Particle number concentration monitor for atmospheric aerosols

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Keywords: particle number concentration monitor, atmospheric aerosol, corona-jet charger
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The concentration of particle matter in ambient air is quantified in air quality monitoring networks. The classical mass-based methods are more and more completed by number-based methods. This enables to quantify the concentration of submicron particles, which especially show adverse health effects (Peters *et al*, 1997). For this purpose, an ultrafine particle monitor (UFPM) was designed and constructed to obtain particle number concentrations of atmospheric aerosols.

Fig. 1 shows a schematic diagram of the UFPM. The aerosol sample passes through a corona-jet charger, which charges all particles positively by diffusion charging. Subsequently, the charged particles are classified in a DMA due to their electrical mobility and quantified by a faraday cup aerosol electrometer. During a measurement with the UFPM the voltage in the DMA is increased from 0 to 10 kV in discrete steps within 10 min. The means of the electrical current, measured with the aerosol electrometer at every classifier voltage, are recorded in the vector **I**. The ranges of electrical mobility, corresponding to the classifier voltages, overlap by half its width. The captured range of particle mobility covers particle sizes from 20 to 720 nm in predefined size classes.

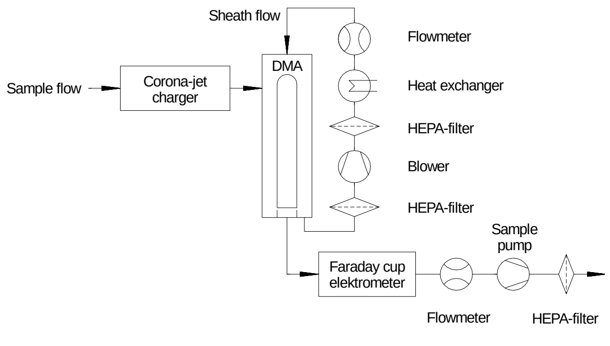

Figure 1: Schematic diagram of the ultrafine particle monitor (UFPM)

The data inversion delivers the connection between the measured electrical current **I** and the particle number concentration **C** by the charge distribution, the transfer function of the DMA and the inlet flow. These functions are summarized in the kernel matrix **K**.

$$\mathbf{I} = \mathbf{KC} \quad (1)$$

A data inversion algorithm, based on the Tikhonov-regularization, was implemented (Tikhonov, 1977).

A method was developed to calculate the kernel matrix from the data of comparison measurements with the UFPM and a reference mobility particle size spectrometer such as a scanning mobility particle sizer. In experimental comparisons, the number concentrations of laboratory and atmospheric aerosols measured by the UFPM were within a range of $\pm 20\,\%$ of the reference concentration determined by a SMPS. The distribution of the counting efficiency of the UFPM measured with atmospheric aerosol is shown as boxplot in Fig. 2. The counting efficiency is mainly between 0.8 and 1.2. The quartiles of the distribution of the counting efficiency of all size classes are between 0.81 and 1.02, the median varies between 0.90 and 0.93.

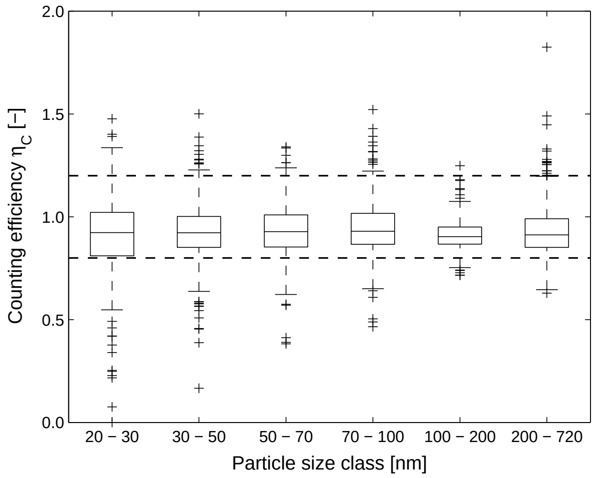

Figure 2: Counting efficiency of the UFPM for atmospheric aerosol

The UFPM is particulary designed to monitor atmospheric particle number concentration in air quality monitoring networks. The contribution will discuss the design and the function of the UFPM. It will focus on the data inversion and the method for the measurement of the kernel matrix data. Results of comparison measurements with the UFPM and a SMPS will be presented to confirm the good agreement of the UFPM to reference mobility particle size spectrometers.

Peters A. et al. (1997), *Am. J. Respir. Crit. Care Med.*, **155**, 1376-1383.

Tikhonov A. N. (1977) *Solutions of ill-posed Problems*, John Wiley & Sons, Hoboken.