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ADRON Instrument for Luna-Resource and Luna-Glob Missions

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The interest to Moon investigations was increasing last decade. Many scientific and exploration missions were developed and about ten spacecrafts reached our nearest cosmic neighbor for detailed studying. Russian instrument LEND (Lunar Exploration Neutron Detector) received new interesting data about global lunar surface and distribution of hydrogen (water) enriched regions near poles in particular using collimation technique. Two of these regions are now landing sites of Russian-Indian project Luna-Resource and Russian lander Luna-Glob with planned launches in 2014 and 2015 respectively. One of scientific instruments onboard landers of both missions is ADRON (Active Detector of gamma Rays and Neutrons). The main tasks of the experiment are: 1) Definition of composition of the soil in the landing site; 2) Hydrogen content and distribution along depth; 3) Radiation background measurement; 4) Registering of Gamma-Ray Bursts.

ADRON instrument is based on available heritage of design of DAN (MSL 2011, NASA) and MGNS (Bepi-Colombo 2014, ESA). The concept ADRON is based on is the well-known method of nuclear well neutron logging for geological applications when detectors measure flux of scattered and moderated neutrons emitted by generator. Using scintillator one can detect spectrum of gamma-rays from soil and the lines intensities of this spectrum will indicate amount of a corresponding element in the subsurface up to 1 m depth during experiment on lunar surface. Instrument consists of two separate units: Pulse Neutron Generator (PNG) and Detectors and Electronic Unit (DEU). DEU (weight 3.8 kg, size $260\times217\times127$ mm), besides of electronic for instrument control, contains LaBr3 crystal for measuring spectra of gamma rays and He3 proportional counters to detect thermal and epithermal neutrons. Fast electronics allow to get time profiles of gamma and neutrons flux with time resolution of up to 1 microsecond. PNG unit (weight 2.6 kg, size $331\times125\times45$ mm) is connected to DEU by cable for commanding and energy supply. PNG is able to produce 107 pulses of 14 MeV neutrons, 107 particles in each pulse. Frequency of pulses is changeable by commands from DEU from 10 Hz down to a separate pulse. PNG usage allows us to measure regolith depth structure and strongly increases statistics of produced gamma rays. Time profile measurements between neutron pulses provide us to separate gamma emission produced by different mechanisms of interaction of neutrons with surface nuclei.

Laboratory tests were made using acting prototype model of ADRON. Spectra with required spectral resolution (3% at 660 keV) for different surrounding materials (salt, water, sand and others) were collected. Neutron measurements were also successful and one can expect that ADRON's ability to detect hydrogen will be similar to DAN instrument. Calculations using MCNPX show ADRON possibility to determine above 0.1 Wt% for major elements, 0.05 Wt% for minor and 0.1-25 ppm for trace elements such as U, Th, Cl. The experiment realization will make it possible to compare lunar neutron data with DAN data from Mars.