Early Technology Development for the Great Observatories: Connections with Science

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Future Great Observatories

Large observatories are a critical component of NASA's astrophysics portfolio

- The Decadal Survey recommends a compelling, feasible, timely portfolio of future great observatories that is part of a balanced Astrophysics program

Today NASA's priority is ensuring mission success for Webb and Roman

- Webb has been launched and has begun its 6-month commissioning phase
- Roman successfully passed its Critical Design Review (CDR) and has been replanned to account for COVID impacts; the new launch commitment date is mid-2027 (7 month delay due to COVID)

Now is not the time to start a Future Great Observatory; now is the time to prepare

NASA will take a deliberate, multi-stage planning and strategy approach to the next large observatory mission

- Stage 1 – Focus on enabling science and technology; begin Stage 1 now
- Stage 2 – Begin the Decadal Survey recommended "Great Observatories Maturation Program"; conduct Analysis of Alternatives (AoA) and science / technology / architecture trades; begin Stage 2 in a few years (driven by planning and budget availability)
- Stage 3 – Pre-formulation and decision to start the next Great Observatory; begin after Stage 2 AoA complete (Decadal Survey estimates 6 years for Stages 2 and 3)

Stage 1 Activities

Science	Workshops - compile metrics and science gaps	Update ROSES Call	Determine efforts beyond ROSES	ROSES Selected	Science Gaps Identified for 3 Great Observatories	Begin Precursor Science Funded activities
				SCIENCE DEVELOPMENT		
Science Evaluation	Stand up Team	Develop initial Metrics	Develop initial parameters	Sensitivity study of key parameters	Iterate with SST and TST	Update sensitivity study with new parameters
				TECHNOLOGY DEVELOPMENT		
Technology	Stand up Team	ID Tech Gaps	Develop high level Tech Dev plans	ID tech studies. Trades & study groups	ID long lead tech investments	Begin tech studies

Note: This is not a timeline; some activities within each lane occur in parallel
There is cross-communication and cross-participation between activities in different rows
ROSES call for presursor science investigations anticipated for January 2023

Stage 1 Teams Enable Science and Technology

Director of Astrophysics

Joint Program Astrophysics Collaboration:
Advises Director and coordinates science and technology activities.
Eric Smith, Lead, with HQ & Program Office leadership

Science

Science Strategy Team: Identify, categorize, and iterate community precursor science investigations relevant to successful maturation of Astro2020's three great observatories. Work with Centers, Program Analysis Groups (PAGs), task groups. Eric Smith & Terri Brandt, Leads

Science Evaluation Teams: Develop and run simulation and yield-modeling tools to help inform strategic science and technology decisions. Rhonda Morgan for ExoSET, Jay Falker (acting) for AstroSET, and TBD for later Great Observatories, Leads

Science Development Management Team: Oversee the selected and directed precursor science activities. Program Scientists, Leads

Precursor Science Investigators

Technology Strategy Team: Identify the capability needs and corresponding technology gaps for each of the future great observatories. Develop high-level plans to close them. Stand up task groups to develop detailed development plans. Work with Centers, task groups. Nick Siegler & Jay Falker, Leads

Technology Development Management Team: Oversee awarded and directed technology development activities. Brendan Crill & Rachel Rivera, Leads

Technology Developers

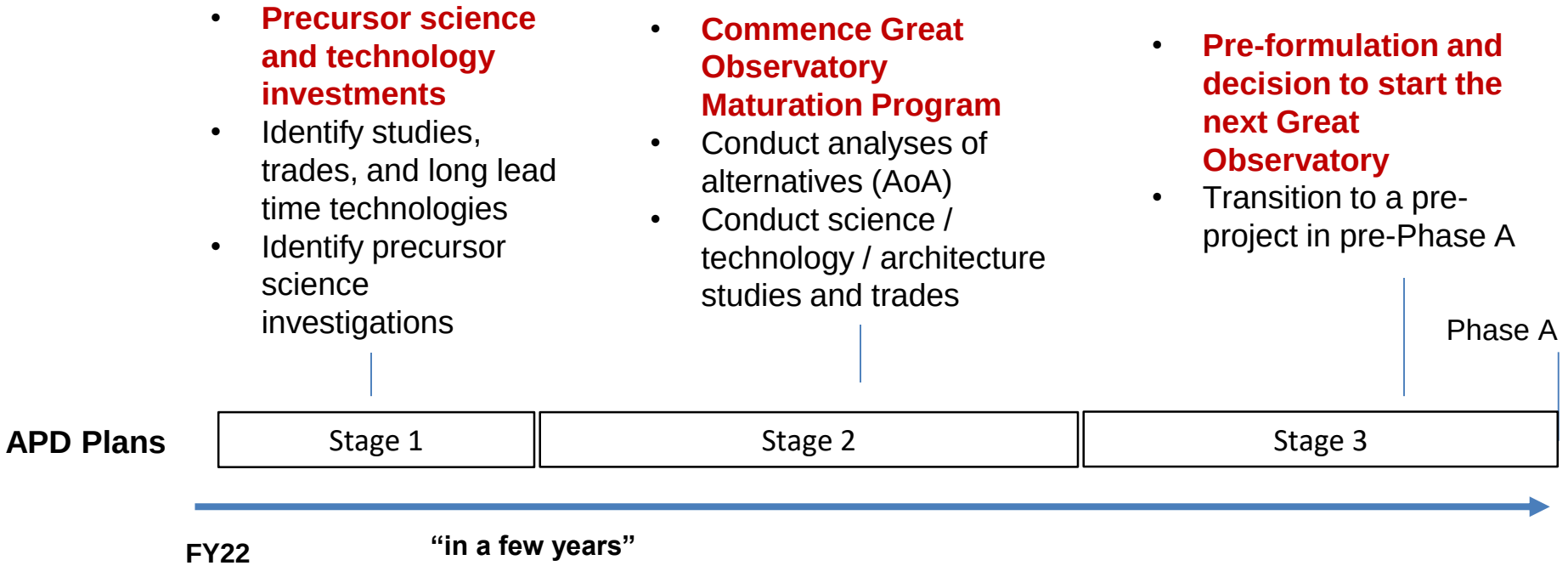
Technology

Notes: This is not an org chart, it is just a description of teams
Box size means nothing other than the amount of inscribed text

NASA | NASA & Community | NASA & SMEs | Community

A Departure from the Past…

- **Longer "Pre-Phase A" period (Stages Model)**
  - Enables technologies to be further matured, more time to consider alternatives, more studies and trades before decision to start
  - Defers detailed mission cost estimate closer to KDP-A
- **Multi-institutional participation; greater APD involvement early**
  - More voices, greater inclusiveness
- **Utilizing lessons learned from JWST and the SMD Large Mission Study**



A Need for Strategic Tech Planning

- The current Stage 1 precursor technology effort mainly consists of a prioritized gap list, a ROSES program (SAT and APRA) targeting it, Center IR&D, and a Segmented Mirror Technology Program.
- However, these Stage 1 programs by themselves don't sufficiently prepare APD to execute the elevated Stage 2 investments. They don't tell us:
  - **how to close the gaps**
  - **which are the tall technology tent poles, the long duration items, estimated cost and schedule**
  - **which studies to conduct first, which trades to open early**
  - **how to best fund gap-closure efforts (competed, directed)**
  - **where to involve industry, gov't labs, academia, and international collaboration**
- Therefore, we added a strategic technology planning activity to the existing Stage 1 activities.
- Which must receive and iterate with science input.

Proposed Stage 1
Strategic Technology Activities

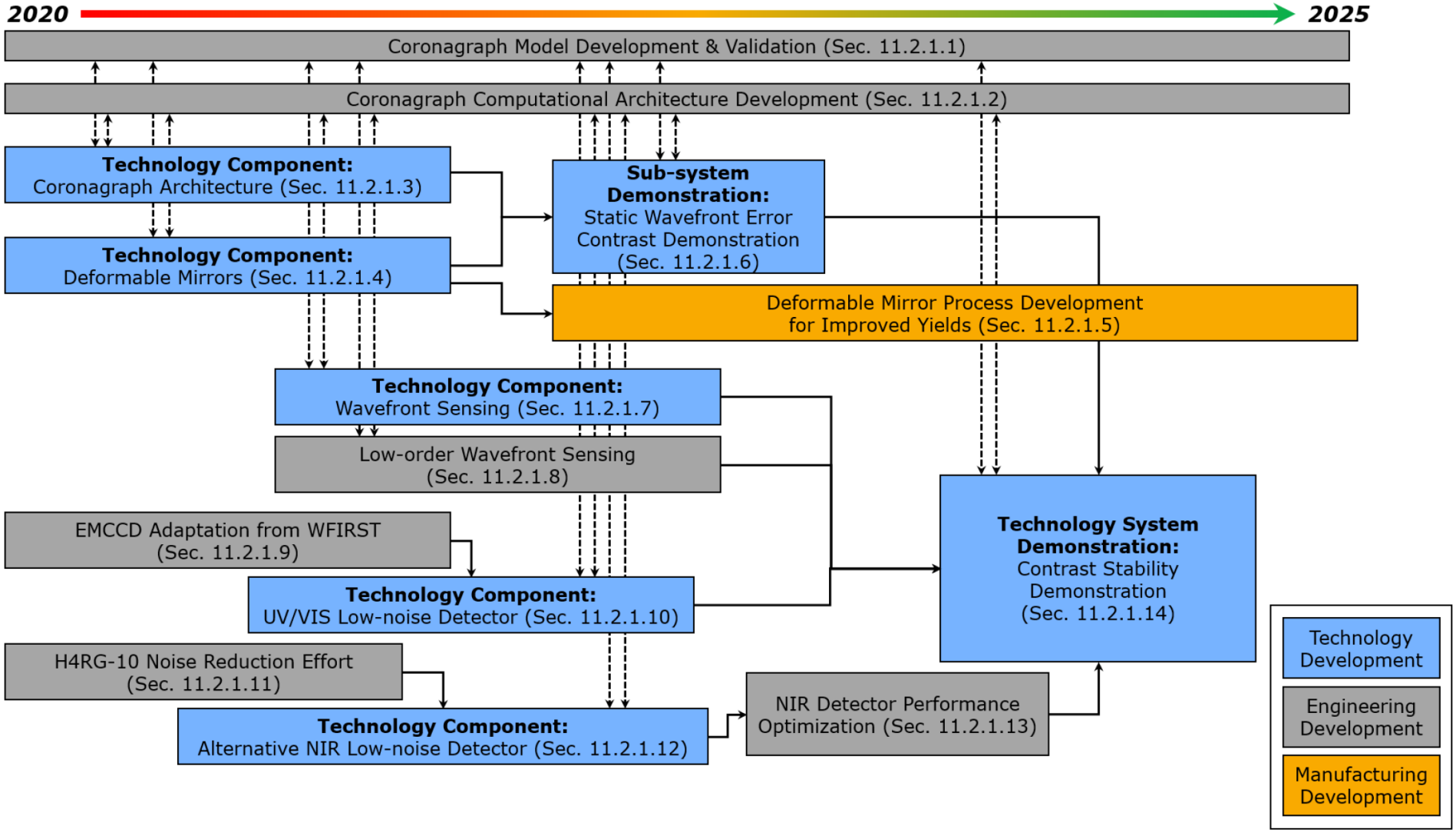
Stage 1 Strategic Technology Activities

1. Identify capability and technology gaps that span the architecture space of the great observatories

2. Develop high-level tech development plans to close each gap
   - Includes preliminary estimates of duration, complexity, cost buckets, suggested funding platforms, risks, and off-ramps

An Example of a Technology Dev Plan

Coronagraph Contrast Gap



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4. Identify technology studies to conduct and trades to open in order to inform future down-selects

Examples of Possible Studies and Trades

a) Can a large monolithic primary mirror be fabricated and survive launch loads?
b) Should the primary mirror be monolithic or segmented?
c) Should a starshade be in the option space?
d) How will UV impact the telescope and starlight suppression techniques?
e) What degrees of in-space refueling and servicing should be considered?
f) How stable does a telescope have to be to meet the wavefront stability requirements of a coronagraph? Can that really be built?
g) How do we loosen the challenging telescope stability requirements?
h) Which are the long lead items needed to be planned in advance?
i) Do new facilities need to be built or old ones upgraded?
j) And many more…

Answers to these questions will inform future architecture and design decisions.

And dialogue between science, engineering, and technologists will be critical.

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5. Identify long-lead technology investments to close the gaps

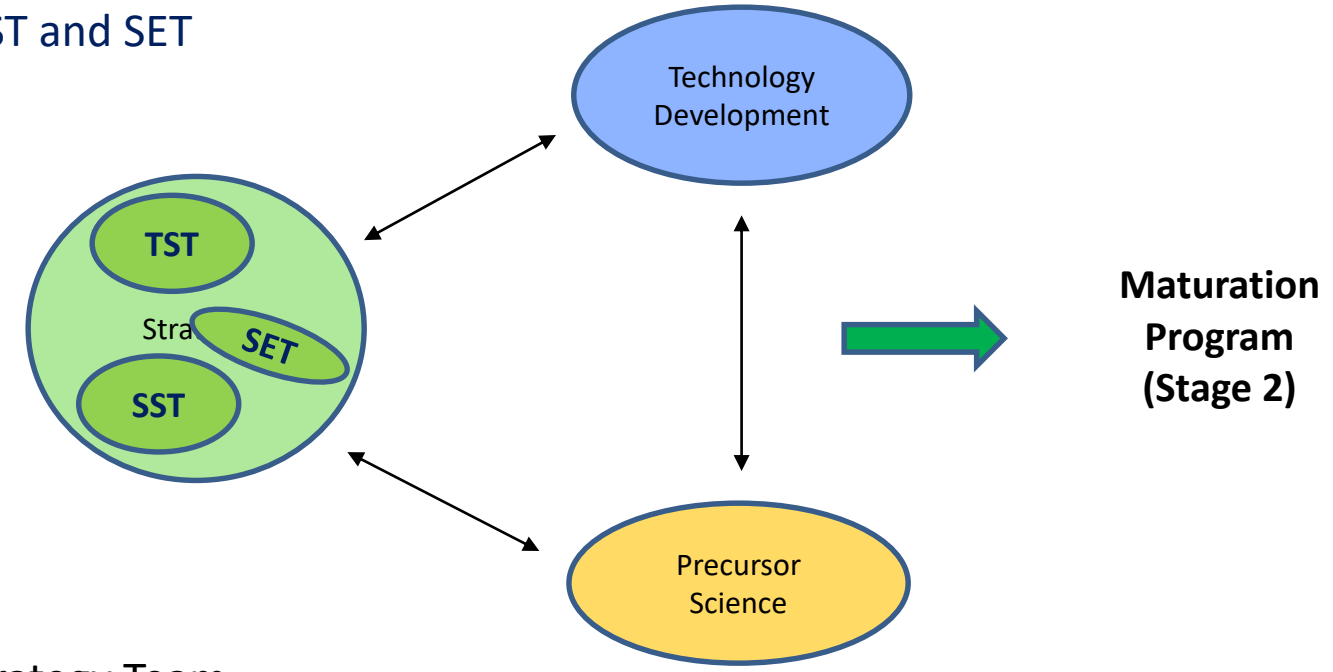
A Technology Strategy Team (TST) can prepare these planning activities for Stage 2

Introducing a
Technology Strategy Team (TST)

Stage 1 Precursor Science and Technology Development

TST

- Multi-disciplinary
- Core Team NASA-only
- Task Groups (community)
- SMEs (community)
- Liaisons from SST and SET



TST = Technology Strategy Team
SST = Science Strategy Team
SET = Science Evaluation Team

Features of a Great Science and Technology Team

- Capable of working as a “badgeless” team
- Objective, willing to challenge preconceived notions
- Respectful of others and collaborative
- Technical depth, with variety of experience and expertise
- Inclusive and diverse (individuals and organizations)

We’re eager to involve the best science and technical expertise from across the whole community.

Final Thoughts…

- **Precursor science** informs the mission architecture
- **Early technology development** also informs the mission architecture
- Science and technology development must work concurrently, collaboratively, and iteratively
- Resist jumping to a point design or baseline too early
- Strive together to understand the driving parameters and sensitivities (integrated modeling will help!)

Stay tuned for more updates at the next Precursor Science Workshop