STANDARDIZED ULTRA-FINE PARTICLE MEASUREMENTS FOR CLEANER AIR IN AUSTRALIA AND NEW ZEALAND

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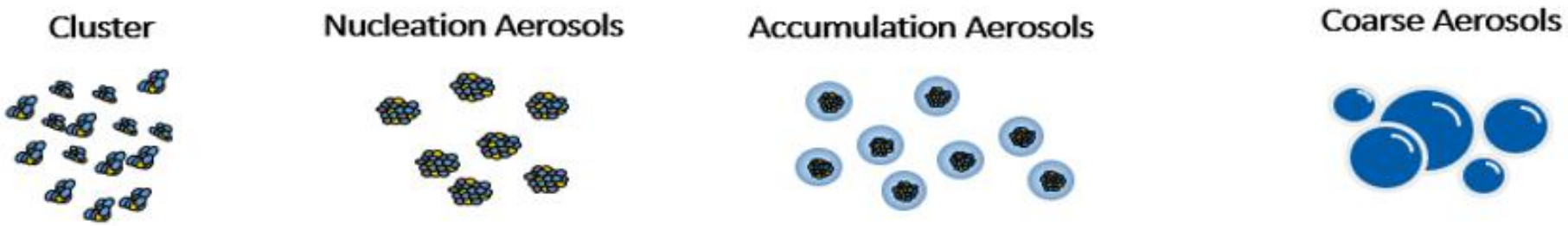
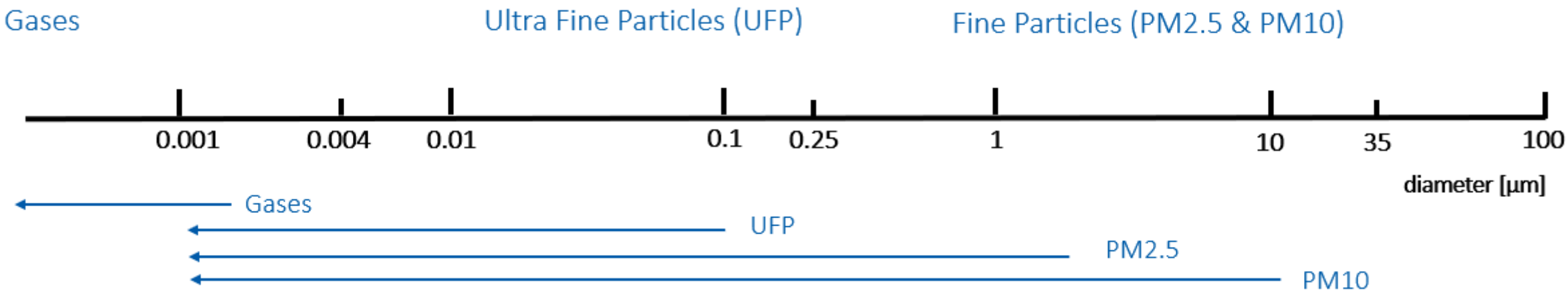
Size range of ambient aerosols





Size range of ambient aerosols

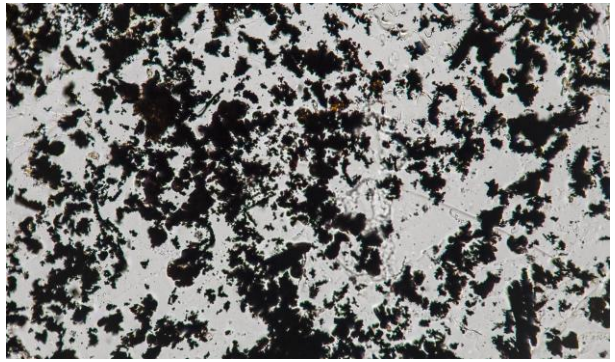
Size of particles depends on the formation (example: traffic)

Small particles

Large particles

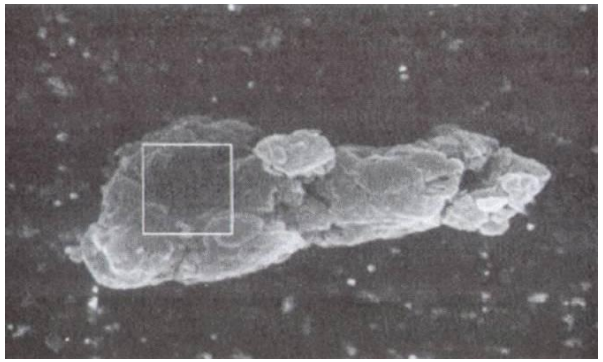
Soot particles

Diameter < 0.1 µm



Abrasion particles

Diameter > 1 µm

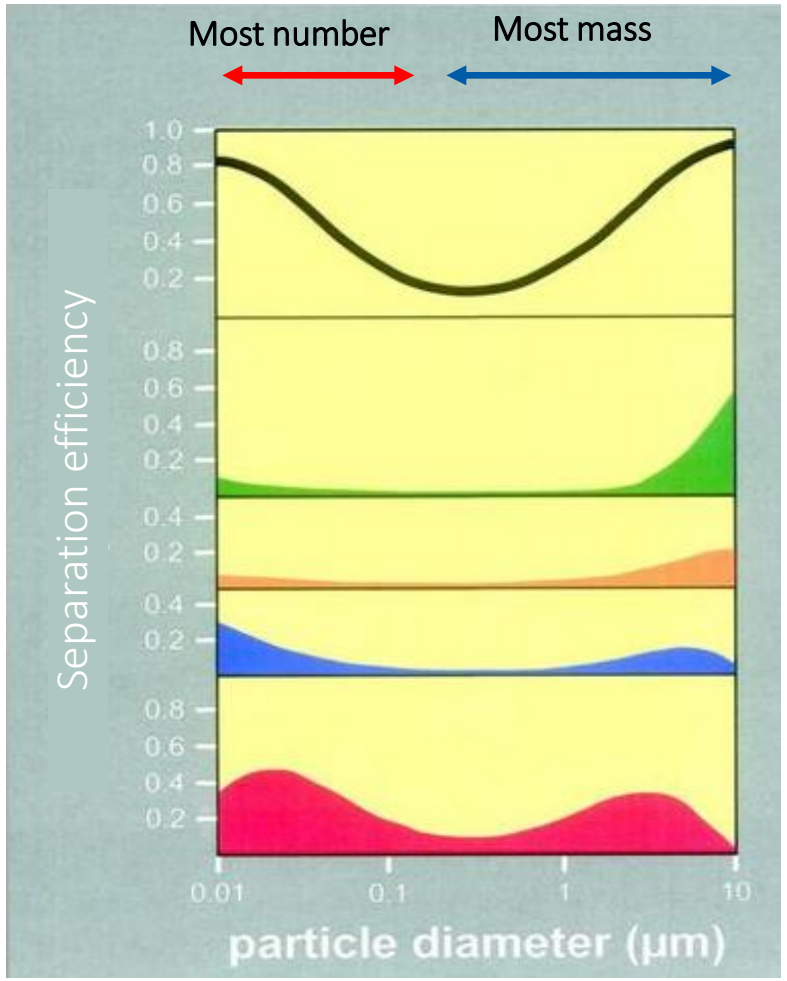


Particles differ in size of 5 orders of magnitude:

0.001 µm to 100 µm.

They should all be of our concern!

Particle separation in the lungs depends on aerosol size



pictures adapted from: Joachim Heyder, GSF

Airways

total

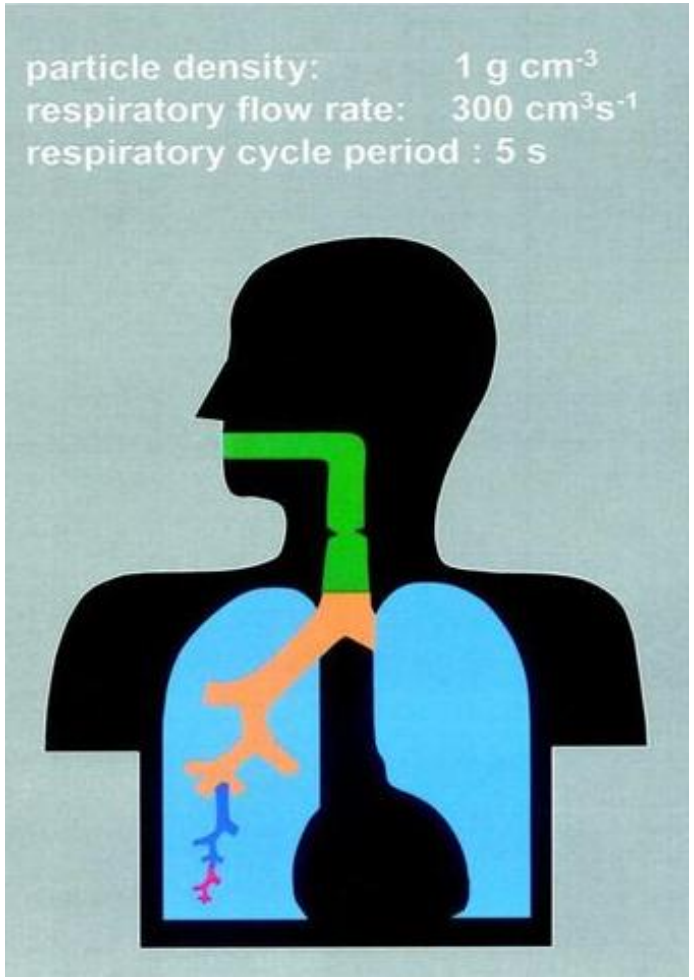
upper

upper bronchi

lower bronchi

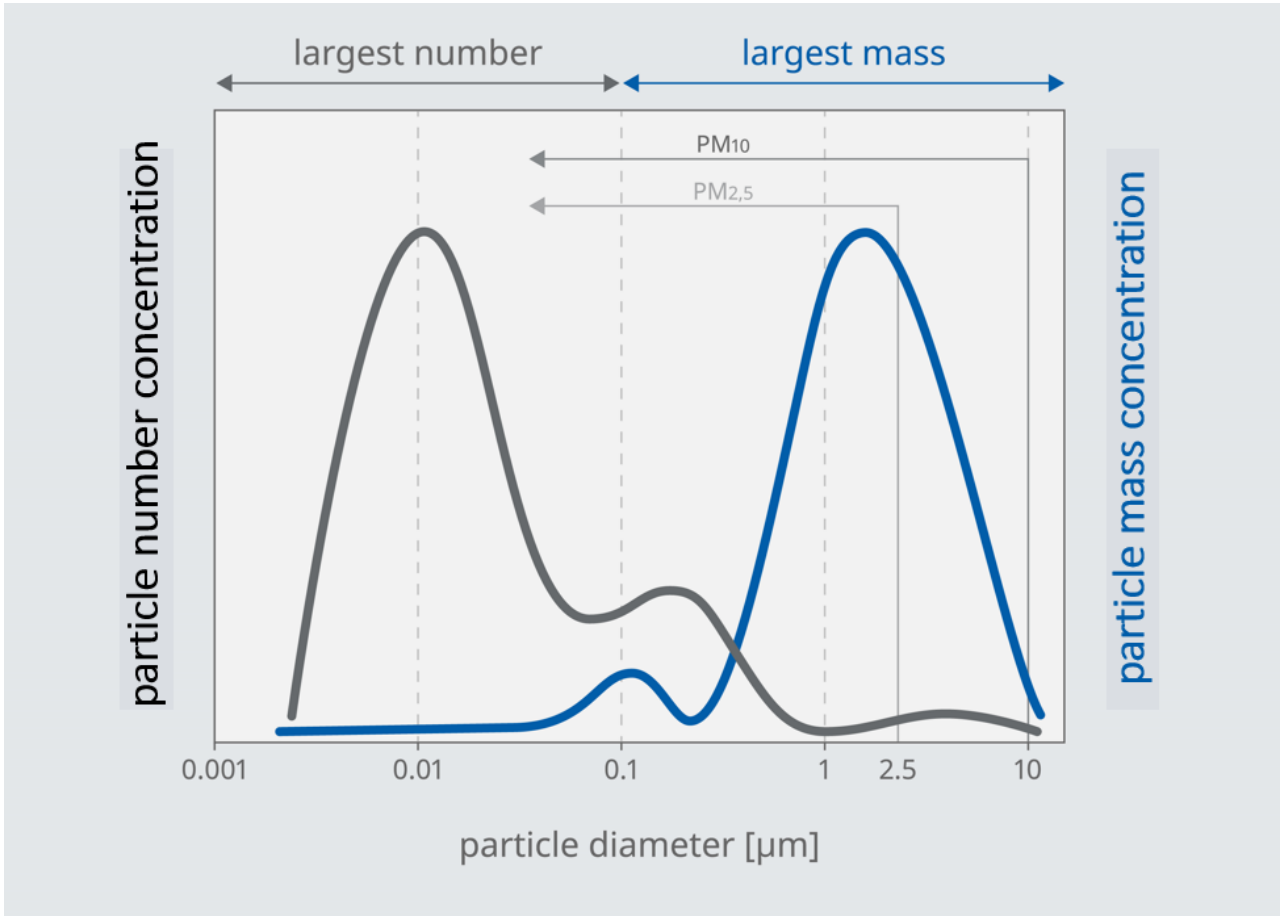
alveolar

- Transport into the blood
- Crossing the blood-brain barrier



Size range of ambient aerosols

Example for PM10, PM2.5, number and mass distributions



PM10

a 10 µm particle (elephant) has the same mass as 8 million 50 nm particles (mosquitos).

A much more appropriate metric than PM10 or PM2.5 for small particles is **particle number and particle size**.

→ take care on UFP

Why to measure Ultrafine Particles (UFP)

Why to measure ultrafine particles (UFP)

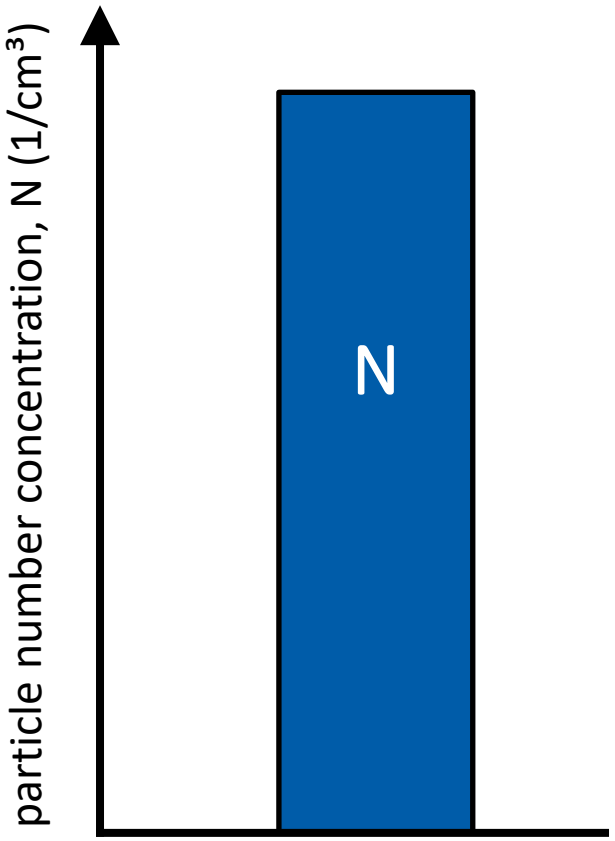
- Traditional air quality monitoring has primarily focused on particulate mass metrics such as PM_{10} and $PM_{2.5}$
- **However, these mass-based metrics only provide limited information on the harmful effects of aerosols on human health and climate change.**
- Revised Ambient Air Quality Directive of the European Commission (AAQD, Directive 2024/2881) incorporated particle number-based measurements into monitoring networks

How to measure standardized Ultrafine Particles (UFP)

Relevant metrics for UFP

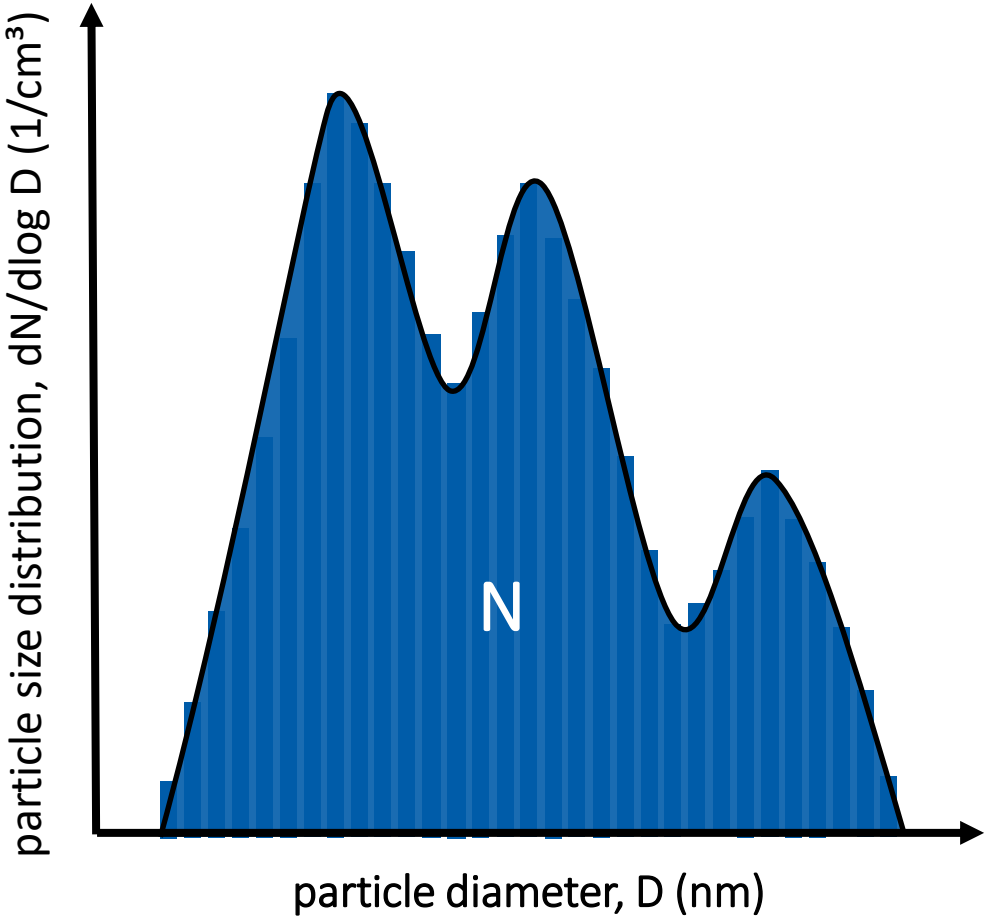
particle number concentration

PNC



particle (number) size distribution

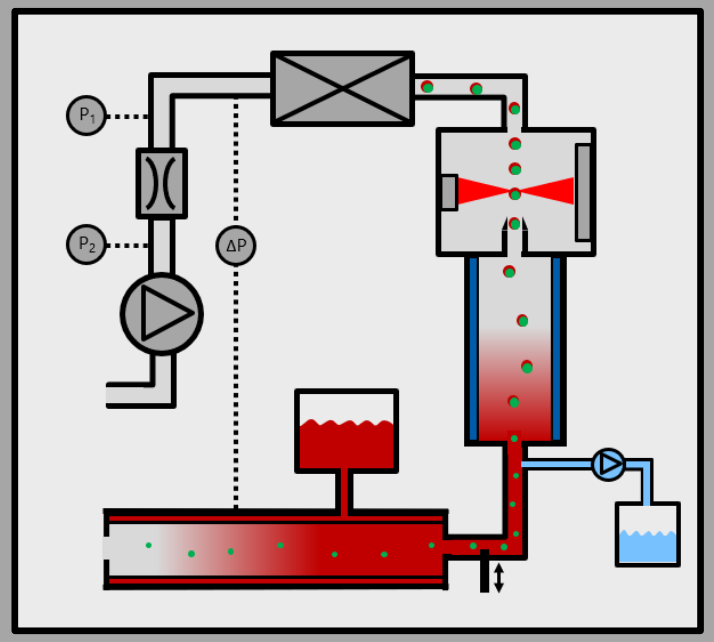
PSD



Reference instruments for UFP

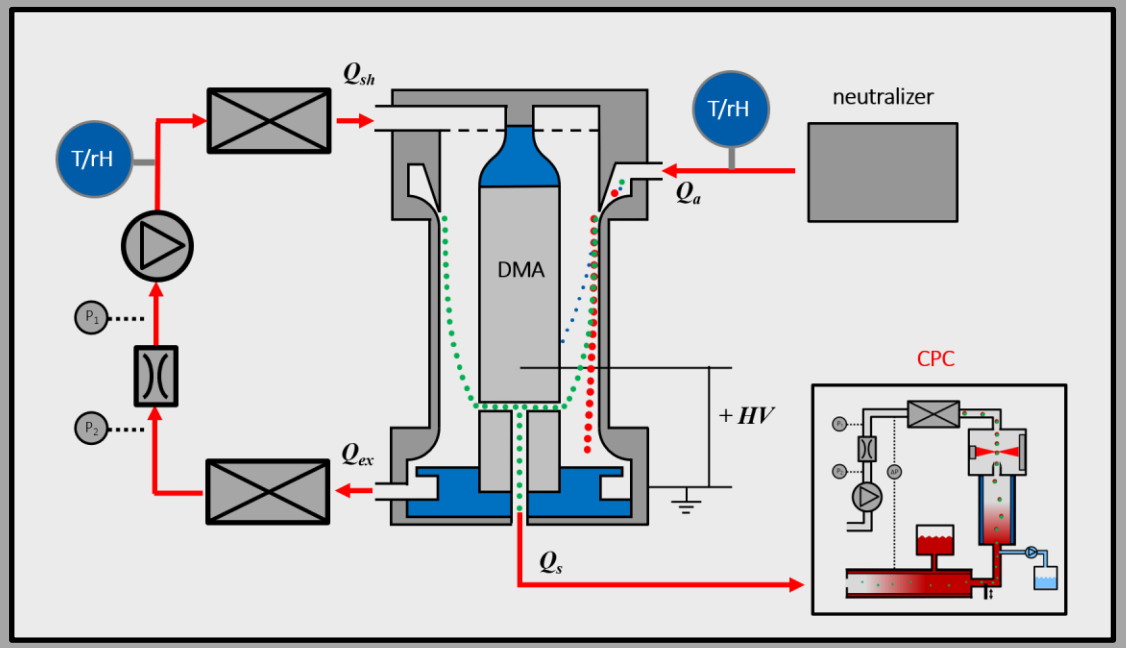
number concentration

Condensation Particle Counter (CPC)

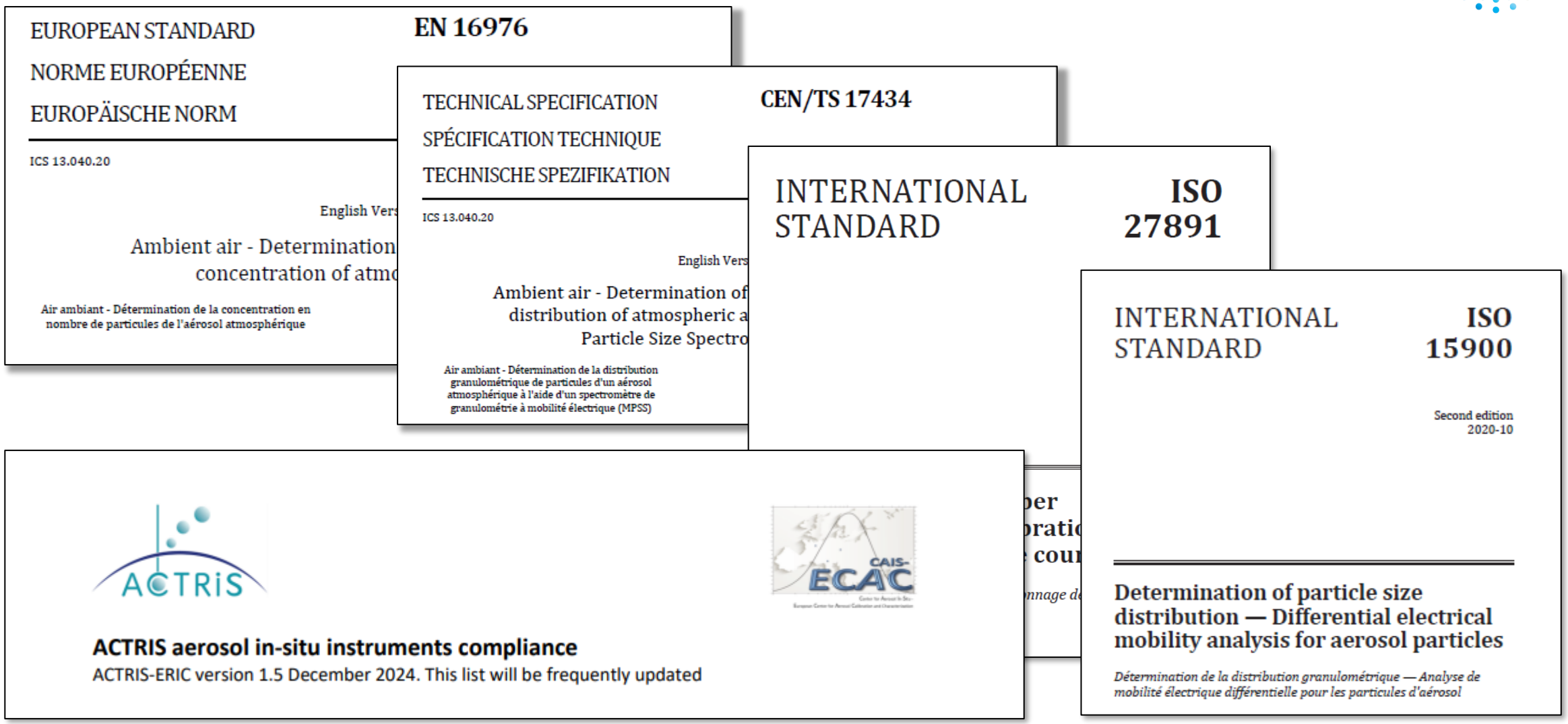


size distribution

Scanning Mobility Particle Sizer with CPC (SMPS+C)



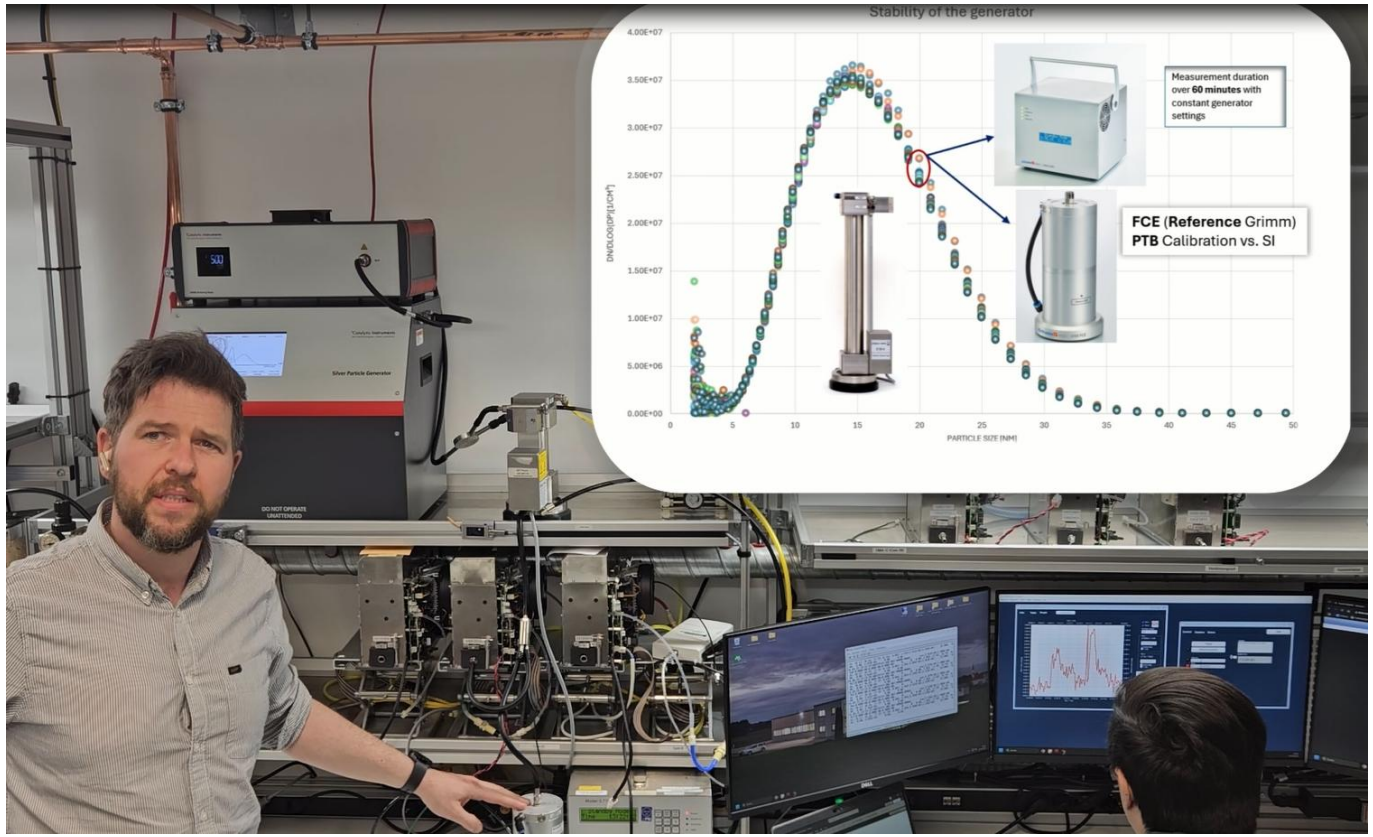
Standarized UFP Monitoring



Standardized UFP Monitoring

- Recent standardization efforts have established harmonized methodologies for measuring **particle number concentration** (PNC), EN 16976 (CEN, 2024) and **particle size distributions** (PSD), CEN/TS 17434 (CEN, 2020)
- These standards provide a comprehensive framework for instrument performance requirements, calibration procedures, and uncertainty evaluation **to ensure comparability across monitoring networks**.
- They explicitly require traceability to reference instruments and clearly define performance metrics such as **counting efficiency** (D_{50}, D_{90}), **linearity, inlet losses, and measurement uncertainty** relative to laboratory reference systems.
- These standards are also fully integrated into the **ACTRIS** (Aerosols, Clouds, and Trace Gases Research Infrastructure) framework.

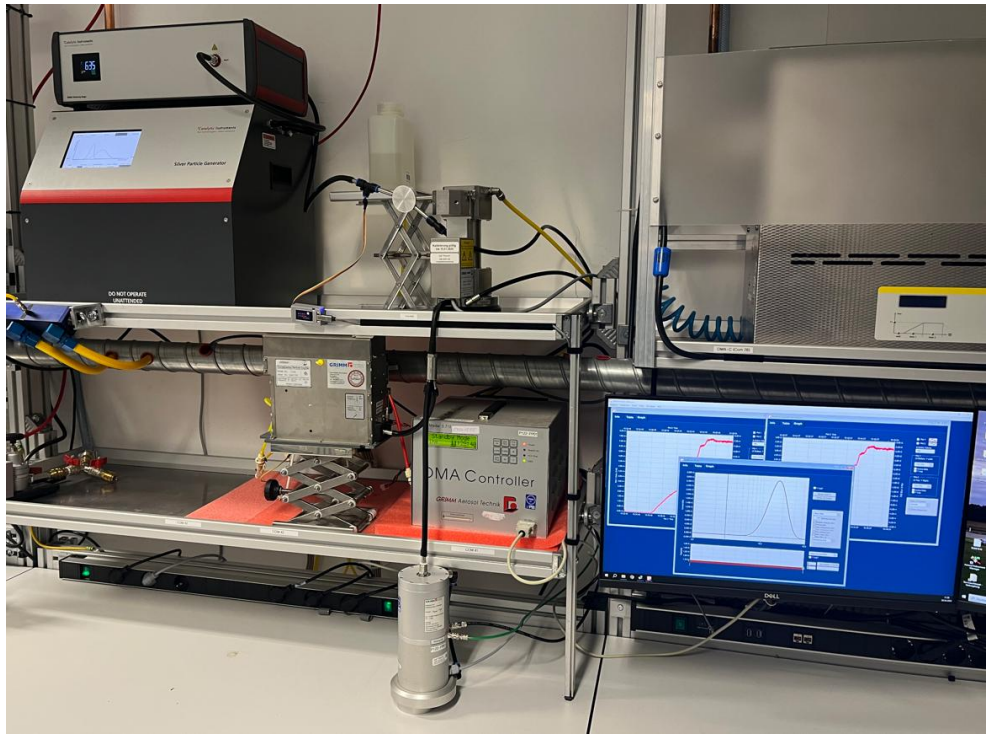
Calibration of standardized UFP devices

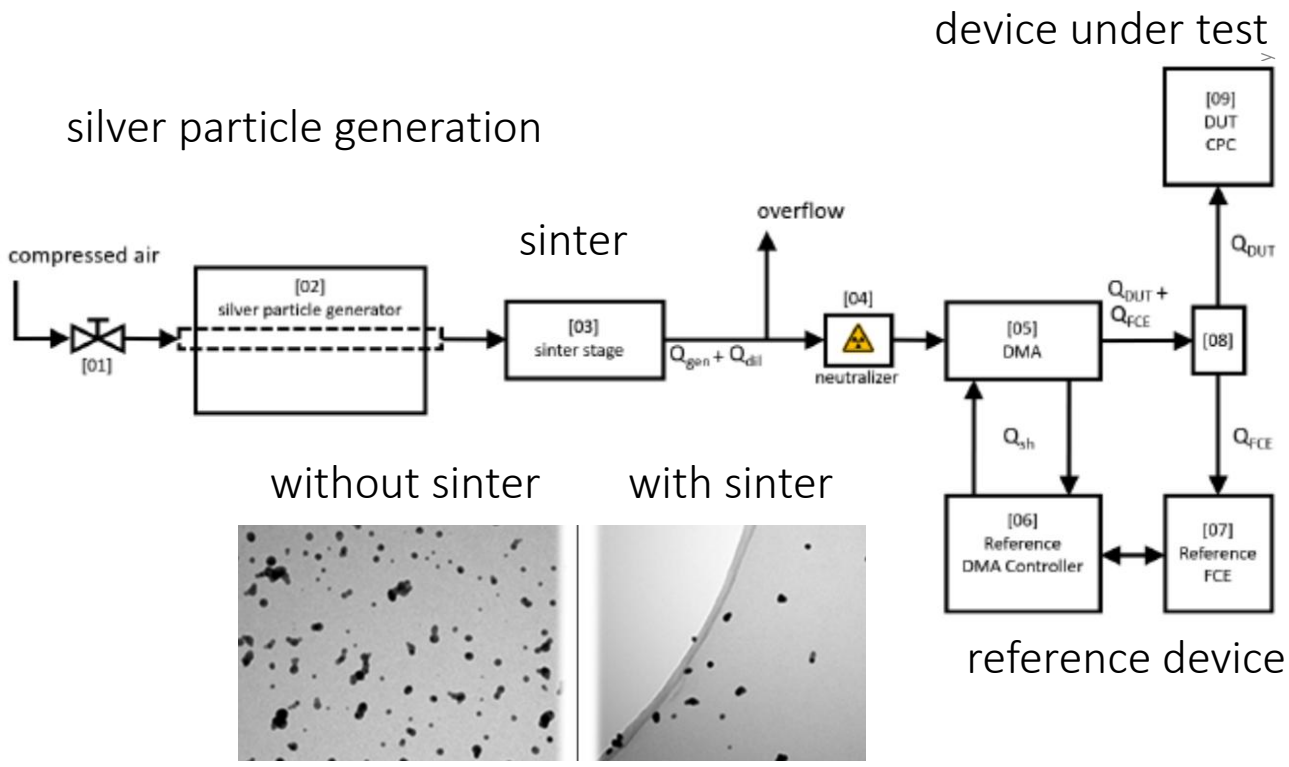


View in our GRIMM Aerosol Technik calibration Lab

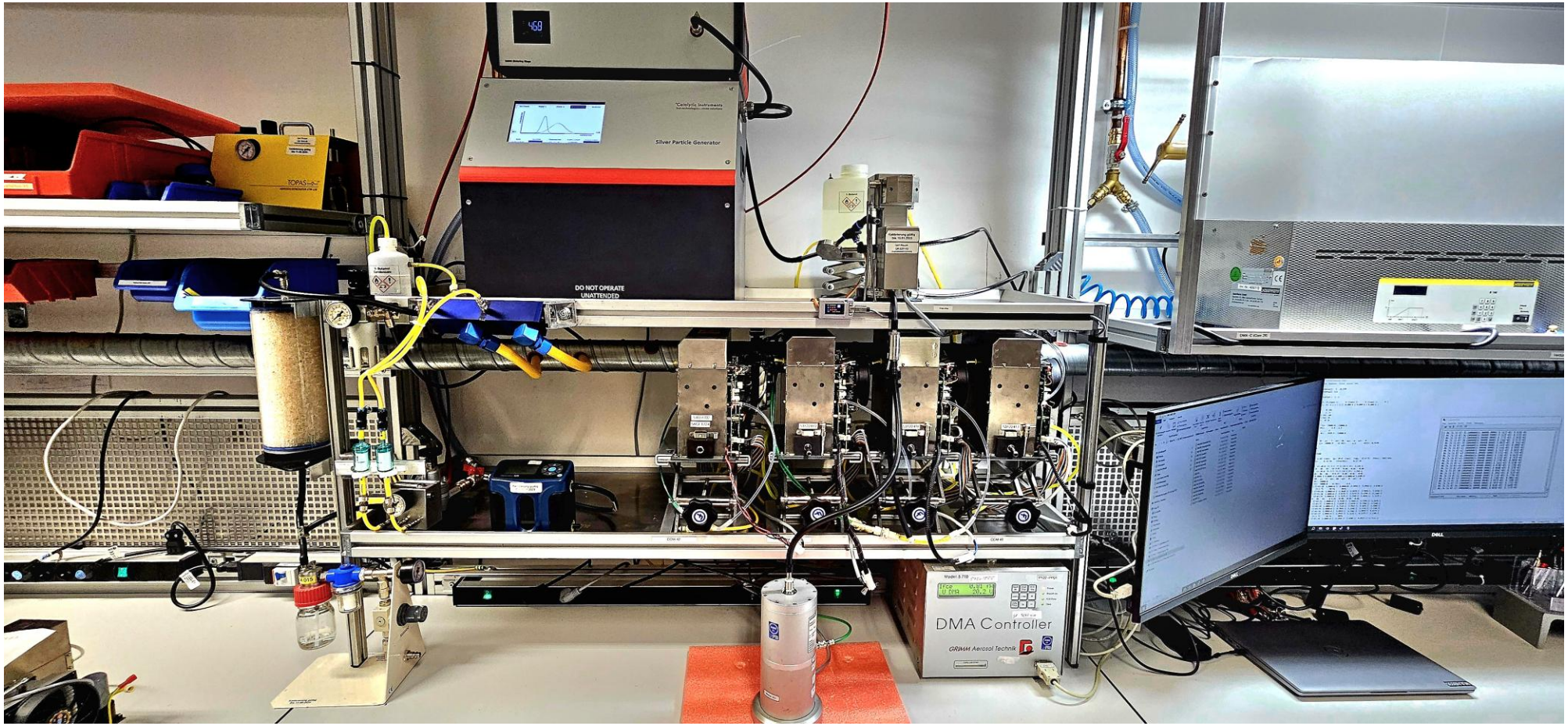
Standardized Calibration of CPC

Silver aerosol calibration setup



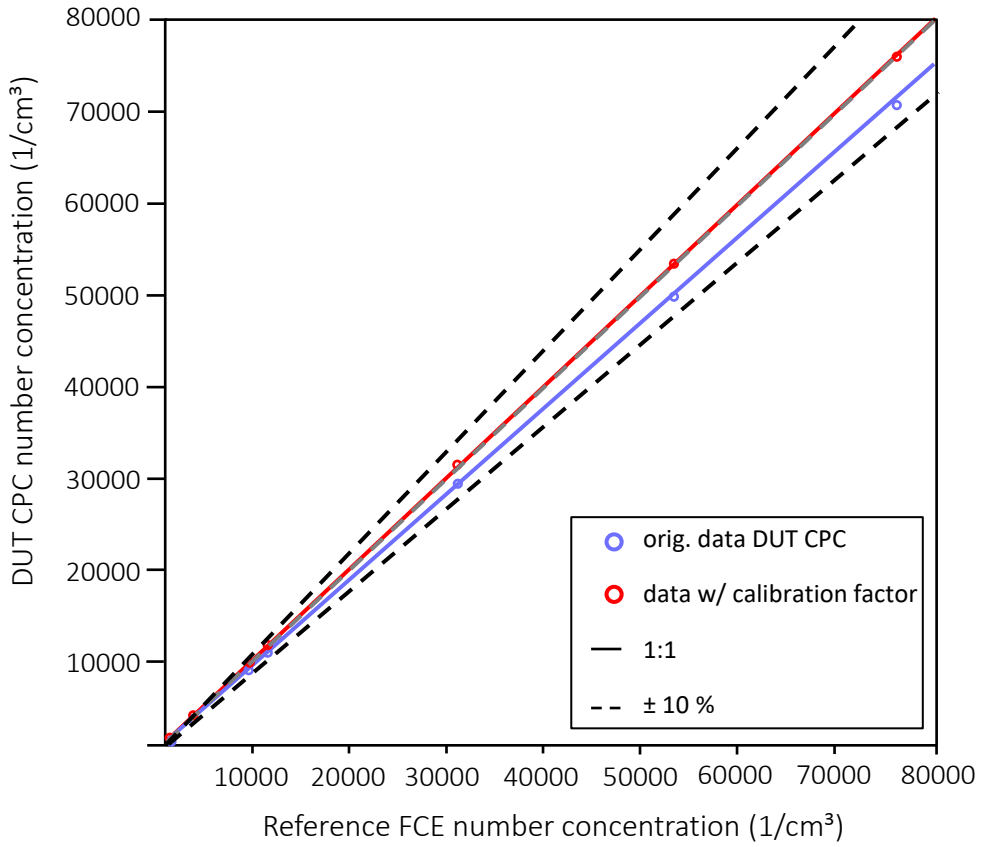


Standardized Calibration of 4 CPC against 1 FCE (Reference)

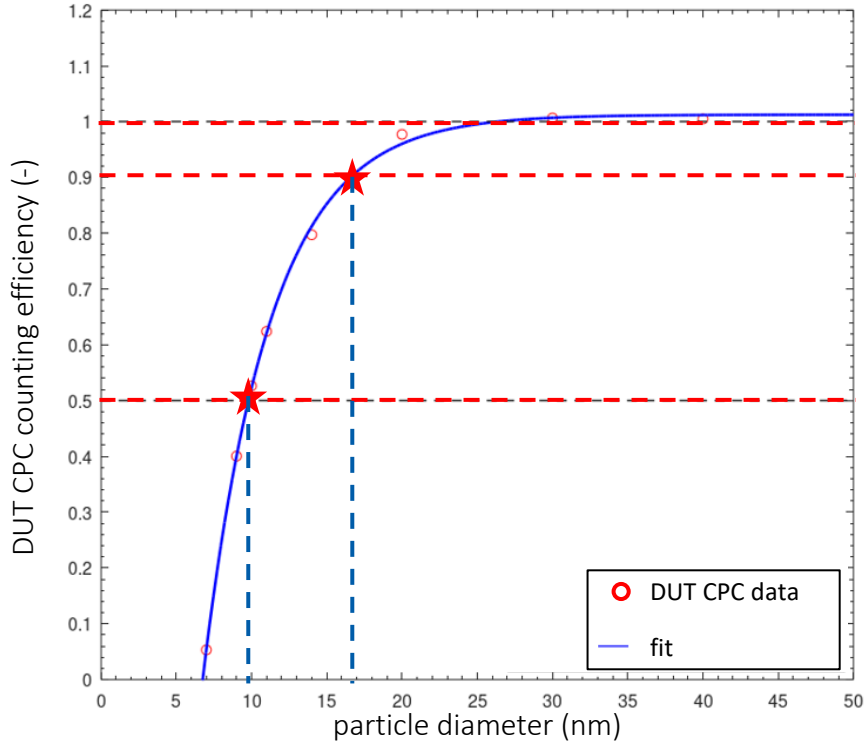


Standardized Calibration of CPC

Calibration results. compliant to EN 16976; according ISO 27891



$y = 0.93242 \cdot x$ $y = 1.0004 \cdot x$



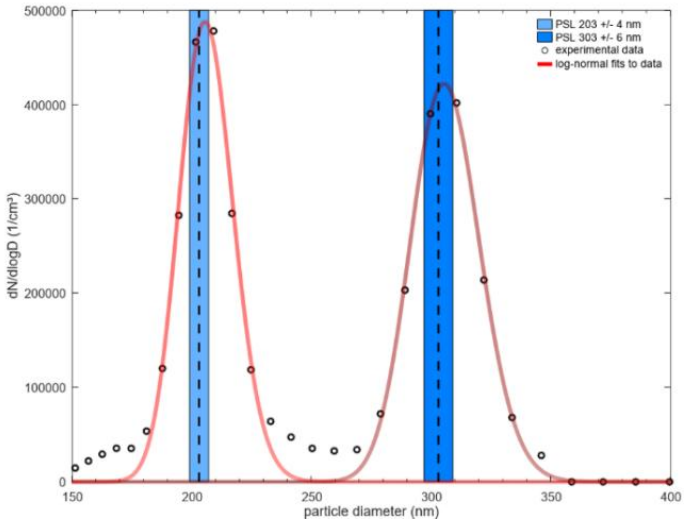
$D_{50} = 9.8\ nm$ $D_{90} = 16.6\ nm$

$(D_{50} = 10 \pm 1\ nm)$ $(D_{90} < 20\ nm)$

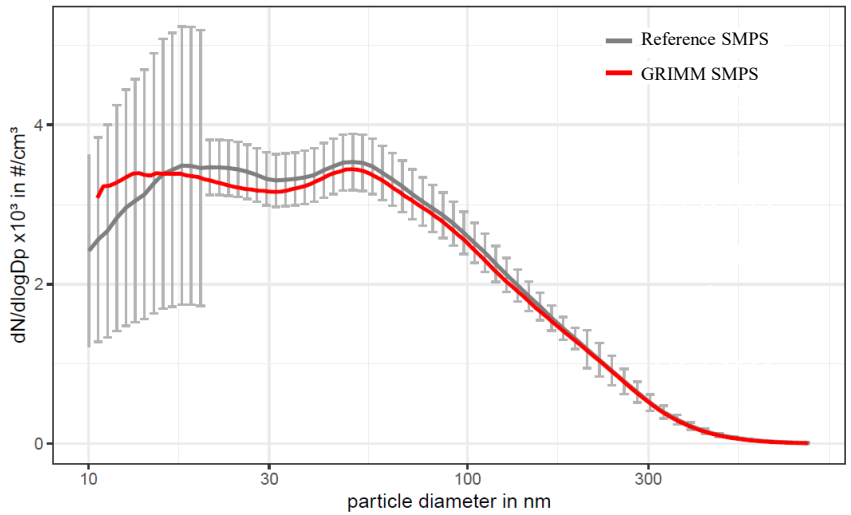
Standardized Calibration of SMPS+C

CEN and ACTRIS compliance

particle sizing accuracy ≤ 3 %



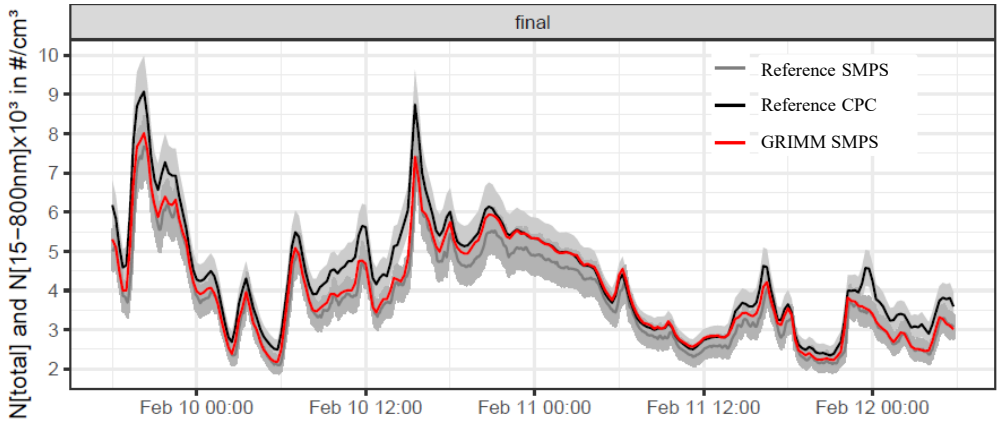
particle number size distribution accuracy



Required accuracy:

10 - 20 nm: ≤ 50 %
20 - 200 nm: ≤ 10 %
200 - 800 nm: ≤ 20%

accuracy of integrated number concentration ≤ 10%



Relevance for Australia and New Zealand

- The adoption of harmonized UFP monitoring in Australia and New Zealand would improve the **comparability of atmospheric research, support source attribution studies, and provide a stronger basis for evaluating the health relevance of ultrafine particle exposure**.
- **Consistent datasets** generated across different locations can further contribute to future air quality management strategies and emerging regulatory considerations.
- Standardized measurements can also **improve the detection of local emission sources**, facilitate comparisons between urban and regional environments, and **strengthen assessments of anthropogenic impacts** against relatively clean background conditions.

Cooperation/Acknowledgements

- TROPOS, Leibnitz Institute for Tropospheric Research (Leipzig, Germany)
  - World Calibration Center for Aerosol Physics (WCCAP)
- METAS, Federal Institute of Metrology , (Bern, Switzerland)
  - Swiss national metrological institute
- INERIS, Institut national de l´environmenr industriel et des risques (Paris, France)
  - French national institute for industrial environment and risks
- PTB, Pysikalisch Technische Bundesanstalt (Braunschweig, Germany)
  - German national metrological institute

Thank you for your attention