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MANFRED MEMORIAL MOON MISSION (4M): A PRIVATELY FUNDED LOW COST LUNAR FLYBY MISSION

Abstract

The first privately funded mission to the moon, the Manfred Memorial Moon Mission (4M), was developed within six months. In addition to the offered attractive launch opportunity itself, three main mission objectives powered the development. First objective, as indicated in its name, was to honour and commemorate Prof. Manfred Fuchs the founder of LuxSpace's parent company OHB who passed away early 2014. Second objective was to demonstrate crowd-based tracking and navigation for deep space missions. For this second objective, the global radioamateur community was gained as a central partner for mission operations. Third objective was to measure the radiation dose on the way to the moon and back. These measurements were performed with a newly developed radiation dosimeter, which was selected from several candidates for technology demonstration. The engineering approach was to act on three maxims: 1) to simplify documentation, 2) to limit complexity and 3) to reduce launch site operations. This approach required continuous communication and trust-based relationship between all project partners (customer, governments, launch provider, system integrator, suppliers and the public). As for previous LEO missions, this approach was a key enabler for mission success. The 12 kg 4M spacecraft is attached to the last stage of a Chinese Long March 3C/G2. Main components of the spacecraft are an on-board computer and an I/Q modulator, a radiation experiment, an amplifier and a quarter-wavelength antenna. The primary power supply with non-rechargeable Li metal cells was designed to provide enough power to fly to the moon, make the flyby and return to Earth. In addition, a secondary power supply with re-chargeable Li-Ion cells and an off the shelf solar panel was included. Despite unfavourable illumination and low temperature, 4M outperformed with more than 4 times the design lifetime (100h worst case) before it turned to hibernation mode on 11.11.2014 (after 438h). From this hibernation mode, 4M may wake up and restart transmissions depending on the illumination of the solar panels. More than 75 registered radioamateurs from 29 countries supported the mission by receiving all uploaded greeting messages transmitted by 4M (from up to 420 000 km away) and forwarding also the data from the radiation dosimeter to the data warehouse. Furthermore, their Doppler data was key to reach the crowd-based navigation objective. Finally, the 4M project increased public awareness and

interest in moon exploration, international cooperation, and affordable space missions, which always were central concerns of Prof. Manfred Fuchs.