Progress Letter
Pasteur Instrument Payload for the ExoMars Rover Mission

Number 5 – 2 October 2006

This is the fifth issue in a structured series of short reports covering the development of Pasteur, ESA's instrument payload to search for traces of past and present life on Mars, and to identify surface hazards to future human missions.

In this Newsletter we briefly describe the activities that will be undertaken to prepare for the ExoMars Implementation Review (IRev). The outcome of the IRev will have important consequences for the ExoMars mission and its scientific output.

1. The ExoMars Implementation Review (IRev)

The Declaration on the European Space Exploration Programme – Aurora, approved at the Berlin Ministerial Conference held in December 2005, states that the participating countries agree to conduct an Implementation Review (IRev) of the ExoMars mission on the basis of:

- The results of the Systems Requirements Review (SRR);
- A committing industrial proposal for the development, launch, and operation of ExoMars; and
- The agreement of the participating states concerning the provision of the mission-selected instruments.

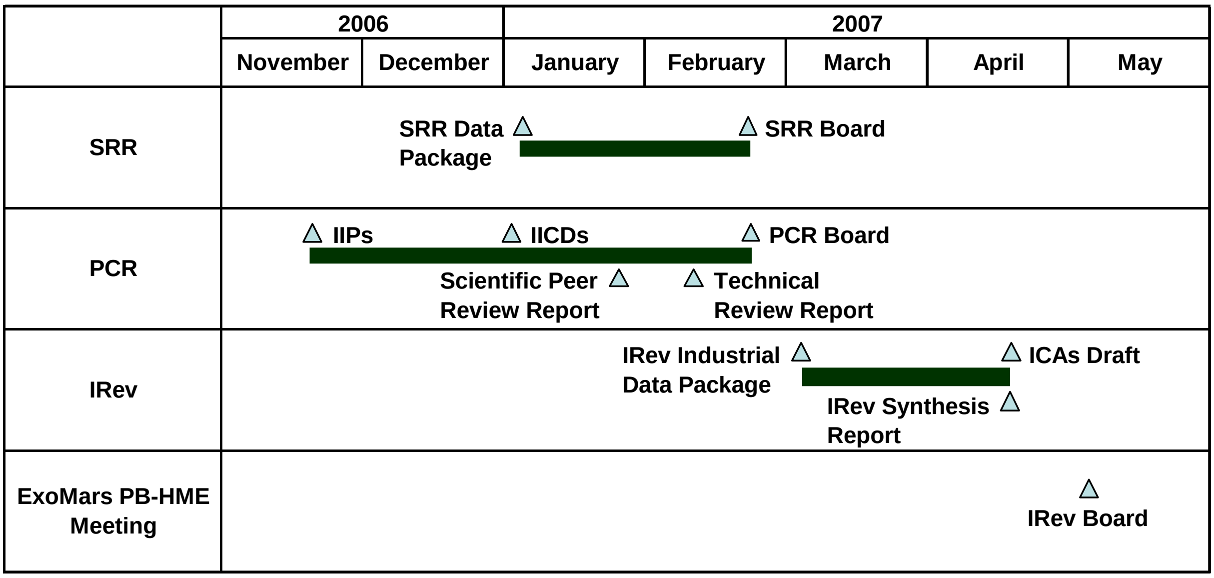
Upon concluding the Implementation Review, the participating states will confirm:

- The mission configuration (Baseline on Soyuz, Orbiter option on Ariane 5, or Baseline on Soyuz plus autonomous European data-relay communications orbiter, most likely on a second Soyuz).
- The final payload configuration; and
- The ExoMars launch date.

The Implementation Review requires careful preparation to ensure that member states can take the appropriate decisions based on the best possible available information.

Achieving a prompt and successful outcome at the Implementation Review is necessary to secure the project's planning and ensure the continuity of the industrial work. Moreover, the decisions stemming from this review will determine the breadth of scientific objectives ExoMars can pursue. For example, the choice of launcher and landing system has large implications for the Rover instrument mass and volume possibilities. Similarly, the Ariane 5 configuration includes a data relay Orbiter with a scientific payload, and affords important risk-reduction capabilities.

Fig. 1 provides a bar schedule for the Implementation Review activities.



IIP: Instrument Information Package; IICD: Instrument Interface Control Document.

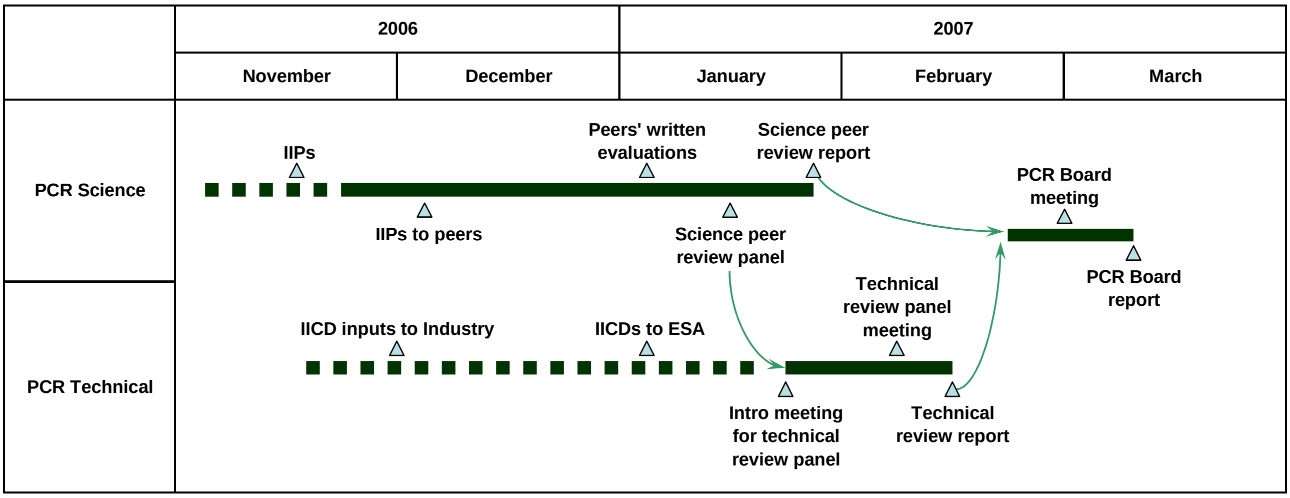
Fig. 1: Implementation Review (IRev) schedule. The two main sources of information for IRev decisions are the results of the Systems Requirements Review (SRR), and the recommendations of the Payload Confirmation Review (PCR). They will be presented, respectively, in the SRR and PCR Board Reports. Together with the draft Instrument Consortium Agreeements (ICA), they will constitute the inputs for the IRev Board deliberations.

The two main sources of information for IRev decisions are the results of the Systems Requirements Review (SRR), and the recommendations of the Payload Confirmation Review (PCR). They will be presented, respectively, in the SRR and PCR Board Reports.

The SRR is an ExoMars Industry/ESA review, which will be implemented according to the established rules and procedures of the Agency. Its objective is to freeze the mission's technical reference design so that Industry can prepare a committing technical, financial and programmatic proposal for the Baseline and optional mission configurations. This will provide two of the IRev inputs required by participating states.

During early January 2007, Industry will deliver to ESA the SRR Data Package, covering the three mission options to be considered at the IRev. The SRR Data Package will include: the ExoMars Design and Development document, Verification Plan, Product Assurance and Risk Mitigation Plan, Management Plan, Work Breakdown Structure, detailed cost of each work package, industrial work share, and resulting industrial return. ESA will examine the available information in detail, request clarifications where necessary, and issue recommendations, all with a view to enable programme decisions to be taken on the basis of reliable quantitative data. The SRR will culminate with a Board Meeting in the second half of February 2007.

Another very important component of the Implementation Review regards the scientific excellence of the ExoMars mission. This will be addressed in the Payload Confirmation Review (PCR). A detailed view of the PCR activities can be found in Fig. 2.



IIP: Instrument Information Package; IICD: Instrument Interface Control Document.

Fig. 2: Detailed view of Payload Confirmation Review (PCR) schedule. The PCR is organised in two subsequent steps: an independent, peer review of candidate instruments, followed by a technical maturity evaluation. The goal is to arrive to payload recommendations for each mission option under consideration in the IRev.

The objective of the PCR is to define the instruments to include in the Rover's Pasteur payload and in the Geophysics & Environment Package (GEP), subject to the constraints imposed by each mission configuration. To achieve this goal, candidate instruments have to be rated for scientific merit. A technical assessment of the readiness level, or maturity, of the instruments is also necessary. Finally, a verification of the interest, at national level, to financially support the various candidate instruments is required. The PCR is therefore organised in two subsequent steps: first, a peer review, following the same rigorous, independent procedure utilised for the 2003 Pasteur call; and secondly, an ESA/Industry technical review. The output of this exercise will be a recommended payload for each mission option under consideration in the IRev. Table 1 contains dates for the various milestones in the PCR planning. They are consistent with the overall IRev schedule.

PCR Milestones	Tentative Dates
Receive finalised instrument IIPs (instrument teams to ESA)	Fri, 17 November 2006
Provide instrument ICD inputs to Industry	Fri, 01 December 2006
Distribute instrument IIPs (ESA to science peers)	Mon, 04 December 2006
Collect written evaluations (science peers to ESA)	Mon, 08 January 2007
Scientific peer-review meeting at ESTEC	17–19 January 2007
Receive instrument ICDs (through Industry to ESA)	Mon, 08 January 2007
Introduction meeting for Technical Review Panel	Tue, 23 January 2007
Finalise Science Peer Review Report (input to PCR Board)	Mon, 26 January 2007
Technical Review Panel meeting	8–9 February 2007
Technical Review Report (input to PCR Board)	Thu, 15 February 2007
PCR Board meeting	Thu, 01 March 2007
PCR Report	Thu, 08 March 2007

Table 1: Payload Confirmation Review (PCR) schedule.

2. The Exploration Science and Technology Advisory Group (ESTAG)

Following the integration of Human Spaceflight, Microgravity and Exploration activities under a single ESA directorate, the existing advisory structure —EPAC, LPSAC, and associated research working groups— has been adapted to the new organisation. As announced in the September 2006 Programme Board, the advisory structure of the Human Spaceflight, Microgravity and Exploration (HME) Programmes will be composed of one HME Advisory Committee (HMEAC); to provide strategic, programmatic, scientific, and technological advice on the full scope of HME programmes; and three Advisory Groups for advice on specific aspects: the Life Sciences Advisory Group (LSAG), the Physical Sciences Advisory Group (PSAG), and the Exploration Science and Technology Advisory Group (ESTAG). The HMEAC chairperson will be *ex-officio* member of the Space Sciences Advisory Committee (SSAC); and likewise, the SSAC Chairperson will also participate to HMEAC meetings. The HMEAC recommendations are presented to the Programme Board, PB-HME. The new HME advisory structure is shown in Fig. 3.

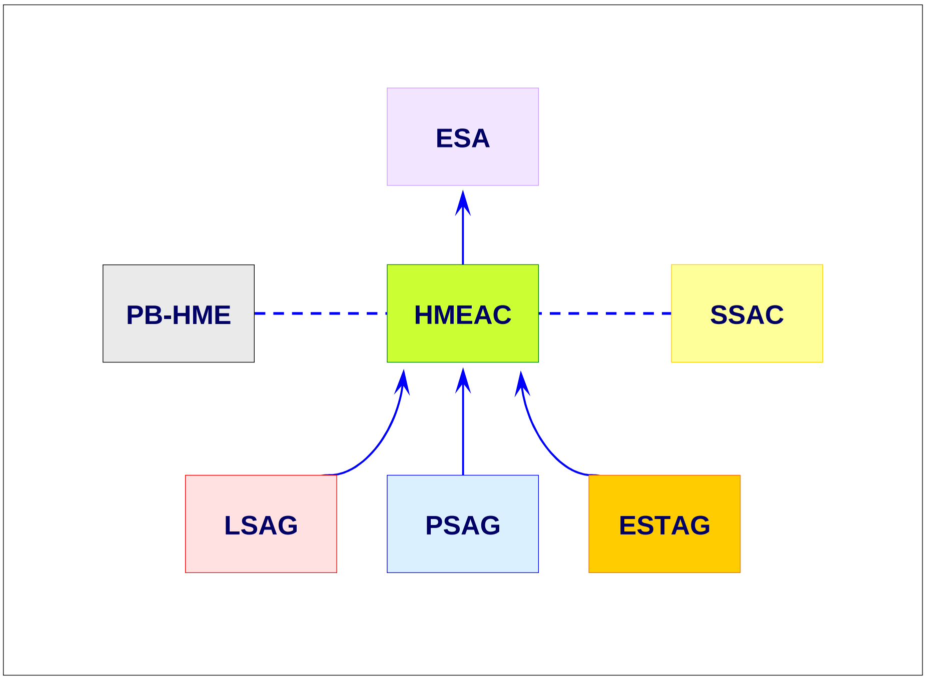


Fig. 3: The HME advisory structure: The Human Spaceflight, Microgravity and Exploration Advisory Committee (HMEAC) advises the ESA Director General on the full scope of HME programmes. Three advisory groups, reporting to HMEAC, advise on specific aspects: the Life Sciences Advisory Group (LSAG), the Physical Sciences Advisory Group (PSAG), and the Exploration Science and Technology Advisory Group (ESTAG).

Concerning ExoMars, the relevant advisory group is the ESTAG. Its main tasks are to advise on:

- The detailed formulation an updating of medium and long-term exploration research policies, architectures, and future mission proposals;
- Scientific and technological matters of approved and planned exploration programmes;
- Contents and priorities for future exploration programmes;
- Formulation of "calls for ideas" and "calls for proposals" for scientific instruments and technological experiments on approved and planned exploration missions, and the evaluation of the responses;
- Selection of instruments/experiments for exploration missions;
- Selection of peer groups and Topical Teams.

ESA is in the process of setting up this new advisory structure. Every effort will be made to present the ESTAG with a full description of the ExoMars mission's state of advancement, and to seek their advice and recommendations for the Payload Confirmation Review at the earliest possible opportunity.

3. Preliminary Phase B1 results

The ExoMars Phase B1 activities started in October 2005, under the responsibility of the mission's prime contractor, Alcatel Alenia Space – Italy (AAS-I). A Spacecraft Composite Requirements Review was completed in Spring 2006. This resulted in modifications to the avionics architecture and functional allocation between the various spacecraft elements, contributing to an increase in the overall design efficiency, ensuring adequate mass and power margins, commensurate with the project's present stage of advancement.

A number of meetings have taken place with NASA, concerning scientific cooperation, the utilisation of their data relay orbital assets, and the Deep Space Network; and with Roscosmos for RHU/RTG matters and aspects related to entry, descent, and landing.

On the payload front, ESA started the Pasteur Technology Readiness Level (TRL) Upgrade Programme for seven Pasteur instruments. These instruments were deemed to require additional work before the design of the flight units could begin. They are: the X-Ray Diffractometer, the IR Spectrometer, the Raman/LIBS, the Life Marker Chip, the Dust Suite of instruments, the UV Spectrometer, and the Gas Chromatograph / Mass Spectrometer. The first breadboard will be completed and tested in October 2006. The others will follow in a staggered sequence during the coming year.

Concerning the launch date, an ESA project-independent review has concluded that only the 2013 launch option provides a robust development schedule, including sufficient contingency for achieving the necessary technology readiness level for critical items; such as airbags, supersonic parachutes, descent control and stability, Rover locomotion and navigation, and subsurface drill operation. Therefore, from now on the ExoMars industrial team will concentrate mainly on the 2013 mission.

4. Mission configuration: implications for ExoMars science

Two landing configurations are being studied for ExoMars. The first, shown in Fig. 4 (a), uses non-vented, or bouncing, airbags. In combination with solid retrorockets, this system was successfully utilised for Pathfinder and the two MER rover landings. However, with MER this design is considered to have reached its maximum landed mass capability. Furthermore, since all sides must be protected against the expected many bounces, a relatively large structure is required. Additionally, the system's attitude after landing cannot be guaranteed, so a self-righting mechanism becomes necessary to ensure that the Rover can be safely deployed. The above notwithstanding, the most challenging aspect of this solution is that the Rover must be stowed within a tetrahedral volume. This places many limitations on the Rover's design, some of which are extremely difficult to overcome. Fig. 4 (b) depicts the alternative vented, or deadbeat, airbag configuration. This airbag system deflates in a single stroke. The impact's kinetic energy is fully absorbed by gas escaping through a number of rupture membranes, which are triggered upon contact with the Martian surface. An important advantage of vented airbags is that their associated structure is very simple, and therefore light. This is because the airbags are on the landing platform's underside only. This mass gain, however, is partially offset by a more complex reaction control system, which must ensure good vertical and lateral velocity control. The vented airbag solution also offers much more freedom in terms of Rover volume and shape. Finally, vented airbags have growth capability beyond the present needs of ExoMars. Although relying on military heritage, this system would require a new development for space applications.

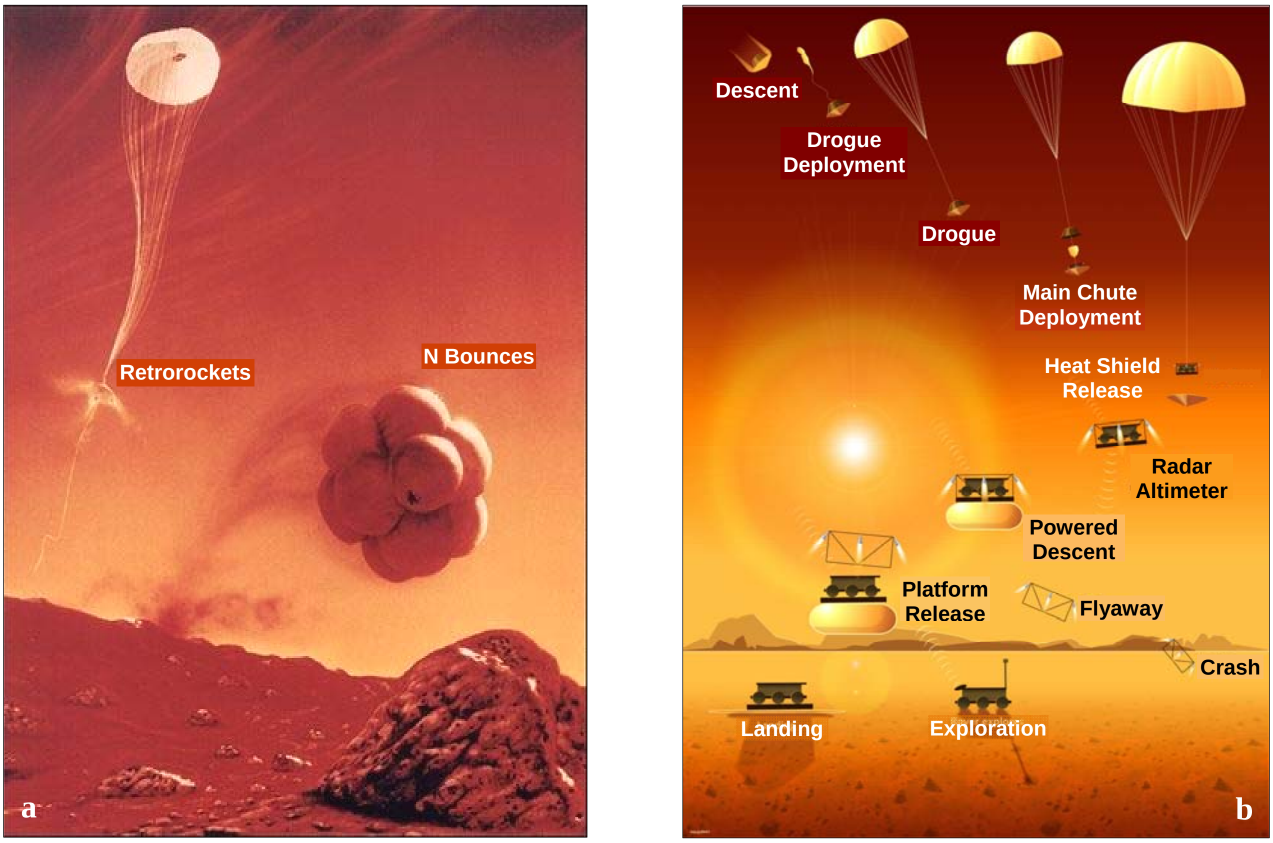


Fig. 4: The two landing configurations under study for ExoMars are: a) a MER-like, non-vented airbag solution; and b) a system using a vented or deadbeat airbag design. Credits: JPL and Astrium Ltd.

Based on the Industrial Phase B1 work performed so far, from a science perspective, three different mission options can be contemplated. They are:

1. Soyuz launcher with MER-like airbags: For this configuration, the maximum, MER-qualified landed mass of 570 kg becomes the limit. As illustrated in Fig. 5, the tetrahedral shape of the airbag arrangement severely constrains the Rover volume. The preliminary indications are that only 8 kg of Pasteur instruments can be guaranteed. Furthermore, it is not possible to integrate a 20-kg GEP powered by solar arrays in this mission option. When the GEP mass is allocated to the Rover, in theory up to 12.5 kg become possible; however, this is provided the Rover can remain within the very tight allowable volume.

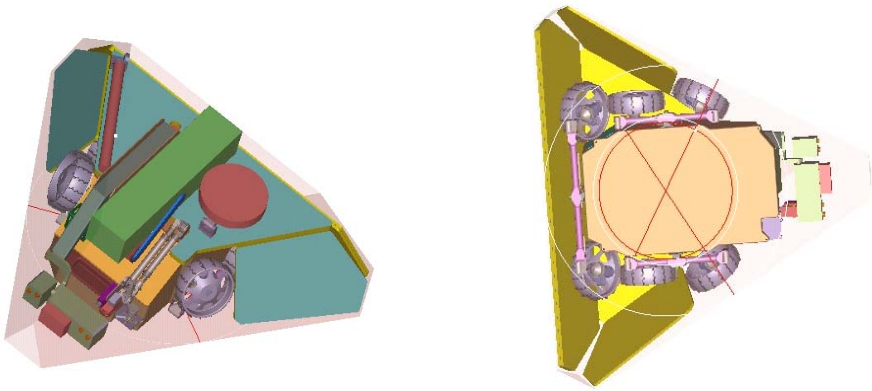


Fig. 5: Rover stowed configuration with non-vented (MER-like) airbags. Credit: Astrium Ltd.

2. Soyuz launcher with vented airbags: With Soyuz, the maximum landed mass that can be accommodated by this airbag design is 640 kg. Unfortunately, also in this instance it is very unlikely that a 20-kg GEP powered by solar arrays can be accommodated. Fig. 6 shows that for this case the Rover is no longer shape-constrained, and hence has more volume available. The first results confirm that 12.5 kg of Pasteur instruments are feasible.

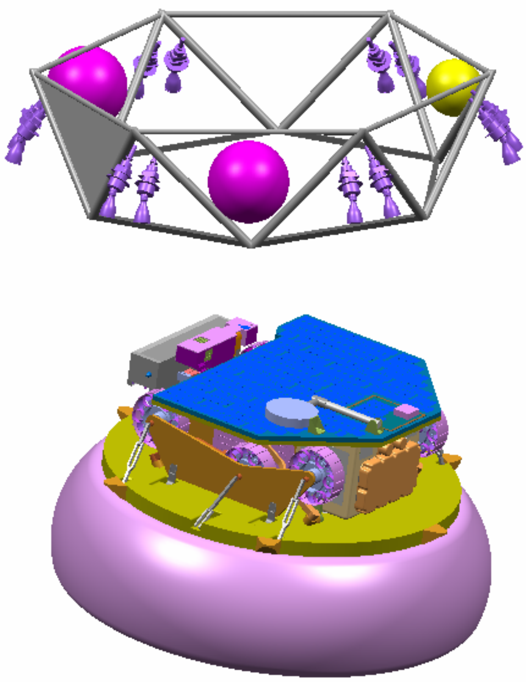


Fig. 6: Rover stowed configuration with vented airbags solution. Credit: Astrium Ltd.

3. <u>Ariane 5 launcher with vented airbags</u>: The much more powerful Ariane 5 option permits the enlargement of the landing platform's diameter, and proportionally, of the Descent Module. A comparatively larger volume can be allocated to the Rover, to possibly accommodate 16.5 + TBC kg of Pasteur instruments.

   This mission also includes an Orbiter (please see Fig. 7). The Orbiter under study can provide the much-needed data relay capability, and includes a significant science payload —in the order of 30 kg. This option also allows a release from orbit, ensuring better landing accuracy for the Rover. Finally, ESA will also study if a 20-kg GEP, powered by solar arrays, can be safely integrated in the landing platform.

Fig. 7: Artistic representation of the ExoMars Rover operating its subsurface drill. The Descent Module's release from orbit is only possible with the Ariane 5 mission. Credit: ESA.

5. Pasteur instrument status

Forty scientists from the Pasteur-selected teams gathered at ESTEC for the 2nd Pasteur Working Groups meeting held on 30 August–1 September 2005. Also present were investigators from the GEP community and from ESA's advisory bodies, delegations, and NASA representatives. The participants recommended a 12.5-kg payload for the Rover. They stressed that ExoMars, with its subsurface drill will provide a unique opportunity to search for life on Mars. They also underlined that the recommended payload is considered the minimum necessary to do the job properly. The meeting concluded with a strong request by the scientists that the proposed 12.5-kg Pasteur payload for life detection be implemented in its entirety on board the Rover. Equally firmly was stressed the need to include the Pasteur environment instruments in the mission, and to confirm the implementation of the GEP station in ExoMars.

The Pasteur Model Payload is presented in Tables 2–4.

Table 2: Recommended Pasteur exobiology instruments, with their respective 2005 mass estimates.

Instrument	Scientific rationale	Mass (kg)	Participating Countries
Panoramic Instruments:	To characterise the Rover's environment context, both on the surface and in the subsurface. Typical scales span from kilometres to metres, with sub-cm resolution for close targets.		
Panoramic Camera System	2 wide-angle stereo cameras + 1 high-resolution camera; to characterise the Rover's environment and its geology. Very important for scientific target selection.	0.4 0.3	UK D A, CH, F, I, USA
Infrared (IR) Spectrometer	For the remote identification of water-related minerals, and for scientific target selection.	1.0	I, RUS, E, NL, PL
Ground Penetrating Radar (GPR)	To establish the subsurface stratigraphy down to 3-m depth, and to help plan the drilling strategy.	1.0	F, N, USA, D, I, B, E, UK
Contact Instruments:	To investigate surface rocks and soils. Among the scientific interests at this scale are: macroscopic textures, structures and layering; and bulk mineralogical and elemental content. This information will be fundamental to collect samples for more detailed analysis. The preferred solution is to deploy the contact instruments using an arm-and-paw arrangement, as in Beagle II. Alternatively, in case of mass limitations, they could be accommodated at the base of the subsurface drill.		
Close-Up Imager	To visually study scientific targets at cm-range with sub-mm resolution.	0.2	CH, F, USA, D, UK, I, NL
Mössbauer Spectrometer	To study the mineralogy of Fe-bearing rocks and soils.	0.3	D, DK, F, CDN, UK, BRA, USA, RUS
Raman-LIBS* external optical heads	To determine the geochemistry of rocks and soils. These are external heads connected to the instruments inside the analytical laboratory.	0.2	E, NL, F, UK, D, I, A, USA
Analytical Laboratory:	To conduct a detailed analysis of each collected sample. The first step is a visual and spectroscopic inspection. If the sample is deemed interesting, it is ground up and the resulting particulate material is used to search for organic molecules and to perform more accurate mineralogical investigations.		
Microscope (IR)	To examine the collected samples to characterise their structure and composition at grain-size level. These measurements will also be used to select sample locations for further detailed analyses by the Raman-LIBS spectrometers.	0.2	F, CH, I, UK
Raman-LIBS	To determine the geochemistry of the collected samples.	1.1	E, NL, F, UK, D, I, A, USA
X-Ray Diffractometer (XRD)	To determine the true mineralogical composition of the collected sample's crystalline phases.	0.8	I, P, UK, NL, E, F, RUS, USA, AUS
Urey (Mars Organics and Oxidants Detector)	Mars Organics Detector (MOD): to search for amino acids, nucleobases, and PAHs in the collected samples with extremely high-sensitivity (ppt). Can also function as front-end to the GC-MS. Mars Oxidants Instrument (MOI): determines the chemical reactivity of oxidants and free radicals in the soil and atmosphere.	3.2	USA, NL, CH, UK, F, D, I
GC-MS	Gas Chromatograph Mass Spectrometer: to conduct a broad-range, very-high sensitivity search for organic molecules in the collected samples; also for atmospheric analyses.	3.0	D, USA, NL, F
Life-Marker Chip	Antibody-based instrument to detect organic molecules with very high specificity.	0.8	UK, NL, USA, D, N, E

Total mass: 12.5 kg. *LIBS: Laser-Induced Breakdown Spectroscopy.

Table 3: Facility support equipment provided by the Rover vehicle.

Instrument	Scientific rationale	Mass (kg)	Participating Countries
Facility-Support Equipment:	These essential are devoted to the acquisition and preparation of samples for detailed investigations in the analytical laboratory. They must follow specific acquisition and preparation protocols to guarantee the optimal survival of any organic molecules and volatiles in the samples. The mission's ability to break new scientific ground, particularly for signs-of-life investigations, depends on these two instruments.		
Subsurface Drill	Capable of obtaining samples from 0 to 2 m depth, where organic molecules and volatiles might be well-preserved. It also integrates temperature sensors and an IR spectrometer for borehole mineralogy studies.	–	I, P, F, PL
SPDS**	Receives a sample from the drill system, prepares it for scientific analysis, and presents it to all analytical laboratory instruments. A very important function is to produce particulate material while preserving the organic and water content.	–	I, D

**SPDS: Sample Preparation and Distribution System.

<u>Note</u>: These instruments are part of the ExoMars industrial development contract.

Table 4: Recommended Pasteur environment instruments.

Instrument	Scientific rationale	Mass (kg)	Participating Countries
Environment Instruments:	To characterise possible hazards to future human missions and to increase our knowledge of the Martian environment.		
Dust Suite	Determines the dust grain size distribution and deposition rate. It also measures water vapour with high precision.	0.8	I, DK, E, UK, USA
UV Spectrometer	Measures the UV radiation spectrum.	0.3	UK, D, B, I, USA
Ionising Radiation	Measures the ionising radiation dose reaching the surface due to cosmic rays and solar particle events.	0.5	D, I, UK, B
Meteorological Package	Measures P, T, Wind speed & direction, and sound.	0.3	UK, FIN, D, F, DK, I

Total mass: 1.9 kg. The Pasteur environment instruments are candidate instruments for the GEP.

6. The Geophysics & Environment Package (GEP)

An important outcome of the Second Aurora Science Conference, held in Birmingham (UK) in April 2005, was the request to also include in the ExoMars mission a provision for performing geophysics and meteorology investigations. This interest resulted in a proposal for the Geophysics & Environment Package (GEP). In June 2005, the geophysics scientific community produced a report entitled "Preliminary Study of a Long-Lived Mars Surface Package," which identifies a model payload for the GEP. The model payload includes "core" and "additional" instruments. This unsolicited document was submitted to the national space agencies CNES and DLR, and to ESA. Shortly thereafter, at the 2nd Pasteur Science Working Groups meeting held at ESTEC on 30 August–1 September 2005, it was agreed to consider accommodating the Pasteur environment instruments in the GEP.

The GEP configuration and its integration in ExoMars have been studied extensively over the past twelve months by CNES, with the support of DLR, and by ESA/Industry. The assumptions for the feasibility work performed are the following:

- The GEP is carried to Mars on the DM, is powered by a small Radioisotope Thermal Generator (RTG) that guarantees the six-year lifetime science requirement, becomes operational after the egress of the ExoMars Rover, and is independent for its operation from both the Rover and the DM.
- The 12 instruments considered for the GEP payload include:
  - The Pasteur environment instruments (Dust Suite, UV Spectrometer, Ionising Radiation, and Meteorological Package); initially on the Pasteur payload, but then considered for the GEP.
  - The original “core” instruments:
    - Atmospheric Electricity Probe (AEP)
    - Atmospheric Probes (ATM)
    - Magnetometer (MSMO)
    - HP3/Mole
    - Seismometer (SEIS)
  - The “additional” instruments:
    - Low-Frequency Ground-Penetrating Radar (EISS)
    - Radio Science Experiment (NEIGE)
    - Short-Period Seismometer (SEIS-SP)
- The GEP overall mass allocation is 20 kg, including all interfaces with the DM, deployment mechanisms, and design margins.
- The GEP must be compatible with the DM design and configuration.
- The GEP must accommodate the already selected Pasteur environment instruments.
- The GEP must be completely autonomous (it must not impose any requirements on either the DM or Rover, e.g. for deployment, power, communications, etc.).
- Any dedicated heat-rejection capability required during the cruise phase must be accounted for within the 20 kg GEP mass allocation.

A first study was performed in October–November 2005 by CNES at their Toulouse Concurrent Design Facility (CIC) to determine the feasibility to accommodate GEP in the ExoMars DM. This work was supported by ESA, Industry, and DLR. The main findings were that to integrate all candidate instruments, having an approximate combined mass of 8 kg, a large, >30-kg mass, GEP is necessary. This figure does not include the GEP to DM interface structure, the deployment mechanism, and a provision for RTG heat dissipation during the cruise phase, which would require an estimated additional 40 kg. Besides this mass incompatibility, also the volume was found to be a major concern. Various fixation positions were investigated for the GEP unit. All cases required a larger DM structure, translating into a more massive DM design, exceeding the DM entry stability requirements and the Soyuz launcher capabilities.

On February 2006 the three agencies' specialists met at ESTEC for a GEP Interface Workshop to define new interface activities to prepare for further GEP studies. A second CNES CIC study was conducted during February–March 2006.

The second CNES study explored several spatial configurations in an effort to contain the resources needed to implement GEP in ExoMars. A first important decision was to impose a maximum instrument mass of 5 kg. The team, however, did not specify which instruments would be retained. For this reason, a GEP facility design was selected that is, in principle, compatible with each candidate instrument. Of all the possible distributed (multiple box) options, the preferred one was Configuration 1C (please see Fig. 8), consisting of two elements: a Main Box, plus a smaller seismometer/mole unit. The latter is connected to the Main Box by a cable, necessary for power and data communication. An advantage of this approach is that only the seismometer/mole unit would need to be deposited on the Martian surface. The mass of Configuration 1C is 21.5 kg, not including the deployment mechanism for seismometer/mole unit and a provision for RTG heat dissipation during the cruise phase. It is important to note that simple deployment mechanisms having a mass in the order of 5–10 kg —like ejection devices, pyrotechnically deployed swinging arms, etc.— are not able to guarantee a reliable contact of the seismometer/mole unit with the terrain. Any obstacle, such as a rock in the wrong place or a tilted landing platform, could impede the correct deployment of the seismometer/mole unit. Other solutions are possible, but they either require a mass and volume greatly exceeding the Soyuz mission's capabilities, or result in unacceptable risks to the mobility of the ExoMars Rover. In addition, it was found that the development of the efficient RTG unit necessary to power the GEP over its expected 6-year lifetime constitutes a major technical and programmatic risk, even for a 2013 launch. This was recently confirmed by an assessment performed by external nuclear experts.

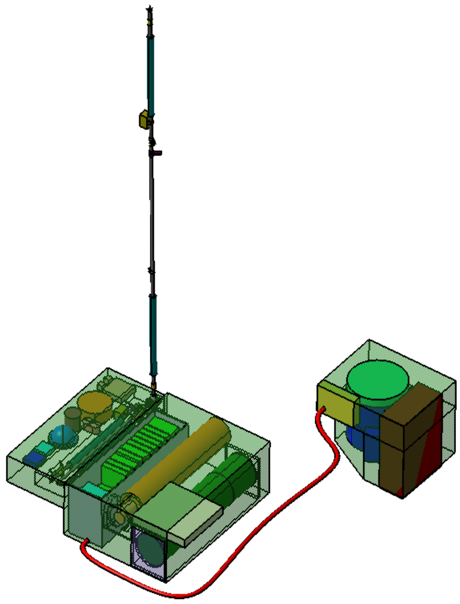


Fig. 8: GEP Configuration 1C. Credit: CNES.

6.1 GEP Original Concept

The outcome of the studies conducted so far could not demonstrate the feasibility of the original GEP concept (single unit) and of other alternative concepts (distributed units, whether located in the DM base plate or on the petals) for the Soyuz mission:

- No practical design solution has been found that can guarantee GEP instrument contact with the Martian surface. This has a negative impact on the feasibility to deploy the seismometer and the mole—important mission risks.

- The development of new more efficient RTGs by a Russian company carries unacceptable technical and programmatic risks.

- The GEP accommodation is incompatible with the allocated resources and applicable interface requirements.

- All studied GEP configurations and interfaces result in major drawbacks for the ExoMars spacecraft composite design (Carrier Module, Descent Module, and Rover).

On the basis of these results, ESA consider that the implementation of the proposed GEP as an autonomous unit in a Soyuz-based ExoMars mission is not feasible.

6.2 GEP Design Alternatives

Another option analysed was to use solar panels in place of the RTG unit, sacrificing the long science lifetime requirement. The solar panels would be fastened to the internal side of the DM Support Structure and Rover Egress System's (SES) petals. This solution would still require RHUs for thermal conditioning; but these units are commercially available from Russia. Two important drawbacks were identified: 1) the GEP would need 2.4 m^2 of solar panel area, but only 1.6 m^2 can be accommodated on the SES petals and structure. 2) In order to egress onto the Martian surface, the Rover would require driving on the fragile solar cells. One suggestion was to add rails to the petals, creating "egress tracks" for the Rover. However, this would violate the safety requirement to allow the Rover to egress in three different directions. In conclusion, also this option was judged incompatible with the Soyuz mission's many constraints.

At a dedicated GEP review meeting, on 11 September 2006, it was proposed to accommodate a subset of the GEP instruments on board the ExoMars Rover, making use of its existing instrument support infrastructure (solar arrays, power supply, data handling, telecommunication, etc). This solution, however, was not deemed attractive by the geophysics scientists. During the September 2006 Programme Board (PB-HME), the GEP was once again discussed. Assuming it can be provided as a DLR national contribution, the Agency, Industry, and DLR will continue to study its potential integration in the landing platform, but will mainly concentrate on the Ariane 5 mission scenario.

7. The Payload Confirmation Review (PCR)

The objective of the PCR is to provide participating states with a clear indication of the ExoMars mission's scientific content for each of the options under consideration in the Implementation Review. Section 4 briefly discussed the instrument possibilities that each mission configuration can offer. Section 5 presented the mass needs of the peer-reviewed Pasteur instruments, as they were known in mid 2005. Over the past twelve months the ExoMars mission prime contractor, AAS-I, and ESA have worked with the Pasteur instrument teams to define interfaces for all candidate instruments to be integrated in the Rover. Potential problems have been identified regarding mass, volume, and data requirements. Concerning mass, the present situation is that the 12.5 kg figure of 2005 is today estimated to be in the order of 17 kg. Similarly, the environment instruments' mass has increased from 1.9 to 2.5 kg. In the case of a Soyuz mission, with NASA's MRO data relay orbit the ExoMars nominal mission cannot be completed within 180 sols due to insufficient data link capabilities. Clearly, it is not feasible to accommodate and serve all identified instruments in every mission configuration. A decision process must be implemented to define the best possible payload compatible with each of the three cases. The following approach was presented at the September 2006 Programme Board.

Taking into account that,

- ExoMars is first and foremost a "search for life" mission;
- ExoMars paves the way for future ESA missions by developing novel European technologies for landing, surface mobility (with the Rover), and subsurface access (with the drill),

ESA will organise an independent peer review of the pre-selected Pasteur instruments, and of new potential geophysics instruments, with the goal to identify the best possible science payload for each of the three mission options addressed in Section 4.

7.1 Peer Review Rules

Subject to the endorsement of the ESA Advisory Bodies, the peers will be instructed to conduct their evaluation according to these proposed rules:

1. For all mission configurations, the first priority must be given to defining a payload that can credibly pursue the following ExoMars mission objectives:
   a. To search for traces of past and present life on Mars;
   b. To characterise the water/geochemical environment as a function of depth in the shallow subsurface.

   Environment instruments that can contribute to the above two objectives should be treated with the same high priority.

2. For all mission configurations, and particularly in the case of the Ariane 5 option, an effort will be made to address other environment and the geophysics objectives:
   c. To study the surface environment and identify hazards to future human missions;
   d. To investigate the planet's deep interior to better understand Mars's evolution and habitability.

A document describing the criteria and procedure for the Peer Review will be discussed at the November 2006 Programme Board (PB-HME).

7.2 Peer Review Outcome

The peers will be requested to make a recommendation for the following three Rover payloads:

1. <u>Soyuz launcher with MER-like airbags</u>: Highest priority 8-kg payload + ranked list (up to 2 kg) in case more instruments were to become possible.
2. <u>Soyuz launcher with vented airbags</u>: Highest priority 12.5-kg payload + ranked list (up to 2 kg) in case more instruments were to become possible.
3. <u>Ariane 5 launcher with vented airbags</u>: Highest priority 16.5-kg payload + ranked list (up to 2 kg) in case more instruments were to become possible.

The peers will also recommend up to 3.5 kg of geophysics and environment instruments to be studied for integration in a possible GEP, in case a vented airbag solution can be adopted.

7.3 *PCR Organisation*

Over the coming days, ESA will invite the already identified Pasteur instrument teams and the geophysics community to participate in the ExoMars PCR.

ESA recognises that the pre-selected Pasteur instruments (please refer to Tables 2–4) already underwent a rigorous peer-review screening in 2003. Moreover, the Pasteur payload is the result of much consolidation and technical work performed by the instrument teams, who have met at regular intervals to arrive to the present instrument composition. The peers will be informed of this. The Pasteur instrument documents must therefore adhere to the instrument concepts and science that was subject of the original peer review, which was further discussed and agreed at the two Pasteur Working Groups meetings, in 2004 and 2005.

As depicted in Fig. 9, two different document inputs are required to participate in the ExoMars PCR. For the science peer review evaluation, it is the Instrument Information Package (IIP) Part A; whereas for the ESA technical evaluation is the instrument Interface Control Document (ICD). The preparation of the instrument ICDs is under the responsibility of the ExoMars prime contractor AAS-I, who will assist the instrument teams in filling the appropriate document templates.

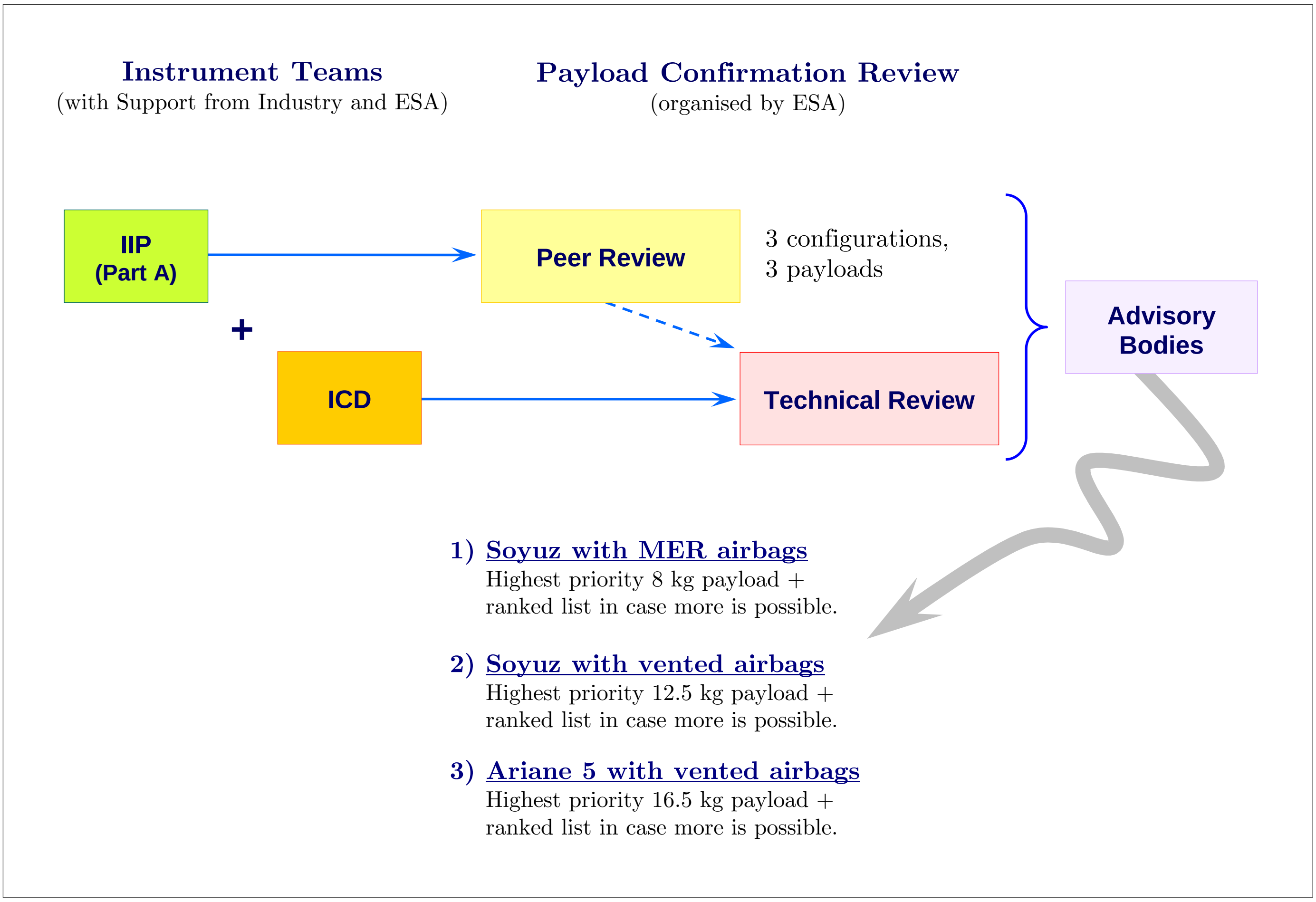


Fig. 9: The PCR document inputs required are the Instrument Information Package (IIP) Part A for the science peer review; and the instrument Interface Control Document (ICD) for the technical review.

The Pasteur instrument teams will therefore need to either update or produce an Instrument Information Package (Part A) using the supplied ESA template. Only documents provided in the correct format will be transmitted to the peers for consideration. As in the past, ESA will assist the Pasteur instrument teams, by reviewing their IIPs, and making suggestions as necessary.

The geophysics IIPs, on the other hand, which have yet to undergo a peer-review selection process, will be strictly regarded as new proposals.

In all cases, the teams are requested to please transmit a copy of their submitted IIP to the national delegations of all participating team members.

ESA will provide templates for the IIP Part A and instrument ICD, and instructions to properly complete the documents. All participants are assumed to be familiar with the contents of the ExoMars Science Management Plan.

Only those instruments that have undergone the PCR screening/evaluation will be considered during the ExoMars project's upcoming phases.

Deadlines for the final submissions to the ExoMars PCR are, respectively:

IIP Part A: Friday, **17 November 2006**.

Inputs to ICD: Friday, **1 December 2006**, to AAS-I,
with final submission to ESA by Monday, **8 January 2007**.

Do you have any questions or suggestions? Please contact the author at:

Jorge.Vago@esa.int