



**Jet Propulsion Laboratory**  
California Institute of Technology

**AbSciCon**

**Bellevue, WA, June 25, 2019**

# Technology Activities for the Search for Life on Exoplanets

Nick Siegler

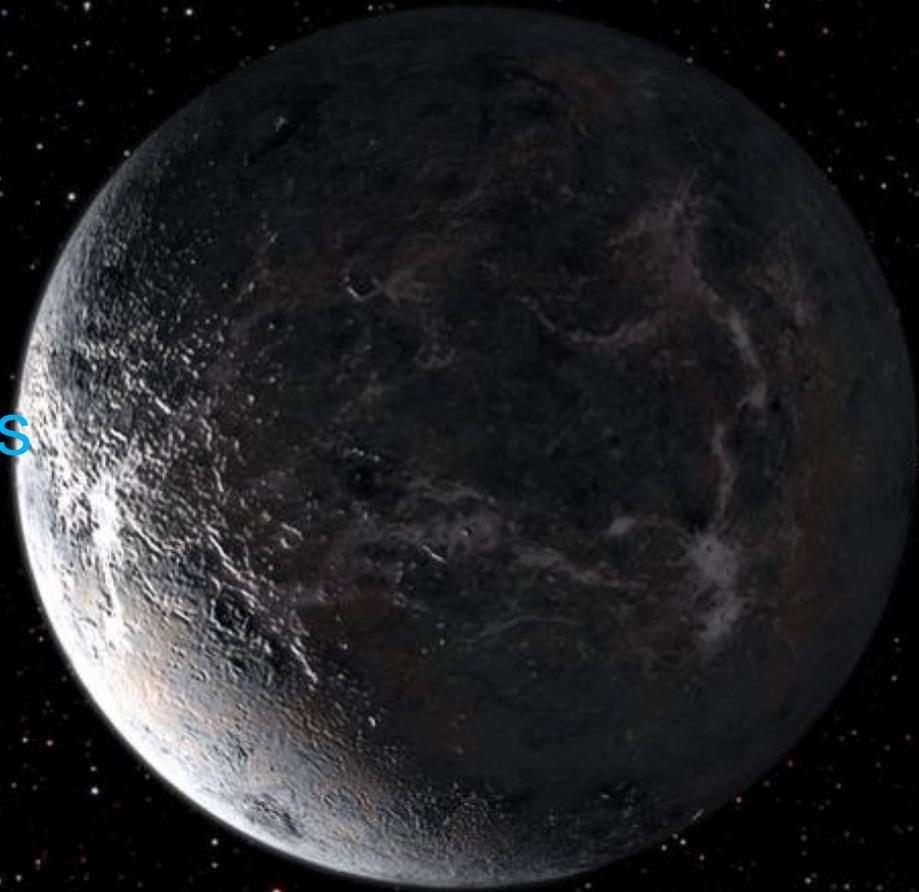
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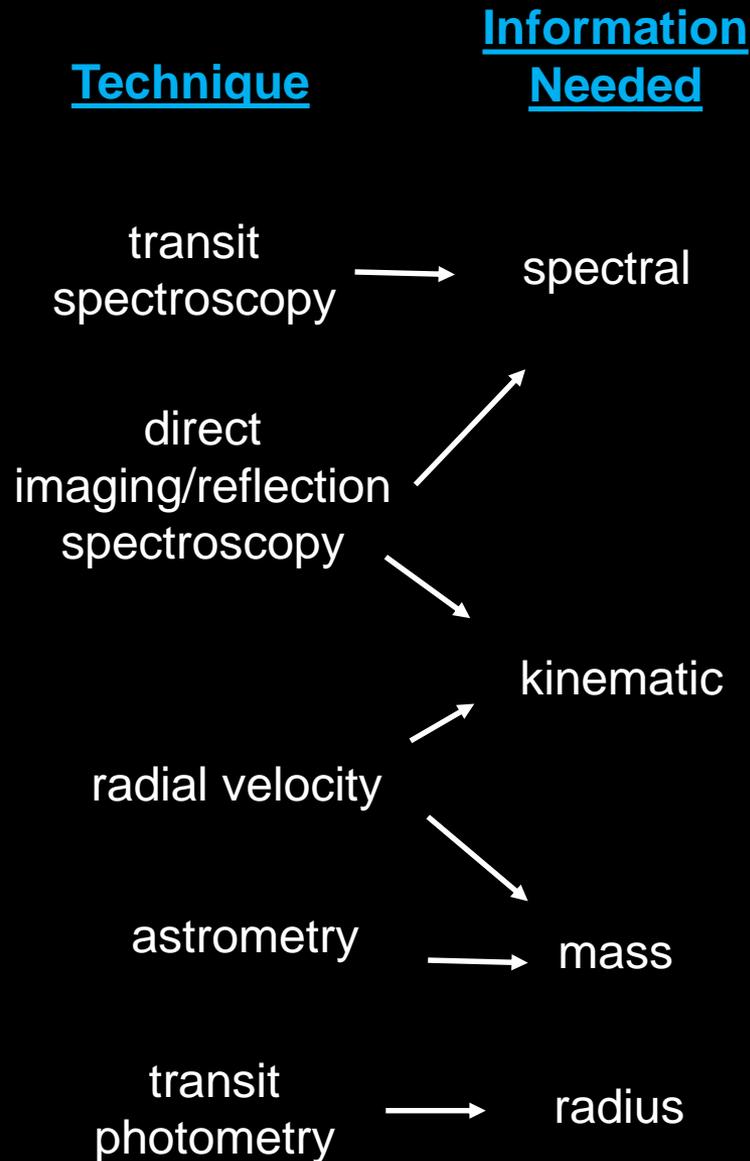
Jet Propulsion Laboratory – California Institute of Technology



This work was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

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# The Key Evidence for Life on Earth-Size Planets



# The Key Evidence for Life on Earth-Size Planets Around Sun-Like Stars

Key Technology

Technique

Information Needed

starlight  
suppression

transit  
spectroscopy

spectral

direct  
imaging/reflection  
spectroscopy

kinematic

extreme  
precision radial  
velocity

radial velocity

mass

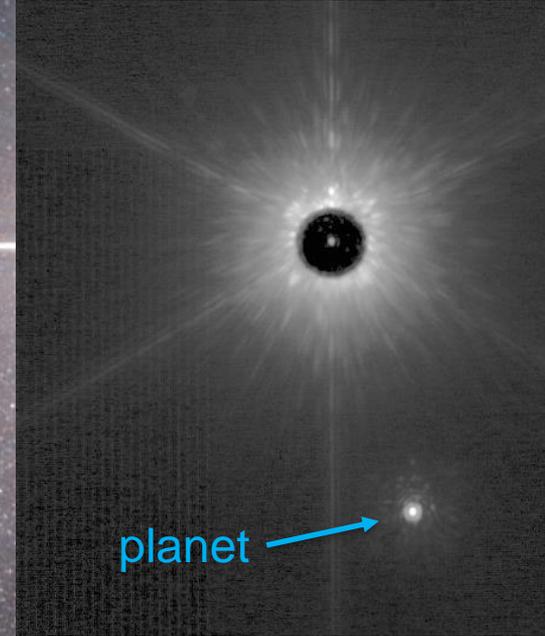
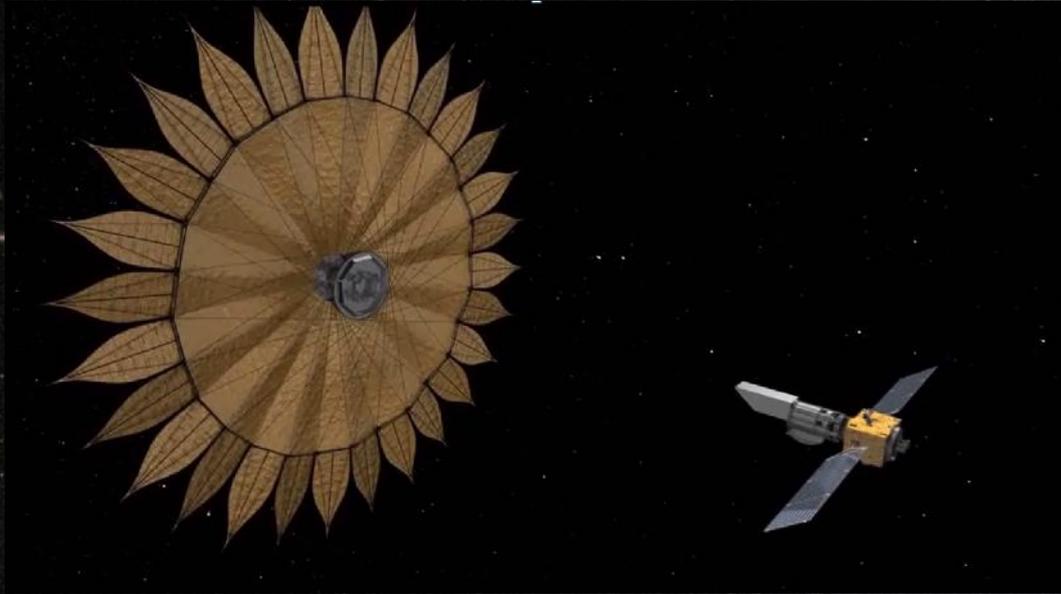
astrometry

transit  
photometry

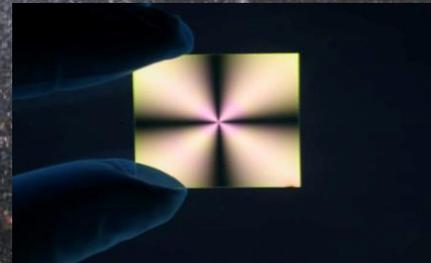
radius

# Starlight Suppression (at visible wavelengths)

## External Occulters (Starshades)

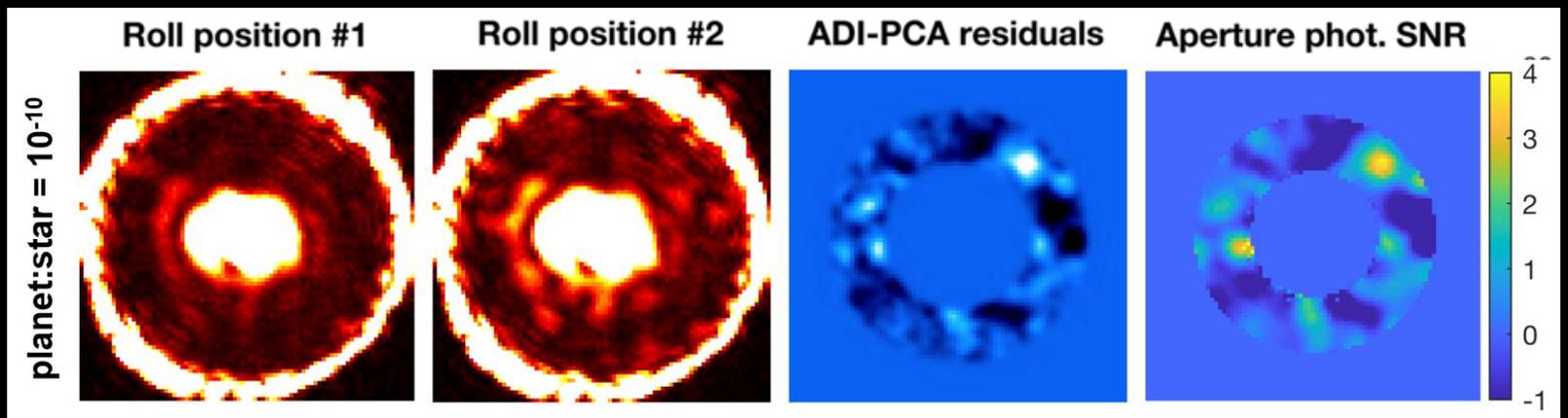
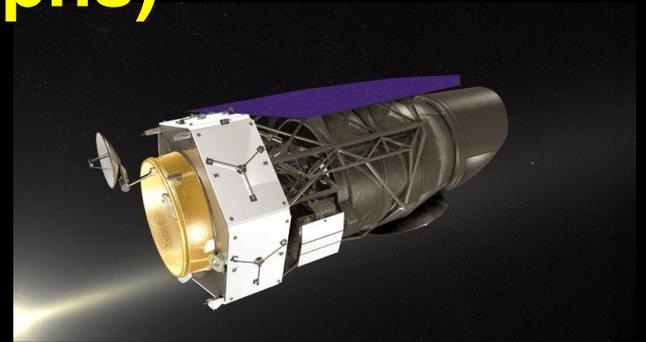


## Internal Occulters (Coronagraphs)



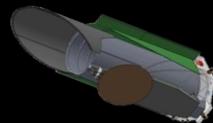
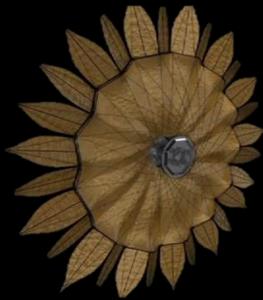
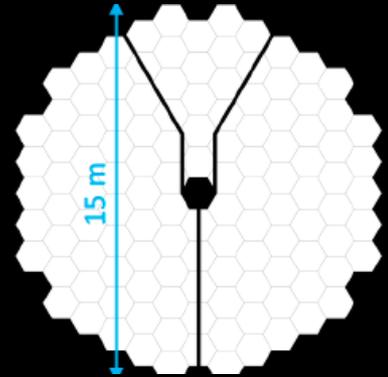
# Internal Occulters (Coronagraphs)

- WFIRST's Coronagraph Instrument
- NASA's competitive grant programs
  - Strategic Astrophysics Program (9 active)
  - Astrophysics Research and Analysis (8 active)
- New ExEP coronagraph testbeds
  - $3.8 \times 10^{-10}$  contrast at 550 nm, 10% bandpass



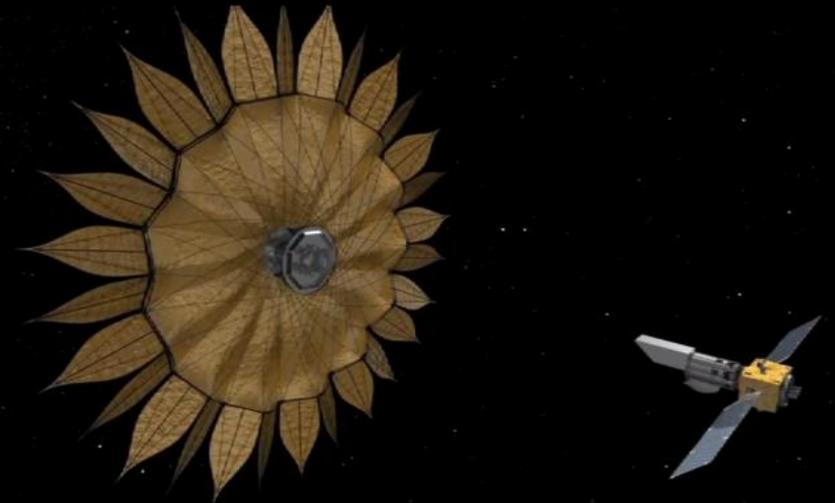
# Internal Occulters (Coronagraphs)

- Design study for segmented telescopes
  - Three candidate coronagraph designs
  - New result: 10-20 pm rms wavefront error stability required for segment-segment errors
- Systems-level segmented telescope design studies
  - Competitive industry grants
- Mission concept studies (HabEx and LUVOIR)



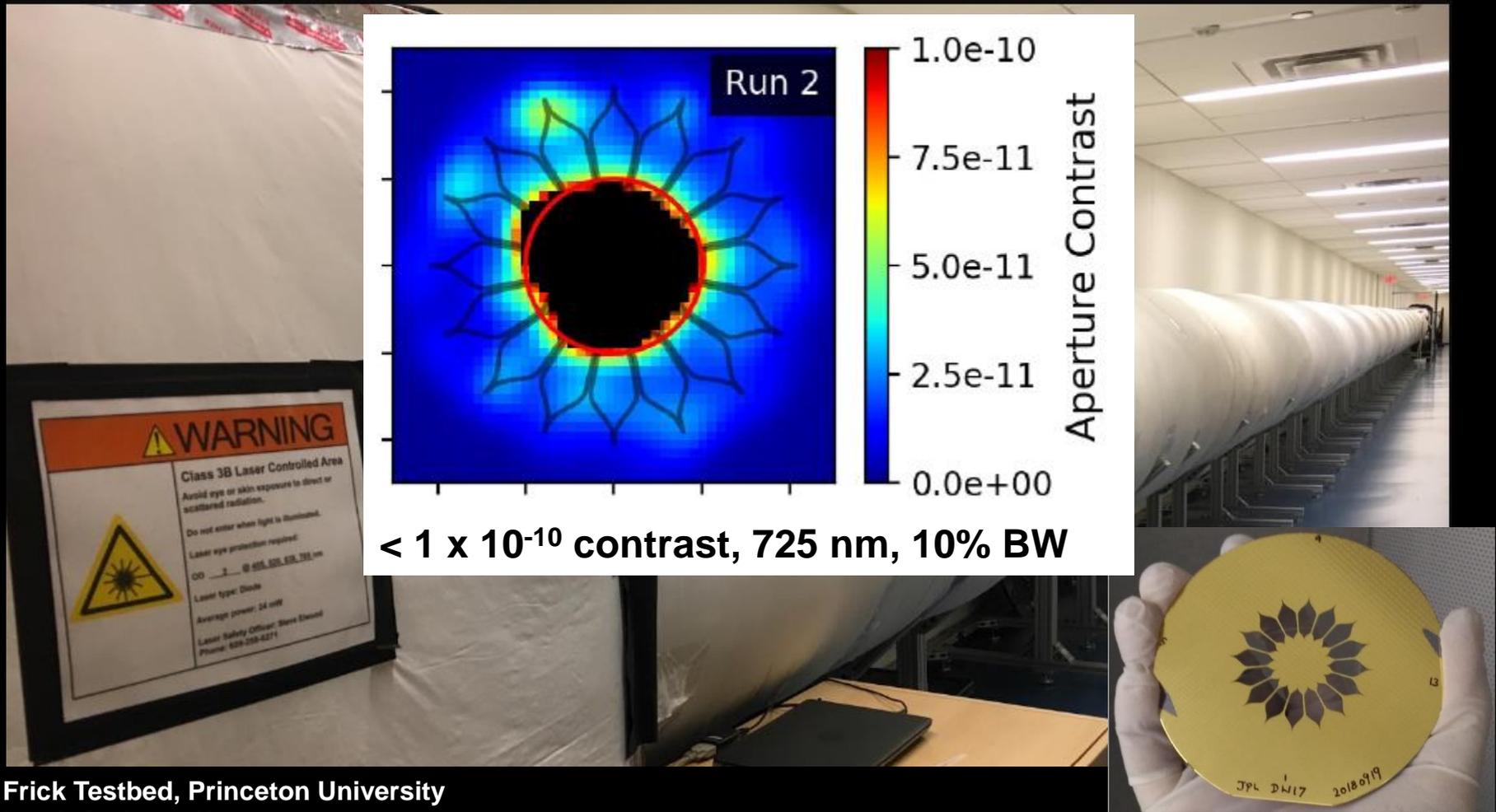
# External Occulters (Starshades)

- Mission concept studies (HabEx and WFIRST Rendezvous)
- NASA's technology development activity (S5)
  - Progress on formation flying
  - Progress on optical demonstration
  - Progress on mechanical deployment and stability



# External Occulters (Starshades)

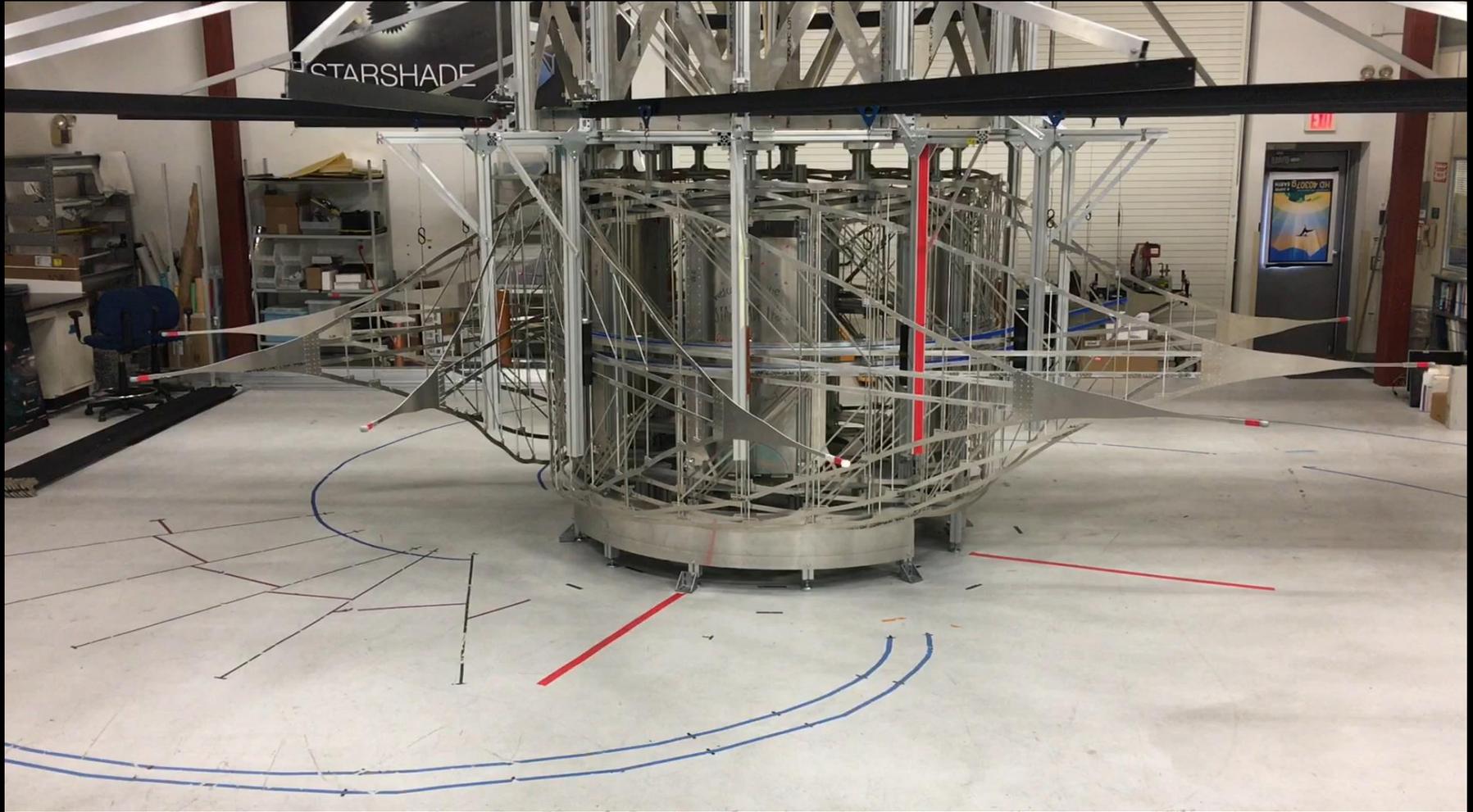
Progress on optical demonstration



Frick Testbed, Princeton University  
Lead: Anthony Harness

# Petal Unfurling

10 m prototype



Tendeg/NASA/JPL-Caltech

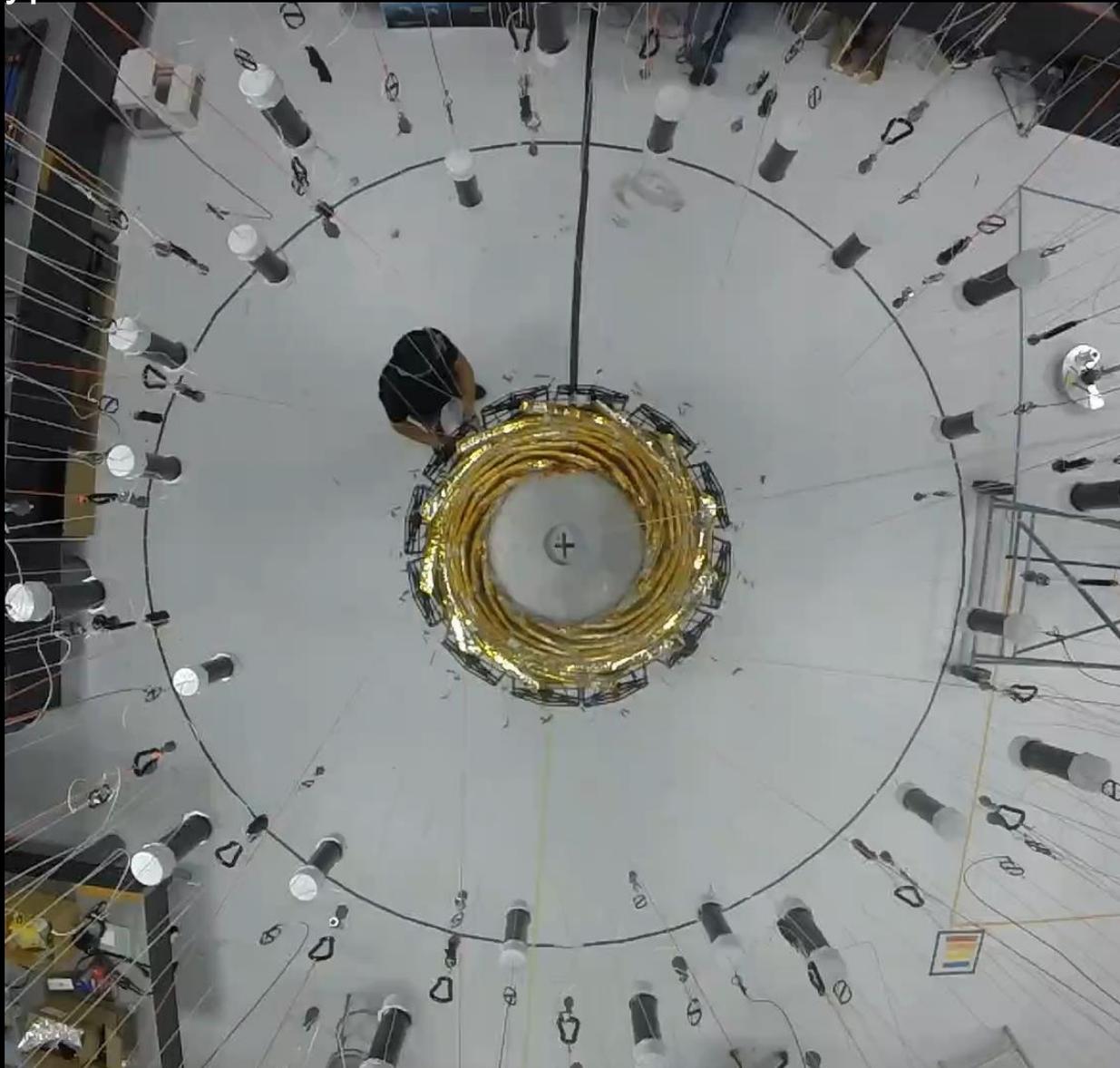
# Inner Disk Deploying

10 m prototype



# Optical Shield Deployment

5 m prototype

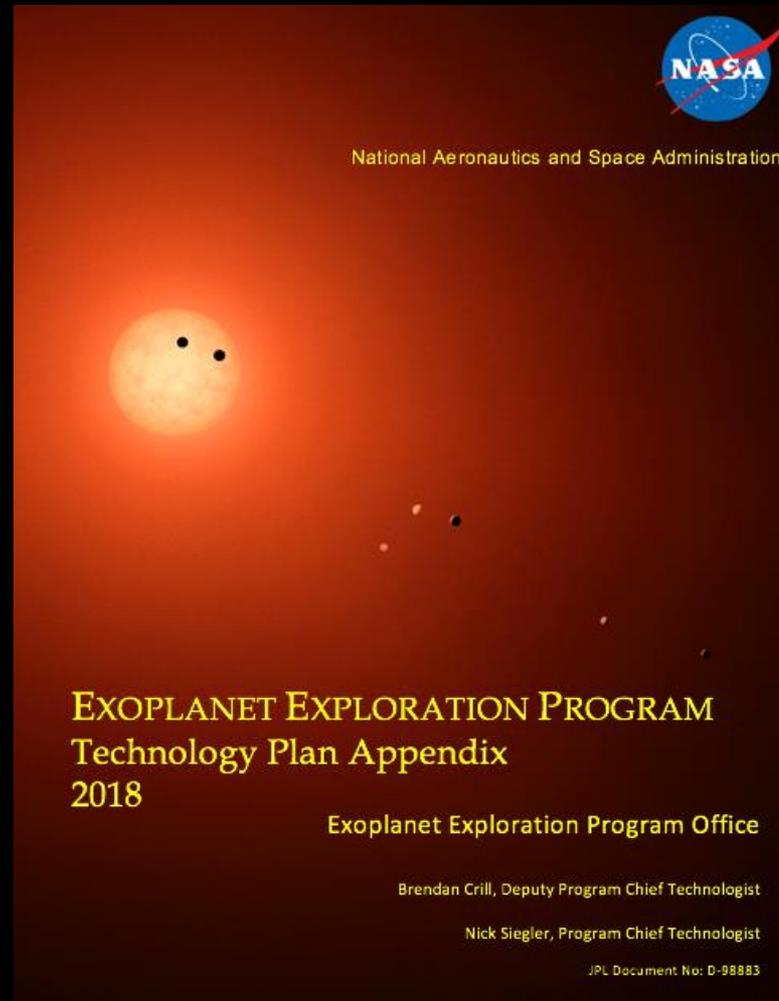


# Extreme Precision Radial Velocity (EPRV)

Measuring exoplanet masses

- For Earth-sized planets around Sun-like stars, need sensitivity to ~ 10 cm/s
  - State of Art is currently ~ 100 cm/s
  - NEID instrument at the WYNN telescope < 50 cm/s (commissioning expected in 2019)
- Many natural challenges that exceed the 10 cm/s goal
  - Star's activity and telluric contamination
- New EPRV initiative to develop a plan to reach the 10 cm/s goal.
  - Recommendations in Spring 2020

Please visit the NASA ExEP website for more details



<https://exoplanets.nasa.gov/exep/>