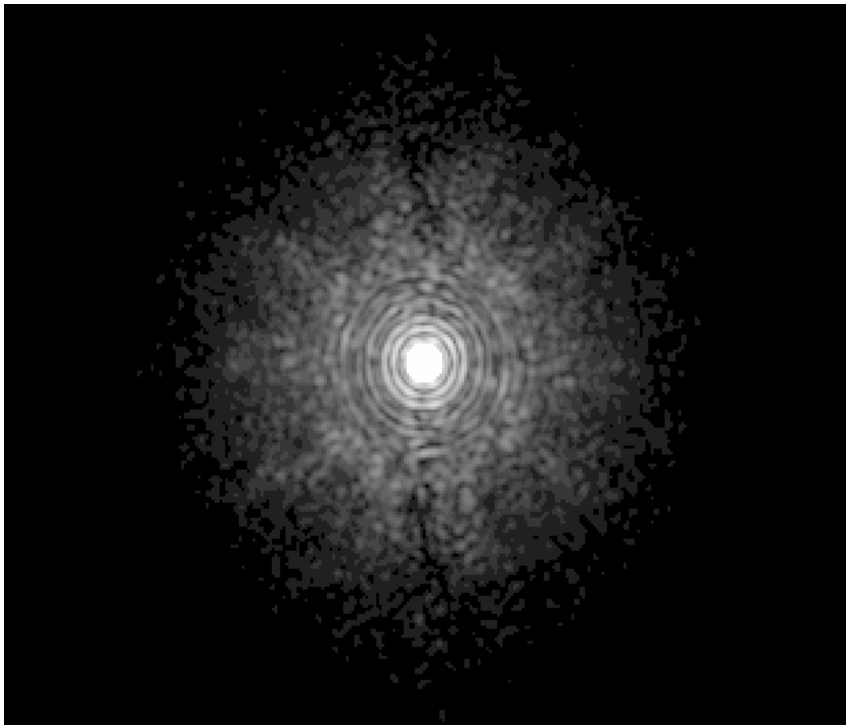
DRM Update
on
RSP imaging case

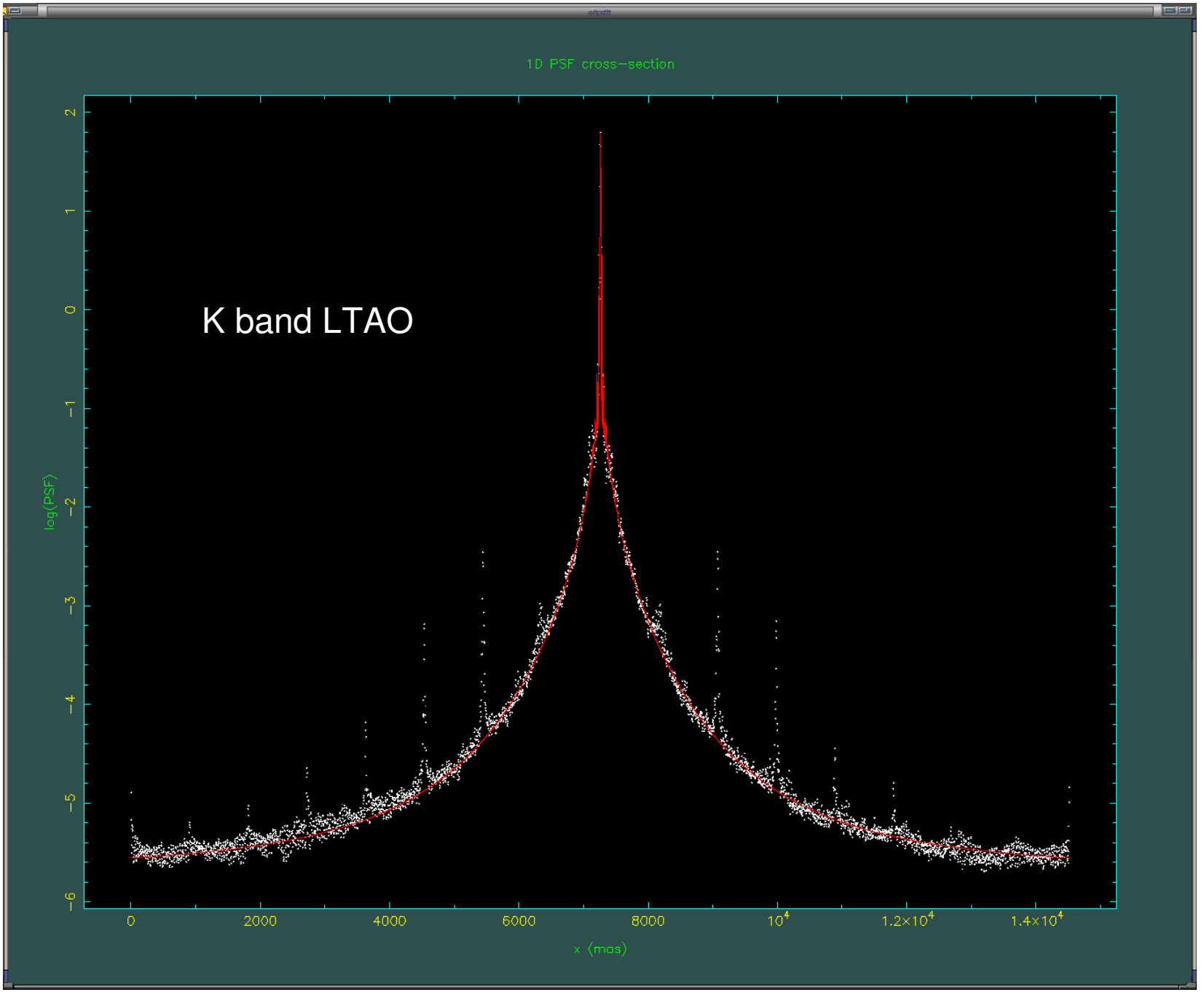
Joe Liske

PSF update

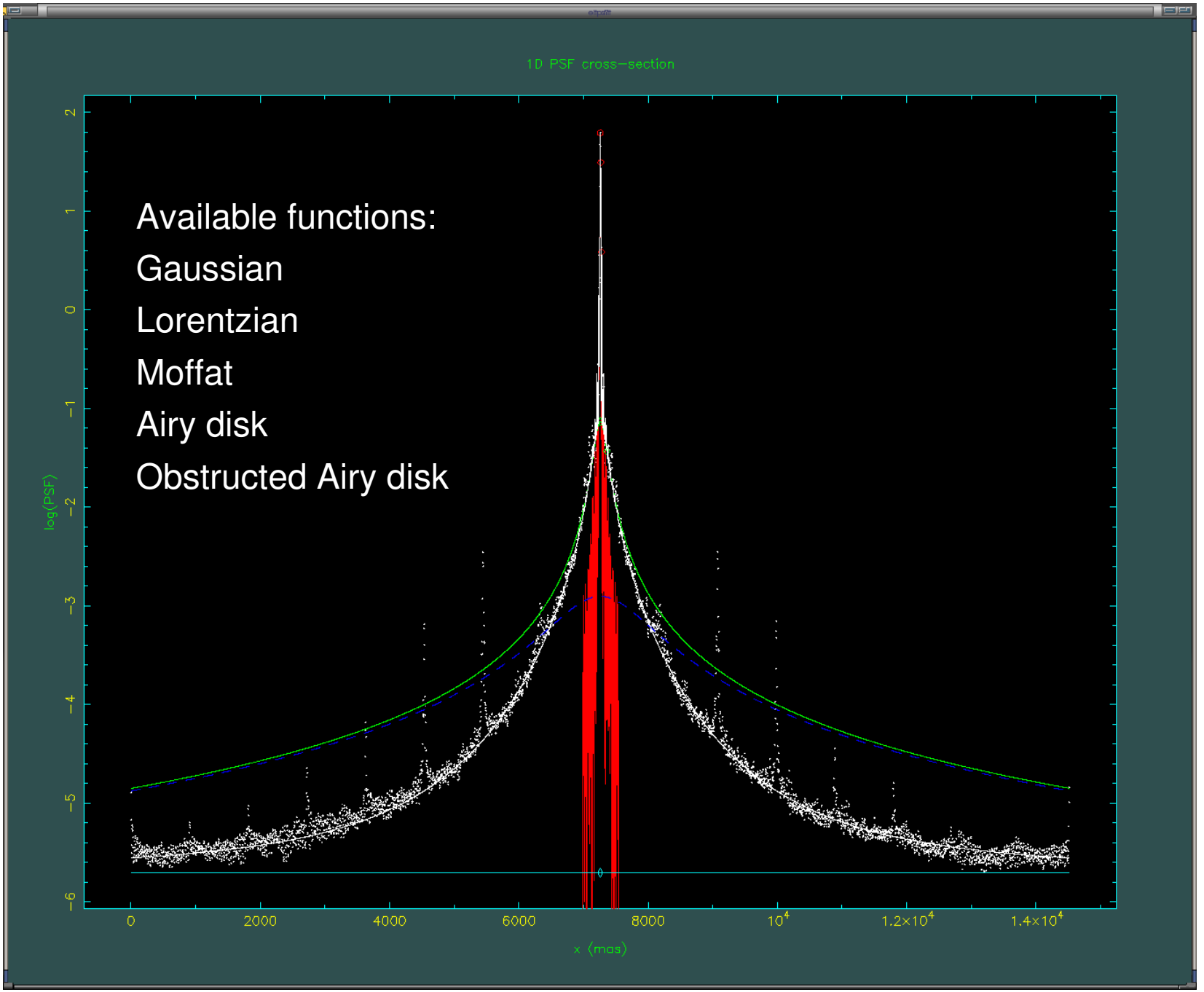
- Because ESO's PSF simulations are computationally so expensive so far only short integration PSFs (4s) have been simulated.
- Problem: speckle noise
- Also: the PSF images have to be very large in order to sample a good contrast range.
- Solution: represent PSFs with a 'small' number of analytic components.
- New code: ELTPSFFIT



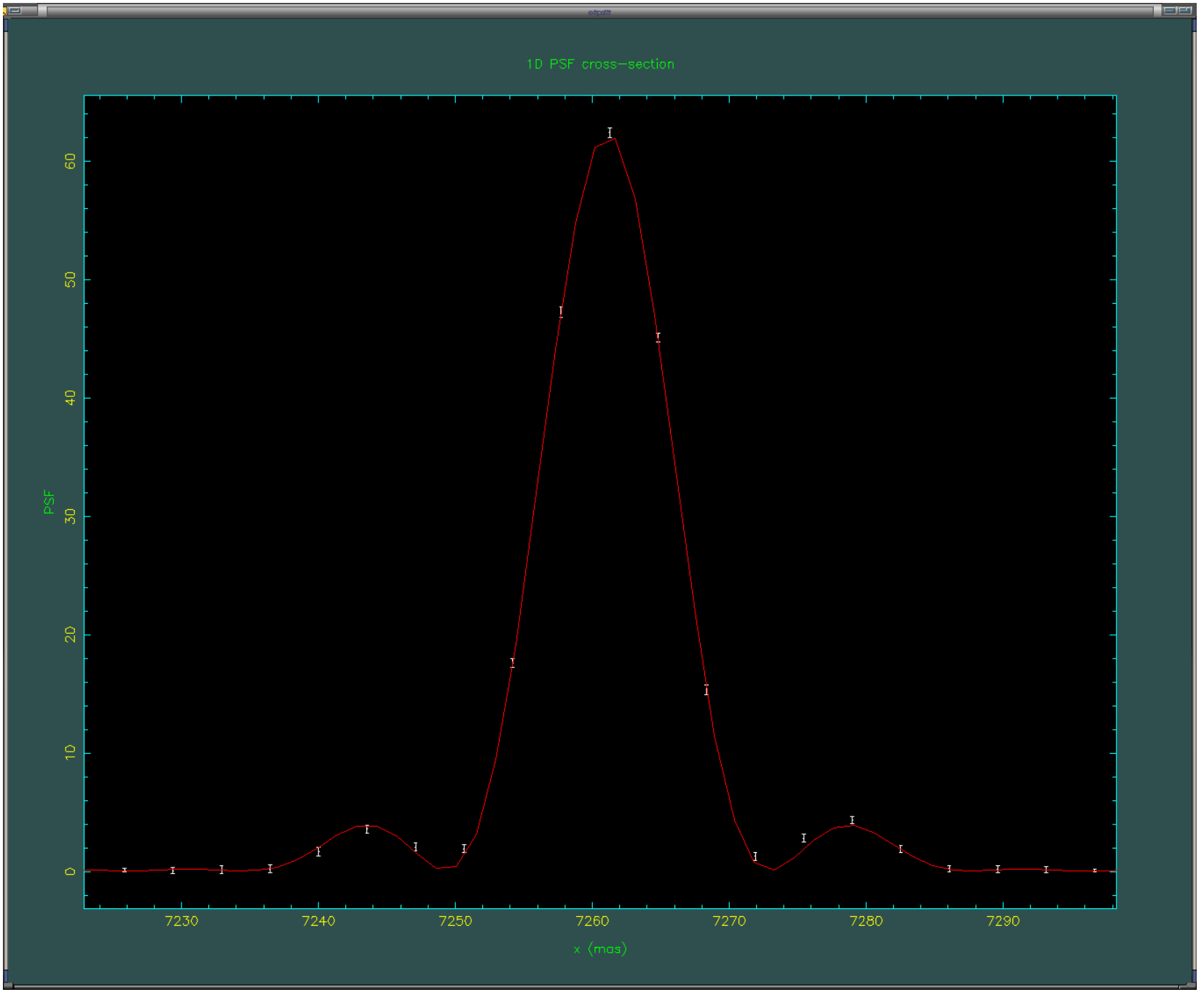
PSF fitting


1D PSF cross-section
K band LTAO
log(PSF)
x (mas)
2
1
0
−1
−2
−3
−4
−5
−6
0
2000
4000
6000
8000
10^4
1.2×10^4
1.4×10^4

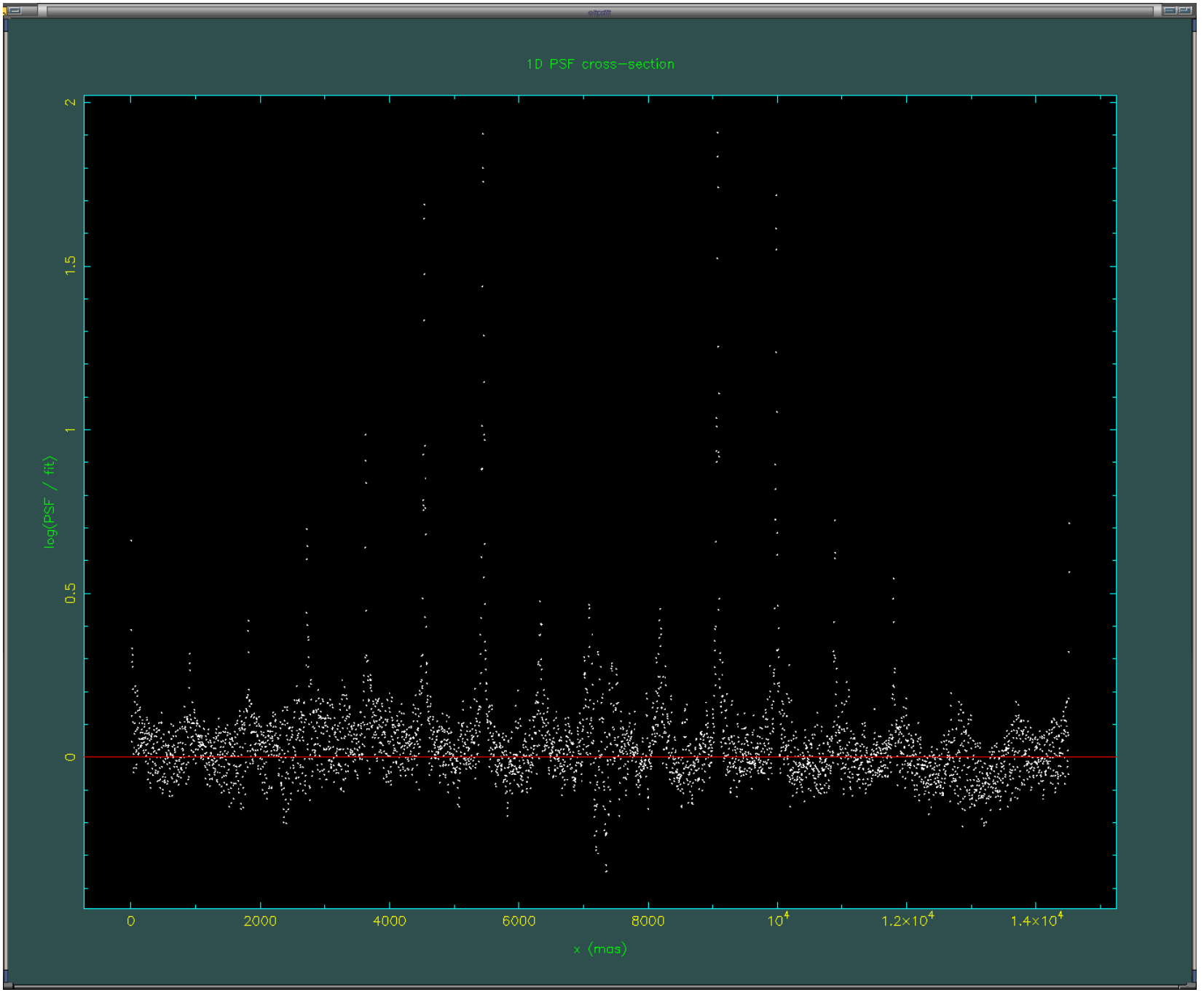
PSF fitting


1D PSF cross-section
Available functions:
Gaussian
Lorentzian
Moffat
Airy disk
Obstructed Airy disk
log(PSF)
x (mas)
2
1
0
−1
−2
−3
−4
−5
−6
0
2000
4000
6000
8000
10^4
1.2×10^4
1.4×10^4

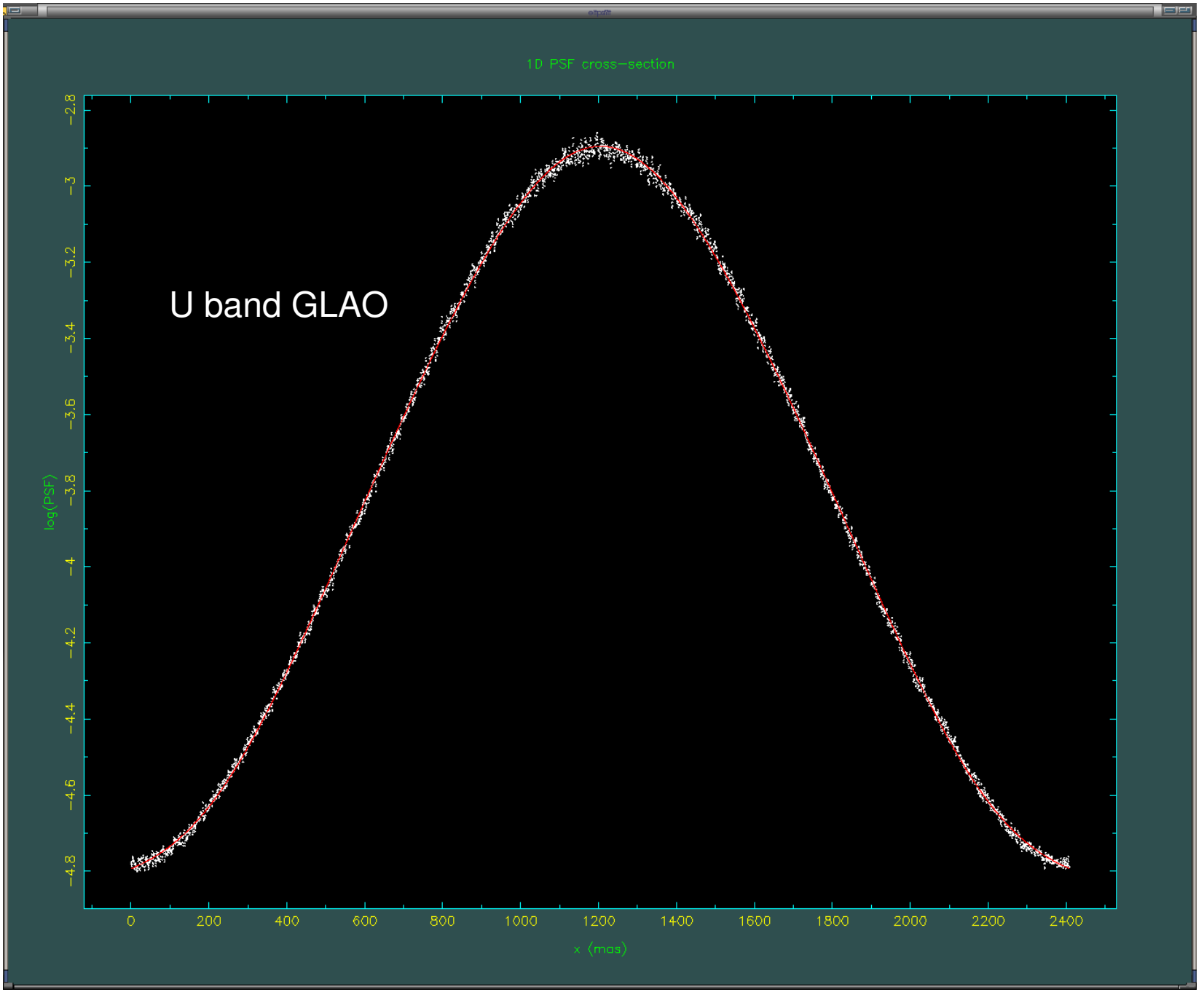
PSF fitting


1D PSF cross-section
PSF
0
10
20
30
40
50
60
7230
7240
7250
7260
7270
7280
7290
x (mas)

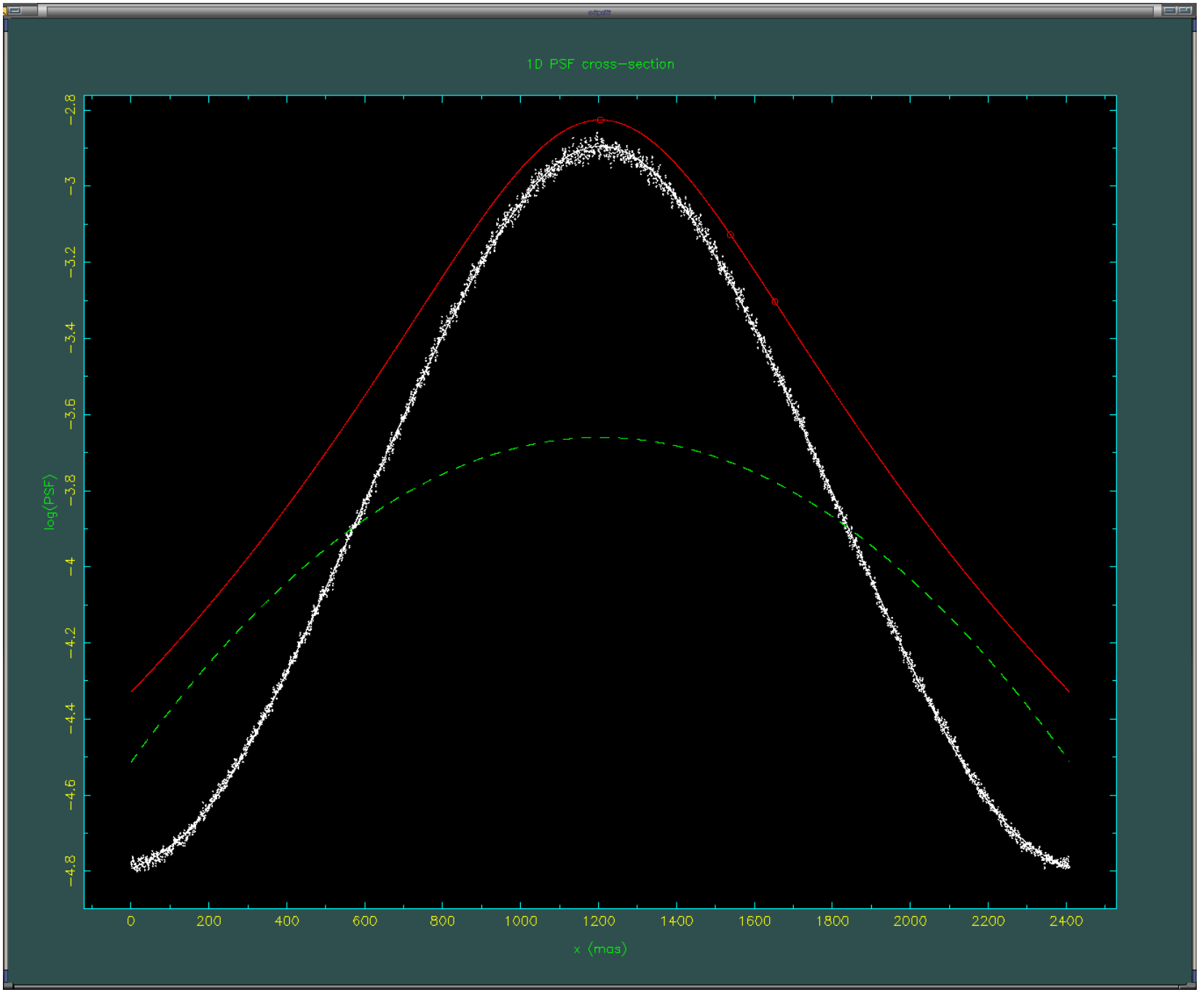
PSF fitting


1D PSF cross-section
log(PSF / fit)
2
1.5
1
0.5
0
0
2000
4000
6000
8000
10^4
1.2×10^4
1.4×10^4
x (mas)

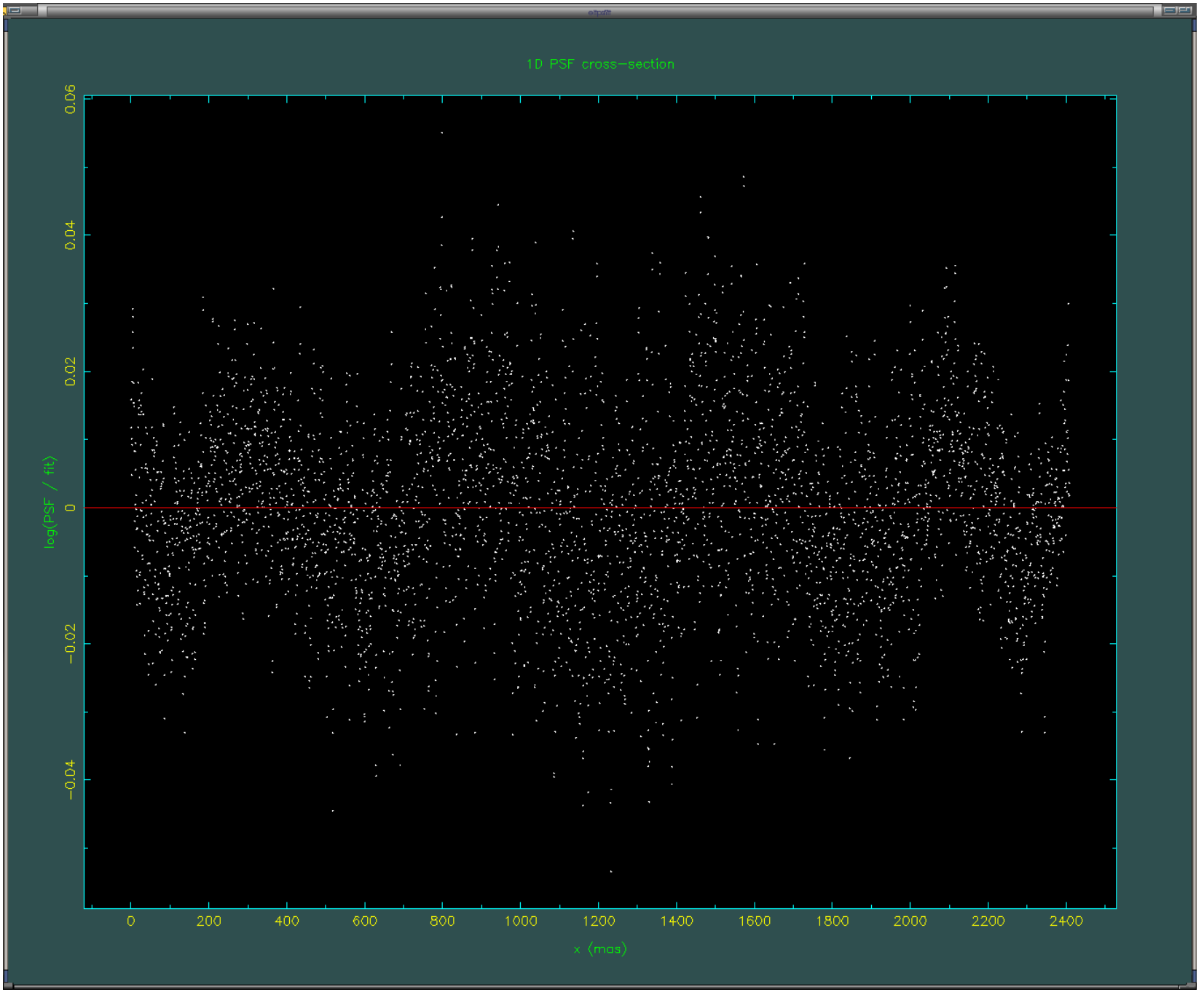
PSF fitting


1D PSF cross-section
U band GLAO
log(PSF)
-2.8
-3
-3.2
-3.4
-3.6
-3.8
-4
-4.2
-4.4
-4.6
-4.8
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
x (mas)

PSF fitting

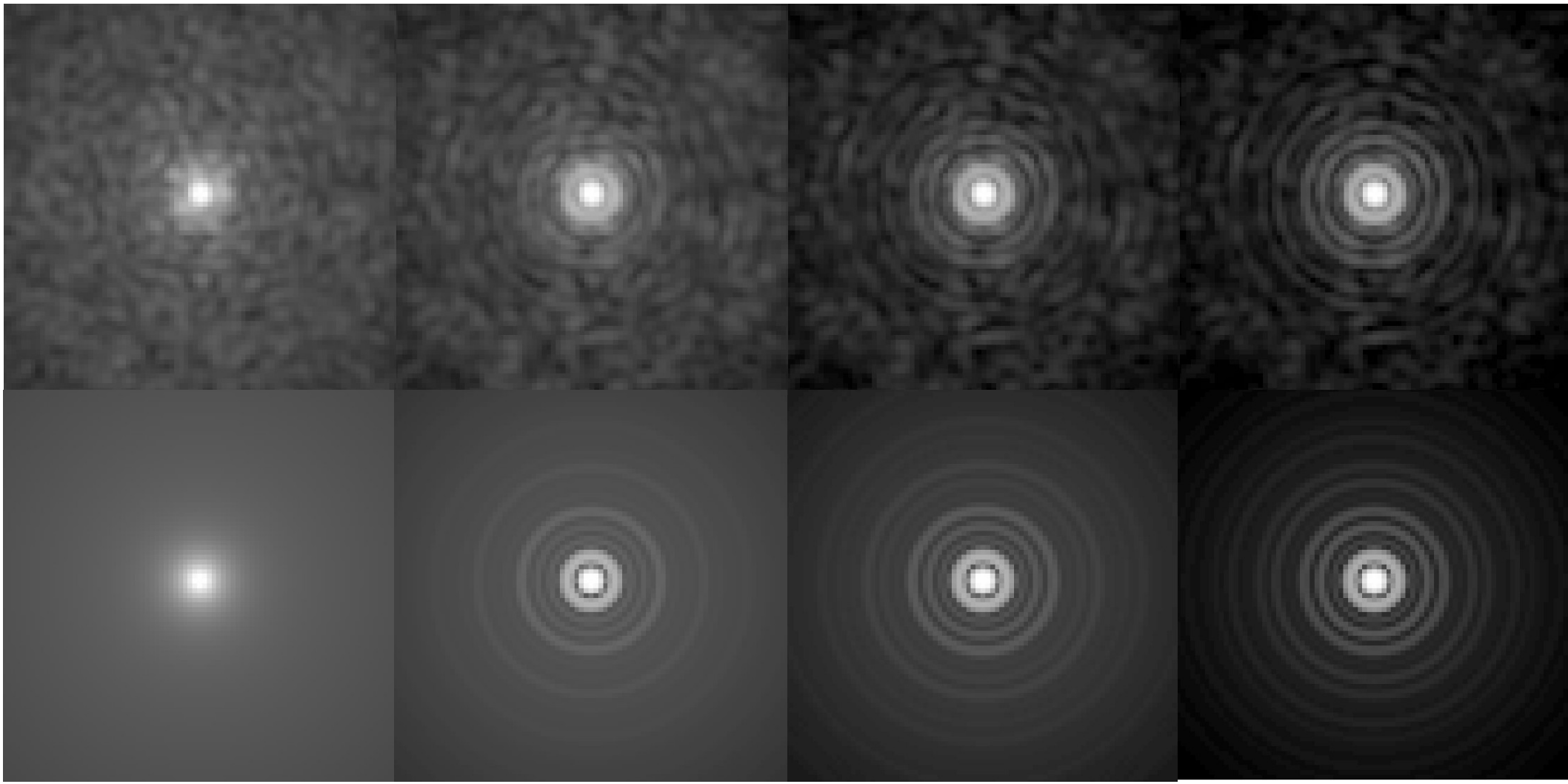

1D PSF cross-section
log(PSF)
−2.8
−3
−3.2
−3.4
−3.6
−3.8
−4
−4.2
−4.4
−4.6
−4.8
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
x (mas)

PSF fitting


1D PSF cross-section
log(PSF / fit)
0.06
0.04
0.02
0
−0.02
−0.04
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
x (mas)

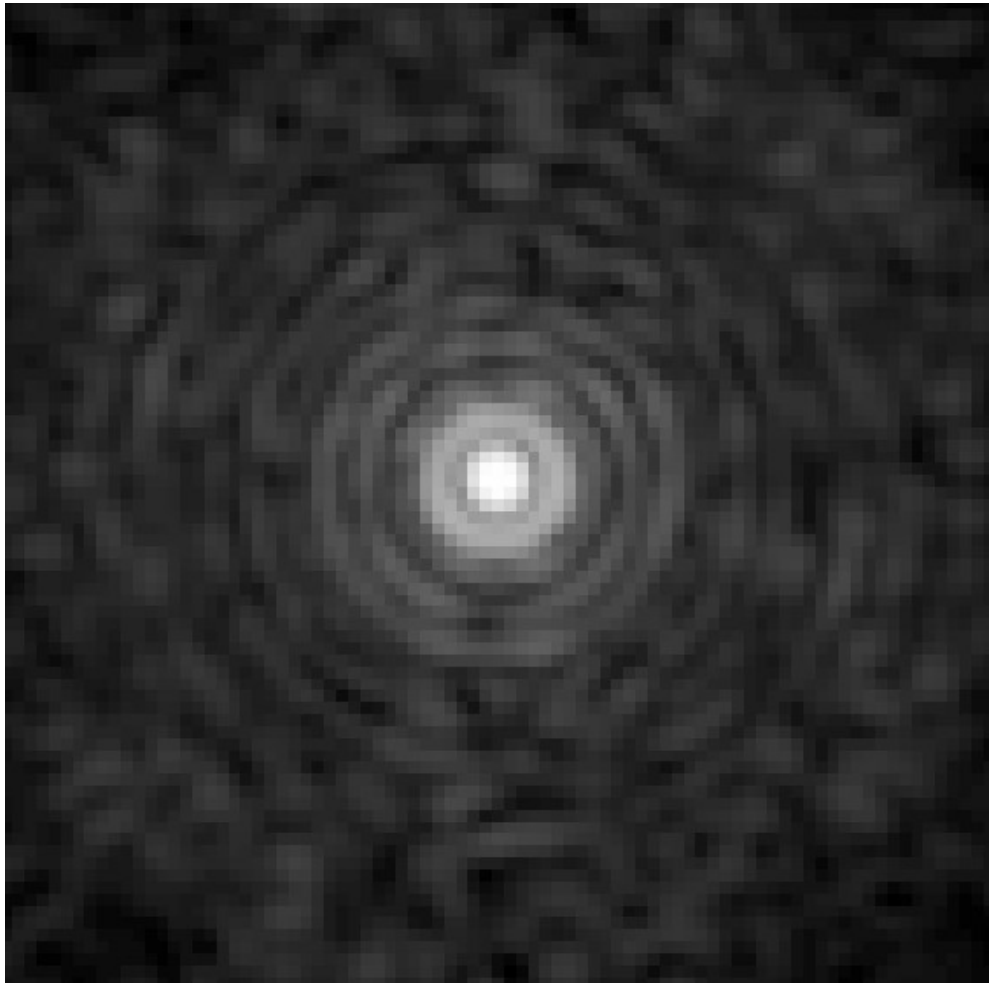
PSF fitting

I J H K

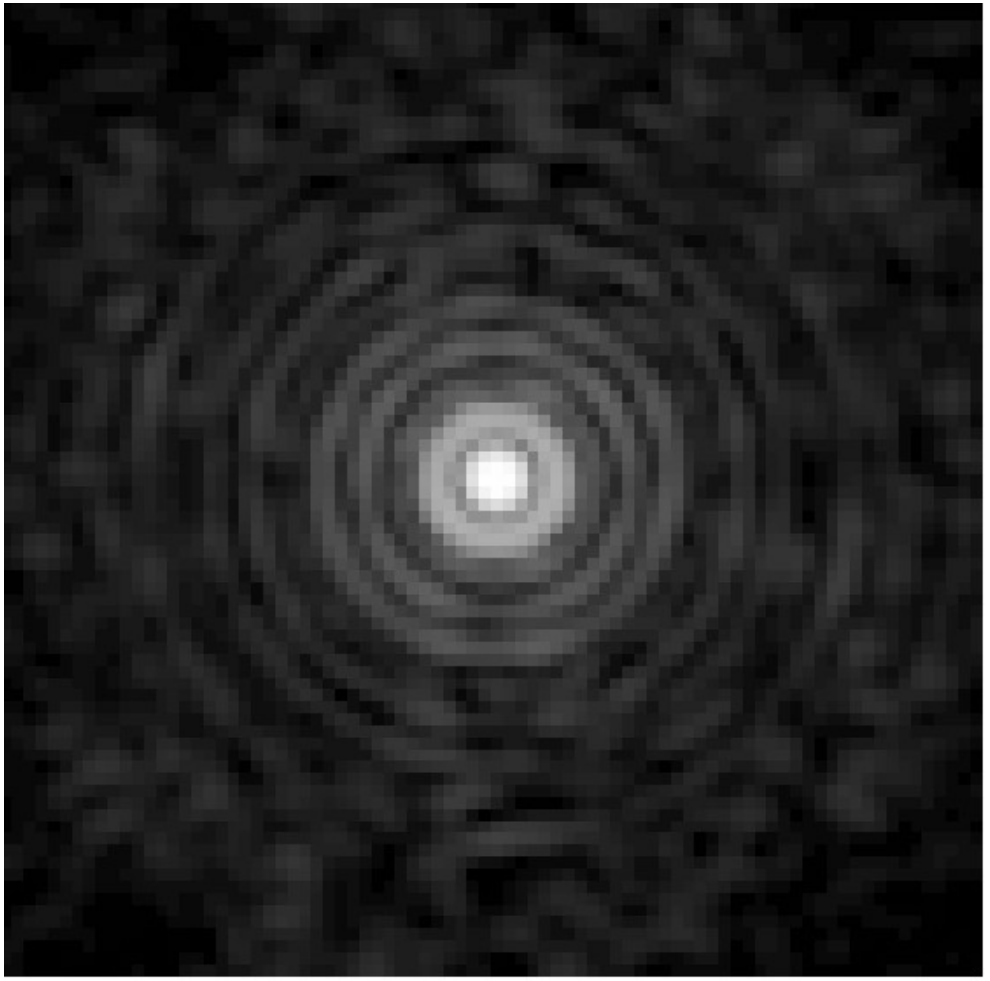


PSF fitting

H

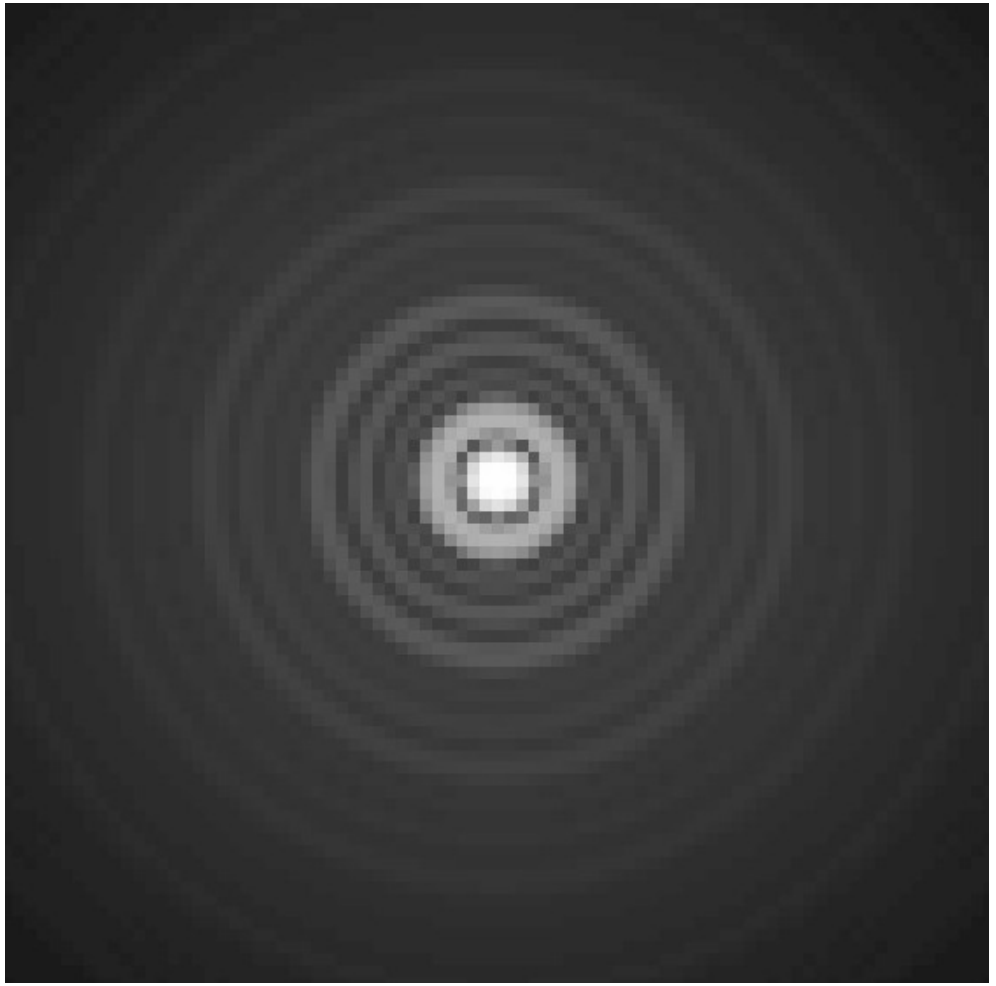


K

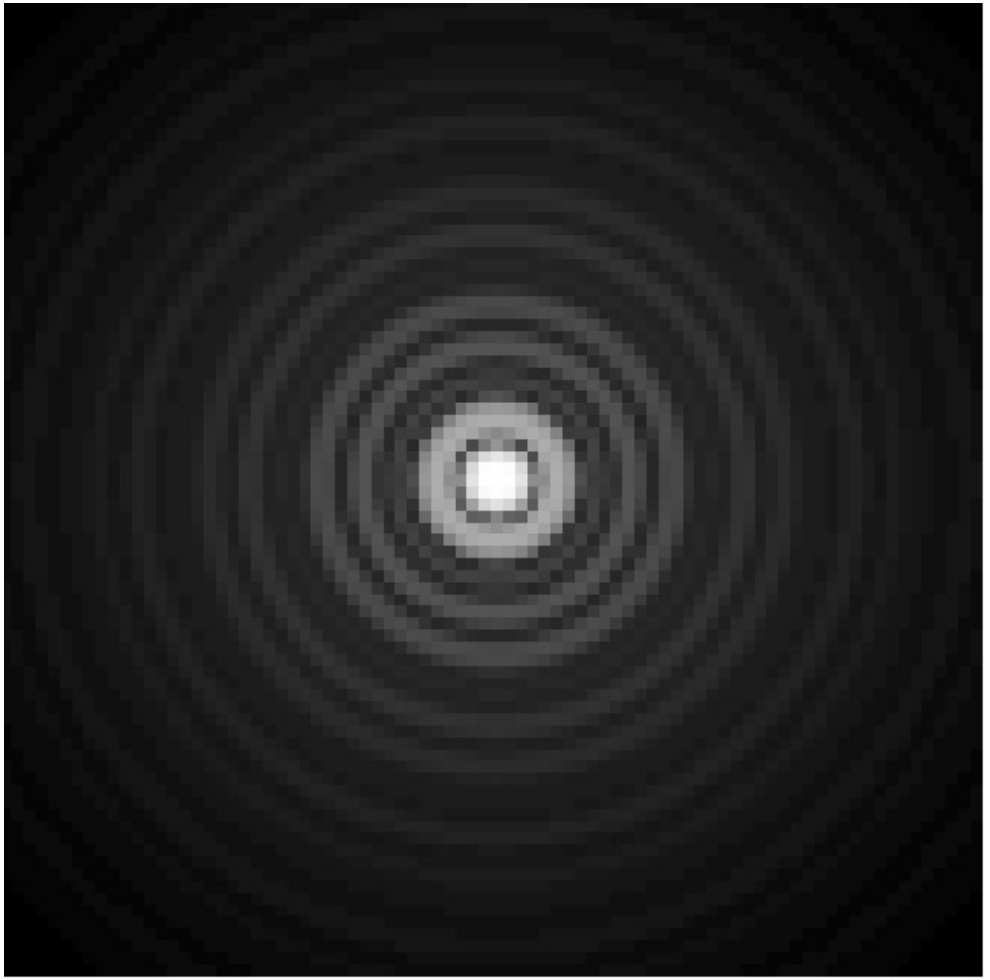


PSF fitting

H



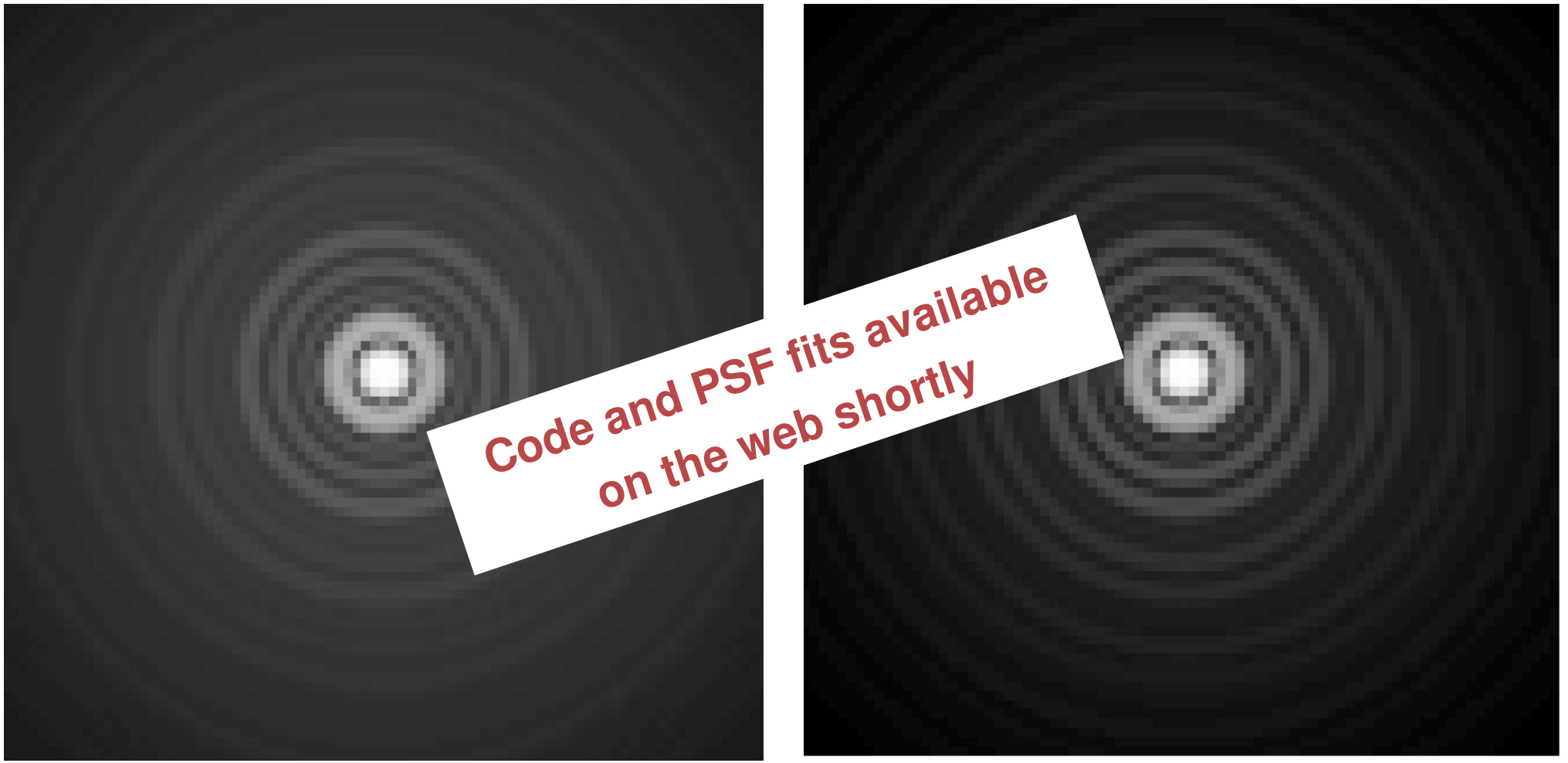
K



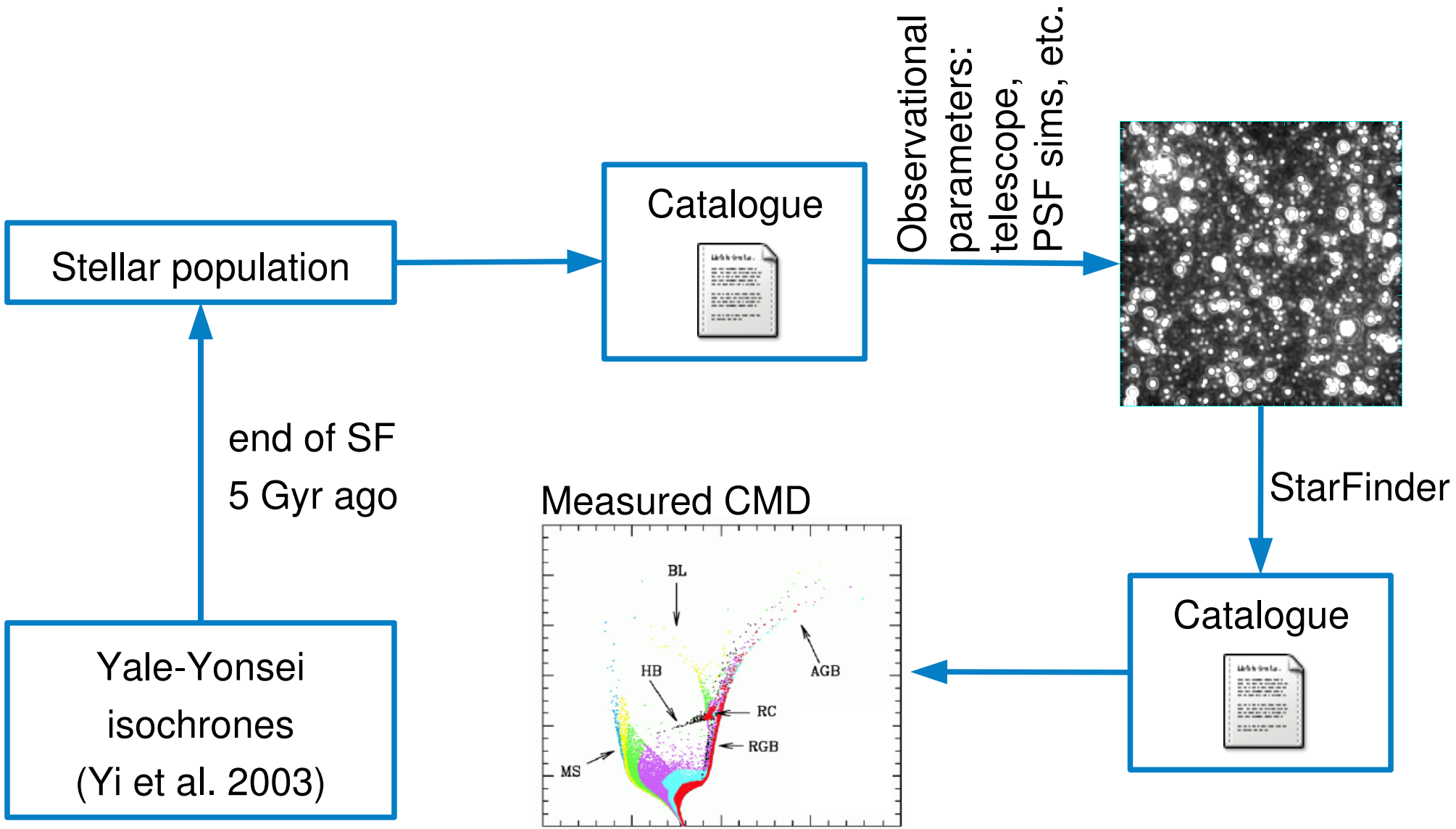
PSF fitting

H

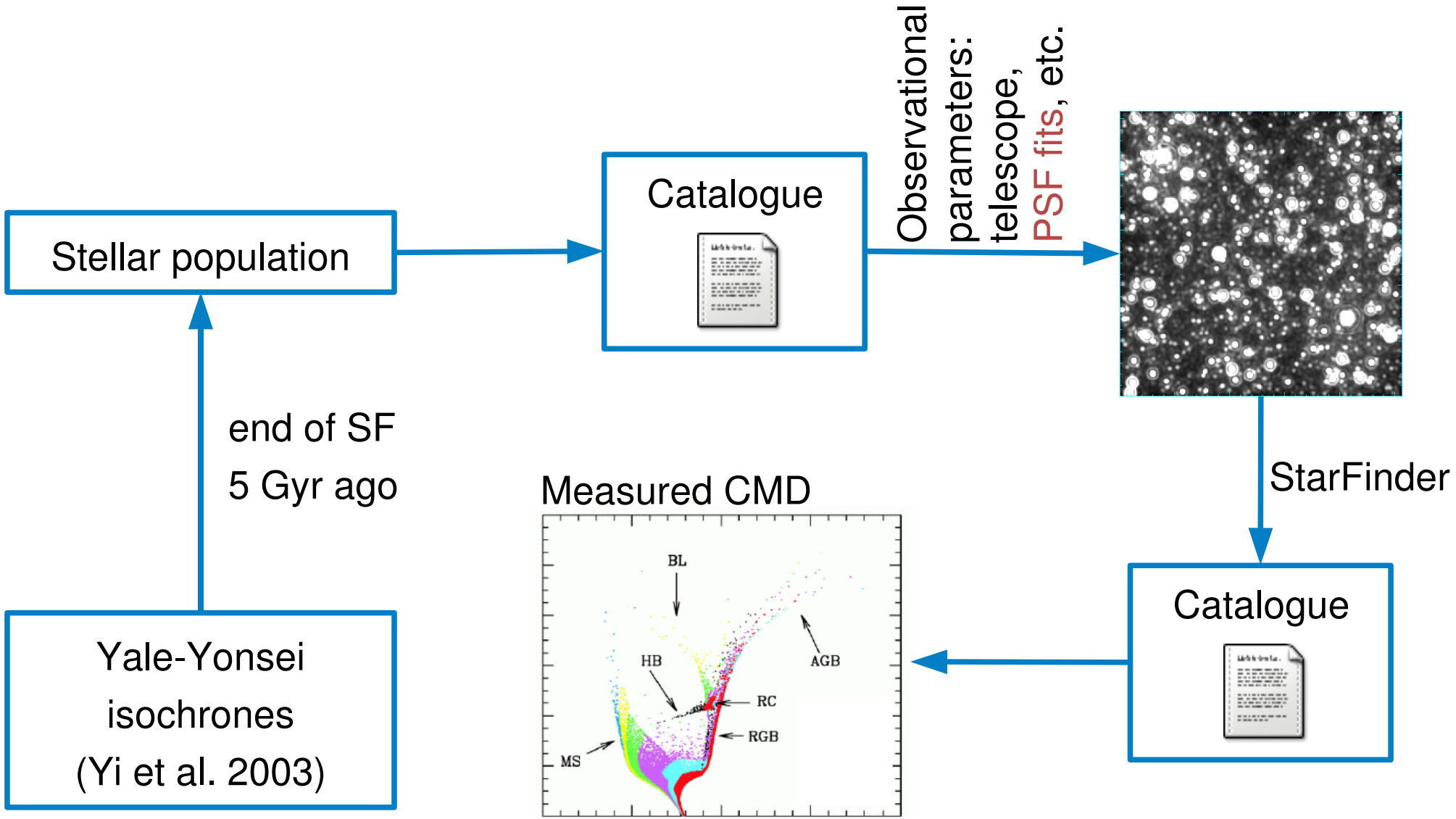
K



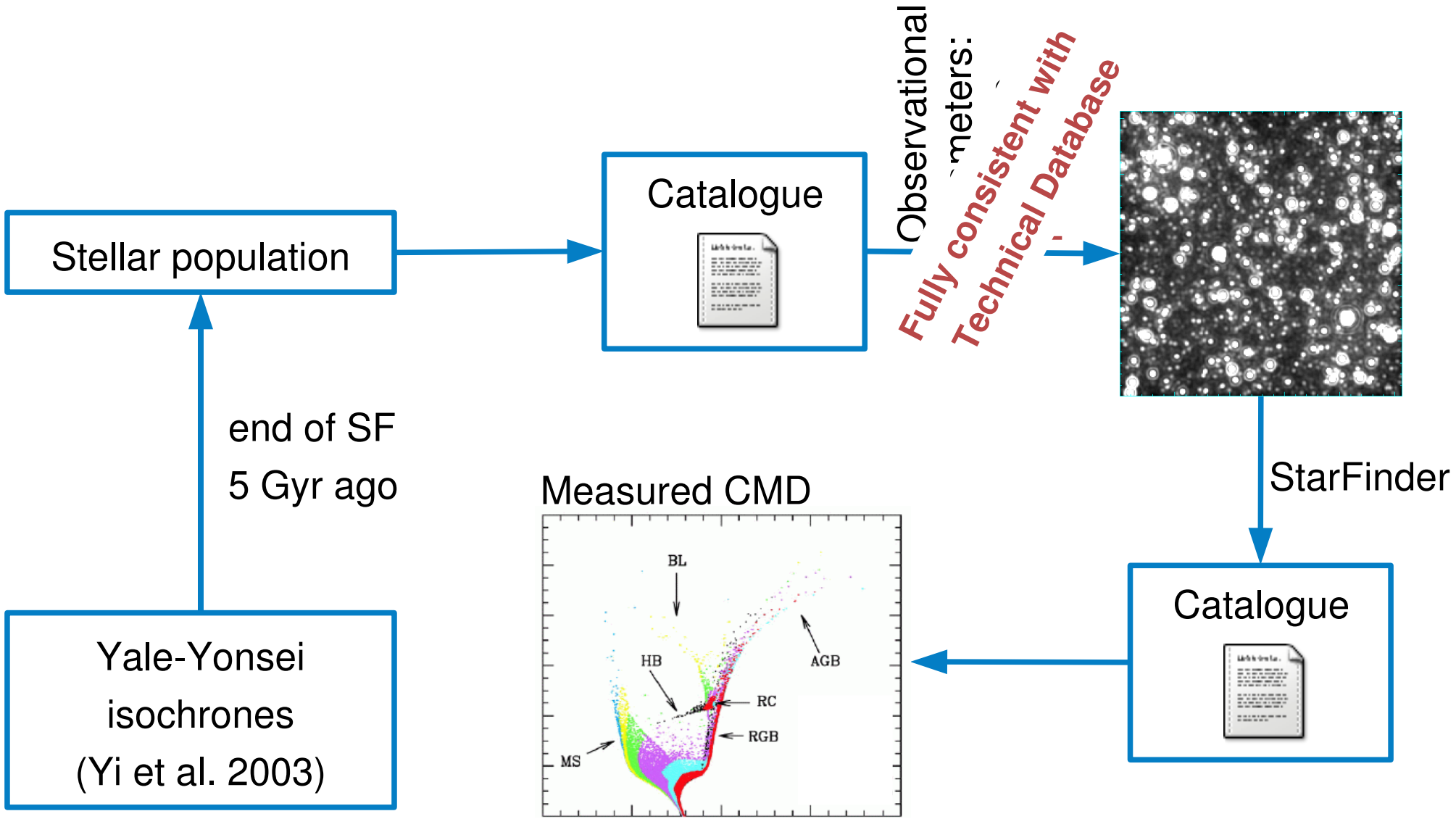
Pipeline updates



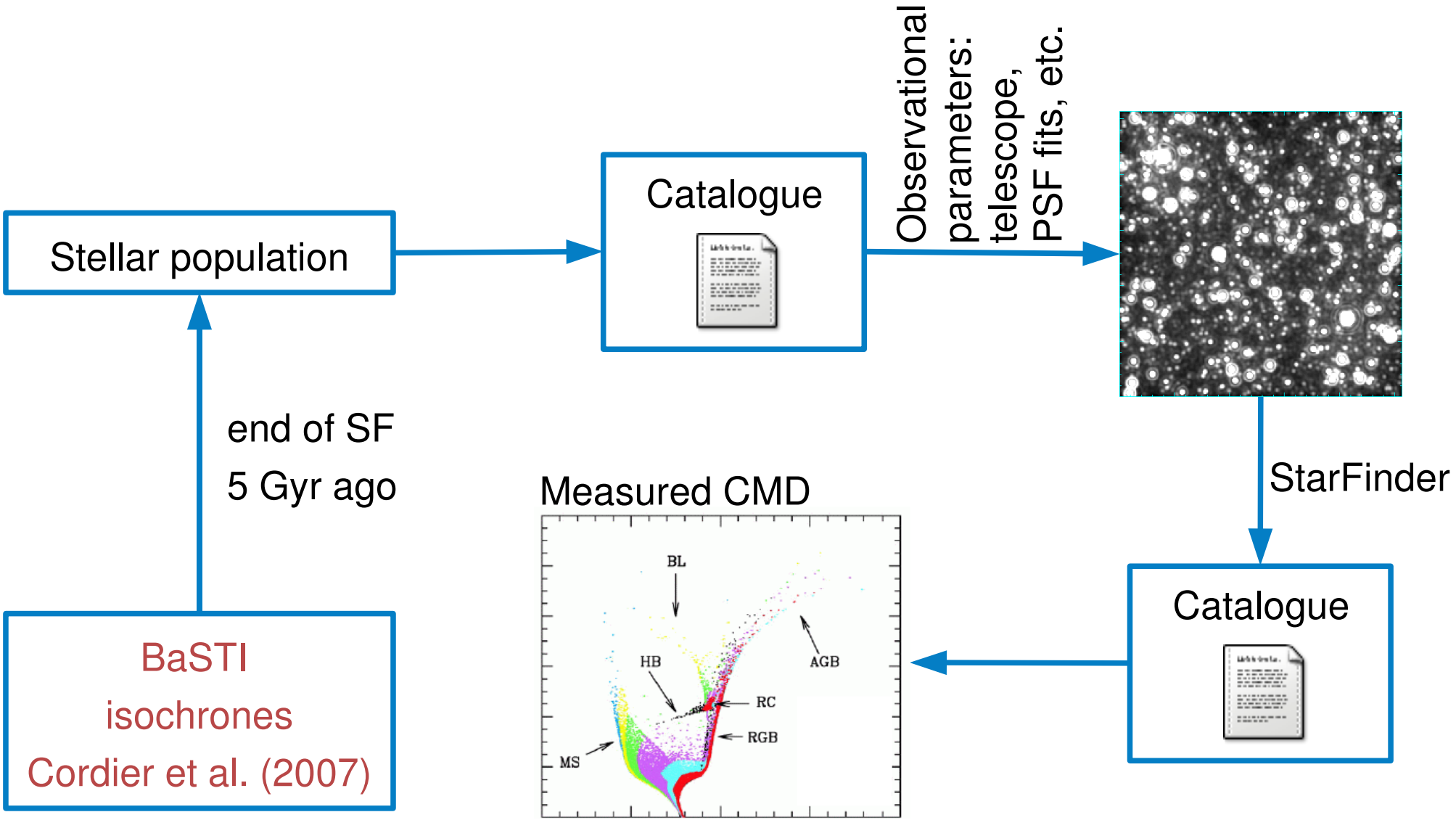
Pipeline updates



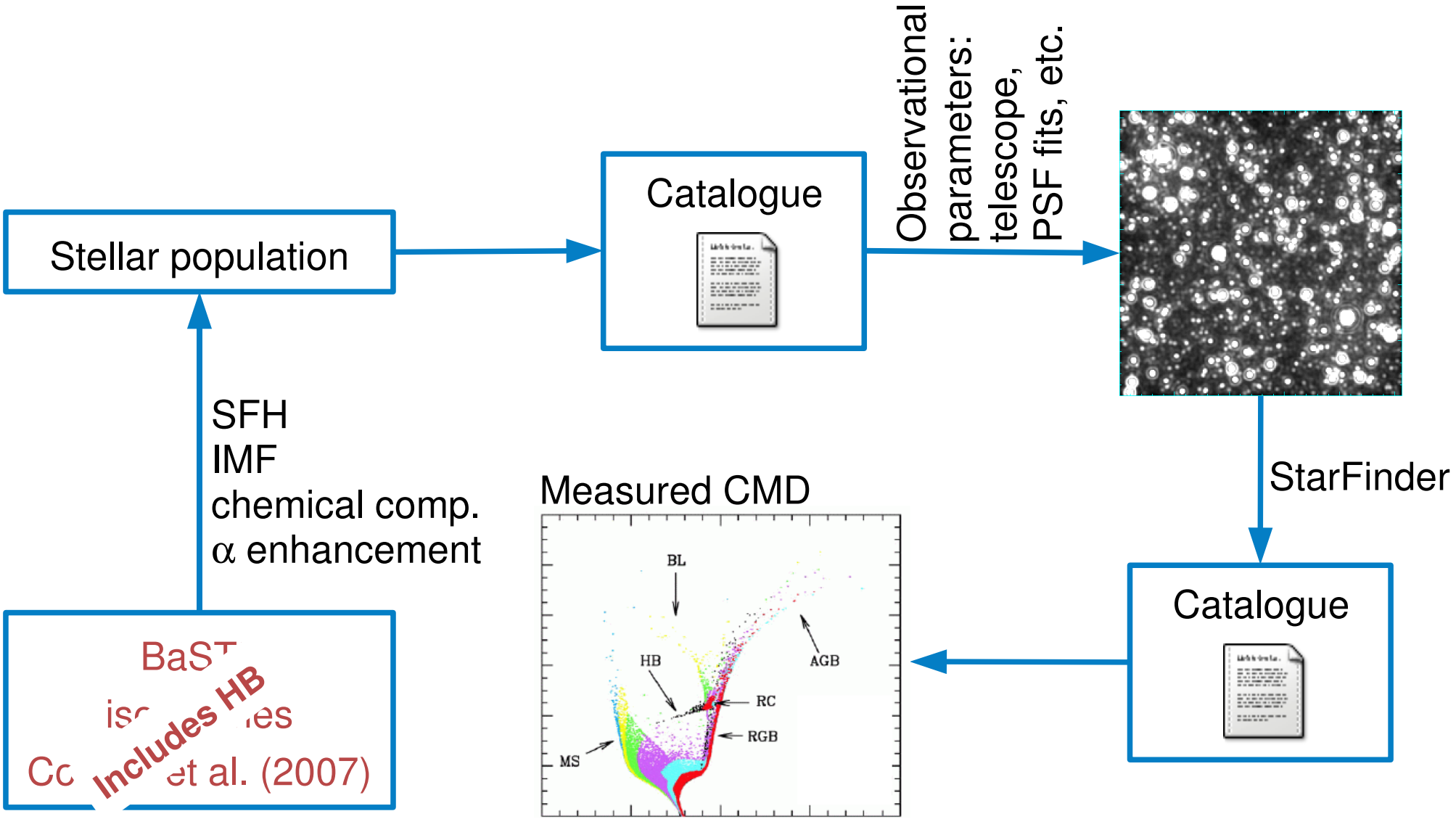
Pipeline updates



Pipeline updates



Pipeline updates



Building a noise model

The simulations don't do anything magical! It's a predictable process.

Based on the knowledge of how exactly StarFinder (or any photometry package) measures the fluxes, one can build a model for the error on these fluxes, including the effects of:

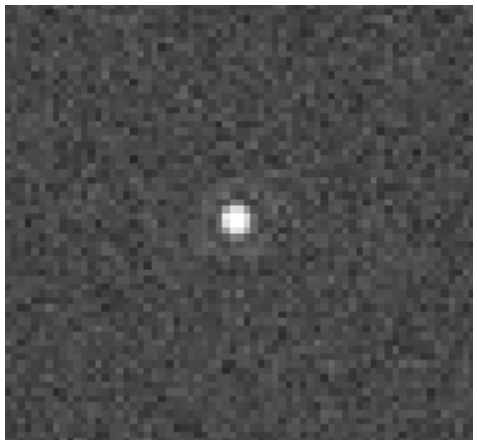
- Photon noise, background, read-out noise and dark current
- Additional photon noise from PSF wings
- Poisson fluctuations of the 'background' of undetected stars (e.g. Olson et al. 2003), including the effect of the PSF

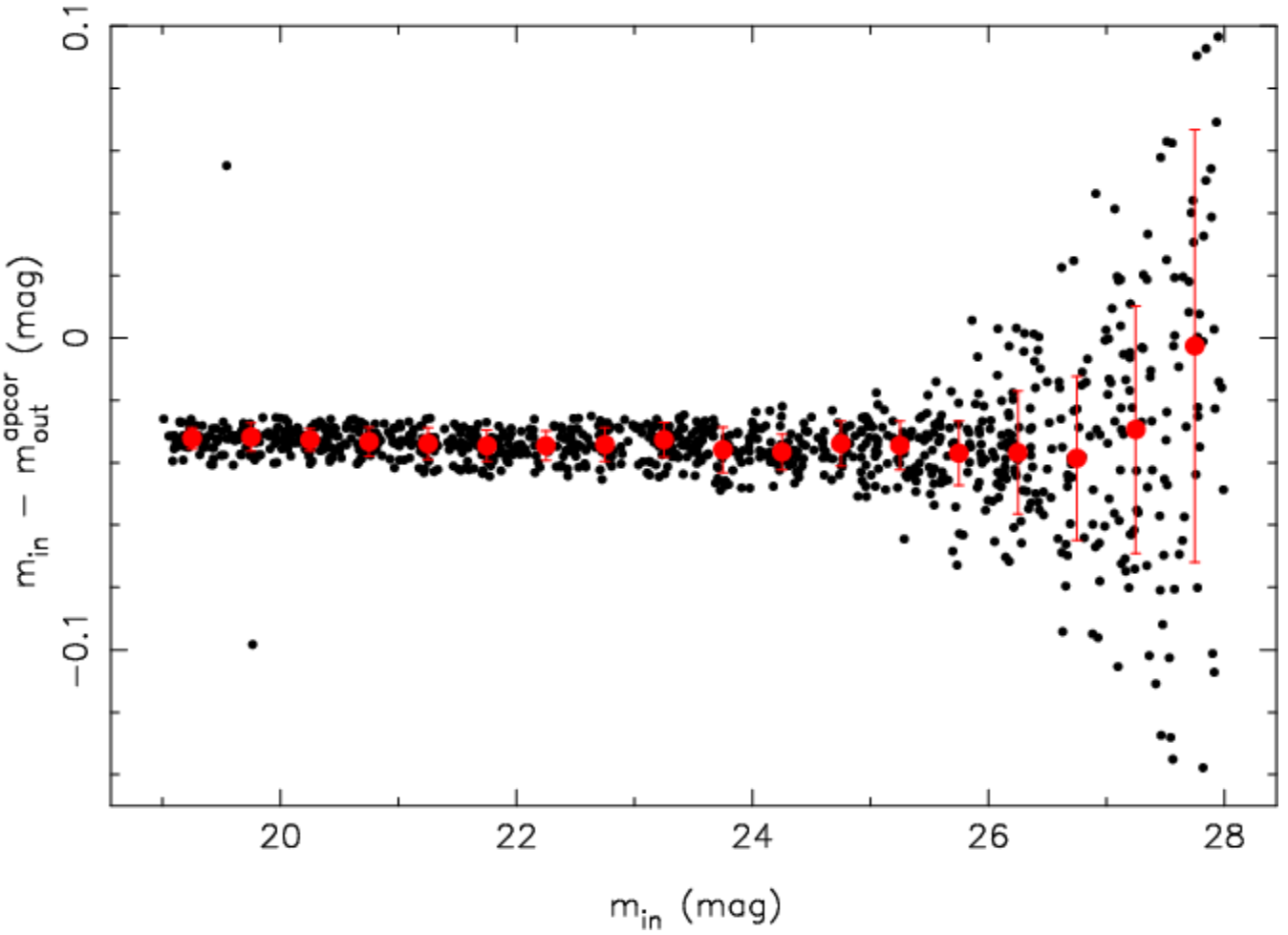
Simulations are used to validate each component of the model.

Model validation

Photon noise

object and background

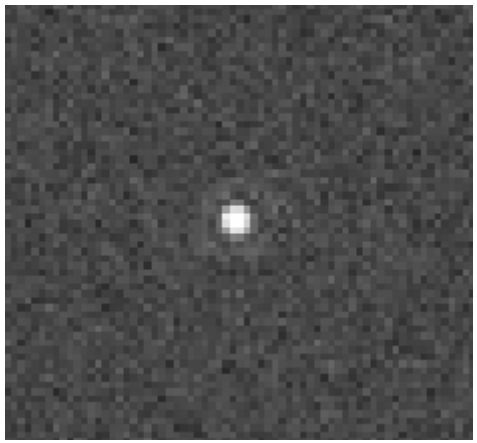


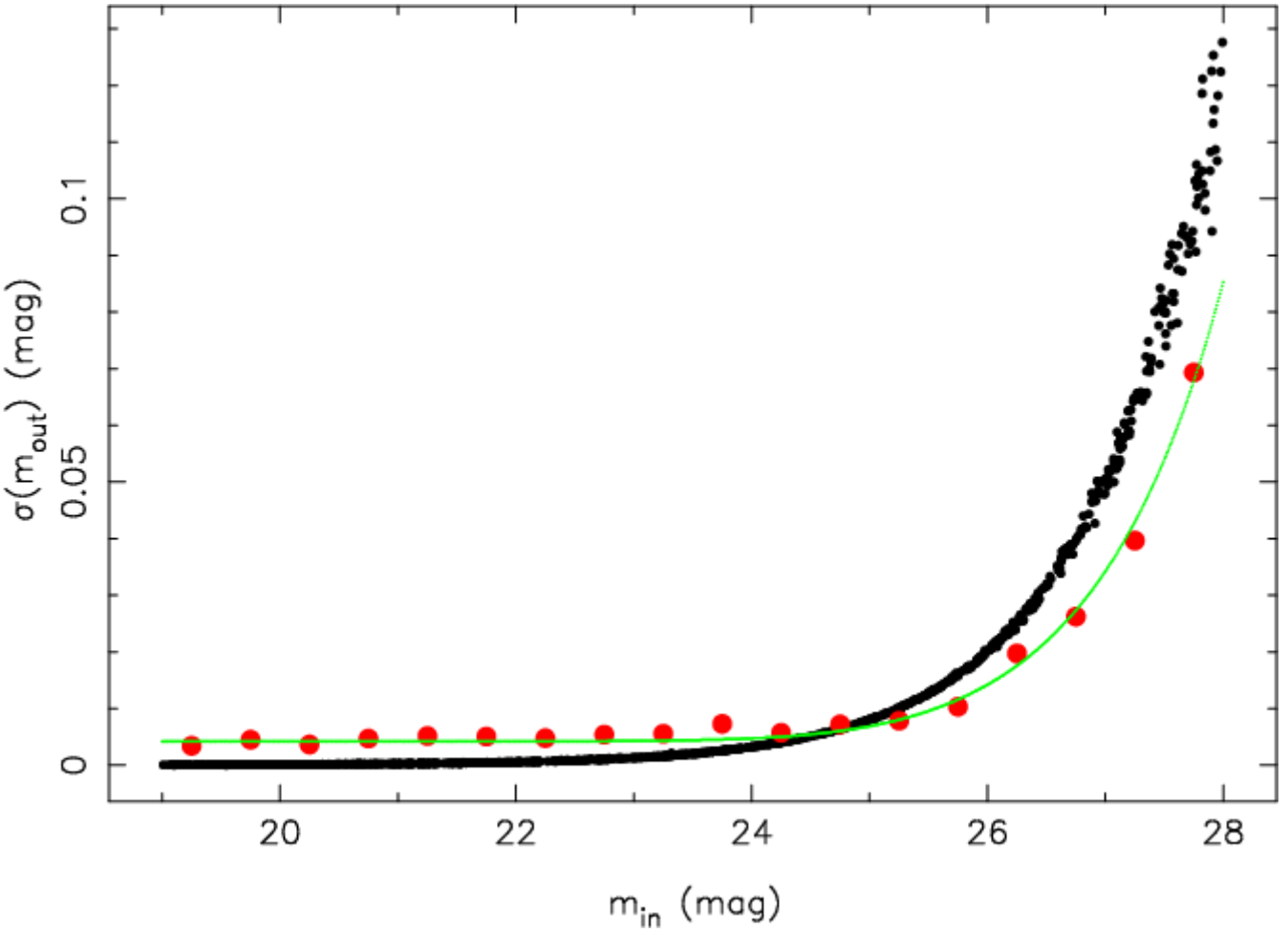


Model validation

Photon noise

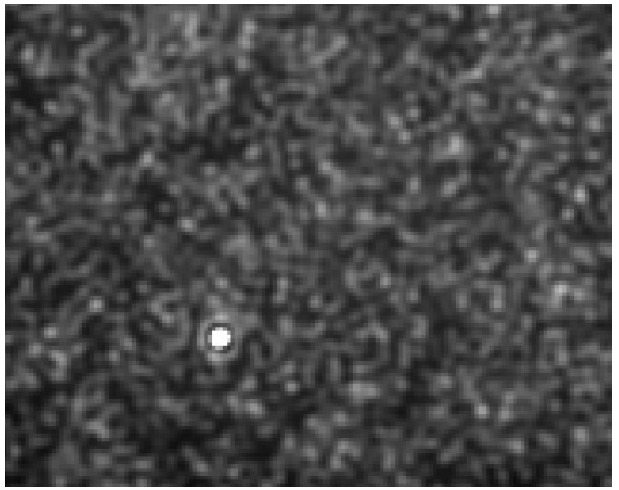
object and background

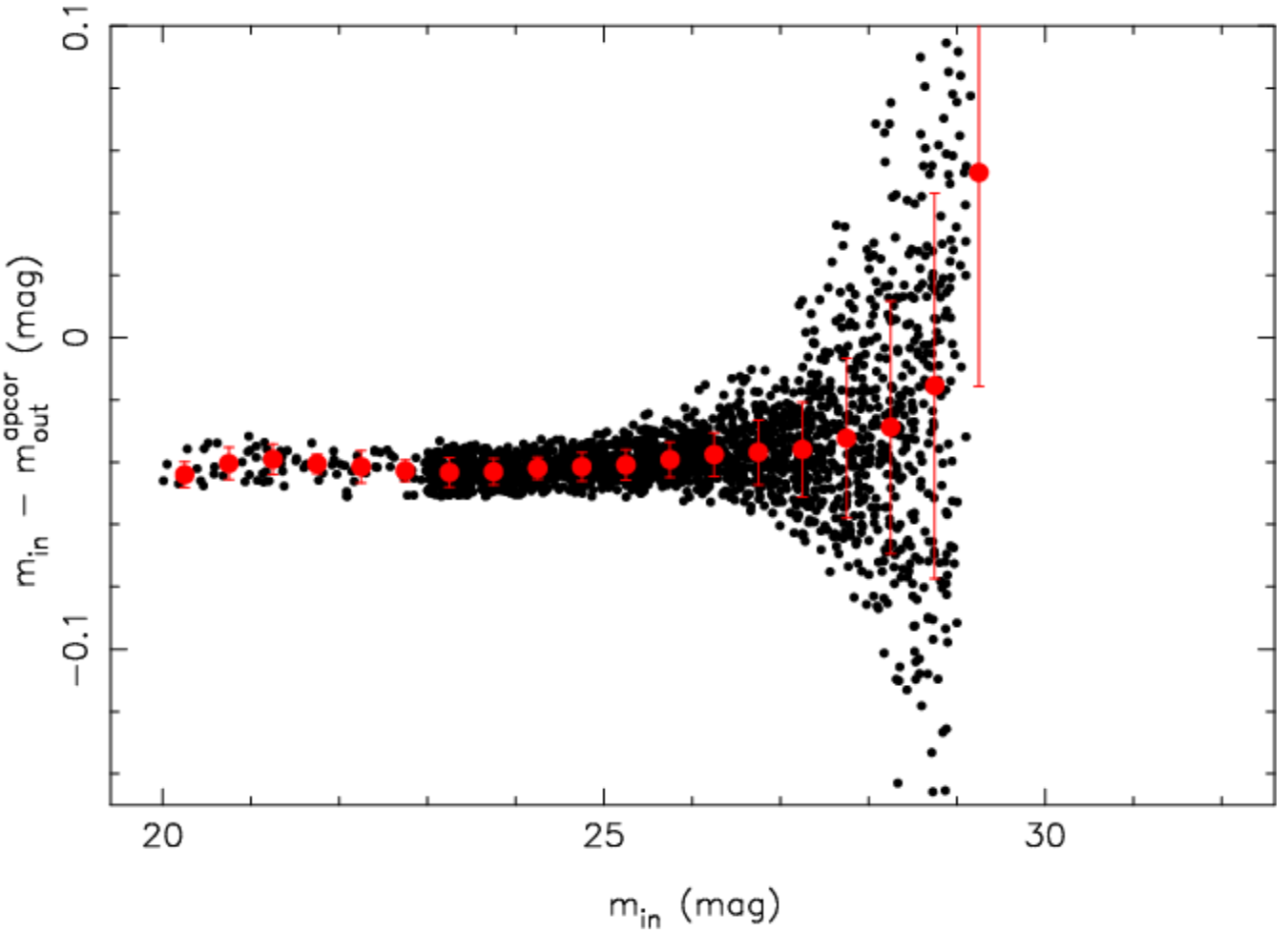




Model validation

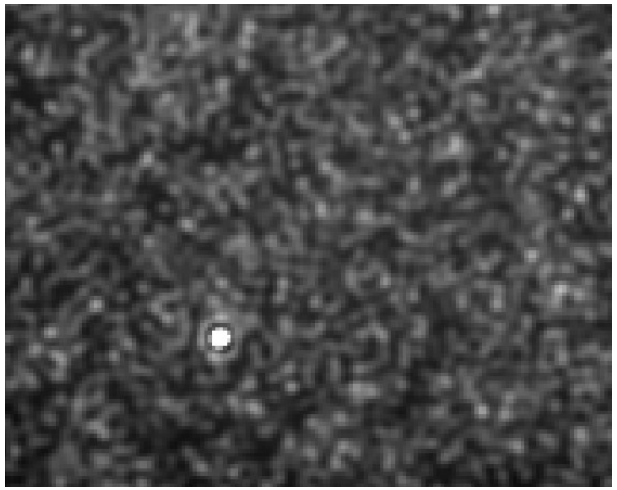
Simple 'background' of unresolved stars

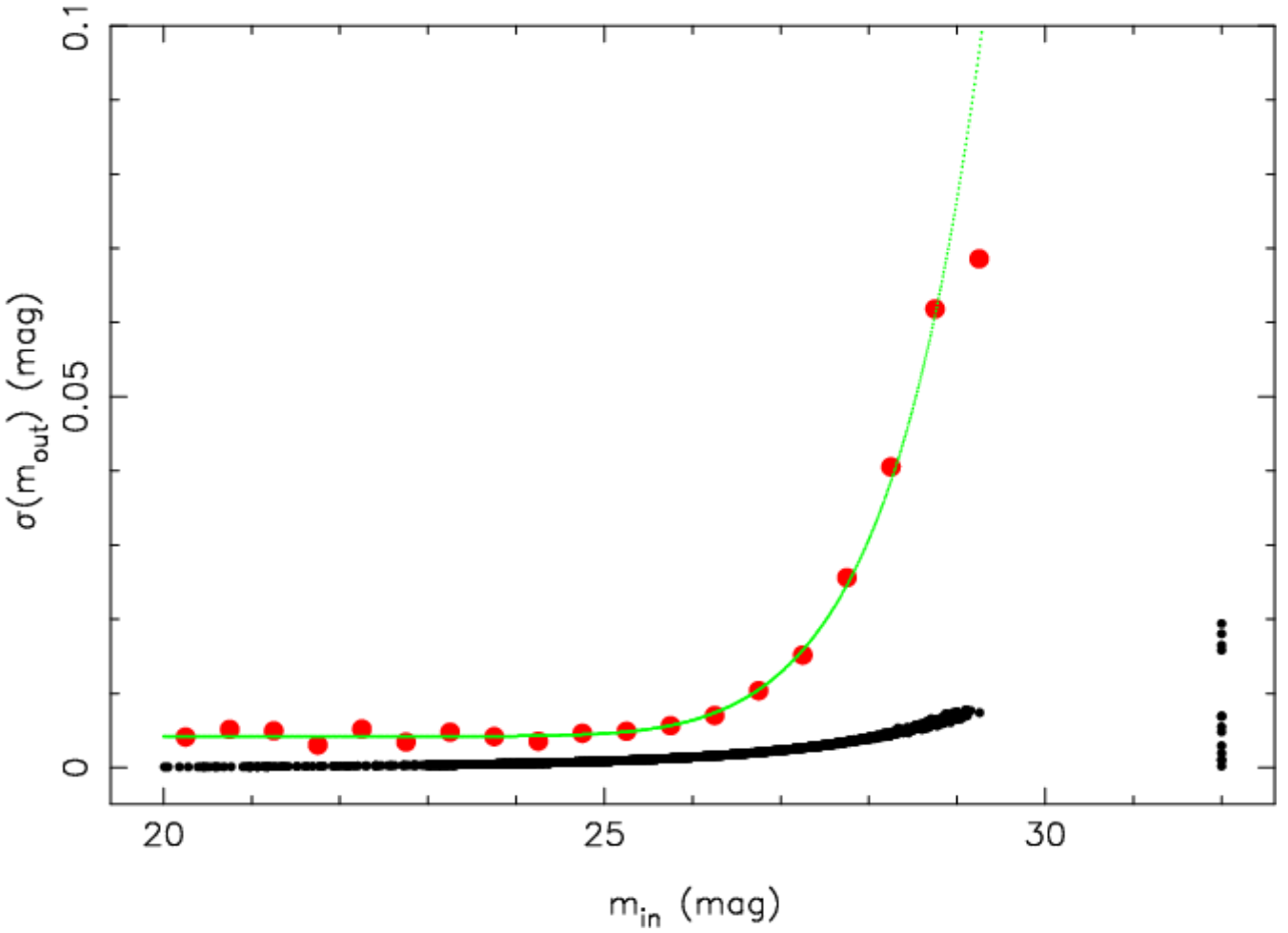




Model validation

Simple 'background' of unresolved stars



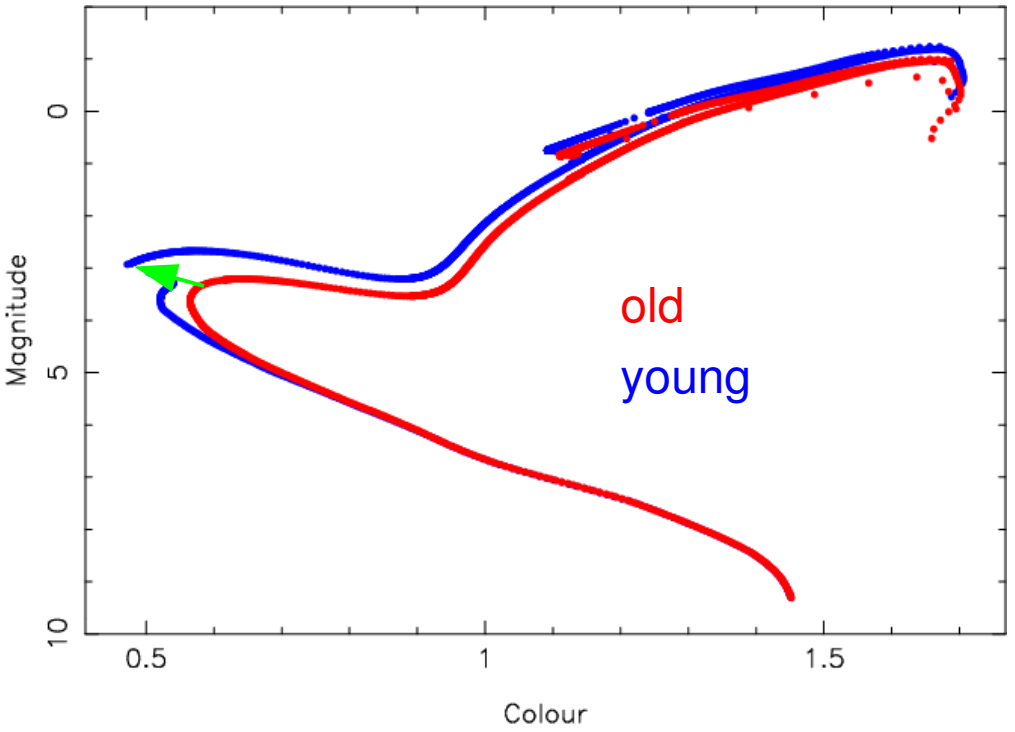


Using the model

- Once completed, the noise model can predict the expected error on the magnitude and colour at each point in the CMD for any given DM, surface brightness, stellar population, filter combination, assumed PSF, etc.
- Combine this with the theoretical sensitivity of the given population's CMD to physical parameters of interest. For example:

$$\frac{(\Delta mag^2 + \Delta col^2)/\Delta t}{\sigma_{mag}^2 + \sigma_{col}^2}$$

- Such a quantity combines the observational data quality with the sensitivity of the analysis and predicts the ability of the data to constrain the physical parameters of interest.



Can HST do Virgo CMDs?

The Astrophysical Journal, 651:822–834, 2006 November 10

COLOR-MAGNITUDE DIAGRAMS OF RESOLVED STARS IN VIRGO CLUSTER DWARF GALAXIES

Nelson Caldwell
Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, MA 02138; caldwell@cfa.harvard.edu
Received 2006 May 15; accepted 2006 July 19

ABSTRACT

The Advanced Camera for Surveys (ACS) on the *Hubble Space Telescope* (*HST*) has been used to image two fields in the core of the Virgo Cluster that contain a number of dwarf elliptical galaxies. The combined F555W and F814W images have resolved red giant stars in these galaxies, down to 1 mag below the giant branch tip. Two of the galaxies were targeted because of their extremely low central surface brightnesses ($B_o > 27.0$); thus, the successful resolution into stars confirms the existence of such tenuous galaxies. Red giant stars were also found that are not ostensibly associated with any galaxy. Color-magnitude diagrams in V and I have been derived for the five dwarfs, as well as the halo of a nearby spiral galaxy and the intracluster stars in the two fields. These diagrams were used to derive distances and metallicities via the magnitude of the red giant branch tip, and the mean color of the giant branch. The mean
n the dwarfs range from $-1.2 < [Fe/H] < -2.4$, and fall along the relation between galaxy
ty found for Local Group and M81 group dwarf elliptical galaxies. [Fe/H] does not appear to
galaxy surface brightness, as the two extremely low surface brightness galaxies do not have
he mean distance modulus of the six Virgo galaxies is 31.0 ± 0.05, or 16.1 ± 0.4 Mpc,
acluster stars in those fields is 31.2 ± 0.09 (17.4 ± 0.7 Mpc).
ies: clusters: individual (Virgo cluster) — galaxies: dwarf — galaxies: stellar content
figures

The Astrophysical Journal, 656:746–755, 2007 February 20

THE RESOLVED STELLAR POPULATIONS OF A DWARF SPHEROIDAL GALAXY IN THE VIRGO CLUSTER

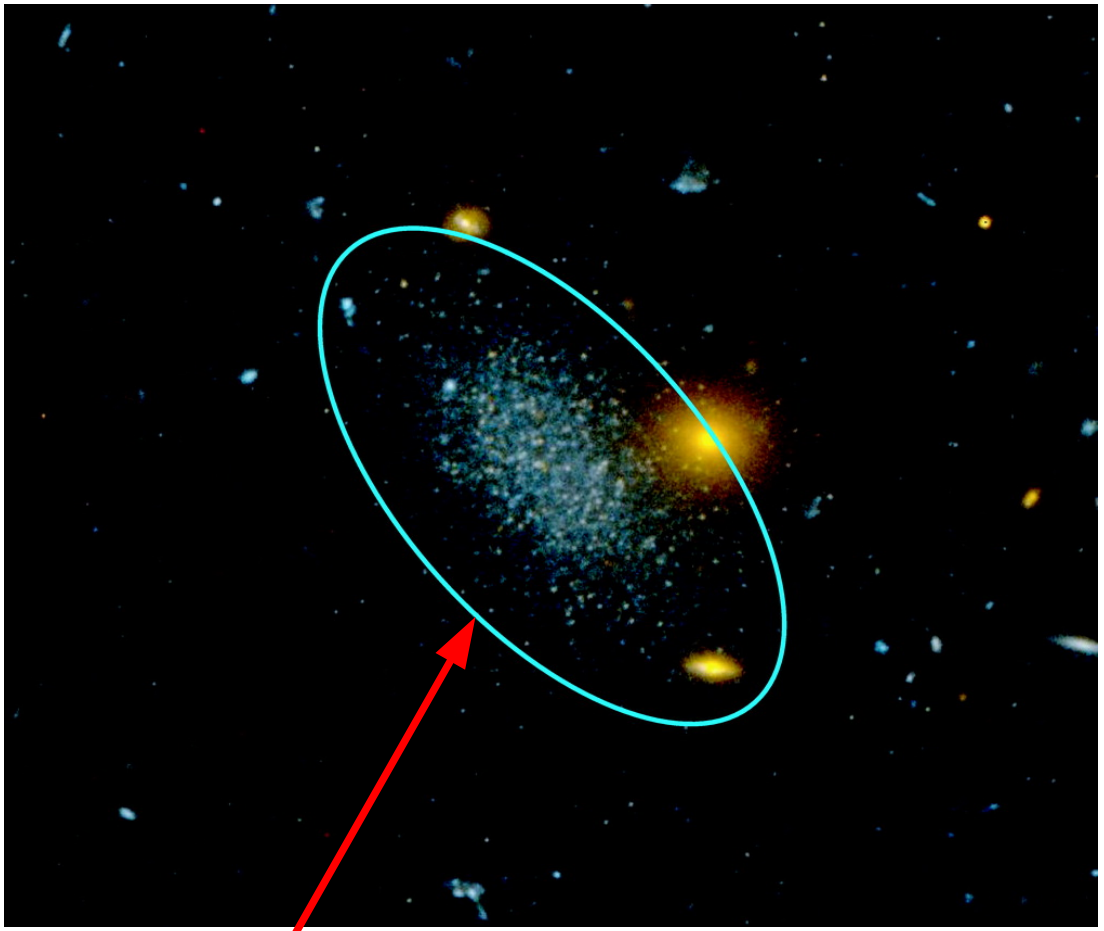
Patrick R. Durrell,[1] Benjamin F. Williams,[2] Robin Ciardullo,[2] John J. Feldmeier,[1,3] Ted von Hippel,[4]
Steinn Sigurdsson,[2] George H. Jacoby,[5] Henry C. Ferguson,[6] Nial R. Tanvir,[7] Magda Arnaboldi,[8]
Ortwin Gerhard,[9] J. Alfonso L. Aguerri,[10] Ken Freeman,[11] and Matt Vinciguerra[2]
Received 2006 September 25; accepted 2006 November 1

ABSTRACT

We report on the discovery of a faint ($M_V \sim -10.6 \pm 0.2$) dwarf spheroidal galaxy on deep F606W and F814W *Hubble Space Telescope* images of a Virgo intracluster field. The galaxy is easily resolved in our images, as our color magnitude diagram (CMD) extends ≥1 magnitude beyond the tip of the red giant branch (RGB). Thus, it is the deepest CMD for a small dwarf galaxy inside a cluster environment. Using the colors of the RGB stars, we derive a metal abundance for the dwarf of $[M/H] = -2.3 \pm 0.3$ and show that the metallicity dispersion is less than 0.6 dex at 95% confidence. We also use the galaxy's lack of AGB stars and the absence of objects brighter than $M_{bol} \sim -4.1 \pm 0.2$ to show that the system is old ($t \gtrsim 10$ Gyr). Finally, we derive the object's structural parameters and show that the galaxy displays no obvious evidence of tidal threshing. Since the tip of the red giant branch distance [$(m - M)_0 = 31.23 \pm 0.17$ or $D = 17.6 \pm 1.4$ Mpc] puts the galaxy near the core of the Virgo cluster, one might expect the object to have undergone some tidal processing. Yet the chemical and morphological similarity between the dwarf and the dSph galaxies of the Local and M81 Group demonstrates that the object is indeed pristine and not the shredded remains of a much larger galaxy. We discuss the possible origins of this galaxy and suggest that it is just now falling into Virgo for the first time.

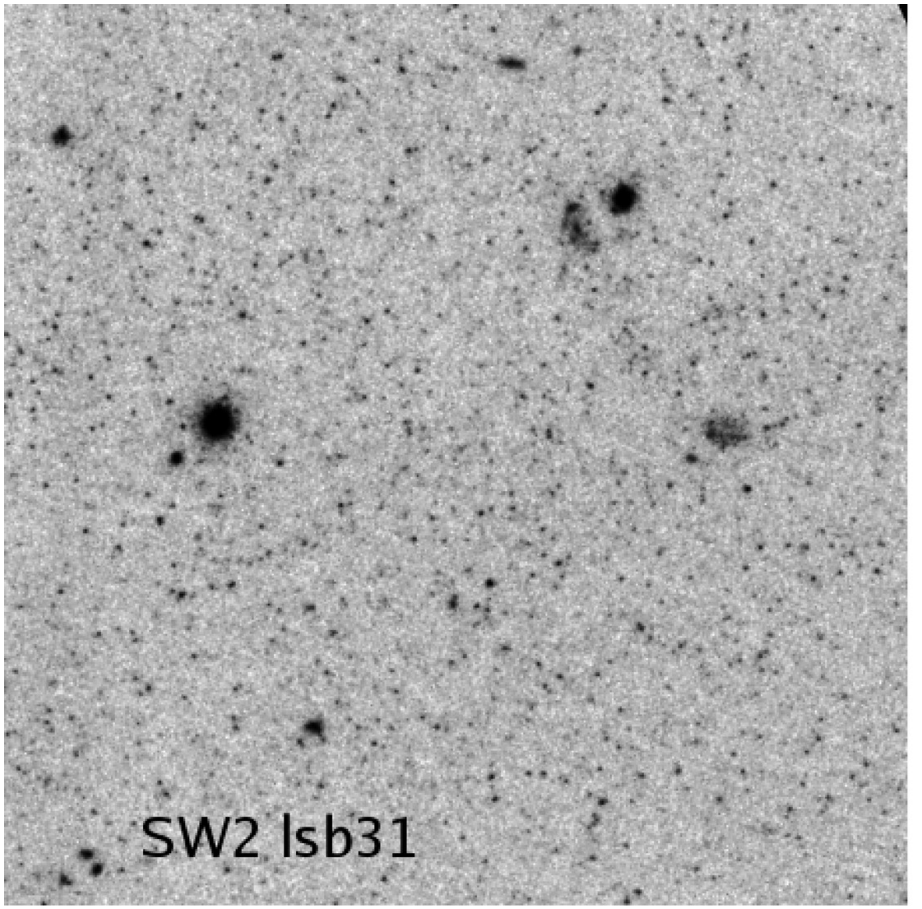
Subject headings: galaxies: abundances — galaxies: clusters: individual (Virgo) — galaxies: dwarf — galaxies: stellar content

Can HST do Virgo CMDs?

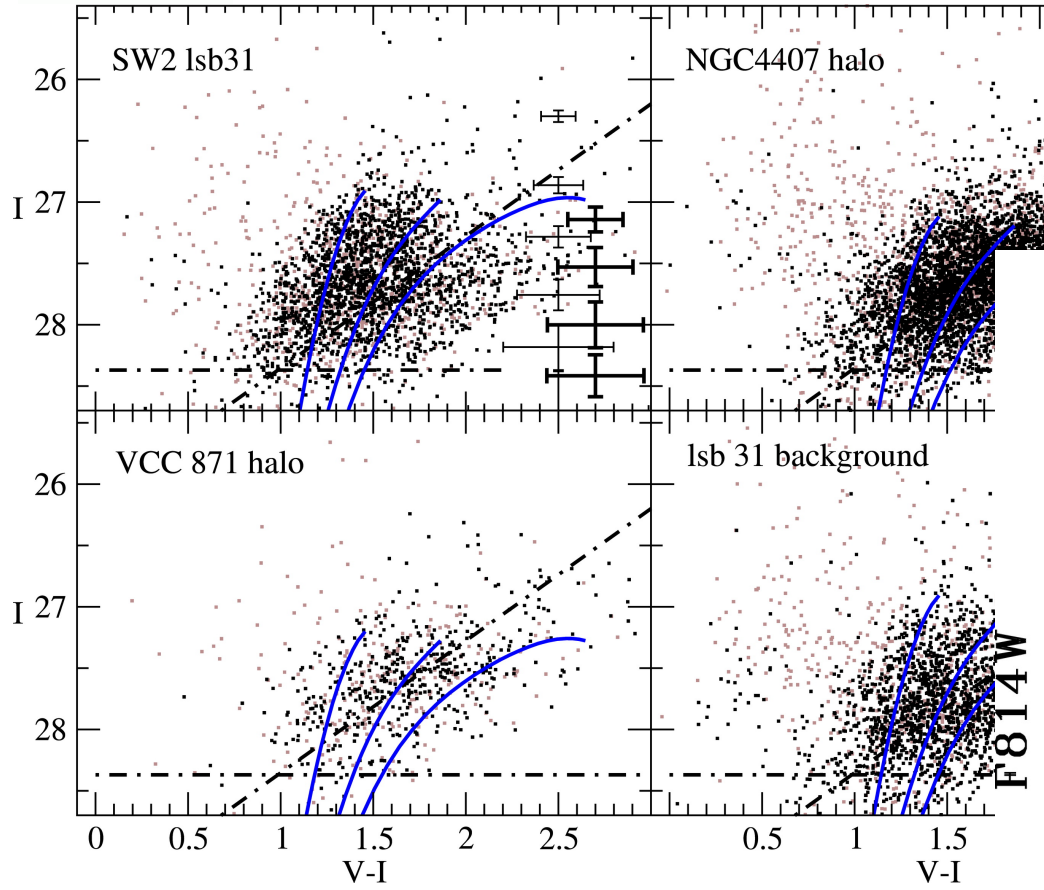


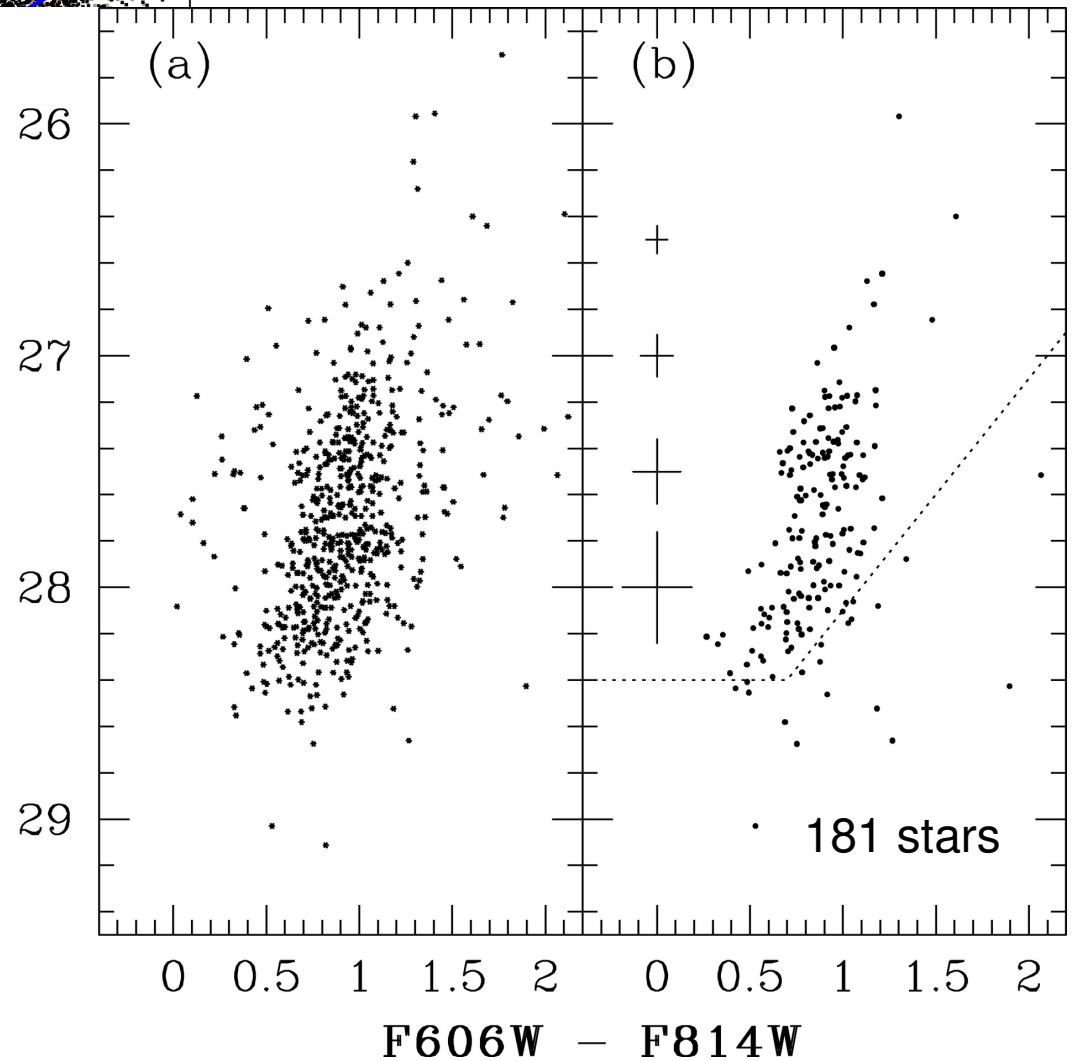
V ~ 27.5 mag/arcsec^2

Yes, but only in extremely low surface brightness environments.



Can HST do Virgo CMDs?





Yes, but only at the very tip of the RGB with ratty photometry.

E-ELT

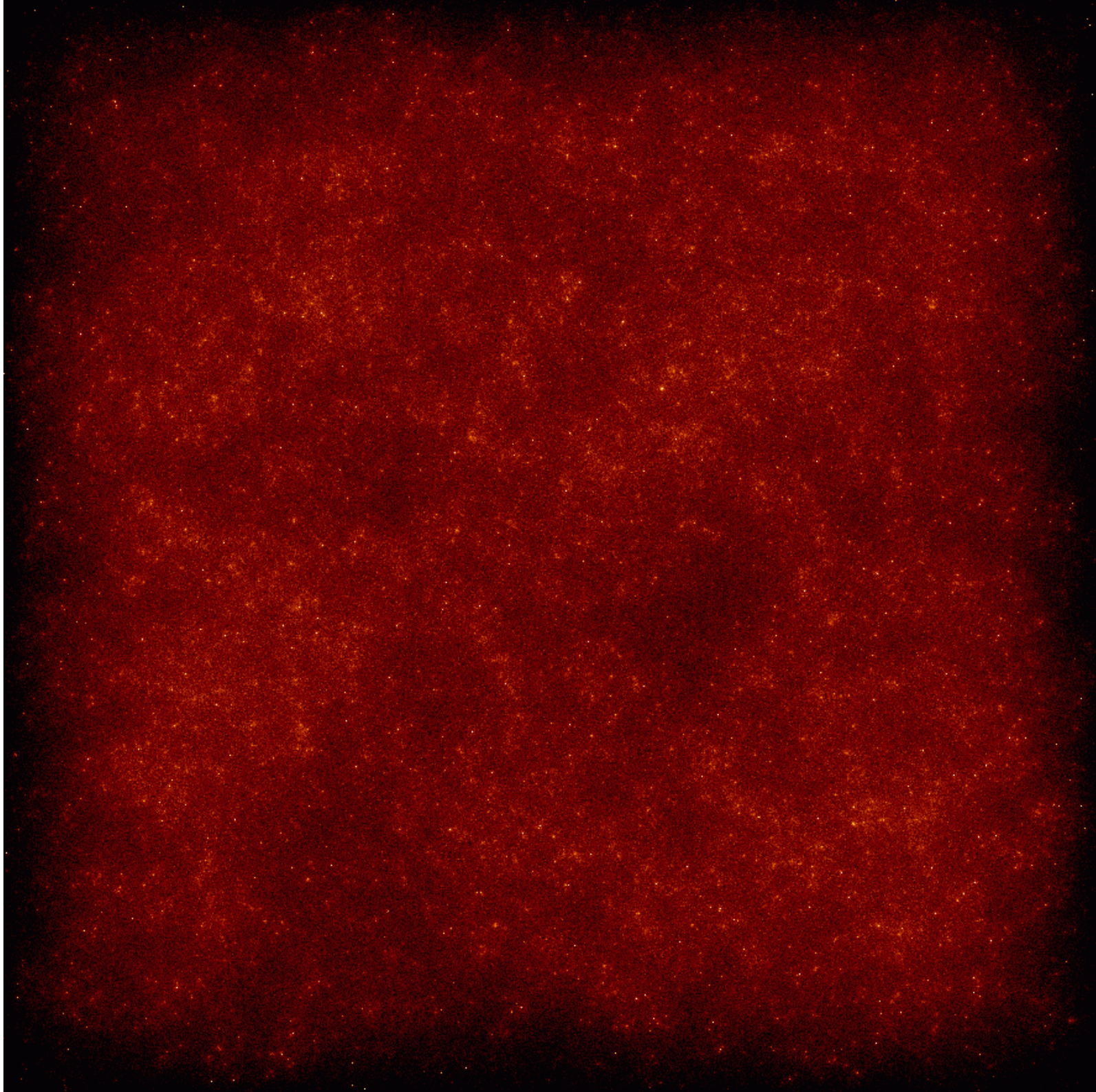
I-band

10 hours

3x3 arcsec^2

DM = 31.2

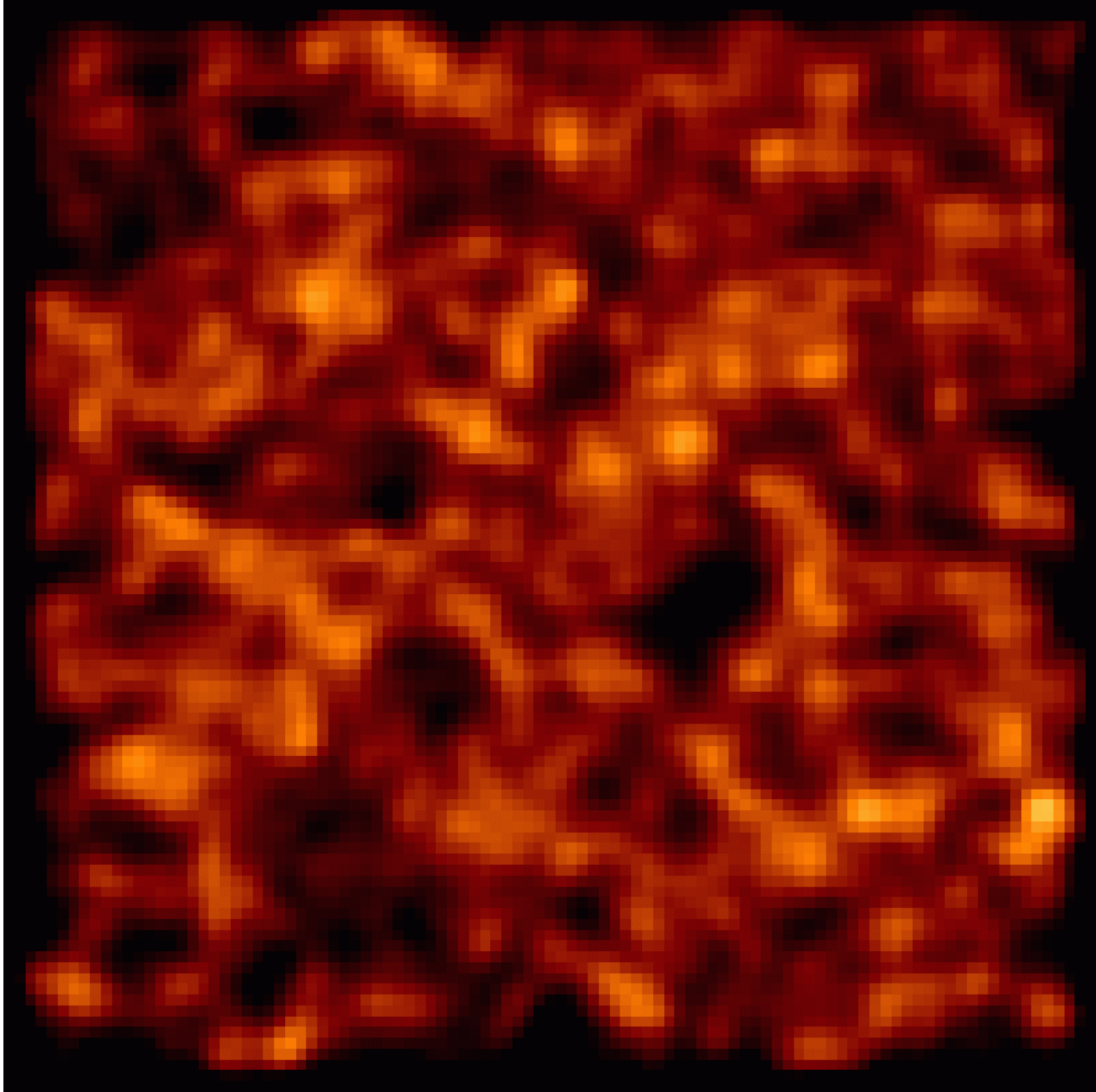
μ = 23 mag/arcsec^2



E-ELT

I-band
10 hours
3x3 arcsec^2
DM = 31.2
μ = 23 mag/arcsec^2

No background, other parameters the same, but now use TinyTim model of HST ACS F814W PSF from Rhodes et al. (2007)



E-ELT

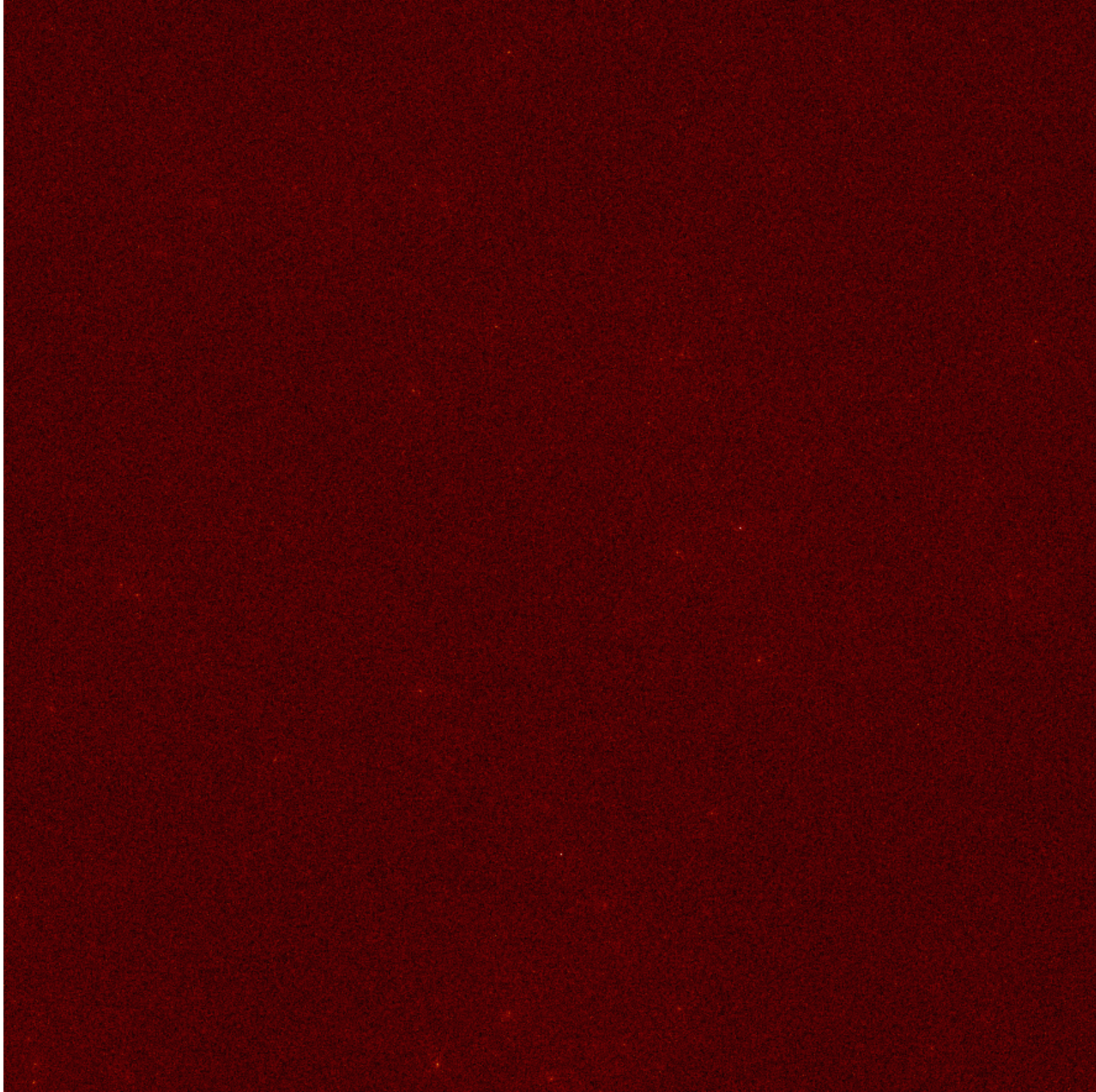
I-band

10 hours

3x3 arcsec^2

DM = 31.2

μ = 27.5mag/arcsec^2



E-ELT

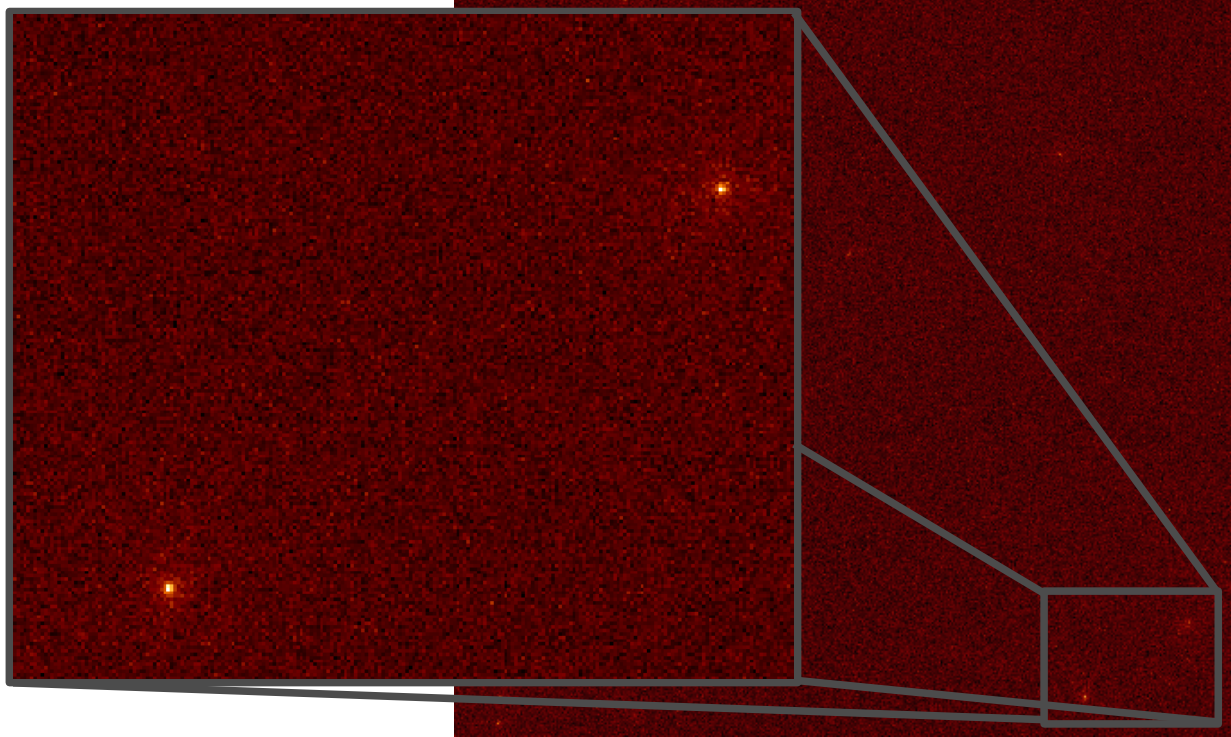
I-band

10 hours

3x3 arcsec^2

DM = 31.2

μ = 27.5mag/arcsec^2



E-ELT

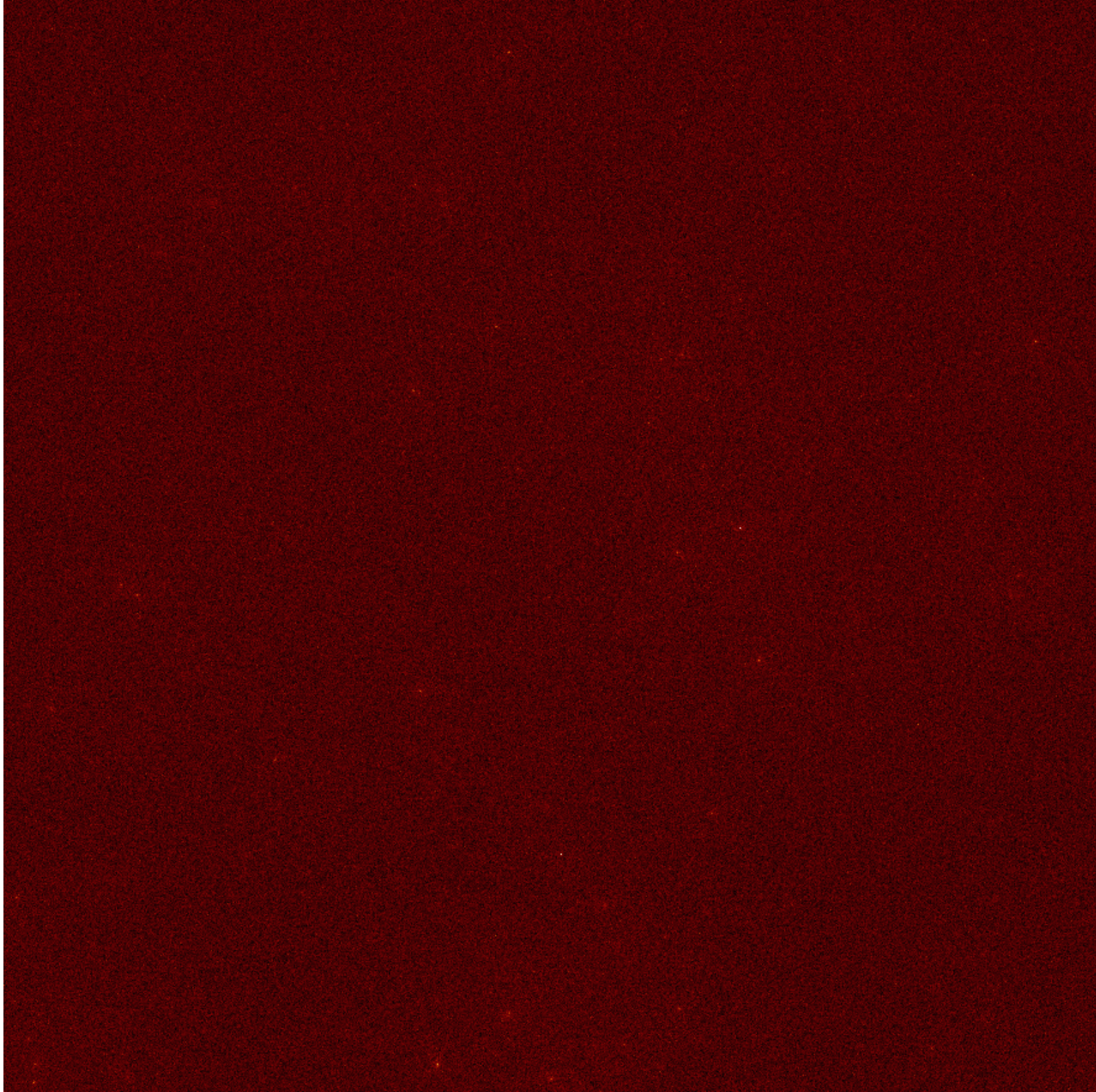
I-band

10 hours

3x3 arcsec^2

DM = 31.2

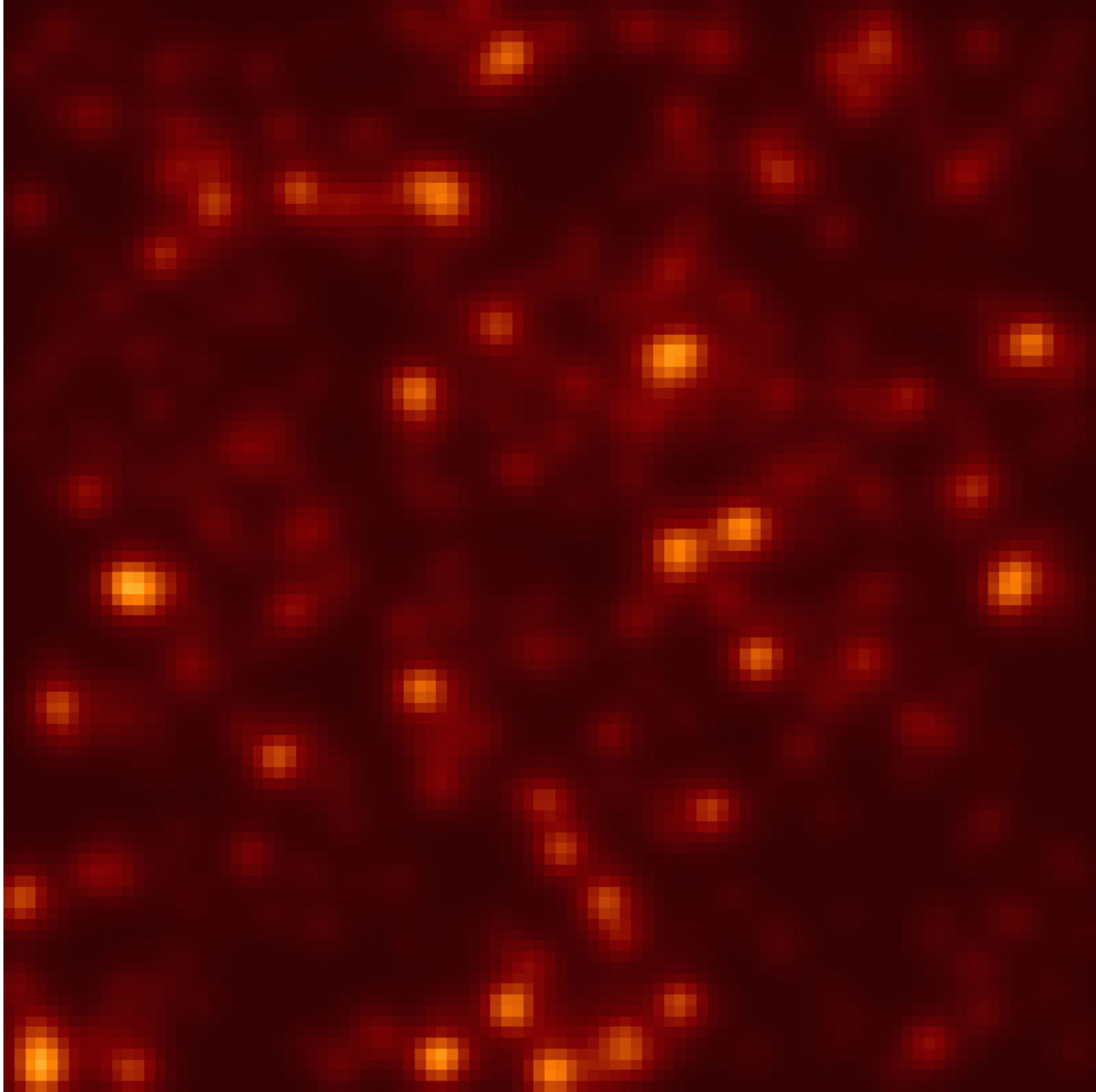
μ = 27.5mag/arcsec^2



E-ELT

I-band
10 hours
3x3 arcsec^2
DM = 31.2
μ = 27.5mag/arcsec^2

No background, other parameters the same, but now use TinyTim model of HST ACS F814W PSF from Rhodes et al. (2007)



E-ELT

SW2 lsb31

(Caldwell 2006)

3x3 arcsec^2

9.2 hours in F555W