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

John Krist, A.J. Riggs, Brandon Dube

October 26, 2021

Jet Propulsion Laboratory, California Institute of Technology
Links for Deep Dive Sessions


• 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 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/
Output of run_flatten.pro

Output of run_hlc.pro

Before EFC  After EFC  After EFC
mean polarization  full polarization
FALCO + 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 >=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 (~2.2kHz)
- 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

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

forward sensitivities at LOCAM for LOWFS modes in HLC configuration

Trajectories of hundreds of LOS capture studies