Exoplanet Characterisation Observatory (EChO)

Assessment Phase Payload Study

Scheduling the current EChO Core Sample

ECHO-TN-0001-CNES

Issue 0.1

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DOCUMENT CHANGE DETAILS

Issue	Date	Page	Description Of Change	Comment

Scope of the exercise: This note has been prepared to address the following issue:

- Can we schedule a nominal EChO mission, with targets known today, given the science requirements, realistic performances and operational constraints?

We carried out with the help of CNES a realistic scheduling exercise for EChO. The core sample was selected out of existing targets compliant with the SciRD requirements/goals (119 transiting planets in total).
It is clear that in the coming 10 years, different projects will discover a larger number of planets orbiting bright stars and that the final list of targets will be determined at a later date (TN Micela et al., TN Ribas et al.). However, we want to show that if EChO were launched tomorrow, we would already fulfill the mission's science objectives. Brighter targets discovered in the future could maximize the number of observed objects and optimize the coverage of the parameter space probed, as they will require fewer visits to reach the needed S/N.

In this document we summarise the constraints we used in the exercise and we describe the 3 catalogues we created, based on the existing list of targets and the requirements/goals described in the SciRD document.

We detail the results of the scheduling of the EChO mission as done by CNES using 4 different algorithms, taking into account the performances of the satellites, the calibrations, house keeping, downloads. Note that a further optimisation is possible and should be implemented in the future, but this exercise is more a proof of feasibility with currently existing targets. It is clear that with brighter targets and a larger sample of targets to choose from (available in 2022), this exercise will be even more favorable.

We then conclude about EChO scheduling to perform the 3 surveys described in the SciRD.

<u>Executive summary:</u>

We created 3 catalogues containing a total of 119 existing sources to test realistic mission scenarii as if EChO were launched today. For each target, using EChOSIM we estimated the needed number of visits (transits or occultations) to reach the required S/N for each of the observing mode adopted by EChO [Ref. ECHO-TN-0001-UCL].

The total observing time needed without calibration and scheduling is 2.4 years, to be spread over 4.5 years. The 3 catalogues can be summarized as:

•Rosetta Stones (long term monitoring, time variability, and/or SNR~20, 30 < R < 300): 8 sources, 16 sequences, 502 visits, 101 days

•Origins (S/N~10, 30 < R < 100): 43 sources, 76 sequences, 1032 observations, 435 days

•Chemical Census (S/N~5, 30 < R < 50): 68 sources, 111 sequences, 883 observations, 332 days

We took a realistic model of the EChO platform, calibration scheme (short and long calibration sequence using bright G stars) and we tried 4 different algorithms with different levels of sophistication.

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1. Constraints used for the scheduling exercise:

We needed performance estimates for the EChO platform to be used for the scheduling exercise. These numbers are either coming from the MRD or have been discussed with ESA SST members. These are reasonable estimates and updates to these values will have a low impact on our conclusions.

Summary of the working hypotheses,:

- EChO is positioned at Lagrange L2 point. We do not make precise modeling of the orbit around L2.
- The mission duration will be ~ 4.5 years, starting on June 1, 2024.
- +- 36 deg around the axis perpendicular to Sun-Earth-L2
- Telescope will point at 5 deg/min

- Thermal and mechanical stabilization delay: 5 min
- Short calibrations, 1h every 36 hours (minimum 30 hours, maximum 48 hours, no short term calibration planned at a moment when a long is done)
- Long calibrations, 10h every 10 days (minimum 7 days, maximum 15 days)
- The targets used for calibrations are G bright G stars (catalogue of 537 sources)
- 2 downloads per week, (2h each) (minimum 3 days, maximum 4 days)
- No observation simultaneous to download
- Once every 28 days, house keeping operation (8 hours) (minimum 25 days, maximum 30 days)
- No simultaneous observation/download during house keeping.

In Fig. 1, we give the orientation of the satellite with respect to Sun-Earth-L2.

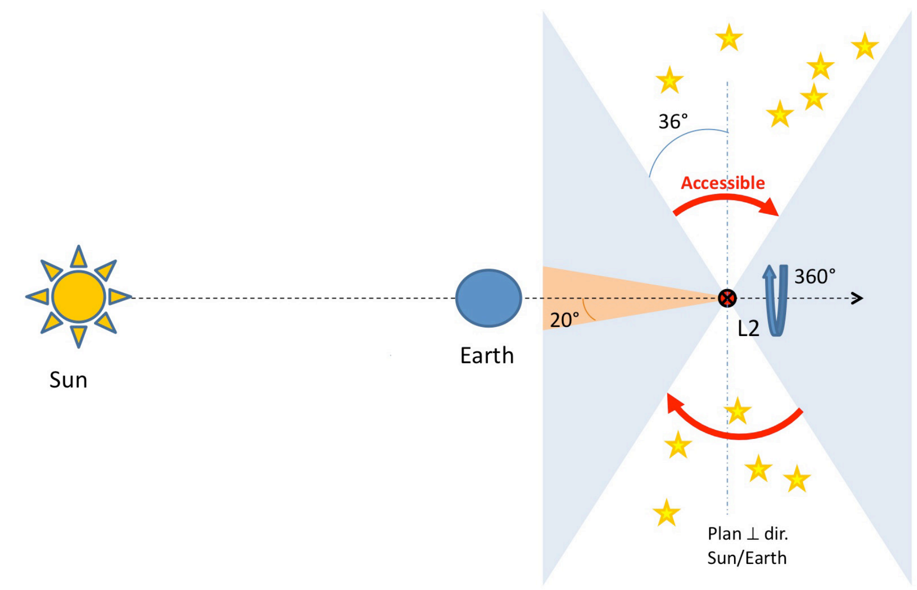


Figure 1 : EChO pointing constraints.

2. The catalogues used

All the known transiting planets today have been processed through EChOSIM (see ECHO-TN-0001-UCL). The needed number of visits in transit or in occultation to meet the requirements described in the SciRD was used as input to our scheduling exercise. We excluded those who would require more visits than what it is achievable within the EChO life time. We then decided to make a selection in order to maximize the efficiency of the core survey while keeping its diversity.

- Rosetta Stones: a small fraction of time, spread over the full life of the mission with large number of visits to a small number of targets, either for time monitoring or very deep observations.

- Origins: deep survey, with targets requiring multiple visits.

- Chemical Census: a wide survey with lower S/N requirements than for the deep and Rosetta surveys.

Table 1 summarises the catalogues. The full catalogues are given in the annexes.

Note that we chose to observe for a time span lasting for 3 transit duration. This is a conservative approach based on the experience with HST and Spitzer.

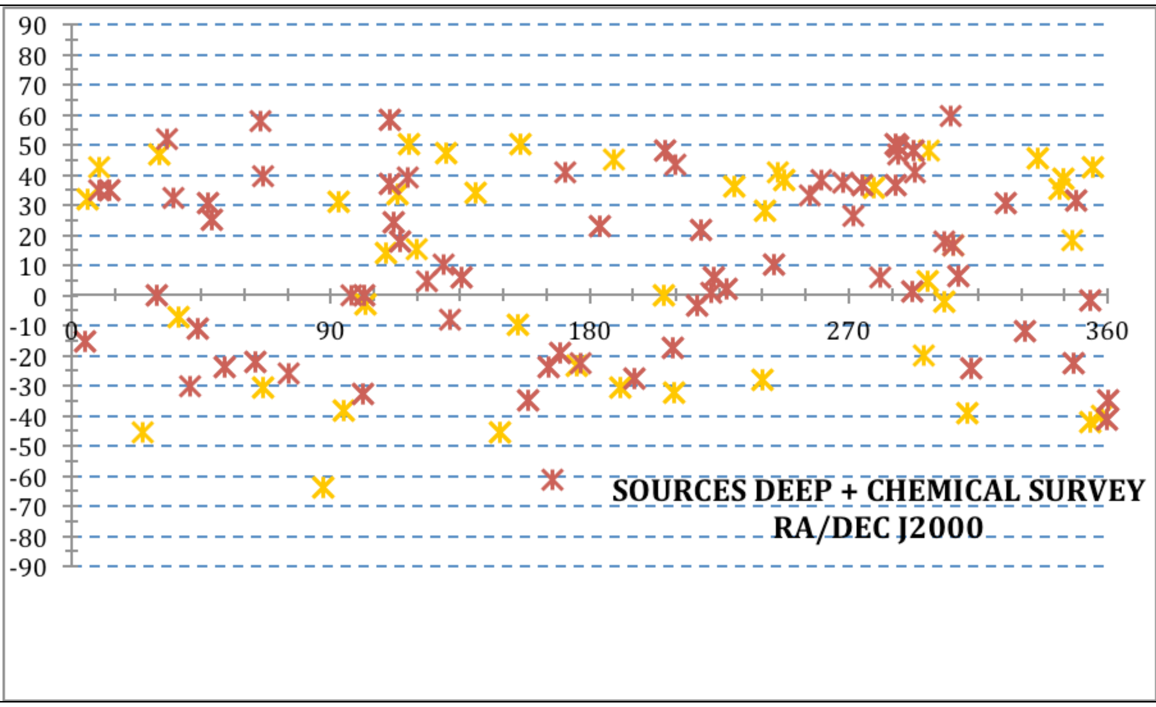


Figure 2: Spatial distribution of sources for the deep (yellow) and chemical (red) surveys. The Rosetta targets are all from the North hemisphere. The 537 G stars we are considering as sample for the calibration are spread uniformly on the skies.

1. Rosetta catalogue:

A small catalogue of 8 targets for which we will perform repeated observations. It is done either because we want to perform meteorology by monitoring these planets over a long period of time, or because we need a large number of orbits to obtain the needed S/N or a challenging target.

We propose to observe 10 transits and 30 occultations for the hot Jupiters HD189733b, HD209458b, and the two extreme Jupiters WASP-12b, WASP-33b. The first two are two bench mark hot Jupiters, the others are the hot Jupiter where we could expect the more dramatic variations.

Very important targets to date will receive special attention, hot super earth 55CnCe (20 transits, 24 occultations), hot super Earth Gliese1214b (20 transits, 200 occultations), and hot Neptune Gl436b (12 transits, 58 occultations). These are just an example to illustrate the impact on scheduling of very demanding targets for EChO.

The very eccentric Jupiter on a period of 113 days is also included (4 transits, 4 occultations). In this particular case we choose to have a long period of observations around the secondary transit to track the very fast reheating of the atmosphere when approaching the perihelia of the orbit.
What we adopted here for Gl1214b is just a test to probe the impact on scheduling of a very large number of visits for a few targets.

Note that being HD189733 an active star with a cycle of 11.9 days, we decided to add as a scheduling constraint, that any transit should be done between two occultations.

The transiting hot Jupiter on a very eccentric orbit HD80606b has also been added to the list to enable study atmospheric response to strong variation in insolation. With a period of 111 days it will be observed over a long period of time.

We did not explicitly included phase curve measurements, but it is easy to implement those in the scheduling scenario by making the duration of a visit around an occultation longer.

2. Origins (Deep survey):

The objective is to understand the origin of exoplanet diversity by doing deep observations with higher S/N, as described in the SciRD. For this scheduling exercise, we have chosen 43 targets (somewhere between the requirements and the goals). Some of the Rosetta Stone targets may also be included in the studies of the deep survey. Therefore, we could in principle have 52 targets available for deep studies.

3. Chemical Census:

The objective is to explore exoplanet chemical diversity with EChO observations, as decribed in the SciRD. The sample in this scheduling exercise is made of 68 targets (only listed in the CC list). Additionally, the 43 targets from the Origins and the Rosetta targets will also have high enough S/N. As a consequence, we have a total of 119 targets that will be used for the chemical studies.

	Rosetta	**Origins**	**Chemical Census**
Number of targets Number of sequences	8 16	43 76	68 111
Number of visits	502	1032	883
Total shutter time	101 days	435 days	332 days
Min-Max number of visits to 1 target	8-220	1-49	1-30
Median number of visits	~30 visits	~14 visits	~8 visits

Table 1: we summarize in this table the 3 different input catalogues for the scheduling. The numbers of targets given corresponds to target belonging to each of the 3 lists. Nevertheless, Rosetta targets have high enough S/N to integrated in the analysis of the deep survey. The deep survey having a higher S/N compared to the Chemical survey, its targets will be integrated in the analysis of chemical survey. We have 8 Rosetta targets. We have 43+8=51 targets for the deep survey study, while we have 43+8+68=119 targets for the chemical survey.

4. Catalogue format:

The detailed format is given in appendix. The catalogue files contains one line for each sequence of observation for each target, RA DEC, ephemeris, needed visits, transit duration. The first field contains the unique sequence number used for the identification of the different targets. Below are a few examples:

SEQ-3. Gliese1214bT Gliese1214b T 17:15:19 +04:57:50 1.58040482 4983.9087558 54.73 164.19 0 20 N N
20 transit observations of GJ1214b

SEQ-4. Gliese1214bS Gliese1214b S 17:15:19 +04:57:50 1.58040482 4984.69895821 54.73 164.19 0 200 N N
200 occultation observations of GJ1214b

SEQ-11. HD189733bT HD189733b T 20:00:43 +22:42:39 2.21857312 3988.80336 111.40 334.21 0 10 S S
10 transit observations of HD189733b, bracketed by two occultations each time

SEQ-12. HD189733bS HD189733b S 20:00:43 +22:42:39 2.21857312 3989.91264656 111.40 334.21 0 30 N N
30 occultation observations of HD189733b. 20 of them are bracketing transit observations, the other 10 are scheduled randomly.

5. The catalogues and the final version of the requirements

The catalogues were built and selected in June 2013, whereas the final version of the requirement document have been produced on September 30, 2013. There are tiny differences.
We are fully compliant with the requirements R-SCI-001, R-SCI-003, R-SCI-004, R-SCI-005. All the objectives for the chemical Census and the origins survey are reached. Moreover, for the Origins, we are getting close to the goal of 50 targets (with 38 targets observed with primary and secondary transits, and 5 with only one of the two).
For the Rosetta Stones we chose 8 targets whereas the requirement has now been put to 10 (R-SCI-007). Moreover, concerning GJ1214, even with very large number of observations we will not reach S/N=20 the requirement defined in SCI-007. However, for the scheduling exercise we want to show that we are able to schedule a large number of observations for a small number of targets to reach high S/N and/or monitor variability, while not impairing the possibility of conducting the other surveys. Our Rosetta stones are not exactly compliant with the requirement, but it is very informative for the scheduling of the mission since Rosetta Stone targets will give similar constraints.

3. Scheduling the 3 catalogues with EChO

We have 3 catalogues of targets.

- Catalogue Rosetta Stones:
  –8 sources, 16 sequences, 502 visits, 101 days
  Note that 1 source has 200 observations of the same type : Gliese1214b (total integration of 23 days on the target)

- Catalogue Origins:
  –43 sources, 76 sequences, 1032 observations, 435 days

- Catalogue Chemical Census:
- 68 sources, 111 sequences, 883 observations, 332 days

First, for all the targets we compute the visibility intervals, moments when the observations can be carried out for each target. We will then try four different scheduling algorithms.

The different algorithms:

Algorithm-0: Only visibility and flexibility are used (immediate pointing, no slew time). It could be viewed as scheduling in an ideal world.

Algorithm-1: We consider systematically the maximum slew time (for a 180° shift angle) and the pointing time and the thermal/mechanical stabilization delay.

Algorithm-2: We add a constraint on the maximum acceptable angle between two consecutive observations (in practice, 90 deg).

Algorithm-3: We add a constraint in order to minimize the cumulative angle between the previous, the current and the next observation.

Algorithm-4: An initial scheduling is done with Algorithm-2, followed by 2 iterations with Algorithm-3. As a consequence, algorithm-4 is the most sophisticated and realistic scenario. Once all the observations have been scheduled, we then examine the gaps where to fit in the calibrations, downloads and house keeping. If needed, observations can be postponed to match the required frequencies of calibration, download or housekeeping operations.

Scheduling, how does it work in practice:

For each target we have computed the visibility intervals, then we calculate the "Flexibility" of the source. The flexibility is defined as:

Flexibility = 1 – (Number_obs_required / Number_intervals_available)

The higher the flexibility, the lower the priority. Note that some cases the flexibility could be negative, therefore this target is not feasible and the catalogue should be updated or the target dropped.
The same procedure will be applied with each algorithm.

For the 203 sequences of observations, we have the visibility intervals and the flexibility of the targets. We choose one algorithm. We proceed in 3 passes to fill up the 4.5 years. First we schedule the Rosetta Stones catalogue, then the Origins and finally the Chemical Census. A way to view it is that we use the catalogue with the strongest constraint in terms of repeated observations first (RS), followed by the Origins that require typically 10-20 visits. Finally, in the gaps we schedule the Chemical Census targets (requiring typically a few visits). We treat the 3 subsequently. Currently, we decided to optimize each of the 3 passes separately. We then estimate the different gaps and we schedule the short and the long calibration sequences, the downlinks of data twice a week and the house keeping.

In a later phase, a global optimization could be done to maximize the efficiency. Ribas et al., have shown using mock catalogues that we could reach > 85 % efficiency. Here, we want to demonstrate the existence of solutions to the scheduling exercise, with real targets, taking into account the known constraints of today. Therefore, the exercises are complementary.

Key results:

1. First, we have been able to schedule all the 3 catalogues with 3 out of 4 of the algorithms with a 100 % success rate. This is a robust conclusion since they are very different.
2. Two of the algorithms are very demanding for the satellite. By contrast algorithm-2, which has a constraint on the maximum acceptable angle between two consecutive observations of 90 degrees, implements only ~69 % of the core sample.

Algorithm	Success Rosetta Sones	Success Origins	Success Chemical Census	Total Success	Average Shift Angle
0	100%	100%	100%	100%	88.70°
1	100%	100%	100%	100%	89.61°
2	99.8%	100%	68.85%	88.58%	47.73°

3	100%	100%	100%	100%	67.76°
4	100%	100%	100%	100%	57.32°

Table 2: success rate with the different scheduling algorithm and average shift angle between two subsequent observations.

Another way to view it is that in order to optimize the observing time, it is better to have a larger tolerance of the shift angle. With algorithm 3 and 4, we can perform the survey completely, and the average angle between two consecutive pointing is 57-68 deg. Agility between subsequent pointing is therefore important. If it is constrained too strongly (as seen with algorithm 2), then some targets are not feasible. It was not expected a priori.

3. A key product from scheduling the targets from the 3 catalogues is the gaps and their distribution. In Fig. 3 we are showing cumulative histograms for gap durations coming from the scheduling done with different algorithms. First, the algorithm 1, 3, 4 are showing a similar shape for the distribution of gaps. We will focus on algorithm-4. 80% of the gaps have a duration between 2 and 10 hours. It is in these gaps that we schedule calibrations (short and long), downlink and house keeping. It would be easy to add more targets to extend the chemical census catalogue and fill up the gaps, or we could leave to Open Time a fraction of the time available in these gaps.

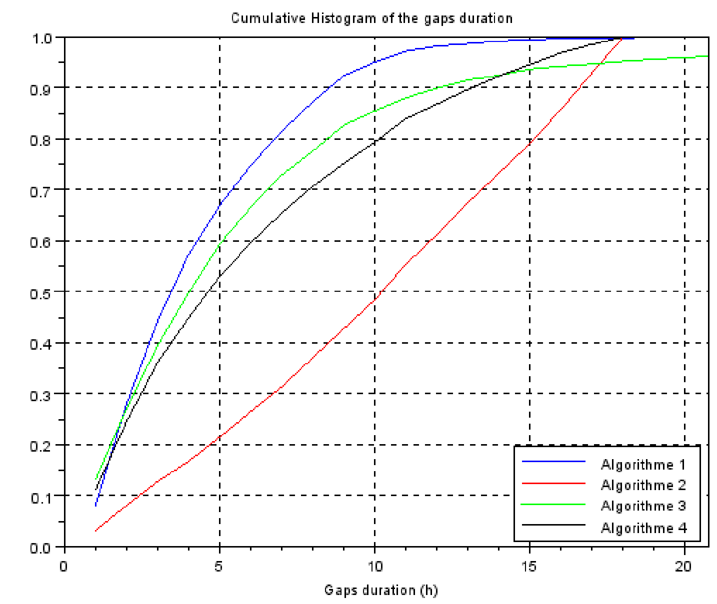


Figure 3: cumulative histogram fo durations with different scheduling algor First, most of the algorithms are shar same trend. In particular, the Algori plotted in black is showing that 50 % of t have duration of less than 5 hours, wh 20 % have duration of more than 10 hou during these gaps that we schedu calibrations, house keeping and dov Further astrophysical observations co scheduled too, either as part of Legacy or more targets for the chemical cen instance.

We detail here the results obtained with algorithm 4. Fig 4 is shown a 10 days sequence of scheduling 430 days after the beginning of the survey. The vertical axis is the number of the sequence and is color-coded. Positive sequence numbers are the targets (red Rosetta Stones, blue Origins, green Chemical Census), negative are calibrations (short and long), downloads, house keeping. We have been able to schedule a realistic scenario for the whole EChO mission.
We start with a target from Chemical Census, followed by one from the Origins, then house keeping (day 431). We observe a new target from the Origins then we do a short calibration. We observe a target from the Chemical Census we download the data to Earth then observe a target from the Origins.etc.
On day 435 we will observe a target from the Origins, then a Rosetta Stone target followed a long calibration sequence.

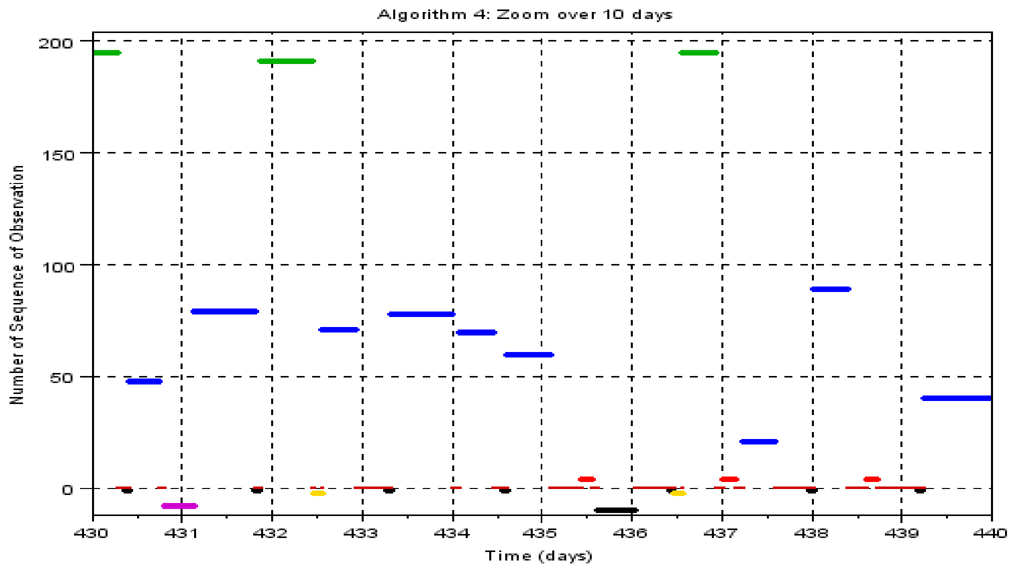


Figure 4: ECHO scheduling during 10 days (from the algorithm 4). The numbers are labels to the different sequence numbers for the different targets, numbers 1-16 (from Rosetta catalogue, plotted in red), 17-92 (from the Origins plotted in blue), 93-203 (from the Chemical Census plotted in green).). Calibrations are plotted in black, downlink of data in yellow and house keeping in pink.

In Fig. 5 we show a month of scheduling. It can be noticed that we have a Rosetta Stone target being repeated (GJ1214 for which we requested 200 occultations), a high density of Origins targets, two from the chemical census and all the needed calibrations, house keeping and downlink.

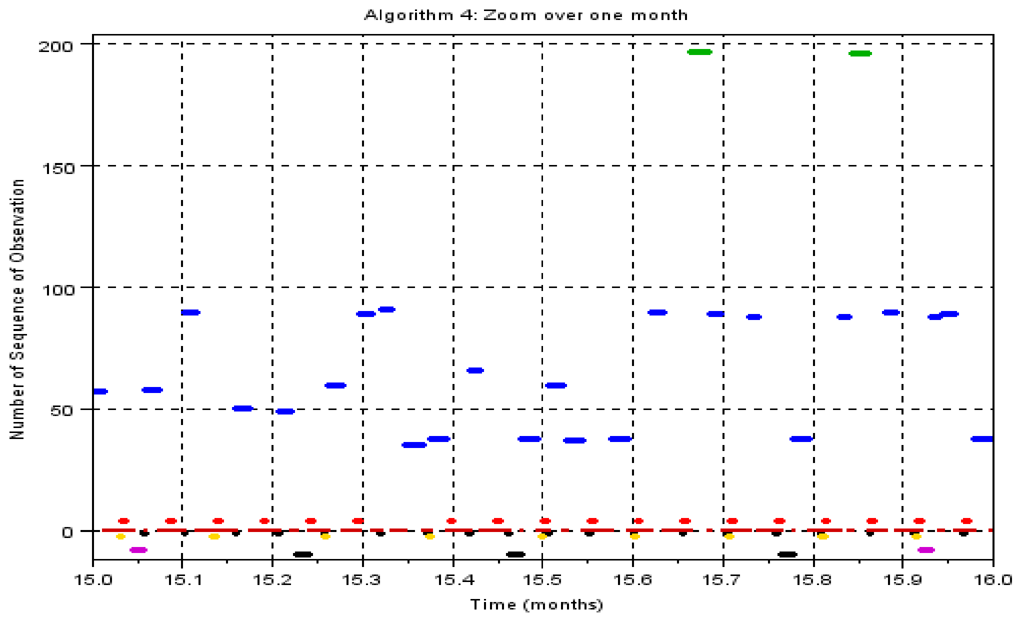
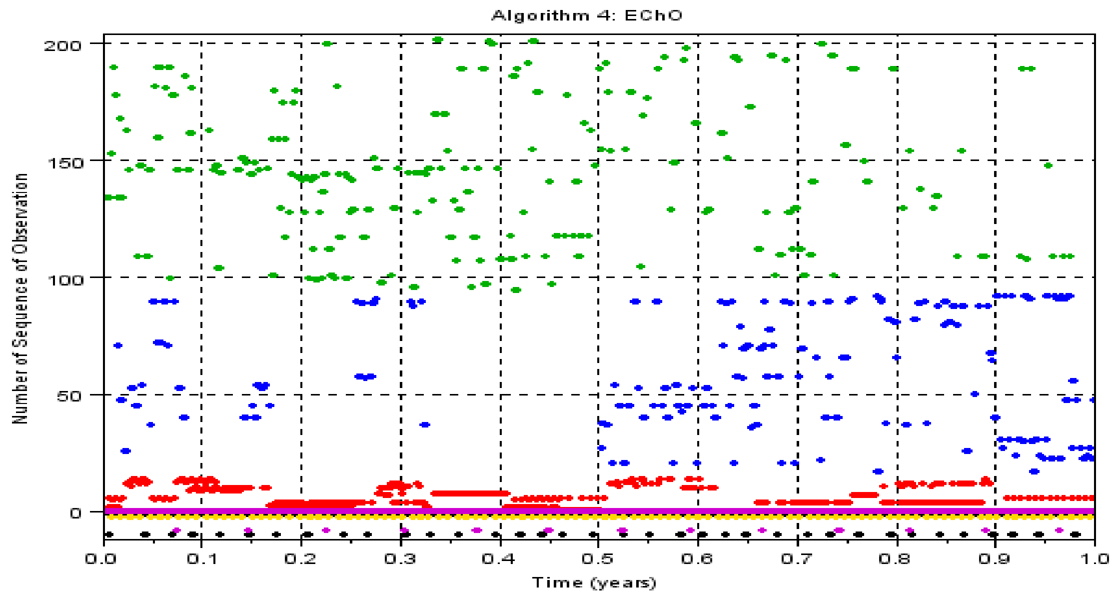


Figure 5: ECHO scheduling during one month (from the algorithm 4). The numbers are labels to the different sequence numbers for the different targets, numbers 1-16 (from Rosetta catalogue, plotted in red), 17-92 (from the Origins plotted in blue), 93-203 (from the Chemical Census plotted in green).). Calibrations are plotted in black, downlink of data in yellow and house keeping in pink.

Fig 6, 7, 8 are showing the scheduling over 4.5 years computed with algorithm 4. A realistic mission scenario, taking into account conservative constraints and existing targets from September 2013 has been obtained.



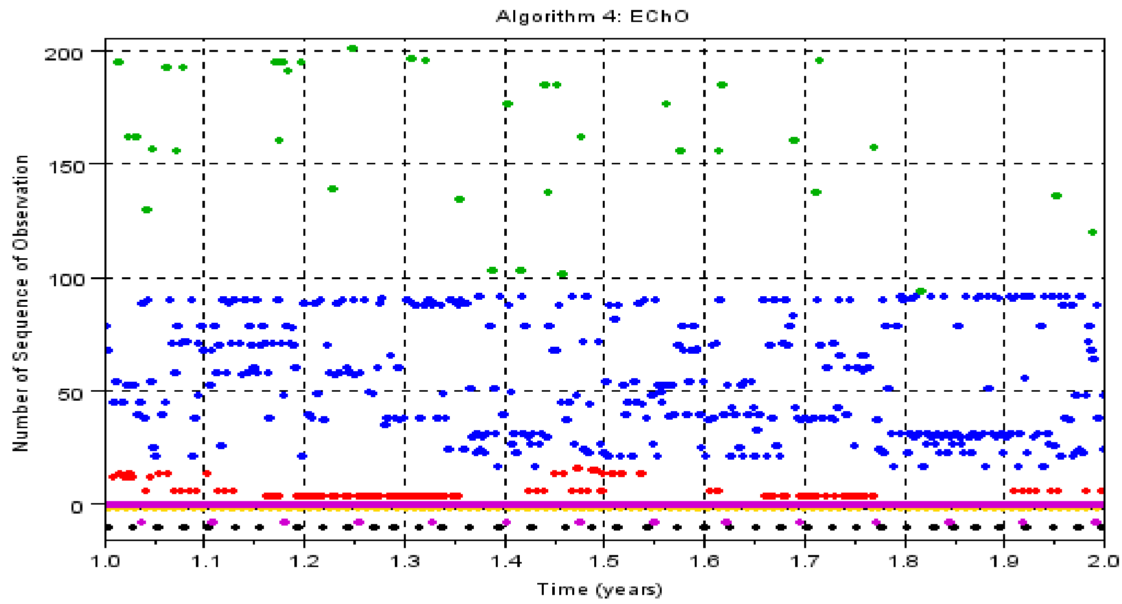
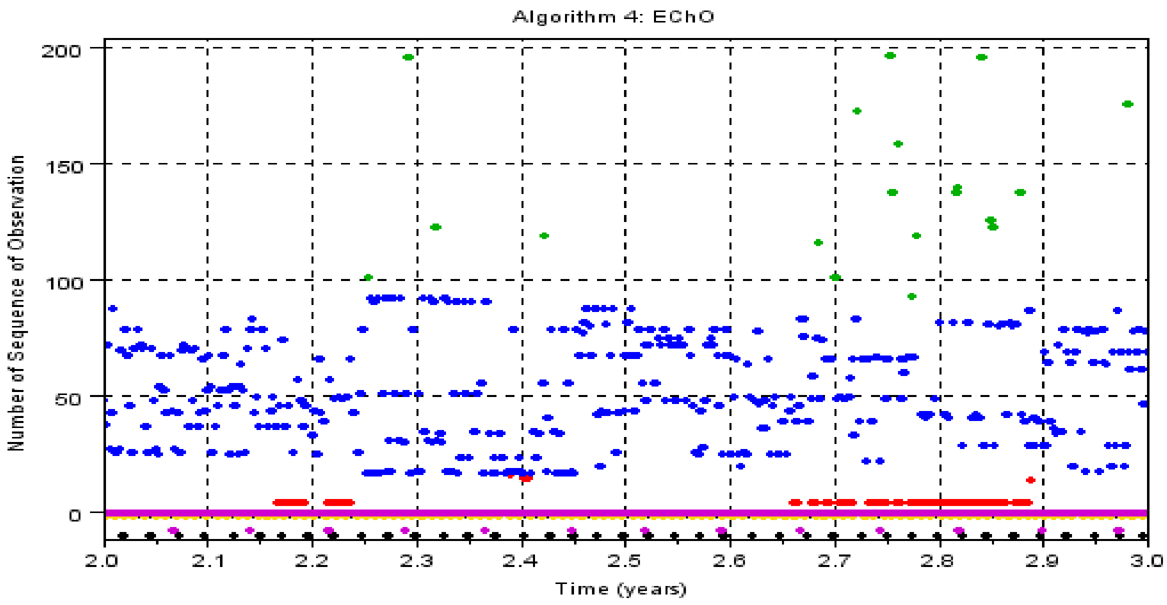


Figure 6 : ECHO scheduling during the first 2 years (from the algorithm 4). The numbers are labels to the different sequence numbers for the different targets, numbers 1-16 (from Rosetta Stones catalogue, plotted in red), 17-92 (from the Origins plotted in blue), 93-203 (from the Chemical Census plotted in green).



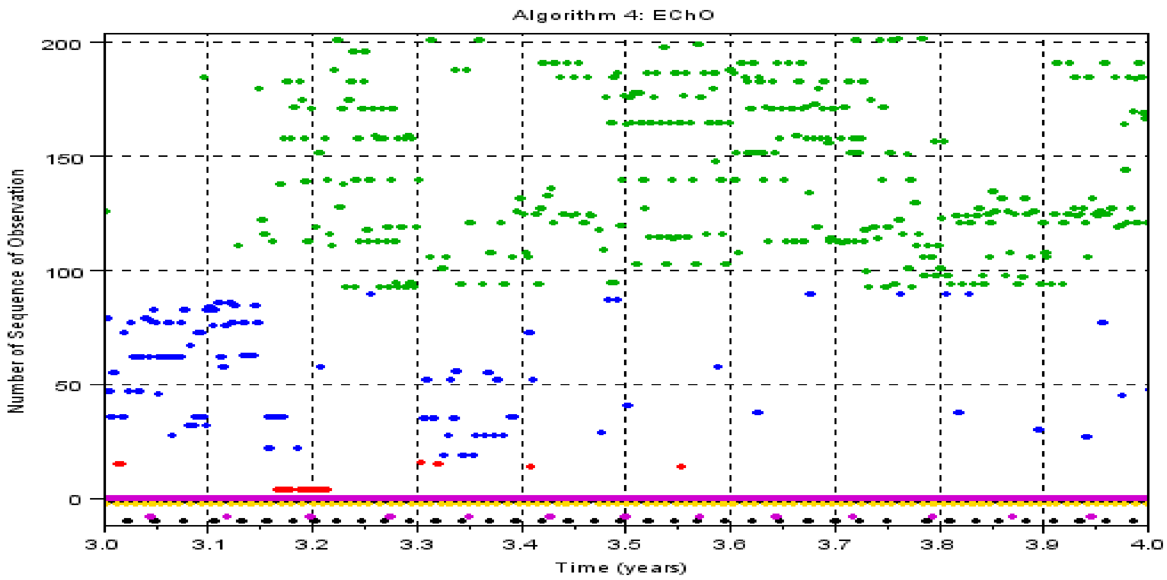


Figure 7: ECHO scheduling during the years 3 and 4 (from the algorithm 4). The numbers are labels to the different sequence numbers for the different targets, numbers 1-16 (from Rosetta Stones catalogue, plotted in red), 17-92 (from the Origins plotted in blue), 93-203 (from the Chemical Census plotted in green).

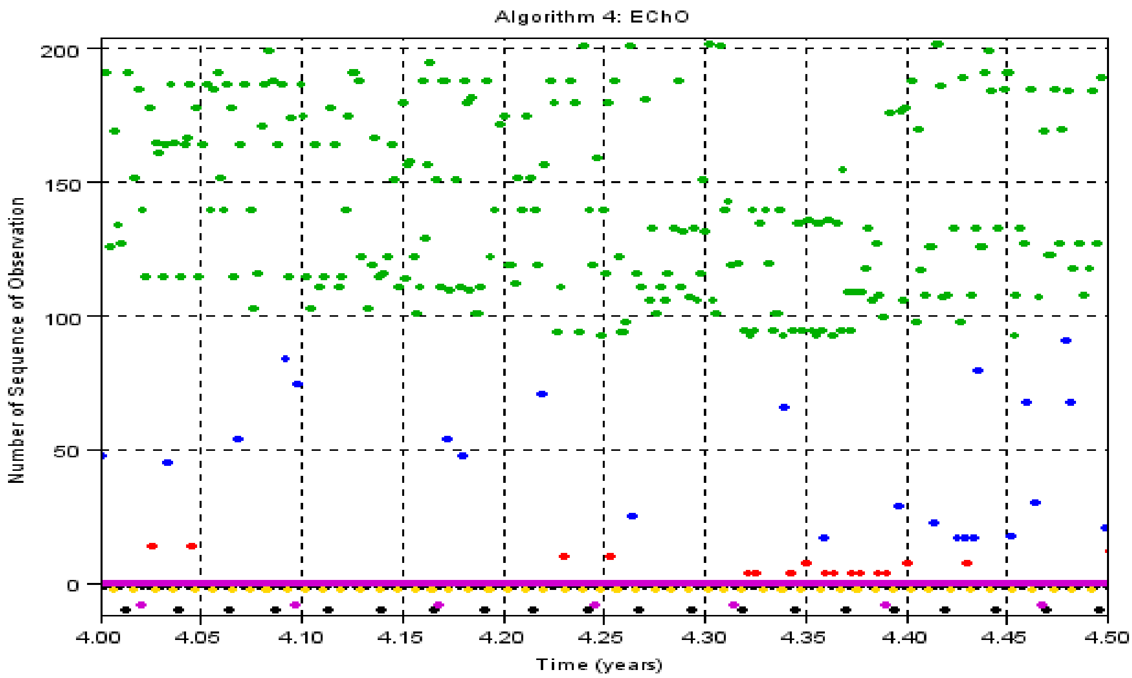


Figure 8: ECHO scheduling during the last 6 months (from the algorithm 4). The numbers are labels to the different sequence numbers for the different targets, numbers 1-16 (from Rosetta Stone catalogue, plotted in red), 17-92 (from the Origins plotted in blue), 93-203 (from the Chemical Census plotted in green).

Figure 9 is showing year by year the type of observations that are being made. On Year 1, we have similar fraction of the three survey modes. Year 2 and 3 are dominated by the Origins (deep). Year 4 and 4.5 are dominated by the Chemical Census. The small fraction of Rosetta is the target that is scheduled for 200 secondary transit observations and the one with a very long period. The targets from the Origins in year 4 and 4.5 are those needing the largest number of visits.

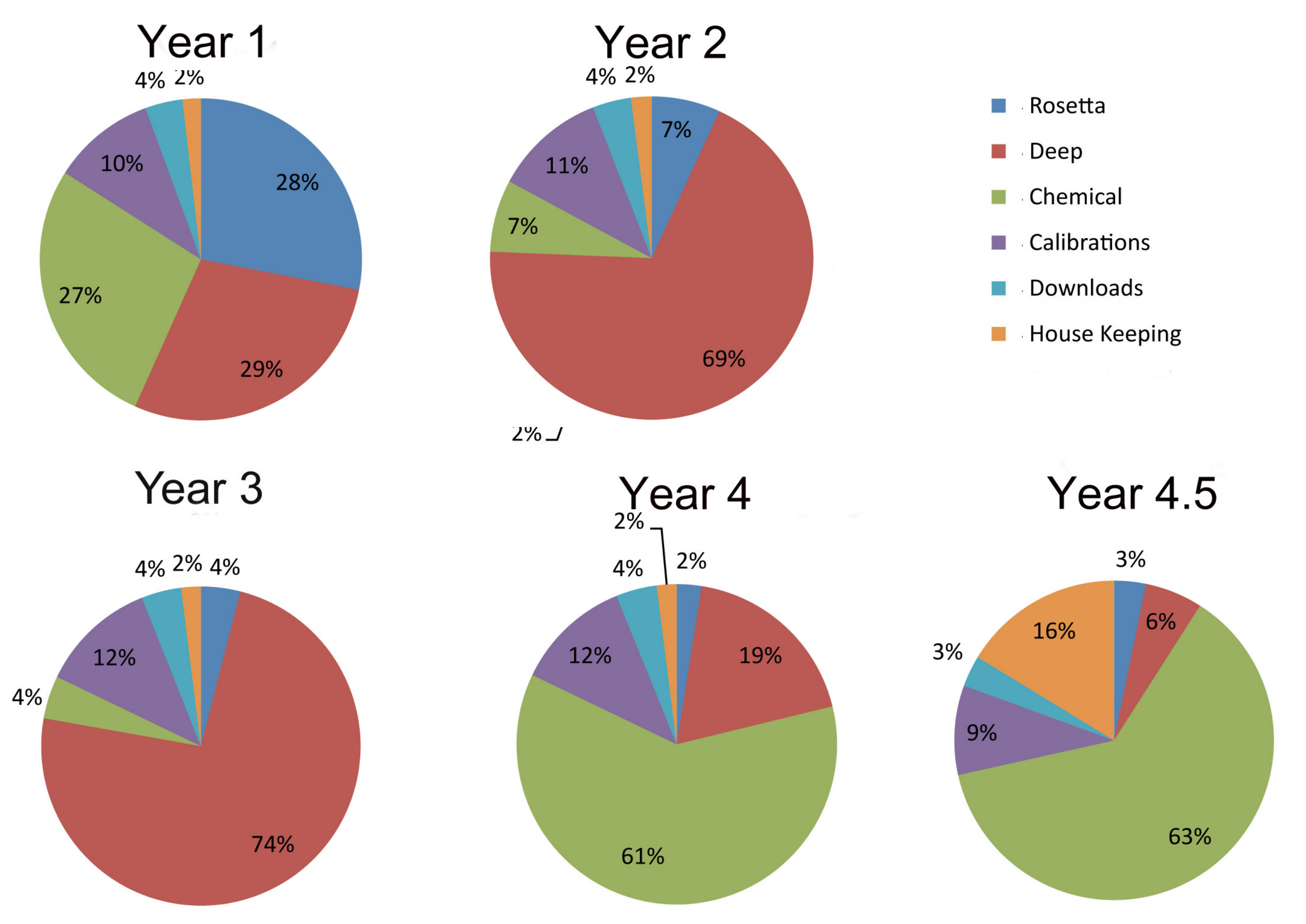


Figure 9: Statistics of different types of observations during the EChO mission. We can the evolution with time of relative importance of the different surveys.

Conclusions on the EChO survey scheduling

- *The 3 catalogues can be scheduled subsequently quite easily and are not algorithm critical. We can perform the planned survey within the 5 years of the EChO mission.*
- *Both the Chemical census and Origins catalogues are compliant with the requirements of the mission. The used Origins catalogue is actually close to the goals. For the Rosetta stones, we used 8 targets instead of 10 because the requirements evolved between June and September.*

- *The average angle between consecutive targets is around 60 deg, which requires agility of the satellite. Constraining this angle has a strong impact on the scheduling and its efficiency.*

- *The schedule is already dense, but further optimization is possible (Monte Carlo by Ribas et al. show that we should be able to go to about 85 % efficiency).*

- *We could choose to optimize further or to leave these gaps to Open Time.*

- *Repartition of gaps from scheduling the science is mostly compatible with calibration, house keeping and downloads of data.*

- *We have shown that using targets that exist today, we can address the scientific requirements of the EChO mission.*

- *Using brighter targets (to be detected by TESS, NGTS, etc) will either give the possibility to reach the scientific requirements in a shorter period of time, or to increase significantly the number of targets and reach the goals of the EChO mission. Assuming that we stick to our observing visit that lasts 3 transit durations, it should be possible to carry about 800 visits to targets per year (~4000 visits for 5 years) when pushing the optimization. For example, with brighter targets where we could reach the requirement in one transit/occultation, we could devote half of the life time of EChO to a wide survey of ~1000 bright targets, and keep the other half for deep and Rosetta observations. We can meet the science requirements today. There is a possibility to push them one order of magnitude further in 2024.*

- *The 3 catalogues were scheduled over 4.5 years of survey, making sure that it is fully compliant with all the calibrations and technical constraints. We did not push the optimization of the observing time, keeping some of it for the "Open time" of the mission. Would it be possible to do this survey within 3.5 years. Given the Monte Carlo by Ribas et al. showing an efficiency of up to 80-85 %, it should be possible to*

Appendix A: Detailed file formant of lists of targets

For scheduling alone, CNES would like to have an ASCII file containing the minimum but needed observations. We extracted the data from [ECHO-TN-0001-UCL]. An example of such ascii file is given below:

Equinox: J2000
Column KEYWORDS
KEYWORD FORMAT UNIT DESCRIPTION
INDEX 8A - SEQ followed an integer number, number of the sequence to observe
OBS_ID 40A - name of observing sequence
PLANET_ID 30A - Planet name
OBS_TYPE A - T: transit / S: occultation / C: calibration / P: phase curve
RA 10A hh:mm:ss.ss Right Ascension coordinate in hours
DEC 10A dd:mm:ss.s Declination in degrees
PERIOD D days Period of the exoplanet orbit
TREF D HJD-2450000.0 Central transit/occultation reference time
TR_DURATION D minutes Duration of the transit/occultation (from ETD)
OBS_DURATION D minutes Duration of the observation sequence (in minutes centred on the transit/occultation)
PRIO I - 0: top priority / 1: regular priority / 2: low priority
NOBS I - Number of observations needed to reach S/N
OBS_BEFORE 8A - Type of observation done before. N: no requirement /T: transit / S: occultation / C: calibration
OBS_AFTER 8A - Type of observation done after. N: no requirement /T: transit / S: occultation / C: calibration
#
SEQ-3. GJ1214bT GJ1214b T 17:15:19.0 +04:57:50 1.58040482 4980.748795 52.73 240 0 20 N N
SEQ-4. GJ1214bS GJ1214b S 17:15:19.0 +04:57:50 1.58040482 4981.538997 52.73 240 0 220 N N

SEQ-11. HD189733bT HD189733b T 20:00:43.0 +22:42:39 2.21857312 3988.80336 109.06 480 1 10 S S
SEQ-12. HD189733S HD189733b S 20:00:43.0 +22:42:39 2.21857312 3989.912646 109.06 480 1 40 N N

Note : OBS_ID is a string of character used to name a given block for one target. :
PLANET_ID+TYPE_OF_OBS +NOBS+sequence number:

For HD189733b, since it is an active star, we need to have any singly transits bracketed between two occultation observations. We request 10 transits, each of them bracketed by two occultation observations. We will do an additional 20 occultations for a total for 40 occultations.

Appendix B:

ECHO Rosetta Stones catalogue used in scheduling exercise:

SEQ-1. 55CnceT 55Cnce T 08:52:37 +28:20:02 0.7365417 5962.0697 99.64 298.93 0 20 N N

SEQ-2. 55CnceS 55Cnce S 08:52:37 +28:20:02 0.7365417 5962.43797085 99.64 298.93 0 24 N N
SEQ-3. Gliese1214bT Gliese1214b T 17:15:19 +04:57:50 1.58040482 4983.9087558 54.73 164.19 0 20 N N
SEQ-4. Gliese1214bS Gliese1214b S 17:15:19 +04:57:50 1.58040482 4984.69895821 54.73 164.19 0 200 N N
SEQ-5. Gliese436bT Gliese436b T 11:42:11 +26:42:23 2.6438986 4222.6172 42.22 126.66 0 12 N N
SEQ-6. Gliese436bS Gliese436b S 11:42:11 +26:42:23 2.6438986 4223.9391493 42.22 126.66 0 58 N N
SEQ-7. WASP-12bT WASP-12b T 06:30:33 +29:40:20 1.0914222 4508.98074 181.83 545.50 0 10 N N
SEQ-8. WASP-12bS WASP-12b S 06:30:33 +29:40:20 1.0914222 4509.5264511 181.83 545.50 0 30 N N
SEQ-9. WASP-33bT WASP-33b T 02:26:51 +37:33:02 1.21986967 4590.18025 163.12 489.35 0 10 N N
SEQ-10. WASP-33bS WASP-33b S 02:26:51 +37:33:02 1.21986967 4590.79018484 163.12 489.35 0 30 N N
SEQ-11. HD189733bT HD189733b T 20:00:43 +22:42:39 2.21857312 3988.80336 111.40 334.21 0 10 S S
SEQ-12. HD189733bS HD189733b S 20:00:43 +22:42:39 2.21857312 3989.91264656 111.40 334.21 0 30 N N
SEQ-13. HD209458bT HD209458b T 22:03:10 +18:53:04 3.52474859 1370.048 181.01 543.04 0 10 N N
SEQ-14. HD209458bS HD209458b S 22:03:10 +18:53:04 3.52474859 1371.81037429 181.01 543.04 0 30 N N
SEQ-15. HD80606bT HD80606b T 09:22:37.0 +50:36:13 111.43740 5210.6449 698 2100 0 4 N N
SEQ-16. HD80606bS HD80606b S 09:22:37.0 +50:36:13 111.43740 4424.7360 110 600 0 4 N N

ECHO Origins catalogue used in scheduling exercise:

SEQ-17. CoRoT-1bT CoRoT-1b T 06:48:19 -03:06:08 1.5089557 4160.2009 150.75 452.24 1 30 N N
SEQ-18. CoRoT-1bS CoRoT-1b S 06:48:19 -03:06:08 1.5089557 4160.95537785 150.75 452.24 1 15 N N
SEQ-19. Gliese3470bT Gliese3470b T 07:59:06 +15:23:30 3.33671 6090.47705 114.53 343.59 0 3 N N
SEQ-20. HAT-P-1bT HAT-P-1b T 22:57:47 +38:40:30 4.4652934 4363.94726 168.13 504.38 1 5 N N
SEQ-21. HAT-P-1bS HAT-P-1b S 22:57:47 +38:40:30 4.4652934 4366.1799067 168.13 504.38 1 23 N N
SEQ-22. HAT-P-11bT HAT-P-11b T 19:50:50 +48:04:51 4.887804 4605.89132 145.97 437.92 1 5 N N
SEQ-23. HAT-P-13bT HAT-P-13b T 08:39:32 +47:21:07 2.916243 4779.92979 194.39 583.16 1 21 N N
SEQ-24. HAT-P-13bS HAT-P-13b S 08:39:32 +47:21:07 2.916243 4781.3879115 194.39 583.16 1 16 N N
SEQ-25. HAT-P-16bS HAT-P-16b S 00:38:18 +42:27:47 2.77596 5028.98091 182.66 547.98 1 16 N N
SEQ-26. HAT-P-2bS HAT-P-2b S 16:20:36 +41:02:53 5.6334729 4216.29683645 311.57 934.71 1 17 N N
SEQ-27. HAT-P-22bT HAT-P-22b T 10:22:44 +50:07:42 3.21222 4930.22001 174.16 522.47 1 21 N N
SEQ-28. HAT-P-22bS HAT-P-22b S 10:22:44 +50:07:42 3.21222 4931.82612 174.16 522.47 1 7 N N
SEQ-29. HAT-P-23bS HAT-P-23b S 20:24:30 +16:45:44 1.212884 4852.871082 144.55 433.65 1 13 N N
SEQ-30. HAT-P-24bT HAT-P-24b T 07:15:18 +14:15:44 3.35524 5216.97669 220.50 661.50 1 21 N N
SEQ-31. HAT-P-24bS HAT-P-24b S 07:15:18 +14:15:44 3.35524 5218.65431 220.50 661.50 1 32 N N
SEQ-32. HAT-P-32bT HAT-P-32b T 02:01:10 +46:41:16 2.150009 4420.44637 213.61 640.84 1 3 N N
SEQ-33. HAT-P-32bS HAT-P-32b S 02:01:10 +46:41:16 2.150009 4421.5213745 213.61 640.84 1 3 N N
SEQ-34. HAT-P-33bT HAT-P-33b T 07:32:44 +33:50:06 3.474474 5110.92595 277.10 831.29 1 6 N N
SEQ-35. HAT-P-33bS HAT-P-33b S 07:32:44 +33:50:06 3.474474 5112.663187 277.10 831.29 1 10 N N
SEQ-36. HAT-P-36bS HAT-P-36b S 12:33:04 +44:54:55 1.327 -1994434.15506 141.38 424.14 1 16 N N
SEQ-37. HAT-P-4bT HAT-P-4b T 15:19:58 +36:13:47 3.0565114 4365.91538 253.44 760.32 1 23 N N
SEQ-38. HAT-P-4bS HAT-P-4b S 15:19:58 +36:13:47 3.0565114 4367.4436357 253.44 760.32 1 26 N N
SEQ-39. HAT-P-40bT HAT-P-40b T 22:22:03 +45:27:27 4.457243 5813.17584 371.03 1113.09 1 10 N N
SEQ-40. HAT-P-40bS HAT-P-40b S 22:22:03 +45:27:27 4.457243 5815.4044615 371.03 1113.09 1 22 N N
SEQ-41. HAT-P-41bT HAT-P-41b T 19:49:17 +04:40:20 2.69404 4983.86167 247.86 743.57 1 7 N N
SEQ-42. HAT-P-41bS HAT-P-41b S 19:49:17 +04:40:20 2.69404 4985.20869 247.86 743.57 1 7 N N
SEQ-43. HAT-P-6bT HAT-P-6b T 23:39:06 +42:27:58 3.853003 4035.67652 210.97 632.91 1 14 N N
SEQ-44. HAT-P-6bS HAT-P-6b S 23:39:06 +42:27:58 3.853003 4037.6030215 210.97 632.91 1 11 N N
SEQ-45. HAT-P-8bT HAT-P-8b T 22:52:10 +35:26:50 3.0763402 4437.67582 236.49 709.48 1 24 N N
SEQ-46. HAT-P-8bS HAT-P-8b S 22:52:10 +35:26:50 3.0763402 4439.2139901 236.49 709.48 1 11 N N
SEQ-47. HATS-1bT HATS-1b T 11:42:06 -23:21:17 3.446459 -2394758.71278 152.60 457.81 1 5 N N
SEQ-48. HATS-1bS HATS-1b S 11:42:06 -23:21:17 3.446459 -2394756.98955 152.60 457.81 1 23 N N
SEQ-49. HD149026bT HD149026b T 16:30:29 +38:20:50 2.8758916 3317.836 199.38 598.13 1 12 N N
SEQ-50. HD149026bS HD149026b S 16:30:29 +38:20:50 2.8758916 3319.2739458 199.38 598.13 1 14 N N
SEQ-51. KELT-2AbT KELT-2Ab T 06:10:39 +30:57:26 4.1137914 5974.60361 317.83 953.49 1 12 N N
SEQ-52. KELT-2AbS KELT-2Ab S 06:10:39 +30:57:26 4.1137914 5976.6605057 317.83 953.49 1 4 N N
SEQ-53. WASP-1bT WASP-1b T 00:20:40 +31:59:24 2.5199464 4774.3502 215.96 647.88 1 21 N N

SEQ-54. WASP-1bS WASP-1b S 00:20:40 +31:59:24 2.5199464 4775.6101732 215.96 647.88 1 19 N N
SEQ-55. WASP-13bT WASP-13b T 09:20:25 +33:52:57 4.353011 5575.5143 253.82 761.47 1 2 N N
SEQ-56. WASP-13bS WASP-13b S 09:20:25 +33:52:57 4.353011 5577.6908055 253.82 761.47 1 8 N N
SEQ-57. WASP-15bT WASP-15b T 13:55:43 -32:09:35 3.7520656 4584.69823 224.77 674.32 1 8 N N
SEQ-58. WASP-15bS WASP-15b S 13:55:43 -32:09:35 3.7520656 4586.5742628 224.77 674.32 1 21 N N
SEQ-59. WASP-17bT WASP-17b T 15:59:51 -28:03:42 3.735438 4577.85879 227.48 682.45 1 2 N N
SEQ-60. WASP-17bS WASP-17b S 15:59:51 -28:03:42 3.735438 4579.726509 227.48 682.45 1 10 N N
SEQ-61. WASP-18bS WASP-18b S 01:37:25 -45:40:40 0.9414518 5085.2636569 131.61 394.83 1 1 N N
SEQ-62. WASP-19bT WASP-19b T 09:53:40 -45:39:33 0.78884 5252.58584 96.96 290.87 1 20 N N
SEQ-63. WASP-19bS WASP-19b S 09:53:40 -45:39:33 0.78884 5252.98026 96.96 290.87 1 5 N N
SEQ-64. WASP-21bT WASP-21b T 23:09:58 +18:23:46 4.322506 5084.52049 188.88 566.65 1 4 N N
SEQ-65. WASP-29bT WASP-29b T 23:51:31 -39:54:24 3.922727 5320.23485 166.26 498.77 1 5 N N
SEQ-66. WASP-3bT WASP-3b T 18:34:32 +35:39:42 1.8468372 4605.55978 170.78 512.33 1 23 N N
SEQ-67. WASP-3bS WASP-3b S 18:34:32 +35:39:42 1.8468372 4606.4831986 170.78 512.33 1 4 N N
SEQ-68. WASP-4bT WASP-4b T 23:34:15 -42:03:41 1.33823187 4697.798226 160.92 482.76 1 28 N N
SEQ-69. WASP-4bS WASP-4b S 23:34:15 -42:03:41 1.33823187 4698.46734193 160.92 482.76 1 9 N N
SEQ-70. WASP-41bT WASP-41b T 12:42:28 -30:38:24 3.052394 5343.464 173.46 520.39 1 17 N N
SEQ-71. WASP-41bS WASP-41b S 12:42:28 -30:38:24 3.052394 5344.990197 173.46 520.39 1 26 N N
SEQ-72. WASP-43bT WASP-43b T 10:19:38 -09:48:23 0.81347753 5726.54336 73.76 221.27 1 24 N N
SEQ-73. WASP-43bS WASP-43b S 10:19:38 -09:48:23 0.81347753 5726.95009877 73.76 221.27 1 4 N N
SEQ-74. WASP-54bT WASP-54b T 13:41:49 -00:07:41 3.6936411 5518.35087 200.49 601.46 1 2 N N
SEQ-75. WASP-54bS WASP-54b S 13:41:49 -00:07:41 3.6936411 5520.19769055 200.49 601.46 1 6 N N
SEQ-76. WASP-62bT WASP-62b T 05:48:34 -63:59:18 4.411953 5855.39272 229.50 688.49 1 3 N N
SEQ-77. WASP-62bS WASP-62b S 05:48:34 -63:59:18 4.411953 5857.5986965 229.50 688.49 1 10 N N
SEQ-78. WASP-63bT WASP-63b T 06:17:21 -38:19:24 4.37809 5921.6535 323.23 969.69 1 8 N N
SEQ-79. WASP-63bS WASP-63b S 06:17:21 -38:19:24 4.37809 5923.842545 323.23 969.69 1 43 N N
SEQ-80. WASP-67bT WASP-67b T 19:42:59 -19:56:58 4.61442 5824.375 115.81 347.44 1 6 N N
SEQ-81. WASP-7bT WASP-7b T 20:44:10 -39:13:31 4.9546416 5446.63493 243.06 729.19 1 6 N N
SEQ-82. WASP-7bS WASP-7b S 20:44:10 -39:13:31 4.9546416 5449.1122508 243.06 729.19 1 9 N N
SEQ-83. WASP-77AbT WASP-77Ab T 02:28:37 -07:03:38 1.3600309 5870.44977 152.09 456.26 1 10 N N
SEQ-84. WASP-77AbS WASP-77Ab S 02:28:37 -07:03:38 1.3600309 5871.12978545 152.09 456.26 1 2 N N
SEQ-85. WASP-79bT WASP-79b T 04:25:29 -30:36:02 3.6623817 6285.035358 372.89 1118.66 1 2 N N
SEQ-86. WASP-79bS WASP-79b S 04:25:29 -30:36:02 3.6623817 6286.86654885 372.89 1118.66 1 2 N N
SEQ-87. WASP-80bT WASP-80b T 20:12:40 -02:08:44 3.0678504 6125.417512 126.75 380.24 1 4 N N
SEQ-88. WASP-80bS WASP-80b S 20:12:40 -02:08:44 3.0678504 6126.9514372 126.75 380.24 1 24 N N
SEQ-89. XO-1bT XO-1b T 16:02:12 +28:10:11 3.9415128 3808.9177 180.13 540.39 0 18 N N
SEQ-90. XO-1bS XO-1b S 16:02:12 +28:10:11 3.9415128 3810.8884564 180.13 540.39 0 49 N N
SEQ-91. XO-2bT XO-2b T 07:48:07 +50:13:33 2.615838 4466.88535 159.44 478.32 0 20 N N
SEQ-92. XO-2bS XO-2b S 07:48:07 +50:13:33 2.615838 4468.193269 159.44 478.32 0 39 N N

ECHO Chemical Census catalogue used in scheduling exercise:

SEQ-93 CoRoT-11bS CoRoT-11b S 18:42:45 +05:56:16 2.994325 4599.1768625 87.70 263.09 1 17 N N
SEQ-94 CoRoT-19bS CoRoT-19b S 06:28:08 -00:10:15 3.89713 5259.390365 281.08 843.23 1 17 N N
SEQ-95 CoRoT-2bT CoRoT-2b T 19:27:07 +01:23:02 1.7429964 4237.53562 136.85 410.56 1 14 N N
SEQ-96 CoRoT-2bS CoRoT-2b S 19:27:07 +01:23:02 1.7429964 4238.4071182 136.85 410.56 1 2 N N
SEQ-97 CoRoT-5bT CoRoT-5b T 06:45:07 +00:48:55 4.0378962 4400.19963 189.49 568.48 1 3 N N
SEQ-98 CoRoT-5bS CoRoT-5b S 06:45:07 +00:48:55 4.0378962 4402.2185781 189.49 568.48 1 9 N N
SEQ-99 HAT-P-12bT HAT-P-12b T 13:57:34 +43:29:37 3.2130598 4419.19556 142.95 428.84 1 1 N N
SEQ-100 HAT-P-14bS HAT-P-14b S 17:20:28 +38:14:32 4.627657 5312.6047685 85.61 256.84 1 7 N N
SEQ-101 HAT-P-15bT HAT-P-15b T 04:24:60 +39:27:38 10.863502 -2395361.43981 276.03 828.09 1 16 N N
SEQ-102 HAT-P-17bT HAT-P-17b T 21:38:09 +30:29:19 10.338523 4801.16943 226.26 678.79 1 1 N N
SEQ-103 HAT-P-17bS HAT-P-17b S 21:38:09 +30:29:19 10.338523 4806.3386915 226.26 678.79 1 11 N N
SEQ-104 HAT-P-18bT HAT-P-18b T 17:05:24 +33:00:45 5.508023 4715.02174 171.37 514.10 1 1 N N
SEQ-105 HAT-P-19bT HAT-P-19b T 00:38:04 +34:42:42 4.008778 -1994908.46583 162.37 487.10 1 1 N N

SEQ-106 HAT-P-20bT HAT-P-20b T 07:27:40 +24:20:11 2.875317 5080.92661 111.42 334.26 1 16 N N
SEQ-107 HAT-P-20bS HAT-P-20b S 07:27:40 +24:20:11 2.875317 5082.3642685 111.42 334.26 1 5 N N
SEQ-108 HAT-P-21bS HAT-P-21b S 11:25:06 +41:01:41 4.124461 4998.4753505 195.90 587.69 1 15 N N
SEQ-109 HAT-P-23bT HAT-P-23b T 20:24:30 +16:45:44 1.212884 4852.26464 144.55 433.65 1 19 N N
SEQ-110 HAT-P-25bT HAT-P-25b T 03:13:45 +25:11:51 3.652836 5176.85173 167.40 502.20 1 4 N N
SEQ-111 HAT-P-25bS HAT-P-25b S 03:13:45 +25:11:51 3.652836 5178.678148 167.40 502.20 1 16 N N
SEQ-112 HAT-P-27bT HAT-P-27b T 14:51:04 +05:56:50 3.039577 5186.01879 102.03 306.09 1 7 N N
SEQ-113 HAT-P-27bS HAT-P-27b S 14:51:04 +05:56:50 3.039577 5187.5385785 102.03 306.09 1 16 N N
SEQ-114 HAT-P-28bT HAT-P-28b T 00:52:00 +34:43:42 3.257215 5417.59832 190.52 571.56 1 8 N N
SEQ-115 HAT-P-28bS HAT-P-28b S 00:52:00 +34:43:42 3.257215 5419.2269275 190.52 571.56 1 15 N N
SEQ-116 HAT-P-29bT HAT-P-29b T 02:12:31 +51:46:44 5.72318 5197.5754 206.94 620.83 1 13 N N
SEQ-117 HAT-P-3bT HAT-P-3b T 13:44:23 +48:01:43 2.899703 4856.70195 124.73 374.20 1 6 N N
SEQ-118 HAT-P-3bS HAT-P-3b S 13:44:23 +48:01:43 2.899703 4858.1518015 124.73 374.20 1 13 N N
SEQ-119 HAT-P-31bS HAT-P-31b S 18:06:09 +26:25:36 5.005425 4323.3893125 262.44 787.31 1 15 N N
SEQ-120 HAT-P-34bS HAT-P-34b S 20:12:47 +18:06:18 5.4527 -2394565.67736 256.89 770.68 1 6 N N
SEQ-121 HAT-P-35bS HAT-P-35b S 08:13:00 +04:47:13 3.6467 5580.48416 234.20 702.59 1 13 N N
SEQ-122 HAT-P-38bT HAT-P-38b T 02:21:32 +32:14:47 4.640382 5863.11957 180.79 542.36 1 7 N N
SEQ-123 HAT-P-39bT HAT-P-39b T 07:35:02 +17:49:48 3.54387 5208.75049 253.33 760.00 1 4 N N
SEQ-124 HAT-P-39bS HAT-P-39b S 07:35:02 +17:49:48 3.54387 5210.522425 253.33 760.00 1 7 N N
SEQ-125 HAT-P-42bT HAT-P-42b T 09:01:22 +06:05:50 4.641876 5952.52606 243.89 731.66 1 13 N N
SEQ-126 HAT-P-42bS HAT-P-42b S 09:01:22 +06:05:50 4.641876 5954.846998 243.89 731.66 1 10 N N
SEQ-127 HAT-P-43bT HAT-P-43b T 08:35:42 +10:12:24 3.332688 22109997.3711 196.22 588.67 1 13 N N
SEQ-128 HAT-P-5bT HAT-P-5b T 18:17:37 +36:37:18 2.788491 4241.77663 170.92 512.76 1 10 N N
SEQ-129 HAT-P-5bS HAT-P-5b S 18:17:37 +36:37:18 2.788491 4243.1708755 170.92 512.76 1 6 N N
SEQ-130 HAT-P-7bT HAT-P-7b T 19:28:59 +47:58:10 2.204737 4342.42691 232.02 696.06 1 7 N N
SEQ-131 HAT-P-7bS HAT-P-7b S 19:28:59 +47:58:10 2.204737 4343.5292785 232.02 696.06 1 1 N N
SEQ-132 HAT-P-9bT HAT-P-9b T 07:20:40 +37:08:26 3.922814 4417.9085 204.75 614.25 1 6 N N
SEQ-133 HAT-P-9bS HAT-P-9b S 07:20:40 +37:08:26 3.922814 4419.869907 204.75 614.25 1 11 N N
SEQ-134 HATS-2bS HATS-2b S 11:46:57 -22:21:46 1.354133 5955.2628265 124.34 373.02 1 6 N N
SEQ-135 HATS-3bT HATS-3b T 20:49:59 -24:25:44 3.547849 6092.10547 242.80 728.40 1 7 N N
SEQ-136 HATS-3bS HATS-3b S 20:49:59 -24:25:44 3.547849 6093.8793945 242.80 728.40 1 4 N N
SEQ-137 Kepler-12bT Kepler-12b T 19:04:58 50:02:25 4.4379637 5004.00835 280.19 840.56 1 2 N N
SEQ-138 Kepler-12bS Kepler-12b S 19:04:58 50:02:25 4.4379637 5006.22733185 280.19 840.56 1 8 N N
SEQ-139 KOI-13bS KOI-13b S 19:07:53 +46:52:06 1.7635892 5139.6256946 277.03 831.10 1 2 N N
SEQ-140 KOI-254bT KOI-254b T 19:31:30 +41:03:51 2.455239 5160.956396 111.60 334.80 0 30 N N
SEQ-141 OGLE2-TR-L9bS OGLE2-TR-L9b S 11:07:55 -61:08:46 2.4855335 4494.04284675 216.53 649.58 1 4 N N
SEQ-142 TrES-1bT TrES-1b T 19:04:09 +36:37:57 3.0300722 3898.876696 154.17 462.52 1 3 N N
SEQ-143 TrES-1bS TrES-1b S 19:04:09 +36:37:57 3.0300722 3900.3917321 154.17 462.52 1 5 N N
SEQ-144 TrES-2AbT TrES-2Ab T 19:07:14 +49:18:59 2.470613402 4502.56227 115.76 347.28 1 8 N N
SEQ-145 TrES-2AbS TrES-2Ab S 19:07:14 +49:18:59 2.470613402 4503.7975767 115.76 347.28 1 4 N N
SEQ-146 TrES-3bS TrES-3b S 17:52:07 +37:32:46 1.30618608 5359.51945304 90.99 272.98 1 7 N N
SEQ-147 TrES-5bS TrES-5b S 20:20:53 +59:26:55 1.4822446 5443.9951023 109.14 327.43 1 8 N N
SEQ-148 WASP-10bT WASP-10b T 23:15:58 +31:27:46 3.0927616 4664.033369 138.56 415.67 1 6 N N
SEQ-149 WASP-10bS WASP-10b S 23:15:58 +31:27:46 3.0927616 4665.5797498 138.56 415.67 1 3 N N
SEQ-150 WASP-11bT WASP-11b T 03:09:29 +30:40:25 3.722469 4759.68683 160.36 481.09 1 1 N N
SEQ-151 WASP-11bS WASP-11b S 03:09:29 +30:40:25 3.722469 4761.5480645 160.36 481.09 1 8 N N
SEQ-152 WASP-14bT WASP-14b T 14:33:06 +21:53:41 2.2437661 4463.57657 168.70 506.11 1 14 N N
SEQ-153 WASP-14bS WASP-14b S 14:33:06 +21:53:41 2.2437661 4464.69845305 168.70 506.11 1 1 N N
SEQ-154 WASP-2AbT WASP-2Ab T 20:30:54 +06:25:46 2.15222144 5147.25721 107.24 321.72 1 4 N N
SEQ-155 WASP-2AbS WASP-2Ab S 20:30:54 +06:25:46 2.15222144 5148.33332072 107.24 321.72 1 4 N N
SEQ-156 WASP-22bT WASP-22b T 03:31:16 -23:49:11 3.5327313 5497.40043 195.22 585.66 1 4 N N
SEQ-157 WASP-22bS WASP-22b S 03:31:16 -23:49:11 3.5327313 5499.16679565 195.22 585.66 1 8 N N
SEQ-158 WASP-24bT WASP-24b T 15:08:52 +02:20:36 2.3412083 5081.38018 130.56 391.67 1 20 N N
SEQ-159 WASP-24bS WASP-24b S 15:08:52 +02:20:36 2.3412083 5082.55078415 130.56 391.67 1 8 N N

SEQ-160 WASP-25bT WASP-25b T 13:01:26 -27:31:20 3.76483 5274.99727 169.97 509.92 1 1 N N
SEQ-161 WASP-25bS WASP-25b S 13:01:26 -27:31:20 3.76483 5276.879685 169.97 509.92 1 3 N N
SEQ-162 WASP-26bT WASP-26b T 00:18:25 -15:16:02 2.7566004 5228.38916 153.36 460.09 1 5 N N
SEQ-163 WASP-26bS WASP-26b S 00:18:25 -15:16:02 2.7566004 5229.7674602 153.36 460.09 1 3 N N
SEQ-164 WASP-28bT WASP-28b T 23:34:28 -01:34:48 3.408821 5116.5573 185.41 556.23 1 12 N N
SEQ-165 WASP-28bS WASP-28b S 23:34:28 -01:34:48 3.408821 5118.2617105 185.41 556.23 1 13 N N
SEQ-166 WASP-31bT WASP-31b T 11:17:45 -19:03:17 3.405909 5192.6895 161.18 483.55 1 2 N N
SEQ-167 WASP-31bS WASP-31b S 11:17:45 -19:03:17 3.405909 5194.3924545 161.18 483.55 1 5 N N
SEQ-168 WASP-34bT WASP-34b T 11:01:36 -23:51:38 4.3176782 4647.55434 84.50 253.51 1 1 N N
SEQ-169 WASP-34bS WASP-34b S 11:01:36 -23:51:38 4.3176782 4649.7131791 84.50 253.51 1 5 N N
SEQ-170 WASP-36bS WASP-36b S 08:45:19 -08:01:37 1.5373653 5570.60677265 110.55 331.64 1 7 N N
SEQ-171 WASP-37bS WASP-37b S 14:47:47 +01:03:54 3.577471 5340.4083355 189.99 569.96 1 14 N N
SEQ-172 WASP-38bT WASP-38b T 16:15:50 +10:01:57 6.87188 5335.92127 282.53 847.59 1 6 N N
SEQ-173 WASP-38bS WASP-38b S 16:15:50 +10:01:57 6.87188 5339.35721 282.53 847.59 1 3 N N
SEQ-174 WASP-39bT WASP-39b T 14:29:18 -03:26:40 4.055259 5342.9696 169.02 507.05 1 1 N N
SEQ-175 WASP-39bS WASP-39b S 14:29:18 -03:26:40 4.055259 5344.9972295 169.02 507.05 1 9 N N
SEQ-176 WASP-47bT WASP-47b T 22:04:49 -12:01:08 4.1591399 5764.34677 215.68 647.05 1 7 N N
SEQ-177 WASP-47bS WASP-47b S 22:04:49 -12:01:08 4.1591399 5766.42633995 215.68 647.05 1 7 N N
SEQ-178 WASP-5bT WASP-5b T 23:57:24 -41:16:38 1.6284246 4375.6251 144.84 434.51 1 18 N N
SEQ-179 WASP-5bS WASP-5b S 23:57:24 -41:16:38 1.6284246 4376.4393123 144.84 434.51 1 3 N N
SEQ-180 WASP-50bT WASP-50b T 02:54:45 -10:53:53 1.955096 5859.691755 108.95 326.84 1 12 N N
SEQ-181 WASP-50bS WASP-50b S 02:54:45 -10:53:53 1.955096 5860.669303 108.95 326.84 1 5 N N
SEQ-182 WASP-55bT WASP-55b T 13:55:02 -17:30:13 4.465633 5737.94039 212.15 636.46 1 3 N N
SEQ-183 WASP-55bS WASP-55b S 13:55:02 -17:30:13 4.465633 5740.1732065 212.15 636.46 1 11 N N
SEQ-184 WASP-56bT WASP-56b T 12:13:27 +23:03:20 4.617101 5730.799 191.75 575.26 1 5 N N
SEQ-185 WASP-56bS WASP-56b S 12:13:27 +23:03:20 4.617101 5733.1075505 191.75 575.26 1 20 N N
SEQ-186 WASP-6bT WASP-6b T 23:12:38 -22:40:26 3.361006 4596.43341 165.11 495.33 1 3 N N
SEQ-187 WASP-6bS WASP-6b S 23:12:38 -22:40:26 3.361006 4598.113913 165.11 495.33 1 16 N N
SEQ-188 WASP-61bS WASP-61b S 05:01:12 -26:03:15 3.8559 5861.45696 238.48 715.45 1 15 N N
SEQ-189 WASP-64bT WASP-64b T 06:44:28 -32:51:30 1.57329 5582.60169 142.05 426.14 1 13 N N
SEQ-190 WASP-64bS WASP-64b S 06:44:28 -32:51:30 1.57329 5583.388335 142.05 426.14 1 4 N N
SEQ-191 WASP-66bT WASP-66b T 10:32:54 -34:59:23 4.086052 5929.09693 273.44 820.32 1 20 N N
SEQ-192 WASP-66bS WASP-66b S 10:32:54 -34:59:23 4.086052 5931.139956 273.44 820.32 1 3 N N
SEQ-193 WASP-71bT WASP-71b T 01:57:03 +00:45:32 2.9036747 5738.8505 136.28 408.85 1 5 N N
SEQ-194 WASP-71bS WASP-71b S 01:57:03 +00:45:32 2.9036747 5740.30233735 136.28 408.85 1 2 N N
SEQ-195 WASP-72bS WASP-72b S 02:44:09 -30:10:08 2.21672 5584.76126 183.88 551.65 1 7 N N
SEQ-196 WASP-78bT WASP-78b T 04:15:02 -22:06:59 2.17517656 5882.35953 282.41 847.22 1 6 N N
SEQ-197 WASP-78bS WASP-78b S 04:15:02 -22:06:59 2.17517656 5883.44711828 282.41 847.22 1 2 N N
SEQ-198 WASP-8bT WASP-8b T 23:59:36 -35:01:53 8.158715 4679.33394 210.57 631.71 1 4 N N
SEQ-199 WASP-8bS WASP-8b S 23:59:36 -35:01:53 8.158715 4683.4132975 210.57 631.71 1 4 N N
SEQ-200 XO-3bS XO-3b S 04:21:53 +57:49:01 3.1915239 4866.36260195 171.94 515.83 1 3 N N
SEQ-201 XO-4bT XO-4b T 07:21:33 +58:16:05 4.1250823 4485.933 265.74 797.22 1 12 N N
SEQ-202 XO-4bS XO-4b S 07:21:33 +58:16:05 4.1250823 4487.99554115 265.74 797.22 1 5 N N
SEQ-203 XO-5bS XO-5b S 07:46:52 +39:05:41 4.1877537 4487.77807685 186.21 558.62 1 17 N N