Deep optical and Near-Infrared photometry of the globular cluster ω Cen

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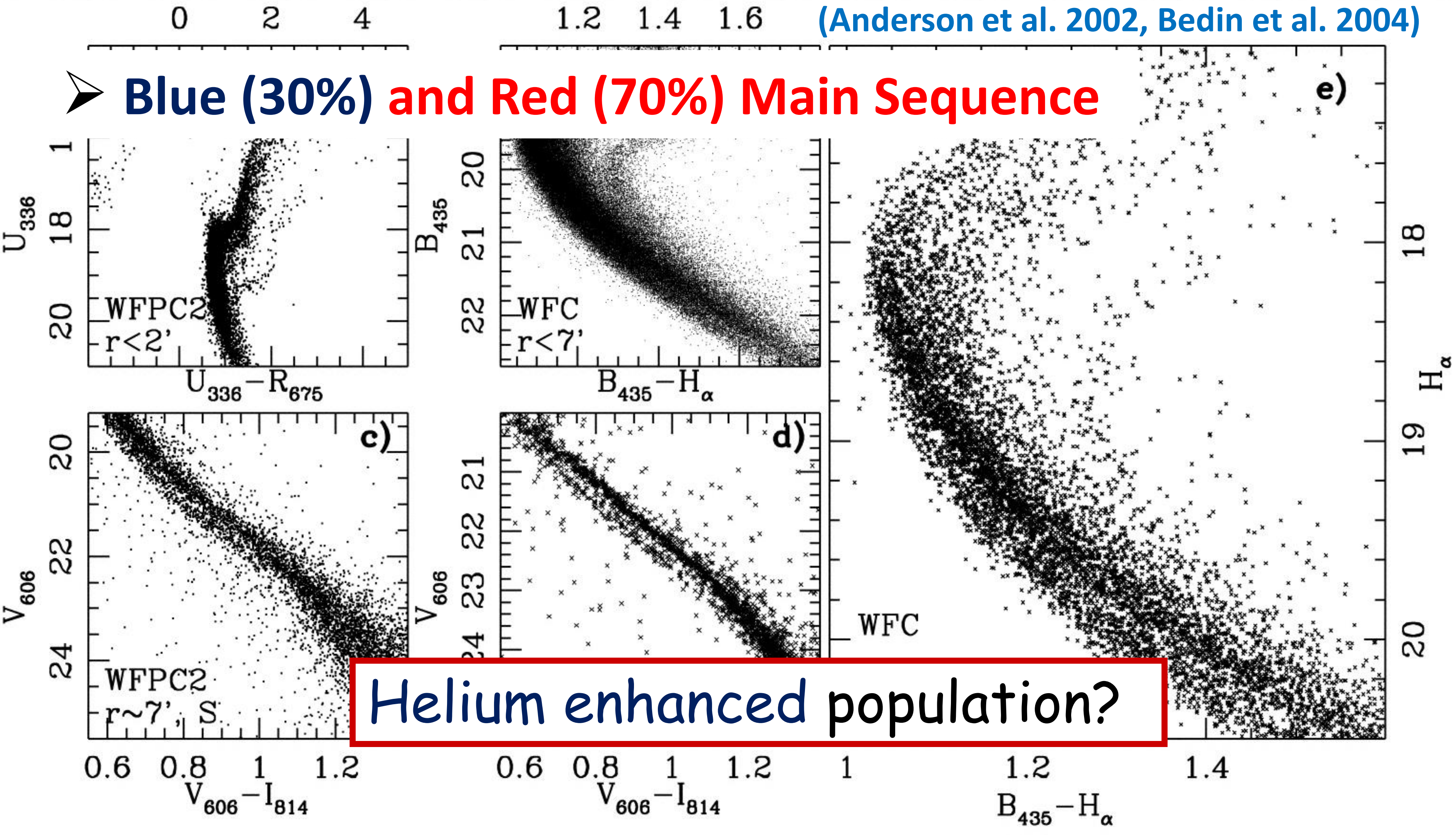
Why ω Cen?

- Most massive galactic globular cluster ($M \sim 2.5 \cdot 10^6 M_\odot$, van de Ven et al. 2006)

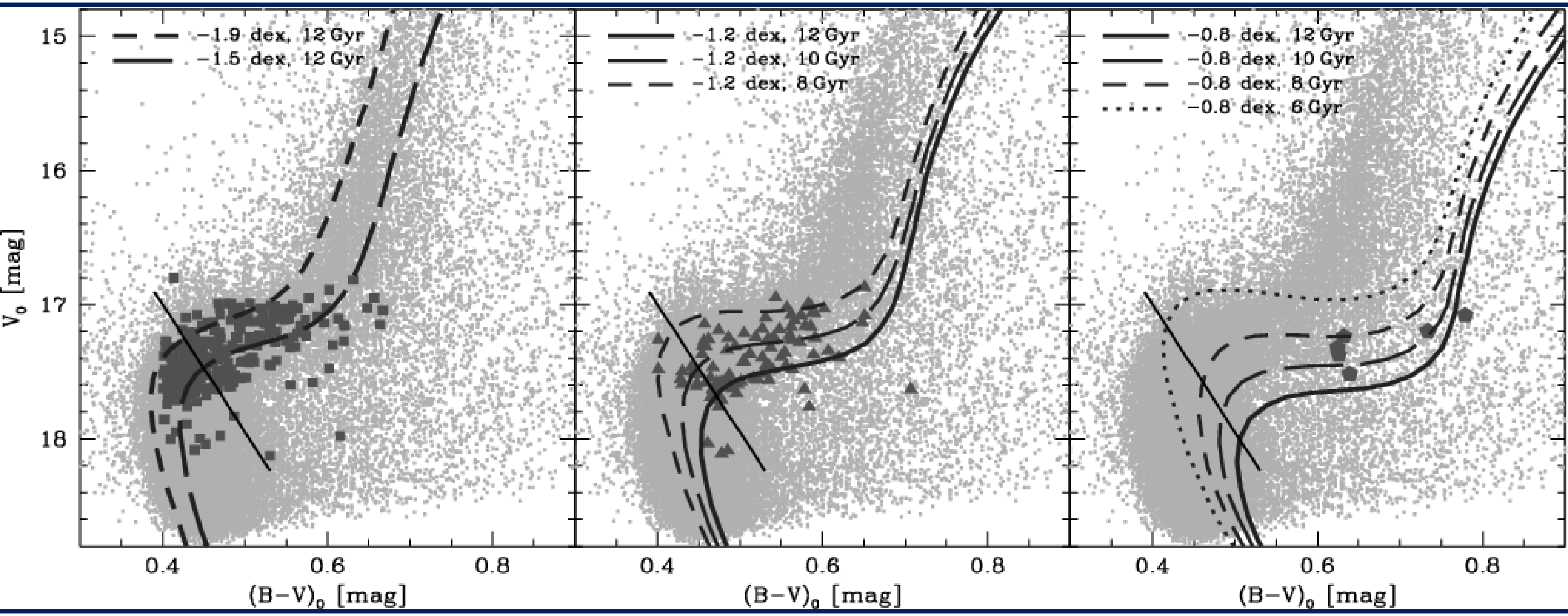
(Anderson et al. 2002, Bedin et al. 2004)

- Blue (30%) and Red (70%) Main Sequence



Helium enhanced population?

Age spread



Hilker et a. (2004): medium res. spectra of ~ 400 SGB & MSTO stars

Stanford et al. (2006): low res. spectra of 442 MSTO stars

Total age spread: ~ 3-4 Gyr

Age spread

ACS photometry+Giraffe spectra of 80 SGB stars

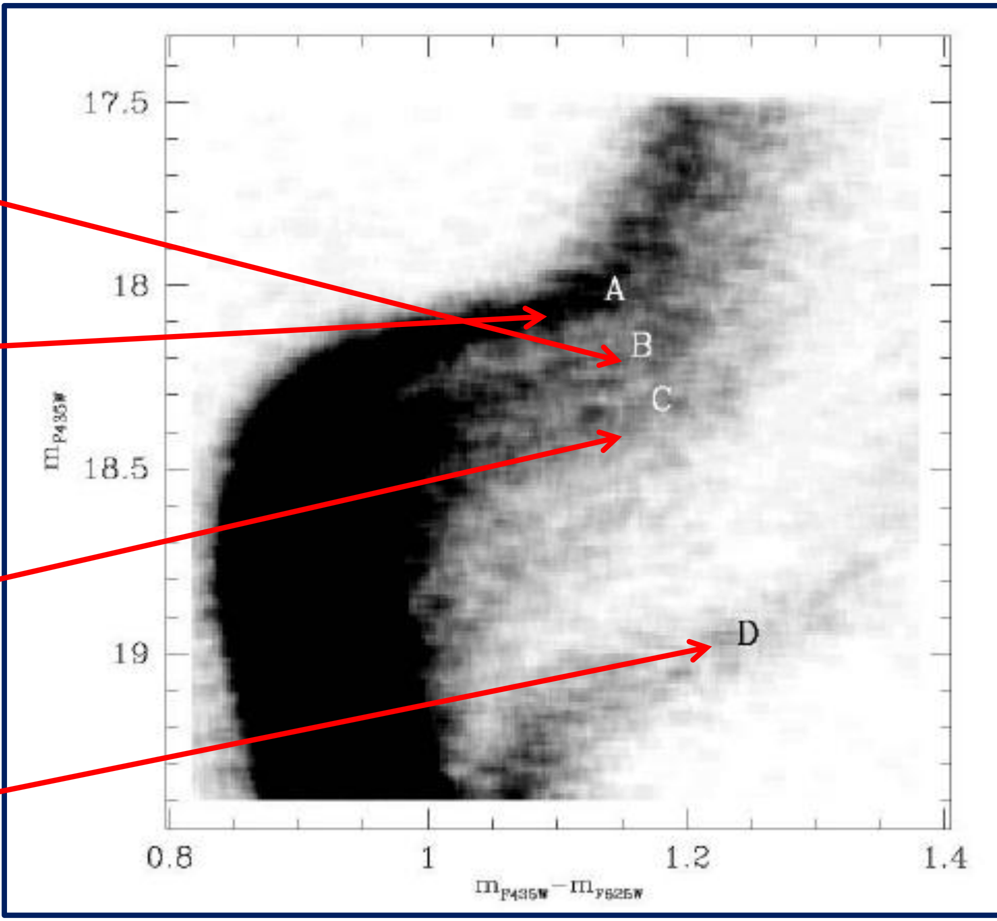
Villanova et al. (2007)

✓Old (13 Gyr) metal-poor ([Fe/H] ~ -1.7 dex) pop.

✓ Young (9-10 Gyr) metal-poor pop. ([Fe/H] ~ -1.7 dex)

✓ Young (9-10 Gyr) intermediate-metallicity ([Fe/H] ~ -1.4 dex) pop.

✓ Old (13 Gyr) metal-rich ([Fe/H] ~ -1 dex) pop.

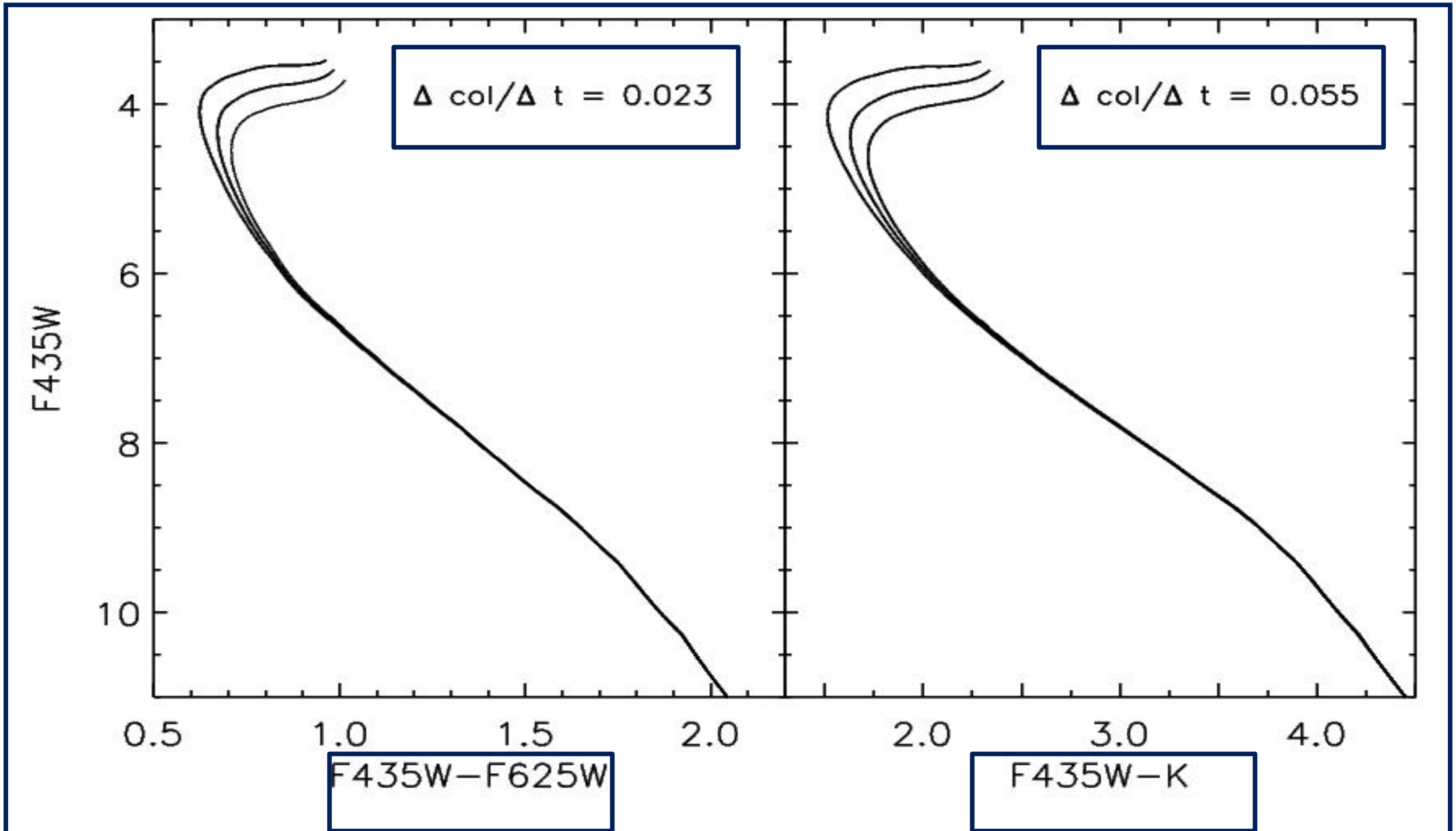


NIR CMD PROS ☺

- **Much less affected by reddening & diff. reddening**
- **Faint MS stars are brighter in NIR** than in optical
- Calibration: 2MASS (using SOFI/ISAAC/HAWK-I data as a bridge)

Pisa Evolutionary models (Cariulo et al. 2004) for **t = 10, 11, 12 Gyr & Z = 0.0006** (CTRs by Brott & Hauschildt 2005)

The F435W-K color-age derivative is a factor of 2 larger than the F435W-F625W one.



MAD first light!

Two nights:

03/04/2007 → 5 Ks (5×24s), 3 J (5×24s) →

T_{tot} (K) = 600s, T_{tot}(J) = 360s

04/04/2007 → 4 Ks (10×24s), 3 J (10×24s) →

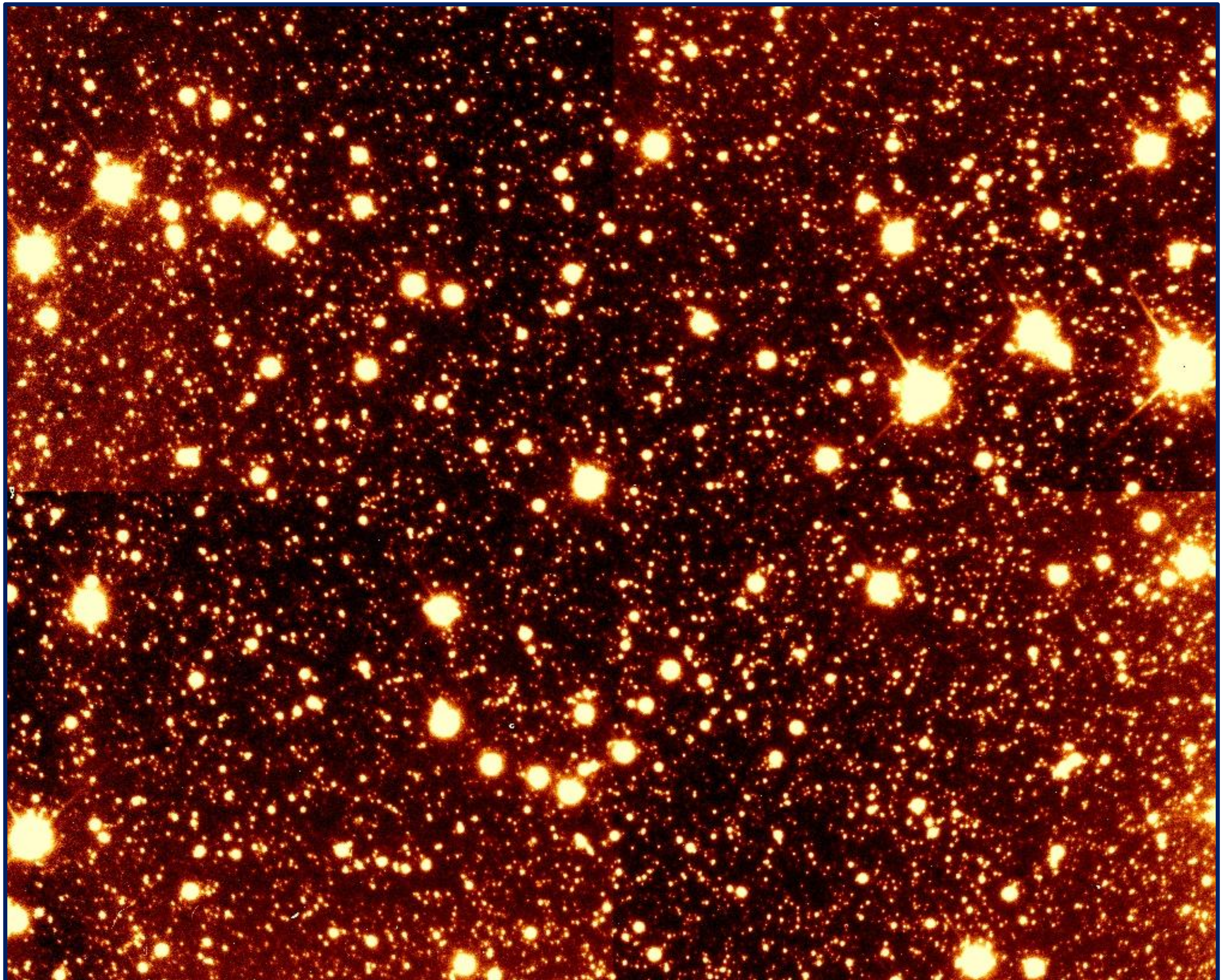
T_{tot}(K) = 960s, T_{tot}(J) = 720s

Dimm seeing: ~ 0.7-1.2″

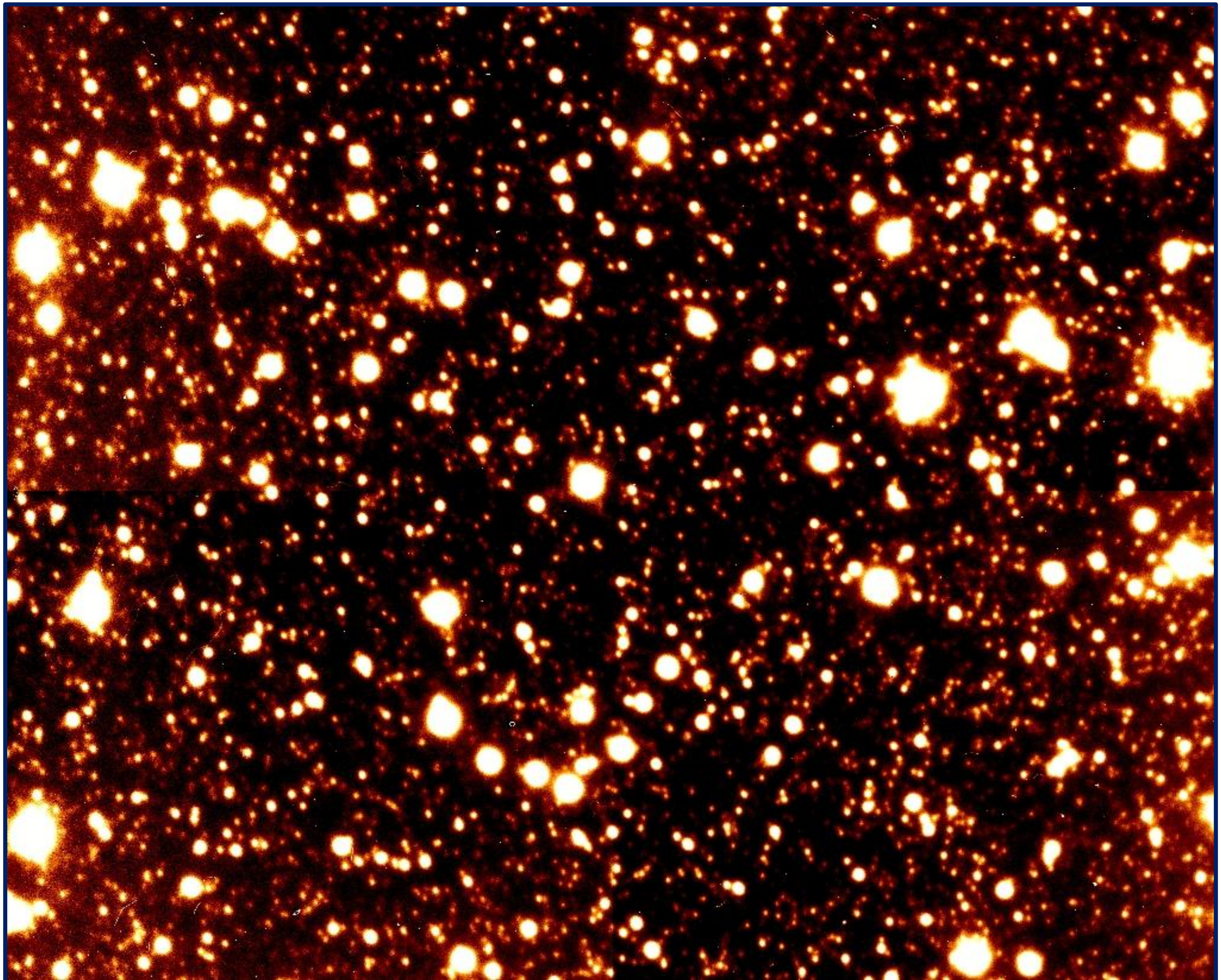
Image FWHM: K: $\lesssim$ 0.1" & J: $\lesssim$ 0.25"

Credit: M. Nonino

1 Ks-band image, April the 3th 2007, t_{exp} = 120s

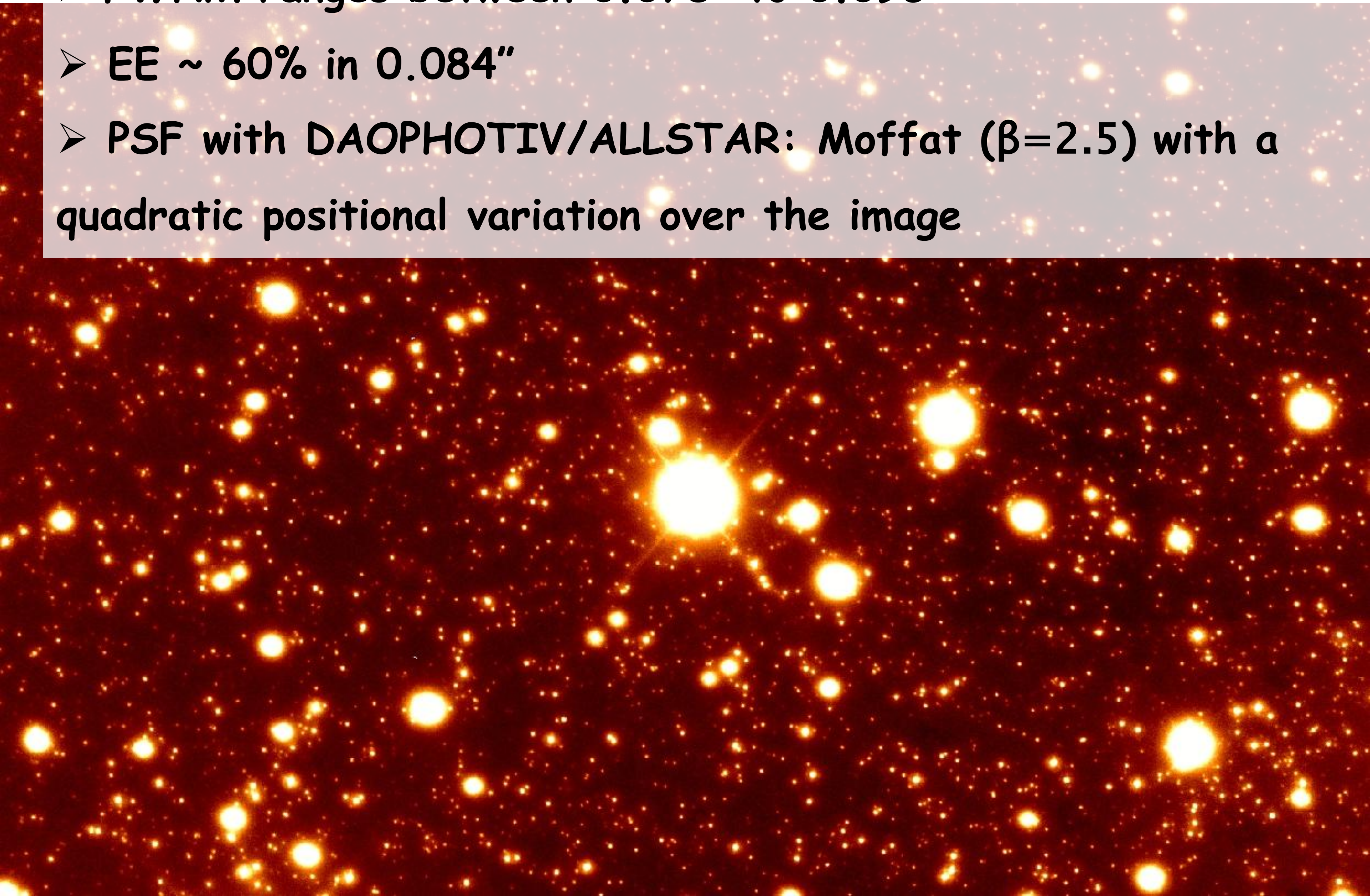


1 J-band image, April the 3th 2007, t_{exp}=120s



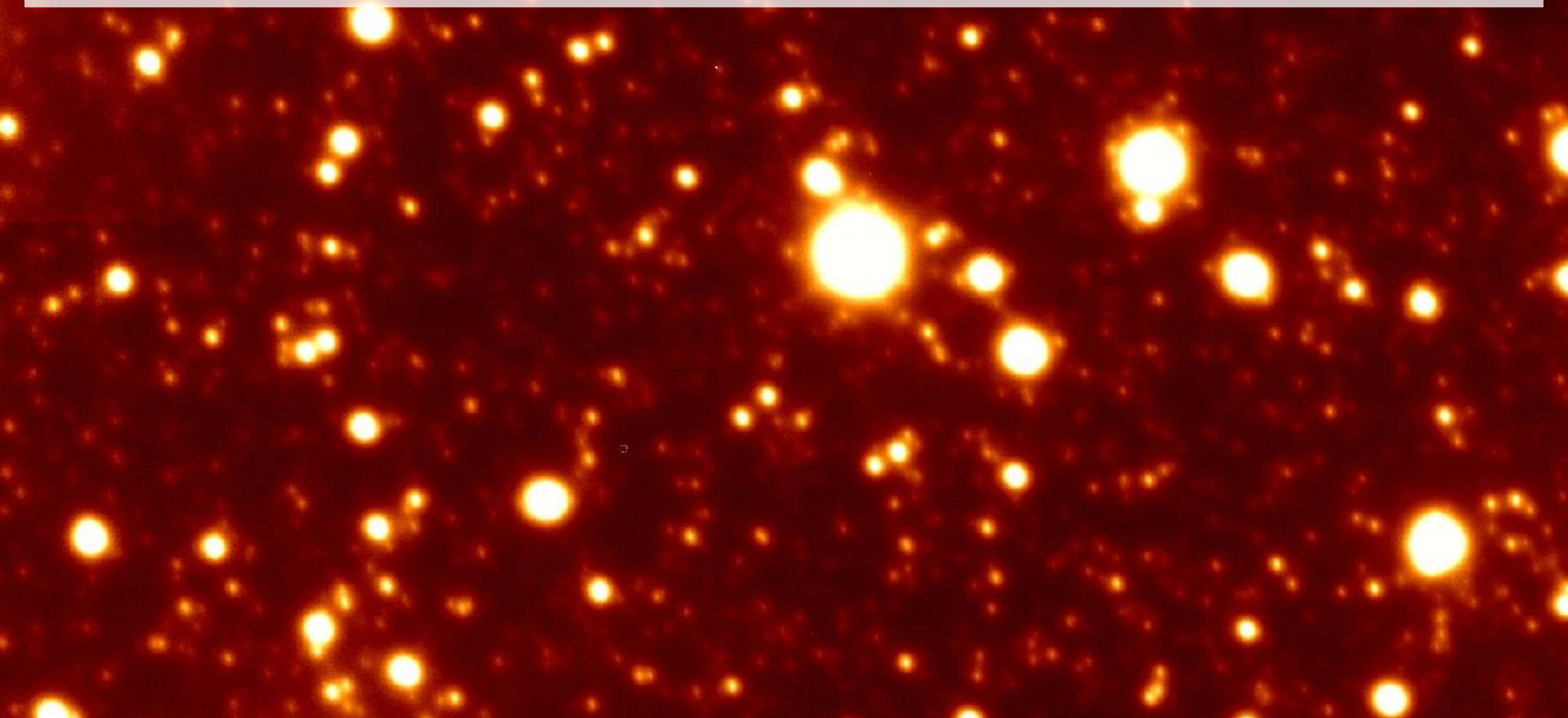
Median K image, April the 4th

- FWHM ranges between 0.078" to 0.095"
- EE ~ 60% in 0.084"
- PSF with DAOPHOTIV/ALLSTAR: Moffat ($\beta=2.5$) with a quadratic positional variation over the image



Median J image, April the 4th

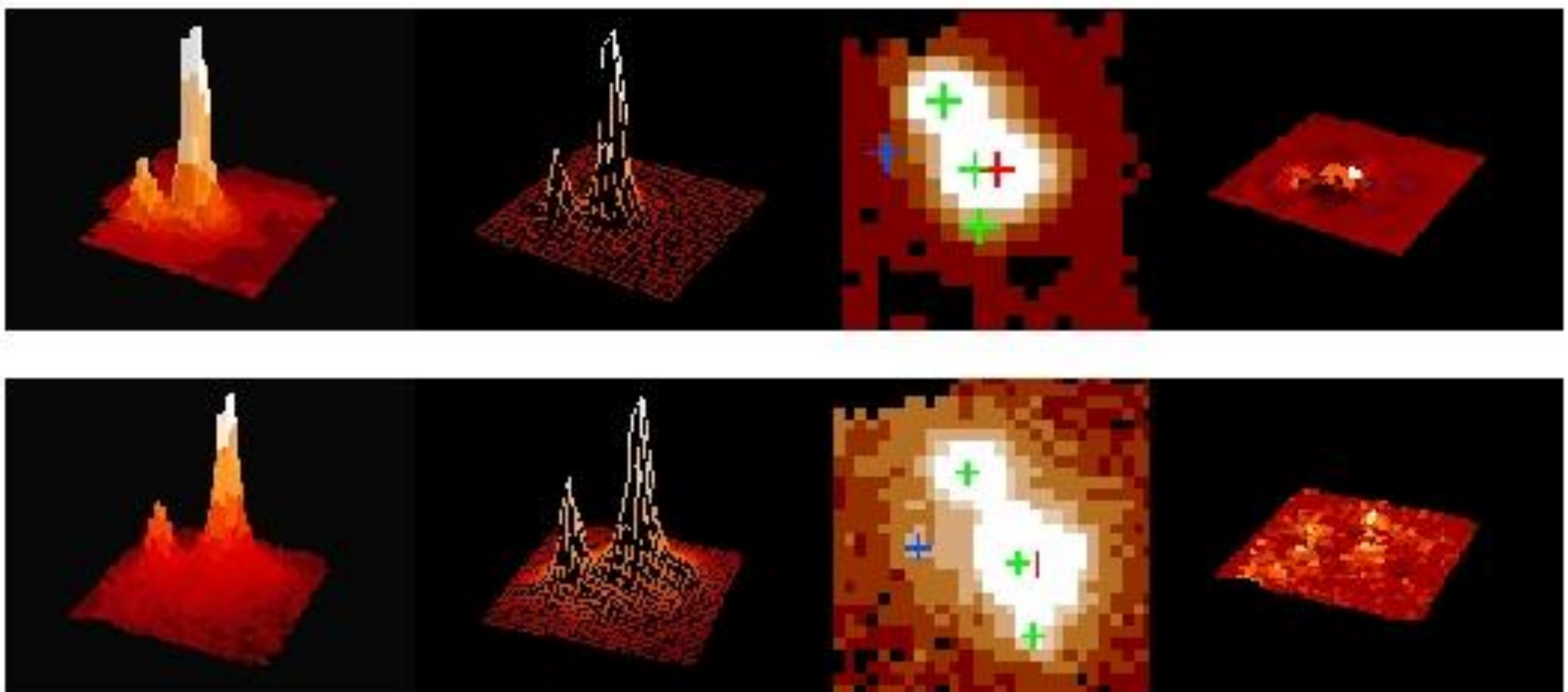
- FWHM ranges between 0.21" to 0.25"
- EE ~ 60% in 0.22"
- PSF with DAOPHOTIV/ALLSTAR: Moffat (β=1.5) or Lorentz with a linear positional variation over the image



Strategy: combine MAD & ACS images

- B, R, H_α → ACS/HST, 60 frames

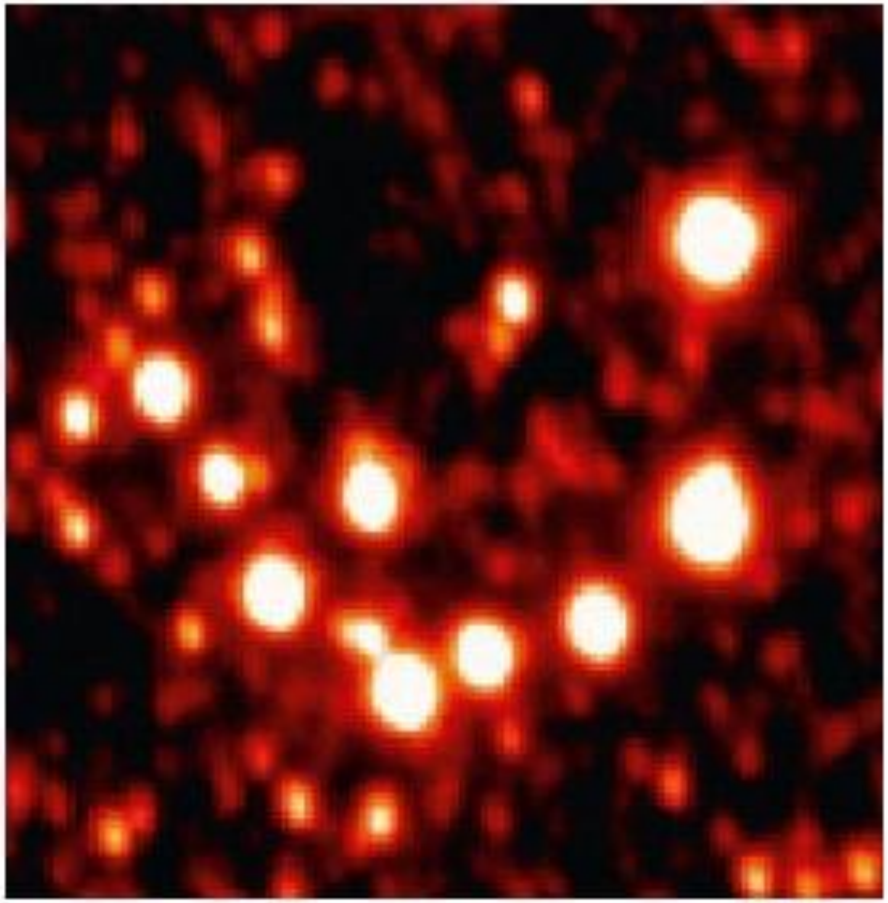
- Perform simultaneous optical (60)-NIR (15) PSF-fitting photometry with ALLFRAME



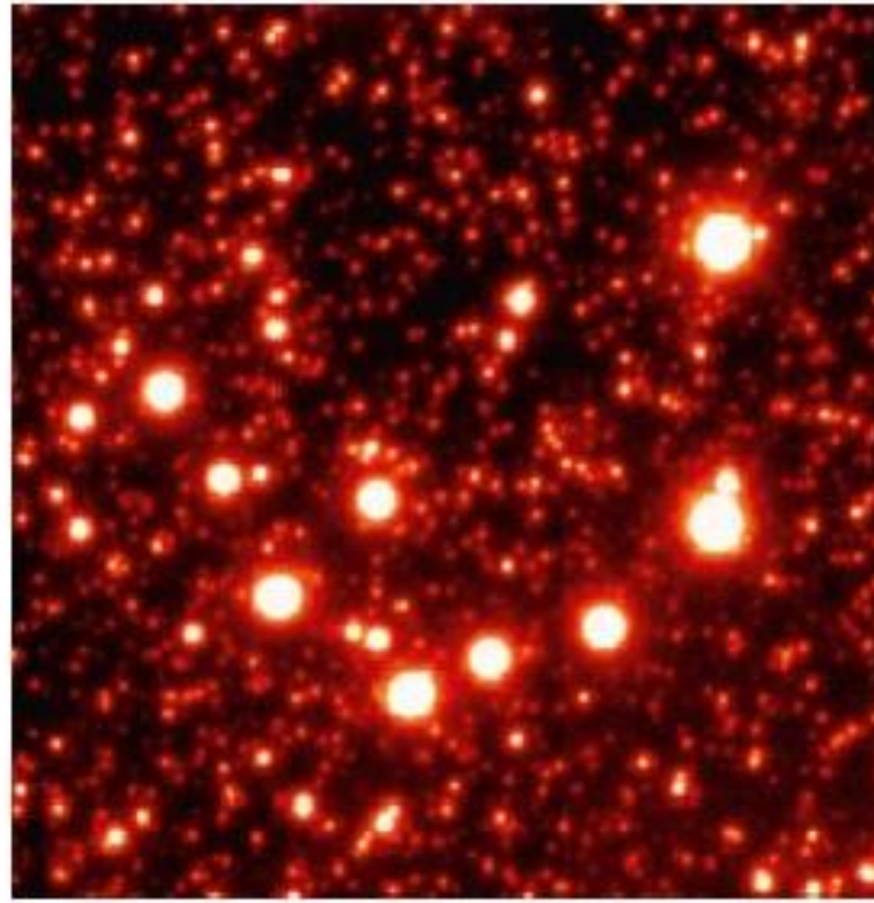
- Final combined catalog: ~ $7.5 \cdot 10^5$ stars (~ 49,000 stars with K mag & ~ 41,000 with J mag)

- MAD completeness: we detected on MAD images ~ 90% (Ks) and ~ 75% (J) of stars detected on ACS images

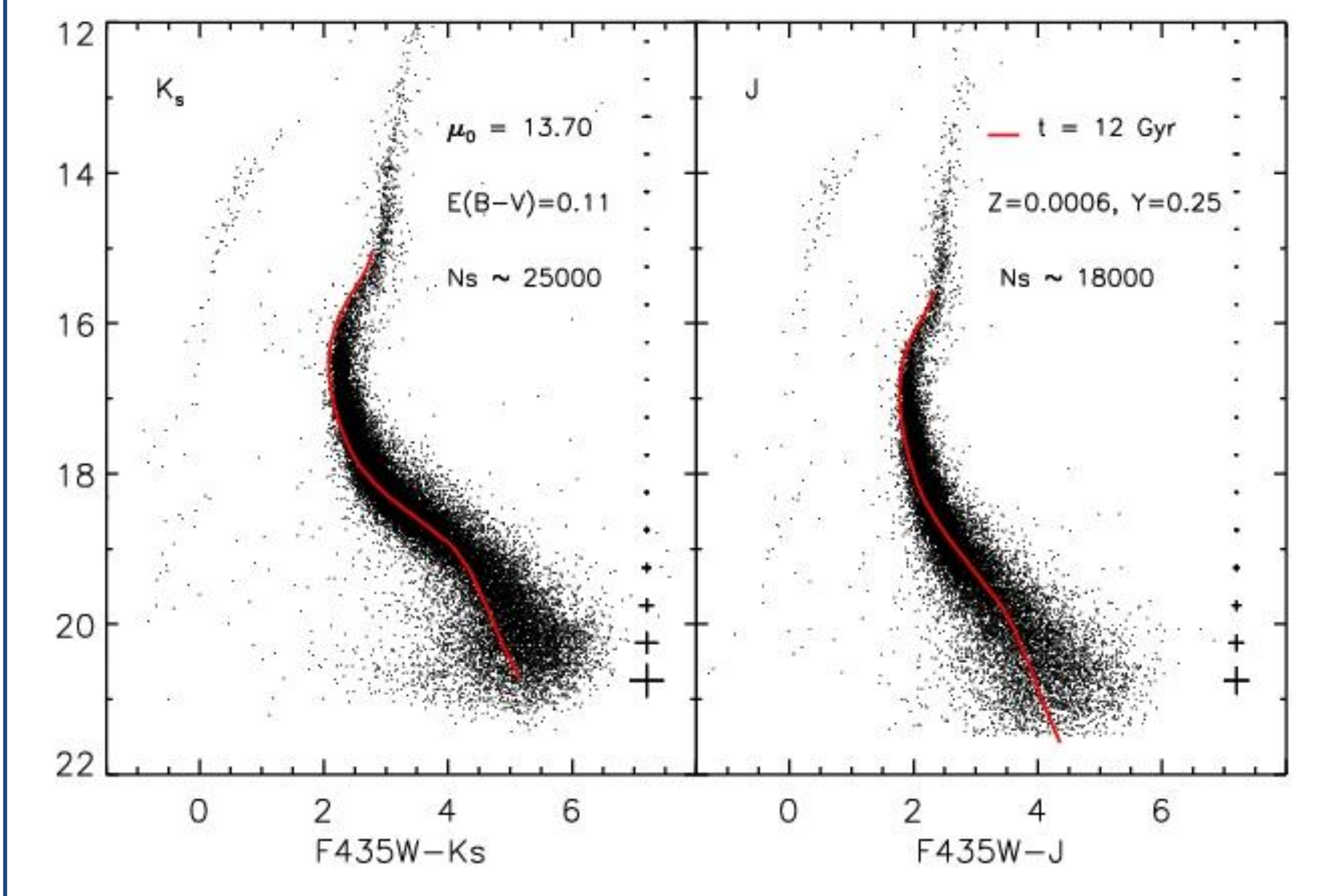
- Calibration to 2MASS system using a sample of ~5,000 local standard stars (SOFI+ISAAC)



ISAAC@VLT:
FWHM ~ 0.6"



MAD@VLT
FWHM ≤ 0.1"



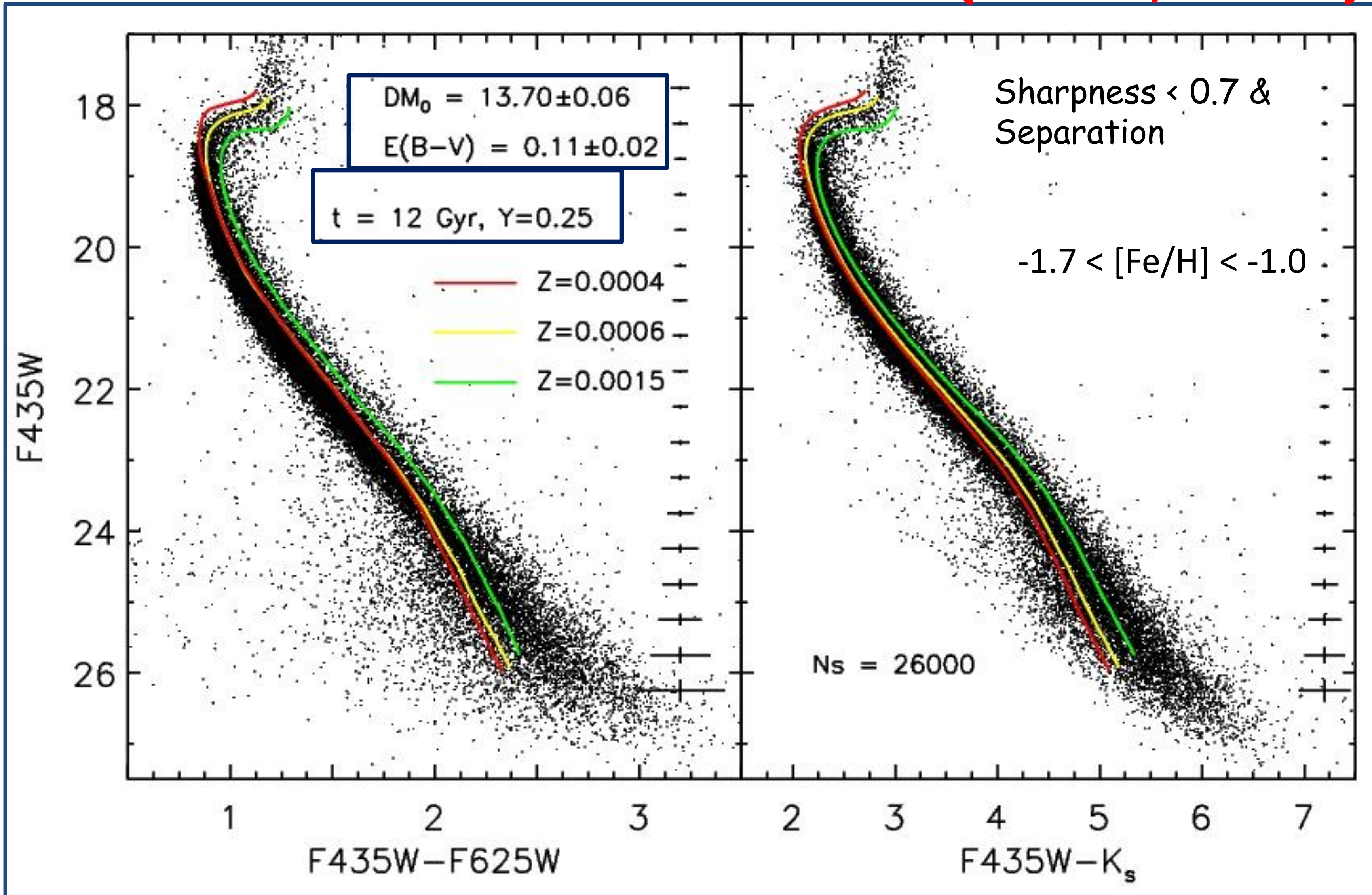
(Bono et al. 2009)

MAD@VLT

K~20.5 & J~20 with SNR =10

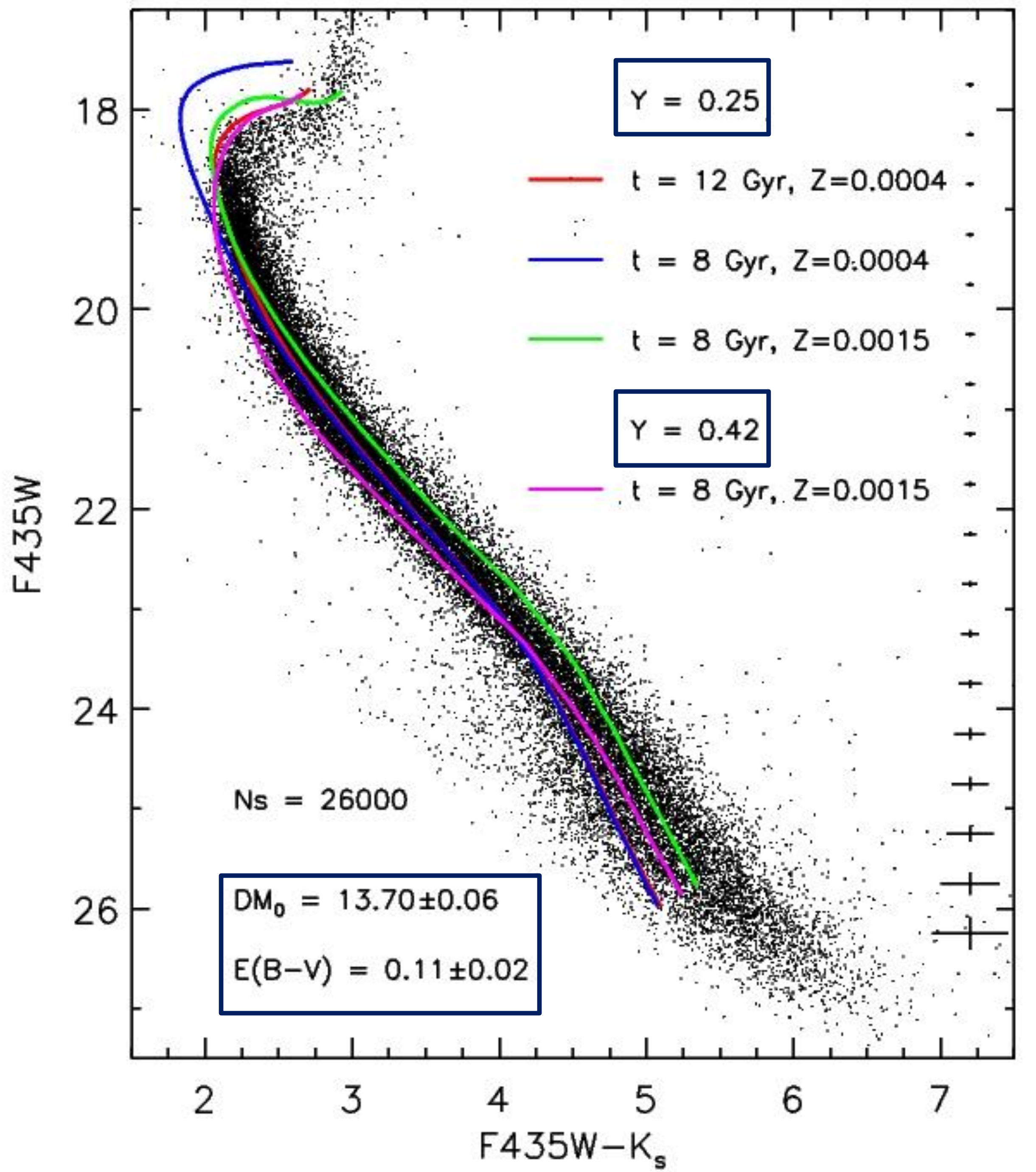
First time that we can constrain ω Cen parameters adopting simultaneously the TO and the lower MS.

We detected MS stars with M ≈ 0.3M⊙ (Ks ≈ 21, SNR~3)



The age spread in ω Cen is limited ($\Delta t \lesssim$ 2 Gyr) for a fixed distance modulus and reddening

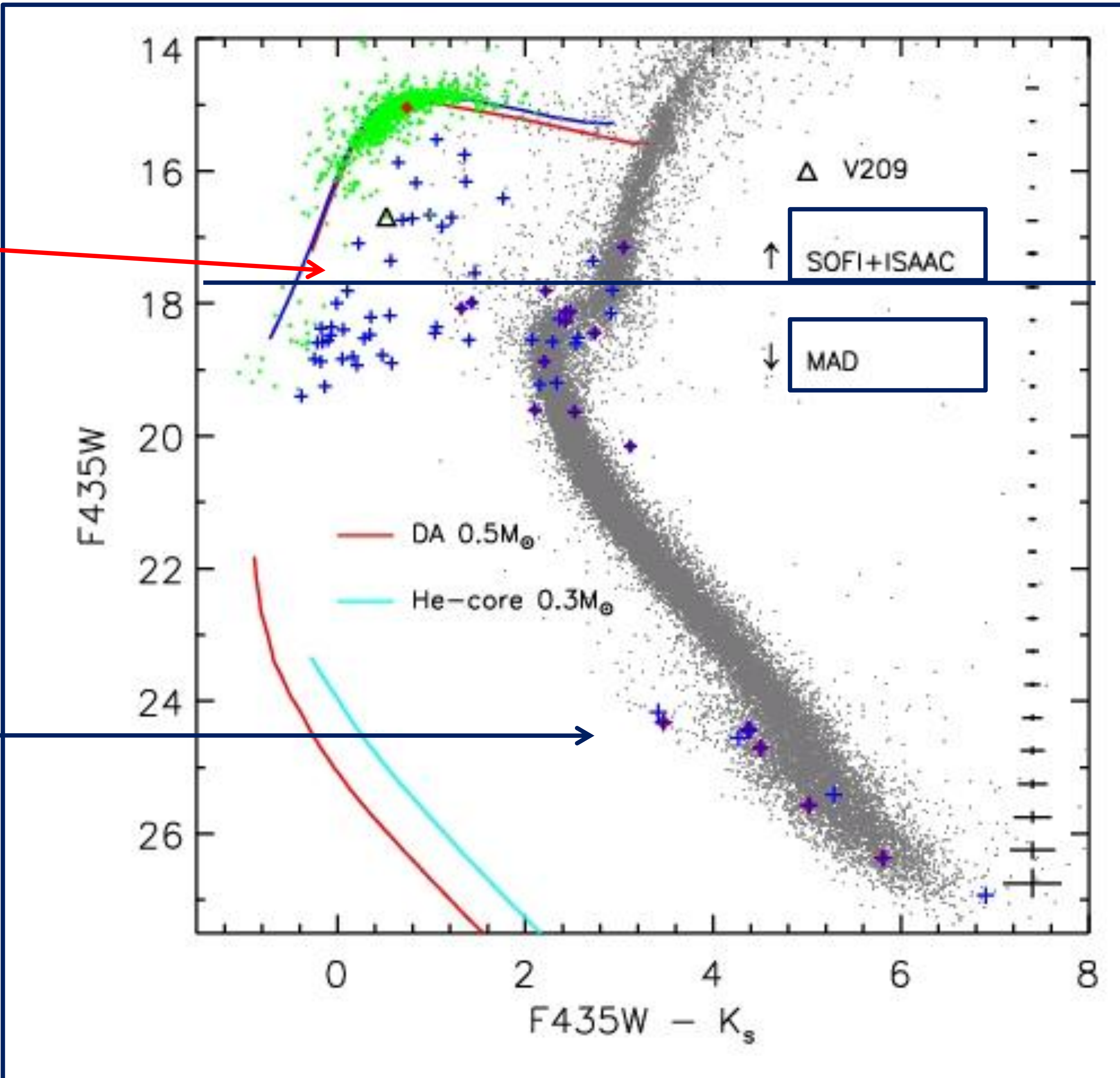
The 8 Gyr metal-intermediate helium-enhanced isochrone is systematically bluer than the cluster MS



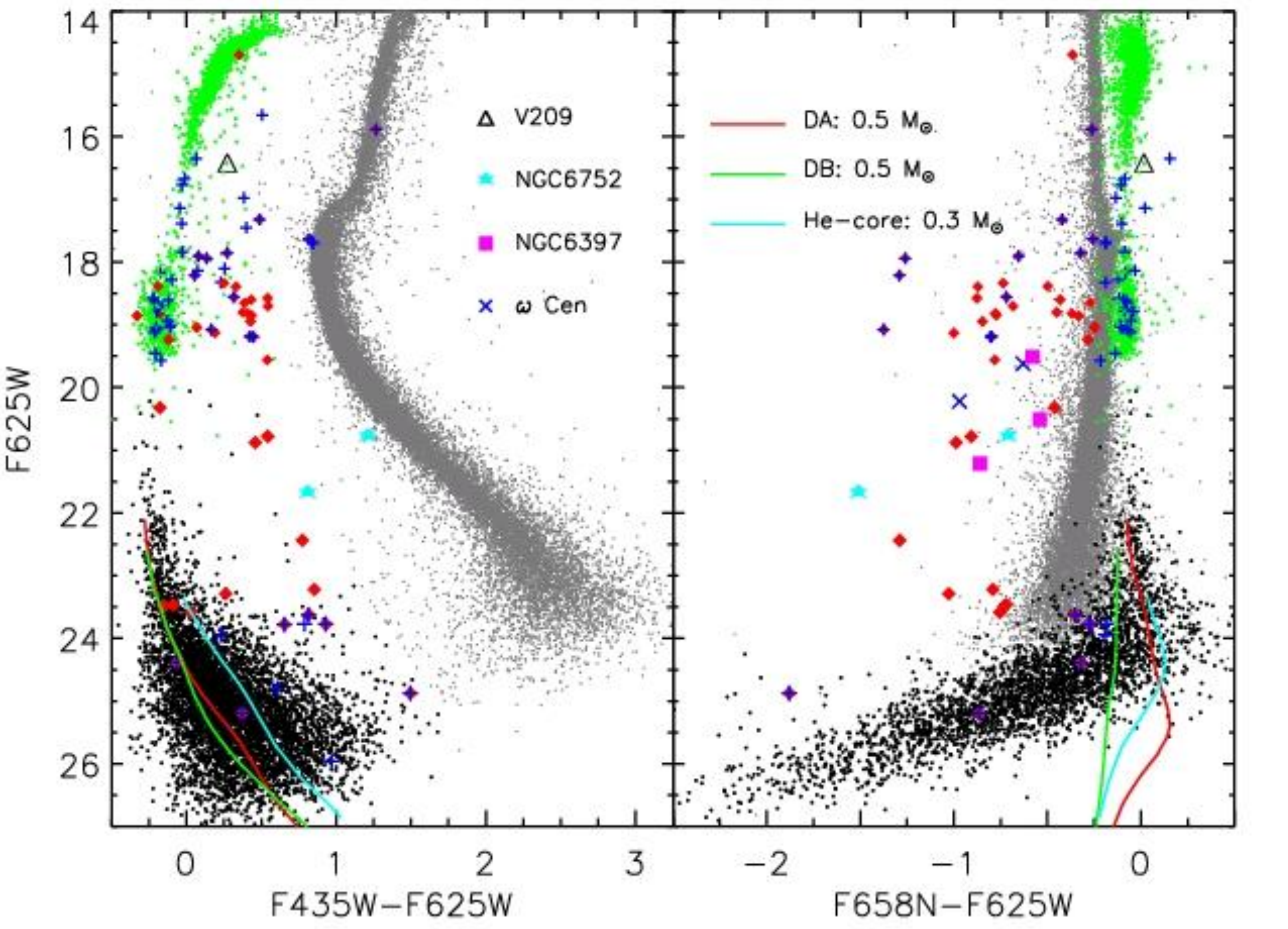
Candidate HBs & WDs in the IR

HB stars showing NIR excess

NIR excess: 4-5 mag in K!



ACS images:Ha excess



Conclusions

To rule out possible uncertainties on the zero-points we plan to collect new J,K images with HAWK-I (DDT?)

- ✓ We identified ~50 HB stars with NIR excess, ~30 with Hα excess. 15 HBs are in common, and the 87% of them show both Hα and NIR excess.
- ✓ We identified for the first time in a globular cluster 9 WD candidates with NIR excess (6 of them show also Hα excess)

Future perspectives

For a double check need to apply for DDT observations with HAWK-I to fix possible zero-points problems or systematics