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Comparison of Condensation Particle Counter (CPC) and Laser Particle Counter (LAPAZ)


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Introduction

The challenge of quantitative particle measurement is the traceability of the particle number concentration. No common procedures exist yet to establish the traceability of aerosol particle counters. Our concept bases on the fact that the existing measuring principles don't cover the same range of particle size and the same range of particle number concentration on the size-concentration-surface (Figure 1).

Therefore none of the measuring principles shall be defined as the main principle in the whole size-concentration-surface. Each instrument has a specific measuring accuracy for each point and has a region of maximal accuracy.

The validation of a measuring instrument is gained in two steps: First, the evaluation of the uncertainty, and second, the comparison with another measuring instrument using another measuring principle. The evaluation of the uncertainty according to GUM (Guide to the Expression of Uncertainty in Measurement) requires the knowledge of the measuring instrument in detail and all influencing parameters. The comparison with another measuring instrument approves the evaluation for both measuring instruments.

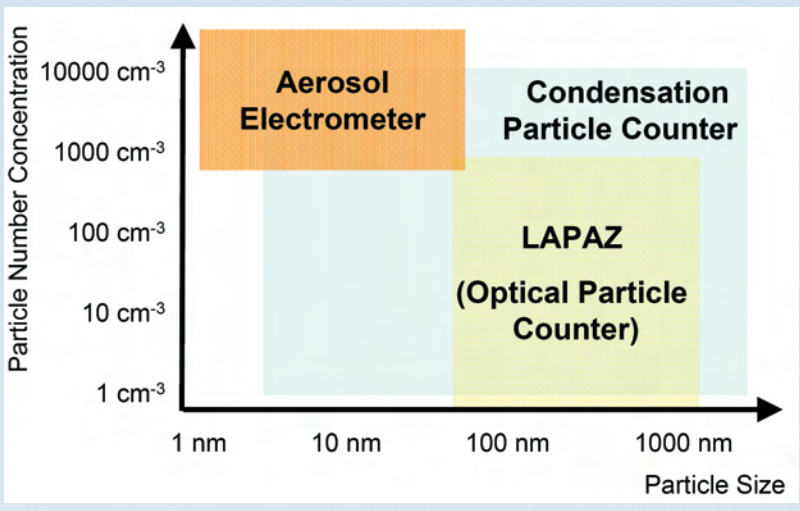

Figure 1: Various measuring principles for particle number concentration in the size-concentration-surface. Each principle has a region of maximal accuracy.

Materials and Method (Figure 2)

The aerosol was generated by atomizing a suspension of polystyrene latex spheres (PSL). The particle concentration was defined by the flow of the dilution air.

In a Differential Mobility Analyzer (DMA TSI 3081) the particle size was selected according to the PSL diameter. The size selection removes the fraction of small particles called residuals. This separation with a DMA only works, if the size of the PSL is much larger than the size of the residuals.

The aerosol was fed to CPC Grimm 5.400, CPC TSI 3022 and LAPAZ (laser particle counter) simultaneously. In order to get reliable aerosol flow information thermal mass flow meters were installed downstream of the instruments.

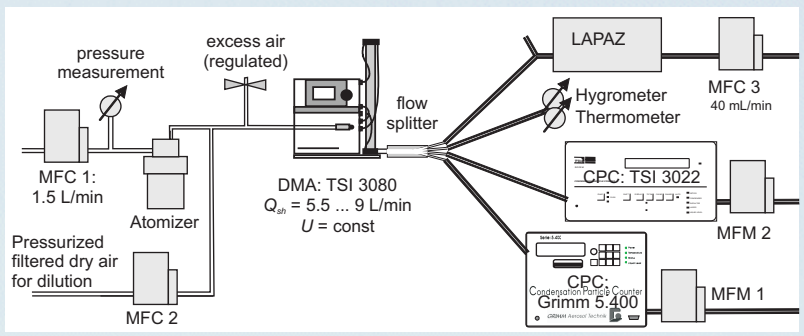

Figure 2: Measurement setup for the comparison of the Condensation Particle Counters: Combustion aerosol from CAST is diluted in two stages, size selected and fed to Grimm CPC and two TSI CPCs

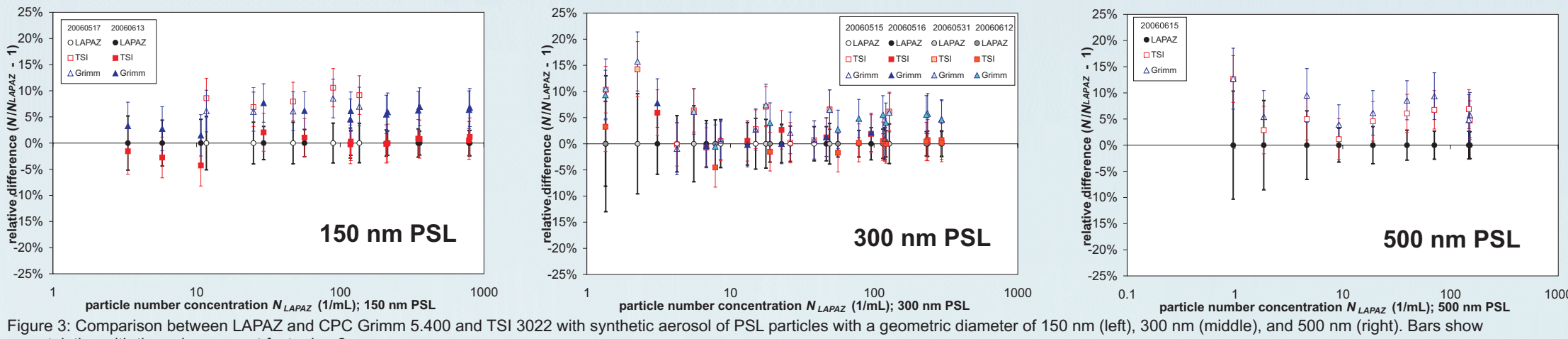

Figure 3: Comparison between LAPAZ and CPC Grimm 5.400 and TSI 3022 with synthetic aerosol of PSL particles with a geometric diameter of 150 nm (left), 300 nm (middle), and 500 nm (right). Bars show uncertainties with the enhancement factor k = 2.

Results and Discussion (Figure 3)

The comparison between CPC's and LAPAZ was made with various PSL diameters several times. The results of the comparison show relative differences mainly below 10 %.

The uncertainty calculation includes: The variance of the repeated measurement; aerosol flow measurement (2 % with k = 2); losses (CPC: 3 %, LAPAZ: 2 %); time measurement (LAPAZ: 0.1 %, CPC: < 0.1 %). The following contributions were assumed to be much smaller and were neglected in the calculation: Inhomogeneous splitting of particles in the flow splitter; variations of the particle concentration; coincidence in LAPAZ; noise (ghost particles). The over all uncertainty of LAPAZ reaches 10 % and of the CPCs about 5 %.

Conclusions

The majority of the resulting deviations between CPC's and LAPAZ lay within the uncertainty of the instruments (overlapping uncertainty bars). Therefore the uncertainty calculation of the instruments is reasonable. Nevertheless the deviations show a tendency of LAPAZ towards smaller values than the CPCs and there are some results outside the acceptable range. Future work shall focus on these questions.

Acknowledgment

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