



Exoplanet Exploration Program Technology Plan

Peter Lawson

Jet Propulsion Laboratory
California Institute of Technology

8 January 2010



Technology and Architecture Selection



ExoPlanet Exploration Program

- Technological readiness would be only one part of the selection criteria for an architecture: coronagraph, starshade, or interferometer.
- Other issues to consider
 - Our understanding of the demographics of exoplanets and exozodiacal dust may change the priority of architectures
 - **Mission science:** number and types of detectable and/or characterizable exoplanets, exozodiacal dust disks, and other astrophysical targets
 - **Cost**
 - **Risk**

The technology plan is constrained by

1. Funding through the ROSES Strategic Astrophysics Technology
2. Time until the mid-decade

The proposal and review process is not directed or managed by the Exoplanet Program, but the call can be focused on specific technology



Technology Demonstrations for Exoplanet Missions



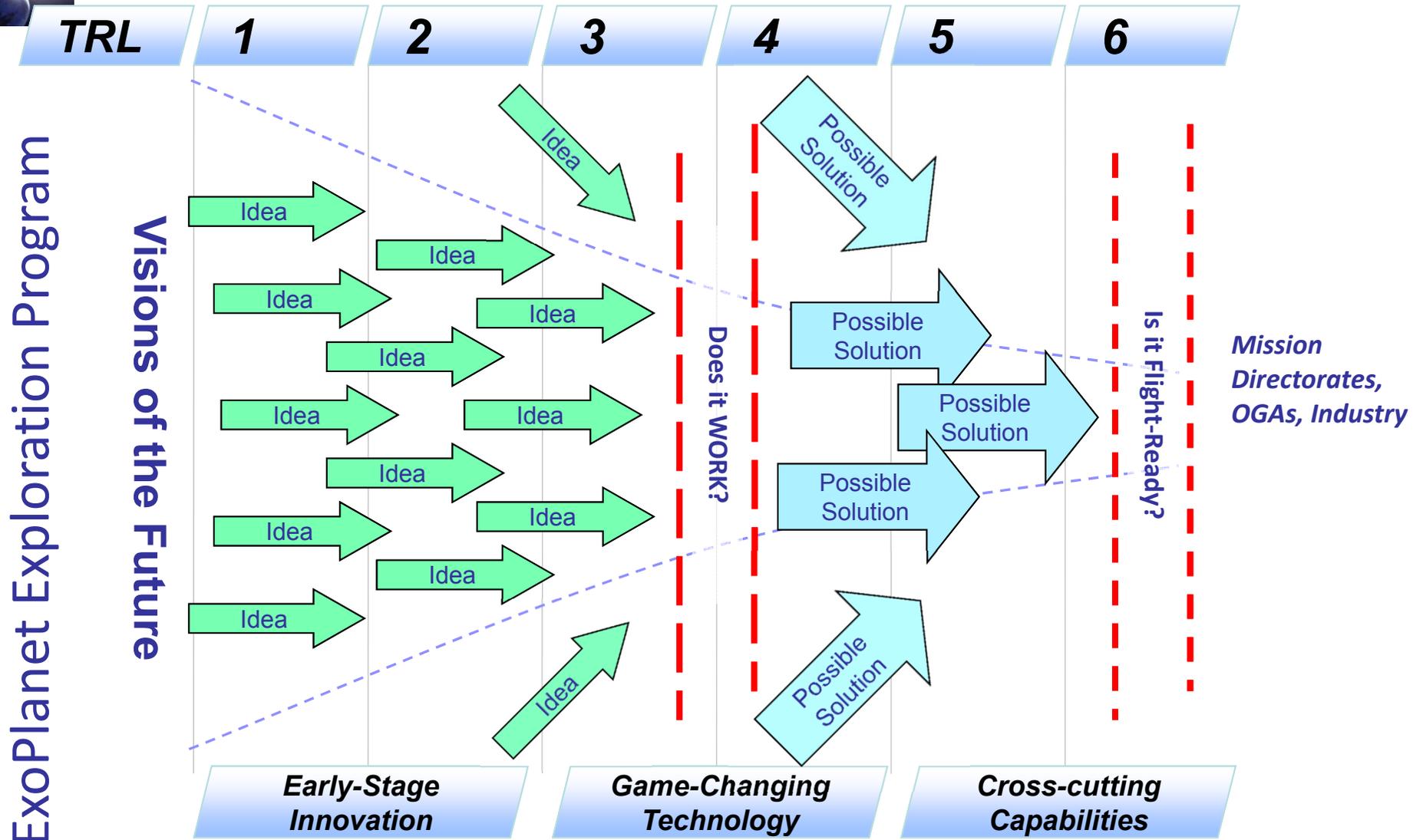
ExoPlanet Exploration Program

1. Starlight Suppression Demonstrations
2. Wavefront Sensing and Control
3. System Performance Assessment

“Technologies that are specifically excluded from the SAT/TDEM solicitation at this time are (1) detector technology; (2) mirror technology (with the exception of adaptive systems); (3) telescope assembly technology; (4) sunshields and isothermal control; (5) propulsion systems; (6) vibration isolation systems; (7) spacecraft pointing control; and (8) formation flying technology”



Comments on the NASA Space Technology Program





NASA Technology Roadmaps

http://sites.nationalacademies.org/DEPS/ASEB/DEPS_059552

Q NASA OCT Roadmap

NASA Technology Roadmaps

AERONAUTICS AND SPACE ENGINEERING BOARD

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine.

NATIONAL ACADEMY OF SCIENCES NATIONAL ACADEMY OF ENGINEERING INSTITUTE OF MEDICINE NATIONAL RESEARCH COUNCIL January 4, 2011

Search

- ASEB HOME
- COMPLETED PROJECTS
- ABOUT US
- BOARD MEMBERS & MEETINGS
- STAFF
- PUBLICATIONS
- NEWSLETTER
- RELATED LINKS
- CONTACT US
- DEPS HOME

NASA Technology Roadmaps

Special Announcement (updated December 21, 2010) : While the committee and panels for this activity are yet to be appointed, the ASEB welcomes community input on the statement of task for this study (see below) and the draft **NASA technology roadmaps**. If you would like to provide such input then email the ASEB at roadmaps@nas.edu. Please note that all input will be placed on the NRC Public Access File for this activity. A more comprehensive set of questions for the community may be posted once the committee for this study has been appointed and has met. Please return to this page for future updates in this regard.

The NRC will appoint a steering committee and six panels to solicit external inputs to and evaluate the 14 draft **technology roadmaps** that NASA has developed as a point of departure. The study committee will also provide recommendations that identify and prioritize key technologies. The scope of the technologies to be considered includes those that address the needs of NASA's exploration systems, Earth and space science, and space operations mission areas, as well as those that contribute to critical national and commercial needs in space technology. (This study will not consider aeronautics technologies except to the extent that they are needed to achieve NASA and national needs in space; guidance on the development of core aeronautics technologies is already available in the **National Aeronautics Research and Development Plan**)

The steering committee and panels will:

- The steering committee will establish the technology areas that the NASA study committee will focus on.
- Each panel will conduct a workshop with NASA, industry and academia on the 14 draft roadmaps.

Interim Report

Based on the results of the community input and its own deliberations, the steering committee will prepare a brief interim report that addresses high-level issues associated with the roadmaps, such as the advisability of modifying the number or technical focus of the **draft NASA roadmaps**.

Final Report

Each panel will meet individually to suggest:

- the identification of technology gaps,
- the identification of technologies not included in the roadmaps,
- development and schedule changes,
- a sense of the value (such as potential economic benefit, facility to operate, terrestrial benefit) for key technologies,
- the risk, or reasonableness, of the technology line items in the NASA technology roadmaps, and
- the prioritization of the technologies within each roadmap by groups such as high, medium, or low priority; this prioritization should be accomplished, in part, via application of relevant criteria described above in a uniform manner across panels.

Each panel will prepare a written summary of the above for the steering committee

The steering committee will subsequently develop a comprehensive final report that:

- Summarizes findings and recommendations for each of the 14 roadmaps
- Integrates the outputs from the workshops and panels to identify key common threads and issues
- Prioritizes, by group, the highest priority technologies from all 14 roadmaps

8 January 2011

Copyright © 2011. National Academy of Sciences. All rights reserved. 500 Fifth St. N.W., Washington, D.C. 20001. Terms of Use and Privacy Statement

Roadmaps will be under review by NRC through 2011

Programs funded by the OCT are unlikely to start until mid-2012



Exoplanet Program and NASA Office of Chief Technologist



The key technology for 2011-2015 would support

1. Starlight suppression demonstrations
2. Model validation

We are unlikely to receive other NASA funding for **key** technology than through ROSES – Strategic Astrophysics Technology – TDEM.

What is key to us is *not* applicable to other Astrophysics themes within the Science Mission Directorate, nor is it of interest to other NASA Divisions – so it is not a likely subject of funding from OCT.

Subjects that might be of benefit to the Exoplanet Exploration Program and the Office of Chief Technologist are possible strategic technology such as

1. Advanced mirror technology
2. Optical communications
3. Formation flying

However, these subjects are unlikely to influence an architecture selection in 2015



Four year plan

- Conducted within the funding constraints of TDEM
- Aimed at retiring the major risks of competing architectures

Key Milestones for all architectures:

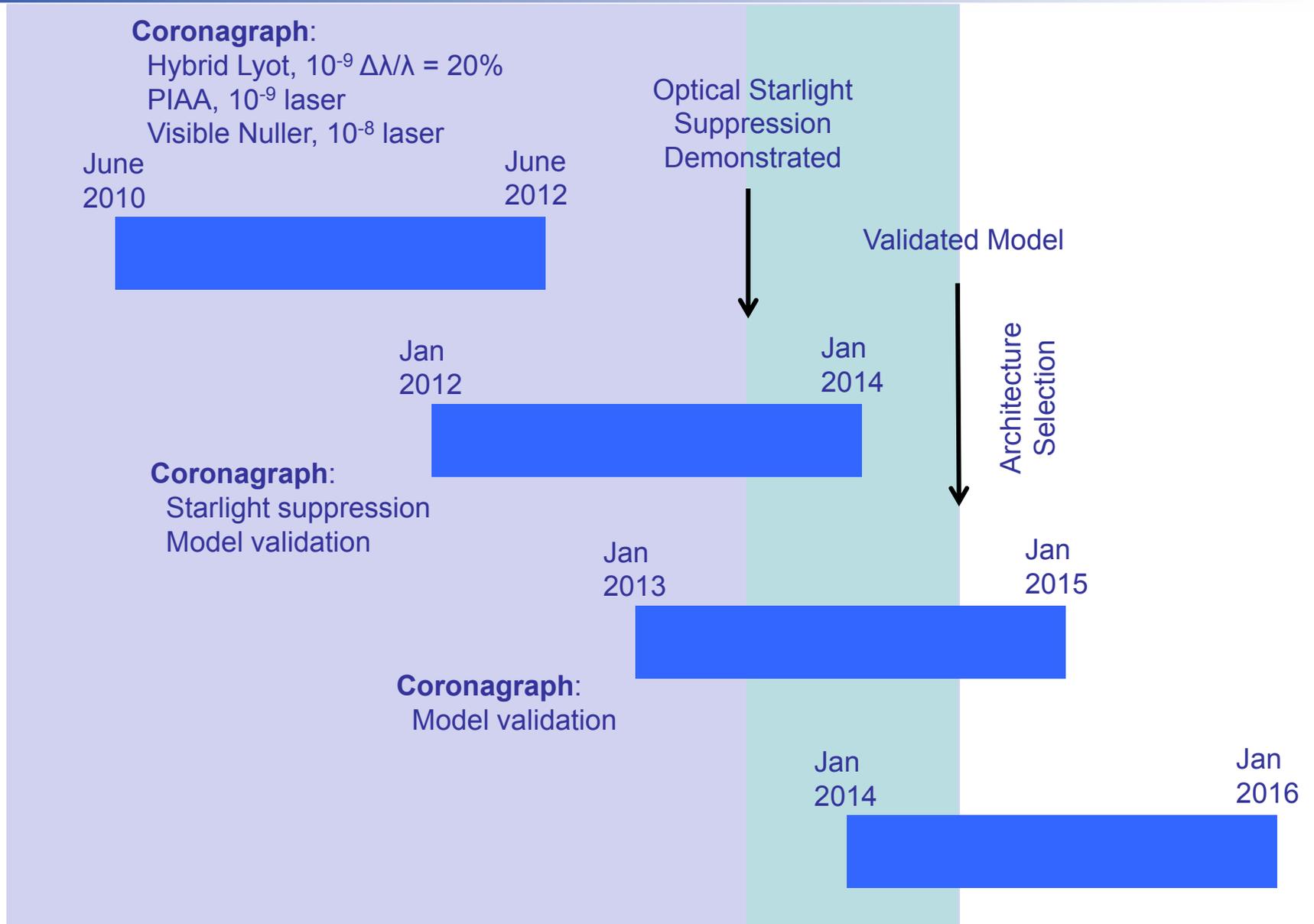
- Starlight suppression
- Model validation



Coronagraphs



ExoPlanet Exploration Program

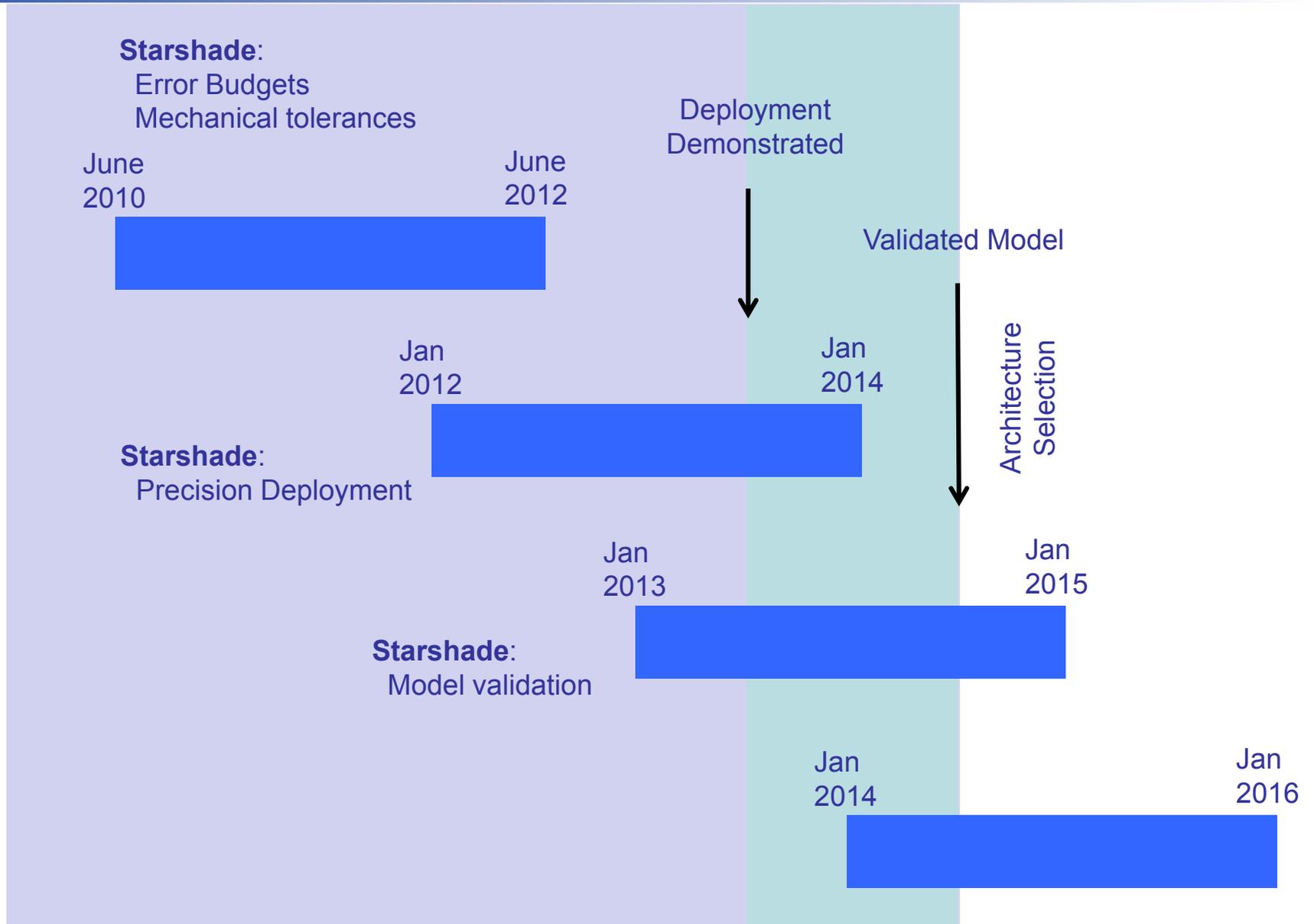




Starshades



ExoPlanet Exploration Program

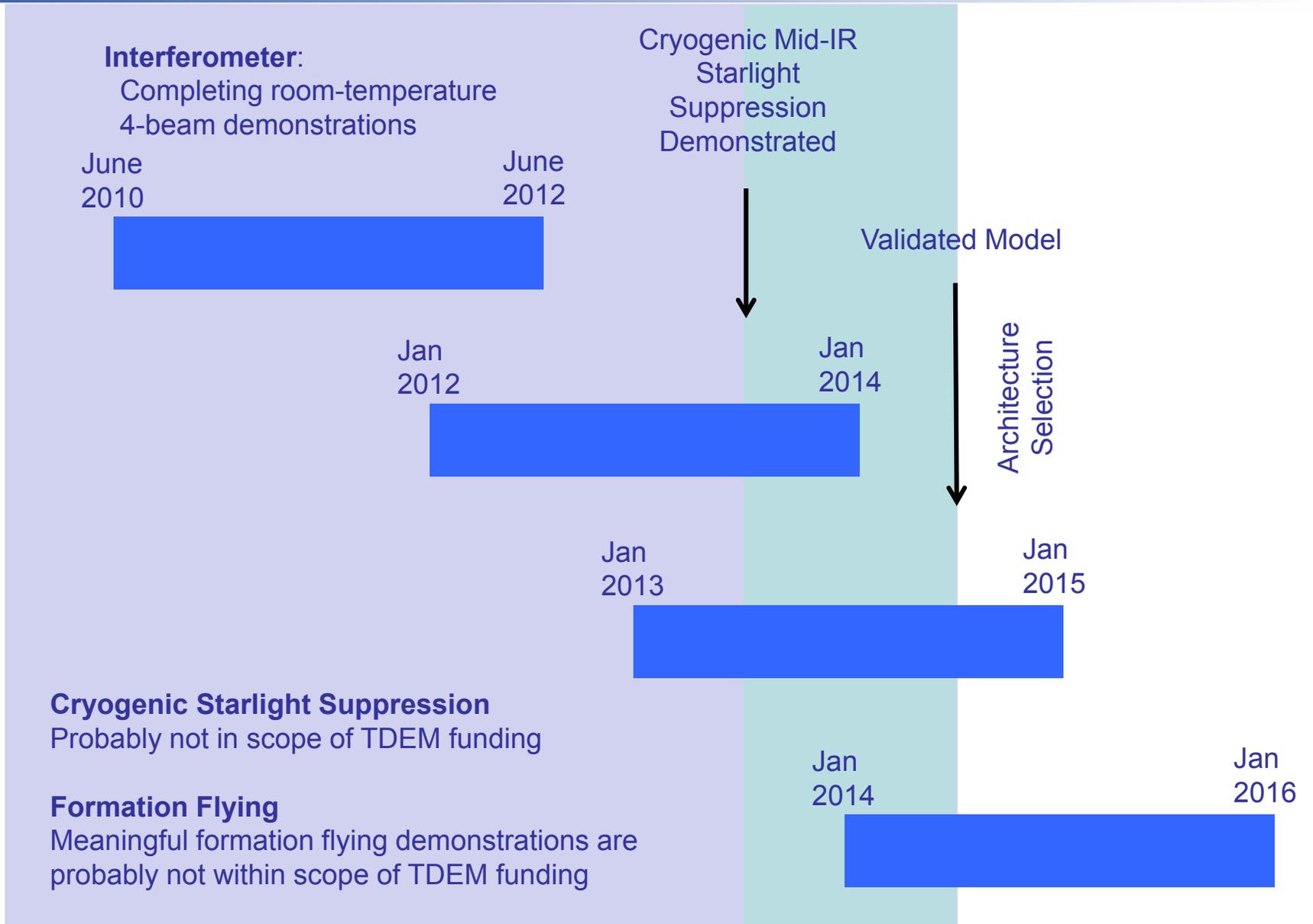




Mid-IR Interferometers



ExoPlanet Exploration Program

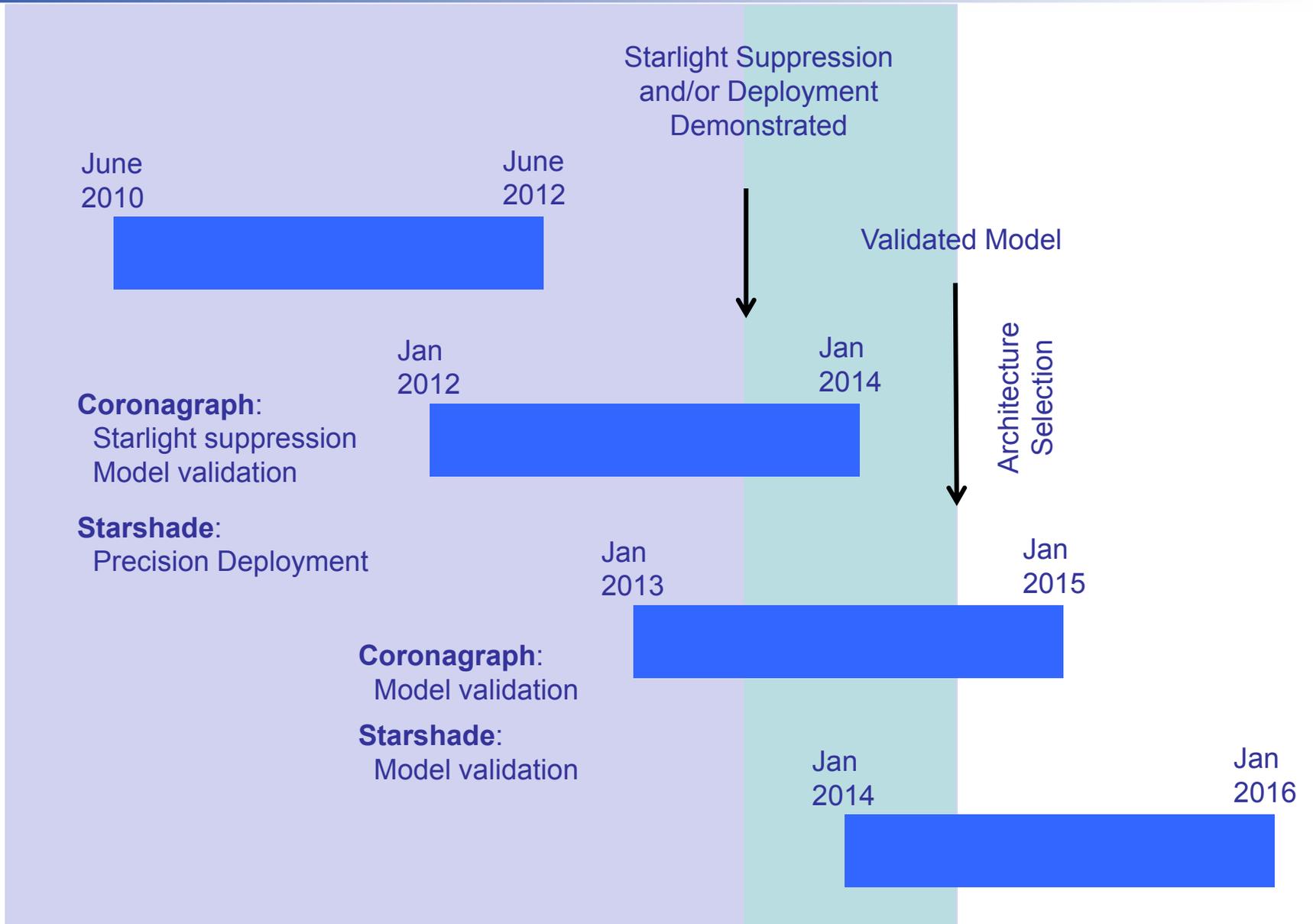




Summary



ExoPlanet Exploration Program





Acknowledgements



ExoPlanet Exploration Program

This work was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration

Government sponsorship acknowledged



ExoPlanet Exploration Program

Backup



Coronagraph Milestones



ExoPlanet Exploration Program

- Demonstrate starlight suppression
 - to contrasts within a factor of 10 of flight requirements, $\leq 10^{-9}$
 - to fractional bandwidth representative of the science band, $\geq 10\%$
- Demonstrate validated models of the starlight suppression demonstration
- Bring supporting technology to TRL 5



Starshade Milestones



ExoPlanet Exploration Program

- Demonstrate precision starshade deployment
 - Demonstrate that the position tolerances of petal edges can be achieved
- Demonstrate validated models of the starlight suppression, achievable with a starshade of the above design
- Demonstrate the retargeting and alignment of starshade and occulter