Author's Comments on "A high transmission axial ion mobility classifier for mass-mobility measurements of atmospheric ions" *by Leiminger et al. – amt-2022-29*

We thank Reviewer #1 for the comments and suggestions, which helped to improve the manuscript. In the following, we present our reply. The reviewer's comments (RC) are marked in *italic*, our replies (AC: author comment) follow in roman and the improved manuscript text is shown in blue.

Response to Reviewer #1:

(RC 1-x: reviewer #1 - comment x)

RC 1-1: L132: 'The sheath flow is recirculated via a brushless blower (model code: 465.3.265-841) from Domel, Slovenia, at experimentally determined flow rates of approximately 50 to 115 L/min.' I was confused by this expression, as the sheath flow rate is obviously an important parameter for the AMC. Detailed descriptions about the measurement and control of the sheath flow would be needed.

AC 1-1: We thank the reviewer for this comment. We agree that the reader would benefit from a more detailed description of the sheath flow control. We changed the manuscript text accordingly.

Line 132: The sheath flow is recirculated via a brushless blower (model code: 465.3.265-841) from Domel, Slovenia. The rotation speed of this device can be controlled with a pulse width modulated (PWM) signal. We used an Arduino uno board (Elegoo UNO R3 Controller Board) to set the speed of the blower. The Arduino offers an output voltage of 0 to 5 V. These can be realized by PWM in 256 discrete steps. The blower would allow up to 10 V as input. The maximum output voltage of 5 V from the Arduino board turned out to be sufficient for a full characterization of the instrument. We figured out that the blower did not start for voltages below about 2 V. Therefore, we selected voltage steps of 0, 2, 3, 4 and 5 V allowing to run the blower at five different speeds to generate the sheath flow of the AMC. Taking the known electrical mobility Z of the THAB monomer as the half-pass mobility $Z_{1/2}$ and the corresponding AMC voltage determined from the sigmoid fit, we estimated sheath flow rates of roughly 50 to 105 L/min with Equ. 5, see section 3.2.3.

Line 165: The blower was set to voltages 0, 2, 3, 4 and 5 V.

Line 278: Here, r is the tube radius, Q_{total} the **total** flow rate, $\Delta\phi$ the electric potential difference **obtained from the sigmoid fit of the AMC scan corresponding to $Z_{1/2}$**.

RC 1-2: Figure S1. It seems that the values for y-axis (e.g., fraction of THAB 3er (-)) are occasionally smaller than zero. I am wondering how the data were measured/analysed.

AC 1-2: In the supplement, we only show pre-processed data. Here, the offset of the electrometer is not yet accounted for. The final data processing involved the following steps: A) electrometer offset correction, B) conversion from ion current in units of fA (femto Ampere) corresponding to particle number concentration in units of cm^{-3}, C) correction for the different flow rates passing the detectors of the electrometers 1 and 2, D) correction factor accounting for systematic differences in ion current measurement from the electrometer position. We added the following sentence in the caption of Fig. S1.

The figure shows pre-processed data prior electrometer offset correction.

RC 1-3: L257: 'Fig. 5 panels C and D.' - Figure 6?

AC 1-3: Correct, we wanted to address Fig. 6. We corrected the expression in the main text.

Line 257: Fig. 6 panels C and D

RC 1-4: L268: 'We attributed the reason for this initial increase in transmission to the combined effect of sub-isokinetic sampling in the region of the core sampling and elevated electric fields that might reach into the core sampling as is exemplarily illustrated in Fig. S5.'

AC 1-4: We explain now in more detail the observed effect.

We explain the reason for the observed initial increase in transmission with the following. In Fig. S5 the electric field lines inside the AMC device are illustrated. Some of the field lines reach the entrance of the core sampling. Considering the flow profile in z-direction, see the lower panel of Fig. 4, there is a sharp drop in flow velocity in the tube centre at the entrance of the core sampling. In front of the core sampling the flow streamlines split into a small sample flow being drawn into the core sampling that reaches the detector and a much larger flow being pulled to the blower and the exhaust. The larger the difference between aerosol- and sheath flow the smaller is the area of the aerosol streamlines. With a smaller area of the aerosol flow at high sheath flows, the way for the discarded aerosol flow around the core sampling is longer. A combination of a lower ion drift velocity at this location and elevated electric fields pointing into the core sampling might force additional ions to enter the core sampling instead of following the streamlines.

RC 1-5: L293: 'The results of the sizing resolution in relation to the ratio Q total /Q ae are shown in the lower panels of Fig. 7.' How was the resolution defined? It needs to be explicitly explained.

AC 1-5: We would like to point to section 3.2.1. where we describe how we define the resolution. In addition, we will update Fig. 5 with two additional lines to indicate the parameters used for determining the resolution to improve the interpretability. We will add the following to the text and the figures caption.

Line 226: The half-pass mobility at the maximum of the pseudo-peak corresponds to the electrical mobility of the ion of interest**, as indicated in Fig. 5**.

Line 442: The black line indicates the half-pass mobility, $Z_{1/2}$, and the dashed black line the FWHM, ΔZ.

RC 1-6: *Figure 8, Figure caption/legend does not tell what the dashed lines are. They need to be updated.*

AC 1-6: We agree. We will update the line styles of Fig. 8 accordingly.

RC 1-7: *Figure 9, x-axis of the upper panel is hidden by the lower panel. It needs to be modified.*

AC 1-7: In this figure, the x-axis of the lower and the upper panel is the same and therefore we removed the duplicate x-axis of the upper panel to allow reduction of the overall size of this large figure. The same was done with the y-axis of the upper and the right panel. We added a comment in the figure caption raising attention to the reader about this fact.

In the central panel of the figure, an exemplary mass-mobility scan of ambient ions, averaged from 10 am to 4 pm on 12.03.2020, is shown. The lower panel shows selected m/z traces during the AMC scan. **The central and the lower panel share the same horizontal axis.** In the right panel, a mass spectrum integrated over all AMC voltages is shown. The two magenta-coloured lines represent the extrapolated half-pass voltage (mobility) for all m/z estimated from the average half-pass voltage for the three mass ranges 200 to 300, 300 to 400 and 400 to 500. The line in light blue indicates the half-pass mobility voltage of m/z 102.128, and the dark blue line to m/z 186.222. The AMC voltage integration step width is 26 V.