2) Reply to Referee 2
The work is a good paper outlining all the peculiar aspects to apply the muon radiography to the Mars geology. The aspects are discussed rather in detail and the results which can be achieved are described. The past experiences done on earth by the group is important to understand the problematics on Mars. So I support the publication of the paper. I have anyhow some points that would need some more details or additional comments, the most important been related to the reduced filter of the Mars atmosphere.

> *We would like to thank the referee for his detailed reading of the paper and support of publication.*

Here in the following the list of points:

Points on pag 831(rows 5): mistyping "on the order" correct to "of the order" or take off "on the order of"

> *Fixed.*

Points on pag 831(rows 12-15): (4) you introduce the concept of "passive" detector (and also "active" below): it is not well clear the meaning you attribute to this word. So somewhere in the introduction has to be described a passive detector to better understand the paper.

> *You raise a good point. We are calling the imaging system passive since it is not necessary to generate the penetrating probe as in radar, sonar or X-ray tomography. We have modified the line in the introduction to clarify this point.*

Points on pag 831(rows 29): "weakly" generate confusion since the muon interactions with matter are "electromagnetic" (i.e. Ionization). I suppose it means that muons do not have hadronic interactions so their range is well related to the energy.

> *Agreed, the sentence has been modified.*

Points on pag 833(rows 14 and following): it is not clear if the numbers on table 1 come from Earth data or from simulation. I suppose are data from Earth but why not to compute the flux via Monte Carlo with the right atmosphere? This could be very useful (or necessary) to deeper understand the problem of background (see next point).

> *The estimation of hadronic background in Table 1 was estimated using Earth cosmic ray data but the Mars muon production rate were from a detailed 2007 Monte Carlo study [Tanka (2007)]. To clarify this point line 14 on page 3 was modified and a reference was added [Barringer et. al. (2012)] in line 8 on page 6. We also agree that a full simulation is straightforward but the trade-off space is quite large and should be part of a larger study. Text has been added at the bottom of page 7 to explain this is detail.*

Points on pag 833(rows 25 and following): The analysis of how to reject the background is correct but, I think, should be more complete. Muons and hadrons are well mixed in all the directions and muons are few respect to all the hadrons. It seems you have not considered the vertical hadrons interacting with the rock nearby the detector and generating al lot of pions in all the directions, including the horizontal one. So the method proposed to filter hadron using their interations in the detector could be too poor especially if the iron interaction lenghts are few for reducing the weight. Since this a crucial point for the success of the radiography, it would be better to be more quantitative on the background level reachable after the cuts and if or how its presence affects the result. Alternatively you could estimate at which background level the result loses it validity.

> *Yes, it is a very important point. The degree of suppression of the horizontal background due to the vertical protons interacting with the target, detector and surroundings is directly related to the spatial resolution and imaging depth in the target. We estimate on Mars for spatial resolutions of ~100 meters, density resolutions of ~5 % at depths of <~1km the technique seems feasible, however, the authors feel that detailed detector design, performance, cost… (… surface, granularity, redundancy) should be part of a larger study, which employs a full GEANT Monte*

Carlo simulation of the detector and cosmic ray interaction with the target and the resulting impact to science objectives.

On page 7 lines 7,8 and 9 were modified to clarify this point.

Points on pag 835(rows 7): also here "passive. The separation backward/foreward direction implies "active" elements like PMT's .
Addressed earlier.

Points on pag 835(rows 22): I suppose the spatial rover track is well known otherwise the spatial reconstruction mixing several viewpoints is impossible. Add a comment on this point.
Comment added on line 20 on page 8.