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LUCIPHERA: THE TECHNOLOGY CHALLENGE OF A VENUS SAMPLE RETURN MISSION

Abstract

The paper presents the phase A results for a Venus sample return mission which address the numerous technology challenges such a mission offers. Venus, in fact, compared with other planets, presents a further hurdle due to inaccessible environmental conditions that have limited previous explorations. Requirements on the mission include the retrieval of both ground and atmosphere specimen; more in details the Venus surface shall be penetrated at least for 20-30 cm depth and should collect 2 kg of ground specimen. No limit is imposed about the number of atmosphere samples. Scientific payloads both on orbiter and on the lander are given for a total mass of 65 kg. A launch after 2019 is imposed, with preference for European launchers exploitation; the landing area is imposed at the Ovda Regio, in the equatorial region. The proposed solution sees two satellites, a 900kg (dry mass) orbiter and a 2600kg (dry mass) lander, launched separately from Earth. The first launch sends the orbiter out of Earth sphere of influence and then a chemical propulsion system brings it to Venus. Aerobraking maneuvering is exploited to finally park the orbiter around the planet. While the orbiter reaches its operative trajectory, the second vehicle launch occurs to send the lander on the Venusian surface, tank to chemical propulsion too. The main design challenge for the lander vehicle has been represented by the thermal control system design: aerogel revealed to be a well-suited solution to cope with the very demanding surface environment. Surface specimens are collected by means of a robotic arm provided with a drill as end effector. A balloon solution has been design to get rid of the very thick atmospheric layers near the surface: while ascending, atmosphere specimens are collected. At 60 km height liquid rockets are turned on, ascent vehicle reaches the parking orbit and docks with the orbiter, that brings the specimen to Earth. The requirements critical analysis, the drivers identification and alternative system architectures, together with considered subsystem designs trade-offs are deeply discussed within the paper and the final mission design presented together with the most relevant design budgets. Requirements for future design refinement and critical aspects which ask for techonology enhancements are also addressed.