La mission spatiale PLATO: démographie et évolution des systèmes planétaires.

M. Deleuil & PLATO consortium

PLATO - Status

ESA : 3rd M-class mission - European consortium
> 1000 members

Launch: second half January 2027 with Ariane 6.2

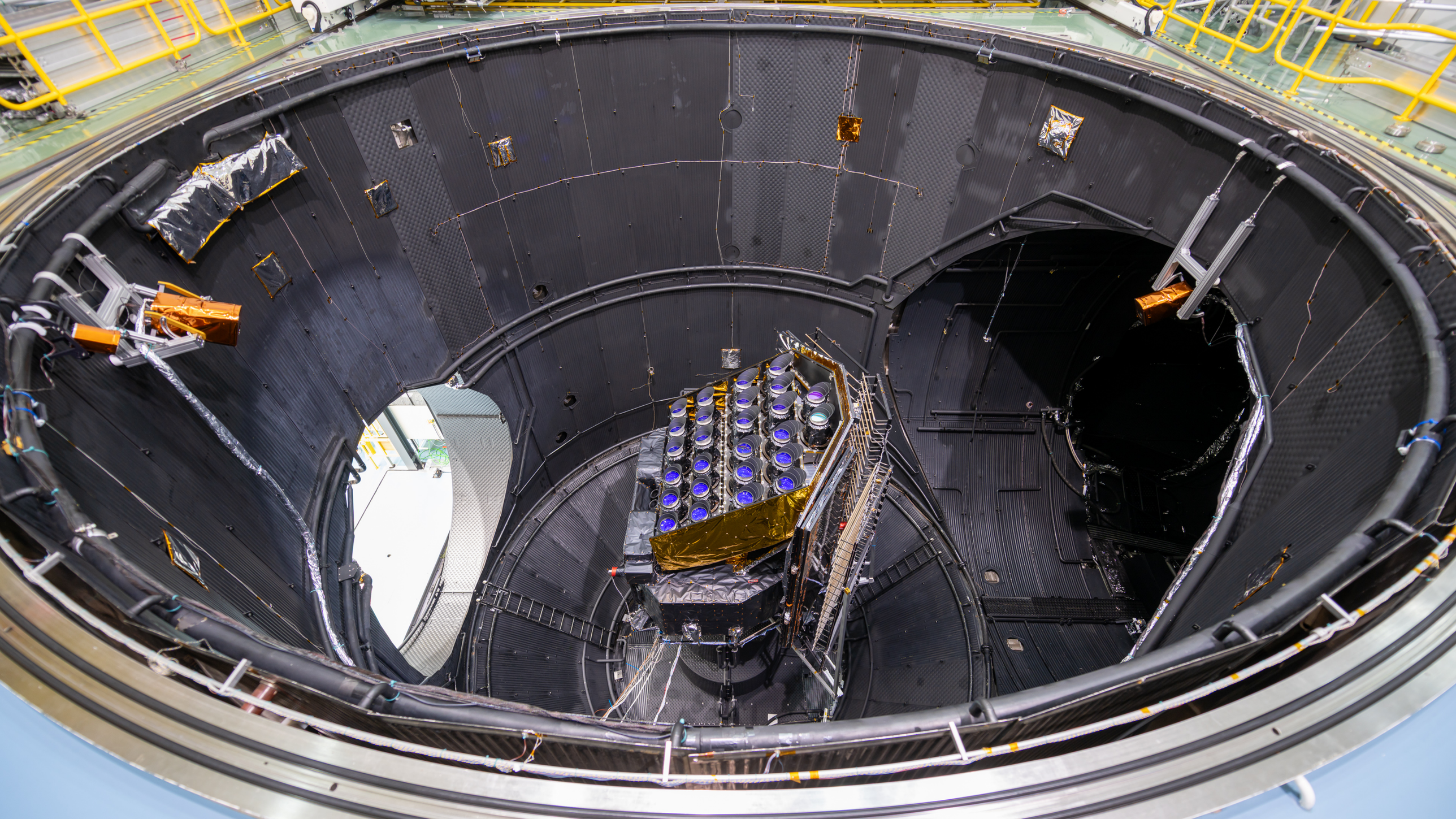
24 Normal cameras:

- 12cm aperture telescopes
- Camera FOV 1037 deg2
- Each camera has 4 x CCD,
  each 4510×4510px
- read-out cadence: 25 sec
- operate in “white light” (500 – 1050 nm)
- Photometric range : 4 - 16 Vmag

2 Fast cameras:

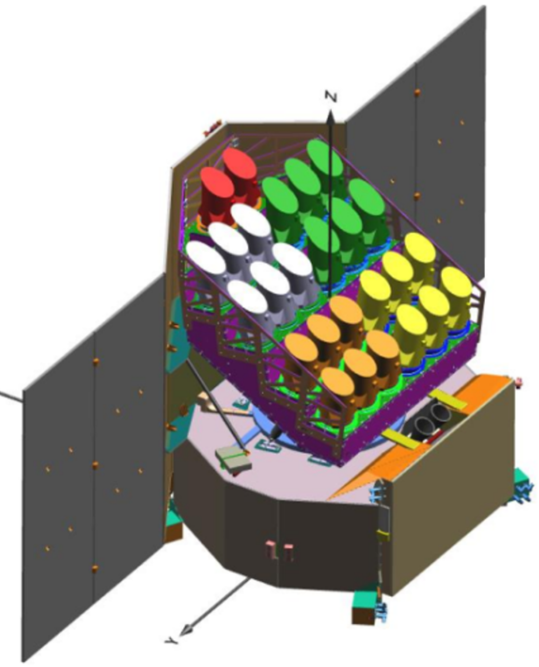
- read-out cadence: 2.5 sec
- Camera FOV: 610 deg2
- one “red“ & one “blue“ camera
- Photometric range : 4 - 8.2 Vmag

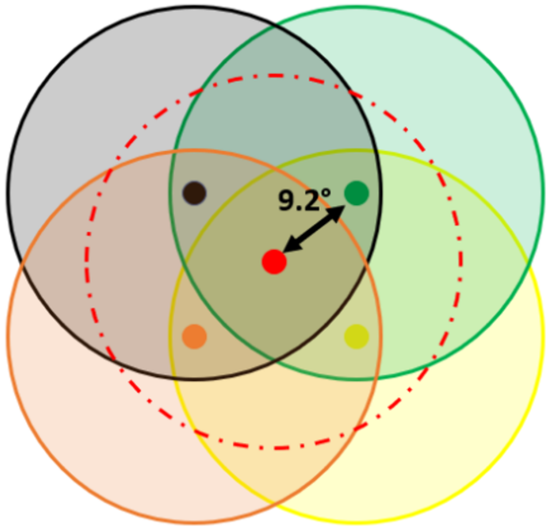
104 CCD in total + spares
Instrument in the very last stage of technical tests

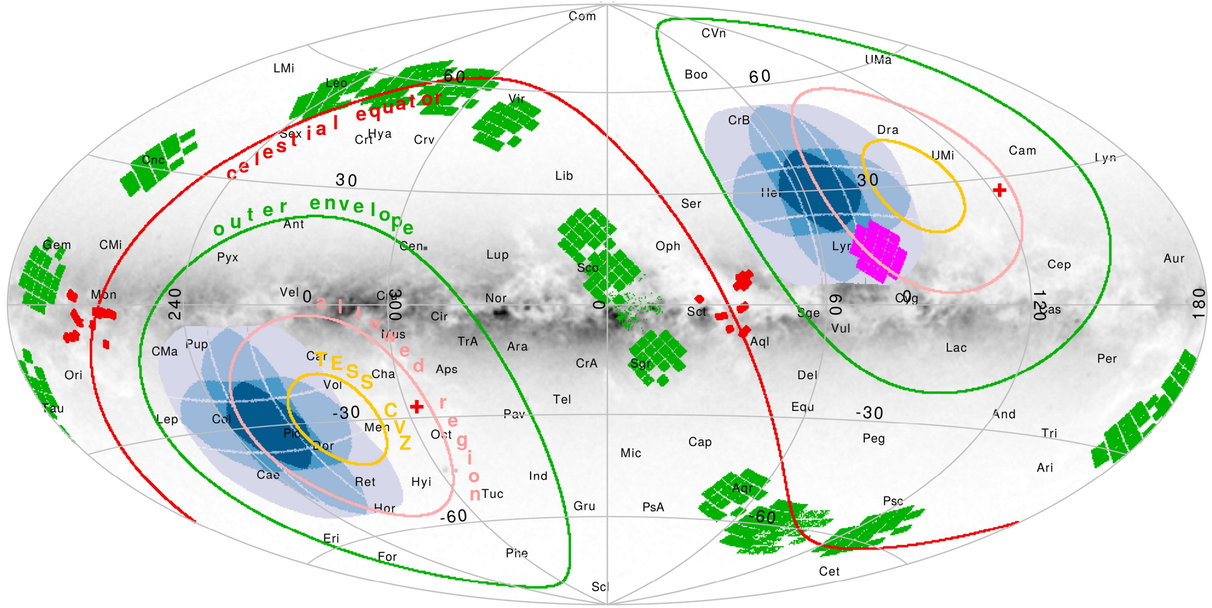


PLATO observing strategy

- Nominal lifetime: 4 years (extension up to 8.5 years)
- Baseline: 2 long pointings (2yrs+2yrs or 3yrs+1yrs)
- First field (South) selected, second field (North) one year after launch







PLATO fields *Kepler* field *K2* fields *CoRoT* fields

- Total FOV ~ 2232 deg², with 4 groups of cameras respectively looking on 301 deg², 247 deg², 735 deg², and 949 deg²
- PLATO Input Catalogue PIC 2.2 based on GAIA DR3 (Montalto + 2021 ; Nascimbeni +2022) released in Fev. 2026

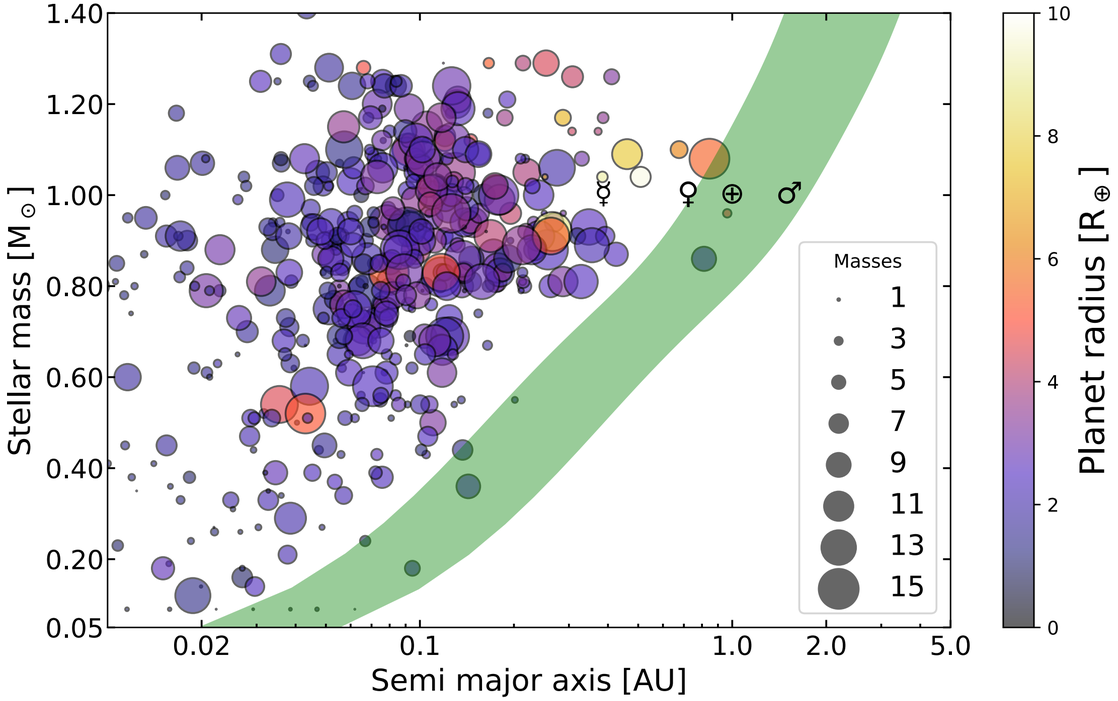
PLATO main objectives - 1

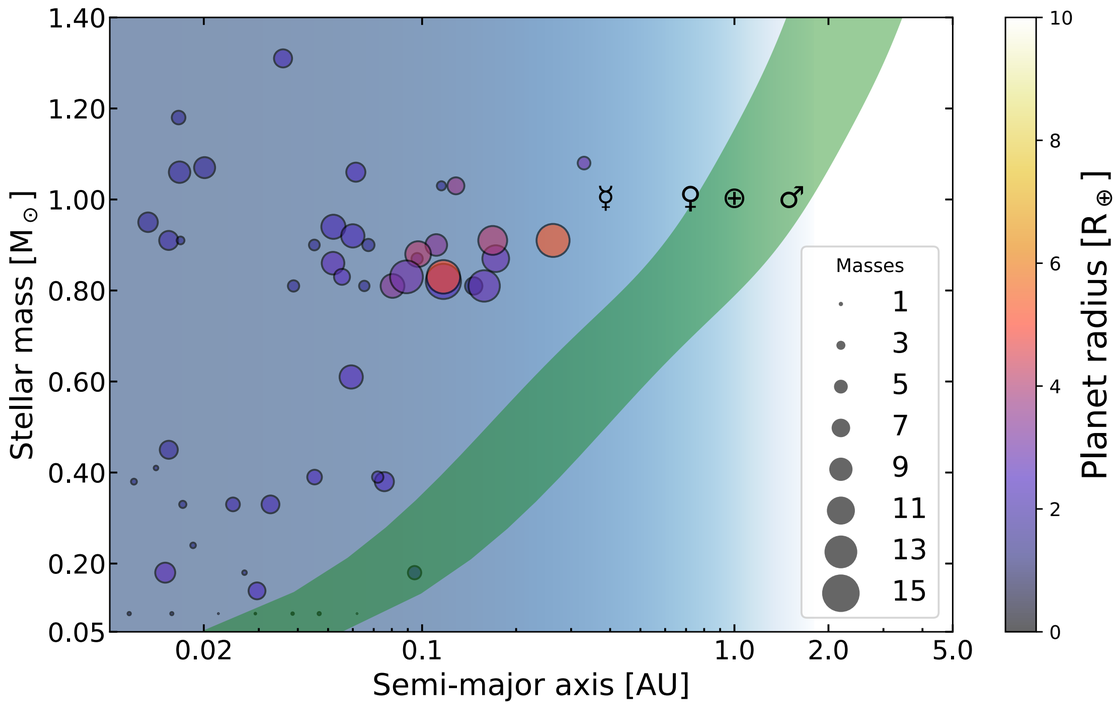
Characterize planets to: • explore planet diversity
• detect and characterize terrestrial planets

PLATO

Planets with precision better than 5% and 10% in radius and mass

Mass < 15 $M_\oplus$, radius < 10 $R_\oplus$





Determine the bulk properties (mass, radius, mean density) of planets for a wide range of systems, including *terrestrial planets in the habitable zone of solar-like stars.*

PLATO main objectives - 2

From Kepler and radial velocity surveys:

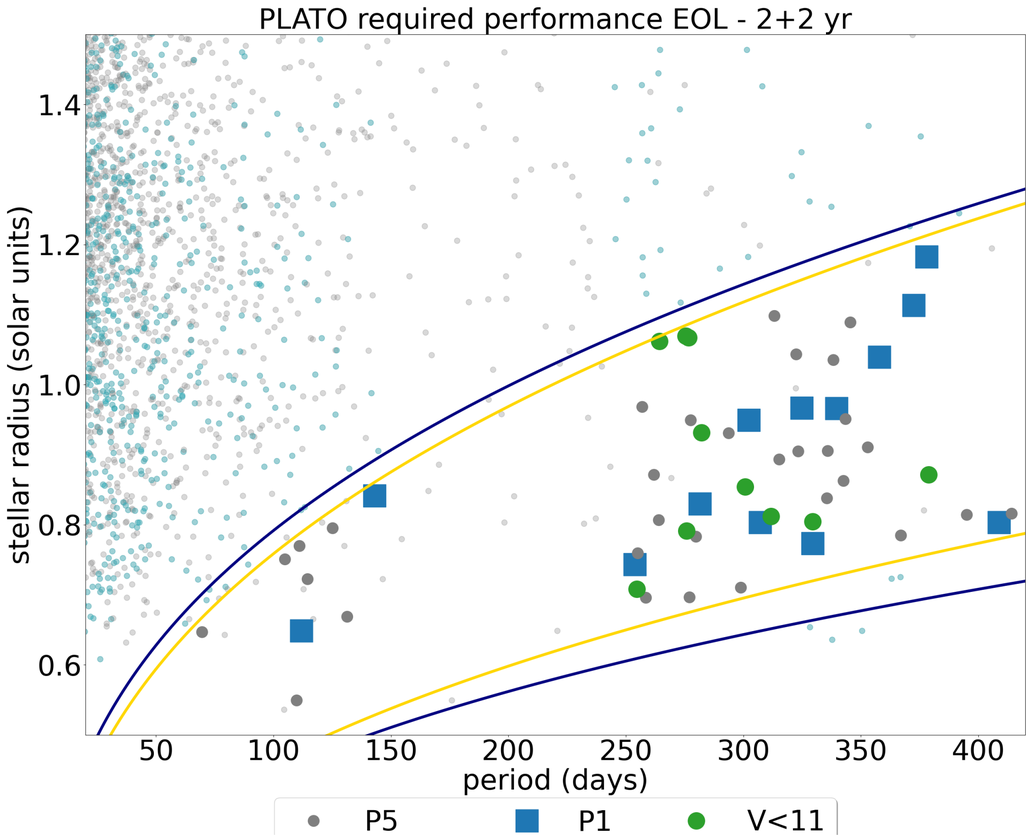
Occurrence rates	Host stellar type	Reference
1% - 3%	Sun-like stars	Catanzarite and Shao (2011)
20% - 58% (34%)	FGK stars	Traub (2012)
31% - 64% (46%)	dwarf stars	Gaidos (2013)
7% - 15% (11%)	GK stars	Petigura et al (2013)
11% - 22%	GK stars	Batalha (2014)
0.8% - 2.5% (1.7%)	G stars	Foreman-Mackey et al (2014)
5.3% - 9.8% (6.4%)	FGK stars	Silburt et al (2015)
20% - 30%	Sun-like stars	Kopparapu et al (2018)
16% - 85% (37%)	Sun-like stars	Bryson et al (2021)
11% - 21% (14%)	FGK	Bergsten et al (2022)
<14.1%	FGK	Kunimoto and Matthews (2020)
28% - 95% (41%)	M dwarfs	Bonfils et al (2013)
9% - 28% (15%)	M dwarfs	Dressing and Charbonneau (2013)
24% - 60% (48%)	M dwarfs	Kopparapu et al (2013)

Occurrence of (super) Earths in the habitable zone of their host star remains unknown

Statistics based on small numbers, issues with completeness of the survey detection, extrapolations, systematics, more or less optimistic (complex) definitions of the HZ ...

PLATO will determine planet occurrence rates including those of Earth-analogs.

Predicted yields in the HZ



Kasting & Harman, 2013 (optimistic)

A few tens of planets expected

Kopparapu et al. 2013 (conservative)

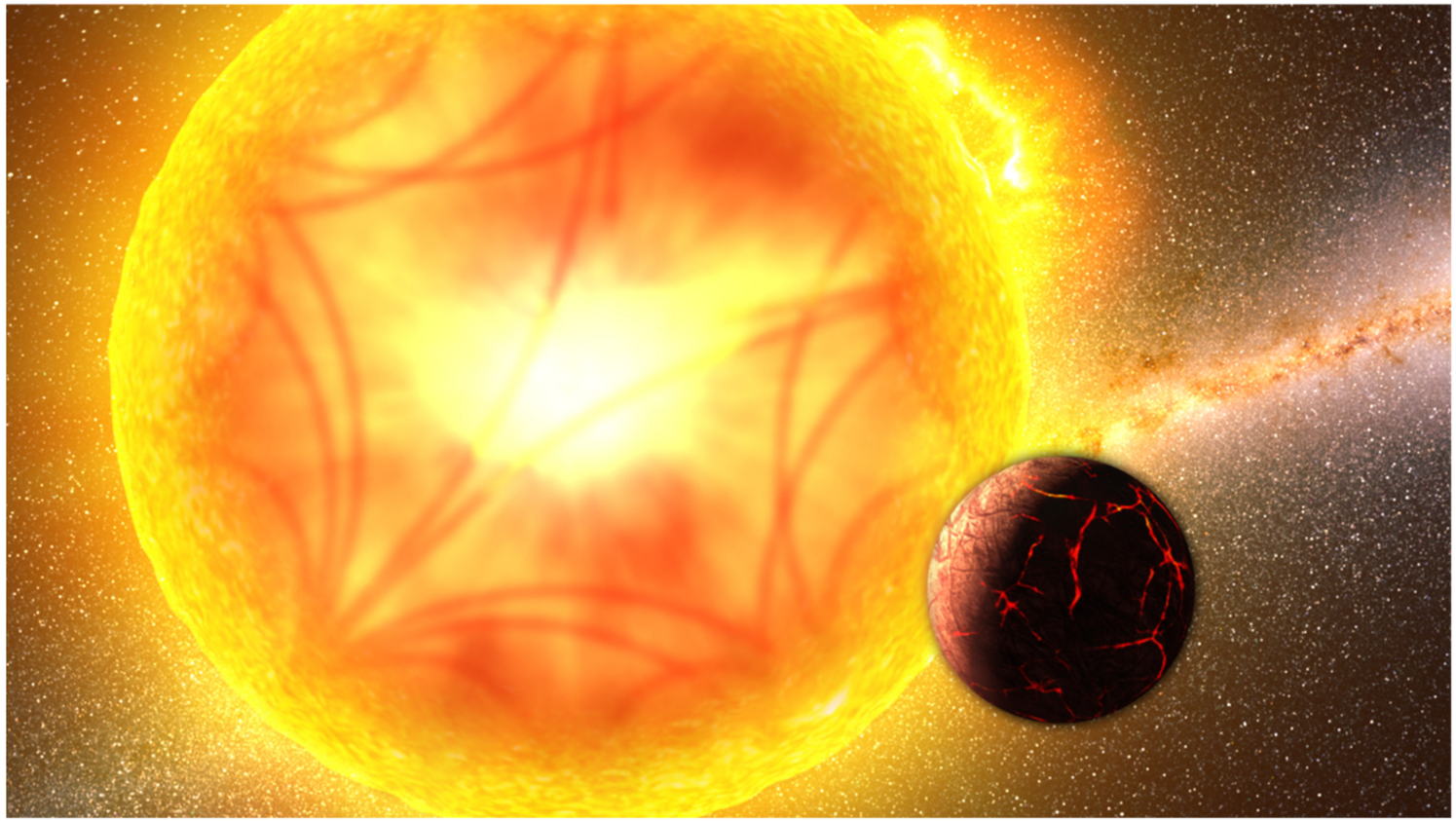
Planets with <2 R⊕ in the HZ for the 2+2 years scenario

assuming 40% occurrence rate

PLATO main objectives (on the stellar side)

Stellar science and asteroseismology:

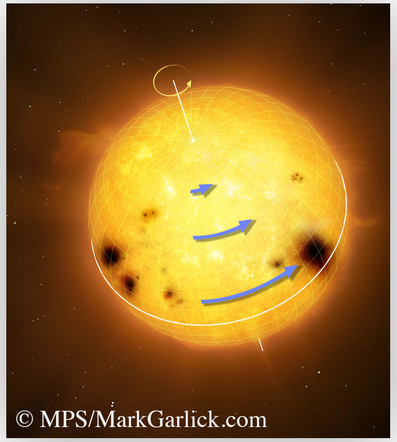
• Precise and accurate characterization of stars hosting planets (in particular their **ages**)



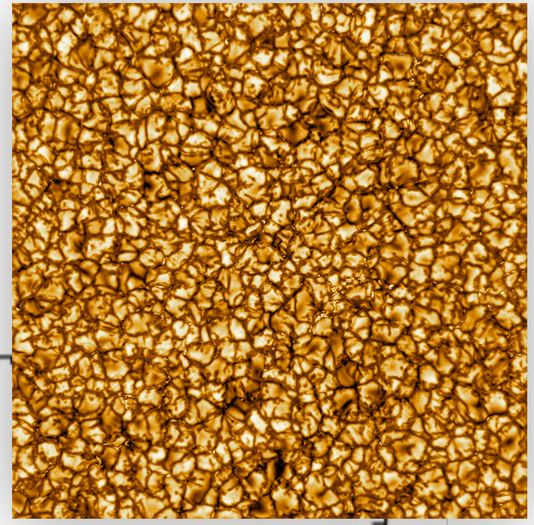
PLATO Goal (for a Sun-like star at V=10):

- ages to 10% accuracy
- mass to 15% precision
- radii to 1-2% precision

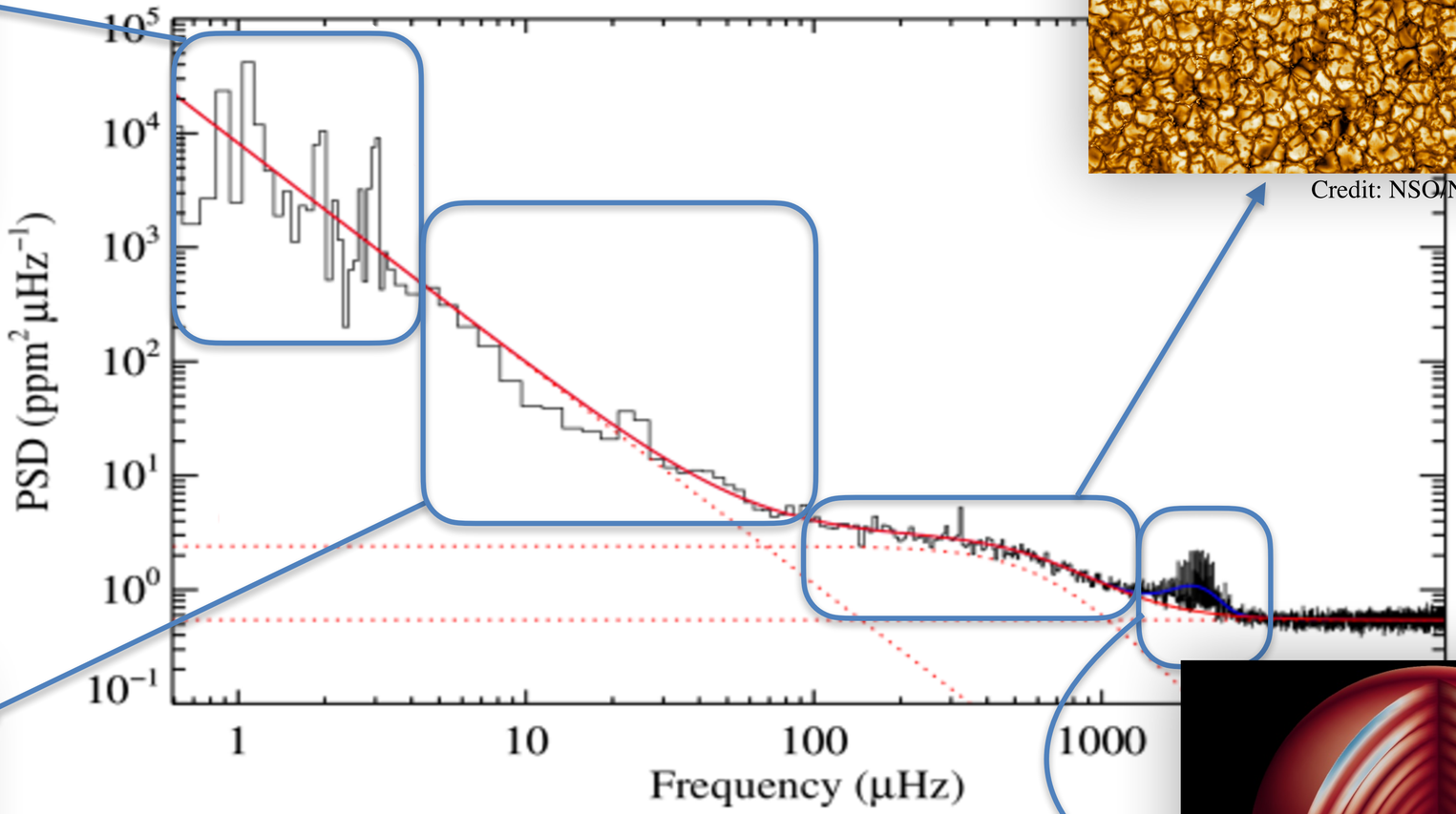
PLATO main objectives



Stellar surface rotation



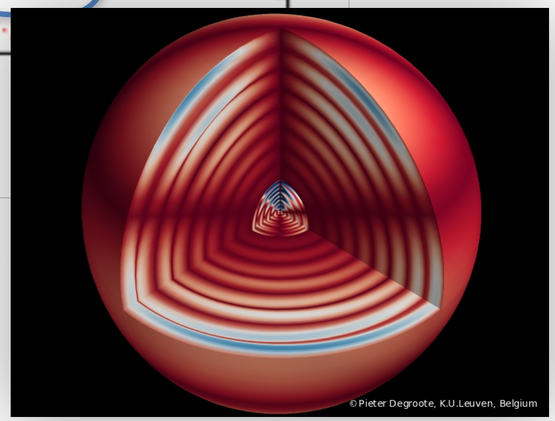
Stellar surface granulation



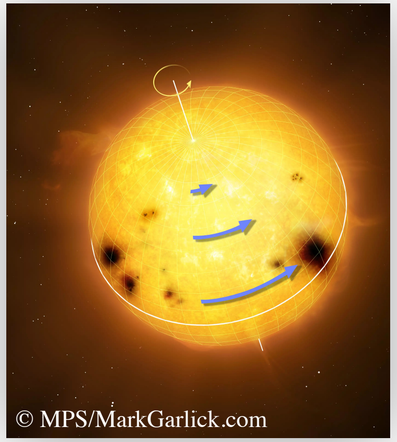
e.g.: Power spectrum density (PSD) of the CoRoT target HD52265 (Garcia & Ballot 2019)

Stellar activity

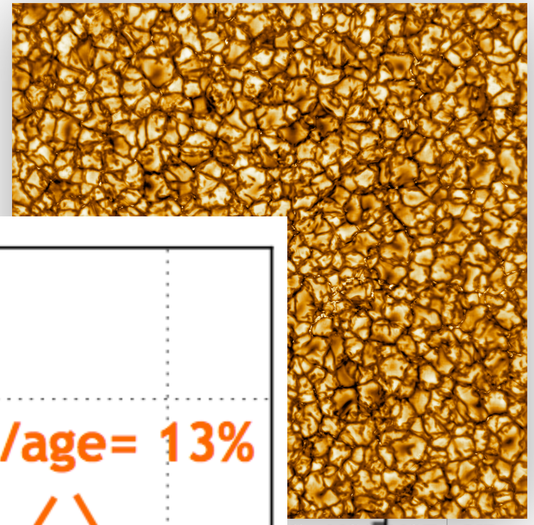
Stellar oscillations = stellar interiors



PLATO main objectives



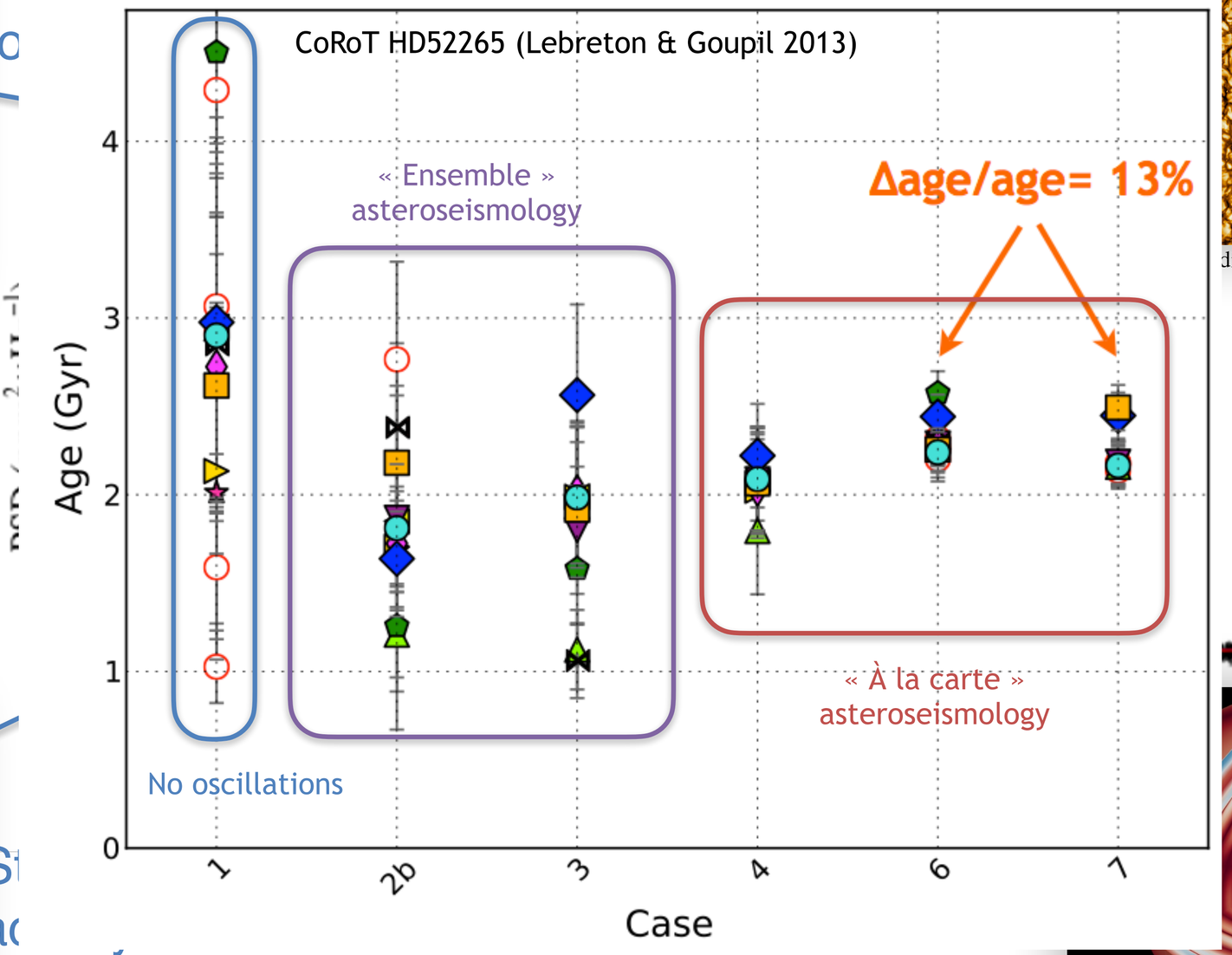
Stellar surface ro



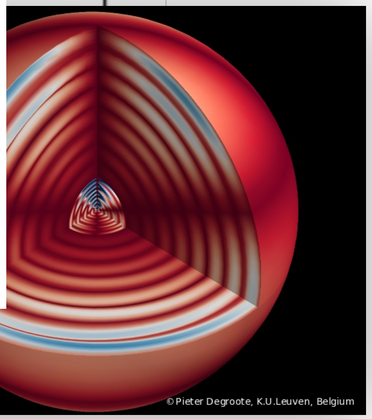
Stellar surface granulation

dit: NSO/NSF/AURA

St ac



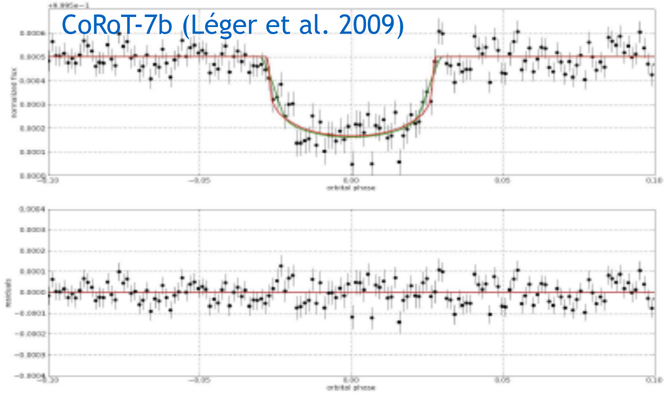
= stellar interiors



e.g.: Power spectrum density (PSD) of the CoRoT target HD52265 (Garcia & Ballot 2019)

PLATO in a nutshell

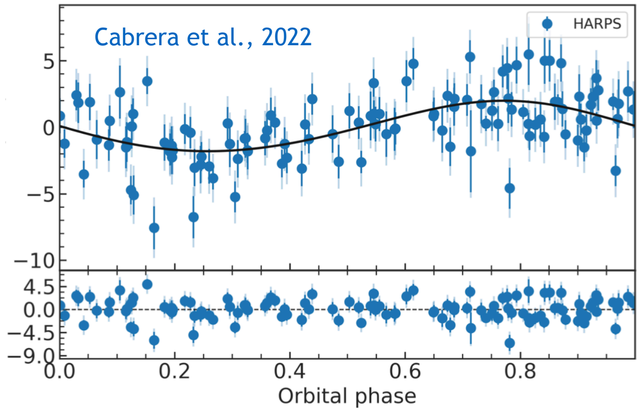
- Transits



→ $R_p/R_\star$ + inclination

+

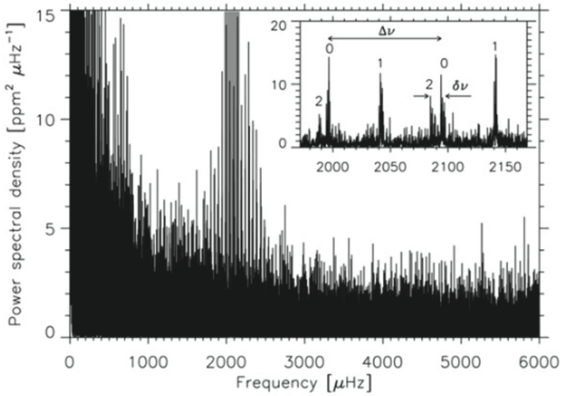
- Radial velocities



→ $M_p/M_\star$ + eccentricity

+

- Asteroseismology



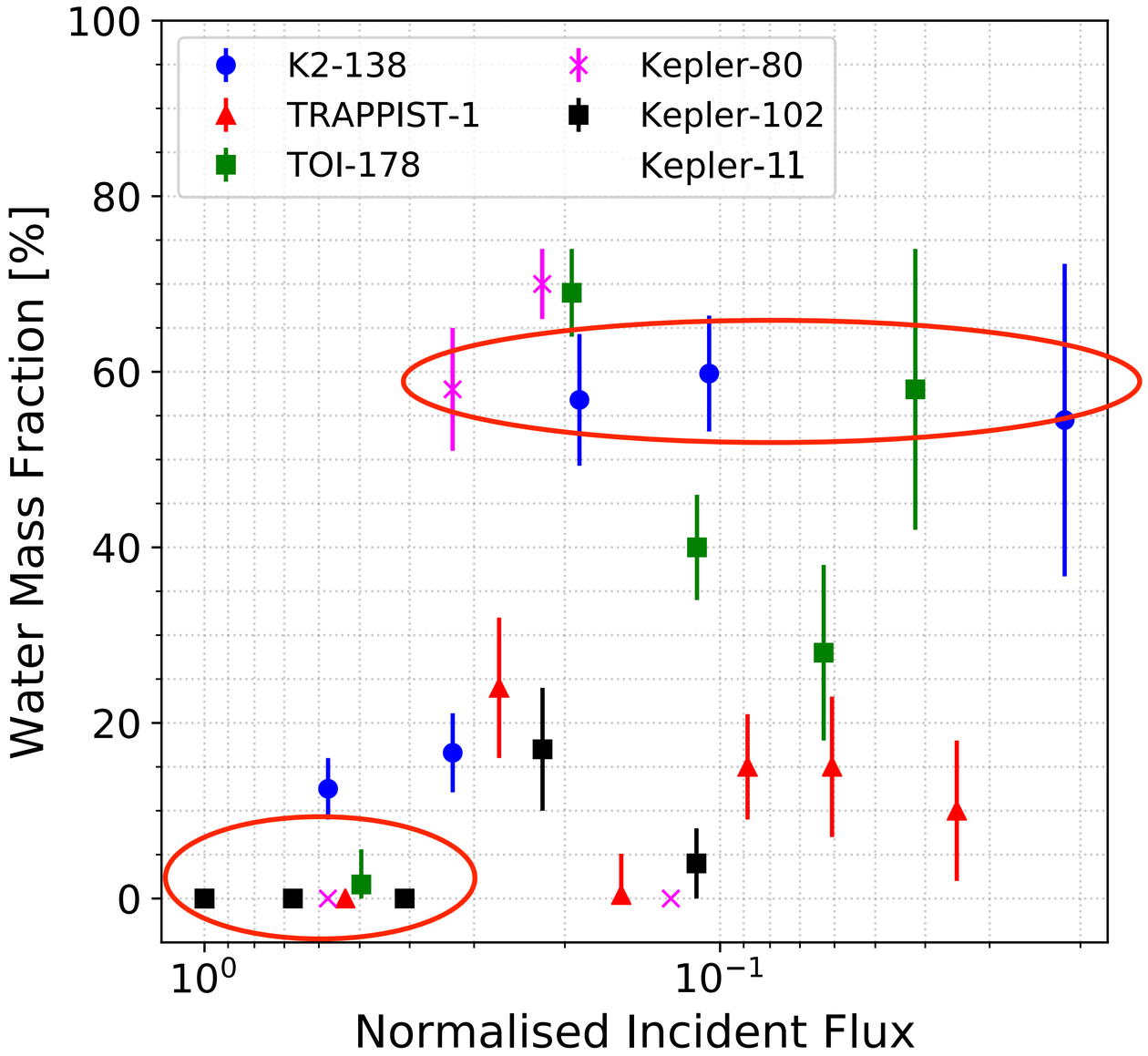
HD52265 (Gizon et al. 2013)

→ $R_\star, M_\star, \mathrm{Age}, \ldots$

Radius + mass = composition of planets

Homogeneous analysis of 6 multiplanet systems with > 5 planets:

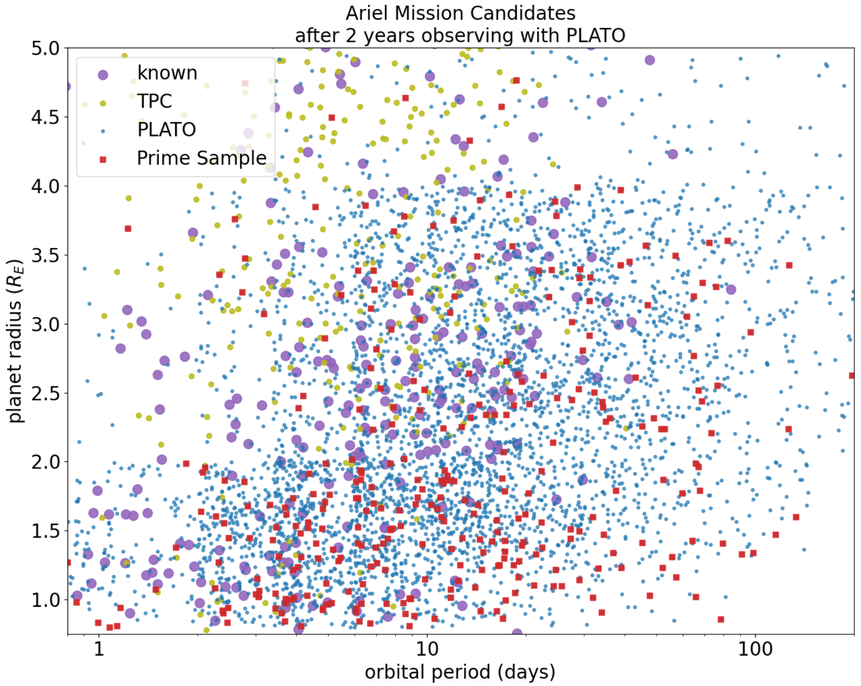
- heterogeneous compositions: dry Mercury-like planets, water-rich or atmosphere with more volatile gases as in the Kepler-11 system
- Trend for an increase of volatile gases with increasing distance



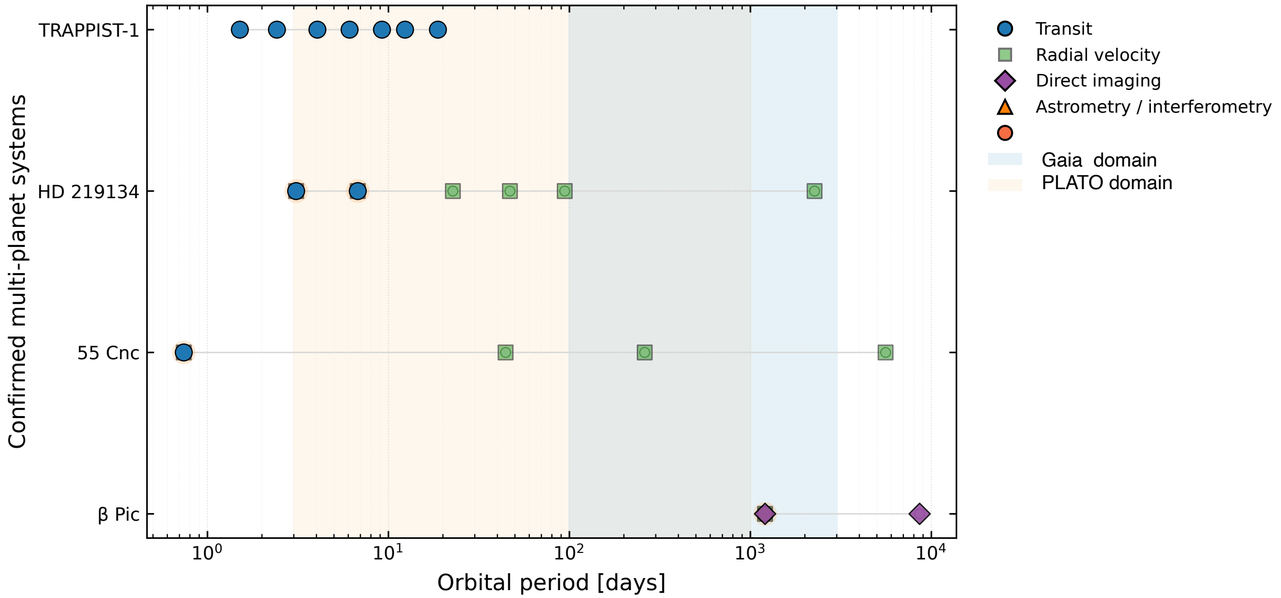
Acuna et al., 2022

Synergies

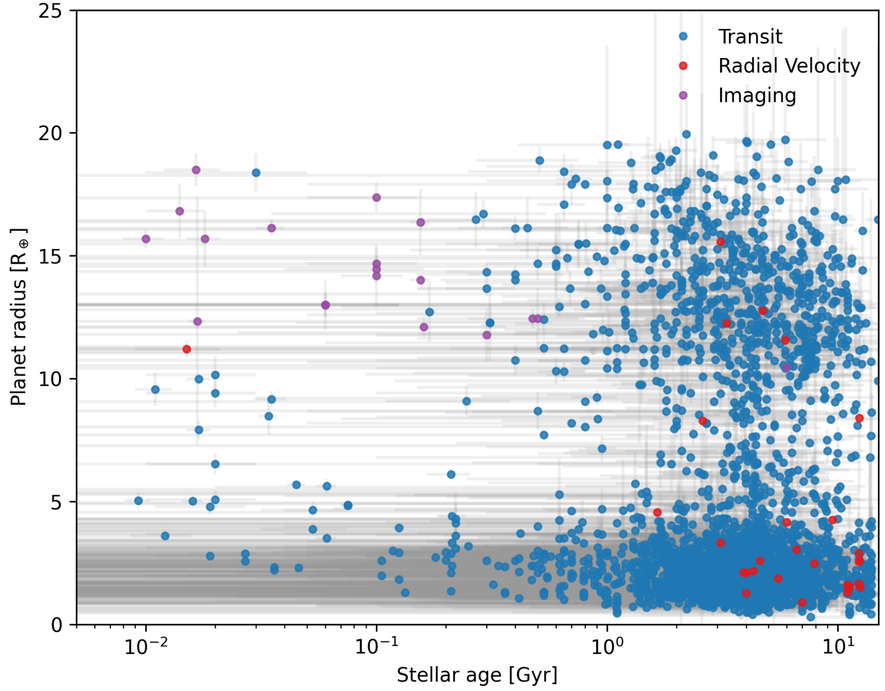
Atmospheres



Architectures

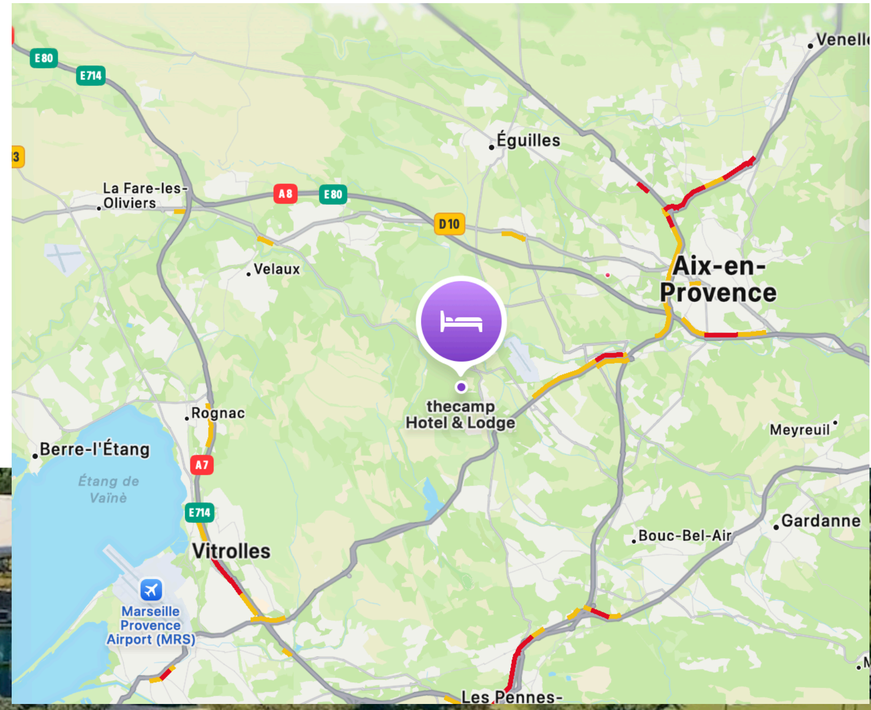


Planetary evolutionary paths



“Spring” school : PLATO data products and analysis

15 - 19 March, 2027 - The camp, Aix-en-Provence



Collaboration européenne: plus de 800 personnes, laboratoires et industriels

PLATO scientific programs

The PLATO core program

- FGK dwarfs (F5 to K7)
- Cool dwarfs (M)

Designed to fulfill the science objectives of the mission

The Science Calibration and Validation stars (scv stars)

- Red giant stars
- γ Doradus stars
- Binaries
- Photometrically stable stars

Designed to test, improve, and validate stellar models

Complementary Science program

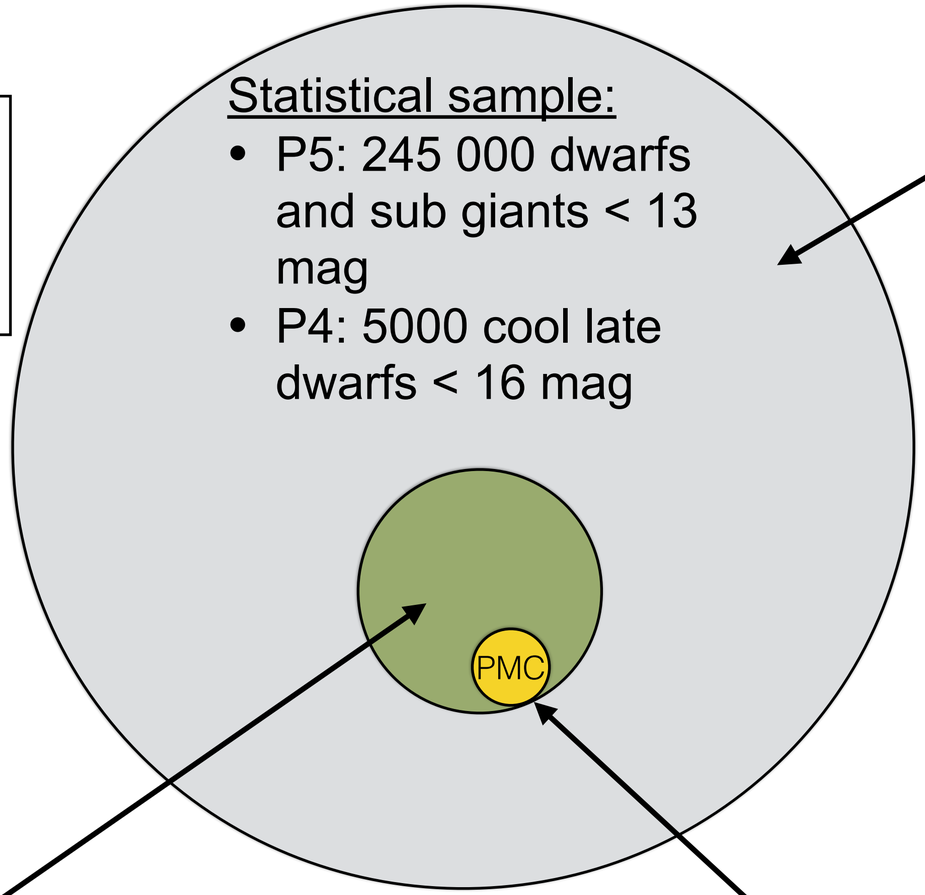
- Binary and multiple stars
- Pulsating stars (earlier than F5)
- Magnetic stars and rotational variables
- Stars with mass loss
- Quasars
- …

Designed to serve the wider community with photometric obs.

1st Call will **open in mid-March 2026** (9 months before launch) with a duration of approx. 6 weeks.

Stellar samples and data releases

L0, L1, & L2 data products are released per quarters (3 months period between spacecraft rotation)



Statistical sample:

Q1: end Q1 + 9 months

Q2: end Q2 + 6 months

Qn : end Qn + 3 months

Core sample:

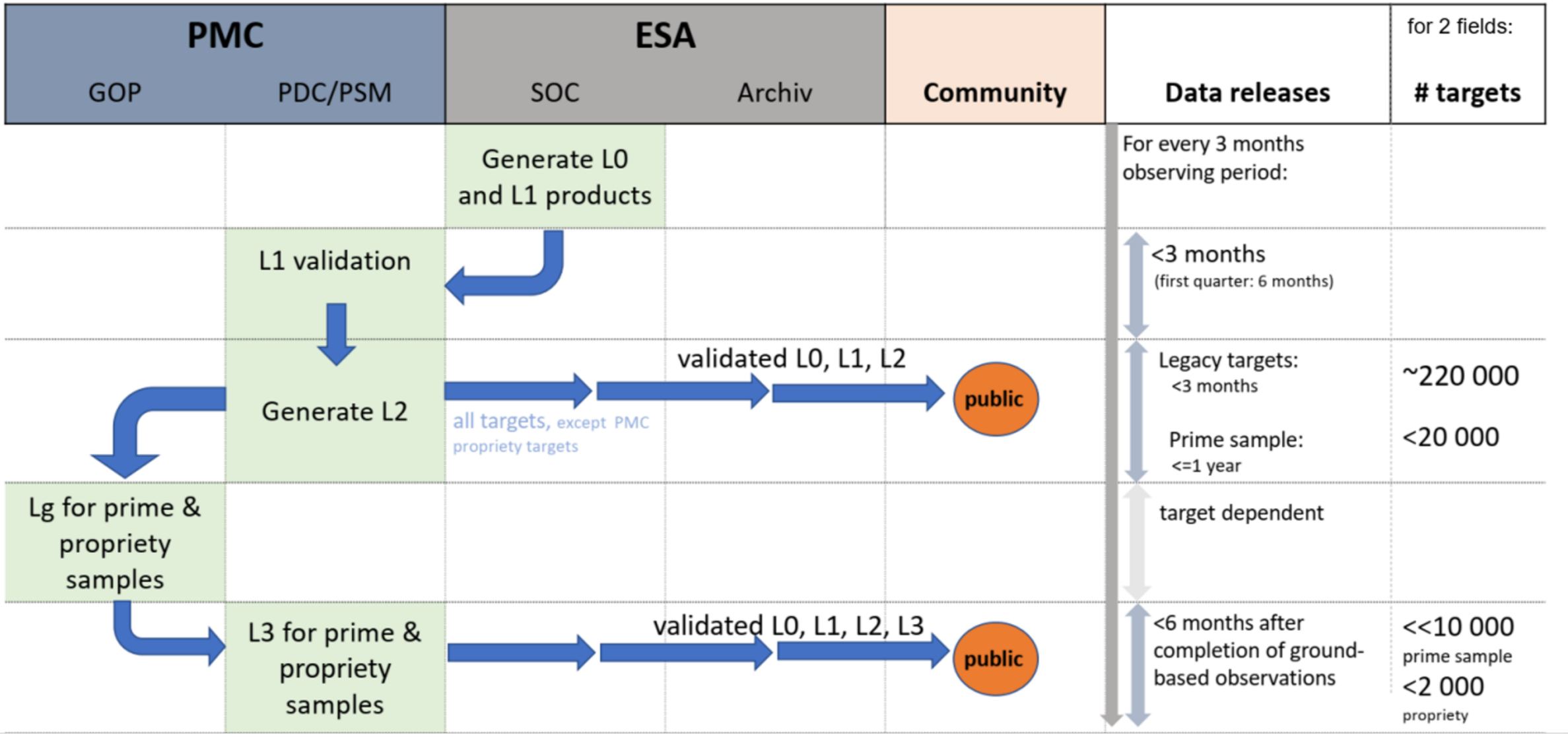
Q1 data sample: end Q1 + 1.5 yr

Qn data sample: end Qn + 1.25 yr

PMC Proprietary targets:

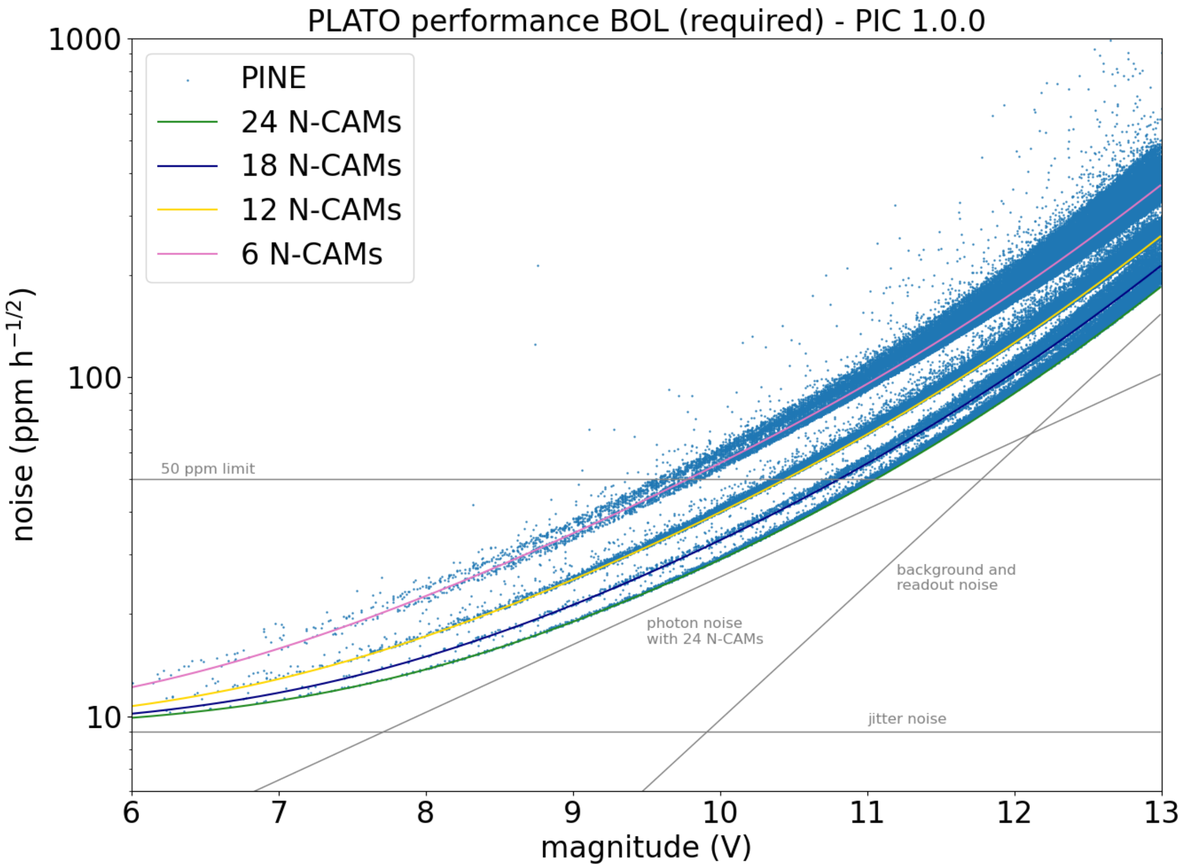
Data released by end of ground based observations

PLATO data release



Credit: H. Rauer

PLATO estimated performances & yields



- Uninterrupted observations for ≥2 years
- Duty cycle >93% in-flight
- (Kepler ~88%, see Burke et al. 2015)
- Noise budget dominated by:
- jitter in the bright end
- background and readout noise in the faint end
- photon shot noise everywhere else
- The SNR varies across the FoV

The current instrument design is compatible with the performance requirements for characterization of small planets

Data Product generation

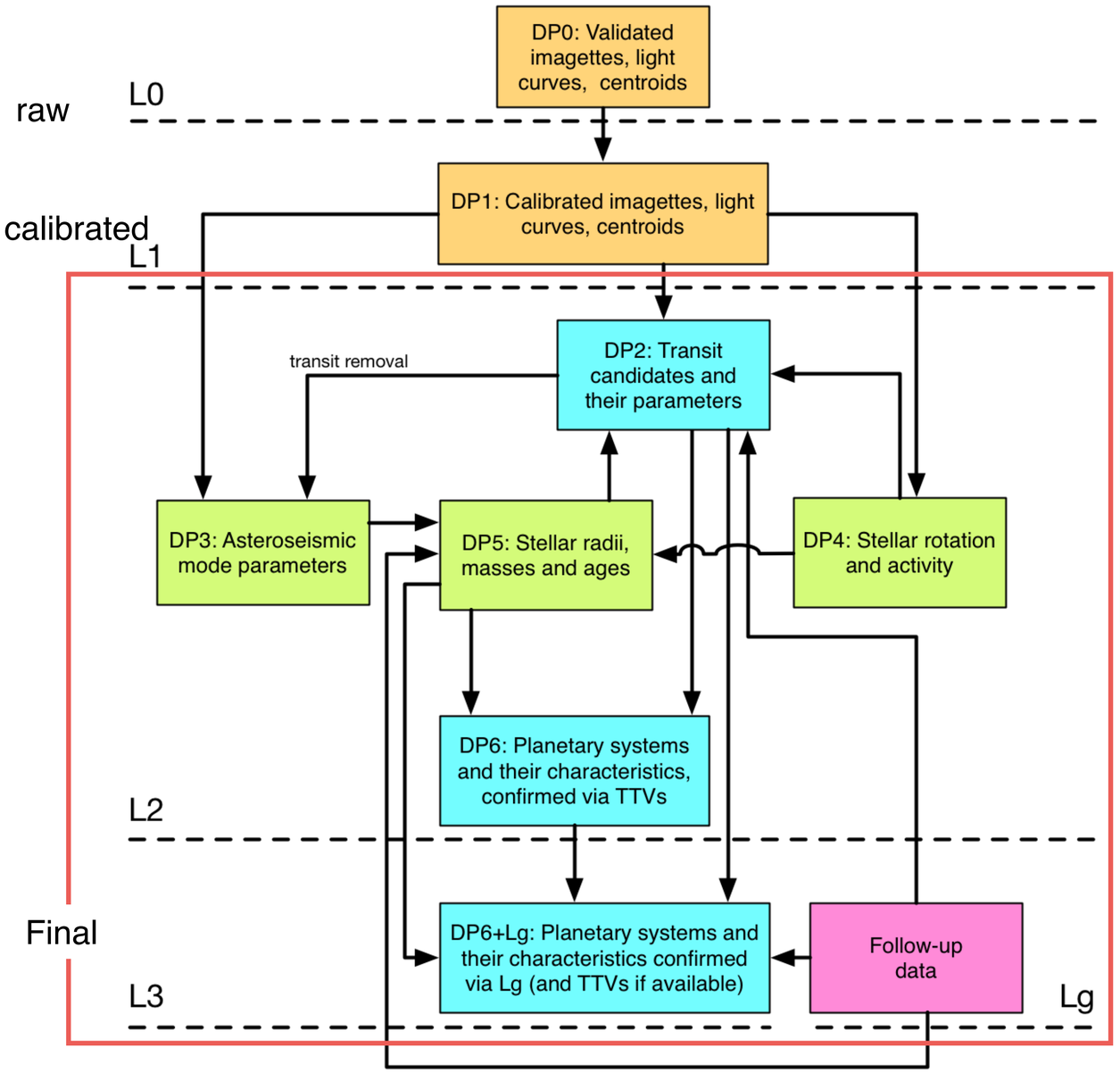


Figure 2: Flow diagram for DP generation.

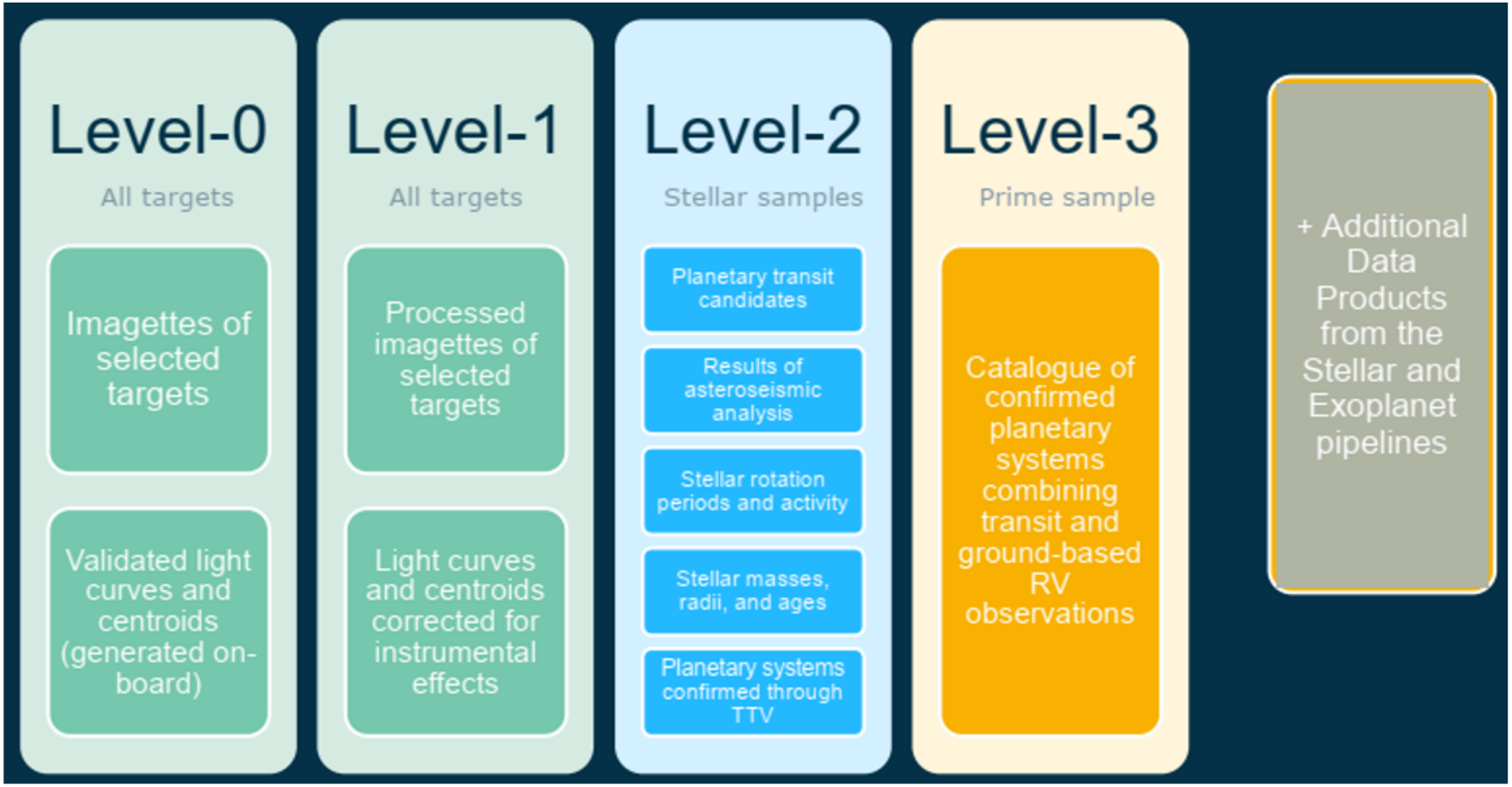
2 automated data analysis pipelines

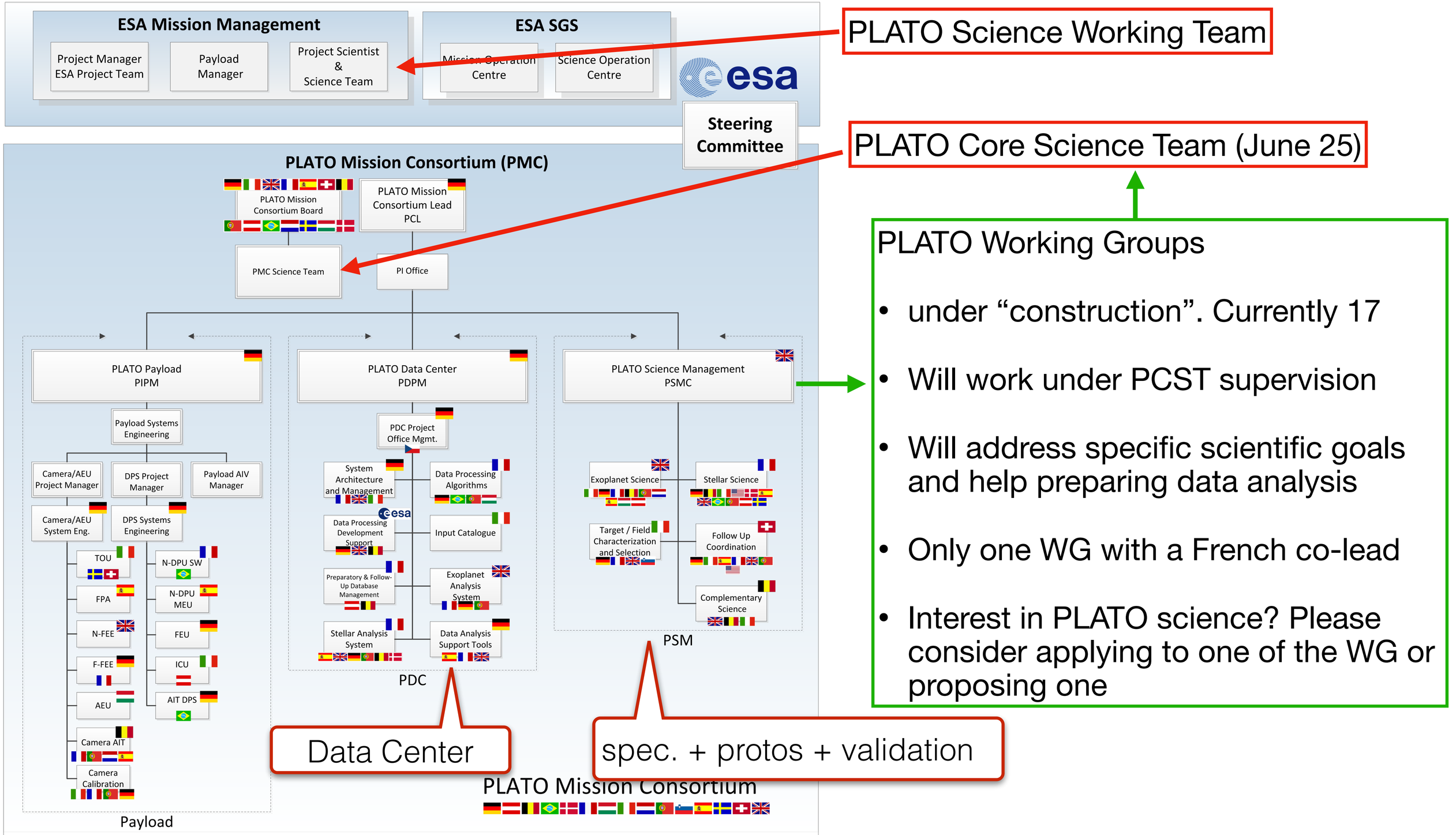
Exoplanet Analysis System

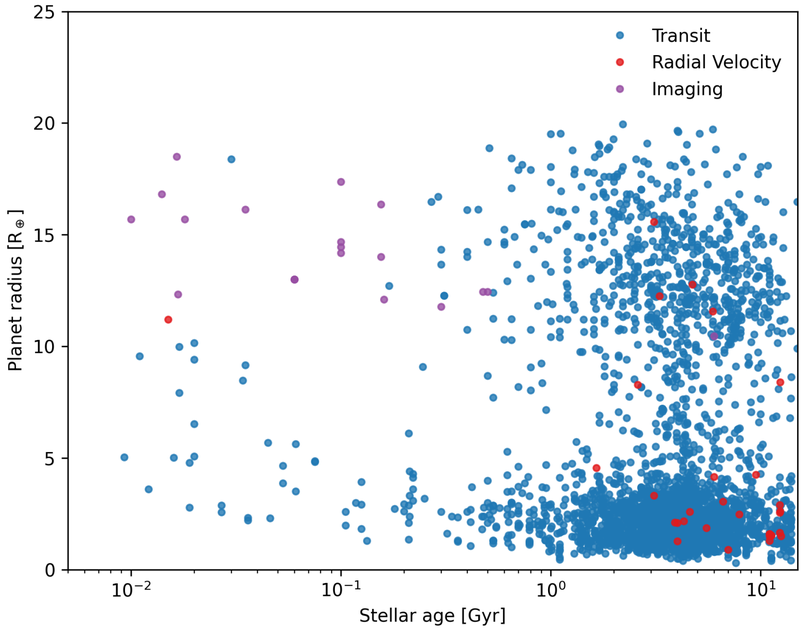
Stellar Analysis System

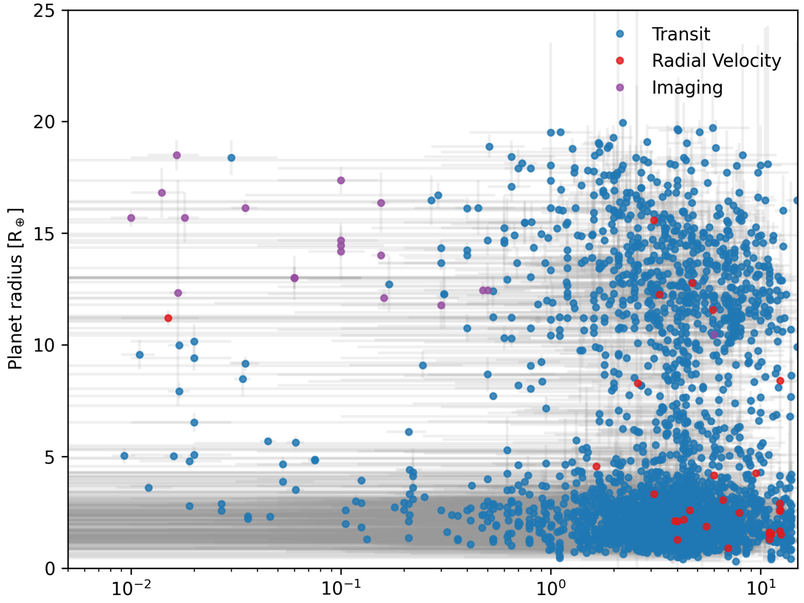
↠ Supply of an homogeneous catalogue of planetary systems

Main data products




ESA Mission Management
Project Manager
ESA Project Team
Payload
Manager
Project Scientist
&
Science Team
ESA SGS
Mission Operation
Centre
Science Operation
Centre
esa
Steering
Committee
PLATO Science Working Team
PLATO Core Science Team (June 25)
PLATO Working Groups
under “construction”. Currently 17
Will work under PCST supervision
Will address specific scientific goals and help preparing data analysis
Only one WG with a French co-lead
Interest in PLATO science? Please consider applying to one of the WG or proposing one
PLATO Mission Consortium (PMC)
PLATO Mission
Consortium Board
PLATO Mission
Consortium Lead
PCL
PMC Science Team
PI Office
PLATO Payload
PIPM
Payload Systems
Engineering
Camera/AEU
Project Manager
DPS Project
Manager
Payload AIV
Manager
Camera/AEU
System Eng.
DPS Systems
Engineering
TOU
FPA
N-FEE
F-FEE
AEU
Camera AIT
Camera
Calibration
N-DPU SW
N-DPU
MEU
FEU
ICU
AIT DPS
Payload
PLATO Data Center
PDPM
PDC Project
Office Mgmt.
System
Architecture
and Management
Data Processing
Algorithms
Data Processing
Development
Support
Input Catalogue
Preparatory & Follow-
Up Database
Management
Exoplanet
Analysis
System
Stellar Analysis
System
Data Analysis
Support Tools
PDC
PLATO Science Management
PSMC
Exoplanet Science
Stellar Science
Target / Field
Characterization
and Selection
Follow Up
Coordination
Complementary
Science
PSM
Data Center
spec. + protos + validation
PLATO Mission Consortium


Transit
Radial Velocity
Imaging
Planet radius [R⊕]
Stellar age [Gyr]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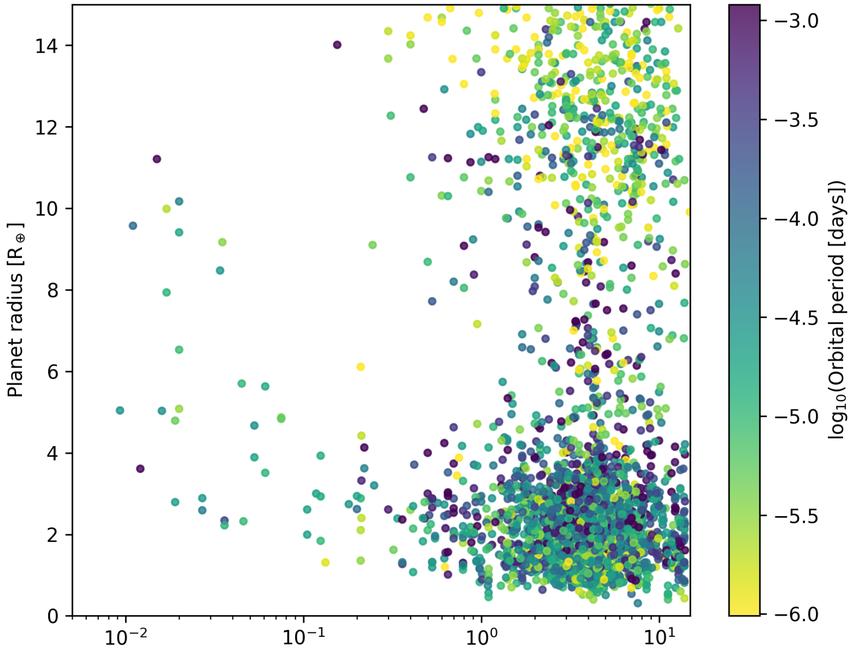
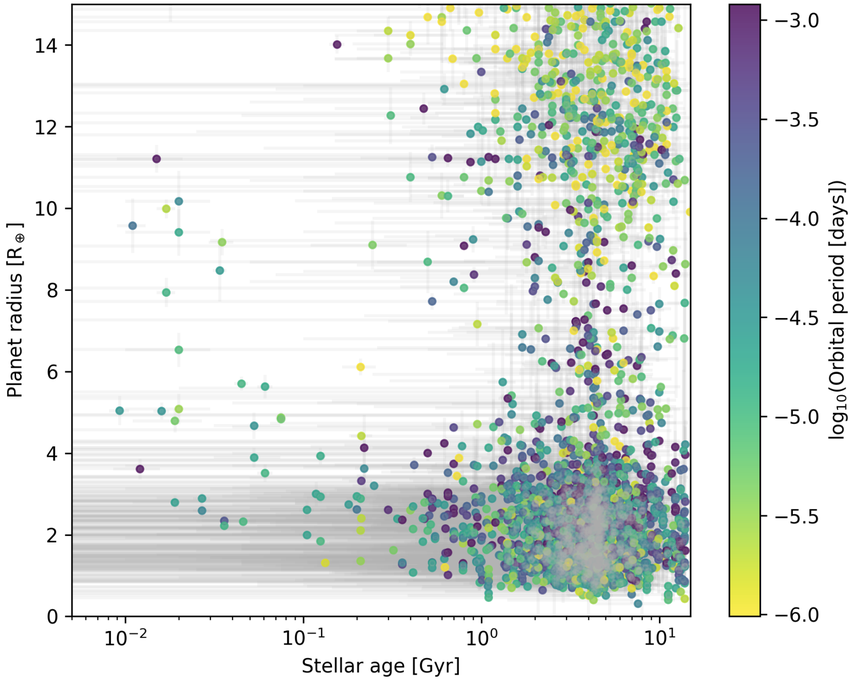
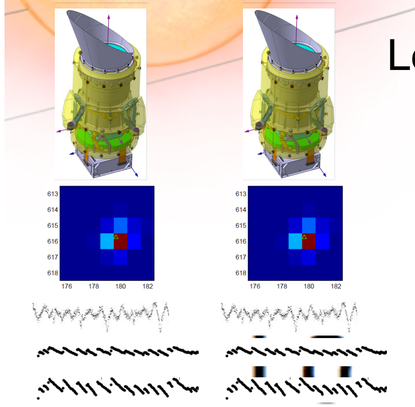

Planet radius [R⊕]
log10(Orbital period [days])


Planet radius [R⊕]
Stellar age [Gyr]
log10(Orbital period [days])

PLATO: un défi numérique



Level 0: télémétrie K-band : 50 GB/jour (3.5 heures par jour chaque jour)

Logiciels de traitement et d'analyse automatiques -
Plus de 150 000 étoiles à analyser avec une mesure de leur lumière toutes les 25 sec, pendant 2 ans (au moins)