ALMA Status Update

August 2015

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Revision History:

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Ver. 1.0	Nov 10, 2014	L. Nyman, J. Hibbard, D. Espada, S. Corder, P. Andreani, K. Tatematsu, A. Remijan
Ver. 2.0	August 6, 2015	L. Nyman, J. Hibbard, A. Remijan, S. Corder, P. Andreani, K. Tatematsu,

Contributors

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1 Summary

This report summarizes the status of Early Science observations, with a focus on Cycle 2, including "Cycle 1 Transfer" projects, as of August 3 2015. It includes events since the last Status Update (published in the ALMA Science Portal on November 10, 2014). The science produced during the inaugural ES sessions is substantive, with new press releases appearing almost every week. To date, over 256 refereed ALMA papers have appeared in the literature (many in the highest impact journals), garnering over 2500 citations. More than 75% of the delivered Cycle 0 projects have produced publications. For an overview of ALMA's science results, see the ALMA Science Portal at http://www.almascience.org/alma-science or the Proceedings of the conference 'Revolution in Astronomy with ALMA – the 3rd Year' (in press).

This report includes a summary of observing progress, Cycle 1 and 2 project completion statistics, a description of the actions that are being taken for project components that are no longer eligible to be scheduled, progress on data reduction and delivery, a summary of the Cycle 3 submitted proposals and user survey, the status of the commissioning effort called "Extension and Optimization of Capabilities (EOC)", and preparations for Cycle 4.

2 ALMA Cycle 2

Cycle 2 is the third 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 2 PIs share risk with ALMA, and project completion cannot be guaranteed. Major new capabilities for this cycle include: Band 4 and Band 8 receivers (~150 GHz and ~460 GHz respectively), polarization (on-axis, continuum only, Bands 3, 6 and 7) and maximum baselines out to 1.5 km.

Cycle 2 PI observing began on June 3, 2014. In addition to ~1700 h allocated to Cycle 2 A- and B-graded proposals, there were ~300 h of Cycle 1 Highest Priority projects that transferred into Cycle 2 (see November Status Update). Cycle 2 will extend through the end of September 2015. Only incomplete Cycle 2 "A" graded proposals will transfer into Cycle 3, regardless of the overall completion percentage.

Early Science (ES) observing "blocks" are scheduled from Tuesdays to Mondays over a three-week cycle for two consecutive ES weeks, followed by one EOC week dedicated to improving and extending array capabilities. During ES observing blocks, science observations are scheduled 16h per day on weekdays, with 24h observing on the weekends.

As of the date of this report, we have finished 28 (out of 34) ES observing blocks. Six blocks remain, representing a potential of 720 hours available to schedule for science. For an execution efficiency of 50%, this means that 360 h out of the initial allocation of 2000 h remain, or 18% of the observing season. Due to the efforts to improve the system stability and streamline observing procedures such as the initial quality assurance and scheduling, the overall observing efficiency has been significantly increased (see below).

3 Observing Progress

Table 1 gives the statistics of all the ES observing blocks since the start of Cycle 2 and until July 27 for the 12-m Array observations. The table presents the following information: (1) the ES observing block number; (2) the dates of the observing block; (3) the time allocated for ES observing; (4) the time associated with successful executions of PI science observations; (5) the Science execution efficiency (the fraction of the scheduled time used for successful PI observations as opposed to calibrations or weather or technical downtime)); (6) the overall observing efficiency (time spent on successful PI observations and calibrations divided by the allocated time after excluding any weather downtime); (7) the average number of antennas available over the session; and (8) the approximate configuration[1] of the available 12-m antennas, using the

[1] The configurations are considered "representative", since the array is seldom exactly in one of the advertised Cycle 2 configurations (due to antenna or receiver maintenance or other issues). But at any given time the array should be in a configuration with similar imaging properties – resolution and Maximum Recoverable Scale – as one of the representative configurations.

naming convention given in the Cycle 2 Proposers Guide (where the most compact configuration is called C34-1, and the most extended is called C34-7. Configurations listed with a slash indicate that the configuration contained sufficient baselines to approximate either configuration). The numbers in first nine ES observing blocks differ slightly from the numbers presented in the November 2014 ALMA Status Update due to updates and improvements in the reporting procedures and the system used to produce the observing statistics.

Overall, more than 1700 h of successful 12-m Array executions have been obtained. An additional 1274 h of successful executions have been completed on the ACA (561 h with the 7-m Array and 713 with the TP Array). These values include some Cycle 2 C-graded proposals that were observed when no higher priority projects suited to the prevailing conditions were available. The overall science execution efficiency matches the number adopted for Cycle 2 planning (50%). The trend is encouraging, with most observing blocks achieving efficiencies well above this value. Since December, the average number of antennas used for 12-m Array observations has consistently exceeded the planned number for Cycle 2 (34).

Table 1: Cycle 2 Observing Session summary for the 12-m Array

(1) Block	(2) Dates	(3) Allocated time (h)	(4) Successful Executions (h)	(5) Science Execution Efficiency (%)	(6) Overall Observing Efficiency (%)	(7) Average number of antennas	(8) Approx. 12-m Array config.
1	Jun 3-10	109.6	38.4	35%	47%	34.2	C34-4
2	Jun 10-17	125.7	57.4	46%	54%	34.5	C34-4
3	Jun 24-July 1	112.3	39.4	35%	57%	31.2	C34-4
4	Jul 1-8	124.7	35.3	28%	48%	31.6	C34-4
5	Jul 15-22	122.4	50.4	41%	52%	32.4	C34-4/5
6	Jul 22-29	116.4	49.4	43%	60%	31.3	C34-5
7	Aug 5-12	124.0	7.8	6%	26%	31.4	C34-5
8	Aug 12-19	122.2	32.6	27%	42%	33.6	C34-5/6
9	Aug 26-Sep 1	118.4	65.8	56%	80%	34.7	C34-6
10	Dec 2-9	114.4	65.6	57%	68%	32.5	C34-1/2
11	Dec 9-16	84.5	55.7	66%	75%	38.2	C34-1/2
12	Dec 23-30	130.0	83.7	64%	80%	39.0	C34-1/2
13	Dec 30-Jan 6	130.3	88.3	68%	77%	37.1	C34-1/2
14	Jan 13-20	123.4	83.3	68%	73%	35.3	C34-1/2
15	Jan 20-27	124.0	44.2	36%	85%	37.3	C34-1/2
16	Jan 27-Feb 2	119.2	18.2	15%	62%	37.2	C34-1/2
17	Mar 31-Apr 7	121.7	59.1	49%	69%	37.3	C34-1/2
18	Apr 7-14	125.2	60.1	48%	93%	37.2	C34-1/2
19	Apr 21-28	118.5	53.2	45%	64%	38.2	C34-1/2
20	Apr 28-May 5	119.7	63.7	53%	63%	36.9	C34-1/2
21	May 12-19	119.2	97.4	82%	88%	37.3	C34-3/4
22	May 19-26	124.2	85.4	69%	83%	35.5	C34-3/4
23	Jun 2-9	119.7	86.9	73%	83%	37.5	C34-4/5
24	Jun 9-16	126.0	97.9	78%	85%	36.4	C34-4/5
25	Jun 23-30	120.0	79.3	66%	84%	41.1	C34-6/7
26	Jun 30-Jul 6	117.3	59.7	51%	80%	41.0	C34-6/7
27	Jul 15-20	118.0	79.4	67%	81%	41.5	C34-6/7
28	Jul 21-27	124.3	78.3	63%	68%	41.9	C34-6/7
1-24	**2014 Jun 3 - 2015 Jul 27**	**3355**	**1716**	**51%**	**69%**	**36.2**	

The 12-m Array is now in a configuration with baselines from 40-1500 m, suitable for scheduling science goals with angular resolutions originally matched to the C34-6 or C34-7 configurations. It will remain in this configuration for the remainder of Cycle 2 until September 30, 2015. A summary of ES observing blocks and properties of the current configuration is maintained in the ALMA Status Page available from the Science Portal (under the “Observing” menu item, or directly at http://almascience.org/observing/alma-status-pag).

4 Project Components that can no longer be Observed

Now that the 12-m Array antennas have been moved into an extended configuration (maximum baselines > 1 km), there are a number of projects that cannot be completed because they have 12-m Array components that require an angular resolution or Largest Angular Scale that can not be recovered by this configuration. Additionally, any 12-m Array, 7-m Array, or TP Array project components that will only be visible during the day for the remainder of Cycle 2, and which require high frequency observations (Bands 8 and 9) also cannot be completed, since the daytime atmospheric phase fluctuations are too large. Together, these amount to ~230 h of 12-m High Priority observations[2], along with ~180 h of Cycle 2 C-graded proposals that were prepared to fill gaps in the observing schedule (mostly low-frequency projects).

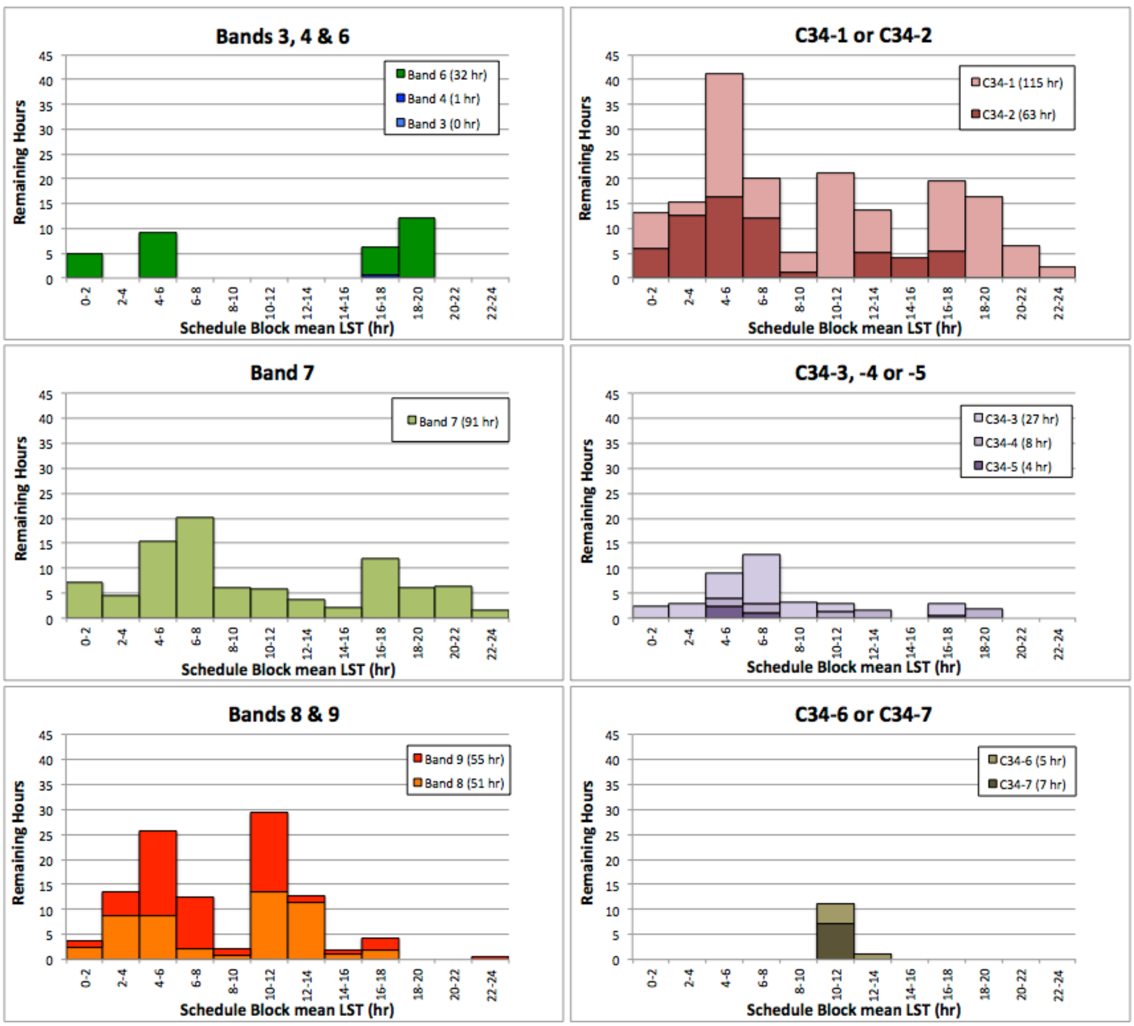

Figure 1: Distribution of the Cycle 1 & 2 High Priority 12-m Array project components that can no longer be scheduled, as a function of required LST, and separated by observing band & best-matching 12-m Array configuration. This plot does not include Grade-C projects.

[2] All times that are reported are approximate. They are calculated based on the expected number and duration of uncompleted observation. For Scheduling Blocks (SBs) that have been executed at least once these are good estimates, but for SBs that have never been executed (including most of the remaining C34-6/7 observations), these are much less certain. The uncertainty could be as large as 30% for individual project components, or ~15% overall.

The LST distribution of these "unobservable" project components is given in Figure 1. These are plotted separately for different observing bands and for the best matching Cycle 2 12-m Array configuration. These plots show that the uncompleted observations are primarily those requiring the higher observing frequencies and the most compact configurations. Recall that earlier problems with infrastructure readiness lead to a longer than expected period in the intermediate array configurations (C34-3, -4 and -5) compared to the original plans, at the expense of the more compact and extended configurations (see ALMA Status Update from March 2014, available from the ALMA Science Portal).

Any unobservable components ("ObsUnitSets" or OUSs) for projects awarded an A-grade will remain in the "READY" state, but will not be scheduled for observations. The corresponding Scheduling Blocks (SBs) will transfer into Cycle 3. The state of unobservable OUSs from lower priority projects will be set to "ObservingTimedOut" and the corresponding Scheduling Blocks (SBs) put into the "suspended" state, meaning that no further observations are possible. Contact Scientists from the ARCs and ARC nodes will contact affected PIs. PIs can also check themselves using the Project Tracker (available from the ALMA Science Portal).

Any unobservable OUS that has been started but not finished will be sent for data processing. These data will go through the official Quality Assurance process; however, they will likely not meet the PI science goals on sensitivity (and maybe angular resolution): in this case, they will be marked as QA2-semipass and delivered to the PI.

After accounting for the unobservable components, approximately 430 h of Cycle 1 & 2 High Priority 12-m Array observations remain that are eligible for scheduling in the remaining C34-6/7 configuration. The distribution of these hours binned by the mean LST of the targets in each SB is shown graphically in Figure 2, color-coded by the required ALMA frequency band. The numbers within the figure legend represent the number of hours still needed for the corresponding observing band.

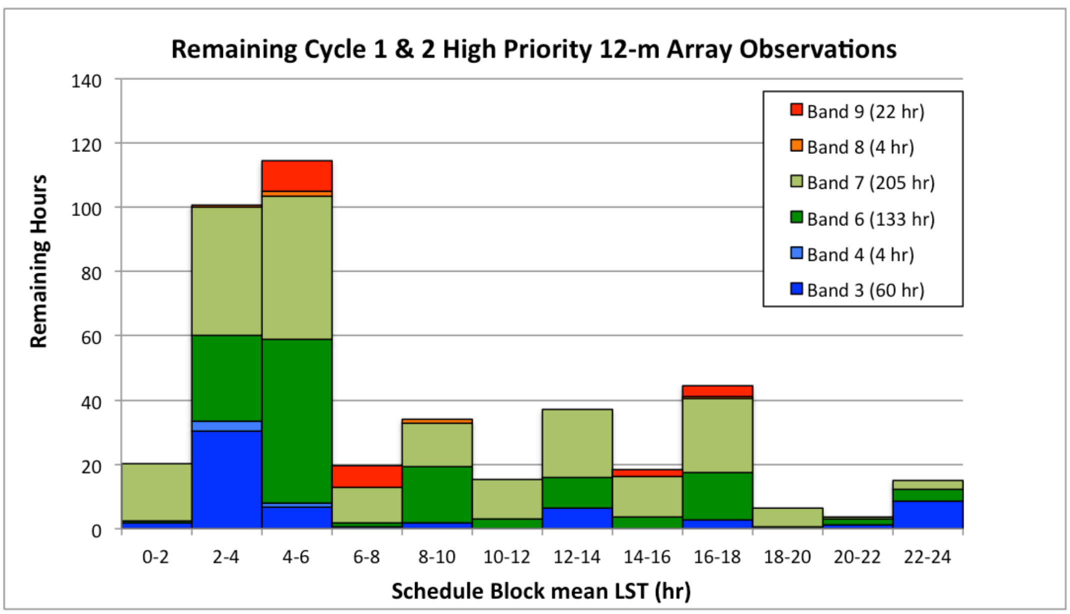

Figure 2: Histogram of the remaining number of hours needed to complete Cycle 1 & 2 High Priority 12-m Array observations as a function of the mean LST of each remaining Schedule Block, after removing the "unobservable" project components (those that are unsuitable to be observed in the remaining Cycle 2 configuration, or that require high-frequency daytime observations). The different colors represent different ALMA observing bands.

5 Completion Statistics

The progress towards project completion is given in Tables 2 & 3 and Figures 3 – 6, separately for Cycle 1 and Cycle 2 and separately for Projects as a whole, and for the individual components (OUSs) that make up projects. Since most projects are comprised of several SBs (each resulting in a single OUS), project completion is less than the overall OUS completion rate. Similarly, the fraction of projects with no observations is less than the fraction of OUSs with no observations.

Table 2: Cycle 1 Project Status Summary

State	Number of High Priority & DDT Projects	Number of Filler Projects
Accepted	198	93
With at least one successful observation	179 (90%)	34 (37%)
With at least one completed OUS	176 (89%)	34 (37%)
With at least one OUS delivered	149 (75%)	33 (35%)
Have data being processed	77 (39%)	3 (3%)
Completed & delivered	83 (42%)	13 (14%)

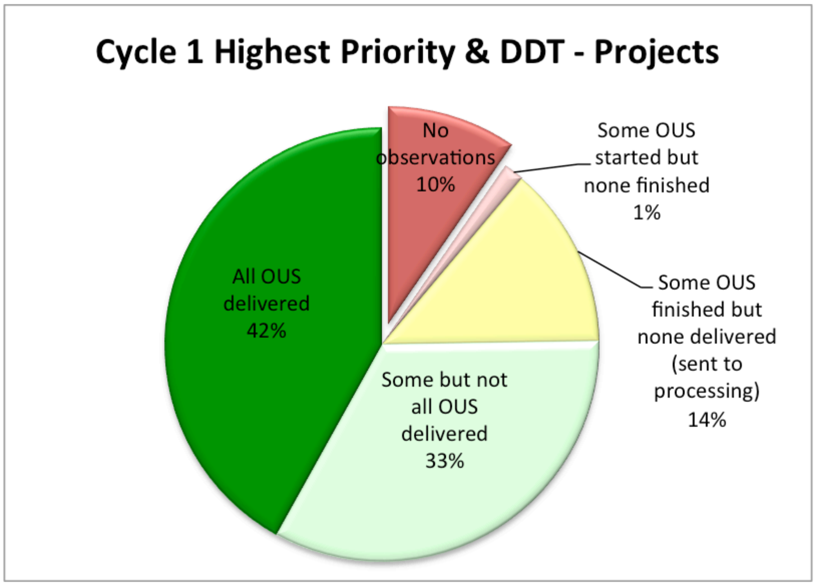

Figure 3: Completion fractions for all Cycle 1 Highest Priority projects.

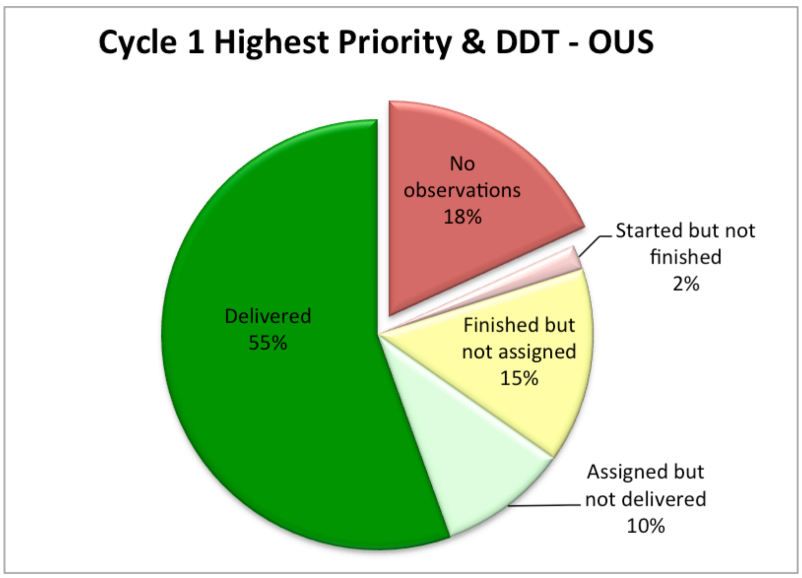

Figure 4: Observing Status of all Highest Priority Cycle 1 OUSs. "Assigned" means assigned for data reduction.

Table 3: Cycle 2 Project Status Summary

State	Number of High Priority (grade=A,B) & DDT Projects	Number of Filler Projects (grade=C)
Accepted	355	159
With at least one successful observation	286 (81%)	52 (33%)
With at least one completed OUS	276 (78%)	50 (31%)
With at least one OUS delivered	199 (56%)	35 (22%)
Have data being processed	164 (46%)	24 (15%)
Completed & delivered	76 (21%)	10 (6%)

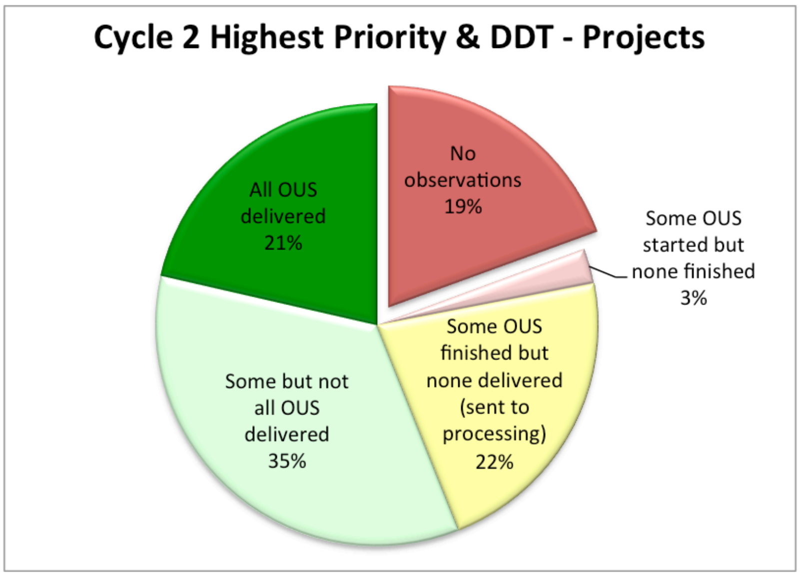

Figure 5: Completion fractions for all Cycle 2 Highest Priority projects.

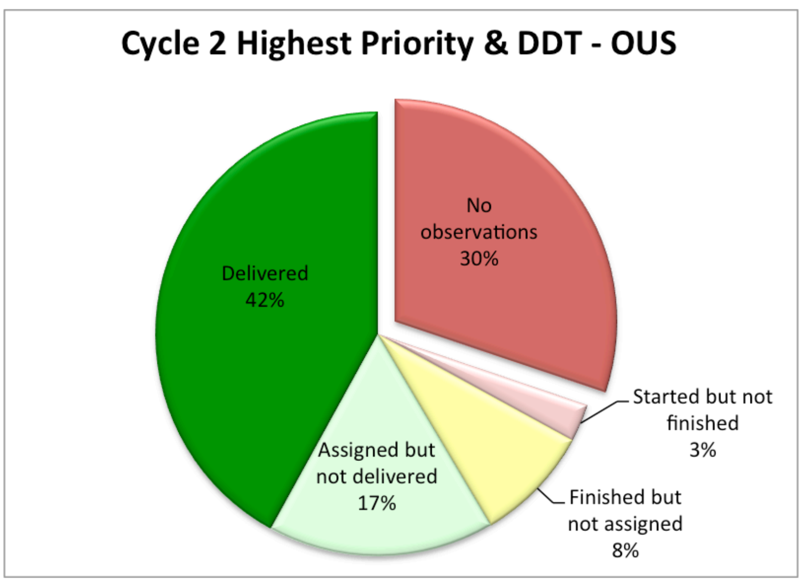

Figure 6: Observing Status of all Highest Priority Cycle 2 OUSs. "Assigned" means assigned for data reduction.

Overall, these tables and plots show that the majority of projects have some useful data, but the fraction of completed projects remains fairly low. There is a relatively large fraction that have data currently being processed. Considering the remaining six ES observing blocks and considering the required LST and configuration of the remaining scheduling blocks in the observing queue, and assuming an average execution efficiency of 50%, we estimate an overall SB completion rate prediction of 85%. At the end of the observing season, all incomplete Cycle 2 A-graded SBs will be transferred to Cycle 3, while the incomplete Cycle 1 and Cycle 2 B-graded components will be set to "ObservingTimedOut" and dealt with as described in Section 4 above.

6 Data reduction progress & timescales

As in previous cycles, Cycle 2 data reduction is a work-intensive process done at the JAO and the three ARCs, and involves customizing standard data reduction scripts, identifying problematic data, conducting quality assurance checks, and packaging the data for delivery to PIs. Table 4 shows the median timescales for each post-observing stage from OUS completion to delivery, for all three Early Science cycles. The time for assigning datasets for reduction has decreased significantly since the last Status Update, due to the start of the calibration pipeline in Chile. About 70% of all data can be processed through the calibration pipeline (the other 30% is sent to the more work-intensive manual reduction path). However, the number of days to process the data has increased. This is because there is more data coming out of the calibration pipeline than there are staff at the ARCs and JAO available to do the imaging and perform the quality assurance on the data before it can be delivered (the shorter processing time for Cycle 1 data compared to Cycle 2 reflects the fact that priority is given to processing older data, which tends to be Cycle 1 observations since they have scheduling priority over Cycle 2 B-graded proposals). In response to these considerations, the JAO and ARCs have recently hired additional staff to assist in the world-wide data reduction effort.

Table 4: Data Processing & Delivery Timescales for Cycles 0-2

Data Processing & Delivery times (Medians, in days)	Cycle 0	Cycle 1	Cycle 2
Days since completed to assigned for reduction	7.0	11.2	4.7
Days from assigned to QA2 evaluation	45.0	19.8	38.8
Days from QA2 evaluation to delivery to PI	12.0	5.2	4.1

As of the date of this status update, the first version of the automated ALMA imaging pipeline was released for testing. We expect the next version (to be deployed by the start of Cycle 3) to be of some assistance with imaging and quality assurance, but not to take over the majority of imaging until experience is gained and fed back into the imaging heuristics. When accepted, the biggest advantage of the imaging pipeline is that it should enable the imaging of all sources and all spectral windows (only a subset of these are currently produced in order to speed data delivery to PIs).

There are still a number of projects that will not run through the calibration or imaging pipeline, including observing modes that are not yet implemented in the pipeline (e.g. Total Power, polarization, high frequency, bandwidth switching) or projects that fail pipeline processing (e.g. low signal-to-noise calibrators, poor phase stability). These data are manually processed by experts at the JAO and ARCs.

As a result, PIs may receive data that were calibrated either manually or by the pipeline. Consequently, there are two methods for reproducing calibrated measurement sets – one for manually calibrated data, and another for pipeline calibrated data (see http://almascience.org/documents-and-tools/cycle-2/alma-qa2-products-v2.1 for details). To reproduce pipeline calibrated data, users need to download the special CASA tarfile that includes ALMA pipeline. This is available from the CASA webpage at http://casa.nrao.edu/casa_obtaining.shtml.

Some ALMA projects require the combination of data obtained with different Arrays (two 12-m Arrays, or 12-m Array and ACA). In order to not further delay the delivery of the individual data components, the combination of these different observations is currently not being done by observatory staff. Instead, PIs will need to combine these data on their own. The data combination process is described in the recently released M100 Science Verification CASAguide (https://casaguides.nrao.edu/index.php?title=M100_Band3_Combine_4.3).

However, this guide assumes that the component datasets have properly calibrated weights, which is not the case for older data (data manually processed using a CASA version before CASA 4.3). Additionally, it may be desirable to modify the weights considering the relative observing times for the different components. For such data, additional steps are needed to properly weight the data before they can be combined. Further considerations and details are provided in the "Data Weights and Combination" CASAguide at https://casaguides.nrao.edu/index.php/DataWeightsAndCombination.

Finally, we note that processed TP and polarization data has so far not been delivered to PIs, pending the finalization of the data calibration and quality assurance procedures. We expect to start delivering TP data by late August and polarization data by October.

We remind all researchers that there are opportunities 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.

7 ALMA Cycle 3 Proposal Process and Users Survey

The proposal submission deadline for ALMA Early Science Cycle 3 proposals closed on the 23 of April 2015. The ALMA review panels met in June 2015 and proposers will be informed of the outcome of the review process during August 2015. Cycle 3 will start in October 2015 and will span 12 months; there are expected to be 2100 hours of 12-m Array time available to projects receiving a grade of A or B, and an additional ~600 h to those receiving a grade of C.

ALMA received 1582 unique proposals during the Cycle 3 call, estimated to require 9037 hours of 12-m Array (representing an over-subscription request of 4.3, similar to previous cycles) and 3640 hours of ACA time. By comparison, 1382 proposals were received in Cycle 2 and 1131 in Cycle 1. The ALMA Regional Centers handled a total of 345 helpdesk tickets between the issuing of the Call for Proposals and the proposal submission deadline.

A total of 1122 unique Principal Investigators and 3608 proposers (Principal and Co-investigators) were involved in the submitted proposals. Some statistics of the submitted proposals are summarized graphically in Figure 7. The percentage of proposals that requested observations in various bands was 31% (Band 3), 9% (Band 4), 45% (Band 6), 40% (Band 7), 6% (Band 8), 5% (Band 9) and 2% (Band 10). The total time requested for standard observing modes was 6913h and for non-standard modes 2124h.

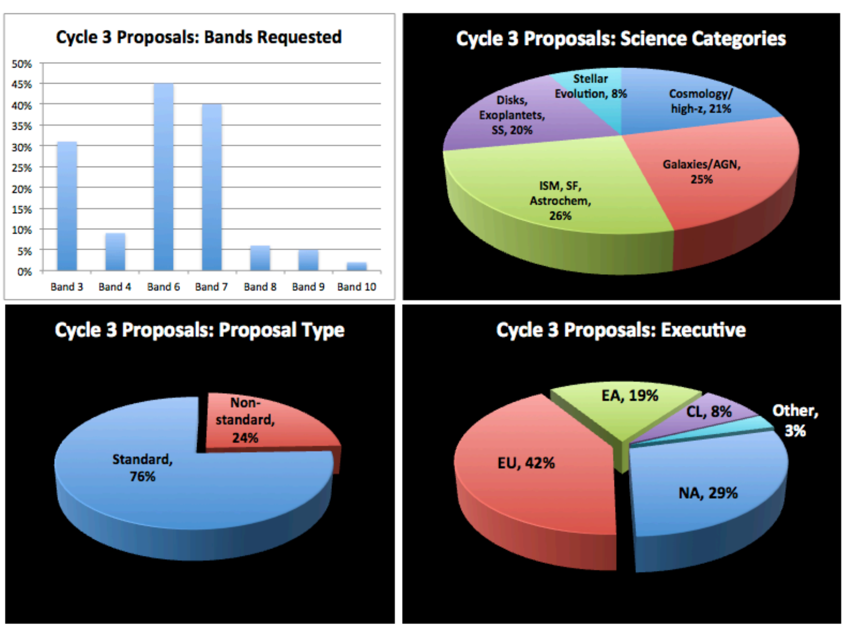

Figure 7: Statistics for Submitted Cycle 3 proposals

The distribution of proposals across science categories was 21% (Cosmology and the high redshift universe), 25% (Galaxies and galactic nuclei), 26% (ISM, star formation and astrochemistry), 20% (Circumstellar Disks, Exoplanets and the Solar System) and 8% (Stellar evolution and the Sun). The fraction of proposals coming from the three Executives, Chile and outside the partnership was NA:29%, EU:42%, EA:19%, CL:8% and 'Outside': 3%, similar to the previous two cycles. A detailed report of the cycle 3 proposal process and results will be posted to the Science Portal shortly after the results are released to PIs.

Following the proposal deadline, a User Survey was conducted among all the PIs and co-Is of a Cycle 2 and/or a Cycle 3 ALMA proposal. A total of 536 users (representing 15% of the users who were sent the questionnaire, including 44% of Cycle 3 PIs) responded to the survey, which focused on the topics of proposal preparation and submission and usability of tools such as the helpdesk or the science portal. A News Item reporting the results of this survey has recently been posted to the ALMA science portal (http://almascience.org/news/alma-cycle-3-user-survey-3).

8 Extension and Optimization Activities & Plans

Since the end of long baseline campaign (November 2014), the Extension and Optimization of Capabilities (EOC) has been allocated one week out of every three (alternating with Early Science observations) for the testing and verification of new and enhanced capabilities. This section is a summary of EOC activities since the last status summary from 2014 November. The EOC group will cease to exist at the end of September, 2015. Continued EOC-like activities will take place under the management of DSO with support from the ALMA Regional Centers. The detailed reports on various aspects of this work are posted to the EOC Memo Series and ALMA Technical Notes Series (available at the ALMA Science Portal http://almascience.org/documents-and-tools).

8.1 Total Power (TP) Observations

TP observations were accepted in November 2014 and PI data started to be taken when early science observations resumed in December 2014. New Science Verification data on M100, including Total Power observations, were posted to the Science Portal on July 28, 2015, along with an accompanying CASAguide (https://casaguides.nrao.edu/index.php/M100_Band3_SingleDish_4.3). The Single Dish pipeline and final data reduction procedure and the quality acceptance criteria are being finalized, and the delivery of PI Total data are expected in August 2015.

8.2 ACA Correlator Upgrade

Concluding in 2015 May, the ACA correlator underwent a significant overhaul, which included changes to the hardware and control software. The change handles the 3 bit linearity correction. The frequency profile synthesis (FPS) is moved to the control software from the hardware to fix a bug that the hardware FPS was producing cross-talk between the two subarrays and thereby preventing the 7-m and TP arrays from operating concurrently.

Overall, the online 3-bit linearity correction has been revised in the control software so that the update interval of its correction factors is now the integration/channel-average duration for full-resolution/channel-average data. This change is realized using a digital power meter, which is a new feature of ACA Correlator hardware and which calculates the mean and variance of a 3-bit time-series data input to the correlator for total-power estimation. The new amplitude correction was verified and a report on both the continuum flux and line intensity verification is in preparation that shows good coincidence between the ACA correlator, baseband detectors and baseline correlator measurements.

8.3 Polarization Capabilities

In February 2015, the polarization commissioning plan until the end of 2015 September was reviewed. The following capabilities were identified as priorities to commission: 1) Improved polarization calibration efficiency; 2) Increasing the field of view up to the primary beam in full polarization (Stokes I, Q, U, and V); and 3) Full commissioning of spectral-line circular polarization (for measurement of the Zeeman effect). During the first part of year, the polarization commissioning team collected data to test these capabilities as well as to troubleshoot the problems that have been found with existing Cycle 2 polarization projects. As a result, Cycle 2 polarization projects are now eligible for scheduling during ES observing sessions. These projects are challenging to complete, as they require long periods of continuous observations in order to obtain the appropriate calibration data.

8.4 Subarray and ONLINE Control Software Testing

From October 27, 2014 until November 15, 2014, there was a dedicated mission to continue the work on the subarrays. This capability allows subsets of antennas to be split into different arrays for concurrent observations. It will initially be used to allow observatory operations (e.g. antenna maintenance, calibrations, integration of antennas after array reconfigurations etc.) to take place in parallel with science observations, helping to increase the overall observing efficiency (subarrays for concurrent science observing will be commissioned at a later date). The main objectives of the subarray mission were to:

- Finalize the verification of the concurrent subarrays (up to four) by exercising different scheduling situations and different correlator modes.
- Verify that interfacing software works as expected.
- Provide training and documentation to Operations staff.

A dedicated campaign was also run in 2015 March to test the functionality of subarrays. The primary goals of the mission were to continue verifying concurrent sub-arrays (up to four) under as many possible scenarios as possible to mimic real time observations, engineering tasks and antenna integration and regression. By the end of April, it was determined that the mechanism for running multiple subarrays was thoroughly tested and exercised. There were still some data corruption issues but the subarray team had an understanding of the causes for these issues. EOC formally started testing the subarray functionality in 2015 May, which included coordination both technically and operationally.

While the use of subarrays and other features of the new control software will not be used for Cycle 2 observations, its validation and testing is an integral part of the future acceptance testing of the candidate CONTROL software for Cycle 3. The final acceptance is scheduled for the end of August.

8.5 The Long Baseline Campaign

From September – November 2014, EOC conducted Long Baseline Observing Campaign (LBC). The major goal of this campaign was to determine the best observation and reduction methods needed to obtain high-quality images for ALMA configurations with baselines in excess of 2 km.

The minimum requirements for the success of the LBC included having secure imaging capabilities at Bands 3, 4 and 6 at 5 km baselines, although imaging with 10 km baselines at Band 3 was the goal. During the initial phase testing in mid-September it became clear that the band 3 observations would easily be offered up to baselines as long as 10 km and tests also showed that phase referencing could be done in bands 6 and 7 up to 5 km baselines. During the initial testing phases, metrics were assembled that measured various meteorological conditions including water vapor content and atmospheric phase stability to determine the overall “GO” and “NO GO” decisions for long baseline observations. The LBC team investigated the efforts that were needed to test the capabilities which would eventually be offered for Cycle 3. These tests included in roughly chronological order:

- Antenna Configuration Plan
- Band-to-Band Phase Transfer
- WVR Online and Offline Use
- Antenna Position Determination
- Calibrator Resolution and Searches
- Phase Referencing Metrics
- Determination Go-NoGo Phase Conditions
- Imaging and Self-calibration
- Science Verification (SV)
- Scripting and Pipeline

The LBC testing in September proved remarkably successful. As such, several press releases and news items were posted including the press release on the move of antenna DV19 to a greater than 9km baseline: http://almaobservatory.org/en/press-room/announcements-events/753-alma-extends-its-arms. In October the LBC's focus shifted to imaging and a review was held to evaluate the currently tested capabilities as well as the plans for the remainder of the campaign through the end of November. The major priorities that came out of the review were:

1. The decision to move antennas DV07 and DA55 for to achieve a baseline on the order of 15 km.
2. The investigation of the possibility of long baseline daytime observations in bands 3-6.
3. Expand the scope of the science verification effort and the overall general use (at night) of bands 7-8 for the long baseline campaign.
4. The investigation of the imaging characteristics of 2 km baselines at bands 9 and 10 (if possible)

At the end of October, the final expanded long baseline array was completed and is shown in Figure 8.

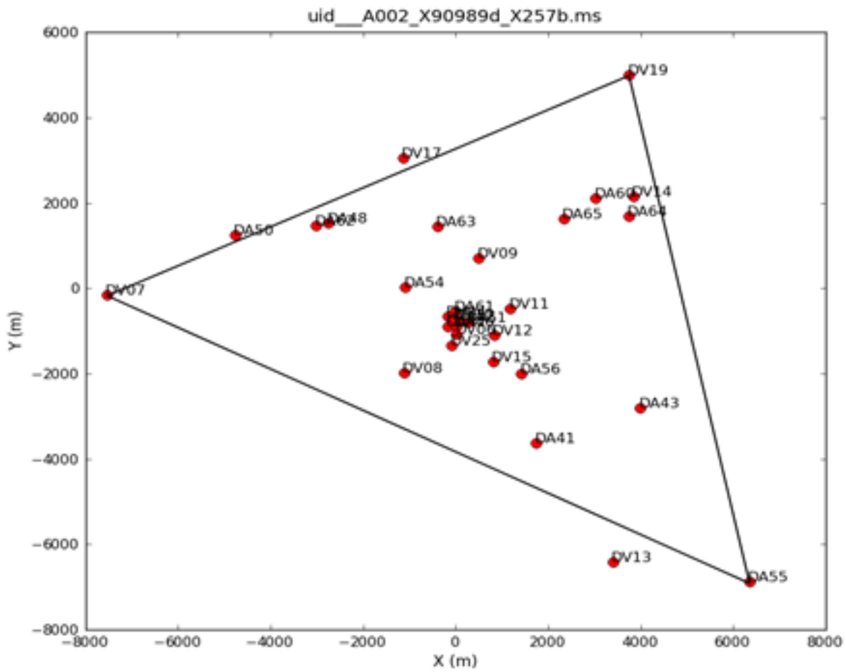

Figure 8: LBC array as of mid-October during the middle of the imaging and SV phase of the campaign. Note this includes the moves of antennas DA55 and DV07 to achieve a baseline >15 km.

Two news items were posted during the campaign announcing the planned LBC Science Verification (SV) observations and data products (http://almascience.org/news/new-targets-for-science-verification-long-baselines, http://almascience.org/news/additional-scope-for-long-baseline-science-verification-targets) On 17 February, the first release of science verification data to the scientific community took place, and includes data for HL Tau, SDP.81, Juno and Mira (available at: http://almascience.org/alma-data/science-verification). The polarization data from 3C 138 were still undergoing reduction and analysis and were not ready for release during this time. The stunning results from the campaign were also highlighted in press releases, including the now highly publicized Band 6 image of HL Tau (http://almaobservatory.org/en/press-room/press-releases/771-revolutionary-alma-image-reveals-planetary-genesis), and four papers were published by the ALMA partnership to the Astrophysical Journal Letters (http://www.almaobservatory.org/en/press-room/press-releases/821-alma-partnership-publishes-first-results-on-long-baselines).

8.6 The ALMA Phasing Project (APP) Campaign

The ALMA Phasing Project (APP) is an ALMA Development Project to "phase up" all the individual elements of the 12-m Array so that it behaves like a very large, sensitive single dish telescope. This capability is critical in order for ALMA to be used as part of Very Long Baseline Interferometry (VLBI) networks.

The first commissioning mission for the APP took place during the ALMA EOC Week from January 6-13, 2015. The formal commencement of APP commissioning activities followed the provisional acceptance of the APP hardware during a formal review by JAO that took place on 2014 December 11. The primary objectives for the first APP commissioning campaign were two-fold: (1) local (i.e., short-baseline) VLBI fringe tests between ALMA and nearby sites (APEX and an ALMA antenna at the Operations Support Facility or OSF); (2) systematic testing and characterization of the phasing system. A secondary goal was to begin to familiarize ALMA science and support staff with APP operations. As a result of this mission, The APP met the objective of recording VLBI mode data simultaneously with ALMA and two nearby independent sites (ALMA antenna PM01 on pad TF01 at the OSF and APEX, respectively). However, the cadence of the data precluded the planned on-site correlation and analysis of the data. The results of the observations taken between ALMA and APEX were highlighted in a press release: (http://www.almaobservatory.org/en/press-room/announcements-events/813-alma-gains-new-capability-in-its-first-successful-long-baseline-observation-).

8.7 Solar Observing Campaign

The last EOC campaign of the year involved teams from an ALMA development study to investigate new and innovative ways to observe the Sun in interferometric mode as well as testing the capabilities of single dish solar observing given the fast scanning tests from September, 2014. Both interferometric and single dish data were collected over the course of the campaign and the Solar observing team set a new record by observing interferometrically with more than 50 array elements (including both 12m+7m antennas) for more than 6 hours. Initial tests showed that the new signal attenuation mode for solar observations was effective and the team also caught a solar flare during an eruption event on 18 December. The campaign also demonstrated the power of ALMA's single dish fast scanning capability.

8.8 EOC activites for the rest of Cycle 2

For the remainder of Cycle 2, EOC will complete the testing and validation of the following residual Cycle 3 items:

1. High frequency observing including the "band-to-band transfer" and "bandwidth switching" calibration techniques as well as conducting imaging tests at Band 10 for baselines longer than 1 km.
2. Long baseline observing including the final observing phase metrics and "Go/No Go" decision points for long baseline observations and testing of the longest baselines possible at ALMA before the start of routine Cycle 3 observations.
3. Online WVR corrections will be enabled for all data collected for Cycle 3 while the pipeline will continue to process the offline WVR corrected data as in Cycles 0-2. The online corrected data will be used for comparison purposes and refining data reduction heuristics with the goal of moving all pipeline reduction to online WVR corrections at the start of Cycle 4.
4. In order to improve observing efficiency, multiple intents will be used in Cycle 3 in cases where queries return the same field source for bandpass, amplitude or polarization calibration. In addition, the differential gain calibration approaches for the "band-to-band transfer" and "bandwidth switching" calibration techniques will be well defined and included in the ALMA Observing Tool. Finally, the use of subarrays for antenna integration, verification and engineering tasks will be offered at the start of Cycle 3, which will greatly enhance the efficiency of routine science observing.

Starting in September, the commissioning and testing of new capabilities will be transferred to Science Operations, and the dedicated EOC staff will move to new or previous positions. After this transition, observing time and staffing resources to work on new capabilities will need to be priortizied not just against each other but also against science observing and other operations tasks. Progress on the remaining items will therefore take place at a slower rate. This includes the following capabilities: Mapping of External Ephemeris Objects; 90 degree Walsh switching; Frequency Switching within SBs; single dish Fast Scanning for non-Solar observations; Polarization of extended sources (including single dish & 7-m Array Polarization); Polarization at high frequencies (Bands 9 & 10); Wide field, Mosaics & off-axis Polarization; On-the-fly Interferometry (OTFI = larger mosaics); Improved (more efficient) Spectral Scans using differential gain calibration; Time Domain Observations.

9 Cycle 4 planning

As described in the previous section, the months before the end of Cycle 2 will be spent validating various new capabilities. The results of these efforts will inform the selection of the new capabilities to be offered for Cycle 4, and which capabilities will be "non-standard" (meaning that the number of proposals requesting such capabilities will be limited). December 1, 2015 is the decision point for deciding what will be included in the Cycle 4 Call for Proposals, and this information will be announced in a Cycle 4 "pre-announcement" on the ALMA Science Portal and broadcast to all registered ALMA users by the ARC network. The Cycle 4 proposal timeline will closely follow that of Cycle 3, with a call expected in March 2016, a deadline in April 2016, and the outcome of the proposal process sent to PIs by August 2016. For Cycle 4, the panel meetings will continue to include a face-to-face component, which is scheduled to take place in Europe. .

10 Observer information

The observatory will continue to produce periodic Status Updates. Additional information on the observatory or project status can be obtained through the Project Tracker, the ALMA Helpdesk, the Data Archive or from the Contact Scientists (see ALMA Status Update from March 2014). There is an 'ALMA status' webpage available at the Science Portal under the "Observing" menu item that provides weather conditions and forecast, information on the array configurations and schedule, and links to observing reports for each Early Science observing block.

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.