Geophysical Research Abstracts,
Vol. 11, EGU2009-11693, 2009
EGU General Assembly 2009

Design and Performance of the WISDOM Antenna System aboard the ExoMars Rover

D. Plettemeier (1), V. Ciarletti (2), S. Hamran (3), C. Corbel (2), S. Linke (4), and W. Benedix (1)

(1) TU-Dresden, RF and Photonics, Dresden, Germany (dirk.plettemeier@tu-dresden.de), (2) Centre d'Etudes des Environnements Terrestre et Planétaires, Vélizy, France, (3) Forsvaret forskningsinstitutt, Kjeller, Norway, (4) INVENT GmbH, Braunschweig, Germany

Abstract—A full polarimetric antenna system on board the ExoMars rover is part of the Experiment "Water Ice and Subsurface Deposit Observations on Mars" (WISDOM). The WISDOM-Experiment is a Ground Penetrating Radar (GPR) selected to be part of the Pasteur payload aboard the rover of the ExoMars mission. The Pasteur Panoramic Instruments (wide angle camera PANCAM, infrared spectrometer MIMA and WISDOM) will perform large-scale scientific investigations at the sites the Rover will visit. Among these instruments, WISDOM is the only one that can provide a view of the subsurface structure prior to drilling. WISDOM is the first space borne GPR aboard a rover and has been designed to characterize the shallow subsurface structure of Mars. WISDOM will give for the first time access to the geological structure, electromagnetic nature, and, possibly, of hydrological state of the shallow subsurface by retrieving the layering and properties of the buried reflectors. It will address some important related science questions regarding the planet present state and past evolution. The measured data will also be used to determine the most promising locations at which to obtain underground samples with the drilling system mounted on board the rover. The instrument objective for WISDOM is to get high-resolution measurements down to 2-meters depth in the Martian crust. The radar is a gated step frequency system covering the frequency range from 500 MHz to 3 GHz. The radar is fully polarimetric and makes use of four ultra wideband Vivaldi antennas. This poster describes the requirements, the design and the realization of the WISDOM antenna system accommodated on the ExoMars rover. Simulated antenna performance and measured antenna parameters as well as preliminary antenna test measurements performed in the lab and in permafrost regions on earth will be discussed in this poster presentation.

The main design requirements of the WISDOM antenna system are driven one hand by the required science return of the Experiment and on the other hand by the specific GPR configuration and accommodation on the Mars Rover. The resolution of a few centimetres and a penetration depth of more than two meters results in a bandwidth of 2.5 GHz. To be able to study depolarization effects in the subsurface a fully polarimetric antenna system is required. To realize the best radar performance the antenna system is equipped with two perpendicular linear polarized transmitting antennas and two co- and cross-polar oriented antennas for reception. Usually GPR antennas are placed on ground or accommodated in a close-by ground configuration with respect to the wavelength. Considering the requirements for the design of the ExoMars rover the GPR antenna system has to have a ground clearance of about 30 cm, which is equal to 3 wavelengths for the highest operating frequency. Taking into account that the GPR antennas on the rover are not able to use the advantages of a close-by ground arrangement and that due to mass, volume and planetary protection requirements the application of absorbing material and reflectors are not appropriate, the antenna pattern of each single antenna element should be directed towards ground and should provide a large forward to backward ratio. The radiation pattern should be wide in rover path direction, so that a visibility of point reflectors for long distance is possible. The across path pattern should be narrow. These and other constraints like EMC requirements as well as pattern deformation due to radiation coupling effects with the rover structure led to an antenna design that is based on two perpendicular oriented Vivaldi structures for each antenna. The antennas will be covered by thin dielectric foil to protect the sensitive parts from Martian dust particles. The overall size of the dual polarized transmitting and receiving antenna is less than 20 cm x 20 cm x 20 cm. The total mass for a whole antenna unit is about 200 g. Taking into account all the requirements, a very powerful space qualified broad band antenna system is developed and successfully tested in different environments.