QUANTITATIVE MEASUREMENT OF DYNAMIC CHANGES OF TRACE ELEMENT CONTENT IN AMBIENT AEROSOL BY MICAP-TOFMS

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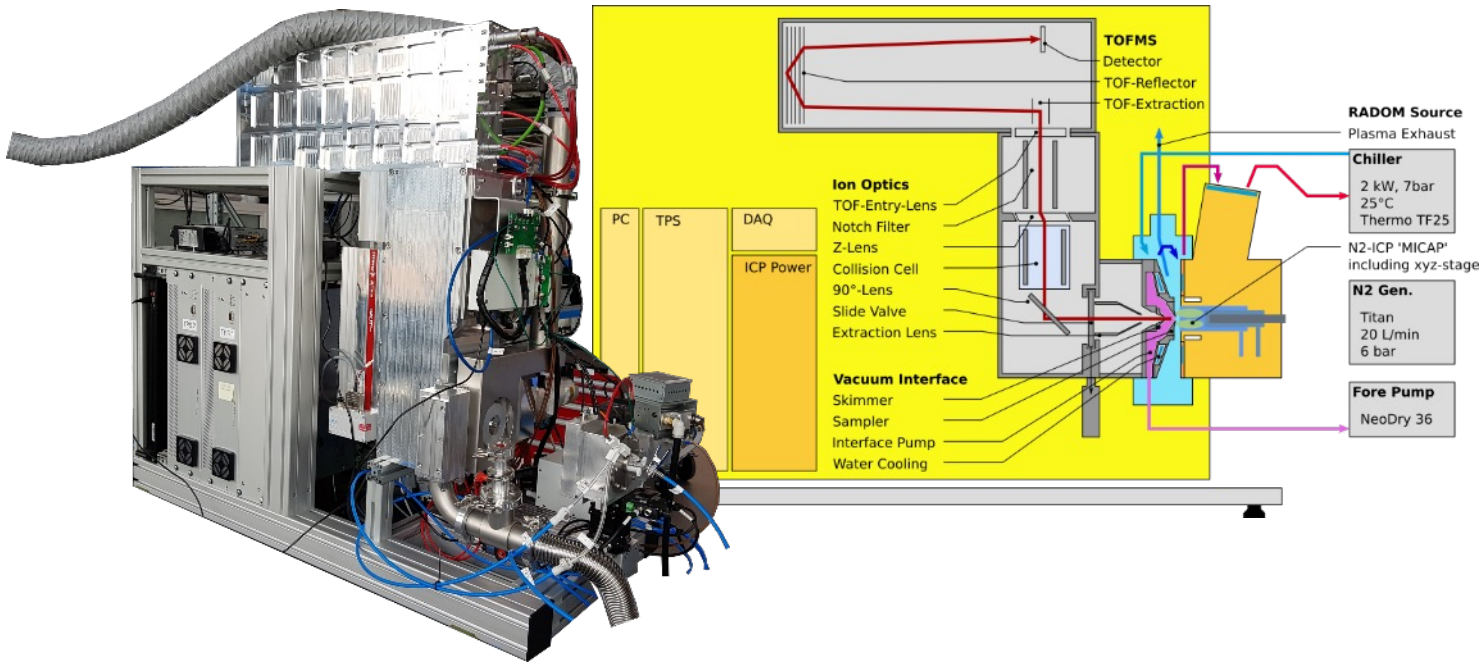
27th ETH-Nanoparticles Conference (NPC-24)

INSTRUMENT LAYOUT AND PERFORMANCE

First Proof of Concept Instrument at TOFWERK

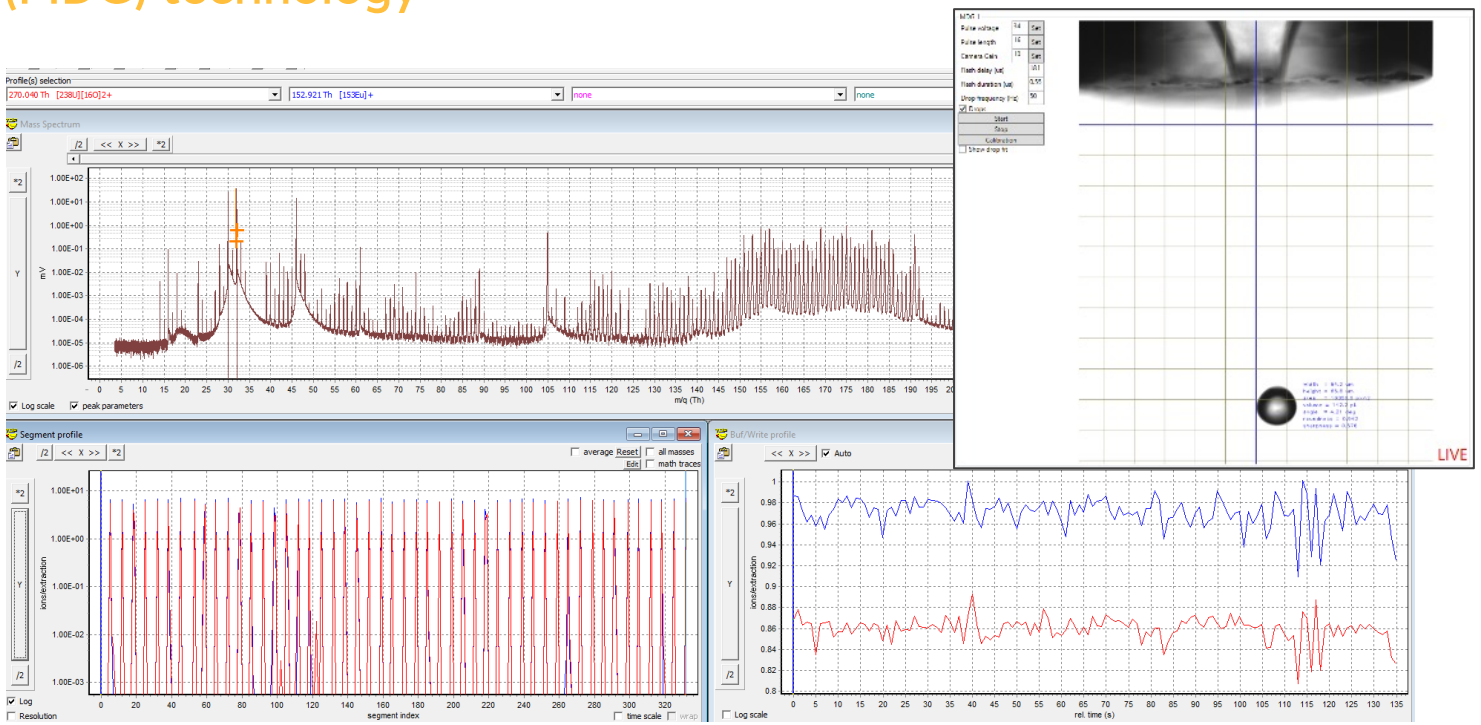


N2ICP-001 Prove of Concept (POC) Instrument and Schematics

- MICAP plasma source (RADOM Corp.)
- Grounded sampler and skimmer
- Extraction lens
- 63 mm gate valve
- Ion Mirror
- Collision-/Reaction Cell
- Notch Filter
- TOFMS with R3000

INSTRUMENT LAYOUT AND PERFORMANCE

Performance Characterization using Micro Droplet Generator (MDG) technology

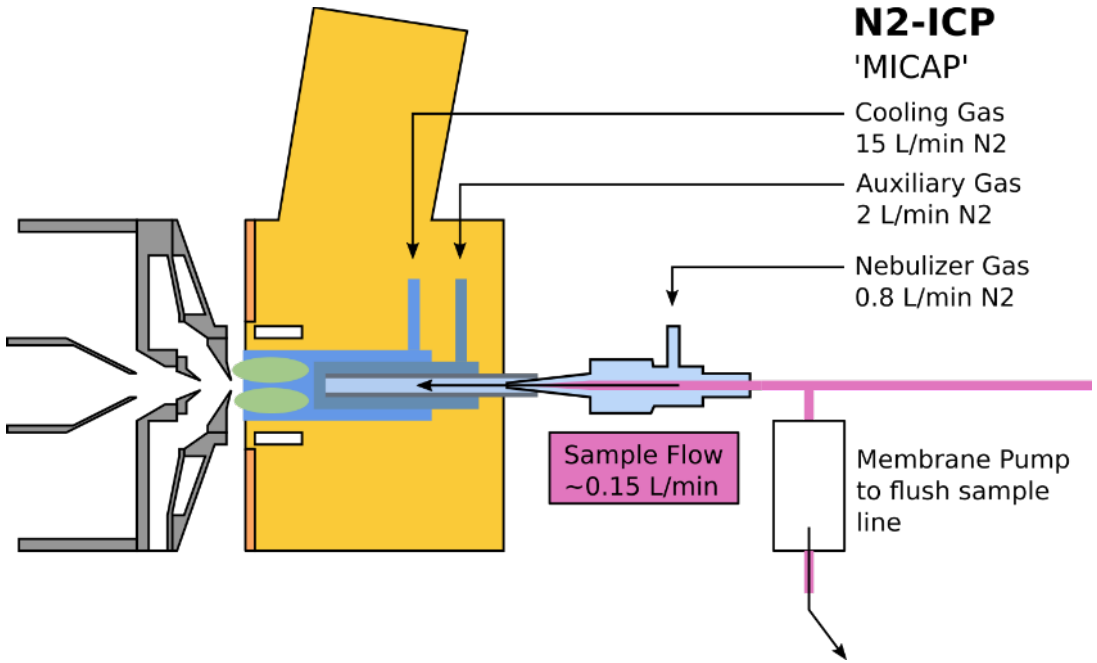


Video capture of Single droplet
Mass Spectrum and time dependent signals of single droplets

- 100 ppb multi-element standards (Merck IV, REE's)
- Droplet volume: 142 pL
- Analyte per droplet: 14.2 fg
- 3 ms integration time
- Plasma on
  - Air (not dried)
  - N2 (Generator using PSA principle)

DIRECT AIR SAMPLING

Passive Sampling by Venturi Effect

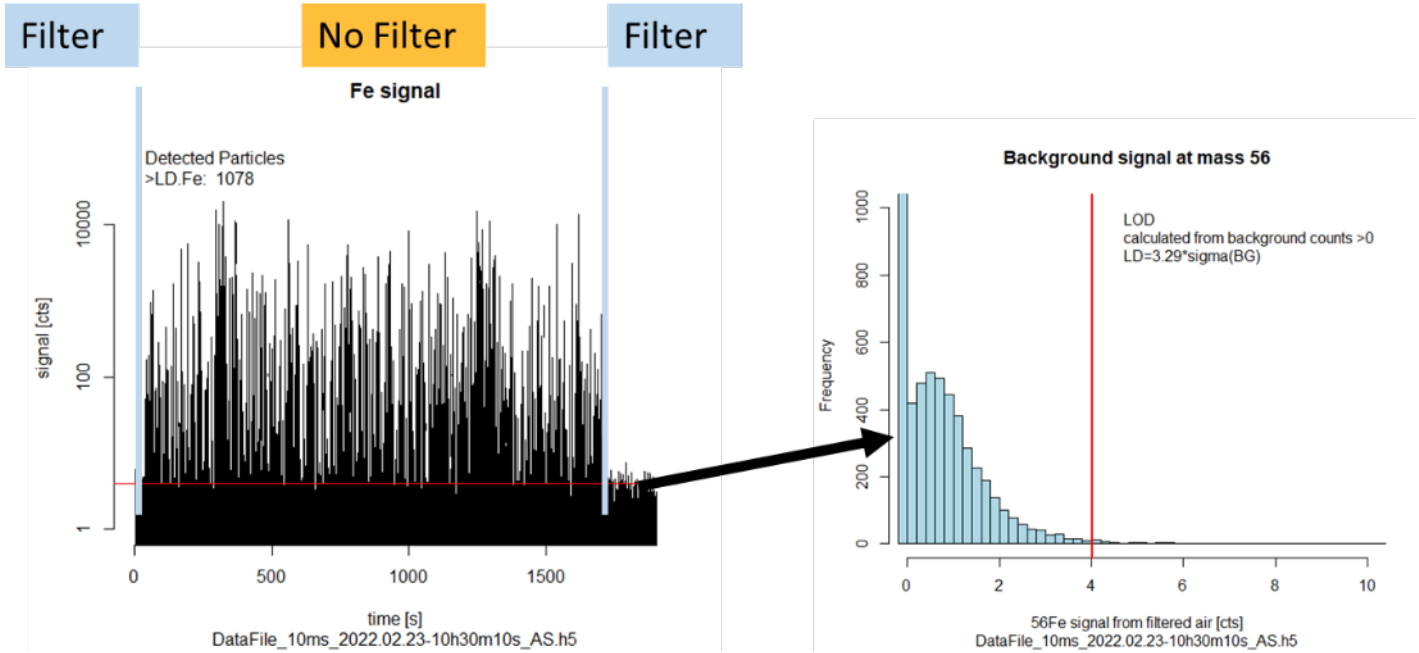


Air sampling using standard nebulizer

- Air sampling without pump in the sample flow path to the ion source (no GED required)
- Membrane pump to flush sample line
- Use of conventional Nebulizer
  ~0.15 L/min air sampling

DIRECT AIR SAMPLING – DATA STRUCTURE

Single particle signals, LOD's from filtered air



Signal from filtered and un-filtered outdoor air (left)
LOD calculation from filtered air signal (right)

- Background: HEPA Filter
- Continuous measurement with 1 s integration time
- Background LOD determined from filtered aerosol
  - Log-Normal background fit accepting 5% false-positive/-negative

DIRECT AIR SAMPLING – CASE STUDY

Are there Metals in the Air?

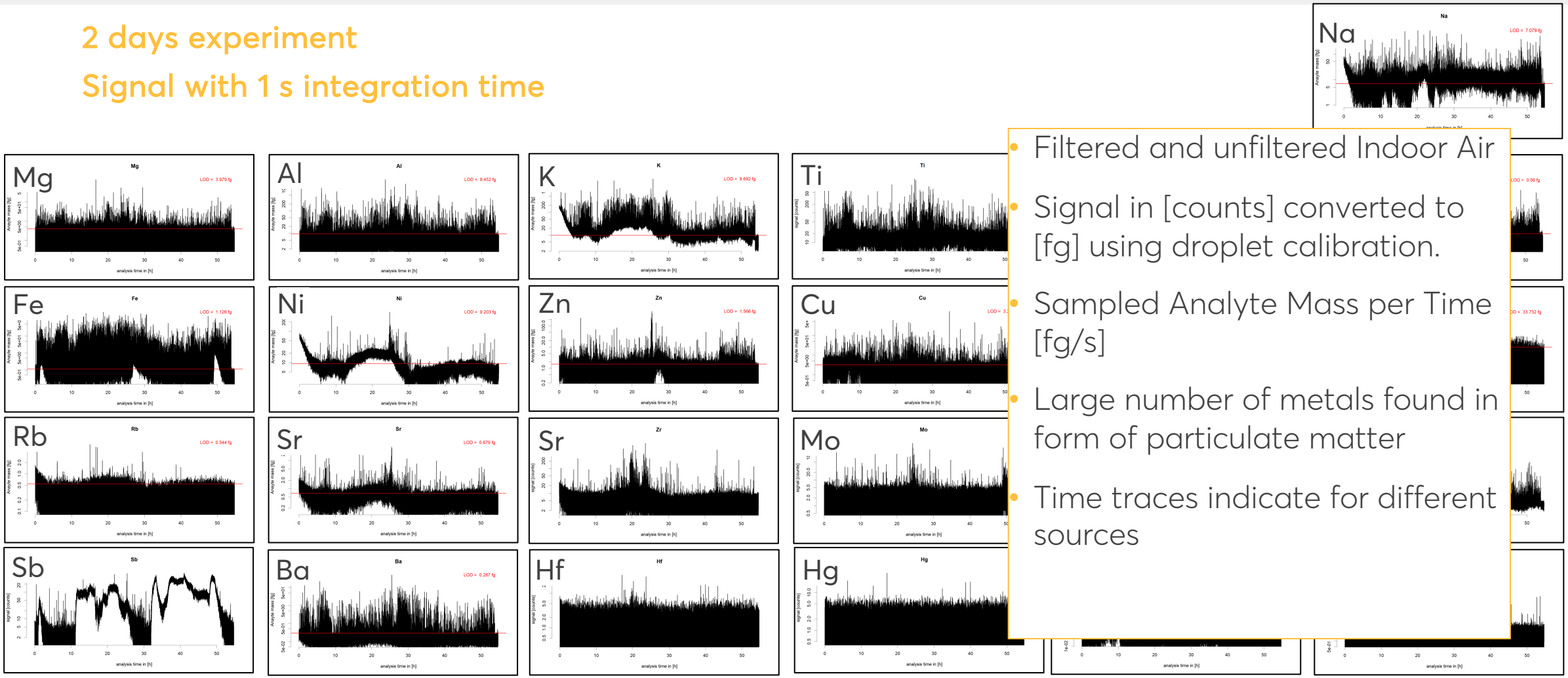
TOFWERK headquarters in Thun (left)
Workspace shared with solar industry (right)

- Indoor Air
- TOFWERK shares workspace with solar industry
- Are there metals in the air?
- Are metals indicative for manufacturing activities?

DIRECT AIR SAMPLING – PARTICLE INFORMATION

2 days experiment

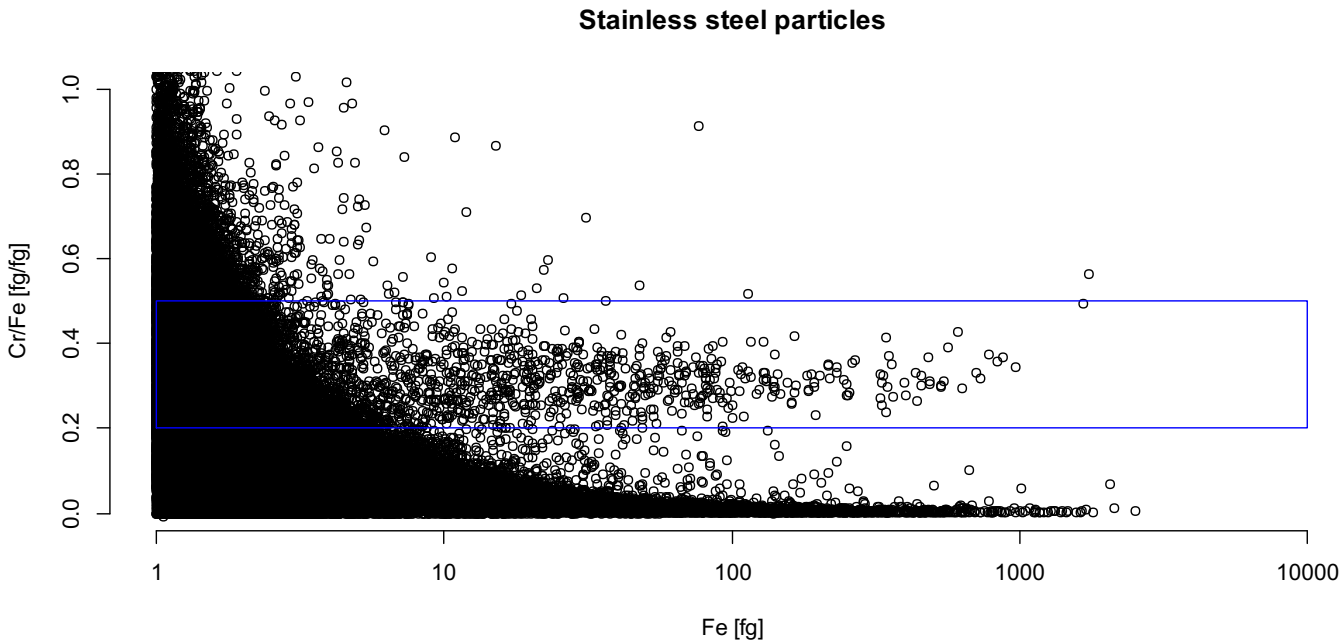
Signal with 1 s integration time



- Filtered and unfiltered Indoor Air
- Signal in [counts] converted to [fg] using droplet calibration.
- Sampled Analyte Mass per Time [fg/s]
- Large number of metals found in form of particulate matter
- Time traces indicate for different sources

DIRECT AIR SAMPLING – PARTICLE INFORMATION

Element ratios

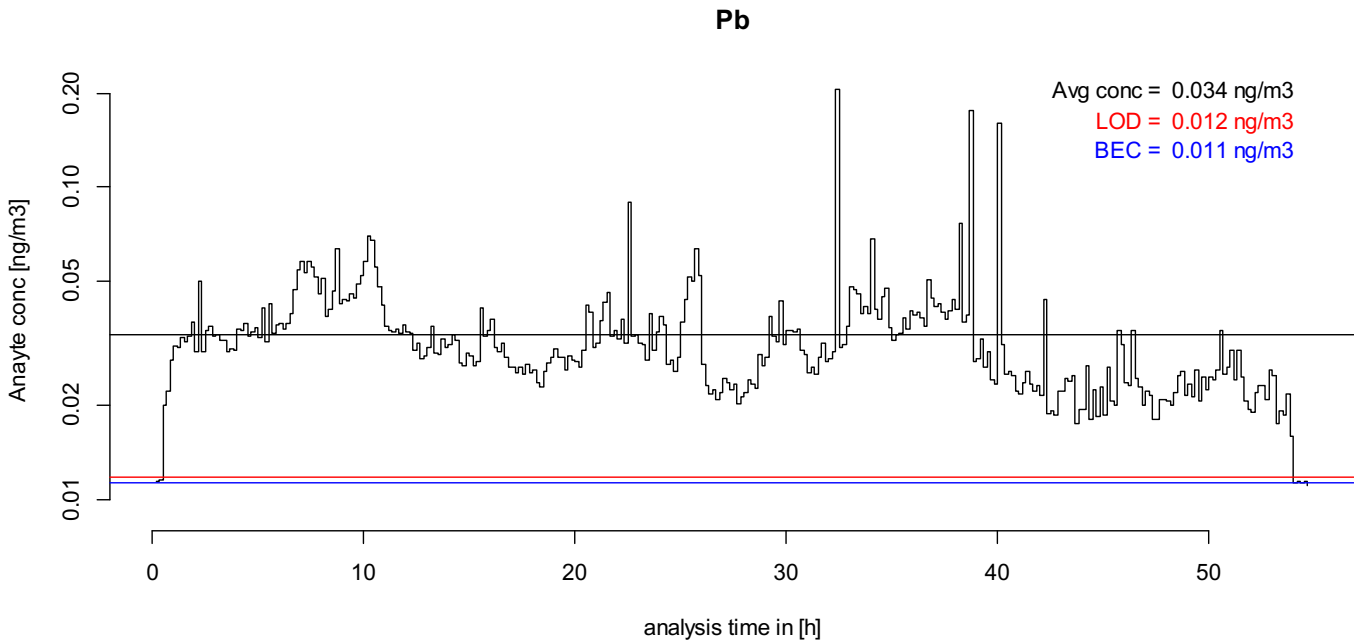


Element ratio depending on particle mass

- 1s integration time
- Ratios of mass per particle: Cr/Fe
- Stainless steel particles
  high Cr content – soldering wire

DIRECT AIR SAMPLING - QUANTIFICATION

Average Concentration in ng/m3



Lower LOD than from single Particle Data

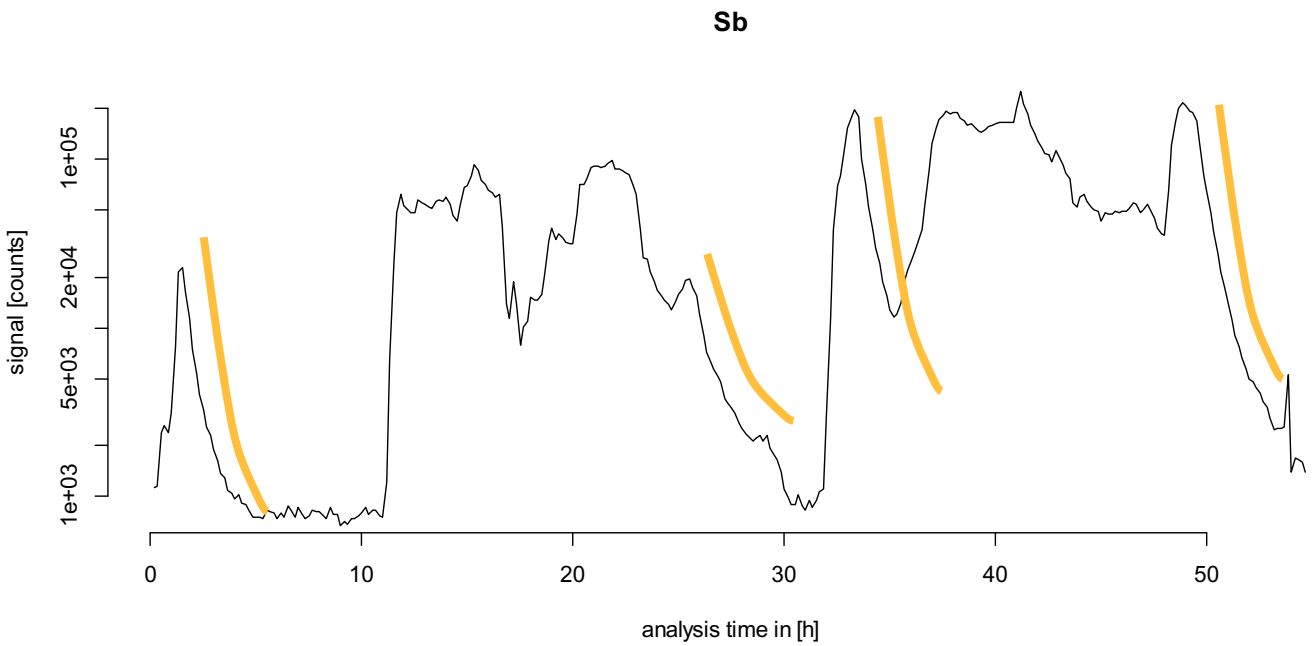
Signal summed to 10 min intervals

- Sampled air volume per time [m^3/s]
- Sampled Analyte Mass per Time [ng/s]
- Analyte concentration in sampled air [ng/m^3]

MAK values for Pb in air
0.1 mg/m3 - Pb and Pb-compounds (except Pb-Me4 and Pb-Et4)
0.05 mg/m3 - Pb-Me4 and Pb-Et4
Source: SUVA

DIRECT AIR SAMPLING

Signal summed to 10 min integration time



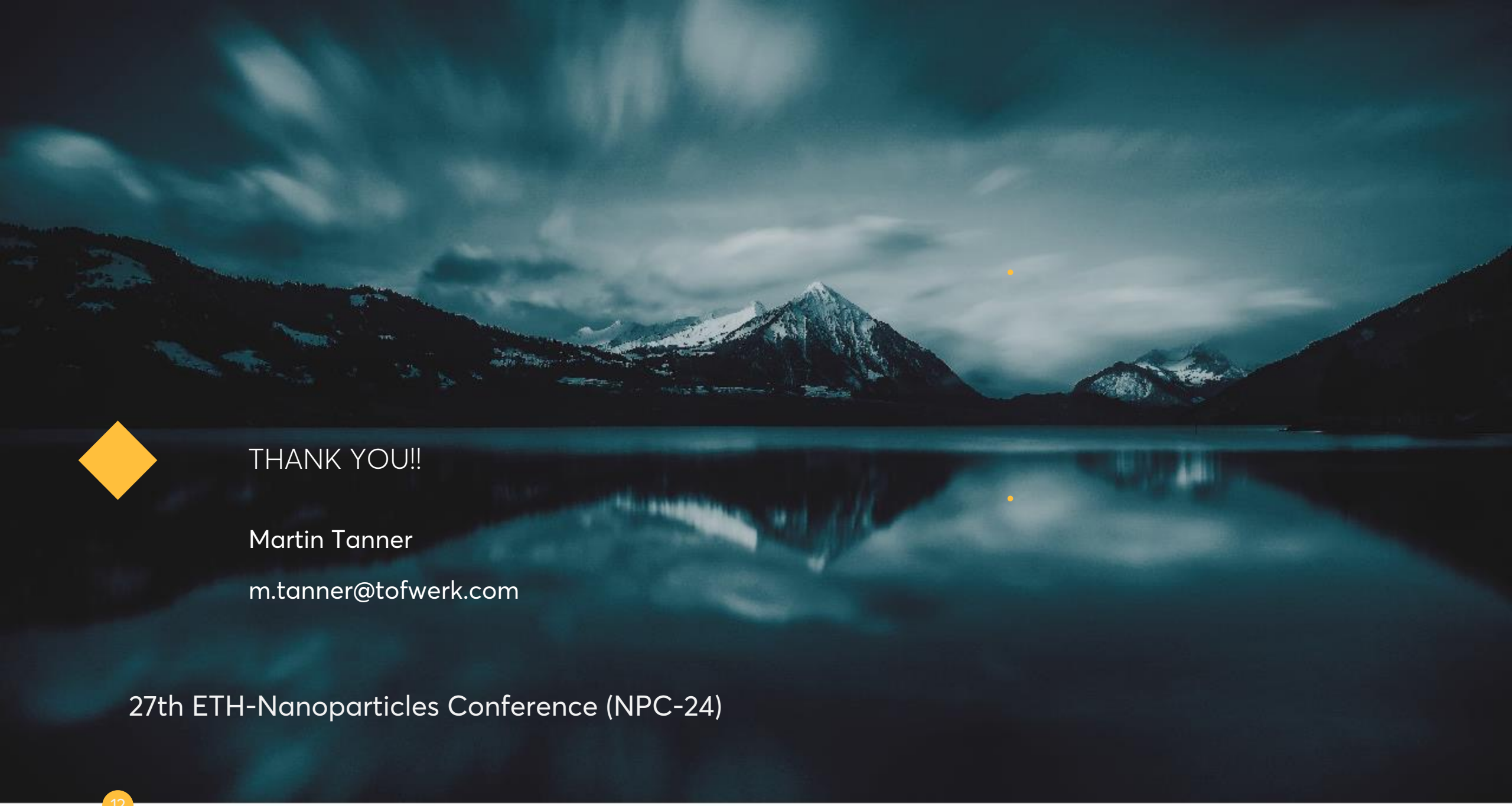
- Signal measured at **1 s** integration
- Smoothing of the Signal by summation to 10 min intervals
- Ability to follow dynamic events
- Washout after intense events?

Lower LOD than from single Particle Data

DIRECT AIR SAMPLING - SUMMARY

MICAP-TOFMS provides

- Direct air sampling
- Single particle information [fg/particle]
- Detection of concentrations in [ng/m^3] range.
- Measurement intervals:
  - Milliseconds, minutes, days
- Ability to follow dynamic concentrations
- Indication for particle sources
  - Dynamic time dependent signal
  - Composition of individual particles



THANK YOU!!

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