SCIENTIFIC OPPORTUNITIES WITH A STARSHADE WORKING WITH A 2.4 METER TELESCOPE AT L2

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Exoplanet Probe – Starshade (EXO-S)

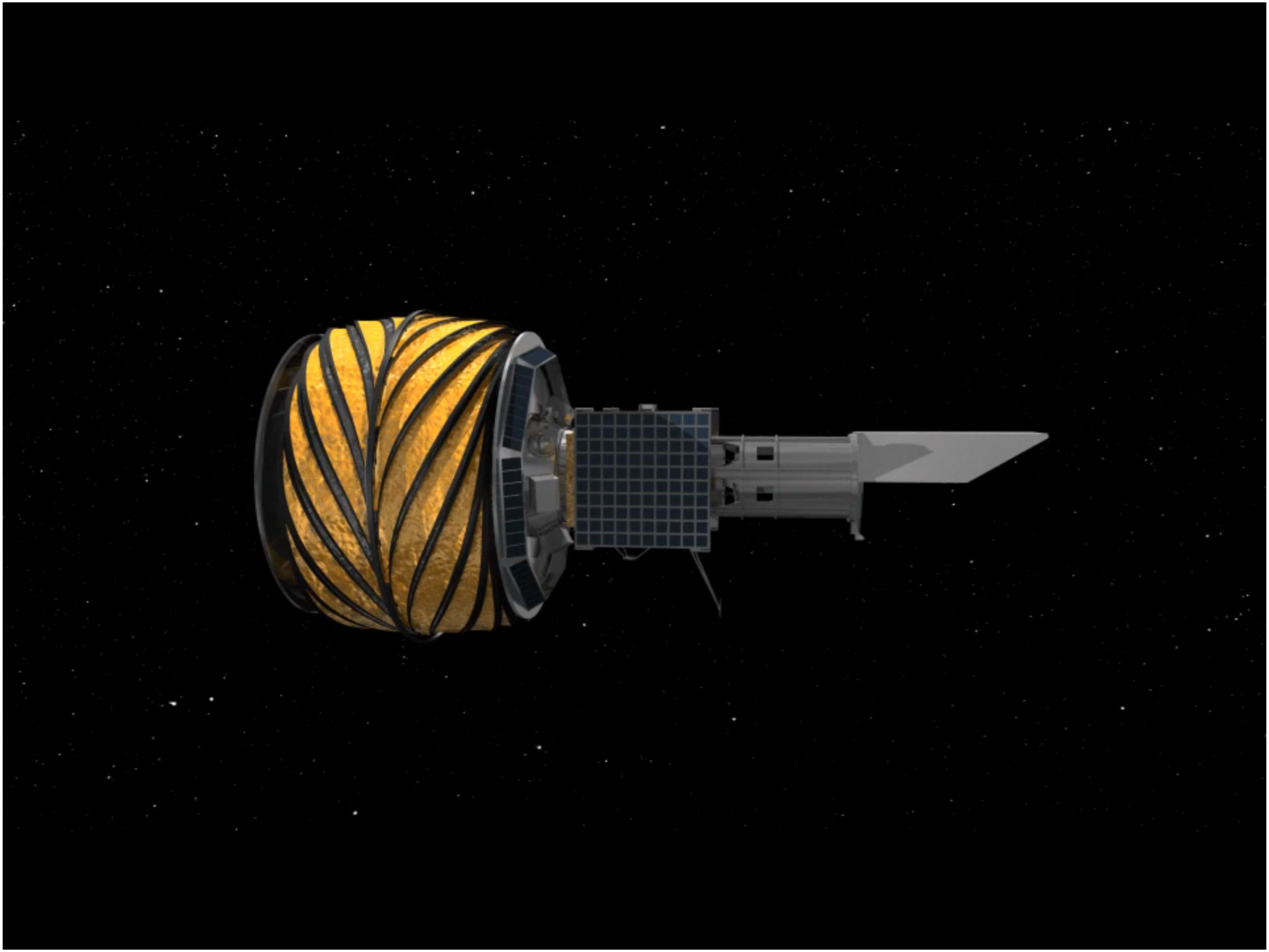
Science & Technology Definition Team

- Sara Seager (MIT – chair)
- Maggie Turnbull (GSI)
- N. Jeremy Kasdin (Princeton)
- Bill Sparks (STScI)
- Shawn Domagal-Goldman, Marc Kuchner, Aki Roberge (GSFC)
- Web Cash (Colorado)
- Stuart Shaklan, Mark Thomson (JPL)

JPL Design Team

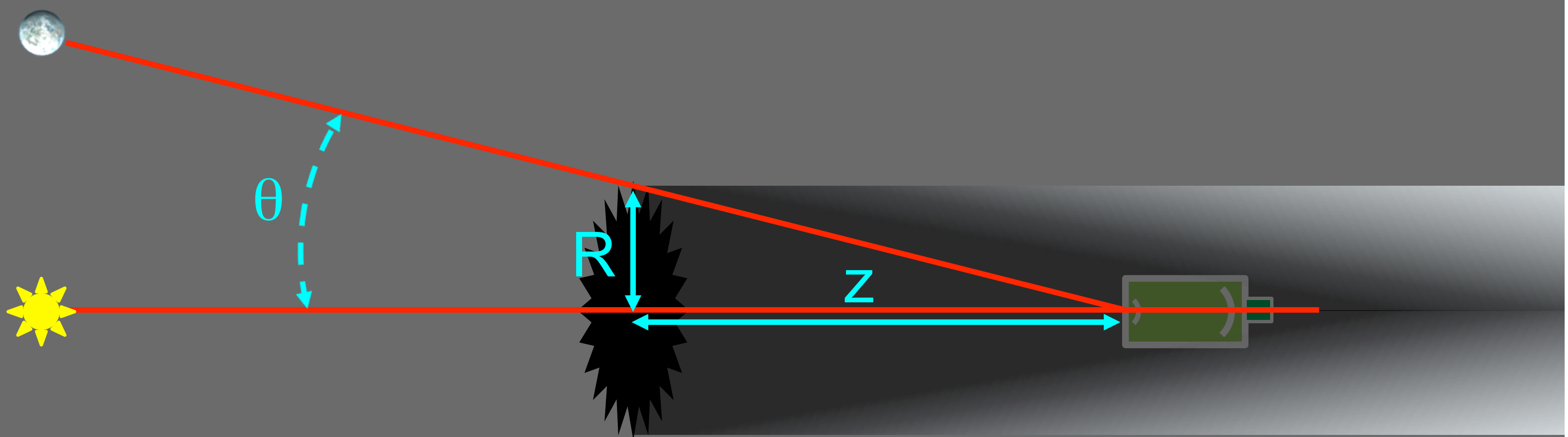
- Keith Warfield (lead)
- Doug Lisman
- Rachel Trabert
- Stefan Martin
- Eric Cady
- David Webb
- Brian Lim
- Cate Heneghan

- Investigating concepts for relatively low-cost missions
- Largely informational studies. No current opportunity to actually execute probe missions



Starshade strengths

- Contrast and inner working angle decoupled from telescope aperture size



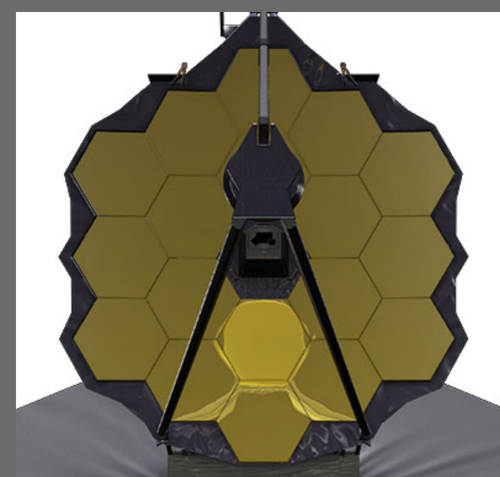
IWA ~ angle to edge of starshade

$$\theta \sim R / z$$

Starshade strengths

W. Cash (Colorado)

- No outer working angle
- 360 degree suppression
- Broad bandpass, high throughput
- High quality telescope not required
  - Segments & obstructions not a problem
  - Wavefront correction unnecessary



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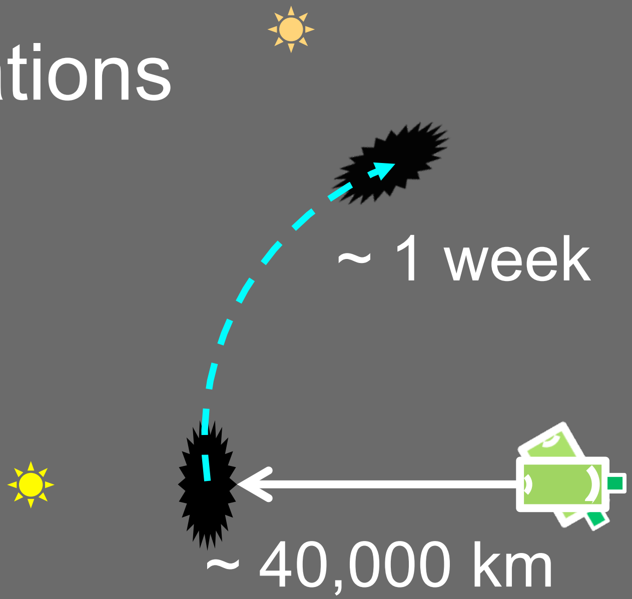
Starshade drawbacks

- Full-scale end-to-end optical test on ground not possible
  - Sub-scale lab and field tests possible (more tomorrow)

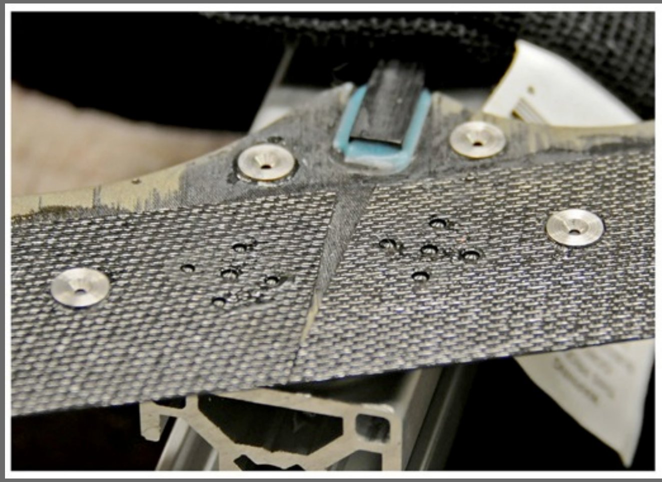
T. Glassman / NGAS

- Long times between observations
- Limited number of starshade movements
- Can't be in Earth orbit



Technical challenges

- Precise edge profile (~ 50 μm tolerance) required over large structure
- Knife-edge to limit sunlight scattering into telescope
- On-orbit deployment of large structure
- Precise lateral alignment between starshade and telescope needed (± 1 meter)



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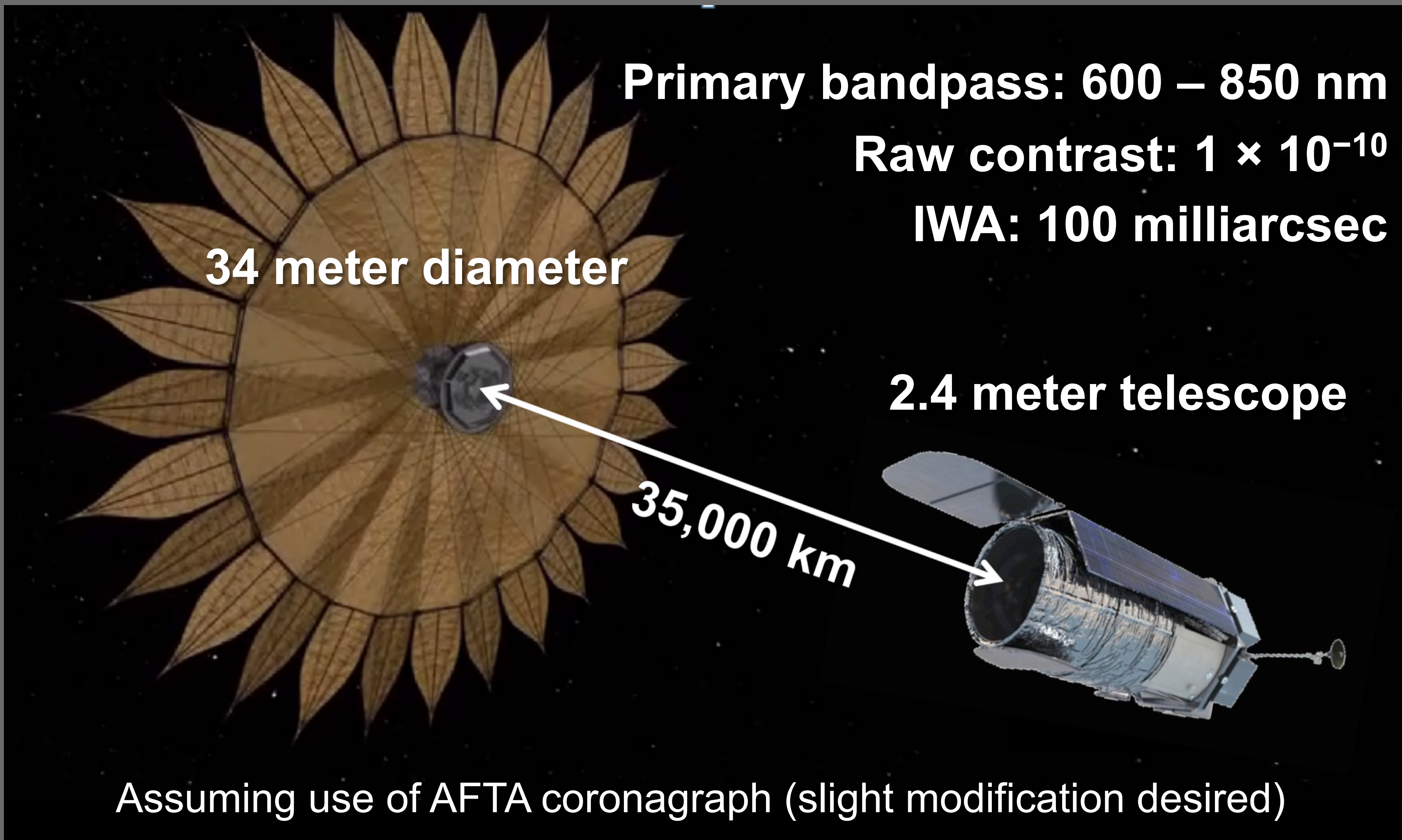
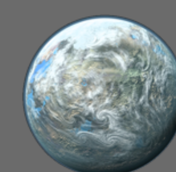
Starshade for a 2.4 meter

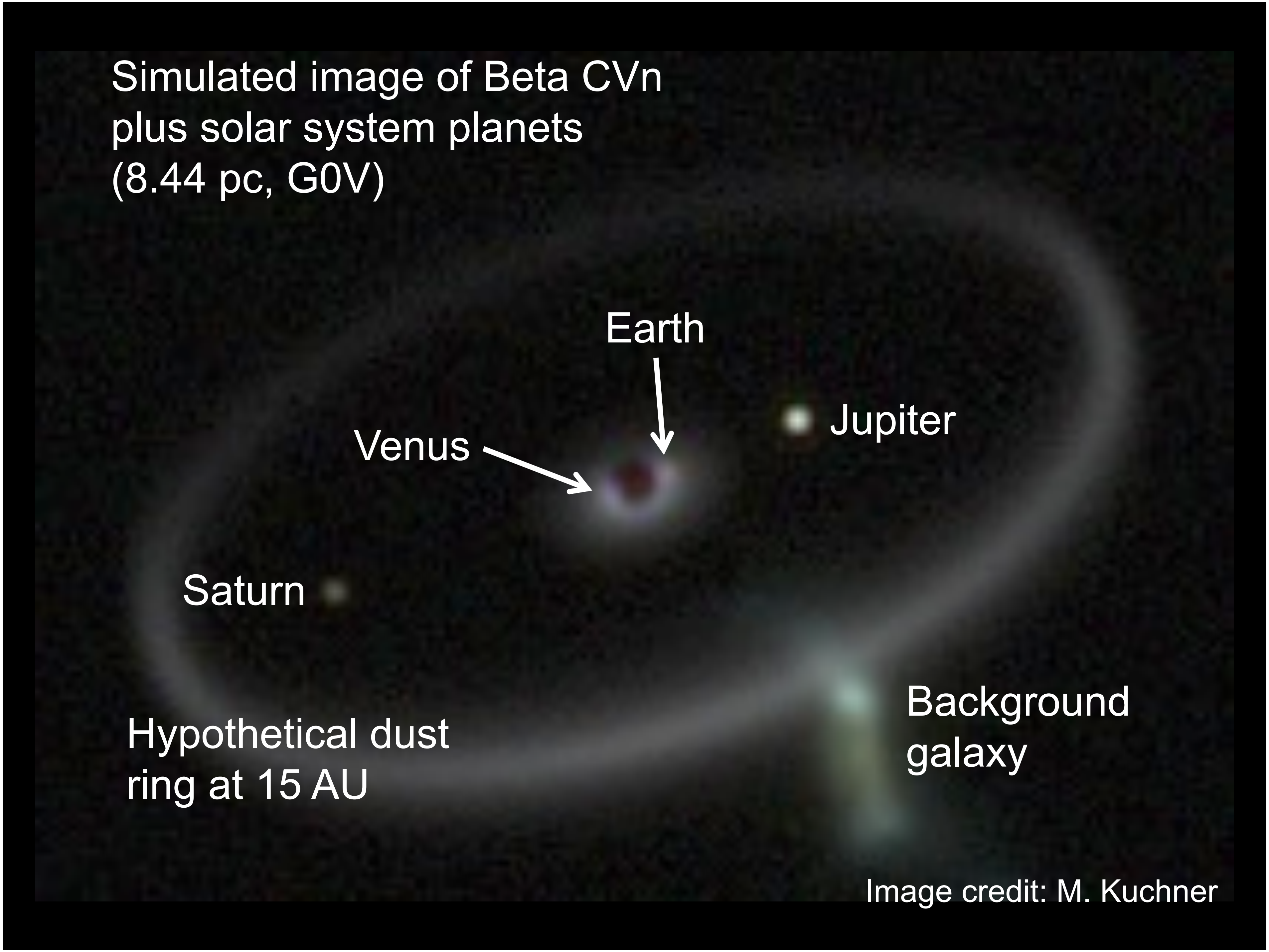


Preliminary science performance

- Current strategy (not yet optimized)
  - Target known exoplanets (from RV) at right times to measure masses. R = 70 spectroscopy.
  - Fill in w/ blind search targets, minimizing fuel use & prioritizing hab. zones. R ~ 10 spectroscopy.
- Observe 52 stars in 2 years



  - 13 known exoplanets
  - 19 HZ targets. Expect ~ 2 Earths or Super-Earths
  - Can detect sub-Neptunes to Jupiters around all HZ targets and 20 additional stars


Simulated image of Beta CVn
plus solar system planets
(8.44 pc, G0V)
Earth
Jupiter
Venus
Saturn
Background
galaxy
Hypothetical dust
ring at 15 AU
Image credit: M. Kuchner

Questions for the community

- Would interleaving starshade observations affect WFIRST primary science goals?
  - Wide field instrument can operate while the starshade is moving and while it's being used
- How to prioritize spectroscopy of known giant exoplanets?
  - Valuable guaranteed science, but constrain observing schedule

More info

EXO-S Interim Report, http://exep.jpl.nasa.gov/stdt/Exo-S_InterimReport.pdf

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