Time Allocation Committee for
MPG time at the ESO 2.2m-telescope
c/o MPI für Astronomie
Königstuhl 17
D-69117 Heidelberg / Germany

Application No.	
Observing period	P109
Received	

APPLICATION FOR OBSERVING TIME

from [X] MPIA [ ] MPG institute [ ] other

1. Telescope: 2.2-m [X] 0108.A-9003(A) [L]

2.1 Applicant

Dr Melissa J. **Hobson**	MPIA
Name	Institute
Königstuhl 17	69117 Heidelberg
street	ZIP code - city
mjhobson	melihobson@gmail.com
ESO User Portal username	e-mail

2.2 Collaborators

Henning[1], Trifonov[1], Eberhardt[1] Schlecker[1],	[1]MPIA
name(s)	institute(s)
Espinoza[2], Brahm[3], Jordán[3], Tala[3]	[2]STScI, [3]UAI
name(s)	institute(s)

2.3 Observers

T. Trifonov	M. Hobson
name	name

By specifying the names under item 2.3 it is obligatory to also send out these observers to La Silla, if required. Correspondence on the rating of this application will be sent to the applicant (P.I.) as quoted under 2.1 above.

3. Observing programme: Category: [E]

Title : **Warm gIaNts with tEss (WINE): planet validation with FEROS**

Abstract : The discovery and characterization of transiting giant planets ($R_P > 4\,R_\oplus$) orbiting bright stars is key for tackling at least two major challenges, namely (i) which properties govern the internal structural composition of giant planets, and (ii) how they can be found orbiting significantly inside the ice line. The *TESS* mission, already in operation, is expected to detect > 300 warm giant planets at periods of $10 - 300$ days orbiting stars brighter than $V = 13$ mag. Warm giants are ideal for tackling the challenges described. In the context of a collaboration including researchers from Chile we propose to use FEROS, complemented by a suite of other instruments in Chile, to lead the discovery and detailed characterization of warm giant planets and other interesting systems whose transits are uncovered by *TESS*.

4. Instrument: [ ] WFI [X] FEROS [ ] GROND

5. Brightness range of objects to be observed: from 9 to 14 V-mag

6. Number of hours:

applied for			already awarded	still needed
157			801	56
no restriction	grey	dark		

7. Optimum date range for the observations: .... 01.04.2022 – 30.09.2022
Usable range in local sideral time LST: .... 8:00h – 4:00h

Astrophysical context

The number of transiting exoplanets has increased steadily, thanks to dedicated ground and space based (e.g., HATNet [1], *Kepler*) transit surveys. The successfully working TESS mission [2] is expected to find ~4000 transiting planets around bright stars (V<13 mag) [3], thus doubling the number of known systems. Transiting exoplanets provide us with a unique opportunity to improve our knowledge of planetary formation, structure, and evolution. For example, combining the photometry-derived radius with the radial velocity (RV)-derived mass allows us to constrain planetary composition by comparing the parameters with those predicted by structure models (e.g. [4]).

Despite the large number of known transiting exoplanets, only 666 have masses and radii known to 20% precision [5]. Most are hot Jupiters (HJs, Fig. 1), which have periods < 10 days. Their cooler counterparts, warm Jupiters (WJs), defined as giant planets with periods 10−300 days, remain poorly characterised as many of them orbit faint stars, complicating RV follow-up. The existence of these close-in giant planets poses many challenges for planet formation models. It is thought that they formed beyond the ice line and migrated inwards through either *(i)* disk interactions [6], in which planets are kept on circular and aligned orbits, or *(ii)* interactions with a third body, resulting in eccentric and misaligned orbits. While the eccentricities and obliquities of HJs are strongly affected by tidal and/or magnetic interactions with the host star, for WJs these parameters contain reliable information about their formation and migration. Hence, a systematic detection of transiting WJs, and a detailed characterization of their orbital parameters, is crucial. Simulations of the expected TESS yield [3] predict >300 giant planets ($R_p > 4R_\oplus$) with P>10d orbiting bright stars (V<13) in the Southern hemisphere (see Fig. 2). This statistically significant sample of warm giant planets will allow for the first time to constrain long-standing challenges about their formation, evolution, and structure. Likewise, the ongoing extended TESS mission will increase the expected yield, e.g. by finding second transits for ~400 monotransiting planets from the primary mission ([7]).

Immediate aim

We propose to obtain precise RV measurements with FEROS of TESS candidates to perform for the first time a systematic characterization of the transiting WJ population. Our plan includes a wide range of facilities, but the project's scientific success heavily relies on FEROS time.

TESS's large pixel size makes it hard to identify the source producing the transits. We use FITO600, a 0.6 m telescope at El Sauce, and the LCOGT network with 1.0 m telescopes at Siding Springs and SAAO, to perform photometric follow-up observations to identify the star hosting the transit signal. GAIA DR2 is also used to exclude false-positive scenarios and improve stellar parameters. Likewise, we were granted 13 nights at NTT/Astralux Sur to identify close companions to TESS targets via lucky imaging, which we are currently analysing. In terms of spectroscopy follow-up, we have ~ 90 guaranteed nights per year with the FIDEOS spectrograph at the ESO 1.0 m telescope to monitor WJ candidates orbiting the brightest stars (V<10). We also submitted a 9n HARPS proposal to detect ~ 20 WJs with K<30 $\mathrm{m\,s^{-1}}$. In this proposal, we aim to use FEROS to detect ~80 WJs with amplitudes K>30 $\mathrm{m\,s^{-1}}$ orbiting moderately bright stars 11<V<13, and ~35 WJs with K<30 $\mathrm{m\,s^{-1}}$ orbiting stars with V<11. The full analysis of the systems (transits + RVs) will be MPIA-led using the `juliet` code, which was developed at MPIA ([8]) and focuses on disentangling stellar activity and planetary signals around active stars.

Previous work

Our team has published several TESS gas giant exoplanets ([9, 10, 11, 12, 13, 14]), even pushing the limits of FEROS to detect an ultra-short period planet ([15], see Fig. 3). We also have nine confirmed WJs in preparation (Brahm et al., Espinoza et al., Rojas et al., Eberhardt et al., all in prep) and many promising candidates needing RV follow-up observations. Our team is a dedicated partner in the HATS project, leading 1/3 of HATS papers ([16, 17, 18, 19, 20]) and participating in all other papers. We have also characterized several transiting exoplanets from the $K2$ mission ([21, 22, 23, 24]). Our team has the experience and the facilities needed to be a leading group on exoplanet characterization in the TESS era.

Layout of observations

We plan to obtain FEROS spectra in Object-Calibration mode, in order to trace the instrumental velocity drift through the night. Exposure times will be calculated via the FEROS exposure time calculator, taking into account the brightness of the stars to obtain a sufficient signal to noise ratio for precise RV measurements. Typical exposure times for a $V \sim 12$ mag star are of ~20 min. The reduction and analysis will be performed with the CERES pipeline ([25]) developed for the La Silla echelle spectrographs (FEROS, CORALIE, and HARPS), enabling to reach RV precision down to 5 $\mathrm{m\,s^{-1}}$ (see section 8e).

Strategic importance for MPIA

Building on the success of HATS, we established a new strategic collaboration for TESS follow-up observations, which will combine FEROS with other facilities. The search for WJs is an important goal for the PSF department with strong links to formation models, which will be investigated with our theory group.

8b. Figures and tables

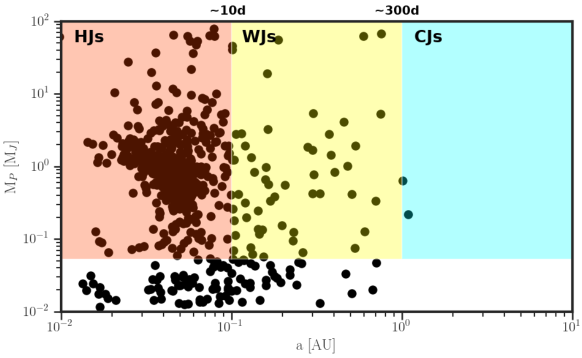

Figure 1: Distribution of transiting planets in the planet mass versus semi-major axis plane having masses and radii determined with a 20% precision or better, as listed in TEPCat [5]. The coloured regions represent the different insolation regimes (orange: hot Jupiters, yellow: warm Jupiters, blue: cold Jupiters). Warm Jupiters, which are key for constraining theories of the formation and orbital evolution of giant planets, have been sparsely detected.

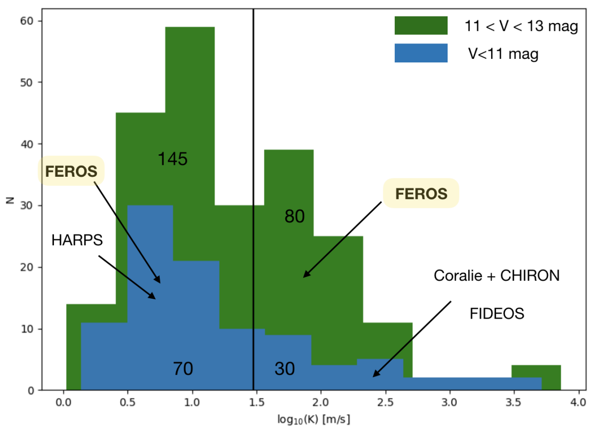

Figure 2: Predicted TESS yield of warm giant planets orbiting bright stars (P>10d, R_P >4 $R_\oplus$, V<13) according to [3]. The FEROS time of this proposal will be primarily used for characterizing the population of giant planets ($K > 30$ m s^{-1}) orbiting moderately bright stars (11<V mag<13), and super Neptune mass planets ($K < 30$ m s^{-1}) orbiting bright stars (V<11 mag).

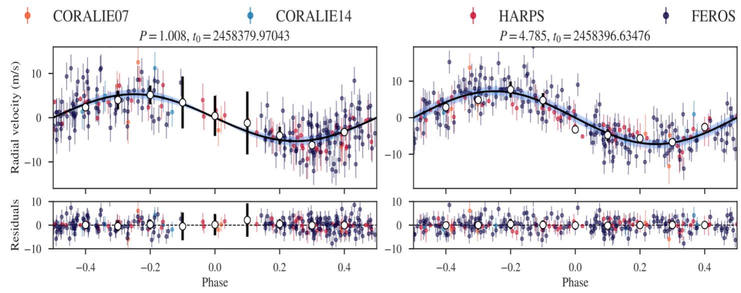

Figure 3: Phase folded radial velocities for the multi-planetary system HD213885 discovered by TESS and analysed using our in-house tool `Juliet`. Note the low-amplitude of the signals detected (5.3 ± 0.39 m s^{-1} and 7.26 ± 0.48 m s^{-1}) and the number of FEROS RV observations that were a key to characterize precisely this system.

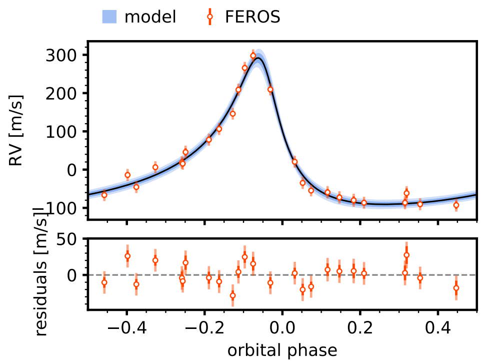

Figure 4: Phase folded FEROS RVs for TIC-237913194 b, a WJ with a period of 15.17d, on one of the most eccentric orbits of all known warm giants ($e = 0.575 \pm 0.011$). Figure from [12].

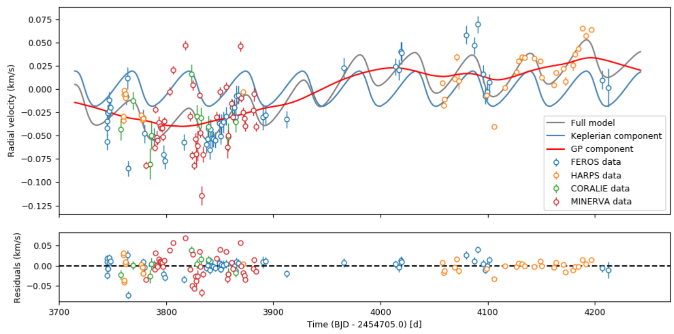

Figure 5: RVs for TOI-201, a WJ with period of 52.9781 d and $e = 0.23^{+0.08}_{-0.10}$, orbiting a young, active star. The long temporal baseline of the FEROS RVs was key to characterizing the stellar activity through a Gaussian process. Figure from [14].

Over the past 25 years, more than 4300 exoplanets were discovered mostly thanks to ground-based radial velocity surveys and the Kepler mission ([26]). The transit method is by far the most successful detection technique contributing to more than 3700 exoplanets. This large sample allows one to do statistical analysis, which was not previously possible. One major discovery is that even though HJs are easy to detect, they are very rare ([27]). These close-in giant planets still present a challenge for theorists, as their radii are larger than is predicted by standard thermal evolution models ([28]). WJs, on the other hand, generally have equilibrium temperatures of T_{eq} <1000 K, and their structures are not significantly affected by proximity effects. The detection and characterization of transiting WJs is crucial to calibrate theoretical structural models that can then be used on HJs to understand which variables are responsible for inflating their radii. Therefore, increasing the sample of such planets is very important and would allow us to better understand their evolution. By carrying out a systematic, long-term RV follow-up programme with FEROS, we can confirm and characterize these WJs while also disentangling stellar activity effects. A long temporal baseline on a stable, precise instrument such as FEROS is vital to this project. With the TESS extended mission currently reobserving the Southern skies, this is a critical time for simultaneous RV monitoring.

This proposal is also linked to Jan Eberhardt's PhD thesis, whose goal is to analyse exoplanets with combined methods; FEROS data will be vital for combined TESS/RV analyses. He also aims to revisit TW Hya with new TESS, CRIRES, HARPS and FEROS data to study the planet vs. spot hypotheses.

Data reduction and analysis

The spectra obtained with FEROS are extracted using the CERES pipeline, expressly written for this instrument and optimised for the subsequent radial velocity measurements. A complete description of CERES can be found in ([25]). In brief, each spectrum is extracted and subsequently calibrated in wavelength using the ThAr spectra. The RV is then measured by cross-correlating the observed spectrum with a binary mask chosen according to the spectral class of the target. Additionally, the bisector of the CCF (i.e., the deformation of the line shape) is determined as a supplemental parameter, serving as a diagnostic tool to rule out false-positive scenarios such as blended eclipsing binaries or stellar activity effects. We also measure stellar activity indicators such as H_α and $\log R'_{HK}$, and estimate the atmospheric stellar parameters including effective temperature $T_{\rm eff}$, surface gravity $\log g$, and metallicity [Fe/H]. The precision in RV obtainable with CERES is of the order of 5-10 m/s. FEROS is, therefore, a very competitive instrument for the measurements of the RVs of stars in the southern hemisphere.

Results highlight

Our team achieved many exoplanet discoveries using ground-based (HATSouth) and space-based ($K2$) surveys, and has characterized several TESS candidates. The planets span a large region in parameter space, from a $\sim 9\,\mathrm{M}_\oplus$ planet around an active M dwarf ([24]) to massive ones three times Jupiter's mass ([29]). Regarding HATSouth confirmations, we highlight HATS-59 [19], its first multi-planetary system, with a hot Jupiter and an outer massive companion; and HATS-17 b, the longest period transiting planet discovered by a ground-based transit survey ([30]); plus many well characterized hot Jupiters ([16, 17, 20]). Our team also characterized 3 warm Saturns on eccentric orbits, discovered by $K2$ ([23, 21]). Our TESS follow-up is producing excellent results, with eight hot and warm Jupiters confirmed at least partly with FEROS data. We highlight one of the most eccentric known warm Jupiters ([12], Fig. 4), a still-contracting warm giant orbiting a 0.8 Gy star ([14], Fig. 5), and two warm giants near the 2:1 resonance ([31]). Finally, this program provided crucial candidates for the theoretical work by Paula Sarkis, who recently constrained the radius anomaly of hot Jupiters ([32]).

Future Plans

TESS is the most important exoplanet search mission in orbit. After observing the full sky over two years, it is now re-observing the Southern hemisphere and expected to discover > 300 giant planets around bright stars (V < 13 mag), suitable for RV follow-up with FEROS. We aim to systematically characterize the full population of transiting WJs that will be unveiled by TESS. **To accomplish this, we require a total 780 hours of telescope time distributed into 5 semesters, of which we received 309 hours for P103 and P104. We were awarded 157 hours for P105, but none were observed due to the COVID-19 shutdown. Likewise, only 52 of 157 hours were observed in P106, and only 49 of 157 in P107.** For the next semesters, should we be able to complete 157 hours in both P108 and P109, we still need a further 56 hours to complete the RV monitoring of the systems predicted from TESS prime mission simulations (Fig 2, see also Section 10). This does not take into account the increased yield of the extended mission, for which more time will likely be necessary. Many of these discoveries will be suitable for atmospheric characterization with JWST and hence will have a large impact.

FEROS is a strategically well-placed instrument and is one of the few suitable instruments in the Southern hemisphere for follow-up RV observations. Our well-established team of researchers at the MPIA, STScI, and PUC and UAI in Chile has demonstrated the experience and facilities needed to excel in the exoplanet field and be a leading group in the TESS era.

9. Objects to be observed

(Objects to be observed with high priority should be marked in last column)

Designation	α (2000)	δ (2000)	magnitude in spectral range to be observed	priority
TIC7145074	$0^h\,18^m\,03.16^s$	$-43°\,24'\,34.84''$	11.56	1
TIC398673587	$0^h\,55^m\,06.52^s$	$-7°\,36'\,50.82''$	12.37	1
TIC243167068	$1^h\,4^m\,15.60^s$	$19°\,44'\,13.57''$	13.75	1
TIC52059926	$1^h\,7^m\,05.44^s$	$-68°\,22'\,05.17''$	13.72	1
TIC67599025	$1^h\,10^m\,46.16^s$	$-31°\,30'\,20.38''$	12.87	1
TIC206541859	$1^h\,12^m\,11.64^s$	$-56°\,55'\,31.40''$	10.94	1
TIC248387177	$1^h\,16^m\,31.37^s$	$0°\,17'\,24.37''$	11.95	1
TIC54002556	$1^h\,34^m\,05.15^s$	$-14°\,25'\,08.94''$	12.46	1
TIC184397998	$1^h\,56^m\,58.05^s$	$-45°\,52'\,33.73''$	13.73	1
TIC394287035	$2^h\,6^m\,45.77^s$	$-81°\,14'\,50.55''$	12.33	1
TIC231071138	$2^h\,11^m\,46.40^s$	$-56°\,45'\,22.41''$	12.70	1
TIC147660886	$10^h\,56^m\,07.60^s$	$-43°\,22'\,36.11''$	9.87	1
TIC49043968	$10^h\,57^m\,23.79^s$	$-29°\,59'\,49.64''$	11.97	1
TIC322807675	$11^h\,34^m\,48.79^s$	$-25°\,36'\,16.98''$	12.56	1
TIC385332171	$12^h\,6^m\,46.32^s$	$-16°\,30'\,37.06''$	11.85	1
TIC334305570	$12^h\,12^m\,28.50^s$	$-49°\,0'\,27.85''$	9.84	1
TIC22317640	$12^h\,15^m\,38.24^s$	$-47°\,11'\,53.31''$	11.95	1
TIC204671232	$12^h\,19^m\,55.81^s$	$-27°\,17'\,05.41''$	12.65	1
TIC204698337	$12^h\,22^m\,07.07^s$	$-24°\,56'\,35.47''$	13.54	1
TIC83154030	$12^h\,35^m\,20.30^s$	$-18°\,1'\,46.12''$	13.48	1
TIC286864983	$12^h\,40^m\,45.94^s$	$-21°\,52'\,22.01''$	11.57	1
TIC124206468	$13^h\,8^m\,48.13^s$	$-31°\,29'\,58.07''$	11.93	1
TIC308211363	$13^h\,12^m\,37.00^s$	$-17°\,52'\,08.82''$	12.89	1
TIC20579360	$13^h\,24^m\,40.24^s$	$-19°\,53'\,46.18''$	13.37	1
TIC328934463	$13^h\,40^m\,49.04^s$	$22°\,59'\,02.29''$	11.94	1
TIC437329044	$13^h\,50^m\,20.36^s$	$-23°\,23'\,00.16''$	10.55	1
TIC418012030	$14^h\,10^m\,33.31^s$	$26°\,25'\,24.35''$	11.68	1
TIC158978373	$14^h\,34^m\,37.99^s$	$-40°\,44'\,23.50''$	10.55	1
TIC75650448	$15^h\,3^m\,20.89^s$	$-35°\,13'\,50.08''$	12.90	1
TIC148478039	$15^h\,21^m\,17.40^s$	$-38°\,49'\,58.49''$	13.29	1
TIC186072225	$15^h\,32^m\,20.38^s$	$-25°\,26'\,00.02''$	11.94	1
TIC311179742	$17^h\,10^m\,51.61^s$	$-75°\,43'\,47.97''$	12.79	1
TIC76228620	$17^h\,56^m\,59.33^s$	$-55°\,47'\,16.59''$	11.36	1
TIC380836882	$18^h\,0^m\,32.36^s$	$-65°\,36'\,49.71''$	11.57	1
TIC254142310	$19^h\,6^m\,06.92^s$	$-38°\,59'\,25.89''$	11.87	1
TIC390874411	$19^h\,48^m\,10.41^s$	$21°\,31'\,30.69''$	10.33	1
TIC90850770	$20^h\,30^m\,23.21^s$	$-44°\,53'\,15.42''$	11.32	1
TIC355096431	$20^h\,58^m\,18.40^s$	$-40°\,16'\,07.08''$	13.38	1
TIC207078179	$21^h\,23^m\,22.54^s$	$-38°\,31'\,56.81''$	12.01	1
TIC265465927	$21^h\,23^m\,39.97^s$	$-62°\,55'\,25.69''$	12.62	1
TIC290403522	$22^h\,3^m\,49.93^s$	$-72°\,26'\,26.98''$	10.79	1
TIC219332978	$22^h\,34^m\,34.71^s$	$-57°\,34'\,13.52''$	11.23	1
TIC161169240	$22^h\,37^m\,25.88^s$	$-53°\,19'\,08.55''$	12.75	1
TIC139147770	$22^h\,57^m\,46.88^s$	$-42°\,56'\,16.49''$	11.85	1
TIC139251123	$23^h\,8^m\,32.68^s$	$-45°\,1'\,35.37''$	11.30	1
TIC317089588	$23^h\,9^m\,51.11^s$	$-79°\,41'\,59.99''$	14.30	1
[a]				

[a] TESS alerts of each Sector are made public after the observations of the Sector. Hence, the list of candidates could evolve when future data from upcoming sectors are released.

10. `Justification of the amount of observing time requested:`

Using the predicted yield of TESS ([3]), we estimate that TESS will detect ~ 300 WJs ($R_p > 4R_\oplus$ and $P > 10$ days) around bright and moderately bright stars ($V < 13$ mag). FEROS will be systematically used to characterize all (∼80) moderately bright systems (11<V<13) presenting RV semi-amplitudes of K>30 m s^{-1} (type I candidates), and also a fraction (∼50%) of the lower mass systems (K<30 m s^{-1}) orbiting bright (V<11) stars (type II candidates). In order to constrain the orbital parameters and measure the planetary mass with a precision around 20%, we anticipate we need around 20 spectra at different orbital phases. We assume that there will be also an equal number of false positives among our candidates that can be discarded after 4 RV observations.

For type I candidates, with a mean exposure time of 1200s, we require 640 hours to fully characterize these systems. **As for type II candidates**, with an execution time of 600s, we need 140 hours.

Thus, to succeed in systematically characterizing warm giant planets detected with the TESS primary mission, we need around **780 hours** of telescope time, distributed into 5 semesters.

For this semester, we are applying for 157 hours.

We reduce and analyse the data immediately every night. This allows us to quickly discard false-positives and hence focus on promising targets and use the allocated time more efficiently.

11. `Constraints for scheduling observations for this application:`

Since our candidates have a wide spread in RA and DEC, the schedule can be very flexible, and as we have many candidates to observe at any time, we can avoid collecting redundant data. **We, however, prefer if our observations can be scheduled evenly throughout the semester as much as possible.** In the previous semester, we successfully managed to share time with Olga Zakhozhay. This allowed us to have approximately 2 months of continuous observations. This is especially important for the planets where only one transit was observed. However, we understand that this might not be feasible and we plan to continue sharing time with Olga Zakhozhay.

12. `Observational experience of observer(s) named under 2.3:`
`(at least one observer must have sufficient experience)`

Trifon Trifonov has experience observing with FEROS. Melissa Hobson has experience with other spectrographs such as HARPS, and with FEROS in the current remote mode.

13. `Observing runs at the ESO 2.2m-telescope (preferably during the last 3 years)`
`and publications resulting from these`

Telescope	instrument	date	hours	success rate	publications
2.2m	FEROS	Oct 15 - Mar 16	143 hrs	83%	[18] [29],[19]
2.2m	FEROS	Apr 16 - Sep 16	163 hrs	85%	[16], [17], [20]
2.2m	FEROS	Oct 16 - Mar 17	162 hrs	85%	[16], [17], [20]
2.2m	FEROS	Apr 17 - Sep 17	181 hrs	100%	[16], [20]
2.2m	FEROS	Oct 17 - Mar 18	124 hrs	100%	[16], [20]
2.2m	FEROS	Apr 18 - Sep 18	165 hrs	100%	[9], [15]
2.2m	FEROS	Oct 18 - Mar 19	160 hrs	100%	[10], [15], [14]
2.2m	FEROS	Apr 19 - Sep 19	149 hrs	100%	[23], [12], [13], [14], [31]
2.2m	FEROS	Oct 19 - Mar 20	145 hrs	93%	[12], [13], [14], [31], +in prep
2.2m	FEROS	Apr 20 - Sep 20	157 hrs	0%	Note: site closed
2.2m	FEROS	Oct 20 - Mar 21	157 hrs	30%	Note: site partially closed
2.2m	FEROS	Apr 21 - Sep 21	157 hrs	31%	Note: site partially closed

14. References for items 8 and 13:

[1] Bakos *et al.* (2004), PASP, 116, 266

[2] Ricker *et al.* (2014), SPIE, 9143, 914320

[3] Barclay *et al.* (2018), ApJS,239,2

[4] Thorngren *et al.* (2016), ApJ, 831, 64

[5] Southworth J. (2011), MNRAS, 417, 2166

[6] Lin *et al.*(1996), Nat, 380, 606

[7] Cooke *et al.* (2021), MNRAS, 500, 5088

[8] Espinoza *et al.* (2019b), MNRAS, 490, 2262

[9] Brahm *et al.* (2019), AJ, 158, 45

[10] Kossakowski *et al.* (2019), MNRAS, 490, 1094

[11] Jordan *et al.* (2020), AJ, 159, 145

[12] Schlecker *et al.* (2020), AJ, 160, 275

[13] Brahm *et al.* (2020), AJ, 160, 235

[14] Hobson *et al.* (2021), AJ, 161, 235

[15] Espinoza *et al.* (2020), MNRAS, 491, 2982

[16] Henning *et al.* (2018), AJ, 155, 79

[17] Espinoza *et al.* (2016), AJ, 152, 108

[18] Mancini *et al.* (2015), A&A, 580, 63

[19] Sarkis *et al.* (2018b), AJ, 156, 216

[20] Espinoza *et al.* (2019), AJ, 158, 63

[21] Brahm *et al.* (2018b), MNRAS, 477, 2572

[22] Espinoza *et al.* (2017), MNRAS, 471, 4374

[23] Jordan *et al.* (2019), AJ, 157, 100

[24] Sarkis *et al.* (2018a), AJ, 155, 257

[25] Brahm *et al.* (2017), PASP, 129, 034002

[26] Borucki *et al.* (2010), Science, 327, 977

[27] Howard *et al.* (2012), ApJS, 201, 15

[28] Guillot & Showman (2002), A&A, 385, 156

[29] Ciceri *et al.* (2016), PASP, 128, 074401

[30] Brahm *et al.* (2016), AJ, 151, 89

[31] Trifonov *et al.* (2021), arXiv:2108.05323

[32] Sarkis *et al.* (2021), A&A, 645, 79

Tolerance limits for planned observations:

maximum seeing:	2.5″	**minimum transparency:**	60%	**maximum airmass:**	1.9
photometric conditions:	no	**moon: max. phase / ∠ :**	1/30°	**min. / max. lag:**	0/0 nights