UFP measurement: comparison of commercial equipments using different measuring principles

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Particulate matter (PM) is known to cause adverse health effects when inhaled. Currently, air quality standards are in force for PM_{10} and $PM_{2.5}$. However, epidemiological and toxicological studies suggest that the driving characteristics for health effects are more related to the sub-micron particles (Pope and Dockery 2006). Their measurements should thus be promoted and not only episodically. Therefore, a lot of monitoring networks are developing ultrafine particles (UFP) measurements.

As the monitoring of UFP is neither regulated yet by a European directive nor normalized, major variations exist between measurement principles and commercial equipments available on the market.

Only a few comparisons between instruments are available in the literature (Ji Ping Shi et al., 1999 - B. Wehner et al. 2007) and these are generally limited to two instruments carried out in lab conditions. A technical standard should be prepared soon by CEN/TC264/WG32, but has not yet started. In a joint measurement campaign ISSeP, TSI and LABORELEC investigated different commercial equipments. Results obtained for some of them are presented in this paper.

Instruments deployed were a scanning mobility particle sizer (SMPS 7-850 nm), an ultrafine particle monitor (TSI3031 20-800 nm) and an electrical low pressure impactor ($ELPI^+$ 6nm–10µm). The measures were carried out during 3 winter months at different locations including 2 traffic stations, 1 urban background station and 1 urban station. All instruments were installed using the same sampling line and aerosol was dried so that relative humidity remains below 40%.

Typical time series recorded by the three instruments at a traffic location (Herstal, BE) are presented in figure1 and Pearson correlations obtained on full period are in table 1

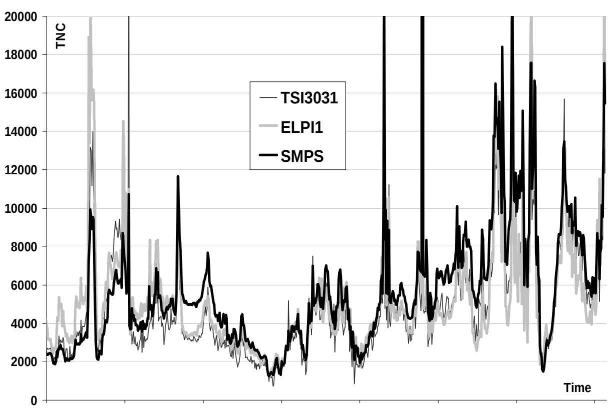

Figure 1: Typical recorded time series

Table 1: Pearson correlation between instruments

<20nm	SMPS	TSI3031	ELPI+	100-200nm	SMPS	TSI3031	ELPI+
SMPS	1	NA	0.56	SMPS	1	0.91	0.79
TSI3031	-	1	NA	TSI3031	-	1	0.87
ELPI+	-	-	1	ELPI+	-	-	1
20-50nm	SMPS	TSI3031	ELPI+	200-800nm	SMPS	TSI3031	ELPI+
SMPS	1	0.92	0.89	SMPS	1	0.61	0.84
TSI3031	-	1	0.95	TSI3031	-	1	0.53
ELPI+	-	-	1	ELPI+	-	-	1
50-100nm	SMPS	TSI3031	ELPI+	20-800 nm	SMPS	TSI3031	ELPI+
SMPS	1	0.95	0.93	SMPS	1	0.92	0.92
TSI3031	-	1	0.95	TSI3031	-	1	0.98
ELPI+	-	-	1	ELPI+	-	-	1

TSI3031 seems not to be in phase for its biggest channel (200-800 nm), nevertheless the impact of this class size on total number is not so high and other instruments (scattering) are available for this size range.

ELPI seems to overestimate the smallest channel (< 20 nm), but the true cut off is not clear as the yield of the corona charger depend on the particle/droplet size. We also expect possible overestimation of the correction algorithm and an impact of the diffusion losses.

The pros and cons of each type of instruments are discussed in the study. Trueness and reproducibility is not the only aspect for a monitoring network: robustness, compatibility with other instruments, equipment cost and maintenance, training of personal, compatibility with all measurement sites should also be taken into account.

Table 2: Summary of pros and cons of each instrument

	Cost	Maintenance	Training	Trueness	urban	Rural
SMPS	−−−	−−−	−−−	+++	+++	+++
TSI3031	−−	−	−	++	++	?
ELPI+	−−	−−	−−−	++	++	?

SMPS, TSI3031 and $ELPI^+$ seem to be good candidates for continuous monitoring of UFP. Each instrument has advantages and disadvantages. Further tests in rural areas are already planned to get results at low concentration.

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