Expected performance of a dust detector in presence of solar wind particles

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The interplanetary dust particles are present everywhere in the solar system and they are expected to be originated from the Asteroid belt. It is possible to study the particles using an impact ionization dust detector from an orbiter around a planet. We are designing a dust detector at PRL to carry out the study of interplanetary dust particles by a future planetary mission. Since, the dust detector is not available commercially, it needs to be designed and developed as per the requirements. In the interplanetary space, the dust detector encounters the hypervelocity dust particles and some other emissions like ultraviolet radiation from Sun as well as the solar wind. It is suggestive to predict the performance of a dust detector in response to the other emissions, which essentially create noise for the dust detector. We have carried out simulation in the SIMION software to understand the effect of detector biasing used to capture the charge carriers. The detector biasing can affect the rise time of a signal generated by the charge carriers, after they are captured and processed in the charge sensitive preamplifier. Also, the capture efficiency is an important parameter in any dust detector and we have studied this for our detector geometry. The rise time, capture efficiency and detection area have been obtained through the SIMION software. Further, we have studied two different detector geometries, viz., square cross-section and hemi-spherical.

In addition, we have simulated effect of high energy solar wind particles using Geant4 software. We bombarded the dust detector by proton, alpha particles and gamma rays in the simulation through Geant4 software. We found that the high energy particles produce secondary electrons only in the electron channel of the detector. Since, a dust impact produces electrons and ions, it can be identified in the presence of noise, using signal coincidence technique.

References:

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