



## Long-wave planetary radar for remote sounding the Phobos ground in the project «Phobos-Grunt»

N.A. Armand (1), V.M. Smirnov (1), V.N. Marchuk (1), O.V. Yuschkova (1), V.V. Abramov (2), A.S. Bajanov (2), and B.S. Lifanzev (2)

(1) (1) Fryazino branch of the Institution of Russian academy of sciences Kotel'nikov Institute of Radio Engineering and Electronics of RAS, Fryazino, Russia (marchuk@ms.ire.rssi.ru, vmsmirnov@rambler.ru), (2) (2) Special design bureau of Kotel'nikov IRE RAS, Fryazino, Russia

The project «Phobos- Grunt», which basic purpose - delivery to the Earth samples of a ground from a Phobos for detailed laboratory researches, is included in the Federal space program of Russia for 2006-2015. Realization of the project of delivery of a ground from a Phobos essentially supplements the international program of research of Mars, connected with delivery to the Earth samples of a martian ground. Research of electrophysical characteristics of the Phobos ground, revealing of deep structure and density determination of breeds composing it, research of a relief and roughness of Martian satellite surface will allow understand better the nature of relic substance from which, probably, the Phobos consists. With a greater share of reliability, it is possible to search for answers on these questions using data of radar-tracking sounding of the Phobos ground. The long-wave planetary radar LWPR which is a part of a complex of the scientific equipment of the project «Phobos-Grunt» is intended for remote sounding a surface and subsurface structures of the Phobos ground by a method of pulse radiosounding along a flight line of a spacecraft «Phobos- Grunt».

The basic purpose of planning radar experiment is revealing deep structure and an estimation of breed density of the Phobos ground, research of a relief and a roughness of the Phobos surface, an estimation of dielectric properties of a ground on different depths along a flight line of spacecraft.

The long-wave planetary radar represents the radar-tracking complex intended for sounding a ground of the Martian satellite on frequencies of 125-175 MHz. The chosen range of frequencies will allow carry out deep sounding of the Phobos ground at the accepted model of structure of a surface and subsurface up to depths from units up to hundreds meters. LWPR differs from the georadars used usually for research of earth's ground a big range of distances and necessity to work both from spacecraft orbit and from the Phobos surface.

The variant of the "organized" signal is accepted in LWPR. Operating modes of the device provide formation of a signal in the form of periodically repeating single impulse consisting of four periods of a radio frequency - a simple signal and in the form of sequence radio-frequency sub pulses - a complex signal. Parameters and types of radiated signals are determined by statement of a task on sounding structure of a ground and technical opportunities of a spacecraft.

It is stipulated three types of experiments.

1. Large-scale sounding with quasi-synchronous orbits around of Mars from distances from 50 up to 100 km up to the Phobos surface. Expected depth of sounding is no more than 10's meters.
2. Small-scale sounding from small heights from several kilometers up to 100 m, carried out at landing spacecraft to the Phobos surface. At this scheme of carrying out of experiment detection of objects in the size from several meters and more on depths up to 100 m is expected.
3. Deep sounding from a surface of the Phobos. Sounding is possible on depth over 100 m, but without an opportunity to determine a direction from which the reflected signal as the diagram of an orientation of the antenna is wide, and the radar is motionless comes (it is not present opportunities to apply a method of synthesizing of the aperture of the antenna). Therefore in the given mode it is possible to receive only inclined range up to reflecting objects.

LWPR consists of the radiate-receive antenna and the block of electronics. Total weight of the de-vice is 3.5 kg, average power consumption about 6 W. One antenna serves both for radiate and for reception of a signal with separation on time. Therefore there is a restriction on the minimal range of the sounding, caused by time of switching

from a mode of radiate to a mode of reception. For big heights it does not represent problems, for sounding from a surface depth of sounding will begin from one impulse till two lengths in space (that is approximately with 8-16 meters).