Roman Coronagraph Instrument Status Update

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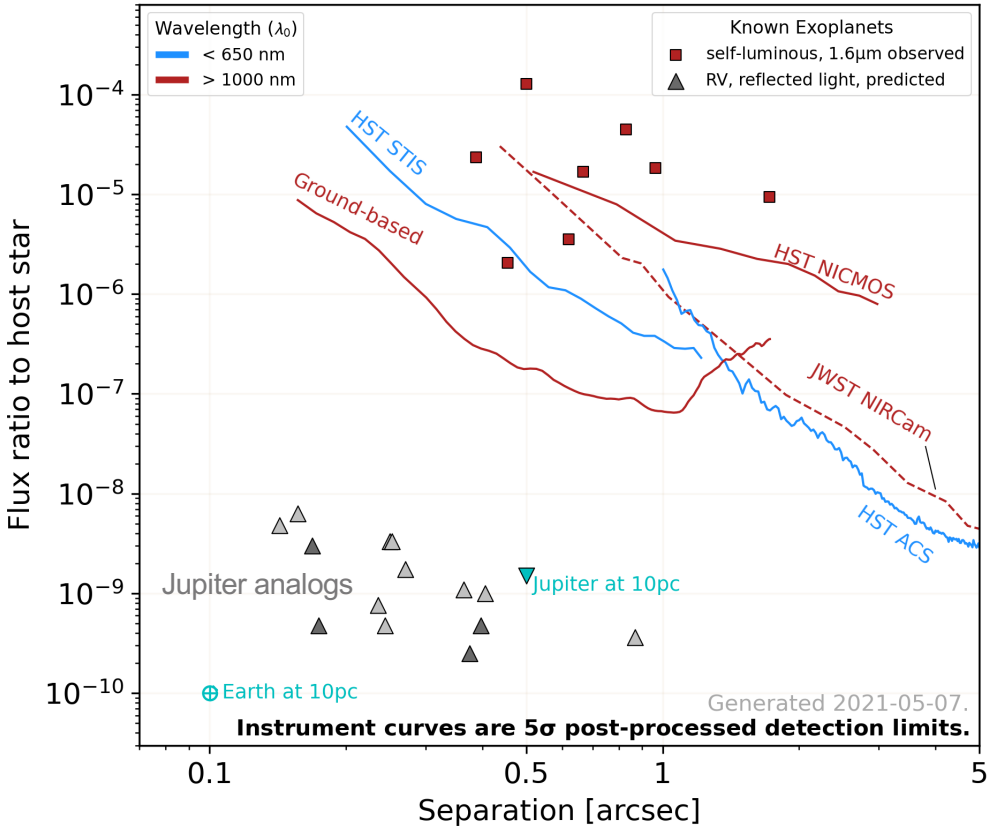
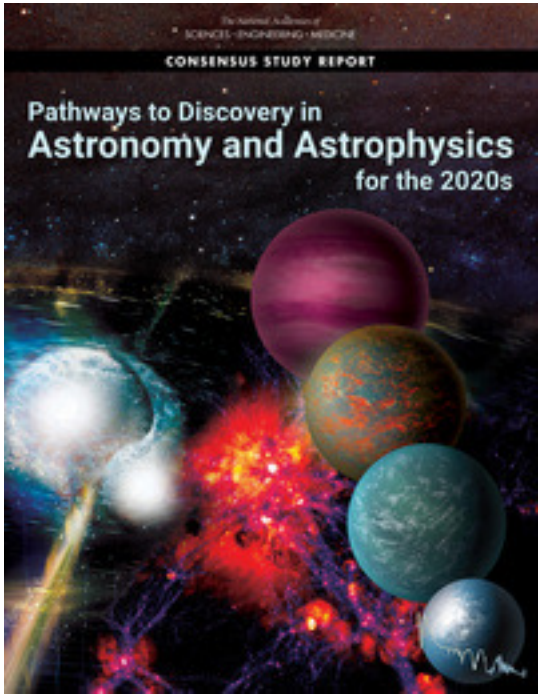
Outline

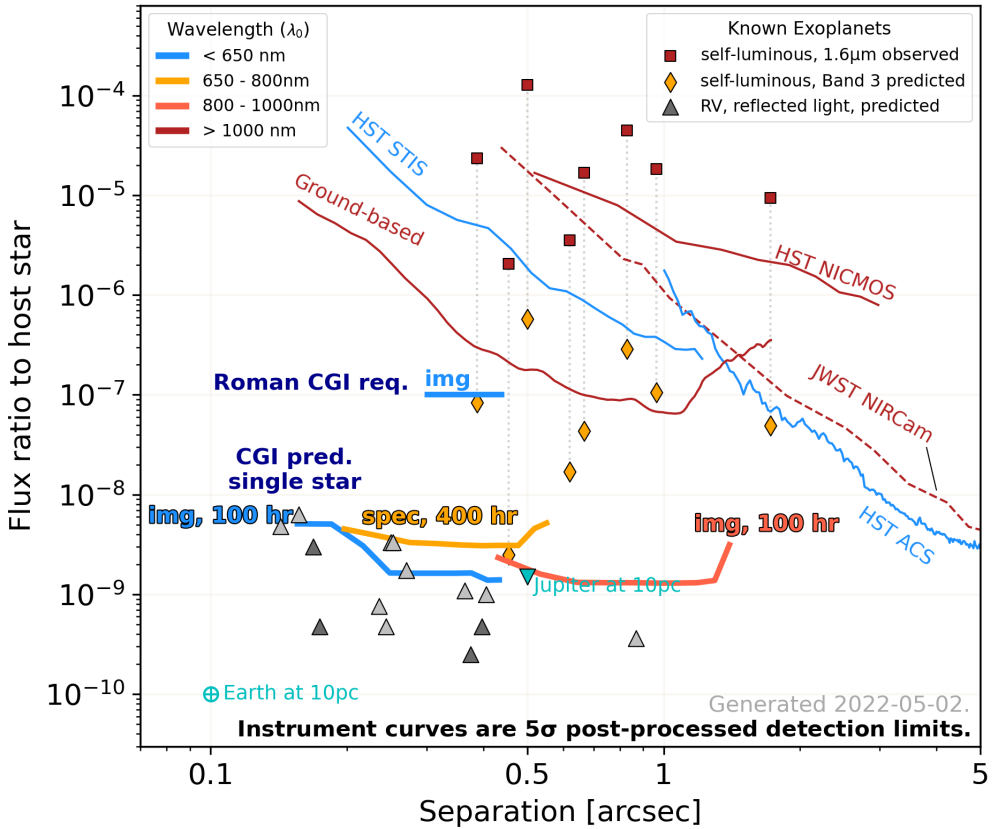
- Roman Coronagraph is a technology demonstrator for the future exo-Earth characterization mission
- In-flight “technology demonstration phase” aims to test limits of key technologies, *while observing scientifically interesting targets*
- Roman Coronagraph’s Community Participation Program (CPP) will engage community in observation planning

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





Coronagraph is expected to significantly advance key technologies & be capable of imaging exoplanets

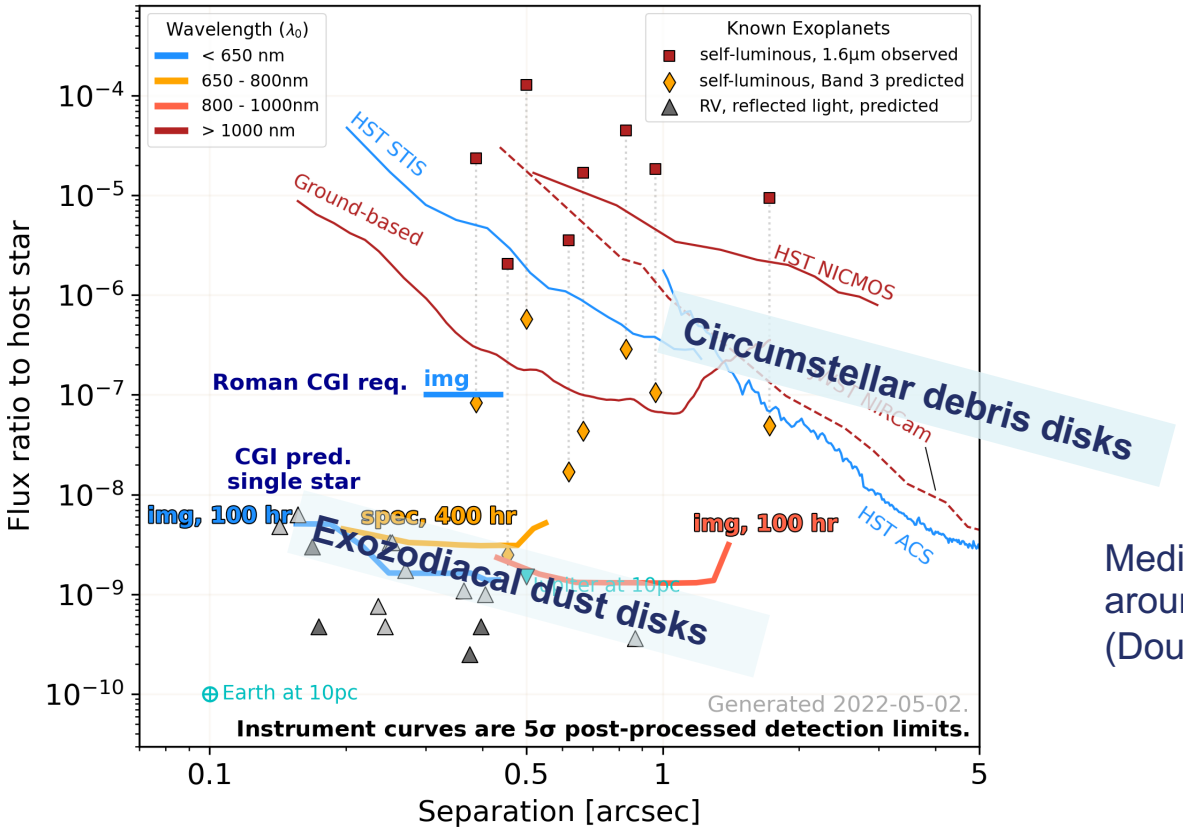


github.com/nasavbailey/DI-flux-ratio-plot/
NEW: more options for conservatism & exposure time

NEW: Exoplanet Exposure Time Calculator
https://roman.ipac.caltech.edu/sims/ETC.html
Built on EXOSIMS

Natasha Batalha
John Debes
Ewan Douglas
Brianna Lacy
Nikole Lewis
Dean Keithly
Brian Kern
John Krist
Bijan Nemati
Dmitry Savransky
Leah Sheldon
Corey Spohn
Sergi Hildebrandt Rafels
A.J. Riggs
Hanying Zhou

Coronagraph will be able to observe circumstellar disks at a new range of surface densities and separations



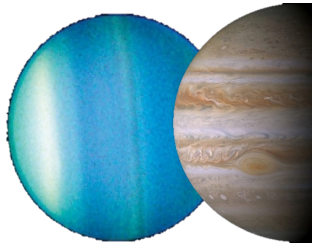
Median expected exozodi sensitivity around nearby Sun-like stars is 12 x solar (Douglas et al. 2022, PASP, 124, 1032)

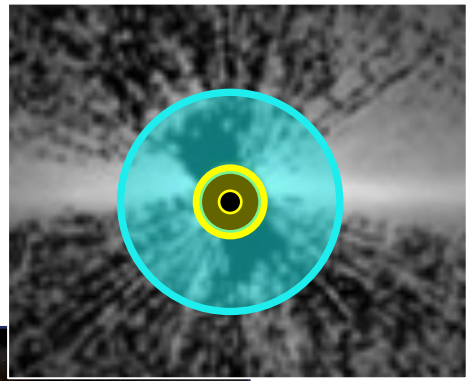
Coronagraph “Technology Demonstration Phase”

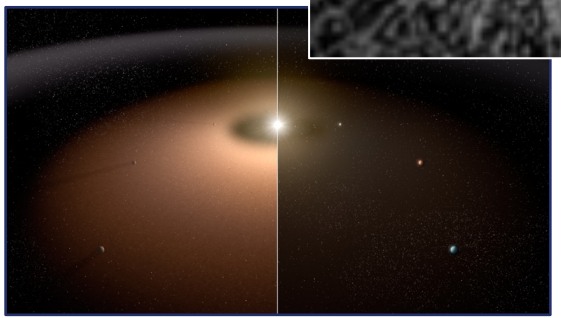
- Baseline: 2200hr (90 days) during first 18mo of Mission
- Top priority: achieve L1 Technology Requirement
  - Flux ratio of at least 10^{-7} on a V<5 star in Band 1 (575nm)
- Then, push performance limits to learn
  - Maximize long-term value to Future Great Observatory
- Use scientifically-interesting targets whenever possible
  - No current funding or infrastructure for GO program during TD phase or after; will solicit community input on target selection
  - Roman data has no proprietary period

Capable of exciting exoplanetary system science

- Characterize known, self-luminous planets at visible wavelengths
  - (eg: Lacy & Burrows 2020)
- Potential for first images and spectrum of true Jupiter analog
  - (eg: Batalha+2018, Saxena+2021)
- Low surface brightness disks, improved morphology
- Potential for first visible light images of exozodi
  - (Douglas+2022)

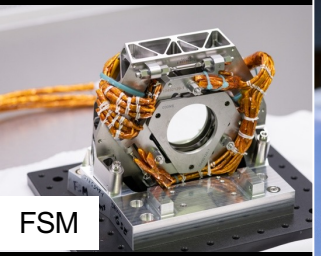


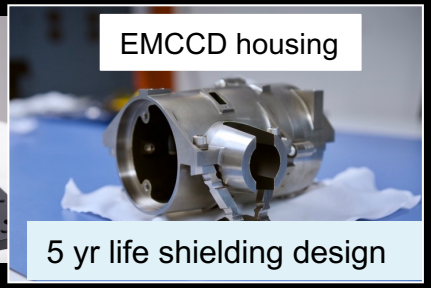




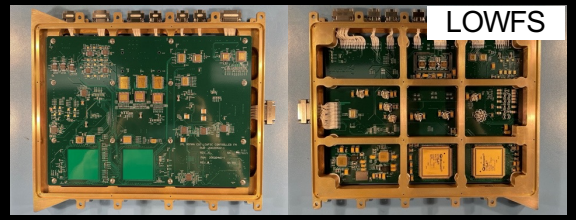
Instrument delivery ~1.5 yrs away

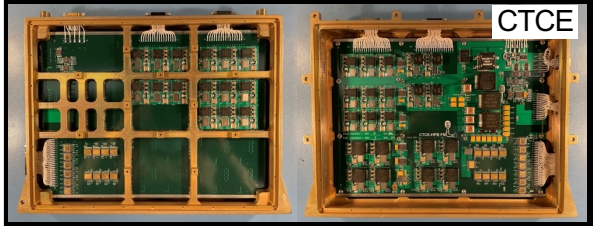
From CL#21-6276 & 22-5699

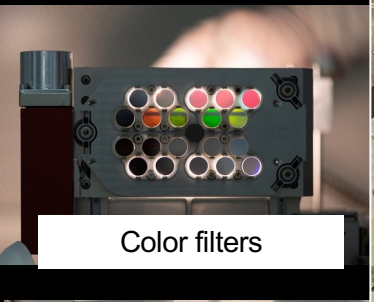

FSM

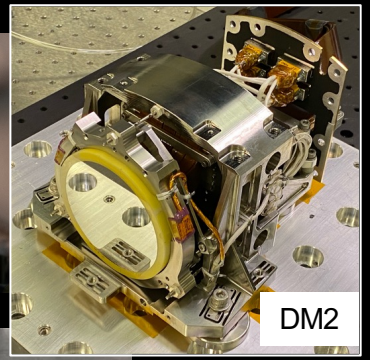

EMCCD housing

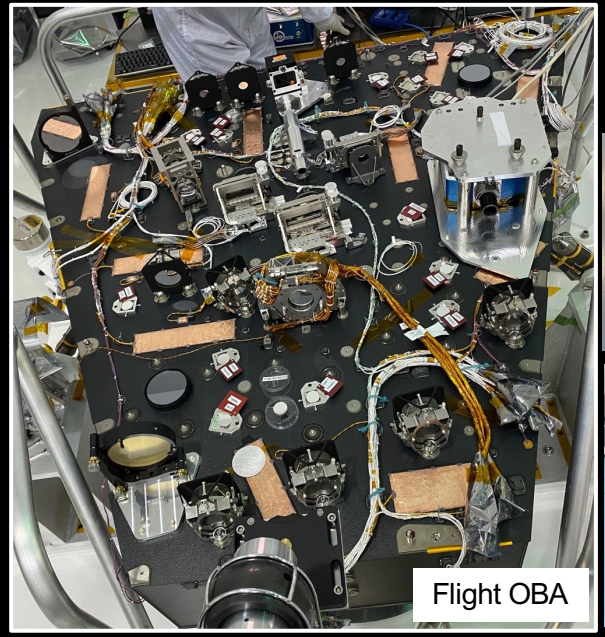
5 yr life shielding design

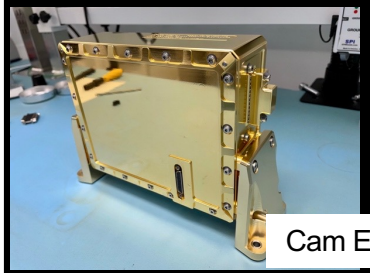

LOWFS

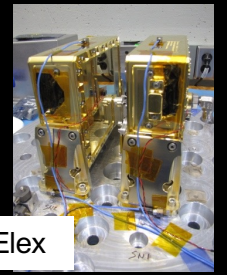

CTCE

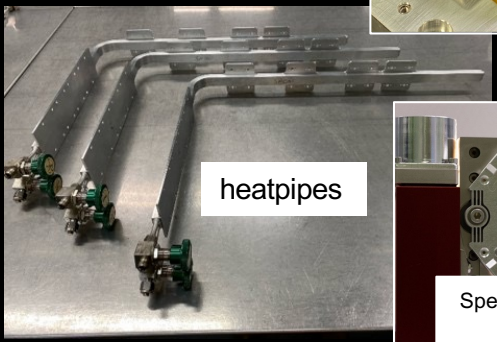

Color filters

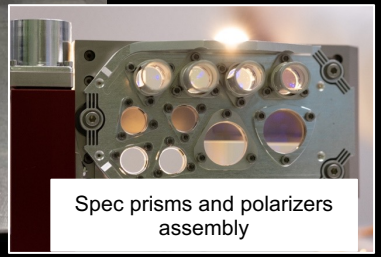

DM2

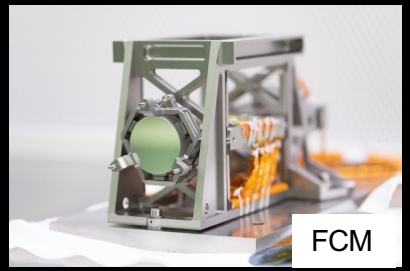

Flight OBA

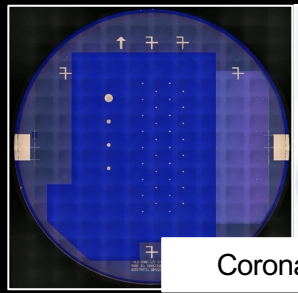

Cam Elex




heatpipes


Spec prisms and polarizers assembly


FCM




Coronagraph masks and stops

FY23/24 HQ overguide funds may enable additional work to improve performance beyond requirement

- Additional (non-Roman) funds may be available in FY23/24, if there is a compelling case for how they would be used to improve Coronagraph performance beyond its threshold requirement
- Small, non-binding advisory group was spun up to rank potential development and test activities proposed by the Coronagraph team and to identify gaps
  - 1 rep each from: ExEP technology, ExEP science, Astro2020, LUVOIR, HabEx, Roman Coronagraph
- Recommended priorities
  - 1) Improve performance and/or buy down risk for the required (Hybrid Lyot Coronagraph) mode
  - 2) Execute basic functional checkout of spectroscopy and polarimetry; document lessons learned across the project; review available telemetry and compare against performance analysis needs
  - 3) Improve confidence that spectroscopy, polarimetry, and wide field of view imaging will meet performance goals (planning and modeling effort, not end2end instrument performance testing)
  - 4) Execute end2end performance testing of goal modes prior to delivery
- Much of (2)-(4) are only feasible if the instrument delivery date is allowed to slip beyond March 2024
  - (4) would require months of schedule slip, so is very unlikely
- In practice, with the currently available resources, the recommended priorities align well with what Project was already planning under OG2a funding and had previously communicated

Coronagraph Community Participation Program (CPP)
(part of broader Roman Research and Support Participation Opportunity)

- Draft list of solicited topics are in ROSES D.14
  - Observation design, preparatory work, data analysis, simulations, …
  - **Engaging external research community** to optimize tech demo observations for broad, long-term impact (eg: target selection, …)
  - Add-ons: wavefront sensing and control and/or commissioning modes beyond required one
- CPP will be relatively small
  - ~6 US proposals to be selected via ROSES; each annual budget <$200K
  - + 4 selected by CNES, ESA, JAXA, MPIA
- Selected teams become integral part of Coronagraph team, *not just end users*

Summary

- The best way to pave the way for future missions is to go beyond requirements and observe challenging targets
  - Could take first reflected-light image & spectrum of a Jupiter analog & exozodi
  - New parameter space in circumstellar disks & self-luminous young planets
- Building flight hardware
  - Deliver for payload integration in 2024
- Community Participation Program solicited via ROSES **D.14**
  - Resources at https://roman.gsfc.nasa.gov/science/roses.html
- Thank you to 1st gen Science Investigation Teams!
  - Led by B. Macintosh/E. Douglas/N. Lewis and M. Turnbull/A. Mandell/A. Roberge

Like to Know More about the Roman Coronagraph?

- Nancy Grace Roman Space Telescope at GSFC: https://roman.gsfc.nasa.gov
- Nancy Grace Roman Space Telescope at JPL:
  - https://www.jpl.nasa.gov/missions/the-nancy-grace-roman-space-telescope
- Nancy Grace Roman Space Telescope at IPAC https://roman.ipac.caltech.edu and https://roman.ipac.caltech.edu/sims/Coronagraph_public_images.html#CGI_OS11_report
- Nancy Grace Roman Space Telescope at STScI: https://www.stsci.edu/roman/
- Interested in applying to CPP call (NASA ROSES Program element D.14 on)?
  - https://nspires.nasaprs.com/external/solicitations/summary.do?solId=%7b1BD0AA55-40BB-1419-EEA1-64FF5B4269D3%7d&path=&method=init
- Roman Coronagraph performance vs future exo-Earth direct characterization mission requirements
  - https://arxiv.org/pdf/2008.05624.pdf
- Roman Coronagraph Information Sessions from October 26 & 28 2021
  - https://roman.ipac.Caltech.edu/mtgs/Roman_CGI_workshop.html