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Intercomparison of SMPS with CAST particles

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The Scanning Mobility Particle Sizer (SMPS) consisting of a Differential Mobility Analyser (DMA) and a Condensation Particle Counter (CPC) is a well established system for the measurement of exhaust particle size distributions. In March 2003 three SMPS's (TSI 3081) were compared with an aerosol from a *Combustion Aerosol STandard* (CAST) at METAS. The goal of the intercomparison was the quantification of the deviations, when the instruments were operated by the owner. The combustion aerosols had median mobility diameters between 30 nm and 190 nm and number concentrations between 10^3 cm^{-3} and $6 \cdot 10^5$ cm^{-3}.

The instruments were placed in a climatised laboratory at METAS. All instruments were supplied with the same aerosol at the same time (see figures 1 and 2). The measurements followed the scheme in Figure 2: The flame in the CAST was stabilised and four different concentrations with the identical particle size were produced without changing the flame.

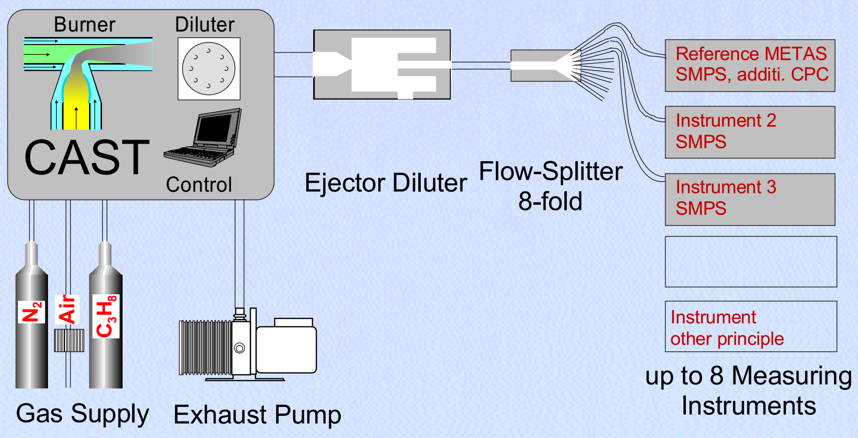

Figure 1: Typical CAST set-up for an intercomparison

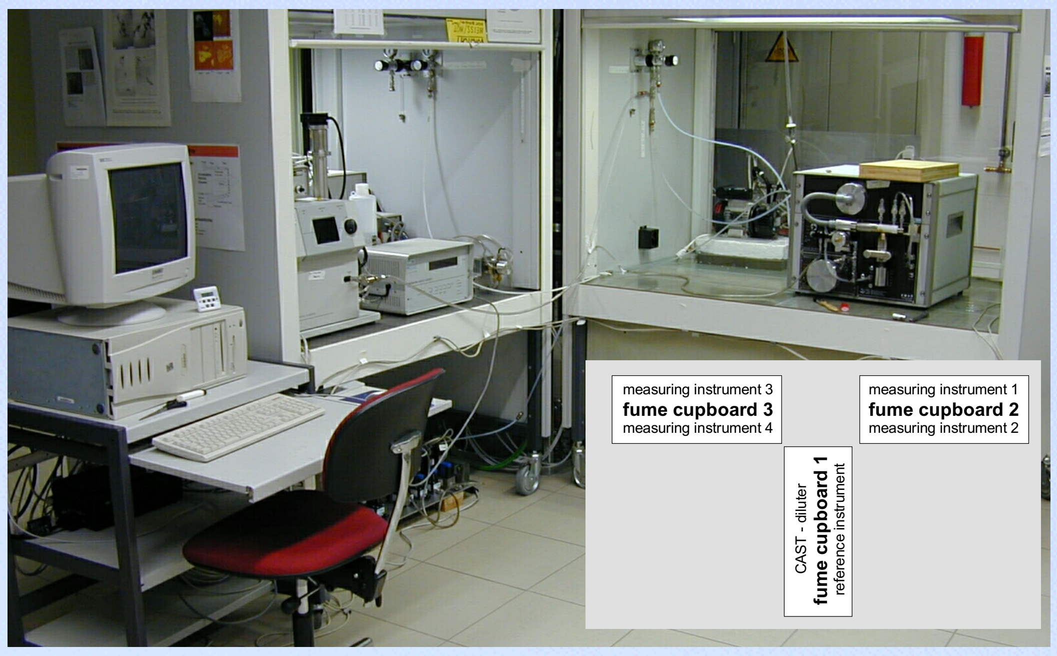

Figure 2: View on the laboratory with two fume cupboards

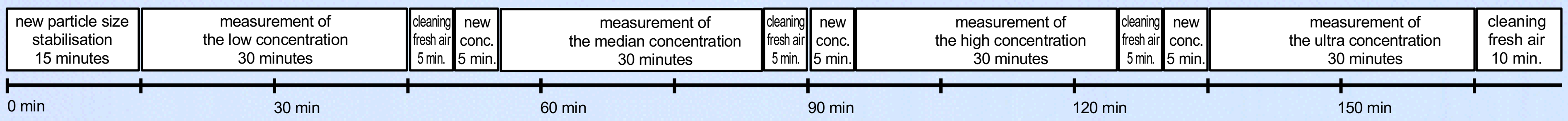

Figure 3: Schedule of the intercomparison procedure with one size at four different concentrations.

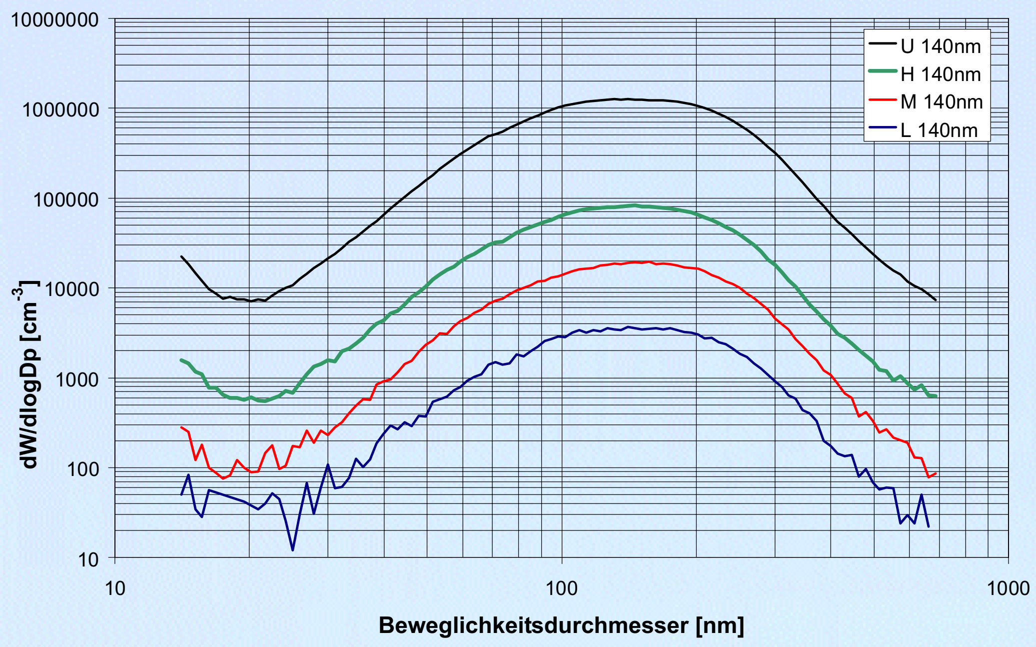

Figure 4: Examples of 4 number density distributions at same size

The raw data were analysed with the Software SMPS 3.2TSI and the number density distributions (example in figure 4) in an Excel-Table (fit of logarithmic normal distribution, calculation of mean, mode and number concentration).

The intercomparison demonstrates the conformity of the measurement results for the particle diameter within the uncertainty of the METAS standard (U_{95} of 7 nm to 11 nm) (figure 5). For the number concentration the measurement results derive over 50 %. This value exceeds the uncertainty of the METAS standard (U_{95} of 8 % to 18 %) and shows therefore a significant deviation (figure 6). The main contribution to the deviation ensues from the calibration and adjustment of the flows in the DMA and the CPC.

The intercomparison shows, that the calibration of particle measurement instruments is indispensable, because deviations can only be discovered and quantified in a comparison with standards.

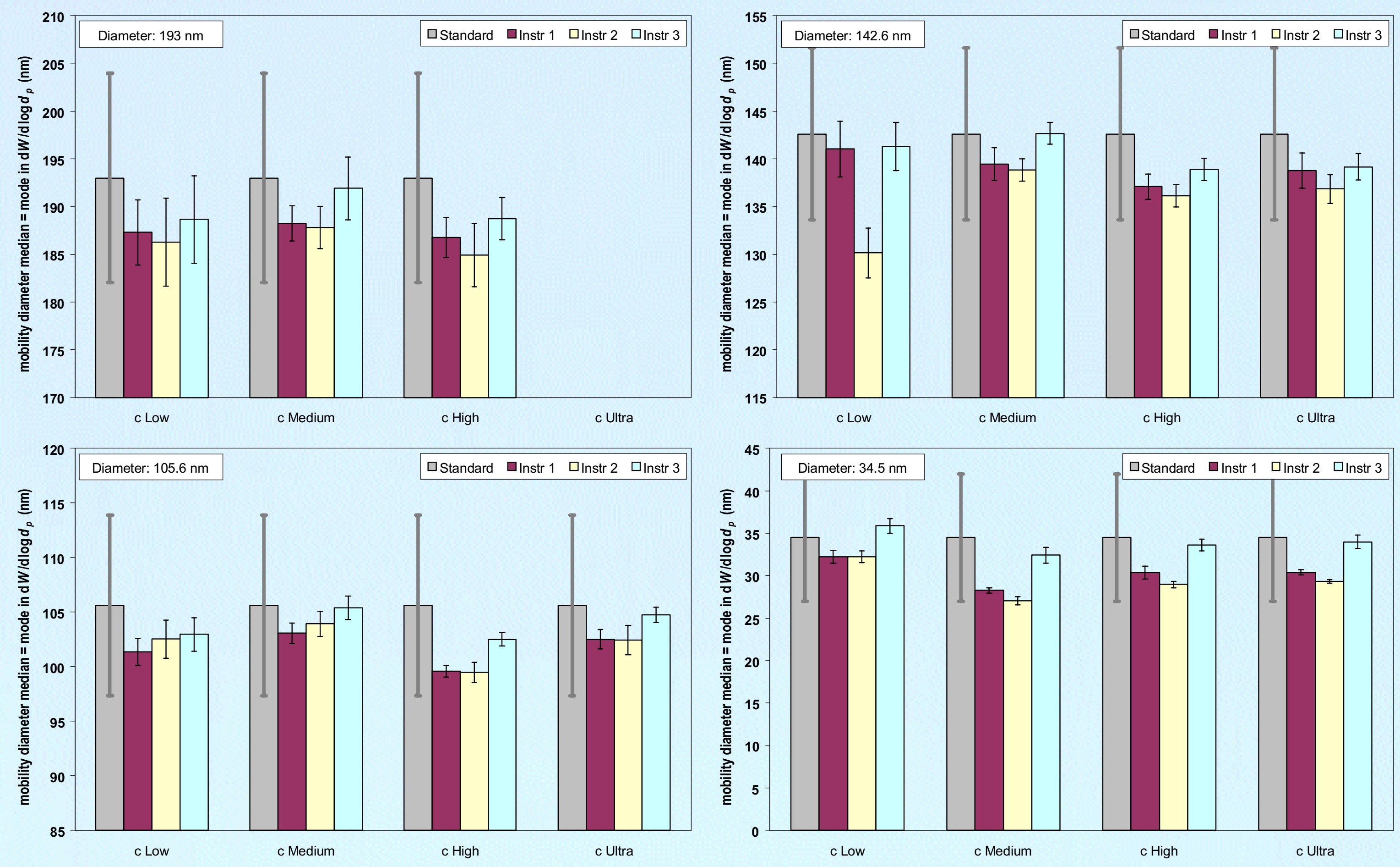

Figure 5: Comparison of particle size measurement at four diffferent sizes. Grey bars represent the uncertainty for the standard with k = 2, the black bars are the standard deviations.

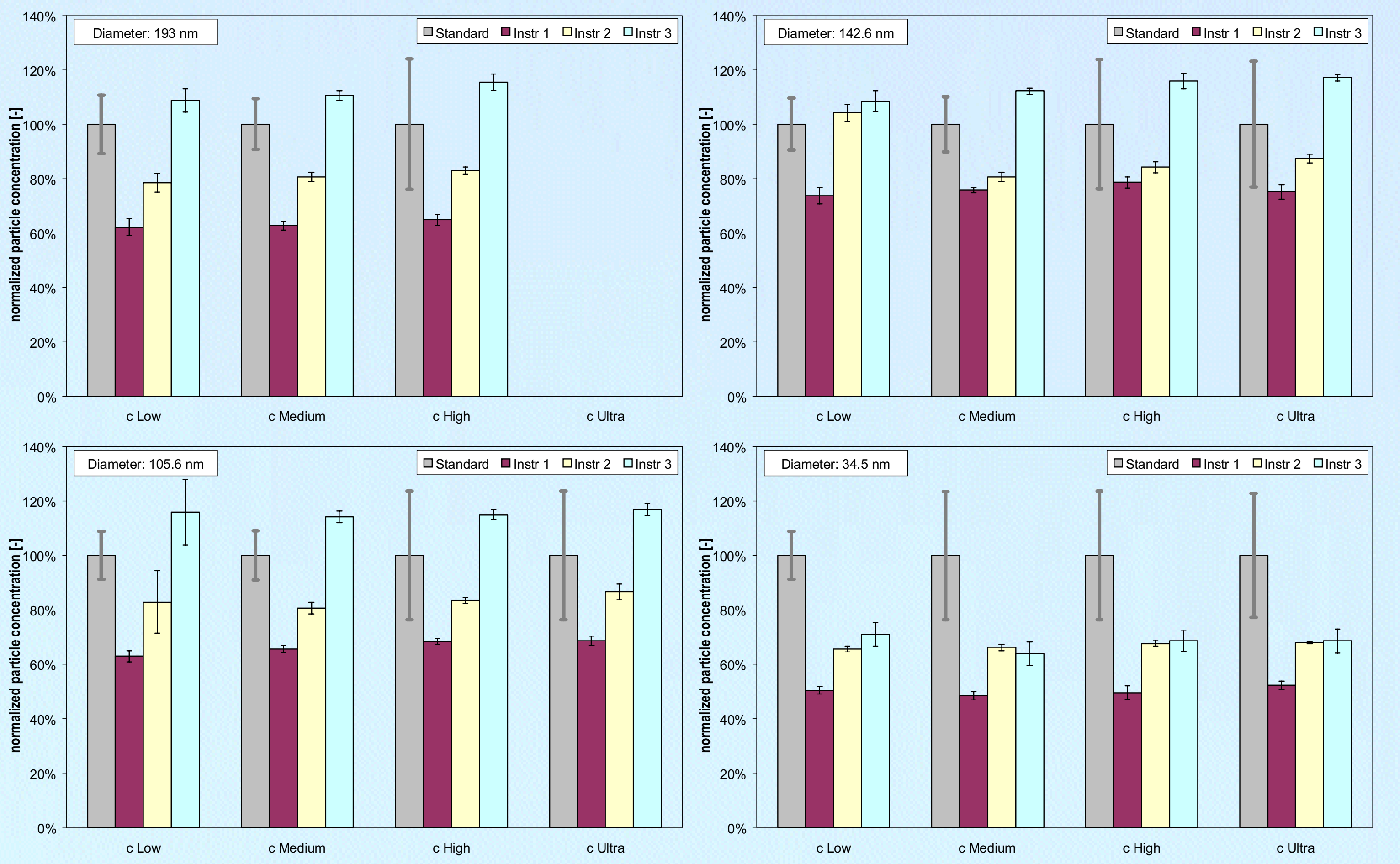

Figure 6: Comparison of particle concentration measurement at four diffferent sizes. Grey bars represent the uncertainty for the standard with k = 2, the black bars are the standard deviations.

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