Russian High Energy Neutron Detector HEND for Mars Surveyor Orbiter 2001 Mission. Igor G.Mitrofanov[1], Dmitrij S.Anfimov[1], William V. Boynton[2], Sergej P.Handorin[1], Andrej A.Kondabarov[1], Maxim L.Litvak[1], Dmitrij A.Litvin[1], Lev B.Pikel'ner[3], Yuri P.Popov[3], Valery N.Shvetsov[3], Alexander V. Strelkov[3] and Alexander K.Tonshev[1], [1]Institute for Space Research (IKI), Moscow, Russia (imitrofa@space.ru); [2]University of Arizona, Tucson, AZ, USA; [3] Joint Institute for Nuclear Research, Dubna, Russia.

Cosmic rays are known to produce large number of high energy neutrons at the Martian surface. These neutrons produce gamma-ray lines from the nucleus either via inelastic scattering (I-type lines), in which they keep their original high energy, or via capturing reactions (C-type lines), in which they are slowed down to epithermal or thermal energies These lines together with the lines produced by natural decay of K, Th and U (N-type lines) will be measured by the Gamma-Ray Spectrometer with high purity Ge detector [1]. The mapping of these lines will allow the investigators to determine the distribution of the principal minerals globally over the martian surface, which is one of the primarily goals of the Mars Surveyor Orbiter 2001 mission [2].

The main scientific objectives of Russian High Energy Neutron Detector HEND are consistent with this goal. HEND, as a part of GRS facility, will provide the map of high energy neutron albedo, which will allow (together with the complementary map of low energy neutron albedo from the Neutron Spectrometer NS [3]) to distinguish I-type, C-type and N-type lines among the forest of lines from the GRS spectrometer.

With the increase of hydrogen content in the surface layer, the termalization path of high energy neutrons is shortened, and the ratio between original high energy neutrons and thermal neutrons decreases. The mapping measurements of this water-sensitive signature is the second main objective of the HEND.

To achieve these goals, HEND is integrated into the GRS [1] (along with Gamma Sensor Head and the Neutron Spectrometer [3]). HEND has three ^{3}He-based counters of neutrons for energy ranges 0.01 – 1.0 eV, 1.0 – 1000.0 eV and 1.0 – 1000.0 keV with thin, medium and thick moderators, receptively. For the highest energy range of 1.0 – 10.0 MeV HEND has one Stilben-based scintillating detector with active anti-coincidence shielding around it. The ^{3}He-based detectors with thin and medium moderators will ensure the complementary measurement verification to the Neutron Spectrometer at low energy ranges below 1 keV and will provide the data for cross-calibration between HEND and NS. The ^{3}He-based detector with thick moderator and the Stilben scintillator will provide the data for high energy neutrons at 1 keV – 10 MeV range to build the map of the elemental composition of the martian surface, and to determine the regions with increased abundance of hydrogen in the shallow subsurface.

The HEND data on of neutrons at four energy ranges will be accumulated during the mapping stage of the mission. The resulting map of neutrons will be registered by the GRS team together with mapped energy spectra of nuclear lines. Also, the data of high energy neutrons from HEND will characterize the radiation environment during the interplanetary cruise and in Mars orbit, as related to radiation-induced risk to human explorers. Special data formats with time profiles will be used to measure with fine time resolution the fluxes of high energy neutrons and gamma-rays during strong solar flares and gamma-ray bursts.

Numerical computation of HEND sensitivity will be performed to optimize the thickness of moderators around ^{3}He-tubes for expected energy spectra of neutrons in Mars orbit. The instrument will be calibrated on the neutron beams of Van de Graaf accelerator and neutron pulsed reactors of Joint Institute of Nuclear Researches. The cross-calibration between the HEND and the NS in the overlapping range of neutrons energy will be performed by numerical computations. The Institute for Space Research will develop the data base for HEND data which will allow remote access for all authorized users.

References

[1] Boynton W. et al. (1999) in these Proceedings.
[2] Saunders S. et al. (1999) in these Proceedings.
[3] Feldman W. et al. (1999) in these Proceedings