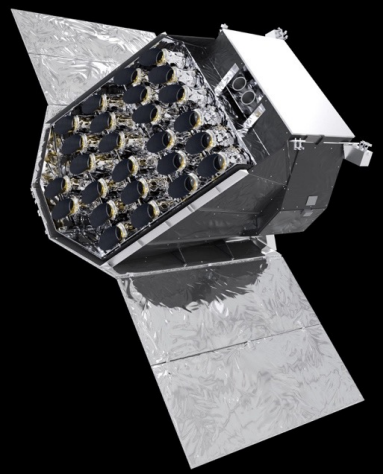
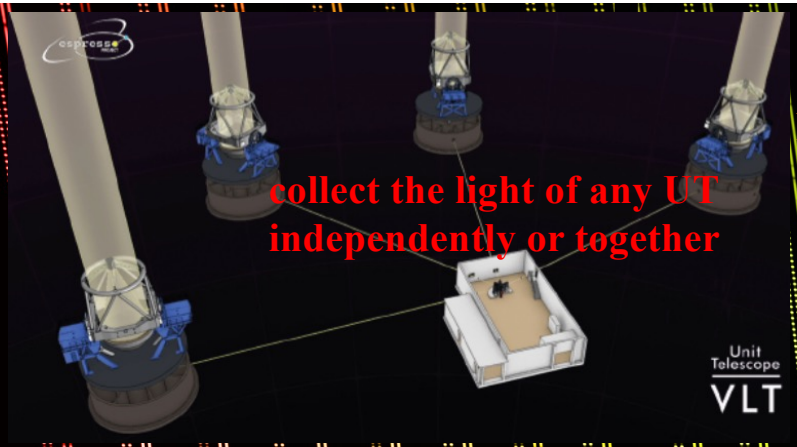
The ESPRESSO follow-up of small transiting exoplanets: perspectives for PLATO

F. Bouchy, M. Hobson, C. Lovis, F. Pepe, X. Dumusque, S. Udry, B. Lavie,
and the ESPRESSO consortium



ESPRESSO in a nutshell

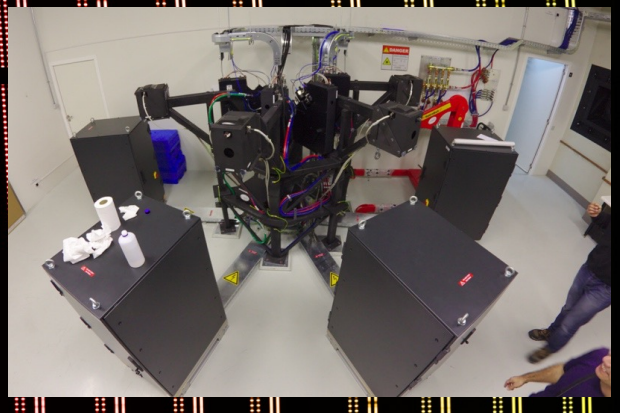
Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observation

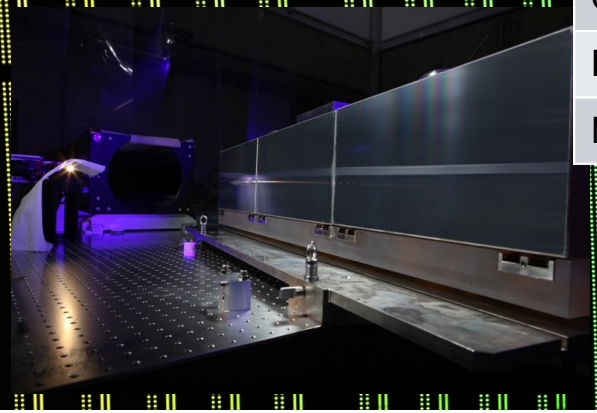


- 2007 STC and ESO identified need for a "HARPS'' on the VLT
- Jan 2011 : Project Kick-Off
- Nov 2017 : First light at Paranal
- Oct 2018 : Start of scientific operations
- Apr 2023 : End of GTO
- second most demanded instrument on the VLT

Parameter	*singleUHR*	*singleHR*	*multiMR*
Wavelengths	Blue arm: 378 – 520 nm Red arm: 520 – 788 nm		
Resolving power	>190'000	138'000	70'000
Aperture on sky	0.5 arcsec	1.0 arcsec	4x1.0 arcsec
Spectral sampling	2.5 pixels	4.5 pixels	10 pixels

RV photon-noise uncertainty for Texp=15min	
Spec-Type	V=11
G2V	98 cm/s
G8V	74 cm/s
K5V	62 cm/s
M2V	54 cm/s



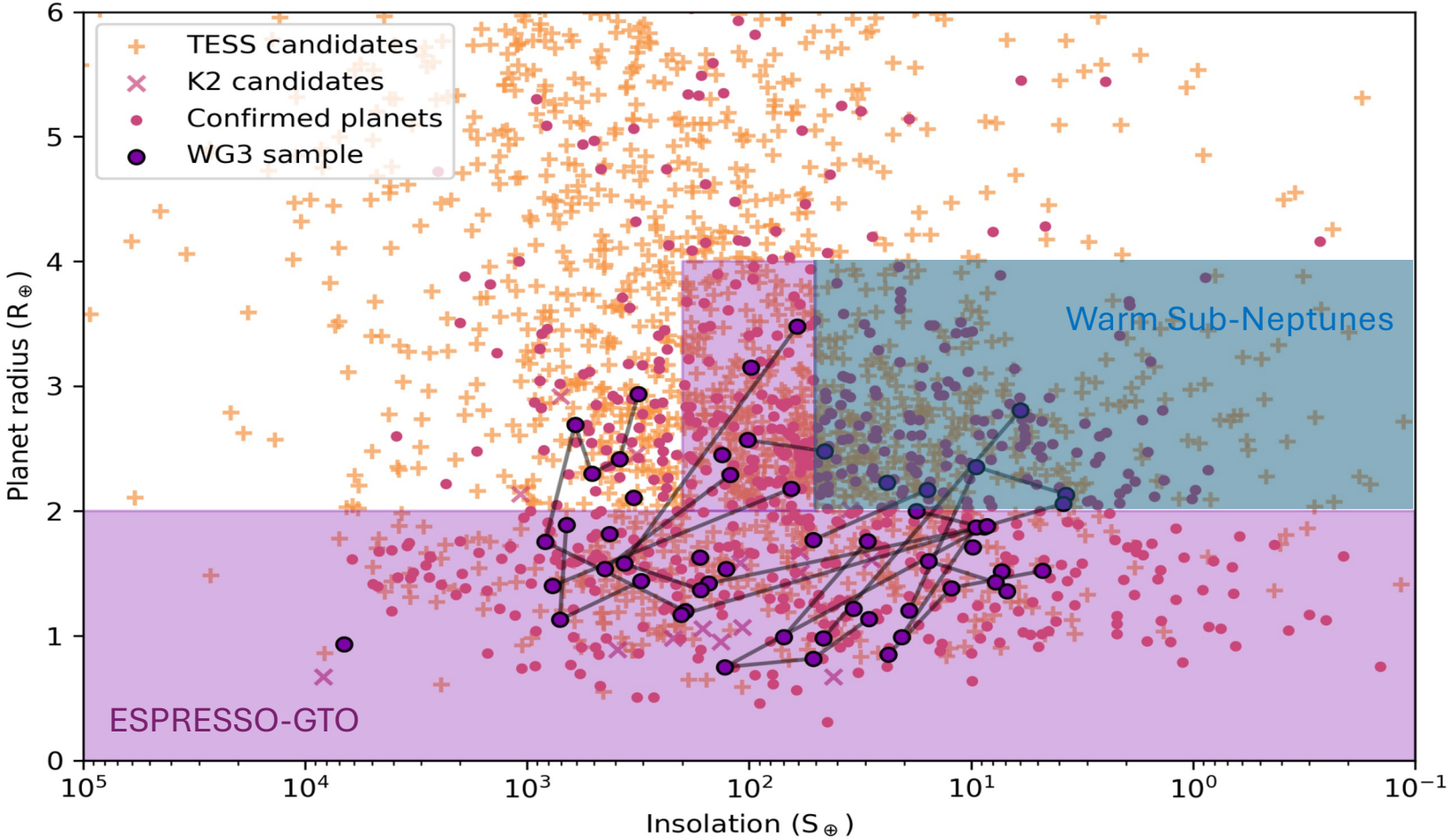


Pepe et al. 2021

ESPRESSO-GTO WP3 science goals (PI F. Pepe) ~ 12 nights / semester x 8 semesters

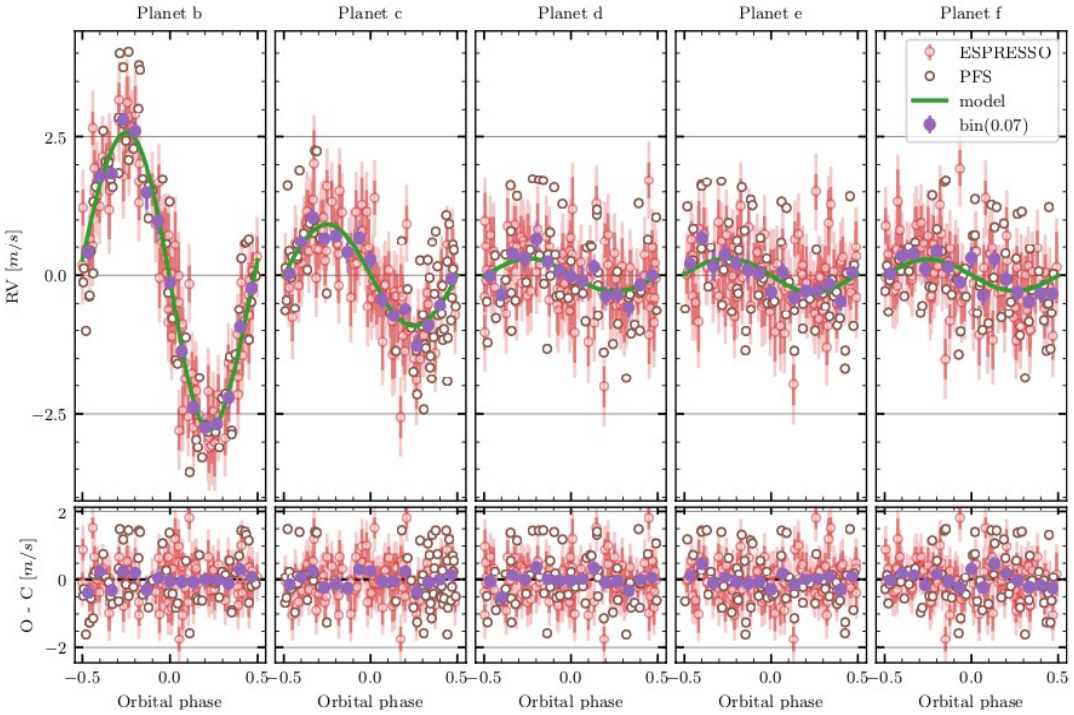
WP3.1) Characterize rocky population up to the habitable zone

WP3.2) Explore rocky/sub-Neptune transition within the 50-200x Earth irradiation



HD 23472: a multi-planetary system with three super-Earths and two potential super-Mercuries★,★★

Barros et al. 2022

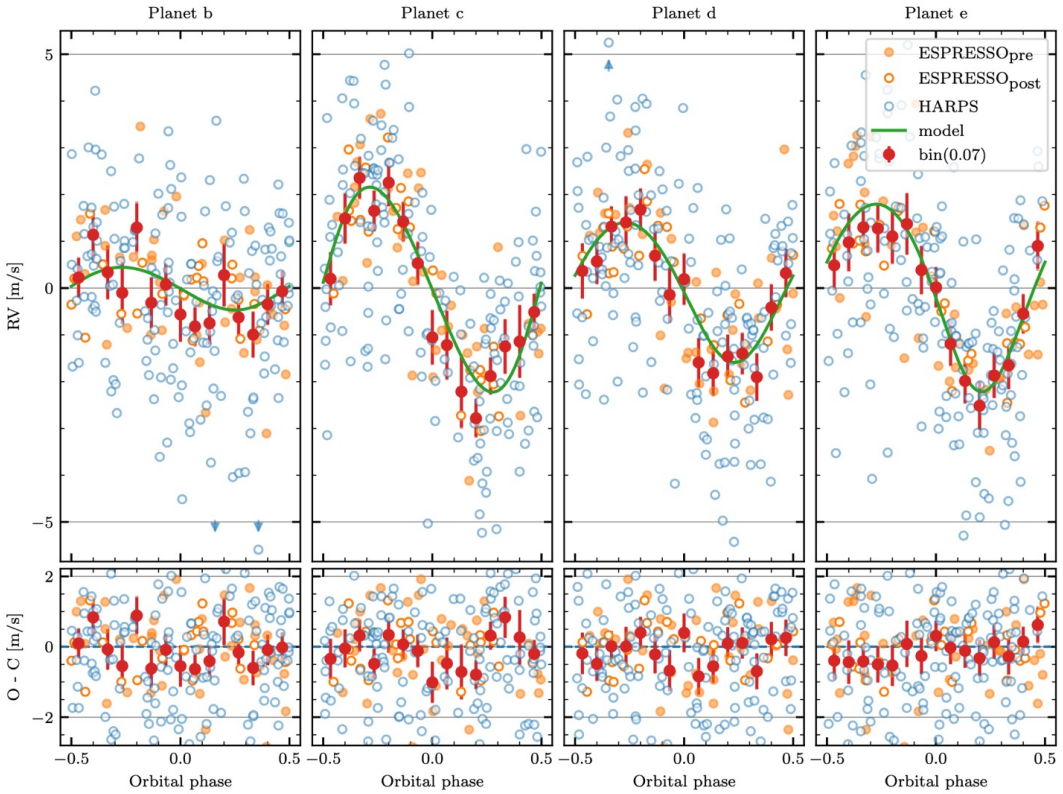


8.3$M_\oplus$ @ 17.7d | 3.4$M_\oplus$ @ 29.8d | 0.55$M_\oplus$ @ 4.0d | 0.72$M_\oplus$ @ 7.9d | 0.77$M_\oplus$ @ 12.2d

HD23472 K4V V=9.7
104 ESPRESSO + 64 PFS 2.3 years

Warm terrestrial planet with half the mass of Venus transiting a nearby star★,★★

Demangeon et al. 2021

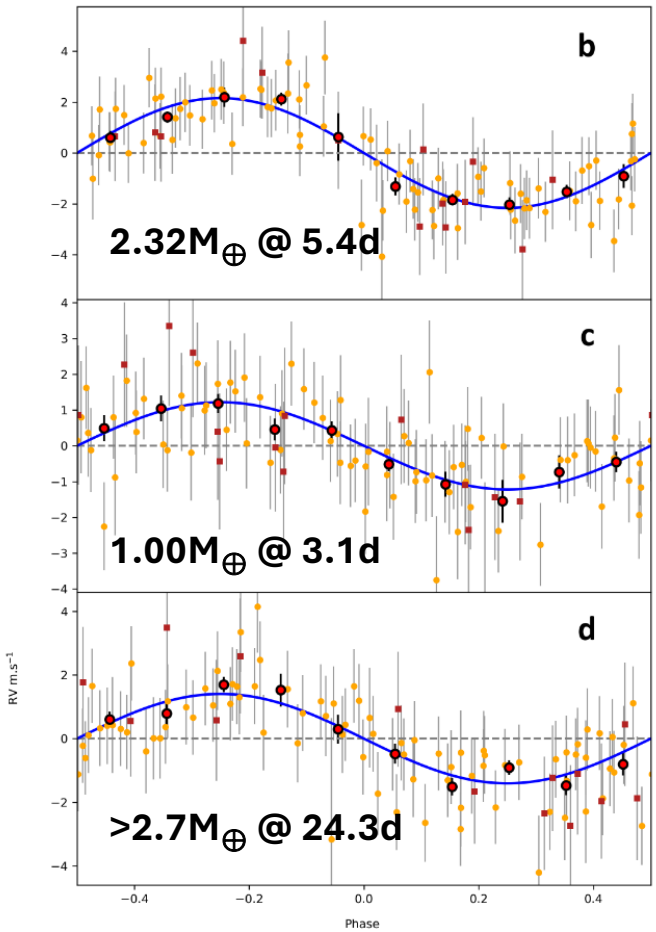


0.40$M_\oplus$ @ 2.25d | 2.22$M_\oplus$ @ 3.69d | 1.94$M_\oplus$ @ 7.45d | >3.06$M_\oplus$ @ 12.8d

L98-59 M3V V=11.7
66 ESPRESSO + 165 HARPS 1.5 years

Planetary system around LTT 1445A unveiled by ESPRESSO: Multiple planets in a triple M-dwarf system[★,★★]

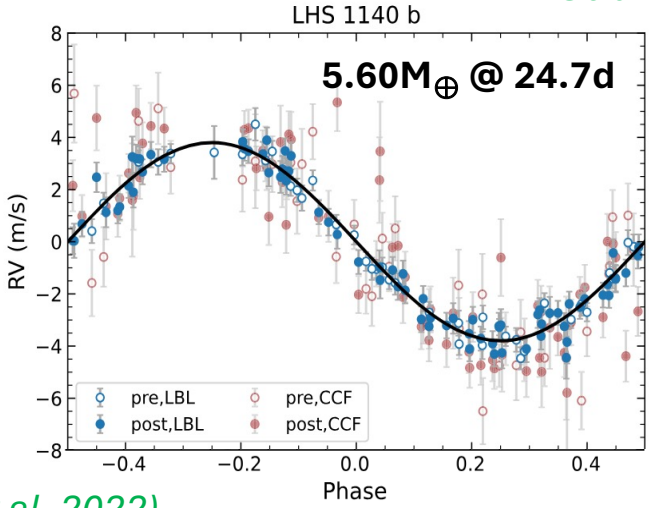
Lavie et al. 2023



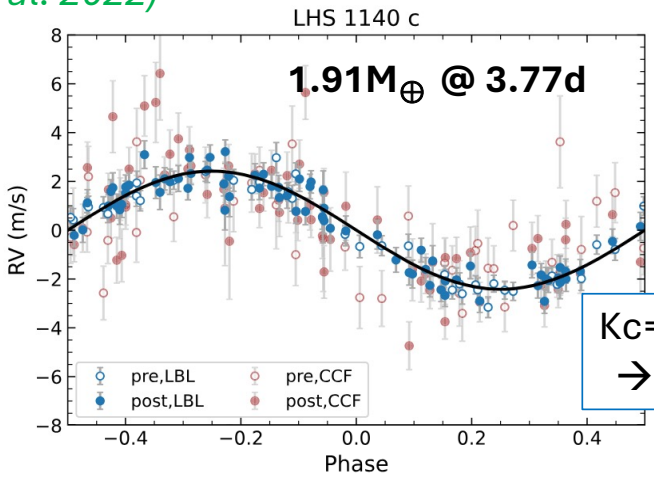
LTT1445A M3V V=10.5
84 ESPRESSO 1.7 years

New Mass and Radius Constraints on the LHS 1140 Planets

Cadieux et al. 2024



LBL (*Artigau et al. 2022)*



Kc=2.22±0.20 m.s^{-1}
→ 2.42±0.07 m.s^{-1}

LHS1140 M4.5 V=14.1
117 ESPRESSO 1.2 years

see also poster from Y. Eschen about Gl12b
and talk from S. Grouffal about HIP41378

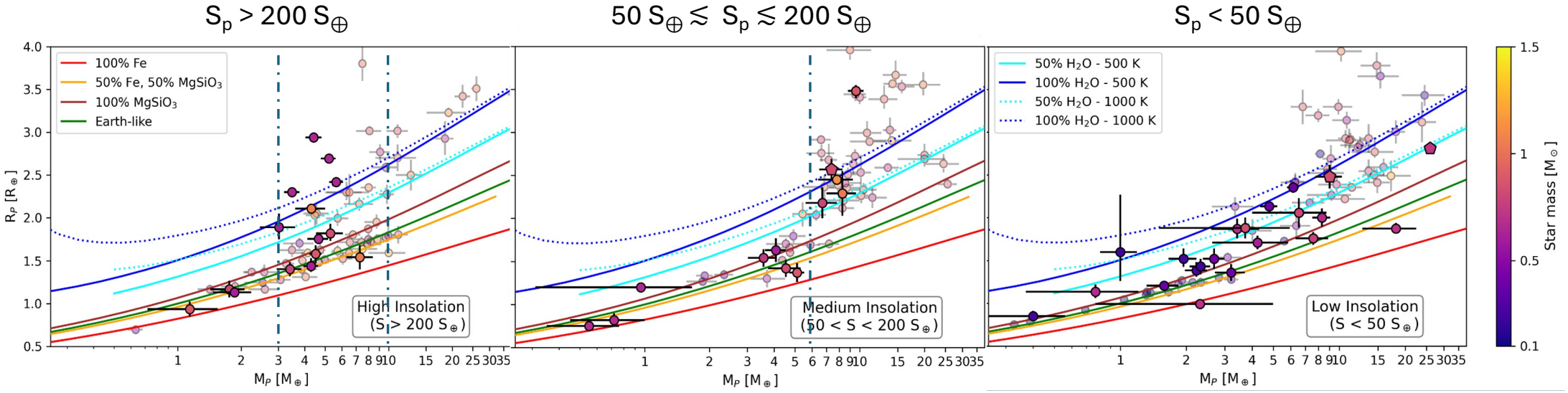
ESPRESSO Harvest

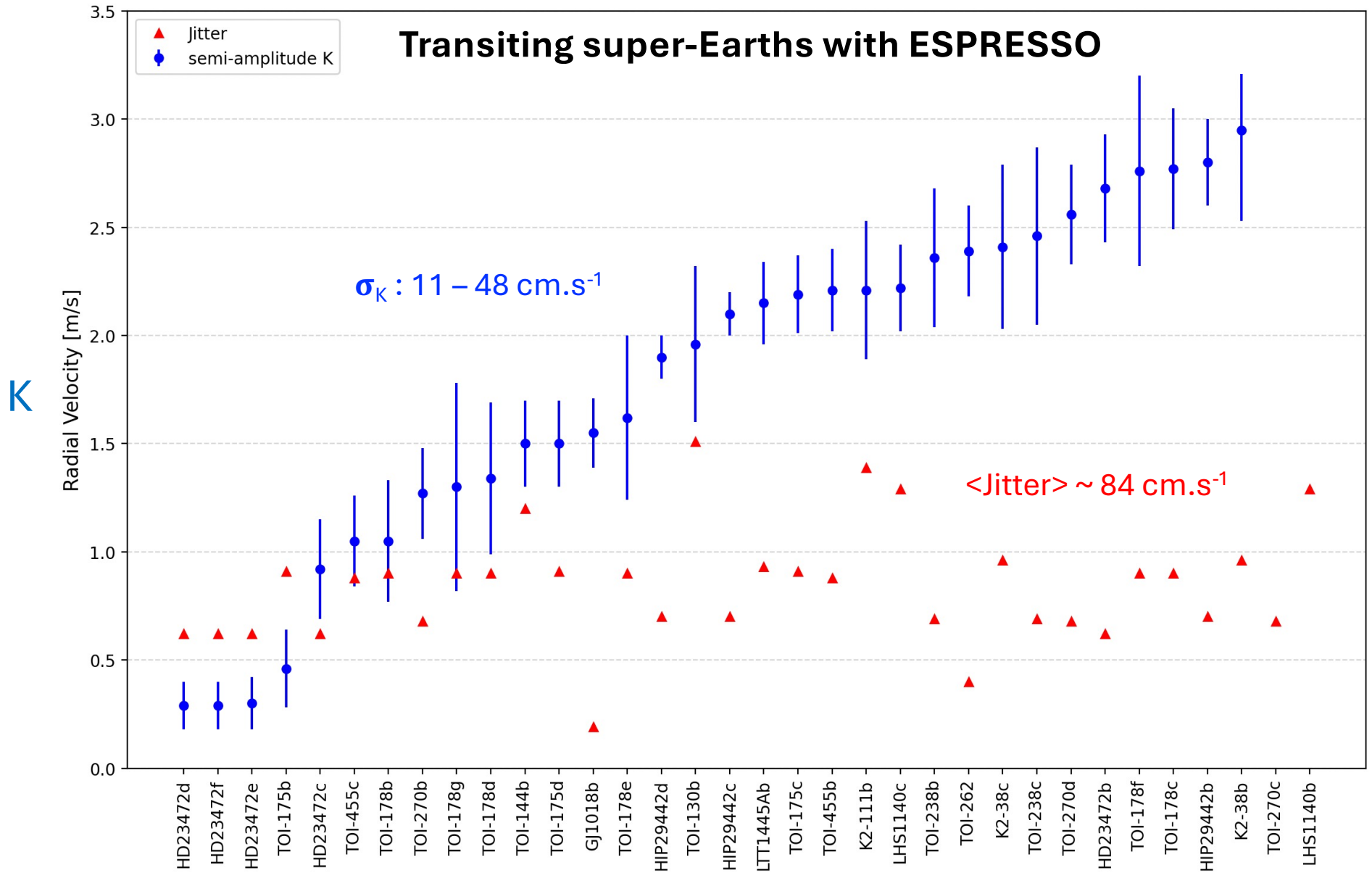
Hobson et al. 2025, in prep

52 planets in 26 systems from ESPRESSO-GTO WP3

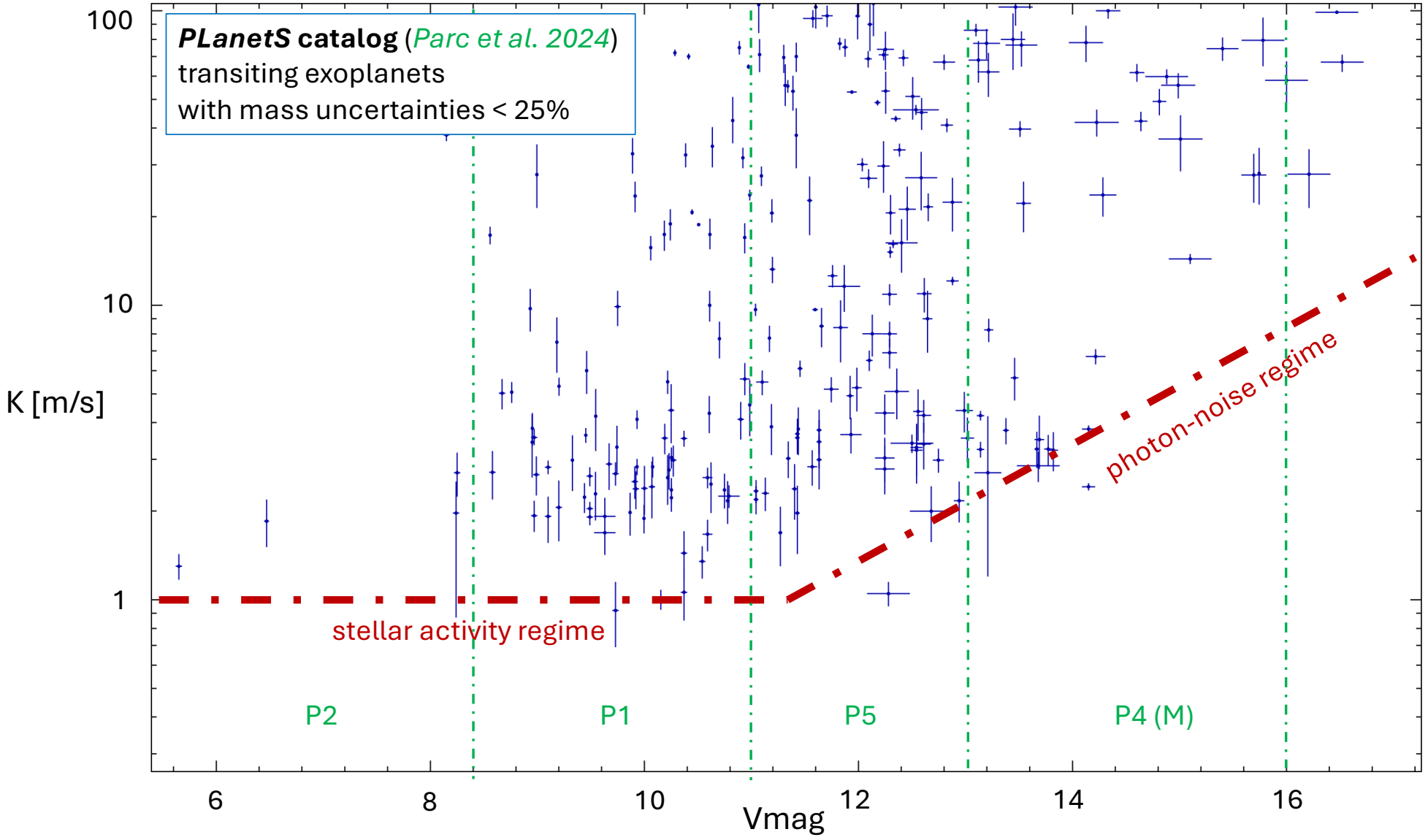
Studies of rocky-to-volatile transition for different regime of insolation

Comparison with the *PlanetS* catalog (*Parc et al. 2024*)



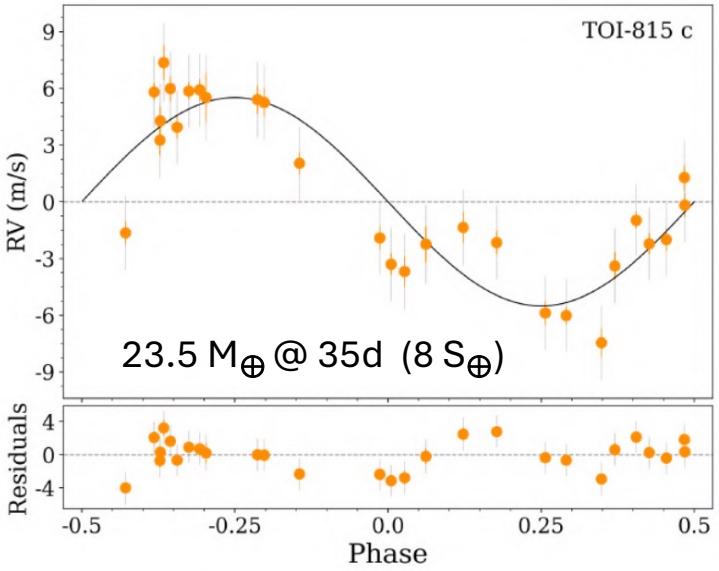

Transiting super-Earths with ESPRESSO
Jitter
semi-amplitude K
Radial Velocity [m/s]
σK : 11 – 48 cm.s-1
<Jitter> ~ 84 cm.s-1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
HD23472d
HD23472f
HD23472e
TOI-175b
HD23472c
TOI-455c
TOI-178b
TOI-270b
TOI-178g
TOI-178d
TOI-144b
TOI-175d
GJ1018b
TOI-178e
HIP29442d
TOI-130b
HIP29442c
LTT1445Ab
TOI-175c
TOI-455b
K2-111b
LHS1140c
TOI-238b
TOI-262
K2-38c
TOI-238c
TOI-270d
HD23472b
TOI-178f
TOI-178c
HIP29442b
K2-38b
TOI-270c
LHS1140b

K


PLanetS catalog (Parc et al. 2024)
transiting exoplanets
with mass uncertainties < 25%
100
10
1
K [m/s]
stellar activity regime
photon-noise regime
P2
P1
P5
P4 (M)
6
8
10
12
14
16
Vmag

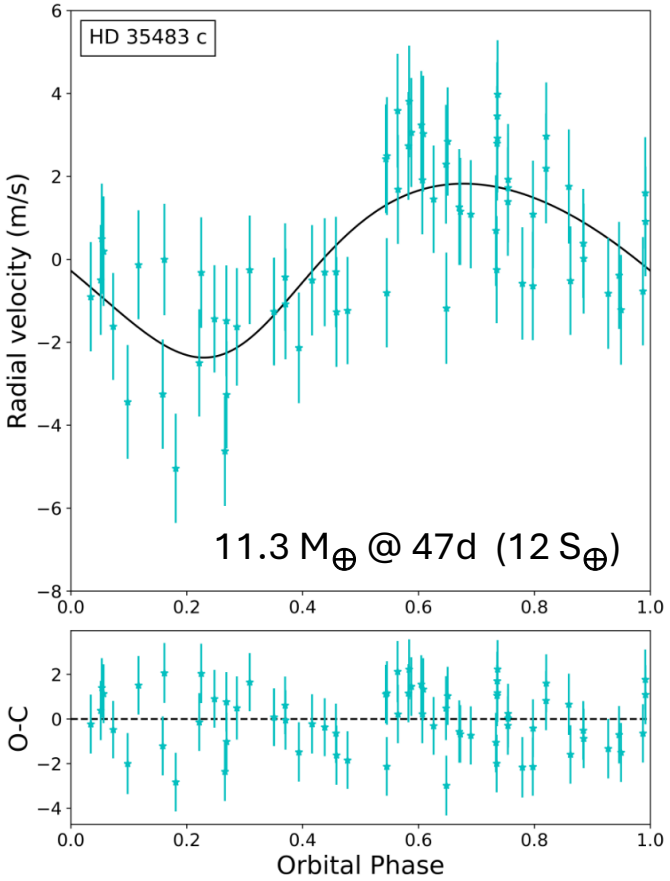
Warm sub-Neptunes with ESPRESSO

Psaridi et al. 2024



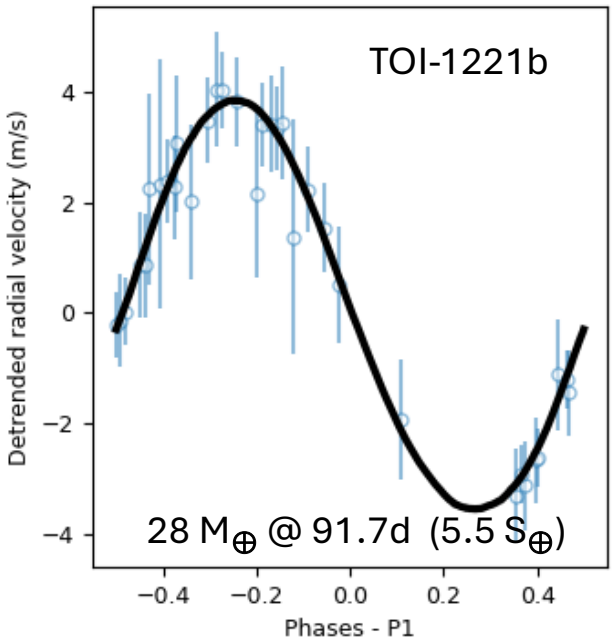
TOI-815 K3V V=10.2
34 ESPRESSO 1.7 years

Hesse et al. 2025 in press

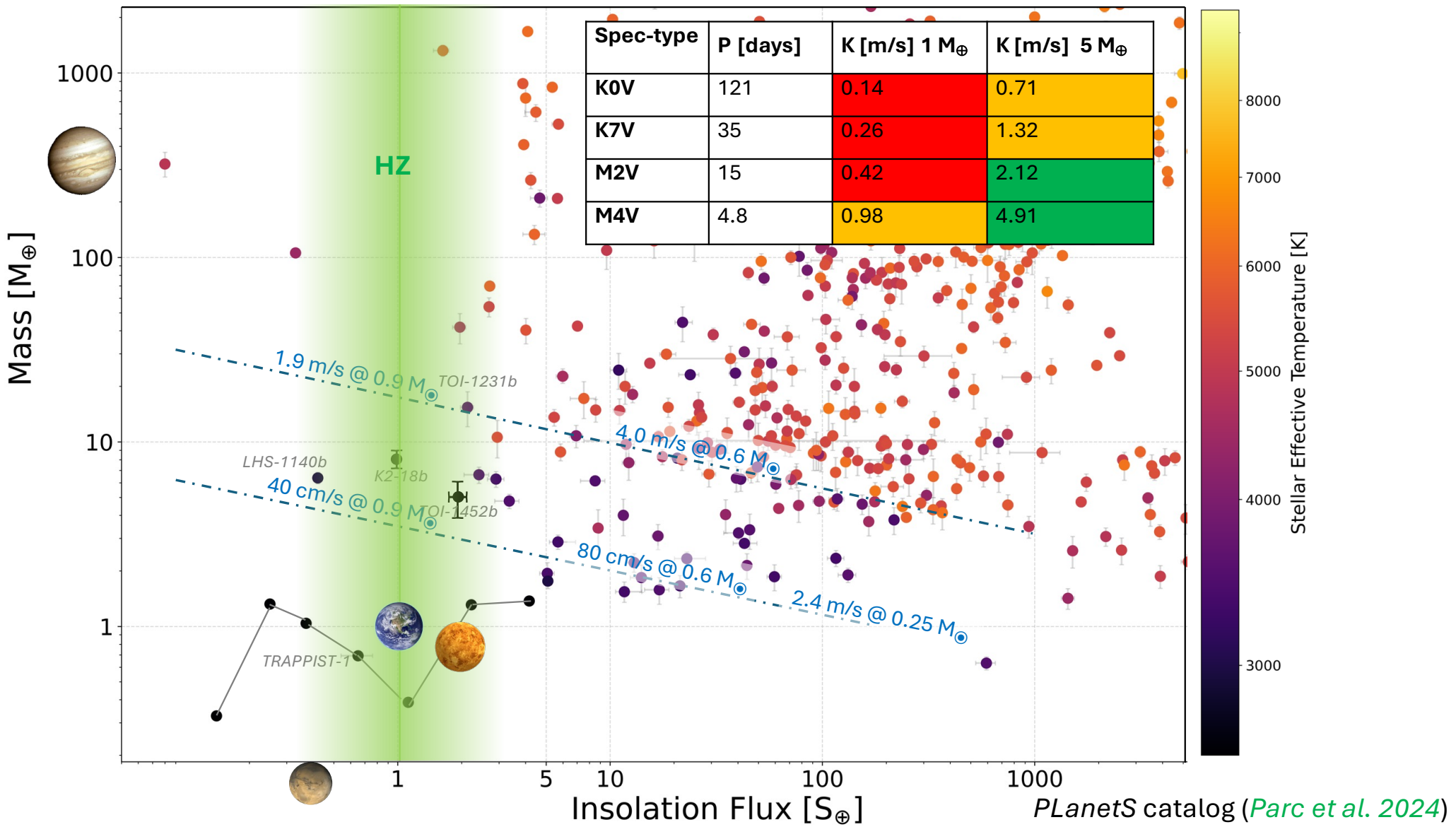


HD35483 G5V V=9.4
70 ESPRESSO 0.5 year

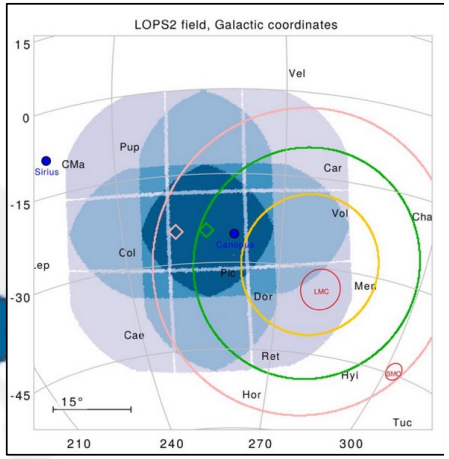
Bouchy et al. in prep



TOI-1221 G8V V=10.5
33 ESPRESSO 1.0 year


Spec-type | P [days] | K [m/s] 1 M⊕ | K [m/s] 5 M⊕
K0V | 121 | 0.14 | 0.71
K7V | 35 | 0.26 | 1.32
M2V | 15 | 0.42 | 2.12
M4V | 4.8 | 0.98 | 4.91
HZ
1.9 m/s @ 0.9 M⊙
4.0 m/s @ 0.6 M⊙
40 cm/s @ 0.9 M⊙
80 cm/s @ 0.6 M⊙
2.4 m/s @ 0.25 M⊙
TOI-1231b
LHS-1140b
K2-18b
TOI-1452b
TRAPPIST-1
Mass [M⊕]
Insolation Flux [S⊕]
Stellar Effective Temperature [K]
PLanetS catalog (Parc et al. 2024)

ESPRESSO will be key for PLATO **LOPS2** follow-up



06h21 -47°53

SPIROU/3.6m
HIRES/10m
PFS+IRD/8.2m
iShell/3.2m
MAROON-X/8.1m

+19°49'

equator

ESPRESSO/8.2m
CRIRES+/8.2m
4MOST/4m
ANDES/39m

CORALIE/1.2m
FEROS/2.2m
HARPS+NIRPS/3.6m
CHIRON/1.5m
PLATOspec/1.5m

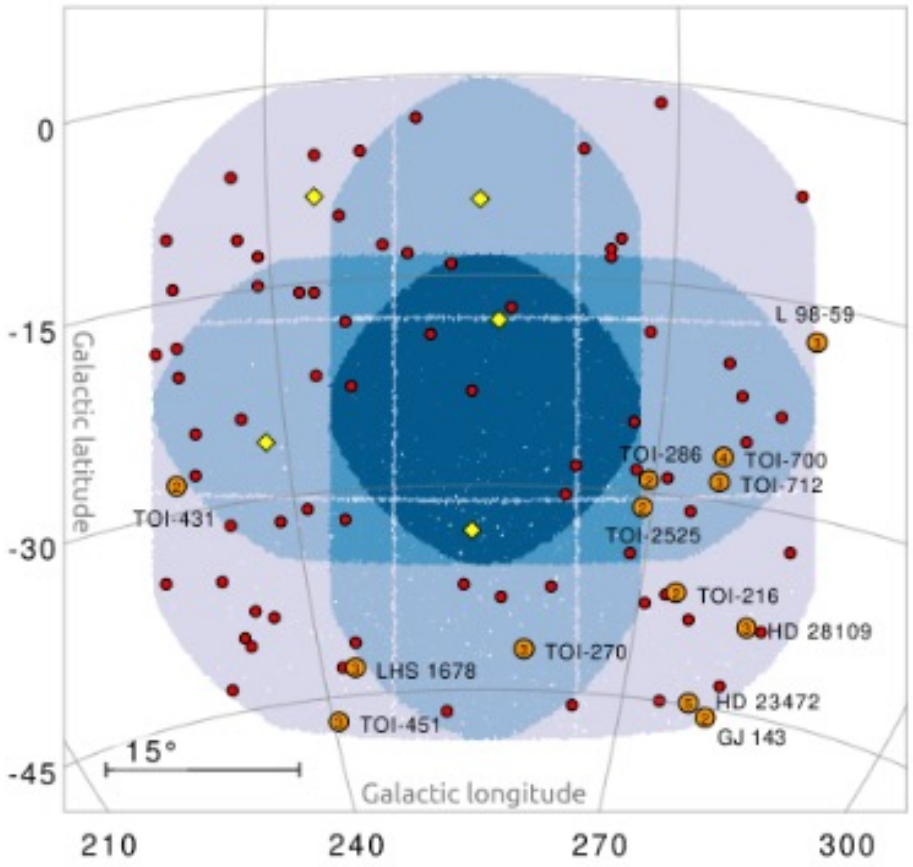
PFS/6.5m
G-CLEF/24.5m

HRS/9.2m

Veloce/3.9m
Minerva-Aus/0.7m

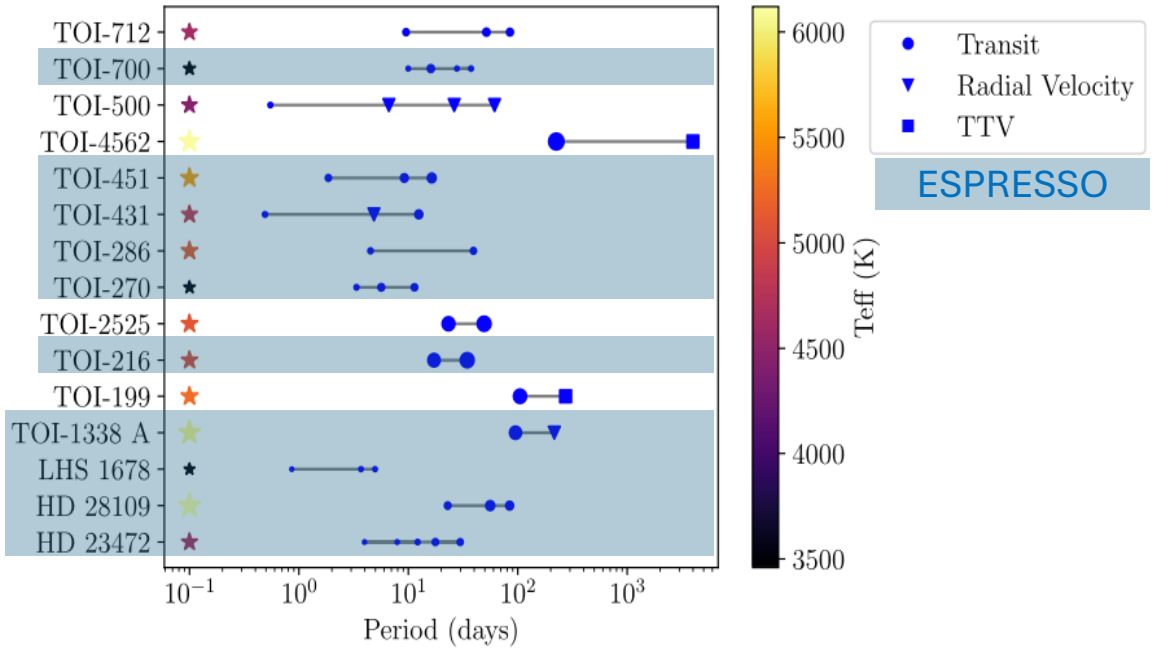
Non-European facilities

LOPS2 Center : Obs lat < +6° for airmass < 1.7
LOPS2 edge 24 cameras : Obs lat < +17° for airmass < 1.7



108 confirmed transiting exoplanets

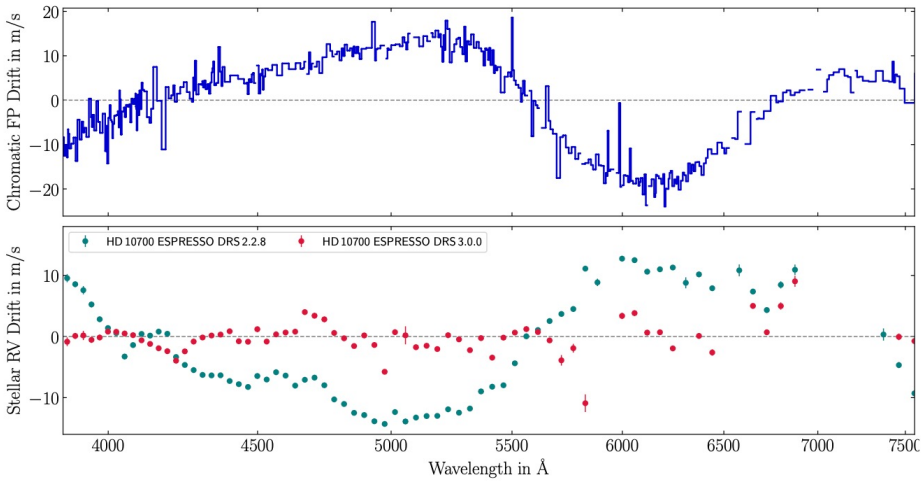
Nascimbeni et al. 2025



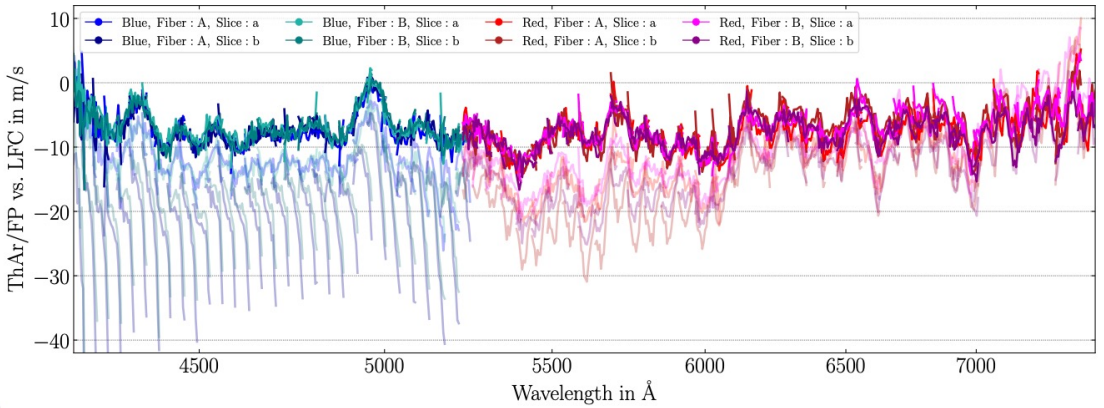
15 systems with multiple exoplanets
(10 of them monitored by ESPRESSO)

Eschen et al. 2024

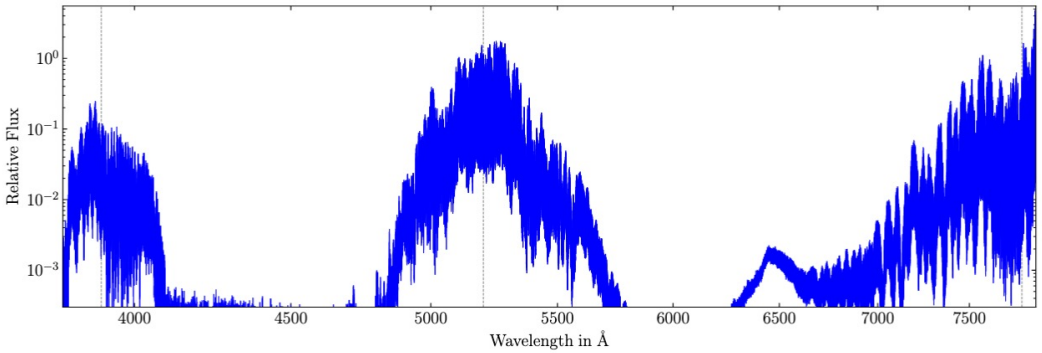
Continuous improvement of calibration sources and Data Reduction Software



Chromatic drift of the ESPRESSO Fabry-Pérot
Schmidt et al. 2022



Impact of modeling the instrument LSF
Schmidt & Bouchy 2024



Recent development BLUVES-LFC tested on ESPRESSO
Schmidt et al. in prep

ESPRESSO will be key for the PLATO follow-up of small transiting exoplanets

On-sky RV precision of better 40 cm.s^{-1} over 3.5 yr (*Figueira et al. 2025 in press*)

A lot of ESPRESSO archival data on multi-planetary systems part of LOPS2

PLATO+ESPRESSO : a niche for temperate exoplanets around K dwarfs

Stellar activity mitigation is fundamental
(*talk L. Malavolta + talk G.J. Talens + talk S. Aigrain & N. Meunier*)

Combination of TTVs + ESPRESSO RVs to derive masses of systems close to MMR
(*talk R. Mardling + talk A. Leleu + talk L. Pietro*)

On-going developement/upgrade on LFC (for long term accuracy)

Continuous upgrade of data reduction software and RV post-processing
(*talk of A. Silva , talk of M. Crétignier & N. Hara*)