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Geoscientific Instrumentation Methods and Data Systems Discussions

Interactive comment on "Development of the very long range muographic imaging technique to explore the internal structure of an erupting volcano, Shinmoe-dake, Japan" *by* T. Kusagaya and H. K. M. Tanaka

Anonymous Referee #2

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This a very interesting ,well written article presenting a first attempt, world-wide to image a volcano through muography from 5 km away. As such it is well within GI scope and the scientific conclusions very interesting for the GI community. It is however a first result and I felt that the authors did not yet fully exploit their data and that the conclusions and interpretations are likely not yet definite yet. That does not mean that they should not be published, just that the conclusions should be phrased with some caution. Fully exploiting this kind of experiment takes an incredible amount of work and

I am already impressed with the results as they are.

All my following, detailed remarks should be therefore understood as an attempt to help the authors improve an already very interesting article. As a more general point, it should be interesting to state in the conclusion/discussion section if the authors feel that their detector is adequate for this kind of measurement. Assuming they would have access to whatever detector they would need, what would be the detector improvement that they would mostly benefit from?

As the authors state in the text, imaging from such large distances greatly reduces the solid angle for the volcano observation. Likely a better angular resolution would be useful. How would your conclusions change assuming the position resolution to be 1cm instead of 10cm?

The density reconstruction suffers from low statistics. How longer should your detector acquire the data on site in order to solve this problem ? Do you have an estimate on the level of systematic uncertainties affecting the density measurement?

Section 2.2.2

The authors rightly point out that the horizontal low energy electromagnetic flux (10 MeV to 1 GeV) is of the order of magnitude of the horizontal muon flux. However the impact of these electrons and positrons on the muographic measurement is very much dependent on quality of the telescope used to perform the muographic measurement. If the position and angular resolution resolution of the telescope is good, the electrons and positrons will be tagged since they scatter much more than the muons in the detector shielding. It might be therefore hazardous to infer the level of contamination from the electromagnetic component of the air showers in a general case without being specific on the detector used.

Section 3.2.1

The tracking procedure is unusual. I would expect the angular resolution might be im-

proved if the differed detection layers are used more uniformly in the fit procedure. How well the chi2 distribution of the fitted tracks reproduces the theoretical chi2 distribution ?

Did you estimate the energy threshold for muons being accepted by your tracking and selection procedure?

Section 3.2.2

In order to estimate the amount of scattering the muons undergo in the telescope, the authors simulated 0.5 Million muons with zenith angles between 60 and 70 degrees. Since the scattering depends mostly on the muon momentum, it would be useful to state the lowest muon energy considered by simulations.

A fast estimation based on the geometry of the detector shows that the angular acceptance of the detector extends from about 63deg to 90deg. Could you explain the angular range of 60 to 70 deg that you used in order to simulate the muons?

The flux and energy dependence of the nearly horizontal muons is very badly known. What would be the incertitude you would quote on the scattered muon fluxed in paragraph 10? I would expect the figures 11 and 12 to be highly dependent on the model you assume for the energy and angular spectrum of the horizontal muons.

Maybe it should be safer to state in the text that those are likely orders of magnitude estimates ?

Section 4.1 Could you explain also the meaning of the red and blue dots in Fig 4? It is difficult to judge the level of agreement between the short range and low range muographic measurements on the logarithmic scale, but the long range measurement seems to be systematically higher than the short range one. Could you comment on it?

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 5, 207, 2015.