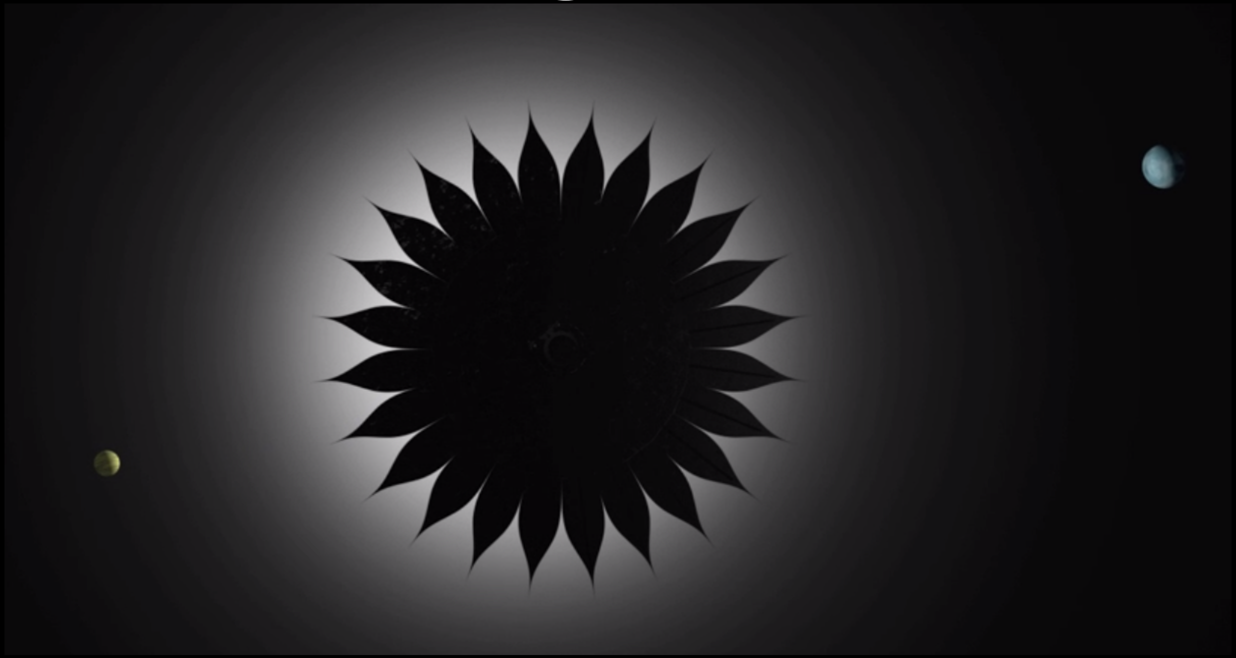
Probe STDT Progress - Starshade



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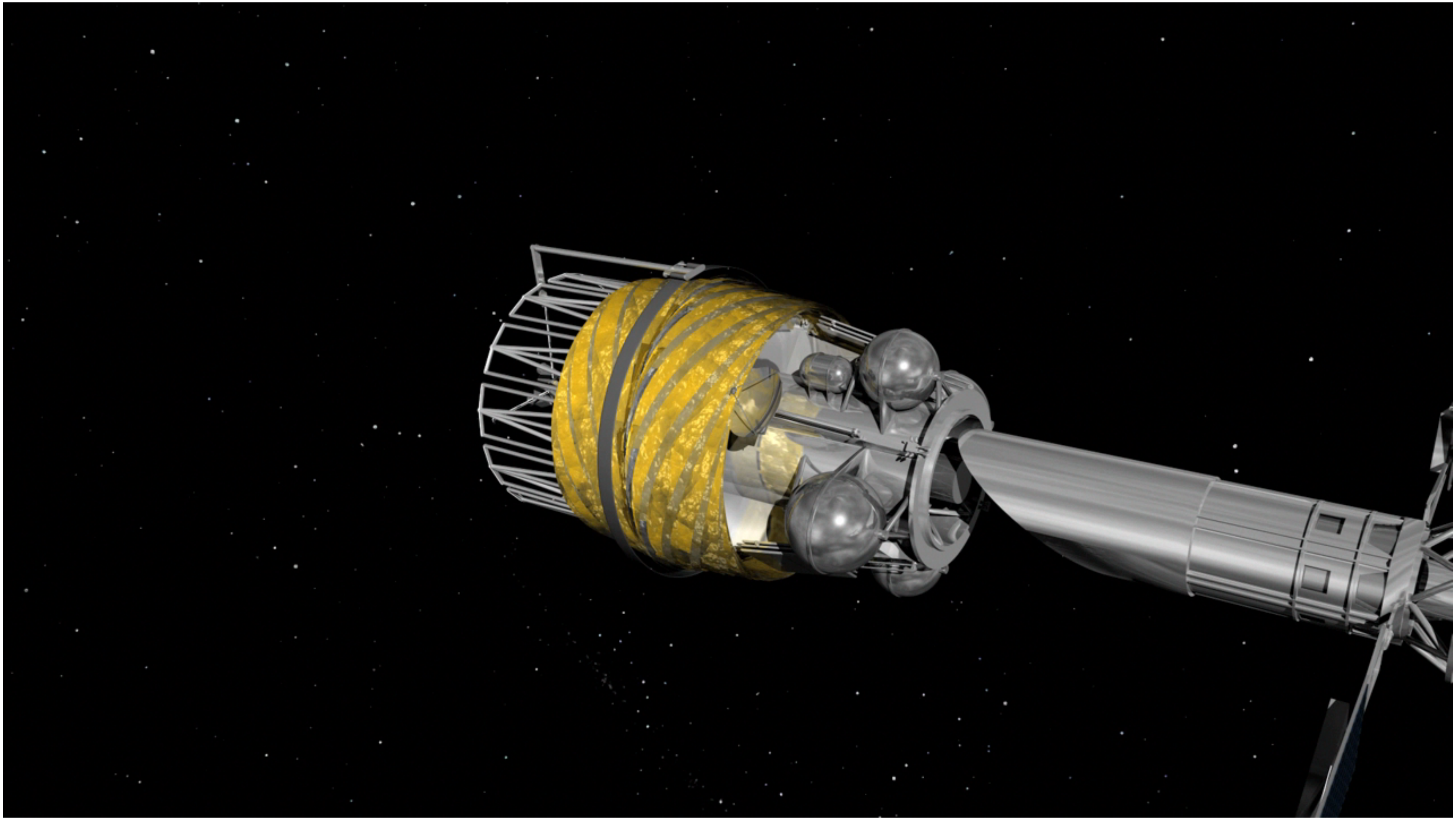
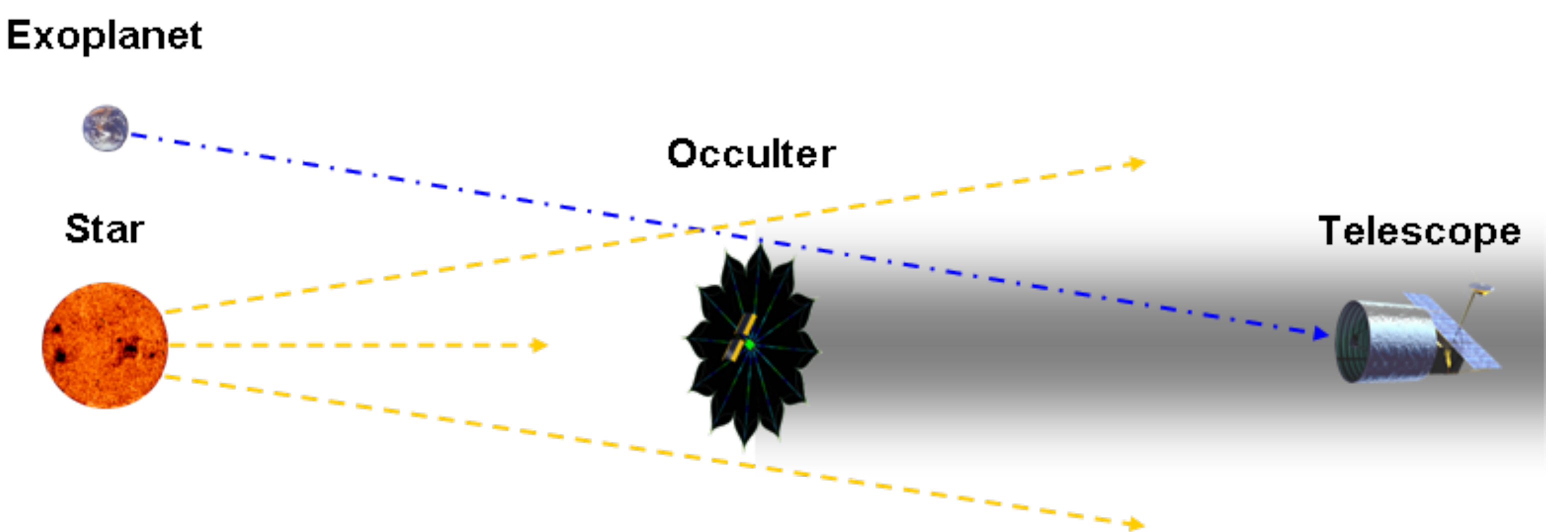
Design Team: D. Lisman, E. Cady, S. Martin, D. Webb (NASA JPL)

Starshade Introduction



Starshade Strengths

- Contrast and inner working angle is decoupled from the telescope aperture size
  - A “simple” space telescope can be used
  - No wavefront correction is needed
- No outer working angle



Starshade Strengths

- High quality telescope is not required
  - Segments and obstructions are not a problem
- High throughput, broad bandpass
- Inner working angle can be changed by altering the telescope-starshade separation
- 360 degree suppressed field of view
- No constraints on other astronomical instruments

Starshade Challenges

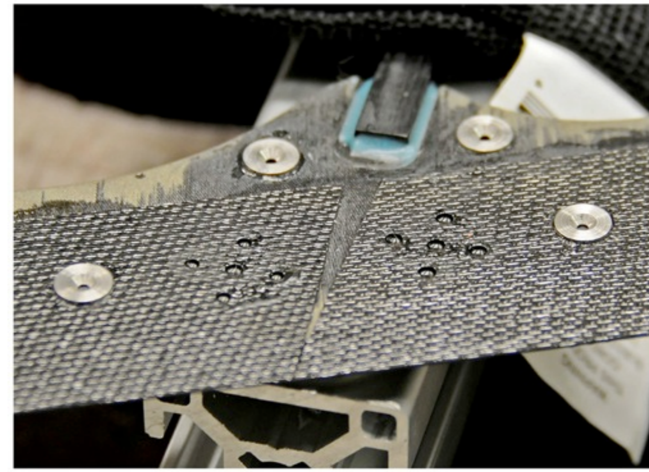
- Full scale end-to-end system test on the ground is not possible
  - Subscale lab and field tests are ongoing

T. Glassman / NGAS

- Limited number of starshade movements
- Long durations between observations while moving the starshade

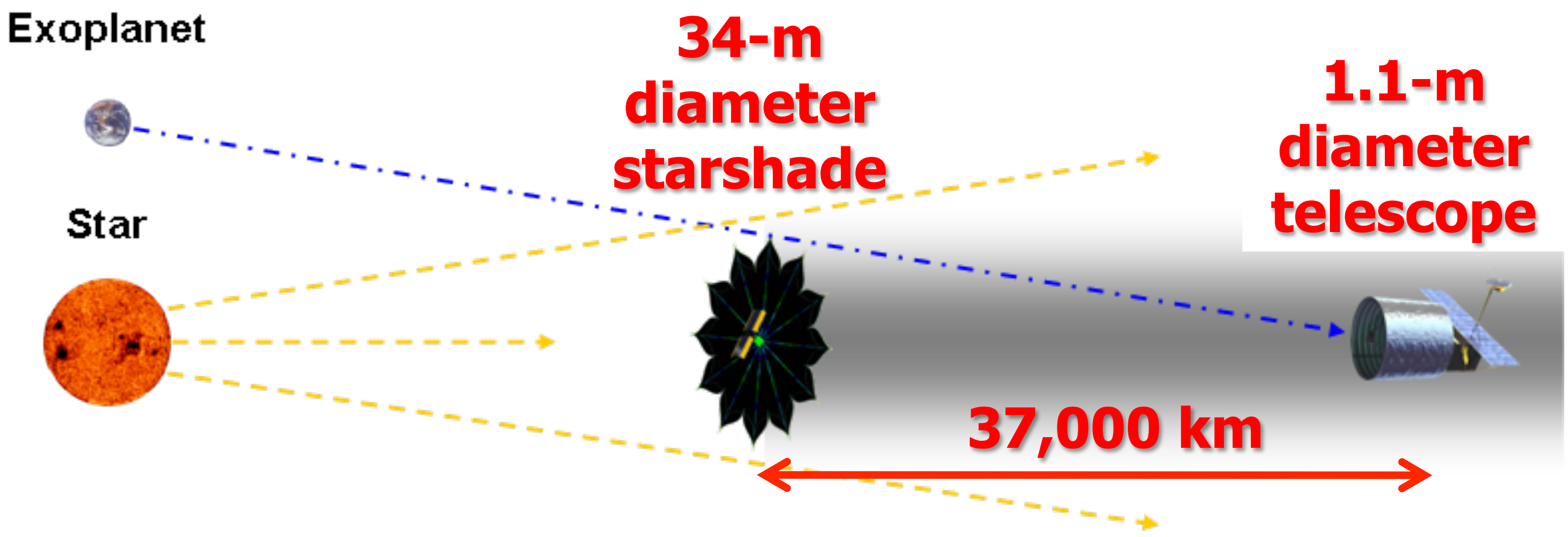
Starshade Challenges

- On orbit deployment of a large structure
- Precise edge profile (~ 50 µm tolerance) required over large structure
- Precise alignment between starshade and telescope (i.e., formation flying) to ± 1 meter tolerance
- Costing



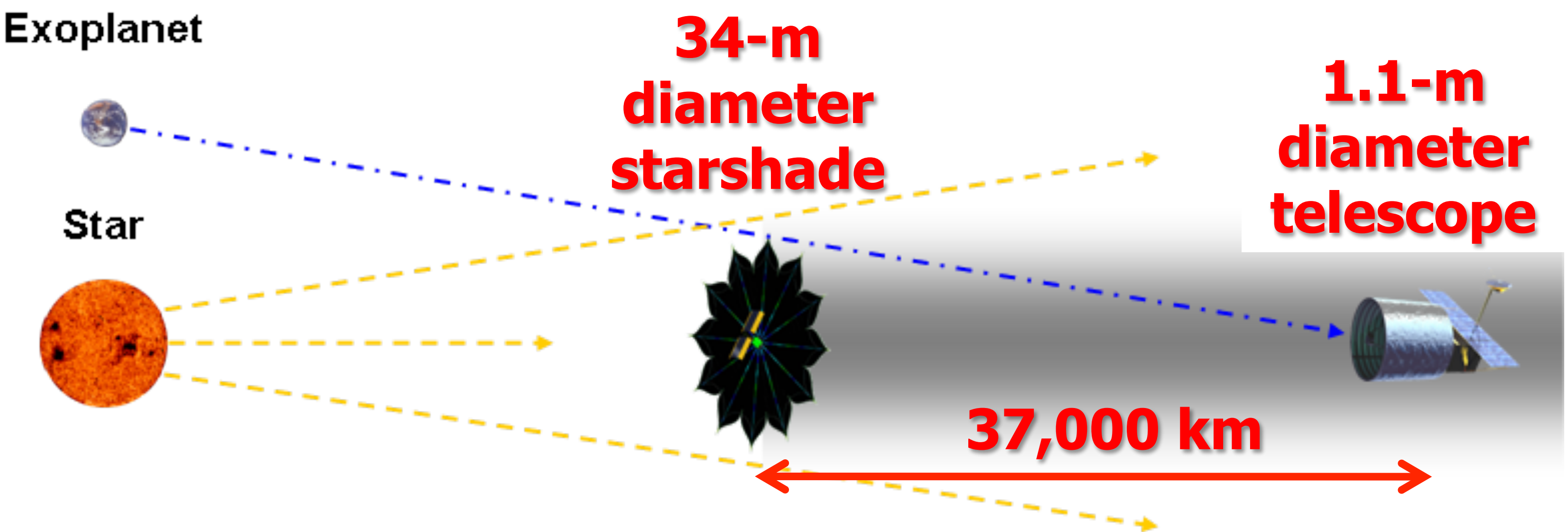
NASA / JPL / Princeton

Probe Baseline Design Specs



- Off-the-shelf on-axis optical telescope (1.1 m NextView)
- Earth-leading orbit
- Move telescope, not starshade for retargeting
- Instrumentation: imager and low resolution spectrograph

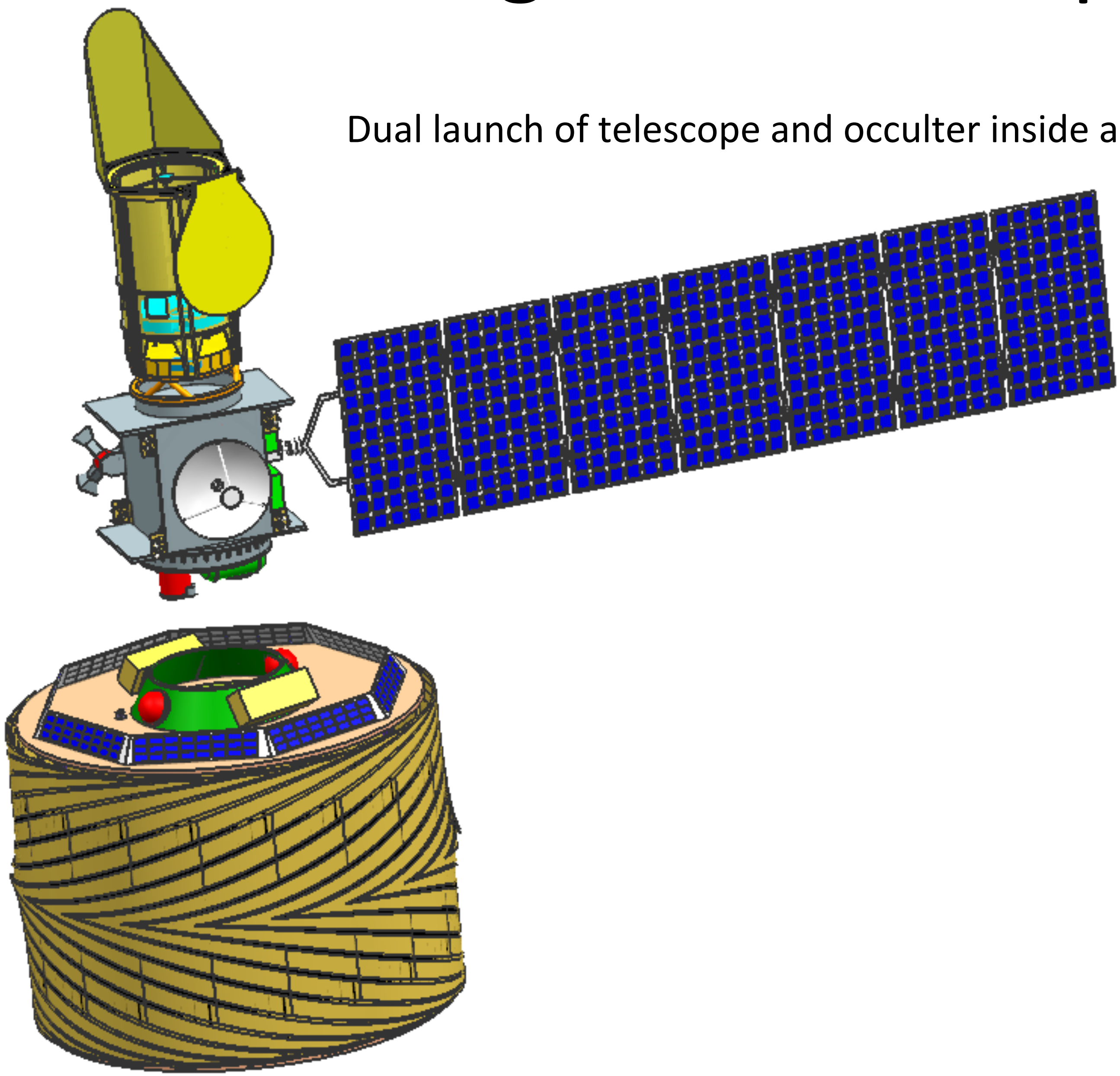
Probe Baseline Design Specs



- Primary operating mode
  - 500 – 850 nm bandpass
  - 95 milli-arcsecond inner working angle
  - Limiting fractional planet brightness ~ 9 x 10^{-11}
- Other bands with different IWAs for follow-up

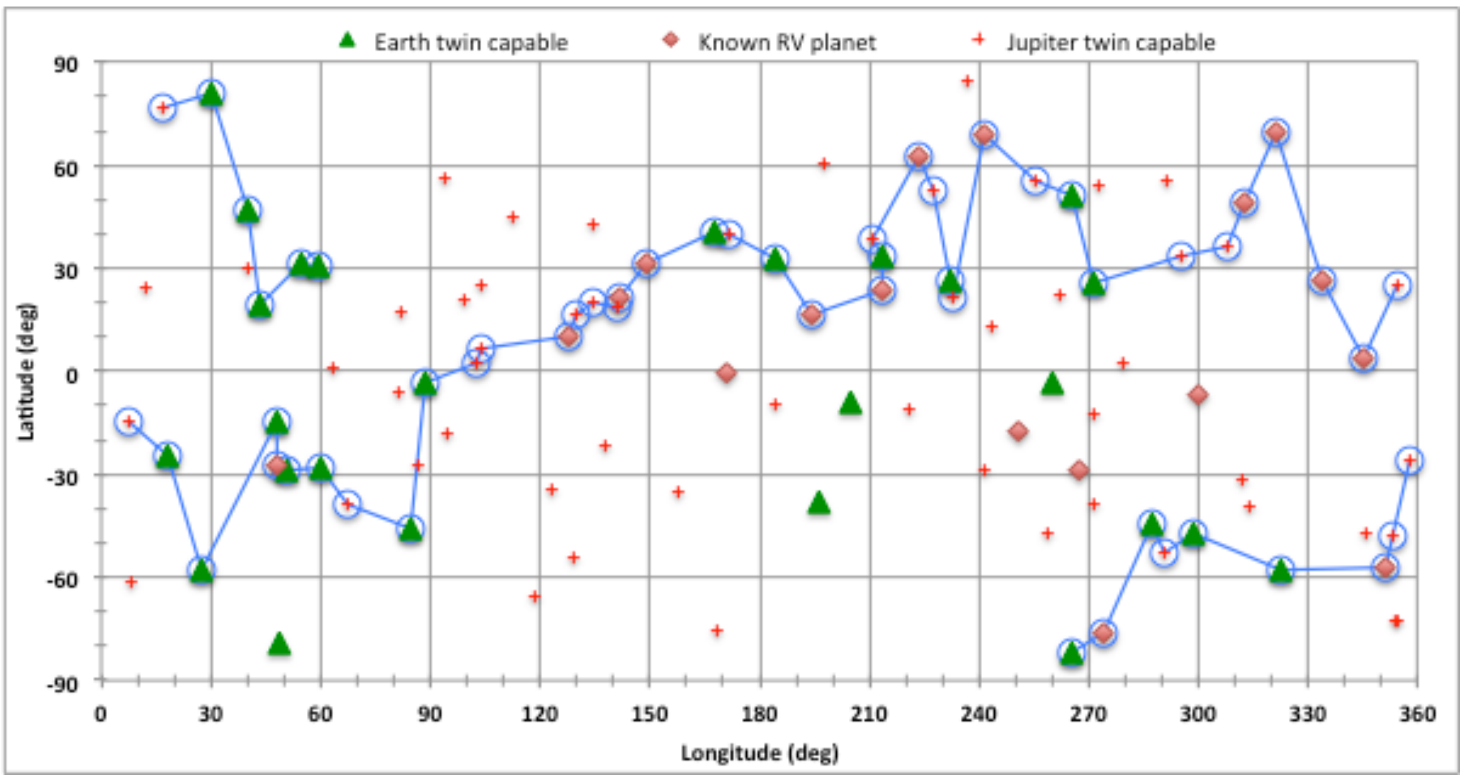
Configuration at Separation

Dual launch of telescope and occulter inside a Falcon-9



Preliminary Observing Strategy

- First 18 months in "reconnaissance mode"
  - Multi-color imaging only to find candidates
- Second 18 months for revisits and spectroscopy

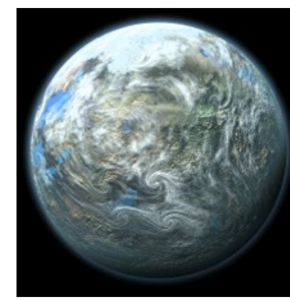


D. Lisman (NASA JPL)

Preliminary Science Yield Predictions

- In 18 months, observe 55 stars
  - Assuming 1 zodi of exozodi dust …
  - Can detect Jupiter-twins around all stars
  - 14 stars with detectable known giant planets from radial velocity surveys
  - Possibility of detecting Earth-analog exoplanets around 22 stars

NASA



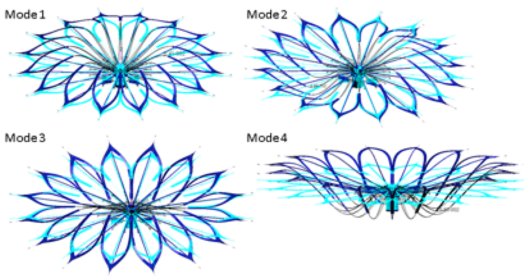
L. Cook

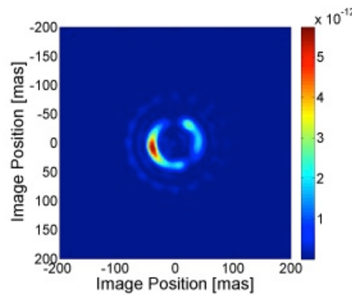
- Remainder of mission for revisits, follow-up spectroscopy, potentially disk observations

Technology Demonstrations

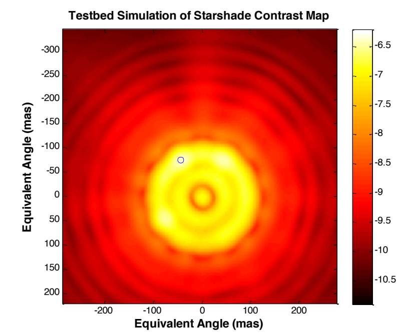
Performance Modeling and Testing

Optical models with distortions





0.1% scale lab testing



~ 1% scale field testing

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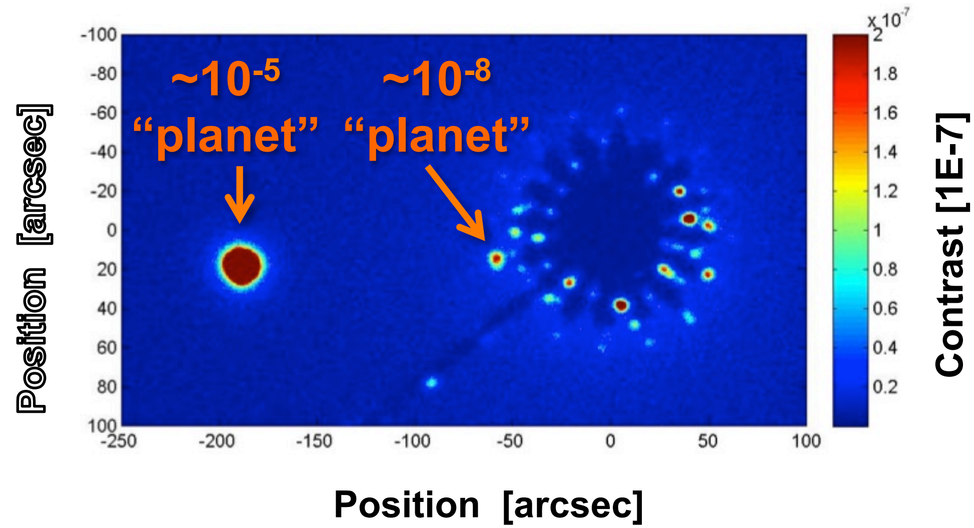
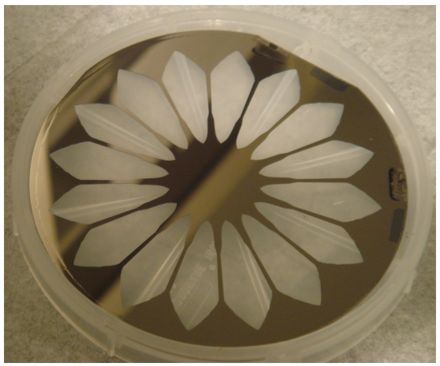
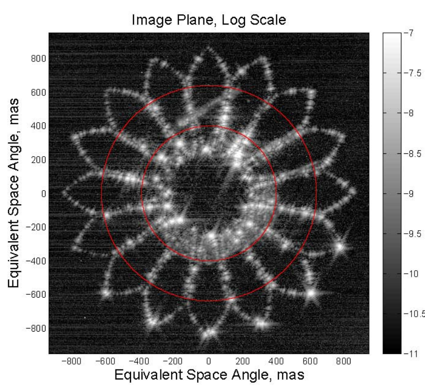


Technology Demonstrations

Precision petal manufacturing

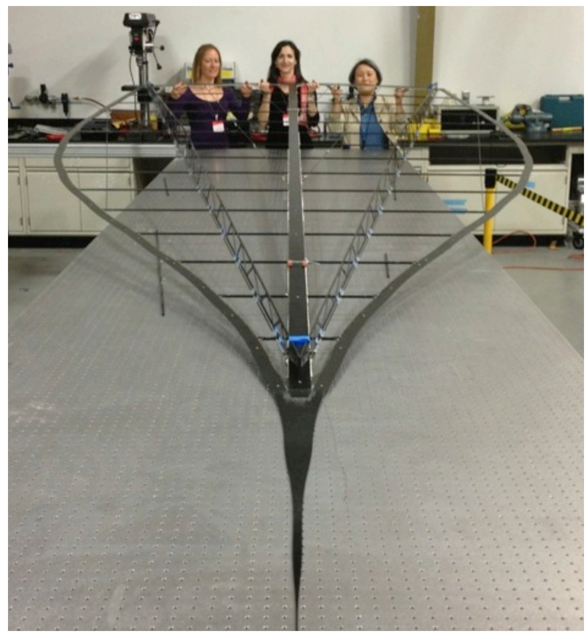
Sub-scale full starshade





Sirbu, Kasdin, & Vanderbei 2013

Full-scale petal with required edge profile

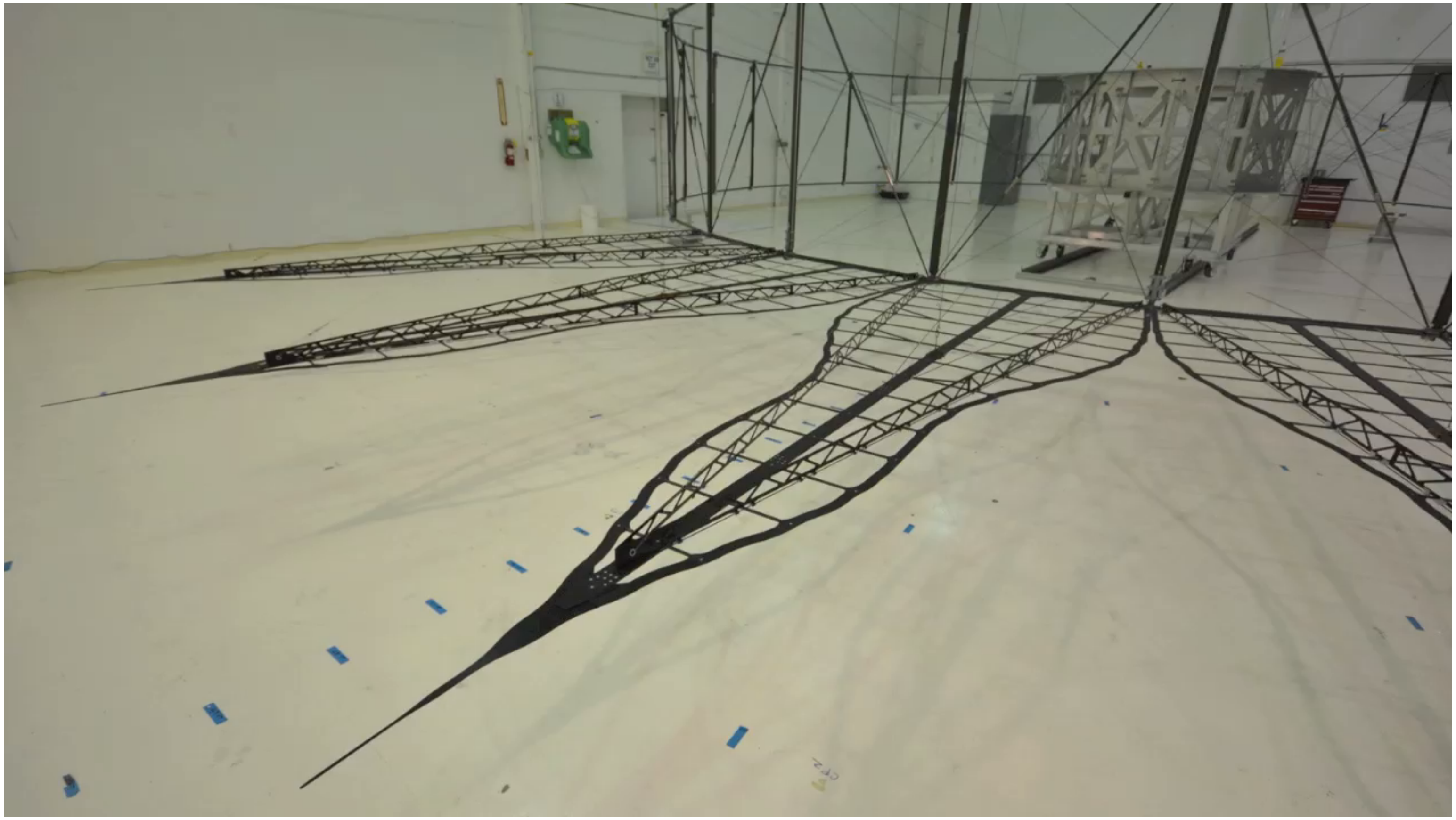


D. Lisman

- Development of knife-edge to control edge scatter underway

Technology Demonstrations

Starshade stowage and deployment



http://www.youtube.com/watch?v=G68sqgRhP2E

STDT Next Steps

- Baseline Probe Design
  - Refine Design Reference Mission and science yield simulations
  - Complete trades for the baseline design of starshade + occulter system
- "Starshade Ready" Design
  - Starshade design for a future or existing telescope (e.g., NRO/AFTA)
  - Starshade readiness of telescope
- Technology Development
  - Priorities recommended by STDT
  - Technology development will continue by the community through competed NASA technology programs; some STDT members participating