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HERSCHEL RE-SUPPLY MISSION FEASIBILITY STUDY

Abstract

The ESA Herschel mission was a space observatory that completed its operations in April 2013, after nearly 4 years of operation, when it ran out of liquid coolant. Orbiting on a Lissajous orbit at L2, it was designated to study formation processes across the universe, and chemical composition of distant bodies. To capture the coldest and dustiest objects in space, the telescope operated in the far infrared and submillimeter wavelength range, and its detectors had to be cooled down to temperatures close to the absolute zero. A cryostat employing about 300 kg of superfluid Helium at 1.6 K was used to maintain the detectors temperature within operational ranges.

In-Situ Resource Utilization opens new scenarios in which satellites can extend their operational lifetime accessing resources in their surroundings and raises the question whether Herschel mission could be extended by refilling the cryostat with liquid coolant produced on the moon at low cost. For this purpose, a feasibility study on Herschel Re-Supply Mission (HRSM) was conducted at the Interdisciplinary Center of Security, Reliability and Trust with the support of Luxembourg Space Agency.

The HRSM proof of concept assumes the availability of a human outpost on the moon, providing a significant amount of the infrastructure. The study relies on regolith mining on the surface of the moon, that is producing 4-Helium as a side product, in the amount needed for the refilling of the Herschel's cryostat. It also considers the possibility to employ a cargo module used during lunar gateway operations and to adapt it to servicing Herschel.

The overall HRSM mission scenario is conceived as follows. The Herschel mission is launched nominally from Earth for its first operational lifetime. The cargo module and the dedicated re-supply module are prepared on the moon and launched towards L2 to enable the refill of Herschel before the cryogenic coolant is depleted. The re-supply spacecraft returns to the moon. After being separated of the re-supply module, the cargo returns to its original activity for the lunar gateway until the next refilling mission.

This paper addresses the design of the lunar-gateway cargo module, describes its preparation on the moon, consisting in the installation of the re-supply module, i.e. the robotic servicing and the cryogenic transfer modules (Helium dewar + Helium transfer line), and in the filling of the Helium dewar with lunar Helium, proposes a trajectory to rendezvous Herschel and illustrates the docking and the re-supply activities.