Guide to the European ALMA Regional Centre

ALMA

National Astronomical Observatory of Japan

NRAO

www.almascience.org

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 Centre at ESO, NAOJ or NRAO.

Revision History:

Version	Date	Editors
1.0	25 February 2011	Martin Zwaan
2.0	25 May 2012	Martin Zwaan, Evanthia Hatziminaoglou
3.0	14 October 2013	Martin Zwaan
3.1	23 July 2014	Martin Zwaan, Evanthia Hatziminaoglou
4.0	12 March 2015	Martin Zwaan, Evanthia Hatziminaoglou
4.1	29 November 2015	Martin Zwaan, Evanthia Hatziminaoglou, ARC nodes
5.2	16 March 2016	Martin Zwaan, Evanthia Hatziminaoglou, ARC nodes
6.0	20 March 2017	Martin Zwaan, Evanthia Hatziminaoglou, ARC nodes
7.0	March 2019	Martin Zwaan, Evanthia Hatziminaoglou, ARC nodes
8.0	March 2020	Martin Zwaan, Evanthia Hatziminaoglou, Gergö Popping, ARC nodes
8.1	March 2021	Martin Zwaan, Evanthia Hatziminaoglou, Gergö Popping, ARC nodes
9.0	March 2022	Martin Zwaan, Evanthia Hatziminaoglou, Gergö Popping, ARC nodes

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Purpose of this document

The purpose of this document is to help users to find their way around the European ALMA Regional Centre (ARC). The European ARC is the 'one stop shop' for all European ALMA users. This document explains how the ARC structure works and how it can help users to carry out their science with ALMA.

ALMA in a nutshell

The Atacama Large Millimetre/sub-millimetre Array (ALMA) is the leading observatory at millimetre and sub-millimetre wavelengths and will be for many decades to come. ALMA is a global collaboration involving East Asia, Europe, North America and the host country Chile. ALMA comprises 66 high-precision antennas equipped with receiver and digital electronics systems to observe in the frequency range from 30 GHz to 1 THz and at angular resolutions down to 6 milliarcsec. Using a fully dynamic scheduling system and innovative calibration strategies, the ALMA system allows observers to make the best use of the atmospheric conditions on the Chajnantor plateau at 5000 m altitude in the Atacama desert. The European contribution to the ALMA project is led by ESO on behalf of its member states.

ALMA has performed scientific observations since September 2011, in addition to regular commissioning and science verification. Each observing period offers another opportunity for astronomers to propose science projects with ALMA. Details on the new capabilities in this cycle are given in the Proposer's Guide, available at the ALMA Science Portal at (http://almascience.org). More information on the ALMA project can also be found on the Science Portal.

The ALMA Regional Centres (ARCs)

The interface between ALMA and the astronomical community is provided by the three partners through the ALMA Regional Centres (ARCs). These are located at NAOJ in Mitaka, Japan, for the East Asian partnership, at ESO in Garching, Germany, for the European partnership, and at NRAO in Charlottesville, USA, for the North American partnership. The ARCs are staffed by scientists with expertise in radio astronomy, millimetre and sub-millimetre astronomy, and interferometry, and their purpose is to work with the community of astronomers to maximise the scientific productivity of the telescope.

Organisation of the European ARC structure

The ARC structure in Europe supports the scientific use of ALMA by the European user community. The ARC forms the interface between the ALMA observatory and the user community throughout the lifetime of a project, i.e., from proposal preparation to data analysis. In Europe, the services to the community are provided by a distributed network of ARC nodes at Bologna, Bonn/Cologne, Grenoble, Leiden, Manchester, Ondřejov, and Onsala, under the coordination of the ESO ARC in Garching.

The primary aim of the European ARC is to maximise ALMA's scientific return for European users. Each ARC node is staffed with scientists providing a range of experience in interferometry, (sub-)millimetre observing and ALMA data reduction and interpretation, as well as a range in scientific interests. The staff at the ESO ARC and the ARC nodes work together to provide optimal support to users during the complete lifetime of a project from proposal preparation, validation of the Phase 2 material, delivery of the calibrated science products to the users, and, if required, additional data reduction support, advice regarding observing strategies and they can help with ALMA archival research. The ARC network organises (virtual) community days, tutorials and workshops throughout Europe to reach out to the community and to train users in proposal preparation, data reduction and archival research. Several ARC nodes also supervise Master's and PhD students and give university lectures on ALMA-related topics.

The central point of contact for current and prospective ALMA users is the ALMA Helpdesk, which is available to all registered

For all ALMA questions: use the ALMA Helpdesk to contact the ARC.

users from the *ALMA Science Portal*. There is one Helpdesk for all ALMA users, but queries from European users will be primarily addressed by the European ARC, either by scientists in Garching or by staff in one of the ARC nodes. The Helpdesk includes a library of "Knowledgebase" articles that address a number of common issues and questions. If the answer is not found in the suggested Knowledgebase articles, the user can submit a ticket. During normal operations, users can expect a response within two business days. During the week prior to a proposal deadline, extra staff will be assigned to the Helpdesk and every effort will be made to address time-critical questions in a rapid manner.

Role of the central ARC and the ARC nodes

The central ARC in Garching and the ARC nodes distributed throughout Europe work together to provide optimal support to European ALMA users. It is however important to realise that the roles that the central ARC and the nodes fulfil are very different. For example, all face-to-face support, one of the core functions of the ALMA project, takes place at the ARC nodes.

The different roles of the ARC and the ARC nodes are outlined below. Note that the typical ALMA user does not need to know the specifics of how tasks are divided between the central ARC and the ARC network: All initial contacts between the user and the ARC staff happen through the ALMA Helpdesk. The ARC staff may answer the user's question immediately, refer to documentation, or forward the query to an expert within the ARC network. The ARC may advise that face-to-face help is required, or the users may indicate themselves that they need to get in touch with their Contact Scientist (CS) or request face-to-face support.

The main tasks of the central ARC, of direct relevance to ALMA users, are:

- Phase 1 operations: distribution of the call for proposals to prospective European ALMA users, user support during proposal preparation as well as assistance in coordinating the proposal reviewing process.

- Manual generation and update of Scheduling Blocks when necessary, inspection of the automatically generated Scheduling Blocks and implementation of changes following successful change requests.

- Data product support: quality assurance (QA2) of science data sets and delivery of the final raw and reduced data to the PIs.

- Delivery of calibrated measurement sets.

- Staging of proprietary raw data deliveries.

- Archive operations: the ESO ARC node holds a complete synchronised copy of the ALMA archive.

- Running the ALMA Helpdesk.

- The ARC at ESO is also involved in science operations, policies, scientific coordination of subsystems, enhancement of capabilities and development.

The relevant tasks of the ARC nodes are:

- User support with proposal preparation by means of face-to-face meetings, dedicated workshops and through the ALMA Helpdesk.

- Answering questions on technical details pertaining the scheduling and execution of the proposed observations.

- Face-to-face help with data reduction, including expert support in data processing for specialised observing techniques.

- Help in archival research, including assistance to users of the ALMA archive in identifying and using the data products suitable for their scientific projects.

- Support to the QA process of science data sets.

- Facilitate science coordination between ALMA users, i.e. providing space for small meetings, putting people with similar interests in contact if mutually desired etc.

- Close interaction with the community and regular updates on ALMA (Community Days and other events, newsletter, webpages), as well as community education through lectures, tutorials, and online material.

- Outreach to the general public.

The following section describes in more detail the kind of support to be expected throughout the lifetime of an ALMA project.

How the ARC can help with your ALMA observing project

For each scheduling period, a Call for Proposals for ALMA is issued. The ESO ARC distributes this call among the European user community by email and makes it available on the ALMA Science Portal (http://almascience.org/). The call provides information about the available capabilities for each cycle, necessary information for the electronic submission of proposals as well as links to documentation such as the Proposer's Guide, the ALMA Technical Handbook and the Observing Tool (OT) User and Reference Manuals, as well as the OT Quick Start Guide. For the complete list of documentation, see the relevant section on the ALMA Science Portal.

The ALMA Science Portal

All ALMA users need to register to the ALMA Science Portal. This is a single sign-on gateway to the various tools described below, the Helpdesk, the ALMA Science Archive, and other relevant information. Each astronomer who uses ALMA is assigned a single ARC for user support based on their affiliation. ALMA users should have *one* ALMA account, that they should update in case any of their profile details change (e.g. e-mail address, affiliation etc). Users are furthermore expected to update their scientific expertise area, as this information is used for the distributed peer review process.

To submit a proposal, download ALMA software, or gain access to the Helpdesk, you will need to register with the ALMA Science Portal.

The proposal stage

The Phase 1 material of the proposals must be prepared with the ALMA OT, available from the ALMA Science Portal, section "Tools". The OT requires the users to provide a scientific and technical justification, target specification, and sensitivity. The OT provides the users with time-on-target plus overhead specification, integration time estimation, transparency and atmospheric conditions, etc.

Use the ALMA Observing Tool to prepare your proposal. Need help? Use the Helpdesk to contact the ARC.

The ALMA Observing Support Tool (OST), hosted at the UK node (http://almaost.jb.man.ac.uk/) provides an easy web-based interface to preparing simulations. The user can upload a FITS image and 'observe' it with ALMA at different frequencies, bandwidths, configurations, integration times and weather conditions. The results are images as ALMA would produce them, together with point spread functions and maps of the uv-coverage. This information can help users in planning their ALMA observations.

More experienced users may want to use simulation capabilities included in the CASA data reduction package, which have more flexibility. For more details see (http://casaguides.nrao.edu).

Staff at the European ARC network assist users with the preparation of their Phase 1 material. This assistance includes for instance explanations on new observing modes, consultation regarding observing, help with the OT, the ALMA exposure time calculator and the simulator, formulating the technical justification, archival queries in support of requested observations and more. Staff are also available for consultation regarding the dual anonymous and distributed peer review procedure.

Need help with proposal submission? Use the Helpdesk. Need face-to-face help for preparing a complicated proposal? Use the Helpdesk to coordinate a visit to an ARC node.

Users may also choose to visit an ARC node for face-to-face support during proposal preparation or join one of the community events organized by the network in the weeks before the ALMA proposal deadline.

Phase 2

Since Cycle 8 2021, PIs of accepted proposals will no longer have to submit their Phase 2 Science Goals. In practice, this means that there is no longer a Phase 2 deadline and PIs are responsible for correctly providing all necessary information when submitting the proposal to successfully schedule the requested observations. PIs who are preparing a proposal and are unsure if they have listed all necessary information correctly are encouraged to get in contact with a node for support.

Immediately after the outcome of the proposal review process, the Scheduling Blocks (SBs) of accepted programs will be automatically generated by the observatory and the ARC Phase 2 team will place them in the observing queue for scheduling and eventual execution. The Phase 2 group will make sure all SBs will run smoothly at the telescope (e.g. check calibrator variability, target proper motion). In case alterations to the program are needed, the user can consult with the CS whether a change request should be submitted or if a small change can be implemented by the Phase 2 group directly.

The SBs can be executed at any time without further intervention from users, CS or ARC staff. If a problem is found at run-time, execution of the SB is halted. The Phase 2 group at the ESO ARC will fix the problem and the affected SBs are put back in the queue for scheduling. The PI will be kept informed throughout the process.

Tracking your project

The Snooping Project Interface (SnooPI) allows PIs, Co-Is and Data Delegees to follow the status of their ALMA observing projects. It allows the PIs to search for their active projects and get an overview of the SBs that have been observed (including QA0+ reports), those in the queue, those that are under processing, etc.

Follow project progress with SnooPI, which is available on the Science Portal under the "Observing' menu.

After data have been taken

ALMA observing projects are dynamically put in the queue, taking into account weather conditions, the configuration of the array, the proposal ranking and possibly other constraints. Short projects may be observed within one day, whereas others may take several weeks or months to complete. After the observations for a project have been completed, users are notified by email and the completion of the observations are reflected in SnooPI. Note that B- and C-rated projects will not be carried over to the next cycle when not completed, while A-rated projects will automatically be carried over for one cycle. Accepted proposals under Director's Discretionary Time (DDT) will stay in the queue for the 365 days following their approval.

All data pass through a multi-tier quality assurance (QA) scheme before they are released to the user. ALMA data sets can vary enormously in size depending on correlator settings, averaging times and total integration time. Data size may range from tens of GB for the shortest observations to many TB for lengthy projects. Users can download the data from the ALMA archive.

It is important to realise that *all* ALMA data are kept in the archive. All requests for data of any observing program are handled through this archive. This ALMA Science Archive is accessible through the Science Portal.

PIs can request via the ALMA Helpdesk that QA0-pass raw data should be staged for download as soon as they are available (i.e. before the full QA2 products are ready). The proprietary period for the entire Member Observing Unit Set (MOUS) will start after the raw data from the first Execution Block (EB) in the MOUS have been made available to the PI. The release of raw data to the PIs will have no implications on the QA2 process. The access of QA0-pass raw data replaces the previous stale data and early release of Target of Opportunity

(ToO) and time critical data policies, but with immediate start of the clock for the proprietary time of the respective MOUS the raw data belongs to.

The data reduction pipeline

When a block of data for a particular program has been observed, the ALMA data reduction pipeline is activated. This pipeline runs on dedicated machines in Chile and in the ARCs and it uses a heuristics system to automatically edit, calibrate, and image data. The pipeline heuristics have captured the knowledge of experienced radio interferometer users and incorporated it into the reduction scheme. The output of the data reduction pipeline is stored in the ALMA Science Archive and is subject to a final QA2 before the reduced data are made available to the user.

Pipeline calibration has been fully commissioned for most observing modes employed in previous cycles. Calibration is performed manually for a number of observing modes (e.g., full polarization, solar data and very long baseline interferometry). The data processing will be done using a combination of the pipeline and manual analysis using CASA.

Data reduction support

The data reduction pipeline produces high-quality science products, which are carefully checked by ARC and ARC node staff during the 'weblog review' process before the data are delivered to PIs. Expert hands-on help with data reduction may be required however, especially when more complicated observing techniques are used. The ARC is the primary contact point for users who need assistance with data reduction. ARC staff provide basic data analysis support, ranging from simple advice, to providing appropriate data analysis documents and products, to detailed assistance for users who require it.

The primary responsibility of the ESO ARC is to ensure that the reduced data from all ALMA observing modes meet the requirements set by the approved observing proposal. The ARC nodes can provide further assistance to users who require it. A likely scenario may be the following: the ALMA data reduction pipeline has processed a user's data set. If the

Basic data reduction support: use the Helpdesk. Advanced data reduction support: visit an ARC node (use the Helpdesk to coordinate a visit).

data meet the requirements defined in the proposal, the data are delivered to the user. However, the user may wish to make images with a different weighting scheme to achieve a higher spatial resolution or higher sensitivity. The ARC nodes can help to reprocess the data, using different weighting schemes in the imaging stage. Another user may need higher dynamic range image cubes and can work with an ARC node to apply self-calibration to the data. For the use of nonstandard analysis techniques and the utilization of the advanced algorithms and software developed by a specific ARC node, ALMA users may also arrange a visit to this ARC node, where the best possible support can be provided.

The ARC nodes provide the latest (or any relevant) version of CASA, installed on high-performance workstations with ample disk space. For any first-line CASA support, please visit the CASA Guides website at http://casaguides.nrao.edu.

Calibrated measurement sets

Calibrated measurement sets can be requested through the Helpdesk. More information is given at this link.

Scientists can request calibrated data products, which are generated using the calibration scripts in the ALMA Science Archive. These requests are made through the ALMA Helpdesk: select Archive and Data Retrieval department followed by the "Data request" sub-category. Scientist can request the calibrated data for up to 10 datasets (MOUSs) per ticket, after which scientists in the ARC will stage the calibrated data products for download for a period of 28 days. The service is open both for ALMA PIs or Delegees with proprietary ALMA data and for archival users wanting to use datasets for which the proprietary time has expired. More information is provided at (https://almascience.eso.org/local-news/requesting-calibrated-measurement-sets-in-europe).

Additional help from the European ARC

Archive research support

A complete, synchronised mirror of the ALMA archive is kept at ESO and is a valuable resource for data mining. Assistance for archive research encourages broader approaches to scientific investigations. Therefore, scientists in the ARCs and ARC nodes offer support for astronomers accessing the ALMA science archive. The ALMA Science Archive is available through the User Portal.

Basic archive research support: use the Helpdesk. Advanced archive exploitation support: visit an ARC node (use the Helpdesk to coordinate a visit).

Prospective ALMA users are likely to want to consult the Archive when planning observations as well as for data mining. To ensure that the archive (and ALMA) is exploited to its full potential, ARC network staff can assist users in using the archive. This includes face-to-face visits. Note that only PIs and Data Delegees can access projects completed within the last 12 months.

The ARC network can also help users extract information effectively (such as potential calibration source properties, or whether there are public domain data matching the required criteria) as well as assist with analysis of archive data. In support of this, nodes in the ARC network develop various software tools to effectively query the archive.

Users can inspect data in the archive directly from their browser using the Cube Analysis and Rendering Tool for Astronomy (CARTA; https://cartavis.org), a next generation mage visualization and analysis tool designed among others for ALMA. All image products ingested into the archive are directly accessible for investigation with CARTA through the ALMA request handler.

Need training?

The European ARC regularly organises workshops, tutorials and schools related to ALMA. Dedicated CASA data reduction tutorials are held throughout Europe, as well as sessions describing the ALMA OT and more general workshops explaining the current ALMA capabilities. Additionally, the European ARC Network offers online video tutorials and training sessions such as the regular series of Interactive Training in Reduction

Need information on upcoming ALMA related tutorials and workshops? Check the European ARC announcements or subscribe to the mailing list of your local ARC node.

and Analysis of Interferometric data (I-TRAIN; https://almascience.eso.org/tools/eu-arc-network/i-train) and the ALMA explained series of 3-minute videos with the purpose of introducing and explaining ALMA and basic interferometry principles to non-experts.

Promotion of ALMA science in Europe

The European ARC network organizes several events to promote ALMA science in Europe and stimulate the communication between European ALMA users. These events include for example science days and workshops that are frequently organized by individual nodes. The network furthermore started a series of network-wide virtual events. These includes the 'ALMA recounts of cosmic conundrums' talk series, in which ALMA's contribution to major astronomical questions is discussed and the Meeting for ALMA Young Astronomers (MAYA), aiming to bring together early-career scientists with an interest in ALMA.

The European ALMA newsletter and announcements provide a list of all scheduled training and science activities and the mailing lists of the ESO ARC and the local nodes are used to disseminate this information. ALMA users with Europe as their preferred executive are automatically added to the European ALMA newsletter. Instructions to sign up for the newsletters and mailing lists of the nodes can be found here.

General questions

For any general questions related to ALMA capabilities, availability of observing modes, or other relevant topics, please use the Helpdesk.

How to organise a face-to-face visit

The preferred way to requesting any type of support (virtual or in person) is through the ALMA Helpdesk: select "Face to Face Visit". To easily identify the requested support and make the most of the face-to-face visit the user should give as much information as possible on the purpose of the visit and the proposed node and dates when submitting the ticket.

Support staff at this node are responsible for arranging the details of the (virtual) visit. Each visitor is assigned a dedicated member of staff for support purposes and can expect that this support person will be able to respond as quickly as possible to their requests for help.

Depending on the exact request for support, users either visit their local ARC node or the node that has the best specialist knowledge to support the user (to be determined by the user and the ARC (node) staff). Users can request a face-to-face visit regardless of the existence of a local node in their country.

ALMA data reduction will normally be performed using dedicated computing facilities such as those provided by the ARC nodes. The data volumes are too large for laptops in most cases, except for the later stages of image or spectral analysis, possibly using subsets of the data. Please consult ARC staff if you want to use your laptop.

To ensure data are downloaded locally and ready for the PI, the PI must give explicit permission for processed and raw data to be downloaded from the ALMA Science Archive by the ARC node staff via the "Project delegation" tab in their ALMA Science Portal User Profile. ARC nodes provide facilities for the user to copy data onto a hard disk drive. Data backup should be discussed prior to the visit, so that the user can bring appropriate storage devices. Some nodes can also support ftp of data provided the link at the user's home institute is fast enough.

ARC nodes keep a copy of the data the user has been working on for at least a few weeks after the end of the user's visit. This enables the node staff to address any post-visit questions which may arise.

After a visit, the user is encouraged to submit a feedback form on the service received, indicating, among other things, whether the goals of the visit were met.

Funding for visits

It is foreseen that most users will apply for funding from their local agencies for travel to one of the nodes in the ARC network. Some ARC nodes have access to funds for visiting scientists. Please check the details in the next section or visit the ARC node web pages. Funding is also available through the Opticon Radionet Pilot (ORP) program. Requests for funding through the ORP program should be sent via this form, prior to the visit. ORP-funded visits are paid by the users' institute, which then is reimbursed through the ORP program.

If you receive useful assistance from a European ARC node or the ESO ARC and/or funding from ORP, please include this in the Acknowledgement section of any paper based on ALMA data of the supported project.

The ARC nodes

Each node has its own area(s) of expertise. Users are encouraged to visit the individual ARC node web pages to obtain the most up-to-date information. Most ARC nodes also maintain email lists that are used to inform their local communities about activities and region-specific news items.

The Italian node in Bologna

The Italian ARC is hosted by the INAF-Istituto di Radioastronomia in Bologna. Support is offered with proposal preparation and submission, tracking of accepted ALMA projects, data reduction with CASA, and with ALMA archive mining, polarimetry and mm-VLBI with ALMA, our three areas of expertise.

The Italian ARC also investigates new techniques of data reduction and handling and is heavily involved in the development of the ALMA science data archive. It organizes seminars, tutorials and workshops to inform and train the Italian community and to stimulate scientific discussion and collaborations. ARC personnel are involved in teaching and supervising students.

Multi-wavelength research, especially through the use of archives, is becoming more and more requested. The Italian ARC therefore also offers assistance with reduction and analysis of data taken with other interferometers.

The Italian ARC researchers are involved in several (sub-)millimetre scientific projects covering different topics (from galactic and local-Universe studies to high-redshift galaxies and cosmology), and offer general scientific support on their specific area of expertise for continuum and spectroscopic observations.

At the host institute, the ARC node can accommodate visitors for face-to-face support and visits. Visitors can connect to a dedicated computer server, to access the data and run the CASA data reduction software.

The ARC node is connected to the outside world through a high-speed optical fibre network, allowing fast data transfer (10 Gbit/sec). Outside users of ALMA and CASA can access the ARC node cluster facilities for a certain period of time.

No local funding is available for visitors.

The Dutch node in Leiden: Allegro

Allegro, the ARC node in the Netherlands, is located at Leiden Observatory. The node employs approximately six postdocs and staff members who coordinate the node's activities. Allegro provides general user support for the ALMA community and offers expert help on high-frequency and long-baseline ALMA observations, mm-VLBI observations, archival research tools and science analysis tools.

The Allegro node supports users in all the steps, from ALMA proposal preparation through data delivery and data analysis. We offer assistance tailored to the needs of the user and organise activities for our user community. Allegro has guest desks available for visitors, who can make use of the dedicated high-performance computing facilities and connected fast-access storage system.

Allegro also contributes to the progress of the field within its own expertise areas. The node hosts expert knowledge in high-frequency and long-baseline observations with ALMA. By investigating techniques to overcome the impact of atmospheric effects, such as water vapour fluctuations, we drive ALMA towards reaching its full potential at the highest possible resolution and frequencies. The team has also partnered with the mm-VLBI group to develop Very Long Baseline Interferometry with ALMA, offered since Cycle 4 with the Global Millimetre VLBI Array (3mm) and the Event Horizon Telescope (1mm). Additionally, Allegro has developed an interactive and easy to use ALMA archive mining and visualization toolkit (ALminer) which allows users to query, analyse, and visualize the ALMA Science Archive (https://www.alma-allegro.nl/alminer/). Finally, Allegro develops science analysis tools, like ARTIST/LIME, to assist scientists in the analysis and interpretation of their observations.

The German node in Bonn/Cologne

The German ARC node is a collaboration between the astronomical institutes at the universities of Bonn and Cologne. The node's main facilities are located at the Argelander-Institut für Astronomie in Bonn, right next to the Max-Planck-Institut für Radioastronomie and a 30-minute commute from the University of Cologne. A number of staff members and postdocs are associated with the ARC node, working on various support tasks.

Areas of special expertise include the combination of interferometric data with single-dish data as well as advanced analysis and modelling of spectral line data. The node maintains and continuously extends the Cologne Database for Molecular Spectroscopy and offers a number of data analysis tools developed in-house. In close collaboration with the mm-VLBI group of the Max-Planck-Institut für Radioastronomie, the node also supports the use of ALMA in global mm-VLBI networks.

Visitors to the German ARC node can use the spacious ARC visitors' room equipped with workstations, switches for laptops and a conference phone, and a parent-child office, located next to the ARC visitors' room. The workstations offer fast connections to two high-performance servers dedicated to ALMA-related work. The servers run all the latest ALMA software necessary for the proposal stage, data reduction and analysis and for ALMA archive searches. Up to two visitors can be accommodated simultaneously.

In addition to user support, development and services to ALMA operations, the German ARC node reaches out to the local community with community meetings, a local newsletter and various online services available from the node's homepage. The node's regular training opportunities include (remote) participation in a lecture series on introductory radio astronomy, a comprehensive (remote) hands-on CASA tutorial and a variety of video tutorials. In addition, the ARC node engages in public outreach with talks, workshops and a very popular LEGO model of ALMA.

The IRAM node in Grenoble

IRAM (Institut de Radio-Astronomie Millimétrique) is an international institute supported by the Max Planck Society (Germany), the CNRS (France), and the IGN (Spain). The institute operates the 30-m Pico-Veleta antenna and the NOEMA mm-interferometer.

Visit the IRAM ARC node at www.iram.fr/IRAMFR/ARC

The IRAM ARC node activities are built on the in-house experience with user support and on the involvement of the institute in the ALMA design and construction phases (e.g. the development of the ALMA real-time Telescope Calibration software). The face-to-face support for ALMA uses the same procedures and infrastructures as those used for the NOEMA support. A computer room dedicated to data reduction is available and each project is assigned to a local contact. The ARC node involves 4 core members (3 staff and 1 postdoc), with additional help from other IRAM staff. The IRAM ARC node provides a good opportunity to use synergies between the IRAM instruments and ALMA, as, e.g. an access to the full sky for interferometric observations or to large-scale surveys with the 30-m antenna.

Funding is available for travel and accommodation, with the usual IRAM rules: one mission/one person per project. Funding is however limited to astronomers affiliated to one of the IRAM funding agencies.

The Nordic node in Onsala

The main mission of the Nordic ARC node is to provide full support for ALMA users in Sweden and other Nordic and Baltic countries. The Nordic node employs experienced millimetre wave observers and IT support. The node is physically located at the Onsala Space Observatory (OSO) near Gothenburg,

Visit the Nordic ARC node at www.oso.nordic-alma.se

Sweden. OSO is the Swedish National facility for Radio Astronomy and is hosted by Chalmers University of Technology. OSO has a long history in millimetre/sub-millimetre astronomy and presently runs the 20-m single dish telescope at Onsala and is a partner in the APEX sub-millimetre single dish telescope at the ALMA site in Chile.

Nordic ARC node services include e.g. face-to-face support for ALMA proposal preparation, project follow-up, data reduction and analysis as well as access to archives. The node has expertise in the areas of astrometry, self-calibration, multi-frequency synthesis, deconvolution algorithms, visibility fitting, polarization and total power observations. The node also maintains several advanced data analysis packages. In collaboration with academic staff at Chalmers, there is also extensive scientific expertise on-site in the areas of radiative transfer and astrochemistry. The Nordic node is also active in community outreach and organises meetings and training events for the whole Nordic community.

The ARC node has high capacity data links for downloading archival data and high performance computer facilities to support ALMA data reduction. The node offers flexible face-to-face support in any combination of on-site visits and remote support. There is ample dormitory and guest room accommodation on-site to support data reduction visits and small workshops. No local funding for travel and accommodation is available.

The UK node in Manchester

The UK ARC Node is centrally located at the University of Manchester, Jodrell Bank Centre for Astrophysics, conveniently placed for all national and international transport links and high-speed internet connectivity. Five ARC staff (plus IT and administrative support) divide their time between face-to-face user support and related research and development. Facilities for visiting astronomers include a large, dedicated room with ample desk space and powerful computers, which can also be used for small meetings and tutorials. Absolute beginners or experts are welcome and resources can be made available by arrangement for teams working on ALMA projects with demanding computational and skills requirements.

Visit the UK ARC node at http://www.alma.ac.uk

The UK ARC Node draws on local and national expertise to offer specialised assistance in a number of areas:

• Interferometry skills, in particular advanced calibration, extended array configurations (high resolution), wide-band high-sensitivity continuum imaging (multi-frequency synthesis), mosaicing and wide-field imaging (including combining ALMA configurations to improve image fidelity), and polarimetry.

• Multi-instrument research, in particular comparing data from different telescopes, (e.g. *Herschel*, JCMT, e-MERLIN, EVN) combining ALMA and compatible data, and interoperability between CASA and AIPS. The UK ARC Node is part of the JBCA Interferometry Centre of Excellence which provides support for these instruments, others such as LOFAR and prospective SKA users.

• Data management, in particular data mining the ALMA Archive, development of pipelines and scripts for large projects, standards and documentation for data publication.

• Simulations using the OST (http://almaost.jb.man.ac.uk) or inside CASA: choosing suitable input images, estimating the brightness on ALMA scales and so on.

• No local funding for travel and accommodation is available

The Czech node in Ondřejov

The Czech node is located at Ondřejov observatory near Prague, well accessible by public transport, hosted by the Astronomical Institute of the Czech Academy of Sciences. The node's mission is to provide support to ALMA users namely from the central and eastern regions of Europe, but due to its exclusive expertise in solar observations to all European users. The node's duties are distributed over two staff members and four postdocs, plus IT and administrative support.

Visit the Czech ARC node at www.asu.cas.cz/alma

The team is ready to provide (face-to-face) support with preparation and submission of proposals to ALMA and other (sub-)mm and radio telescopes, with data processing, interpretation of observations and numerical modelling of some observed processes. A dedicated office equipped with personal workstations and access to a HPC computer cluster is available for up to three visitors. Accommodation in the guest rooms of the Astronomical Institute at Ondřejov can be offered. Visits at the Prague department of the Astronomical Institute can also be managed.

The expertise areas of the Czech node are:

• Solar ALMA observing mode: specifics of proposal preparation, calibration and imaging; solar radio spectroscopy; non-LTE radiative transfer; physics of the solar chromosphere, prominences and filaments; solar flare plasma astrophysics.

• Galaxy evolution in clusters and groups, triggered star formation, proto-planetary disks, Galactic Centre and AGN.

• High-resolution microwave laboratory spectroscopy of small molecules, in collaboration with the University of Chemistry and Technology in Prague.

Visitors can apply for a local support for travel and accommodation.

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of the European Organization 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 National Science Council of Taiwan (NSC) 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.