The challenge of the detection of transiting terrestrial extrasolar planets

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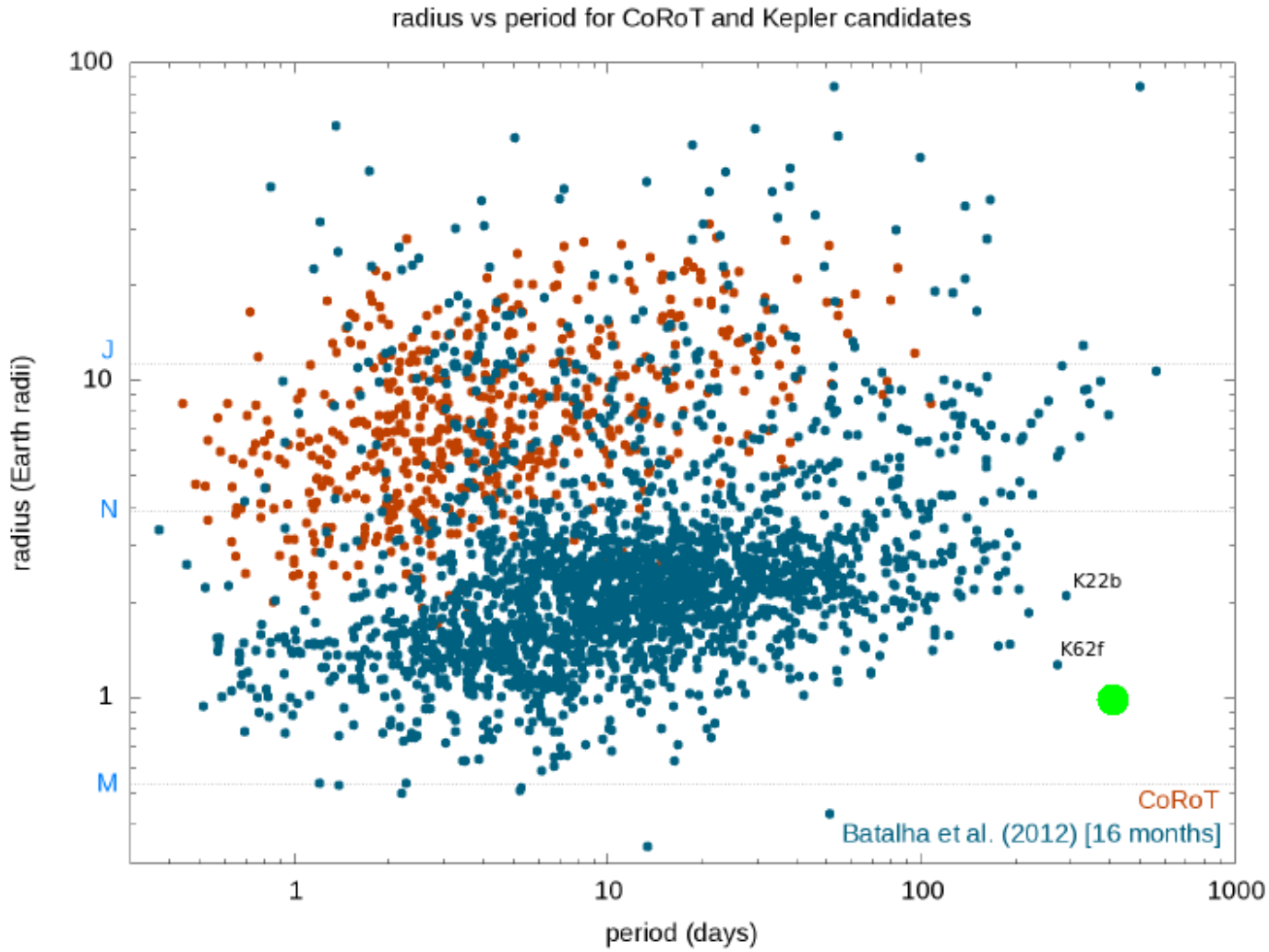
science case

- the characterization of Earth-like planets in the Habitable Zone of solar-like stars is one of the main science drivers of PLATO 2.0



the challenge

- the transit signal is $\sim$84 ppm
  (see talk by J. Jenkins)
- stellar activity is an issue

Aigrain et al. (2009) A&A, 506, 425

Gilliland et al. (2011) ApJS, 197, 6

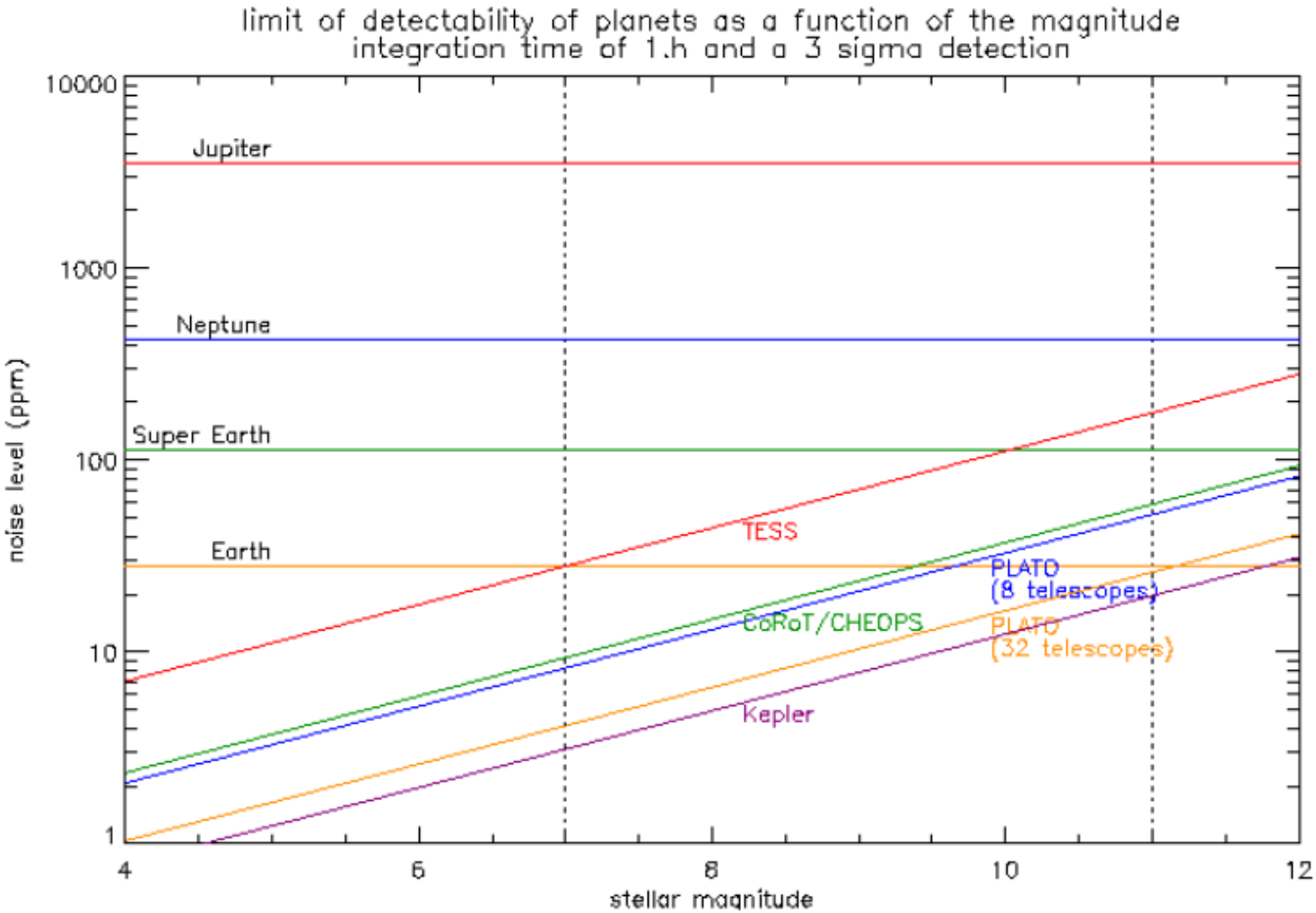
Ciardi et al. (2011) ApJ, 141, A108

McQuillan et al. (2012) A&A, 539, A137

Basri et al. (2013) ApJ, in press

Christiansen et al. (2012) PASP, 124, 1279

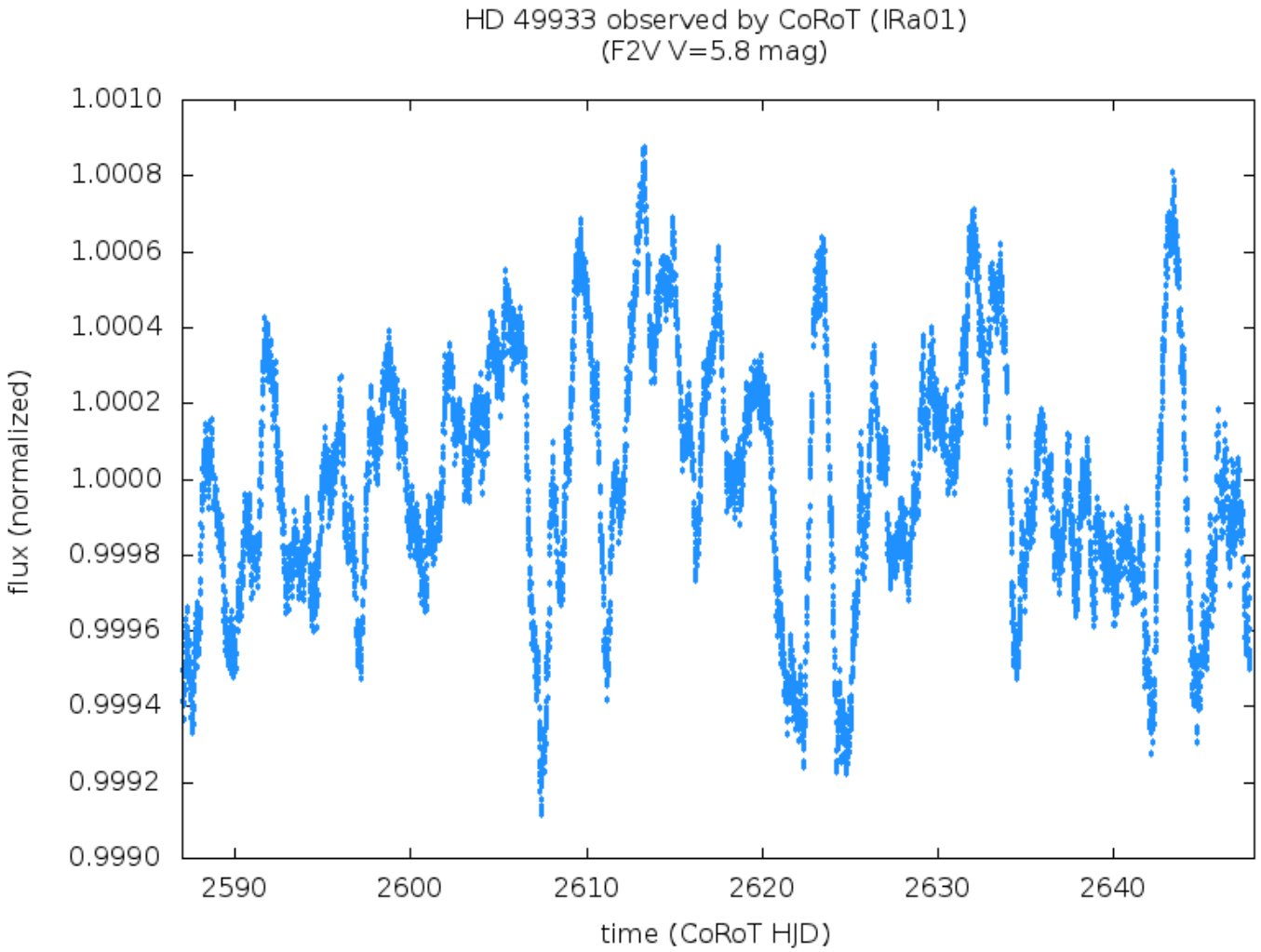
photon noise



$$N_{\text{photons}} = \left(\frac{R_s}{D}\right)^2 \pi \left(\frac{d}{2}\right)^2 t \int B_\lambda(T_{\text{eff}}) \frac{\lambda}{hc}$$

correlated noise

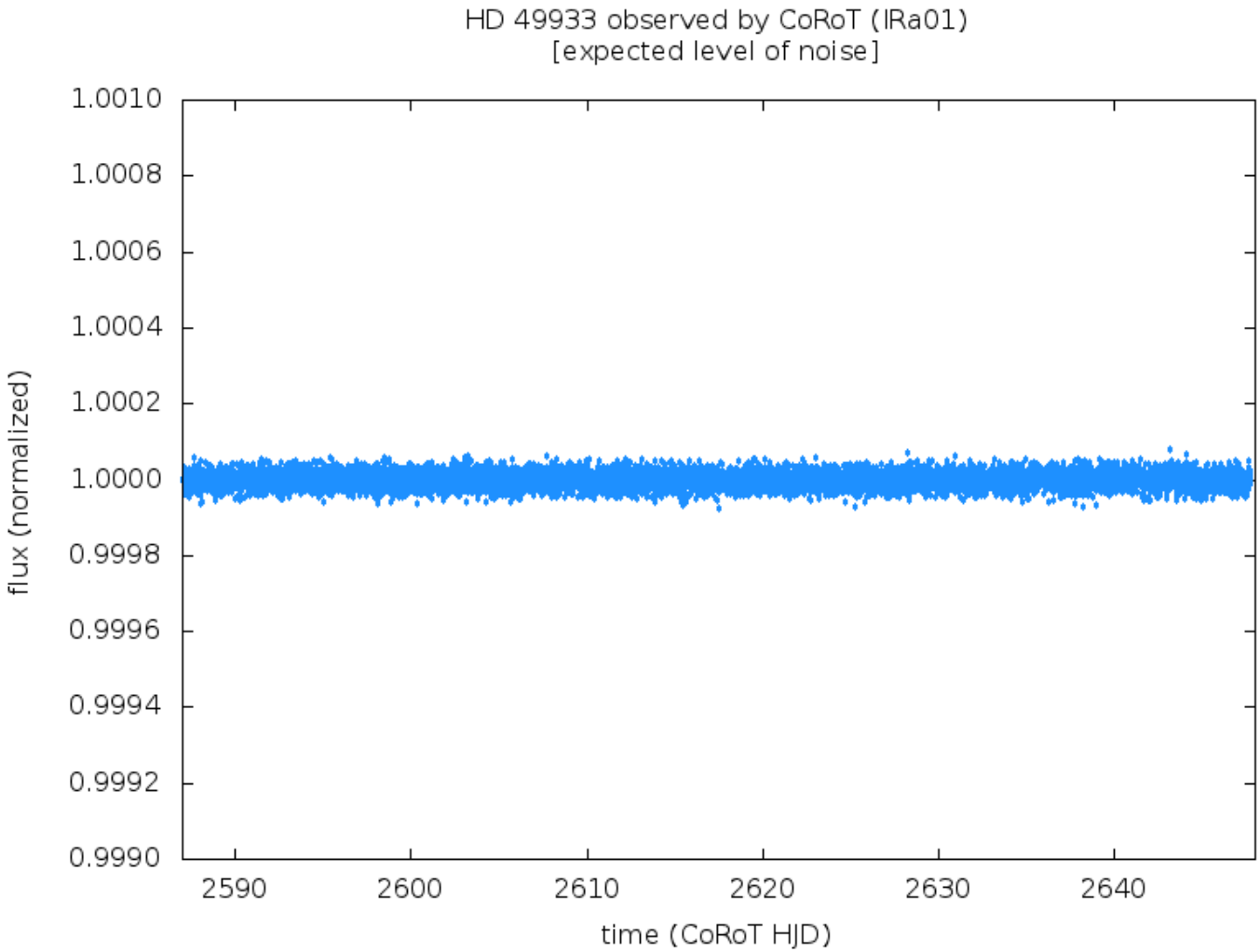
a case example: HD 49933



DLR

correlated noise

a case example: HD 49933



correlated noise

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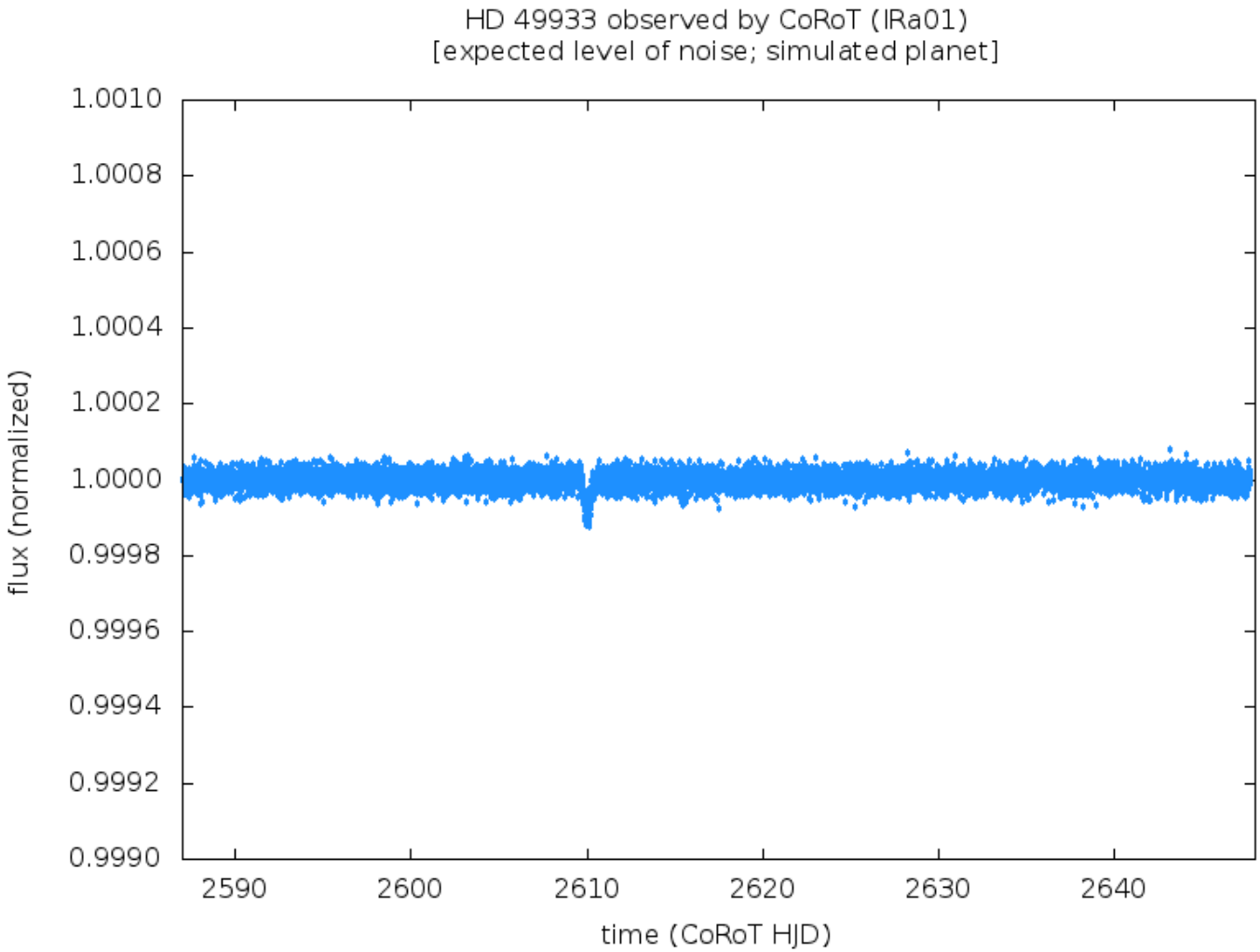

correlated noise

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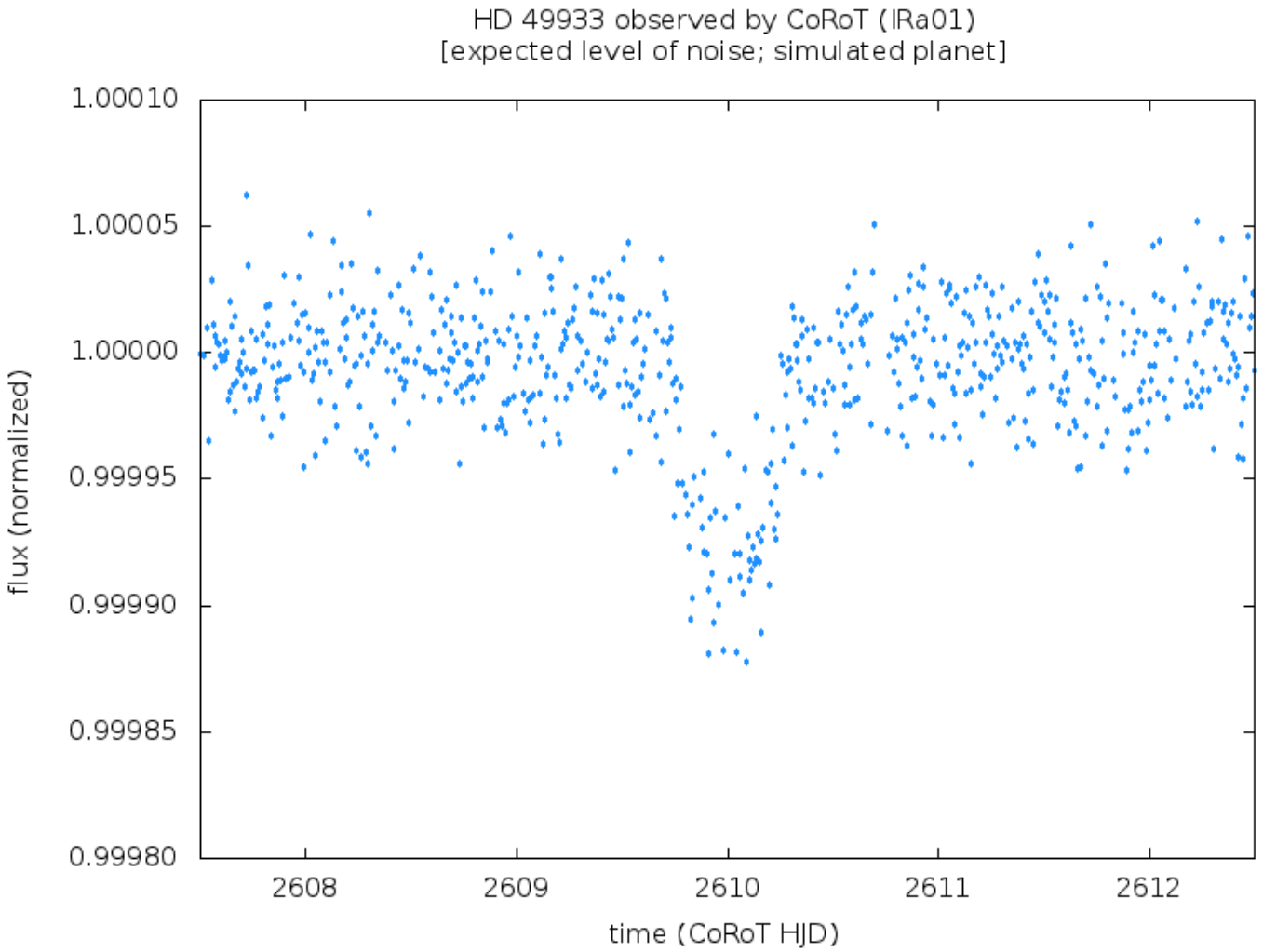

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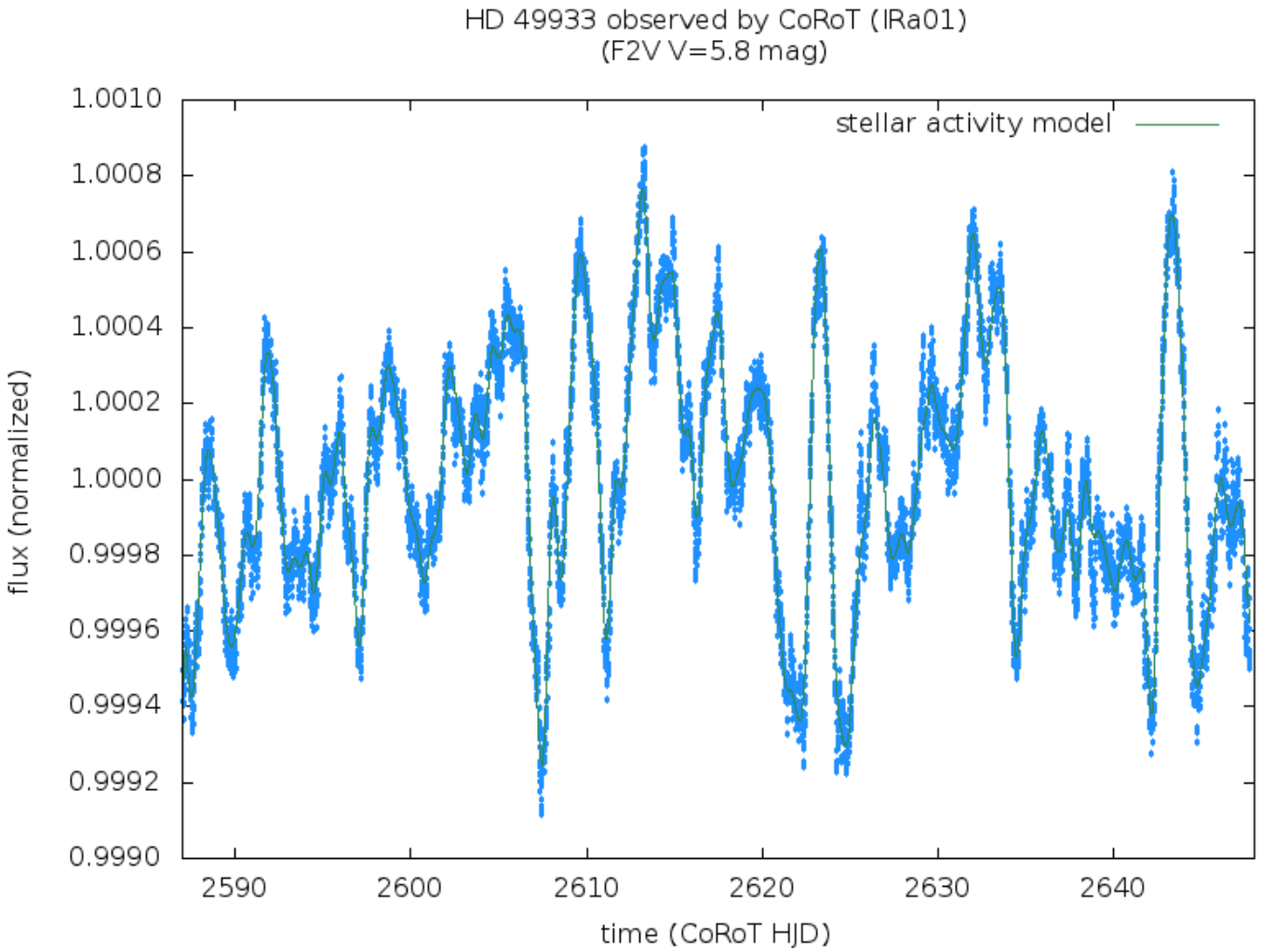

correlated noise

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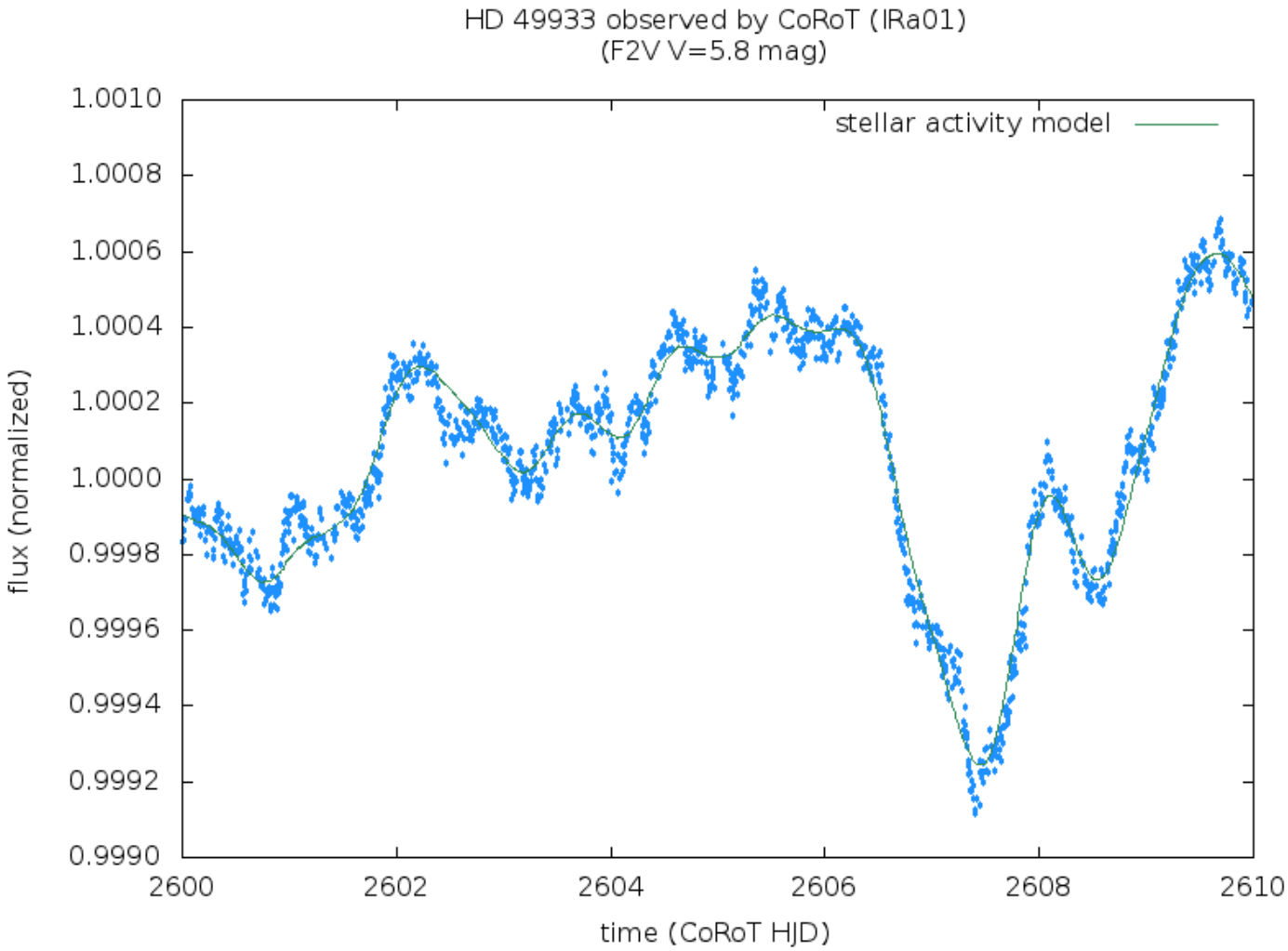

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correlated noise

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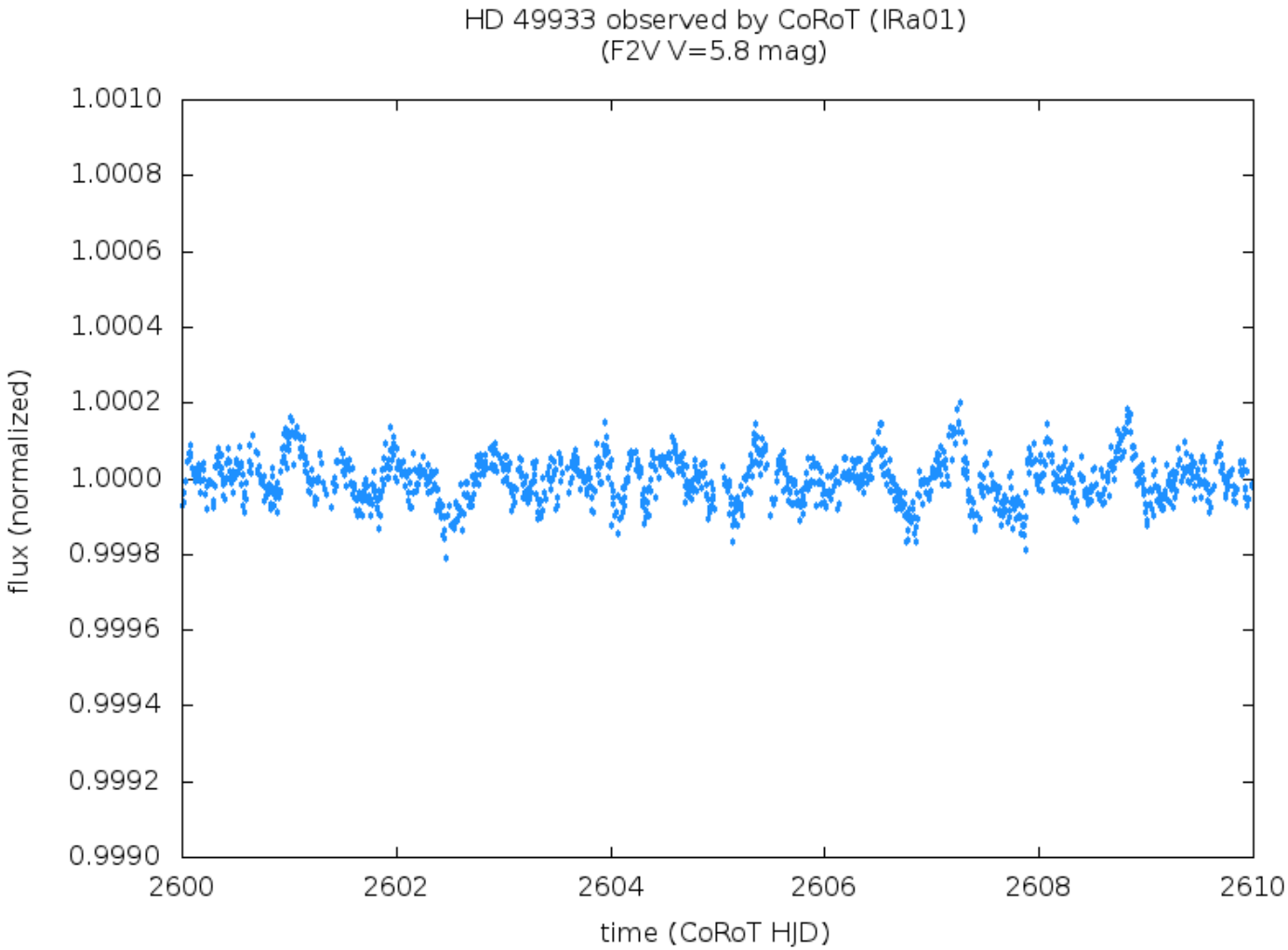

correlated noise

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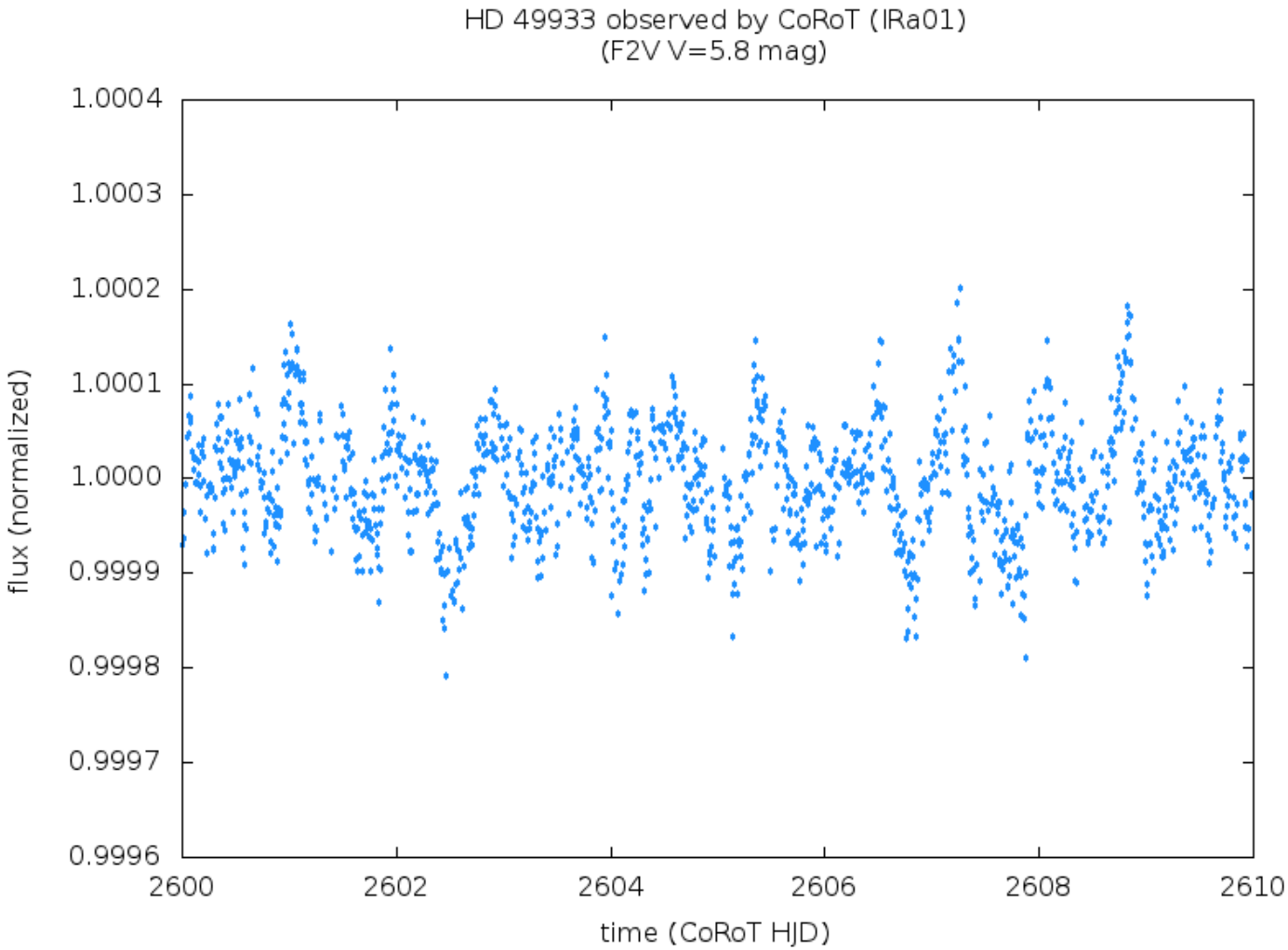

terrestrial planet detection in the context of PLATO

- the characterization of Earth-like planets in the Habitable Zone of solar-like stars is one of the main science drivers of PLATO 2.0
- fast and secure identification needed
- many stars are more active than expected (Sun)
  - Gilliland et al.; McQuillan et al.; Basri et al.; . . .
    (and see talk by J. Jenkins)
- room for improvement
  - stellar activity $\rightarrow$ stellar knowledge (PLATO 2.0!)
  - transit detection $\rightarrow$ new paradigms for PLATO 2.0
    - Berta et al. (2012) AJ, 144, A145
    - Carter & Agol (2013) ApJ, 765, A132
  - new strategy of observation $\rightarrow$ optimized for PLATO 2.0

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additional slides

stellar population observed by different missions

number of stars observed	to detect Earth-like planets, obtain mass from RV and perform asteroseismology	to detect super-Earths (2 Earth radii) but without RV or asteroseismology
Kepler	dwarf stars brighter than magnitude 11 1805 dwarfs observed for 4 years	dwarf stars brighter than magnitude 16 96 000 dwarfs observed for 4 years
TESS	stars brighter than magnitude 7 11 600 dwarfs observed for 27 days 232 dwarfs observed for 1 year	stars brighter than magnitude 10 340 000 dwarfs observed for 27 days 6 800 dwarfs observed for 1 year
PLATO	stellar population P1 (V<11 mag) 85 000 dwarfs during the whole mission 21 300 dwarfs observed in long pointings	stellar population P5 (V<13.5 mag) 1 000 000 dwarfs during the whole mission 267 000 dwarfs during long pointings

stellar population observed by PLATO

The basic outcome of these performance evaluations is summarized in Table 4.2. For this evaluation, we have assumed two long runs of 2 years each, and a 2 year step & stare including the following successive runs: 3 x 5 months, 1 x 4 months, 1 x 3 months, 1 x 2 months.

PLATO star sample	# of stars			
	after two long monitoring phases 4,300 deg^2	science requirement	incl. step & stare phase 20,000 deg^2	science requirement
P1 : dwarfs/sub-giants later than F5, noise ≤34 ppm in 1 hr	21,300	20,000	85,000	n/a
P2, P3 : dwarfs/sub-giants later than F5, $m_V \leq 8$, noise ≤34 ppm in 1 hr	1,250	1,000	3,100 (≥ 5 months)	3,000
P4: M dwarfs, noise ≤800 ppm in 1 hr	>5,000 (TBC)	5,000	>5,000 (TBC)	5,000
P5 : dwarfs/sub-giants later than F5, noise ≤80 ppm in 1 hr	267,000	245,000	1,000,000	n/a
# dwarfs/sub-giants later than F5, $m_V \leq 11$	36,000	maximize	145,000	n/a

correlated noise

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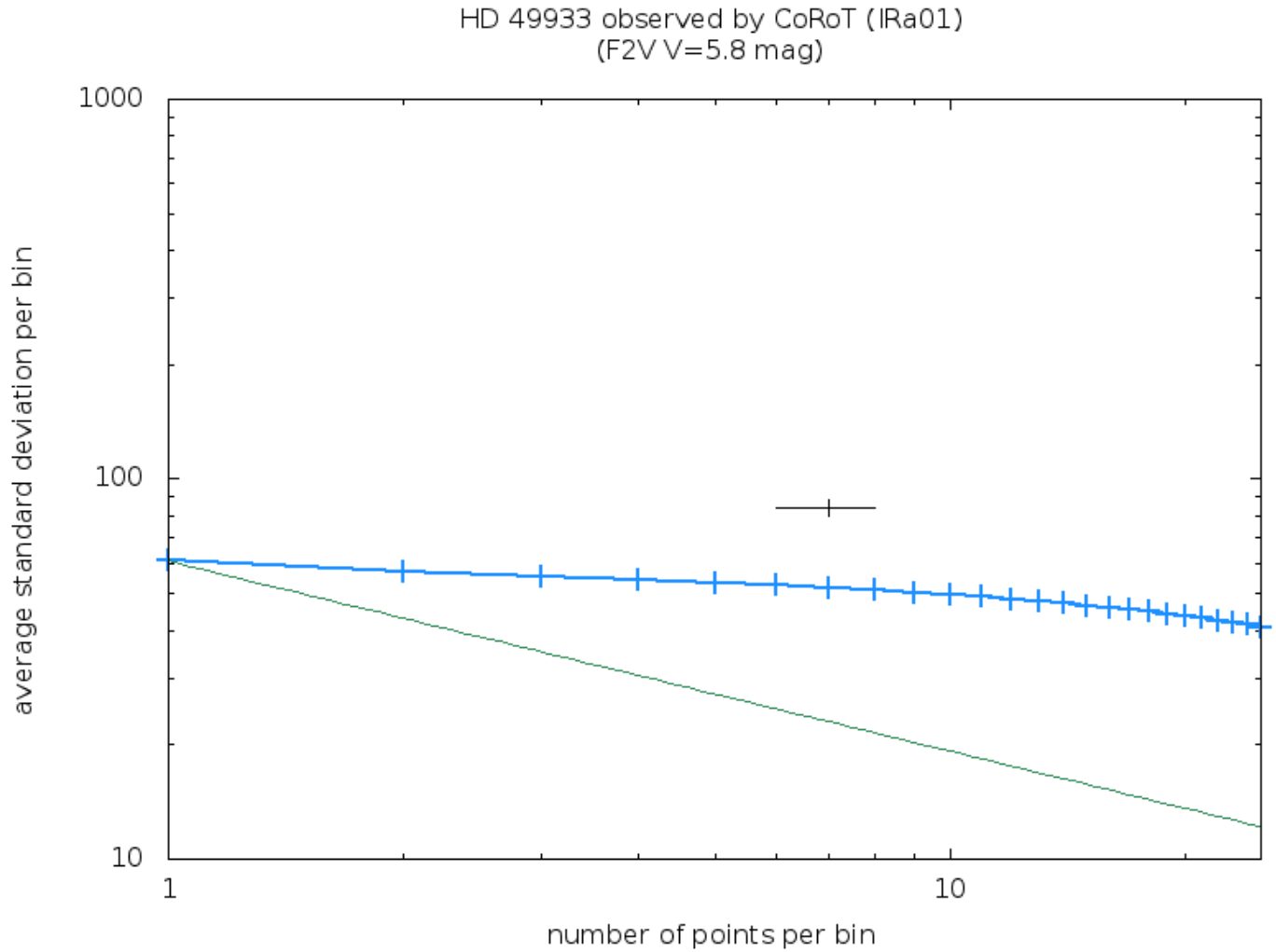
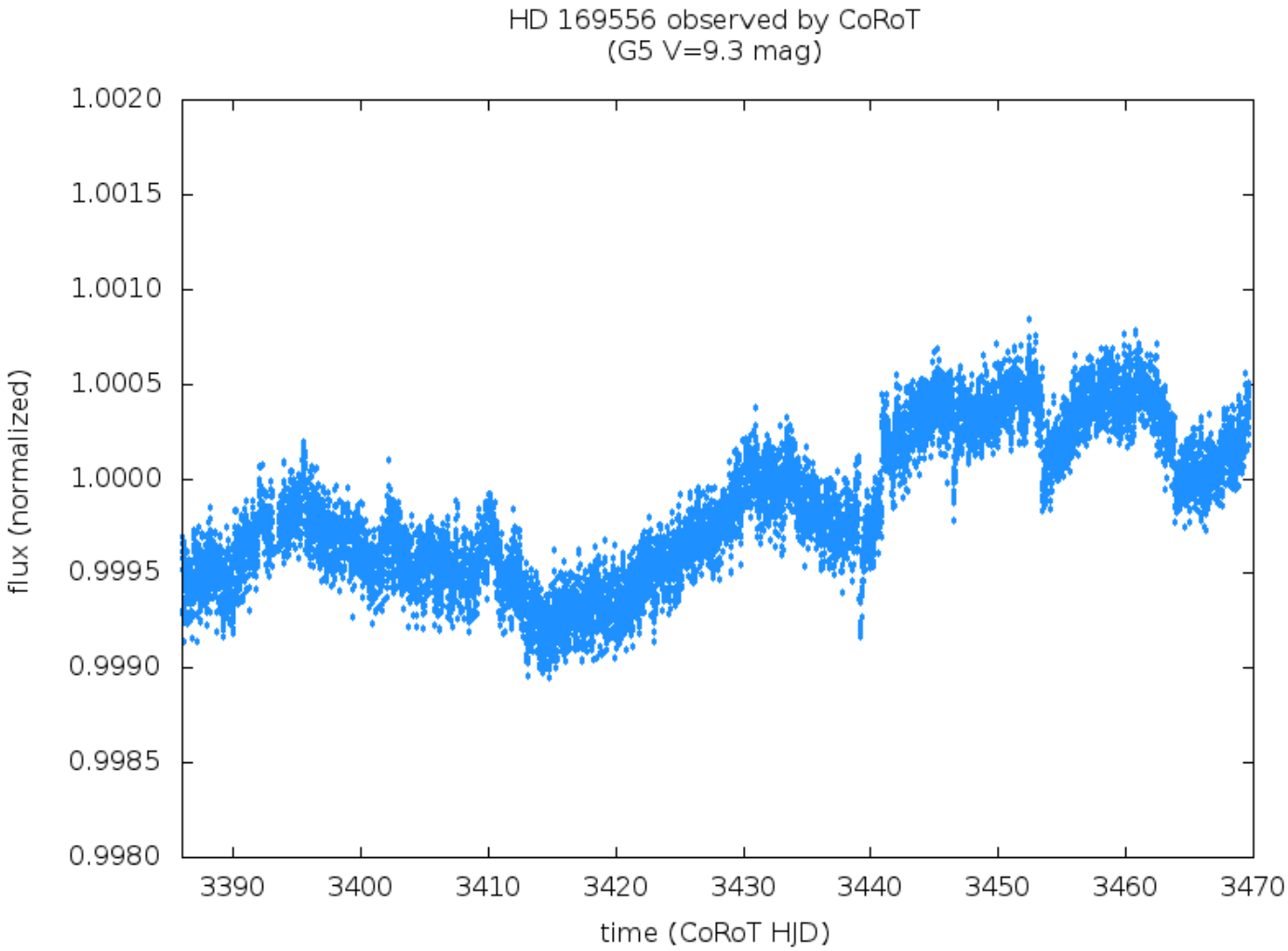


see also Pont et al. (2006)

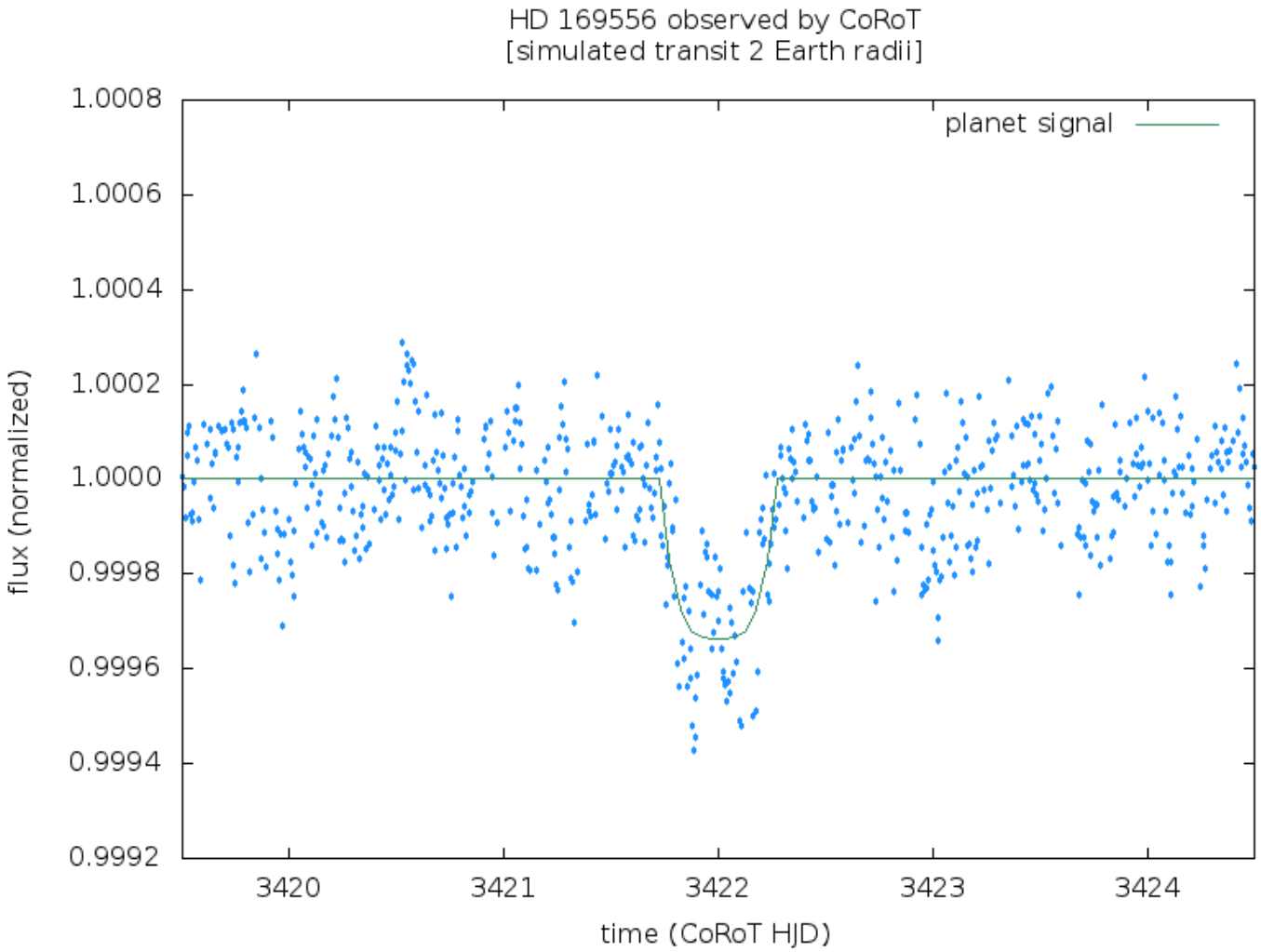
correlated noise

another case example: HD 169556



correlated noise

another case example: HD 169556



correlated noise

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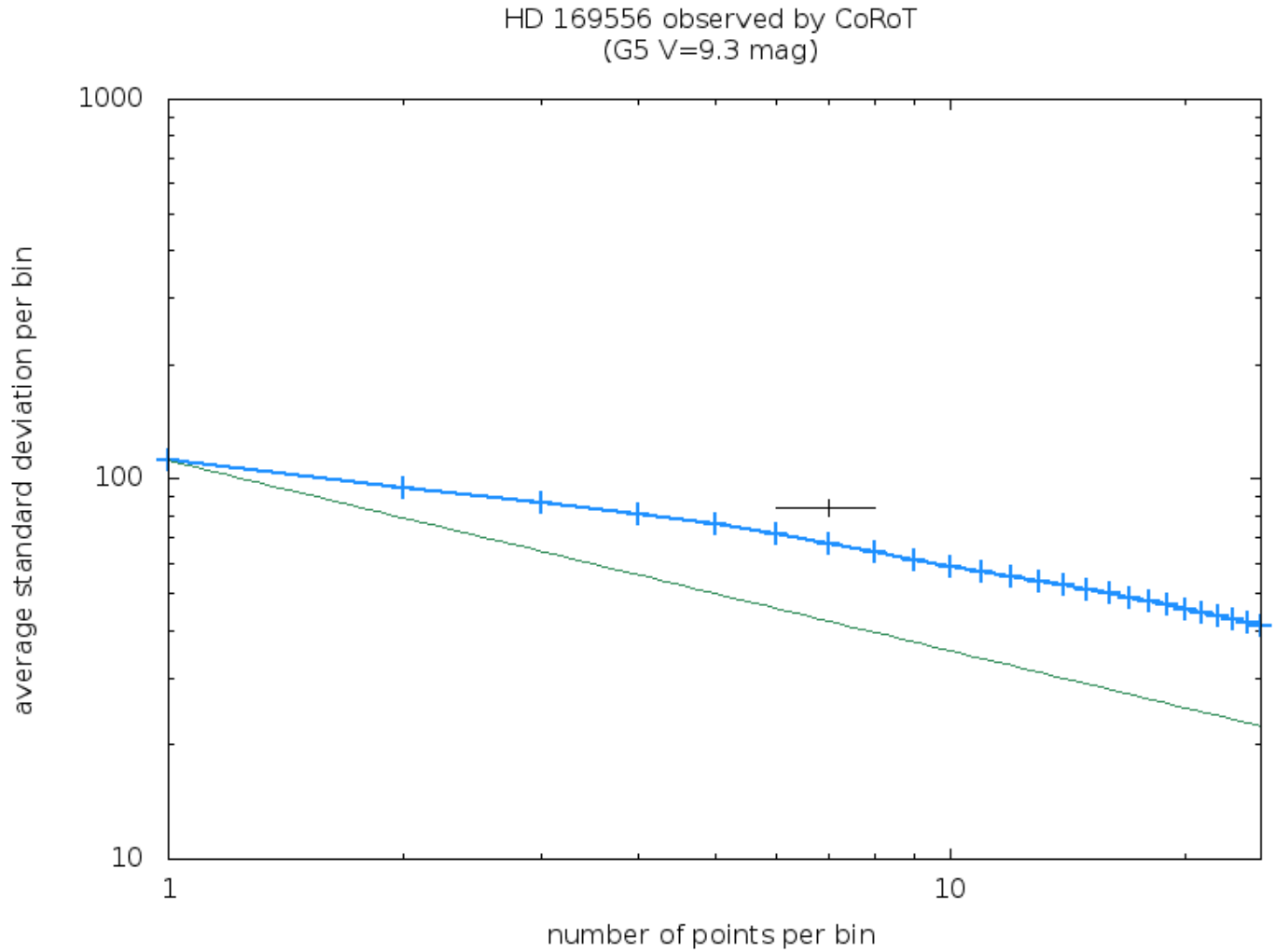


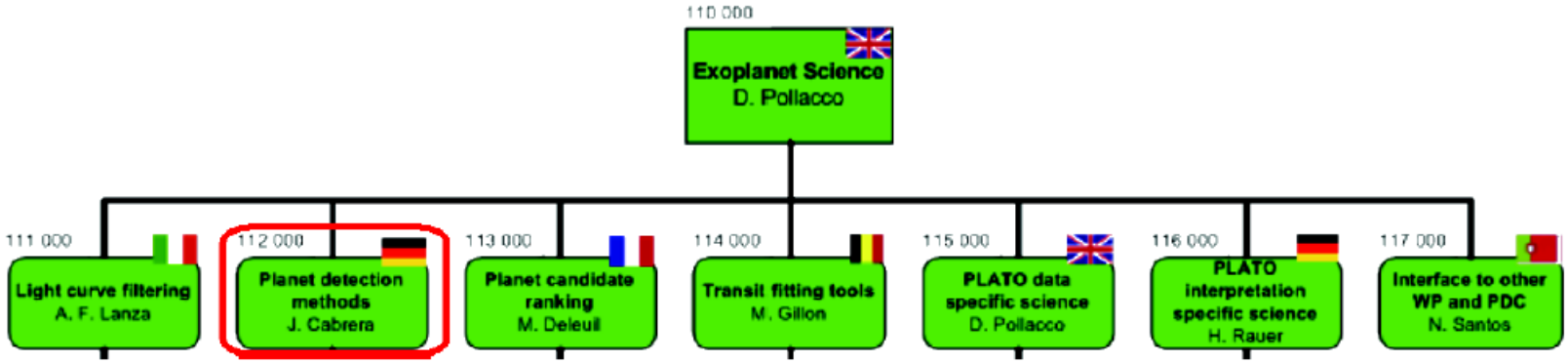
see also Pont et al. (2006)

PLATO scientific organization

WP 110 000

PSPM activities

ensure a maximum scientific return of the PLATO mission by refining the scientific requirements and specifications of algorithms and tools



- WP 112 is within WP 110 (Exoplanet Science) in the PSPM
- WP 112 000 coordinates the WPs related to different planet detection methods:
  - transits, reflected light, multiple systems, other methods (TTVs,. . .)

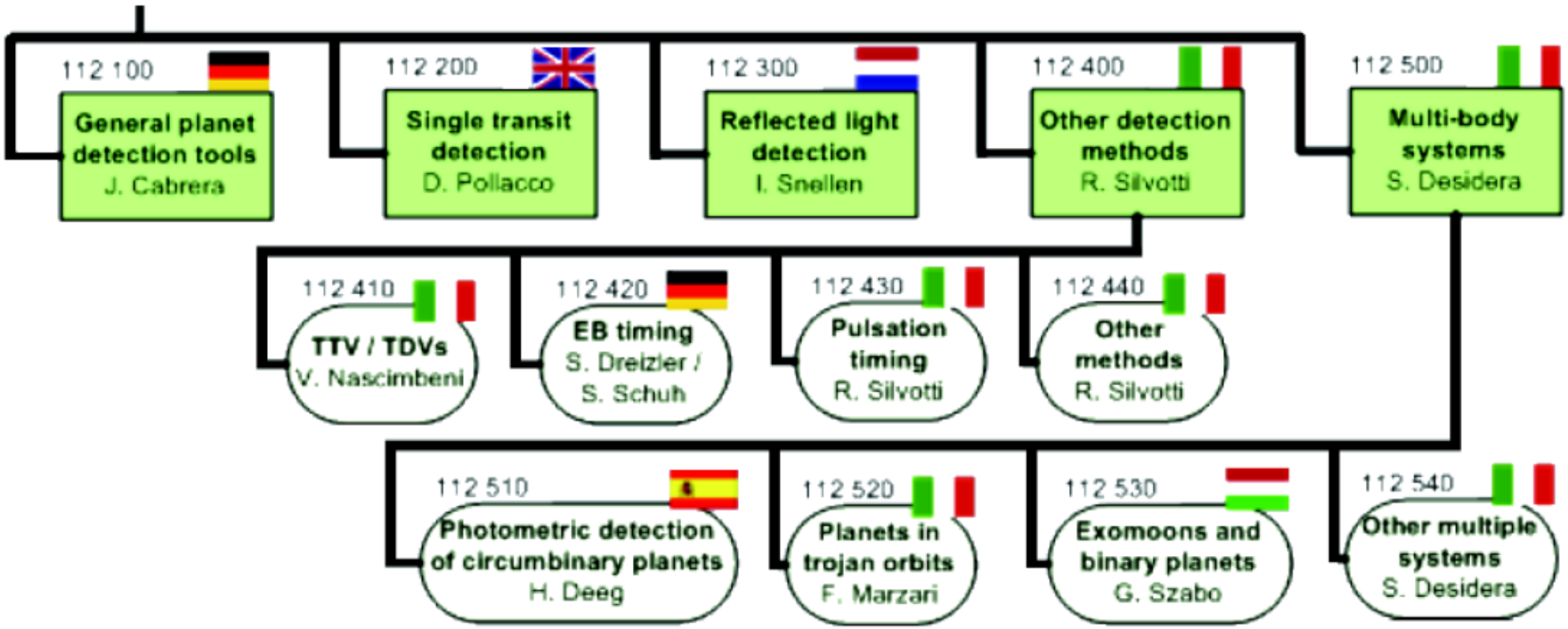
DLR

PLATO scientific organization

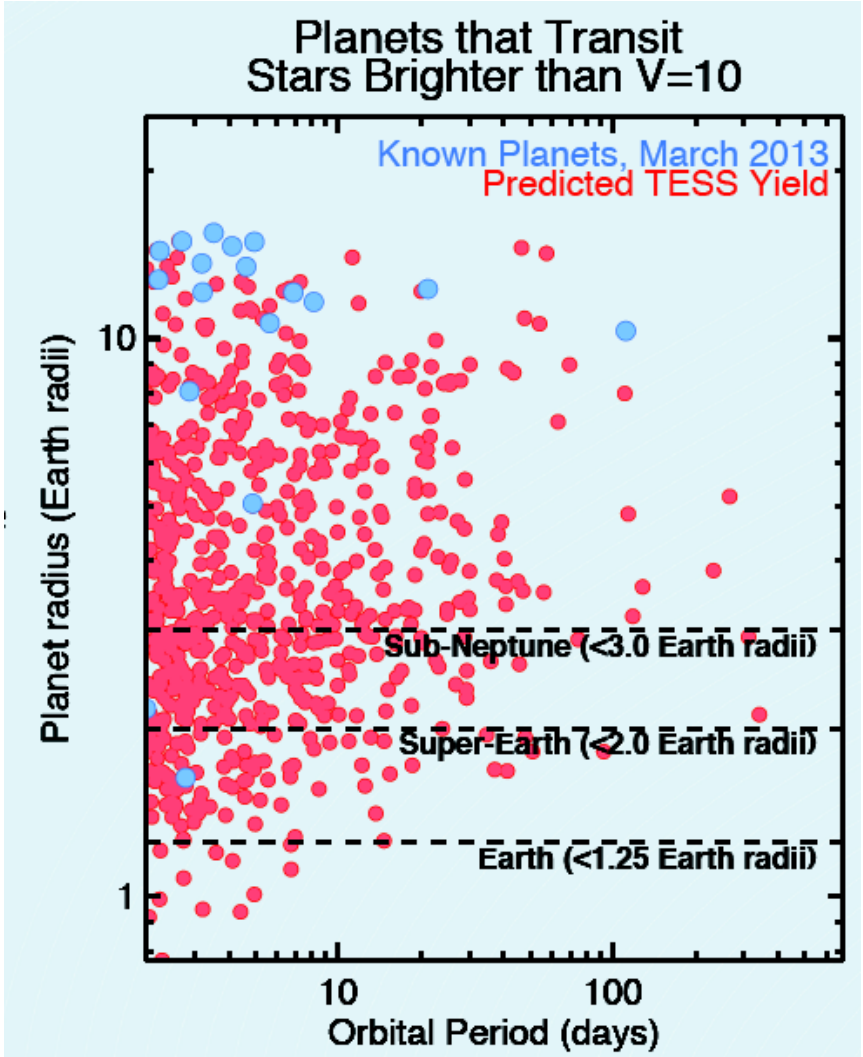
WP 112 000

PSPM activities

ensure a maximum scientific return of the PLATO mission by refining the scientific requirements and specifications of algorithms and tools



TESS discovery space



taken from a slide by G. Ricker

compact multiple systems