The author would like to thank both reviewers for their thoughtful and helpful comments and suggestions. Their reviews have made a significant contribution to the improvement of this paper. Comments of the reviewers are highlighted with grey color and answers are in normal text. Text in green color is included in the revised manuscript. The line numbering in the reviewers' comments refers to the manuscript initially submitted in Atmospheric Measurement Techniques journal, whereas the line numbering in the responses refers to the new version of the manuscript.

REVIEWER #1:

General:

Panagiotis Kokkalis derives in his manuscript analytical formulas to calculate the overlap of a lidar system by using paraxial approximation. These are useful information for anyone who is interested in designing a lidar system, although he stated that a 3D ray tracing simulation is still necessary. The polarization effects of the optical elements cannot be described by paraxial approximation, additional literature is necessary. To assess the focal lengths and the diameters of the lenses and the acceptance angles of the interference filters, these calculations are helpful in lidar design. To study the planetary boundary layer it is desired to have a lidar system with a low distance of full overlap, which can be achieved by the presented formula. Therefore this manuscript is suitable for publication in AMT with some improvements.

The major remarks:

A comparison of the theoretical overlap calculations with the signals of a real EARLINET lidar system would be of great value. Does a lidar system with a given set of parameters (focal lengths, FOVs,…) reach the calculated overlap? In the current version it is only compared to ZEEMAX simulations.

I would like to thank the reviewer for this comment. Indeed, in the uploaded manuscript a theoretical system has been described and simulated with ZEMAX, and finally some parameters were compared with the results from the paraxial approximation formulas.

However, the formulas described in this manuscript, in parallel with ZEMAX simulations, has been already used by the author for redesigning the multi-wavelength EARLINET Raman lidar of the National Technical University of Athens (EOLE). The system was similar to the idealized system presented in the manuscript (see Section 3), with the only exceptions that the beam expander of EOLE is x3, and the initial laser beam diameter 10 mm.

In the aforementioned values some tolerances were taken also into account (including aberration of the lenses, mounting accuracy and laser beam pointing stability (± 0.05 mrad for beam expansion x1)) leading to an effective receiver field of view equal to 1.25-0.2=1.05 mrad.

Demanding for a maximum distance of $\mathrm{Z_1}$ ($\mathrm{Z_1} = 200$ mm) and $\mathrm{A_{IFF}} = 1.5^{\mathrm{o}}$, we estimated the focal lengths as well as the mounting distances of the needed lenses, with the paraxial approximation formulas. Moreover, extensive ray tracing simulations has been initiated with ZEMAX software, for optimizing the design. For the simulations we used lenses, available from ZEMAX database, with the closest specifications (focal length and diameter) to what has been already estimated with paraxial approximation. All the aforementioned parameters are leading to a $\mathrm{DFO} = 552\ \mathrm{m}$, while with an optimum laser tilting angle of $\mathrm{A}_{\mathrm{tilt}}^{\mathrm{opt}} = 0.625\ \mathrm{mrad}$, DFO reaches the minimum value of $\mathrm{DFO}_{\mathrm{min}} = 276\ \mathrm{m}$.

In the framework of EARLINET network, and for keeping the highest possible standards for the operating systems, a calibration procedure is followed, every time a new system intends to become a member, or an existing member-system has been under an upgrade. For this reason, EOLE was intercompared last month with the mobile lidar system from Potenza (Italy; MUSA), which is an EARLINET reference system. The preliminary results indicated that EOLE was well aligned both in near and far range (Fig. 1a), with similar signals to be obtained from 603 m above ground (Fig. 1b).

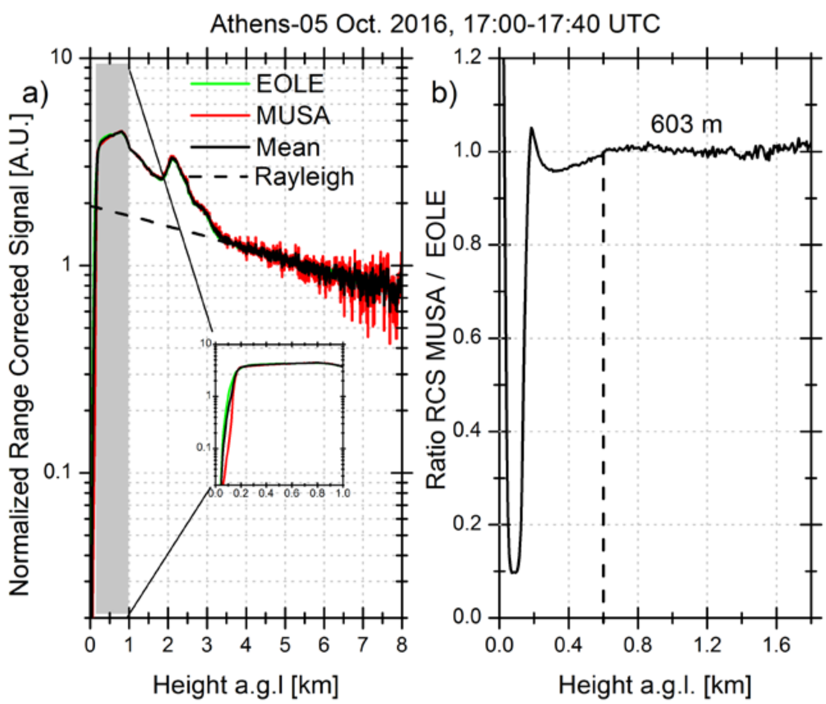

Figure 1: (a) The normalized range corrected signals (RCS) obtained by EOLE (green line) and MUSA (red line) at 532 nm, along with their mean value (black line) versus altitude. The signals are fitted to Rayleigh signal estimated by the radiosounding data. (b) The ratio of RCS (MUSA/EOLE) is demonstrated with black solid line while the dashed black line is indicating the height range above ground in which this ratio becomes 1.

Please consider that those are preliminary results and further processing is needed for coming up also with comparison of the optical products. However, it is obvious that the simulated DFO value (552 m) and the experimental (603 m), are really close.

Moreover the entire set of equations, described in the uploaded manuscript, has been integrated in a Microsoft Excel Worksheet, through Visual Basic for Application (VBA) code, and is available to the EARLINET members, with supplementary documentation (http://www.meteo.physik.uni-muenchen.de/~stlidar/earlinet_asos/raytracing/Basic_design/basic_lidar_design.html).

The aforementioned worksheet can be used as a quick check up tool of an existing lidar system.

The minor remarks:

- Fig 1: The DFO should start where the laser emits the beam, not at the back of the laser housing. L4 is not mentioned in the text. "with a free aperture diameter of Dobj, located at distance Z1 from L1 under an incident angle AIFF" -> it is L2 (as shown in the figure)

This is correct. I would like to thank the reviewer for pointing this mistake. Fig. 1 and its caption has been corrected according to reviewer's suggestion in the revised manuscript.

- Fig 2: Too much information, too less description text to explain it, not even subdivided in a, b, c. Achieve a better relation to eq. 9-13.

The reviewer is gratefully acknowledged for this comment.

Fig. 2 is updated including the a) b) c), for proper identification, and a better relation to Eqs. (9)-(13), has been achieved in the revised manuscript (see also the specific remark No. 27 of the second reviewer).

- Fig 3: Important figure. The acceptance angles (2.9^o and 1.15^o) for different BW are not explained in the description text.

The author would like to thank the reviewer for this comment. In the revised manuscript the reader is suggested to go through the appendix for the details regarding the estimation of the maximum acceptance angles of the two filters with different bandwidths. In the caption of Fig.3 the following text has been inserted:

"The blue horizontal dashed lines corresponds to the maximum acceptance angles (2.9^o and 1.15^o) of two IFFs with bandwidths of 0.5 and 0.15 nm respectively (see appendix)."

- Fig 4: missing a) and b) in the picture are the ZEEMAX calculations really from 2008? Someone may wonder, why it is such an old figure. What is fig 4a supposed to tell the reader? What exactly is shown in the 5 fields?

ZEMAX simulations are not for 2008, this was a mistake and I really thank the reviewer for the comment. Fig. 4 has been updated with the correct one. The missing a) and b) as well as the complete description of Fig. 4a regarding the 5 fields, has been addressed in the revised manuscript (see also answer on specific remark No. 35 of the second reviewer).

- Fig 6: missing space "DFO relative"

Corrected. Thank you.

- Tab 2: indices should not be written in italic, but as normal text.

Corrected. Thank you.

-p3, l3 "a decreased bandwidth"

Thank you for this comment. This sentence was misleading and has been changed in the revised manuscript according to your comment and the specific remark No. 8 of the second reviewer.

- p5, l2 "Fcol"; indices should not be written in italic, but as normal text.

Corrected. Thank you.

- p6, l3 (TFOV x EX)ˆ-1 or TFOV x EXˆ-1 ?

The reviewer is gratefully acknowledged for pointing this typo. In the revised manuscript this formula has been corrected to $\mathrm{LBD} \times \mathrm{EX}^{-1}$. Please note here, that the acronym for describing the laser beam divergence has been changed in the revised manuscript from TFOV to LBD, according to specific remark No. 5, of the second reviewer.

- p8, l12 "In addition, an advantage of using : : : makes the detection surface", something is missing

I would like to thank both reviewers for pointing this incomplete sentence. The missing word "an eyepiece lens" has been added in the revised manuscript (see also specific remark No. 32 of the second reviewer).

- p9, l9 "The IFF allows for incident angles lower than $\mathrm{A}_{\mathrm{IFF}}^{\mathrm{max}}$, incomplete sentence

Thank you once again for pointing this incomplete sentence. The entire sentence has been rephrased as follows:

"The IFF allows for acceptable transmission of the backscattered rays with incident angles lower than $\mathrm{A}_{\mathrm{IFF}}^{\mathrm{max}}$ (see appendix)."

- p10, l11 Why do you use 252 m for the near field in the ZEEMAX calculations? The DFO is 257 m.

The reviewer is gratefully acknowledged for pointing this typo. The DFO was simulated to be 257 m and this value has been used regarding the near field rays in ZEMAX. In the revised version of the manuscript the value of 252 m has been corrected to 257 m.

- p10, l19 "the slightly different parameters of lenses used from ZEMAX database" Why do you not create lenses in ZEEMAX with the same parameters as used for the paraxial approximation to exclude this source of deviations and to better assess the other effects?

I would like to thank the reviewer for this suggestion, but I believe that creating custom lenses in ZEMAX is out of the scope of this manuscript. However, this approach could be followed in the future.

- p11, l11 "The real performance of a lidar system"

Corrected. The word "a" has been added as suggested by the reviewer. Thank you.

- p11, l13 "However, with paraxial approximation it is feasible to estimate the diaphragms size and its location on the optical axis."

Corrected as suggested by the reviewer. Thank you.

- p11, l17 "transmitted to the left, the collected light travels to the right", usually light does not travel just to the left or the right, you should make clear that you are referring to figure 7.

Thank you. I agree with reviewer's comment. In the updated manuscript is stated that this scenario refers to Fig. 7.