

**Mars Organic Molecule Analyzer (MOMA) as an example for Contamination Control for Life Detection Instrumentation.** H. Steininger<sup>1</sup>, F. Goesmann<sup>1</sup>, F. Raulin<sup>2</sup>, W. B. Brinckerhoff<sup>3</sup>, P. R. Mahaffy<sup>3</sup>, C. Szopa<sup>4</sup>, MOMA Team, <sup>1</sup>Max Planck Institute for Solar System Research (MPS), 37077 Göttingen, Germany (steininger@mps.mpg.de), <sup>2</sup>LISA, Universités Paris Est-Créteil, Paris, Denis Diderot et CNRS, CMC, 94010 Créteil cedex, France, <sup>3</sup>NASA Goddard Space Flight Center, Greenbelt, Maryland 20771, USA Laurel, MD, <sup>4</sup>UMPC Univ. Paris 6, Universités Versailles St-Quentin, Paris, CNRS/INSU, LATMOS-IPSL, 75055 Créteil cedex, France.

**Introduction:** The Mars Organic Molecule Analyzer (MOMA) is a combined pyrolysis gas chromatograph mass spectrometer (GC-MS) and laser desorption mass spectrometer (LD-MS). It will be the key instrument of the ESA Roscosmos ExoMars 2020 mission to search for extinct and extant life on Mars. Additionally the instrument should detect the organic background on Mars, e.g. the one caused by meteoritic influx. The drill system on board ExoMars is capable to provide a drill core from down to 2 m depth. The sensitivity of the instrument to organic contamination is high and even a small background of organic contamination would make the identification of martian organics challenging. Contamination of biological origine could lead to a false positive life detection on Mars. This makes the Contamination Control one of the key points for the scientific success of the mission.

**Laser desorption-Mass Spectrometry:** Laser desorption-mass spectrometry is a method to detect large organic molecules without degrading them during the volatilization step. This method needs a laser source in the UV-range.

In the MOMA instrument a solid-state laser source generates UV light ( $\lambda = 266$  nm) with a 1-ns pulse width. A miniaturized linear ion trap mass spectrometer similar to a Thermo LTQ ion trap is used to detect the generated ions.

A crushed sample from the drill is moved under the laser and the mass spectrometer. The laser pulses generate plumes of ions which are injected into the mass spectrometer via gas flow and electrostatic voltages through the aperture valve and capillary ion inlet. After closing of the valve the pressure in the MS is reduced to the working conditions of the linear ion trap mass spectrometer and the ions are analyzed.

**Gas Chromatography-Mass Spectrometry:** The MOMA instrument is capable to submit the sample to a derivatization process, consisting of the reaction of the sample components with specific reactants (MTBSTFA, DMF-DMA or TMAH) which increase the volatility of complex organic species. In the pyrolysis mode the sample material can be heated to above 850°C. In this step most of refractory organic compounds break down and can be analyzed by the GC-MS.

**Contamination Control:** Several issues defined the requirements and the implementation of the contamination control approach within the instrument and in the entire rover. The science requirements of several instruments had to be combined and molded into top level CC requirement of the mission. The changes in the instrument payload led to a challenging task to combine the requirements. The original set of instruments was chosen to cover most of the possible biomarkers and organic compounds in several sensitivity ranges. There were highly specific instruments with a narrow field of view and other instruments with a broad spectrum but much higher detection threshold, like MOMA. The first more complex requirement for the mission would have been hard to verify and hard to implement for the instruments because it would have needed test methods of the same complexity. With the decreasing number of life detection instruments on the mission the requirement became less complex and was by a large part influenced by the needs of the MOMA instrument. The situation for the rover was simplified by the approach of an ultra-clean part of the rover interior. All the sample processing and science observations are happening in this ultra-clean zone. Although now the number of instrument groups affected by the stringent CC requirements was small the test procedures and the effective implementation of the CC requirement into the assembly and integration of the instruments and rover was challenging. The amount of contamination at the beginning of the science mission on Mars was fixed, but the distribution to the individual teams and the approach of every team to meet the requirements had to be implemented.

The allowed amounts of organic contamination were in the ng range and for every instrument parts cleaning procedures and verification methods had to be tested and approved. But the final prove of concept that every part of the ultra clean zone was clean enough would first be tested with the qualification model of the rover exterior.

For sample return missions the requirements have to be even more stringent because laboratories here on earth have a larger pool of methods compared to space instruments for life detection. This would make the Contamination Control the driver of a lot of technical innovations to meet the requirements.

