Atacama Large Millimeter/submillimeter Array

ALMA Achieves Field Interferometry

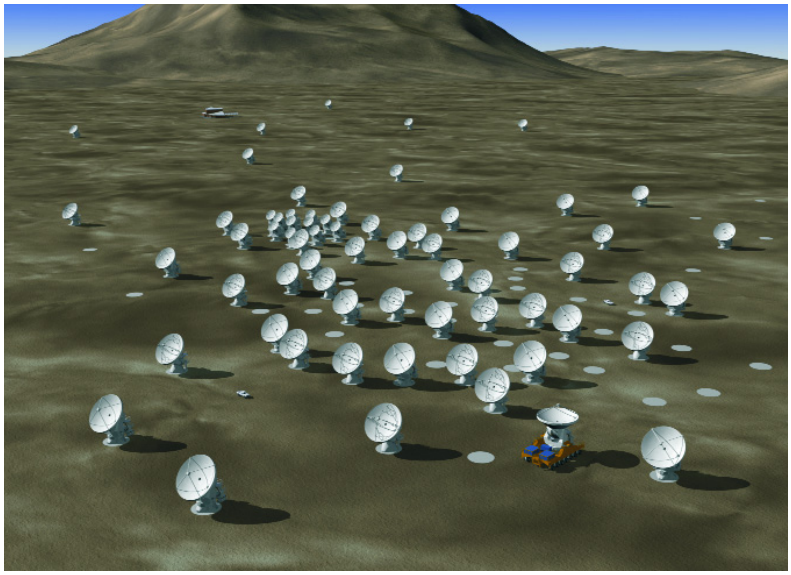


Figure 1. An artist's concept of the ALMA array, including the Atacama Compact Array at left center. Image courtesy ESO.

The ALMA prototype system was tested for the last many months in the NRAO Array Operations Center (AOC) labs in Socorro. During the fall and winter of 2007, this system has been integrated into the two prototype antennas and their associated hardware at the Antenna Test Facility (ATF) near the VLA. The ALMA holography system was thoroughly tested on the VertexRSI antenna and after a final acceptance test will be shipped to the Operations Support Facility (OSF) in Chile for use on the first production antennas, which will arrive at the OSF soon. The results of the holography measurements were confirmed with photogrammetry; the system is believed ready for the production antennas. Pointing of the two prototype antennas has proceeded through optical pointing (the Optical Pointing Telescopes will also be shipped to Chile soon) to radiometric pointing, which is proceeding. The throughput of the prototype system has been demonstrated by detection of the transmitter signal at 3 mm from the holography tower. The final step in the process will be interferometric detection of astronomical sources (see next article). A team of Chilean ALMA employees has been deployed in Socorro, Charlottesville, and Garching to train for their tasks in assembling ALMA and verifying its performance on the Chajnantor site.

A review of prototype system integration (PSI) was held at the NRAO AOC in Socorro on January 24 and at the ATF on January 25. The purpose of the meeting was to plan and coordinate the integration, testing, and commissioning activities to be done at the ATF in 2007 and Q1 2008. At the meeting, the work on elements of the prototype system in the AOC labs was discussed and methodologies for assessing system performance in the less controlled field environment were considered.

The receivers currently installed are special purpose receivers built to evaluate the prototype antennas. The ALMA receivers, populated with cartridges for all four bands (3 mm, 1.3 mm, 0.8 mm and 0.65 mm) from

Figure 2. The prototype ALMA antennas (VertexRSI, foreground; AEC, background) stand ready for prototype system integration near the Very Large Array in New Mexico.

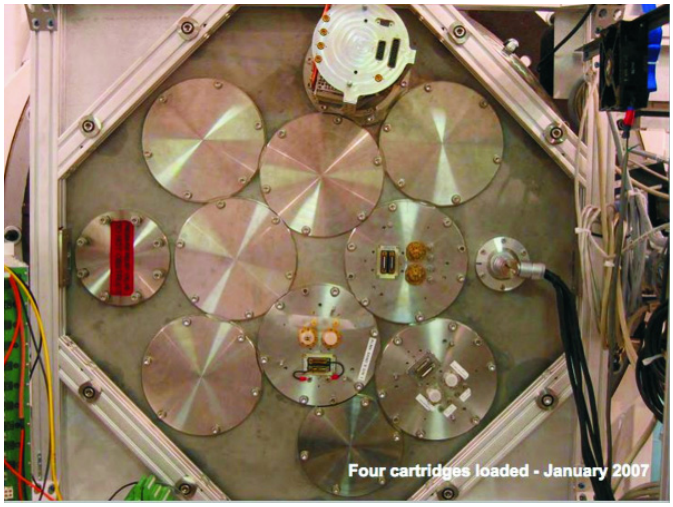


Figure 3. The ALMA dewar under test in the NTC Front End Integration Facility in Charlottesville. The four first receiver band cartridges are inserted.

Europe and North America, are being tested at the Front End Integration Center located in Charlottesville at the NRAO Technology Center (NTC). The testing has been proceeding very well; all cartridges are meeting their noise temperature specification handily, and in fact showing considerably better than specified performance. Once tested, the ALMA front end assembly will be shipped to the ATF for integration into the prototype system; after this step it will go to the OSF for installation on the first ALMA production antennas later this year. Subsequent front end assemblies move directly to Chile for installation in the steadily arriving production antennas. The bilateral ALMA correlator, one quadrant of which has been running at the NTC for many months, will be upgraded to include tunable filter banks and then moved to Chile for installation in the 5000 m Array Operations Site (AOS) Technical Building later this year. Construction of the second quadrant is in an advanced stage at the NTC. A new version of the prototype correlator now installed at the ATF, enhanced with the tunable filter banks, will replace the current prototype at the ATF in the fall.

At the AOS Technical Building, whose construction will be complete by arrival of this *Newsletter*, the installation of ALMA equipment (notably the correlator) will proceed. At the 2900 m OSF, construction of ALMA infrastructure continues at full bore. The building in which the first production antennas will be assembled, the VertexRSI Site Erection Facility, is in an advanced stage of construction (see Figure 4) alongside its sister facilities where the first Japanese production antenna will be assembled later this year, followed by the first European production antenna next year. Activities at the OSF will be centered in the OSF Technical Building, now under roof and proceeding toward 2008 completion.

At the Joint ALMA Office in Santiago, hiring continues for the positions that will carry out assembly of the array and operate its infrastructure. The current building cannot contain the projected level of personnel, and a process has been initiated to construct a permanent ALMA headquarters on the grounds of the ESO facility at Vitacura. In the fall, Richard Hills will join the JAO as Project Scientist, (in the interim A. Wootten fills this post). Alison Peck will join ALMA in Santiago in April as Deputy Project Scientist. Hills and Peck will be joined by a number of commissioning scientists as the array moves toward its commissioning and science verification stages.

The ALMA Board approved an updated version of the ALMA Operations Plan (AOP). The AOP was reviewed at ESO during January. Members of a National Science

Figure 4. The VertexRSI antenna site erection facility building rises on the OSF grounds. Antennas will be assembled in this large facility which is nearly eight stories tall.

Figure 5. Comet McNaught, seen here in the sky above the Array Operations Site to the left of the Technical Building, put on a spectacular show for the committee reviewing the ALMA Operations Plan on 2007 January 23. Photo H. Heyer (ESO).

Foundation panel charged with reviewing the proposal visited the ALMA site during January. The panel met under auspices of the ALMA Board and the National Science Foundation in Arlington, Virginia on February 27–28 to conclude their report.

President George W. Bush presented the funding request for fiscal year 2008 to U.S. Congress in February. Funding requested in FY 2008 from the Major Research Equipment and Facilities Construction account for ALMA reflects the new baseline configuration and cost as approved by the National Science Board.

Transitions

Prof. Richard Hills has been appointed as the ALMA Project Scientist, and Dr. Alison Peck as the Deputy Project Scientist. Richard Hills is Professor of Radio Astronomy, and a member of the Astrophysics Group, in the Physics Department of Cambridge University, UK. His work is well known in the field of millimeter and sub-millimeter-wave astronomy. Prof. Hills is recognized as an expert in radio astronomical instrumentation, telescopes, and interferometry. Dr. Alison Peck is a staff member of the Sub-Millimeter Array (SMA) at the Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA. Dr. Peck is responsible for all science and observer scheduling at the SMA telescope on the summit of Mauna Kea, HI. As such, her responsibilities range from designing and implementing a system of dynamic scheduling, optimizing data taking and reduction procedures, to outreach activities. We look forward to their leadership in, among other matters, the science commissioning and science verification of ALMA.

Mark Holdaway has left NRAO to pursue his business interests. I want to thank him for the wisdom and advice he has so generously provided over the years. Although he may be retiring, he will always be the *Wizard of ALMA* to those of us in the Science IPT. We wish him every success with his business and hope, of course, that it is so successful he might still find time to provide us with advice on occasion.

Al Wootten

ALMA Achieves Major Milestone with Antenna-Link Success

The Atacama Large Millimeter/submillimeter Array (ALMA), an international telescope project, reached a major milestone on March 2, when two ALMA prototype antennas were first linked together as an integrated system to observe an astronomical object.

The milestone achievement, technically termed “First Fringes,” came at the Antenna Test Facility (ATF) on the grounds of the National Radio Astronomy Observatory’s (NRAO) Very Large Array (VLA) radio telescope in New Mexico.

Radio waves emitted by the planet Saturn were collected by the two ALMA antennas, then processed by new,

Antenna Test Facility, New Mexico: VertexRSI antenna, left; AEC antenna, right. Credit: Drew Medlin, NRAO/AUI/NSF

state-of-the-art electronics to turn the two antennas into an interferometer.

The successful Saturn observation began at 7:13 p.m., U.S. Mountain Time Friday (0213 UTC Saturday). The planet's radio emissions at a frequency of 104 GHz were tracked by the ALMA system for more than an hour.

"Our congratulations go to the dedicated team of scientists, engineers, and technicians who produced this groundbreaking achievement for ALMA. Much hard work and many long hours went into this effort, and we appreciate it all. This team should be very proud today," said NRAO Director Fred K.Y. Lo. "With this milestone behind us, we now can proceed with increased confidence toward completing ALMA," he added.

ALMA, now under construction at an elevation of 16,500 feet in the Atacama Desert of northern Chile, will provide astronomers with the world's most advanced tool for exploring the Universe at millimeter and submillimeter wavelengths. Astronomers will use ALMA's transformational capability to study the first stars and galaxies that formed in the early Universe, to learn long-sought details about how stars are formed, and to trace the motion of gas and dust as it whirls toward the surface of newly-formed stars and planets.

"This was fantastic work. Using our two prototype antennas to observe Saturn was the first complete, end-to-end test of the advanced systems we are building for ALMA," said Adrian Russell, North American Project Manager for ALMA. "ALMA is an extraordinary international endeavor, and the collaboration of partners from around the world is vital to the success of the project," Russell added.

"The success of this test is fundamental proof that the hardware and software now under development for ALMA will work to produce a truly revolutionary astronomical tool," said Massimo Tarenghi, ALMA Director.

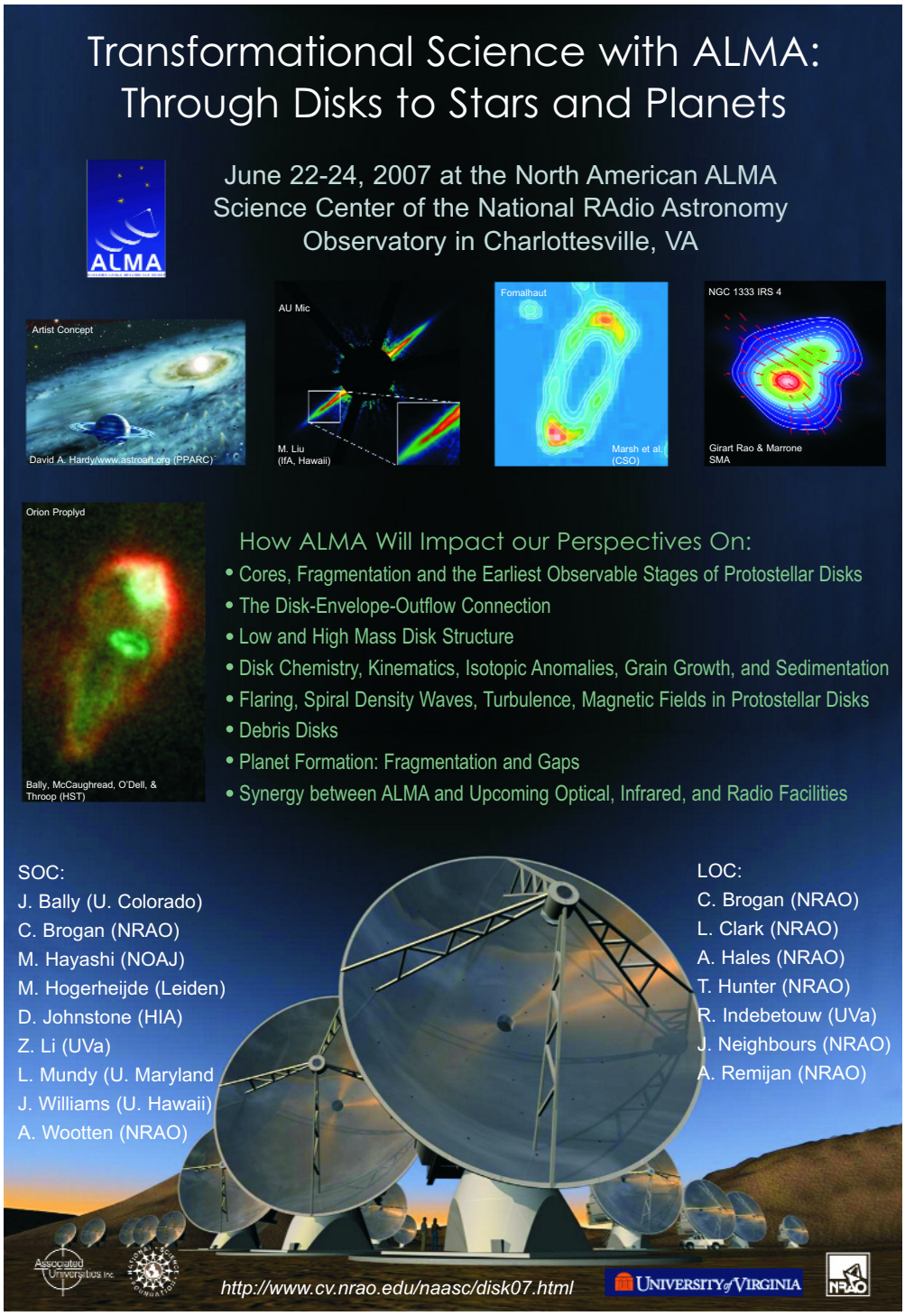
"This achievement results from the integration of many state-of-the-art components from Europe and North America and bodes well for the success of ALMA in Chile," said Catherine Cesarsky, ESO's Director General.

In addition to the leading-edge electronic and electro-optical hardware and custom software that proved itself by producing ALMA's first fringes, the system's antennas are among the most advanced in the world. The stringent requirements for the antennas included extremely precise surfaces, highly accurate pointing, and the ability to operate reliably in the harsh, high-altitude environment of the ALMA site.

The Antenna Test Facility includes prototype antennas built by VertexRSI in the U.S. and by the AEC Consortium (ALCATEL Space of France and European Industrial Engineering of Italy). These antennas were evaluated individually at the ATF. Both prototypes were fitted with electronic equipment for receiving, digitizing and transmitting signals back to a central facility. At the ATF, a small-scale prototype version of ALMA's correlator has been installed. The full-scale ALMA correlator is being built at the National Radio Astronomy Observatory's Technology Center in Charlottesville, Virginia, and will be installed at the high-altitude site in Chile when completed. ALMA also will include Japanese antennas built by Mitsubishi.The complete press release, photos, and graphics are available on-line at *http://www.nrao.edu/pr/2007/almafringes.*

Dave Finley

Second NAASC ALMA Science Workshop



The second NAASC ALMA science workshop (poster above) will generate extensive discussion and new ideas regarding how ALMA may be used to transform the subjects of protostellar and protoplanetary disks through presentations on the current state of our understanding, predictive theories, as well as simulations. Pre-registration and abstract submission are now complete, and we have had a very positive response—with more than 120 pre-registrants. Full registration opens April 2, and will be on a first-come-first served basis due to the size of our venue which can accommodate ~75 participants.

Crystal Brogan

The North American ALMA Science Center (NAASC)

A major external review of the ALMA Operations Plan was held on February 27, 28, and March 1, 2007 near National Science Foundation (NSF) headquarters in Arlington, VA. This review involved both an international panel with North American, European, and Japanese representation, to review the global ALMA operations plan, plus a North American-specific panel that reviewed both the global plan plus the NAASC proposal, as submitted to the NSF in October 2006. The international panel was chaired by the IRAM director, Pierre Cox, and the North American panel was chaired by the Gemini South director Jean-Rene Roy. Both panels heard a series of presentations on the operations plan from the international operations team, including members of the NRAO staff, with ample time for direct questioning of the operations team.

The panels presented their main findings at the end of the review. Overall, the response was extremely positive, and both panels were very impressed by the plan, concluding that no ground-based observatory has ever had such a detailed operations plan in place prior to full operations. They found the staffing levels and schedule were well considered and adequate, and they felt that the operations plan has an excellent chance of success. Both panels also emphasized the need for adequate staffing during early operations, to ensure support of users at a time when the observatory will be at a critical juncture in terms of rapidly increasing capabilities, and increasing demand from the user community.

This review represents the primary pre-operations milestone for the operations team, and successful completion can be considered a major affirmation of the hard work of the operations working group and the NRAO staff involved with operations planning.

While most of the time of the NAASC staff was spent preparing for the operations review, staff were also deeply involved in software testing. Testing was done of the ALMA pipeline, and the CASA-PY post-processing software, including the CASA user interface.

The spectral line database (Splatalogue) was released to the public at *http://www.splatalogue.net* on February 1, 2007. To date, over 400 species have been resolved and new data are planned to be included starting in July with the help of Frank Lovas (NIST). Work has also begun to incorporate the Splatalogue into the ALMA observing and proposal tool.

Chris Carilli