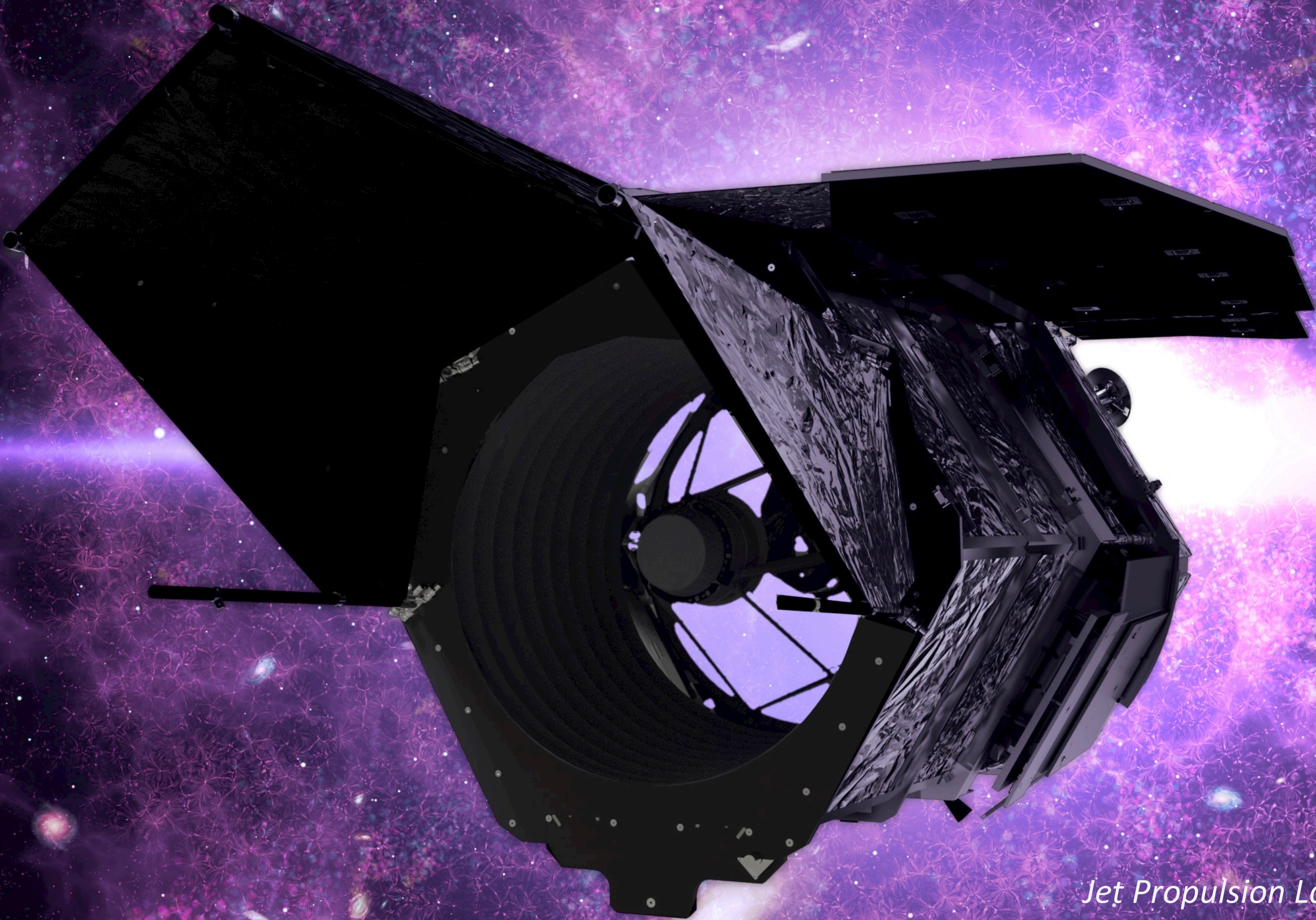
Coronagraph Instrument Overview



Vanessa Bailey

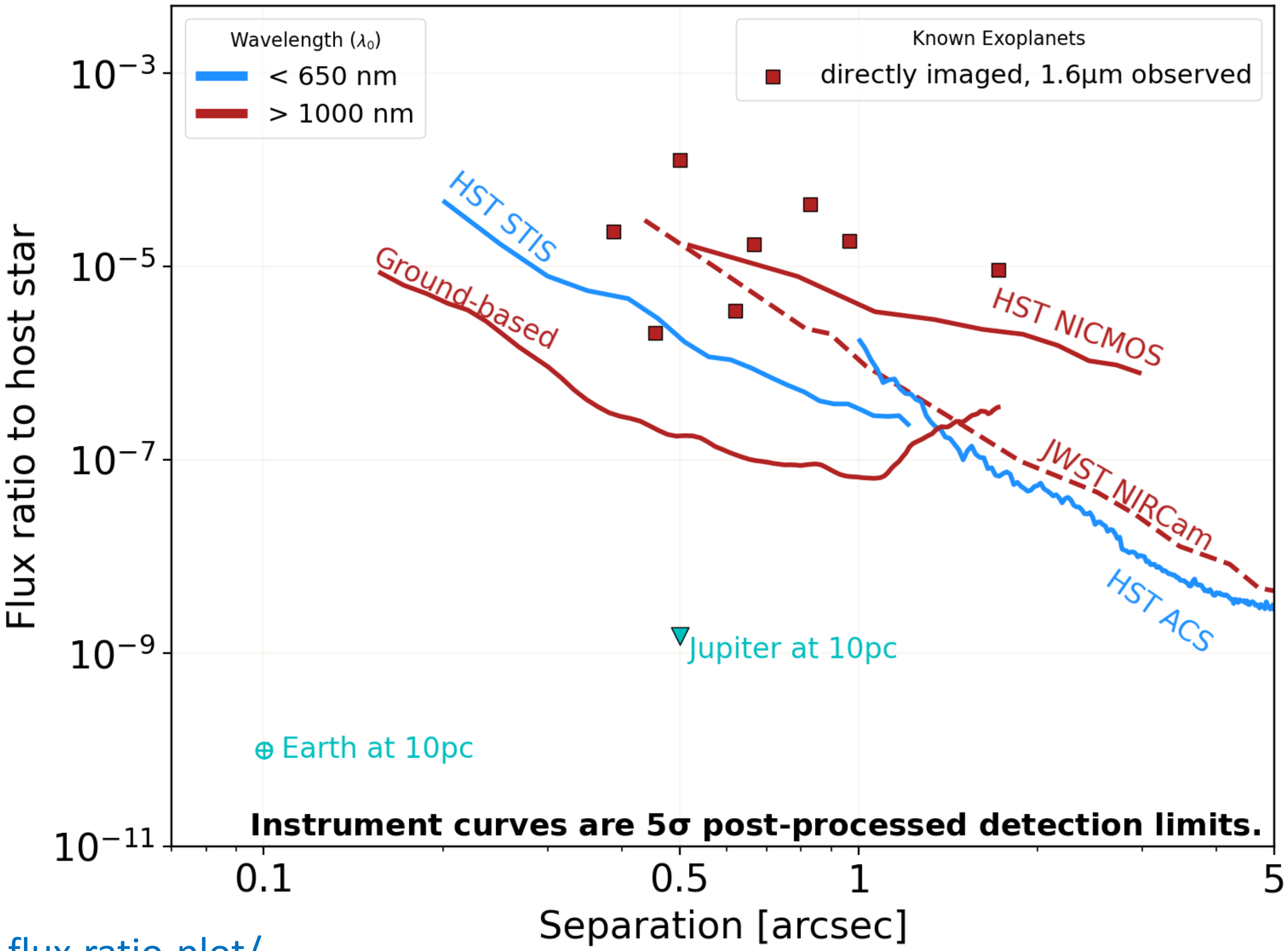
Jet Propulsion Laboratory, California Institute of Technology

AAS Roman Town Hall
Jan 15, 2021

What do we need to find a Solar System twin?

planetary system architecture like our own, around a Sun-like star

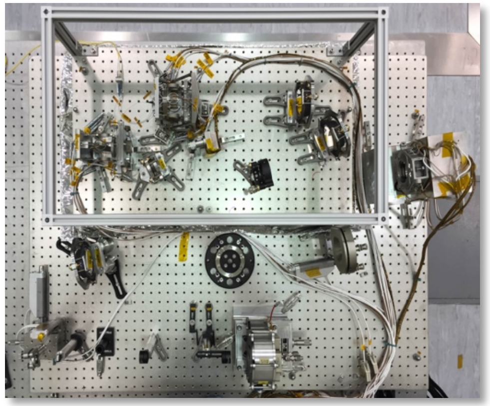
Goal: bridge the gap between massive self-luminous planets (IR) and reflected light exo-Earths (visible)



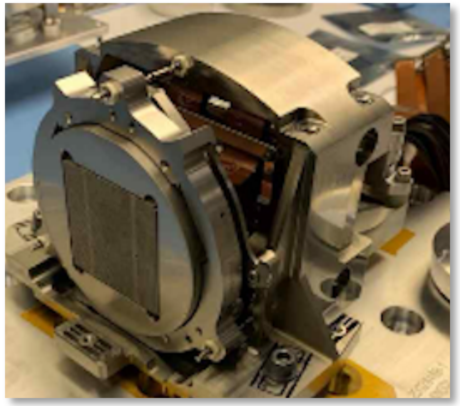
github.com/nasavbailey/DI-flux-ratio-plot/

CGI will demonstrate **key technologies** for future missions

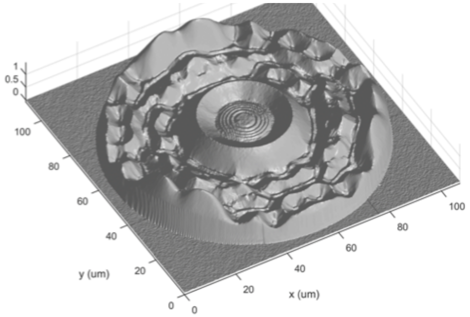
Ultra-Precise Wavefront Sensing & Control (now Ground-In-The-Loop)



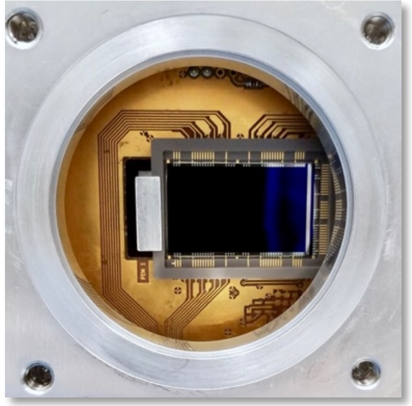
Large-format Deformable Mirrors



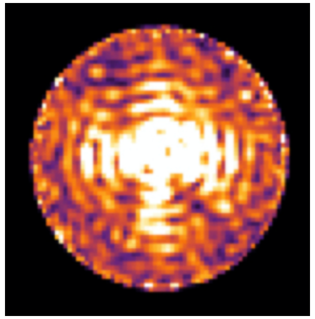
High-contrast Coronagraph Masks

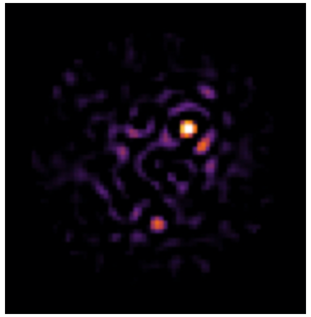


Ultra-low-noise Photon-counting EMCCDs



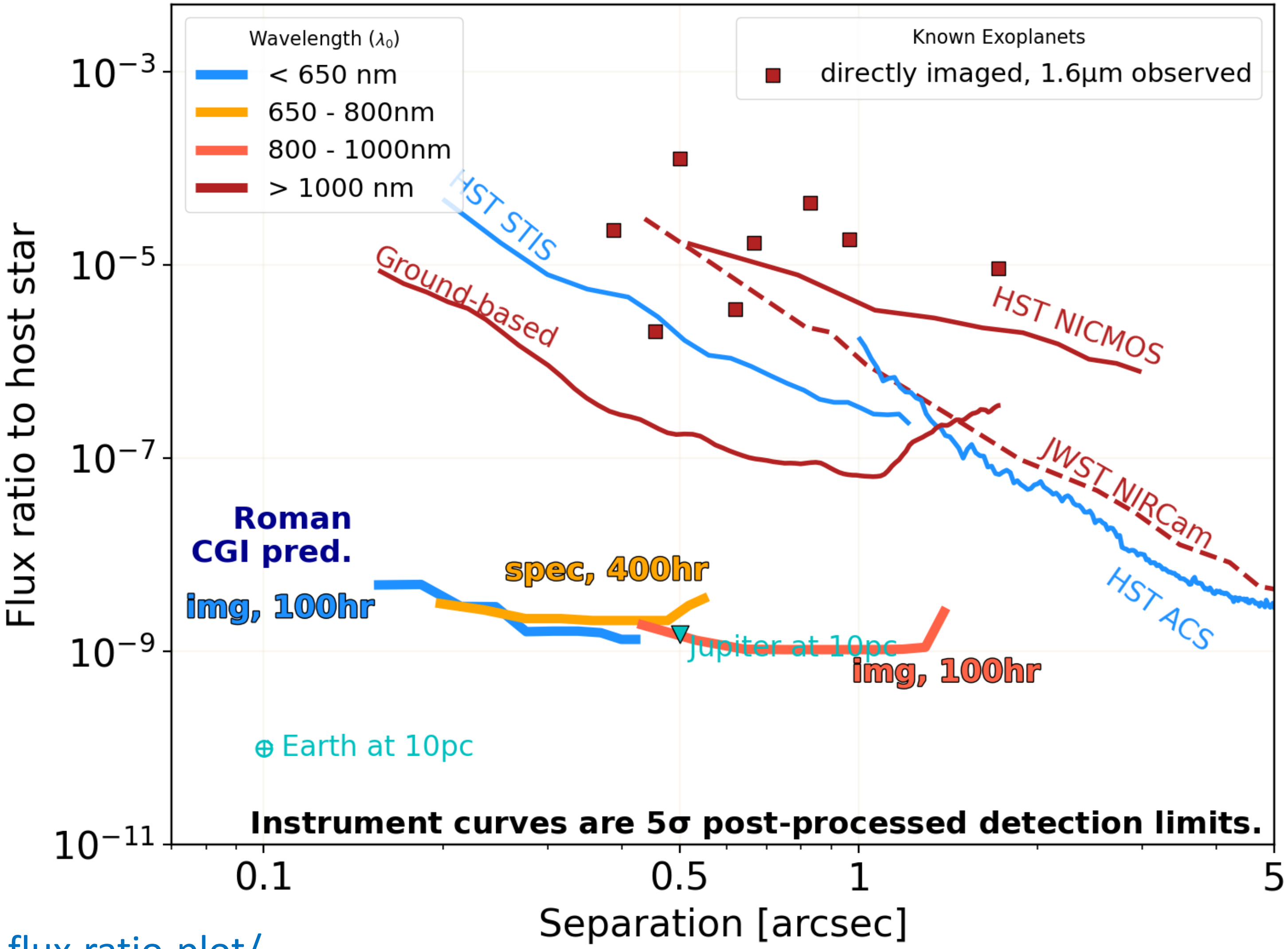
Data Post-Processing





All hardware now at TRL ≥ 6

CGI's predicted performance is 100-1000x better than State-of-the-Art



Based on lab demonstrations as inputs to high-fidelity, end-to-end thermal, mechanical, optical models.

NASA terminology: MUF=1 predictions

Brian Kern (JPL)
John Krist (JPL)
Bijan Nemati (UA Huntsville)
A.J. Riggs (JPL)
Hanying Zhou (JPL)

github.com/nasavbailey/DI-flux-ratio-plot/

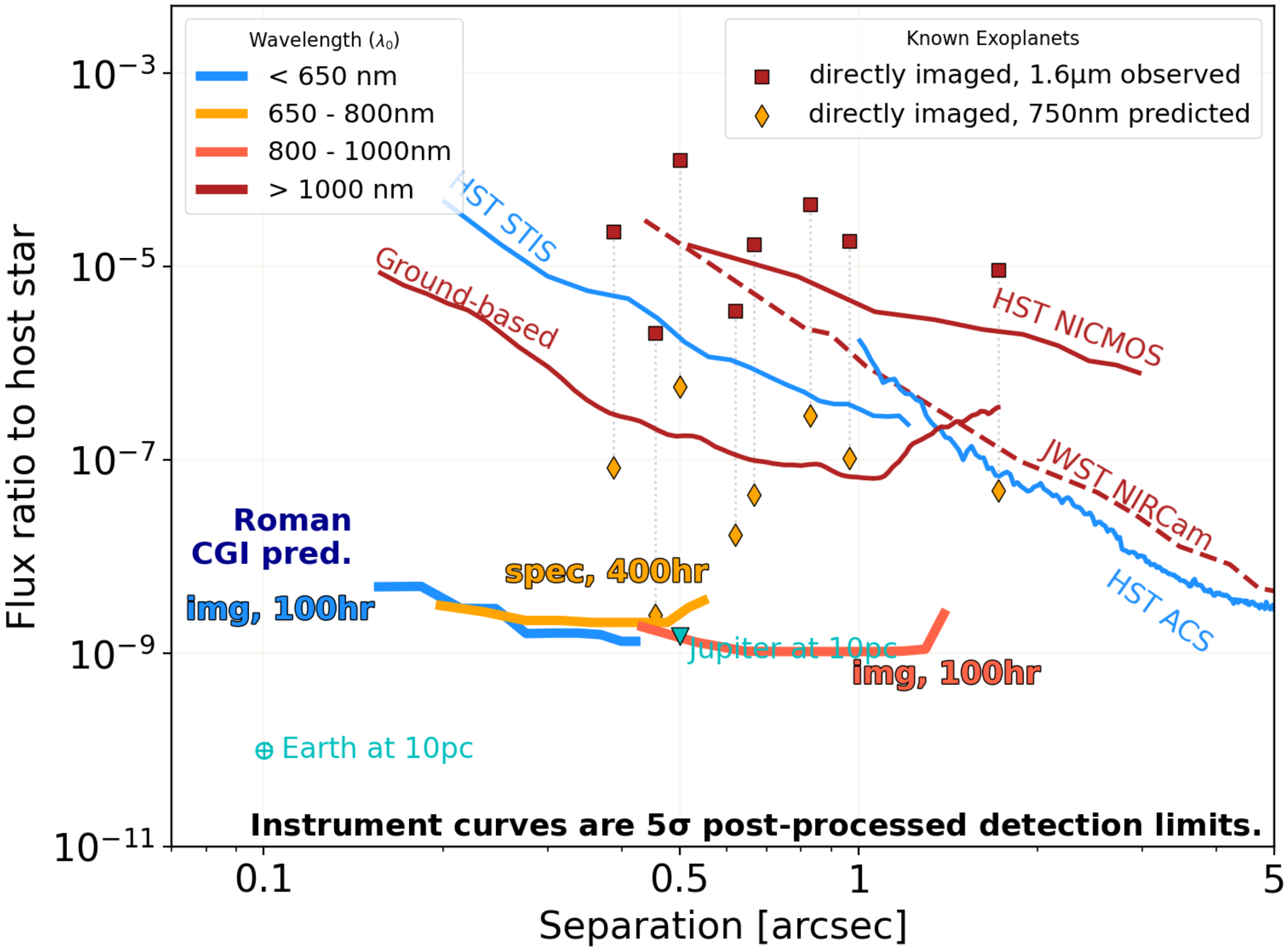
Primary Observing Modes

Exercised during the "technology demonstration phase" (~2200hr spread over 1st 21mo)

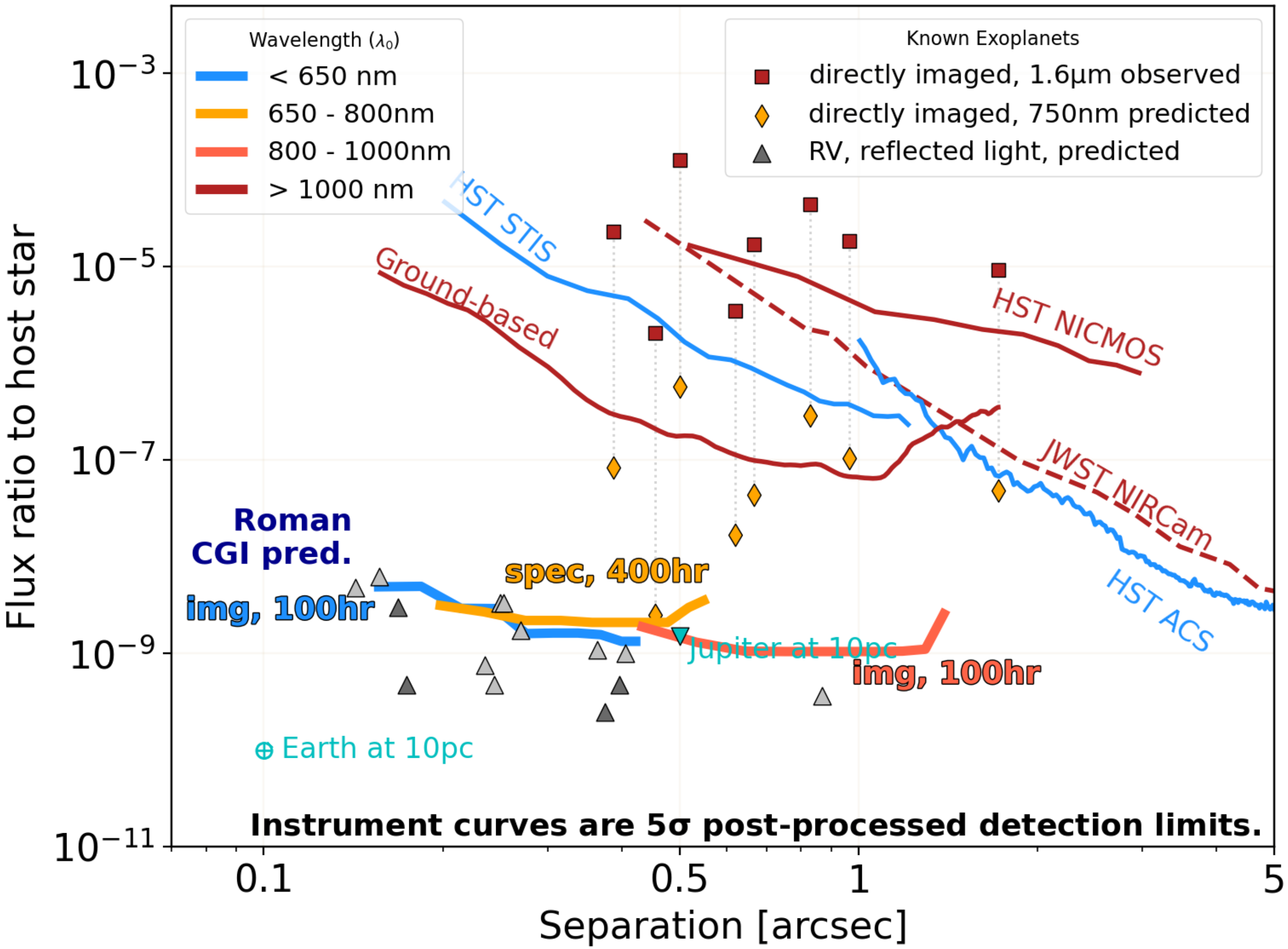
λ_{center}	BW	Mode	FOV radius	FOV coverage	Polarimetry
575 nm	10%	Narrow FOV Imaging	0.14" – 0.45"	360°	Y
730 nm	15%	Slit + R~50 Prism Spectroscopy	0.18" – 0.55"	2 x 65°	-
825 nm	10%	"Wide" FOV Imaging	0.45" – 1.4"	360°	Y

Other filters and masks are installed but are not guaranteed.

CGI can study young, self-luminous planets at new wavelengths

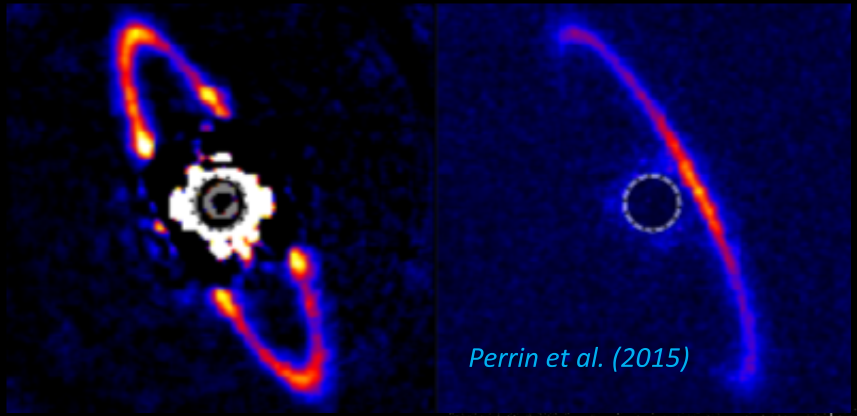


CGI can take the first reflected light images & spectra of true Jupiter analogs

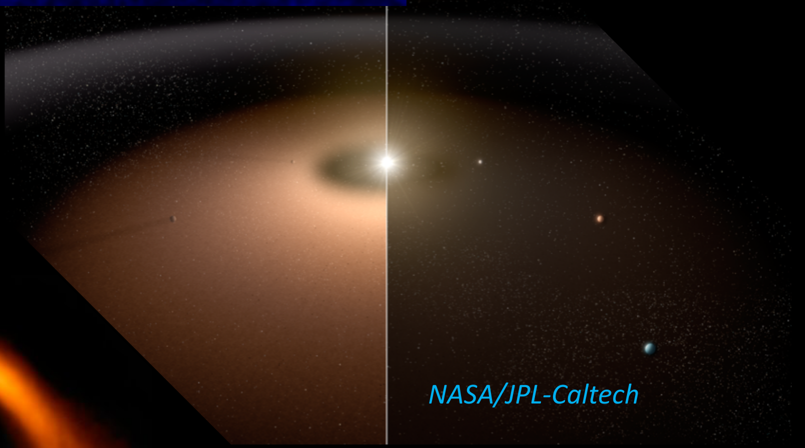


CGI can study the inner regions of disks

- Debris disks
  - Structure, color, polarized fraction
  - RMSE~3% on polarized fraction
- Exozodi disks
  - Can potentially shroud planets from observations
- PP & Transition disks
  - Planets vs. disk clumps (Halpha & RDI)
  - Caveat: CGI only required to observe V<5 host stars; performance on fainter stars is currently unknown



Perrin et al. (2015)



NASA/JPL-Caltech

ESO/A. Müller et al.

Summary

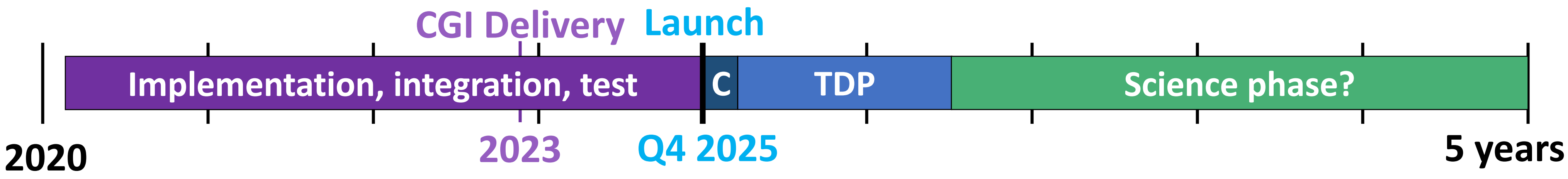
- **CGI paves the technological path toward exo-Earth missions**
  - Wavefront sensing and control, starlight suppression, photon-countin gEMCCDs

- **CGI will be capable of interesting science**
  - Imaging & spectroscopy of young planets
  - First reflected light imaging and spectroscopy of mature Jupiter analogs
  - Imaging and polarimetry of circumstellar disks, including exozodi

- **Get involved**
  - CGI data challenges **exoplanetdatachallenge.com**
  - Instrument parameters and image simulations **roman.ipac.caltech.edu**
  - RV planet simulated photometry & observability **plandb.sioslab.com**
  - Performance predictions **github.com/nasavbailey/DI-flux-ratio-plot/**
  - **Community Participation Program** call via ROSES later this year

Thank you

CGI Community Participation Program



- **Feb 2020: Entered implementation phase (Phase C)**
- **Q3 2023: Instrument delivery to payload integration & test**
- **Q4 2025: Launch**
- **Commissioning Phase**
  - 450 hr in first 90 days after launch
- **Technology Demonstration Phase (TDP)**
  - **~2200 hr (3 months) baselined** in next 1.5 years of mission
- **If TDP successful, potential science phase**
  - 10-25% of remainder of 5 year mission
  - Commission unofficial observing modes (add'l mask+filter combo's)
  - Support community engagement
  - Not guaranteed: would require additional resources
  - Starshade rendezvous, if selected

CGI Observing Modes

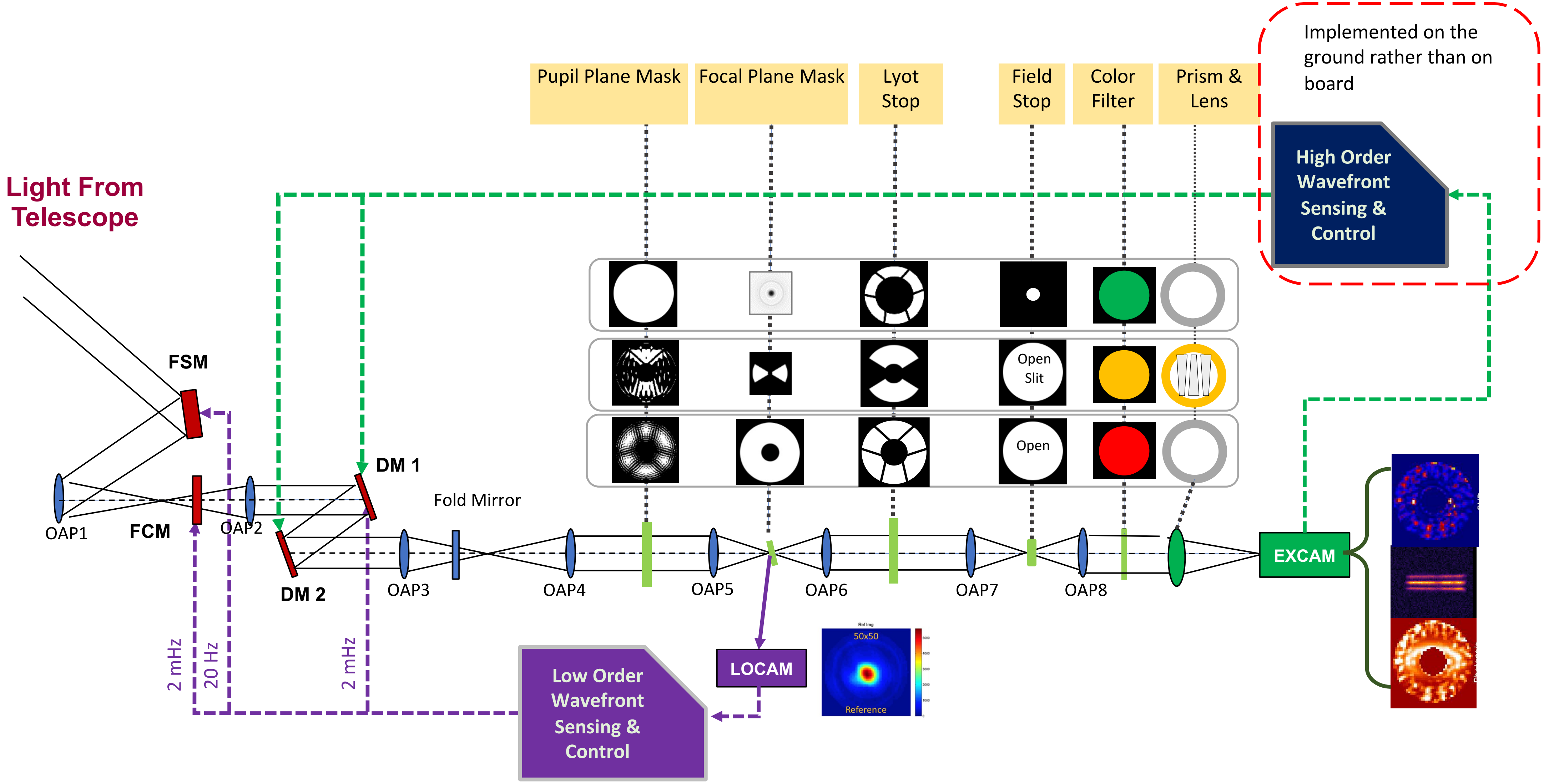
λ_{center} (nm)	BW	Mode	FOV radius	Polarimetry?
575	10%	Imager	0.14” – 0.45”	Y
730	15%	Slit + R~50 Prism	0.18” – 0.55”	-
825	10%	Imager	0.45” – 1.4”	Y
630	15%	Slit + R~50 Prism	0.17” – 0.5”	Y
Hα	1%	Imager	0.17” – 0.5”	Y
575	10%	Imager	0.35” - 1”	Y
825	10%	Imager	0.2” - 0.65”	Y

Additional narrow *sub-bands* (2.5-3.5%) installed

Three “official” modes will be fully tested prior to launch.

Additional modes installed but not fully tested before launch

Key technologies work together as a system to deliver high performance



OAP = Off-Axis Parabolic [Mirror]