Jet Propulsion Laboratory
California Institute of Technology

Starshade Science and Industry Partnership

Telecon #14

NASA Exoplanet Exploration Program

Renyu Hu

May 20, 2021

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Telecon Agenda

- Introduction - **Renyu Hu**
- Experimental investigation of the starshade prototype petal creep behavior – **Gregg Freebury, JoAnna Fulton, Darin Brubaker, Tendeg, LLC**
- Perspective of the technology and science working group – **Simone D'Amico**
- Open Floor for Discussion

Motivation for Starshade Science and Industry Partnership

The purpose of the Starshade SIP is to maximize the technology readiness level of starshades to enable potential future exoplanet science missions.

- Starshades (or External Occulters) are **one of the starlight suppression technologies** for high contrast imaging of exoplanets and are baselined for large- and probe-class mission concept studies funded by the NASA Astrophysics Division for submission to the Astro2020 Decadal Survey.
- The Astrophysics Division authorized the Exoplanet Exploration Program (ExEP) to **execute a directed technology development activity** to advance starshades to Technology Readiness Level (TRL) 5.
- The Starshade **Technology Development Activity to TRL5, or S5**, follows an approved **Technology Development Plan** with technology milestones that respond to documented mission performance requirements.
- The ExEP recognizes that robust and impactful technology maturation requires **ongoing consideration** of new technology approaches and new mission concept drivers.

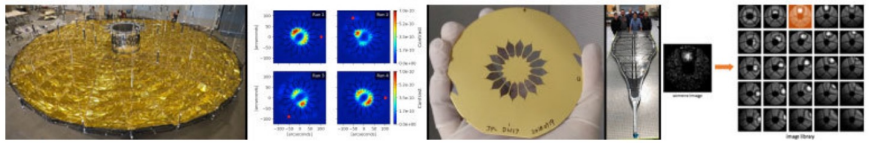
https://exoplanets.nasa.gov/exep/technology/starshade/

EXOPLANET PROGRAM

About | Studies | News | Meetings/Events | Resources | Technology | NExScI | ExoPAG | For the Public

Overview | Needs and Gap Lists | SAT Awards | Colloquium Series | iSSA | SCDA | Starshade Technology Development | Starshade Da

Starshade Technology Development



The Exoplanet Exploration Program Charter identifies one of the Program's critical functions to be to "…manage exoplanet-related technology initiatives, including the management of specifically directed technology activities, facilitation of a coordinated NASA Astrophysics technology identification/prioritization process, oversight of competitively-selected technology activities, and certification of technology milestones and or Technology Readiness Levels (TRLs)."[1]

A key method in the pursuit of these goals and objectives is the direct imaging of planets around other stars. Directly sampling the light from an exoplanet separately from that of its host star facilitates measurement of its size, orbit, albedo, and ground and atmospheric spectra, which provide clues to its habitability, and potentially could provide signatures of the presence of life itself. However, direct observation of small, rocky planets like Earth close enough to their host stars to harbor liquid water is very difficult due to the extreme faintness of the exoplanet relative to the very nearby star. The starlight must be suppressed, either interferometrically or by an occulter, to allow exoplanet detection. Occulters that are internal to the telescope are referred to as coronagraphs. Occulters that are external to the telescope are referred to as starshades.

Starshades benefit NASA by enabling and enhancing NASA's capability to detect planets around other stars, characterize them, and search them for signs of life. They do this by dramatically extending the 'field of regard' of direct imaging studies towards small, rocky planets orbiting in the habitable zones of their host stars, the regions where liquid water can be sustained on the planets' surfaces, and towards characterization of the surfaces and atmospheres of those planets.

** NEW ** (4/6/2021)
Special Section on Starshades in the April 2021 issue of the Journal of Astronomical Telescopes, Instruments, and Systems

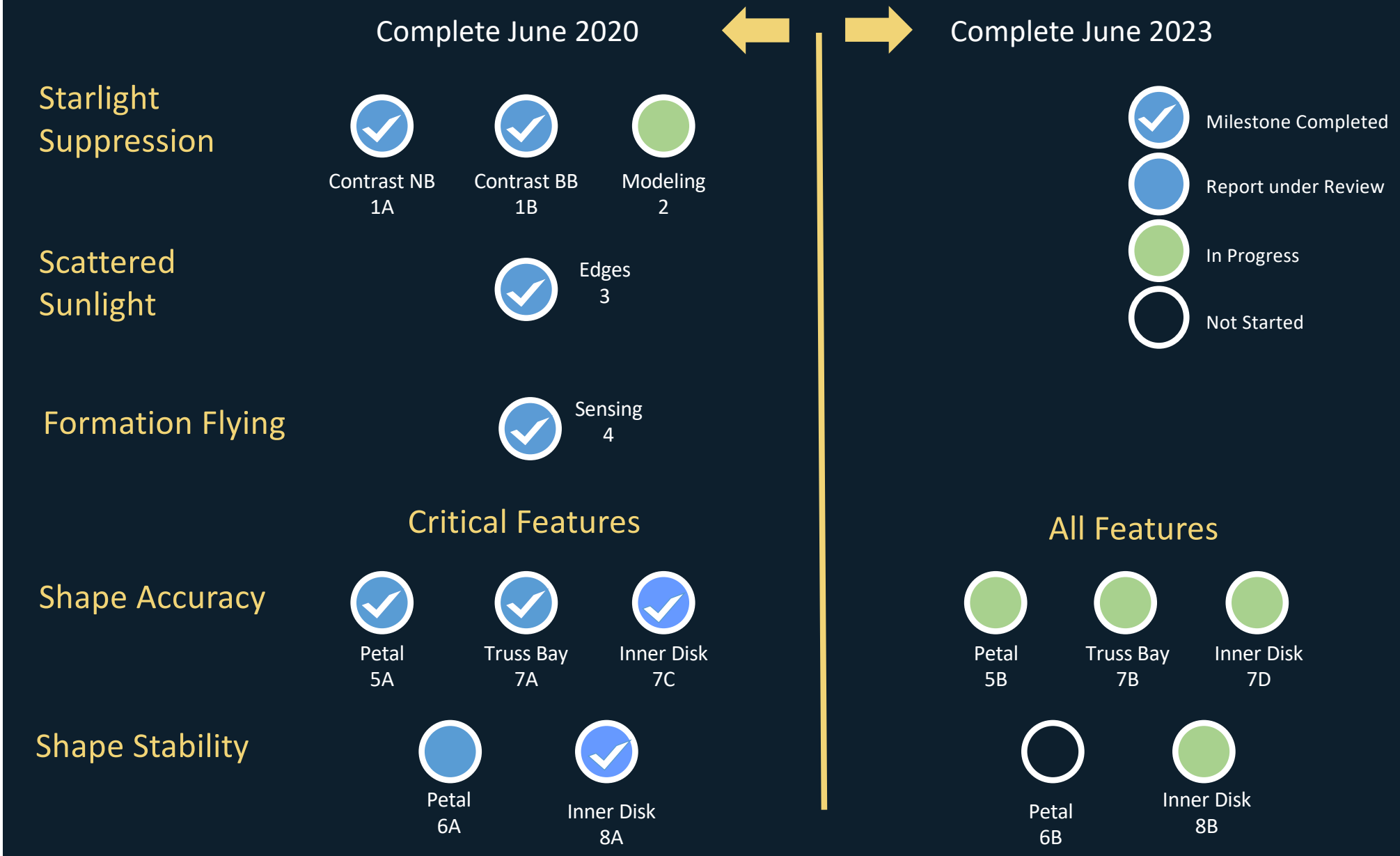
Starshade Technology Development Activity (S5) Documents

- Starshade Technology Development Plan
- Level 1 Technology Milestones – Summary Table

Milestone #1

- 1A Report - Narrowband Optical Contrast Performance
- 1B Report - Broadband Optical Contrast Performance
- ExoTAC Review of #1A, #1B

S5 Technology Milestones Scorecard



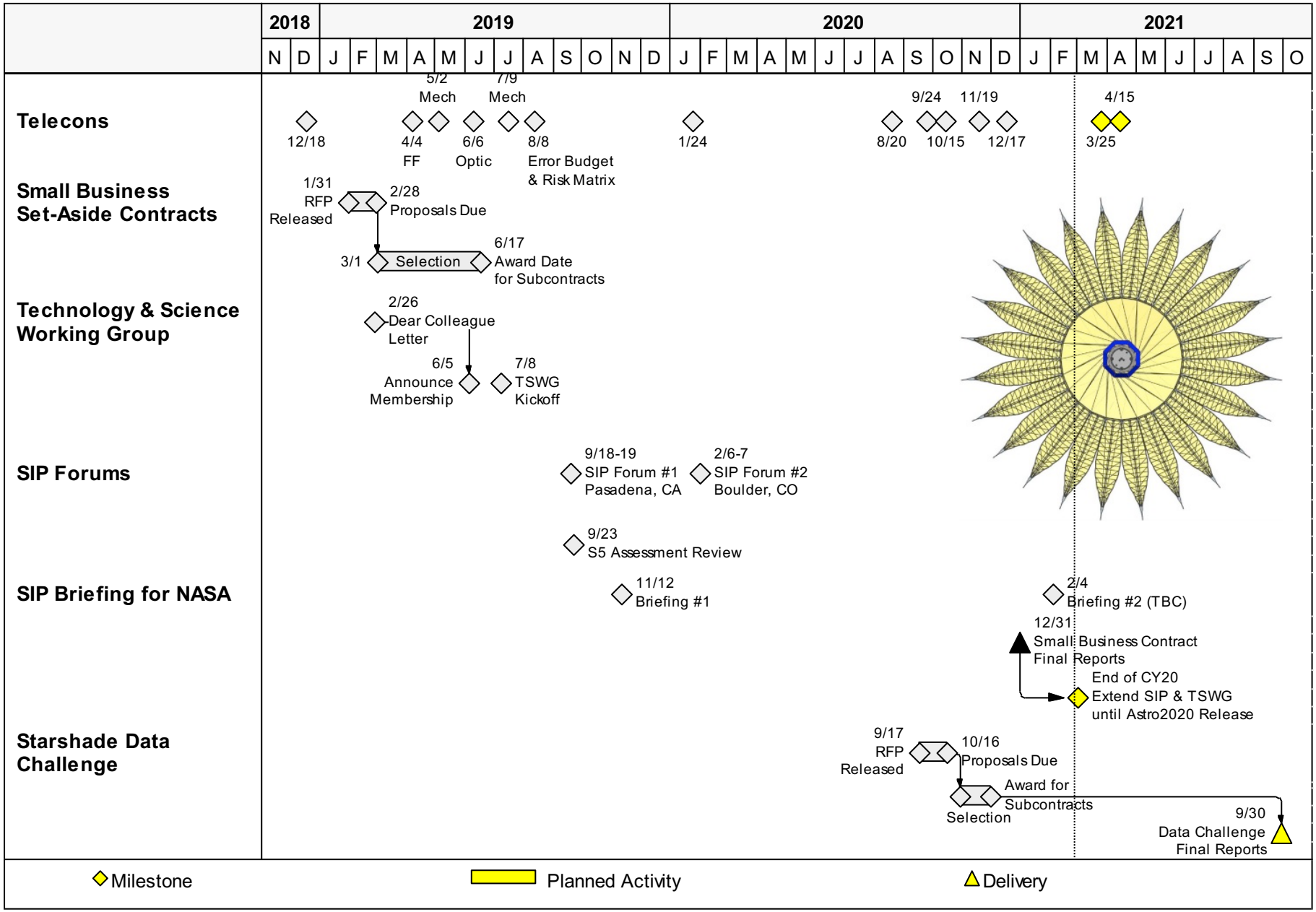
Expected Outcomes of the Starshade SIP

1. Identify **solutions to challenges** faced by the S5 development activity;
2. Propose **new approaches, techniques, and research** beyond planned S5 activities that can maximize starshade technology readiness;
3. Document **new mission concept drivers** for starshade technology performance requirements;
4. **Maintain alignment** between S5 technology development activities and future mission needs;
5. **Facilitate** groups of investigators to communicate research, new technology, and new mission concepts across disciplinary, organizational, and geographic boundaries;
6. Enable **continued participation** of the community in NASA's starshade technology development activities.

Starshade Science and Industry Parnership (SIP)

Tier 2 Schedule

2/26/2021



SIP Activities

- SIP Forums #3 and #4 are replaced by a series of SIP telecons
  - Topics from TSWG recommendations and other SIP activities
  - 10am PT on the third or fourth Thursday of each month
- Agenda of SIP telecons
  - Aug: Stray light analyses. Starshade data challenge announcement
  - Sep: Mechanical milestones. Starshade data challenge Q&A
  - Oct: Presentations from ATA and Zecoat
  - Nov: Effects of binary companions and other astrophysical backgrounds
  - Dec: Presentation from Opterus / Roman exoplanet imaging data challenge
  - Mar: JATIS special issue on starshade
  - May: Presentation from Tendeg

Starshade Exoplanet Data Challenge

- Objectives of the Data Challenge
  - Validate requirements from science to key performance parameters
  - Quantify the accuracy of calibration of solar glint and exozodiacal light
  - Prepare science community for analyzing starshade exoplanet observations
- Two teams have been selected from submitted responses to a JPL Request for Proposals
- S5 are preparing synthesized images for the data challenge
  - The simulated images include effects of optical edge coating, exozodiacal disk, formation flying variability, and slit/prism spectroscopy
- 1st and 2nd community telecons took place in January and April
  - The 1st and 2nd set of the simulated images made public through a dedicated webpage, along with reference documentations and relevant publications:
    - https://exoplanets.nasa.gov/exep/technology/starshade-data-challenge/
  - A total of 1440 images have been simulated and released to the community
    - Broadband observations with Roman in 425-552 nm and 615-800 nm
    - Nominal and a “worse” starshade (10x contrast, 2x solar glint)
    - Smooth exozodiacal dust density and resonant cloud structures
  - The Data Challenge is open to the general astronomy and exoplanet community

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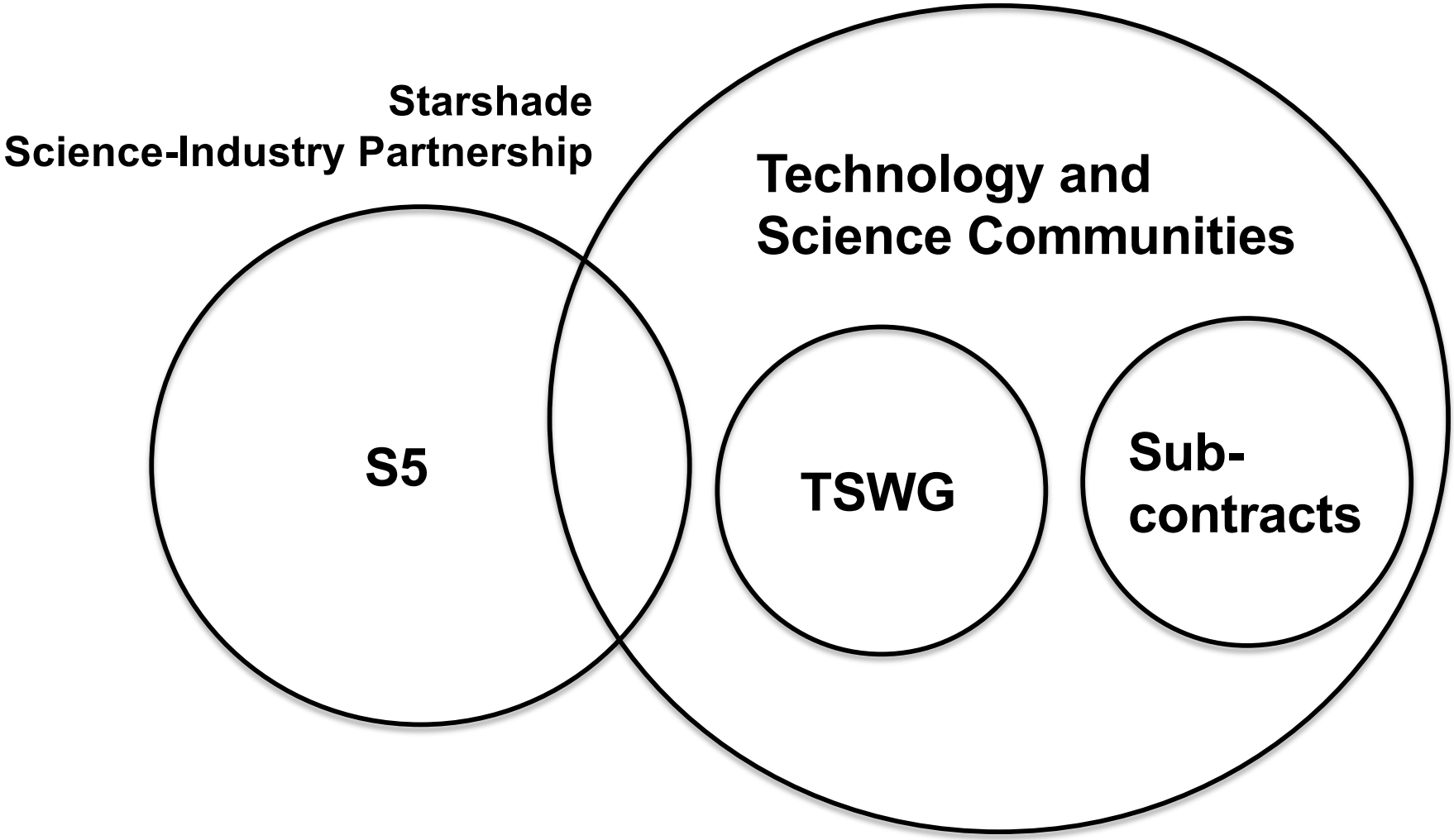
Next Steps

Anticipating the outcome of the Astro2020 decadal survey

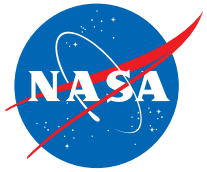


- Post-decadal S5 assessment review to include recommendation of the SIP communities

Closing

Future telecon topics

- **Starshade SIP mailing list:** Follow instructions at https://exoplanets.nasa.gov/exep/technology/starshade/
- Suggest future topics of discussion to:
  - Gary Blackwood and Renyu Hu
  - Simone D'Amico, Chair of TSWG
- Open the floor for further discussion



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Disclaimer

The cost information contained in this document is of a budgetary and planning nature and is intended for informational purposes only. It does not constitute a commitment on the part of JPL and/or Caltech.

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Science and Industry Partnership

- **Gary Blackwood**, NASA ExEP Manager, Starshade SIP Chair
- **Renyu Hu**, ExEP Scientist for Starshade Technology

Starshade Technology Development Activity (S5)

- **Phil Willems**, Manager of S5, LBTI Project Manager

NASA Headquarters Leadership

Astrophysics Division

- **Shahid Habib**, Program Executive for ExEP
- **Douglas Hudgins**, Program Scientist for ExEP
- **Mario Perez,** Division Technology Lead
- **Jeff Volosin**, Deputy Division Director
- **Paul Hertz**, Division Director