**DAN/MSL INSTRUMENT: ROAD FROM FIELD TESTS TO THE ESTIMATION OF HYDRATED MINERALS IN THE MARTIAN SUBSURFACE** 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, 141980, Dubna, Russia

**Introduction:** The Dynamic Albedo of Neutrons instrument 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. 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).

The DAN instrument is composed of two separated units: DAN Pulsing Neutron Generator (DAN/PNG) and DAN Detectors/Electronics (DAN/DE). DAN/PNG is used to emit high energy neutrons in pulsing mode and irradiate martian subsurface. DAN/DE contains the Counter of Thermal Neutrons (CTN), Counter of Epithermal Neutrons (CETN), and associated electronics. It is designed to measure neutron albedo from martian subsurface produced as a result of irradiation with DAN/PNG.

**Calibrations & Field Tests:** In summer 2008 before delivery to JPL for integration with MSL rover Flight model of DAN has passed through series of physical calibrations and field tests in Joint Institute for Nuclear Research (Russia, http://www.jinr.ru/). The major tasks of this activity were: a) calibration of DAN/PNG neutron output, b) deconvolution of DAN response function and c) Perfomance of DAN indoor field tests to measure DAN ability to detect hydrogen beared materials. The field tests were done in large facility (100 m x 50 m x 20 m) with small backround (corresponded to the open air) and with simulation of martian environment. We have modeled martian regolith with silicate materials and used polyethelene as an analog of hydrogen rich material. During these tests we have also used special movable mechanical fixture to model exact allocation of DAN instrument onbard MSL rover.

All field tests has been performed in two ways. First one concerned measurement of depth distribution of hydrogen rich material and second one suggested simulation of rover's approaching to the hydrogen rich spot on the martian surface. The some results of first and second cases are illustrated on the figure 1 and 2. On figure 1 we have shown measured die away curves for different depth distribution of hydrogen rich material (polyethelene). It is seen that DAN will be able to distigusih water or bound water at the depth as deep as 64 g/cm$^2$.

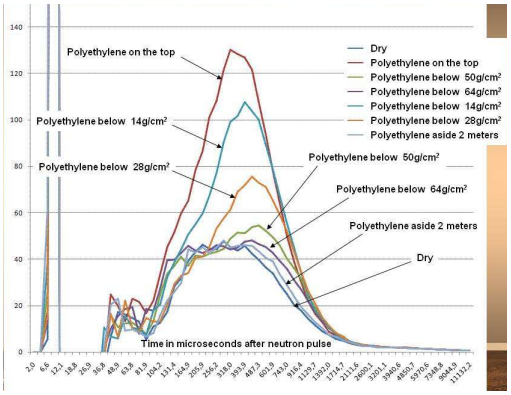


**Fig.1.** The measured die away curves for different depth distribution of hydrogen rich material.

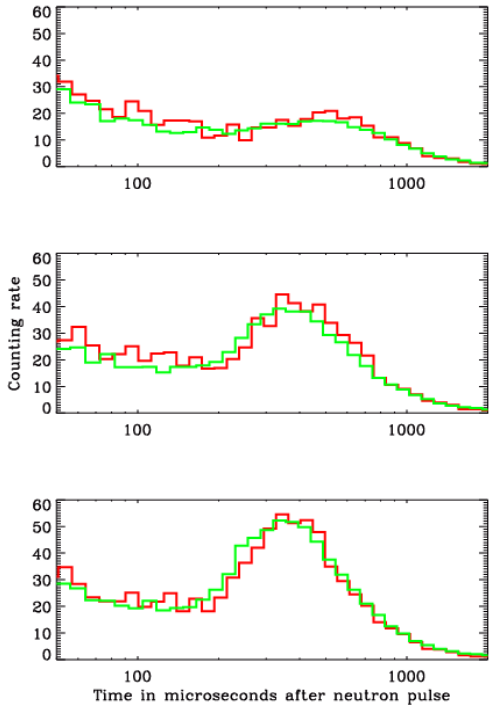


**Fig.2.** The measured (green) and modeled (red) DAN die away curves obtained along MSL path (field tests) when rover is approaching to the hydrogen spot on the martian surface. Top graph corresponds to the position of rover far away from hydrogen spot, mid graph corresponds to the position of rover in the vicinity of hydrogen spot and bottom graph corresponds to the position where rover is right above hydrogen spot.

On figure 2 we have presented results of measurements where MSL is approaching to the hydrogen spot. Three positions are shown: MSL is far away, MSL is approaching to the hydrogen spot (distance is about 60 cm) and MSL is right above hydrogen spot.

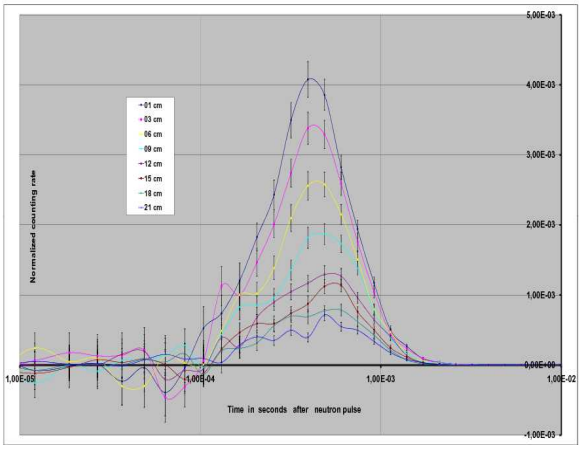


**Fig.3.** The modeled DAN die away curves for hydrated mineral (nontronite) buried at different depth from 01 cm (top dark blue curve) down to 21 cm (bottom blue curve).

**Observation of hydrated minerals.** With help of DAN calibration and field tests we have created numerical model of DAN instrument which describes its geometrical configuration, internal structure, neutron output and detector efficiency. The results of field tests have been used to verify this model. The results of comparison between model predictions and measurements are shown on the figure 2.

Taking into account that main candidates of MSL landing sites are closely related with possible location of hydrated minerals we have simulated DAN measurements onboard MSL suggesting different distribution of chemical bound water which is included in the hydrated minerals. Some of these results are presented on the figure 3 where we have shown predicted DAN die away curves for phyllosilicates (Si-nontronite with high hydratation mixed with standard regolith) buried at different depths.

**References:**

[1] Litvak M.L. et al. (2007) *38th LPSC*, abstract # 1554. [2] Litvak M.L. et al. (2008) *39th LPSC*, abstract # 1549 [3] Litvak M.L. et al. (2008), *Astrobiology*, 8,3, 605-612.