

Ultrafine Particle Monitoring:

Elements of a Consistent Method for Measuring Particle Number Concentration (PNC) and Particle Size Distribution (PSD)

Introduction

Ambient aerosol measurement involves an interplay of instrumentation, sampling systems, and measurement protocols. To produce data that can be compared, the equipment and methodology must be consistent from one site to the next. A prominent example of this effort is in the EU, which focuses on Ultrafine Particle (UFP) measurements: European specifications (CEN/TS 16976:2016 and CEN/TS 17434:2020) provide details of an experimental setup that enables the collection of accurate and highly intercomparable data for particle number concentration (PNC) and particle size distribution (PSD), respectively.

This poster will outline the elements of a consistent experimental method for monitoring UFPs that is compliant with the requirements of the CEN specifications, but can particularly benefit research that is not seeking CEN compliance. The TSI Ultrafine Particle Monitoring instrumentation addresses each of these elements, providing a complete solution for continuous ultrafine particle monitoring.

Sampling

When monitoring UFPs, it's critically important to attend to each of these concerns, while also maintaining the resulting particle population (in terms of number concentration and size distribution) as much as possible.

- Draw a representative sample of particles from the atmosphere
- Condition the resulting flow as needed (temperature, humidity, dilution level)
- Remove unwanted particles or other material
- Split flow as needed for conditioning, and to divide among instrumentation

The **Sampling System for Atmospheric Particles 3750200** addresses all of these concerns via the components noted above. Particulate losses within the sampling system can be corrected for within the SMPST[™] software; see "SOFTWARE" below. To purchase a system without the PM10 head, order 3750210.

Counting

For particles as small as many UFPs are, number concentration measurements are far more sensitive than traditional mass-based measurements. Number-based data provides invaluable insight into human UFP exposure, sources, and aerosol transport. Condensation Particle Counters (CPCs) are widely used in unattended UFP monitoring around the world. The comparability of CPC data is affected by several things, including:

- D50 cutpoint
- Concentration range
- Working fluid

For a standalone CPC, the **3750-CEN** is a common choice. It is compliant with the requirements of CEN/TS 16976:2016. Other CPC models are also suitable, particularly **3789** or **3756**. Consider the above aspects when selecting a standalone CPC.

References and Resources

- CEN/TS 16976:2016. Ambient air – Determination of the particle number concentration of atmospheric aerosol
- CEN/TS 17434:2020. Ambient air – Determination of the particle size spectra of atmospheric aerosol using a Mobility Particle Size Spectrometer (MPSS)

Sizing

Size distribution measurements of UFPs provide invaluable insight into particle sources, impacts, and potential fates. Scanning Mobility Particle Sizers (SMPST[™]) are used in unattended UFP monitoring globally.

There are multiple aspects of SMPST[™] measurements that should be kept as consistent as possible when monitoring UFPs:

- Inlet impaction
- Aerosol neutralization
- Differential mobility analyzer
- Sheath: Aerosol flow ratio
- Scan range
- Scan duration

Two SMPST[™] models are ideally suited for ambient monitoring:

- **Wide-range Ambient Monitoring Scanning Mobility Particle Sizer[™] (SMPST[™]) 3938W50-CEN:** uses butanol, in accordance with CEN/TS 17434:2020
- **Water-based Wide-range Ambient Monitoring Scanning Mobility Particle Sizer[™] (SMPST[™]) 3938W89:** uses water

Accessories

The proper supporting equipment can make a continuous monitoring system robust to environmental changes and capable of longer-term unattended operation. These accessories help to ensure UFP monitoring success:

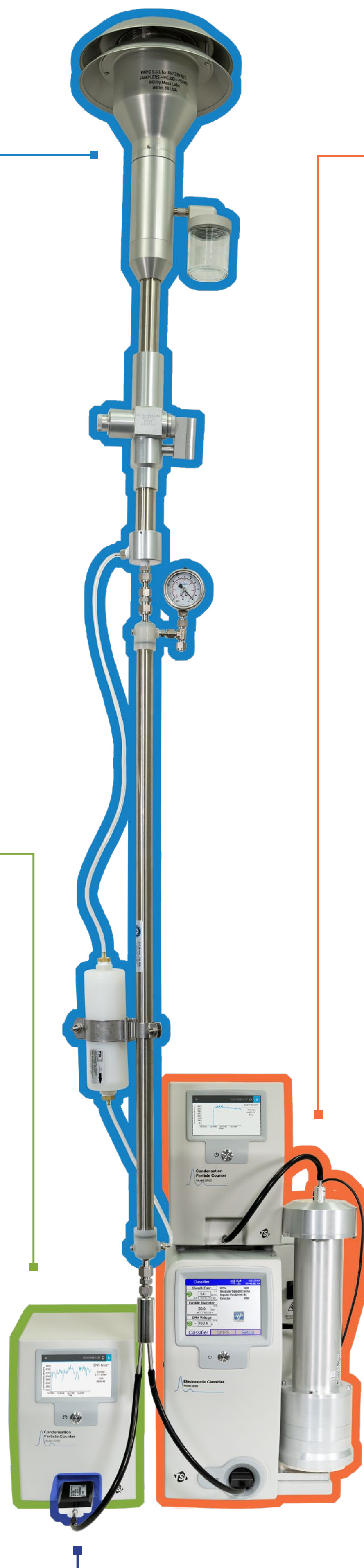
- Pump
- Sheath flow dryer
- Diluter
- Relative humidity and temperature sensor
- Flow calibrator
- Conductive tubing

Software

Data collection and handling in a 24/7 application is no small matter, particularly when the instruments are frequently unattended. Key features of the **AIM 11 CPC** and **AIM 11 SMPS** software packages include:

- Auto-export of data
- Delay time calibration*
- Auto-recovery from power failure
- Sampling system loss correction*
- Station ID field*

* Features are unlocked via the AIM11CPCMONITORING and AIM11SMPSMONITOR licenses



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