Response to reviewer's comments:

The authors are thankful to the reviewer for the constructive comments and suggestions. The authors' responses are provided in *italics*.

Anonymous Referee #1:

This manuscript presents an optimization of a previously published low-cost optoacoustic black carbon (BC) sensor designed for long-term BC measurements in highly polluted environments. The sensor is based on an ellipsoidal chamber that separates the quartz tuning fork transducer from the aerosol flow path. The optimization consists of a protective clean-air sheath flow that prevents BC from depositing on sensitive components while minimizing acoustic noise from the sheath flow. This results in a reduction in contamination by orders of magnitude, as demonstrated by an experimental study and statistical evaluation. The authors claim a significant reduction in maintenance requirements, enabling the deployment, monitoring, and regulation of BC emissions in harsh environments.

In my opinion, the paper is well organized, fits the scope of the journal, and should be published, subject to minor revisions as detailed below:

Thank you for the constructive comments and suggestions.

Methodology:

- At which temperature(s) were the sensors operated?
  - *The following sentence is added to the methods section: "The sensors were operated at room temperature around 21°C and a slightly warmer sample temperature around 25°C."*
- The tests were mainly conducted with „dry" soot - Would humidity and/or volatiles affect contamination?
- *The following sentence is added to the discussion: "In laboratory tests, the burner exhaust sample retained some 40% relative humidity. Humidity should be controlled at a level that does not risk condensation inside the chamber, as in any optical system. Controlling the sheath flow humidity levels offers additional protection, even when the sample itself is at high humidity.*

Results section:

It would be interesting to see a performance comparison of the sensor with and without sheath flow regarding:

- *noise
  - *The noise is analysed in Figure 3 d) showing the standard deviation via the BC mass exposure. While the initial noise of the sensors is similar, the noise increases for the unprotected control due to contamination. The following sentence is added to the methods section: "The noise, and especially the baseline offset, depends on the total flowrate through the sensor rather than by each individual flow stream. With the current version of the sensor, a whistle-like noise is introduced when total flowrate increases above 3.5 lpm, that could be improved by better aerodynamic design, if so needed."*
- *LoD & linearity

- *The following has been added to the methods section: "The limit of detection (LOD) and linearity might be affected by the protective flows introducing an unwanted additional dilution. To investigate, the signal intensity has been monitored for different ratios between the sample and protective flows to ensure that the sample is not diluted by the protective flows. In preparation to the presented experiments, suitable flow settings have been identified for which no change in the signal was observed for constant BC concentration."*

- *rise time
    - *The following has been added to the methods section: "In general, the rise time is dependent on the flow rate, the dilution and the length of the sample lines. The sample lines and flow rate are the same for the unprotected control and the IDSS. ~~A dilution from the protective flows has been excluded.~~ Therefore, the rise time for both sensors is the same. However, different dilution and sample lines are present for the reference instrument MSS resulting in a delayed response in comparison to the IDSS."*

- *Allan deviation
    - *The following sentence has been added to the discussion: "An Allan deviation analysis has not been performed but is planned for future experiments. Since the oscillation behaviour of the QTF is not impacted by the sample and the protective flows due to the large spatial separation, we do not expect different behaviour for the IDSS in comparison to the unprotected control."*

How is the baseline correction performed in more detail? Is a lock-in technique used? If yes, is the phase of the signal considered for the background subtraction?

- *The following has been added to the methods section to describe the correction in more detail: "The baseline correction is a simple subtraction of the mean offset determined during BC-free sampling. In case of a baseline increase, a linear increase of the offset was assumed during BC sampling and considered during subtraction. The signal was determined via a digital IQ-demodulation; however, phase differences could not be resolved. Faster signal acquisition would allow for more in-depth analysis of the phase difference between noise and OptA signal. Considering phase information could make the baseline correction more precise if necessary."*

Fig 3: the colors of the data points are hard to distinguish

- *The color scheme has been changed to distinguish the plots better.*

Fig. 3a: What does the rising line represent?

- *The rising line represents the control sensor, which is not protected from contamination. The signal rises as particles attach on the optical windows and an additional signal is generated, which is always present even during BC-free sampling intervals. This is why a baseline correction is implemented*.

Fig. 3b: Where are the spikes in the control and IDSS coming from?

- *This sentence has been added to the results section: "Spikes are visible in the data of the IDSS, which are similarly present in the MSS data. Thus, the spikes are originating from the sample itself."*

Discussion:

- How was the sensor calibrated (MAC vs. BC mass concentration), and what would a calibration scenario for field deployment look like?
    - *The following has been added to the results section: "The sensor was calibrated via a linear fit of the signal in mV versus the mass concentration of BC measured by the MSS." (Additional references were included in the manuscript.)*
- Would there be a possibility to track possible contamination (e.g. resonance frequency of the tuning fork) during field deployments?
    - *The following has been added to the discussion: "For optimal signal capture during field deployment, the resonance frequency of the QTF can be tracked by implementing regular frequency sweeps of the laser modulation. However, a contamination effect of the QTF as such has not been observed so far. Observed contamination is caused by deposition on the optical windows, which also results a change in baseline signal. In field deployment, regular measurement of the background signal can be automatically implemented to determine the condition of the sensor."*