

# A wide view of different sub-populations in NGC2808



**STScI** | SPACE TELESCOPE  
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**DECam at 10 years workshop, Tucson, September 12th, 2022**

# Why NGC2808?

- **2<sup>nd</sup> most massive Galactic globular cluster** (after  $\omega$  Cen)
- [Fe/H] spread: **NGC2808 0 dex** ( $\omega$  Cen  $> 1$  dex)
- Three main sequences ( $\omega$  Cen 3+ MSs)
- Tidal radius  $> \sim 15$  arcmin ( $\sim 45$ pc) ( $\omega$  Cen  $> \sim 1$  deg,  $\sim 100$ pc)
- **Light elements enhancement and O/Na anti-correlation**

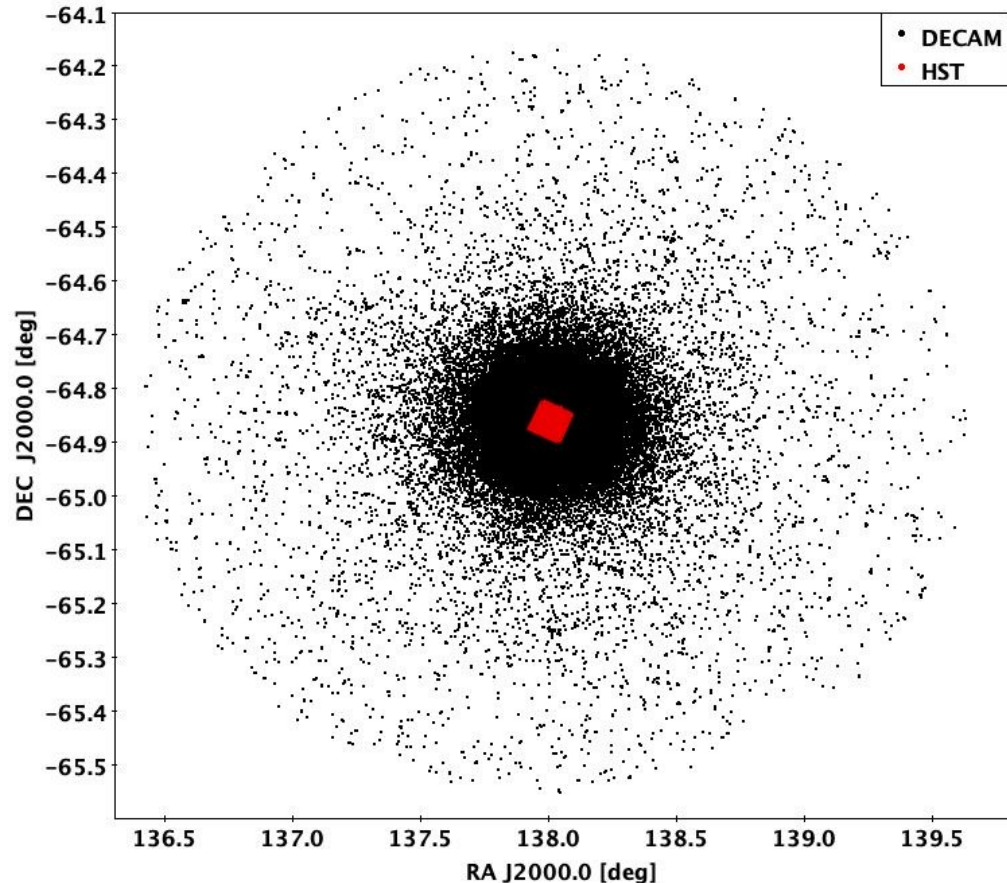


# NGC2808 data

**NGC2808:** archival HST data for the core and DECam data covering the full cluster extent.

## Main goals:

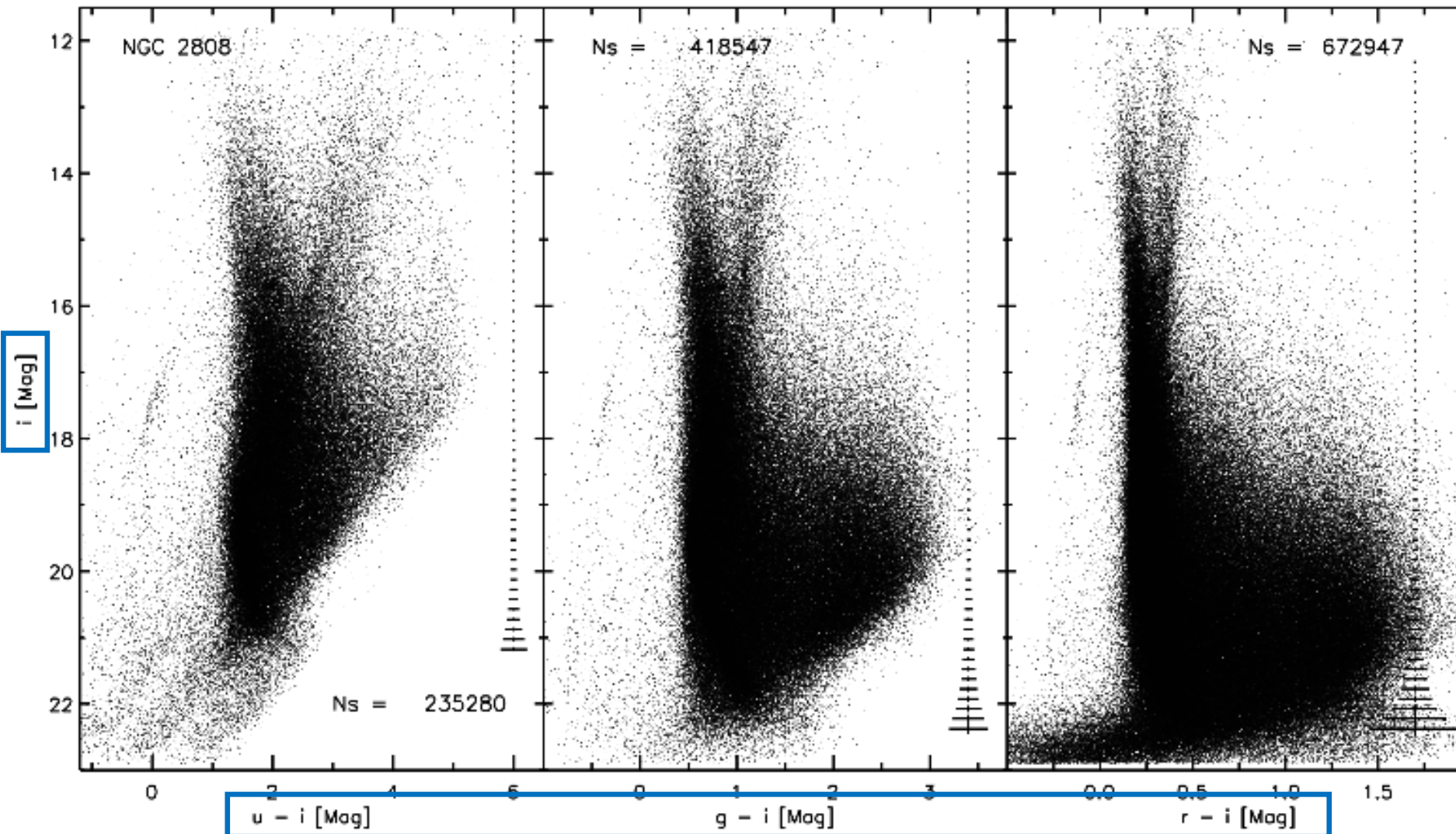
- radial distribution of different sub-populations and stellar evolutionary phases
- new truncation radii and presence of extra-tidal stars or a stellar halo



- ~ 800 *u,g,r,i* DECam@4m-Blanco images (FoV ~ 3° x 2°)
- *F275W, F336W, F438W, F606W, F814W* archival **WFC3 & ACS**@HST images (FoV ~ 3' x 3')

# DECam color-magnitude-diagrams

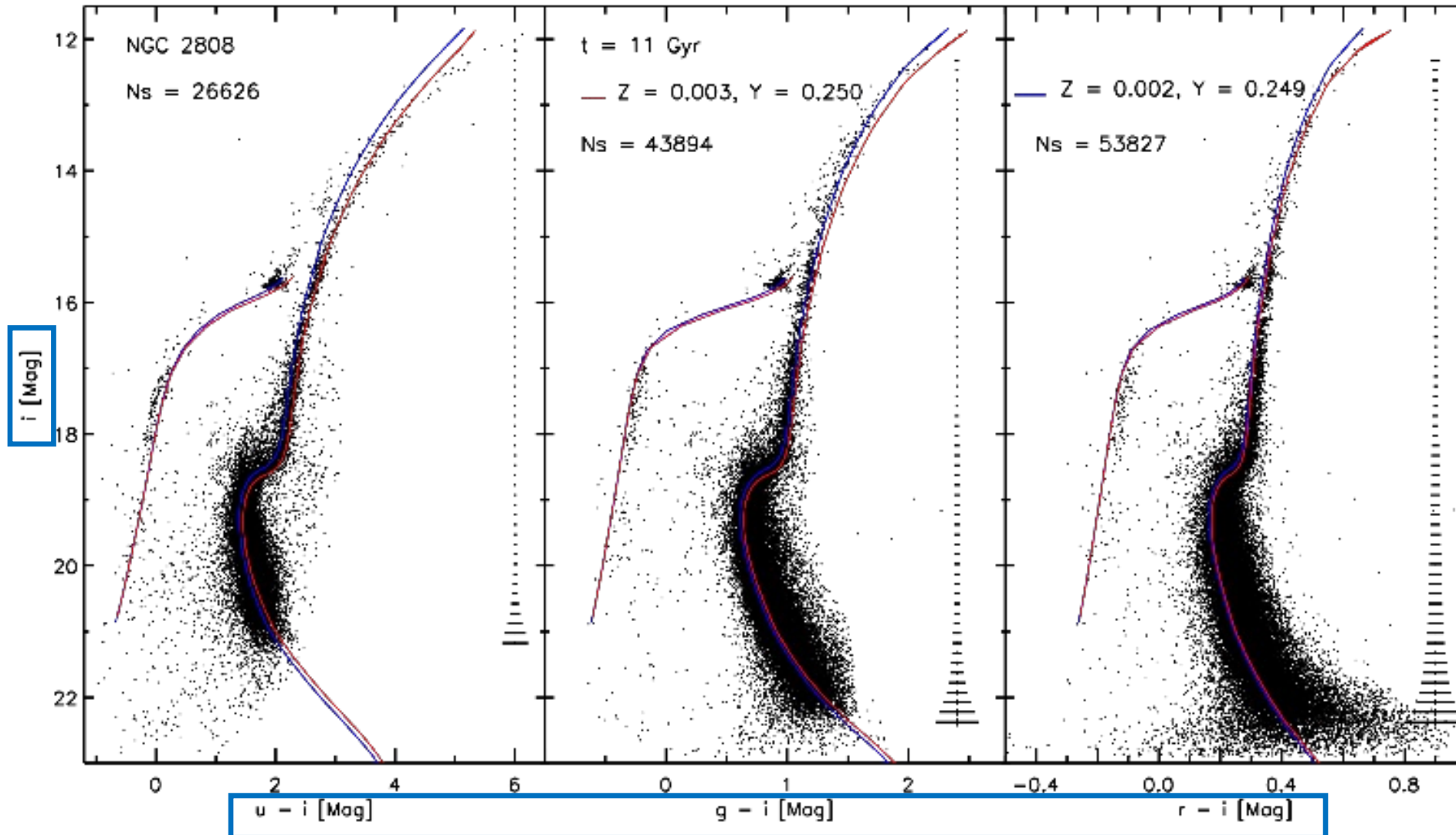
**Contamination by field stars:** *no HST or Gaia proper motions available for the faintest stars*



**u filter:** increased sensitivity to temperature and metallicity => **better separation of cluster and field stars**

# DECam color-magnitude-diagrams

Used **color-color-magnitude planes** to separate cluster & field stars as in Calamida et al. (2017, 2020)

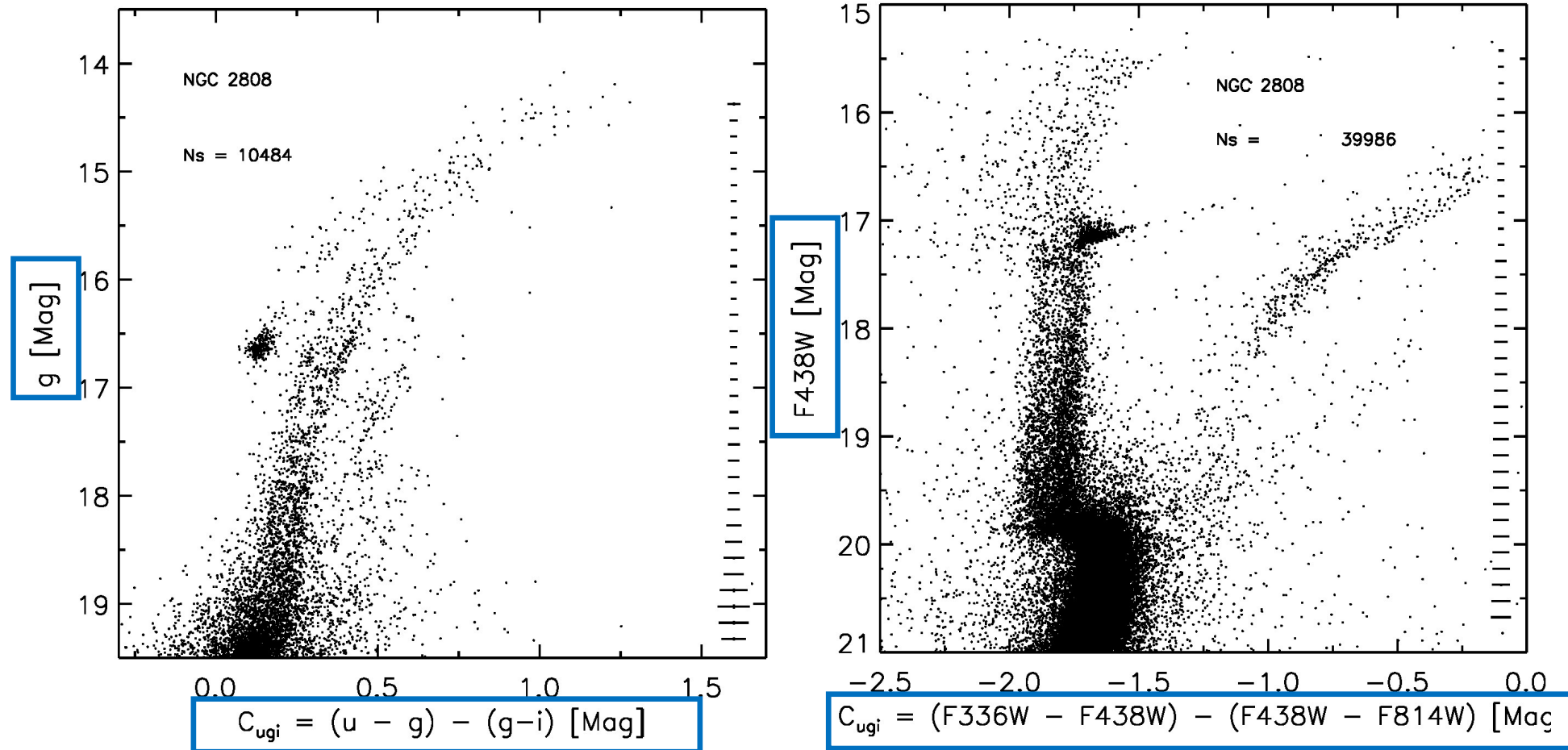


**u filter:**  
increased  
sensitivity to  
temperature and  
metallicity =>  
better separation  
of cluster and  
field stars

**Models and  
Observations are in  
good agreement**

# The Cugl index

- **Cugl = (u - g) - (g - i)** -> DECam photometry
- **Cugl = (F336W - F438W) - (F438W - F814W)** -> HST photometry

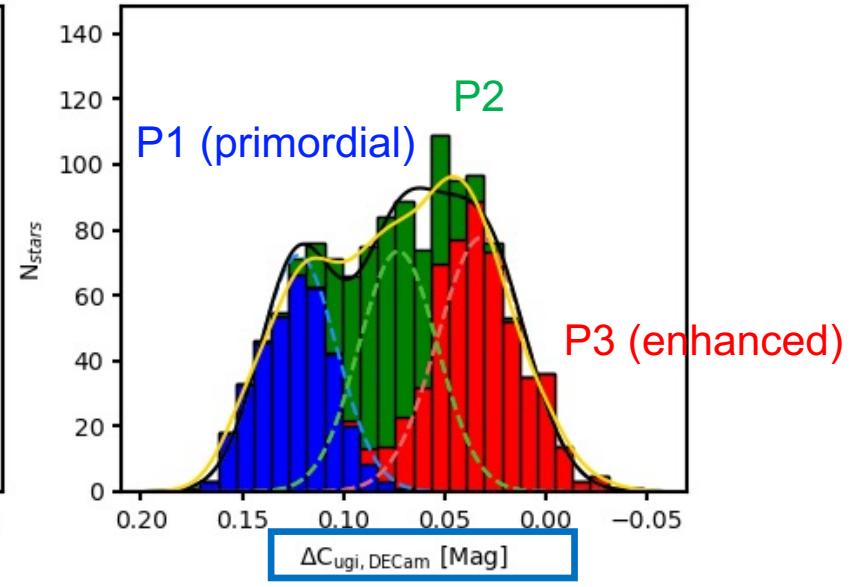
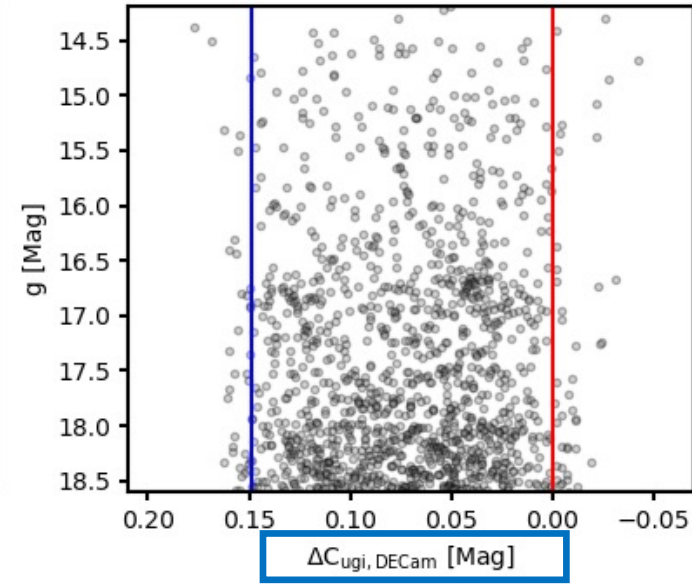
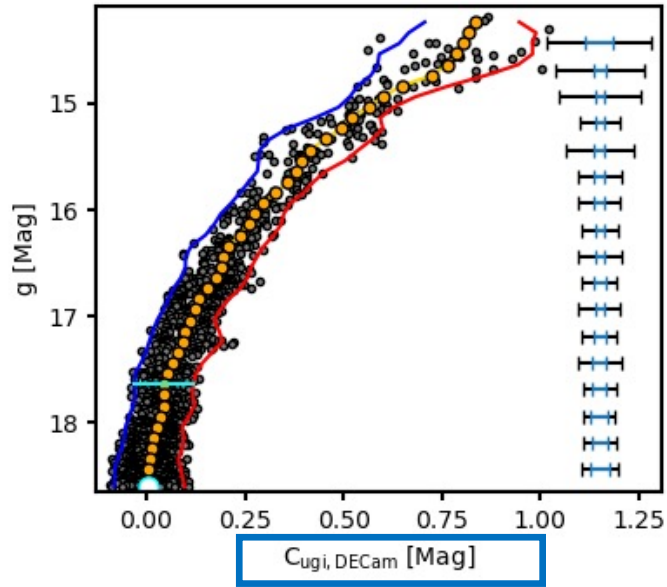


u (F336W) filters very sensitive to light-element abundances

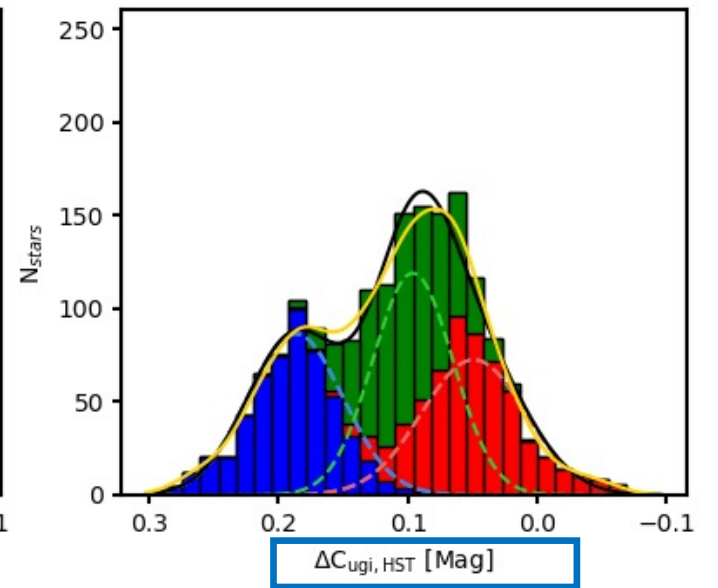
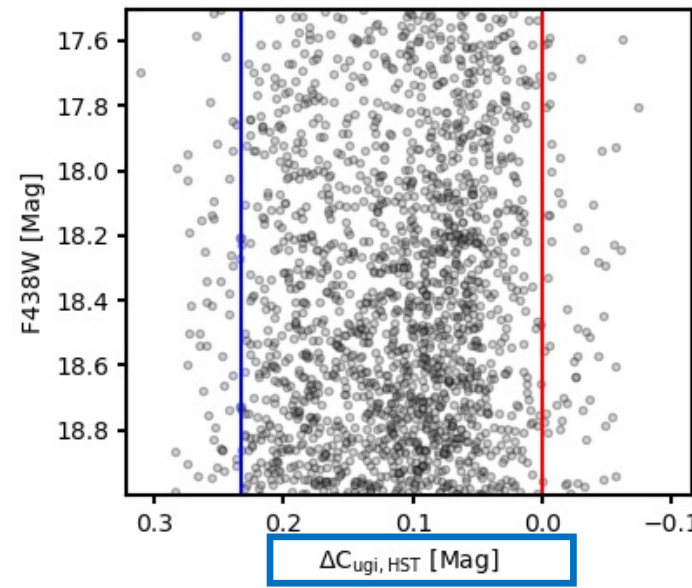
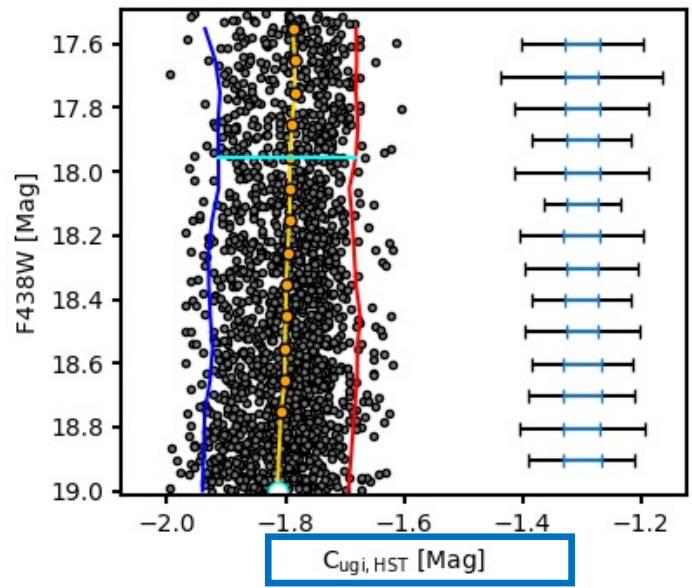
# Gaussian Mixture Modeling

Three-component GMMs best fit the data

DECam



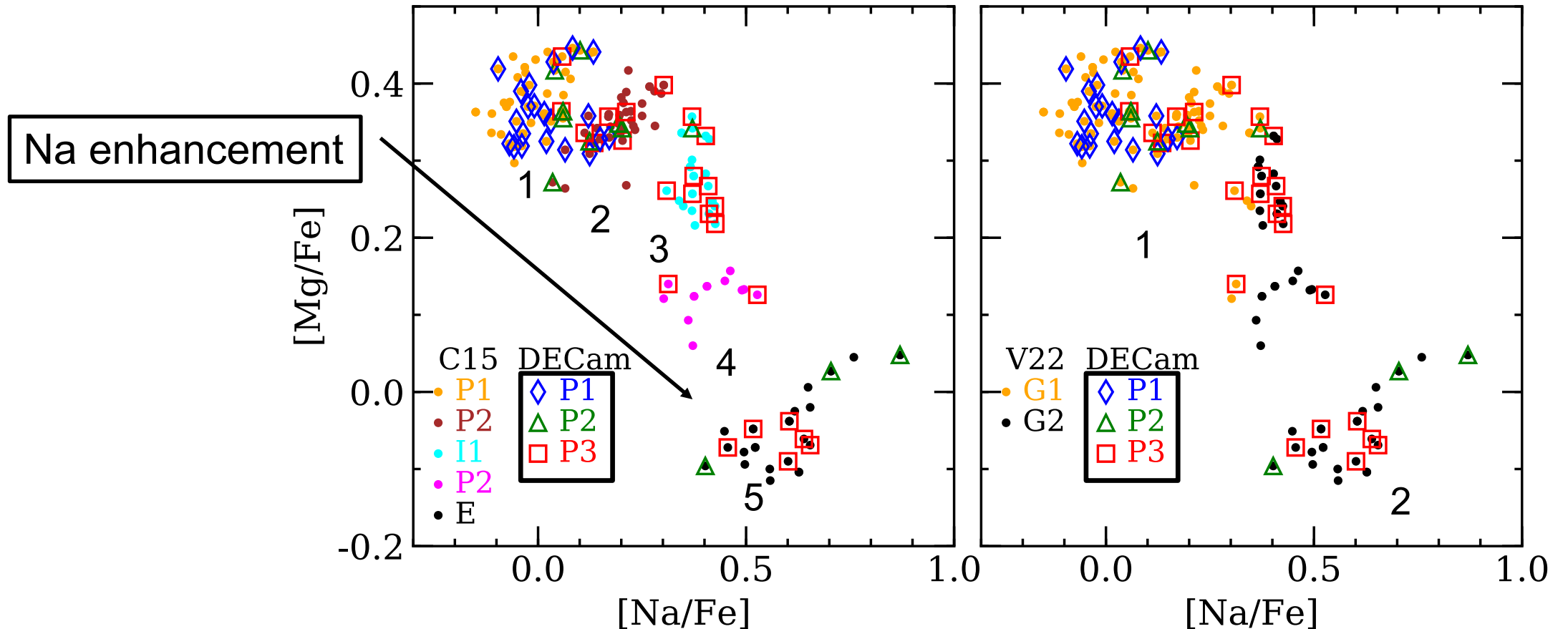
HST



Credits: Justin Kader

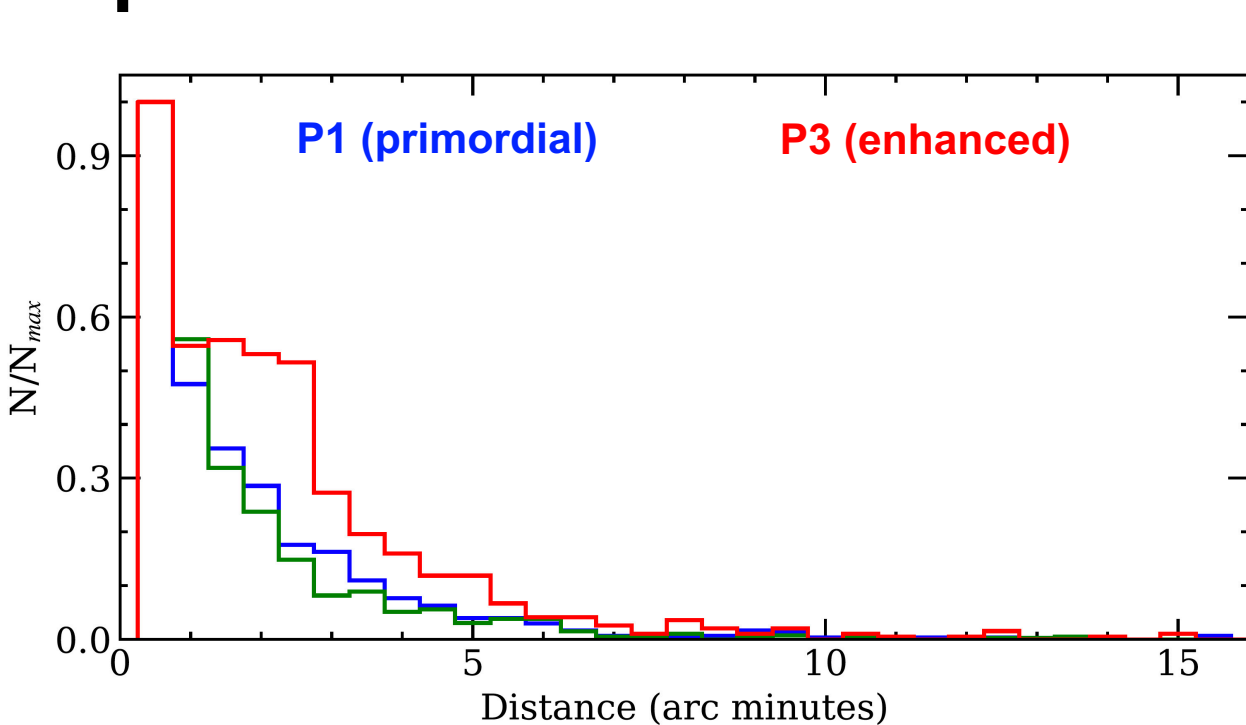
# Comparison with literature

- Carretta et al. (2015): **5 sub-populations** on the RGB (high-res. spectroscopy)
- Valle et al. (2022): **2 sub-populations** on the RGB (photometric statistical study)
- Latour et al. (2019): **4 sub-populations** on the RGB (mid-res. spectroscopy)
- Hong et al. (2021): **4 sub-populations** on the RGB (low-res. spectroscopy)

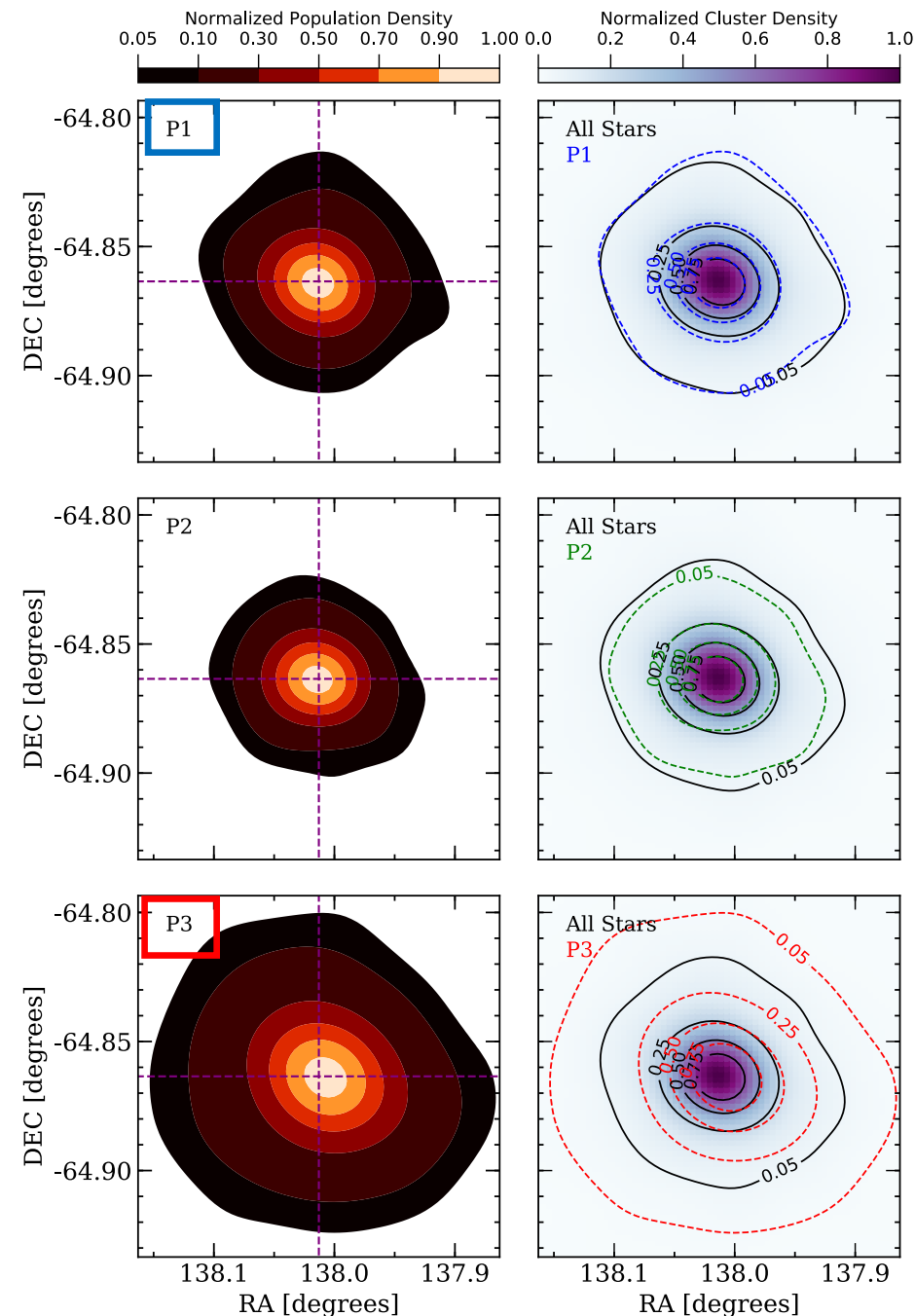




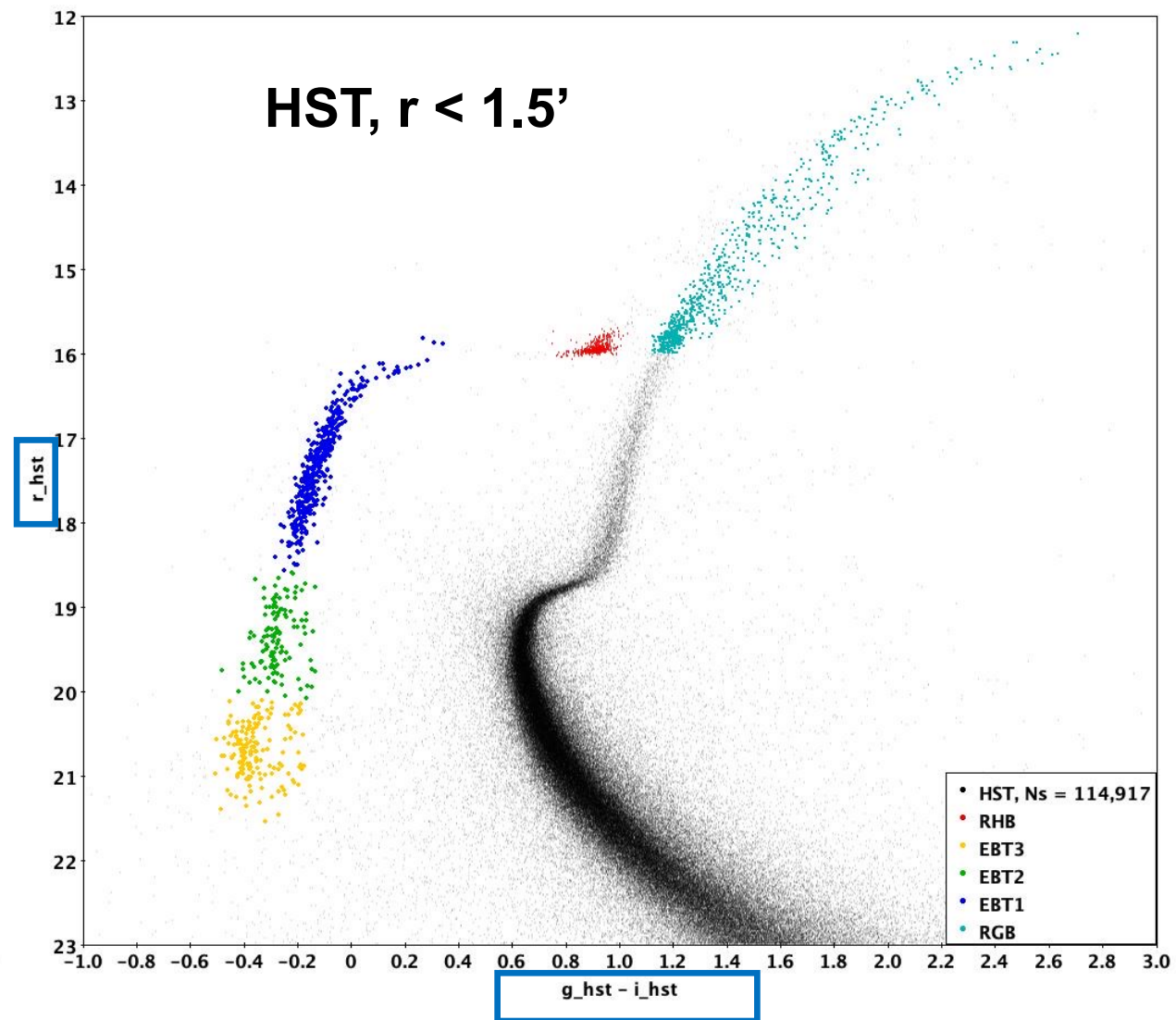
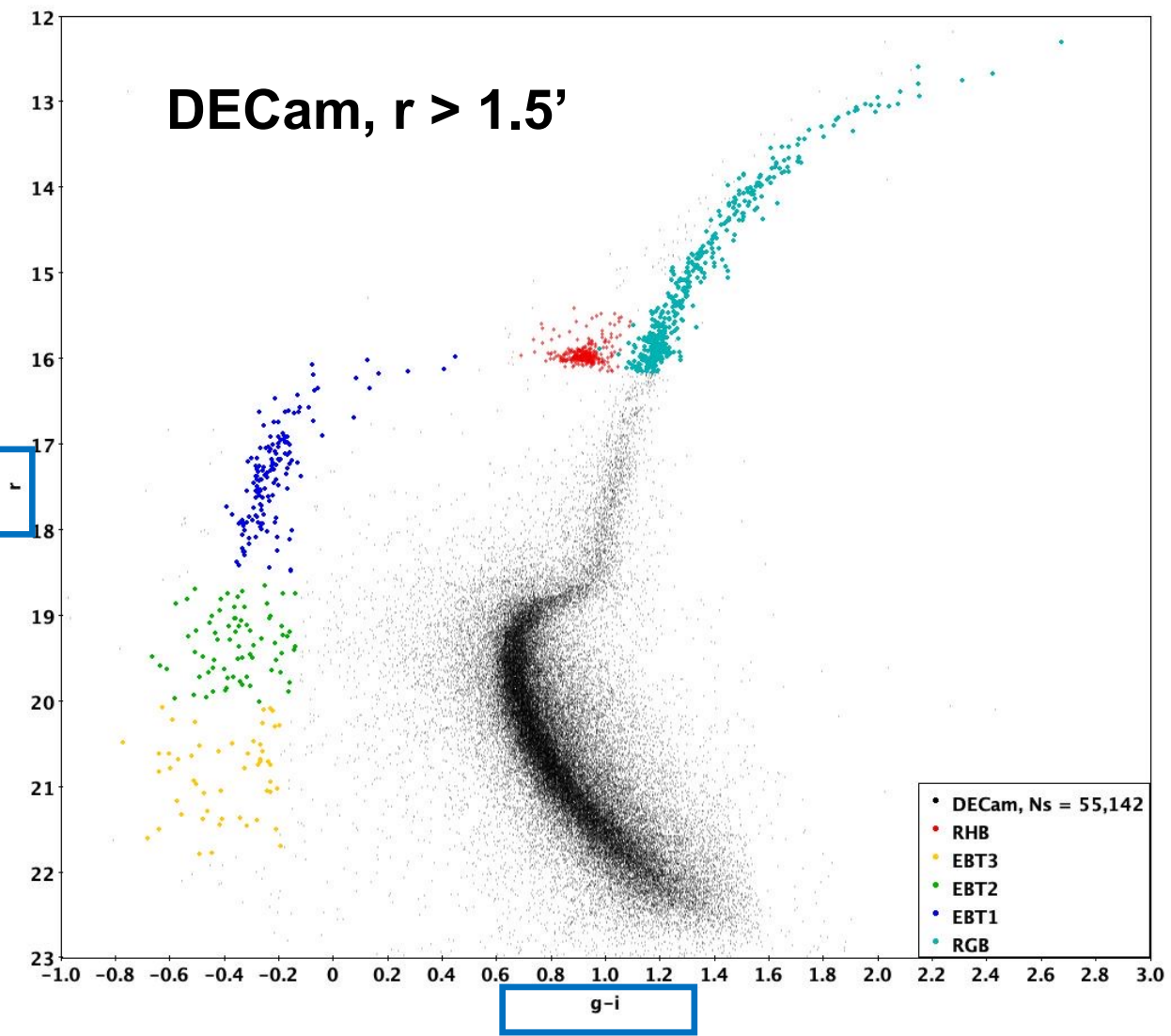
# Spatial distribution of the RGB sub-populations



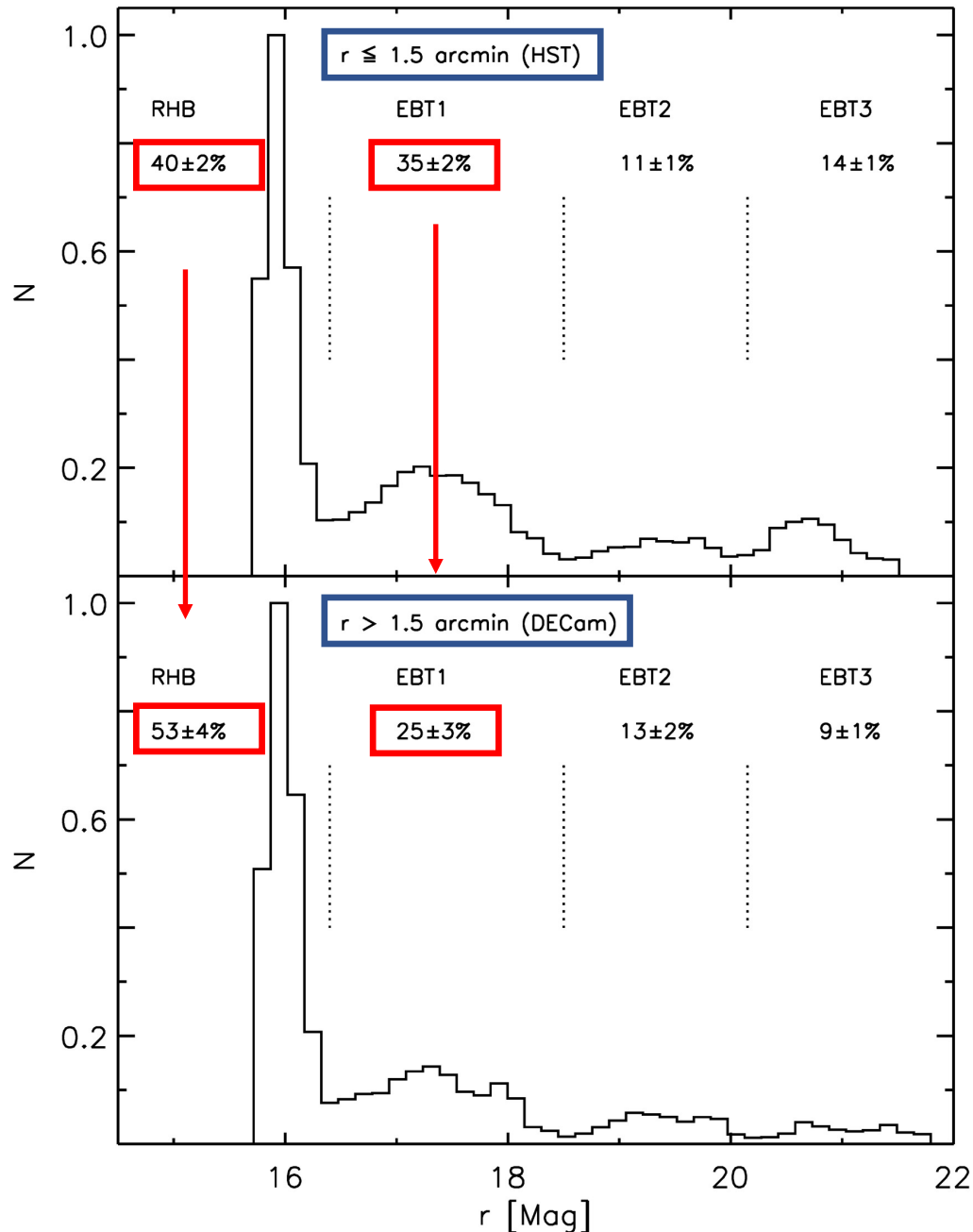
- **The enhanced P3 RGs** have a more **extended distribution** compared to **the primordial P1 RGs**
- The **center of the P3 group** is shifted  $\approx 0.1'$  SW of the geometrical center of NGC2808;
- **P3 group** has a slightly different position angle



# Spatial distribution of the HB groups



# HB luminosity distribution



- A slight **increase of RHB** and decrease of EBT1 stars for **distances  $> 1.5'$**  ( $\sim 2 r_h$ )
- A substantial **flat distribution of HB stars across the cluster** (in agreement with results from Bedin et al. 2000 and Iannicola et al. 2009)

**R parameter:**

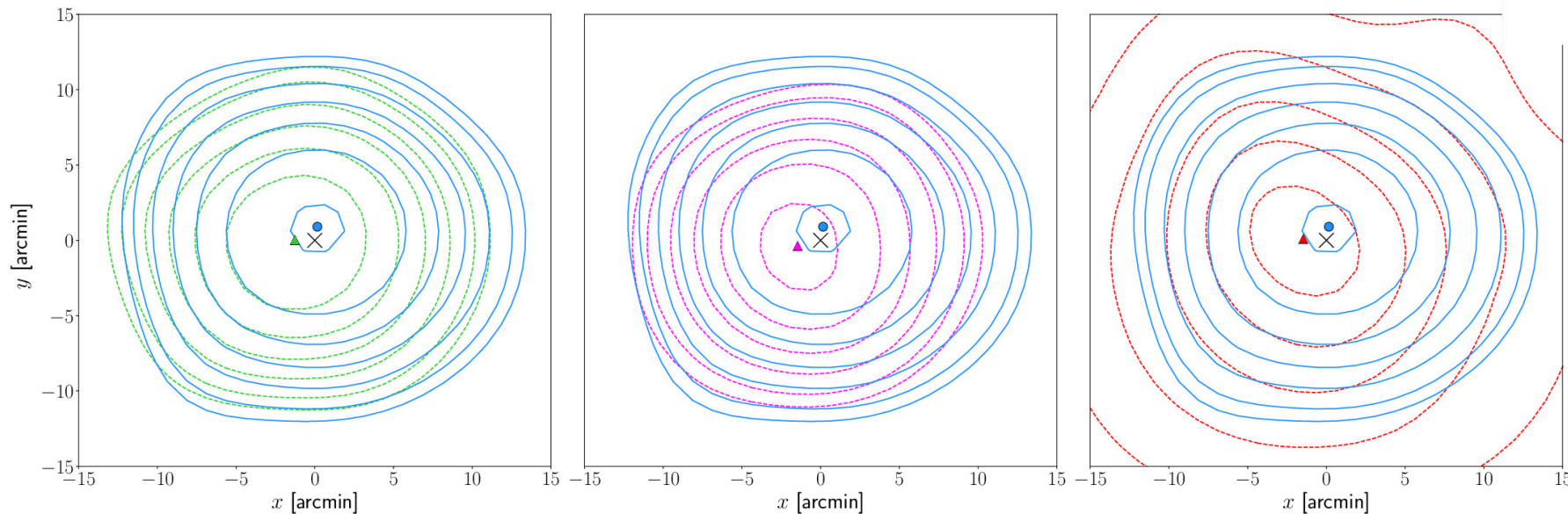
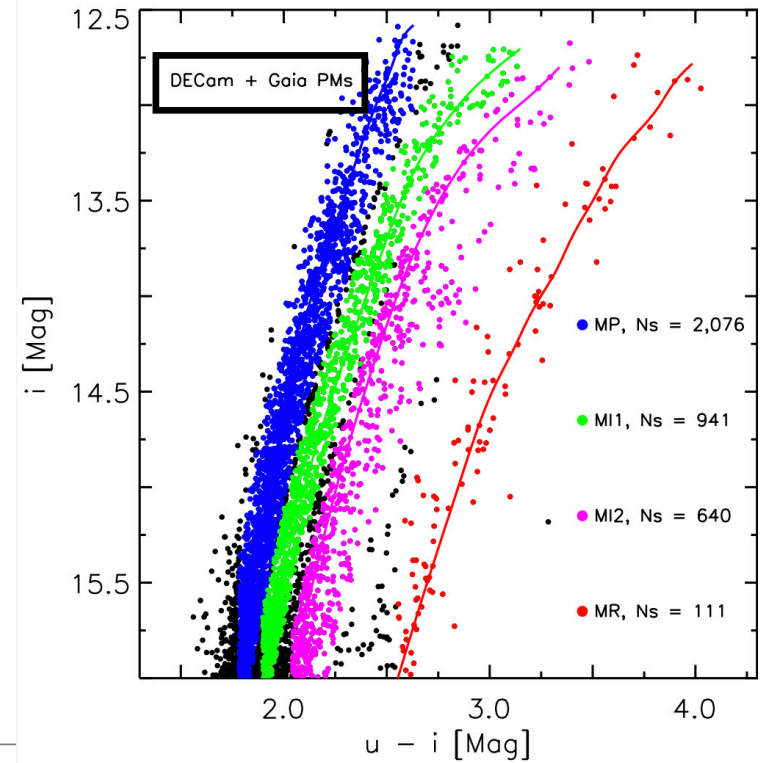
$$R_{\text{HST}} = N_{\text{HB}}/N_{\text{RGB}} = 1.42 \pm 0.06$$

$$R_{\text{DECam}} = N_{\text{HB}}/N_{\text{RGB}} = 1.32 \pm 0.08$$

approximately **constant** from the **center up to the NGC2808 tidal radius**

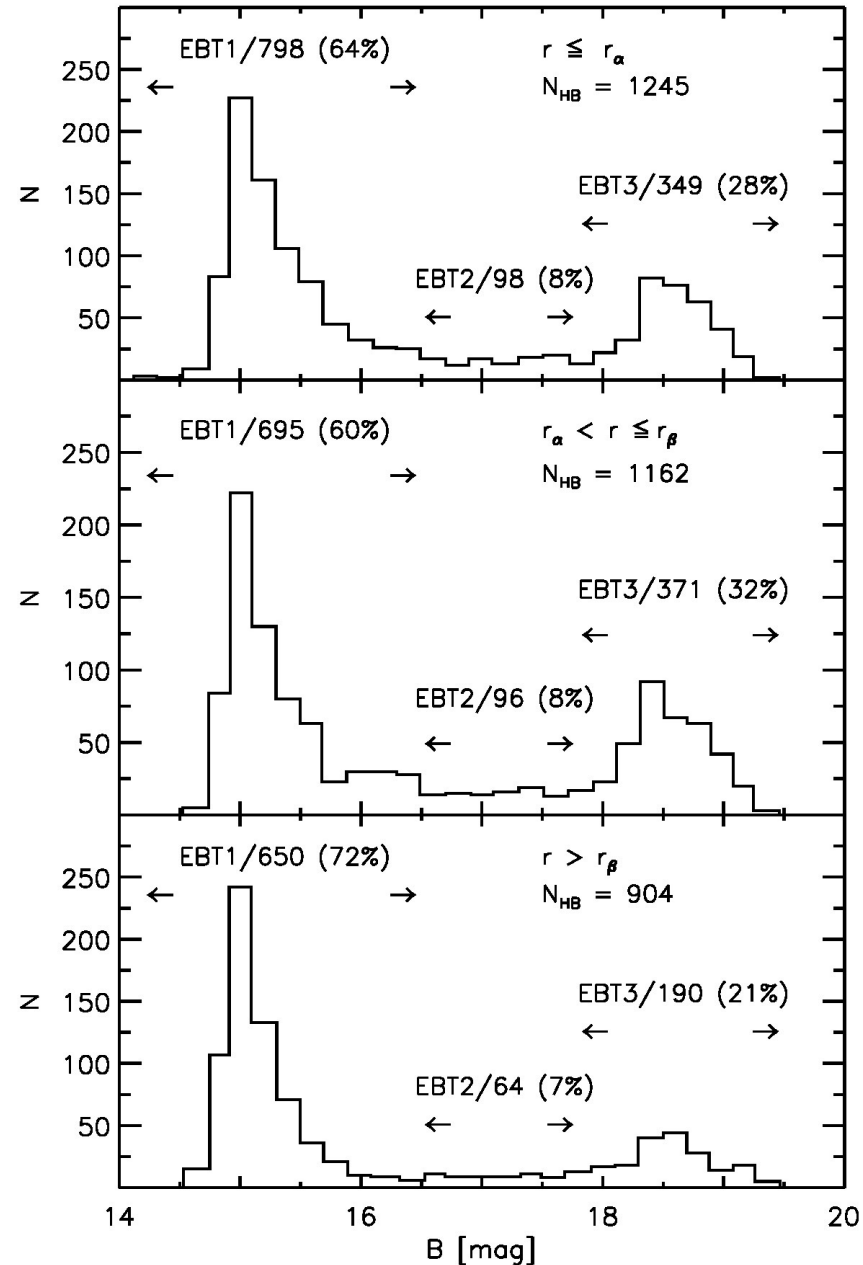
# $\omega$ Cen: spatial distribution of RGB stars

- **Metal-Rich (MR) RGs** have a more **extended distribution** compared to **Metal-Poor (MP) RGs**
- The center of the **MP** group is shifted  $\approx 1'$  N of the geometrical center of  $\omega$  Cen;
- Centers of the **MI1**, **MI2**, **MR** groups are shifted  $\approx 1.4'$  SE

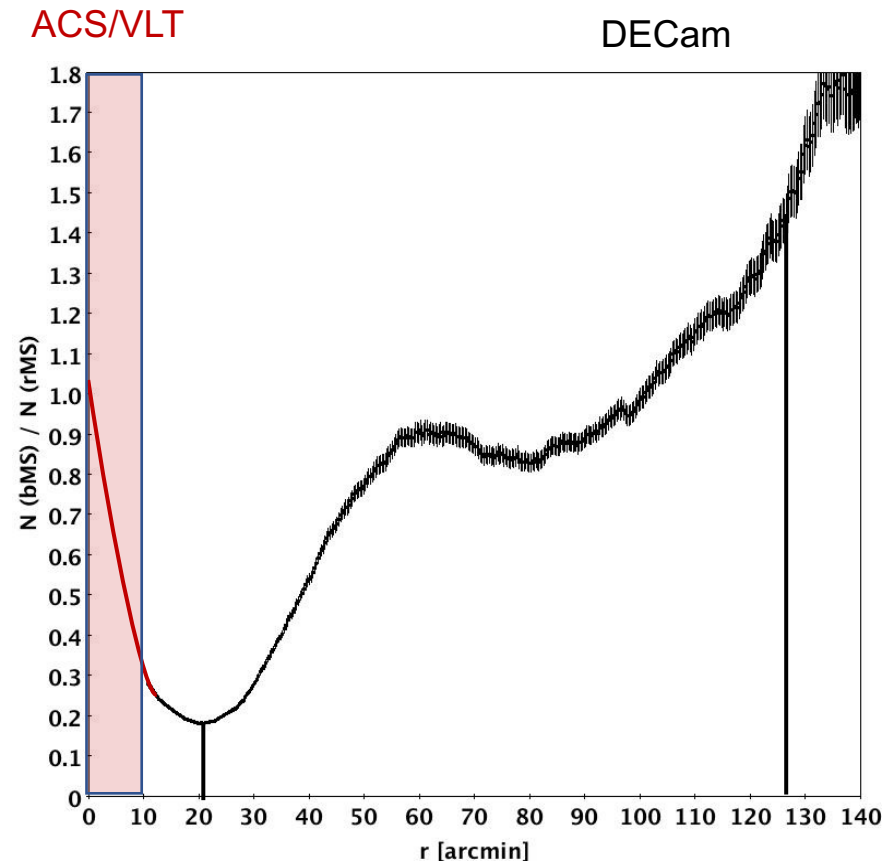


# $\omega$ Cen: spatial distribution of HB & MS stars

A slight decrease of EBT3 and increase of EBT1 stars for distance  $> 7.5'$  ( $\sim 1.5 r_h$ )



The frequency of **blue Main Sequence (bMS)** stars steadily increases for  $r > 25'$  compared to **red Main Sequence (rMS)** stars (only possible to observe with DECam!)



# Conclusions

- ✓ **DECam** data for the **entire extension of NGC2808** and HST for the core: **Cugli index** identified **3 RGB sub-populations**, the **primordial P1**, **enhanced P2** and **most enhanced P3**
- ✓ **Most enhanced (Na-rich) RGB sub-population, P3**, more concentrated  $\text{dist} < r_{\text{half-mass}}$  ( $\sim 1.6'$ , 5pc) and has a **more extended spatial distribution**
- ✓ **P3 group** center is offset by  $0.1'$  (0.3pc) relative to the primordial **group P1**
- ✓ **NGC2808 HB stars** show a **flat distribution across** the entire **cluster**
- ✓ **Findings similar to  $\omega$  Cen ones**: **most metal-rich RGB** sub-population, **MR**, more concentrated in the center and has a **more extended spatial distribution**. The center is  $1.4'$  ( $\sim 2\text{pc}$ ) offset compared to the **metal-poor RGBs, MP**
- ✓  **$\omega$  Cen HBs also** show a quite **flat distribution across** the entire **cluster, but no RHB!**

# Questions & Future work

- ✓ Does the **P3 RGB sub-population** correspond to the **bluest main sequence** (possibly Helium enhanced)?
- ✓ Could the more extended spatial distribution of the **P3 group** be due to **mass-segregation**? (The most He-rich RGBs may be  $\sim 0.2 M_{\odot}$  less massive than the He-normal)
- ✓ Could the **P3 RGB sub-population** center offset be the result of cluster mergers for the formation of NGC2808 (but no iron spread) ?
  - Analysis of **AGB and WDs** stars
  - **Density profile of NGC2808** based on HST+DECam data: verify for the presence of a stellar halo and/or tails