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Spectrometer ISEM for ExoMars-2020 space mission: from qualification prototype to flight model

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Abstract

Robust design, small dimensions and mass, the absence of moving parts in acousto-optic tunable filters (AOTFs) make them popular for space applications [1-3]. Here we introduce a pencil-beam near-infrared AOTF-based spectrometer ISEM for context assessment of the surface mineralogy in the vicinity of a planetary probe or a rover analyzing the reflected solar radiation in the near infrared range [4,5]. The ISEM (Infrared Spectrometer for ExoMars) instrument is to be deployed on the mast of ExoMars Rover planned for launch in 2020.

ISEM spectrometer

The instrument covers the spectral range of 1.15–3.3 μm with the spectral resolution of ~25 cm-1 and is intended to study mineralogical and petrographic composition of the uppermost layer of the regolith and to estimate H2O/OH content and behavior in this layer. The instrument is able to detect the most important water-bearing minerals (i.e. phyllosilicates, sulfates, opal) and other minerals formed in the aqueous environments. Besides, it will help in real-time assessment of surface composition in selected areas, in support of identifying and selection of the most promising drilling sites. A study of variations of the atmospheric dust properties and of the atmospheric gaseous composition is also of interest.

The instrument (Fig. 1) consists of two parts: Optical Box and Electronic Box. The optical scheme includes entry optics, the AOTF, focusing optics, and a Peltier-cooled InAs detector. A wide-angle acousto-optic tunable filter manufactured on the base of TeO_2 crystal is used. Incident optical radiation has ordinary polarization and the diffracted optical beam has the extraordinary polarization. The angle between the passed and diffracted optical beams is 6° at the output of the AO crystal. A pair of polarizers with crossed polarizing planes is used to filter out the non-desired zero diffraction order.

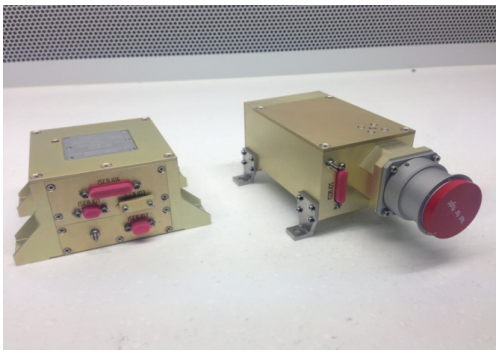

Figure 1: ISEM spectrometer: Optical Box (on the right) and Electronic Box.

Two qualification models of the instrument were manufactured. One of them has passed qualification tests including thermal-vacuum tests down to -130°C. The second one is delivered to ESA for integration into ground-test model of the rover. At present, test

campaign and planetary protection activities with the flight model of the instrument has started.

Example of the gypsum reflectance spectrum obtained by qualification model of ISEM is shown in Fig. 2. Sample was crashed to powder.

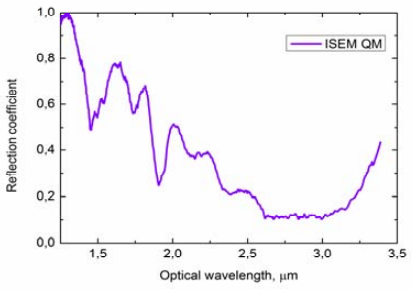

Figure 2: Gypsum spectra measured by ISEM.

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