

OPERATION DESIGN OF THE RLS INSTRUMENT, FOR THE EXOMARS 2020 MISSION

L. Seoane¹, S. Ibarmia¹, A. Moral¹, J. Zafra², C. Quintana¹, C. Pérez¹, G. López-Reyes³, J. Saiz³, F. Rull³

(1) Instituto Nacional de Técnica Aeroespacial (INTA). Torrejón de Ardoz (Spain). seoanepl@inta.es

(2) Ingeniería de Sistemas para la Defensa de España, S.A (ISDEFE). Madrid (Spain)

(3) Universidad de Valladolid. Valladolid (Spain)

Abstract

The goal of the Raman Laser Spectrometer (RLS) instrument is to perform Raman spectroscopy on Mars samples acquired by the ExoMars2020 Rover's drill.

To accomplish this objective, RLS Operations have been designed to fulfill the needs during all the mission phases. Thus, the instrument can be commanded at three different levels: telecommands, actions and tasks.

Quick quasi-automatic data assessment of RLS science and engineering data can be performed to obtain the information needed to plan the following instrument activities in a very short time. Software tools for further analysis without so strict time constraints are also available.

The Rover Operations Control Centre (ROCC) will be sited at ALTEC, in Torino. There, data downloaded from the Rover will be stored and the next activities for the Rover will be agreed between platform and instrument teams. The RLS Operations Control Centre will be placed at INTA, where besides data assessment and activity plan generation, it is possible to pre-execute RLS activity plans on SW simulation or with a representative RLS hardware model.

1. Introduction

Surface operations of the Raman Laser Spectrometer (RLS) instrument, as part of the Rover Module of the ExoMars2020 mission, must be performed in a coordinated way with the rest of the Rover units (scientific and platform elements); sharing the available resources of the Rover in terms of power, data link, etc. and taking all together decisions of the location of the next sample to analyze.

Furthermore, taking into account the mission context: communication windows between the Rover and the Mars orbiter (nominally TGO) and the Mars orbiter and the Ground Segment are short and different from day to day, communication jitter, etc., quick analysis of the received data and fast decisions of the next activities to do must be accomplished at ground in order to maximize the mission science return.

The surface mission operations after the Rover egress, will be handled through two operational processes performed in parallel, both at science and engineering level: the Strategic and Tactical processes; whose aim is to select the most interesting science objectives and define the Rover sequence activities for the next Martian days, respectively.

These processes will be carried on by scientists and engineers from instruments and platform in an agile and cooperative way, since there are only few hours since telemetry arrives until new activity plans have to be uplinked to the Rover. Thus, automated tools and well-established organization between teams, are needed to optimize rover science operations.

2. Operations overview

The main activities of the RLS Operations team have been structured in 3 main functions to be executed sequentially: Ground Data Processing, Ground Data Analysis and Activity Plan Generation.

2.1 Ground Data Processing

As soon as RLS data is received by the ROCC, an automatic process starts to decode, unpack and store in PDS4 format on the ROCC database the received data. Some of the processors included in this pipeline must be developed and delivered by the RLS team.

2.2 Ground Data Analysis

Different software tools are being developed for RLS science and engineering data analysis.

The engineering assessment tool will allow to know the health status of the instrument few minutes after data arrives; this includes, checking of voltages, currents, temperatures, CCD status, reported events, instrument mode and expected telemetries. Furthermore, data will be stored in a friendly database to be available for deeper analysis of all the data got during the mission.

On the other hand, the science assessment tool, called IDAT, will automate some processes in order to speed up the spectra analysis. Further analysis requires the scientists to be involved in the loop of the process.

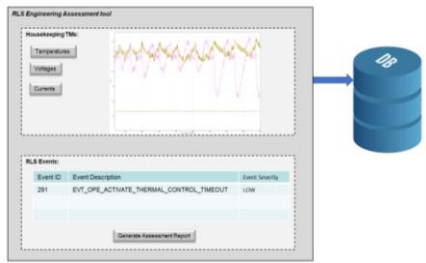


Figure 1. RLS Engineering Data assessment tool

2.3 Activity Plan Generation

Taking into account the feedback provided by the data assessment, new activities for RLS must be planned. For this purpose, a software tool is being developed to simulate RLS activity plans on the RLS SWIS or to execute them on the RLS Spare/EQM-2 models.



Figure 2. RLS Planning tool

3. Operations organization

Operations is organized as follows:

- Ground station and Communications Network: Direct communications with Rover during cruise and via an orbiter (nominally the TGO) during surface operations
- Mission Operations Control (MOC) Centre: ESOC (Darmstadt)
- Rover Operations Control Centre (ROCC): ALTEC (Turin)
- PPL Science Operations Centre (SOC): embedded in ROCC. ALTEC (Turin)
- RLS Operations Centre: INTA (Spain)
- ExoMars Science Archive: PSA at ESAC (Madrid)

Until the completion of rover egress (six wheels on Mars), the overall responsibility for mission operations will be with ESOC). Thereafter, the ROCC will be responsible for rover surface mission operations.

3.1 RLS Operations Control Centre at INTA

The RLS Operations Control Centre at INTA will host instrument planning and engineering and science assessment software tools, which will be also hosted in the ROCC.

Additionally, this Control Centre will provide the following capabilities:

- RLS data retrieved from ROCC will be stored in a friendly database accessible to ease further analysis required at any time.
- The activity plans generated by the planning tool will be able to run on an instrument simulator implemented by software (SWIS) or on a real instrument, the RLS Spare/EQM-2 model.

4. RLS Commandability

The RLS instrument operations are decomposed in three levels: TCs, actions and tasks; being the first individual commands, the second sequences of TCs including some logics, and the last sequences of TCs and actions. Ordered sequences of actions and tasks form a RLS Activity Plan, which will have to be integrated with the rest of Activity Plans until create the final Plan for the Rover.

5. Training and field campaigns

INTA RLS team has participated in ExoFit#1 (Tabernas, Spain) and ExoFit#2 (Atacama, Chile) Rover operations campaigns.

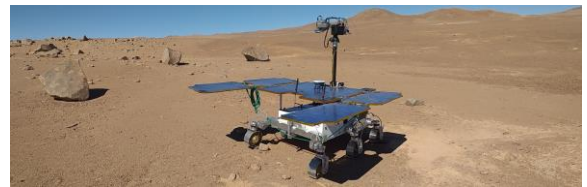


Figure 3. Rover Module operating during ExoFit#2

6. Conclusions

RLS Operation has been designed taking into account the mission requirements in terms of short-term response (quick data analysis and plan generation) for the Strategic process and also having flexibility enough to allow in-depth data analysis for the Tactical process and improve science return. Different software tools are being developed to help with these purposes.

7. Acknowledgements

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8. References

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