



DAN instrument for NASA's MSL mission: fast science data processing and instrument commanding for Mars surface operations and for field tests

A. Vostrukhin, A. Kozyrev, M. Litvak, A. Malakhov, I. Mitrofanov, M. Mokrousov, A. Sanin, and V. Tretyakov
Space Research Institute, Moscow, Russia, 117997 Profsojuznaya st. 84/32 fax: +7(495)333-12-48

The Dynamic Albedo of Neutrons (DAN) instrument is contributed by Russian Space Agency to NASA for Mars Science Laboratory mission which was originally scheduled for 2009 and now is shifted to 2011. The design of DAN instrument is partially inherited from HEND instrument for NASA's Mars Odyssey, which now successfully operates providing global mapping of martian neutron albedo, searching the distribution of martian water and observing the martian seasonal cycles.

DAN is specially designed as an active neutron instrument for surface operations onboard mobile platforms. It is able to focus science investigations on local surface area around rover with horizontal resolution about 1 meter and vertical penetration about 0.5 m. The primary goal of DAN is the exploration of the hydrogen content of the bulk Martian subsurface material. This data will be used to estimate the content of chemically bound water in the hydrated minerals.

The concept of DAN operations is based on combination of neutron activation analysis and neutron well logging technique, which are commonly used in the Earth geological applications. DAN consists blocks of Detectors and Electronics (DE) and Pulse Neutron Generator (PNG). The last one is used to irradiate the martian subsurface by pulses of 14MeV neutrons with changeable frequency up to 10 Hz. The first one detects post-pulse afterglow of neutrons, as they were thermalized down to epithermal and thermal energies within the martian subsurface. The result of detections are so called die away curves of neutrons afterglow, which show flux and time profile of thermalized neutrons and bring to us the observational signature of layering structure of martian regolith in part of depth distribution of Hydrogen (most effective element for thermalization of neutrons).

In this study we focus on the development, verification and validation of DAN fast data processing and commanding. It is necessary to perform deconvolution from counting statistic in DAN detectors (raw data) to the real science products such as estimated average content of Hydrogen content or its depth distribution along the rover trace. For the rover surface operations it is necessary to provide real time data analysis to combine DAN data with data from all other science instruments and to develop the best observation strategy for the future periods of operation activity.

In our approach we use:

- 1) Onboard FPGA data processing for recording neutron die away curves for epithermal and thermal neutrons of post-pulse afterglow
- 2) Getting raw data of DAN at the Mission operation center
- 3) Validation of instrument parameters and operational performance
- 4) Fast first level science data processing (statistical analysis, background subtraction, normalization)
- 5) Fast deconvolution of detector counts into the Hydrogen content (including numerical simulation, comparison with the known standard models of regolith),
- 6) Comparison with known information obtained with another instruments
- 7) Development of the near-term and long-term strategy for next DAN operations onboard MSL.
- 8) Generation and testing commanding sequences for the next period of MSL autonomous operations

All this activity shall be adjusted in the real time, so the steps 2-8 shall not exceed 2-3 hours.

Before launch we plan to validate this approach through the instrument calibrations, field tests and MSL science group activity. The first experience will be presented of fast data analysis and commanding for the field tests of DAN, which were performed in the testing facility of the Joint Institute of Nuclear Research (Russia). Also, we will discuss our plans of DAN operations for coming field tests in Antarctica.