MILLIMETER ARRAY/ALMA-US
DESIGN AND DEVELOPMENT

MONTHLY REPORT
MONTH END DECEMBER 2000

1 Executive Summary

The ALMA project reached a major milestone in the month of December with the completion of the ALMA Joint Project Book. This document contains the complete description of the scope and design choices for the baseline project. The complete project book can be found on the ALMA web site at

http://www.alma.nrao.edu/projectbk/construction/

In addition, concurrent with the completion of this document, a configuration control plan has been adopted for this and future project level documents. Changes to the Project Book now require a review by the leaders of any subsystem potentially affected by the change. A configuration control board (CCB) will review all comments and make a recommendation of the change request on the disposition to management.

A significant test of the ALMA Common Software (ACS) was successfully completed using the Kitt Peak 12M as a testbed. The 12M, which is on loan from NRAO to the University Of Arizona, was "loaned back" for these tests. The ACS controlled the telescope to point and track making use of its optical telescope. The success of this test demonstrated both the maturity of the software development effort and the ability of the distributed development team to work collaboratively to produce high quality software.

2 Programmatics

2.1 Financial Statement

[Not Included]

2.2 Personnel

The ALMA Project staffing is reported by WBS Level-1 category based on the joint project WBS. The total number of full-time equivalent employees was 59.0.

2.3 Progress Against Project Milestones

Attached to this report is the Project Gantt chart displaying the summary-level tasks of the Phase 1 Project WBS. For each of these summary tasks the progress against the baseline is reported as a percent complete. The same information is shown graphically; progress is reported as horizontal bars colored green; work still pending is shown in black or solid blue. Milestones are indicated by triangles, colored green for completed milestones and colored red for pending milestones. A vertical red line is used to indicate the date of the presentation.

In December, two major milestones were scheduled for completion. These were the completion of the ALMA Joint Project Book and the Design Approval for the Vertex Antenna. The Project Book was completed on 8 December and is now under configuration control. Design approval of the Vertex Antenna awaits formal responses from Vertex on the issues identified at CDR. While none of these issues are expected to be critical, the delay in this milestone may have an impact on the schedule for prototype antenna delivery.

3 Meetings And Memos

3.1 Meetings Held During December 2000

ALMA U.S. DH Meeting Teleconferences - December 4, December 11, December 18
ALMA Joint DH/TL Meeting Teleconferences - December 4
ALMA Joint Receiver Development Group Teleconference - December 7
ASAC Teleconference - December 4
ALMA Configuration Meeting - December 20
ALMA/NSF Meeting - weekly teleconferences
ALMA Lo/Rx Meeting - weekly teleconferences
ALMA Imaging and Calibration Meeting - weekly teleconferences
ALMA Executive Committee Meeting - weekly teleconferences

3.2 Planned Meetings in January 2001

ALMA Configuration Group Teleconference - January 4, 23
JRDG Teleconference - January 4, 31
Polarization Teleconference - January 4
ALMA DH Meeting - January 15, 22
ALMA Joint DH/TL Meeting - January 5, 29

ALMA Optics Teleconference - January 12
ASAC Teleconference - January 19
ALMA CV Site Meeting - January 25
ALG Meeting - January 15-16 (Tokyo, Japan)
ALMA/NSF Meeting - weekly teleconferences
ALMA Lo/Rx Meeting - weekly teleconferences
ALMA Imaging and Calibration Meeting - weekly teleconferences
ALMA Executive Committee Meeting - weekly teleconferences
ALMA Control Software - weekly teleconferences
ALMA Joint Software Management - weekly teleconferences
ALMA Joint Software Workers - monthly teleconferences
ALMA SSR - monthly teleconferences

3.3 ALMA Technical Memos Distributed in December 2000

334	Atmospheric Transparency at 225 GHz over Chajnantor, Mauna Kea,and the South Pole	Simon Radford and Richard A. Chamberlin
338	The Best Sites for the Compact ALMA Configuration	Bryan Butler, Simon Radford, and Angel Otarola
339	Aspects of the Antennas for the ALMA Compact Array (ACA)	Jacob W.M. Baars
340	Measurements of Commercial Vacuum Windows for ALMA Bands 3 and 6	G.A. Ediss, S-K. Pan, J. Effland, and T. Globus
342	An Improved FX Correlator	J. Bunton

The full catalog of the ALMA Memo Series can be found at the ALMA web site at http://www.alma.nrao.edu/memos/.

4 Technical Progress Reports

4.1 Antennas

A formal response on CDR Issues was submitted to Vertex. These were mostly requests for additional details or further modeling results.

A review of the Vertex and EIE antenna foundation designs was initiated including review of the Geo-Test soils reports of the ALMA antenna foundations taken at the VLA site.

Preparations have begun to convert the foundation designs from Eurocode standards to US standards. This will allow a larger number of local contractors to bid on the job.

Vertex has delivered a Safety Plan for the prototype antenna. A review of this plan is being coordinated with the NRAO safety office.

4.2 Frontend

Receiver Components

Serious international collaboration on the use of integrated preamplifiers with SIS mixers was begun with a visit to SRON in the Netherlands by E. Lauria. We delivered a 4-12 GHz amplifier to the group working on the Band 9 receiver for use in their development, and discussions were held on the technical details of that integration. Work continued for the 211-275 SIS mixer-preamp integration with further calculations on the noise match between the mixer and preamp. It appears that removing one stage of RF choke on the mixer will improve the match, reducing the noise ripple at the upper end of the IF band. First calculations were performed to analyze the noise match for a balanced SIS mixer configuration; a new interstage network was designed for this purpose. Work was also begun on the detailed layout of integrating the Band 6 sideband-separating, balanced mixer with two preamps, including the required bias networks.

Tests of additional 211-275 GHz sideband-separating, balanced mixer chips were performed. It appears that all the mixers from the first prototype chip have a higher than satisfactory noise temperature. It was possible to diagnose what fabrication deficiencies resulted in this excess noise, and a new wafer which is expected to correct the problems will be delivered in January.

Work is continuing on improved optics for the test system, including matching layers for windows, lenses, and IR filters. Some experiments in machining the plastic materials are in progress in the shop, and some materials have been characterized. Most of the measurements have been made with an HP 85106 vector network analyzer at 100 GHz.

Laboratory measurements of the cryogenic characteristics of phosphor bronze wire were located and distributed. Use of this wire is expected to result in greater mechanical strength, and still improve the temperature of the SIS mixer stage.

More work was performed on the design and simulation of waveguide quadrature hybrids for use in balanced and sideband-separating SIS mixers; an ALMA memo is being prepared.

An ALMA memo on how to make the choice between HFET and SIS mixer receivers for Band 3 was written and issued.

A memo detailing the number of wires required to operate various SIS mixer receiver configurations was prepared, showing that on the order of 100 wires maximum could be needed. Work was performed on an improved heat-sinking system to reduce the heat load on the 4K refrigerator stage due to thermal conduction. A memo on the use of Nanonics connectors for cryogenic applications was researched; these connectors are certified for spaceflight and are used extensively and successfully on the SIRTF dewar.

Work continued on making operational the second closed-cycle test dewar for SIS mixers, named JT1. Much work remains to be done on this system to equip it for routine use, but the cryogenic performance has already been improved.

4.3 Local Oscillator System

Local Oscillator Drivers and Multipliers

Detailed planning was carried out for LO drivers and multipliers. Knowledge acquired with increased design and simulation effort is now making clearer exactly which components (amplifiers and multipliers) can be expected to cover which frequencies. A plan was generated for easing the construction and use of the test receivers by incorporating a new, fixed-tuned frequency tripler for 80-240 GHz. This will also be part of the ALMA Band 6 LO system. Delivery of working prototypes to Tucson is now tentatively planned for April 2001; although these prototypes may not achieve the full bandwidth needed for final use, they are expected to deliver sufficient power to cover most of Band 6, which will meet the requirements of the test receivers.

Work continued on characterizing phase noise and drift, and an ALMA memo on this subject is being prepared.

Local Oscillator Reference System

Changes to the Central Reference Generator digital board were finalized. Components for the distribution of the 20.833 Hz signal were researched and selected. Up to 40 RS-422 loads and 8 LVDS loads can be accommodated. A quote for the comb generator was received from Omniyig

Test Interferometer 1st LO

This effort includes constructing phase-locked LO sources for all three bands of the TI (Bands 1, 3, and 6) and also constructing the first downconverter for Band 3 (from its 14-22 GHz first IF to the ALMA-standard IF of 4-12 GHz).

Various millimeter wave components were ordered and others were received. Most parts for all four subsystems are now on hand, and breadboarding in the laboratory has started. Procurement of the Gunn diode oscillators (GDOs) for Band 3 and Band 6 continues to be a problem. Design of the mechanical connections between these GDOs and motor-driven actuators is in progress. We have adopted the automated GDO tuning system designed for the Sub-Millimeter Array (Harvard-Smithsonian Center for Astrophysics); we have on hand a sample of their control board and we have developed initial software for communicating with it. Design of modified firmware for that board, as well as for our monitor-control interface board, has started.

Photonic subsystems

Photonic systems for the ALMA test interferometer include two laser synthesizers and a master laser that together will synthesize the reference for the first LO. These units, along with two fiber line stretcher modules, will all be located at the central building. At

the antennas, photomixers are provided to convert the lightwave to the appropriate millimeter references.

Most of the work was focused on trying to improve the phase noise of the breadboard laser phase lock setup. A reduction of about 50 percent was achieved by using a high speed optical modulator in the phase locked loop to cancel residual noise. This gives us confidence that the photonic reference phase noise can eventually be improved to meet the ALMA phase noise specifications. Also, a commercial laser was selected for the laser synthesizers and these will be ordered in January 2001. The photomixers for band 1 have been selected and will be ordered from a commercial supplier. Development of the photomixers for the higher frequency bands is ongoing at Rutherford Appleton Laboratory.

4.4 Backend Subsystem

Data Transmission Fiber Optic Link

Work was started on the layout of the demultiplexor board for the receiving end of the link.

Downconverter

Four bids for the 1.6-4.0 GHz pin diode digital attenuators for the Test Interferometer downconverters were received and reviewed. An order will be placed for 13 units with expected deliveries of 4 months.

Received 1-4 Ghz and 1-18 GHz tunnel diode detectors in flat packs and dual polarity. Will evaluate them then requisition in quantity for the Test Interferometer. Six weeks after ordering, received a mixer and several tunnel diode detectors from Advanced Microwave. Variation of mixer conversion loss vs. LO power is significant and may be a problem. Quotes were received from only 2 out of 32 vendors solicited for 1.6 GHz filters with 100 and 800 MHz bandwidths for the TI. Both claimed14 week deliveries.

4.5 Correlator

Intensive simulation of the ALMA-1 custom correlator chip has continued. A new computer with 1 Gbyte memory, purchased for use in electromagnetic simulations by the SIS mixer group, was delivered and was used by the correlator group during December; in January, it is expected that the entire chip will be simulated. So far, the design has been verified. It is expected that the simulations will be completed by the end of January, and that we will be ready to go to prototype chip fabrication at that time.

A memo on the successful FIR filter card testing reported last month was completed.

The prototype station card and FIR filter test fixture are in Tucson being assembled. Testing is expected to begin in January.

The selected fabricator of the Long Term Accumulator cards had difficulty in manufacturing the boards on the first two tries, but seemed not to be discouraged. Delivery of good boards is expected in January.

Initial software for the Infineon microprocessor, which will be used on the ALMA correlator control cards, was written.

4.6 Computing

A joint NRAO-ESO team consisting of G. Chiozzi, R. Heald, R. Karban and A. Perrigouard was involved in the 12 m Kitt Peak test. This was successfully performed in the nights of Dec.1-8 in KP with the support of R. Freud. B. Glendenning attended also the last night of these tests. The telescope was used to point and track making use of its optical telescope. First the same tests done one year ago were repeated and then the new prototype Mount System (AMS) built on top of the prototype release of the ALMA Common Software (ACS) was tested, as a way of validating ACS. The same pointing/tracking results were obtained and this was useful not only to advance with software prototype development, but also to create a good team spirit in view of joint tests at the VLA site in one year from now. After the tests, the NRAO Tucson offices had an ACS development environment installed, with the assistance of R. Karban.

Progress meetings were held with prototype antenna Contractors. In particular, the ICD#9 (command interface) was discussed and made as similar as possible at its CDR level with both the US and European Contractors.

Comments were collected for the Software Standards Review to be held in January.

Planning (final budget, software release schedule) for the test interferometer control system (TICS) was reviewed internally.

The SSR Committee work continues with the objective to bring Version 2 of the requirements to review early in the New Year.

Work of the Analysis and Design team continued, in view of a completion of the first Analysis document for Feb. 2001.

Next Month

Document template and coding standards documents will be reviewed

4.7 Systems Engineering

(Holography)

Refinement of the receiver design and procurement of components continued. Many of the millimeter wavelength and microwave parts are now on hand. Design of the main antenna feed horn has started.

(Documentation)

Editing of the draft Project Book was completed.

An automated system for tracking engineering documents was created on the WWW, allowing numbers to be assigned by authors and electronic copies of the documents to be located by anyone.

(Design Issues)

Discussions continued on standardization, concentrating on the monitor-control interfaces.

Detailed design of the optical fiber configuration for the test interferometer was completed, and suitable cable was ordered. This avoids a potential schedule problem, since such cable is currently in short supply.

4.8 Imaging and Calibration

I. Imaging - Configuration Studies, Site and Water Vapor Radiometry

The imaging and calibration group held several phone meetings during December, with the agenda, indices and linked documents to be found at:

http://www.cv.nrao.edu/~awootten/mmaimcal/

A. Configuration Studies

The simulation efforts for the primary ALMA array progressed substantially moving toward configuration preliminary design review 26-27 February in Grenoble. At the PDR, the external reviewers will be Lee Mundy, of U. Md. and BIMA, and Eric Anterrieu of Toulouse. Steve Heddle in the UK continued to progress on the imaging simulation, focussing on metrics by which differences between the images as seen by different configurations may be evaluated. The next teleconference was to be held 4 January.

Wootten compared site maps and the configuration pad locations, producing a set of pad locations which may be close to quebradas or have other problems, so that Butler, Radford and Otarola might inspect them as time was available during their visit to Chajnantor, which occurred this month also (see below).

B. Site

With the arrival of the austral summer, the first of the seasonal campaigns at the site occurred during December. The field work at Chajnantor involved J. Bolyard (GB), B. Butler (Soccoro), M. Diaz (U. Chile & SAO), A. Otarola (ESO), and R. Vivera (U. Antofagasta & ESO). During this period, there were visits by C. Canizares (MIT & AUI), B. and B. Millard (MIT alumnus), and A. Dutrey (IRAM).

Bolyard conducted a safety assessment of NRAO field operations at Chajnantor. Specific concerns were task lighting and cable management in the instrument container. Vehicle safety and safety rules were also discussed.

Various maintenance items to keep the site testing equipment operating were performed. The ALMA/US interferometer was beyond field repair and parts were shipped to Tucson, but the ALMA/EU interferometer was confirmed operational. The multiwavelength (1300/350/260/200 um) submillimeter tipper was restored to operational status but the 350micron-only tipper was returned to Tucson for repair and upgrade.

Otarola supervised the installation of another container adjacent to the existing ESO container. This will support another solar electrical system to provide adequate power for all the ESO instruments, especially in winter.

Butler launched two or three radiosondes daily, with helpers. Canizares and the Millards were impressed with site and enjoyed assisting with a radiosonde launch. Dutrey also assisted with radiosonde launches and with the antenna location survey.

She was favorably impressed with site and feasibility, if not ease, of working there. She was concerned about safety aspects, in particular that bad habits established early on would be hard to correct later.

A. Readhead (Caltech) confirmed the seasonal change in weather pattern. For the first time since August, the CBI has observed a few instances of localized clouds over Chajnantor this month. Readhead and S. Myers (Soccoro) will review their observing logs and identify these events for correlation with other data.

With helpers, Butler surveyed several candidate locations for compact configurations and for antennae in extended configurations. All field workers agree field checks of candidate configurations will be necessary because, for example, some relevant topographic features are below the resolution (10 m pixels) of our maps. As a result, roughly half of the 12 sites identified as questionable and which were examined were found to have terrain which was probably too rough for easy antenna transport.

Radford and others also proceeded to the SAO site on Sairecabur, at 5500m, to tend the FTS, recover data, and run calibrations.

Upon return to the US, Radford began reduction of data recovered during the visit and Butler worked on reduction of the radiosonde data. Radford will co-chair a session on Millimeter and Submillimeter Wavelength Atmospheric Radiometry at the URSI meeting in Boulder in January.

II. Calibration

Mangum continued work on defining errors in the ALMA calibration system. At the URSI meeting, there were to be several ALMA sessions involving Imaging and Calibration. One session will be Millimeter Wavelength Observing and Calibration Techniques, which will be chaired by Mangum.

Radford and Mangum continued work on the subreflector system for the prototype antenna, which includes a calibration system of the sort pioneered at BIMA.

B. Pointing Calibration

Mangum continued with formulation of the plan for the second optical pointing system. Using a cooled CCD detector, increased sensitivity may be achieved with this system. It will also be CFRP-based.

III. Science

A. ALMA studies, including the ASAC

Butler will chair a session on radar and radiometric observations of planetary surfaces at the URSI meeting in Boulder.

Wootten participated in design of brochures for ALMA, one version designed for use by the informed lay public, and another for use by astronomers. These will be ready for distribution at the AAS Meeting in San Diego and at the URSI meeting next month.

The ASAC held its regular meeting on 11 December. At that meeting, nine Japanese members were welcomed on the recommendation of the ACC at its Fall meeting. Members of the ASAC expressed some concern that ALMA was not being optimized for polarization measurements. An ad hoc teleconference of antenna, receiver, ASAC and imaging and calibration group members was planned for early January to address these concerns.

Emerson explained some issues having to do with fringe tracking and Booth reported on issues discussed at the Morroco site testing meetings in November.

A report on last month's meeting with Tony Readhead on what ALMA might learn from the first year of CBI experience at Chajnantor was prepared.

Plans for Next Month

During January, work will concentrate on preparation for the Configuration PDR, to be held in February, and on preparation for the MMA OC meeting and ASAC meetings to be held the week before. We expect final resolution of the question of the metric whereby configuration imaging properties will be measured.

Issues and concerns

One concern which surfaced during polarization discussions was that the front end package will need to be sent to production before its properties are well measured on the prototype antennas.

MILLIMETER ARRAY/ALMA-US

PROJECT STAFFING

MONTH END DECEMBER 2000

WBS Task Name	Number Of Persons Participating in Activity*	Full-time Equivalent Employees
Administration	11	6.9
Site Development	1	0.0
Antennas	4	3.0
Front-End	21	15.3
Local Oscillator	11	8.8
IF and Fiber Optics	6	6.0
Correlator	5	4.0
Computing	9	8.5
System Integration	5	4.5
Calibration	2	2.0
TOTAL:	75.0	59.0

* Several persons in this column are counted two or more times. These particular individuals are involved part-time in more than one activity.

Atacama Large Millimeter Array

ALMA Phase 1 Milestone Progress

(as of 2000-12-14)

Phase 1 Major Milestones selected

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View: ALMA Phase 1 Progress
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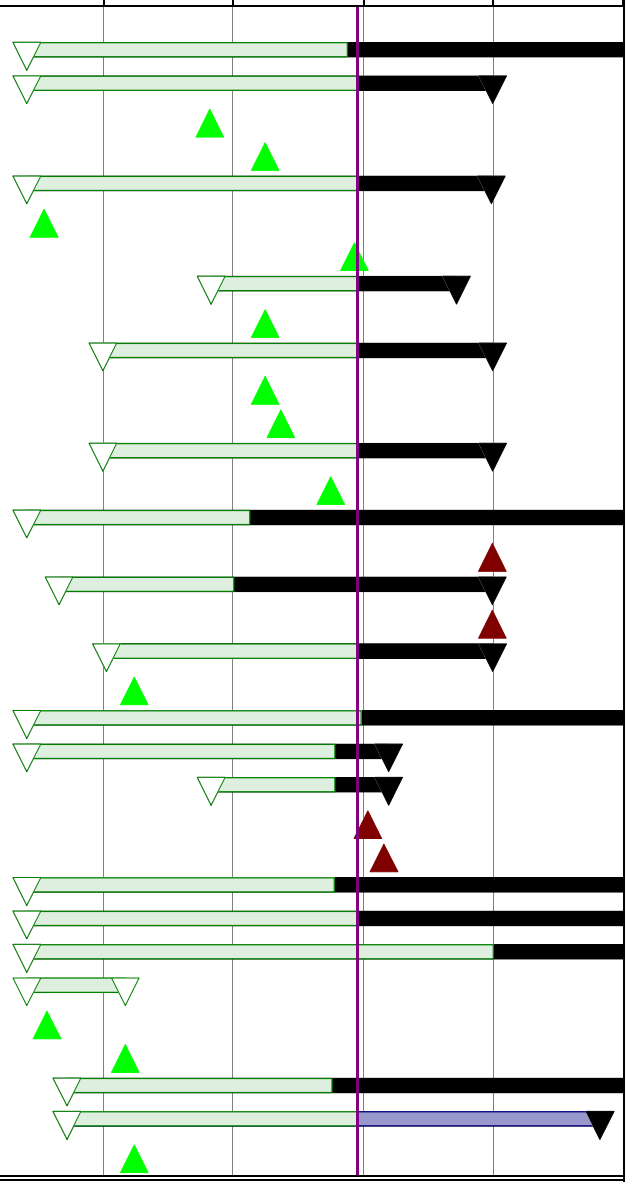
ID	WBS (f)	Task	Start	Finish	% Done
0		**ALMA Joint Work Plan**	**1998-06-01**	**2010-12-31**	
1	1	**Management/Administration**	1998-06-01	2010-12-31	43%
2	1.05	Phase 1 Management	1998-06-01	2001-12-31	71%
4	**1.05.10**	**Deliver WBS for ALMA D&D phase**	**1999-10-28**	**1999-10-28**	**100%**
6	**1.05.20**	**Deliver final WBS for ALMA project**	**2000-03-31**	**2000-03-31**	**100%**
7	1.05.25	Project Book	1998-06-01	2001-12-28	71%
9	**1.05.25.10**	**MMA Project Book: Version 1**	**1998-07-20**	**1998-07-20**	**100%**
10	**1.05.25.15**	**ALMA Project Book: Joint Version**	**2000-12-08**	**2000-12-08**	**100%**
11	1.05.30	Phase 1 Joint Management Plan	1999-11-01	2001-09-21	58%
13	**1.05.30.10**	**Deliver Phase 1 Joint Management Plan**	**2000-03-31**	**2000-03-31**	**100%**
53	1.10	Phase 2 Planning	1999-01-01	2001-12-31	62%
56	**1.10.15**	**Deliver Baseline Scope of Phase 2**	**2000-03-31**	**2000-03-31**	**100%**
58	**1.10.25**	**Deliver Draft Phase 2 Plan**	**2000-05-15**	**2000-05-15**	**100%**
60	1.10.35	Management Planning	1999-01-01	2001-12-31	69%
61	**1.10.35.05**	**Deliver Management Plan for Construction**	**2000-10-02**	**2000-10-02**	**100%**
76	1.20	Agreements in Chile	1998-06-01	2010-12-31	20%
78	**1.20.10**	**CONICYT Use Permissions**	**2001-12-31**	**2001-12-31**	**0%**
79	1.20.15	OSF Agreement (Operations Support Facility)	1998-08-31	2001-12-31	46%
82	**1.20.15.15**	**Access to OSF Land**	**2001-12-31**	**2001-12-31**	**0%**
85	1.25	Partnerships and Agreements	1999-01-11	2001-12-31	59%
87	**1.25.10**	**Partnership Recommendations to NSF**	**1999-03-30**	**1999-03-30**	**100%**
94	2	**Site Development**	1998-06-01	2010-12-31	19%
100	2.10	Development Plans	1998-06-01	2001-03-14	95%
110	2.10.10	Estimate Development Costs	1999-11-01	2001-03-14	81%
129	**2.10.10.15**	**PDR: Review Site Development Plan**	**2001-01-15**	**2001-01-15**	**0%**
131	**2.10.10.25**	**Deliver revised development Plan**	**2001-03-01**	**2001-03-01**	**0%**
247	3	**Antenna Subsystem**	1998-06-01	2010-12-31	15%
248	3.05	Antenna Management/Subsystem Engineering	1998-06-01	2010-12-31	18%
251	3.05.10	Antenna Subsystem Engineering	1998-06-01	2010-07-01	16%
252	3.05.10.05	Antenna Subsystem Design & Specification	1998-06-01	1999-03-05	100%
258	**3.05.10.05.30**	**Antenna PDR**	**1998-07-28**	**1998-07-28**	**100%**
260	**3.05.10.05.40**	**CDR: Antenna RFP/CfT**	**1999-03-05**	**1999-03-05**	**100%**
262	3.10	Prototype Antennas	1998-09-22	2003-04-01	29%
263	3.10.05	U.S. Prototype Antenna	1998-09-22	2002-10-29	36%
266	**3.10.05.15**	**Issue Prototype Antenna RFP**	**1999-03-30**	**1999-03-30**	**100%**



Milestones: **bold type**
Summary Tasks: **underline**

Joint Task
Eur Task
US Task
Summary (Joint)
Summary (Eur)
Summary (US)
Progress
Milestone
Completed Mlstn
Summ. Progress
Split

Atacama Large Millimeter Array

ALMA Phase 1 Milestone Progress

(as of 2000-12-14)

Phase 1 Major Milestones selected

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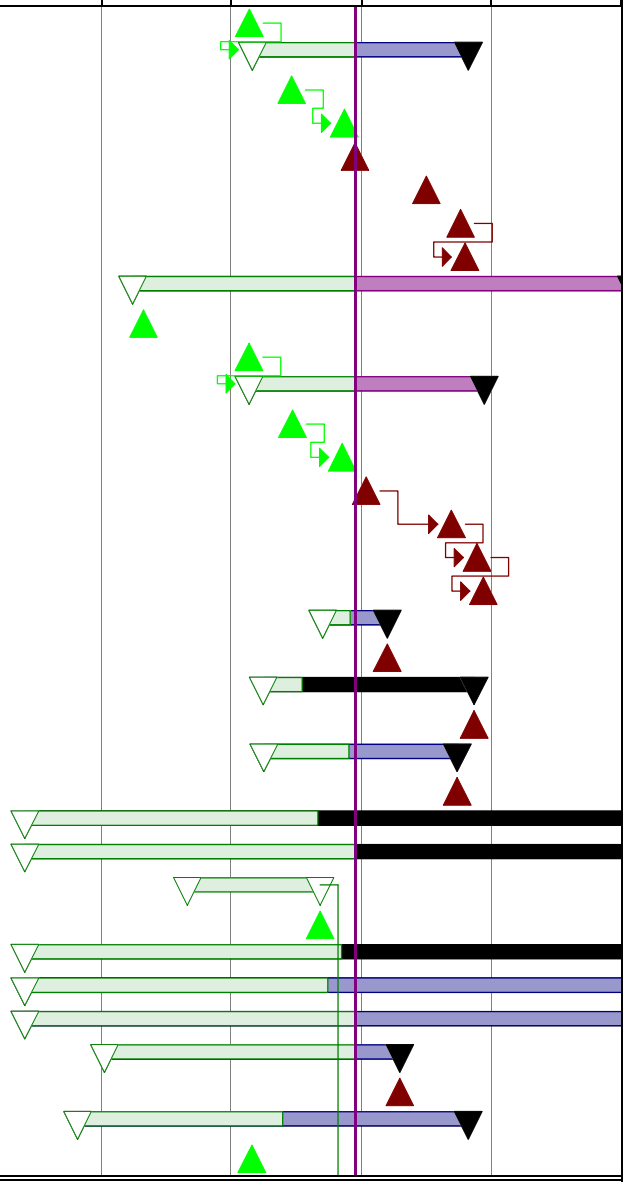
View: ALMA Phase 1 Progress
Printed: 4:17 PM 2000-12-14

ID	WBS (f)	Task	Start	Finish	% Done
270	**3.10.05.35**	**Sign Contract (Prototype Antenna #1)**	**2000-02-22**	**2000-02-22**	**100%**
271	3.10.05.40	US Prototype antenna contract supervision	2000-03-02	2001-10-30	47%
273	**3.10.05.40.10**	**Vertex Prototype antenna PDR**	**2000-06-20**	**2000-06-20**	**100%**
274	**3.10.05.40.15**	**Vertex Prototype antenna CDR**	**2000-11-15**	**2000-11-15**	**100%**
275	**3.10.05.40.16**	**Vertex Design Approval**	**2000-12-15**	**2000-12-15**	**0%**
280	**3.10.05.40.22**	**Vertex Prototype Site Assembly Start**	**2001-07-04**	**2001-07-04**	**0%**
282	**3.10.05.40.40**	**Begin Vertex Prototype ant. on-site acceptance tests**	**2001-10-08**	**2001-10-08**	**0%**
283	**3.10.05.40.45**	**Deliver Vertex Prototype Antenna**	**2001-10-20**	**2001-10-20**	**0%**
286	3.10.10	European Antenna Prototype Procurement	1999-03-31	2003-01-30	43%
288	**3.10.10.10**	**Issue prototype antenna CfT**	**1999-04-30**	**1999-04-30**	**100%**
292	**3.10.10.30**	**Sign prototype antenna #2 contract**	**2000-02-21**	**2000-02-21**	**100%**
293	3.10.10.35	Prototype antenna contract supervision	2000-02-21	2001-12-13	46%
295	**3.10.10.35.10**	**EIE Prototype antenna PDR**	**2000-06-22**	**2000-06-22**	**100%**
296	**3.10.10.35.15**	**EIE Prototype antenna CDR**	**2000-11-09**	**2000-11-09**	**100%**
298	**3.10.10.35.25**	**Prototype antenna final design approval**	**2001-01-15**	**2001-01-15**	**0%**
301	**3.10.10.35.30**	**Prototype antenna fabrication complete**	**2001-09-12**	**2001-09-12**	**0%**
302	**3.10.10.35.35**	**Prototype antenna site assembly complete**	**2001-11-23**	**2001-11-23**	**0%**
305	**3.10.10.35.45**	**Deliver EIE Prototype Antenna**	**2001-12-11**	**2001-12-11**	**0%**
308	3.10.15	VLA Site foundation	2000-09-15	2001-03-15	43%
312	**3.10.15.20**	**Foundation completed**	**2001-03-15**	**2001-03-15**	**0%**
313	3.10.20	Prototype Metrology/Test Equipment	2000-04-01	2001-11-15	17%
338	**3.10.20.40**	**Deliver Prot. Antenna Metrology System**	**2001-11-15**	**2001-11-15**	**0%**
339	3.10.25	Prototype Nutator	2000-04-03	2001-09-28	44%
342	**3.10.25.15**	**Deliver Prototype Nutator**	**2001-09-28**	**2001-09-28**	**0%**
377	4	**Front End Subsystem**	1998-06-01	2010-12-31	23%
378	4.05	Front End Management/Subsystem Engineering	1998-06-01	2010-12-31	27%
383	4.05.10	Front End Subsystem Design & Specification	1999-09-01	2000-09-08	100%
387	**4.05.10.20**	**Final Front End Specifications**	**2000-09-08**	**2000-09-08**	**100%**
391	4.10	SIS Mixer Development	1998-06-01	2003-12-17	85%
399	4.10.10	Balanced, sideband separating SIS mixers	1998-06-01	2003-12-17	92%
463	4.10.10.40	Mixers	1998-06-01	2003-12-17	76%
468	4.10.10.40.10	230 GHz	1999-01-11	2001-04-20	88%
516	**4.10.10.40.10.2**	**Deliver prototype 230 GHz Mixer**	**2001-04-20**	**2001-04-20**	**0%**
616	4.20	Antenna Evaluation Front Ends	1998-10-27	2001-10-29	68%
624	**4.20.40**	**CDR: Evaluation Front End**	**2000-02-29**	**2000-02-29**	**100%**



Milestones: **bold type**
Summary Tasks: **underline**

Joint Task
Eur Task
US Task
Summary (Joint)
Summary (Eur)
Summary (US)
Progress
Milestone
Completed Mlstn
Summ. Progress
Split

Atacama Large Millimeter Array

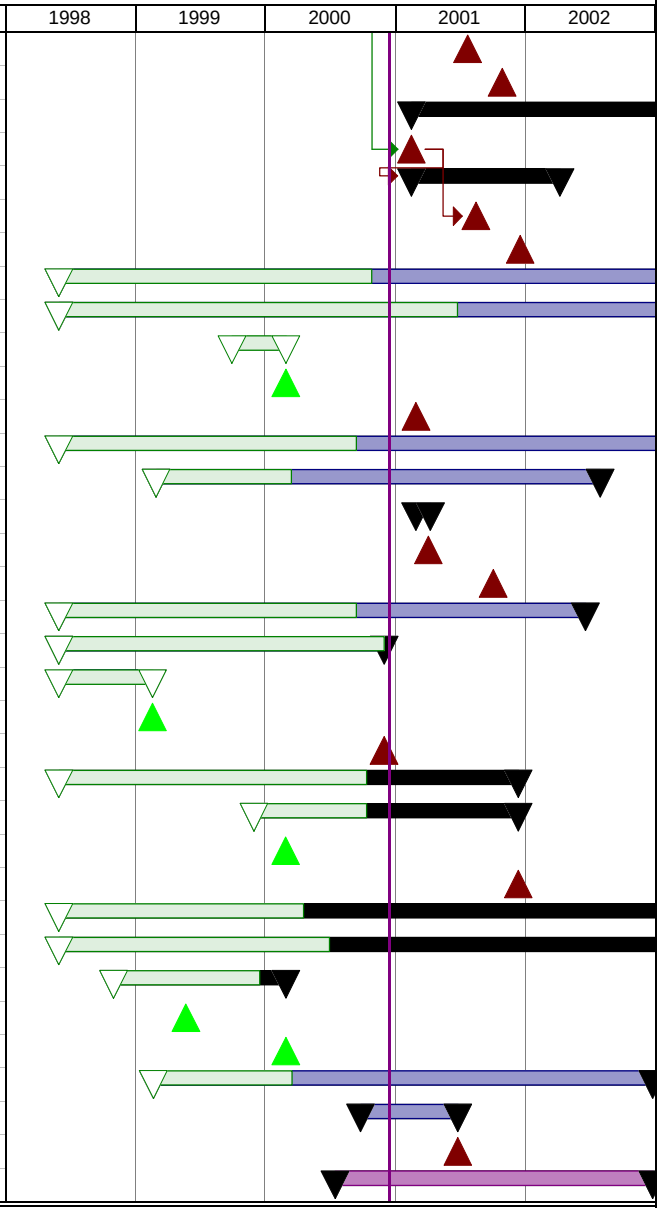
ALMA Phase 1 Milestone Progress

(as of 2000-12-14)

Phase 1 Major Milestones selected

File: almaplan2000dec14.mpp
View: ALMA Phase 1 Progress
Printed: 4:17 PM 2000-12-14

ID	WBS (f)	Task	Start	Finish	% Done
630	**4.20.70**	**Deliver Antenna Test Eval Front End #1**	**2001-07-24**	**2001-07-24**	**0%**
632	**4.20.80**	**Deliver Antenna Test Eval Front End #2**	**2001-10-29**	**2001-10-29**	**0%**
633	4.25	Prototype Front Ends	2001-02-16	2003-09-17	0%
634	**4.25.05**	**PDR: Front End Subsystem**	**2001-02-16**	**2001-02-16**	**0%**
635	4.25.10	Front End Engineering Model	2001-02-16	2002-04-10	0%
648	**4.25.10.20**	**Front End Eng. Model Progress Review 2**	**2001-08-16**	**2001-08-16**	**0%**
649	**4.25.10.25**	**Deliver Front End Eng. Model Components**	**2001-12-19**	**2001-12-19**	**0%**
714	5	**Local Oscillator Subsystem**	1998-06-01	2010-12-31	16%
715	5.05	LO Management/Subsystem Engineering	1998-06-01	2010-12-31	20%
719	5.05.15	LO Ref system definition	1999-10-01	2000-02-29	100%
723	**5.05.15.20**	**PDR: LO Reference**	**2000-02-29**	**2000-02-29**	**100%**
724	**5.05.17**	**PDR: LO Subsystem**	**2001-03-01**	**2001-03-01**	**0%**
730	5.10	Prototype LO	1998-06-01	2009-12-24	48%
734	5.10.05	LO Reference Prototype	1999-03-01	2002-07-31	2%
982	5.10.05.15	LO Ref Bench system, integrate and test	2001-02-28	2001-04-10	0%
985	**5.10.05.15.15**	**Deliver LO Ref bench prototype**	**2001-04-05**	**2001-04-05**	**0%**
987	**5.10.05.25**	**Deliver LO Ref field prototype**	**2001-10-04**	**2001-10-04**	**0%**
990	5.10.10	Multiplier Chain LO Prototype	1998-06-01	2002-06-20	76%
1009	5.10.10.15	Multiplier R&D	1998-06-01	2000-12-01	99%
1010	5.10.10.15.05	Prototype multiplier development	1998-06-01	1999-02-19	100%
1013	**5.10.10.15.05.1**	**PDR: Multiplier Chain LO**	**1999-02-19**	**1999-02-19**	**100%**
1055	**5.10.10.15.40**	**CDR: Multiplier Chain LO**	**2000-12-01**	**2000-12-01**	**0%**
1088	5.10.15	Photonic LO Distribution Prototype	1998-06-01	2001-12-13	53%
1091	5.10.15.48	Photonic Distribution Development	1999-12-01	2001-12-13	45%
1092	**5.10.15.48.05**	**PDR: Photonic Distribution**	**2000-02-28**	**2000-02-28**	**100%**
1125	**5.10.15.50**	**Deliver Photonic LO Dist Prototype**	**2001-12-13**	**2001-12-13**	**0%**
1182	6	**Backend Subsystem**	1998-06-01	2010-12-31	12%
1183	6.05	Backend Management/Subsystem Engineering	1998-06-01	2010-12-31	23%
1186	6.05.10	Backend system definition	1998-11-02	2000-02-29	94%
1191	**6.05.10.25**	**Decision: Analog/Digital Transmission**	**1999-05-24**	**1999-05-24**	**100%**
1193	**6.05.10.35**	**CDR: Backend Subsystem**	**2000-02-29**	**2000-02-29**	**100%**
1197	6.10	Prototype Backend Subsystem	1999-02-22	2002-12-26	20%
1477	6.10.20	Bench system, integrate and test	2000-09-26	2001-06-26	0%
1480	**6.10.20.15**	**Deliver Backend bench prototype**	**2001-06-26**	**2001-06-26**	**0%**
1484	6.10.45	Prototype Digitizer/Sampler	2000-07-17	2002-12-26	0%



Milestones: **bold type**
Summary Tasks: **underline**

Joint Task
Eur Task
US Task
Summary (Joint)
Summary (Eur)
Summary (US)
Progress
Milestone
Completed Mlstn
Summ. Progress
Split

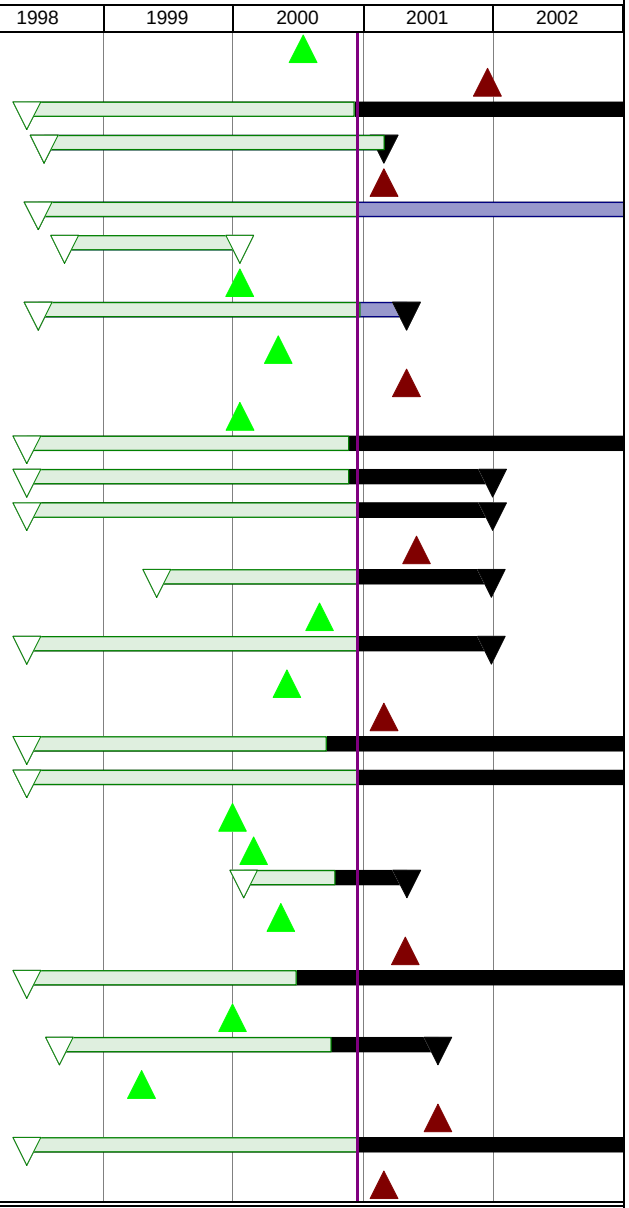
Atacama Large Millimeter Array

ALMA Phase 1 Milestone Progress

(as of 2000-12-14)

Phase 1 Major Milestones selected

ID	WBS (f)	Task	Start	Finish	% Done
1486	**6.10.45.10**	**Pre-prototype ASIC design to foundry**	**2000-07-17**	**2000-07-17**	**100%**
1492	**6.10.45.40**	**Prototype Sampler Final Report**	**2001-12-17**	**2001-12-17**	**0%**
1509	7	**Correlator**	1998-06-01	2010-12-30	25%
1517	7.10	Test Correlator	1998-07-20	2001-03-01	99%
1523	**7.10.30**	**Deliver Test Correlator to Alma Test site**	**2001-03-01**	**2001-03-01**	**0%**
1524	7.15	Baseline Correlator	1998-07-03	2007-11-29	55%
1525	7.15.05	Baseline Correlator Preliminary Design	1998-09-15	2000-01-20	100%
1530	**7.15.05.25**	**PDR: Correlator**	**2000-01-20**	**2000-01-20**	**100%**
1531	7.15.10	Finite Impulse Response Filter Development	1998-07-03	2001-05-03	89%
1542	**7.15.10.40**	**PDR: Finite Impulse Response Filter**	**2000-05-08**	**2000-05-08**	**100%**
1548	**7.15.10.75**	**Deliver Prototype FIR Filter**	**2001-05-03**	**2001-05-03**	**0%**
1612	**7.15.30**	**CDR: Prototype Correlator**	**2000-01-21**	**2000-01-21**	**100%**
1651	8	**Computing Subsystem**	1998-06-01	2010-12-31	18%
1652	8.03	Computing Development (Phase 1)	1998-06-01	2001-12-31	66%
1653	8.03.05	Management	1998-06-01	2001-12-31	71%
1655	**8.03.05.10**	**Deliver Phase 2 Computing Plan**	**2001-06-01**	**2001-06-01**	**0%**
1656	8.03.10	Science Software Requirements	1999-06-01	2001-12-28	60%
1658	**8.03.10.10**	**Deliver Science Software Requirements v2**	**2000-09-01**	**2000-09-01**	**100%**
1673	8.03.30	Control Software	1998-06-01	2001-12-28	65%
1677	**8.03.30.20**	**PDR: Control Software**	**2000-06-01**	**2000-06-01**	**100%**
1678	**8.03.30.25**	**CDR: Control Software**	**2001-03-01**	**2001-03-01**	**0%**
1716	9	**System Engineering & Integration**	1998-06-01	2010-12-31	12%
1719	9.10	System Engineering	1998-06-01	2010-12-31	25%
1721	**9.10.10**	**System Block Diagram for Array**	**1999-12-31**	**1999-12-31**	**100%**
1723	**9.10.20**	**System Design Review**	**2000-02-28**	**2000-02-28**	**100%**
1728	9.12	Test Site Preparation/Outfitting	2000-02-01	2001-05-04	56%
1730	**9.12.10**	**Design Review: Test Int. Site Preparation**	**2000-05-15**	**2000-05-15**	**100%**
1737	**9.12.35**	**Test Interferometer Site Complete**	**2001-04-30**	**2001-04-30**	**0%**
1738	**9.15**	**ALMA Prototype Interferometer Evaluation**	**1998-06-01**	**2003-04-09**	**1%**
2	**9.15.10**	**Deliver Prot. Ant. Testing Plan**	**1999-12-31**	**1999-12-31**	**100%**
1751	9.20	Holography System	1998-09-01	2001-07-30	17%
1754	**9.20.15**	**Design Review: Holography System**	**1999-04-19**	**1999-04-19**	**100%**
1757	**9.20.30**	**Deliver Holography System**	**2001-07-30**	**2001-07-30**	**0%**
1766	10	**Science**	1998-06-01	2009-12-31	52%
1770	**10.17**	**CDR: ALMA Array Layout**	**2001-03-01**	**2001-03-01**	**0%**



Summary Tasks: **bold type** / **underline**

Joint Task
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