

## ***Interactive comment on “Characterization of three new condensation particle counters for sub-3 nm particle detection: ADI versatile water CPC, TSI 3777 nano enhancer and boosted TSI 3010” by Juha Kangasluoma et al.***

### **Anonymous Referee #1**

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Reviewer's comments on the Characterization of three new condensation particle counters for sub-3nm particle detection: ADI versatile water CPC, TSI 3777 nano enhancer and boosted TSI 3010

#### General Comments

The major outcome of this work is systematic comparisons between two newest CPCs for detecting sub-3 nm particles, which are TSI-3777 and ADI v-WCPC. The reported results are valuable to the potential users of these instruments. However, readers are expected to feel that B3010 are not compared a systematically with v-WCPC and

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3777. For example, authors are showing that the detection efficiencies of v-WCPC and 3777 shifts to large sizes when TDDAB are used as the test particles. Reader would expect to see whether the butanol based instruments are also affected in a similar way or not. The same comments apply to the effect of moisture content on the detection efficiencies. Some readers may wonder whether the detection efficiencies of butanol instruments are different between unsheathed and sheathed. It is interesting to know the effect of flowrates on the detection efficiencies of B3010. However, since authors believe that the results are less impressive than their previous results obtained using 3772, it is probably not worth to presenting this results in this paper. I personally recommend to remove the results associated with B3010 in this paper, and gather and emphasize positive aspects of B3010 in another paper.

#### Specific Comments

Line 15-16. This statement communicates well but it sound too casual. I recommend to use more intellectual expressions since it is the first line of the abstract.

Line 24-26 Authors do not clearly state whether high  $\dot{V}_{ADT}$  setting detect ions generated by bipolar ion source or not throughout the paper. Please clarify somewhere in the text.

Line 73-74. I believe that one great benefit of using water as working fluid is that water vapor is generally not considered as a source of contamination whereas the organic vapor are often considered as contaminates.

Line 90 “effect of electrical charge” sounds more proper.

Line 98-110 The statement in line 101-102 “possibly altering the detection efficiency...” is not needed at this point since the purpose of this paragraph to describe the structure of the 3777, not to comment on its performance. Instead, authors may emphasize that saturator of the 3777 has a meandering path in a metal block instead of a porous wick used in butanol based ultrafine-CPCs. It is cumbersome to remove DEG liquid absorbed in a porous wick since DEG is viscous and has a relatively

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low vapor pressure.

Line 127 “Cheap second hand” sounds inappropriate. It give an impression that authors are looking down on older models. Is it true that simpler electronics of the older model made the modifications much easier?

The style of the schematic for B3010 are very different from those of 3777 and v-WCPC. If the data for B3010 are going to be included in this paper the style of the schematic should be similar to 3777 and v-WCPC.

Line 182-184 Uncertainty should include the particles size after neutralization since recombination between a charged particle and ions of opposite polarity may not transfer just electrical charge. The particle and ion may stick together to generate a larger particles as shown by Sipilä et al (2009).

Line 184-185 “it is the only method to measure d50 for neutral particles. . .” This statement is not entirely true since Winkler (2008, Science) measured the activation efficiencies for electrically neutral and charged particles using their expansion chamber.

Line 188: Title of the section 2.3 should be “Concentration Calibration and Atmospheric Sampling” to be consistent with the titles of 3.4 & 3.5.

Line 211 to 212 Resolution with respect to mobility diameter is about twice of the resolution with respect to the electrical mobility in free molecular regime. It seems more conventional to express uncertainty as the square root of a variance not as the full width half maximum.

Line 215-216 The statement “such as commonly used for mobility based . . .” does not seem necessary since the role of the bipolar ion source is already introduced in previous section

Line 243-254 The results shown in Figure 7 is very interesting although the measured values are being affected by several sources of uncertainties. It is recommended that authors discuss the sources of observed differences between positively and negatively

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charged particles after neutralization. One potential source is the difference in their chemical compositions as already stated by authors in line 235-236. Isn't it also possible that the neutralization efficiency depend not only on particle size but also on the polarity of the bipolar ions due to the difference in their mobility?

Line 260-261, and Line 338-342 The statements in these lines are rather extreme or too demanding. It is generally true that compositions of freshly nucleated nanoparticles are partially known from other measurement techniques or previous studies. It is still very useful to be able to measured particle size distributions and their uncertainties in sub 3 nm range after size-classification although their chemical compositions are not known completely. For example, if we are to investigate the effect of conditioning on the freshly nucleated particles it is not important to know the chemical composition of the DMA-classified particles since the material dependence of the detection efficiencies cancels out between before and after the conditioning.

Line 265 It is unclear the “error” stated by the authors refer to what measured variables.

Line 274-276 I understand that authors would like to support the instruments developed by their colleagues, but this statement is somewhat irrelevant to the objective of this paper. In addition readers would not understand why replacing internal pump with MFC reduces the water content.

Line 308-317, 3.5 Atmospheric sampling There seems to be equal number of bus departure time which does not show clear spikes. I believe that most reader would see from Figure 13 are the followings. The number concentration generally high during traffic hours, and both CPCs reacts instantaneously to the occasional spikes in the number concentration. Readers would be able see the concentration dependence more clearly if the data in Figure 14 are plotted on a log-log scale. One-to-one lines needs to be shown. Plotting data on log-log scale does not stop authors stating that there is an offset.

Line 336: not perfect => imperfect?

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