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Exploration of planetary subsurfaces with a bi-static HF GPR: results from the TAPIR GPR in the White Egyptian Desert

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The impulse polarimetric Ground Penetrating Radar (GPR) named TAPIR (Terrestrial And Planetary Investigation Radar) has been developed in the frame of the NetLander mission in order to investigate the geological features of the Martian subsurface and search for potential water reservoirs. TAPIR operates at very low frequencies (1-8MHz) and lies on a novel concept that allows to retrieve the direction of arrival of the detected backscattered waves and thus to provide a 3D imaging of the underground reflectors with a spatial resolution of $\sim$ 70 meters.

Recently, the instrument was improved in order to operate in a mono and a bi-static configuration. Two identical radars are used, the first one for transmission and reception (i.e. as a mono-static radar) and the second one, located at a distance from the first one, for reception thus providing bi-static observations. This more complete configuration is of very significant interest because the bi-static measurements allow to reduce drastically the blind zone and to explore the close subsurface. It opens the way to detailed "tomographic" observations of the underground when the distance between the two radars is varied.

In November 2005, this updated version of TAPIR was tested in the White Egyptian Desert, near the Farafrah Oases (600km southwest of Cairo). Deep soundings of the Abou Saied limestone Plateau were performed for various frequencies, polarisations and GPRs separations. Echoes have been detected with both the electric and the magnetic antennas and a preliminary analysis has established the consistency of the

measurements. The retrieval of the direction of arrival of the reflected waves combined with the multi-frequency analysis allows to provide a detailed interpretation of the observed signals. Electrical parameters of the shallow subsurface (permittivity and conductivity) are derived from the electrical antenna impedance measurement. These measurements will be analyzed in the frame of a collaborative program with research teams from LPI (Lunar and Planetary Institute, Houston, Texas) and SwRI (Southwest Research Institute, San Antonio, Texas) who performed complementary GPR and TEM measurements.

Taking the advantage of the new configuration of the EXOMARS mission with a fixed lander (the Geophysical and Environmental Package) and the PASTEUR payload on the rover, similar measurements can be performed on Mars which should be of major interest to explore the geological structure of the subsurface and search for water reservoirs.