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ASTERO CHRONOMETRY

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Clusters in the PLATO field

Lorenzo Briganti

(Angela Bragaglia, Andrea Miglio, Valerio Nascimbeni)

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esa plato

Outline

- Stellar variabilty in Clusters
- Description of PLATO
- Stellar variability: Giants and γ-Doradus
- Open Clusters and Moving Groups
- Globular Clusters
- Conclusions

Stellar variability in Clusters

Advantages:

- Determination and calibration of stellar parameters (e.g. M, R, age) with high precision
- Models testing (e.g. convective cores, mass loss, rotation)
- Gyrochronology (see Messina et al., 2022; Lanza, 2022)
- Planets detection (e.g. transits; see Nascimbeni et al., 2022)

State of the art:

- Kepler:
  - 2 well populated Open Clusters (NGC 6791, NGC 6819)
  - Few young Open Clusters (e.g. NGC 6866)
- K2:
  - 80 days observations (not enough for stellar structure studies)

PLATO

(PLAnetary Transits and Oscillations of stars)

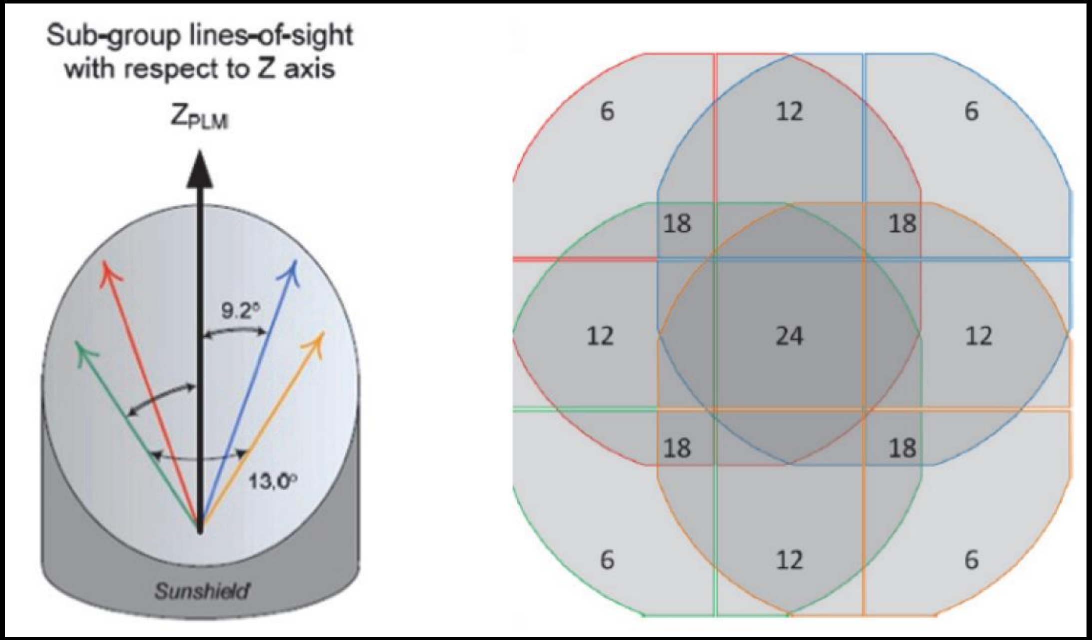
- **Launch:** late 2026
- **Nominal mission duration:** 4 years
- **Science objectives:**
  - Constrain planet formation models
  - Constrain interior composition of terrestrial and gas planets
  - Characterise terrestrial planets in orbits up to the habitable zone around Sun-like stars
  - Determine stellar properties with asteroseismology

Mission	PSF (arcsec)
CoRoT (seismo)	914
TESS	84
Kepler	21
PLATO	37
HAYDN	1.3

PLATO:
The PayLoad Module

- **2 “fast’’ cameras:**
  - 8 > V > 4
  - cadence: 2.5s

- **24 “normal’’ cameras:**
  - V > 8
  - cadence : 25 s
  - divided into 4 groups of 6 cameras with the same FoV: the lines of sight of the 4 groups are misaligned by 9.2° from the PLM Z-axis, in order to cover a greater region of sky.

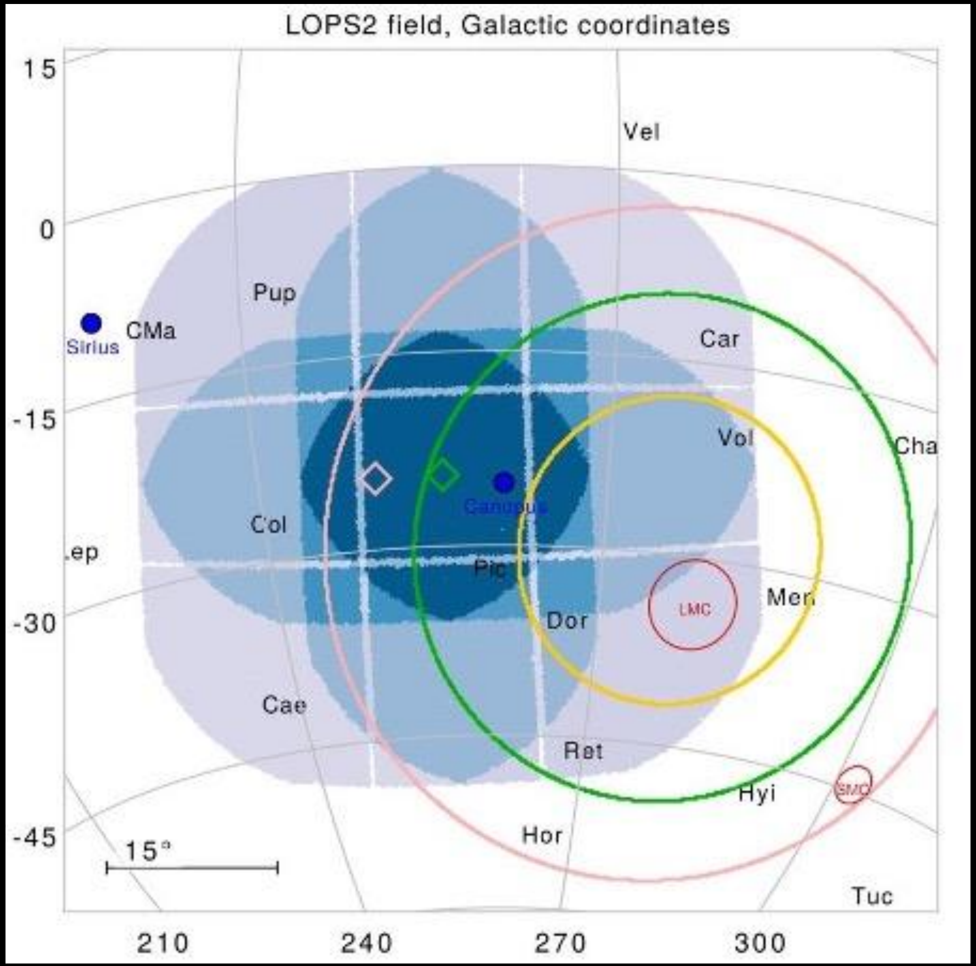


Credits: PLATO Definition Study Report, 2017

PLATO LOPS2

(Long-duration Observation Phase field South 2)

- First field to be pointed by PLATO
- Monitored for at least two years
- Centred in:
  $$(\alpha, \delta) = (95.310417, -47.88694)$$
  $$(l, b) = (255.9375, -24.62432)$$

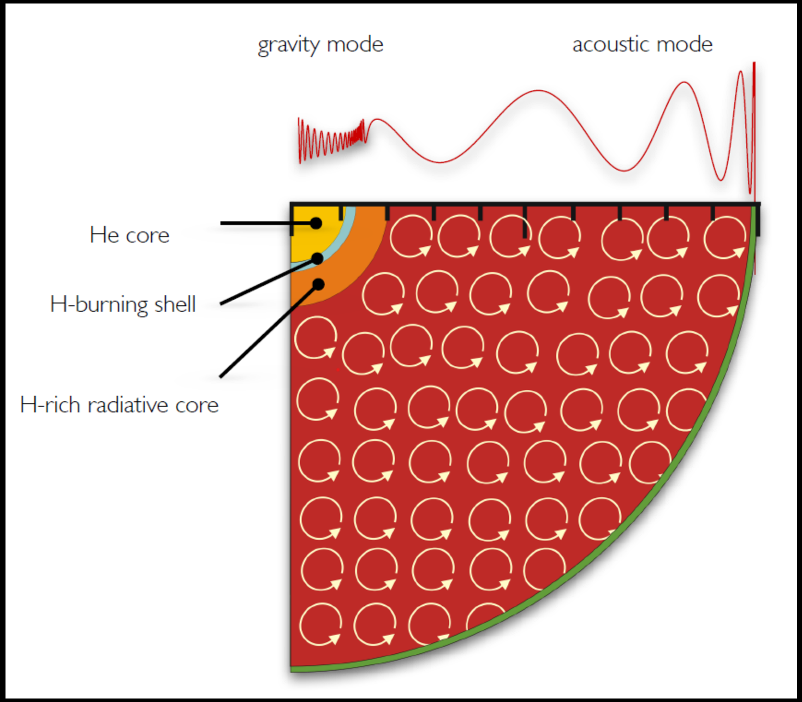


Credits: Nascimbeni et al., in prep.

Stellar variability:
Giant stars

Asteroseismology of Giant Stars:

- Solar-like oscillations
- $\Pi \sim hours$
- Mixed modes:
  - g-like behaviour near the centre:
    core-contraction -> higher frequencies
    modes equally spaced in period
  - p-like behaviour in the envelope:
    envelope expansion -> lower frequencies
    modes equally spaced in frequency

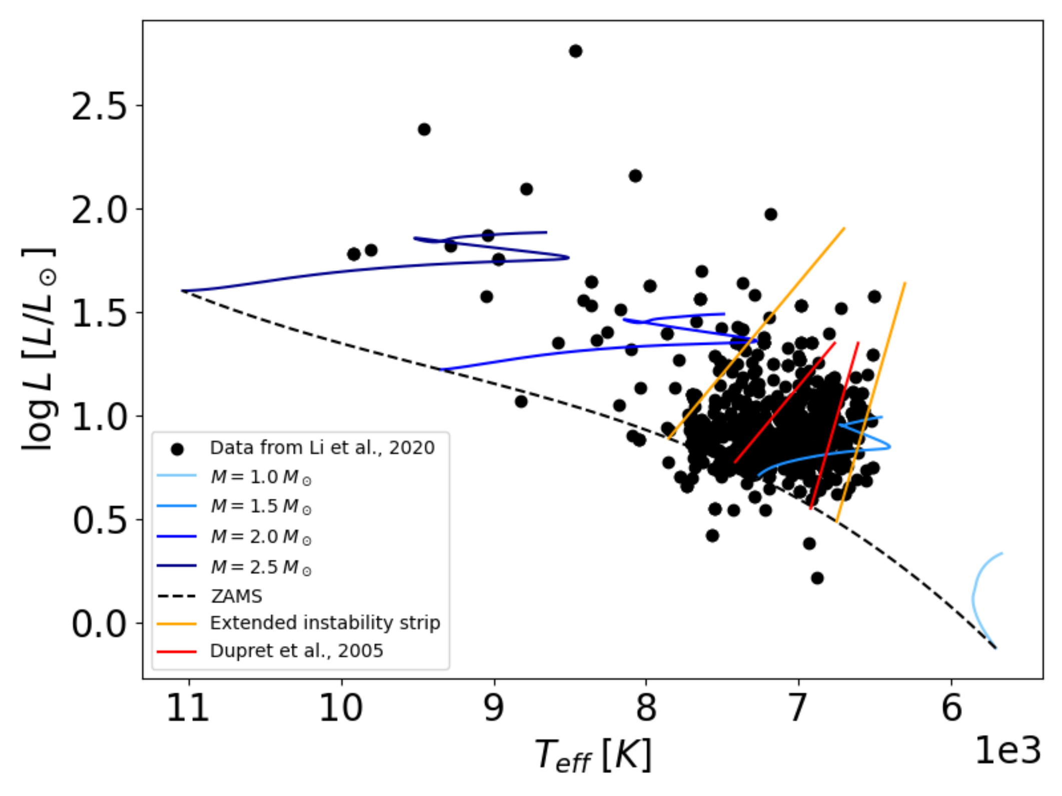


Credits: Miglio et al., 2021

Stellar variability:
γ-Doradus stars

Asteroseismology of γ-Doradus stars:

- A- to F-type MS stars
- $M \sim 1.4 - 2.0\ M_{\odot}$
- $\Pi \sim 0.3\ - 3\ days$
- gravity modes with high radial order $(100 \geq n \geq 20)$ and low degree $(l \leq 4)$



Open Clusters and Moving Groups

IN THE PLATO LOPS2:

- Data from Hunt & Reffert, 2023
- 366 Open Clusters (OCs)
- 10 Moving Groups

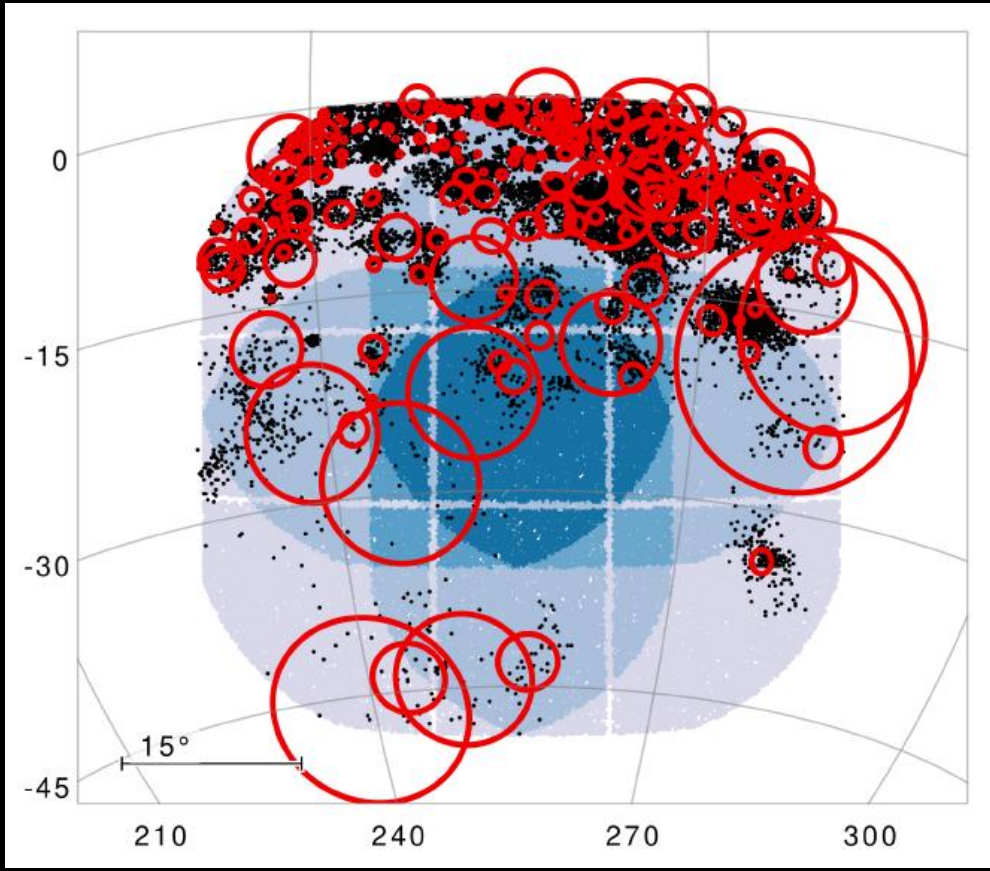
(private communication of Valerio Nascimbeni)

Giant stars:

- 943 giants
- 686 brighter than G=15
- Hopefully will be observed spectroscopically by 4MOST

γ-Doradus stars:

- 5249 γ-Dors
- 1980 brighter than G=15

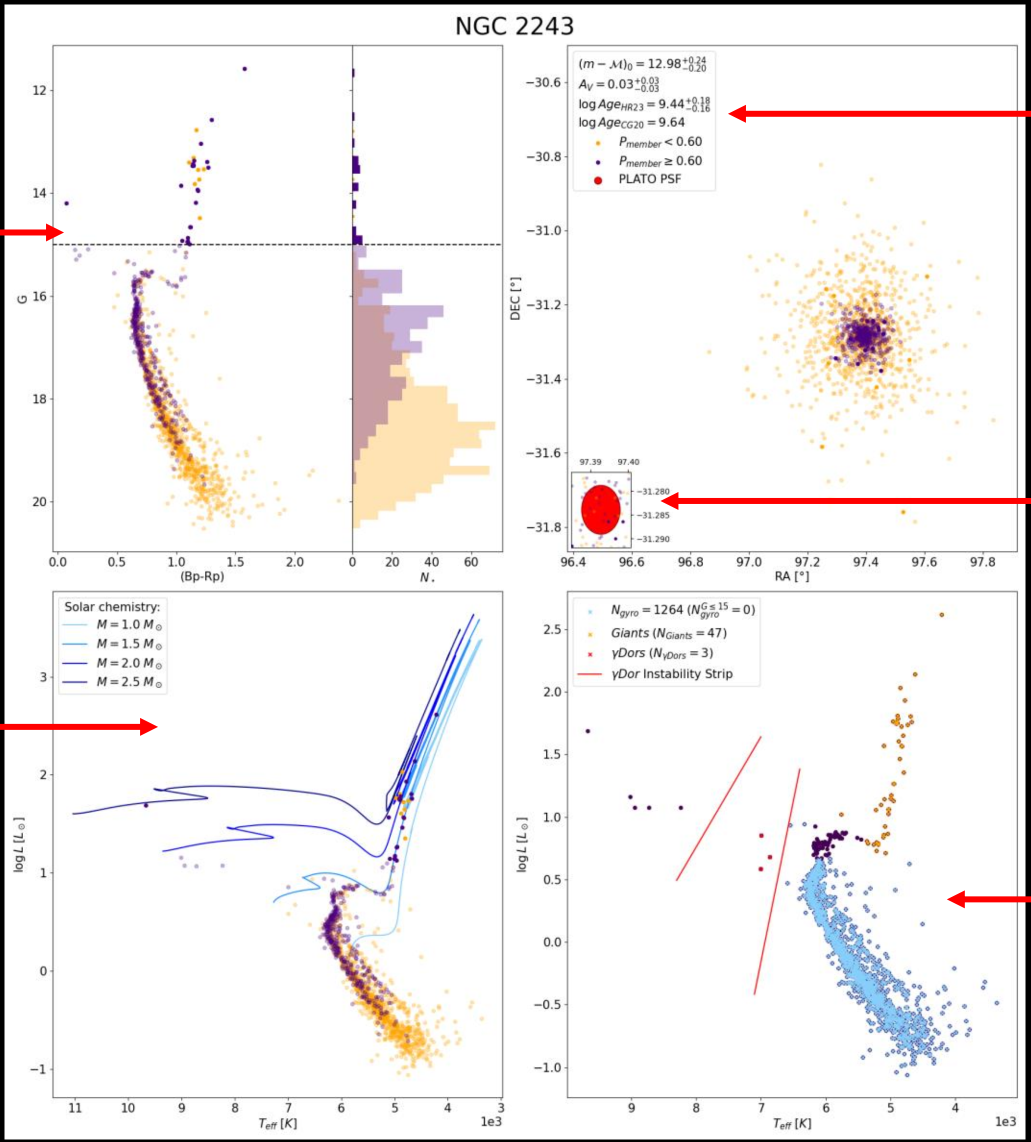


Credits: Nascimbeni et al., in prep.

Open Clusters classification

CMD with magnitude cut at G=15 and luminosity distributions above (solid points) and below (shaded points) the magnitude threshold

HRD computed with Mucciarelli et al., 2021 (Bp-Rp)-Teff relation and containing evolutionary tracks of solar chemical composition



Cluster parameters: age is taken both from HR23 and CG20

Inset in the RA-DEC plane showing the PLATO PSF in the median position of the cluster

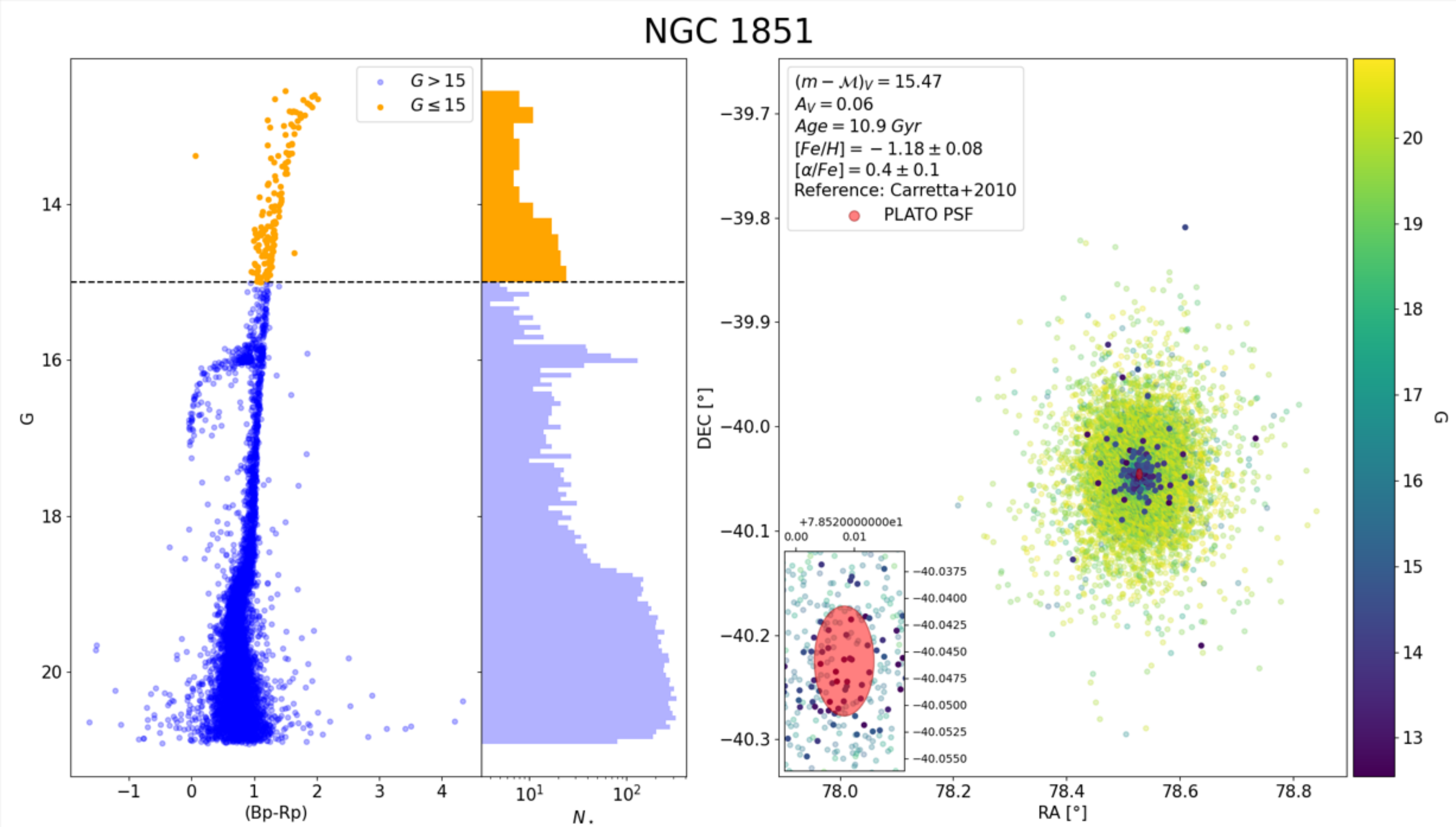
HRD with selected giants (orange), γ-Dors (red) and stars of interest for gyrochronology (light-blue)

Globular clusters

2 GCs in the PLATO LOPS2:
- NGC 1851
- NGC 2298

Giants with G≤15:
- NGC 1851: 149
- NGC 2298: 34

Contamination:
- Counted stars within the PLATO PSF centered on each giant
- Counted stars brighter than $G_{giant} + 3$ within the PLATO PSF



Conclusions

- We studied nearly 400 stellar associations (OCs, MGs, GCs) in the PLATO LOPS2
- We selected in those clusters giant stars and γ-Dors
- Next step: suggest those stars as targets for the PLATO Science Calibration and Verification catalog
- Evaluate PLATO expected performance on those targets