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Russian contribution to ExoMars Trace Gas Orbiter: Atmospheric Chemistry Suite (ACS)

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Atmospheric Chemistry Suite (ACS) is a part of science payload of Trace Gas Orbiter (TGO), ExoMars mission. This project developed by European Space Agency (ESA) in collaboration with Russian Space Agency (Roscosmos). Russian contribution to ExoMars TGO is the Proton rocket and two science instruments ACS (three infrared spectrometers) and FREND (neutron detector).
ACS consists of three infrared spectrometers (ACS/NIR, ACS/MIR and ACS/TIRVIM) capable to take spectral measurements from near to thermal infrared range simultaneously or separately. Spectrometric channels of ACS share common mechanical, electrical, and thermal interfaces. Electronic box (ACS/BE) provides to spectrometric channels power and data transfer interfaces. SpaceWire link is used for science data transfer and MIL-1553 link – for commanding and housekeeping data transfer.
The NIR channel is an echelle spectrometer with acousto-optic tunable filter (AOTF) for the selection of diffraction orders. ACS NIR is capable to perform nadir and occultation observations. NIR covers the spectral range of 0.7-1.7 μm with resolving power of $\sim$25000. NIR will perform unique for TGO instruments nightglow science (searching for O_2, OH, NO nightglow emissions on Mars). From the 1.38 μm band NIR will do water vapour mapping in nadir and H_2O vertical profiling in solar occultations. High resolution NIR measurements of 1.27 μm O_2(a1Δg) dayglow will supply indirect ozone observations on the dayside on nadir. In solar occultation mode, the O_2 vertical profiles will be measured from the surface (in case of low dust activity) to the 40 km altitude based on 0.76 μm absorption band. Together with MIR channel in solar occultation NIR will support the measurements of CO_2 density profiles (based on 1.43 μm band) and aerosols characterization from 0.7 to 4 μm. The wide spectral range will allow not just determine aerosol particle sizes and density at different altitudes, but also distinguish between dust and ice particles.
The MIR channel is a novel, high-aperture cross-dispersion spectrometer working in 2.3-4.2 μm spectral range, with resolving power of 50000, and covering simultaneously up to 300 nm per measurement. Targeting very high spectral resolution the MIR channel will operate in solar occultation only with a narrow FOV. MCT detector array with cryo-cooler is applied. The main science goal of MIR channel is to do record-breaking measurements and detections of minor gaseous species (CH4, C2H2, H2S, HCl and others), some yet undetected, some possibly related to volcanic or biologic activity. For the methane we predicting $\sim$20 ppt sensitivity. The spectral range of MIR includes several CO_2 absorption bands allowing doing measurements of density and temperature. D/H and its vertical profile in the Martian atmosphere will be measured for the first time. The short-wavelength side of MIR's spectral range is extended to cover almost the whole carbon monoxide band.
TIRVIM is a 2-inch double pendulum Fourier-transform spectrometer covering in one interferometric channel the spectral range of 2-17 μm. Instrument has maximal optical path difference of 6 cm so its apodized spectral resolution is 0.2 cm–1. Single element PV-MCT detector with Stirling cooler is applied. To calibrate TIRVIM data onboard, internal black body and one-coordinate scanner are implemented. Scanning mirror provides possibility of observation in both nadir and solar occultation modes. FOV of the TIRVIM is 2.5deg. Main science goals of TIRVIM are detection of trace gases (solar occultation) and measurement of thermal profiles using 15μm-CO_2 band (nadir). Martian aerosol properties and profiles can be also retrieved. Trace gases NO and N2O can be detected.