FOLLOWING SUBSURFACE WATER ON MARS: FIRST FIELD TESTS WITH DAN/MSL INSTRUMENT. M.L Litvak[1], I.G. Mitrofanov[1] , V. N. Shvecov[2], G.N. Timoshenko[2], A.S. Kozyrev[1], A.V. Malakhov, M.I. Mokrousov[1], A.B. Sanin[1], V. Tretyakov[1], A. Vostrukhin, D. Golovin[1], A. Varenikov[1] , [1]Space Research Institute, RAS, Moscow, 117997, Russia, litvak@mx.iki.rssi.ru , [2]Joint Institute for Nuclear Research, [6]Joliot-Curie, 141980, Dubna, Russia

Introduction: The Dynamic Albedo of Neutrons instrument, provided by the Russian Federal Space Agency, is designed to perform an in-situ analysis of the hydrogen content of the bulk Martian subsurface at depths of up to about 1 meter, likely manifested as water or OH. DAN is also designed to perform an in-situ analysis of the layering structure of hydrogen bearing minerals (or water) in the Martian subsurface, with horizontal resolution up to 1 m as MSL traverses on Mars (see 1-3).

DAN operates under the principle that H- and OH-rich minerals significantly change the secondary epithermal and thermal neutron fluxes that arise when the Martian surface is actively bombarded by high energy neutrons (E_n~14 MeV). The "die away" behavior (also called dynamic albedo) of these secondary neutrons can be used to characterize the hydrogen content and/or layering structure of the Martian subsurface.

The DAN instrument is composed of two mechanically separated units:

- The first unit is called the DAN Pulsing Neutron Generator (DAN/PNG). It is able to emit high energy neutrons in pulsing mode, with different frequencies up to 10 Hz, where the duration of one neutron pulse is less than 1 μs (see figure 1).

- The second unit is called DAN Detector and Electronics (DAN/DE) and contains the Counter of Thermal Neutrons (CTN), Counter of Epithermal Neutrons (CETN), and associated electronics. The two DAN/DE detectors are based on industrial LND, Inc. ^{3}He proportional counters with and without cadmium coating (see figure 2).

Outdoor tests of DAN: In December, 2007 the Engineering Model of DAN (DAN EM) instrument has been delivered to the Jet Propulsin Laboratory for the integration tests with MSL testbed. With minor deviations DAN EM can be considered as practically full analog of the Flight Model of DAN instrument. That is why before delivery to JPL DAN EM gone through set of initial field tests (indoor and outdoor) to estimate sensitivity of instrument (as a primary instrument onboard MSL rover which shall monitor distribution of subsurface wter along the rover's path) These tests have been performed in the international Joint Institute for Nuclear Research (Dubna, Russia, http://www.jinr.ru/).

Fig.1. The photo of DAN EM Pulsing Neutron Generator.

The main concept of these tests includes DAN measurements on the open air (minimal neutron background) with different elemental composition of soil. The schematic view of these tests is presented on the figure 3. We tried to implement first version of special outdoor testing area with known composition of soil and possibility to locate water spot indicator (polyethylene material with dimensions 1m x 1m x 0.1 m) at different depths. During the these tests DAN was moved through the testing area to detect water spots distributed

at the different depth (0-50 cm) in the subsurface. The example of measurements where water spot has (not) been located under the DAN instrument is shown on the figure 4. that For these measurements DAN thermal neutron counter (CTN detector) shows the significant difference in the counting rates for the dry (2-5% of water by mass fraction) homogeneous soil and dry soil with water spot (polyethelene) located under the rover.

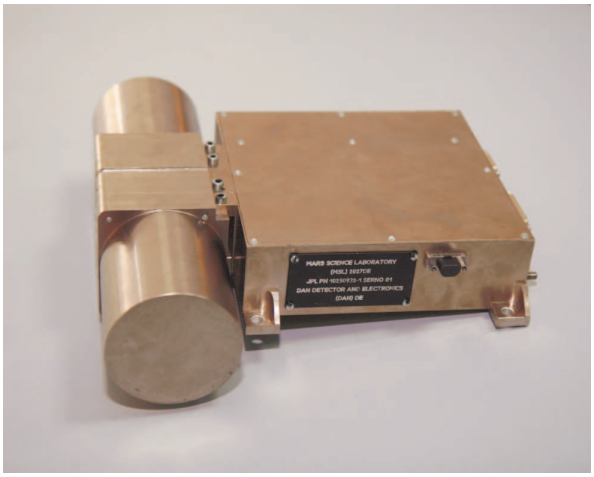

Fig.2. The photo of DAN EM Detectors and Electronics.

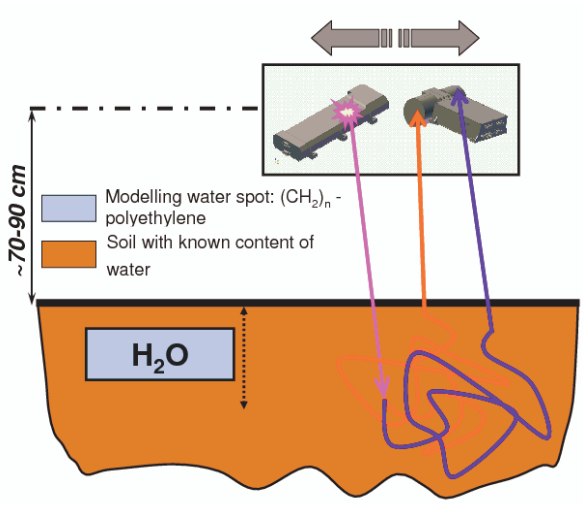

Fig. 3. Concept of DAN outdoor measurements with different location of water spot in the soil.

Data analysis. Each measurement was numerically modeled (MCNPX) and results of numerical simulations were compared with real measurements to correct numerical model of DAN instrument.

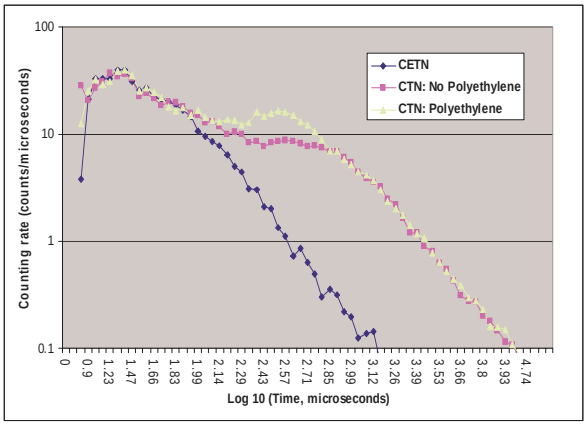

Fig.4. The example of DAN EM outdoor measurements: 1) water spot under DAN instrument (polyethylene layer is placed on the top of soil, yellow curve); 2) Homogeneus dry subsurface under DAN instrument (2-5% of water by mass fraction in the subsurface, magenta curve); 3) Counting rates in epithermal neutron detector for both cases (dark blue curve).

We plan that resulted numerical model of DAN instrument (which fit all indoor/outdoor calibration tests) will be used to create the numerical library of DAN CTN and CETN responses (die away curves) containing different Martian soils with different distribution of water/bound water in the Martian subsurface. During the measurements onboard MSL rover the measured responses from DAN CTN and CETN detectors will be compared with the reference responses taken from the library.

References:

[1] Litvak M.L. et al. (2007) 38th LPSC, abstract # 1554. [2] Litvak M.L. et al. (2007) Seventh International Conference on Mars, abstract # 3101. [3] Mitrofanov I.G. (2005) 36th LPSC, abstract # 1635