Answer to RC1

The manuscript titled “STRAS: a new high time resolution aerosol sampler for PIXE analysis” has developed a new hourly sampler, called STRAS, which can be used to automatically collect sequential samples of up to 168. Specially, a small surface area for depositing particles is designed for detecting elements using the Particle Induced X-ray Emission (PIXE) technique. Field measurements were conducted to perform comparison between STRAS and other sampling instruments. Overall, it is a good advancement of the sampling technique. There are several comments that need to be addressed as below.
The main issue is how to verify the accuracy and reproductivity of the newly invented sampler? The manuscript has compared the results between STRAS and Gemini, which both shared the same inlet, cabinet, pump, air flow control system as stated by the authors. As samplers are subject to various uncertainties and Gemini is not a reference sampler, the good consistency between STRAS and Gemini doesn’t guarantee the reliability of STRAS. It is essential to use standard particles with known concentrations and compositions for verifying a new instrument.

Gemini and STRAS share the same inlet, cabinet, pump and air flow control system, but the sampling chamber and filter holder are extremely different, and these are the critical points we wanted to test. With a high-resolution continuous sampler, like STRAS, the critical point is the forcing of the air flow through a small surface on a filter, which has to move every hour.
In general, for a single mode sampler, the important aspects are the inlet and the flowrate, which together determine the cut-off diameter, and the absence of leakages (both lack of sealing and loss of particles on the internal surfaces).
In both Gemini and STRAS samplers the same commercial inlets are mounted in order to guarantee equivalent cut-off performances for PM10, PM2.5 and PM1 when operating at a flow of 1.0 m3/h; the flow is controlled and measured, and remains stable within 2-3%. These inlets are commercial ones; for PM10 and PM2.5 they are made according to CEN design (EN 12341:1998 and EN 14907:2005) but remodulated to work at a flow of 1m3/h, while for PM1 there is no international standard and therefore they have been designed - as do all those who sell PM1 sampling inlets - using the inertial impact theory.
As for Gemini, it may be considered as a reference sampler as it complies with EN 12341:2023 and it has just successfully completed all the tests conducted by TÜV Rheinland. As for STRAS, the aspects related to leakages were instead to be tested and for this reason the measurements described in this article are relevant. Possible air flow losses and loss of particles on surfaces were minimized in the design of the sampler (e.g., sampling lines are realized in anodized aluminum, a widely used conductive material which reduces wall losses which might affect especially small sized particles) and tests were performed to prove it by comparison with Gemini as described in the paper.
We agree that the use of standard particles is important especially for multistage samplers, and we already plan to use them to test the advanced two-stages version of STRAS.

Section 4.1, Since the authors have revealed the filter collection efficiency, is this collection efficiency robust or random? how to account for the loss of particles in the application?

This is an important point.
The 0.8 micron membranes have a minimum in collection efficiency below 100 nm (Hinds, 1999). Thus, filter collection efficiency is not random, but it depends on the size distribution of the particles: only elements with a size distribution strongly skewed towards the Aitken or condensation modes can be affected by significant losses. Focusing on the elements detected with PIXE (Z>10), significant contribution to the Aitken and accumulation mode (at least in urban areas) is expected for S and K only, as S is mainly present as secondary aerosol and K may be produced by biomass burning (see e.g. Bernardoni et al., 2017). In the measurements presented in this work and from previous measurements, a fair reproducibility is observed: the loss is always between 15 and 30% for S and between 20 and 30% for K. Conversely, for crustal and marine elements the effect is expected and proved to be minimal, as a result of the measurements we made to evaluate these effects. This allows a reasonable evaluation of the effect due to the collection efficiency and the correction of the results.
We also want to point out that this is a membrane type issue. STRAS can also work with the 0.4 micron pore size polycarbonate membranes, and with these the collection efficiency is close to 100%.

We have added in the conclusions of the text the following recommendations on how to account for these effects:

“Possible PM losses due to a reduced collection efficiency of these membranes were investigated by simultaneous sampling on ring-supported thin Teflon filters: significant effects (15-30% underestimation) were observed only for S and K, which are elements typically related to smaller particles originated by secondary aerosol processes and biomass burning, respectively (and thus with size distributions which extend down to below 100 nm, where the polycarbonate 0.8 membranes have a minimum in collection efficiency). As a consequence, it is important to be aware that S and K concentrations can be underestimated when using these membranes. In our tests these underestimations were found to be quite stable; however, some parallel sampling, even on a daily basis, may be helpful in determining correction coefficients for other sampling sites. It should be noted that the values found in this work can be considered maximum limits of underestimation since the tests were carried on in places characterized by a strong prevalence of ultrafine aerosols, such as secondary and combustion ones.”

Line 95 - 105: The description is not written in a scientific manner, it is more like a manual.

This part has been rewritten as follows:

The sampler has been conceived and designed in order to obtain a high-time resolution (modulable from 30 min to a few hours) PM10, PM2.5, and PM1 collection, on “small” (about 1 cm2) deposit areas, with automatic sequential sampling of at least 168 samples (1 week of hourly samples), to be mechanically robust, easy to use, compact and easily transportable

Line 288 – 289: I cannot foresee the application of STRAS in measurement of black carbon or brown carbon as aethalometer has advantages especially on its time resolution.

Indeed STRAS may be used “side-by-side” with the aethalometer. However, the possibility of off-line black carbon and brown carbon measurements on the filters collected with STRAS has its advantages. First of all, there is no need for a different instrument (i.e. an Aethalometer) running in parallel to STRAS sampling. Further, laboratory instrumentation (see e.g. the polar photometer PP_UNIMI (Bernardoni et al., 2017) and the multi-wavelength absorbance analyzer MWAA (Massabò et al., 2015)) measuring both transmitted and scattered light and applying the same radiative transfer scheme as the one used by the Multi-Angle Absorption Analyzer (MAAP; Petzold and Schonlinner, 2004) can provide the information on the aerosol absorption coefficient at different wavelengths (and consequently on BC and BrC) with no need of loading corrections and assumptions on multiple scattering enhancement parameters.