
ASTEP
Nice workshop
14&15/03/2011

Objectives of the meeting

- To present the status of ASTEP
  - ASTEP South
  - ASTEP 400
- To share the data
- To share the softwares
  - Data pipeline
  - Lightcurves analysis (detrending/searching for planets)
- To prepare future observations
  - ASTEP 400
  - Follow-up
- To start writing the papers

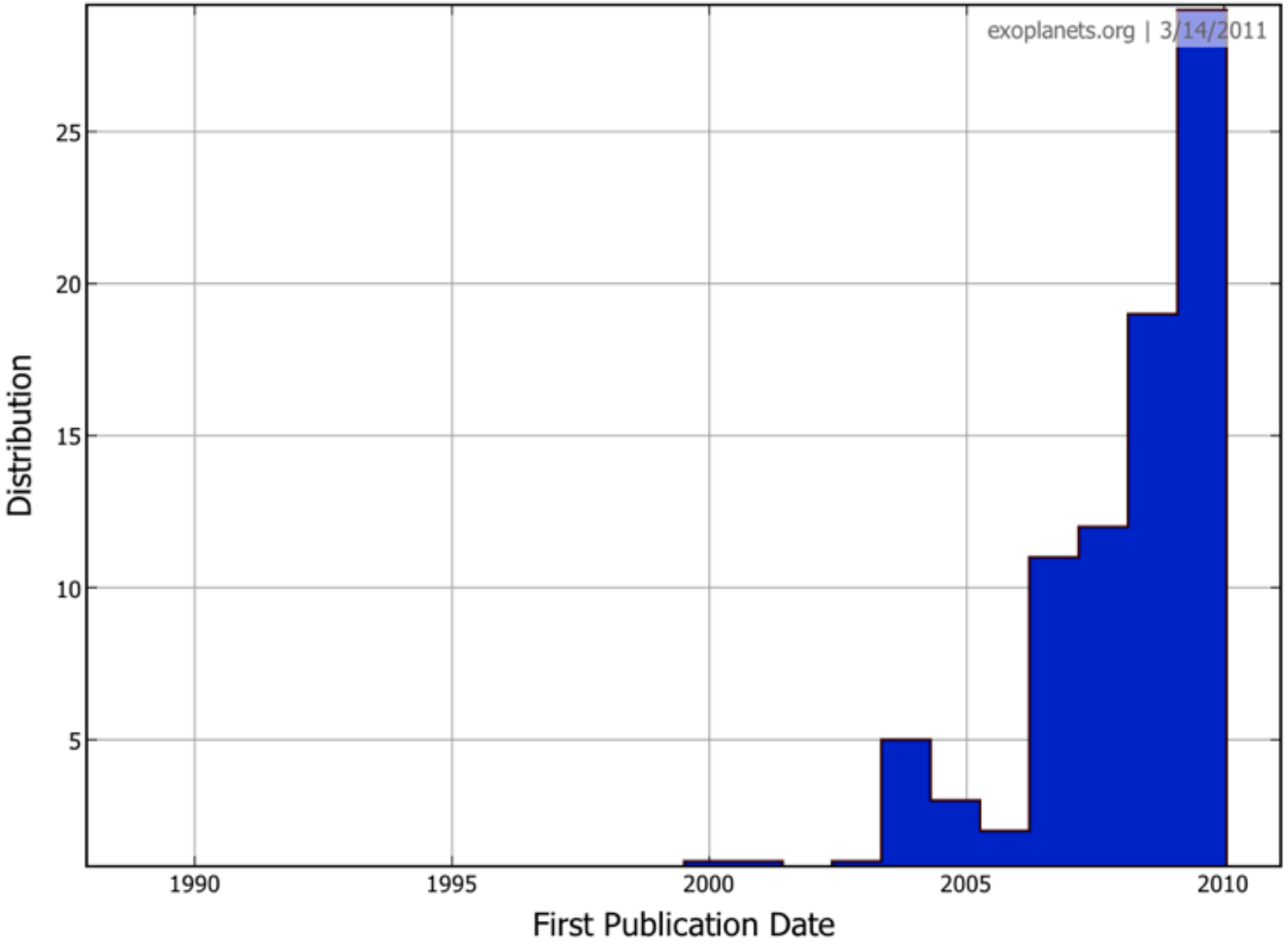
ASTEP: Objectives

- **Determine the limits of Dome C for precise wide field photometry in the visible**

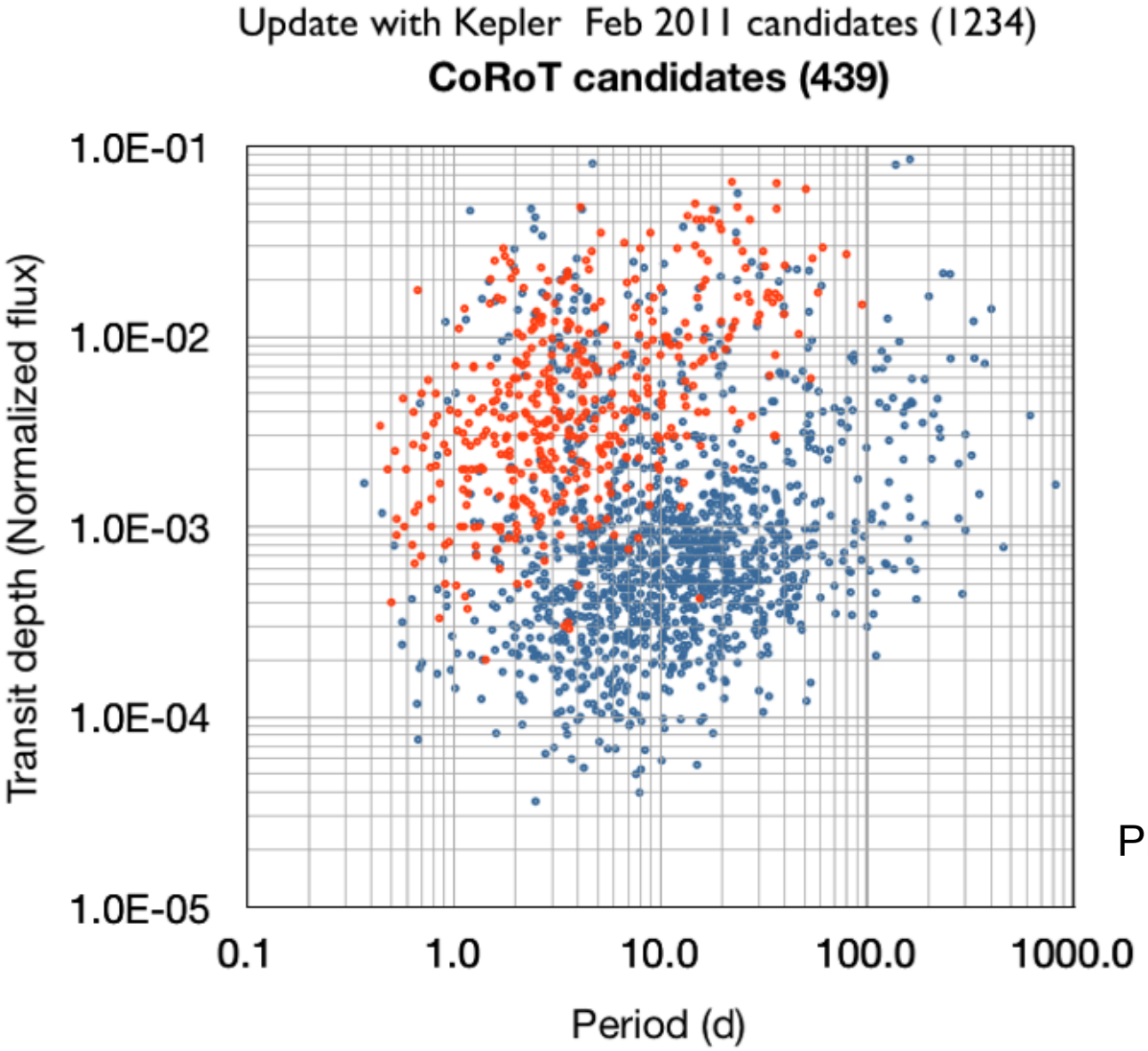
- **If the site is competitive with space and transit search limits are well understood, establish the bases of a mid-term massive detection project**

- **Search for transiting exoplanets, characterize them.**

of transiting planets

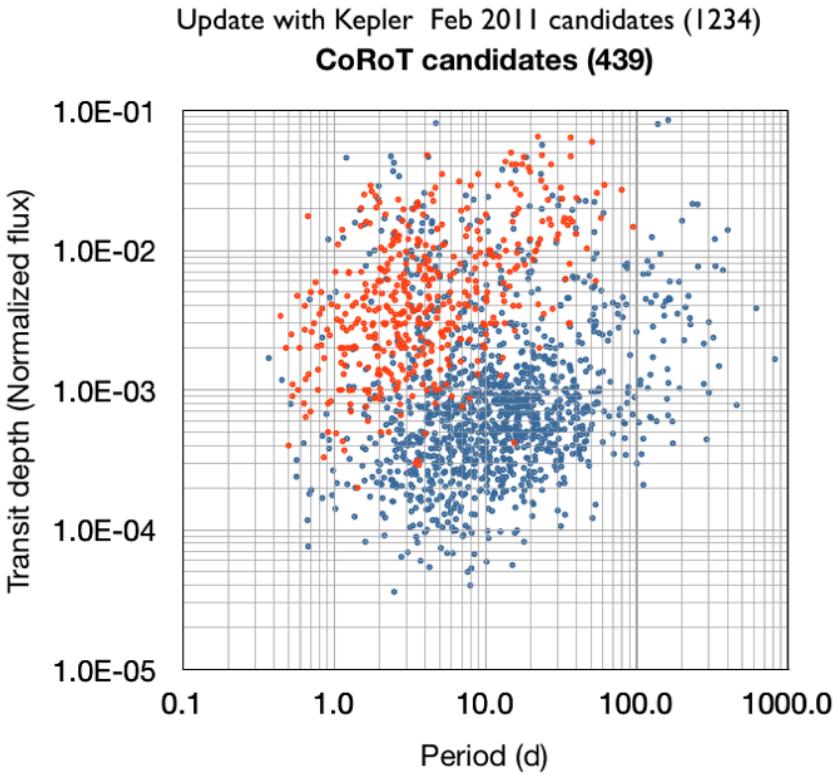


CoRoT & Kepler

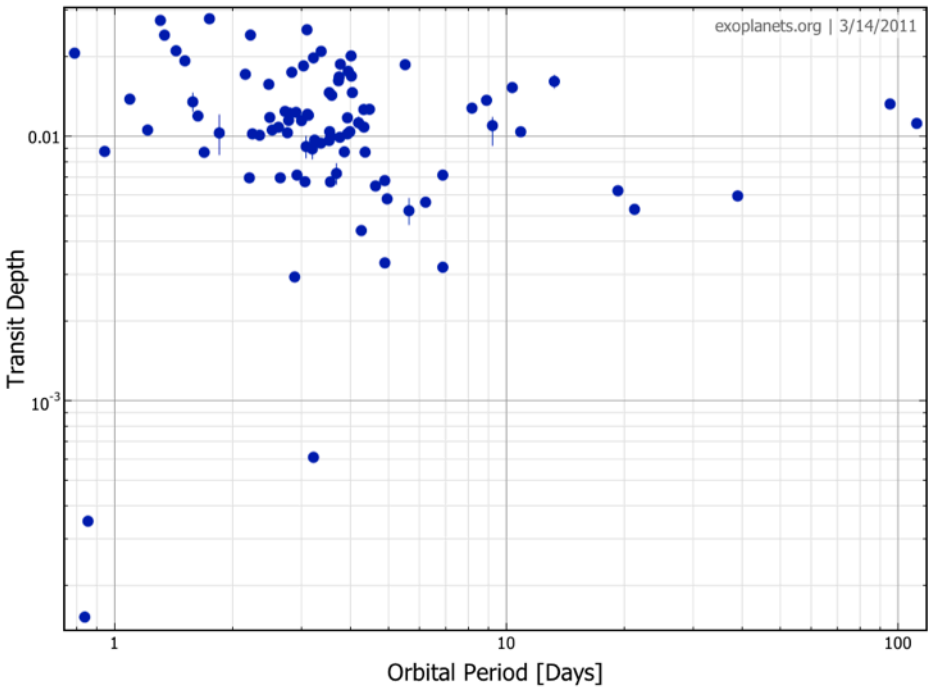


Plot by R. Alonso

CoRoT & Kepler vs. others



Confirmed transiting planets



Program: Monday (PHC)

0945-1000: Welcome
1000-1015: Aims of the workshop [Tristan Guillot]
1020-1050: Presentation of the 2010 winterover [Karim Agabi]
1050-1110: The 2010-2011 Summer campaign [Jean-Pierre Rivet]
1110-1140: News from Concordia [on the phone with Djamel Mékarnia & Eric Artistidi]
1140-1200: The ASTEP 400 observations [Tristan Guillot]

Lunch

1400-1430: Summary of the ASTEP South 2008-2010 campaigns [Nicolas Crouzet]
1430-1500: BEST II observations [Anders Erikson]
1500-1530: The WASP-19 (& 18) observations [Lyu Abe]
1530-1600: WASP-18 & 19 & the photometric quality of ASTEP 400 data [by skype: Aude Alapini Odunlade & Frederic Pont]
Break
1630-1700: The microlensing ASTEP observations [by skype: Jean-Philippe Beaulieu]
1700-1730: ASTEP exoplanet mining: field selection & the 2010 observations [Mauro Barbieri]
1730-1800: Preparing the ASTEP 400 observation season [discussion, conducted by Tristan Guillot]

Program: Tuesday (Fizeau+4)

0900-0915: Welcome
0915-0940: Data storage, access, CPUs, disks... [Yan Fantei]
0940-1010: The ASTEP South automatic analysis & pipeline [Nicolas Crouzet]
1010-1040: The ASTEP 400 data pipeline [Lyu Abe]
Break
1100-1130: The DLR data pipeline [Thomas Fruth]
1130-1150: The PLANET pipeline & the analysis of the ASTEP 400 microlensing observations [Christian Coutures]
1150-1210: TFA: the Trend Filtering Algorithm & its application to ASTEP South data [Judit Szulagyi]

Lunch

1400-1530: Planned papers/work [discussion chaired by Tristan Guillot]
1530-1600: Follow-up observations [discussion chaired by Mauro Barbieri]
Break
1630-1700: Archiving/working on the data [discussion chaired by Lyu Abe]


ASTEP
The ASTEP 400 observations


First light: 25/3/2010

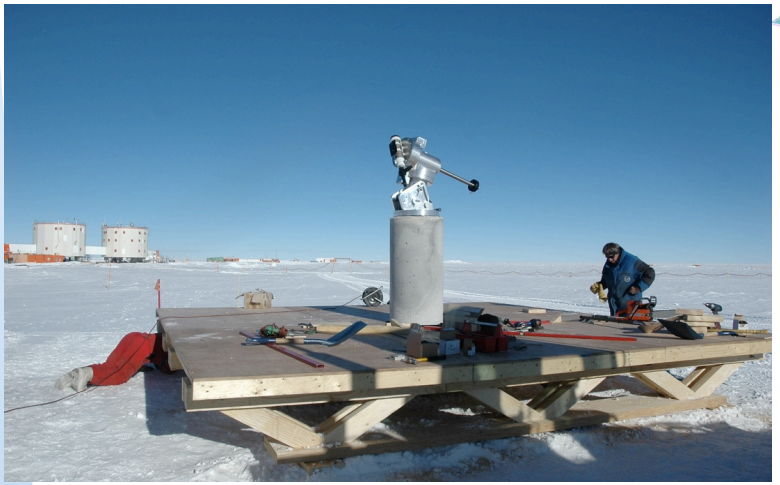

ASTEP

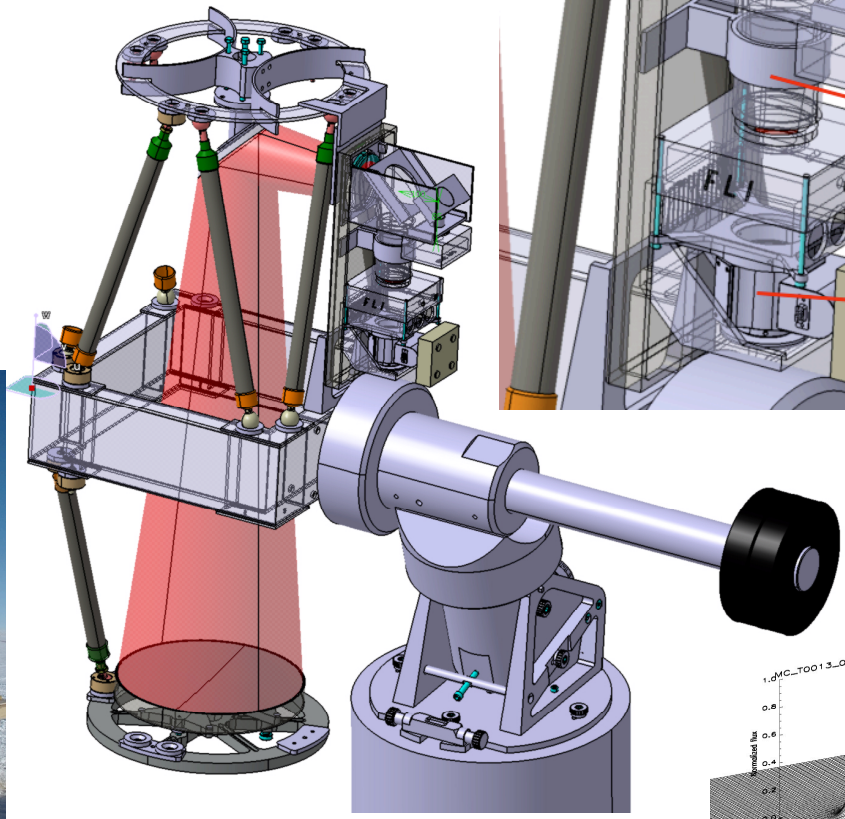
The ASTEP 400 observations

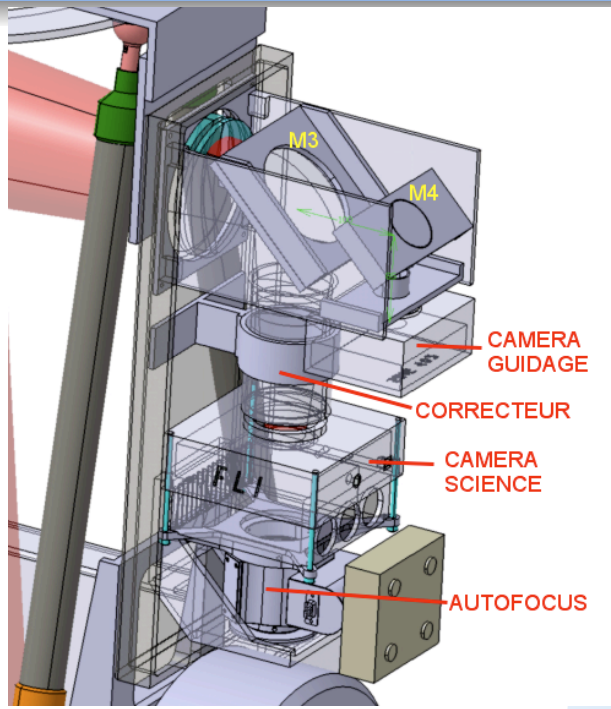
- 5 fields to mine for transiting exoplanets
- WASP-19 & WASP-18: looking for secondary transits
- microlensing alerts
- a star with a known planet
- M-dwarfs (looking for super-Earths)
- tests of turbulence with mirror heating

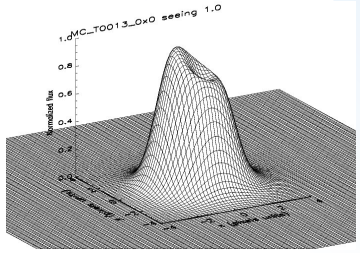
ASTEP 400

- Newton de 40cm
- CCD: 4k x 4k
- Miroir M1 en zerodur
- Correcteur de Wyne optimisé
- Autofocus pour compensation des écarts de températures
- Caméra de guidage
- Monture Astrophysics
- Dome type “pétales”



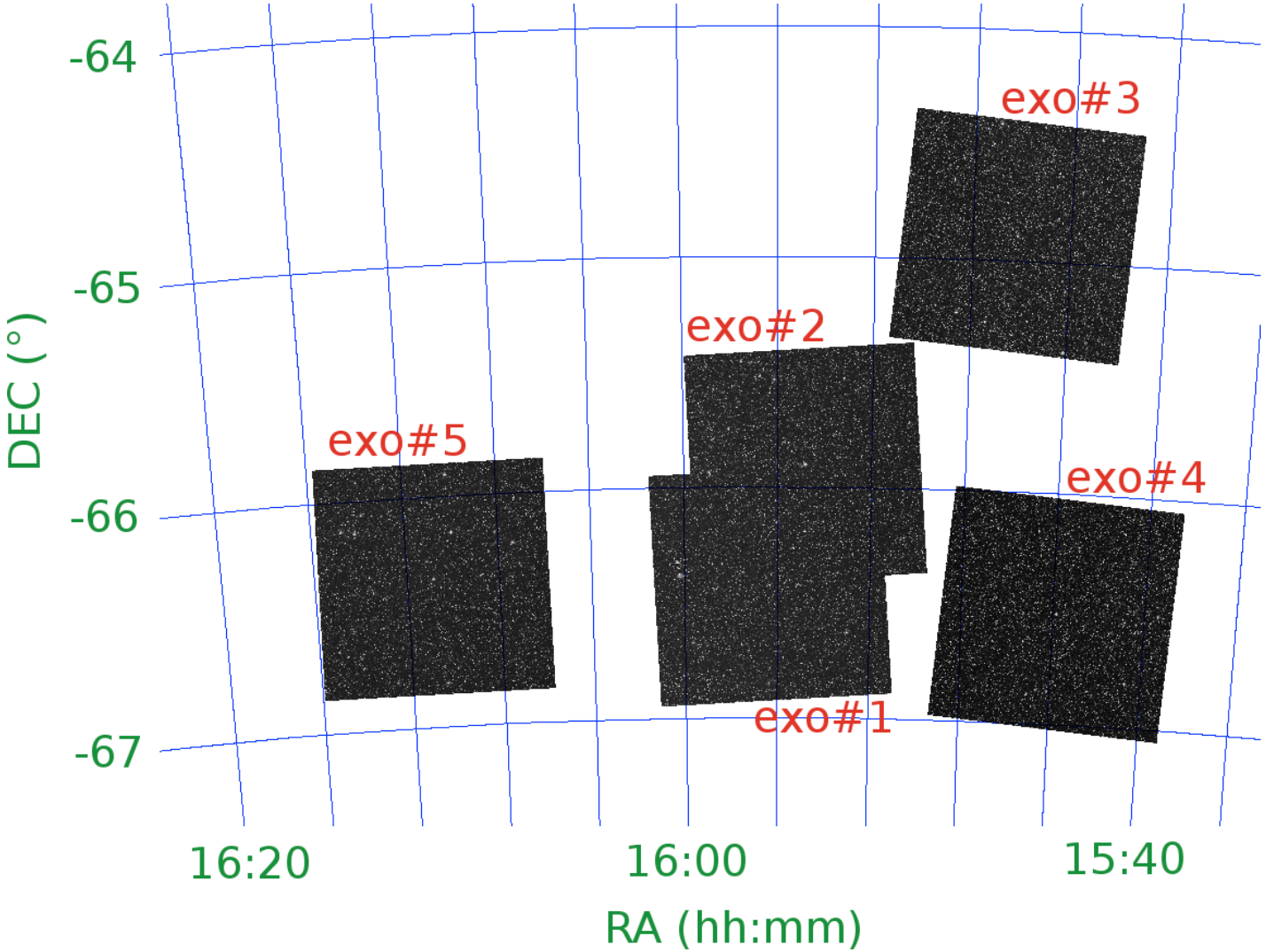




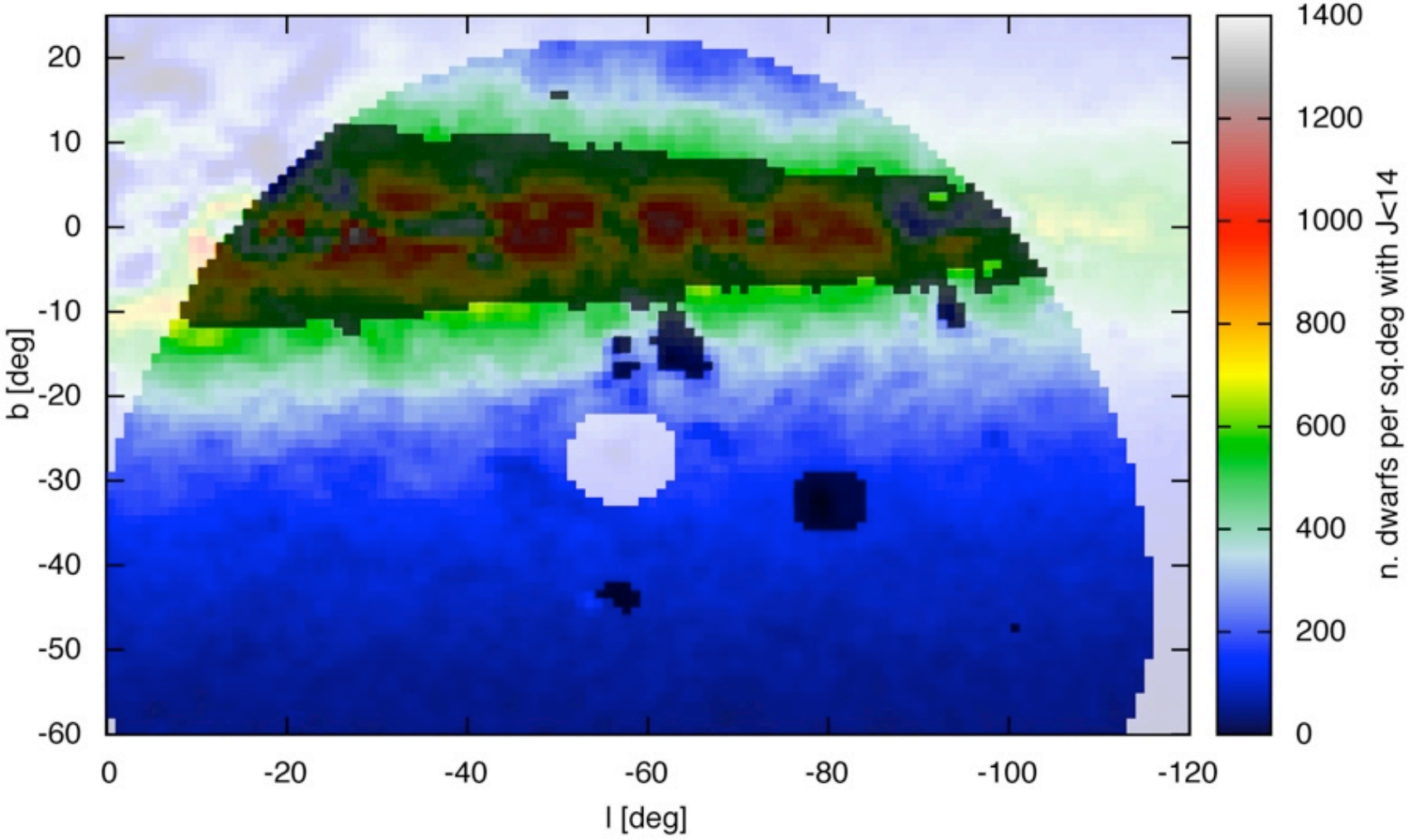


Mining for exoplanets

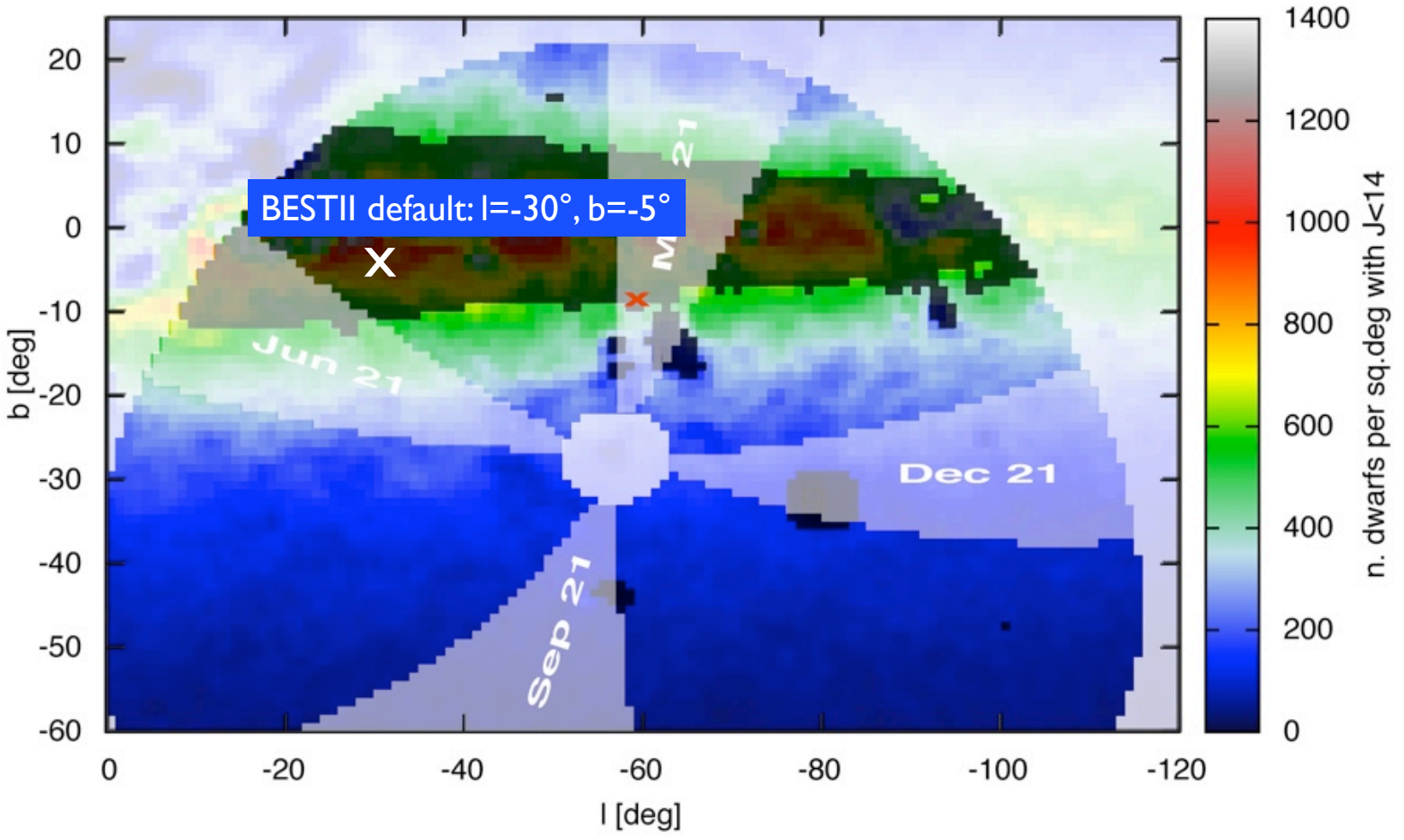
Mining for exoplanets



Search for transiting planets in (N) stellar dense fields



Search for transiting planets in (N) stellar dense fields



Looking for phase curves & secondary transits

WASP-18b and 19b

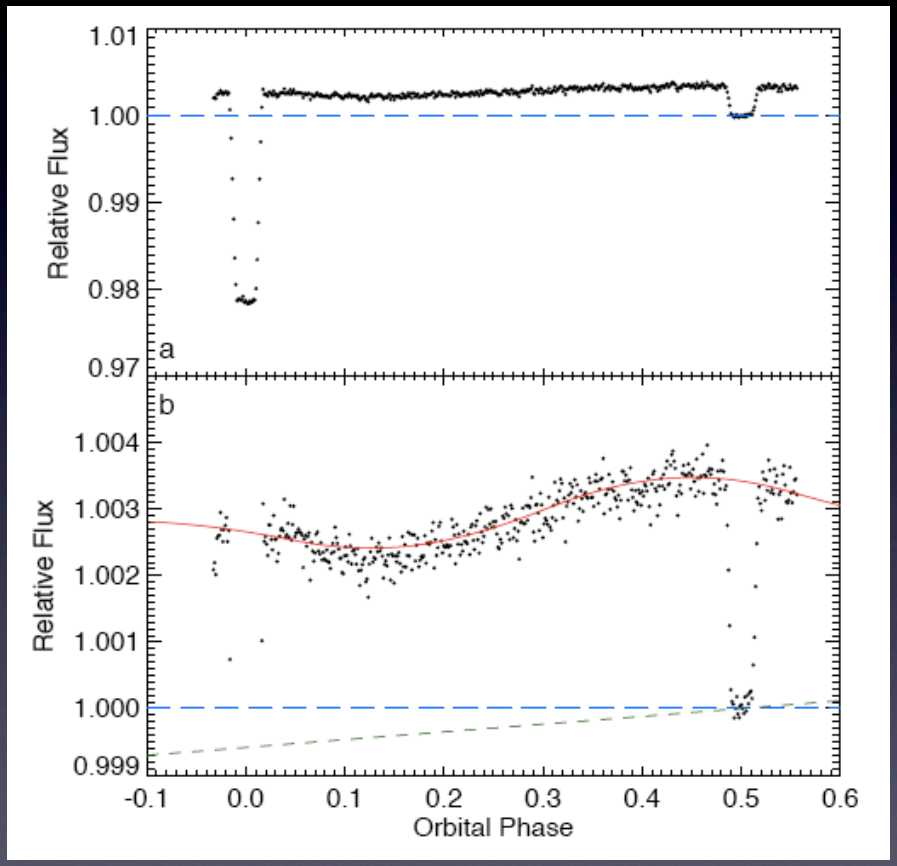
Name	WASP-18	
Distance	100 (± 10) *pc*	ref.
Spectral Type	F6	
Apparent Magnitude V	9.3	
Mass	1.24 (± 0.04) M_{sun}	ref.
Age	0.63 ($_{-0.53}^{+0.95}$) *Gyr*	ref.
Effective Temperature	6400 (± 100) *K*	ref.
Radius	1.23 (± 0.045) R_{sun}	ref.
Metallicity [Fe/H]	0 (± 0.09)	ref.
Right Asc. Coord.	01 37 25	
Decl. Coord.	-45 40 40	

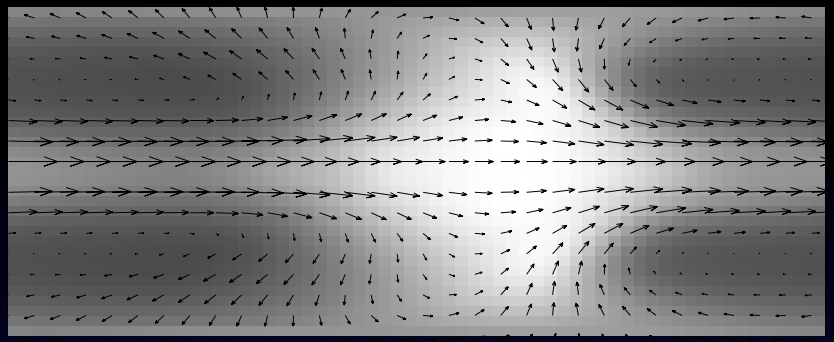
Name	WASP-18 b	
Discovered in	2009	
Mass	10.43 (± 0.4) M_J	ref.
Semi major axis	0.02047 (± 0.00038) *AU*	ref.
Orbital period	0.9414518 (± 4e-07) *days*	ref.
Eccentricity	0.0088 (± 0.0012)	ref.
ω	-91 (± 3) *deg.*	ref.
Radius	1.165 (± 0.077) R_J	ref.
$T_{transit}$	2454221.48163 (± 0.00038)	ref.
Inclination	86 (± 2.5) *deg.*	ref.
λ	4 (± 5) *deg.*	ref.
Update	29/11/10	

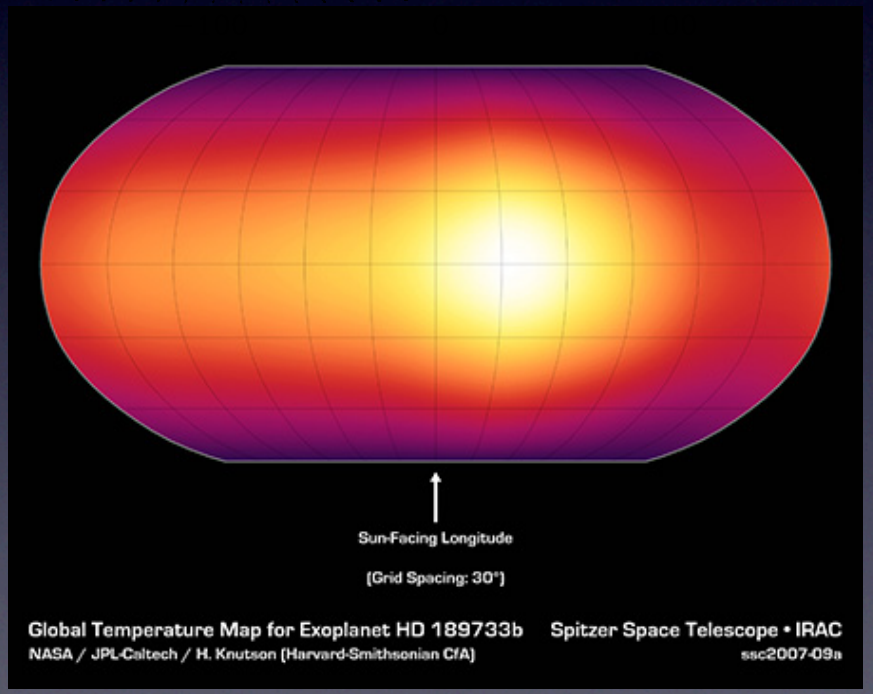
Name	WASP-19	
Distance	-	ref.
Spectral Type	G8V	
Apparent Magnitude V	12.3	
Mass	0.97 (± 0.02) M_{sun}	ref.
Age	0.6 *Gyr*	ref.
Effective Temperature	5500 (± 100) *K*	ref.
Radius	0.99 (± 0.02) R_{sun}	ref.
Metallicity [Fe/H]	0.02 (± 0.09)	ref.
Right Asc. Coord.	09 53 40	
Decl. Coord.	-45 39 33	

Name	WASP-19 b	
Discovered in	2009	
Mass	1.168 (± 0.023) M_J	ref.
Semi major axis	0.01655 (± 0.00013) *AU*	ref.
Orbital period	0.78884 (± 3e-07) *days*	ref.
Eccentricity	0.0046 ($_{-0.0044}^{+0.0028}$)	ref.
ω	3 (± 70) *deg.*	ref.
Radius	1.386 (± 0.032) R_J	ref.
$T_{transit}$	2455168.96801 (± 9e-05)	ref.
$T_{sec-transit}$	2454777.31281 (± 0.00014)	ref.
Inclination	79.4 (± 0.4) *deg.*	ref.
λ	4.6 (± 5.2) *deg.*	ref.
Update	18/01/11	

Phase curves



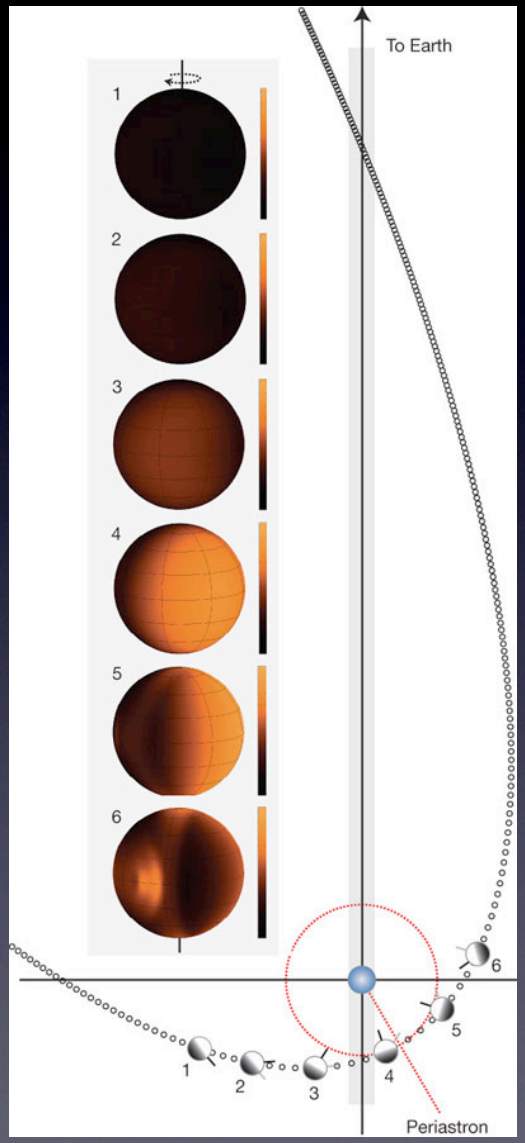


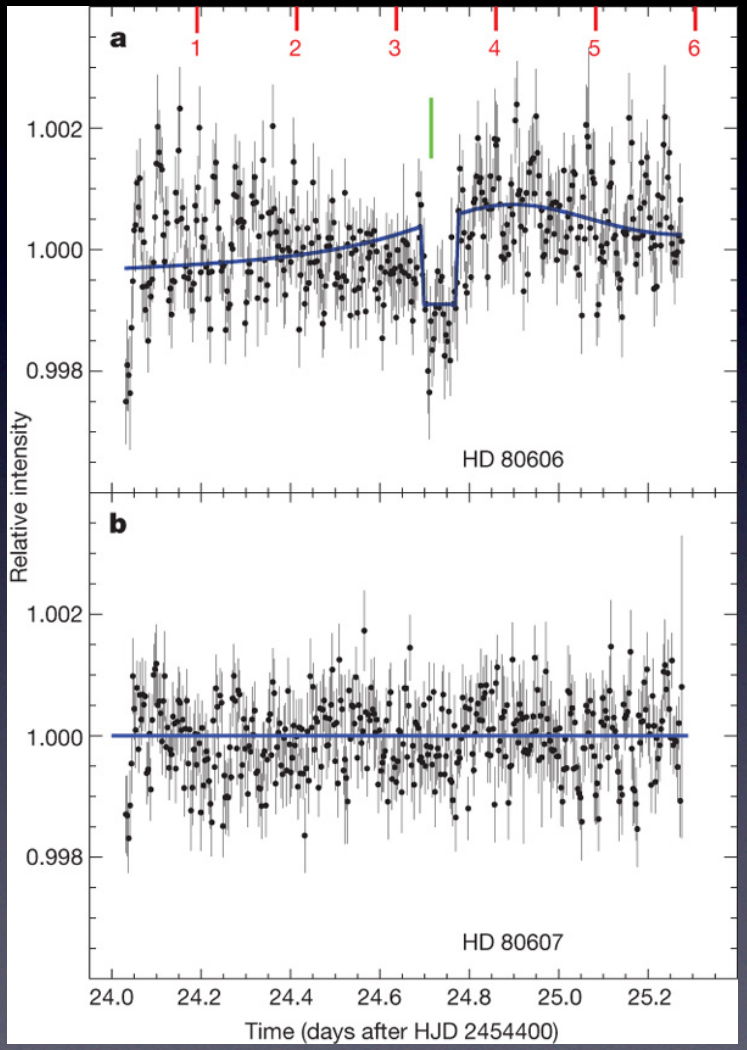


HD189733 with Spitzer

Knutson et al. 2007

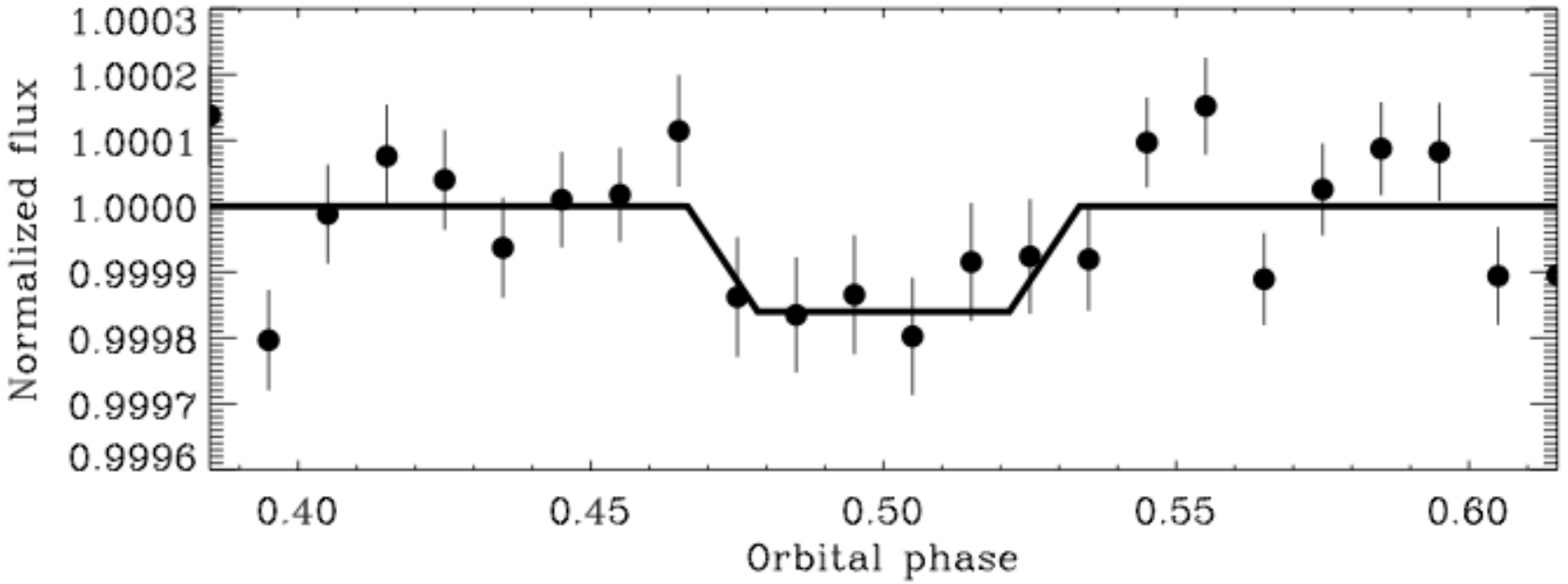
HD 80606 (Spitzer)





Laughlin et al. 2009

Phase curves



CoRoT-1b

Alonso et al. 2009
voir aussi Snellen et al. 2009

Phase curves

In the optical domain, such a detection is extremely challenging because of the faintness of the signal, of order 10^{-4} (100 ppm) in the most favorable cases and was achieved in only a few cases. Sing & López-Morales (2009) detected the secondary transit of OGLE-TR-56b in the z'-band, a case for which the planet is so hot that thermal emission from the planet contributes to the 363 ± 91 ppm signal. Using CoRoT data, Snellen et al. (2009) identified the changing phases of the planet CoRoT-1b (with an amplitude $\sim$ 130 ppm) and its secondary transit was independently measured by Alonso et al. (2009b). Secondary transits of CoRoT-2b (a 60 ± 20 ppm signal) were detected by Alonso et al. (2009a). With Kepler data, Borucki et al. (2009) measured the secondary eclipse of HAT-P-7b (130 ± 11 ppm). With HD 46375 we have the opportunity of detecting planetary phase changes of a non transiting exoplanet. Such a detection was achieved in the infrared with the Spitzer Space Telescope for υ And (Harrington et al. 2006) (amplitude $\sim$ 2900 ppm) but it would be the first time for optical wavelengths.

Phase curves

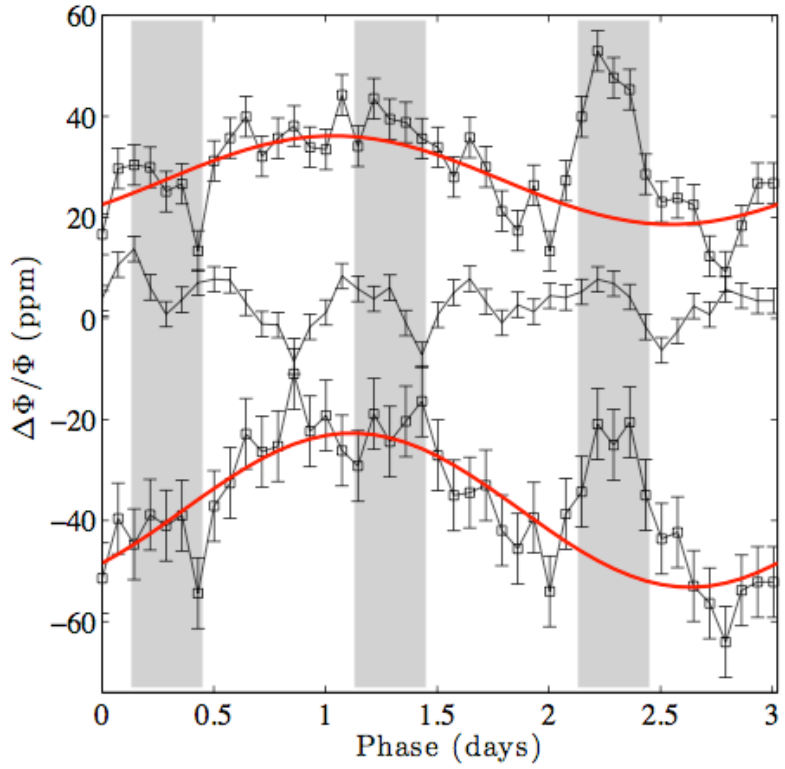
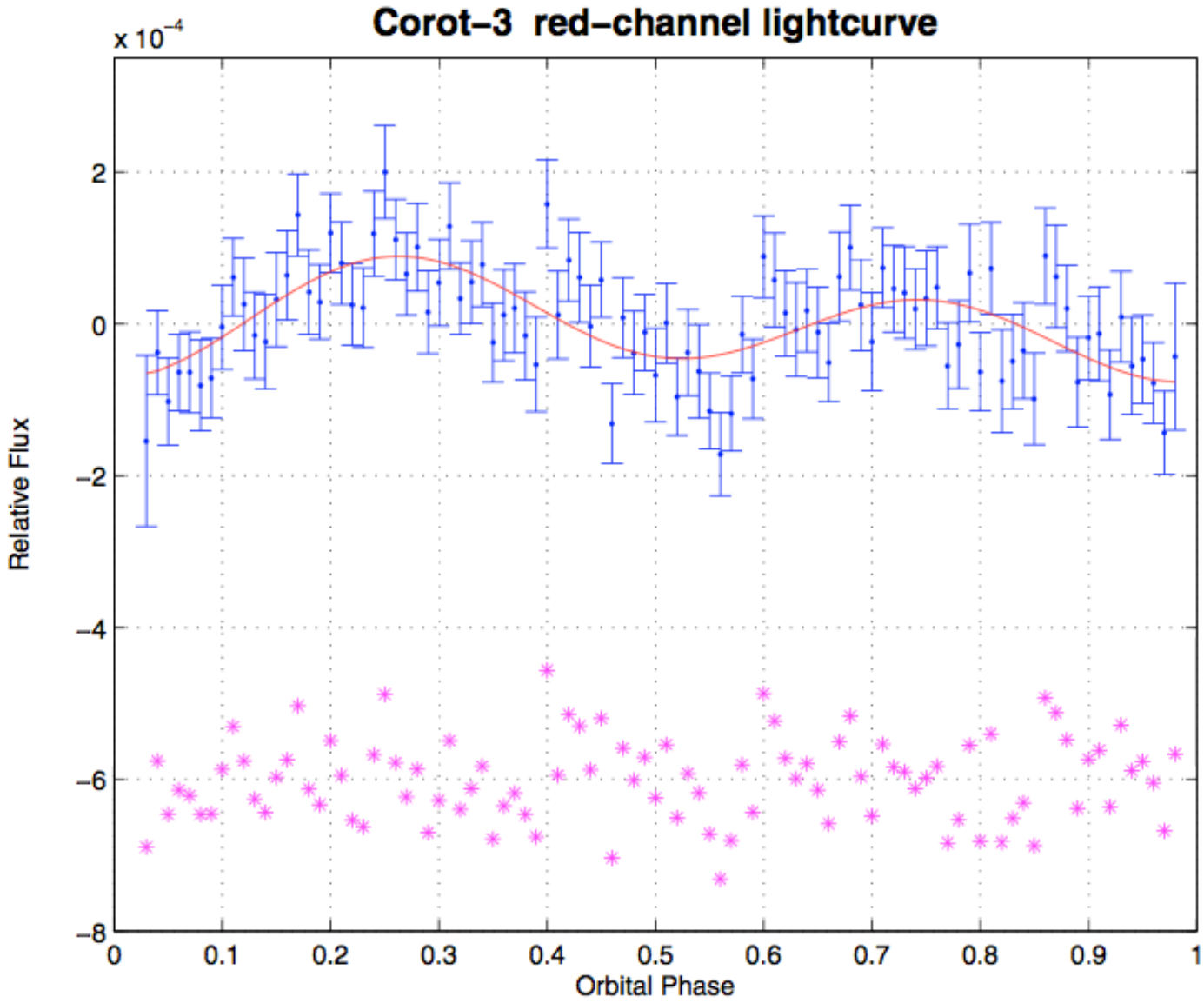


Fig. 4. Top: folding of HD 46375 time series over the planetary period. Middle: folding of HD 46179 over the same `period`. Bottom: folding of the time series made of the difference between HD 46375 and HD 46179 light-curves. The red sine curves indicate the data fitting by excluding the regions indicated in Fig. 3 .

Gaulme et al., A&A (2010)

Tidal & beaming effects

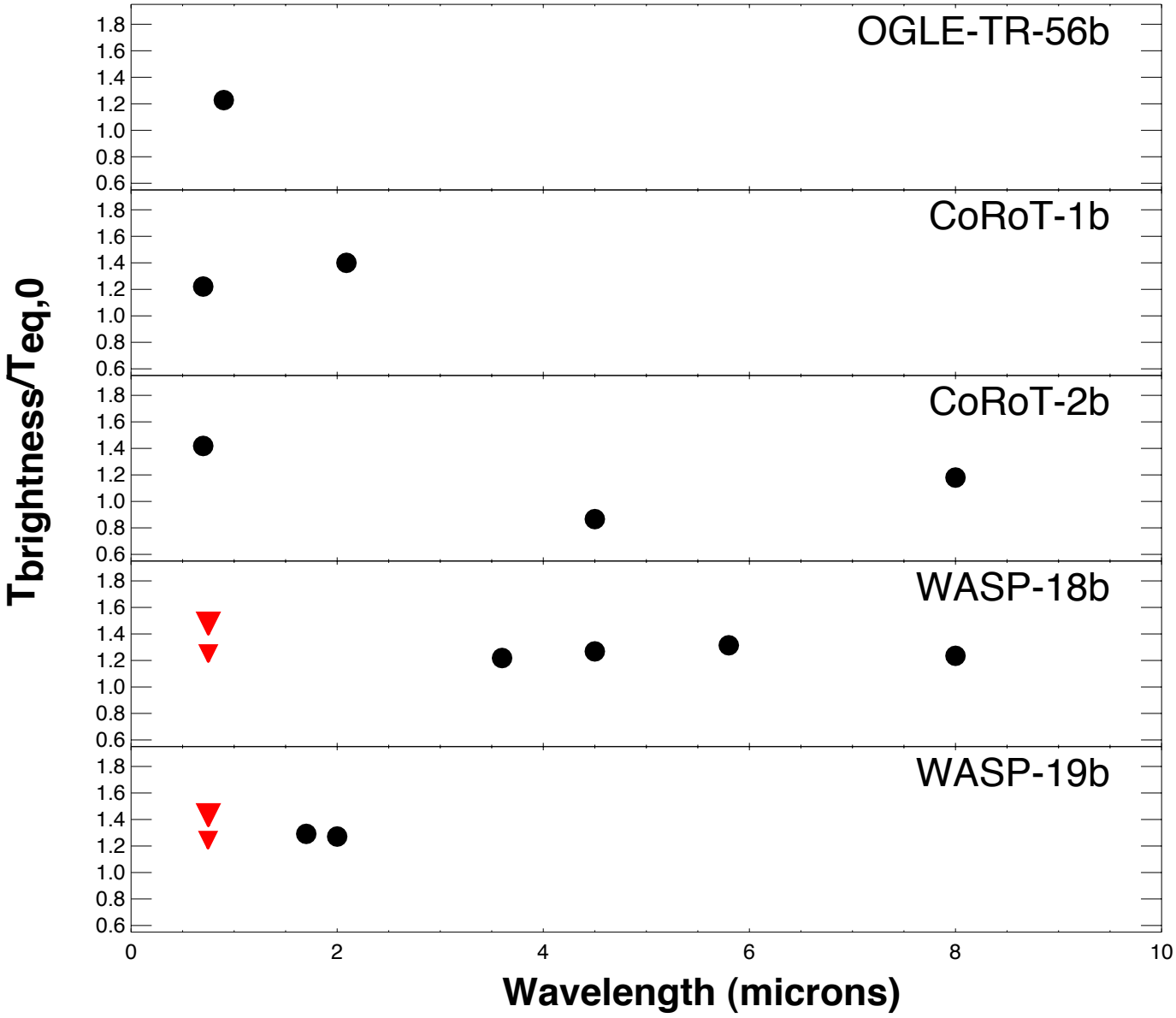


Mazeh & Faigler (2010)

Magnitude of the effects

	WASP-18	WASP-19
Reflected light:		
1.2 Teq	145 ppm	126 ppm
1.5 Teq	645 ppm	720 ppm
Tidal effect	~200ppm?	~20ppm?
Beaming effect	~100ppm?	~10ppm?

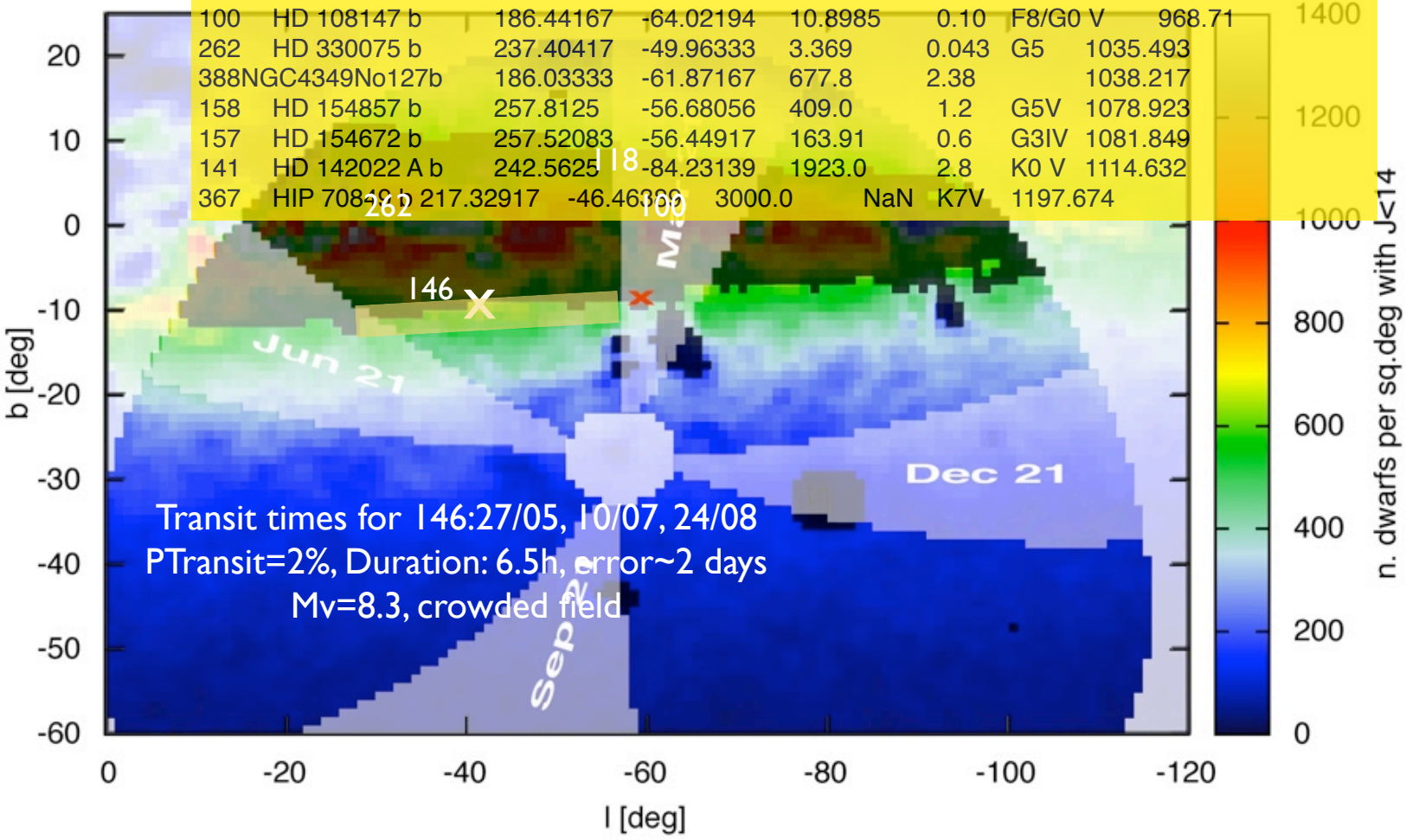
Preliminary results



Looking for primary transits of known RV planets

Search for transiting planets in (N) stellar dense fields

129	HD 129445 b	221.5125	-68.7625	1840.0	2.9	G8V	184.187
131	HD 131664 b	225.025	-73.53528	1951.0	3.17	G3V	452.117
142	HD 142415 b	239.41667	-60.2	386.3	1.05	G1 V	521.507
146	HD 147018 b	245.75	-61.68889	44.236	0.24	G9V	602.952
147	HD 147018 c	245.75	-61.68889	1008.0	1.92	G9V	602.952
118	HD 121504 b	209.32083	-56.0463.33	0.33	G2 V	747.163	
105	HD 111232 b	192.2125	-68.425	1143.0	1.97	G8V	766.024
100	HD 108147 b	186.44167	-64.02194	10.8985	0.10	F8/G0 V	968.71
262	HD 330075 b	237.40417	-49.96333	3.369	0.043	G5	1035.493
388	NGC4349No127b	186.03333	-61.87167	677.8	2.38		1038.217
158	HD 154857 b	257.8125	-56.68056	409.0	1.2	G5V	1078.923
157	HD 154672 b	257.52083	-56.44917	163.91	0.6	G3IV	1081.849
141	HD 142022 A b	242.5625	-84.23139	1923.0	2.8	K0 V	1114.632
367	HIP 70849 b	217.32917	-46.46389	3000.0	NaN	K7V	1197.674



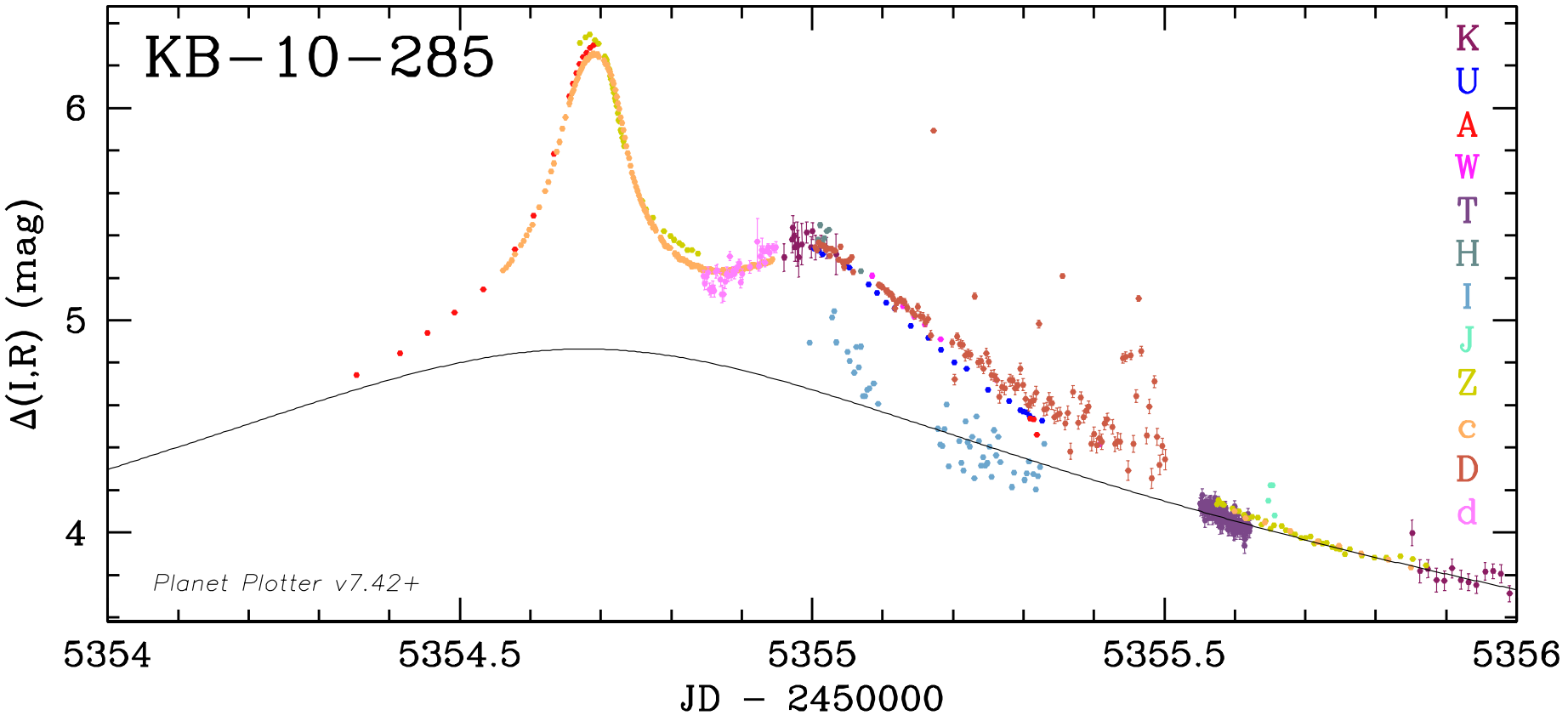
Microlensing

Microlensing alerts

- Microlensing events of high magnification are very interesting to observe with ASTEP for several reasons:
  - (1) the alerts (from OGLE & MOA mostly) near the Galactic bulge can be followed almost continuously from Concordia,
  - (2) a continuous coverage (to be complemented by other telescopes) is essential for the detection of small, Earth-mass planets, and with high-magnification events the detection probability becomes large (very dependent on planetary mass and orbital distance, but it can be close to 100% even down at Earth-masses for some really large magnification event),
  - (3) it is relatively easy to implement (no follow-up programme) and the data can be processed directly on-site.

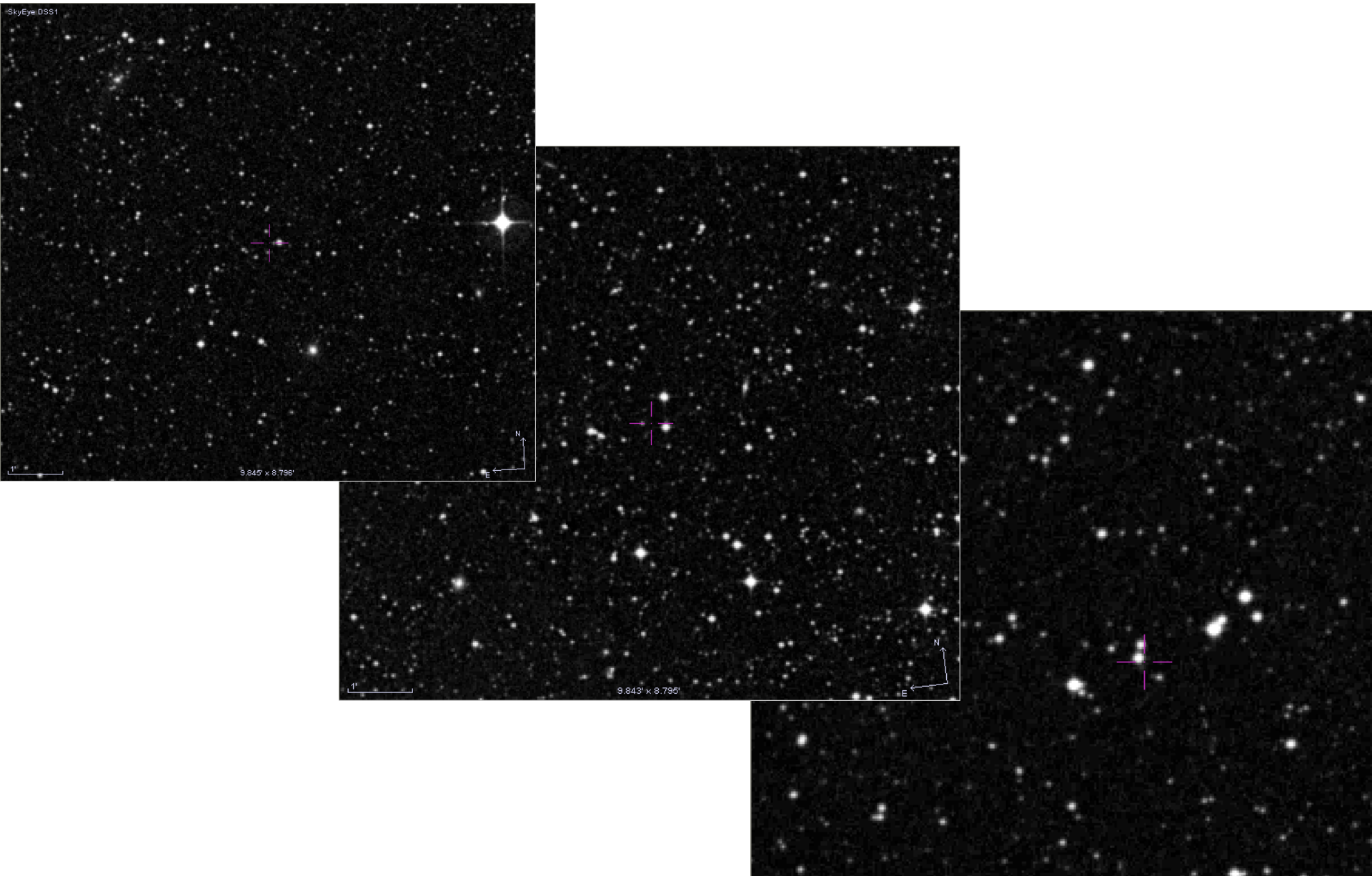
- I therefore propose that up to 20-30% of the ASTEP 400 observation time be dedicated to the follow-up of these alerts, as part of the PLANET program. We are expecting about 10 very high-amplifications events/year with about a 1/3rd probability of detecting Earth-like planets.

Microlentilles



M-dwarfs

M-dwarfs



M-dwarfs

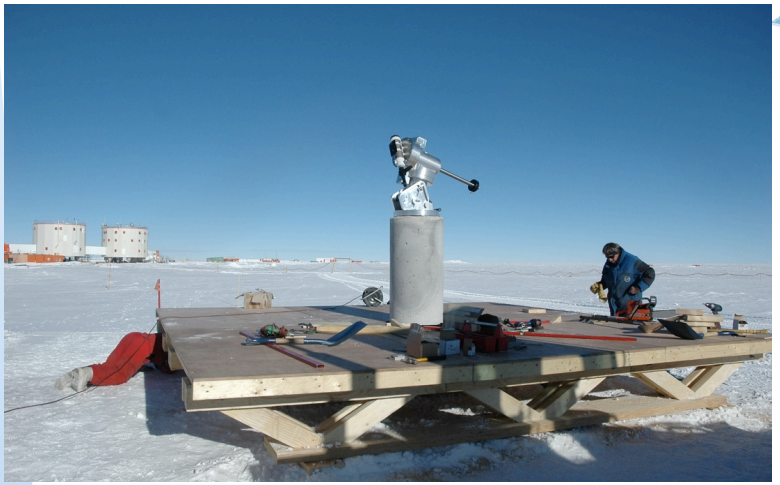
Fressin's Dwarf stars database (2010-08-06)														
Name	α (ICRS)			δ (ICRS)			Δα.cosδ (mas/yr)	Δδ (mas/yr)	Vrad (km/s)	Parallaxe (mas)	MagJ	MagK	MagR	Identifier
Naine 1	01	18	29,911	-75	04	54,325	446	81	0	0	10,846	10,021	14,200	2MASS J01182974-7504544
Naine 2	01	31	45,717	-73	19	34,302	527	188	0	0	10,210	9,45	14,710	LHS 1259
Naine 3	02	10	45,139	-66	22	26,594	0	0	0	0	10,970	10,09	14,89	2MASS J02104520-6622262
Naine 4	05	53	26,434	-71	33	50,220	0	0	0	0	10,35	9,36	15,03	2MASS J05532643-7133502
Naine 5	06	30	46,619	-76	43	09,450	-27	482	0	0	8,89	7,92	13,76	2MASS J06304661-7643094
Naine 6	07	02	50,347	-61	02	47,638	516	590	0	0	10,36	9,52	15,420	2MASS J07025026-6102482
Naine 7	09	44	23,734	-73	58	38,291	-510	-119	0	0	10,23	9,38	14,5	WT 244
Naine 8	11	44	13,198	-65	16	06,881					9,02	8,18	13,21	?
Naine 9	12	28	14,340	-62	06	43,650					10,45	9,58	13,65	?
Naine 10	13	25	00,298	-61	08	10,403					5,96	4,59	10,1	?
Naine 11	18	55	47,878	-69	14	15,065	0	0	0	0	10,47	9,51	15,43	2MASS J18554792-6914153
Naine 12	22	41	58,150	-69	10	08,900	334	-738	0	0	10,05	9,15	15,7	2MASS J22415815-6910089

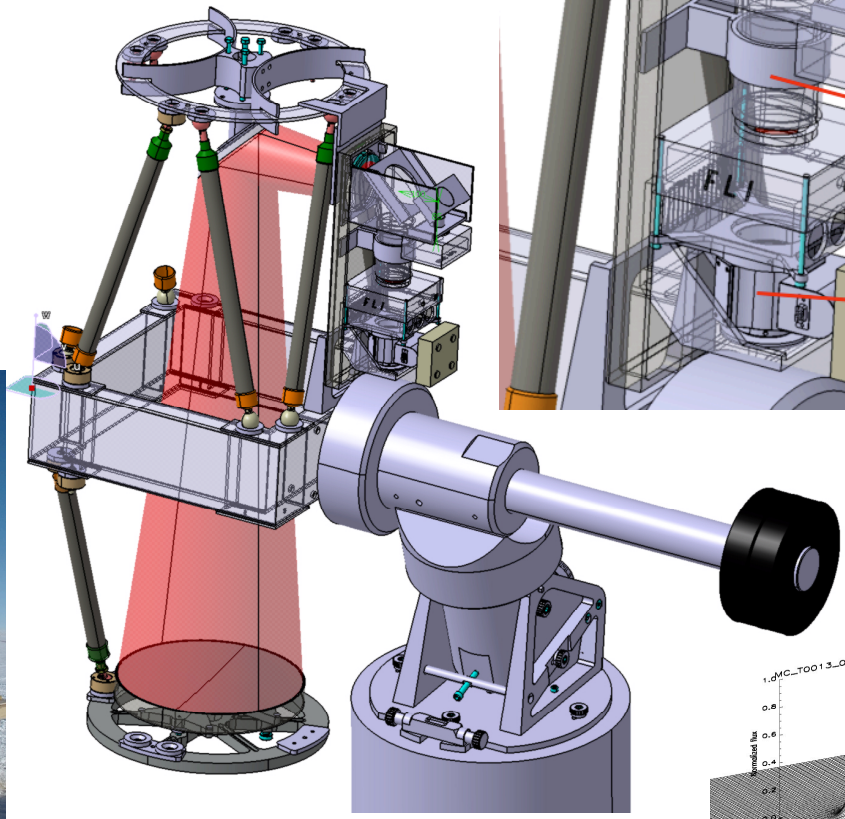
#1, 2, 8 &10 were observed for a couple of days in 2010.

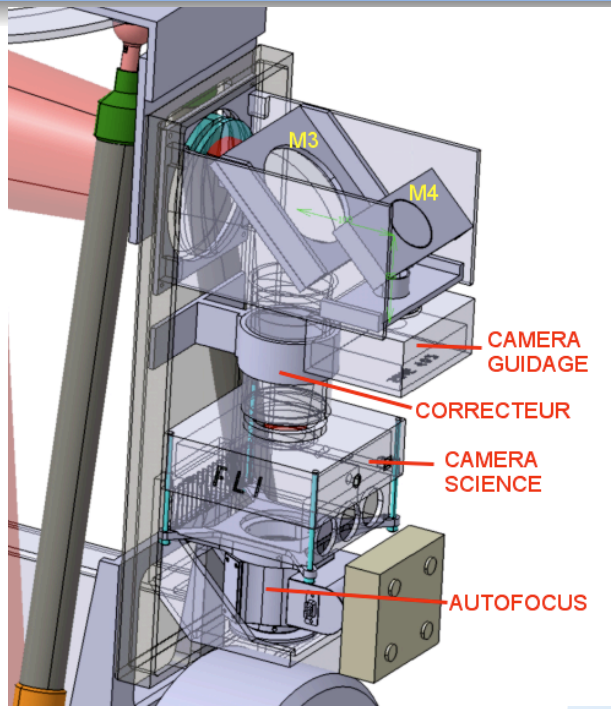
Testing the influence of mirror-heating

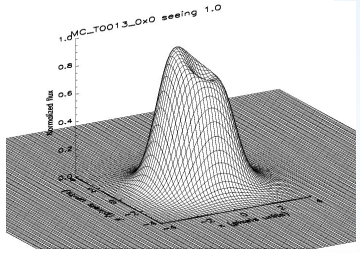
ASTEP 400

- Newton de 40cm
- CCD: 4k x 4k
- Miroir M1 en zerodur
- Correcteur de Wyne optimisé
- Autofocus pour compensation des écarts de températures
- Caméra de guidage
- Monture Astrophysics
- Dome type “pétales”









Le problème de la turbulence

This section describes the qualitative effects of flow patterns on optical beams and a first-cut method of relating flow patterns to seeing. The analysis is drawn mainly from Gilbert et al..[5] Density fluctuations affect optical beams in different ways, depending upon the scale size of the turbulence and the turbulent layer thickness. The general pattern is a composite of broad scatter (small scales), image centroid shift, or jitter (large scales), and beam spread (intermediate scales). Fast tip/tilt correction can remove the jitter produced by large scale turbulence. Small-scale turbulence in thin layers does not change the system resolution, but reduces the Strehl ratio. This may be tolerable, and in some cases not even noticeable.[9]

The wave front variance, σ, may be estimated using

$$\sigma^2 = 2G^2 \int_0^L \langle \rho'^2 \rangle l_z dz \tag{4}$$

where G is the Gladstone-Dale parameter ($= 0.22\text{cm}^3/\text{g}$ over visible wavelengths),[10] ρ' is the fluctuating density, l_z is the correlation length along the optical axis, and L is the total path length through the disturbance. Aberrations may be classified as weak or strong, depending upon the magnitude of σ. The quantity $\langle \rho'^2 \rangle$ is the strength of the turbulence. The wave front variance scales with the square root of the product of the layer thickness and the turbulence correlation length.

A typical seeing estimation goes as follows: flow parameters L, l_z, and ρ' are estimated using a variety of methods. The wavefront variance σ can then be estimated using eq. (4). The magnitude of σ determines whether a strong or a weak aberration calculation should be used, and finally the blur angle θ is calculated using the following:

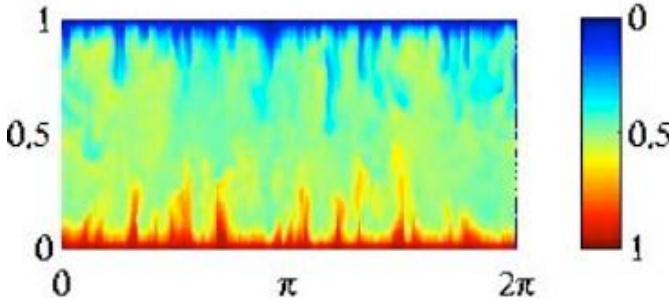
$$\theta = \begin{cases} 2.4\frac{\lambda}{D}\sqrt{\mathrm{e}^{(k\sigma)^2} - 1} & \sigma < \frac{\lambda}{\pi} \quad \text{(weak)} \\ 4\frac{\sigma}{l_z}\sqrt{-\ln(1-p)} & \sigma \gg \frac{\lambda}{\pi} \quad \text{(strong)} \end{cases} \tag{5}$$

Here, D is the primary mirror diameter, k is the wavenumber, and λ is the wavelength. p is the fraction of encircled energy of the desired result. This approach uses only the layer thickness along the optical axis to estimate seeing degradation.

Le problème de la turbulence

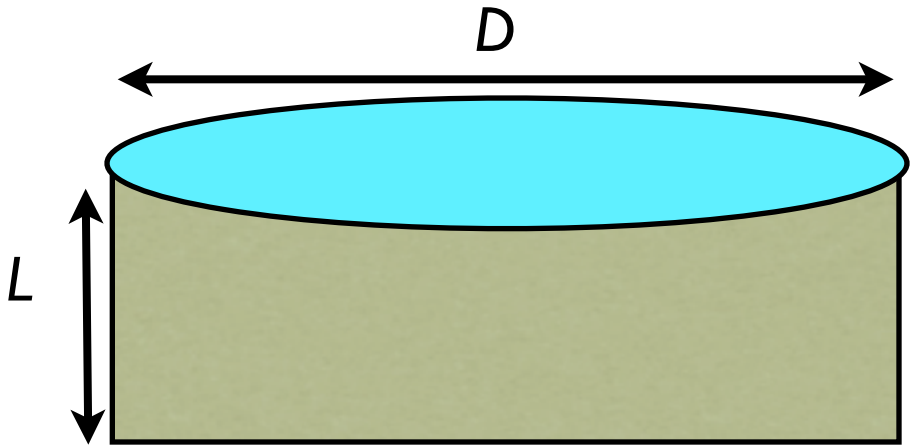
En turbulence forte (mais ~isotrope, de la taille du miroir):

$$\theta_{50\%} \approx 1.26\left(\frac{\Delta T_{cell}}{1K}\right) \text{arcsec}$$

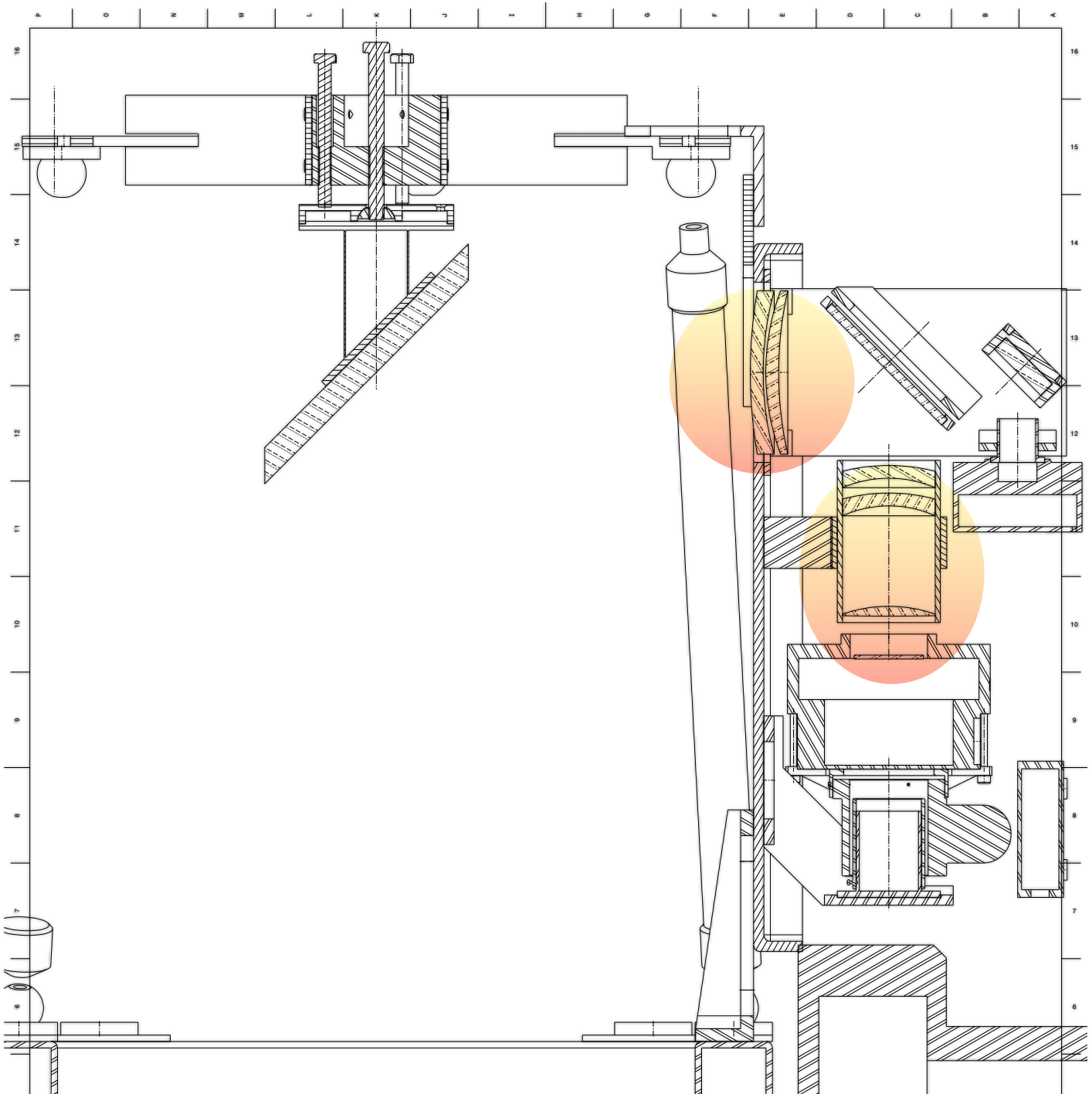


En turbulence faible (utilisant k=π/λ):

$\theta = 1.9\ \alpha(\Delta T/1K)\ (L/D)$ arcsec



α: rapport entre fluctuations de température turbulente et ΔT
0.1 ??????




ASTEP
ASTEP 400: The 2011 observations

The ASTEP 400 program (TBC)

- Mining for transiting exoplanets
- WASP-19 & WASP-18: looking for secondary transits
- microlensing alerts
- stars with a known RV planet
- M-dwarfs (looking for super-Earths)
- tests of turbulence with mirror heating

- Planets around white dwarfs?
- Planets around young stars?