

# Simulating PSFs for WFIRST-AFTA

## Introduction

WebbPSF-WFIRST provides a customizable interface to perform point-spread function (PSF) simulations and calculations for the Wide-Field Instrument (WFI) planned for WFIRST. Simulated PSFs provide a useful tool for predicting the observatory's performance at a particular combination of wavelength (or bandpass), field position, and pixel scale. PSFs are also an important input to simulate astronomical scenes, predict signal-to-noise and exposure times, and prepare data reduction tools for future missions.

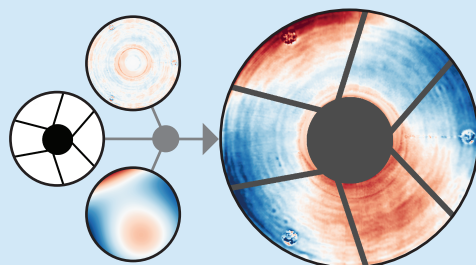
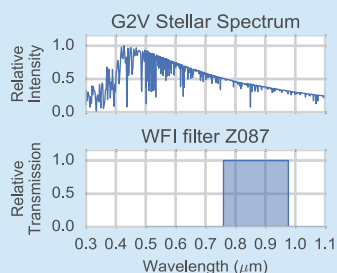
## Get WebbPSF

WebbPSF is free, open-source software originally developed at STScI to simulate JWST instruments, and has been expanded to include the WFIRST WFI. The software consists of a Python package and a corresponding data package containing instrument data. For detailed installation instructions, as well as more information on WebbPSF for WFIRST, visit:

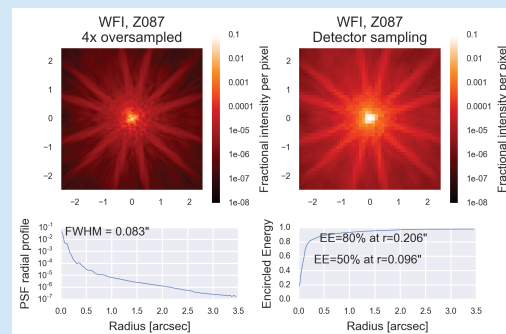
<http://www.stsci.edu/wfirst/software/webbpsf>

## Steps to calculate a PSF for WFIRST

1. Broadband PSF calculations sample a wavelength range based on filter bandpasses. WebbPSF calculates and combines a specified number of monochromatic PSFs.
2. For each wavelength, an input wavefront is generated from the appropriate pupil shape. Phase information from approximated mirror polishing errors is added, and field-dependent PSF variations are added from NASA Goddard models.
3. The resulting PSF is computed at a configurable oversampling factor by Fourier transforming the wavefront array, then binned down to finite-size detector pixels. It can be analyzed with WebbPSF functions, or saved to a FITS file.

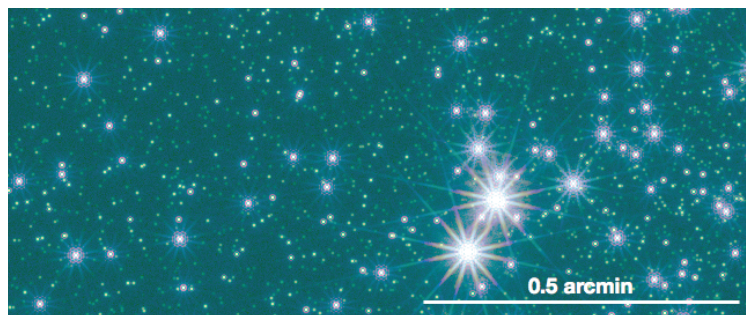
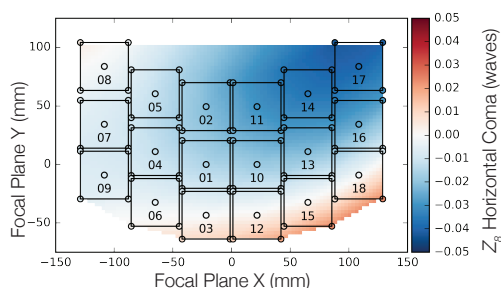


RMS wavefront error  $\approx 86$  nm



## Field dependence of the PSF

The WFI model in WebbPSF allows users to specify a particular detector, and a location in pixel coordinates within that detector, at which to compute the PSF. The WFIRST optics team at NASA Goddard has released a table of aberrations as Zernike coefficients covering the field position and wavelength ranges of the WFI. For example, the plot below shows how WebbPSF interpolates  $Z_8$  horizontal coma (at 0.76 microns) across the 18 SCAs from the values at the sampled field points (shown as circles).



## Using WebbPSF in scene simulation

WebbPSF produces standard FITS files which can be used as inputs to astronomical scene simulation tools. One such example is STIPS, the Space Telescope Image Products Simulator developed at STScI (output pictured above,  $\approx 1/1620^{\text{th}}$  of the entire FOV). The GalSim toolkit can also use user-supplied images as PSF kernels, allowing users to substitute WebbPSF PSFs into their simulated scenes.

