

## ATACAMA LARGE MILLIMETER/SUBMILLIMETER ARRAY

### ALMA Project Progress



Figure 1. Artist's conception of ALMA operating in an extended array. (Image courtesy of ALMA/ESO/NRAO/NAOJ)

ALMA's achievements in 2007 have poised the project to assemble the first complete production system in Chile during 2008. Laying the groundwork for this, the ALMA Test Facility (ATF) in New Mexico has brought together most of the pieces of the ALMA interferometer to demonstrate the operation of the system. In June 2007, a ceremony was held welcoming the Array Operations Site (AOS) Technical Building, the nerve center for the array at an altitude of 5000m, to the collection of NRAO facilities on the occasion of NRAO's 50th anniversary. During the first half of 2008, the correlators will occupy the building; the first correlator has arrived in Chile from Japan. From April 2007 through year's end, seven antennas have been delivered to Chile, and the first antenna from Mitsubishi Electric Co. (Melco) underwent holography and other tests during the final quarter. Shortly, ALMA is expected to begin to accept antennas from the contractors for testing, leading to installation of the ALMA receiver package, which is undergoing its readiness reviews as this is written. The ALMA transporters have been demonstrated in Germany and will embark on their journey to meet the antennas at the Operations Support Facility (OSF) by year's end. The plan for operating the Joint ALMA Observatory was reviewed by an international committee in February 2007, which led to the adoption by the

ALMA Board of the ALMA Operations Plan, a blueprint for ALMA to produce its transformational science.

During 2008, a focus of the project will be demonstration of the production ALMA system at the OSF, where the Technical Building is nearing completion, and leading to demonstration at the AOS in the first part of 2009. Initially, with the delivery of antennas to the OSF well along, the focus will be on testing the antennas to ensure they meet the demanding ALMA specifications. Upon acceptance of the transporter, antennas will be delivered to the OSF area for incorporation into the two-antenna interferometer scheduled to operate there in the latter half of the year. Six additional antennas are scheduled for delivery to the OSF by the end of 2008.

At the North American Front End Integration Center (NA FEIC) located in the NRAO Technology Center (NTC) in Charlottesville, final tests and reviews are under way leading to the shipment of the first ALMA Front End, carrying the electronics associated with detecting the radio signals. That first Front End will arrive in Chile early in 2008. Also at the NTC, a second two-antenna correlator is reaching completion



Figure 2. Three Melco antennas under operation at the OSF. On the right is Melco unit-1, the most thoroughly tested of these antennas. Photo courtesy NAOJ.

and will be ready for shipment to Chile in January, where it will be installed at the OSF for the first interferometric tests of the production antennas later in the year. The first quadrant of the powerful ALMA correlator, which can accommodate 32 antennas, will be shipped to Chile for installation at the AOS in the second quarter of the year. ALMA will need two more Front End Integration Centers to supply its complement of receivers; a European installation at Rutherford Appleton Laboratories in England had a kickoff meeting in November. A third installation in Taiwan is approaching readiness. To assess the state of the production line for ALMA electronics, a Workshop was held in mid-November in Charlottesville.

Regular interferometry has continued at the ALMA Test Facility in New Mexico, where the assembled hardware has been linked by ALMA software and tested by scientists visiting the installation. The software drives the local oscillator (LO) fringe rate along with both coarse and fine delays. The system is phase stable over hours. Further tests are under way; interferometry will be used to fine-tune the antenna pointing solutions during the latter part of 2007.

Holography tests on the first of the three Melco antennas gave results that were repeatable to within four microns. The ALMA specification for the antenna surface accuracy is 25 microns. Optical pointing and control testing continues; a goal is that NAOJ might accept the antenna from the contractor shortly. The fourth 12 m antenna constructed by Melco arrived at port in Chile early in December.

The first of the VertexRSI antennas, a North American deliverable to ALMA, will undergo its testing early in 2008. The second antenna of this design is being assembled in the Site Erection Facility at the OSF, while the elements for the third antenna are in transit and should arrive in Chile in mid-December.

As components of ALMA flow toward the OSF, the Warehouse, part of the Technical Facility complex nearing completion, is ready to store them. Major components of the Back End, the signal distribution and processing portion of the ALMA system, arrive at the OSF in mid-December.

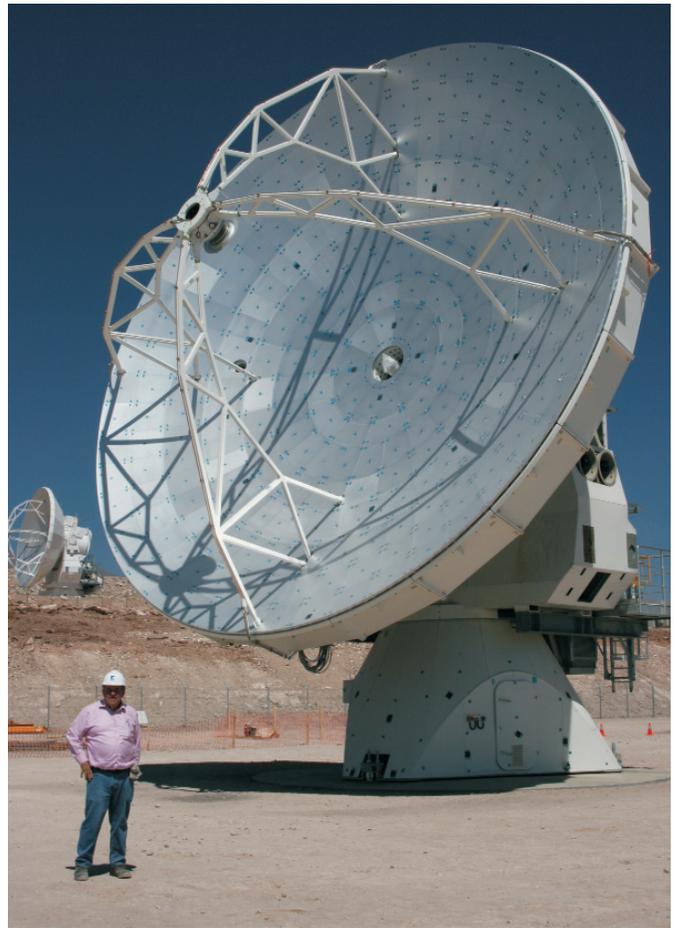


Figure 3. The first VertexRSI antenna was demonstrated at the ALMA Board meeting at the OSF on October 31, 2007.

The population of the Camps at the OSF reached over 500 people for construction activities. The balance of population will slowly shift from contractor personnel, now in the majority, to ALMA personnel as construction moves toward operations. One of the first elements of the operation of ALMA is managing the facilities; handover of this task occurs as construction of the facilities reaches completion during 2008. ALMA personnel are housed and fed in the ALMA camp, which is currently undergoing its final phases of expansion to accommodate the increased numbers.

At the 5000m elevation site, outfitting of the Technical Building with ALMA equipment has begun as the Atacama Compact Array (ACA) correlator is installed. Construction of a hangar for the antenna transporters has also begun and will complete in early 2008. Not



Figure 4. The Operations Support Facility Technical Building complex, seen from the holography tower in mid-October, is nearing completion. The warehouse is on the left, with offices and labs on the right. The transporter shelter can be seen in the background.

far to the south of the building, the central cluster of the array will stand. The first stage of readying the Chajnantor Plain for the cluster, involving substantial earthwork, will begin early in 2008.

A new ALMA outreach and education book was publicly presented to city officials of San Pedro de Atacama in Chile as part of the celebrations of the anniversary of the Andean village, a Sister City to Magdalena, NM. Entitled *Close to the Sky: Biological Heritage in the ALMA Area*, and edited in English and Spanish, the book collects unique on-site observations of the flora and fauna of the ALMA region performed by experts commissioned to investigate it and to provide key initiatives to protect it. Copies of this new book are available at <http://www.nrao.cl>.

In November 2006, an international ALMA conference was held in Madrid as a forum for astronomers interested in ALMA to exchange views, to plan preparatory observations looking forward to the interferometer's transformational science, and to obtain information needed to orient their scientific work to the best possi-

ble use of ALMA. The Proceedings of that conference will be available March 2008 as a special issue of *Astrophysics and Space Science* entitled *Science with the Atacama Large Millimeter Array: A New Era for Astrophysics*, edited by R. Bachiller, Rafael and J. Cernicharo. Many of the articles are available now at the journal's website.

During the last few months, the Santiago ALMA contingent has expanded to support the construction progress. In early November, Richard Hills assumed the post of Project Scientist; Joe McMullin took up his post as System Integration Lead; and Masato Ishiguro and Lewis Knee took up positions on the system integration team. To accommodate the burgeoning staff,

additional space was obtained in the Alsacia building adjacent to the current offices at 40 El Golf.

*Al Wootten*

### North American ALMA Science Center

Hiring at the NAASC is beginning in earnest. The NRAO recently announced two joint appointments with the University of Virginia. Dr. Aaron Evans, formerly from the State University of New York at Stony Brook, and Dr. Remy Indebetouw, formerly a Spitzer Fellow at the University of Virginia, have joined the NAASC. There are four other NAASC positions currently advertised:

- Two Commissioning and Science Verification (CSV)-related scientific staff positions.
- A position for ALMA-related education and public outreach.
- A scientific programmer position for ALMA-related CASA development.

Closing dates are January 30, 2008. Please bring these positions to the attention of your colleagues. See: [http://www.nrao.edu/administration/personnel\\_office/careers.shtml](http://www.nrao.edu/administration/personnel_office/careers.shtml).

The ALMA North American Science Advisory committee is organizing the 2008 NAASC workshop. The topic will be massive star formation, and the co-chairs of the Scientific Organizing Committee (SOC) will be Andrew Baker (Rutgers) and Remy Indebetouw (NRAO/UVa). Details will be available in the next NRAO *Newsletter*. The ANASAC is also considering scientific community efforts in the ramp-up years to ALMA, preparing for early science in 2011.

A major milestone for the offline data reduction package for ALMA: Common Astronomy Software Applications (CASA) has been achieved with the first beta release in October (see <http://casa.nrao.edu/> for more information) and NAASC staff continue to be extensively involved in the testing and development of CASA. NAASC staff members and their counterparts worldwide participated in a CASA training workshop in October (in Socorro, NM) to train User Support Specialists who will provide user support to the wider community in the future. In addition to testing by ALMA and NRAO project members, the CASA beta has also been released to >20 representatives of ALMA and NRAO scientific advisory committees. Feedback from this initial beta users group will be used to improve CASA and the newly commissioned CASA helpdesk in preparation for a wider user base. Testing also continued on all ALMA software subsystems, including the pipeline, CASA ALMA simulator, Obstoal, and archive.

The NAASC staff is assisting with, and training at, the ALMA Test Facility in Socorro, NM, in preparation for ALMA commissioning and science verification (CSV) and early science.

Work continued on the spectral line database in anticipation of its beta release on January 1, 2008 including the purchase of a dedicated database server to handle the expected number of queries. The database is currently a transition-resolved compilation of the JPL, CDMS, Lovas/NIST, and now Frank Lovas' (NIST) own Spectral Line Atlas of Interstellar Molecules (SLAIM) list. It currently contains 3,916,043 spectral lines in 865 chemical species including H, He and C recombination lines. Intelligent search filters have been added that allow the user to display the type of line strength (A<sub>ij</sub>, S<sub>ij</sub>, S<sub>ijmu</sub><sup>2</sup>, Astronomical Intensity, JPL/CDMS intensity) or energy (K, cm<sup>-1</sup>) preferred, what line list they want displayed, as well as upper limits to the errors on transitions. For a demonstration of all these new features, and more, visit [www.splatalogue.net](http://www.splatalogue.net).

Operations staff in Chile is undergoing extensive training as part of AIV/CSV activities. The ALMA operations plan version D has been approved by the ALMA Board. Special thanks go to the ALMA operations working group on their extensive efforts in preparing the revised operations plan. In the coming year, ALMA Chilean operations will be hiring a significant number of operations staff, including astronomers. See: <http://www.alma.cl/jobops/>.

Heads of the ALMA Regional Centers continue to hold regular telecons and quarterly face-to-face meeting to discuss global ALMA operations plans and progress. The next meeting is in Santiago in December, where main topics will be the ALMA Science Operations Plan, the ALMA helpdesk, regional recruitment activities, and planning the ARC mirror archives. If your institution is interested in having an NRAO staff member visit and discuss ALMA, please contact [ccarilli@nrao.edu](mailto:ccarilli@nrao.edu).

*Chris Carilli*