

GAMMA-RAYS AND NEUTRON SPECTROMETERS NS HEND - TOOL FOR STUDY OF PHOBOS SURFACE COMPOSITION. A.S. Kozyrev¹, M.L. Litvak¹, A.A. Malakhov¹, M.I. Mokrousov¹, I.G. Mitrofanov¹, A.A. Rogozhin², A.B. Sanin¹, R. Schulz⁴, V.N. Schvetsov³, V.I. Tretyakov¹, A.V. Vostrukhin¹. ¹Institute for Space Research, 84/32 Profsojznaja str., Moscow 117997, Russia, kozyrev@mx.iki.rssi.ru; ²All-Russia Scientific Research Institute of Mineral Resources named after N.M. Fedorovsky, 31 Staromonetnyi per., Moscow 119017, Russia; ³Joint Institute for Nuclear Research, Joliot-Curie, 141980, Dubna, Russia; ⁴ESA/ESTEC, Keplerlaan 1, 2201 AZ, Noordwijk, The Netherlands.

Introduction: The Neutron Spectrometer HEND (NS HEND) has been proposed for studying elemental composition of Phobos (the Mars's moon) regolith by "Phobos-Grunt" mission (see Figure 1). NS HEND have been selected by the Federal Space Agency of Russia for the Lander of the "Phobos-Grunt" mission scheduled for launch in October 2009.

The shallow subsurface of Phobos might be studied by observations of induced nuclear gamma-ray lines and neutron emission. Secondary gamma-rays and neutrons are produced by energetic Galactic Cosmic Rays within 1-2 meter layer of subsurface. The knowledge of the spectral density of neutrons in addition to measurements of nuclear gamma lines allows to deconvolve concentrations of soil-constituting elements. That is why nuclear instruments include both the segment for detection of gamma ray lines and segment of neutron spectrometer for the measurement of the neutron leakage spectra [1-3]. Moreover, measurements of neutrons at 2.2 MeV line will also allow to study the content of hydrogen within subsurface layer about 1 meter deep.

Instrument design: The concept of NS HEND instrument is based on the heritage of HEND instrument onboard NASA's Mars Odyssey mission launched in 2001 year, which is now successfully operating on Mars orbit [2]. Additional element of NS HEND instrument is gamma-ray spectrometer, which allows to measure gamma-ray lines together with neutrons from the surface of Phobos. NS HEND will be proto-flight instrument for the Mercury Gamma and Neutron Spectrometer MGNS, which is under development now for ESA's BepiColombo mission to Mercury scheduled in 2014 [2].

Concept design of NS HEND is presented in Figure 2. The total mass for this instrument is less than 3.8 kg and the power consumption is less than 8.0 W.

Instrument NS HEND includes the set of three ³He proportional counters inside polyethylene and cadmium enclosures for measurements of thermal and epithermal neutrons, scintillation stilben crystal for measurements of fast and high energy neutrons with energies from 0.5 MeV up to 10 MeV and scintillation crystal of LaBr₃ for measurements of gamma-ray lines with energy resolution better than 3% at 662 keV.

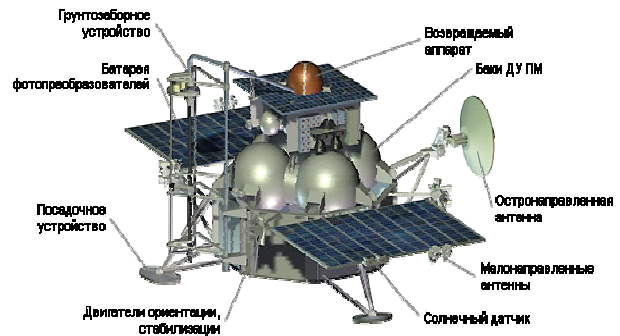


Figure 1. The concept design of landing module for Phobos-Grunt mission.

Conclusion: At present, development of NS HEND instrument is at the stage of testing of qualification unit and final tuning of flight unit. The flight units will be delivered to "Phobos-Grunt" project for integration tests at March 2009.

This instrument, as the part of "Phobos-Grunt" mission, will be able to provide observational data for composition of Phobos regolith and content of natural radioactive elements K, U and Th, and also for content of hydrogen or water ice in the Phobos subsurface.

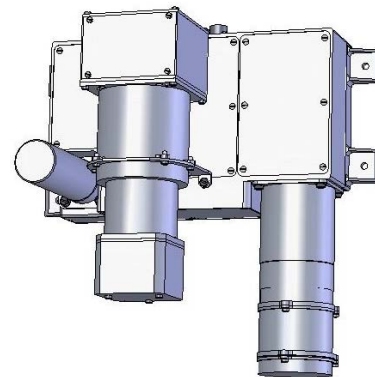


Figure 2. The mechanical design for NS HEND instrument.

References: [1] W. C. Feldman, et al., (2002), *Science*, vol. 97, Issue 5578, pp. 75-78; [2] I. G. Mitrofanov et al., (2002), *Science*, vol. 297, Issue 5578, pp. 78-81; [3] W. V. Boynton et al., (2002), *Science*, vol. 297, Issue 5578, p. 81-85; [4] A.S. Kozyrev et al., (2007), *Lunar and Planet. Conf. XXXVIII*, abstract # 1589.