INTERCOMPARISON OF PARTICLE NUMBER SIZE SPECTROMETERS

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Introduction

The measurement of particle number size distributions is one of the most important tasks describing the physical properties of aerosol particles. Up to now there is no standard to compare those systems for particle sizing and counting efficiency. A comparison of DMPS/SMPS systems is very difficult since most of the systems are home-made and based on different types of DMAs, CPCs, and programming languages. In this work, that is part of the NORPAC network project (http://NORPAC.dmu.dk), an intercomparison unit is introduced to compare DMPS/SMPS systems located at different measurement sites in sizing and counting efficiency.

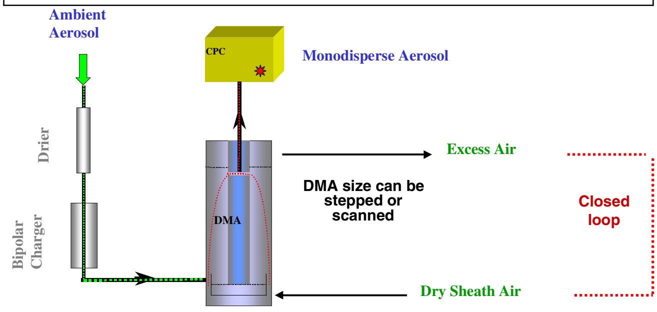

Figure 1: Schematic sketch of a DMPS/SMPS system.

Impact on the sizing of DMPS/SMPS systems:

- Sheath flow stability (small impact)
- Ambient pressure in the DMA (small impact)
- Ambient temperature in the DMA (small impact)
- Relative humidity in the DMA (possibly high impact, because of particle growth in the system, efficient drying is recommended for closed loop systems)
- Correct DMA geometry (possibly high impact)
-Voltage calibration (large impact especially for small particle sizes, low voltages)
- Residence time of particles in the system (only SMPS: DMA, tubing, CPC)

Impact on measured number concentration of DMPS/SMPS systems:

- Aerosol flow stability (small impact)
- Penetration losses in the inlet and the DMA (small impact for fine aerosol fraction)
- DMA transfer function (small impact)
- Probability of bipolar charging (possibly high impact if aerosol particles are not dried before)
- CPC efficiency (large impact especially for small particle sizes)

Methods

Our main goal is to compare DMPS/SMPS systems without moving those. Therefore, an intercomparison unit has been provided that can be sent around to different groups participating in the intercomparison. The unit is simple to use, easy to transport and possible to be operated at various measurement sites. Latex spheres (PSL) can be sprayed by a nebulizer and a comparison in sizing for Dp = 101, 277, and 420 nm can be provided.

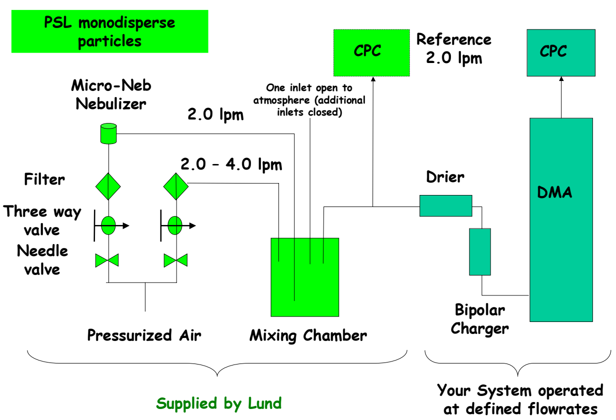

Figure 2: Schematic sketch of the intercomparison unit (sizing).

Methods

For comparison in counting efficiency atmospheric aerosol number size distributions will be taken over several days with the DMPS/SMPS systems in conjunction with a CPC with well-known efficiency belonging also to the intercomparison unit. The measured total number will be compared.

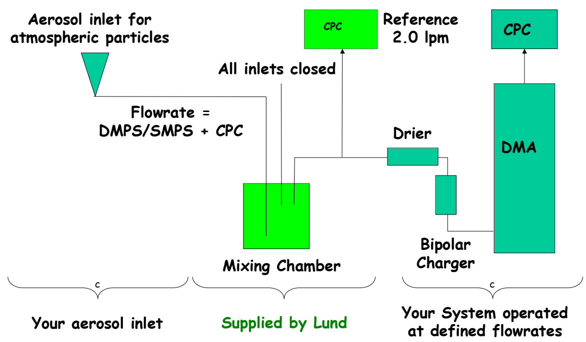

Figure 3: Schematic sketch of the intercomparison unit (counting efficiency).

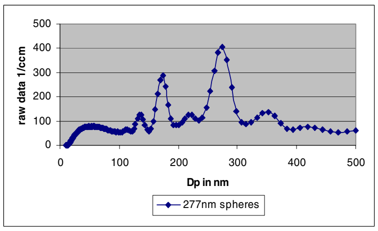

Figure 4: Size calibration (Dp = 277nm).

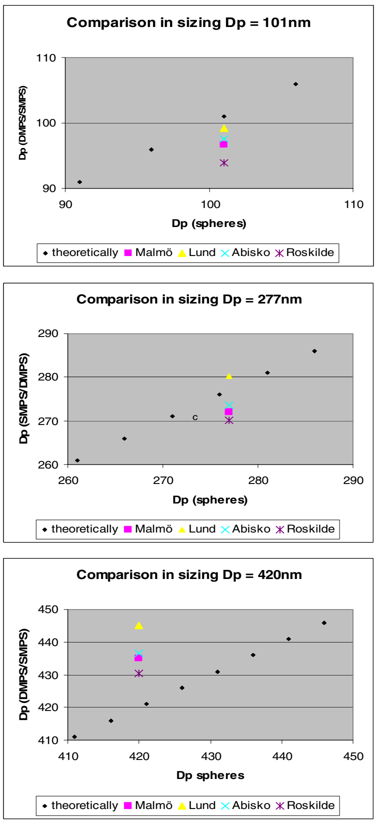

Figure 5: Comparison in sizing for different DMPS/SMPS systems.

Results

On the left, a typical size distribution of Dp = 277nm spheres is shown. Singly and doubly charged particles can easily be identified by the main peaks.

Up to now, the intercomparison unit has been tested for four different measurement devices and the sizing has been compared.

First results show a systematic underestimation of the tested systems for particles of smaller sizes (Dp = 101, 277nm ~ 1-3%) and a systematic overestimation for particles of larger sizes (Dp = 420nm ~ 4%).

However, variation for sizing within the four tested systems is relatively small with +/- 2%.

Outlook

In the future several groups within the Nordic countries continuously operating DMPS or SMPS systems will participate in the intercomparison experiment. The systems will be compared for sizing and counting efficiency.

Participation

Groups that are interested in our intercomparison experiment are fairly welcome to participate.