

## 2.9 Science IPT

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

During the period, the Project Scientists have attended Board meetings in Pasadena and The Hague, providing supporting advice (e.g. on the science impact of multiple antenna designs) as the project strides toward antenna procurement. The Science IPT has provided the review panel chair, Robert Laing, for the Water Vapor Radiometer and ACA Correlator PDRs; Robert also helped commission the APEX variety of Vertex antenna, at Chajnantor. The ALMA Scientific Specifications and Requirements (ALMA-90.00.00.00-001-A-SPE) passed the Change Control Board and were sent to the ALMA Director to forward to the Board. 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.

#### *Scientific Advisory Committees*

As planned, the Science IPT facilitated the ASAC report to the Board in Pasadena, providing supporting figures and data. A White Paper on the dependence of ALMA science on antenna number was distributed to management. Background material as well as image simulation support was provided to the Committee to Review the Science Requirements for the Atacama Large Millimeter Array of the National Research Council; some of this material subsequently appeared in the report **The Atacama Large Millimeter Array (ALMA): Implications of a Potential Descope** published in June. Wilson attended a meeting of the European ALMA Board immediately after a meeting of ESO Council.

The ANASAC met face-to-face in Cambridge on 12 June 2005 at a meeting facilitated by the Science IPT. At the meeting, Richard Crutcher was elected chairman of the ANASAC. Members discussed the project status and began consideration of ASAC Charges. Crutcher initiated a message from the ANASAC to NSF strongly encouraging them to pursue procurement of at least 25 production antennas.

#### *Milestones*

The Table gives the status of Level 2 milestones due during the current quarter and the next quarter.

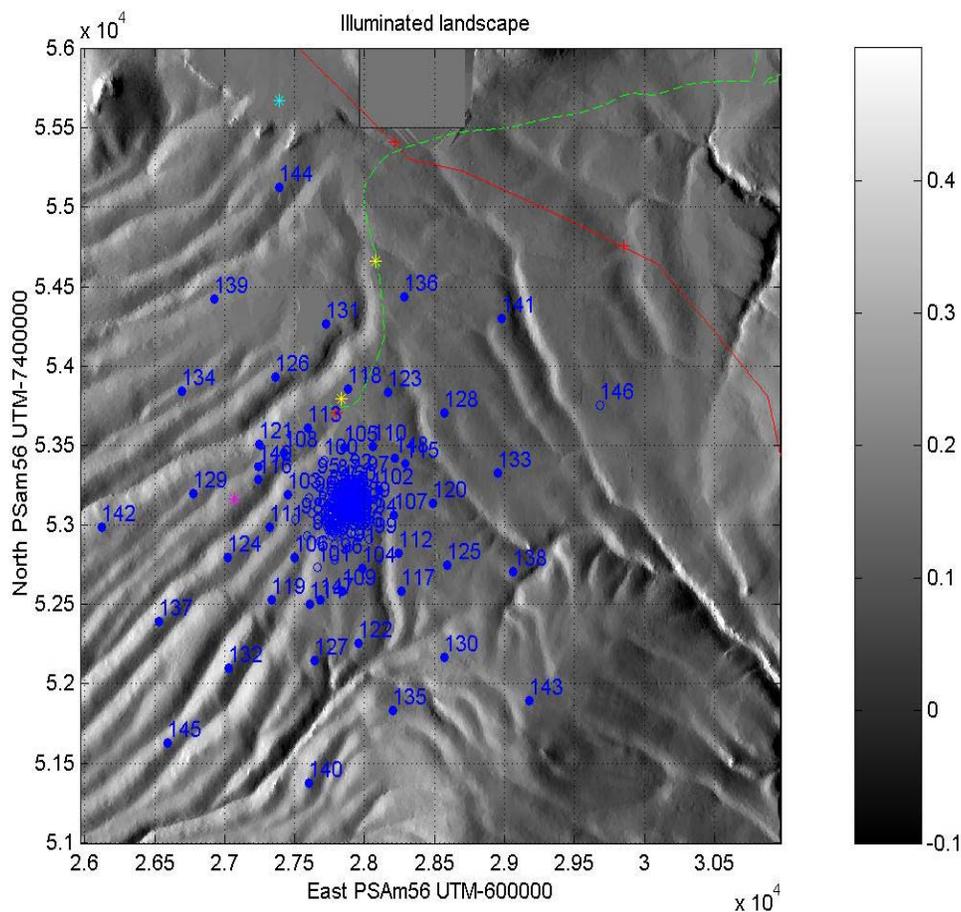
Milestone	Level	Title	Date	Status
09.2.20.12	2	ICD 57 Site-Meteorology & SCIE-Weather Stations Submit	2005-Sep 1	In Progress, 95% finished (await input from JP)
	2	Redesign configuration for 50-60 antennas	2005-Aug-30	In Progress; 95% finished.

WVR field testing at the Smithsonian Submillimeter Array is being considered.

## *Technical status and technical performance results achieved*

### **Configuration, Antennas**

A mitigation plan was developed to produce a configuration appropriate for 50 antennas. The plan calls for a configuration with fewer pads which can provide excellent imaging but in which pads may also be populated with 64 antennas without sacrificing imaging performance or sensitivity. Conway has nearly completed his design for this configuration, and Holdaway is extending and optimizing it for highest resolution and imaging performance while avoiding known vizcacha haunts. Otarola clarified long-standing issues concerning ground truth of the digital elevation images of the Chajnantor site, a critical component to configuration design. The new configuration design will shortly be submitted for approval. On-site investigation of the new pad locations is expected to occur during August.



**Figure 1** The new draft 50-antenna configuration for ALMA's inner regions.

### **Calibration**

The Calibration Group leader, Jeff Mangum, has updated **Calibration System Specifications and Requirements**, ALMA-90.03.00.00-006-A-CRE. This document will now be submitted to the CCB. A feasibility study continues under the FE IPT for the multiple load amplitude calibration device described in ALMA Memo No. 461. A hot

load was developed and tested at IRAM and RAL. A two load amplitude calibration system, simpler than that proposed in Memo No. 461, appears capable of meeting ALMA needs

A new document, Ancillary Calibration Instruments Specifications and Requirements SCID-90.05.13.00-001-A-SPE, outlines the requirements for the instruments needed to provide the atmospheric information necessary for effective scheduling and accurate calibration of ALMA. The document provides a general discussion of the problem and a list of the instruments expected to be most valuable, together with an indication of their roles.

ALMA Memo No. 517, 'Turbulence simulations of dry and wet phase fluctuations at Chajnantor. Part I: The daytime convective boundary layer,' by A. Stirling, J. Richer, R. Hills, and A. Lock was issued. Although the simulations show that dry phase fluctuations are concentrated in two layers -- near to the ground, and at the temperature inversion. The wet fluctuations are concentrated at the inversion, while the total phase fluctuations are more uniformly distributed within the convective layer. Nonetheless, the total and wet phase fluctuations are well-correlated. The study suggests that, even under conditions where the dry phase fluctuations are expected to be at their highest, water vapor radiometry is expected to be able to remove a high percentage of phase fluctuations at Chajnantor.

Several other memos relating to ALMA Calibration appeared:

- ALMA Memo No. 529, "Velocity and Structure Function of Phase Screen aloft at Chajnantor", by Hideharu Ishizaki and Seiichi Sakamoto
- ALMA Memo No. 521, "Joint Distribution of Atmospheric Transparency and Phase Fluctuations at Chatnantor", by Larry D'Addario and Mark Holdaway (formerly LAMA Memo No. 801)
- ALMA Memo No. 520, "A Refined Method for Estimating Calibrator Counts Above 90 GHz", by M.A. Holdaway and Frazer Owen

### **Site Characterization**

An assistant, Juan Bravo, was hired to accompany Rivera on visits to the AOS site in conformance with site safety rules. The suite of batteries powering the NRAO container are ten years old, far beyond their expected lifetimes. Electrolytic tests showed that fewer than half the complement remains in good shape; the load was decreased through resiting of some equipment resulting in few power failures during the winter. Instrumentation needed for atmospheric characterization for WVR phase correction has been identified, costed, and an ICD to the Site written. Assumptions behind this instrumentation plan (sparse sampling of conditions across Chajnantor) can be tested with near-simultaneous radiosonde launches; planning for these tests is advanced. Stirling advanced a plan for this; details are in the process of being specified.

### **Science Requirements**

During this quarter, the [Science - Specifications and Requirements](#) document, ALMA-90.00.00.00-001-A-SPE, was approved by CCB and sent to the Director for disposition.

More detailed science requirements were drafted for Frequency Switching (Frequency Switching on ALMA [SCID-90.00.00.00-012-A-SPE](#)), for the Nutator (ALMA Nutator Scientific Requirements SCID-35.03.00.00-001-A-SPE) and for Weather Instruments on the Array (Ancillary Calibration Instruments Specifications and Requirements SCID-90.05.13.00-001-A-SPE).

### **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 separately with Wilson and with Wootten to discuss Science IPT organization.

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

Nearly two hundred potential ALMA users met at the [Workshop on submillimeter wavelength astronomy](#) in Cambridge, Massachusetts on 13-16 June. Christine Wilson presented a talk on ALMA and Alison Stirling presented a talk on ‘Atmospheric Phase Correction for ALMA’ which was particularly well-received. Wootten presented a paper at the [2005 IEEE International Conference on Acoustics, Speech, and Signal Processing March 19-23 2005](#) on ALMA signal processing, during a special session on radioastronomy. An ALMA workshop on ALMA and the S-Z effect was held in Paris in early April, attended by Myers,, at which the importance of Band 1 to this aspect of ALMA Science was emphasized. ALMA was represented at booths at the CASCA meeting in Montreal and at the AAS meeting in Minneapolis, for which Wootten developed an automated slide presentation. A series of telecons was initiated with other observatory directors to discuss synergies with Herschel, Spitzer and other telescopes which will be ALMA’s contemporaries or soulmates. Wilson submitted an ALMA article for the ESO Newsletter and Wootten submitted an article for the NRAO Newsletter. A proposal was made and accepted for an ALMA Town Meeting to be held at the AAS meeting next January in Washington, D. C. meetings. There are several ALMA workshops planned for the near future:

- [“Galactic and Extragalactic ISM Modelling in an ALMA Perspective”](#) will be held October 13-15 2005 in Onsala, Sweden.
- *"From Z-Machines to ALMA: (Sub)millimeter Spectroscopy of Galaxies"* will be held on Friday & Saturday, Jan 13-14 2006 in Auditorium & Rm230 at NRAO-CV. We expect about 60 registered participants.

### ***Highest level technical and managerial risks and concerns.***

Issue	Probability Score	Impact Score	Risk Exposure	Category
ALMA Performance fails to reach science requirements	1	5	5	Medium
ALMA consists of only 50 antennas	3	2	6	Medium

ALMA consists of only 40 antennas	2	5	10	High
Phase mitigation techniques fail to meet spec	1	5	5	Medium
WVR phase mitigation techniques fail to meet spec	2	2	4	Medium
FS phase mitigation techniques fail to meet spec	1	2	2	Low

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

Site – As preparations continue for construction beginning on Chajnantor, the characterization equipment will be moved to a trailer which can be used for storage of equipment in addition to the testing equipment. The new configuration layout will be staked on the site, with older configuration stakes removed. We will measure the vertical profile of the atmosphere at two sites nearly simultaneously to determine the consistency of a single atmospheric model for Chajnantor.

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

Calibration – Detailed planning continues for tests on the prototype system integrated at the Antenna Test Facility. Amplitude Calibration Science Requirements will be drafted. Nutator Science Requirements will be completed.

Imaging – Holdaway, along with Myers, will pursue imaging goals with ALMA, including self-pointing.

Outreach – ALMA presence at several meetings is planned. Wootten will attend IAU231 in California. An ALMA workshop on [“Galactic and Extragalactic ISM Modelling in an ALMA Perspective”](#) will be held at Onsala in mid-October.