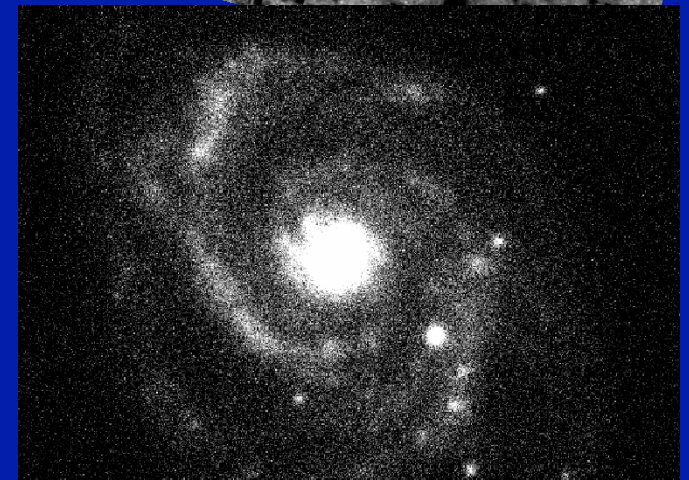
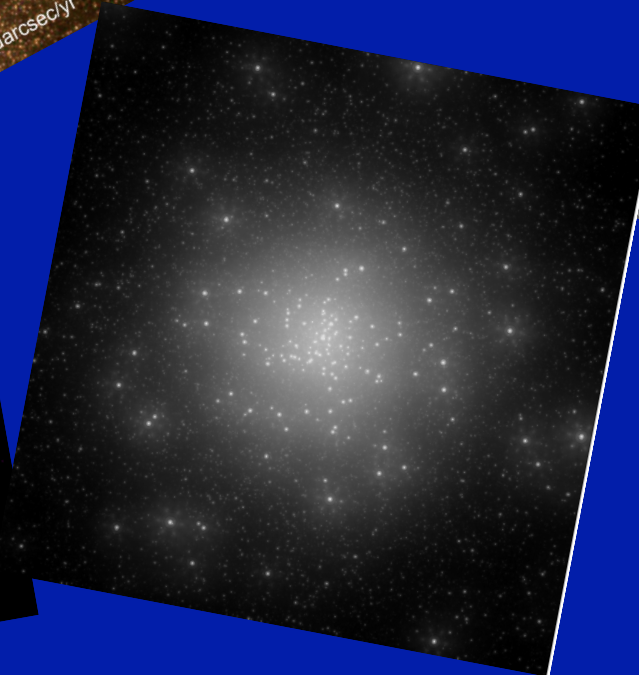
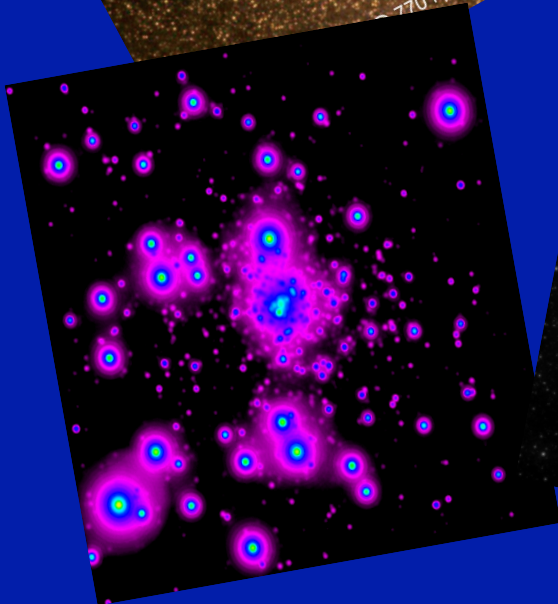
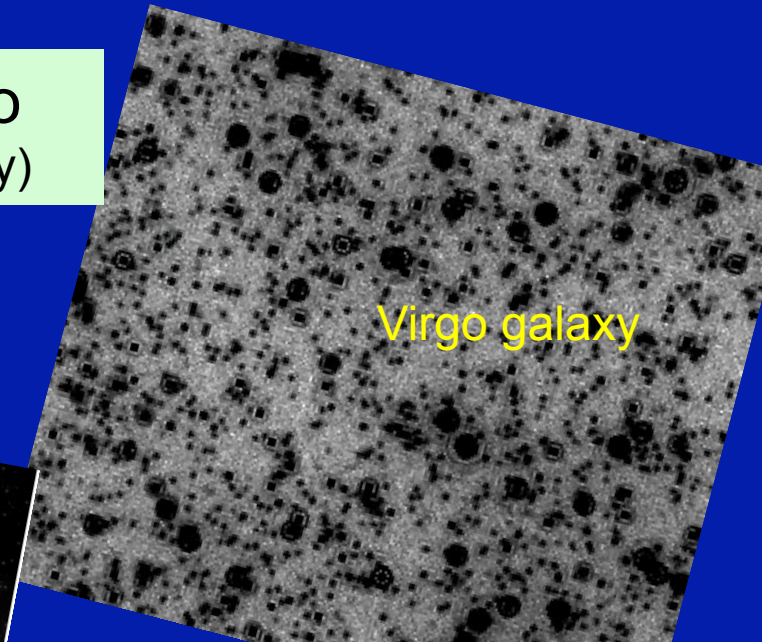
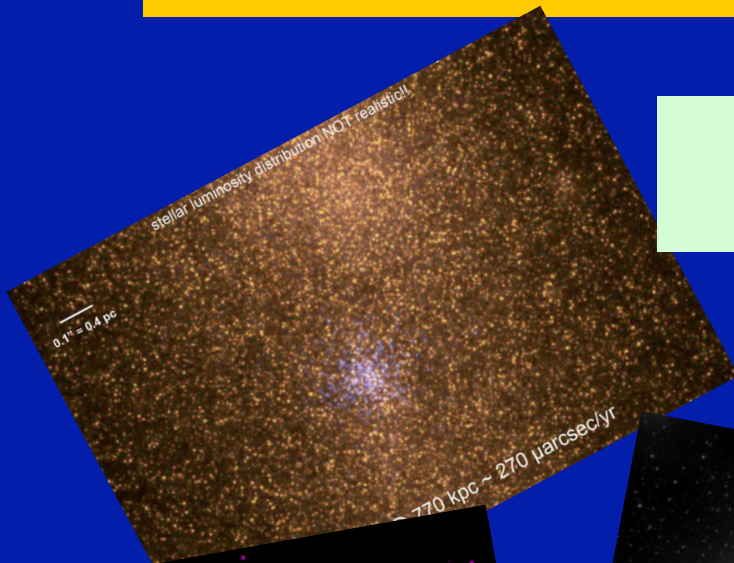


MICADO consortium meeting

Science Cases & Simulations

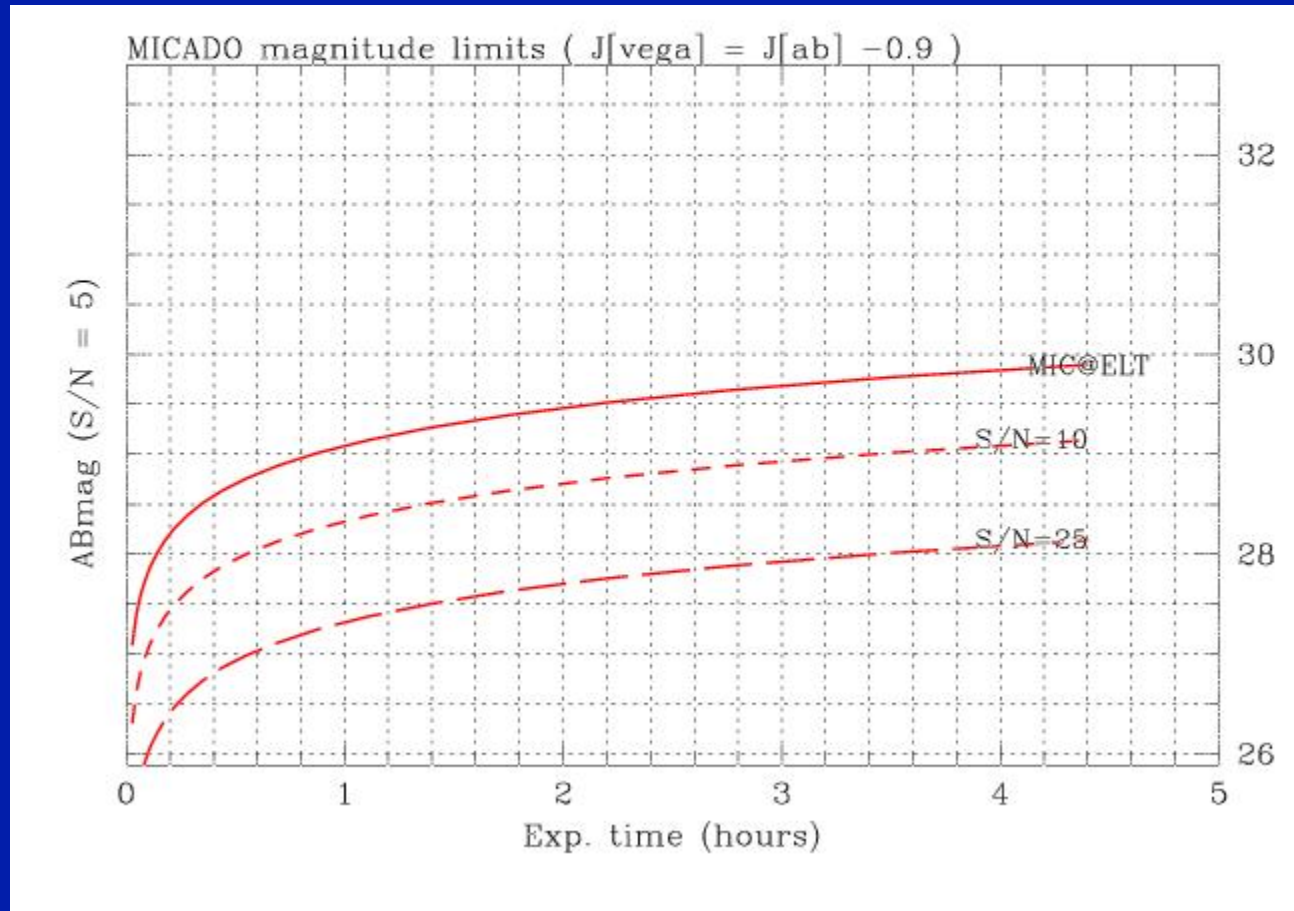
Renato Falomo
INAF – Padova (Italy)



Garching 10 March 2014

MICADO - Expected performance

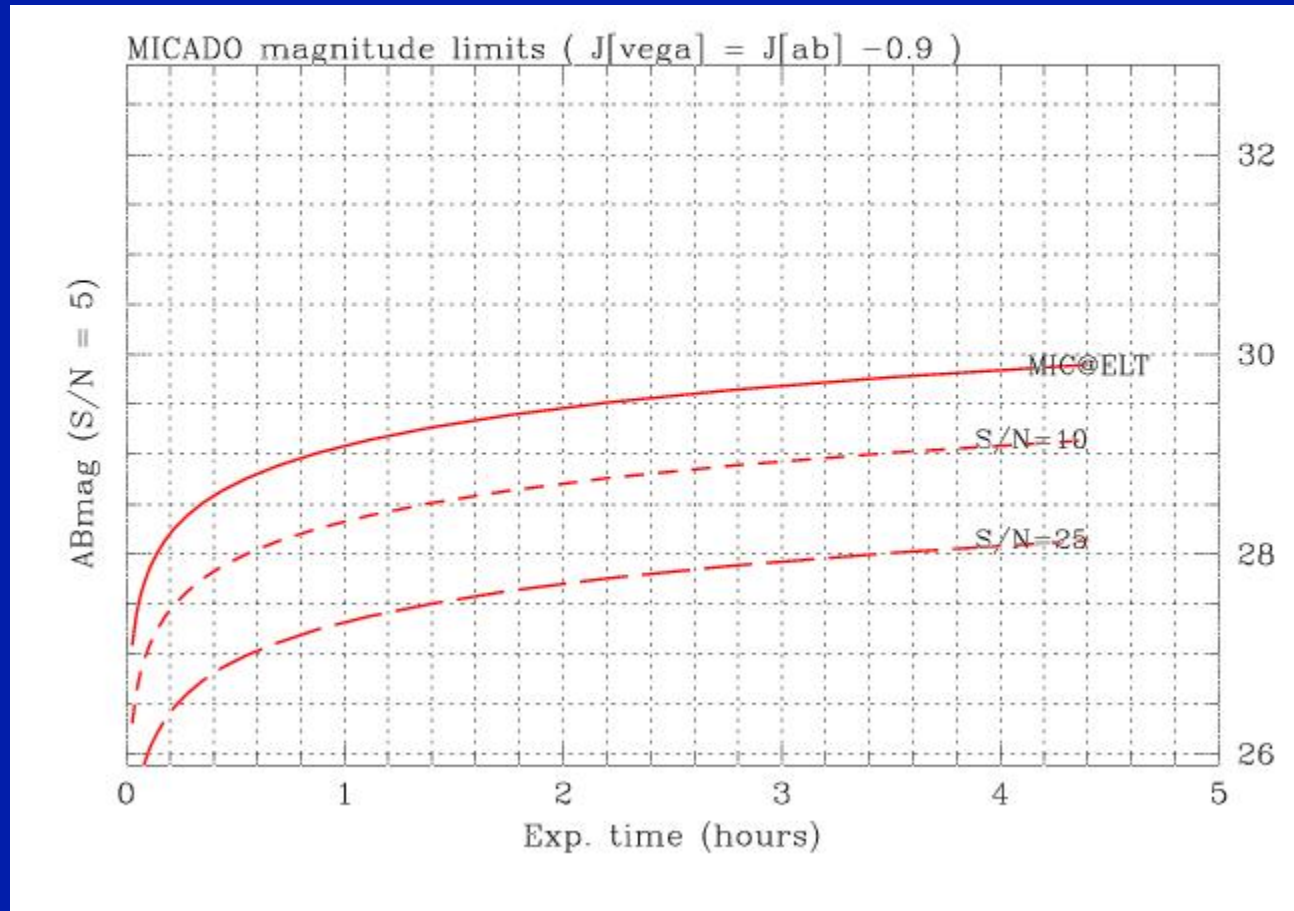
AB mag limits for isolated point sources



$J(\text{AB}) = 30$ in 5h (S/N=5)

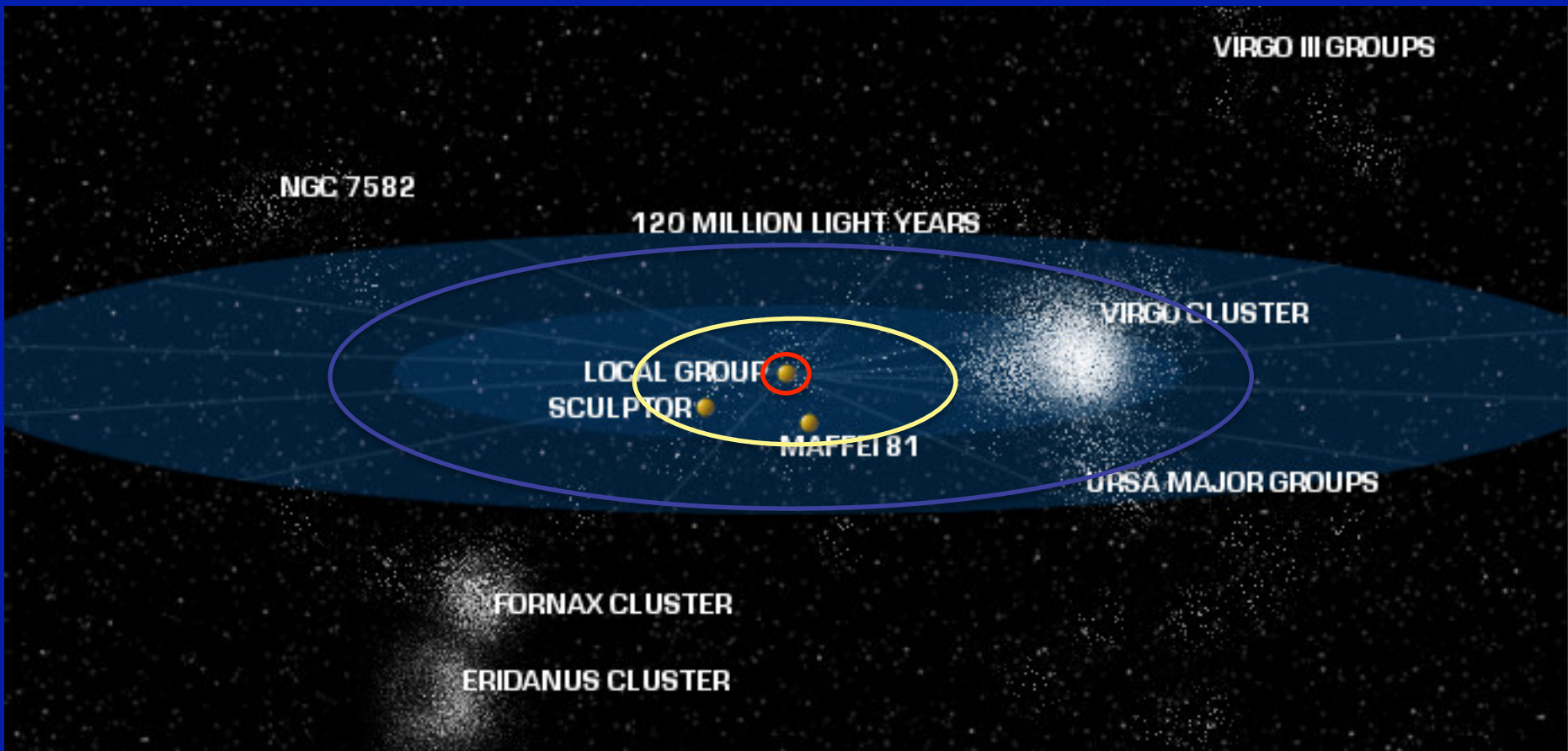
MICADO - Expected performance

AB mag limits for isolated point sources



$K(\text{AB}) = 29.5$ in 5h (S/N=5)

THE GALAXIES AROUND US



MICADO will be able to resolve stars in distant galaxies and explore their centers

E-ELT simulation of NGC 300 core



E-ELT + MICADO

Exp = 3 h

Filter J

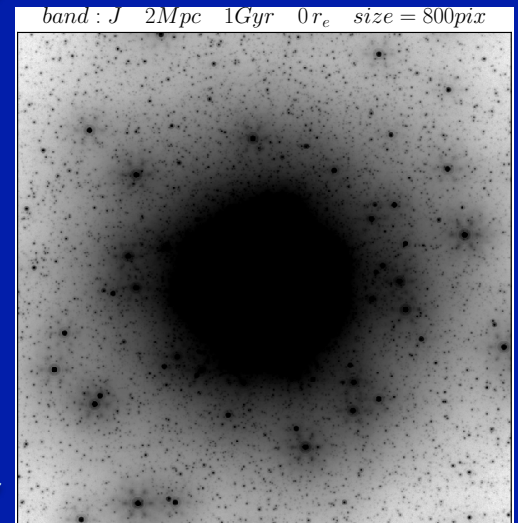
NGC 300

$D = 2 \text{ Mpc}$

NSC (king profile)

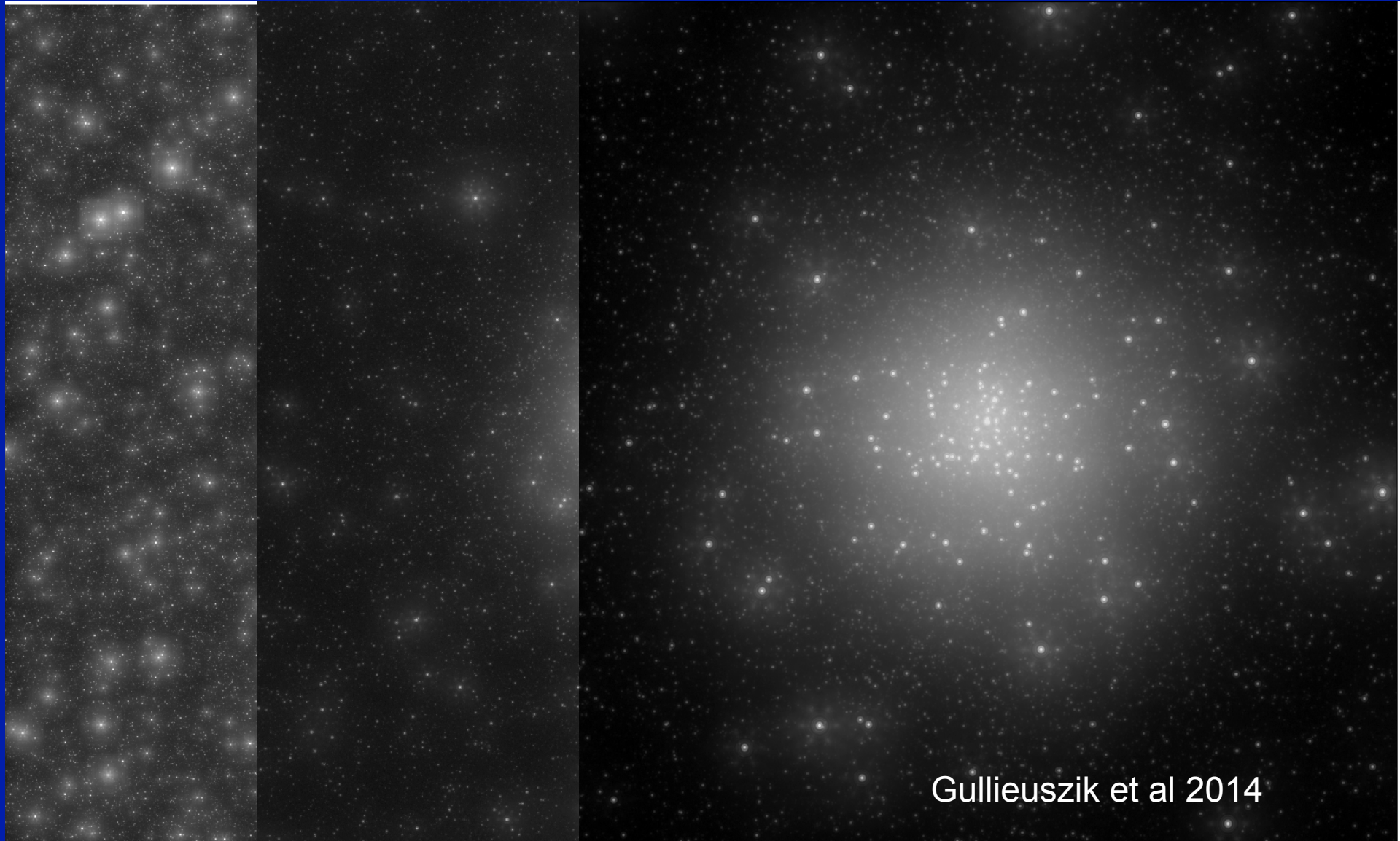
$R_c = 0.095''$

$R_t = 2.87''$



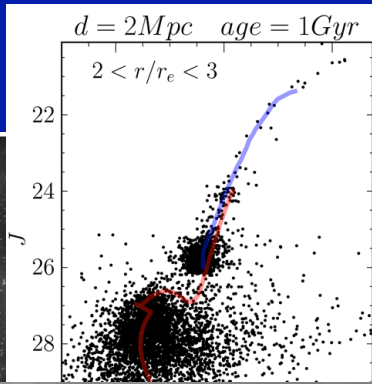
E-ELT simulation of NGC 300 core

1.0''



Gullieuszik et al 2014

E-ELT simulation of NGC 300 core



1.0"

NIRCAM@JWST

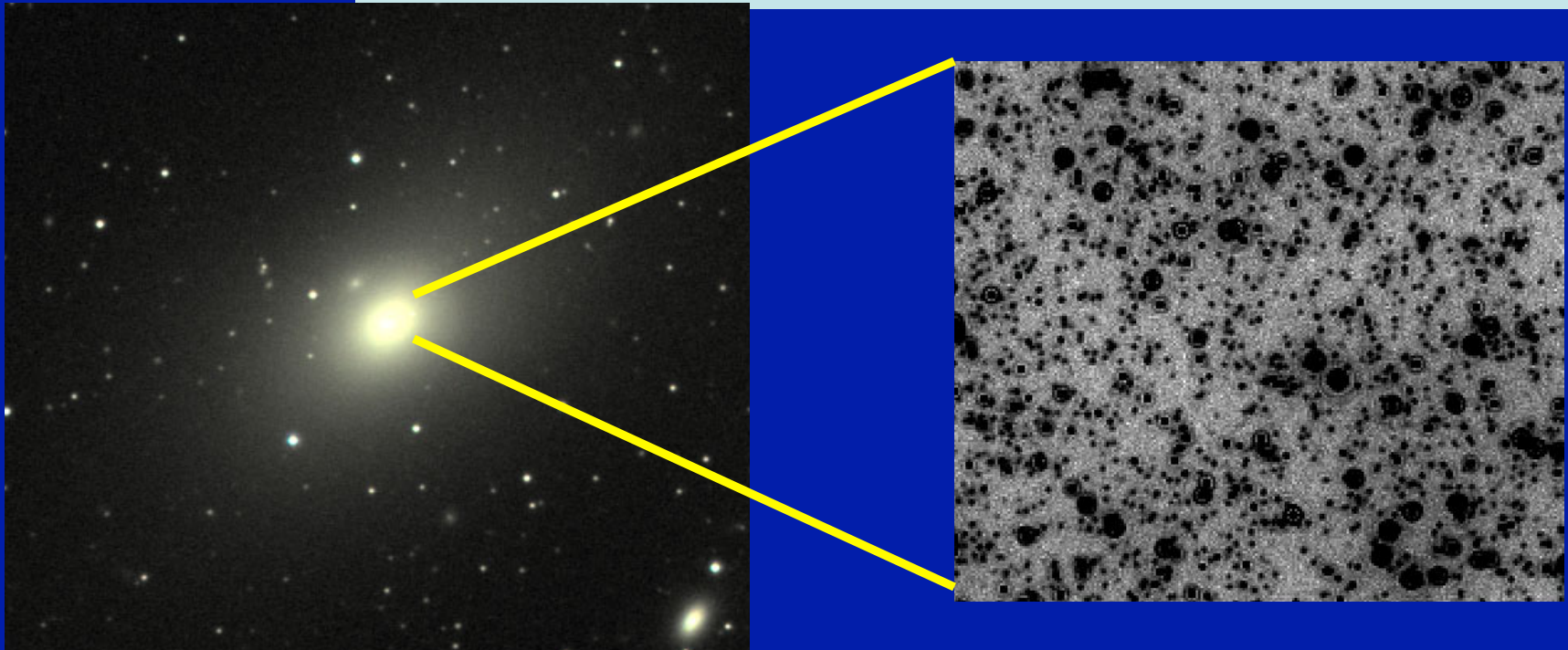
Gullieuszik et al 2014

VIRGO - the closest rich cluster of galaxies

A deep-field astronomical image of the Virgo galaxy cluster. The image shows a vast field of galaxies, including several prominent bright, yellowish-white elliptical galaxies. There are also many smaller, fainter galaxies and a dense field of distant stars. The galaxies are scattered across the frame, with some appearing as bright, diffuse clouds and others as more compact, point-like sources. The overall color palette is dominated by the yellow and white of the galaxies and stars against the deep black of space.

VIRGO cluster ($DM = 31$)

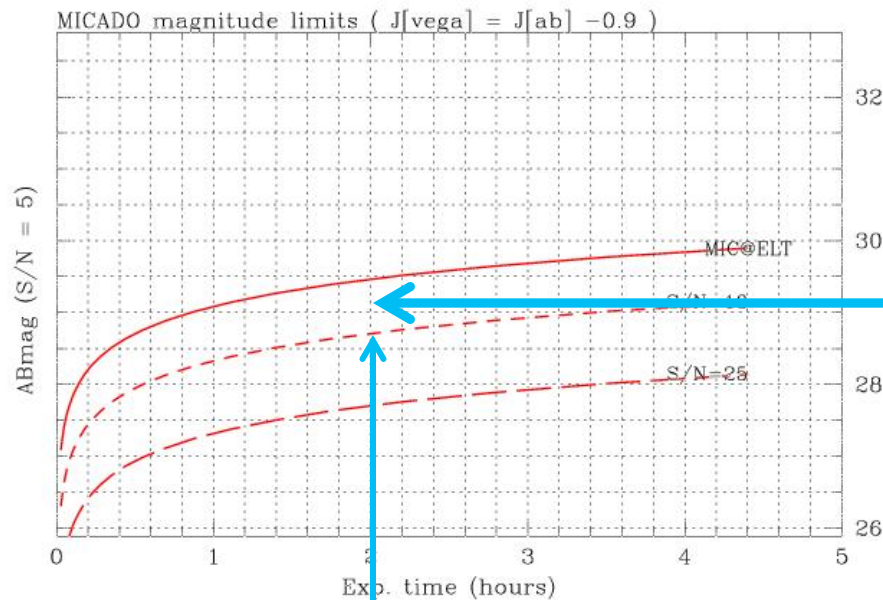
The study of the resolved stellar population in distant galaxies is one the main science drivers for the realization of ELTs



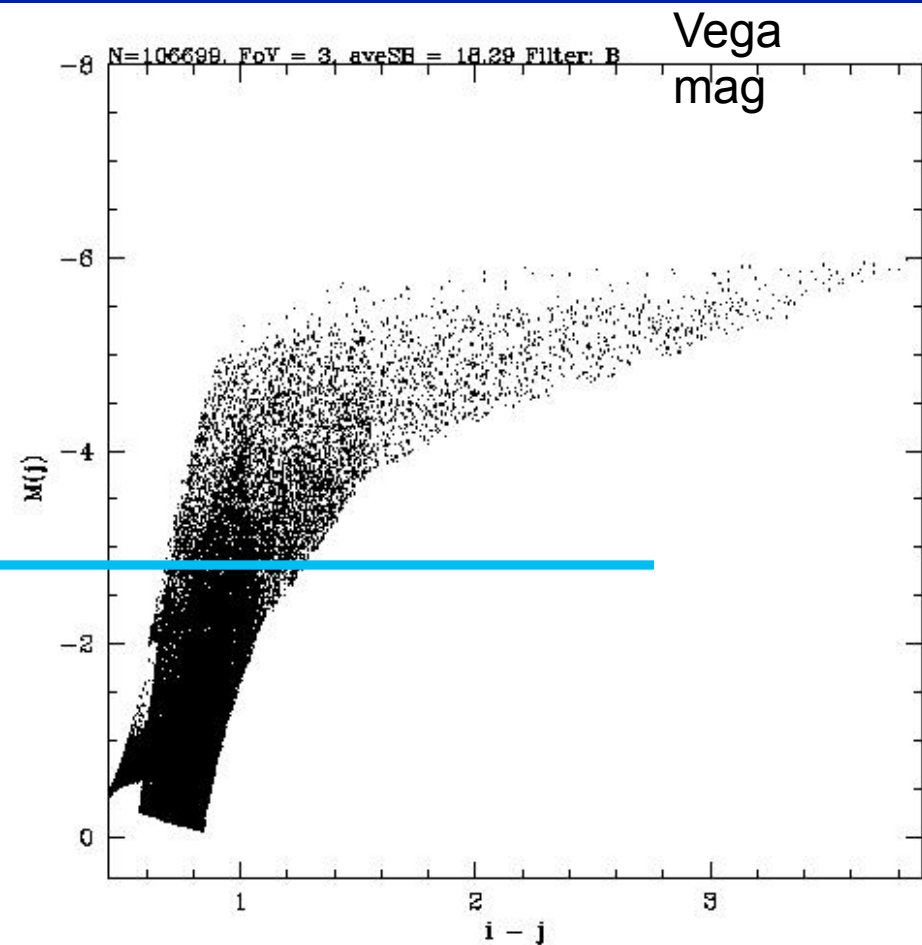
Reconstruction of the star formation history for a stellar system by analyzing its color-magnitude diagram (CMD) is a fundamental tool for understanding its age and chemical composition.

The SP of the E galaxy in Virgo

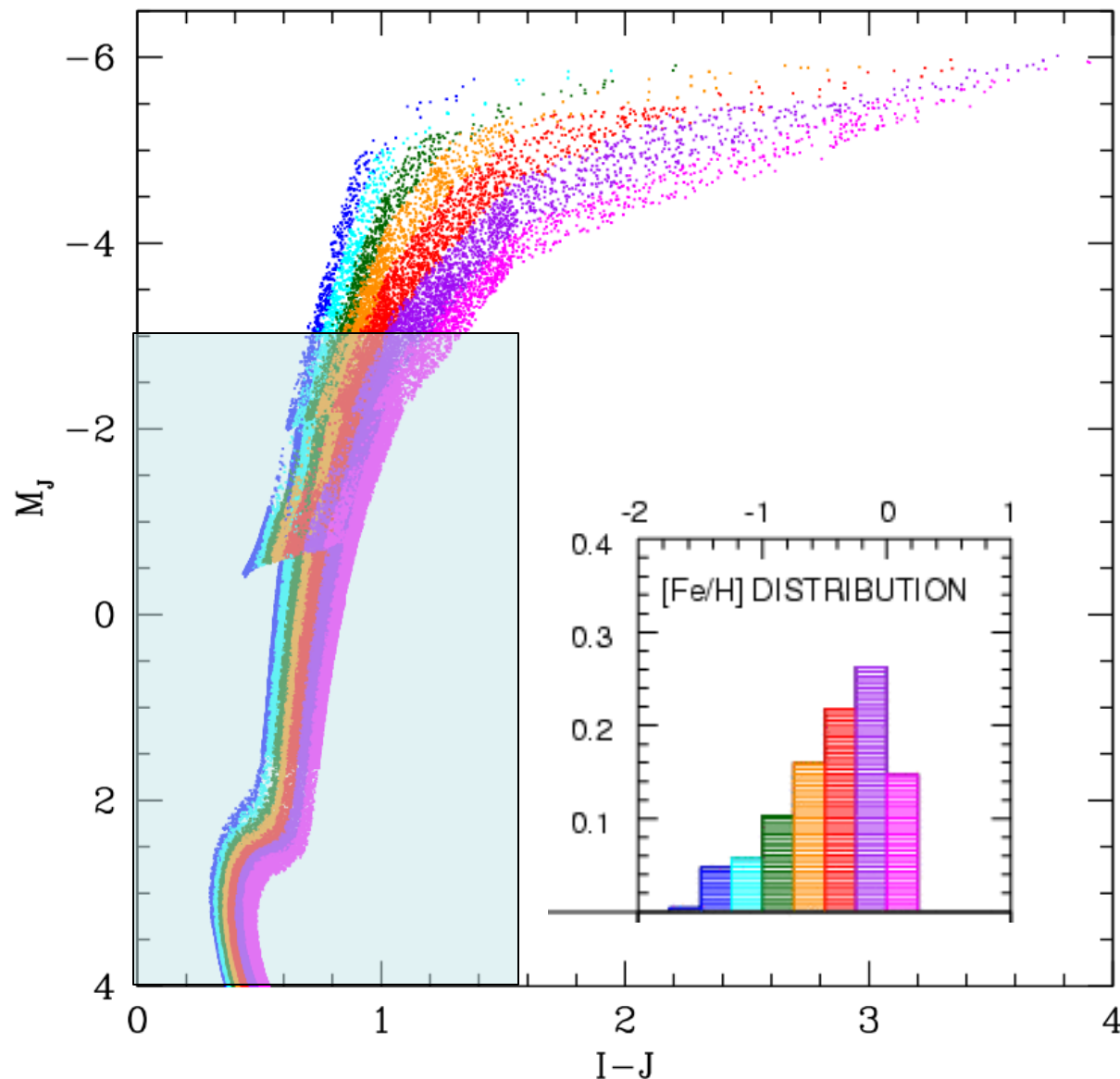
Virgo DM = 31



2h integration



Stellar population of giant Elliptical galaxy



OLD Stellar
Population

Code YZVAR
by G.P. Bertelli

(Padova tracks
database) :

Resolved Stellar Population of Distant Galaxies in the ELT Era

L. GREGGIO, R. FALOMO, S. ZAGGIA, AND D. FANTINEL

Istituto Nazionale di Astrofisica, Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio 5, I-35122,
Padova, Italy; laura.greggio@oapd.inaf.it

AND

M. USLENGHI

Istituto Nazionale di Astrofisica, Istituto di Astrofisica Spaziale e Fisica Cosmica, Via Bassini 15, I-20133 Milano, Italy

Received 2012 February 07; accepted 2012 May 23; published 2012 August 6

ABSTRACT. The expected imaging capabilities of future Extremely Large Telescopes (ELTs) will offer the unique possibility to investigate the stellar populations of distant galaxies from the photometry of the stars in very

two representative science cases is of distant galaxies. Specifically, distance of 4.6 Mpc) and case (2) distance of 18 Mpc). We generate tentative instrumental setup, i.e., a discussed in detail, showing how it is approached. We find that (1) n to $I \sim 28.5$, $J \sim 27.5$, allowing Virgo to within ~ 0.1 dex; (2) the 7.0, enabling reconstruction of the dexes. For the latter case, we discuss history from the analysis of their

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MNRAS **437**, 2966–2979 (2014)

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Studying the metallicity gradient in Virgo ellipticals with European-Extremely Large Telescope photometry of resolved stars

L. Schreiber,¹★ L. Greggio,² R. Falomo,² D. Fantinel² and M. Uslenghi³

¹INAF, Osservatorio Astronomico di Bologna, Via Ranzani 1, I-40127 Bologna, Italy

²INAF, Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio 5, I-35122 Padova, Italy

³INAF, Istituto di Astrofisica Spaziale e Fisica Cosmica, Via Bassini 15, I-20133 Milano, Italy

Accepted 2013 October 30. Received 2013 October 30; in original form 2013 September 13

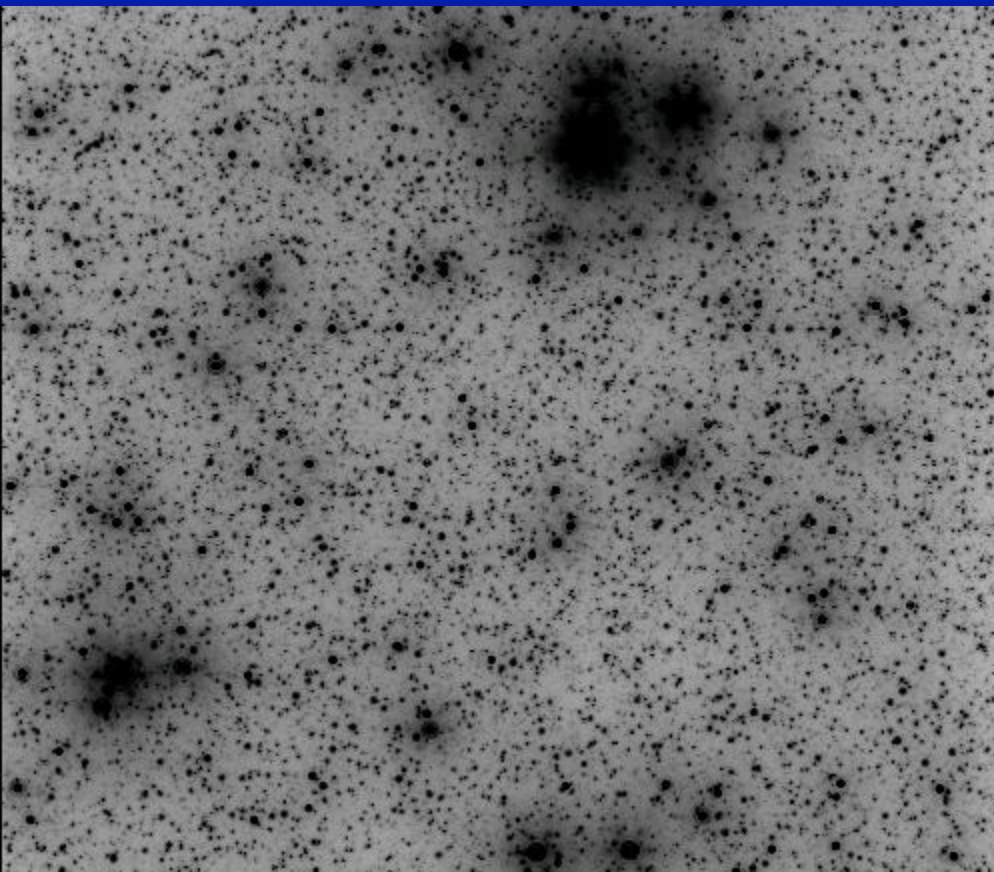
ABSTRACT

The next generation of large aperture ground-based telescopes will offer the opportunity to perform accurate stellar photometry in very crowded fields. This future capability will allow one to study in detail the stellar population in distant galaxies. In this paper we explore the effect of photometric errors on the stellar metallicity distribution derived from the colour distribution

The view of resolved of stellar populations

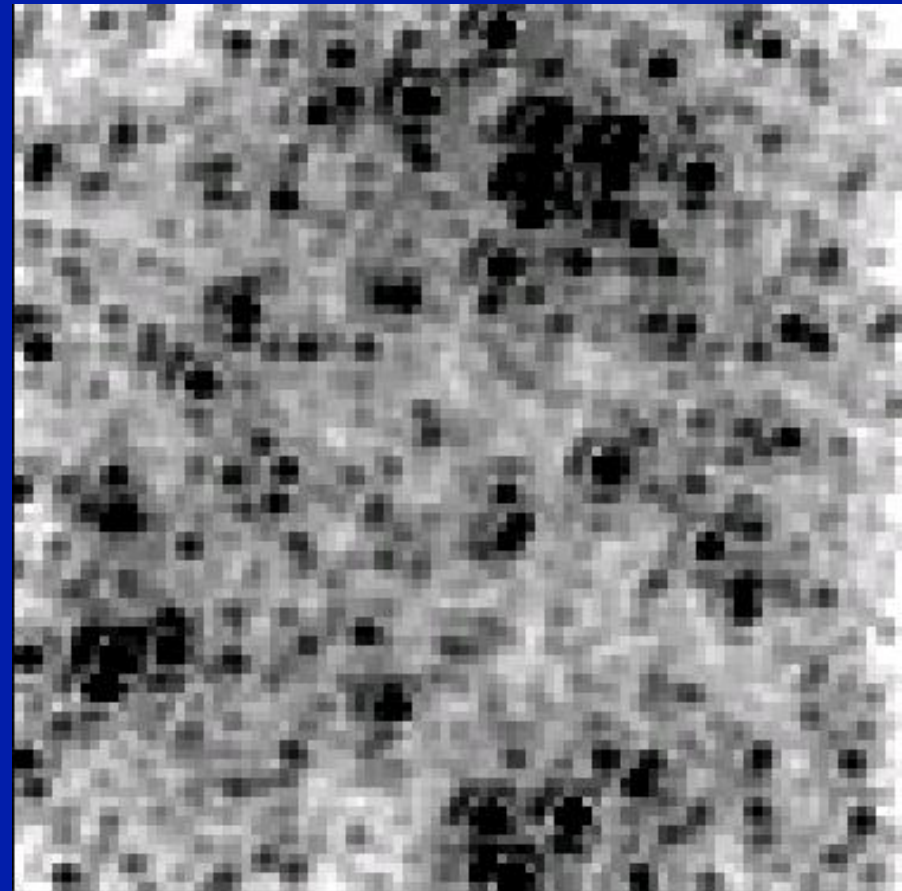
Disk galaxy (young SP) $M(J) = -23$, HLR = 5 kpc

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



MICADO E-ELT

FoV = 3"

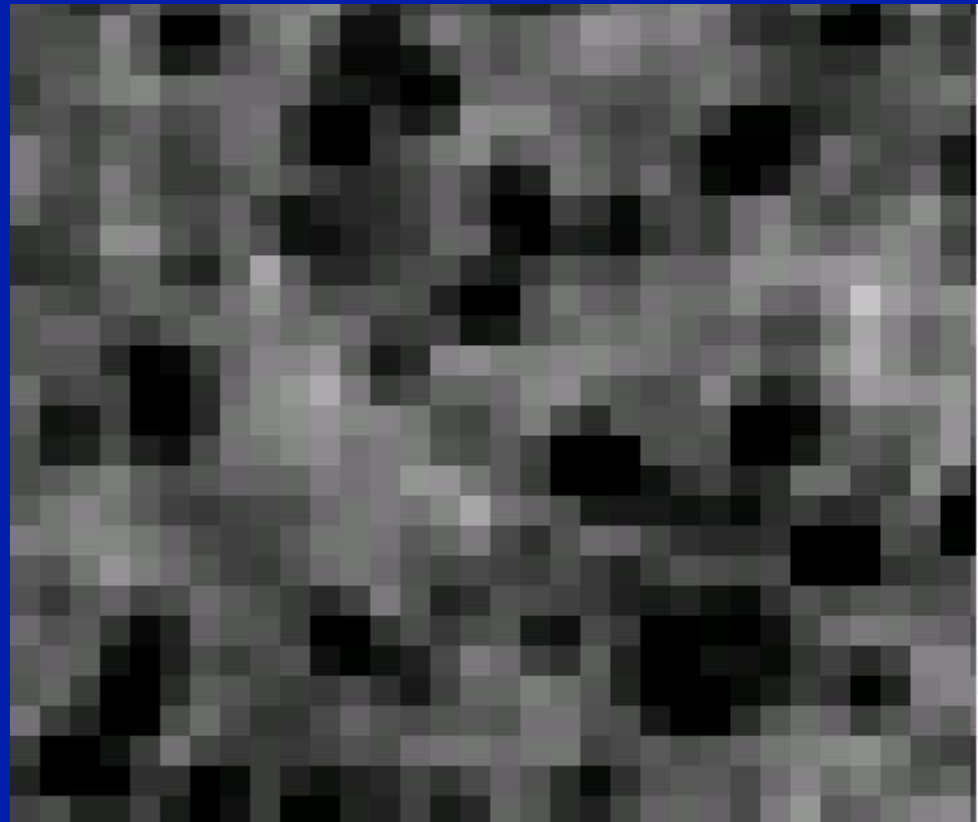
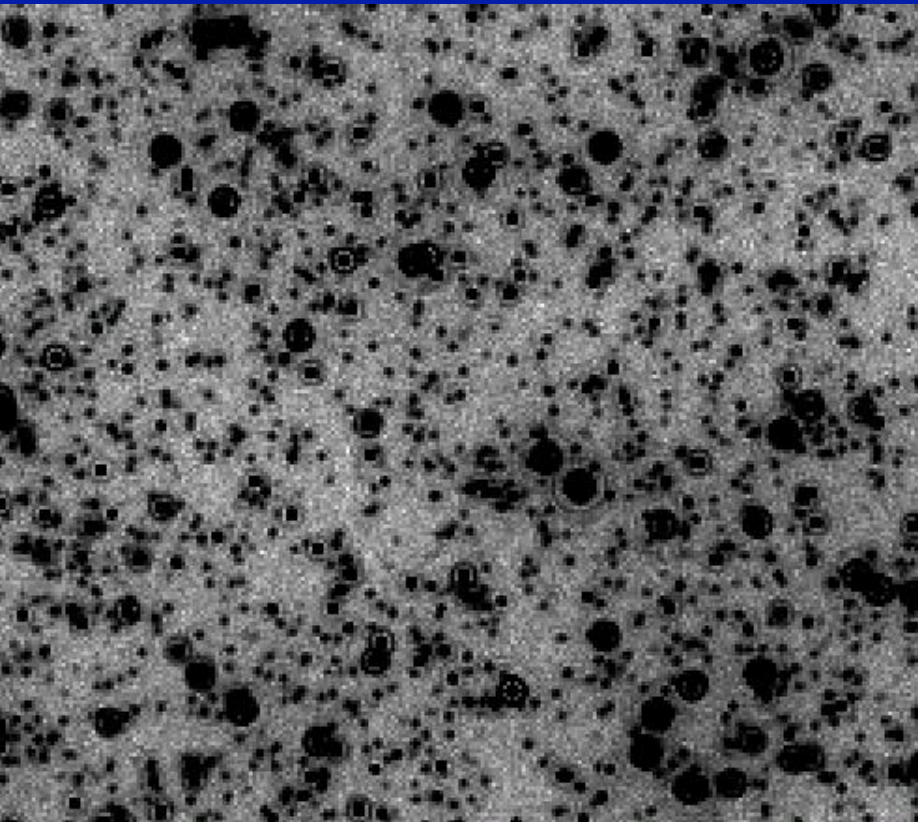


NIRC2 JWST

The view of resolved of stellar populations

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

Distance = 18.3 Mpc $R/HLR = 1$



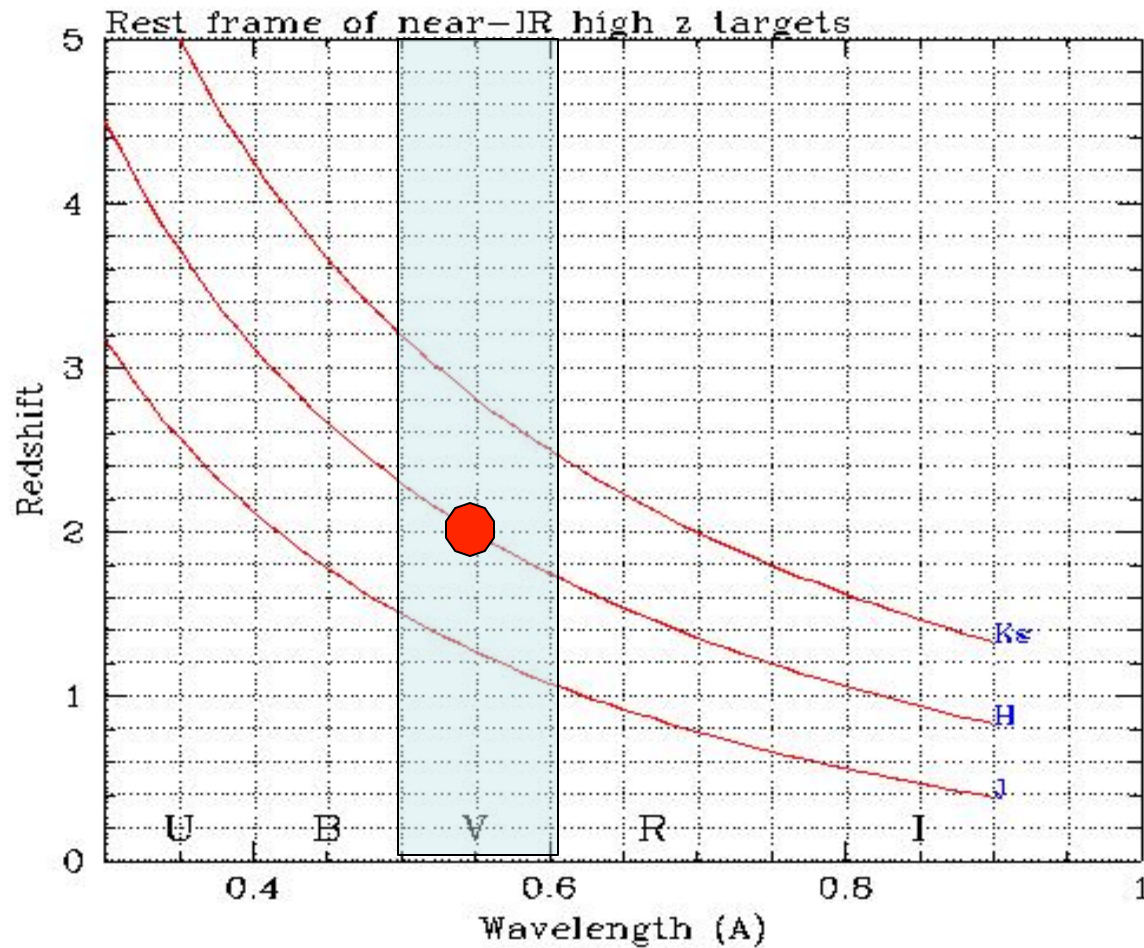
MICADO E-ELT

FoV = 1"

NIRCcam JWST

GALAXIES
with
MICADO @ EELT

MICADO view of high z galaxies



MICADO view of high z galaxies

Redshift $z = 2$; Filters: V and H (V= green; dashed green is V at $z=2$; H= yellow)

Template Spectrum: sed.Sb.tab at $z=0$ (white) and $z=2$ (red)

Correction (V - H) = 2.540 mags

Flux in filter V = 0.99; $m(V) = -21.11$; $ZP(V) = -21.12$

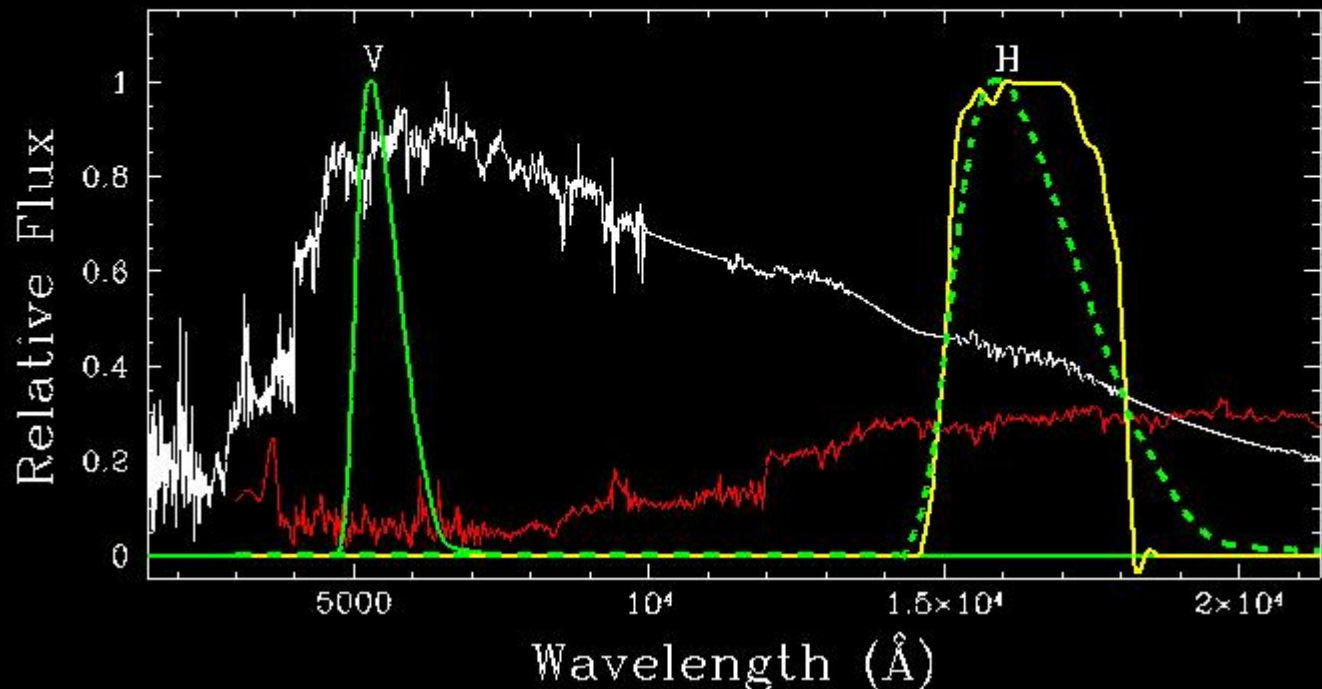
Flux in filter H = 0.33; $m(H) = -23.85$; $ZP(H) = -24.85$

The above correction is the sum of the following terms:

Different photometric ZP [$zpi(V) - zpi(H)$] = 3.73 mags

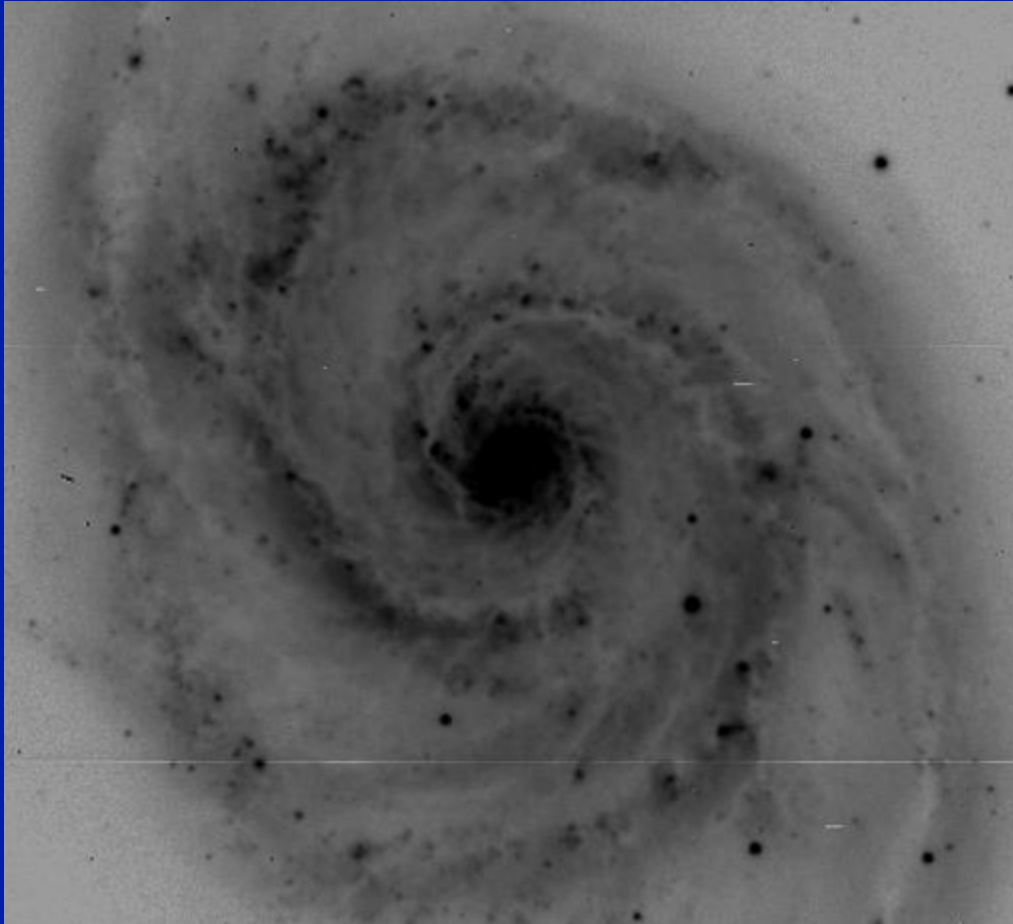
Flux reduction due photon energy losses $-2.5 \cdot \log(1+z) = -1.19$ mags

Different flux due to spectral shape and filter response = 0.01



MICADO view of high z galaxies

Example 1



$M(V) = -21$
 $R_e = 5 \text{ kpc}$

Redshift : 1-5

SB dimming $(1+z)^4$

*Size evolution helps to
detect high z galaxies*

*Include k-correction & filter
transformation*

Galaxy template → simulated images

MICADO view of high z galaxies

SIMULATION

AETC

Size 0.3 "

$Z = 1$

$Z = 2$

MICADO view of high z galaxies

SIMULATION

Size 0.3 "

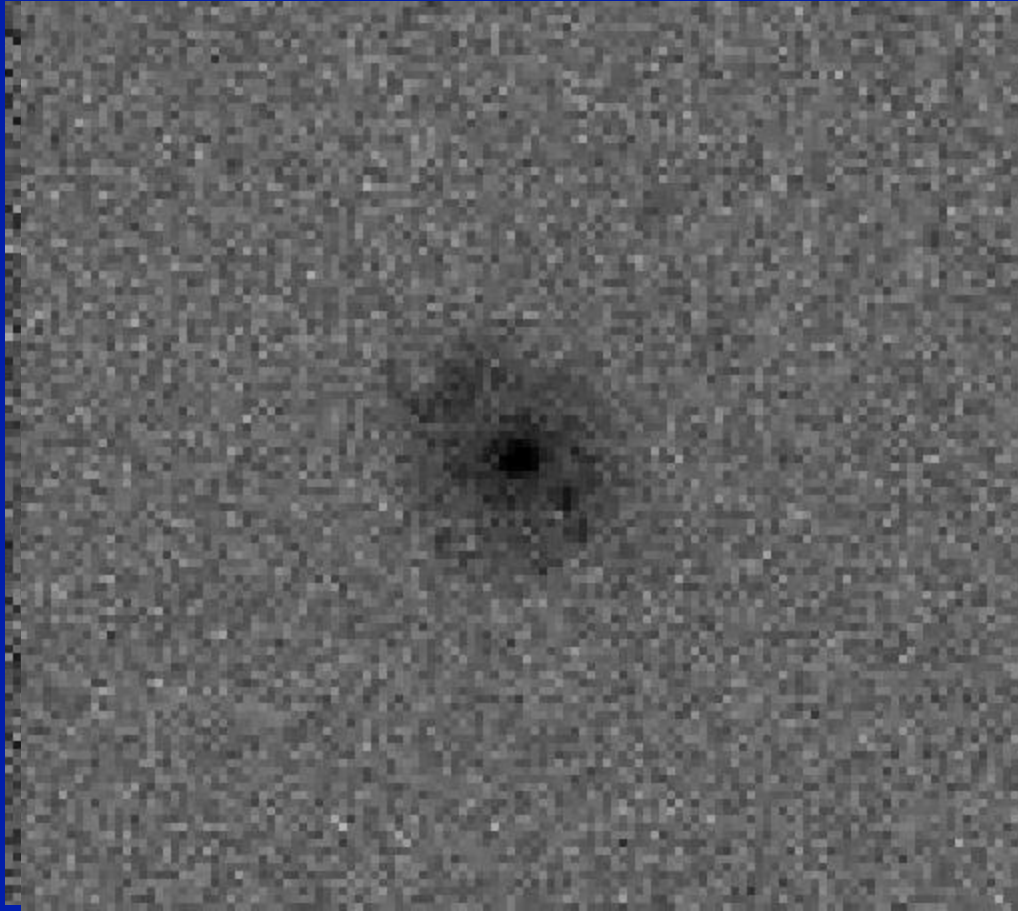
$z = 3$

$z = 4$

MICADO view of high z galaxies

SIMULATION

AETC

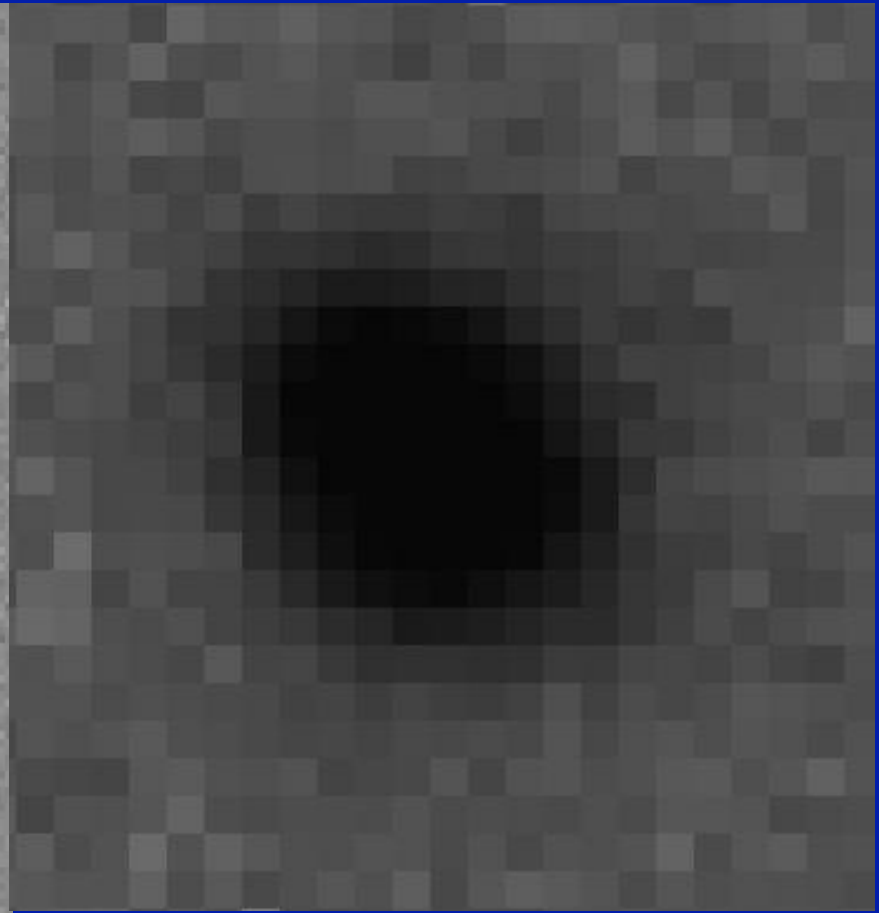
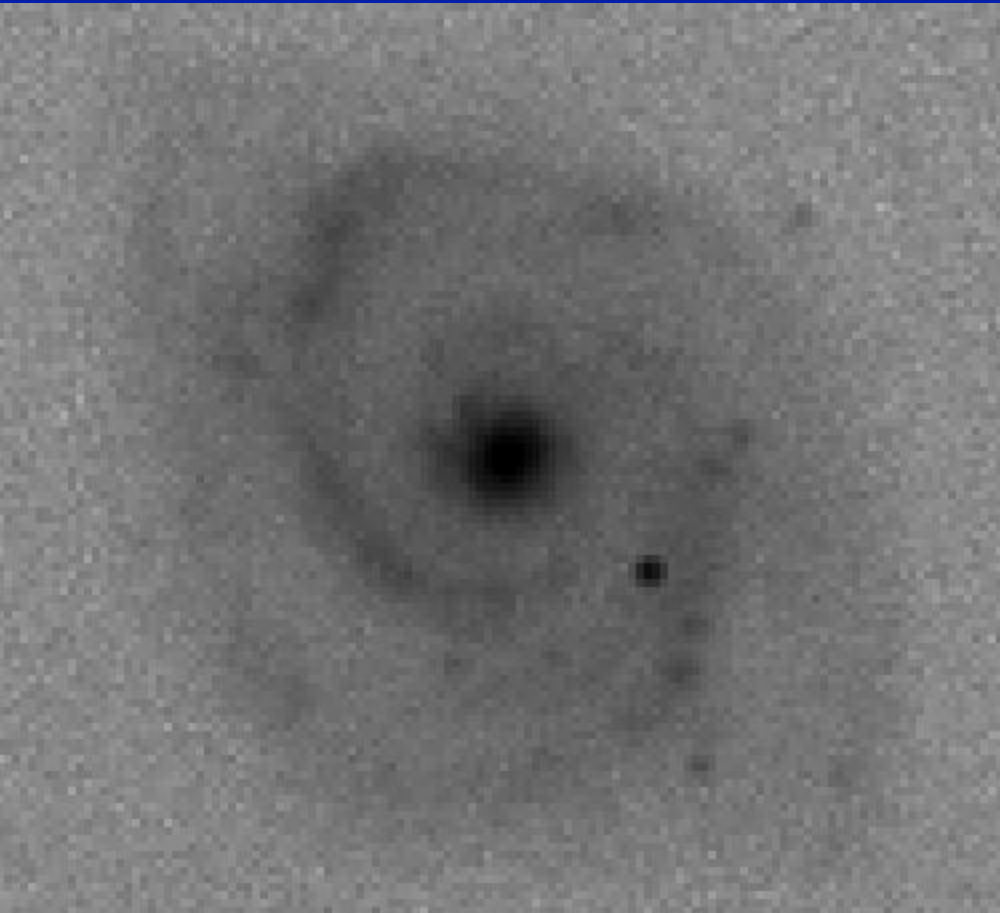


$Z = 4$ size = $0.1''$

Including size evolution₂₁

Spiral galaxy at $z = 2$ Re 5kpc (0.3")
H band -- 5h

SIMULATION



MICADO@ELT

NIRcam@JWST

JWST will select samples & measure basic galaxy properties

MICADO will provide the details of their structure to answer:
What are the physical processes driving their evolution?

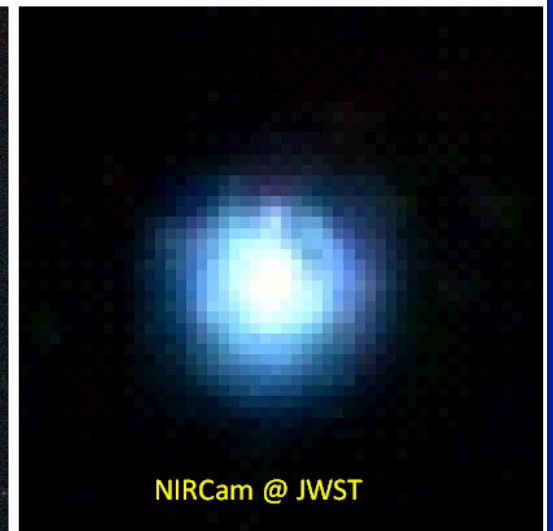
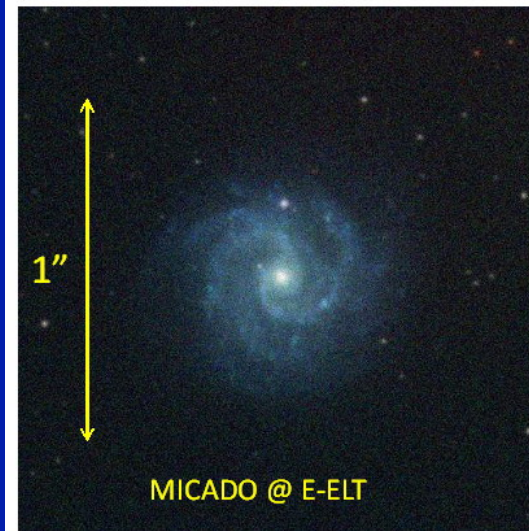
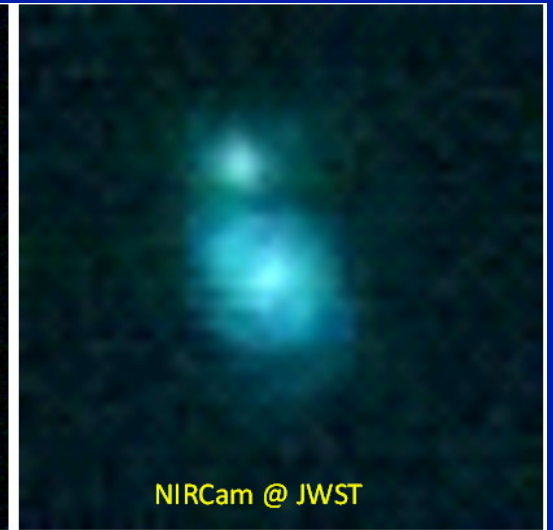
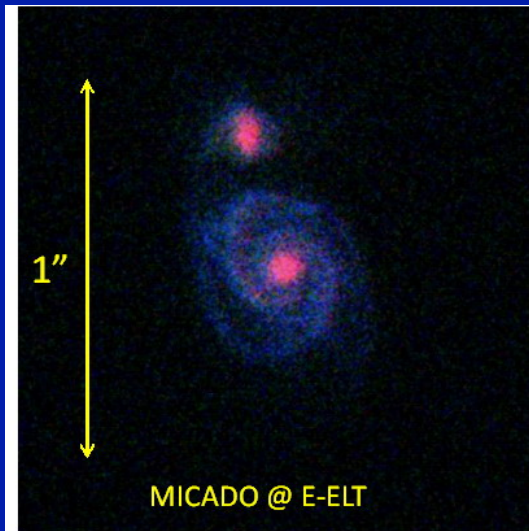
obvious synergies with

ALMA

HARMONI

EAGLE

for kinematics (rotation curves, clump dispersions) & gas content



combined JHK images of local templates (BVR bands) shifted to $z=2$ (top) and $z=1$ (bottom), with $R_{\text{eff}}=0.5''$ and $M_v=-21$. 5hrs integration.

The simulation tool : AETC

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

Total Exposure Time (sec)

☐ fixed ☐ Encircled Energy

Encircled Energy: ☐ seeing limited ☐ seeing function FWHM (arcsec)

☐ psf ☐ PSF Table ☐ PSF user file

PSF function

PSF map: ☒ Uniform ☐ Not uniform



Source Specifications

☒ Single Object

SED:

☐ Black Body

$^{\circ}\text{K}$

☒ Template Table

☐ Power Law

Spectral index

☐ By User

Redshift

Flux:

☒ computed

Magnitude

Band

Mag System

☐ direct input

Flux(λ_0)

λ_0

☒ Image Simulator

X size

Y size

Gain

FPN

Dark

Convolution

Rad min

Saturation level

Threshold

System coordinates

Add Noise ☒

Subtract Background ☒

☐ Stars

☐ Galaxies

☐ Objects

Object file

Template files

The simulation tool : AETC

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

03 09:49:12

Input configuration

Object: MicadoJ
Primary mirror diameter: 3900 cm
Plate scale: 0.003 arcsec/pixel
Number of reflections: 5
Fraction of obstruction: 0.28
Observation band: J 9800.0 - 15400.0 Å
Photometric system: UBVRI_Johnson
Mirror reflectivity: 1
Instrument efficiency: 1
Detector efficiency: 0.4
Sky Brightness: mag: 16.3, band: J, mag system: Vega
Exposure time: 18000sec
Number of exposure: 180
Readout noise: 5e-
Aperture Ø: 0.012 arcsec
Encircled Energy: 0.19 (psf function: 2D, psf file: ELT_Micado_seeing0.6 J)
Air Mass: 1
Atmospheric Absorption: Rayleigh: at 2000m
Single Object - SED: Stars vega (900.0 - 100000.0) Å
Input: mag: 25, band: J, mag system: Vega
Star file: No Star file
Galaxy file: No Galaxy file
Object file: No Object file

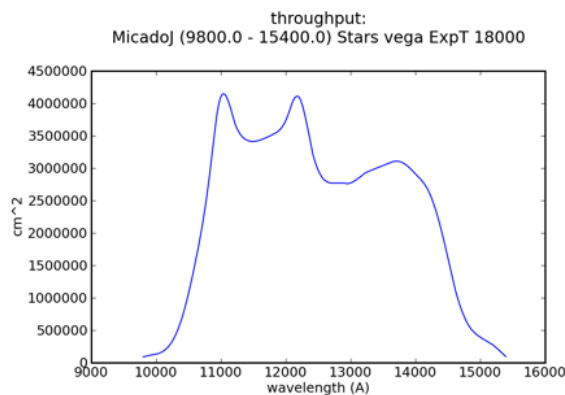
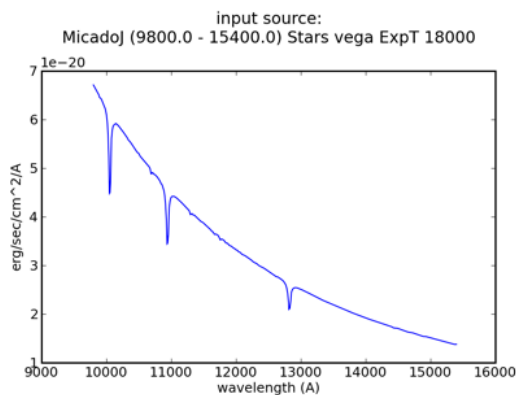
Aperture Output Signals:

Collecting area: 11009347 cm²
S/N area: 12.6 px
Source: 8.328477e+05 ph/aper/expT
Effective wavelength: 12200.0 Å
Extinction at λ_{eff}: 0.0
Background : 1.588126e+06 ph/aper/expT (7.02 ph/sec/px)
StoN 535.23
Zero Point 30.97

AETC



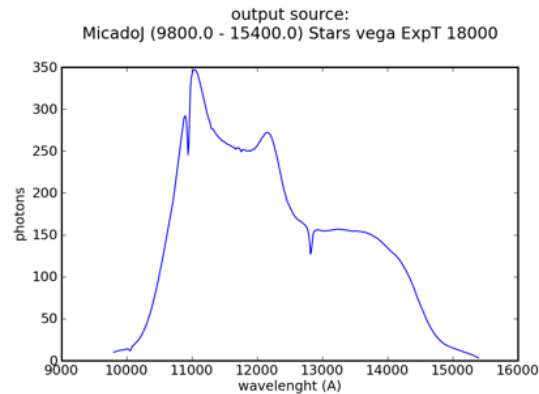
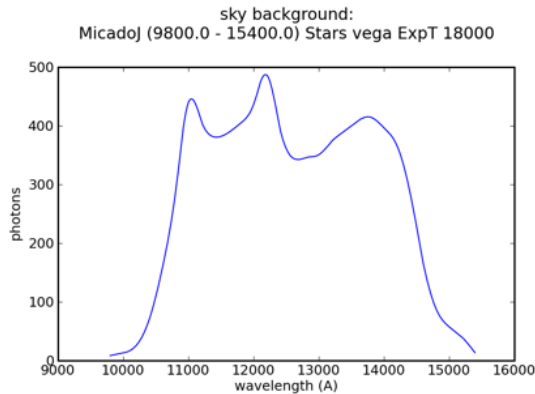
Sensitivity Graphs



The simulation tool : AETC

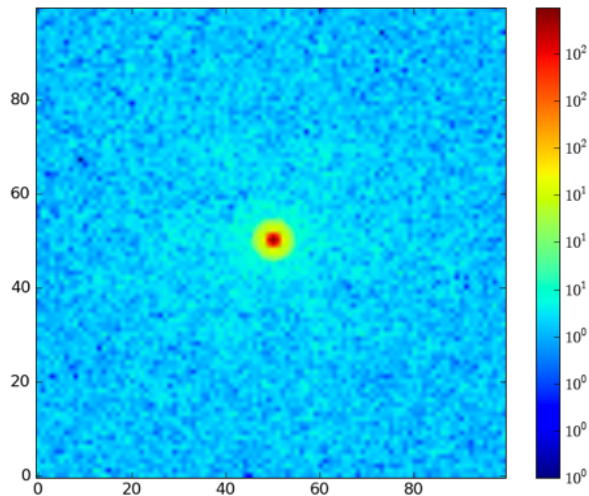
Falomo, R., Fantinel, D., Uslenghi, M 2011 Proc. SPIE 8135, 813523
(2011)

03 09:49:12



AETC

Preview Image



<http://aetc.oapd.inaf.it>

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)

