# Roman CPP Splinter Session
# Hardware Working Group Update

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# Hardware Working Group Members

- 39 CPP team members part of the Hardware working group
- Team members include Coronagraph project members, IPAC team, and CPP participants

Dan Sirbu (Co-Lead)
Laurent Pueyo (Co-Lead)
Ruslan Belikov
Vanessa Bailey
Eric Cady
John Krist
Alexandra Greenbaum
Karl Stapelfeldt
Rob Zellem
Neil Zimmerman
Hanying Zhou
Markus Feldt
Jessica Gersh-Range

Aoi Takahashi
Frans Snik
David Doelman
Axel Potier
Tyler Groff
Jun Nishikawa
Hibiki Yama
Motohide Tamura
Remi Soummer
N. Jeremy Kasdin
Naoshi Murakami
Kenta Yoneta
Oliver Krause

Arthur Vigan
Max Millar-Blanchaer
Julien Girard
Emiel Por
Marie Ygouf
Susan Redmond
Leonid Pogorelyuk
Pierre Baudoz
Alexis Lau
Byoung-Joon Seo
Eduardo Bendek
Iva Laginja
Jorge Llop Sayson

# Charter & Objectives

**Charter:** Leverage both guest higher order wavefront sensing & control (HOWFSC) techniques and to advance technology demonstration objectives for the Roman coronagraph instrument. Identify and develop techniques that can enhance benefit to HWO. Coordinate with coronagraph project to assist commissioning and operation of baseline modes including analysis of FFT, TVAC, and on-orbit data.

**Resources:** Roman coronagraph instrument data (FFT, TVAC, operations), HCIT OMC, community testbeds

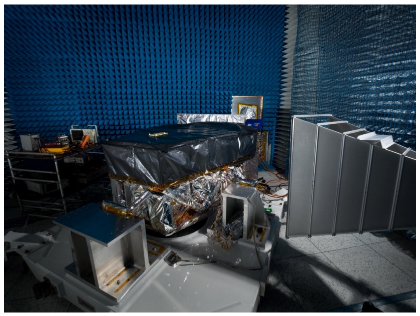
**Objective 1: *Assisting the Coronagraph Project* with commissioning and operation of the baseline mode:**
1. Learn about and document the current commissioning and operating baseline mode (HLC Band 1) including wavefront sensing and control.
2. Identify technical gaps and needs in the commissioning and operation mode and match with the working group members.
3. Develop a CPP working group model of the Roman HLC Band-1 wavefront control and sensing to enable simulated tests of baseline operation and simulated tests of anomalies.

**Objective 2: *Assisting the Coronagraph Project* with additional modes*:**
1. Inventory of additional operating modes and their technical requirements
2. Augment instrument model for baseline mode with additional modes
3. Identify technical requirements and differences to baseline mode

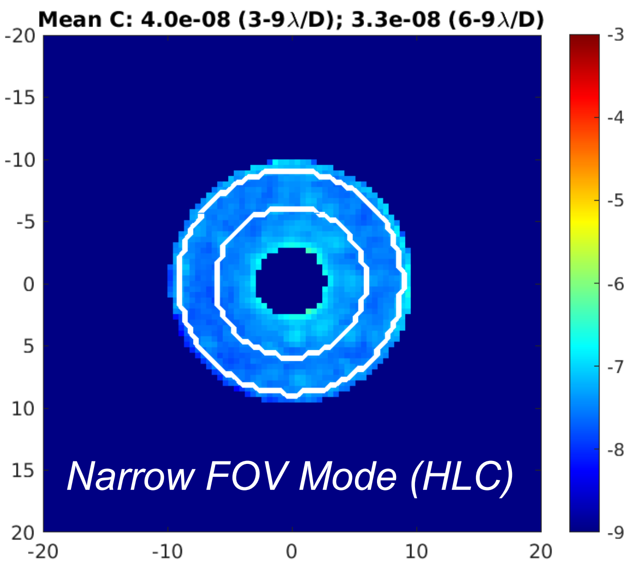
**Objective 3: Researching additional HOWFSC algorithms*:**
1. Inventory HOWFSC algorithms that can be deployed to the Roman coronagraph
2. Identify their technical requirements and modifications compared to baseline mode
3. Augment instrument model to include additional HOWFSC algorithms

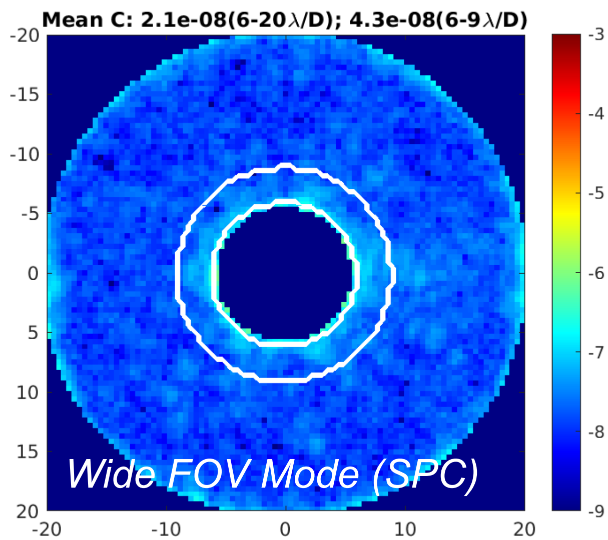
**if the opportunity is available*

# Coronagraph Integration & TVAC



*Credit: Caltech/JPL Roman Coronagraph Instrument*



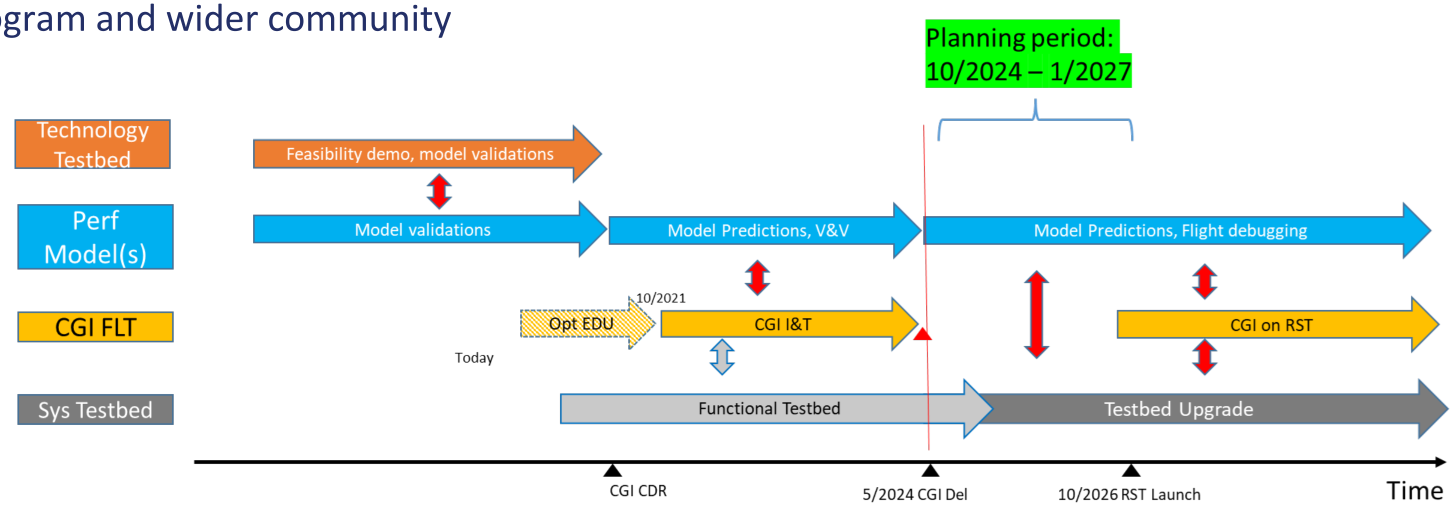




*Credit: Performance summary Eric Cady, TVAC Info Session August 2024*

- Roman coronagraph has reached
- Requirements in TVAC tests
- Coronagraph instrument assembled and integrated with Roman by December
- Hardware WG manages TVAC data release

# CGI Post-Delivery: Hardware WG

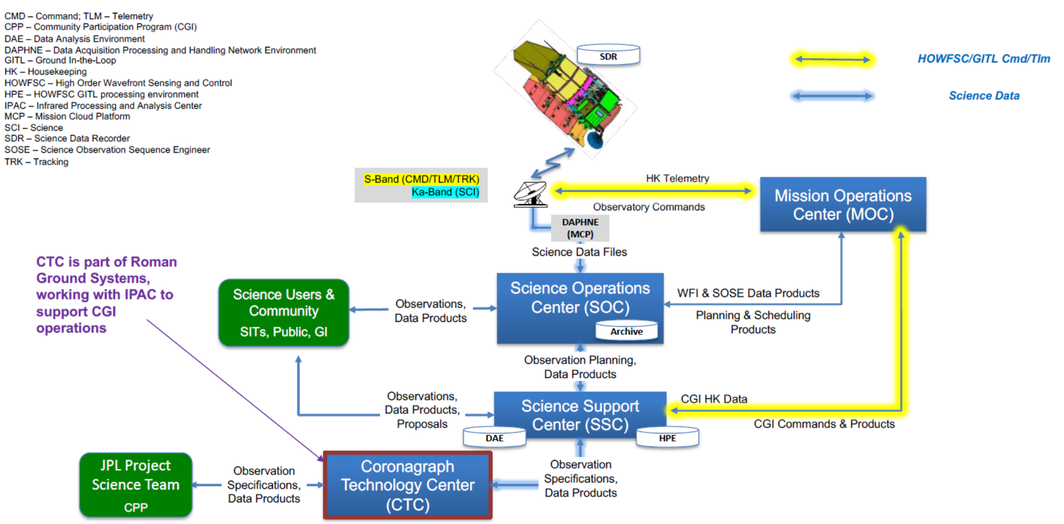
- Define an enhanced mode development and maturity process to provide the opportunity for guest HOWFSC wavefront sensing & control algorithms to be operated with GITL, if possible
- Coronagraph Project Charge: Produce <u>enhanced mode performance simulations</u> based on the as-built CGI hardware, making these simulations to the Coronagraph Community Participation Program and wider community




*Note:* The CGI project shall manage this additional work to ensure that no adverse impact is made on the continued support of the Coronagraph flight hardware and operations preparation.

*From: Feng Zhao TVAC Info Session August 2024*

# Ground-in-the-Loop (GITL) Architecture

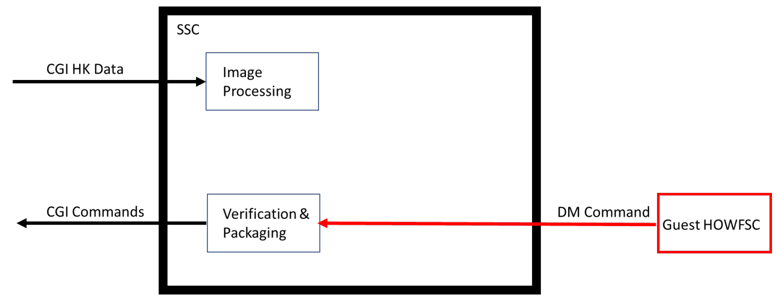



*Credit: Alex Greenbaum (IPAC)*

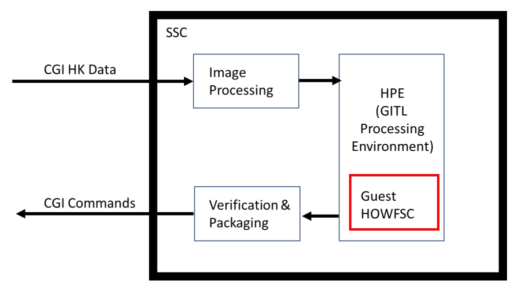
- Hardware WG members have been interfacing with the coronagraph project and SSC to determine current GITL
- Interface to define guest HOWFSC algorithm operation.

**Cannot adopt algorithms that make changes to the Roman Flight SW*

***Case 1***: Open-loop operation of guest HOWFSC algorithm




***Case 2***: Closed-loop operation of guest HOWFSC algorithm



# Enhanced Mode Development Process

***Who?*** | ***What?***

**Roman CPP**

***Step 1: Description of enhanced mode***
- summary of method, benefits, and needs (modifications) compared to standard EFC

Informational

***Step 2: Description current maturity level applied to Roman CGI (testbed demos)***
- summary of simulations of method showing performance benefits, experimental demos

Proof of concept

***Step 3: Simulation using baselined Roman coronagraph tools***
- Can the enhanced mode be simulated using publicly available project tools e.g., Roman pre-flight model, CorgiSim, FALCO, etc.

Roman CGI compatibility

***Step 4: Robustness of enhanced mode to expected Roman CGI conditions***
- Does the enhanced mode work under a variety of realistic conditions? e.g., Roman TVAC data, OS11/12, Monte Carlo initial conditions, etc.

Roman CGI preparation

**Project Modelers**

***Step 5: Validation of enhanced mode outputs***
- Sanity-check DM outputs, exposure times, calibration requirements, etc.

Initial Validation

***Step 6: Project validation of enhanced mode functionality***
- Project sets requirements to test inputs and validate outputs

Thorough Validation

**Project Developers**

***Step 7: Implementation of enhanced mode***
- Roman coronagraph project implements necessary changes to GITL, performs final functional testbed demonstrations (if available)

Implementation

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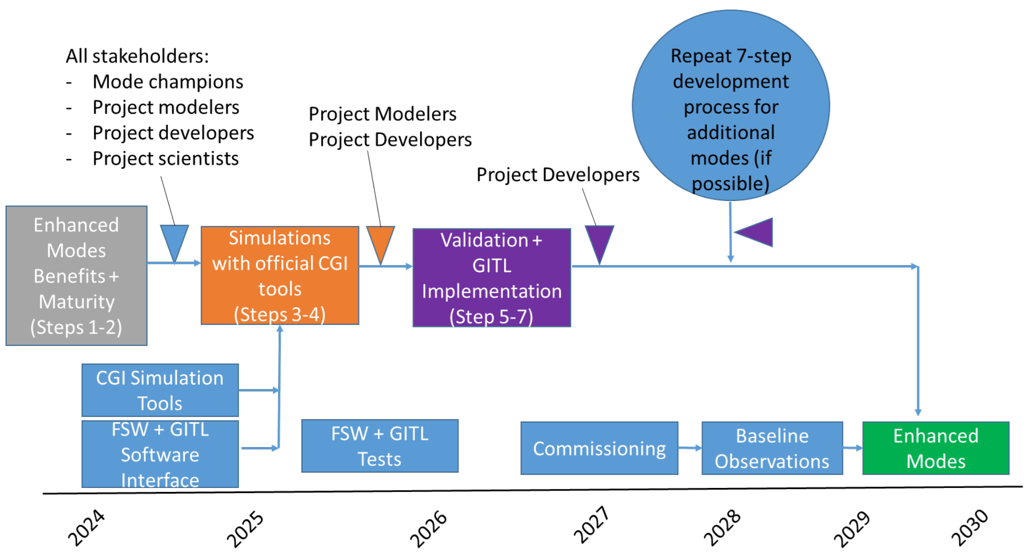
# Enhanced Mode Development Summary

- Hardware WG organized within development teams for individual enhanced modes
- Defined mode summaries and initial technical descriptions responding to coronagraph questionnaire

***Development Process Timeline***




***Enhanced modes summary & POCs:***

[1] *Coherent Differential Imaging on Speckle Area Nulling (CDI-SAN), Kenta Yoneta (NAOJ)*

[2] Coherent Reference Differential Imaging (CoRDI), *Susan Redmond (Caltech)*

[3] Dark Zone Maintenance, *Susan Redmond (Caltech)*

[4] High-order mode dither library (HOM-dither), *Elodie Choquet (LAM)*

[5] Implicit Electric Field Conjugation (iEFC), *Justin Hom (Univ. of Arizona)*

[6] Multi-Star Wavefront Control (MSWC), *Ruslan Belikov (NASA Ames)*

[7] Optimizing pairwise probes for extended linearity, *Iva Laginja (Obs. Paris)*

[8] Speckle Area Nulling (SAN), *Kenta Yoneta (NAOJ)*

# Conclusions

- Hardware Working Group consists of 39 Roman community partnership program members interfacing with the coronagraph project team at JPL and IPAC
- Provides access to resources including TVAC data, descriptions of coronagraph and ground-in-the-loop (GITL) architecture to enable baseline and enhanced modes
- Hardware WG is defining a development process for maturing enhanced modes by individual CPP teams to be compatible with Roman coronagraph GITL architecture.
- Currently received 8 guest HOWFSC algorithm summaries and technical descriptions.
- Next development steps include: (1) review of technical descriptions, (2) simulations with official CGI + CPP tools, (3) observation sequence definition, (4) more detailed technical descriptions
- Seeking community testbeds available to test enhanced mode algorithms in configurations relevant for Roman coronagraph