

# REVIEWER'S REPORT

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Manuscript Title : **Measuring the attenuation length of muon number in the air shower with muon detectors of 3/4 LHAASO array**

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In this paper authors reported the preliminary results of the study of the attenuation length of muons in EAS using the data of muon detectors of 3/4 LHAASO array. The results look interesting, to be useful in the various aspects of studies of cosmic rays in future and hence the paper can be published in the proceedings of ISVHECRI 2022. However, before publish the paper it needs extensive language editing and few technical corrections. Some of them which I have notice are as follows:

## **Title:**

I think it would be more appropriate if authors replace the term “**attenuation length of muon number**” by the “**attenuation length of muons**”. This change should be applied in the whole body of the paper.

## **Abstract:**

1) In line 2, I would suggest replacing the term “**with 30 m spacing**” by “**with 30 m inter-detector spacing**”. This is applicable to the whole paper.

2) In line 2, it would be more appropriate if the word “**of**” after “**muon number**” is replaced by the word “**in**”.

## **Introduction:**

1) In the first line authors wrote that muons are produced in the decay of baryons and mesons. But what I know is that in cosmic rays muons are basically produced from the decays of mesons, mostly in the decays of pions and kaons. Authors should clarify this issue, otherwise the sentence should be corrected.

2) In line 4, the word “**air**” should be written before the word “**shower**”. The term “**and hence**” should be written after the word “**energies**” after replacing the existing comma.

3) In page 1, last paragraph, line 4, the word “**increasing**” should be replaced by the word “**increases**”.

4) The last sentence in the page 1 should be modified as “**Recent experiment results also show that the muon deficit is greater at larger distances to the shower axis [4], and the attenuation of the muon content measured is lower than that of the predicted [5].**”

5) In page 2, first paragraph, line 1, the word **“The”** is required before word **“LHAASO”** and the word **“built”** should be replaced by the word **“has”**.

6) In page 2, first paragraph, line 3, the term **“cosmic ray** should be replaced by **“cosmic rays”**. This should be followed in the rest of the paper appropriately.

### **Section 2:**

1) In paragraph 1, line 1, the term **“above sea level”** should be replaced by the proper one **“above mean sea level”**. In line 2, the word **“that”** in front of **“consists”** should be removed. In lines 5 and 6, the term **“which will record”** should be replaced by the **“which record”**.

2) In paragraph 2, line 1, the month **“Jan”** should be written in the full form as **“January”**.

### **Subsection 2.1:**

1) In paragraph 1, line 4, the term **“which diameter is 6.8 m”** should be corrected as **“whose diameter is 6.8 m”**.

2) In page 3, paragraph 2, line 4, the sentence **“On the other hand, the hits 200 m far from the shower core isn’t counted also...”** should be rewritten as **“Also, the hits far from 200 m of the shower core are not counted...”**. In line 6, the term **“the total muons by counting”** should be modified by **“the total muons that are obtained by counting”**.

### **Subsection 2.2:**

1) In paragraph 1, line 2, the term **“EAS of cosmic ray”** should be modified as **“EASs of cosmic rays”**. In line 5, the word **“the”** would be appropriate before the word **“simulation”**. In line 7, the term **“which developed”** should be corrected as **“which was developed”** and the term **“noise in single”** should be corrected as **“noise in the single of”**.

2) In paragraph 2, line 1, the term **“data normalized”** should be corrected as **“data is normalized”**. The comma after the Ref. **“[9]”** should be replaced by full stop and the next line should be changed accordingly. In line 3, the sentence **“The hit rate is matched well between simulation and data except below the 0.2 muons.”** should be modified as **“The simulated hit rate is matched well with the data except below the 0.2 muons.”**. In line 5, the word **“angle”** is required after the word **“zenith”** with the word **“interval”** as **“intervals”**. In the last line no comma is required after the word **“that”**.

### **Figure 2:**

1) What is  $N_{\mu,u}$ ? I think it should be  $N_{\mu}$ . So the title of the  $x$ -axis of both the plots should be corrected.

2) The caption of the figure should be corrected as **“The hit rate distribution of one single MD with respect to the muon number of the hit  $N_{\mu}$ . Left plot shows the simulation result together with the data, which match well above 0.2 muons as indicated by the green vertical line. Right plot shows the hit rate for various zenith angles, where the single muon peak is same for all the zenith angles as indicated by the vertical green line.”**.

3) Most importantly, it is clear from the figure that the vertical green line of the left plot is misplaced. It should pass through  $\log(N_\mu) \sim -0.4$ , which corresponds to  $N_\mu \sim 0.4$ . That is the simulated hit rate and data match well above the 0.4 muons only not 0.2 muons. Therefore all related analysis and texts including the caption of the figure are to be corrected accordingly.

4) For clarity the legend of the right plot should be enlarged.

### Subsection 2.3:

1) In paragraph 2, line 2, the term “of these events” should be added after the word “distribution”. In line 4-5, the term “selection, the event rate of the data is also plotted together with simulation” should be written as “selection together with the event rate data”. The last sentence is not clear and should be written clearly. what is ratio plot? How such ratios are obtained.

### Figure 3:

1) The bottom plot of this figure is not clear. It should be drawn as a separate plot.

2) The second sentence in the caption of the figure is not clear. Should be written clearly.

### Section 3:

1) In paragraph 1, line 1, there is an extra “the” after the first word. In line 3, the term “of cosmic rays” should be added before the word “varies”. In line 4, the word “shower” should be replaced by “showers”. In line 5, the word “the” is required before the word “formula”.

2) A full stop is required at the end of equation (1).

3) For the better readability the sentences below equation (1) should be modified as “**Where  $N_\mu(\theta)$  is the muon number in the shower with the zenith angle  $\theta$ ,  $N_\mu^0$  is the normalization parameter,  $X_0$  is the vertical atmospheric depth, which is  $600 \text{ g/cm}^2$  at the LHHASO level, and the  $\Lambda_\mu$  is the attenuation length of muons.**”

4) It is not clear how the constant intensity lines are plotted in Fig. (4). Process of obtaining these lines should be written in the text of the paper. What is “lg J” in this figure? I think it is “log J” and should be like this.

5) In page 4, last paragraph, the first line is not clear. Should be written clearly.

6) The caption of the Fig. 5 should be written correctly and clearly.

7) Below Fig. 5, in line 2 what is “cutting integral intensity”? In lines 2-3, the sentence “The attenuation length decrease as the intensity increase.” should be written as “The attenuation length is found to decrease as the intensity increases.”. Similarly, the last sentence of the paragraph beginning from line 5 should be checked and to be made readable.

8) In page 5, last paragraph, in line 1, the word “the” would be appropriate before the word “same”. Similarly in line 3, the word “the” would be appropriate before the word

**“LHAASO”**. In the line before the last line, the word **“for”** would be appropriate before the word **“full”**.

9) In the caption of Fig. 6, the word **“indict”** should be replaced by the word **“indicate”** or **“represent”** appropriately in its locations.

#### **Section 4:**

1) In paragraph 2, line 2, what is **“CIC ?** I think it means **“Constant Intensity Cut”**, but this abbreviation is not mentioned earlier. In line 3, the term **“TeV to tens PeV, the increasing trend as the shower energy is clear”** should be rewritten as **“TeV to tens of PeV, where the increasing trend of the attenuation length with the shower energy is clear”**.

\*\* Overall, the clarity of all figures should also be increased.