DETERMINATION OF THE CONDUCTIVITY AND PERMITTIVITY OF THE SURFACE MATERIAL AND MONITORING OF THE OUTGASSING ACTIVITY OF THE COMETARY NUCLEUS; R. Grard, Space Science Department of the European Space Agency, ESTEC, Noordwijk, The Netherlands; H. Laakso, Finnish Meteorological Institute, Department of Geophysics, Helsinki, Finland; M. Hamelin, Laboratoire de Physique et de Chimie de l'Environment, CNRS, Orléans, France; B. Goldstein and D. Winterhalter, Jet Propulsion Laboratory, Pasadena, California, USA; H. Kochan and S. Ulamec, Institute for Space Simulation, DLR, Köln-Porz, Germany.

The Permittivity Probe (PP) is one component of the Surface Electrical, Seismic and Acoustic Monitoring Experiments (SESAME). This suite of instruments is presently under consideration as a payload element of Roland, a cometary lander, which is part of the ESA corner stone mission, ROSETTA.

Conductivity and polarizability are very sensitive the temperature of the material, the frequency of the applied electric field, and below 10 kHz to the presence of water, which is the only common rock-forming substance which has a marked polarizability.

Permittivity measurements will therefore help answering such fundamental questions as:

- what is the water content of the ice mixture which forms the cometary material?
- how does sublimation of ice control the evolution of the nucleus?
- does sublimation take place at the surface or deep below the dust mantle?
- why is the surface temperature of the nucleus so high?
- how does the mantle evolve as function of solar illumination and heliocentric distance?

The Permittivity Probe is an active instrument that measures the influence of a material upon the electrical coupling between two dipoles in contact with its surface. Unlike all microwave techniques (e.g., radar, interferometry, and antenna impedance measurements), the PP is operated in a frequency domain, below 10 kHz, where the electrical signature of the material is the most influenced to the presence of water ice.

In the passive mode, this experiment has also the capability of a plasma wave investigation. It is consequently proposed, as a secondary objective, to detect the electric fields of electrostatic and electromagnetic waves with frequencies up to 1 MHz, which are generated by the interaction of the solar wind with the charged dust and ionized outgassing products of the nucleus. The plasma wave observation on RoLand will consequently provide a continuous monitoring of the nucleus activity.

Additional information about the PP instrument is given in the following data sheet.

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Name of Instrument	Permittivity Probe
Acronym	PP
Objectives	**Primary objective**: • Determination of the electrical conductivity and polarizability of the cometary surface materials **Secondary objective**: • Characterization of the outgassing activity and electromagnetic environment of the nucleus
Nominal ranges	**Complex permittivity**: • conductivity: $10^{-8} - 10^{-4}$ Siemens • relative dielectric constant: 1 – 100 • frequency: $10^2 - 10^4$ Hz **Waves**: • amplitude: $10^{-5} - 10^{-2}$ V m^{-1} $Hz^{-1/2}$ • frequency: $10^2 - 10^6$ Hz
Spatial resolution	3–D: 10 cm and 100 cm
Cycle rate	2 per hr
Cycle duration	3 min
Data volume per measurement cycle	Permittivity: 500 b Waves: 500 b
Average telemetry rate(1)	0.5 b s^{-1}
Processing requirements	Averaging, formatting
Mass	Electrodes and cables(2): 150–350 g Electronic board(3): 250 g Total: 400–600 g
Power (average/peak)	10/100 mW (including margin)
Dimensions	Electrode envelope: 25×10×2 cm per unit (×6) Board: 9×6×1 cm
Preferred location	Electrodes: landing tripod Electronics: warm area
Sensitivity to contamination	EMI < 1 MHz
Generation of contamination	Electrode voltage: <10 V in 10^2–10^4 Hz range Injected power: <2 mW
Temperature range	Electrodes: –200 … +100 °C Electronics: –50 … +60 °C
Lander attitude and positioning	No requirement, but knowledge desirable
Additional requirement	Sensors should be electrically decoupled from the lander. The surface of the lander should be preferably conductive.

(1) Higher telemetry rate desirable for occasional transmission of wave bursts
(2) Depending upon electrode array configuration
(3) Assuming that the electronic board can be placed in an existing box