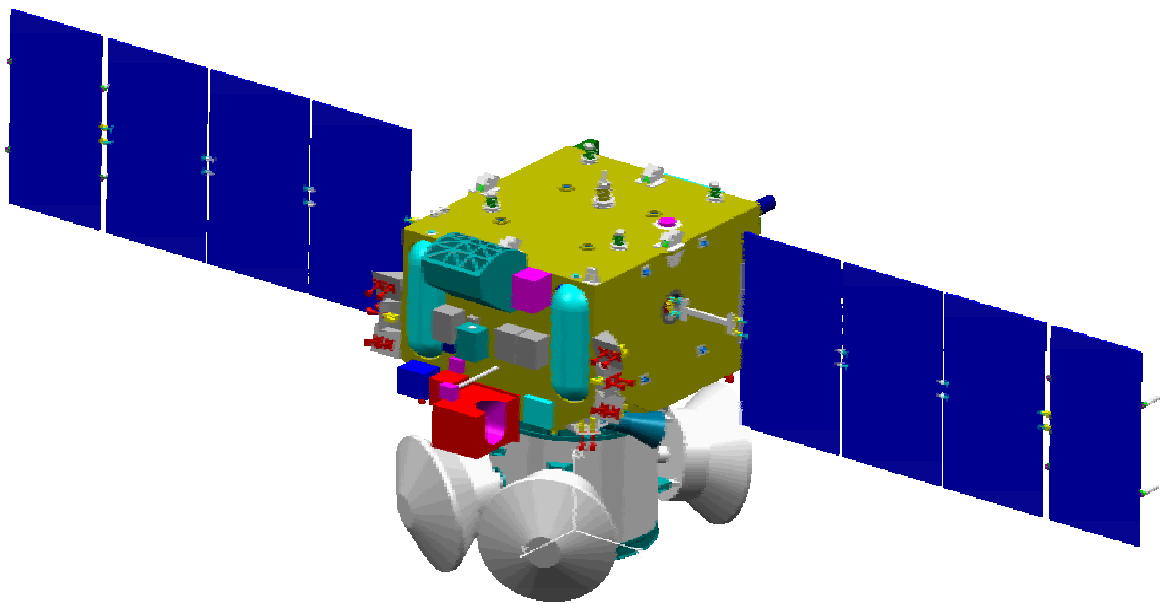




**Announcement of Opportunity  
for Scientific Payloads onboard the  
CNES Mars 2007 Orbiter**



**Letter of Intent due: March 15, 2002**

**Full Proposal due: May 15, 2002**

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# **Announcement of Opportunity for Scientific Payloads Onboard the CNES Mars 2007 Orbiter**

## **I DESCRIPTION OF THE OPPORTUNITY**

### **I.1 Genesis of the French Mars exploration programme**

Mars exploration is a priority widely shared amongst the solar system scientific community and the international Space agencies. Mars is indeed a key planet for improving our understanding of the Solar system formation and evolution. Although studied by several missions since the pathfinder Mariner and Viking missions, key scientific issues related to Mars are still unsolved. Amongst these issues, but not limited to them, are the internal structure of the planet, its thermal evolution, the fate of its atmosphere, the past and present presence of water, and last but not least, its possible biological history.

CNES and the French scientific community have been involved in exploration of the solar system since very early in the history of space conquest, at first in the framework of cooperation with the former Soviet Union, then through the ESA science program. The French will to be involved in Mars exploration has not been weakened by the failure of the Russian mission MARS-96 of which France was the main foreign partner. It has even been reinforced by the offer by NASA to CNES as early as summer 1996 to cooperate on the first Mars Sample Return (MSR) missions, which at that time were planned for launch in 2003 and 2005. In March 1998, on the occasion of a scientific prospective seminar organised by CNES, the French scientific community recommended that CNES implement a long-term ambitious programme of Mars investigation consistent with other international Mars exploration missions. This recommendation had been endorsed by the CNES Science Programme Committee and by the French research authorities.

This recommendation resulted in the elaboration by CNES of the PREMIER programme (Programme de Retour d'Echantillons Martiens et Installation d'Expériences en Réseau). PREMIER comprises several elements:

- the development with a consortium of European partners (Finland, Germany, Belgium) of a network of four Mars ground stations aimed at performing geophysical measurements (NetLander project)<sup>1</sup>;
- the development and the operation of the orbiter vehicle of the future MSR mission to be performed in cooperation with NASA.
- provision of experiments for ESA's MARS-EXPRESS mission<sup>2</sup>.
- planned procurement of French instruments and/or contributions to the payloads of the future Mars missions, particularly NASA's 2009 "smart lander" mission.

The PREMIER programme has the objective to maintain a balance between the three poles of Mars exploration :

- global investigations from orbit,
- landed science with both network science (NetLander) and in situ investigations,
- sample return preparation.

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<sup>1</sup> NASA also contributes to the NetLander project. The NASA participation to the ATMIS, NEIGE and SEIS instruments is funded as a mission of opportunity within the Discovery Program. The contribution of other equipments is under discussion.

<sup>2</sup> In particular, OMEGA and SPICAM have French PIs.

CNES and NASA have signed in July 2001, a Letter of Agreement for a long term cooperation in Mars exploration, a major, but not exclusive element of which is the preparation of the first MSR mission. The restructuring of the US Mars exploration program that has followed the Mars Polar Lander and Mars Climate Orbiter failures in late 1999 has postponed this first MSR mission from 2005 to the next decade. This delay will be used for getting a better knowledge of the red planet via orbital and landed assets and for testing key technologies, which will be needed for MSR, and for future Mars missions.

An important milestone of this exploration plan is the 2007 opportunity where CNES will launch the PREMIER-07 Mission with goals of (i) preparing for MSR through technological validations in Mars orbit of some of its critical steps, e.g. Rendezvous in orbit, and (ii) fulfilling a scientific mission including the deployment and data relay of the NetLander probes and the performance of additional orbital science experiments.

The PREMIER-07 mission, composed of the Mars 2007 orbiter (MO-07) and of the 4 NetLanders, will be launched by Ariane 5 in September 2007. After a 11 month cruise to Mars, the 4 NetLanders will be jettisoned along paths leading to their individual landing sites, and the orbiter will be inserted into orbit about Mars. Once in Mars orbit, MO-07 will ensure a telecommunication relay function for the NetLanders and perform an additional orbital science mission whose content will be detailed as the result of the present Announcement of Opportunity (AO).

## **I.2 Announcement objectives**

The present AO aims at selecting instruments proposed by Principal Investigators (PIs) to flight onboard the MO-07.

These selected instruments will be referred to as Additional Instruments with regard to the two primary objectives of the mission, namely relaying the NetLanders and validating critical technologies for preparing the MSR mission.

All the instruments selected will compose the Additional Payload (AP).

The scientific objectives of the Additional Payload have been endorsed by the CNES Science Programme Committee in consistency with the NetLander and the other scheduled missions to Mars. Those objectives detailed in the next section are:

- to complement the measurements of the NetLander network by providing either simultaneous measurements or environment data;
- to investigate the Mars climate and atmosphere and in particular, the Mars water cycle, including the water storage in the polar caps, its circulation in the atmosphere and its presence in the subsurface ;
- the investigation of the escape processes of the Mars atmosphere if the access to the requested low periapsis orbit (170 km x 1000 km) within the allocated propellant margins is confirmed.

However, other proposals not focussed on those topics may be submitted in response to this AO and will be evaluated through the same process (see section III).

## **II Scientific objectives of the PREMIER-07 mission**

### **II.1 NetLander Scientific objectives**

The scientific rationale of the NetLander project is to investigate the interior, the surface, and the atmosphere of Mars. These investigations will be performed using the first network of geophysical stations ever installed on the surface of the red planet. Given our very poor knowledge of the planet and in particular of its subsurface and interior, the scientific objectives of the mission are of first priority with respect to Mars exploration.

The NetLander mission will allow to answer crucial questions with regard to Mars formation and evolution such as : is there a core like on Earth and how deep is it ? Is this core liquid or solid ? Is there

still seismic activity ? What has been the role of the magnetic field in the evolution of the planet (atmospheric depletion, surface radiation rate...)?

The history of water is also a key question. Although clear evidence of flooding can be seen on the surface, and layered structures identified in MGS images have been interpreted as of sedimental origin, the present localisation and abundance of water are still unclear. NetLander will also be able to quantitatively answer whether the water is frozen in the uppermost layers of the subsurface and whether liquid water exists in the deeper layers.

The NetLander data will be used to determine the physical state of the Mars interior (mineralogical composition, conductivity profiles, thermal profiles,...) to characterise the surface processes (regolith weathering effects,...), the surface-atmosphere coupling (dust devil triggering and propagation), and the global atmospheric circulation (seasonal and secular variations, ...).

## **II.2 Scientific objectives of the Additional Payload of MO-07**

The two primary scientific criteria that will be taken into account in the selection of the PI Instruments selected through the present AO are :

- the synergy of the proposed investigations with the NetLander payload and its scientific objectives,
- the ability of the instrument to cover scientific fields not covered or at least only partially covered by the past, present and planned missions to Mars. The scientific priorities of the Additional Payload are described hereafter. They have been set by the CNES Solar System Advisory Working Group and endorsed by the CNES Science Programme Committee.

### **II.2.1 Atmosphere dynamics and the seasonal cycles of water, dust and CO<sub>2</sub> composition**

Understanding the current Martian climate system requires a good knowledge of its key component: the circulation of the atmosphere and its coupling with the seasonal cycles of dust, water and CO<sub>2</sub><sup>3</sup>. This knowledge is of high interest to 1) understand the processes that have controlled climate changes in the past and shaped Mars's surface 2) achieve comparative meteorology and learn more about our own atmosphere; and 3) better characterise the Martian environment for future space missions.

To constrain the Martian atmospheric circulation from orbit, the following measurements are highly desired:

- The temperature profile from the surface to above 100 km. Extending the vertical resolution of the temperature measurements compared to previous missions is of key importance since meteorological phenomena are thought to extend above 100 km. In addition, performing in-orbit measurements simultaneously with ground measurements (e.g. using ATMIS on NetLander) looks very promising;
- The winds. Although the atmospheric circulation may be retrieved by analysing the thermal structure, the strong waves-mean flow interaction on Mars makes this analysis difficult if not impossible. Therefore, direct measurements of winds performed from orbit would provide capital information.

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<sup>3</sup> As an example, the MEPAG (Mars Exploration Payload Analysis Group), chartered by NASA has stated the required accuracy to reach these objectives:

- Water vapor: 0-40 km with sensitivities of 3 % - 30% in mixing ratios over that range for reasonable water amounts (e.g., 5-10 precipitable microns column amounts);
- Dust and water ice cloud extinction: 0-60 km with  $\pm 10\%$  in extinction;
- Temperature/Pressure: 0-80 km with typically 1-2 K precision and pressure registration to  $\pm 1\%$ ;
- Surface pressure: Required accuracy is a few percent for seasonal variations,  $< 1\%$  relative precision for dynamical (weather) variations;
- Energy Balance: Albedo and thermal irradiance measurements adequate to compute surface net heat balance (and equivalent carbon dioxide flux) to  $\pm 20\%$  over representative regions of the permanent and seasonal polar caps.

In addition, measuring the quantity of airborne dust would be of high interest, since the heat absorbed by the dust is the main forcing of the atmospheric circulation, and controls the variability of the Martian weather.

On this basis, the mapping of water vapour in combination with the observation of the general circulation, should allow to characterise the water cycle and in particular the transport of water by the atmosphere and possibly locate sources and sinks. Only the column abundance of water has been measured on Mars so far, and observing vertical profiles of water vapour should be of high interest. The process controlling the water cycle (condensation, sublimation, interaction with the surface) may also be constrained by observing the variation of the D/H ratio (controlled by fractionation processes), and by measuring the quantity of airborne ice aerosols.

## **II.2.2 Atmospheric composition**

Although the main components of the Martian atmosphere ( $\text{CO}_2$ ,  $\text{N}_2$ , Ar) are relatively well known, the abundances of its minor components, their variations, and the control by photochemical processes are still to be determined. For instance, monitoring CO should provide information on the  $\text{CO}_2$  photolysis and the transport from the upper atmosphere source. Observing ozone in combination with water vapour would allow to better understand the relationship between the two species (ozone and water vapour are supposed to anti-correlated). Of particular interest would be observations of  $\text{H}_2\text{O}_2$ . This specie has never been observed on Mars, yet. However, several models have shown its key importance for the photochemistry of the Martian atmosphere and for its role (thought to be major) in oxidising the Martian soil, a problem of high interest in exobiology.

## **II.2.3 Atmospheric escape**

The middle atmosphere is dynamically coupled with higher atmospheric layers, where atmosphere escape takes place. Escape processes are thought to be particularly efficient on Mars, because of the lack of a global magnetosphere stopping and deflecting the solar wind far above the atmosphere. Unlike the Earth case, solar wind closely interacts with atmosphere, resulting in exchanges of fluxes of mass, momentum and energy. It is thought that a substantial amount of the primitive atmosphere, and possibly water, were lost to space because of the relatively weak gravitational field prevailing on Mars over geological time, although models are, due to the scarcity of data, noticeably under-constrained. Understanding the dynamics of upper layers, and of solar wind interactions, is of prime importance to quantify present escape, and the way it evolved in the past, when the Sun was a stronger UV emitter.

Investigating simultaneously atmospheric dynamics and composition in the escape zone, together with energetic particles populations resulting from solar wind interaction, will allow to better understand the nature of the different kinds of escape processes, their relative magnitudes, and to estimate their cumulated effects since solar system origin. This objective requires to characterise : (i) the dynamical and chemical state of the thermosphere, coupled with both middle atmosphere (at the bottom) and solar wind interaction regions (at the top), (ii) ionospheric dynamics, ion-molecule chemistry, magnetic field and plasma wave activity, (iii) the various kinds of suprathermal and energetic populations, including escaping species (neutral atoms, ions), (iv) the response of the high atmosphere and ionosphere, and energetic populations, to solar activity, (v) the role of the complex structure of the magnetic field. Moreover, a detailed picture of high atmosphere and solar wind interaction would allow to study other related phenomena, like possible auroras, or ionospheric meteoritic activity.

## **II.2.4 Magnetic field**

Because the history of volatiles on Mars is closely related to the presence of an intrinsic magnetic field, deciphering the history of the core dynamo is an important link in our understanding of climate evolution. In a broader perspective, understanding Mars as a system, and the way the thermal history of the inner planet influenced, or was influenced by, climatic evolution is of great interest for better understanding the conditions of life appearance and development on our planet and other planets. Performing a detailed mapping of Mars magnetic field at the highest accessible resolution from orbit, and possibly of the small scale structure of the gravity field in regions of interest, would certainly, from this point of view, be of great added value.

Measuring the magnetic field is also of interest to complete the magnetic data recorded by MGS, which have revealed a primitive dynamo in the inner planet. Many questions are indeed still open relative to this observation: when did the dynamo stop? which rocks bear the remanent magnetisation much more intense than on Earth and what is the acquisition process involved? There is no doubt that accumulation of new magnetic data, recorded in observational conditions different from those from MGS (altitude, orbit inclination), will complement the coverage and be of major interest to decipher the thermal history of the inner planet, search for magnetic inversions, ancient tectonic features. Such new data will also give information on the electric conductivity of the crust and the mantle. This parameter is sensitive to the temperature and to the presence of conductive phases (carbon, fluids, partially melted mantellic material).

In these respects, in-orbit magnetic measurements, supportive to NetLander ground measurements and that could complement existing MGS measurements, are highly desirable.

### **III Composition of the additional payload**

CNES considers that two types of instruments, an atmospheric sounder (referred to as INST-1, for instrument 1) and an Escape Mechanism Package (referred to as INST-2 for instrument 2) are well suited to meet the scientific objectives assigned to the Additional Payload (AP).

#### **III.1 Atmospheric Sounder (INST-1)**

An heterodyne receiver operating in the microwave range will allow to observe the atmospheric composition and dynamics in an innovative way and with an unprecedented sensitivity and coverage. Such instrument may perform observations at the limb in order to measure Doppler shift winds and to take advantage of the enhanced limb optical thickness to measure trace species in the lower atmosphere, and monitor temperatures and winds in the upper atmosphere up to 120 km.

#### **III.2 "Escape Mechanisms Package" (INST-2)**

A low-energy ion and neutral mass spectrometer, associated with specific sensors (e. g. density gauges, accelerometer), is required for a complete description of the atmospheric physical state. Energetic particles (ions, electrons, ENAs) have to be characterised, according to their nature, flux and velocity distribution, by using an optimised set of spectrometers, with some minimum mass discrimination. A Langmuir probe may be needed for adequate restitution of the ionospheric environment, associated with more specific instruments giving access to the detailed physical state of low-energy electrons, and to plasma wave activity. Continuous monitoring of the static component of the magnetic field requires the use of a dedicated 3-axis magnetometer.

These instruments would benefit from the presence of a UV airglow spectrometer which allows the probing of high exospheric levels, and possibly lower atmospheric levels using nadir sounding and solar occultation.

A radio-occultation experiment could be proposed to provide ionospheric vertical profiles of electron content, synergistically with the NEIGE on NetLander experiment.

A complete radio-science package including the capacity of measuring Mars gravity field would be of great added value.

#### **III.3 Other sensors**

At the present level of definition of the MO-07 interfaces, two options in term of resources available for the Additional Payload are considered, a nominal option and a enhanced option.

##### **III.3.1 Nominal option**

In the nominal option, it is anticipated that very small resources, say at most 6 kg, will be available in addition to the resources anticipated for INST-1 and INST-2. In other words, the selection of an additional instrument (INST-3) whose resources (FoV, mass, volume) are in the same range as INST1 and 2 will be considered only if for any reason, INST-1 or INST-2 is not selected.

The selection of small instruments, with minimal demands in terms of thermal control, FoV, and resources appears realistic and CNES will do its best to select one or two instruments of this kind. If the

present AO succeeds in selecting an INST-1 and INST-2 type instrument, the scientific objectives of these small instruments will not be strictly restricted to those presented in section 2.

These instruments may in particular address the following topics:

- monitoring of the atmospheric dust and ice aerosols that would be of high interest to complement the INST-1 data,
- radiative environment monitoring,
- fundamental physics experiments,
- etc....

### **III.3.2 Enhanced option**

The enhanced option will be envisaged if extra resources turn out to be available, in particular if all of the resources reserved for the Rendezvous (RV) payload are not consumed.

In this option, one (INST-3) or two (INST-3 and INST-4) PI instruments of the class of INST-1 and INST-2 in term of mass, FoV, volume, may be selected in addition to the instruments of the nominal option.

## **IV PREMIER-07 Mission Scenario**

### **IV.1 Launch**

The PREMIER-07 mission will be launched with an Ariane V rocket. The launch period is expected to occur between September 6 and October 1<sup>st</sup> 2007. The declination of the departure trajectory asymptote will range between  $-4^{\circ}$  and  $21^{\circ}$  (corresponding C3 between 14 and  $16.4 \text{ km}^2/\text{s}^2$ ). The exact declination will be known when the precise Mars Orbit Insertion (MOI) parameters will be definitively set.

### **IV.2 Cruise, Mars approach and insertion**

The cruise phase to Mars will last around 11 months. During this period, no scientific measurement will be performed. Nevertheless, check-out and calibration sessions may be implemented if requested by the PIs and manageable by the MO-07 Project team.

During the final weeks of cruise, the NetLanders targeting operations will be performed. The NetLanders ejection consists of a sequence of four identical sub-phases, combining trajectory manoeuvres and NetLander probe ejections. The operations sequence starts 38 days before MOI and is expected to be completed no later than 8 days before MOI in order to be able to prepare safely the final MOI manoeuvres.

The key mission steps are listed hereafter:

Event	Date
Launch	Between September 6 & October 1, 2007
NetLander deployment	Between June & August 2008
Mars Arrival	Between mid-July and mid-September 2008
Beginning of NetLander relay mission	Two weeks after Mars Arrival
End of nominal mission	Three terrestrial years after Mars arrival
Extended mission	

### IV.3 MO-07 in Mars Orbit

#### IV.3.1 Commissioning phase

The commissioning phase is expected to last about two weeks and will be completed when the final orbit for operational phase 1 (see above) is reached and the MO-07 primary functions are demonstrated to be operational:

- relay of the NetLanders
- acquisition of NEIGE data
- RV validation
- Additional Payload.

#### IV.3.2 Routine Orbital Phases

The routine exploitation of the MO-07 starts when the commissioning phase is completed. Two successive orbital phases are anticipated which differ in their scientific priorities.

##### IV.3.2.1 Routine Orbital Phase 1 (OPh1)

The identified priorities of the first routine orbital phase of the MO-07 will be to relay the NetLander data, to acquire NEIGE data and to validate the RV concept.

During OPh1, the PIs' instruments requests will be considered with a lesser priority and in particular they will be switched on only if the orbiter resources (power, TM/TC rates, data storage) allow it.

The MO-07 orbit during OPh1 has the following characteristics:

- sun-synchronous
- circular, 500 km  $\pm$  50 km
- inclination 93,2°  $\pm$  0,2°
- local mean solar time: day side node at noon  $\pm$  TBD.

During this phase the RV concept validation will be performed through a series of sessions that are expected to each last around seven days. The last stage of the RV concept validation sessions may require that the orbiter be almost continuously in communication with the Earth. During this final stage, neither the NetLander data relay activities nor the PIs instrument operation will be possible.

OPh1 is anticipated to last at least one terrestrial year. In practice, the duration of OPh1 is dictated by NetLander lifetime. The requirement for NetLander lifetime is one terrestrial year. Nevertheless, the scientific request, considered as a target by the NetLander project team is two terrestrial years.

During OPh1, a conjunction period of 35 days will occur (between November 18 and December 22, 2008) during which no operation will be possible.

##### IV.3.2.2 Routine Orbital Phase 2 (OPh2)

The OPh2 phase of the MO-07 mission is particularly aimed at achieving the scientific objectives addressed by the Additional Payload.

As said in the former paragraph, the date of transition between OPh1 and 2 will depend on the actual life duration of the NetLanders. If the NetLanders are still functioning after one terrestrial year of operation, OPh2 may be either delayed or its orbit set so as to simultaneously perform orbital science and continue to relay the NetLander data under satisfactory conditions.

The orbit(s) for OPh2, will be more precisely known after selection of the Additional Payload in order to optimise the orbit to the PIs' Instruments requests. In this respect, the proponents are invited to detail their needs and wishes in their proposal.

OPh2 is expected to last until three terrestrial years after MOI i.e. until late 2011. During OPh2, a conjunction period of 43 days will occur (between January 14 and February 25, 2011) during which no operation will be possible.

At the time of issuing of the present AO, it is proposed that OPh2 be divided in two sub-phases OPh2a and OPh2b with two different types of orbits in order to be able to address a wider set of scientific objectives.

#### IV.3.2.2.1 Routine Operational Phase 2 a

During OPh2a, MO-07 is placed on a circular high inclination orbit at an altitude of about 350 km. This orbit is thought to be particularly well suited for the atmospheric studies as anticipated to be performed by INST-1. Depending on the successfulness of the RV tests performed during OPh1, these tests may be continued into OPh2a.

The MO-07 orbit during Operational phase 2a is the following:

- circular, 350 km  $\pm$  50 km
- inclination 93,2°  $\pm$  TBD

The Delta V allocation for this phase, including orbit changes and maintenance, is 65 m/s.

#### IV.3.2.2.2 Routine Orbital Phase 2 b

During OPh2b, MO-07 is manoeuvred into an highly elliptical orbit with a low periapsis suited to investigate the atmosphere/ionosphere interactions. Such an orbit is anticipated to be the best compromise, given the propellant resources available, to investigate the atmospheric escape mechanisms anticipated to be accomplished by INST-2.

The MO-07 orbit during OPh2b is the following:

- apoapsis: 1000 km  $\pm$  50 km
- periapsis: 170 km  $\pm$  10 km
- close to 93,2°

As said before, this orbit may be modified to take into account PI's needs within the overall constraints. In particular the inclination may be modified within the propellant margins available at this point in the mission.

The Delta V allocation for this phase, including orbit changes and maintenance, is 220 m/s. The availability of such an amount will be confirmed before the end of 2002.

#### **IV.4 Extended mission.**

MO-07 is designed to have sufficient resources to perform a one terrestrial year extended mission.

#### **IV.5 Planetary Protection constraints**

MO-07 is required to satisfy a number of planetary protection constraints<sup>4</sup>. In this respect, the MO-07 orbit must be easily changed in case of emergency, to an orbit with a sufficient high periapsis, say 400 km. Contingency planning for such a propellant consuming manoeuvre may influence the orbital phases described earlier.

If the two Orbital Phases and the extended phases go well, MO-07 will be put in a safe orbit in late 2012 where it may continue to be used, if still operational, as a telecommunication relay between Earth and Mars assets.

#### **IV.6 Mission phases summary tables**

A table synthesising the mission phases is displayed in section 5 of Annex 4.

### **V AO-Instruments mission requirements and constraints**

The proponents are invited to refer to Annexes 2, 3 and 4,

- Annex 2 entitled "Scientific payloads/MO-07 Orbiter interface requirement document,
- Annex 3 entitled "2007 Orbiter Preliminary Development Plan",
- Annex 4 entitled "2007 Orbiter Mission Specification" ,

for a more detailed presentation of the mission requirements and constraints that they shall take into account in their proposal

#### **V.1 Observation conditions**

INST-1 and INST-2 will be mounted on the MO-07 so that their Line of Sight (LoS) will be in a plane containing the nadir direction and fixed with respect to the MO-07 structure. Both the plane and the instrument LoS will be defined taking into account the PI's instruments needs and MO-07 own constraints (energy, telecom, ...). At the present level of definition of the orbiter, no information can be given on the FoV available for the small instruments that may be selected in addition to INST-1 and 2 in the nominal option. In any case, the proponents are invited to clearly define the requested/required conditions of observation.

Whatever the LoS is, the expected pointing characteristics in the orbiter related frame are the following

- Pointing knowledge : 0.1 deg around each axis,
- Pointing accuracy : 0.1 deg around each axis,
- Stability : 0.1 deg/s around each axis.

This budget does not include the bias and variations at the instrument level of the LoS pointing with respect to the orbiter related frame.

#### **V.2 Telemetry**

Telemetry/telecommand rates are dependent on the Earth-Mars distance. The minimum telemetry daily rate available for

- NetLanders relay
- RV experiment
- Additional payload

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<sup>4</sup> Planetary Protection constraints impose a requirement that the probability that MO-07 impacts Mars be less than 1% in the 20 years after launch and less than 5% in the 50 years after launch.

is of 400 Mbits/day, in the worst case, that is for a distance of 2.7 AU between Mars and the Earth,. This rate increases as the Mars-Earth distance decreases but is in any case limited to 1Gbit/day by the capabilities of MO-07.

The data rate available for the Additional Payload depends then upon both the ongoing orbital phase and the Earth-Mars distance.

### V.2.1 OPh1

During OPh1, the priority is given to the NetLanders relay that is presently estimated to require a average rate of 120 Mbits/day. In addition, during the final stage of the RV validation sessions, the telemetry is fully dedicated to this test and hence is not available to the Additional Payload.

It is then expected (but not guaranteed) that during OPh-1, a minimum rate of 280 Mbits/day will be available for the Additional Payload under "standard conditions " (no RV tests, no need of emergency telemetry sessions, ...)

### V.2.2 OPh2

During OPh2, a minimum of 400 Mbits/day will be available for the Additional Payload.

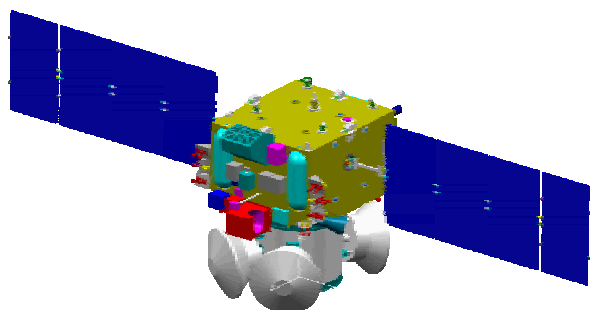
### V.2.3 Conjunction and opposition phases

No telecommand activity is planned during solar conjunction phases.

During opposition phases, the MO-07 is not able to receive telecommands from Earth. Nevertheless, MO-07 is designed to continue transmitting telemetry to Earth.

## V.3 Accommodation scheme of the additional payload

The PI's instruments shall be mounted on the mission stage of the MO-07 (see figure 1). The MO-07 provides interface mounting points to each PI instrument, including mechanical fixtures and screws.



*Fig 1: Scheme of the MO-07 in its cruise configuration. The four NetLanders are fixed to the first stage of the orbiter. The face(s) on which the PIs' instruments will be mounted will be known when the selection in response to the AO is completed.*

### V.3.1 Available volumes and fields of view (FoV)

The exact positioning of the PI's instruments on the MO-07 will be known late June 2002, when the results of the Additional payload selection are known. In any case, Proponents are requested to strictly respect the allocated volumes described hereafter.

#### V.3.1.1 Nominal option

The volumes and FoVs expected to be available for INST-1 and INST-2 are described in Figure 2. Their main characteristics are the following:

- INST-1

Length: 500 mm  
Width: 430 mm  
High: 370 mm  
FoV:  $-90^{\circ}/-45^{\circ}$  and  $45^{\circ}/90^{\circ}$  with respect to Nadir in the direction perpendicular to the speed vector. No angular opening in the perpendicular plane.

- INST-2

Length: 500 mm  
Width: 430 mm  
High: 370 mm  
FoV:  $120^{\circ}$  solid angle centre on the Nadir direction  
+  $120^{\circ}$  solid angle centre on the Speed direction.

Figure 2a : allowable volumes and fields of view for INST-1

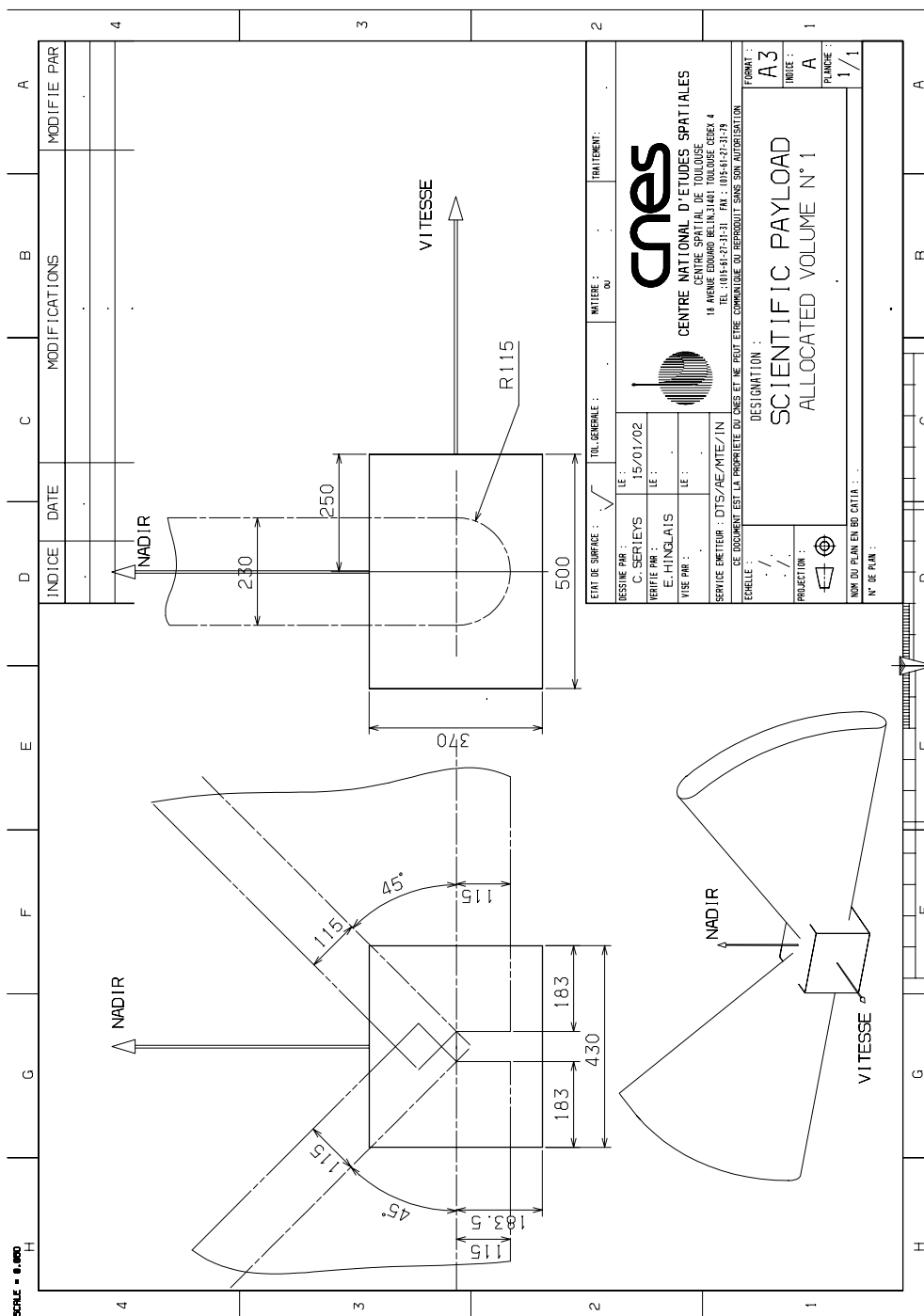
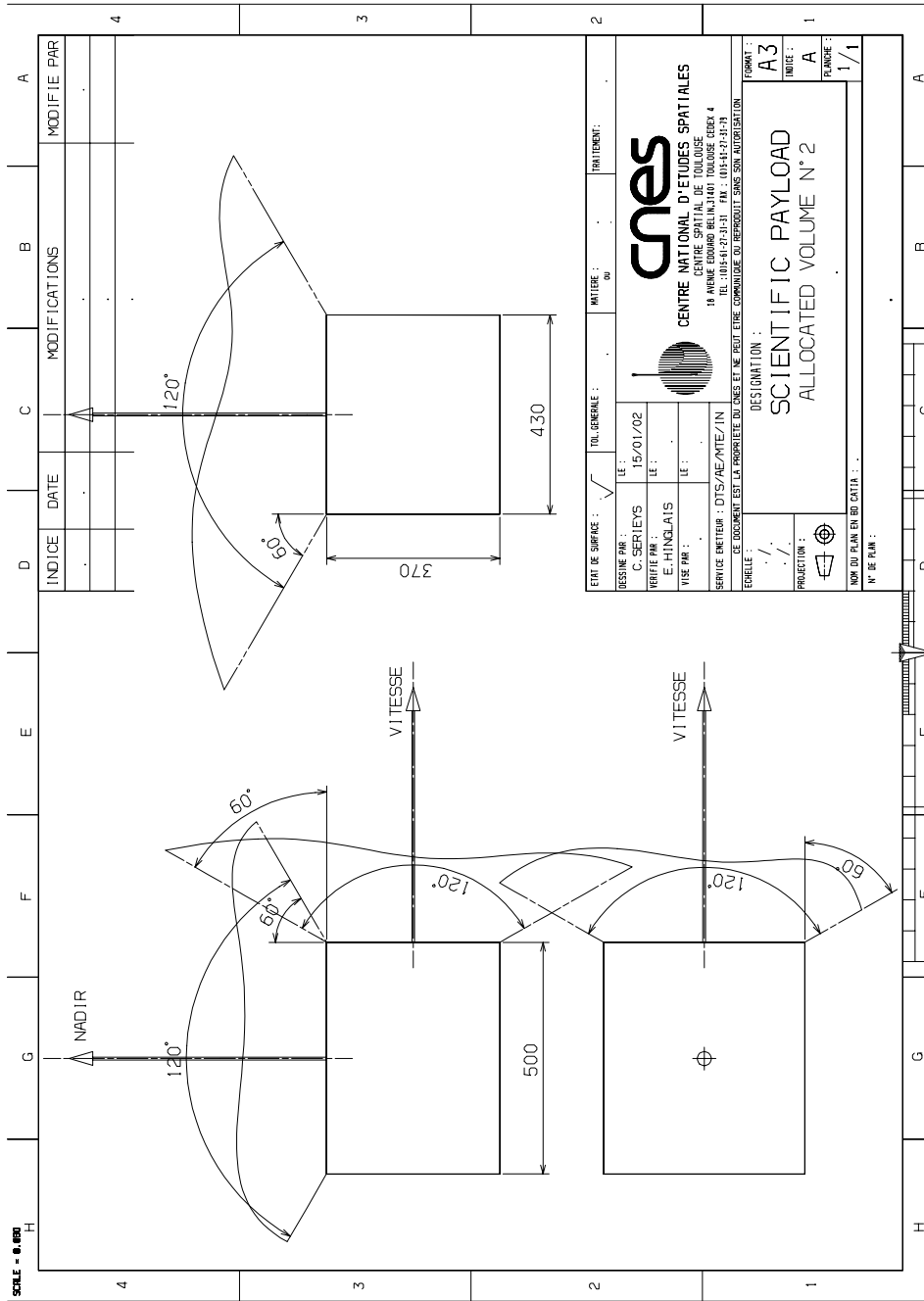


Figure 2b : allowable volumes and fields of view for INST-2



### V.3.1.2 *Enhanced option*

In addition to the nominal option instruments, one or two additional instruments can be accommodated with volume and FoV similar to those described in §V.3.1.1 for INST-1 and 2.

### V.3.2 **Particular case of the magnetometer**

The magnetic moment of MO-07 is expected to be :

- 1 A.m<sup>2</sup> for each solar array,
- 2 A.m<sup>2</sup> for the main body of the MO-07 orbiter.

This value seems to preclude any precise measurement of the Martian environment magnetic field by a sensor in the immediate vicinity of the main body of the MO-07 orbiter. In these conditions, the only realistic option to perform magnetic measurements appears to be to put the magnetometer at the end of a sufficiently long boom.

The weight of the boom is to be included by the proponents in the instrument's mass budget.

## V.4 **Mass Budget**

The proponents are invited to identify their mass margins. At the time of the MO-07 PDR in October 2003 (TBC), each PI instrument shall demonstrate a 20 % mass margin. PIs instruments with significant needs in telemetry and mass memory are required to take into account the mass memory in their mass budget. In the case of small instruments (typically less than 5 kg) with limited mass memory needs, the use of the MO-07 main memory can be envisaged and will be studied by the Project team.

### V.4.1 **Nominal option**

In the "nominal option", the total allocated mass for the Additional Payload is 65 kg.

- 50 kg for the instruments themselves
- 15 kg as a global provision for mechanical interfaces. This provision is managed at the MO-07 Project level.

At the time of release of the present AO, the targeted mass breakdown for the PI instruments in the nominal option is the following:

INST-1:	22 kg
INST-2:	22 kg
others instruments (total)	6 kg

#### V.4.1.1 *Enhanced option*

In the enhanced option, the total allocated mass for the Additional Payload is 117 kg.

- 90 kg for instruments themselves
- 27 kg as a global provision for mechanical interfaces. This provision is managed at the MO-07 Project level.

At the time of release of the present AO, the targeted mass breakdown for the PI instruments in the enhanced option is the following:

INST-1:	22 kg
INST-2:	22 kg
INST-3	20 kg
INST-4	20 kg
others instruments	6 kg (total)

## V.5 Power Budget

During orbital phases, MO-07 delivers 100 W maximum for the Additional Payload, including heating power. During the cruise to Mars, MO-07 delivers 30 W for the Additional Payload.

In any case, it seems not acceptable that a single proposed instrument requests more than say 40 or 50 % of the total power budget.

The Power budget is not expected to change significantly in the Enhanced option.

## V.6 Thermal environment

The PIs' instruments shall perform autonomously their own thermal control. Each PI instrument shall be compliant with the thermal environment defined in Annex 2.

## V.7 MO-07 and Additional Payload physical interfaces.

The PI's instruments shall provide the harness between their Digital Processing Unit (DPU) and Power Distribution Unit (PDU) and any equipment units or scientific instrument.

The MO-07 provides the harness between the MO-07 and the scientific payloads DPU and PDU until the interconnection brackets.

## VI Overall MO-07 Development schedule

The MO-07 development schedule is described in the following chart. All dates and duration will be confirmed mid July 2002 when the Additional Payload is selected.

Phases	Main activities	Duration (months)	Start	End/date
Compl. study	Preliminary design (feasibility)	2	02-2002	04-2002
B	Preliminary design	12	10-2002	10-2003
	PDR review	-	-	10-2003
C	Consolidated Design	20	10-2003	06-2005
	CDR review	-	-	06-2005
D	FM fabrication and procurement	20	06-2005	03-2007
	Orbiter PFM AIT	14	12-2005	02-2007
	Orbiter PFM Acceptance review		-	03-2007
	Margin	3	-	-
	Launch campaign	3	06-2007	09-2007
	PREMIER-07 launch	-	-	09-2007

Further details on the MO-07 development schedule are available in Annex 4.

## VI.1 Deliverables & Models

The selected PIs shall deliver a series of models according to the indicated schedule.

<i>Phase</i>	<i>Item</i>	<i>Number</i>	<i>Delivery Date</i>
B	Science payload ICD	-	PDR - 6 months
B	Mechanical & thermal models	-	PDR - 6 months
C	STM (Structural and Thermal Model)	1	09-2004
C	NS (Numerical Simulator) ; if any	1	08-2004
C	EM (Engineering Model)	1	03-2005
D	FM (Flight Model)	1	01-2006
D	SM (Spare Model)	1	01-2006 (TBC)

**Table 1 :Deliverables**

The MO-07 PDR is presently expected to be held in October 2003 (see detailed schedule in Annex 3)

## VI.2 Model characteristics

The proponents are invited to refer to Annex 2 for a description of the characteristics of the models identified in the table above.

## VII DATA MANAGEMENT AND DATA POLICY

This section gives general information relative MO-07 data flow and distribution. The comprehensive MO-07 data policy will be described in a document "MO-07 Science Management" not available at the time of issuing of the present AO.

The data policy applicable to the PI's data will be clearly stated in the agreement to be established between, the PI, and/or the PI funding Agency and CNES after selection.

### VII.1 PREMIER-07 Data flow

After acquisition by the MO-07 Earth reception stations, data from the MO-07 mission will be gathered at the PREMIER-07 Operation Centre located at CNES Toulouse Space Centre. Raw science data will then be demultiplexed, pre-processed and sent to the PI teams.

Each PI team will process the instrument data into elaborated physical products and make it available to the scientific community and to CNES through an appropriate procedure to be agreed between the PI team, the instrument funding Agency and CNES.

### VII.2 Data dissemination and distribution

#### VII.2.1 Validation period

For a given instrument, the validation period starts with the reception on Earth of the first data and ends when the first coherent set of data usable to perform scientific analysis has been properly calibrated and its physical meaning has been confirmed by the PI team.

The validation period is anticipated to last no longer than six months.

#### VII.2.2 Routine Phase

For a given instrument, the Routine phase starts when the validation of the instrument data is pronounced. During the Routine phase the MO-07 scientific data will be available to the scientific community, as soon as the PI's team processes them.

### **VII.2.3 Data rights**

CNES has rights to use all MO-07 data, under the terms and conditions to be defined in the MO-07 Science Management Plan.

Each PI team and/or instrument funding Agency has rights to use and distribute the data from their instrument, under the terms and conditions defined in the MO-07 Science Management Plan.

### **VII.3 Public and Educational Outreach Policy**

CNES encourages the utilisation of MO-07 data for Public and Educational Outreach purposes.

CNES will implement an Public and Educational Outreach Plan at the PREMIER-07 level. In this respect, the PIs and the PI's funding agency(ies) shall coordinate with CNES for the elaboration and implementation of their own Public and Educational Outreach plans. In particular, the PI and the instrument's funding agency(ies) shall provide CNES with a copy of all their Public Outreach products.

CNES shall have a royalty-free right under the copyright to reproduce, distribute and use any Public outreach product by a given PI team or instrument's funding Agency.

## **VIII PROPOSAL SUBMISSION AND EVALUATION PROCEDURES**

### **VIII.1 Schedule of the MO-07 Additional Payload selection**

The schedule of the payload selection is the following:

Issue of the Announcement:	February 13, 2002
Letter of Intent due	March 15, 2002
Deadline for proposals' submission	May 15, 2002
Review and evaluation	May 16 to July 10
Announcement of the selection	July 12, 2002
Start of Phase B	September 1, 2002

**IMPORTANT NOTICE:** All the Proponents should send a Letter of Intent (LoI) to propose no later than March 15, 2002. The LoI (typically two pages) should clearly detail the nature of the scientific investigation and the main characteristics of the instrument proposed.

### **VIII.2 Conditions of submission**

#### **VIII.2.1 Conditions applicable to all Proponents**

By submitting a proposal, the proponent agrees to the conditions and procedures usually applied by CNES and in particular to those described in the present AO .

All proposals should be received before the established closing date (May 15). Those received after the closing date will be treated in accordance with CNES provisions for late proposals.

By submitting a proposal, the proponent and their institution agree that CNES has the option to make a tentative selection pending a successful feasibility study (phase B) of the proposed investigation and, in addition, upon confirmation of the availability of adequate financial support by the proponent's funding agency.

The proponent should also understand that:

- CNES may, for various reasons (e.g. power budget, mass budget, schedule, ...) be in the obligation to select only a portion of the proposal.

- If two or more proposals address similar scientific objectives and are successfully evaluated, CNES may desire to merge those proposals into a single instrument project, providing appropriate sharing of responsibilities and costs. In that case, a single individual will be designated as the PI for the instrument. Should no agreement be found between the proponents, CNES will choose a single proposal between all those successfully evaluated.
- If a proposal (A) is judged to benefit from the addition of or replacement by a subsystem or sensor proposed by another proponent (B), CNES may invite the proponent (A) to revise **their** proposal in order to include the subsystem or sensor proposed by the proponent (B). In such case, the proponent (A) will be the PI of the re-defined proposal.

If one of these situations happens, all the proponents involved will be given the opportunity to accept or decline the proposed modification.

### **VIII.2.2 Conditions applicable to non-French Proponents**

Should a non-French proponent be selected, CNES will make arrangements with the sponsoring foreign agency for the proposed participation on a cooperative (no-exchange-of-funds) basis, in which CNES and the sponsoring agency will each bear the cost of discharging their respective responsibilities, including travel and subsistence for their own personnel. Non-French Individuals who plan to participate as Co-Principal Investigator (Co-PI) or Co-Investigator (Co-I) in a proposal submitted by a French PI must have their contributions endorsed by their appropriate governmental agency.

A copy of official correspondence between the non-French proponents and their sponsoring organisations should be sent to CNES .

### **VIII.3 Endorsement of the proposals**

#### **VIII.3.1 Proposals by French Proponents**

Proposals originating from France do not have to be formally endorsed at the time of submission. The endorsing procedure will be managed by CNES in parallel with the technical evaluation procedure.

#### **VIII.3.2 Proposals by non-French Proponents**

Non-French Persons planning to submit a proposal (or to be involved as a co-PI or Co-I) should arrange with their appropriate governmental agency for review and endorsement of the proposed activity. Such an endorsement should indicate that :

- the proposal (or the contribution to the proposal) merits careful consideration by CNES ,
- if the proposal is selected, sufficient funds will be available to undertake the activity envisaged.

Endorsements by the supporting agency (ies) shall in principle be available at the time of submission. Supporting agencies may, in exceptional circumstances, send by anticipation copies of unendorsed proposals if review and endorsement are not possible, before the May 15 deadline. In such cases, CNES should be advised when endorsement can be expected and in any case no proposal will be selected if the endorsement of the supporting agency is not available.

#### **VIII.3.3 Case of multi-national proposals**

A proposal built in a multi-national framework should very clearly identify the respective contribution and responsibilities of each partner. Each national contribution to a multi-national proposal should follow the guidelines given in the present AO. In particular, each national contribution should be endorsed by its supporting organism. In particular,

- in case of a proposal led by a French proponent and with foreign contribution, the full proposal should be sent to CNES by the French proponent with a clear identification of their participation and the budgets requested.

- in case of a French participation to a proposal led by a foreign proponent, a letter separate from the full proposal should be sent to CNES by the French Co-PI with a clear identification of their participation and detailing their implication and the associated funding requested.

#### **VIII.4 Where to send the proposals.**

The LoIs and the full proposals shall be sent to Jean-Louis Council:

- an electronic copy (pdf format) to the following address  
council@cnes.fr

#### **AND**

- fifteen paper copies (21x29,7 mm; A4 format) to the following address

Jean-Louis COUNIL  
Mars Exploration Programme Scientist  
DPI/E2U  
CNES  
18 Avenue Edouard BELIN  
31401 Toulouse  
FRANCE

#### **VIII.5 Evaluation and selection procedures**

All proposals received by CNES will be initially screened to determine their general relevance to the objectives of the AO. Proposals considered to be unresponsive to the stated objectives of the AO will be returned to their authors immediately with a written explanation of this determination. CNES will not consider such proposals further.

After an initial analysis at the project level, those proposals considered to be responsive to the AO objectives will subsequently be peer-reviewed by an International Scientific and Technical Review Board (ISTRB-07) composed of individuals with widely recognised expertise in the technical and scientific fields covered by the MO-07 mission. Experts pertaining to the international scientific community are expected to participate in this panel. The purpose of this review will be to evaluate the scientific and technical merit of each proposed investigation in terms of its strengths and weaknesses. Proposals that do not request funds from CNES, will be subjected to the same review and evaluation procedures as those proposals requiring financial support.

CNES on the basis of the recommendations by the ISTRB-07 will make final decisions concerning the acceptance of individual proposals. These decisions will also take into consideration and the availability of dedicated funds.

Successful and unsuccessful proponents will be notified by CNES to the proponents.

CNES will then begin making the necessary arrangements for the participation of the selected PI and Co-PI in the programme. Depending on the nature and extent of the proposed co-operation, these arrangements may entail a letter of notification by CNES, an exchange of letters between CNES and the sponsoring governmental agency, or an agreement between CNES and the sponsoring governmental agency.

#### **VIII.6 Evaluation criteria**

CNES and the ISTRB-07 in evaluating individual proposals will use all the following criteria, listed in descending order of importance.

- The technical feasibility of the accommodation of the instrument on the MO-07.
- The relevance of the proposed instrumentation to the PREMIER-07 opportunity. In particular the proponent is invited to refer to §II for the scientific objectives of the proposal.
- The technological merit of the proposed instrument.

- The competence and relevant experience of the PI and any collaborators as an indication of their ability to carry the proposal to a successful conclusion.
- The reputation and interest of the PI's and Co-PI's institution as measured by the willingness of the institution to provide the necessary support to ensure that the proposal can be completed satisfactorily.

If collaboration with national or foreign partners is crucial to the success of the proposal, the proposal must clearly indicate the adequacy and practicality of any plan to settle this co-operation. In addition to the criteria listed above, cost and management factors will be considered separately in all selections. Management aspects include the time and attention that the PI plans to devote personally to the payload instrument development and exploitation.

## **IX GUIDELINES FOR PROPOSAL SUBMISSION**

Each full proposal should be submitted no later than May 15 in the form of a single bound document that contains five parts (15 paper copies and an e-copy shall be provided, see § VIII.4):

Part 1: Table of contents and general information

Part 2: Science investigation

Part 3: Technical and data plan

Part 4: Management and cost plan

Part 5: Annexes.

A letter or cover page should be sent with the proposal. It should be signed by the proponent and an official of the proponent's organisation who is authorised to commit the organisation to the contents and implementation of the proposal.

The proposals should be written in English.

The proposal format outlined is merely a guide for the proponent. Strict adherence to most of these guidelines is not absolutely necessary. However, page limits will be strictly enforced and proposals should provide information related to all items described below and as otherwise specified in this AO.

### **IX.1 Table of content and general information**

The proposal should be single spaced, type written.

#### **IX.1.1 Table of content**

The proposal should contain a table of contents.

#### **IX.1.2 Identifying information**

The proposal should contain a short descriptive title for the investigation, the full name of the proposed PI, their address with postal code, their telephone and fax numbers and E-mail and/or telex number, the names of all Co-Is and their organisation or institution. For multi-national proposals, each national contribution as well as the person responsible (Co-PI) should be clearly identified.

It must be emphasised that all Co-Is quoted in the proposal shall have a clear and well identified role in the definition, realisation, testing of the instrument, or in the definition and execution of the scientific strategy of the instrument, or in the reception, validation and routine processing of the scientific data.

Envisaged Co-Is, participating only in the science data analysis are expected indeed to be selected later by a specific AO, and should be kept to a minimum number by the proponents.

#### **IX.1.3 Executive Summary**

The executive summary should emphasise:

- the scientific objectives of the proposed study and their compliance to the scientific objectives of the announcement stated in section 2;
- the importance and scientific significance of the anticipated results;
- the technical status of the proposed instrument, its heritage, its maturity and the degree of innovation compared to recent, on-going or decided Mars missions.

This summary should not exceed 2 single-spaced, typewritten pages.

## **IX.2 Science investigation plan**

The proposal should give a coherent presentation of the field of science addressed, the results of the past missions in the field and the present state of the art. The proponent should then discuss the prospects of increasing our knowledge in those fields of Mars exploration and why the instrumentation proposed is the most appropriate.

Particular attention should be paid to replacing the science investigation proposed within the scope of the main scientific objectives of the mission detailed in section 2:

- Mars climate,
- atmospheric circulation,
- escape mechanisms
- complement to the NetLander network science objectives.

As discussed in section 2, the relevance of the proposal to these scientific objectives is not strictly mandatory and in particular, a proposal not focused on one or several of these objectives will not be a priori rejected. In any case, the proponents should clearly establish through reference to existing scientific literature and other publications how the proposed investigation stands with regard to the current state of the art and to the specific objectives of the PREMIER-07 mission.

The science investigation plan should not exceed 10 single-spaced, typewritten pages.

## **IX.3 Technical and Data Plan**

The proponents are invited to give a precise Technical and Data Plan. Although no adherence to a strict table of content is required, the proposal should include six specific paragraphs addressing the following issues.

- Compliance of the Proposal with MO-07 resources.
- Development plan and compliance with MO-07 development plan (see Annex 3).
- Specific needs of the instrument with regard to MO-07:
  - Requested FoV, pointing performances, and types of orbit.
  - coupling with MO-07 manoeuvres (attitude changes and other possible programmed operations), needs for orbiter house-keeping data, specific calibration sessions.
- Heritage: the proponent shall clearly indicate to which extent the proposed instrument utilises space qualified and space experienced hardware.
- New developments: the proponent shall clearly identify the critical technological developments necessary to achieving the proposal.
- Adequacy of the technical specifications chosen (resolution, wavelength, operation modes, ...) to the scientific objectives stated in the proposal.

Any further technical information relative to the MO-07 Project should be requested to the CNES MO-07 Project team:

Mars Project  
 CNES; DSO/ED/MA  
 18 Avenue Edouard BELIN  
 31401 Toulouse

e-mail: isabelle.sahl@cnes.fr

The technical plan should not exceed 20 single-spaced pages including illustrations, tables, references.

Information concerning the technical expertise of the PI and of the PI's team in the proposal should be presented in a separate paragraph. Proponents who wish to provide evidence of their experience and competence in particular disciplinary fields are encouraged to quote relevant publications in general scientific literature of which they are the authors. References to earlier publications should be limited to main publications that are directly relevant to the proposed investigation.

### **IX.3.1 Compliance with the MO-07 resources**

The proponent shall give a comprehensive detailed technical description of the proposed instrument. A description of resources (mass, power, FoV, volume, telemetry,...) and interfaces (mechanical, thermal, electrical,...) shall also be stated. The different functional operating modes (and their power consumption profiles) shall be explained.

The proposal should clearly demonstrate the ability of the proposed instrument to meet the resources, interfaces and schedule requirements imposed by the MO-07 mission and detailed Annexe 2,3 and 4.

In particular,

- possible inconsistencies between the scientific payloads/2007 Orbiter Interface Requirements document (see Annex 2) and the proposed instrument shall be clearly identified and the reasons of these inconsistencies highly documented.
- Requirements stated in Annex 2 for which the Proponent is unable to commit (for instance because of the present lack of maturity of the Proposal) shall also be clearly identified.

### **IX.3.2 Conditions of observations**

As stipulated in §IV.3, the orbit of the routine Orbital Phases will be precisely frozen only when the Additional Payload will be selected. The proponent must then be conscious of the particular importance to precisely describe in their proposal:

- the adequacy of the orbits described in §IV.3 to address their scientific objectives, and if these orbits are not fully satisfactory, the type of orbit required for their instrument,
- their needs in term of FoV to properly operate their instrument and in particular whether or not the FoV presented for INST-1 and INST-2 in §V.3 are suitable.

### **IX.3.3 Data Plan**

The data plan should be presented and preliminary indications should be given on :

- the scientific data flow (daily, seasonal, annual, existence of low telemetry modes)
- needs in data from other past or contemporary Mars sensors (MO-07, NETLANDER, ...) to support the analysis of the instrument's data.
- expected duration of the initial validation period
- expected time delay (routine phase), between data reception and delivery of physical products.

## **IX.4 Management and Cost Plan**

Management plans are required for all hardware and software equipment.

Cost plans are required for all proposals.

### **IX.4.1 Management Plan**

The Management plan shall provide a description and justification of the proposed development plan and schedule, identification of development status, critical problems and risk assessment. It shall identify any possible inconsistencies with the MO-07 Preliminary Development Plan (see Annex 3).

The management plan sets forth the investigator's approach for efficiently managing the work, the recognition of essential management functions and the effective overall integration of these functions.

The management plan gives insight into the organisation proposed for the work, including the internal operations and lines of authority with delegations, together with internal interfaces and relationships with CNES, major subcontractors and associated investigators. Likewise, the management plan usually reflects various schedules necessary for the logical and timely pursuit of the work, accompanied by a description of the PI's work plan, the amount and responsibilities of the scientific collaborators (if any) and the amount and responsibilities of the technical collaborators (if any).

All major facilities and equipment essential to the proposed investigation should be indicated including those of the investigator's proposed subcontractors. Existing equipment should be explicitly differentiated from facilities that will be developed to implement the investigation. Schedules for the acquisition and installation of new equipment and facilities should also be indicated.

#### **IX.4.2 Cost plan**

Cost plans are required from all proponents.

The cost plan shall summarise the total proposal cost by major categories of cost.

##### **Cost categories**

- Instrument development and delivery

This should give the total cost of materials including estimated cost of each major item (preliminary models, test facilities, etc...) and all related costs included technical missions, field trips, etc

- Science activities

This should give the total cost of the science activities such:

- labour costs of the PI, Co-PIs, Co-Is and all personal involved,
- organisation of the PI team,
- travels in relation to the scientific objectives of the Proposal,

- Data processing activity

This should give the total cost of all the activities in relation to Data calibration, validation and analysis including the possible ground-segment specific developments and the amount and cost of computer time.

For each cost category, a annual breakdown should be given.

It is emphasised at the attention of the French proponents that the cost plan shall include the labour costs of French state institutions' employees (CNES, CNRS, universities, ...).

##### *IX.4.2.1 French proposals and French contributions in non-French proposals*

In addition to the general indications applicable to all proposals, the French proponents and French participants in non-French proponents shall indicate in a separate table the funding requested to CNES.

The funding request to CNES shall make appear the cost categories defined above and a annual breakdown shall be given.

## **X ANNEXES.**

All the annexes can be loaded on the web site: <http://smsc.cnes.fr/PREMIER-2007/>

Annex 1: List of Acronyms.

Annex 2: Scientific Payloads/2007 Orbiter Interface Requirements Documents.

Annex 3: 2007 Orbiter Preliminary Development Plan

Annex 4: 2007 Orbiter Mission Specification