After reading the revised version and exchanging with the reviewers, I have some concerns that should be addressed before the manuscript can be accepted for publication in AMT.

I have exchanged with Reviewer 3, and I would like to share with you some of his points. To summarize, the question of the pixel size (related to the PIP compression approach) still needs some clarifications, as well as the influence of motion blurring on the derived particle size. These are items 1 and 2 below, that should be addressed. A 3rd item is listed and should be discussed, even if briefly only.

I copy below the detailed comments from Reviewer3 (concerning the last revised version).

1. Pixel size and compression

Re "average of 1.01 pixels added", which now is "1.0 pixels when suspended based on our statistical analysis" (L359 in ATC2-1)

I assume this could or should read "1.0 pixel on average when ...".

However, it is still not clear where the 1.0 pixel added on average comes from.

If this value is 0 or 1.0, depends on how the pixels are averaged during compression. As the authors claim that 1.0 pixels are added based on their statistical analysis, I assume that the PIP compression use the second way (of the two that I describe below) of averaging during compression. This is likely a result of the algorithm used. It should be clearly explained that is, apparently, due to this algorithm that the particle appears larger on compressed PIP images.

Two ways of averaging during compression; one using actual averaging of the cover percentages, another one using an assumed two-step algorithm:

One way of averaging would be to take the mean of the two cover percentages as the cover percentage of the new, compressed (0.1mm x 0.2mm) pixel. In that case, a 4-pixel (uncompressed or decompressed pixels of 0.1mm x 0.1mm) particle would after compression and averaging be still 4 pixels (0.1x0.1). Only in one special case 2 pixels (0.1x0.1) would be added by averaging, and this special case is the one depicted in Fig. 3a), third column, where the particle covers two compressed pixels (0.1x0.2) fully and two partially at 50% with one uncompressed pixel (0.1x0.1) covered (100%) and one uncovered (0%). If starting from this special case, the particle is moved somewhat up or down, then of these two partially covered compressed pixels (0.1x0.2) one will assume a cover percentage of larger than 50% and one smaller than 50%, i.e. only one of the two will be included in the particle image resulting in a 4-pixel (0.1x0.1) particle image. In other words, apart from the special case, all cases result in no additional pixel and 0.0 pixel are added, not 1.0.

Another way of averaging would be to first convert the uncompressed pixels (0.1x0.1) to 100% or 0% depending on the cover percentage being >= 50% or <50%, respectively. Then, in a second step, the mean of two of these 100% or 0% values is taken as the new averaged compressed (0.1x0.2) pixel. As an example (see FIGURE), if the particle covers 70% of one and 0% of the other uncompressed (0.1x0.1) pixel of the two that make up one compressed (0.1x0.2) pixel, then in the second step one becomes 100% and the other 0% and with that the compressed (0.1x0.2) pixel becomes 50% and is counted.

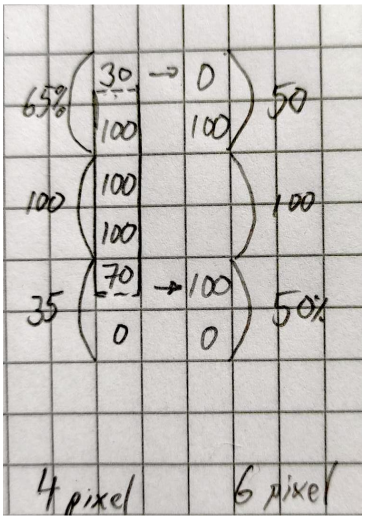

FIGURE: A 4-pixel one-dimensional particle placed on a grid of uncompressed (0.1 mm x 0.1 mm) pixels so that the top-most part of the particle covers 70% of an uncompressed pixel and the bottom end covers 30% of an uncompressed pixel. One way of averaging pairs of uncompressed pixels to get cover percentages of compressed (0.1 mm x 0.2 mm) pixels is indicated on the left, another way on the right.

2. Motion blurring

In the analysis in Sect 5.1, the authors argue that any point on the particle is blurred into a line along the direction of motion. The length of the line is calculated from the speed and exposure time. This length is added to the particle extension and results in a corresponding addition of pixels in the image according to the statistical analysis of randomly placing the enlarged particles on the pixel grid.

On a particle picture with sufficient quality, the particle would indeed appear extended by one time the motion-blurring length. It would appear "blurred" at both the top and bottom edges (in case of vertical motion). The blurring at these two edges would occur over one motion-blurring length at each edge. If and by how much the particle size will be modified by this motion blurring, depends on how the particular instrument "takes" the image of the blurred particle. I am referring to the technique or algorithm that decided which pixel belongs to the particle or not. In case of a suitable threshold discriminating background from particle pixels, the particle size will result unchanged. Depending on the exact threshold value, the particle could be smaller by up to one motion-blurring length, larger by one motion-blurring length. Or anything in between. It appears that the authors have implicitly chosen a very sensitive threshold that accounts to the particle everything that has the slightest difference to background and, in this way, enlarges the particle by one motion-blurring length.

Thus, this method of determining the additional pixels by adding one motion-blurring length to the particle without considering instrument specific thresholds or techniques may clearly over-estimate the measured size. The inevitably diffuse edges of the optical image (due to motion blurring and also other effects of optics or particle location within the sampling volume) will result in a sizing accuracy or bias. The particle enlargement presented in Sect 5.1 represents the maximum contribution that motion blurring can have on this sizing accuracy or bias. Depending on the instrument, the actual effect of motion blurring may be smaller. This should be discussed and the amount the effect will likely have be evaluated for each instrument, MASC, PIP, and DVD.

There is a last point that could be clarified, related to

3. Artificial cap and discussions around Fig 7 and Fig 8

I still believe that the main reason for the artificial cap is primarily due to pixelation effects and not due to the sensitivity indicated in Fig 9. That the cap is so pronounced is, as pointed out in the discussion of Fig 9, a result of the sensitivity to changes in the perimeter stretching factor when it is close to 1.

I would suggest that the authors do a new statistical analysis of circles being pixelated. Circles of various sizes are placed randomly on pixel grids and are then pixelated using a suitable algorithm (e.g. each pixel covered by more than 50% by the circle is accounted as particle pixel). From the analysis of these pixelated images a histogram as in Fig 9 can be plotted. Clearly, for a circle one would expect the perimeter stretching factor to be 1. Due to pixelation, however, I expect the perimeter determined from the pixelated image to be longer than the actual circle perimeter. Consequently, the perimeter stretching factor will be larger than 1 and, in the histogram, it will likely have a peak at a certain value (just as in Fig 9 now). There will also be a minimum perimeter stretching factor (which will result in an artificial cap if the same data are plotted as in Fig 5g). I would not be surprised if this minimum stretching factor would be around 1.05, i.e. explaining the artificial cap at 0.65.