PHILAE

agenzia spaziale italiana

cnes
CENTRE NATIONAL D'ETUDES SPATIALES

DLR

esa

FMI

IWF

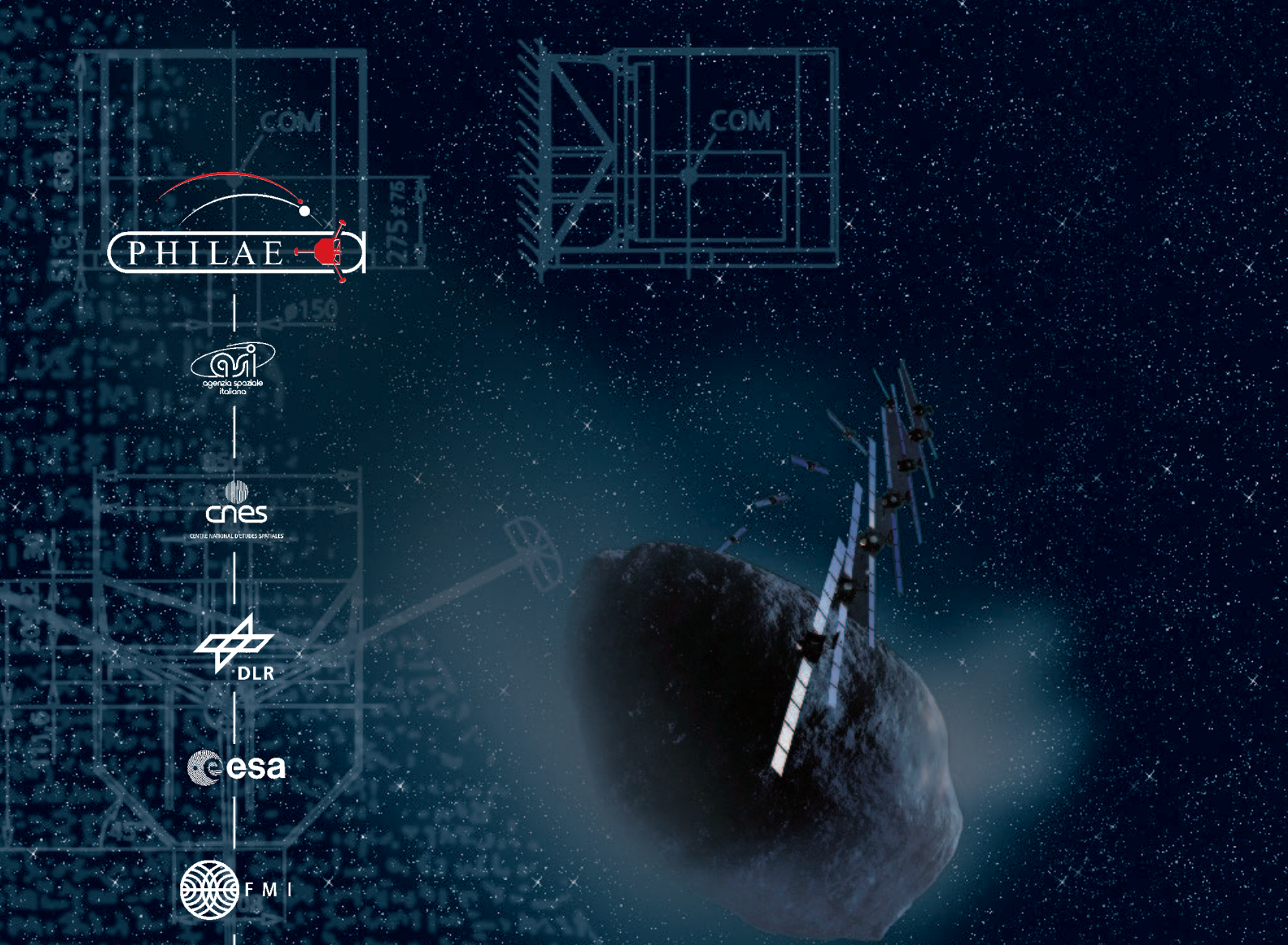
KFKI RMKI

MPAE

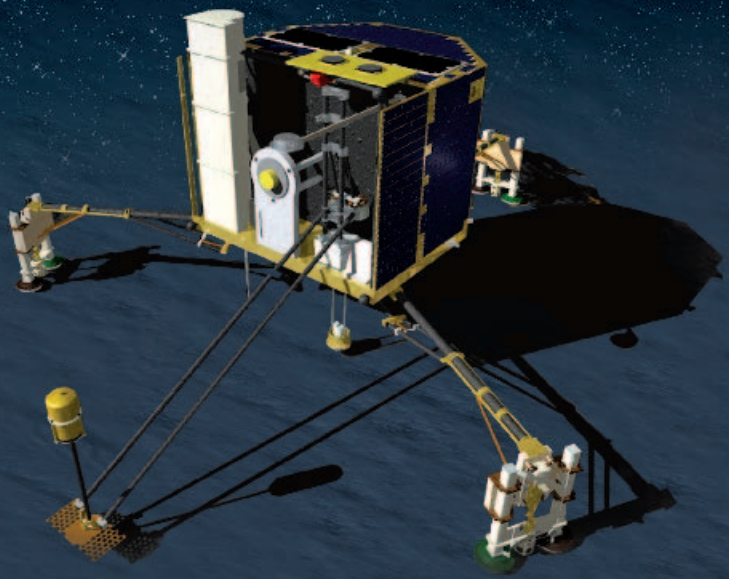
MPE

PPARC

Space Technology (Ireland) Ltd.



PHILAE LANDER FACT SHEETS



Contact: sylvie.espinasse@asi.it
Internet site: http://ars.asi.it/~webars/esa/rosetta/rosetta.html

ASI role in the Philae Lander Program

Comets are the most primitive bodies of the Solar System and their study can provide unique information on its formation and evolution. ASI recognizes this scientific goal as a guideline within the Italian National Space Plan. Therefore ASI is participating to the Lander of the Rosetta mission providing engineering support by a Co-Project Manager, on board hardware as the Sample Drill & Distribution instrument and the Photo Voltaic Assembly and is actively participating to the Lander Steering Committee.

SD2: Sample Drill & Distribution

SD2: Sample Drill & Distribution instrument.

Description: The SD2 system consists of an integrated drill, sampler tool, and a carousel. SD2 will collect soil samples at different depths up to 230 mm and will distribute them using a carousel device, accommodating 26 ovens for sample containment, capable to move the ovens to the different experiment locations. SD2 also provides a volume checker to estimate the collected sample volume. The instrument operates through an electronic unit in order to manage the whole system with a high degree of autonomy.

P.I.: Amalia Ercoli Finzi, Politecnico di Milano
Industrial Prime Contractor: Tecnospazio SpA
Main Features:
- Drilling depth: 230 mm
- Integrated drill/sampler diameter: 12 mm
- Sample size: 3 mg or 20 mm^3
- Soil type: hardness ranging from fluffy snow to basalt
- Tool box dimensions: 150 mm diameter, 760 mm height
- Carousel dimensions: 126 mm diameter, 90 mm height
- Mass: 4.8 kg including electronics
- Power: 1 W standby, 12 W max
- Environmental conditions:
-150°C operating, and -170°C non operating

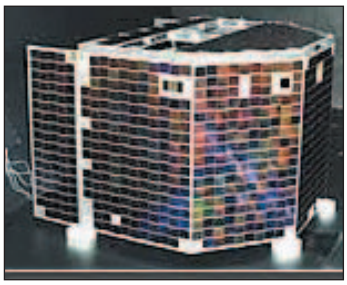


Photo Voltaic Assembly.

Photo Voltaic Assembly

Description: The Photo Voltaic Assembly is designed to provide the electric power to the Lander batteries when it is operating on the comet 67P/Churyumov-Gerasimenko.

Industrial Prime Contractor: Galileo Avionica SpA
Features:
- Type: body mounted
- Cells Type: Si, Hi-ETA LILT
- Cells Size: 3x3 cm^2
- Power equiv. @ 3 AU: 32 W
- Total Size: 2.2 m^2,
- Lifetime: 10 years

Contact: Denis J.P. MOURA (denis.moura@cnes.fr)
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The French participations to the Philae Lander are provided by the French Space Agency (CNES) and some scientific laboratories (IAS, SA, LPG, LISA). They concern several levels :

- **system engineering:**
  overall lander architecture (configuration, payload optimisation etc.)
  and mission analyses (separation, descent and landing strategy & performances),
- **sub-systems procurement:**
  radiocommunications (see photo 1) and battery assembly (see photo 2),
- **instruments procurement:**
  Consert (see photo 3) and Civa (see photo 4), plus parts of Cosac
  (tanks and chromatography columns),
- **ground segment:**
  overall engineering and development/operation of the Scientific Operation & Navigation Centre in Toulouse.

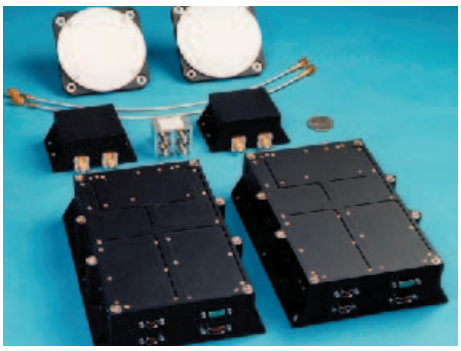

Photo 1: Radiocommunications units – To fit with the resource constraints (RF unit mass < 1 kg), the design required the use of commercial highly integrated chips, specially tested to guarantee the compliance with the space environment.

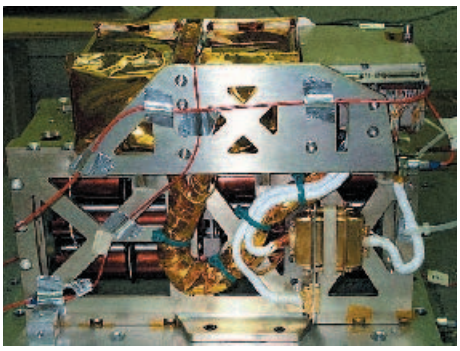

Photo 2: Battery assembly – The lander energy storage is based on two types of sources: primary batteries for short term activities (1000 W.h), secondary batteries for long term activities (140 W.h). The assembly includes the associated electronics.

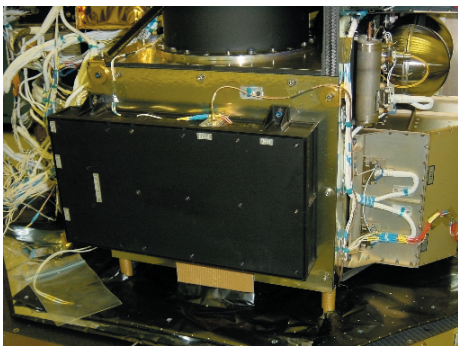

Photo 3: Consert unit – This experiment will sound the comet nucleus thanks a 2 ways communication between the units on the orbiter and on the lander. To insure ground penetration, a low frequency is used (100 MHz).

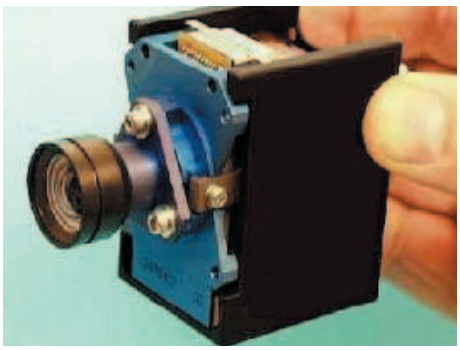

Photo 4: The CIVA micro-cameras-3D technology packaging, allowing to minimise volume (< 90 cm^3 for the head), mass (< 100 g) and power (< 2 W), has been used. Tests down to -150 deg, for storage, and -120 deg, for operation, have demonstrated outstanding thermal behaviour.

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

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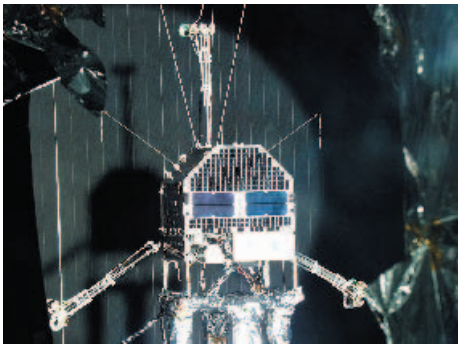
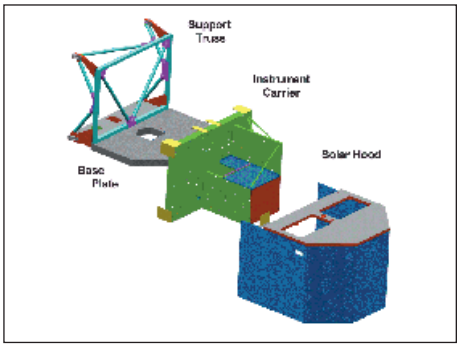
Participation

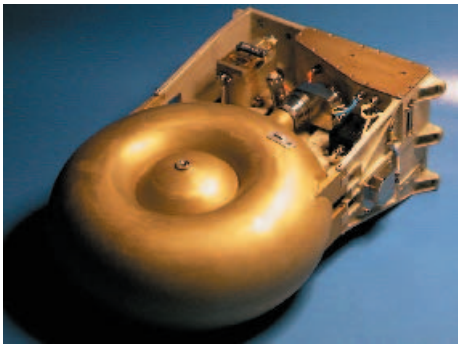
- **Management and PA:** overall Lander project management, Lander level product assurance
- **Engineering:** system, mechanical, electrical and thermal engineering
- **AIV:** coordination of system AIV activities
- **Subsystems:** Structure, Thermal Subsystem, Flywheel, Active Descent System (cold gas thruster)
- **Instruments:** ROLIS, downward-looking camera, SESAME-CASSE, acoustic sounding and seismic instrument
- **Ground Segment:** operation of the Lander Control Centre (hosted at MUSC, Cologne), operation of the Lander Ground Reference Model, procurement and operation of the Lander Software Simulator



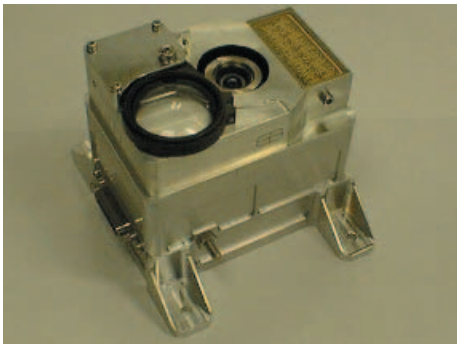
The Philae Lander in Thermal Vacuum during the environmental tests campaign at IABG.



Structure, provided by the DLR Institute for Structural Mechanics, Braunschweig.



Active Descent System – cold gas system procured by DLR Cologne from Bleuler-Baumer, Oberrieden, Switzerland.



ROLIS camera, developed by the DLR Institute for Planetary Exploration and Sensor Technology, Berlin.

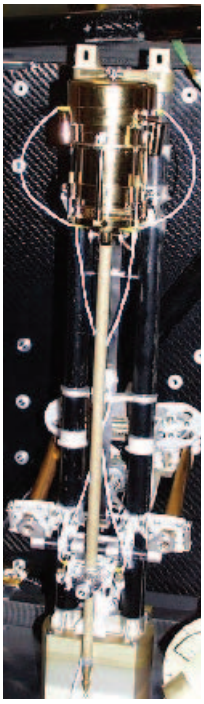
Participating institutes: Institute for Space Simulation, Cologne
Institute for Structural Mechanics, Braunschweig
Institute for Planetary Exploration and Sensor Technology, Berlin

Contact: Tilman Spohn (spohn@uni-muenster.de)
Internet site: http://ifp.uni-muenster.de/pp/MUPUS/

Contact: Uli Auster (uli.auster@tu-bs.de)
Internet site: http://www.tu-bs.de/

University of Münster

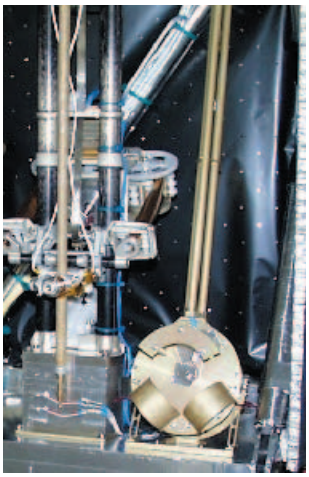
Participation
MUPUS instrument



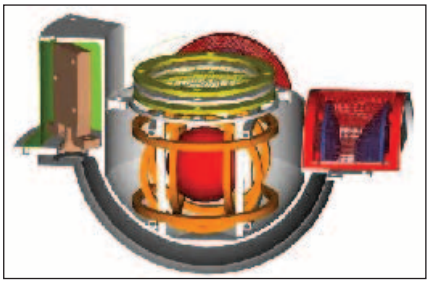
MUPUS – flight instrument.

University of Braunschweig

Participation
ROMAP instrument



ROMAP – flight model sensor

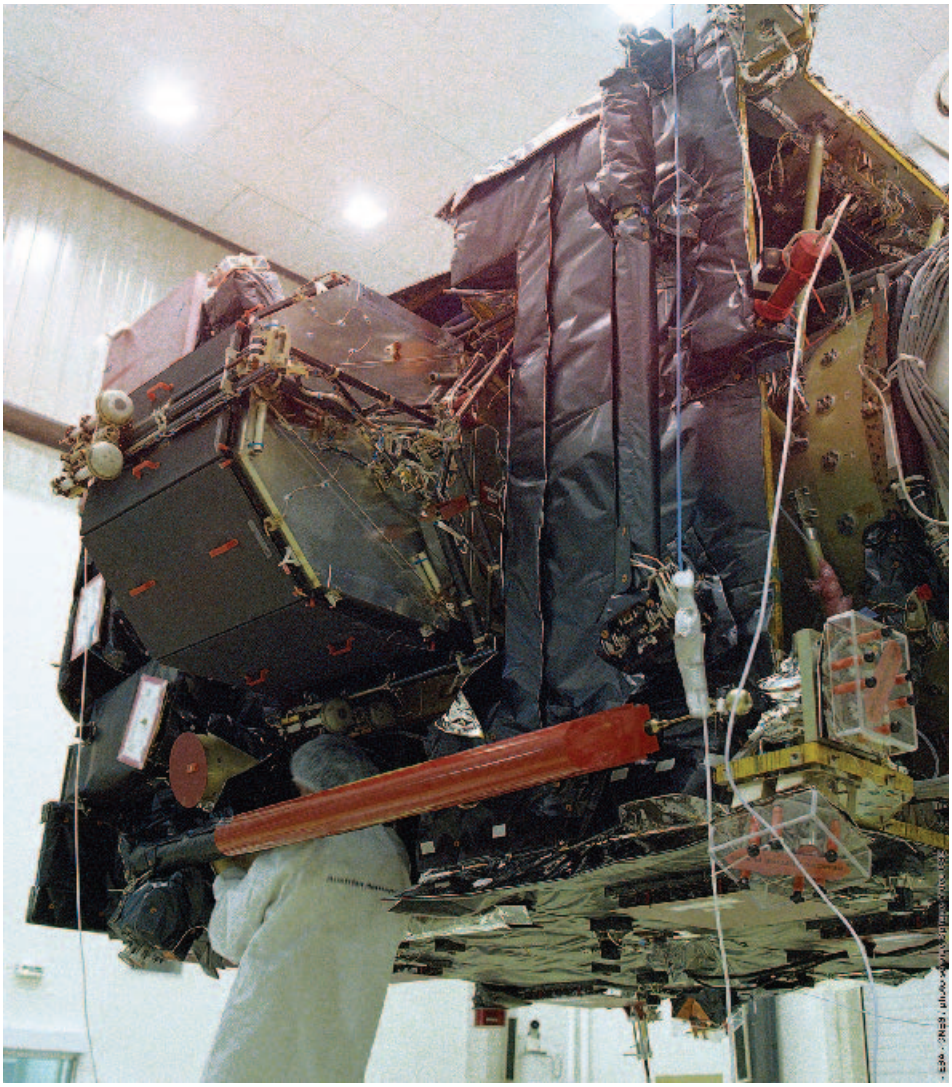


ROMAP – instrument schematics.

Contact: P. Kletzkine (philippe.kletzkine@esa.int), G. Schwehm (gerhard.schwehm@esa.int), R. Schulz (rita.schulz@esa.int)
Internet site: http://sci.esa.int/rosetta

In the overall framework of the ESA Rosetta project, ESA contributed to the Lander development with supplementary funding and expertise for

- Electrical Support System parts procurement and software,
- Supplementary Landing Gear technology,
- environmental and functional testing of several subsystems (including the cold-gas Active Descent System, the Solar Generator, the Electrical Support System) and the Lander itself, and
- System Engineering, Assembly, Integration and Verification and documentation at Lander level.



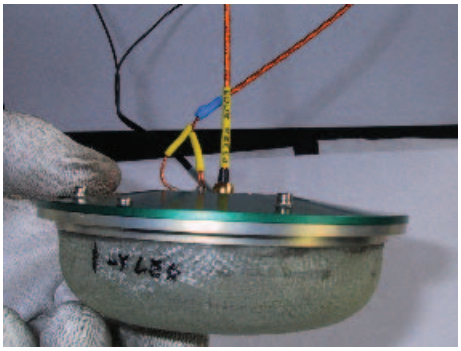
Preparation of the Rosetta spacecraft in Kourou.

FINNISH METEOROLOGICAL INSTITUTE

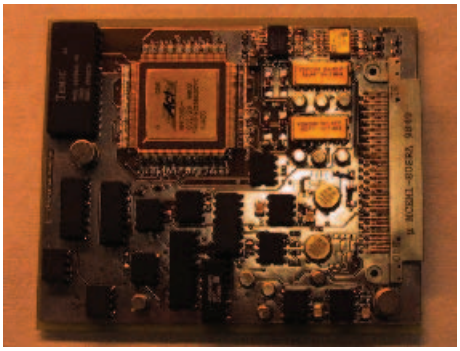
Contact: P. Kletzkine (philippe.kletzkine@esa.int), G. Schwehm (gerhard.schwehm@esa.int), R. Schulz (rita.schulz@esa.int)
Internet site: http://sci.esa.int/rosetta

The Finnish Meteorological Institute in Helsinki provides to the Lander the Mass-Memory of the Command, Data and Management System (CDMS) and the Permittivity Probe (PP) as part of the SESAME consortium. The mass-memory stores all payload data during times without radio contact to the Rosetta orbiter. If the Lander's batteries become empty during the comet night, the data are saved in none-volatile memory until the next contact is established.

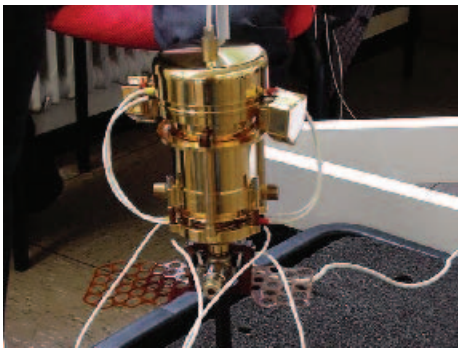
PP measures the electrical properties of the comet surface material down to a depth of 1.5m. From these values temperature variations between comet day and night and the water ice contents can be derived. Additionally the outgassing changes are monitored between day time and comet night and while approaching the sun. PP utilizes as sensor areas the Landing Gear (LG) feet, the APX sensor's bottom side and a mesh around the MUPUS instrument's PEN sensor.



Sensor in LP-foot.



PP Control electronics.



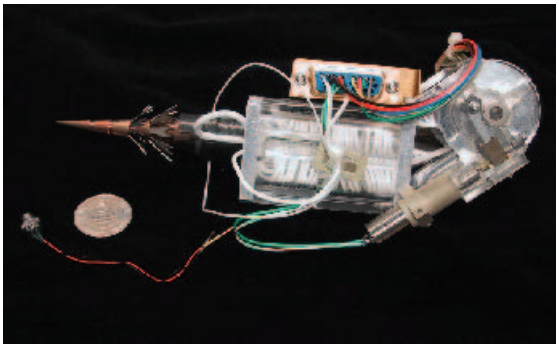
Electrode at MUPUS PEN.

Contact: Dr. Norbert Kömle (norbert.koemle@oeaw.ac.at)
Internet site: http://www.iwf.oeaw.ac.at/german/welcome1024_d.html

IWF participated in the development of the Philae Lander in two respects:

1. Development of the design of the Philae Lander Anchor and performance of the corresponding tests (jointly with MPE Garching, where the hardware was built).
2. IWF was responsible for two sensors within the experiment MUPUS (ANC-M and ANC-T). Both sensors are integrated into the anchor tips.

ANC-T is a temperature sensor (Type: Heraeus FX 1Pt100, 416.5) which will continuously measure the temperature variations at some depth below the cometary surface, when the anchor has come to rest after the shot. ANC-M is a shock accelerometer (type: ENDEVCO 2255B-1). The attached conditioning electronics allows this sensor to measure the deceleration history of the anchor with a frequency of 33 kHz. Decelerations up to 12 000 g can be measured due to the special conditioning of the signal.



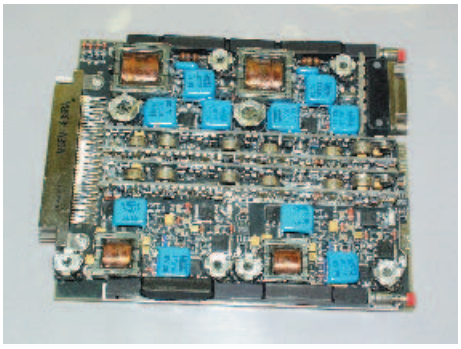
The Philae Lander anchoring harpoon where the MUPUS-accelerometer and a temperature sensor are integrated.

Contact: Prof. K. Szegõ (szego@rmki.kfki.hu)
Internet site: http://www.rmki.kfki.hu/new/space/

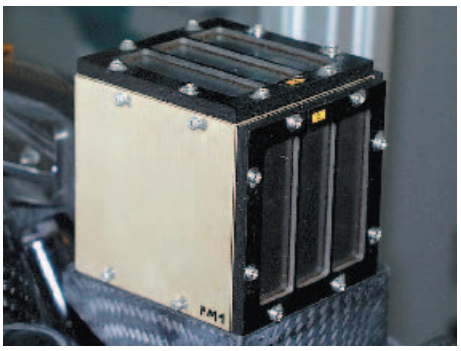
The BUTE-SRG took part in the design, assembly and tests of the Power Conditioning and Distribution Subsystem (PSS). The fault tolerant PSS assures that the power coming fom the batteries and solar arrays are properly handled, controls battery charging, and manages the onboard power distribution. BUTE also participated in providing the EGSE. Key persons: A. Gschwindt, A. Banfalvi.

The contribution of KFKI AEKI to Simple Plasma Monitor (SPM) is to design and manufacture the low voltage and high voltage units of the sensor, and to participate in calibrating and testing SPM and ROMAP (the Small Instrument Package containing SPM). The contribution of KFKI AEKI to Dust Impact Monitor (DIM) is to design and manufacture the sensor and electronic part, and its Ground Support Equipment; to design the software flowchart and the model source code, to participate in calibrating and testing DIM and SESAME (the Small Instrument Package containing DIM). Key persons: I. Apathy, A. Peter.

The KFKI RMKI took part in the development of the fault tolerant Lander Command and Data Management Subsystem (CDMS). It has developed the central data and command interface (CIU) for CDMS. The other parts of the CDMS were designed and tested by SGF Ltd. A major contribution to the Lander is the CDMS flight software, which was developed together with SGF Ltd. This code contols all the onboard lander operation at system level. The KFKI RMKI was responsible for the development of the CDMS EGSE, too. KFKI RMKI participates at Co-I level in the dust and plasma experiments of the Lander. Key persons: S. Szalai, A. Balazs.



Power Subsystem Board.



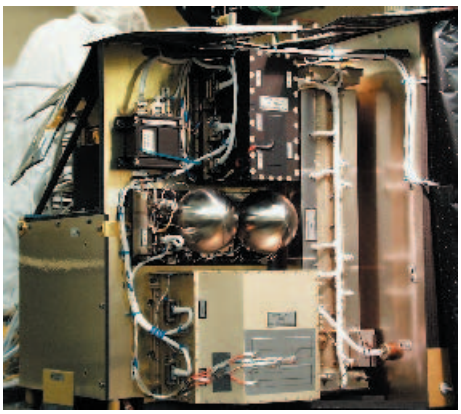
Dust Impact Monitor.

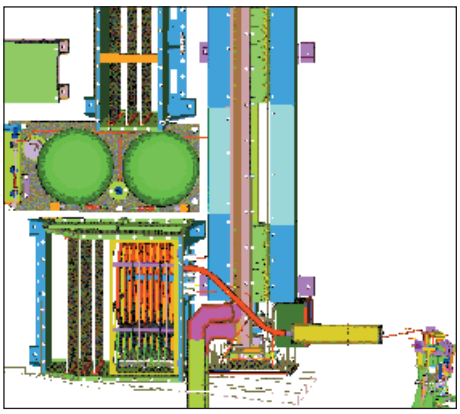
Institutions:
- KFKI Atomic Energy Research Institute (KFKI AEKI)
- KFKI Research Institute for Particle and Nuclear Physics (KFKI RMKI)
- Budapest University of Technology and Economics, Space Research Group (BUTE-SRG)
- SGF Technology Associates Ltd.

Contact: Helmut Rosenbauer (Rosenbauer@linmpi.mpg.de)
Internet site: http://roland.mpae.gwdg.de/

Participation

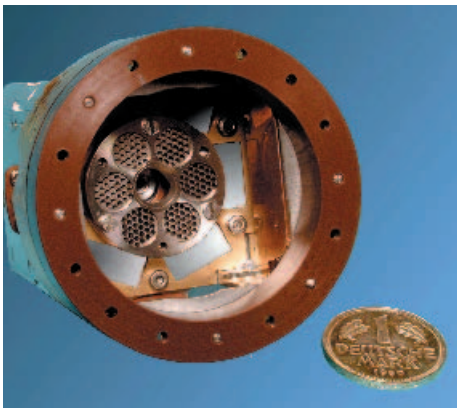
- **Science Lead:** function of Lander Lead Scientist; coordination and optimisation of payload
- **Engineering:** payload engineering
- **AIV:** assembly and integration activities for all Lander models
- **Subsystems:** Eject Mechanism, Landing Gear, Anchoring Harpoon, Central Computer (CDMS), Power Control System, Common Electronics Box
- **Instruments:** COSAC, Evolved Gas Analyzer, APXS, alpha-x-ray flourescence spectrometer





COSAC – Evolved Gas Analyser, to determine the chemical composition of the comet material.

Landing Gear – three-legged device to secure safe landing as demonstrated here during tests at Lindau.



APXS, developed by the Max Planck Institute for Chemistry, Mainz.

PPARC

Contact: Julia Maddock, PPARC Press Office (Julia.Maddock@pparc.ac.uk.)
Internet site: http://www.pparc.ac.uk/

The United Kingdom's role in the Philae Lander

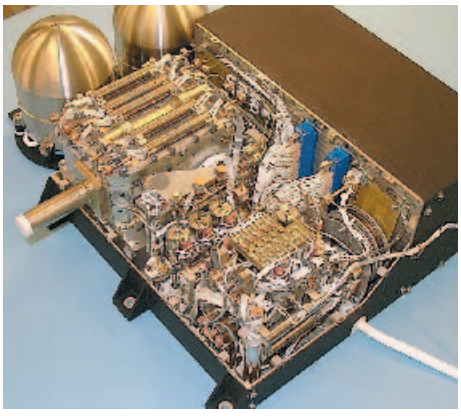
Scientists and organisations from the UK have played key roles in developing the Philae Lander.

The Open University and the Rutherford Appleton Laboratory (RAL) have developed Ptolemy, a miniature laboratory that will investigate the chemical make-up of comet Churyumov-Gerasimenko. Dr Ian Wright from the Open University is the Principal Investigator for Ptolemy, which was funded by the UK's Particle Physics and Astronomy Research Council. Ptolemy will take surface and sub-surface measurements of light elements such as hydrogen, carbon and oxygen. By comparing data from comet Churyumov-Gerasimenko with measurements from Earth, Ptolemy's science team will investigate the role of comets in bringing water and the seeds of life to Earth. RAL designed Ptolemy's lightweight structure and the electronic subsystem to control the mass spectrometer. Nanotechnology developed at RAL was used to build the miniature ion trap mass spectrometer.

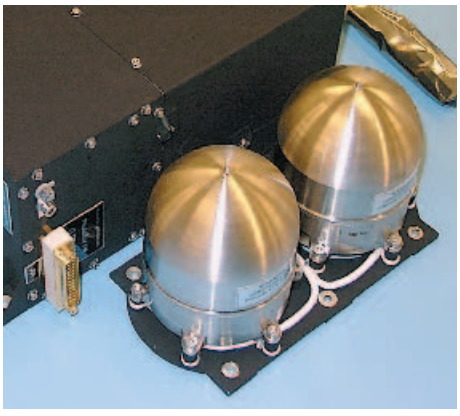
RAL has also contributed to the thermal design of the Philae Lander and constructed the blankets that will keep the Lander warm throughout its mission.

Surrey Satellites Technology Ltd. (SSTL) constructed the momentum wheel for the Philae Lander. It uses an innovative dry-lubricated bearing to minimise energy loss through friction. SSTL's momentum wheel will stabilise the module during the descent and landing phases.

In addition, scientists from the UK have co-investigator roles on the MUPUS, SESAME and CONSERT instruments.



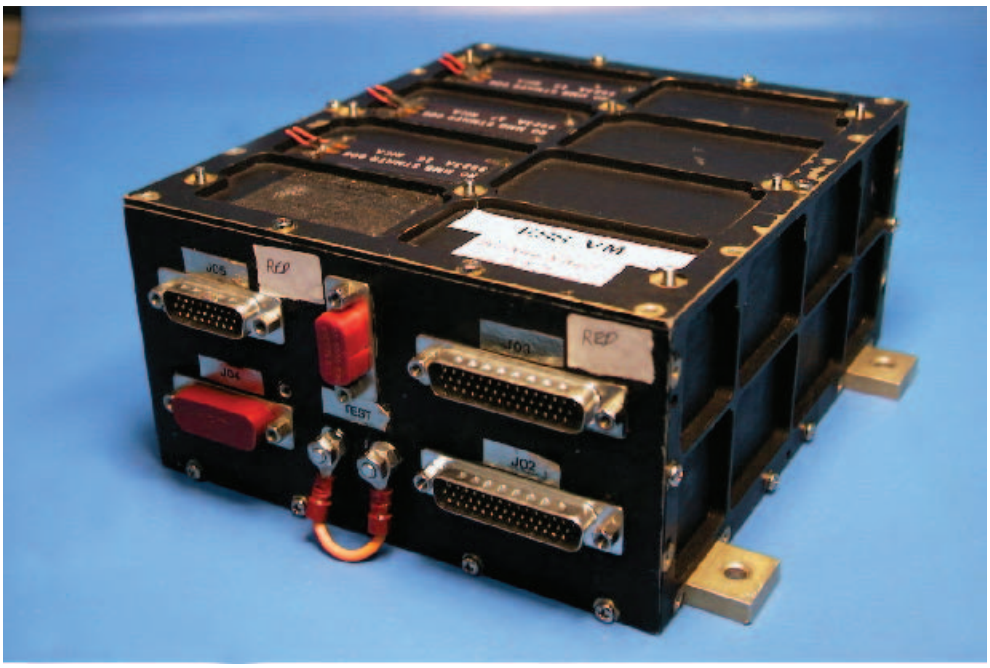
The Ptolemy instrument with part of the covers removed.



The Ptolemy instrument.

Contact: Professor Dr. Susan McKenna-Lawlor (stil@may.ie)
Internet site: http://www.may.ie/academic/physics/

Space Technology Ireland, Ltd. on the campus of the National University of Ireland at Maynooth has designed, tested and constructed the sophisticated Electrical Support System Processor Unit (ESS) for the Rosetta mission. ESS will store, transmit and provide decoding for the command streams passing from the spacecraft to the Lander, and it will also handle the data streams coming back from the various scientific experiments on the Lander to the spacecraft. The ESS is thus mission critical since the success of the Lander depends on the successful acquisition of scientific data from the comet nucleus. During the Cruise Phase to comet Churyumov-Gerasimenko, the command and data streams passing through the umbilical connector of the Lander to Rosetta's onboard computer will also be handled by the ESS.



Electrical Support System (ESS) for the Philae Lander.