How will the JWST short wavelength performance affect faint galaxy parameters?

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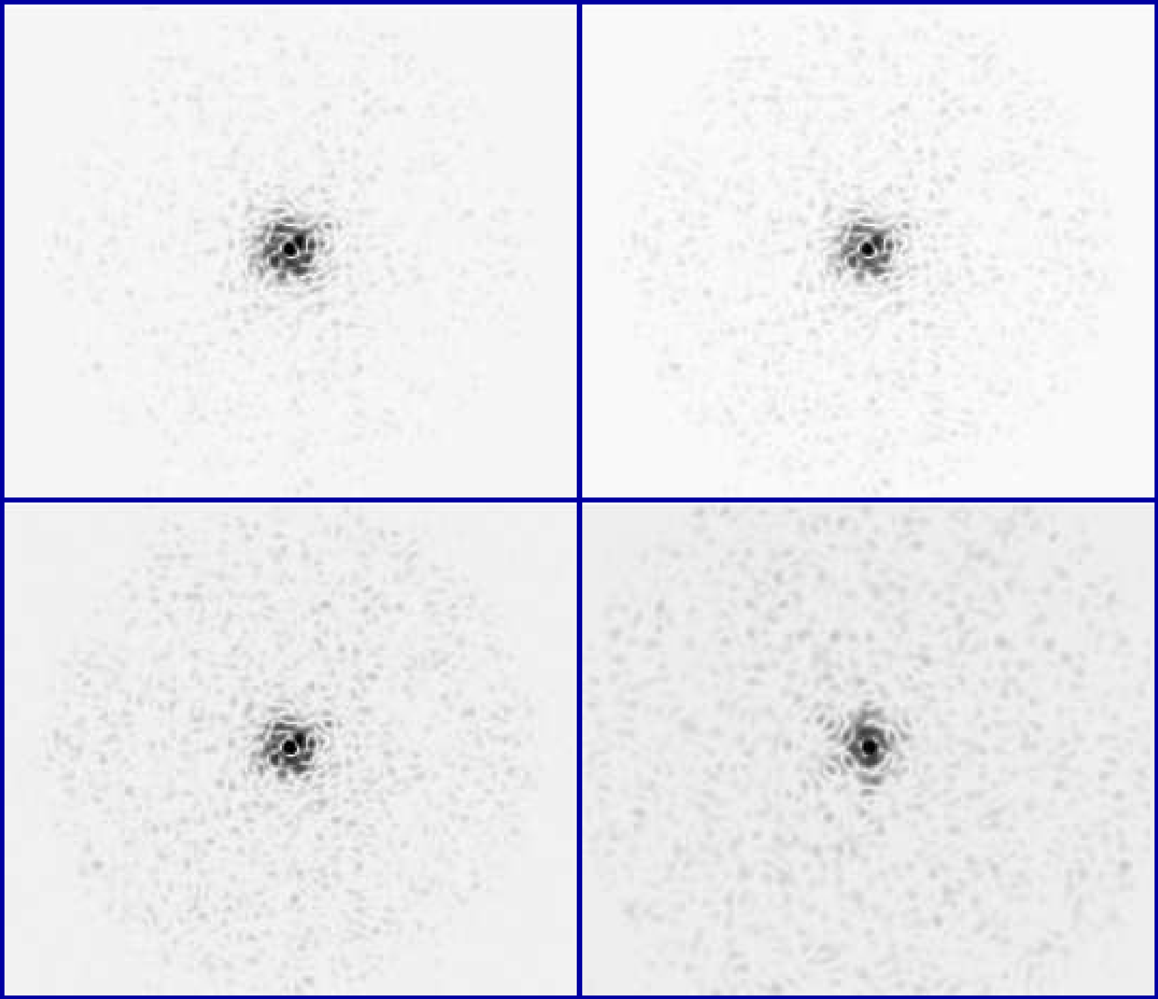


JWST SWG Mtg, Oct. 1, 2003, STScI, MD

Outline

How will JWST short-λ performance affect faint galaxy parameters?

Method of Computation and assumptions:

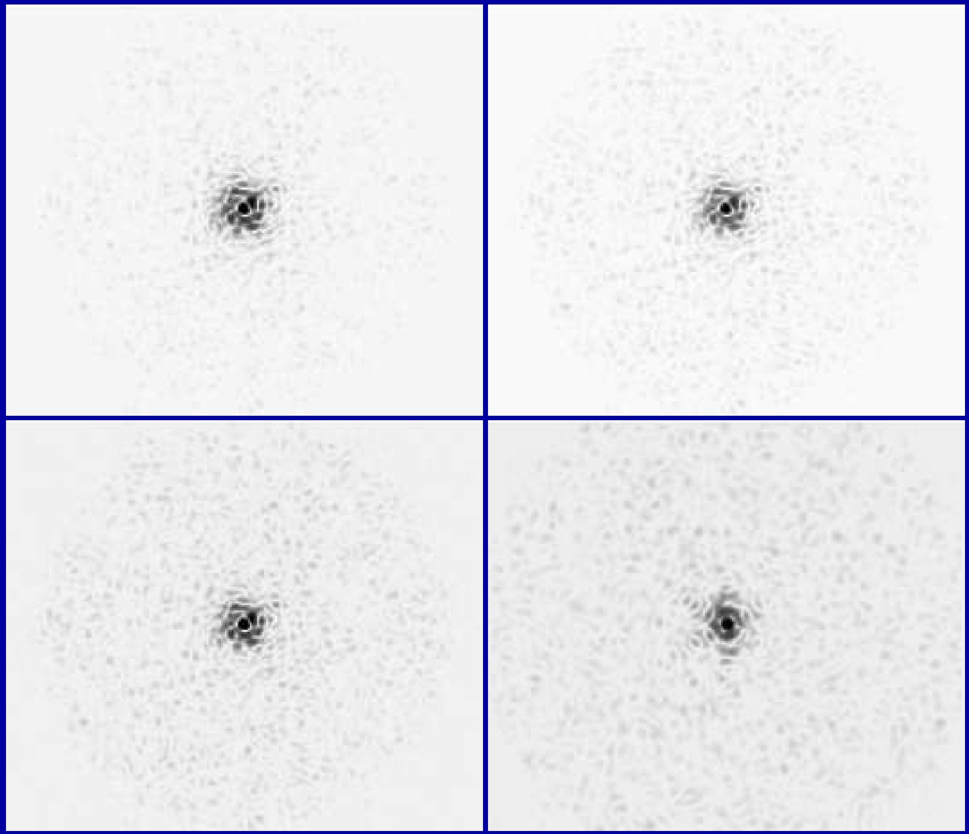
- (1) Use the real (drizzled) HDF I814-band image as input ("truth"). Should be close, given minor differences in N(z) and K_{morph} .
- (2) Convolve with the suite of JWST PSF's
- (3) Add noise back in to exactly match the input HDF noise level
- (4) Run SExtractor and LMORPHO for faint object finding and galaxy parameter estimation
- (5) Evaluate impact on various faint galaxy parameters as function of JWST PSF characteristics
- (6) Conclusions

- (1) Use (drizzled) HDF I814-band image as input ("truth")
- (2) Convolve with the suite of JWST PSF's:

```
lap> ls psf*
lap> ls psf*fits

psf_100_110_28_0.7micron.fits  psf_120_85_28_2.0micron.fits
psf_100_110_28_1.0micron.fits  psf_133_64_28_0.7micron.fits
psf_100_110_28_2.0micron.fits  psf_133_64_28_1.0micron.fits
psf_110_98_28_0.7micron.fits   psf_133_64_28_2.0micron.fits
psf_110_98_28_1.0micron.fits   psf_150_100_110_28_0.7micron_
psf_110_98_28_2.0micron.fits   psf_150_100_110_28_1.0micron_
psf_120_85_28_0.7micron.fits   psf_150_100_110_28_2.0micron_
psf_120_85_28_1.0micron.fits
```

- Summary of PSF's used at 1.0 micron:



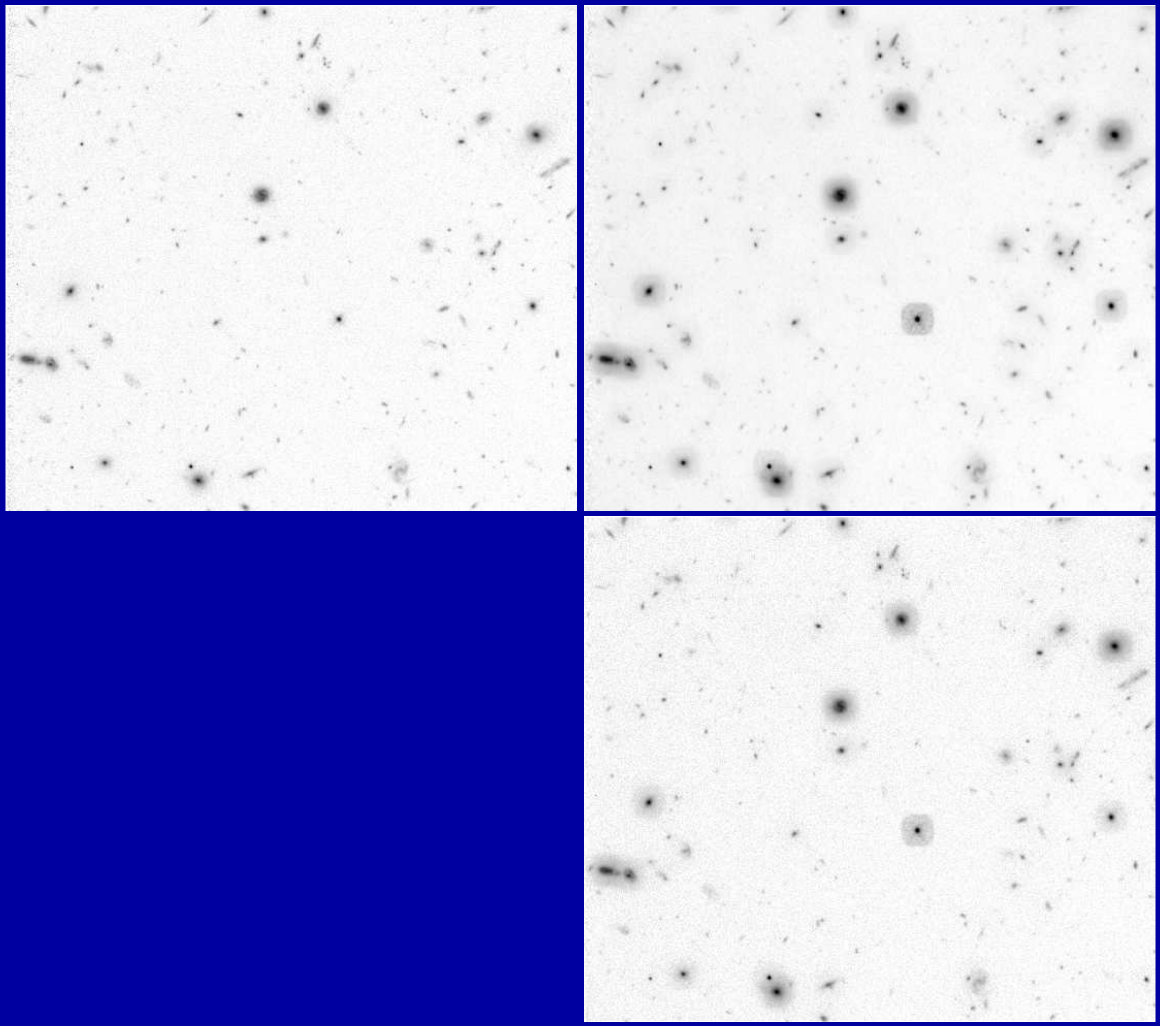
UL: psf_133_64_28_1.0micron.fits

UR: psf_120_85_28_1.0micron.fits

LL: psf_110_98_28_1.0micron.fits

LR: psf_100_110_28_1.0micron.fits

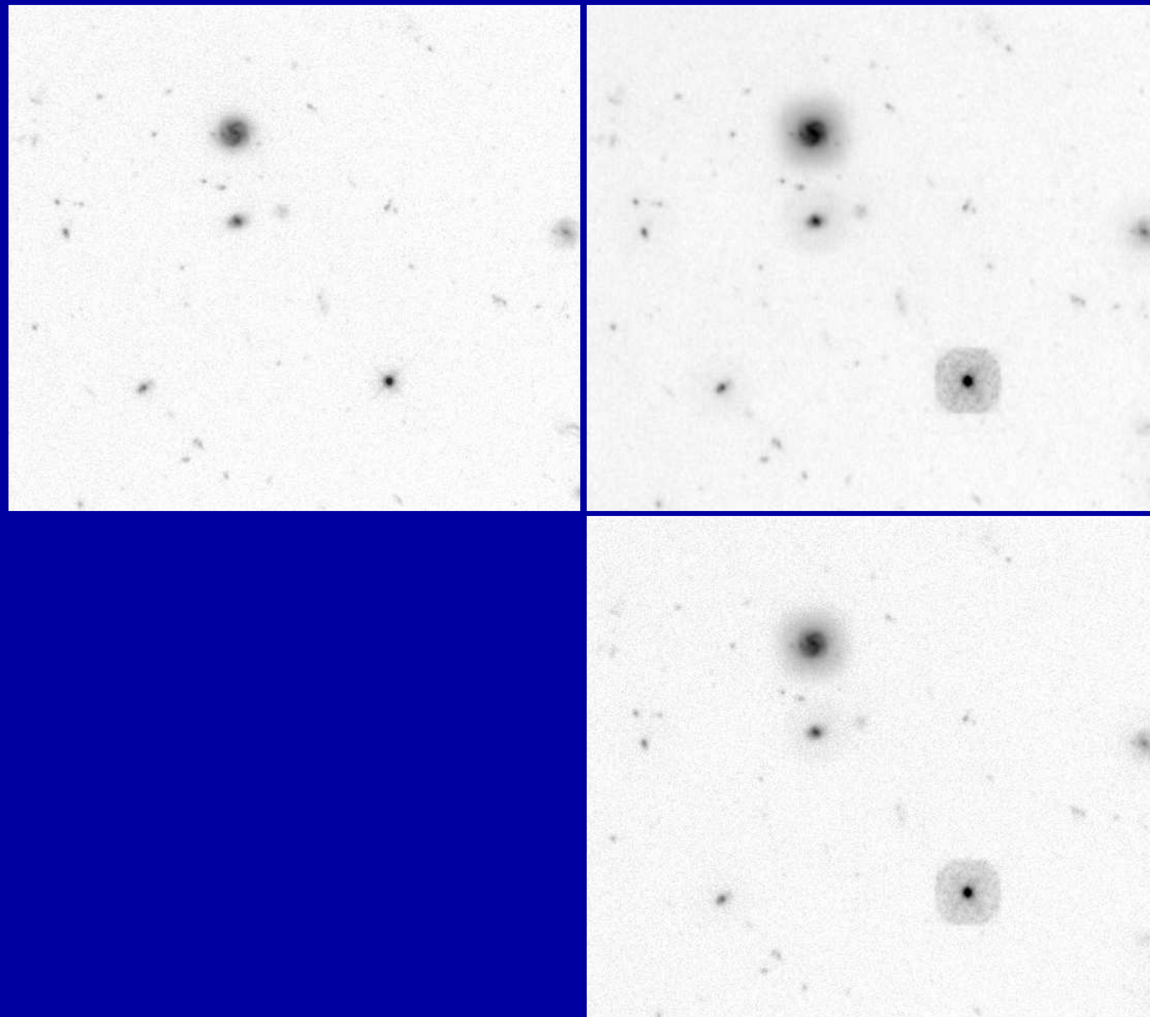
(3) Add noise back in to exactly match the input noise level (cont)



UL: Original HDF I-band (similar to 1-hr JWST 1 micron)
UR: Convolved with psf_100_110_28_1.0micron.fits
LR: Convolved and with same noise as HDF input image

Note the significant wings around brighter objects, even galaxies.

(3) Add noise back in to exactly match the input noise level (cont)



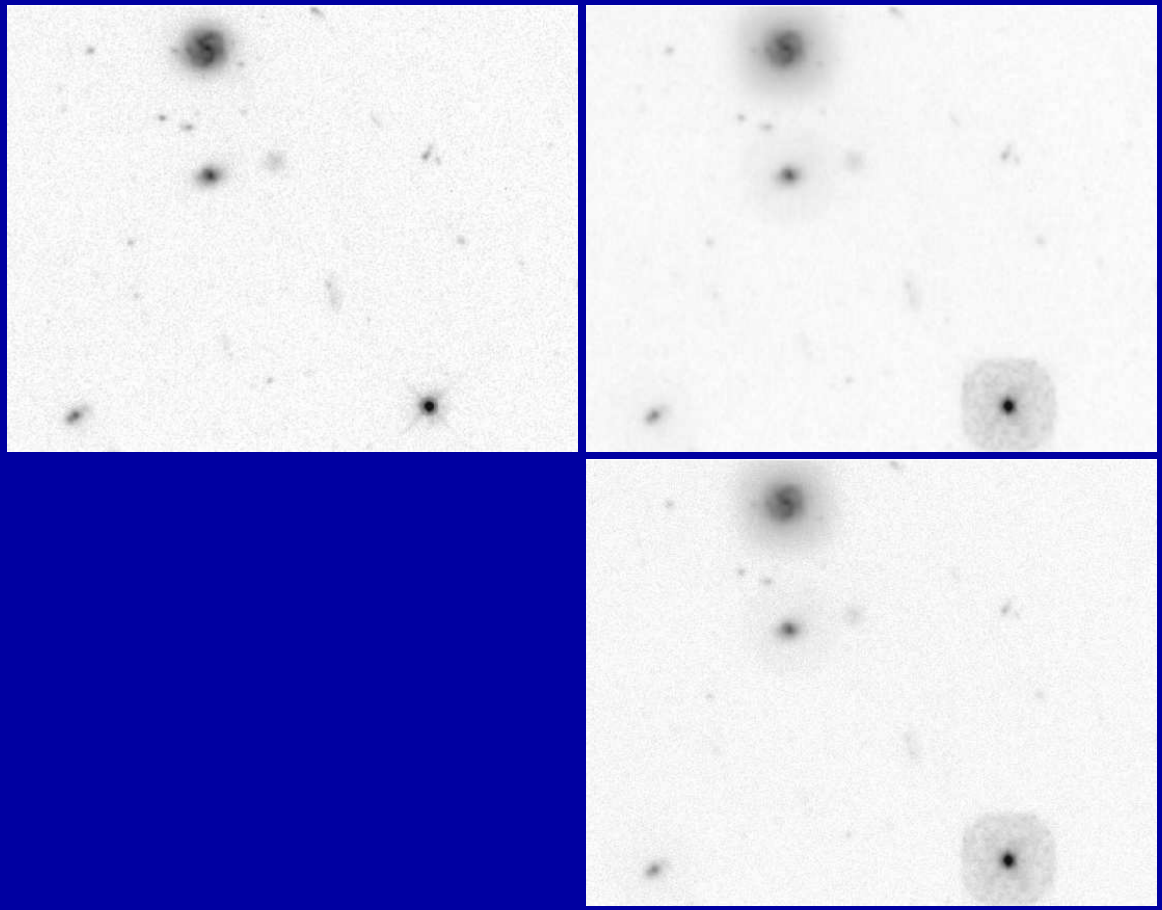
UL: Original HDF I-band (similar to 1-hr JWST 1 micron)

UR: Convolved with psf_100_110_28_1.0micron.fits

LR: Convolved and with same noise as HDF input image

Note for bright star that PSF-wings extend beyond convolution kernel

(3) Add noise back in to exactly match the input noise level (cont)



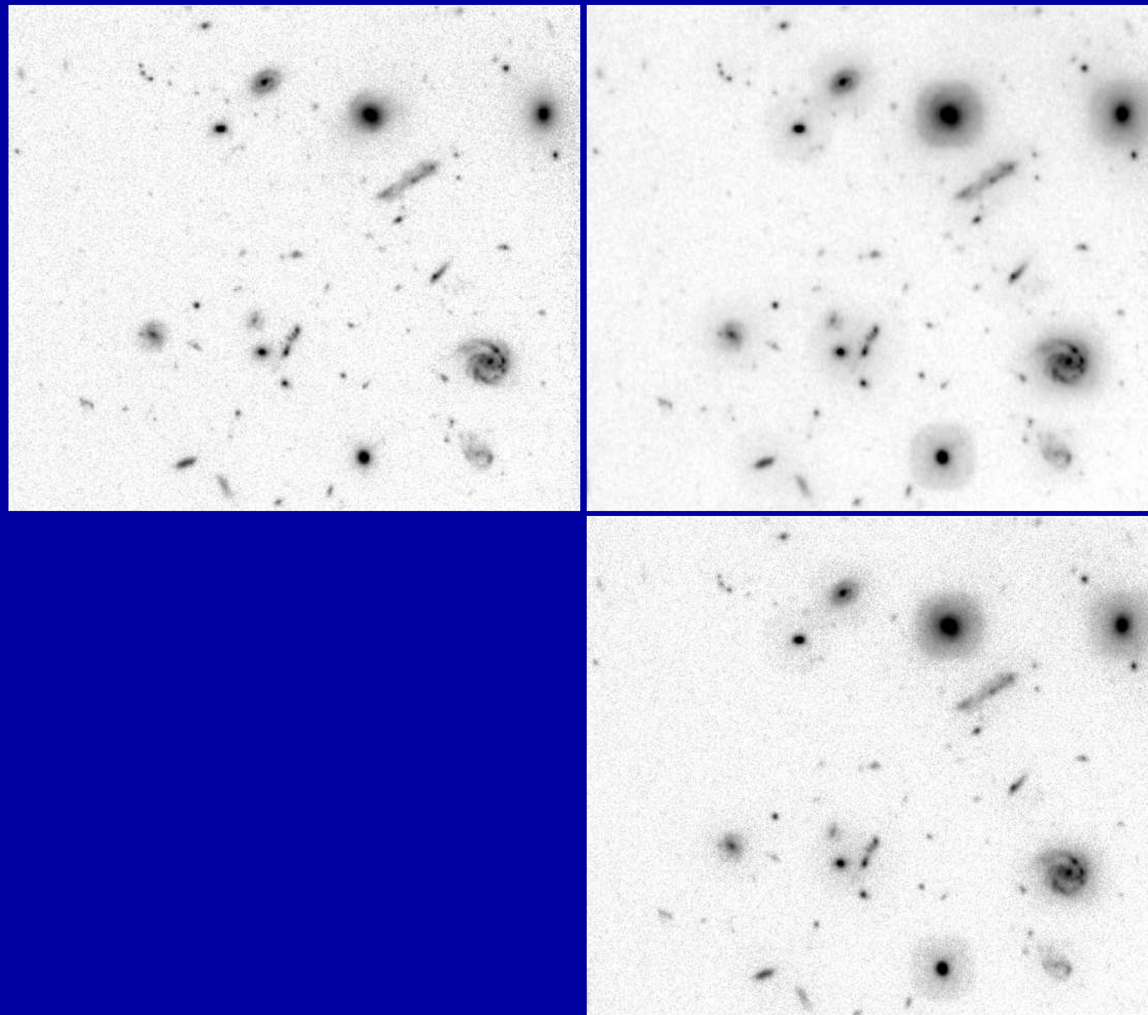
UL: Original HDF I-band (similar to 1-hr JWST 1 micron)

UR: Convolved with psf_100_110_28_1.0micron.fits

LR: Convolved and with same noise as HDF input image

Galaxy structure still visible but contrast is noticeably lowered due to the wings of the short-wavelength PSF.

(3) Add noise back in to exactly match the input noise level (cont)



UL: Original HDF I-band (similar to 1-hr JWST 1 micron)

UR: Convolved with psf_100_110_28_1.0micron.fits

LR: Convolved and with same noise as HDF input image

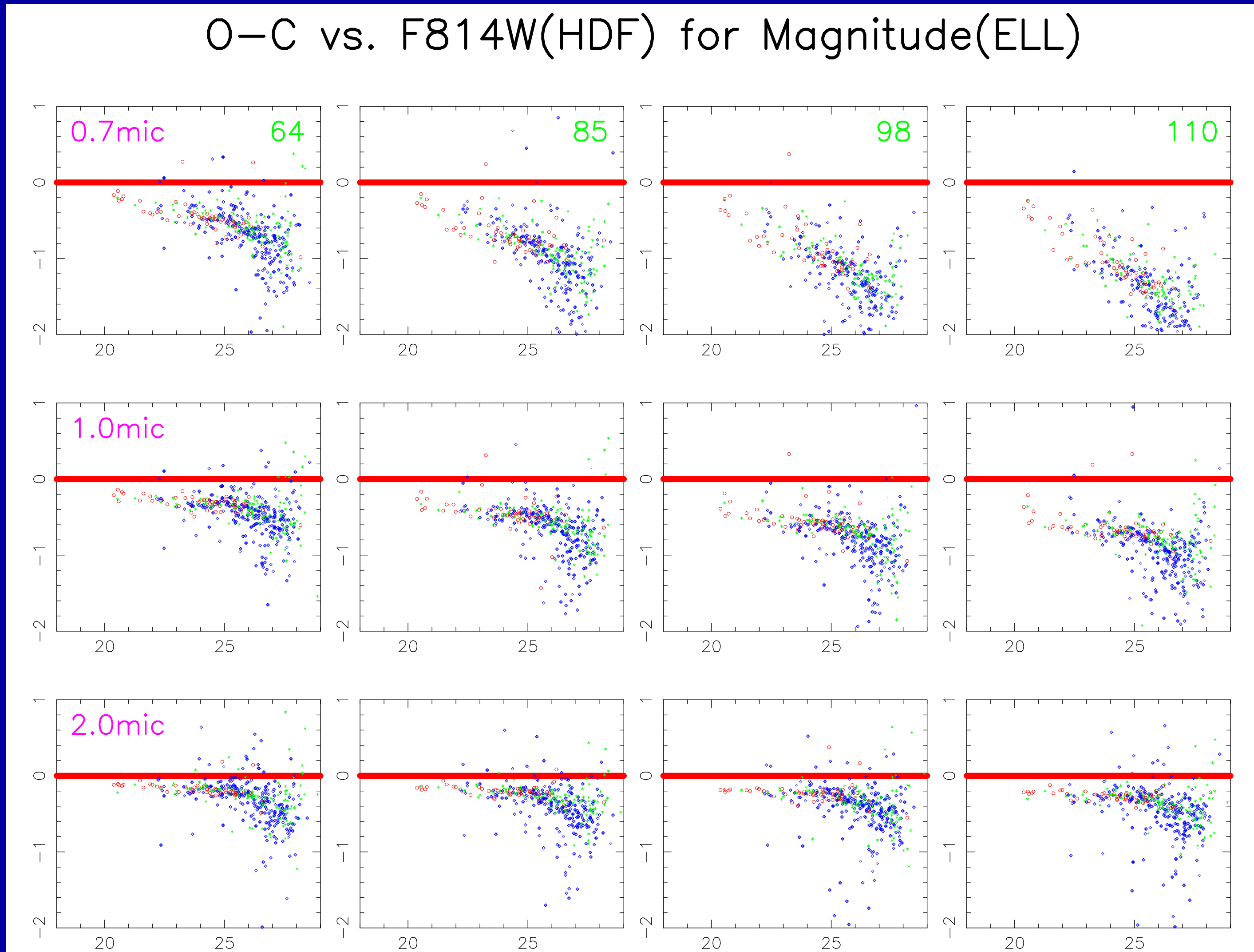
Deep crowded JWST fields ($\gtrsim$1 hr) will have PSF-confusion issues.

• (4) Run SExtractor and LMORPHO for faint object finding and galaxy parameter estimation

• (5) Evaluate impact on various faint galaxy parameters as function of JWST PSF characteristics at 0.7, 1.0 and 2.0 microns

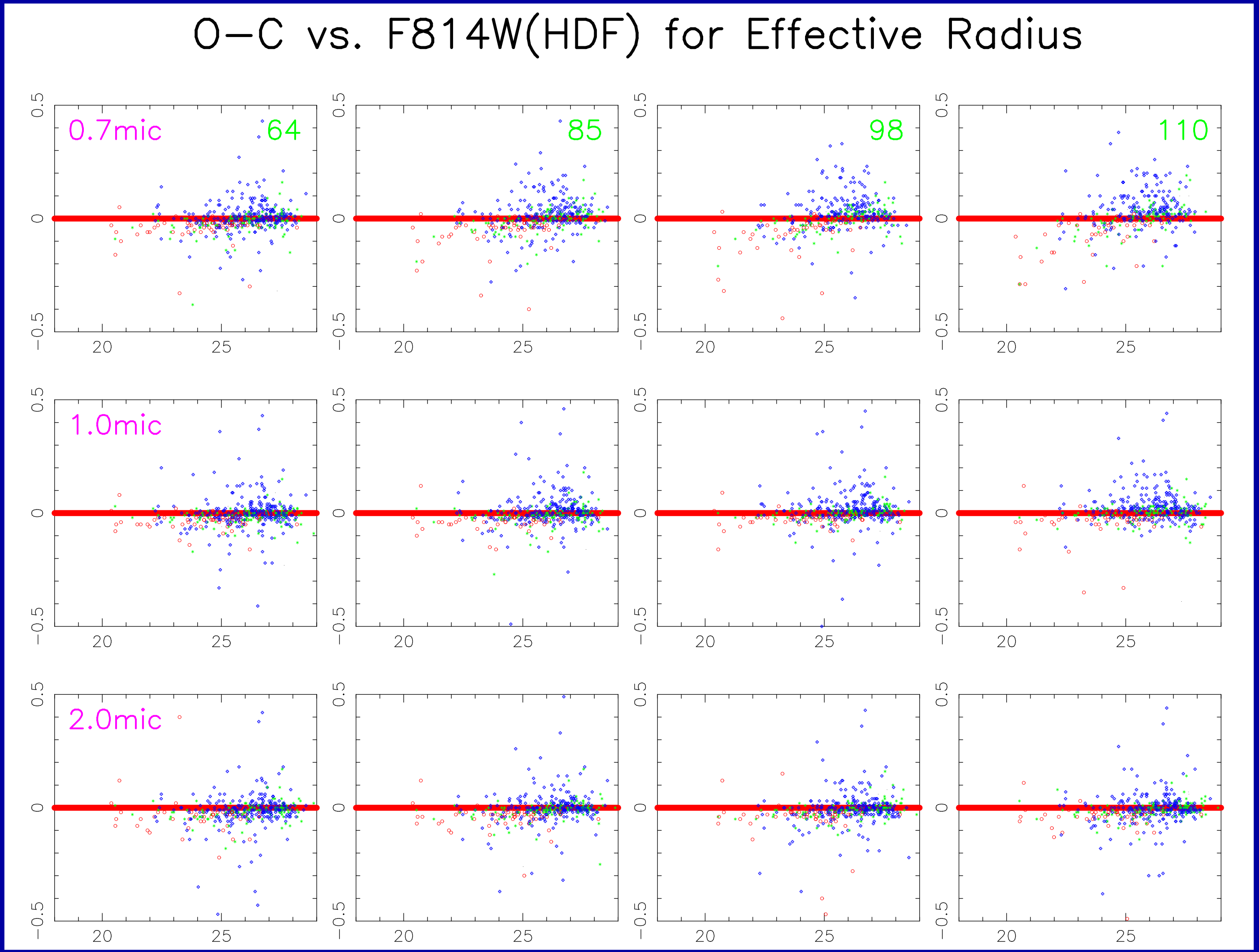
Galaxy parameters considered here:

- Total and isophotal magnitude
- Object ellipticity b/a
- Effective radius r_e or half-light radius
- Galaxy type from ANN's (on the 16-step deVauc scale)



Horizontal: AB-magnitude; Vertical: (O–C) = (HDF-input - Convolved)
Color coding: Early, mid-, and Late types.

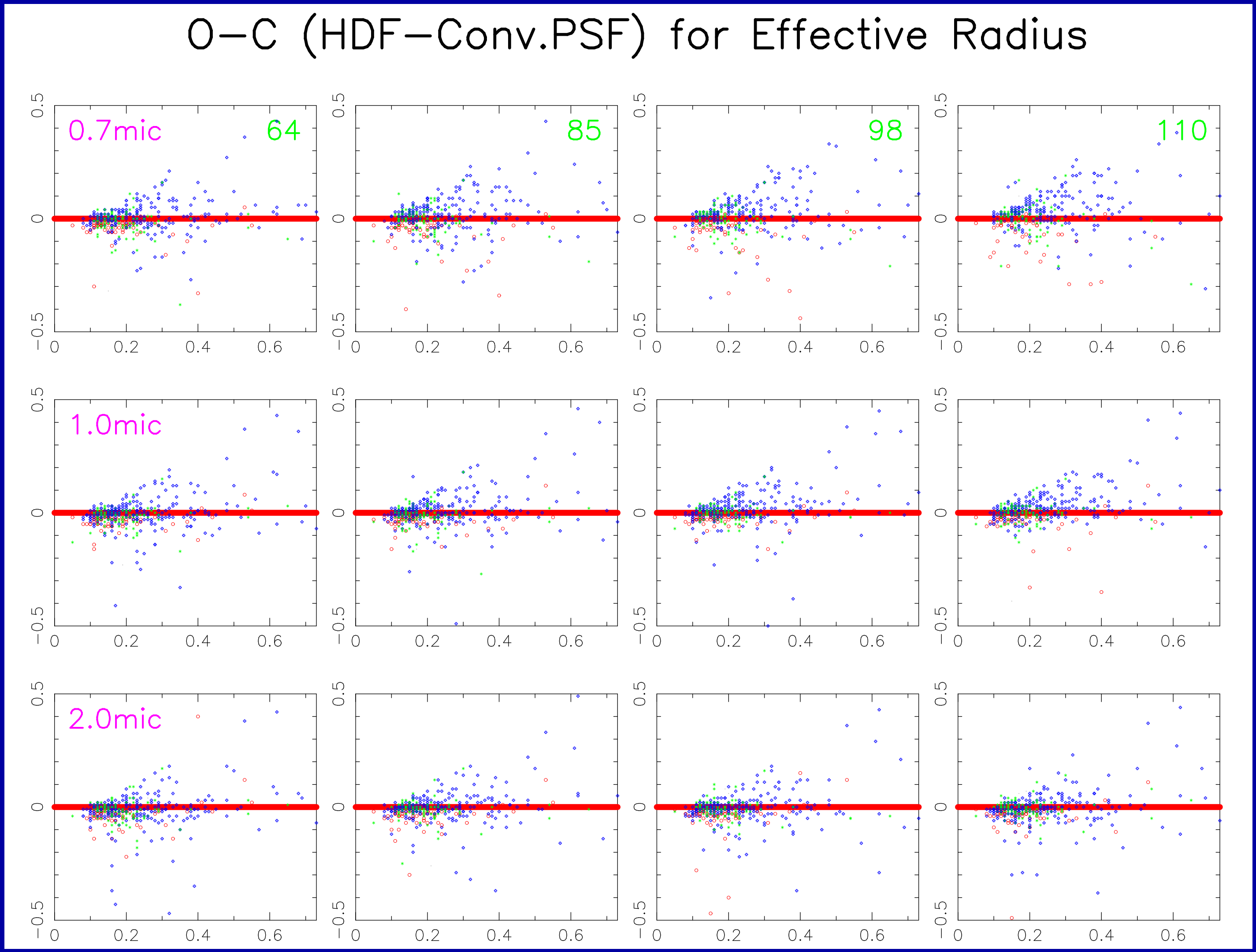
The convolved faint-object flux is generally too faint, even at 2.0μm, This trends does get noticeably worse towards mid-freq=110 nm and towards 0.7μm. BUT, the PSF still does not converge well at 2.0μm.



Horizontal: AB-magnitude; Vertical: (O–C) = (HDF-input - Convolved)

If object is faint, the convolved r_e is generally too small, especially towards 0.7μm and towards mid-freq=110 nm rms.

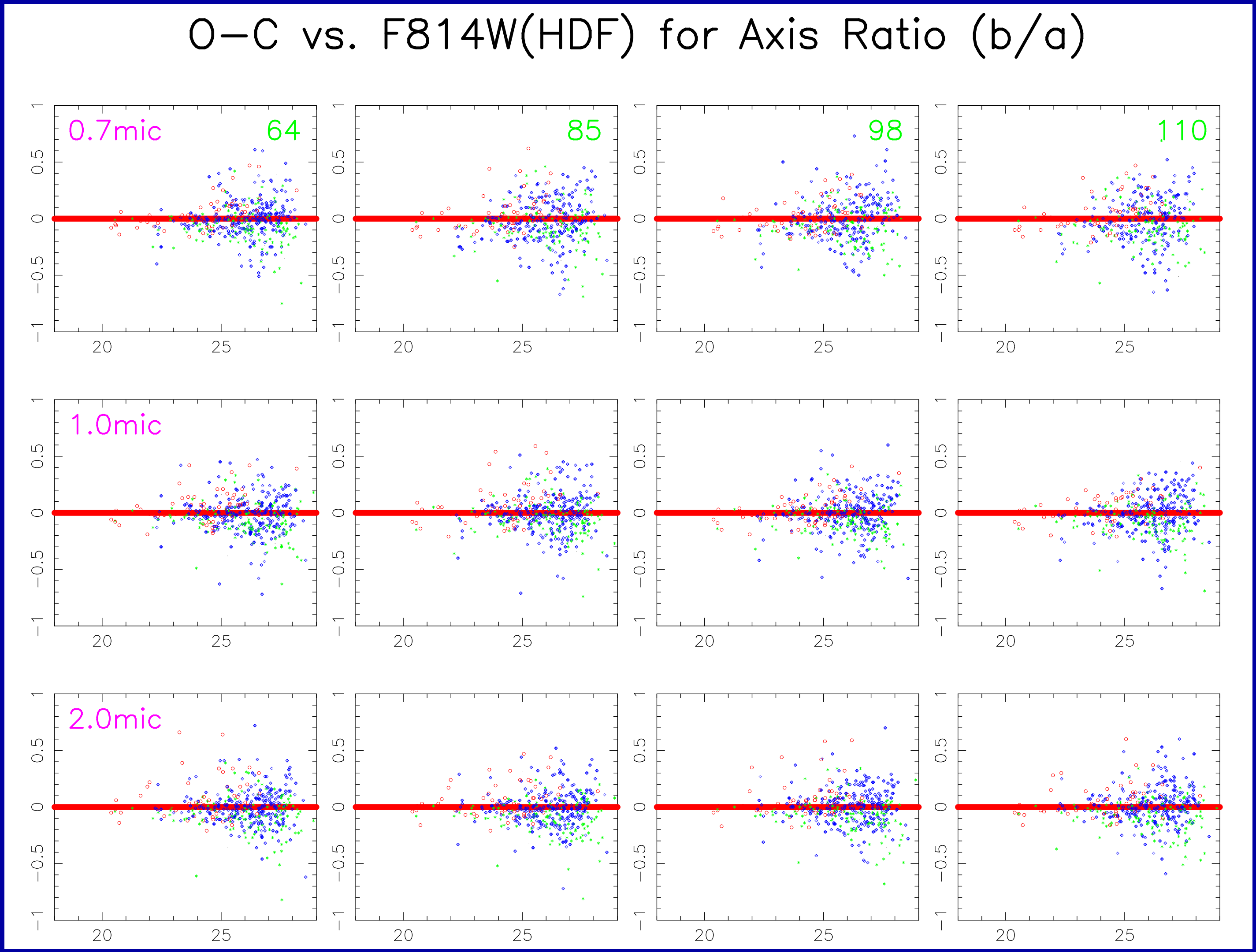
At 2.0 micron, r_e generally somewhat overestimated, especially at faint S/N (normal trend in faint object fitting).



Horizontal: r_e (arcsec); Vertical: (O–C) = (HDF-input - Convolved)

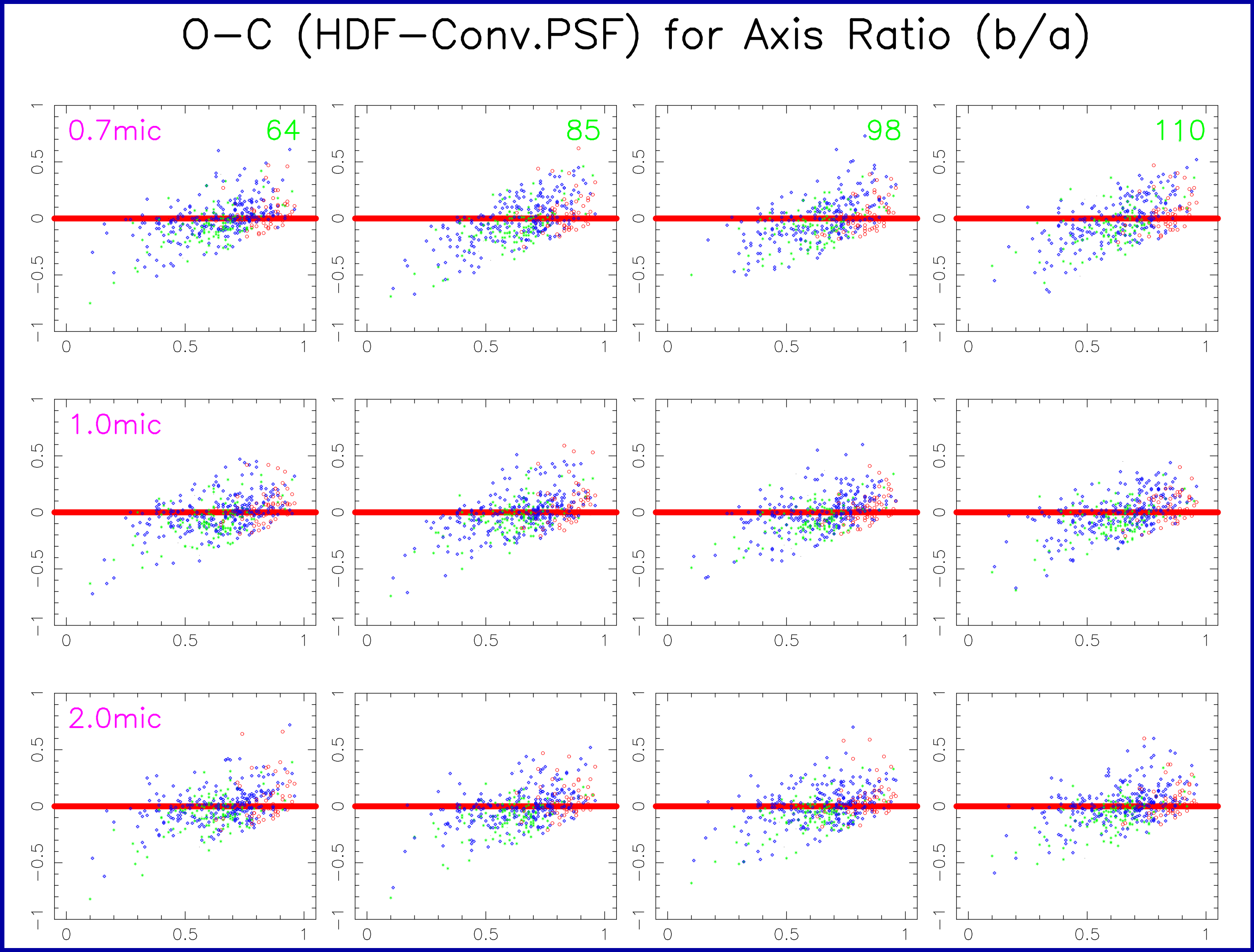
If object is small (earlier types), the convolved r_e is generally overestimated (normal trend).

If object is large (later type), the convolved r_e is generally underestimated ("self–sky-subtraction"), especially towards larger mid-freq=110 nm.



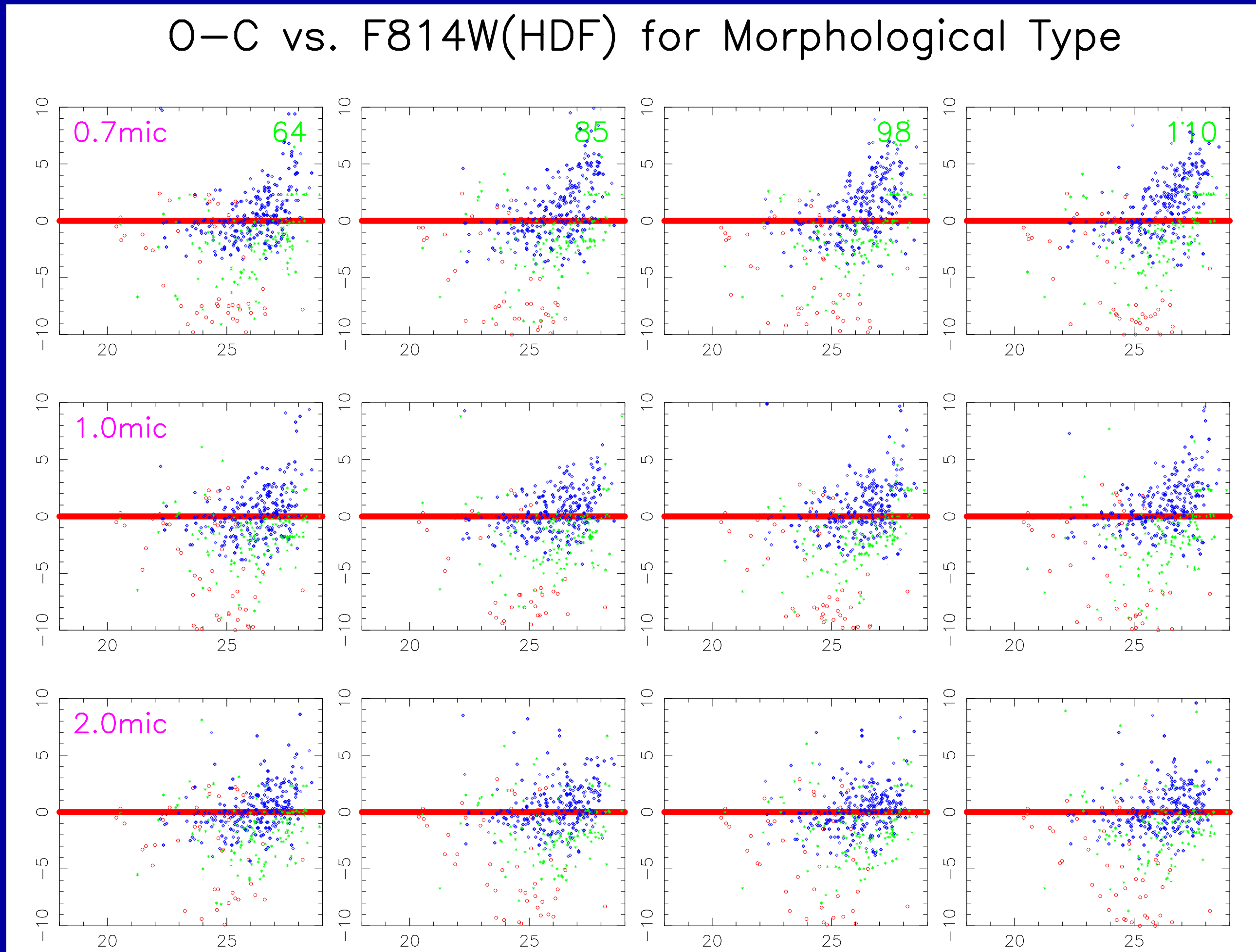
Horizontal: AB-magnitude; Vertical: (O–C) = (HDF-input - Convolved)

The convolved faint-object ellipticity b/a is the least affected for the current PSF's, but there are some trends. First, noise on b/a gets larger towards fainter magnitudes (as expected).



Horizontal: ellipticity b/a; Vertical: (O–C) = (HDF-input - Convolved)

The general trend for faint-object ellipticity b/a is that flatter galaxies ($b/a \rightarrow 0$) become rounder and rounder galaxies become flatter ($b/a \rightarrow 1$).



The convolved faint-object types behave as following:

Brighter early-types stay early, most fainter early-types become later types (since the classifier interprets lower SB as later-type).

Mid-types become slightly too late.

Most late-types stay late-types, some fainter late-types become earlier-type.

These trends get worse towards mid-freq=110 nm rms and towards 0.7μm, but the random S/N component in these errors is also large.

(6) Conclusions

- The short-λ PSF's have significant wings, visible around brighter objects.
- The PSF integral converges only very slowly and its wings extend beyond convolution kernel.
- Faint galaxy structure is still visible, but contrast is noticeably lowered due to the wings of the short-wavelength PSF.
- Deep crowded JWST fields ($\gtrsim$1 hr) will have PSF-confusion issues.
- The convolved faint-object flux is generally too faint, even at 2.0μm.
- If object is faint, the convolved r_e is generally too small, especially towards 0.7μm and towards mid-freq=110 nm rms.
- The convolved faint-object ellipticity b/a is less affected, but flatter galaxies become rounder and rounder galaxies become flatter.
- Brighter early-types stay early, most fainter early-types become later.
- Mid-types become slightly too late. Some late-types become earlier.

Most of these trends get worse towards mid-freq=110 nm rms and towards 0.7μm, but the random S/N component in these errors is also large.