

Simulating the Point-Spread Functions of JWST and WFIRST Instruments

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AAS 227



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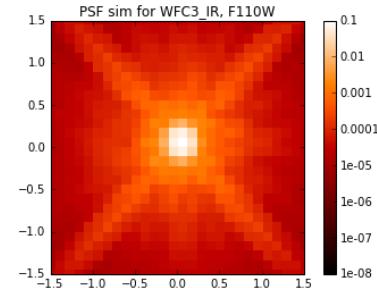
WebbPSF

- Models all JWST instruments and now WFIRST WFI
- Developed at STScI to simulate JWST instrument PSFs (*Perrin et al. 2014, Proc. SPIE*)
- Inspired by TinyTim for HST (*Krist et al. 2011, Proc. SPIE*)
- Open source (on GitHub)
- Python-based
- Scriptable interface (with a GUI available)

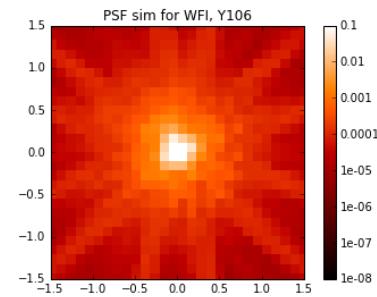


Why simulate instrument PSFs?

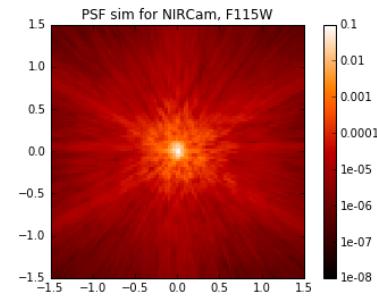
- Ground-based instrument PSFs limited by atmospheric seeing
 - Gaussian, Moffat profiles
- Spaceborne instrument PSFs
 - temporally stable
 - diffraction limited
- Used to improve photometry, astrometry, observation planning, and more



WFC3 IR, Hubble
TinyTim



WFI, WFIRST
Webbpsf

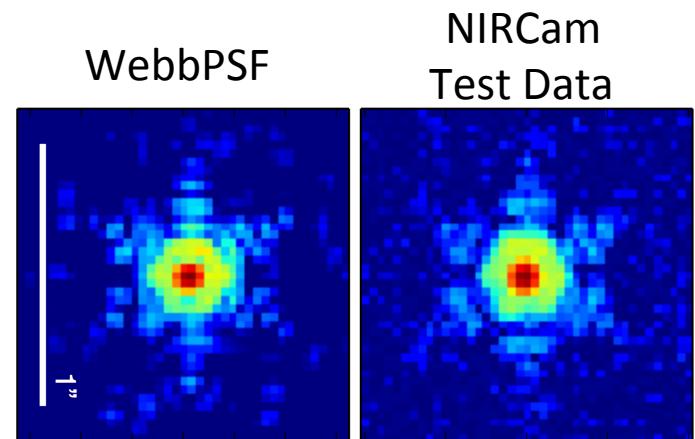


NIRCam, JWST
Webbpsf



Why simulate instrument PSFs before launch?

- Provide input to predictions about instrument performance
- Ensure our models agree with ground test data
- Use in exposure time calculations
 - JWST ETC (Pandeia)
- Use to simulate scenes
 - STIPS: Space Telescope Image Product Simulator



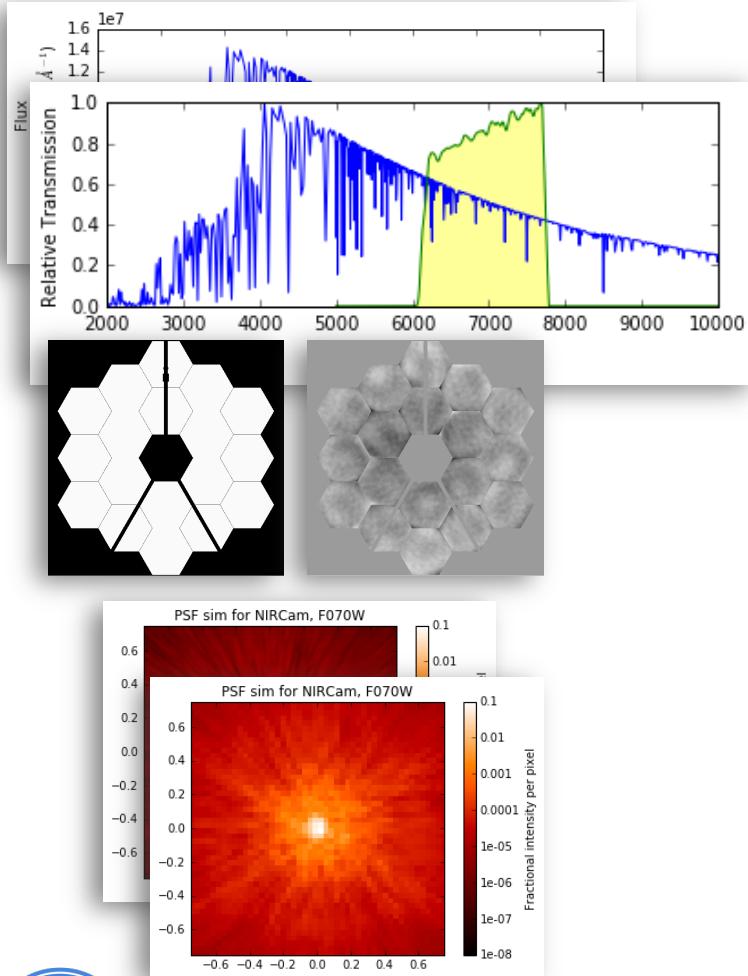
Perrin et al. 2014, "Updated Point Spread Function Simulations for JWST with WebbPSF"



STIPS image courtesy Brian York, STScI



Walking through a PSF Calculation



Source spectrum

Filter transmission

(sets wavelength sampling)

Aperture shape & wavefront error

Fourier transformed to PSF

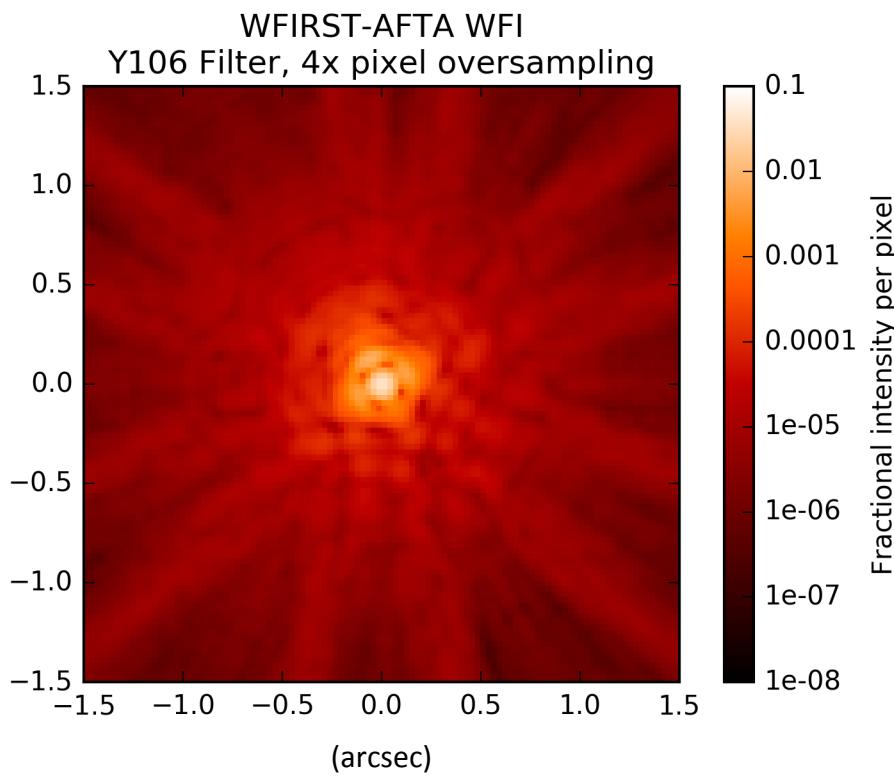
Plate scale

(sets spatial sampling)



WebbPSF-WFIRST

- WebbPSF-WFIRST effort at STScI
 - Develop Wide-Field Instrument model
 - Provide to ETC and STIPS scene simulator teams
- Simulates field-dependent PSF aberrations
- Released to the community November 2015
- Based on the Cycle 5 reference design

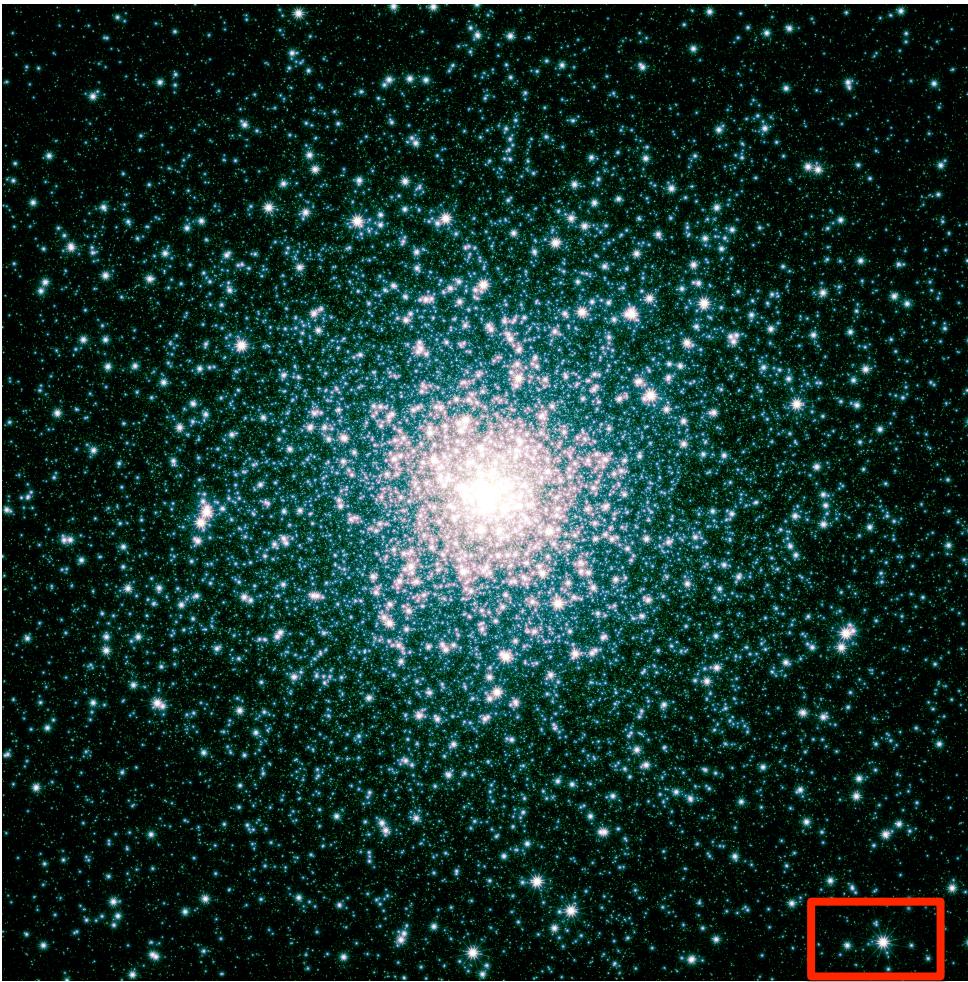


WFIRST Wide Field Instrument



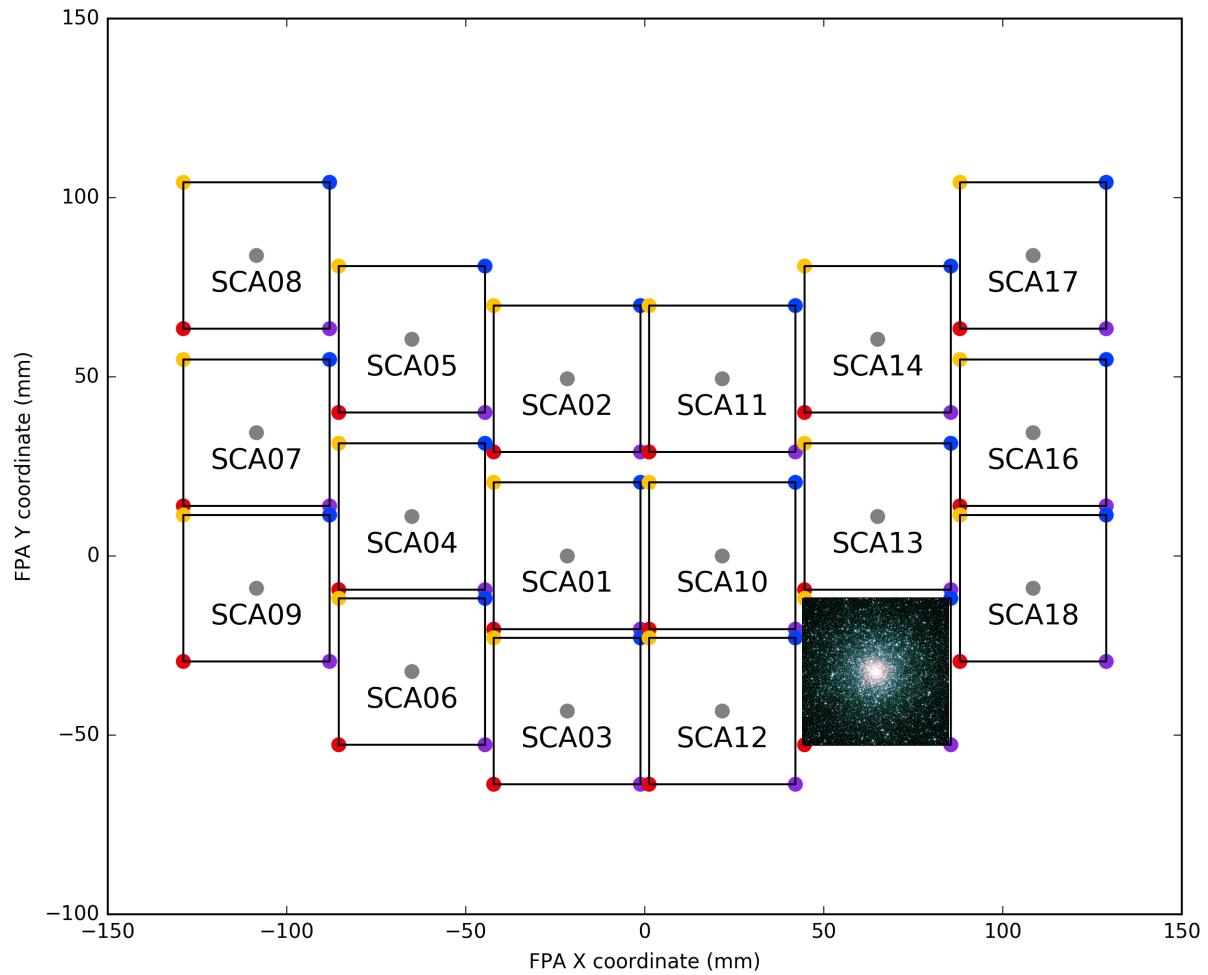
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WFIRST Wide Field Instrument

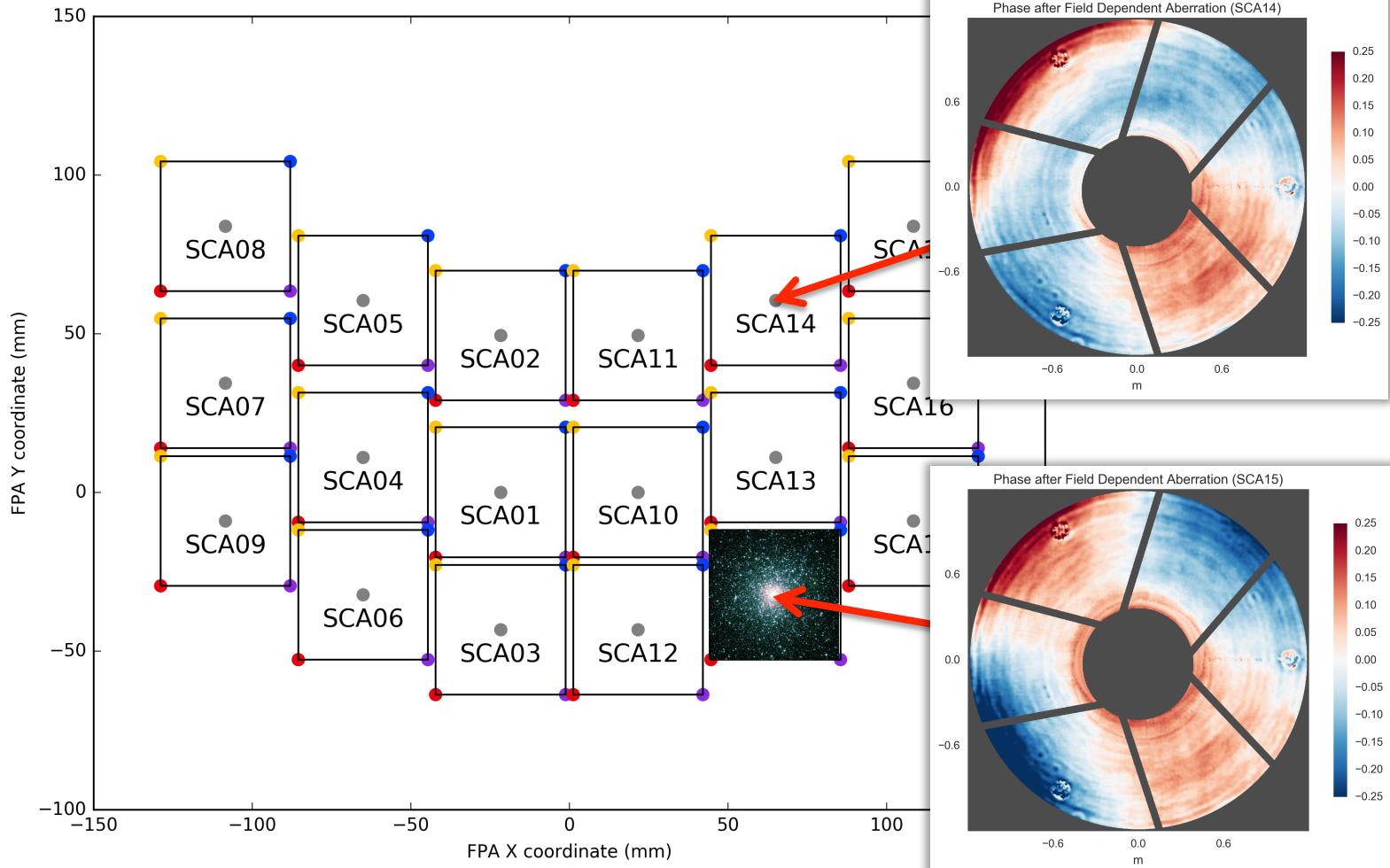


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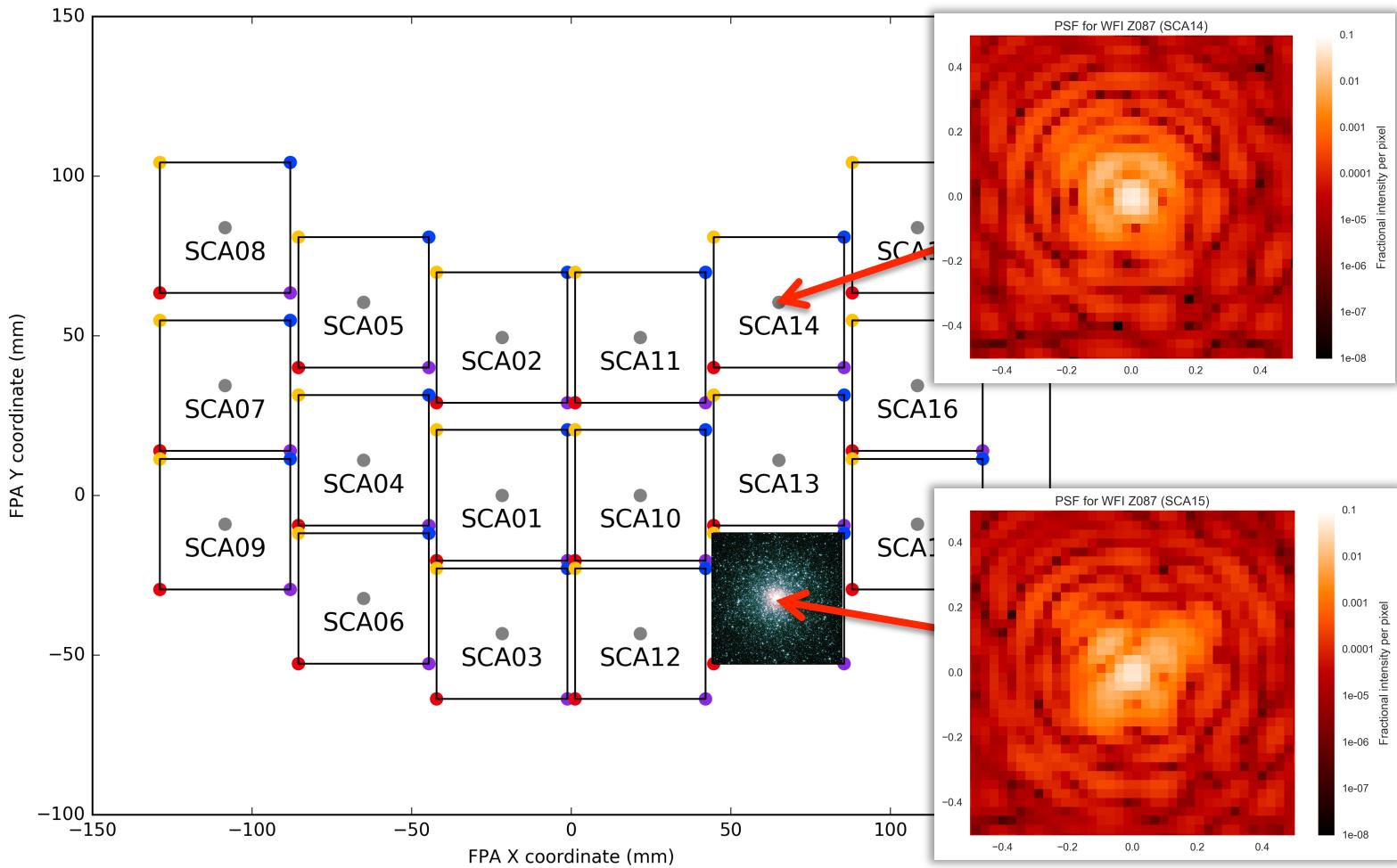
WFIRST Wide Field Instrument



WFIRST Wide Field Instrument



WFIRST Wide Field Instrument



Future Work

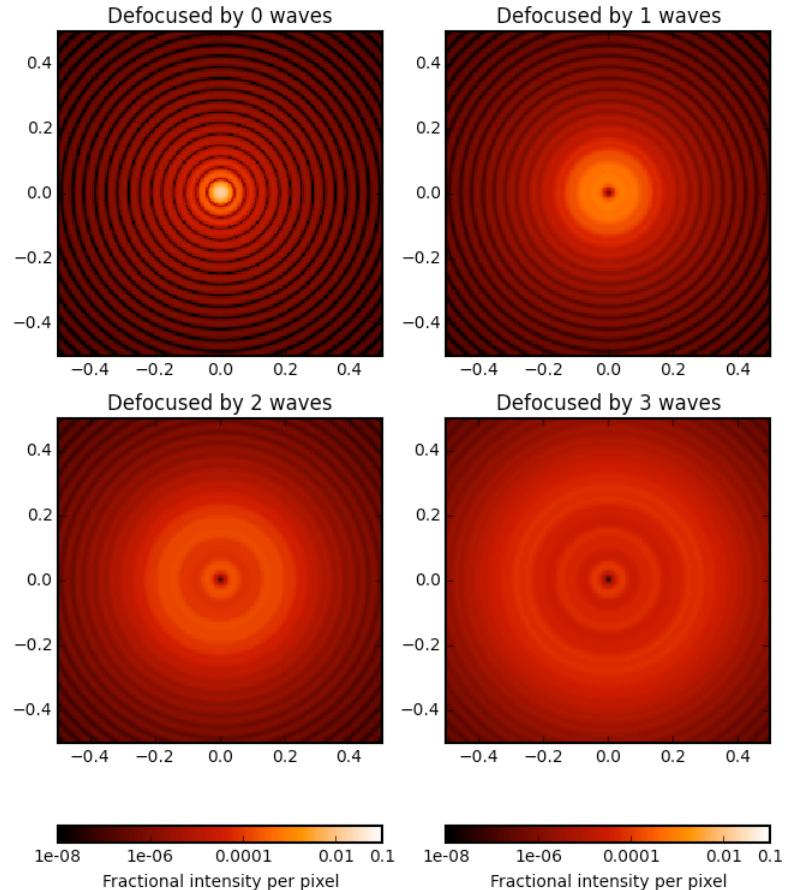
- Field dependent PSF variation in JWST instruments
- Coronagraph simulation for WFIRST ETC
- Geometric distortion of apparent pupil shapes with field position
- Other fixes and features by community request!



POPPI

Physical Optics Propagation in Python

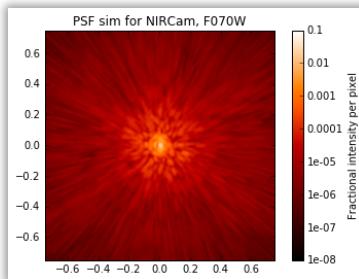
- Not mission-specific
- Used to build WebbPSF instrument models
- Fraunhofer domain (Fourier-transform based) optical systems
 - And, since November 2015, Fresnel propagation! (Thanks, Douglas Ewan)
- Define optics as FITS files or analytic functions
- Parallelize calculations across CPUs



Questions?

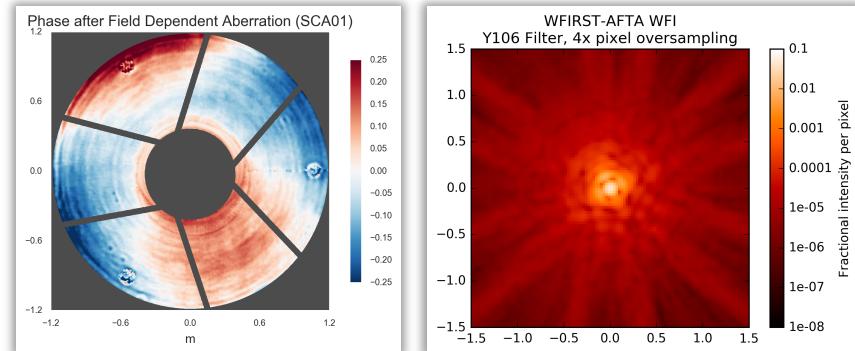
WebbPSF

- Simulate monochromatic and broadband PSFs for all JWST instruments
- Install it today!
tinyurl.com/webbpsf-install



WebbPSF-WFIRST

- Included in WebbPSF, simulates WFI
- Come see us at the STScI booth for more info!



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