PLANETARY PROTECTION POLICY APPLIED TO HPL-EXOMARS SEISMOMETER. P. Schibler[1] , P. Lognonne[1] , D. Mimoun[2], P. Zweifel[3], R. Roll[4], I. Kreuse[4], W.T. Pike[5], S. Calcutt[6], A. Debus[6], [1]IPGP (4 avenue de Neptune, 94100 Saint-Maur, France, schibler@ipgp.fr), [2]ISAE (10 avenue E. Belin, 31000 Toulouse, France), [3]ETH (CH-8093 Zürich), [4]MPS (Max-Planck-Str. 2, 37191 Katlenburg-Lindau, Germany), [5]Imperial College (London SW7 2AZ, UK), [6]Oxford University (Parks Road, Oxford OX1 3PU, UK), [6]CNES (18 avenue E. Belin, 31000 Toulouse, France).

Origin of Planetary Protection policy: Article 9 of the UN "*Outer Space treaty*" specifies "*States Parties of the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination… and where necessary, shall adopt appropriate measures for this purpose*". This Treaty has been signed and ratified by all space faring Nations on January 27th, 1967.

The present COSPAR policy is the following: "*… the conduct of scientific investigations of possible extraterrestrial life forms, precursors and remnants must not be jeopardized*". This policy has been proposed by Space Agencies and Scientific Organisations involved in planetary exploration.

COSPAR give recommendations classified in five categories depending on the explored body (Venus, Mars,…) and on the type of mission (orbiter, lander, fly-by, Earth return…).

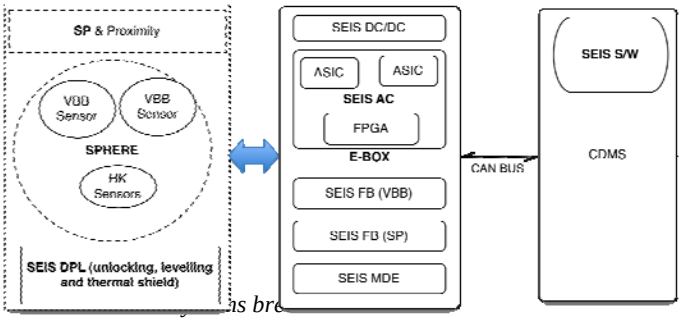
Planetary Protection constraints for ExoMars mission: The ExoMars mission will search for traces of past and present life, characterize Martian geochemistry and water distribution, identify possible surface hazards to future human exploration missions and improve the knowledge of the Mars environment including the deep interior). The Humboldt payload (HPL) and the Pasteur Payload (PPL), the latter related to the rover, are two payloads of the ExoMars mission to planet Mars. The mission launch baseline is in year 2016.

The ExoMars planetary protection classification based on the mission objectives is in agreement with the COSPAR Planetary Protection Policy. The ExoMars mission is classified as Planetary Protection Category IVb. Planetary Protection category IVb is for landed systems with life-detection experiments. The ExoMars mission is not intending to access a Mars special region.

HPL-ExoMars Seismometer instrument:

Scientific objectives: The ExoMars HPL Seismometer will study the seismic activity of the Planet and frequency of meteorites impacts. These seismic events will be characterized by their approximate distance and azimuth, as well by their magnitude. The seismometer will also allow to characterize shallow and deep interior of the planet, and especially the water environment as a function of depth in the deep subsurface, the crust thickness of the landing site, the core size and possibly, if the seismic activity is between the middle and upper bound of present estimates, the mantle structure.

Instrument design: The seismometer will be powered and serviced by the HPL. It is based on a hybrid 4-axis instrument, composed of 2 Very Broad Band (VBB) sensors, 2 Short Period (SP) sensors and has a mass of about 3100 g, including the sensors deployment system and the sensors acquisition and control electronics, including margins.



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Specific Planetary Protection specifications for HPL-ExoMars Seismometer: As the whole Humboldt payload, HPL-ExoMars Seismometer is classified in Group 1 with respect to the project PP specification, with the following specifications,

- 100 bacterial spores max for the whole instrument,
- 200 bacterial spores/m^2
- Bioburden reduction by using isolation or encapsulation.

General approach to planetary protection compliance : the general approach to fulfil planetary protection requirements for the whole instrument HPL-ExoMars Seismometer is to consider that each subsystem (SEIS-Sphere, SEIS-AC, SEIS-DPL, SEIS-SP, SEIS-E-Box) will be sterilized and cleaned at its own level and will be delivered in sterile bags (Tyvek) to the AIV facilities (CNES Toulouse) for final integration.

Bioburden reduction approach: the preferred methods for sterilization will be Dry Heat Microbial Reduction (DHMR @110°C during 50h) according to Planetary Protection specifications or using H_2O_2 gas plasma (Sterrad100s® process) with a medical quali-

fied procedure (SAL 10^{-6}) as it was done for the Mars96 mission. The process will be submitted to the Exomars Planetary Protection Officer for approval.

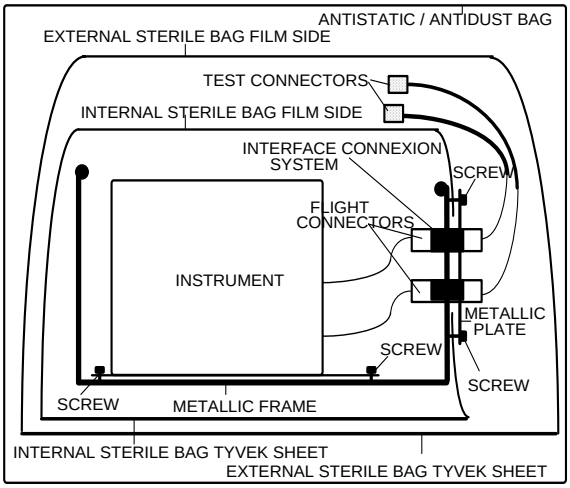
This is a medical qualified procedure (high sterilization margin) which should be qualified on EQM for compatibility with H/W. The biological level will be certified through parametric verification and microbiological indicators on FM. Packaging will be done with double Tyvek® bag and through-feed connectors.

Compatibility tests of H/W samples : tests with Sterrad 100S® process have been realized (Dec 2008) at ASP Johnson and Johnson Company (Illkirch, France facilities). We tested,

- for SEIS-Sphere subsystem, PCB with specific components (large capacitors)
- for SEIS-SP subsystem, harness (copper on Kapton), connectors and heater (copper on Kapton),
- for SEIS-DPL subsystem, Dyneema ropes (polyethylene) for deployment system

This will permit to identify critical materials.

Mars96 mission heritage (OPTIMISM Seismometer): for Planetary Protection aspects the seismometer team can benefit of Mars96 heritage in terms of procedures. Specific procedure has been validated using the Sterrad 100S® process (ASP Johnson and Johnson medical process). The procedure was used with reduced plasma phase. Sterilized equipments were packaged into two successive similar bags (qualified for the sterilization method).



Identification and description of controlled facilities : Work of integration will be done in laminar flow hood within a clean room (ISO7 or better)

As explained in SEIS Planetary Protection plan, each subsystem will be cleaned, sterilized and packaged at its own level in facilities belonging to each Institute responsible of sub-system. That means that we will use facilities on each integration site :

- IPGP and sub-contractor facilities for SEIS-Sphere sub-system
- Oxford University facilities for SEIS-SP subsystem
- MPS Lindau facilities for SEIS-DPL subsystem
- Swiss subcontractor facilities for SEIS-AC subsystem
- CNES Toulouse facilities for final AIV at whole instrument level.

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NASA NPR 8020.12C Planetary Protection provisions for robotic extra-terrestrial missions.

CNES MA1-PO-0-0321-2845-CN MARS Project - Planetary protection program - Hydrogen peroxide plasma gas sterilization procedure.