Atmospheric Electricity

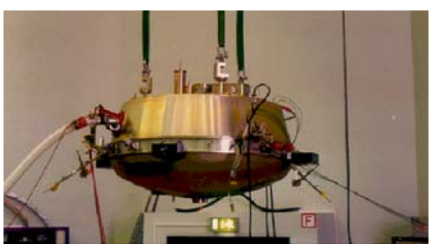
Balloons, HUYGENS
…ARES, …TANDEM

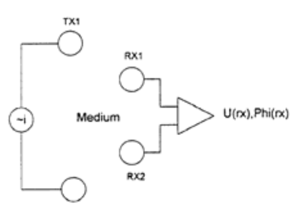
Magnetospheric Satellites

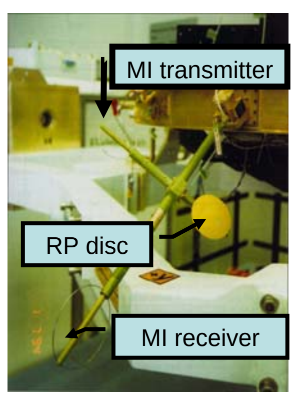
DEMETER…

M. Hamelin, J.J. Berthelier & PWA, ARES, DEMETER teams

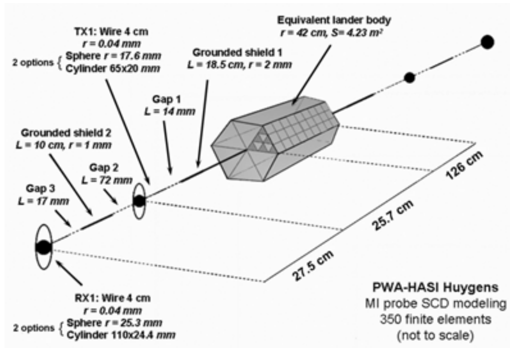
The Mutual Impedance Probe (MI)





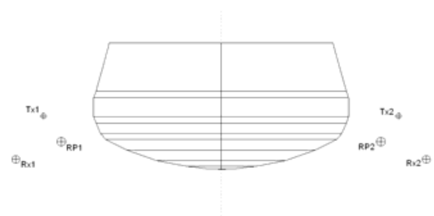


Space Charge Distribution Model



General software for axial symmety with an adapted geometry of our problem. With 350 elements this model represents accurately the links to the electrodes.

7 electrodes Model



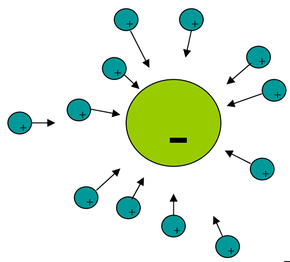
Femlab software solves the Laplace equation around HUYGENS, the 4 MIP electrodes and 2 other (RP) electrodes. The result is a 7x7 impedance matrix for the case of a vacuum.

Relaxation of electrode potential in a conductive and homogeneous atmosphere

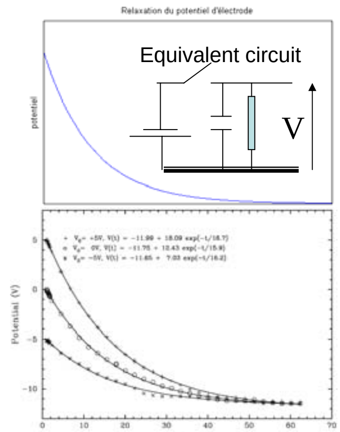
We charge the electrode, negatively for instance.

The positive atmospheric charges will move towards the electrode.

From Ohm's law, the electrode potential returns to equilibrium as exp(-t/w).



The conductivity is : $v = \varepsilon_0 / w$



(Comas-Sola Flight, 1995; from J.J. Lopez-Moreno et al.)

Difficulties

Space charge effects

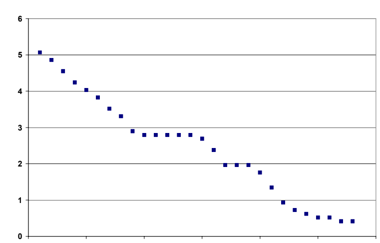
Debye length ~ 2-50 cm

The theory of probes in a plasma is used to derive the conductivity

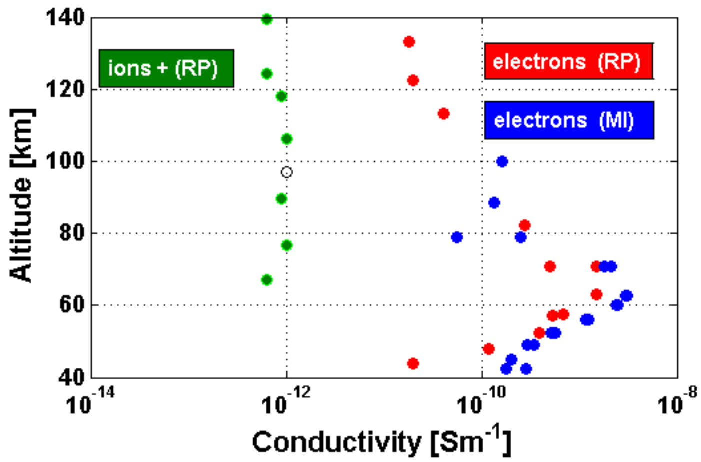
Plateaus

Hardware artefact ?

If not, the Probe is crossing a bubble or a layer with low density of electrons



Results: RP and MI conductivity profiles

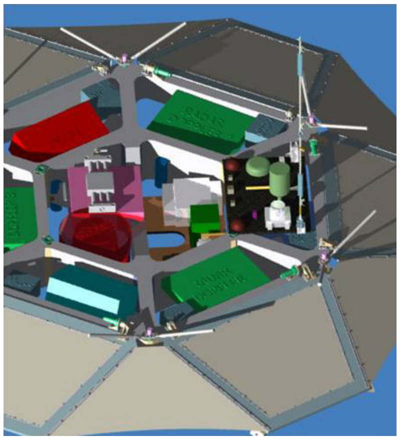


Atmospheric electricity at the surface of MARS: ARES/EXOMARS (2016)

2 cylindrical sensors

- length 10 cm, diameter 3 cm
- mounted on an insulated boom

at ~ 60-100 cm distance



Modelling the lander environment is necessary (shape of devices, solar panels)

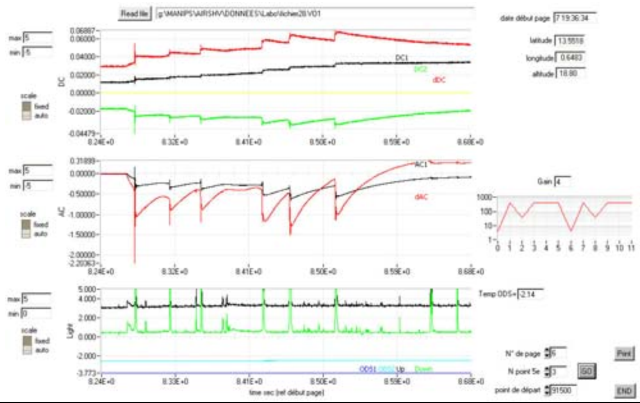
VALIDATION AIRSHV SCOUT AMMA - 2006

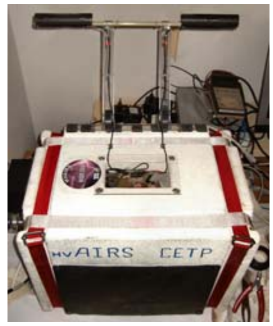
Balloon flight validation of ARES in Niger

Thunderstorm activity

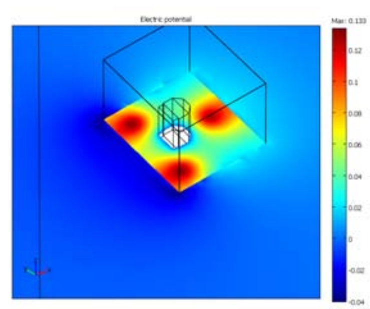
10 Kg payload

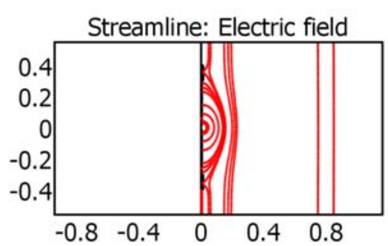
Top altitude 22 km





Modelling needs





PP-SESAME / Philae-ROSETTA

ARES sensor

Needed:

- More detailed geometry
- Physical effects as photoelectrons,

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Objectives of models developped by CETP/ARTENUM.

- - Floating potentiel of the satellite: validate indirect measurements and understand quantitatively the behavior and some events linked with large variations of plasma density (auroral holes, equatorial plasma bubbles)
- Model accurately the plasma-satellite interaction and its consequences et ses conséquences on measured thermal particles to understand and suppress the measurement errors.
- Need of accurate models + validations through measurements. Not only engineering evaluations.

11

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NEEDS:

- include in SPIS the description of thin and long elements.
- include automatic search of the satellite potential in the case of polarisation of satellite or devices with known current.
- measure of work function and photo-electric emission on current materials (in particular thermal painting)

12