

ACS AT EXOMARS TGO

O. Korablev¹, A. Fedorova¹, N. Ignatiev¹, A. Trokhimovskiy¹, Franck Montmessin²,
and the ACS Team

¹Space Research Institute (IKI), 84/32 Profsoyuznaya, 117997 Moscow, Russia,

²LATMOS/IPSL, 11 bd d'Alembert, 78280 Guyancourt, France

The Atmospheric Chemistry Suite (ACS) package is an element of the Russian contribution to the ESA-Roscosmos ExoMars 2016 Trace Gas Orbiter (TGO) mission. ACS consists of three separate infrared spectrometers. This ensemble of spectrometers has been designed and developed in response to the Trace Gas Orbiter mission objectives that specifically address the requirement of high sensitivity instruments to enable the unambiguous detection of trace gases of potential geophysical or biological interest. For this reason, ACS embarks a set of instruments achieving simultaneously very high accuracy (ppt level), very high resolving power (>10,000) and large spectral coverage (0.7 to 17 μm – the visible to thermal infrared range). The near-infrared (NIR) channel is a versatile spectrometer covering the 0.7-1.6 μm spectral range with a resolving power of ~20,000 [1].

ACS-NIR employs the combination of an echelle grating with an AOTF (Acousto-Optical Tunable Filter) as diffraction order selector. This channel will be mainly operated in solar occultation and nadir, and can also perform limb observations. The scientific goals of NIR are the measurements of water vapor, aerosols, and dayside or night side airglows. The mid-infrared (MIR) channel is a cross-dispersion echelle instrument dedicated to solar occultation measurements in the 2.2-4.4 μm range. ACS-NIR follows the lineage of the SPICAM-IR instrument operating in orbit around Mars since 2004 [2]. The SPICAM-IR instrument family concept relies on a simple pencil-beam AOTF spectrometer covering the spectral range of 1 to 1.7 μm with a resolving power of ~2,000. This small instrument has continuously delivered high-quality data for the last 14 years to help us characterize the Martian climatic processes and aeronomy phenomena [3]. ACS-NIR with its ten-fold better spectral resolution will significantly enhance the fidelity of atmospheric measurements.

ACS-MIR achieves a resolving power of >50,000 in range of 2.2-4.0 μm and SNR of >5000 per pixel per 1s-acquisition. This new instrument based on echelle cross-dispersion concept and has been designed to accomplish

the most sensitive measurements ever of the trace gases present in the Martian atmosphere.

The thermal-infrared channel (TIRVIM) is a 2-inch double pendulum Fourier-transform spectrometer encompassing the spectral range of 1.7-17 μm with apodized resolution varying from 0.2 to 1.3 cm^{-1} . TIRVIM is primarily dedicated to profiling temperature from the surface up to ~60 km and to monitor aerosol abundance in nadir. One may note its resemblance to 2.5-inch PFS/Mars Express [4], but the mass allocation for TIRVIM on TGO was far smaller than that for PFS. One-channel TIRVIM is expected to provide temperature profiling with higher accuracy along with better estimated of dust/clouds opacity. TIRVIM also has solar occultation capability for the retrieval of gases otherwise not detected by the two other channels, *i.e.* O_3 and H_2O_2 , two gases of fundamental importance for photochemistry.

The science goals of the ACS experiment, the the expected performances of the instrument's three channels will be described and copared with the Mars Express PFS and SPICAM.

References:

- [1] Korablev O. et al., The Atmospheric Chemistry Suite (ACS) of Three Spectrometers for the ExoMars 2016 Trace Gas Orbiter. *Space Science Reviews*, 214:7 (2018) DOI 10.1007/s11214-017-0437-6.
- [2] Korablev O. et al. SPICAM IR acousto-optic spectrometer experiment on Mars Express," *Journal of Geophysical Research-Planets* **111**, E09S03- (2006).
- [3] Montmessin F. et al., SPICAM on Mars Express: A 10 year in-depth survey of the Martian atmosphere, *Icarus* **29**, 195-216, 2017.
- [4] Formisano V. et al. The Planetary Fourier Spectrometer (PFS) onboard the European Mars Express mission *Planetary and Space Science* **53**, 963-974 (2005).

Acknowledgements: ExoMars is a space mission of ESA and Roscosmos. OK, AF, and AT acknowledge grant of Ministry for Education and Science of Russian Federation #14.W03.31.0017.