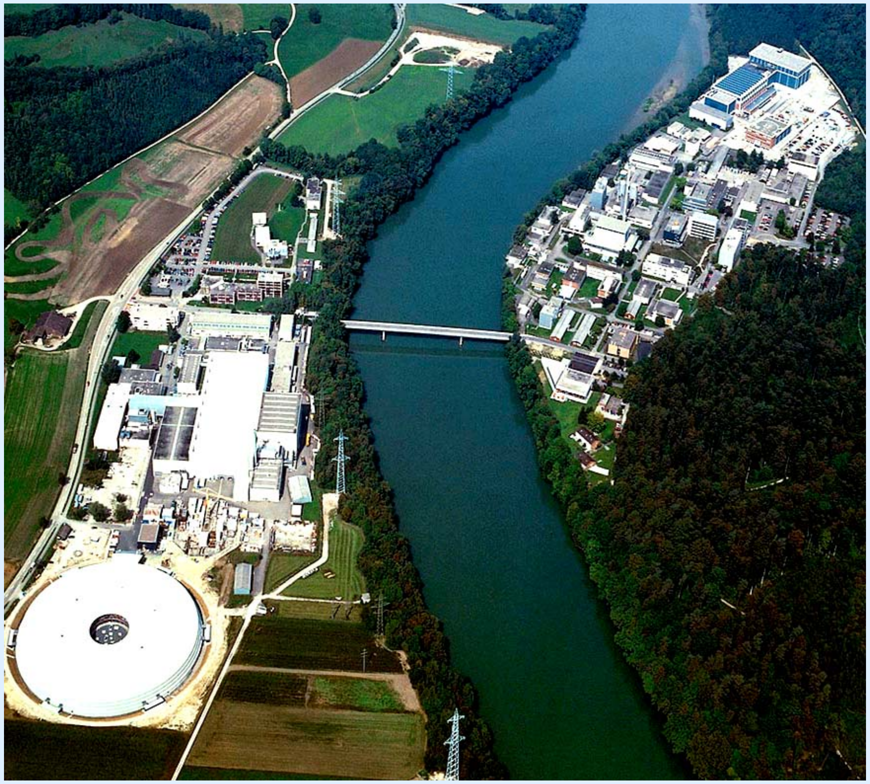
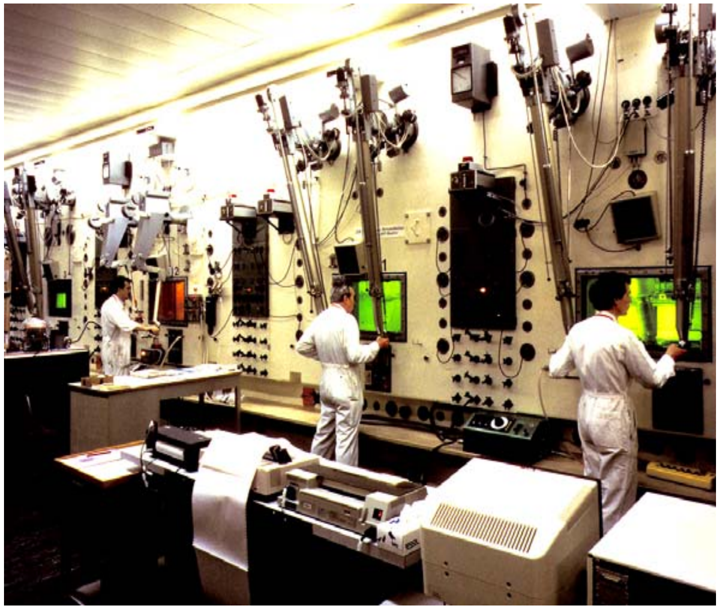
The analytical infrastructure in the Hotlaboratory of PSI

Ines Günther-Leopold

Didier Gavillet

Laboratory for Materials Behaviour





Analytical groups within the Laboratory for Materials Behaviour

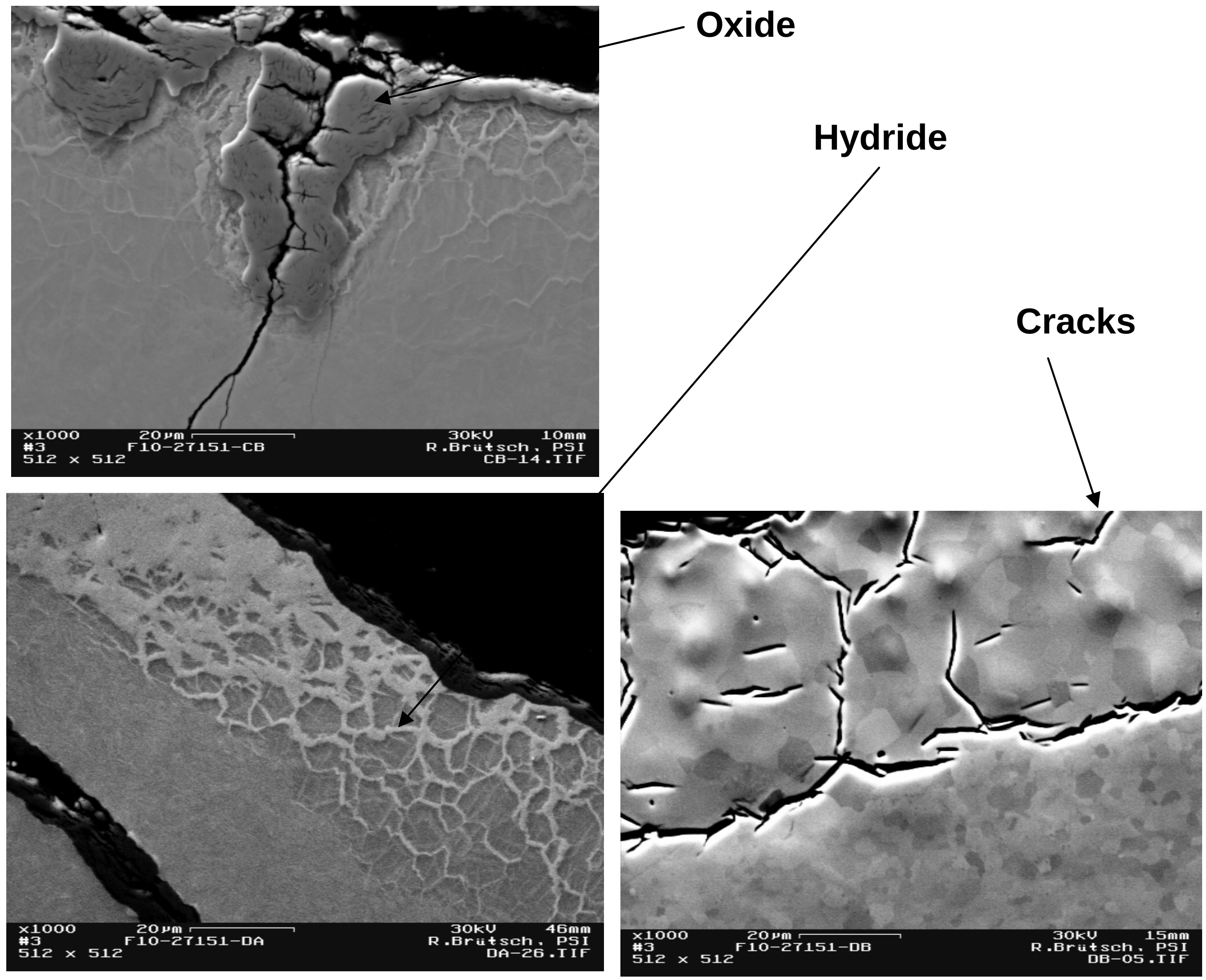
- Surface and Solid State Analysis
- Isotope and Wet Chemical Analysis

Surface and Solid State Analysis
(Didier Gavillet)

- SEM (Scanning Electron Microscopy)
- EPMA (Electron Probe Microanalysis)
- SIMS (Secondary Ion Mass Spectrometry)

SEM analysis of polished surfaces

- Irradiated Zircaloy with large hydrogen content
- BSE observations
- Possible if the dose rate of the specimen is lower than 1 mSv/h at 1 cm.
- EDX analysis also possible for specimen dose rate lower than 0.5 mSv/h at 1 cm.

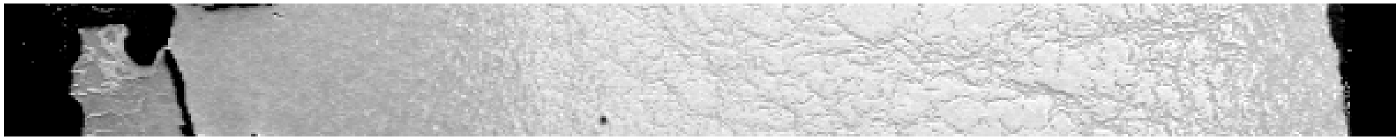


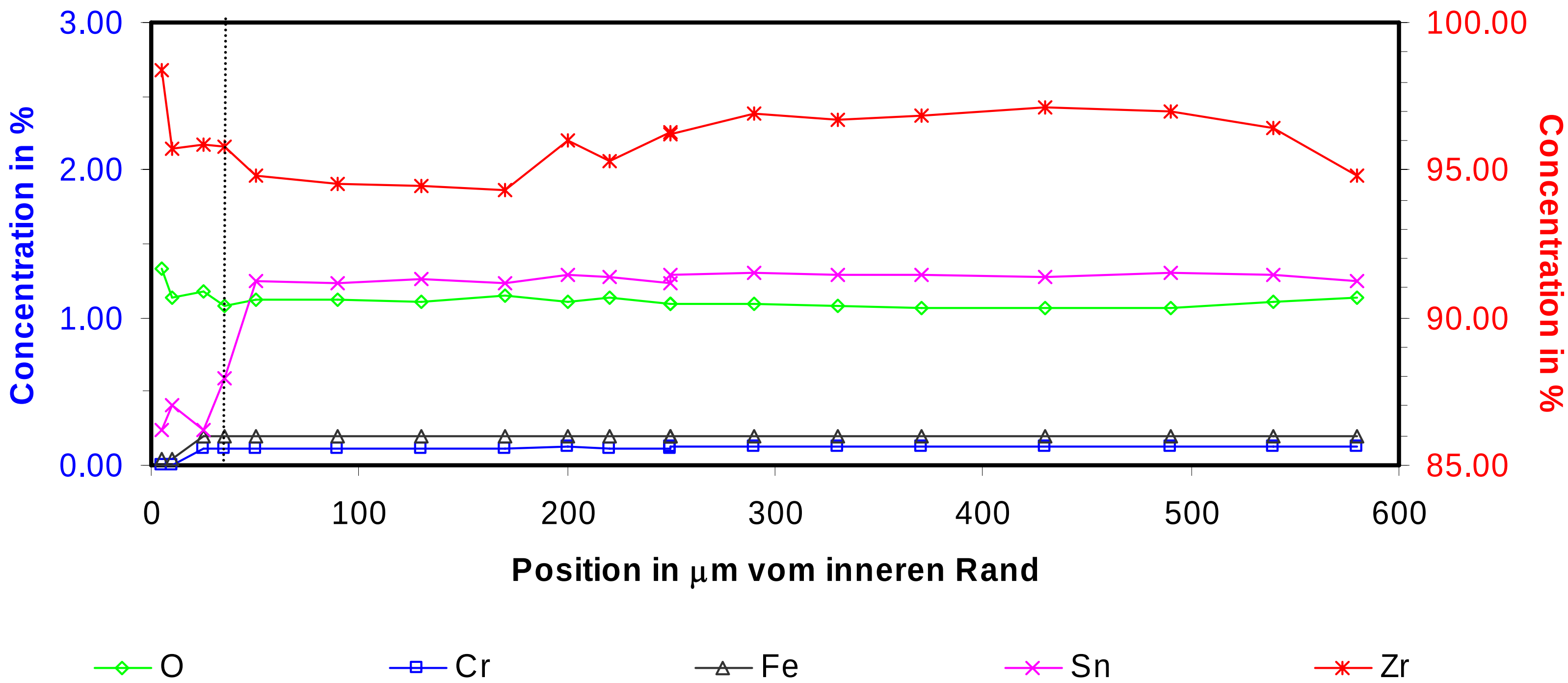
PAUL SCHERRER INSTITUT

Nuclear Energy and Safety Research Department
Laboratory for Materials Behaviour (LWV)

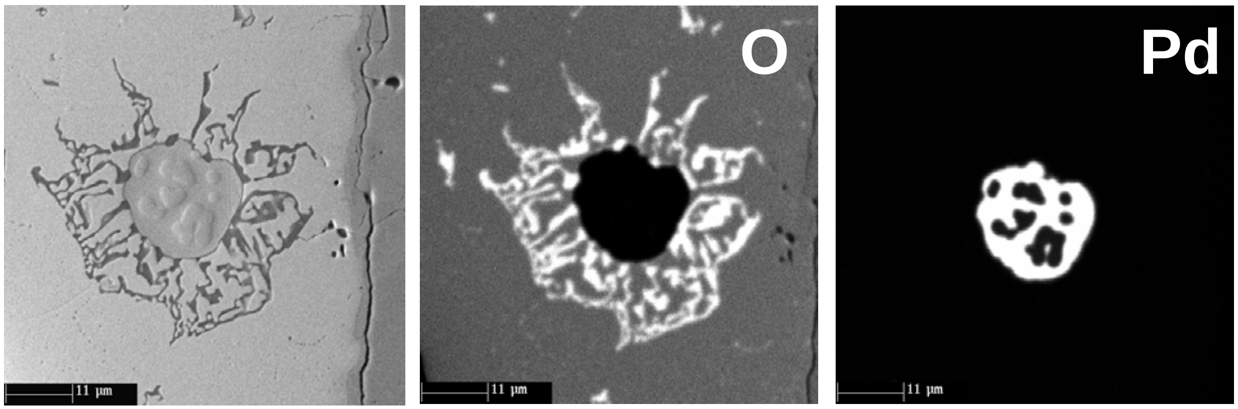
Quantitative EPMA-Analysis

Line scan through an heavily hydrated Zircaloy tube

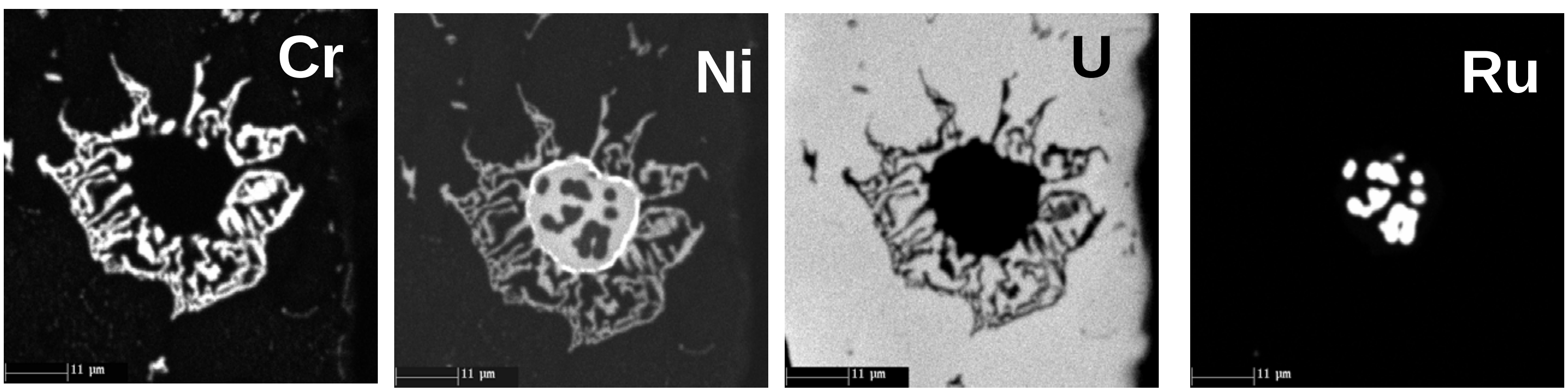




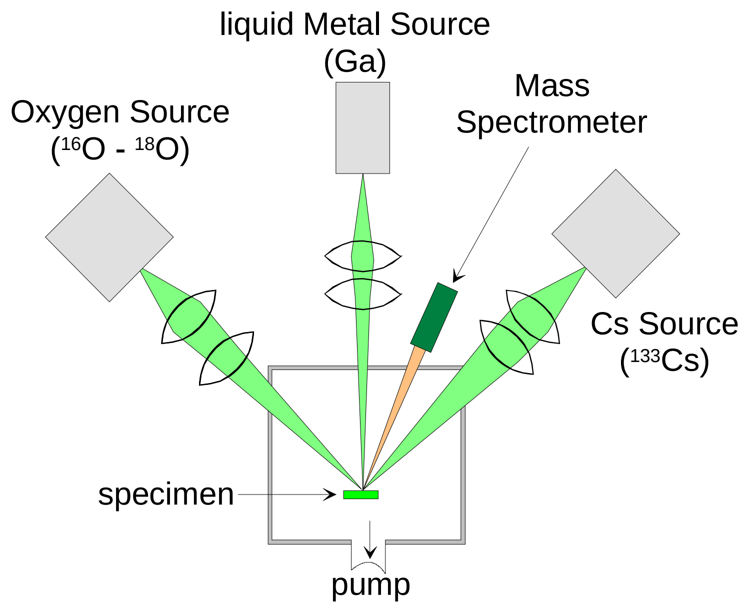
EPMA – Complex element distribution in melted UO_2 / ZrO_2 /Steel material

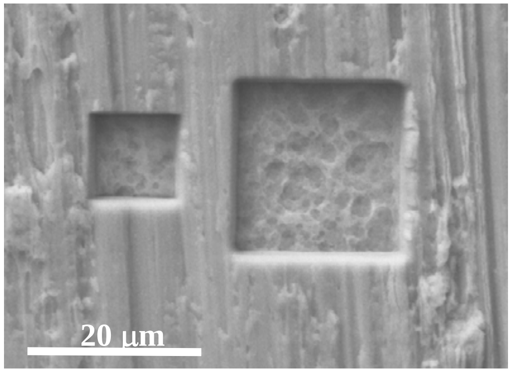


Element concentration must be larger than about 0.2 to 0.5 wt%



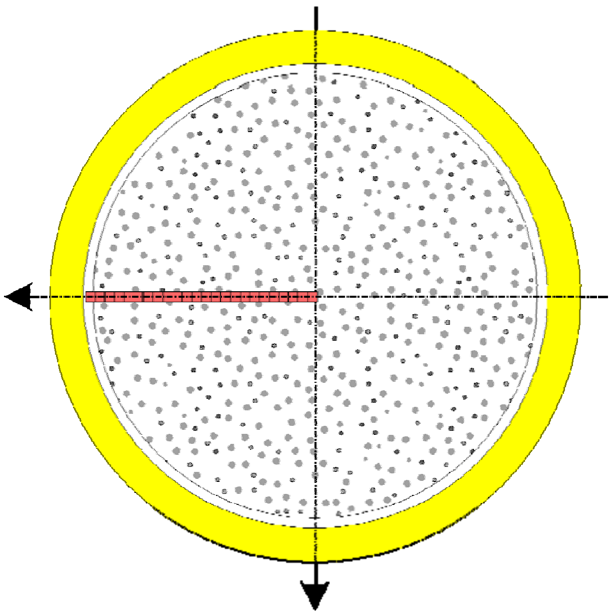
SIMS measurement principle



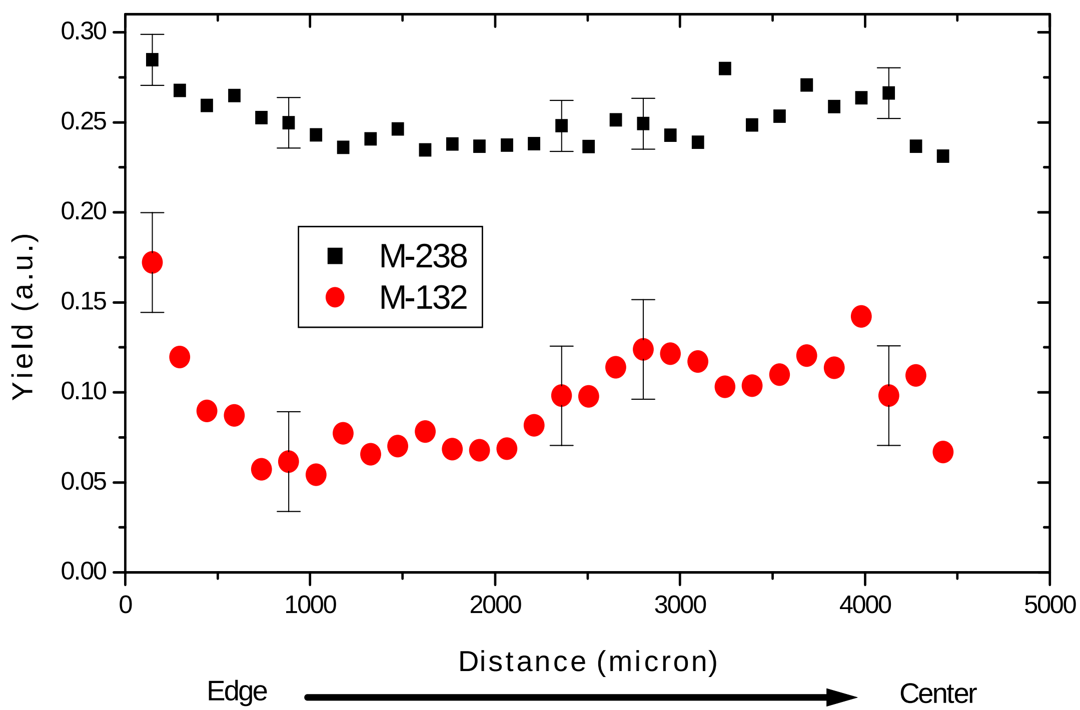


SIMS – Xe measurement in high burnup fuel

Line scan through the pellet radius

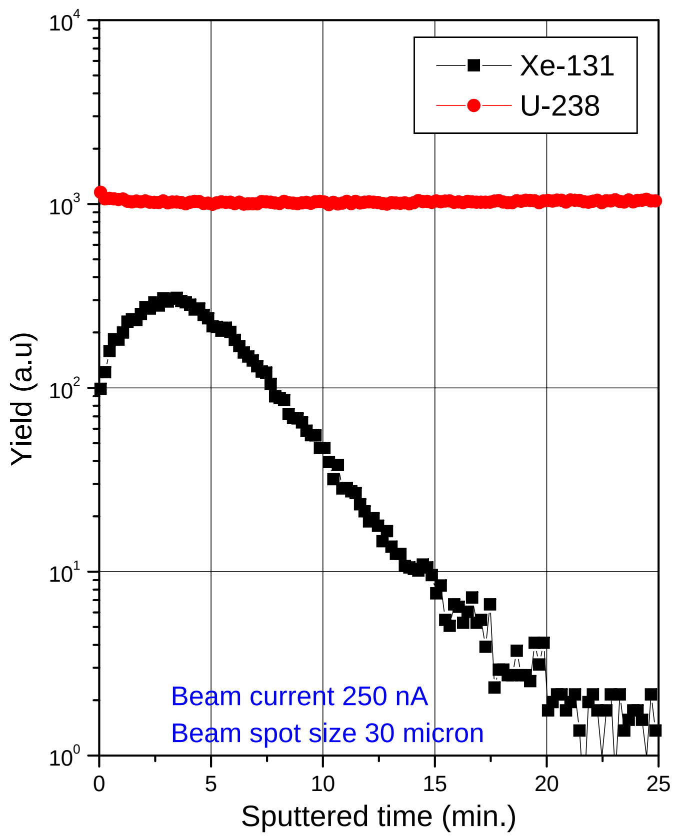


Linescan using SIMS on Fuel specimen

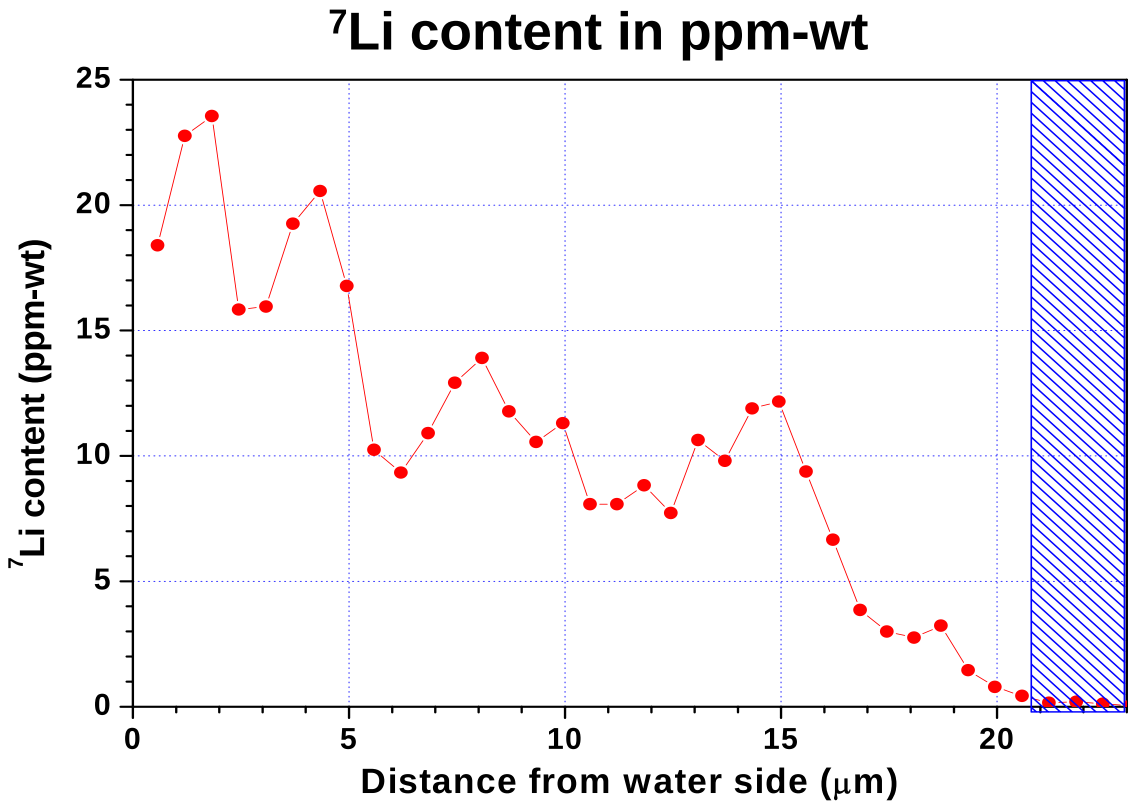


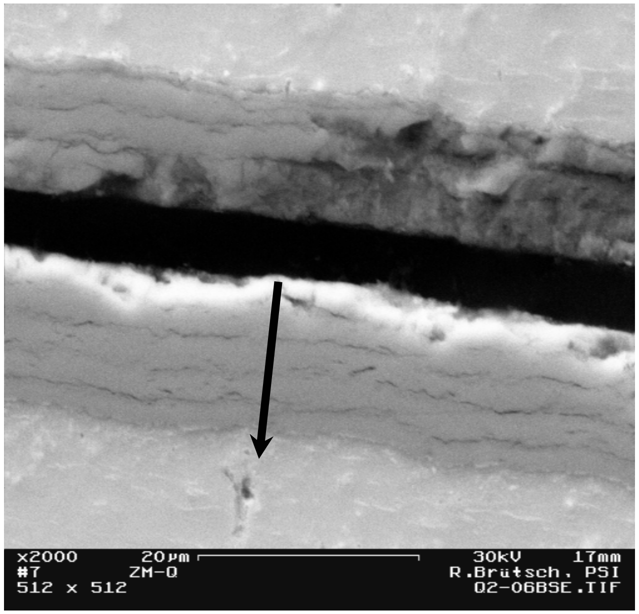
SIMS – Xe measurement in implanted UO_2

UO_2 pellet implanted with 500 keV $^{131}Xe^+$ to a dose of 2×10^{16} cm^{-2} in.



SIMS - Li quantitative distribution determination in the corrosion layer of irradiated Zircaloy

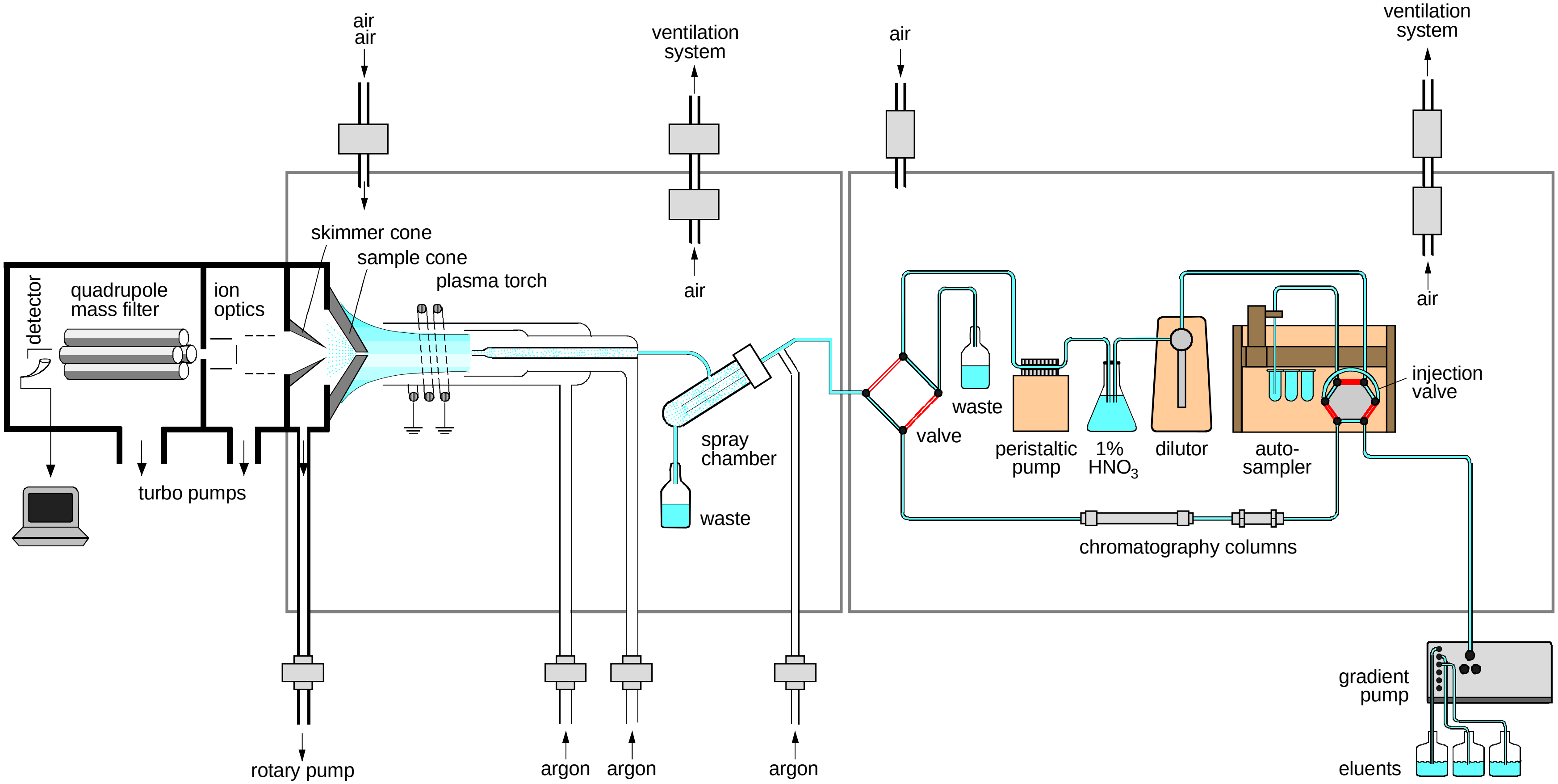




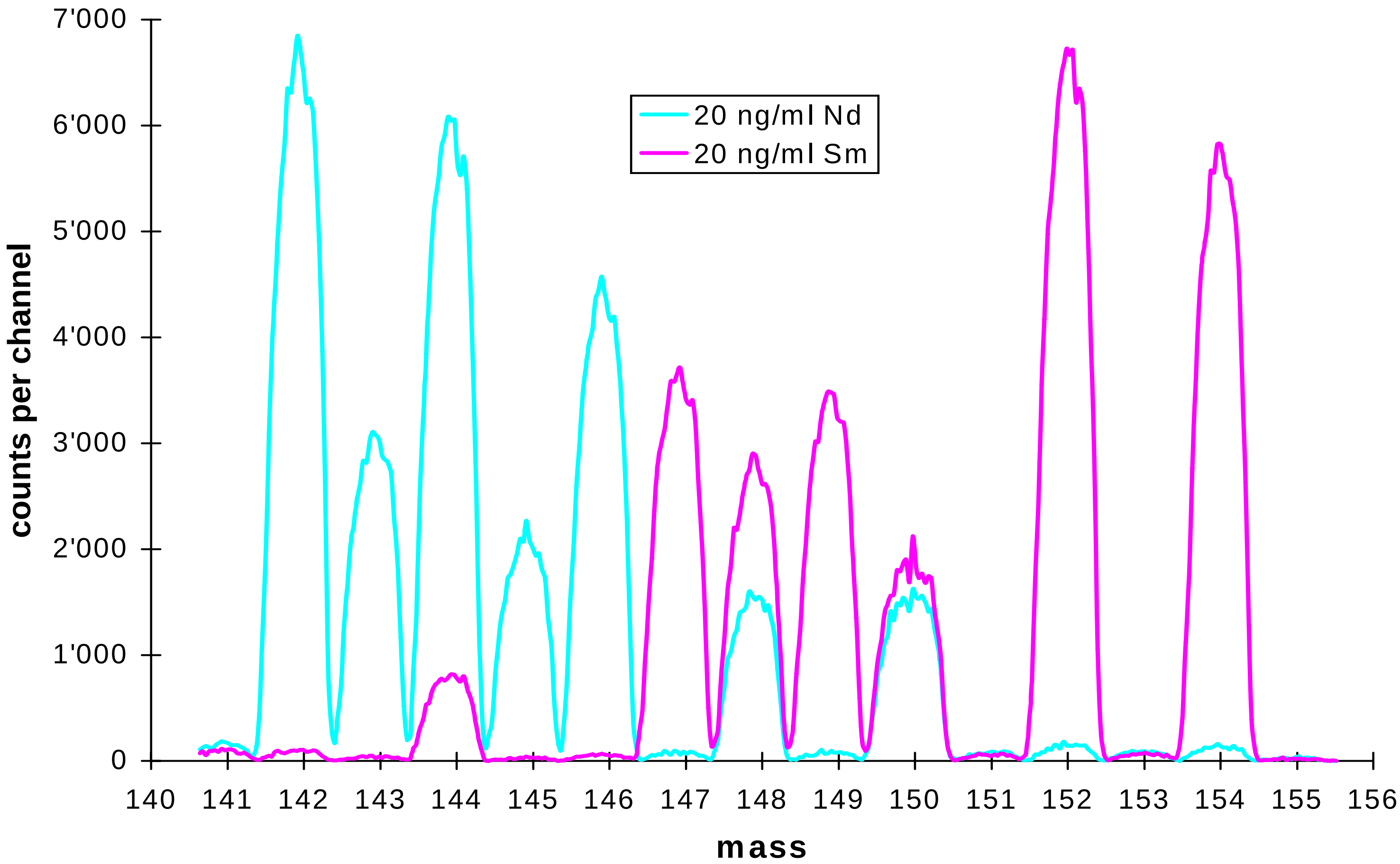
Isotope and Wet Chemical Analysis
(Zlatan Kopajtic, Ines Günther-Leopold)

- Inductively Coupled Plasma Mass Spectrometer (mainly for liquid samples)
- Laser Ablation (for solid samples and gas inclusions)
- Gas Mass Spectrometer (fission gases)

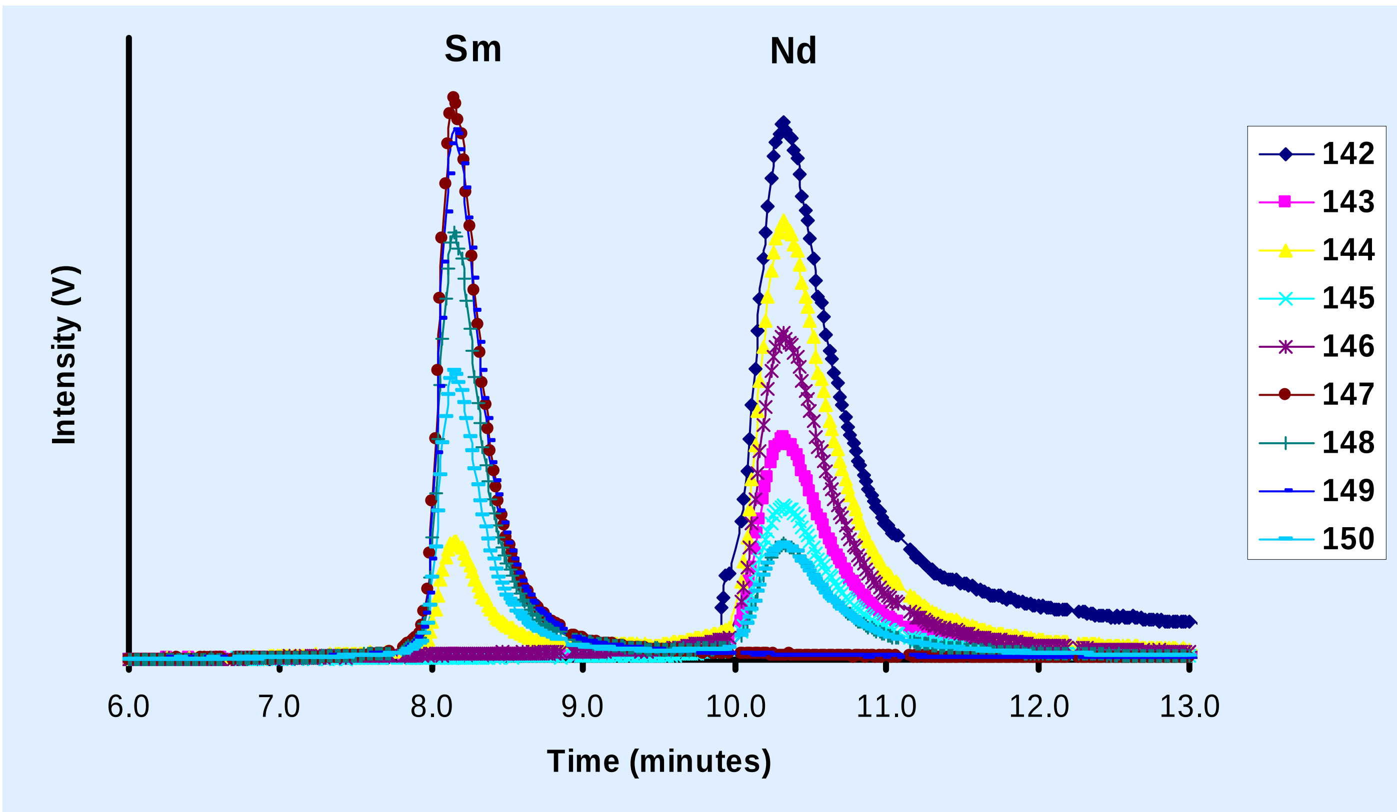
ICP Mass Spectrometry



ICP Mass Spectrometry



Separation of interfering elements by HPLC-MC-ICP-MS

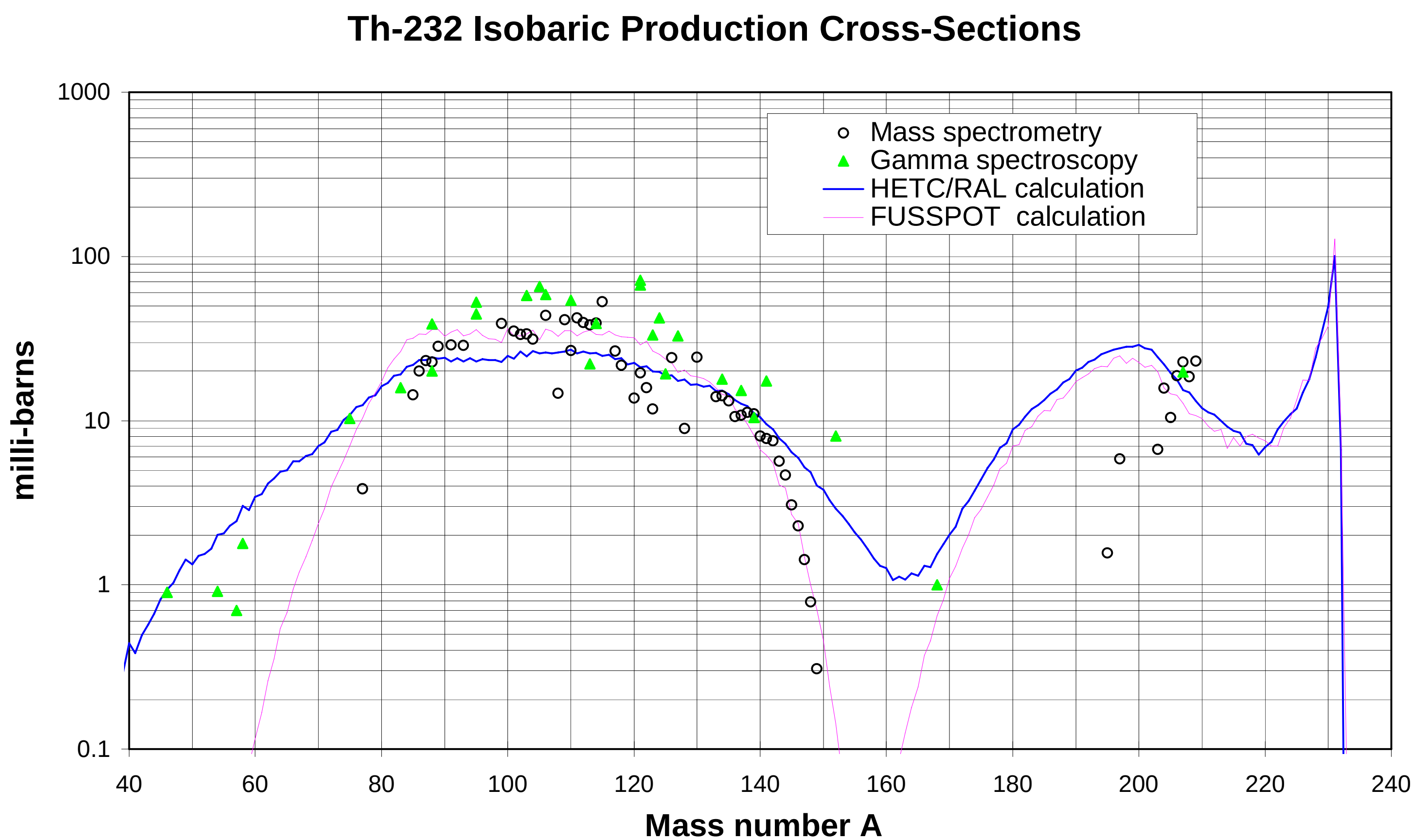


Quantitative characterization of nuclear fuels

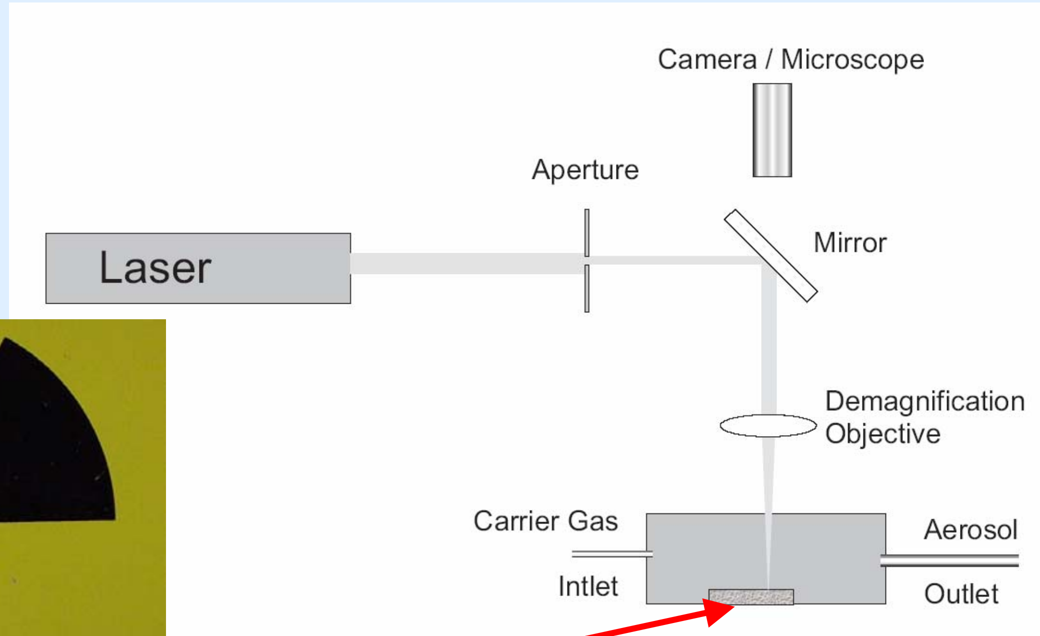
HPLC-MC-ICP-MS	^{234}U, ^{235}U, ^{236}U, ^{238}U ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu ^{142}Nd, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, ^{150}Nd ^{241}Am, ^{242m}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm ^{90}Sr ^{133}Cs, ^{134}Cs, ^{135}Cs, ^{137}Cs ^{147}Sm, ^{148}Sm, ^{149}Sm, ^{150}Sm, ^{151}Sm, ^{152}Sm, ^{154}Sm ^{151}Eu, ^{153}Eu, ^{154}Eu, ^{155}Eu ^{147}Pm, ^{155}Gd
Q-ICP-MS	^{95}Mo, ^{99}Tc, ^{101}Ru, ^{103}Rh, ^{109}Ag, ^{237}Np

ATHENA

(Actinide transmutation using high energy accelerators)



A laser ablation ICP-MS system for the analysis of radioactive samples



Marcel Guillong, Peter Heimgartner, Ines Günther-Leopold, Matthias Horvath and Zlatan Kopajtic

Background and Motivation

- Digestion, HPLC-MC-ICP-MS

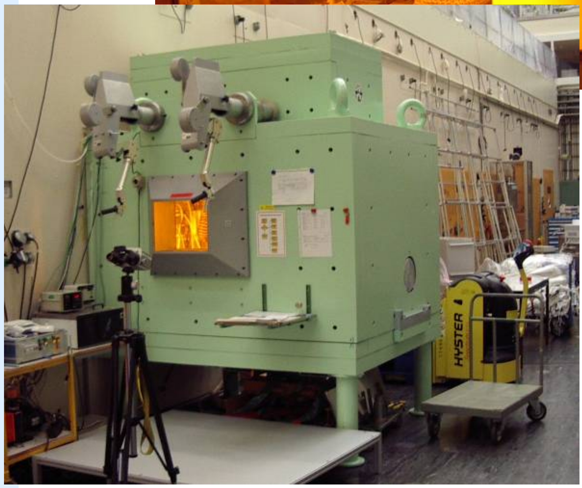
(Bulk, very precise and time consuming)

- SIMS

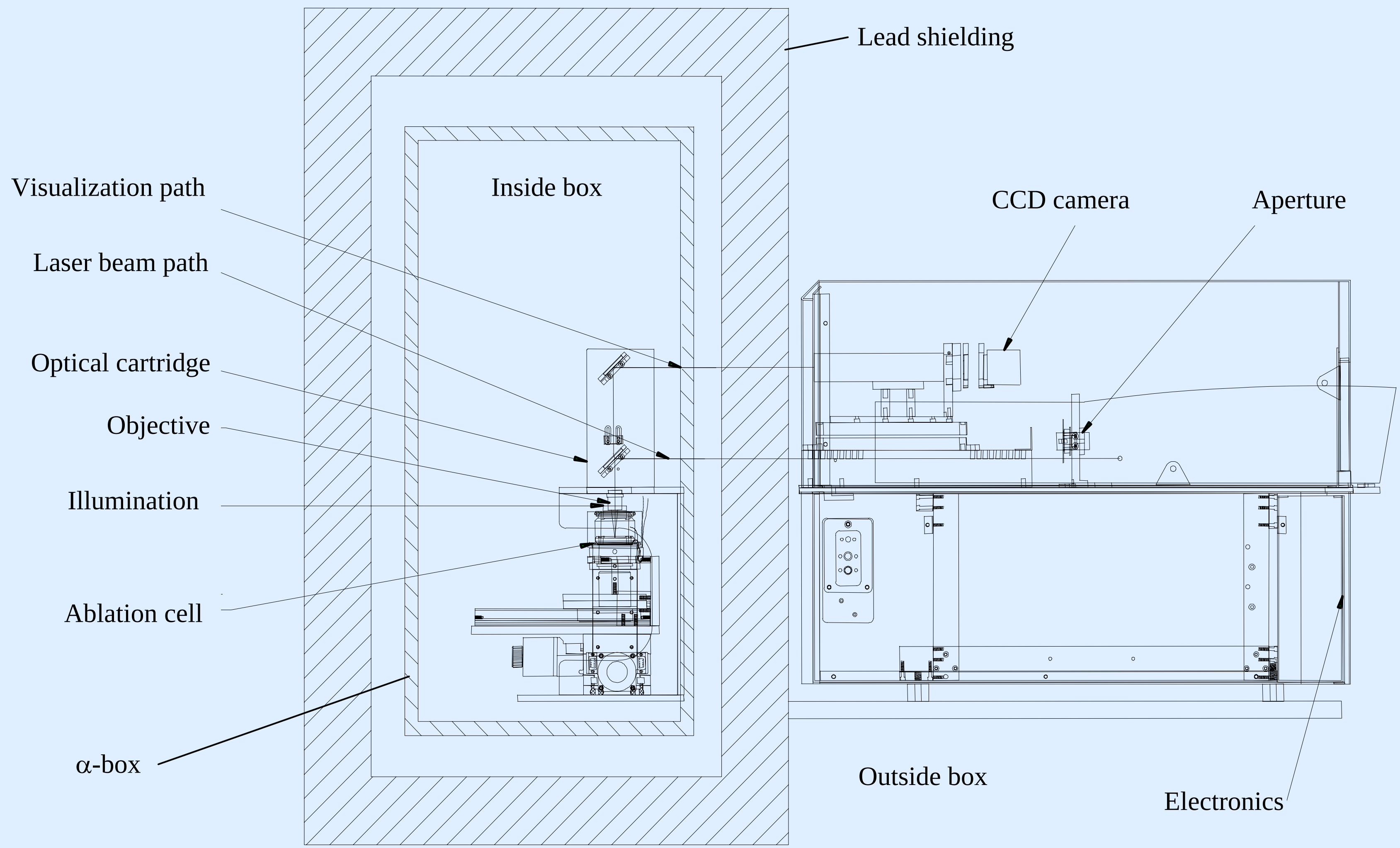
(difficult quantification)

LA-ICP-MS a perfect tool?

(high spatial resolution, quantification possibilities)

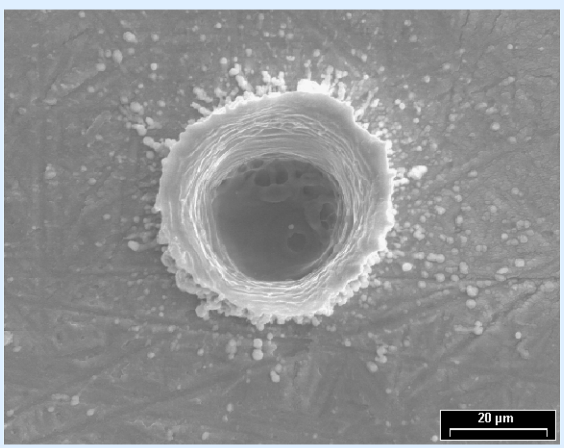


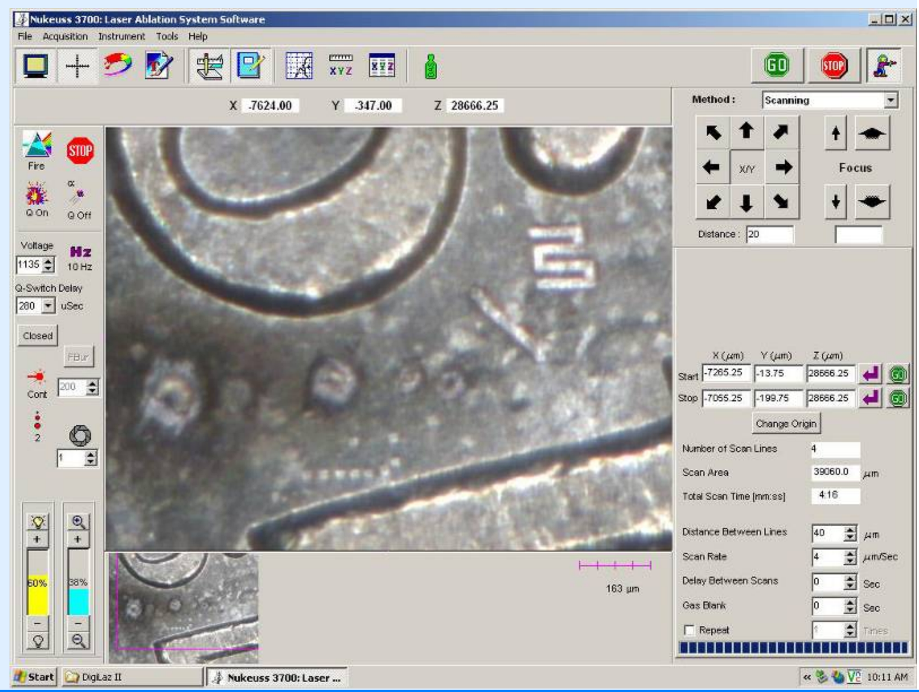
Instrumentation



Instrumentation

- CETAC LSX 500 / 3000 Nd YAG with 266 nm
- Output energy up to 60 mJ / pulse
- Crater sizes down to 10 µm (microns)



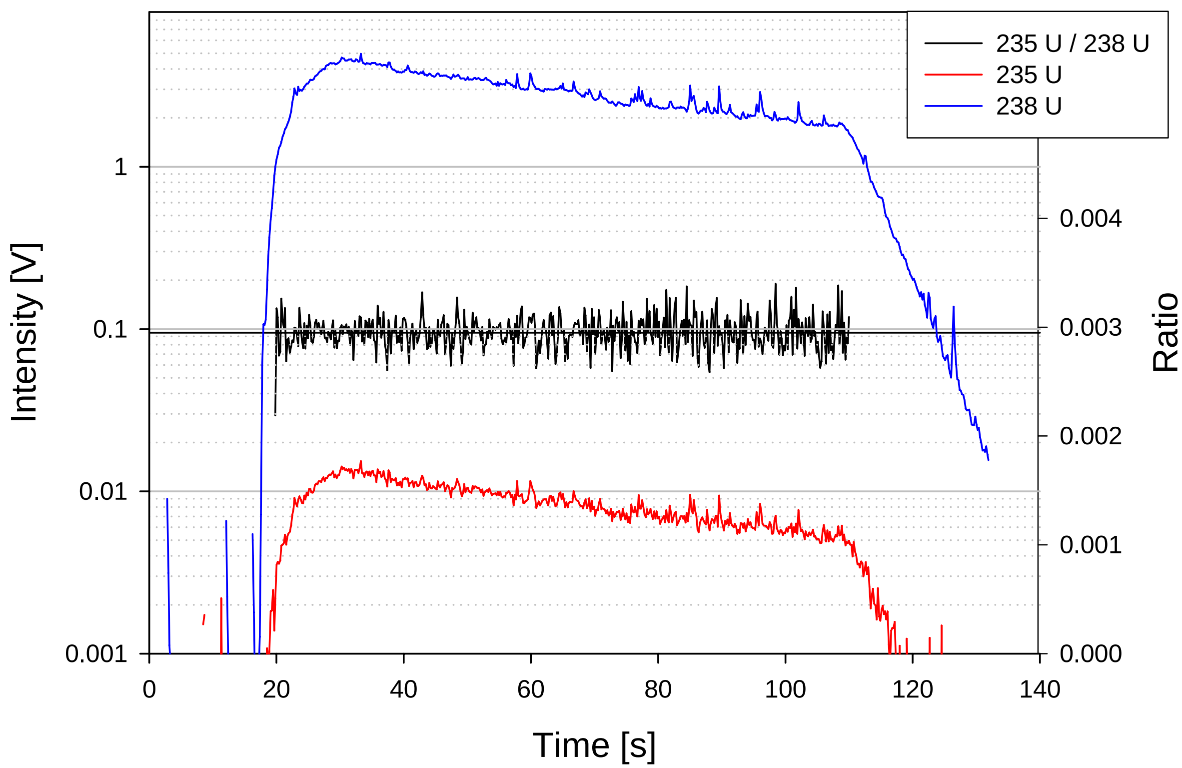


Results

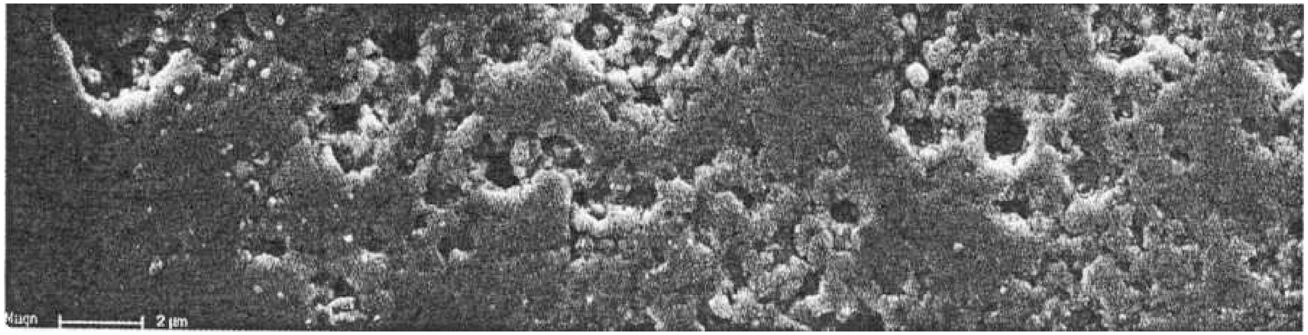
Transient signal

UO_2 5/1

10Hz, 25 μm, 10 Jcm^{-2}, single hole



Outlook



JNM 257 (1998), 78-87

- High burn up structure (~ 80% ^{235}U are fissioned)

Xe and Kr in the matrix and in µm-bubbles under high pressure

Localize with EPMA, analysis with LA-ICP-MS