



The Second Earth Initiative Spectrograph (2ES)

An extreme-precision radial velocity spectrograph on a dedicated telescope to discover temperate Earth-mass planets around the brightest solar-type stars in the sky

Second Earth Initiative Septrograph (2ES)

A next-generation extreme-precision radial velocity spectrograph on a dedicated modest-size telescope.

- 2/3 of total observing time over 5-years at the MPG/ESO 2.2m Telescope on La Villa, Chile.
- Observe ~30 of the brightest nearby solar-like stars in the sky over a \geq 5-year period.
- High-cadence observations (~every night).
- **Goal:** discover temperate terrestrial Earth-mass planets in the habitable zone around these stars.
- Parallel similar initiative on northern Hemisphere (La Palma), led by Didier Queloz (“*Habitable planets beyond the solar system*”).
- The discovered planets will be the targets of next-generation flagship telescopes (e.g. Habitable World Observatory) to search for biosignatures.
- **Timeline:** First light anticipated 2027
- **Budget:** ~2 M€ (mostly already secured)

La Silla —
ESO's First Observatory



MPG/ESO 2.2 m



- Lars A. Buchhave (PI, professor, DTU Space, Technical University of Denmark)
- Thomas Henning (director, Max Planck Institute for Astronomy, Heidelberg)
- Andrés Jordan (assoc. prof. Uni. Adolfo Ibáñez, Chile)
- Laura Kreidberg (director, Max Planck Institute for Astronomy, Heidelberg)
- Andreas Quirrenbach (prof., Universität Heidelberg)
- Ansgar Reiners (professor, Institute for Astrophysics, Uni. of Göttingen)
- Andreas Seifahrt (assoc. prof., Uni. of Chicago)

2ES Consortium

High-level experts in radial velocity measurements and instrument design

Plus several more people working on the spectrograph
as well as on the target list.

Hardware (Spectrograph):

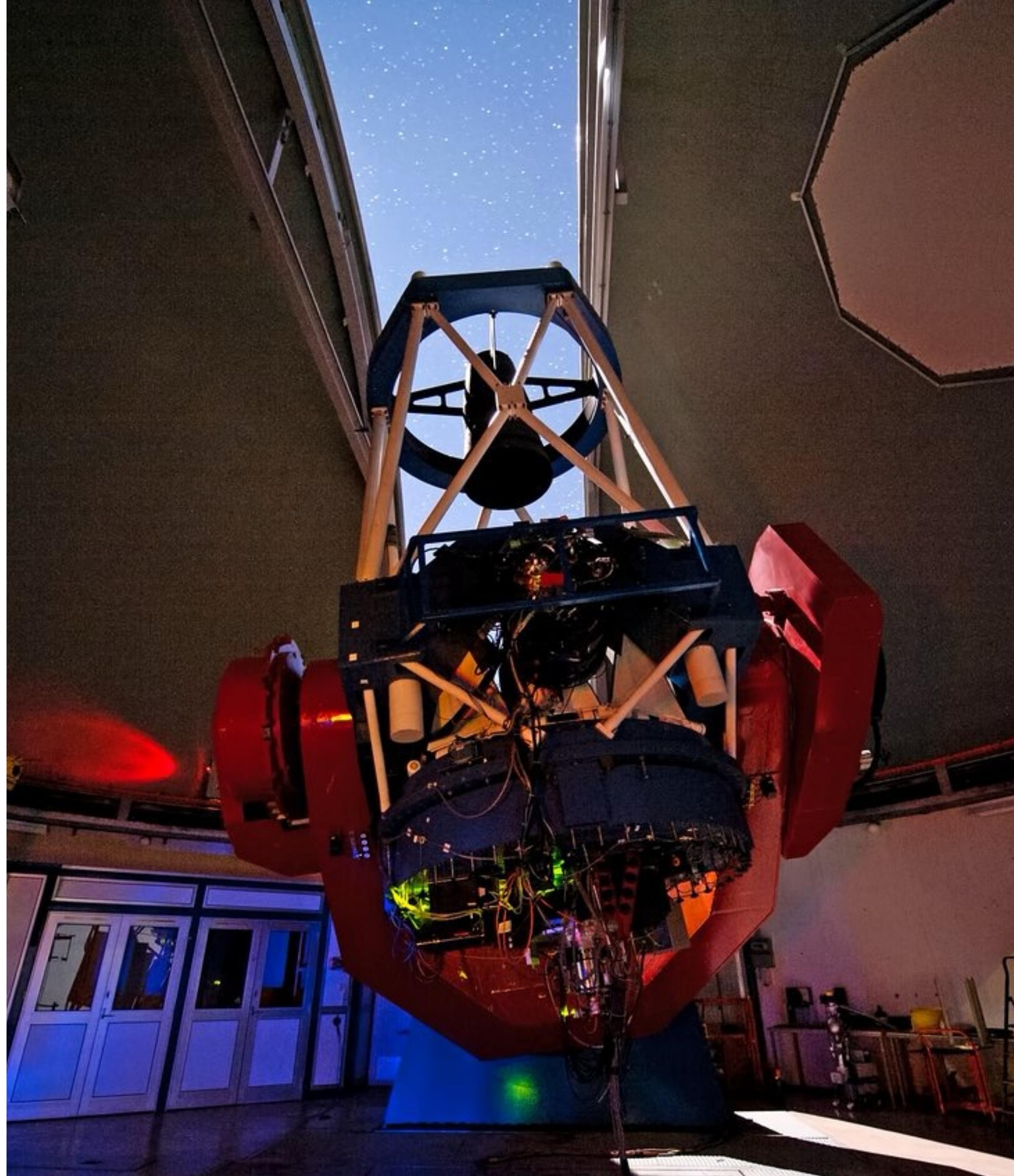
Andreas Seifahrt (Chicago)
from HD: Julian Stürmer (LSW)
XXX (MPIA
and more

Target List Preparation:

Lars Buchhave
Jingling Zhao
Ralf Launhardt (Melissa Hobson)
Felix Stündel
and more

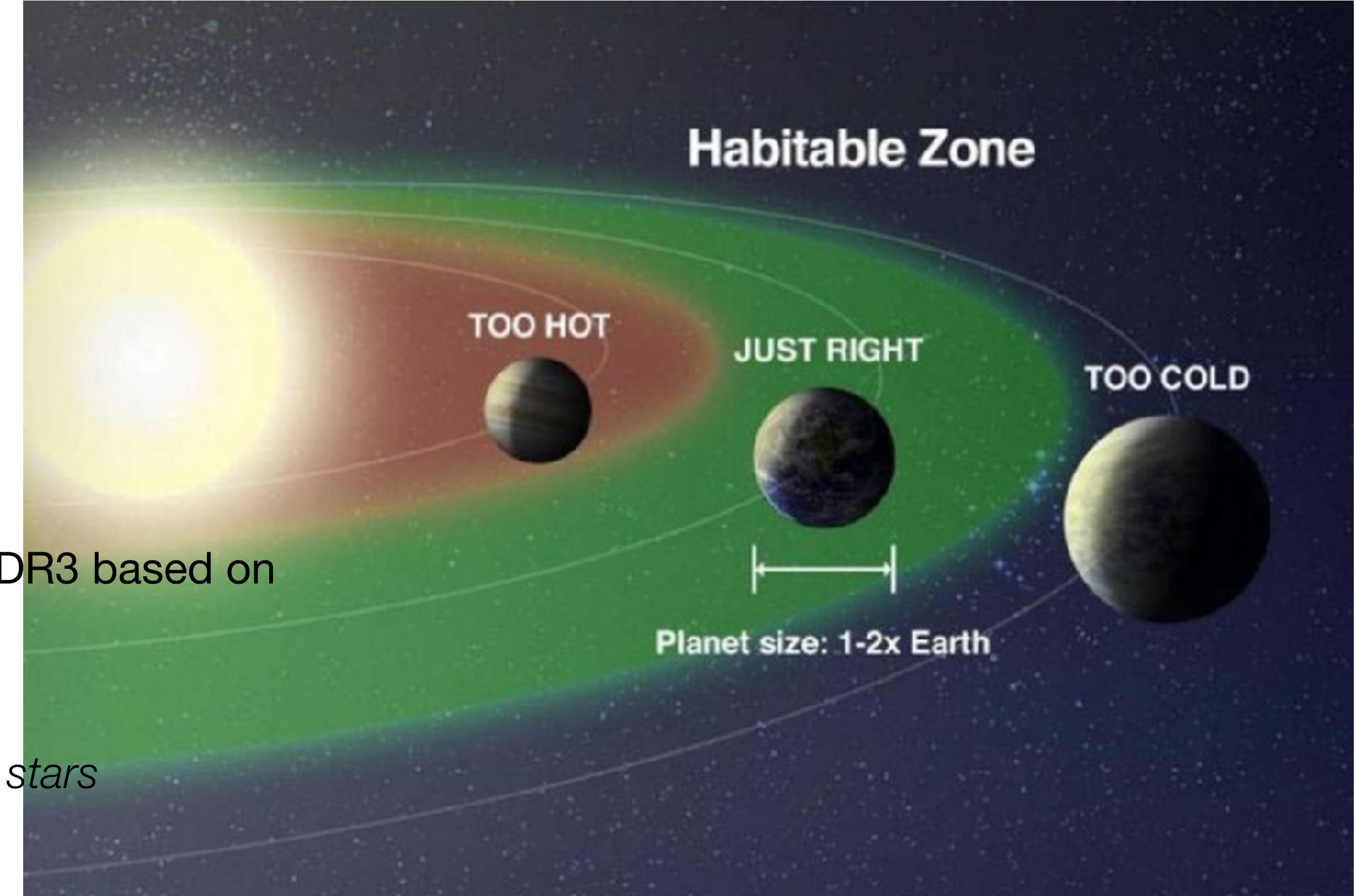
Data Reduction and Analysis:

Ansgar Reiners
Matthias Zechmeister
Trifon Trifonov
and more

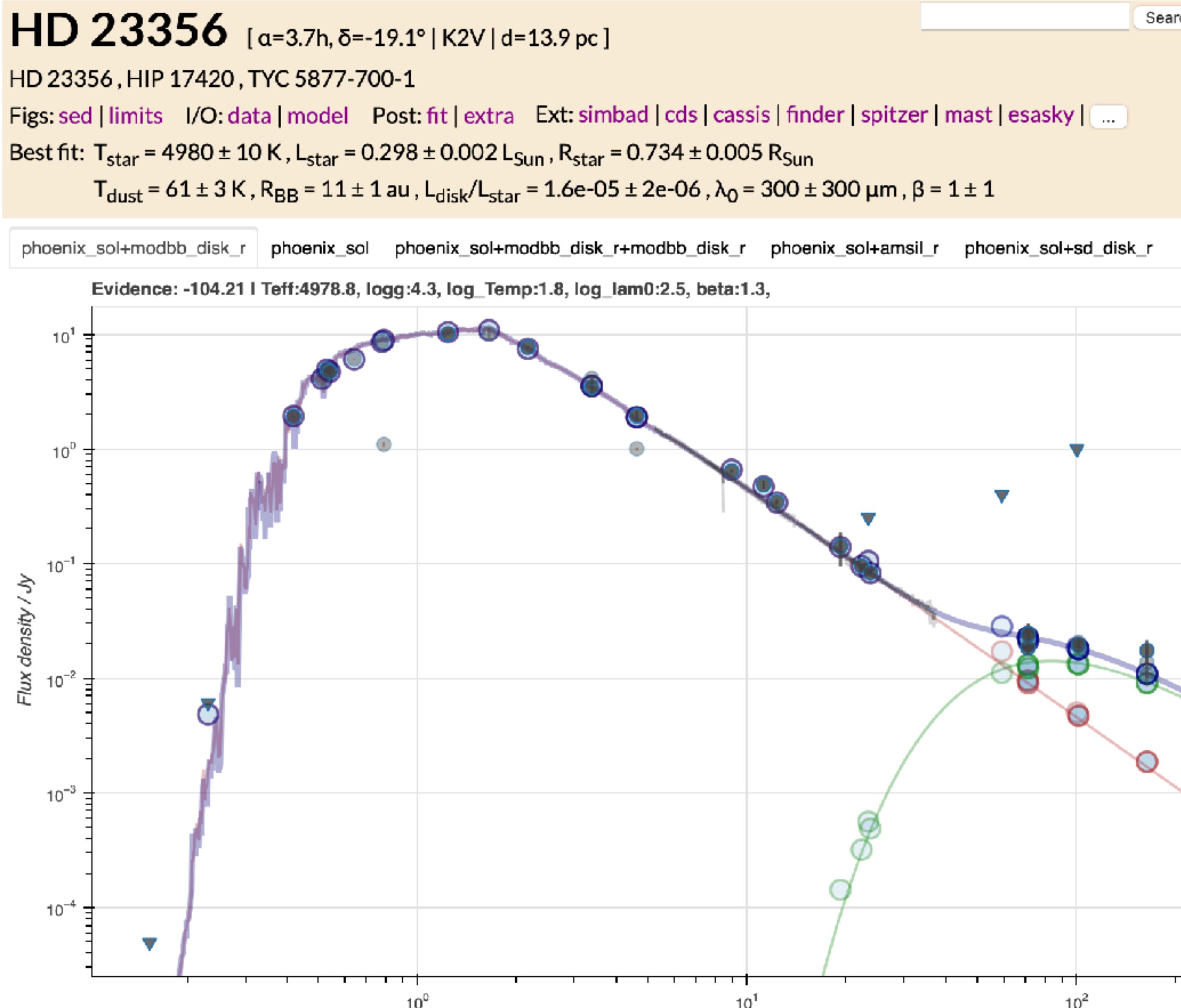


2ES - the initial target candidate list

- Currently **258** pre-selected target candidates, selected from Gaia DR3 based on Gmag < 9, dist < 20pc, and CMD G{BP}-G{RP}
- **71 stars rejected:** close VB, SB, hot or warm Jupiters, giants, PMS stars ($a < 500 \text{ Myr}$), certain types of activity or interacting binaries.
- => **187 stars** potentially suitable
- Goal: compile ≥ 300 potentially suitable candidates, i.e., at least 10 times more than can be surveyed => *Work in progress*
- Make sure we select the best candidates, and don't miss any good targets
- Parallel similar initiative on northern Hemisphere (La Palma), led by Didier Queloz ("Habitable planets beyond the solar system").



2ES target candidate list - Derivation of stellar parameters



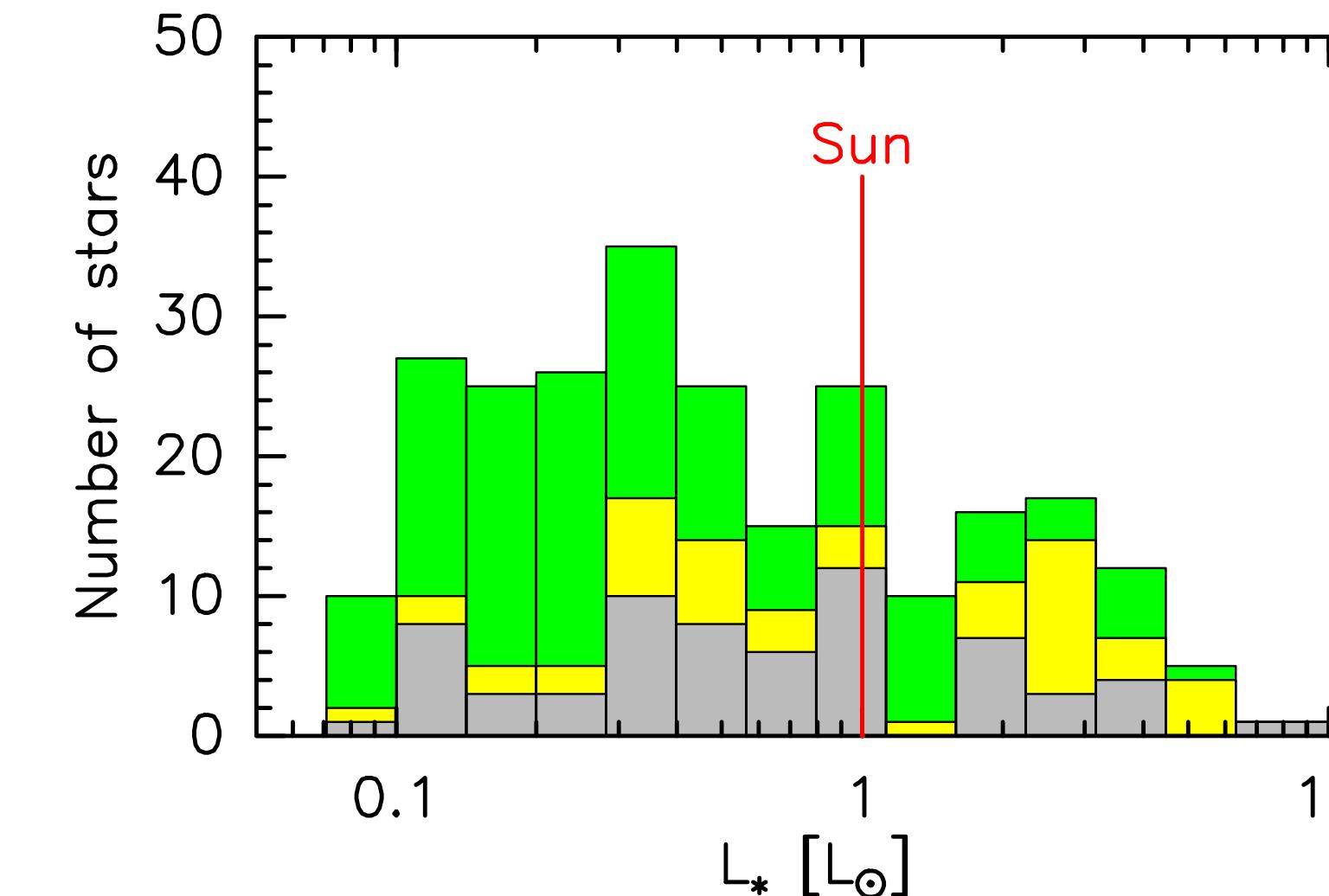
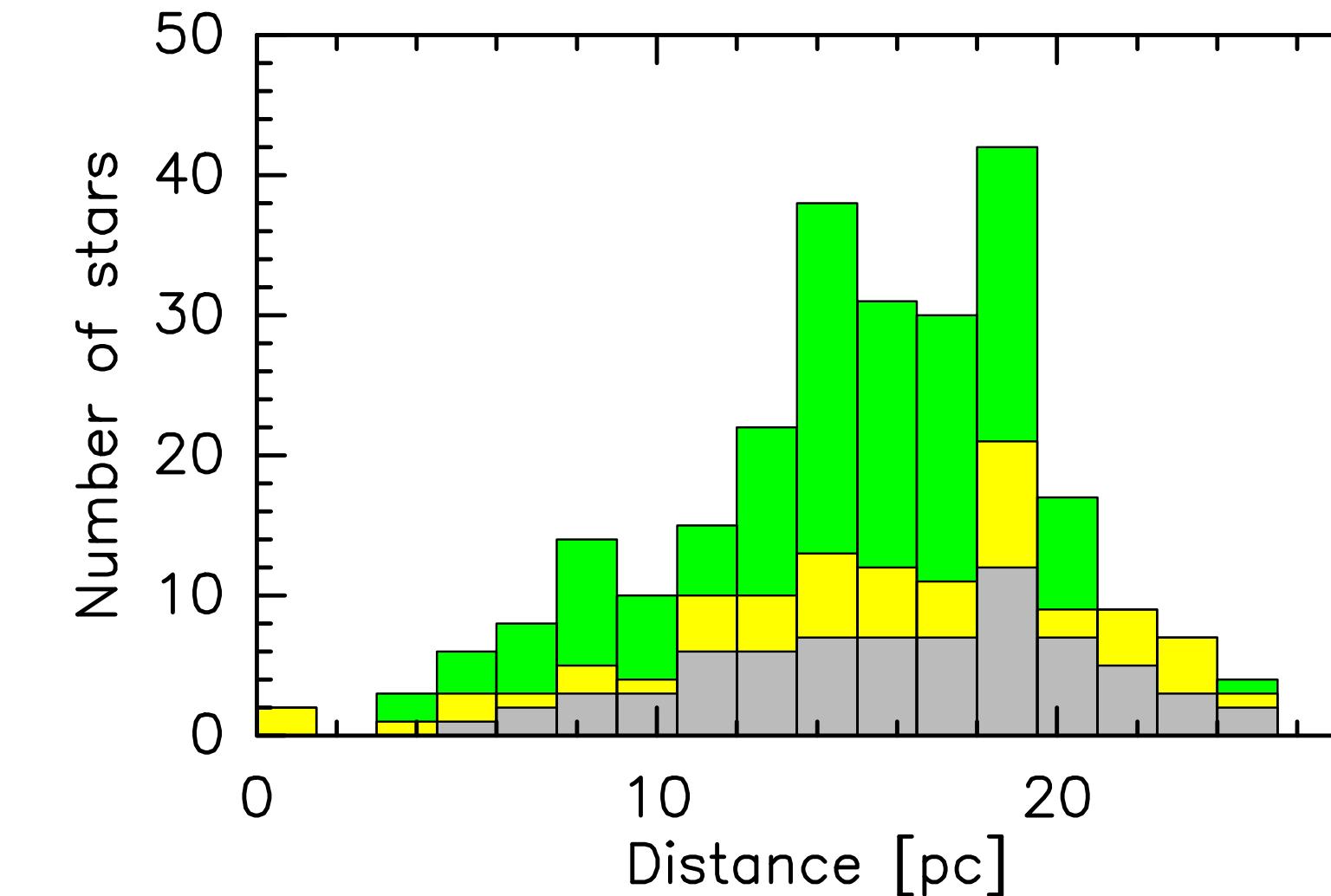
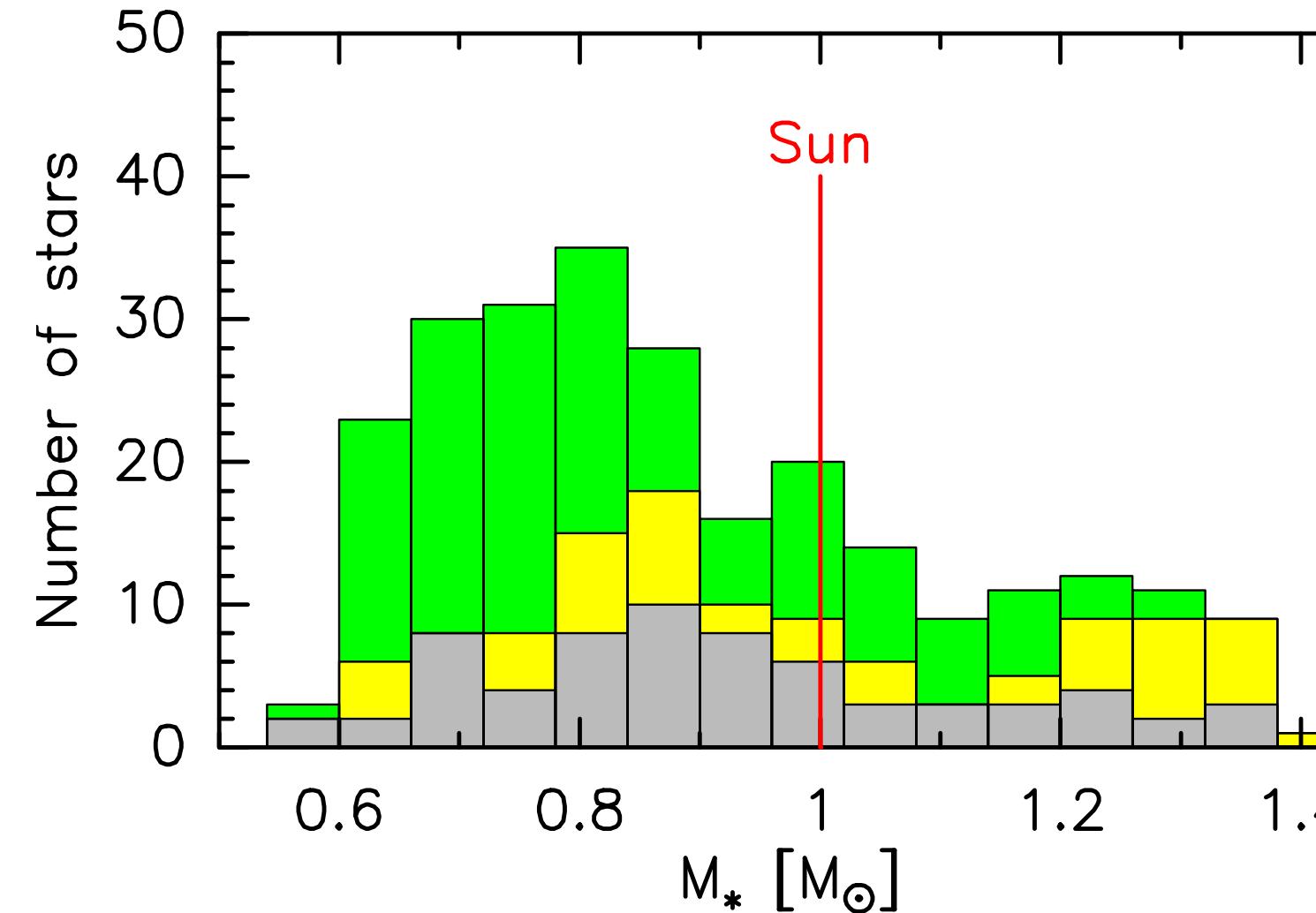
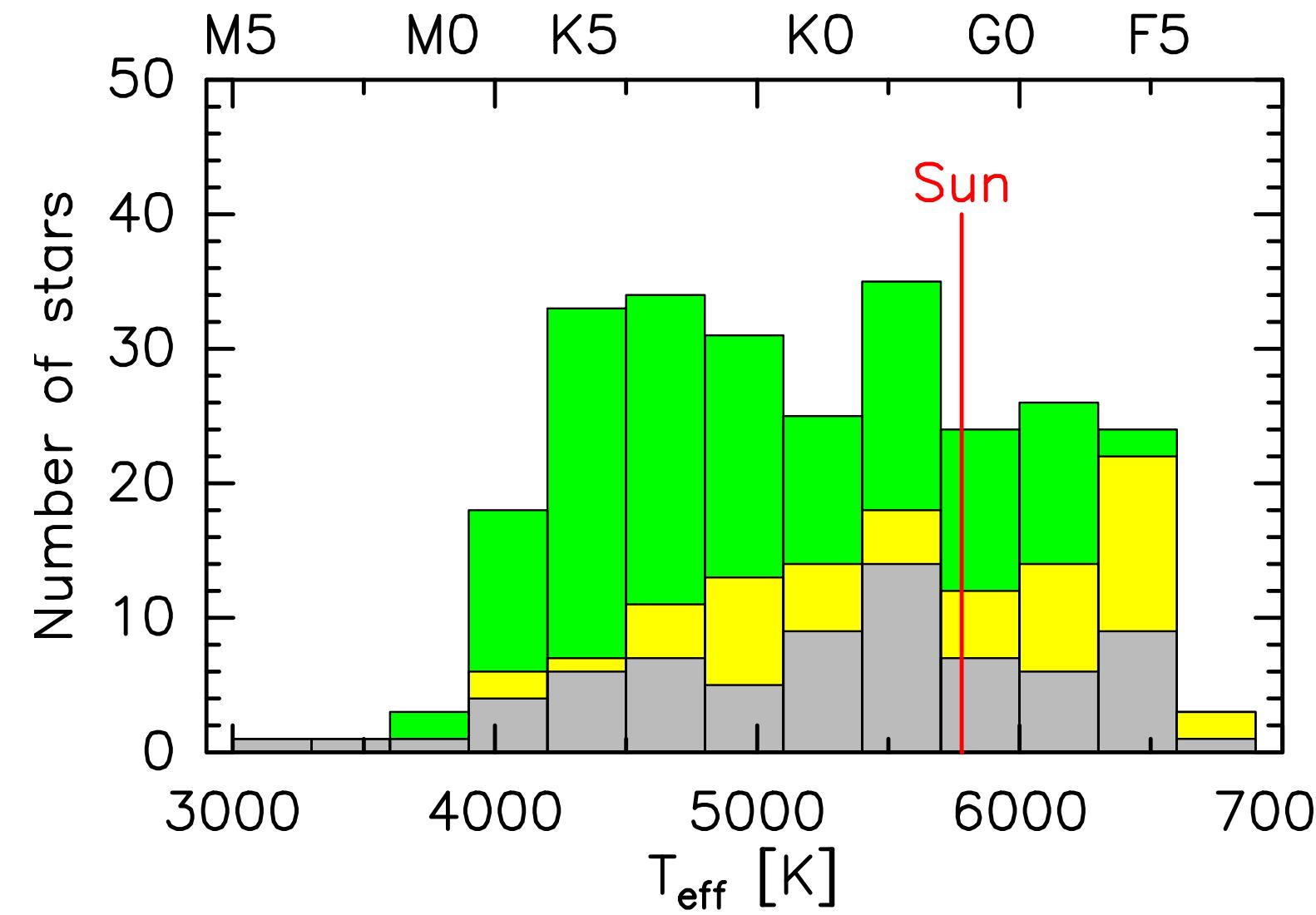
- Phoenix model atmosphere fit to entire SED (incl. debris disk excess where applicable) gives much more accurate Teff etc. than Gaia only Values.
- Get spectra from archives or new FEROS observations and derive spectroscopic parameters and activity => work in progress (Rafa Brahm)

2ES target candidate list - distribution plots 1

258 target candidates total

187 stars potentially suitable

71 stars rejected (hot and warm Jupiters, vis. Binaries with $a < 1''$, eclipsing or other interacting binaries, ...)

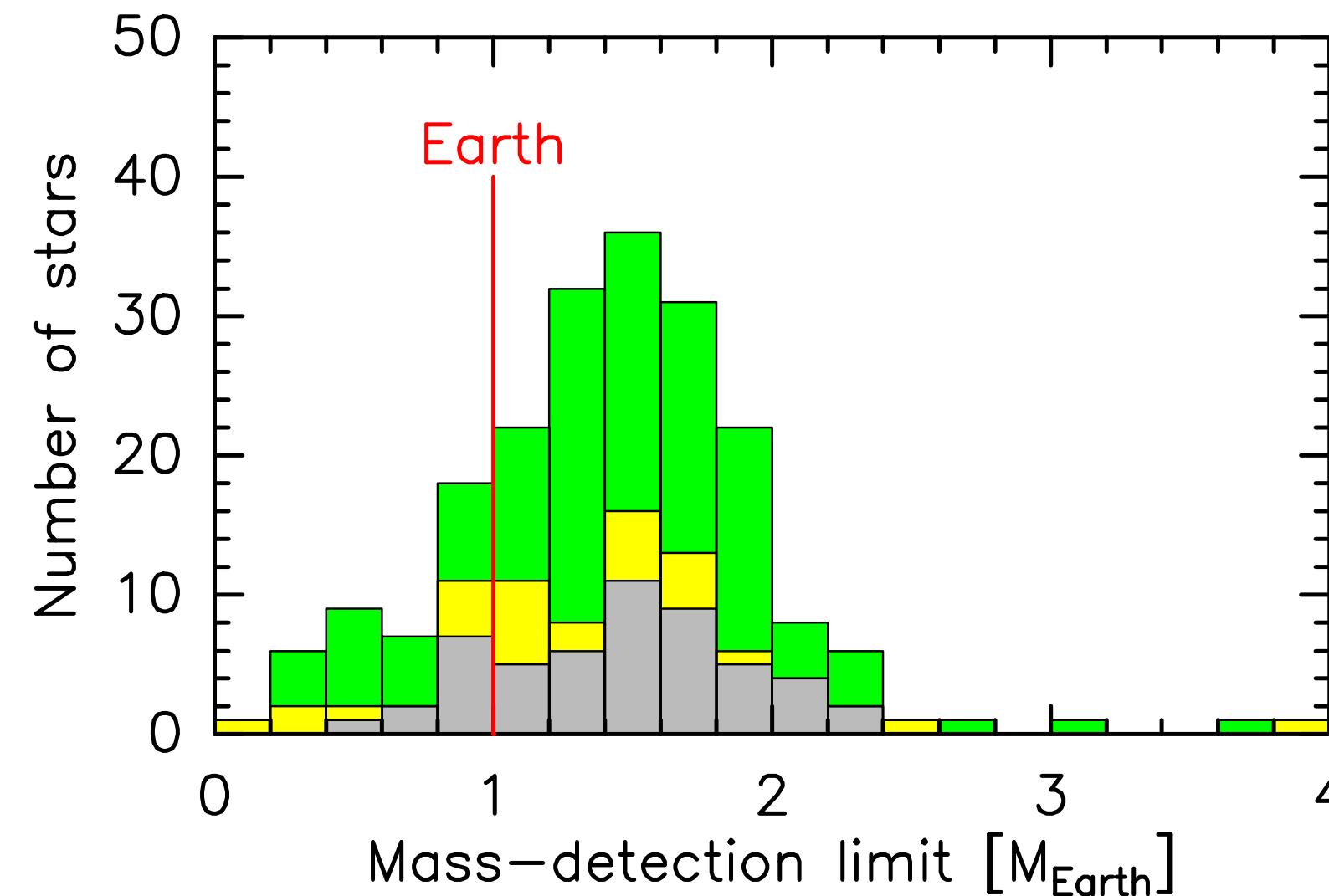
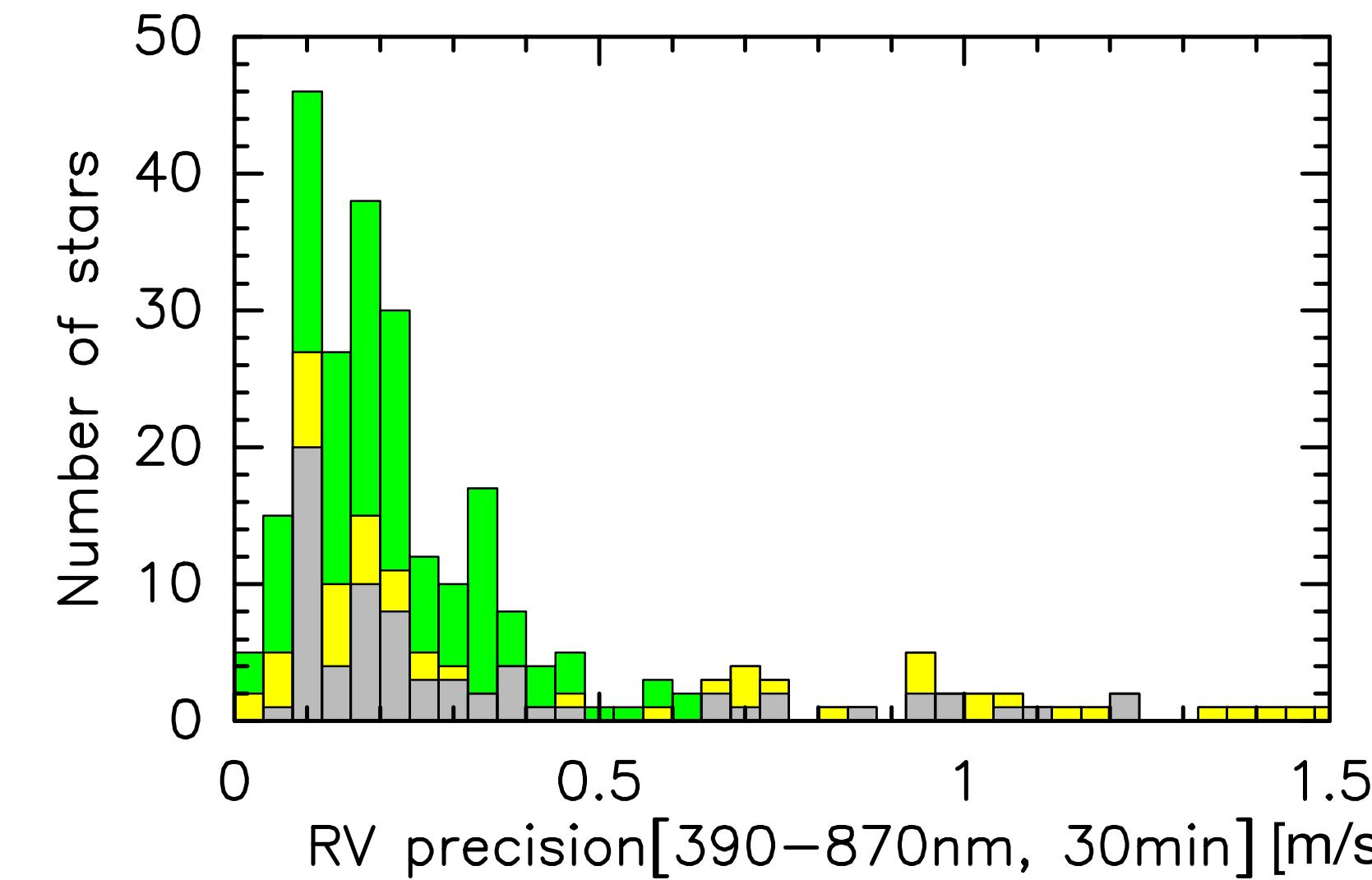
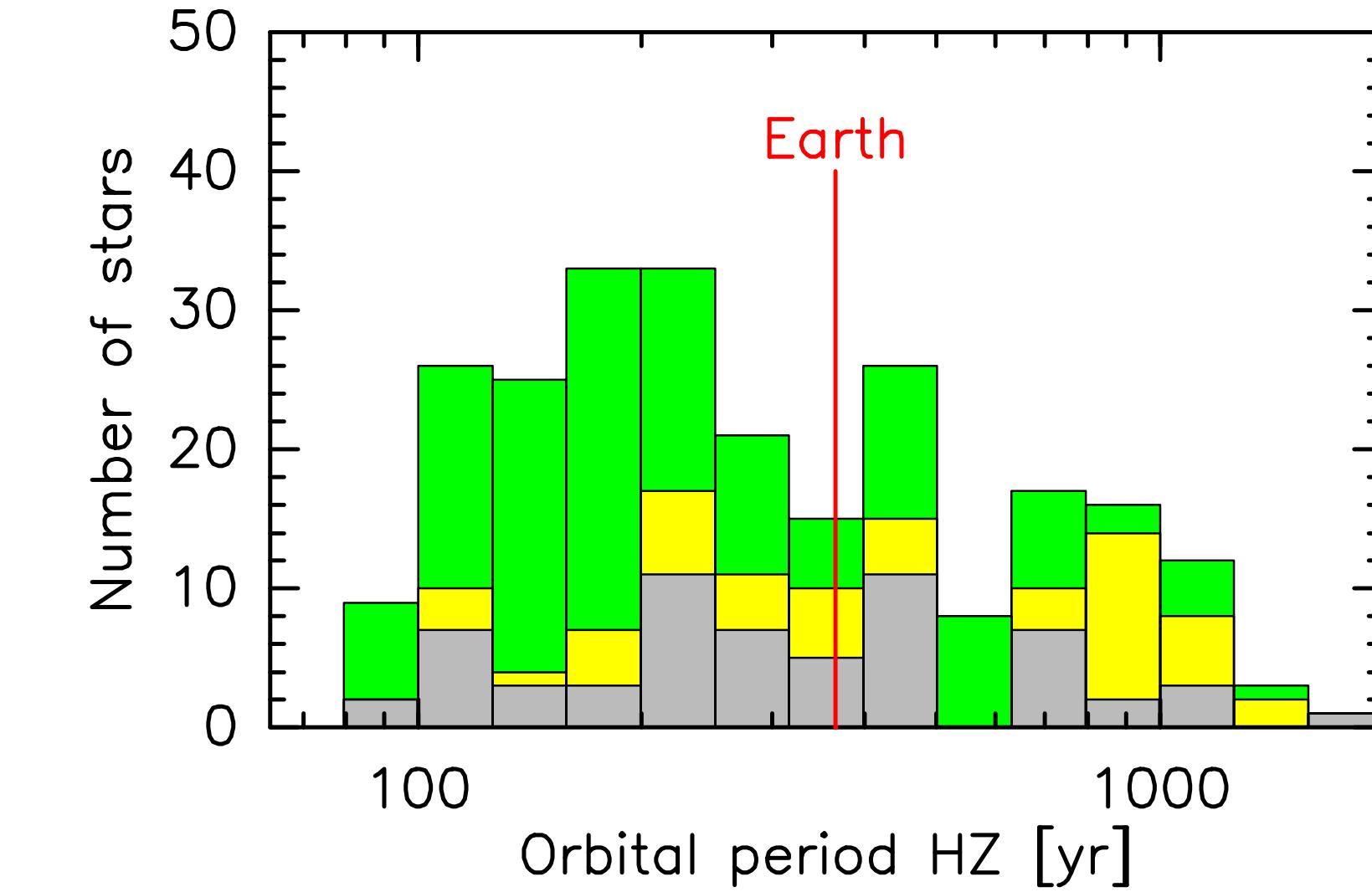
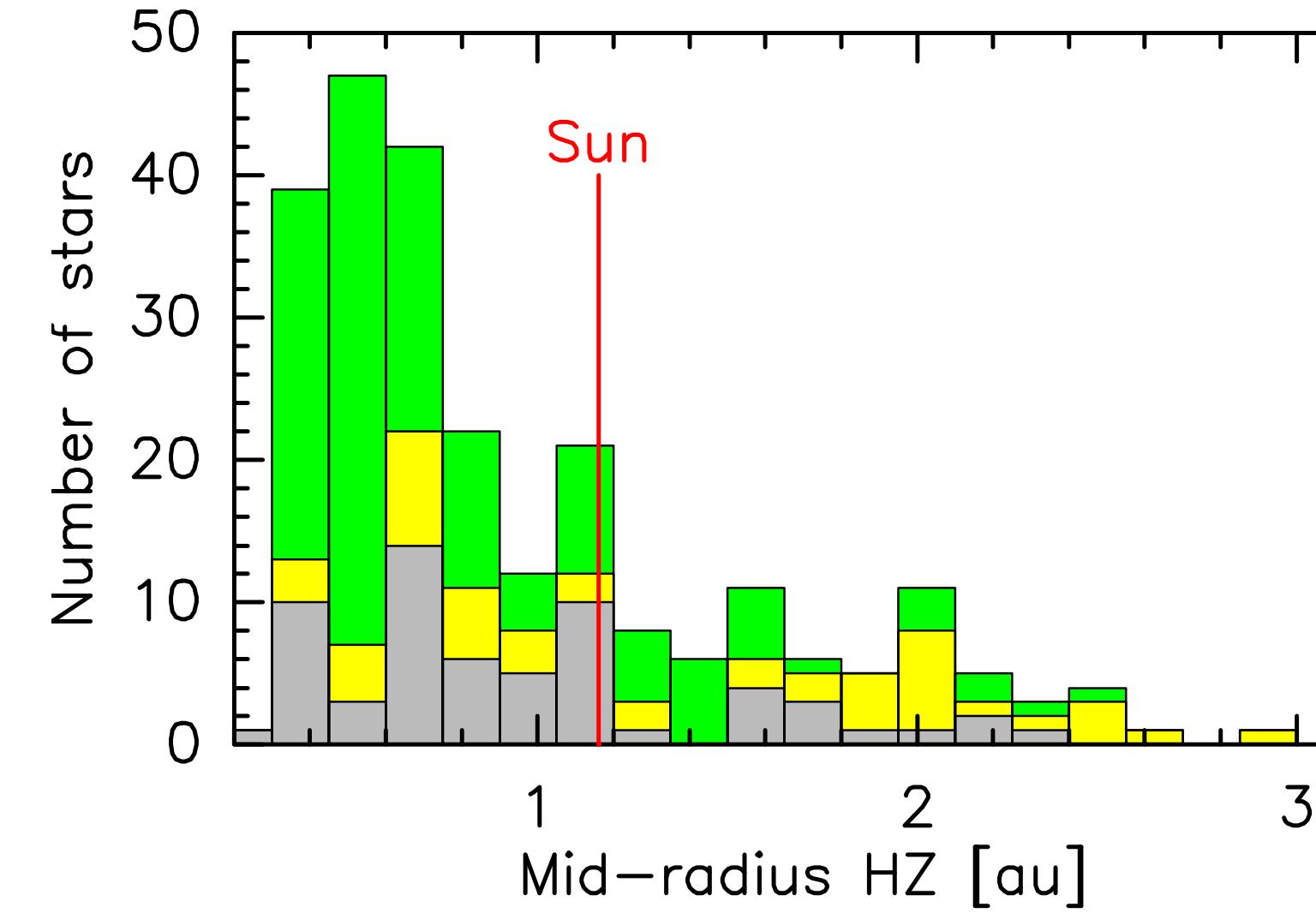
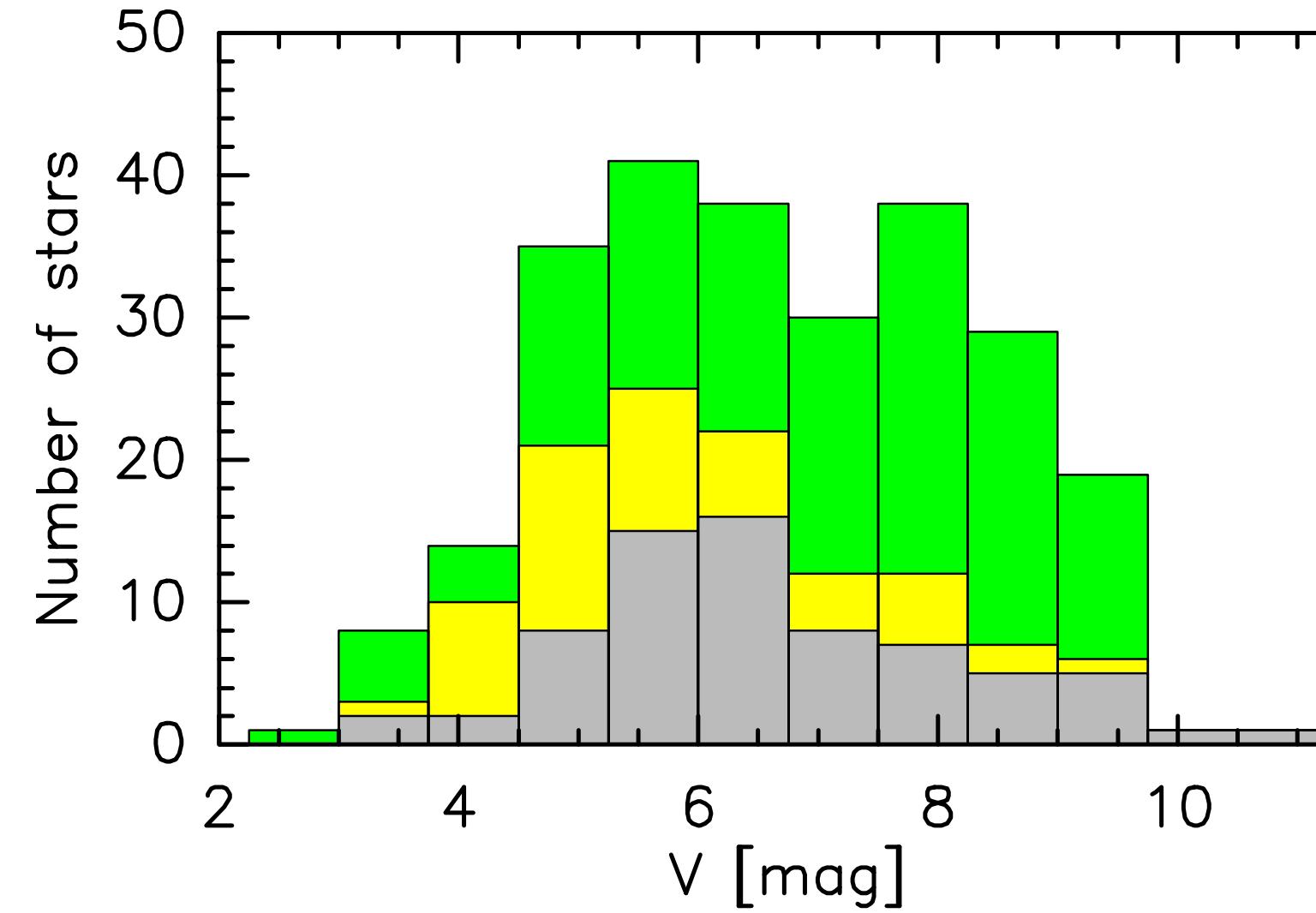


2ES target candidate list - distribution plots 2

258 target candidates total

187 stars potentially suitable

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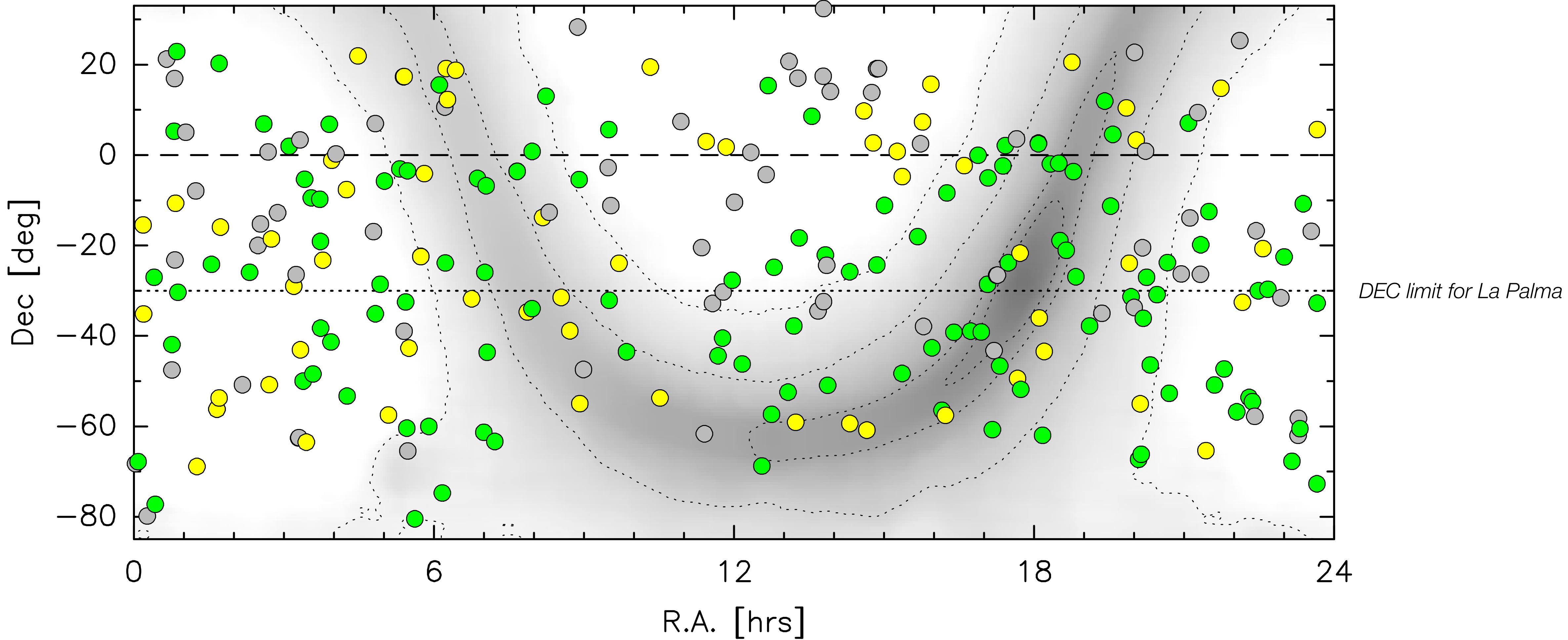


2ES (2nd Earth project) target list - distribution on sky

258 target candidates total

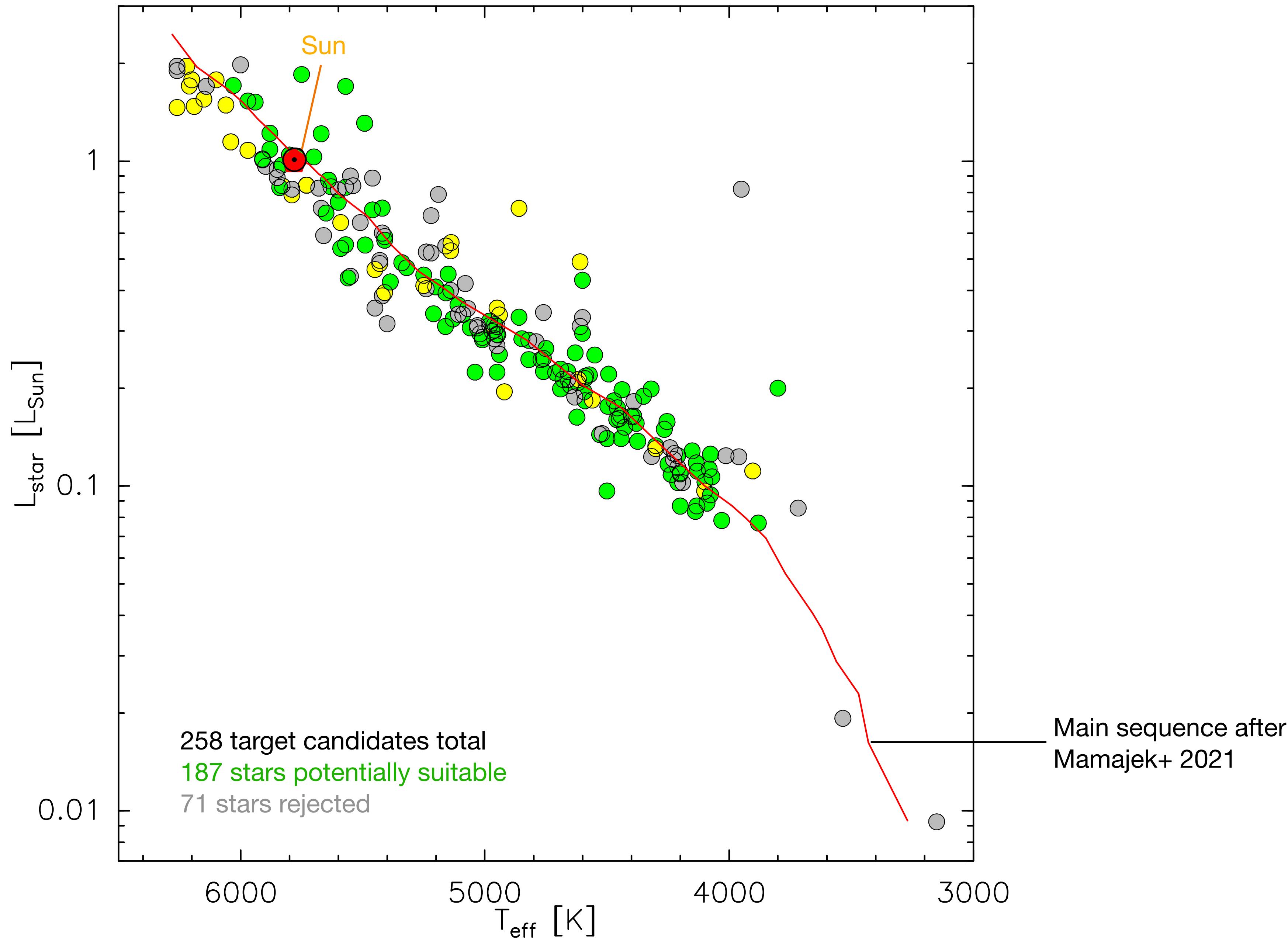
187 stars potentially suitable

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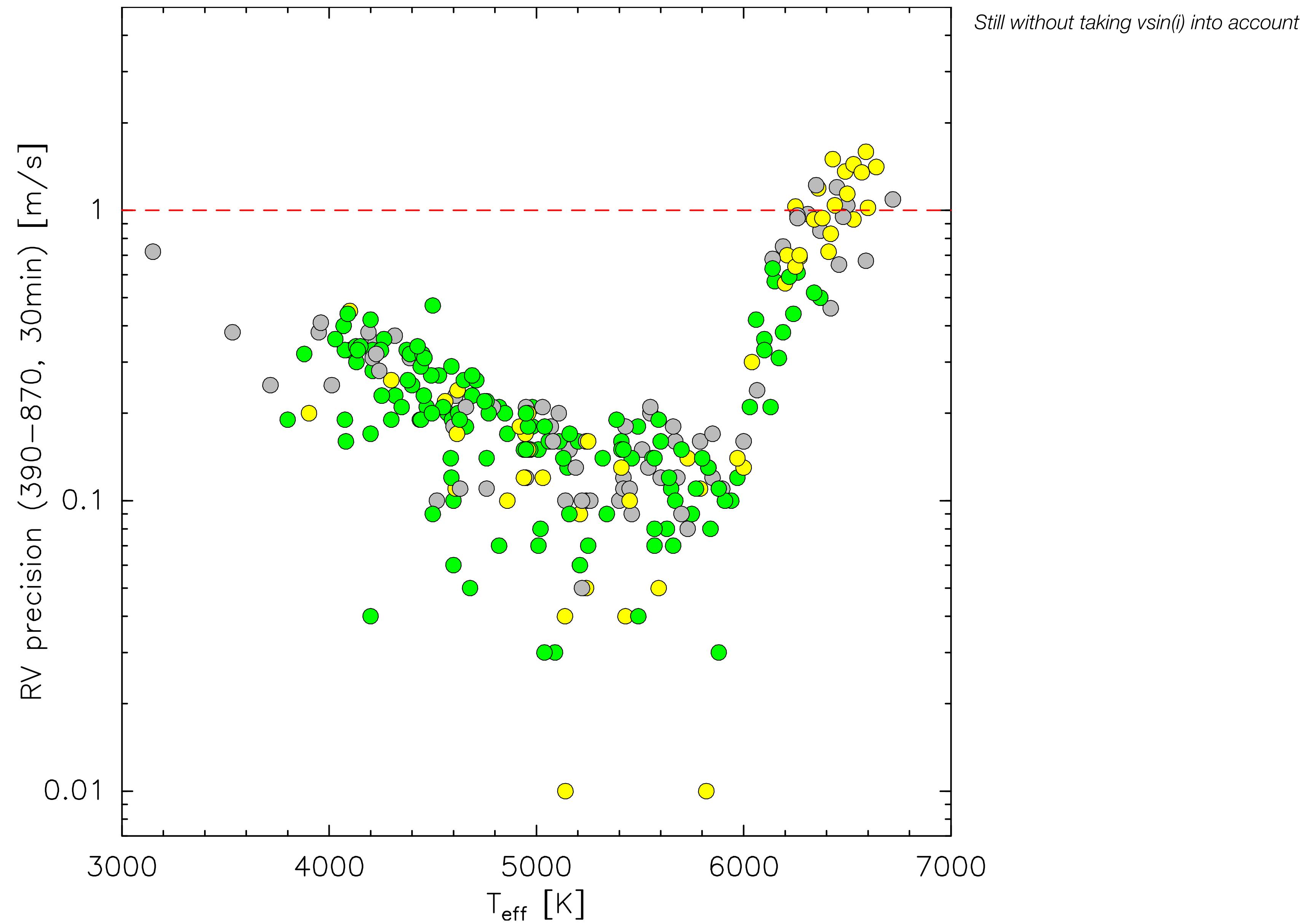


Q: how much potential overlap do we want to have with the northern survey by DQ?

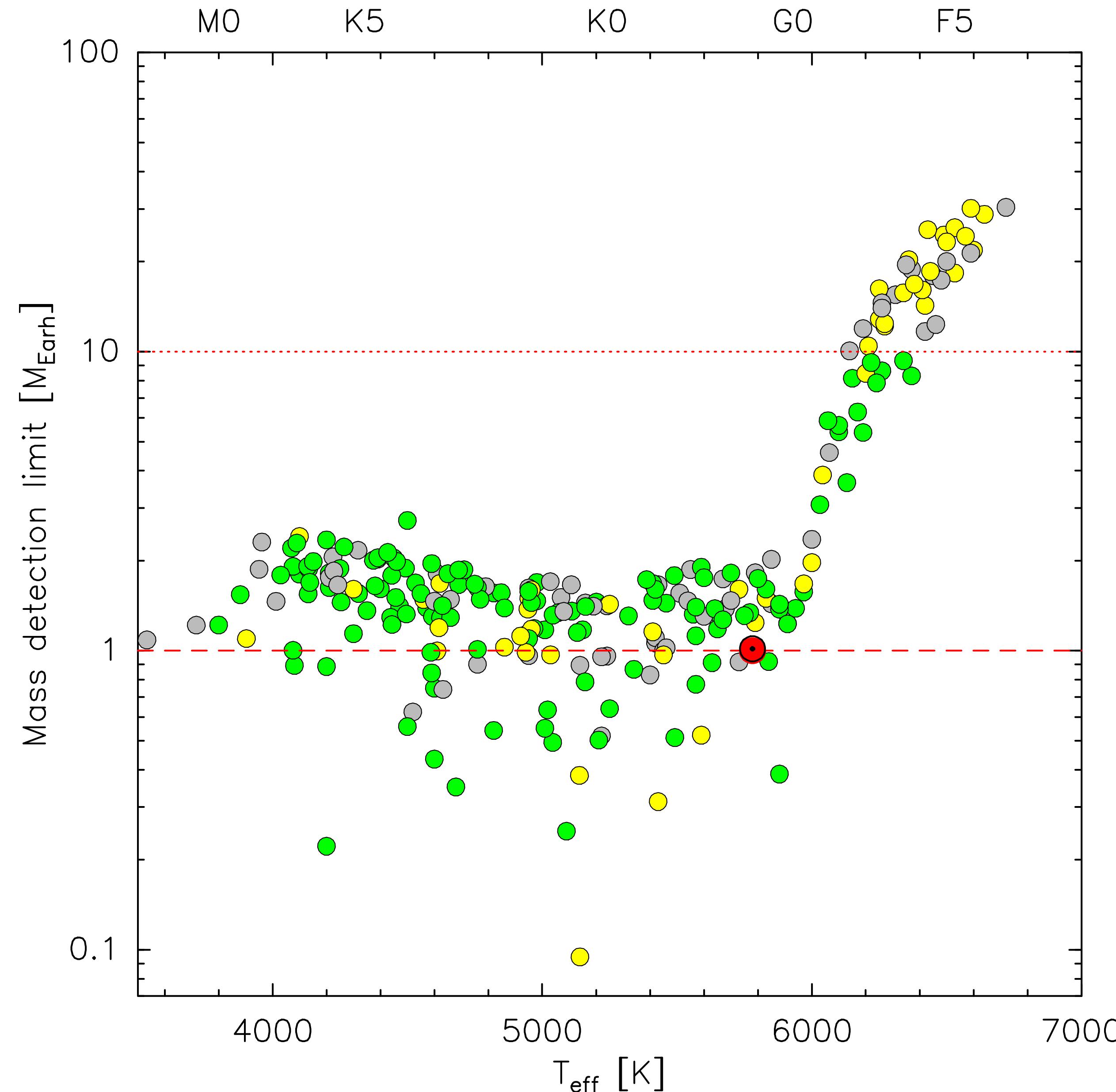
2ES (2nd Earth project) target list - HRD



2ES (2nd Earth project) target list - achievable RV precision



2ES (2nd Earth project) target list - mass-detection limits



Still without taking $v \sin(i)$ into account