MONITORING OUTDOOR AIR PARTICLE CONCENTRATIONS WITH THE PPS-M SENSOR

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Summary
In this study the capability of the Pegasor PPS-M particle sensor for outdoor air monitoring was tested in urban environment. A good correlation with the lung deposited surface area concentration was observed. Correlation with PM2.5 was found to be lower because the signal is weighted toward smaller particle sizes. The PPS-M was found to be especially suitable for monitoring vehicle based particle emissions in outdoor air.

Introduction
The most important motivation for air quality monitoring is the health effects of air pollutants. Outdoor air quality is typically analysed by measuring particle mass: PM10 and PM2.5 or gas concentrations: NO, NO_2, SO_2 and O_3. However, in case of particles, it has been proposed that these mass based quantities PM10 and PM2.5 would not be the best metric to describe the health effects. The monitoring of particle surface area concentration (e.g. Oberdörster, 2001) has been indicated to correlate better with the hazardous effects of particulate matter than the monitoring of particulate mass concentration or number concentration, although the discussion related to topic is still continuing. The real time measurement of surface area requires different instruments than the PM measurement. The diffusion charging and electrical measurement produces a signal which is well proportional to the lung deposited surface area concentration (Fissan et al. 2007). The Pegasor PPS-M sensor is based on this type of construction. The sensor uses compressed air which is ionized and used to charge particles. This flow is also used to generate the sample flow through the device. The electric measurement signal is generated when the unipolarly charged particles are extracted from the sensor by the flow, principle introduced by Lehtimäki (1983).

Experimental
The PPS-M sensor was used to measure particle concentrations in three different environments in Helsinki area: (1) Stationary measurement in residential area, (2) Stationary measurement close to a major road, (3) On board a mobile laboratory in Helsinki city centre. The PPS-M signal was compared to reference data including PM2.5, NO_x, ELPI total current, CPC number concentration and NSAM lung deposited surface area concentration. The sensor was installed inside measurement stations or inside the mobile laboratory and it was sampling outdoor air without any preconditioning. The sampling rate of 1 Hz was used for the PPS-M (100 Hz maximum), the ELPI and the NSAM.

Results
The PPS-M signal was found to correlate well with the total current of the ELPI. The PPS-M signal was 0.27 times the ELPI total current in both stationary measurements stations. A good correlation with the lung deposited surface area concentration (NSAM) was also observed, see Fig. 1. The correlation with PM2.5 was found to be lower. Depending on the environment, the PPS-M response to PM2.5 was between 7-30 fA/(μg m^{-3}). The variation was caused by differences in aerosol i.e. the mean particle size affect the response. Thus the sensor response is not directly proportional to the particle mass but to a metric close to lung deposited surface area concentration. The PPS-M required practically no maintenance during over 2 week measurements.

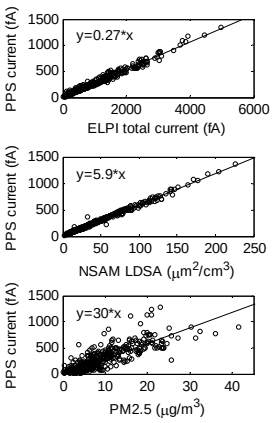

Fig.1 The PPS-M response to reference instruments in measurement site 2 (close to a major road). Each point represents 1 h average.

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