Successful application of PSF-R on globular cluster observations

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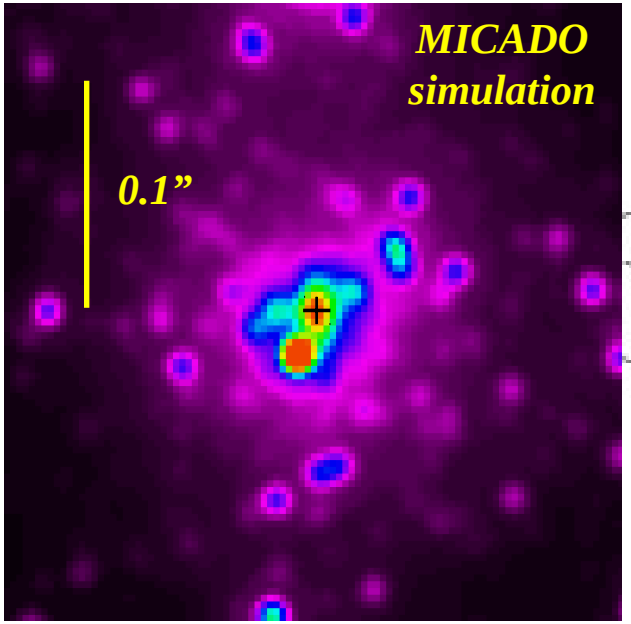
ELTs - science cases

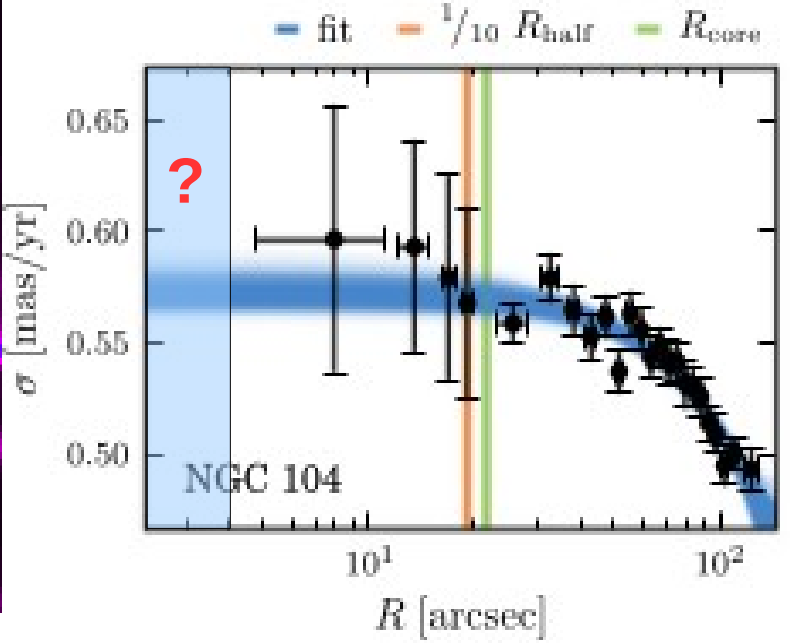
ASTROMETRY

Galactic SMBH



GRAVITY collaboration et al.2018

IMBH in globular clusters



Watkins et al. 2015

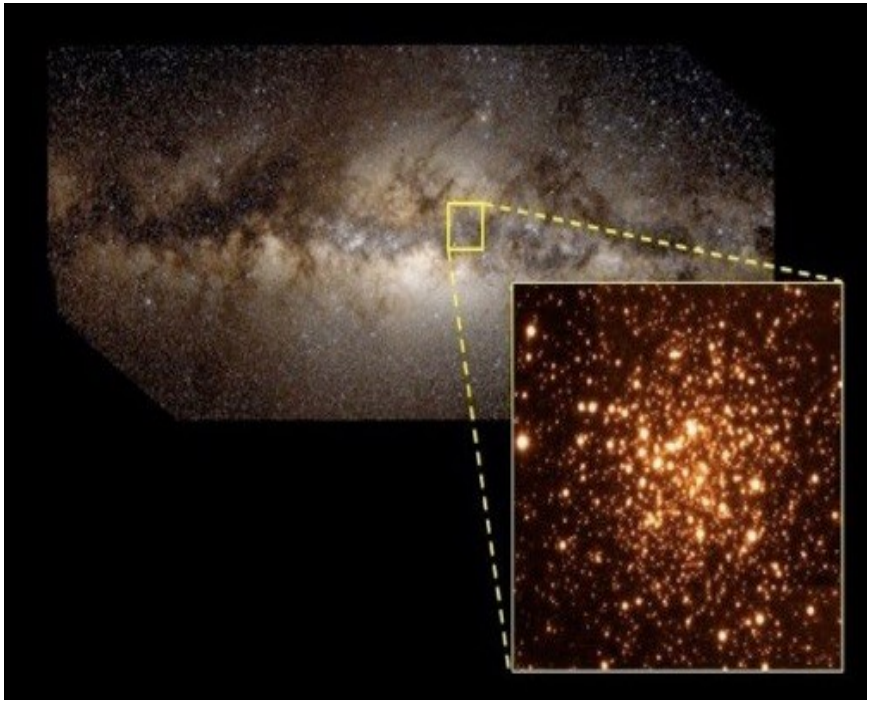
Dynamics of dwarf spheroidals

Massari et al. 2018

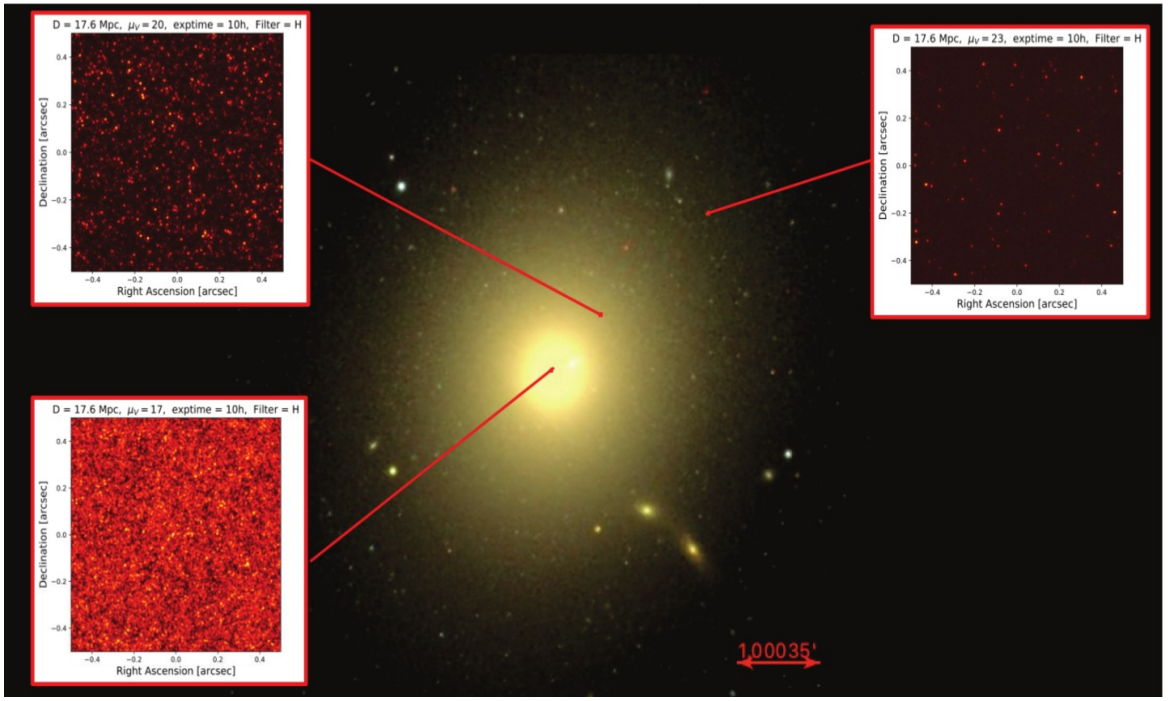
ELTs - science cases

PHOTOMETRY

Bulge globular clusters



Elliptical galaxies d>1 Mpc



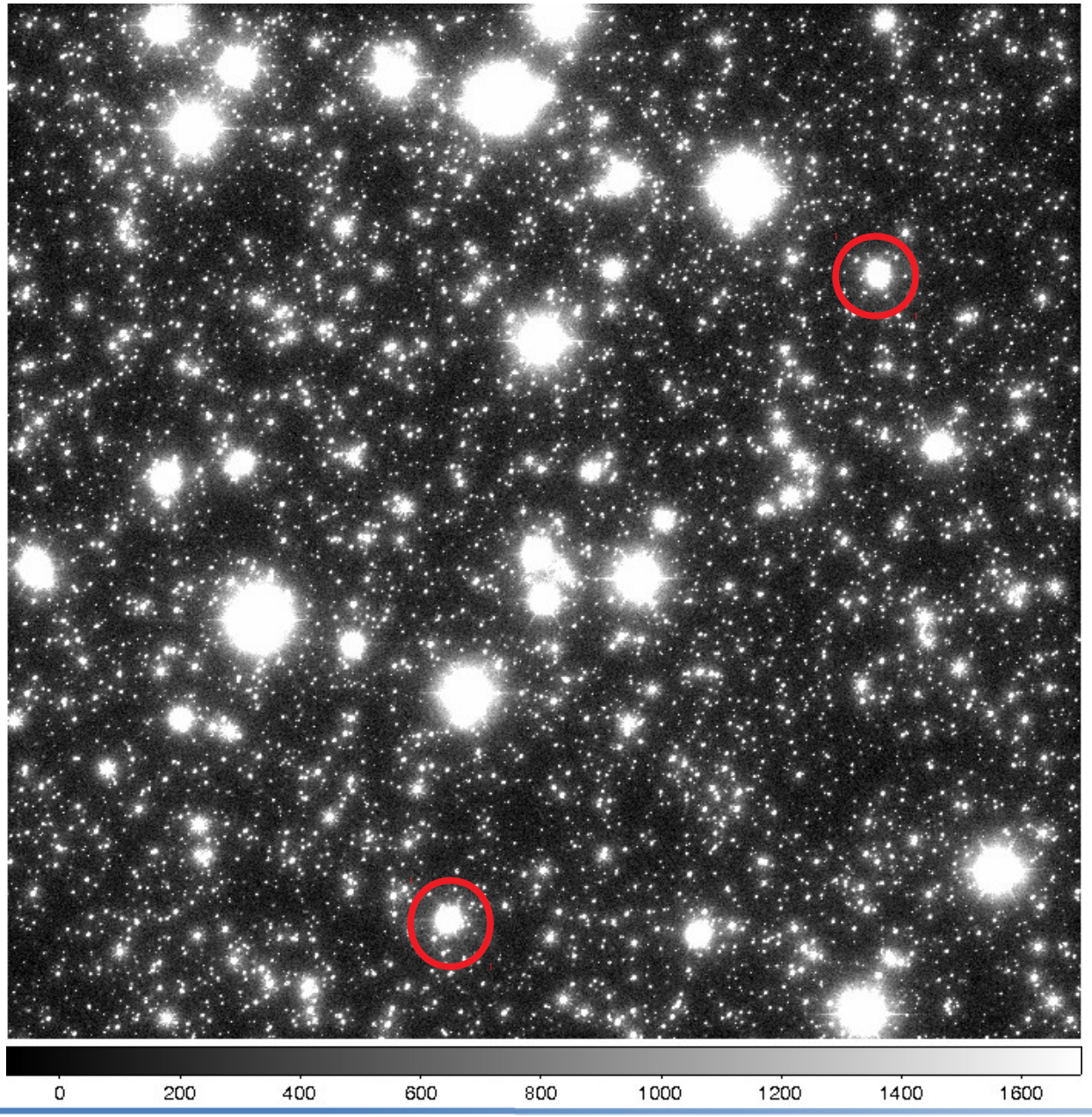
Plus many other extragalactic science cases

SUCCESS

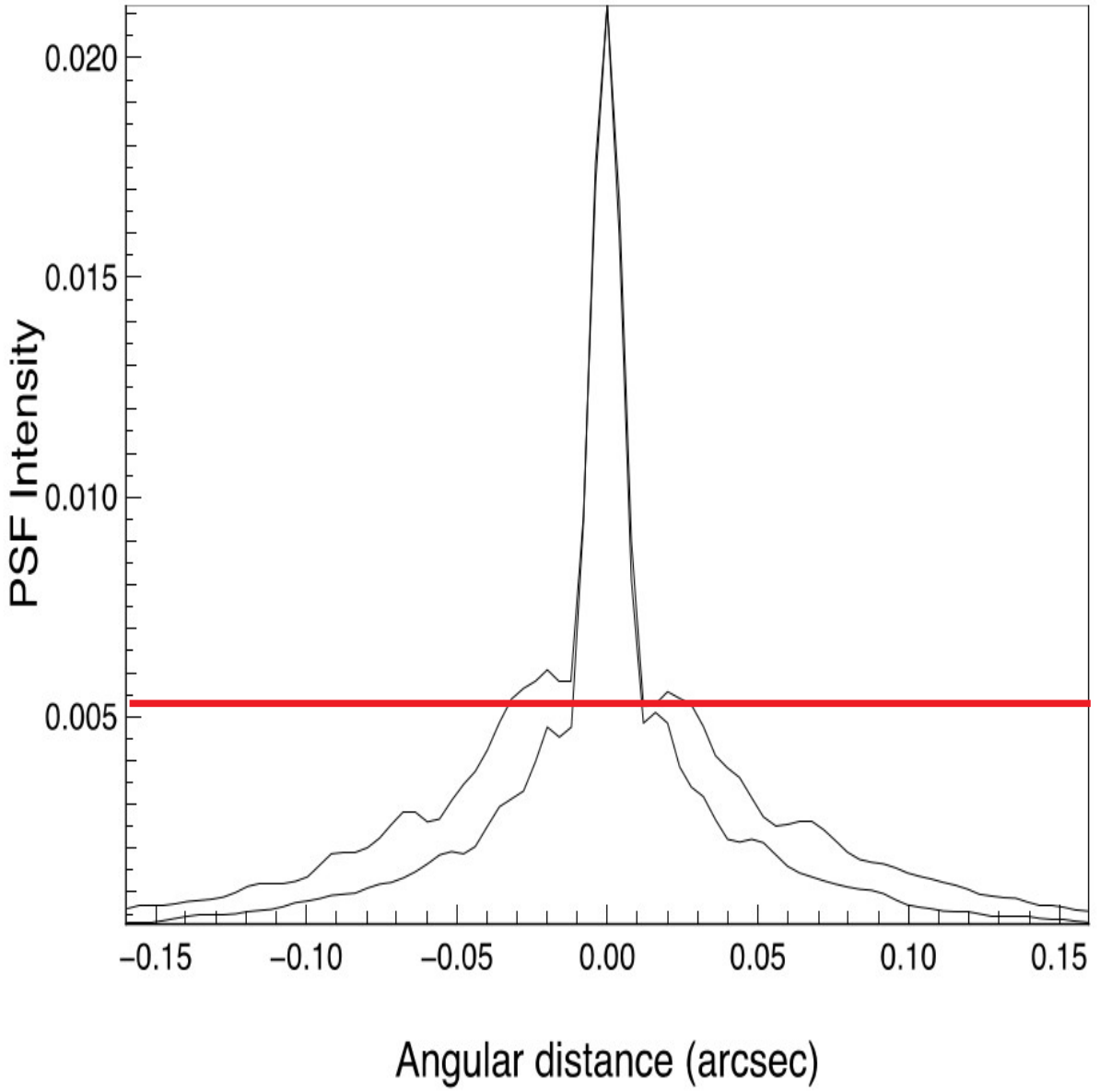
=

PSF

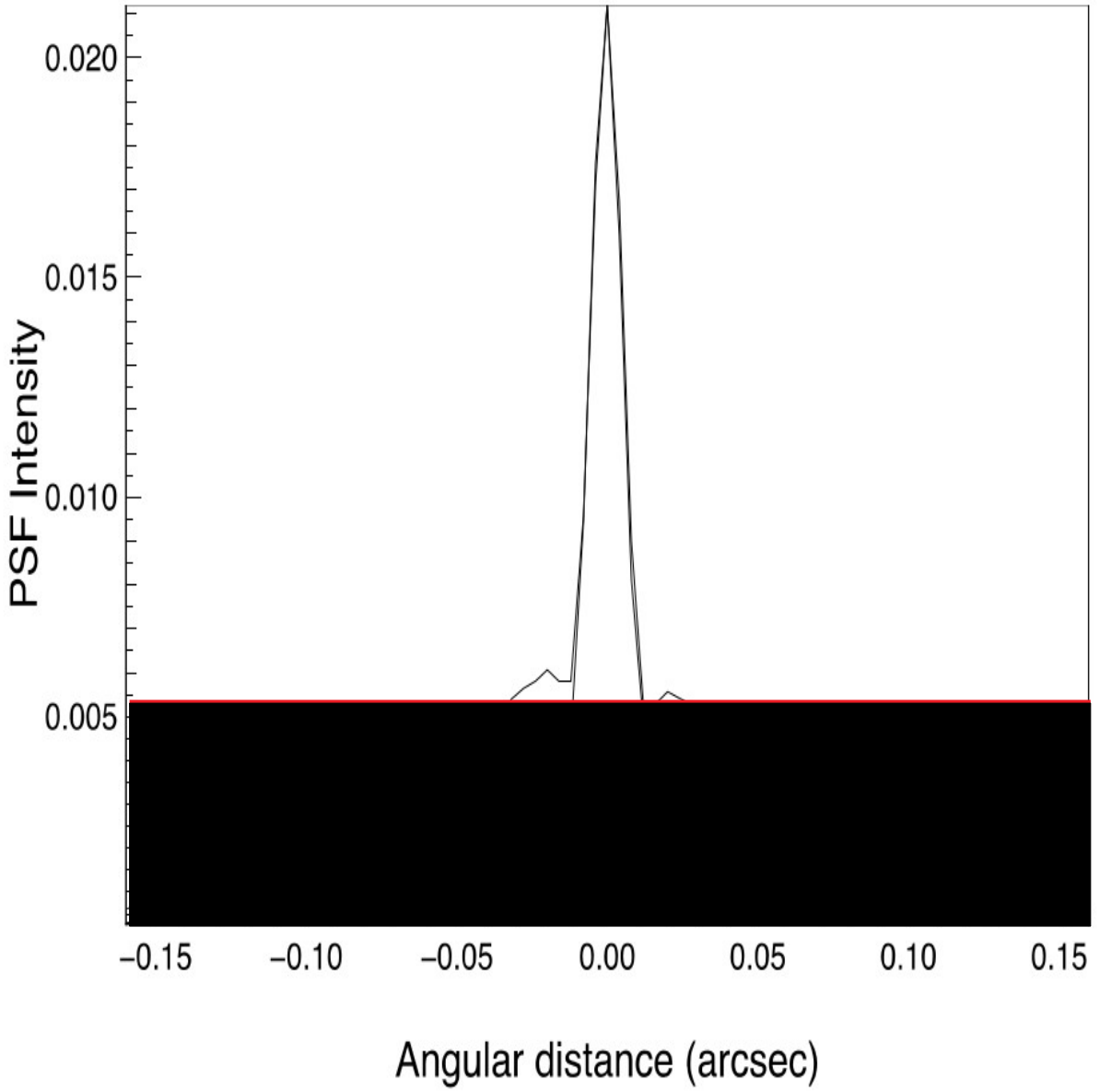
PSF Knowledge



PSF Knowledge – a posteriori

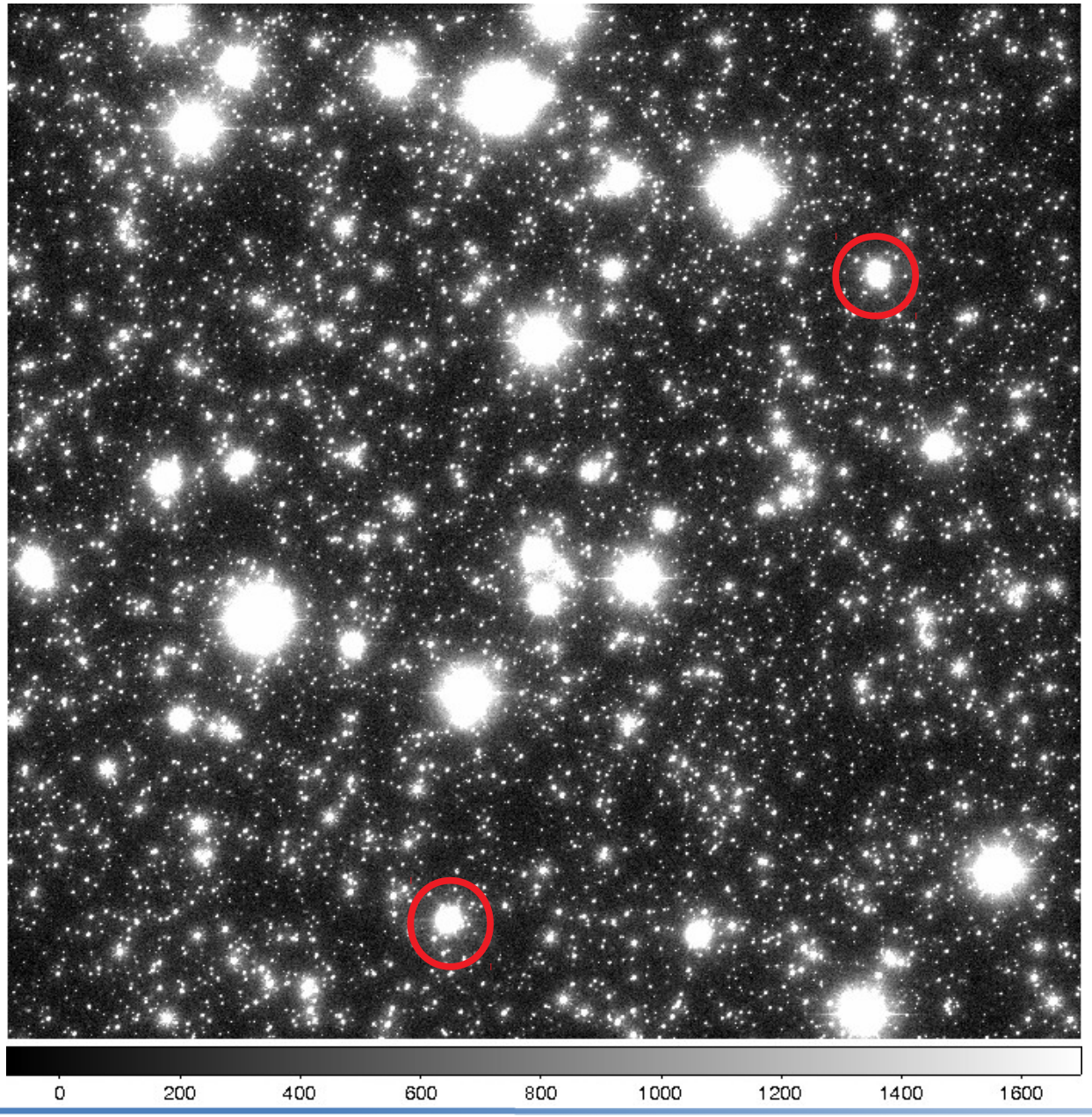


PSF Knowledge – a posteriori



Lost information
on Strehl Ratio

PSF Knowledge – a posteriori

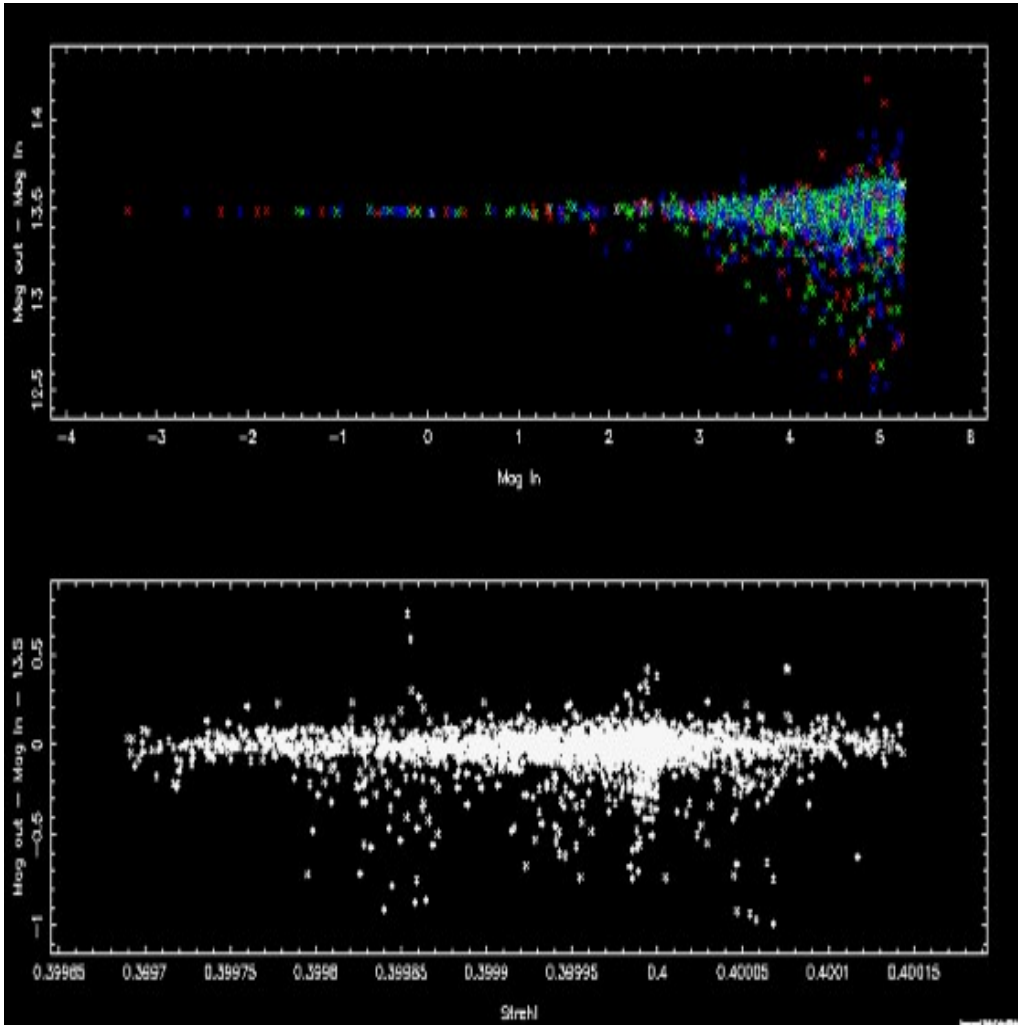


Strehl Ratio is varying!

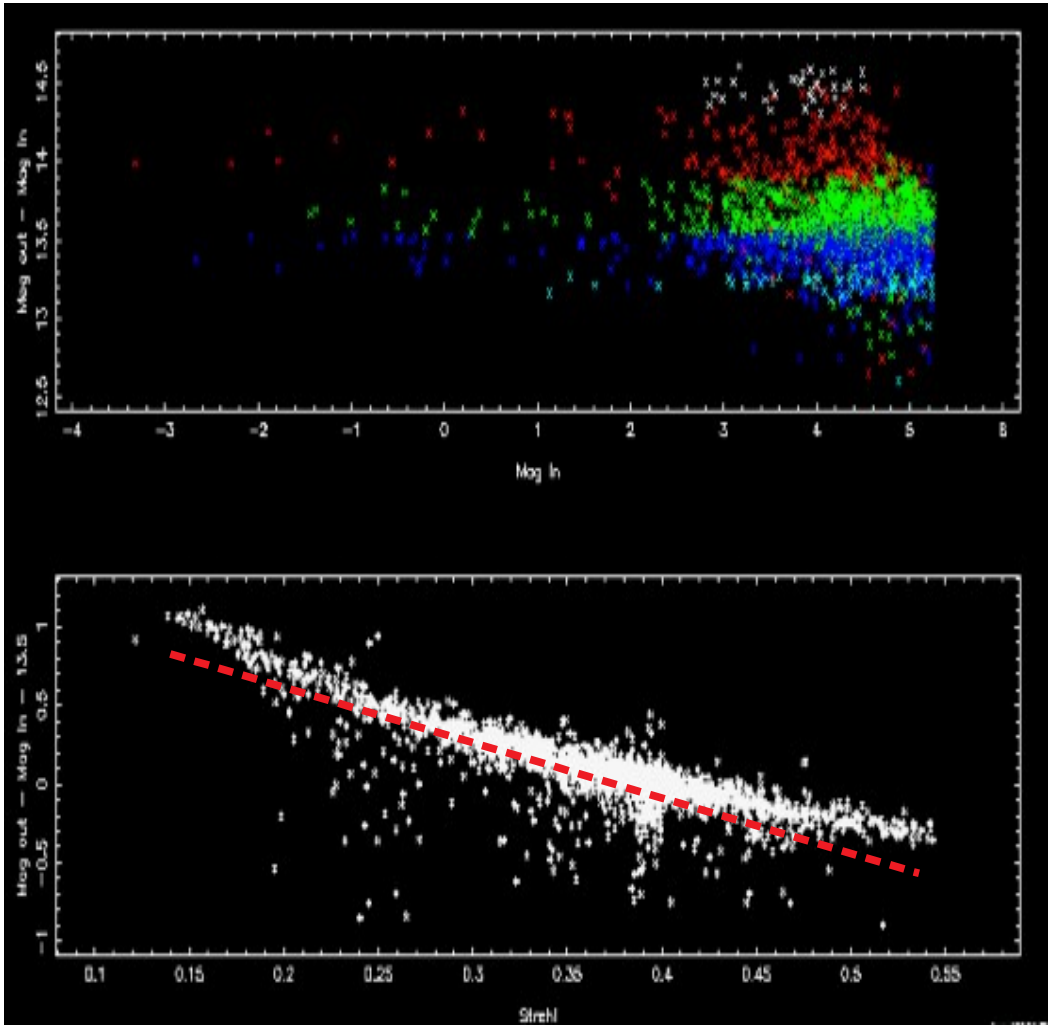
Strehl Ratio Magnitude degeneracy

PSF Knowledge – a posteriori

1% SR variation

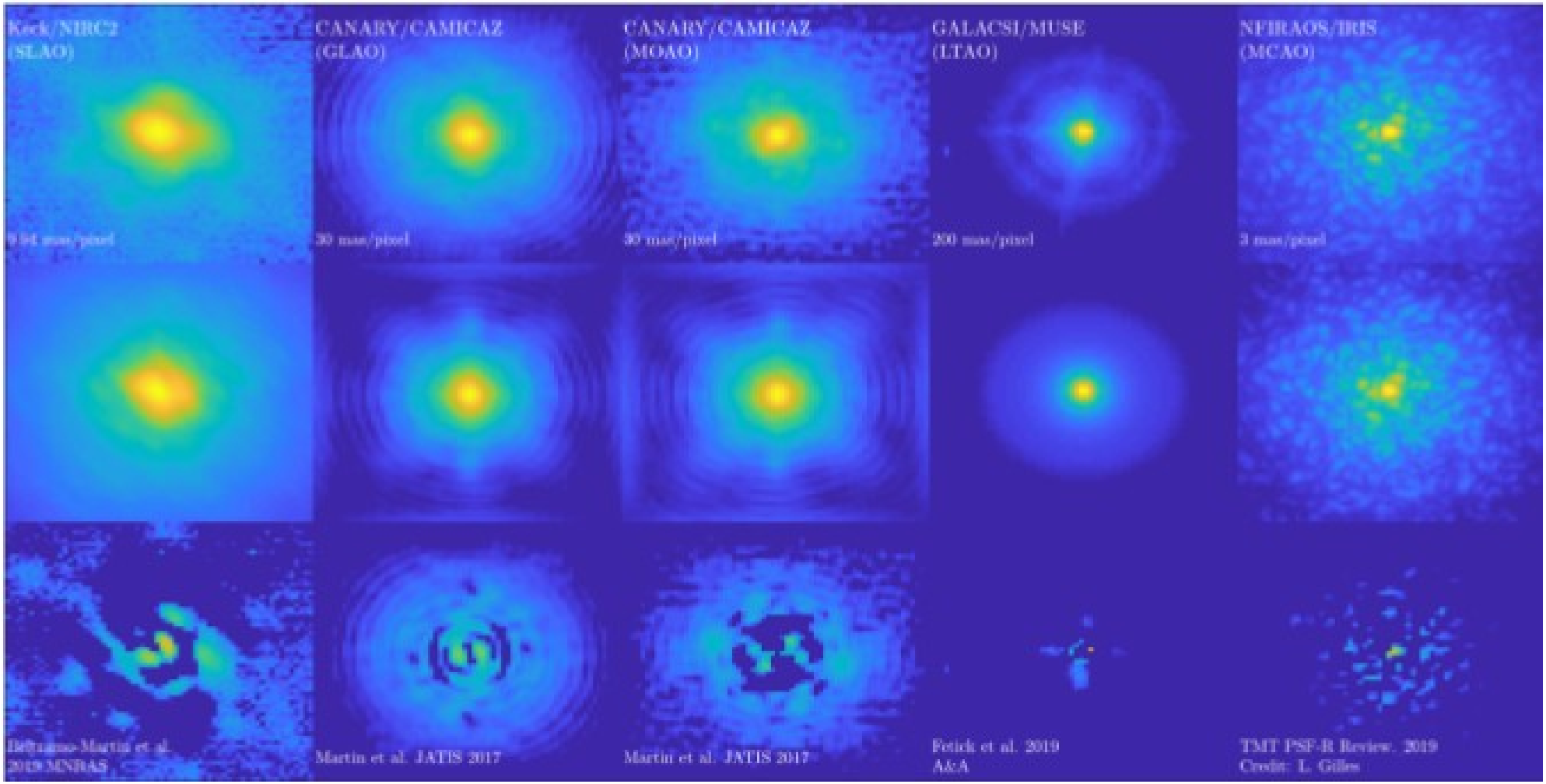


30% SR variation



0.03 mag / 1%SR

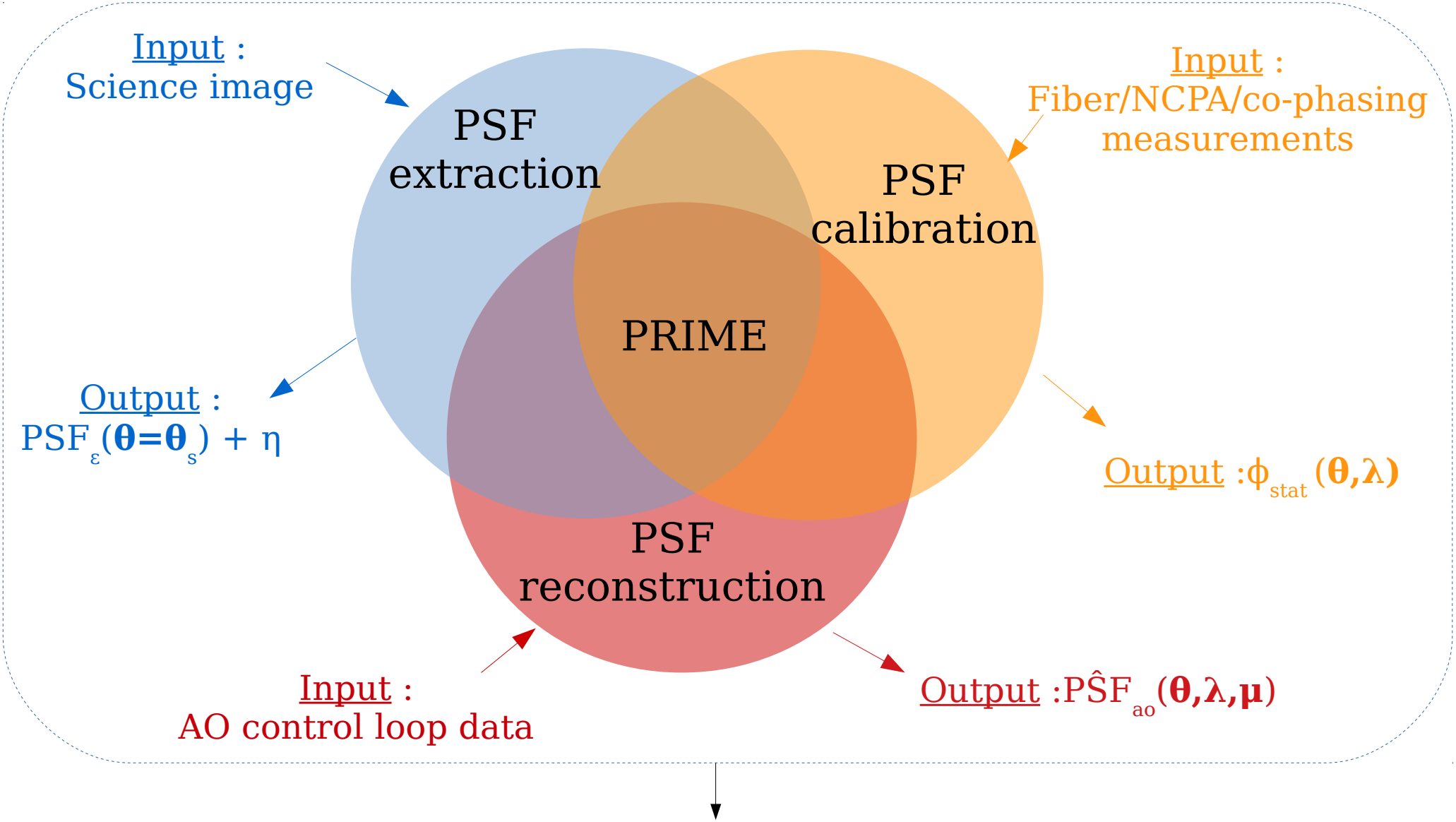
PSF Knowledge – a priori



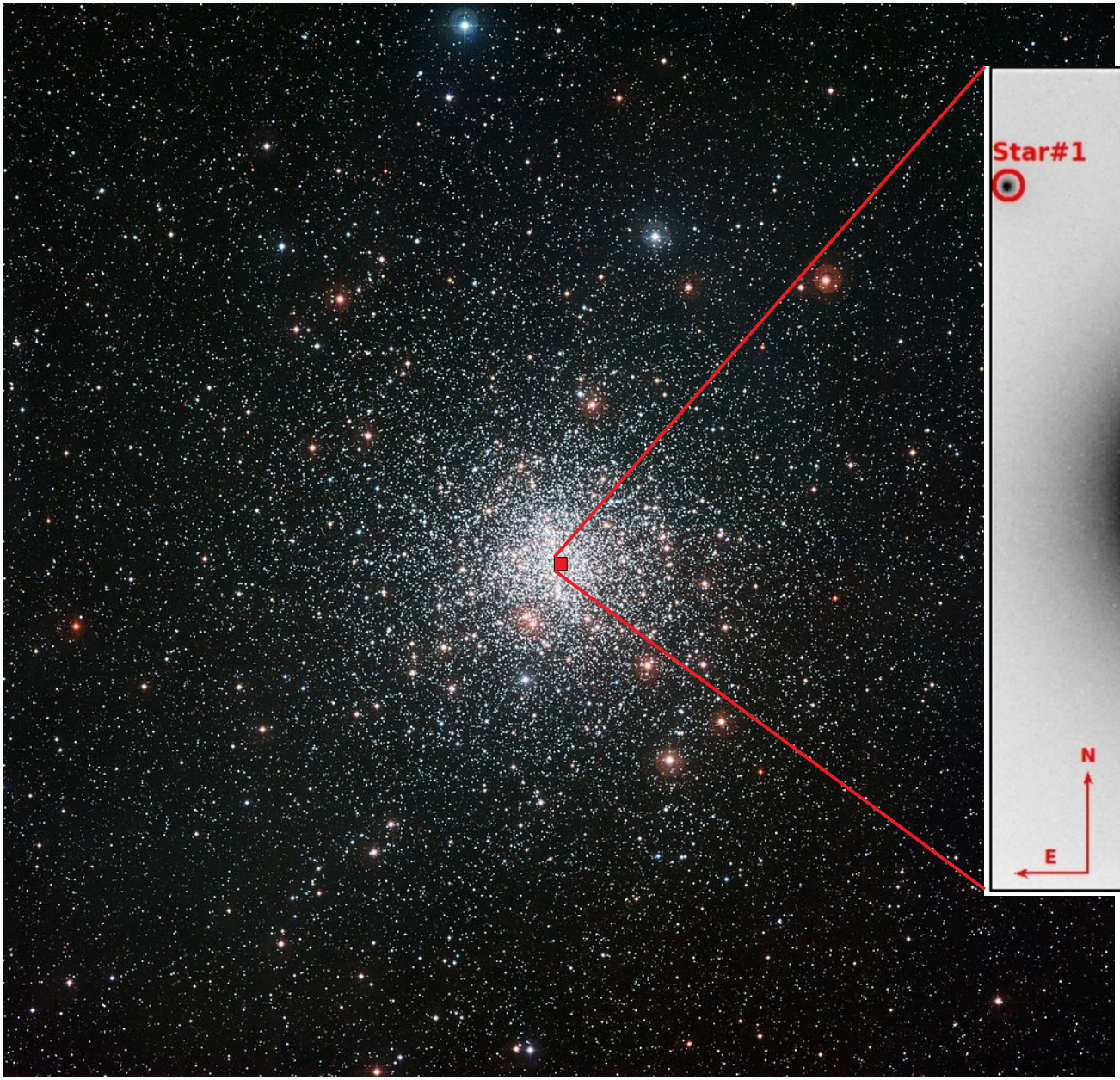
- Performance quality often based on residuals only
- Photometric and astrometric measurements poorer than standard a-posteriori methods

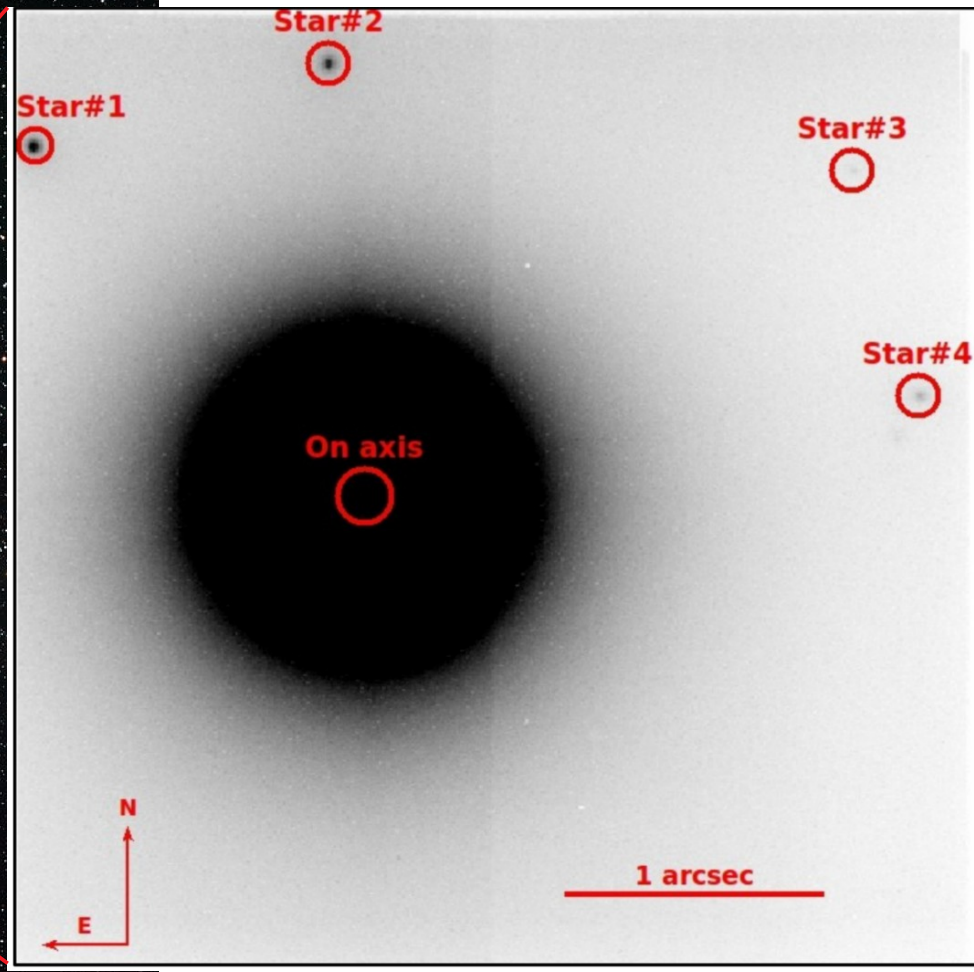
3. Get beyond with PSF reconstruction

PRIME: combine pupil-plane and focal-plane information to estimate the PSF (Beltramo-Martin et al. 2019)



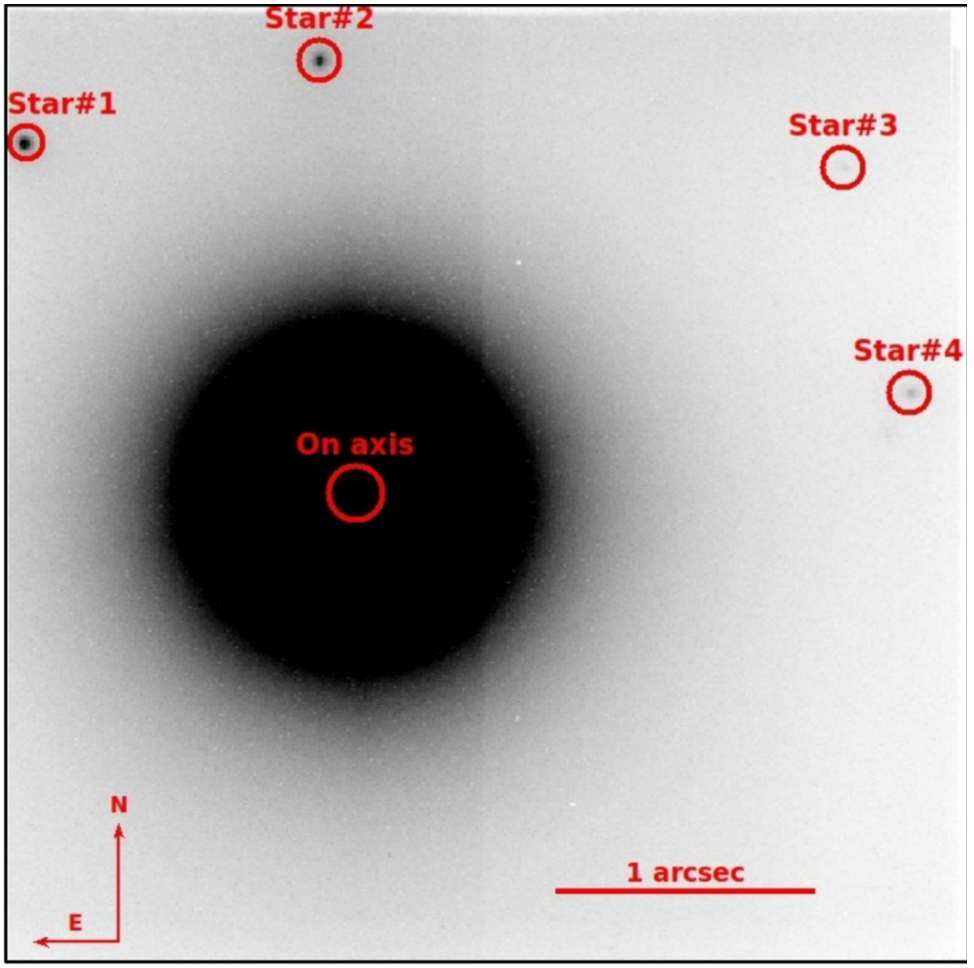
NGC 6121 - data analysis





ZIMPOL/SPHERE

NGC 6121 - data analysis



- 2x12 exposures (DIT=100s, NDIT=2)

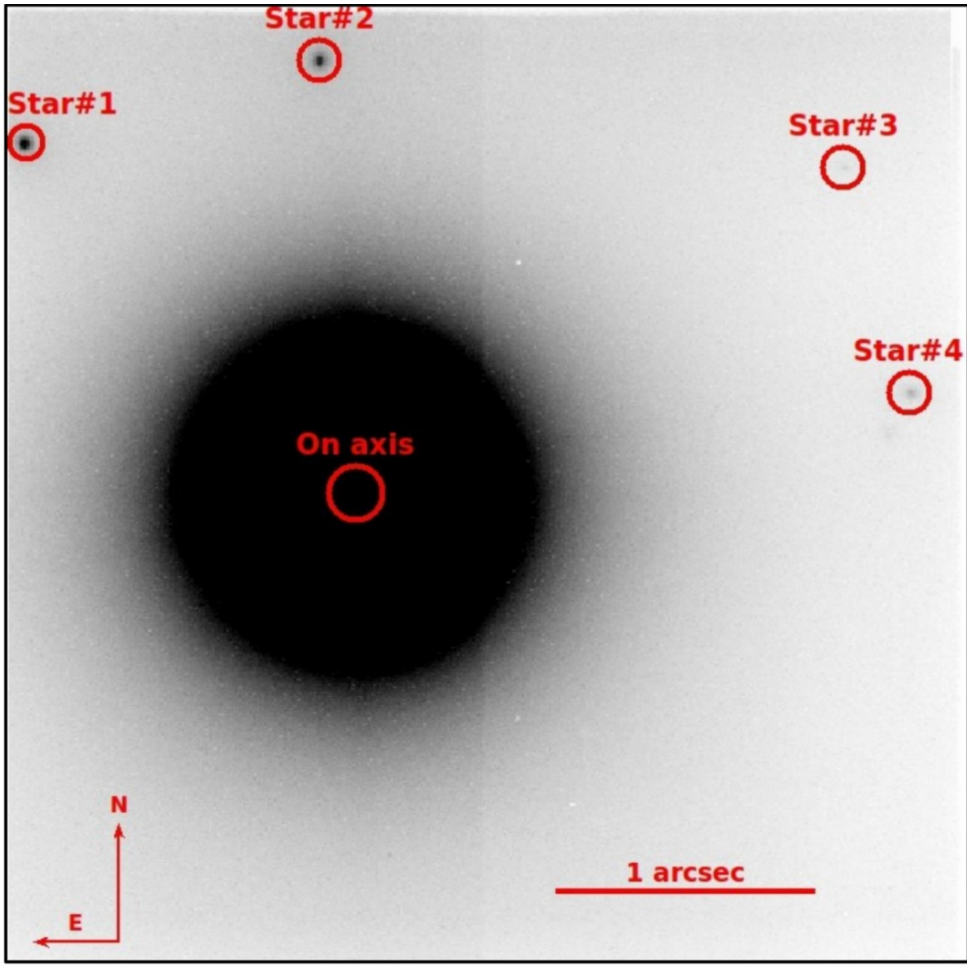
- 3.5” x 3.5” FoV

- pixel scale = 7.2 mas/pixel

- H-band mean Strehl Ratio = 65%
  (V-band mean Strehl Ratio = 2%)

- Stable conditions (seeing=0.7-0.9)

NGC 6121 - data analysis



Position and magnitude measurements

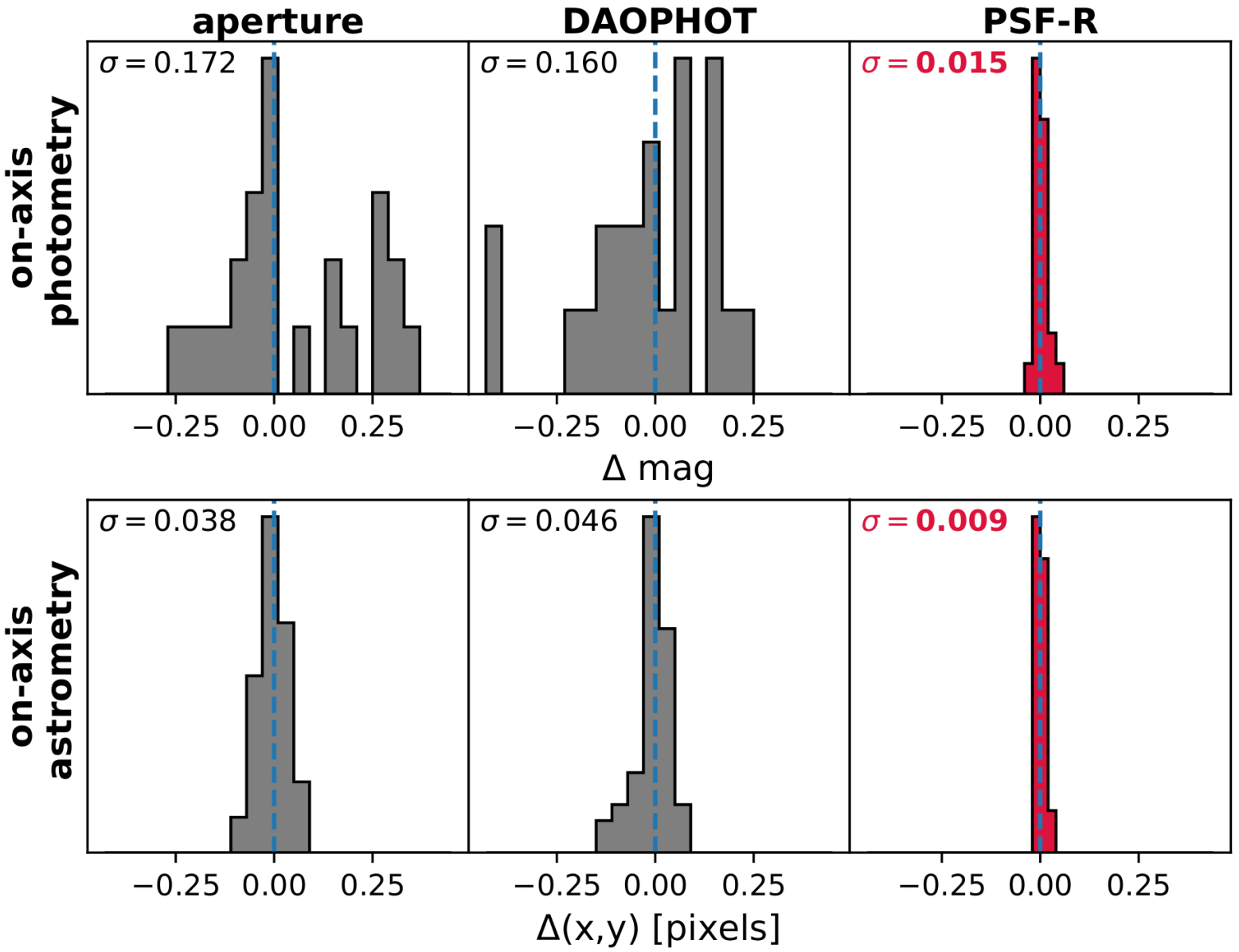
1-Standard PSF modelling
(DAOPHOT)

2-PRIME PSF
(SuperStar, see A. Marasco talk)

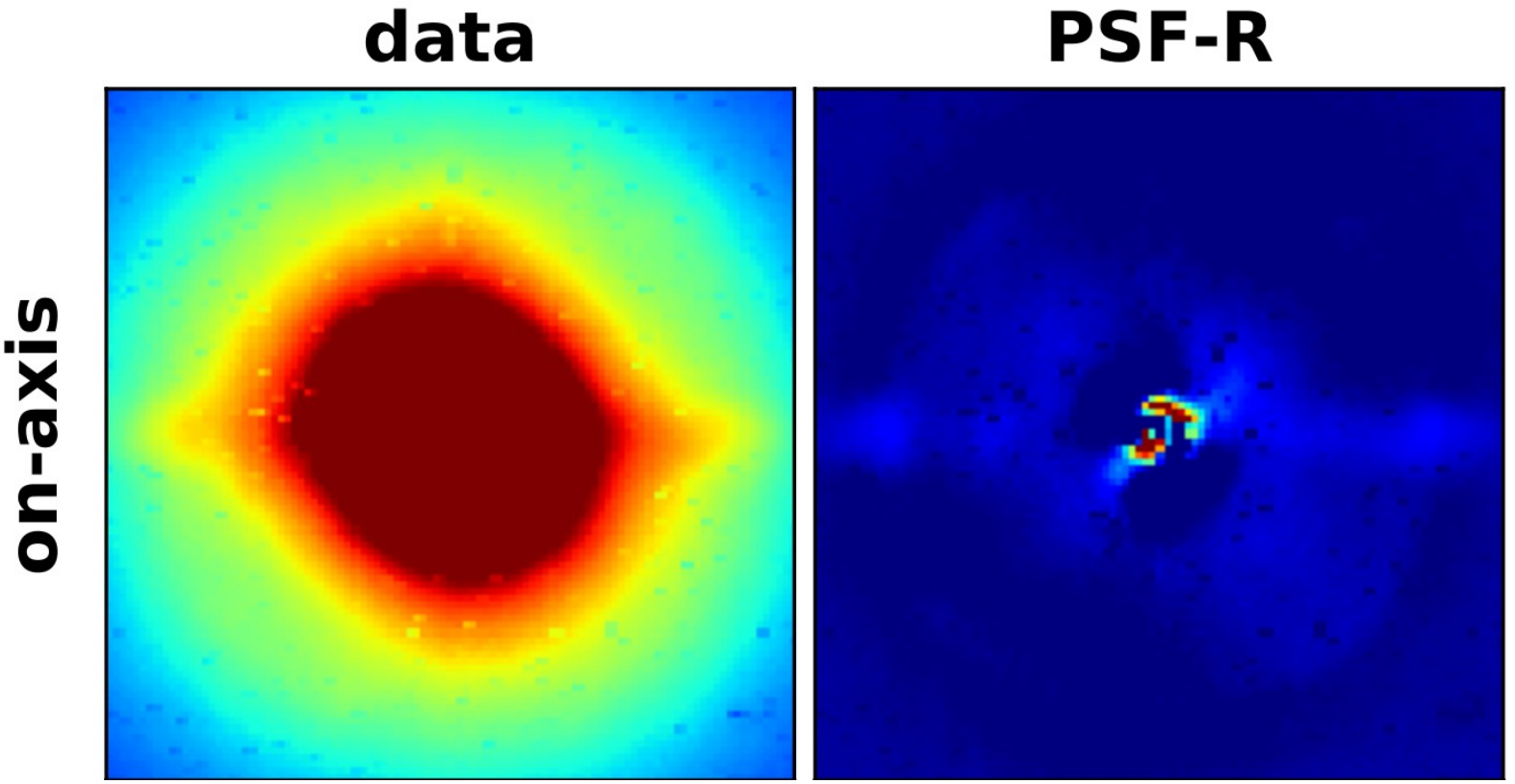
3- Aperture photometry

(Details in **Massari et al. 2020**
and **Beltramo-Martin et al. 2020**)

NGC 6121 – on axis precision



NGC 6121 – on axis accuracy



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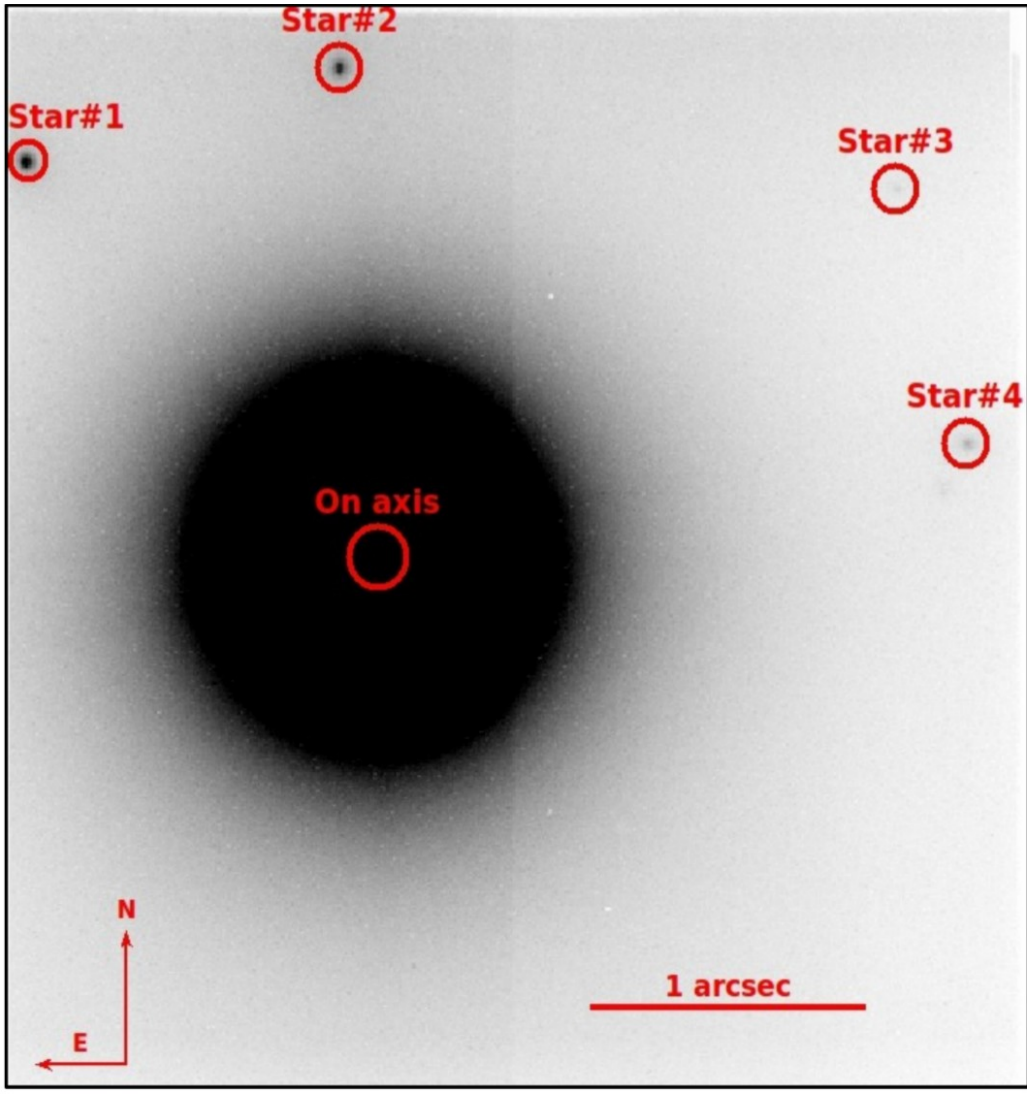

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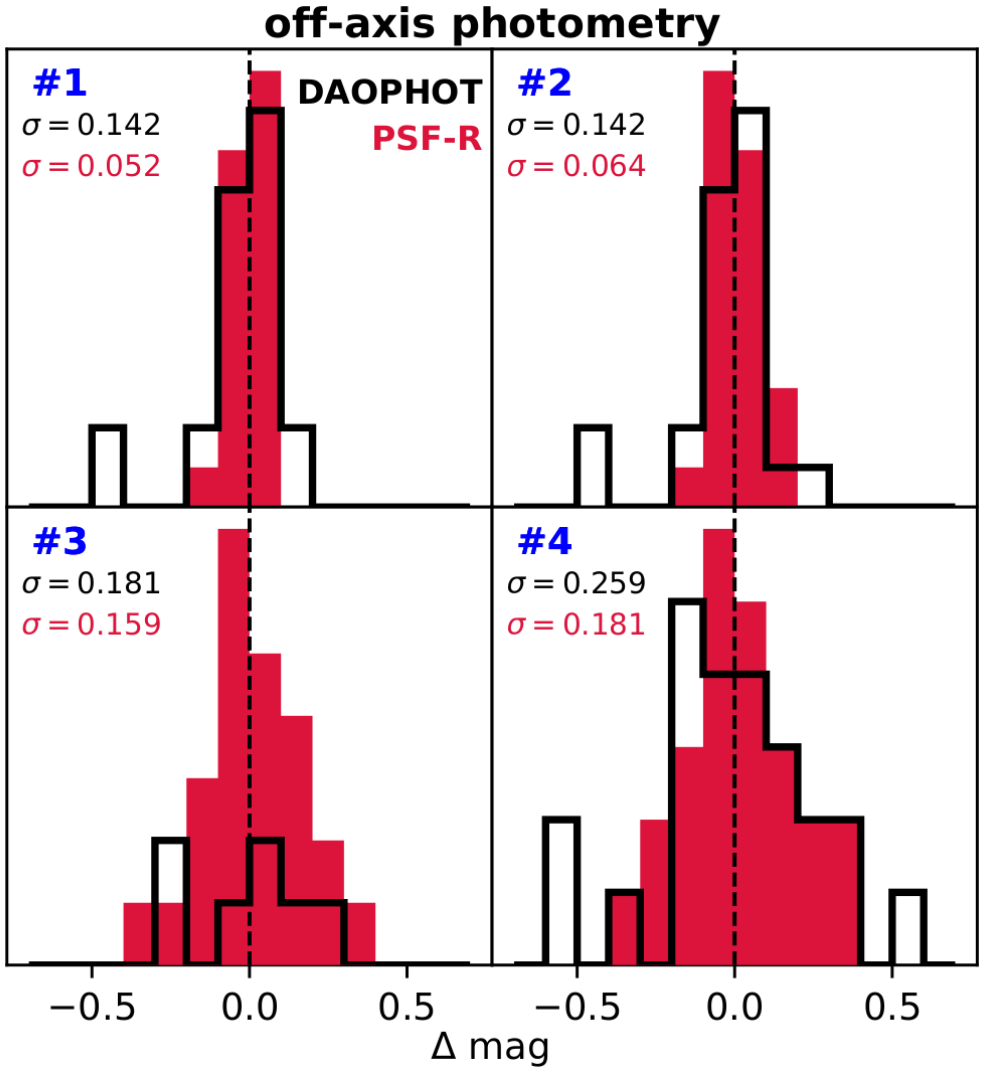

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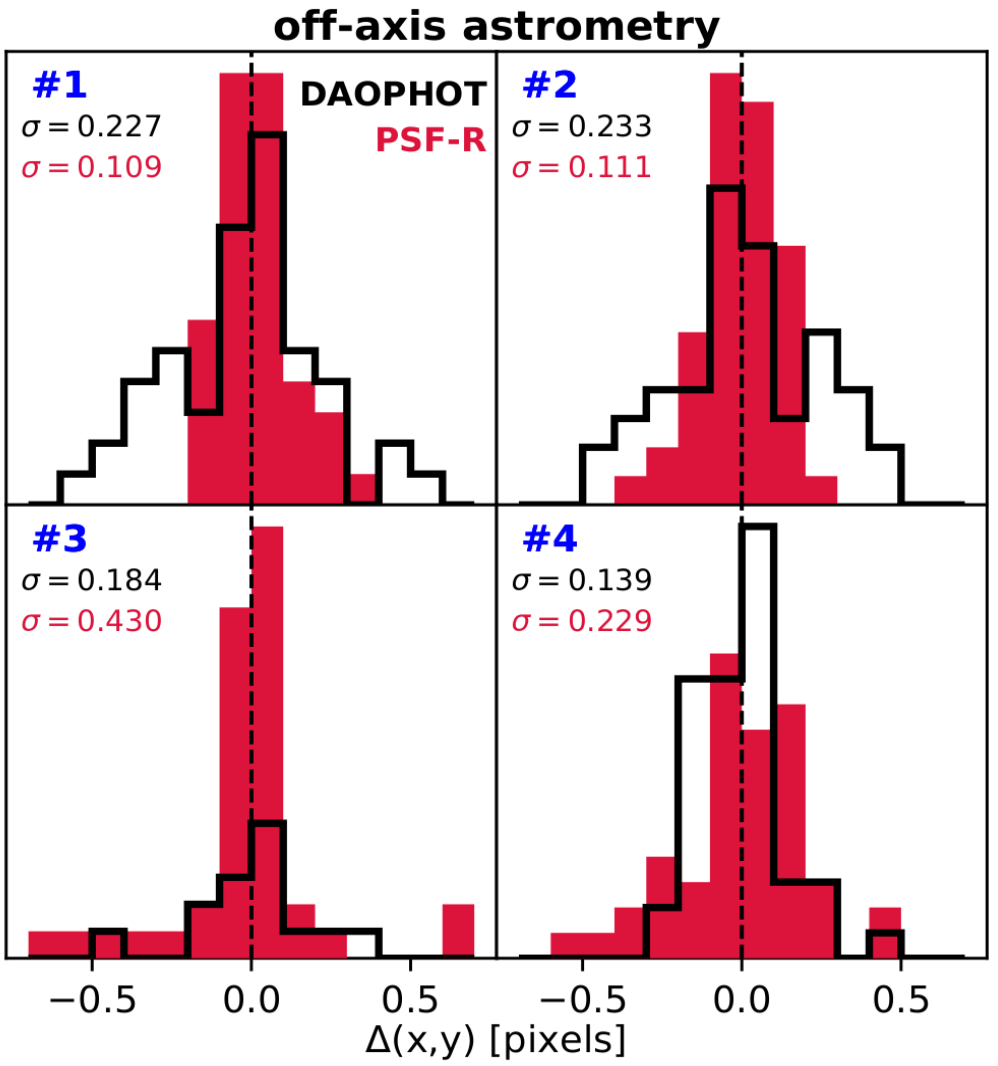
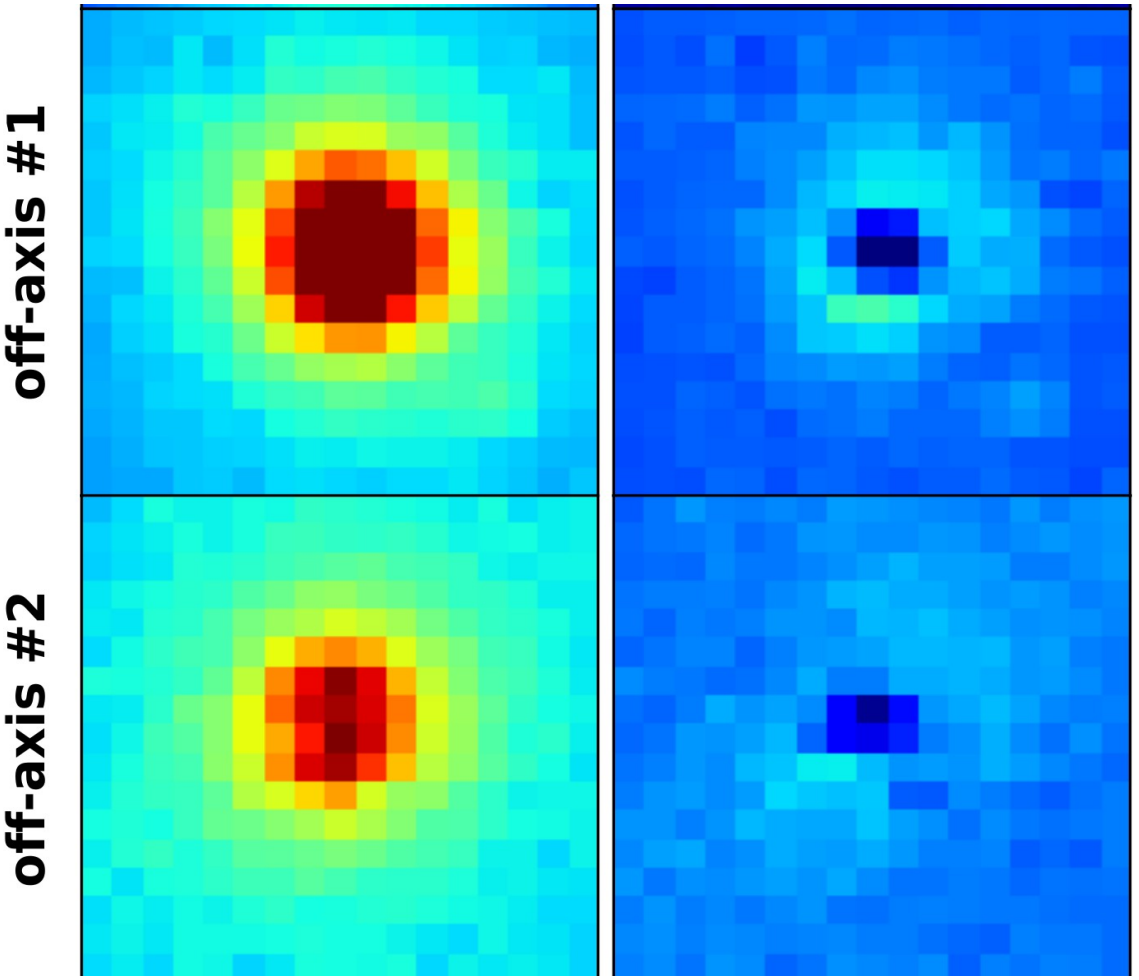


NGC 6121 – off axis accuracy



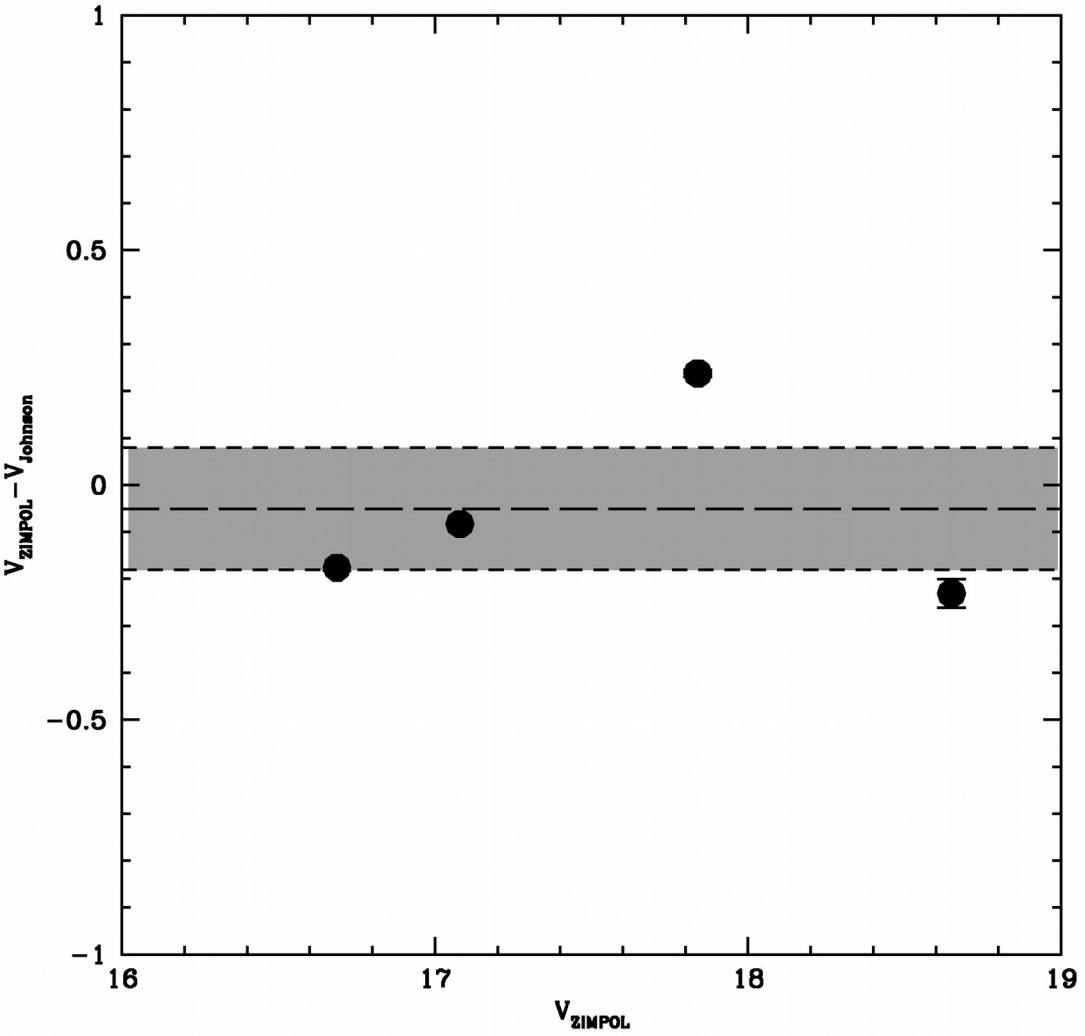
NGC 6121 – off axis accuracy

No photometric standards observed (proposal on relative astrometry)

Quantify “relative” accuracy assuming the magnitude of the on-axis star is perfect

Use on-axis star to calibrate the transformation between ZIMPOL counts and Johnson magnitudes

Comparison with publicly available HST Johnson magnitudes (Anderson et al.2008)



NGC 6121 – Results

	Standard PSF modelling (DAOPHOT)	Hybrid PSF modelling (PRIME)
On axis photometry		**x10**
On axis astrometry		**x4-5**
Off axis photometry (bright)		**x2-3**
Off axis astrometry (bright)		**x2**
Off axis photometry (faint)	**=**	**=**
Off axis astrotometry (faint)	**=**	**=**

Caveats and next steps

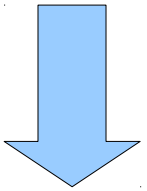
1- Quantify astrometric accuracy (using relative distances)

2- Use spatially varying PSFs

Tests ongoing (see Beltramo-Martin et al. 2020)

3- Worst case possible for standard PSF modelling

Test PRIME on more crowded fields (need data, including standards)



Yet, important results for cases where few-to-no stars will be available in the FoV (Planets, extragalactic objects, lensed quasars etc...)