08/19/2022

RC3: 'Comment on amt-2022-185', Anonymous Referee #3, 21 Jul 2022

Author statement: The authors thank the referee for reviewing this manuscript. An itemized **response** for the rebuttal can be found below for each response given in blue. The tracked-changes version can be found below for each response in red and the already existing text is in *italic*.

General comments:

A modified version of Commercial POPS is presented. Authors used a high-precision multichannel analyzer to improve count rate limitation. A needle valve and vacuum pump are used to provide additional flow stability. The overall goal of the manuscript is to characterize the modified POPS instrument along with the comparison with commercial one. Authors also presented a practical application of the modified POPS, which is the detection of phase transition using high-resolution pulse height data. The reviewer finds the manuscript exciting and a good read. Authors have taken care of explaining minute details and nicely present the work. Review recommends publications with the following comments/suggestions:

1. Reviewer is interested in knowing the commercial aspects of modified POPS, for example, cost, size, and portability. Can we still use the modified one for field measurement?

Manuscript: *As shown in Fig. 2, the unit was placed inside a 19" rackmount enclosure. No effort was made to minimize the height and weight of the enclosure or the power consumption of the unit. The additional power requirement beyond the factory design depends on the vacuum pump. We used an ~400W model, but smaller pumps will be sufficient. The rackmount form factor is suitable for laboratory and field applications, including measurements from mobile platforms such as vehicles or airplanes where size and weight are less critical than in balloon-borne deployments. The cost to modify the factory supplied unit was ~US $6,500, including the MCA card, enclosure, vacuum pump, needle valve, power supply, Swagelok fittings, electrical connections, and particle filters*.

2. Reviewer would suggest showing a laboratory picture of modified POPS setup/instrument.

Response 2: We added a picture of the modified version of the POPS.

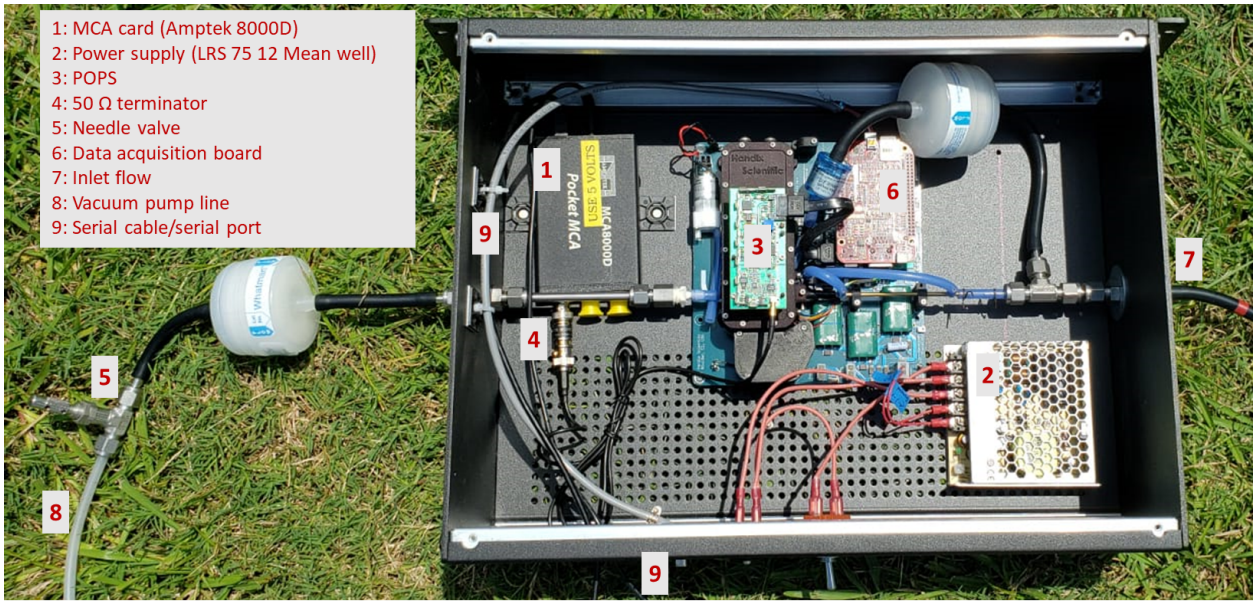

Figure 2: *Photograph of the modified POPS.*

3. Reviewer thinks section 2 should contain the details of the modified POPS, and sections like 2.1 to 2.4 should be discussed in the result section (3). Additionally, section 2.5 should go in the supplementary material.

   Response 3: Thank you for the suggestion. However, per standard convention, we prefer to keep Methods and Results as separate sections.

Minor comments:

1. Reviewer wonders why figures in the manuscript have a faded axis. Also, authors may wish to remove grid lines from figures.

   Response 1: We increased the darkness of the gridlines in the revised manuscript. We prefer to keep this style of plotting the data.

2. In figure 4, reviewer thinks it is better to give the plot names instead of indicating the top, bottom, and middle. The inset of figure 7a is not clearly visible to the reviewer, and a box should be added to indicate the ROI.

   Response 2: We added labels (a), (b), and (c) to Figure 4 and modified the caption.

Manuscript: *Figure 5: (a) Digitizer-PH and (b) MCA-PH histograms for dry size selected ammonium sulfate particles between 200 nm and 700 nm. The histograms were normalized such that the largest value equals unity. (c) Comparison of Digitizer-PH and MCA-PH at the peak of the histogram. Error bars correspond to the 95% confidence interval of the mode determined via a curve fit of the data to a lognormal distribution. The line corresponds to linear regression with the equation Digitizer-PH=MCA-PH*50.59-92.57.*

3. L75, reviewer thinks author should write a line about how and why the 50 Ω terminator reduces the noise. Reviewer understands the use of a preamplifier, but what is the role of a shaping amplifier.

   Response 3: Significant noise was observed in the lower channels of the MCA. The 50 ohm terminator helped to reduce the noise. The shaping amplifier is part of the MCA card. As described in the documentation of the MCA card, the role of the shaping amplifier is to filter noise, to stabilize the baseline, and to provide enough gain for accurate measurement.

Manuscript: *A 50 Ω terminator was integrated to reduce electronic noise that was present in the lower MCA channels. The MCA card consists of a preamplifier and a shaping amplifier. The role of the shaping amplifier is to filter noise, to stabilize the baseline, and to provide enough gain for accurate measurement.*

4. L75, maybe reviewer misunderstood why high gain is 0-1V and low gain is 0-10V, expecting the reverse.

   Response 4: There are two different input voltage scales in MCA 8000D which correspond to 0-1 and 0-10 V.

Manuscript: *The card allows configuration for user selectable input ranges of either 0-1 V or 0-10 V. In this work, the 0-1 V setting was used.*

5. L95, what authors mean by critical flow conditions. Is it a predefined flow condition or maximum flow, or optimum flow?

   Response 5: Clarified as below.

Manuscript: *...is replaced with a needle valve and vacuum pump, operated at critical flow conditions. Critical flow refers to conditions where the flow across the orifice reaches sonic velocity and further decreases in downstream pressure have no further effect on the volumetric flow rate.*

6. In figure 1, the definition of HFDMA should be included in the abbreviations.

   Response 6: Done.

7. L105, from the reader's point of view, a sentence should be added to explain custom DMA. Furthermore, figure 2 should be moved to page 5.

   Response 7: The DMA is a high-flow DMA column operated at 9 L min^{-1} sheath flow.

Manuscript: *The response of the Digitizer-PH and MCA-PH data were characterized downstream of a DMA. A schematic of the setup is shown in Fig. 2. …The DMA consisted of a high-flow column (Stolzenburg et al., 1998) operated at 9 L min^{-1} sheath flow.*

8. L115, author compared the results of other bins? If a higher bin number is assumed to give better statistics, 1000 bins would be more appropriate.

   Response 8: The 500 bin resolution was a compromise between size resolution and counting statistics. As shown in Figure 4, 500 bins are sufficient to resolve the DMA distribution. Higher bin resolution will not improve the calibration accuracy.

9. L140, reviewer did not understand the meaning of a high-level overview. Is it a detailed overview?

   Response 9: Changed as follows:

Manuscript: *Figure 3 provides an overview of the setup.*

10. L140, reviewer thinks the short form of HFDMA should be introduced earlier. Maybe in figure 1 or in L105.

    Response 10: The abbreviation explanation is now also given in Figure 1 in the main manuscript.

11. L145, Form reader point of view unit should be consistent. Author can use either inches or m.

    Response 11: In this line we prefer to give both. Units should generally be given in metric but the imperial units here add context for why these values were selected.