The PI-Led Mission Proposal Process

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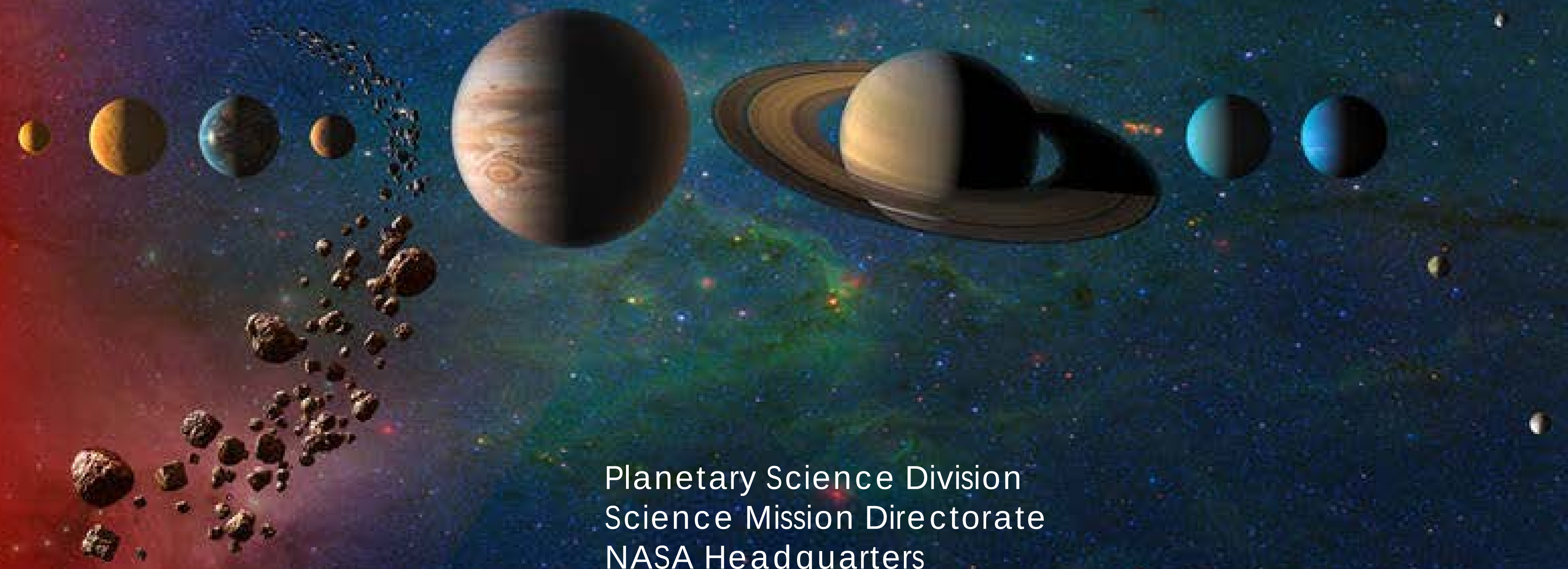


Planetary Science Division
Science Mission Directorate
NASA Headquarters

February 8, 2021
Revision 3 February 5, 2021

Outline

https://commons.wikimedia.org/wiki/File:CircusTent02.jpg

Development of Announcements of Opportunity (AOs)

Review Process

Recent Changes

Diversity

Principal Investigators and cultural differences across SMD

Backup—Details on evaluation process SMD

Today is intended to be a discussion. I've put question breaks in at the end of key sections. But ask questions via the chat window and I'll make a periodic look.

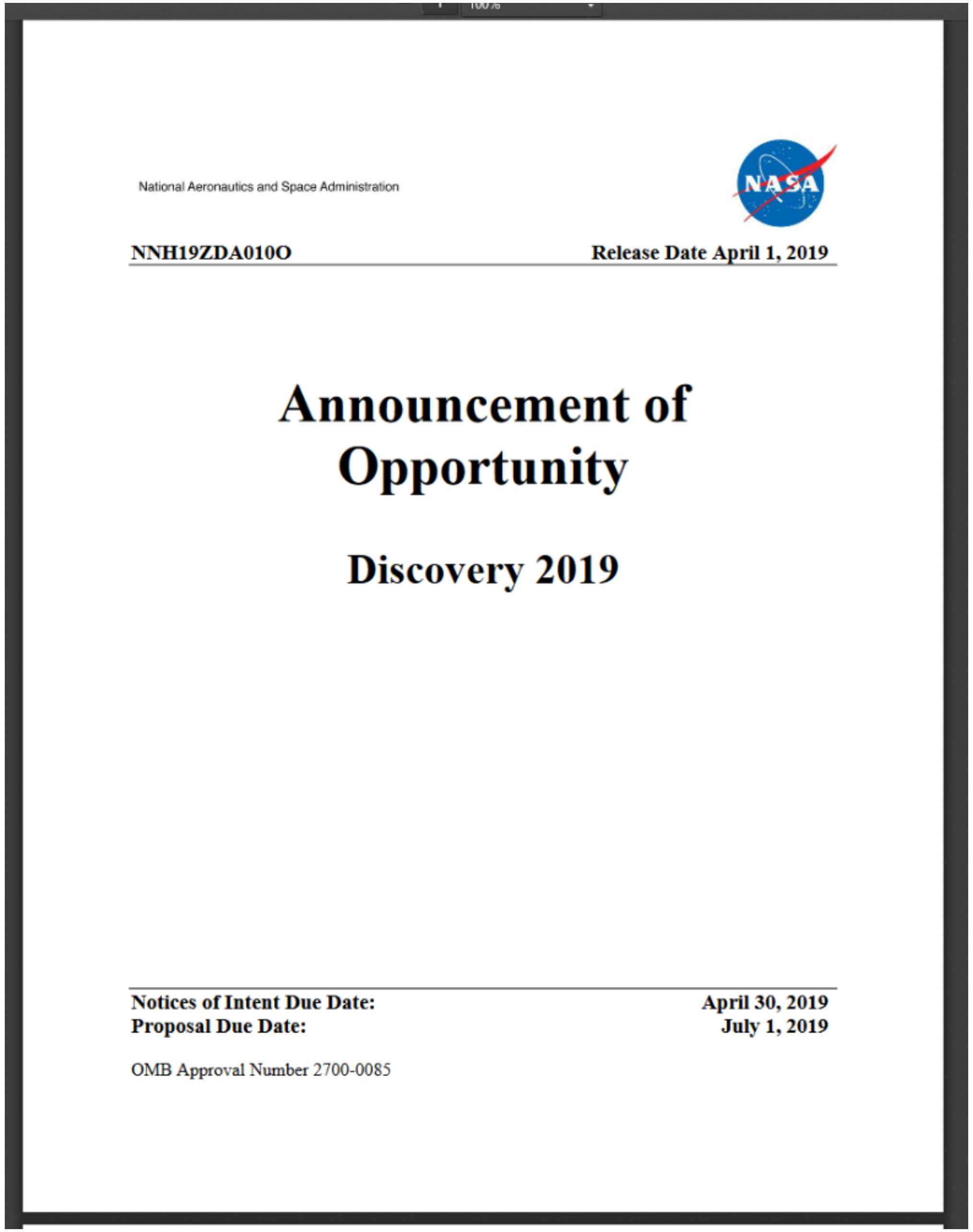
Development of AOs

Ideas and content for AOs come from:

- **Decadal Survey recommendations, which can include:**
  - Recommendations for program that are open to any topic, e.g., Discovery, Earth Ventures
  - Specific recommendations to bound submissions to a competed program; e.g., New Frontiers
  - Competing aspects of strategic missions, such as the instruments
  - Moving continuity measurements that had been strategic to competed AOs, e.g., recent Earth Science Decadal.
- **Administration or other NASA priorities**
  - Emerging areas such as SmallSats.
  - Lowering costs of specific missions.
- **Comments and feedback from the science community, proposers, advisory committees are also routinely considered in AO development, especially to reduce the burden on proposers, improve the process.**

Requests for Information (RFIs) and Draft AOs are published for comment on betaSAM.gov

- Responses are open to anyone
- All feedback is collected and reviewed in detail
- Often results in revisions.


National Aeronautics and Space Administration

NNH19ZDA010O Release Date April 1, 2019

Announcement of Opportunity

Discovery 2019

Notices of Intent Due Date: April 30, 2019
Proposal Due Date: July 1, 2019

OMB Approval Number 2700-0085

Example of an AO

…provide frequent flight opportunities for high quality, high value, focused, planetary science investigations that can be accomplished under a not-to-exceed cost cap.

Investigations must

- Support the goals and objectives of the Discovery Program,
- Be implemented by Principal Investigator (PI) led investigation teams
- Provision of complete spaceflight missions.
- $500M cost cap
- Goal to release every 4 years and select 2 missions.

The AO is 142 pages long with ~200 detailed requirements…highly proscribed.

The resulting proposal will be ~300 pages. A lot of work for the proposing team!

Proposal Structure and Page Limits		
Section	**Contents**	**Page Limits**
A	Proposal Summary Information Graphic Cover Pag	As per NSPIRES 1 0.5 0.5
		2
C	Table of Contents	None
D E	Science Investigation Science Implementation	30 + 2 pages / additional non-identical instrument + 1 page for linkage to Decadal Survey (Requirement 13) **

Only 30 of the 300 pages is science!

Point being: Hard to write and much work in proposals for all of the participating teams.

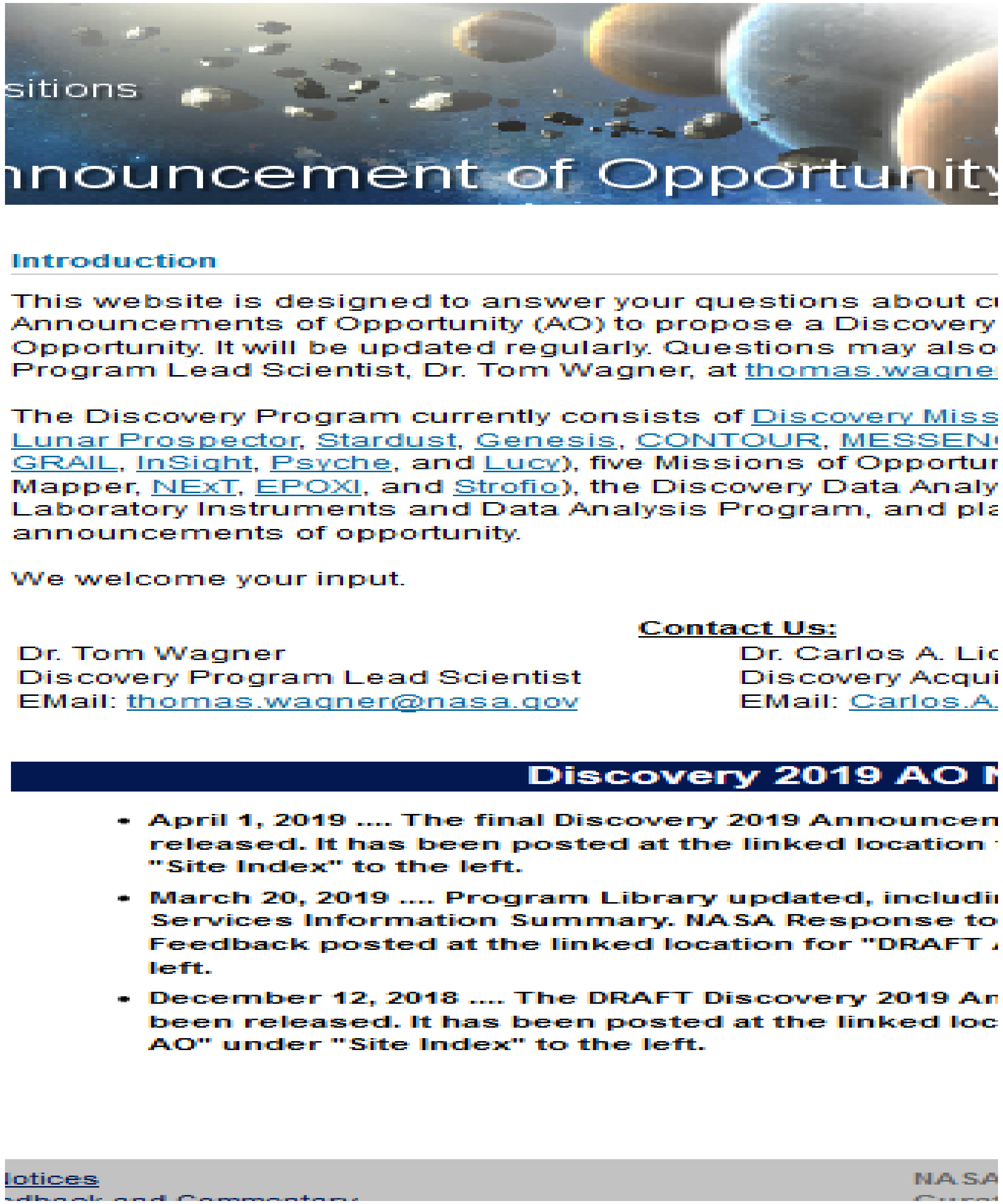
The Acquisition Site

Wide-ranging information on the AO:

- AO, its development, and public comment
- Questions from proposers
- Available technologies and launch vehicles
- Library of documents, such as recommendations of Analysis Groups

Documents in the *Program Library* on the acquisition website are intended to provide guidance for the development of proposals; they are specifically not intended to impose requirements.

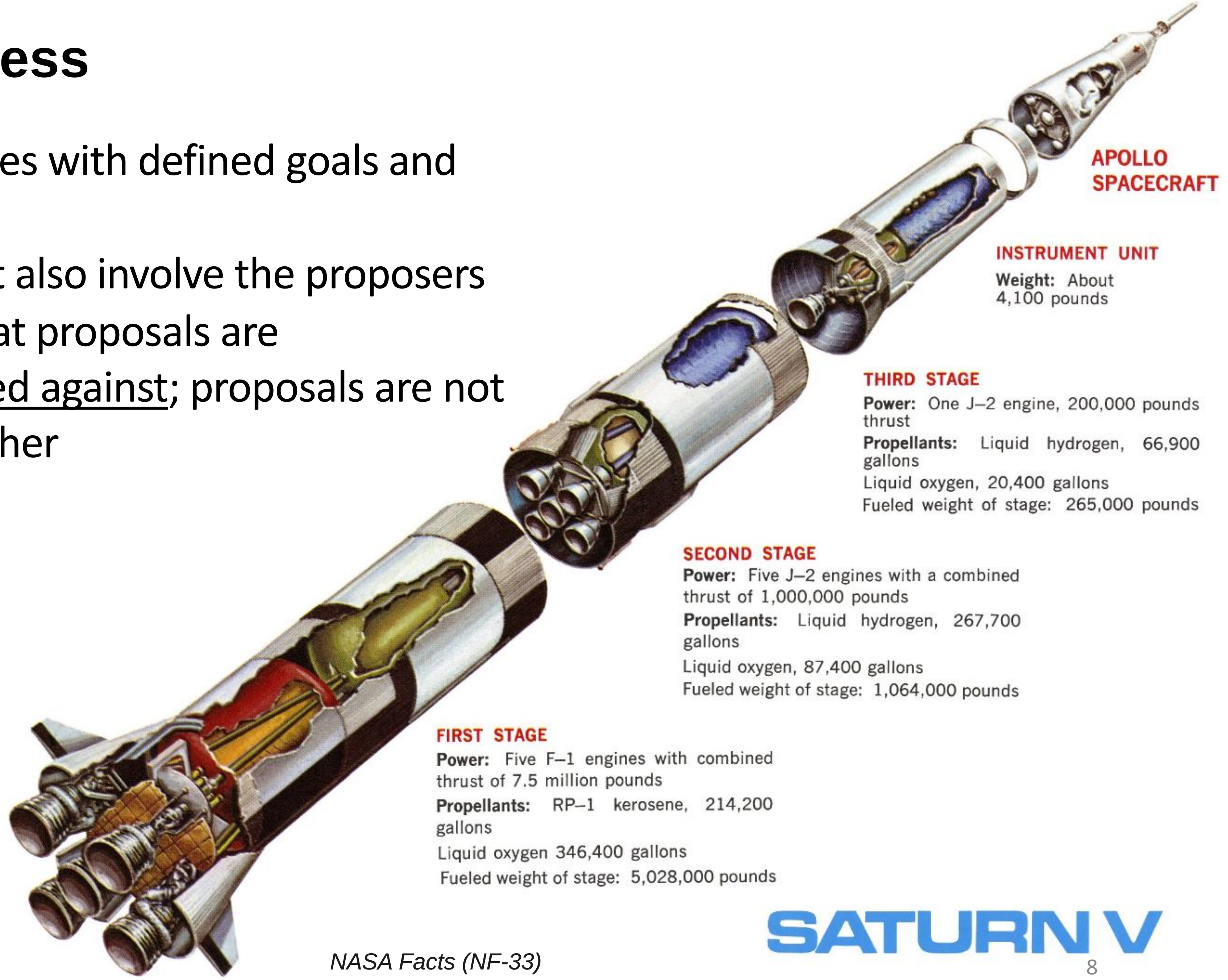
https://discovery.larc.nasa.gov/index.html



Review Process

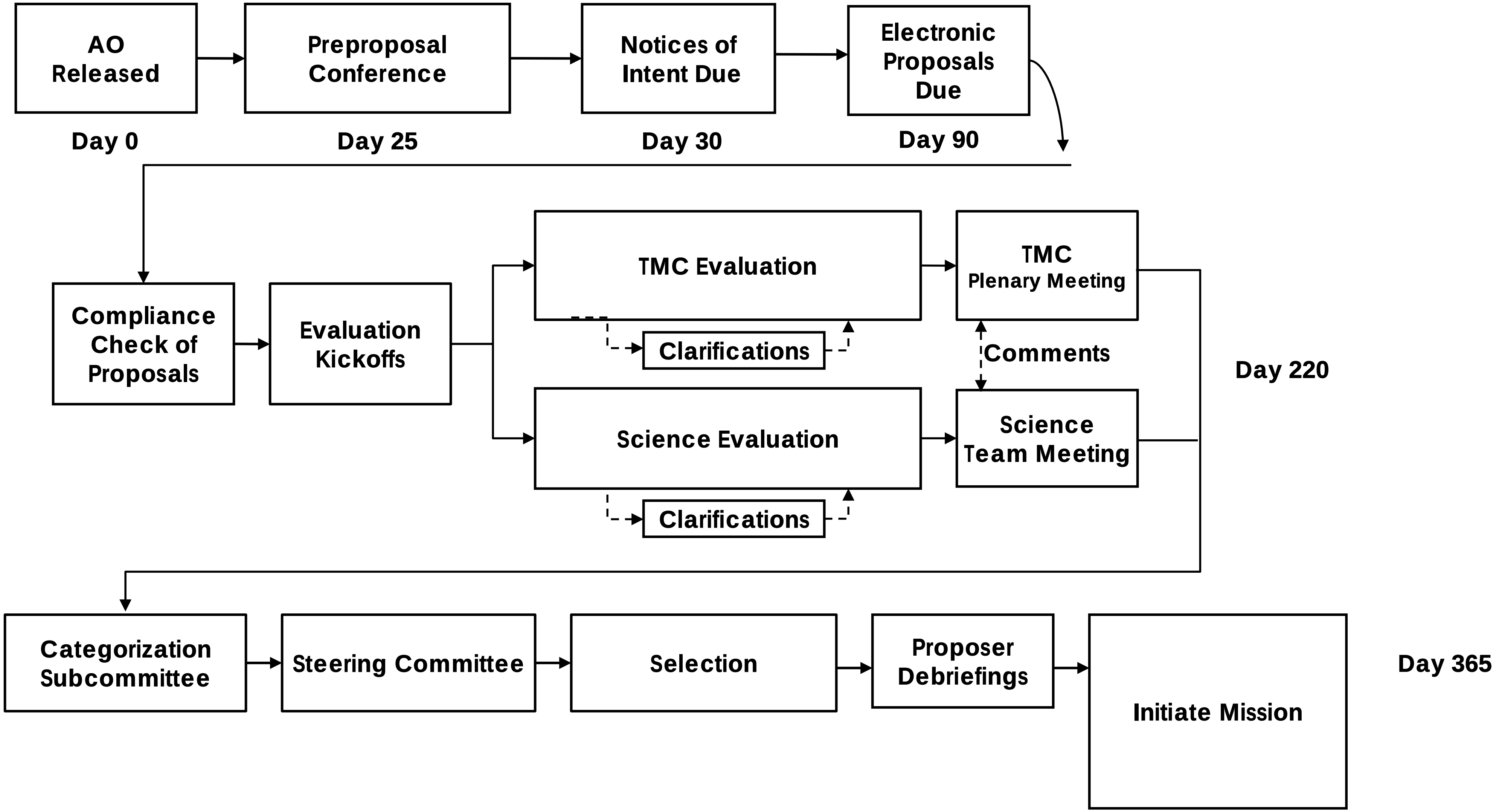
Review Process

- Broken into critical stages with defined goals and reviewer roles
- Deadlines to meet, that also involve the proposers
- Very specific criteria that proposals are <u>independently evaluated against</u>; proposals are not pitched against each other

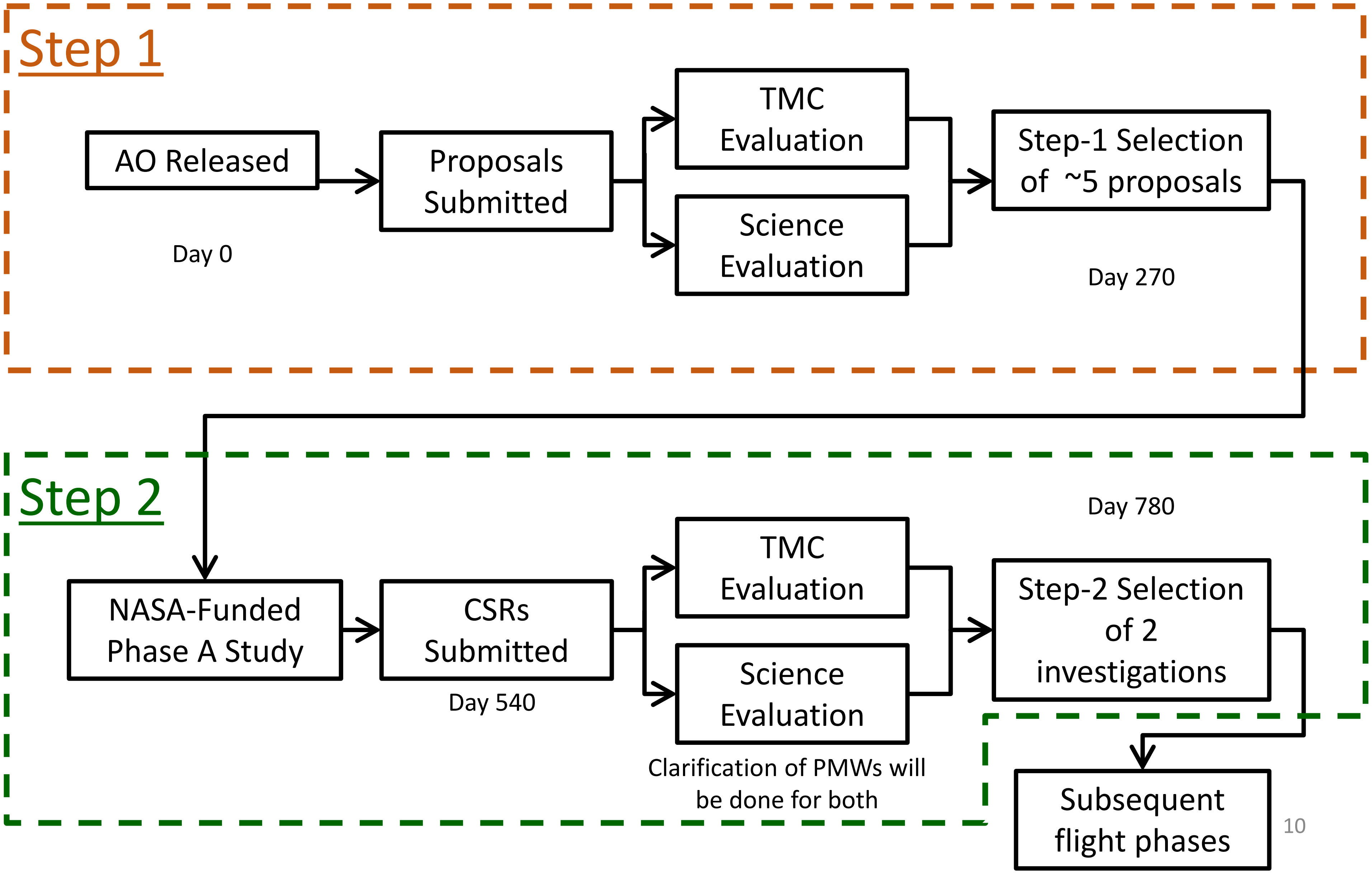


NASA Facts (NF-33)

Review Process, 1-Step Selection



Two-step selection



Evaluation Criteria

The criteria are grouped into three forms, A, B, and C. (Section 7.2)

Each form focuses on a different aspect of the proposal (Details in B/U slides):

- Form A assesses the scientific merit; the compelling nature and programmatic value of the science investigation and science questions
- Form B assesses the merit of the plan for completing the proposed investigation from a scientific perspective
- Form C assesses the detailed technical feasibility of the implementation

Forms A, B, and C are independent of one another and we avoid convolving them

- When assessing the science merit (Form A), we assume that a workable approach to conduct the necessary investigation is proposed (Form B) and that the team can build the instrument to specifications (Form C)
- But they are separate, and carefully consider how peer reviewers with expertise in these different factors will consider these factors individually

«Proposal_»

Form A

Scientific Merit of the Proposed Investigation

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.

Major Strengths:

Minor Strengths:

Major Weaknesses:

Minor Weaknesses:

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.

Minors are points that are worth noting, but do not affect your Adjectival Summary Rating. Minors generally do not affect decisions on a proposal, but they are raised to the PIs.

Reviews are a series of *Findings* that are classified as strengths or weaknesses, and further assessed as major and minor.

- Major Strength: An aspect of the proposal that is judged to be of superior merit and can substantially contribute to the ability of the project to meet its scientific objectives.

- Major Weakness: A deficiency or set of deficiencies taken together that are judged to substantially weaken the project's ability to meet its scientific objectives.

- Minor Strength: An aspect of the proposal that is judged to contribute to the ability of the project to meet its scientific objectives.

- Minor Weakness: A deficiency or set of deficiencies taken together that are judged to weaken the project's ability to meet its scientific objectives.

Reviewer Roles

Lead
Expected to draft the panel summaries and lead discussion of the proposals on the telecons and at meetings. Designated as “Primary” in NSPIRES.

Scribe
Take notes on the calls and at meetings in the Google Doc version of the panel summary. Serve as backup lead when the lead cannot attend. There is no designation in NSPIRES for Scribe.

Reader
Read proposal and participate in discussion and help draft summary in Google Docs. Designated as “Secondary” in NSPIRES.

Mail reviewers
Some proposals may have mail reviewers. The panel decides how these reviews will be used and may keep or reject. If panel feels additional expertise is needed, we get more.

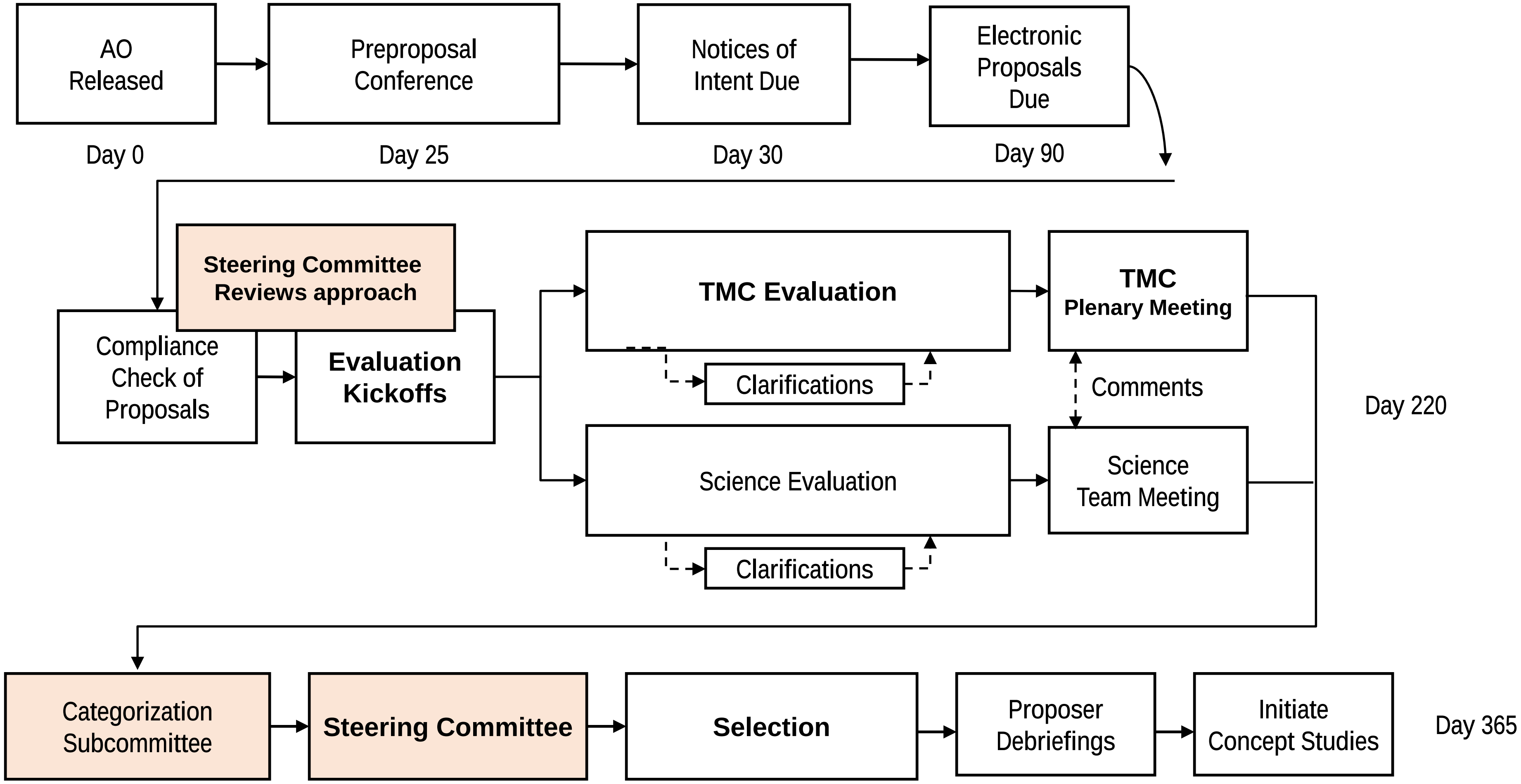
Levelers
Note-takers that are also checking to see that review criteria are treated the same for each proposal. Postdoctoral fellows and graduate students. Their notes will be available.

Reviewer Identification Process

- Step 1: Develop a list of review requirements based on science, techniqu instruments, etc.
- Step 2: Search for reviewers
  - Create conflicts-of-interest list from proposing organizations; this generally eliminates most of the institutions with deep involvement in spaceflight missions.
  - Review relevant science departments in US and internationally (largest source of reviewers); also industry, government agencies and NASA centers.
  - Perform subject matter reviews of journal articles, conference abstracts, and other publications.
  - Gather suggestions from HQ colleagues.
- Step 3: Support inclusion through specific searches for and invitations to potential reviewers from underrepresented groups.
- Step 4: Selected reviewer pool evaluated by an HQ steering committee

http://clipart-library.com/clipart/47745.htm

Review Process



Categorization and Steering

- Subsequent to the evaluation process, NASA will convene separate Categorization and Steering Committees, composed wholly of Civil Servants and Intergovernmental Personnel Act appointees.

- The Categorization Committee will consider the evaluation results and categorize the proposals as defined in Section 7.1.2 of the AO.

- The Steering Committee will review the results of the proposal evaluations and categorizations, and conduct an independent assessment of the evaluation and categorization processes.

Sections 7.1.2 and 7.1.3

B5

Categorization

B2

B3

A1

- Category I. Well-conceived, meritorious, and feasible investigations pertinent to the goals of the program and the AO's objectives and offered by a competent investigator from an institution capable of supplying the necessary support to ensure that any essential flight hardware or other support can be delivered on time and that data can be properly reduced, analyzed, interpreted, and published in a reasonable time. **Investigations in Category I are recommended for acceptance and normally will be displaced only by other Category I investigations.**
- Category II. Well-conceived, meritorious, and feasible investigations that are recommended for acceptance, but at a lower priority than Category I, whatever the reason
- Category III. Meritorious investigations that require further development. Category III investigations may be funded for further development and may be reconsidered at a later time for the same or other opportunities.
- Category IV. Proposed investigations which are recommended for rejection for the particular opportunity under consideration, whatever the reason.

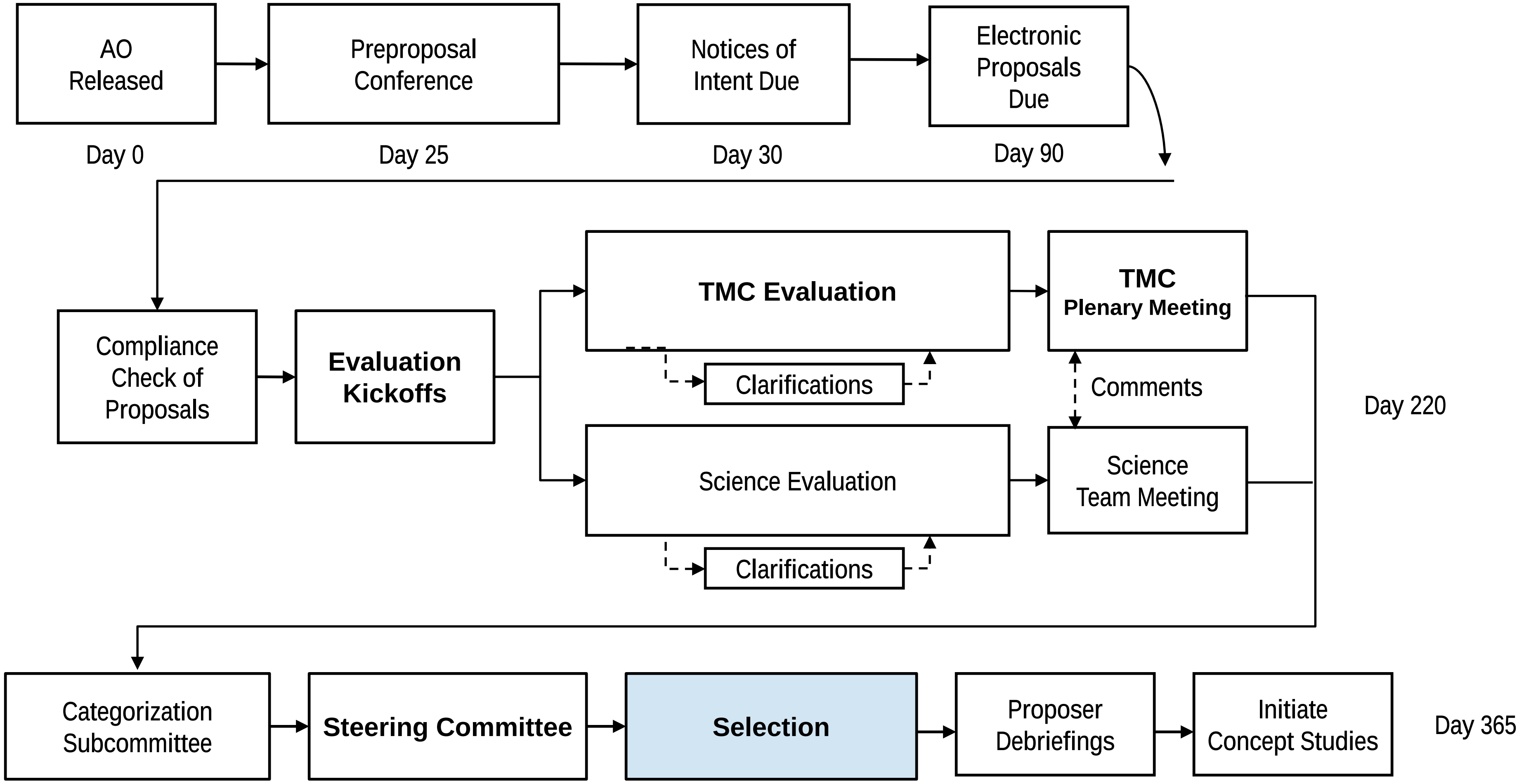
B1

A2

B4

A3

Review Process



Programmatic issues considered at Selection.

Selection Process

As stated in our AOs

- The results of the proposal evaluation will be presented to the Associate Administrator for the Science Mission Directorate (SMD AA), who will make the final selections.

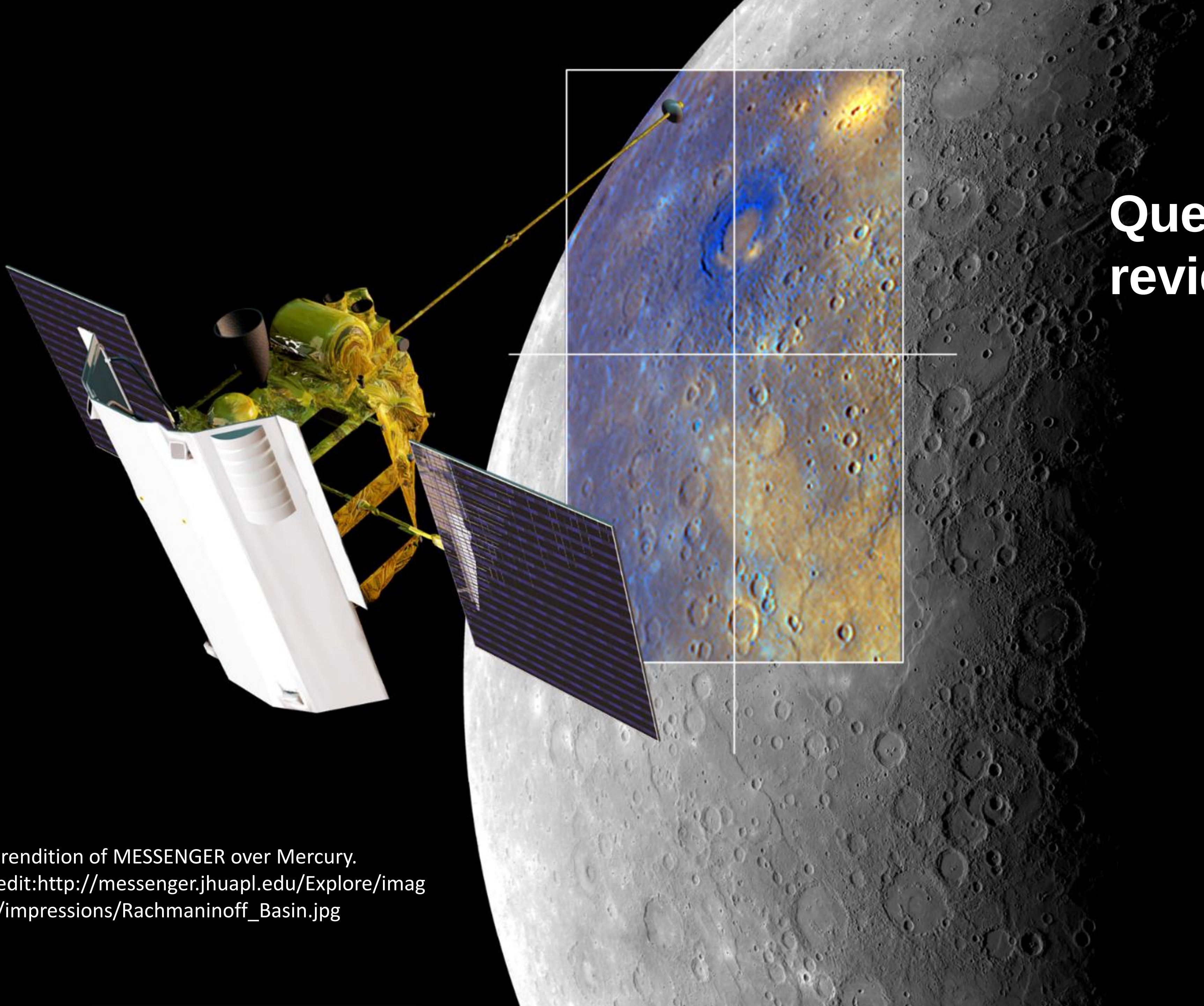
- *The **overriding consideration for selection will be to maximize scientific return and minimize implementation risk** while advancing NASA's science goals and objectives within the available budget for this program.*

- *In addition, the SMD AA **may take into account a wide range of programmatic factors** in deciding whether or not to select any proposals and in selecting among top-rated proposals...* See section 7.3 for details.

- Programmatic factors can be administration priorities, recent discoveries, balancing portfolio, etc.

Discovery 2019 AO, Section 7.3

Questions about review process?



Artist rendition of MESSENGER over Mercury.
Credit:http://messenger.jhuapl.edu/Explore/images/impressions/Rachmaninoff_Basin.jpg

Recent Changes to AOs

Improving the Proposal Process

Reducing workload on proposers and evaluators

- Some content was limited:
  - Schedule content
  - Heritage Appendix (30 pages)

- Some content was deferred to Step 2, notably but not limited to:
  - Student Collaborations
  - Science Enhancement Options
  - Technology Demonstrations
  - Communications plans
  - Final Curation plan elements
  - Final Planetary Protection Plan
  - Detailed disposal plan
  - Independent Verification and Validation of Software
  - Costing of Conjunction Assessment Risk Analysis
  - Schedule-based end-to-end Data Management and Archiving Plan
  - Detailed breakdown of real year dollar costs

See specific details about each of these in the AO!

Improvements

- Input files for parametric cost model are now accepted

Diversity

Building an Inclusive Community

NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and fully expects that such values will be reflected in the composition of all proposal teams.

Discrimination and harassment, including sexual harassment, are not tolerated at NASA. Proposers are reminded that contracts awarded under this AO will include conditions enforcing the civil rights acts that prohibit employment discrimination in all of its forms, including harassment.

Training the next generation of mission leaders is a priority for NASA, and proposers are encouraged to include career development opportunities.

Discovery 2019, Section 1.2

Diversity included in Comments to NASA in Panel Summaries

Factors B-5 (+C-4)

Inclusion became a core value at NASA in 2020, and it is working its way into the AO criteria at present.

Principal Investigators and cultural differences across SMD

The Role of the Principal Investigator

For PI-led missions, the PI fills a challenging, multidisciplinary role, which demands excellent communication, team building, and management skills. The PI is responsible for all aspects of the successful implementation of the mission. (Section 4.1.3.2)

A proposal shall identify and designate one, and only one, PI as the individual in charge of the proposed investigation. At least one deputy PI (DPI) must also be named. (Requirement 49)

Discovery 2019 AO, Section 4.1.3.2; Requirement 49

When we evaluate proposals we ask whether the PI has adequately considered these requirements and the demands that will be placed them.

Who proposes a NASA mission? (1 of 2)

A team of teams typically from multiple institutions, comprised of:

- Host institution (typically the PI’s home institution)
- Managing institution (often a NASA center, but also some private)
- Spacecraft provider (industry)
- Instrument providers (wide range of partners and international)
- Participating institutions (wide range of partners supplying scientists and other services)

Hardworking people that have invested significantly:

- $1 million or more in staff time including writers, project managers, engineers and cost personnel
- Much unpaid, after-hours work and large opportunity-costs
- Years of developing and pitching the mission; prior AOs, conferences etc.
- Some concepts take 20 years to get supported

Who proposes a NASA mission? **(2 of 2)**

There is a tremendous filter on who gets selected to be a PI before the proposal is submitted.

- Because of the costs and resources involved in creating a proposal, there are many mission concepts that never become proposals. Some are even withdrawn after an NOI is submitted.
- In essence, there is a competition before the competition which may be a bigger filtering step than our AO competition on PIs and concepts.
- Something to consider is that NASA can add diversity evaluation requirements, but it only applies to proposals that are submitted.

A brief and oversimplified word on cultural differences across SMD

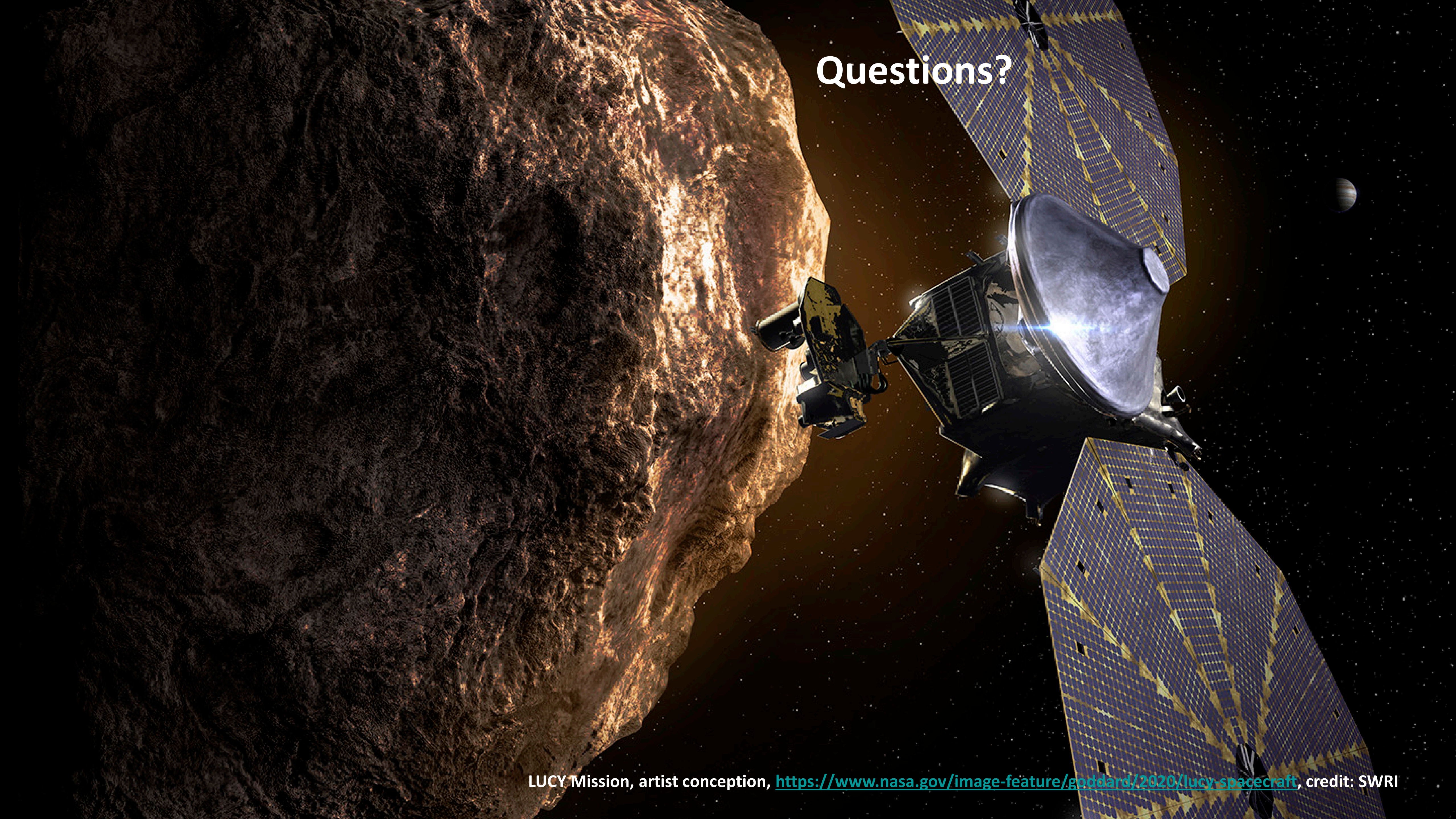
- **Scientific communities vary in size, structure, and history across and within SMD's five divisions. These variations strongly affect the PI pool as well as the scope and # of mission proposals.**
  - Large communities with strong histories in mission work often have many legacy concepts that dominate submissions to both decadal surveys and AO competitions.
  - Established communities that have long scientific legacies but little background in satellite missions can have trouble developing mission concepts.
  - Emerging scientific areas often have no legacy projects; but with connections to institutions that develop mission proposals (e.g, NASA centers), they can pose strong mission proposals.
- **Mission proposals and PI pools reflect the culture, technical expertise, and history of the community. Some examples of how they vary are:**
  - Origins: Some communities emerged from engineering disciplines rooted in satellite mission work, while others come from science often based on field work.
  - Groupings within community: Some communities are organized into competitive groups with mission concepts that directly compete with one another. Other communities work together at larger scales.
  - Science versus technology development focus: Some communities see science as emerging from the new measurement and are very focused on instrument development; others use existing technology to answer new or refine existing science questions.
  - Some fields benefit from broad interest in industry or government sectors (e.g., NOAA, DOD) that affect mission proposal opportunities, the community size, and available off-the-shelf technologies.

A brief and oversimplified word on cultural differences across SMD (continued)

- **Sources of PIs and proposals for missions varies widely**
  - Mission communities can be based at NASA centers, soft-money research institutions, and academia, with important differences across the divisions.
  - There are few, but some, PIs and proposals from industry
  - These differences can strongly affect the resources available to craft proposals.
- **Opportunities for missions vary widely across SMD; independent of division budgets, which affects the community of proposers.**
  - **Earth Sciences has many opportunities for launch and hosting**
    - Instruments can be deployed on dedicated orbiters or commercial satellites or ISS
    - Various launch opportunities, including rideshare, especially for SmallSats
    - There are other instruments on orbit to enhance the scientific return from a single instrument
  - **Planetary Science requires dedicated approaches, with less opportunity and higher stakes**
    - Generally require dedicated launches
    - Missions to most bodies in solar system need to bring everything they need
- **Participation in international missions is an important avenue for US scientists to participate in missions, but is generally dependent on personal relationships**

A brief and oversimplified word on cultural differences across SMD (continued)

- **The role that missions play in career development for scientists varies widely across and within SMD's divisions**
  - Incentives and paths to success for scientific careers vary widely.
  - In most fields being a PI is a major career milestone, but it is not required for general measures of success,
  - Participation in missions requires a lot of time that is not spent writing papers required for academic advancement.
  - The PI role is seen as taxing with significant personal cost for leading and managing such a large project, including dealing with the cultural differences between science and engineering.
- **Some scientific disciplines simply do not require mission participation to have a successful scientific career**
  - Where there is much data available to be explored, scientific achievement can be made without ever being involved in a mission.
  - Astrophysics and Earth Sciences are two examples.
- **Some scientific disciplines require mission participation to have a successful scientific career**
  - In planetary sciences, especially, but also in other disciplines, key advances often come from new missions.
  - Time—on decadal time scales--must be committed to preparing for and participating in missions to participate in these advances.



Questions?

LUCY Mission, artist conception, https://www.nasa.gov/image-feature/goddard/2020/lucy-spacecraft, credit: SWRI

Backup—
Details on evaluation criteria and findings

Form A

Scientific Merit of the Proposed Investigation

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-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-3

Scientific value of the Threshold Science Mission. This factor includes the scientific value of the Threshold Science Mission using the standards in the first factor of this section and whether that value is sufficient to justify the proposed cost of the mission.

"As expected" parts of the proposal do not result in a finding. Minor findings do not affect overall adjectival ratings and generally do not affect selection decisions.

Scientific Merit (Form A) and Implementation Merit (Form B) are assessed through *Findings* that are classified as strengths or weaknesses, and further assessed as major and minor.

- Major Strength: An aspect of the proposal that is judged to be of superior merit and can substantially contribute to the ability of the project to meet its scientific objectives.
- Major Weakness: A deficiency or set of deficiencies taken together that are judged to substantially weaken the project's ability to meet its scientific objectives.
- Minor Strength: An aspect of the proposal that is judged to contribute to the ability of the project to meet its scientific objectives.
- Minor Weakness: A deficiency or set of deficiencies taken together that are judged to weaken the project's ability to meet its scientific objectives.

Form B
Scientific Implementation Merit and Feasibility of the Proposed Investigation

Factor B-1

Merit of the scientific implementation in supporting the scientific goals and objectives. This factor includes the appropriateness of the proposed mission architecture, instruments, and measurement techniques for addressing the goals and objectives; how well the anticipated measurements support the goals and objectives; and the appropriateness of the mission requirements for guiding development and ensuring scientific success.

Factor B-2

Probability of technical success. This factor includes the maturity and technical readiness of the instruments or demonstration of a clear 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-3

Data adequacy, sufficiency, analysis, and archiving. This factor includes the degree to which the proposed mission and instruments can provide the necessary data, particularly the adequacy of the quality and quantity of data provided by the investigation to complete the investigation and meet the proposed science goals and objectives and result in the publication of science discoveries in the professional literature. Additionally, this factor includes the merit of plans for data analysis, data archiving, cartography, and/or sample analysis and curation to meet the goals and objectives of the investigation and to preserve data and analysis samples of value to the science community. Considerations in the assessment of each of these plans include adequate resources (e.g., budget, schedule, equipment) and the timely execution of the plans, especially for release to the public domain of data usable to the entire science community (and associated high-level data products and software) and/or samples for enlarging the science impact.

Factor B-4

Science resiliency. This factor includes both developmental and operational resiliency. Developmental resiliency includes the approach to descoping the Baseline Science Mission to the Threshold Science Mission 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-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 during evaluation. The inclusion of career development opportunities to train the next generation science leaders will also be evaluated.

TMC (Form C) Proposal Evaluation Factors

Factor C-1. Adequacy and robustness of the instrument implementation plan.
Factor C-2. Adequacy and robustness of the mission design and plan for mission operations.
Factor C-3. Adequacy and robustness of the flight systems.
Factor C-4. Adequacy and robustness of the management approach and schedule, including the capability of the management team.
Factor C-5. Adequacy and robustness of the cost plan, including cost feasibility and cost risk.

TMC Evaluation Findings

Major Strength: A facet of the implementation response that is judged to be well above expectations and can substantially contribute to the ability of the project to meet its technical requirements on schedule and within cost.

Minor Strength: A strength that is worthy of note and can be brought to the attention of proposers during debriefings, *but is not a discriminator in the assessment of risk.*

Major Weakness: A deficiency or set of deficiencies taken together that are judged to substantially weaken the project's ability to meet its technical objectives on schedule and within cost.

Minor Weakness: A weakness that is sufficiently worrisome to note and can be brought to the attention of proposers during debriefings, *but is not a discriminator in the assessment of risk.*

Items that are considered "as expected" will not be documented as findings.

TMC Risk Ratings for proposals only consider Major Strengths and Major Weaknesses.

Type of Risk Evaluated by TMC

Total Risk of Investigation

Inherent Risks

Risks that are unavoidable to do the investigation:

- *Launch environments*
- *Space environments*
- *Mission durations*
- *Technologies or technology extensions*
- *Unknowns*
- *Etc.*

Programmatic Risks

Risks that are uncertainties due to matters beyond project control:

- *Environmental Assessment approvals*
- *Budgetary uncertainties*
- *Political impacts*
- *Late/non-delivery of NASA provided project elements*
- *Stability and reliability of proposed partners and their contributions*
- *Etc.*

Implementation Risks
(Evaluated by TMC)

- **Risks that are associated with implementing the investigation:**
- **Adequacy of planning**
- **Adequacy of management**
- **Adequacy of development approach**
- **Adequacy of schedule**
- **Adequacy of funding**
- **Adequacy of Risk Management (planning for the known and unknown)**

TMC Evaluation Risk Ratings Definitions

Based on the narrative findings, each proposal is assigned an overall Risk Rating:

- **Low Risk:** There are no problems evident in the proposal that cannot be normally solved within the time and cost proposed. Problems are not of sufficient magnitude to doubt the proposer's capability to accomplish the investigation well within the available resources.
- **Medium Risk:** Problems have been identified, but are considered within the proposal team's capabilities to correct within available resources with good management and application of effective engineering resources. Investigation design may be complex and resources tight.
- **High Risk:** One or more problems are of sufficient magnitude and complexity as to be deemed unsolvable within the available resources.