VERA C. RUBIN
OBSERVATORY

AOS closed loop with imSim

NSF

AURA

U.S. DEPARTMENT OF ENERGY

SLAC

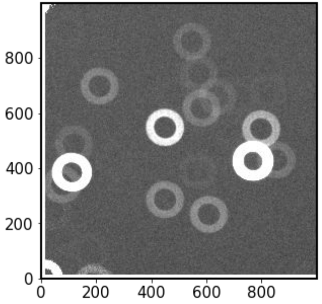
CHARLES AND LISA SIMONYI FUND
FOR ARTS AND SCIENCES

LSST CORPORATION

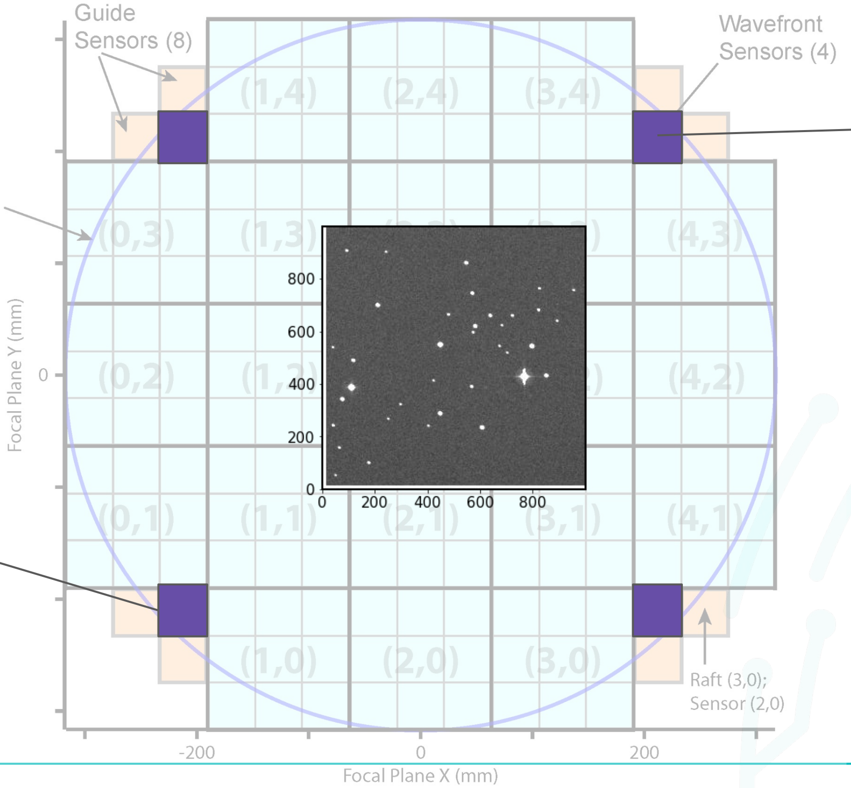
Active Optics System: wavefront sensors

LsstCam

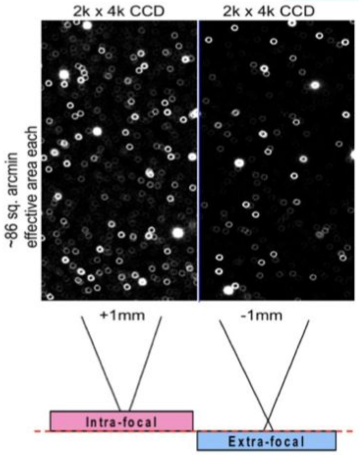
Stars become donuts due to annular mirrors



3º.5 Field of View

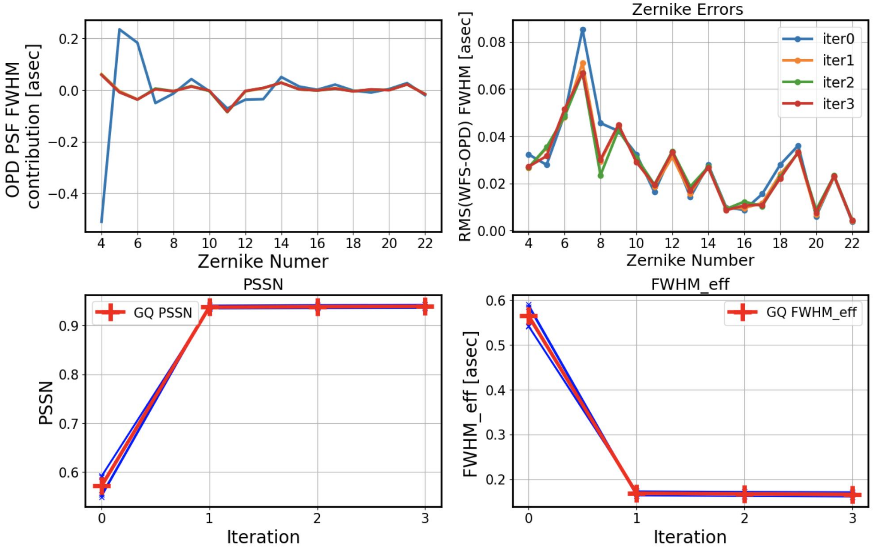


Wavefront sensors - out of focus (half of each sensor above, and half below the focal plane)



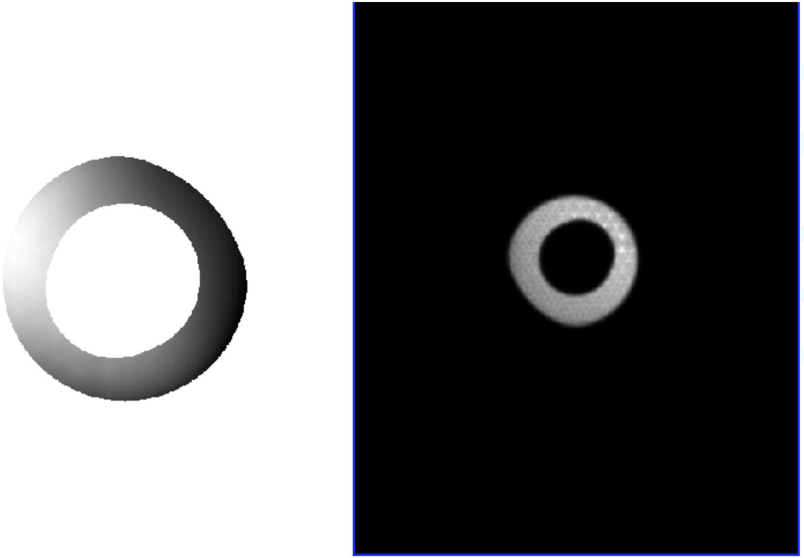
AOS Closed Loop

- The Active Optics System (AOS) team uses closed loop simulations to test the performance of the AOS algorithms in a variety of situations.
- In the closed loop we start with the telescope's optics in a perturbed state and iterate solving for the wavefront error and calculating corrections to the optical system until we reach convergence of the algorithm.



AOS Closed Loop Code (ts_imsim)

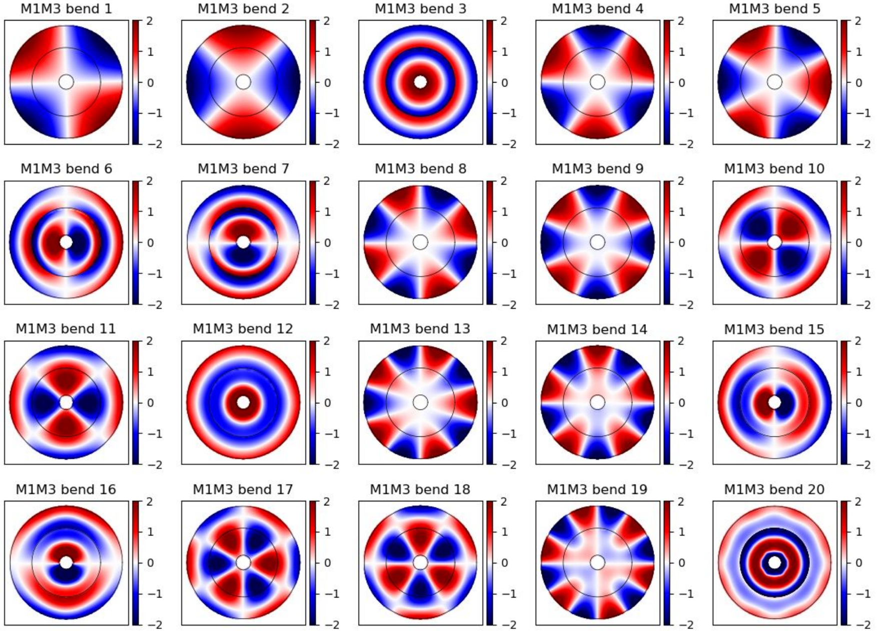
- Closed Loop implementation with imSim
  - Configure imSim
    - Set up perturbations in initial telescope configuration file.
    - Set other imSim configurations in smaller configuration files specific to each submodule (telescope perturbations, atmospheric PSF, sky model, vignetting…).
    - Define a pointer file that has the configuration files you want to use.
  - Take imSim configuration and run simulation of first iteration
  - Analyzes image quality with the OPD
  - Ingests imSim donut images into butler repository



Left: OPD, Right: Simulated Wavefront Sensor

AOS Closed Loop Code (ts_imsim)

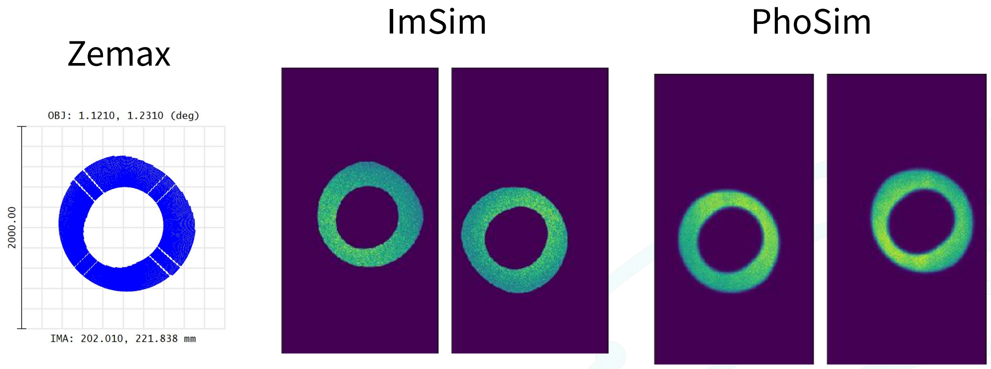
- Closed Loop implementation with imSim
  - Runs ingested images through the AOS Wavefront Estimation Pipeline (WEP)
  - WEP produces estimates of the wavefront error on each sensor in terms of Zernike polynomials
  - Optical Feedback Control (OFC) calculates corrections to hexapods and mirrors
  - Degree of freedom corrections are added into imSim configuration for next iteration
  - The 50 DOFs are:
    - 0-4: M2 dz, dx, dy, rx, ry
    - 5-9: Cam dz, dx, dy, rx, ry
    - 10-29: M1M3 20 bending modes
    - 30-49: M2 20 bending modes



Credit: Josh Meyers

Why move to imSim?

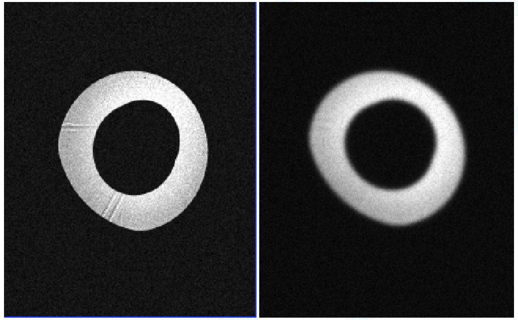
- Phosim Issues
  - Camera rotation not implemented
  - Shape of donuts on wavefront sensors don’t match model donuts from Zemax
  - Unable to make changes to Phosim code to fix problems
  - Required maintaining a separate package to process output into butler ready images
  - Speed


Zemax

ImSim

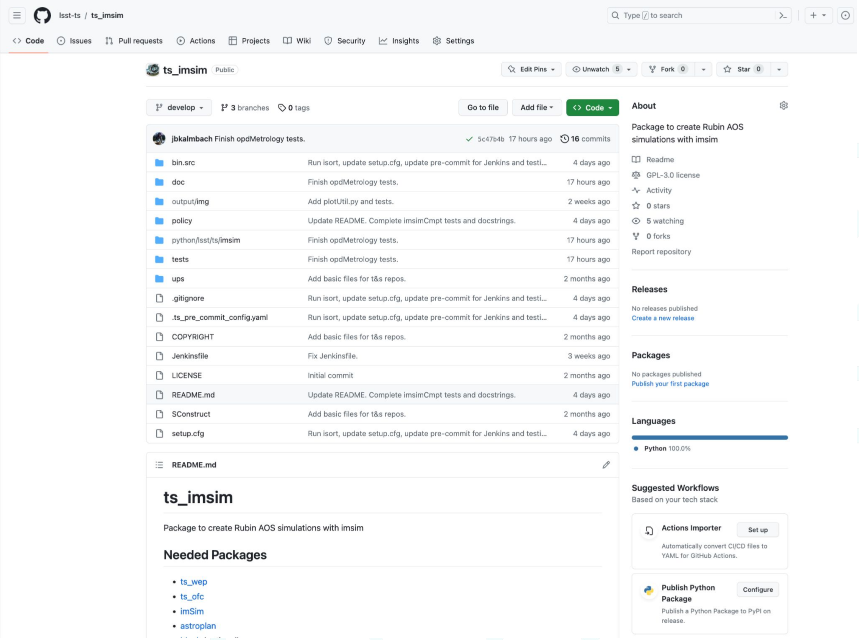
PhoSim

Credit: Josh Meyers


Donuts generated in closed loop.
Left: Phosim
Right: imSim

Current ts_imsim status

- Closed loop running on LSSTCam corner wavefront sensors
- Still need to implement LSST Full Array Mode (LSST FAM)
- Convergence of closed loop under investigation (more in a minute)
- Integrated with T&S Jenkins CI
- Hosted on github: https://github.com/lsst-ts/ts_imsim



jbkalmbach Finish opdMetrology tests. ✓ 5c47b4b 17 hours ago 16 commits

bin.src	Run isort, update setup.cfg, update pre-commit for Jenkins and testi...	4 days ago
doc	Finish opdMetrology tests.	17 hours ago
output/img	Add plotUtil.py and tests.	2 weeks ago
policy	Update README. Complete imsimCmpt tests and docstrings.	4 days ago
python/lsst/ts/imsim	Finish opdMetrology tests.	17 hours ago
tests	Finish opdMetrology tests.	17 hours ago
ups	Add basic files for t&s repos.	2 months ago
.gitignore	Run isort, update setup.cfg, update pre-commit for Jenkins and testi...	4 days ago
.ts_pre_commit_config.yaml	Run isort, update setup.cfg, update pre-commit for Jenkins and testi...	4 days ago
COPYRIGHT	Add basic files for t&s repos.	2 months ago
Jenkinsfile	Fix Jenkinsfile.	3 weeks ago
LICENSE	Initial commit	2 months ago
README.md	Update README. Complete imsimCmpt tests and docstrings.	4 days ago
SConstruct	Add basic files for t&s repos.	2 months ago
setup.cfg	Run isort, update setup.cfg, update pre-commit for Jenkins and testi...	4 days ago

README.md

ts_imsim

Package to create Rubin AOS simulations with imsim

Needed Packages

- ts_wep
- ts_ofc
- imSim
- astroplan

About

Package to create Rubin AOS simulations with imsim

Readme
GPL-3.0 license
Activity
0 stars
5 watching
0 forks
Report repository

Releases

No releases published
Create a new release

Packages

No packages published
Publish your first package

Languages

● Python 100.0%

Suggested Workflows

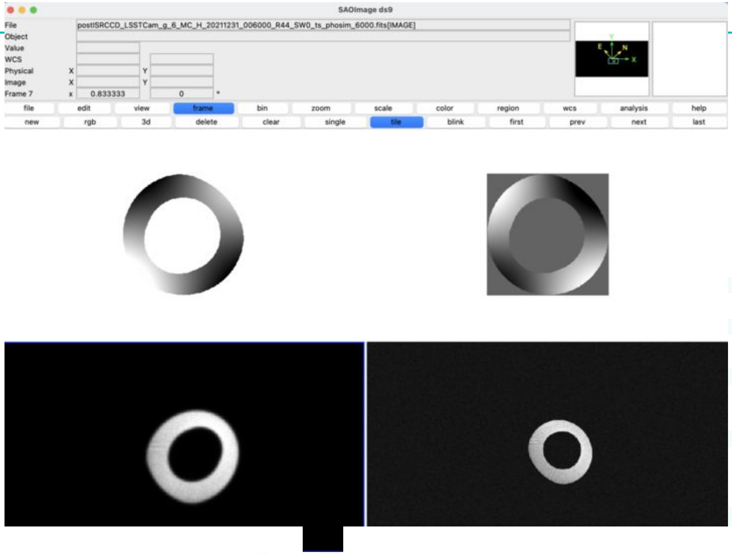
Based on your tech stack

Actions Importer — Set up
Automatically convert CI/CD files to YAML for GitHub Actions.

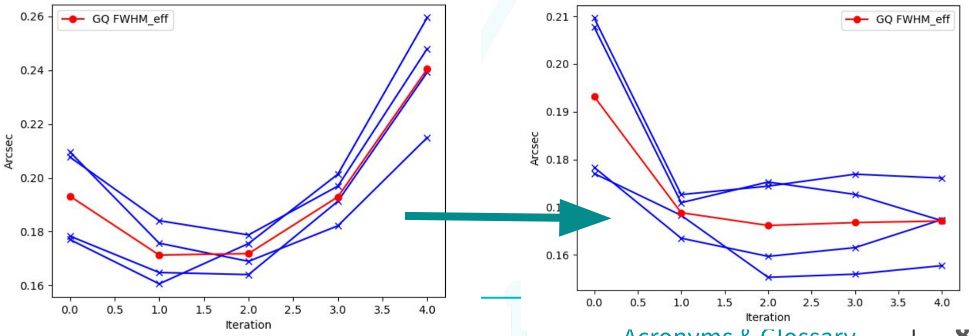
Publish Python Package — Configure
Publish a Python Package to PyPI on release.

Closed Loop Convergence with imSim

- Using the same process as we used with phosim we were unable to get the closed loop to converge in initial testing
- Discovered that on some bending modes there seems to be a sign flip between phosim and imSim
- Flipping the signs of certain Zernike coefficients to offset this seems to correct this and the closed loop converges


SAOImage ds9

File: postISRCCD_LSSTCam_g_6_MC_H_20211231_006000_R44_SW0_ts_phosim_6000.fits[IMAGE]
Object:
Value:
WCS:
Physical X Y
Image X Y
Frame 7 x 0.833333 0 °



Future Development

- Validate performance with camera rotation
- Add additional camera settings (LSST FAM)
- Move to use the SkyCatalog interface for generating input
- Tie in to use OpSim so we can simulate sequences of observations with realistic observing conditions
- Keep synchronized with new imSim features that increase realism