

**THE LASER RAMAN INSTRUMENT (RLS) FOR EXOMARS 2018 MISSION AND THE SCIENTIFIC OPERATION ON MARS** F. Rull<sup>1</sup> (and the RLS team), <sup>1</sup>Unidad Asociada UVA-CSIC al Centro de Astrobiología. Parque Tecnológico de Boecillo. 47152- Boecillo, Valladolid, Spain. [rull@fmc.uva.es](mailto:rull@fmc.uva.es).

**Introduction:** The Exomars programme to Mars consists of two missions: the 2016 Exomars Orbiter mission carrying an orbiter and an entry, descent, and landing demonstrator module (EDM); and the 2018 Exomars rover mission which aims to place on the Martian surface a European rover and a Russian surface platform. The rover will include a drill able to obtain samples below the Martian surface up to two meters and a scientific payload (Pasteur) that will analyze the samples obtained by the drill under the form of powder. The Raman spectrometer (RLS) is one of the three essentials instruments forming this payload which is situated inside the analytical laboratory of the rover (ALD).

Exomars rover main scientific objectives are: 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 to better understand the evolution and habitability of Mars. The RLS specific objectives are directly related with those of the mission: 1/ 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; 2/ the description of water-related processes, which is associated to the identification of minerals phases produced by fluid-rock interactions, and the characterization of igneous minerals and their alteration products.

This work intends to describe how the RLS instrument can contribute to the scientific goals of the 2018 mission. This description include the present status of the instrument, the potential for analysis of the powdered samples and the modes of operation foreseen inside the mission.

**The RLS instrument:** The Raman instrument under development by a European consortium consists of three main units which are presented in Figure 1 in the current configuration inside the rover: the electronic control unit (ICEU) that include the excitation laser, a transmission spectrometer (SPU) coupled to a CCD detector and an internal optical head (iOH) that allows illuminating the sample and collecting the scattered light from the same spot on the surface of the samples. The optical head and the excitation laser and spectrometer are connected respectively by optical fibres.

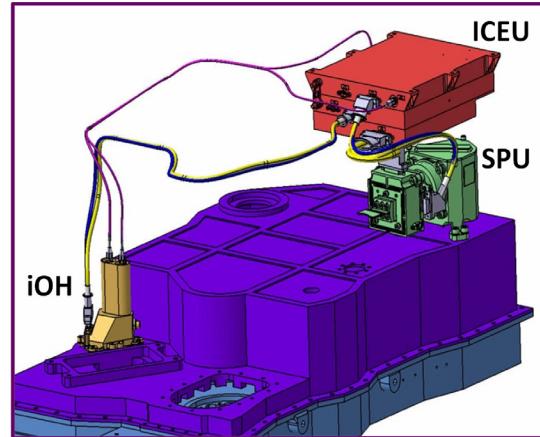


Figure 1. The RLS instrument configuration inside the Exomars rover

The excitation is a CW laser working at the wavelength of 532 nm. The laser spot size is around 50 µm on the target and the irradiance will be between 0.6 and 1 kW/cm<sup>2</sup>. The upper limit is fixed to remain below the threshold of powder grain thermal damage mainly in oxides and hydroxides. The spectrometer uses a transmission holographic grating covering the Raman spectral shift from ~150 to 3800 cm<sup>-1</sup> with a spectral resolution of ~6 cm<sup>-1</sup> in the fingerprint spectral region below 2000 cm<sup>-1</sup> and ~8 cm<sup>-1</sup> above this limit. The Raman spectrum is registered on a 2048x512 pixel CCD operating in the range of -10 to -20°C. This temperature maintained by means of a TEC cooling device.

**The operation mode on powdered samples:** One of the main issues related with the analysis of the powder produced from a core or bulk sample at micro scale is the loss of the spatial context for the mineral grains. On the other hand the powder allows to investigate the bulk composition which in the case of the bulk samples is only accessible with Raman at the surface. In the case of Exomars the observed area on the powdered and flattened sample is an arc of about 10 mm long provided by the movement of a carousel (which is part of the complex system for crushing, dosing and flattening the powder samples) turning the sample container below the Raman optical head. The Raman measurements will be performed through an optical window.

The RLS will operate in two main modes, a systematic mode taking spectra at regular intervals on the sample (nominally 25 spots) with acquisition parameters automatically estimated by the algorithms inside

the RLS processor. And a smart mode, in combination with the infrared spectrometer inside the rover (MicrOmega) from which the presence of interesting spots inside the RLS observing line will be automatically detected. In this case the carousel will positioning the RLS optical head around the selected spot and a fine mapping of the area will be performed.

To investigate the potential of the Raman technique on powdered samples and the operation modes several tools have been developed and tested at INTA and the Unidad Asociada UVA-CAB in Valladolid. In the last case, the most important device is the Raman powder analysis simulator (Fig. 2) which could be used for powder analysis in Terrestrial or in Martian conditions.

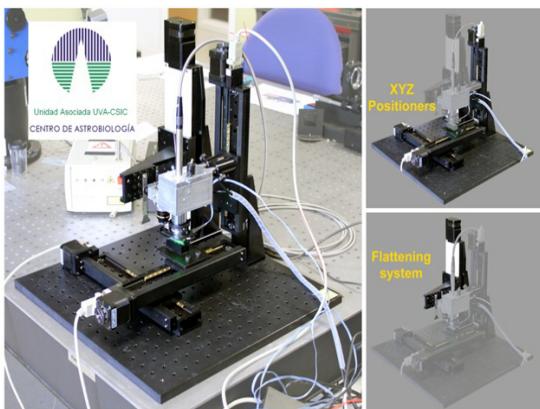


Figure 2. The Raman powder analysis simulator at the Unidad Asociada UVA-CSIC.

In the present work we will present and discuss some of the results obtained with these systems on different materials including mineral and organic samples. We will devote particular attention to the effect of the Martian conditions on the spectral response of those materials (see Fig. 3).

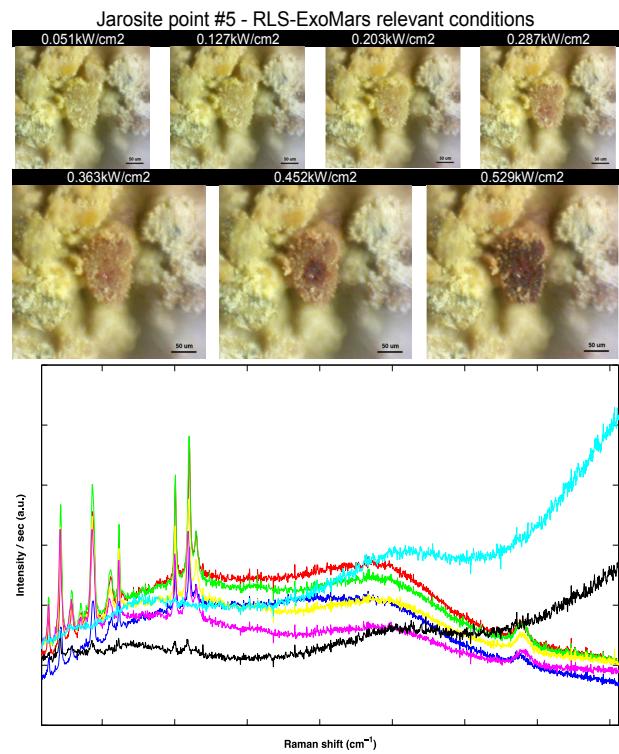


Figure 3. Raman spectra of jarosite powdered samples under Martian conditions at different laser power on sample using the Martian chamber at the Unidad Asociada UVA-CSIC.

**Acknowledgement:** The author acknowledges the whole Raman team for the effort on conducting the technical and scientific task leading to the development of the instrument for Exomars. The author also acknowledges support to this work from the projects: Ministerio de Ciencia e Innovación AYA-2008-04529 and AYA2011-30291-C02-01.