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MARS ORBITER MISSION'S JOURNEY TO RED PLANET - PRECISE ORBIT ESTIMATION DURING EARTH AND HELIOCENTRIC PHASE

Abstract

India's first Mars mission, Mars Orbiter Mission's (MOM) successful voyage from Earth to Red planet was achieved within short time frame and tight fuel budget. One of the important contribution to this feat is precise orbit estimation. Mars Orbiter Mission was launched on 5th November 2013 from Satish Dhawan Space Centre, Sriharikota, India by India's Polar Satellite Launch Vehicle PSLV-C25. The spacecraft was placed in an elliptical orbit of 248.4 X 23550 km around Earth. MOM revolved about 25 days around the Earth and performed six maneuvers to achieve the escape velocity. After a sequence of five Earth bound maneuvers, the satellite apogee was raised to 190000 km, and through Trans Mars Injection on 30th November, 2013 the spacecraft was allowed to escape Earth sphere of influence and was put into Mars Transfer Trajectory orbit around Sun. Mars Orbit Insertion (MOI) was carried on 24th September, 2014 into the Martian orbit of about (428 X 77000) km. Due to stringent fuel budget, orbit estimation has to be accurate and should be delivered in time. Orbit estimation was carried out with JPL/DSN and ISRO/ISRAC network of stations. Range and Doppler data were collected from both these network stations. Heliocentric phase started after Dec. 3rd, 2013 and lasted upto Sep. 22nd, 2014. This paper emphasis on Orbit determination aspect of MOM spacecraft during Earth and Heliocentric phases of the mission. Delta DOR data was collected and added with range and Doppler to estimate the orbit during Heliocentric phase. JPL navigation solutions based on JPL/DSN tracking data were available during the above phases. This paper also brings out the comparison of estimated orbit with JPL solution. The Estimated orbit parameters for the injected orbit was compared with launch vehicle GPS based INS parameters and with JPL provided orbit solutions. The differences in perigee and apogee heights with respect to expected orbit are 3.06 km and 22.4 km respectively. ISRO estimated orbit and JPL estimated Orbit matched very well. Five Earth bound maneuvers and three TCM's to keep the satellite on the required track were carried out. Estimated orbit parameters before TCM-4 prediceds 3904 km and -6099 km in terms of B.R and B.T. These results closely matched with JPL results. With the determined orbit,

TCM-4 was planned and executed on 22nd Sep. Intended orbit around Mars was achieved on 24th Sep. 2014 precisely with the help of accurate orbit estimation and maneuver execution.