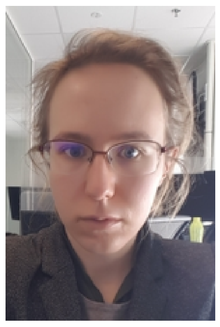
Roman Coronagraph Community Participation Program & ESCAPE Project:

Simulating Roman Coronagraph Observations with CorgiSim and CPGS



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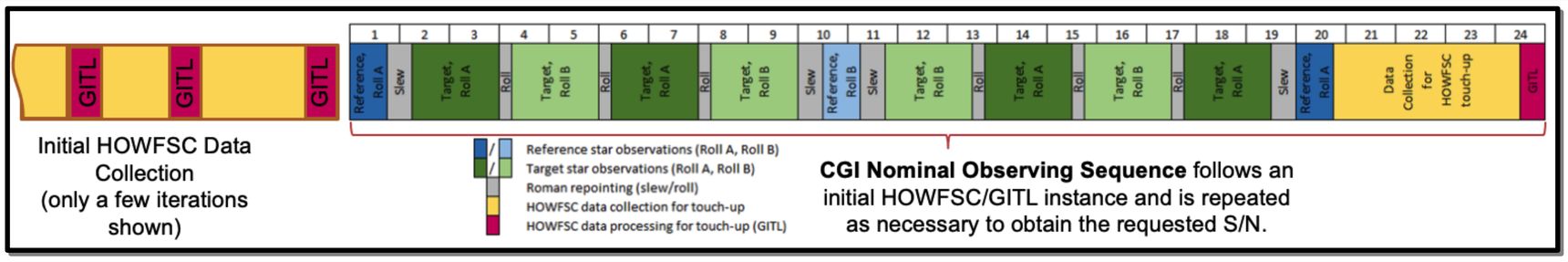
Introduction: The Nancy Grace Roman Space Telescope will host the Roman Coronagraphic Instrument (CGI), a technology demonstrator for high-contrast imaging and direct detection of giant exoplanets. **CorgiSim** will be the baseline pipeline to simulate the observing programs for CGI. It generates realistic detector data and can simulate complete observing sequences through its integration with the Command Product Generation Software (CPGS).



Commande Product Generation Software (CPGS)

Target Selection

Target Name: Eps Eri — SIMBAD Lookup

V Magnitude: 3.73 | Spectral Type: K | Subtype: 2.0

Reference Selection

Observe Target Only

Reference Name: Delta Eri — SIMBAD Lookup

V Magnitude: 3.54 | Spectral Type: K | Subtype: 0.0

CGI Configuration

Coronagraph/Mask: HLC/Narrow

Filter: Band 4 (825 nm)

Observation Scenario

D_{seq}, the Duration of an observing sequence (hours): 16 | N_{seq}, the number of observing sequences: 1

Orientation A (degrees): -3.0 | Orientation B (degrees): 3.0

N, the Number of Target Star visits prior to the mid-cycle Reference visit (each visit toggles the orientation): 2

R, the ratio of Reference to Target Star durations (hours): 0.1875

Orientation Constraint Select Constant Roll Angle if you want these angles to fix the observatory roll (azimuthal orientation of boresight with respect to the Sun) for your target and reference star(s). Select Constant Position Angle if you want these angles to instead fix the azimuthal orientation of the FOV on the sky (centered on the target/reference star).

- ○ Constant Roll Angle
- ◉ Constant Position Angle

Target Integration Parameters

AutoGain: ○ Yes ◉ No

Gain: 1000

Exposure Time per Frame (seconds): 5

Photon Counting Mode Photon counting mode is recommended in most if not all cases for direct imaging of faint targets at high contrast.: ◉ Yes ○ No

☑ Obtain satellite spot image every visit

Number of pairs: 2 pairs

Satellite Spot Intensity (Pair 1) (relative to Target Star): 0.000001 | Satellite Spot Intensity (Pair 2) (relative to Target Star): 0.000001

Clocking angle on camera of 1st spot(Pair 1) (0 degrees = along camera X): 0.0 | Clocking angle on camera of 1st spot(Pair 2) (0 degrees = along camera X): 90.0

Radial Distance from Star (Pair 1) (λ/D): 10 | Radial Distance from Star (Pair 2) (λ/D): 10

```
<target_name>Eps Eri</target_name>
<target_v_mag>3.73</target_v_mag>
<target_spec_type>K</target_spec_type>
<target_sub_type>2.0</target_sub_type>
<observe_target_only>0</observe_target_only>
<reference_name>Delta Eri</reference_name>
<reference_v_mag>3.54</reference_v_mag>
<reference_spec_type>K</reference_spec_type>
<reference_sub_type>0.0</reference_sub_type>
<coronagraph_mask>1</coronagraph_mask>
<filter>1</filter>

<cgi_visit number="6">
  <!--Roll Angle: 3.00 degrees-->
  <!--Absolute position angle (deg):-->
  <position_angle>24.40</position_angle>
  <coronagraph_configuration>WFOV</coronagraph_configuration>
  <fixed_target>
    <!--Eps Eri-->
    <target_id>6</target_id>
    <reference_target>Y</reference_target>
  </fixed_target>
  <cgi_excam>
    <auto_gain>N</auto_gain>
    <gain>1000.0</gain>
    <!--Per-frame exposure time (s)-->
    <frame_time>5.000</frame_time>
    <!--Process using photon-counting mode?-->
    <photon_counting>Y</photon_counting>
    <!--Number of frames per exposure (approximate)-->
    <number_of_frames>20</number_of_frames>
    <observe_satellite_spots>Y</observe_satellite_spots>
    <!--Satellite Spot Pair ID for slot "AAC_OCCAPP_SLOT0"-->
    <satellite_spots_pair_id>2</satellite_spots_pair_id>
    <satellite_spots_gain>888.000</satellite_spots_gain>
    <!--Satellite spots per-frame exposure time (s)-->
    <satellite_spots_frame_time>2.622</satellite_spots_frame_time>
    <!--Number of frames per satellite spot exposure (commanded)-->
    <satellite_spots_number_of_frames>3</satellite_spots_number_of_frames>
  </cgi_excam>
</cgi_visit>
```

CorgiSim

Scene
+ host_star_properties: dict
  - host_star_Vmag
  - host_star_magtype
  - host_star_sptype
  - ref_flag
+ point_source_info
...

Optics
+ optics_keywords: dict
  - cor_type
  - ...
+ bandpass
+ roll_angle
+ satspot_keywords: dict
  - num_pairs
  - sep_lamD
  - angle_deg
  - contrast
...

Detector
+ em_gain
+ photon_counting
...

User defines path to .xml file, planet position and magnitude

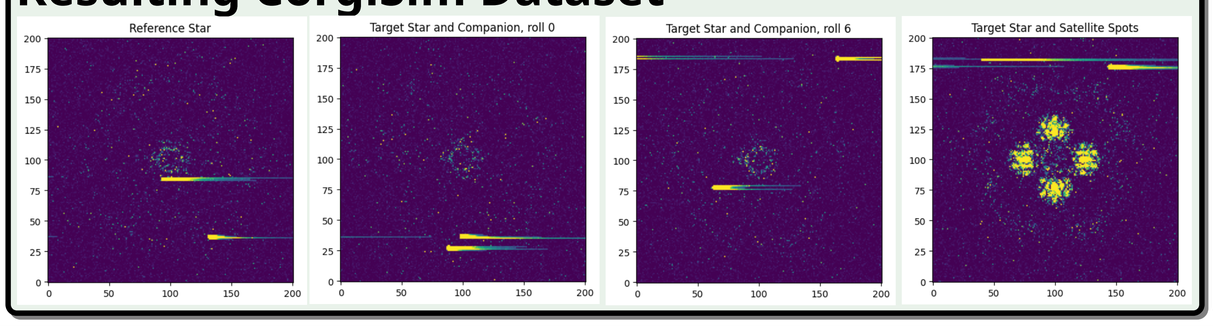
mag_companion = [24.73]

companion_dra = [-750]

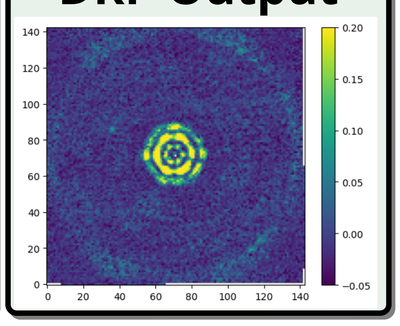
companion_ddec = [300]

```
observation.generate_observation_scenario_from_cpgs('path/to/xml',
                                                    point_source_info=point_source_info)
```

Resulting CorgiSim Dataset



DRP Output



REFERENCES

- Bailey, Vanessa P., et al. "Nancy Grace Roman Space Telescope coronagraph instrument overview and status." *Techniques and Instrumentation for Detection of Exoplanets XI* 12680 (2023): 283-293.
- Millar-Blanchaer, Maxwell Andrew, et al. "The Roman Coronagraph community participation program: data reduction and simulations." *Space Telescopes and Instrumentation 2024: Optical, Infrared, and Millimeter Wave*. Vol. 13092. SPIE, 2024.

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