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The Raman Laser Spectrometer (RLS) for 2020 Exomars (ESA) Mission: Instrument development and operation on Mars

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Abstract

Raman Laser Spectrometer (RLS) is part of the Exomars 2020 key instruments devoted to the analysis of samples collected below the Martian surface. This paper aims to describe the instrument technical characteristics, the scientific performances and the operation it will perform on Mars in the context of Exomars 2020 rover mission.

1. Introduction

The main ExoMars 2020 mission scientific objective is “Searching for evidence of past and present life on Mars". For that purpose the ExoMars rover will carry a drill able to obtain samples up to 2 meters depth under the Martian surface. These samples will be analyzed by a suite of instruments (Pasteur Payload) located inside the Rover’s Analytical Laboratory Drawer (ALD) and dedicated to exobiology and geochemistry research at the mineral grain scale after these samples have been crushed and powdered. The Raman Laser Spectrometer (RLS) is one of these key instruments. The RLS will contribute to this scientific goal through the precise identification of the mineral phases and the capability to detect organics on the powdered samples (1). RLS is being developed by a European Consortium composed by Spanish, UK, French and German partners.

2. Instrument description

The RLS Instrument is made by the following units: SPU (Spectrometer Unit), iOH (Internal Optical Head), ICEU (Instrument Control and Excitation Unit) and CT (the calibration target) (see Fig.1). The instrument main scientific characteristics are:

- Laser excitation wavelength: 532 nm
- Irradiance on sample: 0.4 - 8 kW/cm2
- Spectral range: 150-3800cm-1
- Spectral resolution: between 6 and 8 cm-1
- Spectral accuracy: < 1 cm-1
- Spot size: 50 microns

And the instrument main technical and physical characteristics are:

- Mass ~ 2.4 kg
- Power consumption between 20W and 30 W (depending on the temperature and operation-al mode).
- It is designed to provide full performances in a thermal environment between -40ºC and 0ºC and survive in a non-operational envi-ronment between -60ºC and +50ºC
- Active focusing of laser onto the crushed sample of ±1mm range and sub-µm resolution
- Redundant laser excitation chain
- Processing activities are shared between RLS and rover processors
- Storage needs on Rover memory is around 200Mbits (20 measurements + auxiliary data)

The RLS instrument operation on Mars consists on a micro analysis of the powdered samples along a line defined by the motion of the rover’s carrousel. This analysis is performed in automatic mode with the optimal spectral acquisition parameters defined my specific algorithms.

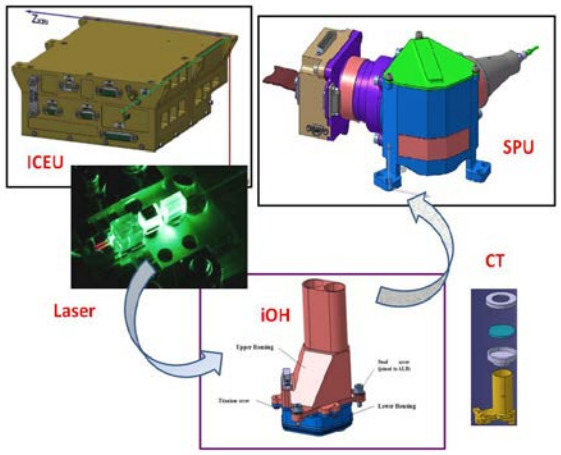

Figure 1: Overview of the RLS instrument showing the main component units.

3. Summary and Conclusions

This paper aims to describe the RLS instrument and the operation it will be perform on Mars in order to contribute to the Exomars 2020 scientific objectives. The model philosophy and the technical and scientific steps leading to the current flight model (FM) RLS instrument will also be presented and discussed. In particular the results obtained with the EQM model at room conditions and relevant Martian conditions. These results will be compared with those obtained in a specific simulator of the Exomars powder analysis operation. Finally the discussion will include the conclusions obtained from these results and the potential scientific capabilities of the Raman technique in the context of the rover operation on Mars.

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References

[1] Rull, Maurice, Hutchinson, Moral et al., Astrobiology, 2017, 17, 627-654.