



Jet Propulsion Laboratory
California Institute of Technology

Exoplanet Exploration Program Overview

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Program Manager

NASA Exoplanet Exploration Program

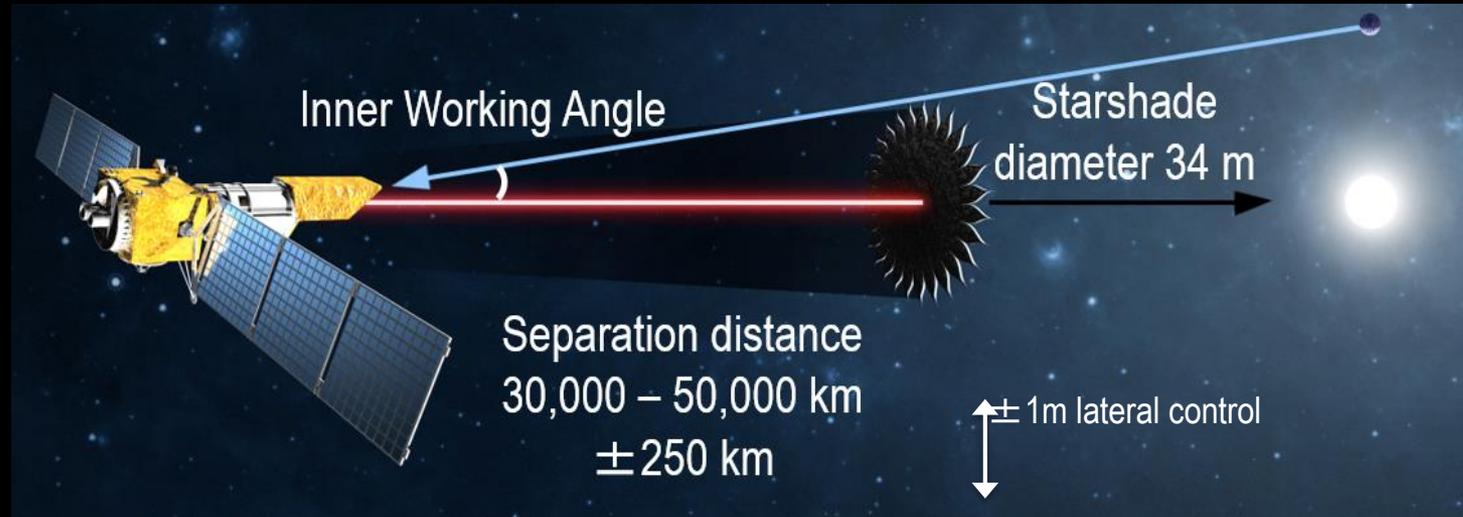
Jet Propulsion Laboratory, California Institute of Technology

Starshade Technology Workshop

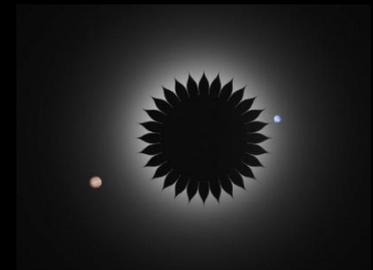
December 1, 2016

Pasadena CA

Why is NASA interested in Starshades?



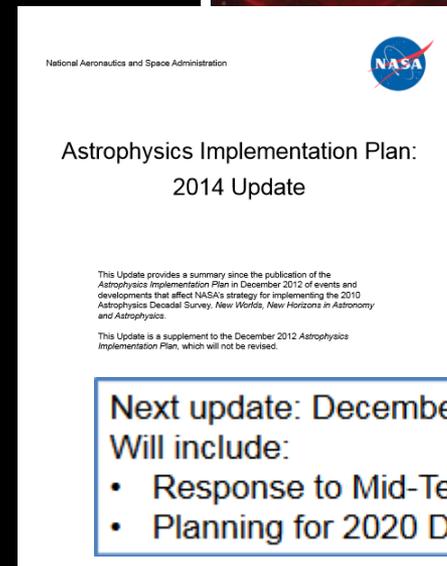
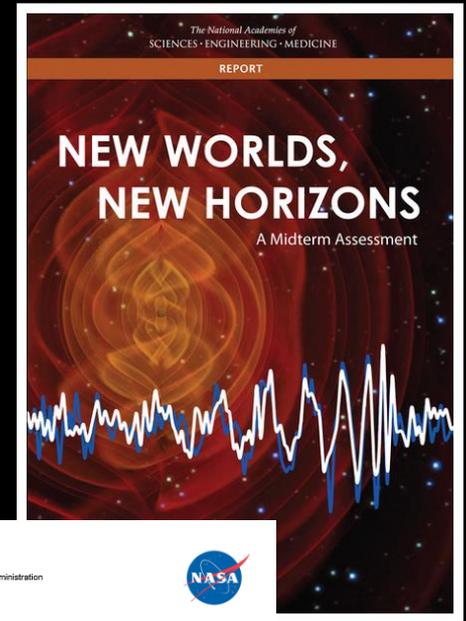
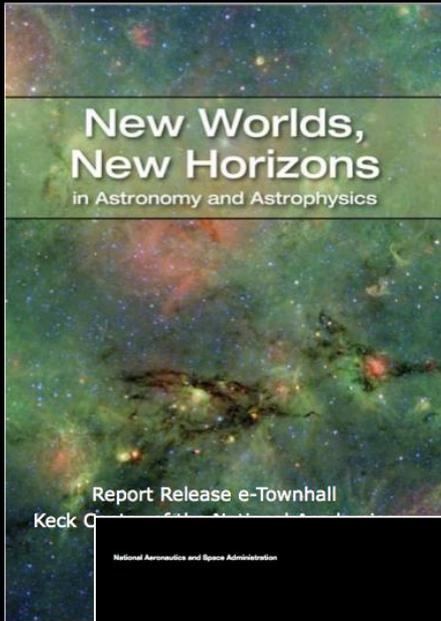
- One of two technologies for high-contrast imaging of earth-sized planets in habitable zones of sun-like stars
- Provides small inner working angle, high throughput
- Different technology challenges to coronagraph
- Complementary to coronagraph
- Provides access to Earth-sized planets in habitable zones of sun-like stars for small apertures



Astrophysics Division: Driving Documents

Results of NWNH:

- WFIRST is top large-scale recommended activity
- NWNH technology program is top medium-scale recommended activity

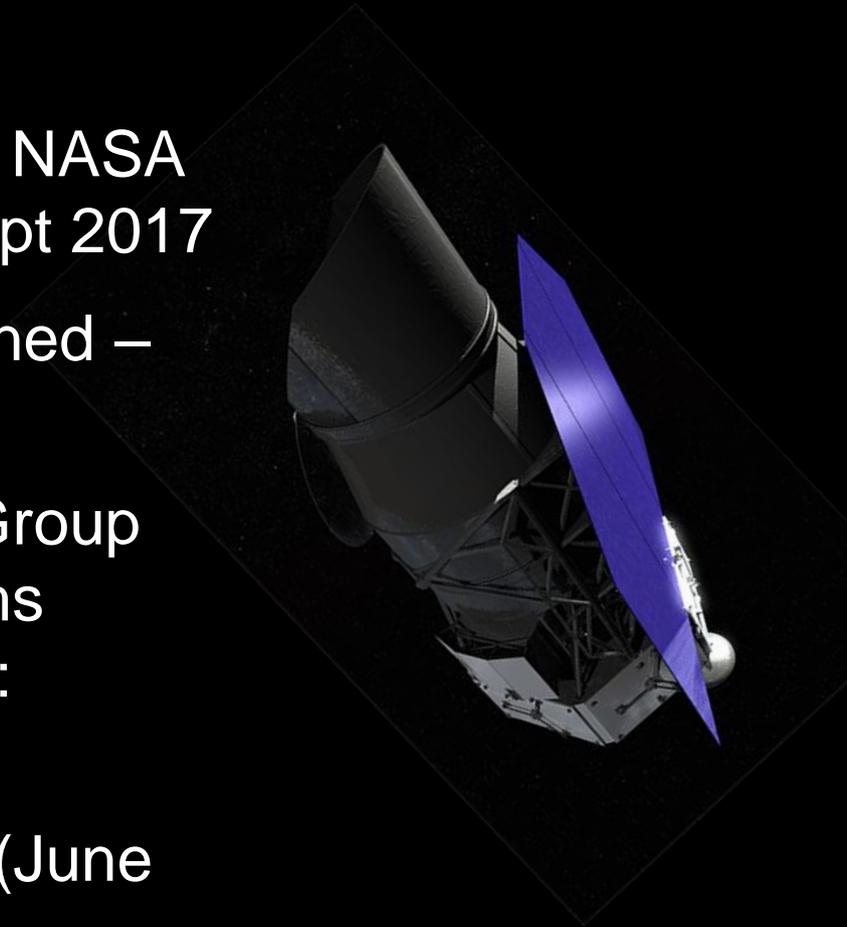


<http://science.nasa.gov/astrophysics/documents>

WFIRST

Dark Energy, Alien Worlds

- WFIRST in Formulation Phase: NASA Key Decision Point (KDP)-B Sept 2017
- Coronagraph Instrument baselined – exoplanet direct imaging
- Formulation Science Working Group and Science Investigation Teams underway (two for coronagraph: Macintosh, Turnbull)
- Project received APD direction (June 2016) to incorporate starshade compatibility into Phase A DRM – for SMD decision following SRR/MDR



Why is Starshade Technology Urgent Now?

- Decadal Large Mission Studies (HabEx, LUVOIR) are considering starshades and the science they enable
- Possibility for “Rendezvous at L2” of Starshade with WFIRST
 - Would require new probe-scale mission start early in 2020’s, and Decadal Survey endorsement of directed or competed probe budget line
- In all cases: Be ready and inform the 2020 Astrophysics Decadal Survey with mature technology (at TRL5 or close to it)

NASA Exoplanet Exploration Program

Astrophysics Division, NASA Science Mission Directorate

Purpose described in 2014 NASA Science Plan

1. Discover planets around other stars
2. Characterize their properties
3. Identify candidates that could harbor life

ExEP serves the science community and NASA by implementing NASA's space science vision for exoplanets

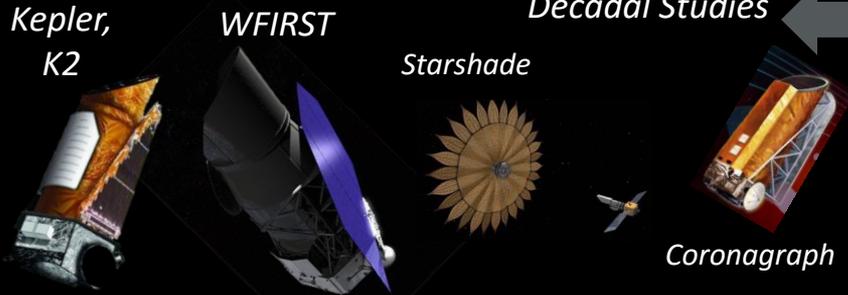
Exploring a galaxy of worlds while inspiring our own

<http://exoplanets.jpl.nasa.gov>

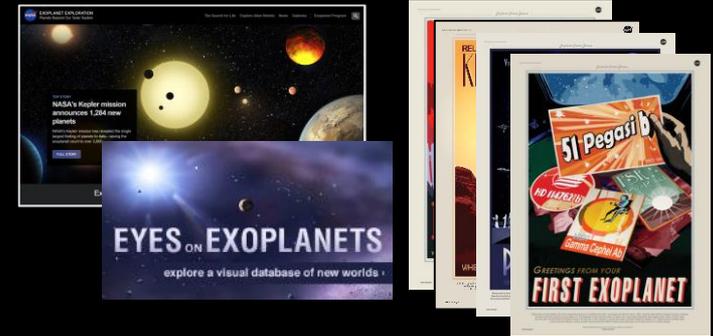


NASA Exoplanet Exploration Program

Space Missions and Mission Studies



Public Communications



Supporting Research & Technology

Key Sustaining Research



Large Binocular Telescope Interferometer

Keck Single Aperture Imaging and RV



NN-EXPLORE

Technology Development



High-Contrast Imaging



Deployable Starshades

NASA Exoplanet Science Institute



The NASA Astrophysics Division

JPL manages the Exoplanet Exploration Program for the Division



Exoplanet Exploration

Cosmic Origins

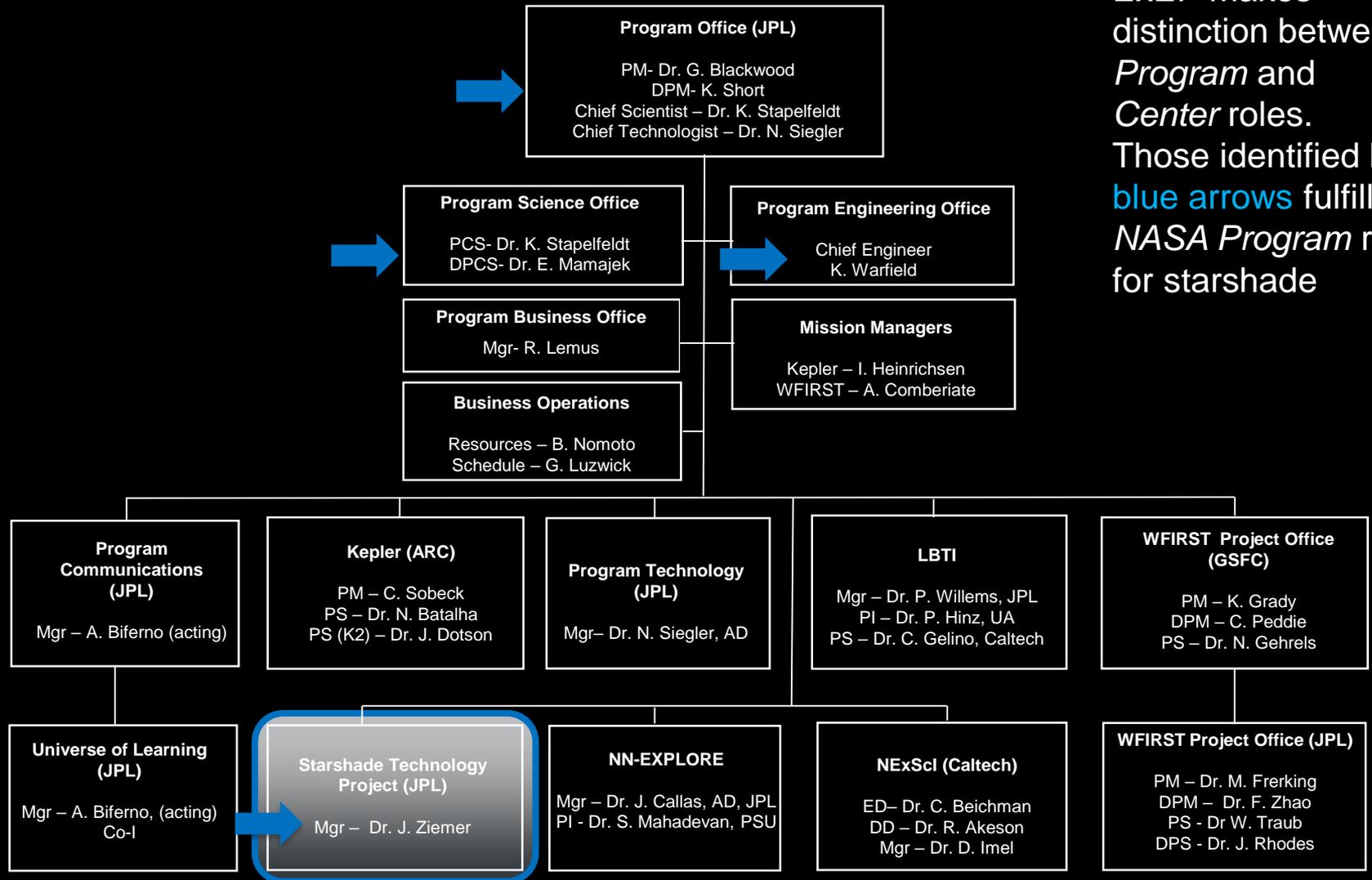
Physics of the Cosmos

Astrophysics Explorers

Astrophysics Research

Starshades in the Exoplanet Exploration Program

ExEP makes distinction between *Program* and *Center* roles. Those identified by **blue arrows** fulfill *NASA Program* role for starshade



Current Starshade Context: Developments since 2015



ExoPlanet Exploration Program

- **3/2015:** Final report from **Exo-S Probe-Scale Study**. Developed concept for (34m) starshade standalone mission and introduced concept for WFIRST Starshade Rendezvous (34m)
- **1/2016:** Signed charter of the **Starshade Readiness Working Group (SSWG)**
- **2/2016:** Final Report of the **Exo-S Extended Study**. Explored Rendezvous variants: larger (40m) and smaller (26m) starshade sizes
- **3/2016:** **Starshade Technology Development Activity** created to achieve TRL5.
- **4/2016:** Decadal large studies chartered, both **HabEx and LUVOIR** considering starshades for exoplanet direct imaging
- **6/2016:** APD directs **WFIRST to be designed to accommodate a starshade**, under study by project, ExEP and SITs.
- **11/2016:** SSWG final briefing to APD Director. Concludes that WFIRST Rendezvous starshade mission does not require a prior tech demo.
- **12/2016:** Starshade Technology Workshop (12/1)
- **12/2016:** WFIRST Starshade Accommodation - Interim assessment to APD Director (12/13), final decision prior to KDP-B

Starshade Technology – Plan Forward

- Plan in FY17, Execute during FY18-20 (conditional upon APD Director's authorization to proceed)
- What level of funding are we talking about?
- Next steps:
 - Informed by this workshop, recommend FY17 investments to APD Director
 - APD Director makes the decision
 - Present FY18-20 plan to APD Director by end of 2017



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