Review of egusphere-2024-928

The authors report on a systematic comparison study of single-particle mass spectrometers (SPMS), focusing on particles with high potential for cloud condensation and ice nucleation. This is a large and important task that has been undertaken with great effort. One of the greatest uncertainties of the SPMS technology is the lack of knowledge about the comparability of data sets, which emphasizes the importance of direct comparisons. This unique study is well designed and provides important insights into the performance, practical considerations and a fair and unbiased comparison of the different instruments and concepts. The manuscript is technically sound, interesting and well written; I have no concerns that this manuscript is suitable for publication in ACP.

I found a few minor errors and have some comments that might help to further improve the manuscript:

- From their study, the authors gained detailed insights into some well-known general weaknesses of SPMS technology. In the conclusion/outlook, development directions for improvements and developments beyond the current technology could be discussed. For example, optical detection of all SPMS is limited to particles larger than ~150 nm (and not MS sensitivity) due to light scattering limitations. Strategies to improve quantification were also suggested (and referred to) and could be briefly discussed.
- L43/44: Repetitive wording "We found…"
- The abstract could also be a bit shorter. E.g. one of the studies key finding "We found that instrument-specific DE was more dependent on particle size than particle type." is somehow hidden behind detailed correlation data.
- L89: 405 nm diodes → 405 nm laser diodes
- L99: The two step approaches do not only reduce fragmentation. As part of the ionization occurs in the particle's gaseous plume, quantification can be improved (Woods et al., 2001) and resonance effects can be used to increase the sensitivity to organics (Passig et al., 2022, Schade et al., 2019).
- L240 The LOD refers to the optical detection limit, so consider e.g. "…most of the particles were smaller than the optical detection limit of most SPMSs…."
- L244: was the abbreviation DSF introduced before? Maybe I missed it…
- L253: PALMS has high hit rates because the second detection laser is very close to the ion source. However, this design has also drawbacks, as solid-state ionization lasers cannot be used and the particle detection optic's layout is limited by the ion source. Therefore, ATOFMS and ALABAMA seem to be superior for ultra-fine particles, see e.g. Fig. 3c (Snomax).
- L263: Could the DE values for both modes of the miniSPLAT be shown in table 1?
- L330: Two Typos: "ALABMA" and "LAATOF"
- Table 1: The ATOFMS sizing lasers have probably 532 nm wavelength, if they are Nd:YAG.
- Table 1: Use mm or cm consistently.
- Table 1: Hit Rate PSL for miniSPLAT should also be annotated with footnote "b".
- Table 3: "One fork shape" and "Two fork shape" sound nice but should be put in quotation marks.
- Fig 1: In case you have problems with the length of the manuscript, consider to remove figure 1 as it contains no important information for the reader.

References

- Woods, E.; Smith, G. D.; Dessiaterik, Y.; Baer, T.; Miller, R. E. *Anal. Chem.* **2001**, *73*, 2317–2322
- J. Passig, J. Schade , R. Irsig , T. Kröger-Badge , H. Czech , T. Adam , H. Fallgren , J. Moldanova , M. Sklorz , T. Streibel and R. Zimmermann, *Atmos. Chem. Phys.*, 2022, **22** , 1495—1514
- J. Schade , J. Passig , R. Irsig , S. Ehlert , M. Sklorz , T. Adam , C. Li , Y. Rudich and R. Zimmermann, *Anal. Chem.*, 2019, **91** , 10282 —10288