Call for Ideas

for the Next Exploration Science and Technology Mission of the European Space Exploration Programme - Aurora

1. Introduction

At the Berlin Ministerial Council in 2005 ESA Member States approved the European Space Exploration Programme – Aurora as an optional programme of the Directorate of Human Spaceflight Microgravity and Exploration. The programme consists of two components:

- *Core Programme*
- *Exploration Missions*

The *Core Programme* aims at establishing the ability of Europe to participate as a recognised partner in the international exploration endeavour to extend human presence further out into the Solar System. The Core programme follows the approach established by the Aurora preparatory phase initiated at the Edinburgh Ministerial Council in 2001. In this long-term prospective initially robotic missions play a fundamental role to acquire the necessary knowledge and to develop the enabling capabilities which will eventually allow humans exploration of the Solar System.

As part of the *Exploration Missions* Component of the Aurora Programme the first mission, ExoMars, was approved by the Ministers in Berlin and is now being implemented. In line with the objectives of the programme this missions has dual objectives, technology and science. The ExoMars mission will search for traces of past and present life, characterise Martian geochemistry and water distribution, improve the knowledge of the Mars environment and geophysics and identify possible hazards. On the technological side the mission is to demonstrate European capability to land medium size payloads on Mars and to demonstrate surface mobility and access to the subsurface.

Ministers have also recognised a Mars Sample Return (MSR) mission as the major milestone in the medium term for the exploration of Mars. Consequently the Core Programme includes significant technology development activities for the preparation of an MSR mission.

In view of the large financial resources required by such a mission it is assumed that it will be implemented in co-operation with international partners. Europe therefore needs to determine what the challenges are and which of the enabling capabilities would like to contribute to the MSR mission, consistent with its long term ambitions and goals. To this end the Core Programme has initiated an MSR Phase A2 System Study, building on the results of two previous Phase A1 studies. In this frame *Entry, Descent and Soft / Precision Landing,* on the one hand and *Autonomous Rendezvous* *and Docking/Capture* on the other hand were identified as key elements of interest for Europe.

As an intermediate step, after ExoMars and before the international context will allow the initiation of a MSR mission, the Executive considers proposing to the Ministerial Council in 2008 an ExoMars class mission, for launch in the 2015 – 2018 timeframe, to demonstrate in particular key MSR technologies and to achieve a step change in the European capabilities over and above present possible contributions to the MSR mission and provide an opportunity for scientific investigations. Ideas that would include aspects relevant to the human exploration scenario are welcome.

The mission will constitute the next Mission of the Aurora Programme. As a working title this mission is named **Next Exploration Science and Technology (NEXT)** Mission.

It is the purpose of this Call for Ideas to collect from Industry, Technical Centres and the Scientific Community proposals/suggestions for mission concepts that would combine, in the spirit of Exploration, technology development (focussed, but possibly not limited to the areas mentioned above) with first class science.

In the Annex A information about on going activities in the field is provided together with some examples of potential mission concepts. These should be taken as guidelines. Additional / alternative ideas are welcome.

2. Purpose

The Director of Human Spaceflight, Microgravity and Exploration invites proposals for the *Next Exploration Science and Technology Mission* of the optional European Space Exploration Programme – Aurora.
It is intended to propose such a mission to the Council at Ministerial Level in 2008 with the aim to adopt it for launch in the period 2015-2018. The technological goal of the mission is to demonstrate key enabling capabilities as needed for a future Mars Sample Return Mission which may be realized in international co-operation after 2020.

3. Proposal Evaluation and Selection

3.1 Assessment Phase

Proposed ideas/suggestions will be evaluated by the Executive for their suitability as a candidate mission for the Next Exploration Science and Technology (NEXT) Mission. The original ideas, together with the Executive assessment, will be submitted to the advisory structure of the Human Spaceflight, Microgravity and Exploration Programme, which will evaluate both the technological and the scientific aspects of the proposed mission concept.

The results of this evaluation will be presented to the Technical and Scientific Community and PB-HME Delegations in a dedicated workshop.

Up to three mission concepts and associated science ideas will be proposed to the PB-HME to enter in an Assessment Study Phase. These will undergo internal studies using the ESTEC Concurrent Design Facility (CDF), to establish an initial mission Design and Payload Definition.

The results of the internal study will be evaluated together with the results of MSR pre-cursor phase A studies, which the Executive has initiated in the context of the MSR system study (for more information see Annex A). Again, the evaluation will be done, as before by the Executive and the Advisory Structure and the results presented to the PB-HME for concurrence. The evaluation will focus on technological and scientific merit. The aim is to select two mission concepts to propose to the PB-HME for Phase A industrial studies.

3.2 Industrial Phase A studies

It is envisaged to run the above mentioned Phase A studies in the first half of 2008, possibly each of the studies will be carried out in parallel by two industrial contractors, subject to the approval of the competent ESA bodies. The activities will be under the responsibility of an ESA Study Manager supported by a Science Study Team (SST) chaired by an ESA Study Scientist. The SST will be responsible for all scientific aspects of the study activities; in particular it will support the definition of a model payload for the purpose of the study.

3.3 Proposal for Implementation

At completion of the Industrial Phase A study phase, the study results will be described in study reports available to the advisory bodies and to the community. The results will also be presented at a dedicated workshop open to the community at large. Supported by its Advisory Structure the Executive will propose to the PB-HME the candidate mission to be included into the programme proposal for the Council at Ministerial level at the end of 2008.

4. Payload Funding

As a general rule, national provision of payload instruments is assumed.

5. International Cooperation

Proposals involving international cooperation must include a clear identification of the interests and potential role and responsibilities of the various partners and where the additional resources above the ESA envelope may come from. The intended shares of responsibilities between the partners should be outlined so as to permit an assessment of the financial envelopes involved in the proposed cooperation.

6. Schedule of activities

The following tentative schedule of major activities is presented for information:

Activity	Date
Release of the Call for Ideas	9 March 2007
Proposal for ideas submission	13 April
Preliminary Evaluation and classification	13-25 April
Presentation to ESTAG	25 April
Presentation to PB-HME of assessment results	23 May
Briefing to proposers at ESTEC	End May
CDF studies	May – July
MSR Phase A2 Industrial studies results	July-August
Submission of selected study proposals to PB-HME	18 September
ITT for parallel industrial studies	End September
Phase A industrial studies	Jan-July 2008

7. Selection Criteria

The following primary selection criteria will be applied:

1. Technological relevance for a medium-term European and international exploration programme
2. Relative technological and scientific excellence versus mission cost
3. Budget compatibility with Exploration Programme long term plans
4. Timeliness of mission in the international context

8. Submission of ideas

8.1 Format for proposal submission and deadline

The answer to this call for Ideas should not exceed 2 pages. The first part should outline the mission concept proposed with a short description of the technologies of interest in line with the principle of the Exploration Programme. The second part should provide a more detailed description and justification for the proposed scientific investigations. It is important to emphasise the novelty of the science proposed and to explain its value in the context of the international exploration effort. Possibilities for international and multinational cooperation should be highlighted.

Name, contact, information and affiliation (university, institutes…..) must be included. Be reminded that this initiative can only be successful if a large scientific community will express its interest.

Preferably ideas should be submitted electronically, using the form provided in Annex B and also available from

http://sci.esa.int/cv2015

Documents should be sent as attachments to the following address:

explorationcall@esa.int

not later than **13 April 2007**

8.2 Contact person

ESA point of contact:

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Annex A

Summary status of system level preparatory activities for Mars Sample Return and related Precursor Missions

A. Context

Europe has identified the exploration of Mars as one of its main objectives in contributing to the international effort of exploring the solar system. With the ExoMars mission now scheduled for 2013 and the Mars Sample Return (MSR) mission not foreseen to take place earlier than 2020, there is an opportunity to consider an intermediate so called "precursor" mission. This would enhance and complement the capabilities acquired through ExoMars, whilst also preparing Europe for the Mars Sample Return and other possible exploration missions.

This approach is being implemented in the frame of the MSR Phase A2 Study, which started in September 2006 with Alenia Alcatel Space Italia S.p.A. as Prime Contractor. This study initially focuses on refining the MSR mission architecture and the design of the associated space elements, whilst deriving a development plan for the key MSR-enabling capabilities. It also devises a set of high -level requirements for potential capability demonstration missions.

The second part of the study will concentrate on defining several options of specific capability demonstration mission in order to collect complete and reliable data (technical and programmatic) in preparation for the 2008 Ministerial Conference. Particular interests, heritage and possible synergies have already been identified in the areas of:

- Entry, Descent and Soft/Precision Landing
- Autonomous Rendezvous and Docking/Capture

Other capabilities (e.g. planetary ascent, sample return…) relevant to the future MSR mission may be considered also.

B. Precursor Missions definition

In line with the basic approach of the Aurora Exploration Programme, in the present concept all the precursor mission options are expected to include the demonstration of certain MSR technological capabilities (up to a certain level of representation of the performance required by the MSR mission) and offer in the same time the possibility to perform first class science investigations. A sound combination of both aspects is considered an essential prerequisite to gain the necessary support from the ESA delegate bodies.

The mass available for the scientific payload will vary depending on the mission. Typically a precursor mission as envisaged today may be based on a launcher of the class of the Soyuz-Fregat (although a final decision has not been made) which provides limited capability in case of an interplanetary mission. An indication on the available payload mass for science will come from the preliminary studies of the proposed missions later in 2007.

C. Preliminary Mission concepts (examples)

The following precursor mission options with a potential scientific component have been identified and are provided herewith for information:

1. Lunar Orbiter / Lander Mission

Preliminary Lunar Lander Precursor Mission Characteristics
Two main types of insertion orbit could be investigated, either polar or equatorial.
A polar orbit would enable the region around the Peak of Eternal Light to be targeted as a potential landing site. A payload deployed in this area would benefit from constant sunlight conditions.
The landing site reached from an equatorial orbit will experience a fourteen day / night cycle per month, which will have an impact on the available scientific payload mass.

Technological Capabilities
The primary technological goal of this type of mission will be to demonstrate **Soft Precision Landing** with **Hazard Avoidance**[1]. It would represent the next step in landing technology development after ExoMars, which would then prepare the way for more complex payloads. This Soft Precision Landing capability would allow very specific areas of scientific interest to be reached.

Questions to scientists

- Identify scientific goals that can be addressed with a lunar lander in the second half of the next decade, taking into account the scientific investigations that are already ongoing or approved for missions (Chinese, Japanese, Indian, and US).
- Please identify the relevant scientific investigations, including possible orbital science.
- Please identify the appropriate scientific instruments for the scientific investigations with very preliminary requirements on length of operation (days, weeks, months, years), power (night/day, continuously/sporadic), data volume (Mbite/Gbite per unit time), and needs for sample processing.
- Do you have a preferred landing site/area (equatorial/polar, front/back side)?

[1] Definitions in Glossary

2. Mars Orbiter Mission

Preliminary Mars Orbiter Precursor Mission Characteristics

The spacecraft could perform the autonomous Rendezvous and Docking/Capture demonstration in Mars orbit, possibly a low altitude (500-700 km) circular orbit. The available scientific payload mass depends on the final target Mars orbit the extent to which the demonstration of an end-to-end rendezvous and docking/capture manoeuvre is completed. Concerning the mission science content two possibilities may be considered:

a. Net Science with one-possibly two, small landers of the NetLander class, released from interplanetary hyperbolic approach. Synergy with one of the planned NASA missions is a possibility.
b. Orbital Science

Technological Capabilities

The primary technological goal of the mission will be the demonstration of the **Autonomous Rendezvous and Docking/Capture** capability and validate the complete design of guidance, navigation and control approach with an ad hoc target. This mission will be able to call upon strong European heritage, namely Mars Express and Venus Express, and build on the ExoMars development. The spacecraft could also explore the possibility of using a series of **Aerobraking** manoeuvres.

Questions to scientists

- Please identify scientific goals that can be addressed with a Mars orbiter in the second half of the next decade, taking into account the scientific investigations that are already ongoing or approved for missions (including MEX and MRO).
- Please identify the relevant scientific investigations.
- Please identify the appropriate scientific instruments for the scientific investigations with preliminary requirements on payload mass, volume, length of operation (months, years), power (continuously/sporadic), data volume (Mbits / Gbits per unit time), and specific need for deployment.
- Please suggest the preferred orbital parameters and pointing accuracy as applicable.

3. Mars Lander Mission

Preliminary Mars Lander Precursor Mission Characteristics

In principle, the lander will be based on solar generation with a lifetime on the surface of one Mars year maximum. Use of RHUs / RTGs may be considered only if available in time for the planned mission. The mission design requires investigations on suitable launch windows, trip duration and the occurrence of dust storms.
The role of an Orbiter would be limited to communications relay.

Technological Capabilities

The primary technological goal of this type of mission will be to demonstrate **Entry, Descent and Soft Precision Landing** (EDL) with **Hazard Avoidance**[2]. Landing

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[2] Definitions in Glossary

accuracies in the order of 5 to 10 km shall be expected. It would represent the next step in landing technology development after ExoMars, which would prepare the way for more complex payloads..

Questions to scientists

- Please identify scientific goals that can be addressed with a Mars lander in the second half of the next decade, taking into account the scientific investigations that are already ongoing or approved for missions (including ExoMars, Phoenix, MSL, and Aeronomy Scout).
- Please identify the relevant scientific investigations.
- Please identify the appropriate scientific instruments for the scientific investigations with very preliminary requirements on length of operation (months, years), power (continuously/sporadic), data volume(Mbite/Gbite per unit time), and specific sample acquisition and preparation.
- Please specify if you prefer a fixed station or a mobile rover to address the scientific investigations.

4. Near-Earth Object Sample Return Mission

Preliminary NEO Sample Return Mission Characteristics

The mission would require large delta-V manoeuvres for deceleration on the outbound journey. The delta-V for escape is eased by the low gravity level of the body. The sample collection method will depend on whether the spacecraft employs a landing, touching, hovering, and anchoring system.

Technological Capabilities

This mission type will aim to return a sample from a Near-Earth Object (NEO), back to Earth, building upon heritage from previous missions (e.g. Rosetta) and refining some capabilities needed for the MSR mission. It would reproduce to some degree the operational sequence required by the MSR mission, from sample collection on a foreign body to sample recovery on Earth, while the coverage of technologies associated with Entry Descend and Landing and Planetary Ascent would be very limited. Contrary to the lunar and Mars precursor mission types, this one includes the return leg. Thus, one of the key MSR capabilities to be demonstrated would be the **High Speed Earth Re-entry**.

Questions to scientists

- Please identify scientific goals that can be addressed with a NEO sample return mission in the second half of the next decade, taking into account the scientific investigations that are already ongoing or approved for missions.
- Please identify the relevant scientific investigations (only upon return and/or in-situ before return of the samples).
- Do you need sub-surface access or only access to surface samples?
- Do you have a specific NEO in mind that would be at its Earth fly-by in the second half of the next decade?
- Would you consider a Phobos / Deimos sample return or a NEO sample return as more relevant from a scientific point of view?

5. Phobos Sample Return Mission

Preliminary Phobos Sample Return Precursor Mission Characteristics
The spacecraft would be able to use Mars to assist with the deceleration delta-V, but on the return trip a relatively large delta-V would be required to escape the Martian gravity. The mission operations require investigations on suitable launch windows and trip duration. A possible/likely scenario may entail cooperation with Russia on the Phobos Grunt mission.

Technological Capabilities
This mission type is very similar to the Near-Earth Object Sample Return one. It would reproduce to some degree the operational sequence required by the MSR mission, from sample collection on a foreign body to sample recovery on Earth, while the coverage of technologies associated with Entry Descend and Landing and Planetary Ascent would be very limited. Contrary to the lunar and Mars precursor mission types, this one includes the return leg. Thus, one of the key MSR capabilities to be demonstrated would be the **High Speed Earth Re-entry**.

Questions to scientists
- Please identify scientific goals that can be addressed with a Phobos/Deimos sample return mission in the second half of the next decade, taking into account the scientific investigations that are already ongoing or approved for missions.
- Please identify the relevant scientific investigations (only upon return and/or in-situ before return of the samples).
- Do you need sub-surface access or only access to surface samples?
- Do you have a preference between Phobos or Deimos?

D. Glossary

The following terms have been defined as follows:

Soft Landing – terminal descent using retro rocket assistance to reduce impact loads at landing.

Precision Landing – landing within a predefined target area ellipse in the range of kilometres to tens of kilometres depending on the planetary body.

Hazard Avoidance – avoiding surface features which could jeopardise the success of the landing, on the metre/sub-metre range (e.g. boulders).

Annex B

Submission Form: Call for Ideas NEXT Exploration Mission

Name	
Contact information	
Affiliation (University, Institute etc.)	
Your scientific /technology area	
Brief description of the proposed mission concept , discuss and justify the technology aspects in the long term perspective of the European participation in international exploration programmes	
Description of the proposed scientific investigations, discuss and justify the science long term perspective in the context of the international exploration programmes	
Description of the scientific payload with main characteristics, mass, volume, power demands etc	
Comments	
Trans-national cooperation	With which laboratories would you be collaborating? In how many different European countries:
Keywords describing your idea[3]	

[3] Examples: planetology, atmospherics, (exo)biology, geology, in- situ resource utilisation, life support systems, medicine, origin of life, physics, radiation, EDLS, aerocapture, robotics, advanced materials