Geosci. Instrum. Method. Data Syst. Discuss., 2, C357–C359, 2013
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Geoscientific Instrumentation Methods and Data Systems
Discussions

Interactive comment on "Muon radiography for exploration of Mars geology" *by* S. Kedar et al.

Anonymous Referee #3

Received and published: 27 January 2013

The application of the muon radiography in Mars is extremely interesting, and this paper should be published. My main comments are related to the lack of detector details and the need for more detailed consideration of the different atmospheres and very different constraints for working in a space mission. The only descriptions of the possible muon telescope are found in the bibliography. I recommend to add a section describing in more detail the proposed detector. The authors mention low power (5 to 6 W) but I see in the references large solar panels. It's not clear what the consumption from each component is. Also, in the abstract (line 830.8) they mention a ten meter scale resolution when in the cited papers the resolution is an order of magnitude larger. Maybe the detector has a very different design, and can achieve a better resolution, but again there are no details. (In the Tanaka et al papers, the typical space resolution is ∼100 m.) One general point that is important to clarify is the energy range of interest. In Fig 2 they should muons up to 10 TeV (which is puzzling), but in Fig 3b the energy of

the primary protons is up to 20 GeV. Then are the fluxes in Table 1 integrated in energy? (Or for what energies are the fluxes shown in Table 1?) I'm also confused in Fig 3a as for why it goes up to 120 km in height. In Fig 3b is the flux of protons integrated in solid angle? I mean, these are muons per incident proton of a given energy, but for what incoming directions? It should be done for a fixed range in zenith angle (very inclined protons), but it's not explained. I understand the direct relationship, but I'm used to see atmospheric depth in grams per square cm, and not in hPa. (For example in the caption of Fig 3a, in line 833.18, etc.) In line 832.29 The sentence "Muons interact only weakly with matter" is wrong. I understand what they're trying to mean, but they should rephrase it. In line 833.26 it's mentioned 5 or 6 layers of detectors. The telescopes used in the bibliography are made with four layers of scintillators. This is another example where a description of the detector would help. (Another one is line 834.5 where lead plates are mentioned.) The other important considerations is working in Mars. In line 833.9 they mention a shorter integration time. Given the measurements presented in the cited bibliography, this correspond to ∼two weeks. Is this reasonable for a Mars mission? How does the detector design change to adapt to even shorter integration times? In line 833.11 they mention "A large fraction of primaries at the surface" and it's not clear whether this is from Geant simulations or from where? It should be possible to run these simulations, and even to carry out experiments in balloons. There is also the issue of proton background. This should be easily simulated. It is not clear that the proposed methods can be implemented. The measurements from pure atmosphere and from a direction going through several hundreds of meters of rock will have very different ratios of protons to muons, for example. In line 835,7 they mention "weak" pointing requirements. It is not clear what this means. In relation to this point, in line 836.2 they use a "roving" detector from the bibliography. The cited paper did not use a roving system, but two fixed telescopes. I did not find in the bibliography examples of a roving system. I think that it is important to demonstrate this capability. It should be straight forward to make a test with an existing telescope. My guess is that a roving system would be trickier than the combination of two fixed detectors. In line 839.19

they mention a detector with a reduced size. This should be demonstrated on Earth beforehand. (As the shorter integration time.)

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 2, 829, 2012.