RLS CALIBRATION TARGET DESIGN TO ALLOW ONBOARD COMBINED SCIENCE BETWEEN RLS AND MICROMEGA INSTRUMENTS ON THE EXOMARS ROVER

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Abstract

The RLS Calibration Target (CT) has been designed both to verify the calibration status of the instrument during the mission duration, but also to perform the spatial cross-registration between the instruments of the Analytical Laboratory Drawer (ALD). This will provide the knowledge of the relative positions between the instruments once the rover is deployed on the Martian surface.

1. Introduction

The ExoMars 2020 rover has two unique features compared to other rover Mars missions [1]: 1-the ability to acquire well-preserved samples from the Martian subsurface and 2- a suite of instruments able to analyze the same areas of the sample. To do so, the rover accommodates a 2m depth drill, a sample crusher, and a refillable container, where the crushed sample is deposited and flattened prior to investigating it with the ALD with a rotating carrousel, that will position the same sample surface below the different instruments of the ALD.

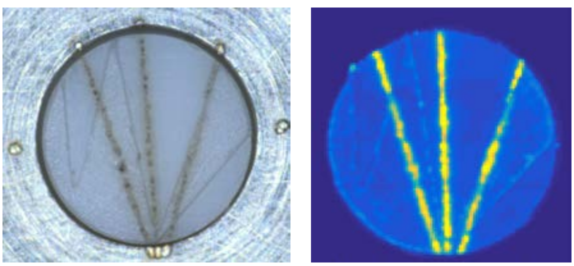

Figure 1. *RLS CT with pattern (left). Characterization of the RLS CT with the RLS ExoMars Simulator (right)*

These features constitute an important step forward for in situ analysis on Mars, as they allow, for the first time, to analyze the same spot(s) with several complementary techniques, such as Raman spectroscopy (RLS), visual plus infrared spectroscopy (MicrOmega-MICR) and laser desorption mass spectrometry LDMS (MOMA).

In this sense, the RLS CT will play a key role in the identification of the optical path followed by the RLS instrument, allowing the spatial cross-registration between the instruments of the ALD, especially with MicrOmega, resulting in a more accurate combined science between the ALD instruments.

2. The RLS Calibration Target

The RLS CT is a 2.4 mm white PET (Polyethylene Terephthalate) disk fixed on top of a metallic structure and placed in the sample plane on the rover carrousel, included in the Ultra-Clean Zone (UCZ) of the ALD. Though in principle designed for RLS calibration only, the carrousel allows the movement of the different samples (including the instruments' CTs) to be presented to the other ALD instruments. Profiting from this feature, the RLS CT was finally designed with an engraved pattern performed with laser, plus some mechanical milling with a determined shape on the upper face of the PET disk (see Fig. 1 left). Thus, the RLS CT design features a mechanically engraved pattern to provide two different-height flat surfaces on the PET disk identifiable with the RLS autofocus, and the laser mark to induce spectral modifications on the PET that can be detected by the RLS and MicrOmega instruments.

The rationale behind the pattern design is such that, when analyzing a line along the CT with RLS, it will be possible to identify the 50µm RLS path on it, which will be cross-correlated with a MICR image of the CT surface. This will allow performing a spatial cross-registration of the instruments once on Mars.

RLS will map a line along the RLS CT in 20 microns steps (the minimum movement of the rover carrousel) to acquire, at each point, a Raman spectrum plus several housekeeping acquisitions from the autofocus (AF) photodiode. The information from the photodiode provides an insight to the position of the mechanical marks, while the spectral information obtained at each point will allow the identification of the laser marks (and sometimes also the mechanical marks).

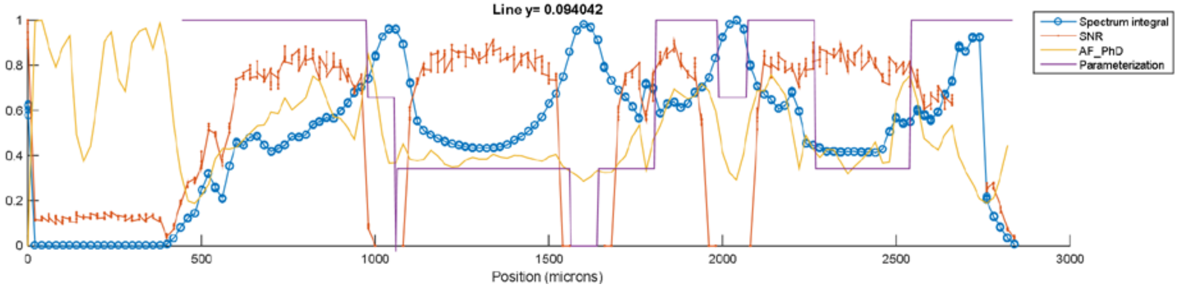

Figure 2. *Data obtained from the analysis of the CT by the RLS instrument* at +20ºC

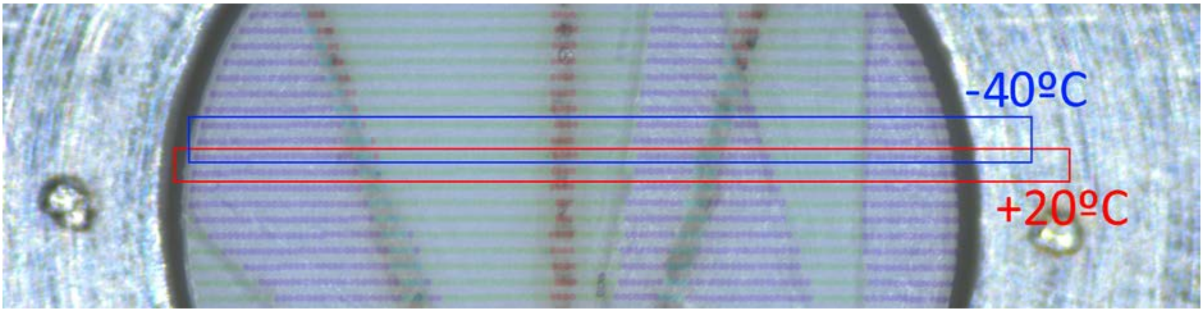

Figure 3. *Estimated lines at different temperatures of the CT path traversed by the RLS instrument*

3. Spatial cross-registration

In order to be able to perform the extrapolation from the RLS data to map the area analyzed on the CT surface, a thorough characterization of the flight CT was performed with the RLS ExoMars Simulator [2], mapping the surface of the CT with a 110x110 point matrix of 25 microns steps. One spectra is acquired at each point of the matrix, then the SNR and/or the curve integral are calculated, providing the results shown in Fig. 1 right, with a pixel size of 25 microns.

The cross-registration procedure was tested performed during the environmental tests with the ALD FM, at two different ambient temperatures, +20ºC and -40ºC. The results obtained with the RLS instrument at +20ºC are represented in Fig. 2. By correlating the obtained curves with the parameterized pattern, it is possible to establish the area along which the RLS field of view (FoV) is passing, as represented in Fig. 3. The CT features are detectable by both RLS and MicrOmega. Thus, once on Mars, it will be possible to know what is the intersecting FoV of the samples.

4. Conclusions

The modifications performed of the RLS CT are key to allow the combined science concept of the ExoMars rover mission. This will help increase the science value and efficiency of sample analysis by the ExoMars rover, providing for the first time the possibility to have several instruments analyzing the very same spot of the same sample.

5. References

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