Training sessions for the Philae comet lander

18 March 2013

The original Philae comet lander has been travelling through space since 2 March 2004. It is currently in hibernation mode, awaiting its arrival at Comet 67P/Churyumov-Gerasimenko. But the Philae models on the ground are being put through their paces: they are being tested to breaking point and examined by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR). The scientists and engineers want to be as well prepared as possible for the first landing on a comet in November 2014. For this reason, there is a replica of the lander in Bremen – sometimes it sits on soft sand and sometimes on hard ground, because nobody knows what the surface of the comet is like yet. One of Philae's replicas in Cologne is radioed commands and put into operation. "Our simulations involving landing and operating the models will allow us to be properly prepared for any problems during the actual landing," says Stephan Ulamec, DLR project manager for the comet lander, which is travelling on board the European Rosetta spacecraft.

Philae will land on an object about which little is known; the scientists and engineers will decide upon the precise landing site using the first camera images acquired by Rosetta upon arrival at its destination. The exact gravitational attraction exerted by the body, the composition of its surface – these are all unknowns for the scientists. "The comet might have a hard icy crust, or its surface might have a loose, dusty covering," says Lars Witte, who is responsible for the tests involving one of the Philae models at the DLR Institute of Space Systems in Bremen.

Testing the limits of the lander

Time and again the life-size, three-legged model has had to survive landing on the surface, on the robotic arm of the LAMA Landing and Mobility Test Facility – sometimes at 1.1 metres per second, sometimes a bit more slowly. At times in a vertical descent, or sometimes with an inclined touchdown. Sometimes in three tubs filled with sand, others on a solid surface. The scientists have even used a steel plate coated with a film of oil to test how the lander responds in the event of little ground adhesion. The ice screws in the lander's 'feet', which are intended to hold Philae onto the comet, have been unscrewed repeatedly during these tests. “Ultimately, we are testing the limits of the lander," says Witte. Its delicate structure makes it look flimsier than it is.

During the landing, an absorber will soak up the forces affecting Philae. As soon as the refrigerator-sized lander with 10 instruments on board touches down, two harpoons will be shot into the surface, anchoring it to the comet. Although the lander weighs 100 kilograms on Earth, on the comet it will only weigh the same as a sheet of paper. It is also highly probable that the comet, due to its proximity to the Sun, will be active, forming the characteristic tail of ice and dust particles. Touching down safely on the comet will be no easy task for the Philae team. "The landing will take place automatically – due to the large distance, a control command from Earth would take around 30 minutes to reach the lander," says Ulamec. When the critical phase begins, the scientists will have to trust that the software on board is working perfectly.

Prepared for faults and malfunctions

Therefore, another Philae model at the Microgravity User Support Center (MUSC) in Cologne must demonstrate that it can also cope with faults and malfunctions. When the Rosetta spacecraft, with Philae on board, arrives at the comet, operation of the lander will be controlled by a team in the MUSC control room. Cables, connections and components faithfully correspond to the interior of Philae as it travels through space. However, the components are not always where they are on the actual lander. The bottoms of the 'feet' are sitting in a drawer,

next to the outer skin of the harpoons that will bore into the surface. "For us, the important thing is that the connections between the individual components are the same as the original – the design is secondary for the tests," explains Koen Geurts, technical project leader for Philae.

Two engineers control the lander model via multiple computers. “We can simulate everything that could happen to the flight model,” says Geurts. "Including things we would rather not experience." How should Philae respond if individual subsystems malfunction as a result of a short circuit during the descent? What are the first things to do following a successful landing? The engineers are rehearsing adverse events that the software will then need to resolve autonomously – without support from the ground. Shortly before arriving at its destination, the final software will be transmitted to Philae.

Once it has landed on Comet 67P/Churyumov-Gerasimenko, Philae will get to work immediately. The 10 instruments are then expected to send data to the scientists for many months. DLR has primary responsibility for three instruments: the ROLIS camera will take images of the comet’s surface during the landing phase. The SESAME and MUPUS instruments are set to investigate the core of the comet, measure the surface temperature and explore the cohesiveness of the comet. "Landing on a comet for the first time is a truly difficult mission," says Ulamec. “But also an extremely exciting one."

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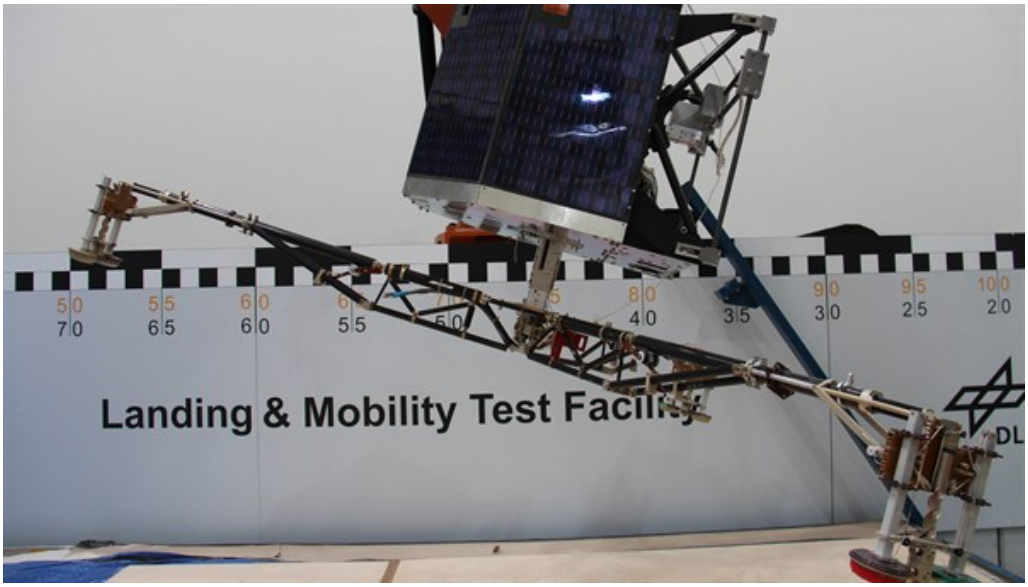
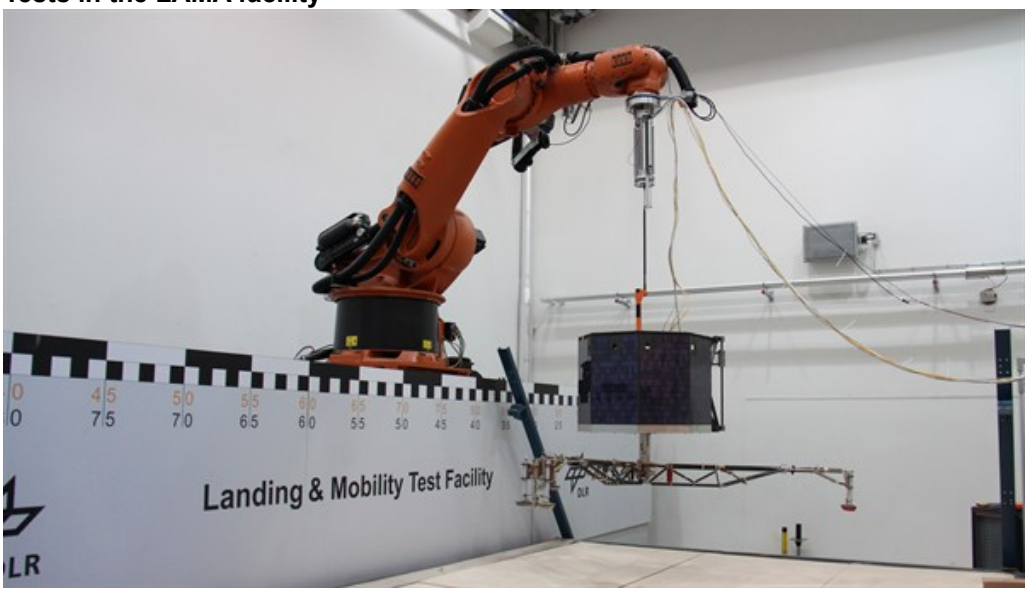
'Philae' comet lander



The refrigerator-sized comet lander Philae, on board Rosetta, will arrive in November 2014 in unknown territory. While the original Philae soars through space en route to comet 67P/ Churyumov-Gerasimenko, DLR engineers are testing models in Bremen and Cologne, to be prepared for the first ever landing on a comet.

Credit: DLR (CC-BY 3.0).

Tests in the LAMA facility



At the DLR Landing and Mobility Test Facility (LAMA) in Bremen, test engineers work with a model of Philae. Here, the probe's landing is simulated on different soils.

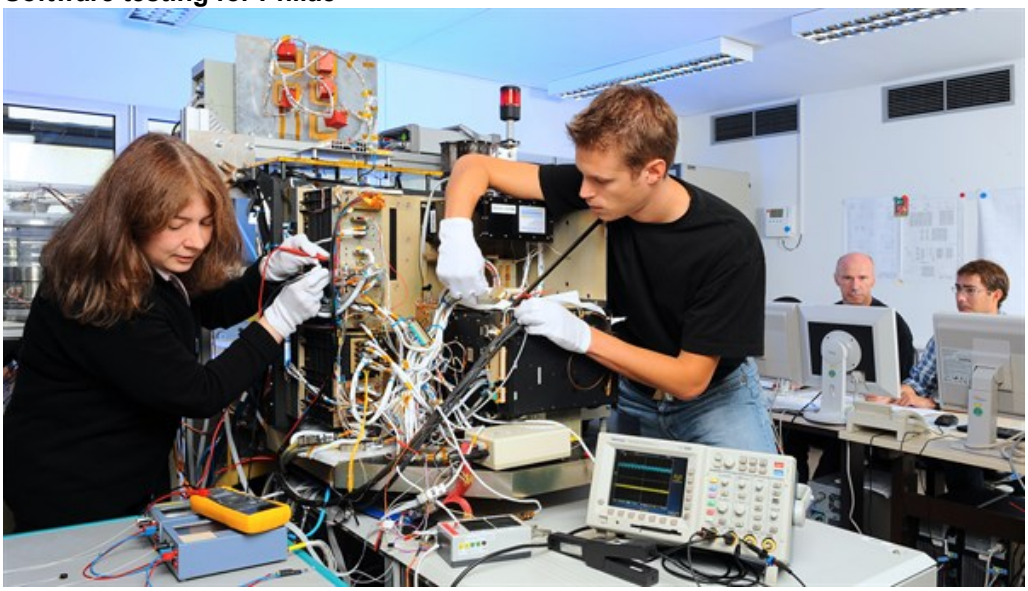
Credit: DLR (CC-BY 3.0).

Rosetta spacecraft with Philae lander on board

The Philae comet lander has been travelling on board the European Rosetta spacecraft since 2 March 2004. The lander is scheduled to touch down on the comet 67P/Churyumov-Gerasimenko in November 2014. The operation of the lander and its 10 experiments will be conducted from the Microgravity User Support Center (MUSC) of the German Aerospace Center (DLR).

Credit: ESA.

Software testing for Philae



With an authentic model of comet lander Philae the engineers can rehearse the adversities that could arise, and that the software must solve autonomously – without support from the ground. Shortly before arriving at the destination, the final software will be sent to Philae. The comet lander has been travelling on board Rosetta since 2 March 2004.

Credit: DLR (CC-BY 3.0).

DLR control room in Cologne

From the control room of the MUSC facility, the engineers and scientists will carry out the operation of comet lander Philae. The lander is being carried on board the European spacecraft Rosetta.

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