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The EISS radar of the ExoMars mission : Characterization of the deep Martian sub-surface

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The main objective of the EISS (Electromagnetic Investigation of the Sub Surface) instrument proposed for the ExoMars mission is to probe the subsurface of Mars at large depths from several tens of meters to more than one kilometre. EISS is an impulse Ground Penetrating Radar operating at central frequencies of a few MHz that allows to perform deep soundings of the sub-surface. The instrument will take benefit from the simultaneous presence on the Martian soil of the immobile GEP and of the rover. The electromagnetic pulse is transmitted from the fixed GEP using a 2 X 35 m long loaded dipole antenna deployed on the ground from the immobile GEP. A small receiving magnetic antenna located on the rover will receive the direct wave and the echoes due to interaction with the reflecting structures. This single magnetic antenna, which can be successively positioned along 3 mutually orthogonal directions, provides 3 independent orthogonal magnetic components. This information is essential not only to localize properly the sub-surface reflecting structures but also to discriminate between the echoes coming from the subsurface and those potentially due to the surface clutter. Additional information will be gathered from the mono-static mode of operation where reflected waves are detected on the GEP by using the same electric antenna, which is used for transmission. The expected horizontal resolution is of the order of magnitude of 100 meters and the vertical resolution around 50 meters depending on the mode of operation chosen.

These observations extend over a range of depths that will help to understand the large scale and global geophysical context of the ExoMars rover environment. In addition to the soundings of the deep sub-surface, the measured impedance of the electrical antennas deployed on the soil will provide an estimation of the permittivity of the shallow subsurface[2]. EISS will also be operated in a passive mode to characterize the HF electromagnetic background in order to detect natural emissions that may be associated with electrical discharges in the atmosphere. Measurement of the variations of the HF galactic noise at times of solar events will also bring information on the lower ionosphere disturbances.

The mono-static and bi-static operating modes of the proposed instrument have been already experimentally tested and validated with a lab model called TAPIR (Terrestrial And Planetary Imaging Radar) that has been designed and developped at CETP [3]