

**RAMAN LASER SPECTROMETER (RLS) FOR EXOMARS 2018 ROVER MISSION: CURRENT STATUS AND SCIENCE OPERATION MODE ON POWDERED SAMPLES.** F. Rull<sup>1</sup>, S. Maurice<sup>2</sup>, E. Diaz<sup>3</sup>, G. Lopez<sup>1</sup>, A. Catala<sup>1</sup>, and the RLS Team, <sup>1</sup>Unidad Asociada CSIC-CAB, Universidad de Valladolid, Boecillo, Spain <sup>2</sup>Institut de Recherche en Astrophysique et Planétologie, <sup>3</sup>Instituto Nacional de Técnica Aeroespacial (INTA), Torrejón de Ardoz, Spain, (rull@fmc.uva.es).

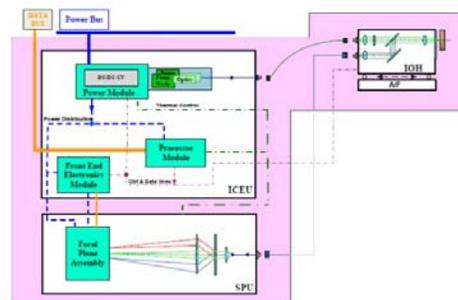
**The Raman instrument inside the mission.** The 2018 ExoMars rover mission has experienced several modifications in the last two years affecting particularly the international consortium and the original instrumental payload [1]. The mission being at the present a collaboration between the European Space Agency (ESA) and the Russian Federal Space Agency (Roskosmos). Despite these important changes the key scientific objectives still remains giving to ExoMars an important role on the exploration of Mars previous to the future sample return missions. These objectives are mainly: to search for signs of past and present life on Mars; to characterize the water/geochemical environment as a function of depth in the shallow subsurface; to study the surface environment and identify hazards to future human missions; to investigate the planet's subsurface and deep interior to better understand the evolution and habitability of Mars. These goals are in a great extent based on the unique capability to drill the subsurface and collect samples up to 2 meters depth.

The Raman (RSL) instrument is part of the analytical suite of four instruments located in the analytical laboratory of the rover (ALD) and capable to address these mineralogical, geochemical and exobiological issues. For that the Raman spectrometer will analyze at the mineral grain scale samples crushed into a fine powder by means of an automatic crusher and a dosing station [2]. The RLS instrument is focused in the search for past or present life, which is related to the direct identification of organic compounds, and the identification of minerals products as indicators of biological activity; and also the description of the water-related processes, which is associated to the identification of minerals phases produced by fluids-rock interactions, and the characterization of igneous minerals and their alteration products [3].

**Instrument design and current status.** The RLS consists of three units:

- *Control and Excitation Unit.* It includes the excitation laser (CW at 532 nm) with two redundant outputs, its control, the CCD FEE electronics, and the autofocus driver. Also the DC/DC power converters and the data processing capability ( $\mu$ controller, RAM, clock and CANBus).

- *Optical head.* The laser is focused on the powdered sample using an optical head which produced a spot of 50  $\mu\text{m}$  allowing to autofocus in a range of  $\pm 1$  mm. This target size produces an irradiance on the target between 0.8 and 1.2  $\text{kW}/\text{cm}^2$ . The upper limit is fixed to remain below the threshold of powder grain thermal damage mainly in oxides and hydroxides and potential organics. The scattered signal is also collected by the optical head and sent to the spectrometer. The optical connection is assured by 50  $\mu\text{m}$  optical fibers and mini-connectors.
- *Spectrometer Unit.* The dispersion of Raman light is obtained using a holographic transmission grating. The Raman lines are projected on a 2048x512 pixels CCD being cooled down by means of a TEC cooling device. The spectrometer cover the spectral Raman shift from  $\sim 150$  to  $3800$   $\text{cm}^{-1}$  with an average spectral resolution of  $\sim 7$   $\text{cm}^{-1}$ . Figure 1 shows the RLS functional diagram

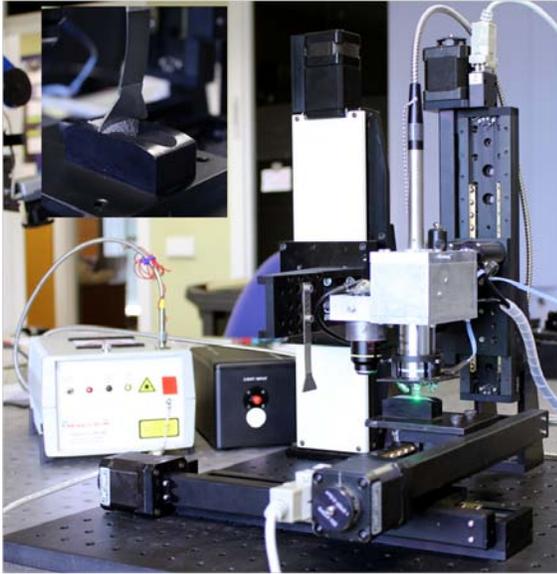


**Fig.1** : Instrument functional diagram

Because the mission evolution the RLS instrument has been modified in several occasions being at the present at TRL 5 and pending to start Phase C at the end of 2013. Also a laboratory prototype in the form of a fully functional breadboard has been developed at INTA in Madrid and a power analysis simulator has been developed at the Unidad Asociada UVA-CSIC-CAB in Valladolid (see Figure 2)

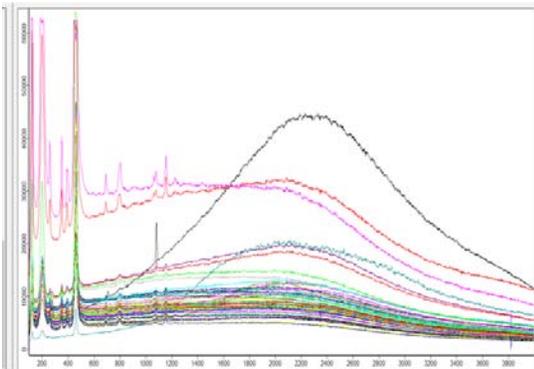
**Operation mode and the science to be performed on Mars.** The instrument will obtain Raman spectra on the flattened powder surface along a line. The potential of the science derived using this mode appears in principle limited as compared with the analysis on cores or bulk samples because the spatial

context is lost on the powder. Nevertheless the results obtained on natural samples and synthetic mineral admixtures show the capability to detect minor phases (<1%) for strong to medium Raman scatters materials with a density of at least 20 points automatically selected on the surface at random positions.



**Figure 2.** Raman powder analysis simulator showing in the onset the flattening system

The simulator allows to obtain spectra in automatic mode estimating the optimal acquisition parameters and in case of admixtures the system allows a pseudo quantification of the mineral species from the overall integrated spectrum. In figure 3 an example of the results obtained in mineral admixtures using the automatic mode.



**Figure 3.** Raman spectra on powdered samples obtained automatically.

**RLS science team:** The development of the RLS instrument is a large team effort. The consortium is led by the science team, in Spain: F. Rull (PI) and J.M. Frias, in France S. Maurice (deputy-PI) and L. d'Uston, in Germany J. Popp and E. Jessberger, in United Kingdom H.G.M. Edwards and I. Hutchinson, and in the US. A. Wang and S. Sharma.

**References.** [1] Vago et al. (2006) European Planetary Science Congress 2006, Berlin, p76.  
[2] The ExoMars Rover Instrument Suite/Raman Spectrometer on exploration.esa.int.  
[3] Rull et al. (2009) Geo. and Cosmo. Acta Supplement, vol 73, p. A1133.

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