

MILLIMETER ARRAY/ALMA-US DESIGN AND DEVELOPMENT

MONTHLY REPORT MONTH END JUNE 2001

1 Executive Summary

Two major meetings were held in June, each having significant impact on the ALMA project. The first meeting of the ALMA Management Advisory Committee (AMAC) was held in Garching, Germany at ESO headquarters. Immediately following this meeting, the Expanded ALMA Coordinating Committee (EACC) met.

The AMAC heard two days of detailed presentation on the current development status and plans for construction for the ALMA project. The meeting focused on the bilateral project, but considered the impact of a third partner in each of the areas. The review panel will submit a written report to the ACC. In the exit interview, the committee indicated that they were very impressed with the Phase I progress to date in technical development and design, and in joint organization and planning.

The major focus of the EACC meeting was to define a scope for a Tripartite ALMA. The EAEC presented the costs associated with completing the baseline scope in a three-way partnership. Also presented was the cost of adding capabilities that were deferred in the bilateral project to reduce costs. The ALMA Science Advisory Committee (ASAC) prioritized these deferred capabilities. The EAEC cost estimates showed that the ASAC's highest priorities could be included in a Tripartite ALMA at a total cost that realized a 10% savings to the original partners compared to the baseline bilateral project. The EACC endorsed this scope and directed the EAEC to pursue appropriate planning.

The project learned in June that the European prototype antenna is delayed due to a contract dispute between ESO and the antenna contractor, EIE. The design phase for the prototype is complete and EIE is in the process of submitting the Complete Design Documentation. This is a contract milestone. EIE has informed ESO that they do not have sufficient resources to complete fabrication and cannot proceed until this issue is resolved. ESO is considering options to resolve this situation. Until a date for the start of fabrication is determined, it is impossible to project a credible completion date.

The Vertex procurement continues to move forward. The current delivery date of 23 April 2002 remains unchanged since last month.

2 Programmatic

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 66.3.

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.

In June, three major milestones were scheduled for completion. These are shown in the table below.

WBS Number	Task	Scheduled Completion	Status
2,15.15.20	Submit EIA Document to Chile	6-15-2001	Document is complete. Submission to the Chilean government has been delayed until negotiations on land use have progressed.
5.1.10.15.20.30	Deliver 80-240 GHz Tripler	6-1-2001	CDL version delayed due to foundry problems with MMIC. Commercial source of tripler obtained that will satisfy

10.22	Calibration PDR	6-21-2001	requirement for evaluation receiver. Completed per schedule.
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3 Meetings And Memos

3.1 Meetings Held During June 2001

ALMA Management Advisory Committee Meeting - June 8 - 9 - Garching, Germany
 EACC Meeting - June 11 - 12 - Garching, Germany
 Calibration PDR - June 21 - 22 - Cambridge, England
 Tri-lateral Project Teleconference - June 25
 ALMA US Division Head Teleconferences - June 04, 18
 ALMA Tri-Project DH Teleconference - June 25
 ASAC Teleconferences
 EAEC Teleconferences
 AEC/SE Teleconferences
 ALMA Systems Group Weekly Teleconferences
 ALMA Imaging & Calibration Teleconferences

3.2 Planned Meetings in July 2001

ALMA US DH Teleconference - July 2, 9, 16, 23
 Tri-lateral Project Teleconference - July 30
 SSR Face-to-Face Meeting - July 16-17 - Berkeley, CA
 ALMA US Division Head Teleconferences - July 02, 09, 30
 ALMA Tri-Project DH Teleconference - Jul 30
 ASAC Teleconferences
 EAEC Teleconferences
 AEC/SE Teleconferences
 ALMA Systems Group Weekly Teleconferences
 ALMA Imaging & Calibration Teleconferences

3.3 ALMA Technical Memos Distributed in June 2001

371	Receiver Calibration Schemes for ALMA	S.Guilloteau (IRAM/ESO), R.Moreno (IRAM)
377	Design and Fabrication of Quartz Vacuum Windows With Matching Layers for Millimeter-Wave Receivers	Daniel Koller, A.R. Kerr, G.A. Ediss, and D. Boyd
378	A 200-300 GHz SIS Mixer-Preamplifier	E. F. Lauria, A. R. Kerr, M. W.

with 8 GHz IF Bandwidth
380 The Correlator at the OSF?

Pospieszalski, S.-K. Pan, J. E.
Effland, A. W. Lichtenberger
Bryan Anderson and Roshene
McCool

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

Vertex reports they remain on schedule for a 23 April 2002 handover of the prototype antenna. They have made major progress to start the fabrication of the pedestal structure and the BUS. Contracts with two big companies for the steel and the CFRP structures have been negotiated and will be signed early in July. Both have committed to a supply in December 2001 and accepted a 10 per cent penalty clause for later delivery.

A panel surface treatment by simple etching has been investigated and appears to be a solution capable of meeting the ALMA specifications. Testing of surface samples at ESO/MPI will give final confirmation.

The foundation contractor will begin construction of the pad for the Vertex antenna early in July. This will be the first concrete poured for the ALMA project. The VA embedded beam arrived at the VLA site. Assembly of the beam is complete and the beam has been leveled to within 1 mm at all three points. The Concrete Contractor will have little problem in achieving the +/-0.35 mm accuracy required for the final level.

The project learned in June that the European prototype antenna is delayed due to a contract dispute between ESO and the antenna contractor, EIE. The design phase for the prototype is complete and EIE is in the process of submitting the Complete Design Documentation. This is a contract milestone. EIE has informed ESO that they do not have sufficient resources to complete fabrication and cannot proceed until this issue is resolved. ESO is considering options to resolve this situation. Until a date for the start of fabrication is determined, it is impossible to project a credible completion date.

4.2 Frontend

ALMA Memo 378, "A 200-300 GHz SIS Mixer-Preamplifier with 8 GHz IF Bandwidth" describes initial results for a 200-300 GHz SIS mixer/preamplifier with an IF bandwidth of 8 GHz. The mixer uses Nb/Al-oxide/Nb tunnel junctions in a circuit with low IF capacitance and inductance. The mixer block mounts directly on the body of a three-stage 4-12 GHz preamplifier which uses discrete InP HFET devices. Mixer bias is provided through the input circuit of the preamplifier. At a LO frequency of 230 GHz, the measured mixer-preamp gain is 30-35 dB, and the DSB receiver noise temperature is 45-

57 K across the whole IF band. The preamp alone has 40 dB of gain, and dissipates 7.7 mW. This mixer/preamplifier has demonstrated that an IF bandwidth of 8 GHz is indeed achievable for ALMA Band 6.

4.3 Local Oscillator System

There is significant interest in the capabilities of a photonic phase cal system. Such a system would use technology identical to that used in for the photonic LO. A proposal was presented at the ALMA Calibration PDR that describes the capabilities such a system could provide for ALMA. The possible extension of this calibration source to polarization calibration was also discussed.

Three power amplifiers for a phase-locked 108-GHz driver are undergoing tests. These cover this range (100-112 GHz) with about 100mW output power. Drift versus temperature measurements was characterized. Also, the ability to achieve level control using amplifier gate bias was demonstrated.

4.4 Backend Subsystem

Nick Peereboom joined the Backend group filling an open position. He will initially work on the downconverter design.

Tests are progressing on a number of commercial components for possible use in the downconverter modules. Catalog components such as switched-pad attenuators and bandpass filters will be significantly cheaper than custom or semi-custom designs if they can meet the necessary specifications. Manufacturers specifications are often incomplete and tests of samples are required to verify suitability for the ALMA designs.

4.5 Correlator

Routing of the correlator card is now complete. The card has 8 layers, 3 power and 5 routing layers. None of the 20,342 vias are hidden or blind. This is a significant achievement.

Good progress has been made on the filter card testing. Correct loading of the tap weights has verified and the filter shape obtained for a sample $\frac{1}{2}$ band filter has the appropriate transfer function. An interim report has been posted on the ALMA correlator web site.

Testing of the Long Term Accumulator continues. A very short duration test of operation above 125 MHz was performed. Testing above the intended frequency of 125 MHz demonstrates necessary design margin. Using a test where a built-in pseudo number sequence drives the LTA input, and accumulating for 10 seconds, the results at all 2 Million accumulation results on the LTA card were compared to predicted values, with no errors found up to the highest clock speed presently available, 140 MHz.

The first level of control logic used to control the allocation of correlator output bandwidth among multiple sub-arrays has been tested. The results demonstrate that the

approach taken is viable. This is the first step for transferring accumulated results into the output adder tree stream.

4.6 Computing

Significant progress has been made on a correlator simulator using CORBA and the ACS software. This simulator runs under Linux where a CORBA server makes available simulated property values like power supply voltages, and sample spectral data sets to CORBA clients. This functionality will be useful for TICS in the near future and allows the simulation of the test correlator without needing the actual correlator hardware. Also this exercise is extremely helpful in learning about CORBA and to provide the European authors of ACS with feedback on their development effort.

A complete monitor data chain was operated including a from monitor point in vxworks box, data collector in a linux box, and a archiver feeding a DB2 database, with connection to data pickup via a windows pc using odbc from excel.

Command system / scripting functions have been created to handle Test Interferometer Startup. This includes communications services, process control and equipment monitoring. Also included are the Monitor Archive Database functions of data collection, archiving, table maintenance and remote access.

4.7 Systems Engineering

The Optical Pointing Telescope (OPT) is now completely functional. We can now interface to our two CCD cameras (one cooled, one uncooled) and acquire frames at video rates. The camera interface software was upgraded to allow for a command-string-based control of the system. The OPT can now be commanded to produce live video sent to a remote display, acquire an image with a designated integration time, produce jpg and fits formatted images, and allow for crosshair interaction with an image.

A heater has been added to the optical telescope's dew shield to prevent ice on the lens cover mechanism and the formation of dew on the lens. A circuit to control the heaters and at the same time monitor the temperature of the dew shield is available. This will complete the design of the control board.

4.8 Imaging and Calibration

A very successful Calibration PDR was held at Cambridge, England. The minutes of the meeting can be found at <http://www.cv.nrao.edu/~awootten/mmaimcal/asac/calpdr.htm>.

Atmospheric phase stability has been measured at Chajnantor and Pampa la Bola for many years now with Site Test Interferometers. A preliminary analysis of these data showed Chajnantor had smaller phase fluctuation amplitude than Pampa la Bola, but only 6 weeks worth of data were included in that analysis. Given the more extensive data set available now, it seems appropriate to make a more complete comparison. This analysis

is available in ALMA Memo. No. 365, *Atmospheric Phase Stability at Chajnantor and Pampa la Bola*.

Data from side-by-side comparison at Chajnantor in April of NRO 220 GHz tipper and NRAO 225 GHz tipper show both instruments measure the same optical depth (τ). Hence, the measured difference in atmospheric transparency between Pampa la Bola and Chajnantor is real.

A western extension of the digital topographic map was received from McLain Aerial. The necessary reformatting prior to distribution is underway.

**MILLIMETER ARRAY/ALMA-US
PROJECT STAFFING**

MONTH END JUNE 2001

WBS Task Name	Number Of Persons Participating in Activity*	Full-time Equivalent Employees
Administration	11	6.4
Site Development	1	0.0
Antennas	4	2.5
Front-End	22	18.3
Local Oscillator	11	8.8
IF and Fiber Optics	9	9.0
Correlator	5	4.0
Computing	9	8.5
System Integration	6	5.8
Calibration	3	3.0
TOTAL:	81.0	66.3

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

ALMA Milestone Progress (as of 2001-05-30)

Selected Phase 1 Major Milestones and Tasks

Line	WBS (f)	Task	Start	Finish	%done	1999	2000	2001	2002
1	<u>1</u>	Management/Administration	1998-06-01	2010-12-31	52%				
2	1.05	Phase 1 Management	1998-06-01	2001-12-31	84%				
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	1.05.22	Review: ALMA Management Advisory Committee	2001-06-08	2001-06-08	0%				
8	1.05.25	Project Book	1998-06-01	2001-12-28	84%				
10	1.05.25.10	MMA Project Book: Version 1	1998-07-20	1998-07-20	100%				
11	1.05.25.15	ALMA Project Book: Joint Version	2000-12-08	2000-12-08	100%				
12	1.05.30	Phase 1 Joint Management Plan	1999-11-01	2001-09-21	83%				
14	1.05.30.10	Deliver Phase 1 Joint Management Plan	2000-03-31	2000-03-31	100%				
54	1.10	Phase 2 Planning	1999-01-01	2001-12-31	77%				
57	1.10.15	Deliver Baseline Scope of Phase 2	2000-03-31	2000-03-31	100%				
59	1.10.25	Deliver Draft Phase 2 Plan	2000-05-15	2000-05-15	100%				
61	1.10.35	Management Planning	1999-01-01	2001-12-31	82%				
62	1.10.35.05	Deliver Management Plan for Construction	2000-10-02	2000-10-02	100%				
77	1.20	Agreements in Chile	1998-06-01	2010-12-31	25%				
79	1.20.10	CONICYT Use Permissions	2002-12-31	2002-12-31	0%				
86	1.25	Partnerships and Agreements	1999-01-11	2001-12-31	77%				
88	1.25.10	Partnership Recommendations to NSF	1999-03-30	1999-03-30	100%				
91	1.25.25	Final ALMA Partnership Agreements	2001-12-31	2001-12-31	0%				
97	<u>2</u>	Site Development	1998-06-01	2011-12-29	25%				
98	2.05	Site Development Management	1998-06-01	2006-01-19	34%				
99	2.05.03	Site Development Management Phase 1	1998-06-01	2001-12-28	84%				
103	2.07	Site Development Requirements	1998-06-01	2001-12-31	96%				
105	2.07.10	Deliver Initial Operations Plan	2000-05-01	2000-05-01	100%				
106	2.07.15	Deliver Revised Operations Plan	2001-03-30	2001-03-30	100%				
107	2.07.20	Approval of the Operations Plan	2001-12-31	2001-12-31	0%				
108	2.10	Development Plans	1998-06-01	2002-07-01	85%				
109	2.10.05	Prepare Preliminary Development Plan	1998-06-01	1999-10-15	100%				
118	2.10.10	Estimate Development Costs	1999-11-01	2002-07-01	65%				
119	2.10.10.05	Prepare Initial Plan	1999-11-01	2001-05-31	99%				
127	2.10.10.05.38	Deliver Initial Site Development Plan	2000-06-05	2000-06-05	100%				

Milestones: bold type Summary Tasks: underline	Joint Task	Summary (Joint)	Milestone
	Eur Task	Summary (Eur)	Progress
	US Task	Summary (US)	Completed Mlstr

ALMA Milestone Progress (as of 2001-05-30)

Selected Phase 1 Major Milestones and Tasks

Line	WBS (f)	Task	Start	Finish	%done	1999	2000	2001	2002
137	2.10.10.15	PDR: Site Development Plan	2001-10-01	2001-10-01	0%				
139	2.10.10.25	Deliver revised development Plan	2002-07-01	2002-07-01	0%				
140	<u>2.15</u>	<u>Site Legal Issues</u>	<u>2000-08-21</u>	<u>2011-12-29</u>	<u>5%</u>				
141	2.15.05	(CONICYT Use Permissions Delivered from WBS 1)	2002-12-31	2002-12-31	0%				
142	2.15.10	(Access to OSF Land Delivered from WBS 1)	2002-12-31	2002-12-31	0%				
143	<u>2.15.15</u>	<u>Process Environmental Documents (EIA)</u>	<u>2000-08-21</u>	<u>2002-09-30</u>	<u>37%</u>				
145	2.15.15.07	EIA Started	2000-10-02	2000-10-02	100%				
146	2.15.15.10	Deliver Initial EIA	2000-12-09	2000-12-09	100%				
147	2.15.15.15	Complete EIA Documents	2000-12-11	2001-06-29	90%				
148	2.15.15.20	Submit EIA Documents to Chilean Authorities	2001-10-01	2001-10-01	0%				
149	2.15.15.25	EIA Approval Process	2001-10-02	2002-02-01	0%				
254	<u>3</u>	<u>Antenna Subsystem</u>	<u>1998-06-01</u>	<u>2010-12-31</u>	<u>28%</u>				
255	<u>3.05</u>	<u>Antenna Management/Subsystem Engineering</u>	<u>1998-06-01</u>	<u>2010-12-31</u>	<u>20%</u>				
258	<u>3.05.10</u>	<u>Antenna Subsystem Engineering</u>	<u>1998-06-01</u>	<u>2010-07-01</u>	<u>16%</u>				
259	<u>3.05.10.05</u>	<u>Antenna Subsystem Design & Specification</u>	<u>1998-06-01</u>	<u>1999-03-05</u>	<u>100%</u>				
265	3.05.10.05.30	Antenna PDR	1998-07-28	1998-07-28	100%				
267	3.05.10.05.40	CDR: Antenna RFP/CfT	1999-03-05	1999-03-05	100%				
269	<u>3.10</u>	<u>Prototype Antennas</u>	<u>1998-09-22</u>	<u>2003-09-19</u>	<u>57%</u>				
270	<u>3.10.05</u>	<u>U.S. Prototype Antenna</u>	<u>1998-09-22</u>	<u>2003-06-02</u>	<u>47%</u>				
273	3.10.05.15	Issue Prototype Antenna RFP	1999-03-30	1999-03-30	100%				
277	3.10.05.35	Sign Contract (Prototype Antenna #1)	2000-02-22	2000-02-22	100%				
278	<u>3.10.05.40</u>	<u>US Prototype antenna contract supervision</u>	<u>2000-03-02</u>	<u>2002-05-06</u>	<u>58%</u>				
280	3.10.05.40.10	Vertex Prototype antenna PDR	2000-06-20	2000-06-20	100%				
281	3.10.05.40.15	Vertex Prototype antenna CDR	2000-11-15	2000-11-15	100%				
287	3.10.05.40.22	Vertex Prototype Site Assembly Start	2001-11-12	2001-11-12	0%				
291	3.10.05.40.45	Deliver Vertex Prototype Antenna	2002-04-23	2002-04-23	0%				
298	<u>3.10.10</u>	<u>European Antenna Prototype Procurement</u>	<u>1999-03-31</u>	<u>2003-09-19</u>	<u>50%</u>				
300	3.10.10.10	Issue prototype antenna CfT	1999-04-30	1999-04-30	100%				
304	3.10.10.30	Sign prototype antenna #2 contract	2000-02-21	2000-02-21	100%				
305	<u>3.10.10.35</u>	<u>Prototype antenna contract supervision</u>	<u>2000-02-21</u>	<u>2002-10-25</u>	<u>54%</u>				
307	3.10.10.35.10	EIE Prototype antenna PDR	2000-06-22	2000-06-22	100%				
308	3.10.10.35.15	EIE Prototype antenna CDR	2000-11-09	2000-11-09	100%				

Milestones: bold type Summary Tasks: <u>underline</u>	Joint Task	Summary (Joint)	Milestone
	Eur Task	Summary (Eur)	Progress
	US Task	Summary (US)	Completed Mlstr

ALMA Milestone Progress (as of 2001-05-30)

Selected Phase 1 Major Milestones and Tasks

Line	WBS (f)	Task	Start	Finish	%done	1999	2000	2001	2002
312	3.10.10.35.28	EIE Starts Installation on Site	2002-05-01	2002-05-01	0%				
317	3.10.10.35.45	Deliver EIE Prototype Antenna	2002-09-30	2002-09-30	0%				
323	<u>3.10.20</u>	<u>Vertex Metrology/Test Equipment</u>	<u>2000-04-01</u>	<u>2002-04-09</u>	78%				
350	3.10.20.40	Deliver Vertex Antenna Metrology System	2002-04-09	2002-04-09	0%				
352	<u>3.10.22</u>	<u>EIE Metrology/Test Equipment</u>	<u>2000-04-01</u>	<u>2002-09-27</u>	52%				
379	3.10.22.40	Deliver EIE Antenna Metrology System	2002-09-27	2002-09-27	0%				
381	<u>3.10.25</u>	<u>Prototype Vertex Nutator</u>	<u>2000-04-03</u>	<u>2001-10-01</u>	79%				
385	3.10.25.15	Deliver Prototype Vertex Nutator	2001-10-01	2001-10-01	0%				
387	<u>3.10.27</u>	<u>Prototype EIE Nutator</u>	<u>2001-07-16</u>	<u>2002-04-11</u>	0%				
389	3.10.27.15	Deliver Prototype EIE Nutator	2002-04-11	2002-04-11	0%				
429	<u>4</u>	<u>Front End Subsystem</u>	1998-06-01	2010-12-31	27%				
430	<u>4.05</u>	<u>Front End Management/Subsystem Engineering</u>	<u>1998-06-01</u>	<u>2010-12-31</u>	31%				
435	<u>4.05.10</u>	<u>Front End Subsystem Design & Specification</u>	<u>1999-09-01</u>	<u>2000-09-08</u>	100%				
439	4.05.10.20	Final Front End Specifications	2000-09-08	2000-09-08	100%				
443	<u>4.10</u>	<u>SIS Mixer Development</u>	<u>1998-06-01</u>	<u>2003-12-17</u>	82%				
449	<u>4.10.10</u>	<u>Balanced, sideband separating SIS mixers</u>	<u>1998-06-01</u>	<u>2003-12-17</u>	83%				
512	<u>4.10.10.40</u>	<u>Mixers</u>	<u>1998-06-01</u>	<u>2003-12-17</u>	69%				
517	<u>4.10.10.40.10</u>	<u>230 GHz</u>	<u>1999-01-11</u>	<u>2002-05-02</u>	75%				
563	4.10.10.40.10.25	Deliver prototype 230 GHz Mixer	2001-12-31	2001-12-31	0%				
585	<u>4.10.10.45</u>	<u>Automated Mixer Testing</u>	<u>1998-06-01</u>	<u>2001-08-31</u>	92%				
606	<u>4.10.10.53</u>	<u>Integrated IF</u>	<u>2000-03-01</u>	<u>2001-12-31</u>	54%				
612	<u>4.10.10.55</u>	<u>Vacuum Windows</u>	<u>1998-06-01</u>	<u>2000-02-11</u>	100%				
671	<u>4.20</u>	<u>Antenna Evaluation Front Ends</u>	<u>1998-10-27</u>	<u>2002-04-11</u>	75%				
678	4.20.40	Review: Evaluation Front End	2000-02-29	2000-02-29	100%				
684	4.20.70	Deliver Antenna Test Eval Front End #1	2002-01-11	2002-01-11	0%				
686	4.20.80	Deliver Antenna Test Eval Front End #2	2002-02-14	2002-02-14	0%				
687	<u>4.25</u>	<u>Prototype Front Ends</u>	<u>2001-02-19</u>	<u>2004-07-01</u>	8%				
688	4.25.05	PDR: Front End Subsystem	2001-02-19	2001-02-19	100%				
689	<u>4.25.10</u>	<u>Front End Engineering Model</u>	<u>2001-02-20</u>	<u>2002-08-30</u>	18%				
691	<u>4.25.10.15</u>	<u>Front End Eng. Model Fabrication</u>	<u>2001-03-20</u>	<u>2001-12-28</u>	19%				
692	4.25.10.15.05	Cryostat & Front End Chassis Eng. Model	2001-03-20	2001-11-30	30%				
693	4.25.10.15.10	Front End Warm Optics Eng. Model	2001-03-20	2001-12-28	27%				

Milestones: bold type Summary Tasks: underline	Joint Task	Summary (Joint)	Milestone
	Eur Task	Summary (Eur)	Progress
	US Task	Summary (US)	Completed Mlstr

ALMA Milestone Progress (as of 2001-05-30)

Selected Phase 1 Major Milestones and Tasks

Line	WBS (f)	Task	Start	Finish	%done	1999	2000	2001	2002
695	4.25.10.15.20	Band 3 (89-116GHz) Front End Cartridge Eng. Model	2001-03-20	2001-12-28	10%				
696	4.25.10.15.25	Band 6 (211-275 GHz) Front End Cartridge Eng. Model	2001-03-20	2001-12-28	10%				
697	4.25.10.15.30	Band 9 (602-720 GHz) Front End Cartridge Eng. Model	2001-03-20	2001-12-28	27%				
698	4.25.10.15.35	Band 7 (275-370 GHz) Front End Cartridge Eng. Model	2001-03-20	2001-12-28	27%				
703	4.25.10.25	Deliver Front End Eng. Model Components	2001-12-31	2001-12-31	0%				
768	5	Local Oscillator Subsystem	1998-06-01	2010-12-31	21%				
769	<u>5.05</u>	<u>LO Management/Subsystem Engineering</u>	<u>1998-06-01</u>	<u>2010-12-31</u>	<u>21%</u>				
773	<u>5.05.15</u>	<u>LO Ref system definition</u>	<u>1999-10-01</u>	<u>2000-02-29</u>	<u>100%</u>				
777	5.05.15.20	PDR: LO Reference	2000-02-29	2000-02-29	100%				
778	5.05.17	PDR: LO Subsystem	2001-10-15	2001-10-15	0%				
783	<u>5.10</u>	<u>Prototype LO</u>	<u>1998-06-01</u>	<u>2009-12-24</u>	<u>58%</u>				
784	<u>5.10.03</u>	<u>LO Reference US Phase 1</u>	<u>1998-06-01</u>	<u>2002-05-28</u>	<u>76%</u>				
788	<u>5.10.05.10</u>	<u>LO Reference Test Int Prototype Modules</u>	<u>2000-08-23</u>	<u>2002-03-28</u>	<u>69%</u>				
789	<u>5.10.05.10.10</u>	<u>LO Reference Receiver</u>	<u>2000-12-01</u>	<u>2002-03-28</u>	<u>60%</u>				
824	<u>5.10.05.10.15</u>	<u>Two-Laser generator, RF synthesizer</u>	<u>2000-08-23</u>	<u>2001-08-21</u>	<u>65%</u>				
835	<u>5.10.05.10.20</u>	<u>Second LO synthesizer</u>	<u>2000-11-01</u>	<u>2002-03-07</u>	<u>40%</u>				
870	<u>5.10.05.10.25</u>	<u>Fringe Generator</u>	<u>2000-10-16</u>	<u>2001-12-06</u>	<u>80%</u>				
905	<u>5.10.05.10.30</u>	<u>Central LO Reference Generator / Distributor</u>	<u>2000-08-23</u>	<u>2002-02-13</u>	<u>80%</u>				
940	<u>5.10.05.15</u>	<u>LO Ref Bench system, integrate and test</u>	<u>2001-08-27</u>	<u>2001-10-05</u>	<u>0%</u>				
943	5.10.05.15.15	Deliver LO Ref bench prototype	2001-08-27	2001-08-27	0%				
944	5.10.05.25	Deliver LO Ref field prototype	2002-02-28	2002-02-28	0%				
950	<u>5.10.10</u>	<u>Multiplier Chain LO Prototype</u>	<u>1998-06-01</u>	<u>2002-10-11</u>	<u>62%</u>				
969	<u>5.10.10.15</u>	<u>Multiplier R&D</u>	<u>1998-06-01</u>	<u>2002-04-01</u>	<u>74%</u>				
974	<u>5.10.10.15.10</u>	<u>55->110 GHz Doubler (Band 9)</u>	<u>1998-06-01</u>	<u>1999-02-26</u>	<u>100%</u>				
986	<u>5.10.10.15.15</u>	<u>110->220 GHz Doubler (Band 9)</u>	<u>1998-06-03</u>	<u>2000-01-30</u>	<u>100%</u>				
999	<u>5.10.10.15.20</u>	<u>80->240 GHz Tripler (Band 6)</u>	<u>1998-08-03</u>	<u>2001-07-02</u>	<u>100%</u>				
1005	5.10.10.15.20.30	Deliver Prototype 80-240GHz tripler	2001-07-02	2001-07-02	100%				
1053	<u>5.10.15</u>	<u>Photonic LO Distribution Prototype</u>	<u>1998-06-01</u>	<u>2002-06-18</u>	<u>71%</u>				
1056	<u>5.10.15.48</u>	<u>Photonic Distribution Development</u>	<u>1999-12-01</u>	<u>2001-11-15</u>	<u>71%</u>				
1057	5.10.15.48.05	PDR: Photonic Distribution	2000-02-28	2000-02-28	100%				
1058	<u>5.10.15.48.10</u>	<u>Photomixer Modules</u>	<u>1999-12-01</u>	<u>2001-09-28</u>	<u>81%</u>				
1068	<u>5.10.15.48.15</u>	<u>Laser Synthesizer and Phase Lock</u>	<u>2000-02-22</u>	<u>2001-10-31</u>	<u>75%</u>				

Milestones: bold type Summary Tasks: <u>underline</u>	Joint Task	Summary (Joint)	Milestone
	Eur Task	Summary (Eur)	Progress
	US Task	Summary (US)	Completed Mlstr

ALMA Milestone Progress (as of 2001-05-30)

Selected Phase 1 Major Milestones and Tasks

Line	WBS (f)	Task	Start	Finish	%done	1999	2000	2001	2002
1077	<u>5.10.15.48.20</u>	<u>Correctors for F/O round trip</u>	2000-01-31	2001-10-15	78%				
1088	5.10.15.55	Deliver Photonic LO Dist Prototype	2001-11-15	2001-11-15	0%				
1090	<u>5.10.18</u>	<u>Photonic LO Development</u>	<u>1998-06-01</u>	<u>2002-07-01</u>	71%				
1092	5.10.18.10	Pump 490 GHz SIS mixer photonically	2001-05-15	2001-05-15	100%				
1094	5.10.18.20	Pump 650 GHz SIS Mixer Photonically	2001-12-31	2001-12-31	0%				
1152	6	Backend Subsystem	1998-06-01	2010-12-31	23%				
1153	<u>6.05</u>	<u>Backend Management/Subsystem Engineering</u>	1998-06-01	2010-12-31	28%				
1156	<u>6.05.10</u>	<u>Backend system definition</u>	1998-11-02	2000-02-29	100%				
1161	6.05.10.25	Decision: Analog/Digital Transmission	1999-05-24	1999-05-24	100%				
1164	6.05.16	Backend Subsystem PDR	2001-10-15	2001-10-15	0%				
1168	<u>6.10</u>	<u>Prototype Backend Subsystem</u>	1999-02-22	2002-12-30	56%				
1170	<u>6.10.10</u>	<u>Test Int IF Down-Converter</u>	2000-02-01	2002-01-31	75%				
1176	<u>6.10.15</u>	<u>Test Int Data Transmission System</u>	2000-02-29	2002-03-07	75%				
1387	<u>6.10.20</u>	<u>Bench system, integrate and test</u>	2001-08-27	2001-10-12	0%				
1390	6.10.20.15	Deliver Backend bench prototype	2001-08-27	2001-08-27	0%				
1392	6.10.24	Deliver Test Int Backend Field Prototype	2002-02-21	2002-02-21	0%				
1396	<u>6.10.45</u>	<u>Prototype Digitizer/Sampler</u>	2000-03-01	2002-12-30	31%				
1398	6.10.45.10	Pre-prototype ASIC design to foundry (CMOS)	2000-07-17	2000-07-17	100%				
1403	6.10.45.35	Test Bench qualification tests	2001-07-03	2001-09-03	0%				
1421	Z	Correlator	1998-06-01	2010-12-31	27%				
1429	<u>7.10</u>	<u>Test Correlator</u>	1998-07-20	2001-03-01	100%				
1435	7.10.30	Deliver Test Correlator to Alma Test site	2001-03-01	2001-03-01	100%				
1436	<u>7.15</u>	<u>Baseline Correlator</u>	1998-07-03	2008-04-23	50%				
1437	<u>7.15.05</u>	<u>Baseline Correlator Preliminary Design</u>	1998-09-15	2000-01-20	100%				
1442	7.15.05.25	PDR: Correlator	2000-01-20	2000-01-20	100%				
1443	<u>7.15.10</u>	<u>Finite Impulse Response Filter Development</u>	1998-07-03	2001-09-25	91%				
1454	7.15.10.40	PDR: Finite Impulse Response Filter	2000-05-08	2000-05-08	100%				
1461	7.15.10.85	FIR Filter Performance Report	2001-09-25	2001-09-25	0%				
1462	<u>7.15.15</u>	<u>Custom Board Development</u>	1999-06-23	2002-05-07	67%				
1463	<u>7.15.15.05</u>	<u>Station Card</u>	1999-06-23	2002-03-08	65%				
1476	<u>7.15.15.10</u>	<u>Correlator Card</u>	2000-01-03	2002-03-21	72%				
1485	7.15.15.10.55	Deliver Correlator Card	2002-03-21	2002-03-21	0%				

Milestones: bold type Summary Tasks: <u>underline</u>	Joint Task	Summary (Joint)	Milestone
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ALMA Milestone Progress (as of 2001-05-30)

Selected Phase 1 Major Milestones and Tasks









Line	WBS (f)	Task	Start	Finish	%done	1999	2000	2001	2002
1486	<u>7.15.15.15</u>	<u>Long-Term Accumulator</u>	2000-01-03	2001-12-24	74%				
1495	7.15.15.15.55	Deliver Long Term Accumulator	2001-12-24	2001-12-24	0%				
1496	<u>7.15.15.20</u>	<u>System Control Card</u>	1999-09-02	2002-05-07	59%				
1506	<u>7.15.20</u>	<u>Correlator Chip Development</u>	1999-01-04	2001-10-19	84%				
1546	<u>7.25</u>	<u>Future Correlator</u>	1999-09-01	2010-12-31	8%				
1547	7.25.05	Future Correlator Conceptual Design and Specification	1999-09-01	2001-12-31	75%				
1555	8	Computing Subsystem	1998-06-01	2010-12-31	5%				
1	<u>8.03</u>	<u>Computing Development (Phase 1)</u>	1998-06-01	2002-04-24	54%				
2	<u>8.03.05</u>	<u>Management</u>	1998-06-01	2002-01-16	82%				
6	8.03.05.20	US/European Joint Software Meeting	2000-11-20	2000-11-21	100%				
8	8.03.05.30	Deliver Phase 2 Computing Plan	2001-08-31	2001-08-31	0%				
10	<u>8.03.10</u>	<u>Science Software Requirements</u>	2000-07-14	2001-09-01	99%				
17	<u>8.03.15</u>	<u>High Level Analysis and Design</u>	2000-07-14	2001-09-02	99%				
18	8.03.15.05	Computer Design Concept	2000-11-15	2000-11-15	100%				
37	<u>8.03.25</u>	<u>ALMA Common Software</u>	2000-07-14	2001-12-02	9%				
43	8.03.25.30	Kitt Peak ACS test	2000-12-01	2000-12-01	100%				
47	8.03.25.50	Release of ACS for Test Interferometer	2001-12-02	2001-12-02	0%				
48	<u>8.03.30</u>	<u>Control Software</u>	2000-07-14	2002-04-24	33%				
49	<u>8.03.30.05</u>	<u>Test Interferometer Control Software</u>	2000-07-14	2002-04-24	33%				
204	<u>8.03.30.80</u>	<u>TICS 1.0: Single Dish/Total Power</u>	2001-11-12	2002-01-08	0%				
211	8.03.30.80.35	TICS Release 1.0	2002-01-08	2002-01-08	0%				
226	<u>8.03.35</u>	<u>Correlator Software</u>	2000-07-14	2002-03-01	43%				
227	<u>8.03.35.05</u>	<u>Test Correlator</u>	2000-07-14	2001-06-20	66%				
237	<u>8.03.37</u>	<u>Prototype Correlator</u>	2001-03-12	2002-03-01	0%				
244	8.03.37.35	CDR: Prototype Correlator Software	2002-03-01	2002-03-01	0%				
270	<u>8.03.65</u>	<u>Telescope Calibration</u>	2000-11-19	2001-12-01	0%				
276	8.03.65.30	Release for Test Interferometer	2001-12-01	2001-12-01	0%				
1556	9	System Engineering & Integration	1998-06-01	2010-12-31	16%				
1559	<u>9.10</u>	<u>System Engineering</u>	1998-06-01	2010-12-31	28%				
1561	9.10.10	System Block Diagram for Array	1999-12-31	1999-12-31	100%				
1563	9.10.20	System Design Review	2000-02-28	2000-02-28	100%				
1566	<u>9.12</u>	<u>Test Site Preparation/Outfitting</u>	2000-02-01	2001-11-01	83%				

Milestones: bold type Summary Tasks: <u>underline</u>	Joint Task	Summary (Joint)	Milestone
	Eur Task	Summary (Eur)	Progress
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ALMA Milestone Progress (as of 2001-05-30)

Selected Phase 1 Major Milestones and Tasks

Line	WBS (f)	Task	Start	Finish	%done	1999	2000	2001	2002
1568	9.12.10	Design Review: Test Int. Site Preparation	2000-05-15	2000-05-15	100%		▲		
1569	9.12.15	ALMATSF	2000-07-31	2001-11-01	81%		▶	▶	
1	<u>9.12.15.05</u>	<u>PROCURE TEST SITE MATERIALS</u>	<u>2000-07-31</u>	<u>2000-12-04</u>	99%		▶		
25	<u>9.12.15.20</u>	<u>ANTENNA TEST SITE PREPARATION</u>	<u>2000-10-02</u>	<u>2001-02-14</u>	100%		▶		
56	<u>9.12.15.25</u>	<u>Vertex ANTENNA SITE FOUNDATION</u>	<u>2001-02-08</u>	<u>2001-08-16</u>	7%			▶	
1571	9.12.35	Test Interferometer Site Complete	2001-08-16	2001-08-16	0%			▲	
1604	9.15	ALMA Prototype Interferometer Evaluation	1998-06-01	2003-12-16	11%	▶	▶	▶	▶
7	<u>9.15.20</u>	<u>Vertex Antenna Integration and Testing</u>	<u>2001-11-13</u>	<u>2003-02-07</u>	0%				▶
9	<u>9.15.20.10</u>	<u>Vertex Antenna Installation</u>	<u>2001-11-13</u>	<u>2002-03-13</u>	0%				▶
39	<u>9.15.20.30</u>	<u>Vertex Antenna Systems Installation and Testing</u>	<u>2002-04-23</u>	<u>2002-10-29</u>	0%				▶
1605	<u>9.20</u>	<u>Holography System</u>	<u>1998-09-01</u>	<u>2002-02-28</u>	53%	▶	▶	▶	▶
1610	9.20.25	CDR: Holography System	2000-10-10	2000-10-10	100%		▲		
1621	9.20.30	Deliver Holography System	2002-02-28	2002-02-28	0%			▲	
1631	10	Science	1998-06-01	2009-12-31	61%	▶	▶	▶	▶
1632	10.05	Scientific Requirements	1998-06-01	2001-12-28	84%	▶	▶	▶	▶
1633	10.07	ASAC Face-to-Face Meeting	2001-09-10	2001-09-10	0%			▲	
1634	10.10	Site Monitoring and Characterization	1998-06-01	2001-12-28	84%	▶	▶	▶	▶
1635	10.15	Array Design and Operation	1998-06-01	2001-12-28	84%	▶	▶	▶	▶
1636	10.17	PDR: ALMA Array Layout	2001-02-26	2001-02-26	100%		▲		
1638	10.20	Calibration	1998-06-01	2001-12-28	84%	▶	▶	▶	▶
1639	10.22	PDR: Calibration	2001-06-21	2001-06-21	0%			▲	
1640	<u>10.25</u>	<u>Imaging</u>	<u>1998-06-01</u>	<u>2001-12-28</u>	<u>84%</u>	▶	▶	▶	▶

Milestones: bold type Summary Tasks: <u>underline</u>	Joint Task		Summary (Joint)		Milestone	
	Eur Task		Summary (Eur)		Progress	
	US Task		Summary (US)		Completed Mlstr	