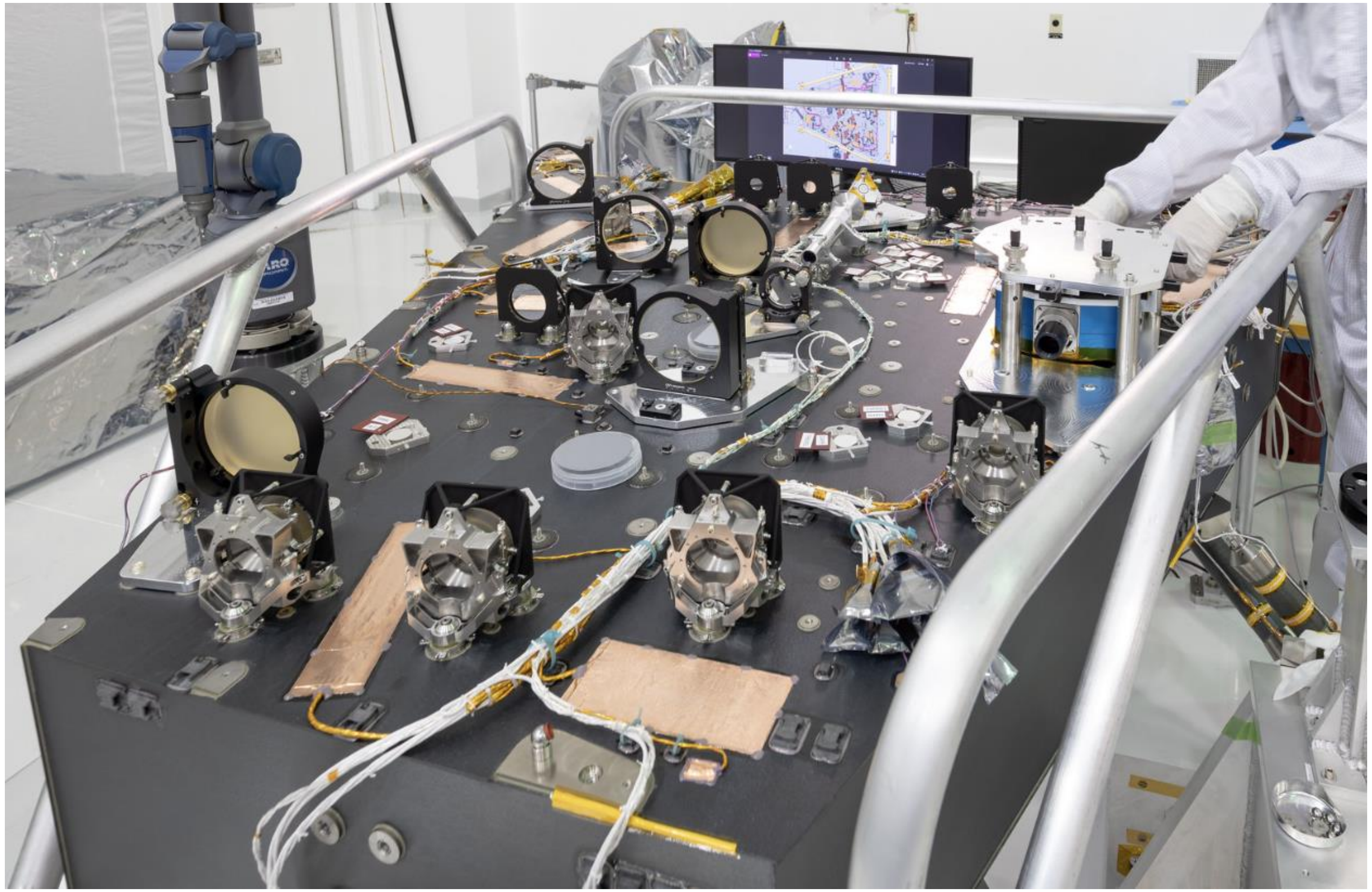
The Nancy Grace Roman Space Telescope Coronagraph Community Participation Program

Dmitry Savransky, on behalf of the CPP Team

September 25, 2024

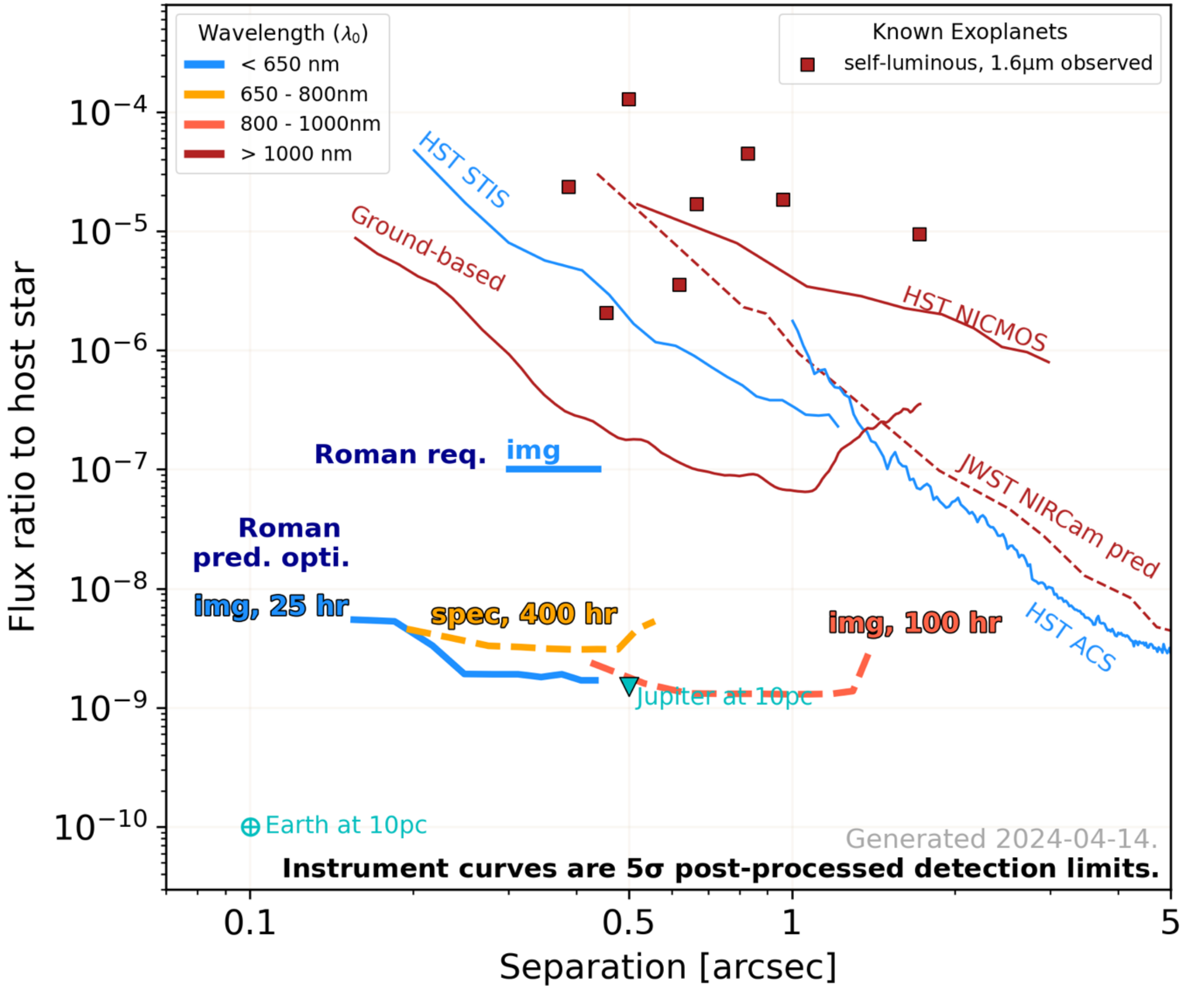
What is the Coronagraph Instrument?

- The first space-based coronagraph with active wavefront control
- A visible light technology demonstration instrument
  - Requirement: 10^{-7} detection limit
  - Goal: ~ a few 10^{-9}
- An indispensable step on the way to HWO
- We get: 450 hours of commissioning; ~90 days of observing time during 1st 18 months of mission



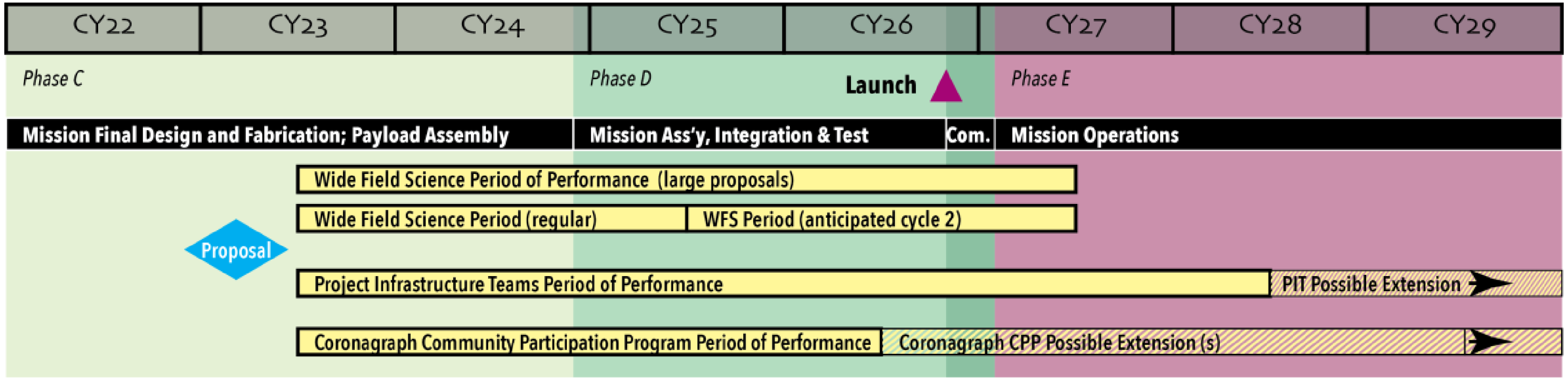
What will the Roman Coronagraph Look At?

- After demonstrating our Level 1 requirement:
  - Known, self-luminous planets at visible wavelengths (Lacy & Burrows 2020)
  - Known RV planets (potential for first images and spectrum of true Jupiter analog; Batalha et al. 2018; Saxena et al. 2021)
  - Low surface brightness disks (improved morphology; Mennesson et al. 2018)
  - Potential for first visible light images of exozodi (Douglas et al. 2022)
  - Additional technology demonstration observations



What is the CPP?

- Established by 2022 NASA ROSES Nancy Grace Roman Space Telescope Research and Support Participation Opportunities program element
  - Solicited proposals aimed at supporting the progress of and exploiting the scientific and technical data from Roman
  - CPP category limited to sole-PI/small-group proposals with intent to form a single, cohesive CPP Team composed of:
    - Selected teams
    - International partners
    - Representatives from Coronagraph science and engineering teams
    - Members of Science Support Center (SSC)



What are the CPP's top Priorities?

- To make the Roman Coronagraph Instrument as productive as possible
- Near-term high-priority tasks:
  - Development of coronagraph instrument data reduction pipeline (DRP)
  - Development of target and reference star database
  - Vetting programs for reference stars
  - Finalization of instrument calibrations
  - Development of observation scheduling tools
  - Simulating *everything*
- Next: Preparing for beyond-requirements observations

How is the CPP Organized?

Core Team

7 US PIs, 4 International Partner PIs, Roman project ex officio members

Project Team

PI teams' members

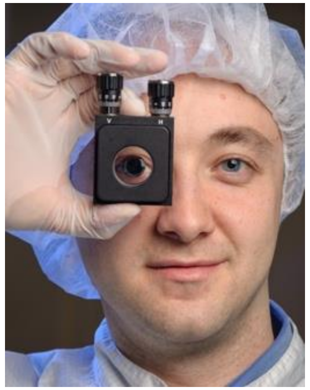
Community Team

Anyone wishing to contribute

- Observations Working Group
- Data Reduction and Simulation Working Group
- Hardware Working Group
- Polarimetry Working Group
- Climate Committee

Who’s leading the CPP?

Vanessa Bailey, *JPL*
CPP Chair
Roman Coronagraph
Instrument Technologist



Rus Belikov
Ames

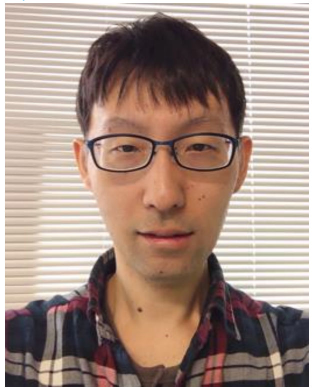
Beth Biller
ESA

Alexandra Greenbaum
Caltech/IPAC
SSC

Oliver Krause
MPIA

Bertrand Mennesson
JPL Roman Deputy
Project Scientist

Max Millar-Blanchaer
UCSB
DRP & Sims WG co-lead



Naoshi Murakami
JAXA

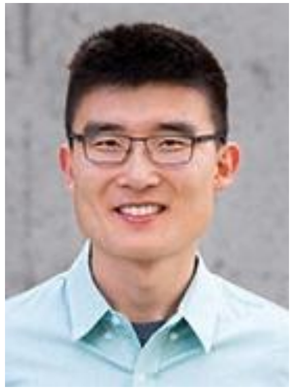
Laurent Pueyo
STScI

Jason Rhodes
JPL Roman Project Scientist

Ty Robinson
U. Arizona

Dmitry Savransky, *Cornell*
Inaugural CPP co-chair

Arthur Vigan
CNES



Jason Wang
Northwestern
DRP & Sims WG co-lead

Schuyler Wolff
U. Arizona
Obs WG lead

Neil Zimmerman, *GSFC*
Roman Project
Coronagraph Scientist

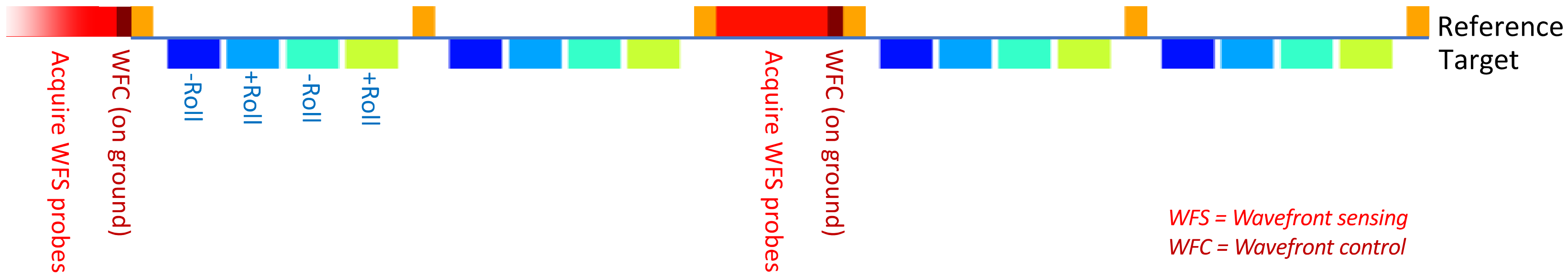
Who’s Actually Doing the Work?

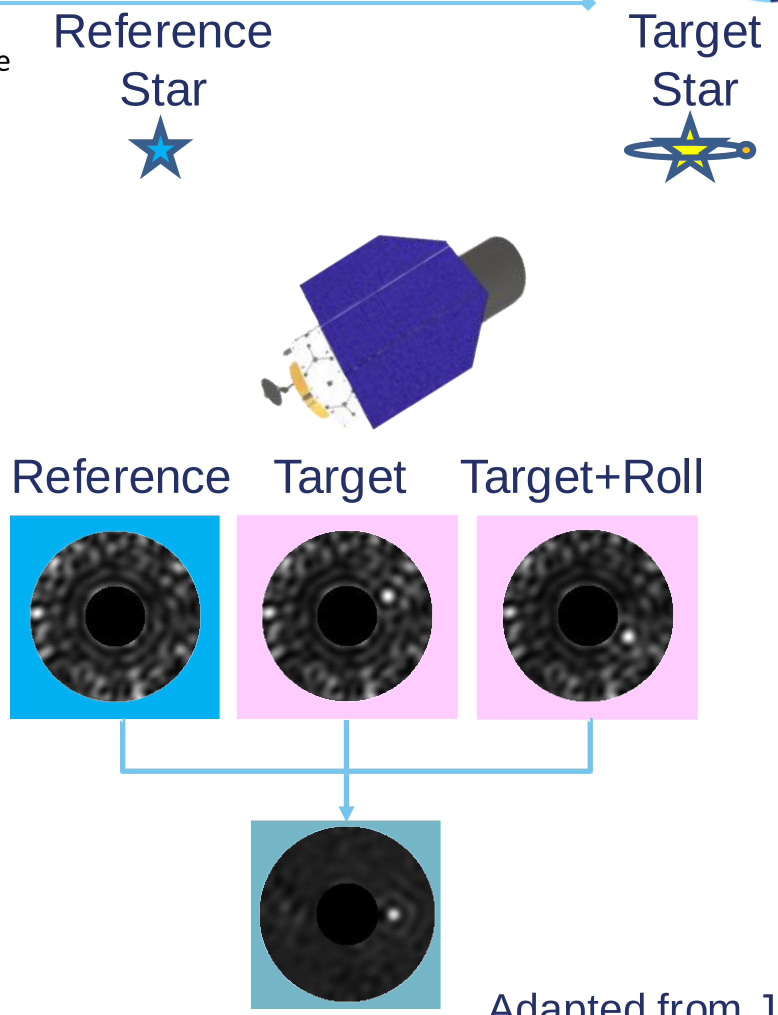
Ramya Anche (UArizona)
Ewan Douglas (UArizona)
Jessica Gersh-Range (Princeton)
Satoshi Itoh (Nagoya Univ.)
Bruce Macintosh (UC Observatories)
Jun Nishikawa (NAOJ)
Frans Snik (Leiden University)
Takahiro Sumi (Osaka Univ.)
Taichi Uyama (Cal State U. Northridge)
Michele Woodland (GSFC)
Hibiki Yama (Osaka Univ.)
Hanying Zhou (JPL)
Oscar Carrion-Gonzalez (LESIA)
John Debes (STScI)
David Doelman (SRON)
Markus Feldt (MPIA)
Hajime Kawahara (ISAS/JAXA)
John Livingston (ABC/NAOJ)
Axel Potier (Bern)
Matthias Samland (MPIA)
Aoi Takahashi (ABC/NAOJ)
Pierre Baudoz (LESIA)
N. Jeremy Kasdin (Princeton)
Jürgen Schreiber (MPIA)
Lisa Altinier (LAM)
Eduardo Bendek (JPL)

Ellis Bogat (UMaryland)
Robert De Rosa (ESO (Chile))
Motohide Tamura (UTokyo/ABC)
Jorge Llop Sayson (JPL)
Tsutsumi Nagai (Osaka Univ.)
Masataka Aizawa (Riken)
Yui Kawashima (ISAS/JAXA)
Kenta Yoneta (NAOJ)
Benjamin Charnay (LESIA)
Malachi Noel (Northwestern)
Justin Hom (UArizona)
Samantha Hasler (MIT)
Patrick Lowrance (IPAC)
Lee Armus (IPAC)
Zhexing Li (UCR)
Stephen Kane (UCR)
Toru Yamada (ISAS, JAXA)
Masayuki Kuzuhara (NINS Astrobiology Center)
Emmanuel Joliet (Caltech / IPAC)
Eric Mamajek (JPL)
Susan Redmond (Caltech / JPL)
Nick Schragal (University of Arizona)
Alexis Lau (LAM)
Leonid Pogorelyuk (RPI)
Toshiyuki Mizuki (ABC/NAOJ)
Marah Brinjikji (ASU)

Sarah Blunt (Northwestern)
Elodie Choquet (LAM)
Julien Girard (STScI)
Sergi Hildebrant Rafels (JPL)
John Krist (JPL)
Sarah Moran (UArizona)
Karl Stapelfeldt (JPL)
Marie Ygouf (JPL)
Robert Zellem (JPL)
Mark Marley (UArizona)
Remi Soummer (STScI)
Tyler Groff (GSFC)
Bijan Nemati (Tellus1)
Cynthia Wong (JPL)
Kevin Ludwick (U. Alabama-Huntsville)
Tim Koch (JPL)
Jennifer Sobeck (IPAC)
James Ingalls (IPAC)
Amanda Chavez (Northwestern)
Zarah Brown (UArizona)
Gaël Chauvin (OCA)
Dan Sirbu (Ames)
Wolfgang Brandner (MPIA)
Shota Miyazaki (ISAS/JAXA)
Emiel Por (STScI)
Johan Mazoyer (LESIA)

Roman Coronagraph Observing Sequence





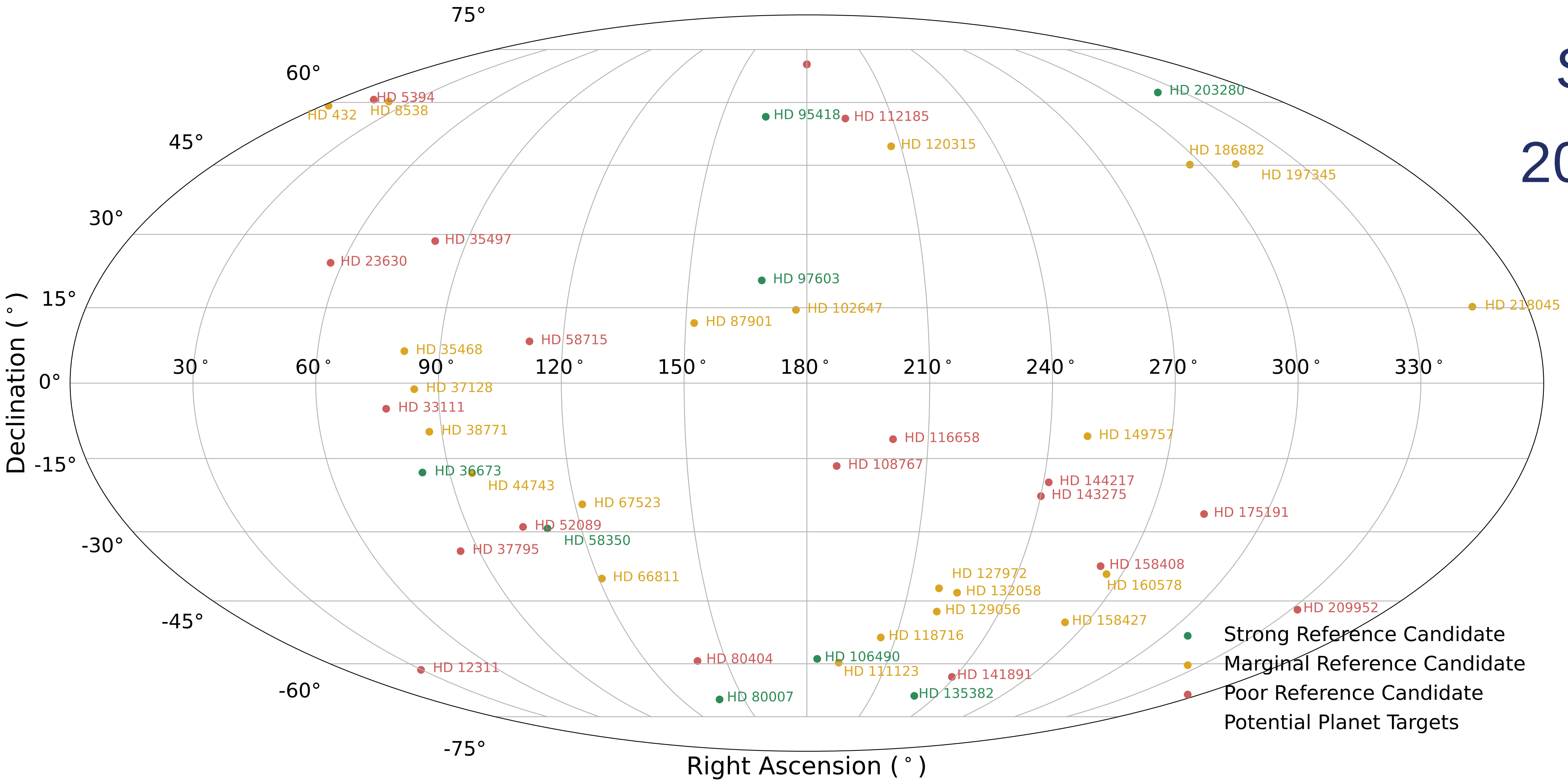
- Reference stars used for both wavefront sensing/control and as PSF references
- Reference stars must be:
  - Single
  - Bright: V < 3
  - Angular diameter < 2 mas
  - In favorable geometries (minimize delta solar pitch angle)

Adapted from J. Krist

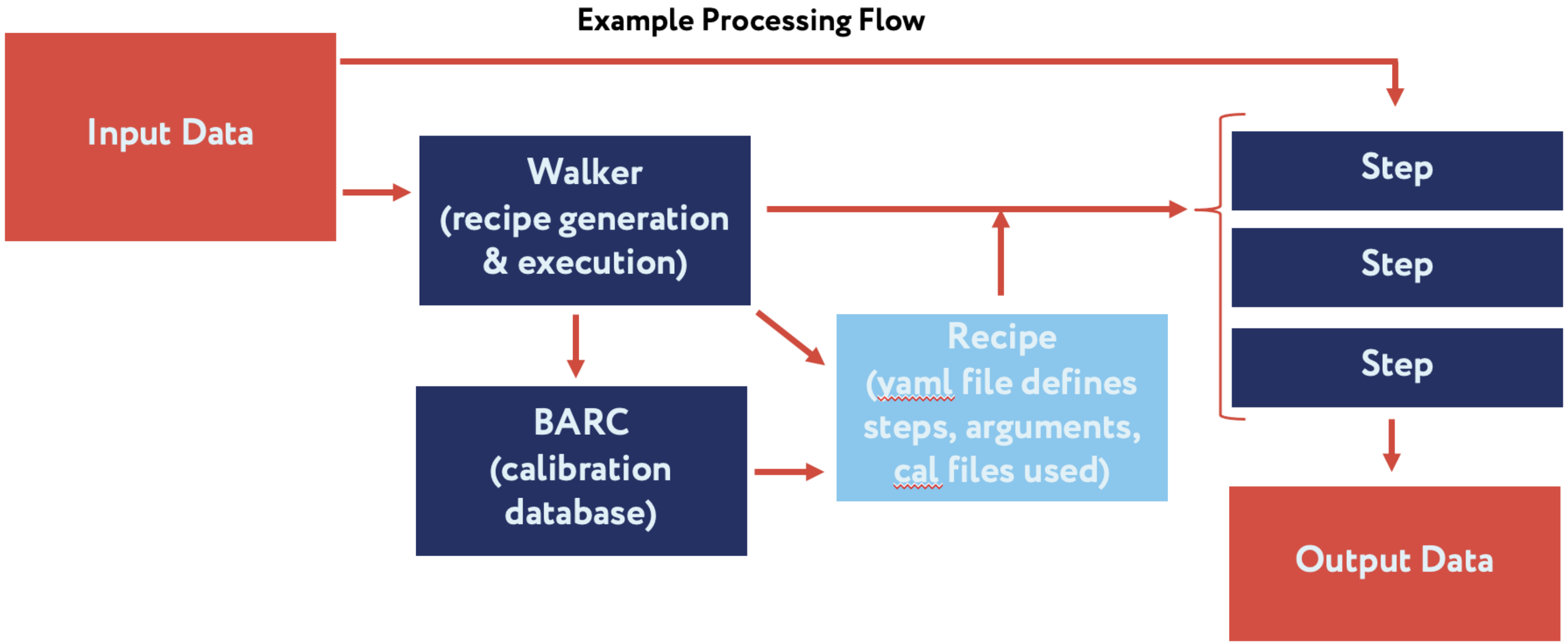
Reference Stars will be a Key Challenge

See Wolff et al.

2024 Proc. SPIE



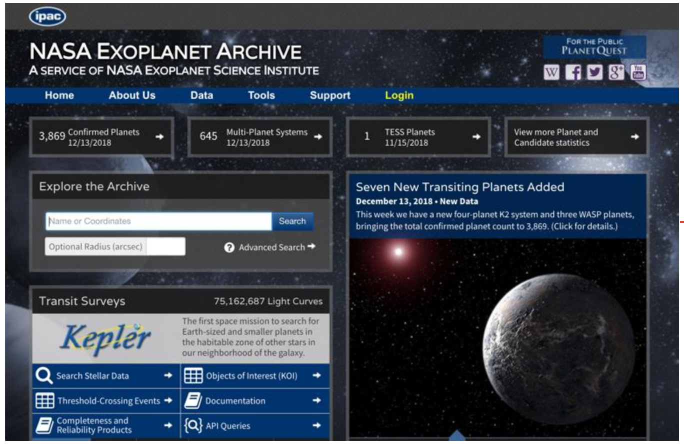
Data Reduction Pipeline Development



See Millar-Blanchaer et al. 2024 Proc. SPIE

https://github.com/roman-corgi/corgidrp

The Imaging Mission Database → Roman Target Database



Pick best orbital fits

Calculate Additional Properties

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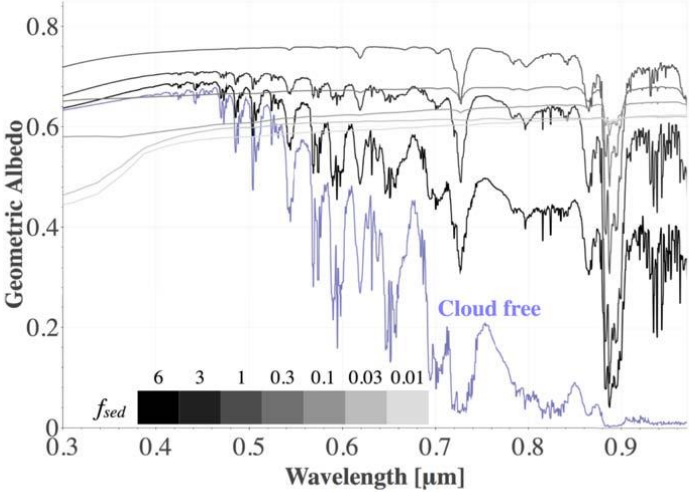

Batalha et al. (2018)

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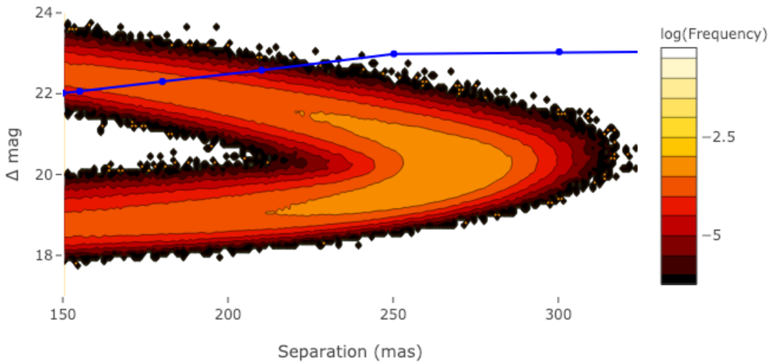
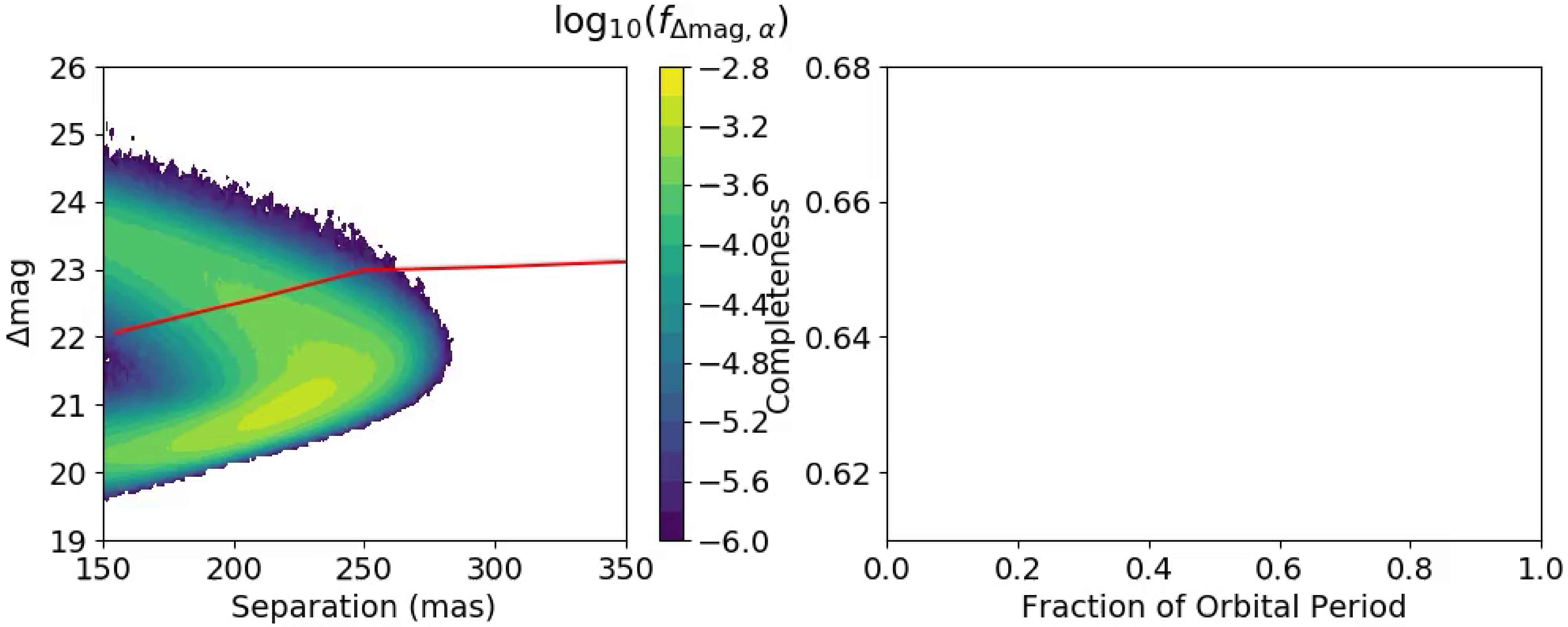
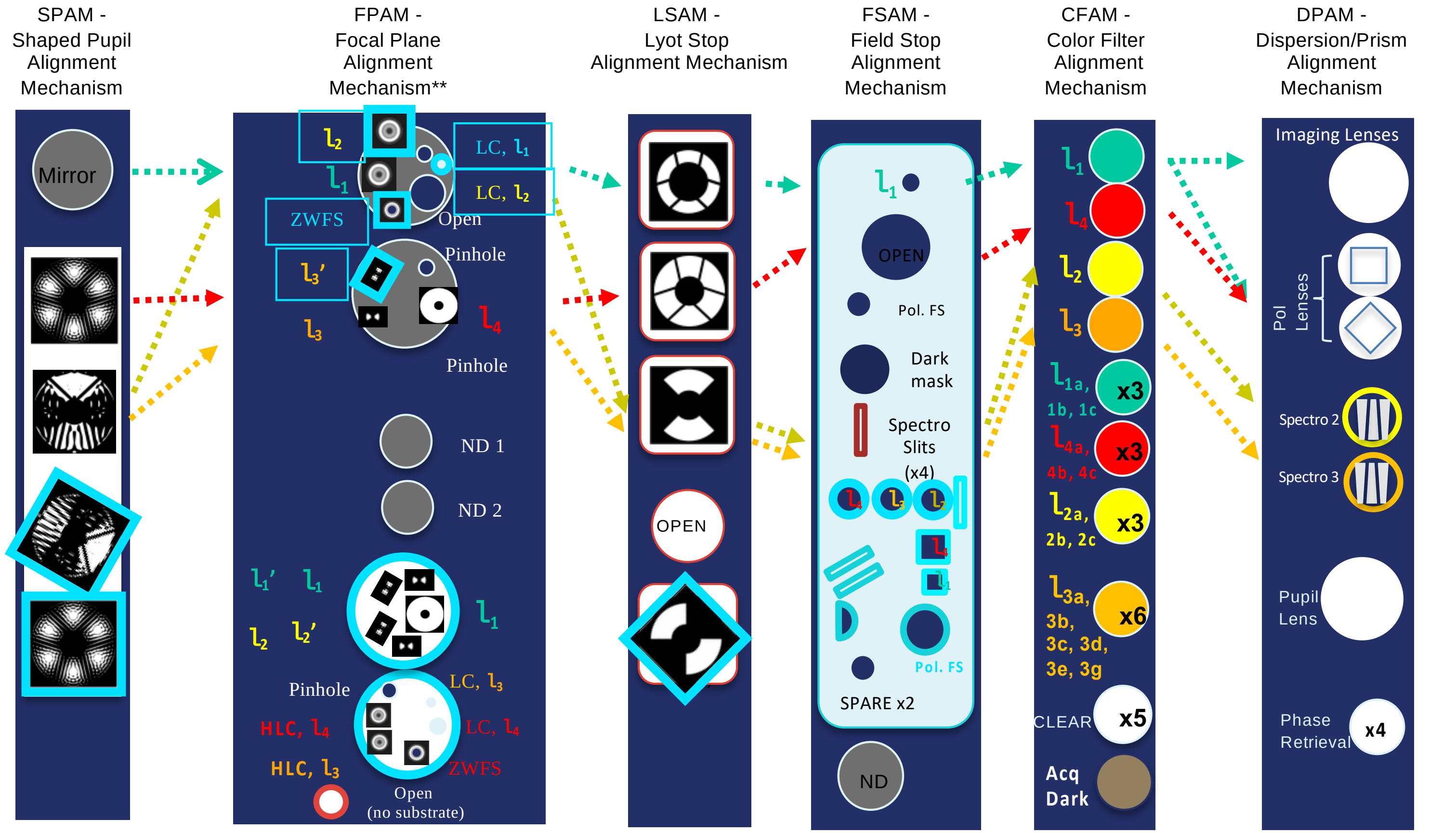


Finding the Best Times to Look



Coronagraph Elements



**Magnified for illustration. Each FPAM substrate can carry multiple coronagraphic elements.

Blue-indicated contributed optics that are not part of requirements

λ_1 = 575 nm, 9.8% λ_2 = 660 nm, 16.8%
λ_3 = 730 nm, 16.8% λ_4 = 825 nm, 11.7%

See also: Riggs et al. (2021)

Note: can’t mix-and-match arbitrarily

Primary Coronagraph Observing Modes

Band	λ_{center}	BW	Mode	FOV radius	FOV Coverage	Pol.	Coronagraph Mask Type	TTR5
1	**575 nm**	**10%**	**Narrow FOV Imaging**	**0.14” – 0.45”**	**360°**	**Y**	**Hybrid Lyot**	**Y**
3	730 nm	15%	Slit + R~50 Prism Spectroscopy	0.18” – 0.55”	2 x 65°	-	Shaped Pupil	-
4	825 nm	10%	“Wide” FOV Imaging	0.45” – 1.4”	360°	Y	Shaped Pupil	-

* Other filters and masks installed but not fully ground-tested and will not be guaranteed (eg: 660nm spectroscopy and ExEP-contributed coronagraph masks)

Complete list of filters available at https://roman.ipac.caltech.edu/sims/Param_db.html

Ground-in-the-Loop

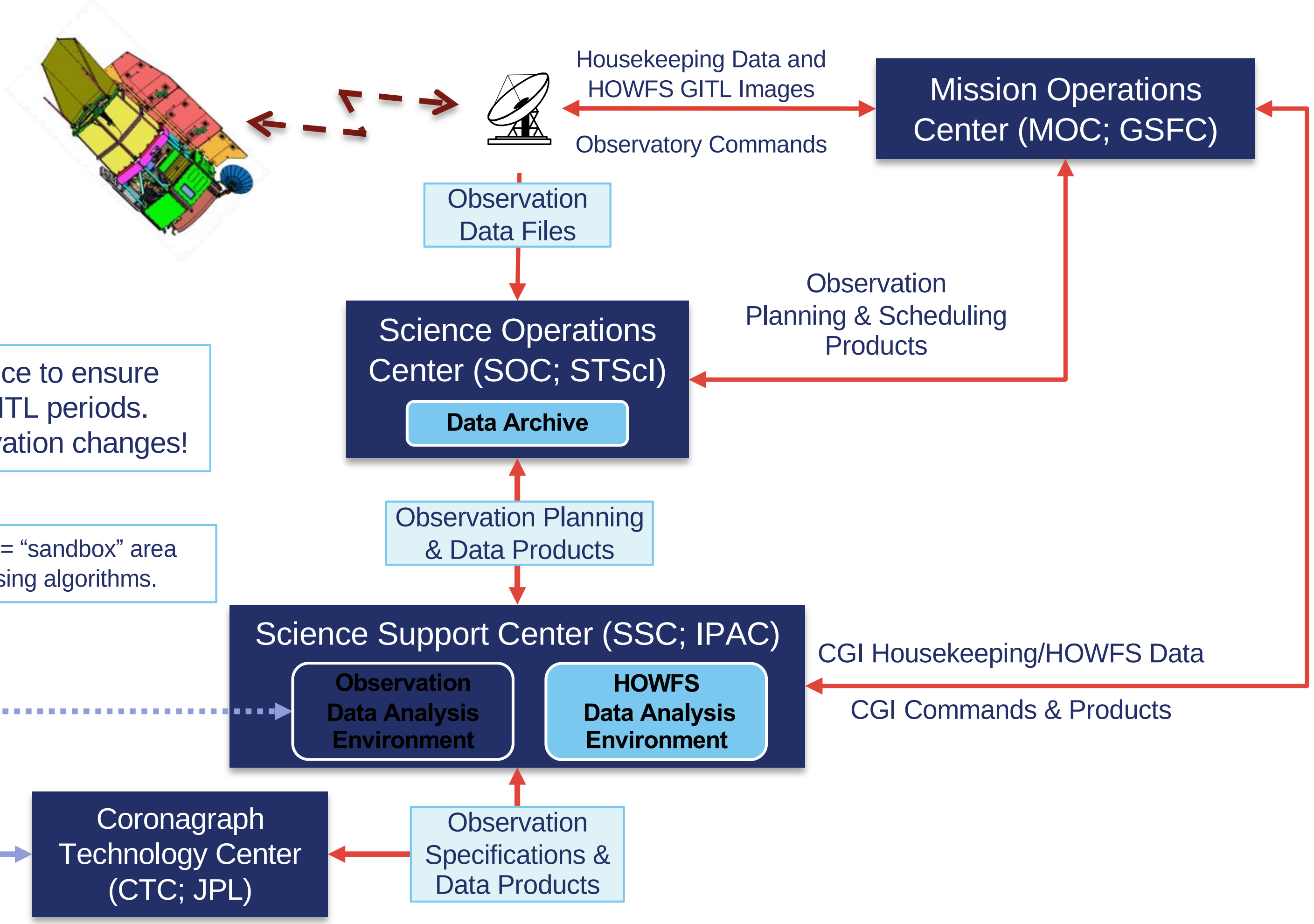
HOWFS = high-order wavefront sensing
GITL = Ground In The Loop

Data Downlink:
Ka-Band (observation data)
S-Band (commands, housekeeping and HOWFS data)

Raw observation image files (”L1 data products”) will be in STScI Archive < 72hr after observation.

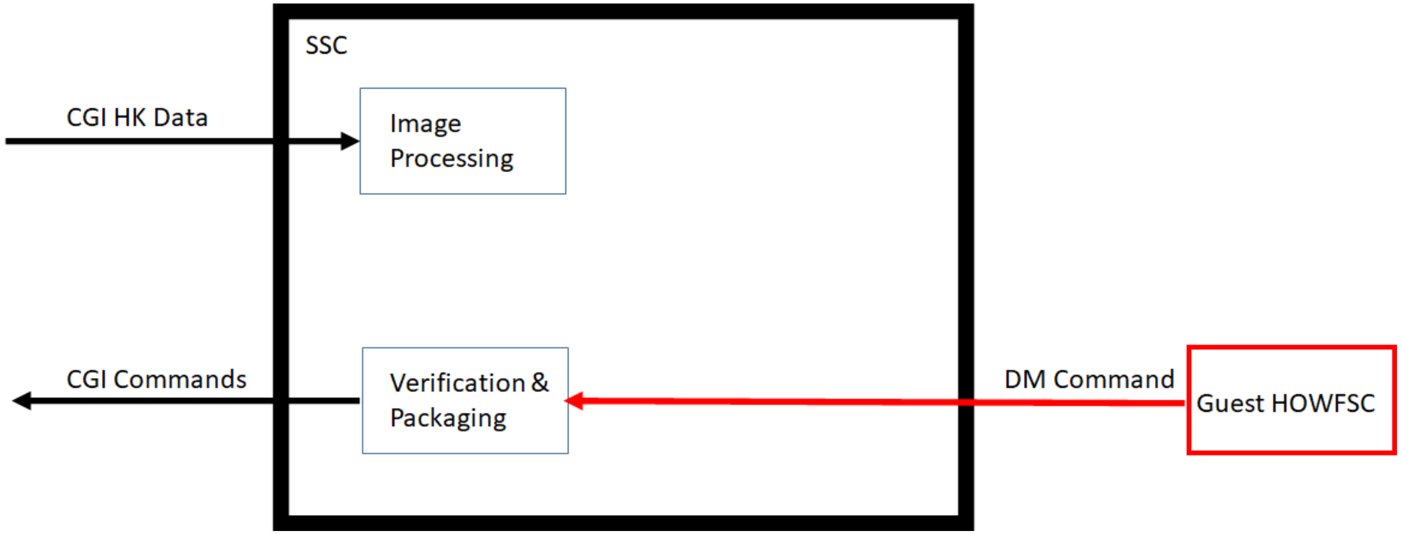
CGI scheduling done weeks or months in advance to ensure ground station contact during critical HOWFS GITL periods. CGI does not support ‘joysticking’ or mid-observation changes!

Purple area of the Observation Data Analysis Environment = “sandbox” area available to CPP and CTC to develop and test data processing algorithms.

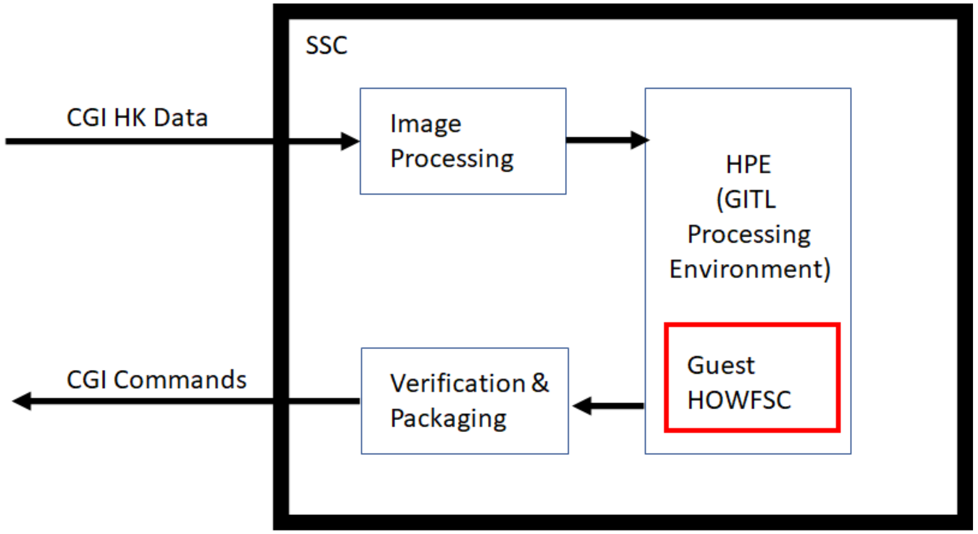


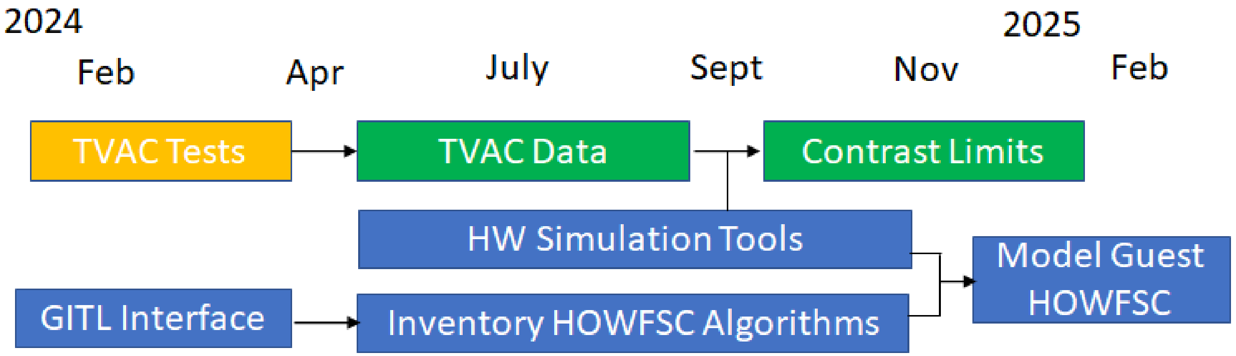
Potential for Guest HOWFSC

Guest HOWSFC: Open Loop



Guest HOWSFC: Closed Loop





Note: guest GITL modes not yet officially supported.

What Comes Next

- Launch!!! (October 2026)
- But there's still so much to do
  - Next Roman Research and Support Participation Opportunities Call Draft available now. Comments Due 10/1/2024
  - Stay tuned for AAS 245 CPP Splinter session announcement