Proposed Description of iSAT Activity 2a: Subjective Cost and Risk Assessments

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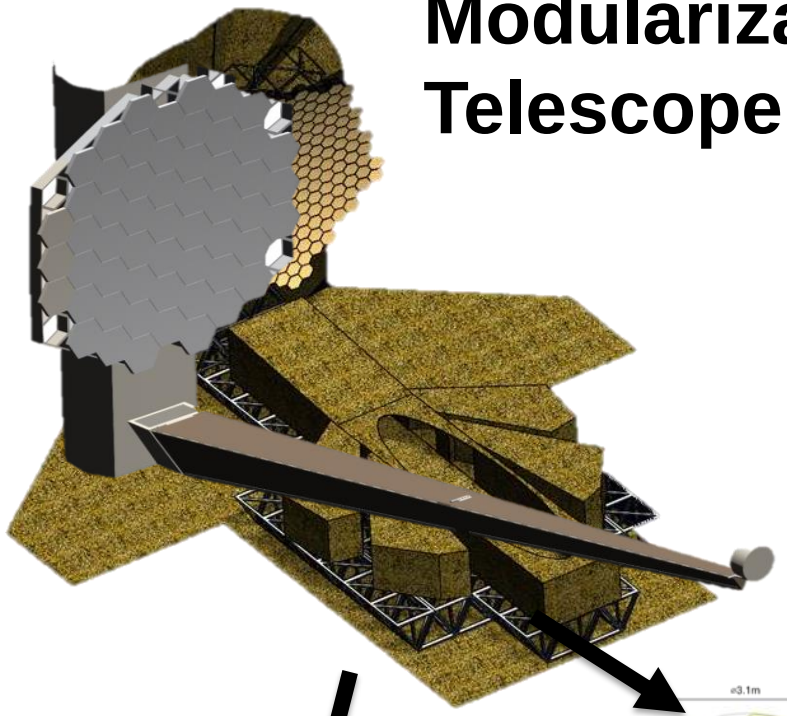
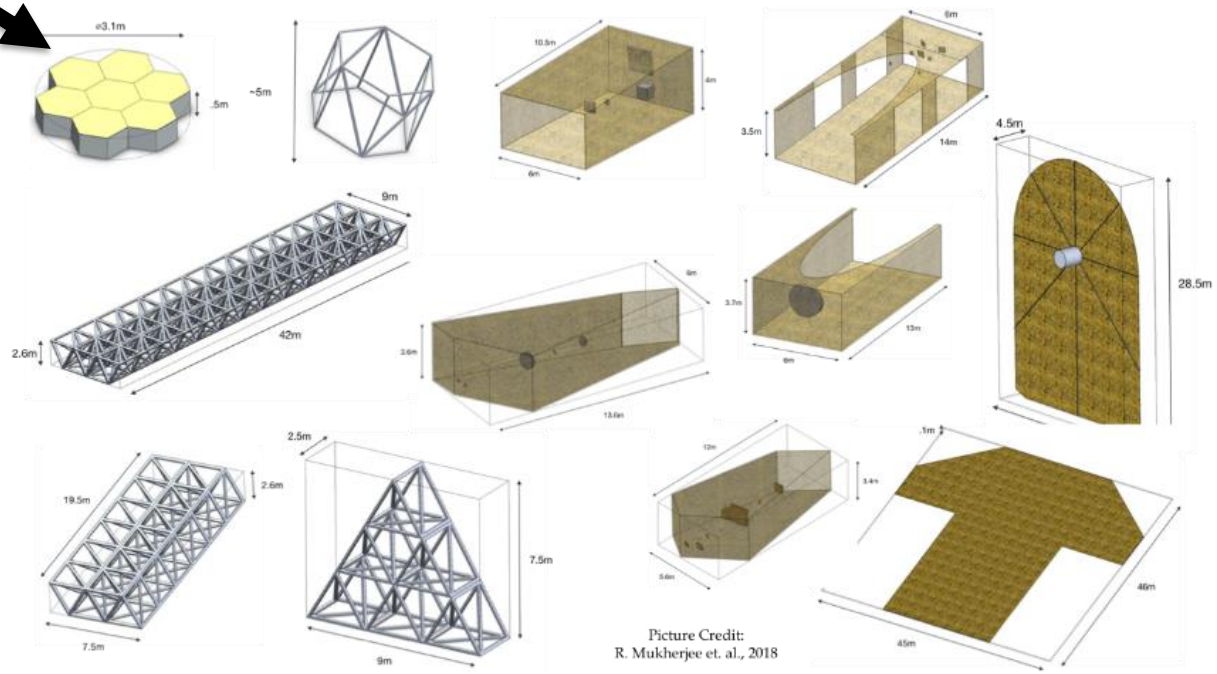
Today’s Agenda

1. Quick recap
2. Start the activity
3. Plans moving forward

Quick recap

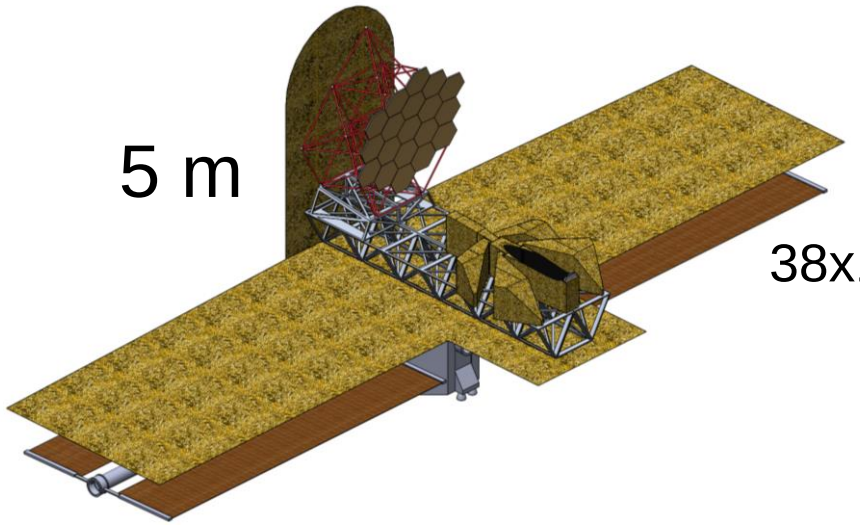
Modularization of a 20 m Space Telescope





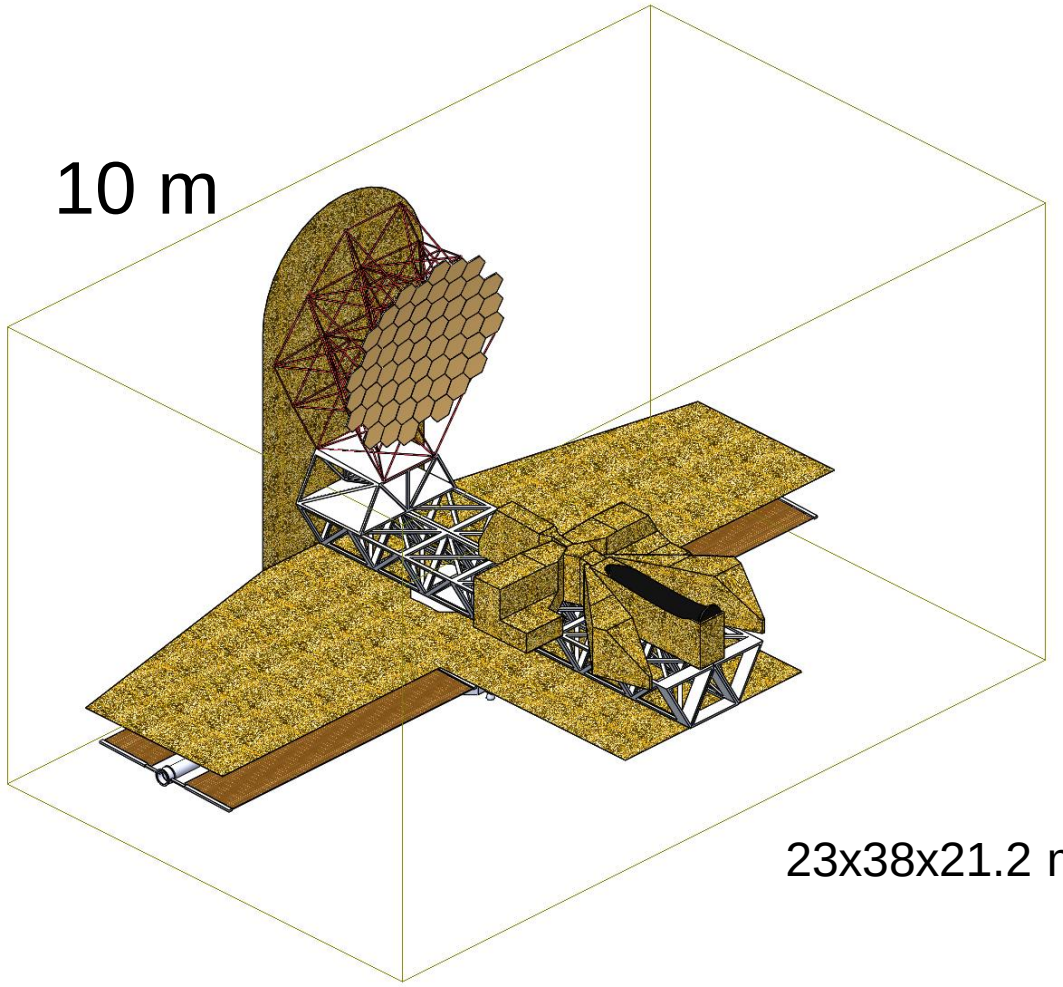
Picture Credit:
R. Mukherjee et. al., 2018

5 m



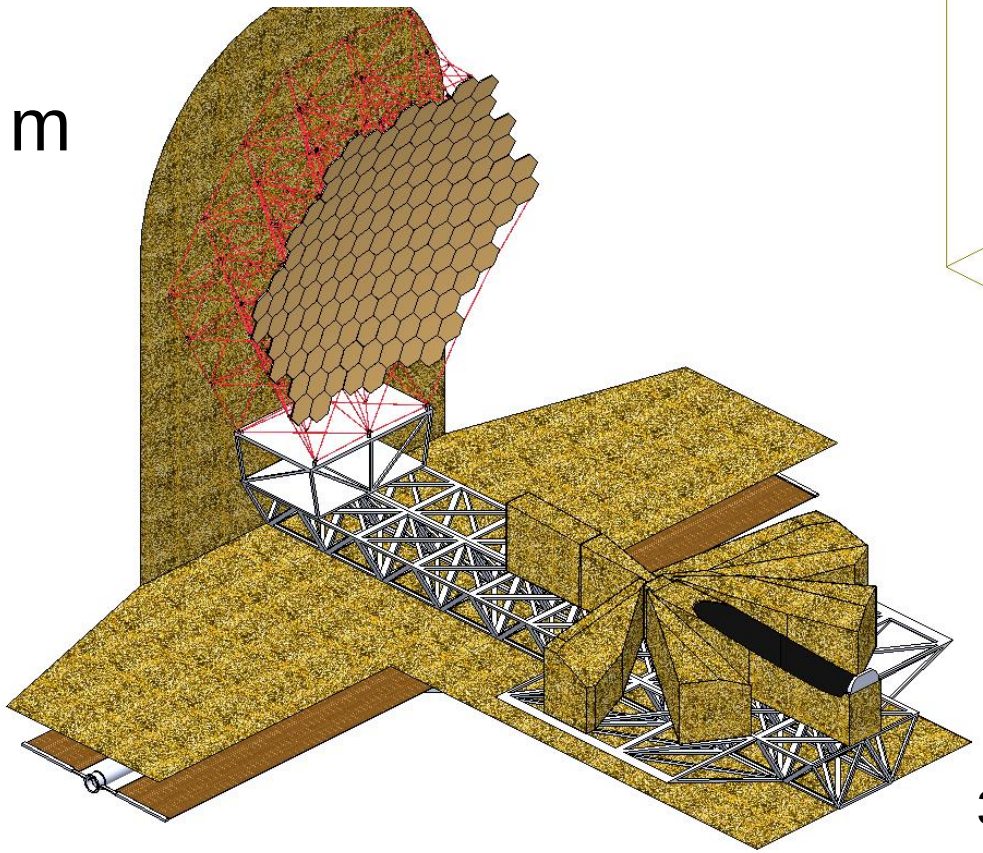
38x14x14.2 m

10 m



23x38x21.2 m

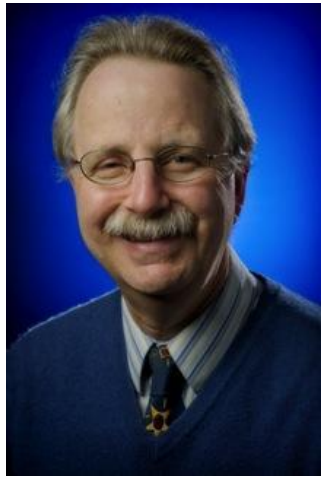
15 m



32x38x27.7 m

Go to assembly animation

Study Objective and Deliverables



Dr. Paul Hertz
Director
Astrophysics Division
NASA Headquarters

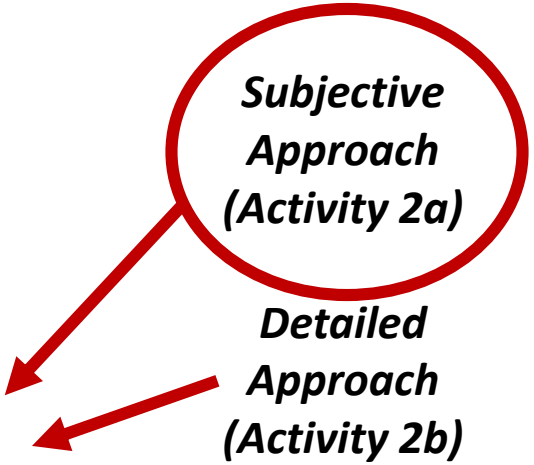
Study Objective:

- ***"When is it worth assembling space telescopes in space rather than building them on the Earth and deploying them autonomously from single launch vehicles?"***

Deliverables:

A whitepaper by June 2019 assessing:

1. the telescope size at which iSA is necessary (*an enabling capability*)
2. the telescope size at which iSA is cheaper or lower risk with respect to traditional launch vehicle deployment (*an enhancing capability*)



Cost and Risk Assessment

Three Approaches

What we will be working on

1. **(2a) The Subjective Effort:** Qualitative, seeking insights by understanding parametric relations and interactions, creating high level “claims and support”, identify risk benefits

2. **(2b) The Detailed Effort:** Quantitative, grass-roots, high level planning and cost estimation exercise and development plan

3. **The Concurrent Engineering Study:** Review and update the findings of the detailed effort. Expectation of formalization of wrap factors and margins based on legacy data

If the findings are mutually convergent then we can claim some verification of our plan and estimates; if they are conflicting, we have a problem.

The Subjective Cost and Risk Assessment Team

#	Name	Organization
1	Beth Keer	NASA GSFC
2	Scott Knight	Ball Aerospace
3	John Grunsfeld	NASA retired
4	Gordon Roesler	Robots in Space
5	Dave Miller	The Aerospace Corporation
6	Joe Pitman	Heliospace Corporation
7	Keith Warfield	NASA JPL
8	Keith Belvin	NASA LaRC
9	Kim Aaron	NASA JPL
10	Ben Reed	NASA GSFC
11	Bill Vincent	NRL
12	Phil Stahl	NASA MSFC
13	David Van Buren	NASA JPL
14	Ron Polidan	PSST Consulting
15	Jeff Hoffman	MIT
16	Marshall Perrin	STScI
17	Bob Shishko	NASA JPL

… and Nick, Harley, and Rudra; Lee Feinberg consulting

Problem with Just Listing Benefits and Challenges of iSA

- **One doesn’t understand the magnitude of the claims.**
  - Is it a high cost impact or low?
- **One doesn’t understand if there is coupling to other parameters that may negate or amplify the impact.**
- **How do the claims scale with size?**
- **Little to no support for the claims**
- **What project phase do the claims impact?**
- **List is not complete**
  - These were good suggestions offered during meetings
  - Focus was on benefits but need more focus on challenges

Step 1: Create a list of parameters that characterize the iSAT mission. This includes traditional mission parameters as well as unique aspects of iSA.

- Examples: mass margin, launch vehicles, assembly, I&T, V&V, workforce, adjustability and control authority, system complexity, critical path, funding phasing, facilitization, etc.

- A parameter is anything that impacts the mission cost or risk or that is potentially impacted by another parameter. A parameter can be increased or decreased.

Step 2: Based on your experiences or on these parameters, hypothesize "claims" that you believe iSAT will impact (positively or negatively) mission cost or risk.

- **Examples:**
  - Increased mass margin will not require extreme light-weighing and complex modeling
  - iSA will not require ruggedization of system to survive launch loads
  - Modularization will simplify assembly and I&T (work force)
  - Modularization will reduce standing army (work force)
  - Modularization will preempt need for new test facilities
  - Increased adjustability and control authority will reduce assembly, I&T, and V&V time, but result in more actuators throughout the observatory.
  - Robotic assembly is a new cost upper for iSAT.
  - Medium-lift launch vehicles and iSA will not require an SLS (opportunity – cost and risk)
  - Launch failure is not a mission failure (opportunity – risk)

Step 3: Create a table that shows the impact of these parameters, in isolation, on the iSAT mission in terms of risk and cost.

- Show the impact through subjective metrics (i.e arrows up or down).
- Green down arrows means “positive impact”; red arrows up mean “negative impact”.
- One arrow means “low impact”, two means “medium impact”, and three means “high impact”.
- A dash means “no impact”; a question mark means “we don’t yet know”.

Parameter	Cost	Risk
Parameter 1	↑ ↑ ↑	↓ ↓
Parameter 2	↓	↑ ↑
Parameter 3	↓ ↓ ↓	↓ ↓

E.g. We expect mass margin will be a cost and risk reducer

Step 4: Create the relational diagram, one for risk and one for cost. This diagram aims to capture the "coupled" impact of these parameters on the iSAT mission.

Fill only the upper diagonal area as diagram will be symmetric

	Parameter 1	Parameter 2	Parameter 3
Parameter 1	↑ ↑ ↑	↓ ↓	↓
Parameter 2		↓	↑
Parameter 3			↓ ↓ ↓

E.g. Mass margin, multiple launches, standing army and schedule interplay to have a net low positive impact on cost

Step 5: Create “Claim Sheets” to capture the impact of the coupled parameters

- **These claim sheets are the outputs of this activity**
  - They will be summarized to get an overall idea of the total impacts on cost and risk.
  - This will inform us qualitatively whether iSAT could be competitive with traditional single LV integrated system deployments (i.e. “enhancing”) regarding cost and risk.
- **Each Claim Sheet will be in reference to the iSAT mission concept identified in Activity 1b.**

Claim Sheet

Cognizant Person/Lead:

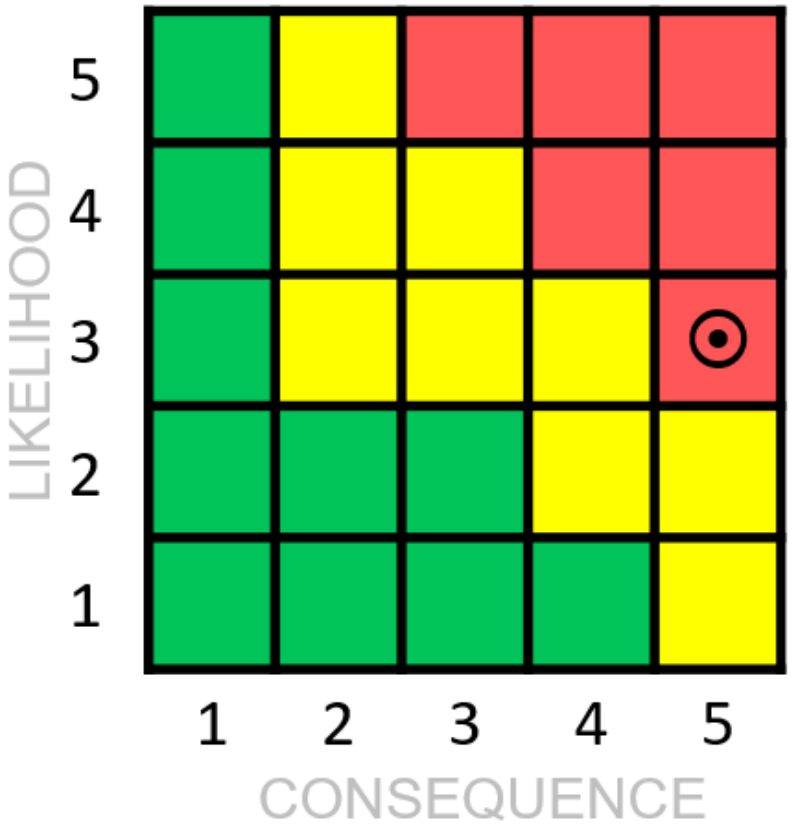
Claim: Write the claim from the relationship diagram: e.g. Mass margin correlates with multiple launches, standing army, and schedule to have a net low positive impact on cost.

Support: Rationalize your claim (use $ impact whenever possible)

Traceability: Show how your claim and support map to activities in Life Cycle Phases A-E

Scalability: Discuss how the claim holds over the different sizes of telescope (5,10, 15, and 20 m)

Step 6: Completely decoupled, create the traditional "risk" diagram (probability vs consequence) for the iSAT mission concept.



Example:

- Autonomous robotic assembly may falter causing important damage. (5,3)

Start the activity

(go to Excel)

Plans moving forward

Moving Forward

- **Weekly recurring meetings – what day/slot works best for this team?**

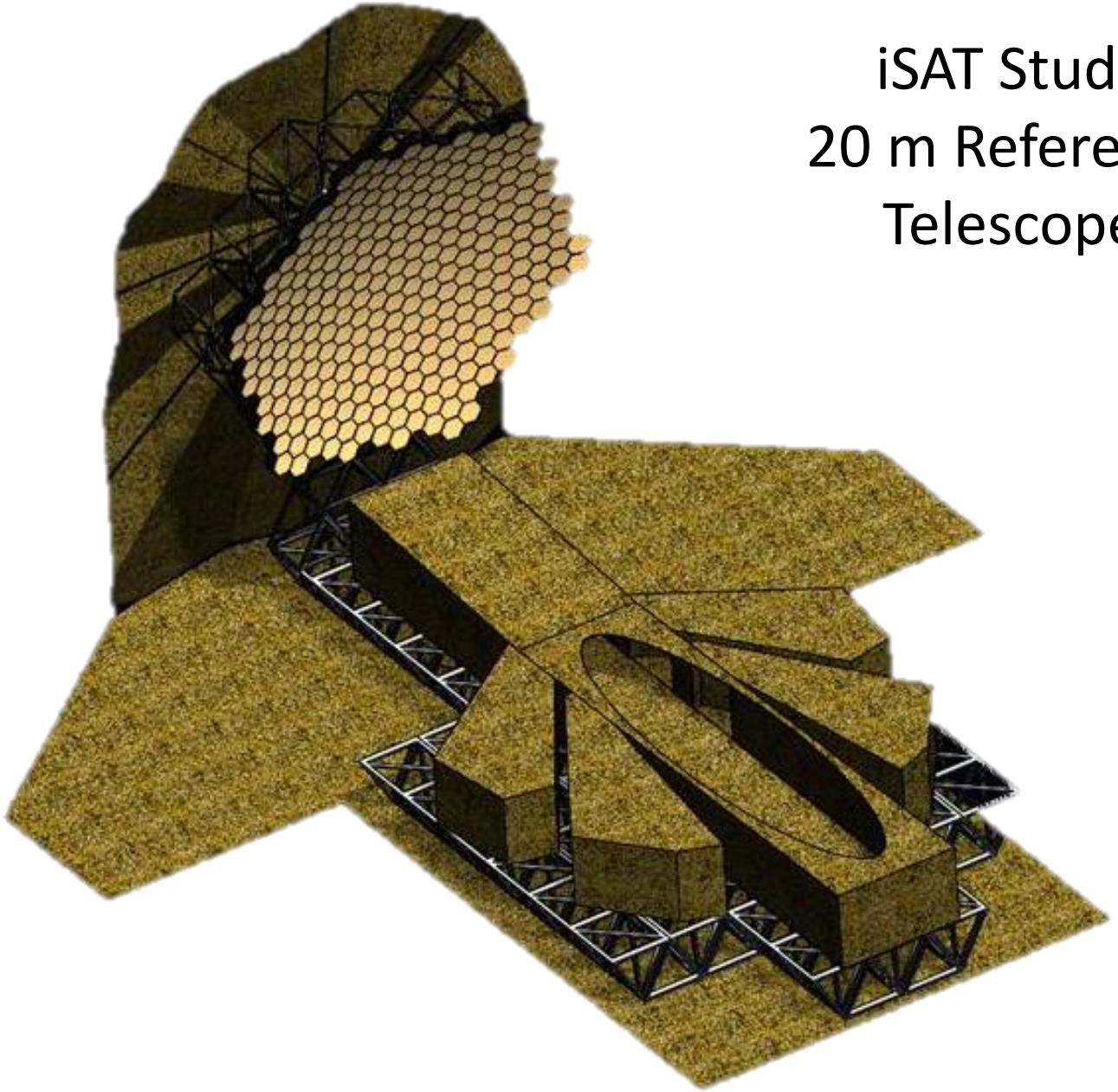
- **Face-to-face – Two full days to accelerate this activity**
  - End February / Early March
  - JPL

Tentative Schedule

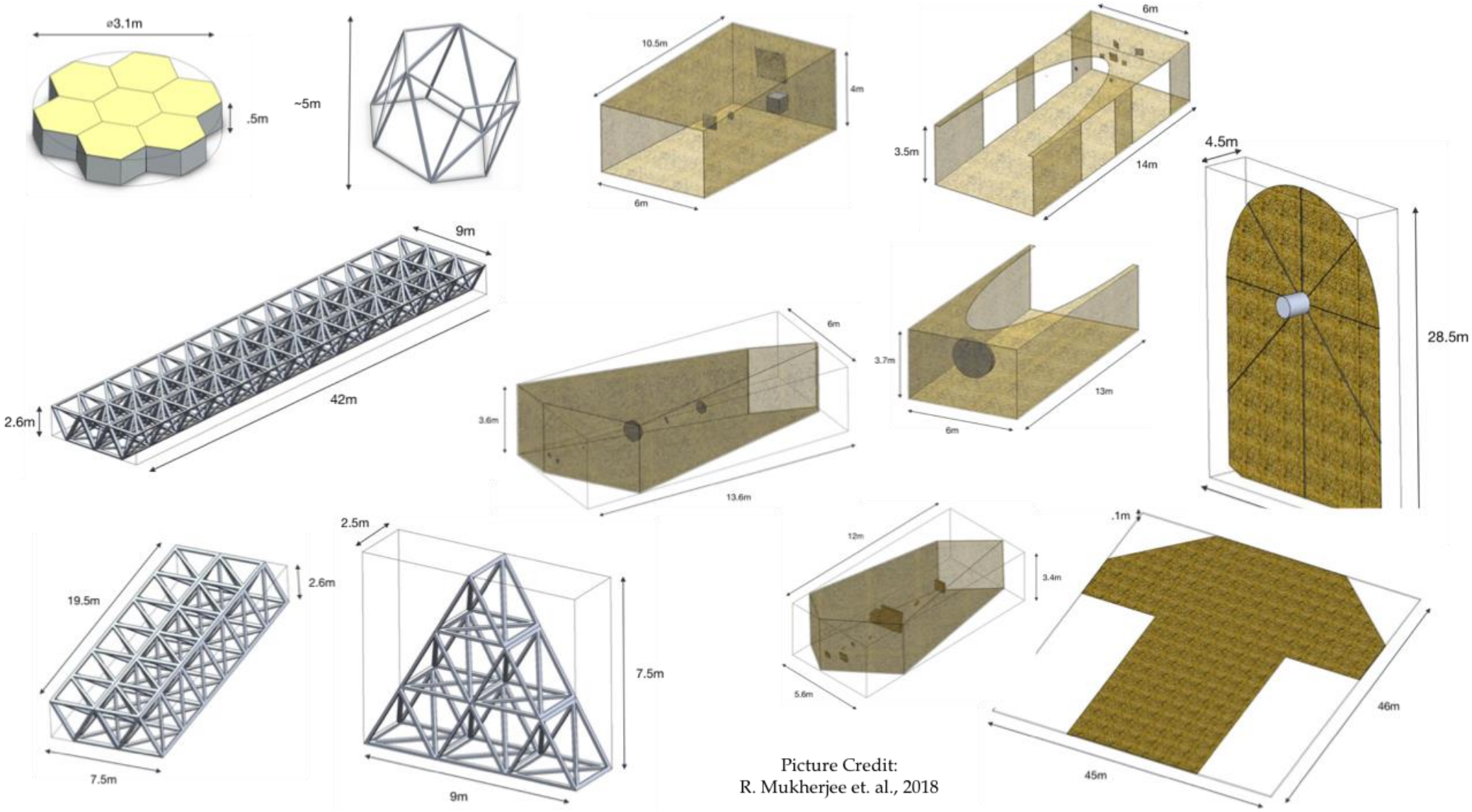
#	Week Of	Objective
1	Dec 10	Kickoff meeting
4	Jan 21	Start list of parameters
5	Jan 28	Start writing claims on parameter
6	Feb 4	Continue writing claims on parameter
7	Feb 11	Complete writing claims on parameters
8	Feb 18	**Face to face meeting: Draw relational diagram, advance all tasks together**
9	Feb 25	Start claim-sheets telecon – discuss multiple claims
10	Mar 4	Claim-sheets telecon – discuss multiple claims
11	Mar 11	Claim-sheets telecon – discuss multiple claims
12	Mar 18	Claim-sheets telecon – discuss multiple claims
13	Mar 25	Claim-sheets telecon – discuss multiple claims
14	Apr 1	Create Risk Diagram
15	Apr 8	Finalize Risk Diagram

Additional Slides

iSAT Study
20 m Reference Telescope



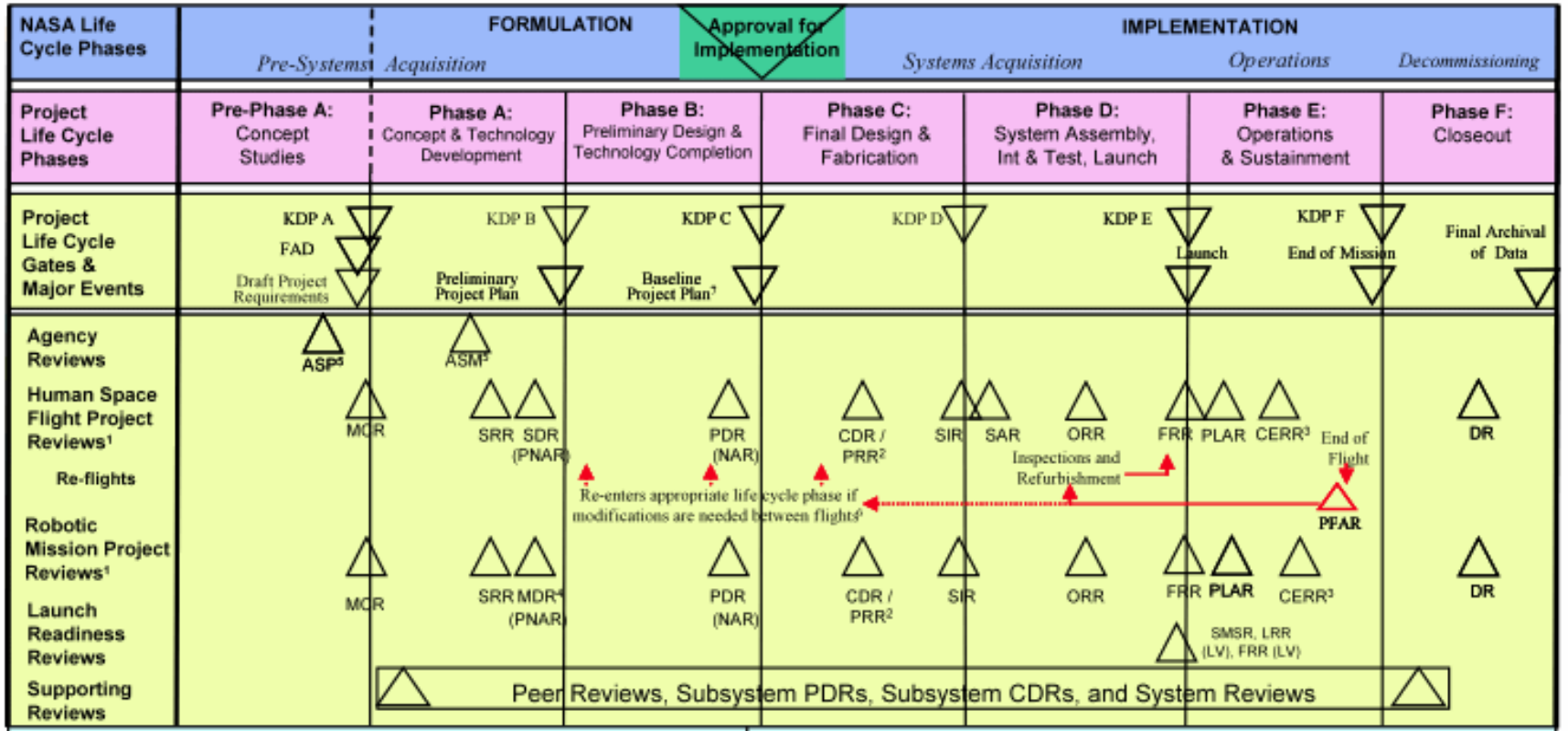
The Notional Modularized Components



Picture Credit:
R. Mukherjee et. al., 2018

NASA Project Life Cycle

NPR7120.5E



FOOTNOTES

1. Flexibility is allowed in the timing, number, and content of reviews as long as the equivalent information is provided at each KDP and the approach is fully documented in the Project Plan. These reviews are conducted by the project for the independent SRB. See Section 2.5 and Table 2-6.
2. PRR needed for multiple (≥4) system copies. Timing is notional.
3. CERRs are established at the discretion of Program Offices.
4. For robotic missions, the SRR and the MDR may be combined.
5. The ASP and ASM are Agency reviews, not life-cycle reviews.
6. Includes recertification, as required.
7. Project Plans are baselined at KDP C and are reviewed and updated as required, to ensure project content, cost, and budget remain consistent.

ACRONYMS

ASP—Acquisition Strategy Planning Meeting
ASM—Acquisition Strategy Meeting
CDR—Critical Design Review
CERR—Critical Events Readiness Review
DR—Decommissioning Review
FAD—Formulation Authorization Document
FRR—Flight Readiness Review
KDP—Key Decision Point
LRR—Launch Readiness Review
MCR—Mission Concept Review
MDR—Mission Definition Review
NAR—Non-Advocate Review
ORR—Operational Readiness Review
PDR—Preliminary Design Review
PFAR—Post-Flight Assessment Review
PLAR—Post-Launch Assessment Review
PNAR—Preliminary Non-Advocate Review
PRR—Production Readiness Review
SAR—System Acceptance Review
SDR—System Definition Review
SIR—System Integration Review
SMSR—Safety and Mission Success Review
SRR—System Requirements Review

Figure 5-2 – The NASA Project Life Cycle

Writing Schedule

#	Week Of	Objective
1	Apr 15	Start Draft: PPTX and Doc of team findings
2	Apr 22	Deliverable: Above, end of week
3	Apr 29	Start first “Formal” draft of DSP – based on continual absorption draft
4	May 6	WIP
5	May 13	**Deliverable:** First formal draft of DSP at week’s end
6	May 20	Reviews, Edits and Iterations
7	May 27	**Deliverable:** First draft to Sponsor at Week’s end
8	Jun 3	Inputs and Iterations
9	Jun 10	Inputs and Iterations: **Deliverable:** Submission to Decadal Survey

The Subjective Cost and Risk Assessment Effort

iSAT Activity 2a

Objective:

- To identify the key parameters of iSAT and qualitatively assess their impact on the Phase A-E costs and risks with respect to a traditional space telescope.
- We will use the results as a qualitative indicator whether iSAT may be advantageous to the traditional paradigm of space telescope missions and a sanity check when compared to the detailed cost assessment of iSATs.
- We expect the results of this subjective effort (Activity 2a) and the detailed effort (Activity 2b) to be consistent.

Approach:

Using the team's experiential insights and lessons learned from past space telescope missions we will identify these key parameters and examine their relations and interactions with each other to understand where the benefits of iSAT, if any, may lie.