RECAP OF STRATEGY AND RISK CONSIDERATIONS

Aki Roberge (NASA GSFC)

LUVOIR STDT Meeting 3
New Haven, CT
Nov 9, 2016

The Aerospace CATE (D. Emmons)

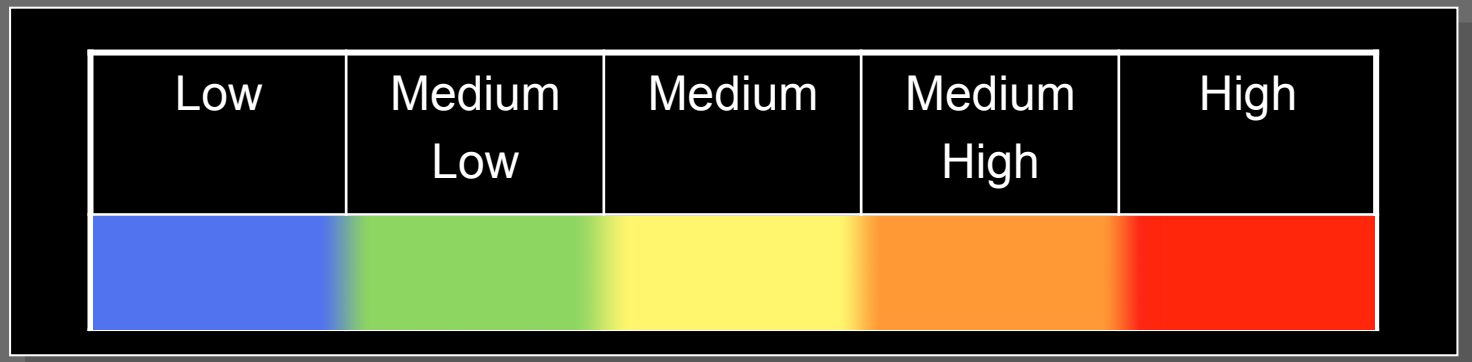
- Cost and Technical Evaluation used for missions during the Decadal Surveys
  - Begins with typical Independent Cost Estimate, ICE
  - Adds three types of cost threats, where appropriate:
    - Schedule, design (mass & power growth), and launch vehicle
- Historical costs, analogies, and parametric models are used

Cost evaluation

- CATE cost likely higher than team estimate
  - Design growth threat (e.g. future modifications) typically biggest disconnect
- Potential available funding
  - $400M - $500M could be made available annually in FY25 and beyond
  - $3.5B by 2030, $7B by 2035

Technical evaluation

- Technical risk approach
  - Significant deviations from current state-of-the-art
  - Trace performance risk to science impact
  - Evaluation of planned risk mitigation efforts
- Assign a color to mission concept



Recommendations & thoughts

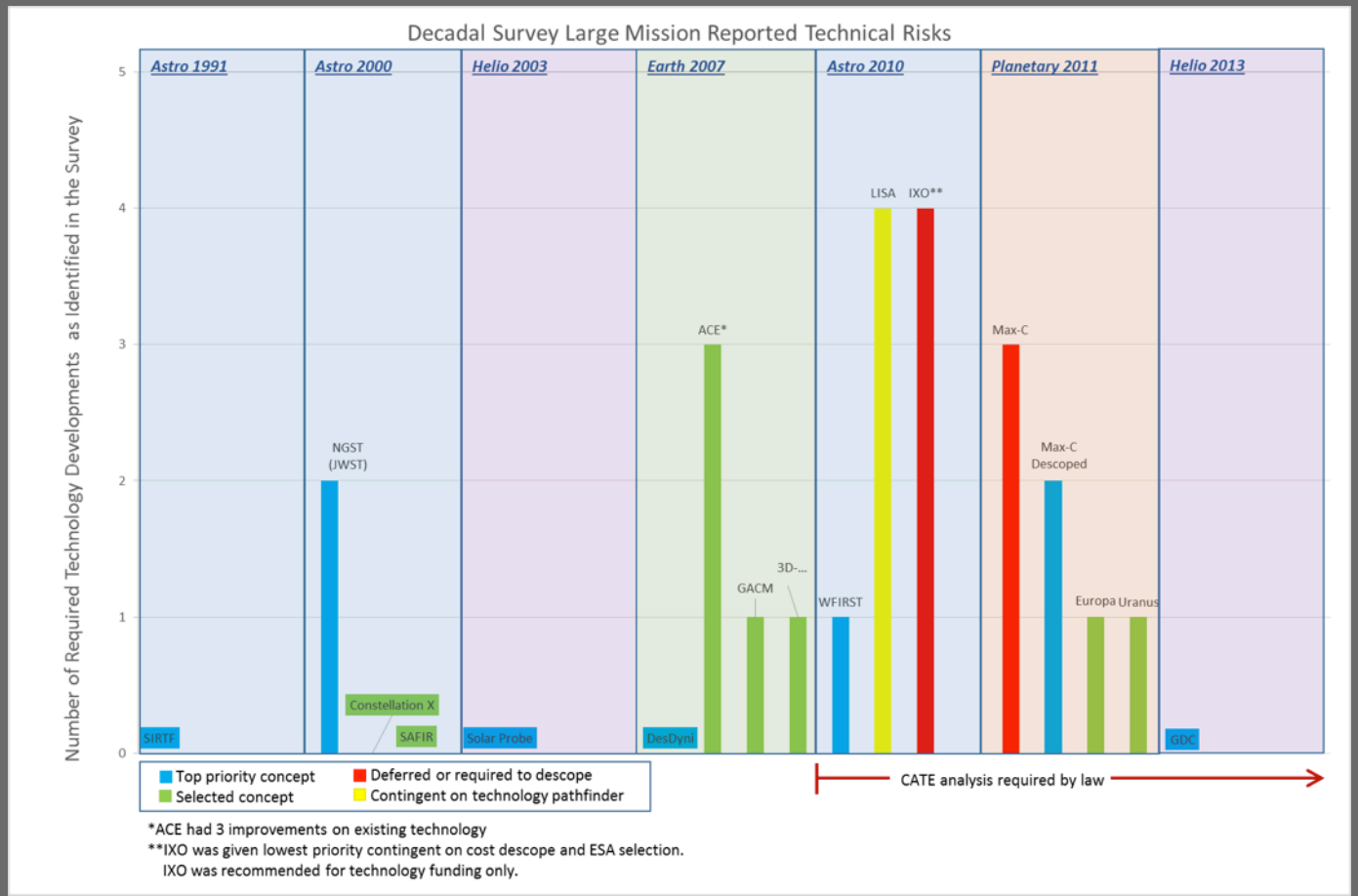
- Aerospace recommended having multiple concepts for evaluation – we're doing this
- Leave margin on launch vehicles
  - Understand that relying on a vehicle in development will be assessed as a cost risk
- Heritage / analogs matter for cost assessment
- Red missions rarely (if ever) get approved
- Number of identified risks matter for color and cost
  - More than ~ 3 major items at < TRL4 likely to get red

Observations on past Decadals (K. Warfield)

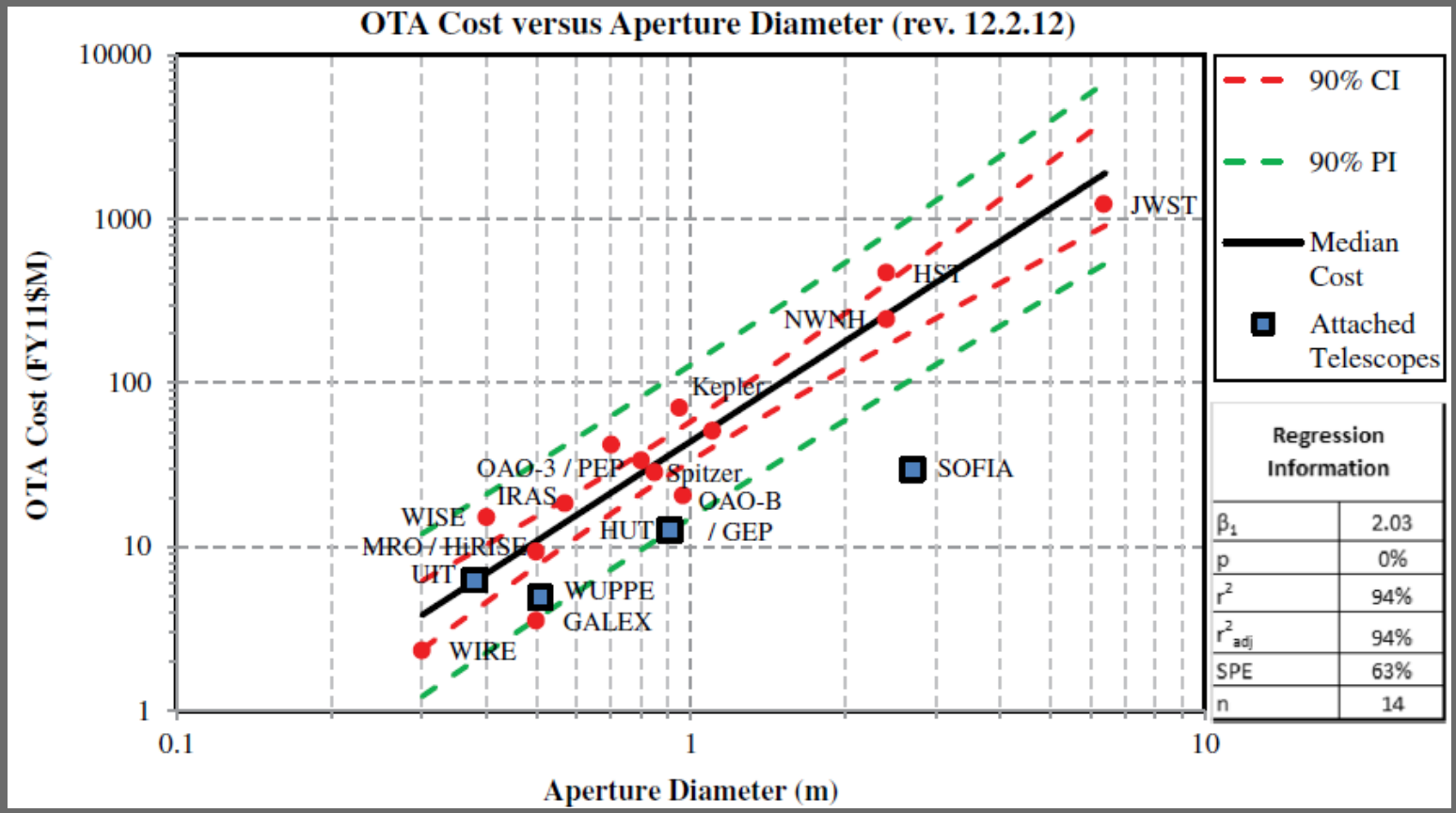
- Decadals want balance across disciplines, activities, & mission sizes
  - Decadals have only prioritized mission that leave money for other astro. communities
- Science creep on large missions is major factor in cost growth
  - Surveys should identify acceptable compromises / descopes
- "All past missions prioritized by the Decadal Survey were thought to be under $3B in FY16 $"

K. Warfield cont'd

- "Missions prioritized for a start (without required precursor missions or descopes) have always been seen as having 3 or fewer technologies to develop"



Stahl telescope cost model



Implies 8-m telescope costs ~ $2B

10-m telescope costs ~ $4B

The future of space astrophysics is in your hands (M. Mountain)

- Myth #1: Large missions "eat the lunch" of smaller ones
  - They have always been about 30% of total SMD budget
- Myth #2: LUVOIR will cost $20B if you scale up JWST
  - Telescope is only ~ 12% of total JWST mission cost
  - Spacecraft & instruments always about 50%
  - Real mission costs for warm LUVOIR not intuitively scaleable

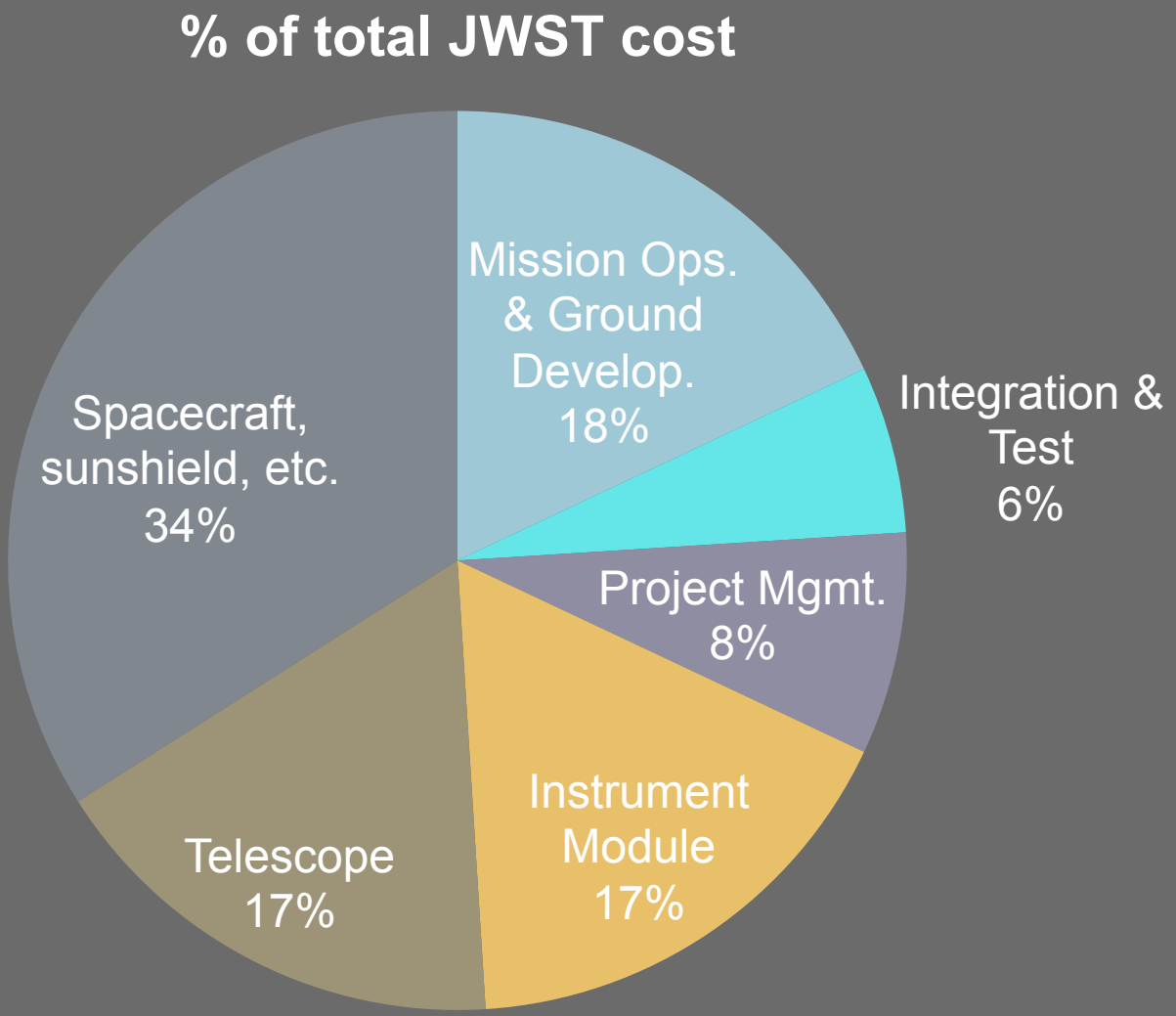
The future of space astrophysics is in your hands (M. Mountain)

- Myth #3: Decadal surveys have only selected missions that cost less than $3B in FY16 $
  - "Flagships are the foundation of Decadal Surveys because they demand transformative science … and only one cost < $3B in FY16 $"
  - Doesn't seem to jive with Warfield conclusion

The future of space astrophysics is in your hands (M. Mountain)

- Marginally capable experiments (e.g. Tevatron) don't find the Higgs (e.g. Large Hadron Collider)
- Search for life is compelling to wide range of stakeholders & public
- Ground-based ELTs set the bar high for transformative science in the 2030s

JWST Lessons Learned (L. Feinberg)



No single metric drives mission costs

JWST Lessons Learned (L. Feinberg)

- Four critical things for controlling mission cost
  1. System complexity
     - Limit number of key technical challenges
     - Work to relax requirements in technology development phase
  2. Critical path and marching army
     - Reduce fabrication time, use economies of scale
     - Get mature as early as possible

JWST Lessons Learned (L. Feinberg)

- Four critical things for controlling mission cost
  3. Verification challenges (modeling, facilities, testing)
     - Focus on what you care about
     - Cryogenic testing is expensive
  4. Programmatic constraints (phasing, reserves, replans)
     - Robust plan up-front

"Aperture size is a contributor to these 4 areas, especially critical path, but not necessarily the biggest driver"

The Survey of Surveys (A. Dressler)

- "High-profile missions" = performance-driven missions rather than cost-constrained
- Important for Decadals to strike balance between high-profile missions and smaller competed missions
- High-profile missions still critical since certain missions cannot be broken down into smaller parts and still achieve the science

The Survey of Surveys (A. Dressler)

- Mission creep and unwillingness to descope high-profile missions can result in large negative impacts to overall program
- Decadals advised to explicitly state what aspects of a project are essential and which can be reconsidered
- Advise clear decision rules for high-profile missions that include descope / cancellation options

My general thoughts on all this

- Don’t defeat ourselves with low expectations
- But remain flexible to change, new knowledge, and uncertain futures
  - Be adaptable and have contingency plans
- Our goal is to convince ourselves and the community that LUVOIR is possible and worth it