

Mars Observer Interplanetary Cruise Orbit Determination

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Abstract

This section summarizes the Mars Observer orbit determination activity extending from launch to Mars encounter, and includes quantitative results and conclusions derived from mission experience. The major topics covered include (i) a description of the relevant orbit determination models, (ii) an identification and quantification of the major orbit determination error sources, (iii) a review of salient orbit determination results, with emphasis on the Mars approach phase orbit determination, and (iv) a comparison of predicted versus actual orbit determination performance. Special emphasis is given to the consistency of the orbit determination results across different radiometric observation type combinations and data arc lengths.

The Mars Observer (MO) interplanetary cruise phase lasted eleven months, starting, 25 September 1992. The final confirmed receipt of navigation tracking data was 0112.2 August 1993, less than three days before the planned Mars Orbit Insertion (MOI) maneuver. During the cruise phase of the mission, the orbit determination analysts of the MO navigation team determined the spacecraft's trajectory, provided orbit determination solutions for maneuver designs, and assessed the quality and effectiveness of the navigation tracking data.

Orbit determination models are introduced in the following categories: (i) measurement observables, (ii) spacecraft dynamics, (iii) geodetic models, and (iv) filter models. Attention is given to the radiometric data quality throughout cruise and uncertainties associated with the Mars encounter estimates. The salient orbit determination history is presented, leading up to the solutions selected for the backup and final MOI maneuver designs. These two solutions, created 57 days apart, exemplify the consistency of the MO orbit determination results. They were found to be within 0.6 km and 1 mm/s in radial distance and velocity, respectively, to the orbit reconstruction. In addition, orbit determination solutions created with different radiometric observation type combinations and data arc lengths were in agreement during the entire cruise phase. Finally, the predicted versus actual orbit determination performance is presented.

1. OAO Corporation, Altadena, CA.
2. Sterling Software, Pasadena, CA.