Science drivers for ERIS as a stepping stone for E-ELTs

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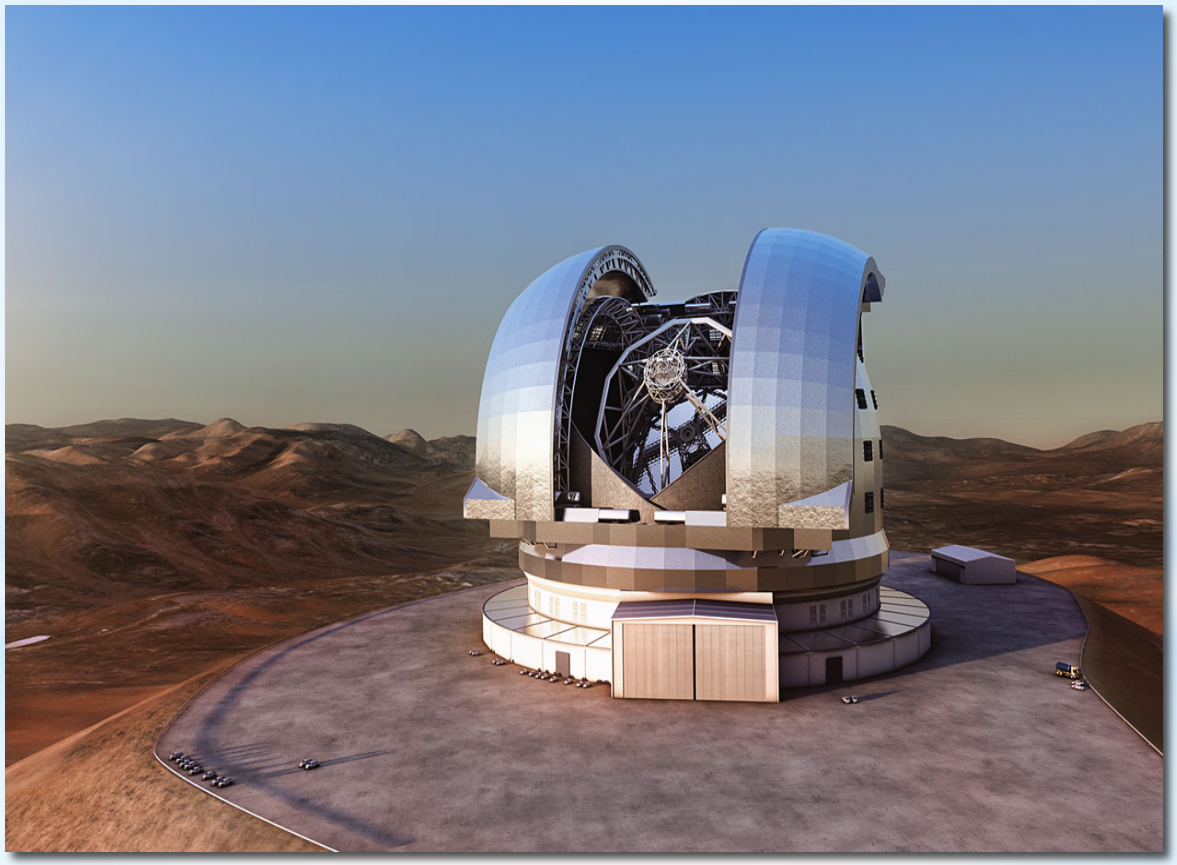


Setting the scene

E-ELT in a nutshell

First light instruments

ERIS Paving the way for E-ELT

Future Perspectives

First Generation E-ELT Instruments

First Light

E-ELT -- CAM (MICADO): R. Davies

E-ELT -- IFS (HARMONI): N. Thatte

E-ELT – MIR: L, M, N: B. Brandl

MAORY (AO module) E. Diolaiti

4) E-ELT – HIRES (Optical – NIR)

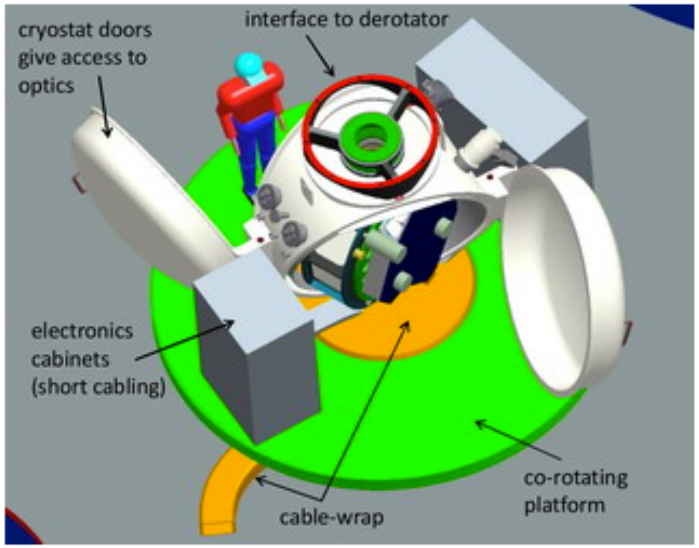
5) E-ELT – MOS: Fibers + IFUs (optical, NIR)

6) E-ELT – Not defined yet

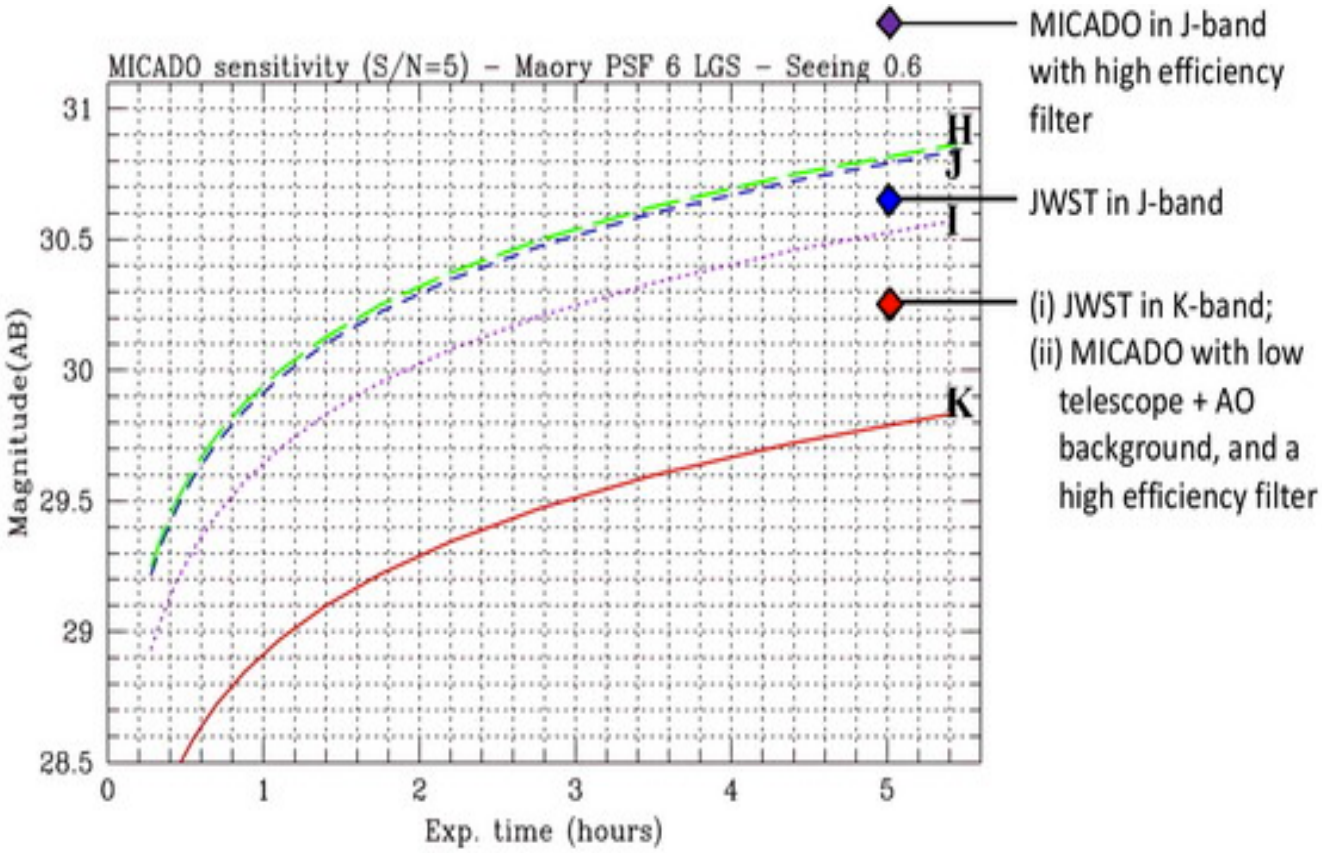
E-ELT CAM: MICADO

Plus SCAO + MCAO (MAORY)

NIR long-slit medium resolution spectrog.



Overview of MICADO



Broadband imaging sensitivity of MICADO as a function of integration time

MICADO@E-ELT vs NIRCAM@JWST

FoV	~1′ X 1′	2 X (2.16′ X 2.16′)
Pixel scale	~3 mas + "HR"	~30 mas
K-band	~29.5	~30
J-band	~31	~29.5

t_exp=5 hrs -- S/N=5 -- MAORY + 6 LGS -- seeing 0.06

high efficiency filters → AB Mag -- HR→ 1.5 mas smaller FoV

F115W & F220W -- t_exp=5 hrs -- S/N~5
Extraction region in a circle of 0.8"

Synergies among JWST, EUCLID & ERIS@VLT

NIRSPEC@JWST

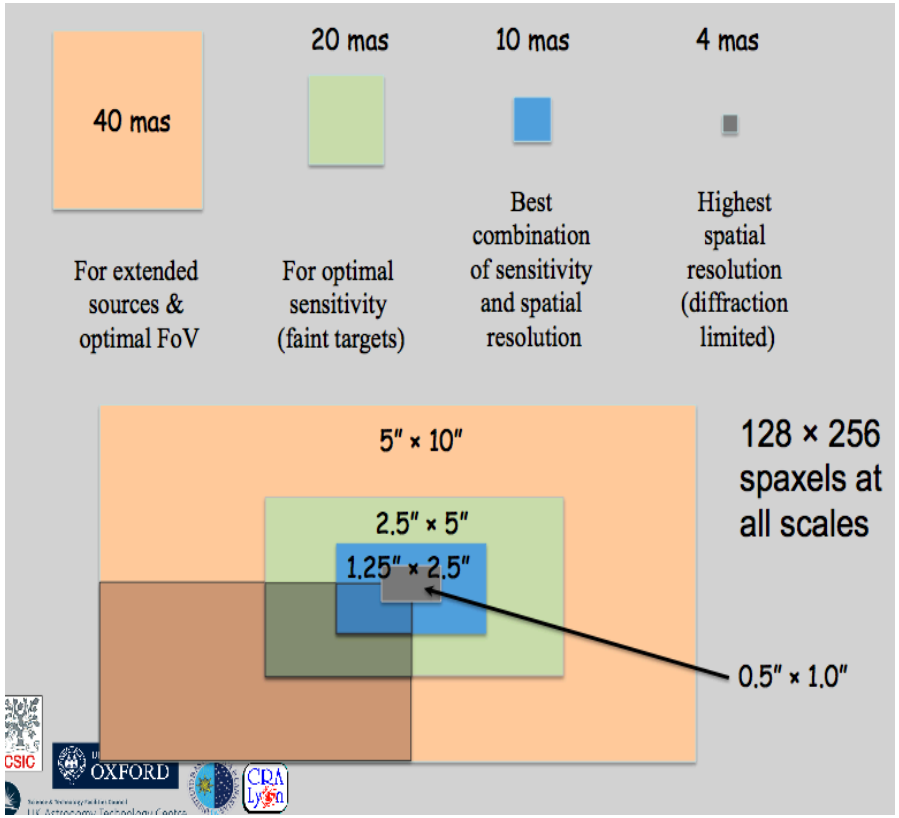
FoV	~3′ X 3′ for MOS
Slit width	~200 mas
Slits	Micro Shutter Array Fixed slits IFU (3″″ X 3″)
Spectral Resolution	R~100 → 0.7 -- 5 μm (single prism) R~1000 → 1 -- 5 μm (3 gratings) R~2700 → 1 -- 5 μm (3 gratings)

R=100 → t_exp ~ 10,000 sec point source continuum at 3 μm

S/N=10 is AB~26 mag

Synergies between JWST & ELTs

E-ELT Integral Field Spectrograph: HARMONI



33,000 spaxels per exposure!

Plus SCAO + LTAO

Wavelength Ranges & Resolving Powers

Bands	R
V+R, I+z+J, H+K	~4000
V, R, I+z, J, H, K	~10000
Z, J_high, H_high, K_high	~20000

- Exploring adding simultaneous V-K coverage at R~500-1000
- Re-assessing the need for high spectral resolving power at visible wavelengths (< 0.8 micron)

Requirements for IFS@E-ELT in J,H,K-band

FoV	> a few arcsec
High multiplex	> intrinsic
Spatial res.	< 0.004—0.005 arcsec

Abundances (Iron, α-, s-, r-elements)

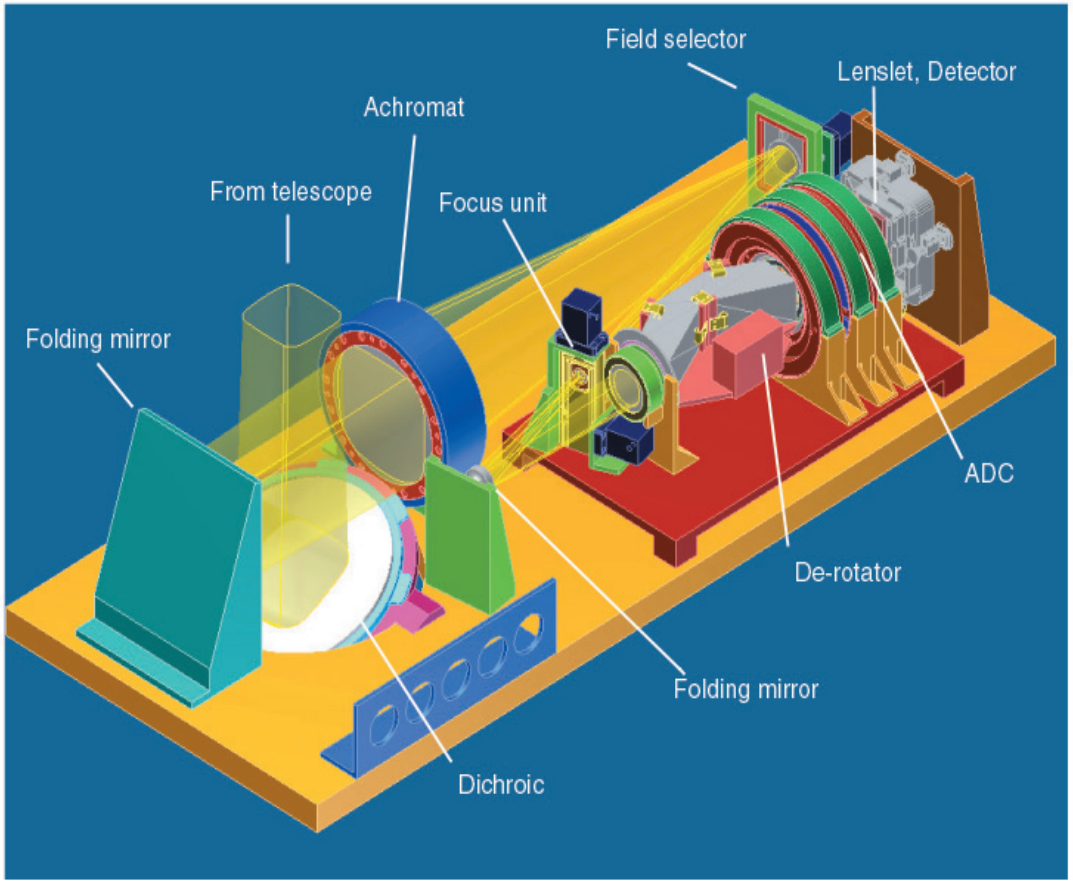
High-res R~20,000

Limiting mag. K~23 mag

CRIRES (+GIANO+WINERED)

crucial preliminary steps

E-ELT METIS



Coronagraphy in L & N bands

N-band polarimetry

Diffraction-limited imaging in L, M & N bands FoV 18 x 18"

Low resolution slit spectrograph (R < 5000)

IFU high-resolution spectrograph in L & M bands, FoV 0.4 x 1.5"

and resolving power of ~100,000

Adaptive Optics

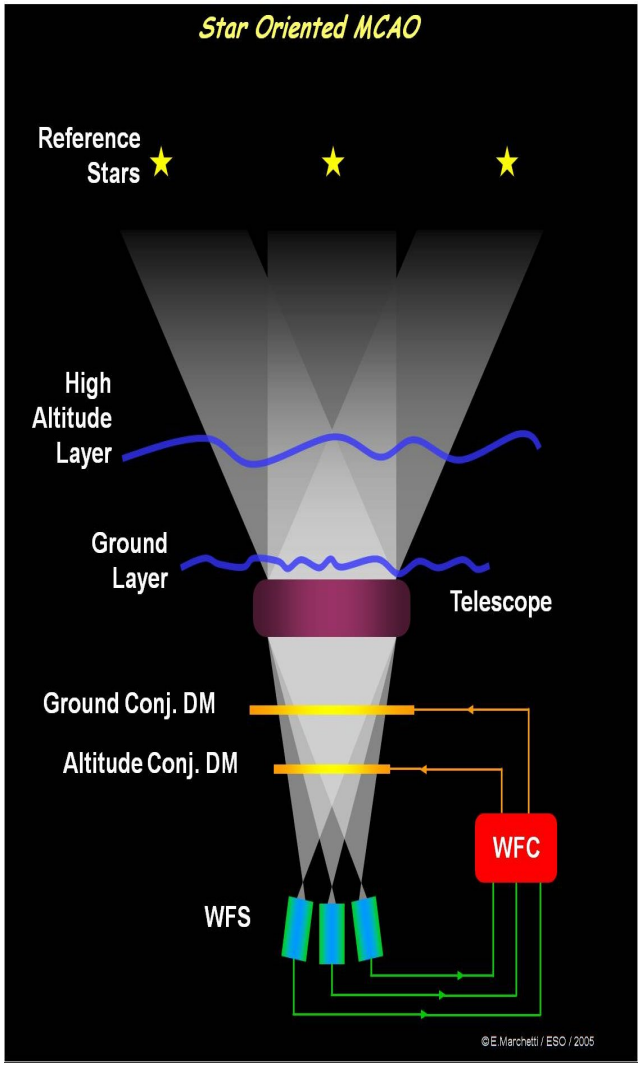
SCAO, MCAO, MOAO, LTAO

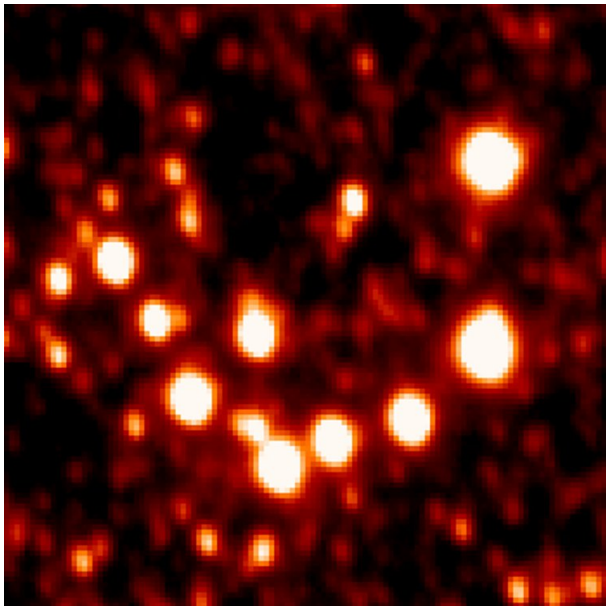
HERE & NOW

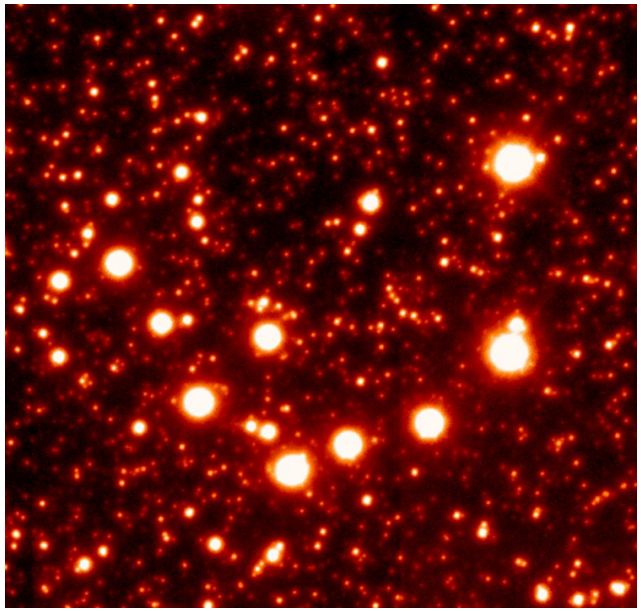
.....But life isn't a bed of roses!!

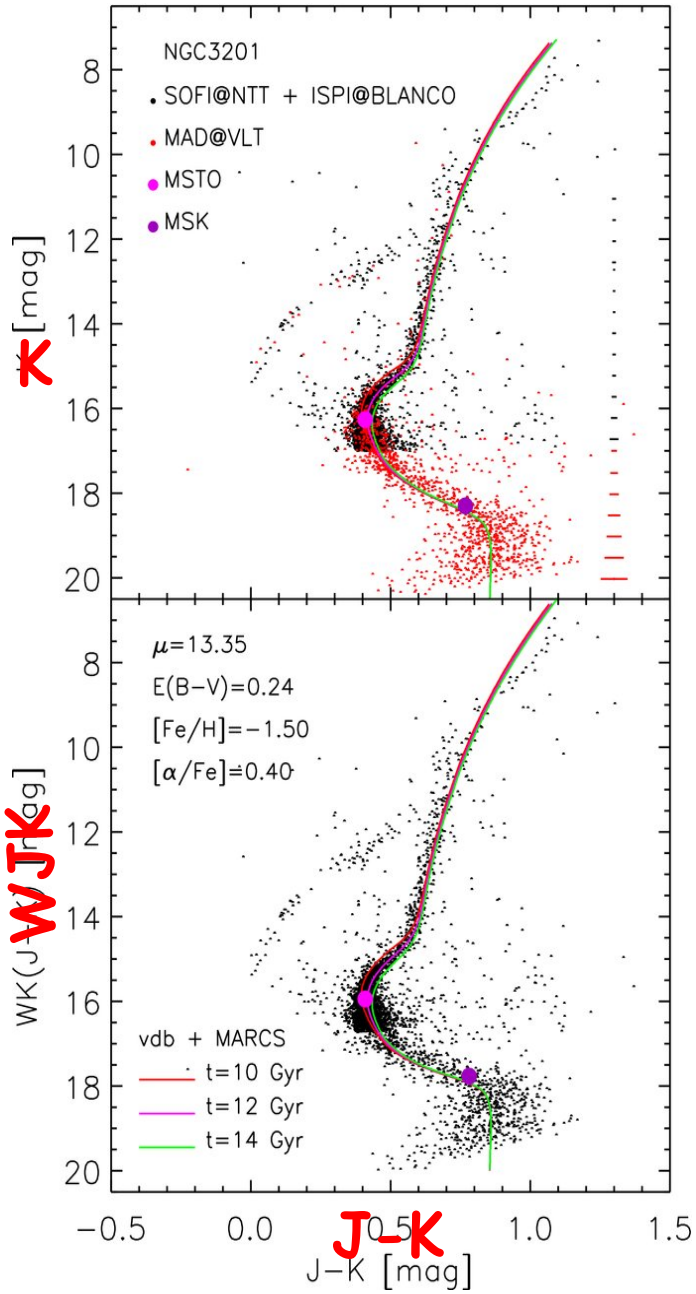
In the beginning was …. MAD@VLT

Marchetti + (2007)
GB + (2010)
t~11±1 Gyr

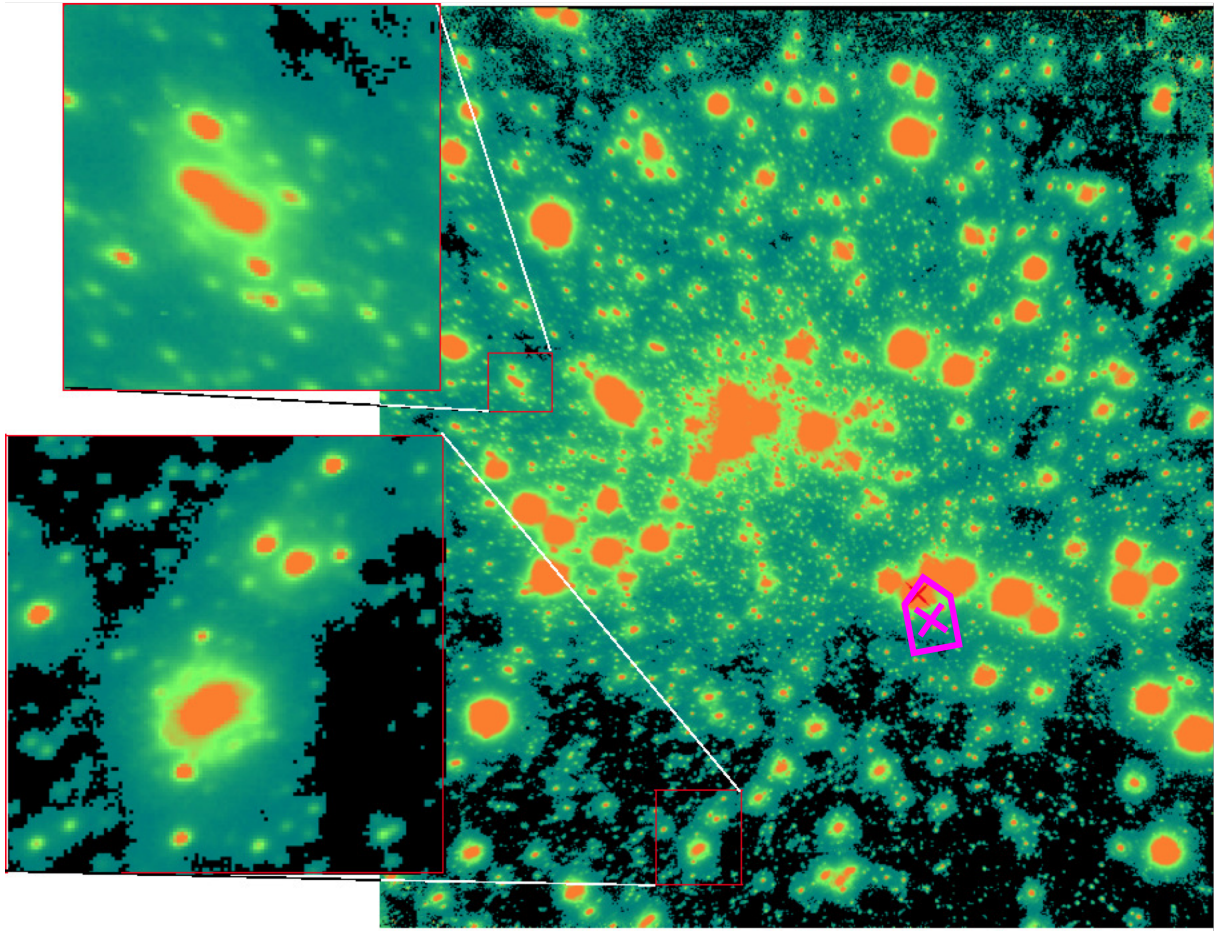








Later on was FLAO@LBT



J-band image

SCAO

M15 core (pcc)

FWHM of 0.05 (J) & 0.06 (Ks) arcsec.

Strehl ratio
13-30% (J), 50-65% (Ks)

Limiting magnitudes:
J~22.5 mag
Ks~23 mag

Esposito + (2010)+lecture

Drift of the PSF shape at larger Distances from the NGS

The absolute age of M15

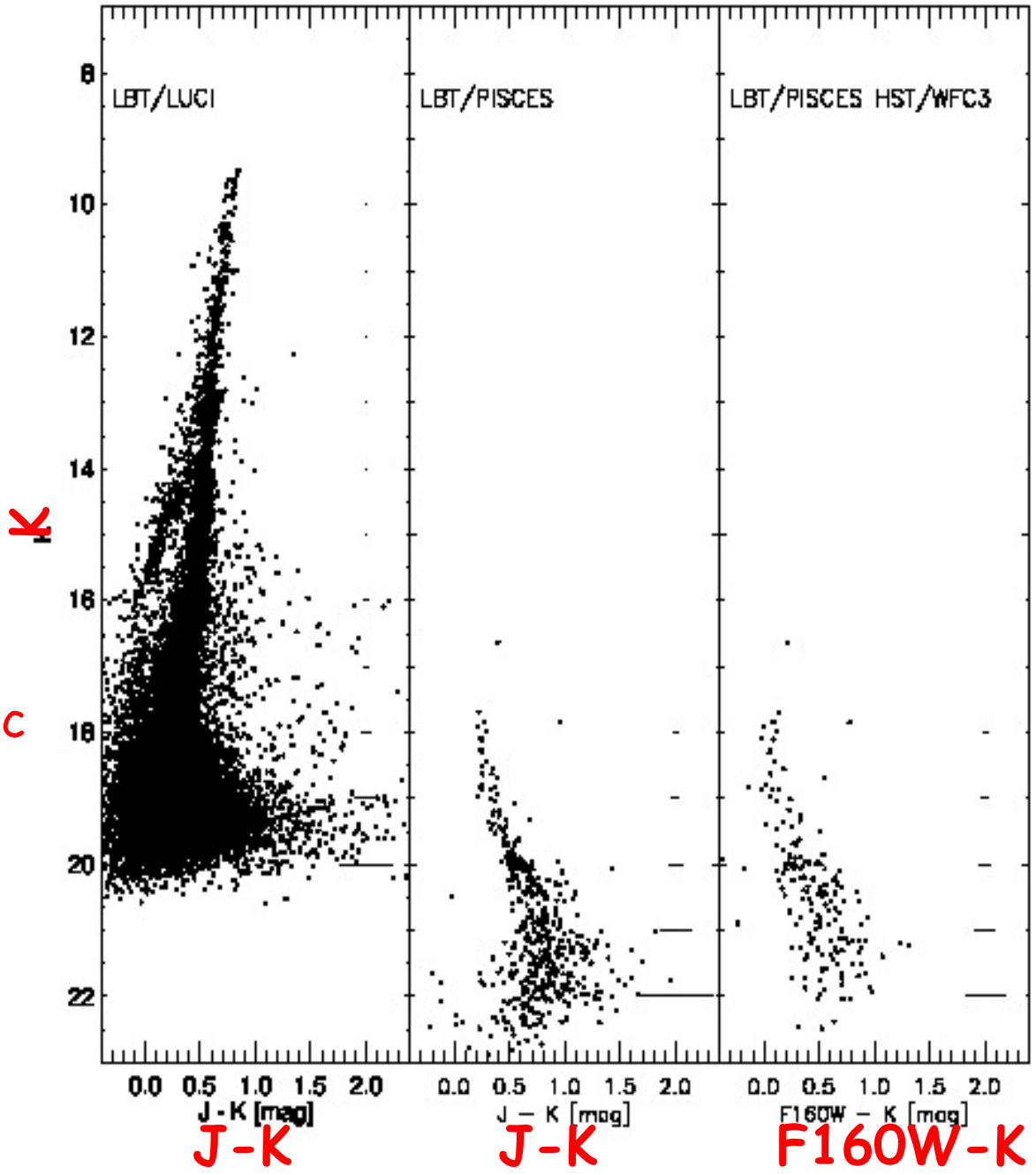
LUCI (4x4arcmin):
19J 20-40 sec
20K 20 sec

PISCES (26X26arcsec):
30J 30 sec
30K 15 sec

WFC3:
F160W(H) 3X200+6X250sec

t= 13±1 Gyr

Monelli et al. (2015)

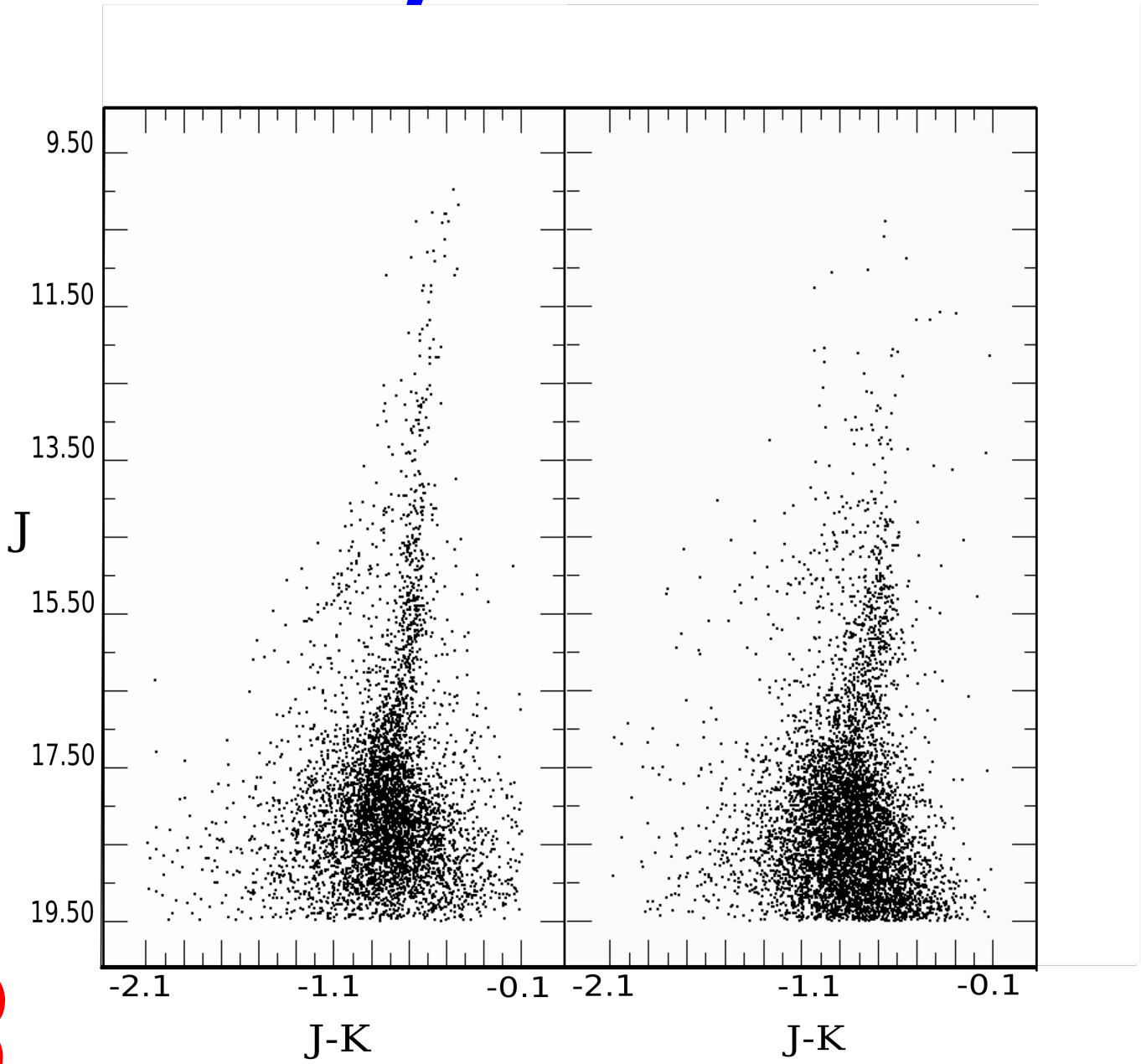


Symmetric vs asymmetric PSF

ROMAFOT

FLAO@LBT

M15: core

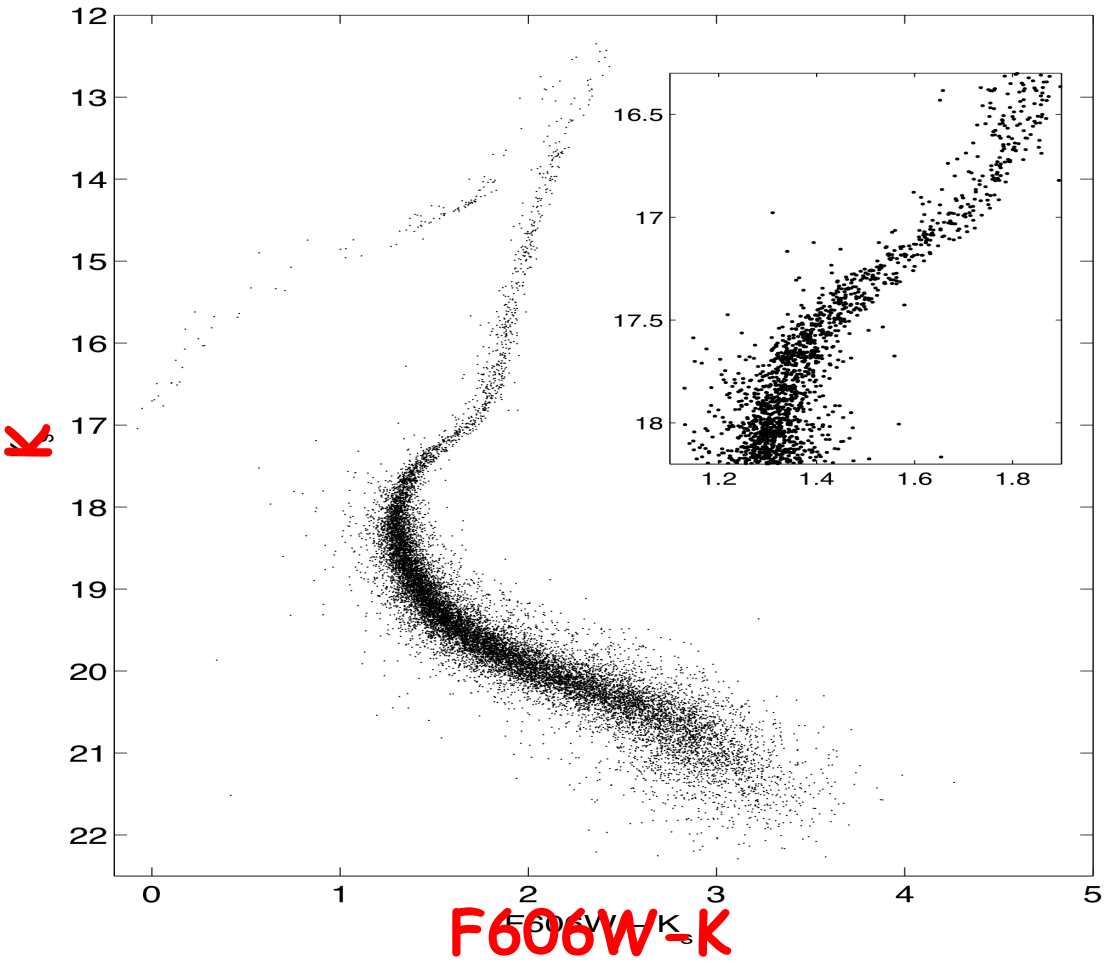


Fiorentino + (2014)
Schreiber + (2014)

… and more recently GEMs@Gemini

Rigaut + (2014)
Turri + (2015)

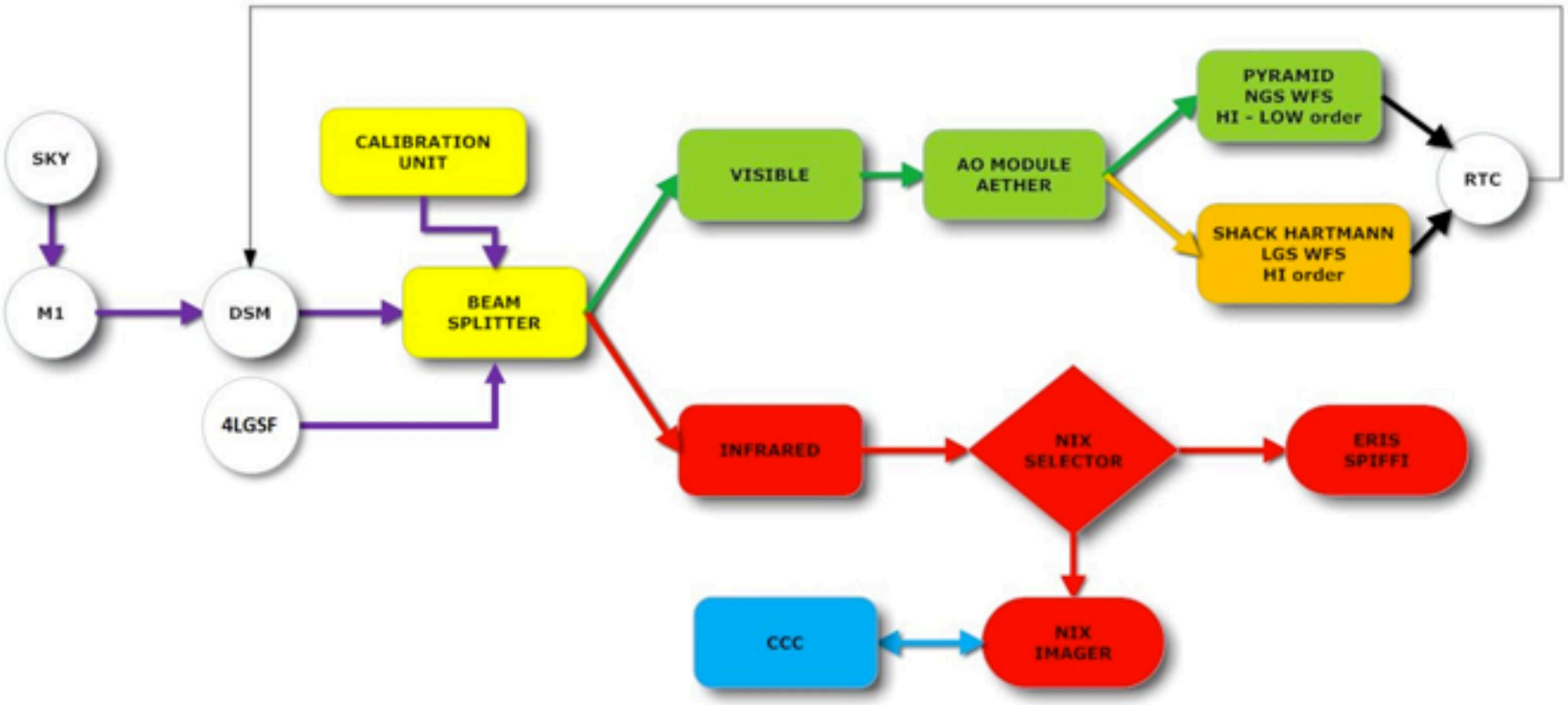
NGC1851 core



Two DMs + 5 Na LGS to deliver a FoV of 83" X 83"

Detection of multiple populations in the SGB confirming opt. findings

ERIS@VLT [2019/2020]



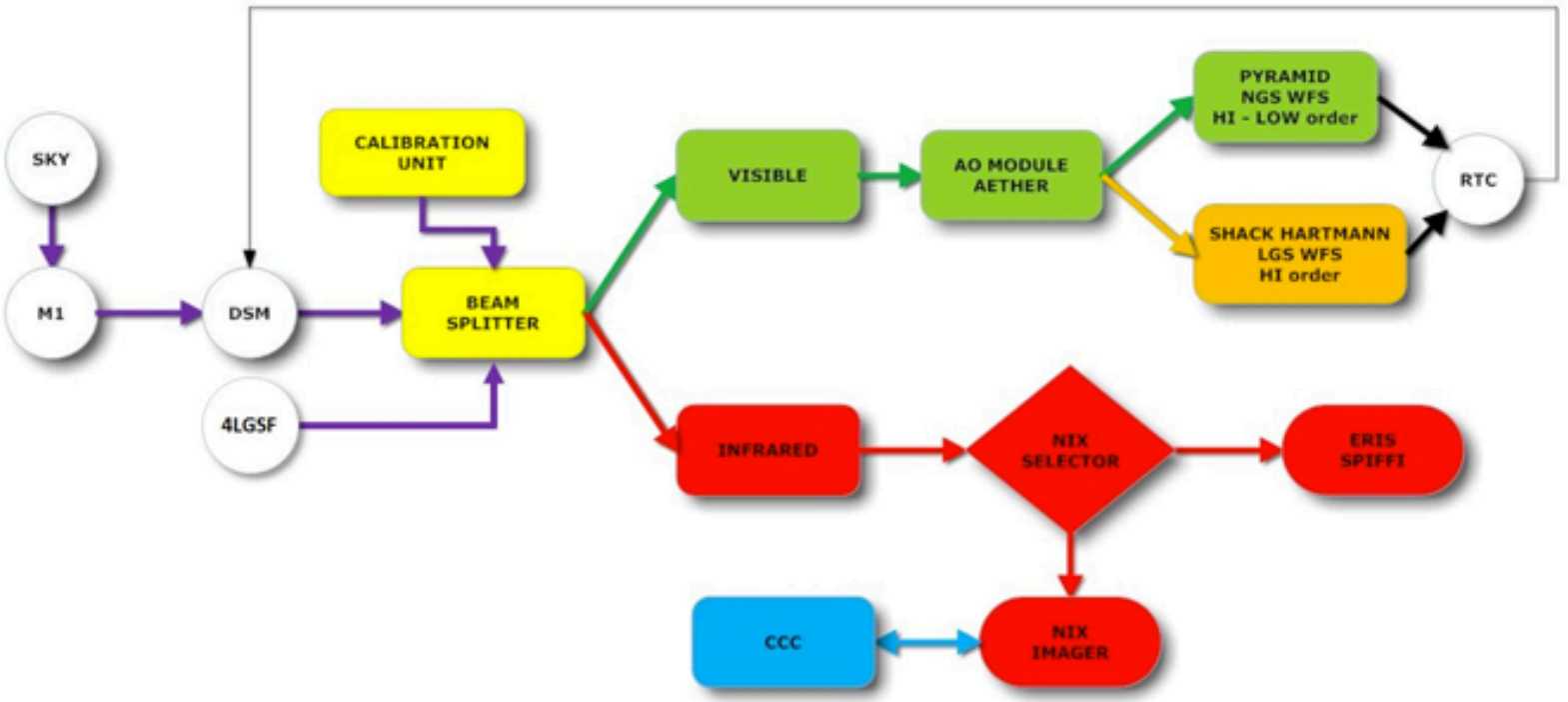
Imager (NIX)

Enhanced Resolution Imager & Spectrograph

FoV 27x27, 54x54 arcsec^2
Pixel scale 0.013, 0.027 mas/pix
Spectral coverage J -- M

1-5 µm for UT4
[AOF, laser] + SCAO

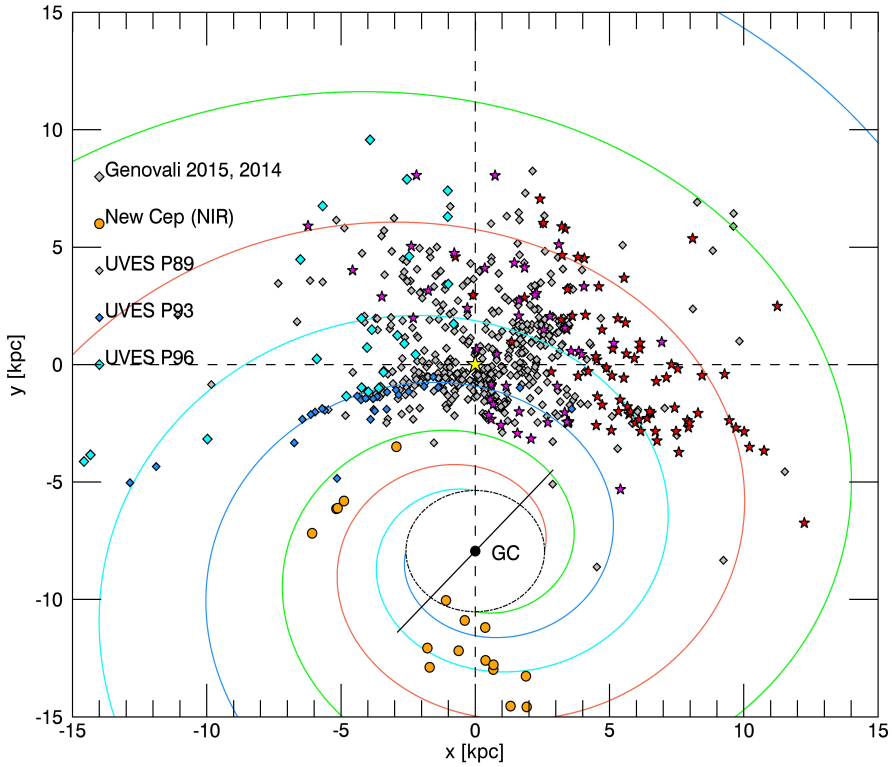
ERIS@VLT [2019/2020]



Integral Field Spectrograph (SPIFFI)

FoV 8x8, 3.2x3.2, 0.8x0.8 arcsec^2
Pixel scale 250—25 mas/spaxel
Spectral coverage JHK → R up to 8000

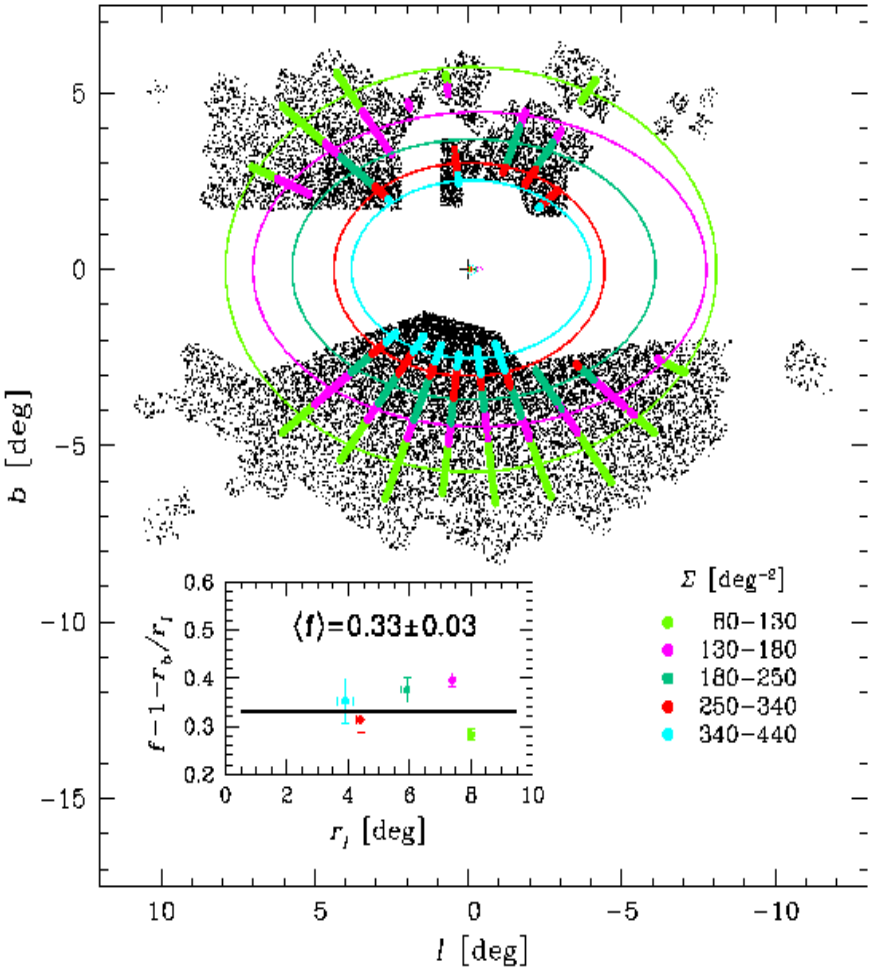
Cepheids in the Galactic centre and … beyond!!



Matsunaga + (2013, 2015)

Similar for type II Cepheids

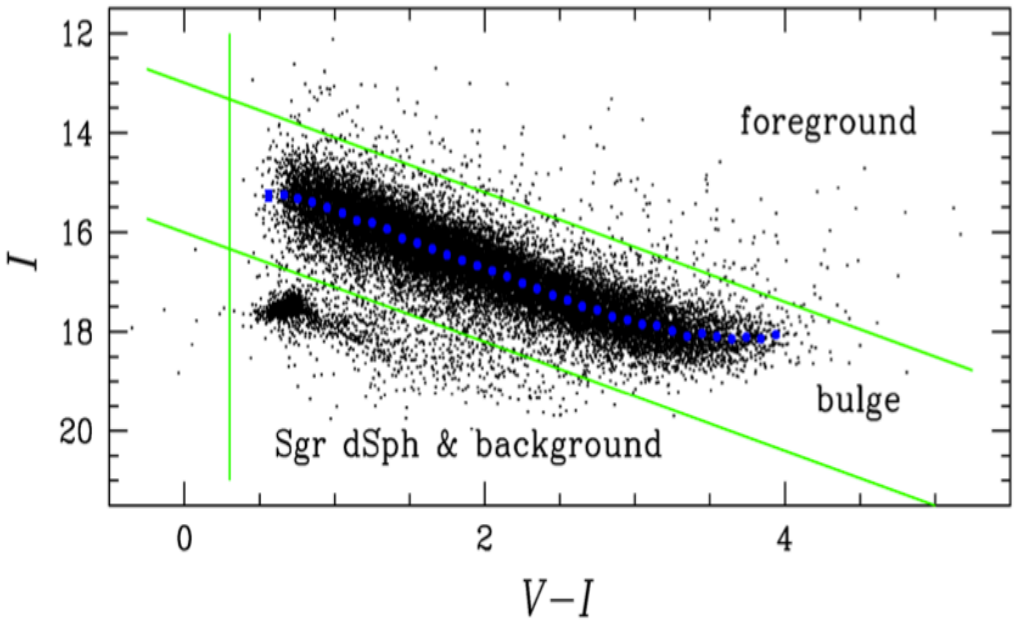
Unveiling the inner bulge



Pietrukowicz + (2015)

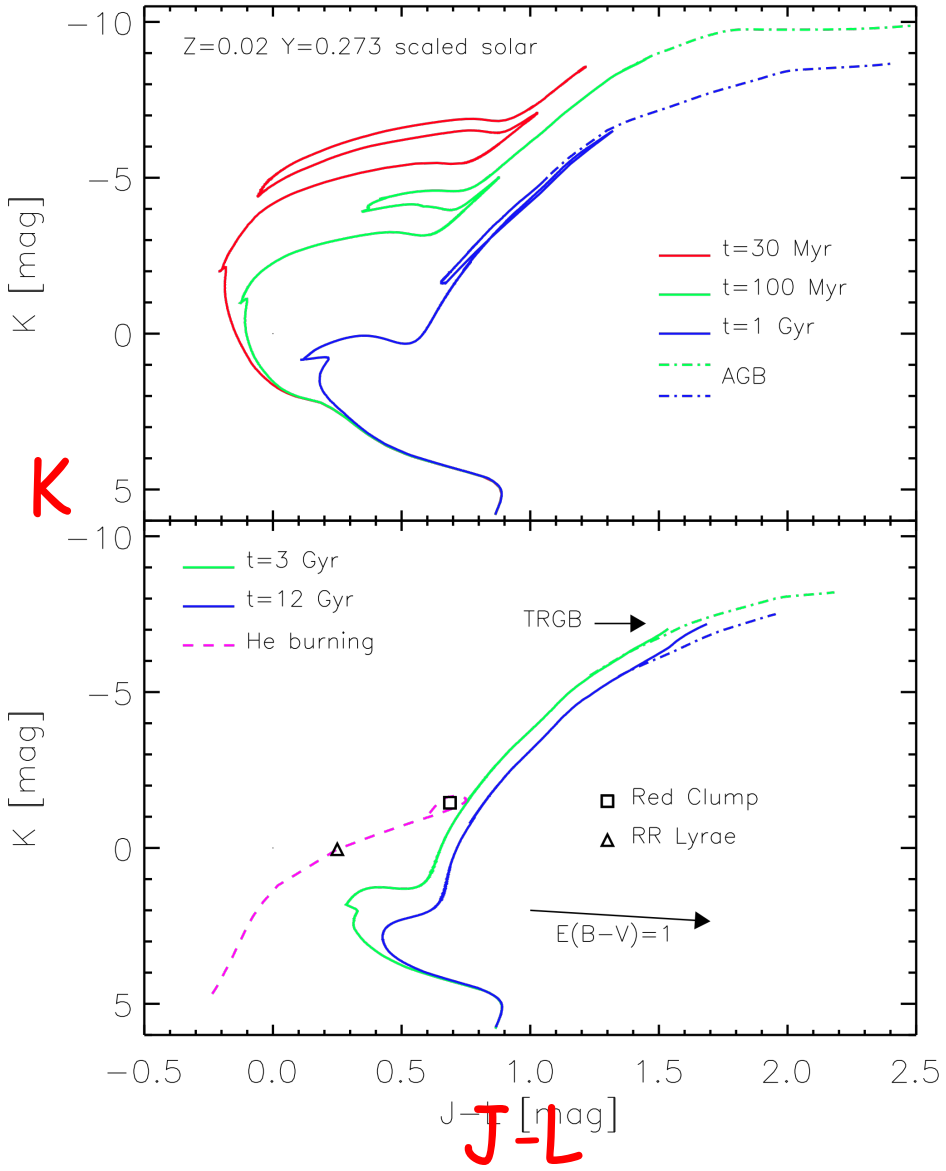
~25,000 RR Lyrae by OGLE IV

Census far from being complete!



VVV → JHK~16-18

Complete census of the old stellar populations in the Galactic spheroid



Nuclear Bulge

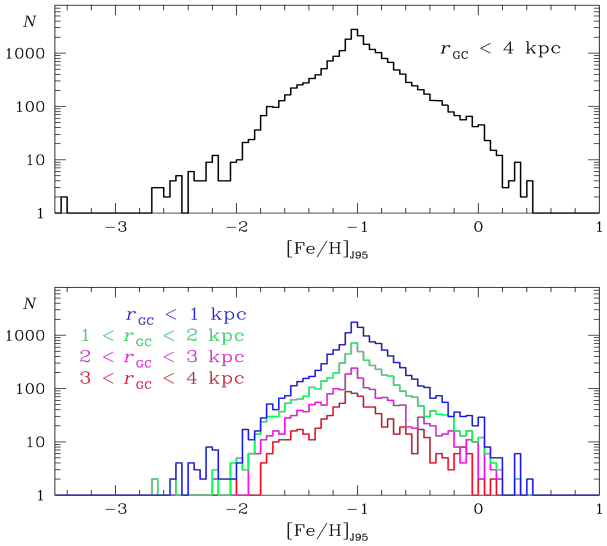
In situ vs accreted formation

μ = 14.5
Ak ~ 2.5—3
MSTO-MSK~ 3.5—5

mK ~ 22-23 (10σ)
mH ~ 23
mL ~ 20.5

TRGB
M81, Cen A → μ~28-29
Virgo (μ=30), Eridanus (μ=32)
Coma (μ=35) → SPITZER

Metallicity distribution

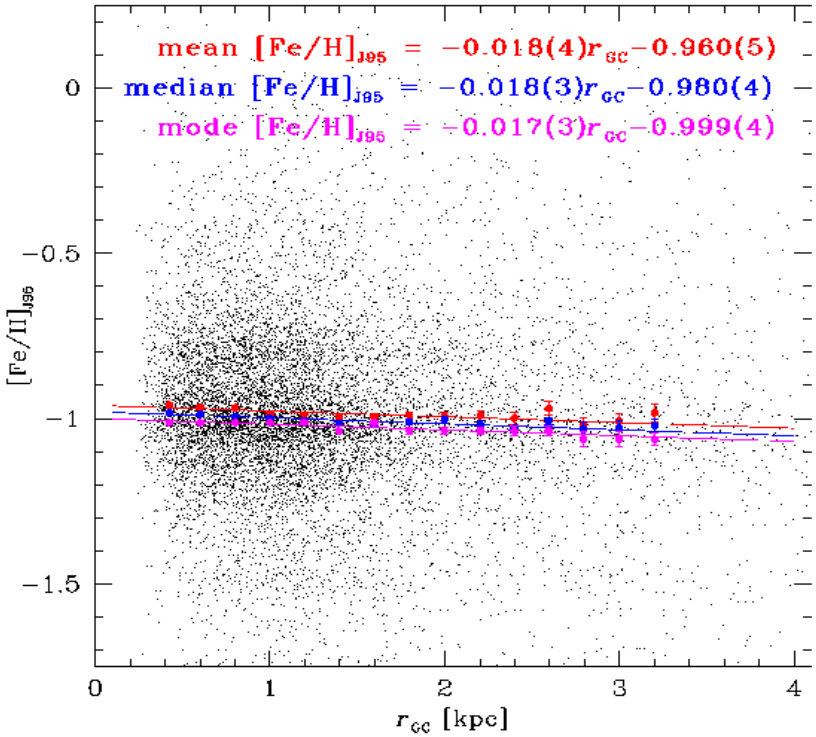


Fourier parameters of light curves
Peaked at [Fe/H]=-1

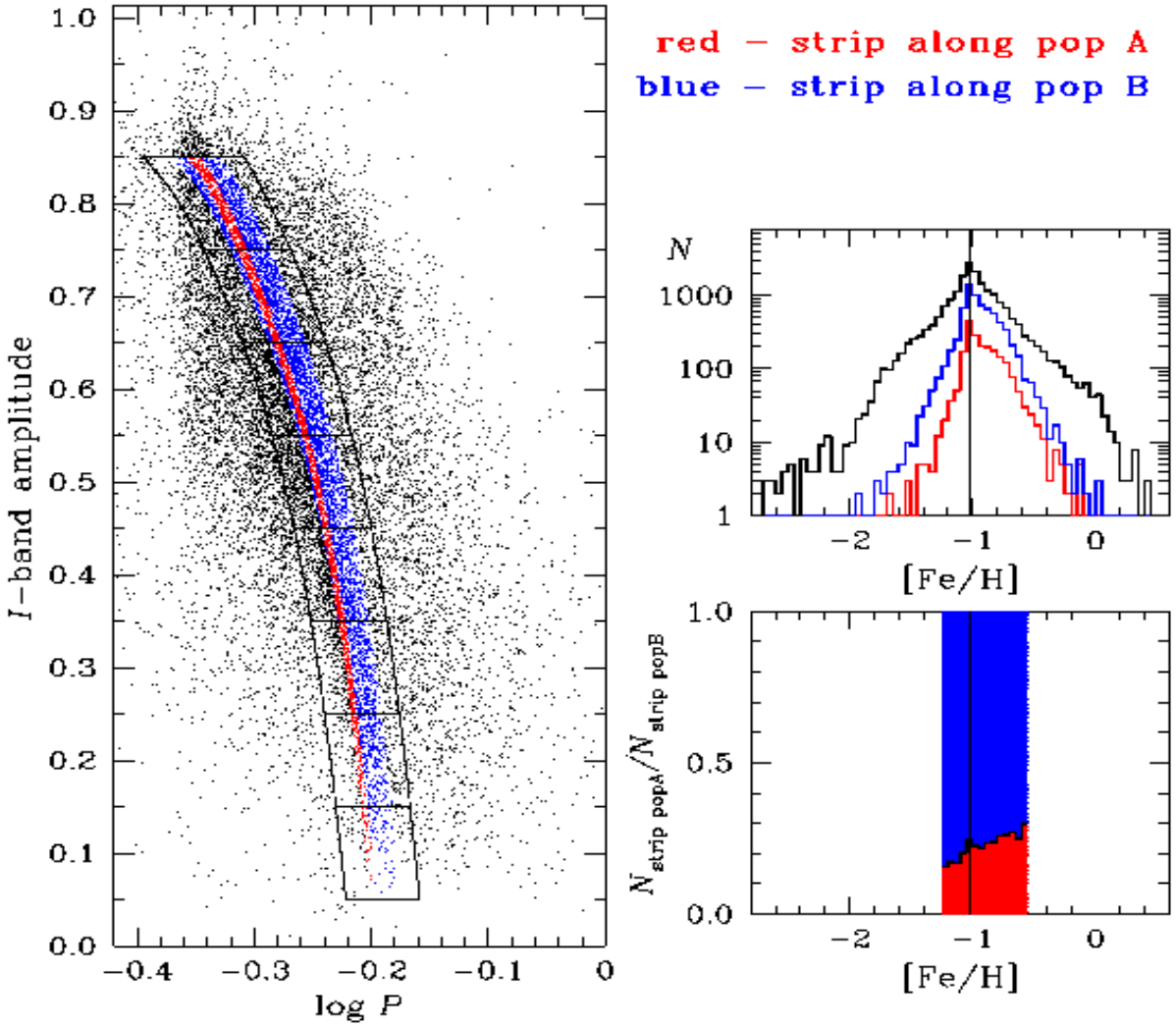
Zoccali + (2008) RC+RG stars
broad range from -1.5 to super solar

Is there evidence of a metallicity gradient?

& the α-element distribution?



New open questions:



There is tripe for SPIFFI!

GLOBAL GROWTH

Evolutionary, Pulsation, Atmosphere models → 1D vs 3D

Opacity, EOS, line identifications, molecules (NIR)

Multiband Asymmetric PSF

Integral field spectroscopy

Conclusions

8-10m class telescopes are paving the way to E-ELTs:

Photometry & Spectroscopy

Community (tech.+science) has to grow learning from our previous mistakes!