European Partnership on Metrology
Call 2025 – Health, Integrated European Metrology, Regulation and Research Potential

Selected Research Topic number: **SRT-n04**
Version: 1.0

Title: Metrology support for particulate matter metrics in the revised EU Air Quality Directive

Abstract

The revised EU 2024/2881 Air Quality Directive has introduced the obligation to measure additional particulate matter metrics such as particle number concentration (PNC), particle number size distribution (PNSD), ultrafine particles and black carbon. Additionally, the limit values for $PM_{2.5}$ mass concentrations were lowered from 25 µg/m³ to 10 µg/m³ and supersites need to be installed to monitor a wide range of air pollutants across Europe. Therefore, to meet these new regulations, standardised measurement procedures, with reduced measurement uncertainties, need to be developed for these metrics with validation through interlaboratory comparisons between European air quality monitoring sites.

Keywords

Air quality monitoring networks, black carbon, condensation particle counter, diffusion charger, European air quality directive, interlaboratory comparisons, particulate matter, particle number concentration, particle number size distribution, ultrafine particles

Background to the Metrological Challenges

In 2021, the World Health Organization published revised global air quality guidelines. The EC took these into account when revising the Air Quality Directive meaning that new limit values were set and an obligation to measure ultrafine particles and black carbon was introduced. The revised EU 2024/2881 Air Quality Directive, which came into force in December 2024, includes lower limit values, the mandatory measurement of new metrics (such as particle number concentration (PNC), particle number size distribution (PNSD), ultrafine particles and black carbon) and the installation of supersites, which will monitor a wide range of components across Europe to provide comprehensive data to support health studies. These metrics must be measured with a high temporal resolution (data capture > 80 %) and there must be ≥ 90 sites measuring PNC and ≥ 70 sites measuring PNSD and black carbon. This must be implemented one year after adoption into national law.

The metrological traceability chains and calibration procedures for PNC and PNSD measurements are known and well described. There is however a need for additional calibration capacities across Europe. More effort is also needed to adapt the traceability chain and to harmonise calibration procedures to all monitoring sites for measuring the new metrics across Europe by e.g. interlaboratory comparisons between the calibration laboratories and at a later stage between European monitoring networks. CEN/TC 264 [1] and EMN Climate and Ocean Observation [2] have identified standardisation priorities and metrology needs. This SRT addresses these requirements and those arising from the revised EU 2024/2881 Air Quality Directive [3].

The PNC of ambient ultrafine particles is measured using condensation particle counters (CPC). This is a robust and mature technology, with standardised and traceable calibration methods, but they are expensive (> 20-30 k€), complex in design, require frequent maintenance and most use toxic/hazardous solvents as their working fluids. Alternative, and more affordable, low-grade CPCs have become available, which use water, or less hazardous solvents, as their working fluids. A test procedure, which is equivalent to the existing 'reference' method (EN 16976:2024), needs to be developed for these CPCs and they need to be tested in a range of environments polluted with ultrafine particles.

EURAMET MSU,
Email: part.msu@euramet.org
Metpart.eu

European Partnership Co-funded by the European Union
METROLOGY PARTNERSHIP EURAMET

The revised EU 2024/2881 Air Quality Directive does not include reference methods for PNC and PNSD because CEN standards were not available. Since its revision, an EN standard (EN 16976:2024) has been published for PNC, but there is currently no standard for PNSD. Therefore, a new EN standard needs to be developed, based on CEN/TS 17434:2020, but this technical specification needs to be validated before it can be adopted as the reference method for PNSD. This validation will require a protocol to be developed to enable interlaboratory comparisons to be performed between existing and newly created air quality reference laboratories in Europe.

There is a need to significantly increase the number of sites that are capable of implementing ultrafine particle measurements across Europe, in compliance with the revised EU 2024/2881 Air Quality Directive; also, cost-effective small-scale measurement systems, such as sensors based on diffusion charging (DC), need to be characterised. Although previous tests demonstrated the poor performance of DC sensors for large and small particle sizes, after improvement, they have recently been shown to be capable of measuring the PNSD of ambient ultrafine particles. Therefore, their accuracy and measurement uncertainty need to be assessed to enable a cost-effective network for this metric.

The inclusion of black carbon as a metric to be measured at supersites across the EU introduces the need for a calibration infrastructure and protocols for this pollutant. This has been identified as a need by CEN TC 264 WG 35 [2]. Traditionally, black carbon has been measured using filter-based absorption photometers, but these lack traceability to the SI. Metrology Partnership JRP 22NRM02 STANBC is developing the necessary primary methods for measuring aerosol light absorption at different wavelengths (UV to infrared) and will provide a technical specification or standard for this metric, which is closely linked to black carbon mass concentration. This black carbon absorption standard needs to be implemented as a fit-for-purpose calibration protocol for filter-based photometer devices, which are based on filter light attenuation.

The state-of-the-art reference method for measuring particulate matter (PM) mass concentration is the (manual) gravimetric method, which is based on collecting particles on a filter. Particle mass is calculated by comparing the mass of the filter before and after sampling. However, this method suffers from large uncertainties. The revised EU 2024/2881 Air Quality Directive has reduced the annual limit value from 25 µg/m³ to 10 µg/m³ for the mass concentration metric $PM_{2.5}$. At even lower mass concentrations (< 3 µg/m³), the measurement uncertainty of the gravimetric method can be > 30 %. Therefore, a new candidate method needs to be validated for low particle mass concentration based on a novel particle mass analyser coupled to an aerosol electrometer, with measurement uncertainties reduced to < 5 % (at 95 % confidence interval).

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The proposal shall focus on metrology research necessary to support the revised EU 2024/2881 Air Quality Directive.

The specific objectives are

1. To develop a test procedure, which is equivalent to the existing ‘reference’ method (EN 16976:2024), for the measurement of particle number concentration (PNC) in ambient air using alternative and affordable low-grade condensation particle counters (CPC). Tests should be performed in the laboratory and in field studies in a range of environments polluted with ultrafine particles. In addition, the measurement uncertainty of the equivalent test procedure should be derived within the ± 30 % range (with a 95 % confidence interval).
2. To initiate the development of a new EN standard by CEN TC 264 WG 32 based on the CEN/TS 17434:2020 technical specification for particle number size distribution (PNSD) of atmospheric aerosol. A protocol should also be developed for interlaboratory comparisons between existing and newly created air quality reference laboratories in Europe. In addition, the performance of diffusion charger-based measurement techniques for PNSD should be assessed to enable a cost-effective network for this metric.
3. To implement transfer standards for the field calibration of the filter-based photometer devices, which are used for black carbon measurement. This should make use of the calibration protocols and technologies developed in Metrology Partnership JRP 2NRM02 STANBC.
4. To develop the metrological capabilities needed to meet the requirements of the EU 2024/2881 Air Quality Directive with respect to the new annual limit value of 10 µg/m³ for the mass concentration

metric $PM_{2.5}$. This should include organising and conducting an interlaboratory comparison for the validation of a candidate method for this metric based on a novel particle mass analyser coupled to an aerosol electrometer, with a target expanded uncertainty < 5 % (with a 95 % confidence interval).

5. To support the implementation of the revised EU 2024/2881 Air Quality Directive and facilitate the take up of the technology, methods and measurement infrastructure developed in the project by regulatory authorities (EU), the measurement supply chain (NMIs/DIs, EMN-COO, EMN-PolMo, the network of the European Reference Laboratories (AQUILA), instrument manufacturers), standards developing organisations (CEN, ISO), and end users (air quality monitoring networks).

The proposed research shall respond to documented requirements related to specific regulations and legislation or explore the background and feasibility of expected possible future regulation. To enhance the impact of the research, the involvement of the appropriate user community such as regulatory authorities, conformity assessment bodies, standardisation bodies, and industry, is strongly recommended. Where relevant, proposals are encouraged to build on, or seek collaboration with, existing projects and develop synergies with other relevant European, national or regional initiatives and funding programmes. In particular, links are encouraged with (i) the projects funded under earlier relevant topics of the Horizon Europe programme; or (ii) other relevant European Partnerships.

Proposers should establish the current state of the art and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMPIR and Metrology Partnership projects 16ENV07 AEROMET I, 19ENV08 AEROMET II and 22NRM02 STANBC and how their proposal will build on those.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.0 M€ and has defined an upper limit of 1.3 M€ for this proposal.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 30 % of the total EU Contribution across all selected projects in this TP.

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the 'end user' community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your proposal's results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Facilitate improved industrial capability, or improved quality of life for European citizens in terms of personal health, protection of the environment and the climate, or energy security,
- Transfer knowledge to the air quality sector and regulatory authorities.

You should detail other impacts of your proposed JRP as specified in the document "Guide 4: Writing Joint Research Projects (JRPs)"

You should also detail how your approach to realising the objectives will further the aim of the Metrology Partnership to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Timescale

The project should be of up to 3 years duration.

Additional information

The links provided in this section are only correct at the time of publication up until the end of the Call year.

The references below were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] *018 CEN TC 264 Air Quality WG 35: Determining organic carbon and elemental carbon* https://www.metpart.eu/go/need18

[2] *EMN Climate and Ocean Observation Strategic Research Agenda* https://www.euramet.org/research-innovation/metrology-partnership/strategic-research-and-innovation-agendas

[3] *EU Regulation (EU) 2024/2881* http://data.europa.eu/eli/dir/2024/2881/oj