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LUNAR SOURCE: LUNAR SOUNDING RADAR CUBESAT EXPERIMENT

Abstract

There is one big question about the feasibility of the human settlement on the Moon: “Is there water ice on the Moon?” and if so, “How much water is there?” and “At what depth?”. Although some missions, like the Japanese SELenological and ENgineering Explorer and the American Lunar Reconnaissance Orbiter, did not find evidence to answer to these questions, last year the first one received an answer. Indeed, Dr. Shuai Li published a paper titled “Direct evidence of surface exposed water ice in the lunar polar regions”, using the data from Chandrayaan-1 mission. However, the last two questions remain open and further investigations are needed.

The aim of this paper is to propose a nanosat mission (e.g. a 12U Cubesat) carrying on-board a sounding radar to analyse the lunar subsurface and to quantify the mass of ice on the Moon. The Lunar SOUnding Radar Cubesat Experiment – SOURCE – will use a 5-meter long dipole as radar antenna that generates an HF signal of 20-meter wavelength. The combination of these two parameters will give a beam-width of 87° and a maximum gain of 1.85 dB that can be still useful, if the orbit is lowered down to 50 km altitude from the moon surface. Such orbit gives a Noise Equivalent Sigma Zero (NESZ) of -53 dB at the nadir point, which enables the analysis of the subsurface interfaces down to a useful depth for water ice detection. However, due to the low altitudes expected for this kind of mission, the irregularities of the mass distribution of the Moon have a significant impact on the orbit stability and on the lifetime of the mission.

This paper analyses the possible orbits for mapping the lunar surface with enough space coverage and time resolution. The identification of the mission and system requirements draws the foundations for the feasibility study of the mission, enabling a preliminary selection and sizing of the main subsystems of the Cubesat. The link budget is computed to ensure that Lunar SOURCE is able to send back to Earth the scientific data with the communication antenna. A trade-off for the power budget is performed to assess whether the mission is able or not to perform observation even when in eclipse. The resulting design will identify and compare commercial-off-the-shelf-components applicable to this mission. The viability of the mission and the feasibility of the design are assessed though numerical calculations and simulations.