RAMAN LASER SPECTROMETER FOR 2020 EXOMARS MISSION. ENGINEERING AND QUALIFICATION MODEL CAPABILITIES AND FUTURE ACTIVITIES

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Introduction: The Raman Laser Spectrometer (RLS) is one of the Pasteur Payload instruments, within the ESA's Aurora Exploration Programme, ExoMars 2020 mission.

ExoMars Rover would carry a drill and a suite of instruments dedicated to exobiology and geochemistry research and its main Scientic objective is "Searching for evidence of past and present life on Mars".

The RLS is being developed by an European Consortium composed by Spanish, UK, French and German partners. It will perform Raman spectroscopy on crushed powdered samples, obtained from 2 meters depth under Mars surface, inside the Rover's Analytical Laboratory Drawer (ALD).

The Raman Laser Spectrometer Instrument: The RLS Instrument is made by the following units:

- SPU (Spectrometer Unit)
- iOH: (Internal Optical Head)
- ICEU (Instrument Control and Excitation Unit)

Other instrument units are EH (Electrical Harness), OH (Optical Harness) and RLS Application SW On-Board.

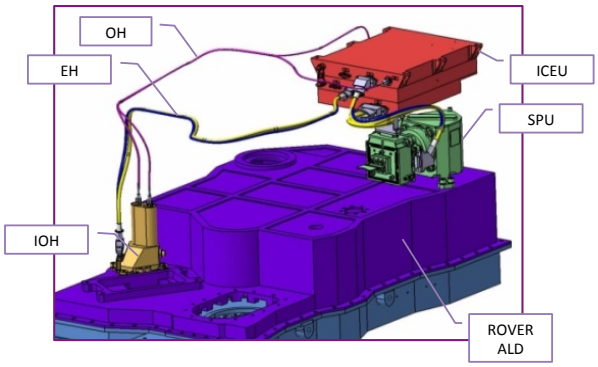

Figure 1: RLS layout on ExoMars Rover ALD (Analytical Laboratory Drawer)

RLS Instrument Desing description: RLS main scientific functional requierements and performances are shown below:

- Laser excitation wavelength: 532 nm
- Irradiance on sample: 0.4 - 8 kW/cm^2
- Spectral range: 150-3800cm-1
- Spectral resolution: between 6 and 8 cm^{-1}
- Spectral accuracy: < 1 cm^{-1}
- Spot size: 50 microns

Main instrument technical characteristics are:

- Mass ~ 2.4 kg
- Power consumption between 20W and 30 W (depending on the temperature and operational mode).
- It is designed to provide full performances in a thermal environment between -40ºC and 0ºC and survive in a non-operational environment 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)

RLS EQM Results: RLS EQM (Engineering and Qualification Model) was at the beginning of 2017 ~~Q1~~ and fully tested until late 2017 at INTA facilities. And finally delivered to TAS-I (ESA contractor) for its integration at the Exomars ALD-QM with the rest of instruments (MicrOmega and MOMA)

After a wide qualification campaign for assesing instrument qualification readiness, by means of intensive tests: mechanical, thermal, EMC, operation… all succesfully passed, the instrument reached TRL8.

Also the instrument followed an intense scientific qulification campaign in order to verify the functional requirements and scientific capabilities. Presentation of some of the results obtained is also the goal of the present paper. An overview of the RLS EQM functional testing setup is shown in Figure 2.

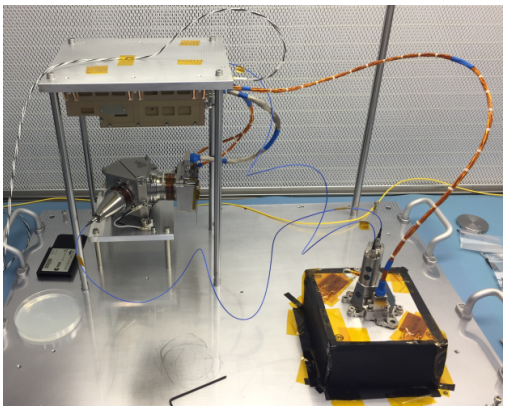

Figure 2: RLS EQM functional test setup

In Figures 3 to 5 some spectral results are shown on liquid and solid samples to check instrument performances. These spectra were obtained under relevant Martian conditions.

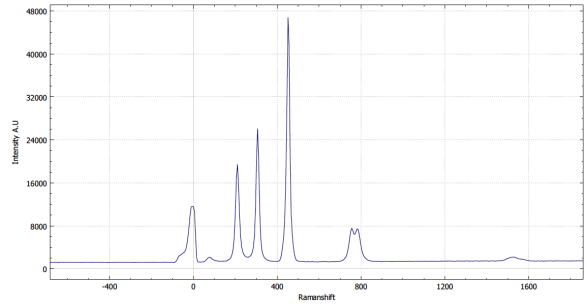

Figure 3: CCl_4 spectrum with RLS EQM obtained at 5ºC

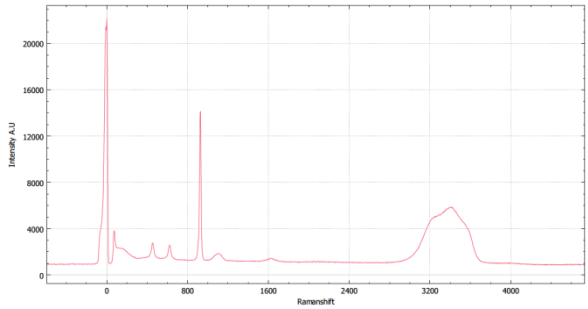

Figure 4: $LiClO_4$ spectrum with RLS EQM obtained at 5ºC

Solid samples, crushed by the rover QM-crusher, were analysed under relevant Martian conditions with few second integration times. Results are shown in Figure 5.

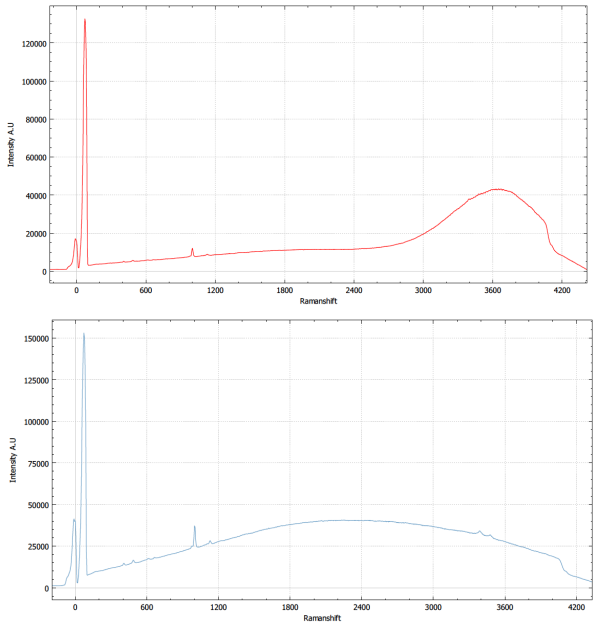

Figure 5: Typical Mars like samples Raman spectra with RLS EQM

Conclusions and Future Activities:

The obtained results with the RLS-EQM on powdered minerals allow to verify the scientific requirements and capabiulities for the Exomars mission in which Raman has to play a very important role. And the results obtained in liquids and brines of different salts allow to see the potential for new planatary mission such as Europa Lander, Lunar and others.

Finally, RLS FM is currently under integration and testing activities, and will be ready for delivery to TAS-I-ESA by March-April 2018. It will have full performances and functionalities, implementing all SW and operation algorithms, fully optimized thermal control for laser TEC and CCD TEM.