



**Jet Propulsion Laboratory**  
California Institute of Technology

# Starshade Science and Industry Partnership

Telecon #12

NASA Exoplanet Exploration Program

**Renyu Hu**

December 17, 2020

# Telecon Agenda

- Introduction - **Renyu Hu**
- Modeling Starshade Petal Shape Stability – **Patrick Rodriguez, Opterus R&D, Inc.**
- Results of the Roman Space Telescope Exoplanet Imaging Data Challenge – **Ell Bogat, Julien Girard, Margaret Turnbull**
- Open Floor for Discussion

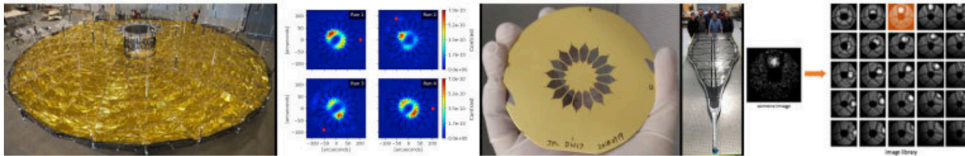
# Motivation for Starshade Science and Industry Partnership

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.



## 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)."<sup>1</sup>

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.

### Starshade Technology Development Activity (S5) Documents

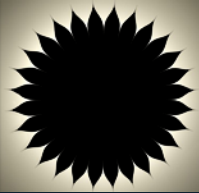
- [Starshade Technology Development Plan](#)
- [Level 1 Technology Milestones – Summary Table](#)

#### Milestone #1

- [1A Report - Narrowband Optical Contrast Performance](#)
- [1B Report - Broadband Optical Contrast Performance](#)
- [ExoTAC Review of #1A, #1B](#)

#### Milestone #3

- [Report- Demonstration of Solar Glint Lobe Scatter Performance](#) **\*NEW**



# S5 Technology Milestones Scorecard

Complete June 2020



Complete June 2023

## Starlight Suppression



## Scattered Sunlight



## Formation Flying



## Critical Features

## Shape Accuracy



## All Features



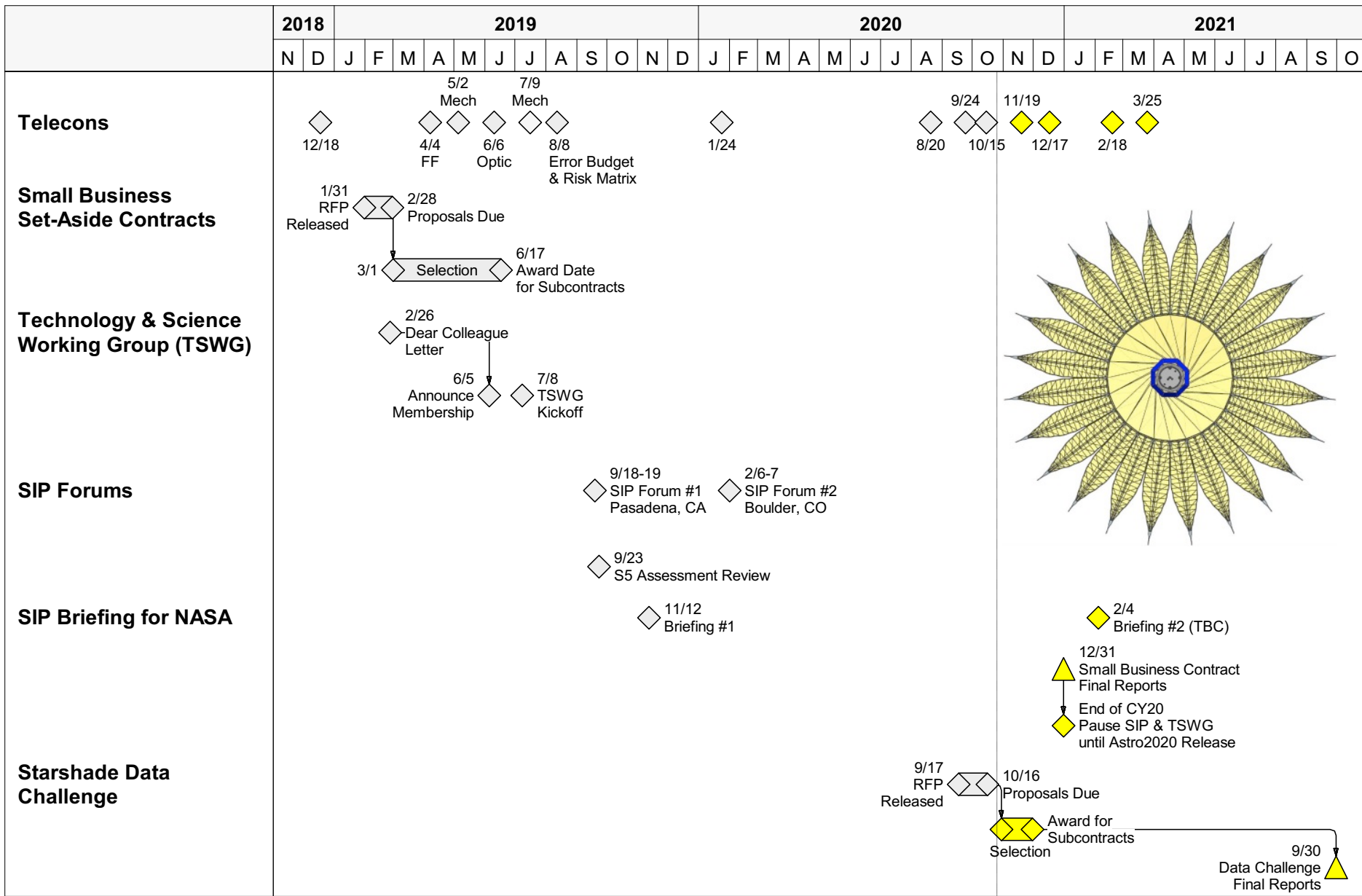
## Shape Stability



# Starshade Science and Industry Partnership (SIP)

## Tier 2 Schedule

10/25/2020



◇ Milestone

▬ Planned Activity

▲ Delivery

# SIP Activities

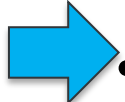
- SIP Forums #3 and #4 are replaced by a series of SIP telecons
  - Topics from TSWG recommendations and other SIP activities
  - 10am PT on the third or fourth Thursday of each month
- Agenda of SIP telecons
  - Aug: Stray light analyses. Starshade data challenge announcement
  - Sep: Mechanical milestones. 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
  - Feb: Presentation from Tendeg
  - Mar: Summary and overview of the JATIS special issue on starshade / More suggestions are welcome
  - Will be keen on including student and postdoc presentations

# 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
  - **Mississippi State University**, Mississippi State, MS. The Principal Investigator is Dr. Angelle Tanner
  - **Quartus Engineering Incorporated**, El Segundo, CA. The Principal Investigator is Brian Dunn
- S5 are preparing synthesized images for the data challenge
  - The simulated images will include effects of optical edge coating, exozodiacal disk, formation flying variability, and slit/prism spectroscopy
- A kick-off meeting will take place in January
  - Information will be announced to the SIP mailing list
  - The first set of the simulated images will be made public prior the kick-off meeting



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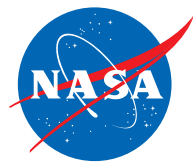
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# Closing

Future telecon topics

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



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# **Acknowledgements**

This work was carried out at the Jet Propulsion Laboratory, California Institute of Technology under contract with the National Aeronautics and Space Administration. © 2020 All rights reserved.

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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.

# Contact Information

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# Program Office – Key Participants

NASA Exoplanet Exploration Program (ExEP)

## 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