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Laboratory calibrations of the PP-SESAME instrument on Philae for measuring the cometary surface permittivity

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Abstract

The complex permittivity of terrestrial and planetary grounds can be derived from Mutual Impedance (MI) measurements using a four-electrode array [1]; the system is working at a fixed frequency with the electrodes not necessarily in contact with the ground and with a dedicated electronic system. This concept was used to build the Permittivity Probe (PP) as part of the SESAME experiment of the Philae Rosetta cometary lander. However severe constraints due to the payload facilities and to the particular environment lead to the actual design of the instrument. Unfortunately it was not possible to perform calibrations of the full system before lauch and the ground model consists of several parts used by various instruments. Here we report the results of basic calibration tests performed with a model of the Philae Landing Gear built in DLR. These tests involve only the three feet electrodes and a mockup of the the Philae body with very simple and well defined targets for characterizing the instrument. Further measurements on natural targets would be the next step.

1. Introduction

1.1 Geometry

On Philae the probe consists of a system of 5 electrodes, 2 receivers and 3 transmitters, and works in principle as a quadrupolar probe utilizing only two receivers and two transmitters at a given time, as shown in Fig.1. The 3 feet of the lander hold the 2 receivers and one transmitter, whereas the two other transmitters are hosted by the MUPUS and APX sensors. On the Landing Gear mockup shown in Fig. 2 the electrode array is reduced to the 3 feet electrodes, two receivers and one transmitter (in fact each foot holds a couple of electrodes connected together). During the tests the transmitter return electrode is either a conductive mockup of the Philae body or another electrode simulating APX or MUPUS.

1.2 The two basic test configurations

When an electrode array stands over a half space of given permittivity it has been shown that the mutual impedances can be derived from a combination of two models: (i) the array in a vacuum, and (ii) the same array over a perfect conducting half space [2].

(i) This configuration with the instrument in open space is the more difficult to set up: the instrument is placed as far as possible from walls ceiling and floor.

(ii) The instrument is placed at several heights from a conductive floor. The influence of electric images increases as the distance to the floor is reduced.

2. Conclusions

This basic calibration test allows to characterize the full measurement loop in a well known geometry and controlled environment. However several elements discard from the flight units. This aspect is discussed as well as the effects of a noisy electromagnetic environment in the laboratory.

3. Figures

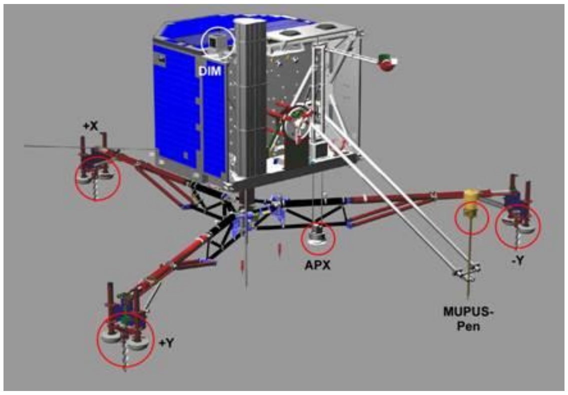

Figure 1: The Philae lander with the full set of PP electrodes.

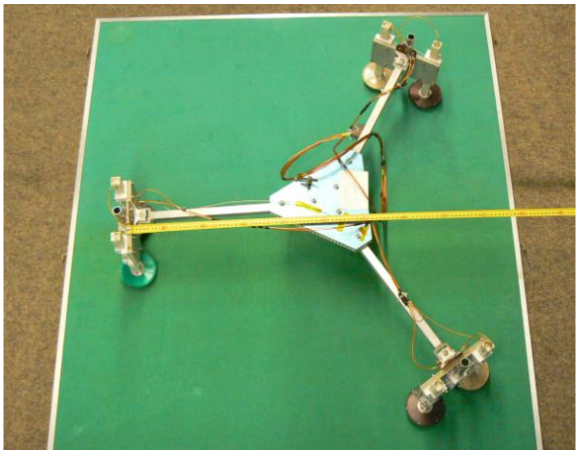

Figure 2: The Landing Gear used for the tests

References

[1] Grard, R.: A quadrupolar array for measuring the complex permittivity of the ground: application to Earth prospection and planetary exploration, Meas. Sci. Technol. Vol. 1, p. 295, 1990.

[2] Hamelin, M., F. Simoes and W. Schmidt, Philae Cometary Permittivity Probe model and operations with a reduced set of electrodes, Geophys. Res. Abstracts, **11**, EGU2009-7813, 2009.