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Numerical simulation of DAN instrument in MCNPx.

A. Varenikov (1), M. Litvak (1), I. Mitrofanov (1), R. Starr (2), and V. Shvetsov (3)

(1) Space Research Institute, RAS, Moscow, 117997, Russia, (2) Catholic University, Washington DC, USA, (3) Joint Institute for Nuclei Research, Russia

Introduction: The Dynamic Albedo of Neutrons (DAN) was flown onboard Mars Science Laboratory (MSL) to provide measurements of the dynamic albedo of thermal and epithermal neutrons induced by a pulsing generator of fast neutrons.

The DAN instrument consists of neutron pulsing generator (DAN/PNG) electrically and logically combined with neutron detection system (DAN/DE). The major science objective of DAN instrument is detect and provide a quantitative estimation of the hydrogen in the subsurface layer of Mars.

As a high-energy neutron from DAN/PNG roams in the subsurface, it loses its energy over time though collisions with soil nuclei until it exits the subsurface or is captured. Neutron detectors DAN/DE on the surface observes exiting neutrons (over a given energy range) as a die-away time profile of count rates following each pulse within hundred of microseconds.

Results: Mathematical model of DAN is based on mcnpx program and almost all calculations were made in Catholic University, Washington DC, USA. Model tested on calibration experiments which took place in Joint Institute for Nuclei Research, Russia.

The amplitude and shape of the die-away time profile strongly depends on the content and depth distribution of water ice/bound layer. Die-away curves of thermal neutrons as modelled in the DAN/DE detectors for a homogeneous model of regolith with different contents of water.

All calculations could be spited on two global groups: single layer model and double layer model. In the first case the surface in model consists of single layer with different water percentage in it. It provide the estimation of DAN sensitivity which is equal to 0.2% after 20.000 impulses.

Second group, double layer models, provide the DAN sensitivity to the depth of water rich layer. Estimation of maximum depth of 100% water layer which could be detected by DAN is about 100 centimetres.

References: [1] Litvak M.L. et al. (2008) Astrobi-ology, Volume 8, Issue 3, pp. 605-612. [2] Litvak M.L. et al. (2009), 40th LPSC