Response to Referee 1

"A Comparison of Contact Charging and Impact Ionization in Low Velocity Impacts: Implications for Dust Detection in Space" as submitted by Antonsen et al. to ANGEO

We thank the referee for their time to review the manuscript, and for a number of helpful and important comments. In the following, we have tried to respond to all of them, and we have presented the revisions we have carried out in connection to the respective comments. We have not made any major revisions in the overall structure of the paper as both referees seem to agree with the structural setup. Major revisions in the content have been made, and we also refer to the open response to Referee 2. We note, especially, that we have given a better overall description of the mechanisms discussed in the paper. We have also revised the abstract.

Regarding our equations (1) and (2): We have used the wrong citation here. The correct source is John et al (1980), and this has now been corrected. We have also revised the citations in the first paragraph of section 2.2; Here we have now stated that we use the general theory of John et al. (1980) and the results of Wang and John for plastic collisions. The alpha-parameter is, as very correctly stated, not trivial to derive and we have relied on Soo's (1970) utilization of Hertzian deformation. Have added a reference to this work below the eqs.

Regarding the referees second comment (range of velocities in Mocker et al experiments and extrapolation of results): This is a very good point (raised by both referees), and is due to a poor description of our utilization; The reason why we have used Mocker et al. results is that the quality of the data is very good in their range of interest. What is not clearly stated here, is that their result is almost "indestinguishable" (for our purpose; Fe-on-Ag) from the findings of Collette et al 2014, who have investigated impacts done to speeds of 2 km/s – which is well embedded into the range of velocities we need comparison data for in order to compare contact charging and impact ionization. Therefore we have used Mocker's result, however, we could have used Collette et al. with identical conclusions. The data from both Mocker et al and Collette et al for speeds below 10 km/s is furthermore not in the volume ionization regime, which is only expected when impact energies exceed the Fermi-limit (several tens of km/s). Revision: Have tried to specify why we have chosen the Mocker et al results in the start of paragraph 2 of section 3.2.

Regarding the MUDD-results and Figure 7: A very helpful comment. The simulated current is based on high-resolution dust density and size (average size, monodisperse) data as obtained by Havnes et al (2019). This is referenced in the last paragraph of the section. Due to the very low impact velocity, for reasons discussed in section 4.2., we felt the inclusion of the Saha-Langmuir solution in figure 7 was unnecessary. In fact, even the pre-charges on the ice particles alone would completely dominate the current in MUDD in comparison to shock wave ionization, in the case of rocket. We agree with the referee that the text discussing figure 7 can be improved, and have therefore implemented a revision of this. Hopefully, the text reads better.

Minor comments:

For corrections of typos and insertion or removing of certain words, we have not listed the revision below.

(1) Revised as suggested.
(3) Yes, underestimate.
(5) Defined MSP.
(6) Revised.
(7) Added explanation and abbreviations.

(9) Yes, there might be an additional factor there, but lowering the filling factor into the lower end around 1%, there is still a significant overestimation present.

(11) We have changed Z to capital Delta.

(25) Added descriptions of pre-charge.

(26) This was chosen due to the "common" practice, as well as it allows for direct comparison between the results. As far as the contact charging model goes, since it is specific yield (C/kg), it does not matter whether or not the incoming (modelled) projectile is 30 or say 100 nm, since – as shown in the appendix – Qp is proportional to r^3. Thus, the specific yield is the same for any size. A difficult question is then how the plasticity and other modelling parameters change with velocity, which can become complex to give a thought out answer to.

(28) Rephrased.

(32) The speed range of beta meteoroids is still not very well known due to the fact that we are not certain about where the formation region lies. Even at present, different authors use formation radii in the range 5-20 Solar radii, which would yield very different velocity ranges (assuming only conservation of energy and angular momentum control the orbits of the meteoroids). We hope Parker solar probe and solar orbiter will answer open questions about beta meteoroids and their velocities.

(35) It is raised to the power of 1/3 after, so 4/5 -> 4/15.