Subsurface Sounding in "Mars Advanced Radar for Subsurface and Ionosphere Sounding" (MARSIS)

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According to the Mars Express mission, the MARSIS primary *scientific objectives* are to *map the distribution of water, both liquid and solid, in the upper portions of the crust of Mars*. Detection of such reservoirs of water will address key issues in the hydrologic, geologic, climatic and possible biologic evolution of Mars, including the current and past global inventory of water, mechanisms of transport and storage of water. According to the previous scientific objectives, this paper provides a description of the design approach and expected performances of the MARSIS, taking into account of Mars Orbital Laser Altimeter (MOLA) data. The principle of operation of MARSIS the following: the transmitted radar pulse will reach the top of the Mars surface producing a first reflection echo which propagates backward to the radar. However, due to the long wavelengths employed, a significant fraction of the e.m. energy impinging on the surface is transmitted into the crust and propagates downward. Additional reflections, due to subsurface dielectric discontinuities, will occur and the relevant echoes will propagate backward to the radar. As consequence time domain analysis of the strong surface return, eventually after multi-look non-coherent integration, will allow estimation of surface roughness, reflectivity and mean distance, just like in classical pulse limited surface radar altimeters. The presence of weaker signals after the first strong surface return will enable the detection of subsurface interfaces, while the estimation of their time delay from the first surface signal will allow the measurement of the depth of the detected interfaces.The detection of these subsurface echoes is limited by the surface echoes (especially if surfaces are rough), for this reason three different methods will be implemented in MARSIS: Doppler Beam Sharpening, Secondary Monopole Antenna, and Dual Frequency Processing. Finally, the Marsis frequency-agile design will allow to tune the sounding parameters in response to changes in sun illumination condition, latitude etc.. According to the previous scientific objectives and the operation planning, this paper provides a description of the approach referred to the data inversion and expected performances of the MARSIS

New results from the robotic exploration of Mars

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The Mars Exploration Rover *Spirit* landed successfully in Gusev Crater on January 4, 2004 (UTC), followed three weeks later with the successful landing in Meridiani Planum of its twin, *Opportunity*.

Guesev Crater: The landing site at Gusev Crater lies on a densely populated rock-strewn plan. Rocks identified around the lander range in a variety of sizes and angular shapes. Preliminary results of the rock textures show that a majority of the rocks consist of fine-grained volcanic and several (Adirondack) appear to contain some sort of surface coating.. Preliminary results are that the concentrations of presumably dust-borne elements like sulfur and chlorine decrease and you go deeper into the rock. A majority of the rock observations from the plains rocks being classified as an unweathered olivine, magnetite-bearing, low silica basalt. At the present time, three distinct rock types have been identified in the Columbia Hills. Since the initial landing, Spirit has traveled over 4 km and is presently heading up to the top of the Columbia Hills.

Meridiani Planum: The Opportunity landing site lies inside a 20 m diameter impact crater. The lander came to rest near an exposed layer (roughly 12 m long; 0.5 m high) of bedrock in the crater wall. Initial results from microscopic images (MI) data suggest this unit consist a fine-grained rock with a variety of sedimentary structures consisting of cross-bedded, thin layer of sediments. Alpha Particle X-ray Spectrometer (APXS) suggest a high concentration of sulfur. Embedded within the outcrop and weathering out are highly spherical granules. Opportunity spent 90 sols examining Endurance crater and is presently outside the crater examining its own heatshield which landing approximately 2 km from its initial landing spot.