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ExoMars Raman Laser Spectrometer scientific required performances check with a Breadboard.

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Abstract

The Raman Laser Spectrometer (RLS) is one of the Pasteur Payload instruments, within the ESA's Aurora Exploration Program, ExoMars mission. For being able to verify the achievement of the scientific objectives of the instrument, a Breadboard campaign was developed, for achieving instrument TRL5. Within the Instrument TRL5 Plan, it was required to every unit to develop its own Unit Breadboard, to check their own TRL5 and then to deliver it to System Team to be integrated and tested for finally checks Instrument performances.

1. Introduction

The Raman Laser Spectrometer (RLS) will perform Raman spectroscopy on crushed powered samples deposited on a small container after crushing the cores obtained by the Rover's drill system.

1.1 TRL5 Achievement

For being able to check that the Instrument fulfils main scientific requirements, a breadboard which verifies the TRL5 (Technology Readiness Level 5) achievement by the Instrument, has been developed. With results obtained from that model campaign, it has been demonstrated that the Instrument satisfies scientific functionality in a relevant environment

2. Instrument description

The Instrument breadboard has kept all optical critical parameters, interfaces between units, and relevant functionalities.

The RLS is composed by the following units:

- SPU (Spectrometer Unit): a spectrometer concept based on a single transmission holographic grating, used as dispersion element; and with a thermally controlled CCD detection.
- iOH: (Internal Optical Head): an optical unit which focus (autofocus mechanism capability) the laser excitation light over the sample through the excitation path, and filters the scattered Raman signal for its processing at the SPU through the reception path.
- ICEU (Instrument Control and Excitation Unit): within this unit it is housed the high stability laser source, the Front End Electronics; and the power and processor modules.
- Other Instrument units are: Electrical Harness, Optical Harness, Operation SW and Calibration Target

3. Breadboard description

A breadboard unit was developed and tested for each of the previous subsystems; and finally integrated and tested at Instrument level (designed as modular as possible in order to be able to upgrade the breadboard in a step by step process), for checking main scientific requirements for significant samples identification.
The Instrument breadboard program has been developed for two years, and has been able to achieve the following objectives:

- To verify RLS critical scientific performances: spectral resolution, spectral accuracy, SNR…
- To validate the System Radiometric Model
- To validate RLS critical functionalities, such as: CCD control and commanding, iOH autofocus…

- To confirm the overall concept of the Instrument operation: spectra extraction, operation timing, operation algorithms…

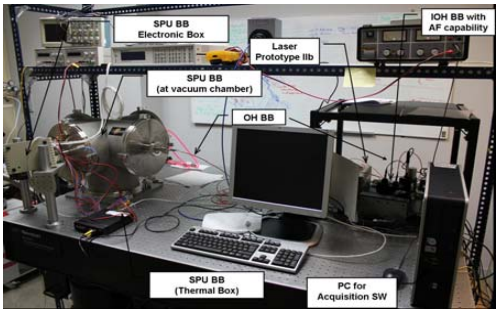

Figure 1: RLS BB Overview.

After RLS breadboard campaign, Instrument scientific critical performances have been verified, allowing go on with future Instrument models. And also, with the radiometric model validation it will be easy to predict how future possible Instrument design modifications could affect to Instrument final performances.

4. Main results obtained

Instrument spectral resolution, measured with a Ne and Hg-Ar lamps is shown below. Also "should" and "shall" instrument requirements are shown in the Figure.

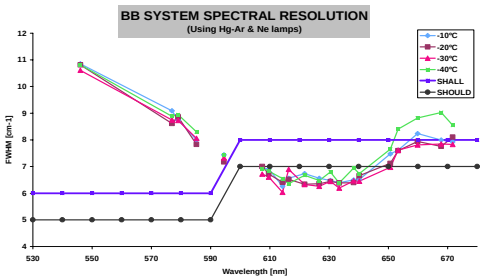

Figure 1: RLS BB Spectral resolution at different temperatures in the CCD

Instrument accuracy, calibrated with Ne and Hg-Ar lamps, obtained at different CCD temperatures, are shown in Figure 2.

RLS BB ACCURACY CALCULATION at diferent temperatures																
			PEAK (pxl)				PEAK (cm-1)				ADJUST ERROR (cm-1)			
	nm	cm-1	-10	-20	-30	-40	-10	-20	-30	-40	-10	-20	-30	-40
Peak1	671,70	3927,17	343,0	343,0	343,1	343,0	3927,4	3927,3	3927,3	3927,3	-0,2	-0,2	-0,2	-0,2
Peak2	667,83	3840,76	390,1	390,1	390,2	390,1	3840,6	3840,7	3840,7	3840,7	0,1	0,0	0,0	0,1
Peak3	659,90	3660,75	484,0	484,1	484,2	484,0	3660,6	3660,5	3660,5	3660,6	0,2	0,3	0,3	0,1
Peak4	653,29	3507,49	560,1	560,2	560,3	560,1	3507,4	3507,3	3507,2	3507,3	0,1	0,2	0,3	0,2
Peak5	650,65	3445,50	590,0	590,0	590,0	589,9	3445,4	3445,4	3445,5	3445,4	0,1	0,1	0,0	0,1
Peak6	640,23	3195,17	705,8	705,8	705,8	705,7	3195,3	3195,3	3195,4	3195,3	-0,1	-0,2	-0,2	-0,1
Peak7	638,30	3148,04	726,8	726,8	726,8	726,7	3148,1	3148,2	3148,3	3148,2	0,0	-0,1	-0,2	-0,2
Peak8	633,44	3027,94	779,4	779,3	779,5	779,3	3028,1	3028,2	3028,0	3028,1	-0,1	-0,2	-0,1	-0,2
Peak9	630,48	2953,72	811,1	811,2	811,3	811,1	2954,0	2953,8	2953,8	2953,9	-0,2	-0,1	-0,1	-0,2
Peak10	626,65	2856,78	852,0	852,0	852,1	851,9	2856,8	2856,8	2856,8	2856,9	-0,1	-0,1	-0,1	-0,1
Peak11	621,73	2730,47	903,9	903,9	904,0	903,9	2730,5	2730,5	2730,4	2730,4	0,0	0,0	0,0	0,1
Peak12	616,36	2590,36	960,1	960,1	960,2	960,1	2590,4	2590,4	2590,4	2590,3	0,0	0,0	0,0	0,1
Peak13	614,31	2536,14	981,4	981,4	981,5	981,4	2536,1	2536,1	2536,0	2536,0	0,1	0,1	0,1	0,1
Peak14	609,62	2410,91	1029,9	1029,9	1030,1	1029,9	2410,8	2410,8	2410,7	2410,9	0,1	0,1	0,2	0,0
Peak15	607,43	2351,98	1052,3	1052,4	1052,4	1052,4	2351,9	2351,8	2352,0	2351,7	0,1	0,2	0,0	0,2
Peak16			1097,8	1097,9	1097,9	1097,7	2230,9	2230,7	2230,8	2230,9				
Peak17			1153,3	1153,3	1153,4	1153,2	2079,6	2079,7	2079,5	2079,7				
Peak18	594,48	1993,34	1184,5	1184,5	1184,6	1184,4	1993,0	1993,0	1993,2	1993,2	0,3	0,3	0,2	0,1
Peak19			1248,1	1248,2	1248,2	1248,0	1813,2	1813,1	1813,1	1813,2				
Peak20	585,25	1727,93	1277,7	1277,7	1277,8	1277,6	1727,9	1728,0	1727,9	1727,9	0,1	0,0	0,0	0,0
Peak21	579,07	1545,49	1339,8	1339,9	1340,0	1339,8	1545,7	1545,6	1545,6	1545,6	-0,2	-0,2	-0,1	-0,1
Peak22	576,96	1482,45	1361,0	1361,0	1361,1	1361,0	1482,6	1482,6	1482,6	1482,5	-0,2	-0,2	-0,2	-0,1
Peak23	546,07	502,14	1672,0	1672,0	1672,1	1672,0	502,1	502,1	502,1	502,1	0,0	0,0	0,0	0,0

Figure 2: RLS BB Spectral accuracy at different temperatures in the CCD

To be completed.

5. Summary and Conclusions

To be written.

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