ALMA Newsletter

January 2010

Introduction

Dear ALMA newsletter recipients,

Once again, it is a pleasure for me to introduce the new edition of our newsletter.

First of all, I would like to wish all of you an happy New Year, which I sincerely hope will bring you success, happiness and interesting new opportunities. For us in ALMA, the end of 2009 and the beginning of 2010 have been very exciting and this is once more a special moment in the development of our observatory. After transporting our third antenna to the high altitude Chajnantor plateau, at 5000 meters above sea level, our team successfully combined the outputs of these antennas using "phase closure", a standard method in interferometry. This achievement marks one more milestone along the way to the beginning of Commissioning and Science Verification, CSV, which, once completed, will mark the beginning of Early Science for ALMA. There was an official announcement about this milestone at the AAS meeting early January and we also wanted to share this good news with you through this newsletter, which contains the content of the announcement.

In another area, this newsletter contains the progress on site and a presentation of the Atacama Compact Array (ACA). This is the second part of a two part series on antennas, a continuation of the article in the last newsletter. The ACA plays a crucial part in the imaging of extended sources with ALMA. Without the ACA, the ability to produce accurate images would be very restricted. Finally, as you know, we like to show the human face of this great endeavour we are building and this time, we decided to highlight the Department of Technical Services, another fundamental piece working actively to make ALMA the most powerful radio observatory ever built.

Enjoy ALMA's universe !

Thijs de Graauw, ALMA Director

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.

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Credit: ALMA (ESO/NAOJ/NRAO), W. Garnier (ALMA)

Focus on...

Closing the loop for ALMA

Three antennas working in unison open new bright year for revolutionary observatory

The Atacama Large Millimeter/submillimeter Array (ALMA) has passed a key milestone crucial for the high-quality images that will be the trademark of this revolutionary new tool for astronomy. Astronomers and engineers have, for the first time, successfully linked three of the observatory's antennas at the 5000-meter elevation observing site in northern Chile. Having three antennas observing in unison provides the missing link to correct errors that arise when only two antennas are used, thus paving the way for precise images of the cool Universe at unprecedented resolution.

On 20 November 2009 the third antenna for the ALMA observatory was successfully installed at the Array Operations Site, the observatory's "high site" on the Chajnantor plateau, at an altitude of 5000 meters in the Chilean Andes. Later, after a series of technical tests, astronomers and engineers observed the first signals from an astronomical source making use of all three 12-meter diameter antennas linked together, and are now working around the clock to establish the stability and readiness of the system.

Three ALMA antennas linked together as an interferometer for the first time, on the 5000-meter altitude plateau of Chajnantor. Credit: ALMA (ESO/NAOJ/NRAO)

"This is a moment that we have been looking forward to for a very long time", says Richard Hills, the ALMA Project Scientist. *"Now we can finally say that we have put together a full set of all the components of ALMA as a complete system and what's more, it works! It is particularly pleasing that this was achieved within a few days of the target date, set over a year ago, for reaching this point.*

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Focus on...

Having three antennas observing in unison makes it possible to correct errors that arise when only two antennas are used, thus paving the way for precise images of the cool Universe at unprecedented resolution.

Credit: ALMA (ESO/NAOJ/NRAO)

We will be looking forward eagerly to more excitement over the next few months as we add more antennas and receivers to the array and start to make our first images with ALMA."

The successful linking of the antenna trio was a key test of the full electronic and software system now being installed at ALMA, and its success anticipates the future capabilities of the observatory. When complete, ALMA will have at least 66 high-tech antennas operating together as an "interferometer", working as a single, huge telescope probing the sky in the millimeter and submillimeter wavelengths of light. The combination of the signals received at the individual antennas is crucial to achieve images of astronomical sources of unprecedented quality at its designed observing wavelengths.

The three-antenna linkup is a critical step towards the observatory's operations as an interferometer. Although the first, successful measurements employing just two antennas were obtained at the ALMA high site in October 2009 and demonstrated the excellent performance of the instruments, the addition of the third antenna is a leap of vital importance into the future of the observatory. This major milestone for the project is known as "phase closure" and provides an important independent check on the quality of the interferometry. Indeed, the use of a network of three (or more) antennas in an interferometer gives astronomers control over possible features which degrade the quality of the image, arising due to the instrument or to atmospheric turbulence. By comparing the signals received simultaneously by the three individual antennas, these unwanted effects can be cancelled out, which is completely impossible using only two antennas.

To achieve this crucial goal, astronomers observed the light coming from a distant extragalactic source, a quasar with the prosaic name 1924-292, which is well known to astronomers for its bright emission in the millimeter/submillimeter wavelength range probed by ALMA. The stability of the signal measured from this object shows that the antennas are working impressively well.

"This result, combining the individual signals received by the first three antennas installed at the Chajnantor site, is a milestone for the observatory", comments Thijs de Graauw, ALMA Director. *"We will have many more antennas installed over the coming months, allowing astronomers to start producing early scientific results with the ALMA system around 2011. The interferometer will then steadily grow over the following years to reach its full scientific potential, with at least 66 antennas."*

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

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Progress at the ALMA site

Here is a short synopsis regarding the recent progress of the site construction work:

Array Operations Site (AOS)

At the ALMA Operations Site (AOS), the pouring of concrete for the antenna foundations for the ACA (Atacama Compact Array) is now complete. All of the ACA foundations are the smaller, triangular-shaped structures. These must be anchored to bedrock for stability. In addition to the concrete work, this anchoring has been completed, and the lightning protection grounding of the foundations is finished. During the curing process, the concrete shrinks slightly. However the accuracy needed for the placement of the antenna inserts is so high that the positioning of these inserts must wait until the concrete stabilizes. During this waiting period, work at the ACA goes on: connections for the utilities (i.e. the signals for steering the antennas and the signals from the receivers) and the power for the antennas are being completed. The work is moving ahead with the highest speed. Within 1 year, the ACA and the Central Cluster with 66 foundations will be completed. By 31 December 2009, 166 (of 192) antenna foundations at the AOS have been provisionally accepted. The remaining 26 foundations have been finished. The actual coordinates of all foundations have been communicated to the Science IPT (Integrated Product Team) for verification. Next will be the installation of the inserts in the antenna foundations. In 18 months, all of the foundations to 5 km will be completed and within 2 years, the entire set of antenna foundations, with roads, signal and power connections will be completed.

Photo of an Atacama Compact Array (ACA) antenna foundation showing the three inserts that are used to accurately position the antenna, and the connection devices (so-called "vaults") for signal transmission to command the antenna and to transmit signals from the receivers to the correlator, and power. The correlators for the ALMA interferometer array and the ACA are located in the AOS Technical Building. After correlation, the data are transmitted to the OSF.

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Progress at the ALMA site

An additional project is the permanent power supply. At present, there are temporary power connections to allow interferometry at the AOS with three antennas. These antennas were placed on foundations that were separated from the rest of the construction and also spaced by less than 200 meters. The next step is the installation of a temporary substation at AOS. This allows a better organization of the power distribution, and also an increase in the voltage from 400 volts to 23 KV, as a preparation for the final stage of the “island mode” power generation at the Operations Support Facility (OSF).

Operations Support Facility (OSF)

The provisional implementation of the new Computer Room occurred in September 2009. All the Heating, Ventilating and Air Conditioning equipment for the OSF has arrived to the ALMA site.

Additional antenna foundations at AEM and MELCO areas are finished, documented and delivered to the corresponding teams.

The Culverts and Drainage structures for the AOS and OSF construction is complete and the Road Pavement construction is ongoing.

As far as the communications AOS-OSF is concerned, the temporary microwave link will be sufficient to support operations until end of 2010. From then on the permanent high speed glass fiber link installed, as part of the 23 kV power distribution system, will become available.

Picture of the newly finished final control room, located inside the OSF Technical Facility

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General view of the assembly sites for the European, East Asian and North American antennas

Progress at the ALMA site

Antennas

News from East Asia:

There are now 5 East Asian antennas on-site, one of which has been conditionally accepted by ALMA. On October 30, the first 7-m antenna arrived on site and the movement test started successfully on December 8. Holography measurement has been continued on PM01 and the accuracy of 7.4 micron has been achieved so far. Last but not least, PM02 is under final polishing up for the acceptance scheduled in February 2010.

News from North America:

There are now 13 North American antennas on-site in Chile. Four have been conditionally accepted into ALMA, two more antennas are in the final stages of acceptance testing and the remaining 7 antennas are in various stages of assembly and integration. Two of the North American antennas have been moved from the OSF to new foundations at 5000 meters and are joined with the East Asian antenna to form the three antenna ALMA interferometer and two other North American antennas are in use as a two-antenna interferometer at the OSF.

News from Europe:

Integration of the first European Antennas by the AEM Consortium is proceeding at the OSF. To date the first five antennas have arrived at the OSF and are in different state of assembly. The first two antennas, which are assembled inside movable shelters, are rather advanced. The first one is close to receive the primary reflector structure. The 2nd is being prepared for the assembly of the receiver cabin. Equipment of the other three steel structures, not protected by shelters, has also started with the assembly of the access platform and electronic cabinets, and the first works performed inside the antenna base. Inside the BUS (Back-Up Structure) integration building, the installation of the adjusters and panels on two CFRP (Carbon Fiber Reinforced Plastic) BUS's is taking place. As expected, in this first phase of assembly on site, some minor issues slowing down the integration phase were encountered in the past months. These were linked to details of interfaces between the various subsystems and to the preparation of the relevant assembly procedures. These issues have been successfully dealt with and it is expected that beginning of 2010 we will finally be able to see the first two antennas completely assembled. Internal commissioning is planned for spring 2010.

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General view of the assembly sites for the European, East Asian and North American antennas

Progress at the ALMA site

Santiago Central Office:

The construction of the ALMA Santiago Central Office started in March 2009 and is currently ongoing normally and is scheduled for completion at end 2010. The major concrete work on the building is finished and installation of electrical equipment has begun. The implementation of the Computer Room and the Science Archive facilities will both be similar to what was done at the OSF.

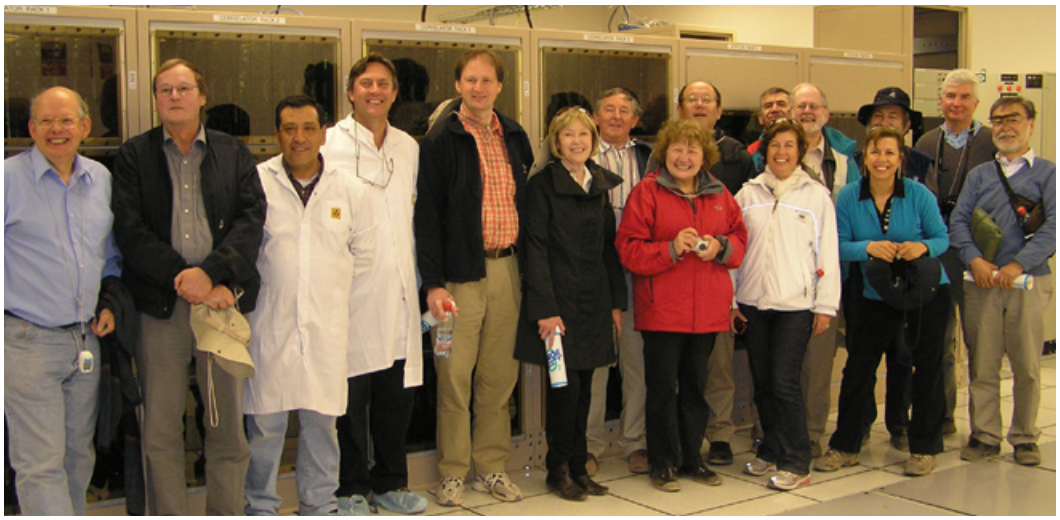
This picture shows the progress in the construction of the future ALMA Santiago Central Office in Vitacura. It is expected that the ALMA Headquarters will be ready for occupancy toward the end of 2010.

ALMA Events

ALMA Board Meeting

2009
- nov -
11/13

The ALMA Board is the observatory's highest governance body. Its members convene eight to ten times per year, two or three of which are face-to-face meetings. Their most recent meeting took place at the ALMA site in November 2009. At the meeting, the cost-to-completion and status of the most critical items to complete the observatory were presented by Joint ALMA Observatory (JAO) and Executive staff. These presentations discussed progress of the antennas and front-ends, and actions aimed at meeting the delivery schedule. Other topics discussed were the update of the ALMA Operations Plan, the ASAC report and reviews of the Science Operations Implementation Plan and Commissioning and Science Verification. The Board expressed their gratitude and pleasure at the progress made and their excitement about the cutting-edge instrument ALMA is building. The next ALMA Board face-to-face meeting will take place in April 2010 in Santiago, Chile.



Some members of the ALMA Board while visiting the correlator room at the AOS Technical Building.

ALMA Annual External Review (AAER)

2009
- nov -
17/19

The ALMA Annual External Review (AAER) consists of members from the three partner regions. Their most recent meeting took place at the ESO Vitacura permises in Chile in November 2009. At the meeting, the Joint ALMA Observatory (JAO) delivered a number of presentations on the status and future plans for ALMA construction and the transition to operations.

In the picture above, members of the AAER, together with a representative from NSF and members of the JAO are shown in front of the site of the construction of the future ALMA Headquarters Building in Santiago.

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ALMA In-depth

Above: This picture, taken mid-December, shows three of the 12-meter diameter antennas and one 7-meter diameter antenna of the Atacama Compact Array (ACA) at their Assembly Site at the Operations Support Facility

The Atacama Compact Array: An Overview

By Satoru Iguchi (NAOJ) and Tom Wilson (JAO)

When completed, ALMA will comprise a 12-meter diameter antennas array (12-m Array) of a minimum of fifty antennas, and the ACA (Atacama Compact Array), composed of four 12-meter diameter antennas and twelve 7-meter diameter antennas. Out of the fifty antennas of the 12-m Array, one-half are provided by the North American partners of ALMA, the other half by the European partners. The sixteen antennas that will comprise the ACA are provided by the East Asian Partners of ALMA.

In the last issue of the ALMA Science Newsletter, we outlined the testing of the prototype ALMA 12-meter diameter antennas and the procurement process for these antennas. In that article, only a short account was given of the antennas for the Atacama Compact Array (ACA). In the following we give an overview of the ACA, starting with an introduction to imaging using interferometers.

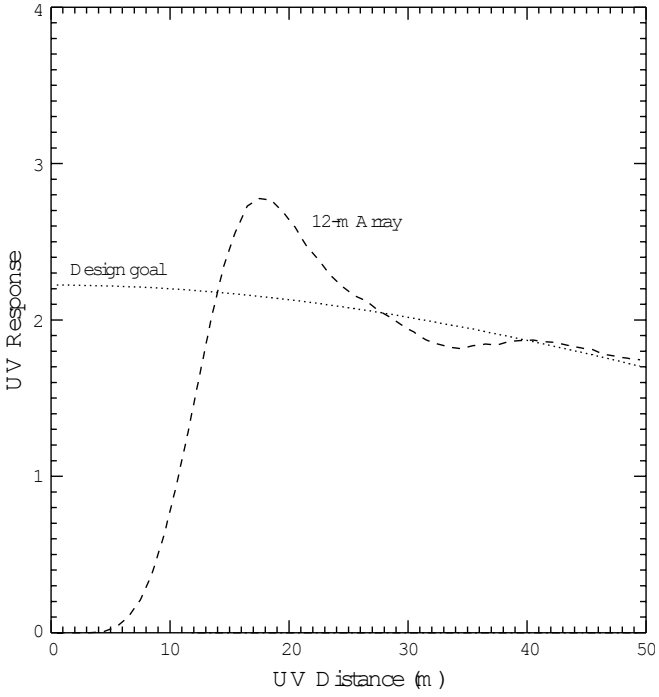
Imaging and Interferometry

When waves pass through an aperture, there is a fundamental limit to details that can be imaged with any instrument. At 150 meters, the human eye can recognize features in the face of a person, while with a single ALMA 12 meter antenna at a wavelength of 4 mm, one can distinguish features that are separated by 3% of the diameter of the Moon.

ALMA In-depth

For an interferometer, finer details can be imaged, so the situation is better. However, there is a drawback. First, the advantage. For the ALMA 12-m Array, the largest spacing between antennas is 18.5 km. This spacing determines the angular resolution of ALMA from the relation θ (arcsec)= 0.14 λ (mm) /D (km)[1]. At the shortest wavelength λ, of 0.3 mm, when D is 18.5 kilometers, one can distinguish details to an angular scale of θ=0.002 arc seconds or 2 milli arc seconds. This fineness of detail exceeds that of the Hubble Space Telescope; it corresponds to the size of an auto at the distance of the Moon.

The drawback is that the details that can be recorded are limited by the minimum possible spacing for the ALMA 12 meter interferometer array. This is determined by the minimum spacing between two antennas, 15 meters. Thus at 4 mm, measurements of details larger than 50 arc seconds are not recorded by the 12-m Array. If this lack of response is not compensated for, the science that can be done with ALMA becomes seriously restricted. This lack of response to extended source structures is illustrated in Fig. 1. For unresolved sources, this lack of response is not important, since the image of an unresolved source is just the instrumental beamsize. However for extended sources, features are not recorded. Typical examples of extended sources are galactic molecular clouds, or CO in nearby galaxies. For these, the lack of short antenna spacings causes a loss of image fidelity.



The ACA Design

The problem of a lack of response to extended structure is well known; this is referred to as 'missing short spacings' problem. To improve images, one must provide additional data. Two possible solutions for this problem were discussed during the planning phase of the ALMA project. One possible solution was a 20 meter diameter single radio telescope. The difficulty consisted in calibrating and combining data from this single dish with data produced by the 12 meter array. The technical demands on the 20 meter antenna would be most severe at 0.3 mm, the shortest wavelength. There, the pointing accuracy would have to be 0.4 arc seconds, which is at the limits of mechanical

Fig. 1. The response of ALMA with the 12 meter interferometer array compared to the design goal. The dotted line is the desired response, while the dashed line shows the response determined on the basis of the design of the 12 meter interferometer array. The difference is caused by the limitation that the closest spacing of the 12 meter antennas is 15 meters.

stability but also at the limits of atmospheric stability. These considerations led the project to consider a set of antennas that would improve the response in Fig. 1. From design studies, the best approach consisted of the Atacama Compact Array (ACA). This is combination of an interferometer consisting of 7 meter diameter antennas (the "ACA 7-m array") together with

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1 The relation between angular resolution, wavelength and baseline is sometimes used with the coefficient "0.14" or "0.2". The 0.2 is merely a conversion factor to allow use of convenient units (arc seconds, mm and km). In that specific case, the use of 0.14 is meant to express the use of a greater illumination of the ACA.

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ALMA In-depth

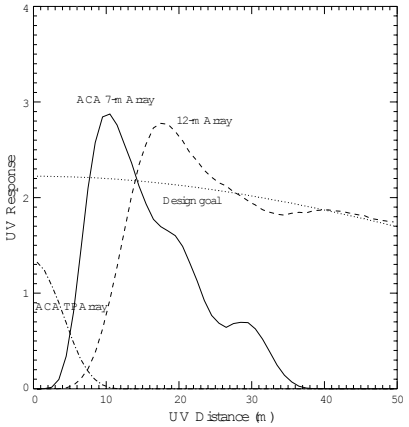


Fig. 2. This shows the response of the ALMA instrument to sources of extended emission. There are three components: the 12m Array which consists of the antennas in the interferometer array (response is shown as a dashed line), the four 12 m antennas used for total power measurements in the ACA TP Array (response is shown as a dash-dotted line), and the twelve 7m antennas (response is shown as a solid line).

single 12 meter antennas for total power (ACA TP Array). Use of this combination of smaller antennas and interferometry would avoid instrumental difficulties but still provide the response to extended emission. Simulations of the response of the ACA allow an estimate of the performance. The result is the response of the combination of the ACA with the 12 meter interferometer array as shown in Fig. 2.

From Fig. 2, the response of the ACA four 12 meter Total Power antennas (in the ACA TP Array) is about a factor of two below the response of other parts of the system. In part this is caused by the smaller number of antennas in the ACA TP Array.

As shown in Fig. 3, for the ACA the four 12 meter Total Power antennas will be located at the corners of the area containing the twelve 7 meter interferometer antennas of the ACA Interferometer array. The dashed circles marked "NS-7" through "NS-12" are those antenna positions for measuring sources in the northern sky. These sources reach lower elevations, so to avoid one antenna blocking the view of another, the spacings must be larger.

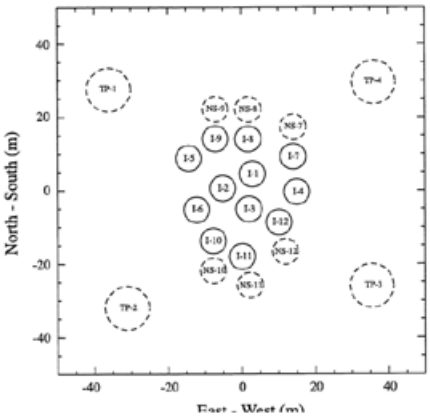
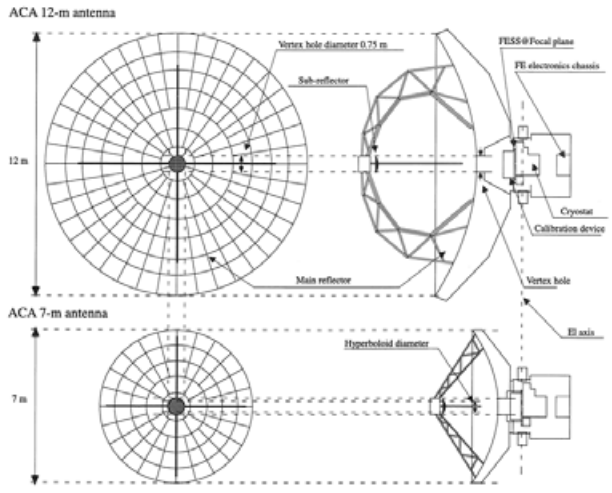


Fig.3. The locations of the ACA 7m Interferometer (I) and ACA 12m Total Power (TP) antennas. The four TP antennas will remain at fixed locations under normal operations. The smaller dashed circles mark the locations of the ACA 7m antennas when these are used to measure sources at northern declinations. This more spread-out arrangement reduces any blockage of the inner antennas by outer antennas.

ACA Antennas

As reported in the previous article on the ALMA 12 meter antennas, a Mitsubishi Electric Corporation (MELCO) 12-meter prototype antenna was constructed and brought to the Antenna Test Facility at Socorro New Mexico for testing. This antenna fulfilled the ALMA specifications, but was returned to Japan for refitting and upgrading. This antenna and three other newly constructed MELCO antennas are now in Chile. These will form the ACA TP Array (see Fig. 3). The MELCO PM03 was conditionally accepted by ALMA in December 2008. This was the first antenna brought to the Array Operations Site (AOS) on September 17, 2009. The second MELCO 12-meter antenna, PM02 is now undergoing tests at the OSF. The first of the 7-meter antennas for the ACA Interferometer Array arrived at the Operations Support Facility (OSF) in October 2009 and was assembled in November. In Fig. 4 are cross sectional drawings of the 12-m and 7-m antennas. The MELCO 12-m antennas are functionally compatible with the 12 meter antennas in the 12-m array. The 7-m antennas are also compatible, in that these are to be placed on any of the ALMA antenna foundations, will be moved with the ALMA transporter and must accommodate the same receiver equipment. Thus to meet these conditions, the design must be radically different from the 12-m antennas. Some of the changes are obvious from the drawings.

Fig. 4. Engineering drawings of face-on and side views of the ACA 12 m and 7m antennas.



ALMA In-depth

Conceptual Drawing of ALMA in one of its configurations. The red oval illustrates the Atacama Compact Array (ACA).

The ACA TP Array will be used to take broadband continuum data by scanning the instrument in one or two directions. Since the earth's atmosphere also contributes broad band continuum radiation, the 12-meter antennas will be equipped with a nutating subreflector or "wobbler". The wobbler allows rapid comparison of emission toward the source with a position nearby. For spectral line measurements, an off-source reference is needed, but under normal circumstances, the wobbler will not be used.

Data Taking and Correlator for ACA

Since the ACA must spend four times as much time on a source as the 12-meter Array, it must have a separate data taking system. The data transmission is the standard ALMA system, but a specific correlator, housed in the AOS Technical Building, has been designed for the ACA. In ACA Correlator, the outputs of each ACA 12-meter antenna and each ACA 7-meter antenna are converted from a series of time samples to a set of frequencies, and are then processed so the data can be then placed in the (u,v) plane. We can obtain high-fidelity images by combining the data from the 12-meter Array and ACA.

References

- Iguchi et al. PASJ 61, 1-12 (2009)
- Morita, K-I, Holdaway, M. ALMA Memo 538 (2005)

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Luis Roa, the Antenna Transporter Supervisor, moving 2 antennas (almost) simultaneously

Who's who:

Joint ALMA Observatory (JAO)
Department of Technical Services

IT and contractors installing the first communication link in Chajnantor (Cerro Chico) pointing to AOS-TB

Preparing for the Future

by R. Prestage, Head, Department of Technical Services

At present, the high-profile group at the JAO is AIV (Assembly, Integration and Verification). As described in the #2 issue of this Newsletter, this group is responsible for receiving equipment from the Construction IPTs (Integrated Product Teams) – everything from antennas to water vapor radiometers – and integrating these into the complete ALMA Interferometer system. Working in the background however, is another group: the Department of Technical Services (DTS). The Department of Technical Services is building up the staff, equipment and expertise that we will need to operate all of the ALMA equipment after it has passed through the commissioning process. Although comparatively small at the moment, with about 50 staff, in full operation, DTS will employ ~150 people, and thus will be the largest single group within the Joint ALMA Observatory.

DTS covers a wide range of activities coordinated by 5 main groups: the Antenna, the Computing, the Electronics, the IT and the Maintenance Groups. The detailed activities for each of these groups are as follows:

Antenna Group: This group is responsible for all aspects of operation of the ALMA antennas, including operation of the two ALMA transporters, Otto and Lore. As well as performing all of the preventive and corrective maintenance, the Antenna Group is responsible for the antenna relocations – moving antennas from the close packed "central cluster", to the outermost reaches of the array, and back – which allows the telescope to reach several possible configurations and thus operate like a "zoom lens".

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Who's who:

Joint ALMA Observatory (JAO)
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Cryogenics and Vacuum Course at the OSF held last July and organized by the DTS department. Armin Silber from ESO and Günther Piller from the German company InfraServ taught the students an interesting mix of theory and lab practice to help keep the ALMA Front Ends cold at 4 Kelvin (-269 C).

Computing Group: The computing group will be responsible for all local support and development of the ALMA computing systems over the life-time of the observatory, supported by and integrated with the "Operations Software IPT" which will be the continuation of the Computing IPT once in operations. This will include support for the whole end-to-end software system, from the real-time computers which control the antennas, to the high-level user interfaces and everything in between. One of the key responsibilities of the computing group is the support of the "master archive", which will be located in Chile, distributed between two sites (OSF and Santiago). With a peak data-rate of 64 Mbytes/sec, and an expected average data volume of 200 TBytes a year, this is a huge undertaking. By comparison, the Hubble Space Telescope data archive contains 0.8 TBytes, once again illustrating the massive scale of ALMA.

Electronics Group: This group will be responsible for all of the equipment which is installed into the antennas, as well as the Central Local Oscillator (CLO) which provides an extremely precise frequency and timing reference, the Correlators, and other equipment in the Array Operations Site (AOS) Technical Building (TB). Both in the amount of electronics and its technical complexity, ALMA truly represents the state of the art in astronomical telescopes. Thus the Electronics Group will be kept busy with the world's largest set of superconducting receiver systems, which are cryogenically cooled to -269ºC, the two ALMA correlators - extremely fast, but highly specialized supercomputers - and all of the equipment in between, some 10,000 items in all (counting spares).

IT Group: This group is responsible for support of all personal computing equipment, and the IT infrastructure which is so vital to any modern organization. The IT infrastructure includes electronic mail, web servers, internet links, IP phones and so on. Given the number of meetings ALMA requires, support of the videoconferencing equipment is another task which keeps the IT group permanently busy!

The transporters were some of the first pieces of ALMA equipment to be completely accepted by the Project, and all antenna moves, including both from the vendor assembly areas to the OSF, and from the OSF to the High Site, are the responsibility of the DTS Antenna Group.

Who's who:
Joint ALMA Observatory (JAO)
Department of Technical Services

Maitenance work on an ALMA antenna

Maintenance Group: This group will be responsible for maintaining all of the ALMA technical facilities not explicitly supported by the antenna and electronics groups. This will include maintenance of the power and fiber networks at the High Site, the air-conditioning and fire suppression systems in the AOS-TB and Operations Support Facility (OSF) Technical Facility (TF), and so on. Although perhaps not as high-tech as the other groups, proper maintenance of these facilities is equally vital to achieving the high availability specification that ALMA requires. The maintenance group will also be responsible for the implementation of a Computerized Maintenance Management System (CMMS).

DTS Support Offices include the System Engineering Office and the Spectrum Management Office. The former will be responsible for providing system-level diagnostic and support capabilities, as well as maintaining the ALMA engineering standards, performance budgets and so on into Operations. The Spectrum Management Office will be responsible for monitoring the stringent Radio Frequency Interference (RFI) standards necessary to ensure that ALMA observations are not contaminated by locally-generated interference.

Last, but of course by no means least, DTS is supported by outstanding Administrative Assistants, shared with the Department of Science Operations of the JAO and assisted when necessary by AIV. In full operations DTS will also have Documentation Specialists and other support positions.

ALMA has a very systematic acceptance process. Equipment first passes through Assembly, Integration and Verification (AIV), and is then handed over for Commissioning and Science Verification (CSV) before being delivered to Operations. Since we have only recently started the CSV process, you would be forgiven if you might think DTS staff currently have an easy life. In fact nothing could be further from the truth! We are currently busy with a wide range of activities. The more prominent of these are:

- **IT support:** the DTS IT Group provides IT support for all of the JAO groups, including both Construction and Operations.
- **Integrated Computing:** The software engineers within the DTS Computing Group were fully integrated with the AIV staff into a single, merged, Computing Group basically from day one. This allows them to perform operations support duties (such as software builds and regression tests) now, while at the same time becoming familiar with the software they will need to support in the future by participating in some of the development and preventive/corrective software maintenance activities.
- **Antenna moves:** The ALMA transporters were some of the first pieces of ALMA equipment to be completely accepted by the Project, and all antenna moves, including both from the vendor assembly areas (so-called Site Erection Facilities) to the OSF, and from the OSF to the High Site, are the responsibility of the DTS Antenna Group. The number of moves has increased dramatically in recent months, with five individual moves in a single week in November.

Who's who:
Joint ALMA Observatory (JAO)
Department of Technical Services

Left. An Antenna Group operator checking that all is well during the first move of an ALMA antenna to the high site at 5000 meters (September 17, 2009).

Right. DTS operators working in the harsh conditions of the Chajnantor Plateau during the positioning of the first ALMA antenna.

- **AIV support.** DTS staff in the ALMA Engineering Pool are providing assistance for AIV activities, again both to provide extra effort, and as a learning exercise.
- **Setting up equipment and laboratories.** DTS staff are already providing considerable support to complete the final outfitting of the AOS-TB and OSF-TF buildings, including installation of the first archive computers at the OSF. Work will start soon on outfitting the Cryogenics Labs, Machine and Welding Shops, and so on.
- **Recruiting:** The ALMA Operations Plan calls for filling 65 new positions in 2010. This will keep both DTS and HR staff extremely busy!

The Department of Technical Services, with all of its five main groups is building up the staff, equipment and expertise that we will need to operate all of the ALMA equipment after it has passed through the commissioning process.

ALMA Newsletter

January 2010

Job Opportunities

The Joint ALMA Observatory (JAO) is seeking

Assistant Scientist/A

Secondary Title: ALMA Science Operations Astronomers

Position Type: International Scientist Position

Division: Joint ALMA Office

Location of Position: Santiago, Chile

Job Status: Regular Full Time | **FTE:** 3 | **Length of Appointment:** Three year appointment with likelihood of extension. | **Work Schedule:** Rotating Shift

Amount of Travel Required: Minimal to Moderate

Number of Positions Supervised: 0

Position Summary: The Joint ALMA Office invites applications for the position of Science Operations Astronomer based primarily in the ALMA offices in Santiago, with regular trips to the Operations Support Facility (OSF) to serve as Astronomer on Duty (AoD). The Astronomer will also travel periodically to the ALMA Regional Centers (ARCs) to work with the ALMA partners.

Position will be filled at assistant, associate or scientist level depending on experience.

Job Duties Summary: Responsibilities of Operations Astronomers include:

- Scheduling and execution of observations.
- Execution and development of the ALMA Calibration Plan

- Data quality assurance

- Tracking the progress of observing programs

- Support of array reconfigurations

- Development of operations documentation and web pages; and technical reviews of ALMA proposals

Before ALMA early science operations (2011), the Science Operations astronomers will support the Commissioning and Science Verification team, assisting the Project Scientist in planning and executing the scientific commissioning of ALMA. They will participate in tests and evaluations of the ALMA control software and software tools for science operations, and in the planning of science operations.

The successful candidates will be expected and encouraged to conduct astronomical research. Research in areas directed towards use of ALMA will be strongly encouraged.

Minimum Education: Applicants for this position must have a PhD in astronomy, physics, or a related field.

Minimum Experience: We are seeking astronomers with substantial experience in millimeter observations as well as a proven track record of scientific research. The ideal candidate will have previous experience in operating radio interferometers and/or single-dish telescopes and instruments. A good command of the English language, proven communication skills and the ability to work in a multidisciplinary team, including operators, astronomers and system/software engineers, are essential.

Work Environment: These positions require a significant amount of time working at the ALMA sites at the OSF (2,900m elevation) and occasionally at the Array Operations Site (5,000m elevation).

ALMA Newsletter

January 2010

Job Opportunities

A successful high altitude medical check is a necessary condition for this position.

Requisition Number: 00158

Job Open Date: 11-10-2009

Job Close Date: Open Until Filled

Special Instructions to Applicants: Deadline for receipt of applications to be considered for these positions is March 1, 2010. Please include an updated resume or curriculum vitae.

In addition, you should arrange to have letters of reference sent DIRECTLY to NRAO by your three (3) references. The letters must be sent to hr@nrao.edu as PDF files named as "ApplicantLastName_2009NAASC_ RefLastName.pdf" before Sunday, March 7, 2010 (although, earlier is preferable).

ALMA international staff will be recruited as employees of either AUI/NRAO or ESO. Both organizations offer attractive remuneration packages including a competitive salary, comprehensive social benefits, and provide financial support in relocating families. Furthermore, an expatriation allowance as well as some other allowances may be added. This is a three year appointment with likelihood of extension subject to budget availability.The NRAO and ESO are equal employment opportunity employers. M/F/D/V

To apply through ESO: Applicants may submit their application to ESO at https://jobs.eso.org/. ESO also requires three letters of reference which shall be sent to vacancy@eso.org.

To apply through NRAO: In addition, applicants should arrange to have letters of reference sent DIRECTLY to NRAO by the three references. The letters must be sent to hr@nrao.edu as PDF files named as "ApplicantLastName_2009NAASC_ RefLastName.pdf" before Sunday, March 7, 2010 (although, earlier is preferable).

Required Applicant Documents: Resume/ Curriculum Vitae; Cover Letter

Optional Applicant Documents: Other Document.

For more information, application forms and deadlines:

(through ESO) (through NRAO)

ALMA Newsletter

January 2010

If you wish to receive email announcements when new editions become available, please send an email to almanewsletter@alma.cl, with "subscribe ALMA newsletter" in the body.

To find out if you are already on the email list, send an email to almanewsletter@alma.cl, with "which" in the body.

This newsletter is also available here.

Please send comments on the newsletter or suggestions for articles and announcements to the editors at
twilson@alma.cl
wgarnier@alma.cl

More information on ALMA and contact details can be found on the ALMA homepage
www.almaobservatory.org

Regional newsletters:
http://www.eso.org/sci/facilities/alma/newsletter/2009/

http://www.nrao.edu/ news/ newsletters/

http://www.nro.nao.ac.jp/ alma/E

Upcoming events

ESO Workshop: The Origin and Fate of the Sun: Evolution of Solar-mass Stars Observed with High Angular Resolution

The goal of this workshop is to review recent results on solar-mass stars obtained with infrared and millimeter interferometers, and to discuss their importance for our understanding of stellar evolution from star formation to stellar end products. The workshop will concentrate on the mass range from approximately 0.5 to 2 solar masses, will discuss what new results for one stage of stellar evolution mean for the next stage, and will bring interferometric results into context with our knowledge based on other observational techniques and with theory. It will also include prospects with 2nd generation instruments at the VLTI and with ALMA. Interferometry experts and non-interferometrists alike are welcome to attend the workshop and to bring together their different perspectives.
Dates: 2 to 5 March 2010. **Location:** Garching, Germany.
More information: http://www.eso.org/sci/meetings/stars2010

Computational Star Formation Symposium

Computational Astronomy is a relatively new branch of research that spans a wide range of skills, including the theory of gaseous and stellar dynamics, computational and algorithmic science, and visualization. It is also usually accompanied by serious comparisons with observations. Simulations of star formation and young cluster evolution have now reached a level of sophistication where they can reproduce the initial stellar mass function, the binary distribution as a function of stellar mass and period, the spatial distribution of stars in young clusters, the evolution of clusters, and the structure and evolution of galaxies. At the same time, there are large differences in techniques, algorithms, and computer hardware, and equally large differences in the assumptions about initial and boundary conditions and what physical processes to include.

This Symposium will be the forum to discuss simulations and observations of star formation in 2010. The result of this Symposium will be a better understanding of the similarities and differences between computational techniques, and a recognition of the successes and shortcomings in matching the simulation results to detailed observations of star formation.

Dates: 31 May to 4 June 2010. **Location:** Barcelona, Spain'
More information: http://www.iaus270.org