



Call for a Medium-size mission opportunity in ESA’s Science Programme for a launch in 2025 (M4)

1 BACKGROUND

The ESA Science Programme has for more than two decades been based on long-term planning of scientific goals. The first long-term plan for the Science Programme has been *Horizon 2000*, started in 1984, followed by *Horizon 2000+*, in 1995, and, in 2005, by the *Cosmic Vision* plan. The *Cosmic Vision* plan, established on the basis of a bottom-up process that started with a consultation of the broad scientific community, contains the wide-ranging and ambitious scientific questions to be addressed by missions in the ESA Science Programme. The plan (available as ESA BR-247) describes science themes and topics, and leaves the definition of the actual space missions that will address the science themes in question to a series of competitive, peer-reviewed “Calls for Missions”.

The first call for missions in the *Cosmic Vision* plan was issued in 2007 and resulted in the selection in 2011 of Solar Orbiter as the first Medium mission (M1) and Euclid as M2, followed by the selection in 2012 of JUICE as the first Large mission (L1). The second call for M missions was issued in July 2010 and resulted in the selection of the PLATO mission for the M3 opportunity. In March 2012 the call for the first small mission (S1) in the *Cosmic Vision* plan was issued and resulted in the selection of CHEOPS.

With the aim of selecting the science themes for the L2 and L3 launch opportunities, a “Call for White Papers” was issued in March 2013 and a Senior Survey Committee assessed the received proposals. Following this process, “The hot and energetic Universe” science theme, to be pursued by implementing a large collecting area X-ray observatory, and “The gravitational Universe” science theme, to be pursued by implementing a gravitational wave observatory, were selected in November 2013 for the L2 and L3 opportunities respectively, with planned launch dates of 2028 and 2034. Based on a “Call for mission concepts” for the L2 mission opportunity, the ATHENA mission was selected in June 2014.

2 PURPOSE OF THE PRESENT CALL FOR MISSIONS

Through the present Call for Missions the Director of Science and Robotic Exploration solicits from the broad scientific community proposals for the competitive selection of mission concepts to be candidate for the implementation of the “M4” Medium mission for launch in 2025.

The present Call is open to missions in all areas of Space Science. Missions proposed in response to the present Call should make reference to the science goals and questions described in the *Cosmic Vision* plan, with the relationship between the goals of the proposed mission and the *Cosmic Vision* plan to be addressed explicitly in the proposal.

No limitations to the science goals addressed, other than their relevance to the Cosmic Vision plan, are imposed on the proposals.

2.1 Utilization of the International Space Station (ISS)

Proposals for the utilization of the ISS are not solicited in the present Call. Interested potential users of the ISS are invited to contact ESA’s directorate of Human Spaceflight and Operations (HSO) for details of the ISS utilization opportunities.

2.2 Mars and Lunar science

ESA is running, in parallel with the Science Programme, a Robotic Exploration Programme, that at the moment is working on the implementation of two Mars exploration missions for launch in 2016 and 2018, and on a longer-term plan for Martian exploration, which is directed ultimately to achieve a joint Mars Sample Return mission, and in the immediate term places a high priority on astrobiological goals. Lunar exploration falls under the responsibility of the ESA directorate of Human Spaceflight and Operations (HSO). The present Call has no restrictions in terms of the science themes that can be addressed. However, proposals addressing Mars or Lunar science should clearly explain the potential relationship with the activities currently being carried out in the context of the Robotic Exploration Programme and the activity of the HSO directorate, and explain if and how they are complementary to, and should be funded independently of, these activities.

3 BOUNDARY CONDITIONS

Through the present Call for Missions the Director of Science and Robotic Exploration solicits from the broad scientific community proposals for the competitive selection of mission concepts to be candidate for the implementation of the “M4” Medium mission for launch in 2025.

3.1 Cost and schedule

The ESA cost ceiling for the M4 mission is of 450 M€ (2014 economic conditions), including the cost of the mission’s nominal operations. The mission’s definition and Technology Readiness Level (TRL) must be such as to allow a start of the mission’s implementation phase in 2018, with a foreseen launch date of 2025. A nominal implementation schedule for the M4 mission foresees a definition and preparation phase lasting approximately 3.5 years (i.e. until late 2018) followed by an implementation phase lasting 7 years (leading to a launch readiness in 2025).

3.2 Technology readiness level

Regardless of the type of proposal, its implementation timescale and financial envelope, the proposed missions must rely on available technology, and in particular must rely on technology that will be at TRL 5-6 in the ISO scale by the end of the Definition Phase. This TRL level must be reached prior to the mission being adopted for Implementation. Considering the limited time available between the selection of the mission candidate following the Call and its adoption, in practice the mission must rely on available technologies already at the time of the proposal, although mission-specific technology verifications can be foreseen during the preparation phase as long as feasible within 2-2.5

years. The specific technical requirements for the proposals are described in detail in the Annex.

3.3 Mission profiles

Any mission profile can be proposed in response to the present Call as long as it fits the boundary conditions spelled out above. A set of example mission profiles that can fit these boundary conditions is described in some detail in the Annex to the present Call. These examples cover a range of possible mission types. However, while these mission profiles provide examples of feasible responses to the present Call, they are in no way meant to be prescriptive. Proposers are free to propose different mission profiles, as well as the use of other launch vehicles, conditional to achieving the required budget and schedule. Note that European launchers must in principle be used for ESA missions, unless the launch vehicle is provided by a partner agency on a no exchange of funds basis, or unless the required launcher capabilities are not available in the portfolio of European launchers.

3.4 International collaborations

M missions are a key vehicle for pursuing collaboration opportunities between the ESA Science Programme and other space agencies. As such, M missions can be entirely European, or they can be European-led with junior participation by international partners. Alternatively, the budget allocation (or part of it) of M missions can be used to implement a junior European contribution to a mission led by a partner agency. All these scenarios have been implemented in the Programme’s history.

The present Call is open to all possible international collaboration schemes, i.e., proposals are allowed for both European-only missions as well as for missions in collaboration with international partners. In case an international collaboration is proposed, the proposal must clearly identify whether the mission is proposed as European-led or as a contribution to a partner-led mission, with a clear management scheme proposed in either case.

A letter of endorsement by the proposed international partner(s) is requested as part of the proposal. The letter of endorsement, addressed to the Director of Science and Robotic Exploration (and sent by email to M4support@cosmos.esa.int, with a copy attached to the proposal) must clearly explain the programmatic status of the mission in case of proposed contributions to partner-led mission, and must explicitly state the availability of the proposed partner to support a study phase and to undertake the necessary step to secure the funding necessary for the development and implementation phase, contingent to the mission successfully achieving its review goals, analogously to the letters of endorsement required from national funding agencies (see below).

ESA can provide guidance and support to prospective proposers in their interaction with potential partner agencies, in particular in verifying the potential interest of the partners.

4 PAYLOAD FUNDING AND ENDORSEMENT BY NATIONAL FUNDING AGENCIES

ESA Science missions are, in general, collaborative undertakings between ESA and its member states (as well as, in a number of cases, international partners, see above). For the majority of missions, the relative share of responsibilities between ESA and the Member

States is based on ESA procuring the spacecraft and the launch vehicle, and being also responsible for the launch services and for the operations. Payload elements are in most cases procured under the responsibility of scientific consortia funded by member state agencies, with a varying degree of ESA involvement, with some missions featuring payloads which are funded entirely by the Member States (and in some cases by international partners e.g., JUICE) and other missions featuring payload for which the procurement is shared between ESA and the nationally funded consortia. For Euclid, for example, ESA is procuring the telescope assembly and the optical detectors, and the complete suite of focal plane detectors for PLATO is ESA-procured. For some missions (e.g., the recently launched Gaia mission) the payload is entirely ESA-procured.

The science ground segment of the missions is also in most cases procured under the shared responsibility of ESA and of the Member States, with ESA normally being responsible for the science operations and nationally funded consortia contributing to instrument-specific data processing and calibration activities. In some cases (e.g., Gaia through the DPAC) the scientific data processing is almost entirely performed by nationally funded consortia.

Any of the above schemes can be proposed in response to the present Call. Proposers will have to clearly indicate the proposed share of responsibilities between ESA and the member states, by indicating which mission elements they propose to be procured under their responsibility through funding from the Member States and which elements they propose to be ESA-procured.

Proposals will have to include letters of endorsement from the national funding agencies who would be interested in funding the provision of nationally funded elements. National funding agencies must state, in the letters of endorsement, their readiness to fund the Consortia throughout the study phase, and to undertake the necessary action to secure funding for the development and implementation of the nationally provided mission elements falling under their responsibility, contingent on the successful achievement of all the goals of the reviews mentioned above, and to the consolidation of the cost figures for all nationally funded mission elements.

The letters of endorsement will have to be addressed to the ESA Director of Science and Robotic Exploration, and sent directly by the national funding agencies by email to the address M4support@cosmos.esa.int. Copies of the letters must be attached to proposals in Annex as described below.

It is understood that coverage of the complete set of mission elements that are proposed to be nationally funded through letters of endorsement already at the time of the proposal submission may not be achievable. However proposers must strive to demonstrate the funding and feasibility of the proposed payload complement by showing the presence of at least a “core Consortium” (e.g., for astronomical telescopes with an integrated payload complement) or a “core payload complement” (e.g., for solar system missions featuring several individual instruments). It is understood that the funding scheme of the nationally provided mission elements may evolve during the study phase.

Assessment of the adequacy of the proposed Consortium/Consortia as demonstrated by the submitted letters of endorsement will form an important part of the proposal’s technical and programmatic evaluation. Following reception of the proposal, ESA may engage in a dialogue with the funding agencies who have provided letters of endorsement to discuss the

level of support that would be needed to achieve a successful study.

Prior to a given mission being considered as candidate for adoption in the Science Programme, ESA will subject all mission elements to a System Requirements Review (SRR), whose success is a necessary condition for the mission to be considered for adoption. This will include a detailed assessment of the technology readiness level, development and verification approach, schedule, technical risks etc. for all mission elements, including the ones that will be procured under Member State responsibility. The SRR also includes the evaluation of the ESA CaC. A key point will be the verification of the commitment status by the national funding agencies. Successful achievement of all the reviews goals will be a prerequisite for the mission to be considered as candidate for adoption.

5 SCIENCE MANAGEMENT

Proposers must clearly explain their science management concepts, including their proposed approach to data ownership issues, broad community involvement, share of mission responsibilities between ESA, the Member States and the international partners (if applicable, see above). Acceptance of proposal however does not constrain ESA to adhere to the proposed scheme, which will however constitute a starting point for the selected mission. A Science Management Plan will be, for the selection mission, prepared by ESA in coordination with the Science Study Team, and will need to be revised by the Science Advisory Structure of the ESA Science Programme and approved by the SPC.

6 LETTERS OF INTENT AND BRIEFING TO PROPOSERS

Prospective proposers must submit a mandatory letter of intent by the deadline of September 16, 2014, at 12:00 (noon) CEST. Submission of a Letter of Intent is a mandatory step; proposals not preceded by a corresponding Letter of Intent will not be considered. Letters of intent are limited in length to 4 A4 pages (minimum font size 11 pt), and their purpose is to allow ESA to perform an initial assessment of the range of science themes that will be proposed, and to prepare for the evaluation process.

Letters of intent must be structured to contain the following information:

- Proposal title;
- Name and contact information of lead proposer;
- Core team members (institutions, scientists) insofar as known/available;
- Scientific goals of mission;
- Possible mission configuration (including mission profile, payload/instrument configuration, technology, etc.);
- Potential payload consortium/consortia composition, and expected main funding agencies involved in the payload provision;
- Eventual (if applicable) possible proposed international collaboration elements for the mission.

Letters of intent may contain in attachment a list of supporters of the proposal; this attachment should be clearly marked as such, and will not be counted against the page

limit.

It is understood that the proposal’s structure and content may evolve between submission of the letter of intent and submission of the actual proposal, e.g., the composition of the payload Consortia, or the presence of possible international partners may evolve and be different in the actual proposal with respect to the Letter of intent. The lead proposer and the proposal’s title identified in the letter of intent, however, must remain the same throughout the process.

Letters of intent will be made available by ESA to national funding agencies and SPC delegations, hence ESA cannot guarantee their confidential treatment.

Any further communication between ESA and the proposing team will only take place through the lead proposer.

Failure to submit a letter of intent by the deadline stated above will disqualify teams/proposers from the possibility of submitting a proposal.

6.1 Briefing meeting

Following the submission of a Letter of intent, proposers will be invited to a briefing meeting, currently planned for September 26 (date TBC), to be held at ESTEC (The Netherlands). Confirmation of the date and of the logistical details for the briefing meeting will be communicated to the lead proposers indicated in the Letters of intent.

7 PROPOSAL STRUCTURE, PAGE LIMITS AND SUBMISSION

The deadline for submission of proposals in response to the present Call for missions is January 15, 2015, at 12:00 (noon) Central European Time. Late submissions will not be considered. Submissions are accepted exclusively in electronic form, in PDF format, using the interface available at http://sci.esa.int/2014_M4_Call Proposals will be limited in length to 51 A4 pages (not including title page, appendices, bibliography, etc.), with a minimum font size of 11 pt, and a maximum file size of 70 Mbytes. Proposals with file size in excess of the limit indicated above will be rejected by the submission system.

Proposals must contain all the information indicated here. Proposals missing one or more of the elements below may fail the initial technical and programmatic screening. The suggested number of pages for each topic is indicative unless otherwise stated. Proposers are thus free to give more relevance to one topic with respect to other ones. However the total number of pages in the proposal is a hard limit; proposals exceeding the total page limit will not be considered for evaluation.

7.1 Topics to be covered in the proposal and page limits

- Front cover (title page, 1 page, mandatory limit): must clearly indicate the proposal name, and the name of the Lead Proposer. Any other information is optional;
- Back cover (contact information page, 1 page, mandatory limit): must clearly indicate the contact information for the Lead Proposer. The proposal must explicitly state the availability of the Lead Proposer to support the study activities by making available at least 20% of his/her time throughout the study period;

- Executive summary (2 pages mandatory limit): it should contain a summary of the proposal, allowing the reader to gain a preliminary understanding of the proposal's content upon reading;
- Science case (10 pages, suggested length): it should clearly address the scientific rationale for the proposed mission, explaining the broad context, the progress in the relevant field that the proposed mission will achieve, the need to perform the relevant measurements from space, the eventual synergy with other facilities (ground- and space-based), etc. It is suggested to assume that the relevant readers will be scientists from other fields of space science, hence not necessarily experts in the field;
- Scientific requirements (5 pages, suggested length): for the selected mission a Science Requirements Document and a Mission Requirements Document will have to be produced rapidly; the information provided in this section will constitute the starting point for these documents. Proposers should explain how the science is “sized”, what the required measurements are, and how these translate in certain instrumental requirements. It should be understandable by both scientists and engineers;
- Proposed scientific instruments (15 pages, suggested length): it should explain, following on the definition of scientific requirements, what instrument(s) will be needed to achieve the required measurements. While the proposal is not intended to contain engineering blueprints, the information provided should allow readers to assess the feasibility and maturity of the proposed instruments. Relevant information about e.g. Technology Readiness Levels, heritage, etc. needs to be provided. To allow a proper technical evaluation of the proposal the following information needs to be provided:
 - Measurement principle/detection concept;
 - Block diagram: main building-blocks and subsystems, including software;
 - Design description (down to major subsystems) and operating principle;
 - Performance budgets;
 - Required resources: Volume, mass, power, data transmission;
 - Specific/critical interface requirements to the spacecraft and environment constraints, e.g. accommodation, integration, cooling, pointing, contamination and cleanliness, radiations, magnetic cleanliness, etc.
 - Specific calibration needs (on ground and in-orbit);
 - Technology readiness assessment per unit and relevant heritage;
- Proposed mission configuration and profile (10 pages, suggested length): a description of the proposed mission needs to be provided, including details of the orbit, launch, etc. together with the system level requirements imposed by the mission concept (e.g. pointing requirements, sun aspect angle constraints, specific observing modes etc). Relevant options and trade-offs should be identified, and a concept for the operations must be provided, describing the mission phases from launch to end of life (e.g. and as relevant: observing strategy, measurement sequence, specific modes for science or calibration aspects, spacecraft disposal at end of life, etc.). Details of the spacecraft should be provided as far as possible, including possible spacecraft design (if/how available), requirements/description of major sub-systems and estimation of spacecraft key budgets (possibly by benchmarking with previous missions). Proposers may make reference to the mission profiles described in the Annex to the present Call or deviate

from them, by providing necessary elements for enabling the proposal assessment;

- Management scheme (5 pages, suggested length): proposers should spell out the proposed procurement scheme for all mission elements, spelling out which elements are proposed to be ESA-procured and which procured by nationally funded Consortia. Should the mission be proposed as an international collaboration, the proposed collaboration scheme should be described in this section, too. Proposers should also describe their proposed science management plan (data policy, community involvement, etc.) as described in the relevant section in the present Call;
- Costing (2 pages, suggested length): while proposers are not expected to provide detailed costing information about the proposed mission, they should argue convincingly that the proposed mission can be implemented within the M4 ESA CaC ceiling of 450 M€, in particular if the proposed mission is deviating from the guidelines provided in the Annex;
- Bibliography: not required but encouraged. The list of references can be included as an Annex (see below), thus not counting against the page limit.

Letters of endorsement from national funding agencies or from eventual international partner agencies, as well as a bibliography list and eventual list of supporters should be clearly marked as proposal annexes, and will not count against the proposal page limits.

ESA will share the proposals with Member States funding agencies and with SPC delegations, e.g., for the purpose of discussing their commitment, as well as, when applicable, with the proposed international partners. ESA cannot therefore ensure the confidentiality of the submitted material.

8 PROPOSAL EVALUATION

Valid proposals received by the deadline for the present Call will be subject to a strict technical and programmatic screening by ESA, aiming at ascertaining the compatibility of the proposed mission with the Call's boundary conditions. Proposals which will be found to be incompatible with the Call's programmatic boundaries (i.e., within the budget ceiling of 450 M€, or within the planned schedule), or which do not provide the required endorsement for the mission elements proposed to be nationally provided (or provided by international partners) will be marked as “unfeasible” and will not be subject to scientific peer review.

Proposals that are considered feasible will be submitted to a scientific peer review process conducted through the Advisory Structure to the Science Programme, in which proposals will be assessed and graded under a number of criteria. The scientific peer review will provide the ESA Director of Science and Robotic Exploration with a list of proposals ranked on the basis of their scientific interest as candidates for the M4 opportunity. Based on this information, the ESA Director of Science and Robotic Exploration plans to select up to three proposals for a study phase.

A written debriefing will be provided to all proposers, that will comprise in all cases a short technical and programmatic assessment of the proposal, as well as, for the proposals which were submitted to the scientific peer review, a scientific evaluation. No face-to-face

debriefing meetings are planned.

9 DEADLINES AND SCHEDULE

Activity	Date
Release of Call for M4 mission	August 19, 2014
Letter of Intent submission deadline	September 16, 2014 (12:00 CEST)
Briefing meeting (ESTEC)	September 26, 2014 (TBC)
Proposal submission deadline	January 15, 2015 (12:00 CET)
Selection of missions for study	March 2015