Periodic technical inspection of diesel engine exhaust

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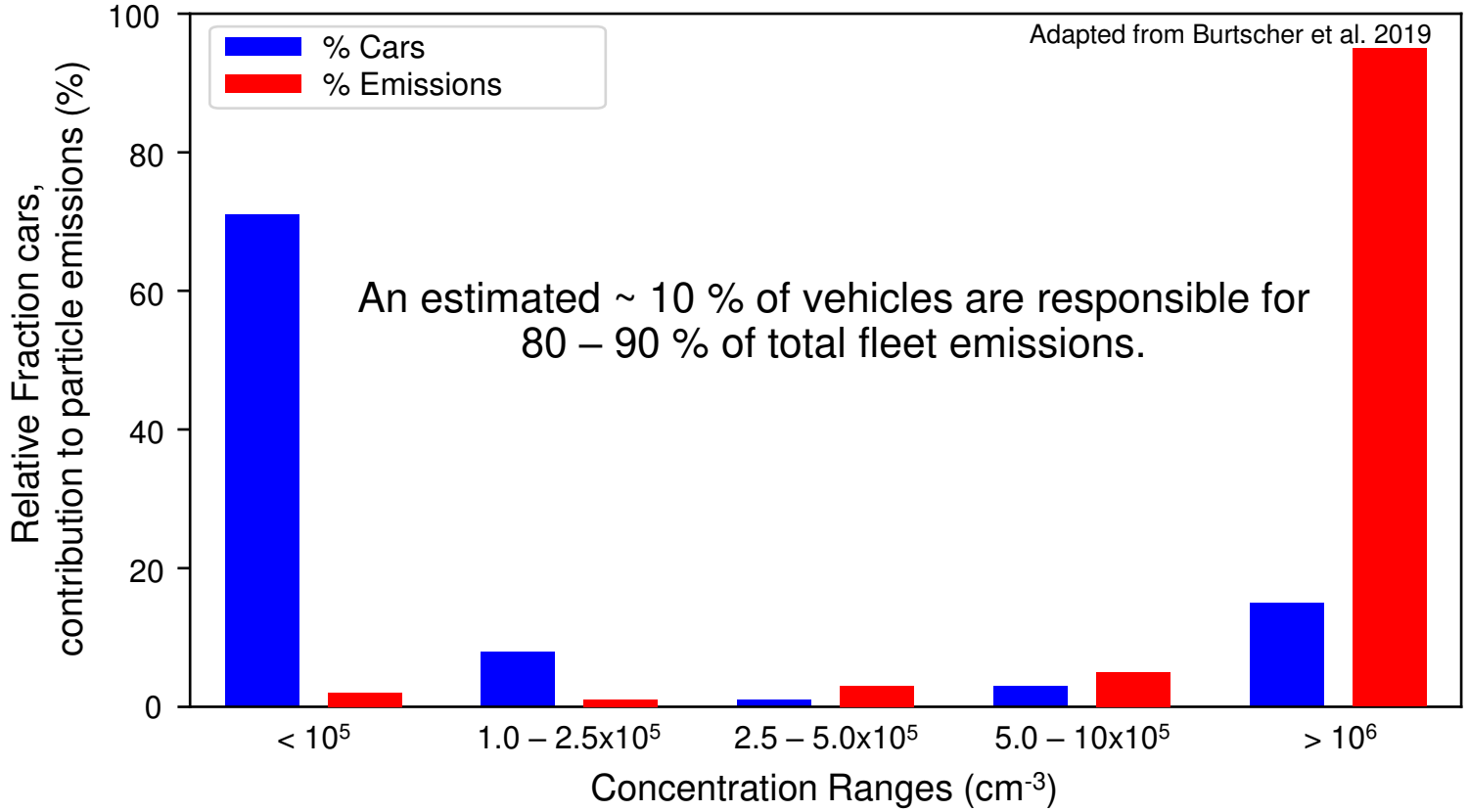
CALAC+ Forum, Lima, 7-8 May 2025

Overview of PN-PTI



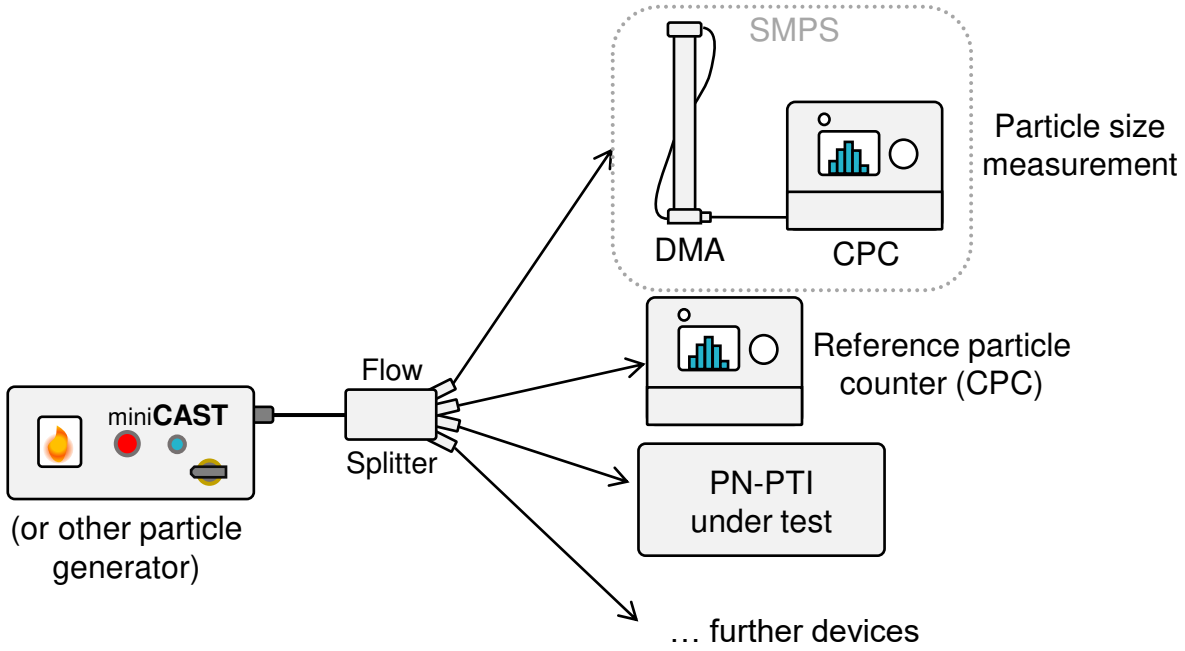
- High (> 10^6 cm^{-3}) emissions are typically the result of a defective diesel particulate filter (DPF)
- PN-PTI aims to identify these high emitters which contribute the most to total emissions
- PN-PTI introduced in Switzerland on 1 January 2023 for passenger cars, light and heavy duty vehicles, and non-road mobile machinery

Burtscher, Lutz, Mayer (2019) A new periodic technical inspection for particle emissions of vehicles. *Emiss. Control Sci. Technol.* 5, 279 – 287, doi: 10.1007/s40825-019-00128-z

Role of METAS in PN-PTI

- METAS performs type approval of PN-PTI instruments, so far 11 have been approved
- Yearly, instruments are sent for service then verified by METAS, more than 2’200 verifications have been performed since the end of 2022
- Provide support to end users (technicians) through:
  1. Online presentations in German; French; Italian; English
  2. Courses in German and French (English also possible)
  3. On-site inspection of measurement procedure
  4. Laboratory tests
- Perform research to improve PN-PTI practices, current research:
  1. Effect of test aerosol on counting efficiency of PN-PTI devices
  2. Feasibility of using existing PN-PTI devices for gasoline engine exhaust

Verification processs

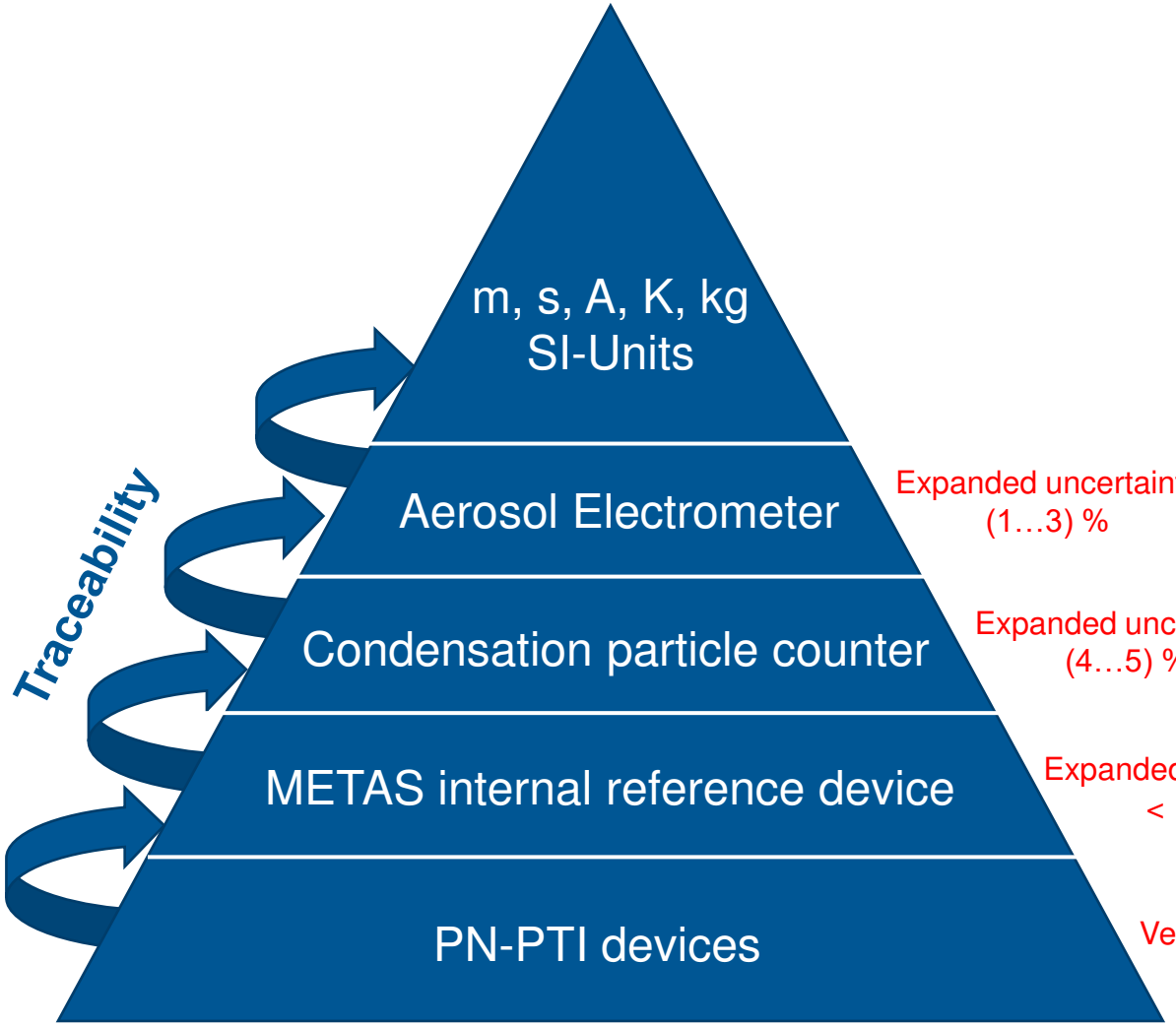


(Simplified schematic, see below papers for full set-up)

- Polydisperse combustion (CAST) soot is used in Switzerland for verification. The reference is traceable to the primary standard for electric current. Expanded measurement uncertainties (95 % confidence interval) are 7 %.
- The use of other test areosols (i.e. spark discharge soot, salt particles) is allowed in Germany, the Netherlands and Belgium
- Studies by METAS in collaboration with the EU Joint Research Centre (JRC) show that the counting efficiency depends on the properties of the test aerosol (Vasilatou et al. 2023, Hammer et al. 2024).

Vasilatou et al. (2023) Effects of the test aerosol on the performance of periodic technical inspection particle counters. *J. Aerosol Sci.* 172, 106182, doi: 10.1016/j.jaerosci.2023.106182
Hammer et al. (2024) Influence of soot aerosol properties on the counting efficiency of instruments used for periodic technical inspection of diesel vehicles. *Aerosol Res.* 2, 261 – 270, doi: 10.5194/ar-2-261-2024

Swiss PN-PTI Traceability



Expanded uncertainty
(1…3) %

Expanded uncertainty
(4…5) %

Expanded uncertainty
< 10 %

Verification error limit
± 30 %

Expensive measurement set up, not portable, time-intensive

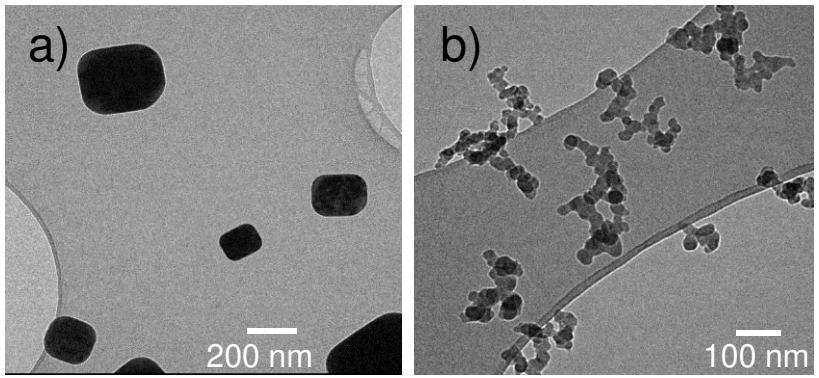
Mid-cost measurement set up, semi-portable, time-efficient

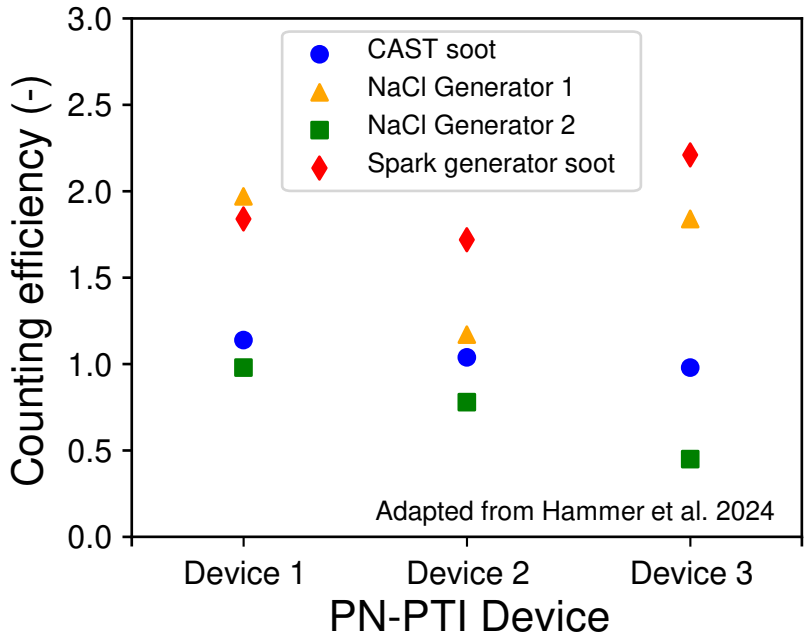
The measurement uncertainty of the reference system shall be < 1/3 of the verification error limit.

Portable, cost-effective measurement device

Correction factors for PN-PTI counting efficiency

Electron microscopy images of:
a) salt b) combustion particles





- Salt nebulizers are more affordable than combustion generators but salt particles have different morphology than soot
- When salt aerosols are used for PN-PTI verification, the counting efficiency must be corrected by about 10−40 %
- METAS is carrying out a laboratory campaign with the EU-JRC. The results will be published in the next few months.

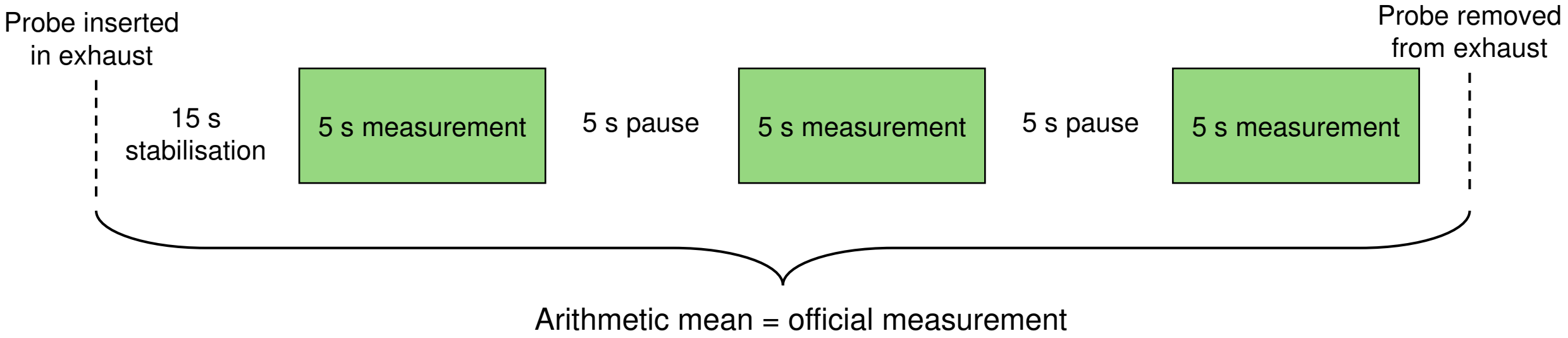
METAS calibrates the reference counters used in Europe with both salt and soot

We determine correction factors for each type of PN-PTI instrument

Hammer et al. (2024) Influence of soot aerosol properties on the counting efficiency of instruments used for periodic technical inspection of diesel vehicles. *Aerosol Res.* 2, 261 – 270, doi: 10.5194/ar-2-261-2024

Possible issues during PN-PTI

- Typical measurement malpractices:
  1. The diesel engine is cold (should be warm)
  2. The inlet of the PN-PTI device has been contaminated with oil
  3. The PN-PTI devices have not been sent to service (at least once a year)
  4. The end users do not apply the official measurment protocol, but instead measure continuously



Possibilities for collaboration

Switzerland is a member of UNIDO | United Nations Industrial Development Organization (www.unido.org)

- UNIDO is a specialized agency of the United Nations with a unique mandate to promote, dynamize and accelerate industrial development.
- UNIDO's vision is a world without poverty and hunger, where industry drives low-emission economies, improves living standards, and preserves the livable environment for present and future generations, leaving no one behind.
- UNIDO provides support to its 173 Member States through four mandated functions: technical cooperation; action-oriented research and policy-advisory services; normative standards-related activities; and fostering partnerships for knowledge and technology transfer.

UNIDO funds projects for the provision of technical support and works in many cases with METAS as a partner

The proposal must be submitted to UNIDO by the party wishing to receive support

Summary

- PN-PTI aims to identify high emitting vehicles to improve air quality
- Proper implementation of PN-PTI requires traceable verification facilities and training for end users
- If a test aerosol other than combustion soot is used for verification/calibration, appropriate correction factors must be applied
- METAS is open for collaboration to help with implementation, training and improvement of PN-PTI programs

Thank you for your attention

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Ihre Referenz.

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