

2.9 Science IPT

Planned versus actual accomplishments over the period

During the period, Science IPT has provided the review panel chair, Robert Laing, for the Tunable Filter Bank PDR; Robert also served on the Fiber Management CDR. Further revisions of the ALMA Scientific Specifications and Requirements (ALMA-90.00.00.00-001-A-SPE) were written by Wootten; the status of this revision is pending CCB Review. The CCB approved the antenna move plan and the plan for the largest 64 antenna configuration. During the December-January period, the Science IPT has focused on the ALMA rebaselining effort, supporting prototype antenna testing at the ATF, the plan for assembly, integration, verification and commissioning of ALMA in Chile and, at the end of the period, providing support for the ASAC as it prepared to address its Charge from the Board. The plan for transition from site characterization activities to site monitoring activities during the ALMA Operations phase was put in place.

Scientific Advisory Committees

As planned, the Science IPT facilitated the meeting of the ALMA Scientific Advisory Committee as it met in Charlottesville during 2004 September and in Garching during 2005 February. The Science IPT provided support to the ASAC as it responded to its Charges from the Board. The IPT distributed the September report to other IPT leads in the project. Additionally, the Science IPT planned to the European ALMA Science Advisory Committee during its meeting in Garching 2004 September 23. Advice on ALMA Regional Centers and Early Operations was provided to the project based on the input of the community via this meeting. This was followed on 2005 Oct 26 by an ESO Scientific and Technical Committee discussion of the ARC. Wilson and Wootten attended the Board meetings in Santiago Oct 29 – Nov 6. An ARC meeting was held in Garching 2005 Feb 4 to discuss the Expressions of Intent for the European nodes to the ARC in Garching. The ANASAC discussed talks and handouts for the Town Meeting at the 205th AAS meeting. At the meeting, Min Su Yun, chairman of the ANASAC, presented the ALMA Science talk. Under its Terms of Reference, terms of ANASAC members expired at the end of February. Plans for rotation of members were developed, a memo written detailing the selection procedure, and new members joined the committee.

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-Nov 30	Revised 2005 Jan 15
9835	2	Report WVR strategy / implementation / operations	2004-Sep-30	Modified; ALMA Memos 515 and 517.
Being assigned	2	Redesign configuration for 50-60 antennas	2005-Aug-30	In Progress

Note that Milestone 9835 in its original form depended upon tests of the WVR at the ATF. In the currently understood schedule, that has slipped to April 2007. Therefore we issued ALMA Memos No. 515 and 517 on the WVR strategy. Given the weather patterns at the ATF it is unlikely that WVR field testing can now be completed before winter 2006/7. As reported in June 2003, the baseline at the ATF is likely to be too short for atmospheric phase correction demonstrations; the field testing is mainly to demonstrate operation of the instrument.

Technical status and technical performance results achieved

Calibration

In early October, an updated and expanded version of the Calibration Plan was produced under the guidance of the Calibration Group leader, Jeff Mangum. Under the impact of support for the prototype testing at the ATF, the Calibration Group's efforts progressed slowly. 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 at and is under test at IRAM. Initial reports of measurements of a simpler, fallback amplitude calibration device utilizing a semi-transparent vane in Madrid have suggested that it may be suitable for ALMA. A final report is expected in March. Plans have been developed to perform astronomical tests of a semitransparent vane amplitude calibration device at the ATF in 2005.

Holdaway, Stirling, Richer and Hills continue to refine their grid of atmospheric models with which to model WVR performance in a study to determine the most effective way to combine fast switching and WVR correction of atmospheric phase perturbation, publishing ALMA Memos No. 515 and 517.

Commissioning and Science Verification

A plan incorporating schedule and resources was developed, based on the revised version of the Science Commissioning (CS) Plan presented at the ALMA Community Day week in Garching, on 24 Sept. and to the ASAC on 27 Sept. A CS team has been formed, comprised of Laing, Emerson, Chandler, Lucas, Mangum, Shepherd, Wilson, Wootten, Saito, Morita and Kawabe. In discussions with the PMCS team, a plan for this phase of ALMA has been laid out in detail. By the end of November, a plan had been received from the Project Engineer and discussions on merging the two plans had begun.

To accomplish this goal, the Science IPT sponsored a meeting of its personnel along with those from system engineering and computing IPTs and the Operations Group at the AOC in Socorro 13-15 January 2005. The meeting was attended by Project Manager Tony Beasley and Project Engineer Rick Murowinski.

As a result of the meeting, several action items were delegated and a more complete version of the plan for assembly, integration, verification and commissioning of ALMA in Chile was developed. Plans for activities at the prototype interferometer at the ATF were also further developed.

Configuration, Antennas

The plan for calibration of ALMA baselines, a complex process for an array in which several elements move every few days was published as ALMA Memo No. 503 after review by several referees. The plan is also being refined in such a way as to ease the specifications on the fiber, in discussions with Shillue.

The final two documents of the plan for the configuration of the 64 element ALMA were approved—the *Array Reconfiguration Sequence* and the *Long Baseline (Y+) Array Configuration Specifications and Requirements*. As ALMA approaches the end of the antenna procurement phase, it has become clear that one outcome of the rebaselining process may be an array of fewer than 64 antennas. Accordingly, a mitigation plan was developed to produce a configuration appropriate for 50 antennas. Work on this plan has begun, with a configuration expected by the end of summer 2005.

Site Characterization

Simon Radford left for another position at the beginning of November. Wilson and Wootten met with Nyman in San Pedro to develop a plan to deal with his loss, involving a gradual descope of characterization activities and phasing into operations period monitoring. It was decided to maintain the record, now a continuous ten years, without introducing new equipment. Monitoring of site conditions continues, with monthly posting of data to the ALMA website. Particular focus has turned to atmospheric characterization data needed during operation of the array. Radford left unfinished the definition of the instrumentation needed; this is now being finished by the Cambridge group. The preliminary document is available in the Science IPT documents area of ALMAEDM and has been provided to members of other IPTs for comment; it will be submitted in 2005 March.

Lars-Ake Nyman continues to lead the site characterization group part time. Roberto Rivera spends his weekdays at the OSF with periodic maintenance visits to the instruments near the future AOS. An assistant, Jorge Diaz, was hired to accompany Rivera on these visits in conformance with site safety rules. Data from the NA instruments is now processed and posted by Mark Holdaway in Tucson. With the development of the ancillary instrumentation plan for monitoring of site weather conditions during the operations phase, plans have been detailed for the transition.

Science Requirements

Papers detailing how ALMA would achieve its Level One Science Requirements, after the project document awaiting approval, were given at the DUSTY04 meeting in Paris; they have been published in ESA-SP577 “The Dusty and Molecular Universe”.

Organization, interaction with other IPTs

The Science IPT has worked closely with the SE&I IPT members to define the activities and milestones during the prototype integration at the ATF and subsequent ALMA

integration in Chile. Wootten and Wilson attended a meeting on Assembly Integration and Verification sponsored by the Science IPT in Socorro 2005 Jan 14-15. Mangum and Emerson have spent most of their time this period working with the prototype antenna testing at the ATF.

Meetings, Outreach and Public Education

On Oct 4-8, 2004 the "Cool Universe: Observing Cosmic Dawn" conference was held in Valparaiso, Chile. The emphasis of the conference was to introduce ALMA science to the Chilean astronomical community. The conference included an number of 1 hour review talks on topics ranging from the CMB and cosmic reionization, to the ISM and star formation, plus numerous short contributions. The conference was well attended (about 100 participants), with the majority coming from the Chilean astronomical community, including good representation from CTIO, ESO, and the Chilean universities. Beasley represented ALMA; Wilson, Beasley and Wootten wrote a paper, '*Status of the ALMA Large Millimeter Array*', for the Proceedings.

More than 230 potential ALMA and Herschel users gathered in Paris for the Dusty and Molecular Universe conference, which focused on the science the community expects to reap from ALMA and Herschel. Paul van den Bout spoke on the origins of ALMA, and Carlos de Breuck and John Richer presented the top level ALMA science requirements from the newly approved Project Plan v2. A number of reviews of ALMA science capabilities were also given. The Proceedings of the conference have already appeared. Wilson attended the RadioNet directors meeting at Jodrell Bank 16/17 Nov. Later he gave an ALMA lecture at the IRAM interferometry school, for which he also sat on the scientific organizing committee. In December, he attended the Herschel preparation meeting and the start of the EU program 'The Molecular Universe.' Wootten worked with van den Bout and Hibbard on defining the North American ALMA Science Center, delineating web content to introduce it to the community. He gave a presentation on ALMA and the NAASC at Johns Hopkins University on 1 February.

An ALMA Town Meeting was held on 2005 January 11 (Tuesday) during the 205th AAS Meeting held in San Diego, CA. Wilson also attended, after a period in Tucson for discussions with ALMA personnel. The meeting was an outstanding success, with discussion continuing afterward such that the room had to be cleared so that the next session could begin. At the meeting, an ALMA booth was manned by ALMA personnel

to answer questions. Wootten presented an introduction to plans for the North American



ALMA Science Center.

Wilson attended a meeting on ALMA-Herschel synergy at the ESA headquarters in Paris on 11 February and is writing a written report for ESA. Wilson is also working on a contract for the EU program 'ALMA Enhancement' which will bring 8.5M Euros to the project for hardware and software, with some obligations on the part of ALMA pending Board approval.

ALMA newsletters for North America and Europe have been released. Wootten continues to issue a biweekly calendar of events within the NRAO ALMA effort.

Highest level technical and managerial risks and concerns.

Issue	Probability Score	Impact Score	Risk Exposure	Category
ALMA Performace 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 – The batteries powering the ALMA/NA equipment at Chajnantor are now ten years old, twice their nominal service lifetime, and are no longer reliable. A plan for their replacement is being developed. Site personnel will be doing ground truth checkout on the terrain map used for configuration development in advance of the redesign. The most recent Digital Elevation Map will be described and made available.

Configuration – Conway, working with Holdaway, will redesign the ALMA configuration for fifty antennas, with provision for placing 64 antennas should that number become available.

Calibration – Mangum will continue detailed planning for tests on the prototype system integrated at the Antenna Test Facility.

Imaging – Holdaway will develop better methods of simulating ALMA data. In particular, he will focus on uses of the pointing self-calibration techniques under investigation at the AOC.

Outreach – ALMA presence at several meetings is planned. Wootten will present 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 will be held in Paris in early April. ALMA information will be available at booths at the CASCA meeting in Montreal and at the AAS meeting in Minneapolis. There will be an ANASAC face-to-face meeting abutting the Submillimeter workshop at the Center for Astrophysics in June.