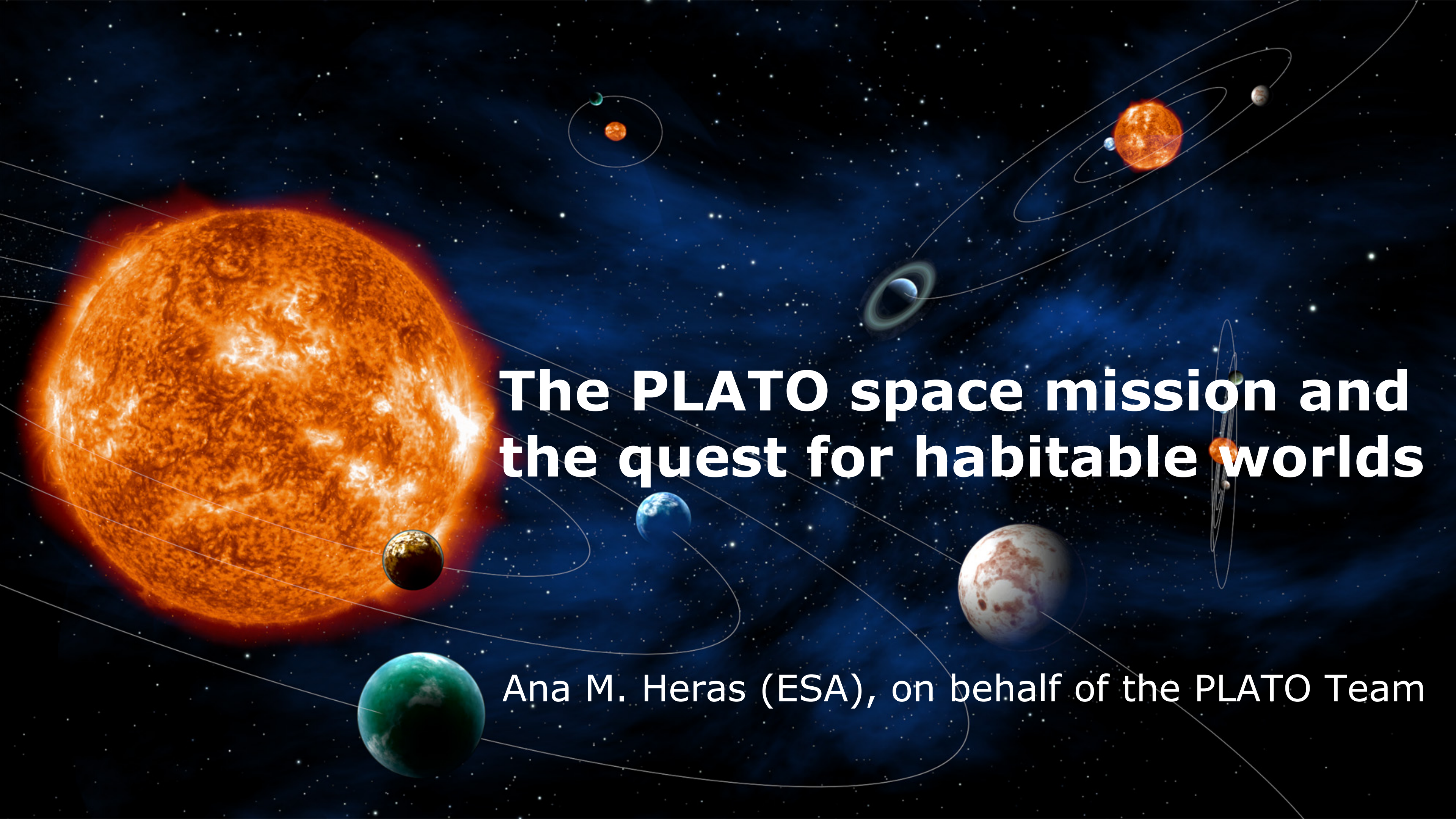


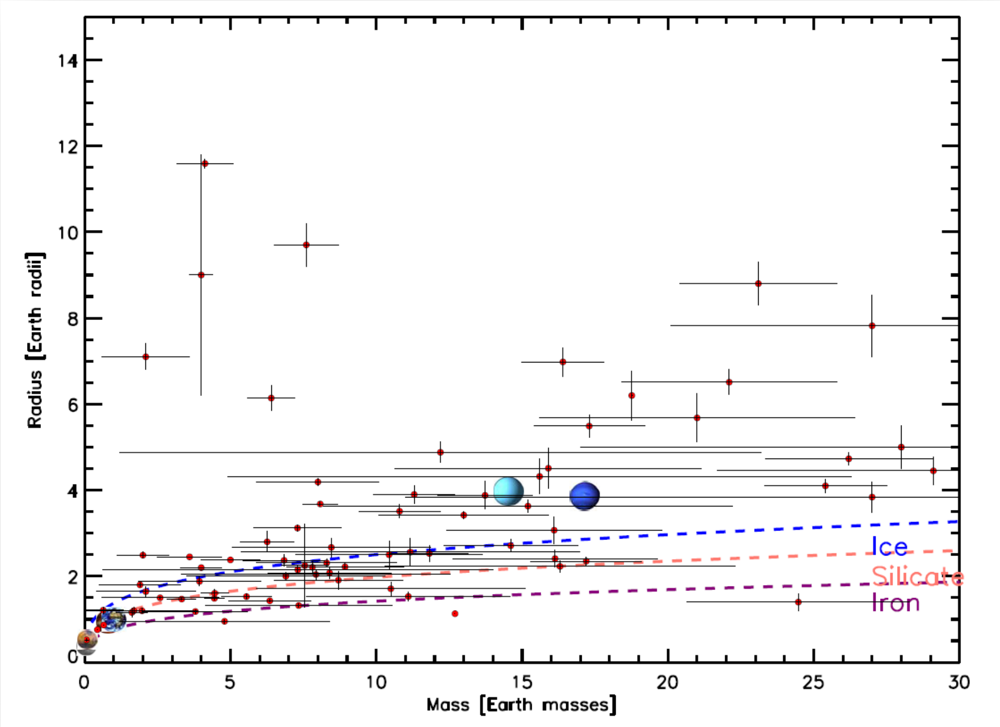
# The PLATO space mission and the quest for habitable worlds

Ana M. Heras (ESA), on behalf of the PLATO Team

# PLATO mission status

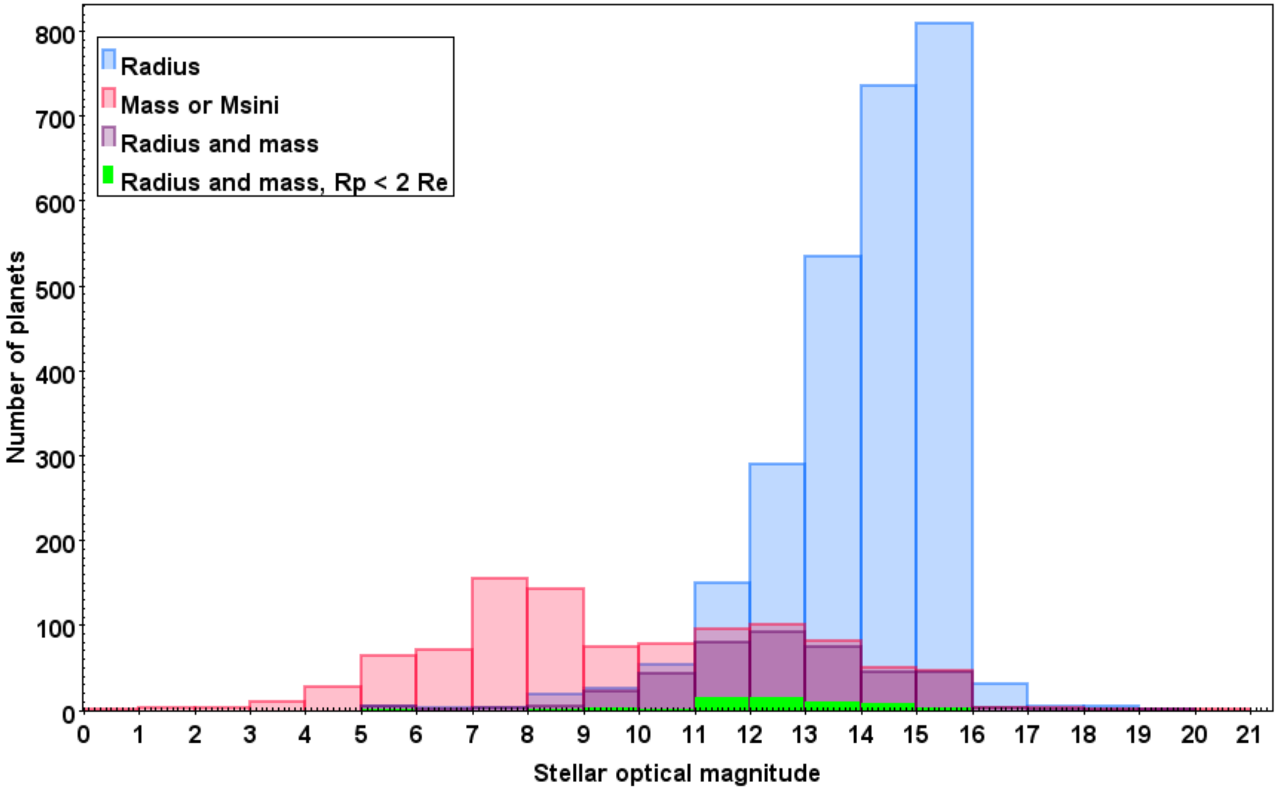
- Selected in February 2014 as the M3 “medium-class” mission in the ESA Cosmic Vision Programme
- Definition phase completed in 2016
- Adoption by the ESA Science Programme Committee on 20 June 2017, with a target launch in 2026
- The implementation phase has started
- ESA provides:
  - ➢ Satellite platform, payload CCDs
  - ➢ Mission and Science operations centres
- The Mission Consortium provides:
  - ➢ Payload
  - ➢ Contribution to Science operations

# Planets are very diverse

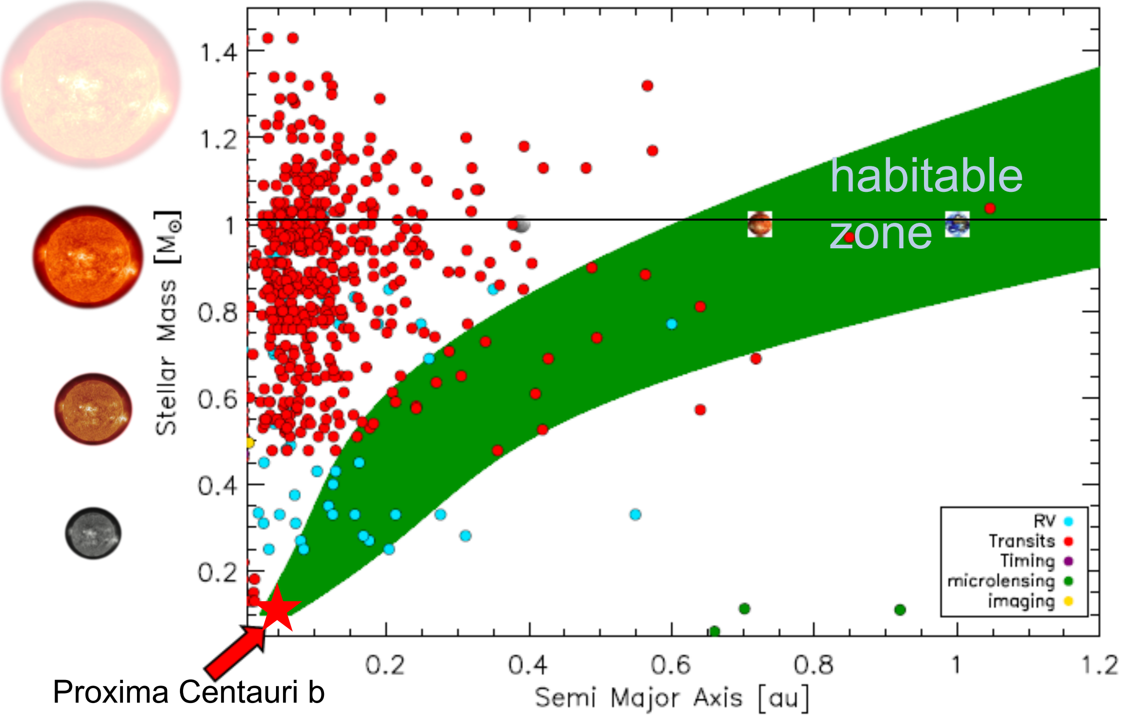



We need accurate planetary radii and masses to understand exoplanet diversity

# Need to observe bright stars



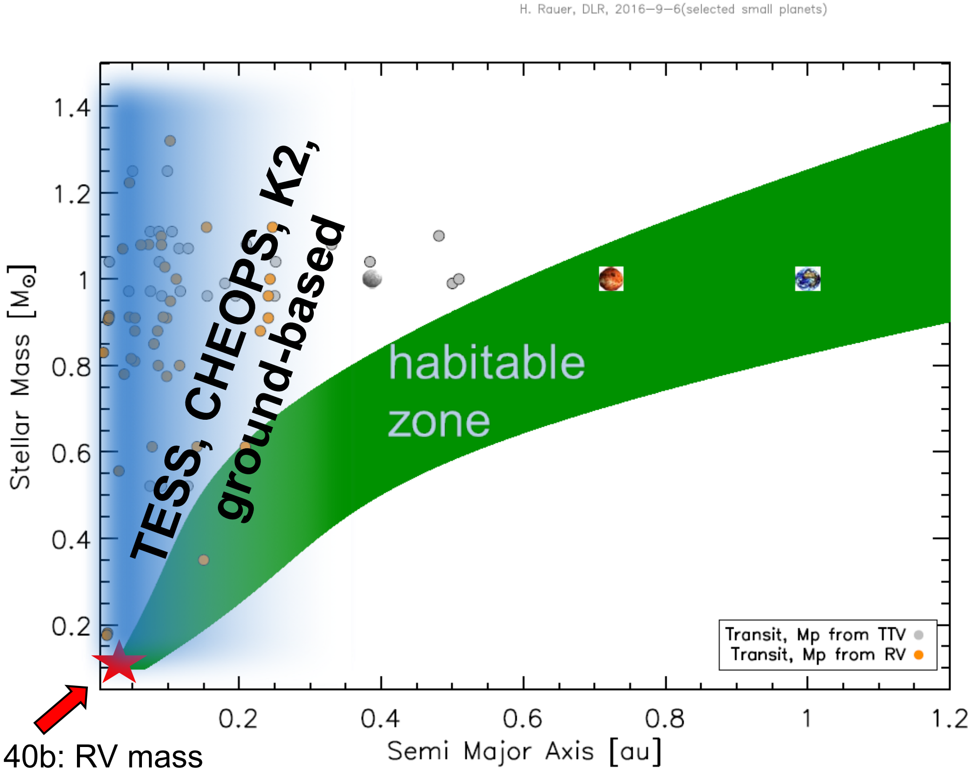
# Known small exoplanets and the HZ




Proxima Centauri b
LHS 1140b
TRAPPIST-1 planets

$1 < M_{planet} \leq 10 M_E$
$R_{planet} \leq 2 R_E$

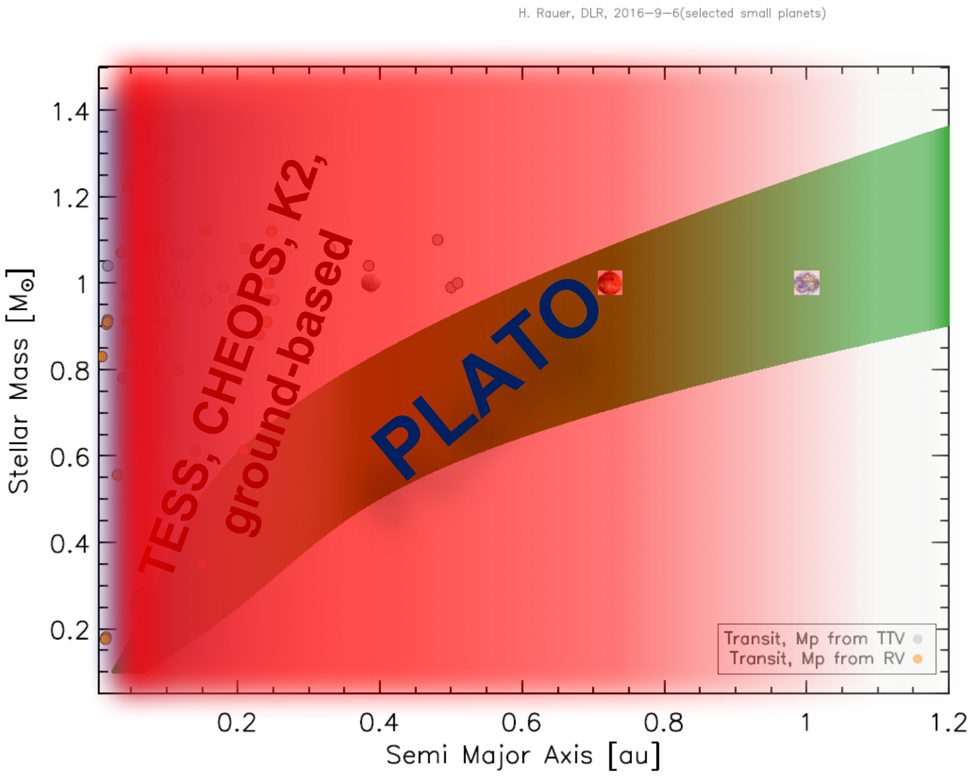
# Bulk characterised super-Earths




$1 < M_{planet} \leq 10M_E$
$R_{planet} \leq 2\ R_E$

LHS 1140b: RV mass
TRAPPIST-1 planets: TTV masses

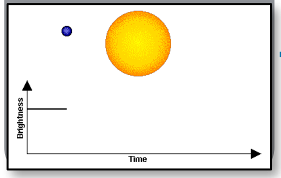
# Bulk characterized super-Earths- PLATO




PLATO will detect and characterise planets up to the habitable zone of solar-like stars

# PLATO Methods

Transit method




Orbit parameters

Orbital inclination, $i$

Planet-to-star radius ratio

Filtering of false positives

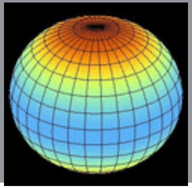
(ground-based observations)

Orbit parameters

Orbital inclination, $i$

Planet $R$, age

Asteroseismology



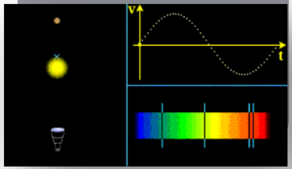
Precise stellar $R$, $M$, age

Stellar $R$, $M$ from catalogues (e.g. Gaia)

Orbit Parameters

Planet $R$, $M$, age

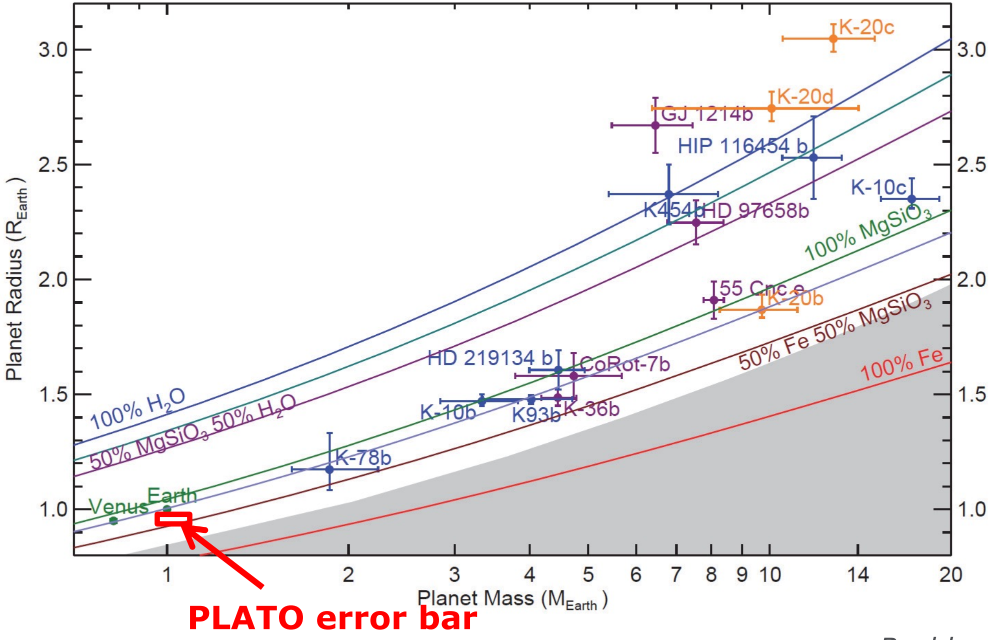
Radial velocity (ground based observations)




Orbit parameters

Minimum planet mass, $M \sin i$

# Diversity of Super-Earths




*Buchhave et al. (2016)*

PLATO will determine:

- radii (3% accuracy)
- masses (10% accuracy)
- ages (10% accuracy)

for Earth-like planets orbiting G stars with $V < 10$

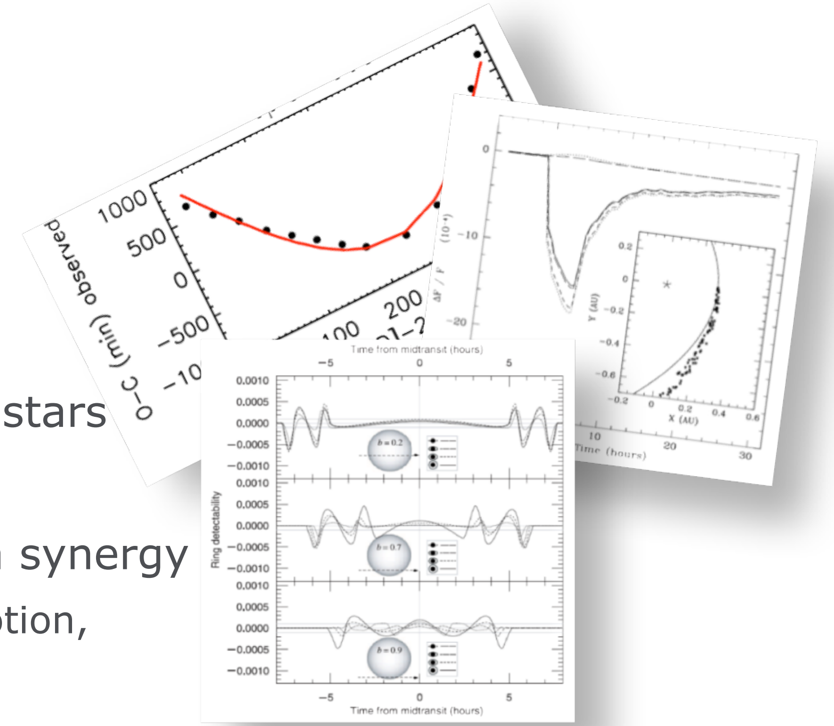
# Additional science

Other topics in planetary science:

- Circumbinary planets
- Exomoons
- Rings/comets
- Misaligned planets
- Planets around young and evolved stars

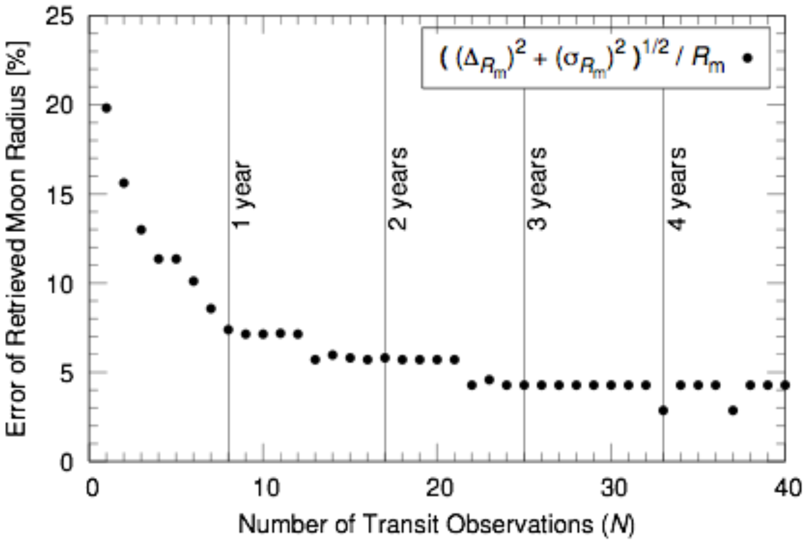
Complementary science (e.g.):

- Stellar and Galactic evolution: Gaia synergy
  - Gaia: radius, distance, proper motion, luminosity, Teff, log g
  - PLATO: stellar masses, ages
- Accretion physics near compact objects



# PLATO detection of exomoons

Exomoons can be detected with transit time variations, transit duration variations, or orbital sampling effect in the phase-folded transit light curve (OSE, e.g. Heller et al. 2016)



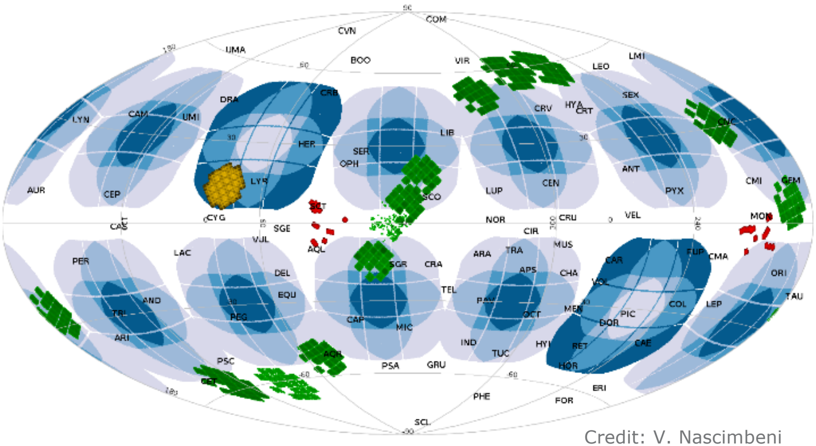

OSE simulation for PLATO

G dwarf star ($m_V$ = 8) transited by a Jupiter-sized planet (P = 45 d) with a 0.7 $R_E$-sized moon

# Observing strategy

- Long uninterrupted photometric monitoring of bright stars in the visible band
  - Core sample: ~15,000 sun-like stars of $m_V < 11$
    *to be complemented with radial velocity ground-based observations*
  - Statistical sample: >245,000 stars of $m_V < 13(16)$

- Mission nominal science operations: 4 years
  - ➢ Baseline strategy:
    2 long pointings, duration 2 years each
    *(will be fixed two years before launch)*
  - ➢ Satellite/instrument designed to last with full performance for 6.5 years
  - ➢ Consumables will last 8 years



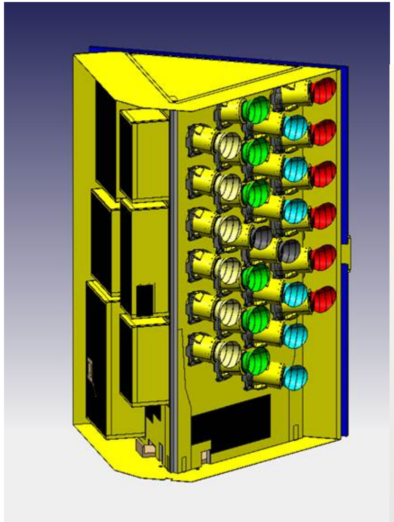
Credit: V. Nascimbeni

# PLATO satellite

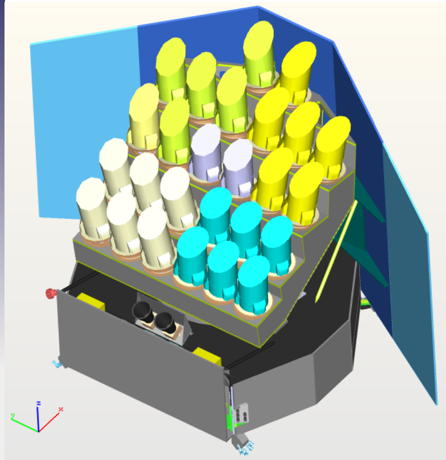
Launch in 2026 into orbit around L2 Earth-Sun Lagrangian point

**Multi-telescope approach**

- Large FOV (large number of bright stars)
- Large total collecting area (high sensitivity)
- Redundancy
- 24 «normal» cameras, cadence 25 sec
- 2 «fast» cameras, cadence 2.5 sec, 2 colours

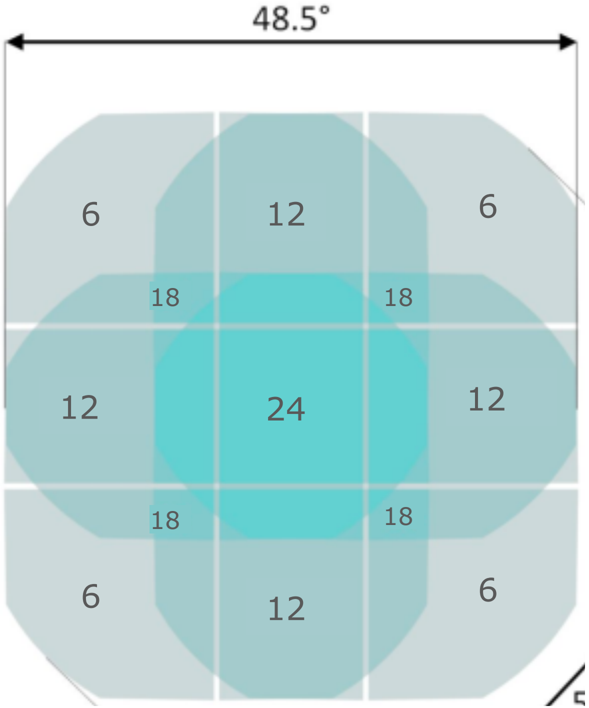


Airbus



OHB

# PLATO cameras

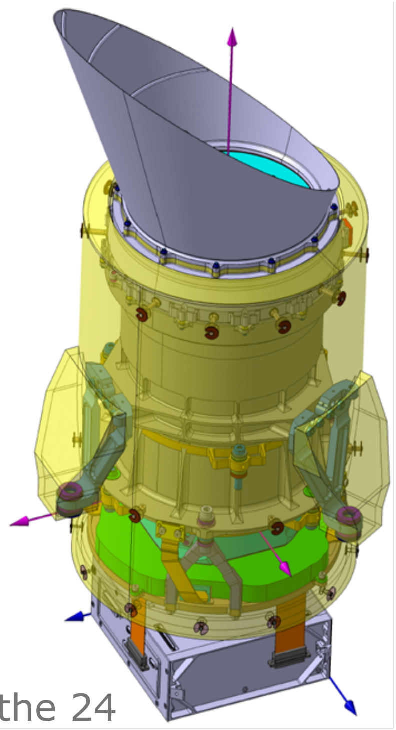



Dynamical range: $4 \leq m_V \leq 11$ (16)

Focal plane: 104 CCDs (4 CCDs per camera) with 4510 x 4510 18 µm pixels

Instantaneous field of view ~ 2250 $deg^2$

PLATO FoV



One of the 24 “normal cameras”

# A new era of planetary sciences

PLATO will detect transit signals of thousands of planets which are bright enough for radial velocity spectroscopy to determine their masses

PLATO will provide:

- A sample of well characterised Earth-Sun analogues
- Characterised terrestrial planets in the HZ
  - high accuracy in radius, mass, age
- Enough accuracy to study small-planet diversity – how unique is Earth?
- Planets at all ages, understand planet evolution
- Accurate knowledge of the host stars, including its activity
- A target list for atmosphere spectroscopy