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ADRON instrument for future missions to Moon and Mars: active neutron and gamma-ray spectroscopy

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The series of ADRON instruments are developed in Russian Space Research Institute (IKI) for Russian Luna-25, Luna-27 and Roscosmos-ESA ExoMars-2022 landers. The main goal of this experiment is studying of elemental composition of planetary sub-surface down to 1 m. Using pulsing neutron generator and observing albedo after-pulse neutron and gamma-ray emission from the soil, one can detect layering stratification of hydrogen and mass fractions of other elements.

Both instruments consist of two blocks: pulsing neutron generator (PNG) with 14 MeV neutron pulse duration around 1 microsecond, and detector block with neutrons and gamma-ray detectors based on ^{3}He counters and $CeBr_3$ (LaBr3) scintillator, respectively. ^{3}He counters allow to detect thermal and epithermal neutrons, which are the most sensitive to hydrogen in underlying soil, and gamma-ray detector allows to detect nuclear lines at the energy range from 200 keV up to 10 MeV. Readout and digital electronics is designed to minimize the dead-time of signal processing. It allows to accumulate the after-pulse profiles of emission of neutrons and gamma-rays with very good time (from 2 microsecond) and spectral resolutions (about 4 % for 662 keV).

The results of laboratory measurements and numerical simulations for ADRON units will be presented for post-pulse emission of neutrons and gamma rays from the planetary soil with different water content, elementary composition and layering structure.