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Application of CAST for comparison of instruments

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Introduction

The Combustion aerosol STandard (CAST) [1)] is a generator for combustion aerosols with adjustable particle size and particle concentration. During the international Particle Measurement Programme (PMP) established by GRPE [2)] the CAST provided standard aerosol [3)] for the comparison of various particle measurement instruments. Before and after the PMP campaign the CAST was calibrated in the laboratory of METAS at defined ambient and operation conditions. This calibration was performed with a Scanning Mobility Particle Sizer (SMPS) system and a separate Condensation Particle Counter (CPC). The relevant components of these instruments were calibrated and traceable to SI (flows, temperature, particle sizing).

Measurements

The PMP comparison required the measurement of two particle sizes and four different concentration levels as emitted from modern combustion engines. A set-up with the CAST (Figure 1) provided both: For 140 nm equivalent mobility diameter in the particle concentration range 6000 cm^{-3} to 50 000 cm^{-3} and for 35 nm from10^4 cm^{-3} to 10^5 cm^{-3}). The particle concentration can be varied by changing the rotation frequency at the diluter (Figure 2). The particle size can be selected by the appropriate setting of the gas flows (Figure 3 and Figure 4). Further essential equipment to run the CAST are: compressed air (particle free, dry with a dew point below 4 °C, stable oxygen content ± 0.1 cL/L (%), pure nitrogen, and pure propane.

During the measurement program the CAST was stabilized for each particle size during 20 minutes. Starting at lowest concentration, each concentration was kept constant for at least 10 minutes. During these periods the concentration from the CAST - measured with a CPC - were stable within 4 % (standard deviation for the fluctuations and slope for the drift, Figure 5 and Figure 6).

Conclusions

The results of the comparison shows, that the CAST is already suited for the calibration of particle measurement instruments. The influence of the ambient air temperature and pressure are not yet quantified.Further investigations are necessary in order to improve long term stability of the concentration and to know further influence parameters.

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1) Lianpemg Jing (1999) Standard Combustion Aerosol Generator for Calibration Purposes, , 3th ETH Conference on Nanoparticle-Measurement

2) Martin Mohr (2002) Comparison study of PMP instrument candidates at EMPA, 6th ETH Conference on Nanoparticle-Measurement.

3) Jürg Schlatter (2001) Legal Aspects of Particle Measurements, 5th ETH Conference on Nanoparticle-Measurement.

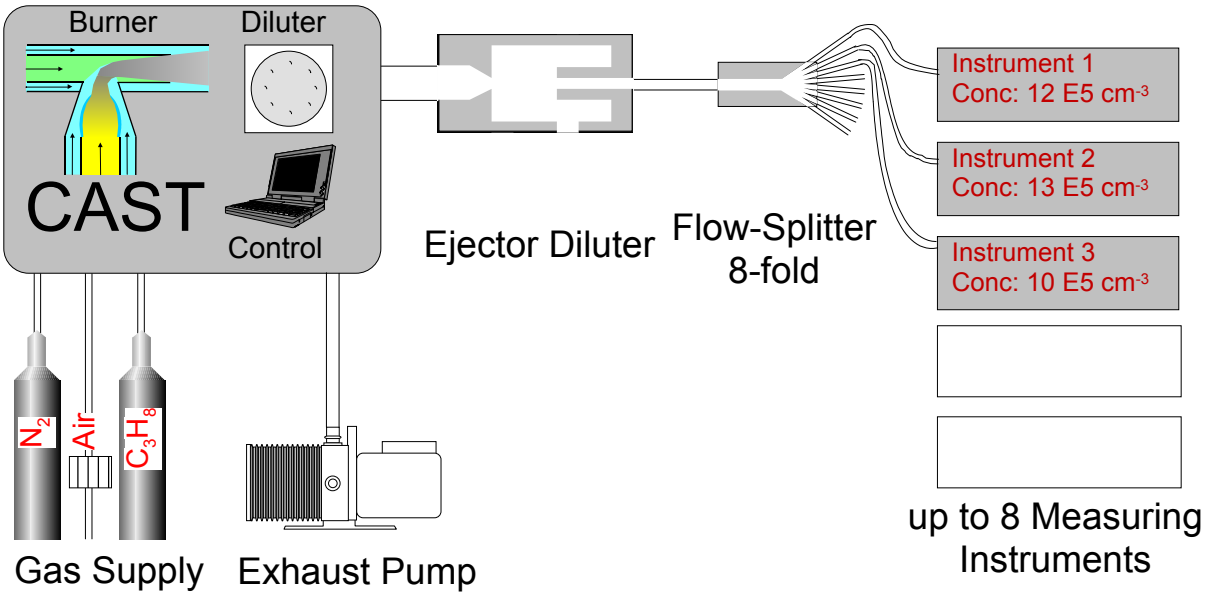

Figure 1: CAST set-up for the PMP campaign. Nitrogen: 50 L gas cylinder, quality 50. Propane: 1 L gas cylinder, quality 35. Pressurised air: particle-free, dry?, oxygen content?. Control with LabView-Application, CAST-internal dilution: adjustable, flow up to 4 L/min. External ejector dilution: 100-fold, increase of aerosol flow to 30 L/min. 8-fold flow splitter: serve up to 8 measuring instruments.

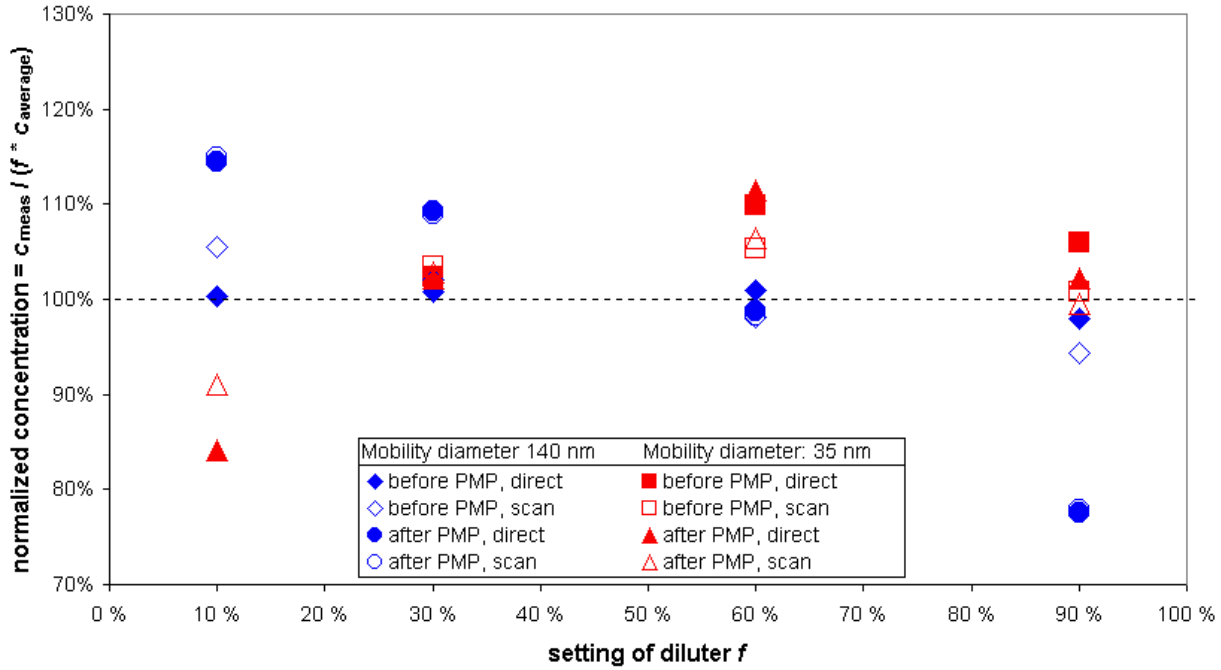

Figure 2: Normalised particle concentration as a function of the dilution setting. The concentrations depend linearly on the selected frequency of the diluter (setting 0 % to 100 %). Measurement for two particle sizes (blue = 140 nm equivalent mobility, red = 35 nm). The filled points correspond to direct CPC measurements and the empty points to SMPS calculations. The measurement was performed before and after the PMP campaign.

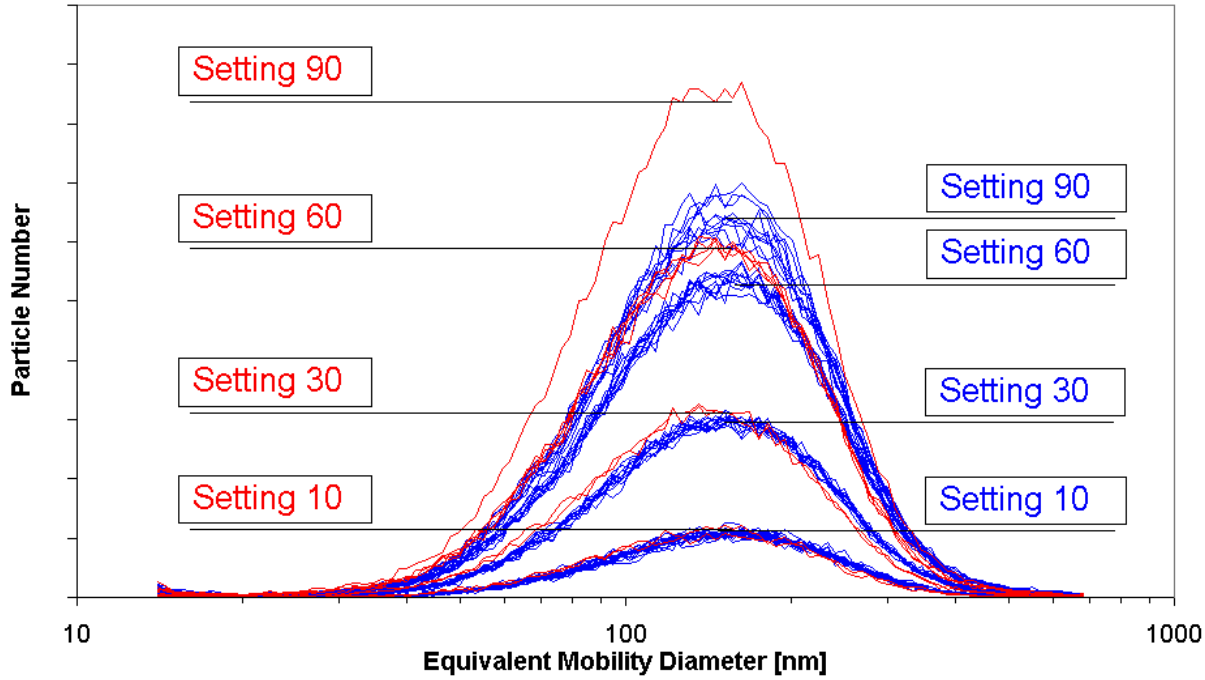

Figure 3: The size distributions for 140 nm particles and four different concentrations (diluter settings 10, 30, 60, 90). Measured before (red) and after (blue) the PMP campaign. Slight drift to larger sizes (ca. 5 nm) and to lower concentrations at high values (weak basis for quantification).

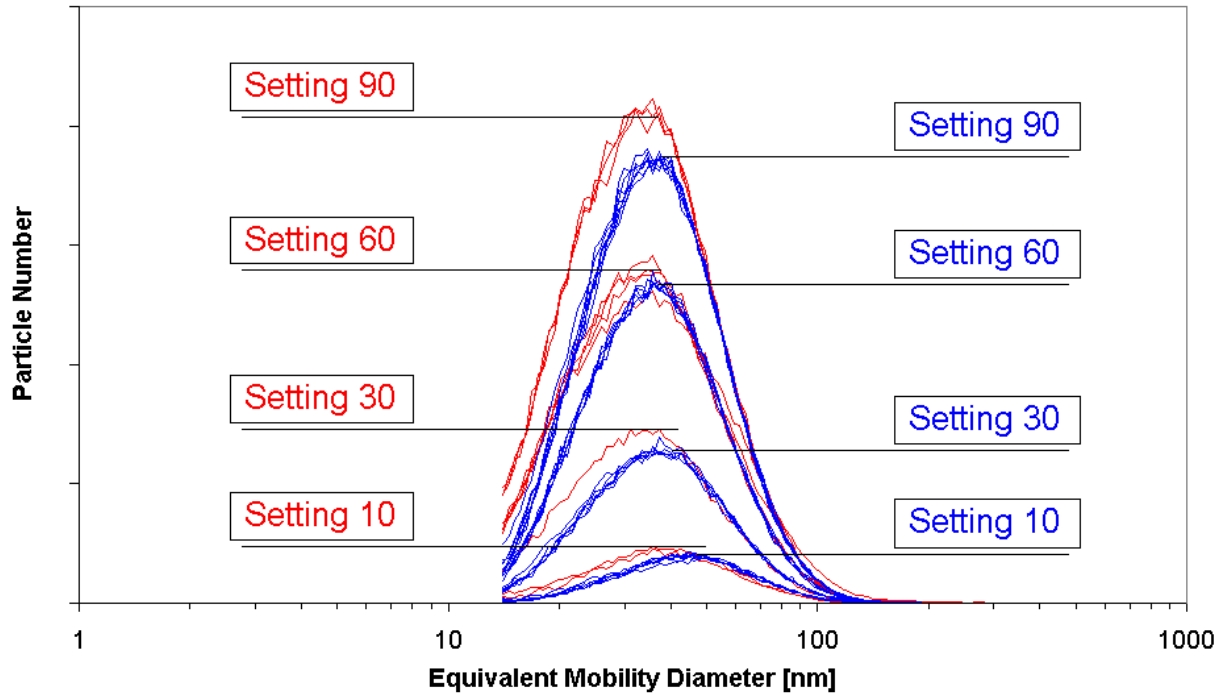

Figure 4: The size distributions for 35 nm particles and four different concentrations (diluter settings10, 30, 60, 90). Measured before (red) and after (blue) the PMP campaign. Slight drift to larger sizes (ca. 3 nm) and lower concentrations (ca. -10 %).

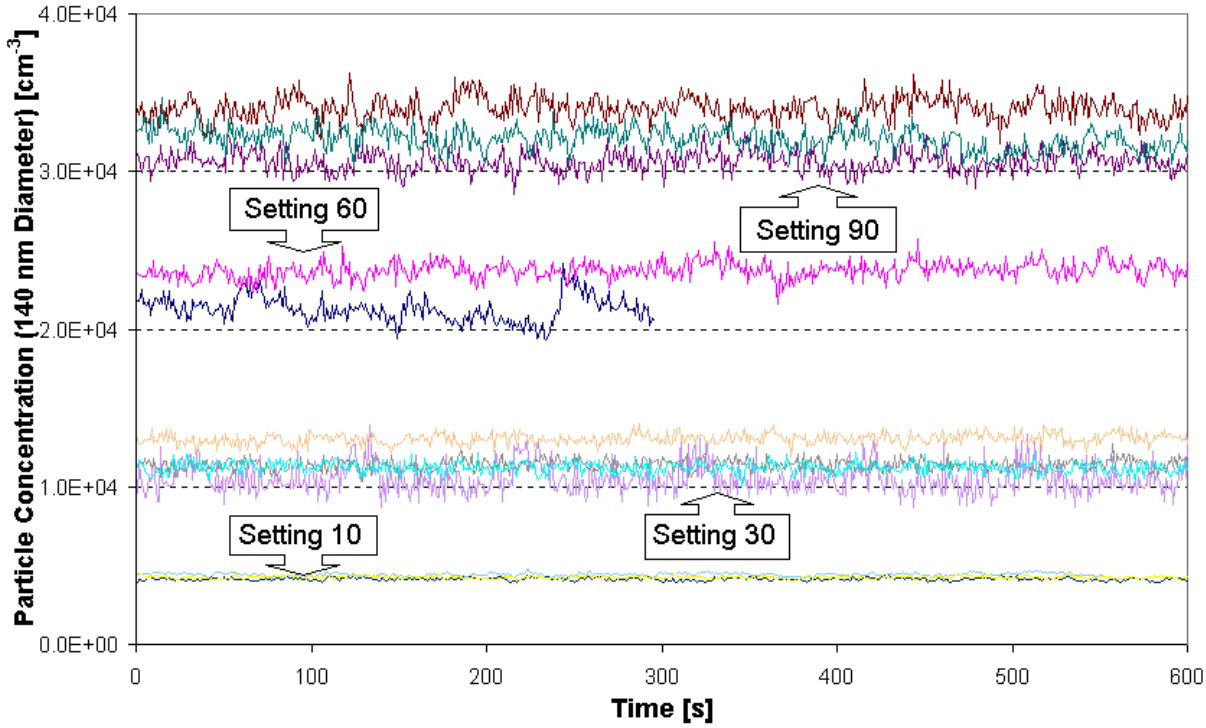

Figure 5: Selected time series at two particle concentrations with 140 nm mobility diameter. The fluctuations (standard deviation) and the drift (slope) are with a few exceptions lower than 4 % during the 10 minutes periods.

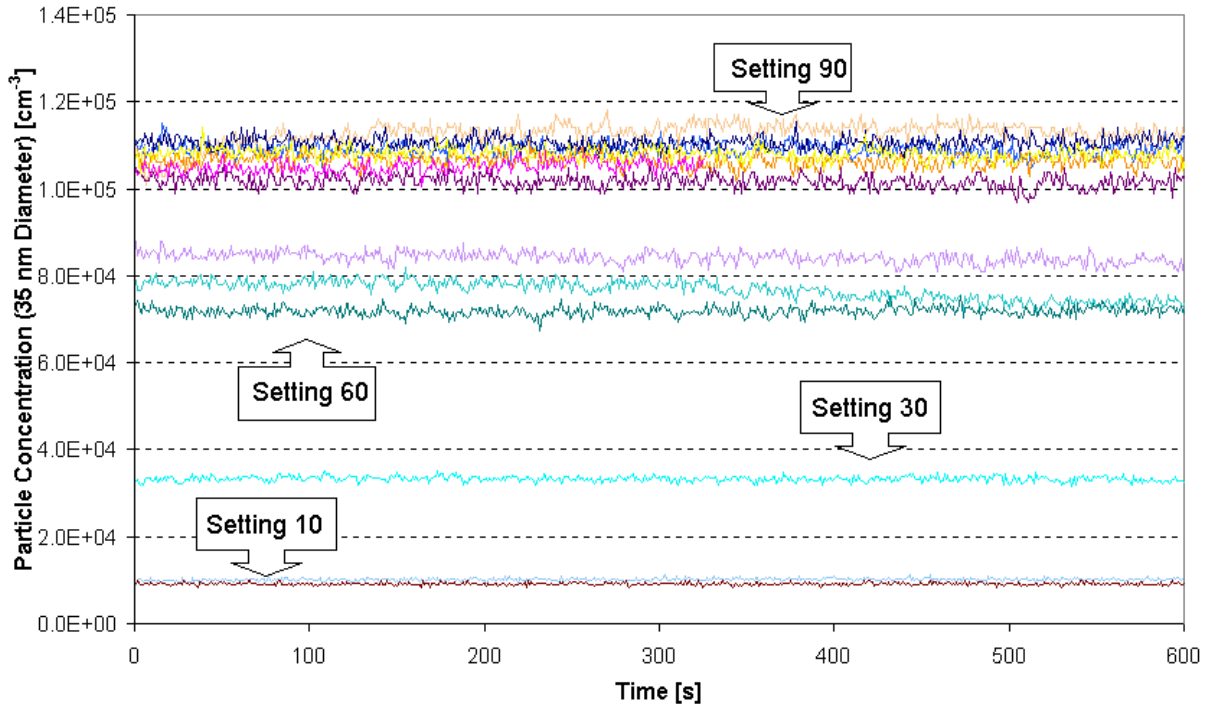

Figure 6: Selected time series at three particle concentrations with 35 nm mobility diameter. The fluctuations (standard deviation) and the drift (slope) are with a few exceptions below 4 % during the 10 minutes periods.

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