



The Exoplanet Exploration Program Technology Plan

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Science objectives defined for TPF are adopted:
Earth-like planets around Sun-like stars

Technology milestones for TPF also adopted with regard to coronagraphs and interferometers

Technology roadmap for starshades not yet formalized

Architecture selection on or before 2015

Program should promote and influence related exoplanet technology, even in areas it cannot directly fund



Technology and Architecture Selection



ExoPlanet Exploration Program

- **Technical 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
 - **Scientific merit**: number and types of detectable and/or characterizable exoplanets, exozodiacal dust disks, and compelling astrophysics
 - **Affordable cost**
 - **Tolerable risk**



Technology and Architecture Selection



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The technology plan is constrained by

1. Funding through the ROSES Strategic Astrophysics Technology (SAT)
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 Development for Exoplanet Missions (TDEM)



ExoPlanet Exploration Program

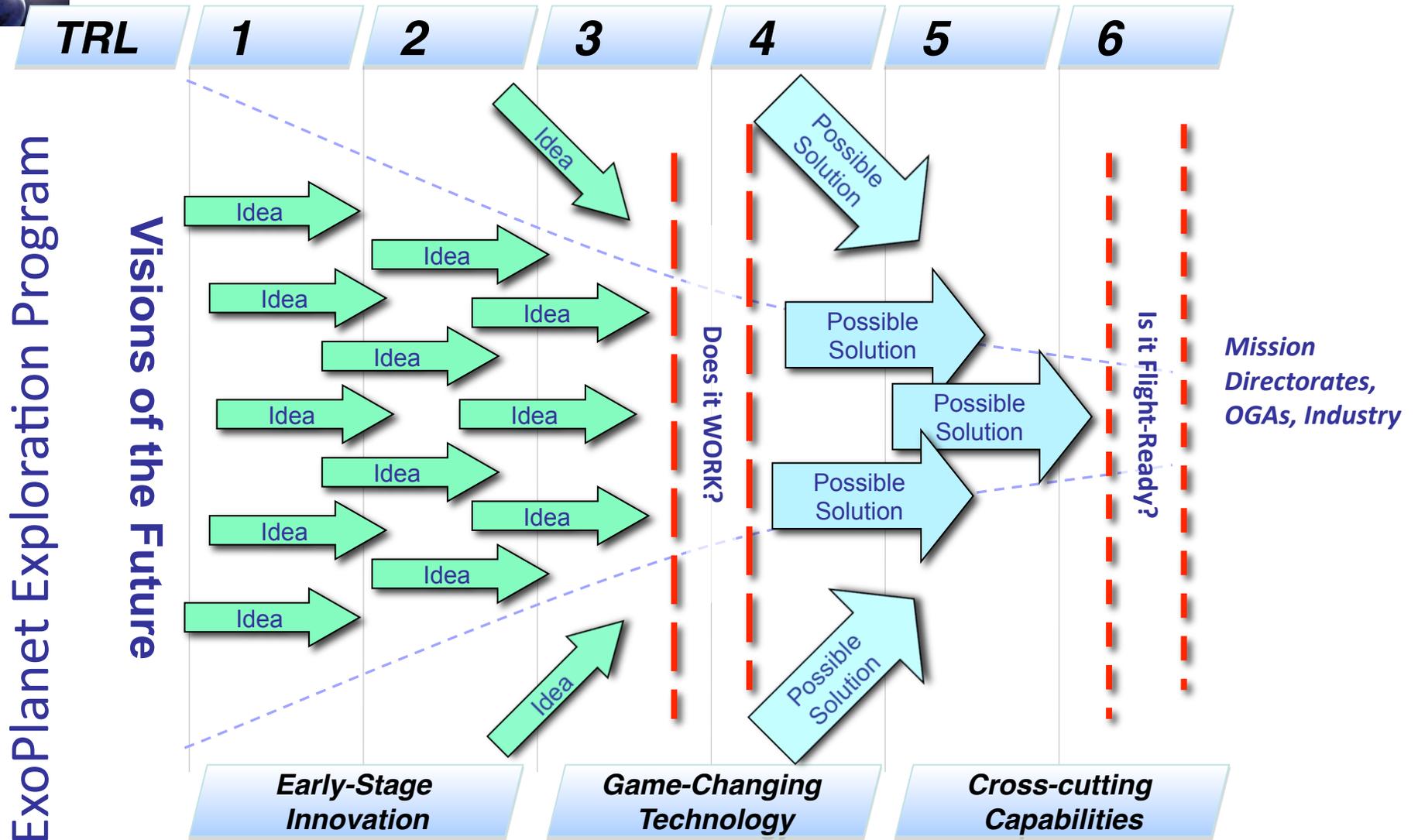
1. Starlight Suppression Demonstrations
2. Wavefront Sensing and Control
3. System Performance Assessment

“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”

Google: “NSPIRES Strategic Astrophysics” for details of NASA Research Announcement



Comments on the NASA Space Technology Program





NASA Technology Roadmaps

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

NASA OCT Roadmap

Greek Mathem...irs (cont.) Pelican Harbor Nest Eagle Cams http://medi.../eaglecam1 JPL Apple (78) eBay Yahoo! Amazon News (147)

NASA Technology Roadmaps

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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. T and space sci technology. (Th needs in space; and Developme

Roadmaps will be under review by NRC through 2011

The steering c

- The ste technol
- Each panel will conduct a workshop focused on one or more roadmaps, as assigned, to solicit feedback and commentary from industry and academia on the 14 **draft roadmaps** provided by NASA at the initiation of the study.

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

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- 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

Programs funded by the OCT may not start until mid-2012

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8 January 2011



Constraints and Goals of the Plan

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

Key Milestones for all architectures:

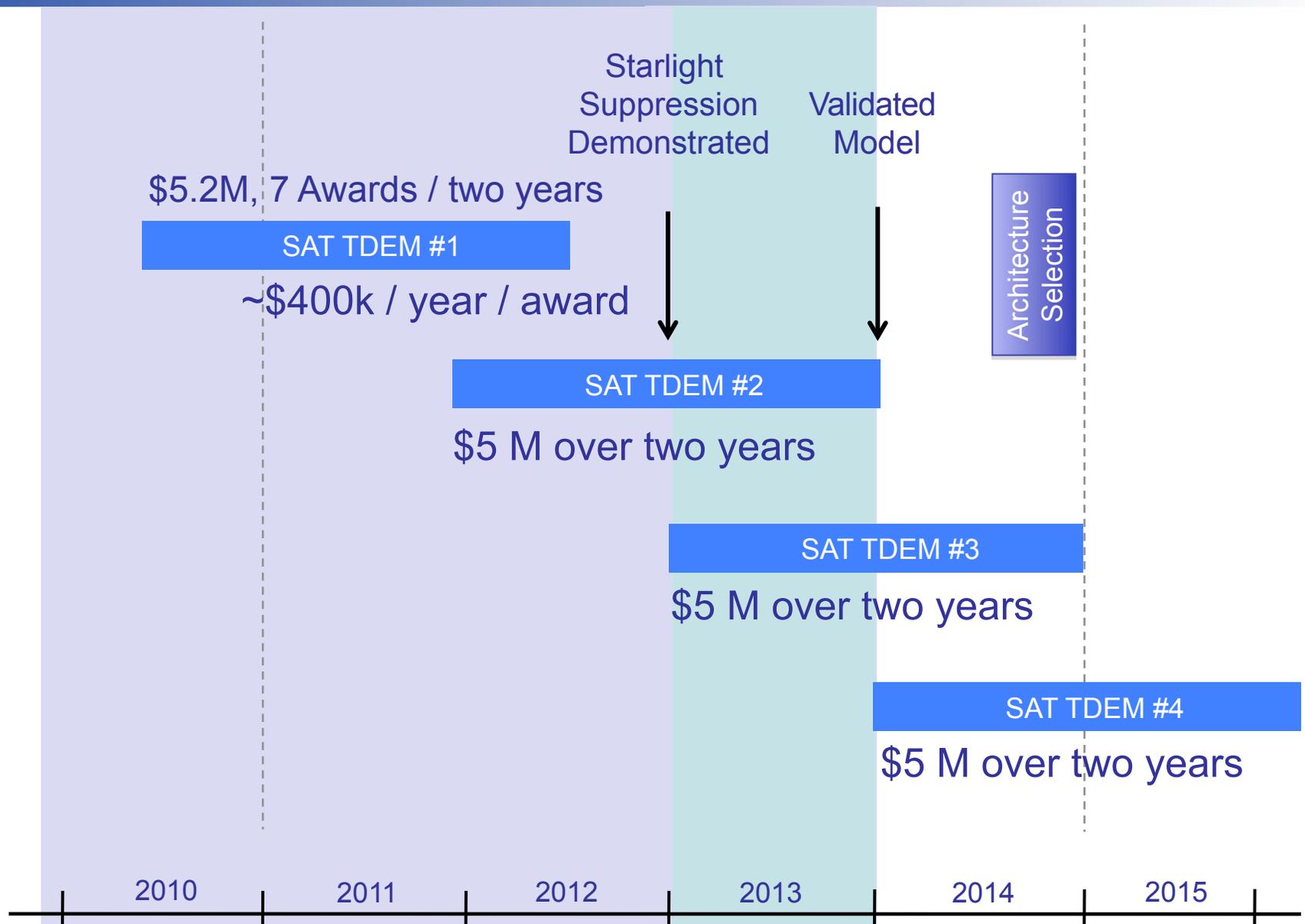
- Starlight suppression
- Model validation



ROSES Strategic Astrophysics Technology : 2011-2015



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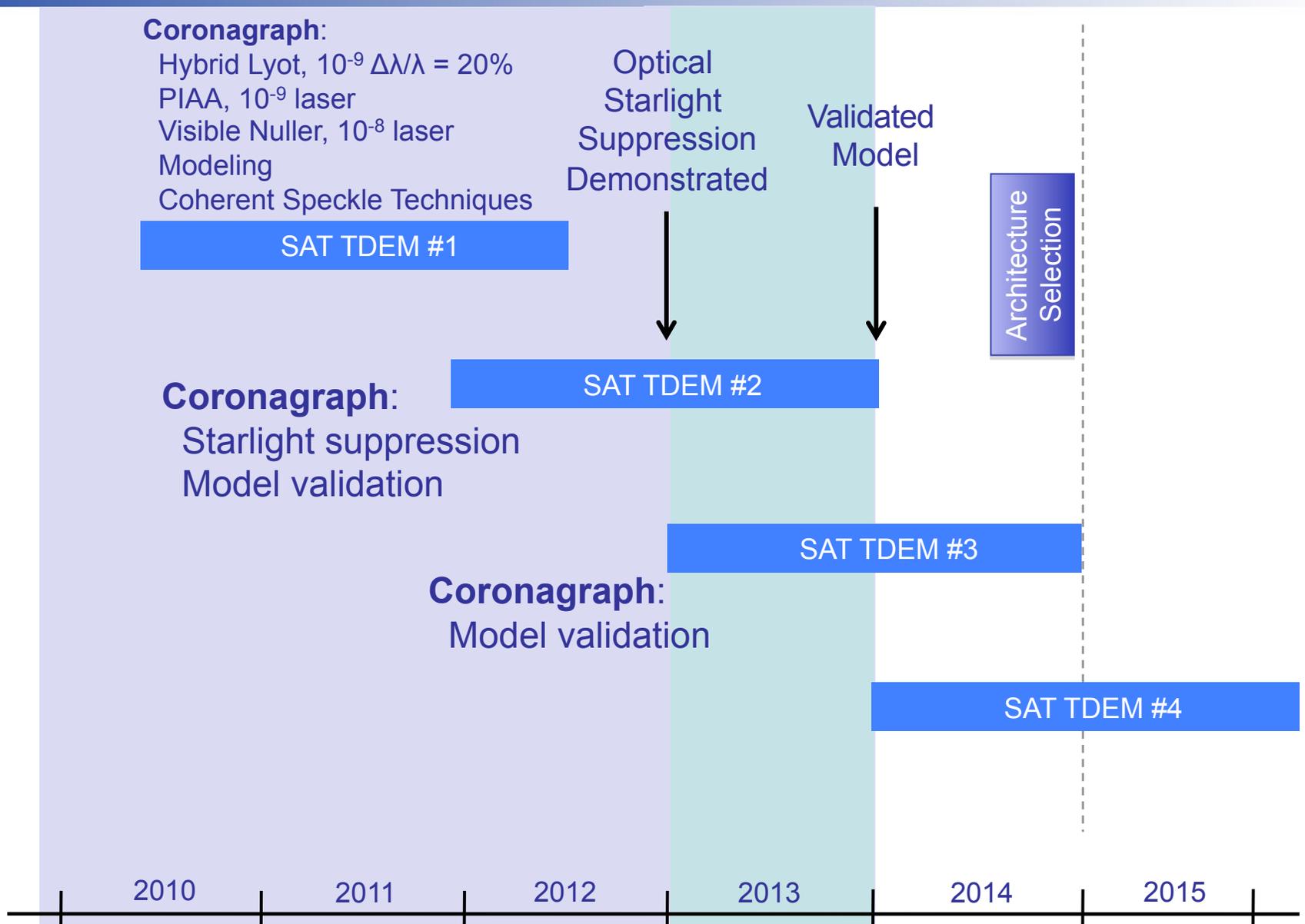




Coronagraphs



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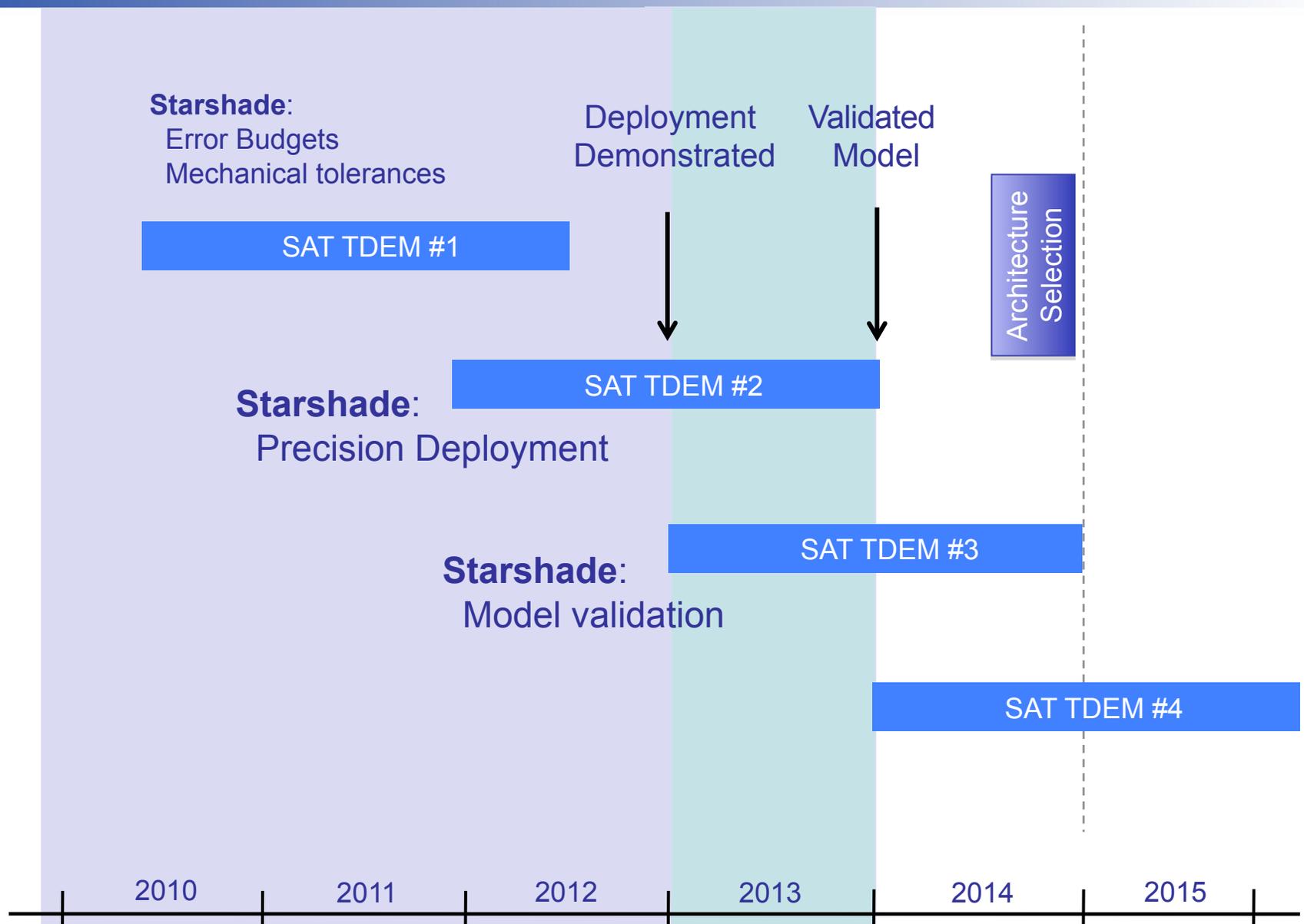




Starshades



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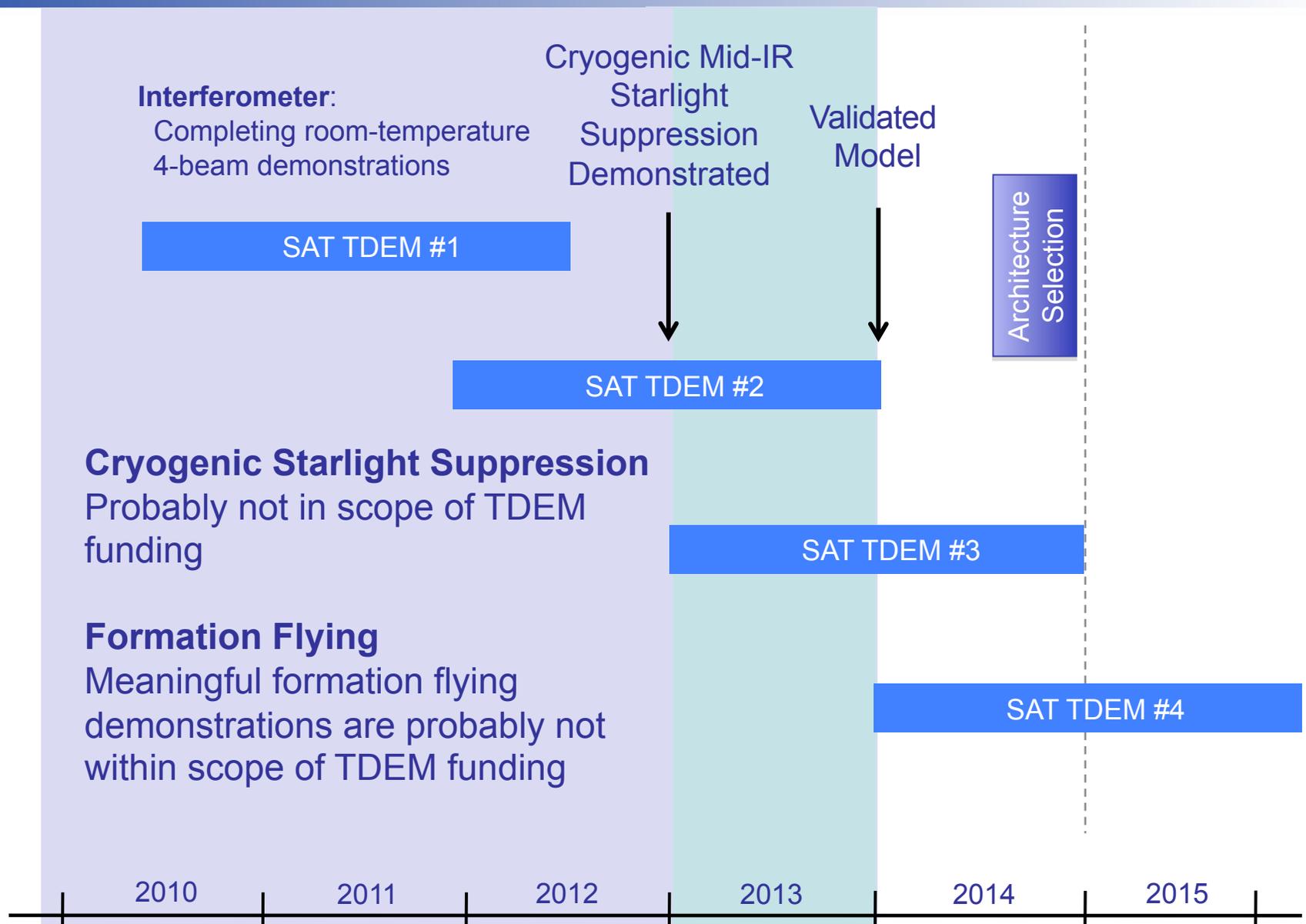




Infrared Interferometers



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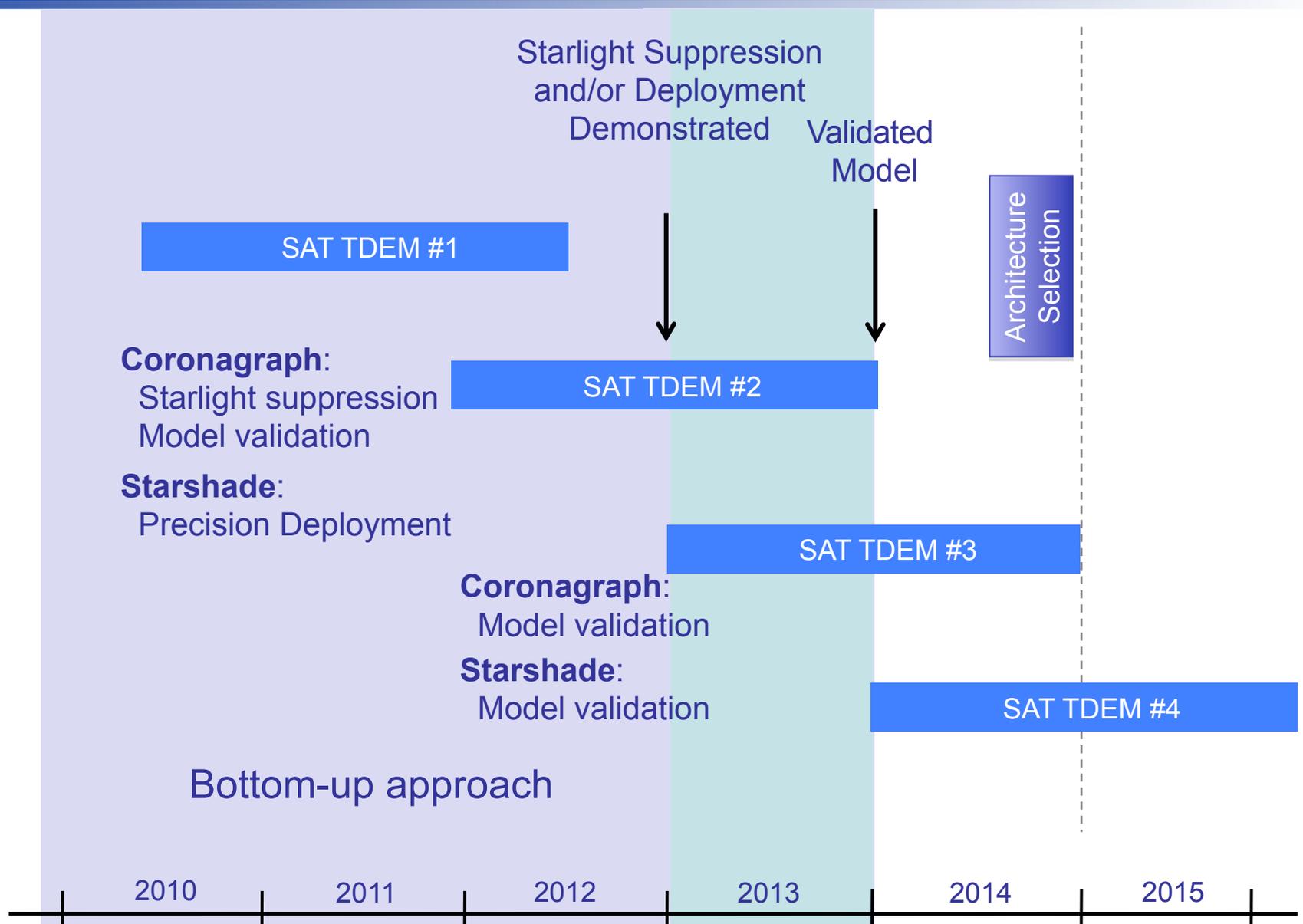




Summary: Bottom-up approach



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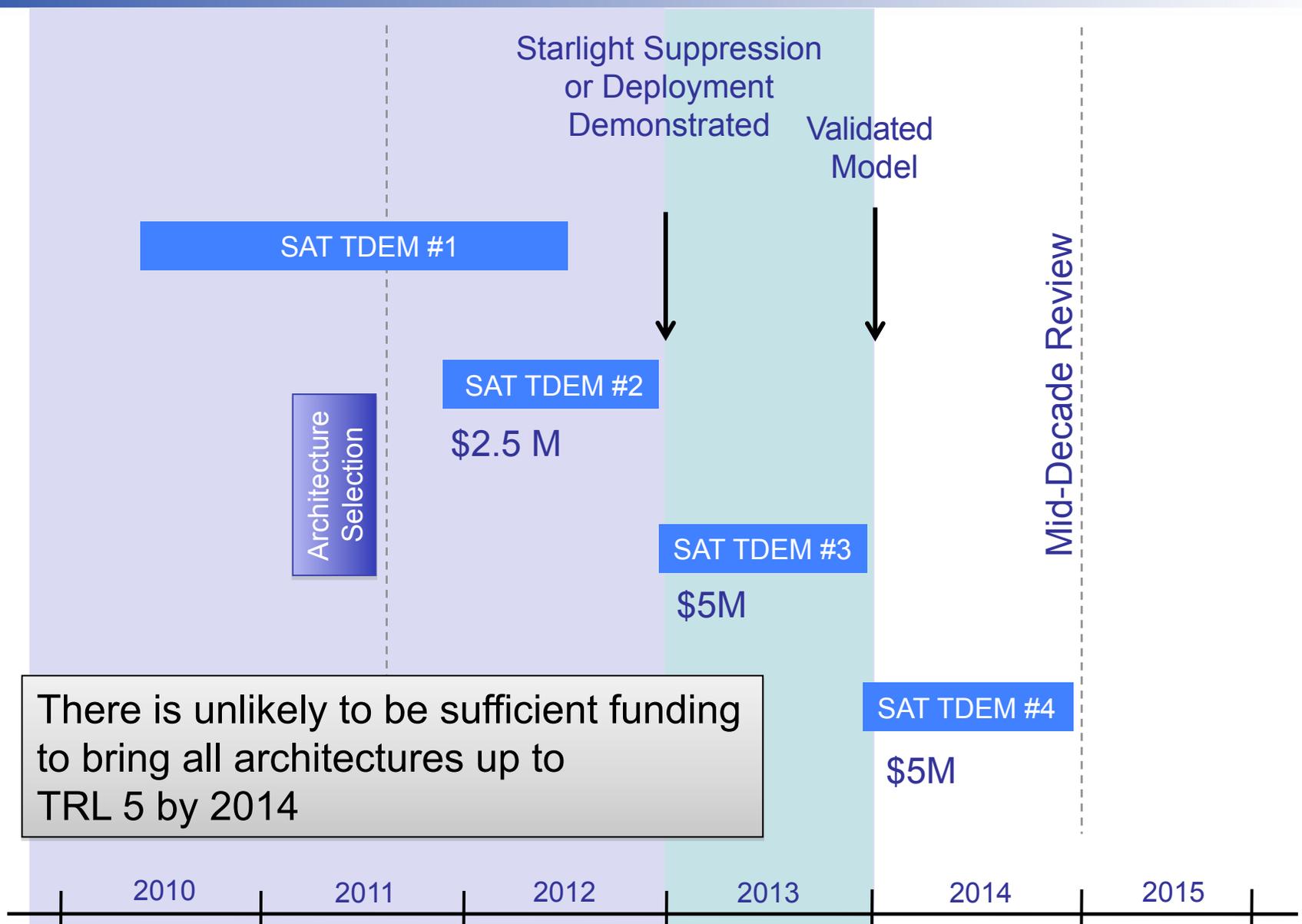




Summary: Top-down Approach



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Comments on Technology Plan



ExoPlanet Exploration Program

- Public document signed and approved by NASA HQ
- Briefly describes the science goals of the Exoplanet Program
- Describes the proposed funding and schedule of Strategic Astrophysics Technology NRA
- Describes the technology tall-polls for each architecture
- Describes areas of potential funding through the NASA Office of Chief Technologist
- Contains a written description following the outline of this presentation, focusing the tasks to be considered for SAT/TDEM in the next three years– in support of the mid-decade review.
- Recommends high-level Milestones through 2015 as illustrated here, but does not assign or budget specific tasks
- Does not contain detailed descriptions of tasks: total document length ~20 pages
- To be completed and signed by NASA HQ, before 31 March 2011



Requested Input from ExoPAG



ExoPlanet Exploration Program

- An analysis for a viable **top-down approach** to be implemented in 2011, that NASA can use as input to a mission architecture down-select in 2011. ...or
 - An analysis of a successful **bottom-up approach** to be used for the next TDEM selection.
- An analysis of the technology tall-poles for starshades
- An analysis of the schedule proposed (within the given constraints)
- Request ExoPAG input on these topics on or 31 January 2011.



Acknowledgements



ExoPlanet Exploration Program

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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