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## ***Interactive comment on “Collection efficiency of the Soot-Particle Aerosol Mass Spectrometer (SP-AMS) for internally mixed particulate black carbon” by M. D. Willis et al.***

**Anonymous Referee #1**

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Review of “Collection efficiency of the Soot-Particle Aerosol Mass Spectrometer (SP-AMS) for internally mixed particulate black carbon” by Willis et al.

The authors present measurements made using the Aerodyne SP-AMS instrument using (mostly) laboratory generated particles that are mixtures between black carbon (Regal Black) and an organic (BES). They find that the measured rBC and organics depend on the extent of coating of the rBC particles by BES, showing that this is a result of particle beam narrowing upon coating and improved overlap between the particle beam and the SP-AMS laser beam. These are useful results to all users of this instrument, and will help to improve future quantification of both absolute rBC con-

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centrations as well as relative measurements of the relative abundances of rBC and associated coatings. I believe that this manuscript is publishable once the authors address the comments below.

P5225/L17: In addition to Bond et al. (2013) I recommend citing Lack et al. (2014) in mentioning different techniques used. See reference below. (Lack et al., 2014)

P5225/L24: Instead of “new” I recommend “recently developed.” “New” implies to me that this is the first reporting of this instrument. Also, I personally don’t think that it is necessary to mention that it uses the SP2 laser system. The SP-AMS simply uses a particular Near-IR laser.

P5226/L7: Although it is true that freshly emitted rBC tends to be smaller than Regal Black particles, by referring to the spherule sizes I find that this gives a somewhat misleading picture.

P5229/L4: “V-ToF” should be defined.

P5229/L4: The tungsten vaporizer should be mentioned earlier in this section. As written, this seems to assume the reader is quite familiar with possible differences in SP-AMS operation conditions.

P5229/L16: I find the sentence beginning “The signals arising. . .” to be a bit difficult to understand, and suggest rephrasing and/or elaboration.

P5229/L21: It is not clear what “was carried with each SP-AMS instrument” means.

P5231/L23: I was of the impression that particle bounce can also be an important issue, and that  $E_b = 1$  is only true for certain particle types. Can this be clarified?

P5231/L26: I am having some difficulty understanding how the mIE\_rBC,app values were determined “for a range of coating thicknesses” when the next section indicates that the apparent sensitivity of the instrument to rBC depends on the amount of coating. Clarification of this section is needed.

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Fig. 2: Why is only the UofT data fit and not the ARI data?

P5232/L23: The authors mention earlier that particle number concentration measurements are made to identify when homogeneous nucleation was a problem. Here, they note that such particles cannot be neglected. Although it may be true that they cannot be neglected, it would seem that the authors might have sufficient information available to let them know when this is a problem (or at least a bigger problem).

P5233: It would have been nice had the authors turned off the laser to determine the RIE for the organics (BES) from the tungsten vaporizer alone. This would have helped to understand the larger RIEs here. Ce'st la vie.

Fig. 2/P5233: One thing not really discussed is why the fractional increase in the apparent RIE is greater for Org than for rBC. Granted, the differences are not huge, but they are nonetheless noticeable. It would be useful if the authors could comment on this. One thought is that it is related to the dual laser/tungsten vaporizer operation. The Org are vaporized by both, but the rBC only by the laser. Further, that the Org apparent RIE increases at all is somewhat surprising, since presumably those particles not vaporized by the laser are vaporized on the tungsten vaporizer. Perhaps this is telling something about differences in the RIE between particles vaporized by the tungsten vs. laser vaporizer? Of course, it could also be related to particle shape and beam divergence when the particles are only thinly coated, which would also influence the organics. I think that much of this is hinted at, but could be more clearly stated.

P5234/L17: The authors state: "A decreasing signal transmission with a BWP centered in the particle beam is indicative of particle beam narrowing." Isn't this additionally complicated by non-unity  $E_s$  values for the uncoated particles?

Fig. 4a/P5235: I'm having some difficulty separating the results with the BWP centered in the particle beam versus positioned outside of the particle beam from this single figure. The associated text indicates that both are shown on this one figure. Can this be clarified?

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Fig. 4b/P5235: That the rBC and organic signal co-vary with an approximately 1-1 relationship is an important result, given that Onasch et al. (2012, Fig. 6b) observed very different dependencies of the organic and rBC signal on laser power, and that by blocking the beam the authors are forcing the particles to pass through outer regions of the laser beam that, presumably, have lower power due to the Gaussian beam shape. I suggest that this is emphasized. Ahh, I see that it is mentioned in more detail later in the manuscript (p5237).

P5237/L1: It is certainly true that a simple comparison between beam widths would not quantitatively provide information on the collection efficiency. However, it should be relatively straightforward to expand to 2 dimensions to account for the asymmetry of the laser geometry.

P5238/L7: “Standard” should be defined. Or perhaps just stated more explicitly as “using the RIE\_rBC for uncoated Regal Black and the and RIE\_Org typically used for organics.”

P5238/L18: It is not only when instrumental sensitivity is well known that the Regal Black fraction can be well estimated, but when the coating state is already known so that the appropriate CE (or RIE\_app) can be applied. Without such a priori knowledge of the coating state, the correct CE to use would not be known. This has important implications for laboratory experiments, but more importantly for ambient measurements. One question is whether some sort of recursive analysis methodology could be applied, where an initial estimate of the coating-to-core ratio could be determined from the raw data, which is then used to estimate the appropriate CE to use. A new coating-to-core ratio could then be estimated, along with a new CE and so on until convergence is reached. But, perhaps no convergence would ever be reached. Something for the authors to, perhaps, consider in future studies.

P5228/L25: Which should be that.

Lack, D., Moosmüller, H., McMeeking, G., Chakrabarty, R., and Baumgardner, D.:

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Characterizing elemental, equivalent black, and refractory black carbon aerosol particles: a review of techniques, their limitations and uncertainties, *Anal. Bioanal. Chem.*, 406, 99-122, 2014, doi:10.1007/s00216-013-7402-3.

Interactive comment on *Atmos. Meas. Tech. Discuss.*, 7, 5223, 2014.

**AMTD**

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