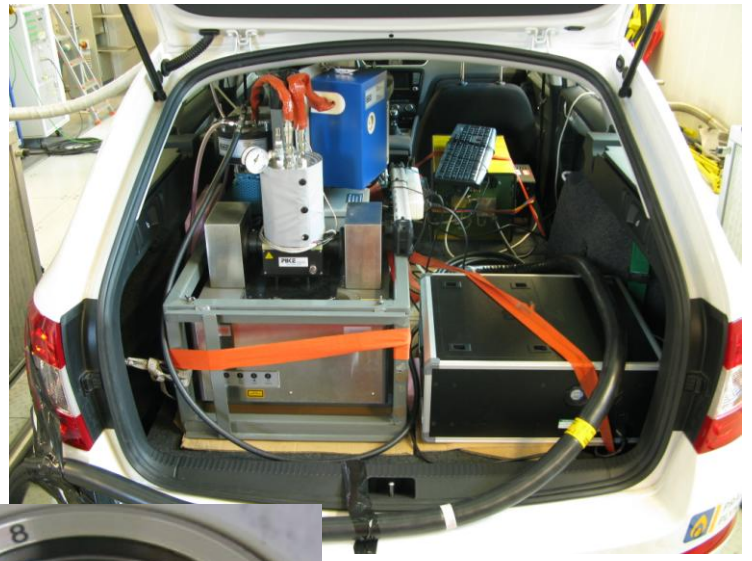
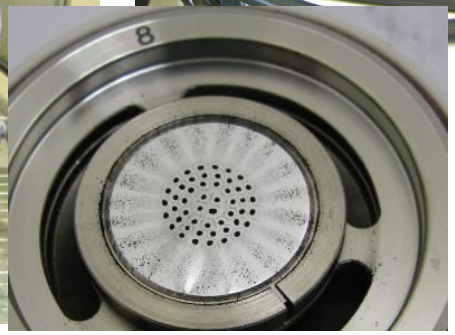
Applying lessons learned from engine exhaust particle measurements to brake wear particle measurements





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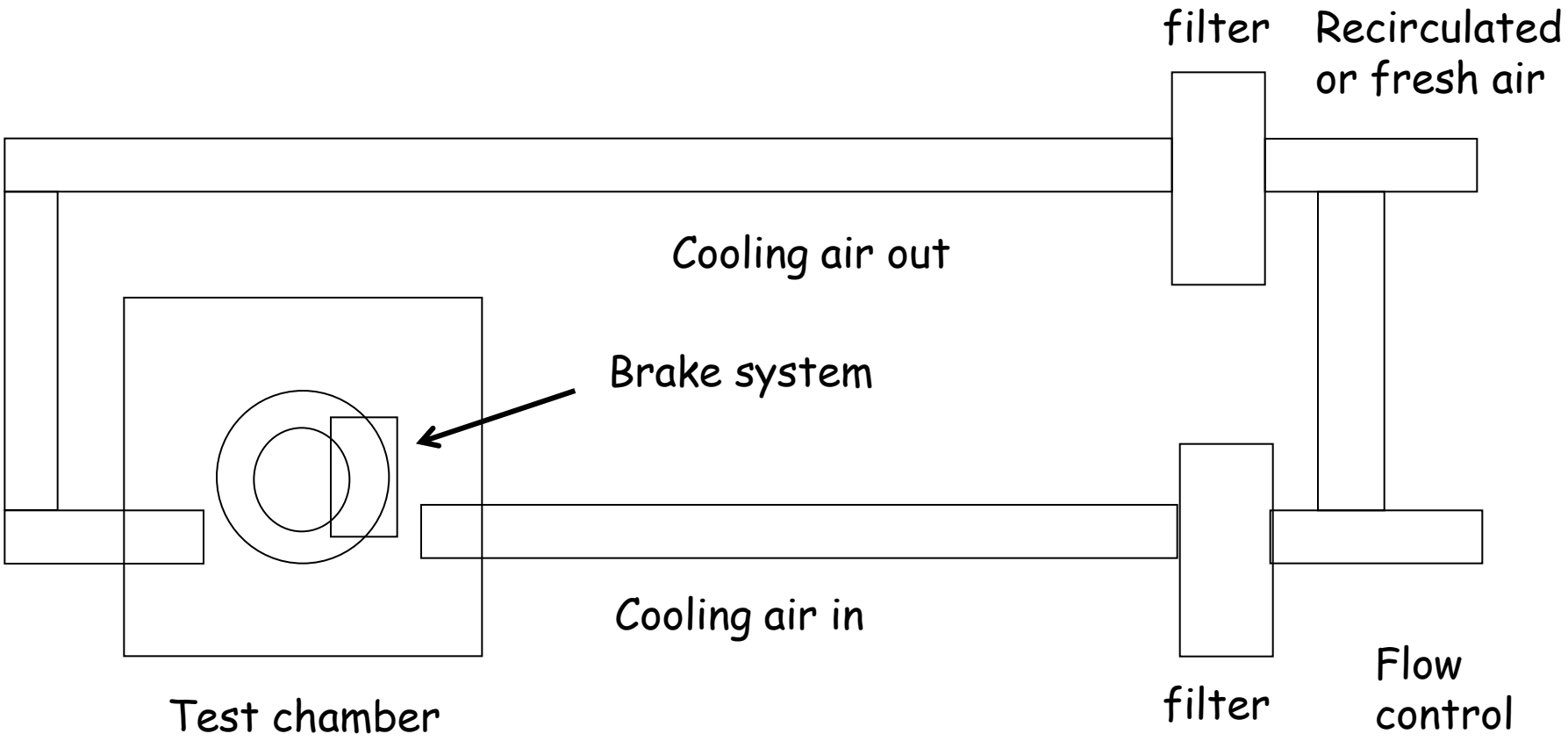
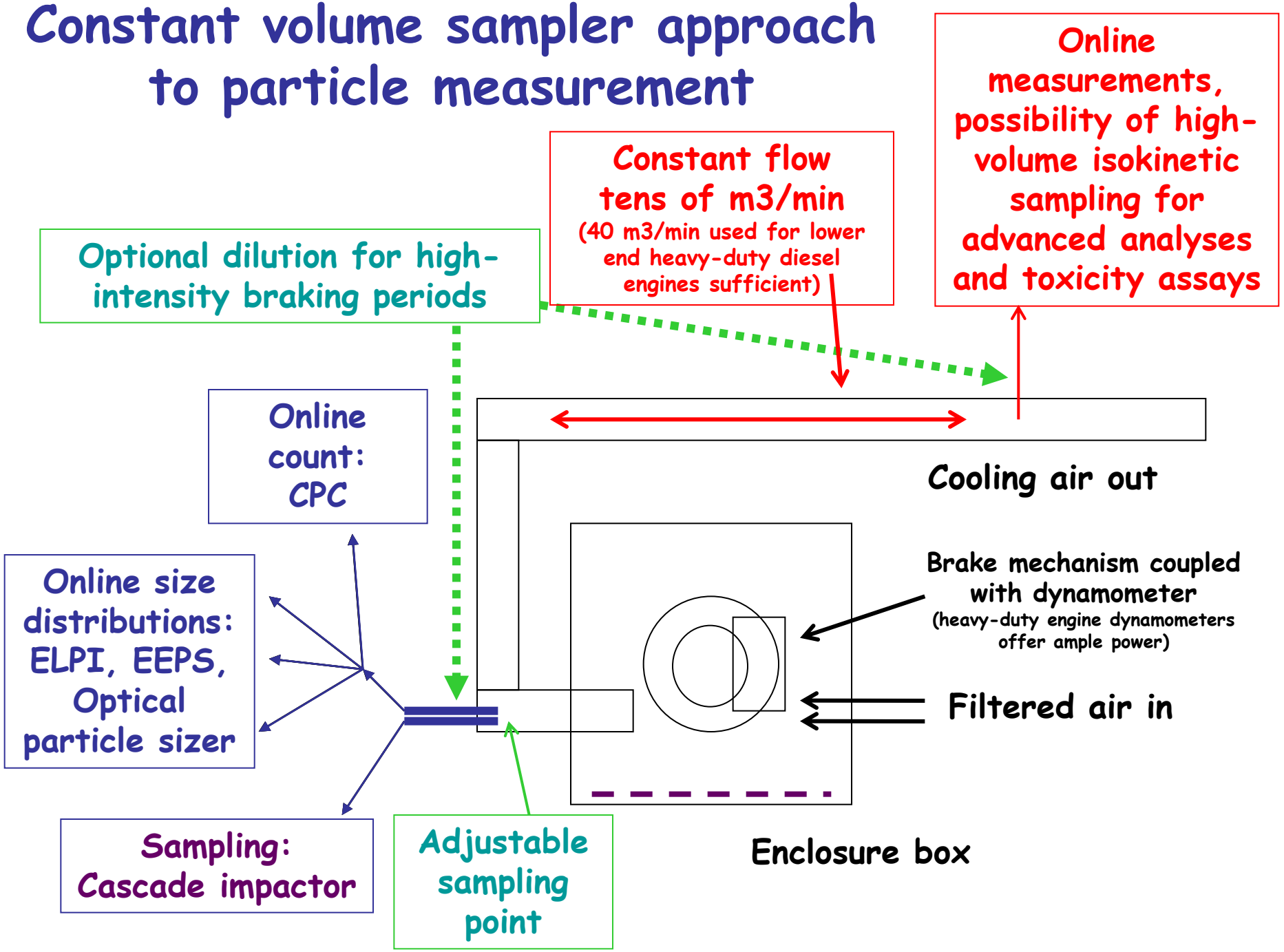
Note: VSB TU Ostrava to share more at a later time

Traditional brake testing setup



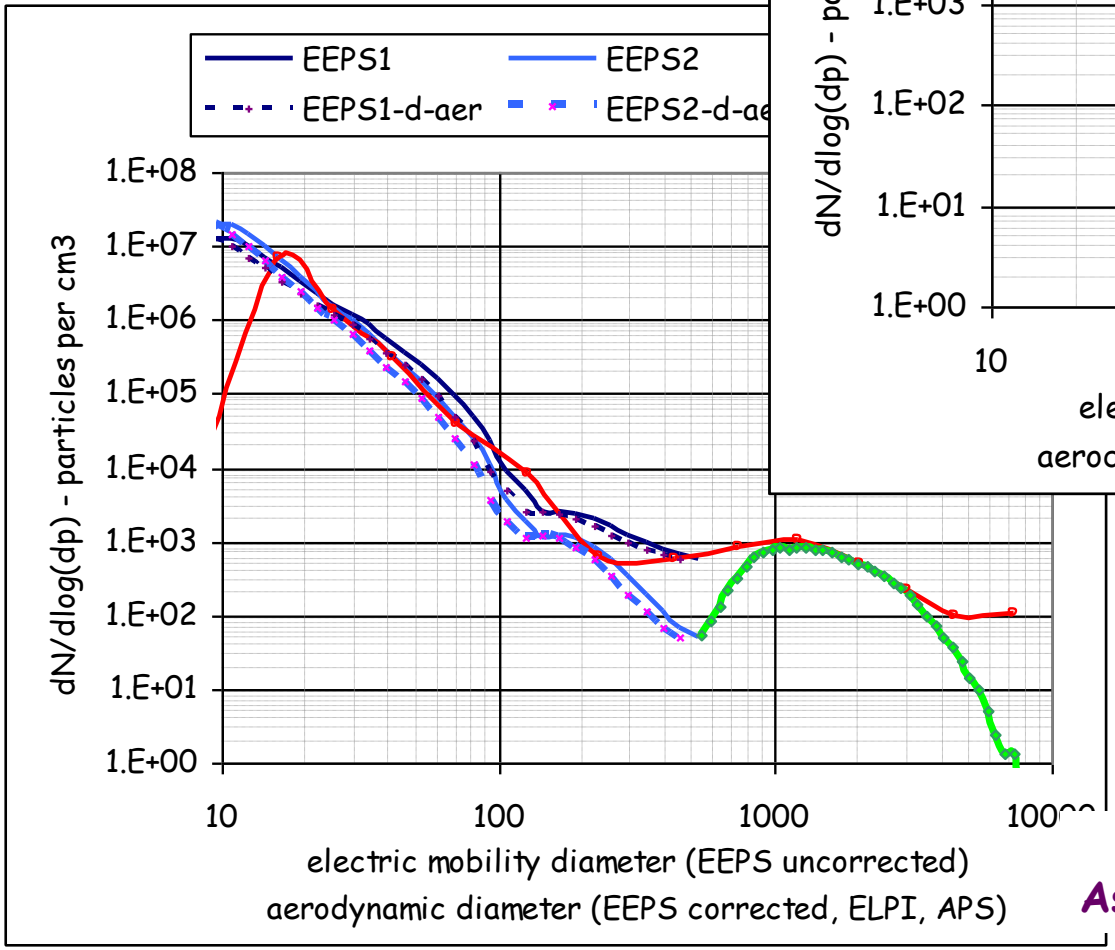
Constant volume sampler approach to particle measurement

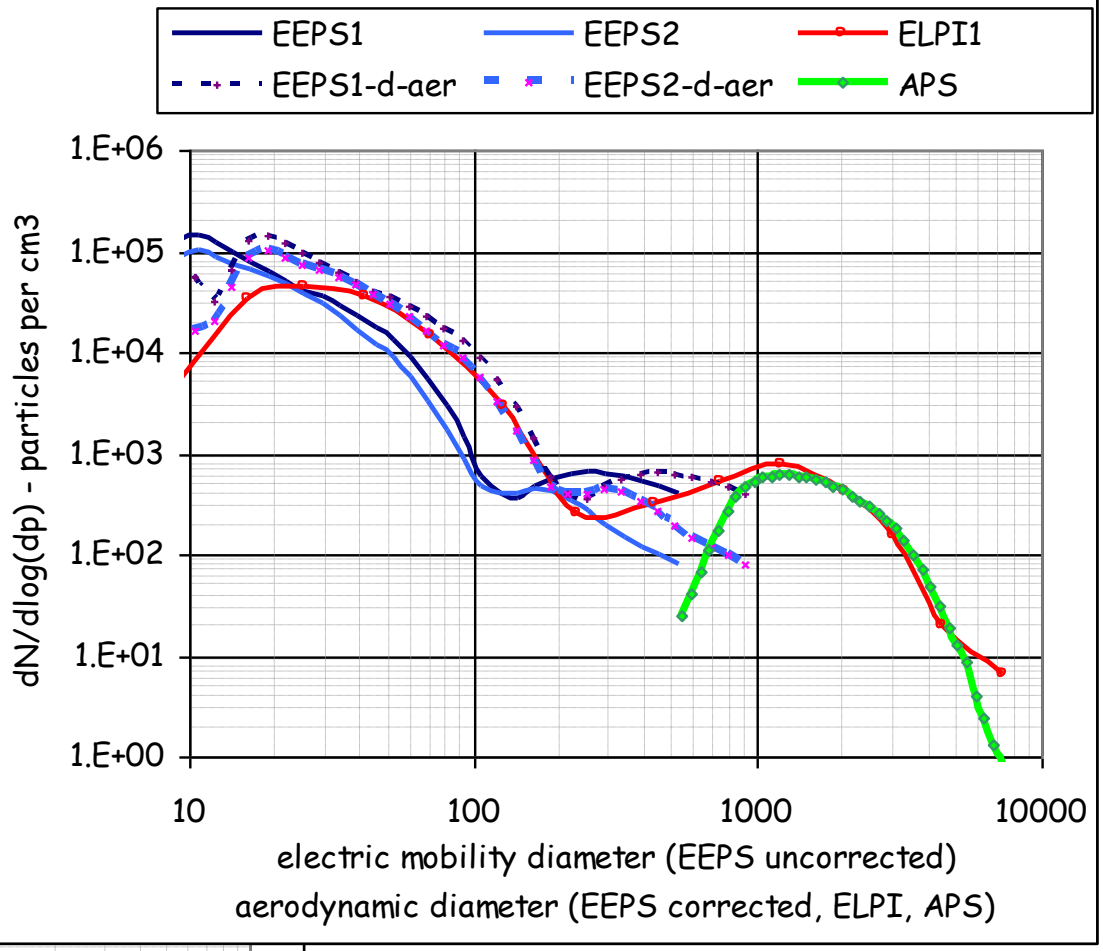


NEDC cycle braking
Assumed eff. particle density of 3.0

Electric mobility (EEPS, SMPS) vs. Aerodynamic (ELPI, APS) diameter

recalculation of EEPS to aerodynamic diameter





Particle effective density varies !!! (metal oxides vs. resins)

Non-NEDC braking
Assumed eff. particle density of 0.75

Our experiences so far: Lessons learned from exhaust emissions measurement very much applicable to brake wear particle emissions measurements.

Size distributions 5 nm – 10 um measured by different methods/instruments.

Larger particles exist but small health effects.

Small particles – measurement uncertainty issue.

High-temperature processes produce nanoparticles (which agglomerate), mechanical processes produce larger particles.

Brake testing has traditionally focused on extreme events to ensure brake performance, safety, durability.

Brake wear particle tests should mimic realistic road conditions.

Many aspects of vehicle/engine exhaust emissions testing can be exploited:

Vehicular tests (NEDC, **WLTC**, Artemis, JP08, FTP, US06, ...) can probably be run (NEDC successfully reproduced here).

Dilution tunnel is feasible if large particles can be excluded.

Total **PM2.5 mass** and **total PN** (nonvolatiles > 23 nm per PMP, or possibly > 10 nm as proposed for aircraft & spark ignition engines) could be suitable metrics.

Future activities

Application of the designed experimental set-up for online particle measurements using:

- **Full-scale brake dynamometer** with environmental chamber (collaboration with VSB – Technical University of Ostrava, CZ),
- **various formulations of automotive brake system components** (collaboration with ITT Friction Technologies, Italy)

The future planned activities with follow current collaboration of ITT and VSB-TUO.

Our experiences so far: Lessons learned from exhaust emissions measurement very much applicable to brake wear particle emissions measurements.

That is, however, just the start...

It may be that nanoparticles, which may contribute substantially to the total particle number, may end up being the most difficult to standardize and even to measure.

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