



**Jet Propulsion Laboratory**  
California Institute of Technology

# Brief Intros to Public Roman CGI Software: CGISim, FALCO, & lowfssim

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# Links for Deep Dive Sessions

- July 27, 2021 — [CGISim](#) and [measured optics](#). John Krist and Gary Kuan (JPL). Recording [here](#).
- Nov 03, 8am **PDT** (not PST) — [FALCO for the Roman Coronagraph Instrument](#). A. J. Riggs (JPL)
- *[November 7: Daylight Savings Time ends in USA]*
- Nov 11, 9am PST — [lowfssim for simulating the Roman Coronagraph Instrument Low Order Wavefront Sensor](#). Brandon Dube (JPL)
- *[not previewed in these slides]*  
Nov 18, 9am PST — [Roman Coronagraph Exposure Time Calculator](#). Sergi Hildebrandt Rafels (JPL)

After each talk, the slides and recording will be posted on the IPAC Roman website [here](#).

# Public CGI Modeling Software

- **PROPER**

- General optical propagation library upon which the CGI model is based
- Available for IDL, Matlab, & Python

- **roman\_phasec\_proper**

- CGI Phase C PROPER-based diffraction model
- Includes telescope & CGI optics, aberrations, polarization, DMs, and masks
- Available for IDL, Matlab, & Python

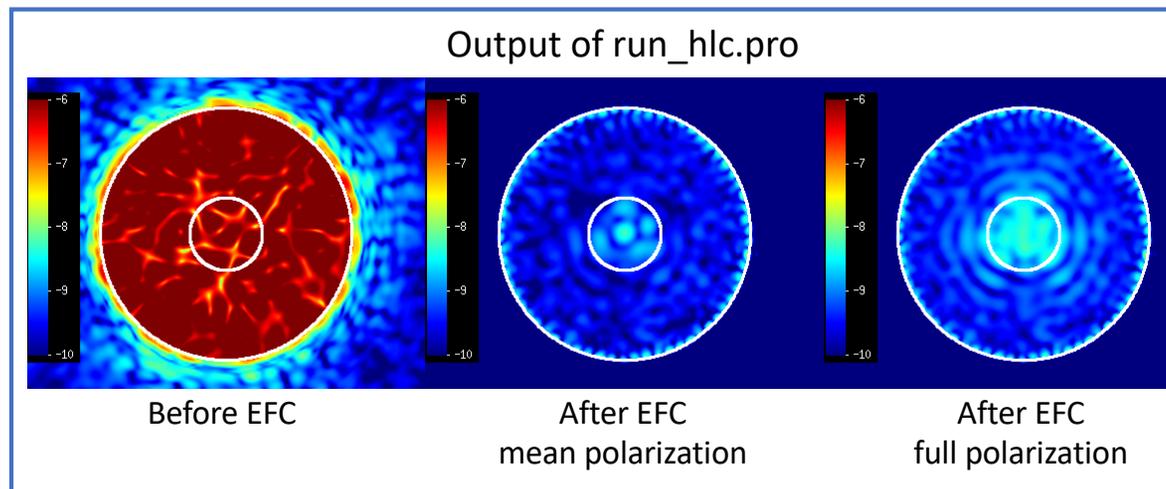
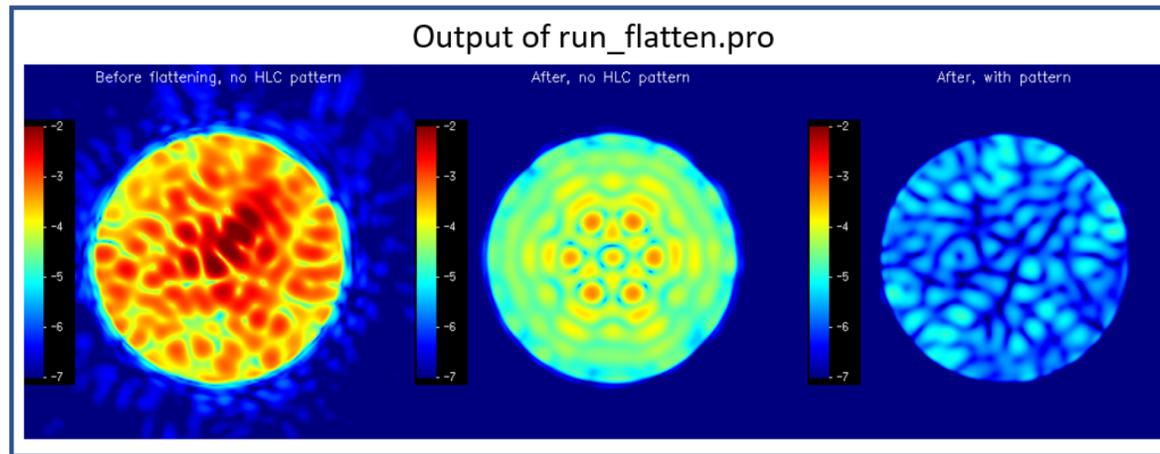
- **CGISim**

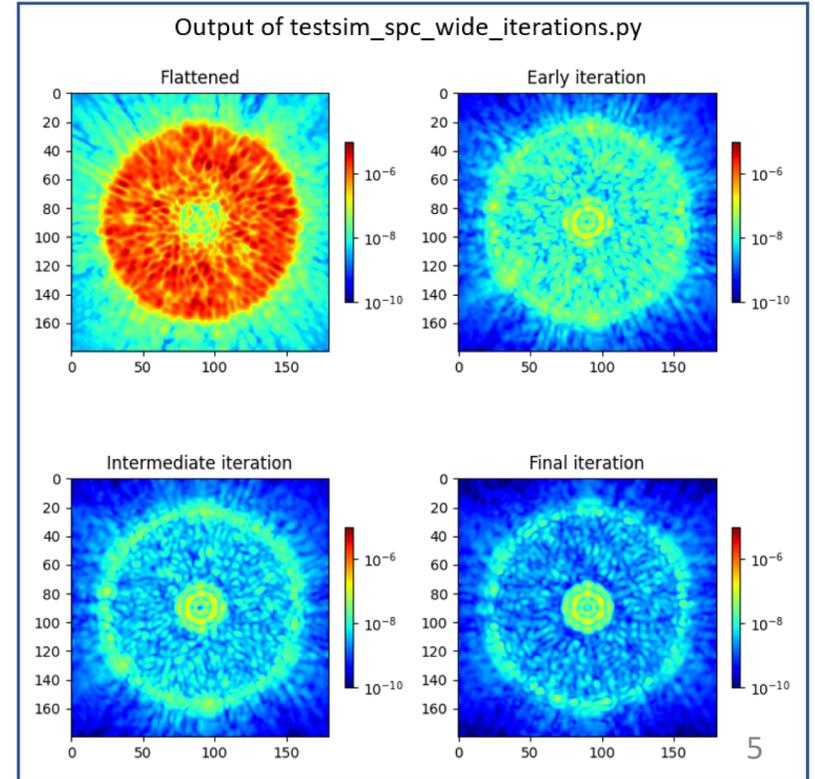
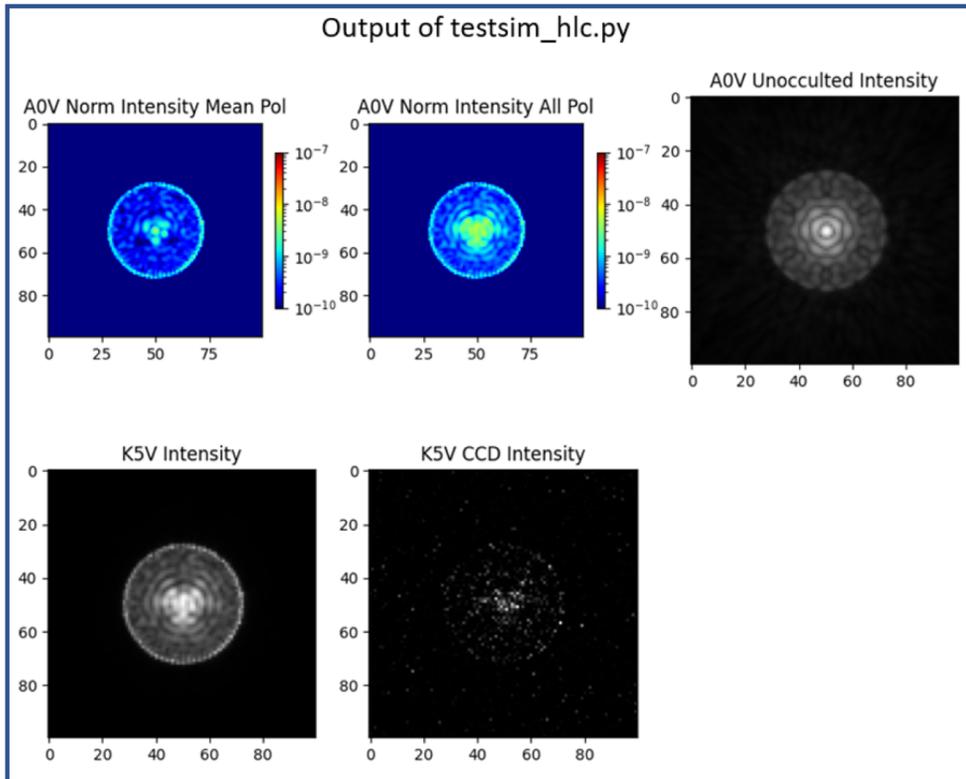
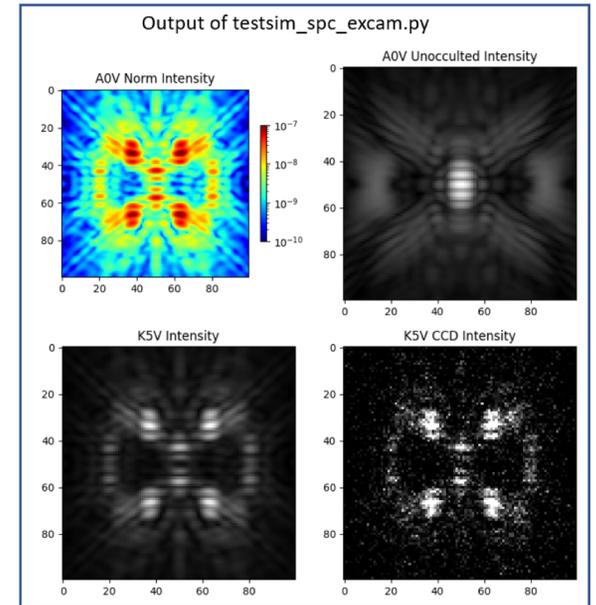
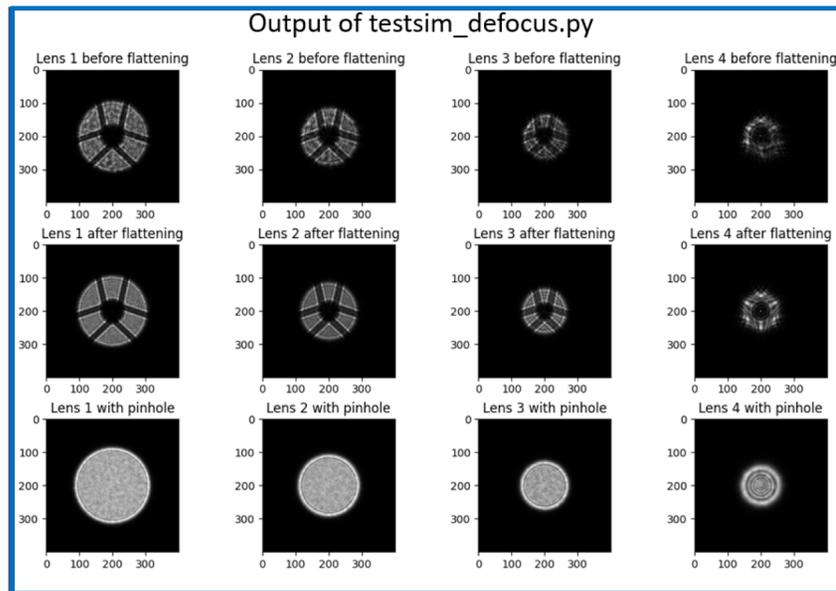
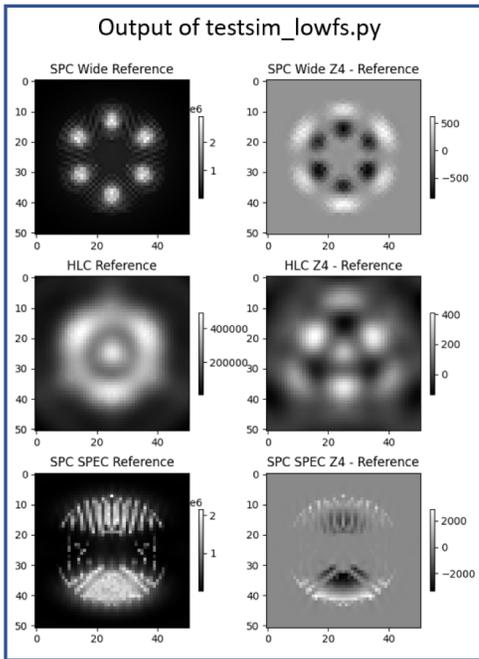
- Python wrapper around roman\_phasec\_proper Python model
- Includes stellar spectra and flux prediction
- Produces intensity images, optionally with EMCCD noise
- Primarily created for for single-image generation to investigate phase retrieval and image morphologies for exposure time estimation

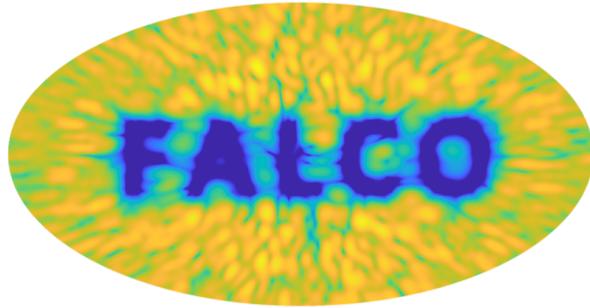
All of these packages include documentation.

None of these perform wavefront sensing/control (that's what FALCO does), or models pointing jitter (need to generate separate pointing offsets)

<https://sourceforge.net/projects/cgisim/>

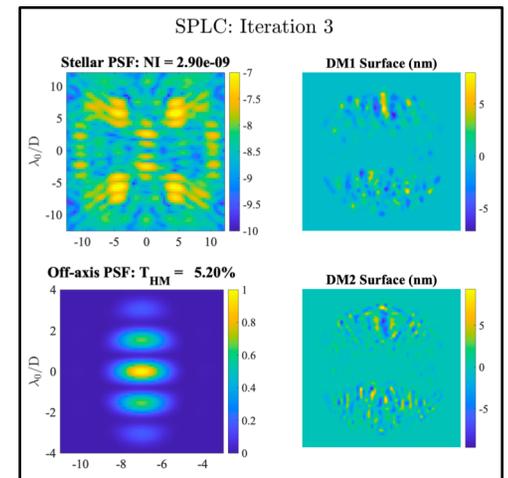






# + roman\_phasec\_proper

- FALCO is a software package for performing high-order wavefront sensing and control (**HOWFSC**) in simulation and on testbeds
  - Available in [Python](#) and [Matlab](#).
- Can be used as a **wrapper** to run HOWFSC with PROPER models.
- Repos include **example scripts** to run HOWFSC on all high-contrast mask configs of the Roman CGI
  - Yes: FALCO + roman\_phasec\_proper
  - No: FALCO + CGISim. (CGISim itself is a wrapper)
- Same general HOWFSC algorithms as the official CGI ground-in-the-loop software, but not the same code or implementation.
- Instructions provided in the GitHub wiki.



<https://github.com/ajeldorado/falco-matlab>  
<https://github.com/ajeldorado/falco-python>

# lowfssim: LOWFS Simulator

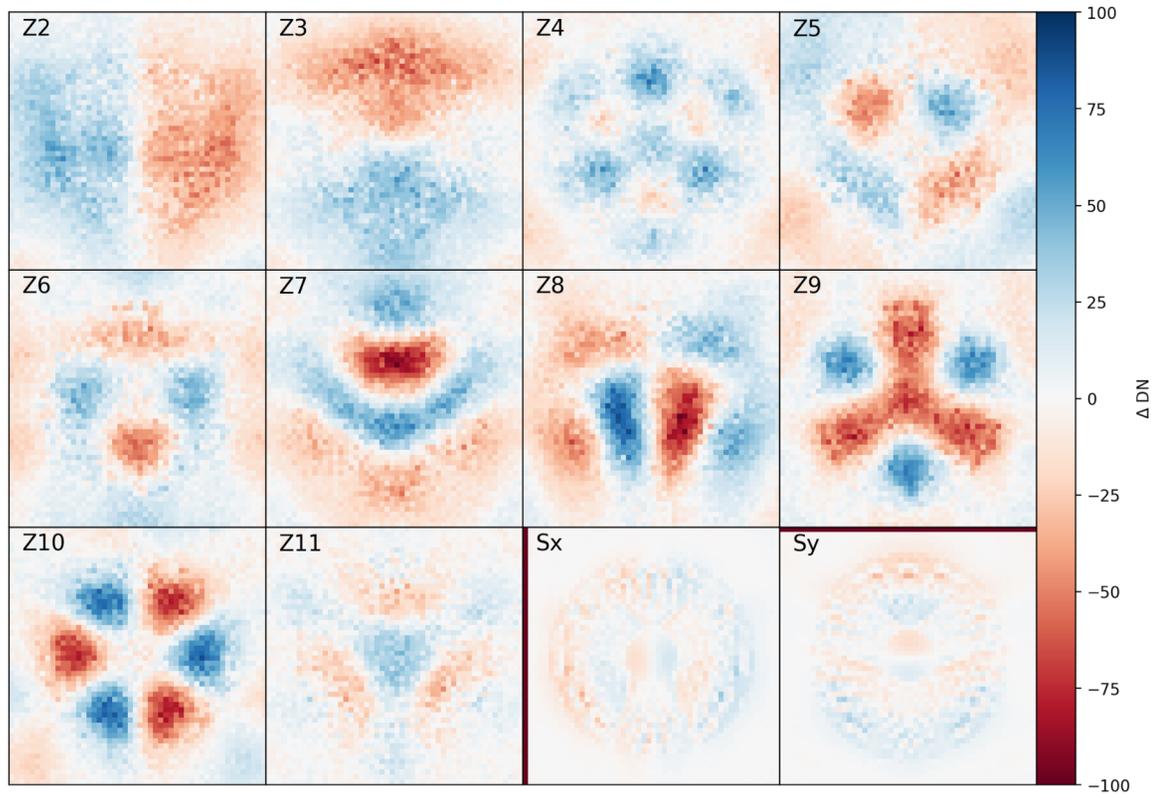
- Python  $\geq 3.6$  integrated model of CGI front-end and LOWFS
- Includes flight wavefront sensing algorithm and calibration procedures
- Public release includes 'framework' for wavefront control, but no controllers\*
- Requires only basic knowledge of python
  
- Can out-speed hardware LOWFS in real-time with no loss of fidelity ( $\sim 2.2\text{kHz}$ )
- Includes examples and thorough API documentation
- With it you can...
  - Evaluate the performance of LOWFS open and closed\* loop
  - Generate matched sets of real Zernike coefficients, LOCAM images, and LOWFS estimates
  - Explore augments to LOWFS for future mission concepts

the underlying diffraction library is prysm

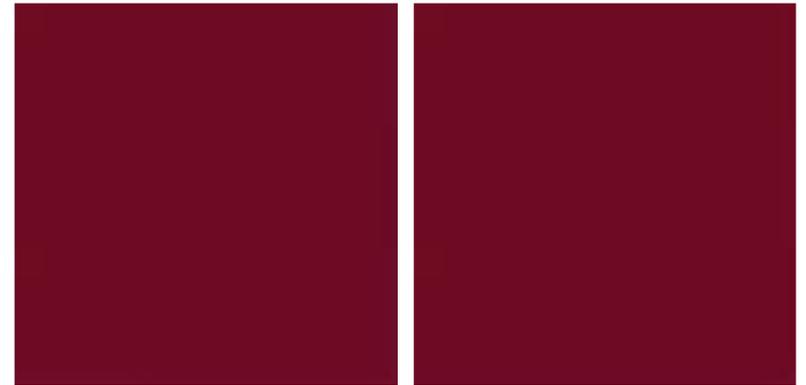
<https://github.jpl.nasa.gov/bdube/lowfssim>

<https://github.com/brandondube/prysm>

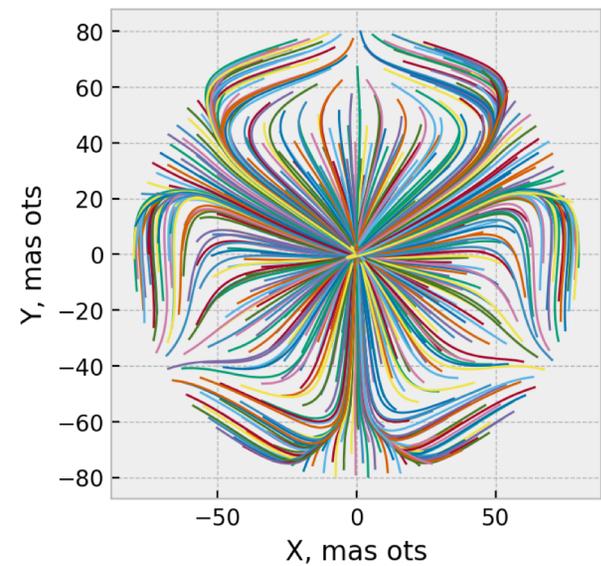
# lowfssim: LOWFS Simulator



*forward sensitivities at LOCAM for LOWFS modes in HLC configuration*



*Dynamics at LOCAM as Z2 calibration is done with influence of WFSC & Disturbances*



*Trajectories of hundreds of  
LOS capture studies*