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Mars Express Bistatic Radar Observations 2016

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One objective of the Mars Express Radio Science Experiment (MaRS) is to address the dielectric properties and surface roughness of Mars, which can be determined by means of a surface scattering experiment, also known as bistatic radar (BSR). The radio subsystem transmitter located on board the Mars Express spacecraft beams right circularly polarized (RCP) radio signals at two wavelengths – 3.6 cm (X-Band) and 13 cm (S-Band) – toward Mars' surface. Part of the impinging radiation is then scattered toward a receiver at a ground station on Earth and both the right and left circularly polarized echo components (RCP and LCP, respectively) are recorded. The dielectric constant can be derived in this configuration from the RCP-to-LCP power ratio. This approach eliminates the need for absolute end-to-end calibration in favor of relative calibration of the RCP and LCP ground receiver channels. Nonetheless, accurate relative calibration of the two receiving channels remains challenging.

The most favorable configuration for bistatic radar experiments is around Earth-Mars opposition, which occurs approximately every two years. In 2016 the minimum distance of about 0.5 AU was reached on May 30^{th}; eleven BSR experiments were successfully conducted between the end of April and mid-June. The specular point tracks during two experiments over the Syrtis Major region were very similar on April 27^{th} and June 2^{nd}, and the data were collected using the same Earth-based antenna. The separation in time and the different observing angles provide an opportunity to check reproducibility of the calibrations and analysis methods.

The paper will illustrate the general spacecraft-to-ground BSR observation technique and describe in detail the calibration procedures at the ground station needed to perform the relative calibration of the two receiving channels. Results from the calibrations and the surface observations will be shown for the two MaRS experiments over Syrtis Major.