

## 2.9 Science IPT

During January-March, Science IPT activity concentrated on ALMA calibration, operations, imaging and configuration considerations. Specific focus lay in preparation of the ALMA Calibration Strategy Plan, construction of an Operations Plan in concert with the Operations Group, including how the plan described in Chapter 6 of the Project Plan might be improved, and also how the ALMA Science Center will operate. Additional foci were development of the Design Reference Science Plan and elucidation of details in the science requirements document. Tom Wilson led the EU Science IPT for his first full quarter

Joint NA/EU Science IPT staff and Calibration Group telecons were held monthly, and the weekly NA Science IPT telecons continued, well into their sixth year (Agendas and notes for all meetings are available; this period's include telecons on 13, 20 (Science IPT) January, 3, 10 (Science IPT and Sci/NA), 17 and 24 February, 9 (Science IPT) and 16 March. During these telecons, progress on action items is tracked toward meeting milestones and assignments (new action items) are made to assure their timely completion. Beginning in January, Wootten distributes a biweekly Calendar of the ALMA Project at NRAO to NRAO employees, the ANASAC and NA Board Members, and to members of the Science IPT.

### *Milestones*

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

Milestone	Level	Title	Date	Status
9818	2	ICD between Science and Site Approved	2004-Apr-30	Draft submitted
9820	2	Calibration strategy submitted	2004-Feb-15	Submitted
9825	2	Science aspects of operations plan complete	2004-Jun-30	Draft submitted
9830	2	Plan for early science configurations complete	2004-Jun-30	Draft submitted

### *Scientific Advisory Committees*

The Science IPT arranged the agenda, minutes and telecon for the monthly ASAC telecons (held on 7 January and 4 February and 3 March 2004; agendas and minutes in ALMAEDM). The Science IPT supported the ASAC as it developed its response to Charges received from the ALMA Board 29 January 2004. The Science IPT leads participated in the 1-3 March System Design Review, with Wootten chairing the review committee and Laing, Guilloteau and Butler among its members. Related to the ASAC are the ALMA North America Science Advisory Committee (ANASAC) group and European Science Advisory Committee (ESAC), both of which also held telecons. In conjunction with the ANASAC and NRAO, the NA Science IPT held a town meeting at lunchtime on January 8, 2004 during the American Astronomical Society meeting in Atlanta. Planning continued for a general North American ALMA Science Meeting to be



**Figure 1 Attendees at the AAS meeting listen to ALMA described at the Town Hall**

held at the University of Maryland conference center on 14-15 May 2004. These meetings were the subject of ANASAC telecons held 30 January, 27 February and 26 March.

### **Calibration**

The Calibration Plan for ALMA was drafted for comment in mid February. In twelve major sections, all elements of ALMA calibration are addressed:

- Types of calibration, technique detailed
- Required hardware
- Frequency of execution of calibration type
- Length of calibration, frequency dependence
- Archiving needs
- Involvement of other IPTs
- Details of plans for further tests and studies

As a result of discussions on phase calibration, one memo has been submitted. The Science IPT seeks referee comments on Calibration memos; this one is in the refereeing process.

A contract with U. of California Berkeley has been worked out whereby James Gibson joins the Science IPT. He will work on making absolute measurements at 3mm at BIMA as an aspect of the Calibration Plan.

ALMA Project Documents:

ALMA-90.00.00.00-006-A-PLA, **ALMA Calibration Plan**, written by many Science IPT members.

*ALMA MEMO #479 Requirements for Subreflector and Feed Positioning for ALMA Antennas*, Bryan J. Butler

*LAMA MEMO #803 Simulation of Atmospheric Phase Correction Combined With Instrumental Phase Calibration Using Fast Switching*, M. A. Holdaway and L. D'Addario.

Science IPT Documents:

*LAMA Memo No. 805. ALMA Calibration Source Counts at 250 GHz*, M. A. Holdaway (NRAO), C. Carilli (NRAO), F. Bertoldi (MPIfR)

*ALMA Memo Unnumbered* **Bandpass Calibration for ALMA**, A.Bacmann (ESO) and S.Guilloteau (IRAM / ESO)

### **Commissioning and Science Verification**

Laing wrote a new document to provide an overview of the commissioning and science verification phase of the ALMA project. It describes the scope of the activity, its relation to systems integration and operations, and an outline of commissioning activities, concentrating on the period up to Early Science (Q4 2007). Staffing, resources and support required from Operations, Systems Integration and other IPTs are also considered briefly.

New ALMA Project Documents:

ALMA-90.00.00.00-007-A-PLA, **ALMA Commissioning and Science Verification Plan**, R. Laing

### **Configuration, Antennas**

A model was proposed, to be incorporated into the Array Reconfiguration Sequence (ALMA-90.02.00.00-003-A-SPE) for the detailed schedule of transporter movement of antennas.

Conway also wrote specifications for the First Science Array Configurations ALMA-90.02.00.00-004-A-SPE. The initial complement of antennas at the Chajnantor site (target date Q3, 2007) will consist of 8 antennas of which 6 will be available for use for interferometry observations. This array will be used both for testing and for the first scientific observations. Such 'first science' observations will be interesting in their own right, allowing high frequency observations on an excellent site and uniquely demonstrating >1km baselines on a millimeter interferometer. In addition such 'first science' observations will provide a stringent 'end to end' test of the array systems.

The document outlines first science configurations using 6 antennas and the 172 pads whose locations are described in document ALMA-90.02.00.00-001-F.SPE. As more antennas are delivered to the site configurations for antennas numbers between 6 and 64 will be required. These additional configuration plans are beyond the scope of the document and will be presented in a subsequent document.

Conway continues work on a document describing antenna position calibration procedures, to be submitted shortly.

New ALMA Project Documents:

ALMA-90.02.00.00-003-A-SPE **Array Reconfiguration Sequence**, by Conway, revision underway.

ALMA-90.02.00.00-004-A-SPE **First Science Array Configurations** by Conway, first draft of new document.

### **Site Characterization**

The Site Characterization group kept the flow of data from the site coming through the austral winter. Two ICDs were drafted between Science and Site. ALMA-20.01.04.00-90.05.13.00-A-ICD describes the weather stations to be installed on the AOS site for the purpose of supplying weather data for phase correction models, antenna pointing, and dynamic scheduling. ALMA-20.08.11.00-90.00.00.00-A-ICD describes Science IPT needs, including weather stations, at the OSF site. Both are in draft form.

New ALMA Project Document:

ALMA MEMO #485 **Chajnantor Windroses** Simon J. E. Radford

New Science IPT Document:

LAMA MEMO #804 **Effect of Global Warming on Precipitable Water Vapor Above Sub-millimeter Wavelength Astronomical Sites**, M. A. Holdaway

## **Science Requirements**

The ALMA Scientific Requirements was considered by the Change Control Board in March, with some modifications suggested. Other additional changes were made to the document during the present quarter. The Science Requirements document provided standards against which, for example, the System Design Review and the ALMA front end design reviews, held in March, could be compared.

## **Design Reference Science Plan**

The Design Reference Science Plan was completed and presented to the project in December. The ASAC recommended that a similar document be prepared which covers typical proposals expected during interim science from 2007--2012 when only a limited number of antennas will be available. Work on this Early Science DRSP has commenced with the identification of 31 proposals executable to at least partial efficacy during the Early Science period by Wilson and Hogerheijde. Wootten and Glendenning are working on identifying a specific set of modes which will be available on the First Science ALMA interferometer.

The DRSP is already proving very useful to other elements of ALMA. The Science and Software Requirements Committee worked to identify the data rates and data product sizes for a subset of DRSP experiments. The ASAC, working with the Science IPT, is working to establish levels of calibration accuracy needed for the components of the DRSP.

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

Many discussions have occurred between the Science IPT leads and members of SE, working to establish a full set of system specifications.

Science IPT was represented at the AMAC meeting by Wootten, who made a presentation on the Science IPT. Wootten, Wilson and Laing attended miniALMA Week near Garmisch, where the Science IPT made several presentations.

The Science IPT held discussions with the FE IPT on tests of calibration devices. A plan for further tests was reconveyed, including the design of the amplitude calibration device described in ALMA Memo No. 461. Implementation of this device in the Array was sought by way of a change request.

The Science IPT participates in the Operations Group. Wootten attended the face-to-face meeting of the Group leadership with leaders of the Software IPT 21-22 January in Charlottesville. Version G3 of the Operations Plan was written as of the end of March, and it was submitted to the Executives for comment. Wootten and Emerson drafted a plan for the North American ALMA Science Center to be presented to the NRAO Director.

A major activity has been construction of the Calibration Plan, some details of which are described above.

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

Wootten planned the AAS Town Meeting mentioned above, chaired by Crutcher with presentations by Tarengi, Lo, Emerson and Wootten. Wootten, Lo and Emerson also made ALMA presentations in Charlottesville to NRAO staff on 20 January and before the AMAC meeting on 10 March. Wootten attended an 'NRAO/AUI/ALMA in Chile' meeting at AUI where he presented results of his survey of NRAO scientists on working in Chile.