KEY ISSUES IN CHINA 2020 MARS ORBITAL SUBSURFACE SOUNDING RADAR SCHEME. S. G. Xing, Y. Su, S. Dai, J. Q. Feng, Y. Xiao, C. L. Li, Key Laboratory of Lunar and Deep Space Exploration, National Astronomical Observatories of China (NAOC), Beijing, 100012, China, xingsg@nao.cas.cn.

Introduction: Two subsurface sounding radar instruments are proposed in China 2020 Mars Project. One is the rover radar, the other is the orbital radar. The orbital radar is designed by the 38th Research Institute of China Electronic Technology Corporation (CETC 38).

The scientific objectives of China Mars radar is to detect interplanetary radio frequency spectrum during Earth-to-Mars phase; to map the dielectric interfaces to several hundred meters depth in the Martian surface, especially the distribution of water ice, during Surround-Mars phase; to detect Martian surface topography and ionosphere total electron content (TEC).

Different from the MARSIS (MAS EXPRESS, 2003) [1] and the SHARAD (MRO, 2005) [2], the main parameters of the China orbital radar are shown in Table 1.

Table 1. The parameters of the China orbital radar, the MARSIS and the SHARAD

Instrument	CHINA RADAR	MARSIS	SHARAD
Frequency Band(MHz)	10~20 30~50	1.3~2.3,2.5~3.5, 3.5~4.5,4.5~5.5	15~25
Transmitter Power(W)	100	10	10
Pulse Length(μs)	40~200	250	80
PRF(Hz)	400~800	700/350	127
Antenna Length(m) (tip to tip)	~10	40	10
Polarization	HH,HV	Signal	Signal

China Mars Data Ground Application System (MDAS) is an essential part of China Mars Project, which is responsible for proposing the effective scientific objectives, designing and carrying out ground testing to evaluate the performance of instruments before launching, and receiving, preprocessing and releasing the instruments scientific data after launching. As the members of MDAS, our work is to implement a number of analysis and studies of China Mars Orbital radar. In this abstract, several key issues of the orbital radar are introduced.

Key issues of the orbital radar: Three key issues of the radar are presented in the following, which are data volume analysis, onboard data processing, dual-polarization to identify the materials.

Data Volume Analysis. The principle of the orbital radar and the expected penetration depth determine the large volume of the raw radar detected data. However, long transmission distance and short visible window only allow the lower rate of data transmission. Taking high frequency subsurface detection mode (30~50 MHz) for example, with time window of 120 μs, sample frequency of 30 MHz, quantization digit of 24 bit (I+Q), coherent azimuth pulses of 512 and dual polarization channels, the data volume of per frame is about 84.375 Mbit. It is impossible to down-link all detected raw data in each orbit. Therefore, how to extract the raw data, whether to do preprocessing onboard, how to coordinate the different detection modes and how the choose the typical Martian locals are crucial to the orbital radar.

Onboard Data Processing. Most onboard processing has been performed within the MARSIS, (e.g., Doppler processing, range processing, surface echo acquisition and tracking, and multi-looking) [3]. Data processing on SHARAD is limited, but it still includes phase compensation, receiving window positioning, pre-summing and data compression [4]. Similar to the MARSIS and SHARAD, in order to reduce downlink data rate and increase detection coverage, some data processing algorithms are onboard in this China Mars Orbital radar. There are five general categories on board China Mars Orbital radar, which are phase compensation, correction of ionosphere distortion, range compression, Doppler processing and BAQ data compression. Phase compensation is used to prevent the relative time shift from pulse to pulse caused by vertical motion of the spacecraft, while correction of ionosphere distortion is aimed to correct the distorted phase structure distorted in two-way propagation through the ionosphere. After the completion of the ionosphere correction, the range compression is to enhance the range resolution. Doppler processing is used to improve both horizontal resolution in along-track direction and signal-to-noise ratio. BAQ data compression is to conveniently reduce data volume after several onboard processing steps. However, the onboard data processing is irreversible. So all the data processing algorithms must be carefully tested before launching. Some specific model-simulations and ground verification tests are designed to evaluate and modify the onboard data processing algorithms.

Dual-polarization to identify the materials. Dual-polarization antenna design is the highlight of the China Mars Orbital radar, which is essentially different from the MARSIS and SHARAD. In theory, pure water ice is anisotropic in the permittivity. There should be a change of the state of polarization of a radio wave after propagation and reflection in the water ice [5],[6]. However, other materials, (e.g., carbon-dioxide ice, soil, rocks), are isotropic, which are not dependent on the orientation of the transmitting and receiving antennas. Therefore, dual-polarization radar echoes could be used to identify the water ice and map the distribution of the water ice on the Martian surface and subsurface. Though the theory of the polarization and propagation of an electromagnetic wave is clear, the laboratory experiments are always not well to achieve the expected results. Therefore, ground testing and analysis are proposed to evaluate the ability of material identification by polarization characteristics.

Besides the three key issues discussed above, a number of analysis and tests, (e.g. calibration, simulations and special experiments), are also needed to be carried out to evaluate the performance of the China 2020 Mars orbital subsurface sounding radar.

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