

Progress Letter
Pasteur Instrument Payload for
The ExoMars Rover Mission

Number 3 – 30 January 2004



This is the third issue in a structured series of short progress reports on 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.

This issue summarises the outcome of the Pasteur Call for Ideas evaluation process^{*}. It also describes the steps to be taken in the coming months to continue with *Pasteur's* definition.

The 2003 Pasteur Call for Ideas

The *Pasteur* Call for Ideas was issued on 14 February 2003. Scientists were invited to propose instruments for the *Pasteur* payload and investigations to be performed on Mars. Instruments could be those in the *Pasteur* Model Payload[▲] or new ones. Researchers were asked to take good note of the level of resources that the mission can provide, since they would have to demonstrate that their proposed instrument is compatible with *ExoMars's* capabilities. In their proposals, they were also requested to describe how their instrument would complement or enhance the results provided by other instruments in the *Pasteur* Model payload.

The scientific organisation of the Call for Ideas followed the approach employed in ESA's ELIPS programme. That is, there are no Principal and Co-Investigators as understood by NASA, or as implemented in ESA's Space Sciences Programme. Instead, in proposals addressing *Pasteur* and *ExoMars*, all investigators are considered equal Team Members, collectively contributing to the scientific excellence of the proposal and the mission. The proposals specify a Team Coordinator whose role is to represent the Team Members, to organise and report the team's activities, and to convey any information received from ESA to the other Team Members. The function of the Team Coordinator is that of a point of contact through which to address the scientific team.

The *Pasteur* Call for Ideas was open to investigators from all countries. However, for logistical reasons, all proposals' Team Coordinator had to be based in one of the ESA member states. The proposals also had to designate a Deputy Team Coordinator, to assist the Team Coordinator and to represent the science team. The Deputy Team Coordinator had to be from a different country than the Team Coordinator.

^{*} For more information on this Call for Ideas, please consult the Call for Ideas document [Ref. CI-Pasteur-2003] and previous issues of this Newsletter.

[▲] To be able to complete preliminary *ExoMars* mission design exercises, ESA needed a reference payload and exploration scenario. The *Pasteur* Model Payload defined for this work was based on the "Red Book Report" instrument list, but was adapted to fit the mission's engineering constraints. Although it should be regarded as a conceptual design, some instrument budgets rely on previously developed payloads and industrial studies.

Large research undertakings such as *ExoMars* require an appropriate critical mass, and benefit greatly from an international dimension. Therefore, the requirement was introduced to include institutions from, at least, three European countries in the proposals' science teams. Furthermore, investigators were also encouraged to form multidisciplinary teams (i.e. incorporating planetary physicists, geochemists, biochemists, palaeobiologists, specialists in Antarctic organisms, instrument engineers, etc.), where Team Member skills would complement each other, resulting in a more thorough treatment of a given problem.

The deadline for the submission of proposals was 14 May 2003. The scientific community's response was extremely encouraging: 580 investigators; from 260 universities, research institutions, and companies; expressed their desire to participate in this interesting mission. In all, 50 proposals were received. The proposing teams consist of international, multidisciplinary groups of investigators focusing either on *Pasteur's* instruments or its research objectives. 30 countries were represented: a demonstration that the interest in exobiology research is shared across national borders; and that, given the chance, scientists favour international collaboration. ESA reported the outcome of this first stage on its *Pasteur* Progress Letter, Number 1, of 3 June 2003.

Peer Evaluation

All Idea Proposals were reviewed for scientific merit by a panel of independent experts drawn from the international scientific community. The target was to have every proposal scrutinised by 5 anonymous peers*. There were 15 peers in the *Pasteur* review panel, and 50 proposals to evaluate. Typically, each peer was assigned 15–18 proposals, according to their main areas of expertise.

Significant effort was devoted to the careful screening and selection of the peer panel members. The *Pasteur* peers came from 8 different countries, and are world-renowned experts in areas such as: analytical chemistry, bioanalytical instrumentation, microbiology, palaeobiology, extremophile research, environmental chemistry, biogeochemistry, aqueous geochemistry, sedimentary geology, Martian soil chemistry, mineralogy, spectrochemistry, environmental hazards, trace-element analysis, etc. Additionally, some of them have actively participated in previous landed missions on the red planet. Many *Pasteur* peers serve in editorial boards of prestigious scientific journals, and all of them have published extensively. Their curricula vitae were carefully studied, as well as their publication record, to verify their suitability and to check their independence from all proposals submitted.

For more details about this evaluation, please consult the *Peer Review Guide* document [Ref. Rev.Guide-Pasteur-2003], distributed with the *Pasteur* Progress Letter, Number 2.

The original Call for Ideas schedule called for the evaluation to be completed by July 2003. Nevertheless, the need to assign highest priority to the formulation of rover & instrument specifications for the industrial development contracts resulted in the evaluation process being put on-hold for approximately two months (June and July 2003). This, in turn, caused the review of the proposals to commence after the summer holiday period, as explained in the *Pasteur* Progress Letter, Number 2, of 25 September 2003.

*This number resulted from the very interdisciplinary nature of the subject addressed by the call. The required expertise included analytical instrument utilisation and design, various scientific competences, and planetary mission experience. Five peers per proposal were thus deemed necessary for this review.

The evaluation started in September 2003. Initially, the peers were given the opportunity to select which proposals they felt most qualified to examine. On the basis of their inputs, and ensuring that sufficient peers having the appropriate expertise covered all proposals, a number of assignment iteration cycles were performed. The peers began their work by reviewing proposals “at home.” For each proposal, they submitted to ESA a 1.5 page (minimum) Review, including preliminary scores. The deadline for this exercise was 27 October 2003. With few exceptions, the majority of the peers completed their assignment by the above date. On 10–12 November 2003, the peer panel met at ESTEC to discuss and review all proposals, to harmonise scores, and to arrive —as much as possible— to a consensus for the final ranking.

To assign their scientific score, the peers were requested to consider the following criteria:

1. “Search for life” and “hazards to humans” relevance: How and to what extent does the proposed work/instrument contribute to the search for past or present life on Mars? How does the proposed work/instrument complement or enhance the results provided by other instruments in the *Pasteur* Model Payload? Is the proposed work/instrument capable to provide an independent verification of the scientific outcome —positive or negative— derived from other instruments? If yes, from which and how? Those few instruments that do not contribute directly to the search for life must, at least, be enabling instruments: instruments that increase the likelihood of obtaining the desired search for life information*. Does the proposed instrument or study address an important problem connected with life on the red planet[♦], or with surface hazards to human missions?

The peers were also asked to evaluate if the proposed work/instrument has the potential to increase our knowledge of planetary evolution processes, either having taken place or presently ongoing on Mars. Nevertheless, this would not constitute the main criterion for selecting an instrument for consideration for *Pasteur*. (Weight 0–40 points)

2. Approach: Are the theoretical framework, experimental design, data analysis, and interpretation methods adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Specifically for instruments, do the proposed technique and implementation have the required sensitivity and accuracy to reliably detect and identify the target molecules/parameters? Do the applicants acknowledge potential problem areas? If so, do they propose a plan to resolve them? Is the proposed work/instrument in line with best laboratory research practices worldwide? (Weight 0–30 points)
3. Innovation: Does the project employ novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies for planetary exploration? (Weight 0–20 points)
4. Personnel: Is there a significant gap in the knowledge of the team? Is the scientific team appropriately trained and well suited to carry out this work? Is the evidence of the personnel’s productivity satisfactory? Are the functions and responsibilities of the Team Members adequately described and appropriate? Does the project employ useful collaborative arrangements? Is the European participation criterion satisfied? (Weight 0–10 points)

*For example, the Ground Penetrating Radar (GPR) is not a direct life-detection instrument, yet it may prove fundamental for deciding where to drill to collect useful underground specimens.

♦The oxidant sensor is not a life-detection instrument either, but its results are needed to understand if and how life could survive in the Martian soil. Additionally, it may also help to identify chemically aggressive substances, which could affect surface equipment. Finally, these data can prove very important for planetary evolution studies, to characterise surface chemistry interactions.

For the final recommendations, the following classification was used:

Scientific Merit	Corresponding Recommendation
85–100	Outstanding
80–84	Excellent
75–79	Very Good
0–74	Insufficient

According to this logic, only the Idea Proposals having a scientific merit of 75 or higher will be invited to take part in the *Pasteur* Working Groups discussions.

Results

The outcome of this selection is as follows*: Out of 50 proposals received, 22 scored higher than the required 75 points. Of this, 11 were “Very Good,” 8 were “Excellent,” and 3 “Outstanding.” To demonstrate the international dimension of the proposed projects, it has been calculated that, on average, the teams consist of 11 research institutions from 5 different countries.

Additionally, there were 3 other proposals that were not recommended to be included in the next payload-definition stage because they did not target instruments. Nevertheless, the panel considered that valuable aspects of these proposals required ESA’s attention, and issued specific recommendations for them (please see Table 2).

In conclusion, the result of this Call for Ideas has been very positive. A number of original and innovative proposals for novel instruments and investigations were received. At least one, and in some cases two, proposals were identified for each major instrument category. The panel, and the Agency, are of the opinion that these form a solid basis for the further definition of *Pasteur* and *ExoMars*.

Table 1 presents an overview of the evaluation results. A more comprehensive description of the successful proposals is included in the Annex, at the end of this document.

* The evaluation process and the results of this Call for Ideas were endorsed by ESA’s Life and Physical Sciences Advisory Committee (LPSAC) and the Exploration Programme Advisory Committee (EPAC) on March and December 2003.

Name/Acronym	Evaluation	Proposal Objective
AEP	Very Good	UV sensors and meteorology
ENVIMAP	Excellent	UV, ionising radiation, dust, and atmospheric environment
EM ³ P	Excellent	Panoramic camera system
PICS	Very Good	Camera system
WATER	Very Good	Characterisation of soil/atmospheric water phases and their evolution
WISDOM	Excellent	Subsurface sounder instrument for the identification of water & ice
DIBS	Very Good	2-m drill system
GEOMICROPAL	Very Good	Optimisation of imaging procedures (including Raman spectroscopy and sample preparation) for extinct life search
AP MALDI	Outstanding	Biomolecule detector, based on laser desorption/ionisation mass spectrometry
MOBILD	Excellent	Life Marker Chip instrument
MOD	Excellent	Extremely sensitive fluorescence amino acid detector
MORE	Very Good	Gas Chromatographer/Mass Spectrometer
SMILE	Excellent	Lab on a Chip instrument
VOICE	Outstanding	Novel Gas Chromatographer/Mass Spectrometer instrument
EXLIBRIS	Excellent	Remote Raman/Laser-Induced Breakdown Spectrometer instrument
GENTNER	Excellent	Local Raman/Laser-Induced Breakdown Spectrometer instrument
MARE + SW	Very Good	Radiation dosimeter
MAX	Very Good	X-Ray diffractometer for characterisation of minerals
GIPF	Outstanding	Moessbauer, Alpha Proton X-Ray Spectrometer, camera combination
MIMOS-II	Very Good	Same Moessbauer spectrometer as above, but proposed alone
MIMA	Very Good	Infrared spectrometer
MEDUSA	Very Good	Dust and water vapour analyser

Table 1: Evaluation outcome for the selected *Pasteur* Idea Proposals (grouped by instrument type).

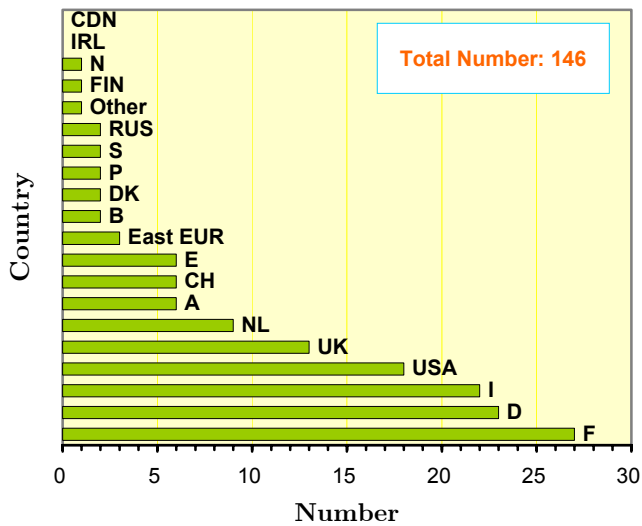
Name/Acronym	Proposal Objective	Recommendation
ELM	Response of organisms to the Martian environment: mission support experiments using Mars simulation chambers	Recommended for funding for ground-based experiments
PROSPECTOR	Utilisation of Australian Pilbara site for scientific field test of ExoMars rover in search of microfossils	Recommends ESA to consider this site for a field campaign
MARS-3CUBE	Highly performing, compact data processor for instrument support	Recommends ESA to consider within industrial development

Table 2: The following 3 proposals received specific recommendations for ESA to consider them, however they were not selected to pass on to the next payload definition stage.

Statistics

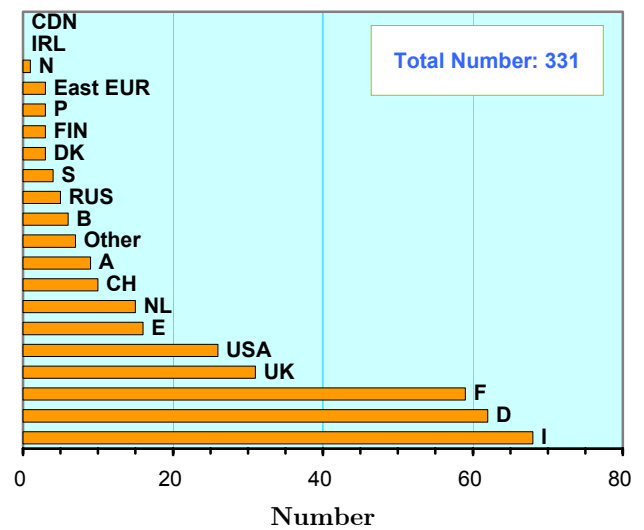
For the 22 peer-recommended *Pasteur* idea proposals, Fig 1 presents the geographical breakdown of a) Universities, research institutions, and companies; b) Investigators; and c) Team Coordinators.

Recommended Proposals: Universities



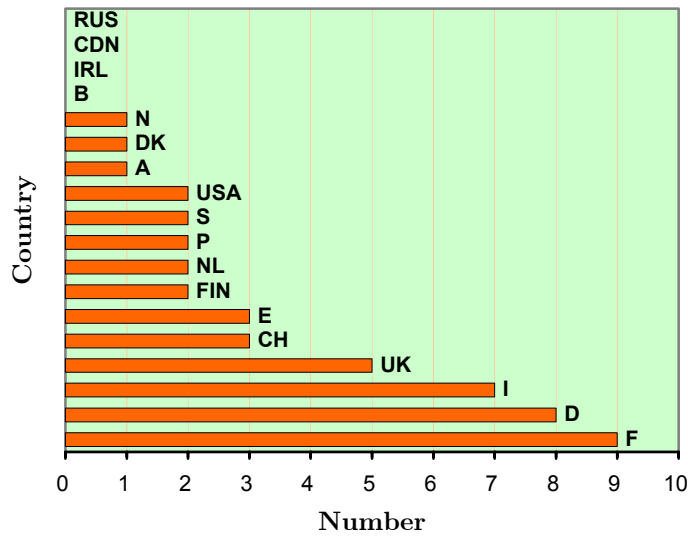
a)

Recommended Proposals: Investigators



b)

Recommended Proposals: Team Coordinators



c)

Fig 1: Geographical breakdown, for the 22 recommended *Pasteur* idea proposals of a) Universities, research institutions, and companies; b) Investigators; and c) Team coordinators

Next Steps

This Call for Ideas was the first step towards the definition of the *Pasteur* payload. As described in the Call for Ideas document, the recommended teams will be invited to appoint **one** scientist from each proposal to serve in the *Pasteur* Working Groups (WG). The objective of these bodies will be to advise ESA on the final instrument composition of the *Pasteur* payload and on its utilisation on Mars. The *Pasteur* Working Groups will convene at ESA/ESTEC (NL) during **8–13 March 2004**.

Starting from the present model payload concept, and subject to the *ExoMars* mission’s engineering constraints, the groups will have the task to define a set of instruments capable of accurately identifying signs of past and present life on Mars. The Past Life WG will recommend reliable markers pointing to the existence of ancient organisms, and the instruments necessary to measure them. Similarly, the Present Life WG will advise on what is required to detect whether any life forms are active on Mars today. Finally, the Hazards to Humans WG will concentrate on instruments to assess surface dangers to future human missions. Besides recommending what to measure, the Working Groups will also have to establish the specificity and precision of the measurements to be performed.

Fig. 1 depicts a graphical breakdown of *Pasteur*’s 40 kg mass allocation: 7 kg are necessary for support equipment (i.e. structure, electronics, insulation, cabling, etc.). The remaining 33 kg can be divided in two broad categories: service instruments—the drill system and the Sample Preparation and Distribution System (SPDS)—requiring 16 kg; and the scientific instruments proper, for which 17 kg are available.

The *Pasteur* scientific instruments must fulfil three specific functions: evaluate hazards to humans and characterise the local environment (1.5 kg); establish the geological context of the site from which the samples are obtained (7.5 kg); and identify signs of life and/or organic molecules present in the samples (8 kg).

Clearly, it will not be possible to implement all instrument concepts contained in the 22 recommended idea proposals. Therefore, a large part of the Working Groups' effort will be one of synthesis, both scientific and technical. It is therefore of the utmost importance that the person representing each recommended proposal's team have a solid scientific background **and** be very familiar with the technical details of their proposed instrument/investigation. He/she should also be prepared to document with images and data the performances reached by the laboratory prototypes, whenever possible using real-life samples —i.e. not standards.

<p style="text-align: center;">Context: 7.5 kg</p> <p>PanCam: 2.0 Microscope: 0.5 Water/Ice: 2.0 Chem./Mineral: 2.5 Oxidants 0.5</p>	<p style="text-align: center;">Service Instruments: 16 kg</p> <p>Drill System: 11.0 (2-m depth & surface)</p> <p>SPDS 5.0</p>
<p style="text-align: center;">Life & Organics: 8 kg</p> <p style="text-align: center;">2 or more instruments</p>	
<p style="text-align: center;">Environment: 1.5 kg</p> <p>UV & Ion. Rad.: 0.8 Dust & H₂O: 0.5 P, T, Wind: 0.2</p>	
<p>Support Equipment: 7 kg</p>	

Fig 1: Breakdown of *Pasteur's* 40 kg mass allocation.

Once *Pasteur's* composition is agreed, ESA and the Working Groups will also have to generate specifications for all instruments and for the sample preparation protocols. These specifications, plus a refined operational scenario, will become a new input for the two ongoing, parallel Phase A industrial contracts. The target date for the delivery of a revised Scientific Requirements Document (SRD) to the two consortia is mid May 2004.

From this ensemble, a smaller group of 4 investigators, the *Pasteur* Facility Science Team, will be elected to assist the companies chosen by the Agency to perform the industrial Phase A/B development by participating in project review meetings. When so requested, the *Pasteur* Facility Science Team should also provide advice to any further studies carried out by ESA.

Finally, all interested scientists are encouraged to keep abreast of future *ExoMars* developments, and to prepare —with your team— for the upcoming *Pasteur* Announcement of Opportunity. This Announcement will be released once the *ExoMars* mission is approved, probably after the next ESA ministerial conference, presently planned for end 2004. ESA will inform you as soon as the new Announcement release dates are known via the *Pasteur* Newsletter.

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

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ANNEX: Summary of Selected Idea Proposals* (Pasteur Call for Ideas 2003)

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-01 Very Good	AEP Advanced Environmental Package	The Open University	J. C. Zarnecki M. C. Towner F. Ferri M. R. Patel T. J. Ringrose M. R. Leese	UK	Environmental conditions are a critical factor in determining the viability of the surface as a habitat, and the resources to carry out meteorology and other environmental measurements are very low, given the high science return. A small sensor suite with a mass below 0.4kg is proposed, based substantially on enhancements to the Environmental Sensor Suite successfully qualified for Beagle 2, improvements to existing instruments on MPF and Netlander, and new sensors concepts. Improved versions of existing instruments will be complemented with new measurements to answer new scientific questions. This proposal cross-references AESOP, WATER, IAPAS, and ENVIMAP. Scientifically such a package, when combined with other measurements, will address a large number of areas: -Meteorology. -Global Circulation and variability of local conditions. -Astrobiology. -The Martian dust cycle, including dust composition, properties, size distribution and transport, electrical charging processes, and the effect of electric fields on dust (which also has meteorological implications). -Local environment levels of UV flux and radiation. -Confirmation of the presence, intensity and depth profile of subsurface oxidising chemicals. -The habitability of the subsurface (with the WATER proposal to investigate the presence of water). -The chemical processes and their consequences associated with electric fields (with the AESOP proposal).
		Finnish Meteorological Institute	A.-M. Harri J. Polkko	FIN	
		University of Leicester	M. R. Sims	UK	
		CETP, Pôle de Planétologie IPSL	J.-J. Berthelier	F	
		University of Aarhus	J. Merrison P. Nornberg	DK	
		DLR, Köln	L. Richter G. Horneck	D	
		DLR, Berlin	D. Möhlmann	D	
		British Antarctic Survey	C. S. Cockell	UK	
		KFKI Res. Inst. Part. Nuclear Phys.	K. Szegö	HUN	
		INAF-Osserv. Astr. di Capodimonte	L. Colangeli	I	
		Università "Parthenope" di Napoli	P. Palumbo	I	
		European Space Agency	J.-P. Lebreton	ESA	

* The proposals are presented in alphabetical order, according to their name/acronym.

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-03 Outstanding	AP MALDI Atmospheric Pressure MALDI for the Detection of Biological Molecules	Leiden Observatory	P. Ehrenfreund O. Botta	NL	The team proposes a novel instrument for the detection of biological compounds (amino acids, bases, peptides) at ambient pressure in sediments, ices and liquid geocosmo-chemical samples on Mars. A new sample ionisation technique: atmospheric pressure matrix-assisted laser desorption/ionisation (AP MALDI), has been coupled with a commercial ion mass spectrometer. This configuration enables the application-specific selection of external atmospheric ionisation sources (e.g. electrospray, commercially available) and AP MALDI (built in house). The detection limit of the novel AP MALDI/ion trap is 10-50 femtomole (fmol) of analyte deposited on the target surface for a four-component mixture of peptides at 800-1700 molecular weight. AP MALDI can also be operated in situ and spectra obtained directly off the surfaces of mineral grains, ices, and liquid samples at ambient Martian conditions. The ability to detect biologically relevant molecules in both a solid (sediments/minerals) and a liquid (ices) matrix allows for the assessment of a variety of environments that may be encountered on Mars
		Univ. of California, Santa Barbara	L. Becker	USA	
		Johns Hopkins University	R. Cotter	USA	
		Applied Physics Lab. Johns Hopkins	W. Brinkerhoff	USA	
		MPI-Chemistry, Mainz	D. P. Glavin	D	
Muséum - LEME	F. Robert	F			
CI-Pasteur-04 Very Good	DIBS Drill-Integrated Package for Borehole Science	IFSI-CNR, Roma	A. Coradini G. Piccioni	I	This is a proposal combining two projects. The proposed concept is to equip a drill system, capable of collecting samples from depths down to 2 meters, with a set of sensors to perform preliminary analysis of the specimens, as well as of the borehole walls. The main sensor is a miniaturised imaging spectrometer that can be included in the drill tip in order to infer the mineralogical characteristics of subsurface layers. The spectrometer makes use of optical fibres, used both to illuminate the wall and to collect the reflected photons. The data are acquired through a flat optical window on the drill wall. The image is acquired by an array of optical fibres simulating a slit. An optical system situated inside the drill will permit to observe details from a few tenths of microns to hundreds of microns and to perform low resolution spectroscopy in the range 0.8-2.8 microns. The spectral reflectance in the visual and near infrared can provide information on the mineralogy and petrology of subsurface materials, and therefore crust composition and genesis diagnostic. Moreover, also the drill itself will be used as a scientific instrument: <ul style="list-style-type: none"> ▪ To estimate rheological properties of the drilled material, like compressive strength, by comparison with the drill calibration database; and through direct measurements, by exploiting engineering instrumentation already foreseen in order to perform the drilling operation, (force/torque sensor, speed sensor). ▪ To measure the temperature. Another important function, of course, will be to collect surface/subsurface material and to deliver it to the Pasteur instrumentation for analysis.
		Politecnico di Milano	A. Ercole-Finzi	I	
		Galileo Avionica SpA	E. Re A. Bini P. Magnani	I	
		IASF-CNR, Roma	F. Capaccioni M. T. Capria M. C. De Sanctis A. M. Di Lellis R. Orosei	I	
		Università di Lecce	S. Fonti	I	
		Università di Perugia	C. Federico	I	
		Inst. d'Astrophysique Spatiale, Orsay	G. Bonello J.-P. Bibring	F	
		Space Research Centre, Warszawa	M. I. Blecka	PL	
		Universidade da Beira Interior	I. Camelier	P	

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-07 Excellent	EM³P ExoMars Mobile Multi-Spectral Panoramic Camera	DLR, Berlin	R. Jaumann H.-G. Grothues E. Hauber H. Hoffmann S. Mottola J. Oberst	D	<p>The main scientific objectives to be addressed by the PanCam experiment are:</p> <ol style="list-style-type: none"> (1) to locate the landing site and rover position and to support the ExoMars rover track planning and scientific exploration, (2) to geologically investigate and map the rover sites (3) to study the properties of the atmosphere and of variable phenomena. <p>The main geo-scientific objectives of the PanCam images are the recognition of surface features like ripples, ridges and troughs, and the identification and characterization of different rock and surface units based on their morphology, distribution, spectral characteristics, and physical properties.</p> <p>Major changes on the Martian surface that can be detected by PanCam are caused by Aeolian activities and condensation processes.</p> <p>Atmospheric studies will concentrate on the detection of clouds, measurements of the aerosol contents and the water vapour absorption at 936 nm.</p> <p>In order to meet these objectives, the proposed PanCam instrument is a highly miniaturized, dedicated stereo and multispectral imaging device. The camera will consist of two identical camera cubes, which will be arranged in a common housing at a fixed stereo base length of 11 cm. Each camera cube will be equipped with a CCD frame transfer detector with 1024 x 1024 active pixels and optics with a focal length of 13 mm, yielding a field of view of 53° x 53° and an instantaneous field of view of 1.1 mrad. A filter swivel device with six positions will provide different colour band passes in the wavelength range of 400 – 950 nm.</p>
		IAS-CNRS, Orsay	Y. Langevin J.-P. Bibring	F	
		Technische Universität Berlin	J. Albertz	D	
		Service d'Aeronomie, IPSL-CNRS	J.-L. Bertaux	F	
		IFSI-CNR, Roma	V. Formisano	I	
		Lab. Astronomie Spatiale, Marseille	P. Lamy	F	
		MPI-Aeronomie, Lindau	W. J. Markiewicz	D	
		ERS-CNRS, Université Paris-Sud	P. Masson	F	
		Observatoire Midi-Pyrénées	P. Pinet	F	
		Institut für Planetologie, U. Münster	T. Spohn	D	
		Jena Optronik GmbH	J. Ehrich F. Kleppe	D	
		von Hoerner & Sulger GmbH	R. Bertrand	D	

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-08 Excellent	ENVIMAP Environmental Mapping as Relevant to Exobiology, Planetary Protection, and Human Exploration	DLR, Köln	G. Horneck G. Reitz P. Rettberg	D	The proposed EnviMap project will provide a comprehensive data set of the environmental conditions at defined sites and season on Mars, including the radiation environment, trace gases in the atmosphere and the characteristics of the dust and soil microenvironment. Whereas the total data set will contribute to ExoMars mission's goals as a whole, the following measurements will specifically serve the following ExoMars mission's goals: (i) Search for signs of extinct life: Comprehensive knowledge of spectral UV irradiance on the surface and oxidising power of the soil will help to understand the so far lacking of organics in the Martian regolith. (ii) Search for signs of extant life: Although the Martian surface seems globally antagonistic for life, understanding of the soil microenvironment, also under the conditions of wetness, will assist identifying "habitable" microenvironments as oases for potential life. (iii) Surface hazards to humans: Knowledge of the radiation climate, especially the ionising, neutron and UV components, and the composition and chemical reactivity of the dust and regolith, also under wet conditions, are a must before human missions to Mars will take place. (iv) Planetary Protection considerations: The data on the toxicity of the surface conditions on Mars will serve to assess the survival potential of resistant terrestrial microorganisms which will have a direct impact on the planetary protection considerations for future Mars lander missions.
		The Open University	J. C. Zarnecki	UK	
		Universität Bern	K. Altwegg N. Thomas P. Wurz	CH	
		DLR, Berlin	G. Arnold	D	
		Universität Kiel	R. Beaujean	D	
		Lockheed-Martin Aerospace	B. C. Clark	USA	
		Cranfield University	D. C. Cullen	UK	
		British Antarctic Survey	C. S. Cockell	UK	
		Technical University Braunschweig	B. Fiethe H. Michalik	D	
		Inst. d'Aeronomie Spatiale, Brussels	D. Fonteyn D. J. Gillotay P. C. Simon	B	
MPI-Aeronomie, Lindau	H. U. Keller W. J. Markiewicz	D			
Kayser-Threde GmbH	V. Klein W. Schulte	D			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-09 Excellent	EXLIBRIS ExoMars Laser-Induced Breakdown / Raman Integrated Spectrometer	Observatoire Midi-Pyrénées	S. Maurice C. d'Uston O. Gasnault F. Poitrasson S. Chevrel J. Platzer P. Pinet	F	EXLIBRIS is expected to be a compact set of a Laser Induced Breakdown Spectrometer (LIBS) and a Raman spectrometer. - LIBS spectroscopy will determine major element compositions of dust or rocks with accuracy < 10%, identify water ice through H and OH bands, determine ice-to-dust ratios, search for organic matter by comparing ratios of C, N, O, H, Si, and measure compositional differences for major, minor, and trace elements. Detection limits of nearly all elements are in the range of 1-500 ppm. Typical elements expected above detection limits include H, Be, Li, C, O, Na, Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Sr, and Ba. Water is detected or inferred via OH emissions and by H lines. One of the great advantages of LIBS is that it can remove dust or weathering coatings and thus allow the analysis of pristine rocks. - The Raman Spectrometer is an instrument that can be used for identification of biogenic (markers such as C-C, CH ₂ , CH ₃ , OH, CO and NH) and a-biogenic materials, different types of ices, organic, and inorganic materials on planetary surfaces. The sharpness of Raman spectral peaks of minerals and ices allows for much less ambiguous detection than other types of spectroscopy. Raman spectra of minerals mixtures exhibit sharp and largely non-overlapping features that are much more easily identified and assigned to various mineral species. Both techniques are complementary scientifically, and can be rather easily integrated technically into a single instrument. It consists of a small pulsed Nd:YAG laser with a telescope coupled to 2 spectrographs. The system will allow quantitative measurements, within a few minutes, on targets distant up to 2.5 m from the instrument. Thus, it will be possible to analyse a potential drill site, but also the rover surroundings for context, or freshly exposed materials by the rover wheels or the drill, while saving manoeuvre time. In terms of ExoMars science specific objectives, EXLIBRIS will address: (i) Determine whether life ever arose on Mars (search for organics). (ii) Characterize the geochemical composition of near surface soil and rocks with an improved precision, accuracy, including water distribution. (iii) Yield mineralogical information of the Martian surface at the sub-millimetre scale. (iv) Assess surface hazards to prepare for human exploration (chemical and environmental data).
		Université Paul Sabatier, Toulouse	P. Simon	F	
		LRSI-CEA, Saclay	J.-L. Lacour	F	
		Institut de Physique du Globe, Paris	G. Manhes	F	
		Université Henri Poincaré, Nancy	J. Dubessy M.-Ch. Boiron	F	
		Universidad de Valladolid	F. Rull F. Sobron	E	
		Centro de Astrobiología, Madrid	J. Gómez-Elvira J. Martínez-Frías	E	
		MPI-Chemistry, Mainz	J. Brückner	D	
		Universität Jena	J. Popp	D	
		Los Alamos National Laboratory	R. Wiens D. Cremers	USA	
University of Hawaii	P. Lucey S. Sharma	USA			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-13 Excellent	GENTNER A Miniaturised Laser Instrument for Planetary <i>in-situ</i> Analysis	Institut für Planetologie, U. Münster	E. K. Jessberger I. Mann D. Rost Th. Stephan I. Weber	D	To “set the stage” for dedicated exobiology experiments – those to study in detail past or present forms of life – the team proposes an interdisciplinary instrument to determine rapidly and with relatively high sensitivity (down to 10 ppm) the concentrations of many elements in Martian rock, coarse fines and soil samples. At the same time the instrument will provide mineralogical information as well as information on possible organic components. This complementarity is essential to understand the results of dedicated exobiology experiments. The detection of the life-related elements H, C, N, O, P, S, and Fe and the investigation of their lateral and vertical distributions in various Martian materials will be indicative of biologic activity. In addition, the knowledge of the elemental inventory and the mineralogy is a prerequisite for understanding the geologic history of the visited sites, as well as of planet Mars as a whole. Finally, this versatile instrument is also excellently suited – in simplified versions – for missions to asteroids and comets. The proposed novel instrument is a combination of Laser-Plasma-Spectrometry (LIPS) and Raman-spectroscopy. The basic GENTNER concept consists of one or more small, ultra-light-weight sensor heads mounted on an arm and/or near the tip of a drill, and the main mass components (pump laser, spectrometer, computers etc.) installed on a rover. Optical fibres connect the sensor heads and the main components. Possibly it can be augmented by cathodoluminescence (CL; for mineralogical aspects) or by laser induced fluorescence (LIF; for further “organic” aspects). An essential feature is the absence of sample preparation.
		Universität Basel	R. Abart	CH	
		MPI-Chemistry, Mainz	J. Brückner	D	
		ENEA, Frascati	E. Colao V. Lazic R. Fantoni	I	
		Johannes Gutenberg-Uni. Mainz	G. Klingelhöfer	D	
		Naturhistorisches Museum, Wien	G. Kurat	A	
		Space Res. Inst., Austrian Ac. Sci.	H. Lammer	A	
		University of Bradford	H. W. G. Edwards	UK	
		Universität Bremen	U. J. Meierhenrich	D	
		Universität Jena	J. Popp	D	
		Universität Salzburg	H. Stan-Lotter	A	
		LPCE-CNRS, Orléans	R. Thomas P. Gille	F	
		LENS, Firenze	E. Castellucci M. Becucci R. Bini	I	
		IFAC-CNR, Firenze	G. Toci M. Vannini	I	
		Universität Graz	R. A. Kaindl	A	
		Space Res. Inst., Austrian Ac. Sci.	H. Lammer C. Kolb	A	
		CBM-CNRS, Orléans	F. Westall	F	
von Hoerner & Sulger GmbH	R. Bertrand	D			
IPAC GmbH, Villach	A. Del Bianco	A			
STAR OPTRON GmbH, Mannheim	K. Schneider	D			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-14 Very Good	GEOMICROPAL Optimisation of Imaging Procedures (Including Raman-Spectroscopy and Sample Preparation) for a Comprehensive Geological, Palaeoenvironmental and Micropalaeontological Approach to the Search for Extinct Life on Mars	CBM-CNRS, Orléans	F. Westall W. Altermann	F	This proposal aims to develop optimal strategies and imaging procedures (including sample preparation, Raman-spectroscopy, and, eventually, AFM techniques) to search for signs of, primarily, extinct life on the surface/near-subsurface of Mars. The outcome will be a logical flow-chart of procedures in the search for fossil life from the macroscopic (panoramic imaging) to the microscopic scale that will intimately incorporate and interact with real-time results from other simultaneous studies (for instance the general geological interpretation group (Ori et al.) and the geochemical data group (Brack et al.; Jessberger et al.). The methodology used in consists of imaging at stepwise increasing resolution. - Stage I comprises global analysis of the geological context of the landing site in order to fully understand the general environment. - Stage II is a more detailed environmental analysis of exposed, layered sedimentary rocks or boulders thereof, as well as of secondary chemical sediment-filled cracks in volcanic rocks or cracks in sedimentary rocks, in order to establish the nature of the material and to identify any sedimentary textures that could provide an indication of the local environment of deposition (e.g. shallow-water or littoral environment, evidence for evaporitic conditions). Stage II will be based on stereo camera images and close-up imaging of rocks, as well as low magnification microscopy of cleaned rock surfaces or drilled samples. - Stage III: When the local to micro environmental context has been well understood, certain layers in the sediments or cracks in sedimentary or igneous rocks be examined for signs of life, including imaging at all available resolutions in situ (where possible), sampling, sample preparation for microscopy and geochemical analyses. Such layers would be suitable candidates for more refined analysis of associated organic molecules, using the Oxi-GC/MS that might provide further information on potential biomarkers.
		Naturhistorisches Museum, Bern	B. A. Hofmann	CH	
		Intl. Res. School of Planetary Sci.	G. G. Ori	I	
		Università di Bologna	R. Barbieri	I	
		Universität Bern	N. Thomas	CH	
		Space-X, Neuchâtel	J.-L. Josset	CH	
		University of Bradford	H. W. G. Edwards	UK	
		Universität München	W. Heckl	D	
		Universität Darmstadt	S. Kempe	D	
Polish Academy of Sciences	J. Kazmierczak	PL			
CI-Pasteur-16 Outstanding	GIPF Geochemistry Instrument Package Facility	Johannes Gutenberg-Uni. Mainz	G. Klingelhöfer	D	The search for life or palaeo life forms (fossils) is embedded into the context of the landing site. Therefore, the team proposes to fully investigate the geochemistry of the ExoMars landing site by carrying out chemical, mineralogical, and textural measurements of soils and rocks for characterization and selection of any samples. The Geochemistry Instrument Package Facility (GIPF) will consist of an APXS, a Mössbauer Spectrometer, and a close-up camera. By rotation of the package, each instrument will be placed into position at the selected sample site, consecutively. <ul style="list-style-type: none"> ▪ The Alpha Particle X-Ray Spectrometer (APXS) determines all elements from sodium up to nickel (increasing atomic weight) and heavier trace elements depending on their concentrations. ▪ The Mössbauer Spectrometer the presence and amount of iron-bearing minerals and oxidation states of iron. ▪ The Close-Up camera MIROCAM has a high-resolution mode of 100 to 50 µm per pixel that uses four different colour light-emitting diodes (LED) to obtain colour close-up images of the texture (size and distribution of grains) of rock and soil surfaces.
		MPI-Chemistry, Mainz	J. Brückner R. Gellert	D	
		DLR, Berlin	H. Michaelis	D	
		C. Etude Spatiale des Rayonnements	C. d'Uston	F	
		University of Leicester	M. R. Sims	UK	
		CBM-CNRS, Orléans	F. Westall	F	
		University of Copenhagen	M. B. Madsen	DK	
		von Hoerner & Sulger GmbH	R. Bertrand	D	

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-23 Very Good	MARE+SW Mars Radioactivity Experiment + Space Weather	Università di Perugia	C. Federico C. Pauselli G. Minelli A. Frigeri S. Scarselli	I	<p>This proposal combines two instruments and scientific teams:</p> <ol style="list-style-type: none"> 1. MARE is a multi-sensor experiment designed to perform the monitoring of the Mars radiation environment and to carry out elemental composition analysis of the Mars soil samples by means of the X ray fluorescence. <ul style="list-style-type: none"> ▪ Dosimeter Package (DOSE): The radiation dose rate to which crews will be exposed is one of the hazards that has to be quantified before the human exploration of Mars may begin. Moreover, data for evaluating radioactivity levels at Martian surface are of great interest for environmental studies related to life in general. The Dose experiment is based on doped thermo-luminescence lithium-fluoride passive detectors. The capacity of these detectors to integrate the energy received from their last reset would be used to measure the possible collected doses during the cruise phase and the permanence on Mars. The measure process is based on the photon counting of luminescence radiation emitted during the detector's heating cycle. ▪ Elemental Analysis Package (MA_Flux): has the goal to scientifically support the use of an instrument which will improve the X-ray fluorescence (XRF) technique to detect the chemical trace elements of the Martian soil materials, down to a few ppm. Together with this experiment, measurements of major chemical elements and characterization of the mineralogy and microphysical structure will be performed by means of an infrared microscope analysis instrument. 2. SPACE WEATHER is a minimum package to accurately diagnose the conditions on the surface of Mars. Firstly a conventional radiation dose meter will register the total equivalent dose an astronaut would encounter. Secondly, an energetic particle counter will diagnose the penetrating components of the radiation. This could also incorporate a small gamma ray detector. Depending on the landing site, it may be highly desirable to also incorporate a magnetometer to measure the absolute strength of the crustal magnetic anomalies. Moreover, this would investigate what might be a highly dynamic effect on the radiation environment and local ionosphere. Finally, it is proposed to include a riometer to measure the total electron column density above the instrument. This will diagnose the ionosphere, and in particular its suitability for sustained radio communications.
		IAS-CNRS, Orsay	O. Forni	F	
		AMDL srl	A. M. Di Lellis	I	
		IASF-CNR, Roma	G. Magni M. T. Capria A. Sambuco	I	
		IFSI-CNR, Roma	M. Storini	I	
		Universidad Rey Juan Carlos	A. Marquez	E	
		Università "La Sapienza", Roma	E. Bonatti	I	
		ETH, Zürich	L. Burlini	CH	
		Rutherford Appleton Laboratory	M. Grande M. Hapgood D. Neudegg	UK	
		Swedish Institute of Space Physics	R. Lundin S. Barabash	S	
		BIRA-IASB, Brussels	D. Heynderickx	B	
		University of Birmingham	Ch. Castelli	UK	
		CESR-CNRS, Toulouse	Ch. Mazelle	F	
		Galileo Avionica SpA	G. Preti	I	
Laben SpA, Milano	P. F. Tua	I			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-28 Very Good	MAX A Miniaturised X-Ray Diffractometer for Mineralogical Analysis of Martian Soils and Rocks	Intl. Res. School of Planetary Sci.	L. Marinangeli A. Baliva M. Bressan G. G. Ori	I	In order to investigate the nature of the rocks and soils of planetary surface and their exobiological potential, the knowledge of their mineralogy (chemical composition and crystal structure) is necessary. For this reason, the team proposes a miniaturised x-ray diffractometer (MAX) for the Pasteur payload. Using the same x-ray source, MAX could be able to perform chemical analysis by x-ray fluorescence, providing a complete rock characterization. The instruments in the Viking and Pathfinder missions (x-ray fluorescence (XRF) and alpha-proton spectrometer (APXS)) and those that are currently under design (i.e., Mössbauer spectrometer), do not detect the mineralogy of rocks, but only their elemental composition. The rock mineralogy inferred from its elemental composition is not precise and, sometimes, the result can be totally misleading. In some cases, a volcanic rock, a sedimentary rock, and a metamorphic rock may have the same chemical composition, although formed under different geological settings. The best candidate for mineralogical analysis is the x-ray diffractometer (XRD). The XRD is the routine instrument used in every Earth Science laboratory to decipher the mineralogical composition of rocks. XRD produces unequivocal results because it is based on the geometrical properties of the crystal lattice.
		Universidade de Coimbra	E. Ivo Alves V. A. Fernandes	P	
		INAF-Osservatorio Astr. di Catania	G. Bonanno	I	
		Università della Calabria	E. Piluso	I	
		Laben SpA, Milano	C. Ponzoni	I	
		Centro de Astrobiología, Madrid	D. Fernández-Remolar J. Martínez-Frías J. A. Martín Gago	E	
		DLR, Berlin	L. Moroz	D	
		Russian Academy of Sciences	A. T. Basilevsky A. S. Krassilnikov	RUS	
		Indiana University	A. Basu	USA	
Wesleyan University	M. S. Gilmore	USA			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-29 Very Good	MEDUSA Martian Environment Dust Systematic Analyser	INAF-Osserv. Astr. di Capodimonte	L. Colangeli J. R. Brucato V. Della Corte F. Esposito G. Ferrini E. Mazzota-Epifani V. Menella E. Palomba	I	The goals of the proposed experiment (study of dust and water vapour in the atmosphere) address major scientific objectives of ExoMars: Study water and dust in relation to the search for signs of life forms on Mars; and identify possible surface hazards to humans due to dust. To achieve these goals, new technologies will be applied to design and produce an instrument (MEDUSA) aimed at measuring <i>in situ</i> the cumulative dust mass flux, the physical properties and size distribution of single intercepted particles, and the water vapour abundance versus time. The instrument will be suitable for accommodation on a rover operating on the Martian surface. From the technical point of view, the proposed experiment is based on the coupling of different techniques, using optical detection, impact sensing, and cumulative mass deposition (micro-balances). The latter will be used in series for dust measurement in different size bins, and in parallel for water vapour detection. This concept is based on past-developed know-how (e.g.: GIADA experiment for Rosetta), and recently developed new instrument concepts.
		Università "Federico II" di Napoli	R. Battaglia A. Panizza	I	
		Università "Parthenope" di Napoli	P. Palumbo A. Rotundi	I	
		Instituto de Astrofísica de Andalucía	J. López-Moreno J. F. Rodríguez-Gómez R. Rodrigo-Montero	E	
		The Open University	J. C. Zarnecki	UK	
		Los Alamos National Laboratory	J. R. Stephens	USA	
		Galileo Avionica SpA	M. Cosi	I	

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-30 Very Good	MIMA Mars Infrared Mapper for Finding Carbonates, Sulphates, and Organics	IFSI-CNR, Roma	G. Bellucci V. Formisano F. Altieri	I	The instrument is an infrared multispectral camera to determine, from afar, the mineralogical composition of the Martian surface; and to select specific rocks and soils to investigate in detail by using the other rover instrumentation. The thermal IR has the ability to penetrate through the dust coatings common on Mars. At these wavelengths, MIMA can recognize carbonates, silicates, organic molecules, and minerals formed in water. Thermal IR data will also help scientists to assess the capacity of rocks and soils to hold heat over the wide temperature range of a Martian day. Regarding the search for evidence of extinct life or prebiotic chemical evolution, imaging of surface materials in the infrared could help to survey rocks in the vicinity of the rover to facilitate sampling of carbonates and other lithologies of exobiological interest. In the current design MIMA will measure the thermal radiation in the 6 – 14 mm spectral range, covered in 7 wavelengths. The filters are located at wavelengths, which are diagnostic for mineral discrimination and identification.
		Università di Lecce	S. Fonti G. Marzo R. Politi V. Orofino	I	
		Università di Parma	M. Sgavetti M. Sandro	I	
		Università di Padova	B. Saggin	I	
		Intl. Res. School of Planetary Sci.	G. G. Ori	I	
		Instituto de Astrofísica de Andalucía	J. López-Moreno	E	
		University of Amsterdam	D. Stam	NL	
		Space Research Center, Warszawa	M. I. Blecka	PL	
		NASA Ames Research Center	T. L. Roush	USA	
		Inst. for Space Res. (IKI), Moscow	L. Zasova B. Moshkin	RUS	
	Galileo Avionica SpA	G. Preti R. Bonsignori A. Romoli P. Coppo	I		
CI-Pasteur-31 Very Good	MIMOS-II In-Situ Mössbauer Spectroscopic Analysis of Fe Mineralogy and oxidation State of the Martian Surface and Subsurface	Johannes Gutenberg-Uni. Mainz	G. Klingelhöfer B. Bernhardt R. Gellert	D	The scientific objectives of in situ Mössbauer spectroscopy on the surface of Mars are the determination of the oxidation state of iron bearing minerals, the identification of Fe carbonates, sulphates, nitrates, etc. that would provide information on early Martian environmental conditions, the identification of iron bearing phases with low detection limits, the determination of the iron oxides and the magnetic phase in the Martian soil, and the detection of nanophase and amorphous hydrothermal Fe minerals that could preserve biological materials. MIMOS II is a rather simple instrument. The main parts are the Co-57 radiation source, the velocity transducer (drive), the Silicon PIN radiation detectors and their pre- and main-amplifiers, and the instrument control and data acquisition system. MIMOS II is already part of a number of Mars missions: MER & Beagle II.
		MPI-Chemistry, Mainz	J. Brückner	D	
		University of Copenhagen	M. B. Madsen	DK	
		University of Leicester	M. R. Sims	UK	
		Companhia Vale do Rio Doce	P. A. deSouza	BRA	
		NASA Johnson Space Center	R. V. Morris	USA	
	Washington University	B. Fegley, Jr.	USA		

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-32 Excellent	MOBILD Molecular Biology for Life Detection	Centro de Astrobiología, Madrid	J. Gómez-Elvira V. Parro C. Briones E. Sebastian F. Gómez	E	Techniques for detecting signs of life are based on the identification of molecules of unequivocal biological origin (biomarkers). Detection of biomolecules (nucleic acids, proteins, polysaccharides, lipids or other metabolites) has greatly developed in last years. Among the available technologies, those based on the specificity of the interaction between proteins (antigen-antibody, ligand-receptor, etc) or complementary nucleic acids, allow the specific and reproducible detection of putative biomarkers. Based on the above idea the team wishes to propose an instrument devoted to the detection of biomarkers from solid samples taken from Mars soils. The project will have three parts: 1. Scientific, where the most relevant biomolecules should be addressed, 2. Molecular biology, where the techniques to detect those biomolecules should be tuned, and 3. Technological, where a specific instrument for performing that detection will be designed. Regarding molecular detection we propose the utilisation and development of microarray technology based on concepts designed and used in biotechnology applications. The covalent attachment of tens of thousands of specific molecular probes (proteins, nucleic acids, organic polymers, etc) on a few square centimetres on a solid support allows simultaneous detection of multiple (macro-) molecules. Advantages like very reduced reaction volumes and high reaction kinetics, together with its great potential for miniaturization and robotisation, make microarrays based technology a system with a high potential for the <i>in situ</i> analysis of biomarkers from complex mixtures for astrobiology purposes.
		Stockholm University	N. Holm M. Dumont	S	
		British Antarctic Survey	C. S. Cockell	UK	
		Carnegie Institution, Washington	J. Toporski A. Steele	USA	
		SENER	C. Compostizo	E	
CI-Pasteur-33 Excellent	MOD Mars Organic Detector	Leiden Observatory	P. Ehrenfreund O. Botta	NL	Looking for key organic compounds that are essential for biochemistry as we know it or indicative of extraterrestrial organic influx is the primary goal of the Mars Organic Detector (MOD). MOD is able to detect amino acids, amines and polycyclic aromatic hydrocarbons (PAHs) at the sub-ppb level. MOD can assess the organic inventory of amines and PAHs on the planet and can also quantify adsorbed and chemisorbed water and evolved carbon dioxide in a stepped heating cycle to determine specific carbon-bearing minerals. No sample preparation and no wet chemistry are required. The detection of amino acids, amines and PAHs is based on a fluorescence detection scheme. The MOD concept has functioned as a laboratory breadboard since 1998. A number of natural samples including meteorites, shells, clays, fossil bones, -DNA and E.-coli bacteria have been used and organic molecules have been extracted successfully in each case. The first prototype of MOD is operational since fall of 1999.
		Scripps Inst. of Oceanography	J. L. Bada	USA	
		MPI-Chemistry, Mainz	D. P. Glavin	D	
		NASA/JPL	F. Grunthaner	USA	
		The Open University	M. Sephton	UK	
		Muséum - LEME	F. Robert	F	

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-34 Very Good	MORE Molecular Organic Residues Experiment	MPI-Aeronomie, Lindau	H. Rosenbauer F. Goesmann M. Hilchenbach R. Roll	D	The upper layer of the Martian soil was thoroughly investigated in situ by instruments on the two Viking Landers. No traces of organic molecules were found originating from the Martian soil samples. Therefore the Viking measurements place a very stringent upper limit for the possible contents of organic molecules in the upper layer of the soil near the Viking landing sites. The team wishes to investigate if there are any, even very, very minute traces, of organic molecules on Mars, in the soil or in the atmosphere. These could then give us important information on whether life may have developed some billion years ago. If organic molecules will be detected, we would like to learn about their chirality. Is there any deviation from the racemic enantiomeric distribution expected for abiotic synthesis of organic molecules? Life, as we know it on earth, is constructed homochiral from enantiomeric components. It is the main objective of our proposed investigation to measure very minute organic trace constituents and their isotopic composition in the Martian soil and atmosphere. The instrument MORE comprises a pyrolysis and/or chemical device, two analytic instruments: a gas chromatograph, GC, and a powerful high-resolution time of flight mass spectrometer, TOF-MS and a vacuum pump. The reasons for duality in the analysing instruments, GC and MS are that there are tasks that neither one of the two instruments could fulfil alone. Furthermore, the combination of the two methods generates a synergetic effect in particular with respect to resolving ambiguities.
		LISA-Universités Paris 12 & Paris 7	F. Raulin R. Sternberg P. Coll	F	
		Service d'Aeronomie, IPSL-CNRS	M. Cabane G. Israël	F	
		Leiden Observatory	P. Ehrenfreund	NL	
		Universität Bremen	U. J. Meierhenrich W. Thiemann	D	
		Universität Giessen	H. Wollnik	D	
CI-Pasteur-36 Very Good	PICS Panoramic Image Camera System	MSSL-University College London	A. J. Coates A. D. Griffiths R. A. Gowen	UK	The panoramic imaging system will be one of the key elements for the ExoMars rover 'Pasteur' payload. In addition to support for navigation activities, the system will have important scientific objectives of its own: <ul style="list-style-type: none"> ▪ Panoramic colour and multi-spectral imaging for remote biological and geological analysis, and to support route selection and navigation to enable close-up analysis and sampling. ▪ Telephoto imaging of distant or hard to access features (i.e. gullies) to determine level of scientific interest before committing rover power resources to moving closer. ▪ Observation of layering and other rock structure morphology for macroscopic evidence of biological activity (i.e. bio precipitated mineralogy, extinct hot springs, microbial mats/stromatolites). ▪ Observation of drilling/coring activities and soil properties from rover tracks/wheel digging. ▪ Observation of sample fraction before analysis by other instruments ▪ Mineralogy/petrology of soil, rocks and mechanically abraded surfaces. ▪ Water vapour and dust optical properties (from solar observations). ▪ Astronomical observations for coarse position location. ▪ Fine position location from comparison of landscape features to orbital imagery.
		Space-X, Neuchâtel	J.-L. Josset	CH	
		Kingston University, London	A. Ellery	UK	
		Joanneum Research, Graz	G. Paar	A	

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-45 Excellent	SMILE Specific Molecular Identification of Life Experiment	University of Leicester	M. R. Sims J. Sykes T. Stevenson W. Grant A. Mills J. Holt D. Pullan	UK	This instrument's goal is to detect and quantify the presence of specific molecules in the Martian environment associated with extinct and/or extant life or potential life processes, including where appropriate measurement of molecular chirality. The instrument will exploit recent developments in biosensor and biochip arrays / micro-systems / micro-fluidics technologies and their integration into packages for sample handling / preparation and subsequent analysis. The proposed instrument will measure specific molecules via a variety of transduction techniques including electrical and optical (surface plasmon resonance – SPR – and fluorescence detection) approaches and utilise molecularly imprinted polymers (MIPs) and traditional biological receptors such as antibodies. Target molecules for the experiment are expected to be biomarkers with a potentially long >10 ⁶ year lifetime along with control markers e.g. related to cometary and meteoritic organic material. Target molecules and detection techniques would be selected following consultation with the community but examples of possible targets include L and D isoleucine (amino acid), isoprenoids and hopanoids (apolar molecular structure i.e. membrane type molecules) and mellitic acid (as a control) amongst others.
		DLR, Köln	L. Richter	D	
		Cranfield University	D. C. Cullen S. A. Piletsky	UK	
		University of Newcastle	I. Head	UK	
		Vrije Universiteit, Amsterdam	H. W. van Verseveld P. Vroon B. M. van Breukelen W. F. M. Röling H. V. Westerhoff	NL	
		Wageningen University	H. Smidt	NL	
		TNO-Environ. Biotech., Apeldoorn	J. Gerritse	NL	
		National Aerospace Lab. (NLR)	R. van Benthem	NL	
		Stork Product Engineering BV	F. Eckhard J. A. J. Brunink	NL	
		LioniX BV, Enschede	A. Prak	NL	
		Dutch Space BV, Leiden	R. H. Huijser	NL	
		CBM-CNRS, Orléans	A. Brack	F	
		Technical University of Munich	B. Hock	D	
		Universität Oldenburg	H. Cypionka	D	
		Seyonic SA, Neuchâtel	B. van der Schoot	CH	
		University of Aberdeen	J. Parnell	UK	
		Cambridge Consultants Ltd.	R. Jones M. Hazell	UK	
		Universität Salzburg	H. Stan-Lotter	A	
Université Louis Pasteur	M. Rohmer	F			
Astrium UK Ltd.	A. Lecuyot	UK			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-48 Outstanding	VOICE Volatiles & Organics Isotopic Composition Experiment: A Combination of Static MS, GCIRMS, and Laser MS for accurate measurement of Martian isotopic ratios (atmosphere, soil, rocks & ice), and for direct chemical characterisation of biogenic compounds	Service d'Aeronomie, IPSL-CNRS	E. Chassefière F. Leblanc C. Malique G. Goulpeau J.-J. Correia S. Yan E. Leymarie	F	VOICE is a 8-kg instrument set combining complementary analytical tools, for the investigation of isotopic ratios in both volatile and solid material, and to search for possible biogenic molecules in solid samples: <ul style="list-style-type: none">▪ Static Mass Spectrometry (Static-MS), with a combination of chemical trapping and cryo-adsorption separation techniques, for analysis of atmospheric noble gases, stable isotopes, and trace species.▪ Dynamical Mass Spectrometry, with chromatographic separation (GCIRMS), for the measurement of C, H, O, N (both organic and inorganic) isotopic ratios in pyrolysis products of rocks, soils, and ices.▪ Time-of-Flight Mass Spectrometer (ToF-MS), shared by the Static-MS and GCIRMS lines (mass range: 1-1000 Da, optionally: 1-10000 Da, mass resolution: 700).▪ Laser Mass Spectrometry (LMS) for analysis of chemical and isotopic composition of solid material, using its own sub-miniature ToF MS (mass range : 1-300 Da, mass resolution : 200).▪ Two-dimensional Gas Chromatography (2DGC), which is part of GCIRMS, for extracting and separating organic compounds that could be found in solid material (and analyzing their isotopic ratios).▪ Reusable pyrolysis oven, coupled with the GCIRMS line, and possibly with the Static-MS line. The main general scientific objectives of VOICE can be listed as following: <ul style="list-style-type: none">• Noble gases abundances and isotopic ratios in atmosphere, and in pyrolyzed samples, at typical accuracy of a few ‰.• Stable isotopes (C, H, O, N, and others) in atmosphere, and their diurnal / seasonal variability, et 1‰ precision level.• Trace gases of exobiological/ geochemical interest (absolute detection limit of a few pptv by using Static-MS).• Mineralogy and chemical composition, including isotopic ratios of both refractory and volatile elements in minerals.• Nature, abundance, chemical, and isotopic properties of carbon compounds (both organic and inorganic) in soils, rocks and ices, or any combination of them, at typical accuracy better than 5‰.• Chemical and isotopic composition of elements other than C that are relevant to life (H, O, N, P, S, Cl, ...) present in rocks, soils, and ices, at typical accuracy better than 5‰.• Search for toxic substances in the Martian surface environment.• Subsurface water content/vertical structure, water exchange fluxes between the regolith and the atmosphere at diurnal and seasonal scales, in synergy with experiments WISDOM) and atmospheric water vapour TDLAS.
		CETP, Pôle de Planétologie IPSL	J.-J. Berthelier J. Covinhes	F	
		Université Pierre et Marie Curie	A. Jambon	F	
		Groupe Géochimie des Gaz Rares	P. Sarda	F	
		Institut de Physique du Globe, Paris	P. Agrinier	F	
		BIRA-IASB, Brussels	D. Nevejans E. Neefs	B	
		IFSI-CNR, Roma	M. Maggi A. Milillo	I	
		MPI-Aeronomie, Lindau	U. Mall A. Korth	D	
		Space Res. Inst., Austrian Ac. Sci.	K. Torkar W. Baumjohann	A	
		Universität Bern	P. Wurz J. Whitby U. Rohner	CH	
		Swedish Institute of Space Physics	S. Barabash	S	
		NASA Ames Research Center	F. Montmessin	USA	
		University of Michigan	J. H. Waite R. D. Sacks	USA	
		Southwest Research Institute	D. T. Young	USA	
Ball Aerospace	R. W. Dissyly	USA			
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Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-49 Very Good	WATER Water-Related Environment Conditions in Martian Soil	DLR, Berlin	D. Möhlmann H. Michaelis	D	<p>The presence and behaviour of water in the Martian near-surface soil are of key importance for understanding conditions for life. Water exists in the Martian soil in all the three phases: ice, unfrozen water and vapour. Unfrozen water is of greatest interest in view of related chemical and possibly also biological processes. It is essential to study in-situ the depth-dependent diurnal behaviour of the water content in all the three interacting and exchanging phases in the soil at low- and mid-latitudes.</p> <p>1) Water in all the three phases will be measured by a Keidel-cell and by humidity sensors, as included in ATMIS on the Netlander mission. Soil structure parameters can be determined by using a balance.</p> <p>2) Unfrozen water is expected to be present as adsorption water and coexisting with ice in the upper Martian surface down to temperatures of 240 K and less. This content can increase by capillary effects and chemical solutes. The water content of soil can be studied by determining the dielectric characteristics of the soil at different frequencies from the kHz to the GHz range, using a variety of EM techniques.</p> <p>3) Surface acidity (pH-value) is essential for characterizing environments in view of chemical and biological processes. It is proposed to measure this property of Martian soil in-situ. It can be determined by observing colour (spectral) changes after (possibly repeated) release of an appropriate chemical substance. This work complements that of the AEP and WISDOM proposals.</p>
		Finnish Meteorological Institute	A.-M. Harri J. Polkko W. Schmidt	FIN	
		CETP-Observatoire de Saint Maur	M. Hamelin	F	
		DLR, Köln	C. Jung D. Neuhaus L. Richter C. Sattler T. Tokano	D	
		Inst. for Space Res. (IKI), Moscow	I. Mitrofanov	RUS	
		Johannes Gutenberg-Uni. Mainz	E. Robens	D	
		Forschungszentr. Karlsruhe GmbH	M. Stacheder	D	
		The Open University	M. C. Towner J. C. Zarnecki	UK	
DEKA GmbH	R. Wernecke	D			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-50 Excellent	WISDOM Water, Ice, and Subsurface Deposit Observations on Mars	CETP, Pôle de Planétologie IPSL	J.-J. Berthelier V. Ciarletti M. Hamelin R. Nev M. Menvielle	F	<p>The WISDOM experiment is devoted to the exploration of the subsurface and the search for water. It will provide information on the nature, structure and stratigraphy of the subsurface and on its water content. In addition, the data returned by WISDOM will support the exobiology investigations of the PASTEUR payload by providing information on the past and present habitability of the area explored by the rover, which will aid in selecting optimal sites for drilling. The WISDOM package includes 2 electromagnetic tools, a Ground Penetrating Radar (GPR) and a Permittivity Probe (PP) to study the electrical properties of the soil, determine the structure and stratigraphy of the subsurface and search for water. The third instrument, NITON, is based on a totally different approach and uses the radioactive radon atoms in the atmosphere as test particles to infer with a very high sensitivity the water content in the underground.</p> <ol style="list-style-type: none"> The GPR instrument will operate in 2 frequency ranges: In the UHF range, at about 1 GHz, the radar can sound to a maximum depth of 2 to 3 meters, commensurate with the expected range of the drilling unit. It will provide high-resolution (~1 cm) observations of the structure, stratigraphy and lithology of the shallow subsurface, where traces of present or the PASTEUR payload will seek past life. In the lower VHF range, the sounder will experience reduced propagation losses that will enable it to probe as much as several hundred meters beneath the surface. Soundings to this depth will provide key data on the geological context and history of the surface and subsurface in the area explored by the rover. In addition it may also permit the detection of water as both ground ice (in most areas) and possibly as a liquid (in areas of anomalous geothermal heating or where concentrated brines may be present). The Permittivity Probe explores the uppermost layer of the Martian soil, from the surface to a depth equivalent to the GPR range at the UHF frequency. PP determines the apparent complex permittivity ϵ_c of the soil from the measurement of the mutual impedance of two dipoles at very low frequencies, from 10 Hz to ~ 100 kHz. It has the outstanding capability of identifying ice embedded in porous materials from the frequency dependence of ϵ_c. In addition, using dipole arrays with different geometries will permit a determination of the variation of ϵ_c with depth and will provide other complementary data that will assist in the interpretation of the GPR data. NITON, the radon instrument, is an innovative, simple and very light geophysical tool to look for water at depths as great as 20 meters beneath the surface. It is based on the detection of the atmospheric Radon-222, a radioactive daughter of Uranium-238, whose exhalation from a porous soil is known to depend strongly on the soil moisture content. <p>The design, development, validation and data analysis of the three instruments will benefit from the team's experience in building similar instruments for planetary applications such as PRISM and NetLander for Mars exploration, CONSERT and PP on the ROSETTA lander, ASI on the HUYGENS Probe and several GPRs for terrestrial applications.</p>
		Lab. de Planétologie de Grenoble	W. Kofman A. Hérique	F	
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		Service d'Aeronomie, IPSL-CNRS	E. Chassefière	F	
		CEA, Saclay	C. Ferry	F	
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		DLR, Berlin	J. Helbert	D	
		IASF-CNR, Roma	R. Orosei	I	
		CISAS-Università di Padova	F. Angrili F. Ferri	I	
		Lunar and Planetary Institute	S. Clifford E. Heggy	USA	
		NASA/JPL	T. G. Farr	USA	
		University of Oslo	S.-E. Hamran	N	
		BIRA-IASB, Brussels	D. Nevejans	B	
		Universidad Politécnica de Cataluña	V. Perez-Gracia	E	
The Open University	J. C. Zarnecki	UK			
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Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-06	ELM Environmental Extremes for Life on Mars	British Antarctic Survey	C. S. Cockell	UK	<p>An accurate knowledge of the present environment on Mars is essential from several biological reasons: 1) For assessing the likelihood of past life on Mars, and whether mitigation of certain environmental extremes found on the surface today, might have made the conditions for past life on Mars more likely. 2) To establish the likelihood of present-day life on Mars. To identify possible locations for life on Mars we need to quantify environmental extremes, particularly the radiation environment. 3) To study the survival of contaminating microorganisms transferred to Mars on spacecraft or on human missions. 4) To determine the threat that these environmental extremes represent to humans.</p> <p>The ELM Scientific Team proposes to use environmental data returned from Pasteur to address some specific scientific questions that relate to the interactions and response of life to Martian extreme environmental conditions. The ELM team would interpret the environmental data returned from Mars within two contexts:</p> <p>1) Laboratory Mars simulation experiments conducted on the ground (such as those performed by the ROME Topical Team members), both in support of the mission objectives before launch and once the data arrives to Earth.</p> <p>2) The known extremes for life in terrestrial ‘Mars-analogue’ environments, such as the Antarctic and the Arctic. Thus, the team proposed here has both a component of field research expertise and laboratory expertise. With this expertise we would be able to interpret data returned from Pasteur and assess what these data tell us about the potential for life on Mars.</p>
		DLR, Köln	G. Horneck P. Rettberg	D	
		DLR, Berlin	D. Möhlmann	D	
		The Open University	M. R. Patel	UK	
		Space Res. Inst., Austrian Ac. Sci.	H. Lammer	A	
		Università "Tor Vergata", Roma	D. Billi	I	
		Natural History Museum	M. M. Grady	UK	
		Università della Tuscia di Viterbo	S. Onofri	I	
		Dynamac Corporation, KSC	A. Schuerger	USA	
		Centro de Astrobiología, Madrid	C. Córdoba-Jabonero F. Gómez	E	
		Universität Salzburg	H. Stan-Lotter	A	
		SETI Institute / NASA Ames	P. Lee	USA	
		Universität Erlangen	D. Häder	D	
		Semmelweis University	G. Rontó	HUN	
		CBM-CNRS, Orléans	F. Westall	F	
		Leiden Observatory	P. Ehrenfreund	NL	
		RWTH Aachen	E. Rabbow	D	
University of Aarhus	K. Finster	DK			
University of Bradford	H. W. G. Edwards	UK			
Universität München	A. Lux-Endrich	D			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-38	PROSPECTOR	Natural History Museum	M. M. Grady	UK	<p>The team's objective is to make a substantial contribution to the ExoMars goal of searching for former life on Mars, and at the same time to help to the understanding the geology of the planet. They will do this through their knowledge of Earth analogues in the Pilbara region in Western Australia, and their techniques for enhancing sample selection and identification.</p> <p>The team suggest that an instrument is required for on-the-ground prospecting prior to sample selection. They propose the use of an infrared spectrometer for rapid identification of rock types likely to be of palaeobiological significance. This would allow precise targeting for more demanding sampling and analysis, within broad areas already defined from satellite data.</p> <p>The Australian team has pioneered the use of a Portable Infrared Mineral Analyser (PIMA™) to develop palaeobiological exploration techniques. It allows the detection of hydrous mineral assemblages characteristically associated with biosignatures. This has proved to be an effective prospecting technique that requires no sample preparation, which complements later analysis of drilled or otherwise prepared samples. A PIMA-style instrument, with on-board mineral identification software (to optionally reduce data transmission), will also provide data that will enhance those collected by the Raman spectrometer of the Pasteur package.</p> <p>The team also proposes to carry out rover scientific campaigns in preparation for Mars surface operations in the Pilbara region. This region would be particularly adequate, as it contains the oldest known palaeofossils existing on Earth, and could be indicative of ancient environments relevant to Mars.</p>
		Macquarie University, Sydney	M. R. Walter J. A. Bailey C. P. Marshall C. A. Oliver A. Allwood P. Davies A. Brown	AUS	
		Auspace, Camberra	R. Franzen	AUS	
		CSIRO Exploration and Mining	J. F. Huntington T. J. Cudahy	AUS	
		Australian National University	S. T. Hyde P. D. Sackett S. Sukkarieh	AUS	
		Geol. Survey of Western Australia	K. Grey F. Pirajno M. van Kranendonk	AUS	
		Anglo Australian Observatory	A. J. McGrath	AUS	
		IFSI-CNR, Roma	G. Bellucci	I	
		British Antarctic Survey	C. S. Cockell	UK	
		Harvard University	A. Knoll	USA	
		Massachusetts Inst. of Technology	R. Summons	USA	
		NASA/JPL	D. Crisp	USA	
		CBM-CNRS, Orléans	F. Westall	F	
		Integrated Spectronics, Sidney	T. D. Cocks	AUS	
Geoscience Australia, Camberra	G. A. Logan	AUS			

Reference	Title	Institute/Company	Coordinators Team Members	Country	Description (50 words)
CI-Pasteur-24	Mars – 3CUBE DPU Payload Support Unit	AMDL srl	A. M. Di Lellis	I	This team wishes to concentrate on the capabilities of the Pasteur Data Processing Unit (DPU). They propose to implement a low-power consumption system, using a state of the art Digital Signal Processor (DSP) and associated electronics adapted to the Martian temperature environment.
		DLR, Berlin	R. Jaumann	D	
		IFSI-CNR, Roma	V. Formisano	I	
		Service d'Aeronomie, IPSL-CNRS	E. Chassefière	F	