2023 Astrophysics Probe Explorer (APEX) Preproposal Conference

Science Evaluation Overview

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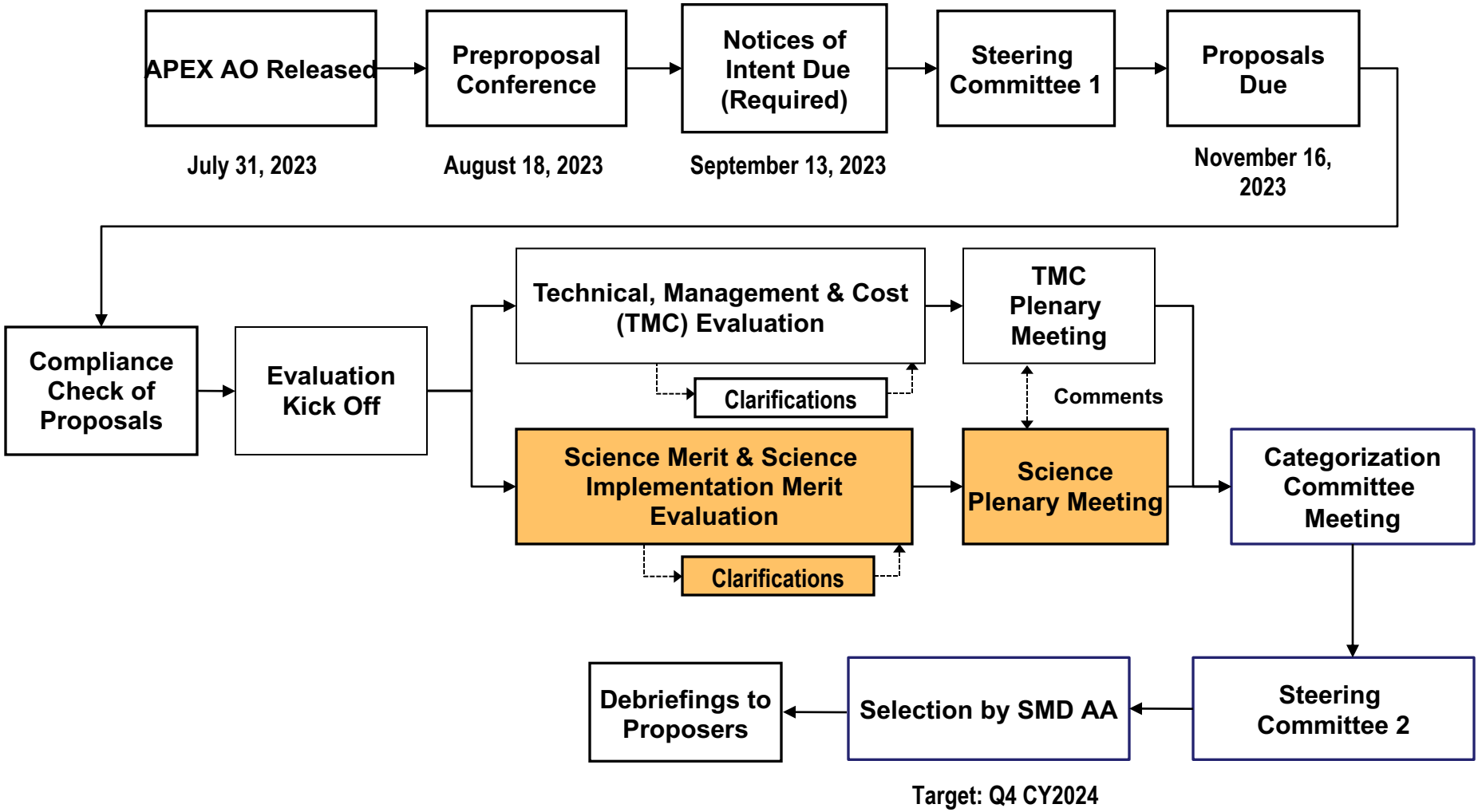
Science Requirements

- In 2021, the National Academies' 2020 Decadal Survey in Astronomy and Astrophysics, Pathways to Discovery in Astronomy and Astrophysics for the 2020s (https://www.nap.edu/catalog/26141/pathways-to-discovery-in-astronomy-and-astrophysics-for-the-2020s) (2020 Decadal Survey), recommended probe missions to be competed in broad areas identified as important to accomplish the 2020 Decadal Survey's scientific goals and objectives. Thus, the Probe class of mission was added to the Explorers Program portfolio.
- For the coming decade, the 2020 Decadal Survey recommends a far-infrared mission or an X-ray mission as a Probe-class mission.
- Responses to the APEX AO are limited to one of those two mission themes recommended by the Decadal Survey. These areas are
  - A far-infrared imaging or spectroscopy mission, and
  - An X-ray probe.
- Proposals must be responsive to the preponderance of the mission theme's objectives as provided in Sections 7.5.3.2 through 7.5.3.4* of the 2020 Decadal Survey.

***Proposals do not need to be responsive to the portion of section 7.5.3.4 of the Decadal Survey that recommends an X-ray probe mission to complement ESA's Athena Observatory objective.**

Proposal Evaluation Flow



Scientific Merit and Science Implementation Merit

- The information provided in a proposal will be used to assess the **intrinsic scientific merit** (Form A) and the **science implementation merit** (Form B) of the proposed investigation.
- Scientific merit will be evaluated for the Baseline Science Investigation and the Threshold Science Investigation.
- "Baseline Science Investigation" is the investigation that, if fully implemented, would fulfill the Baseline Science Requirements, which are the performance requirements necessary to achieve the full science objectives (APEX AO Section 5.1.4, and Req B-12)
- "Threshold Science Investigation" is a descoped investigation that would fulfill the Threshold Science Requirements, the performance requirements necessary to achieve the minimum acceptable data and scientific return for the investigation, below which the investigation would not be worth pursuing. (APEX AO Section 5.1.4, and Req B-13)

Requirement 12: Proposals shall specify only one Baseline Science Investigation and only one Threshold Science Investigation.
Requirement 13: The description of the Threshold Science Investigation must include the impact on the described potential GO/GI science value.

- Only the science panels consider the Threshold Investigation; TMC evaluates only the Baseline Investigation.

APEX Requirements: Scope of Proposed Investigation (APEX AO Section 5.1.1)

Requirement 3: Proposals shall describe a PI-led science investigation with goals and objectives that address the program science objectives described in Section 2, by addressing a preponderance of the science objectives as provided in Sections 7.5.3.2 through 7.5.3.4* of the 2020 Decadal Survey for either an X-ray Probe or a Far-Infrared Probe.
***Proposals do not need to be responsive to the portion of section 7.5.3.4 of the Decadal Survey that recommends an X-ray probe mission to complement ESA's Athena Observatory objective.**

Requirement 4: Proposals shall demonstrate how the proposed investigation will fully achieve the proposed objectives.
Requirement 5: Proposals shall demonstrate how achieving the science objectives of the investigation requires the provision of a spaceflight mission.

A **goal** has a broad scope: e.g., understand dense matter inside neutron stars

An **objective** is a more narrowly focused part of a strategy to achieve a goal: e.g. infer neutron-star radii to xx precision, measure neutron-star masses to yy precision.

An investigation might only **make progress toward a goal** without fully achieving it.

Proposed investigations must (plan to) achieve their proposed objectives: the objectives must be **specific** enough that the proposal can make the case that they are scientifically compelling, and that the investigation can achieve them.

APEX Requirements: Investigation Science Objectives and Requirements (APEX AO Section 5.1.2)

Requirement 6: Proposals shall state the specific science objectives of their PI-led science investigation and the required measurements at a level of detail sufficient to allow an assessment of the capability of the proposed mission to make those specific measurements and whether the resulting data are necessary and sufficient to the achievement of these objectives (see Appendix B, Sections D and E, for additional detail).

Requirement 7: The proposal shall describe the potential scientific value of a General Observer and/or Guest Investigator program consistent with the 2020 Decadal Survey science objectives, and shall describe the programmatic value of potential GO and/or GI science investigations within the context of other ongoing missions.

Requirement 8: The proposal shall describe how achieving the required measurements for the PI-led proposed science objectives would demonstrate the capability of the Observatory to successfully enable the potential scientific value of a General Observer and/or Guest Investigator program.

APEX Requirements: Traceability of Proposed Investigation (APEX AO Section 5.1.3)

Requirement 9: Proposals shall describe the proposed instrumentation, including a discussion of each instrument and the rationale for its inclusion in the proposed PI-led investigation or in enabling GO/GI investigations.

Requirement 10: Proposals shall clearly state the relationship between the science objectives, the data to be returned, and the instrument complement to be used in obtaining the required data (see Appendix B, Section D, for additional detail).

Requirement 11: Proposals shall include a Data Management Plan (DMP). The DMP shall discuss the approach to their PI-led data analysis, management and archiving plans to calibrate (both preflight and in-flight), analyze, publish, and archive their PI-led investigation data returned, and shall demonstrate, analytically or otherwise, that sufficient resources have been allocated to carry out these plans within the proposed mission cost. The DMP shall include a discussion and justification of any data latency period (see Appendix B, Section E.4, for additional detail). The DMP shall be in compliance with the requirements and guidelines in the NASA Plan for Increasing Access to the Results of Scientific Research and SPD-41, or a justification shall be provided that this is not necessary given the nature of the work proposed (see Section 4.4.2). The costs for the data analysis, management and archiving of GO or GI investigations are outside the PIMMC.

APEX Requirements: Traceability of Proposed Investigation (APEX AO Section 5.1.4)

The traceability matrix (**Requirement B-19**) tabulates what must be observed, to what precision, for how many objects, etc. to achieve the science objectives of the mission.

Requirement 14: Proposals shall not include any descopes or other risk mitigation actions that result in the mission being unable to achieve the Threshold Science Mission objectives.

APEX Requirements: General Observer/ Guest Investigator (GO/GI) Program (APEX AO Section 5.1.5)

Requirement 15: A proposed Pointed Observatory shall include a GO program that is no less than 70% of the mission observing time. The time allocated for the GO program shall not be useable by either the baseline PI-led science mission or any proposed SEO. The Guaranteed Time Observing (GTO) allocated to the PI-led science mission and any proposed SEO shall be as small as possible while still enabling the PI-led science investigation. The proposal shall state the fraction of the mission duration that is allocated for GTO and shall demonstrate that this is the minimum observing time required to meet the objectives of the PI-led science investigation.

Requirement 16: If a Pointed Observatory is proposed, the proposal shall include proposed observing cadence for the PI-led program throughout the prime mission years and justify any cadence that does not include time throughout the duration of the prime mission.

A proposed mission that is a hybrid of a survey and a pointed observatory mission will then have 70% of the pointed observatory program required to be available to general observers.

Requirement 17: The proposal shall select one of the NASA General Observer Facility (GOFs) (GSFC, STScI, IPAC, CXC) for the GO/GI activities. NASA reserves the right to decide after selection that the proposed GOF is not the optimal one and will choose an alternate.

APEX Requirements: Science Enhancement Options
(APEX AO Section 5.1.6; deferred to Step 2)

GO or GI programs that would require instrument modes or data processing beyond those that are used or validated for the PI-led science program, or a greater intensity of mission operations (e.g. Targets of Opportunity, solar system objects, etc.) than is planned to be used or validated for the PI-led program, should be proposed as Science Enhancement Options (SEOs) (see Section 5.1.6). SEOs do not count towards the science merit of a proposal.

All APEX missions will include General Observer/ Guest Investigator programs, as applicable. In addition all projects completing their prime science operations (Phase E) will be considered for extended missions as part of SMD's triennial Senior Review process. Consequently, SEOs will only need to be described in Concept Study Reports if they are atypical (e.g., a complementary ground campaign, complementary observations by other NASA observatories, GO/GI instrument modes or data processing beyond those that are used or validated for the PI-led science program). Costs for proposed SEO activities must be defined in Concept Study Reports, but will not count as part of the PIMMC. Proposed SEOs that are for GO/GI instrument modes or data processing beyond those that are used or validated for the PI-led science program should justify the budget profiles. Concept Study Reports will also need to describe any additional effort required by the baseline investigation team to accommodate the SEOs.

Evaluation of Scientific Merit (1)

The information provided in a proposal will be used to assess the intrinsic scientific merit of the proposed investigation. Scientific Merit will be evaluated for the Baseline Science Mission and the Threshold Science Mission. There are 4 factors.

Factor A-1. Compelling nature and scientific priority of the proposed investigation's science goals and objectives.

- This factor includes the clarity of the goals and objectives;
- how well the goals and objectives reflect program, Agency, and national priorities;
- the potential scientific impact of the investigation on program, Agency, and national science objectives;
- and the potential for fundamental progress,
- as well as filling gaps in our knowledge relative to the current state of the art.

Factor A-1 applies only to the PI-led investigation.

Factor A-2. Programmatic value of the proposed investigation.

- This factor includes the unique value of the investigation to make scientific progress in the context of other ongoing and planned missions;
- the relationship to the other elements of NASA's science programs;
- how well the investigation may synergistically support ongoing or planned missions by NASA and other agencies; and
- the necessity for a space mission to realize the goals and objectives.

Factor A-2 applies only to the PI-led investigation.

Factor A-3. Scientific value of the Threshold Science Investigation.

- This factor the scientific value of the Threshold Science Investigation using the standards in Factor A-1 of this section, and whether that value is sufficient to justify the proposed cost of the mission.
- This factor should include the scientific value of the potential GO/GI science during a Threshold Science Investigation.

Factors A-1, A-2 and A-4 are evaluated for the Baseline Science Investigation, assuming it is implemented as proposed and achieves technical success.

Factor A-3 is similarly evaluated for the Threshold Science Investigation.

Scientific Merit (4)

Factor A-4. Compelling nature and scientific priority of any potential General Observer or Guest Investigator investigations.

- This factor includes the potential scientific impact of the GO/GI investigations on program, Agency, and national science objectives; and
- the potential for GO/GI investigations to make fundamental progress
- as well as filling gaps in our knowledge relative to the current state of the art.

Factor A-4 is evaluated for GO/GI investigations enabled by the PI investigation and does not include any GO/GI that are enabled by an SEO as described in Section 5.1.6.

Scientific Implementation Merit and Feasibility (1)

The information provided in a proposal will be used to assess merit of the plan for completing the proposed investigation, including the scientific implementation merit, feasibility, resiliency, and probability of scientific success of the proposed investigation. There are 7 factors.

- **Factor B-1. Merit of the proposed mission architecture, instruments, and measurement techniques for addressing the goals and meeting the science objectives.**
- This factor includes how well the anticipated measurements support the goals and objectives;
- the appropriateness of the selected instruments and mission architecture for addressing the goals and objectives;
- and the appropriateness of the mission requirements for guiding development and ensuring scientific success.

Factor B-1 applies only to the PI-led investigation.

Factor B-2. Probability of technical success.

- This factor includes the maturity and technical readiness of the instruments, or demonstration of path to achieve necessary maturity;
- the adequacy of the plan to develop the instruments within the proposed cost and schedule;
- the robustness of those plans, including recognition of risks and mitigation plans for retiring those risks;
- the likelihood of success in developing any new technology that represents an untested advance in the state of the art;
- the ability of the development team - both institutions and individuals - to successfully implement those plans; and
- the likelihood of success for both the development and the operation of the instruments within the mission design.

Factor B-2 applies only to the PI-led investigation.

Factor B-3. Data adequacy, analysis, and archiving

- This factor includes the degree to which the proposed mission and instruments can provide the quality and quantity of data necessary to complete the investigation and meet the proposed science objectives.
- Additionally, it includes the merit of data analysis plans, including the fidelity of physical models required to connect the measurements to the science objectives; and
- plans for archiving, to preserve data and analysis of value to the science community.

Considerations in this factor include

- planning and budget adequacy, with plans for well-documented, high-level data products and software usable to the entire science community; adequate resources for physical interpretation of data;
- reporting scientific results in the professional literature (e.g., refereed journals); and
- timely release of the data to the public domain.

Factor B-3 applies only to the PI-led investigation.

Factor B-4. Science resiliency.

- This factor includes both developmental and operational resiliency.
- Developmental resiliency includes the approach to descoping the Baseline Science Investigation to the Threshold Science Investigation in the event that development problems force reductions in scope.
- Operational resiliency includes the ability to withstand adverse circumstances, the capability to degrade gracefully, and the potential to recover from anomalies in flight.

Factor B-4 applies only to the PI-led investigation.

Factor B-5. Probability of science team success.

- This factor will be evaluated by assessing the experience, expertise, and organizational structure of the science team and the mission design in light of any proposed instruments.
- The role of each Co-Investigator will be evaluated for necessary contributions to the proposed investigation;
- the inclusion of Co-Is who do not have a well defined and appropriate role may be cause for downgrading of the proposal.

Factor B-5 applies only to the PI-led investigation.

Factor B-6. Merit of the Diversity and Inclusion Plan.

- This factor includes an evaluation of the Diversity and Inclusion Plan.
- Individuals with practical and/or research experience in IDEA topics and the applications of IDEA principles will evaluate the Diversity and Inclusion Plan focusing on how executable and effective the Plan is expected to be.

Related but separate: The panel evaluating the "Science Implementation Merit and Feasibility" will provide comments to NASA regarding the extent to which the proposed investigation provides career development opportunities to train the next generation of science leaders. While these comments will not be considered in the evaluation, they may be considered during selection.

Factor B-6 applies only to the PI-led investigation.

Factor B-7. Merit of the proposed mission architecture, instruments, and measurement techniques for addressing the potential General Observer or Guest Investigator science.

- This factor includes how well the anticipated measurements for the PI-led proposed science would demonstrate the capability of the Observatory to successfully perform the potential General Observer or Guest Investigator program.

Factor B-7 does not apply to any proposed SEOs for GO/GI instrument modes or data processing beyond those that are used or validated for the PI-led science program.

Science reviewers: conflict of interest

Science reviewers are generally active scientists, and must avoid conflicts of interest through their organizational affiliations and scientific activities.

Rules for conflict of interest follow SPD-01A, as for research proposals. But in contrast to research proposal reviews, every APEX proposal competes with every other APEX proposal. This means

- A reviewer with a conflict of interest with one APEX proposal has a conflict with all of them.
- Thus if one APEX proposal includes a Co-Investigator (or other funded participant) from organization X, no employee of organization X can review any APEX proposal.
- Science collaborators, and hence the organizations that employ them, contribute effort to a proposal. Before inviting other scientists from such organizations as reviewers, we must consider scientific community standards on conflict of interest. In particular, someone who is a collaborator on an APEX proposal cannot review any other APEX.
  - **Requirement 65:** Proposals shall identify and designate all collaborators and describe the role of each collaborator in the development of the investigation. This shall include the expected fraction of time the collaborator will be involved in the mission over the course of Phases A-D. Inclusion of collaborators with less than 10% of their time allocated to the mission over the course of Phases A-D must be justified.

An over-large science team may result in a weakness on Factor B-5, and reduces the reviewer pool.

If all the experts in your field are on your science team, who will review your proposal??

Questions?