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Atmospheric Measurement Techniques Discussions

Interactive comment on "Characterization of an aerodynamic lens for transmitting particles >1 micrometer in diameter into the Aerodyne aerosol mass spectrometer" *by* L. R. Williams et al.

Anonymous Referee #1

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In their manuscript "Characterization of an aerodynamic lens for transmitting particles > 1 micrometer in diameter into the Aerodyne aerosol mass spectrometer" Williams and coworkers describe the development and characterization of a new aerodynamic lens and aerosol inlet system for the Aerodyne aerosol mass spectrometer (AMS). The Aerodyne AMS has developed into a standard instrument for chemical aerosol analysis within the last decade. However, still one of the major limitations of this instrument is the limited particle size range that can be measured with the standard aerosol inlet setup. Especially the cut-off for particles larger than $\sim$700 nm inhibits the measurement of true PM1 aerosol composition. After many years of development of an aerosol

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inlet system that enables the AMS to measure particles up to sizes significantly larger than one micrometer, here finally such an inlet system and its characterization are presented. Since the measurement of aerosol particles up to more than one micrometer with the AMS enables not only the true PM1-size range measurement with this instrument but also a measurement of other particle types like a large fraction of biological aerosol particles and in addition allows the measurement of the whole accumulation mode without truncating the larger particle size tail, this development is a very relevant innovation for the whole aerosol measurement community. The manuscript is written very clearly and easy to follow without lengthy passages or incomprehensively short passages. The measurements as well as the results are clearly presented. Besides several minor details I find only one major shortcoming in the manuscript: It is known – and this is also indicated in the text - that work on such a "high pressure lens" for the AMS was ongoing for many years with several copies of the assembly working rather well and others not performing as desired. In their manuscript Williams and coworkers describe in the "Machining the high pressure lens" section how they improved the machining process in order to better reproduce the production of well-working lenses. Still they have to admit that out of five copies of the lens only two generate a satisfactory deposition pattern, i.e. focus all particles into the same direction. This shows that machining is still an issue. Therefore it would be desirable that the authors present data that show that "good" lenses (i.e. the two out of the five) are able to reproduce the transmission properties as shown in Figure 5 for one single copy of the lens. Only if the reader can be convinced that it is reliably possible to produce aerodynamic lenses with all the desired features reproducibly this advancement becomes really relevant to the large number of potential users of this device. Therefore after including this information and taking care of the other very minor issues I suggest publishing this manuscript in Atmospheric Measurement Techniques.

Specific comments: P5035L3/4: "... that transmits particles between 80 nm and more than 3 μm in diameter." This was also true for the standard AMS lens, however with very little efficiency. It would be desirable if a statement would be added how well

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particles were transmitted.

P5035L15: Here are several references to papers from the same or almost the same group. The Canagaratna et al. 2007 paper would be sufficient to cite as it includes all the other references as a review paper.

P5035L22-25: The logic of the sentence is not completely correct. The collection "efficiency" cannot be a "combination" of the transmission "efficiency", particle "loss" and beam "spreading". Please reword.

P5036L3: Indicate how efficient the standard lens transmits particles in this size range.

P5036L18: "microns": slang

P5036L1921: The introduction of a relaxation chamber behind the critical orifice was already described by Gaie-Levrel in his PhD thesis (2009) and in Gaie-Levrel, et al., AMT 2012.

P5035/36: It would be desirable if a broader overview over the current state of the art in aerodynamic lens design and knowledge would be provided here. See also e.g. Lee et al., AST 2013 and discussion therein as well as the papers from the McMurry group.

P5037L4/5: The Stokes number is the ratio of particle stopping distance to a characteristic dimension of an obstacle.

P5038L3ff: It would be desirable if the process how the authors came to the current aerodynamic lens design would be described before the evaluation of this lens using the CFD modeling is described.

P5039L2: "This inlet distribution . . .": please be more specific of which variable is distributed.

P5040L7/8: "A significant fraction of the particles impact the back of the critical orifice or the walls and are lost." This cannot be seen in Figure 2.

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P5040L17: "... residence time in lens system ..." → "... residence time in the lens system ..."

P5041L8/9: Are the continuum assumptions implicit in the CFD software not "strictly valid" anymore in the vacuum or are they "not valid at all"?

P5042L23: Shouldn't it be "effective particle density" instead of "material density"?

P5043L18: The lower limit of 100 nm for particles to be detectable with an ion burst in the MS should be dependent on the particle composition. While some components generate signal at only a few m/z for other components the signal might be spread over many m/z, easily causing this limit to increase by a factor of two.

P5045L7: I suggest using "good" instead of "well" to avoid a potential misunderstanding.

P5046L2: Why was the count method not used for smaller particles than 300 nm if already 100 nm particles generate sufficient signal for counting? This could provide some overlap and thus increased confidence in the measurement results.

P5046L21: "... can select larger dm's than ...": Laboratory slang

P5046L28: Why is the uncertainty of the AMS ion count (+/- 500 Hz) a constant number and does not depend on the number of ions counted?

P5047L7: "Experimental particle velocities were determined ...": Laboratory slang (also in caption for Figure 4)

P5047L10: If there are measurement results for two different copies of the new lens, why is the reproducibility of the transmission efficiency not presented and discussed?

P5048L3: "... CFD model by recording ...": This sounds like a measurement.

P5048L13-22: The order the information is presented in this paragraph is somewhat confusing. Please reorder.

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P5049L11: It would be helpful in this context if at any place the SN of the lens which was used for the measurements presented in Fig. 5 would be provided.

P5049L24: Was the SN10 Lens re-aimed for every particle size individually or was it necessary to re-aim it just once? Please be more specific.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 5033, 2013.