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Collimated neutron detector FREND for the ESA ExoMars Trace Gas Orbiter: objectives and modelling

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Abstract

High Energy Neutron Detector (HEND) is continuously operating onboard the NASA Mars Odyssey spacecraft starting from Mars orbit insertion maneuver at October 24, 2001. It provides data about low, epithermal and fast neutrons fluxes and fluxes of charged particles on the spacecraft orbit. Significant amount of accumulated HEND data allows to study hydrogen distribution in top ~1 meter layer of the Martian regolith, seasonal variations of H_2O permafrost, CO_2 deposition and sublimation and radiation condition on Martian surface during Solar activity cycle. One of the most important results obtained from HEND data analysis is the evidence of presence of significant amount of H_2O permafrost at high latitudes around both poles and enhanced hydrogen concentration at Arabia and Memnonia regions.

The highest spatial resolution of HEND data is about 600*600 km, since the instrument measured neutron fluxes from all directions at the spacecraft orbit. Such resolution is much broader than sizes of most Martian relief features. Even 150-km diameter Gale crater is significantly smaller. It is obvious that such resolution makes difficult any studying of hydrogen distribution across small to medium size Martian relief features and, for example, landing sites of future robotic and/or manned missions.

Fine Resolution Epithermal Neutron Detector (FREND) selected for flight as a part of scientific payload of the ESA ExoMars Trace Gas Orbiter (TGO) contains a neutron collimation module. It will provide a narrow field of view (FOV) for detectors of FREND instrument. LEND instrument onboard the NASA LRO mission is the heritage for FREND. The idea of neutron collimation has been successfully tested during the LRO mission. Mechanical design of the instrument is fixed and it is on manufacturing stage now.

The ESA ExoMars TGO orbiter is scheduled to be launched at January 2016. After about 240 days of cruise the spacecraft will start Mars orbit insertion and aerobraking maneuvers. Science phase of the mission will start at July 2017 and takes about 1 year.

In our presentation we would like to describe the scientific objectives of FREND instrument as well as instrument design and preliminary results of numerical modelling of the instrument's sensitivity to hydrogen in regolith and spatial resolution.