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Raman Spectrometer Unit Flight Model, a very demanding subsystem for planetary exploration

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Abstract

The ExoMars 2020 robotic planetary mission is being instrumentalized to drill down up to 2m and take Martian subsoil samples which will be crushed into a fine powder. Applying Raman Spectroscopy to those samples, Raman Laser Spectrometer Instrument (RLS) [1] pretends to characterize the mineral phases produced by water-related processes and to characterize water/geochemical environment as a function of depth in the shallow subsurface. Also RLS will attempt to identify the mineral products, indicators of biologic activities; to detect organic compounds and search for signs of life.

1. SPU OVERVIEW

One of the most critical Units of the RLS instrument is the SPU [2] that performs spectroscopy technique and operates in a very demanding Martian environment (radiation, temperature, dust, etc.) with very restrictive design constraints of schedule, Size, Weight and Power (SWaP). It is a small optical instrument [3] capable to cope with 0.12–0.15nm/pixel of spectral resolution and withstand with the Martian environment (operative temperature conditions: from -40ºC to 6.3ºC). The design selected is based on a single transmissive holographic diffraction grating especially designed to actuate as the dispersion element.

The main goal of the design of the SPU is not only to reach the scientific requirements as spectral resolution and SNR; but also to reach them in a reduced lightweight and maintaining performances in the operative thermal range with low power consumption.

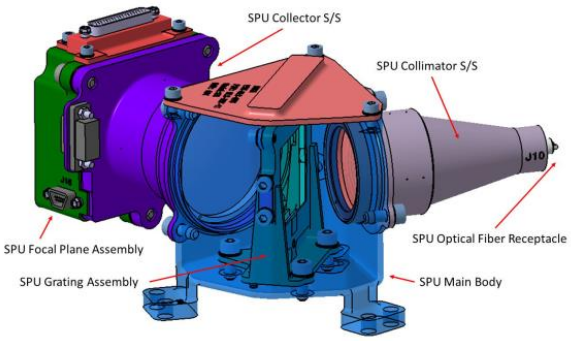

Figure 1. SPU FM Design (main body transparent).

2. SPU FM EXPERIMENTAL RESULTS

SPU FM functional tests consist of verifying, through the optical fibre image on the focal plane, the optical and electro-optics performances by means of spectral resolution and signal to noise ratio (SNR) in room conditions and relevant ambient (Mars conditions).

The spectral resolution is calculated through the linear dispersion measured between two wavelengths separate less than 0.2nm depending on the spectral range zone.

The SPU has a 0.7x magnification which translates the optical fibre to the image plane of the detector, reaching the resolution necessary to resolve the Raman peaks separated by 0.17-0.37nm, depending on the area of the visible spectral range. The quality of the instrument was also evaluated and verified in terms of MTF and impact diagram [4].

After the in-lab conditions integration and attending to the optical performance checks carried out before, during and after AIT campaign can be concluded to be successfully passed (Table 1).

SPU Linear dispersion (nm/mm)			
Spectral Zone	FM Tamb(23ºC)	TVT(-20ºC)	*(Theorical)*
Large (670 nm)	10.3±1.0	8±1	*(7.6±0.8)*
Mid (600 nm)	8.3±1.0	10±1	*(9.6±0.8)*
Short (530 nm)	8.3±1.0	11±2	*(9.9±0.8)*
SPU Image size (spectral; spatial) (pixel ±1)			
Spectral Zone	FM Cold(-45ºC)	Relevant (-20ºC)	Hot (11ºC)
Large (670 nm)	8;3	7;3	8;3
Mid (600 nm)	6;3	6;3	7;3
Short (530 nm)	6;3	6;3	6;3

Table 1: SPU FM experimental optical performances

Figure 2 shows the image in the CCD of the entire spectral working range of the spectrometer and the spectrum of a Ne calibration lamp, both images taken with the SPU FM.

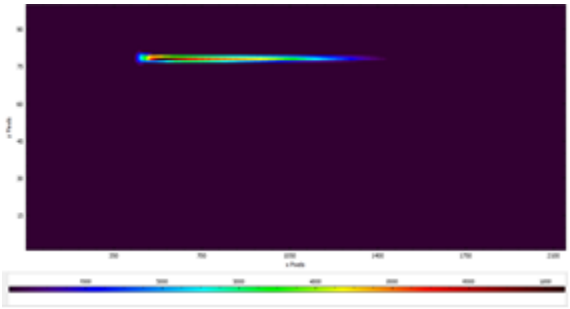

Figure 2. SPU FM images with white light

3. Summary and Conclusions

SPU is a very demanding and challenge Unit which had been successfully qualified for ExoMars2020 under tight environmental conditions (ambient, cruise phase and operation in Mars). Therefore, SPU FM has been, manufactured, tested (acceptance) and delivered to the Instrument for RLS FM test and further delivery to ESA.

Although these plans have been developed for a mission to Mars, the protocol and procedure applied are valid for any planetary exploration mission.

It should be also remarked that this SPU has demonstrated to be as flexible as needed due to several changes in the mission along the last years.

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References

[1] F. Rull, et al, "ExoMars Raman laser spectrometer overview," Proc. SPIE 7819, Instruments, Methods, and Missions for Astrobiology XIII, 781915 (2010)

[2] M. Colombo et al. “EXOMARS RLS SPECTRO-METER: a big scientific and technological challenge” IAC-13,A3,3B,6,x19830, (2013)

[3] T. Belenguer, et al “A very demanding spectrometer optical design for ExoMars Mission”, ICSO (2010)

[4] M. Fernandez et al. “Diseño óptico de un espectrómetro de altas prestaciones para la exploración planetaria”. XII Reunión Nacional de Óptica, RNO (2018).