Preliminary ACTRIS recommendation for aerosol in-situ sampling, measurements, and analysis

- by ECAC-CAIS units -

2nd version, June 09, 2021

This is the first revised version of the preliminary recommendation to everyone, who plans to set up new or to use existing in-situ aerosol instrumentation as an ACTRIS National Facility (NF) observational platform. Supplementary and more specific recommendations for exploratory platforms (simulation chambers and mobile measurement facilities) are currently developed.

These recommendations are preliminary and still unofficial, because

- ACTRIS-ERIC is not finally established yet with all the relevant bodies
- The consortium agreement for Centre for Aerosol In-Situ Measurement – European Center for Aerosol Calibration and Characterization (ECAC-CAIS) Topical Centre is not signed yet.

Despite these limitations, ECAC-CAIS discussed internally which instrument types and which standards should be recommended for the ACTRIS aerosol in-situ variables

- to guarantee the quality of ACTRIS measurements
- to facilitate the harmonization of these measurements.

The following recommendations are important to avoid problems or misunderstandings during the ACTRIS NF-labeling process. The sampling configuration, physical and chemical aerosol in-situ instrumentation, and the applied analysis methods should be ACTRIS compatible.

In general, ECAC-CAIS will not recommend specific instrument models, but instrument types and requirements to be fulfilled by these instrument types. Consequently, the instrument manufacturers have to undergo an ACTRIS compatibility test for each instrument type. Potential in-situ aerosol instruments will be evaluated on whether they follow the requirements and recommendations. Furthermore, the measured aerosol data compared must be within the target uncertainty ranges and be traceable according to reference instruments or standards of the CAIS-ECAC. All the instruments will have to undergo regular calibration workshops with frequency defined by CAIS-ECAC based on the instrument type. ECAC-CAIS will also provide regular training workshops for the scientists and operators of the respective instruments.

The following recommendations are based on more than one decade of experience of the people, working at the different ECAC-CAIS units and within the European research community. The recommendations are also based on pre-existing documents derived from:

- Previous projects such as EUSAAR, ACTRIS-I, and ACTRIS-II
- European standardization documents such as CEN technical specifications and EU norms
- WMO-GAW
- COST Action COLOSSAL

These recommendations are preliminary until ACTRIS NF Technical and Scientific Forum will be established. Therefore, it is important and necessary to also receive further feedback from the NF community to improve this document. Since it is a guideline for the NF-implementation and labeling process, any feedback should be given in written form until July 31, 2021 or during the aerosol in-situ

community meetings. Please address your feedback via email directly to Alfred Wiedensohler (alfred.wiedensohler@tropos.de) as the current interim director of the ECAC-CAIS or to the corresponding TC unit head(s). You may also communicate via the user forum for an online discussion with the people from the different corresponding TC unit head(s).

https://www.actris-ecac.eu/forum.php

The WMO-GAW guidelines for aerosol in-situ measurements can be found under:

https://www.actris-ecac.eu/actris-gaw-recommendation-documents.html

ACTRIS and obligatory aerosol in-situ variables:

Based on previous discussion in ACTRIS-II and later on, five of the 12 ACTRIS aerosol in-situ variables are obligatory for NF (observatories). The obligatory variables for exploratory and mobile platforms may differ and are not finally determined.

Obligatory ACTRIS aerosol in-situ variables for observatories:

- Particle number concentration > 10 nm
- Particle number size distribution – mobility diameter 10 to 800 nm
- Particle light scattering & backscattering coefficient - multi-wavelength, within PM10 fraction*
- Particle light absorption coefficient and equivalent black carbon concentration, within PM10 fraction*
- At least one additional variable (from the list below), preferably a variable on particle chemical or elemental composition, also considering the scientific program of the NF.

Other ACTRIS aerosol in-situ variables:

- Nano particle number concentration < 10 nm
- Nano particle number size distribution 1 to 20 nm
- Particle number size distribution - aerodynamic diameter 0.8 to 10 µm
- Cloud condensation nuclei number concentration
- Mass concentration of particulate organic tracers
- Mass concentration of particulate organic and elemental carbon within PM2.5 fraction
- Mass concentration of non-refractory particulate organics and inorganics within PM1 fraction
- Mass concentration of particulate elements

** PM10 size fraction shall be investigated, except in cases where whole air inlet is required (see below).*

1 General Recommendations

Inlets (WCCAP)

A PM10 inlet should be used for ACTRIS NF (observatories). This cut-off is harmonized with the WMO-GAW network. Exceptions for the inlet cut-off such as PM2.5 are described in the sections of the different aerosol in-situ variables.

However, if the observatory is more than 10 % of the entire year in cloud (typical for mountain sites), a whole air inlet must be used. This is important for the obligatory aerosol in-situ measurements. Classical PM10 or PM2.5 inlets are not recommended for these sites.

Observatories, which are additionally interested in the interstitial aerosol, may also use a separate interstitial inlet.

General recommendations:

- **Reduce diffusional losses** for ultrafine particles. For this the sampling flow in the main sampling pipe, the **Reynolds number** should be **around 2000**. The **individual pipes** to the instruments should be kept **as short as possible**.
- **Nano particle measurements** should be done at a separate inlet with minimized losses. All microphysical measurements for particles smaller than 1 µm could then be done at this specific inlet.
- Avoid losses due to impaction for supermicrometer particles by using **preferably vertical pipes**.
- Avoid sedimentation for supermicrometer particles by using **preferably vertical pipes**.
- Employ an **isokinetic flow splitter** of PM10 related variables to avoid over-or under sampling of supermicrometer particles.

Special recommendations about the size cut-off are given in each dedicated sub-sections of the different variables.

We would also like to refer to existing guidelines & publications, which can be found under:
https://www.actris-ecac.eu/measurement-guidelines.html

Drying (WCCAP)

Generally, only three drying methods are recommended to achieve a relative humidity (RH) below 40 %:

- **Aerosol diffusion dryers** based on silica gel should be avoided due to high diffusional particle losses.
- **Membrane dryer such as Nafion** is the preferred method. However, a Nafion membrane should be exchanged regularly based on the performance, keeping the RH below 40 %.
- **Drying by dilution** with dry particle-free air can be employed in tropical and subtropical regions with high dew point temperatures.

Heating of the sampling pipe to reduce the relative humidity **is not recommended**.

We would also like to refer to existing guidelines & publications, which can be found under: https://www.actris-ecac.eu/aerosol-inlets-and-conditioning.html

Additional considerations

Following additional recommendations are also obligatory:

- Aerosol in-situ measurements should be done at a **relative humidity lower than 40 %**. This is necessary to obtain comparable data, independent of the hygroscopic behavior of the aerosol particles.
- **At the inlet of each instrument, the relative humidity, temperature, and pressure** should be determined. The pressure and temperature are needed for the calculation of the concentration at "Standard Temperature & Pressure" (STP). If a common sampling inlet and a common drying is used for more instruments (with suitable isokinetic subsampling), one sensor for relative humidity, temperature and pressure can be used for this set of the instruments (but only if these variables do not vary between the inlets of the individual instruments due to some additional sampling line parts).
- The **volumetric aerosol flow rate** should be determined **at the inlet of the instrument**.

Near-Real-Time data (NRT)

In future, **ACTRIS aerosol in-situ online instrumentation must be ACTRIS-NRT compatible**. The ACTRIS-NRT logging software must be either provided or approved by ECAC-CAIS. The NOAA logging software must not be used anymore in the near future. More specific information will be provided later.

2 Microphysical variables

2.1 Particle number concentration > 10 nm (WCCAP, PACC)

Obligatory CPC (Condensation Particle Counter) particle number concentration (PNC) measurements should be done alongside MPSS (Mobility Particle Size Spectrometer) measurements in order to be able to perform **Near-Real-Time (NRT) QC checks** for all NFs (National Facility). This will be important for the NF labeling process.

This CPC must not be used for other purposes such as the calibration of other instrumentation to avoid contamination.

The CEN264/32 working group incl. members of the ACTRIS community and the manufacturers have developed a technical specification (TS) to harmonize PNC measurements in Europe. The CEN/TS 16976 recommendations for PNC measurements are obligatory within the ACTRIS-ERIC.

The **CEN/TS 16976** is however currently in the transition phase to become an EU-Norm, in which significant modifications of the existing CEN/TS will be implemented. The CEN working group decided to change lower detection efficiency diameter (D_{P50}) **from 7 to 10 nm** for the EU-Norm to harmonize the lower end of the size range with the CEN/TS 17434 for MPSS measurements. The EU-Norm will probably not be in place before mid 2022. However, the CPCs at the NFs should already use a CPC with the coming up 50 % lower detection efficiency diameter of 10 nm. The change of the 50 % lower

detection efficiency diameter from 7 to 10 nm of a CEN/TS 16976 compatible CPC can be done by the manufacturer or at the ECAC-CAIS.

CPCs must be traceable, meaning that the PNC reading of an ethernet/USB/serial port must be identical to the calculated PNC from the primary output of the photodetector. A “pulse output" port is therefore obligatory. For PNCs below 5000 cm^{-3} (insignificant coincidence), the internally calculated PNC read from the USB/ethernet/serial port must be within 2 % to PNC calculated from the “pulse out” port. This will be part of the ACTRIS compatibility test at the WCCAP or PACC.

The provision of following diagnostic parameters of the CPC is obligatory.

- Volumetric aerosol flow rate
- RH, T, p at inlet of the instrument
- Saturator T
- Condenser T
- Optics T

The provision of following diagnostic parameters of the CPC is useful as additional information to monitor the condition of the instrument:

- nozzle pressure at the inlet to optical cell
- critical orifice pressure (if the CPC flow is controlled using critical orifice)
- laser current
- liquid level

Nano PNC measurements for the size range below 10 nm can be done with an additional CPC such as Ultrafine CPC, PSM etc. (see section 2.2).

2.2 Nano particle number concentration < 10 nm (CCC)

The PNC extending to sizes smaller than 10 nm (Nano PNC) can be measured using a CPC with low cut-off size, e. g. an ultrafine CPC (UCPC) or the nano Condensation nucleus counter (nCNC, consisting of a Particle Size Magnifier (PSM) and a CPC). It is important that the cut-off size and operation of these instruments is carefully and regularly verified using a calibration system designed, especially for sub-10 nm particles. Measurement of Nano PNCs has recently gained substantial interest. However, the measurements are subject to considerable uncertainty. Measurements of Nano PNC also require special attention to r minimizing particle diffusion losses in the sampling line. The Nano PNC measurements cannot be executed by using the same setup that applies for > 10 nm PNCs. Due to different requirements compared to the standard CPC measurements, it is the CCC’s main target to develop recommendations and standard operating procedures (SOPs) for particle counters measuring < 10 nm. We estimate that the SOP for the PSM/nCNC is published within 2021/2022 and the SOP handling other UCPC instrumentation will be developed within the next few years.

2.3 Particle number size distribution - mobility diameter 10 to 800 nm (WCCAP, PACC)

For the particle number size distribution (PNSD) of the submicrometer size range, the CEN264/32 working group incl. members of the ACTRIS community and the manufacturers developed CEN/TS 17434 to harmonize the PNSD measurements in Europe. Therefore, the CEN/TS 17434 for MPSS is obligatory for NFs in ACTRIS-ERIC. This MPSS must not be used for other purposes such as the calibration of other instrumentation to avoid contamination.

Special recommendations for MPSS measurements:

- A special low flow PM2.5 impactor or cyclon is recommended in the front of the regular MPSS (10-800 nm) operation at observatories with a significant fraction of coarse particles. This is important to avoid multiple charged particles of the coarse mode in the MPSS measurement.
- A separate inlet for MPSS measurements with minimized diffusional losses is recommended for observatories using a dual MPSS (3-800 nm) and/or an UCPC

Following MPSS criteria are obligatory:

- The obligatory **particle size range** is defined to **10 – 800 nm** (the size range could be extended to larger particle sizes, if the MPSS allows this).
- Aerosol to sheath flow ratios between 1:10 and 1:5 are allowed.
- **Krypton 85, Nickel 63, and Americium 241 are preferable** nuclides for the **bipolar chargers**. Bipolar chargers based on X-ray, corona discharge, or plasma are not recommended yet (lacking knowledge of long-term stability). MPSS based on unipolar charging are not qualified for these measurements due to increased and unknown uncertainties in the inversion matrix.
- **Makeup/bypass flows** before or after the DMA **are not recommended** (CPC aerosol flow is the DMA aerosol inlet and sample flow).
- The CPC should follow the CEN/TS 16976 (or later the corresponding EU norm). The **50 % lower detection efficiency diameter** should be set to **10 nm**, and the provision of diagnostic parameters of the CPC is obligatory as described above (see section 2.1).
- The recommended **particle size resolution** is **16 to 32 bins/decade**. We do not recommend a higher particle size resolution due to the poor counting statistics for atmospheric measurements.

The provision of the following additional diagnostic parameters is obligatory:

- Volumetric aerosol inlet flow rate
- Volumetric sheath air flow rate
- Aerosol inlet flow RH, T, p
- Sheath flow RH, T

All MPSS must be traceable and have to fulfill the target uncertainties. All data inversions (incl. multiple charge and internal diffusion loss corrections) for MPSS measurements are done centrally in future. Therefore, all manufacturers must bring their instrument (following the above criteria) to the WCCAP or PACC for an ACTRIS compatibility test. As described above already, another CPC (CEN/TS 16976) must be operated in parallel for online QC.

Nano PNSD measurements:

Additional Nano PNSD measurements from 1 to 10 nm can be done with a second Nano-MPSS (see below). Nano PNSD measurements are not obligatory.

Fast PNSD measurements:

For fast measurements on mobile platforms (e. g. airborne measurements), the size range of the MPSS can be different (e. g. 10 to 300 nm) to minimize the weight of the instrument. The uncertainties of PNSD measurements with a scan time of a few minutes should be within the target uncertainty of the reference instruments under laboratory conditions (room temperature and pressure). The performance of fast PNSD measurements must be tested by averaging the PNSDs over 5 minutes. The averaged PNSDs should be within the recommended target uncertainties. The CPC must not be following the CEN/TS 16976 to allow a light-weighting instrument. Nevertheless, it has to be traceable, providing at least a "pulse out" port.

Instruments using unipolar charging are not recommended, since the uncertainty due to the inversion matrix is might be large for the atmospheric aerosol.

We would also like to refer to existing guidelines & publications, which can be found under:
https://www.actris-ecac.eu/pnsd-10-to-800nm.html

2.4 Nano particle number size distribution 1 to 10 nm (CCC)

Measurements from 1 to 10 nm particle size distributions can be done using several commercially available instruments such as the PSM/nCNC, NAIS (Neutral Cluster and Air ion Spectrometer) or a Nano-MPSS optimized for 1 to 10 nm particles (see publication under the link below). For the NAIS we recommend to follow the standard operation procedure.

Measurements of 1 to 10 nm particle size distribution with instrumentation that utilize CPCs as detectors require a careful characterization of the instruments cut-off size and the shape of the detection efficiency curve, as well as minimizing diffusion losses during sampling. Due to the uncertainties and special procedures of calibrating 1 to 10 nm particle size distribution instrumentation, it is the CCCs main target to develop calibration procedures and standard operating procedures (SOP) for the instruments measuring 1 to 10 nm particles. We estimate that the SOP for the PSM/nCNC will be published within a year and the SOP handling other Nano-MPSS instrumentation will be developed within the next few years.

We would also like to refer to existing guidelines & publications, which can be found under:
https://www.actris-ecac.eu/nano-pnsd-1-to-10nm.html

2.5 Particle number size distribution - aerodynamic diameter 0.8 to 10 µm (WCCAP, PACC)

We recommend only using an APSS (Aerodynamic Particle Size Spectrometer) to determine the particle number size distribution for the upper accumulation mode and coarse range. The provision of the level0 NRT data (diagnostic parameters such as inlet aerosol volumetric flow rate, T, p, RH) is obligatory.

Since the counting efficiency of APSS below 0.8 µm aerodynamic diameter rapidly decreases and is unstable, **only data of the particle number size distribution greater than 0.8 µm should be considered**.

The APSS can be connected to the sampling line just with the inner nozzle (sampling 1 l/min) from the common sampling line, while taking the additional sheath flow (4 l/min) from the air in the measurement container. This sheath flow taken from room air should be however dried as well below

40 % RH. This allows for reducing the requirements for aerosol dryers as well as for total flow through the sampling head when sampling using a common inlet for more instruments.

We do **not recommend,** using **OPSS** (Optical Particle Size Spectrometer) for the operation at stationary ACTRIS NFs (observatories), because they are not traceable for the supermicrometer size range (the measured optical diameter cannot be transferred to a volume equivalent diameter due to the unknown particle shape and light absorbing particle composition in the coarse size range).

The recommendations for employment of OPSS at exploratory platforms (chamber and mobile measurements) will be defined later.

2.6 Cloud condensation nuclei number concentration (WCCAP)

The standard operation procedures for Cloud Condensation nuclei concentrations measurements using a CCNC (Cloud Condensation Nuclei Counter) are described in detail in the ACTRIS SOP WP3_D3.13_M24.pdf.

Additionally to this recommendation, the RH of the sampling flow should be also kept below 40 % to be operated as the same RH as the MPSS.

We would also like to refer to existing guidelines & publications, which can be found under: https://www.actris-ecac.eu/ccn-nc.html

3 Optical variables

3.1 Particle light scattering & backscattering coefficient - multi-wavelength (WCCAP, PACC)

The recommendation here is to use an integrating nephelometer. **When possible**, measurements shall be achieved within the **PM10 size fraction** (exceptions are for mountain sites, using a whole air inlet).

The instrument should fulfill the following criteria.

- The instrument should be a **multi-wavelength Integrating Nephelometer** (IN). Single wavelength instruments can't be correct for the truncation error using parameterizations based on the scattering Ångström exponent.
- **Total scattering and backscattering** should be determined.
- The sampling flow rate should be set to a constant value. It should be set so that the response time of the nephelometer is no longer than 5 minutes. Take into account the volume of the measuring cell - depending on the turbulent mixing in the volume, the residence time may be longer than the volume/flow rate quotient.
- The data output rate should not exceed one minute. The internal averaging time should correspond to this time and no further data filtering should take place.
- Capability of calibration with two gases. The preferred calibration gases are particle free air (low span gas) and CO_2 (high span gas).
- Automatic measurement of the baseline at regular intervals (minimum once a day) with particle free air (low span gas). This flow rate must not differ more than 20 % compared to the fixed regular sampling flow rate.
- Instruments can be driven by a blower or a pump. It must be ensured that the flow at the aerosol inlet is rather stable (+/- 1 l/min), even during automatic zero measurements.

- It is sufficient to measure T, RH, and p in the cell of the integrating nephelometer.
- Procedures to correct for light source non-idealities and the truncation error must be available.

These corrections methods can be:

- Mie scattering calculations based on knowledge of the truncation angles and light source characteristics. This method also requires measuring the particle number size distributions. This method is applicable to single and multi-wavelength instruments.
- Tabulated correction function as function of the scattering Ångström exponent (Müller et al., 2011). This method only is applicable to multi wavelength nephelometers.

We would also like to refer to existing guidelines & publications, which can be found under:
https://www.actris-ecac.eu/particle-light-scattering.html

3.2 Particle light absorption coefficient (WCCAP, PACC)

Specifications for instruments measuring the particle light absorption coefficients are given for **filter-based Absorption Photometers** (AP). **When possible**, measurements shall be achieved within the **PM10 size fraction** (exceptions are for mountain sites, using a whole air inlet).

Filter-based APs are simple in their technical construction. Therefore, the list of hardware requirements is rather short. In addition, however, their requirements concerning the data recording and data evaluation.

- The **sample flow through the filter must be measured**. Since an uncontrolled flow decreases when loading a filter may occur, it is recommended to control the sample flow.
- The **attenuation or transmission of light must be recorded**.
- When exceeding an instrument specific maximum attenuation, the filter must be changed either automatically or manually. The station user must estimate how long the device can operate unattended.
- The sample spot size must be regularly checked. Diffuse edges indicate a problem with the closing mechanism.
- The filter type must have been calibrated for use in that instrument. Calibration factors are needed for data evaluation.
- Instruments often report the equivalent BC concentration. The conversion formulas of measurement quantities in optical units to equivalent black carbon used during the measurement by the instrument software must be known.
- The instrument must record housekeeping numbers and the measured raw intensities.
- The sampling flow should be recorded.

Exploratory platforms:

Especially for chamber studies, the flow rate should be minimum to enable long measurements.

We would also like to refer to existing guidelines & publications, which can be found under:
https://www.actris-ecac.eu/particle-light-absorption.html

4 Chemical variables

4.1 Mass concentration of particulate organic tracers (OGTAC-CC)

The calibration center for organic tracers and aerosol constituents (OGTAC-CC) will start their implementation activities as soon as the ACTRIS- Germany funding is available. Training of operators and scientists in good practice related to filter sampling, sample transport and storage, sample preparation until data analysis is one of the main aims of the TC unit. During the implementation phase, OGTAC-CC will focus on harmonizing these different steps as well as to define the respective target compounds in close collaboration with the NFs interested in the respective labelling. For the direct analysis of organic particulate constituents, up to now OGTAC-CC is not recommending a dedicated technique. Classic instrumentation using LC and/or GC with MS or FID detection will enable a sufficient determination. The implementation phase will be used here for laboratory intercomparison to develop standard operating procedures (SOPs) for different (groups of) target compounds, enabling an appropriate analytical measuring strategy. All steps will be evaluated in collaboration between OGTAC-CC and the NFs, finally resulting in measurement guidelines and defined QA/QC procedures.

4.2 Mass concentration of particulate organic and elemental carbon (OGTAC-CC, ERLAP)

ACTRIS recommendation is to follow the **CEN standard - EN 16909:2017**: "Ambient air - Measurement of elemental carbon (EC) and organic carbon (OC) collected on filters". The reference method described in EN 16909 is the off-line thermal-optical method, applying the thermal protocol EUSAAR-2. The following points of EN 16909 are particularly important:

- A**t least one field blank** shall be collected **every 14 samples**.
- **Samples** should be **stored at temperature below 5°C**, if not analyzed within 28 days from sampling.
- Instruments shall be **regularly calibrated for TC at least once every 12 months and after any major maintenance/modifications**.
- The calibration should be checked at least every measurement day, e. g. by the analysis of a sucrose spiked filter. Better use a certified sucrose solution for this.
- To verify the instrument's long-term stability, at least one punch of a large control filter shall be analyzed on each measurement day or for each sample batch. Control filters can be obtained from ECAC on request.
- Temperature probe calibration shall be checked at least every 12 months and after any major maintenance/modification.
- Laser signal noise and drift shall be checked during instrument blank analysis on each measurement day or for each sample batch.

On top of EN 16909, ACTRIS recommendations include:

- Except if technically not feasible, carbon monolith denuders shall be installed downstream of the sampling head and upstream of the filter holder. Denuders' dimension should be such that the residence time in the denuder is about 1s. Denuders should be regenerated at least every 3 months or 2000 m^3. The use of denuder is particularly important at remote or rural background sites where the relative contribution of positive sampling artefacts is higher.
- Field blanks shall be sampled for ca. 30 to 60 s (which is not specified in the EN16909 standard).

- The response of the instrument in the helium and in the helium/oxygen modes shall be checked on each measurement day (or sample batch) by injecting a fixed amount of calibration gas in the two analytical modes and should not differ by more than 5 %.
- The laser correction coefficient shall be ≤ 1 but ≥ 0.9.
- The transit time shall be regularly verified.
- The available integration options (such as the initial laser signal value determination, baseline, laser and detector slope corrections) leading to optimal determinations of the peak areas and split point shall be selected. Be sure to record the applied options in your Metadata.

Until further notice, the use of alternative methods for determining OC and/or EC under ACTRIS is **NOT** prohibited. This includes the thermal-optical **on-line** analysis of OC and EC, for which the use of the **EUSAAR-2 thermal protocol** is recommended. In any case, users of alternative methods shall demonstrate their equivalence with the reference method described in EN 16909 according to international standards (see e. g. EN 12341).

4.3 Mass concentration of non-refractory particulate organics and inorganics (ACMCC)

Based on a less sensitive but more robust technology than state-of-the-art and well-advanced aerosol mass spectrometry, the aerosol chemical speciation monitor (ACSM) has been designed to provide continuous measurements of the main non-refractory chemical species within submicron aerosols over years, which is particularly well-suited for ACTRIS observatory platforms.

There is currently only one company providing such devices. This company is proposing two models of ACSM: one equipped with a quadrupole, and the other with a time-of-flight detector. The Quadrupole ACSM shall be chosen by default, notably because it is less expensive and easier to use. The Time-of-Flight ACSM, displaying lower detection limits, is suitable for NFs located at very remote (or altitude) sites.

At ACTRIS observatory platforms, ACSM measurements shall be preferentially conducted using so-called PM1 lens and standard vaporizer. ACSM equipped with PM2.5 lens and/or capture vaporizer are not recommended yet.

It is expected that all instruments be calibrated and intercompared at the ACMCC at least once every three years. Recommended installation, calibration, sampling and data treatment procedures have been discussed and agreed within the corresponding research community in the frame of the COST Action COLOSSAL.

We would also like to refer to existing guidelines & publications, which can be found under:
https://www.actris-ecac.eu/pmc-non-refractory-organics-and-inorganics.html

4.4 Mass concentration of particulate elements (EMC2)

Offline filter-based measurements could be done within the PM10, PM2.5 or PM1 size fractions alike. Specific recommendations that update what given in the quoted guidelines are the following. It has to be noted that currently no explicit recommendations for online elemental analysis are given, such as those using the Xact 625 or 625i Ambient Multi-Metal Monitor device, other than to follow the specific instructions from the instrument manufacturer.

Filters

The best filters for elemental analysis of aerosol samples using PIXE (or IBA techniques in general), ED-XRF, ICP or IC techniques are those:

- Should not contain the elements one wants to detect (so filters made of light elements alone, atomic number Z < 10);
- Should be clean, with low contamination.
- Should be thin (possibly lower than a few micrometers or 1 mg/cm^2), to reduce the background in PIXE spectra and the contribution of residual bulk contaminants.

EMC2 recommends mainly the use of pure ring-supported stretched thin Teflon (CF2) filters such as Pall Life Science Teflon W/RING 2 um 47 mm (product id R2PJ047) or equivalent, or, as a second choice, Nuclepore filters. However, it has to be noted that Nuclepore filters could pose some problems during sampling (clogging) and during the gravimetric measurements due to the strong tendency of the Nuclepore filter to acquire an electric charge (also filter manipulations is an important cause of charging). The Pall Life Science Teflon filters can be used also for the preliminary gravimetric determination of the total atmospheric aerosol sample mass. The possible electrostatic charging of Teflon filters does not pose a problem for elemental analysis.

Sampling

The sampling should produce as much homogeneous aerosol deposit as possible. The ACTRIS Elemental Mass Calibration Centre recommends choosing/using proper filter supporting grids, and not to have a checkered pattern of the deposit on the filter.

Sample storage

EMC2 recommends that after the sampling the filters should be stored in Petri slides in order to avoid that the filter surface with the aerosol deposit on it could get in contact with materials that could result in loss of the aerosol deposit or in contamination. Putting the filters directly into small ziploc plastic bags or wrapping them with aluminum foils should be avoided. Note that wrapping with aluminum the Petri slides themselves holding the filters or putting them into ziploc plastic bags is allowed. Before the analysis samples should be stored possibly at temperatures lower than 4°C.

We would also like to refer to existing guidelines & publications, which can be found under:
https://www.actris-ecac.eu/pmc-elements.html