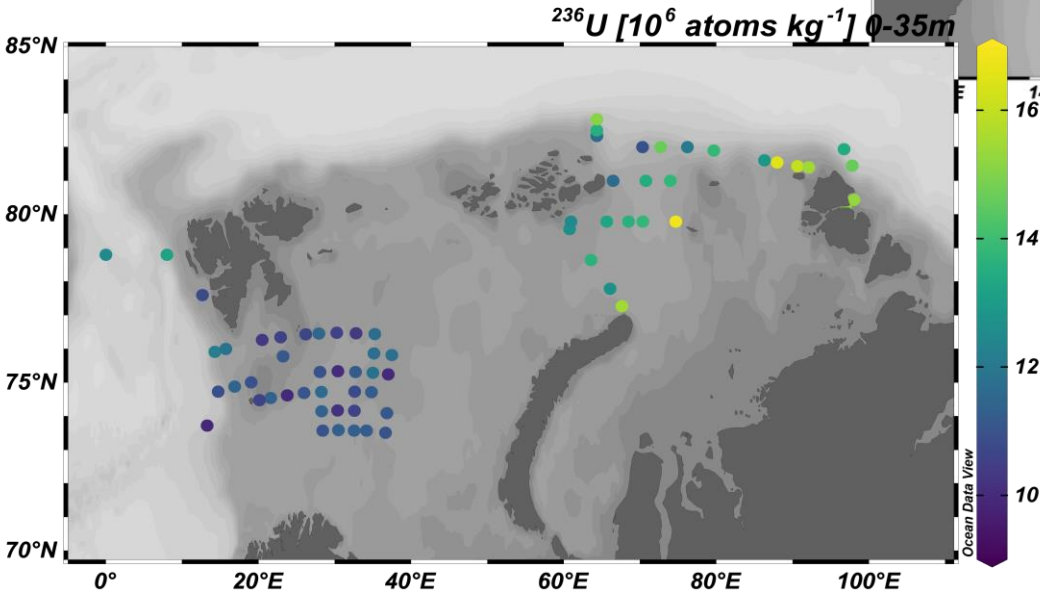
Some applications



Arctic Ocean



Fukushima



Barents Sea/Santa Anna Trough

Thanks for your attention!