

Introducing the Silver Particle Generator

The New Silver Standard

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A.8.1.3.4.7.

SPN10

Incorporate an internal calibration factor from the linearity calibration against a traceable reference, as determined in paragraph A.8.2.1.3, shall be applied to determine PNC counting efficiency. The counting efficiency shall be reported including the calibration factor.

The PNC calibration material shall be 4cSt polyalphaolefin (Emery oil) or soot-like particles (e.g. flame generated soot or graphite particles)...

Consider: (e.g. flame generated soot, graphite/metal particles, etc)...



World Calibration Centre
for Aerosol Physics

Leibniz-Institut für Troposphärenforschung Permoserstraße 15 04318 Leipzig



Leibniz Institute for
Tropospheric Research

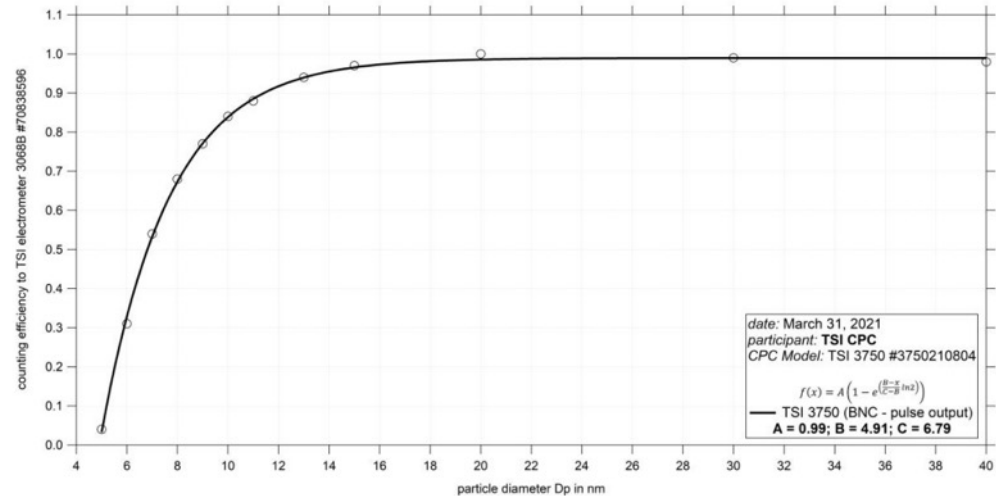


Fig. 1: Counting efficiency for TSI-CPC 3750 SN 3750210804 against aerosol electrometer 3068 SN 70838596; silver particles between 5 nm and 40 nm were used for calibration; the calculated Dp_{50} from the BNC (pulse output) is 6.79 nm.

ISO 27891:2015(E)

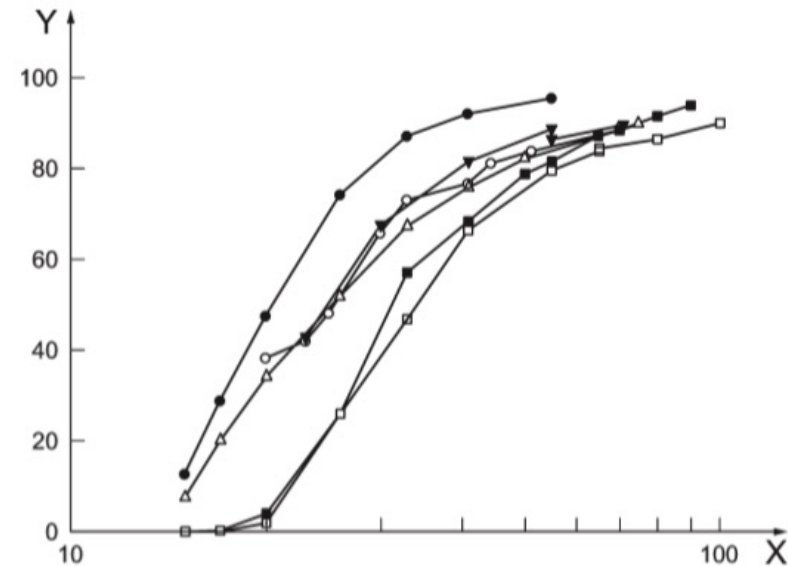
Aerosol particle number concentration — Calibration of condensation particle counters

Densité de particules d'aérosol — Étalonnage de compteurs de particules d'aérosol à condensation

pp52:

— "Therefore, the particle chemical composition shall always be specified when detection efficiencies are certified, and it cannot be assumed that comparable results would be obtained for particles of different chemical composition. In addition, for the reference CPC, **the certificate can only be assumed to be valid for the same particle material that is specified on the certificate**"

ISO 27891:2015(E) does not define the material to be used in the calibration



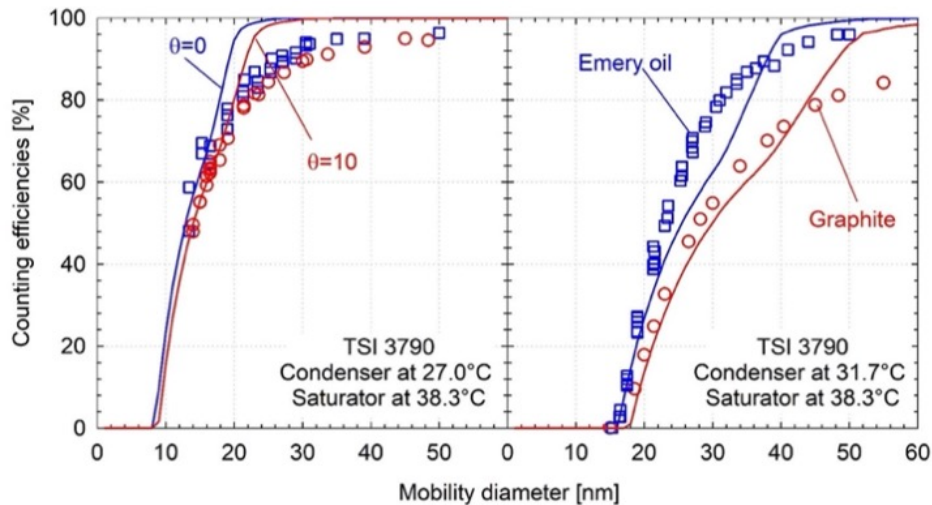
Key

- poly-alpha-olefin (PAO)
- ▼ diffusion flame soot
- sucrose
- polystyrene latex (PSL)
- △ oxidized silver
- sodium chloride

X particle size [nm]
Y detection efficiency [%]

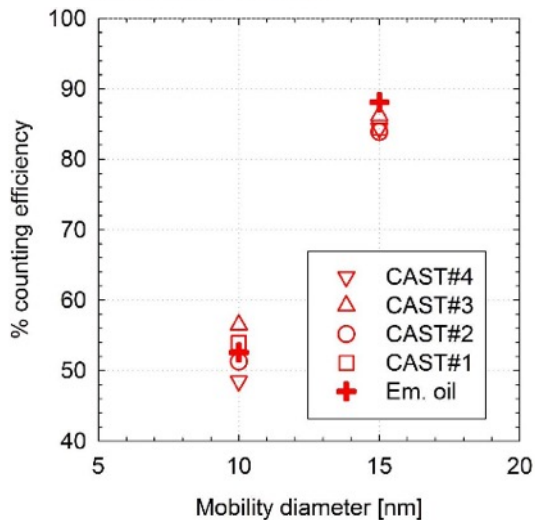
**ISO 27891:2015(E) 5.4.1.2 Aerosol Generator:
c) Evaporation condensation aerosol generator for metallic particles like Ag ... etc**

Down to 10 nm



data from:

Mamakos, A.; Giechaskiel, B. & Drossinos, Y. (2012). *Aerosol Science & Technology*, 47:11-21



Data courtesy of A. Mamakos (AVL)

23 nm CPC

- Strong D_{50} dependence on calibration material
- Increasing dependency with increasing particle diameter

10 nm CPC

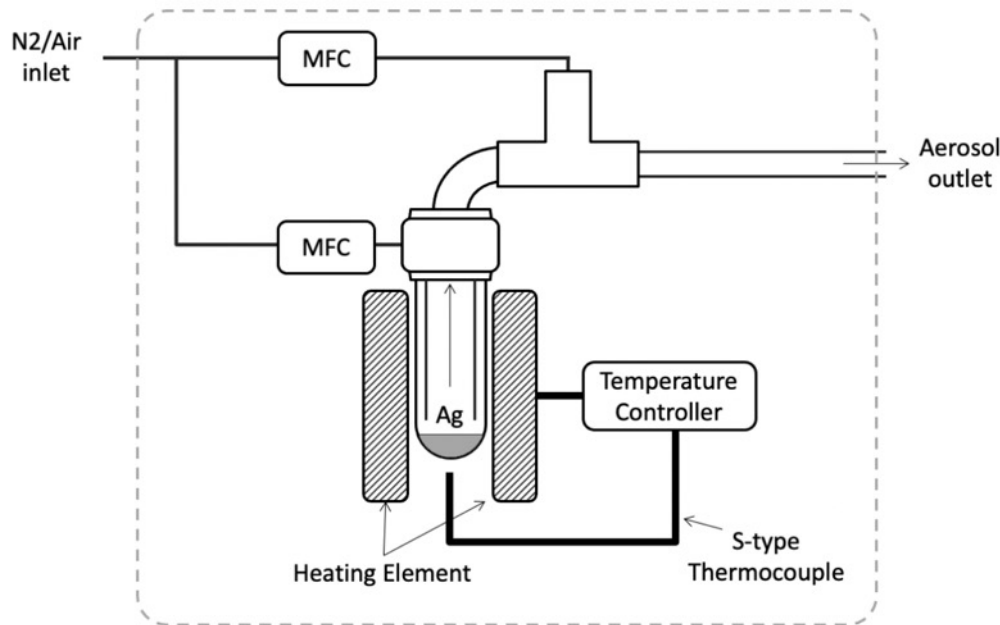
- Little D_{50} dependence on calibration material
- More accurate counting at larger diameters

1-touch Silver Particle Generator

PMP Meeting
1. December 2021



- “Scheibel & Porstendörfer” method
 - Evaporation and condensation
- Regulated flow control
 - “main flow” 2 LPM
 - “Dilution” 0-15 LPM
- Ceramic heater $\sim 1200^{\circ}\text{C}$

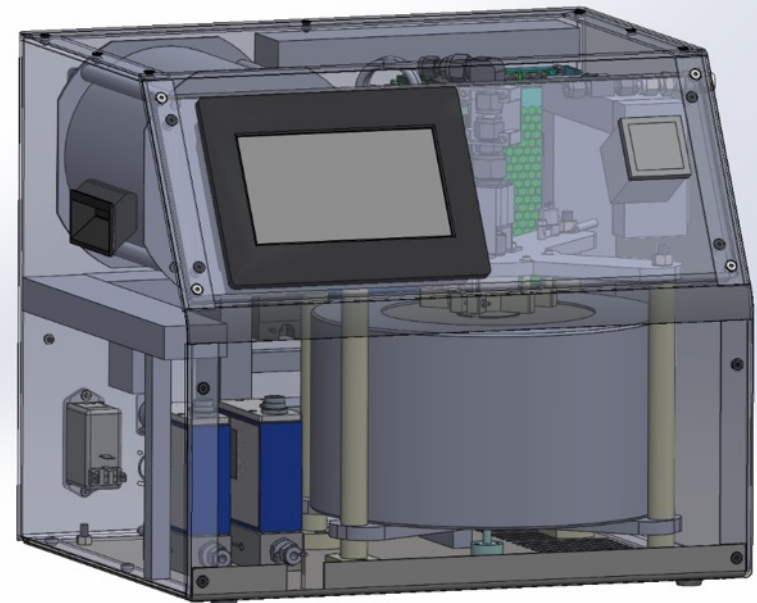


Silver Particle Generator

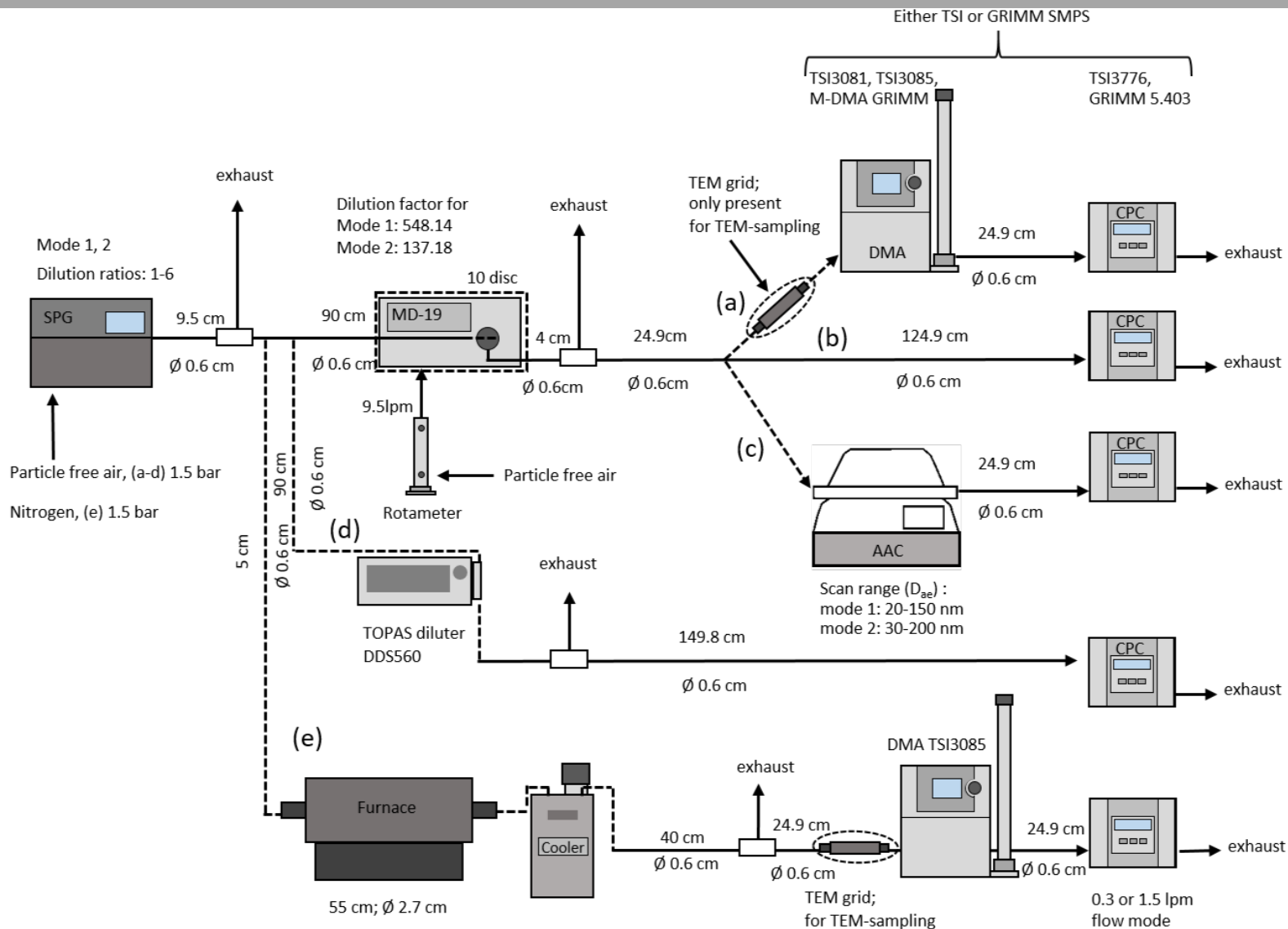
SIZE RANGE < 10 nm ≥ 10 nm	TEMPERATURE GENERATOR 140 °C
FLOW MAIN 0.00 LPM DILUTION 0.00 LPM RATIO 1.00 —	CONTROL GENERATE STANDBY COOLDOWN
STATUS DEVICE OK CHOOSE SETPOINT OK TO SHUT OFF	

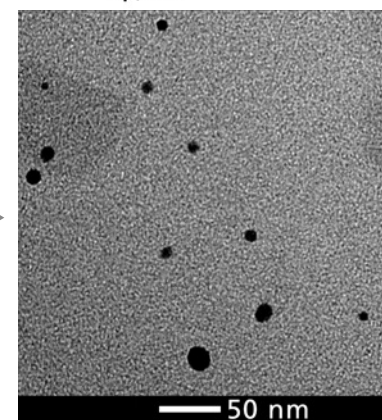
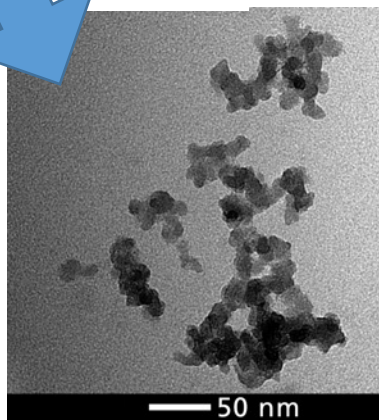
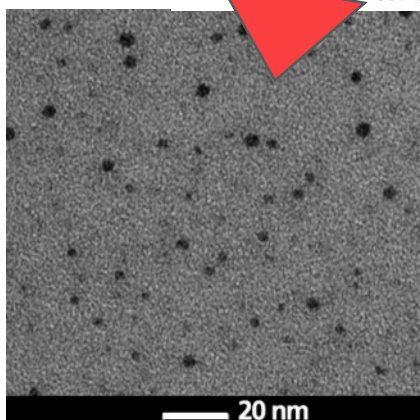
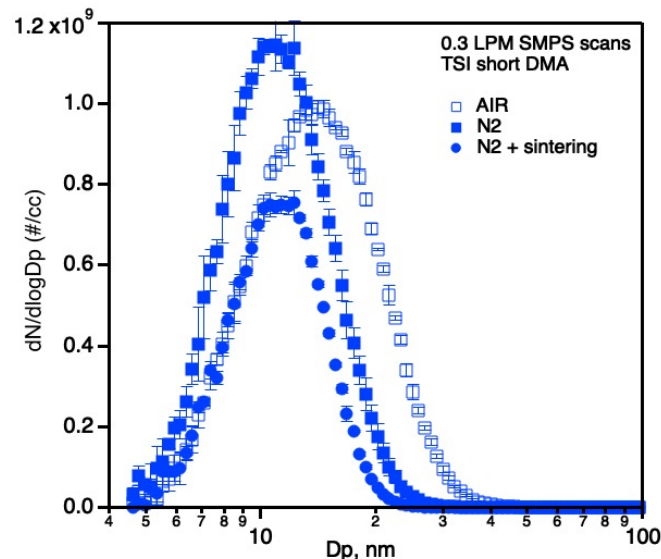
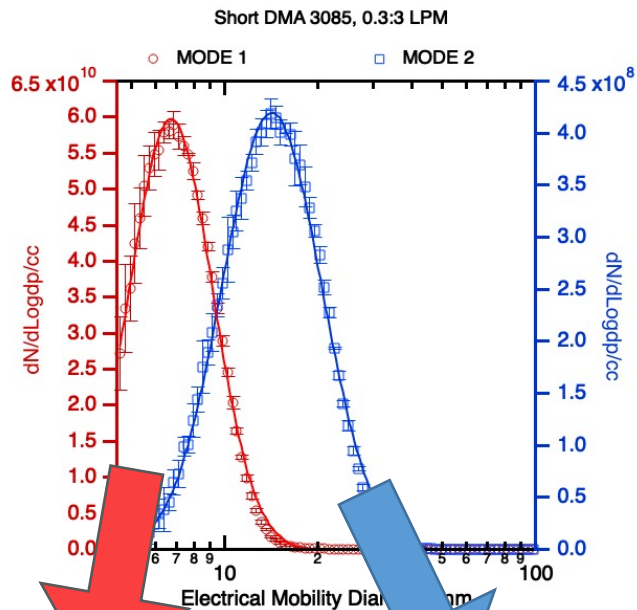
Catalytic Instruments
hot technologies • clean solutions

18:17:26



FULL SETUP

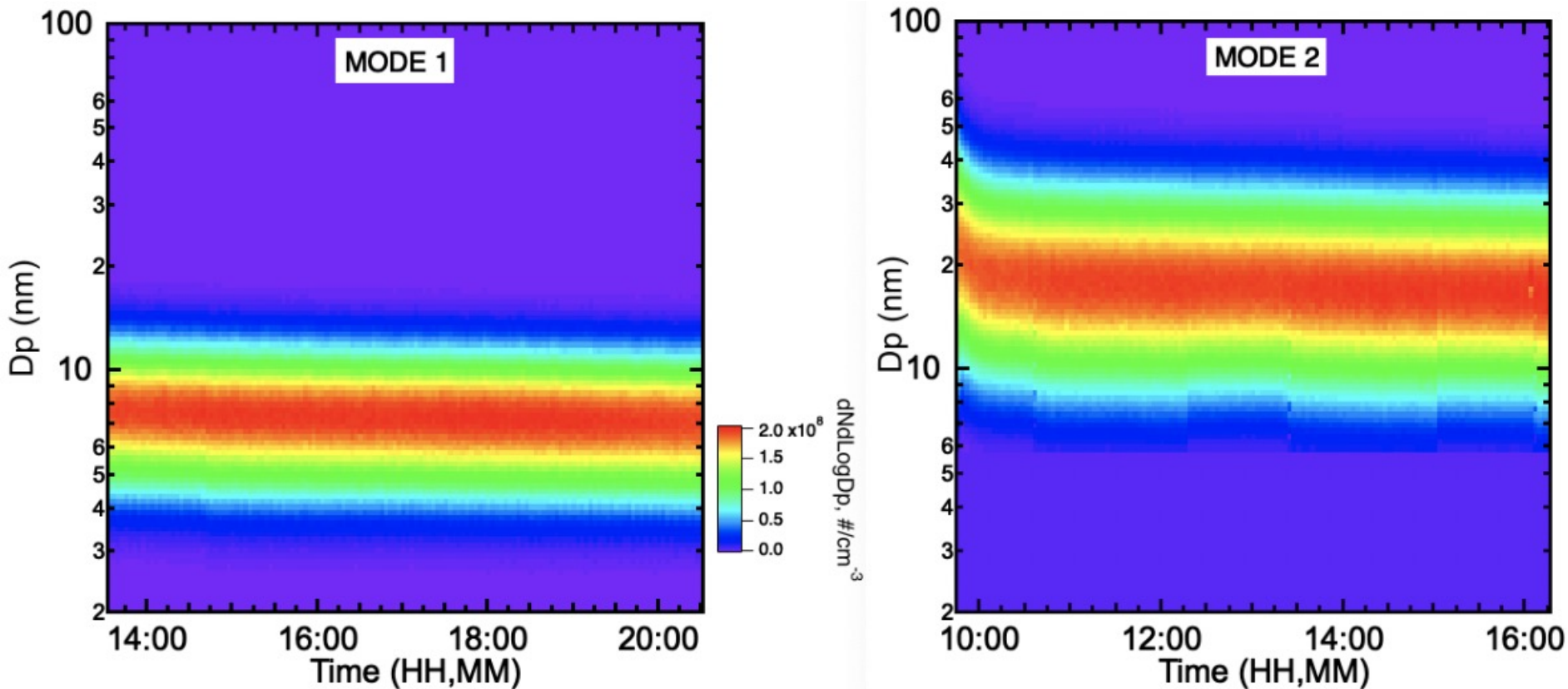




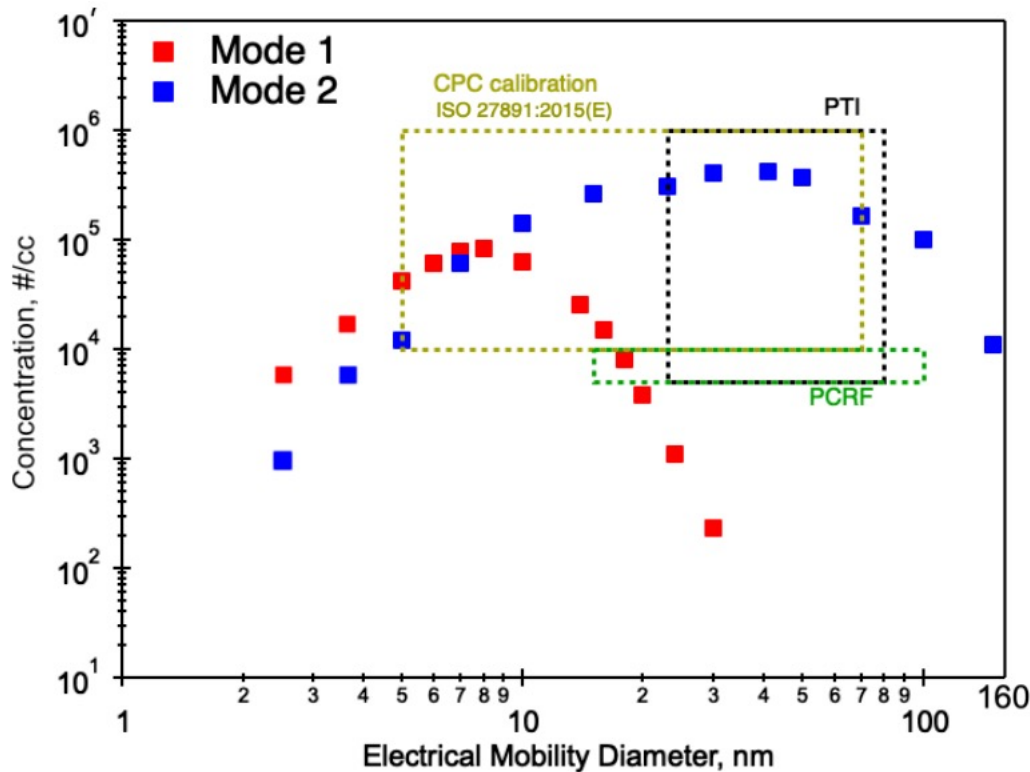
Example TEM image of silver from MODE1

Example TEM image of silver from MODE2

Example TEM image of *sintered* silver from MODE2

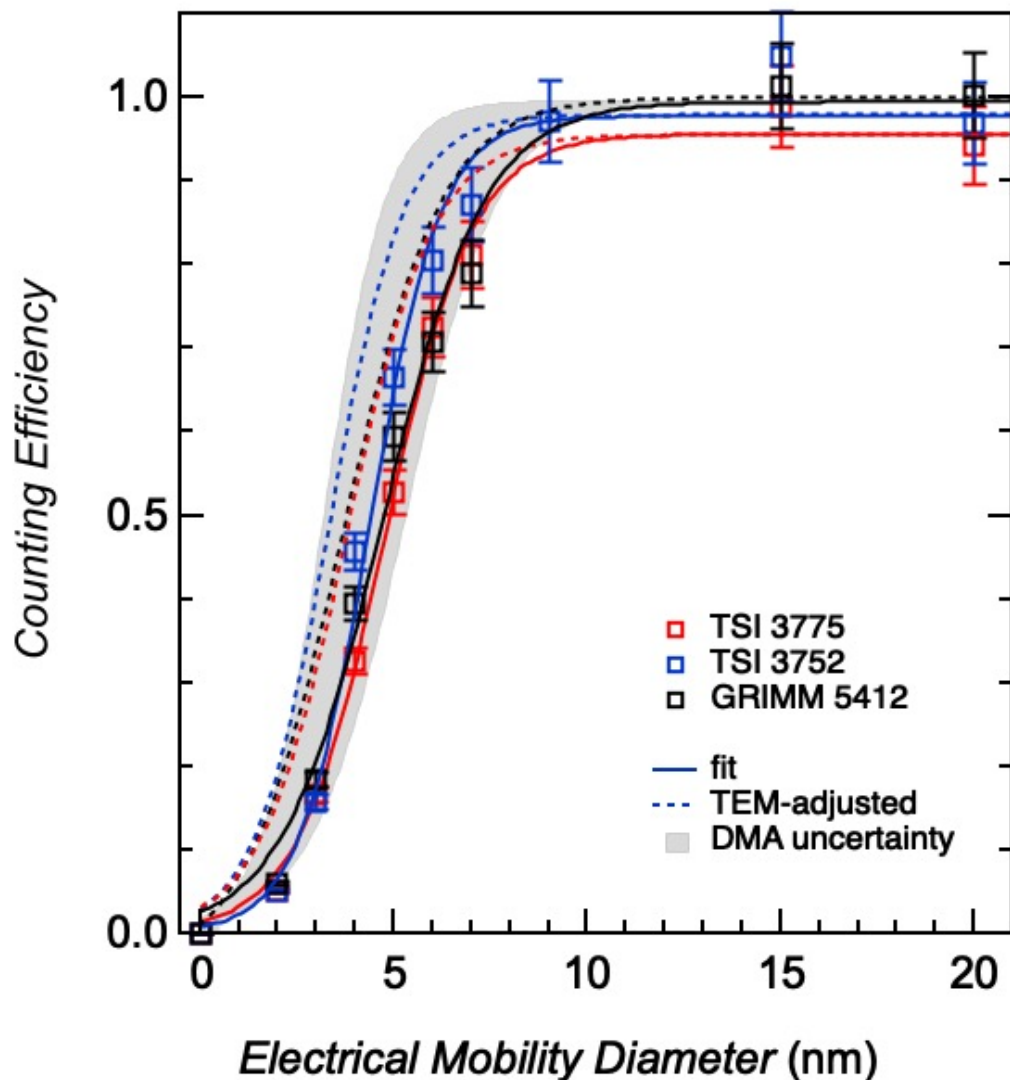


- GSD range 1.1 – 1.42
- c.a. 15 minute warm up stabilization period
- Very little deviation throughout a day's aerosol generation (± 1 nm GMD;)



- Two modes cover a large size range
 - DMA flows adjusted to maximise concentration
- High concentrations sufficient for:
 - ISO 27891:2015(E)
 - PCRF compliance testing
 - PTI
 - Line loss experiments...
- Simultaneous multiple-device calibrations are possible
 - (up to 15 LPM)

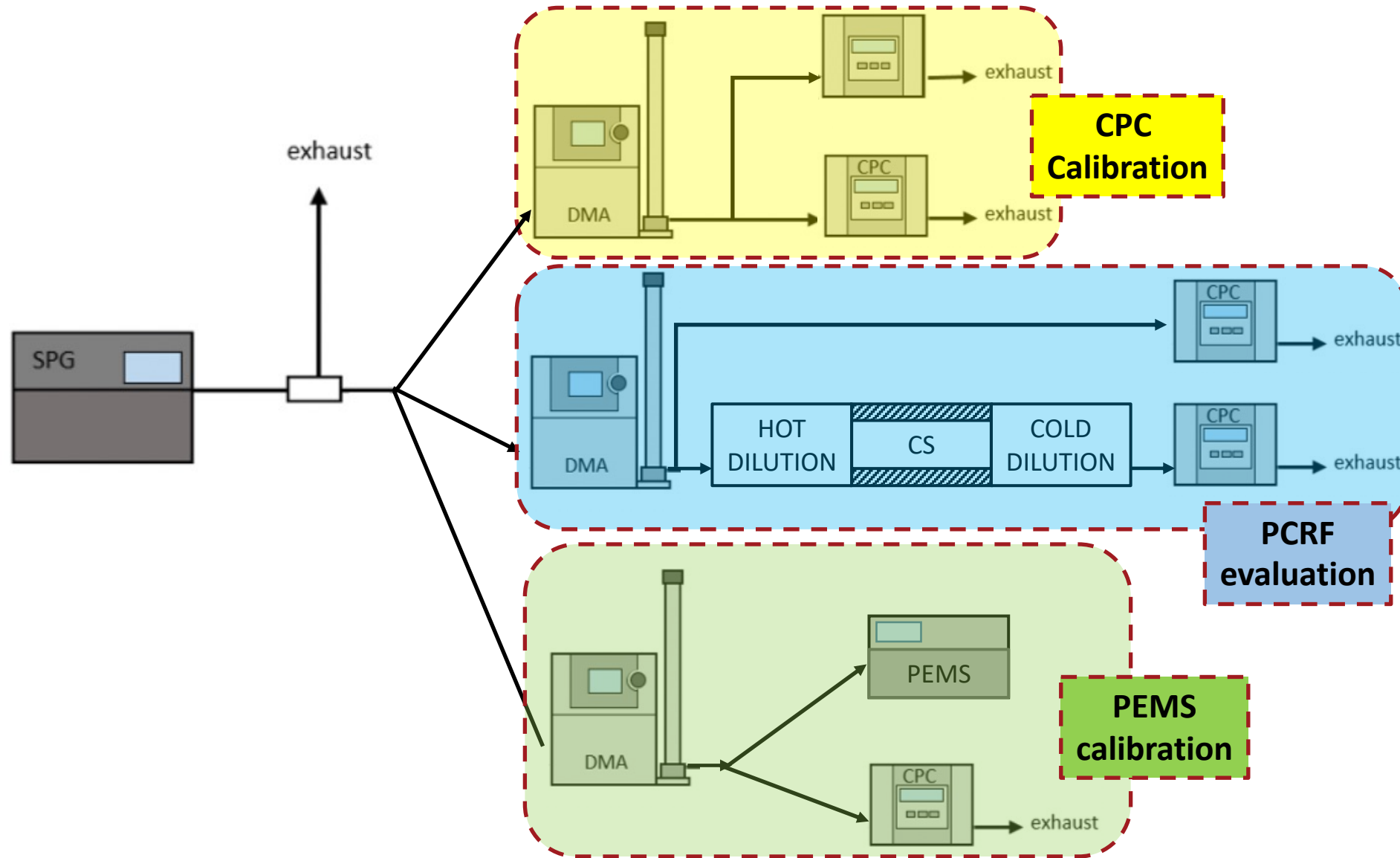
CPC CALIBRATION



- SPG set to Mode 1
- Primary dilution 5 LPM
- All CPCs nominal 4 nm D_{50}
- TEM-adjusted curves (dashed lines)
- Shaded grey area shows DMA uncertainty (up to 20% at small diameters*)

CPC	D_{50} (nm)	TEM-adj (nm)
3775	4.65	3.78
3752	4.24	3.34
5412	4.14	3.73

PMP EXAMPLE USE



SILVER PARTICLE GENERATOR

SPG



- Stable aerosol
- High concentration
- Spherical & aggregate
- “soot like”
- < 15 min warm-up
- Quick mode change
- Built-in dilution
- Multi-instrument calibration source

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PROTOTYPE EVALUATION

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as part of
METROPEMS

<https://www.metropems.ptb.de/home/>

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