DYNAMIC ALBEDO OF NEUTRONS INSTRUMENT ONBOARD MSL MISSION: SELECTION OF LANDING SITE FROM HEND/ODYSSEY DATA. M.L Litvak[1], A.S. Kozyrev[1], A.V. Malakhov, I.G. Mitrofanov[1], M.I. Mokrousov[1], A.B. Sanin[1], V. Tretyakov[1], A. Vostrukhin, [1]Space Research Institute, RAS, Moscow, 117997, Russia, litvak@mx.iki.rssi.ru .

Introduction: The Dynamic Albedo of Neutrons (DAN) instrument has been contributed by Russian Space Agency to NASA for Mars Science Laboratory mission scheduled in 2009. This proposal is partially based on the heritage of HEND instrument which now successfully operates onboard Odyssey mission. It is accepted that DAN will be installed at the back part of MSL rover and will provide measurements of water distribution in Martian subsurface trough the rover path. It means that from global orbital mapping of water distribution with large footprint ~ 600 x 600 km (provided by GRS, HEND and NS instruments onboard Odyssey spacecraft) one can go to "ground truth" measurements with spatial resolution as low as ~ 1 m. It is planned that MSL will be landed within 60S – 60N latitude zone which may allow to validate several locations (if they will be selected as MSL landing site) in Arabia Terra and Memnonia regions where GRS instruments found enhanced water content as large as 10-15% by mass fraction [1-3]. These regions may be explained by presence of large amount of hydrated materials or (which is unlikely) by presence of remnants of ancient ice.

Description of the experiment DAN: DAN contains two main elements: Pulsing Neutron Generator (DAN/PNG), which emits pulses of 10^7 neutrons at 14 MeV with duration of 1-2 microseconds and two detectors of neutrons with and without enclosure of Cd for detection thermal and epithermal neutrons (DAN/DE). Onboard MSL rover DAN components will be separated by several tens of centimeters and installed 80 cm above Martian surface. The design of DAN/PNG and DAN/DE components is presented on figures 1 and 2. Such combination of emitter and reciever in one instrument provides several significant advantages:

A) Pulsing operation of DAN easily helps to distinguish between surface signal and radiation background from MSL plutonium radio thermal generator.

B) DAN is active nuclear instrument which operate like sonar: DAN PNG irradiate subsurface with high energy neutrons and DAN DE record the subsurface response in thermal and epithermal neutron range. This response will be recorded as short (100-1000µs) die away curves. This method is sensitive to the subsurface vertical structure and will be used to deconvolve water distribution down to depth ~ 50 cm.

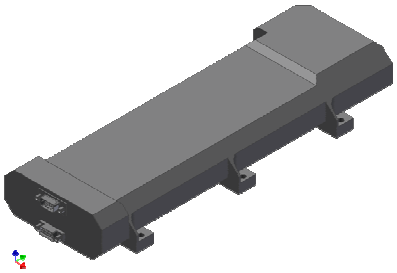

Fig.1. The concept view of Pulsing Neutron Generator developed for DAN.

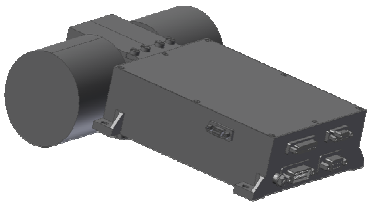

Fig.2. The concept view of Detector and Electronics developed for DAN.

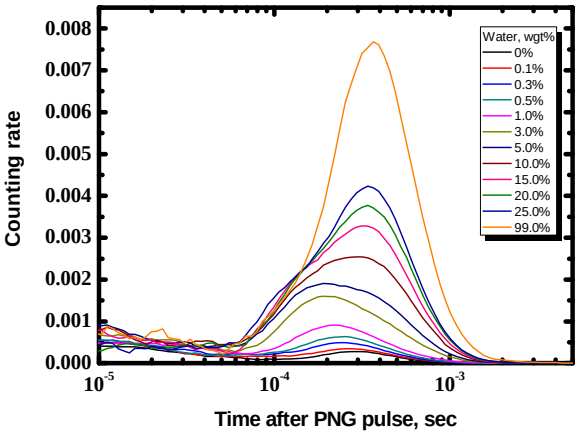

Fig. 3. The modeled die away curves which will be recorded with DAN for soils with different content of water.

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 DAN/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.

Data analysis: During first MSL landing workshop in 2006 the attempt have been made to systematize and prioritize different proposals and suggestions concerning selection of MSL landing site.

In this work we have analyzed different landing locations (taken from First MSL landing site workshop official list) which have been selected with highest rank [4]. These sites related to noachian-aged rocks rich in phyllosilicate, lacustrine deposits, sedimentary layered sequences, valley network outflow, layered deposits, sulfate deposits and layered sulfates. We tried to use HEND/Odyssey data to perform rough estimations of water content for these locations. In our analysis we have taken results of global mapping of water distribution accumulated trough the 5 years of observations. The fine grid 1 degree x 1 degree (~ 60 km x 60 km at equator) have been selected to perform a rough fit of suggested landing ellipses. Such spatial resolution is significantly less than HEND/GRS footprints and leads to smoothing and averaging of water estimation between given pixel (corresponding to the landing site) and neighbors pixels. But this technique give us a navigation about minimal abundance of water around landing site. We found that for all prioritized landing sites the maximal abundance of water is less than 5% by mass fraction according homogeneous model of water distribution in Martian subsurface. This result shows that majority of proposed sites are very dry and probably contains only traces of hydrated activity from ancient epochs. That is why we also suggest to consider another set of 'wet' landing sites with sedimentary layered sequences and network outflows which may contain relative high content of chemically bound water and may be hydrological active until now.

References:

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[4] M. Golombek and J. Grant, First MSL landing site workshop, http://marsoweb.nas.nasa.gov/landingsites/, 2006.