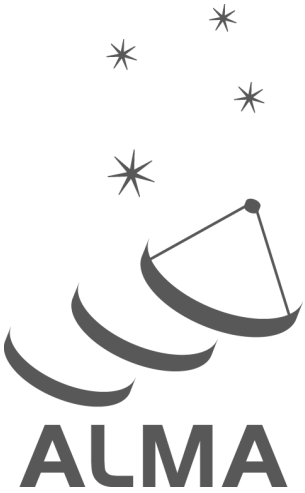
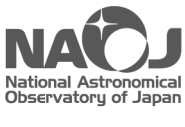
ALMA Status Update

March 2014





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Revision History:

Version	Date	Editors
Ver. 2.0	Mar 07 2014	L. Nyman, J. Hibbard, M. Saito, S. Corder, P. Andreani, K. Tatematsu
Ver. 2.1	Mar 14 2014	L. Nyman, J. Hibbard, M. Saito, S. Corder, P. Andreani, K. Tatematsu (updated Figure 3 & Figure 4)

Contributors

This document was produced by the Joint ALMA Observatory (JAO) with contribution from the North American, East Asian, and European ALMA Regional Centers (ARCs).

In publications, please refer to this document as:

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Table of contents

1 Summary

This report summarizes the status of Cycle 1 Early Science observations as of March 2014 including events since the last Status Update (published in the ALMA Science Portal on October 2 2013). It includes a summary of observing progress, the 12-m Array configuration schedule for 2014 and an assessment of the completion likelihood of Cycle 1 Highest Priority projects by Band, LST and requested angular resolution. The report also contains plans and references to ongoing work as part of commissioning and science verification.

2 Current Status

Cycle 1 is the second Early Science (ES) period that was made available to the international ALMA community for Principal Investigator (PI) science on a "best efforts" basis, meaning that priority is given to the completion of the full 66 element array and the commissioning and delivery of the full ALMA capabilities. Cycle 1 PIs share risk with ALMA, and project completion cannot be guaranteed.

Cycle 1 PI observing was originally planned to start in January 2013 and to span 10 months. However, a decision was made to spend several months giving priority to commissioning and improvements to infrastructure and overall system stability, and to extend Cycle 1 from the end of October 2013 to the end of May 2014 (see Science Portal news items from April & May 2013 at http://almascience.org) As detailed in the last Cycle 1 Status Update (October 2, 2013), the reprioritization efforts were largely successful. The Cycle 1 software for the 12-m Array and 7-m Array were accepted by October 2013 and significant progress on array infrastructure and stability was made. Issues with the power stability were addressed, and whereas the observatory experienced 4 significant, i.e., extended or multiple, unplanned power outages before the end of the reprioritization period, with up to 3-4 weeks to recover all array elements each time, there has been only a single outage since, with a recovery time of a few days due to the implementation of a remote restart option. Work will continue through 2014 on preparing the pads for the more extended Full Science configurations (see Sect. 8). Currently all antennas have been accepted, and 62 are available at the Array Operations Site (AOS). As for receiver cartridges, there are currently 22 Band 4 and Band 8 and 17 Band 10 cartridges installed. Acceptance of all remaining cartridges should be completed by the end of this year.

Further engineering and commissioning activities took place in February 2014 (when good weather is less likely due to the onset of the "Altiplanic Winter" – see Figure 1 from the ALMA Proposers Guide), including the annual maintenance of the switchgears and transformers that cannot be performed during regular array use, and work on the technical building that requires the correlator and central LO to be powered off and a major annual upgrade of the ALMA software. It is anticipated that the Total Power (TP) observing mode will be accepted soon and be available for PI observations after March 2014.

After resuming Cycle 1 ES observations at full priority on October 30, 2013, it became clear that the completion percentage of High Priority projects for Cycle 1 would be considerably less than for Cycle 0 due to the reduced amount of time available for ES observations (6 months at nominal priority vs. the originally planned 10 months). The completion percentage of Cycle 1 High Priority projects was estimated to be ~60% (compared to ~80% for Cycle 0) with projects requiring high frequencies and/or the most extended configurations remaining mostly incomplete. In compensation, the ALMA observatory allowed PIs of Cycle 1 High Priority projects to designate their projects as eligible for transfer into Cycle 2, should they remain incomplete at the end of Cycle 1 (see Cycle 1 status update in October). We expect to complete those projects during Cycle 2 (see Sect. 5 and 6).

3 Observing Progress

Cycle 1 Early Science observing sessions are scheduled from Wednesdays to Tuesdays on alternate weeks during 16h per day. The remaining time is dedicated to commissioning and engineering activities (including maintenance, antenna and receiver integration, software tests etc). Some of the ES Cycle 1 observing blocks 1-18 were reallocated to the reprioritization effort mentioned above and others were also unavailable for PI observations due to weather, power outages, and an employee strike (see Oct 2 Status Update for details). Cycle 1 PI observing resumed at full priority in Session 19, and seven sessions were completed before the transition to Engineering time in February 2014. An additional session was reallocated from commissioning to science observing at the end of February, to take advantage of unseasonably good weather conditions. Tables 1 & 2 give the statistics of each of these ES sessions, separately for 12-m Array and 7-m Array observations. As mentioned above, the Total Power mode has not yet been accepted, so no statistics are provided for the TP Array.

Table 1: Cycle 1 Observing Session summary for the 12-m Array

Block	Dates	Allocated time (h)	Successful executions (h)	Calibra-tions (h)	Technical Down time (h)	Execution efficiency (%)	Average number of antennas	Approximate Configuration
19	Oct 30-Nov5	100.0	54.6	6.1	14.0	60.7	27.8	C32-3
20	Nov 13-20	106.0	53.0	5.6	7.4	55.3	27.8	C32-3
21	Nov 27-Dec3	99.5	58.3	10.8	3.8	69.5	25.3	C32-3
22	Dec 11-17	99.3	40.2	2.4	5.1	43.0	27.7	C32-2
23	Dec 25-31	99.1	31.2	1.4	9.4	32.9	26.8	C32-2
24	Jan 8-14	92.4	15.8	7.7	5.1	25.4	24.3	C32-1
25	Jan 22-28	54.4	20.3	7.6	0.0	51.3	24.9	C32-1
26	Feb 20-25	79.4	40.4	9.2	0.0	62.5	27.0	C32-2

Tables 1 & 2 list the dates of each Observing session, the time scheduled for Early Science observing, the time associated with successful executions of PI science observations, the amount of time dedicated to observatory calibrations, and the amount of time lost for technical reasons (failed executions or array unable to observe for reasons other than weather) for each 7 day observing period. Also listed is the Execution efficiency, which is the fraction of the scheduled time used for successful observations (either science projects or calibration). Finally, the tables list the number of antennas available for science observing averaged over the session and, for 12-m Array observations, the approximate configuration of the available 12-m antennas, using the naming convention given in the Cycle 1 Proposers Guide (where the most compact configuration is called C32-1, and the most extended is called C32-6).

Table 1 indicates that fewer 12-m Array antennas have been available compared to what was advertised in Cycle 1 (~27 compared to 32). This means that more time is needed to obtain the PI requested sensitivity. The situation is less of a concern for 7-m Array observations, where the number of available 7-m antennas has been closed to the advertised number (9; see Table 2).

Table 2: Cycle 1 Observing Session summary for the 7-m Array

Block	Dates	Allocated time (h)	Successful executions (h)	Calibrations (h)	Technical Down time (h)	Execution efficiency (%)	Average number of antennas
19	Oct 30-Nov5	96.0	62.0	0.8	3.9	65.4	9.1
20	Nov 13-20	114.4	61.2	4.0	4.6	57.0	9.6
21	Nov 27-Dec3	94.7	36.8	16.4	0.8	56.2	8.0
22	Dec 11-17	91.8	40.9	2.7	0.4	47.5	7.2
23	Dec 25-31	96.7	33.7	2.1	5.4	37.0	8.5
24	Jan 8-14	84.9	31.1	1.7	1.6	38.6	9.8
25	Jan 22-28	56.7	6.8	4.7	0.2	23.6	9.7

The observing progress is shown graphically in Figure 1, which plots the total number of successful executions of observations from Cycle 1 projects (both High Priority or Filler, and including both 12-m Array and 7-m Array observations), as a function of time. Also plotted are the observing rates needed to complete all Cycle 1 High Priority projects either according to the original schedule (starting in January 2013 and ending December 31, 2013), or according to the revised schedule (starting October 2013 and ending May 30, 2014). The small number of executions obtained prior to Session 19 in October 2013, were taken as part of software commissioning. These data subsequently passed the data quality assurance tests and are suitable for delivery to PIs. The flat progress in August-September 2013 was due to power outages and the labor dispute. Observing progress proceeded at a good rate starting in October, until the onset of the Altiplanic Winter in January. The flat region in February represents the handover of the array to Engineering. Early science observing commenced in late February 2014, and we anticipate an even higher rate for science observing (see Sect. 6). Overall, we have thus far obtained 544 successful executions (including both 12-m Array and 7-m Array observations), or 36% of the estimated 1500 needed for Cycle 1 High Priority projects.

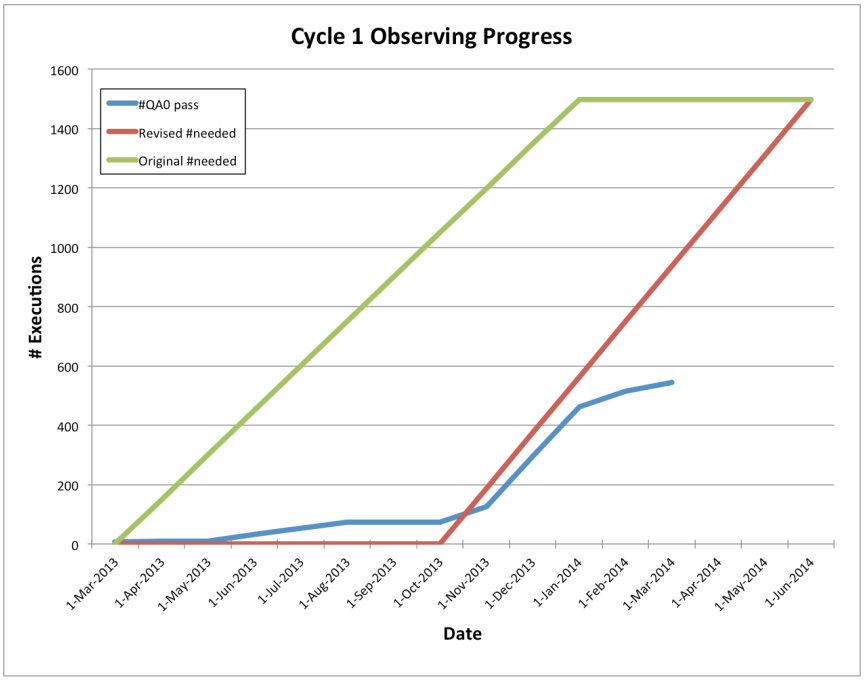

Figure 1: Cycle1 Observing progress, in terms of the number of successful executions ("QA0 Pass") obtained for each observing session, counting both 12-m Array and 7-m Array observations. The green line represents the originally expected rate of observing, prior to the "reprioritization" period. The red line represents the expected rate needed to finish all HP projects, after the reprioritization.

Table 3 provides project completion statistics. In Cycle 1 there were originally 197 projects given "High Priority" status. Four High Priority projects were canceled (either completed in Cycle 0 or target no longer visible), while three DDT projects were added, leaving 196 High Priority projects. An additional 93 projects were given "Filler" status. Thus far, 35% of High Priority projects have some completed components and 25% have some data delivered. Eighteen Cycle 1 projects have been completed.

Table 3: Cycle 1 Project Status Summary (through March 1, 2014)

State	Number of High Priority and DDT Projects	Number of HP, DDT & Filler Projects
Accepted	196	289
Prepared	163 (83%)	221 (76%)
With some successful observations	93 (47%)	106 (37%)
With some completed components	68 (35%)	78 (27%)
Have data being processed	36 (19%)	42 (15%)
With some data delivered	49 (25%)	56 (19%)
Completed	18 (9%)	18 (6%)

Projects were prepared in several batches, based on the near-term array configuration schedule. So far, projects needing 7-m Array observations or 12-m Array observations in configurations more compact than the most extended (C32-6) have been prepared (second row of Table 3). Projects needing C32-6 or the TP Array will be prepared soon. PIs with such observations can expect to be contacted in the next month by the Contact Scientist supporting their project for validation of the observations. Projects with a Filler priority are prepared for observing bands and LST ranges where it appears likely that we will run out of High Priority projects. To date, this has included Band-3 observations in the more compact 12-m configurations (C32-1 to C32-3). The 12-m Array configuration schedule is discussed in more detail in Section 5 below.

4 Data reduction progress & timescales

As in Cycle 0, Cycle 1 data reduction is done at the JAO and the three ARCs following standard data reduction scripts, conducting quality assurance checks, and packaging the data for delivery to PIs. Table 4 shows the median timescales for each post-observing stage from project completion to delivery, both for Cycle 0 and Cycle 1 data deliveries. All timescales after the assignment of a dataset to a reducer are greatly reduced compared to Cycle 0. Further improvements in data processing times are expected towards the end of Cycle 1, when the ALMA Pipeline should be available to help in the preliminary stages of data reduction.

Table 4: Data Processing & Delivery Timescales for Cycle 1

Data Processing & Delivery times (Averages, in days)	Cycle 0	Cycle 1
Days since completed to assigned for reduction	16.6	17.2
Days to process through QA2	54.1	19.5
Days from QA2 evaluation to delivery to PI	23.5	6.9
Days since completed to delivery to PI (MEAN)	94.2	41.5
Days since completed to delivery to PI (MEDIAN)	84.5	34.5

A new document has been posted to the Science Portal, describing in some detail the data delivery products. *("ALMA QA2 Data Products for Cycle 1";* http://almascience.org/documents-and-tools/cycle-2/ALMAQA2Productsv1.01.pdf).

We remind all researchers that they are welcome to visit their regional ARCs or ARC nodes to work on proprietary or archival ALMA data. Visit requests should be submitted using the ALMA helpdesk (http://help.almascience.org). Researchers receiving assistance from an ARC or ARC node should add this to the standard ALMA acknowledgement (see http://almascience.org/alma-data) to be included in all publications making use of ALMA data.

5 Configuration Schedule for 2014

The near-term 12-m Array configuration schedule has also been revised, based on pad and power availability and the number of antenna moves that can be accommodated each month. Up until now, the 12-m Array has been in one of the three most compact configurations (see Table 1). When science observing resumes again in March 2014, the array will be in a similar configuration to C32-3 (the array is seldom exactly in one of the advertised Cycle 1 configurations, which are considered "representative", but it should be in a configuration with similar imaging properties – resolution and Maximum Recoverable Scale – as one of the representative configurations). Each month the configuration will be expanded to the next most extended one (C32-4 in April, C32-5 in May, C32-6 in June). This schedule is depicted in Figure 2, which also plots the remaining number of hours of Cycle 1 High Priority projects, color-coded by ALMA frequency band. This schedule may need to be modified, based on pad and transporter availability, road conditions at the AOS, or power distribution issues.

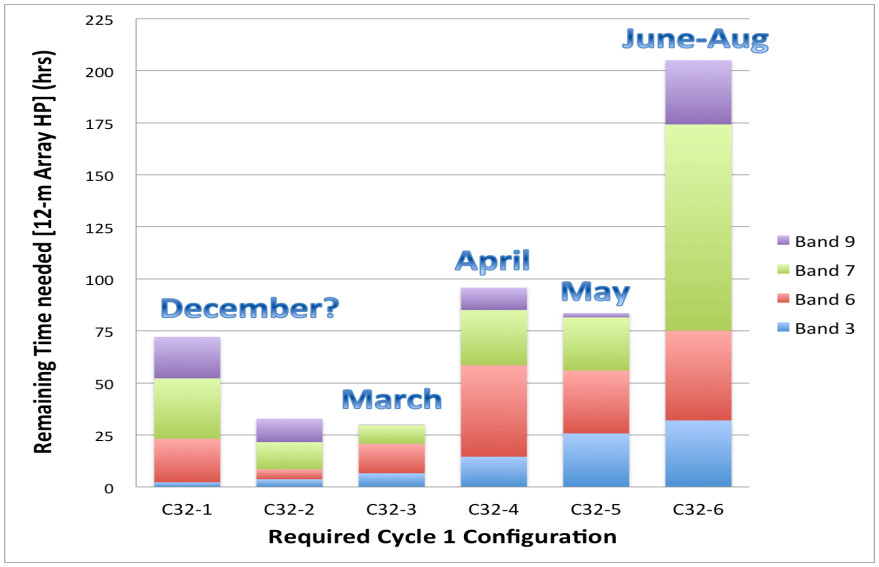

Figure 2: Histogram of the remaining number of hours needed to complete Cycle 1 High Priority 12-m Array observations for each Cycle 1 configuration, with different colors representing the different ALMA observing bands. Above each configuration histogram is the month (in 2014) that is planned for each configuration, according to the current schedule.

According to this schedule, we will not be able to observe in the most extended of the advertised Cycle 1 12-m Array configuration before the end of Cycle 1. Therefore, all Cycle 1 proposal components that require ~1.5 km baselines will need to be transferred to Cycle 2. However, the configuration that we will move to in June may be the configuration until August, depending on snow conditions at the site. Therefore, we anticipate being able to complete most of these projects (as well as a good number of Cycle 2 project components requiring 1.5 km baselines) during the Southern winter.

From September through November 2014, the array will be reconfigured to commission long baselines (see Sect. 8). All antennas will be moved out, and no PI science observing will be possible since the imaging

capabilities of this configuration are incompatible with any of the Cycle 1 or Cycle 2 projects. The ACA correlator will also be upgraded during this period. Thereafter, we expect to move back to one of the more compact configurations (resembling C32-1 or the Cycle 2 configuration C34-1) for December and January, where a significant number of Cycle 1 observations remain. There will be another Science “shutdown” in February 2015. The configuration after that point will be determined considering the results of the Cycle 2 proposal review.

In summary, Cycle 1 PIs with executions requiring the more extended 12-m configurations may expect progress in the coming months. However, those with project components requiring the more compact configurations will have no opportunity for those observations until the end of the year, (but we note that the configuration plan may have to be altered).

6 Update to Cycle 1 Completion Analysis

In the October 2013 Cycle 1 Status Update, we presented a completion analysis for Cycle 1 12-m Array observations, as a function of observing band, configuration (=requested resolution), and LST. In this section, we update those predictions, using the planned 12-m Array configuration schedule (see Sect. 5), and the current ES observing session schedule, which is being modified to provide more ES observing hours.

As mentioned above, ES observing has alternated weeks with commissioning. Starting April, more time will be devoted to ES, with each week of commissioning followed by 2 weeks of ES. In addition, also starting in April we will observe 24hrs on weekends.

Given the above factors, the JAO re-evaluated the completion likelihood of Cycle 1 projects. The method is the same as previously described: remaining science observations were characterized by their mean LST, requested band, requested angular resolution (i.e. configuration), and number of hours needed. These were compared with the configuration schedule, the hours scheduled for science observing (setting the LST ranges available), and the number of those hours expected to be available for each band (based on Fig. 1 from the Proposers Guide). Using this information, hours were assigned first to High Priority projects for the appropriate configuration and LST starting with the highest frequency band, then the next highest until all the hours were allocated. Any unassigned hours were assigned to Cycle 1 “Filler” projects.

The result of this exercise is a table of the remaining hours needed for High Priority projects along with the number of hours that High Priority projects can be scheduled, evaluated separately for each configuration and observing band as a function of LST. The ratio of these two numbers is the completion likelihood for High Priority projects that need that combination of Band, configuration, and LST. These quantities are plotted in Figure 3 (for each Band) and Figure 4 (for each configuration).

According to this analysis, the overall completion likelihood for the remaining High Priority observations is 38% (195 hours completed compared to 519 hours still needed), but this is a strong function of configuration, band and LST (Figs. 3 & 4). We predict that 54 hours of “Filler” projects will also be observed. At the end of Cycle 1, we predict that 324 hours of Cycle 1 High Priority projects will remain unobserved, and will need to be transferred into Cycle 2. These consist of 40 h of observations in Band 3, 83 h in Band 6, 138 h in Band 7, and 63 h in Band 9. This means that ~1700 hours remain available for Cycle 2 High Priority proposals (grades A or B).

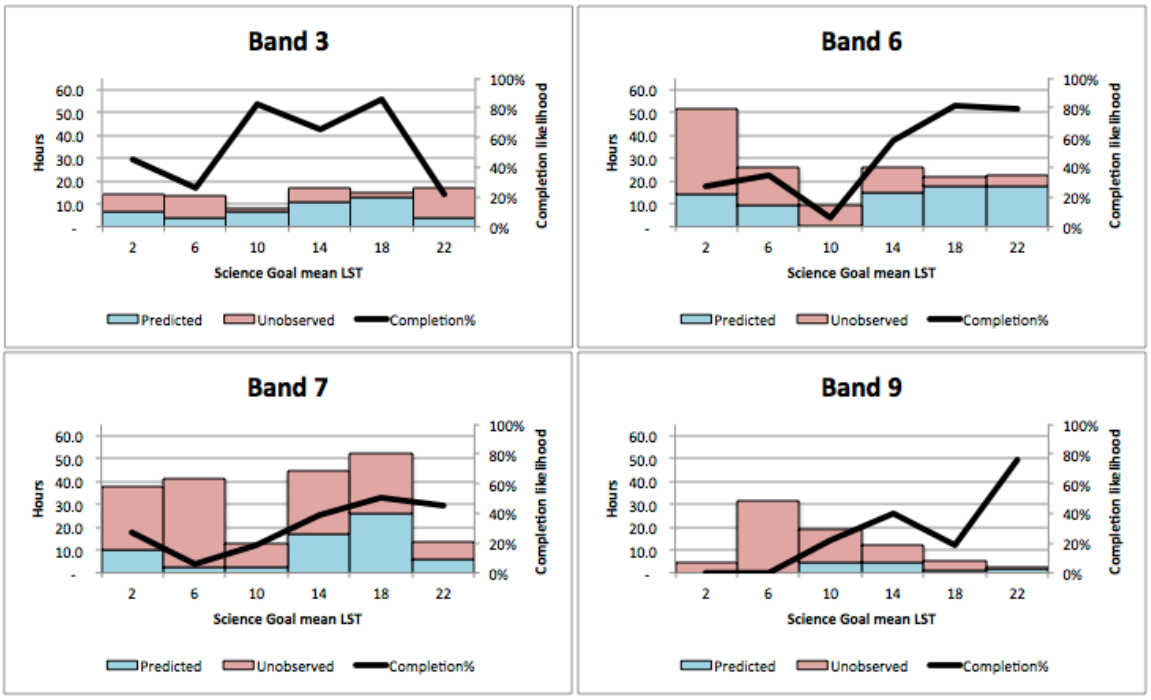

Figure 3: Prediction of the likelihood for the remaining Cycle 1 High Priority observations to be completed by the end of Cycle 1 (May 31, 2014), as a function of observing band. The blue histogram shows the number of hours predicted to be observed before the end of Cycle 1, while the red histogram shows the number of hours predicted to remain unobserved at the end of the cycle. The black line shows the resulting completion likelihood.

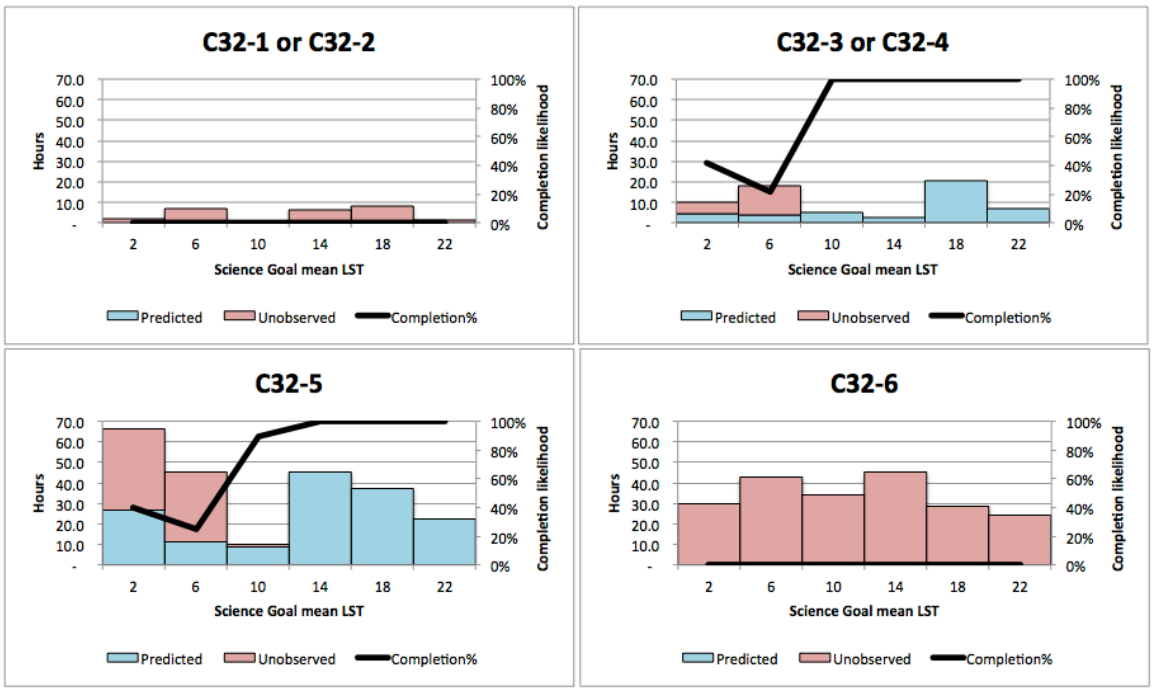

Figure 4: Prediction of the likelihood for the remaining Cycle 1 High Priority observations to be completed by the end of Cycle 1 (May 31, 2014), as a function of desired configuration (based on user requested angular resolution). C32-1 is the most compact (lowest angular resolution) and C32-6 is the most extended (highest angular resolution). The blue histogram shows the number of hours predicted to be observed before the end of Cycle 1, while the red histogram shows the number of hours predicted to remain unobserved at the end of the cycle. The black line shows the resulting completion likelihood.

7 Cycle 2

The proposal submission deadline for ALMA Early Science Cycle 2 proposals closed on the 5th of December 2013 with a record number of proposal submissions (see news item in ALMA Science Portal from December 19 2013 for a breakdown by science category and requested band). The proposal review process is currently ongoing and proposers will be informed of the outcome in the first few weeks of April 2014.

As mentioned above, Cycle 2 observing will commence in June, 2014, and will include unfinished Cycle 1 High Priority project components, whose priority will be intermediate between Cycle 2 "A" and "B" graded proposals (where "A" graded proposals account for up to 10% of the time allocated for Cycle 2; see Sec. 7.1 of the Cycle 2 Proposers Guide for details of the proposal review process including proposal grades)

Cycle 2 will extend until October 2015, with a 3 month Science Observing hiatus from September – November 2014 for the long-baseline campaign, and the annual Engineering time in February 2015. The observing cadence during ES time will be similar to the one we are transitioning to for the later part of Cycle 1: one week for commissioning activities followed by two weeks devoted to ES efforts, and including 24hr observing on the weekends. The 12-m Array configuration schedule for the first part of Cycle 2 is given in Figure 2. The configuration schedule for the second half of Cycle 2 will be determined considering also the requested resolutions of the High Priority Cycle 2 proposals.

8 Commissioning, Extension and Optimization Activities & Plans

Commissioning activities have focused mainly on validating the Cycle 2 online observing software and dealing with residual issues in single dish observing modes for the last few months. Other activities have been carried out in parallel, including enhancements/extensions to polarization capabilities, on-the-fly interferometry, full data rates, and online application of WVR data. These capabilities are not entirely validated and will continue to use array time to push these capabilities to completion. In the coming month, commissioning activities will represent a smaller fraction of total time available on the array. Before this period, the commissioning team will finalize the remaining improvements to Cycle 2, which will include the ability to recycle calibrations more effectively, more efficient management of internal calibrations of the correlators, which will help significantly with ACA observations, and final imaging performance aspects of bands 4 and 8.

Starting in April, the speed at which improvements to the system will be deployed will slow. We will reassess the observation strategy at bands 9 and 10 over the period of June through August. In principle, a combination of greatly enhanced speed of focus measurements, potentially viable 90-deg phase switching and possible use of phase transfer between bands, could vastly improve the performance at the highest frequencies. The start of band 10 commissioning is a good time to reconsider and specialize the approach.

Assuming all remaining antenna stations are available, in September the observatory staff will begin the task of commissioning the long baselines of ALMA. Due to the highly specialized nature of this dedicated campaign, little other work will occur on the baseline array. In total, four weeks will be needed to complete the required relocations, both outward initially and inward at the end. We will execute phase transfer tests on 5 km baselines initially but then rapidly move antennas to ~10-12 km baselines as well. As we conduct these transfer tests, additional antenna relocations will fill in the aperture providing, in the end, a viable 10-km imaging configuration. Over the same period, we will be testing improvements to the ACA correlator and continuing band 10 commissioning on the ACA as possible.

In December, the baseline array will return to a more compact configuration. We anticipate making progress on both the ALMA Phase Project, pending software validation, and solar observing during the month. Throughout the year, we will work on other items of high priority, especially during periods where band 9 and 10 observing is not possible. Also, in parallel to many of the items listed, we will refine the single dish observing approach and add continuum and high frequency spectral line single dish as these capabilities become available.

We will continue to offer science verification products to the community. Due to unforeseen difficulties, the single dish combination dataset is not yet released but will be soon. Following agreements with regional and ALMA Science Advisory Committees, the science verification process will take on the following form. The Observatory will provide a potential list of science verification targets to the community in advance of the observations and allow a comment period. In the event of potential conflict with approved ALMA science proposals, the proposal review committee chair will be consulted. Pending the outcome, observations will be scheduled and the data analyzed. A preannouncement of the data release will be given 2 weeks prior to the official release date. For target of opportunity tests which are needed for validation, such as pulsed signals or Doppler shifts of ephemeris sources, the comment period may be waived due to the rapid response time needed. Due to the scope and significance of the long baselines campaign, the observatory will coordinate initial source selection with the ALMA Science Advisory Committee but the nominal process will still be followed.

9 Observatory information

The observatory will continue to produce periodic Status Updates. Meanwhile, users can get information on observatory or project status through the following channels:

- The ALMA **Project Tracker** (under the "Observing" menu item in the Science Portal, or directly at http://almascience.org/observing/project-tracker): available to all PIs and co-Is of ALMA proposals. It provides the current state of all project components (e.g. "Phase2Submitted"; "Ready", "PartiallyObserved", "Processing", "Delivered"), the observing date for any observations (successful or not), and observing logs. See the Project Tracker Manual at the above link for more information, including the definition of project components and their allowed states.
- The **Contact Scientist**, via the **ALMA Helpdesk** (under the "Helpdesk" menu item in the Science Portal, or directly at http://help.almascience.org): each project is assigned a contact scientist at one of the ARCs or ARC nodes. Submit a helpdesk ticket (or use the one that was opened when the Phase2 products for your project were prepared) to ask any questions about your project status.
- The ALMA **Science Archive query interface** (under the "Data=>Archive" menu items in the Science Portal, or directly at http://almascience.org/aq/): this can be used to get a list of all projects or targets that were successfully observed by ALMA for any range of dates.

All ALMA documentation and other user tools are available under the "Documents and Tools" menu item in the science portal (or directly at https://almascience.nrao.edu/documents-and-tools). These include links to spectral line databases, atmospheric transmission curves and simulator tools. In addition, the ALMA Calibrator Database may be accessed through the ALMA Observing Tool (see https://help.almascience.org/index.php?/na/Knowledgebase/Article/View/241).

We are working on additional tools for PIs for the start of or during Cycle 2, including the following:

- A webtool to access and perform searches on the ALMA Calibrator database.

- The ability for PIs and co-Is to “sign up” for email notification of project state transitions though their Science Portal preferences.

Later in Cycle 2, we also plan to add a page in the Science Portal to give observers access to real-time observatory information and near term plans such as:

- Current weather forecast
- Current array characteristics (Minimum & maximum baselines, histogram of baselines)
- Near-term configuration schedule
- Location of each antenna and a list of available receiver bands.
- Summary of observing progress, project completion statistics, and data processing timescales (similar to Figure 1 & Tables 1-4)

A comprehensive user survey, soliciting user feedback on all areas of ALMA Operations, from proposal submission process to data products and ARC support, will be issued in the coming months. Users are welcome at any time to submit helpdesk tickets with any questions, suggestions, or concerns they may have. The helpdesk is available from the Science Portal or directly at http://help.almascience.org.

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of Europe, North America and East Asia in cooperation with the Republic of Chile. ALMA is funded in Europe by the European Organization for Astronomical Research in the Southern Hemisphere (ESO), in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC) and the National Science Council of Taiwan (NSC) and in East Asia by the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Academia Sinica (AS) in Taiwan. ALMA construction and operations are led on behalf of Europe by ESO, on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI) and on behalf of East Asia by the National Astronomical Observatory of Japan (NAOJ). The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.