



## **Starshade Rendezvous Technology for WFIRST**

## JPL-MPIA at KISS - Caltech

**Doug Lisman** 

April 12, 2018

Jet Propulsion Laboratory, California Institute of Technology. Copyright 2016 California Institute of Technology. U.S. Government sponsorship acknowledged.





## Starshade Mechanical Technology

- Mechanical architecture and deployment sequence
- -Mechanical technology development and status

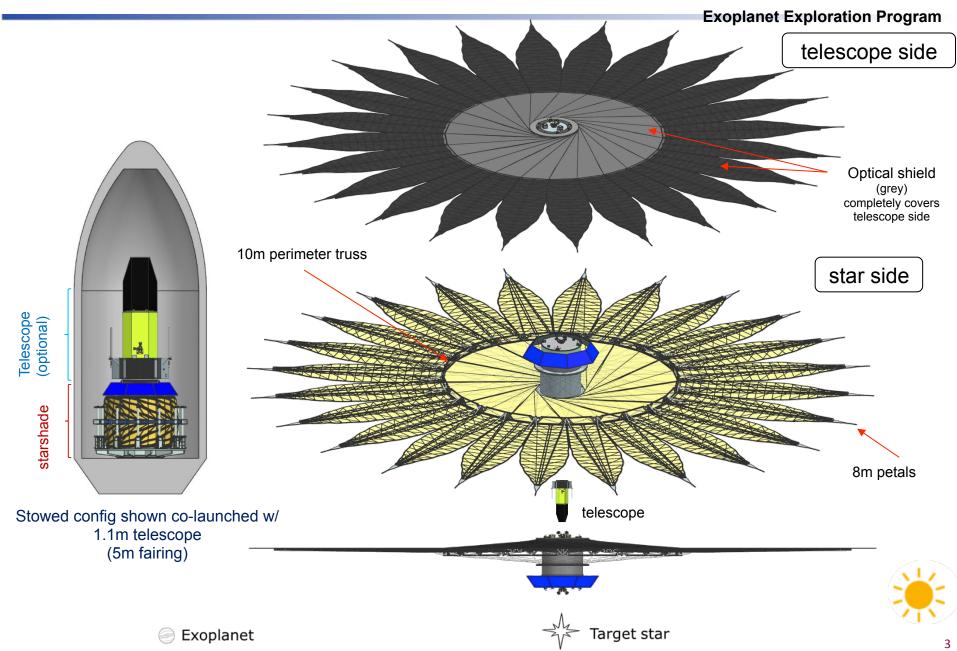
# • WFIRST Starshade Accommodations

- -Overview
- -CGI accommodations



### Wrapped Petal Starshade Mechanical Architecture







## Wrapped Starshade 2-Step Deployment

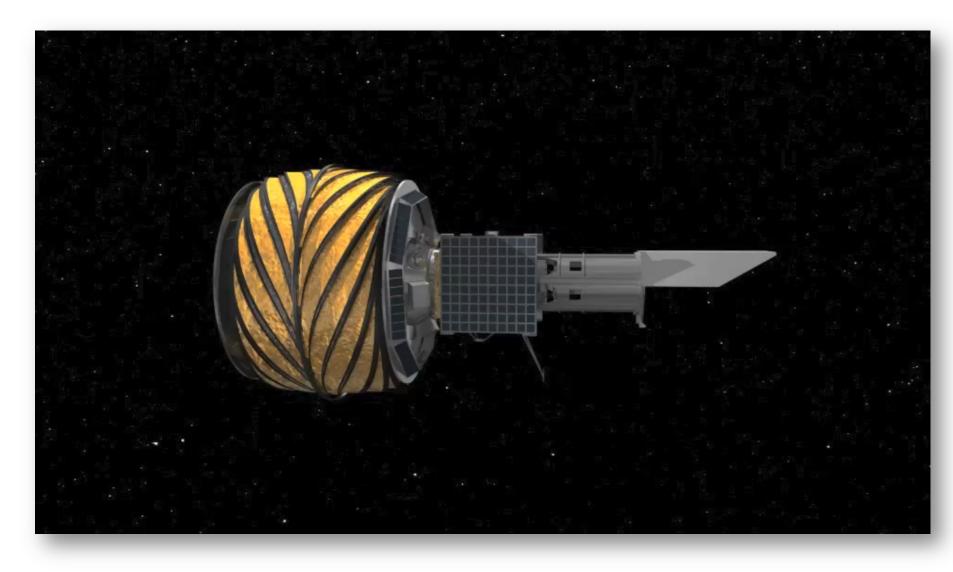


### **Exoplanet Exploration Program** 1. Stowed 2. Petals unfurl 3. Petals rotate 90-deg 4. Truss deploys 5. Deployed Starshade (tangential to radial) (& optical shield) 5m diameter Inner Disk **Petal Unfurling** Deployment Petal Unfurling & Truss Deployment are independent & decoupled Petal Unfurling requires truss as interface only ٠ - (truss remains stowed, does not participate) - 2x redundant motors drive unfurler (1x needed) • <u>Truss Deployment</u> deploys petals passively (petals are attached outboard of deploying truss) - 2x redundant motors drive unfurler (1x needed) 34m diameter

\*\*\* 34m starshade shown here





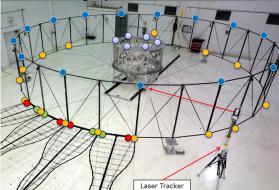




### **Starshade Mechanical Development Status**



#### **Exoplanet Exploration Program** Past efforts demo tolerances for: **Ongoing efforts demo how to: Future efforts need to demo: Petal Manufactured Shape Unfurl Petals On-orbit stability over temperature** The Sun Angle varies from 40° to 83° Sun Angle 40°: Petal is not shadowed Sun Angle 78°: 1/2 of Petal length is shadowed Sun Angle 83°: Full Petal is shadowed *Performance is fortunately insensitive* to uniform shape change. Non-uniform thermal shape changes contribute less than 10% of the total max expected instrument contrast. Jettisoned rotating carousel TDEM-09: J. Kasdin, PI **Disk deploy tolerances Co-deploy an opaque optical shield Disk Deployment (Petal Position)**

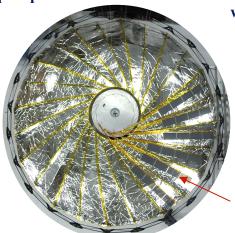


TDEM-10: J. Kasdin, PI

### with optical shield installed.



Wrapped spiral gores

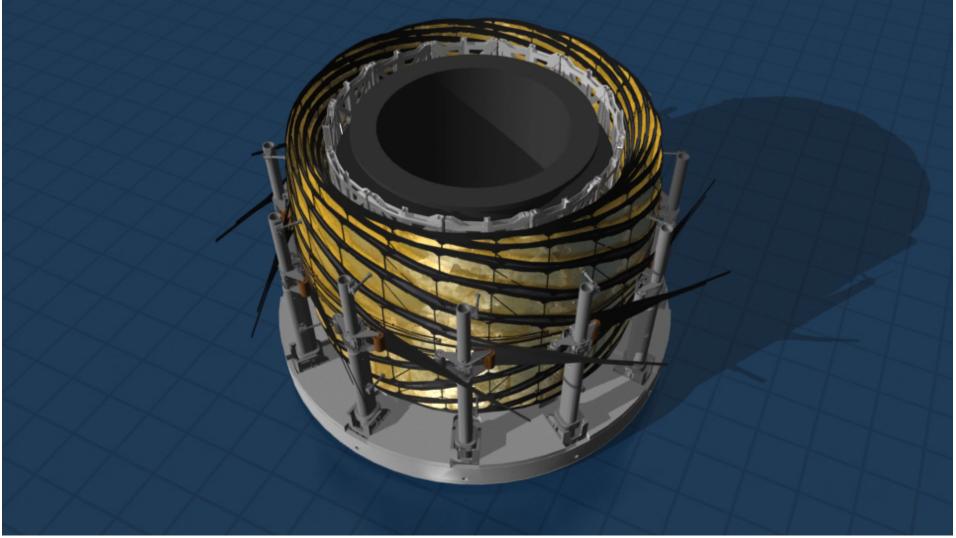


Thin-film solar cells could power SEP



### **Petal Unfurl Animation**

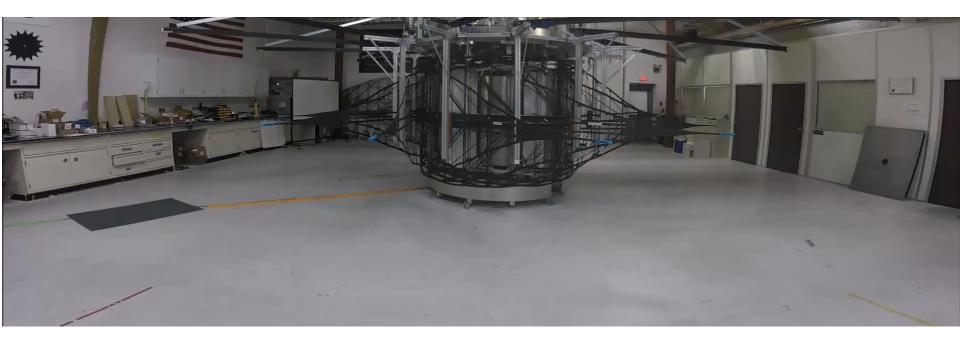






### **Petal Unfurl Testbed**

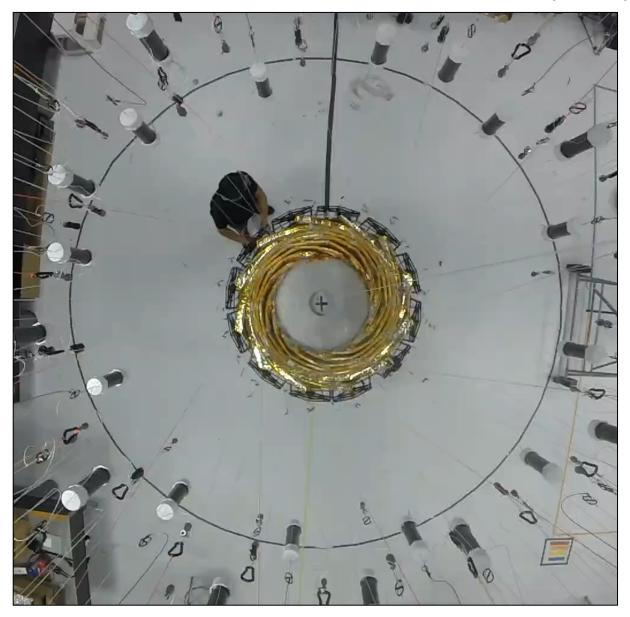






### **Disk Opaque Shield Deployment Video**









- WFIRST baseline includes Starshade accommodation, but implementation is only funded through calander 2020
  - Coronagraph instrument (CGI) provides science instrumentation and lateral formation sensing with no additional focal planes
  - WFIRST spacecraft provides a starshade acquisition camera (a customized star tracker)
  - WFIRST spacecraft provides a S-Band transponder for inter-spacecraft communications and 2-way ranging to measure the telescope-starshade separation distance (copy of direct to Earth transponder)
- CGI accommodations are primarily adding filters and a formation sensing algorithm



### **CGI Architecture and Starshade Accommodations**



