Observation Planning Working Group

AAS Jan. 14

Presented by:

Schuyler Wolff

Meet the Team

Schuyler Wolff
Alexandra Greenbaum
Tyler Robinson
Karl Stapelfeldt
Vanessa Bailey
Rob Zellem
Sergi Hildebrandt
Sarah Blunt
Bruce Macintosh
Ell Bogat
Yui Kawashima
Hajime Kawahara

Frans Snik
David Doelman
Óscar Carrión-González
Jason Wang
Ramya M Anche
Hibiki Yama
Wolfgang Brandner
Matthias Samland
John Debes
Naoshi Murakami
Mark Marley
Robert De Rosa

Oliver Krause
Sarah Moran
Max Millar-Blanchaer
Marie Ygouf
Tsutsumi Nagai
Benjamin Charnay
Julien Girard
Gael Chauvin
John Livingston
Malachi Noel
Justin Hom
Dan Sirbu

Samantha Hasler
Kevin Ludwick
Cynthia Wong
Zhexing Li
Emmanuel Joliet
Beth Biller
Marah Brinjikji
Zarah L Brown
Masayuki Kuzuhara
Taichi Uyama
Tsutsumi Nagai
Elodie Choquet

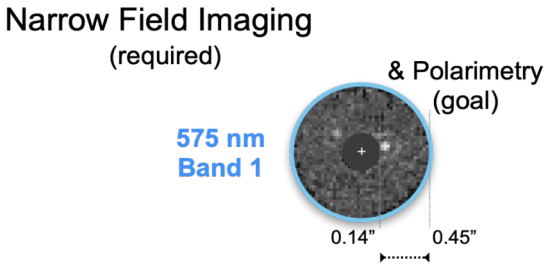
Shota Miyazaki
Toshiyuki Mizuki
Pengyu Liu
Motohide Tamura
Catherine Clark
Bijan Nemati
Guillermo Gonzalez
Alexis Bidot
Macarena Vega Pallauta
Nicholas Schragal

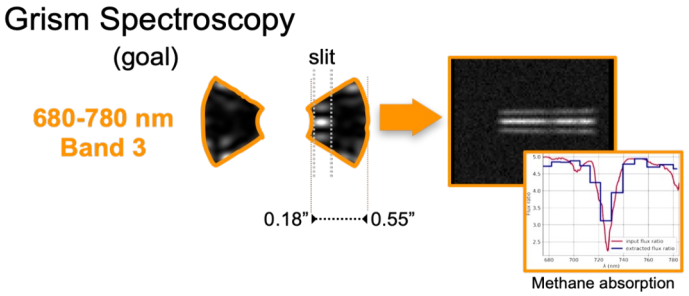
Working Group Goals and Responsibilities:

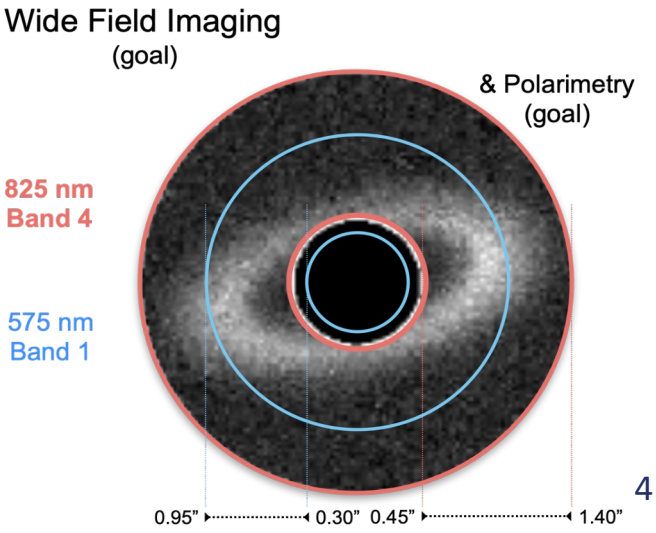
- **Target Selection:** science targets and reference/calibration sources.
- **Target Database:** https://plandb.sioslab.com/
- **Pre-launch target vetting observations**
- **Modeling of astrophysical targets:** shared with DRP and Sims working group.
- **Exposure Time Calculator:** https://github.com/hsergi/Roman_Coronagraph_ETC
- **Schedule of Observations:** Duration, Instrument configuration, requested time windows

Key Science Targets and Technology Demonstrations:

- Self Luminous Giant Planets
- Giant Planets in Reflected Light
- Debris Disks
- Exozodiacal Clouds
- HOWFS and Dark Hole Stability
- Contrast performance vs. stellar brightness, diameter
- Impacts of thermal settling







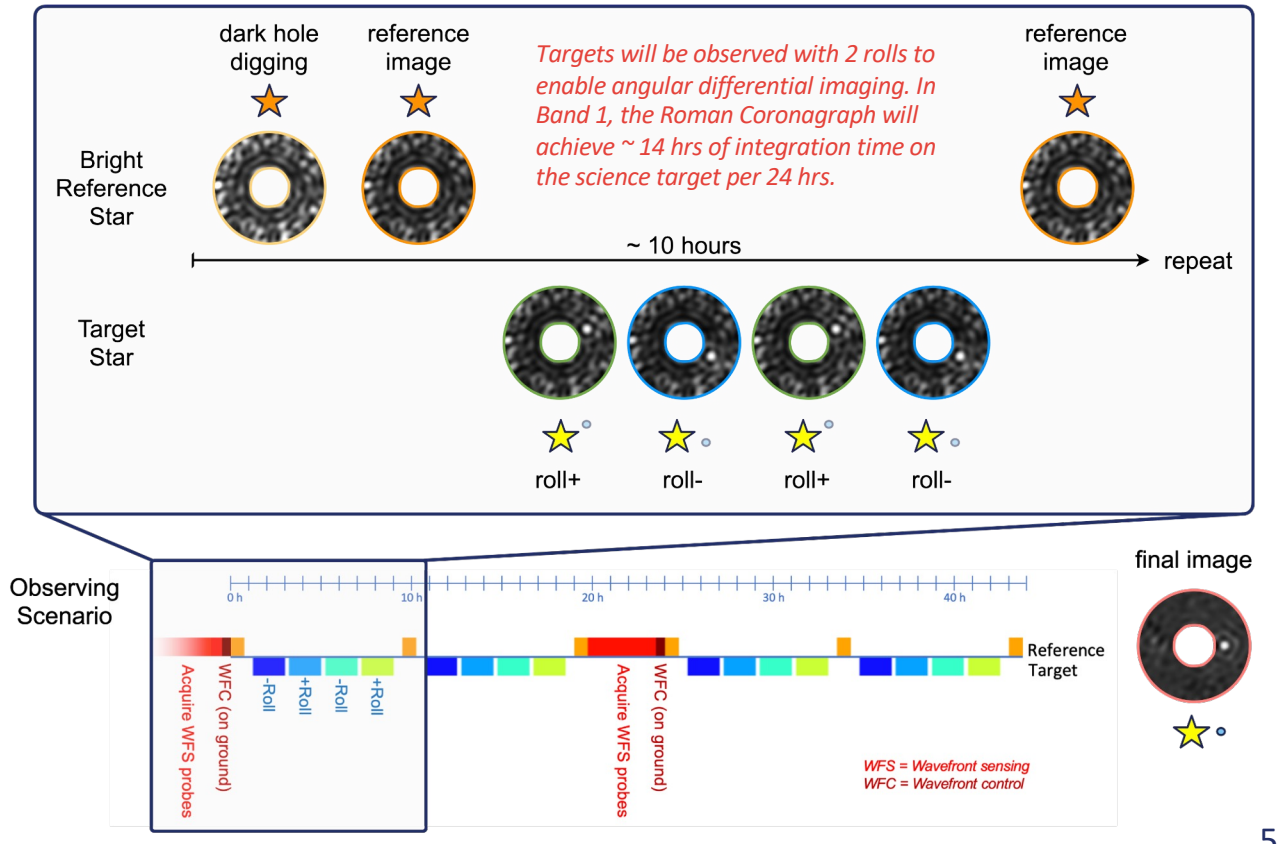
Targets stars preferred to have V < 5 and stellar diameters < 2 mas.

Typical Observing Scenario

5+ days before observing sequence set the DMs, cool cameras, take darks (CGI Secondary)

With CGI as primary:

- Pointing Refinement
- Flat Fields
- High Order Wavefront Sensing and Control (HOWFSC)
- **Run N instances of target/reference observing sequence**
- Core Throughput
- Flux Calibrations
- Astrometric Calibration



Calibration Efforts

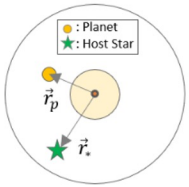
- For direct imaging, calibration provides the link between the extracted planet signal and the astrophysically interesting flux ratio.
- Spectroscopy, Astrometry and Polarized Imaging form additional cases with their own calibration requirements.

Lead: Bijan Nemati

Star Flux

via placement of star in dark hole and using a calibrated ND filter

also employs a 'ladder' of calibration standard stars

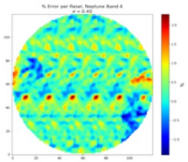


data: on orbit
processing: on ground

Flat Field

use dithered images of Neptune or Uranus

remove common-mode planet features using matched filter

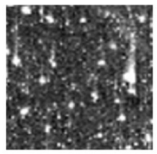


data: on orbit
processing: on ground

Charge Transfer Inefficiency

use trap pumping to identify charge traps

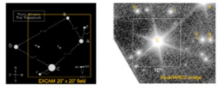
algorithm on ground processes each image for CTI removal



data: on orbit
processing: on ground

Astrometry

Provide absolute astrometric calibration of EXCAM's FOV



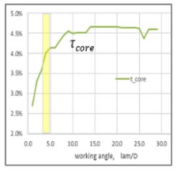
geometric astrometric solutions of stellar clusters obs.

data: on orbit
processing: on ground

Core Throughput

find planet position in dark hole

raster a photometric standard across the dark hole to measure core throughput vs. field position



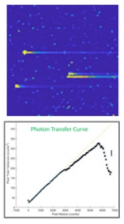
data: on orbit
processing: on ground

Image Corrections

Nonlinearity & Kgain; EM gain, PC corr., CR removal

use image data to: remove cosmic ray tails; calibrate EM gain

algorithm for threshold, coincidence corrections



data: on orbit
processing: on ground

Detector Noise Background

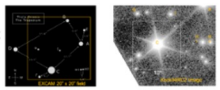
Get darks to: remove structure in dark current and CIC

prepare master dark from large number of frames

data: on orbit
processing: on ground

Polarimetry

Provide polarimetric calibration of EXCAM's FOV



Calculate Mueller matrix from polarimetric standards

data: on orbit
processing: on ground

Summary of Key Tools Under Development

The CPP builds upon existing tools produced by the Roman Science Investigation Teams. For a review of available simulation and performance tools see Douglas et al. (2020).

• **Exposure Time Calculator (ETC):** The ETC for the science camera onboard the Roman Coronagraph allows the user to select between two contrast performance modes: “optimistic” and “conservative.”

The successful completion of instrument performance testing has prompted an ETC update.

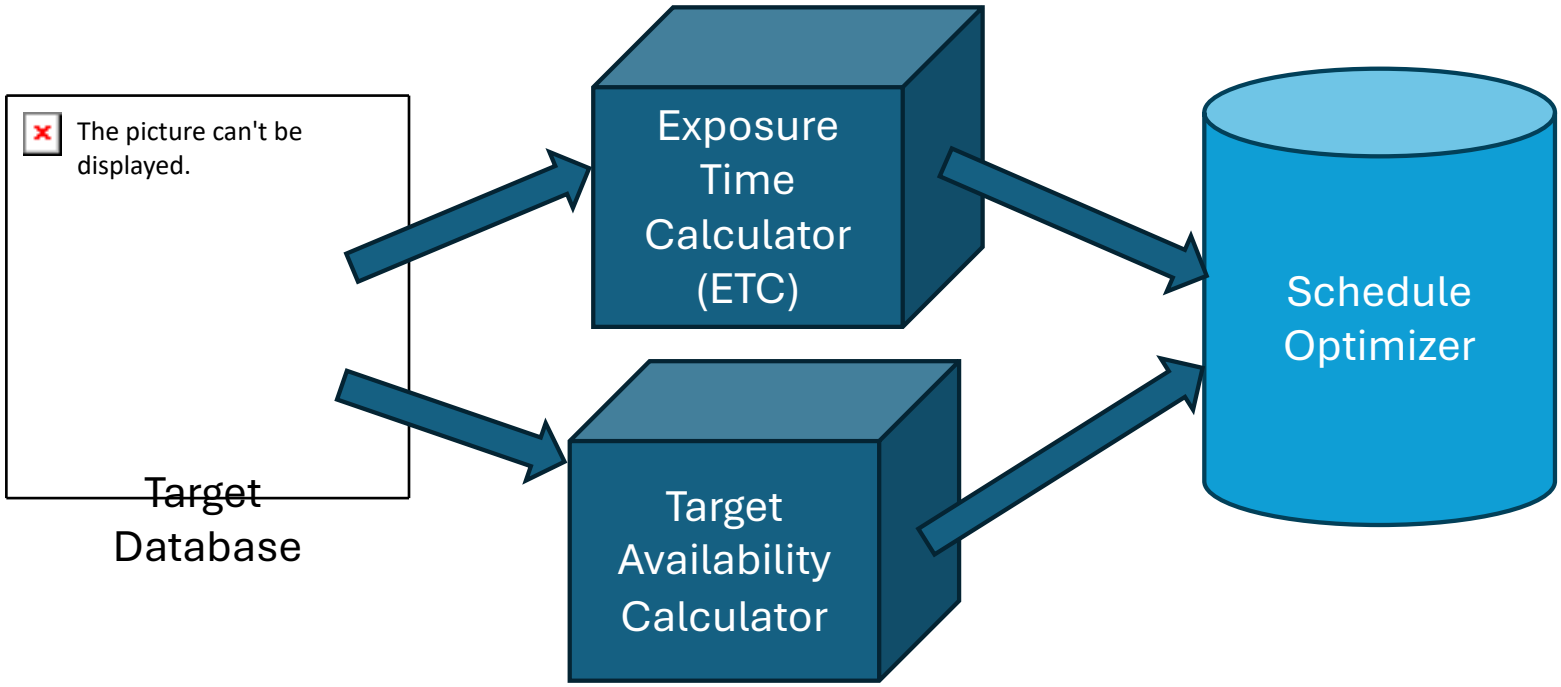
• **Imaging Mission Database:** combines information from the NASA Exoplanet Science Institute Exoplanet Archive (star, planet properties, orbital information) with planet photometry (Batalha et al. 2018) to generate maps of separation and Δmag for Roman targets of interest.

Planned Upgrades:

- *Expand database to include additional science (debris disks, exozodi targets, future GAIA targets) and calibration targets.*
- *Improved treatment of clouds etc. in atmospheric modeling.*
- *Update orbit solutions with RadVel (Fulton et al. 2018).*
- *Incorporate Roman orbital ephemera for optimization of science/wavefront reference pair selection.*

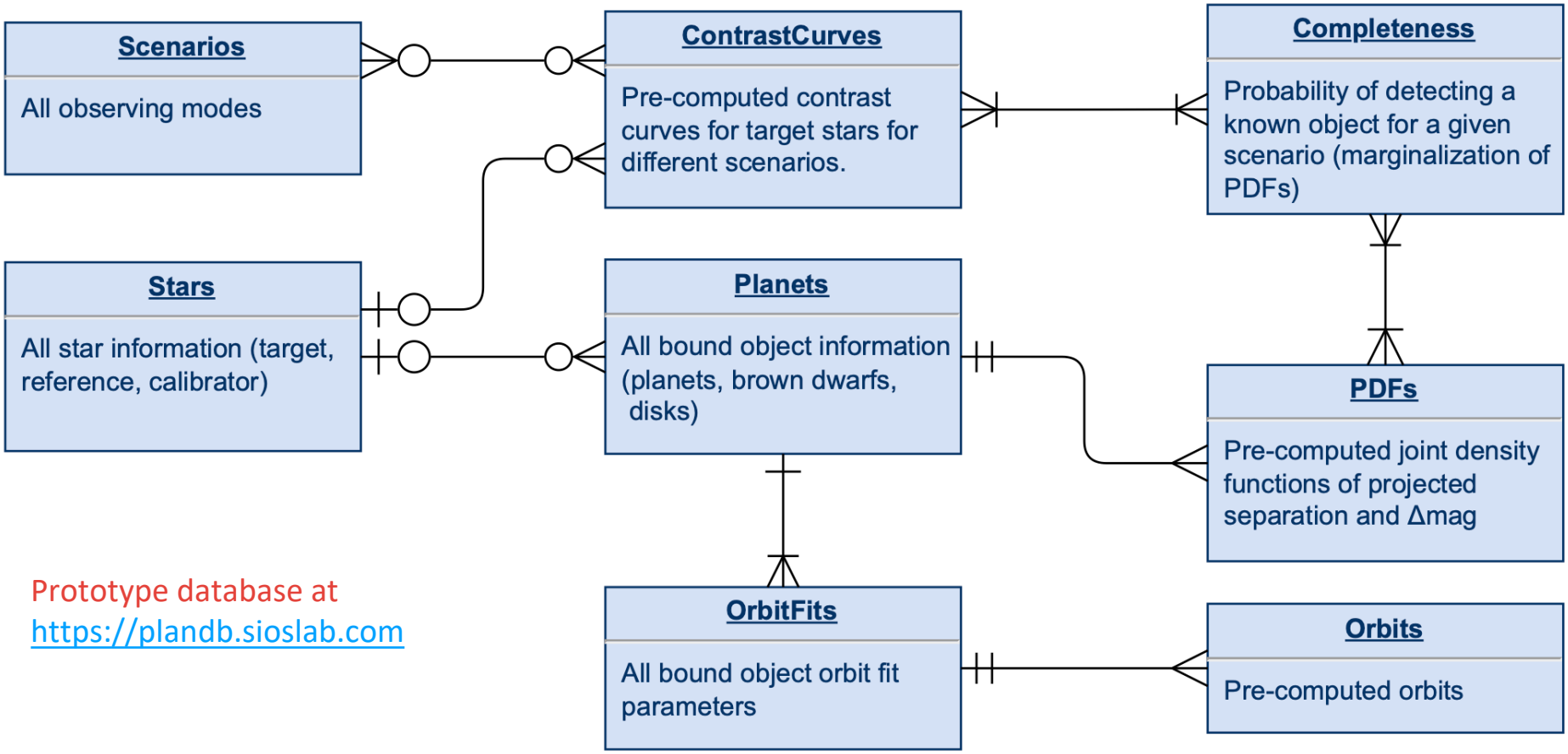
Summary of Key Tools Under Development

Goal: Optimize scheduling (timing and duration) of Coronagraph observations



Lead: Dmitry Savransky

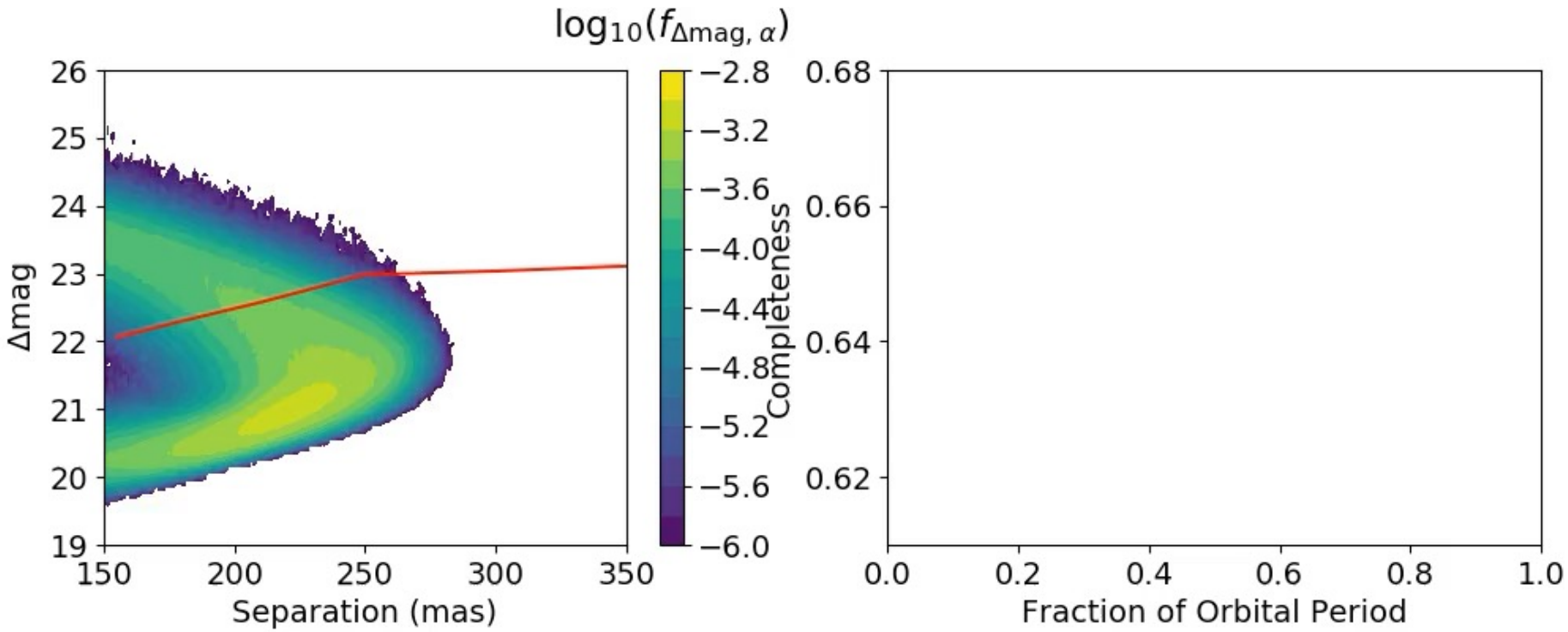
Target Database



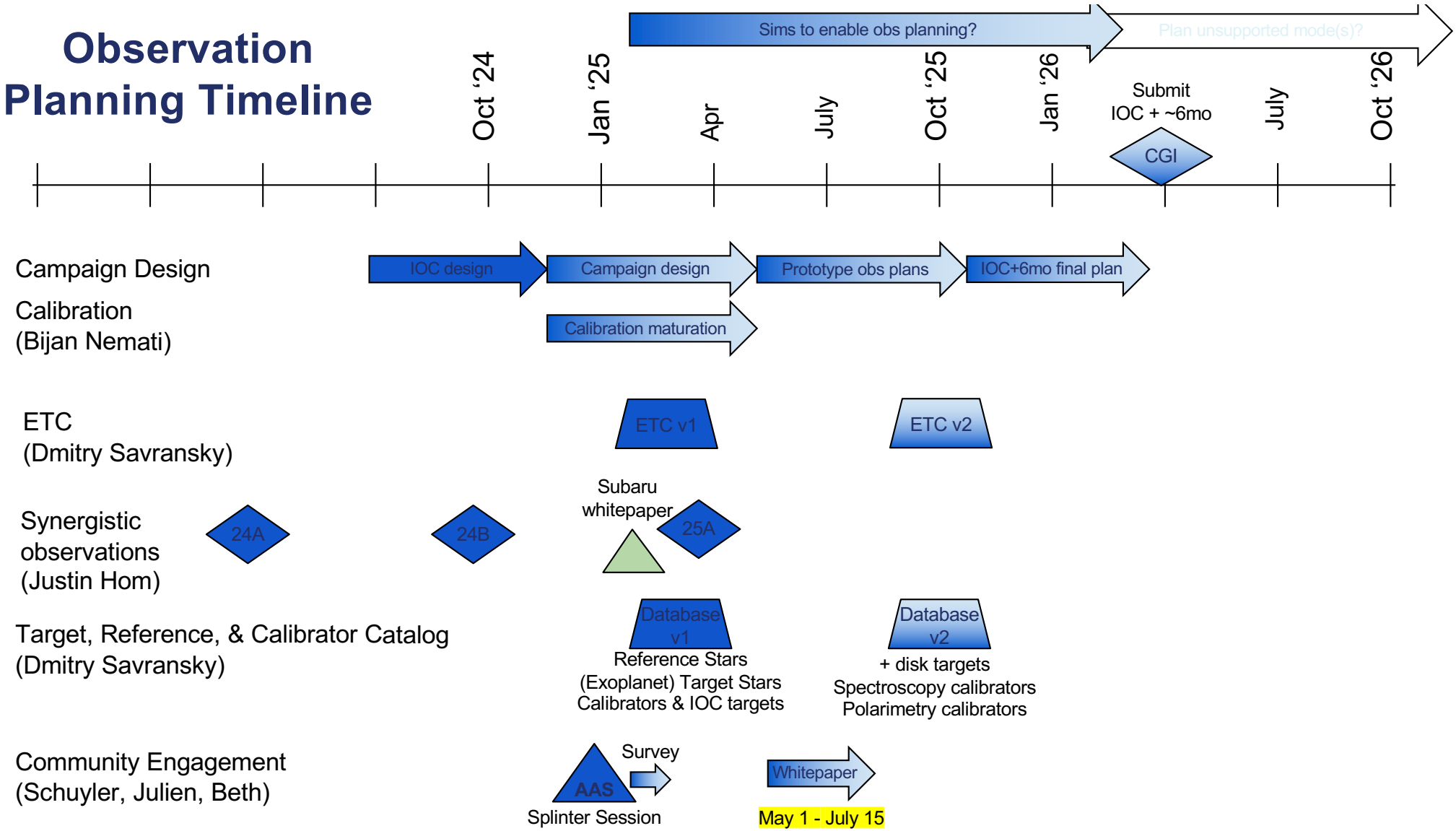
Prototype database at
https://plandb.sioslab.com

Scheduling Optimization

When you look has a major impact on your probability of success



Observation Planning Timeline



High Priority Needs

- Fill out the Community Interest Survey: tell us your priorities for the Roman Coronagraph and let us know if we've missed anything.
- Science, Reference, and Calibration Target vetting
  - Particularly seeking experts in NIRI, PIONIER, CLASSIC, and CLIMB datasets but open to any/all
- To mitigate Scheduling Risks, we'd like more science targets.
  - Do you know of potentially observable planets not yet included in the NASA Exoplanet Archive?

Team Contacts

Observation Planning Working Group Lead
Schuyler Wolff
sgwolff@arizona.edu

Calibrations Working Group Lead
Bijan Nemati
bijan@tellus1.com

Reference Vetting Working Group Lead
Justin Hom
jrhom@arizona.edu

Atmospheric Modeling Lead
Zarah Brown
zarahbrown@arizona.edu

RV orbit modeling lead
Sarah Blunt
sarah.blunt.3@gmail.com
https://github.com/sblunt/roman-orbits

Database and ETC lead
Dmitry Savransky
ds264@cornell.edu