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ALMA Cycle 1 Proposer's Guide

www.almascience.org

ALMA, an international astronomy facility, is a partnership of Europe, North America and East Asia in cooperation with the Republic of Chile.

User Support:

For further information or to comment on this document, please contact your regional Helpdesk through the ALMA User Portal at **www.almascience.org**. Helpdesk tickets will be redirected automatically to the nearest ALMA Regional Center at ESO, NAOJ or NRAO.

Revision History:

Version	Date	Editors
1.0.3	4 June 2012	Gautier Mathys

Contributors

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Contributors' Logos

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1 Executive summary

The Joint ALMA Observatory invites proposals for Early Science observations (Cycle 1) of the Atacama Large Millimeter/submillimeter Array (ALMA). The purpose of Early Science is to deliver scientifically useful results to the astronomy community and to facilitate the ongoing characterization of ALMA systems and instrumentation as the capabilities of the array continue to grow. Early Science will be conducted on a best-effort basis, so as to not unduly delay the construction of the full 66-antenna array. Nonetheless, Early Science provides an important opportunity for first science from this cutting edge facility. Early Science will continue until construction of ALMA is complete.

In Early Science Cycle 1, ALMA will have the following capabilities: thirty-two 12-m antennas for interferometric observations, the Atacama Compact Array (ACA) composed of nine 7-m antennas for interferometric observations (7-m Array) and two 12-m antennas for single dish observations (Total Power Array), receiver bands 3, 6, 7 & 9 (wavelengths of about 3, 1.3, 0.8 and 0.45 mm), several array configurations with maximum baselines ranging from ~160 m to ~1 km, single field imaging and mosaics of up to 150 pointings, and a set of correlator modes that will allow both continuum and spectral line observations simultaneously, as well as a mixed spectral setup mode. Polarization capabilities and solar observations will not be available in Cycle 1. Projects that require detection of extended structures should request ACA observations. Use of the ACA will lengthen the overall time required for an observation.

ALMA Early Science Cycle 1 is expected to span 10 months. It is anticipated that 800 hours of array time will be available for Early Science projects. Any astronomer may submit a proposal in response to the ALMA Early Science Cycle 1 Call for Proposals. Proposals will be assessed by peer review, and ranked on the basis of scientific merit and potential contribution to the advancement of scientific knowledge. Proposals that best demonstrate and exploit the advertised ALMA Early Science Cycle 1 capabilities, producing scientifically worthwhile results from relatively short observations (averaging a few hours), will be favorably considered. High frequency observations (upper band 7 and band 9) will be harder to schedule than low frequency observations (bands 3 and 6) due to fewer available hours of favorable weather conditions. Reviewers will be advised to consider Cycle 1 proposals on their own merit, independent of Cycle 0 results. Projects will not be carried over from Cycle 1 to later cycles (even if they have not been completed in Cycle 1), and will not establish proprietary rights beyond the standard 12 months period.

ALMA staff will conduct quality assurance on ALMA data, and will provide processed data products through the respective ALMA Regional Centers (ARCs). However, it cannot be guaranteed that characterization and quality of the data and data reduction will meet the standards expected when ALMA is fully operational. Experience in radio (in particular, millimeter) interferometry, though not required, will be an advantage in working with ALMA Early Science data products, particularly for projects that include high frequency and/or ACA components. Principal Investigators (PIs) and observing teams should anticipate the need to invest their own time and expertise to insure the quality of the provided data products and to re-reduce the raw data if the quality of the data products is not satisfactory. This may include the need to visit the relevant ARC or ARC node to get help and to assist with quality assurance and potential data re-reduction.

2 Invitation for ALMA Early Science Cycle 1 proposals

The Atacama Large Millimeter/submillimeter Array (ALMA) is an array of high-precision antennas operating at millimeter/submillimeter wavelengths, currently being assembled at a 5000 m high site in northern Chile. The Joint ALMA Observatory (JAO) invites members of the astronomical community to submit proposals for Early Science observations with ALMA. Successful projects are expected to be executed between January 1 and October 31, 2013. The purpose of Early Science is to deliver scientifically useful data to the astronomical community and to facilitate the ongoing characterization of ALMA systems and instrumentation as the capability of the array continues to grow.

Proposals for ALMA are prepared and submitted using the ALMA Observing Tool (hereafter OT; Section 6.2). The OT is available for download from the ALMA Science Portal (*www.almascience.org*). The ALMA Archive will open for Cycle 1 proposal submission starting at:

15:00 UT on May 31, 2012

The Cycle 1 proposal submission deadline is:

15:00 UT on July 12, 2012

Table 1 summarizes the important dates and milestones of Cycle 1.

Date	Milestone
31 May 2012	Release of Cycle 1 Call for Proposals, Observing Tool & supporting documents (Proposers Guide, Technical Handbook, etc.)
31 May 2012 (15:00 UT)	Opening of the Archive for proposal submission
12 July 2012 (15:00 UT)	Proposal submission deadline
November 2012	Announcement of the outcome of the Proposal Review Process
1 January 2013	Expected start of ALMA Cycle 1 Science Observations
31 October 2013	End of ALMA Cycle 1

Table 1. The ALMA Cycle 1 timeline.

3 Overview

3.1 ALMA

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.

3.2 *The ALMA telescope on Chajnantor*

Upon completion, ALMA will be composed of 66 high-precision antennas. Fifty of these antennas will be 12-meter dishes in the 12-m Array, used for sensitive, high-resolution imaging. These will be complemented by the Atacama Compact Array (ACA) composed of twelve closely spaced 7-meter antennas (7-m Array), and four 12-meter antennas for single dish observations (Total Power Array), to enhance wide-field imaging. At full operational capability, the wavelengths covered by ALMA will range from 0.3 mm to 3.6 mm (frequency coverage of 84 GHz to 950 GHz).

The Array is located on the Chajnantor plain of the Chilean Andes, a site that offers the exceptionally dry and clear sky conditions required to operate at millimeter and sub-millimeter wavelengths. The ALMA antennas, weather stations, the two correlators and their computer interfaces, Local Oscillator generation hardware, timekeeping hardware, and the related Array Real-Time Machine computer are all located at the 5000 meter site referred to as the Array Operations Site (AOS). This site is connected via Gigabit fiber links to the Operation Support Facility (OSF), located near the town of San Pedro de Atacama at an altitude of 2900 meters. Science operations will be conducted from the OSF and coordinated from the JAO Central office in Santiago.

ALMA is located at **latitude = –23.029°**, **longitude = –67.755°**. Targets as far north as declination +40°, corresponding to a maximum source elevation at Chajnantor of ~25°, can in principle be observed from the ALMA site, but shadowing by adjacent antennas becomes an increasing problem at low elevations. The imaging capability, as well as the time on source, will necessarily be limited for such northern sources. Shadowing depends on the antenna configuration. Given the short baselines in the ACA configuration, sources with declinations less than −60° or greater than +20° will be subject to significant shadowing. For the 12-meter array, shadowing becomes significant (> 5 %) in the most compact configuration for sources with declination lower than −75° or higher than +25°. For more details, see the Technical Handbook.

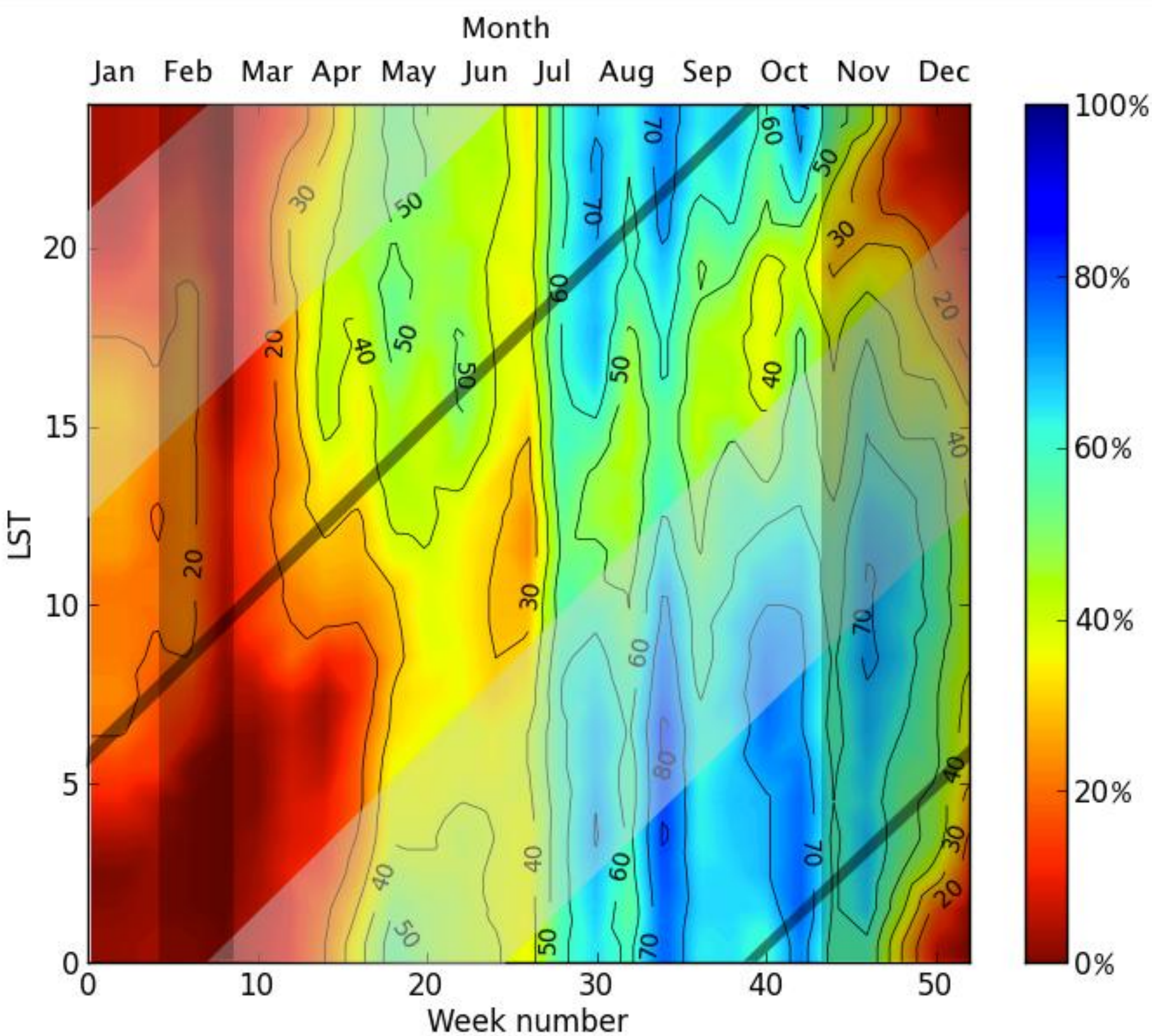

Figure 1. The numbers indicate the percentage of time when the pwv is below 1 mm as a function of Local Sidereal Time (LST) and week number beginning with January 1, 2013. Red indicates times with very little time available at low PWV and therefore less suitable for high frequency observing, while blue indicates times with a large fraction of time available at low PWV. The data were obtained with the APEX radiometer in the years 2007-2011 (5 years). The thin dark grey lines show local midnight, and the thick light grey bands show the ALMA engineering time, which normally is unavailable for Early Science observations. The vertical darker grey bands show the anticipated February shutdown and the end of Cycle 1 in November.

The atmosphere above Chajnantor is one of the best in the world for ground-based observation in the (sub-) millimeter wavelength regime (Evans et al 2002, ALMA Memo No. 471, available at *http://www.alma.cl/almamemos/*). However, both the opacity (primarily determined by the amount of precipitable water vapor – PWV) and the phase stability of the atmosphere limit when ALMA can be used at certain frequencies, in particular in the higher frequency bands and at frequencies near water absorption lines. Both transmission and phase stability follow a yearly cycle (late southern winter is best – see Figures 2 and 4 of Memo 471) and a diurnal cycle (late night and early morning are best – see Figures 3 and 5 of Memo 471). These cycles are illustrated in Figure 1, which shows the fraction of time when the PWV is below 1 mm. Red and blue colors represent low and high probability of good weather, respectively. Regular weather patterns are subject to both short (daily weather patterns) and longer cycles (years; the El Niño Southern Oscillation may be important). During parts of the year, such as a fair fraction of the Altiplanic winter[1] season (January-March), it may be difficult to carry out submillimeter observations. In addition to the transmission and phase stability criteria, low wind speeds and night, or early morning, observing times are required for optimum observing conditions.

Table 2 gives an overview of the fraction of time that is expected to be useful for observing in each band, given the limitations above, excluding complete shutdowns due to excessive wind and to precipitation. This table provides an indication of the limited amount of observing time at the higher frequencies that can be allocated in Cycle 1. However, it should be pointed out that there are large variations within each band; it is as difficult to conduct observations in the upper Band 7 wavelength regime as in the central Band 9 wavelength regime[2].

ALMA Band	**Band 3**	**Band 6**	**Band 7**	**Band 9**
Fraction of time	100%	70%	40%	10%

Table 2. Estimated maximum fraction of Early Science observing time suitable for observations in each band in Cycle 1, excluding total weather shutdowns. Based on atmospheric transmission statistics 1998-2011 from the ALMA Site Characterization and Monitoring program and APEX radiometer in combination with the ALMA Cycle 0 experience from October 2011 to March 2012.

Because of these factors, the actual time to reach a given signal to noise on a target depends on when the project is executed. The ALMA OT is designed so that investigators request a given sensitivity to reach a particular Science Goal (see Section 6.2). The OT calculates an estimated execution time to reach the specified sensitivity, based on the radiometer equation, anticipated calibration overheads, the nominal Cycle 1 capabilities (number of antennas, etc.) and default observing conditions (see documentation for the ALMA Sensitivity Calculation in the **ALMA Cycle 1 Technical Handbook**).

[1] During southern summer, the high-pressure system over the Pacific Ocean weakens and moves southwards, allowing warm humid air from the Amazones to flow over the Andes into northern Chile, causing rain and occasionally snow to fall on the usually dry Altiplano: this phenomenon is known as Altiplanic winter.

[2] To see how the atmospheric transmission varies with frequency, go to http://almascience.org/about-alma/weather/atmosphere-model.

3.3 The Joint ALMA Observatory and the ALMA Regional Centers

The Joint ALMA Observatory (JAO) is responsible for the overall leadership and management of construction, commissioning and operations of ALMA in Chile. The Santiago Central Office (SCO) houses the Director's Office and its associated functional units, as well as astronomers, technicians and administrative staff. The SCO also hosts the ALMA main archive (referred to in the rest of this document as the Archive). The JAO solicits research investigations through Calls for Proposals and organizes the peer review of the proposals by science experts. In addition, the JAO schedules all science observations and places the data in the electronically accessible ALMA Archive.

The three ALMA regional partners (Executives) maintain ALMA Regional Centers (ARCs) within their respective region. The ARCs provide the interface between the ALMA project and its user communities. The ARCs are responsible for user support to the community, mainly in the areas of proposal preparation, observation preparation, acquisition of data through the Archive, data reduction, data analysis, delivery of data, visitor support and workshops/schools. Each ARC operates an archive that is a mirror of the SCO main archive. Browsing and data mining will be done through the ARC mirror archives.

The East Asian ARC (EA ARC) is based at the National Astronomical Observatory of Japan headquarters in Tokyo. It is operated in collaboration with Academia Sinica Institute of Astronomy and Astrophysics (Taiwan), and supports the astronomy communities of Japan and Taiwan.

European researchers are supported by the European ARC (EU ARC). It is organized as a coordinated network of scientific support nodes distributed across Europe. The EU ARC is located at ESO Headquarters in Garching bei München (Germany) and carries the responsibility for all core ARC activities and their coordination with additional support provided by the regional nodes. There are currently seven regional nodes: Bonn-Bochum-Cologne (Germany), Bologna (Italy), Onsala (Sweden), IRAM, Grenoble (France), Allegro, Leiden (The Netherlands), Manchester (United Kingdom) and Ondřejov (Czech Republic).

The North American (NA ARC) is contained within the North American ALMA Science Center (NAASC), based at NRAO headquarters in Charlottesville, VA, USA. It is operated in collaboration with the National Research Council of Canada (Canada) and Academia Sinica Institute of Astronomy and Astrophysics (Taiwan), and supports the astronomical communities of North America and Taiwan.

3.4 ALMA proposal eligibility

ALMA proposals may be submitted by investigators of any nationality or affiliation. Each proposal must identify a single individual who will serve as Principal Investigator (PI). The PI will act as the official contact between ALMA and the proposing team for all correspondence related to the proposal. By submitting a proposal, the PI takes full responsibility for its contents, in particular with regard to the names of the Co-Investigators (Co-Is) and the agreement to act according to the ALMA policies and rules, including the conditions specified in the present Proposer's Guide. The PI will be responsible for the scientific and administrative conduct of the project. Proposals may be submitted only by the PI, not by Co-Is. There is no limit to the number of Co-Is that may appear on a proposal.

Graduate students and post-doctoral scholars can apply for ALMA time as Principal Investigators. All PIs and Co-Is must be registered with the ALMA Science Portal (see Section 6.1).

The main guiding principle of the assignment of observing priorities is to optimize the scientific impact of ALMA. Observing priority assignment will be based on scientific merit, taking into account the expected availability of resources while attempting to ensure that each region receives its share of the time, that is:

- 22.5% for East Asia (EA);
- 33.75% for Europe (EU);
- 33.75% for North America (NA);
- 10% for Chile.

Balancing across regions will be based on the actual execution time of the observations. Successful projects will have their observing time assigned to the region of the PI, which is defined as the region to which the organization that employs the PI belongs, or as the region of residence for unaffiliated PIs. If a PI has access to ALMA through two regions (e.g. due to a joint appointment at organizations in different regions), the PI may select either as their affiliated institute. Users from Taiwan (which is affiliated with both EA and NA) will be able to select either an EA, NA or combined EA/NA affiliation in the OT on a proposal-by-proposal basis.

ALMA proposals may also be submitted by PIs whose affiliation does not lie within any ALMA Executive's region. Such proposals are referred to as "Open Skies" proposals.

ALMA policies prohibit multiple submissions of the same proposal using different Executive affiliations. If such proposals are detected, the first submitted version will be considered and the remaining proposals ignored.

4 Resources

4.1 The ALMA Science Portal

The ALMA Science Portal is the primary access point for science users to ALMA. It is intended to provide a one-stop access gateway to all ALMA web resources, documents and tools relevant to users for proposal preparation, proposal assessment, project tracking, project data access and data retrieval, as well as access to the ALMA Helpdesk (see Section 4.3).

Any user has access to:

- User registration
- Call for Proposals
- Tables explaining ALMA technical capabilities (sensitivity, frequency coverage, available observing modes, etc)
- Download of the OT
- Helpdesk "knowledgebase" articles listing solutions to common questions and problems
- Archive access to non-proprietary data (when available)
- All official ALMA user documentation and some software tools, including the ALMA Sensitivity Calculator, simulators, etc.

In addition, registered users have access to:

- User profile and password management
- Nomination as PI or Co-I on ALMA proposals
- Ability to submit Helpdesk tickets
- Archive access to proprietary data

Furthermore, as of Cycle 1, users with approved proposals will be able to use the Project Tracker to monitor the status of their scheduled observing projects.

There are three instances of the Science Portal available, one at each ARC. There is a common entry point to the ALMA Science Portal at *www.almascience.org*, from which users are able to select the regional instance that they wish to visit. There is also a direct entry point to the regional instances from each ARC: *almascience.nao.ac.jp*, *almascience.eso.org*, or *almascience.nrao.edu*. The multiple instances ensure that the Science Portal is always available even if one instance is temporarily down.

The Science Portal also includes links to the local ARC webpages from which users can access local information and specific services of its ARC, such as local visitor and student programs, schools, workshops, and public outreach activities.

4.2 Documentation

The following documents are relevant for Early Science and submission of Cycle 1 proposals. All of them can be accessed via the ALMA Science Portal at *http://www.almascience.org*.

4.2.1 The Call for Proposals

The Call for Proposals documents are:

- **The ALMA Cycle 1 Announcement**: This is a short overview of the Call for Proposals for Cycle 1. It contains a short description of the ALMA capabilities, deadlines and limitations specific to Cycle 1.
- **The ALMA Cycle 1 Proposer's Guide** (this document): This document defines the Proposal preparation and review procedures, ALMA Capabilities, and Cycle 1 Policies.
- **The ALMA Cycle 1 Technical Handbook**: This handbook describes the more technical aspects of ALMA during Cycle 1, including receiver characteristics, array configurations, available observing modes and correlator setups, and the basis of the OT time estimates.

In addition, users may find the following documents useful:

- **Observing with ALMA: A Primer for Early Science**: brief introduction to ALMA observing, to (sub)millimeter terminology, and to interferometric techniques, which should prove useful for investigators who are new to radio astronomy. Several example science projects illustrating the Cycle 1 capabilities are also provided.

4.2.2 The Observing Tool documentation

The ALMA Observing Tool is the proposal preparation and submission (Phase 1) software application; the Tool is also used for observation preparation (Phase 2). The OT-related documents are:

- The **OT Phase I Quickstart Guide**: A guide to proposal preparation for the novice ALMA OT user. It takes the reader through all the necessary steps to create an ALMA Observing Proposal, without including large amounts of detail.
- The **OT Video Tutorial**: A visual demonstration of proposal preparation and submission with the OT.
- The **OT User Manual**: This manual is intended for all ALMA users, from novices to experienced users. It provides comprehensive information about how to create valid Phase 1 proposals and Phase 2 programs for observing astronomical objects. It is also included as part of the "Help" documentation within the OT application itself.
- The **OT Reference Manual**: This manual provides a more concise explanation for all the fields and menu items in the OT. It is also included as part of the "Help" documentation within the OT application itself.

OT installation requirements are available from the OT trouble-shooting page, which is accessed from the ALMA Science Portal. The known OT issues page lists currently known bugs, their status and possible workarounds.

4.2.3 The ALMA Regional Center Guides

The ARC Guides contain user support details specific to each ALMA regional partner. They are:

- The **East-Asian ARC Guide**
- The **European ARC Guide**
- The **North American ARC Guide**

4.2.4 Proposal preparation utilities

There are two tools available to produce simulated images of simple or user-provided science targets, as observed with ALMA (or other interferometric facilities).

CASA (Common Astronomy Software Applications), the offline data reduction and analysis tool for ALMA data, includes the tasks "sim_observe" and "sim_analyze" to simulate ALMA observations. In addition to these tasks, the CASA 3.4 release includes a representative set of ALMA configurations that span the advertised Cycle 1 capabilities (these configurations are also available on the ALMA Science Portal). This release also contains improvements to the algorithms for simulating mosaics, as well as better approximations for the ALMA primary beam shapes. ALMA related CASA tutorials, including simulations, are available on-line at *http://casaguides.nrao.edu/index.php?title=ALMAguides*. For CASA downloads and additional documentation, see *http://casa.nrao.edu/*. The "Obtaining CASA" link provides access to system requirements, release notes, and installation instructions.

The **ALMA Observation Support Tool** (OST) is the second tool that uses the CASA package to simulate ALMA observations. Users submit jobs to the OST via a standard web interface and are notified when the jobs are completed. The OST documentation is available at *almaost.jb.man.ac.uk/help*.

4.2.5 Other documents & tools

Atmospheric Transmission at Chajnantor can be reviewed with the atmosphere-model tool, which allows the user to model the atmospheric transmission as a function of frequency and amount of precipitable water vapor. The output is a plot of the transmission fraction. Up to six different water vapor contents can be selected.

Splatalogue is a database containing frequencies of atomic and molecular transitions which emit in the radio through sub-millimeter wavelength range. This database is used by the ALMA OT for spectral line selection. To learn more about it, see the Splatalogue QuickStart Guide on the Science Portal.

The **ALMA Memo Series** is a series of technical reports regarding various aspects of the ALMA project development and construction.

4.3 The ALMA Helpdesk

The ALMA Helpdesk is accessed from the ALMA Science Portal or directly at *http://help.almascience.org*. The Helpdesk provides a mechanism for keeping track of user queries, thus ensuring that all tickets are answered in a timely and professional manner. Submitted tickets are directed to support staff at one of the ARCs, who are available to answer any question relating to ALMA, including ALMA policies, capabilities, documentation, proposal preparation, the OT, Splatalogue, CASA, etc. Users may also request information on workshops, tutorials, or about visiting an ARC or ARC node for assistance with data reduction and analysis. Users must be registered through the ALMA Science Portal in order to submit a Helpdesk ticket. As a rule, Helpdesk tickets will be answered within two working days.

The Helpdesk is similar to those used in a number of other astronomical observatory institutes such as the Spitzer Science Center, the Herschel Science Center and NRAO. It has a “knowledgebase feature”, which is a database of answered questions or “articles” on all aspects of ALMA. The knowledgebase is also available to unauthenticated users, and may be searched to find answers to common queries without submitting a Helpdesk ticket. It is also used when a user creates a Helpdesk ticket, whereby matching knowledgebase articles are suggested to a user as they type in a query.

The current ALMA Helpdesk consists of the following departments: General Queries, Project Planning, OT, Data Reduction, Archive and Data Retrieval, and Face-to-Face Support. In addition, a department called Proposal Submission Emergencies will appear 36 hours before the proposal submission deadline to handle any urgent connectivity issues users may have submitting proposals. Tickets submitted to the Proposal Submission Emergencies department will be answered immediately. Therefore, any urgent issue related to proposal submission should be submitted to that department instead of e.g. the Observing Tool department.

5 Cycle 1 general information and policies

5.1 Introduction and policies

Cycle 1 will have a duration of 10 months including a one month engineering shutdown, leaving 9 months for science operations. It is expected to start on January 1, 2013 and finish on October 31, 2013. The engineering shutdown is expected to take place during February 2013.

The ALMA capabilities during Cycle 1 will be limited compared to those of the completed array, and Early Science will not be allowed to delay unduly the construction of the full 66-antenna array.

The time available after engineering and integration activities will be shared between Science Operations and Commissioning and Science Verification (CSV). Science observations will be executed by ALMA operations staff, taking into account (in rough order of priority): the weather conditions, the configuration of the array, target elevation and other practical constraints, the projects' assigned priority group, and executive balance. All other things being equal, the project with the highest scientific rank will be observed.

Cycle 1 observations will be scheduled during blocks of time of 16 h, mainly during nighttime. All Cycle 1 Early Science observing will be conducted on a best effort basis.

ALMA staff will conduct quality assurance on ALMA data, and will provide processed data products through the respective ARCs. However, it cannot be guaranteed that the characterization and quality of the data and data reduction will meet the standards expected when ALMA becomes fully operational. Experience in radio (in particular, millimeter) interferometry, though not required, will be an advantage in working with ALMA Early Science data products, particularly for projects that include Band 9 or ACA components. PIs and observing teams should anticipate the need to invest their own time and expertise to assure the quality of the provided data products and to re-reduce the raw data if the quality of the data products is not satisfactory. This may include the need to visit the relevant ARC or ARC node to get help and to assist with quality assurance and potential data re-reduction.

Cycle 1 projects that have not been completed by the end of the cycle will not be carried over to Cycle 2. Cycle 1 projects will not establish proprietary rights beyond the standard 12 months period.

5.2 Cycle 1 capabilities and limitations

The Cycle 1 capabilities are described in Appendix A. In summary they are: thirty-two 12-m antennas for interferometric observations (12-m Array), the Atacama Compact Array (ACA) composed of nine 7-m antennas for interferometric observations (7-m Array) and two 12-m antennas for single dish observations (Total Power Array), receiver bands 3, 6, 7 & 9 (wavelengths of about 3, 1.3, 0.8 and 0.45 mm), several array configurations with maximum baselines ranging from ~160 m to ~1 km, single field imaging and mosaics of up to 150 pointings, and a set of correlator modes that will allow both continuum and spectral line observations simultaneously, as well as a mixed spectral setup mode. ACA observations are only available to complement 12-m Array observations, and are restricted to projects that require detection of extended structures.

The following limitations in capabilities and types of observations should be noted:

- The characterization and quality of the data and data reduction may not meet the standards expected when ALMA is in full scientific operations;
- The characterization of the instrumentation may not be complete;
- About 800 hours of 12-m Array time will be allocated for the highest priority Cycle 1 projects. As much as one-third of this time will be available for observations that require both the 12-m Array and the ACA. This fraction is based on the expectation that 800 hours of ACA will be available for Cycle 1 science observing, and the fact that for Cycle 1 the OT allocates three times as much time on the ACA than is needed for the corresponding 12-m Array observations (see Appendix Section A.4). Note that observers cannot apply to use the ACA separately from the 12-m Array;
- ACA use is only available for the more compact 12-m Array configurations where there is sufficient overlap in baseline lengths to provide good imaging performance. ACA use is not allowed for Science Goals that request resolutions corresponding to the two most extended 12-m Array configurations;
- About 200 highest priority projects are expected to be prepared for scheduling. Therefore the average 12-m Array observing time per proposal is likely to be about four hours (with a large range). Only a small number of proposals requiring substantially more time than the average can be accepted, and these must be scientifically compelling;
- The maximum observing time per proposal is 100 hours. Note that the 12-m Array time and the ACA time are computed separately, and the 100 hour proposal limit applies to the sum of these two times. The total observing time is reported by the OT on the summary page. Observers who use the Science Case to justify an observing time different from that reported by the OT (see Section 6.3.2) must still adhere to the 100 hour maximum;
- There is no guarantee that a project will be completed.

For each Science Goal, users will specify a desired angular resolution. Acceptable values span the ranges available from the Cycle 1 configurations (see Section A.3 in Appendix A). ALMA operations staff will aim to obtain the requested resolution using observations from a single 12-m Array configuration. Whether to schedule a project over several 12-m Array configurations will be at the discretion of the observatory (depending primarily on configuration oversubscription or other scheduling constraints). The time of year and time spent in each configuration will be planned to meet the scientific demand as much as possible given the anticipated weather conditions (Figure 1). The scientific demand will be based on the number of Science Goals requesting a given set of angular resolutions, sensitivities, and largest angular scales that have to be recovered.

5.3 Proposal types

Standard, Target of Opportunity (ToO) and Director Discretionary Time (DDT) Proposals will be accepted for Cycle 1.

ToO proposals should be used to observe targets that can be anticipated but not specified in detail. Like standard proposals, these proposals must be submitted by the Cycle 1 proposal deadline. While the target list may be left unspecified, observing modes and sensitivity requests must be specified in detail for ToO observations. Associated with these observations there must be a clear indication of the number of triggers needed to reach the science goals of the proposal, what triggers the actual observation to be performed and the necessary reaction time for scheduling the observation after it is triggered.

Only a few ToO proposals are likely to be among the highest ranked Cycle 1 proposals. Those that are will be executed during the time reserved for Cycle 1 Science Observations. This implies that depending on exactly when a ToO observation is triggered, the reaction time for its execution may be as long as 3 weeks. As a rule, CSV activities will not be interrupted to carry out ToO observations. Shorter reaction times (few days) may be possible but are not guaranteed. Therefore, if a high priority ToO proposal is triggered at a time such that the observation requested reaction time cannot be achieved, the trigger will be rejected.

Triggering of observations from accepted ToO proposals will be done through a web form available via the ALMA Science Portal.

Time-critical and monitoring observations may be possible, but are restricted to the time slots reserved for Cycle 1 science observations. Therefore proposals with an execution time tolerance of less than 3 weeks will not be accepted. PIs of highly rated time critical observations may specify only the three week period within which the project start date may occur. This should not prevent observations of recurring phenomena with predictable times (such as, say, maximum elongations of planetary satellites), as long as their occurrences are spread over a sufficiently wide fraction of the Cycle 1 observing period and as long as the number of epochs that need to be observed remains relatively small with respect to the total number of suitable epochs across the Cycle (i.e., that there are many opportunities during the observing season to execute the proposal). Any special timing constraints (e.g. observations that once started need to be continued for a set amount of time or executed with a fixed cadence) must be fully justified.

Time-critical observations can be part of either Standard or ToO proposals.

The review process of standard and ToO proposals is described in Section 7.

DDT proposals may be submitted at any time during Cycle 1, for implementation during this cycle. They must be submitted using a special version of the Observing Tool, available from the Science Portal after the start of Cycle 1 observing. They must belong to one of the following categories:

- Proposals requiring the immediate observation of a sudden and *unexpected* astronomical event ("immediate" should be understood as within a period of 3 weeks following their approval: the same time tolerance restriction applies to DDT proposals as to standard and ToO proposals);
- Proposals requesting observations on highly competitive scientific topic, motivated by developments that have taken place after the regular proposal submission deadline;
- Proposals asking for follow-up observations of a program recently conducted with ALMA or any other observing facility, where a quick implementation is expected to provide breakthrough results.

DDT proposals will be approved for execution by the ALMA Director, based on the advice of a small standing review committee, with members from the JAO and the four regions, appointed by the Executive Directors and Chile. In exceptional cases, the ALMA Director may approve projects that would benefit from a very rapid response, and inform the standing committee of this decision within 24 hours (but note the time tolerance restriction for Cycle 1 specified above). The science assessment of DDT proposals will be based on the same criteria as for standard and ToO proposals (see Sect. 7.1).

Given the limited amount of time available in Cycle 1 and the expected heavy oversubscription of this time by standard proposals, DDT proposals are likely to be approved only if their science case is exceptionally strong, especially if they are not related to the observation of a sudden and unexpected astronomical event.

In Cycle 1, a maximum amount of 5% of the total time available for observations may be dedicated to the execution of DDT programs.

5.4 Science categories

Cycle 1 proposals will be assigned to one of five science categories:

1. Cosmology and the high redshift universe
2. Galaxies and galactic nuclei
3. ISM, star formation and astrochemistry
4. Circumstellar disks, exoplanets and the solar system
5. Stellar evolution and the Sun

Category information is used to distribute the proposals for review to the most qualified assessors. The assignment of a proposal to a category is made by the proposers, but it may be modified by the JAO if another category is judged to better describe the science of the proposal.

Cycle 1 proposers must further specify the area of investigation to which their project pertains by selecting in the OT at least one and at most two keywords from the list in Appendix C.

6 Proposal preparation and submission: Phase 1

6.1 Registering with ALMA

User registration is provided via the “register” button on the Science Portal. During registration, users provide contact information, specify their primary institutional affiliation, and choose a username and a password. The primary institutional affiliation is selected from a drop-down menu based on country (and in some cases, state). If a user’s institute does not appear in the drop-down list, a text field is provided to add it manually. Users who registered for ALMA Cycle 0 need not re-register.

A user’s institutional affiliation defines whether his/her proposals will be accounted to one of the four ALMA regions (East Asia, Europe, North America or Chile), or whether they will be non-ALMA member (“Open Skies”) proposals. Users from Taiwan (which is affiliated with both EA and NA) will be able to select either an EA, NA or combined EA/NA affiliation in the OT on a proposal-by-proposal basis.

A user's institutional affiliation constrains which ARC a user's Helpdesk tickets are initially sent to. Users affiliated with either EA, EU or NA will have their tickets directed to the corresponding ARC. Users from Taiwan may elect to have their tickets directed to either the EA or NA helpdesk. All other users may select which ARC their tickets are directed to. Even though Helpdesk tickets go to a specific ARC, the support staff at the ARCs will consult each other or transfer tickets as needed in order to ensure all tickets are answered appropriately. Users who have changed their institutional affiliation since originally registering, or who wish to change their "Helpdesk for support" should update their profile in the Science Portal.

6.2 The Observing Tool

The ALMA Observing Tool is used for proposal preparation and submission ("Phase 1") and later for detailed planning of observations on the telescope ("Phase 2"). The OT is a Java-based application (client) that resides and runs on the user's computer and interacts with the ALMA Archive and other databases over the Internet while active. Anyone is able to download and use the OT, but only registered ALMA users are able to submit or be Co-Is on ALMA proposals. Users should consult the OT trouble-shooting page for system requirements and the list of known OT issues (cf. Section 4.2.2).

During proposal preparation, the OT is used to specify the details of the proposed observations. The user uploads the Science Case and Technical Justification as a single PDF file through the OT interface. The user also expresses intended scientific goals as a series of specialized OT constructs called Science Goals, and employs various specialized editors to specify target coordinates and mapping field parameters, line frequencies and correlator bandwidths, desired sensitivities, etc. The user's inputs are interpreted by the OT to establish which resources of ALMA (configurations of antennas, etc.) are required, and to make an estimate of how much observing time (including calibration and observing overheads) is needed.

In simple cases, a single Science Goal may encompass the entire scientific purpose of a proposal. However, due to various restrictions, multiple Science Goals will often be necessary. For example, multiple sources can only go into the same Science Goal if they share the same performance goals (resolution, sensitivity, etc.) and observing frequencies, and are close enough on the sky that they can share the same phase calibrator. The OT is designed to give a warning or mark as invalid projects with settings that do not conform to the various restrictions, and to note parameter choices that require extra technical justification. Details of the various restrictions that are enforced by the OT are given in Appendix A.

The Cycle 1 capabilities of the ALMA instrumentation are embedded within the OT as selectable options. Visual editors allow sky viewing of target positions and mapping regions, and spectral editors display the available spectral region against the backdrop of the atmospheric opacity. While a proposal is being prepared, it can be exported to and recalled from the local disk. Once the proposal is validated within the OT, it can be submitted to the ALMA Archive. Note that the proposal can be resubmitted by the Principal Investigator as many times as needed before the proposal deadline.

DDT proposals must use a different the version of the OT from the one used for standard and ToO proposal. Both versions are accessible through the Science Portal.

6.3 General guidelines for writing a proposal

ALMA Cycle 1 proposals must be written in English and include the following sections:

1. Science case;
2. Technical justification;
3. Figures, tables and references (optional);
4. A brief statement on the likely potential for publicity (e.g. images, press releases etc.) arising from the proposed scientific observations.

These sections shall be submitted as a single PDF document. **The total length of this document is limited to 5 pages** (A4 or US Letter format), with a font size no smaller than 11 points. Proposers are free to adjust the length of the various proposal sections within this overall length limit. The recommended breakdown is 2 pages for the science case, 1 page for the technical justification, and 2 pages for figures, tables, references and publicity statement. Figures and tables may be interleaved with the science case and the technical justification, so that e.g. figures appear close to the location in the text where references are made to them. Users are encouraged to use the LaTeX template developed by ALMA for preparation of their proposals.

A file size limit of 20 MB will be enforced at submission. Accordingly, extremely large or complex figures may not be acceptable. Proposals must be self-contained. Their assessment will be based solely on their explicit contents, to the exclusion of external references such as personal webpages, etc. Reference can be made to published papers (including astro-ph preprints), as per standard practice in the scientific literature. Consultation of those references should not, however, be required for understanding of the proposal.

6.3.1 Science case

Each proposal must describe the astronomical importance of the proposed project and include a clear statement of its immediate observing goals. Since the proposal review panels will be encouraged to consider favorably proposals that best demonstrate and exploit the advertised ALMA Early Science Cycle 1 capabilities, producing scientifically worthwhile results from relatively short observations (averaging a few hours), the science case should address this aspect. Additionally, it should explain how the expected intensity of the target source(s) was estimated and justify the Signal-to-Noise (S/N) ratio required to achieve the scientific objectives of the project as well as, when appropriate, the size of the target sample.

Proposers should keep in mind that the topical ALMA Review Panels span a wide range of scientific areas. Therefore, proposals should be written for an expert, but broad-based, astronomy audience.

6.3.2 Technical justification

A mandatory part of each proposal is the Technical Justification. The Technical Justification should fully justify the requested observations, with particular attention paid to those parameters that most directly affect the total time request. There is no specific limit to its length, as long as the total proposal limits are not exceeded. For most proposals, the Technical Justification should fit within one typeset page.

Technical Assessment of the proposals will pay special attention to the following issues. Omissions/errors in any of them may result in the rejection of the proposal on technical grounds.

- Technical Justification that is missing or does not contain all the relevant information needed to make the technical assessment. This includes cases where results of the ALMA simulations are integral to the justification of the observing requirements, but the results of the simulations are not included in the Technical Justification.

- Proposals that have underestimated the required observing time by more than a factor of 2 due to mistakes in the inputs to the OT.

- Every effort has been made to incorporate in the OT all the restrictions for Cycle 1 Proposals (as per this document; also see Appendix A and the **ALMA Cycle 1 Technical Handbook** for details). However, in exceptional circumstances, the OT may validate some observations that are not compliant with Cycle 1 capabilities. The policy of the ALMA observatory is that proposals that do not comply with the limitations of the capabilities of the Cycle 1 ALMA system will be rejected.

- Proposals that have different values for important parameters in the OT and the Technical Justifications will be judged on the numbers stated in the Technical Justification. It is therefore recommended that required field set-ups, spectral resolution and correlator modes, angular resolution, maximum angular size, and sensitivities (per spectral set-up) are explicitly included in the Technical Justification.

- PIs planning to observe a large number of individual positions that are close together on the plane of the sky should specify them as a list of separate, individual pointings, rather than just using the (rectangular) mosaic option. A set of individual specific pointings is generally preferred for such observations on efficiency grounds, unless a strong scientific justification is provided for the use of the mosaic option.

- Special constraints on standard observing modes must be fully justified. These include requests for stringent weather conditions for a given ALMA band, restrictive epochs when a given observation has to be carried out, specific ordering of observations, fast cadence of required calibrations, omissions of standard calibrations, observations whose overheads are very high (> 30% of the total requested time), very short observations (less than 2 minutes on-source time) and lengthy observations (continuous target observations for more than 40 minutes).

- Proposals where the PI intends to smooth the data to resolutions that are comparable to those of a 12-m single-dish telescope will be rejected on technical grounds.

- Requests for user defined calibrators must be justified by adding pertinent supporting information such as light curves, structure description and flux estimates. If this is not fullfilled, the calibrators will be chosen at the discretion of the observatory.

- Specific requests for more than one configuration (for instance, for angular resolution matching at different frequencies) must be fully justified.

- Declining the OT recommendations concerning the use of the ACA (not requesting ACA observations when the OT input parameters advise its use, or requesting ACA observations when the OT input parameters advise against it) must be fully justified.

- Dependencies of the Technical Justification on unavailable data at the time of writing the proposal will not be accepted (i.e., justifications that depend on future measurements).

Except in special cases, a PI will not explicitly request an observing time in the OT. Instead, users specify the *desired sensitivity* for each Science Goal. The ALMA OT will then use the requested sensitivity together with estimates of weather and system performance and calibration overheads to calculate a total estimated observing time with the 12-m Array. If the ACA is selected for the Science Goal, the time for those observations is simply three times the estimated total 12-m Array time. For each Science Goal these times are reported in the OT time estimator (accessed from the "Control and Performance Parameters" pane of the OT), and the total time for the project summed over all Science Goals is reported on the first page of the printable summary of the proposal produced by the OT, separately for the 12-m Array, the ACA (+TP), and in total. If a user wishes to request a time that is not based on the time to reach a given sensitivity, the PI must select the corresponding button within the OT "Control and Performance Parameters" pane, and clearly indicate this request in the Technical Justification. PIs should not request additional observing time to compensate for the possibility of poor weather conditions.

The technical justification also provides an opportunity to describe any special scheduling requirements. In general, PIs do not specify observing sequences, and observations may be broken up and observed independently. If an observation must be executed in a specific sequence (e.g., near-simultaneous observations at two different frequencies), or if the observations should be distributed over a range of hour angles, the PI should also clearly indicate this request in the Technical Justification, as there is currently no other way to do so in the OT. Such requests will be considered when scheduling such proposals, but given the "best efforts" nature of Cycle 1 observing, the execution of special scheduling requests cannot be guaranteed.

The observational parameters may differ for the different Science Goals in the proposal; each set of parameters should be separately justified.

Before final submission, PIs should double check that the parameters described in the Technical Justification agree with those entered into the OT and are consistent with the advertised Cycle 1 capabilities, as detailed in Appendix A. More details on the meaning of the parameters specified in the OT are available from the help facilities within the OT. If users have any questions about technical justification, they should consult the ALMA Helpdesk. Additional considerations for ALMA Early Science observing are included in the ALMA Early Science Primer. Common user technical oversights made in Cycle 0 proposals have been detailed in a Helpdesk Knowledgebase article under the "Early Science – Cycle 1" category.

6.3.3 Figures, tables, and references

Figures, tables, and references that support the Science Case and the Technical Justification may be included. Figure captions, tables and references may be listed in 10-point font and, together with the science case and the technical justification, they must fit within the overall 5-page length and 20 MB size limits of the PDF proposal.

6.3.4 Opportunities for public promotion of ALMA

Opportunities for public and media interest in ALMA science will be very important during Early Science Cycle 1. Proposers are requested to consider the potential media appeal of proposed observations, with regard to scientific content and/or the quality of the visuals that could be produced. Each proposal must include a brief statement on the likely potential for publicity arising from the proposed scientific observations. The statement must fit within the overall 5-page limit of the PDF proposal. This information will not be used in the assessment of the proposal, which will be based solely on scientific merit and technical feasibility.

In the event that a Cycle 1 proposal is successful and is selected for publicity activities, the ALMA Education and Public Outreach (EPO) team will work with the PI to develop materials for presentation to the media and the public (e.g. press releases), including support in the preparation of visuals if relevant. EPO may ask for co-operation on the scientific content and for the PI to be available for possible interviews. Furthermore, the PI will be asked to agree to inform the ALMA EPO team if he/she is planning a press release or similar media interaction (for example through the PI's own institution's press office). ALMA requests that PIs do this at the start of the process, in order to allow for sufficient time to assess the news story and provide assistance to PIs as appropriate. The contact e-mail address for all liaison with the ALMA EPO team is *alma-epo-ipt@alma.cl*.

6.4 Proposal validation and submission

All proposals must validate in the OT (via the use of the "Validate" option under the "File" menu item) before they can be submitted. If the proposal fails to validate, the non-validating parts will be listed in the "Feedback" pane, and clicking on each message will direct the user to the corresponding error.

Upon submission, the science case, technical justification and any other materials uploaded to the OT as a PDF file (Section 6.3) together with the observing specifications entered into the OT are electronically transmitted to the ALMA Archive. Prior to this, PIs should save the proposal as a local file on their computer ("Save" or "Save as" option under the "File" menu item), so as to leave open the possibility of resubmission of the proposal until the deadline. A detailed PDF summary of the entire proposal may also be generated and saved locally by the user (see option listed under the "Tool" menu item).

Submission of standard and ToO proposals to the Archive will be available from 15:00 UT on May 31, 2012.

The proposal submission deadline is:

15:00 UT on July 12, 2012

The proposal submission deadline is firm: proposals received after the deadline will not be considered.

If successfully submitted, a proposal receives a unique code adhering to a standard format. This code incorporates the submission year, a cycle id during this year, a running number and an indicator of the proposal type (Standard, ToO). The format of the proposal code is as follows: YYYY.C.NNNNN.T. Here, "YYYY" denotes the year, "C" is the cycle id, "NNNNN" is the five-digit running number and "T" denotes the proposal type. For example, the code 2012.1.00156.S indicates a Standard proposal which is the 156th ALMA proposal submitted for the regular cycle in 2012.

A Standard or ToO proposal can be submitted and resubmitted until the submission deadline. Modifications of submitted proposals will not be permitted after the deadline. Co-Is can retrieve proposals from the Archive both before and after the deadline, but only the PI can submit (or resubmit) a proposal. In order to ensure that the load on the server does not affect its performance close to proposal submission deadline, users should refrain from unnecessarily retrieving proposals from the Archive between 0:00 and 15:00 UT on July 12, 2012.

Cycle 1 DDT proposals may be submitted throughout the Cycle, from 1 January 2013 to 31 October 2013. Like standard and ToO proposals, they must include a full science case and a detailed technical justification. DDT proposal submission is final; DDT proposals cannot be resubmitted.

When a proposal is submitted for the first time, the proposal handling system assigns it a submission code. In order to allow for later re-submission, *it is essential that, after submitting a proposal, users save a copy of it to their local disk, complete with the proposal submission code*.

To update a previously submitted proposal, users should modify that saved, post-submission copy, in order to ensure that the same submission code is used. *Attempts to update a previously submitted proposal using the local copy without a code should always be avoided, as this will result in a new (duplicate) submission that will be assigned a new code.*

Users wishing to create a new proposal based on a previous one as a template should make sure to take as starting point a local copy without a code, so as to avoid overwriting their original proposal in the Archive.

A Helpdesk ticket should be submitted in order to withdraw a proposal after a code has been assigned.

7 The ALMA Proposal Review Process

7.1 Description

ALMA proposals will be subject to peer review. The policies and procedures for this process are summarized below.

Standard and ToO proposals will be reviewed by the ALMA Proposal Review Committee and the ALMA Review Panels (ARP). There will be at least one ARP per science category, comprising experts in the range of scientific topics covered by this category. The primary criterion for selection of the ARP members (Science Assessors) will be scientific competence. ARP membership will ensure appropriate representation of the ALMA regions.

Proposals will be assessed on the basis of the overall scientific merit of the proposed investigation and its potential contribution to the advancement of scientific knowledge, as well as on the extent to which the planned observations demonstrate and exploit the ALMA Cycle 1 capabilities. Projects having the potential of delivering scientifically worthwhile results from relatively short observations will be favorably considered. Science Assessors will be advised to consider Cycle 1 proposals for their own merit, independent of Cycle 0 results.

In order to keep the workload of the panels to a manageable level, science assessments will take place in two stages. For Stage 1 review, each proposal will be assigned to four members of one of the ARPs of its science category, who will each give it a score and provide a brief written assessment. The individual assessor's scores will be combined to compute a mean preliminary score. A single ranked list of all proposals will be built and the top ~70% of the proposals will proceed to Stage 2, including proposals for which the standard deviation of the individual Stage 1 scores exceeds a given threshold.

All ARPs will meet face-to-face in Santiago to discuss the proposals that proceed to Stage 2. Following its discussion, each proposal will be assigned a single, final ARP score. To this effect, each ARP member will assign it an individual score through a secret vote. For each proposal, the ARP score is the arithmetic mean of the individual scores. The proposals reviewed by the ARP at Stage 2 are ranked according to their ARP score. The resulting ranked list is the final product of the ARP meeting. It may be complemented by additional recommendations as the ARP deems appropriate. In particular, when two or more proposals involve duplication of Science Goals (see Section 7.2.2), the ARP(s) reviewing them will issue unambiguous recommendations about their respective priorities, based on their scientific merits.

The ALMA Proposal Review Committee (APRC), consisting of the ARP Chairs and of an APRC Chair who does not belong to any ARP, will meet face-to-face immediately after the ARP meetings, to review the ARP results and prepare a single ranked list of all proposals. The APRC will pay particular attention to the ARP recommendations for treatment of duplicated Science Goals. It will identify a single proposal in each group of proposals involving duplications to be recommended for execution.

Science Assessors will be advised against de-scoping proposals, except for cases where a fraction of their Science Goals duplicate those of a higher ranked project. For more details see Section 7.2.3.

Proposals that may qualify for execution based on the APRC ranking will be subject to Technical Assessment carried out by a selected group of JAO and ARC experts. Technical assessments will be performed according to criteria reflecting the technical justification requirements described in Section 6.3.2.

The project completion probabilities will be estimated at this stage for communication to proposers. Highest priority will be assigned to the top-ranked proposals of each region until their cumulative execution time exceeds the respective regional share of the available science time for the cycle, taking into account the technical feasibility of the proposals, the limitations on availability of specific configurations (e.g., Atacama Compact Array), and observability constraints. Further down the regional rankings, proposals will be flagged as "fillers" until the cumulative execution time exceeds 1.5 times the regional share of the available science time. Filler projects will be observed only if the conditions do not allow any of the highest priority projects to be executed. The remaining proposals are very unlikely to be observed and may be considered unsuccessful.

The final decision about proposal selection rests with the Directors Council. The JAO will prepare the final recommendation to the Directors Council, based on the APRC ranked list, and taking into account scheduling considerations. After its approval by the Directors Council, the outcome of the Proposal Review Process will be communicated to the PIs of all valid submitted proposals. The notifications will include the following information:

- A statement of the ratio between the total amount of estimated time that would be required to carry out all submitted proposals and the anticipated available observing time over the cycle (that is, the array oversubscription factor);
- The overall ranking of the proposal, as one of the following options: first decile, second decile, 20-40% band, 40-70% band, or bottom 30% of the ranking;
- The probability of completion of the proposal, as one of the following options: highest probability, filler project, unlikely to be scheduled, or infeasible;

- A consensus report, that is, the feedback of the Science Assessors about the strengths and the weaknesses of the proposal;
- A technical feasibility note for those proposals that have been subject to technical assessment and deemed infeasible or affected by technical feasibility issues.

7.2 Proposal Review Process policies

7.2.1 Confidentiality

For proposals deemed to have the highest probability of completion, the project code and title, the name and region of the PI, as well as the names of the Co-Investigators will be made public soon after PIs are informed of the outcome of the proposal review process. For filler projects, the corresponding information will be made public as soon as the first set of data is archived.

In all cases, abstracts of proposals for which observations have been obtained will be released when the proprietary period for the corresponding data has ended.

The scientific and technical justifications of the proposals, as well as information about proposals that are unlikely to be scheduled or infeasible, remain confidential.

Metadata of the observations, for example, the source positions, observation frequencies, requested angular resolutions and integration times will be publicly available once the data of that observation are archived.

7.2.2 Duplication

A high-level principle of ALMA is that identical data should not be taken twice unless scientifically necessary. The term “Duplication” is used to refer to projects that may potentially replicate the data or results obtained in another proposal.

In Cycle 1, potential duplication of proposals may occur when more than one team applies to observe the same objects in the same observing mode (frequency, spatial resolution, area, depth, etc). Duplications will be assessed at the Science Goal level: that is, a Science Goal will be considered a duplication of another Science Goal only if the observations are judged to be scientifically equivalent.

In case of potential duplications, the relevant proposals shall be directly compared with each other, so as to ensure that their relative ranks shall duly reflect their respective scientific merits. The science assessors will determine if the considered duplicate proposals are mutually exclusive or if it would be scientifically meaningful for more than one to be approved. The final verdict will be rendered by the APRC.

As stated in the ALMA Cycle 0 Proposer’s Guide, observations done in ALMA Cycle 0 proposals will not constitute duplications for Cycle 1 proposals.

7.2.3 Descoping

The ARPs and the APRC will be strongly advised against recommending descoping or other modifications of proposals. Nevertheless, the ARP/APRC may recommend the descoping of a project. Descoping of projects shall only arise as a result of the review process, and will be made only for compelling scientific and/or technical reasons.

Descoping rulings will be communicated to the PIs as part of the APRC feedback report. They will include:

- A clear and rigorous description of the reasons for the descoping decision;
- A detailed description of the specific manner in which the intended descoping should be implemented; number and, if needed, identification of the targets to be omitted; observing modes or configurations not to be used, etc.

ToO proposals may be descoped by setting an upper limit to e.g. the number of events that may be observed in the period, and/or on the number of times observations (at different epochs) of these events may be triggered over the period.

8 Preparation & submission of observations: Phase 2

Once a project has been approved for scheduling, the project passes into Phase 2. At this stage, the project is assigned an ALMA Contact Scientist at the associated ARC or ARC node. This Contact Scientist initiates contact with the PI, establishes a preparation timeline and subsequently acts as the primary channel of communication between the project PI and the ALMA Observatory as a whole.

An initial draft version of the Phase 2 program (i.e. the actual Scheduling Blocks) is created by ALMA staff, based on the information originally submitted in the proposal. Any modifications to the submitted proposal mandated as a result of the proposal review process or necessitated by technical considerations are incorporated.

A copy of the project containing these draft SBs is then presented to the PI by the Contact Scientist. At this point, the Contact Scientist will explain the actual expected execution behavior of the SBs, and may provide additional explanatory material as appropriate. Any other details requiring further clarification or possible modification are also discussed at this juncture. The medium for such communication is the ALMA Helpdesk, which ensures that all such discussions are well documented and completed in a timely manner.

Necessary changes to the project may also be implemented at this stage, at the discretion of the Contact Scientist, consisting only of minor changes that do not impact the science scope or increase the total execution time. Examples of these might include (i) a change in a target position that is no more than half the primary beam size, (ii) a change in the target frequency for spectral line observations that is no more than 20% of the width of the original spectral window specified (as long as no additional diagnostic spectral lines would be measured as a result of the change), and (iii) other trivial changes, such as changing the velocity reference frame from LSR to Heliocentric. Any change that is more significant than these examples must be filed as a fully justified formal change request (see Section 8.1), and are generally discouraged.

Once a final version of the Phase 2 program has been agreed to be ready for execution by both the Contact Scientist and the PI, the project is admitted to the ALMA observing queue to await actual execution at the telescope. Starting in Cycle 1, PIs may track the status of their SBs through the Project Tracker (PT), accessible from the ALMA Science Portal. The PT will list the SB status (Phase 2 Submitted; Wait; Ready; Broken; Number of successful executions; QA2 status (pass/fail); Delivered – see PT documentation on the Science Portal).

8.1 Changes to submitted projects

Changes to a submitted project prior to the completion of the review process will not be permitted. Changes to a project accepted for admission to the ALMA observing queue will not normally be permitted. However, should a PI wish to request a change to a project (e.g. to correct a mistake in a field source list, or in response to later additional information obtained that may seriously affect the scientific case of the project), this will be done via a standard change request form accessed from the Helpdesk. Such change requests must include a very clear description of the proposed change along with a clear, substantive justification for the change. All such change requests will be considered by the Observatory on a case-by-case basis. Approved changes will be implemented by ARC staff, in consultation with the PI.

8.2 Project withdrawals, completion and carryovers

Should a PI wish to withdraw his/her project before completion for some reason, then a Helpdesk ticket should be filed to this effect, and no further observations will be performed for that project.

All projects, whether completed or not, will end at the conclusion of Cycle 1 and will not be carried over to Cycle 2.

9 Data processing and data delivery

A proposal will be observed and processed by its components, the "Scheduling Blocks" (SB). Once the requisite number of successful executions of one or more SBs has been obtained, the resulting data will be processed by ALMA staff. This involves calibration and flagging of the visibilities, and imaging enough of the data to validate that the calibration has been successful, that it has obtained the requested sensitivity, and contains no gross instrumental artifact's or calibration defects. The data are assessed using observatory-defined metrics as part of the "Quality Assurance level 2" (QA2 – see Chapter 12 of the ALMA Technical Handbook), which are summarized in a QA2 report.

The data are made available to the PI through the ARC where the PI is registered. Network transfer is the preferred way of data distribution. Data distribution through shipping of hard disks is possible under special request. The data package will include at a minimum the processing log files, data processing script, QA2 report, a README file and the imaging products. The raw data are available upon request.

By default, data obtained as part of an ALMA science program are subject to a proprietary period of 12 months, starting for each data package when the ARC sends the notification to the PI that the data are available. Data taken by the ALMA observatory will be kept confidential for the duration of the proprietary period, to the extent allowed by the quality assurance, technical analysis and face-to-face support processes.

10 ALMA Cycle 1 checklist

1. Read the summary of ALMA Cycle 1 capabilities (Appendix A).
2. Both (sub)millimeter astronomy experts and novices are encouraged to download and read Observing with *ALMA: A Primer for Early Science*. **This document, and all Cycle 1 documentation, is available through *http://www.almascience.org*.**
3. Create an ALMA account by registering on the Science Portal (*http://www.almascience.org*). This step is necessary to submit proposals and Helpdesk tickets, and to access proprietary data (note that access to the Helpdesk knowledgebase does not require registration).
4. Download the OT from the link provided on the Science Portal (under "Documents and Tools") and install it on your computer.
5. Download and read the *OT Quickstart Guide*.
6. Start up the OT and select "Create new Proposal".
7. Select the correct Proposal Type (either **Standard** or **Target Of Opportunity**).
8. Note the evaluation criteria listed in Section 7.1 of this Guide.
9. Prepare your observing proposal according to the Cycle 1 capabilities described in Appendix A and the guidelines listed in Section 6.3 of this Guide. The Science Case and Supporting Documents should be attached as a PDF document of 5 pages or less and no more than 20 MB.
10. Compare the observation setup printed as part of the OT proposal summary PDF file and make sure all quantities agree with what is used in the written Technical Justification (sensitivities, bandwidths, reference frequencies, resolutions, maximum angular space, etc.).
11. Review the "Technical Justification Checklist" produced as part of the proposal summary PDF file and make sure that all listed items are addressed in your Technical Justification.
12. Follow the steps described in Section 6.4 to electronically submit your proposal, cover sheet, and Science Goals. Note that you can resubmit the proposal as many times as you like before the proposal deadline (**July 12, 2012, at 15:00 UT**). Be sure to only resubmit your locally saved copy with the correct proposal code.
13. Submit your proposal well before the deadline to avoid unnecessary last-minute problems. If you experience difficulties when trying to submit your proposal just prior to the deadline, immediately contact the ALMA Project through Proposal Submission Emergencies, a Helpdesk department available for the 36 hours before the proposal deadline.

Appendix A ALMA Cycle 1 capabilities

A.1 Antennas

All proposers should assume that observations in Cycle 1 will have thirty two 12-m antennas available in the 12-m array (hereafter "12-m Array"), and in the Atacama Compact Array (ACA) there will be nine 7-m antennas for short baselines (hereafter "7-m Array") and two 12-m antennas for single-dish observations. These two 12-m antennas are components of the ACA "total power" or TP Array. The ACA is used for short baseline interferometry and single-dish observations. It will only be offered to complement observations with the more compact configurations of the 12-m Array, and not as a stand-alone capability. The use of the TP Array is limited to spectral line observations.

At times, the number of antennas available for observing may be less than the advertised number. When this happens, ALMA staff will endeavor to carry out observations that are not strongly dependent on the number of antennas in the array. The integration times or uv coverage might be increased to compensate where that is practical.

A.2 Receivers

Bands 3, 6, 7 and 9 will be available on all antennas. For all bands, both linear parallel-hand polarizations of the astronomical signals (XX, YY) are received and processed separately.

The receivers are based on SIS mixers and there are two types – dual-sideband (2SB), where the upper and lower sidebands are separated in the receiver and then processed separately, and double-sideband (DSB), where the sidebands are superimposed coming out of the receiver but may be separated in later processing.

The frequency ranges and receiver types are shown in Table A 1.

Table A 1. Properties of ALMA Cycle 1 Receiver Bands

Band	Frequency range (GHz)	IF range (GHz)	Type
3	84 – 116	4 – 8	2SB
6	211 – 275	5 – 10	2SB
7	275 – 373	4 – 8	2SB
9	602 – 720	4 – 12	DSB

These are the nominal frequency ranges for continuum observations. Observations of spectral lines within about 0.2 GHz of a band edge are not possible at present.

Only three receiver bands will be available at any time. Therefore, proposals that require sequential observations in more than three bands are not allowed.

Water Vapor Radiometer (WVR) measurements to correct for errors due to fluctuations in atmospheric water vapor will be available for all 12-m antennas. These corrections will be applied when they improve the phase coherence. No WVRs will be installed on the ACA 7-m antennas and users should assume that in Cycle 1 no WVR corrections will be applied to 7-m Array observations.

A.2.1. Band 9 considerations

Band 9 observations are subject to uncertainties beyond those of the other receivers. The sidebands can be separated reliably only in interferometric observations; for total power observations the two sidebands will remain superposed. Software to address this shortcoming is not yet commissioned. Therefore, observations of sources with lines in both sidebands will have to be designed carefully. Also, owing to the complexity of the atmospheric absorption in Band 9, calibration will be compromised. Further, as mentioned above, the 7-m antennas lack Water Vapor Radiometers – rapid atmospheric phase correction will not be available on the ACA during Cycle 1. Finally, the smaller collecting area of the ACA will limit the network of available calibrators; in particular, bright calibrators will be sparse at the higher frequencies. All of these factors will affect imaging at Band 9 during Cycle 1 and will in particular limit the achievable dynamic range with the ACA.

A.3 12-m Array configurations

The antennas of the Cycle 1 12-m Array will be staged into six distinct configurations intended to smoothly transition from the most compact (with maximum baselines of ~160 m) up to the most extended (maximum baselines of ~1 km). Some properties of these six configurations are given in Table A 2. For more details, see Chapter 6 of the Cycle 1 Technical Handbook.

For each Science Goal in a proposal, a PI requests a single resolution. Acceptable resolutions range from those listed for configuration C32-6 in Table A 2, to twice the listed values for configuration C32-1. The coarsest resolution limit is required because smoothing interferometric data too much will result in a loss of signal-to-noise that is not accounted for in the OT sensitivity calculation.

For Cycle 1, the aim will be to obtain the requested resolution using observations with a single 12-m Array configuration. Whether to schedule a project over several 12-m Array configurations will be at the discretion of the Observatory (depending primarily on configuration oversubscription or other scheduling constraints). As a rule, proposal components that can achieve their requested sensitivity in a single SB execution will not be observed in more than one 12-m Array configuration.

For projects that request observations of point sources or compact spatial structures (i.e., with largest angular scales that are smaller than the "Maximum Angular Scale" for the requested angular resolution, following the values given in Table A 2), observations with only the 12-m Array will be sufficient. Projects that require imaging of extended structures (i.e., larger than the "Max Ang Scale" for the requested resolution) will be advised by the OT to also request ACA observations. However, for resolutions requiring the two most extended 12-m Array configurations (where there is little baseline overlap with the ACA 7-m Array – see Section A.4 below), ACA observations will not be permitted. For finer resolutions (or if the proposer elects not to ask for corresponding ACA observations), the requested largest angular scales must be less than the Maximum Angular Scale values following those in Table A 2.

Table A 2. Angular resolution[1,2] and Maximum Angular Scale[1,2,3] for the six Cycle 1 12-m Array configurations

	C32-1		C32-2		C32-3		C32-4		C32-5		C32-6	
Band (freq)	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale
Band 3 (100GHz)	3.7"	25"	2.0"	25"	1.4"	17"	1.1"	17"	0.75"	14"	0.57"	8.6"
Band 6 (230GHz)	1.6"	11"	0.89"	11"	0.61"	7.6"	0.48"	7.6"	0.33"	6.2"	0.25"	3.7"
Band 7 (345GHz)	1.1"	7.1"	0.59"	7.1"	0.40"	5.0"	0.32"	5.0"	0.22"	4.1"	0.16"	2.5"
Band 9 (675GHz)	0.55"	3.6"	0.30"	3.6"	0.21"	2.6"	0.16"	2.6"	0.11"	2.1"	0.08"	1.3"

Notes for Table A 2:

1. Computation for source at zenith. For sources transiting at lower elevations, the North-Source angular measures will increase as the sin(ELEVATION).
2. All angular measures scale inversely with observed sky frequency.
3. "Maximum Angular Scale" is the largest angular scale that can be observed effectively. If the source contains smoothly varying structures that are larger than this in both directions, those components will be "resolved out". This is the well known "missing flux" problem intrinsic to interferometry. The limit is taken to be 0.6 x (wavelength / minimum baseline), but this is only a guideline.

A.4 ACA observations

The ACA in Cycle 1 is composed of nine 7-m antennas for the 7-m Array and two 12-m antennas for the TP Array. The TP Array can only be used for spectral line observations (not continuum). Only one ACA configuration will be offered in Cycle 1, with minimum and maximum baselines of 8.9 m and 32.1 m, respectively. For more on the ACA see Chapter 5 of the Cycle 1 Technical Handbook.

Images that obtain a high fidelity over a broad range of spatial scales require observations taken with a continuous range of antenna baseline separations. For Cycle 1, the more compact 12-m Array configurations (those with minimum baselines less than 25 m) can be used with the 7-m Array to produce such high-fidelity observations while also providing enough overlapping baseline lengths to tie the different observations together. For spectral line observations, the TP Array provides information on baselines less than 12 m. The OT can advise if the ACA is needed, based on the PI requested "largest angular scale", and will indicate whether the ACA is allowed, based on the user-requested resolution. The allowed combinations are summarized in Table A 3. Table A 4 shows the angular resolution and maximum angular scale that can be recovered from continuum observations using both the 12-m Array and ACA, for each of the four ALMA bands offered for Cycle 1. For spectral line observations, the addition of the TP Array data allows the recovery of structures up to the spatial scale of the mapped region.

Table A 3. 12-m Array Configurations that allow ACA Observations

12-m Array Configuration	Min Baseline (meters)	Max Baseline (meters)	ACA Allowed?
C32-1	15	166	Yes
C32-2	15	304	Yes
C32-3	21	443	Yes
C32-4	21	558	Yes
C32-5	26	820	No
C32-6	43	1091	No

Table A 4. Angular resolution[1,2] and maximum angular scales[1,2,3] for continuum[4] observations using the allowed 12-m Array & ACA combinations

	C32-1 & ACA 7-m Array		C32-2 & ACA 7-m Array		C32-3 & ACA 7-m Array		C32-4 & ACA 7-m Array	
Band (freq)	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale	Ang Res	Max Ang Scale
Band 3 (100 GHz)	3.7"	44"	2.0"	44"	1.4"	44"	1.1"	44"
Band 6 (230 GHz)	1.6"	19"	0.89"	19"	0.61"	19"	0.48"	19"
Band 7 (345 GHz)	1.1"	13"	0.59"	13"	0.40"	13"	0.32"	13"
Band 9 (675 GHz)	0.55"	6.5"	0.30"	6.5"	0.21"	6.5"	0.16"	6.5"

Notes for Table A 4:

1. Computation for source at zenith. For sources transiting at lower elevations, the North-South angular measures will increase as the sin(ELEVATION).
2. All angular measures scale inversely with observed sky frequency.
3. “Maximum Angular Scale” is the largest angular scale that can be observed effectively. If the source contains smoothly varying structures that are larger than this in both directions, those components will be “resolved out”. This is the well known “missing flux” problem intrinsic to interferometry. The limit is taken to be 0.6 x (wavelength / minimum baseline), but this is only a guideline.
4. For spectral line observations, the addition of 12-m single-dish data allows the recovery of even larger scale structures.

If a mosaic is requested along with ACA use, a corresponding mosaic with the 7-m Array will be obtained. For spectral line observations, the full mosaic area will also be covered by the TP Array using On-The-Fly mapping.

Observations with the 12-m Array and the ACA will be conducted independently, and the data from the different arrays will be calibrated separately and combined during data reduction.

The observing strategies for the different elements of the ACA (7-m Array observations and TP Array) are still being commissioned at the time of this writing. For the purpose of evaluating time requests, the Cycle 1 OT assumes that the ACA component of ALMA Science Goals can be obtained within 3 times the estimated time for the corresponding 12-m Array observations (including calibrations and overheads). This factor of three is adopted for both spectral line and continuum observations. Because this is a simple time ratio and not specific to the amount of time spent on overheads, a sensitivity for the ACA components of an observation cannot be reported in the OT.

The total observing time required by a proposal will be estimated in the OT by adding the expected observing times (including calibrations) for all the arrays used in the observations. For Cycle 1, this total time must be less than 100hrs.

A.5 Correlator capabilities

A.5.1. Bandwidth and resolution

The 12-m Array uses the 64-input correlator, while the 7-m and TP Arrays use the 16-input ACA correlator. Both correlators offer the same spectral set-ups. They operate in two main modes – **Time Division Mode (TDM)** and **Frequency Division Mode (FDM)**. TDM provides modest frequency resolution and produces a relatively compact data set. It should be used for continuum observations or for spectral line observations that do not require high spectral resolution. FDM gives high spectral resolution and produces much larger data sets. It should be used for observations of spectral lines unless the lines are very broad. Six FDM set-ups will be available with different bandwidths and resolutions as described in Table A 5.

The correlators provide a set of "spectral windows" (SPW) that can be used simultaneously. For Cycle 1, up to four basebands are available per spectral setup, and one spectral window per baseband is allowed. Different correlator modes can be specified for each baseband (e.g. a high resolution FDM mode can use one SPW, while the other three can use the low resolution TDM mode). SPWs can overlap in frequency, although the total continuum bandwidth for calculating the sensitivity is set by the total independent continuum bandwidth.

Table A 5. Properties of ALMA Cycle 1 Correlator Modes, dual-polarization operation[1,2]

Bandwidth[3] (MHz)	Channel spacing[4] (MHz)	Spectral Resolution[4] (MHz)	Number of channels	Correlator mode
2000[3]	15.6	31.2	128[3]	TDM
1875	0.488	0.976	3840	FDM
938	0.244	0.488	3840	FDM
469	0.122	0.244	3840	FDM
234	0.061	0.122	3840	FDM
117	0.0305	0.061	3840	FDM
58.6	0.0153	0.0305	3840	FDM

Notes for Table A 5:

1. These are the figures for each spectral window and for each polarization.
2. Single-polarization modes are also available, giving twice the number of channels per SPW, and half the channel spacing of the above table.
3. The "Bandwidth" given here is the width of the spectrum processed by the digital correlator. The usable bandwidth in all

modes is limited to a maximum of about 1875 MHz by the anti-aliasing filter, which is ahead of the digitizer in the signal path. For the TDM mode, the anti-aliasing filter also limits the total bandwidth to about 1875 MHz and the number of channels to about 120.

4. The "Channel Spacing" is the separation between spectral channels in the output spectrum. The spectral resolution – i.e. the FWHM of the spectral response function – is larger than this by a factor that depends on the "window function" that is applied to the data in order to control the ringing in the spectrum. For the default "Hanning" window this factor is 2. See the Technical Handbook for full details.

A.5.2. Polarization

For Cycle 1, observations to measure the full intrinsic polarization of a source will not be offered. The correlators will either process both linear parallel-hand polarizations (XX, YY) or a single polarization (XX). Projects to measure the linear polarization of sources using dual polarization will not be supported.

When a **Dual Polarization** setup is used, separate spectra are obtained for each linear parallel-hand polarization of the input signal. This will give two largely independent measurements of the source spectrum that can be combined to improve sensitivity.

In **Single Polarization** mode, only a single input polarization (XX) is recorded. For a given resolution, this provides $\sqrt{2}$ worse sensitivity than the Dual Polarization case, but one can use either a factor of two more bandwidth for the same spectral resolution or a factor of two better spectral resolution for the same bandwidth. Single polarization should therefore be used in cases where having a large number of spectral channels is more important than having the best sensitivity.

A.6 Science Goal and source restrictions

In the OT an observing proposal is specified in terms of Science Goals. A single Science Goal is constrained to include one set of observational parameters that apply to all sources included in that goal. This includes a single angular resolution, sensitivity, largest angular scale, and receiver band. There is a maximum of five Science Goals per proposal.

Sources can be designated by a fixed RA and Dec, or can include moving targets (including the planets, their moons, asteroids and comets). Observations of the Sun, however, are not supported in Cycle 1.

Sources are selected in one of two ways: by specifying a single rectangular field, or by specifying one or more source positions, with or without offsets. Each involves some restrictions. The total number of pointings in a proposal must be less than or equal to 150. The ACA pointings do not count against the 150 pointing proposal limit.

A.6.1. Single rectangular field

A rectangular field (also referred to as a mosaic) is specified by a field center, the length, width and orientation of the field, and a single spacing between the pointing centers. One rectangular field is allowed per Science Goal, so at most five rectangular fields are allowed per proposal.

A single mosaic can have up to 150 pointings, although the total number of pointing positions in a proposal (mosaic or otherwise) must be less than or equal to 150.

The OT will set up a uniform mosaic pattern based on a user-specified pointing separation, and will calculate the time to reach the required sensitivity, considering any overlap. If the position separations are not too large, then the interferometric data are combined in post-processing to produce a single image. If ACA observations are requested as part of a mosaic, then a corresponding ACA mosaic will also be observed.

Observations are conducted using the "mosaic" observing mode. This mode repeatedly cycles through all the pointings in the mosaic so that the imaging characteristics across the map are similar. Because of this added constraint, an N-point mosaic observation is less efficient than a single field interferometry observation of N sources.

A.6.2. Multiple sources

As an alternative to specifying a rectangular field, users can request to observe up to 15 individual sources in a single Science Goal, provided that the sources:

(1) are not separated by more than 15 degrees on the sky,
(2) can be observed with one spectral setup (placement and properties of spectral windows),
(3) can be observed with no more than five separate velocities that all fall within the same receiver band.

The OT automatically calculates how many tunings are required by calculating a solution separately for each velocity and then seeing which of the other sources could be observed using this tuning. The result is a minimum list of tunings required to observe all the spectral lines. The number of tunings is reported in the Time Estimate dialogue.

A.6.3. Offset pointings

Offsets can be specified for all sources within a Science Goal, as long as all positions fall within 15° separation, and that the total number of positions in the proposal is less than or equal to 150. If ACA observations are requested for the Science Goal, then the corresponding ACA observations will be obtained for each source.

The offset pointings associated with each source are conducted using the "mosaic" observing mode. As such, they are subject to the additional overheads mentioned in the subsection on rectangular fields. In particular, a set of N offset pointings will take longer to observe than N sources at the same sky positions. Offsets should therefore not be used to observe many individual sources. If the use of offset pointings is not well justified, then the proposal may be rejected on technical grounds. For offset pointings, the OT does not consider the effect of overlapping pointings; users must take this into account when specifying the required sensitivity. If the offsets are not well spaced, they may not be combined into a single image during data reduction.

A.7 Calibration

Absolute amplitude calibration will be based on observations of objects of known flux, principally solar system objects. It is expected that the accuracy of the absolute amplitude calibration relative to these objects will be better than 5% for Band 3. Calibration in the higher frequency bands is likely to be less accurate. The goal is to achieve better than 10% in bands 6 and 7. Calibration at Band 9 will be challenging even at the 20% level owing to the double sideband nature of the total power observations in that band (Section A.2).

The ALMA Observatory has adopted a set of standard strategies to achieve good calibration of the data (see Chapter 11 of the Technical Handbook). Requests for changes in these strategies will only be granted in exceptional circumstances and must be fully justified. Some flexibility exists in choosing the actual calibrator sources. The default option is automatic calibrator selection by the system. If users opt for providing their own calibrators, justification will be needed. This may result in decreased observing efficiency and/or calibration accuracy.

Appendix B Acronyms and abbreviations

ACA	Atacama Compact Array
ALMA	Atacama Large Millimeter Array
AOS	Array Operations Site
AOT	ALMA Observing Tool
ARC	ALMA Regional Center
ARP	ALMA Review Panel
APRC	ALMA Proposal Review Committee
AS	Academia Sinica
AUI	Associated Universities, Inc.
CASA	Common Astronomy Software Applications
Co-I	Co-investigator
DDT	Director Discretionary Time
EA ARC	East Asian ALMA Regional Center
ESO	European Southern Observatory
EU ARC	European ALMA Regional Center
JAO	Joint ALMA Observatory
NA ARC	North American ALMA Regional Center
NAASC	North American ALMA Science Center
NAOJ	National Astronomical Observatory of Japan
NINS	National Institutes of Natural Sciences
NRAO	National Radio Astronomy Observatory
NRC	National Research Council of Canada
NSC	National Science Council of Taiwan
NSF	National Science Foundation
OSF	Operation Support Facility
OST	Observation Support Tool
OT	Observing Tool
PDF	Portable Document Format
PI	Principal Investigator
PWV	Precipitable Water Vapor
SB	Scheduling Block
SCO	Santiago Central Office
ToO	Target of Opportunity
TP	Total Power
WVR	Water Vapor Radiometer

Appendix C Science keywords

The list below presents for each science category the keywords that can be used in the OT to further specify the scientific area of the proposal. **Proposers must select at least one and at most two keywords.**

Category 1 – Cosmology and the high redshift universe

a. Lyman Alpha Emitters/Blobs (LAE/LAB)
b. Lyman Break Galaxies (LBG)
c. Starburst galaxies
d. Sub-mm Galaxies (SMG)
e. High-z Active Galactic Nuclei (AGN)
f. Gravitational lenses
g. Damped Lyman Alpha (DLA) systems
h. Cosmic Microwave Background (CMB)/Sunyaev-Zel'dovich Effect (SZE)
i. Galaxy structure & evolution
j. Gamma Ray Bursts (GRB)
k. Galaxy Clusters

Category 2 – Galaxies and galactic nuclei

a. Starbursts, star formation
b. Active Galactic Nuclei (AGN)/Quasars (QSO)
c. Spiral galaxies
d. Merging and interacting galaxies
e. Surveys of galaxies
f. Outflows, jets, feedback
g. Early-type galaxies
h. Galaxy groups and clusters
i. Galaxy chemistry
j. Galactic centres/nuclei
k. Dwarf/metal-poor galaxies
l. Luminous and Ultra-Luminous Infra-Red Galaxies (LIRG & ULIRG)
m. Giant Molecular Clouds (GMC) properties

Category 3 – ISM, star formation and astrochemistry

a. Outflows, jets and ionized winds
b. High-mass star formation
c. Intermediate-mass star formation
d. Low-mass star formation
e. Pre-stellar cores, Infra-Red Dark Clouds (IRDC)
f. Astrochemistry
g. Inter-Stellar Medium (ISM)/Molecular clouds
h. Photon-Dominated Regions (PDR)/X-Ray Dominated Regions (XDR)
i. HII regions
j. Magellanic Clouds

Category 4 – Circumstellar disks, exoplanets and the solar system

a. Debris disks
b. Disks around low-mass stars
c. Disks around high-mass stars
d. Exoplanets
e. Solar system: Comets
f. Solar system: Planetary atmospheres
g. Solar system: Planetary surfaces
h. Solar system: Trans-Neptunian Objects (TNOs)
i. Solar system: Asteroids

Category 5 – Stellar evolution and the Sun

a. The Sun
b. Main sequence stars
c. Asymptotic Giant Branch (AGB) stars
d. Post-AGB stars
e. Hypergiants
f. Evolved stars: Shaping/physical structure
g. Evolved stars: Chemistry
h. Cataclysmic stars
i. Luminous Blue Variables (LBV)
j. White dwarfs
k. Brown dwarfs
l. Supernovae (SN) ejecta
m. Pulsars and neutron stars
n. Black holes
o. Transients

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