Geophysical Research Abstracts
Vol. 15, EGU2013-7931, 2013
EGU General Assembly 2013

ExoMars WISDOM Left-Right-Evaluation of Subsurface Features

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The Experiment “Water Ice and Subsurface Deposit Observations on Mars” (WISDOM) is a Ground Penetrating Radar (GPR) selected to be part of the Pasteur payload on board the rover of the ExoMars2018 mission. This experiment has been designed to characterize the shallow subsurface structure of Mars. The radar is a gated step frequency system covering a frequency range from 0.5 GHz to 3 GHz. The antenna system consists of two antennas sending and receiving two orthogonal polarizations each. Its particular arrangement on the rover enables a classification, whether a scattering object is located on the left or the right hand side of the rover path. The setting and the procedure for the left-right-detection of off-track buried objects is described. The method is applied to data from laboratory, test site and field measurements.

The capability of WISDOM left-right-evaluation of scatters is based on the performance of the fully polarimetric antenna system. The ultra-light weight antenna system consists of two crosswise arranged Vivaldi arrays, which operate over a wide bandwidth of 6:1. The antenna is placed at the rear of the ExoMars rover in a way that the E-planes of each single Vivaldi antenna is rotated by 45 degrees with respect to the direction of motion. Moreover, the pattern of this Vivaldi antenna exhibits a narrow beam at the E-plane and a wide beam at the H-plane. Besides the simple detection of objects, these particular antenna and accommodation features allow the location of objects to the left or to the right of the rover path.

In a first step the left-right-evaluation of objects and subsurface features is investigated on laboratory measurements for different geometrical configurations. As expected the radargrams exhibit a strong echo at the co-polar transfer functions. At each lateral distance the echo of each scatterer produces a hyperbola but the position of the maximum of magnitude depends on the lateral distance to the rover path. In the next step measurements in artificial environment with known material parameters is carried out to estimate the performance for buried objects. Finally, the procedure is applied to measurement data gained from a field test. The data were recorded during a campaign in a cave of the Dachstein mountain area in Austria.

Since the echo interpretation of lots of subsurface features at once is not easy, the gray scale data of both polarizations has been set to different color channels and combined. The different colors allow also in a realistic environment the discrimination of subsurface features located on the left from those located on the right hand side of the rover path. This technique is interesting especially for the traverse mode, where the rover is moving long distances from one place of investigation to the next rather that following a grid like pattern necessary to get a real 3D mapping of the subsurface. Even in this case where radar measurements are done on the way one can get a more detailed (3D-like) insight of the subsurface structure.