



NORTH AMERICAN ARC
ALMA Regional Center

North American
ALMA Science
Center



A Quick-Start Guide for Early Science with ALMA

NAASC Memo #

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ABSTRACT

This document provides a starting point to astronomers interested in using ALMA during “early science.” We briefly describe the proposal process and identify the key software tools and other important resources and documents that will help astronomers learn about the capabilities of ALMA, how to submit proposals and observing programs, and how to retrieve and analyze their data.

1 Introduction to This Document

This document is intended to provide a starting point for astronomers planning to use ALMA during its “Early Science” period. We identify key documents and resources that will help astronomers learn about the early capabilities of ALMA, and we point to important software and documentation relating to the proposal process, preparation of observations, and data reduction. Proposals for Early Science will be due in early 2011 and the Early Science observing period will begin later that year and last approximately one year. A second call may be issued during this first year. This document will be updated at least prior to each call, and will have a clear revision history. The latest version will be posted to <http://science2.almaobservatory.org/xxxx>. Users should make sure that they have the latest version before proceeding.

THIS IS A DRAFT VERSION FOR THE ALMA “Science Operations Readiness Review” (October 11-12 2010). The tools and documents will be collected to a central DSO website prior to the formal release of this document.

2 Change Record

Version	Date	Affected Sections	Reason/Initiation/Remarks
2010-A	2010-09-27	All	Pre-release for Operations Readiness Review (JEH)
2010-A1	2010-09-29	Almost all	Incorporating comments from EA & EU ARC; updated links to user docs to point to ESdoc wiki; updated CASA subsection (JEH)

3 The ALMA Project in a Nutshell

The Atacama Large Millimetre/submillimetre Array (ALMA), located on the Chajnantor plain of the Chilean Andes at an elevation of about 5000 m, is expected to be the leading observatory at millimetre and submillimetre wavelengths in the coming decades. ALMA is a global collaboration¹ involving East Asia (EA), Europe (EU), North America (NA) and the host country Chile. The ALMA Observatory operations in Chile are overseen by the Joint ALMA Observatory (JAO) on behalf of the three ALMA Executives: Europe, North America and East Asia.

The proposal review process and day-to-day observatory science operations are run by the JAO under the supervision of the Department of Science Operations (DSO). User support is provided by the ALMA Regional Centers (ARCs), one in each of the three ALMA regional partners. These ARCs provide the gateway to ALMA for all astronomers. North American and Taiwanese astronomers are supported by the North American ALMA Science Center (NAASC) based at NRAO headquarters in Charlottesville, Virginia, USA, with assistance from the Herzberg Institute of Astrophysics (HIA) in Victoria, BC, Canada. European astronomers are supported by the EU-ARC, based at the European Southern Observatory (ESO) headquarters in Garching, Germany, along with regional “ARC nodes” based in several ESO member countries. The East Asian astronomical community, including Japan and Taiwan, are supported by the East Asian ARC (EA-ARC) based at the National Astronomical Observatory of Japan (NAOJ) headquarters in Mitaka, Japan in collaboration with Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) in Taipei, Taiwan.

4 Learning about ALMA for Early Science Observations

When completed, ALMA will comprise at least 66 high precision antennas equipped with receiver and digital electronics system to observe in the frequency range from 31 GHz to 950 GHz. Antennas and electronics started being delivered to the site in 2009, and will continue to be delivered and commissioned through 2013. ALMA Early Science will commence when at least three receivers are available on at least sixteen 12-m antennas, and will last approximately 1 year. Early science is expected

¹ 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.

to start in mid 2011, during which science observing will occur approximately one third of the time.

The ALMA Science web page maintained by the JAO (link given below) is the appropriate starting point for information on ALMA capabilities and access to observer tools, applications and documentation. The “Early Science” link, in particular, outlines the scientific capabilities of ALMA during the early science period beginning July 2011. The Call for Proposals will be posted here, as well as links to all user documentation and any software tools that a user might need. The ARCs also maintain websites that either link back to the relevant JAO pages (description of ALMA capabilities) or include “mirrored” copies of the material (CfP, documents, science archive). The ARC websites may also include other relevant information, such as visitor or student support programs, regional workshops or tutorials, etc.

The document *Observing with ALMA: A Primer* provides an overview and introduction to the ALMA project, its scientific capabilities and terminology, as well as an introduction to terms and concepts used in interferometry and some observing examples. Other relevant articles on the ALMA Observatory, ALMA Science Operations, and ALMA Software tools are also available from the DSO wiki <http://wikis.alma.cl/bin/view/DSO/TrainingMaterial>. A subset of these is collected at the end of this document (Section 7).

ALMA Websites:

- JAO ALMA Science Web Page: <https://science2.almaobservatory.org/>
- ALMA Early Science Capabilities: <http://science.nrao.edu/alma/earlyscience.shtml> [POINT TO JAO WHEN AVAILABLE]
- NA ARC/NAASC Website: <http://science.nrao.edu/alma/>
- EU ARC Website: <http://www.eso.org/sci/facilities/alma/arc/>
- EA ARC Website: <http://alma.mtk.nao.ac.jp/EA-ARC/>

5 ALMA Observing Program Workflow

A users-view of the ALMA observing program workflow, from the Call for Proposal through data delivery, is given in Figure 1. The left-most column gives a rough timeline, while the other columns separate actions by who is performing the action: the User, the local ARC, or the DSO. This section briefly describes the workflow, and the various software tools used at each stage. Subsequent subsections tell where to find the tools and any supporting documentation, and list any platform or operating system requirements.

Call for Observing Proposals: The general procedure is that the DSO generates the text for the Call for Proposals (CfP), which includes the anticipated capabilities of the observatory (available observing bands, correlator modes, observing modes,

configurations, etc.) for the upcoming observing season. Initially, the plan is for a single call every 12-month period issued eight months before the start of the observing season, for a year of observing.

The CfP will be broadcast to the regional and worldwide communities by the ARCs using standard broadcasting means (e.g. society and observatory newsletters and mailing lists), and will be posted to the ALMA science websites (Section 4).

Registering as an ALMA User: All users who wish to be part of any ALMA proposal (either as Primary Investigator or Co-Investigator) or to submit tickets to the ALMA Helpdesk or to retrieve data from the ALMA Science Archive must register via the ALMA User Portal (Section 6.1). Non-registered users may still access ALMA user tools, software, or browse the science archive.

Users will be associated with one of the ALMA partners (EU, NA, EA, or Chile) based on their institutional affiliation(s). This affiliation factors into time allocation and specifies the ARC portal users will be directed to for data retrieval and helpdesk support. Users from non-ALMA member regions or Chile may select any of the three ARCs for support.

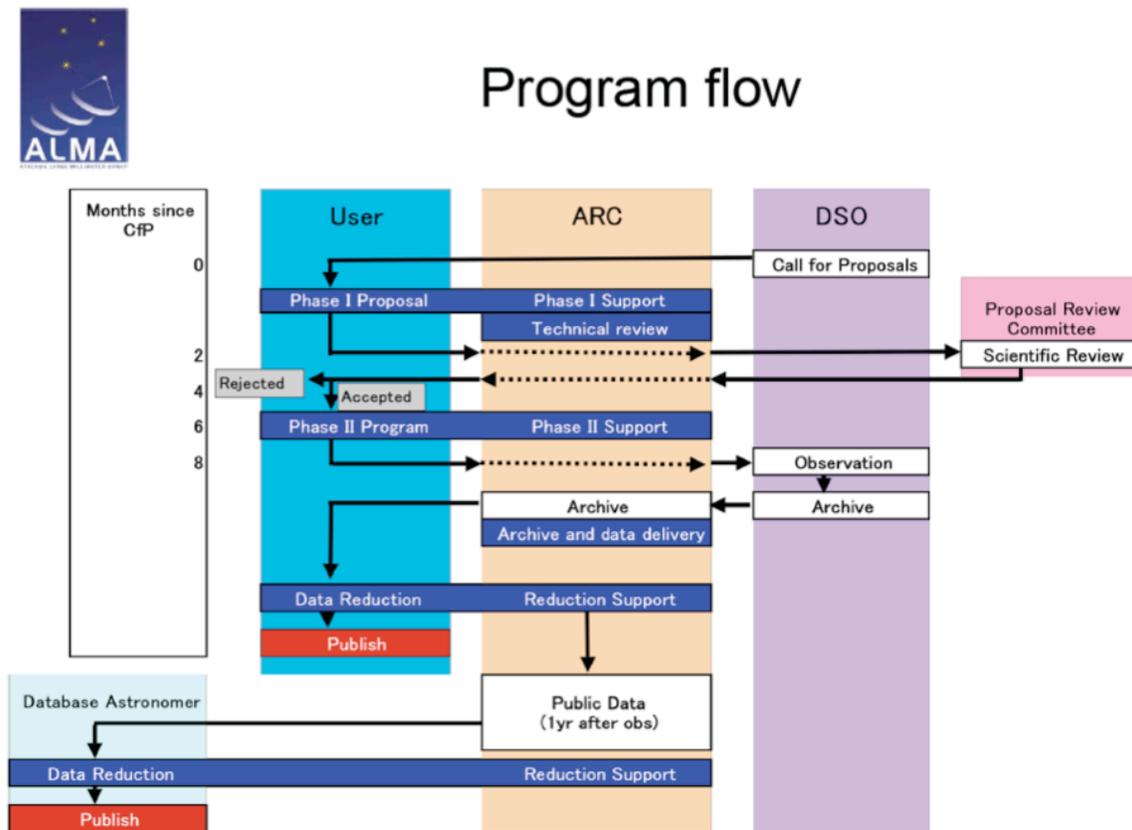


Figure 1: ALMA Observing Program Workflow

Proposal Preparation & Submission: After the CfP is issued, users will have two months to prepare their “Phase I” materials using the ALMA “Observing Tool”

(Section 6.2). The OT is a java-based application based on existing tools for other observatories (Gemini, JCMT, Spitzer, Herschel), so its design should be familiar to many potential observers. Phase I consists of a detailed observing proposal with a scientific and technical justification submitted to the Observatory through the OT. The OT includes calculators for determining sensitivities, and viewers for assisting with correlator setups and mapping parameters. Users can use the ALMA helpdesk (Section 6.2), available from the ALMA User Portal, to get assistance from ARC staff at any stage of the observing process.

If desired, one can simulate ALMA observations using the "*Simdata*" tasks of the CASA software package (Section 6.6). This task takes a model image as input and simulates the resulting ALMA image, accounting for the array configuration, instrumental noise, atmospheric phase delay, as well as the data reduction process. One can also use the compilation of molecular spectral line databases provided by the "*Splatalogue*" on-line catalog (Section 7.3) to help plan spectral line observations.

Proposal Review Process: Phase I submissions from non-Chilean proposers will be peer-reviewed by a single international committee that is divided into a number of science-themed review panels. Time will be awarded based on the proposals scientific ranking and available time. The time available for projects will depend on the proposers' institutional affiliation, with [33.75%, 33.75%, 22.5%, 10%] made available to projects associated with the North American, Europe, East Asian, and Chilean partners, respectively. A certain amount of time may be made available to projects from non-ALMA member regions. Users should consult the ALMA websites (Section 4) and Call for Proposal for details. Users will receive notification of the proposal review process via email.

Phase II Program: Successful proposers will be invited to submit a detailed observing plan, which is handled through Phase II of the OT. This consists of using the OT to develop a series of small blocks of observing time called Scheduling Blocks (SBs), which can be run by the array operators when conditions are appropriate. Again, the ARCs are available to help observers through the Phase II process. Once SBs have been submitted, users will be able to track the status of their project through the ALMA Project Tracker (Section 6.4), a user application available from the User Portal.

Data Retrieval: After all SBs associated with a project have been successfully observed, the data will be processed and quality-assured by ALMA staff and deposited into the ALMA Science Archive (Section 6.5), where they may be retrieved by observers. ALMA user data has a one-year proprietary period. Archived data products include the raw visibilities, telescope logs, relevant data reduction scripts, and reference images and cubes.

Post-processing & Analysis: Users can use the CASA offline data reduction package (Section 6.6) to reprocess, reimage, or further analyze their data.

6 ALMA Software Tools & Applications

6.1 The ALMA User Portal

The User Portal is a web site that links users to a set of tools including a general-purpose helpdesk, a project tracker for following progress in having observations scheduled, and a data archive search tool for access to project data.

The portal is developed in “plone”, which should work in any browser, although it might be a bit more cumbersome on older browsers.

System Dependencies:

None known.

Resources:

ALMA User Portal: <http://asa.alma.cl/asa>

6.2 ALMA Helpdesk

The ALMA helpdesk is a general resource for registered users to submit questions on ALMA and for reporting issues to the ALMA team.

The helpdesk is a web application, run within a browser, and it can be accessed from a link on the User Portal. The helpdesk works from Windows, Linux, and Mac OS X systems, with the preferred browser being **firefox**. Other browsers work as well, but may require enabling “3rd party” cookies (see System Dependencies below).

The helpdesk uses a knowledgebase system to provide immediate help for many user questions. The knowledgebase system searches on key words in the user’s ticket (as it is being typed) to find similar issues resolved previously, and offers suggested answers from that base of previous questions and answers.

System Dependencies:

Safari: for the helpdesk panel that is embedded within the User Portal frame, users will need to enable “3rd party” cookies to work. This is not necessary for the “pop-out” version of the helpdesk.

Resources:

ALMA Helpdesk: accessed from the ALMA User Portal (<http://asa.alma.cl/asa>), or directly at <http://help-alma.nrao.edu>

6.3 The ALMA Observing Tool

The OT is a java application that must be downloaded and run on the user’s local computer. A User’s Guide for the OT is available directly as part of its online help.

The latest OT version is vIT2. Users should verify that this is the version displayed in the upper right corner of the icon that appears when the OT is run. The OT runs on

Linux, Windows (XP, Vista, 7), and Mac OS X (10.5 and later), and it requires Java Version 6, which is available from: <http://www.java.com/download/>.

There are two options for obtaining the OT release: a “Web Start” or a “Tarball”. The “Web Start” option is the preferred option. Installation instructions for the “Tarball” are given on the Download page.

System Dependencies:

Windows Users: None; appropriate Path for JAVA will be set properly.

Linux Users: Some recent Linux distributions (Fedora and Ubuntu are examples, but there may be others) come with the "Iced Tea" OpenJDK version of java, in particular installed as the default "Webstart" application in the web browser. We have found serious issues when using this Open JDK because it is based on an old patch level of Java. If you download the OT webstart and find that left clicking on nodes on the tree does not work then it is probably this issue. Please reconfigure your browser to use a standard (Sun) version of webstart.

Mac Users: Mac Users should be aware that if you have an OSX earlier than 10.5 you would need to use the SoyLatte open source package. More details can be found at

<http://almasw.hq.eso.org/almasw/bin/view/OBSPREP/AlmaOTonAMac>.

Resources:

ALMA Observing Tool application:

<http://www.roe.ac.uk/ukatc/projects/alma/almaot/IT2/>

“ALMA Observing Tool (Phase 1) Walkthrough: Early Science Version”:

https://safe.nrao.edu/wiki/pub/ALMA/ESdocs/OT_Phase1_Walkthrough_0928.pdf

OT User Manual:

<http://wikis.alma.cl/twiki/pub/DSO/ObsPrepAuguste2e/ALMA-OT-UserManual.pdf> (also available directly from within the OT)

OT Reference Manual:

<http://wikis.alma.cl/twiki/pub/DSO/ObsPrepAuguste2e/ALMA-OT-RefManual.pdf>

6.4 The Project Tracker

The project tracker is a Java tool available to users after signing in through the ALMA User Portal.

System Dependencies:

Same as User Portal (Section 6.1), i.e. none known.

Resources:

ALMA Project Tracker: <http://asa.alma.cl/asa/protrack/>.

Project Tracker Operations Manual:

<https://safe.nrao.edu/wiki/pub/ALMA/ESdocs/ProjectTrackerManual.pdf>

6.5 The ALMA Science Archive

The ALMA Science Archive is a “plone” application available from the ALMA User Portal. Unregistered users can browse the archive but cannot download data. Upon signing in, registered users will be (seamlessly) redirected to the mirror archive at their supporting ARC, from which they can download their own proprietary data or any public data.

System Dependencies:

Same as User Portal (Section 6.1), i.e. none known.

Resources:

ALMA Science Archive: <http://asa.alma.cl/asa> (users will be redirected to the appropriate regional ARC mirror of the science archive)

User Portal and ALMA Science Archive (ASA) User Manual:

<https://safe.nrao.edu/wiki/pub/ALMA/ESdocs/ALMA-UserPortal-UserManual-0.1.pdf>

6.6 Common Astronomy Software Applications (CASA), including ALMA Observing Simulator (“simdata” task in CASA)

Post-processing of ALMA data can be accomplished using the Common Astronomy Software Applications (CASA), which runs on Linux systems and Mac OS X (10.5 and later). The CASA infrastructure consists of a set of C++ tools bundled together under an iPython interface as a set of data reduction tasks. This structure provides flexibility to process the data via task interface or as a python script. In addition to the data reduction tasks, many post-processing tools are available for even more flexibility and special purpose reduction needs.

CASA is released semi-annually, with the current release being R3.0.2. Patches come out more frequently. Users should check the “Obtaining CASA” page (see below) for the most up-to-date information.

System Dependencies:

CASA is available for the following operating systems:

Linux:

- RedHat Enterprise Linux: 4 & 5 (32 bit and 64 bit)
- Fedora Core Linux: 6, 7, 8 (32 bit and 64 bit)
- Ubuntu 8.0.4 (32 bit and 64 bit)
- openSUSE 10.0, 11.0 (32 bit and 64 bit)

- Debian 4.0 (32 bit and 64 bit)

Mac OS:

- Mac OS 10.5 (Leopard 32-bit only)
- Mac OS 10.6 (Snow Leopard 64-bit only)

CASA is also thought to work on most other flavors of Linux. The list above covers those operating systems that we run regular tests on. For data processing of large datasets, 64-bit is strongly recommended. A full list of CASA dependencies for user applications is given at <http://casa.nrao.edu/casa-dependencies.shtml>.

Resources:

CASA homepage: <http://casa.nrao.edu/> (includes the following links):

- Obtaining CASA: computing requirements and download instructions
- Getting Started
- CASA Training Materials
- CASA Documentation (both pdf & web-based versions; URLs for web-based versions listed below)

CASA User Reference & Cookbook:

<http://casa.nrao.edu/docs/userman/UserMan.html>

CASA Task Reference Manual:

<http://casa.nrao.edu/docs/taskref/TaskRef.html>

CASA Toolkit Reference Manual:

<http://casa.nrao.edu/docs/casaref/CasaRef.html>

CASA guides (on-line scripts & tutorials): <http://casaguides.nrao.edu/>

- CASA mm/submm data reduction guides/scripts:
[http://casaguides.nrao.edu/index.php?title=Current MM/Submm Guides](http://casaguides.nrao.edu/index.php?title=Current_MM/Submm_Guides)
- CASA Simdata guides:
[http://casaguides.nrao.edu/index.php?title=Simulating Observations in CASA](http://casaguides.nrao.edu/index.php?title=Simulating_Observations_in_CASA)

7 Other Resources

7.1 Additional Documentation

The following resources are kept updated at “ALMA User Support Training Materials & Links” webpage: <http://wikis.alma.cl/bin/view/DSO/TrainingMaterial>

- *“The Atacama Large Millimeter/submillimeter Array”*, Wootten, A. & Thompson, A. R. 2009 IEEE 97, 1463
- *“Observing with ALMA: A Primer for Early Science”*
- *“ALMA Science Operations”*, L.-A. Nyman, P. Andreani, J. Hibbard & S. K. Okumura, 2010, **SPIE, ...**

- “ALMA Science Operations and User Support (Software)”, R. G. Rawlings, L.-A. Nyman & B. Vila Vilaro, 2010, SPIE, ...
- “Principles of the ALMA Proposal Review Process”, The ALMA Board, DATE
- “The ALMA Proposal Review Process”, JAO DSO, Version XX
- [ALMA Early Science capabilities and CSV milestones](#) (R.Hills presentation to ASAC; posted 8/5/2009)
- The ALMA Design Science Reference Plans (DSRPs): a compilation of promising ALMA science projects, which is useful for users to expected capabilities and breadth of science of the completed Array
<http://www.eso.org/sci/facilities/alma/science/drsp/>

7.2 ALMA Calendar of Events

A calendar of ALMA training events, such as tutorials, ALMA community days, and Science Meetings is maintained at:

<http://wikis.alma.cl/bin/view/DSO/ListTrainingActivities>

7.3 Splatalogue

The Splatalogue is an attempt to collate, rationalize and extend existing spectroscopic resources for use by the astronomical community. Splatalogue is a transition-resolved compilation of the JPL, CDMS, Lovas/NIST, Frank Lovas' own Spectral Line Atlas of Interstellar Molecules (SLAIM), H, He and C recombination lines, data from the Toyama Microwave Atlas for spectroscopists and astronomers, data from Frank De Lucia's lab at The Ohio State University and new methanol data provided by Li-Hong Xu from The University of New Brunswick, Canada.

Splatalogue is available at <http://www.splatalogue.net/>. Subsets of the Splatalogue compilation are included with the ALMA Observing Tool and CASA.

Resources:

“The ALMA Spectral Line Catalogue: Splatalogue”, NAASC-00.00.00.10-002-A-PLA, Version B2:

https://safe.nrao.edu/wiki/pub/ALMA/ESdocs/SplatalogueMemo_v2.1.pdf

“Splatalogue Quickstart Guide”, A. J. Remijan, version 2.1:

https://safe.nrao.edu/wiki/pub/ALMA/ESdocs/SplatQuickUserGuide_v2.1.pdf

7.4 ALMA Sensitivity Calculator

An ALMA sensitivity calculator is included as part of the ALMA Observing Tool. A java applet is also available at

<http://www.eso.org/sci/facilities/alma/observing/tools/etc/>.