Simulating WFIRST PSFs across the Wide Field Imager with WebbPSF

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WebbPSF simulates PSFs with physical optics calculations in Python.

As the name suggests, WebbPSF is being developed for JWST as an analogue to TinyTim (the HST PSF package) for the Webb instruments. Recent work for WFIRST at STScI involved extending WebbPSF's suite of instrument models to include the WFIRST wide-field imaging channel.

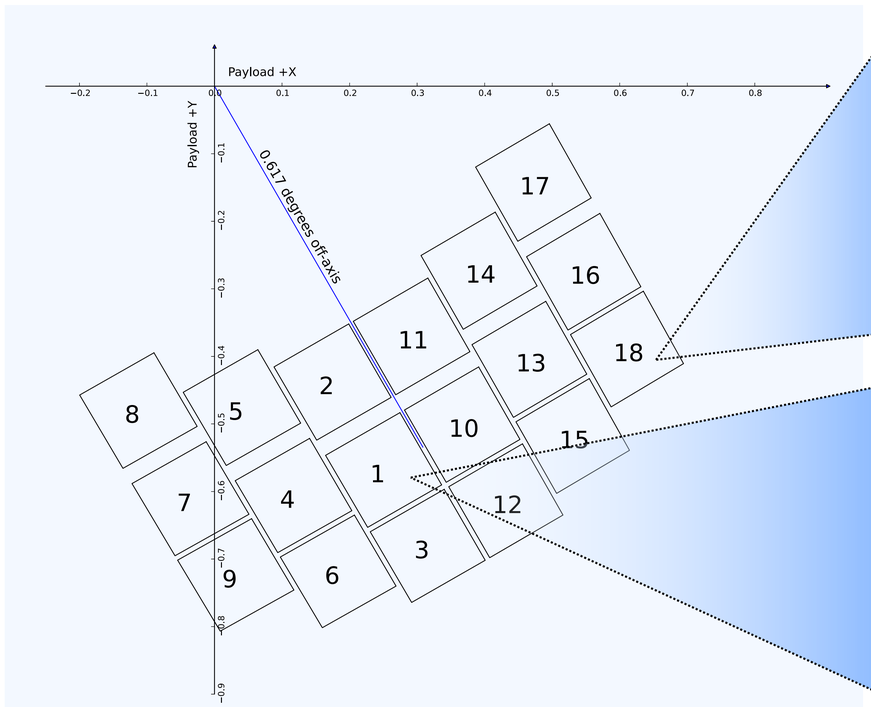
WebbPSF and its companion physical optics library, POPPY, are open-source, freely-available Python packages for the astronomy community. WebbPSF version 0.4 will be available this fall, accompanied by documentation covering the new WFIRST functionality.

Feedback from the community is very welcome! Let us know what you need from a PSF simulation tool, and we'll let you know about new releases: email **jlong@stsci.edu** and/or **mperrin@stsci.edu**.

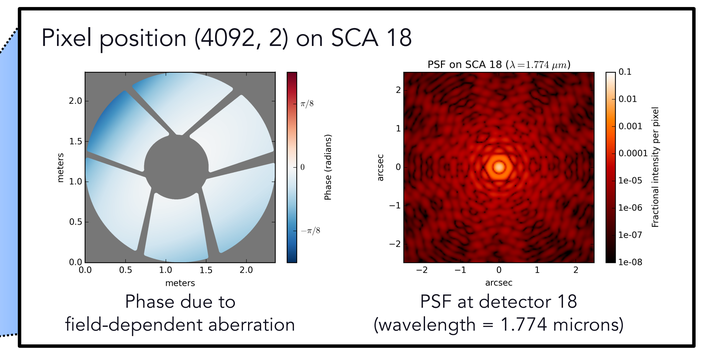
A simple API allows for both interactive analysis and automated scripting-based usage.

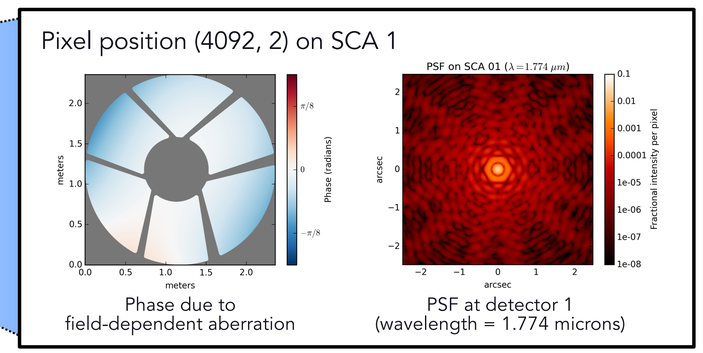
```
>>> import webbpsf
>>> from webbpsf import wfirst
>>> wfi = wfirst.WFIRSTImager()
>>> wfi.filter = 'Z087'
>>> psf_fits_object = wfi.calcPSF()
```

Find the code on GitHub:
github.com/mperrin/poppy
github.com/mperrin/webbpsf



WFIRST focal plane for wide-field imaging





What do WebbPSF images include?

Included:

- Low-spatial-frequency optical aberrations across focal plane (Zernike coefficient tables, via Goddard WFIRST optics team)
- Approximate high spatial frequency terms (representative mirror OPD map)
- PSF sampled to detector pixel scale, or arbitrarily oversampled
- Pupil shape (via Goddard WFIRST optics team)
- Pupil mask for long wavelength filters (via Goddard WFIRST optics team)

Mix in your own:

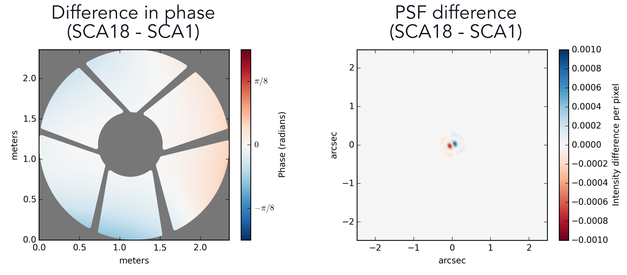
- Detector effects (sensitivity, interpixel capacitance, read noise)
- Photon noise
- Spectral dispersion (though you can make monochromatic PSFs to stitch together)

WebbPSF simulates field-dependent aberrations using pre-computed Zernike coefficients.

Field-dependent aberrations can be interpolated for any pixel position on the wide-field imaging channel. The WFIRST optics team at Goddard has calculated Zernike coefficients at five field points on each detector field-of-view over a range of wavelengths. WebbPSF interpolates these spatially across a detector and in wavelength space to determine the Zernike components of the aberration. (Higher-spatial-frequency aberrations are approximated with an HST mirror OPD map.)

Analysis tools in WebbPSF/POPPY allow users to examine PSF differences across the field-of-view and produce plots like those to the right.

What's the difference?

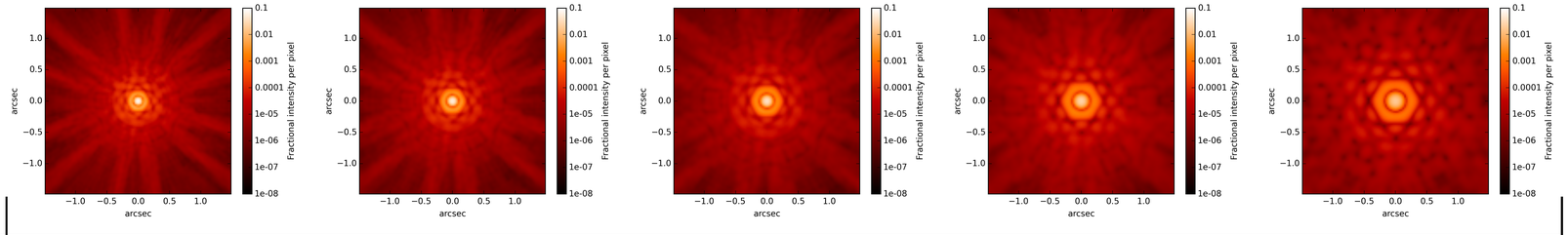


The effective optical path length differs by 114 nm RMS across the pupil (660 nm peak-to-valley) between the two detector locations.

Users can simulate polychromatic WFIRST PSFs for the bandpasses given in the WFIRST Science Definition Team report.

Wavelength dependence in the field-dependent aberration coefficients is accounted for.

Approximate top-hat filters can be replaced with the measured curves without code changes.



References:

Spergel et al. 2015, *WFIRST-AFTA 2015 Report.*

Perrin et al. 2012, "Simulating point spread functions for the James Webb Space Telescope with WebbPSF", Proc. SPIE 8842.

Perrin 2011, "Improved PSF Simulations for JWST: Methods, Algorithms, and Validation", JWST Technical Report JWST-STScI-002469.

Acknowledgments:

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