



The performances of the WISDOM Radar on the ExoMars rover

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In accordance with the primary objectives of the PASTEUR payload of the ESA EXOMARS mission, the WISDOM experiment (Water Ice and Subsurface Deposit Observations on Mars) is devoted to the exploration of the upper layers of the subsurface. Recent efforts have been made to investigate the nature of the Martian subsurface by orbital instruments over very large areas at substantial depth down to maximum of several kilometres (MARSIS and SHARAD HF radar sounders). In contrast, WISDOM will use a UHF ground penetrating radar to probe the top several meters of the regolith at high resolution, enabling a detailed investigation of the geophysical, geologic and volatile context of the physical environment most relevant and accessible to the EXOMARS experiments. This will result in a unique data set that addresses high-priority science and engineering issues regarding a domain that is, so far, totally unexplored.

The electromagnetic waves transmitted by the radar antennas are reflected by the electrical parameters inhomogeneities of the soil, (permittivity and/or conductivity) which are linked to the presence of interfaces between stratigraphic layers with different electromagnetic characteristics or objects buried in the soil – such as boulders and rocks. The WISDOM ground penetrating Radar operates in the frequency range from 500 MHz to 3 GHz. Due to this wide frequency range, a vertical resolution of a few centimetres is expected over a few meters depth commensurate with the expected range of the drilling unit. This will provide high resolution observations of the structure of the shallow subsurface to help identify where possible traces of past or present life may be located and investigated by the PASTEUR payload. This task will benefit from WISDOM's ability to make polarimetric measurements of the returning echoes. Such observations will improve the radar's capability to retrieve the geometrical and physical properties of the rocks buried in the soil and to determine the geometry and roughness of the inter-layer interfaces.

WISDOM is a step frequency GPR that measures the phase and amplitude of the reflected signal at 250 different frequencies effectively measuring the transfer function between the transmitter and receiver antenna. The impulse response is then obtained by performing an inverse Fourier transform of the frequency samples. To avoid the direct signal between the transmitter and the receiver and to lessen the strong shallow reflections the radar is gated. Coherent additions are performed to improve the signal to noise ratio in order to maximize the sensibility of the instrument.

The work presented will focus on the performances of the instrument in terms on dynamic and temporal resolution. Laboratory measurements are compared to simulated data. The former are obtained in controlled conditions, the latter are obtained using a FDTD electromagnetic code. Measurements are performed with a demonstrator of the WISDOM flight model.