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SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 1 (3A)

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SAME BEAM INTERFEROMETRY FOR THE ANALYSIS OF THE INTERNAL STRUCTURE OF CELESTIAL BODIES

Abstract

Landers are an essential element of future missions for solar system exploration. Space agencies are currently considering also network of landers for the Moon and Mars, with the goal to carry out geophysical investigations made possible by simultaneous measurements at different locations, such as the detection of seismic activity. Networks of landers offer also a unique opportunity to carry out a very accurate determination rotational state and tidal deformations of planetary bodies, therefore gathering crucial data for the modeling of their interior structure. When two or more landers are simultaneously visible from the same ground antenna, rotational parameters and tides can be determined with unprecedented accuracy by means of interferometric techniques. We assume that each lander is equipped with X- or Ka-band transponders enabling direct two-way radio links to ground. The simultaneous tracking of transponder pairs using the same frequency standard and the same antenna allows a very effective rejection of common mode errors when the differential phases are computed. In particular, path delays due to the earth troposphere and ionosphere, as well as thermal and mechanical deformations of the ground antenna are almost completely cancelled out. In this works we propose a system configuration capable of attaining sub-millimeter accuracy in the measurement of the differential distances between landers and a ground station. Link budget, power and mass requirements, coverage and mission durations have been analysed both for a lunar and a Mars network. In addition we carry out an assessment of the attainable accuracies in the determination of the lander positions and the rotational and tidal parameters. The radio system is a heritage from the radio science experiments of past and current missions, such as Cassini, Juno and BepiColombo. In view of joint programs of planetary exploration, we emphasize the advantages of spread spectrum communication channels as a standard for planetary lander TTC subsystems.