



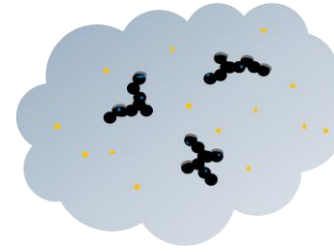
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Occupational diesel exhaust exposure assessment using miniaturized aerosol instruments – intercomparison of aerosol instruments in different workplace environments

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ETH Nanoparticles Conference 2026

Introduction



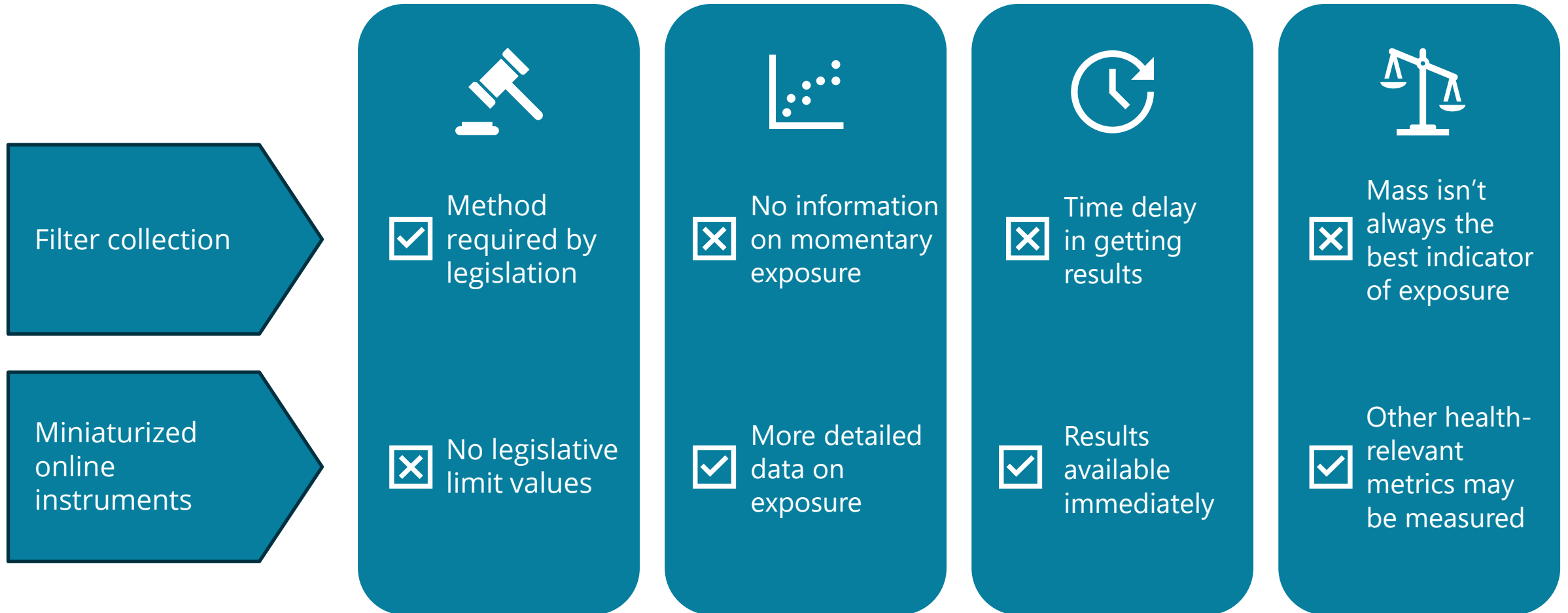
IARC's carcinogen classification

IARC Group	Level of certainty that a substance can cause cancer (typical examples of evidence leading to each group)
GROUP 1	CARCINOGENIC TO HUMANS Sufficient evidence for cancer in humans.

- Diesel exhaust is classified as carcinogenic to humans
 - Occupational exposure regulated by Carcinogens and Mutagens directive (2004/37/EC)
- In addition, exposure to fine particles is also known to cause adverse health effects
- Growing need for a better understanding of occupational exposure as well as monitoring methods to assess exposure
- Study objectives:
 - 1) To measure occupational exposure to exhaust gases and particles among bus drivers, bus depot mechanics, infrastructure construction site workers, street & green area maintenance workers and car inspection station workers
 - 2) Investigate applicability of miniaturized online aerosol instruments in occupational exposure measurements





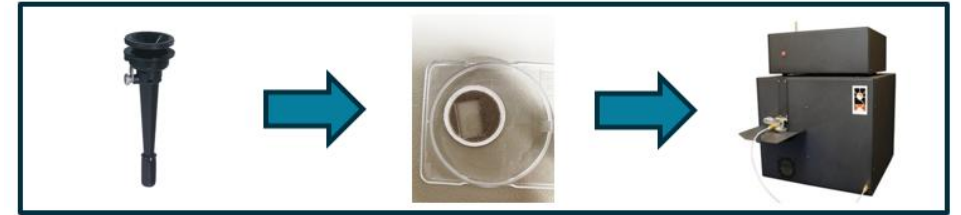
Benefits of miniaturized aerosol instruments in exposure assessment



Measurement methods

Diesel soot

- Elemental carbon (EC) 
 - Filter collection & thermal-optical analysis (NIOSH 5040 method)
→ Method required by legislation
- Black carbon (equivalent black carbon, eBC) 
 - Microaethalometers (**Model MA200 by Aethlabs**)
 - **eBC ≈ EC?**

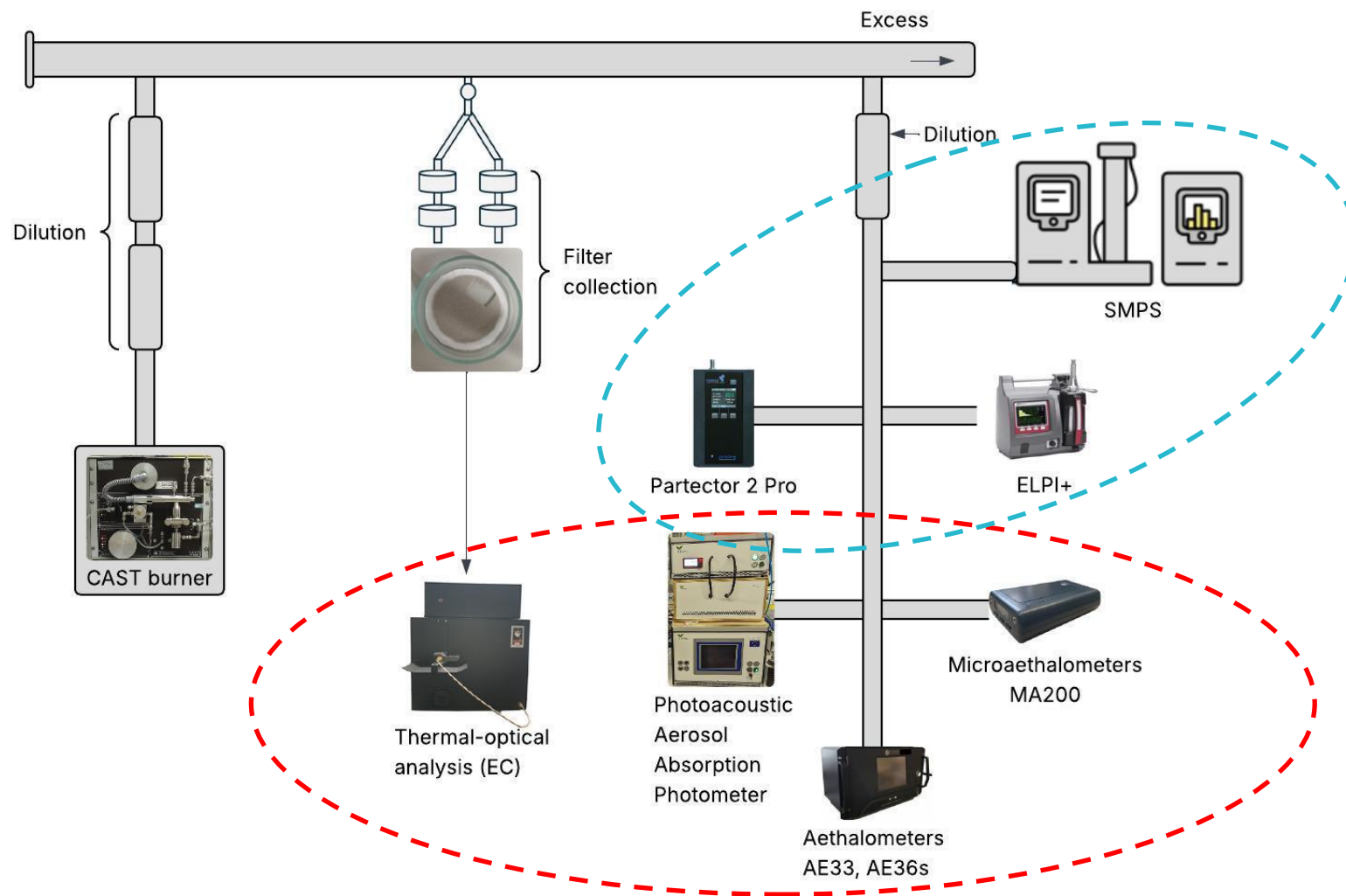


Particles

- Online nanoparticle detector (**Partector 2 Pro by Naneos**)
- Measured metrics:
 - Lung-deposited surface area (LDSA)
 - Alveolar region
 - Particle number concentration (PNC)
 - Particle size distribution



Instrument comparison measurements



Instruments measuring particles

- Comparisons with SMPS and Partector
 - GMD
 - PNC
- Comparisons with ELPI+ and Partector
 - $LDSA_{alv}$

Instruments measuring carbonaceous aerosol

- EC vs. eBC
- eBC comparison between different aethalometers
- Aethalometers vs. PAAS

Instrument comparison - microaethalometer and aethalometers

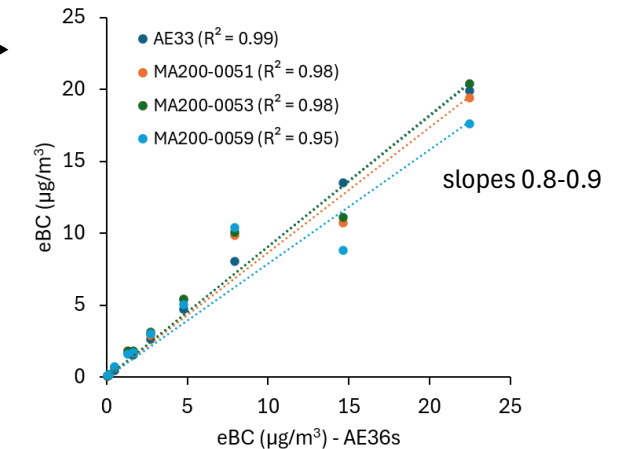
Instrument comparison measurements

- Microaethalometers correlated well with their bigger counterparts
 - For aethalometers AE33 & AE36s multiple scattering parameter (C) was corrected using Photoacoustic Aerosol Absorption Photometer (PAAS)
 - Loading correction was not used for microaethalometer data

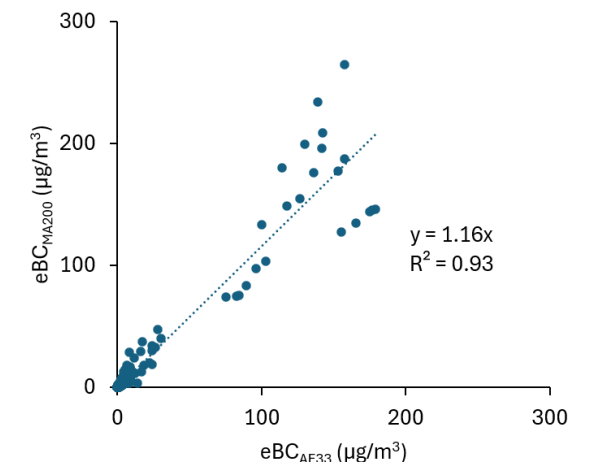
Workplace measurements

- Comparability was also good in field measurements
 - Best in the size range of 5-100 $\mu\text{g}/\text{m}^3$

CAST burner

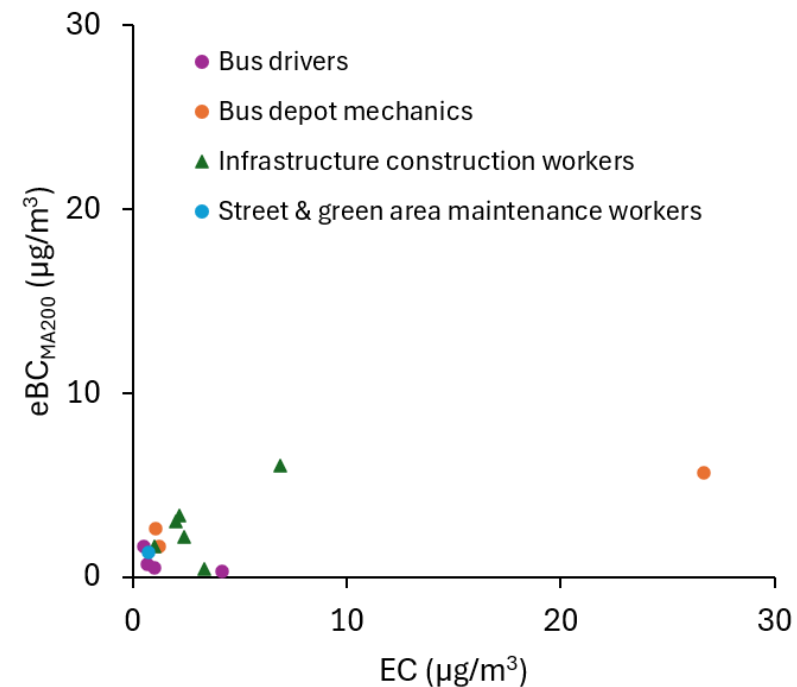
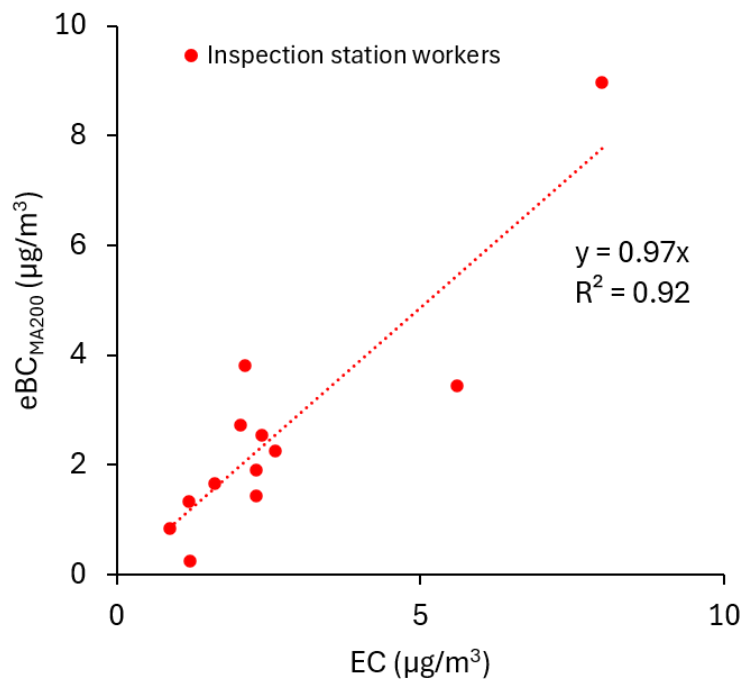


Inspection station ambient air

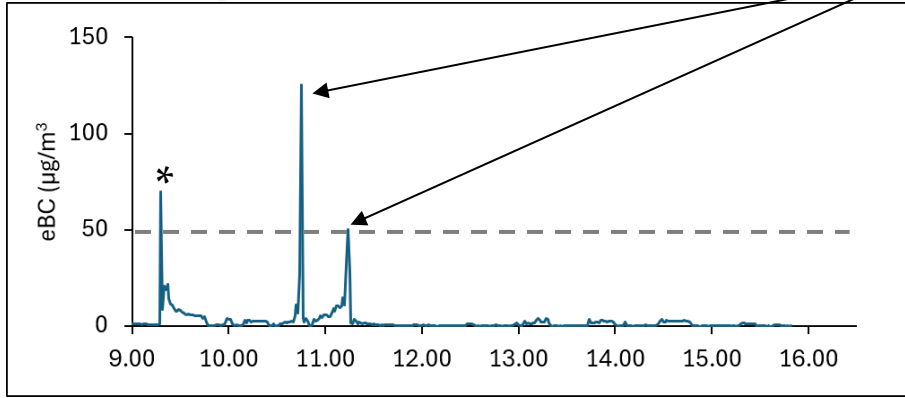
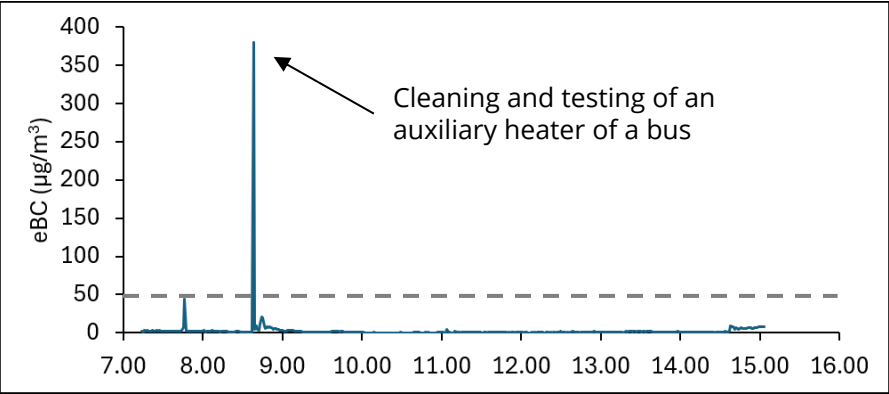
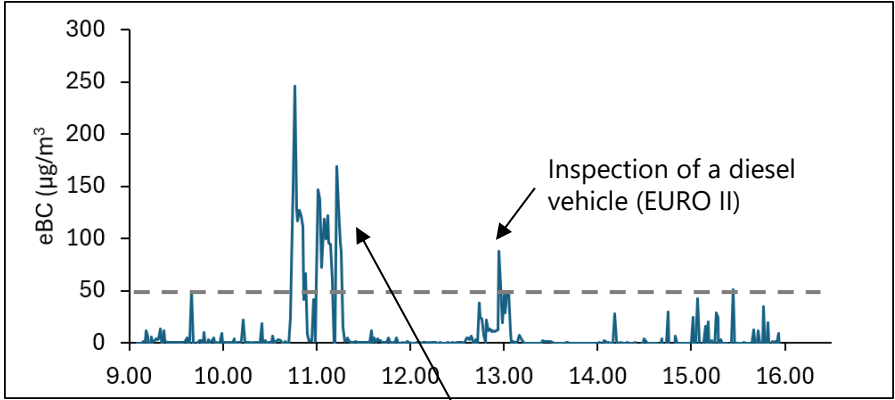
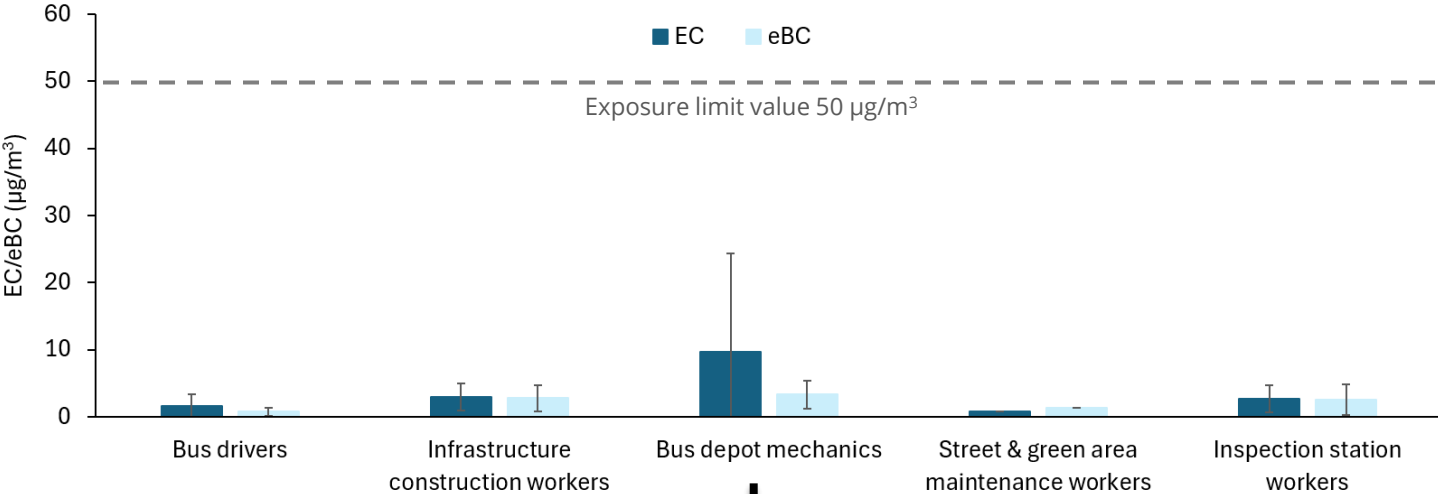


Instrument comparison – aethalometers and EC analyses

- eBC measurement correlated well with elemental carbon (EC) analyses among inspection station workers, but correlation in other groups of workers could not be found
- Low concentrations were found to influence the correlation the most



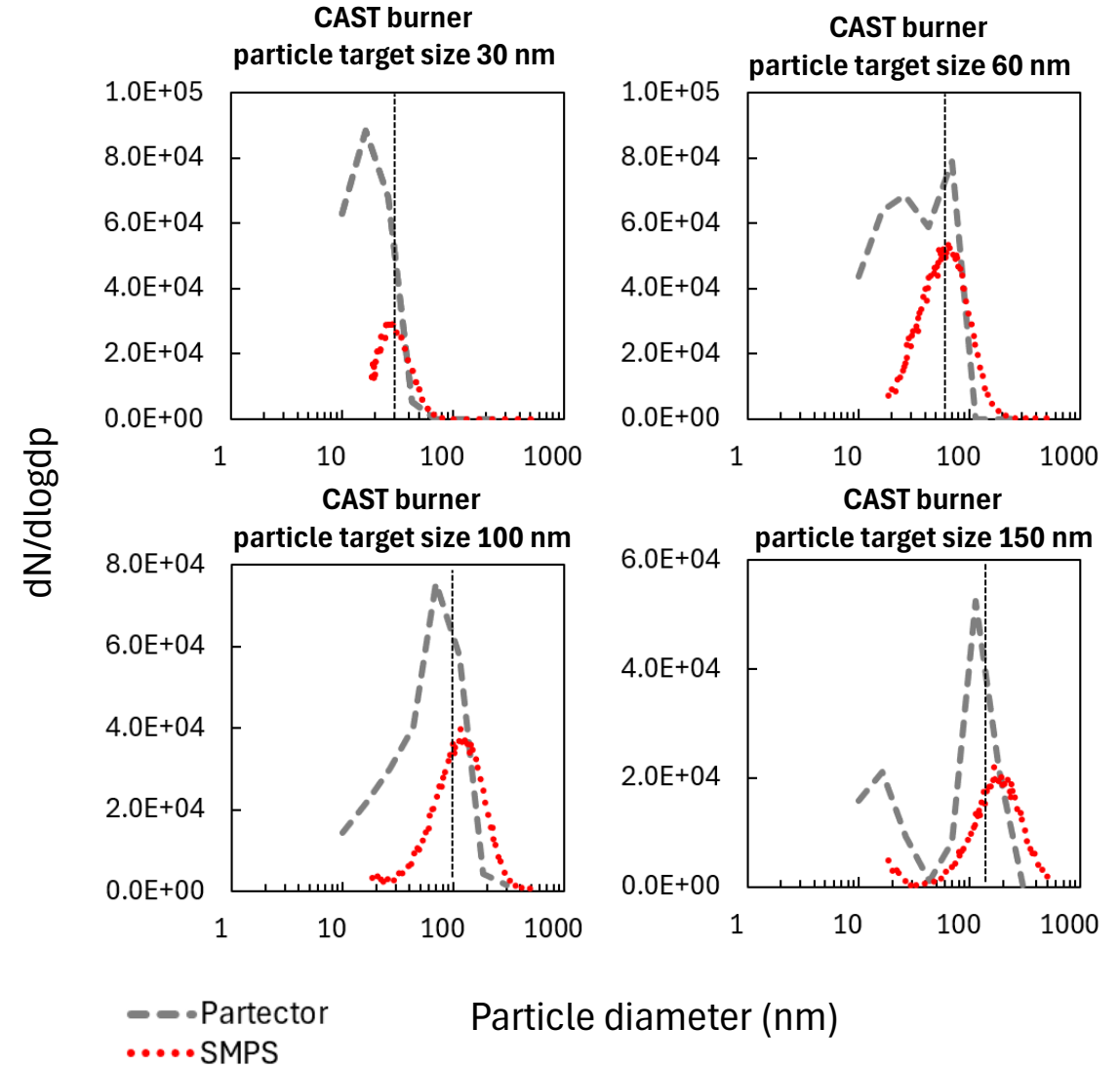
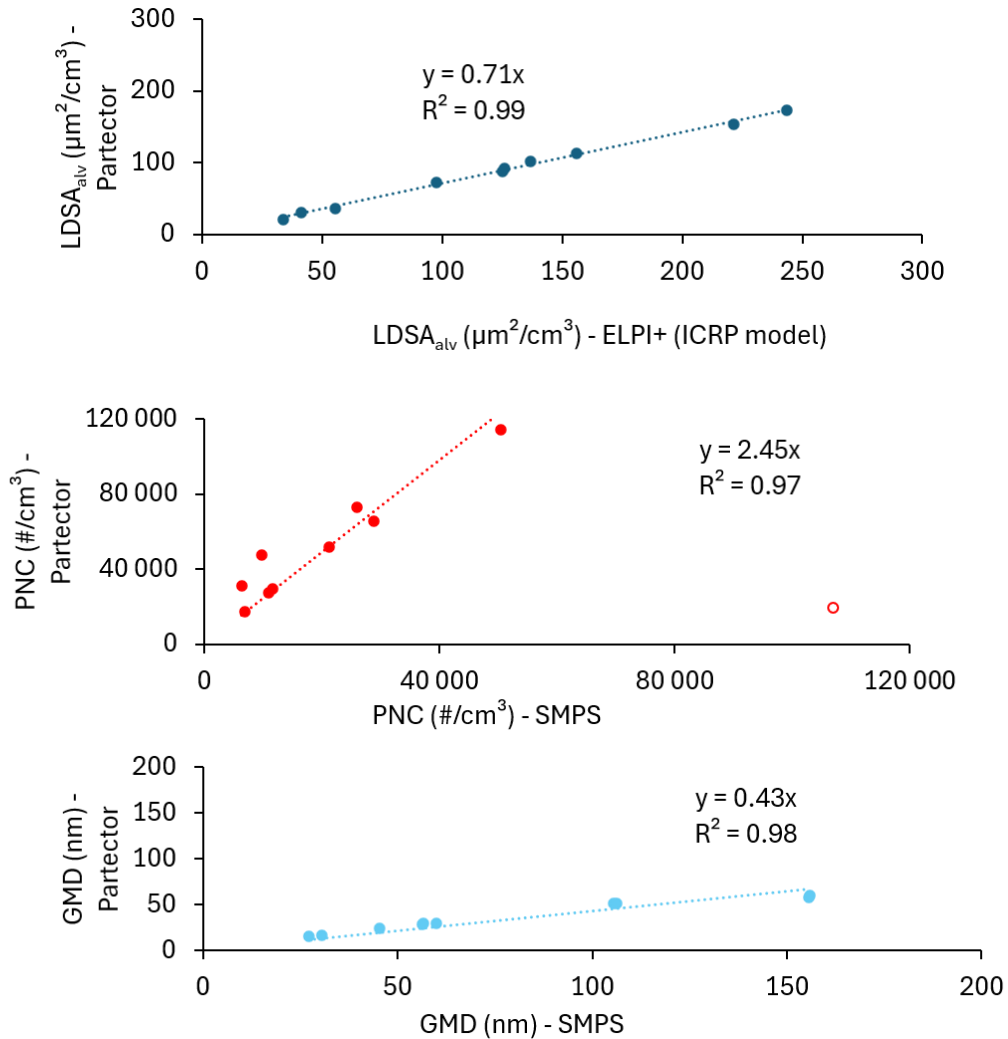
Diesel exhaust exposure



Worker in the same space, where a 90's gasoline vehicle is being inspected

* Inspection of a diesel vehicle (EURO IV)

Instrument comparison – Partector



Conclusions

Using miniaturized aerosol instruments to monitor personal exposure

- Miniaturized aerosol instruments are useful in identifying work tasks causing highest exposure
- Microaethalometers work best in the concentration range of 5-100 $\mu\text{g}/\text{m}^3$
 - This range is suitable considering the binding limit value (50 $\mu\text{g}/\text{m}^3$)
- Of the metrics measured by Partector LDSA compared best to other instruments
 - Preliminary results! → Requires further assessment

Exposure levels

- Overall, diesel exhaust exposure levels were low compared to the limit value
- High momentary concentrations in inspection stations and bus depots

Thank you!



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Patrik Grahn, Marko Hyttinen, Antti Karjalainen, Pertti Pasanen



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