DYNAMIC ALBEDO OF NEUTRONS (DAN): ACTIVE NUCLEAR EXPERIMENT ONDOARD NASA MARS SCIENCE LABORATORY. I.G. Mitrofanov[1], M.L Litvak[1], A.S. Kozyrev[1], M.I. Mokrousov[1], A.B. Sanin[1], V. Tretyakov[1], [1]Space Research Institute, RAS, Moscow, 117997, Russia, imitrofa@space.ru .

Introduction: Successful nuclear experiments GRS, NS and HEND [1-4] onboard NASA Mars Odyssey has proved the high research power of nuclear methods for Mars exploration. The difference of epithermal neutron flux is found to be about one order of magnitude for different regions of Mars, which is associated with strong regional variations of water content in the shallow subsurface from tens of weight percents at high latitudes down to 1-3 weight percents at the driest area of Solis Planium [2-5]. The orbital neutron data from Odyssey corresponds to surface resolution of few hundreds of kilometers, and one could guess that similar of even larger variations of water content would be detected from a neutron detector onboard surface mobile laboratory on Mars.

This surface experiment with neutron instrumentation will be performed onboard NASA Mars Science Laboratory (MSL), which is scheduled for launch at 2009. This mobile platform will have radio-isotope sources of energy, which produce local radiation background of neutrons and gamma-rays around MSL. Therefore, neutron instrument for characterization of water content in subsurface has to be active one: it should emit short pulses of high energy neutrons and then detect dynamic albedo of neutrons after each of them. Local radiation background could be excluded from variable time profiles of induced neutrons die away curves, and shapes of these curves allows to measure content of water and layering structure of subsurface below wheels of MSL. This is the physical concept of Dynamic Albedo of Neutrons (DAN) experiment, which is contribution of Russian Federal Space Agency to NASA MSL mission.

Description of the experiment DAN: DAN contains three main elements: Pulsing Neutron Generator (PNG), which emits pulses of 10^7 neutrons at 14 MeV with duration of 1-2 microseconds; two Sensors of Neutrons SN1 and SN1 with and without enclosure of Cd for detection thermal and epithermal neutrons sensors and Central Electronic Unit for instrument operations and data processing (see Figures 1 and 2). DAN will be installed somewhere at the bottom of MSL at distance of several tens of centimeters between emitting point of PNG and surface.

Numerical simulations of DAN measurements proves very high sensitivity of this method for determination of water content in the shallow subsurface of Mars. Figure 3 presents die away curves of thermal neutrons induced by PNG pulses for soil with different content of water. One could see both different amplitude of dynamic albedo curves as well as different time durations for soil with different content of water. The method is sensitive for layering structure of subsurface: water ice layer at different depth corresponds to different time profiles of die away curves of dynamic albedo (Figure 4).

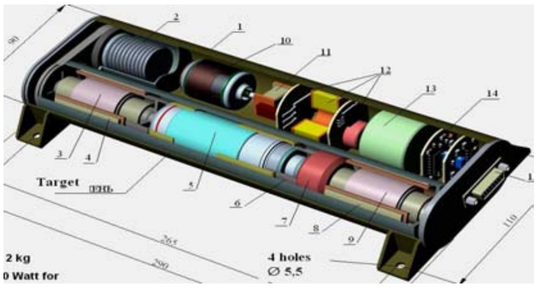

Fig.1. The concept view of Pulsing neutron Generator for DAN.

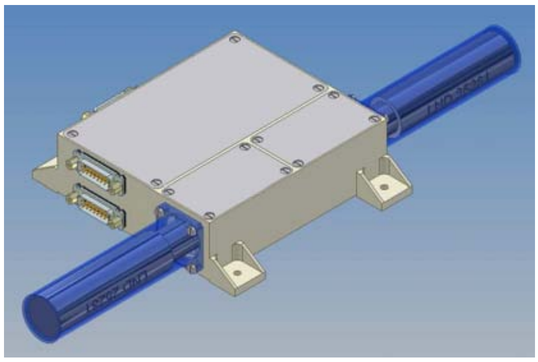

Fig 2. Detectors and Central Electronic Unit of DAN.

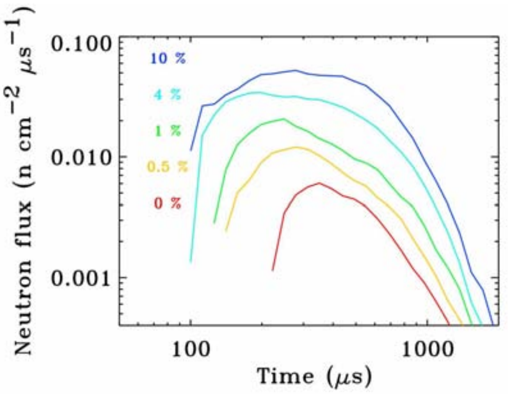

Fig. 3. Calculated die away curves of thermal neutron albedo after pulses from PNG at the surface with different content of water

DAN will be able to produce about 10^7 neutron pulses without decrease of intensity of pulses. Therefore, different operation regimes will be used for DAN on the surface of Mars. These regimes will correspond to different total exposure time of elementary path element of the rover, and correspondingly, to different accuracy of water content measurements in the subsurface.

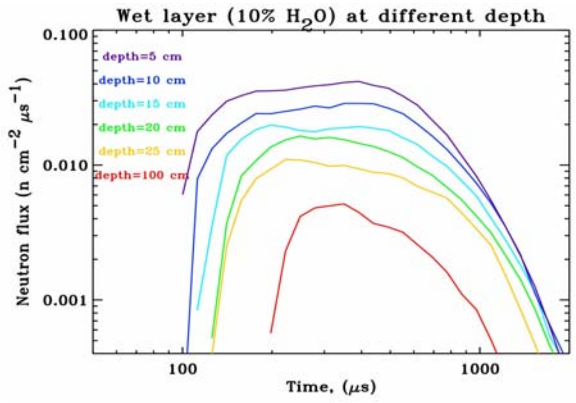

Fig. 4. Calculated die away curves of thermal neutron albedo after pulses from PNG at the surface with different depth of water rich layer.

References:

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