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WP 142 000

PLATO Radial Velocity Follow-up

Main goals:

Organize and realize RV follow-up of PLATO transiting candidates

- establish the nature of the transit events
- characterize the mass from earth-like planets to brown-dwarfs.

By-product:

- Central star spectroscopic parameters [WP 144 000]
- Stellar Activity Indicators and Corrections [WP 144 100]
- Spin-orbit angle measurement (Rossiter) [WP 145 400]
- Long term follow-up (multiple systems) [WP 145 500]

WP 142 000 - Radial velocity follow-up

- Coordination of sub-work packages related to RV measurements

-Estimate the numbers of RV facilities and nights required to follow all the expected transiting candidates

- Identify and list all the existing and in-development RV facilities which will be in operation during the PLATO mission

  - a maintained telescope and spectrograph,
  - a significant number of available nights per years (> 30 nights),
  - an identified technical and scientific team in charge of the instrument and the observations,
  - a Data Reduction Soft. providing in real time the reduced spectra, RV in the barycentric frame, RV uncertainties, bisector span, activity index, …
  - a demonstration of performances on real cases

- If existing and in-development facilities are estimated to be insufficient, define the strategy to build new facilities or/and upgrade existing facilities

CoRoT [5 first Long Runs]

55’605 stars [150 days] ⟶ 227 candidates (0.4%)

136 Followed

15 planets

RV F.U. 30 nights/year **HARPS/3.6-m** & 30 nights/year **SOPHIE/1.93-m**

False positives 70 - 90% *Moutou et al. 2009, Cabrera et al. 2009, Carone et al. 2011*

Kepler [4 months]

156’453 stars [130 days] ⟶ 1202 candidates (0.8%)

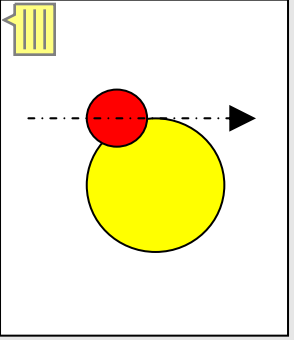
Multiple systems do not always need RV F.U. (e.g. Kepler 11)

~ 13 nights/year **Keck/10-m** & 100 nights/year other RVs

False positives ~ 30% *Borucki et al. 2011*

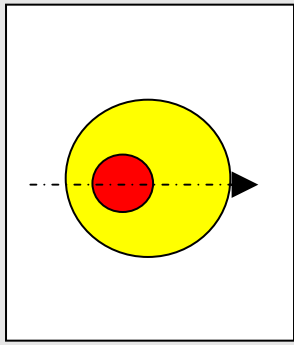
< 10% *Morton & Johson 2011*

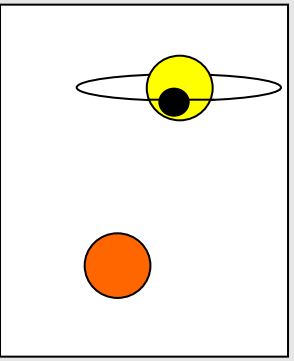
QuickTime™ et un décompresseur
sont requis pour visionner cette image.



Grazing eclipsing binaries [~10%]

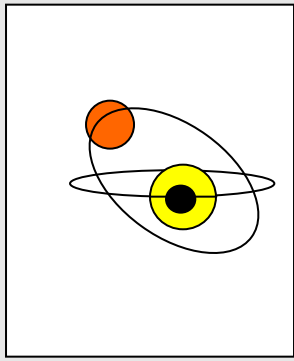
Eclipsing M dwarfs [~20%]

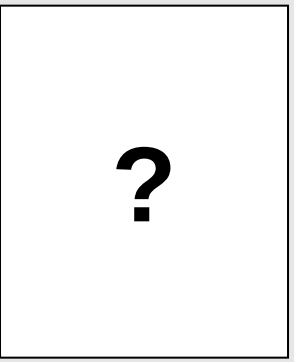




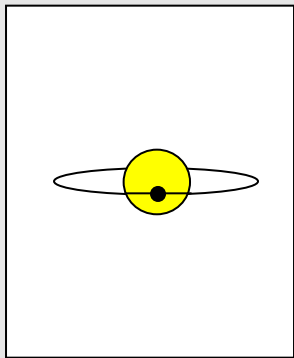
Background eclipsing binaries [~20%]
(inside Photom. window)

Blended eclipsing binaries [~20%]
(inside seeing)





Unsolved cases [~20%]
(no CCF, huge *v*sin*i*, no signif. RV variations)



Transiting planets [~10%]

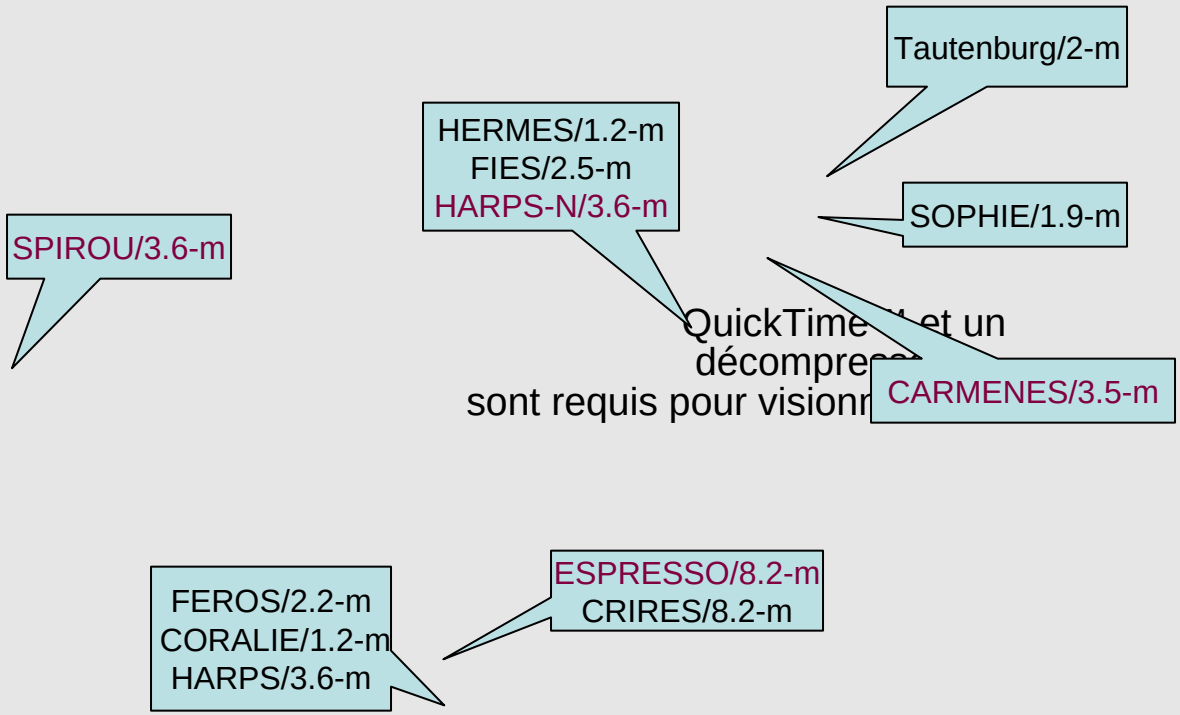
PLATO - 180’000 stars (long & short runs with mv <11)

≥ 3000 candidates

20 meas. of 15 mn = 5 hours per targets

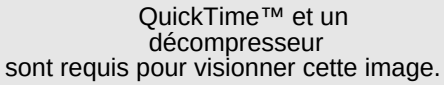
15’000 hours = 1875 nights over 6 years

≥ 50 nights / year x 6 telescopes



European Radial Velocity Facilities

PROJECT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Earth

RV computation and analysis tools **WP142100**

[To compute the RV of stars of different types. To estimate the expected RV amplitude of the candidates. To estimate the RV offset between different instruments. To combine data of different nature to optimize RV F.U.]

RV facilities should be ranked not as function of the telescope diameter but as a function of the RV uncertainties effectively obtained for a solar-type star of magnitude mv=11 in 1-h exposure (mv=8 in 4 mn).

$25 < \sigma_{RV} < 50$ m/s [screening, binaries, brow-dwarfs, massive HJ] **WP142200**

$5 < \sigma_{RV} < 10$ m/s [screening, Jupiter, blend, hot-Saturn] **WP142300**

$1 < \sigma_{RV} < 2$ m/s [Neptune, blend, hot super-Earth] **WP142400**

$\sigma_{RV} < 40$ cm/s [super-Earth, hot-Earth, blend] **WP142500**

Infra-Red RVs [Active stars and low-mass stars] **WP142600**

Strong need of high-precision spectrographs ≤ 1 m/s

In development facilities:

HARPS-N / 3.6-m TNG & ESPRESSO / 8.2-m VLT

SPIROU / 3.6-m CFHT & CARMENES / 3.5-m Calar Alto

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décompresseur
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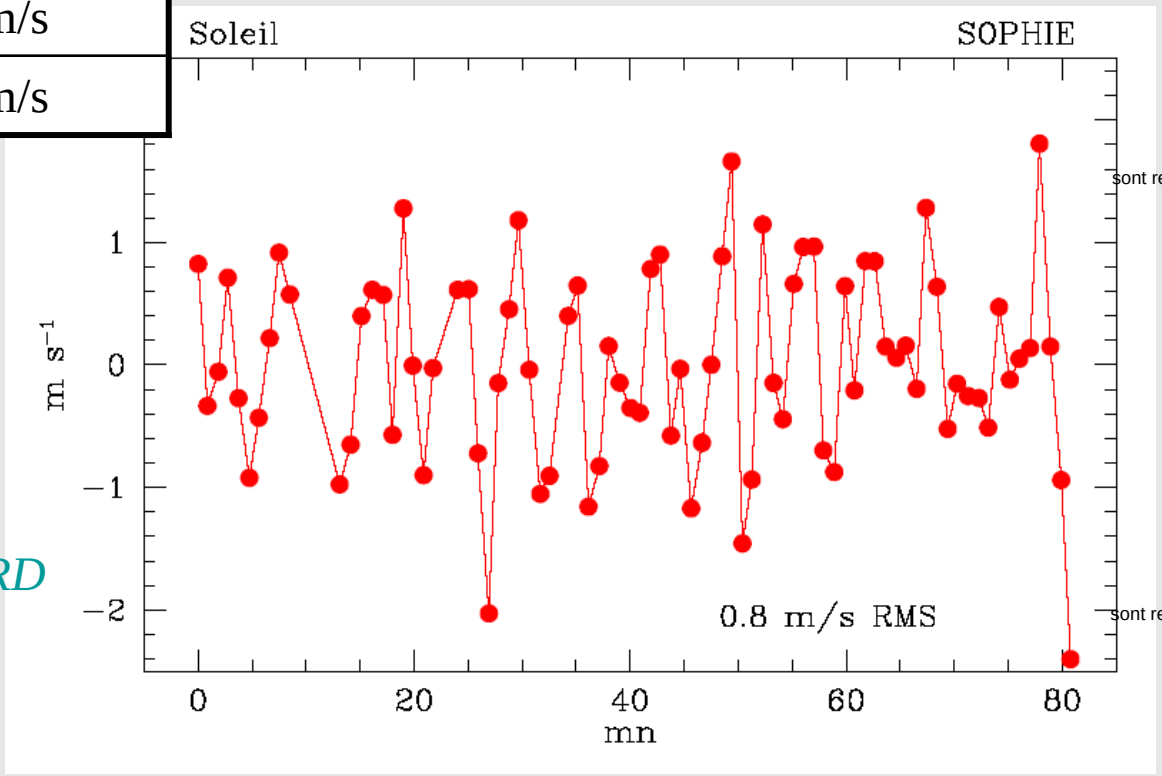
Gain of 10 every 6 years

Optimize and upgrade existing facilities on 2-4 m

*RV photon-noise fondamental limitation on **SOPHIE/1.93-m***

mv	σ_{RV} in 1 hour
8	0.6 m/s
9	1.0 m/s
10	1.5 m/s
11	2.5 m/s

Instrumental jitter ~ 5 m/s due to imperfect fiber scrambling



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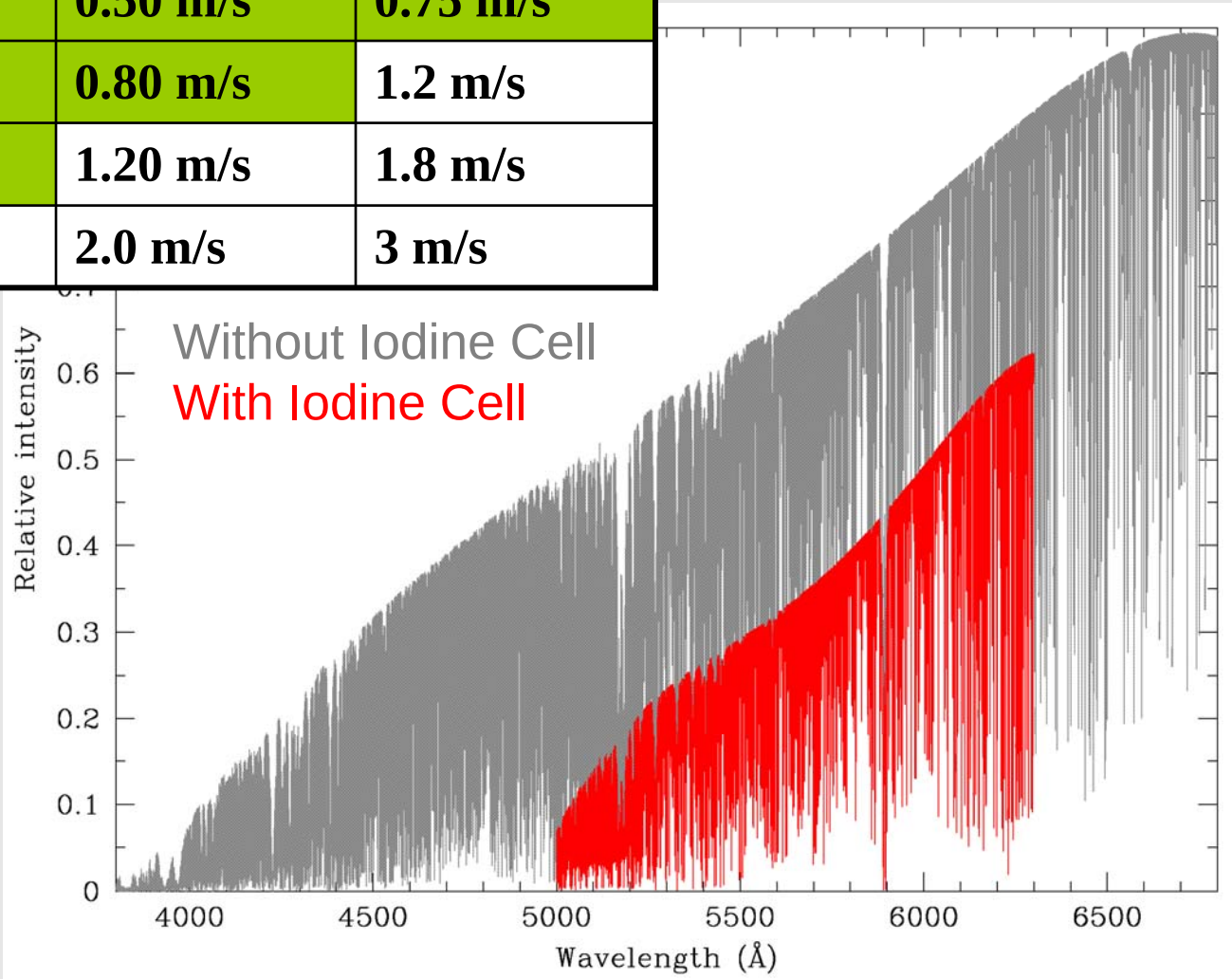
Bouchy et al. 2009
Boisse et al. 2009
Chazelas et al. 2010
POSTER G. HEBRARD

*RV photon-noise fondamental limitation on **HARPS/3.6-m***

mv	σ_{RV} in 1 hour		
	vsini < 2 km/s	vsini ~ 5 km/s	vsini ~ 10 km/s
8	0.25 m/s	0.50 m/s	0.75 m/s
9	0.40 m/s	0.80 m/s	1.2 m/s
10	0.60 m/s	1.20 m/s	1.8 m/s
11	1.0 m/s	2.0 m/s	3 m/s

≈

HIRES/10-m
With Iodine Cell



Nb measurements @ 30 cm/s
to constraint the mass @ 30%
of a planet @ 0.5 UA

$$\sigma_K = \frac{\sigma_{RV}}{\sqrt{N_{obs}/2}}$$

	1 M_{earth}	2 M_{earth}	3 M_{earth}
F0 (1.60 Ms)	158	40	18
G0 (1.05 Ms)	104	26	14
K0 (0.79 Ms)	78	20	9
M0 (0.51 Ms)	50	13	6

Screening at 50-100 m/s possible with 60-cm telescope !

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HD189733

HD195019

QuickTime™ et un
décompresseur
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QuickTime™ et un
décompresseur
sont requis pour visionner cette image.

51Peg

Tau Boo

LHIRES @ Shelyak

To Deal with stellar activity

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WP 144 100

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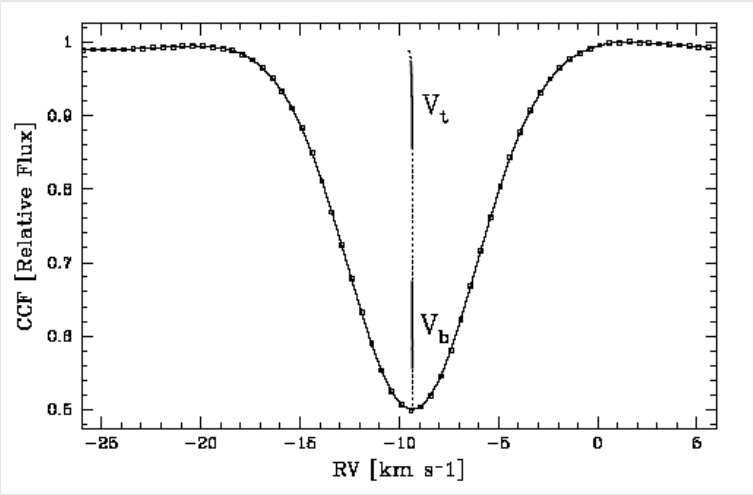
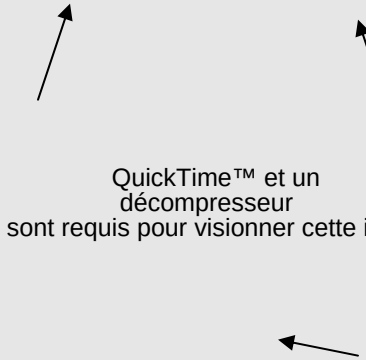


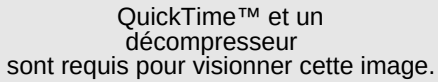
light curve provides P_{ROT}

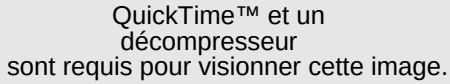
CCF Bisector span
CCF FWHM
Activity Index
Optimum Observing Sampling

Boisse et al. 2011
Dumusque et al. 2011
POSTER I. BOISSE

To Solve Blended Eclipsing Binaries (inside seeing)







Deep inspection of CCFs

Bisector Span

Amplitude change with CCF template

Treatments of stellar Blends **WP142700**

[To simulate blend effects. To identify blend cases from the complete available information]