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Rosetta Lander – Landing and operations on comet 67P/Churyumov–Gerasimenko

Stephan Ulamec [a,*], Cinzia Fantinati [a], Michael Maibaum [a], Koen Geurts [a], Jens Biele [a], Sven Jansen [a], Oliver Küchemann [a], Barbara Cozzoni [a], Felix Finke [a], Valentina Lommatsch [a], Aurelie Moussi-Soffys [b], Cedric Delmas [b], Laurence O´Rourke [c]

[a] DLR, D-51147 Köln, Germany
[b] CNES, F-31055 Toulouse, France
[c] ESA/ESAC, Urb. Villafranca del Castillo, ES-28691 Madrid, Spain

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ABSTRACT

The Rosetta Lander Philae is part of the ESA Rosetta Mission which reached comet 67P/Churyumov–Gerasimenko after a 10 year cruise in August 2014. Since then, Rosetta has been studying both its nucleus and coma with instruments aboard the Orbiter. On November 12th, 2014 the Lander, Philae, was successfully delivered to the surface of the comet and operated for approximately 64 h after separation from the mother spacecraft. Since the active cold gas system aboard the Lander as well as the anchoring harpoons did not work, Philae bounced after the first touch-down at the planned landing site "Agilkia". At the final landing site, "Abydos", a modified First Scientific Sequence was performed. Due to the unexpectedly low illumination conditions and a lack of anchoring the sequence had to be adapted in order to minimize risk and maximize the scientific output. All ten instruments could be activated at least once, before Philae went into hibernation. In June 2015, the Lander contacted Rosetta again having survived successfully a long hibernation phase.

This paper describes the Lander operations around separation, during descent and on the surface of the comet. We also address the partly successful attempts to re-establish contact with the Lander in June/July, when the internal temperature & power received were sufficient for Philae to become active again.

1. Introduction

Rosetta is a Cornerstone Mission of the ESA Horizon 2000 programme [1]. Launched in March 2004, it arrived at its final destination, comet 67P/Churyumov–Gerasimenko (CG), in August 2014 following a 10 year cruise. Since then, both its nucleus and coma have been studied in detail. This mission is dramatically improving our understanding of the formation and evolution of the Solar System as well as the origin of life due to investigations of a comet both from orbit with the Rosetta spacecraft as well as in-situ with the Lander, Philae, positioned on the surface of the nucleus.

Observations with the instruments aboard the Rosetta spacecraft allowed the selection of a landing site for Philae and the preparation of the actual landing sequence [2]. Philae was separated from the Rosetta main spacecraft on November 12th, 2014 and reached the comet surface after seven hours of descent. However, the lander bounced and only came to rest after a leap of about 2 h, in a location approximately one kilometre from the originally targeted site [3]. Philae was operational for almost 64 h after separation and provided

* Corresponding author. Tel.: +49 2203 601 4567.
E-mail address: Stephan.ulamec@dlr.de (S. Ulamec).

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unique information from the surface of the comet. All ten instruments aboard could be operated at least once. First scientific results have since been published e.g. in [4].

Philae is operated by the Lander Control Centre (LCC) at the German Aerospace Center, DLR, in Cologne and the Science Operations and Navigation Centre (SONC) at the Centre national d'études spatiales, CNES, in Toulouse. Commanding is sent via the Rosetta Orbiter which is controlled by the Rosetta Mission Operations Center, RMOC at the European Spacecraft Operations Centre (ESOC) in Darmstadt. The scientific lead is at the Max Planck Institute for Solar System Science, MPS, in Göttingen, Germany, and the Institut d'Astrophysique Spatiale, IAS, in Paris, France.

The Lander system has been provided by an international consortium (with partners in Germany (lead), France, Italy, Hungary, Finland, UK, Ireland and Austria) and supports a scientific payload of ten instruments with an even larger number of sensor elements [5].

Fig. 1 shows a drawing of the Rosetta Lander (Philae), Fig. 2 an image of the Flight Model during integration at ESTEC [6].

2. Scientific and technological background

Comets are believed to be the primitive leftover of the Solar System formation process. Thus, they contain

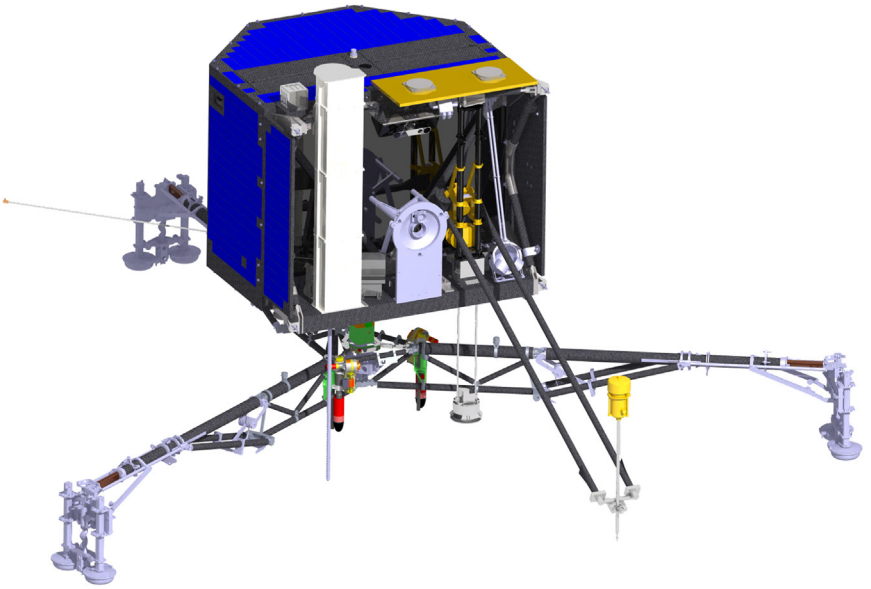

Fig. 1. Rosetta Lander, Philae, in landed configuration.

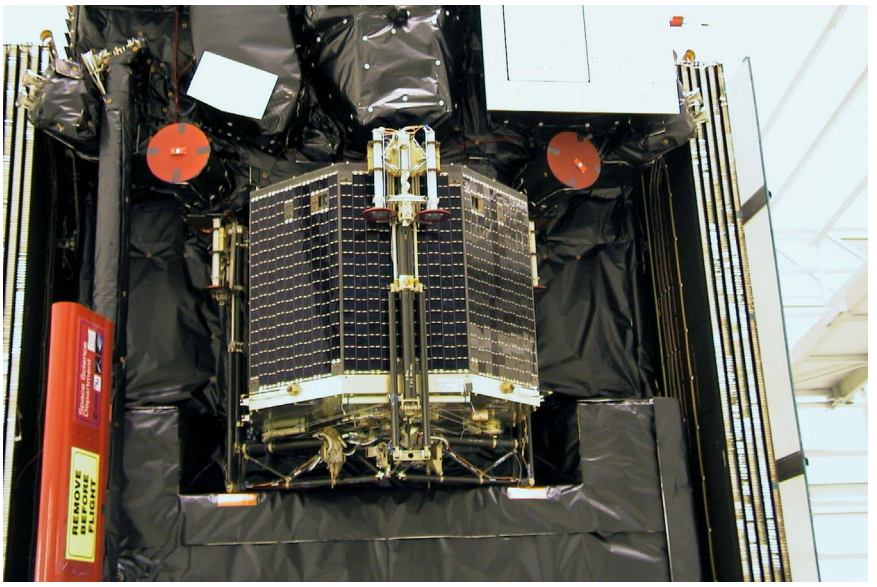

Fig. 2. Rosetta Lander as attached to the Orbiter [6].