National Aeronautics and Space Administration

Astrophysics




NASA Decadal Survey Preparations

Committee on Astronomy and Astrophysics
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Introduction

- NASA has initiated studies for large and medium (a.k.a. Probe) size mission concepts to inform the 2020 Decadal Survey Committee in an organized and coherent way
  - Main purpose is to provide the Decadal Survey Committee with several well-defined mission concepts to facilitate their deliberations

- Specifically, NASA is:
  - Sponsoring 4 community-based Science and Technology Definition Teams (STDTs) to partner with a NASA Center-based engineering team and study large (strategic) mission concept studies selected from the NASA Astrophysics 30-year Visionary Roadmap, a community-based report, and the 2010 Decadal Survey
  - Supporting 10 PI-led Study Teams for Probe-size mission concept studies, selected competitively
  - Supporting several other planning activities / studies / white papers

- All material related to NASA's 2020 Decadal Survey planning activities are posted at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

Task of the CAA

- NASA is asking the CAA to review its planned activities for delivering the mission concept studies to the Decadal Committee and prepare a short report for NASA
- Specifically, the CAA will
  - Review NASA's plans for delivering mission concept studies (large and medium) to the Decadal Survey Committee,
  - Assess the appropriateness of NASA's plans and, if needed,
  - Provide findings for the purpose of improving the value of NASA's preparations to the Decadal Survey Committee.
- NASA is delivering to the CAA the following material:
  - A Statement of Task
  - A list of URLs to documents for the Decadal activities
  - This presentation & presentations at the Space Science Week CAA meeting

Timeline	Milestone
February 24	NASA delivers material to CAA
February 26	Kick off telecon with the CAA
March 27-29	NASA presentations to the CAA
August 1	CAA delivers final report to NASA

Large Mission Concept Studies

Four Large Mission Concept Studies

- Using the 2010 decadal survey, *New Worlds New Horizons in Astronomy and Astrophysics*, and the 2013 NASA report, a 30-year visionary roadmap*, Enduring Quests, Daring Visions*, NASA nominated a small set of large mission concepts for further consideration.

- After a process involving NASA FACA committees and community input, NASA selected four mission concepts for further study:
  - Habitable-Exoplanet Imaging Mission (HabEx)
  - Large UV/Optical/IR Surveyor (LUVOIR)
  - Lynx X-ray Observatory (Lynx) [original X-ray Surveyor]
  - Origins Space Telescope (OST) [originally Far Infrared Surveyor]

Role of the STDTs and NASA Centers

- In Fall 2015, the NASA Astrophysics Division issued a solicitation for nominations to four Science and Technology Development Teams (STDTs) for each of the mission Concept studies:
    - Each team consisted of approximately ~ 30 scientists and technologists from the external community
    - Each team was further augmented with NASA civil service study manager and and a study scientist from NASA Centers.
    - Each study is co-chaired by two community members or STDT chairs
    - NASA to provide budget for these teams
- The STDTs were tasked with providing "*A compelling science case for identifying critical science questions across various scientific areas to be addressed in the following decades and the technical parameters necessary to achieve these goals.*"
- Each Study was assigned to a NASA Center for oversight and execution of the study. Centers host Study Offices, including a Study Scientist, a Study Manager, and related staff.

Preparing for the 2020 Decadal Survey
Large Mission Concepts

	Community STDT Chairs	Center Study Scientist	Study Lead Center	HQ Program Scientist
Habitable Exoplanet Imaging Mission www.jpl.nasa.gov/habex	Scott Gaudi Sara Seager	Bertrand Mennesson	JPL	Martin Still
Large UV/Optical/IR Surveyor asd.gsfc.nasa.gov/luvoir	Debra Fischer Bradley Peterson	Aki Roberge	GSFC	Mario Perez
Lynx X-ray Surveyor wwwastro.msfc.nasa.gov/lynx	Feryal Ozel Alexey Vikhlinin	Jessica Gaskin	MSFC	~~Dan Evans~~* Rita Sambruna
Origins Space Telescope asd.gsfc.nasa.gov/firs	Asantha Cooray Margaret Meixner	David Leisawitz	GSFC	Kartik Sheth

* Dan Evans is on detail to OMB through July 2018

http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/

The Process

- The large mission concept studies were initiated in late 2015 (selection of mission concepts, Center assignments) and early 2016 (appointment of STDTs, kickoff meetings).
- The four STDTs hold F2F meetings and regular telecons to define science goals and objectives, mission requirements, and architecture
- The Studies utilize NASA design labs at GSFC, JPL, and MSFC
- Periodic Pause and Learn (P&L) meetings are being held. These provide a forum for the four STDTs to share results and lessons learned
- NASA has been engaging Aerospace to provide information about cost and risk assessments
- Upon receipt of the Final Reports, NASA will engage an external organization to perform an Independent Cost Analysis (ICA) (but not a CATE) for each Study
- The ICA will be delivered to NASA, which will submit it to the Decadal Committee with the Final Reports.

STDTs Deliverables

The Decadal Studies Management Plan, page 18, lists the deliverables of the STDTs. In particular:

- A detailed study Plan was delivered to NASA in August 2016
- An Interim Report is due to NASA by March 31, 2018
  - The reports will be reviewed by a Large Mission Report Team (LRT) assembled by NASA HQ and including members of the Program Office and community experts in science, technology, engineering, and mission development. The LRT also includes an Aerospace former member. Several of these members have experience with previous Decadal submissions
  - The LRT is chartered by HQ to provide an assessment of the Interim Reports for progress towards a comprehensive Decadal submission
- An Updated Technology Requirements list is due in June 2018
- The Final Report is due to HQ no later than June 2019
  - NASA will submit the reports and the ICAs to the Decadal

Independent Cost Assessment

- NASA will engage an independent expert/company who specializes in assessing the cost of large space missions
- This task for NASA will be independent of the National Academies CATE process
  - NASA will not conduct a CATE
  - If the same independent expert/company provides CATEs for the NAS, strict firewalls be put in place to ensure independence
- NASA plans to conduct this activity after the final delivery of the report

Study Deliverables and High level Contents

M1 Comments on Study Requirements and Deliverables — April 29 2016
- Accept the study requirements/deliverables and submit plan--- or
- Provide rationale for modifying requirements/deliverables

O1 Optional: Initial Technology Gap Assessment — **June 30 2016**
- *To impact PCOS/COR/ExEP 2016 technology cycle*

O2 Optional: Update Technology Gap Assessments — **June 2017**

M4 Interim Report — **March 2018**
- Provide science case and mission concept (use CML 3 as a guide)
- Deliver initial technology roadmaps; estimate technology development cost/schedule
- CML 4 tailored approach (optional)

O3 Update Technology Gap Assessments — June 2018

M6 Draft Final Report at Concept Maturity Level 4 Audit / Freeze Point Design Jan 2019
- Provide science case and mission concept (use CML4 as a guide)
- Support independent cost estimation/validation process
- Submit to HQ for ICA

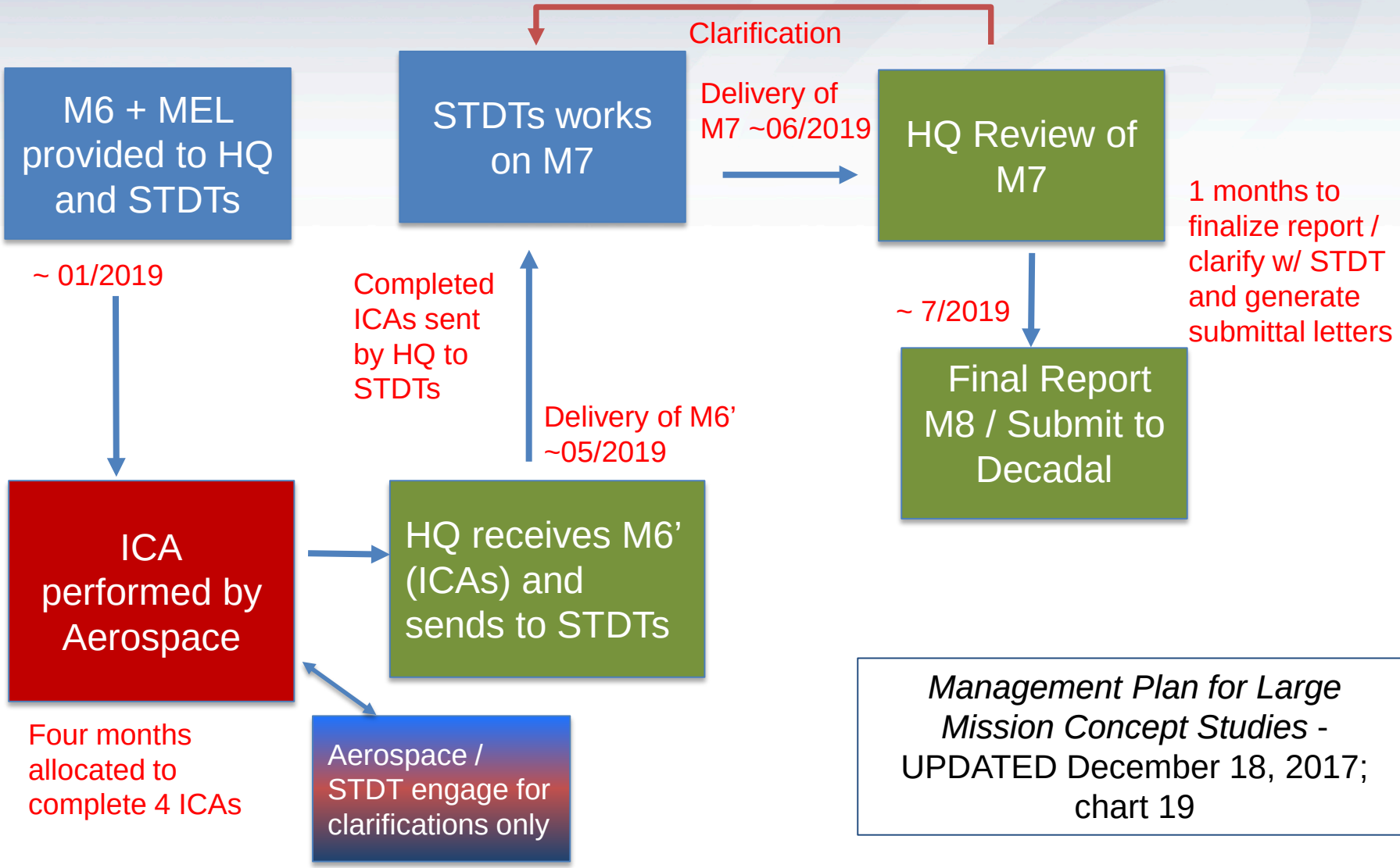
M6' ICA report returned by NASA to STDTs for incorporation into M7 — May 2019

M7 Final Report / incorporate ICA report + final changes — June 2019
- As described in study success criteria chart 15

M8 NASA Submits final report to Decadal — **July 2019**

Management Plan for Large Mission Concept Studies - UPDATED December 18, 2017; chart 18

Delivery Schedule for Final Report



Management Plan for Large Mission Concept Studies - UPDATED December 18, 2017; chart 19

Content of the Final Report

- TBD

At this time, NASA has not provided guidance to the STDTs on the content of the final report

What will NASA do with the Final Report?

- The Study Offices at the Centers will collect the final reports from the four STDTs and send them to NASA by January 2019
- NASA will have an Independent Cost Assessment conducted with results delivered to NASA and the Study Teams by May 2019
- The Study Teams will incorporate the ICA findings and submit a final report to NASA by June 2019
- NASA will submit the Final Reports, ICAs, and any cover material to the Decadal Survey Committee by July 2019

Probe Mission Concept Studies

The Process: Four Phases

Phase I: The Solicitation

- In August 2016, NASA issued a ROSES solicitation to solicit proposals for Probe-size Mission Concept Studies
- A total of 28 compliant proposals were received, for a variety of research fields and topics from exoplanets to cosmology to timing and spectroscopy at high energies
- The peer review was held in January 2017
- Panels were also asked to provide criteria for selection of a balanced portfolio of Probes; the panels unanimously recommended selecting a mix of missions addressing a broad range of astrophysics topics

Phase II: The Selection

- Based on the results of the peer review, 10 proposals were selected for an 18-month study
- Each selected study* was assigned to a design lab of their choice – IDC at GSFC and Team-X at JPL – for a lab run sponsored by NASA
  - *with the exception of one, which was selected as a proof-of-concept only

Selected Probe Mission Concept Studies

PI	Affiliation	Short title
Jordan Camp	NASA GSFC	Transient Astrophysics Probe
Asantha Cooray	Univ. California, Irvine	Cosmic Dawn Intensity Mapper
Bill Danchi	NASA GSFC	Cosmic Evolution through UV Spectroscopy Probe
Jason Glenn	Univ. of Colorado	Galaxy Evolution Probe
Shaul Hanany	Univ. of Minnesota	Inflation Probe
Richard Mushotzky	Univ. of Maryland	High Spatial Resolution X-ray Probe
Angela Olinto	Univ. of Chicago	Multi-Messenger Astrophysics Probe
Peter Plavchan *	Missouri State Univ.	Precise Radial Velocity Observatory
Paul Ray	Naval Research Lab	X-ray Timing and Spectroscopy Probe
Sara Seager *	MIT	Starshade Rendezvous Mission

* Partial Selections

The Selection Document and Probes Implementation Plan are posted at
https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

Four Phases (continued)

Phase III: Implementation

- Each study was assigned to either the Physics of the Cosmos/Cosmic Origins (PCOS/COR) or Exoplanet Exploration (ExEP) Program Office for oversight of the study technical progress by the Chief Engineers
- The Chief Engineers act as liaison between the PI and HQ and oversee the technical execution of the study, in particular the lab design runs

Phase IV: Independent Cost Assessment (ICA)

- The SMD Science Office for Mission Assessment (SOMA) office at LaRC will perform an Independent Cost Assessment, building on their experience conducting TMC reviews for SMD competitive mission proposals.

Role of Probe Studies PIs and Centers

- The Principal Investigator of the Study:
  - Is responsible for the overall study and its outcome
  - Communicates regularly with the POC of the assigned Program Office
  - Manages the funding from NASA
  - Submits the Quarterly Charts
  - Leads the lab design runs
  - Presents status report at the Decadal sessions at AAS

- The Centers (GSFC and JPL)
  - Provide Chief Engineers FTE through their respective Program Offices
  - Provide the lab design facilities
  - Provide additional resources in terms of FTEs and funding (JPL)

Final Study Products

- Each 18-month long Probe Study is required to generate two major products for submission:
  - A Study Report, and
  - An Engineering Concept Definition Package

- The principal product of the 18 month Probe Study is a Study Report.
  - Due no later than December 31, 2018
  - The report and the Master Equipment List (MEL) will be used by SOMA to conduct the ICA. SOMA will interact with the PI for questions and clarifications before releasing the ICA to HQ

- The other major study product is the Engineering Concept Definition Package.
  - The Engineering Concept Definition Package is originally generated by the Concurrent Design Lab supporting the Study.
  - The Engineering Concept Definition Package and the report get submitted to the Independent Cost Estimator organization (SOMA) for an independent cost estimate.
  - SOMA will initiate interactions with the Teams for needed clarifications

Content of the Probes Final Report 1/2

- Executive Overview *2-3 pages including figures and tables*
- Introduction: The Science Landscape
  - State Of The Art In The Field
  - Compelling Outstanding Questions
  - Needed Capabilities For Progress
- [Your Mission Name]:
  - Science Goals And Objectives
  - Perceived Scientific Impact
  - Observations, Measurements (W/ Science Yield Estimates)
- Instrumentation Payload:
  - Optics
  - Detectors
  - Instruments, Etc.
- Design Reference Mission
  - Conops
  - Mission Architecture
  - Flight Dynamics
  - Launch Segment
  - Flight Segment, Spacecraft And Subsystems
  - Ground Segment
  - Mission Ops

Content of the Probes Final Report 2/2

- Cost, Risk Assessment
  - Cost Assessment
  - Risk Assessment
  - Heritage Assessment
- Technology Maturation Plan
  - Requirements
  - Planned Activities
  - Schedule And Milestones
  - Estimated Cost
- Management Plan
- Conclusions
- List Of Participants
- References

Total: 50 pages

Other Planning

Other Planning

NASA HQ is sponsoring, planning, or contemplating several additional studies as input to the 2020 Decadal Survey

- These are independent of studies being initiated and conducted by NASA scientists at NASA Centers without HQ sponsorship

- Balloon Program Roadmap
  - Conducted by community-based Roadmap team chaired by Peter Gorham (U Hawaii)
  - Kickoff at Winter 2018 AAS meeting

Scientific Balloon Roadmap PAG

The Astrophysics Division (APD) Director signed Terms of Reference for the Balloon Roadmap PAG in Feb 2018, which lays out the following tasks. The PAG will be presenting a final report to the APD director in the spring of 2019.

- Articulate and prioritize the key scientific drivers and needed capabilities for NASA's Balloon Program;
- Evaluate the expected capabilities of potential balloon-borne missions for achieving the science goals and maturing important and strategic technologies of SMD;
- Evaluate Balloon Program goals, objectives, investigations, and required measurements on the basis of the widest possible community outreach;
- Articulate and prioritize focus areas for needed balloon mission technologies; and
- Summarize and assess balloon launch opportunities and mission capabilities provided by emerging commercial providers.

Schedule for the PAG activity:

- AAS 231 Jan 2018, National Harbor: kickoff & preliminary call for White Papers
- White paper initial draft deadline: June 2018
- Next public meeting/forum (still tentative):
  - COSPAR in Pasadena, CA, July 2018
- Initial draft of Roadmap recommendations:
  - Fall 2018, with public comments solicited following draft release
- Closeout of public comment period: January 2019
- Committee final drafting period, January-March 2019
- Delivery of final report to APD Director: April 2019

Scientific Balloon Roadmap Team

- The Astrophysics Division (APD) within SMD is managing the Scientific Balloon capability for the entire Agency. Consequently, the Scientific Balloon Roadmap Team reflects the science disciplines of all the stakeholders.
- APD Director signed Terms of Reference for the Balloon Roadmap Team and selected the members.

Chair:	Peter Gorham	U Hawaii
Technology:	Chris Walker	U Arizona
Astrophysics:	Carolyn Kierans	UCB
	William Jones	Princeton
	Abigail Vieregg	U Chicago
Earth:	James Anderson	Harvard
Planetary:	Eliot Young	SWRI
	Supriya Chakrabarti	U Mass Lowell
Solar/Helio:	Robyn M Millan	Dartmouth College
	Pietro N. Bernasconi	APL/JHU
Education:	T. Gregory Guzik	LSU
STMD:	Robert L. Yang	HQ

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- Balloon Program Roadmap
  - Conducted by community-based Roadmap team chaired by Peter Gorham (U Hawaii)
  - Kickoff at Winter 2018 AAS meeting
- Evolution of NASA Data Centers
  - In planning stage, draws on other efforts including
    - STScI 2016 study on big data (http://newsletter.stsci.edu/big-data-strategy-at-stsci/)
    - NASA Big Data Task Force identified areas adapting archives to evolving technology (https://science.nasa.gov/science-committee/subcommittees/big-data-task-force)
    - IPAC leading NASA/NSF/DOE study to scope the work for joint data processing from LSST/Euclid/WFIRST
- In-Space Servicing/In-Space Assembly
  - NASA-led study being initiated, joint SMD/STMD/HEOMD
  - Kickoff meeting in November 2017 (https://exoplanets.nasa.gov/exep/technology/in-space-assembly/)

Technology Development

Technology Inception (TRL <3)

- APRA
- XRP (exoplanet measurements of observables)

Technology Maturation (TRL>=3)

- Competed:
  - APRA (suborbital payloads)
  - SAT (detectors, coatings, mirrors, and opto-mechanical devices)
  - XRP (exoplanet enabling techniques)
  - Smallsats and Cubesats
  - Segmented Mirror Telescope Program (industry system-level studies)
- Directed:
  - Decadal Preparation
    - Large Mission Concepts (HabEX, LUVOIR, Lynx, OST)
    - Probe Mission Concepts (Ten medium mission concepts)
  - Mission Contributions (LISA, Athena, Euclid, XARM)
  - Coronagraph Technologies (w/STMD) and Testbeds
  - Star Shade Development

Preparing for the 2020 Decadal Survey Technology Development

HabEx

- 12 of 12 gaps being addressed
- mirror coatings, starshade starlight suppression, starshade controlling scattered sunlight, starshade lateral formation sensing, starshade petal position accuracy, starshade petal shape and stability, *telescope vibration control*, deformable mirrors, **visible detectors**, *large aperture primary mirror*, **wavefront sensing and control**, ***coronagraph optics and architecture***

LUVOIR

- 7 of 9 gaps being addressed
- closed-loop segment phasing, *vibration isolation*, ***wavefront sensing and control***, *mirror segments*, ***high-contrast segmented-aperture coronagraphy***, deformable mirrors, near infrared detectors, **visible detectors**, mirror coatings

Lynx X-ray Surveyor

- 4 of 5 gaps being addressed
- high-resolution lightweight X-ray optics, non-deforming X-ray reflecting coatings, megapixel X-ray imaging detectors, **large-format, high resolution X-ray detectors**, X-ray grating arrays

Origins Space Telescope

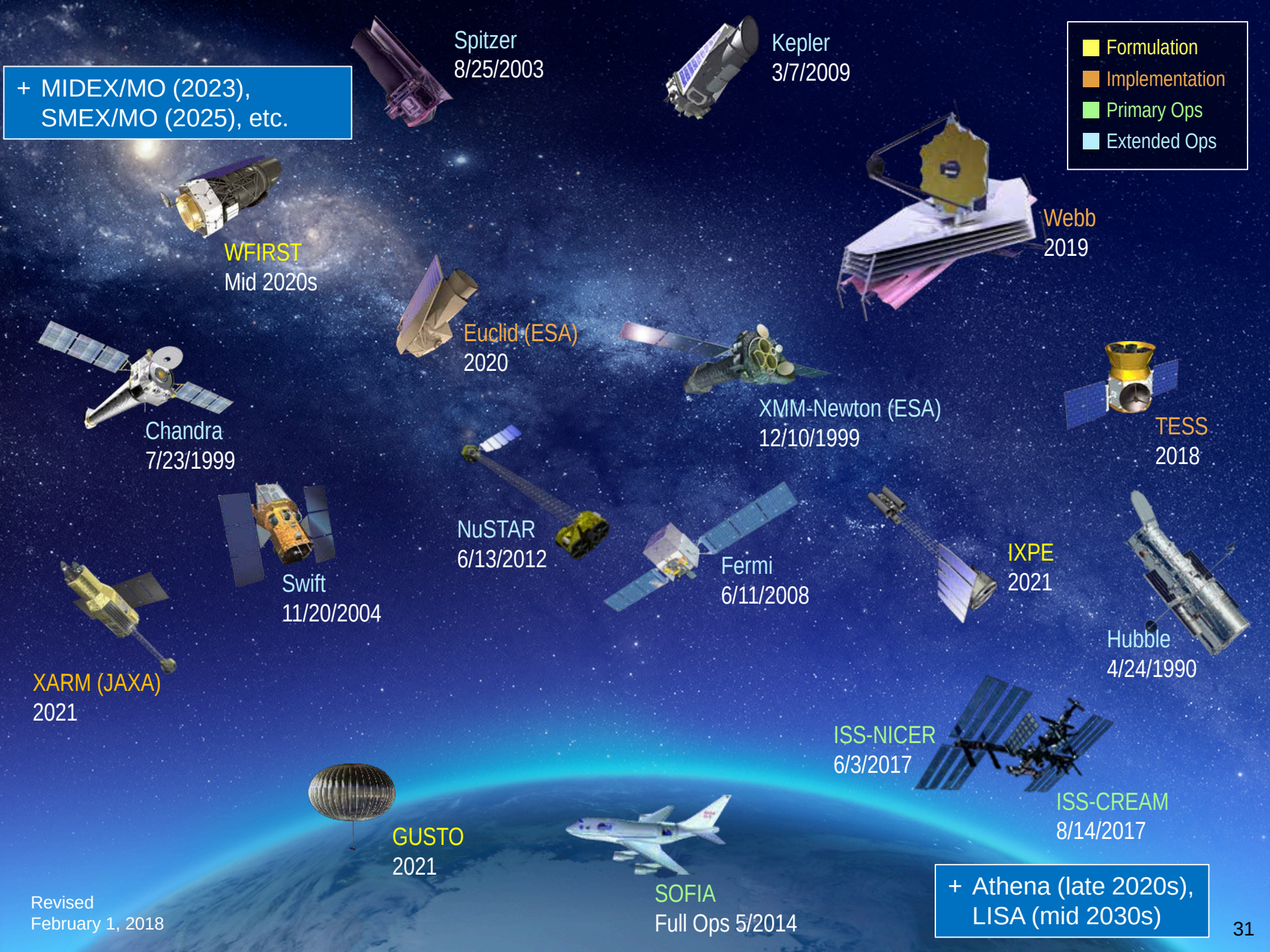
- 2 of 5 gaps being addressed
- far-infrared (FIR) detectors, cryogenic readouts for large-format FIR detectors, warm readout electronics for large-format FIR detectors, sub-Kelvin Coolers, cryogenic FIR mirror segments

- Purple: technologies being advanced through SAT or directed development,
- **Bold**: technologies being advanced by WFIRST or ATHENA
- *Italics*: technologies being worked on through the STDT's design studies
- Additional gaps being addressed through APRA but not tallied here

Segmented Mirror Telescope Technology

NASA is committed to advance and mature key mirror technologies for future large telescopes that could be recommended in the upcoming decade.

- **Genesis**: RFI issued on February 6, 2017 (NNG17FB01RFI), multiple responses received; informed planning.
- **Phase 1**: ROSES NRA (D.15) issued on December 1, 2017; $2.5M available in FY18 to fund one or more 1-year system-level segmented telescope design studies; proposals due February 1, 2018.
  - NASA is soliciting industry proposals to carry out system-level engineering design and modeling studies of large segmented-aperture telescopes, with integrated coronagraphs, that will lead to the identification of priority technology investments.
  - For astronomy at ultraviolet, visible, and near-infrared wavelengths a key technology priority is sub-nanometer wavefront stability.
  - For astronomy at mid- and far-infrared wavelengths, a key technology priority is to dramatically reduce mirror manufacturing and verification costs.
- **Phase 2**: RFP for 2-years soliciting testbed and laboratory demonstrations of key technologies; $10M for FY19 and FY20 (planned).
- **Phase 3**: Post-Decadal, RFP for 3-years soliciting maturing key technologies; $15M for FY21-23 (tentative, depends on Decadal Survey priorities).


+ MIDEX/MO (2023), SMEX/MO (2025), etc.
Spitzer 8/25/2003
Kepler 3/7/2009
Formulation
Implementation
Primary Ops
Extended Ops
WFIRST Mid 2020s
Webb 2019
Euclid (ESA) 2020
Chandra 7/23/1999
XMM-Newton (ESA) 12/10/1999
TESS 2018
NuSTAR 6/13/2012
Swift 11/20/2004
Fermi 6/11/2008
IXPE 2021
Hubble 4/24/1990
XARM (JAXA) 2021
ISS-NICER 6/3/2017
ISS-CREAM 8/14/2017
GUSTO 2021
SOFIA Full Ops 5/2014
+ Athena (late 2020s), LISA (mid 2030s)
Revised February 1, 2018