Jet Propulsion Laboratory
California Institute of Technology

In-Space Assembled Telescope (iSAT)

Study Members Telecon 5

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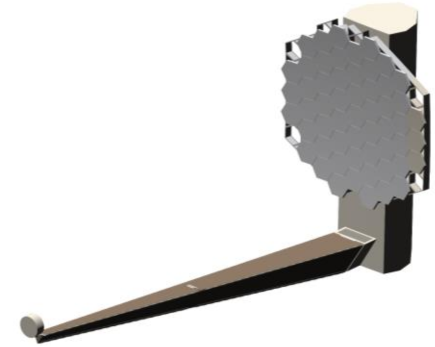
Today’s Agenda

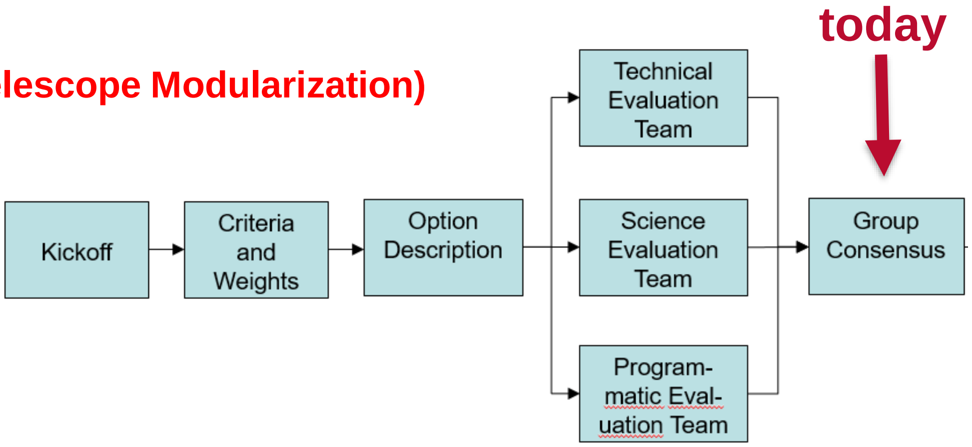
1. **Upcoming Schedule**
2. **Advance Activity 1a Selection Criteria Concurrence**

Upcoming Schedule

iSAT Study Process



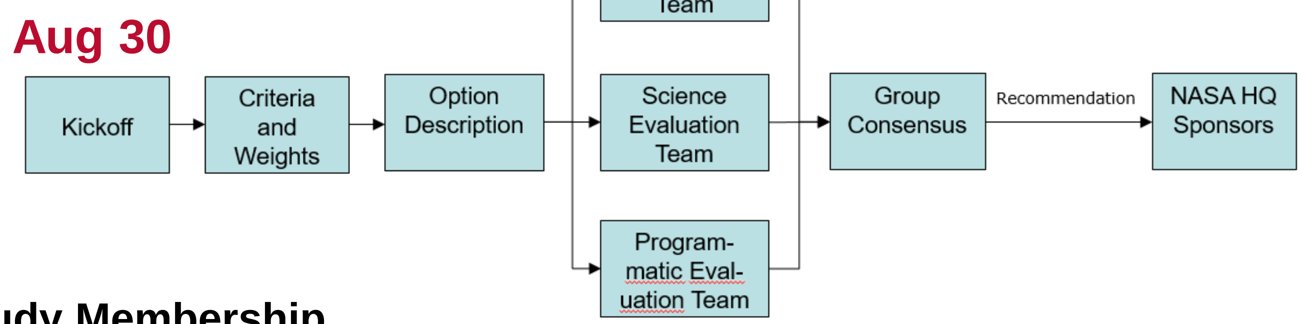
(Activity 1a – Telescope Modularization)



We're done when we concur on:

- CAD model
- Truss architecture options defined
- Scattered light analysis
- Sunshade architecture analysis
- List of all the modules

(Activity 1b – Telescope Assembly and Testing)



New Study Membership being formed more focused on robotics, orbital dynamics, assembly, and assembly platforms.

Face-to-Face at NASA LaRC Oct 2-4

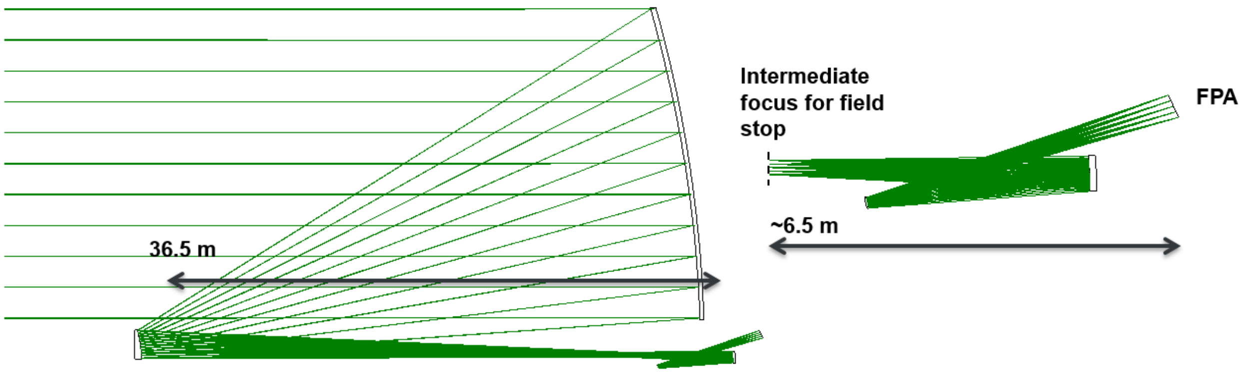
Start planning Activity 2 (identifying cost and risk benefits)

Advance Activity 1a Selection Criteria Concurrence

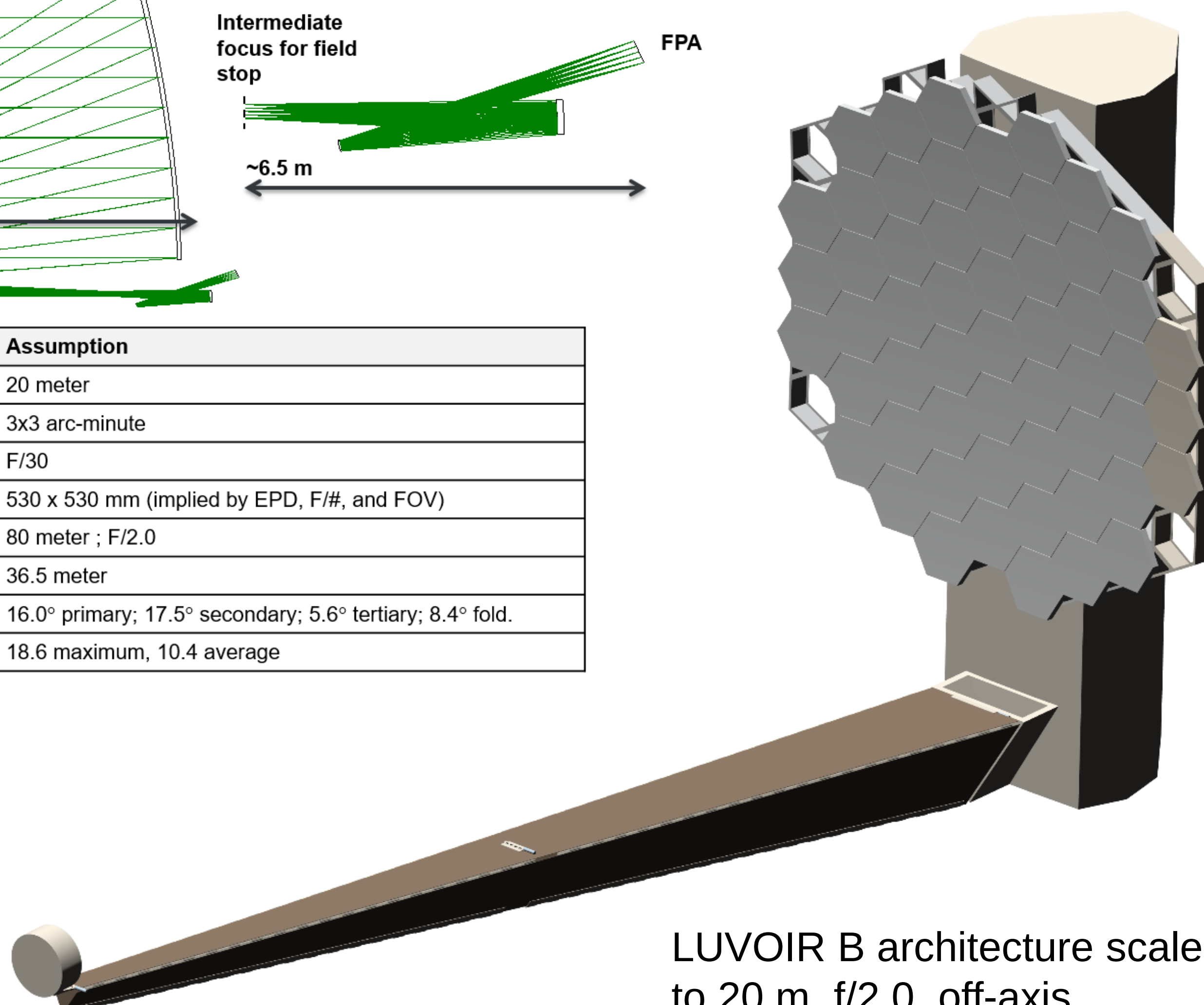
Features of Kepner-Tregoe Decision Process

Decision Statement									
Description				Option 1		Option 2		Option 3	
	Feature 1								
	Feature 2								
	Feature 3								
Evaluation	**Musts**								
	M1			✔		✔		✔	
	M2			✔		?		?	
	M3			✔		✔		✘	
	Wants	*Weights*							
	W1	*w1%*		*Rel score*		*Rel score*		*Rel score*	
	W2	*w2%*		*Rel score*		*Rel score*		*Rel score*	
	W3	*w3%*		*Rel score*		*Rel score*		*Rel score*	
		100%	Wt sum =>	*Score 1*		*Score 2*		*Score 3*	
	Risks			C	L	C	L	C	L
	Risk 1			M	L	M	L		
	Risk 2			H	H	M	M		
Final Decision, Accounting for Risks									
				C = Consequence, L = Likelihood					

Reference 20 m Modularized Telescope Option A



Parameter	Assumption
Entrance pupil diameter	20 meter
Field of View	3x3 arc-minute
Final F/#	F/30
Image size	530 x 530 mm (implied by EPD, F/#, and FOV)
Primary mirror ROC and F number	80 meter ; F/2.0
Primary-secondary spacing	36.5 meter
AOI, maximum on each mirror	16.0° primary; 17.5° secondary; 5.6° tertiary; 8.4° fold.
RMS WFE (nanometer)	18.6 maximum, 10.4 average



LUVOIR B architecture scaled to 20 m, f/2.0, off-axis

Switch to Excel Spreadsheet

Additional Slides

Proposed Definition of Modularity

- Modules are separate elements that are connected to form a larger assembly. Ideally, the separate modules can be verified independently without having to be connected to the rest of the system. Although using a modular design approach can be beneficial for smaller systems, it becomes almost essential when it is impractical to verify at the full system level due to its large size. To the extent possible, modules should have simple well-defined interfaces to keep system level analyses simpler.

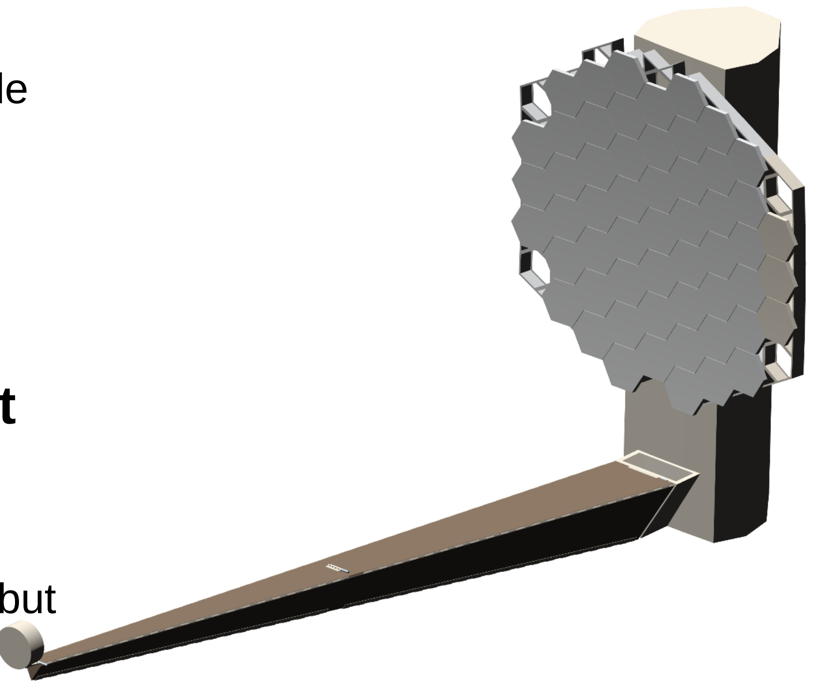
- When possible, modules should be identical to reduce the overall cost of non-recurring engineering. Even when different module types are used, there can still be benefit from the cost savings of using common design features and interfaces.

Thanks to Kim Aaron (NASA JPL)

Generating Modularization Design Options

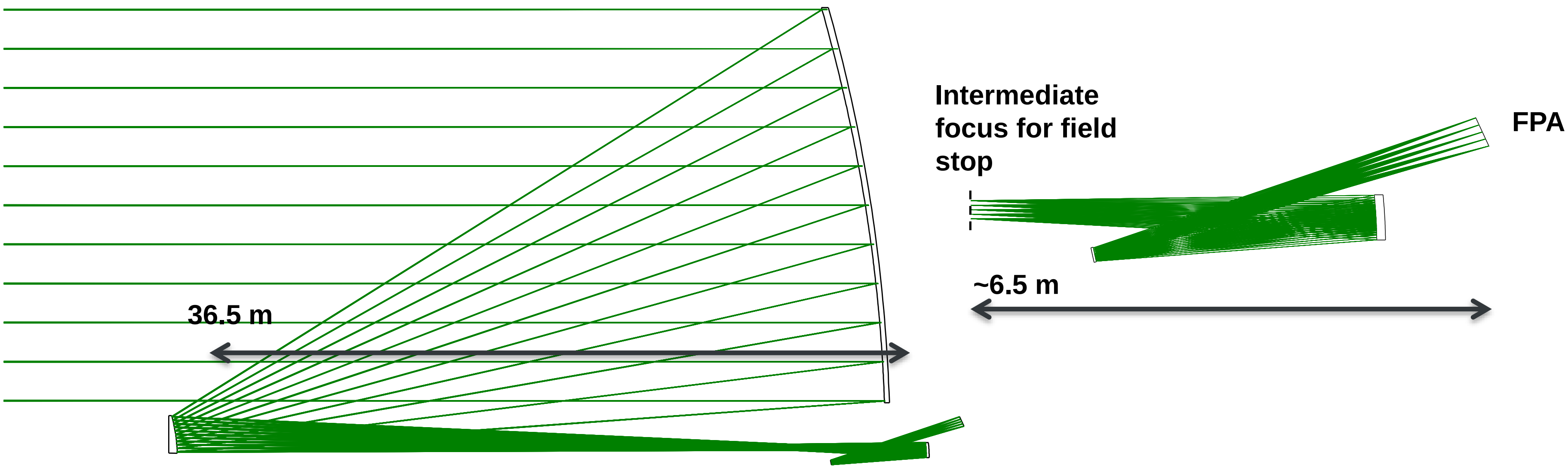
- **Trade space for <u>modularization</u> is very open**
  - Number of modules
  - Segment size, segment carriers, sun shade
  - Backplane architecture
  - Power, latching, harnessing
  - Instrument carriers, thermal

- **Do some telescope designs benefit from iSA more than others?**
  - Let's find out
  - Option generation starts at the Workshop but can continue after
  - Recommendation for Workshop Breakout sessions for Reference Telescopes:
    1) (a) 20 m off-axis and (b) 20 m off-axis with opportunities to move to a different configuration if benefits noted
    2) Max 5-m class fairings



Candidate Reference Telescope Design

Off-Axis 20-Meter Optical Layout



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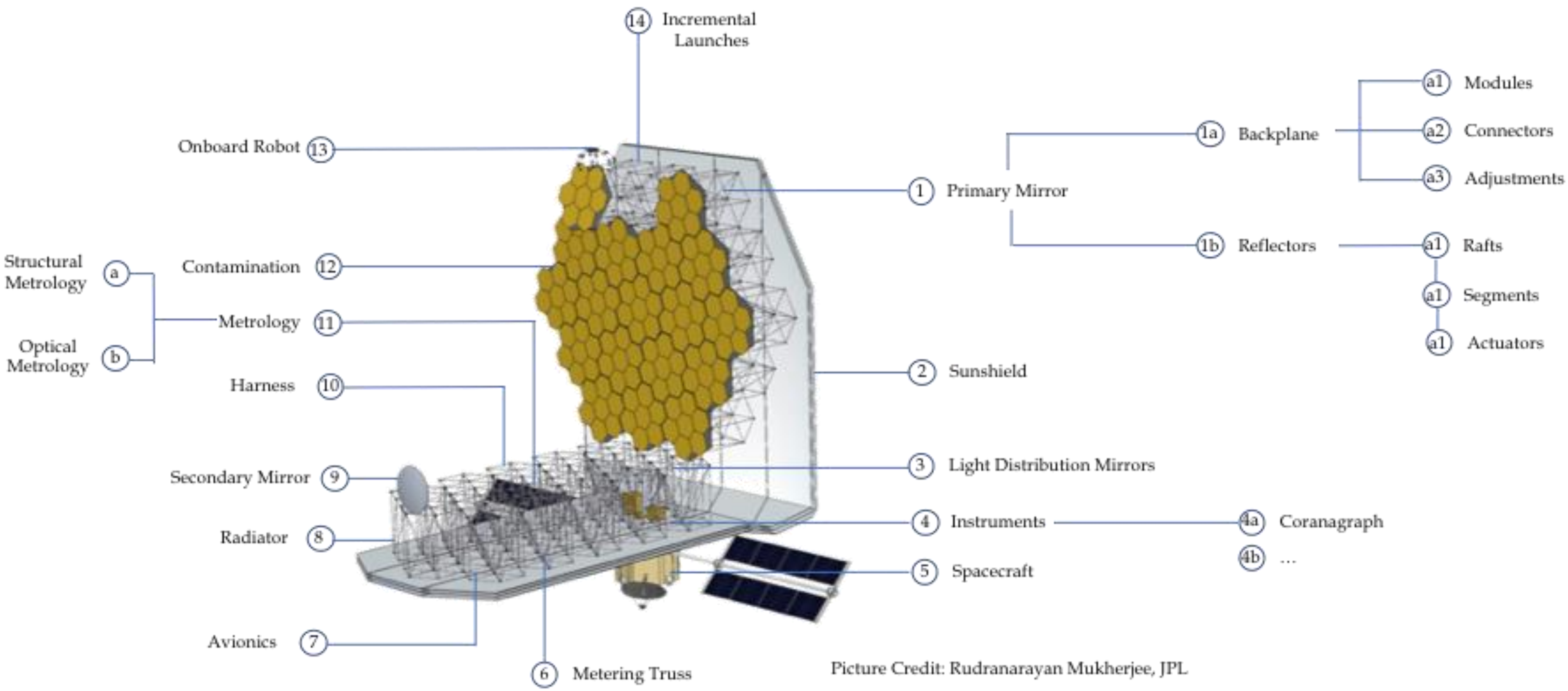
Modularized Telescope Sub-Elements

(all were discussed during the Workshop)

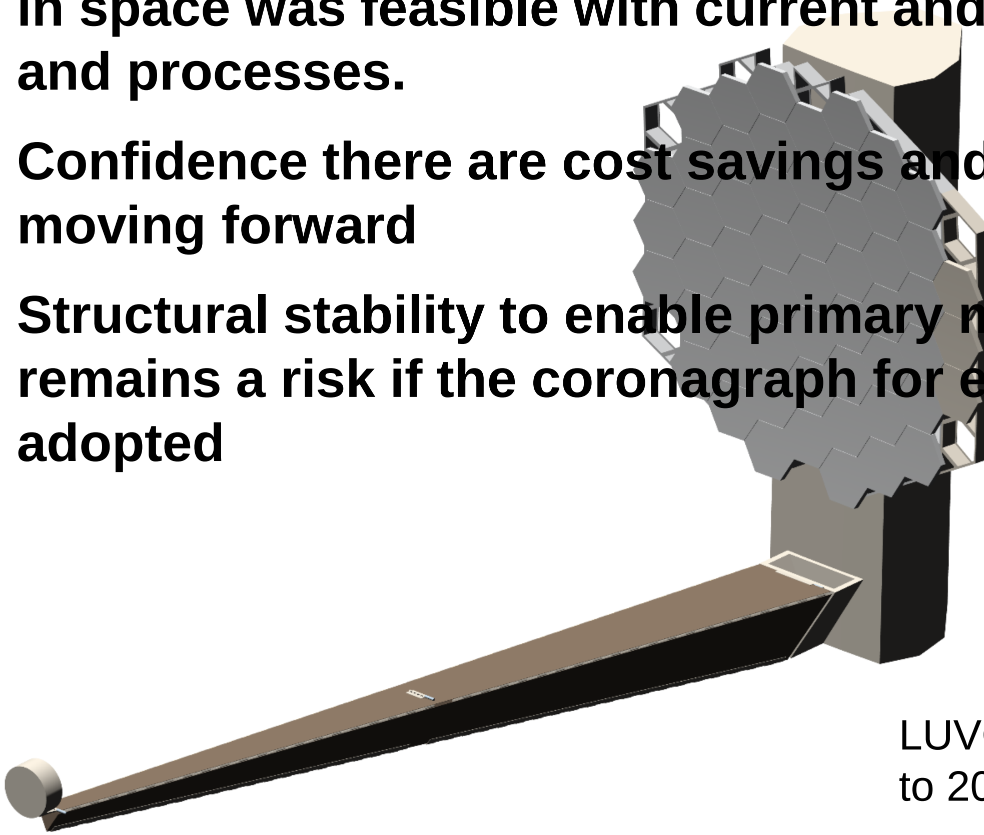


Picture Credit: Rudranarayan Mukherjee, JPL

Telescope architecture and modularization are notional.

Workshop Conclusions

- **The 20 m off-axis f/2 filled telescope would serve as a good reference for the Study**
- **<u>No</u> major show stoppers were found; no real energy for an alternative.**
- **The consensus was that assembling the reference telescope in space was feasible with current and anticipated technology and processes.**
- **Confidence there are cost savings and risk mitigations moving forward**
- **Structural stability to enable primary mirror WFE stability remains a risk if the coronagraph for exo-Earth science is adopted**

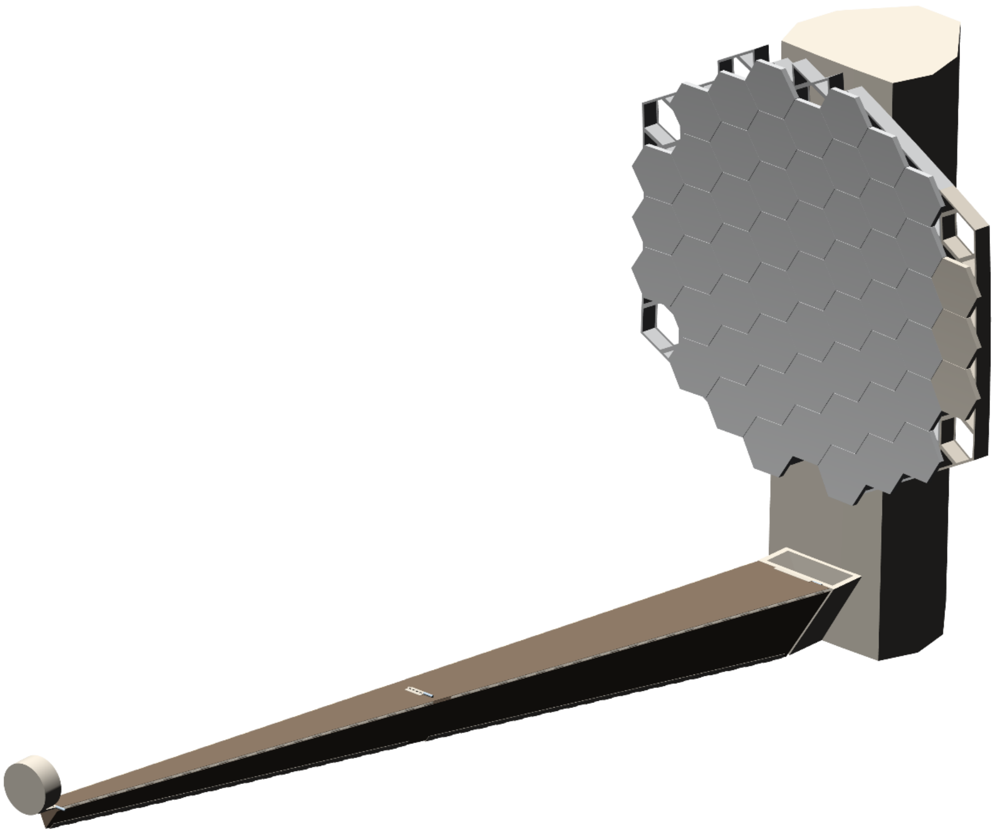


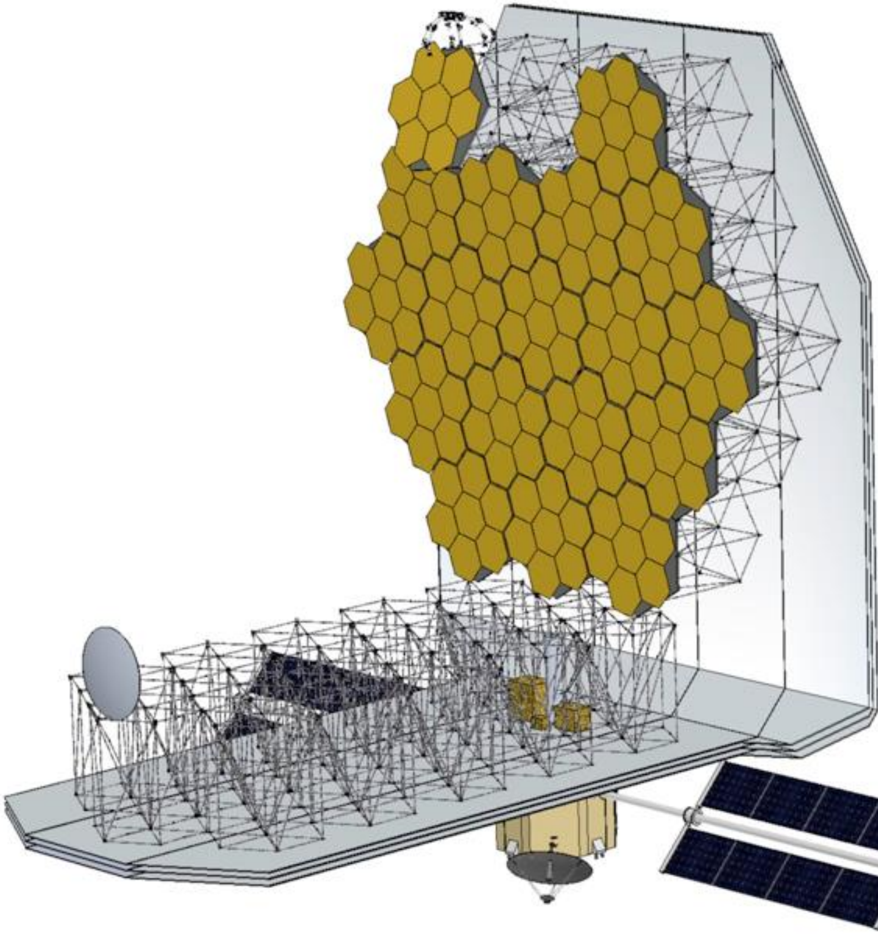
LUVOIR B architecture scaled to 20 m, f/2.5, off-axis

Identified Workshop Analyses

Three analyses requiring advancement:

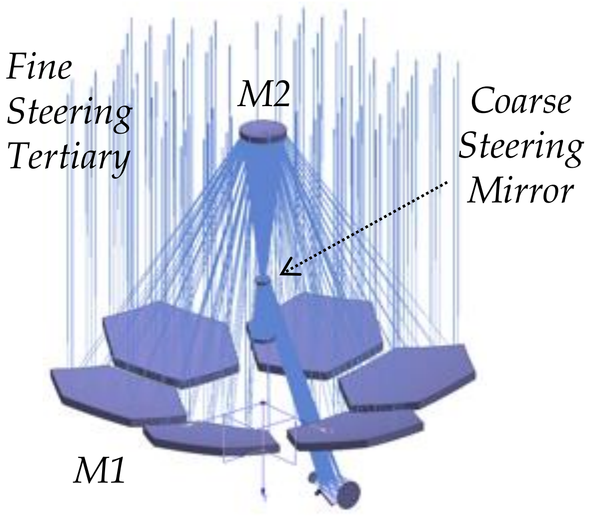
- Primary mirror truss architecture
- Stray light analysis
- Sunshade architectural concept

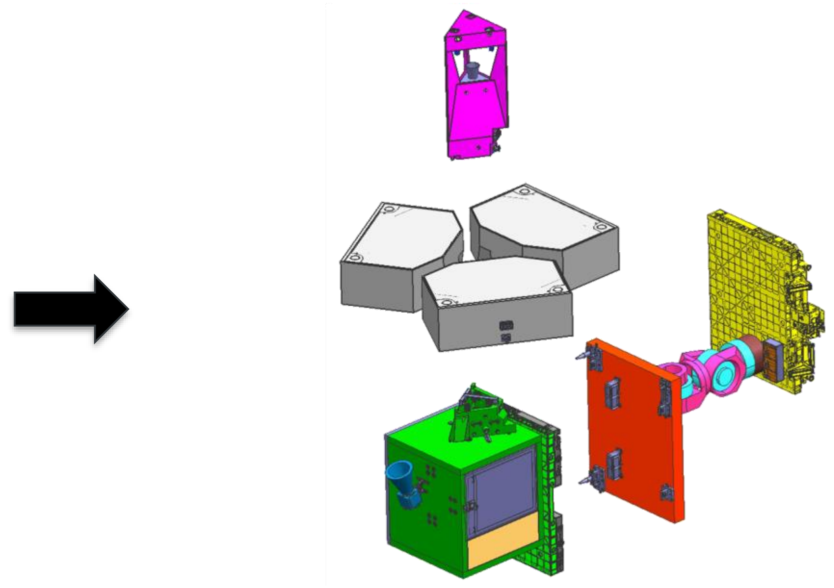




When do we know we're done with Activity 1a?
(Concept Design and Architecture for the iSAT)

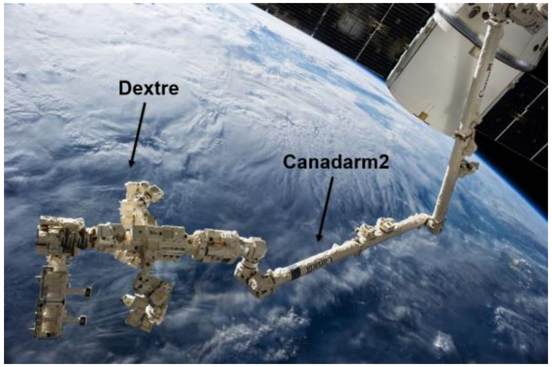
1. **Select a reference design and architecture concept for a 20 m, filled aperture, non-cryogenic space telescope to be assembled and tested in space.**
    - Musts and Wants completed; Risks captured
    - Is there a second concept to bring up?
2. **Advance the three analyses**
3. **Modularization diagram**

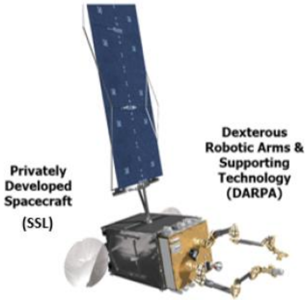


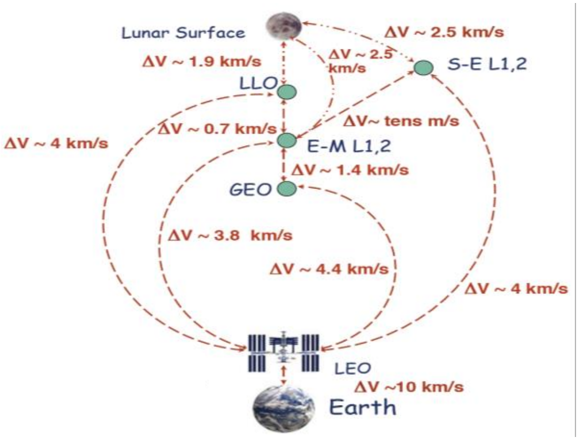


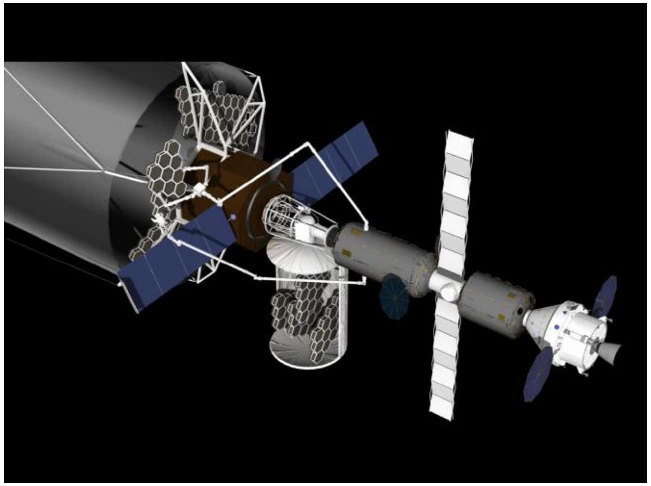
Activity 1b:
Concept for Assembling and Testing the ISAT

Select a reference in-space <u>assembly and testing concept</u> for the "assemble-able" space telescope architecture, defining robotics, orbit, launch vehicle, and assembly platform.









Next Steps

- **Complete Selection Criteria**
  - Through upcoming telecons and emails
  - Weekly cadence
- **Complete Activity 1a (Telescope Modularization)**
  - Complete the three analyses
  - Canvas the Study Members for other modularization concepts for the reference telescope
  - Complete description of Concept A including module definitions and Musts/Wants/Risks
- **Start Activity 1b (Module Assembly, Testing, etc)**
  - Membership (and Steering Committee) will morph towards more assembly/robotics focused
  - Need names
- **Start planning Activity 2 (concept definition - cost and risk benefits)**

Activities 2a and 2b

Detailed Engineering Design and Costed

Activity 2a: Advance the engineering fidelity of the concepts sufficiently so that they can be costed.

a) Inputs from Activity 1a and 1b
b) Select a team of NASA engineers, academia, government labs, and commercial companies to conduct the work.
c) Needs funding

Activity 2b: Estimate, through an independent body, the cost of designing, architecting, assembling, and testing the reference 20 m space telescope?

a) Input design from Activity 2a
b) Identify risks
c) Parameterize the cost to smaller apertures

Activity 3
Deliver Final Whitepaper

Write and deliver the Final Whitepaper

a) Submit to APD Director who submits to 2020 Decadal Survey

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