EVLA Memo No. 225
VLA Dynamic Scheduling and the Effects of Bad Weather

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Abstract

This document aims to evaluate the current interplay between weather constraints, high frequencies and dynamic scheduling in VLA observations. The analyzes made use of the VLA Utilization Reports (2011–2022) and the Tracking VLA Observations spreadsheets (2015A–2022B). The key findings were: i) a tiny fraction of the time (0.22%) is spent on observations discarded by bad weather conditions; ii) observations at high frequencies only use a fraction of the observable time, which can be as low as 51%; iii) the completion rate of priority programs is lower than expected and could be increased by 10% if current allocation rates are maintained. The probable causes are a restrictive assessment of the weather conditions and a poor prioritization of observations with greater weather restrictions in the dynamic scheduling. These findings need to be confirmed by a deeper analysis that includes the impact of clouds on high frequency observations, the constraints imposed by array reconfigurations and the schedule performance per LST range.

Utilization Reports: 2011–2022

The VLA Utilization Report is a monthly publication by VLA Operations. The data from these reports are entered into a database in Charlottesville, where observatory metrics are organized and reported to NSF. These reports offer complementary data presented on EVLA memos 220 and 221. While the mentioned memos focus only on dynamic scheduling time from the VLA's scheduler OST (Observation Scheduling Tool), the reports cover all possible array usage modes.

The VLA utilization is classified in seven categories:

- Maintenance (*maint*): time allotted for maintenance work where the array is not available. For the most part this is composed of the weekly scheduled maintenance periods, currently once a week.
- Test/Calc (*test*): time covers scheduled Software testing periods (two days per week), startup array testing after Maintenance, pointing runs, periodic polarization calibration runs and stress tests, and any other test observations that are run overnight (most project codes starting with the letter "T").
- Holiday (*holiday*): planned interruptions on Holidays. Mostly around Thanksgiving and Christmas.
- Scheduled (*sched*): time where Science observations are executed with dynamic scheduling. Tests in dynamic scheduling are counted as Test/Calc. Within Scheduled there is a division called "Lost time" (*s:lost*). This is further subdivided into smaller events, including inclement weather conditions (*s:lost:w*) and technical issues.
- Unscheduled (*unshed*): any time outside of scheduled Maintenance periods, Software testing periods, or the Holiday shutdowns is potential observing time. If nothing was available to be run then it's counted as Unscheduled.
- Weather (*weather*): bad weather prevented observing. These are usually borderline conditions: high-winds or snow.
- Other (*other*): conditions that do not apply to the previous cases. This includes U.S. government shutdown periods and major technical events, such as Power Outages and Correlator Failures.

This document focuses on aborted or failed observations due to "bad weather", defined as exceeding atmospheric phase limits (APL values specified by the observer) or wind speed (observer specified or due to the limitation of the telescope). They are therefore computed as "lost time" of array usage.

Note that if an observation was aborted then the time employed is also categorized as Unscheduled, unless it was due to a major failure of the system (then the time is added to Test/Calc usually, or sometimes Maintenance depending on the failure) or bad weather prevented observing (Weather).

Also, during both Maintenance and Testing periods, there is some software testing and maintenance happening at the same time where it fits in without disrupting the primary reason for the scheduled period. These are not counted separately.

Figure 1 and Table 1 show how time was spent in each VLA array operation mode. They are grouped by month by month, as this is how the values are reported in the Utilization Reports.

Figure 1: *VLA monthly utilization as percentage of the total available time. For details of the categories, see the text. Data from VLA Utilization Reports.*

Table 1: *Array mode monthly averages and their standard deviation for each category from the VLA Utilization Reports. (2011–2022)*

usage mode	**average (%)**	**std. deviation**
sched	66.5	12.7
test	19.3	7.1
maint	5.6	3.1
unshed	4.1	3.9
other	2.9	13.6
holiday	0.66	1.45
weather	0.35	0.81

In short, between 2011 and 2022, two-thirds of the array time was spent on Scheduled time; a quarter was Tests plus Maintenance, and a twelfth for the rest. The Appendix has the monthly distribution of each category with some statistical information (Figures 8 to 14).

Time in Bad Weather Conditions

Counting the time in which an observation was attempted and the results were not good is not straightforward from the Utilization Reports. These events could be accounted for in different categories (usage modes) and so it is difficult to back-track.

For a better quantitative analysis, the VLA Data Analysts (DAs) provided a list of the Execution Blocks (EBs) that were failed/aborted due to observing conditions out of specification (from February 2013 to December 2022). These were either aborted by the Operator or classified as poor during data reduction/quality assessment. Unfortunately it is not possible to distinguish between these two types of events.

The list is presented in the Appendix (Table 2), where a search for trends in their occurrence is carried out (a total of 252 out of 255 EBs; three of them were counted as less than one minute). Note that we also include EBs that were failed by power glitches that may have been caused by adverse weather conditions (therefore more comprehensive than just wind speed and APL values). The results are in Figures 15 to 18.

In summary, the observing band, time of year, or array configuration do not change the probability of occurrence of these events. The amount of EBs in bad weather that overlapped sunrise and sunset was 17.8%, below the VLA average of 30% (see Appendix subsection for details). Regarding the time of day, 65% of the failed EBs were diurnal, confirming that weather issues are more frequent during daytime, when APL is more unstable and when wind gusts are stronger (VLA daytime observation rate is 43%).

Following the definitions from the Utilization Reports, the time associated with the failed EBs would divide between *s:lost:w* and both *unsched* plus *weather* (when the problem was captured during operations) and *sched* (when captured afterwards).

Figure 2 shows that on average bad weather classified *s:lost:w* corresponds to 0.09% of the total hours. This corresponds to ~0.7 hrs/month, or ~8 hrs/year.

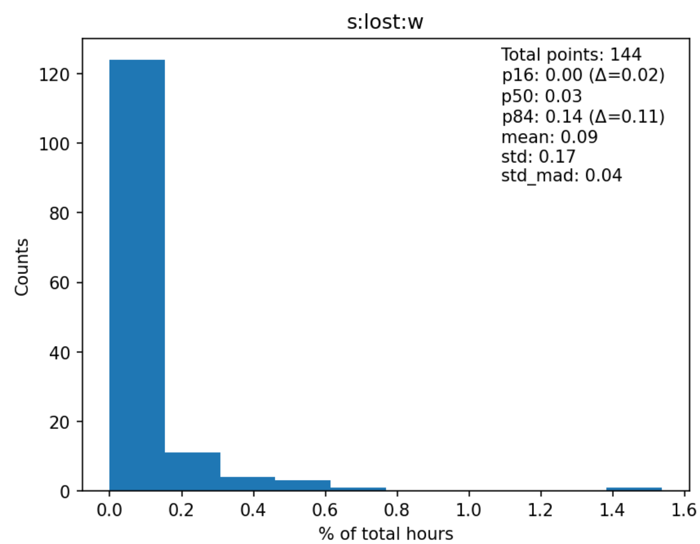

Figure 2: *Histogram of the monthly time spent by the array in the "Time Lost – weather" category as percentage of the total available time.*

Figure 3 shows that on average the time spent on failed EBs are 0.22% of the total hours.

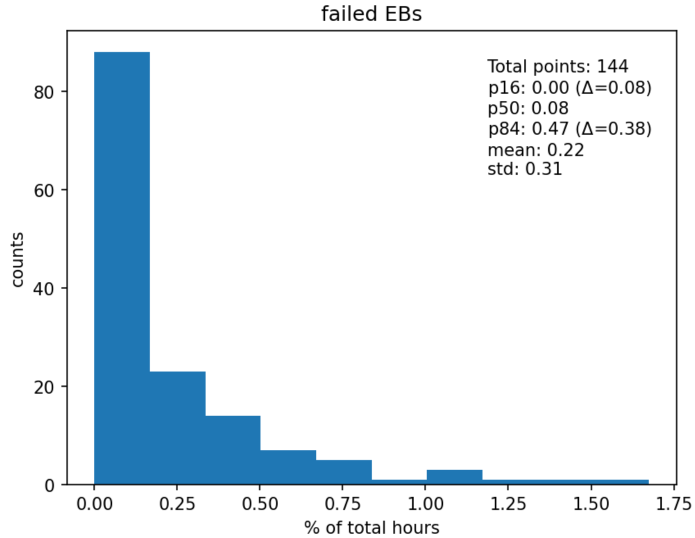

Figure 3: *Histogram of the monthly time spent on bad-weather failed EBs as percentage of the total available time. (Feb 2013–Dec 2022)*

Figure 4 suggests that failed observations due to bad weather divides itself into two approximately equal slices: one captured in loco, and one in data processing. Note that the Utilization Report bars would be higher if we could track times in *unsched* and *weather* categories. Knowing that they combined are 0.22% of the total hours, this corresponds to ~1.7 hrs/month, or ~20 hrs/year.

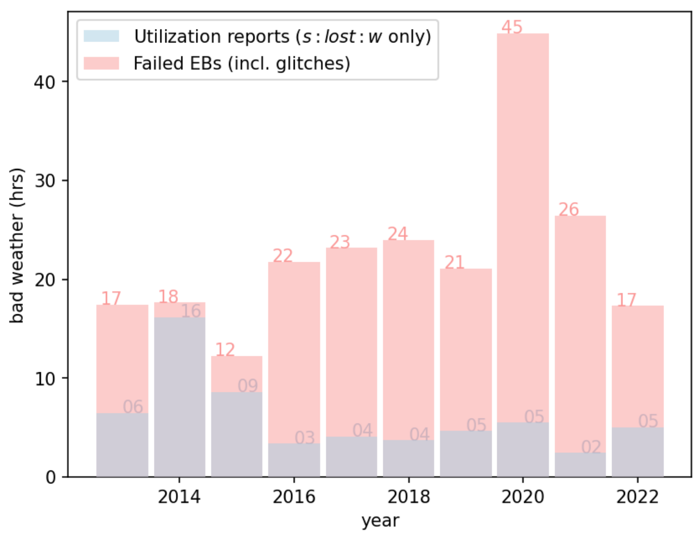

Figure 4: *Comparison of total annual hours spent in the "Time Lost – weather" category in the Utilization Reports (blue bars) and in EBs failed due to bad weather (red bars). The numbers correspond to the rounded value of the bars.*

On the Optimal Time Spent in Bad Weather

The VLA is very resistant to technical issues. Only 2.8% of total hours are lost due to problems during dynamic scheduling (~245 hrs/year; Figure 5). The fact that weather is only a 3.3% of this time lost (0.09% of total time) is already a strong indicator that weather conditions are approached conservatively.

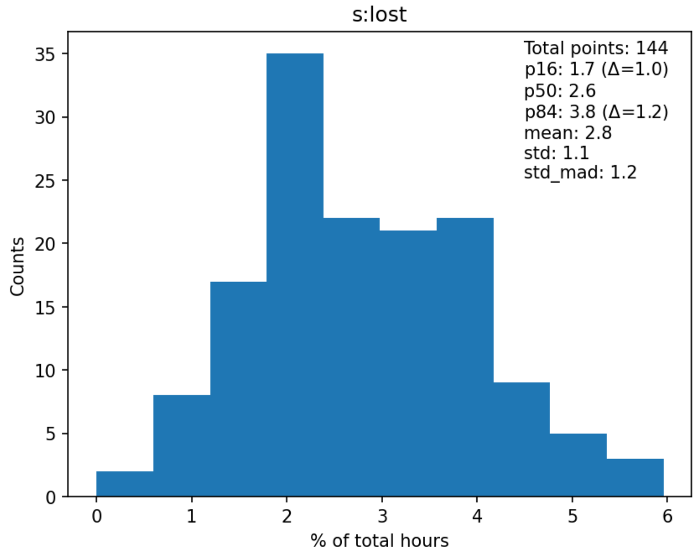

Figure 5: *Histogram of the monthly time spent by the array in the whole "Time Lost" category as percentage of the total available time.*

On a purely qualitative inference, we think that this time should be on the order of time spent with scheduling gaps. This is because gaps are created so that high priority SBs are accommodated in the schedule. As seen in the reference memos, filler SBs are on the order of 20 to 60 minutes, and therefore gaps are typically of this duration (although sometimes shorter). In boundary weather conditions, we believe that if an observation is stable for this timescale (20 to 60 minutes), the chance of it ending up in good condition is quite high – and therefore worth the risk.

EVLA memo 221 estimated that the gaps created by the OST correspond to 3.5% of the total time, but this calculation was not done using a very robust method. The Utilization Reports show that the Unscheduled time is on average 4.1% of the total time, but it is typically 2.7% (median value; Figure 12). As the unscheduled time can grow for a number of reasons (such as bad weather or missing eligible SBs during array configuration changes), the typical value should be very close to that spent on dynamic scheduling gaps.

Tracking VLA Observations: 2015A–2022B

The Tracking VLA Observations spreadsheets are maintained to keep track of the allocation and execution of program blocks each semester. For example, it is important to monitor how many of the program blocks (organized by priority and array configuration) are completed during the semester to ensure that the scheduling is working as planned. These spreadsheets are available since the 2015A semester.

For each semester of VLA observations, the Program Blocks will be associated with one of the two array configurations in the "A" semester, or to a single configuration in the "B" semester. For these, it is expected that they will be completed by the end of the semester or assigned array configuration in that semester. However there are projects that are associated with "Any" array configuration. These are usually programs with triggered observations and/or large programs, and their time allotted for the semester is not expected to be fully completed.

The analysis of the completion rate for the "Any" array configuration (also called multi-semester) programs is in the Appendix (Figures 19 to 22, and Table 4 as a summary). In short, the allocation rate of "Any" programs is around 40%, while for specific configurations it is approximately 90%, corresponding to effective completion rates of about 82%.

Optimal Scheduling

We rely on the Tracking VLA Observations spreadsheets to assess if the dynamic scheduling is working optimally. For that, the following assumptions are made:

- The Tracking VLA Observation spreadsheets contain updated information of the semester allocation times. This may differ from the initial time allocation for the semester;

- Only a fraction of the Program Blocks with "Any" array configuration are expected to be observed in the semester (from 34% to 45%). For the other Program Blocks, it is expected they will be completed;
- Observations are executed normally during array reconfiguration;
- High frequency (HF) observations are defined as belonging to Program Blocks (PBs) using the Ku band or higher frequency band (i.e., Ku, K, Ka or Q bands).

From the point of view of the OST, the following criteria are considered as optimal functioning:

- all allocated A-priority (A) is executed;
- the minimum of C-priority (C) is executed;
- a minimal time is spent on gaps to accommodate priority observations.
- a minimal time is spent on failed observations.

For that to occur, two lower-level requirements are necessary: a) allocated A priorities are up to 50% of the observable time, to allow prioritization; and b) A+B priorities are of the order of the observable time, to fill all scheduled time. Therefore, the dynamic scheduling and the OST performance are directly connected to the ability to predict the observable time in the semester (of both high and low frequencies).

Of the listed criteria, we consider 3.5% of total time or less in gaps to be satisfactory (as seen on EVLA memo 221). We saw here that this value is actually closer to 2.7%, and that the time spent on failed observations is very low (0.22%). Next, we assess how good the other criteria are matched.

Hours of Observation

It is important to have an accurate estimate of how much can be observed with the array in a semester for proper allocation of programs. The expected array scheduled hours (time dedicated to science) is built here as follows:

- the typical array utilization rate (66.5% of the total available time) is used, taking into consideration seasonal effects (i.e., that winter has longer nights and the array spends more time on nighttime observations);
- observable high frequencies (HF) are considered when wind speed and APL constraints match K band or higher frequencies. Its seasonal occurrence is based on the OST weather logs (EVLA memo 220).

Figure 6 shows that the modeled science time is 97% of the predicted for the semesters (median value). The percentiles p16 and p84 are 75% and 104% respectively, indicating that it is common to observe for less time than predicted. That is expected since the model does not take into account large outage periods (e.g., summer of 2018 and 2020). With a mean of 93% and a standard deviation of 14%, the observability model seems satisfactory.

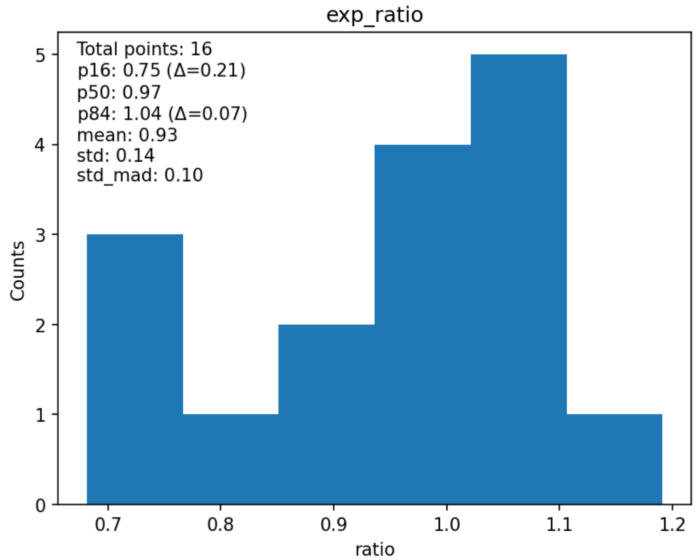

Figure 6: *Histogram of the ratio of actual scheduled time versus its prediction (2015A to 2022B semesters). The prediction follows the prescription in this document.*

On the other hand, the hours applicable to HF show a very different picture (Figure 7). Typically only 56% of the predicted time is observed at HF. The 16% standard deviation is comparable to the total hours, indicating that the model is performing equally well. The low average value (51%) suggests that the array can considerably increase the observed time at HF. This point is discussed further below.

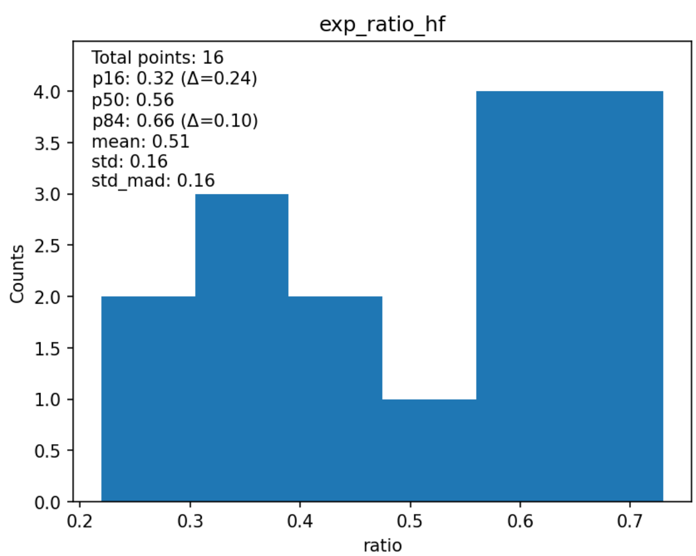

Figure 7: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency).*

A distribution of time by priority each semester can be found in the Appendix (in general, and only for HF; Figures 27 and 28).

The Influence of Clouds on High Frequency Observations

As pointed out by the VLA Observing Guidelines: "*Clouds can cause variations in opacity and Tsys that vary from antenna to antenna based on the extent of the cloud through the direction in which each antenna is pointed... At high frequencies (K-band*

and above), these effects can cause a significant reduction in sensitivity. Under thick cumulonimbus or nimbostratus cloud conditions observing should be limited to Ku-band and lower frequencies... Note that the APL may indicate stable phases even if this is the case, the observing band restriction should be followed." As far as we know, VLA does not have statistics on the incidence of clouds at the site – nor how long HF are excluded in the observation windows.

To know if the shortage of HF observations could be explained by clouds, we relied on NCEI/NOAA Cloudiness data. We estimate that up to 55% of the time clouds could block HF observations (this value is derived in the Appendix). Therefore, if the cloud cover is not correlated (or is anti-correlated) with the off-limit weather constraints, the presence of clouds at ~55% of the time could explain why only 51% of the HF available time is used by the VLA. The analyzes involving allocable time at HF are limited here since this sky cover and its correlation with weather constraints is a rough estimate. For example, it is well known that the incidence of clouds in summer is greater than the rest of the year. Nevertheless, the analyzes involving all frequencies remain valid, as well as the analysis of the priority fractions observed at HF.

Evaluating the Dynamic Scheduling

The histograms used for the analysis of this section are shown in the Appendix, together with complementary statistical information (Figures 29 to 35).

A-priority Completion Rate

The raw completion ration of A-priority programs is shown in Figures 19 and 20 (together with Table 2). Taking into account the expected observation rate of "Any" programs, they indicate that 82% of A-priority observations are completed on average (81% for HF). Unless the A-priority allocation is high (see below), there is room for improvement of the scheduler.

A-priority Allocation Rate

Figures 29 and 30 show the fraction of A-priority time over the expected time for the semester. For A-priority in general, the typical fraction is 36%, with a mean fraction of 42%. Therefore, A-priority allocations are usually below the ideal factor of 50%. For HF, if we consider only the weather constraints, the allocation is even lower, with median value of 25% and mean of 27%.

First, we point out that we would expect a completion rate close to 100% for these allocation rates (assuming no observing pressure clusters in Local Sidereal Time). Secondly, we do not believe that the HF alone can account for the low completion rate since the completion is almost independent of the bands. Figure 31 shows that HF accounts for 44% of the A-priority allocations. That could be suitably scheduled in the 61% of the time available for HF (EVLA memo 220; to be confirmed by a more accurate estimate of the observable time on HF).

C-priority Observation Rate

Figures 32 and 33 show how much the array spent on C-priority program blocks from the total dynamically observed. The overall value is 33%, which is a strong indicator that the prioritization is not optimized, unless the total of priorities A and B does not fill the entire expected observation time. More is commented in the next subsection.

At HF, the mean observation time for C-priority program blocks is 17%. However, this is not a direct indicator that the scheduler is performing better at these frequencies since we do not know how much of the observable hours are being used.

A+B Priorities Allocation Rate

Figures 34 and 35 show how much of the observable time is filled with A- and B-priority programs. The general value is 73%, while for HF it is 49% if only weather constraints are considered.

In the idealized prioritization for all frequencies, if the array usage is 97% of the predicted time and 73% is filled with A and B-priority observations, 24% of C-priority would be observed (not too far from the 33% found; Fig. 32). For HF, a better estimate of the expected time for the semester is needed for an analysis.

Discussion

In this report, data from the VLA Utilization Reports from 2011 to 2022 were analyzed. On average, two-thirds of the array time was spent on dynamic (scheduled) observations; a quarter was Tests+Maintenance, and a twelfth in other modes. They also show the VLA is very resistant to technical problems: only 2.8% of the total time is lost to problems during observations.

The Utilization Reports allowed a better estimation of the time spent in gaps by the OST. The value of 2.7% of the total time (~237 hrs/year) should be more accurate than the 3.5% inferred by the method described in EVLA memo 221.

Although the Utilization Reports provide valuable information on array usage, it is not possible to obtain directly from them the time spent on observations that were invalidated due to adverse weather conditions. One can only infer a lower limit of 0.09% for the time spent on these observations (~8 hrs/year).

Using a comprehensive list of weather-failed EBs as a reference that includes cases captured during data reduction and/or data quality assessment, we found the average value of 0.22% (~20 hrs/year) spent on bad weather observations. This type of array lost time does not show correlation with the band frequency, time of year, or the array configuration and occurs preferably during daytime.

The time spent in bad weather conditions has to be evaluated in the context of overall dynamic scheduling. For that, we analyzed data from the Tracking VLA Observations spreadsheets from 2015A to 2022B.

The first result that caught our attention was the fact that only 51% of the time observable at high frequencies is used by the array. That observable time is calculated based on monthly averages of recorded weather conditions and array usage. There are some factors that have not been investigated that could decrease the amount of time suitable. Among them, we highlight two: the incidence of programs demanding a lot of time in the bands with greater restrictions (Ka- and Q-band), and the exclusion of high-frequency programs during the presence of clouds. For the first factor, a qualitative analysis does not show this to be the case; for the latter, we found that there is not enough data on the impact of clouds on observations.

It could be argued that the predicted weather conditions for high-frequency observations are overly optimistic. If, on the one hand, it does not consider the impact of clouds, on the other the values used are worse than the reference values displayed on the VLA website. In short, the predicted values considered here are 1.0 m/s worse for the wind speed and 1.0 deg worse for the APL, on average. The values were presented in detail in EVLA memo 220.

Similarly to exaggerating the observable time at high frequencies would be if we underestimated the scheduled time at high frequency. However, that should not have been the case: while for HF allocation we considered all program blocks using Ku-band or higher frequency (wind < 10 m/s and APL < 15 deg), we called observable HF only the time predictions satisfying the K-band constraints (wind < 7 m/s and APL < 10 deg).

We also found that the observability of A- and B-priority programs with "Any" array configuration (a.k.a. "multi-semester") is around 40%, which contrasts with approximately 90% for specific configuration ones. There are no significant changes between low and high frequencies in this case.

There are many ways to build the observation schedule and attribute success to it. We found that 33% of the array time has been used with C-priority programs. At first, this could be a strong indicator that the scheduling prioritization is not working optimally. However, this is not entirely the case. To have a small use of C-priority programs, the allocation of A- plus B-priority should be close to 100%, but it is only 73% (when taking into account that 40% of the allocated "Any" configuration observability). So an "effective" rate of observed priority C programs is 9%, which is not that bad. It is worth noting that this is equivalent to the ~90% observability of A- and B-priority programs calculated by a complementary method.

When we look at A-priority programs only, it is clear that dynamic scheduling could be optimized. The completion rate for this priority is close to 82% with allocations well below 50%, which should lead to a completion rate very close to 100%.

We argue that the OST has been too restrictive in matching weather conditions with observation requirements, given the low use of time at HF. The OST could ease weather constraints to cover more HF and/or priority observations, especially in the event of improvement in wind speed forecast. In a purely qualitative comparison, we expected the time spent on weather-failed observations to be about 3% of the total time, or close to that of scheduling gaps (it is currently 0.22% versus 2.7% on gaps). Forecast recipes for the APL values would be useful (if feasible) to the OST.

There was a perception that there were many high-frequency observations carried over between semesters. We showed that the rate for A-priority carry over is the same regardless of the frequency (~20%). The issue could be related to a small use of observable time at HF.

Referring to its manual, the OST does have a factor for prioritizing the observations based on their weather constraints (called "stringency"). However, the weight assigned to the factor is 10x smaller than the default one (such as the "urgency" and "override" factors). The low use of high frequencies could be associated with the following scenario: weather conditions for high frequencies are rarer to happen, and when they do, high and low frequency program blocks compete with similar priorities to be selected. This association can only be made when a better estimate of the impact of clouds on these observations is available. Although this could explain the low use of HF time, it should not be linked to the high incidence of C-priority observations.

Scheduling is a complex subject and for simplicity we did not detail the use of the Local Sidereal Time (LST) interval by the array. The accumulation of priority program blocks in certain preferred LST intervals (such as the Galactic center) may favor the observation of short blocks (i.e., of C-priority), as seen in EVLA memo 221. All this also needs to be convolved with the program array configuration constraints and the array reconfiguration schedule.

Increasing the efficiency of the OST may not be an easy task, and would eventually require actions outside its scope, such as standardizing the quantity of priority blocks over the entire LST interval (which would happen in the time allocation process).

Acknowledgements

The authors thank A. Mioduszewski and P. Beaklini for discussions, and the VLA Data Analysts team for providing the Execution Block information.

References

- EVLA Memo No. 220 - OST logs 2011-2022: Weather and Forecast
- EVLA Memo No. 221 - OST logs 2011-2022: Temporal and Sidereal Coverage
- Monthly Conditions at the VLA page: https://science.nrao.edu/facilities/vla/proposing/VLA-API-wind/monthly-conditions-at-the-vla
- VLA Observing Guidelines page: https://staff.nrao.edu/vla/ops/onlinedocs/vlaObservingGuidelines.html
- NOAA Comparative Climatic Data page: https://www.ncei.noaa.gov/products/land-based-station/comparative-climatic-data

Appendix

Statistical information in histograms

- **p16**: 16-th percentile
- **p50**: 50-th percentile, or median
- **p84**: 84-th percentile
- **std**: standard deviation
- **std_mad**: standard deviation equivalent from the Median Absolute Deviation (MAD)

p16 to *p84* is equivalent to one standard deviation interval in a normal distribution (interval with 68% of the set).

Utilization Report category distributions

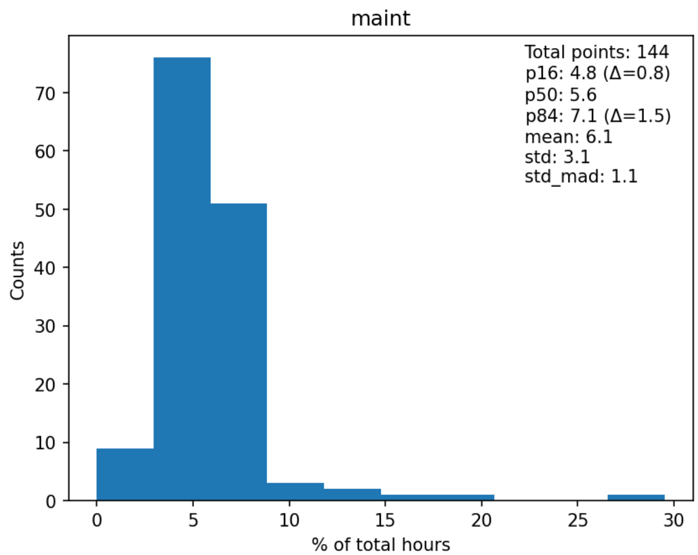

Figure 8: *Histogram of the monthly time spent by the array in the "Maintenance" category as percentage of the total available time.*

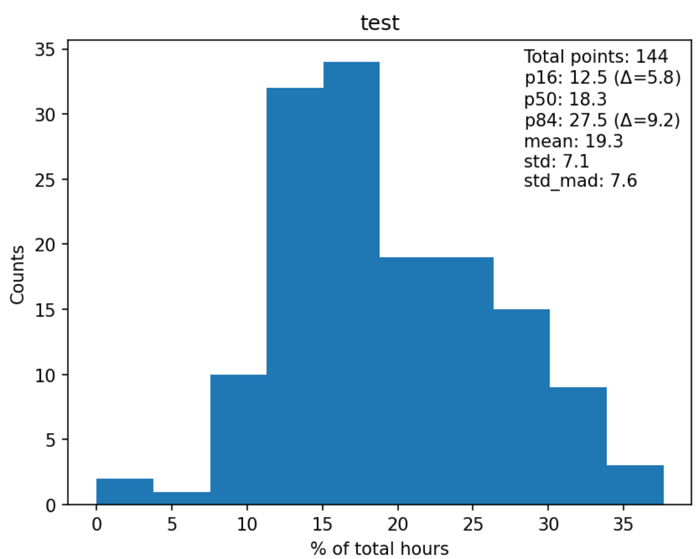

Figure 9: *Same as the previous figure, applied to "Test/Calc" category.*

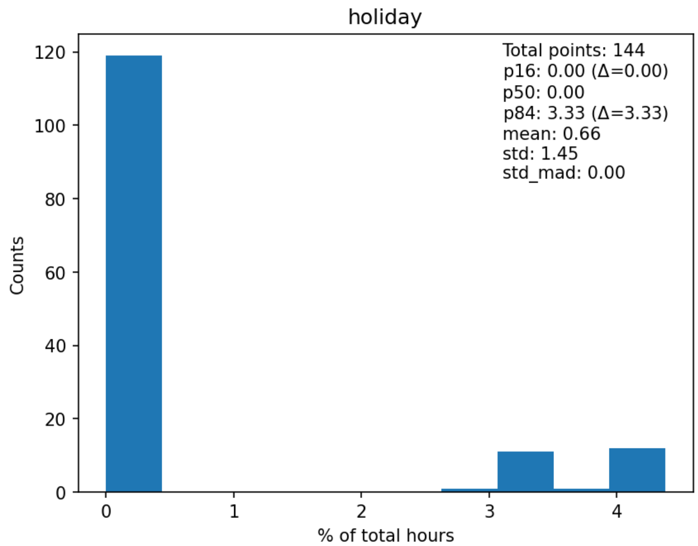

Figure 10: *Same as the previous figure, applied to "Holiday" category.*

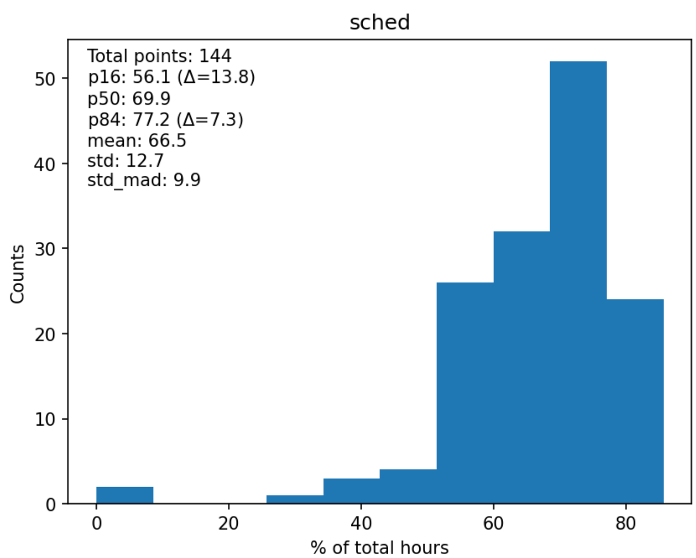

Figure 11: *Same as the previous figure, applied to "Scheduled" category.*

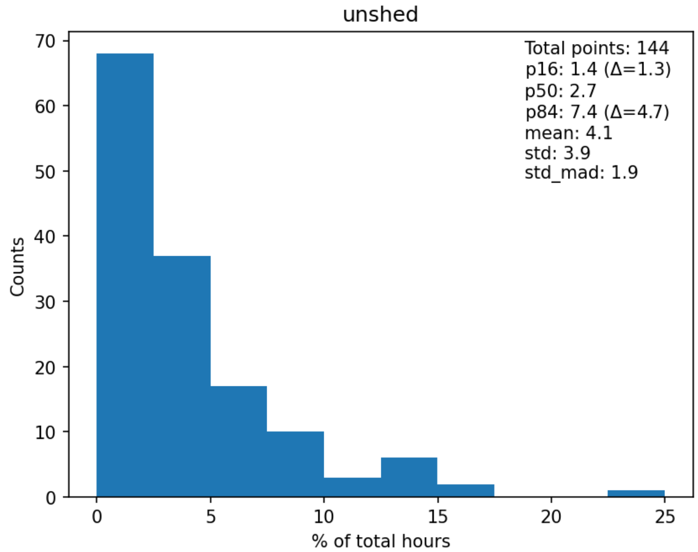

Figure 12: *Same as the previous figure, applied to "Unscheduled" category.*

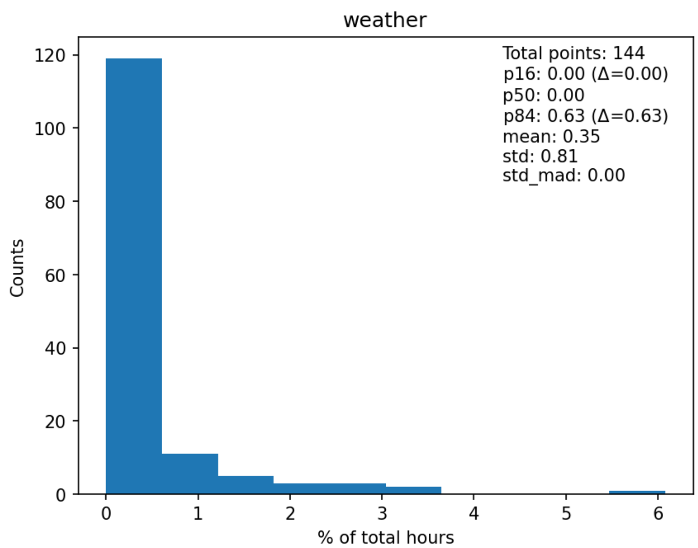

Figure 13: *Same as the previous figure, applied to "Weather" category.*

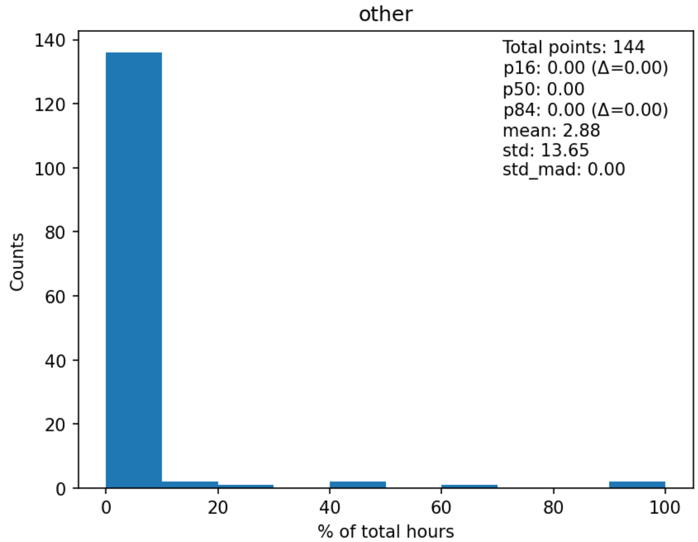

Figure 14: *Same as the previous figure, applied to "Other" category.*

Failed EBs due to bad weather

We assume as a hypothesis that the relative amount of EBs is constant in relation to the used band. If that is true, then the following graphs show that the observing band, time of year, or array configuration do not change the probability of occurrence of EBs failing due to bad weather conditions.

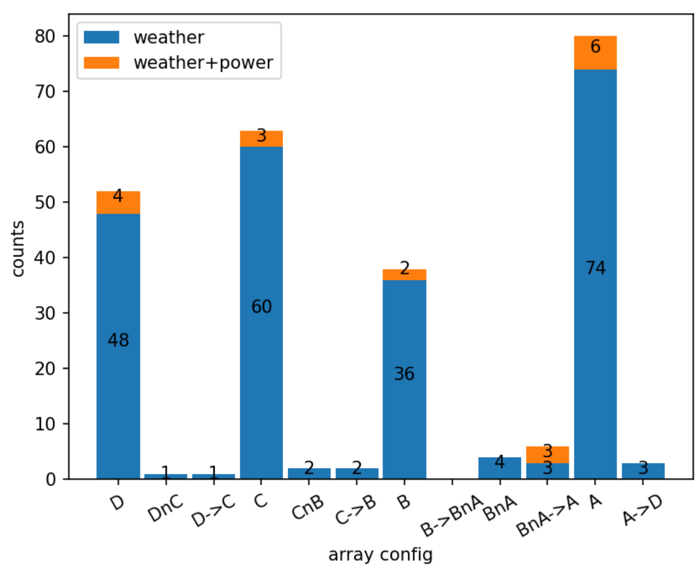

Figure 15: *Number of bad-weather failed EBs per array configuration. The counts approximately follow the observation time in each setting. "weather+power" (orange color) indicates the EBs during power glitches that were likely triggered by adverse weather conditions (Feb 2013–Dec 2022.)*

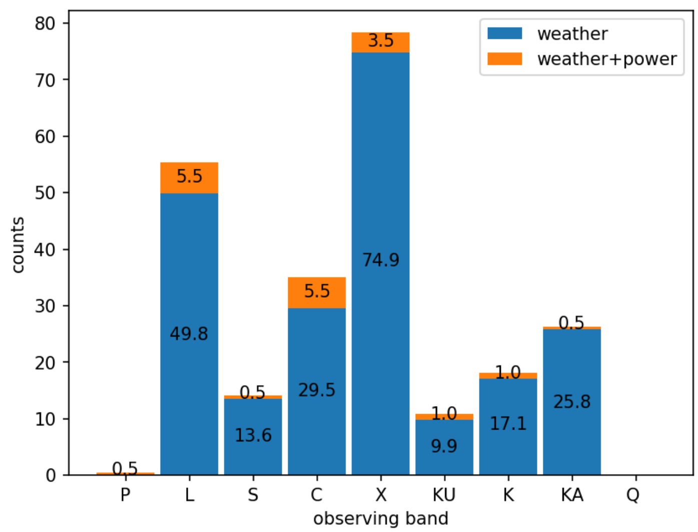

Figure 16: *Number of bad-weather failed EBs per Program Block (PB) selected bands. If more than one band was selected, the count is divided by the total number of bands in the PB.*

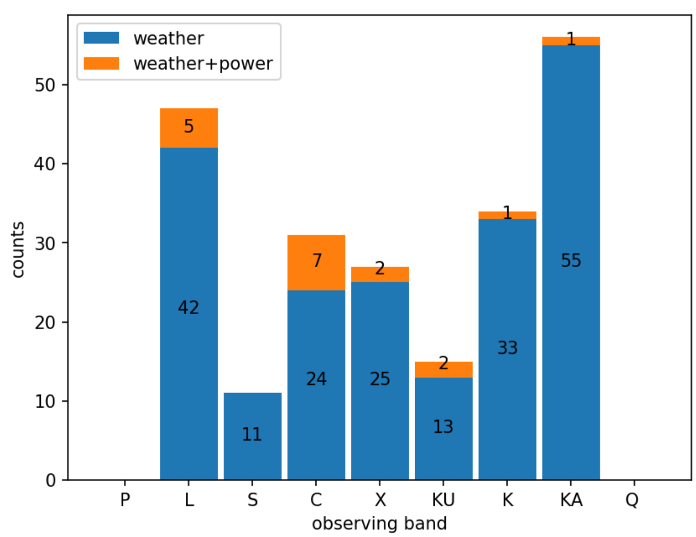

Figure 17: *Number of bad-weather failed EBs per Program Block (PB) selected bands. If more than one band was selected, only the highest frequency band is incremented by one unit.*

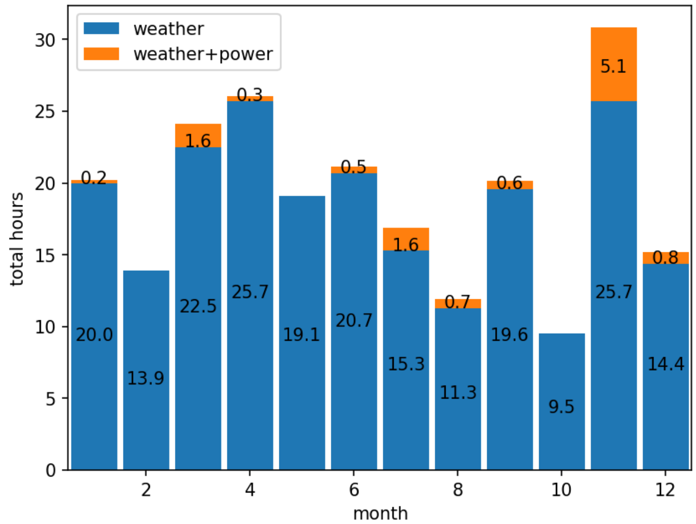

Figure 18: *Total monthly hours spent on bad-weather failed EBs from Feb 2013 to Dec 2022.*

List of Failed EBs Due to Bad Weather

Table 2: *List of failed EBs due to bad weather. "W" type is not associated with technical problems, while "W+PG" is (power glitches).*

EB	Project	MJD	Local time	Type
eb18250835	13A-071	56344.545	2013-02-21 06:04:47	W
eb19514259	13A-262	56379.501	2013-03-28 06:01:26	W
eb20687907	13A-373	56396.562	2013-04-14 07:29:16	W
eb23743136	13A-281	56460.436	2013-06-17 04:27:50	W
eb23827086	13A-258	56467.302	2013-06-24 01:14:52	W
eb24124155	13A-375	56486.697	2013-07-13 10:43:40	W
eb24174414	13A-287	56503.882	2013-07-30 15:10:04	W
eb24177139	13A-142	56505.520	2013-08-01 06:28:48	W
eb24228972	13A-315	56511.051	2013-08-06 19:13:26	W
eb24354011	13A-287	56514.766	2013-08-10 12:23:02	W
eb24560608	13A-287	56521.747	2013-08-17 11:55:40	W
eb24642615	13A-455	56526.293	2013-08-22 01:01:55	W
eb24967553	13A-375	56537.516	2013-09-02 06:23:02	W
eb24986981	13A-206	56538.150	2013-09-02 21:35:59	W
eb25762516	13A-382	56556.672	2013-09-21 10:07:40	W
eb26455521	13A-455	56562.240	2013-09-26 23:45:36	W
eb26629814	13A-012	56564.796	2013-09-29 13:06:14	W
eb28463017	13B-381	56598.717	2013-11-02 11:12:28	W
eb28960340	14A-337	56715.965	2014-02-27 16:09:35	W
eb29076364	14A-139	56743.005	2014-03-26 18:07:11	W
eb29107673	14A-012	56761.008	2014-04-13 18:11:31	W
eb29131435	13A-399	56773.526	2014-04-26 06:37:26	W
eb29131586	13B-326	56774.537	2014-04-27 06:53:16	W
eb29418845	14A-114	56839.336	2014-07-01 02:03:50	W

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Table 2: *List of failed EBs due to bad weather. "W" type is not associated with technical problems, while "W+PG" is (power glitches).* (... continued)

EB	Project	MJD	Local time	Type
eb29419813	14A-114	56840.311	2014-07-02 01:27:50	W
eb29468415	14A-108	56851.240	2014-07-12 23:45:36	W
eb29509241	14A-452	56866.054	2014-07-27 19:17:45	W+PG
eb29698933	14B-096	56923.073	2014-09-22 19:45:07	W
eb29961330	13B-215	56963.292	2014-11-02 01:00:28	W
eb29961862	14B-148	56963.851	2014-11-02 13:25:26	W
eb29982746	14B-002	56971.250	2014-11-09 23:00:00	W
eb30084939	14B-242	57014.230	2014-12-22 22:31:11	W
eb30092735	14B-010	57025.053	2015-01-02 18:16:19	W
eb30449486	14B-165	57076.565	2015-02-23 06:33:35	W
eb30466189	15A-034	57083.572	2015-03-02 06:43:40	W
eb30472391	15A-234	57090.938	2015-03-09 16:30:43	W
eb30517796	15A-421	57114.881	2015-04-02 15:08:38	W
eb30617824	15A-034	57136.426	2015-04-24 04:13:26	W
eb30992724	15A-234	57214.603	2015-07-11 08:28:19	W
eb31011037	15A-144	57227.855	2015-07-24 14:31:11	W
eb31022854	14B-340	57238.166	2015-08-03 21:59:02	W
eb31079467	15A-297	57263.674	2015-08-29 10:10:33	W
eb31098496	15A-476	57274.020	2015-09-08 18:28:48	W
eb31126323	15A-020	57277.663	2015-09-12 09:54:43	W
eb31142612	15A-397	57283.663	2015-09-18 09:54:43	W
eb31160713	15A-197	57290.697	2015-09-25 10:43:40	W
eb31341311	15B-059	57315.191	2015-10-19 22:35:02	W
eb31522908	15B-275	57380.581	2015-12-24 06:56:38	W
eb31547779	15B-307	57385.943	2015-12-29 15:37:55	W
eb31550986	15B-125	57388.291	2015-12-31 23:59:02	W
eb31552270	15B-197	57389.846	2016-01-02 13:18:14	W
eb31893455	16A-197	57447.056	2016-02-28 18:20:38	W
eb31906715	16A-197	57453.098	2016-03-05 19:21:07	W
eb31920768	16A-023	57459.769	2016-03-12 11:27:21	W
eb31960873	16A-370	57478.295	2016-03-31 01:04:47	W
eb31974933	16A-310	57494.560	2016-04-16 07:26:24	W
eb32031636	16A-341	57515.033	2016-05-06 18:47:31	W
eb32295063	16A-225	57548.455	2016-06-09 04:55:12	W
eb32414400	16A-067	57577.959	2016-07-08 17:00:57	W
eb32414409	16A-043	57578.504	2016-07-09 06:05:45	W
eb32590737	16A-167	57624.052	2016-08-23 19:14:52	W+PG
eb32877015	16B-375	57664.337	2016-10-03 02:05:16	W
eb32978106	16B-376	57693.265	2016-11-01 00:21:36	W
eb32989715	16B-126	57700.032	2016-11-07 17:46:04	W
eb33039168	16B-330	57716.016	2016-11-23 17:23:02	W
eb33043028	16B-015	57720.732	2016-11-28 10:34:04	W

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Table 2: *List of failed EBs due to bad weather. "W" type is not associated with technical problems, while "W+PG" is (power glitches).* (... continued)

EB	Project	MJD	Local time	Type
eb33079051	16A-197	57738.238	2016-12-15 22:42:43	W
eb33079904	16B-293	57738.653	2016-12-16 08:40:19	W
eb33082376	16B-248	57738.716	2016-12-16 10:11:02	W
eb33099736	16A-197	57744.328	2016-12-22 00:52:19	W
eb33234675	16B-221	57760.787	2017-01-07 11:53:16	W
eb33358564	16B-305	57775.126	2017-01-21 20:01:26	W
eb33555316	17A-251	57807.264	2017-02-22 23:20:09	W
eb33560564	17A-034	57811.509	2017-02-27 05:12:57	W
eb33617032	17A-198	57830.715	2017-03-18 11:09:35	W
eb33630847	17A-099	57837.802	2017-03-25 13:14:52	W
eb33639802	17A-088	57846.308	2017-04-03 01:23:31	W
eb33643377	17A-425	57851.841	2017-04-08 14:11:02	W
eb33665655	S9230	57871.033	2017-04-27 18:47:31	W
eb33710559	17A-099	57878.685	2017-05-05 10:26:24	W
eb33715231	17A-088	57879.711	2017-05-06 11:03:50	W
eb33762392	17A-088	57888.623	2017-05-15 08:57:07	W
eb33944354	17A-293	57922.886	2017-06-18 15:15:50	W
eb33956094	17A-293	57925.010	2017-06-20 18:14:23	W+PG
eb33984180	17A-323	57930.858	2017-06-26 14:35:31	W
eb33993664	17A-267	57936.661	2017-07-02 09:51:50	W
eb34034692	17A-240	57950.044	2017-07-15 19:03:21	W
eb34036949	17A-467	57952.328	2017-07-18 01:52:19	W
eb34042294	17A-267	57964.653	2017-07-30 09:40:19	W
eb34051614	16B-427	57971.642	2017-08-06 09:24:28	W
eb34432367	17B-045	58012.484	2017-09-16 05:36:57	W
eb34489597	17B-093	58018.765	2017-09-22 12:21:36	W
eb34498109	17B-200	58021.060	2017-09-24 19:26:24	W
eb34601196	17B-200	58041.920	2017-10-15 16:04:47	W
eb34648733	17B-164	58060.528	2017-11-03 06:40:19	W
eb34806509	17B-028	58108.843	2017-12-21 13:13:55	W
eb34886618	17B-130	58138.840	2018-01-20 13:09:35	W
eb34887625	17B-287	58139.917	2018-01-21 15:00:28	W
eb35142310	17B-313	58172.648	2018-02-23 08:33:07	W
eb35215764	18A-424	58188.902	2018-03-11 15:38:52	W+PG
eb35229510	18A-127	58195.719	2018-03-18 11:15:21	W
eb35305098	18A-416	58218.458	2018-04-10 04:59:31	W
eb35340752	18A-081	58221.517	2018-04-13 06:24:28	W
eb35340754	18A-242	58221.600	2018-04-13 08:24:00	W
eb35340946	18A-242	58221.724	2018-04-13 11:22:33	W
eb35341171	18A-242	58221.796	2018-04-13 13:06:14	W
eb35341283	17B-133	58221.858	2018-04-13 14:35:31	W
eb35341285	17B-133	58221.886	2018-04-13 15:15:50	W

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Table 2: *List of failed EBs due to bad weather. "W" type is not associated with technical problems, while "W+PG" is (power glitches).* (... continued)

EB	Project	MJD	Local time	Type
eb35345196	SD0134	58225.441	2018-04-17 04:35:02	W
eb35386061	17B-352	58246.684	2018-05-08 10:24:57	W
eb35402912	18A-232	58249.870	2018-05-11 14:52:48	W
eb35463968	18A-316	58273.509	2018-06-04 06:12:57	W+PG
eb35591069	18A-370	58364.985	2018-09-03 17:38:23	W
eb35633798	18A-342	58397.137	2018-10-05 21:17:16	W
eb35638585	18A-204	58402.292	2018-10-11 01:00:28	W
eb35674813	18A-110	58411.157	2018-10-19 21:46:04	W
eb35934456	18B-245	58445.646	2018-11-23 08:30:14	W
eb35955009	17B-108	58451.454	2018-11-29 03:53:45	W
eb35964845	18B-171	58453.151	2018-11-30 20:37:26	W+PG
eb36087194	18B-302	58480.455	2018-12-28 03:55:12	W+PG
eb36091157	18B-080	58485.711	2019-01-02 10:03:50	W
eb36111150	18B-230	58496.622	2019-01-13 07:55:40	W
eb36137928	18B-273	58501.629	2019-01-18 08:05:45	W
eb36138262	18B-222	58501.695	2019-01-18 09:40:47	W
eb36225712	18B-070	58517.920	2019-02-03 15:04:47	W
eb36269666	18B-126	58525.638	2019-02-11 08:18:43	W
eb36432797	19A-377	58544.899	2019-03-02 14:34:33	W
eb36465888	13B-266	58551.115	2019-03-08 19:45:36	W
eb36473141	19A-166	58554.932	2019-03-12 16:22:04	W
eb36689484	19A-388	58627.641	2019-05-24 09:23:02	W
eb36951077	19A-023	58691.847	2019-07-27 14:19:40	W+PG
eb37057154	18B-242	58708.149	2019-08-12 21:34:33	W+PG
eb37060419	19A-440	58708.735	2019-08-13 11:38:23	W
eb37083343	19A-440	58713.704	2019-08-18 10:53:45	W
eb37165722	19A-024	58728.806	2019-09-02 13:20:38	W
eb37275524	19A-418	58747.151	2019-09-20 21:37:26	W
eb37278037	18B-242	58750.005	2019-09-23 18:07:11	W
eb37287211	19B-287	58753.427	2019-09-27 04:14:52	W
eb37287458	19A-330	58753.607	2019-09-27 08:34:04	W
eb37287986	19A-361	58753.687	2019-09-27 10:29:16	W
eb37322191	19A-230	58759.016	2019-10-02 18:23:02	W
eb37390047	19A-422	58776.689	2019-10-20 10:32:09	W
eb37390477	18B-316	58776.859	2019-10-20 14:36:57	W
eb37390599	19A-138	58776.898	2019-10-20 15:33:07	W
eb37416511	19A-418	58784.056	2019-10-27 19:20:38	W
eb37428680	19A-422	58785.921	2019-10-29 16:06:14	W
eb37530718	19B-211	58805.184	2019-11-17 21:24:57	W
eb37565658	19B-069	58817.886	2019-11-30 14:15:50	W
eb37595558	19B-265	58832.357	2019-12-15 01:34:04	W
eb37662741	19B-216	58853.695	2020-01-05 09:40:47	W

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Table 2: *List of failed EBs due to bad weather. "W" type is not associated with technical problems, while "W+PG" is (power glitches).* (... continued)

EB	Project	MJD	Local time	Type
eb37719178	18A-040	58865.269	2020-01-16 23:27:21	W
eb37729524	19B-216	58867.678	2020-01-19 09:16:19	W
eb37738443	19B-187	58868.850	2020-01-20 13:24:00	W
eb37853820	20A-274	58880.525	2020-02-01 05:35:59	W
eb37882942	20A-109	58885.473	2020-02-06 04:21:07	W
eb37905129	20A-373	58890.028	2020-02-10 17:40:19	W
eb37920906	20A-386	58895.144	2020-02-15 20:27:21	W
eb37960489	20A-154	58914.227	2020-03-05 22:26:52	W
eb37962782	20A-397	58915.786	2020-03-07 11:51:50	W
eb37993743	20A-094	58934.558	2020-03-26 07:23:31	W
eb37995024	20A-123	58934.748	2020-03-26 11:57:07	W
eb38003507	20A-170	58935.701	2020-03-27 10:49:26	W
eb38039321	20A-374	58960.885	2020-04-21 15:14:23	W
eb38084942	20A-083	58971.325	2020-05-02 01:48:00	W
eb38087036	20A-225	58972.606	2020-05-03 08:32:38	W
eb38102996	20A-335	58976.018	2020-05-06 18:25:55	W
eb38262469	20A-535	59006.460	2020-06-06 05:02:23	W
eb38262758	20A-193	59006.654	2020-06-06 09:41:45	W
eb38270394	20A-243	59008.983	2020-06-08 17:35:31	W
eb38270405	20A-243	59009.006	2020-06-08 18:08:38	W
eb38270426	20A-243	59009.071	2020-06-08 19:42:14	W
eb38271143	20A-123	59009.266	2020-06-09 00:23:02	W
eb38409798	20A-401	59027.130	2020-06-26 21:07:11	W
eb38435009	20A-348	59033.745	2020-07-03 11:52:48	W
eb38436604	20A-106	59034.580	2020-07-04 07:55:12	W
eb38458002	20A-211	59039.481	2020-07-09 05:32:38	W
eb38514519	20A-348	59047.850	2020-07-17 14:24:00	W
eb38525899	20A-519	59053.120	2020-07-22 20:52:48	W+PG
eb38598245	20A-568	59086.781	2020-08-25 12:44:38	W
eb38911618	20A-331	59161.709	2020-11-08 10:00:57	W
eb38917284	20A-439	59162.393	2020-11-09 02:25:55	W
eb38918458	20A-331	59162.650	2020-11-09 08:35:59	W
eb38919726	20A-439	59162.775	2020-11-09 11:35:59	W
eb38946468	20B-425	59167.856	2020-11-14 13:32:38	W
eb38946489	20B-425	59167.894	2020-11-14 14:27:21	W
eb39105537	20B-309	59181.578	2020-11-28 06:52:19	W+PG
eb39163087	20B-310	59192.001	2020-12-08 17:01:26	W+PG
eb39179255	20B-341	59196.268	2020-12-12 23:25:55	W+PG
eb39179257	20B-120	59196.281	2020-12-12 23:44:38	W+PG
eb39189316	19A-330	59200.410	2020-12-17 02:50:24	W+PG
eb39189479	20B-062	59201.045	2020-12-17 18:04:47	W
eb39202625	20B-323	59207.131	2020-12-23 20:08:38	W

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Table 2: *List of failed EBs due to bad weather. "W" type is not associated with technical problems, while "W+PG" is (power glitches).* (... continued)

EB	Project	MJD	Local time	Type
eb39210093	20B-322	59217.249	2021-01-02 22:58:33	W
eb39237605	20B-122	59229.735	2021-01-15 10:38:23	W+PG
eb39248488	20B-290	59236.716	2021-01-22 10:11:02	W
eb39251318	20B-280	59238.804	2021-01-24 12:17:45	W
eb39265113	21A-342	59244.180	2021-01-29 21:19:12	W
eb39266168	20B-322	59246.108	2021-01-31 19:35:31	W
eb39278626	20B-062	59252.159	2021-02-06 20:48:57	W
eb39324755	20B-091	59266.069	2021-02-20 18:39:21	W
eb39384171	20A-372	59272.865	2021-02-27 13:45:36	W
eb39384318	20B-241	59272.880	2021-02-27 14:07:11	W
eb39560471	19B-215	59306.652	2021-04-02 09:38:52	W
eb39560810	21A-151	59307.258	2021-04-03 00:11:31	W
eb39563007	21A-386	59310.862	2021-04-06 14:41:16	W
eb39570585	21A-162	59317.056	2021-04-12 19:20:38	W+PG
eb39589693	BM506	59326.106	2021-04-21 20:32:38	W
eb39614328	21A-387	59341.908	2021-05-07 15:47:31	W
eb39617469	21A-145	59342.315	2021-05-08 01:33:35	W
eb39622483	21A-143	59343.257	2021-05-09 00:10:04	W
eb39648259	21A-309	59348.687	2021-05-14 10:29:16	W
eb39651966	21A-143	59351.252	2021-05-17 00:02:52	W
eb39688486	20A-346	59355.624	2021-05-21 08:58:33	W
eb39736500	SD1113	59364.733	2021-05-30 11:35:31	W
eb39742309	SD1113	59365.633	2021-05-31 09:11:31	W
eb39952847	21A-135	59383.808	2021-06-18 13:23:31	W
eb39953299	SG9112	59383.904	2021-06-18 15:41:45	W
eb39964079	21A-276	59387.879	2021-06-22 15:05:45	W
eb39990979	20B-377	59406.071	2021-07-10 19:42:14	W
eb39995822	21A-031	59413.597	2021-07-18 08:19:40	W
eb39996098	21A-031	59414.605	2021-07-19 08:31:11	W+PG
eb40006117	21A-033	59418.944	2021-07-23 16:39:21	W+PG
eb40146874	21A-260	59471.728	2021-09-14 11:28:19	W
eb40917958	21A-275	59513.895	2021-10-26 15:28:48	W
eb41064822	20A-346	59574.833	2021-12-26 12:59:31	W
eb41069434	20A-346	59575.893	2021-12-27 14:25:55	W
eb41074482	20A-346	59580.838	2022-01-01 13:06:43	W
eb41573599	22A-347	59642.628	2022-03-04 08:04:19	W
eb41576548	22A-384	59642.755	2022-03-04 11:07:11	W
eb41722804	22A-276	59658.688	2022-03-20 10:30:43	W
eb41722972	22A-276	59658.912	2022-03-20 15:53:16	W
eb41722974	22A-276	59658.945	2022-03-20 16:40:47	W
eb41745690	22A-314	59667.726	2022-03-29 11:25:26	W
eb41747195	20B-084	59670.041	2022-03-31 18:59:02	W

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Table 2: *List of failed EBs due to bad weather. "W" type is not associated with technical problems, while "W+PG" is (power glitches).* (... continued)

EB	Project	MJD	Local time	Type
eb41779234	22A-042	59691.620	2022-04-22 08:52:48	W
eb41795727	22A-211	59707.736	2022-05-08 11:39:50	W
eb41796655	22A-377	59707.840	2022-05-08 14:09:35	W
eb41797881	22A-065	59708.924	2022-05-09 16:10:33	W
eb41813472	22A-268	59719.911	2022-05-20 15:51:50	W
eb41818501	20A-346	59723.792	2022-05-24 13:00:28	W
eb41826217	22A-284	59728.899	2022-05-29 15:34:33	W
eb41826219	22A-238	59728.947	2022-05-29 16:43:40	W
eb41826221	22A-068	59729.011	2022-05-29 18:15:50	W
eb41827582	22A-068	59729.983	2022-05-30 17:35:31	W
eb41835615	22A-012	59733.342	2022-06-03 02:12:28	W
eb41886672	21B-193	59753.975	2022-06-23 17:24:00	W+PG
eb42457283	22A-378	59786.812	2022-07-26 13:29:16	W+PG
eb42467200	22A-179	59789.805	2022-07-29 13:19:12	W
eb42479610	22A-378	59796.876	2022-08-05 15:01:26	W
eb42525855	22A-311	59806.634	2022-08-15 09:12:57	W+PG
eb42533606	22A-268	59810.704	2022-08-19 10:53:45	W
eb42573120	22A-126	59828.068	2022-09-05 19:37:55	W+PG
eb42582222	21B-286	59831.975	2022-09-09 17:24:00	W
eb42587334	22A-402	59833.714	2022-09-11 11:08:09	W
eb42952386	22B-128	59877.355	2022-10-25 02:31:11	W

Tracking VLA Observations

Tracking VLA Observations Summary Values

Table 3: *Semester hours for the different Program Blocks (PBs) priorities ("A", "B", and "C") that were allocated ("alc") and effectively observed ("obs"). Hours were divided into high- and low-frequency (HF and LF, respectively). PBs that use Ku-band or higher frequency bands are considered HF. Data from Tracking VLA Observations spreadsheets. The predicted observable hours for the semester ("pred") follows the prescription in this document.*

group	**15A**	**15B**	**16A**	**16B**	**17A**	**17B**	**18A**	**18B**	**19A**	**19B**	**20A**	**20B**	**21A**	**21B**	**22A**	**22B**
A_HF_alc	818.3	349.9	613.9	371.9	599.5	291.8	562.7	430.6	605.9	543.8	575.5	626.2	566.6	398.0	967.9	616.7
A_LF_alc	957.0	287.5	607.1	585.0	685.0	761.7	558.0	658.0	886.6	453.5	1109.9	327.1	891.6	583.5	1079.3	1147.8
A_HF_obs	628.4	294.4	491.9	320.9	480.3	189.4	382.5	234.6	360.3	378.8	423.3	439.0	330.3	309.4	672.9	238.9
A_LF_obs	903.7	253.6	489.4	475.8	358.1	523.9	366.0	321.5	566.7	175.6	875.1	203.7	812.8	539.1	844.9	519.1
B_HF_alc	795.1	479.8	502.4	613.9	657.7	185.4	555.6	207.1	465.9	354.7	569.2	677.0	881.2	583.0	939.5	731.5
B_LF_alc	1427.4	312.2	648.9	510.4	672.9	636.5	591.2	340.3	789.2	272.8	612.5	316.6	475.0	447.8	474.5	277.6
B_HF_obs	427.0	316.6	429.2	472.5	522.0	136.6	423.5	68.1	351.6	240.6	410.7	260.2	357.7	262.9	604.8	499.7
B_LF_obs	1225.9	284.2	626.2	456.4	672.5	613.1	487.3	233.5	718.5	221.7	572.5	265.5	414.3	345.3	442.4	241.7
C_HF_alc	664.3	1132.0	650.3	533.9	246.1	106.3	637.5	515.9	147.0	255.0	104.1	87.7	226.5	95.4	216.2	70.6
C_LF_alc	1509.0	604.3	2054.1	924.1	1580.0	1157.5	1355.2	1011.6	1558.6	314.8	1522.6	927.6	1345.7	1057.6	1268.1	968.4
C_HF_obs	310.1	396.8	297.2	294.0	143.9	101.9	244.9	108.4	52.0	115.8	47.6	72.5	108.1	65.9	73.2	59.6
C_LF_obs	590.9	348.2	1217.0	299.7	1151.3	583.3	937.3	450.4	981.8	292.9	1005.6	579.3	674.4	724.4	933.9	423.2
HF_obs	1365.5	1007.9	1218.3	1087.4	1146.2	427.9	1050.8	411.0	763.9	735.2	881.5	771.7	796.1	638.3	1350.9	798.3
LF_obs	2720.5	886.0	2332.6	1231.9	2181.9	1720.3	1790.6	1005.4	2266.9	690.2	2453.2	1048.5	1901.5	1608.8	2221.2	1184.0
HF_pred	2369.0	1380.4	2182.6	1640.3	2018.8	1951.1	2528.0	1126.9	2504.4	1108.6	3003.3	1209.4	1779.9	1810.9	2022.0	1239.3
LF_pred	1601.1	462.0	1500.8	597.2	1407.1	761.6	1642.2	375.1	1651.6	346.9	1834.4	468.5	1299.3	671.6	1434.0	425.0

Observation Time of Multi-Semester Programs

The VLA has triggered and/or large programs that are not intended to be completed in a single semester. These programs are also referred to as "Any" configuration, as they must be observed independently of the array configuration.

A more accurate way to consider the effective semester allotted time needs to take into account the average completion rate of this type of program. Consider the following equations:

- $f\_any + f\_cyc = 1$
- $f\_any \times t\_any + f\_cyc \times t\_cyc = c\_set$
- $f\_any \times t\_any / c\_set = obs\_any$
- $f\_any \times (1 - t\_any) + f\_cyc = a\_upd$
- $c\_set / a\_upd = c\_upd$

where:

- *f_* is the allocated time fraction within a given set (for example, all A-priority); *f_any* is the fraction for any config programs and *f_cyc* its complement (i.e., the fraction of semester-specific programs);
- *t_* is the observation allocation rate for the program type;
- *c_set* is completion rate of the set;
- *obs_any* is the observed fraction for "Any" configuration type;
- *a_upd* is the effective allocated time as a fraction of the total one; and
- *c_upd* is the updated completion rate of the set.

Figures 6 and 7 show that 70% of A-priority observations are completed on average (*c_set*). This is applicable to all frequencies and specific to HF. Figures 8 and 9 show that only 18% (and 22% to HF) of the A-priority observed time correspond to "Any" programs (*obs_any*).

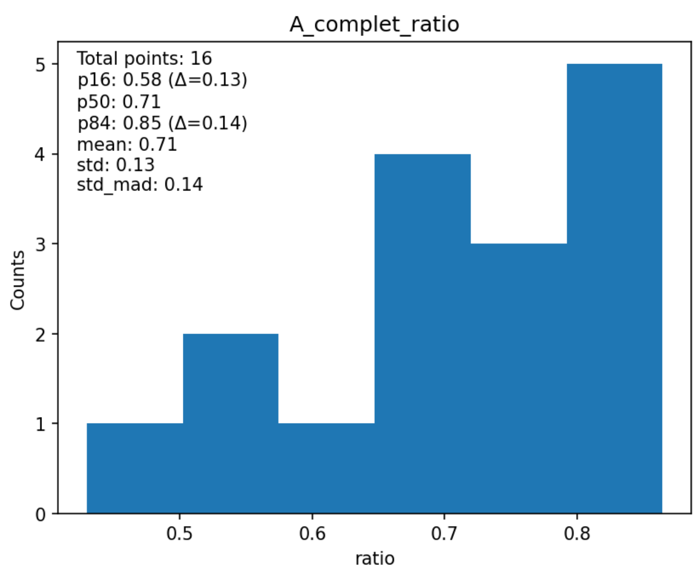

Figure 19: *Histogram of the A-priority completion rate (ratio of allocated over observed time; 2015A to 2022B).*

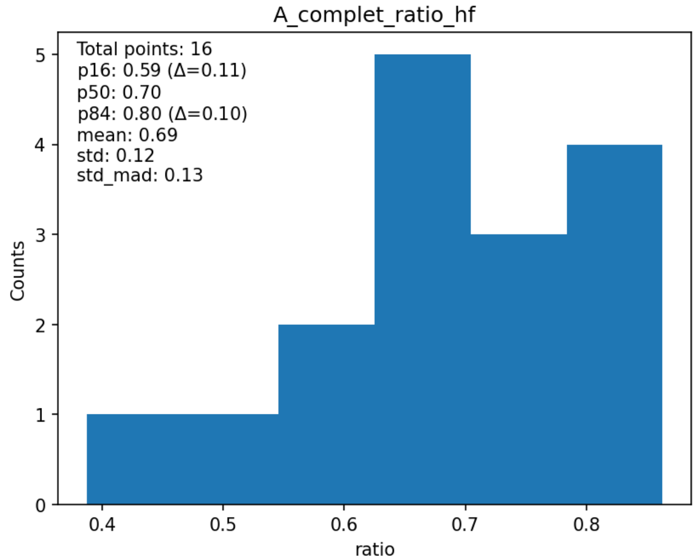

Figure 20: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency).*

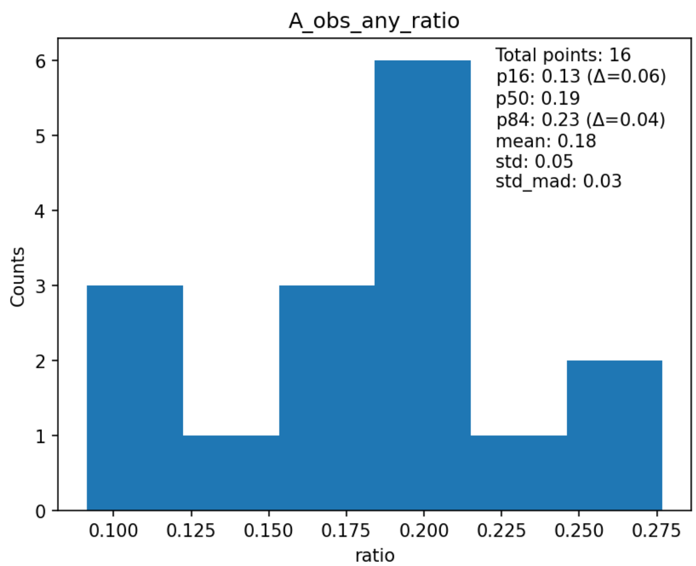

Figure 21: *Histogram of the ratio of "Any" configuration programs over the total of A-priority observed time each semester (2015A to 2022B).*

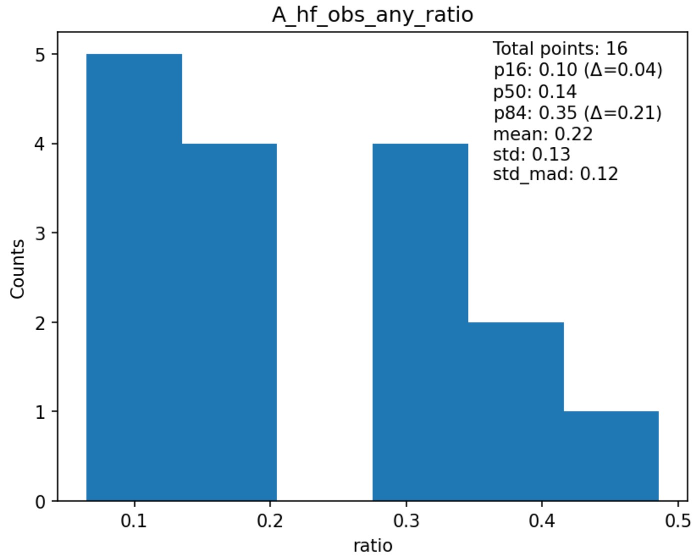

Figure 22: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency).*

Table 4: *Parameters used to determine the effective allocated time taking into account that not all programs of "Any" configuration type are observed. For description of variables, see text.*

set	***f_any***	***f_cyc***	***c_set***	***obs_any***	***t_any***	***t_cyc***	***a_upd***	***c_upd***
A	38%	62%	71%	18%	34%	94%	87%	82%
A_HF	38%	62%	69%	22%	40%	87%	85%	81%
AB	37%	63%	71%	21%	40%	89%	85%	84%
AB_HF	43%	57%	69%	28%	45%	87%	81%	85%

Observation Time of Multi-Semester Programs

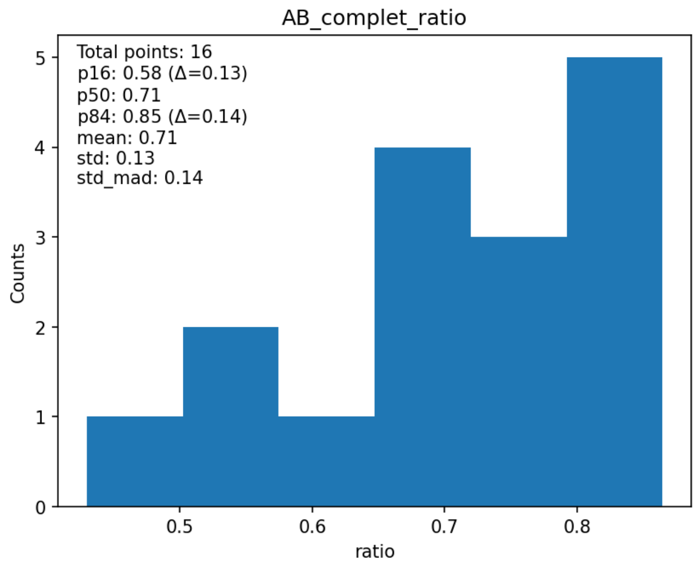

Figure 23: *Histogram of the A- plus B-priority completion rate (ratio of allocated over observed time; 2015A to 2022B).*

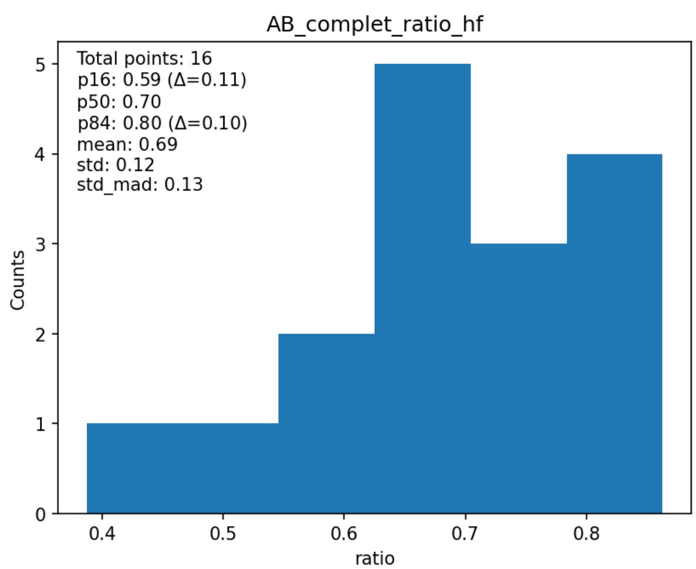

Figure 24: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency).*

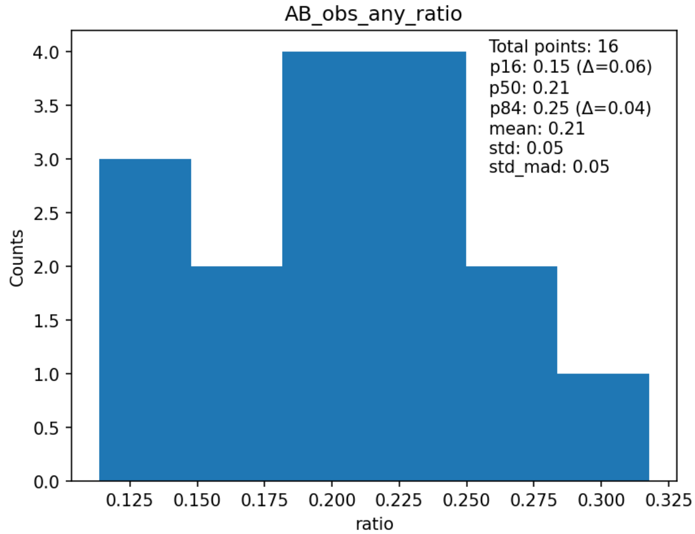

Figure 25: *Histogram of the ratio of "Any" configuration programs over the total of A- plus B-priority observed time each semester (2015A to 2022B).*

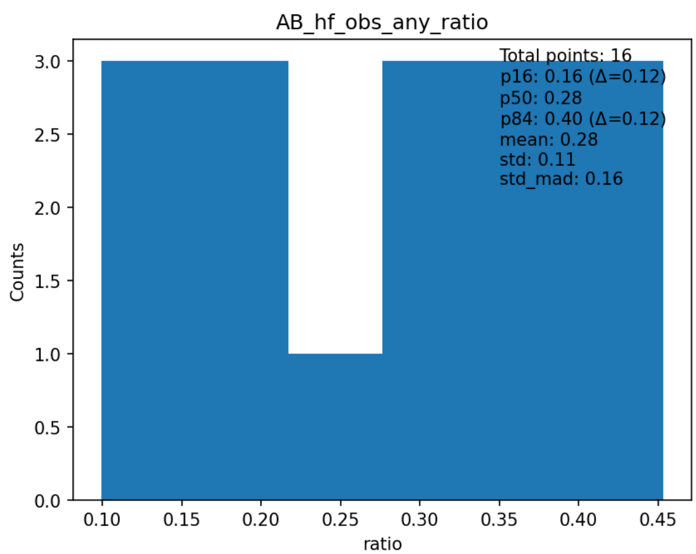

Figure 26: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency).*

Hours of Observation

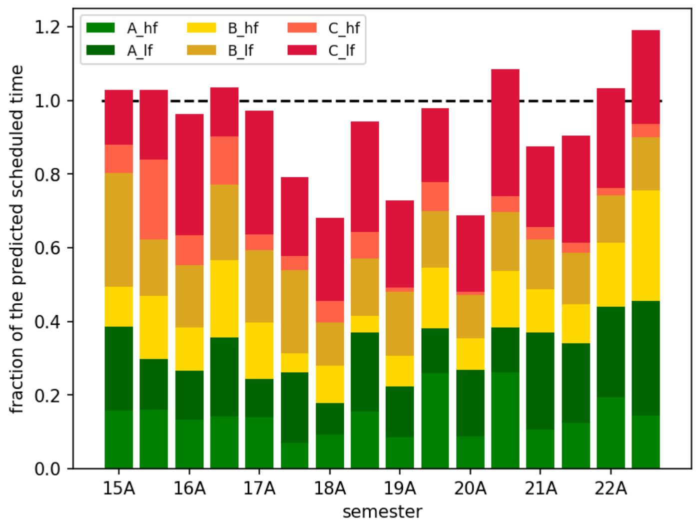

Figure 27: *Fraction of expected array time used by different observation priorities each semester. Light colors represent high frequency, while dark colors represent low frequency.*

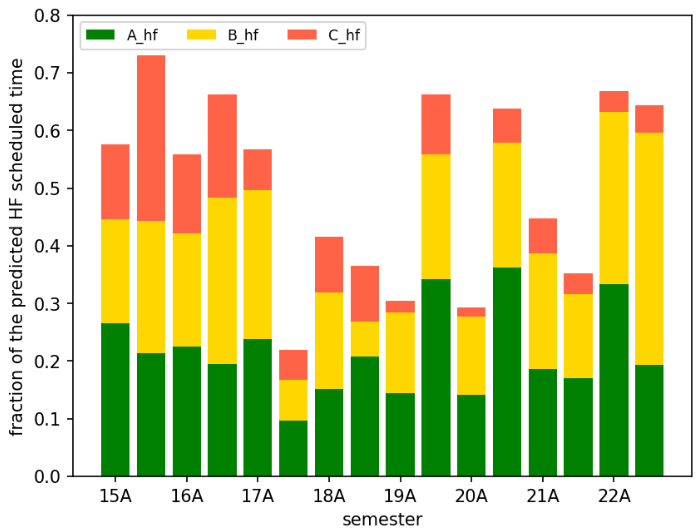

Figure 28: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency).*

A-priority Allocation Rate

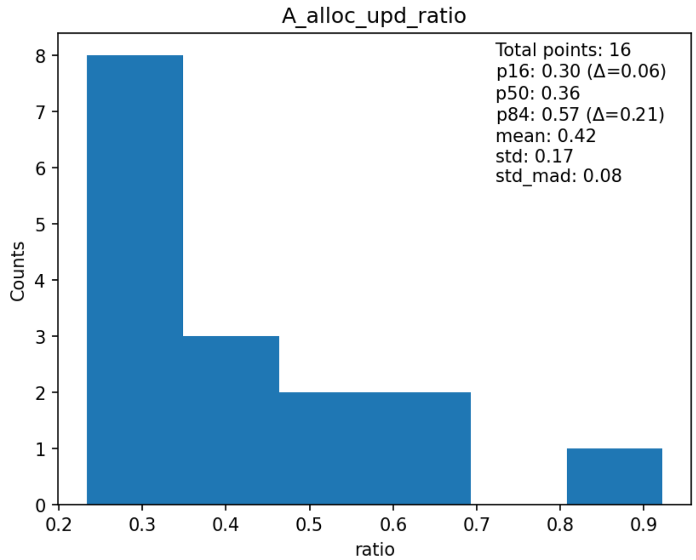

Figure 29: *Histogram of the A-priority allocation rate (ratio of the time allocated for priority A over the predicted scheduled time for the semester; 2015A to 2022B). The allocated time used was 87% of the total, to compensate for observations with "Any" configuration.*

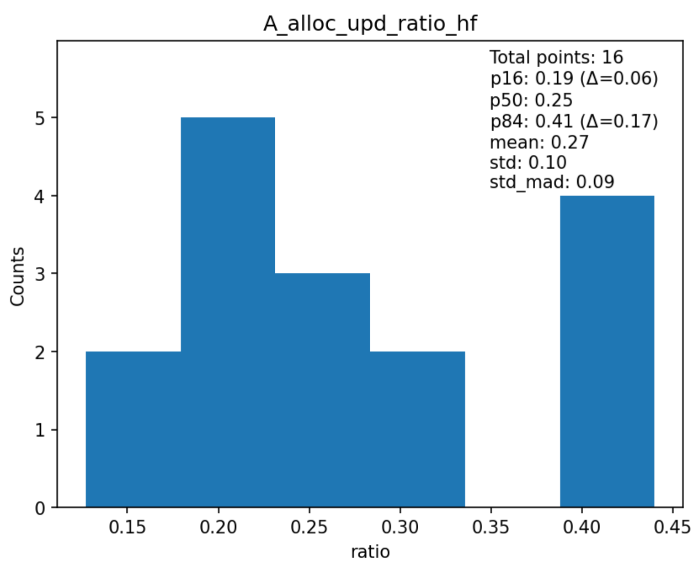

Figure 30: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency). Used 85% of the total time.*

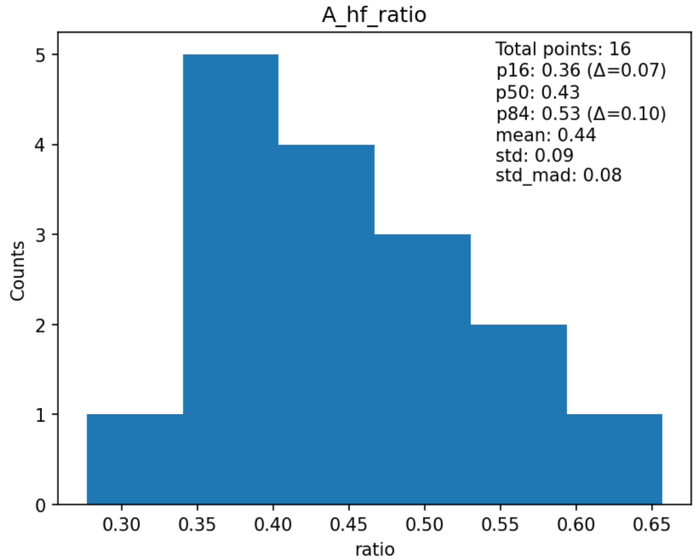

Figure 31: *Histogram of the ratio of time allocated at high frequencies for A-priority observations (all configurations).*

C-priority Observation Rate

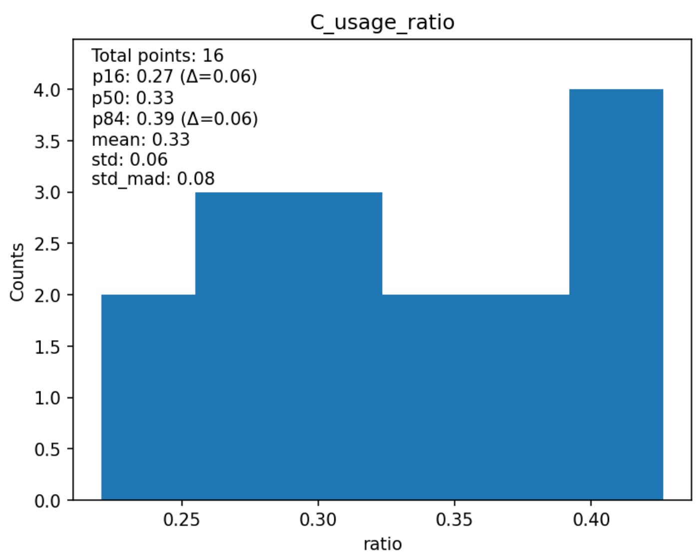

Figure 32: *Histogram of the C-priority completion rate (ratio of the observed priority C blocks over the total observed time; 2015A to 2022B).*

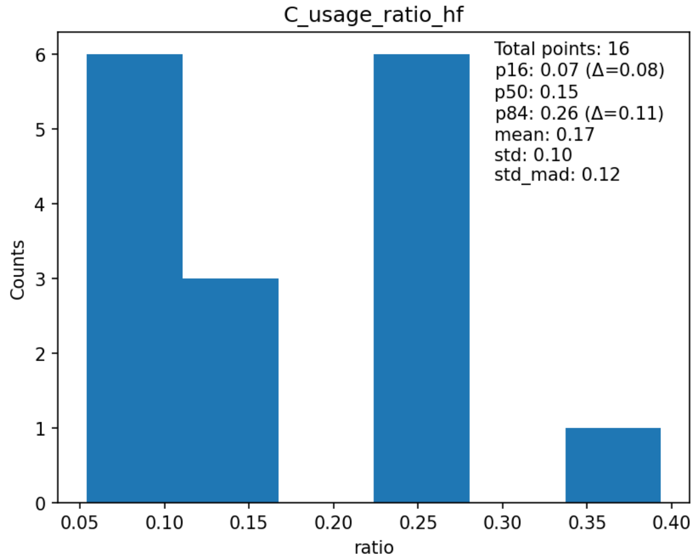

Figure 33: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency).*

A+B Priorities Allocation Rate

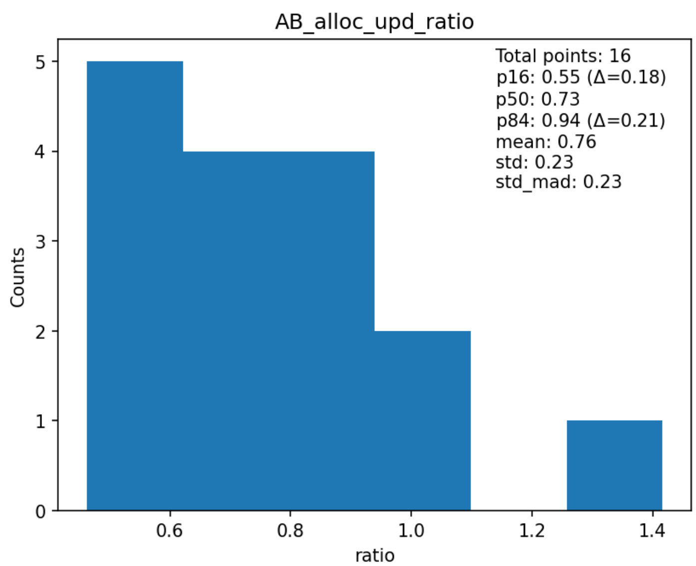

Figure 34: *Histogram of the A- plus B-priority allocation rate (ratio of the total time allocated for priority A and priority B over the predicted scheduled time for the semester; 2015A to 2022B). The allocated time used was 85% of the total, to compensate for observations with "Any" configuration.*

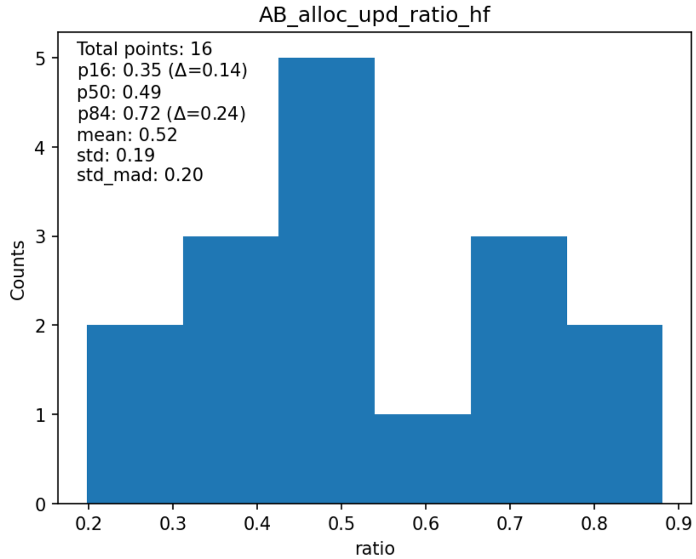

Figure 35: *Same as the previous figure, applied to high frequencies only (wind speed and APL compatible with Ku-band or higher frequency). Used 81% of the total time.*

Frequency of Observations During Sunrise and Sunset

When analyzing the data from EVLA memo 220, we noticed that 30% of the VLA scheduled observations were overlapping sunrise and sunset. It may seem a high rate at first, but such value is actually expected.

The probability of an observation overlapping one of these events is the average duration of the SB added to the duration of the overlap, divided by the event period. The mean SB duration is 2.0 hrs (EVLA memo 220) and the overlay lasts 1.17 hrs (10 min before plus 60 min after the event) with an event average period of 12 hrs. Thus, the individual overlap probability is 26%.

We know that dynamic scheduling does not operate uniformly at all times. For example, scheduled maintenance is always distant from sunrise and sunset. If the scheduled hours are 67% of the array time (this document) but the overlapping times were not interrupted ("100% efficiency"), the overlapping frequency would be 39%. Since some downtime happens during overlap time, the execution efficiency is somewhere between 67% and 100%. If we assume this efficiency as 85%, we recover the overlap rate of 30% seen in the VLA archive.

NOAA Cloudiness Data and Extrapolation to the VLA Site

The NCEI/NOAA data classifies cloud cover in three categories: Clear (zero to 3/10 average sky cover); Partly Cloudy (4/10 to 7/10 average sky cover); and Cloudy (8/10 to 10/10 average sky cover). These categories are determined for daylight hours only.

It only has statistics for three cities in New Mexico: Albuquerque, Clayton, and Roswell. All three cities have very similar results: 45% of Clear; 30% Partly Cloudy; and 25% Cloudy (yearly averages).

To estimate the time when sky cover could exclude HF observations at the VLA site, we made the following assumptions:

- The average of cities in the state apply to the VLA site;
- The daytime averages apply to the nighttime;
- The HF observations are avoided when the sky is not Clear.

Therefore, HF avoidance could reach 55% of the time. This rough estimate ignores both daytime (e.g., more clouds following sunset than in the middle of the night) and seasonal (e.g., more clouds in summer) variations.