# Call for mission concepts for the Large-size "L3" mission opportunity in ESA's Science Programme

## 1 PURPOSE OF THE PRESENT CALL FOR MISSIONS

The Director of Science and Robotic Exploration issued on 5 March 2013 a "Call for White Papers", with the aim of selecting the science themes for the L2 and L3 launch opportunities. A dedicated Senior Survey Committee (SSC) assessed the received White Papers and issued their report in October 2013[1]. The SSC recommended "The Gravitational Universe" science theme for the L3 launch opportunity.

The Science Programme Committee (SPC), at their 142nd meeting on 28-29 November 2013, approved the selection of the "The Gravitational Universe" science theme to be pursued by implementing a gravitational wave observatory for the L3 launch opportunity, with a planned launch date of 2034.

In late 2014, ESA's Director of Science and Robotic Exploration appointed an external committee, the Gravitational Observatory Advisory Team (GOAT), to advise on the scientific and technical implementation of L3. The GOAT issued its final Report[2] in March 2016 and recommended the use of laser interferometry for L3 mission, building on the excellent performance that the LISA-PathFinder (LPF) mission is demonstrating in-orbit. ESA has reinforced the technology preparation for the L3 mission in 2016 and plans to pursue this effort for enabling the mission adoption in due time for a launch in 2034.

The present Call aims at selecting a mission concept able to fulfil the science goals given in "The Gravitational Universe" science theme. The submitted proposals will be subject to technical and programmatic assessment by ESA and to peer review. As a result, a single mission concept will be defined, that will undergo an Assessment study (Phases 0 and A) to be carried out in parallel with nationally funded payload study activities. Following this phase and the confirmation of the necessary level of technological maturity, the selected mission concept will enter its Definition Phase, after which the mission will eventually be adopted.

## 2 BOUNDARY CONDITIONS

The proposals submitted in response to the present "L3 Call" for mission concepts must be compatible with the boundary conditions spelled out in the present section.

[1] http://sci.esa.int/cosmic-vision/53261-report-on-science-themes-for-the-l2-and-l3-missions/

[2] http://sci.esa.int/cosmic-vision/57910-goat-final-report-on-the-esa-l3-gravitational-wave-mission/#





European Space Agency
Agence spatiale européenne

## 2.1 Scientific goals of the proposed mission concepts

The mission concepts proposed in response to the present Call must address the science goals described in "The Gravitational Universe" science theme, to be pursued by implementing a gravitational wave observatory, as indicated in the "Report of the Senior Survey Committee on the selection of the science themes for the L2 and L3 launch opportunities in the Cosmic Vision Programme", mentioned in Section 1.

A space gravitational waves observatory can operate at low frequencies, in the range 0.1 to 100 mHz, where sources are plentiful, and since gravitational waves do not suffer from obscuration, they give access at once to the whole Universe.

The L3 mission will offer the opportunity to test the Einstein's General Theory of Relativity (GR) in strong-curvature space times, especially in the highly relativistic regime near the event horizon of the Schwarzschild-Kerr metric and will have the potential to access to physics on the scale of $10^{12}$ TeV.

The analysis of waveforms of gravitational waves emitted from merging massive black holes and from in-spirals of stellar mass objects into massive black holes will give access to the space-time properties in the strong curvature regime. The direct detection and subsequent quantitative analysis of gravitational waves from such systems will thus open a unique and transformational window to the fundamental physics of gravity.

Analysis of the gravitational waves will be a unique tool to study the otherwise unobservable last phases of the mergers of black holes in galaxy collisions and in-spiral events, as important driving elements of early galaxy evolution. As such observations are possible at very large redshifts, beyond z=15 or 20, thus the initial mass of seed black holes may be determined.

Gravitational waves can also help solving some key questions in Galactic astrophysics, such as: the explosion mechanism of Type 1a Supernovae, or the endpoints of stellar evolution, by measuring the merger rate of white dwarfs, neutron stars and stellar black holes.

## 2.2 Mission profiles

Large missions are defined for the purpose of the present Call as space missions whose total cost to be covered by the ESA Science Programme does not exceed 1.05 B€ and with an implementation schedule compatible with a potential 2034 launch. Experience shows that this funding ceiling allows, in the ESA Science Programme, for the implementation of an ESA-led Ariane 5-class mission, possibly with international collaboration.

ESA Science missions are, in general, collaborative undertakings between ESA and its Member States (as well as, in a number of cases, international partners). 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 aspects of the operations.

Payload elements are in most cases developed 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 with the contribution of international partners, e.g., JUICE or Euclid)

and other missions featuring payload for which the procurement is shared between ESA and the nationally funded consortia. For example, ESA is procuring the telescope assembly and the optical detectors for the Euclid mission. For some missions (e.g., Gaia) the payload was entirely ESA-procured.

The science ground segment of the missions is in most cases developed 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 the scientific data processing is almost entirely performed by nationally funded consortia (e.g., Gaia through the Data Processing and Analysis Consortium).

Any of the above or similar schemes can be proposed in response to the present Call.

Proposers must clearly discuss in their proposals the payload development and funding scheme they propose to adopt, together with the rationale for the approach.

The proposed mission must be compatible with a European launch vehicle using one of the launchers planned to be available at the time of L3 launch (likely Ariane 6.4), regardless of the possible international participation to the mission. The assumptions on launcher capabilities may be refined by ESA at a later stage depending on the evolution of the European launchers and on possible international cooperation schemes. Technical information on the European launchers can be found at http://www.arianespace.com.

The spacecraft operations must be compatible with the existing ESA ground stations (ESTRACK). Typical data rate capabilities vary from tens of kbit/s to tens of Mbit/s, depending on the spacecraft distance from Earth, the ground stations' size, the transmissions band and whether it is in down- or up-link. As an illustrative example, the downlink capability from a spacecraft at the Earth-Sun 2nd Lagrange point using Ka band can be as high as 75 Mbit/s during the visibility period of a ground station such as Malargue or Cebreros. Additional information can be found at http://www.esa.int/Our_Activities/Operations/Estrack/New_Norcia_-_DSA_1.

## 2.3 Management scheme

The proposal must indicate a Lead Proposer (who shall be the formal point of contact between the Agency and the proposing team during the study phase for the selected proposal) and clearly describe the structure and composition of the consortium or consortia proposing the mission and the distribution of responsibilities.

The proposed management scheme must clearly identify the responsibilities for all mission elements, indicating which elements are proposed to be ESA-procured and which procured by nationally funded consortia (with indication of the Funding Agencies expected to be involved for each element). Should the proposal foresee an international participation, the proposed contributions and collaboration scheme should be indicated. The consortium(a) organisation and the distribution of tasks and responsibilities should be described for both the Phase A and subsequent phases.

ESA will interact closely with Member State agencies during the mission selection process following the approach described in Section 3. ESA will also discuss with the proposed international partners any proposal that includes international participation (as detailed in Section 2.4), to verify the programmatic status of the proposed cooperation and the

partners' readiness to support the study phase of the mission under the proposed scheme.

Note that it is not planned to issue an "Announcement of Opportunity" for the payload of the mission selected for study. Hence (while susceptible of evolution if necessary) the consortium or consortia defined in the proposal will be tasked with carrying out the study activities for the selected proposal.

## 2.4 International cooperation

Large missions are European-led missions, which are however open to international participation in the form of contributions from international partners. In principle any mission element (i.e. payload, spacecraft, launch, operations, etc.) is open to "international participation", i.e. to provision of such element from partner agencies from non-ESA member states. Any contribution from international partners will have to foresee potential back-up solutions that are based on European technology, and their total envelope will be limited to approximately 20% of the total mission envelope.

Proposers are welcome to suggest possible schemes for international participation, including possible mission elements to be provided by international partners, bearing in mind that the actual scheme for mission implementation will be the outcome of the phase A study activities, and will depend on direct negotiations between ESA and the partner agencies.

Throughout the present document, the term "nationally funded" used to indicate mission elements (typically scientific instrumentation and science ground segment elements) not funded by ESA, must be understood to also potentially include elements funded by international partners.

## 2.5 Technological readiness

The adoption of the L3 mission is foreseen in 2023-2025, thus the overall time effectively available for mission preparation activities (including technology developments) is 4 to 6 years. The proposed mission concept must be compatible with the available preparation time, taking into account any study maturation activities that could be needed before initiating hardware technology developments. The minimum requirement is to reach ISO TRL 6 prior to mission adoption (see Technical Annex).

The selected mission concept will undergo definition studies leading to the identification and implementation of technology developments where needed. A Science Study Team will be appointed by ESA and will be responsible for providing guidance on all scientific aspects. The implementation approach is further detailed in Section 5.

Since the science payload often drives the technology requirements, the technology development effort will likely be shared between ESA and the Member States (and, if applicable, international partners) according to the respective responsibilities of the parties. The actual details of the responsibility share will be defined once the spacecraft and payload have reached sufficient definition maturity. A coordinated technology development between ESA and the payload consortium(a) is envisaged.

# 3 PROPOSAL ENDORSEMENT BY NATIONAL FUNDING AGENCIES AND INTERNATIONAL PARTNERS

ESA intends to implement an enhanced consultation phase with Member State agencies (and if applicable, with international partners) after Proposals submission and prior to their evaluation. Letters of Endorsement from Member State agencies (and international partners, if applicable) will be required after the Proposals submission, according to the deadline indicated in Section 4.

Proposers are of course strongly recommended to interact with their funding agencies already during the proposal preparation to verify their readiness to support the proposal.

The Letters of Endorsement will have to state the readiness of Member State agencies (or international partners, as applicable) to undertake the necessary activities to secure funding for the study (Phase B1, subject to the mission selection) and implementation (Phases B2/C/D/E/F, subject to the mission adoption) of the nationally provided mission elements falling under their responsibility, contingent on 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 sent directly by the Member State agencies (and international partners, if applicable) by email to the address:

endorsement-L3@cosmos.esa.int

It is understood that commitments by funding agencies of the complete set of mission elements proposed to be nationally funded may not be achievable by the time of the submission of the Letters of Endorsement. 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” for the payload complement. It is understood that the funding scheme of the nationally provided mission elements may require consolidation during the study phase prior to the mission selection.

Assessment of the adequacy of the proposed consortium(a) as demonstrated by its preliminary definition, including a distribution of tasks and responsibilities within the consortium(a) supported by the submitted Letters of Endorsement will form an important part of the proposal’s technical and programmatic evaluation.

# 4 SCHEDULE FOR THE PRESENT CALL FOR "L3" MISSION CONCEPTS

The overall schedule for the present Call is reported in Table 1. Submission deadlines will be strictly implemented.

**Table 1. Overall Schedule for the present Call**

| Activity | Date |
|---|---|
| Release of Call for L3 mission | 25 October 2016 |
| Letters of Intent submission deadline | 15 November 2016 (12:00 noon CET) |
| Briefing meeting (ESA-HQ Paris) | 24 November 2016 (TBC) |
| Proposals submission deadline | 16 January 2017 (12:00 noon CET) |
| Letters of Endorsement deadline | 9 March 2017 (12:00 noon CET) |
| Proposals evaluation | March – April 2017 |

## 4.1 Letters of intent

Prospective proposers are required to submit, by the deadline reported in Table 1, a Letter of Intent (LoI) stating their intention to submit a proposal in response to the present Call. Submission of a Letter of Intent is mandatory.

Proposals not proceeded by a corresponding Letter of Intent will not be considered.

LoIs are accepted exclusively in electronic form, in PDF format, using the interface available at http://www.cosmos.esa.int/web/2016-L3-mission-call

The LoIs should have a maximum length of 2 A4 page, minimum font size 11 pt. The letters should contain: a) the name and contact information of the Lead Proposer, b) the proposal title and c) the names and institutions of the core team members (insofar as known/available). The purpose of the LoI will be to allow ESA to make the necessary preparation for the proposal evaluation process. No support or endorsement letters should be attached to the LoIs.

The Lead Proposer and the proposal's title identified in the LoI must remain the same throughout the process.

LoIs will be made available by ESA to Member State agencies, SPC delegations and international partners (if applicable); hence ESA cannot guarantee their confidential treatment.

Any further communication between ESA and the proposing team will only take place through the Lead Proposer.

## 4.2 Briefing meeting

Following the submission of a LoI, proposers will be invited to a briefing meeting, currently planned for the date reported in Table 1, to be held at ESA-HQ, Paris, France (TBC). Confirmation of the date and location for the briefing meeting will be

communicated to the Lead Proposers indicated in the Letters of Intent.

## 4.3 Proposals

The deadline for submission of proposals in response to the present Call for mission concepts is reported in Table 1. Late submissions will not be considered. Submissions are accepted exclusively in electronic form, in PDF format, using the interface available at http://www.cosmos.esa.int/web/2016-L3-mission-call.

Proposals will be limited in length to 42 A4 pages, with a minimum font size of 11 pt, and a maximum file size of 50 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 in Section 6. Please, consult also the Technical Annex document. Proposals missing one or more of the indicated elements 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.

The submission deadline will be implemented strictly. Proposers are invited to submit their proposals well in advance of the deadline.

Proposals will be made available by ESA to Member State agencies, SPC delegations and international partners (if applicable); hence ESA cannot guarantee their confidential treatment.

# 5 PROPOSAL EVALUATION AND IMPLEMENTATION APPROACH

The purpose of the present Call is to select a mission concept and the payload consortium(a) who will provide the nationally funded payload and science ground segment elements.

Valid proposals (i.e., received by the deadline indicated in Section 4 and supported by Letters of Endorsement from Member State agencies as indicated in Section 3) will be subject to a technical and programmatic assessment by ESA, covering issues such as mission feasibility, technology readiness, management structure and proposed international collaboration scheme (if applicable).

The proposals will be subject to peer review, following which the Director of Science intends to select among competing concepts (if applicable) a single mission concept that is able to fulfil the science goals given in “The Gravitational Universe” science theme for further study. The recommended mission concept could contain elements from different proposals, should this be judged to provide the best overall science return to the European scientific community. All proposers will be notified of the evaluation of their proposals.

ESA will assemble a Science Study Team (SST) to initiate the required study activities. The SST will be selected by ESA to ensure required expertise.

The overall implementation timeline for the L3 mission is summarised in Table 2.

Following the Phase 0, which will be conducted by ESA with the support of the proposing team, the selected mission concept will undergo Phase A parallel industrial studies, to be carried out in parallel with nationally funded payload study activities with duration of approximately 24 months.

Following successful completion of this phase and confirmation of the necessary level of technological maturity, the selected mission concept will enter its Definition Phase.

The mission's adoption is foreseen to take place in 2023-2025, to be confirmed depending mainly on the evolution of the study activities and technology maturation speed.

The foreseen implementation approach described here is indicative only, and may be modified depending on the evolution of the ESA Science Programme.

**Table 2. Reference implementation timeline for the L2 mission**

| **Event** | **Date** |
|---|---|
| Selection of L2 mission concept | April 2017 |
| L3 internal Phase 0 studies completed | September 2017 |
| Industrial Phase A ITT | Late 2017 |
| End of Phase A studies and Mission Selection Review | Second half 2020 |
| Phase B1 completion and Mission Adoption Review | 2023-2024 (*) |
| Mission adoption | 2024-2025 (*) |
| Industrial kick-off of Phase B2/C/D/E1 | 2025 |
| Launch | 2033 - early 2034 (**) |

(*) depending on technology maturation

(**) depending on technology maturation and actual development schedule

# 6 PROPOSAL OUTLINE

Table 3 summarises the expected content of the proposals. The suggested number of pages for each topic is indicative, unless otherwise stated. Please, consult also the Technical Annex document.

**Table 3. Proposal Outline**

| Item | No. Pages |
|---|---|
| Cover Page (1 page mandatory limit) | 1 |
| Proposal contact details (1 page mandatory limit) | 1 |
| Executive summary (2 pages mandatory limit) | 2 |
| Introduction | 1 |
| Scientific performance necessary to achieve the "Gravitational Universe" objectives | 6 |
| Mission profile proposed to achieve the scientific performance | 4 |
| Model payload | 9 |
| System requirements and spacecraft key issues | 5 |
| Science operations and archiving | 2 |
| Technology development requirements | 2 |
| Management scheme and cost analysis | 8 |
| References | 1 |
| **Total** | 42 |

## 6.1 Cover page

*1 page mandatory limit*

Must clearly indicate the proposal name and the name of the Lead Proposer. Any other information is optional.

## 6.2 Proposal contact details

*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. Note that the Lead Proposer will be the formal point of contact between the Agency and the proposing team throughout the study phase.

It can also contain a list of "core team" members and their institutions.

## 6.3 Executive summary

*2 pages mandatory limit*

Must contain a summary of the proposal.

## 6.4 Introduction

Must contain an introduction to the proposal.

## 6.5 Scientific performance

The overall scientific objectives of the proposed mission concept are defined in the "The Gravitational Universe" science theme (see Section 2.1). The proposal should show how the proposed mission concept is able to achieve these goals and what scientific performance is required to do so. The proposers may wish to elaborate briefly on the scientific issues that could be addressed by the proposed mission concept. The proposal should detail how the proposed mission concept will be able to achieve the necessary performance. This includes in particular:

1. Identification of the observable parameters that are relevant to the mission,
2. Identification of the tasks to be achieved for the mission success,
3. Clear description of the measurement objectives, with prioritisation of any options,
4. Measurement and operational requirements to be achieved, such as:
    i. Performance requirement of a mission-specific observable parameter,
    ii. Radiometric performance requirements,
    iii. Observation strategy requirements,
    iv. Stability and reproducibility requirements,
    v. Timing requirements in the execution of the mission.
    vi. Etc.

The measurement and operational requirements should be understandable by engineers and will constitute the skeleton for elaborating the Science Requirements Document and the Mission Requirements Document in the study phases. Examples are the duration of the observations, the required signal-to-noise ratio, the number of observations to be performed, etc.

The proposal should summarise in tabular form the mission success criteria, which are associated with the minimum science requirements defined in "The Gravitational Universe" science theme.

## 6.6 Mission profile

The main requirements on the mission profile should be described, such as:

1. Launcher,
2. Preferred orbits,
3. Operational modes (concept of operations),
4. Mission lifetime,
5. Communication requirements,
6. Ground segment assumptions,
7. Etc.

Alternative mission scenarios (e.g., alternative orbit selection, alternative launcher) should be briefly presented in the proposal. The mission profile should not be assumed as definitive, as it will be subject to future analysis and optimisation.

## 6.7 Model payload

The model payload is the proposed instrumentation for achieving the science measurement objectives and the related science goals. Particular emphasis should be given to its definition and description. The model payload concept and its reference instrumentation should be clearly connected to the discussion on the science requirements.

The model payload description should include:

1. Description of the measurement technique,
2. Instrument conceptual design and key characteristics,
3. Performance assessment with respect to science objectives,
4. Resources: mass, volume, power, on board data processing, data handling and telemetry,
5. Pointing and alignment requirements,
6. Operating modes,
7. Specific interface requirements: configuration needs, thermal needs (e.g. radiator for cooling),
8. Calibration and other specific requirements,
9. Current heritage and Technology Readiness Level (TRL, see Technical Annex),
10. Proposed procurement approach,
11. Critical issues.

The payload can include elements to be procured and funded by ESA, with instrumentation provided by nationally funded consortia (eventually including international cooperation). In this case, the proposal should provide an overall payload conceptual design and address the specific design and performance requirements of the instrumentation. This includes provision of the main design parameters, performance requirements and discussion of accommodation and instrument operation principles.

## 6.8 System requirements and spacecraft key factors

The system requirements applicable to the spacecraft platform design should be identified and discussed. These should be derived from the science measurement objectives and the proposed model payload. This includes requirements impacting on the subsystems necessary to support the payload, in particular:

1. Requirements on the Attitude and Orbit Control System including specific pointing requirements,
2. On-board data handling and telemetry requirements (data volume and rates),

3. Mission operations concept (ground segment),
4. Specific environmental constraints (EMC, temperature, cleanliness),
5. Other specific requirement(s) of relevance to the space and ground segment design (e.g. timing accuracy, on-board software).

The most challenging system requirements should be specifically outlined as design drivers. These requirements will be reviewed and used in future ESA study phases to further iterate the whole mission design, from the ground segment to the space segment, including launcher services and mission operations.

Supported by these system-level requirements and identified design drivers, a basic spacecraft concept should be proposed. It should contain a general description of the overall spacecraft configuration, highlighting how the design and spacecraft key factors meet the requirements. The overall necessary spacecraft resources should be estimated (mass, power) and their compatibility with the selected launcher and mission profile assessed. When relevant, similarity with previous missions or studies can be argued for the resource allocation.

## 6.9 Science operations and archiving

An overview of the envisaged science operations concepts should be provided. Topics to be addressed should include:

1. Community interfaces and interactions,
2. Need, if any, for support from ground-based measurements,
3. Scientific mission planning, scheduling of measurements,
4. Expected volume and format of the acquired data,
5. Quick-look assessment of data,
6. Ground data processing structure (pipelines, etc.) and challenges,
7. Data distribution and archiving.

The proposed approach to management of science operations should be outlined, including proposed share of responsibilities for the operations and proposed funding source(s) (e.g., national institutes, national funding agencies, ESA Science Programme).

The proposal should also outline the proposed science management plan and data policy for the mission (e.g., what is the data return foreseen for all involved partners, what data would be publicly available, etc.), bearing in mind the need to balance between fulfilling the goals outlined in “The Gravitational Universe” science theme and the involvement of the widest scientific community.

## 6.10 Technology development requirements

The proposal should identify the technological development needs that are required for both the payload and the spacecraft platform, and propose how these developments could be implemented. The aim is to give confidence that ISO TRL 6 can actually be reached by the time of the mission adoption, by taking into account the technological steps to achieve

but also other implementation constraints such as the maturation time for the technical definition, organisation aspects, funding and expenditure profile, etc.

TRL 6 does not require a full-scale demonstration of the spacecraft and payload elements. Conversely, it does require that the manufacturing processes of all the spacecraft components, including the science instrumentation, be demonstrated to meet the required performance in the expected environment in orbit, by taking into account potential uncertainties related to coupling effects. TRL 6 is also the minimum technology maturity level that enables the establishment of a meaningful development schedule for the payload and spacecraft.

Therefore, the technology maturity assessment should start by identifying critical elements of the spacecraft platform and payload which are either new, or have never been demonstrated to meet the performance required for the mission success and in the relevant environment. The technology development activities should focus on these critical elements and remove the associated uncertainties through appropriate pre-developments.

The proposal should clearly address the consequences of the technology development activities failing to meet the requirements: back-up solutions relying on existing and demonstrated technologies should be identified whenever possible, and their impact on the science objectives discussed. Proposed checkpoints and milestones should be included in the discussion of a preliminary development plan.

## 6.11 Management scheme and cost analysis

A comprehensive view of the proposed mission implementation scenario(s) and overall management approach should be provided, including:

1. A programme management plan,
2. A basic integration and verification approach and model philosophy,
3. A basic programme schedule,
4. Preliminary risk analysis,
5. Preliminary cost analysis of the mission elements: technology developments, space segment, operations and ground segment,
6. International partners (if applicable) and their proposed role.

As part of the programme management plan, the proposers should provide information regarding specific capabilities and experience in the scientific institutes involved in the proposal and spell out the proposed procurement scheme for all mission elements, indicating which elements are proposed to be ESA-procured and which procured by nationally funded consortia or international partners (if applicable). The consortia organisation and the distribution of tasks and responsibilities (work breakdown structure for the core team with key persons) should be detailed, for both the Phase A and subsequent phases. The proposers are also invited to detail where relevant any specific task they believe should be achieved during the Phase A, in addition to the regular Phase A study activities. Should the mission be proposed as an international collaboration, the proposed collaboration scheme should be described in this section.

The proposal should clearly identify tasks and cost elements that are proposed to be

respectively under the responsibility of the ESA Science Programme, scientific institutes using Member States funding, and international partners, if any.

The overall implementation schedule should be based on the reference implementation timeline given in Table 2. This timeline is indicative and for reference purposes only. The actual timeline will be tailored to the selected mission, and may change depending on the Science Programme's programmatic evolution.

## 6.12 References

Include references as needed.

# 7 BACKGROUND INFORMATION

The definition of the space missions in the Science Programme is based on competitive "Calls for Missions". Through this approach, Solar Orbiter and Euclid were selected in 2011 as the first and second Medium missions (M1 and M2), followed by JUICE, selected in 2012 as the first Large mission (L1) in the Cosmic Vision plan. CHEOPS was selected in 2012 as the first Small mission (S1) and PLATO in 2014 for the M3 opportunity. As already mentioned in Section 1, through a "Call for White Papers" the science themes for the L2 and L3 launch opportunities were selected in 2013: "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, with planned launch dates of 2028 and 2034, respectively. The Athena mission was then selected in 2014 for the L2 mission opportunity. The call for the implementation of the "M4" Medium mission resulted in 2015 in the selection of ARIEL, THOR and XIPE mission concepts for study, with a planned down selection for the M4 opportunity in 2017. Finally, SMILE was selected in 2015 as a joint science mission between ESA and the Chinese Academy of Science.

In February 2016 a Call was issued to solicit from the broad scientific community proposals for the competitive selection of new "Science Ideas", to be investigated in terms of feasibility and needed technology developments. The Call is not intended to replace future Calls for M or L missions, but aims at stimulating the emergence of new and innovative science ideas based on technologies not yet sufficiently mature, possibly to become potential candidates for future M or L mission Calls in the ESA Science Programme.

In April 2016 a Call for Missions was issued to solicit from the broad scientific community proposals for the competitive selection of mission concepts to be candidate for the implementation of the "M5" Medium mission.

# 8 CONTACT

For any further information or questions about the present Call please contact:

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# 9 LIST OF ACRONYMS

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|---|---|
| ARIEL | Atmosheric Remote-sensing Infrared Large-survey |
| ATHENA | Advanced Telescope for High ENergy Astrophysics |
| CaC | Cost at Completion |
| CET | Central European Time |
| CHEOPS | CHaracterising ExOPlanet Satellite |
| EMC | Electro Magnetic Compatibility |
| ESA | European Space Agency |
| ESTEC | European Space Research and Technology Centre |
| ESTRACK | European Space Tracking |
| Gaia | Global Astrometric Interferometer for Astrophysics |
| GOAT | Gravitational Observatory Advisory Team |
| GR | General Theory of Relativity |
| ISO | International Standards Organization |
| JUICE | JUpiter ICy moons Explorer |
| LoI | Letter of Intent |
| LPF | LISA-PathFinder |
| MOC | Mission Operations Centre |
| NASA | National Aeronautics and Space Administration |
| PDF | Portable Document Format |
| PLATO | PLAnetary Transits and Oscillation of stars |
| SMILE | Solar wind Magnetosphere Ionosphere Link Explorer |
| SOC | Science Operations Centre |
| SPC | Science Programme Committee |
| SSC | Senior Survey Committee |
| SST | Science Study Team |
| TBC | To Be Confirmed |
| THOR | Turbulence Heating ObserveR |
| TRL | Technology Readiness Level |
| XIPE | X-ray Imaging Polarimetry Explorer |