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FEASIBILITY STUDY FOR AN AUTONOMOUS EARTH-TO-MOON TRANSFER AND LUNAR OPERATIONS OF A 27U NANOSATELLITE

Abstract

After a first golden age in the 1960s and 1970s, the Moon exploration can now again be called a race. Several missions are scheduled for the end of the 2010s, with new paradigms: 2017 should see the first private company, Moon Express, land on the Moon, and 2018 the first CubeSat missions to the Moon. Several CubeSats are indeed to be released by the maiden launch of the American heavy launcher SLS on an Earth-to-Moon trajectory. Could this CubeSat format become a new standard for the Moon exploration? Without a dedicated launch, a lunar CubeSat would have to perform an autonomous transfer to the Moon before doing any lunar operation. The present study tackles this issue by studying and designing a microsatellite carrying a generic payload weighing 1kg, fitting in 1U, consuming a mean of 5W with peaks at 15W, with 10Gb of data to be downlinked every day. This CubeSat, called MILOU, for Mission for the Insertion on a low Lunar Orbit of a 27U microsatellite, would have to be released in GEO or GSO orbit to lower the radiation budget, the transfer time, and the propellant consumption. Using an electric propulsion thruster developed by the young company "ThrustMe" in France, MILOU would produce 3mN of thrust to join a 100km - 30 lunar orbit in 9 months, using 3.2 kg of propellant. This requirement leads to consider a 27U spacecraft, with 0.74m deployable and pointable solar panels, dealing with an unprecedented total maximum power slightly under 200W, using S-band for uplink communications, and a X-band deployable antenna for data downlink. Specific strategies are proposed to mitigate the new risks of such a mission, using flips of the spacecraft to average the trajectory deviation and the solar heating, solar sailing and thrust modulation to prevent wheel saturation, direct drive between the panels and the thrusters, and motorized radiators to balance the thermal budget. These developments, as well as the deployment of secondary payload in GEO and the commercialization of the thruster are prerequisite for this mission. Shall they be available in the next years, a new standard of larger, autonomous, thrusted CubeSats, still deployed as secondary payloads in Earth orbit, would significantly open the access to the Moon.

Key words: Nanosatellite, Moon, Student project, autonomous Earth-to-Moon transfer, electric propulsion.