SYNERGY OF SAM AND CHEMCAM INSTRUMENTS (CURIOSITY ROVER) TO SEARCH FOR ORGANIC MATTER AT MARS. T. Dequaire[1], P. Coll[1], C. Szopa[2], S. Maurice[3], N. Mangold[4], and The MSL Science Team, [1]LISA, Créteil, France, tristan.dequaire@lisa.u-pec.fr, [2]LATMOS, Paris, France, cyril.szopa@latmos.ipsl.fr, [3]IRAP, Toulouse, France, sylvestre.maurice@irap.omp.eu, [4]LPGN, Nantes, France, nicolas.mangold@univ-nantes.fr.

Introduction: One of the priorities of Mars Science Laboratory science team is the search for indicators of a past or present prebiotic chemistry. Among the studied prebiotic markers, the **organic molecules** are key entities linked to the emergence and the development of life as we know it on Earth. However, this class of molecules has never been observed at Mars, neither with orbital observations, nor by *in situ* analysis by the Viking and the Phoenix probes. One of the most pressing question is to indentify molecules are currently present at Mars, and in which concentration.

Aboard the NASA Curiosity rover (landed August 6th, 2012 at Gale crater), the **ChemCam instrument**[1] (*Chemistry and Camera)* determines the elementary composition of rocks on the Martian surface, which allows to analyse remotely and quickly the rocks arounds the rover (**figure 1**). Such instrument plays the role of the eye of the rover, when it is devoted to determine which targets are interesting ones for some contact science and drills.

This is why we propose to determine ChemCam capabilities to detect organic molecules in the Martian rocks, by coupling LIBS and passive spectroscopy using the ChemCam testbed localized at IRAP (France).

Objectives: Currently Curiosity is on its way to Mount Sharp, where **phyllosilicates**[2] were detected from orbit by OMEGA and CRISM hyperspactral imagers. Phyllosilicates are minerals known on Earth to concentrate organic molecules. If laboratory measurements with ChemCam testbed reveal that ChemCham is able to detect organic matter at concentration level relevant to Mars, then Curiosity could be guided towards interesting outcrops containing some organic matter. Then, these organic molecules would have to be analyzed by the **SAM instrument**[3] (*Sample Analysis at Mars*), developed jointly by the NASA Goddard Space Flight Center, the LATMOS (*Laboratoire Atmosphères, Milieux, Observations Spatiales*) and the LISA (*Laboratoire Inter-universitaire des Systèmes Atmosphériques*), which is dedicated to search for biotic or abiotic materials containing organic molecules[4].

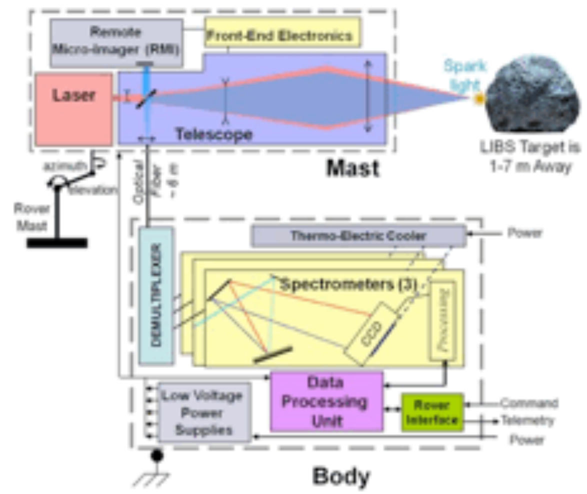

Figure 1 : Overview of ChemCam showing the mast unit and the body unit from, Wiens *et al.* (2012). The three spectrometers are quite sensible to dectect also the reflected light too, so the passive mode of this instrument can give passive spectra in relative reflectance. These spectra are of high interest for organic content studies.

Method: Figure 2 shows the **ChemCam testbed** used to analyse various samples, using its infrared laser (1067 nm). The contact between the laser and the matter generates a plasma, which is analysed by three dispersive spectrometers to cover the ultraviolet (240-342 nm), visible (382-469 nm) and visible/near-infrared (479-906 nm).

These test samples are composed of organic molecules and synthesized mineral mixtures with the aim to determine if the spectral signature of organics can be detected by LIBS technique. The first tests are realized on clay minerals like montmorillonite and nontronite, which are minerals formed in presence of liquid water, and present at Mars surface. The purpose is to determine the organic concentration threshold that ChemCam can detect in a sample. We selected glycine and adenine as the first test organic molecules because they are found in some micro-meteorites and potentially present on Mars. These samples are placed in a pressure containment system (**figure 3**), reproducing the Martian environment (6 mbar of pressure and CO_2-rich atmospheric composition), to reproduce as fully as possible the same spectra vesting conditions as ChemCam at Mars.

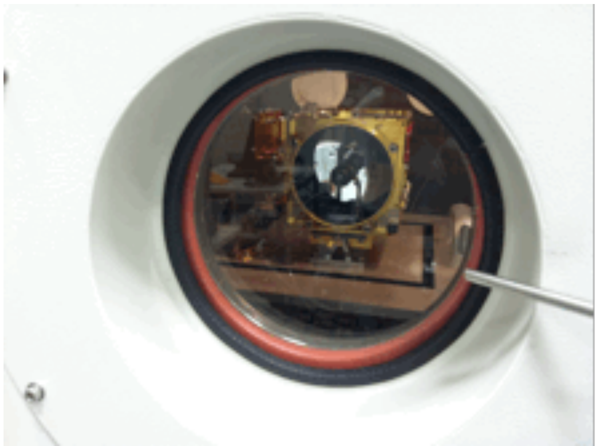

Figure 2 : Close view of the ChemCam testbed located at IRAP (Toulouse) used for laboratory simulations of detection of organic matter in mineral matrixes

This first measurement campaign in LIBS mode would determine if it is possible to detect organic matters and to proceed to a molecular identification. Currently, tests are focusing on reference samples in order to recognize the characteristic emission lines of the different materials and to know if we are able to distinguish an organic molecule from inorganic ones.

Future work : After the accurate caracterization of the spectra of reference materials, samples will be synthetized with a gradually reduction of their organic content to determine the threshold below it appears impossible to trace the organics influence in the sample spectral signature. This study will be done with few "organic-clay" samples to see the impact of the sample nature on this detection threshold.

Following the acquisition of spectra in LIBS mode, it will be interesting to collect some spectra in passive mode. In order to achieve this, few changes will be necessary on the pressure containment system about its lighting. Indeed, during instrument development, the spectrometers have shown that they were quite sensitive to collect directly the reflected sunlight by the target, and so the illumination conditions do not have to be neglected. This acquisition mode will permit to obtain spectra in relative reflectance. This kind of spectra, acquired in the visible range, are often used in terrestrial pedology to quantify the organics content in the soil.

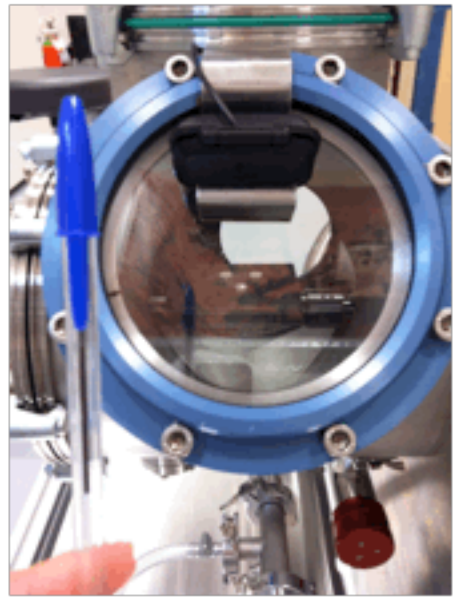

Figure 3 : Pressure containment system where the samples are placed the. This system runs at Martian pressure (6 mbar) and Martian atmosphere analog composition.

References: [1] Maurice S. *et al*. (2013) *LPSC.* [2] Thomson B.J. *et al*. (2013) *Icarus*, 214. [3] Cabane M, Coll P. *et al.* (2013) *LPSC*. [4] Mahaffy P.R. *et al.* (2013) *LPSC.*