

Reviewer Report

Title: Development of the very long range muographic imaging technique to explore the internal structure of an erupting volcano, Shinmoe-dake, Japan

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The submitted paper describes the first and important reports on the following new aspects of the cosmic-ray muon radiography, which no one had ever reported: 1) the effect of positrons/electrons from the in-flight decay of the injected cosmic-ray muons; 2) the background contribution of the scattering of both Forward (toward the mountain) and Backward (toward the open-sky) cosmic-ray muons. They are new and important, in particular, for the radiography of the volcanoes locating in a long (several km) distance from the detection system. Before accepting all the arguments written by the authors in the manuscript, the present referee would like to have their answers to the following questions.

- 1) Regarding elimination of the in-flight decay positrons/electrons background, 6-hold PSD with 5-hold 10-cm Pb and 2x6-cm Fe in intermediate radiation shielding were employed. The explanation is needed why the 6-hold PSP are required instead of smaller number of PSP such as removing #2, #3, #4 and #5 and using #1 and #6 only with keeping same shieldings.
- 2) As for the multiple scattering effect of the incoming cosmic-ray muons, the background contribution from BWD (toward the sky) muon to FWD (toward the mountain) data in VLIM measurement was pointed out for the first time. However, the discrimination between the FWD and BWD was not made experimentally. It should not be difficult to event identification by comparing the absolute timing of #1 counter to that of #6 counter. Total length (3 m) between #1 and #6 counter and expected time resolution of the event-time recording device such as FPGA (less than 10 ns) make such discrimination marginally possible. Please explain why such analysis was not done.

In addition, the following rather minor revisions are suggested.

1. Page 1 line1, the word of “muographic” should be “cosmic-ray muon radiographic”.
2. Page 3 line 43, Fig. 1 should be simplified by removing presently used volcano plane-map as a background.

3. Page 5 line 71, the word of “Level 2” should be explained.
4. Page 5 line 74, the word of “predicting” should be “investigating”.
5. Page 17 line 263, (1400 m) should be (750 m).
6. Page 20 line 311 and others, “opposite the mountains” should be “opposite to the mountains”.
7. Page 47 Fig. 13 (b), Elevation angle (mrad) of horizontal axis should be negative values like -50, -100, etc.