Draft for the Particle Number Measurement Procedure for Regulation Purpose

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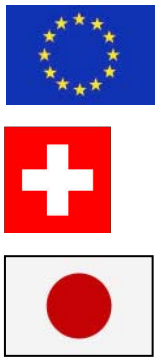
Political background



PMP: Collaborative programme operating under the auspices of the UNECE WP29/GRPE Group
Development of a new number and mass measurement method for type approval

Switzerland
Preparation of a new particle number limit value for diesel cars
Possible measures:

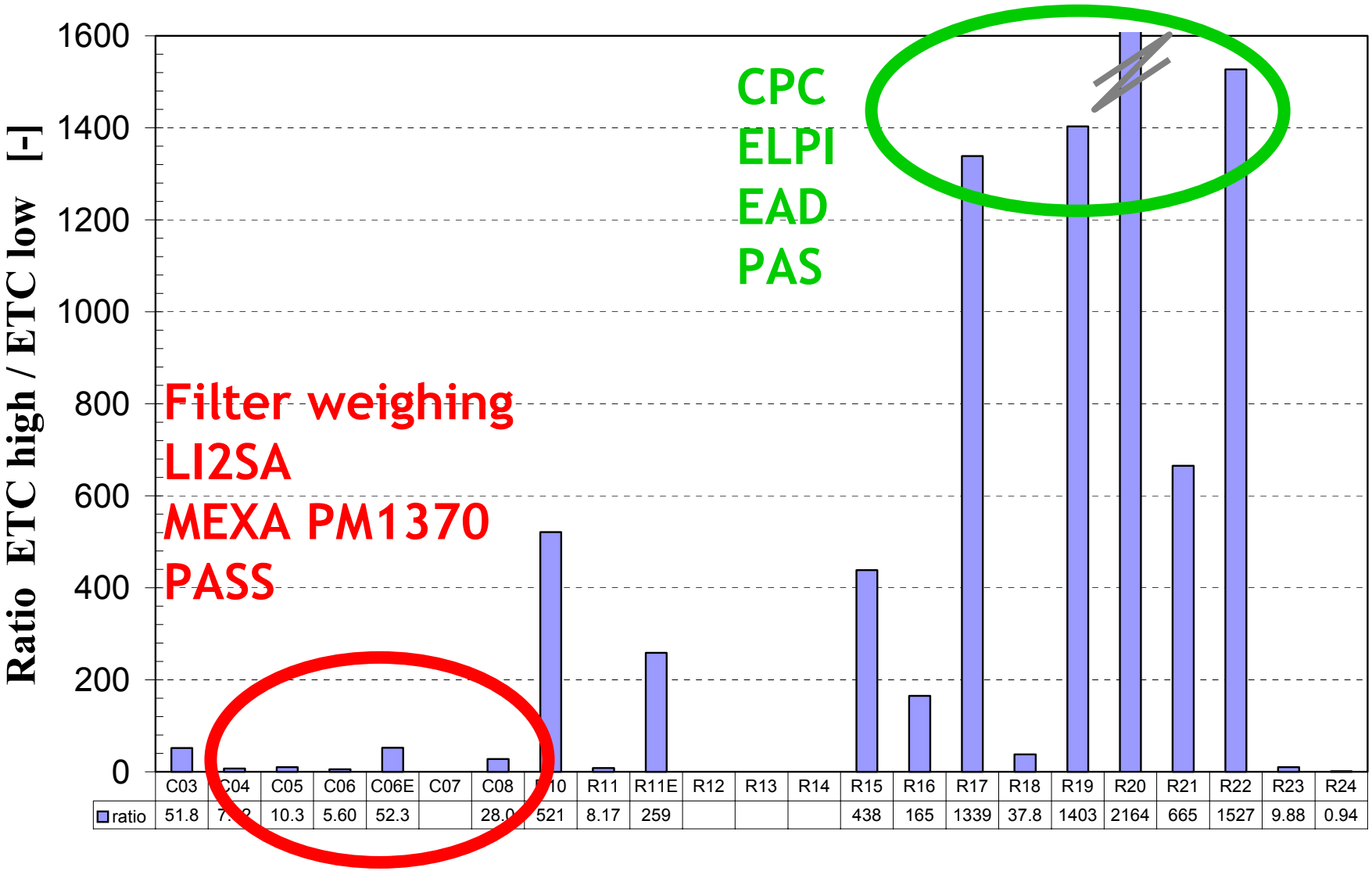
- Import duty compensation scheme
- Obligation for all new diesel cars new diesel cars

Why solid number counting ?

- Lower detection limit / Higher sensitivity
- Clearer specification of the measured particle composition
- Large experience in instrumentation and measurement
- Suspect that also other metrics than mass relate to adverse health impact

Sensitivity

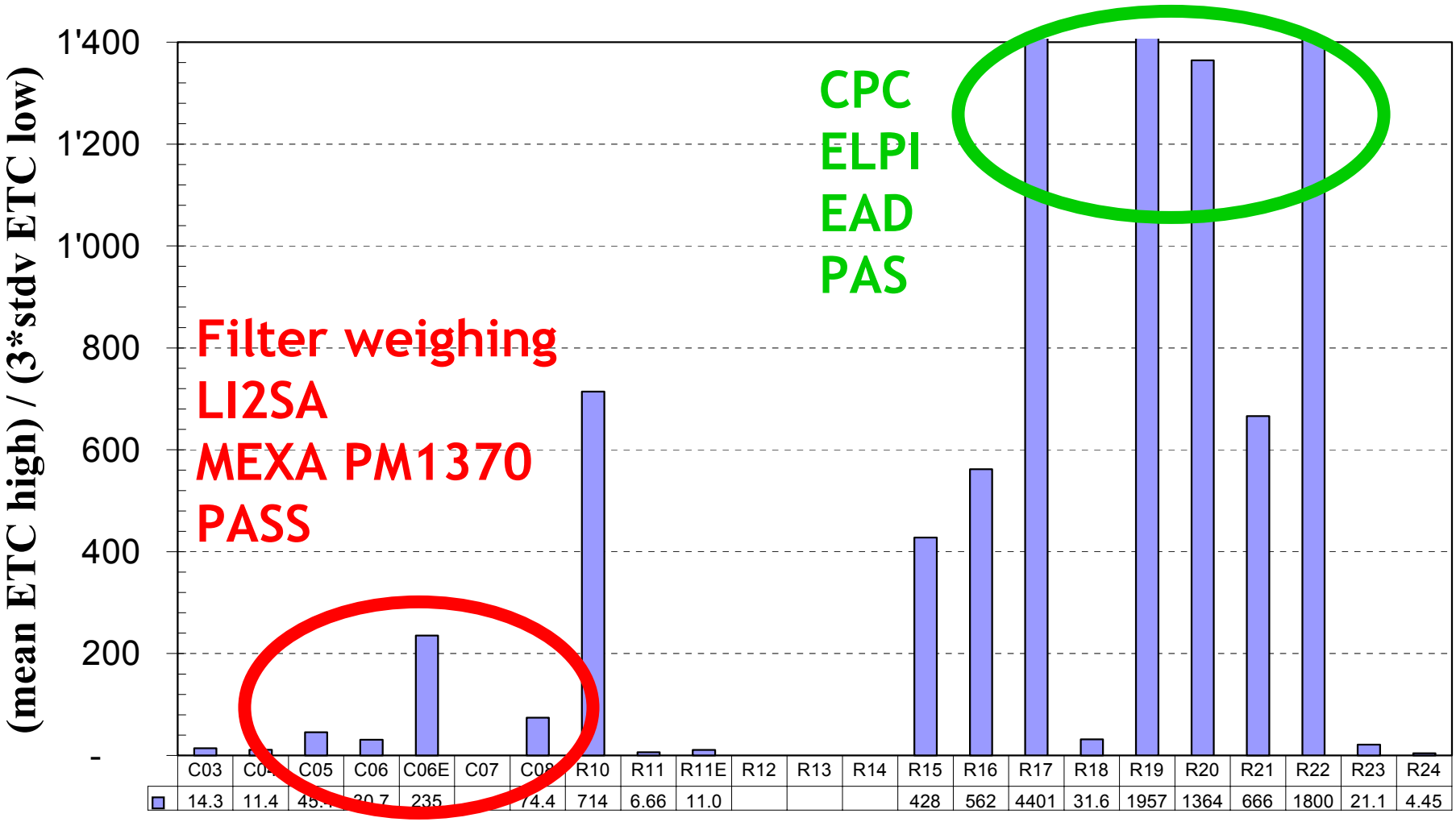
Ratio high to low emission level



Source: Comparison study of measurement systems (EMPA report, 2003)

Detection limit

Limit of detection = 3 * stdev (ETC low)



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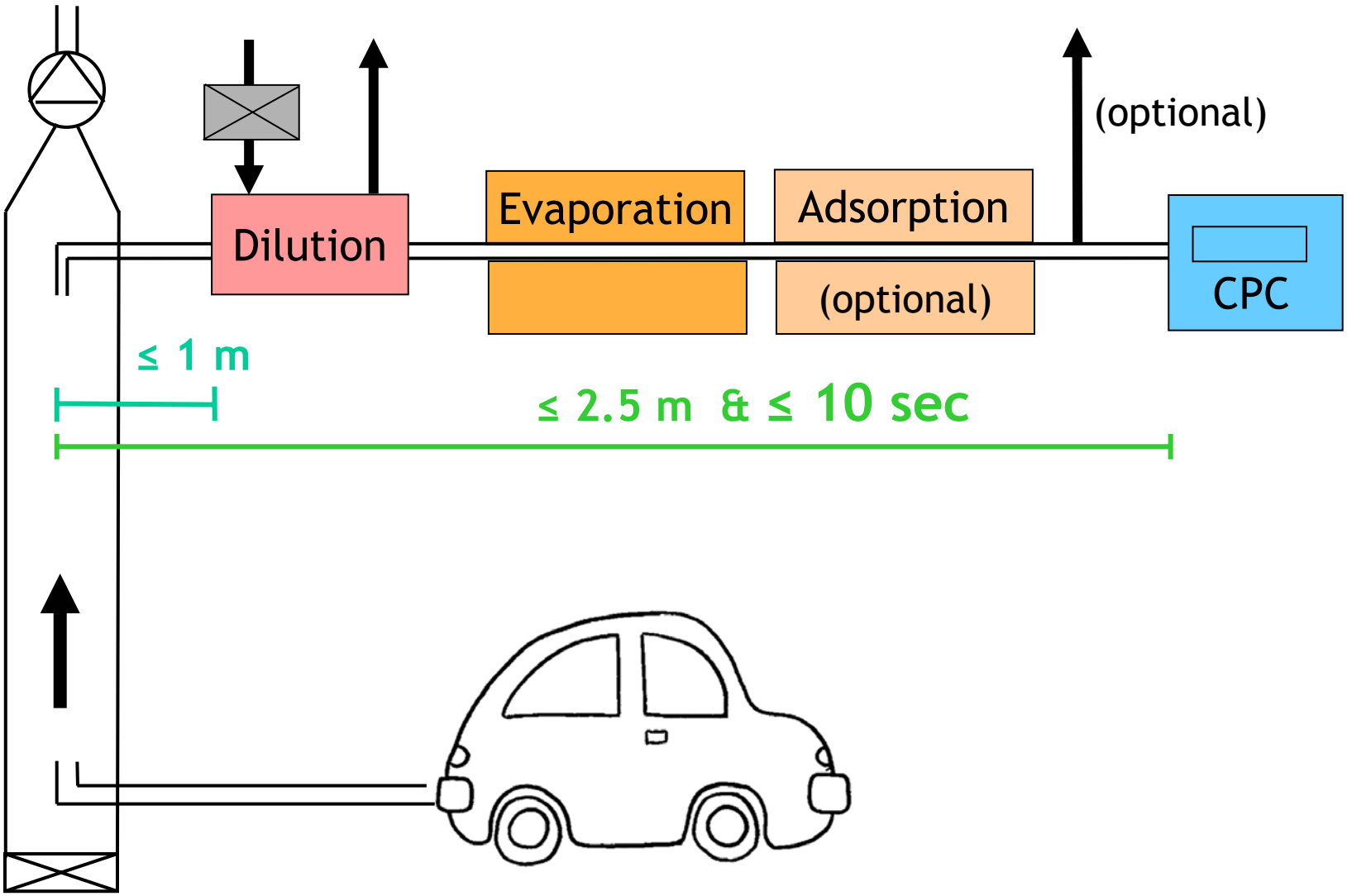
Schematic of experimental set-up

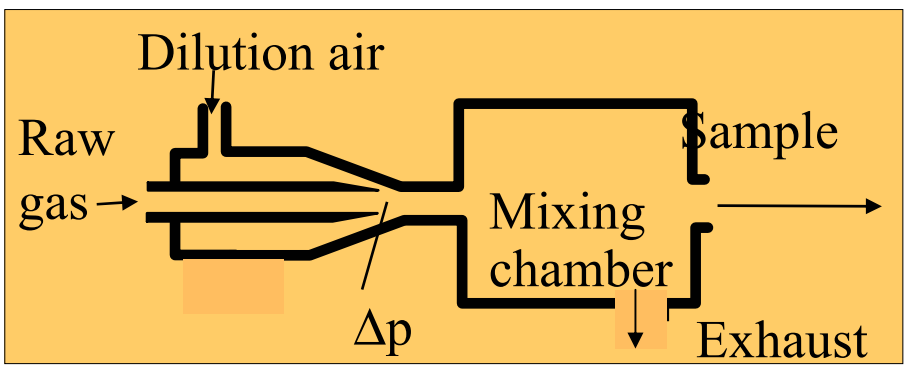


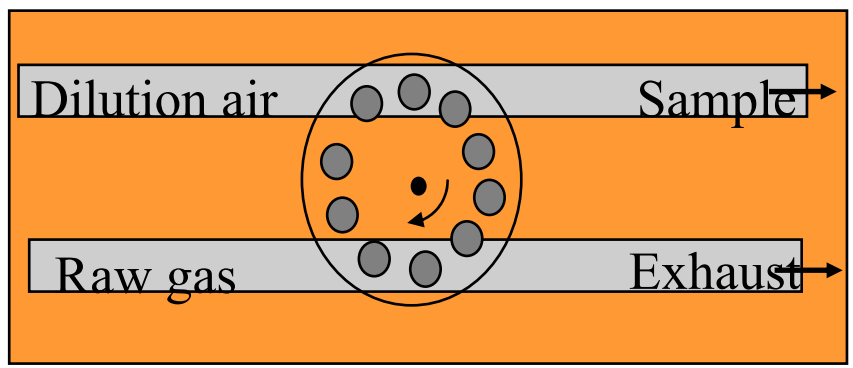
Specification of Probe

- Out of CVS-tunnel
- At the same level as samples for measuring the particle mass
- Tube with an unobstructed aperture facing the flow
- No pre-classifier

Specification of Dilution System

- Dilution with particle-filtered dry air (HEPA filter, RH < 10%)
- Dilution factor between 1 and 1000
- Dilution factor constant within 10%
- Calibration with traceable calibration gas



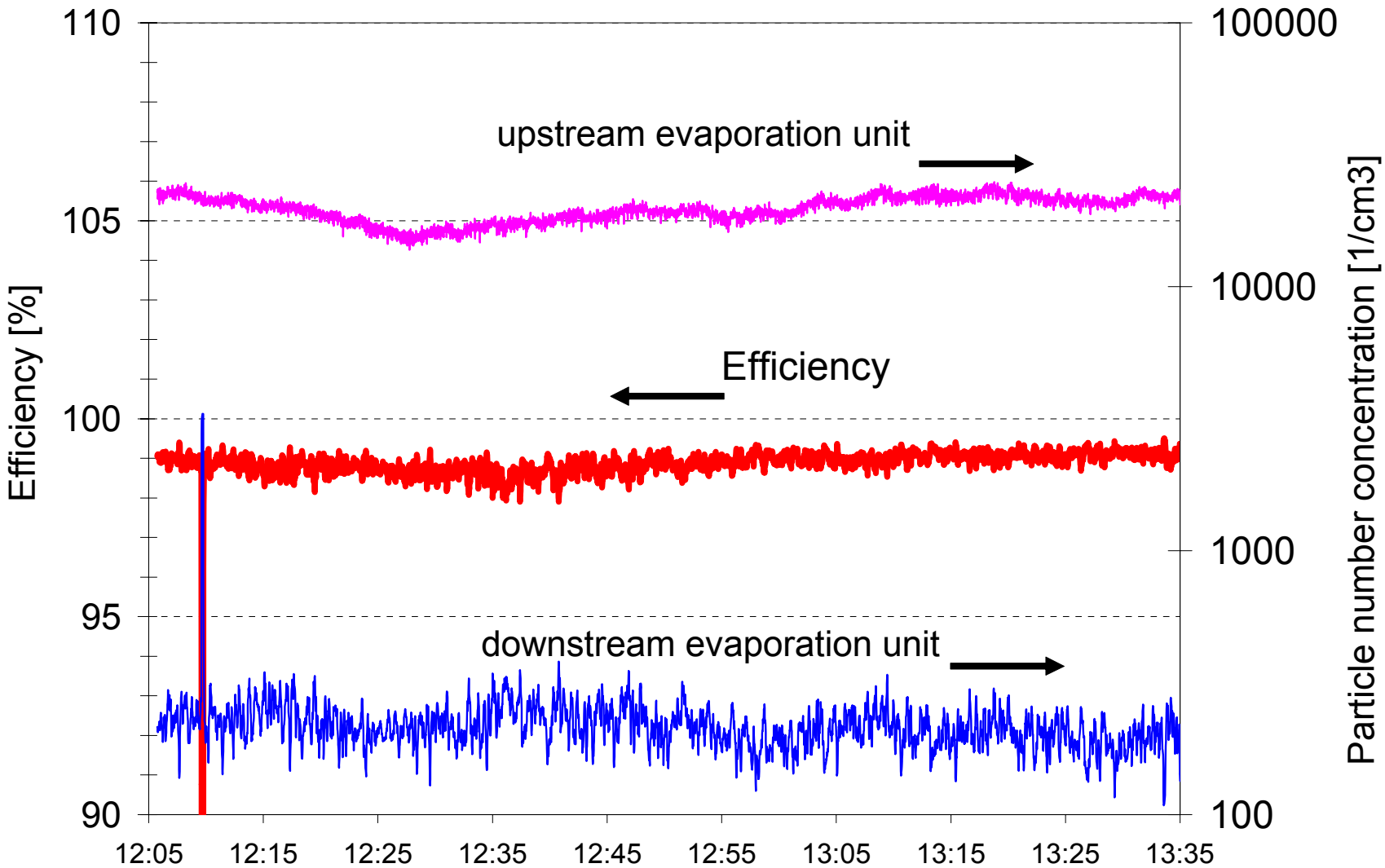


Specification of Evaporation Unit

- Reduction of C_{40} particles (dp ≥ 30 nm, N ≥ 1000 cm^3)
  $\eta \geq 99\%$
- Penetration of solid particles (dp = 30, 50 and 100 nm)
  $\varepsilon \geq 90\%$
- Calculated residence time ≥ 0.5 sec
- Option: adsorption unit
- Length of at least 350 mm and an unobstructed inside diameter of at least 6 mm
- Operation temperature between 200 °C and 450 °C

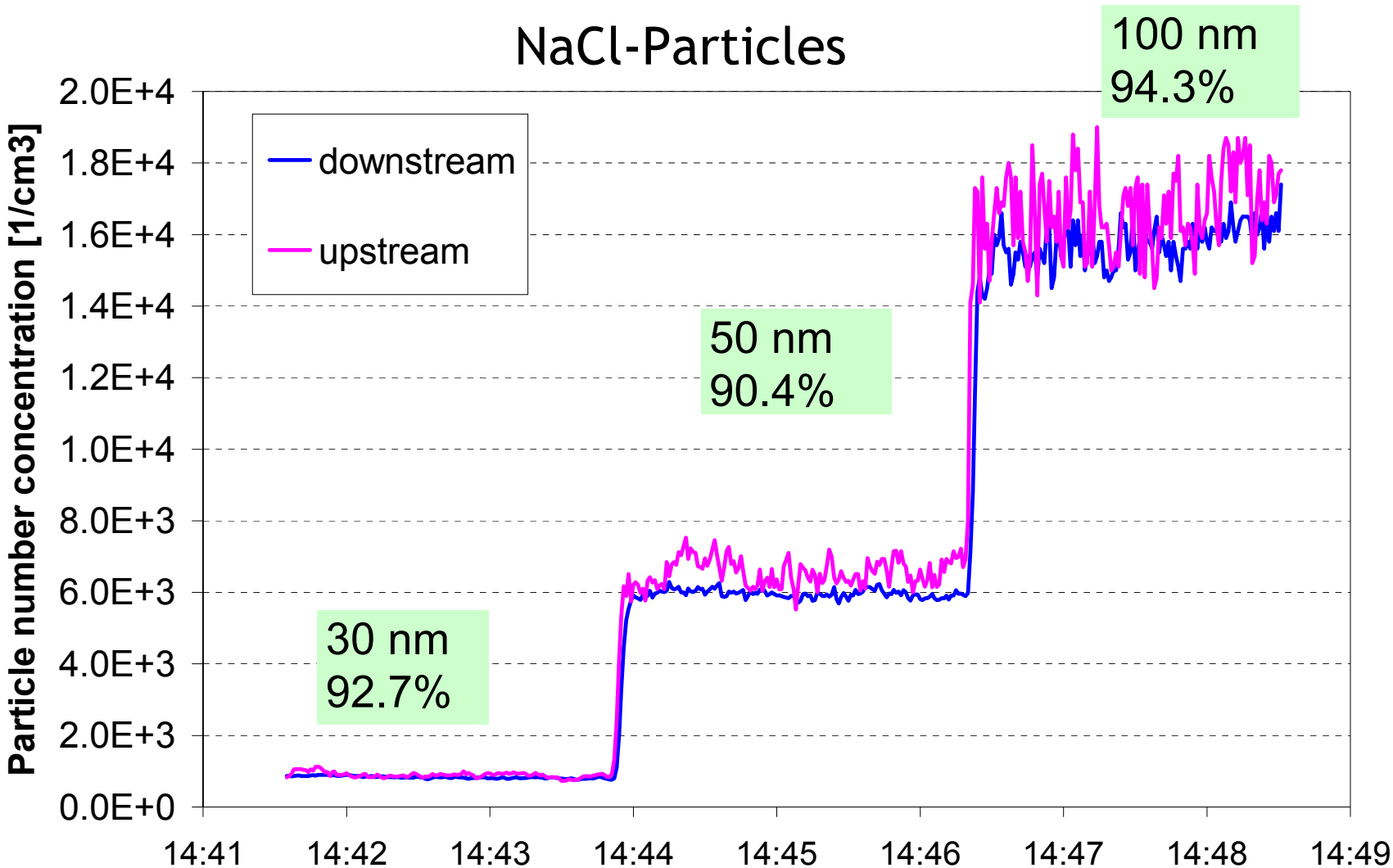
Specification of evaporation unit

Efficiency to remove C_{40}-particles of 30 nm



Specification of evaporation unit

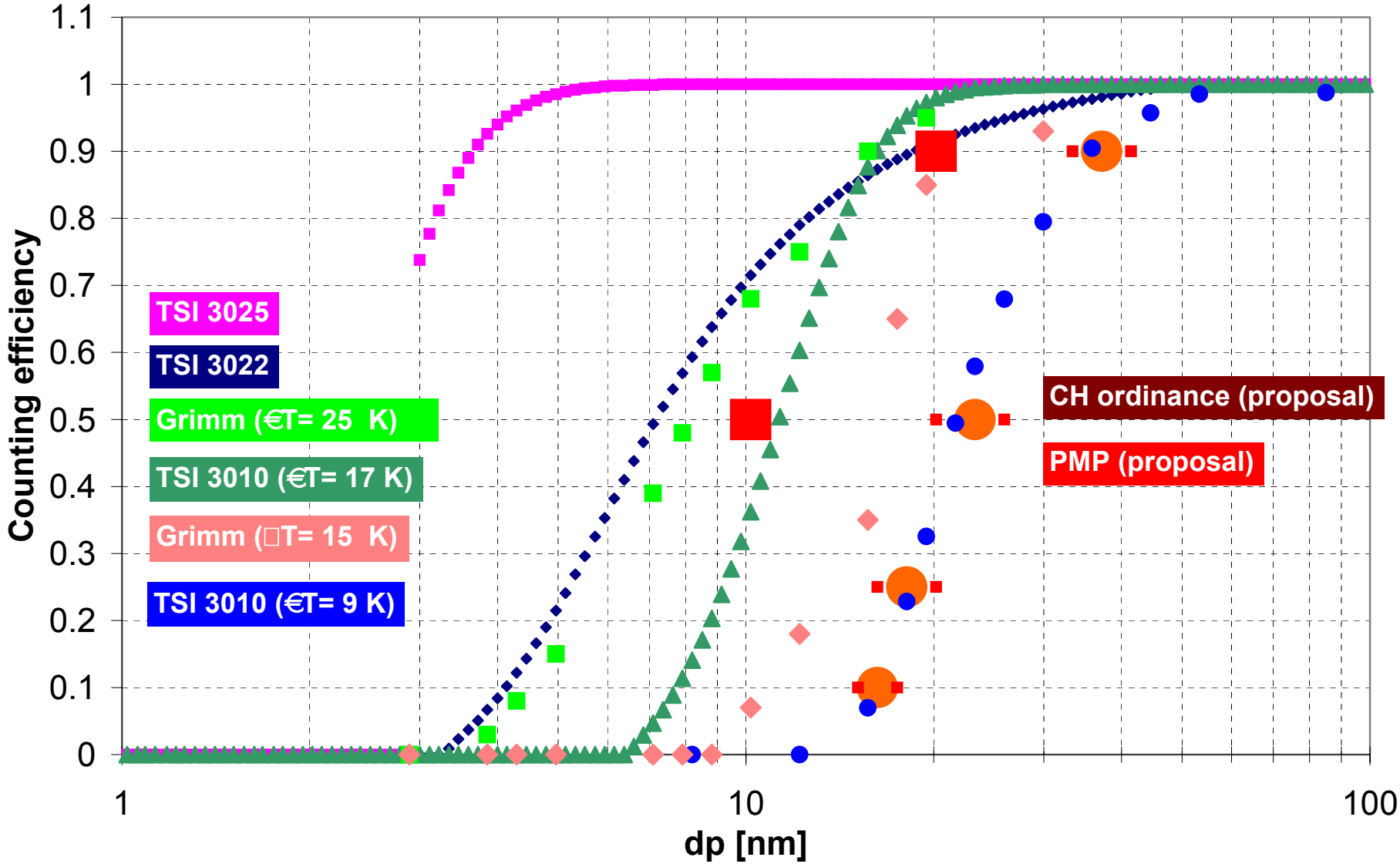
Penetration of non-volatile particles



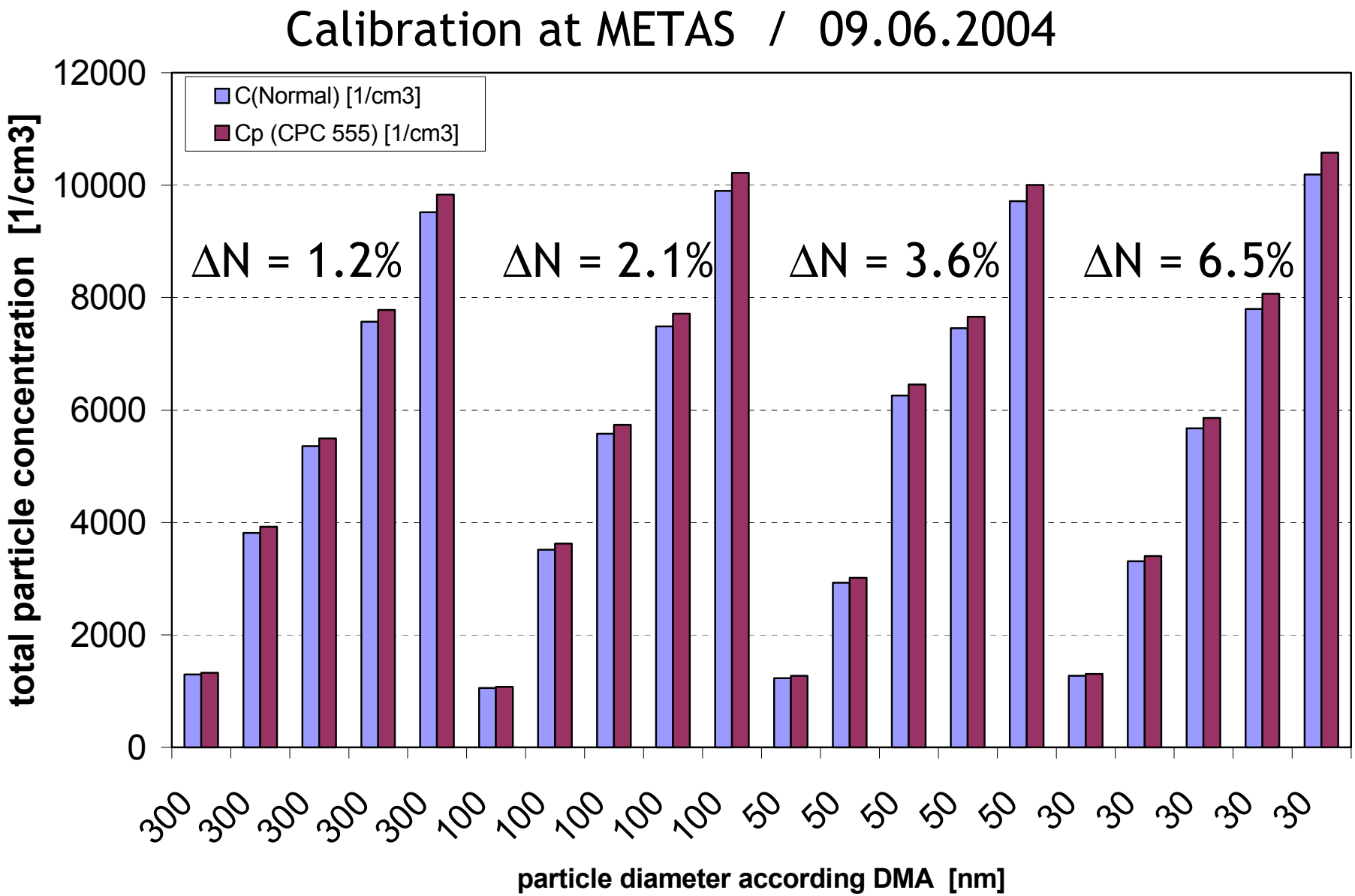
Specification of Particle Counter

- Condensation particle counter (CPC) (VDI 3489)
- Counting efficiency
  $\varepsilon \geq 50\%$ for particles dp ≥ 10 nm or greater,
  $\varepsilon \geq 90\%$ for particles 20 nm ≤ dp ≤ 500 nm
- Measurement range: 0.1 to 10^4 particles/cm^3
- Single particle counting
- Measuring frequency ≥ 0.5 Hz
- Response time t_{10} up to t_{90}: < 15 sec
- The CPC must be traceable to a national standard

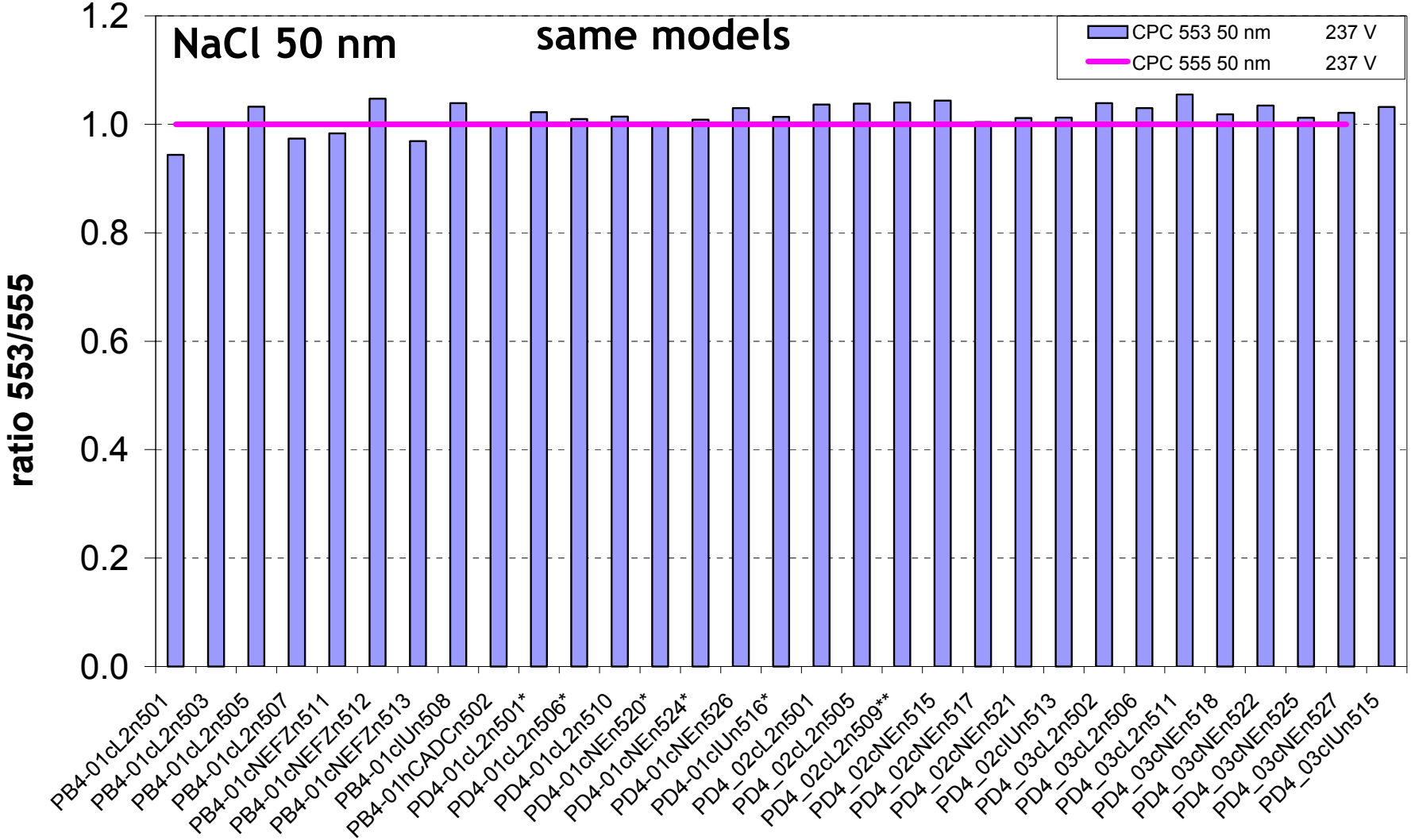
Counting efficiency CPCs



Calibration



Daily check of particle counter
Comparison to another CPC



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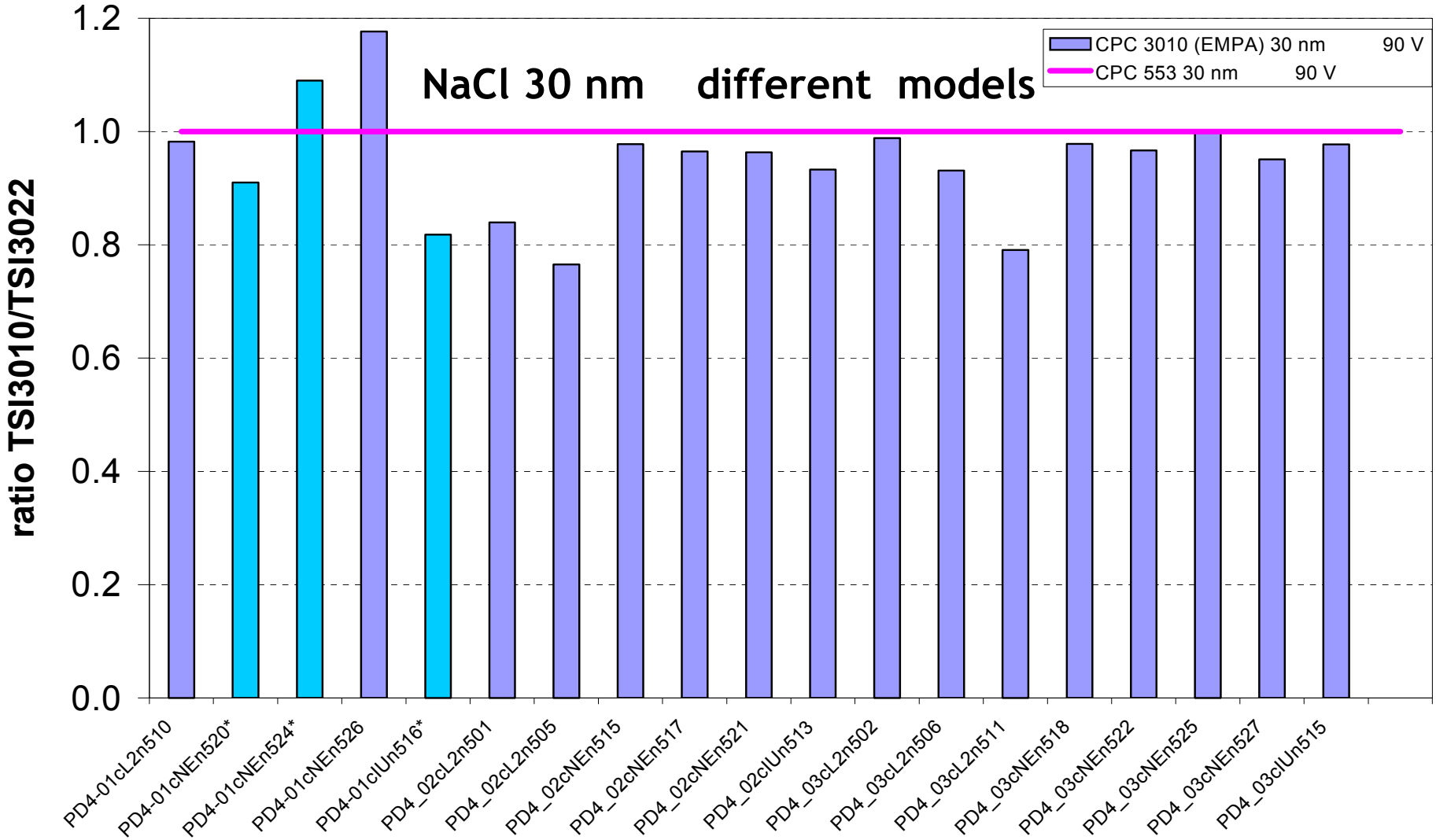

First preliminary conclusions

- No problems in robustness of the measurement set-up was identified for test cell environment
- Specification of evaporation tube is very strict but achievable
- CPCs show good long-term stability

Acknowledgements

Christian Bach, EMPA
Heinz Berger, ASTRA
Heinz Burtscher, FH Aargau
Jan Czerwinski, HTI Biel
Manon Delisle, BUWAL
Anna-Maria Forss, EMPA
Markus Kasper, Matter Engineering Company
Urs Lehmann, EMPA
Andreas Mayer, TTM
Kurt Meyer, ASTRA
Felix Reutimenn, BUWAL
Jürg Schlatter, METAS