

1. ABSTRACT

The availability of thermal vacuum chambers (TVAC) represents a need in today's planetary research. A TVAC must be capable of operate under representative conditions (temperature, gas composition, pressure, radiation flux ...) of space exploration targets but also have a useful volume compatible with the performing experiments and the testing of equipment under mimicked scenarios.

This abstract detail the TVAC designed and installed at UMALASERLAB to serve the astrochemical community. With a length of 12 meters and a useful internal diameter of 1.6 meters, the chamber operates in a temperature range between 200 K - 400 K and can be oil-free pumped down from atmospheric pressure to 10⁻⁴ mbar in the current configuration. Additional upgrades may extend the pressure range up to the 10⁻⁶ mbar range. Such figures and dimensions turn the TVAC of UMALASERLAB a powerful and versatile tool for space-related studies in chemistry, biology and engineering.

The internal surface of the TVAC is black painted with a special enamel to improve the thermal emission of the surface itself and maximize light absorption (> 95 % at any angle) to reduce flares and ghost effects in the recorded spectra. For experiments demanding deep UV illumination, a high-power Xe lamp provides illumination conditions similar to those at Mars surface in the UV-A, UV-B and UV-C spectral regions over a diameter of 50 cm in the geometrical center of the TVC. A graphic user interface allows local and remote visualization, control and data logging of the vacuum pumps, the cooling/heating system, the pressure gauges, the thermocouple gauges, and the mass flow controllers for gas mix load in the chamber.

Different experiments performed inside the TVAC will be described including laser-induced breakdown spectrometry (LIBS), laser-induced plasma acoustic (LIPAC) and thermal imaging monitoring.

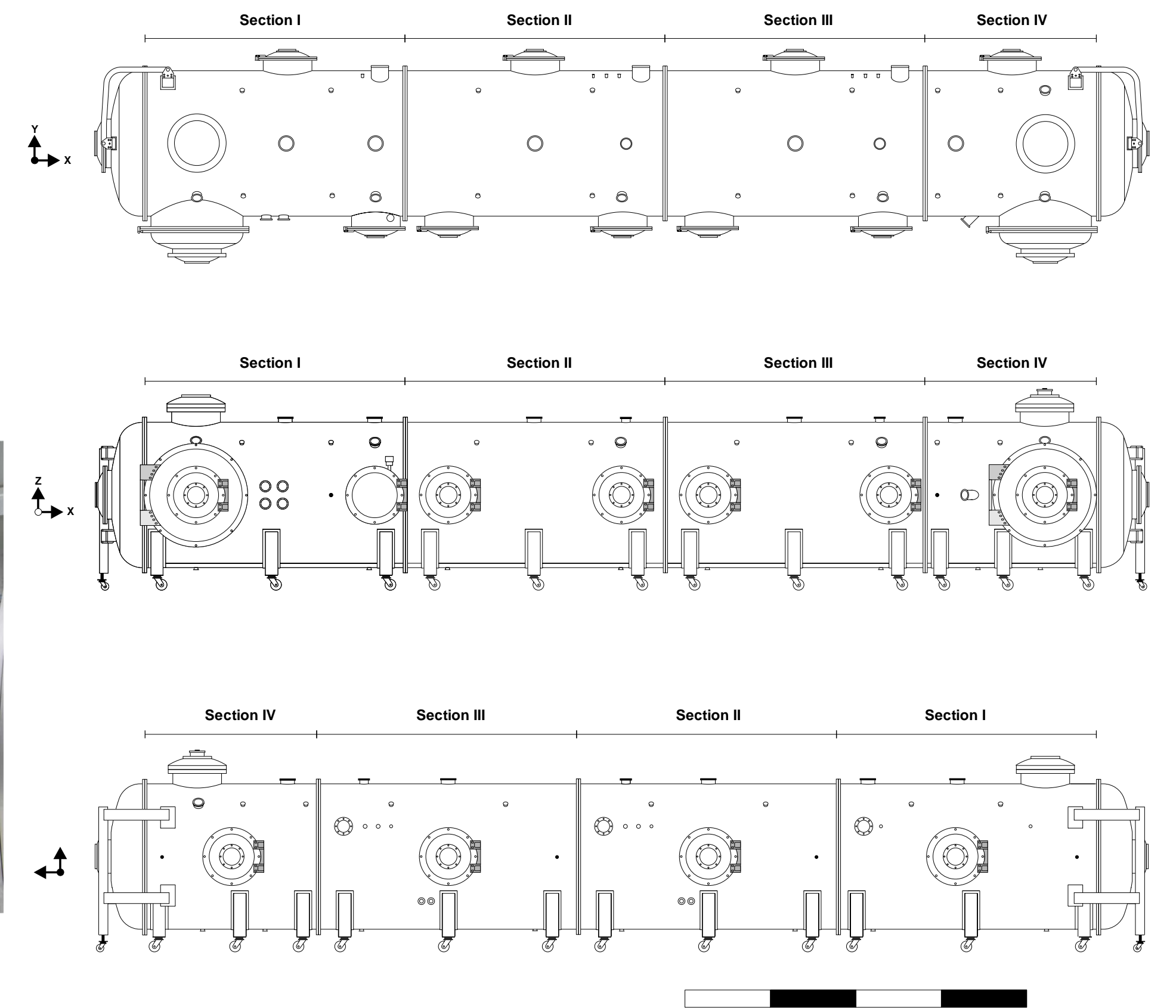
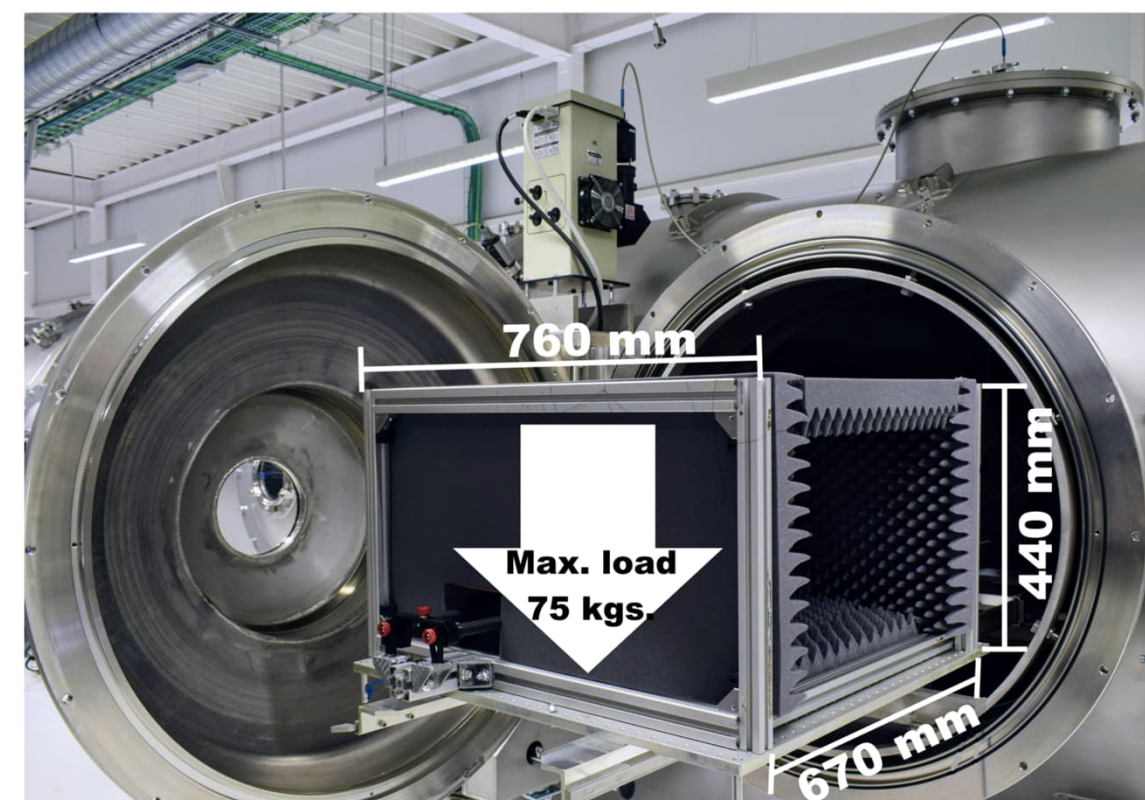
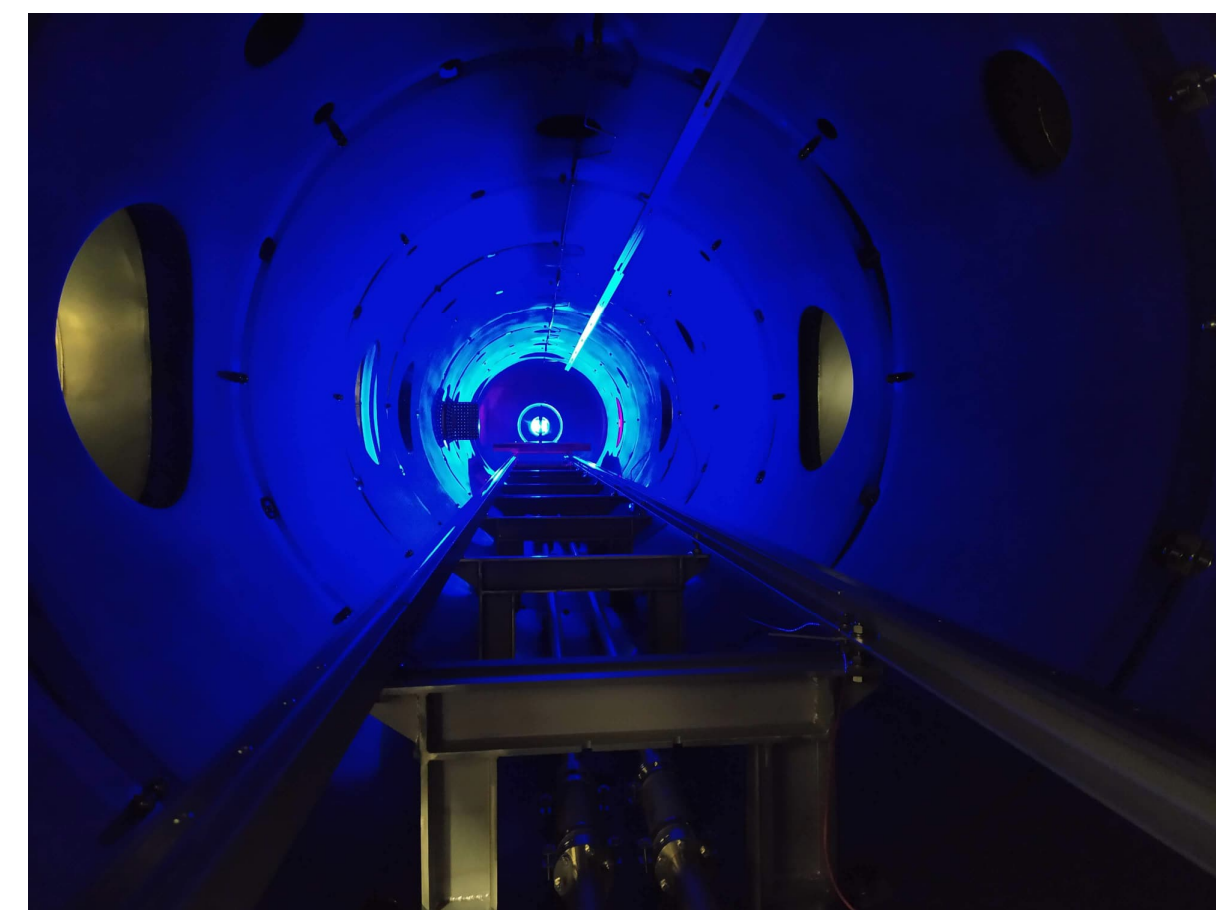
Keywords: Planetary spectroscopy; Stand-off spectroscopies; Thermal Vacuum Chamber

2. THE THERMAL VACUUM CHAMBER AT UMALASERLAB. TECHNICAL SPECIFICATIONS



Material: Stainless steel
Length: 12 meter
Internal diameter: 160 cm
Full data logging

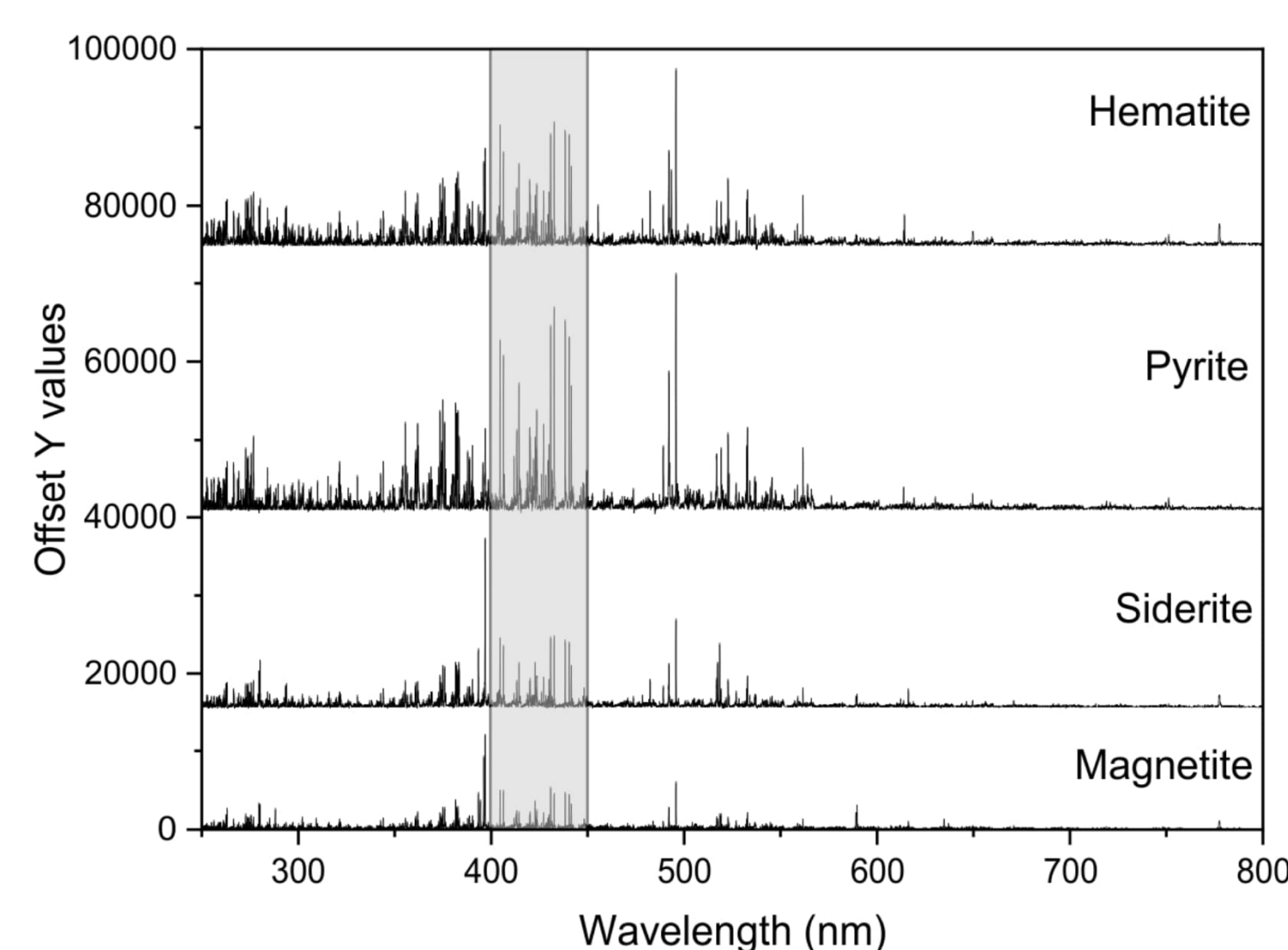
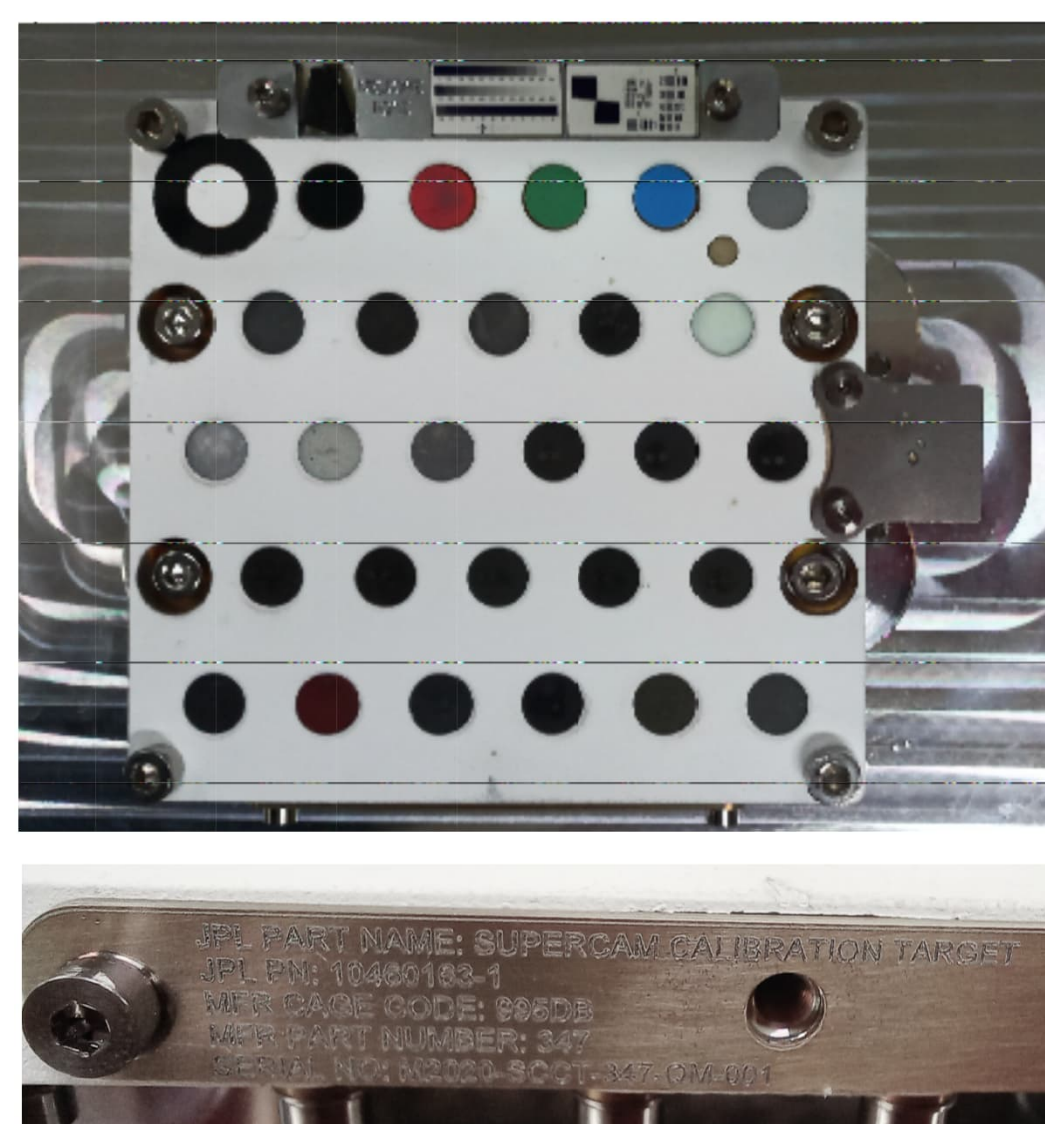
Automatic gas loading
Vacuum range: 10⁺³ - 10⁻⁶ mbar
Temp. range: -70 °C - 150 °C
Solar irradiation (UV A-C)



Loads up to 400 kgr. freely move along the length of the TVAC through stainless steel carriages. The two lateral hinged doors allow easy loading and handling through telescopic slides that accept loads up to 75 kgr in full extension.

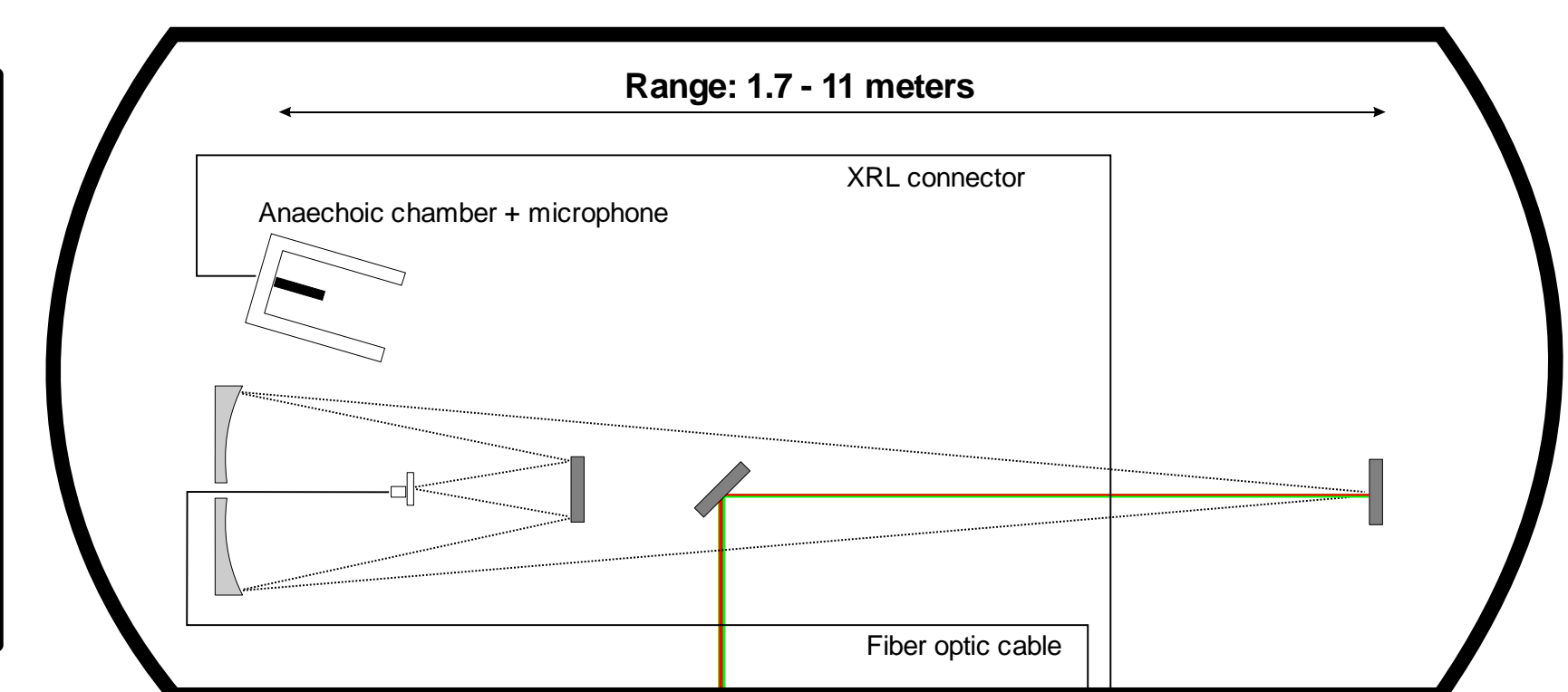
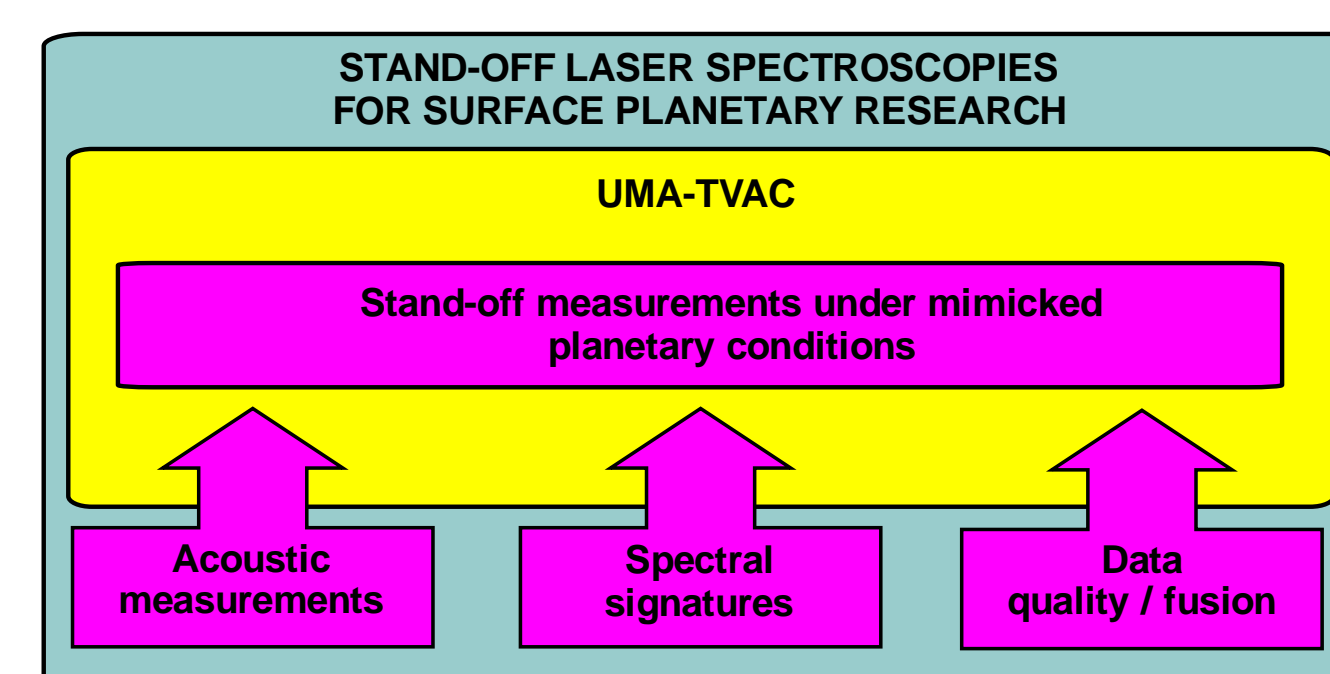
3. WORKS PERFORMED INSIDE THE TVAC

3.1. STAND OFF LIBS ANALYSIS OF MATERIALS

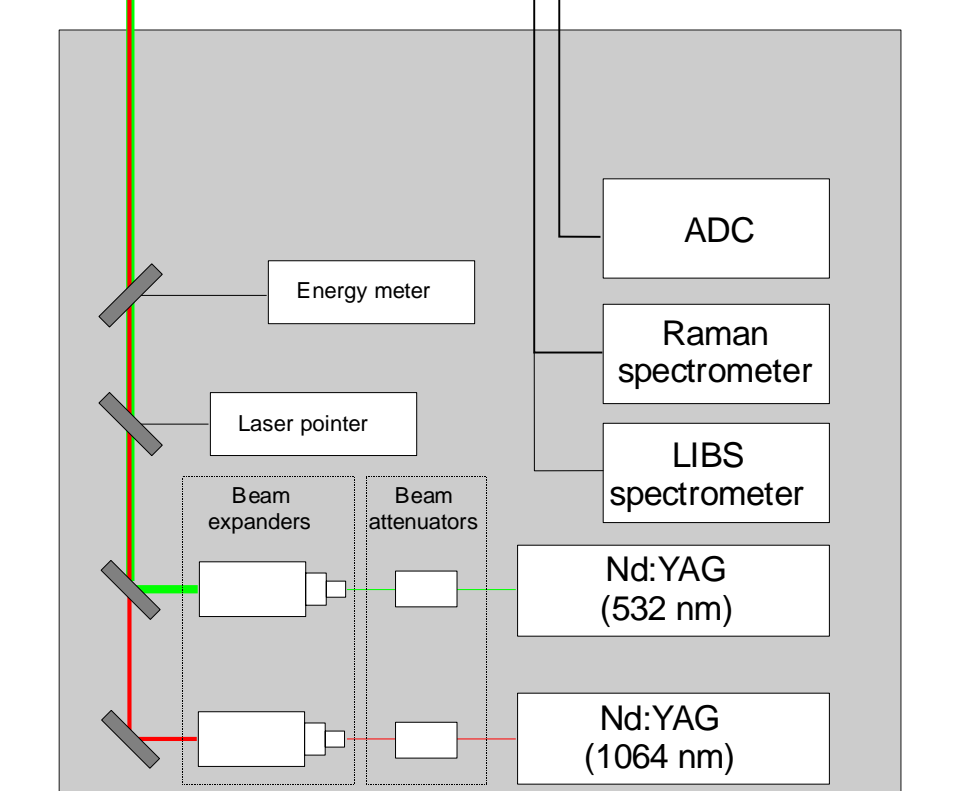


The set of standards installed in the SuperCam Calibration Target (SCCT) were analyzed at UMALASERLAB (among other labs) to assure surface homogeneity. Different techniques (LIBS, XRD, XRF and Raman) were used to provide a complete chemical picture of the standards at the micrometric scale. Additionally, the Engineering Model of the SCCT was object of study by means of laser-induced breakdown spectroscopy (LIBS) and laser-induced plasma acoustics (LIPAC) under mimicked Mars conditions to complete the initial studies. The sample was analyzed at 1.7 meters to fit to the distance in the Perseverance rover.

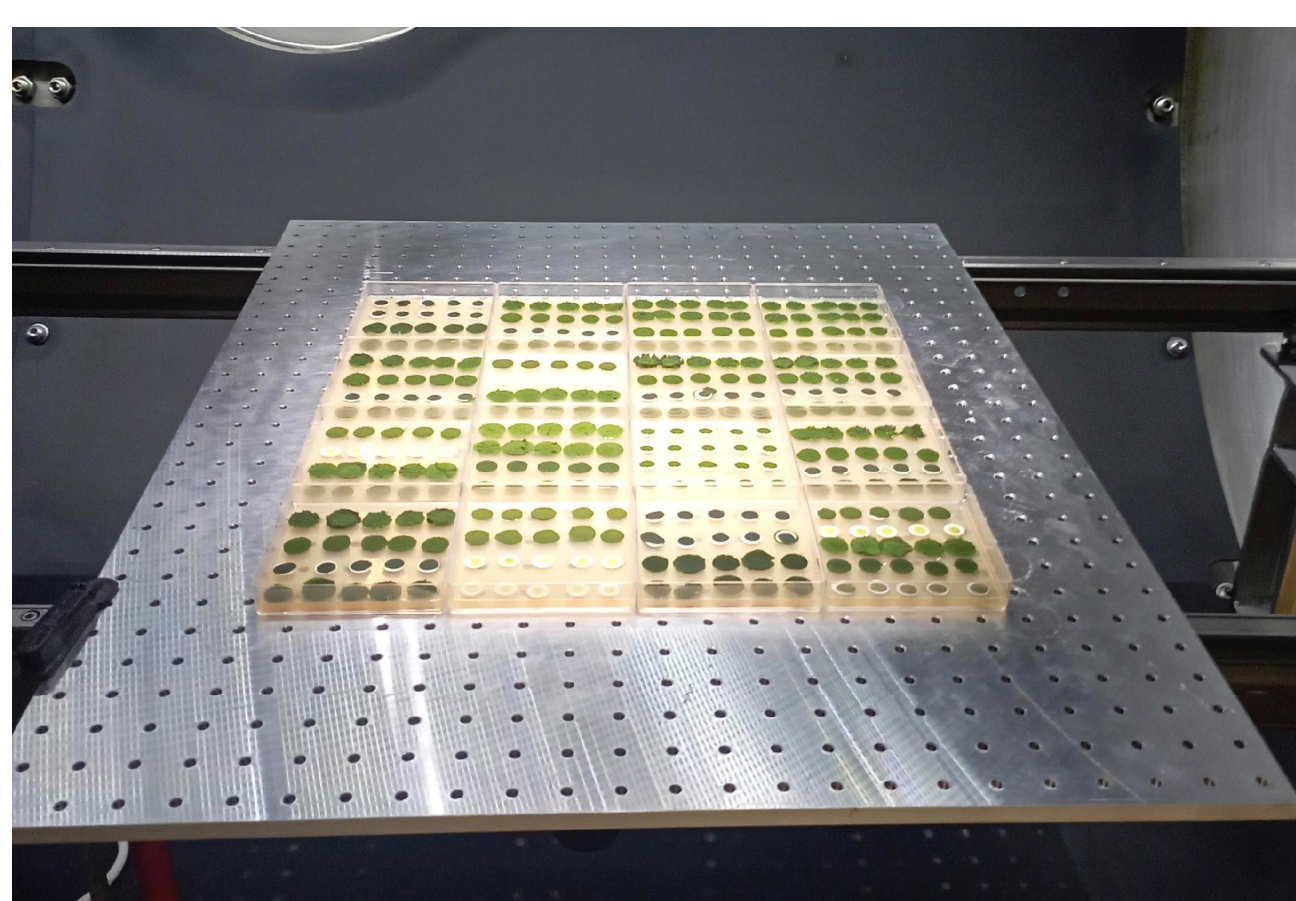
3.2. LIPAC AND THERMAL IMAGING MONITORING



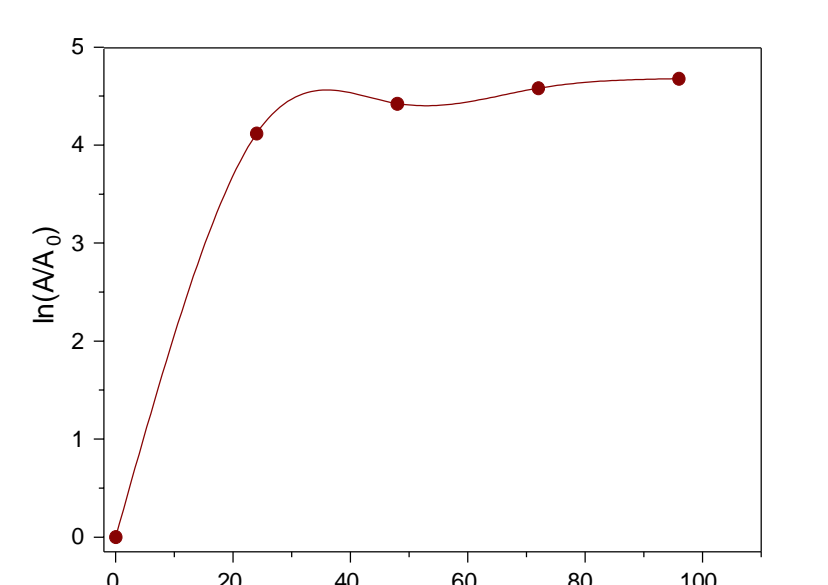
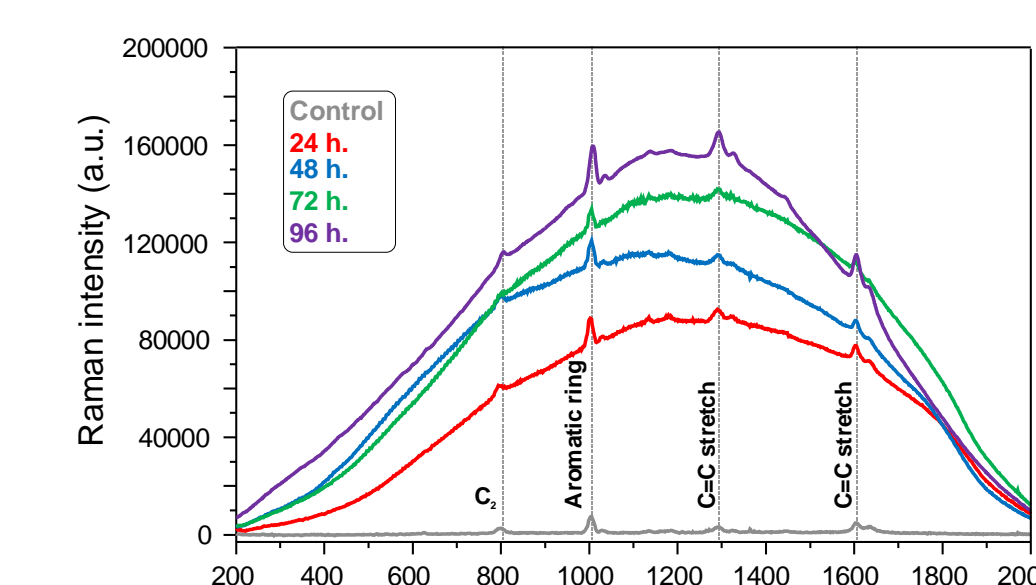
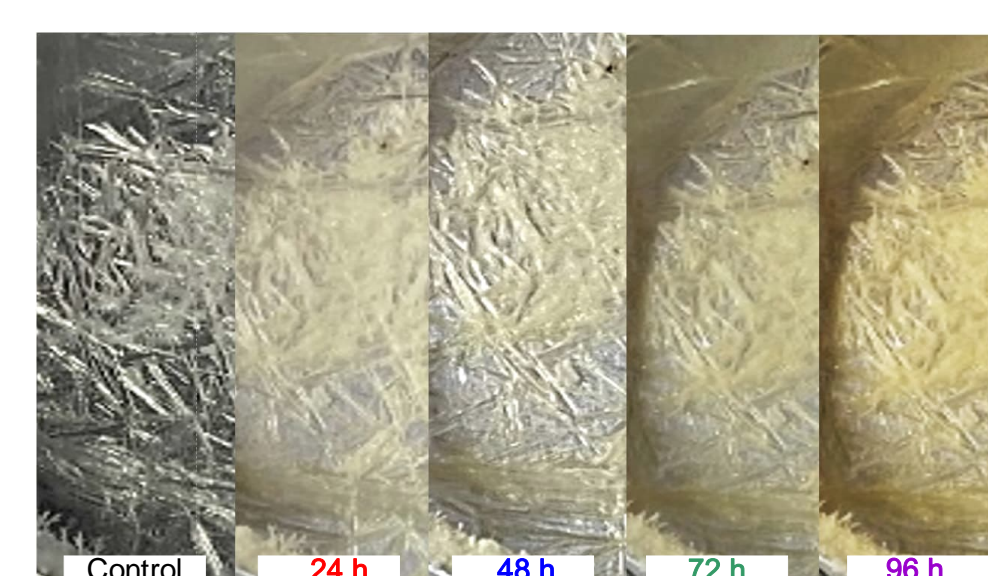
UMA-TVAC fits the different stand-off spectroscopies associated to the SuperCam instrument at the Perseverance rover. In its conventional configuration, Laser-Induced Breakdown Spectroscopy (LIBS), Raman spectroscopy, Laser-Induced Fluorescence (LIF), Laser-Induced Luminescence (LIL) and Laser-Induced Plasma Acoustics (LIPAC) can be performed. In all circumstances, the working range for the different experiments is between 1.7 and 11 meters.



3.3. UV LIGHT IRRADIATION STUDIES



A TVC is a facility capable of operating under representative conditions and scenarios (temperature, gas composition, pressure, radiation flux ...). Its use is required in the control and analysis of components in the aerospace field, as well as in specific research demanding working with mimicked environments.



Molecules under extreme irradiation and temperature conditions are significantly affected. Different experiments are being conducted to understand the degree of alteration of intact molecules under extreme conditions in order to anticipate the modifications in their spectral signatures.

4. REFERENCES

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5. ACKNOWLEDGEMENTS

Fundings for this acquisition of the UMA-TVAC were provided by the project UNMA15-CE-3396 from the Ministerio de Innovación. Continuous support from the Universidad de Málaga through the Servicios Centrales de Investigación is greatly acknowledged. The TVAC was built by Added Value Solutions (Elgoibar, Guipúzcoa, España)

6. CONTACT

UMALASERLAB,
Universidad de Málaga
Jiménez Fraud 4,
29010 Málaga (España)
GPS: 36.715577, -4.474122
00 34 951 953 008 (Administration)
Email: laserlab@uma.es
URL: laser.uma.es

