

## 2.9 Science IPT

### *Planned versus actual accomplishments over the period*

During the Period 2005-July through 2005-December, a JAO Project Scientist turno system was implemented. Under this system, one of the three regional project scientists performs the duties of the JAO Project Scientist for a period of four months, during which they spend at least three weeks in the Santiago JAO office. Wootten served the first shift, extending from September through the end of the year. Wilson will follow for the first months of 2006. The Science IPT assisted the ASAC in responding to its Charges from the ALMA Board, providing a statement on the proposed Baseline Change Proposals (BCPs) for example. While in Santiago, Wootten, consulting with ASAC Chair Testi, prepared the agenda and attended the ASAC face-to-face meeting held there Oct 1-2 and the ALMA Board meeting in early November. At the Board meeting, he reported on the Scientific Requirements document, on the new configuration design, on BCPs, and on the science effects of the two ALMA antenna designs, including for example the dissimilar quadripod position angles. As JAO Project Scientist, Wootten interacted with the Chilean science community. For example, he attended a colloquium at the University of Chile, an ESO-arranged meeting on Groups of Galaxies, and he presented an ALMA talk at the Latin American IAU Regional Meeting in December. The Science IPT leadership attended the ALMA Cost Review in Garmisch, where Wootten made presentations on Science Requirements and on the Science IPT. In Japan, he served on the Review Panel for the ACA 12m CDR and the ACA System PDR. Emerson and Laing also attended, via telephone line. The Project Scientists and Instrument Scientists also served on the panel for the July System Requirements Review (SRR), which Emerson chaired and wrote the panel report. Laing attended FE Delta PDR in Garching. A new version of the ALMA Scientific Specifications and Requirements (ALMA-90.00.00.00-001-A-SPE) containing clarifications of items discussed by the ASAC and the SRR was produced in December. The Science IPT has participated in the ALMA rebaselining effort, with the Project Scientists attending Management meetings to provide comment on the dependence of ALMA Science on various elements of rebaselining activities. Within the Science IPT, planning centered on the creation of a new Work Element for commissioning activities, WBS number 3070. Wootten, Wilson and Kawabe serve on the new Operations Working Group, which had a first meeting in December.

### *Scientific Advisory Committees*

As planned, the Science IPT facilitated the ASAC report to the Board in Santiago, providing supporting documents, an agenda and presentations. The Science IPT also began arrangements for the January meeting. New members joining the ASAC included Jose Cernicharo and Susanne Aalto; Pierre Cox and Ewine van Dishoeck left the ASAC after many years of valued advice. Several ANASAC, ESAC and JSAC telecons were held.

### *Technical status and technical performance results achieved*

#### **Configuration, Antennas**

The Science IPT designed a configuration appropriate for 50 or 64 antennas. The plan requires only ~175 antenna pads, rather than the 216 in the approved configuration. The 151 pad configuration for the inner 4km delivered 2005-Aug-17 provides excellent imaging for 50 antennas, or with an additional 11 pads, for 64 antennas in the bilateral array. Holdaway provided a strawman design for the extension of this array configuration beyond 4km, optimizing it for highest resolution and imaging performance. This extension for 50 antennas requires an additional 24 pads populated with an additional 9 moves of 4 antennas. Otarola, Rivera, Stirling and Bravo conducted an on-site investigation of the pad locations, suggesting modifications to account for local terrain to Conway and Holdaway, who provided quick feedback. Holdaway will finish the extended configuration design in concert with the road and fiber design to optimize performance while minimizing cost.



Figure 1 One of the new pad positions is staked on Chajnantor.

### Calibration

A review was held at IRAM 2005-Aug-25 at which it was decided to implement a two load amplitude calibration system, simpler than that proposed in Memo No. 461. Wilson, Laing and Mangum represented the Science IPT.

Specifications for the instruments needed to provide the atmospheric information necessary for effective scheduling and accurate calibration of ALMA are being drafted, following the recommendations SCID-90.05.13.00-001-A-SPE. Mangum assigned

calibration examples to be written, as a result of the system requirements review. Most have been drafted and are available on the calibration wiki page.

Several other memos relating to ALMA Calibration appeared:

- ALMA Memo No. 517, 520, 521, 529 were in last report.
- ALMA Memo no. 543.

## Site Characterization

The aging complement of batteries powering the NRAO instruments were replaced in August by Roberto Rivera and Juan Bravo.



**Figure 2 (L-R Roberto Rivera, Juan Bravo, Angel Otarola, Alison Stirling)** During the site campaign in August, the Science IPT crew poses for a photograph. We were greatly saddened to learn of the death of Roberto Rivera in an automobile accident near San Pedro on September 1. Roberto came to ALMA in 2001 and had worked under contract with the site characterization team, along with many colleagues investigating the Chajnantor site, impressing many of us and our colleagues with his drive, his talent and dedication and his conviviality. We will all miss him dearly and send our heartfelt condolences to his family and friends.

A campaign was carried out to measure vertical atmospheric profiles as simultaneously as possible to verify the plan for meteorological instrumentation on Chajnantor. Tragedy struck the site characterization group shortly after the successful conclusion of the campaign when Roberto Rivera was killed in an automobile accident (see Figure 2). While in Santiago, Wootten met with Nyman to plan the shutdown of site characterization.

## Science Requirements

During this quarter, the [Science - Specifications and Requirements](#) document, ALMA-90.00.00.00-001-A-SPE, was sent to the ASAC for comment, received in their Nov report. More detailed science requirements were developed the Nutator (ALMA Nutator Scientific Requirements SCID-35.03.00.00-001-A-SPE) and the process was begun for the radiofrequency membrane covering the antenna Cassegrain aperture, and for the quarter wave plates. One new project was submitted, refereed and catalogued to the

DRSP collection; one remains in referee queue. Emerson led a series of telecons to provide plans for holography in Chile.

### **Organization, interaction with other IPTs**

Telecons were held with other IPTs on a number of issues, including Frequency Switching requirements, requirements for Holography at the OSF and Nutator requirements. Ocampo and Grubb, from the PMCS group, met often with Wilson and with Wootten to discuss Science IPT organization in preparation for Cost Reviews. Wilson worked out details of agreements between IRAM, Cambridge University and ESO in conjunction with the EU FP6 program 'ALMA Enhancement'.

*ALMA Memos Published July-December 2005 by Science IPT members.*

543 [Estimating Calibrator Counts at 250 GHz Using MAMBO Observations of Flat Spectrum Quasars](#) M.A. Holdaway, Chris Carilli, Axel Weiss, Frank Bertoldi 11/05

542 [Height and Velocity of the Turbulence Layer at Chajnantor Estimated From Radiometric Measurements](#) Juan Pablo Pérez 11/05

538 [Array Configuration Design of the Atacama Compact Array](#) Koh-Ichiro Morita (NAOJ), Mark Holdaway (NRAO) 10/05

537 [Walsh Function Demodulation in the Presence of Timing Errors, leading to Signal Loss and Crosstalk](#) D. T. Emerson 09/05

535 [Simulation Series of a Phase Calibration Scheme with Water Vapor Radiometers for the Atacama Compact Array](#) Yoshiharu Asaki, Masao Saito, Ryohei Kawabe, Koh-ichiro Morita, Youichi Tamura, and Baltasar Vila-Vilaro 09/05

530 [Coherence Estimation for measured Phase Noise in Allan Standard Deviation](#) H. Kiuchi 10/05

### **Meetings, Outreach and Public Education**

Wilson met with a reporter for *Suddeutsche Zeitung* for an article on ALMA in conjunction with an article on *Astronomical Instruments of the Future*'.

A proposal was developed and submitted for an ALMA special session at AAS/Calgary, which is being held in conjunction with CASCA. D. Johnstone, J. Turner and A. Blain will speak. Meetings at which ALMA was represented include:

- [Astrochemistry throughout the Universe: Recent Successes and Current Challenges 2005 August 29 - September 2; Asilomar, California](#)
- [REVEALING THE MOLECULAR UNIVERSE -- ONE TELESCOPE IS NEVER ENOUGH](#) 9-10 Sept 2005, Berkeley, Ca
- [Protostars and Planets V 24 - 28 October 2005 Hilton Waikoloa Village, The Big Island, Hawaii](#)
- Mm/submm Techniques and Science session, at the [URSI General Assembly](#) 2005 October 23-29, New Delhi, India
- ["IR Diagnostics of Galaxy Evolution"](#). 14-16 November 2005, Pasadena, CA
- "Groups of galaxies in the nearby Universe". DECEMBER 5 - 9, 2005 - Providencia, Santiago, Chile
- [Latin American IAU Regional Meeting](#) 12-16 December, Pucon, Chile
- [National Radio Science Meeting](#) 4-7 January, Boulder, Colorado

There are several ALMA workshops which occurred:

- “[Galactic and Extragalactic ISM Modelling in an ALMA Perspective](#)” held October 13-15 2005 in Onsala, Sweden.
- [Physique stellaire avec ALMA](#) November 14/15, 2005, GRAAL - Montpellier.
- Workshop on Submillimeter Astronomy and Receiver Technologies, held 8-10 Dec 2005 in Nanjing
- Inaugural Japan-Taiwan ALMA Science Workshop, held 15-16 Dec 2005 in Taipei.

***Highest level technical and managerial risks and concerns: Risk Register V6.0***

| Issue   | Probability Score | Cost Impact Score | Schedule Impact Score | Category  |
|---|-------------------|-------------------|-----------------------|-----------|
| ALMA consists of only 50 antennas                 | 3                 | 8                 | 6                     | Very High |
| ALMA consists of only 40 antennas                 | 2                 | 8                 | 8                     | High      |
| Phase mitigation techniques fail to meet spec     | 3                 | 6                 | 4                     | High      |
| WVR phase mitigation techniques fail to meet spec | 2                 | 6                 | 4                     | Medium    |
| FS phase mitigation techniques fail to meet spec  | 3                 | 6                 | 4                     | High      |
| Project Scientist                                 | 3                 | 6                 | 6                     | High      |

***Planned activities for next period.***

Manpower – A first ALMA postdoctoral position in NA will be filled by Dr. Antony Remijan. An offer will be made to a candidate for the second position, beginning in Fall 2006. Negotiations with candidates to fill the European postdoctoral positions continues.

Site – All salaries and travel for site characterization were deleted at the end of 2005. The instruments continue to collect data, which is harvested on an as-available basis.

Configuration –Holdaway, will complete the redesign of the ALMA configuration beyond 4km radius for fifty antennas, with provision for placing 64 antennas should that number become available. ‘Ground truthing’ of this array will be accomplished.

Calibration – WVR prototypes will be installed at the SMA during the period January through April. They will be installed later at the ATF. In the Fall, there will be a meeting at Cambridge, UK, to examine the results.

Imaging – The ASAC was asked to review the existing analysis for the polarization and mosaicking performance of the hybrid ALMA array and consider the priority and

timescale for further analysis by the Science IPT. The Science IPT will assess the resources necessary for a full electromagnetic simulation of the antenna designs to investigate polarization and mosaicking with the bilateral array.

Outreach – ALMA presence at the North American URSI meeting, at the AAS and at the IAU is being coordinated. An ALMA workshop on "*From Z-Machines to ALMA: (Sub)millimeter Spectroscopy of Galaxies*" was held on Friday & Saturday, Jan 13-14 2006 at NRAO-CV. There were 80 registered participants. During the March 26-30 meeting of the American Chemical Society, A. Remijan will present an invited paper on comet chemistry. During 2006 Q2 a workshop will be held on Complex Molecules in Space: present status and prospects with ALMA on May 7 to 11, 2006 at Fuglsoecentret, near Aarhus, Denmark. Beasley will represent ALMA at 'Future Directions for Millimetre Astronomy in the Southern Hemisphere' to be held at **Chowder Bay, Sydney Harbour on 30 - 31 March 2006** and at [SPIE](#) 24-31 May, Orlando, Florida. At the joint CASCA/AAS meeting in Calgary in the Spring, there will be an ALMA special session featuring talks by A. Blain, J. Turner and D. Johnstone. C. Wilson will give an invited talk.