Q1: The introduction would benefit from a brief description of what the parts of the inlet system/aerodynamic lens are and what each one does. such as the critical orifice, the buffer region, the apertures in the aerodynamic lens, etc. It would also help if the nomenclature is consistent between the figures and the text and between different parts of the text. Each part that is called out in the text should be labelled in Figure 1. For example, a virtual impactor is mentioned in line 139 but I can't tell if that is the same thing as the pre-focus hole or the buffer chamber in Figure 1 or something else entirely. Where is the critical orifice and what diameter is it?

A1: Thank you to the reviewer for your helpful suggestion, it led to meaningful improvements in our manuscript. Labels for each section, such as the aerodynamic lens, have been added to Figure 1, and the naming of each part has been checked in the text for consistency. For example, the injection system is now uniformly referred to as "injection system." In Section 2.1 of the manuscript, the roles of the various components in the injection system are described, along with the critical orifice diameter of 0.26 mm. Additionally, the structure of the virtual impactor has been added to Fig. 1, which is the same as that used by Du et al.

Q2: What is the pressure in each stage of the inlet? What does "low-pressure loss" mean in lines 106-107?

A2: We appreciate the reviewer's careful reading and constructive suggestions; they have positively influenced our manuscript's development. The pressure settings have been introduced in Section 2.2. In the simulation setup of this study, the boundary pressure at the inlet is set to 101325 Pa, the boundary pressure at the pumping outlet of the virtual impactor is set to 600 Pa, the boundary pressure at the nozzle outlet is set to 1 Pa, and the boundary pressure at the vacuum chamber outlet is set to 0.01 Pa. The pressure referred to for the buffer chamber and lens being below 300 Pa indicates the pressure inside the buffer chamber and lens under the aforementioned boundary conditions. This pressure condition is specified to align with Zhang et al.'s study to ensure the accuracy of the model setup. The description of low-pressure loss was originally intended to indicate that no acceleration of particles occurs as they pass through the pre-focusing structure, but to avoid any misunderstanding, the low-pressure loss has now been removed in the revised manuscript.

Q3: The authors mention multiple times that their goal is miniaturization of the SPAMS. Making the inlet smaller is not going to accomplish that. The size is really determined by the pumps and the mass spectrometers. It is ok to say that the goal is to extend the range of sizes transmitted by the inlet system.

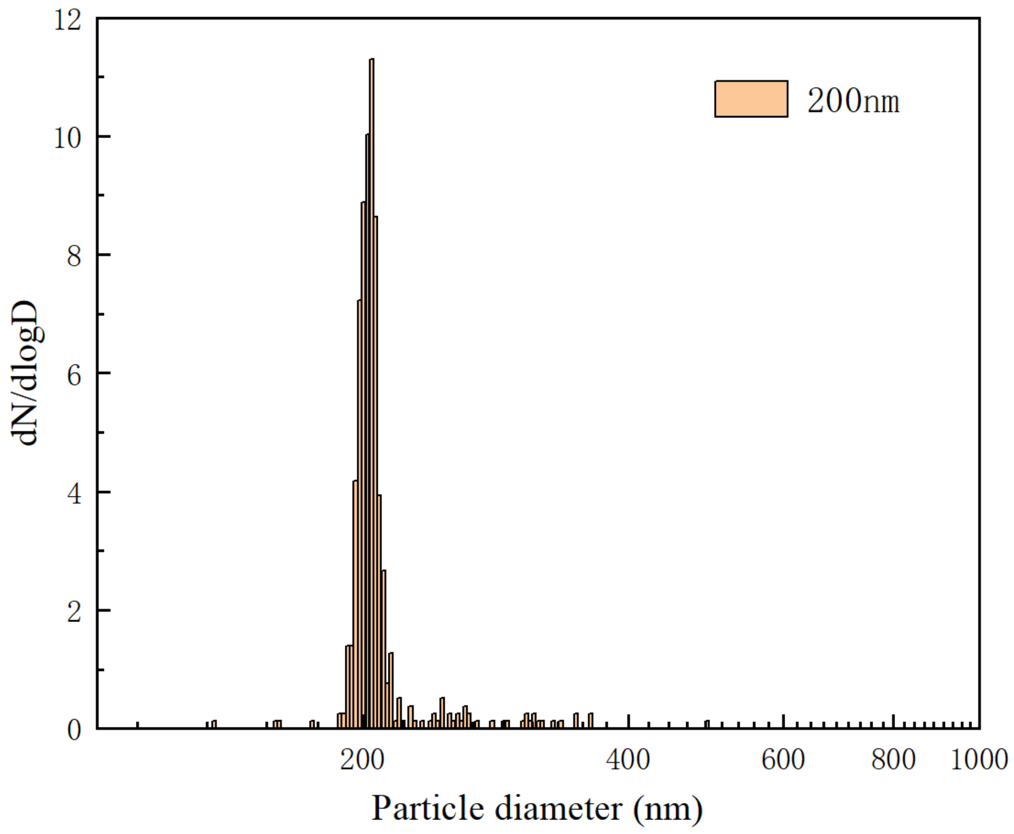
A3: Thank you to the reviewer for the insightful suggestions. In fact, after utilizing the novel pre-focusing structure designed in this study, the width of the particle beam can be significantly reduced, allowing for the use of smaller buffer chambers and fewer stages of lenses. This reduction decreases the volume of the injection system. Since the radial length of SPAMS primarily depends on the volume of the injection system, I believe this will help in reducing the overall volume of the SPAMS instrument.

Q4: The abstract is confusing. There are multiple size ranges and it is not clear how they relate to each other. There are yet more size ranges in lines 110-113.

A4: Thank you to the reviewer for your constructive comments; we have carefully considered your recommendations in our revisions. The description of transmission efficiency has been revised, with redundant explanations removed. The updated text is as follows: "The numerical simulation results demonstrate that the particle transmission efficiency is greater than 90% for sizes ranging from 100 nm to 9 μm."

Q5: I do not understand how you can count PSL particles with the CPC without also counting the surfactant particles from the atomized solution.

A5: We sincerely appreciate the reviewer's thoughtful feedback. I would like to thank the reviewer for the careful examination of this paper. The authors conducted experimental tests on the transmission efficiency of PSL spheres using SMPS, and error bars have been added based on the experimental results. The figure below shows the particle size distribution when generating 200 nm particles, indicating that the produced particles are predominantly 200 nm in size, with no other smaller particles generated.



Q6: Lines166-170: What wavelength is the laser and what is the smallest size particle that can be detected?

A6: Thank you to the reviewer for your expert feedback. This study uses a 405 nm semiconductor laser with a wavelength of 405 nm. In the dual-beam design of Bio-SPAMS, the minimum detectable size is 100 nm.

Q7: Lines 183-185. Are the authors saying that all of those references added a buffer chamber and a virtual impactor? That is not true. Please read those papers and cite them correctly.

A7: Thank you to the reviewer for your keen insights. This citation is simply to demonstrate the wide range of applications for the lens designed by Zhang et al. In this study, the design enhances the transmission range to 10 μm by adding a virtual impactor, without requiring any changes to the lens dimensions proposed by Zhang et al., thereby providing greater possibilities for research across various fields.

Q8: Figure 3. The legend is confusing. Put the year in for Du et al. Are the bottom three all from the present study with different configurations? Or from previous studies? It is not clear.

A8: Thank you to the reviewer for your constructive comments; we have carefully considered your recommendations in our revisions. First, Fig. 3 illustrates the advantages of different structures (such as the virtual impactor and the pre-focus structure) through pairwise comparisons. Additionally, the explanations regarding the different systems in Fig. 3 have been provided in Section 3.1. As stated in the text: "Subsequently, the virtual impactor (orange diamond line, original design) and the pre-focus structure (black square line, current design) were sequentially reintroduced to observe the enhancements in transmission efficiency. By comparing the transmission effects of the three designs above, the advantages of the design in Fig. 1 are highlighted."

Q9: Line 212: What is a "strong" buffer?

A9: Thank you to the reviewer for your expert feedback. The original comparison of speeds in Fig. 3 has been replaced with a comparison of the widths of particle streams at different positions in the various sampling systems. Therefore, the original description has been revised and no longer exists.

Q10: Figure 4. What does the axial velocity impact in terms of particle transmission? What part of the diagram in Figure 1 does the grey box correspond to? Does it really make a difference that the blue line has a few wiggles in the grey box? The transmission efficiency shown in Figure 3 is the same for Du et al. and present study for those sizes. Do the authors have data for 9 or 10 micron particles? That would be more relevant since there is a difference in transmission efficiency.

A10: Thank you to the reviewer for your helpful suggestions; they led to meaningful improvements in our manuscript. The argument regarding how particle acceleration in the pre-focus structure affects the downstream divergence angle is incorrect. In other designs (such as the design by Du et al.), the noticeable divergence is due to the wider radial distribution and higher incidence angles of particles as they approach the critical orifice. Therefore, the comparison of speeds has been changed to a comparison of beam widths. Additionally, global flow trajectory comparisons for 8 μm (e) and 10 μm (f) have been added to Fig. 5.

Q11: Figure 5. Why show both 5 and 6 micron particles? They are very similar. Panels a) and c) are both the "new" system but have different structures in the inset. Why? It's not clear what the authors are referring to with "new" and "old." Is "old" Du et al.? How does the structure in panel e} relate to Figure 1? They look different.

A11: We appreciate the reviewer's careful reading and constructive suggestions; they have positively influenced our manuscript's development. Fig. 5 is designed to show the distribution of particles larger than 5 μm before and after the virtual impactor, primarily to illustrate that there is no significant increase in beam width as the particle diameter increases. Additionally, the different structure of the illustrations is due to screenshot issues and has been modified. The "old" refers to the design by Du et al., and the revised manuscript has provided clear descriptions for the different systems. Fig. 1 is a schematic representation of particle transmission effects, and some details (such as the conical changing diameter interface before and after the buffer chamber) were not fully displayed; the revised manuscript has supplemented details such as the virtual impactor and changing diameter interface.

Q12: Figure 6. I would not label every point with its value. I think it makes the figure too busy. It would be better to put the data values in a table. Same comment for Figure 7. Scale the y-axis in Figure 7 from 0.

A12: We are thankful to the reviewer for the valuable input; your suggestions have been instrumental in refining our work. The Y-axis of Fig. 7 has been modified, and the original Fig. 6 has been merged with Fig. 3 and the values in the figure have been removed.

Q13: Line 260: Why place the target 11 cm downstream?

A13: Thank you to the reviewer for your keen insights. In fact, all lasers are located at a position less than 110 mm from the nozzle outlet, so the author chose 110 mm to demonstrate that good beam width and transmission efficiency can still be maintained at a distance from the laser.

Q14: Lines 286-287. The authors do not know this. It is very common for experimental measurements of transmission efficiency to be different from calculations.

A14: Thank you to the reviewer for your expert feedback. The relevant description has been removed from the revised manuscript.

Q15: Line 309: What do the authors mean by "the 2.5 micron lens system?" Is this the same thing as the "aerodynamic five stage lens group" on line 121 and the "PM2.5 five stage lens" on line 271? Please use consistent names throughout the paper.

A15: We appreciate the reviewer's careful reading and constructive suggestions; they have positively influenced our manuscript's development. The description of the 2.5 μm lens was incorrect. To avoid misinterpretation, all instances of "2.5 μm lens" in the text have been changed to "five-stage lens."

The answer for minor comments:

Q16: Line 287: What is the B-SPAMS? Is it the same instrument mentioned previously? Then use the same acronym. Same comment for line303.

A16: We are thankful to the reviewer for the valuable input; your suggestions have been instrumental in refining our work. Bio-SPAMS refers to the biological aerosol single particle mass spectrometer, which is the single particle mass spectrometer used in this study and is not consistent with Du et al.'s HP-SPAMS. Additionally, the descriptions in the text have been standardized.

Q17: Line 146: Define DPM

A17: Thank you to the reviewer for your expert feedback. DPM refers to the Discrete Phase Model, which is used to simulate the motion of discrete phases (such as particles) in a fluid.

Q18: Line 291: Do not capitalize ULTRAFINE TEST DUST. Define APS. Give manufacturer and model.

A18: Thank you to the reviewer for the suggestion. The supplier of the standard dust sample has been added. The revised text is as follows: “To characterize the analytical capabilities of the PFW-ALens for large particles, standard ultrafine dust (ISO 12103, PTI) was selected as the test sample.”