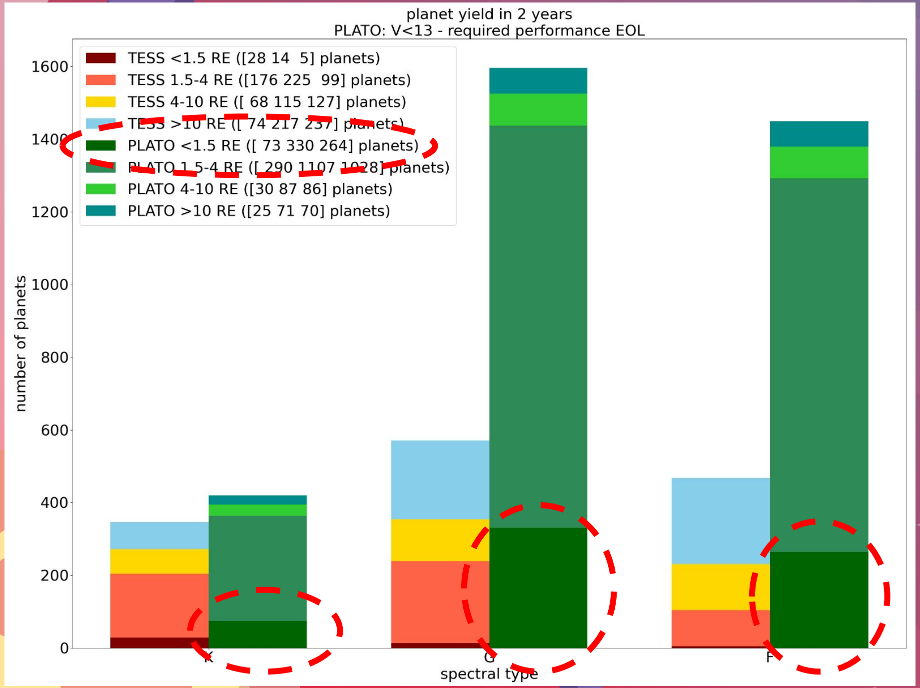
Turning candidates into planets
or: How I learned to stop worrying and love the GOP*

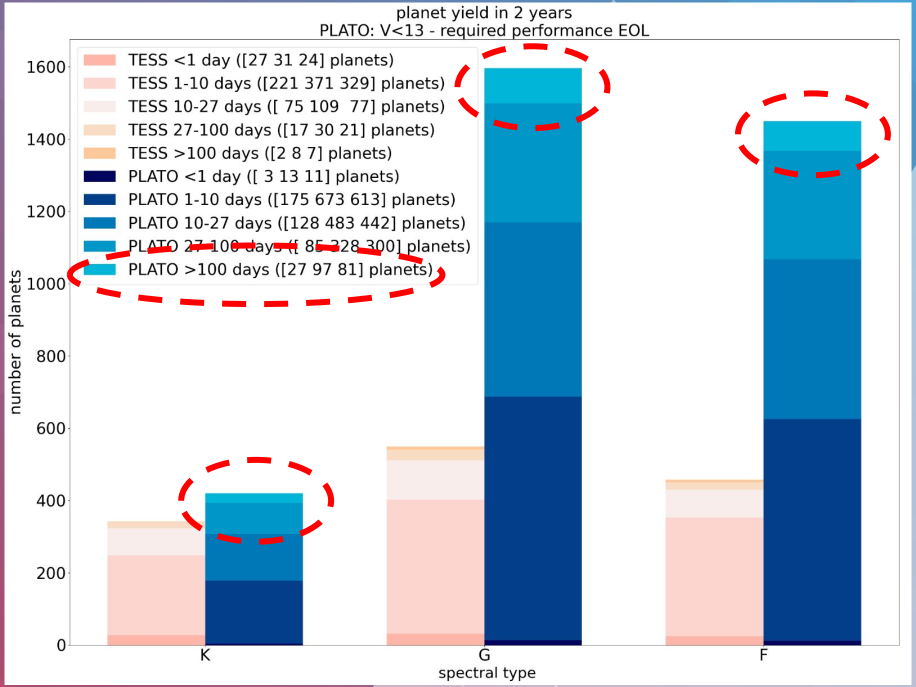
*Ground-based Observation Programme

Thomas Wilson - thomas.g.wilson@warwick.ac.uk - Getting ready for PLATO - 14/09/23

PLATO will provide small and long-period candidates

Tens of R < 1.5REarth planets orbiting in the habitable zone of V < 11mag stars are predicted to be discovered





Rauer et al. in prep.

And will advance our knowledge via several science cases

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

V C

2. *Study how planets and planetary systems evolve with age.*

V C

3. *Study the typical architectures of planetary systems.*

V C

Rauer et al. in prep.

And will advance our knowledge via several science cases

4. *Analyse the correlation of planet properties and their frequencies with stellar parameters (e.g., stellar metallicity, stellar type).*

V C

5. *Analyse the dependence of the frequency of terrestrial planets on the environment in which they formed.*

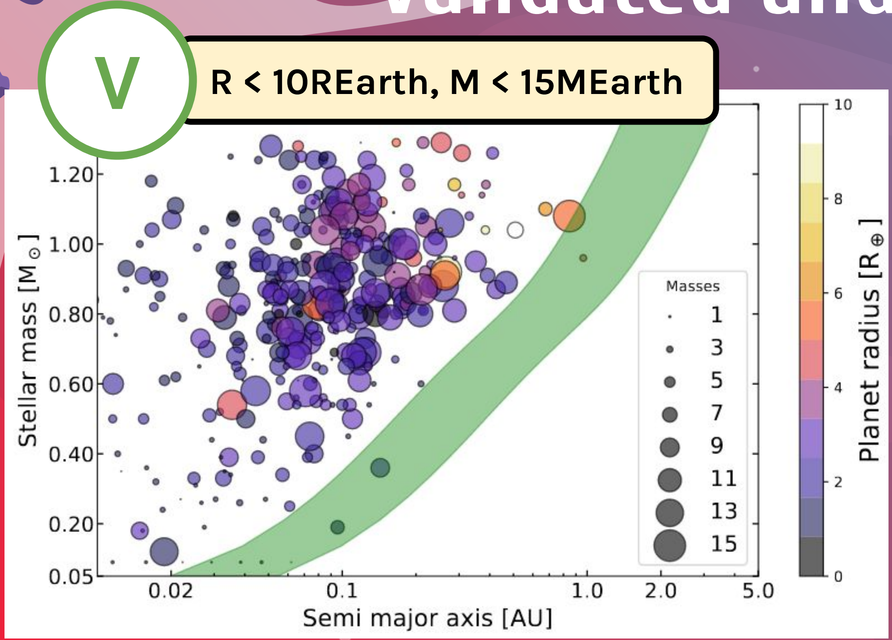
V

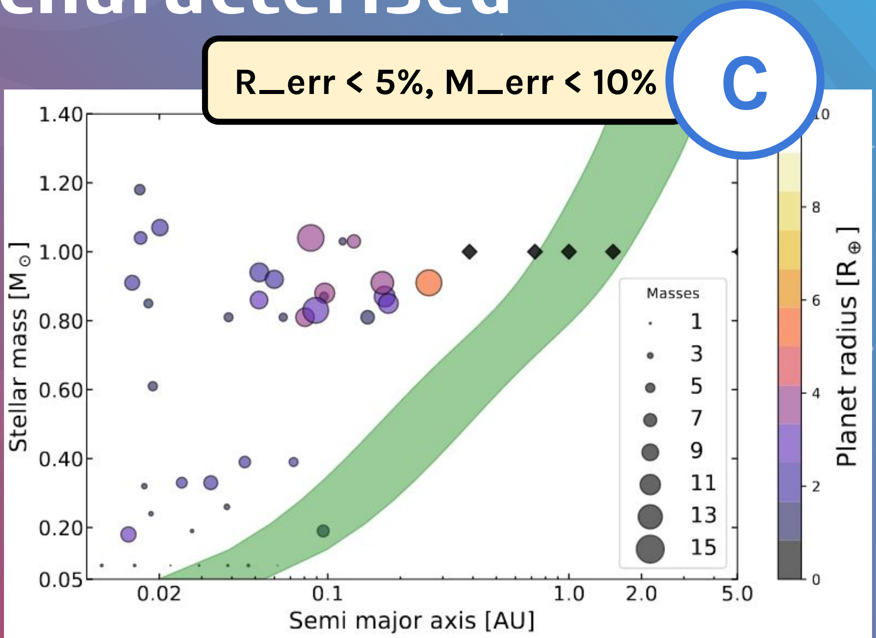
6. *Study the internal structure of stars and how it evolves with age.*
7. *Identify good targets for spectroscopic follow-up measurements to investigate planetary atmospheres.*

V C

Rauer et al. in prep.

This requires planets to be validated and characterised





This cannot be done with PLATO photometry alone

Rauer et al. in prep.

WE NEED A FOLLOW-UP PROGRAM!

V

Validati

Candidates to

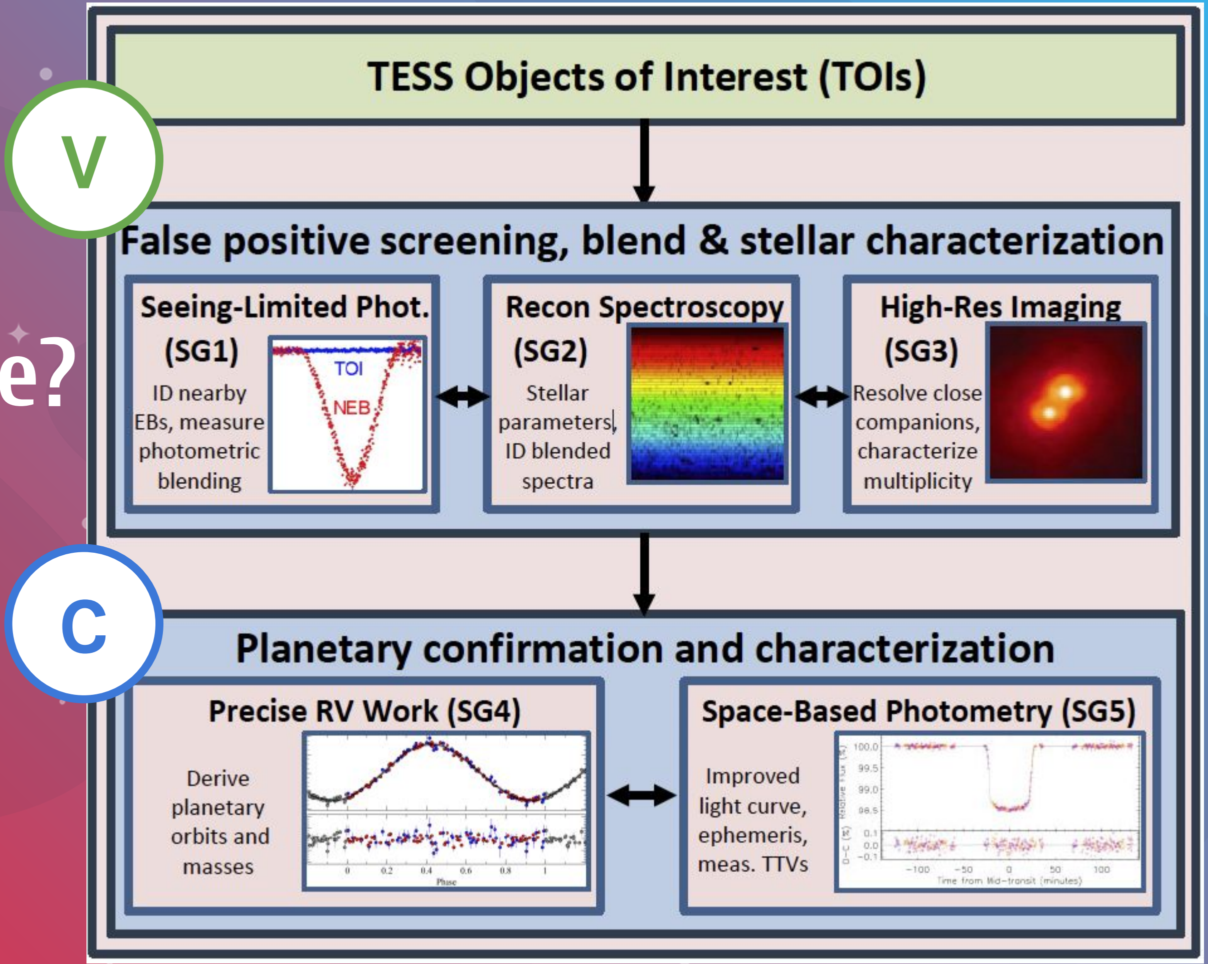
C

terisation

masses and
stellar activity

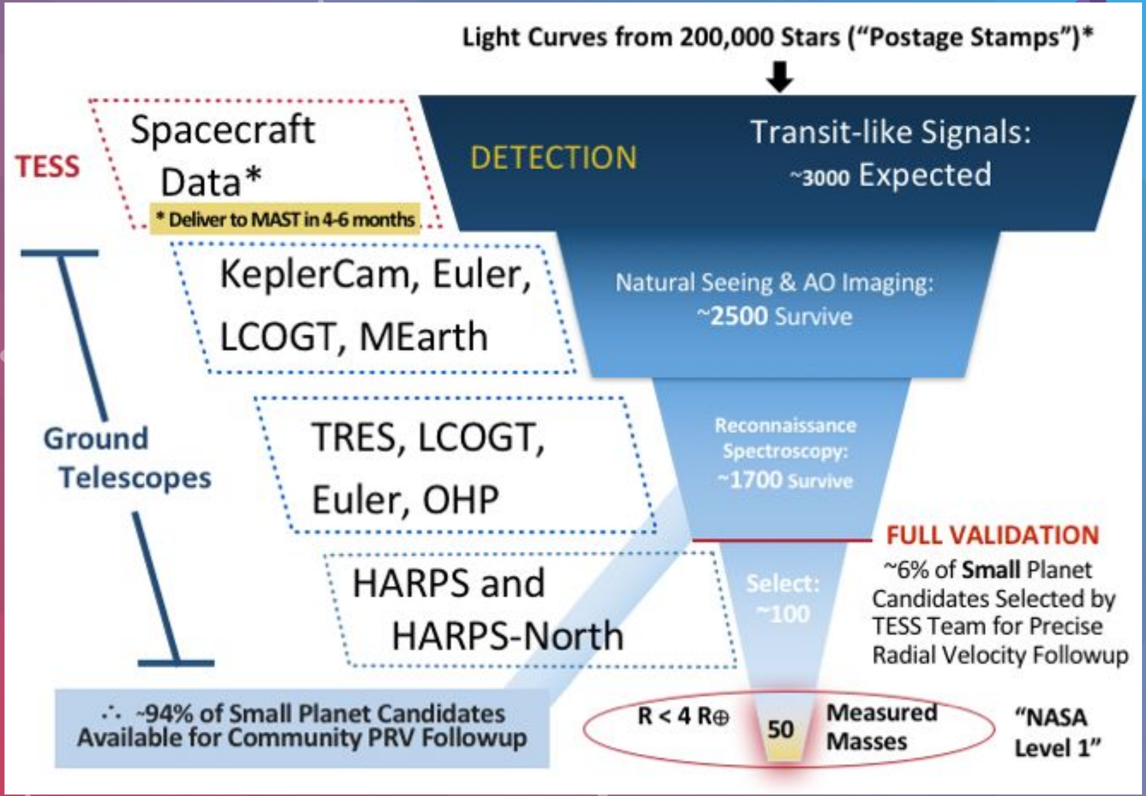
How is this currently done?

The TESS Follow-up Observing Program (TFOP) has 5 sub-groups (SG); 3 focused on validation and 2 on characterisation.



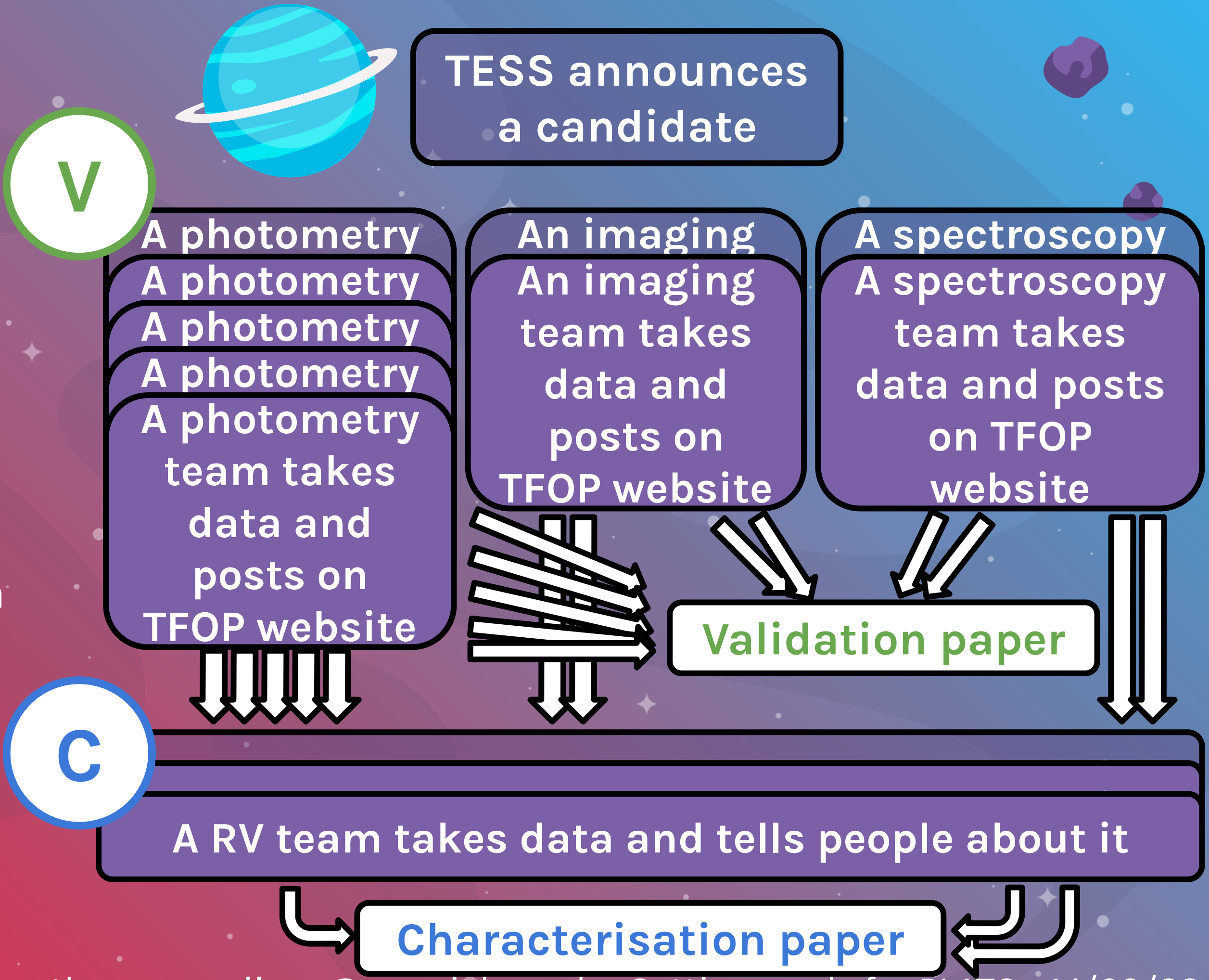
How is this currently done?

A wide array of ground-based telescopes are used to first remove false positives before focusing RV instruments on the best targets.

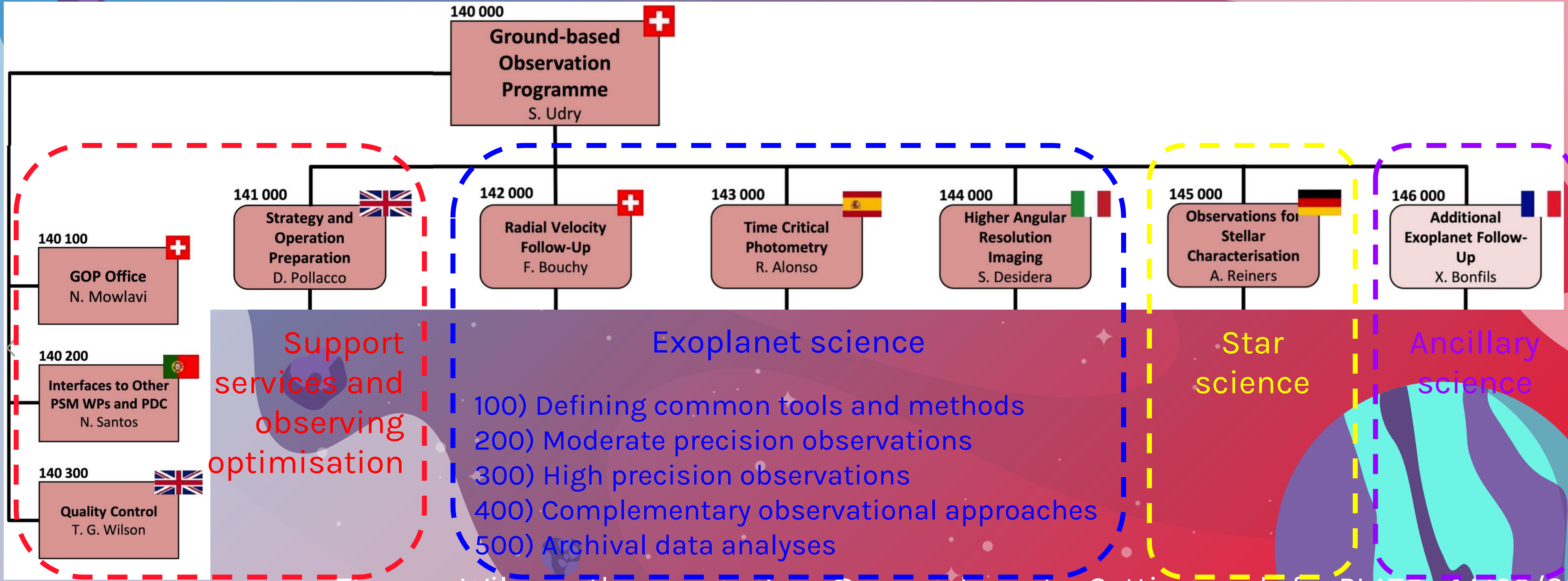


How does TFOP work in practise for exciting targets?

Importantly anyone can join TFOP and take or use validation (and characterisation) data. But the follow-up is not a coordinated network.



We are building an efficient, homogeneous* Ground-based Observation Programme



Support services and observing optimisation

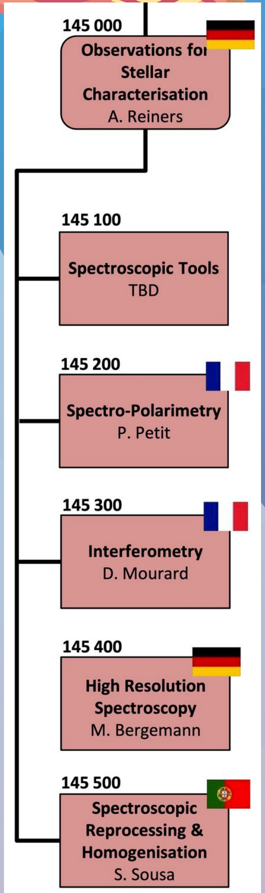
Exoplanet science

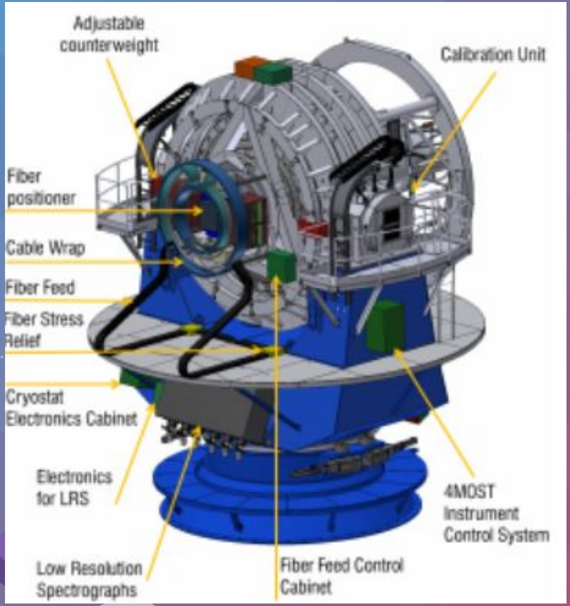
100) Defining common tools and methods
200) Moderate precision observations
300) High precision observations
400) Complementary observational approaches
500) Archival data analyses

Star science

Ancillary science

PLATO-GOP Stellar Characterisation





Specification	Design value
High Resolution Spectrograph (1x)	R~20,000
# Fibres	812 fibres
Passband	392.6-435.5, 516-573, 610-679 nm
Velocity accuracy	< 1 km/s

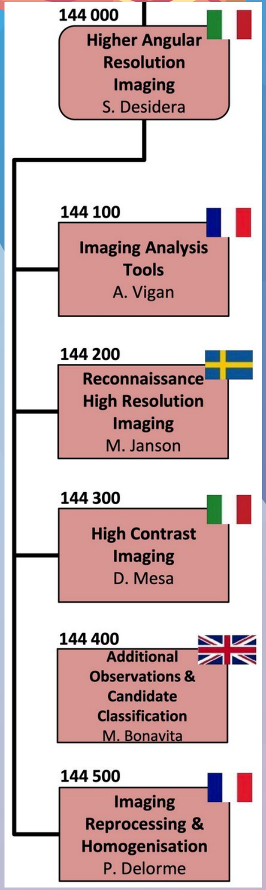
Goal: obtain precise and accurate stellar properties

PLATO+4MOST

Homogeneous stellar parameters and chemistry for P1,P2,P4,P5 samples in up to 7 epochs to obtain:

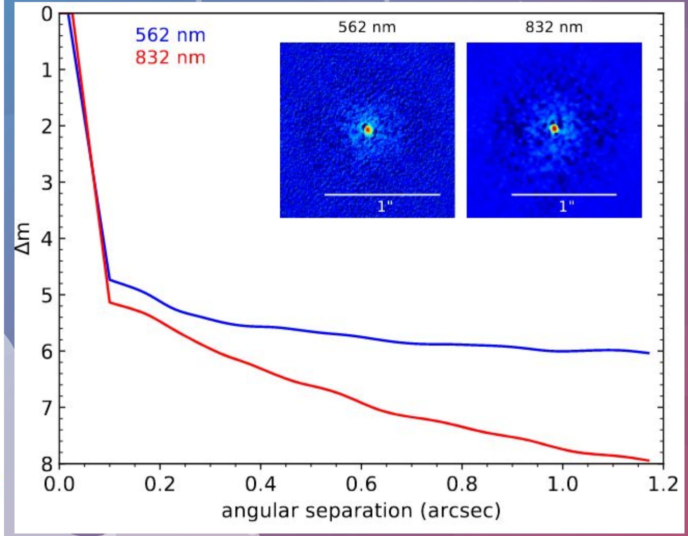
- Li, C, N, O, Mg, Si, Ti, Fe, Mn, Co, Ni, Ba, Sr…
- activity indices (Ca H & K, H_alpha, near-IR Ca T)
- Vsini
- RV

V



PLATO-GOP Imaging

Goal: detect and characterise contaminants

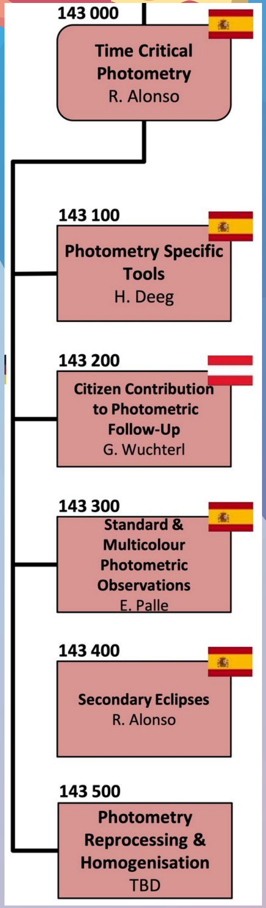


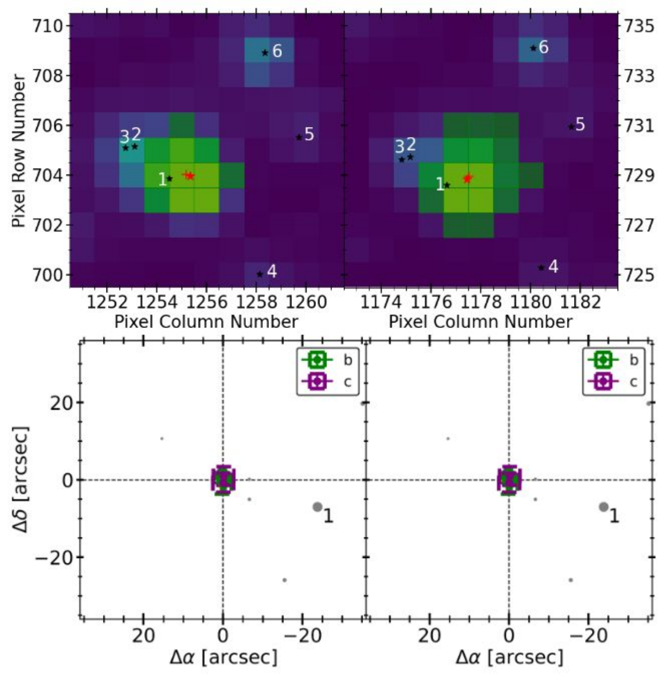
Wilson et al. 2022

We need high-spatial resolution or lucky imaging in a range of standard bandpasses to obtain:

- contrast curves that will allow us to identify nearby contaminants
- the coordinates and magnitudes of any newly identified bodies

PLATO-GOP Photometry





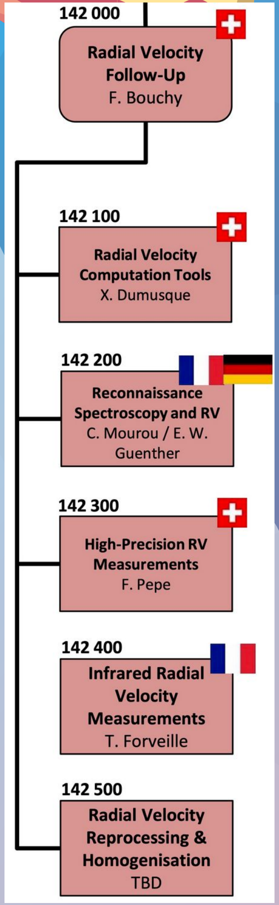
Wilson et al. 2022

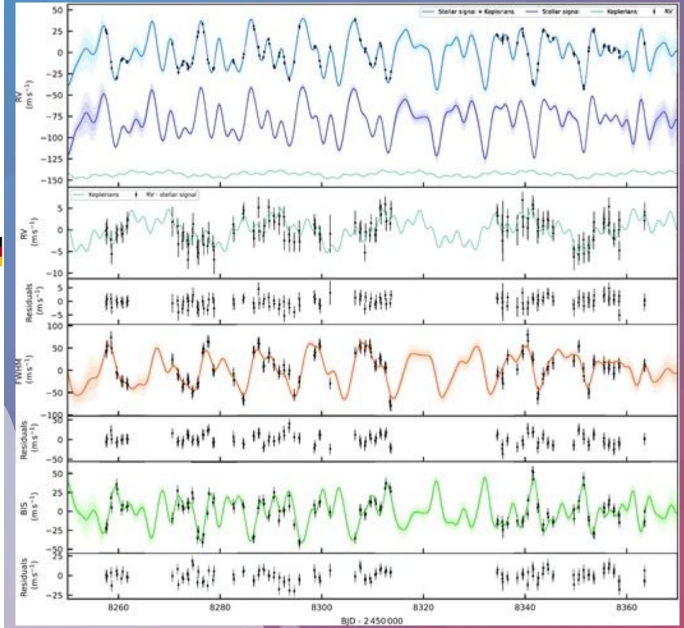
Goal: rule out large in-transit photometric variability of the contaminants

We need seeing-limited multi-band photometry to obtain:

- lightcurves of potential contaminant stars
- on-off transit centroid measurements
- chromatic transit properties

PLATO-GOP Spectroscopy/RV





Barragan et al. 2023

Goal: rule out eclipsing binary and characterise the mass of the validated planet

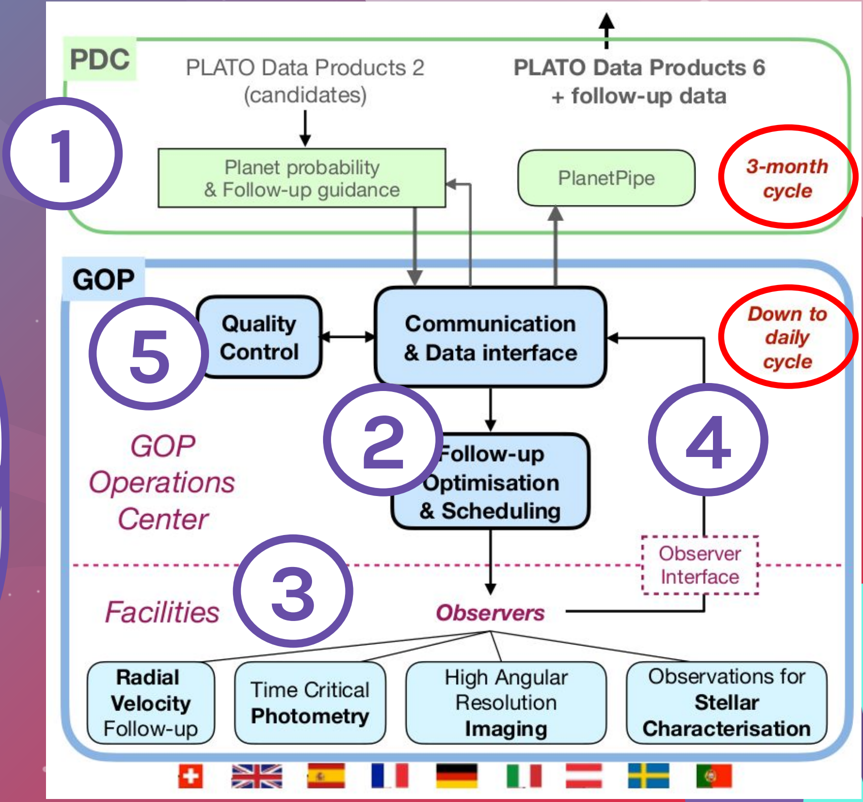
We need low- and high-spectroscopy to obtain:

- ~100 m/s RVs to rule out binarity
- <1 m/s RVs to measure masses
- stellar activity indicators (FWHM, Bis, Log R'HK, Halpha, etc)

How the GOP all fits together

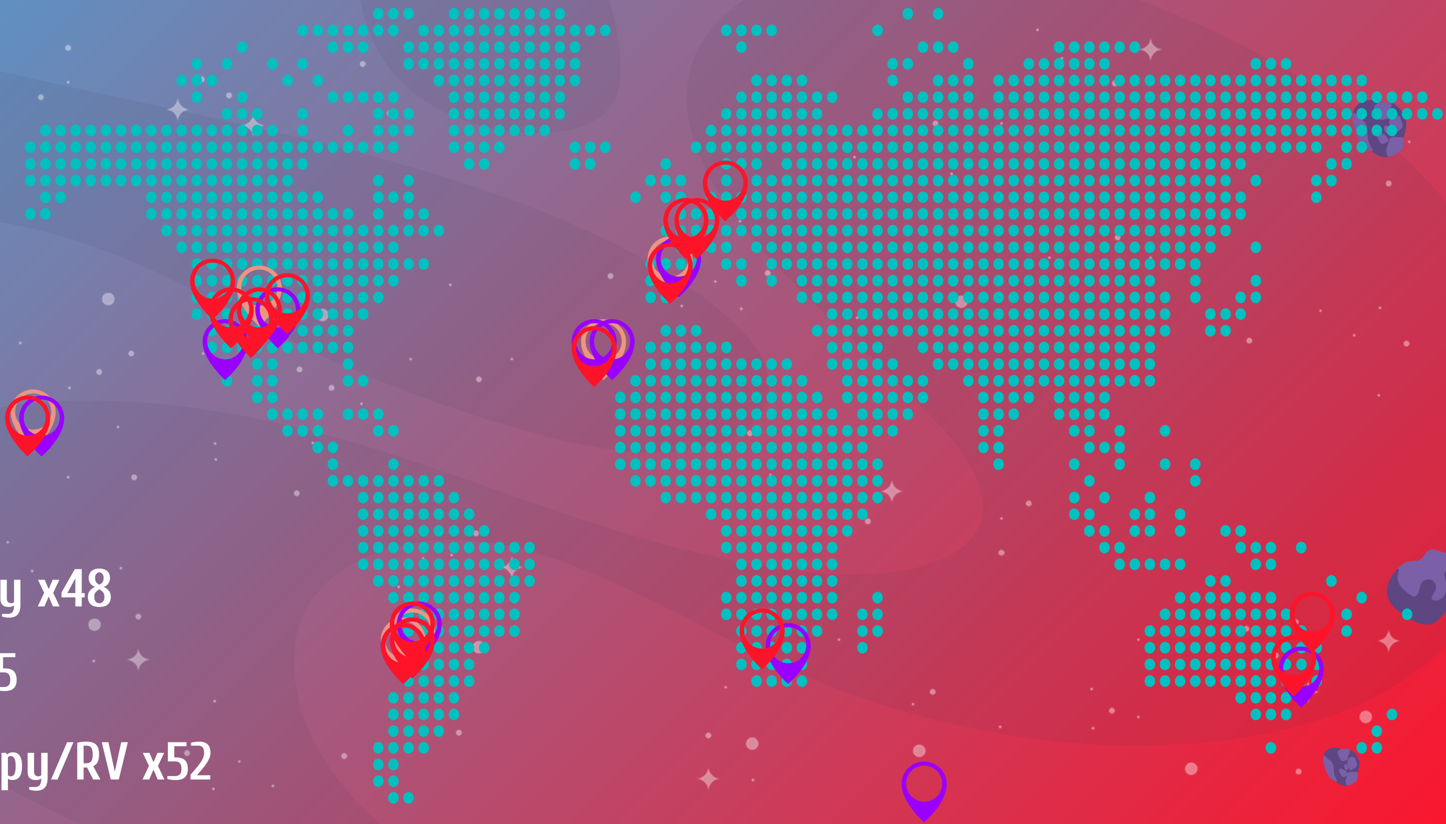
1. Transit properties from PLATO data
2. Optimise observations of prime sample targets
3. GOP-internal observers take data
4. Data sent back to GOP-central
5. Quality control to assess observations

?



We are building a global network shopping list

Anyone,
including
amatuer
astronomers,
are welcome
to join!



- Photometry x48
- Imaging x15
- Spectroscopy/RV x52

The GOP is in the advanced planning phase

2014 – PLATO selected!

2017 – Red book published with key ground-observing program noted

2020 – GOP formalised

2022 – Observing facilities and benchmarks studied

2023 – Support structures defined

2024/5 – Design and implementation reviews and end-to-end tests

2026 – LAUNCH!

2026–32 – GOP operations

2034 – Post-PLATO operations and review

If you have the expertise and interest

Do you run or are you building the next generation of follow-up facilities?

Do you have a new and exciting stellar activity mitigation method?

Do you have novel archival data analysis tools?

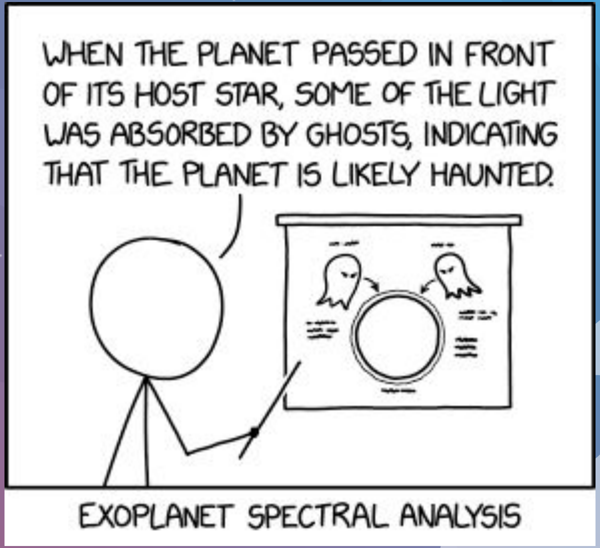
Or any other expertise that would help the GOP validate and characterise Earth-like planets.

JOIN THE GOP AND START

Getting ready for PLATO

THANKS!

Any questions?



xkcd 13/09/23