



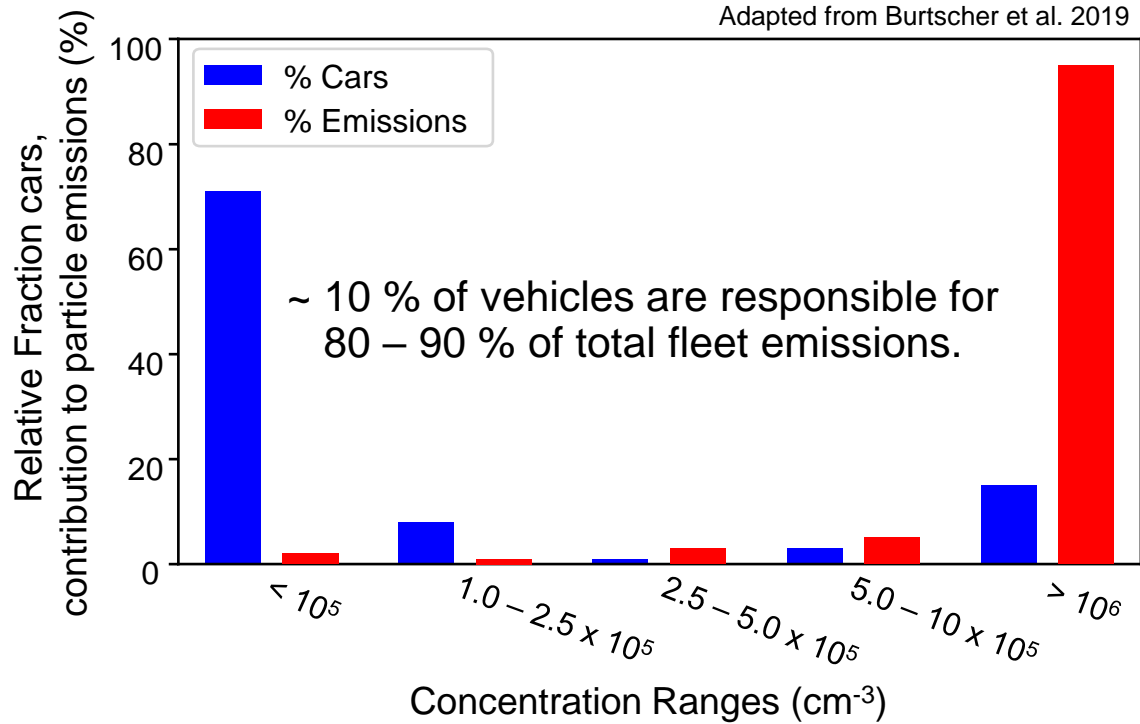
10 years of PN-PTI in Switzerland: from Diesel to Petrol vehicles

Una Trivanovic, Kevin Auderset, Simone Krähenbühl, Konstantina Vasilatou

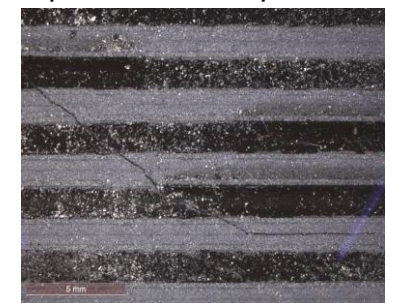
Federal Institute of Metrology METAS & Federal Office for the Environment FOEN

VERT Forum, Bern, 20 March 2026

Overview of PN-PTI



Hairline fracture under optical microscope



Measured PN-Emissions: 2.0 - 3.3 x 10⁶ cm⁻³

Source: EMPA

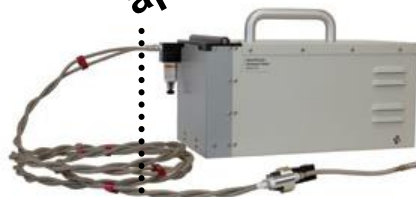
Timeline of PN-PTI in Switzerland



2000
DPF for tunnel construction



2008
DPF required for off-road machinery



2016
First PN-PTI device (worldwide!)
approved by METAS

2020
11 devices approved by METAS

2023
CH, D begin PN-PTI for on-road diesel

2026
PN-PTI for off-road
machinery mandatory

2002
DPF for large construction sites



2013
Regulation of exhaust gas measuring devices
for combustion engines in effect (VAMV)

2016
PN-PTI possible for off-road machinery

2022
NL, BEL begin PN-PTI for on-road diesel

2023
EU recommends on-road PN-PTI

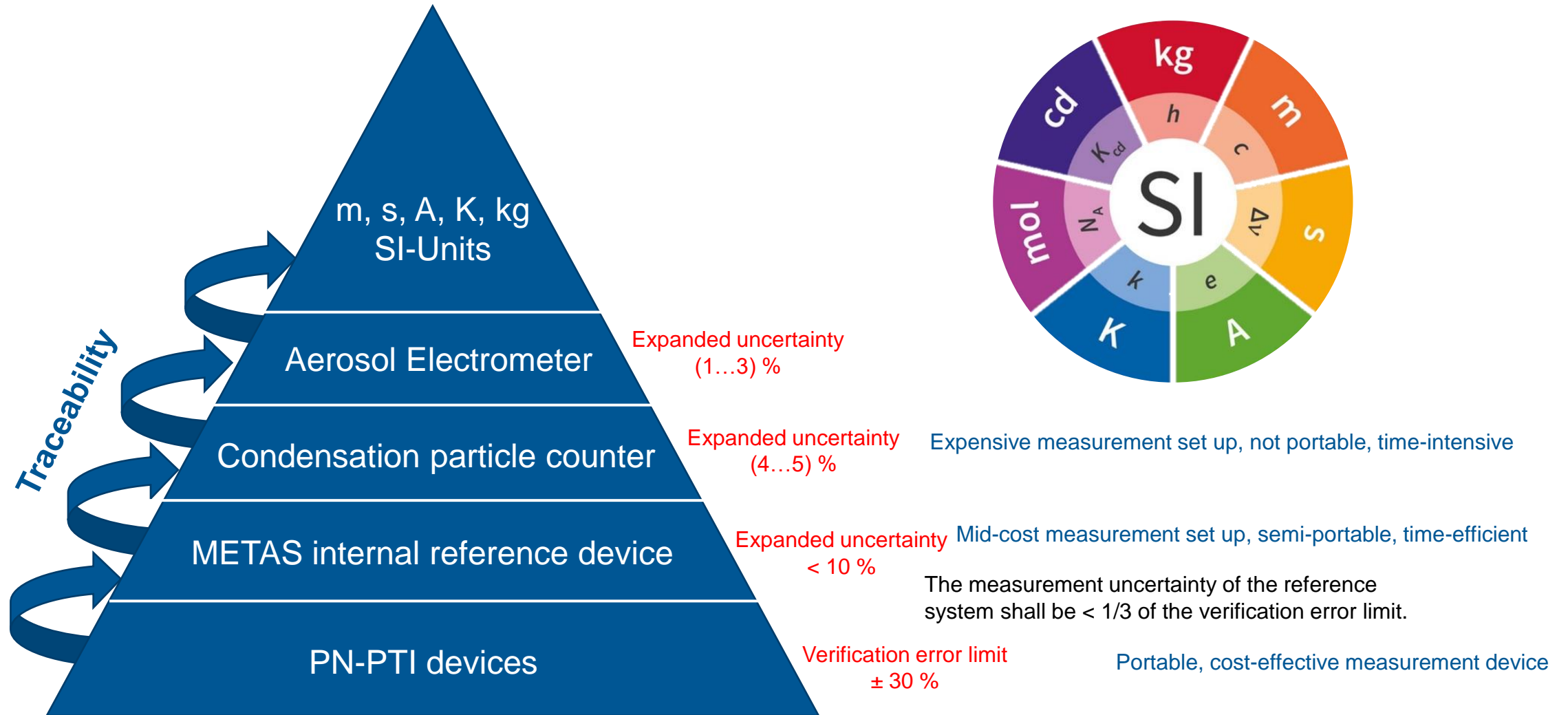


Role of METAS in PN-PTI

- 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



Swiss PN-PTI Traceability

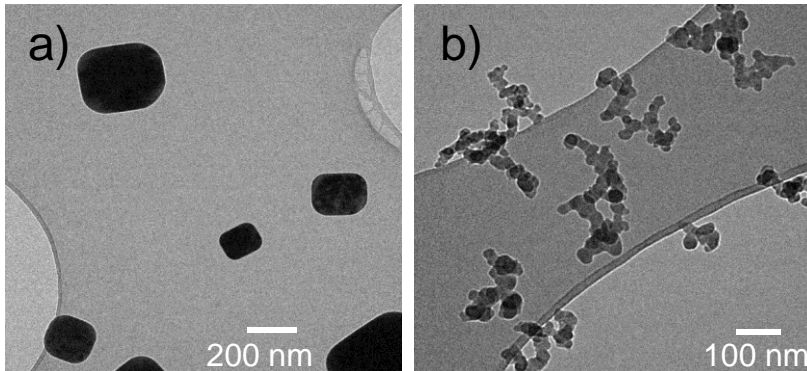


Correction factors for PN-PTI counting efficiency

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
- 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

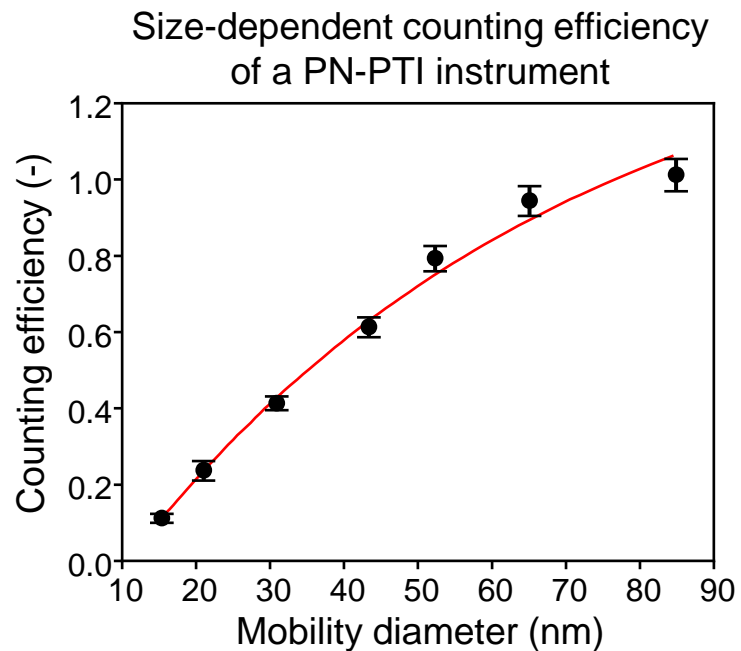
CE from salt varies 10 - 40% compared to polydisperse soot

PN-PTI of gasoline vehicles

Gasoline PN-PTI: [EU to introduce gasoline PN-PTI](#)

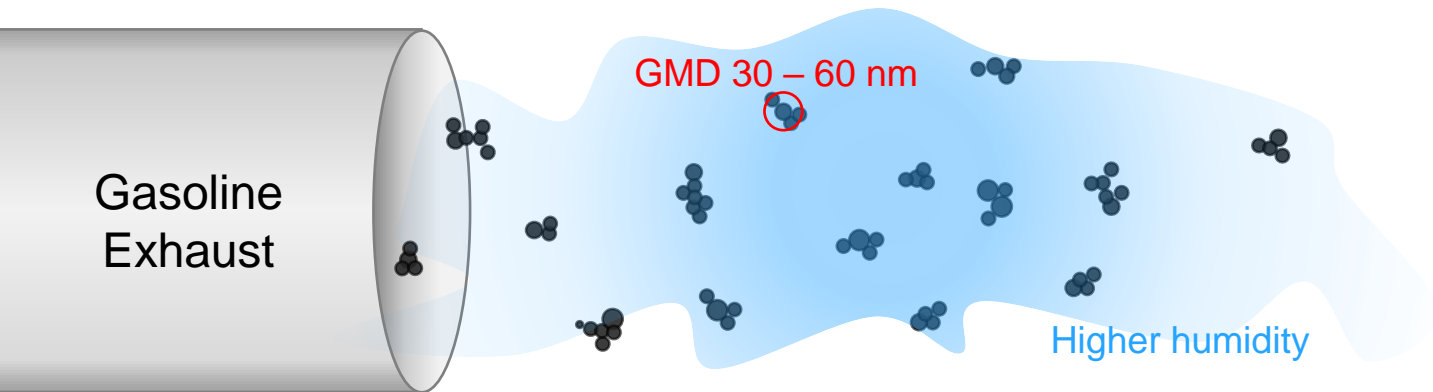
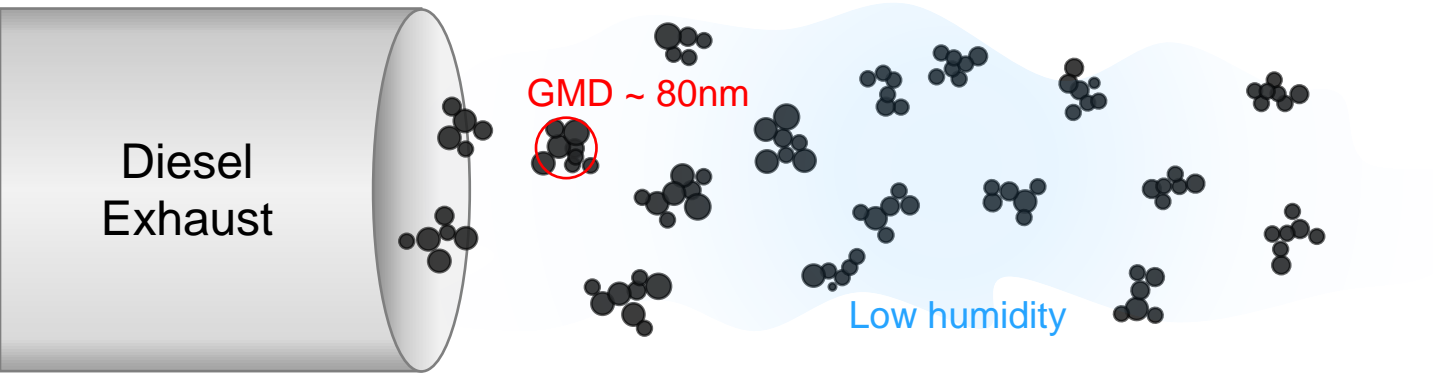
Research in-progress, preliminary results show:

- Some instruments disturbed by high humidity
- Low counting efficiency (about 20%) at 20 nm

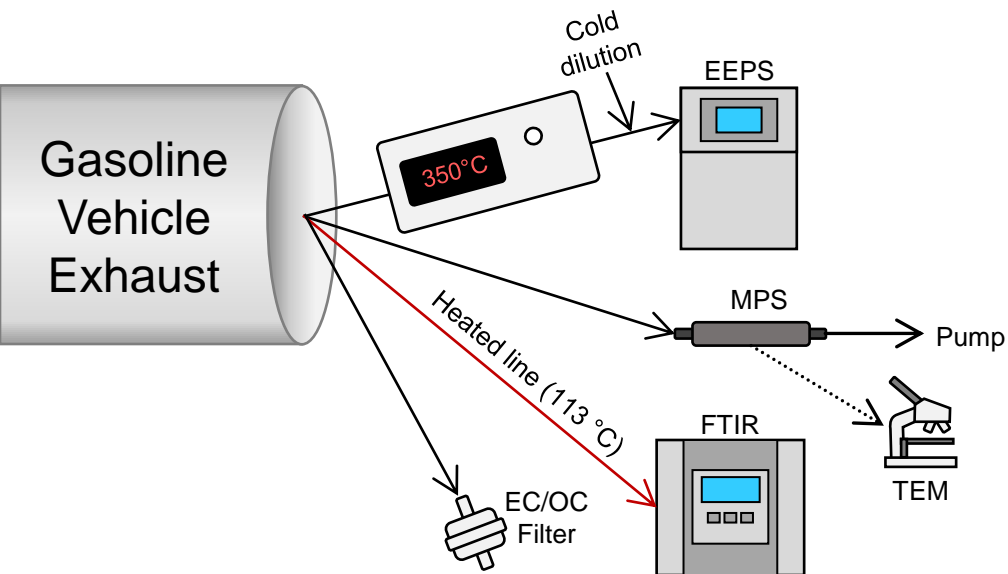
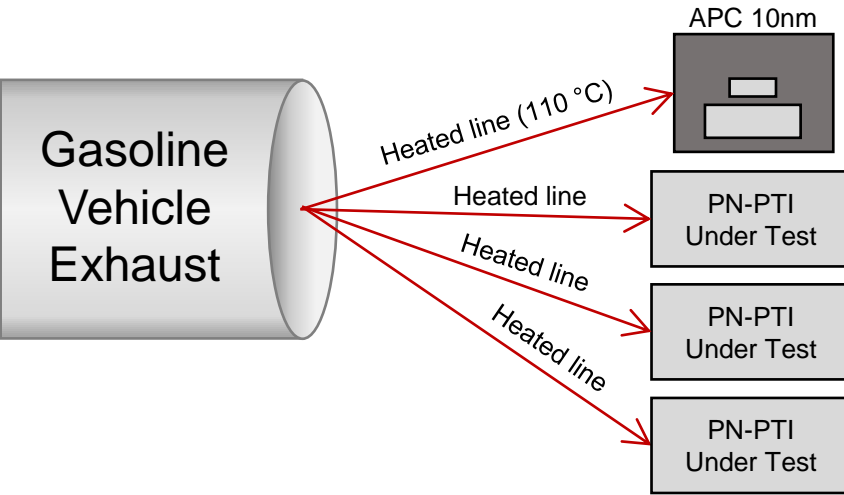


- New test protocol must be developed as highlighted by Melas et al. (2024)

Diesel vs Gasoline Exhaust



Experimental set-up at the JRC



Engines tested:

Manufacturer	Model	Abbreviation	Engine Type	Emission Standard	GPF
Nissan	Qashqai	NN	GDI	Euro 6b	No
Opel	Astra	OL	GDI	Euro 6b	No
Seat	Ibiza S	S DPFI	PFI		No
VW	T-Cross	VW GPF	GDI	Euro 6d	Yes
Seat	Leon S	S DGDI	GDI	Euro 5b	No
VW	Golf	VW GDI	GDI	Euro 6b	No

Test Cycles:

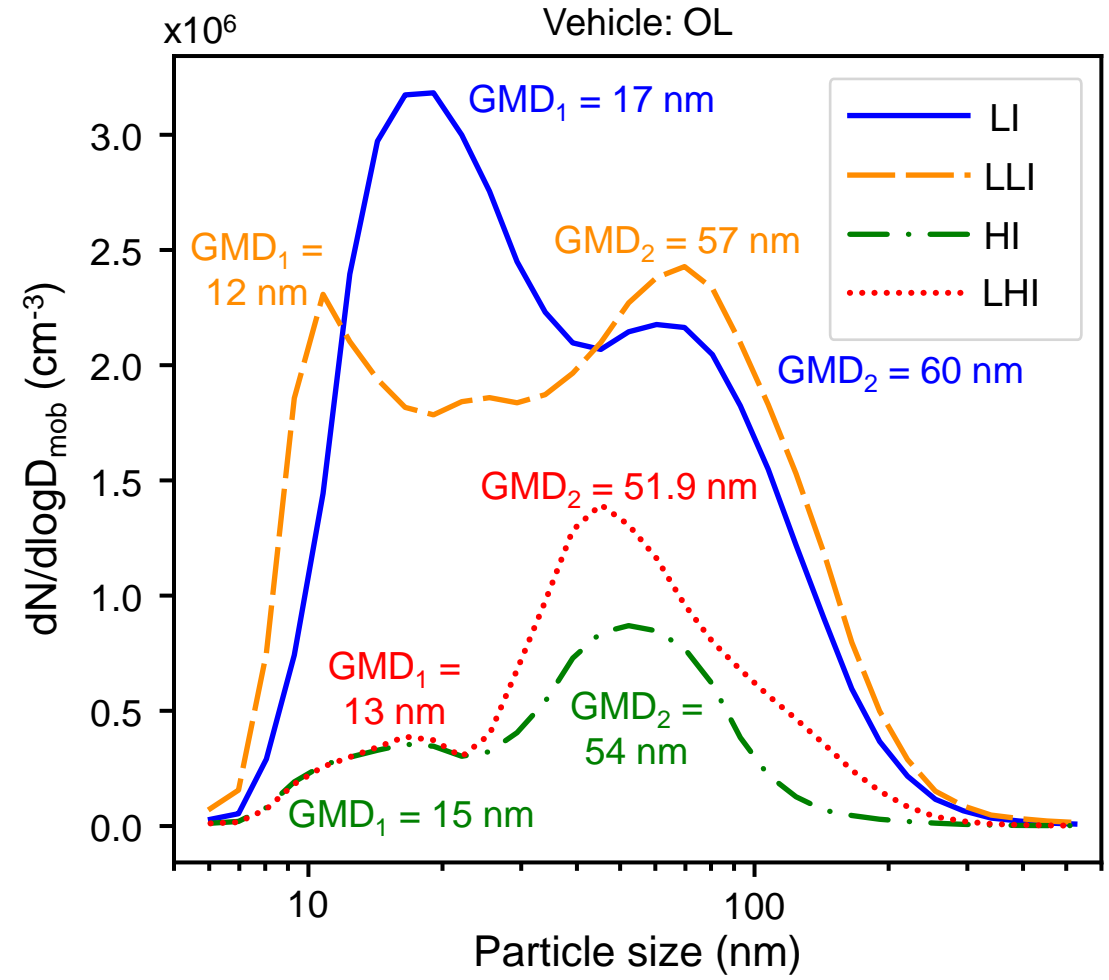
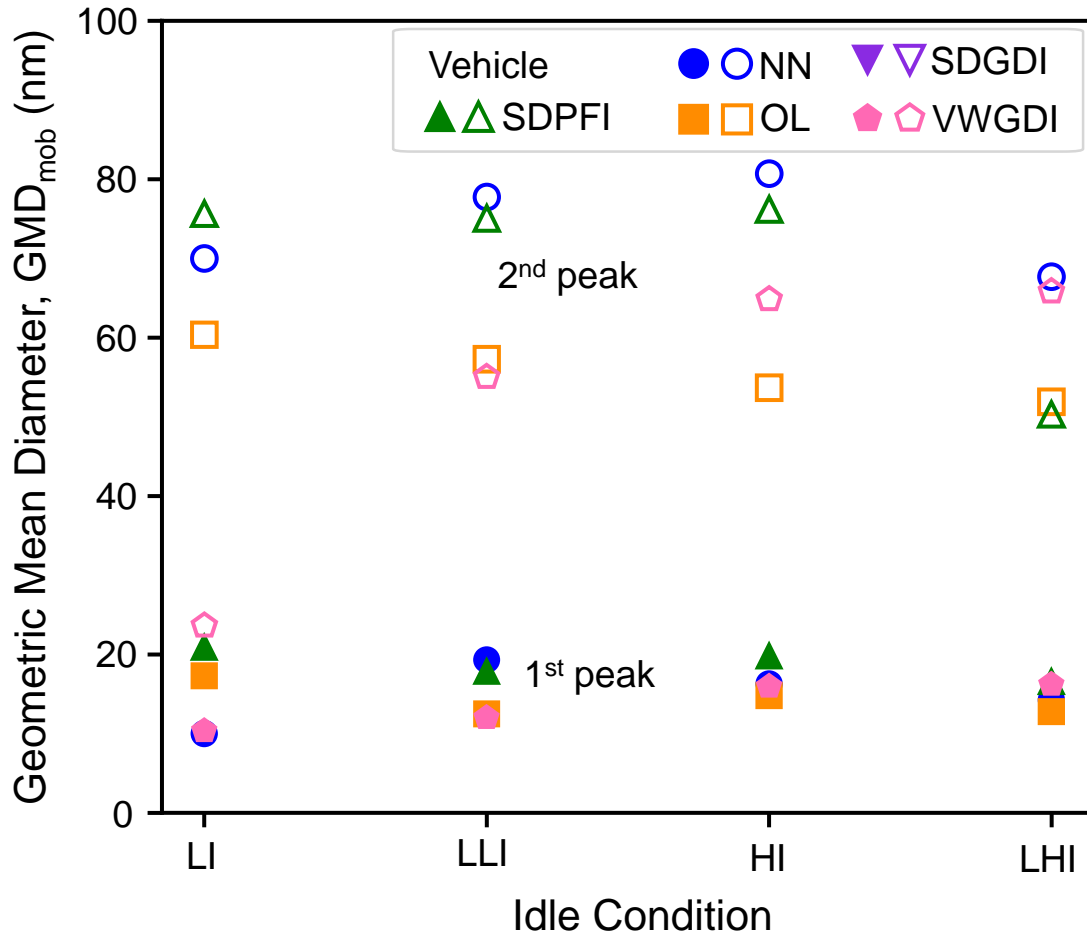
Low Idle (LI) – vehicle idling with no other input

Loaded Low Idle (LLI) – idling with AC on max

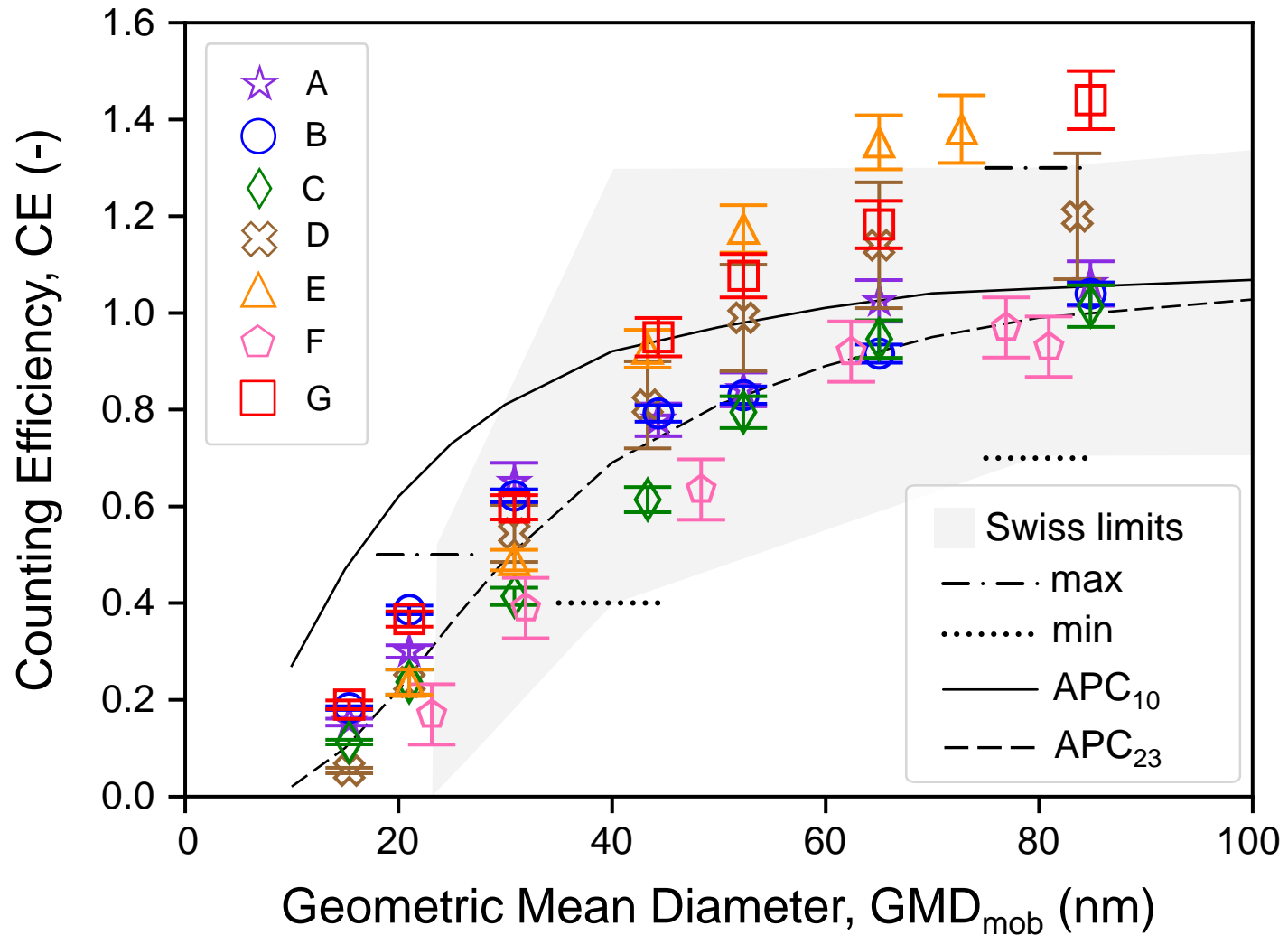
High Idle (HI) – idling with 2000 RPM

Loaded High Idle (LHI) – idling with 2000 RPM and AC on max

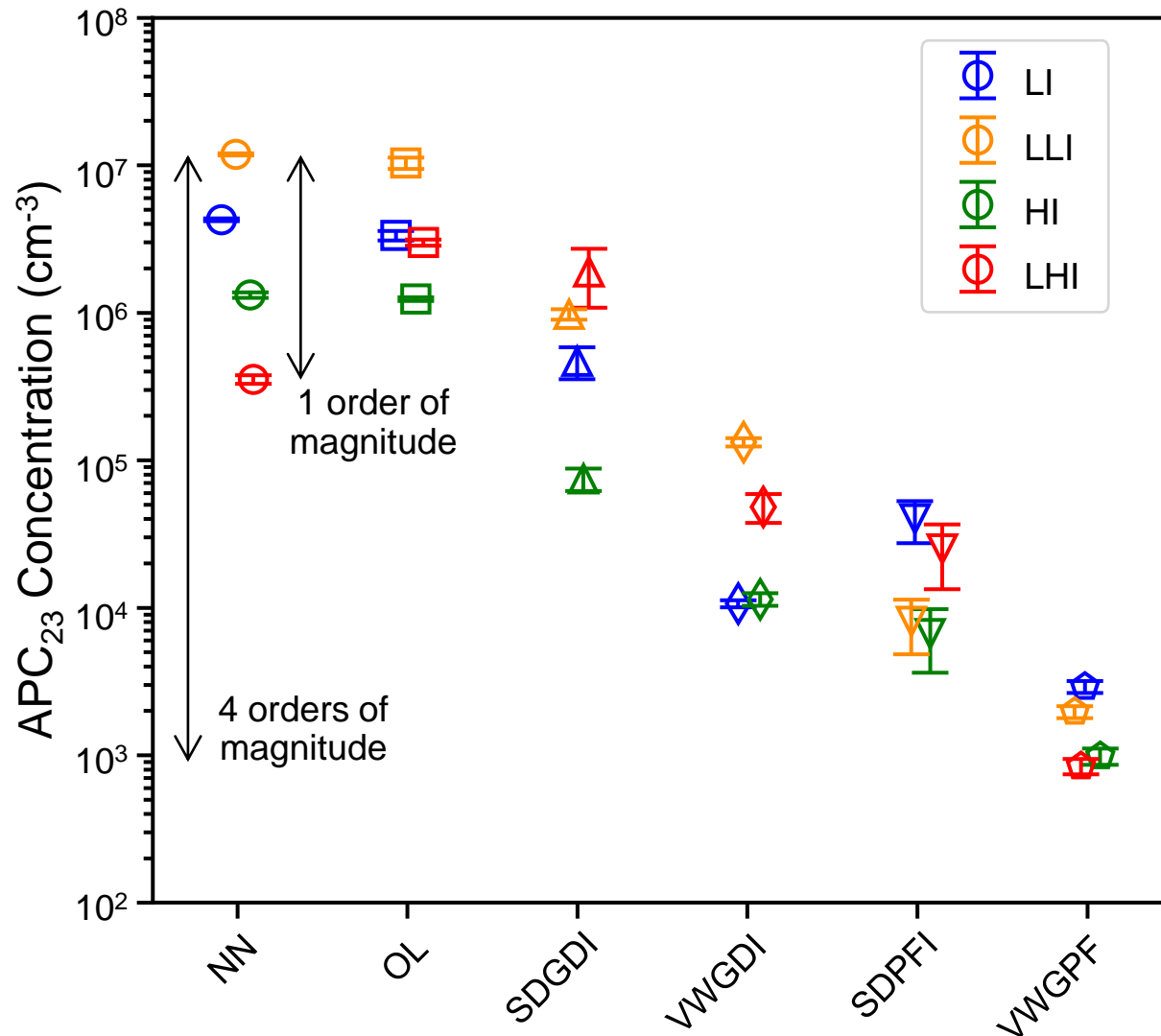
Particle size distributions



Particle size distributions



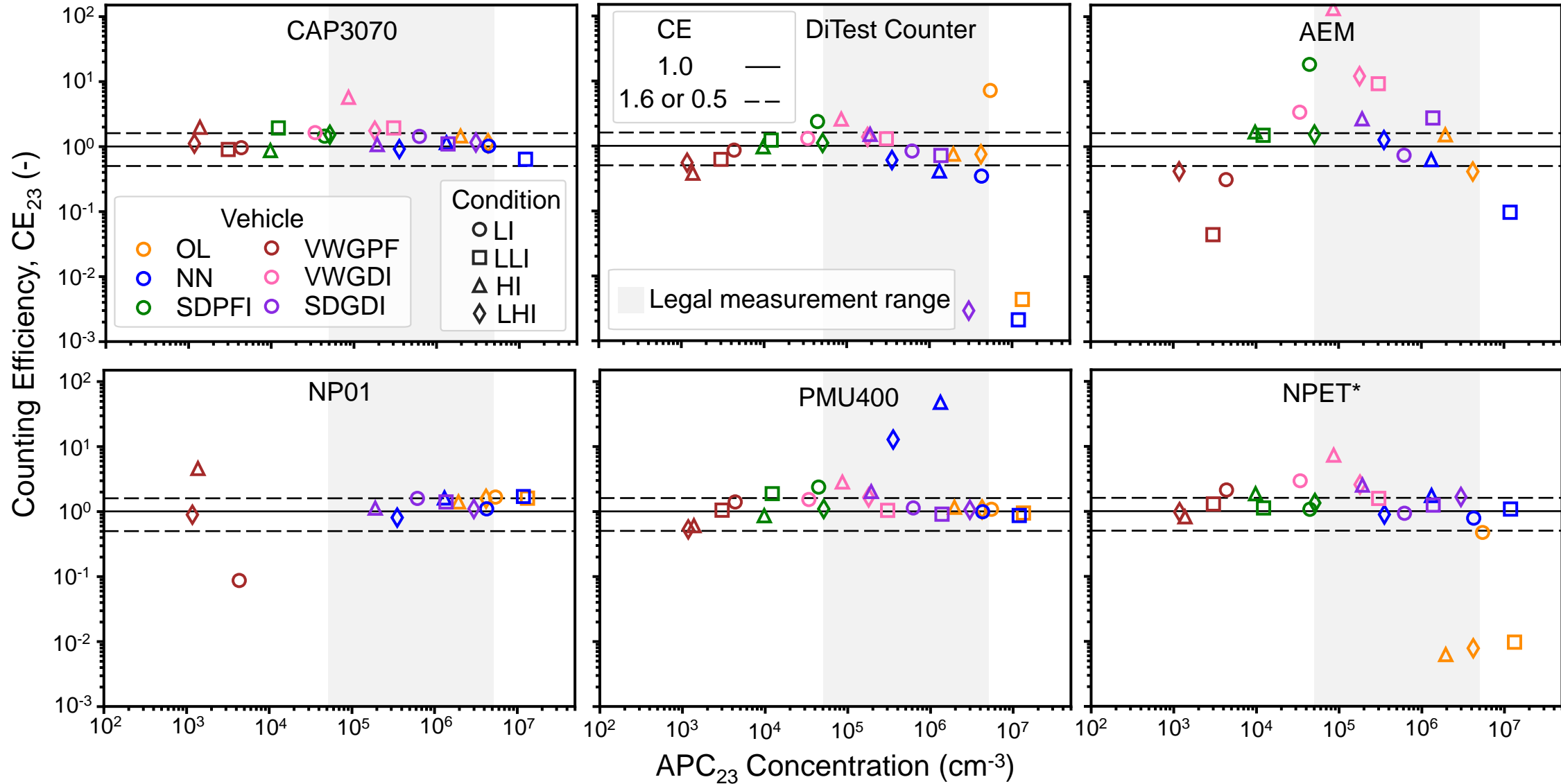
PN concentrations from gasoline engines



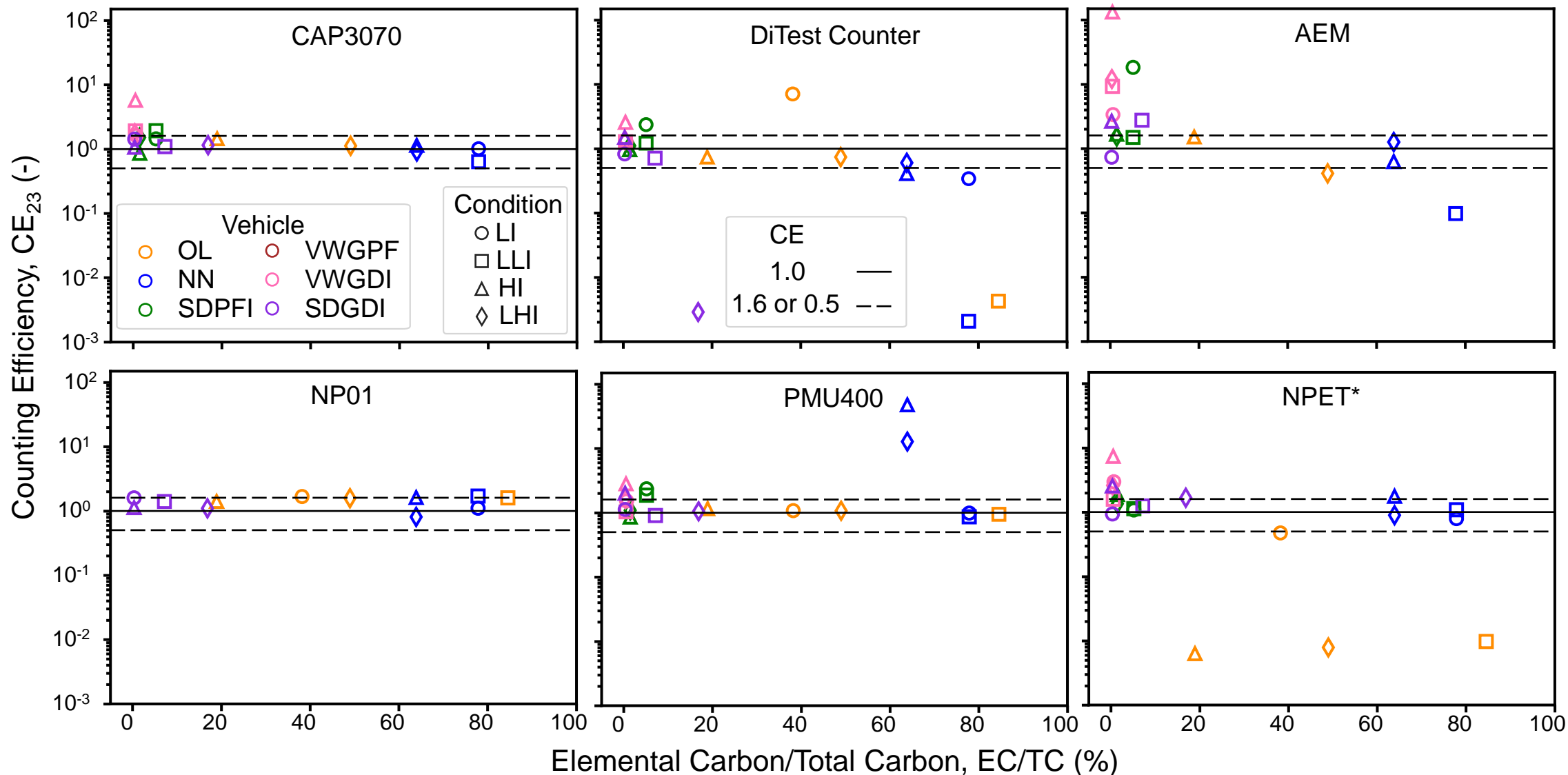
The large spread in concentrations depending on engine load makes it difficult to determine if the GPF is intact or not!

PTI for gasoline may require its own test procedure [1]

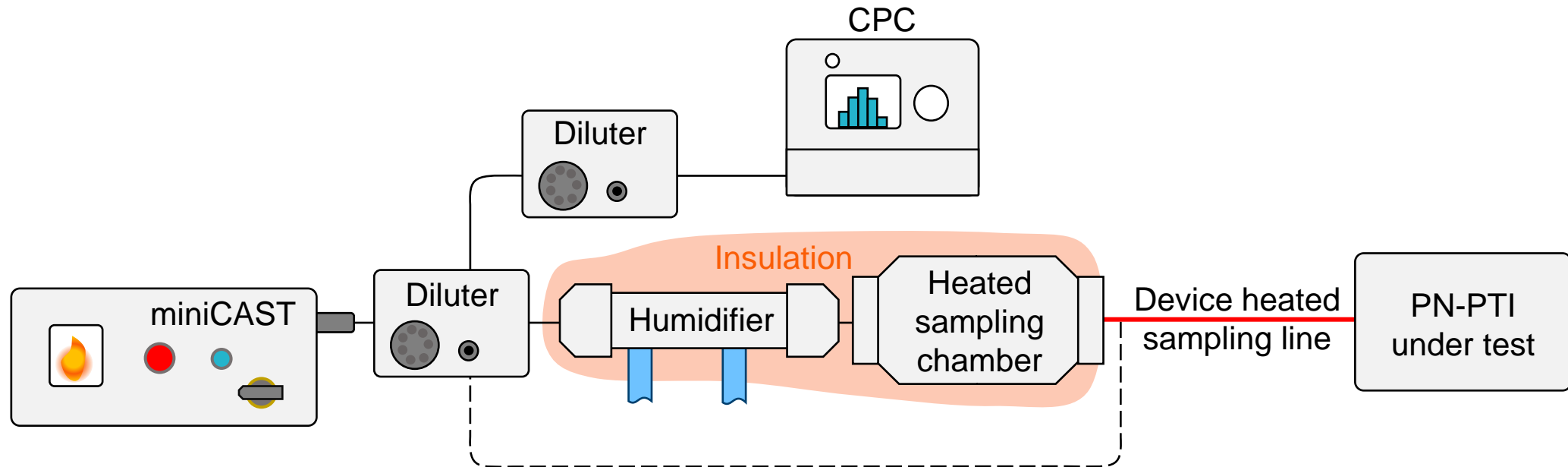
CE₂₃ vs gasoline exhaust concentration



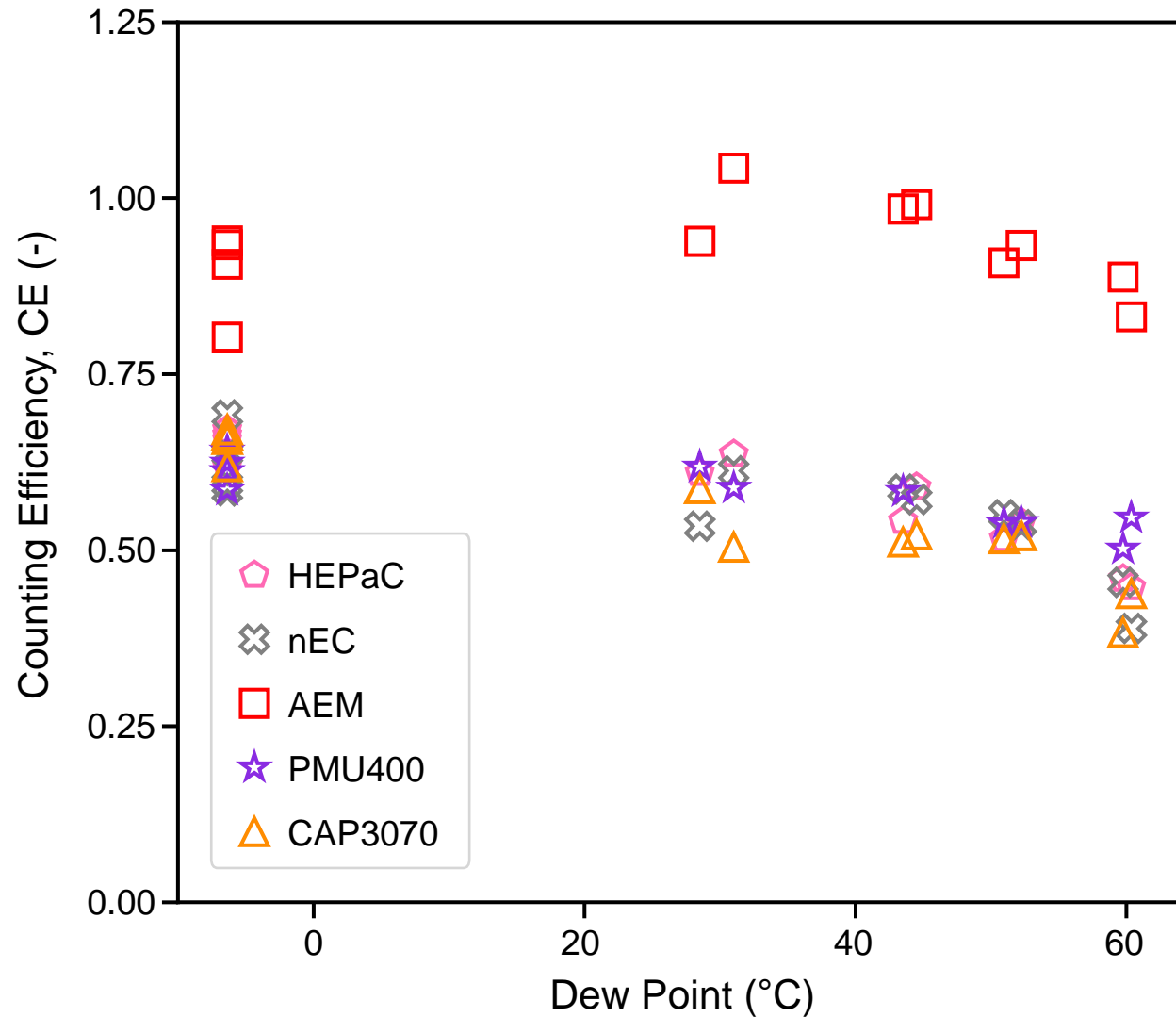
CE₂₃ vs gasoline exhaust EC/TC



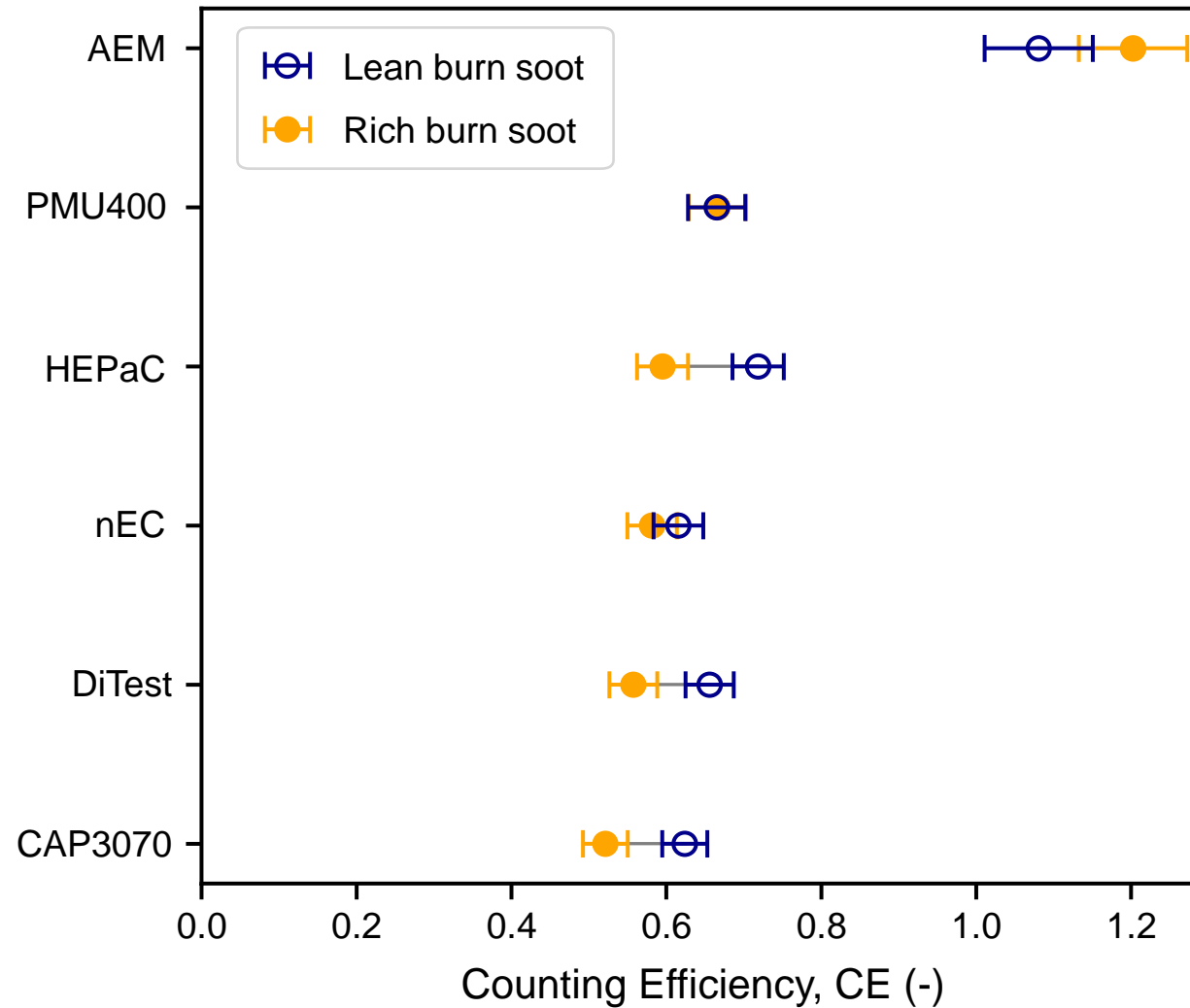
Experimental set-up at METAS



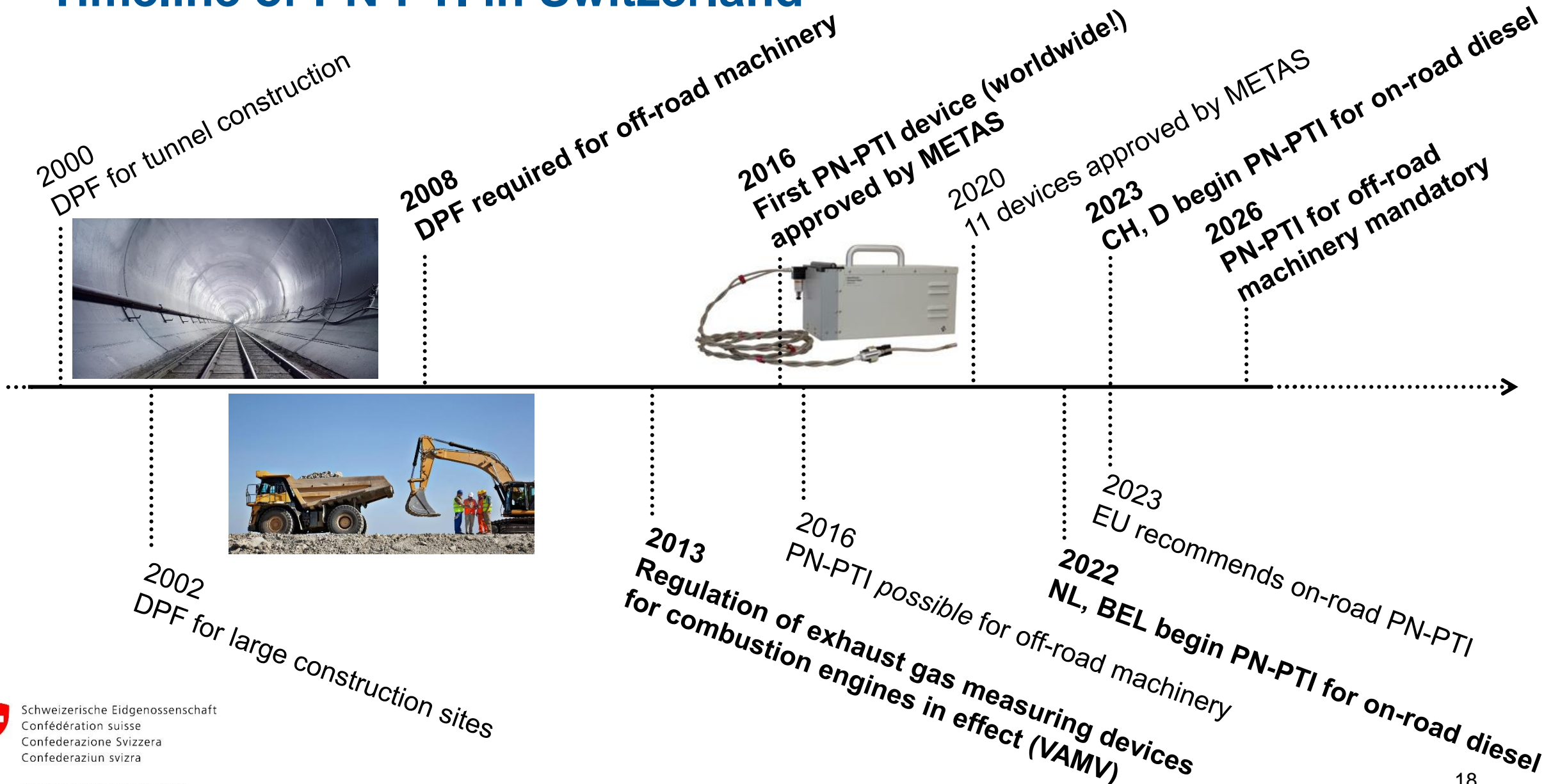
Effect of humidity on CE of PN-PTI devices



Effect of primary organics on CE



Timeline of PN-PTI in Switzerland

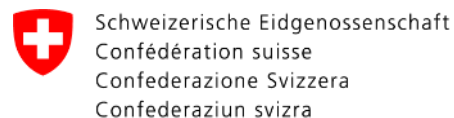


Thank you for listening!

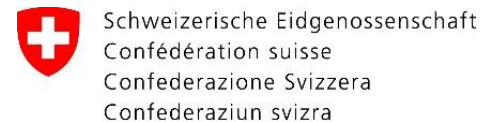
una.trivanovic@metas.ch

konstantina.vasilatou@metas.ch

Thank you to the Federal Office for the Environment (FOEN), Section Traffic
(Simone Krähenbühl and Giovanni Durbano)
for funding this research!



Eidgenössisches Institut für Metrologie METAS



Bundesamt für Umwelt BAFU