ASTROPHYSICS DECADAL SURVEY 2020

Management Plan For Large Mission Concept Studies – Rev A

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http://science.nasa.gov/astrophysics/documents/

This is a living document and will evolve over time

Contents of the Management Plan

- **Plan Objectives**
- **Guiding Principles**
- **Study Success Criteria**
- **Study Deliverables**
  - Interim Deliverables
  - Final deliverables
- **Governance Approach**
  - Roles and Responsibilities
  - Lines of Authority, Communications
  - Oversight/Insight Mechanisms
- **Study Phase Funding Process**
- **Guidelines for Industry Engagement**
- **Guidelines for International Engagement**

Change Log

Date	Change	Pages	Rev
12/28/15	Initial Release		
03/15/16	Replaced “STDT Chair” with “STDT Community Chairs”	P20, 22	A
03/15/16	Removed references to “co-chair” from “Center Study Scientist”	P20, 23	A
03/15/16	Expanded list of points-of-contact for STDT questions	P21	A
3/15/16	Added Program Chief Scientists to the DSMT	P32	A
3/15/16	Replaced “Voting Members” with “Members”, and “Non Voting Members” with “Ex Officio Non Voting Members”	P17, 20, 23, 25	A
3/15/16	Updated the M1 milestone to be Friday 4/29, consistent throughout document	p42	A
3/15/16	Replaced co-chair language with “discipline lead” within the STDT	P22	A

Plan Objectives: Defining the Why, What, When, and How

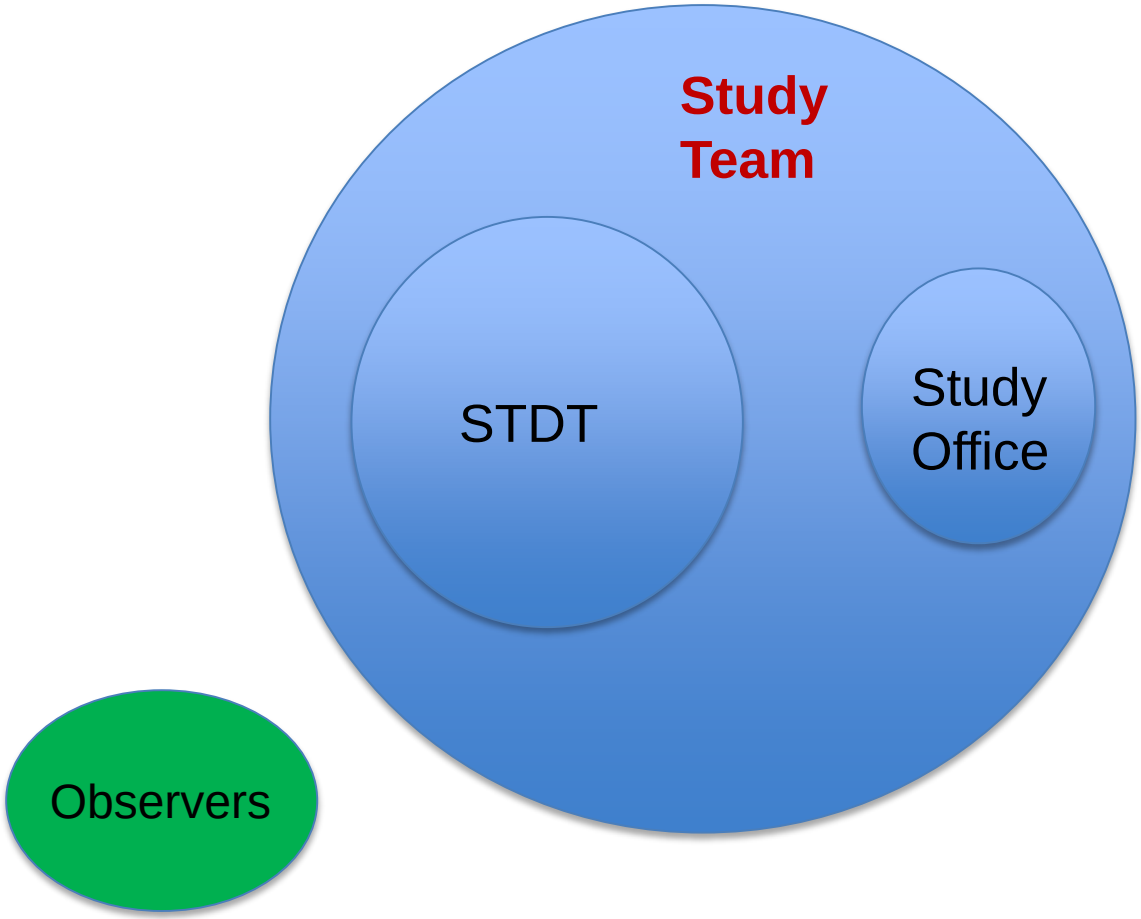
1. **WHY: Establish specific and measurable requirements so that**
   a) The Study Teams can
      1. Benchmark concept status at starting point
      2. Clearly understand the success criteria for each milestone
      3. Plan the execution of the study and determine resources for each milestone
      4. Produce the appropriate products for the Decadal Committee
   b) APD / Program Offices can
      1. Assess and negotiate the resource requirements
      2. Monitor the study progress against specific metrics
      3. Guide the Study Teams in the depth & breadth of the study

2. **WHAT: Define final & interim deliverables that**
   a) Are clear, reasonable and valuable to stakeholders and Study Teams
   b) Provide quantitative measure of progress
   c) Meet the programmatic needs of APD and Program Offices
   d) Set community expectations

3. **WHEN: Define due dates for study deliverables that**
   a) Are consistent with programmatic needs
   b) Provide the necessary time for the Study Teams to achieve the objectives
   c) Are enabled by the near-term schedule

4. **HOW:**
   a. Establish the governance guidelines and approach so that
      1. Lines of authority, roles, responsibilities, and customer relationships, are clearly defined
      2. Lines of communications are clear
   b. Agree on the study funding approach that
      a. Is consistent with the current budget set aside for these activities
      b. Allocates resources according to the individual study plans

Definition of term: “Study Team”



Study Team

- Union of STDT and Study Office
- STDT and Study Office work together as one team for success of Study
- Each has distinct and complementary roles within the Study Team

Observers

- Welcome and not part of Study Team per se
- Attendance is optional or on-call

Guiding Principles (1/3)

- **APD Decadal Success Criteria:**
  - APD defines "full success" as delivery to the Decadal Survey Committee of compelling and executable concepts for all four large missions so that science can be adequately prioritized by the Committee.
  - By executable we mean *feasible* with respect to technical, cost, and risk resources outlined in the Study Report
- **Study Teams are not in competition with one another**
  - Study Teams are making the best case – within fuzziness of boundary conditions – for science and mission concepts that enable science
  - Study Teams (especially leadership) are encouraged to create a collaborative environment that allows for each team to promote their concept and to acknowledge (and not undermine) the other concepts
  - Study Teams are encouraged to share or combine technical areas or observing strategies to optimize design concepts
  - By doing so the Study Teams will collectively and individually further the APD Decadal Success Criteria.
- **This is not an Announcement of Opportunity**
  - Do not expect AO-like, crisp rules and guidelines
  - One Study Team goal should be to define a reference mission that accomplishes a certain level of scientific discovery

Guiding Principles (2/3)

- **Cost Estimating Principles**
  - Perform costing as necessary to drive design trades that inform science capabilities, priorities
  - Perform engineering as necessary to define Master Equipment List (MEL) sufficient for parametric costing, not solely for the purpose of more accurate costing
  - Explore a range of architectures to understand the relative relationship of cost, risk and science for the concepts
  - Present implementation strategies as “reference missions” – credible hardware configurations that can achieve the science goals and are sufficiently defined for a reasonable cost evaluation
  - Recognize that any actual mission is likely to vary from the study concept

- **There isn’t a cost cap on mission lifecycle costs (LCC)**
  - Rather, Study Teams should address the “mission cost vs. science capability”
  - Consider the sweet spot factoring in science, technology, cost, and risk
  - Parametric results for key scientific performance are highly desirable
  - Study Teams may use the published predicted APD budget profile (aka Sand Chart) as one form of guidance until the DS Committee is chartered and provided with a future budget profile
  - Teams may consider other budget profiles to explore additional opportunities

Current APD Predicted Budget Profile

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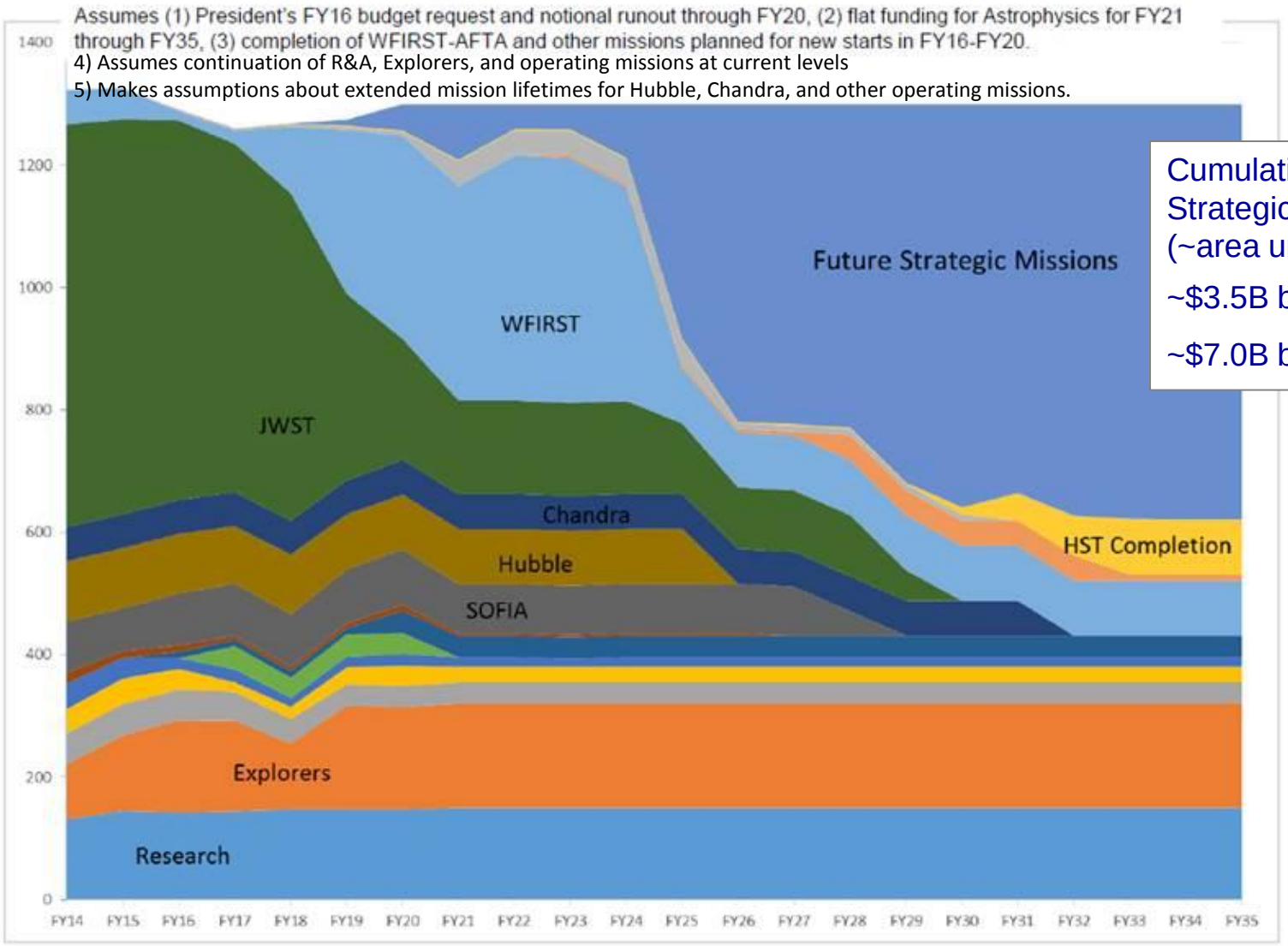
https://www.nsf.gov/attachments/134636/public/Razzaghi-AAAC-Nov15_V6.pdf



Cumulative in Future Strategic Mission Wedge (~area under curve):

~$3.5B by 2030

~$7.0B by 2035

Guiding Principles (3/3)

- **Technology Development Principles**
  - Technology Readiness Level (TRL) of an enabling technology at the time of Decadal submittal will be one factor important to the Decadal Committee and independent cost/risk assessment.
  - Of equal or greater importance will be the credibility of the technology roadmap that shows
    - How TRL5 will be achieved by KDP-B (SMD Handbook[1])
    - How TRL6 will be achieved by PDR (NASA policy[2])
    - Description of technology funding and timeline required to achieve TRL5
  - Reference to TRL Definitions used for the Large Decadal Mission Studies: http://nodis3.gsfc.nasa.gov/npg_img/N_PR_7123_001B_/N_PR_7123_001B_.pdf

[1]Defined in NPR 7123.1B, NASA Systems Engineering Processes and Requirements

[2]According to NPR 7120.5e

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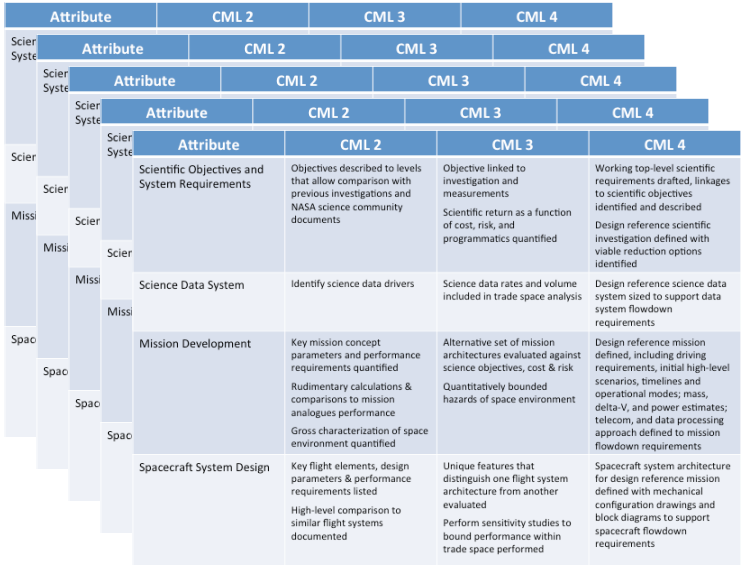
Study Success Criteria (1 of 2)

Physics of the Cosmos Program

Cosmic Origins Program

What is Concept Maturity Level (CML)*:

- CML is a classification scheme for characterizing the various levels of a concept's maturity. The key strength of CML is the ability to evolve mission concepts guided by an incremental set of assessment needs. This process gauges a study conduction through measurable and deliverable milestones which helps to evaluate and manage the products during a given time line.
- Defined in the detailed table in backup charts



Attribute	CML 2	CML 3	CML 4
Scientific Objectives and System Requirements	Objectives described to levels that allow comparison with previous investigations and NASA science community documents	Objective linked to investigation and measurements Scientific return as a function of cost, risk, and programmatics quantified	Working top-level scientific requirements drafted, linkages to scientific objectives identified and described Design reference scientific investigation defined with viable reduction options identified
Science Data System	Identify science data drivers	Science data rates and volume included in trade space analysis	Design reference science data system sized to support data system flowdown requirements
Mission Development	Key mission concept parameters and performance requirements quantified Rudimentary calculations & comparisons to mission analogues performance Gross characterization of space environment quantified	Alternative set of mission architectures evaluated against science objectives, cost & risk Quantitatively bounded hazards of space environment	Design reference mission defined, including driving requirements, initial high-level scenarios, timelines and operational modes; mass, delta-V, and power estimates; telecom, and data processing approach defined to mission flowdown requirements
Spacecraft System Design	Key flight elements, design parameters & performance requirements listed High-level comparison to similar flight systems documented	Unique features that distinguish one flight system architecture from another evaluated Perform sensitivity studies to bound performance within trade space performed	Spacecraft system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support spacecraft flowdown requirements

** Space Mission Concept Development using Concept Maturity Levels, Randii Wessen, Chester S. Borden, John K. Ziemer, Robert C. Moeller, Joan Ervin, and Jared Lang, AIAA SPACE 2013 Conference and Exposition. September*

http://arc.aiaa.org/doi/abs/10.2514/6.2013-5454

Study Success Criteria (2 of 2)

- **The final study deliverable shall be at a tailored CML 4, termed the "Decadal CML 4", as defined in the detailed table in backup charts**
  - CML2, 3, and 4 columns in the backup are all tailored for the Decadal Study
- **High Level Definitions of Maturity Levels:**
  - ***CML 2 Initial Feasibility:*** The mission concept and high-level objective are defined and questioned on the basis of feasibility, from a science, technical, and programmatic viewpoint. Lower-level objectives have been specified, key performance parameters quantified, and basic calculations have been performed. These calculations, to first order, determine the viability of the concept.
  - ***CML 3 Trade Space:*** Exploration has been done around the science objectives and architectural trades between the spacecraft system, ground system, and mission design to explore impacts on and understand the relationship between science return, cost, and risk.
  - ***Decadal CML 4 (Tailored CML-4):*** *Point Design.* A specific design and cost that returns the desired science has been selected within the trade space and defined down to the level of major subsystems with acceptable margins and reserves. Trades have been performed for selective, high-leverage subsystems

What, When:

Deliverables and Schedule

Schedule Drivers Important to Study Deliverables

- Allow the Study Teams to understand and buy-in to the study requirements and governance approach and for APD and Program Offices to normalize requirements, if necessary
- Allow appropriate time for the Study Teams to work together to develop their study plans and resource requirements
- Interim products delivered to allow time to re-direct/modify the study progress, if necessary
- Final products delivered to allow time to fix any shortcomings before delivery to the Decadal Committee

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Study Deliverables

All products delivered to APD Deputy Division Director

M1	**Comments on Study Requirements and Deliverables** – Accept the study requirements/deliverables and submit plan--- or – Provide rationale for modifying requirements/deliverables	**April 29 2016[1]**
O1	***Optional: Initial Technology Gap Assessment*** – *To impact PCOS/COR/ExEP 2016 technology cycle*	**June 30 2016**
M2	**Detailed Study Plan** – Document starting point CML – Deliver detailed study plan for achieving Decadal CML – Deliver resource required to meet the deliverables for the study duration – Deliver schedule to deliver milestones	**August 26 2016**
M3	**Complete Concept Maturity Level 2 Audit** – Identify, quantify and prioritize technology gaps for 2017 technology cycle	**February 2017[2]**
O2	***Optional: Update Technology Gap Assessments***	**June 2017**
M4	**Interim Report** – Substantiate achieving Concept Maturity Level 3 – Deliver initial technology roadmaps; estimate technology development cost/schedule	Early **Dec 2017[2]**
M5	**Update Technology Gap Assessments** – In support of 2018 technology cycle	**June 2018**
M6	**Complete Decadal Concept Maturity Level 4 Audit and Freeze Point Design** – Support independent cost estimation/validation process	**August 2018**
M7	**Final Report** – Finalize technology roadmaps, tech plan and cost estimates for technology maturity	**January 2019**
M8	**Submit to Decadal**	**March 2019**

[1]APD will provide final study requirements by May 2016 (see "Near Term Activities")
[2]Timed to influence following NASA budget cycle

Assumptions to be included in Center Study Implementation Plans

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- Study Team Leadership will present at each Winter meeting of the American Astronomical Society (2017, 2018, 2019)
  - Either special session or at PAG meeting
- Study Team Leadership should assume periodic presentations to National Committee Meetings at the request of Committee Chairs. An estimate of ~4 per year can be used for planning purposes
  - This includes the APS, CAA, AAAC
- Study Team Leadership will present to the Decadal Survey Committee and be prepared for follow-up questions (as needed) during 2019. The schedule for 2019 will be further clarified when the Decadal Survey Committee is chartered in early 2018.
- Study Team Leadership to meet semi-annually to cross-coordinate studies with APD
- Interim and Final reports include a briefing to APD before public release
- Milestones M2-M8 are briefed to APD Decadal Studies Management Team with the Independent Review Team present to provide technical and programmatic analysis.
- Weekly, Monthly, Quarterly reporting (standard NASA) to both the governing Program Office and to the governing Center

How:

Roles and Responsibilities

Lines of Communication

Governance Approach

Roles and Responsibilities: A Team and Customer View

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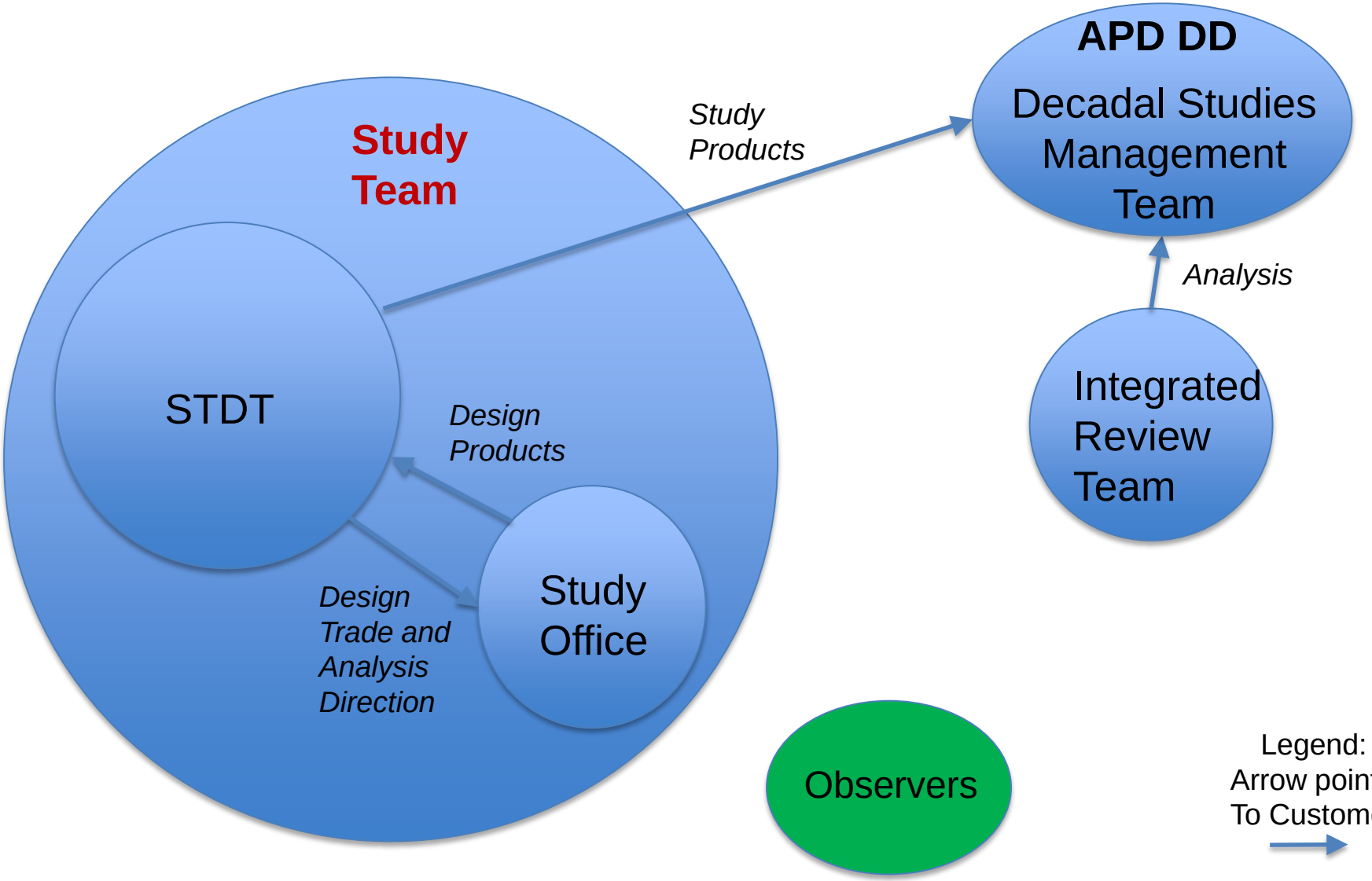


Integrated Review Team

- **A single integrated review team to review deliverables of all Study Teams**
  - Reviews consistency of the study plan
  - Reviews consistency of the final product
  - Provides analysis to APD Decadal Study Management Team
- **Provides synergy across all 4 studies**
- **Chaired by APD DDD or alternate**
- **Makeup of the Integrated Review Team (about 12 people)**
  - Program Chief engineers or alternate (2)
  - Program Technologists (2)
  - Subject Matter Experts (as needed, ~4)
  - Each Study Office Manager (4)
  - Independent cost representative (to be identified)

Study Team: Detail

Members

- Appointed from community by APD DD
- Appointed from Centers and PO by APD DD

Examples

- Members of community and NASA Centers
- Center Study Scientists

Ex-Officio Non-voting Members

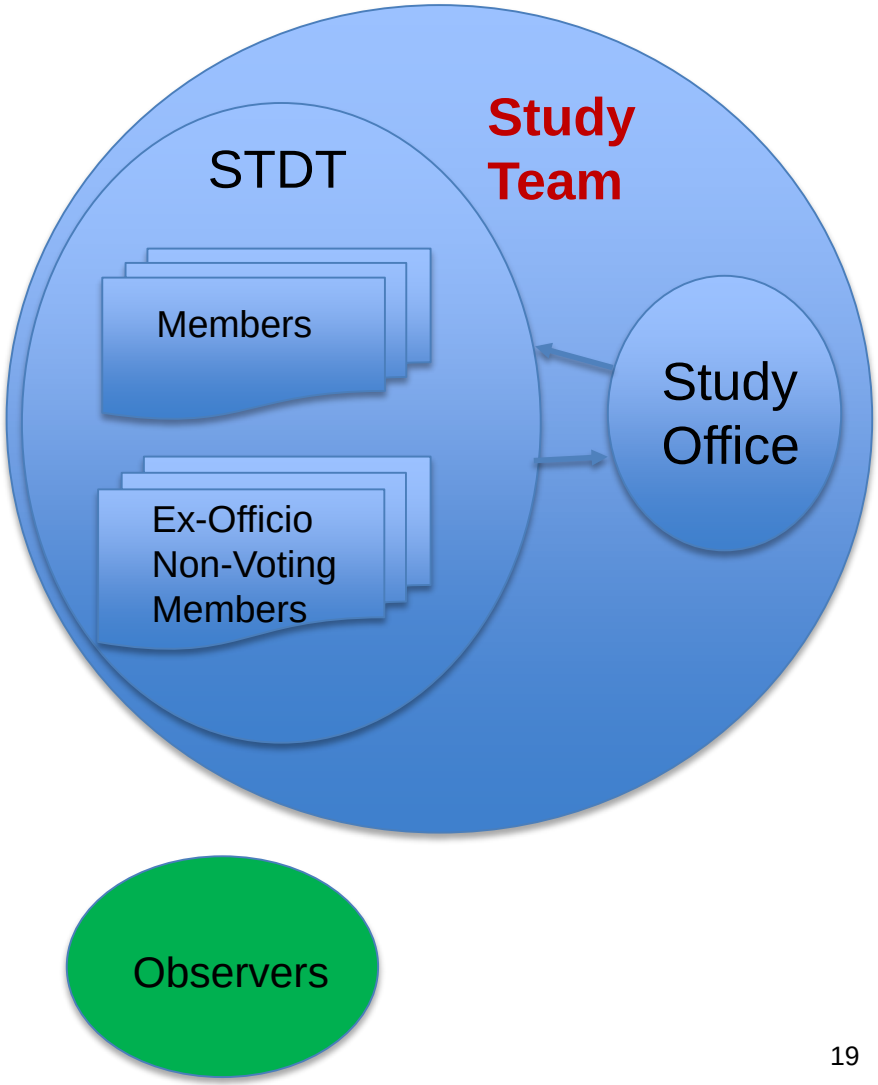
- Appointed by APD DD virtue of office
- Not participate in deliberations

- APD Study Scientists
- Program Chief Scientists
- Representatives of International Partners

Observers

- Welcome and not part of Study Team per se

- Mission Concept Coordinator (APD)
- Program Executive (APD)
- Program Manager (PO)
- Program Chief Technologist
- Program Chief Engineer



Roles and Responsibilities Overview (1 of 2, detail pages follow)

STDT

- **STDT Community Chairs**
  - Members of the non-NASA science community
  - Lead the STDT
  - Ultimate responsibility for interim and final products
  - Responsible for progress briefings to APD, national committees
  - APD DD and Community Chairs may appoint co-chairs as needed (co-chairs will have an area of responsibility within the overall study)
- **STDT Members**
  - Appointed by APD DD
  - Include members of community and of NASA Centers
  - **Center Study Scientist (CSS)**
    - Interfaces to Study Office and Center engineering teams
- **STDT Ex-Officio non-voting members**
  - **APD Program Scientist (APD)**
    - Supports and liaises "up-and-out" with emphasis on science objectives to APD, NASA stakeholders
    - Represents APD at the Study Team meetings
  - **Program Chief Scientist (PCS)**
    - Represents PM in insight/oversight of the study progress

STUDY OFFICE

- **Center Study Manager (of Study Office)**
  - Supports STDT. The STDT is the customer of the Study Office
  - Leads the engineering team
  - Responsible for developing an implementable DRM meeting the science objectives

OBSERVERS

- **Study Program Executive (APD)**
  - Supports and liaises "up-and-out" with emphasis on science objectives to APD, NASA stakeholders
  - Represents APD at the Study Team meetings
- **Program Manager (PO)**
  - Supports APD in providing technical insight/oversight of the Study Teams
  - Supports APD in allocation of resources to the Study Teams
- **Program Chief Technologist**
  - Represents Agency technology plans and progress to STDT and Study Office
  - Represents study technology needs to Agency
  - Integrates technology requirements into the SAT process
- **Program Chief Engineer**
  - Represents engineering and cost capability to STDT
  - Represents study cost needs to APD
  - Provides evaluation of CML compliance and readiness

Roles and Responsibilities Overview (2 of 2)

Additional notes on Responsibilities

- **Technical direction**
  - To Study Office comes from STDT chair
- **Trade decisions**
  - Options assessed and recommended by Study Office
  - Choice made by STDT chair
- **Funding authority**
  - Provided to Study Office by Program Office as representatives of APD
- **Management direction**
  - Provided to Study Office by Program Office as representatives of APD
- **When STDT members have questions:**
  - First point of contact will be the STDT Community Chairs
  - Next POC will be the Center Study Scientist and the Study Office Manager
  - After that, questions should go to the Program Office Chief Scientist and then APD Program Scientist (in practice both will be continuously present on Study Team).
  - Note: Programmatic questions (cost, schedule, governance per this Management Plan) should include the Program Manager for PCOS/COR or ExEP.

STDT Community Chairs

- Lead STDT in defining the science case
- Members of science community
- Ensure that the science case is a community driven process
- Is the Community advocate for this reference mission
- APD DD and STDT Community Chairs may appoint discipline leads from within the STDT as needed within.
- May utilize the Program Analysis Group (PAG) infrastructure to obtain community input and provide status to the community
  - Science Analysis Groups (SAGs)
  - Science Interest Groups (SIGs)

Center Study Scientist (CSS)

- Appointed member of STDT
- Represents STDT in the day to day activities of the engineering team
  - Engineering and science tradeoffs, etc.
- Provides guidance to the STDT regarding NASA processes
- Provides guidance to the STDT regarding the practicality of implementing science objectives

Center Study Manager (CSM)

- Leads the Study Office (engineering team)
- Supports STDT. The STDT is the customer of the Study Office.
- Accountable to
  - The STDT chair (technical direction) and
  - The Program Office (programmatic, cost, schedule)
- Responsible for developing an implementable DRM meeting the science objectives
- Obtains the necessary technical & administrative resources from the center
- Obtains center approval/reviews of the deliverable milestones prior to delivery
- Provides periodic status updates to Program Office and APD
- Responsible for cost estimates and inputs to independent cost estimates
- Responsible for Study Office
- Through Study Office staff is responsible for Study Team logistics: websites, document postings, mailing lists, processing affiliate travel, contracts, export compliance guidelines, budget, schedule, etc.

APD Program Scientist

Represent APD science interests at the STDT meetings

Does

- Serve as a resource to the STDT in providing clarification of STDT charter
- Provide “big picture guidance” to the STDT
- Serve as conduit of information exchange between STDT and APD and science community
- Serve as appointed ex-officio non-voting members of STDT

Does Not

- Direct the Study Team on how or what science case to include/exclude

APD Program Executive

Does

- Represent APD programmatic interests at the Study Team meetings
- Serve as conduit of information exchange between Study Team and APD
- Supports the Study Teams in developing international partnerships, if required
- Serve as Observer/Resource to Study Team

Does Not

- Direct the engineering team on how or what architectures to develop

Program Office (PO)

Does:

- Provide programmatic (cost, approach) guidance to Study Teams as representatives of APD
- Takes the pulse of the study progress on a regular basis (technical & financial)
- Provides status updates to APD in addition to those from Center Study Manager
- Facilitates resolution of any issues/concerns of the Study Teams
- Facilitates synergy between all mission studies
- Integrates the study technology requirements into the SAT selection process
- Provides progress/status of SAT driven technologies to the Study Teams
- Supports the Study Teams in developing industrial partnerships
- Provides independent assessment of all deliverables to APD
  - CML completeness at transition points/gates
  - Thoroughness of the technology roadmap
  - Thoroughness of the systems engineering and trades
  - Study resource requirements
  - Study progress
- Supports APD in conducting independent cost estimates of mission concepts
- Program Offices coordinate with each other

Does Not direct the engineering team on how or what architectures to develop

Program Chief Scientist (PCS)

Program Chief Scientists represent the Program Offices at the Study Team meetings

Does:

- Support the program manager in the insight/oversight activities
- Support the APD scientists in communication with the community
- Facilitate interaction between STDT and PAGs, if required
- May serve as member with approval of APD DD

Does Not:

- Direct (impose upon) the STDT on how or what science case to include/exclude

Exoplanet Standards and Evaluation Team: Specific to Exoplanet Science for HabEx and LUVOIR

ExoPlanet Exploration Program

Aka "Standards Team"

Why:

- Need transparent, common exoplanet science yield estimates to APD for Decadal large missions (HabEx, LUVOIR) and any exoplanet probes. Same yardstick, honest broker.
- Need consistency in inputs definitions for analysis of yield.

What:

- Provide periodic apples-to-apples comparisons to APD for common exoplanet science metrics
- Uses common state-of-the-art analysis tool(s)
  - ExEP is currently funding one analysis tool (module additions to Dmitry Savransky's open-source tool developed under WFIRST Participating Science funding)
  - The Standards Team will include other tools from members (e.g. Altruistic Yield Optimization) to complement and validate the yield of the Program tool
- Standard and consistent definitions of planet and star properties, star lists, instrument properties, detection thresholds.
- Physics-based instrument models to accommodate specific internal and external mask designs .

How:

- Chartered by APD. Coordinated by ExEP for APD.
- Small team of experts drawn from STDTs and general science community.
  - Defined membership (fractions of ~6 people)
  - STDTs will plan for and perform their own yield modeling to perform their study-specific work and specific science metrics
- Active during the period of the design team. Nominally April 2016 to February 2019.

Governance Structure: A Team and Customer view

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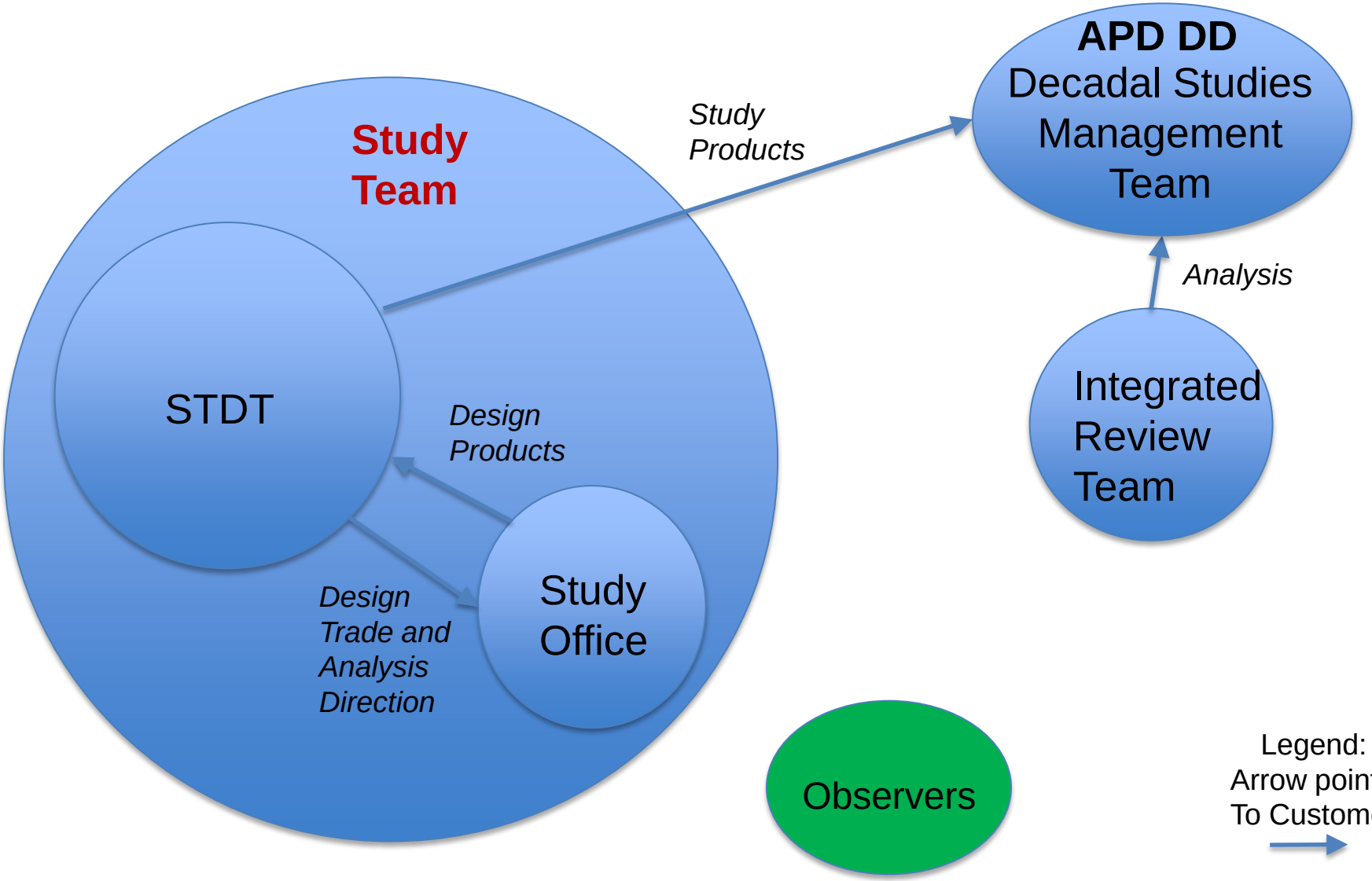

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Governance Key Elements

- **Objectives:**
  - Ensure the studies will produce the required products on time (get the work done)
  - Ensure studies are adhering to the guidelines
  - Ensure studies are following guidelines of collaboration
  - Resolve questions in a consistent, transparent way
  - Provide synergy within the concepts to the extent practicable
    - Promote communications and coordination between studies
- **Insight & Oversight Tools, Mechanisms**
  - Attendance at telecons and Study Team meetings
  - Membership on Study Team mailing list
  - Weekly/Monthly/Quarterly reports from Study Team and program managers
  - Possible monthly status review by Center
  - Reports at national committee meetings
  - Quarterly (TBC) tag up telecon of all 4 study leadership with APD Decadal Studies Management Team
  - Review of study milestone deliverables
- **Governance provided on these Timescales by these Governance Bodies**
  - Daily/Weekly:
    - By ***Study Team:*** internal communications and management to get the work done
    - Primarily by the Study Office, STDT chairs and co-chairs
  - Monthly / Quarterly and as needed:
    - By ***APD Decadal Studies Management Team***: drawn from APD standing leadership team
    - Purposes of quick consistent transparent direction that transcends one study
  - Approximately Semi-annually (at milestones M2-M7):
    - By ***Integrated Review Team***
    - Technical and programmatic review, analysis for APD Leadership Team

APD Decadal Studies Management Team

ExoPlanet Exploration Program

Physics of the Cosmos Program

Cosmic Origins Program

Provided by APD standing leadership team (18 members)

- Overall Study Coordination (2)
- Mission Concept Coordinator (1)
- Program Executives (2)
- Program Scientists for each study (8)
- Program Office Managers (2)
- Program Chief Scientists (3)

- Insight by weekly, monthly and quarterly reports from PO/Study Team
- Work by Occasional Telecon (~4-8w interval) and Program Management Quarterlies
- Provide agile, consistent, transparent guidance

Mission Concept Coordinator (MCC)

- Goal: Coordination, policy, and communication of the STDTs
- Represents APD Division Director
- Objectives: 1. APD coordination with the Program Scientists; 2. Stay informed about Study Teams' progress towards established milestones in this Management Plan; 3. Assist and represent the DD as needed
- Specific tasks:
  - Attend regular telecons with Integrated Team
  - Receive the weekly, monthly, and quarterly reports from PO/Study Team and summarize for the DD
  - Remain cognizant of the science content of the STDTs and synergies across STDTs and summarize for the DD
  - Facilitate interactions among the STDT members, advisory committees, and with the APD DD
  - Assist the APD DD with reporting to advisory committees and the community (slides preparation, written reports, etc.)
  - Document entire process & write Lessons-Learned and Best Practices report

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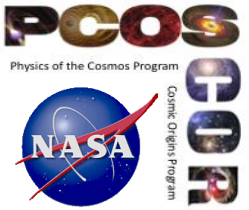
Governance of Decadal Studies

APD Staff Involvement



Study	Program Office	Center Program Office	Study Center	Program Scientists	Program Executives	Mission Concept Coordinator	Overall Study Coordina-tion
X-Ray Surveyor	PCOS	GSFC	MSFC	Dan Evans Lou Kaluzienski	Shahid Habib	Rita Sambruna Represent APD Division Director	Andrea Razzaghi Jeanne Davis
Large UV Optical and IR Surveyor	COR	GSFC	GSFC	Mario Perez Erin Smith			
FAR IR Surveyor	COR	GSFC	GSFC	Kartik Sheth Dominic Benford			
Habitable ExoPlanet Imager	ExEP	JPL	JPL	Martin Still Doug Hudgins	John Gagosian		

Implementation of Decadal Studies

Center participation

Study	Program Office	Center Program Office	Study Center	Center Study Scientist	Study Office Manager	Center Line Management
X-Ray Surveyor	PCOS	GSFC	MSFC	Jessica A. Gaskin	Gregg K. Gelmis	Martin Weisskopf
Large UV Optical and IR Surveyor	COR	GSFC	GSFC	Aki Roberge	Julie Crooke	Mark Clampin TBD
FAR IR Surveyor	COR	GSFC	GSFC	Dave Leisawitz	Kate Hartman (Acting)	Mark Clampin TBD
Habitable ExoPlanet Imager	ExEP	JPL	JPL	Bertrand Mennesson	Keith Warfield	Moshe Pniel Jeff Booth Charles Lawrence

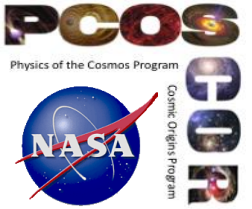
Implementation of Decadal Studies

Program Office participation

Program Office	Center Program Office	Program Manager / Deputy	Program Chief Scientist / Deputy	Program Chief Engineer	Program Chief Technologist
PCOS	GSFC	Mansoor Ahmed / Tom Griffin	Ann Hornschemeier / Peter Bertone	Gabe Karpati	Bernard Seery Bruce T. Pham
COR	GSFC	Mansoor Ahmed / Tom Griffin	Susan Neff / Debbie Padgett	Gabe Karpati	Bernard Seery Bruce T. Pham
ExEP	JPL	Gary Blackwood / TBD	Karl Stapelfeldt / TBD	TBD acting, (Deputy Program Manager)	Nick Siegler

ExoPlanet Exploration Program

Email Contacts



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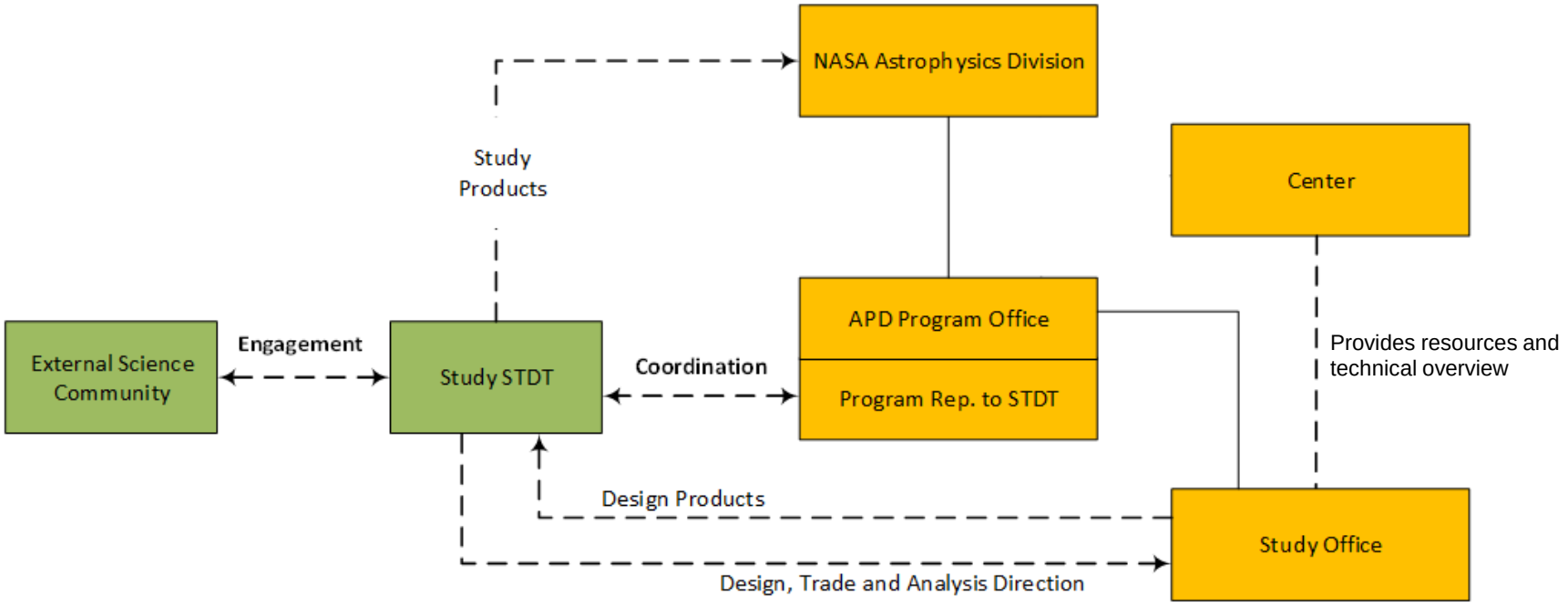
Governance Structure
Lines of Authority, Communication

- Each Center proposed a management / governance structure
- The concept studies provided by the Centers are consistent with this APD/PO customer view



_____ programmatic direction, funding

Guidelines for Industry Engagement

- APD, the Program Offices and the NASA Centers will engage Industry engineering capabilities and technology investments to further the APD Decadal Success Criteria.
- Yet-to-be-finalized RFI/RFP process
- We will engage industry in such a manner that it preserves mission study participants' ability to respond to potential future solicitations related to mission development work
- The next steps are to
  - Define an RFI/RFP timeline and augment Study Offices with embedded industry contributors
  - Engage industry through the annual technology process run by the Program Offices, as updated by the Study Teams

Guidelines for International Engagement

- NASA welcomes international participation in the upcoming Decadal Studies as well as in the implementation of the mission(s) prioritized by the Decadal.
- NASA (APD DD) will formally invite international partners to engage in the concept studies
- Study teams are encouraged to engage with their international counterparts to inform them of this opportunity
- To be a member of the Study Team, the international member needs to be formally endorsed by their respective government agency
  - International partner will be subject to the ITAR regulations
- Interested international individuals are free to attend all open meetings of the study teams, as an observer, in accordance with export regulations

Management Plan Briefing to Centers on 12/16: Funding Guidelines

ExoPlanet Exploration Program

- **Today our intention is to learn Center questions and feedback on the Management Plan**
  - APD received Center management plans on 11/20
  - Those submissions have been factored into this Management Plan For Large Mission Concept Studies
  - We intend to release the Management Plan along with the STDT charter and call for membership at the 2016 Winter AAS

- **Plan to initiate funding allocation around January 22 (subject to budget appropriation)**
  - FY16 allocation for each study will cover approximately one labor-year and travel support for STDT members for two STDT meetings
  - Initial out-year guidance for each study will cover approximately eight additional labor-years (including equivalent of concurrent engineering) and ~$500K for contracts and travel
  - Out-year allocations will be updated following Milestone 2 delivery

Near Term Schedule for Large Decadal Studies

ExoPlanet Exploration Program

Activity	Schedule
Telecon between APD DD and Study Office Managers – review of management plan	Dec 16, 2015
Initiate PPBE (2018) guidelines development	January 2016
Invitation at AAS conference for STDT nominations. Release STDT charter and brief mgmt. approach	Jan 6, 2016 (ref charter and mgmt. approach)
Release FY16 allocation (FY17 preliminary guidance in PPBE process) including feedback on Center study management plans delivered to APD on 11/20	Jan 22, 2016
STDT responses due	Feb 1, 2016
Finalize STDT selections	March 4, 2016
Study Team finalization, set first meetings and telecons	March 10, 2016
Studies kick off	Early April, 2016
M1 Receive comments from Study Team (Deliverable I)	April 29, 2016
Finalize study guidelines and management plan	May 30, 2016
M2 Detailed study execution plan	Aug 1, 2016

External milestones (blue) and internal milestones (green)

See list of major study milestones (M1 – M8) on separate page

Backup

Acronyms

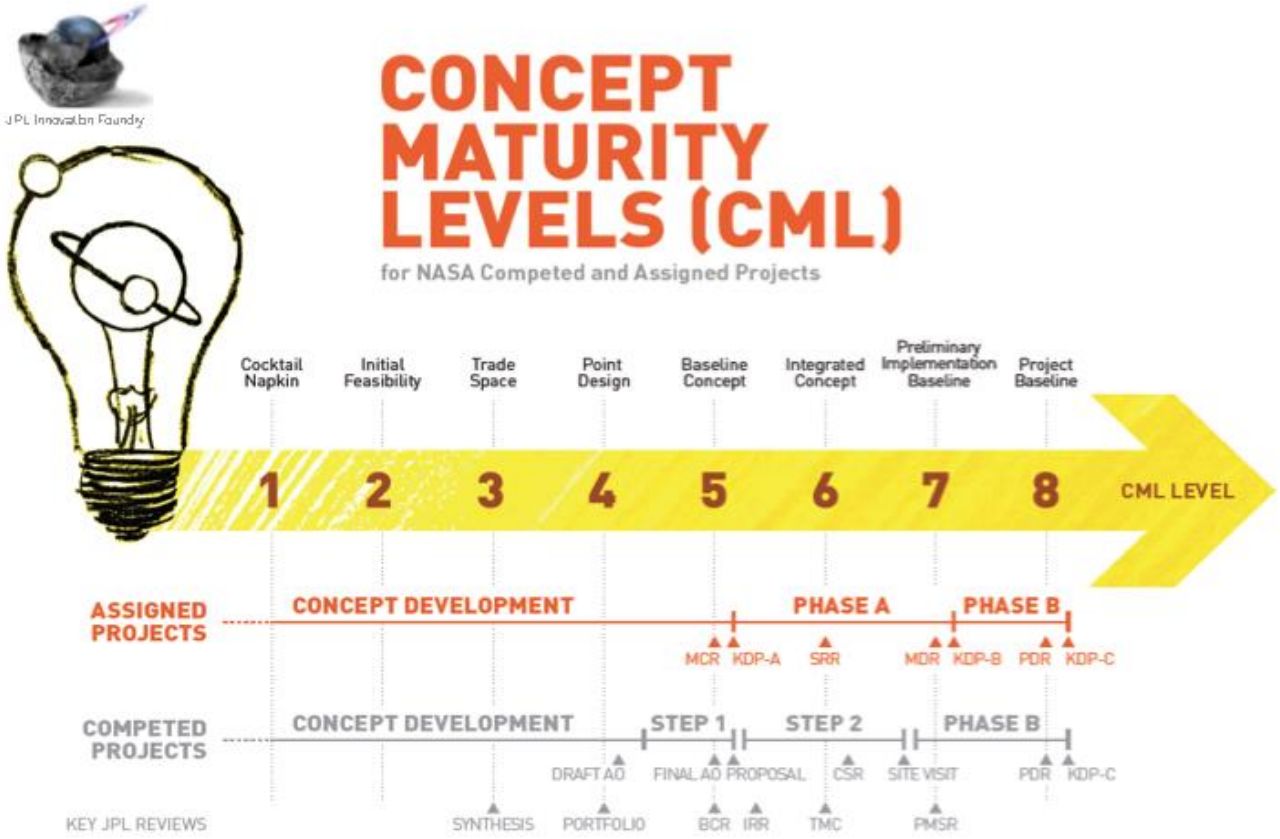
- APD Astrophysics Division
- CML Concept Maturity Level
- COR Cosmic Origins
- CSM Center Study Manager
- CSS Center Study Scientist
- DD Division Director
- DDD Deputy Division Director
- DRM Design Reference Mission
- DS Decadal Survey
- ExEP Exoplanet Exploration Program
- KDP Key Decision Point
- LCC Lifecycle Costs
- LL&BP Lessons Learned and Best Practices
- MCC Mission Concept Coordinator
- MEL Master Equipment List
- PAG Program Analysis Group
- PCS Program Chief Scientist
- PCOS Physics of the Cosmos
- PDR Preliminary Design Review
- PO Program Office
- RFI Request for Information
- RFP Request for Proposal
- SAG Science Analysis Group
- SAT Strategic Astrophysics Technology
- SIG Science Interest Group
- SMD Science Mission Directorate
- STDT Science and Technology Definition Team
- TBC To Be Confirmed
- TRL Technology Readiness Level

Document Change Log

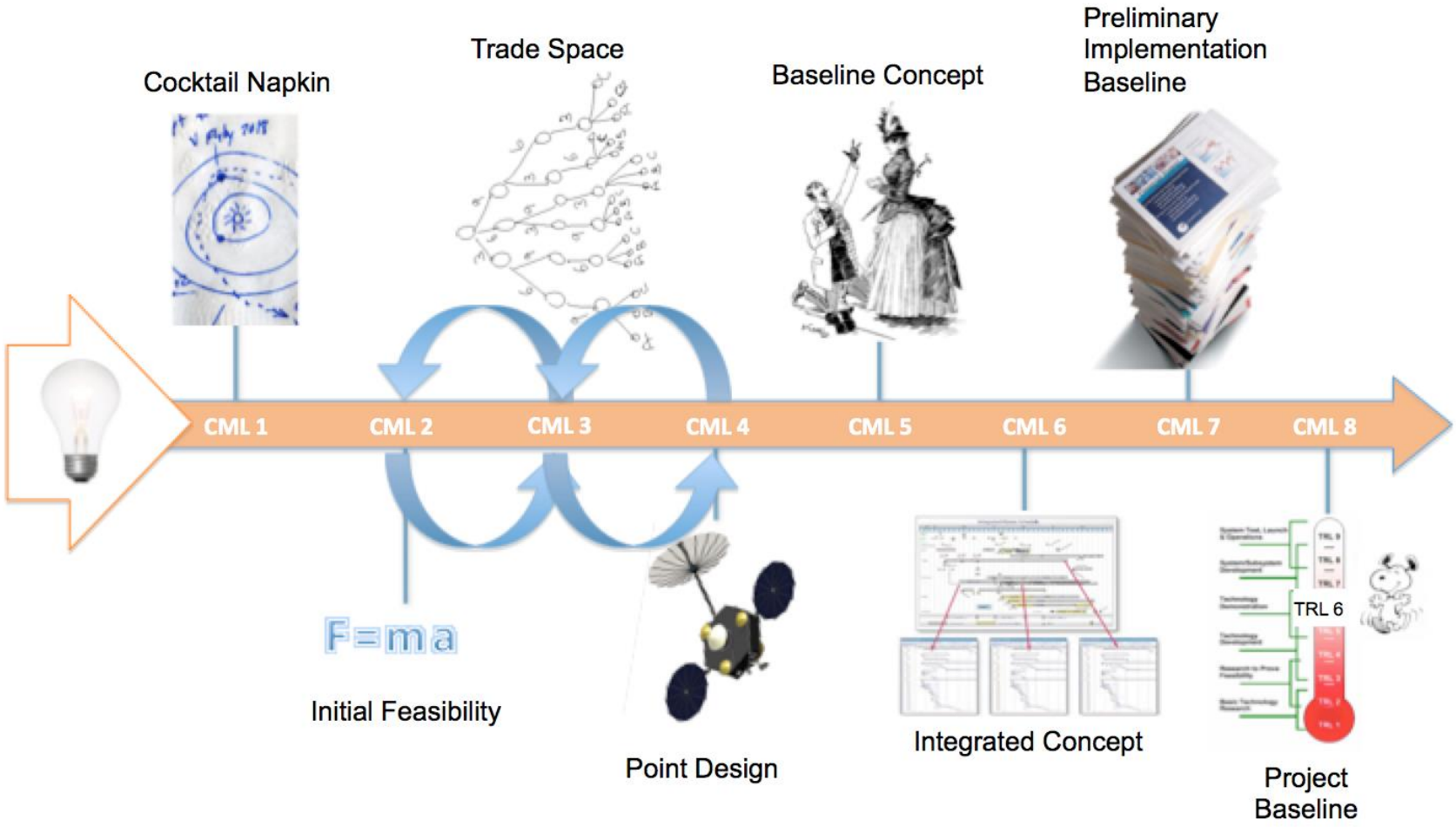
Cover Date	Change	Page
12/28/2015	Initial Release	

Backup: "Decadal CML"

Decadal CML = Tailored CML4



CML Progression



Applicable Metrics (1 of 5)
All columns tailored for Decadal

ExoPlanet Exploration Program

Attribute	CML 2	CML 3	CML 4
Scientific Objectives and System Requirements	Objectives described to levels that allow comparison with previous investigations and NASA science community documents	Objective linked to investigation and measurements Scientific return as a function of cost, risk, and programmatics quantified	Working top-level scientific requirements drafted, linkages to scientific objectives identified and described Design reference scientific investigation defined with viable reduction options identified
Science Data System	Identify science data drivers	Science data rates and volume included in trade space analysis	Design reference science data system sized to support data system flowdown requirements
Mission Development	Key mission concept parameters and performance requirements quantified Rudimentary calculations & comparisons to mission analogues performance Gross characterization of space environment quantified	Alternative set of mission architectures evaluated against science objectives, cost & risk Quantitatively bounded hazards of space environment	Design reference mission defined, including driving requirements, initial high-level scenarios, timelines and operational modes; mass, delta-V, and power estimates; telecom, and data processing approach defined to mission flowdown requirements
Spacecraft System Design	Key flight elements, design parameters & performance requirements listed High-level comparison to similar flight systems documented	Unique features that distinguish one flight system architecture from another evaluated Perform sensitivity studies to bound performance within trade space performed	Spacecraft system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support spacecraft flowdown requirements

* Tailored CML4 = Decadal CML

Applicable Metrics (2 of 5)

All columns tailored for Decadal

ExoPlanet Exploration Program

Attribute	CML 2	CML 3	CML 4
Instrument System Design	One sentence description of potential measurement technique(s) Perform high-level comparison to similar measurement technique(s)	Key instrument performance requirements, measurement techniques and instruments selected against science / mission objectives, cost & risk Sensitivity studies to bound performance within trade space performed	Instrument system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support instrument flowdown requirements and performance simulations Instrument performance requirements traced to scientific requirements
Ground System / Mission Operations System Design	Mission ops approaches defined	Mission ops drivers and sensitivities assessed Major flight / ground trades identified New ground system capabilities identified	Mission Operations System / Ground Data System architecture for design reference mission to support the ops scenarios described
Technical Risk Assessment & Management	Identify risks Identify areas of major concerns	Compare risks across the various architectures Identify mitigation strategies for key risks	Risk drivers listed 5x5 matrix provided with relevant risk drivers (include selected mitigation / development options)
Technology	Identify enabling technologies and / or significant engineering developments required to get to TRL 6 by PDR	Compare technologies and major developments required for design options across the trade space	Technology options described Baseline options selected and justified (technology roadmap) Rationale for TRL(s) explained Risk mitigations (including fallback options, if any) for all new technologies identified

* Tailored CML4 = Decadal CML

Applicable Metrics (3 of 5)
All columns tailored for Decadal

ExoPlanet Exploration Program

Attribute	CML 2	CML 3	CML 4*
Inheritance	Identify source of assumed inheritance	Early evaluation of inheritance options, benefits, and risks across trade space	Discuss all significant heritage assets used by the design reference mission
Master Equipment Lists	N/A	Mass of major elements quantified based on subsystem estimates	MEL documented for design reference mission to assembly level (e.g., antenna, propellant tank, star tracker, etc.)
Technical Margins	Identify high risk areas that need significant margin Assess uncertainty	Use institutional margins where applicable Analyze best and worst case scenarios	Critical performance margins estimated, resource margin estimated for design reference mission (AIAA S-120 margin policies followed)
System Engineering	Initial generation of trade space options	Capture the relative merits of performance, cost and technical risk over a broad range of architectures Subsystem dependencies identified	Selective, high-leverage science, spacecraft, and ground system trades completed
Launch Services	Launch approach and performance identified	Perform trades for candidate launch vehicles demonstrating compatibility with performance and fairing size	Preliminary launch vehicle(s) selection documented (NASA Launch Services used)

* Tailored CML4 = Decadal CML

Applicable Metrics (4 of 5)
All columns tailored for Decadal

ExoPlanet Exploration Program

Attribute	CML 2	CML 3	CML 4*
Verification & Validation	N/A	Identify any major or unique V&V activities	Approach for verifying new and enabling functions of the design reference mission defined to support an acceptable risk assessment by independent reviewers System testbeds and prototype models identified where applicable
Acquisition & Surveillance	N/A	N/A	N/A
Project Organization, Implementation Mode & Partnering	N/A	N/A	N/A
Schedules	Potential launch opportunities identified Use Schedule & Cost Rules-of-Thumb to estimate lifecycle duration	Assess variations and risks to science, development schedule and impacts to mission duration	Top-level schedule (one page) developed for design reference mission to support (coarse) independent cost estimates

* Tailored CML4 = Decadal CML

Applicable Metrics (5 of 5)

All columns tailored for Decadal

Attribute	CML 2	CML 3	CML 4*
Work Breakdown Structure	N/A	NASA Standard WBS & Dictionary (down to level 2 and level 3 for spacecraft and payload) used	N/A
Cost Estimation and Cost Risk	Cost estimate range provided based on analogous missions Cost uncertainty quantified	Cost sensitivities explored across trade space as a function of major drivers Initial estimate down to level 2 and level 3 for spacecraft and payload Cost uncertainty quantified System cost risks identified	Cost estimate and basis of estimate provided for design reference mission Cost uncertainty quantified Cost risks identified at subsystem level, with emphasis on enabling technologies
NEPA Compliance	Identify any nuclear material or public safety issues	Explore options (e.g., non-nuclear options for nuclear power missions)	N/A
Export Compliance	N/A	N/A	N/A

* Tailored CML4 = Decadal CML