Response to comment

We would like to thank Dr. Fierz for his comments. Please find below the point-to-point response to the questions raised.

1) The influence of particle morphology on diffusion charging (unipolar and bipolar) is well known, so it is obvious that instruments based on diffusion charging will - at least potentially - be sensitive to particle morphology (you should add one or more references to this).

   Answer: We have amended the text as follows (Lines 161-163): This indicates that the exact morphology (e.g. primary particle size, effective density) of the test aerosol had an effect on instrument performance as expected from previous studies (see Dhaniyala et al., 2011 and references therein).

2) To my knowledge, the fractal dimension of the particles is usually quoted when discussing effects on diffusion charging (rather than the density - because the density depends on the particle diameter). It would therefore be better to give an estimate of the fractal dimension of the particles rather than the density, also for comparison with previous studies on particle charging.

   Answer: We have now calculated the fractal dimension (see revised Table 1). We have also amended the text as follows: "The fractal dimension D_f of soot particles with a nominal GMD_{mob} of 100 nm was derived via image analysis of high-quality TEM-images using the FracLac feature of ImageJ 1.53e (ImageJ, National institutes of Health, USA). In a first step, the greyscale TEM-images were converted into binary images utilizing the auto-convert function of FracLac. In a second step, the D_f values were determined via the so-called box counting, averaging 12 rotations of each image. The D_f values summarised in Table 1 represent the average values obtained from at least 10 particles for each type of soot. These values agree well with those reported in previous studies for bare (i.e. freshly emitted) soot particles (Pang et al., 2022; Wang et al., 2017)".

3) Also, it is known from the literature that the differences regarding charging due to morphology increase with increasing particle diameter. Since the regulations include counting efficiency limits at 200 nm, where the issue of particle morphology is probably even more critical than at 100 nm, it would have been nice to extend the measurements up to 200 nm. Did you just decide not to measure larger particles, or were there issues of generating a sufficient number of such large particles with your soot generators (just like it is difficult to generate enough smaller particles with the MISG)?

   Answer: It is true that the observed deviations in the counting efficiency of the PN-PTI instruments are expected to increase at larger particle sizes. We chose, however, to focus on particles with a GMD_{mob} of up to about 100 nm because these particles are more representative of soot emitted from diesel vehicles (typical GMD mob between 50 and 90 nm). We estimate that soot particles with a mobility diameter of 200 nm would correspond to less than 10 % of the total number of particles emitted by the diesel vehicles, thus their influence on the counting efficiency of the PN-PTI instrument would be small. For this reason, some countries, e.g. the Netherlands and Belgium do not pose any requirements on the counting efficiency of PN-PTI instruments at a mobility diameter of 200 nm (technical specifications are only defined for particles with a mobility diameter of ≤80 nm).

   We have added the following clarification in Section 1 "Introduction":

   "PN-PTI instruments go through a type-examination procedure which may differ in each country. Among several tests, type-examination includes a counting efficiency and a linearity check typically performed with combustion aerosols. During their lifetime, PN-PTI instruments are checked for their linearity with polydisperse particles (typically with a GMD_{mob} of 70 ± 20 nm).

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The geometric mean diameter of the test aerosol was in the range used for linearity checks of PN-PTI instruments as well as in typical size range emitted by diesel engines. The scope of our study was to investigate possible differences that may arise when using different combustion aerosol generators during the type-examination and verification of PN-PTI instruments as well as to correlate with diesel engine emitted soot. We focused on DC-based instruments because we expect a larger impact of the aerosol properties on their response compared to CPC-based ones (Vasilatou et al., 2023)."

4) Pure diffusion charging is unsuitable for particle counting, as larger particles acquire more charge than smaller ones. There are multiple different ways to achieve a more uniform counting efficiency with a diffusion charger so that it can fulfil the PN-PTI specifications. The method chosen to achieve this is crucial for understanding the behavior of the instrument in experiments like this - e.g. how the device will react to precharged particles of either polarity, and also how it will react to the higher/lower charge that particles with higher or lower fractal dimensions acquire. Therefore, you should briefly explain the operation principle of the different devices. For example, the HEPaC and the DiTEST device use the same principle of operation, so it can be expected that they react in a similar way, whereas at least one of the other 4 devices uses a very different principle of operation and can be expected to react in a different way. Grouping the instruments by principle of operation might help explain the different types of instrument responses you observed.

   Answer: Dr. Fierz is absolutely right that a discussion on the design of the PN-PTI instruments could be useful in explaining some of the observed differences in their performance. However, most of the manufacturers do not provide any information on the operation principle of their DC-sensor neither on their website nor in the manual. The only relevant information that we could find were publications by Dr. Fierz on the design of the Partector. We would like to urge other instrument manufacturers to openly discuss the design of the DC-based devices with the scientific community and end-users as well.