A Guide to the North American ALMA Regional Center and the NAASC

Catherine Vlahakis (NAASC)

www.almascience.org

ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), MOST and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ.

User Support:

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

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1 Welcome

Welcome to the North American ALMA Regional Center (NA ARC) at the North American ALMA Science Center (NAASC), headquartered at 520 Edgemont Rd., Charlottesville, VA 22903, United States of America. The NAASC is a multinational institution that works to provide the scientific community of North America (NA) access to the Atacama Large Millimeter/submillimeter Array (ALMA). Through the NAASC, we provide support and outreach services to our peers including visiting scholars, graduate and undergraduate students and postdocs, underrepresented groups, and other inquisitive parties interested in ALMA science and outreach. The NAASC also facilitates many private and public training events to the international community. The NAASC welcomes you to visit and learn about what we do and what we have to offer to the scientific community. The NAASC is operated by the National Radio Astronomy Observatory (NRAO) in Charlottesville, Virginia, in collaboration with Canada's National Research Council Herzberg Astronomy and Astrophysics Research Centre (NRC Herzberg), and the National Science Council (NSC) of Taiwan. The NAASC supports the science use of ALMA by astronomers in North America and Taiwan and supports research and development for future ALMA upgrades.

The following websites provide additional information on ALMA and the NAASC, and connect users to resources and tools they will need to use the ALMA observatory.

The ALMA Science Portal	http://almascience.nrao.edu
The NAASC website	http://science.nrao.edu/facilities/alma
The ALMA Helpdesk, which is also linked from the ALMA Science Portal and the NAASC website	https://help.almascience.org
The NRC ALMA website	https://nrc.canada.ca/en/research-development/research-collaboration/research-centres/herzberg-astronomy-astrophysics-research-centre
The Taiwanese ALMA website	http://www.asiaa.sinica.edu.tw

2 Highlights & What's New at the NAASC?

Below is new information for the NA ALMA Community regarding Operations at the North American ALMA Science Center (NAASC):

- *Get support for Large Programs!*
  Large Program PIs are particularly encouraged to review the support services that are available in the NAASC, from proposal preparation to data delivery and analysis, and can be included in the ALMA Large Program Data Management Plan. See Section 6.1 of this document – Large Program Support. Support services are also available for PIs of any proposal type.
- *Visit us!*
  The NAASC now offers face-to-face visits in both in-person and virtual formats. Through the face-to-face (f2f) department of the ALMA Helpdesk, users may request an in-person visit (at NRAO headquarters in Charlottesville, VA), a virtual visit, or a virtual "NAASC Chat". NAASC Chats are an opportunity for a user to interact with NAASC staff members at a dedicated time without committing

to a multi-day f2f visit but when they may need more assistance than is practical through a Helpdesk ticket. The f2f visitor program supports data reduction visits, visiting scientists, and sabbatical visits, including those who would like to come for archival research. If you need any help in preparing proposals, reducing data, or help finishing writing up an ALMA paper, consider signing up for a f2f visit to work closely with our data analysts and scientific staff. For more information and to request a visit, please see: https://science.nrao.edu/facilities/alma/visits and submit a ticket to the face-to-face visits department of the ALMA Helpdesk.

- *Get support for your meeting!*
  The NAASC also offers financial and logistical support to organize conferences and workshops hosted by the community to promote ALMA science. For proposals requesting more than $10,000, we will open the call for applications in the summer of 2023. For other proposals, we will accept applications while funds last. For more information and to request support for your conference or workshop, visit https://science.nrao.edu/facilities/alma/community1/NAASC-Conference-and-Workshop-Support.
- *Become an ALMA Ambassador or attend an Ambassador-led workshop!*
  The ALMA Ambassador Program now also hosts data processing workshops aimed towards researchers interested in obtaining help with reducing their own data or archival data. See https://science.nrao.edu/facilities/alma/ambassadors-program/ for details.
- *Get calibrated data on demand!*
  The NRAO Science Ready Data Products (SRDP) initiative now provides on-demand generation of calibrated measurement sets for data from Cycle 5 to present. It also provides the ability for users to request re-imaging of data products via the ALMA User-Defined Imaging (AUDI). More information on SRDP and AUDI can be found at: https://science.nrao.edu/srdp; requests for calibrated measurement sets and re-imaging can be done at: data.nrao.edu.
- *Stay up-to-date!*
  NRAO and the ALMA Observatory have Twitter feeds that provide news, updates and highlights. NRAO also includes updates and news from ALMA and the NAASC on its Twitter feed. If you haven't already done so, sign up on Twitter to follow @TheNRAO and @almaobs to receive these updates.

3 About ALMA

The Atacama Large Millimeter/submillimeter Array (ALMA) enables transformational research into the physics of the cold universe, where the sky is dark in the visible part of the spectrum but shines brightly at (sub)millimeter wavelengths. ALMA is a global collaboration involving partners in North America, Europe, and East Asia, in cooperation with the Republic of Chile. The telescope has 66 high-precision antennas located on the Chajnantor plateau of the Chilean Andes, 5000 m above sea level. ALMA operates at frequencies between 35 GHz and 950 GHz and in Full Operations will image the sky at resolutions as fine as 0.005" with unprecedented sensitivity. The capabilities of ALMA are outlined in the ALMA Proposer's Guide and details on the telescope are given in the ALMA Technical Handbook. New users can learn about ALMA and get an introduction to radio interferometry in the ALMA Primer. These documents are available at the ALMA Science Portal at http://almascience.nrao.edu.

4 Organization and Role of the ARCs and the NAASC

Being an international facility, ALMA serves a worldwide community of astronomers, scientists, and other professionals. To interact with the geographically distributed user community, the three partners have

established ALMA Regional Centers, or ARCs. They are the North American ARC (NA ARC), based in Charlottesville, VA; the East Asian ARC (EA ARC), based in Mitaka, Japan; and the European ARC (EU ARC), based in Garching, Germany. The ARCs are staffed by scientists with expertise in radio astronomy, millimeter/submillimeter astronomy, and interferometry, and their purpose is to work with the scientific community to maximize the productivity of the ALMA telescope. The NA ARC is part of the NAASC, concentrating on internationally agreed core ALMA functions.

Each astronomer who uses ALMA is assigned an ARC for user support at the time they register with the ALMA Science Portal. Astronomers in North America, East Asia, or Europe are assigned to the ARC associated with their region. Astronomers from Taiwan can select either the NA ARC or the EA ARC. Astronomers elsewhere in the world can select any one of the three ARCs.

Stone Hall on the Campus of the University of Virginia and headquarters of the North American ALMA Science Center.

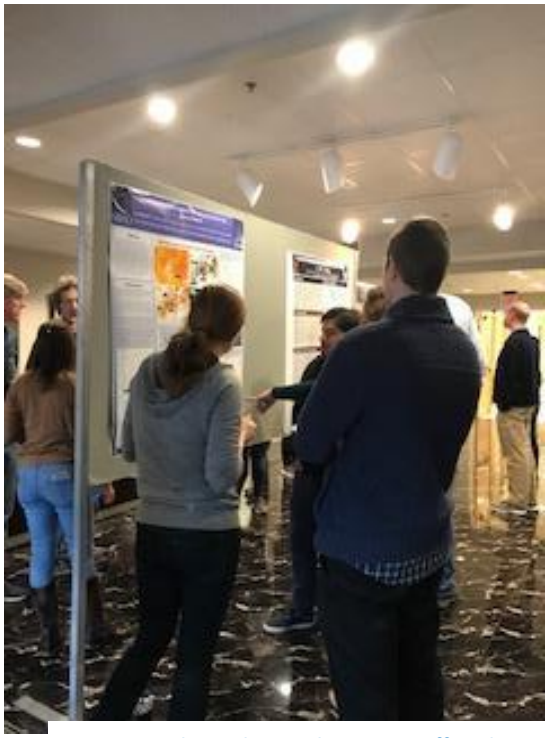
The NAASC is located in part at NRAO Headquarters, on the Grounds of the University of Virginia (UVa), and a short walk from the UVa Department of Astronomy (Section 12). The NRAO and UVa Astronomy share colloquia, journal clubs, science group meetings and lunch talks. Several NAASC staff have joint or adjunct appointments at UVa. The NAASC is also located in part at NRC Herzberg Astronomy & Astrophysics, located in Victoria, BC, Canada. A listing of NAASC staff, including research interests, is available here: http://science.nrao.edu/facilities/alma/ALMApeople/

The key services provided by the NAASC to the North American astronomical community include:

- The Phase 2 Group (P2G) assists users by preparing ALMA Scheduling Blocks (SBs) in anticipation of the upcoming observing cycle. This effort also includes follow-up on change requests reported during the course of the cycle and making the appropriate edits to the SBs before placement into the observing queue.
- Contact Scientists provide support and oversight of approved observing programs, and are the main point of contact between PIs and ALMA for approved projects.
- Tools and algorithm development including the QA2 reporting script for manual calibration, analysisUtils, Splatalogue, *simalma*, calibration and imaging pipeline heuristics, and algorithm research and development (see Section 6.3 of this guide for more information on *simalma* and Splatalogue).
- Providing online data reduction guides for a range of ALMA observing modes. These CASA guides can be found at http://casaguides.nrao.edu/ and more information on CASA can be found at http://casa.nrao.edu.
- Principal Investigator (PI) data reduction and imaging, including Pipeline processing and coordinating and managing the calibration, imaging, and delivery of PI data products through the ALMA Archive and the delivery of calibrated measurement sets through the Labor-saving Added Value Automation (LAVA) service. We also provide ALMA Data Mining Toolkit (ADMIT) products for interferometric

observations which offer a quick-look of data including line identification for well-known chemical species and moment maps. For more information about ADMIT products, see: ADMIT CASA guide

- The calibrated data and ADMIT products are retained on disk for a period of **ONE** month. After that, for data from Cycles 1-4, users can request re-generation of calibrated measurement sets via the ALMA Helpdesk. This service is restricted to projects whose PIs have NA designated as their ARC for support. If the user is not a PI or delegated co-I, and is requesting calibrated measurement sets for public data, there will be a limit of **FIVE** such requests per calendar year per requestor. For Cycles 5-present, users can request re-generation of calibration measurement sets at: data.nrao.edu. This service is provided to all users as long as the data is out of proprietary period. If the data is still proprietary, only the PI or delegated co-(P)Is may make the request.
- NAASC Community Day events, often hosted by ALMA Ambassadors (Section 9), including the development of the strategic plans and initiatives to grow and educate the ALMA user base through the use of schools, tutorials, and workshops.
- Overall management of the ALMA Helpdesk activities including routine ticket reviews, enforcement of ticket service level agreements and formulation of new Knowledgebase articles based on user questions.
- Review and assistance in the preparation of the ALMA documentation including the ALMA Call for proposals, Proposer's Guide, Users' Policies, Science Primer, Technical Handbook, Guide to the NA ARC and the NAASC, software user guides, and additional documentation on how to access NAASC services.
- Face-to-face visitor program including proposal preparation and data reduction visits of PIs (or co-Is), or any scientist doing archival research. We also provide support for visiting scientists, and sabbatical visits.
- Operating a copy of the ALMA data archive including LUSTRE access and management of users to the NRAO cluster-processing pipeline.
- Extension and Optimization of Capabilities (EOC) work and activities. NAASC staff interface with the JAO and the ALMA Science Advisory Committees on setting the priorities of ongoing EOC work as needed for the completion of these activities for future cycles.
- NA ALMA Development Program, aimed at keeping ALMA at the forefront of scientific discovery over the long-term. Over the next several years this program will deliver a new wideband correlator and an upgraded Band 6 receiver as part of the ALMA2030 Wideband Sensitivity Upgrade.
- Providing opportunities for student funding (including archival research) and page charge support for U.S.-based investigators.
- Science outreach events, especially working very closely with the NRAO Department of Diversity and Inclusion (ODI) to promote STEM education through a wide range of initiatives.



ALMA Ambassadors and NAASC Staff at the poster reception during the Ambassador training session – 2019 February

5 Essential Resources

5.1 The ALMA Science Portal

The ALMA Science Portal is the primary access point to ALMA for all science users, and can be found at: http://almascience.nrao.edu

At the ALMA Science Portal, users can:

- Register as an ALMA user
- Access the ALMA Call for Proposals, the ALMA Proposer's Guide, the ALMA Technical Handbook, the ALMA Primer, and other documentation
- Download the ALMA Observing Tool, the software used to prepare and submit ALMA proposals
- Search and access public data from the ALMA Archive
- Access Knowledgebase articles from the ALMA Helpdesk
- Access software tools and documentation, including a sensitivity calculator, the ALMA Observation Support Tool, and Splatalogue
- Get an overview of ALMA's scientific capabilities.

Every astronomer who intends to submit an ALMA proposal as a PI, or appear on one as a co-PI or co-investigator (Co-I), must register with the ALMA Science Portal. Once registered and logged in, users will be able to:

- Submit an ALMA proposal as a PI
- Participate as a co-I or co-PI on ALMA proposals
- Manage their user profile and demographic information, including:
    - Updating personal information that is used to track proposal statistics as we continue to remove bias from the proposal review process.
    - Specifying areas of expertise and conflicts of interest, necessary for the proper dissemination of proposal review during the distributed peer review process.
    - Setting an option to receive automatic email notifications of observing progress, delegate access to their data to other ALMA users or delegate the right to trigger Target of Opportunity observations to other ALMA users.
- Access SnooPI, the tool for PIs and collaborators to monitor the status of their observing programs
- Submit ALMA Helpdesk tickets
- Access their proprietary data through the ALMA Archive.

Once registered with the ALMA Science Portal, a user assigned to the NA ARC is automatically added to the NA ALMA User mailing list. This list is used by the NA ARC Manager and other designated NAASC staff to communicate news, events, science highlights and upcoming science conferences to the NA ALMA User community. These emails may be sent every 6-8 weeks (or more) depending on the urgency of information.

Also, NRAO and the ALMA Observatory have Twitter feeds that provide news, updates and highlights. If you haven't already done so, sign up on Twitter to follow @TheNRAO and @almaobs to receive these updates.

5.2 The NAASC Website

The NAASC website provides up-to-date news and information of particular use to North American ALMA users, and can be found at: https://science.nrao.edu/facilities/alma.

At the NAASC website, users get information on:

- ALMA and NAASC news and events
- Tutorials on ALMA's capabilities and proposal preparation
- Data reduction and analysis support including instructional videos on interferometry and CASA
- Workshops on ALMA data processing and analysis
- Financial support for visiting the NAASC, publications and for organizing conferences and workshops
- Student and postdoc programs
- Education and outreach activities
- NAASC staff

5.3 The ALMA Helpdesk

The ALMA Helpdesk is the main user resource for getting help. The ALMA Helpdesk is a website that can be accessed from the ALMA Science Portal, from the NAASC website, or directly at: https://help.almascience.org.

NAASC Staff members Adele Plunkett (Left) and Andy Lipnicky (2nd from Right) at the high site with ALMA engineer Pablo Carrillo (2nd from Left) and an ABC

The ALMA Helpdesk includes a library of Knowledgebase articles that address a number of common issues and questions. As the user types a question, Knowledgebase articles are searched in real time and relevant articles are presented as the question is being typed. In addition, the Knowledgebase query also accesses the documentation in the ALMA Science Portal and suggests parts of the ALMA documentation that may be relevant to a user's question. If the user does not find an answer in the articles or documentation suggested, the user can submit a ticket. While it is necessary to log in before submitting a ticket, users can browse and search the Knowledgebase articles and ALMA Science Portal documentation without logging in.

The ALMA Helpdesk has the following departments in order to direct tickets to the appropriate people at the user's affiliated ARC:

- General Queries (NA) - Science Portal/Registration, Documentation, Webpages, Proposal reviews and assessment, Project tracking, other
- Project Planning (NA) - Available Capabilities, Call for Proposals, Sensitivity Calculator, Simulators, Splatalogue, other
- Observing Tool (NA) - Proposal Preparation, Proposal Submission (general), Phase2 process
- Proprietary Period Extension Requests (NA)
- Data Reduction (NA) - CASA, pipeline processing, etc...
- Proposal Change Requests (NA) - request for a change to a submitted proposal or accepted project
- Archive and Data Retrieval (NA) - archive access and queries, obtaining your ALMA data, archival research
- Face to Face Support (NA) - Data reduction, science, short term, other

ALMA Helpdesk staff will make every effort to respond to tickets promptly. During normal operations, users can expect a response within two business days. During the last week before the Call for Proposals, a single department called "Proposal Submission Emergency" is set up across all ARCs that will answer urgent tickets concerning proposal submission. Triage for this department will start 72 hours before the deadline with 24-hour coverage by Europe (EU), North America (NA), and East Asia (EA).

6 Getting Help from the NAASC at Each Step of Your Project

The NAASC provides user support through all stages of an ALMA project, from learning the observatory's capabilities to the publication of results.

6.1 Large Program Support

All ARCs provide support for ALMA Large Programs. As stated in the ALMA Proposer's Guide, prospective PIs of Large Programs are **strongly encouraged** to contact their ARC for support in order to better prepare for submitting a Large Program proposal - especially when preparing the Data Management Plan. The sections below describe the services that are available to all PIs that may be especially relevant to Large Program PIs, both when preparing an ALMA proposal and to help with data processing and analysis. Large Program PIs should review these services carefully and decide if any/all of the services are relevant for their program. It is strongly recommended that Large Program PIs reach out to the NA ARC well ahead of submitting their proposal to get agreement on the services that will be provided by the NA ARC such that they can be included in the Data Management Plan. Such service can include, but are not limited to:

1. Access to computing resources and disk space. Any user can work with the NA ARC, but especially Large Programs, to secure access to disk space and the NA ARC high speed computing system to help with data processing and analysis.
2. Support in optimizing proposal observing strategy and setup.
3. Dedicated data analyst support throughout the QA2 Process including incremental checks of the data to ensure the final quality of the delivered data.
4. Server areas (e.g. ftp) where data can be staged and shared with members of the proposal team.
5. Potential PIs are encouraged to visit the ARC (either f2f or virtually) to discuss proposal preparation and data processing needs.
6. Other support provided on request (e.g. help with press releases, page charges, limited travel support)

Additional services may be available upon request and PIs should contact the NA ARC early in the proposal preparation process to discuss their needs.

6.2 Learning about ALMA: Documentation, Workshops, and Community Days

Preparing for an ALMA project begins with learning the observatory's capabilities and the tools needed to design observations, prepare proposals, and submit proposals. The NAASC provides user documentation, including *Observing with ALMA: A Primer*, at the ALMA Science Portal.

The NAASC helps to organize NRAO Community Days and other regional workshops in the USA and Canada to promote ALMA to the astronomical community, describe the tools needed to write proposals, and techniques for PI and archival data processing. These workshops feature talks on the observatory's capabilities, mm/submm interferometry observing techniques, the tools required to design effective ALMA projects, data processing, and data visualization. Attendees learn to use the ALMA Observing Tool (OT), the software used to prepare and submit observing proposals. The workshops may include a hands-on session to introduce attendees to imaging ALMA data with CASA. At the request of the hosts, the workshops may also include talks and information on CASA tasks for simulating ALMA observations. Future workshops are arranged in response to the level of interest from the user community. NRAO Community Days and ALMA workshops can be organized and hosted by university groups or research institutes, or can be tied to other scientific meetings or workshops.

The NAASC also supports NRAO special sessions, splinter sessions, webinars and training events at AAS meetings and other meetings of the astronomical community throughout the year. These events promote all NRAO observing facilities, and include a focus on the tools needed to prepare effective proposals. NAASC staff describe ALMA capabilities, NAASC support services, ALMA user tools, and CASA data reduction and analysis techniques.

Finally, the NAASC hosts periodic workshops that focus specifically on data calibration and imaging. These workshops are aimed at helping users process their own ALMA data or archival data.

To request a community day event at your institution and/or see a list of workshops, Community Days, and training events, visit the workshops page directly at: https://science.nrao.edu/facilities/alma/community

Registration is required for workshops and Community Days, and is available on the website.

6.3 Proposal Preparation

A Call for Proposals is issued prior to each scheduling period, or "Cycle". The Call and supporting documents are made available on the ALMA Science Portal (see Section 5.1). These documents describe the capabilities of the observatory for the upcoming cycle and the policies and procedures for submitting proposals.

ALMA proposals are prepared using the ALMA Observing Tool (ALMA OT), an application that can be downloaded from the ALMA Science Portal. Proposals must include a scientific and technical justification, a list of targets and frequencies to be observed, and details such as the sensitivity and angular resolution required to meet the science goals. The ALMA OT includes a sensitivity and exposure time calculator. Users must be registered with the ALMA Science Portal to be able to submit proposals using the ALMA OT.

NAASC staff are available to help users learn how to use the ALMA OT and prepare proposals. We emphasize here that the ALMA OT is not only used to assemble and submit the scientific and technical justifications, but also to design and specify fully the observations, so users are encouraged to become familiar with the ALMA OT well in advance of the proposal deadline. The ALMA Helpdesk (see Section 5.3 of this guide) is the primary

resource for those seeking assistance. It may be possible to arrange face-to-face assistance at the NAASC for particularly challenging proposals (Section 6.6).

The CASA task *simalma*, and the lower-level tasks *simobserve* and *simanalyze,* allow users to simulate an ALMA observation of a target based on a model with a given source position, structure and brightness. These tasks also help potential ALMA users visualize how different antenna configurations and track durations affect an observation. More information on simulating ALMA observations is available at: http://casaguides.nrao.edu/index.php?title=Guide_To_Simulating_ALMA_Data.

The ALMA Observation Support Tool (OST) provides another method of simulating ALMA observations. The OST provides a web interface to the CASA simulation code through which the user can specify observing parameters and upload a FITS file with a model image, or select a model image from a pre-existing library. The OST is available from the ALMA Science Portal.

The NAASC is also responsible for providing the ALMA user community with a complete, up-to-date spectral line catalog – Splatalogue. Splatalogue is an effort to collate and rationally organize existing spectroscopic catalogues into a single resource for the astronomical community. The focus is on pure rotational and ro-vibrational transitions of astronomically relevant molecules for observations in the microwave and millimeter wave regions using telescopic infrastructure such as ALMA, VLA, and the GBT, amongst many others. As of February 2016, Splatalogue contains over 8.1 million transitions from 1233 species and is updated regularly. Splatalogue also features an interface that is Virtual Observatory (VO) compliant for interfacing with external software or websites.

The main page for Splatalogue features the Basic search capabilities for the Splatalogue database. Use of the Basic search is limited to:

- Common astronomically detected molecules and vibrational states, such as CO, H_2O, methanol, hydrogen cyanide, and others.
- Pre-defined “filtered” sets of molecules, such as those relevant to diffuse clouds, comets, planetary atmospheres, etc.
- Single molecules in the Splatalogue database outside those in the pre-defined categories.
- User-defined frequency ranges as well as ALMA Bands 3-10 and lower state energy ranges.

In all cases, the only frequencies shown are those that are NRAO recommended. These frequencies are typically selected from the most recently updated line list. Observed astronomical intensities for transitions found in the Lovas/NIST database are also included along with the NRAO recommended frequencies. For more information about Splatalogue and its use and functionality, visit http://splatalogue.online.

6.4 Preparing Your Observations

ALMA proposals are reviewed on their scientific and technical merit, and PIs are informed of the outcome of the review process by email from the JAO. Programs eligible for scheduling are assigned a Contact Scientist, a member of the NAASC staff who provides a single point of contact for program support. NAASC staff and the Contact Scientist work with the PI to review observing strategies and prepare Scheduling Blocks. After the observations are made, the Contact Scientist can assist with questions related to data reduction. The main means of interaction between PIs and NAASC staff is via the ALMA Helpdesk. For particularly complex observations, however, users may arrange a visit to the NAASC to prepare the observations (Section 6.6).

Observers do not travel to Chile or elsewhere to take part in the ALMA observations. Observatory staff dynamically schedule ALMA observations, taking into account the weather conditions, instrument status, availability of the targets, and proposal ranking.

6.5 Working with Your Delivered Data Products

The primary software package used to process ALMA data is CASA (Section 6.3 - http://casa.nrao.edu). Note in particular the *CASA Guides* link available from that site. The *CASA Guides* site provides a collection of data reduction and imaging tutorials and step-by-step processing and analysis examples, including scripts for processing Science Verification data.

The challenge posed by storing and processing ALMA data is formidable. The NAASC hosts a copy of the ALMA data archive and the NAASC site serves as the primary data access point for North Americans, and will provide a backup of the archive in Santiago. Upon completion of the observations and initial data processing, PIs are notified and given instructions on how to download their data.

ALMA data are processed in two steps: first they are calibrated, and then imaged. Most ALMA data are now calibrated and imaged using the ALMA Data Reduction and Imaging Pipeline. In some rare cases, observatory or NA ARC staff may prepare CASA scripts for calibration or imaging. Access to these data products are primarily available through the ALMA Archive. The archive products include the raw data written in ALMA Science Data Model (ASDM) format and processed data products. The processed data includes:

- QA2 report file which contains important information about your data including how your data were processed.
- FITS images
- Calibration and imaging scripts (either pipeline- or manually-produced)
- Calibration tables
- Quality Assurance (QA) plots or the weblog if any part was processed by the ALMA pipeline
    - The weblog is an html-formatted collection of web pages containing diagnostic information describing the pipeline run.
    - A more detailed description of the pipeline and weblog can be found under the section ALMA Science Data Tracking, Data Processing and Pipeline, Archive and QA2 Data Products at: https://almascience.org/documents-and-tools#datatrack.

The fully-calibrated measurement set (ms) which includes only the science target data has been provided as an additional "Added Value" service to North American PIs. Calibrated measurement sets are supplied with all NA processed deliveries to the PI and (on request) to delegated co-PI or co-Is. Generally, calibrated data provided to users are ready for science imaging using the ALMA Imaging pipeline or directly with CASA tasks. Visit https://casaguides.nrao.edu/index.php?title=ALMA_Imaging_Pipeline_Reprocessing for imaging examples. In a rare number of cases, however, users may get best results by refining the calibration themselves, with assistance from NAASC staff (if desired).

The calibrated data are retained on disk for a period of **ONE** month. After that, for Cycles 1-4, users can request for re-generation of calibrated measurement sets via the ALMA Helpdesk. This service is restricted to projects whose PIs have NA designated as their ARC for support. If the user is not a PI or delegated co-I, and is requesting calibrated measurement sets for public data, there will be a limit of **FIVE** such requests per calendar year per requestor. For Cycles 5-present, users can request for re-generation of calibration measurement sets at: data.nrao.edu. This service is provided to all users as long as the data is out of proprietary period. If the data is still proprietary, only the PI or delegated co-(P)Is may make the request.

In addition to the calibrated target MS and QA2 information, we also provide the ADMIT products for interferometric observations. ADMIT is an experimental ALMA development project which is designed to look through science images and automatically provide line identification, moment maps, position-velocity diagrams, etc. Please note that ADMIT products are **not** Quality Assured and line identification is only performed for well-known chemical species. For more information about installing and using ADMIT on your data, please see the ADMIT CASA guide

Users are encouraged to visit the NAASC to get help with their data processing (Section 6.6). The NAASC has computers with ample resources to reduce ALMA data, including powerful desktops and a cluster machine connected to a high-speed LUSTRE file system. The NAASC also supports remote access to its cluster machine, which can be obtained by submitting a ticket to the ALMA Helpdesk.

Short term or data reduction visitors will be assigned a temporary login and password to work on their data. This short term visitor account can be used for a couple of days up to a few (2-3) weeks. If additional time is necessary, one extension can be made for this short term account for up to a few (2-3) weeks. After that, if the user still needs additional substantial time to work on their data, they will be directed to request a long-term NRAO account. This long-term account can be open for up to a year before renewal. To be able to qualify for a long-term NRAO account, the user must have the support of an NRAO scientific staff member. NAASC staff will be more than willing to support long-term users working on their data on the NAASC cluster. *Note - NAASC resources are NOT the place for long term curation of user data products. Users will need to make other arrangements for the long term storage of their data.* For information about the cluster, visit: https://info.nrao.edu/computing/guide/cluster-processing. To request remote access to the cluster, submit a ticket to the ALMA Helpdesk.

On the CASA website, there are recommendations for computing hardware required to process ALMA data outside of the NAASC (visit https://casa.nrao.edu/casa_hardware-requirements.shtml).

6.6 Visiting the NAASC

The NAASC welcomes short-term visits to Charlottesville, VA, or Victoria, British Columbia from North American investigators of successful ALMA programs or archival researchers for expert assistance with processing and analyzing ALMA data (including archival data), or with setting up technical aspects of ALMA observing proposals including Large Programs (see Section 6.1).

The NAASC now offers face-to-face (f2f) visits in both in-person and virtual formats. Users may request an in-person visit (at NRAO headquarters in Charlottesville, VA), a virtual visit, or a virtual "NAASC Chat". NAASC Chats are an opportunity for a user to interact with NAASC staff members at a dedicated time without committing to a multi-day f2f visit but when they may need more assistance than is practical through a Helpdesk ticket. In-person visits are expected to last about a week. Virtual visits can vary from a few hours up to a few days depending on the purpose and type of visit. NAASC Chats last 1-2 hours. Up to three visitors can be supported for each scheduled or observed project.

Visitors will have access to office space and high-end computing facilities to process their data, plus support from NAASC staff. Novice visitors, new to radio interferometry, are required to be accompanied by an experienced investigator. Investigators who are requesting a short data reduction visit can apply to the NAASC for assistance with travel expenses for 1-2 members of their team.

To request a visit, send a ticket to the ALMA Helpdesk using the "Face-to-Face Support" department. In-person f2f visits reduction should be requested at least one month in advance. Virtual f2f visits should be requested

at least two weeks in advance. NAASC Chats should be requested at least one week in advance. More details about visiting the NAASC are available at: https://science.nrao.edu/facilities/alma/visitors-shortterm.

The NAASC also hosts Data Reduction Parties during which a group of 10-12 PIs and their students visit the NAASC at the same time for assistance in data reduction and analysis. These parties are similar to individual f2f support visits except that they also include lectures on ALMA data packaging, the ALMA calibration and imaging pipelines, and advanced imaging analysis techniques, depending on interest. The dates for these events are announced via the NAASC webpage and the NRAO eNews newsletter.

Long-term visitors to the NAASC are also strongly encouraged, especially those interested in extending and optimizing the capabilities of ALMA or improving the data reduction and imaging strategies. The length of such visits is negotiable but they typically last between a few weeks to a year. Visit support can range from paying for accommodation, per diem or travel costs, to salary supplements, as needed. More details are available at: https://science.nrao.edu/facilities/alma/community1/opportunities/visitorsprogram.

6.7 Publishing Your Results

Upon request, NRAO provides financial support for page charges to authors at U.S. scientific or educational institutions. The paper may report either original data obtained with an NRAO facility, including ALMA, or original research made with NRAO archival data.

All publications that are funded by NRAO page charges **must** include the following statement as a footnote or acknowledgement: "The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc." and, for ALMA data, the additional acknowledgment: "This paper makes use of the following ALMA data: ADS/JAO.ALMA#2011.0.01234.S. ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), MOST and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ."

Details on the page charge support policy are here: http://library.nrao.edu/pubsup.shtml.

6.8 Getting Support for Conferences and Workshops

The NAASC offers financial and logistical support to organize conferences and workshops hosted by the community to promote and support ALMA science and, in particular, ALMA synergies with other telescopes. There is no restriction on the size of the meeting, and any wavelength and/or topic with a connection to ALMA science, technology, or broader impact objectives will be considered. The NAASC will provide monetary funding (up to $25,000) to organize an inclusive event, encouraging the participation of students, postdocs, and early career researchers as well as promoting diversity within the scientific community. The NAASC will also be able to provide certain logistical support.

For proposals requesting more than $10,000, we will open the call for applications in the summer of 2023. For other proposals, we will accept applications while funds last. For more information and to request support for your conference or workshop, please visit https://science.nrao.edu/facilities/alma/community1/NAASC-Conference-and-Workshop-Support

6.9 Promoting ALMA Science

The NAASC sponsors ALMA-themed science conferences on roughly an annual basis. A listing of previous ALMA conferences and information on upcoming conferences is available at: https://science.nrao.edu/facilities/alma/naasc-workshops.

NAASC activities and ALMA results are publicized in the NRAO eNews: http://science.nrao.edu/enews.

The NAASC is also involved in community outreach through special ALMA special sessions and other events at American Astronomical Society and Canadian Astronomical Society meetings. At these sessions, we provide attendees with highlights of recent ALMA science, describe the current status of ALMA, and give updates on the proposal submission and data processing tools.

The Education and Public Outreach (EPO) team at NRAO works with investigators to publicize newsworthy ALMA projects via news releases, videos, and other outreach products. In addition to providing expertise and advice on outreach activities, the EPO team can develop images, graphics, and other visuals to promote science results. To recommend a potentially newsworthy result or for questions, contact the NRAO Department for Public Relations for ALMA (alma-pr@nrao.edu).

7 Working with the Community to Improve ALMA

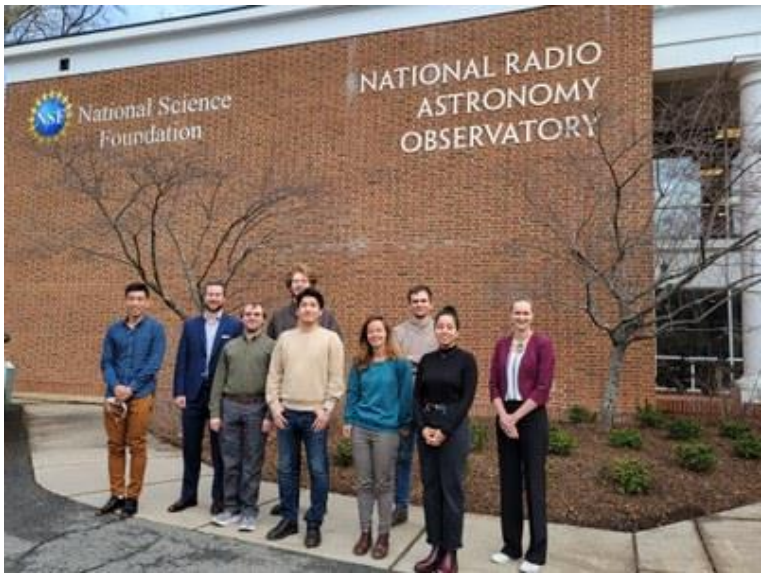
The NAASC encourages involvement from the user community to develop and improve ALMA. The NAASC periodically invites proposals from North American entities for studies or projects for potential inclusion in the ALMA Development Plan. The primary aims are:

- To give groups in North America the opportunity to propose ALMA upgrades that may later be implemented as part of the ALMA Development Plan
- To support the development of conceptual and detailed designs for ALMA upgrades, and
- To encourage relevant long-term research and development

Development proposal calls are announced at:
https://science.nrao.edu/facilities/alma/facilities/alma/science_sustainability/NADevelopmentProgram.

8 Student Support

The NAASC supports student involvement in ALMA research through the NRAO student programs. NRAO has a Summer Student Program aimed at introducing undergraduate and beginning graduate students to cutting-edge radio astronomy research and engineering. In addition, the Student Observing Support Program funds undergraduate and graduate students working on eligible ALMA observations, including support for research



Members of the Cycle 10 ALMA Ambassador cohort visited the NRAO Headquarters and the NAASC in Charlottesville, VA, for training in February 2023.

with ALMA archival data. Finally, the Reber Pre-Doctoral Program gives graduate students in the final two years of their Ph.D. program the opportunity to conduct their thesis research at NRAO sites under the mentorship of an NRAO scientist. Details on the student programs are available at: http://science.nrao.edu/opportunities/studentprograms.shtml.

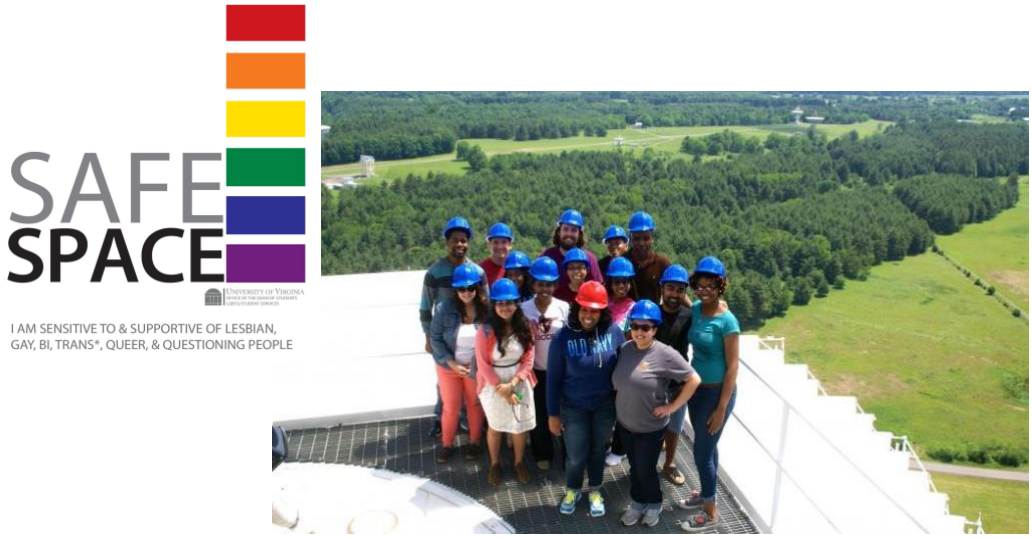
9 ALMA Ambassador Program

The ALMA Ambassador Program provides training (and up to a $10,000 research or travel grant) to early career researchers (including graduate students and postdocs) interested in expanding their ALMA/interferometry expertise and sharing that knowledge with their home institutions through the organization community workshops. Since Cycle 5, each year the NAASC sponsors a group of selected Ambassadors to travel to Charlottesville, Virginia, to receive in-depth training in topics related to ALMA proposal writing (including interferometry basics, ALMA science capabilities, recent ALMA headlines, and use of the Observing Tool), ALMA data processing (including imaging, self-calibration, NRAO's Science Ready Data Products, and CARTA visualization), as well as guidance with speaking on these topics. The Ambassadors then return to their home institutions or an agreed upon location to host 1-2 day proposal preparation workshops in advance of the ALMA proposal deadline and, since Cycle 9, 1-2 day data processing workshops later in the year. More information on the ALMA Ambassadors program, including upcoming deadlines, can be found here: https://science.nrao.edu/facilities/alma/ambassadors-program.

10 NAASC Participation and Initiatives in the Office of Diversity and Inclusion (ODI)

The ODI National Astronomy Consortium (NAC - https://science.nrao.edu/opportunities/student-programs/nac) is a program that had its roots in the NAASC and is led by the National Radio Astronomy Observatory (NRAO) and Associated Universities Inc., (AUI) in partnership with the National Society of Black Physicists (NSBP), and a number of minority and majority universities to increase the numbers of students from underrepresented and underserved groups and those otherwise overlooked by the traditional academic pipeline into STEM or STEM-related careers. The National and International Non-Traditional Exchange (NINE - go.nrao.edu/NINE) Program is geared towards enticing the best and brightest, both nationally and internationally, into high quality programs designed to benefit the participant, each partnering location, and the radio astronomy community as a whole. Finally, NAASC staff actively participate in mentoring students participating in the Louis Stokes Alliance for Minority Participation (LSAMP - https://lsamp.virginia.edu/) program. The LSAMP program consists of 12 partner institutions, including the University of Virginia, and strives for diversification of the Science, Technology, Engineering, and Mathematics (STEM) workforce, with an emphasis on increasing the number of underrepresented minority students earning baccalaureate degrees and matriculating to graduate school. The LSAMP program targets early career undergraduates and work with staff on learning how to do scientific research, especially involving synergistic research between astronomy and chemistry, in an eight week summer program. The NAASC provides financial support for the NAC and NINE programs and supports NINE hubs around the world. The NAASC works very

closely with ODI on best practice for inclusion of all staff and in supporting safe spaces (https://public.nrao.edu/odi/). NAASC management and leadership all have “open door” policies especially when it comes to personnel issues. Finally, the NAASC is a major corporate sponsor of the International Symposium on Molecular Spectroscopy and sponsors new initiatives including the LGBTQIA+ reception.



11 Addresses for the NAASC, NRC-HAA, and ASIAA

The North American ALMA Science Center
520 Edgemont Rd.
Charlottesville, VA 22903
USA

Phone: 434-296-0308
Directions: https://science.nrao.edu/facilities/alma/

National Research Council
Herzberg Astronomy and Astrophysics
5071 West Saanich Road
Victoria, BC V9E 2E7
Canada

Phone: 250-363-6919
Directions: http://www.nrc-cnrc.gc.ca/eng/about/directions/victoria.html

Institute of Astronomy and Astrophysics, Academia Sinica.
11F of Astronomy-Mathematics Building, National Taiwan University
No.1, Roosevelt Rd, Sec. 4 Taipei 10617, Taiwan, R.O.C.

Phone: +886-2-3365-2200
Directions: http://www.asiaa.sinica.edu.tw/guide/transport.php

12 Map of the Area near NRAO Headquarters and the NAASC

NRAO headquarters and the NAASC are located by the red marker labeled "A"

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of the European Organisation for Astronomical Research in the Southern Hemisphere (ESO), the U.S. National Science Foundation (NSF) and the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Republic of Chile. ALMA is funded by ESO on behalf of its Member States, by NSF in cooperation with the National Research Council of Canada (NRC) and the Ministry of Science and Technology (MOST) in Taiwan and by NINS in cooperation with the Academia Sinica (AS) in Taiwan and the Korea Astronomy and Space Science Institute (KASI).

ALMA construction and operations are led by ESO on behalf of its Member States; by the National Radio Astronomy Observatory (NRAO), managed by Associated Universities, Inc. (AUI), on behalf of North America; and by the National Astronomical Observatory of Japan (NAOJ) on behalf of East Asia. The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction, commissioning and operation of ALMA.