The E-ELT view of resolved stellar population in distant galaxies

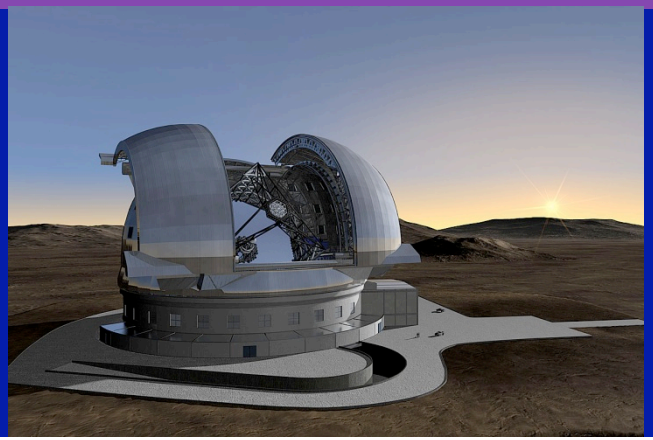
Renato Falomo

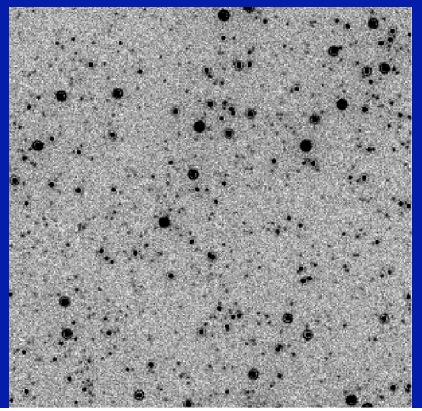
INAF – Observatory of Padova, Italy

In collaboration with

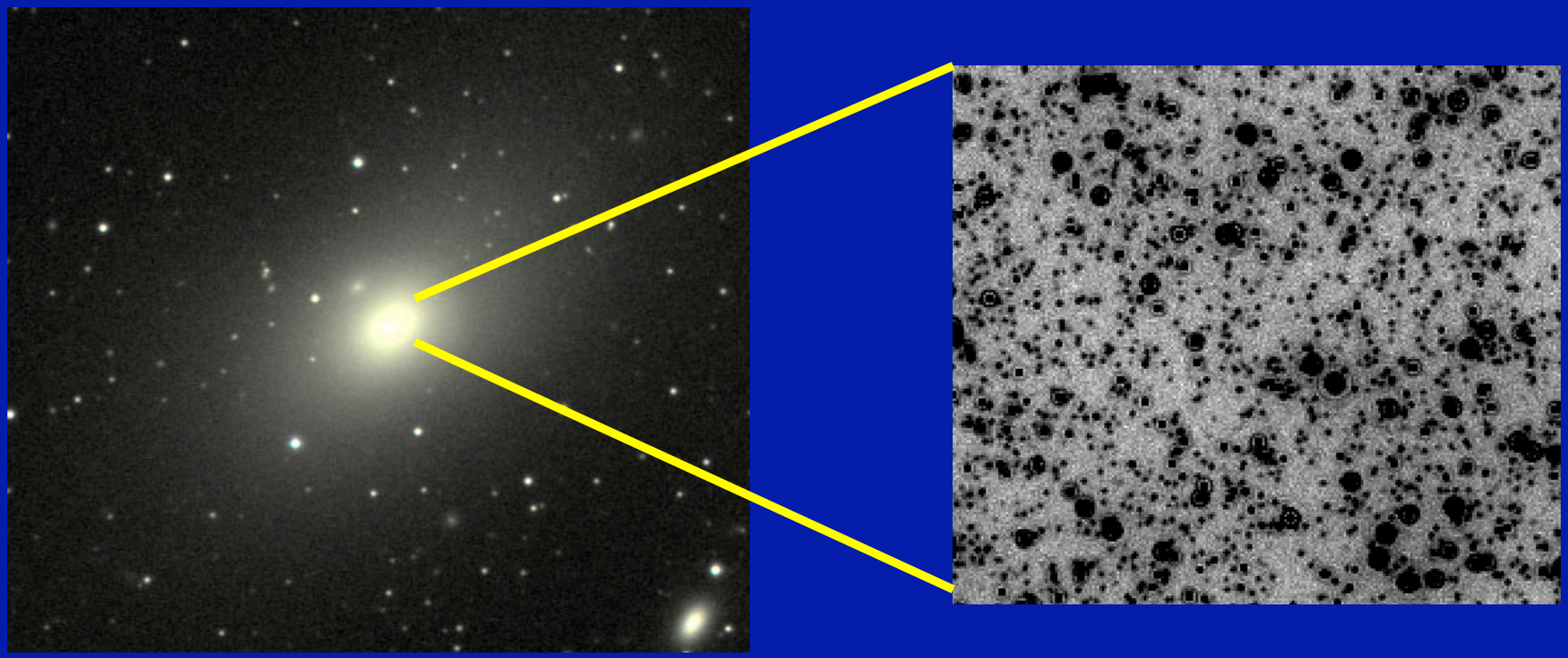
L. Schreiber, D. Fantinel, L. Greggio, M. Uslenghi, S. Zaggia,

- Resolved stellar population in distant galaxies (Virgo cluster)
- The Experiment: : simulated images and photometric analysis



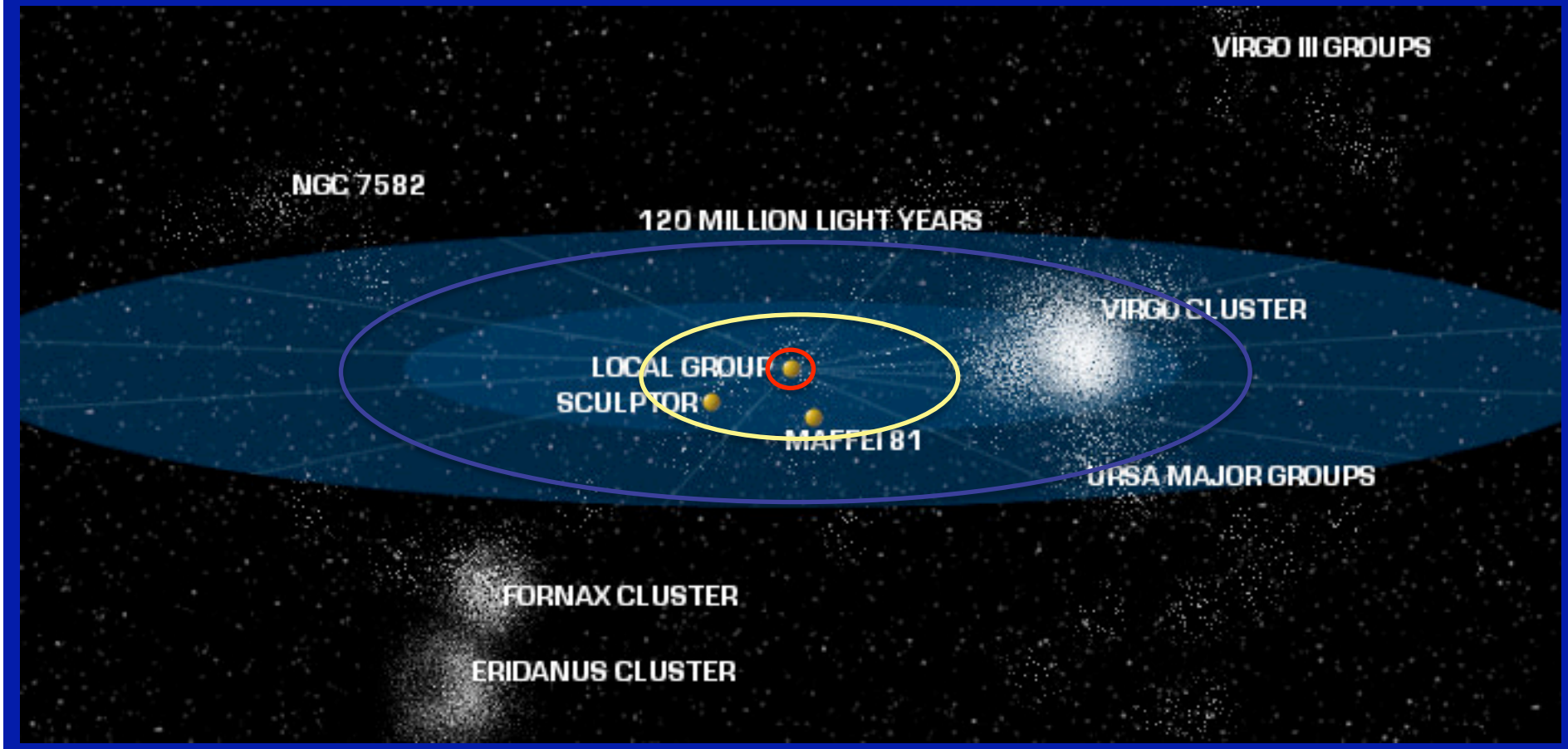


The study of the resolved stellar population in distant galaxies is one the main science drivers for th realization of ELTs



Reconstruction of the star formation history for a stellar system by analyzing its color-magnitude diagram (CMD) is a fundamental tool for understanding its age and chemical composition.

THE GALAXIES AROUND US

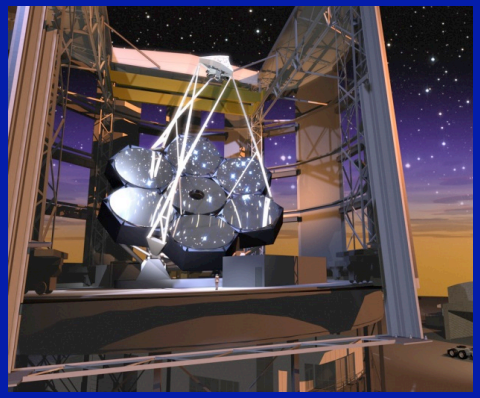


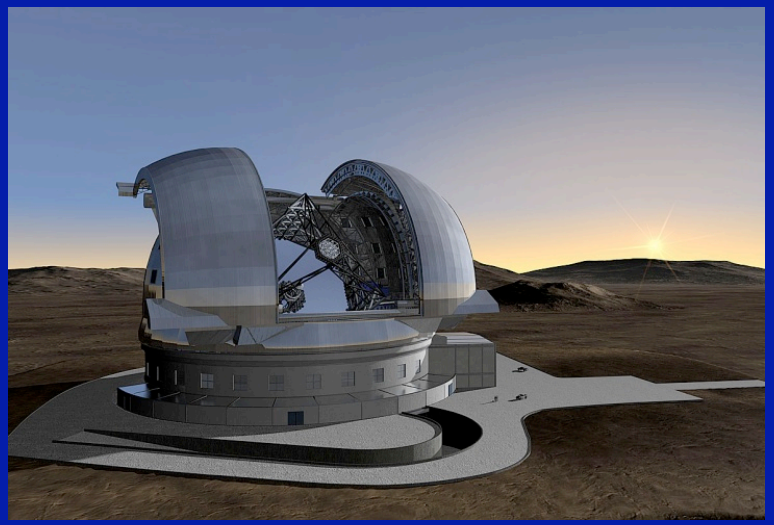
A SIGNIFICANT SAMPLING OF THE SFH IN THE UNIVERSE REQUIRES THAT WE USE THE LUMINOUS PART OF THE CMD TO DERIVE SFH

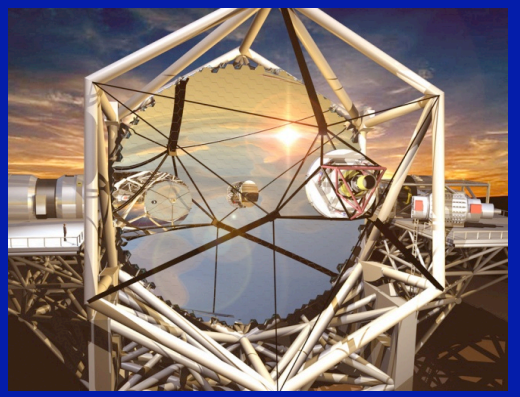
VIRGO - the closest rich cluster of galaxies

VIRGO cluster (DM = 31)

Why an ELT ?







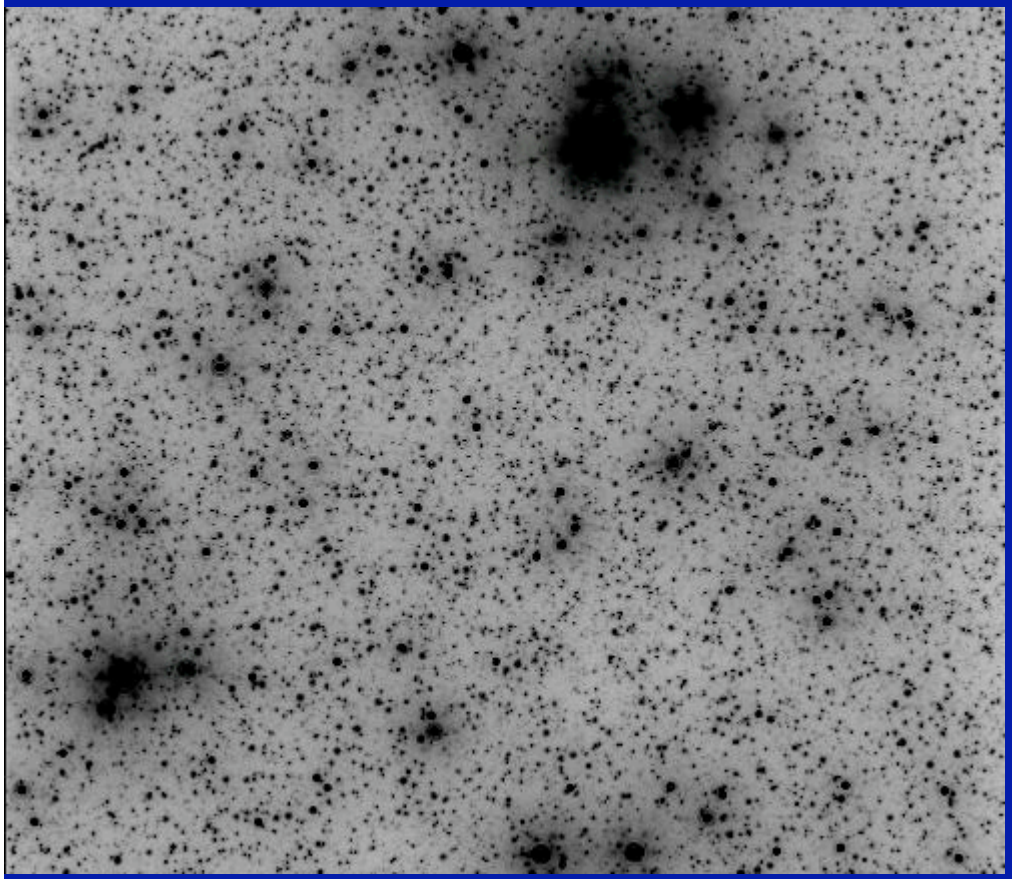
1. Very high throughput
2. Excellent spatial resolution

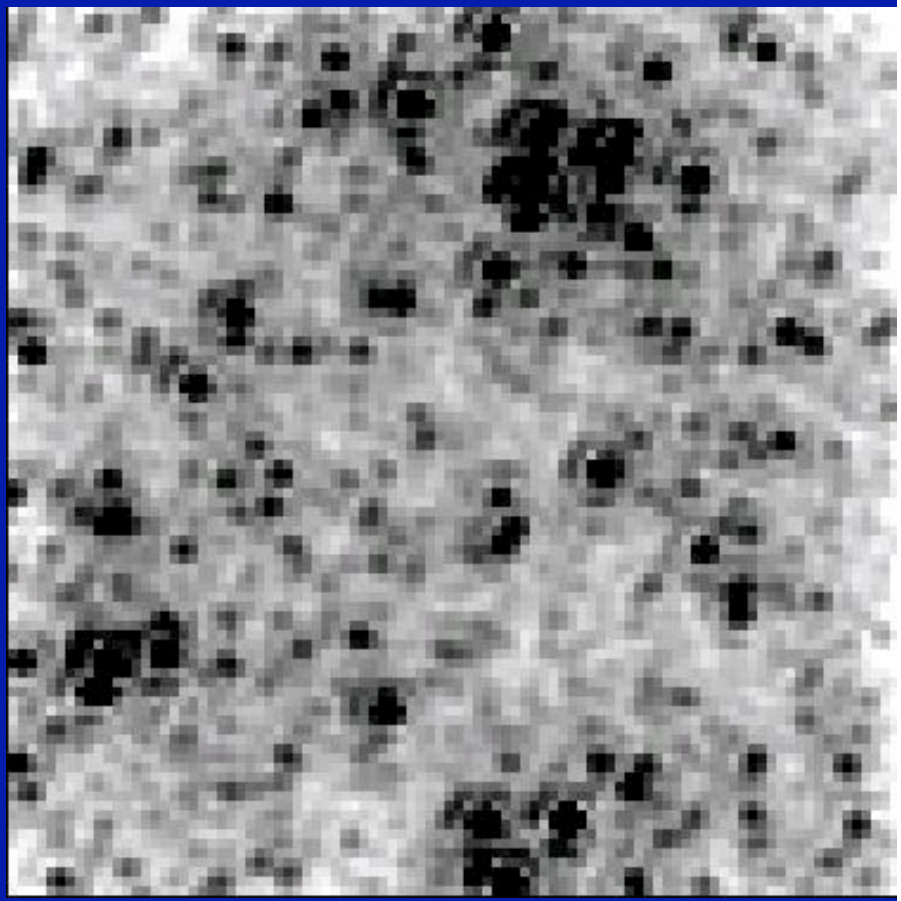
… provided by large aperture and Adaptive Optics

The view of resolved of stellar populations

Disk galaxy (young SP) M(J) = -23 , HLR = 5 kpc

Distance = 3 Mpc R/HLR = 1 (128 000 stars)





MICADO E-ELT

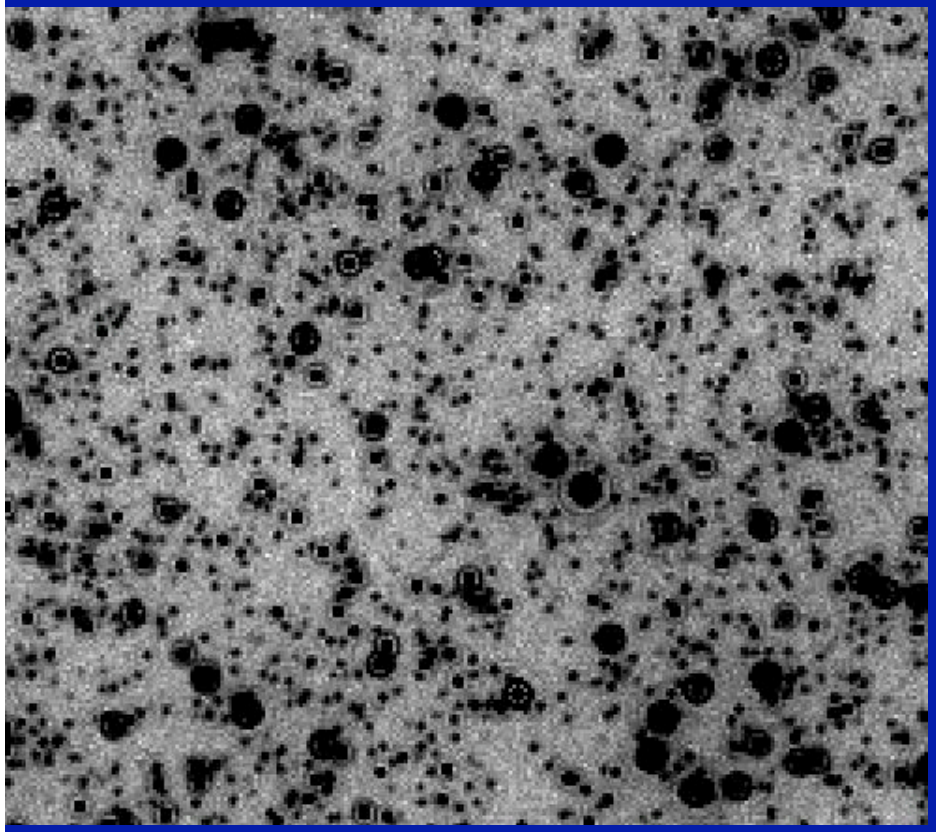
FoV = 3”

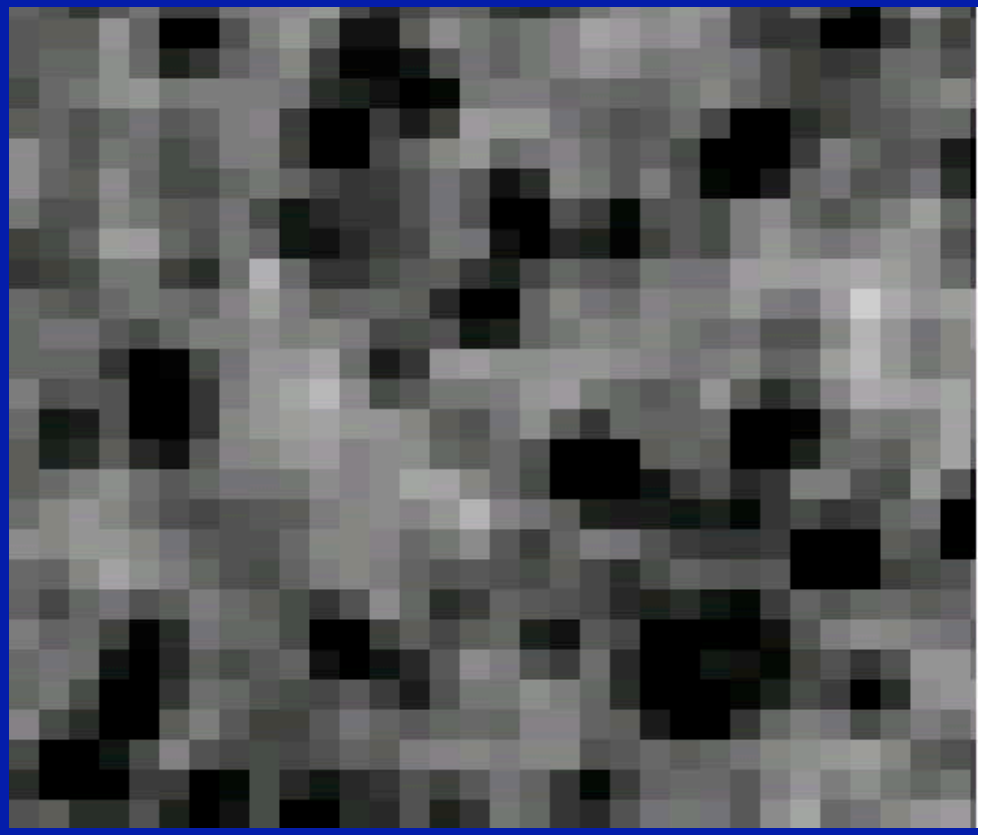
NIRCam JWST

The view of resolved of stellar populations

Elliptical galaxy (old SP) M(J) = -23 , HLR = 5 kpc

Distance = 18.3 Mpc   R/HLR = 1





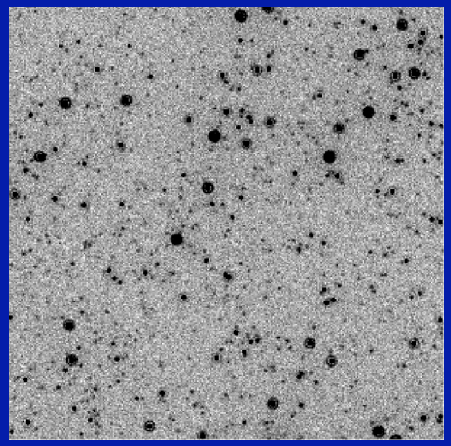
MICADO E-ELT

FoV = 1”

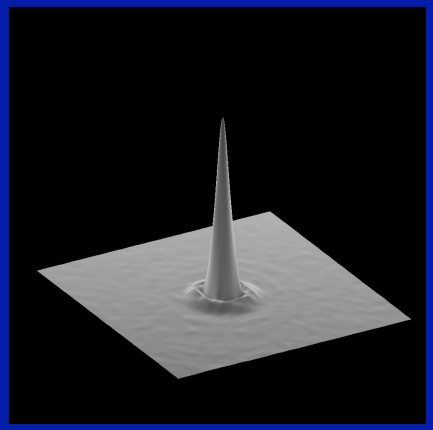
NIRCam JWST

The experiment (in 4 steps)

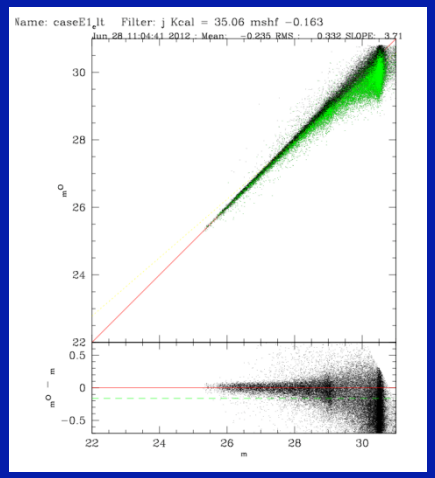
1- Define the galaxy properties



2- Create simulated images



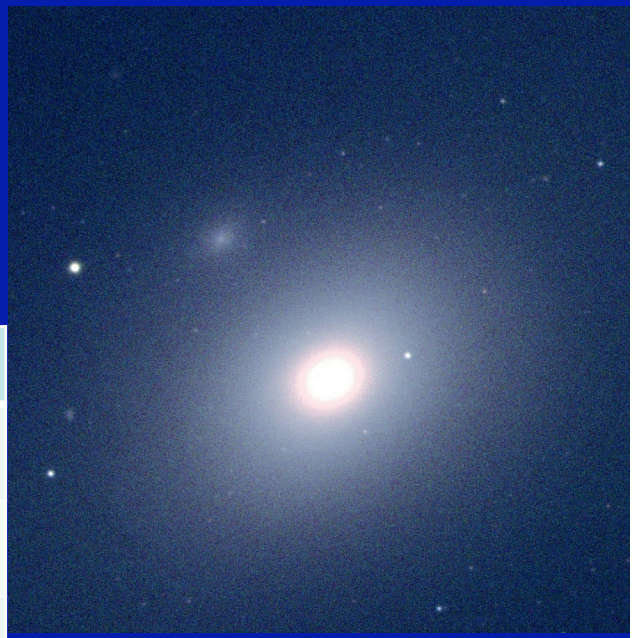
3 – Photometric analysis



4 -Check results

1 – Define the galaxy properties

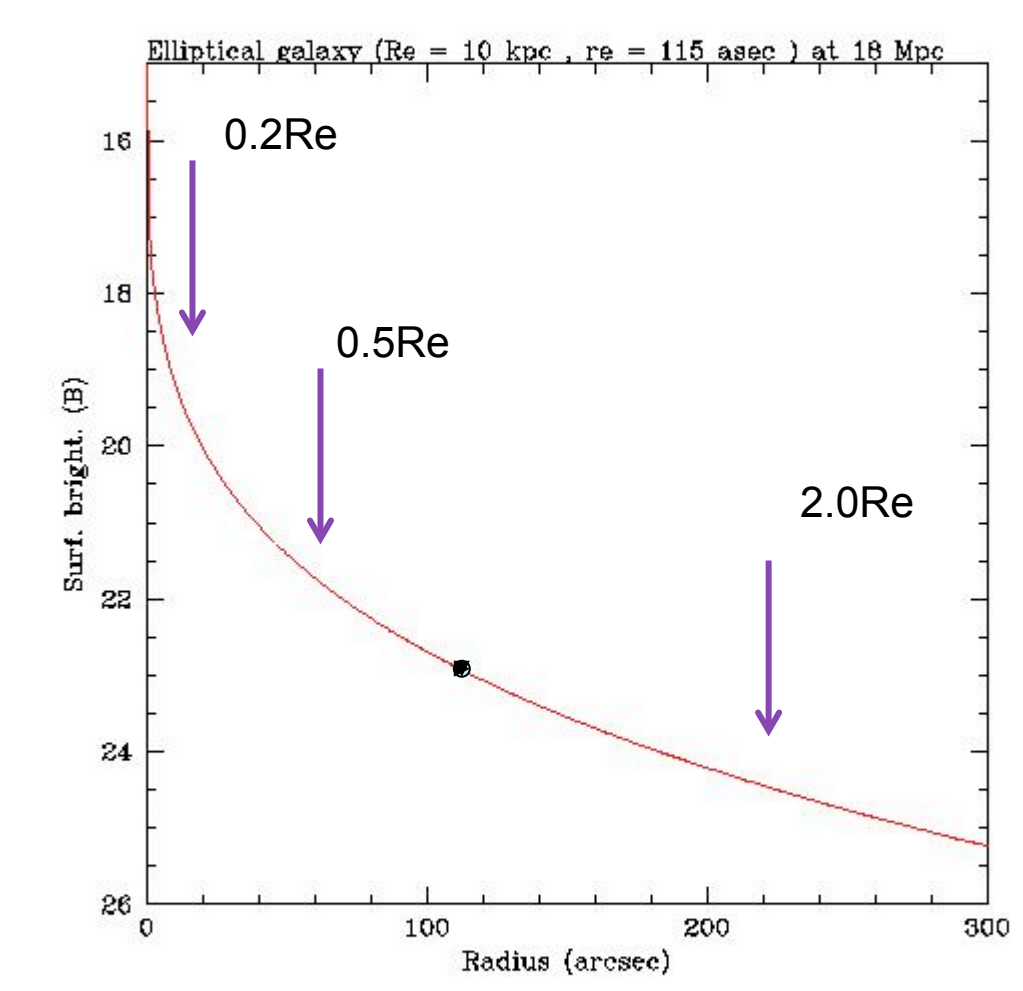
Massive elliptical galaxy

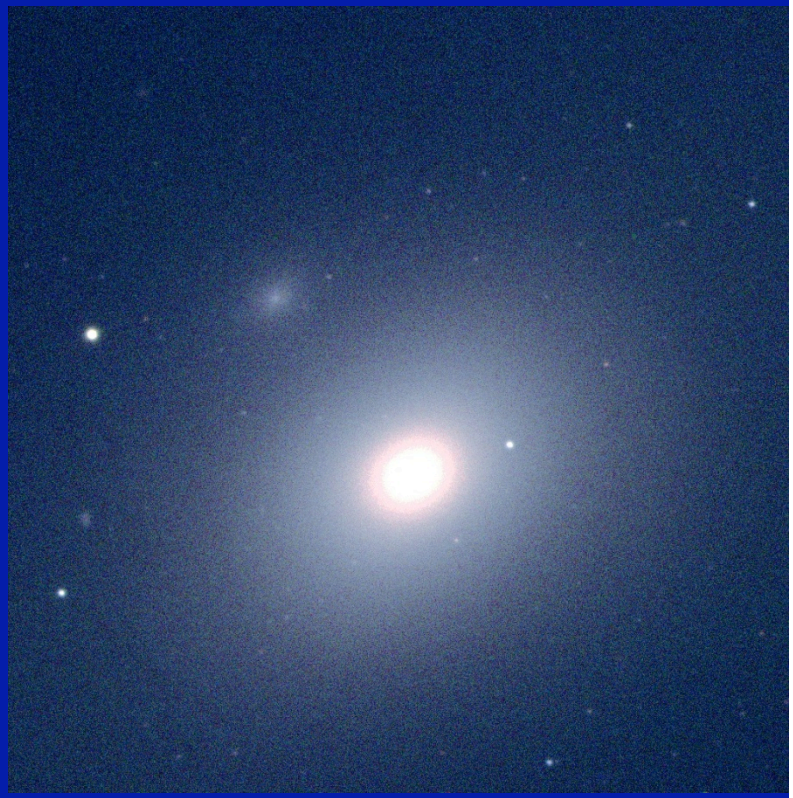


Absolute Magnitude	M(B)	-22
Effective Radius	Re	10 kpc
Distance (Virgo cluster)	18	Mpc
SB (J) = 17 – 22		

Greggio, Falomo, Zaggia et al 2012: PASP in press, arXiv:1206.0909

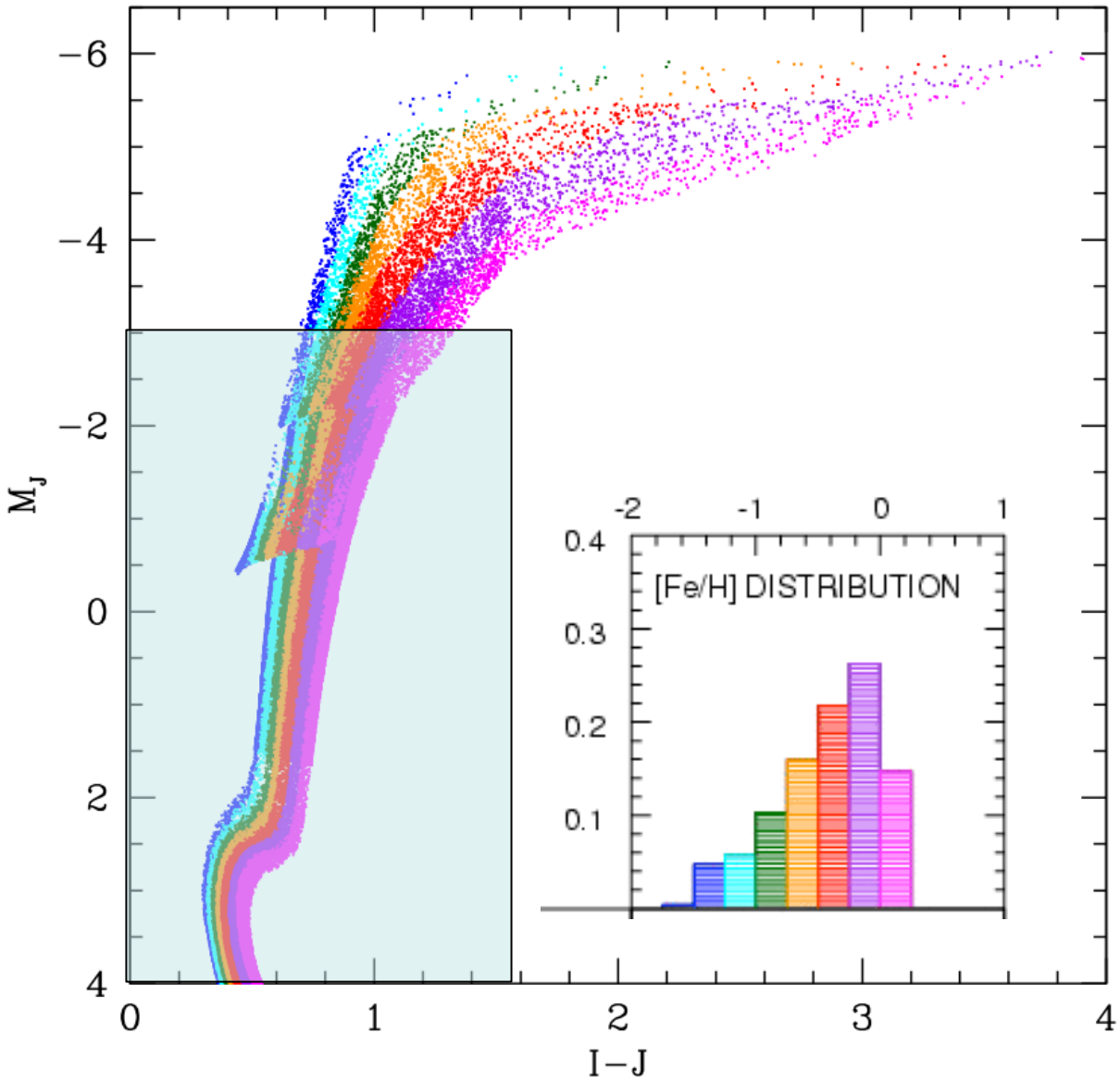
The properties of Elliptical galaxy





- Re = 115 arcsec

Stellar population of giant Elliptical galaxy



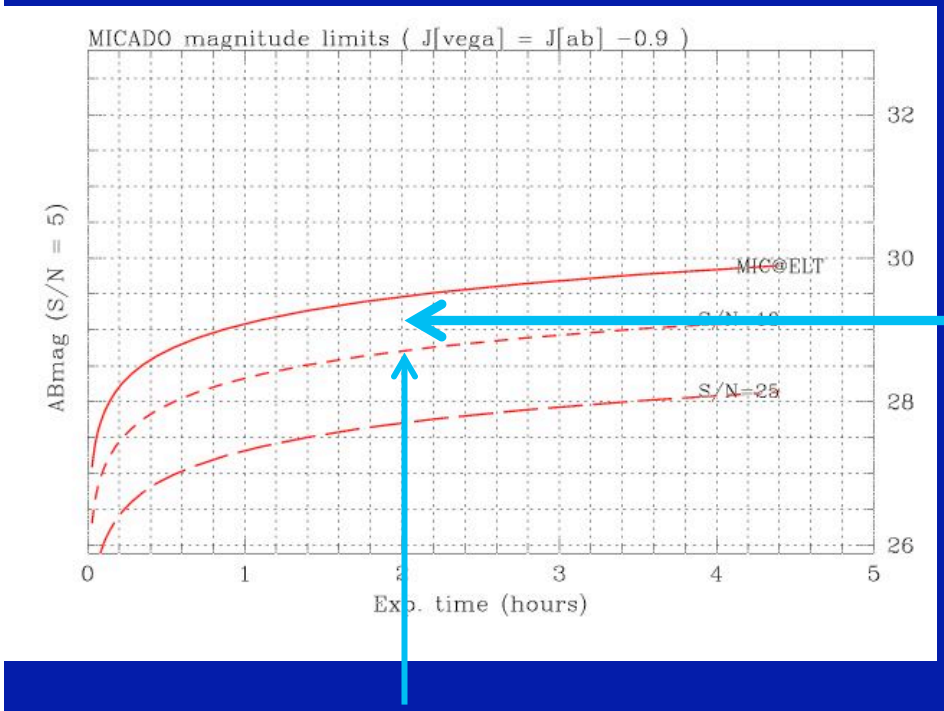
OLD Stellar Population

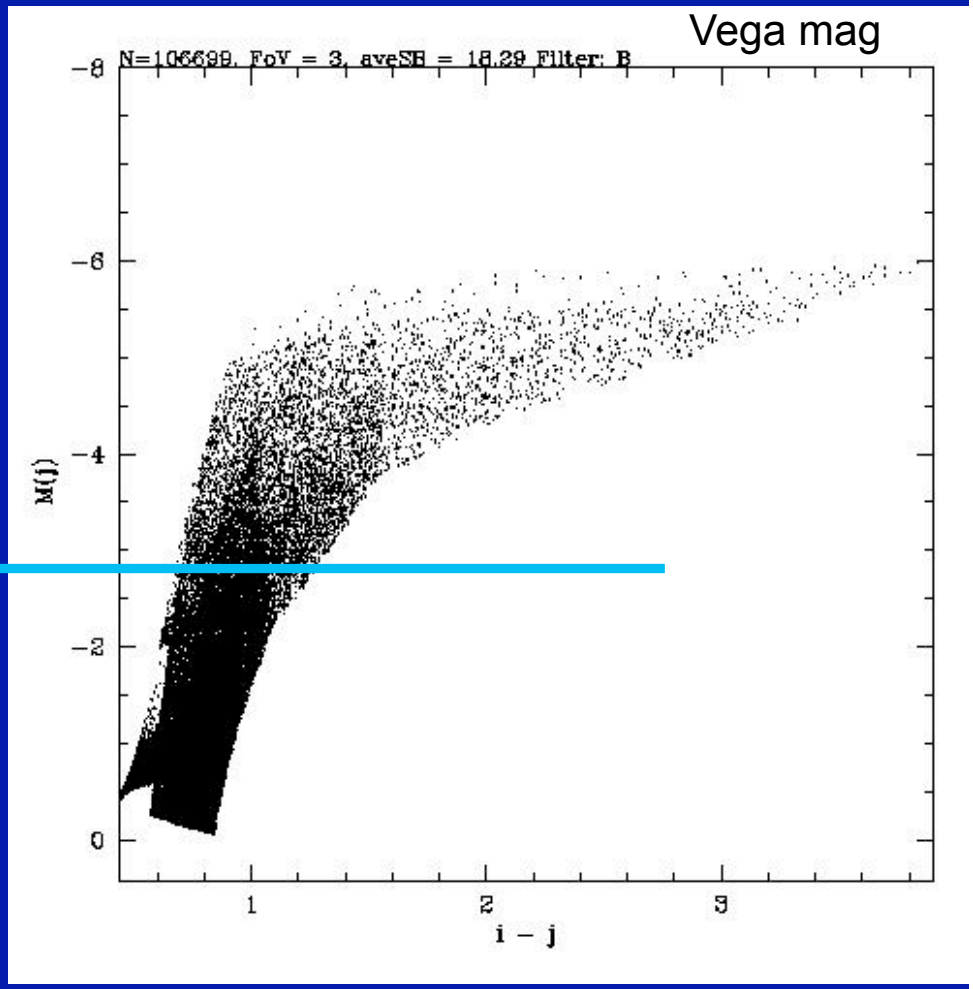
Code YZVAR by G.P. Bertelli

(Padova tracks database) :

The SP of the E galaxy in Virgo

Virgo DM = 31





2h integration

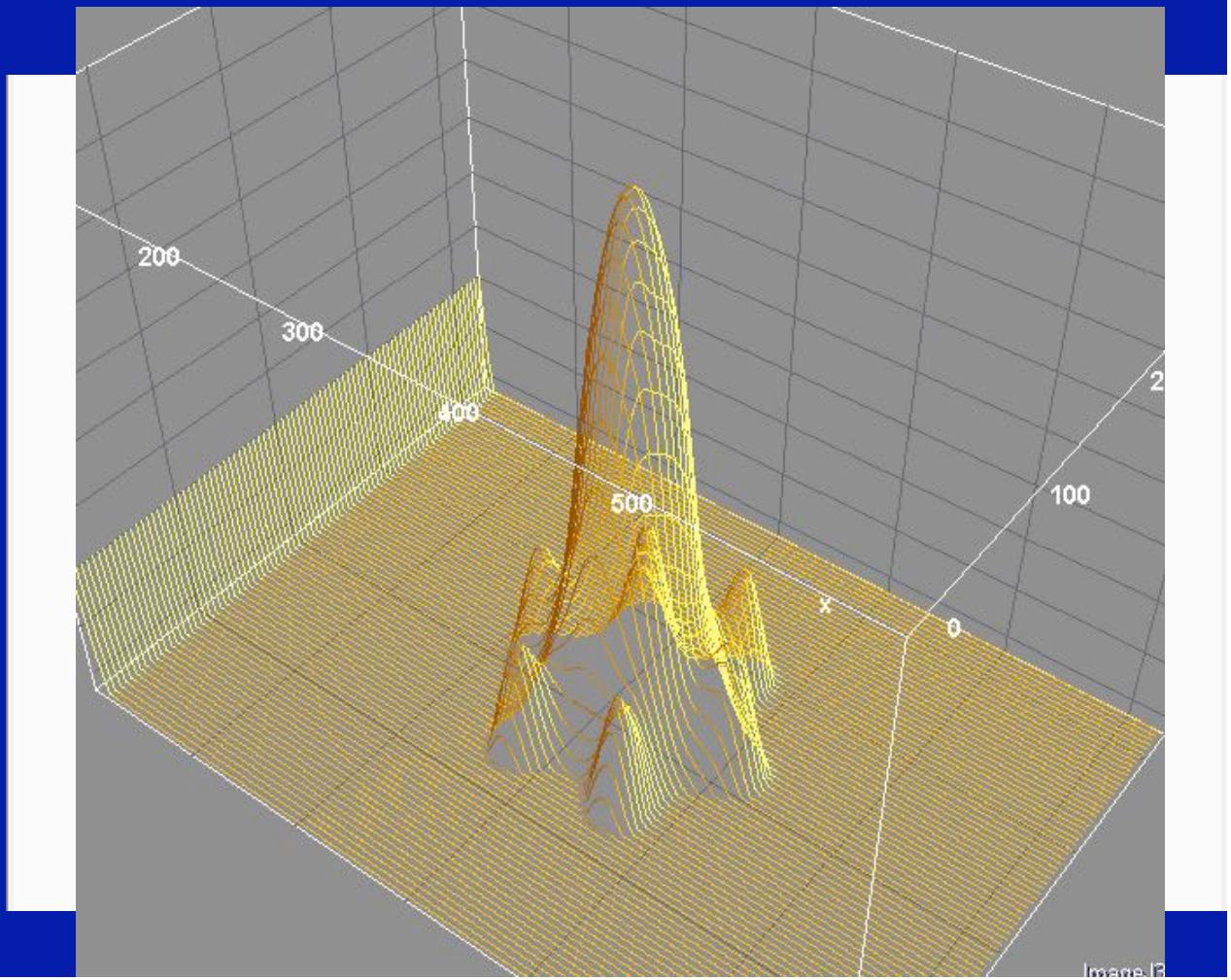
2 - The simulation of images

- Select the distance from the center of the galaxy (SB)
- Extraction of the stellar population from mother dataset down to a given mag limit
- Addition of light contribution from unresolved stars
- Total exposure time : 7200 sec (N. of exp = 100)
- Add sky + instrument background, and statistical noise
- PSF by Maory templates (0.6 arcsec seeing + LGS)
- Simulated field of View : 3 arcsec

MICADO @E-ELT - Simulation

Simulation and testing: Maory PSF

- Six LGS
- Seeing 0.6 arcsec
- J 2.98 mas
- K 5.3 mas
- SR = 0.6 (K)
- Central 3 arcsec (constant PSF)

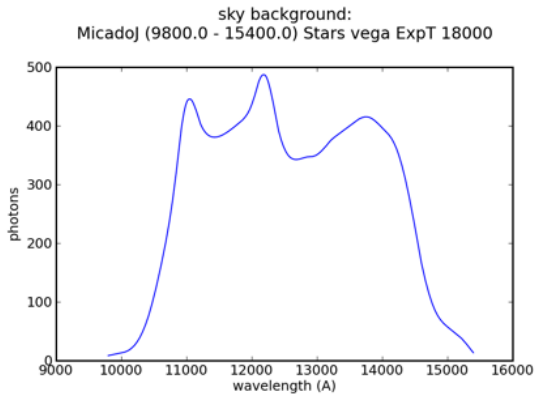


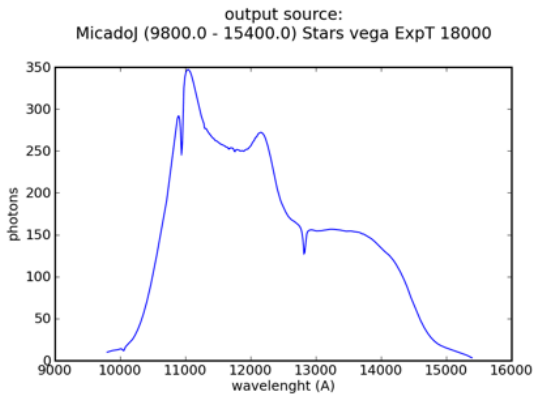
2 - The simulation tool : AETC

Falomo, R., Fantinel, D., Uslenghi, M 2011 Proc. SPIE 8135, 813523 (2011)

-03 09:49:12

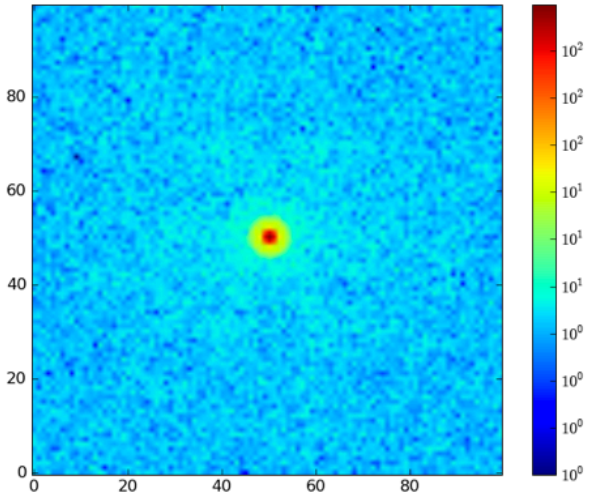
AETC





http://aetc.oapd.inaf.it

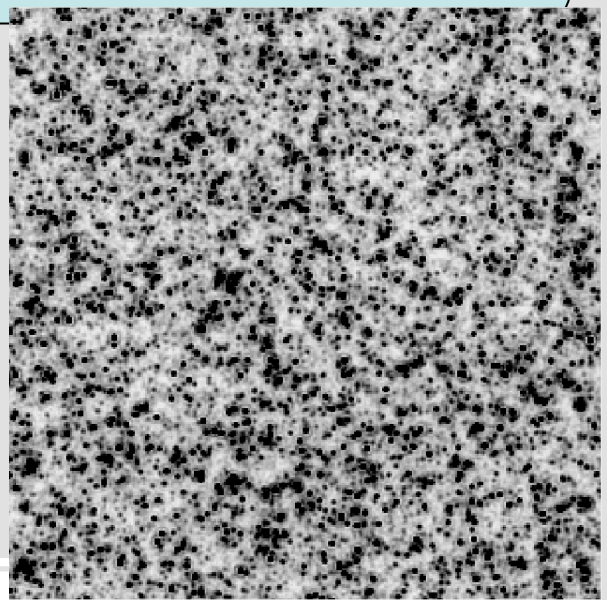
Preview Image

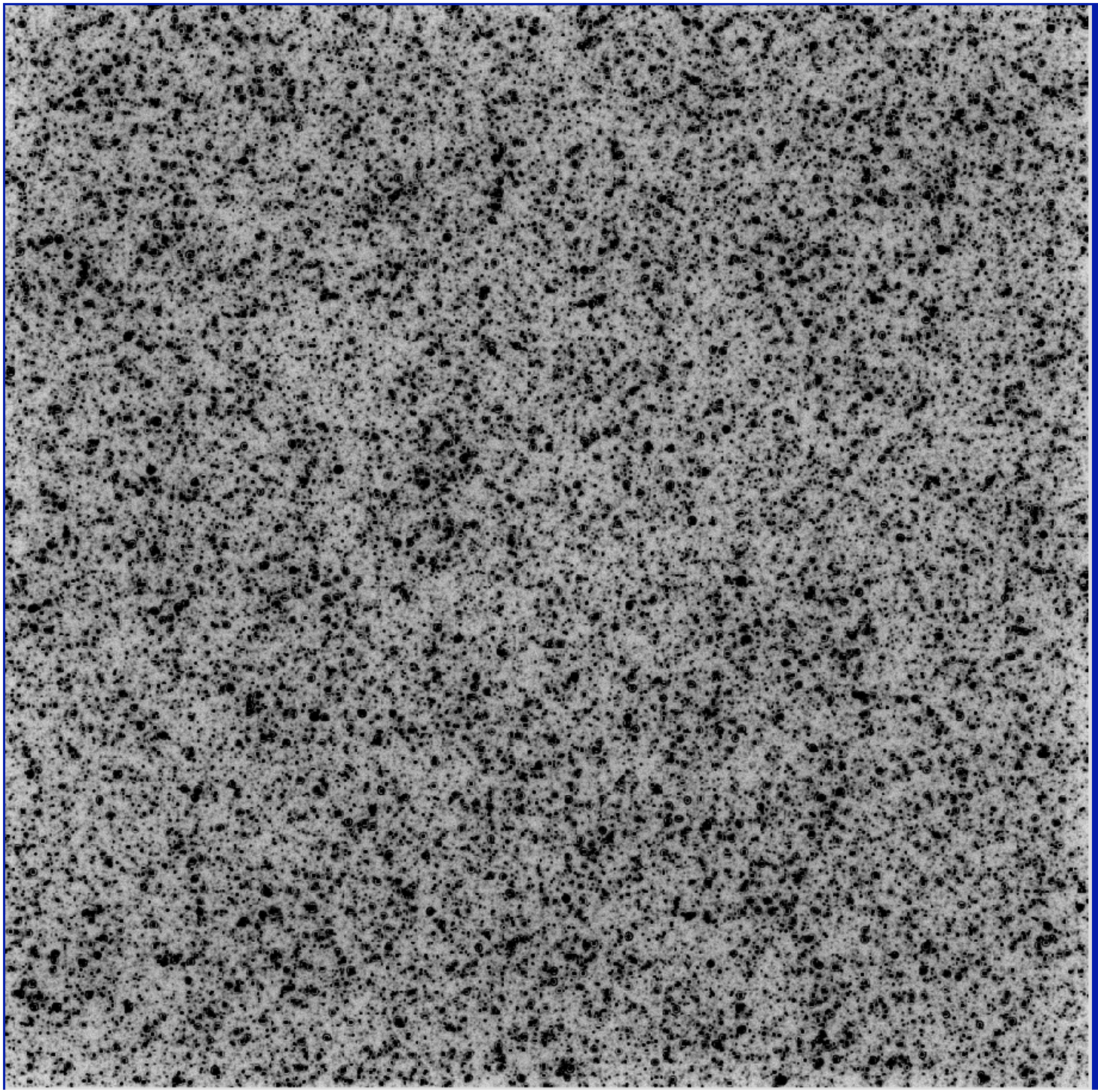


AETC

x size: 100
y size: 100
gain: 1
FPN: 0.0
dark: 0
convolution: standard
rad min: 20
saturation level: 65535
threshold: 0.01
add noise: yes
subtract background: yes

SAVE Image (fits)





Ellptical galaxy

0.5xRe

Filter J

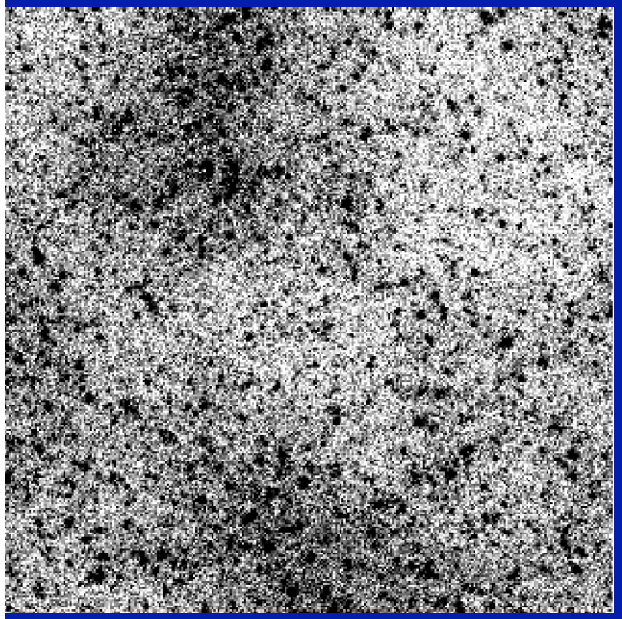
FoV 3 arcsec

Exp: 7200 sec

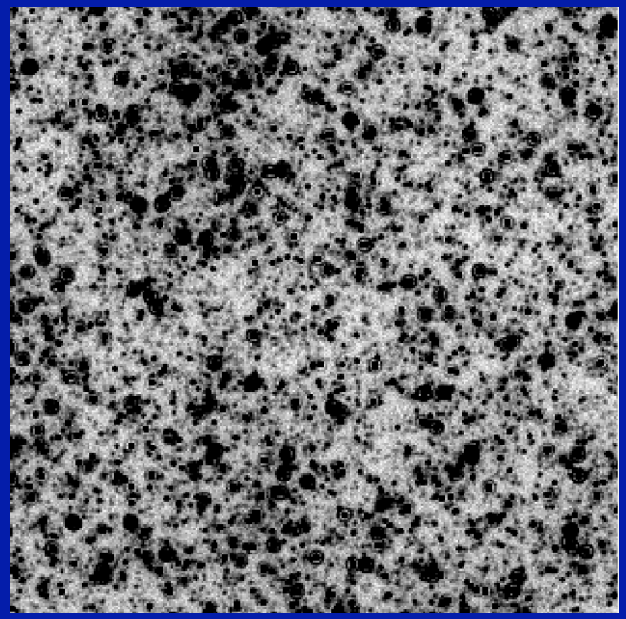
1”

2 - The simulation : Images (0.5xRe)

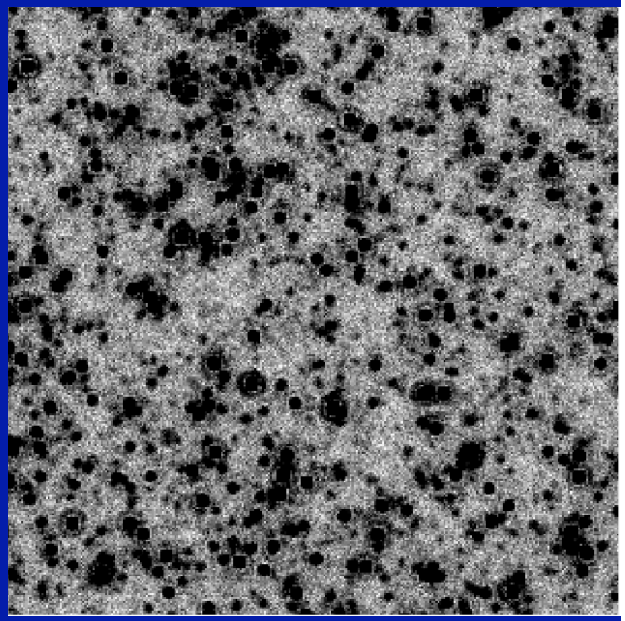
I



J

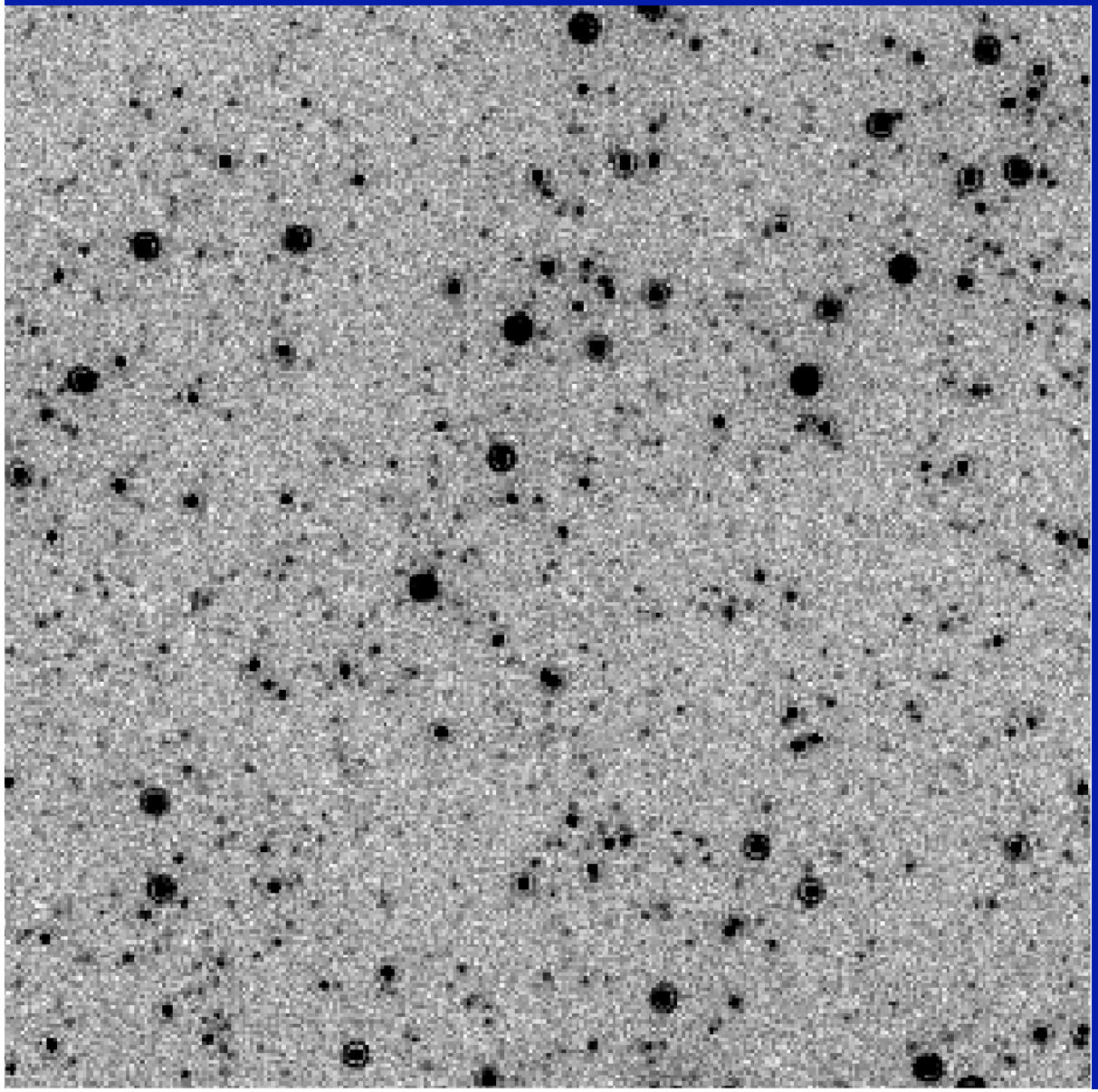


Ks



1”

2 - The simulation : Images – J band

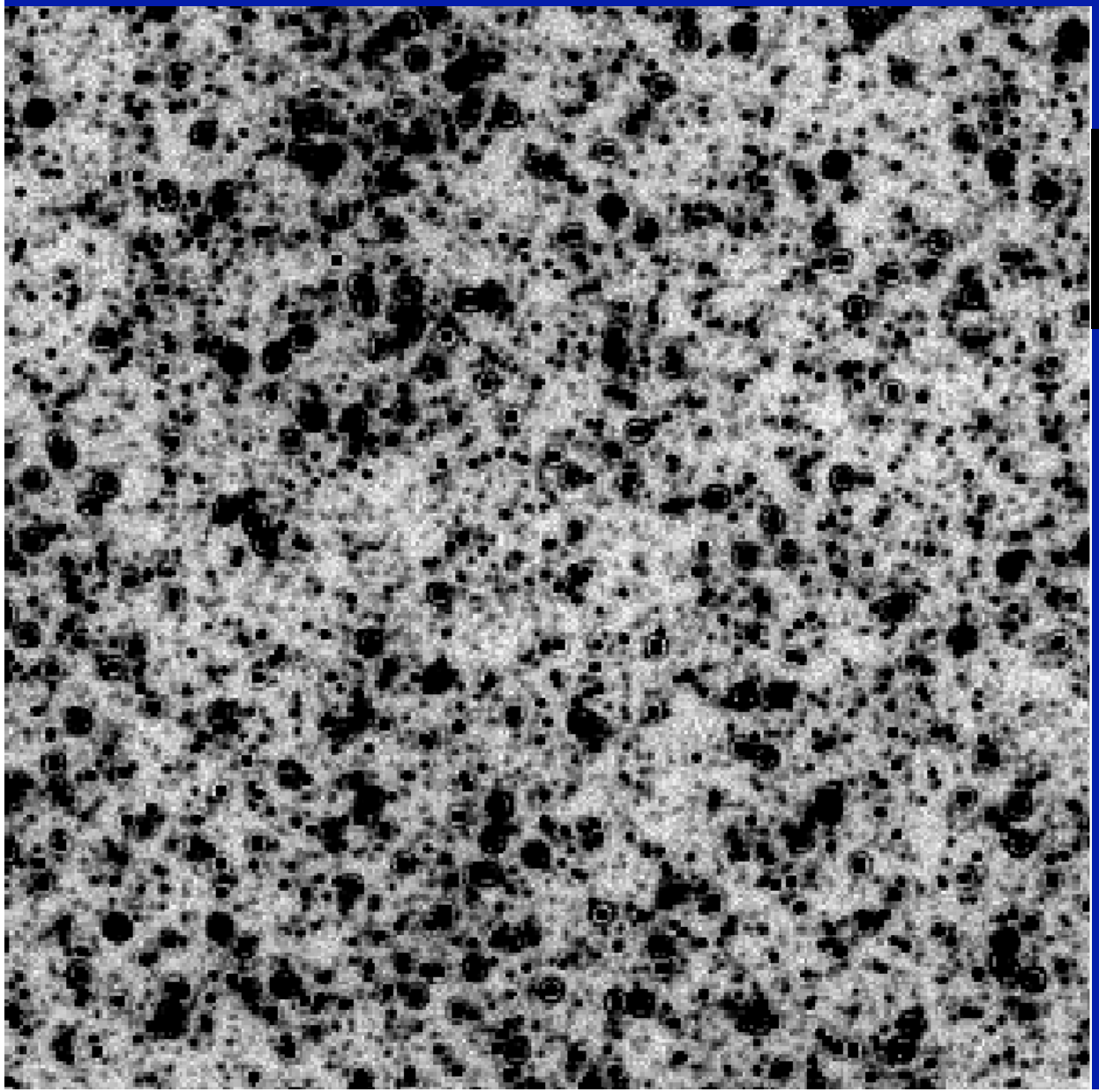


R = 2.0 x Re
20 kpc

SB = 22.1

FoV = 1”„

2 - The simulation : Images – J band

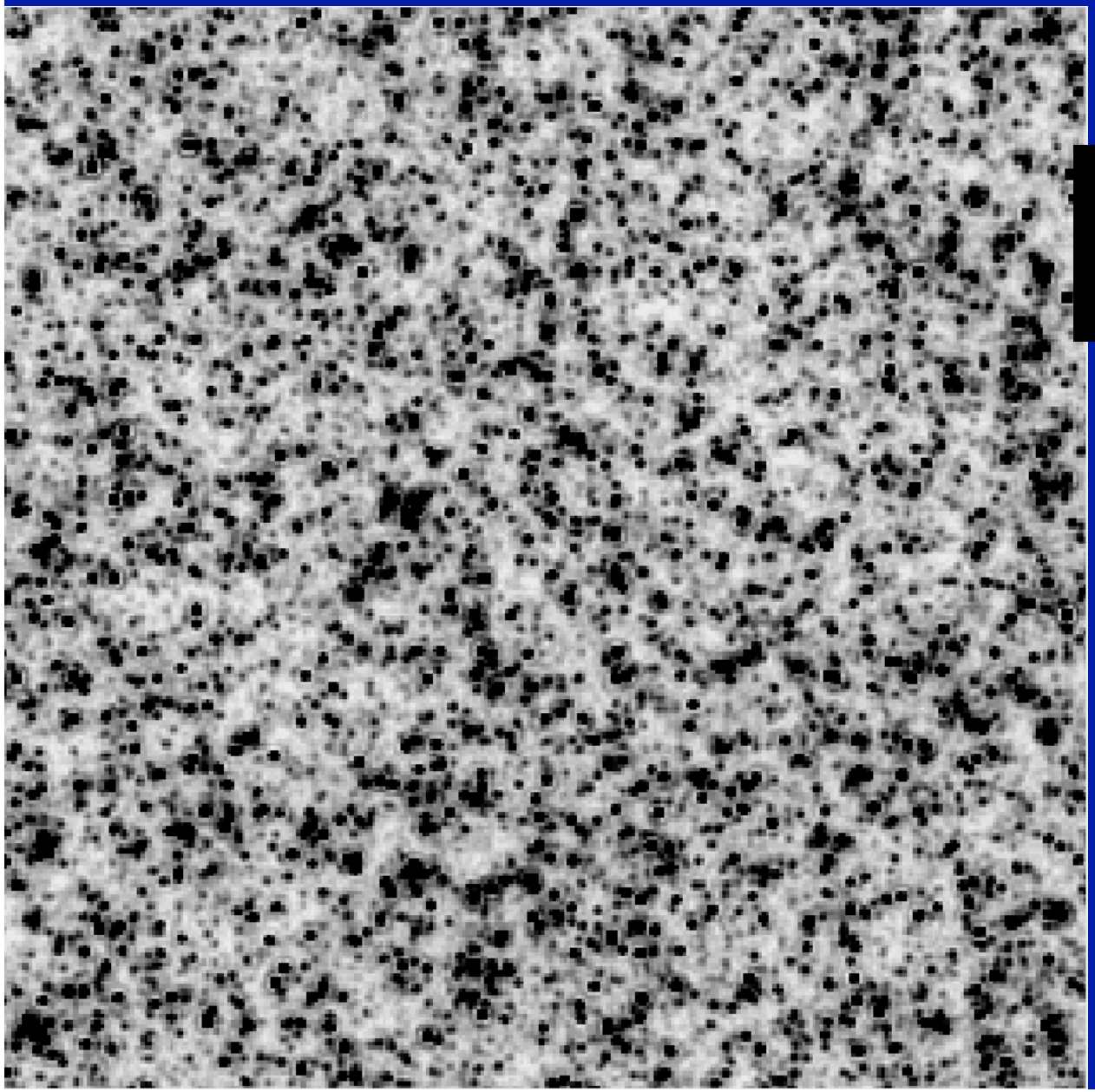


FoV = 1”

R = 0.5 x Re
5 kpc

SB = 19.2

2 - The simulation : Images – J band

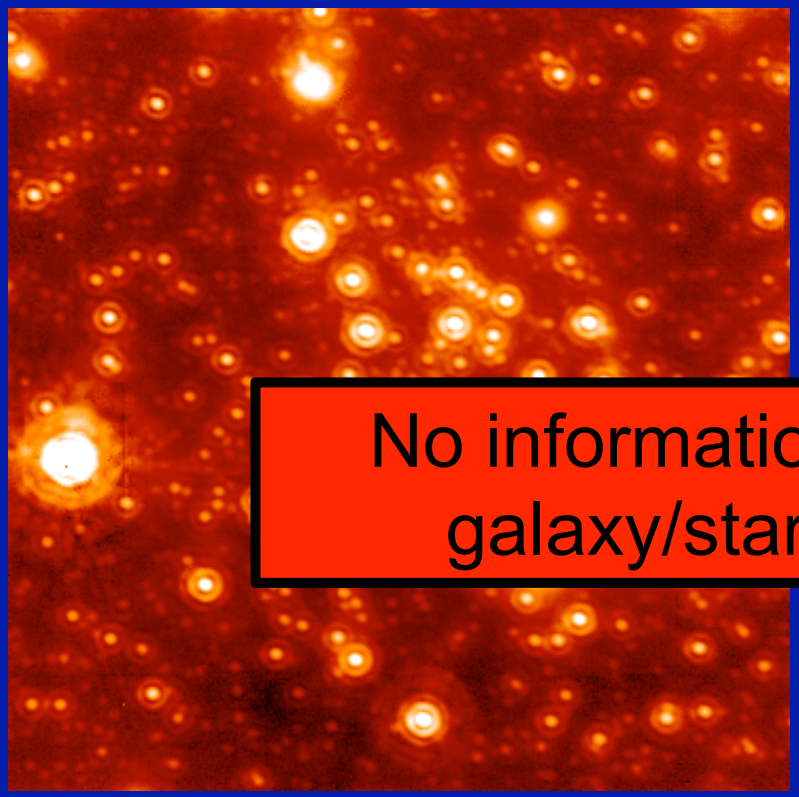


R = 0.2 x Re
2 kpc

SB = 17.6

FoV = 1”„

3 - The photometric analysis with Starfinder



Galactic Center (Rigaut et al. 1998)

CFHT PUEO
K band
Field of view: 13"×13"
Strehl Ratio ≈0.40

- Designed and developed (1997-2000) for images with **structured PSF but uniform across field of view**

analysis
SF fitting

No information on the simulated galaxy/star field is provided

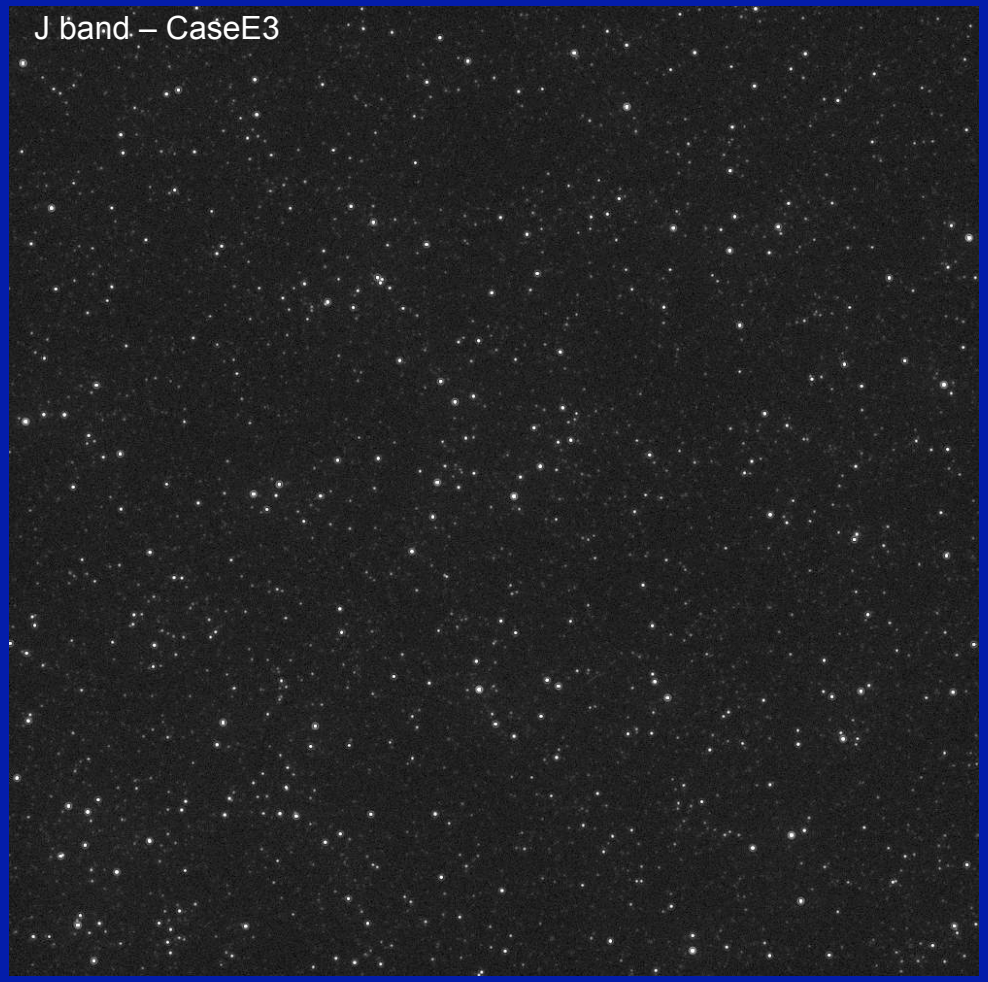
- Numerical PSF

- Written in IDL
- Graphical User Interface
- Available on the Web

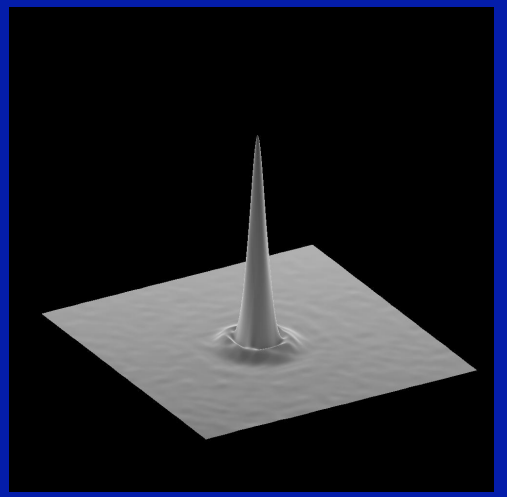
Diolaiti et al. 2000, A&AS 147, 335

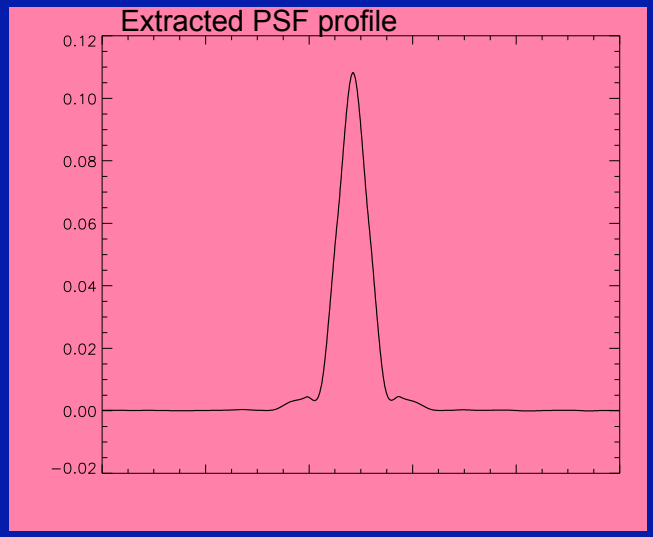
Method: constant PSF

Numerical PSF template extracted from the entire frame and obtained as a median of a set of star images



Extracted PSF 3D model



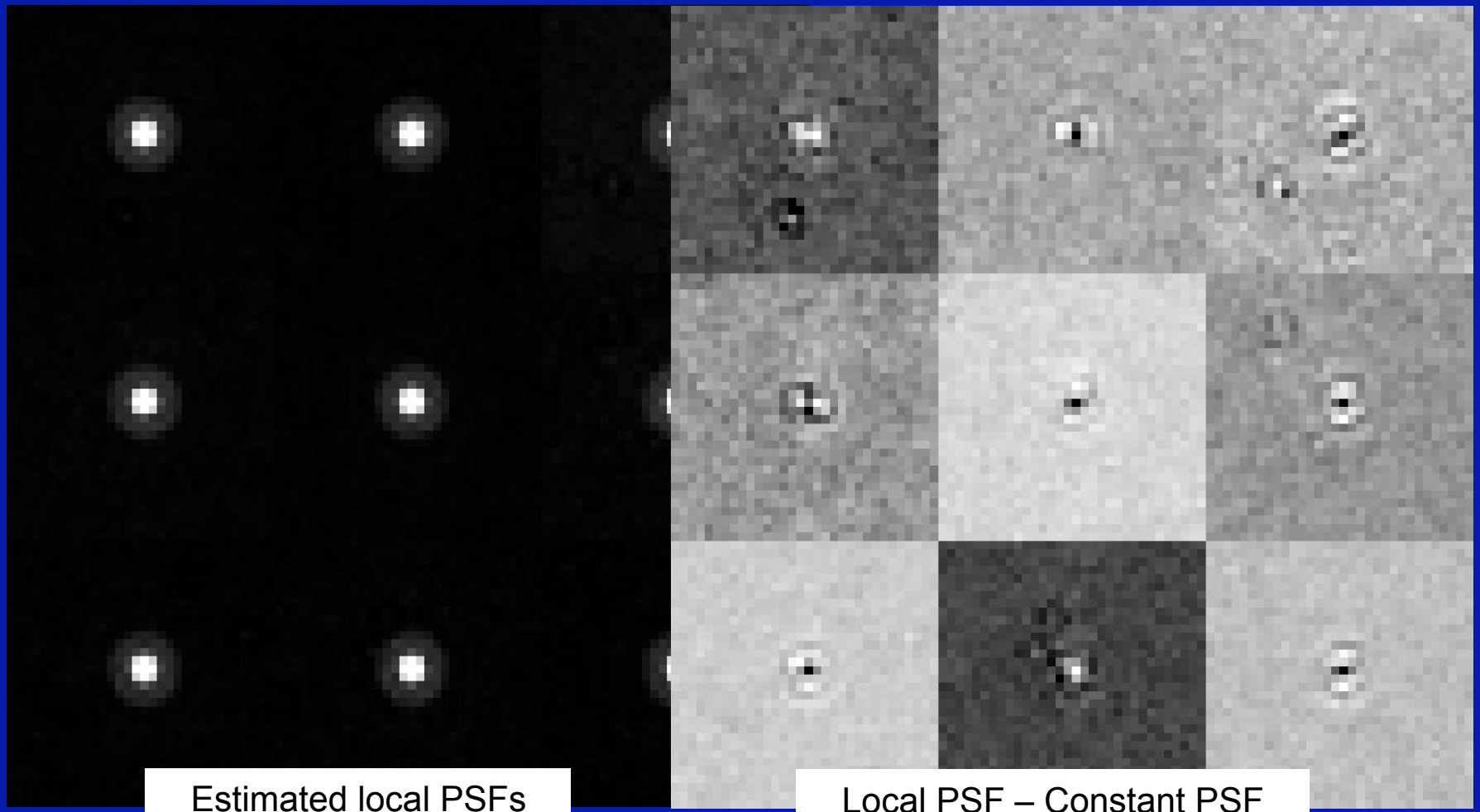


Method: variable PSF

Implemented in Starfinder
(but not in GUI)

Divide image in sub-domains and use set of local PSFs

→ Photometric errors among sub-domains

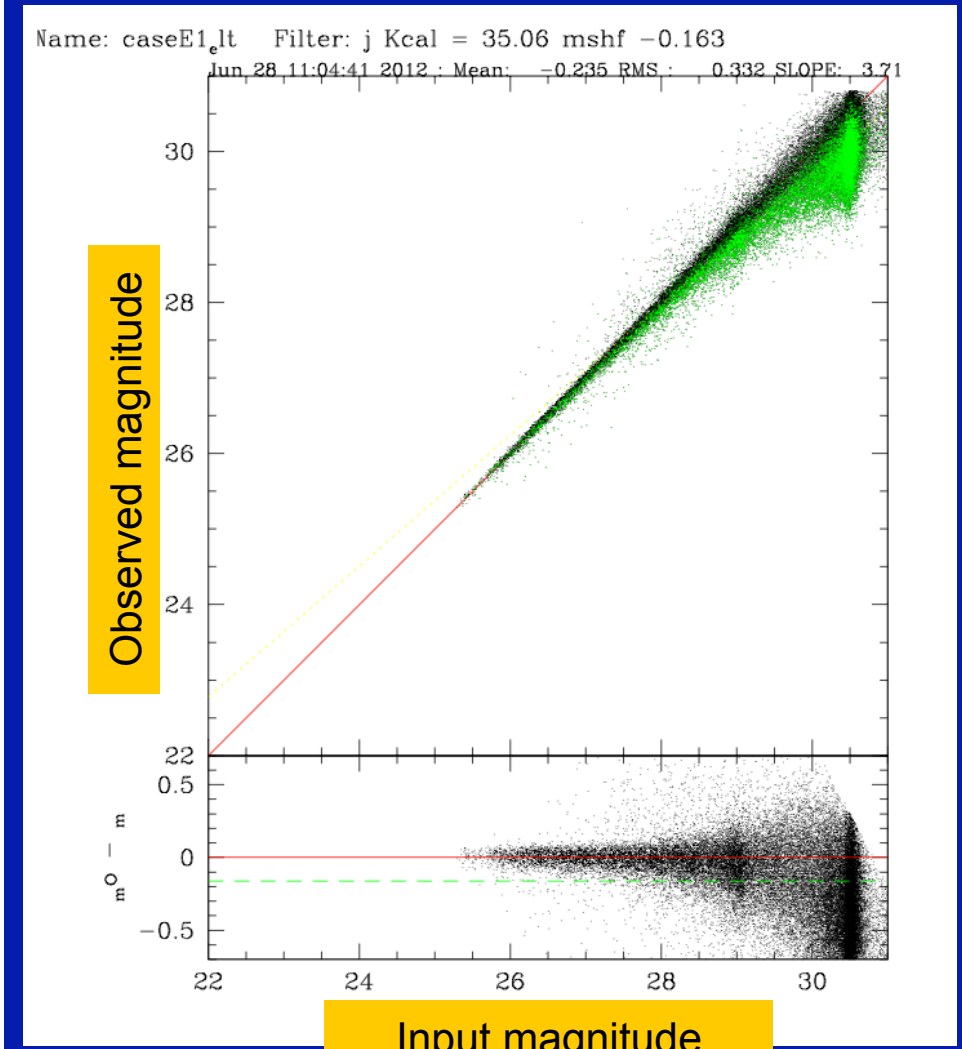


Estimated local PSFs

Local PSF – Constant PSF

4 – Check the results of photometry

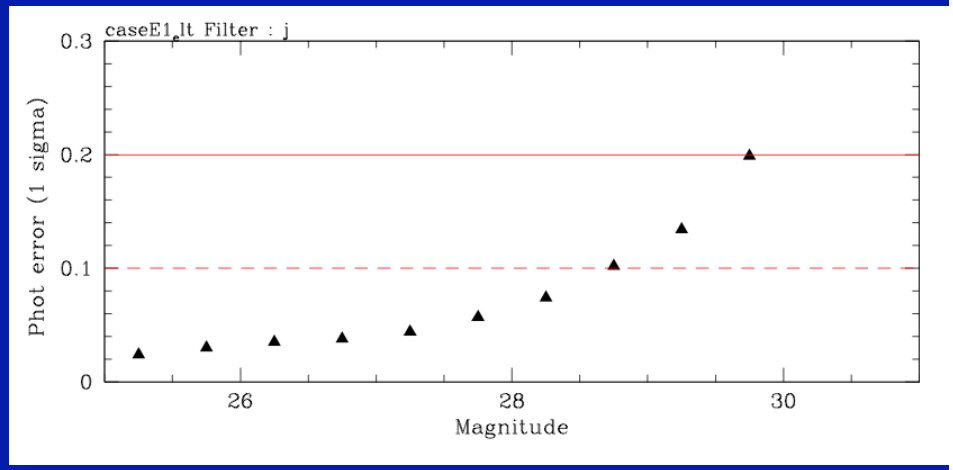
Comparison : Input VS observed mag : **J**



Matched by X,Y positions

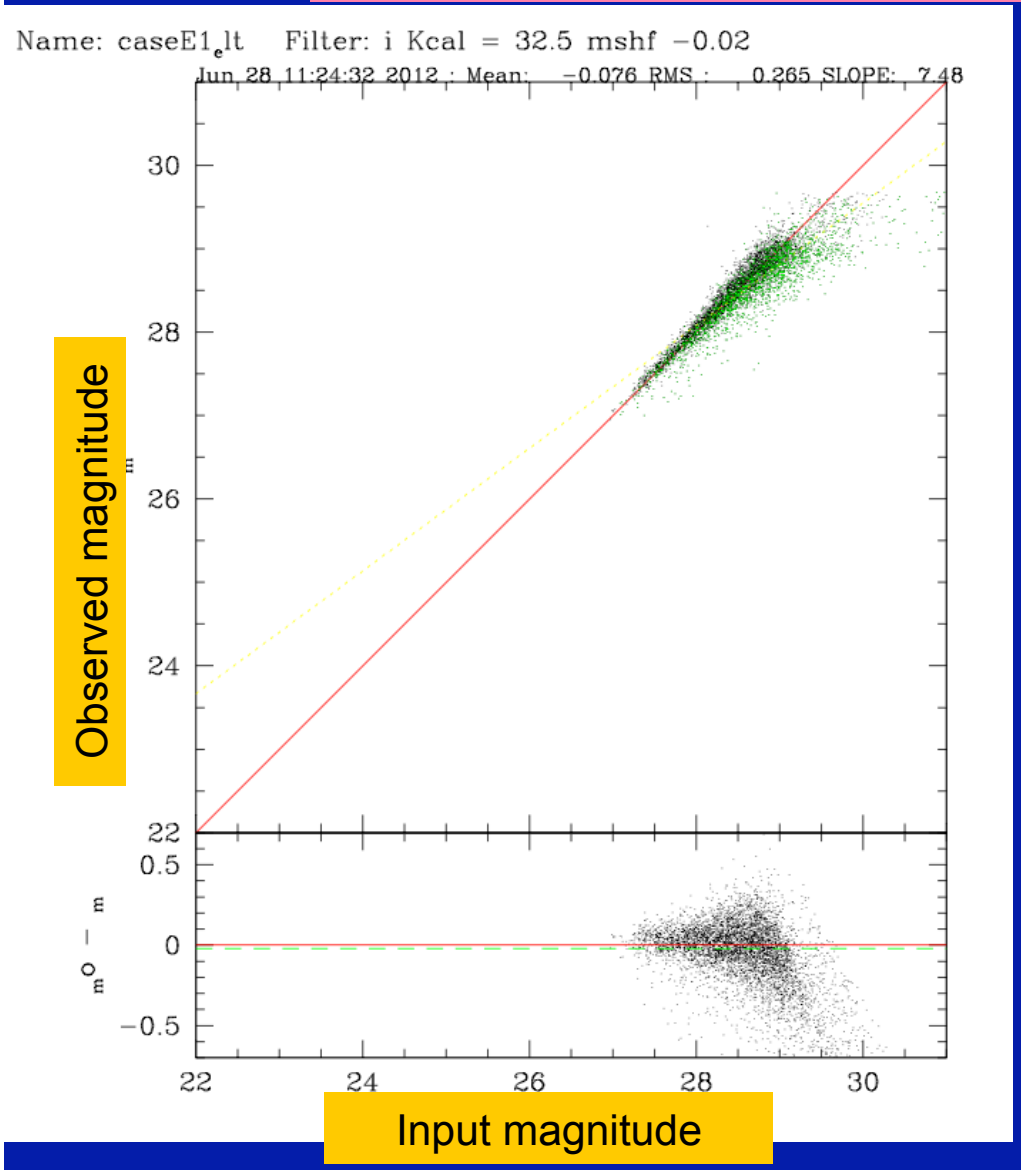
Single match

Multiple match



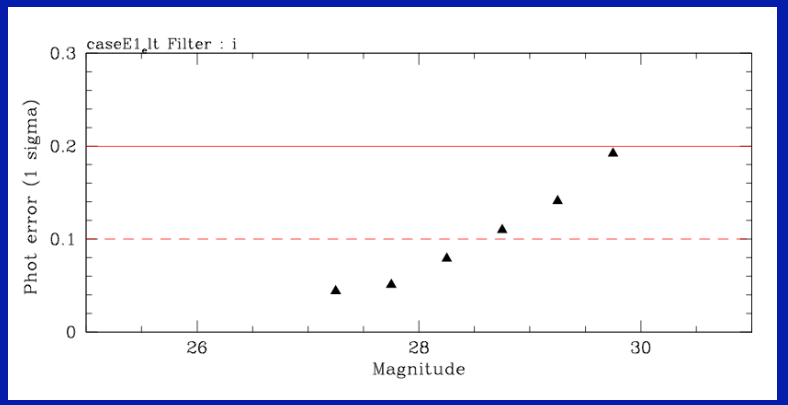
4 – Check results of photometry

Comparison : Input VS observed mag : I



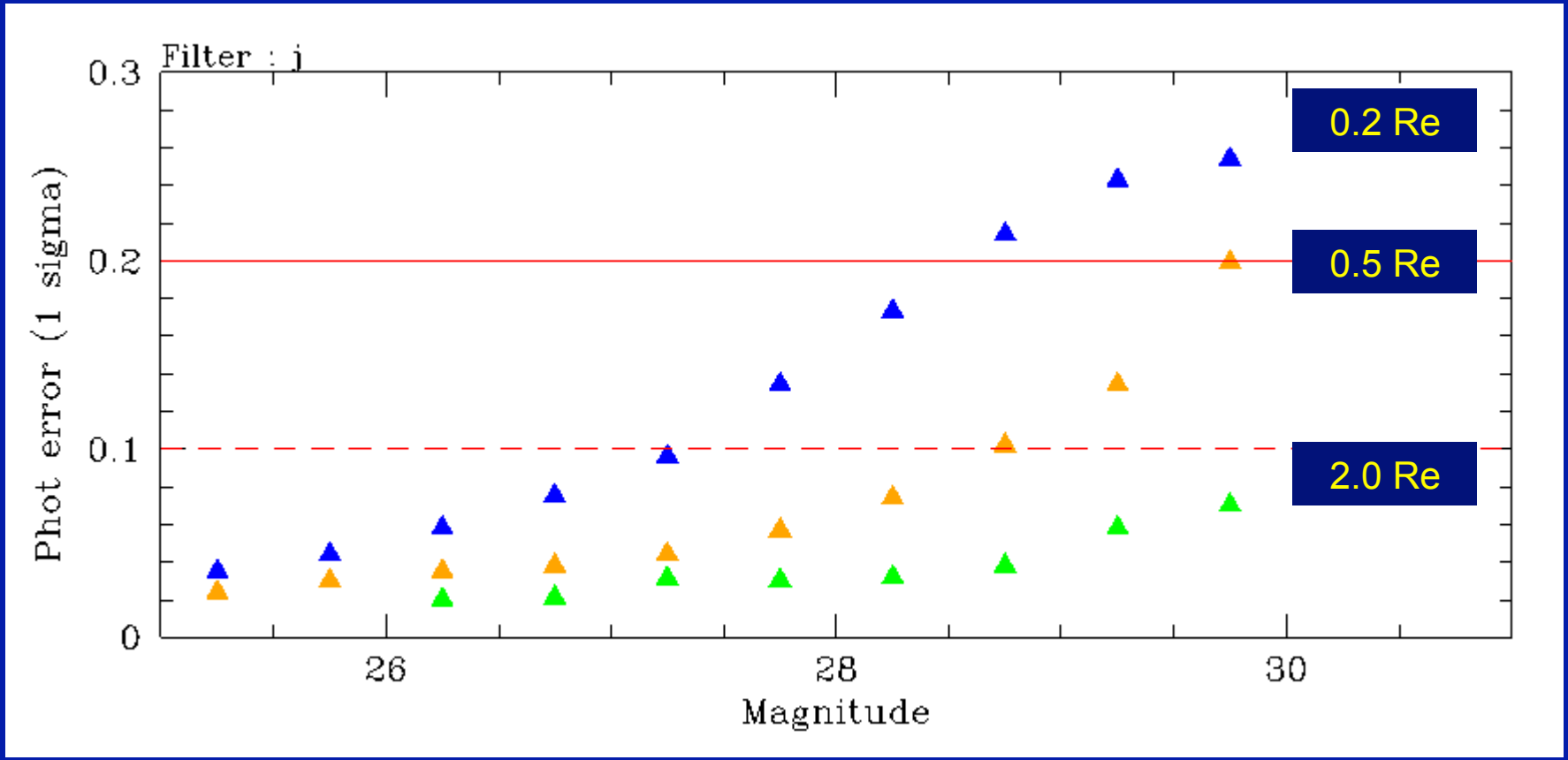
Single match

Multiple match



4 – Check results of photometry

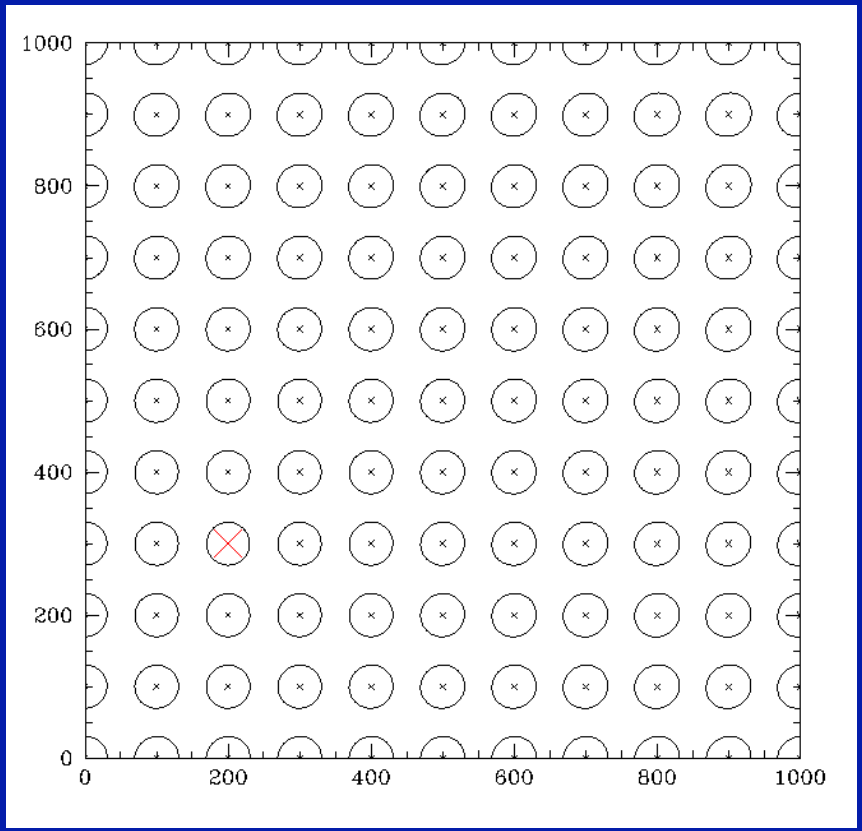
Comparison : mag error vs SB/crowding

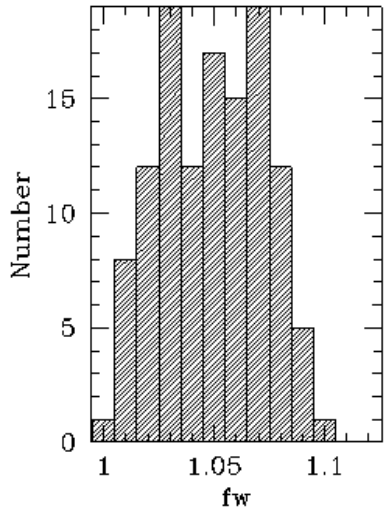


4 – Check results of photometry

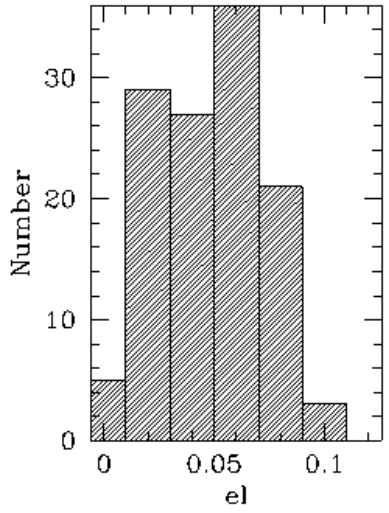
Distorted PSF: mag errors

10% distortion





FWHM

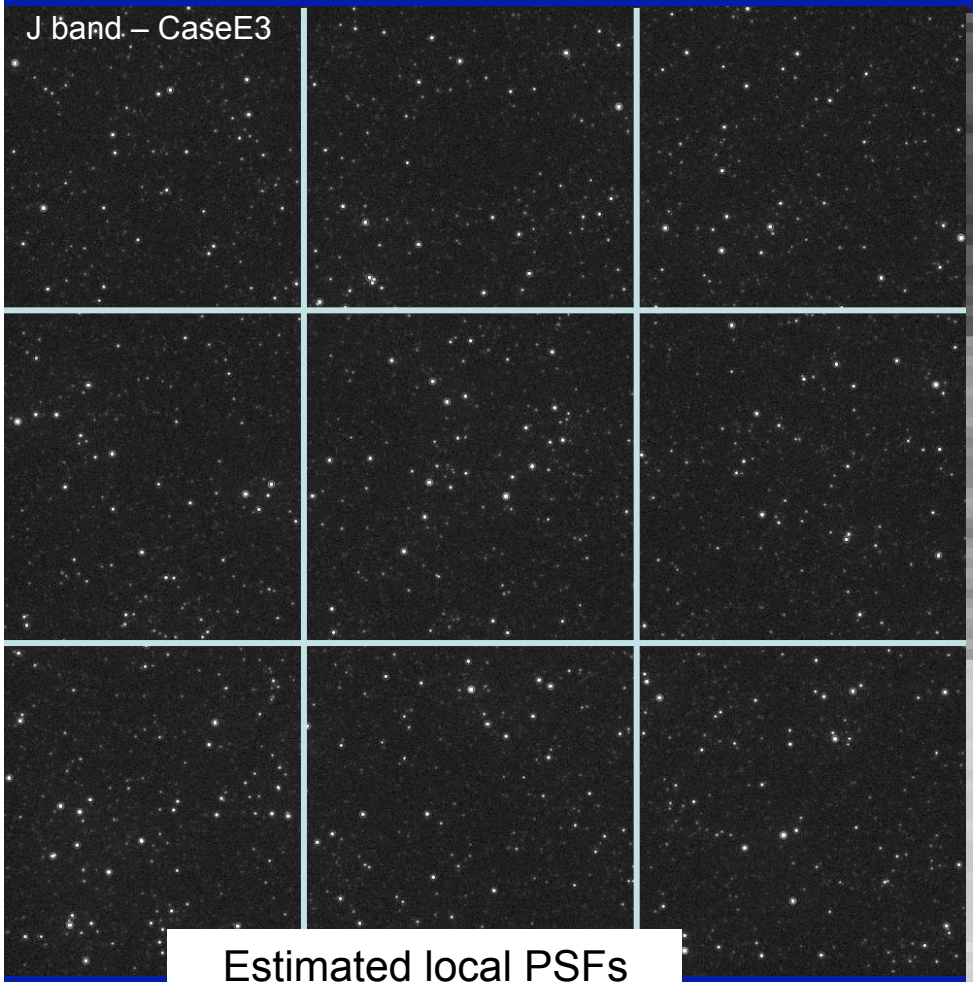


Ellipticity

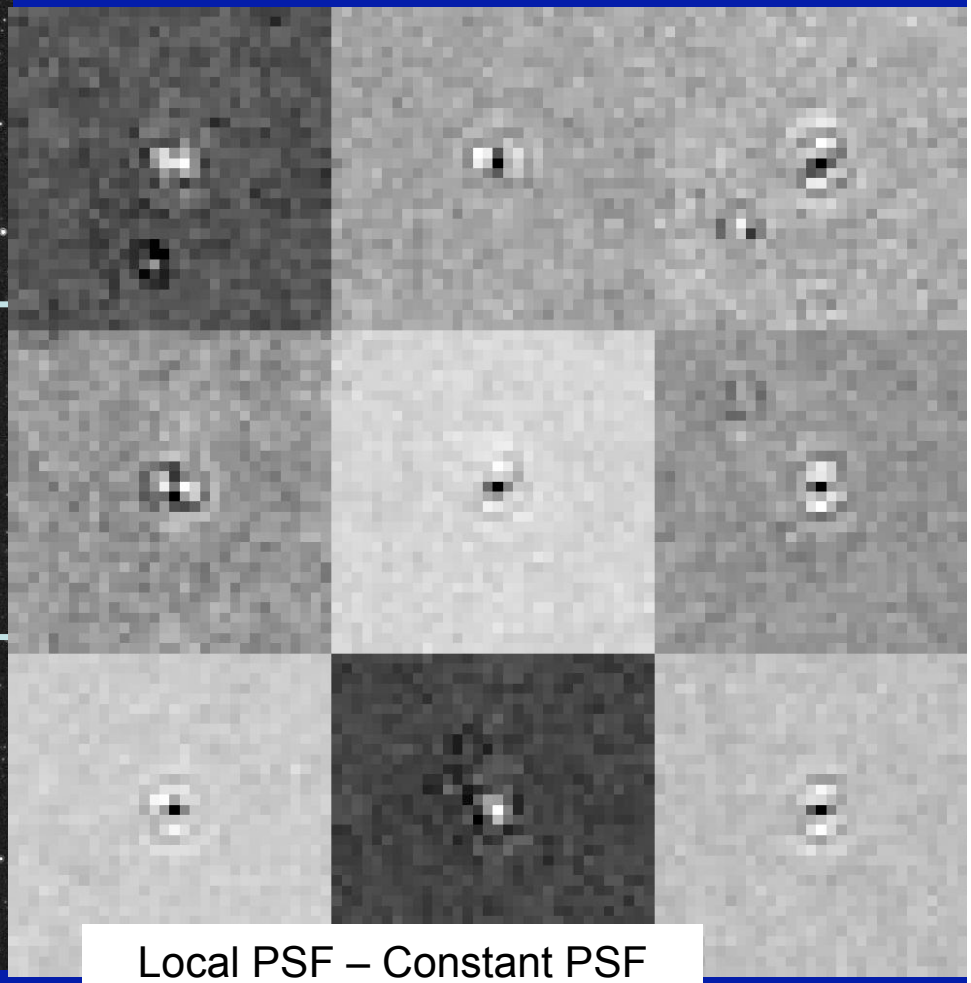
Method: variable PSF

Divide image in sub-domains and use set of local PSFs

→ Photometric errors among sub-domains



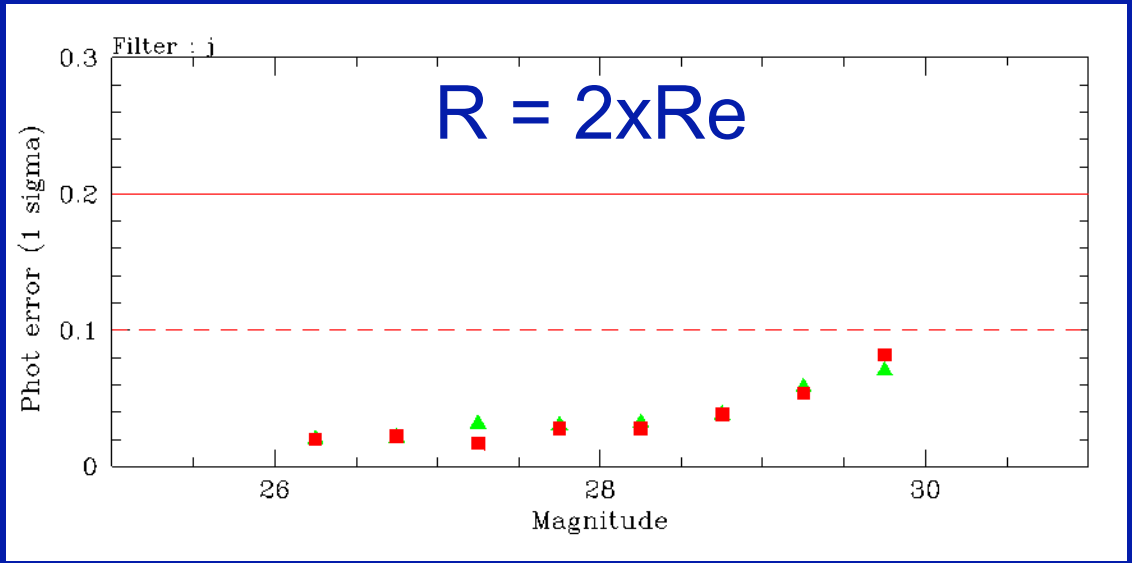
Estimated local PSFs

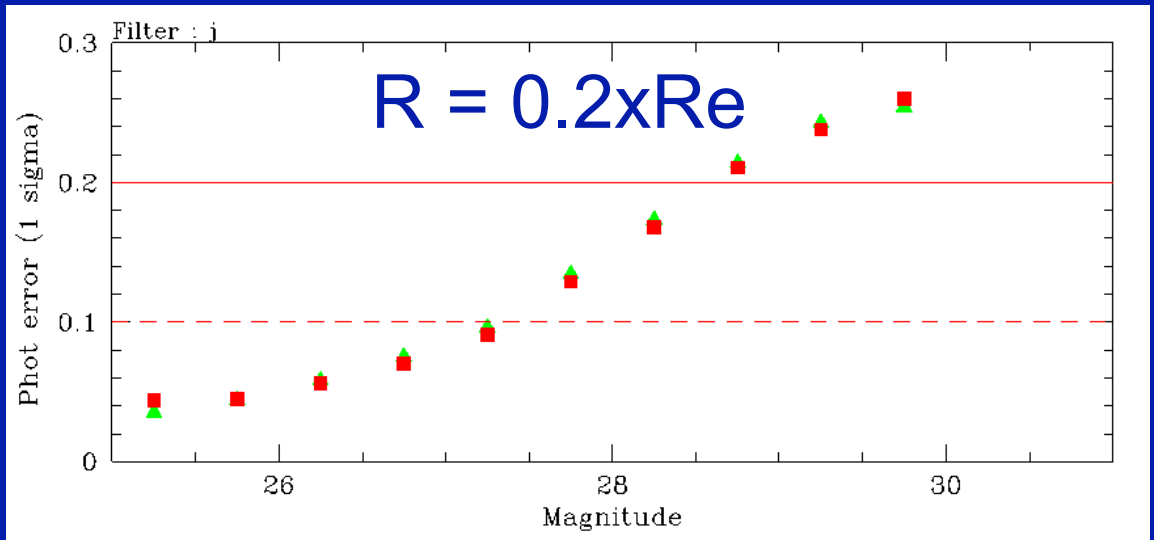


Local PSF – Constant PSF

4 – Check results of photometry

Uniform vs Distorted PSF: mag errors – J band





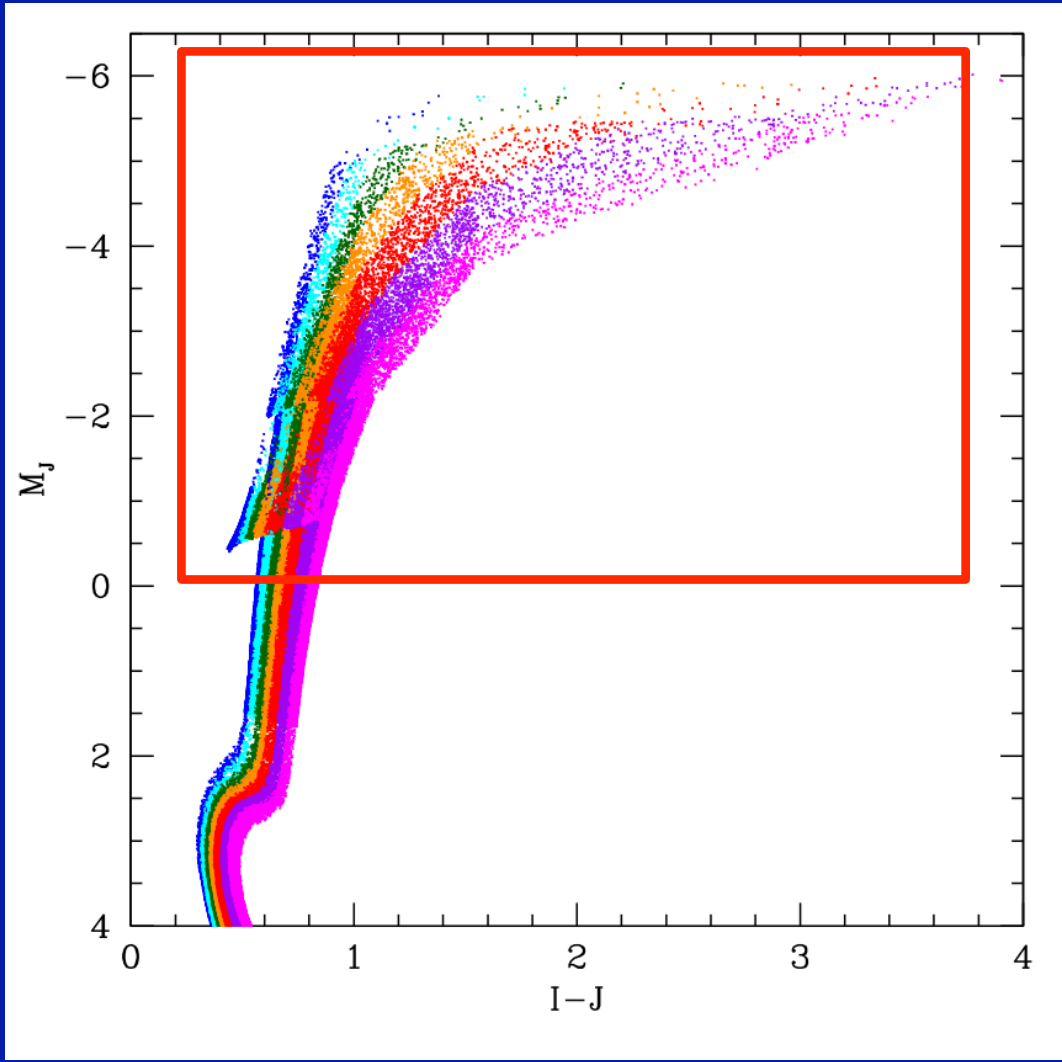
Uniform PSF
Distorted PSF

No significant difference found for 10% PSF distortion

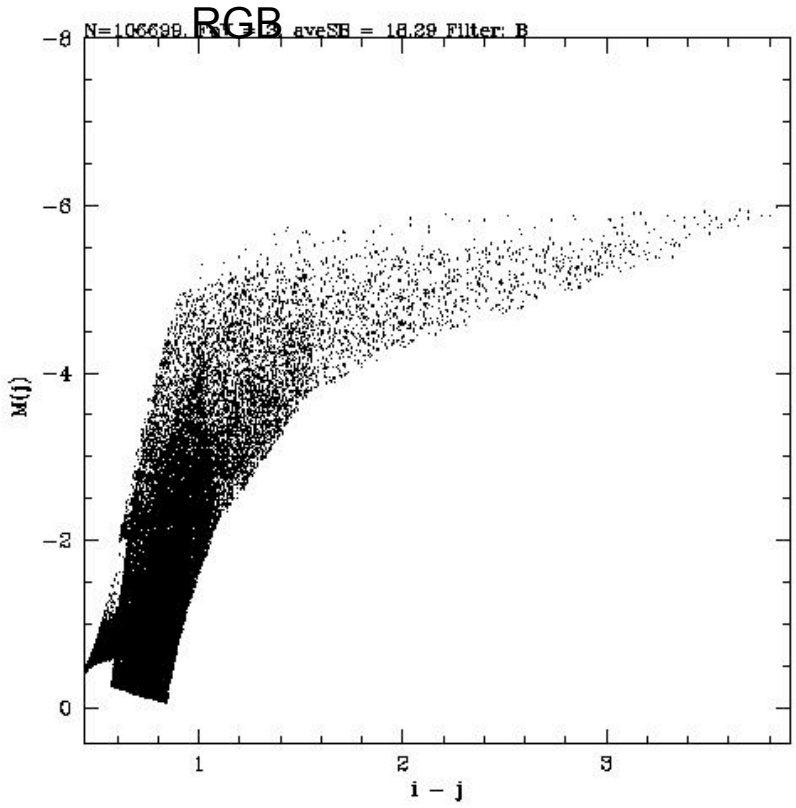
Statistics and crowding dominate the photometric error

4 – Check results of photometry

Galaxy in Virgo DM = 31 (18 Mpc)



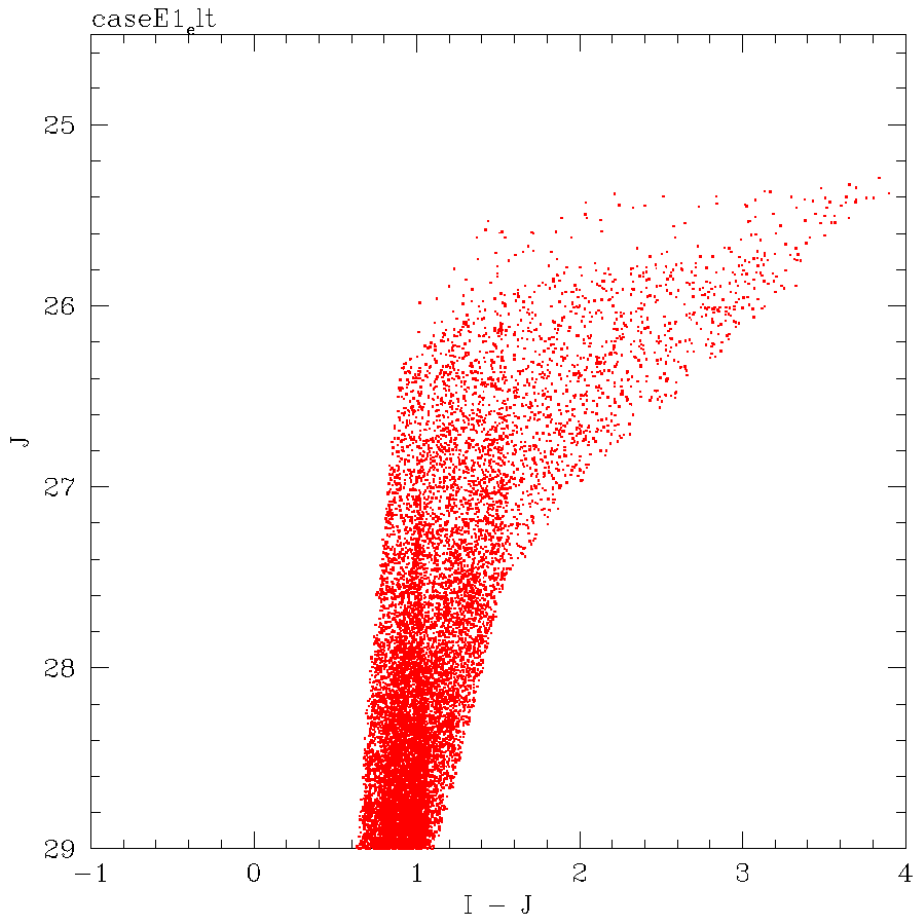
Input CMD



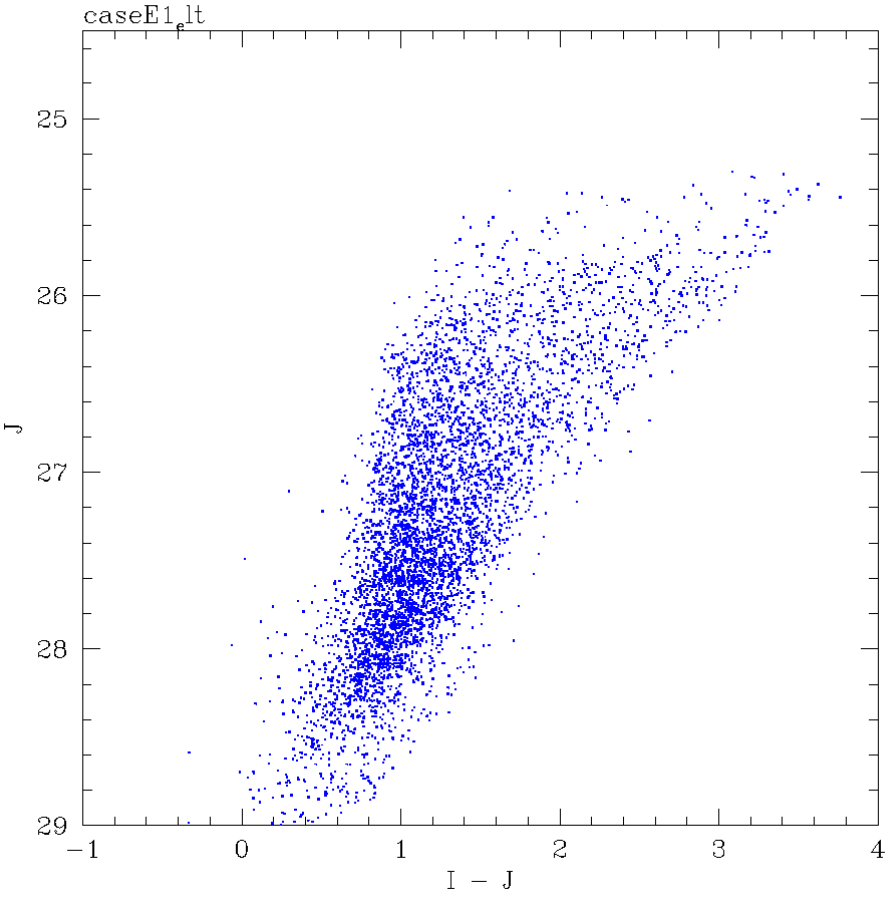
4 – Check results of photometry

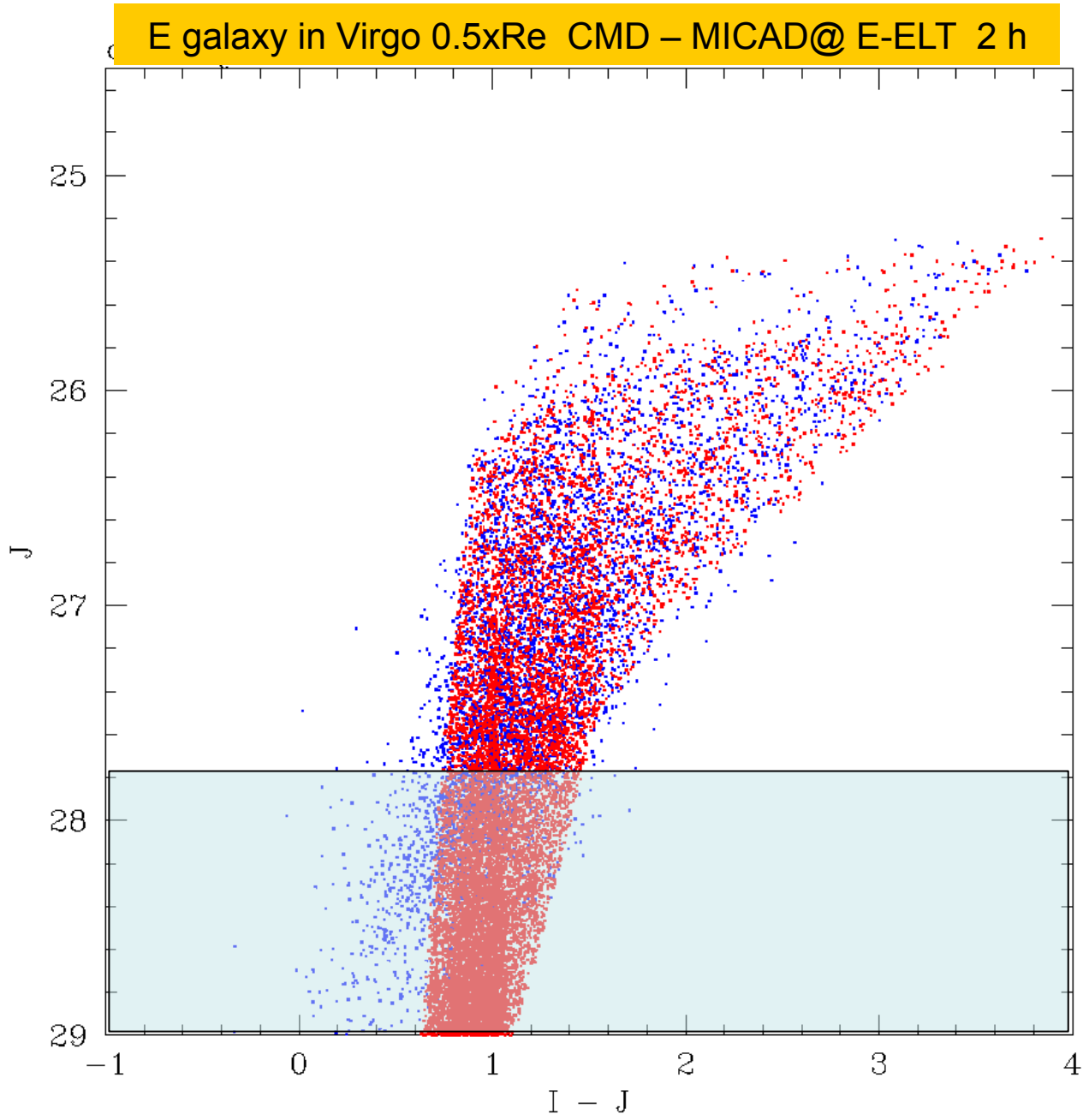
Comparison of CMD – case E1 (0.5 Re)

Input

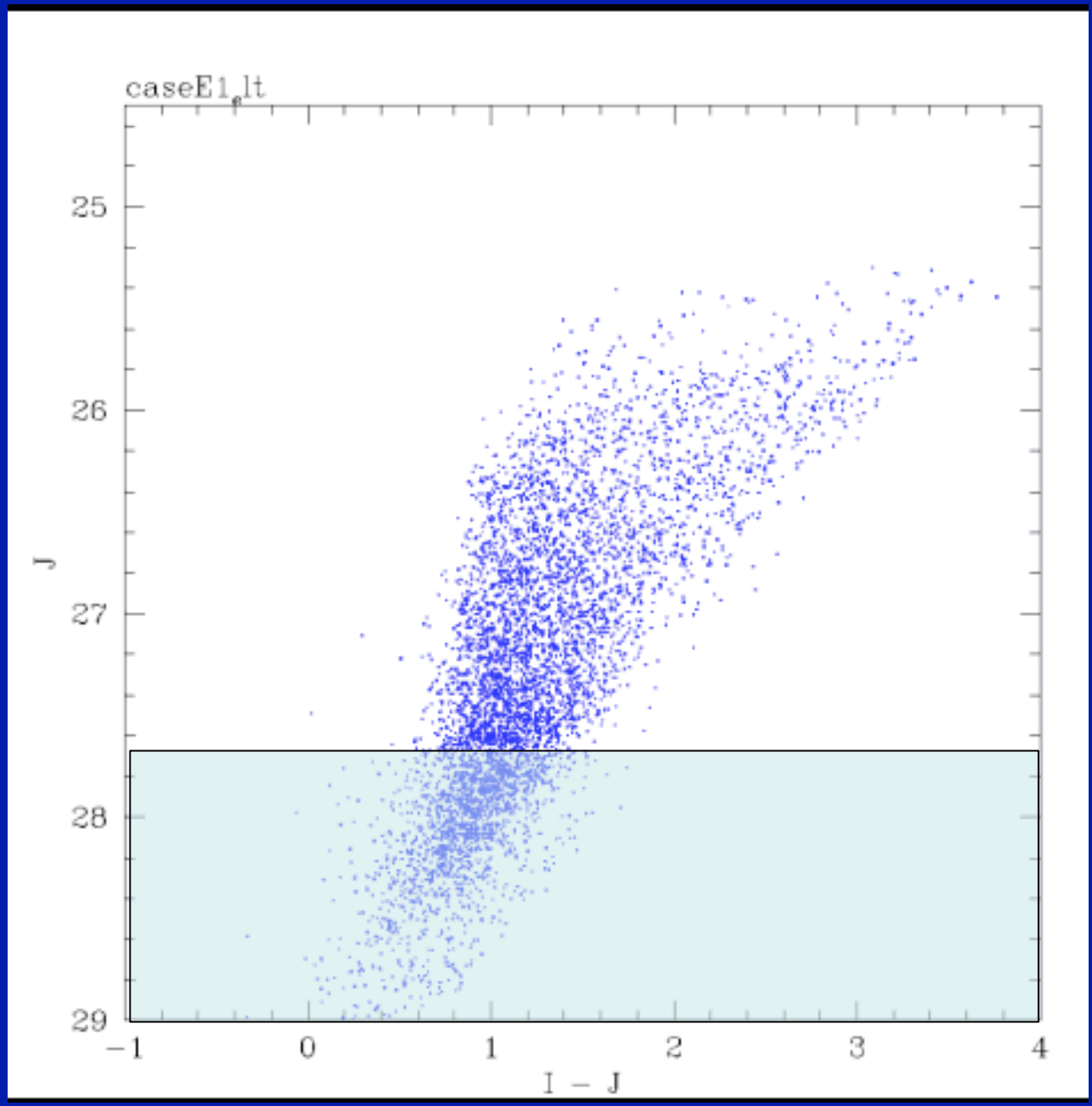


Observed




E galaxy in Virgo 0.5xRe CMD – MICAD@ E-ELT 2 h
25
26
27
28
29
J
−1
0
1
2
3
4
I − J

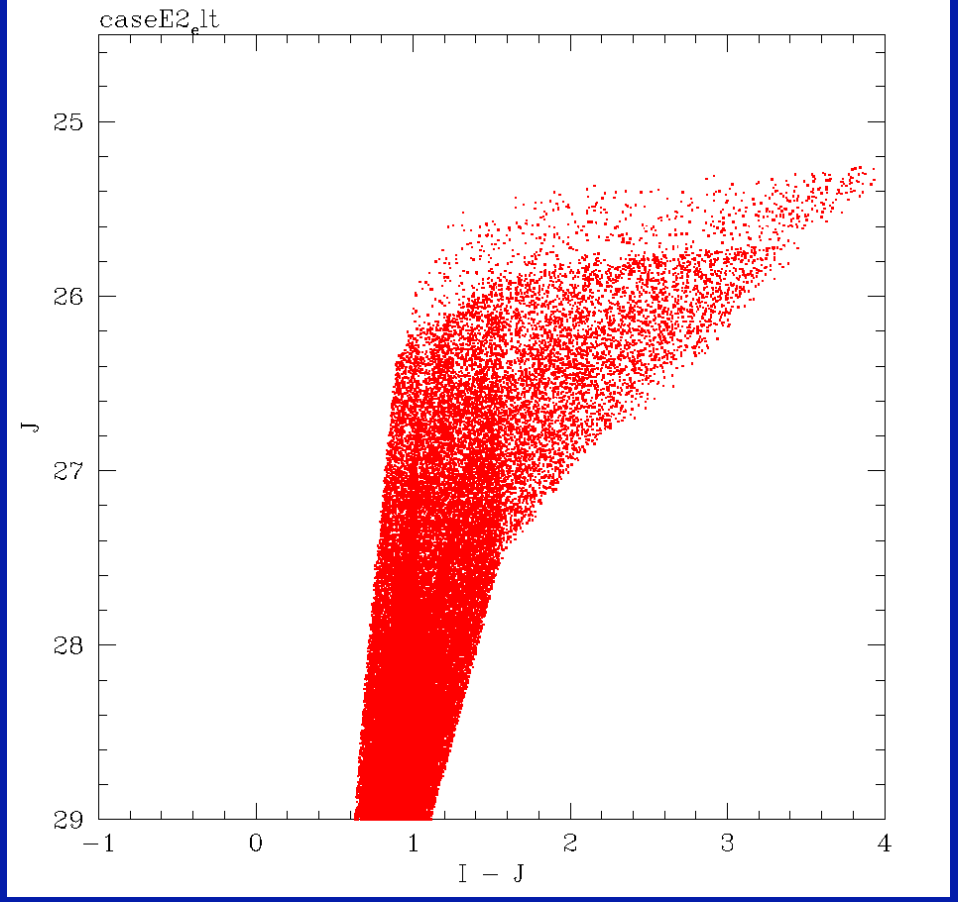
E galaxy in Virgo 0.5xRe CMD – MICAD@ E-ELT 2 h



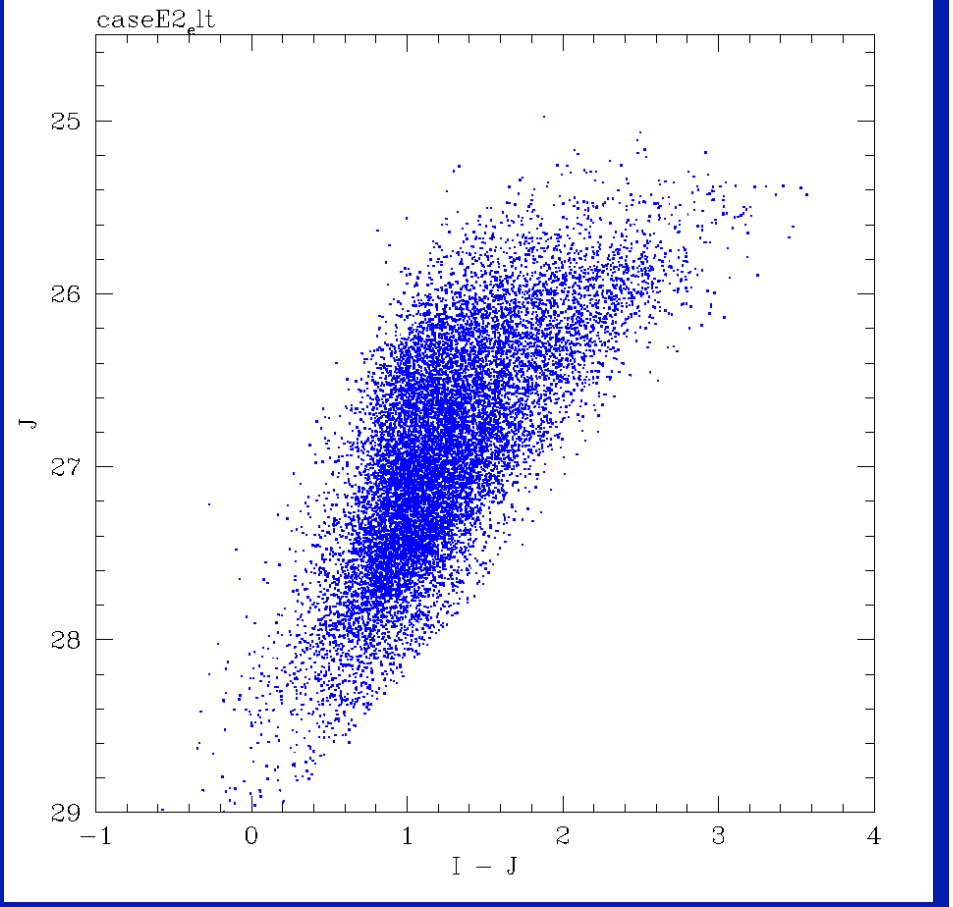
4 – Check results of photometry

Comparison of CMD – case E2 (0.2 Re)

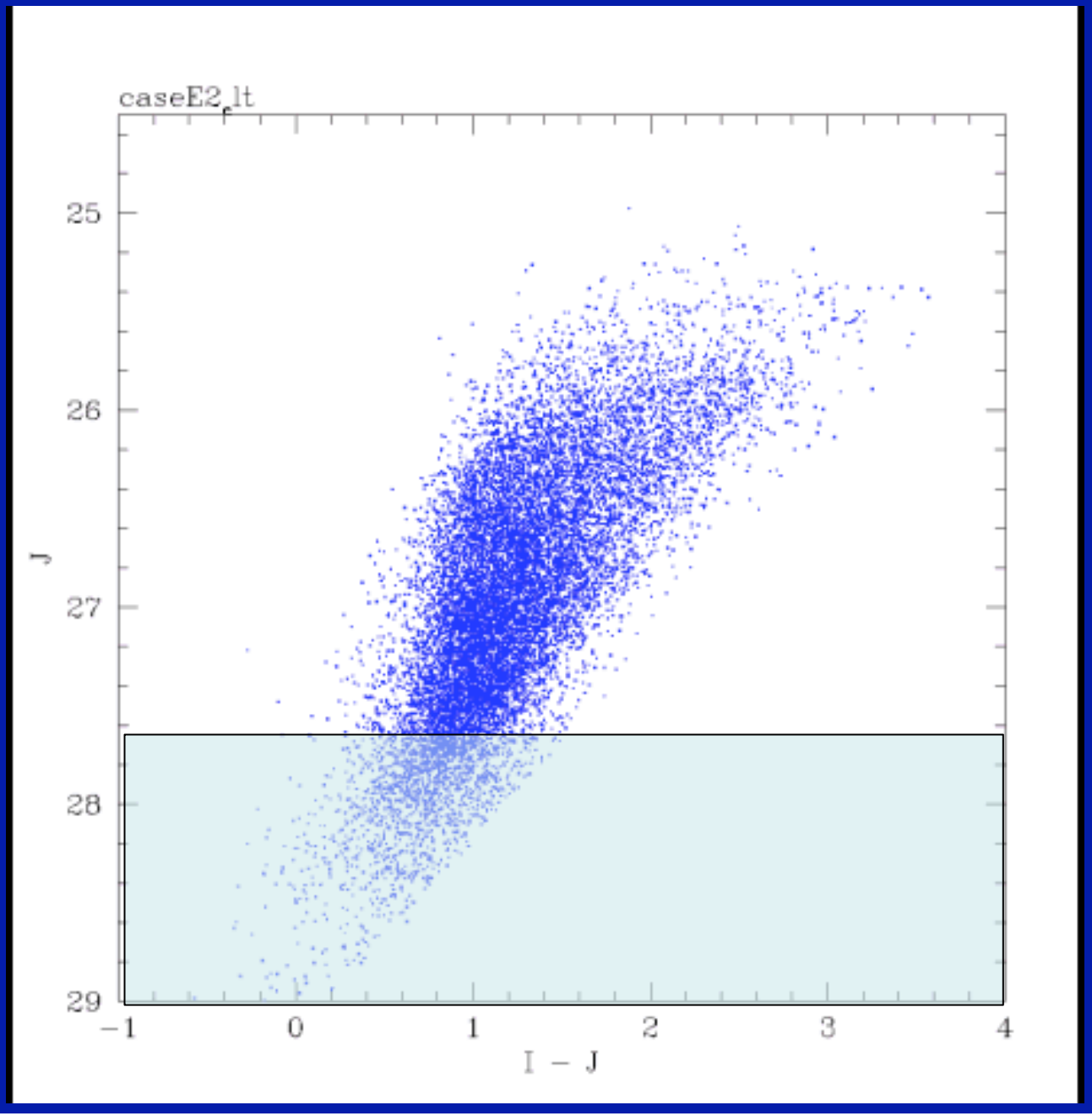
Input



Observed

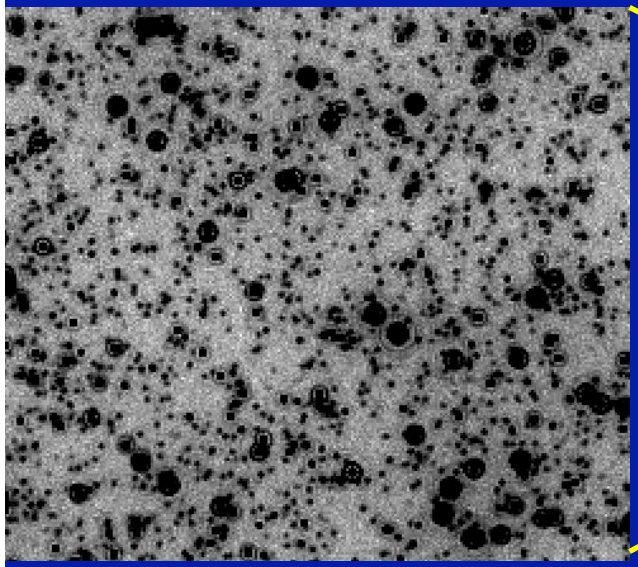


E galaxy in Virgo 0.2xRe CMD – MICAD@ E-ELT 2 h



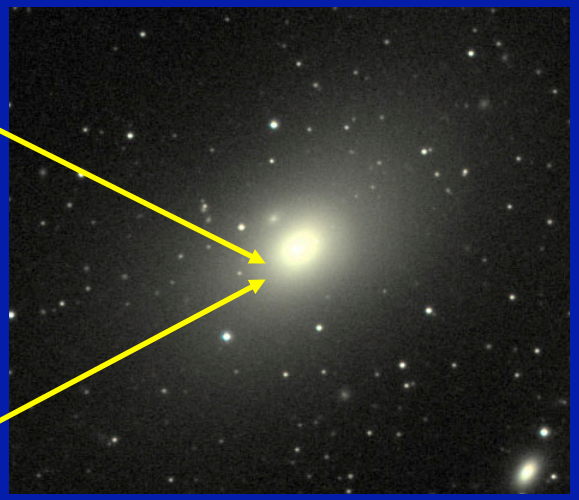
Conclusions

Detailed experiment to probe the ELT capabilities to obtain direct information on the SFH in distant galaxies



FoV = 1”

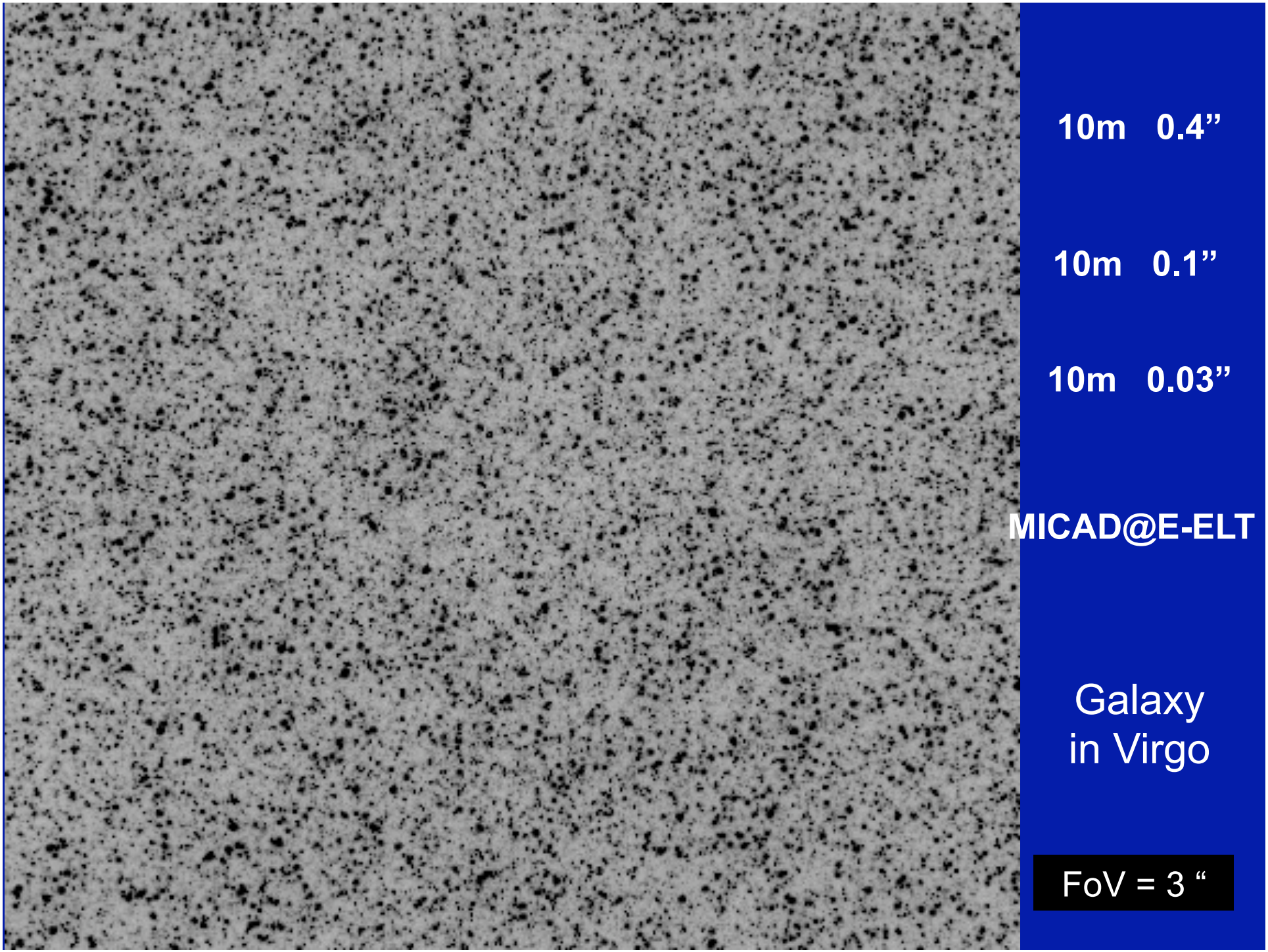
MICADO @ E-ELT



Massive elliptical galaxy in Virgo

High resolution NIR imaging at ELT offers a unique opportunity to investigate stellar population in distant galaxies up to Virgo distance

Greggio, Falomo, Zaggia et al 2012: PASP in press, arXiv:1206.0909


10m 0.4”
10m 0.1”
10m 0.03”
MICAD@E-ELT
Galaxy
in Virgo
FoV = 3 “

END