



Atacama Large Millimeter Array Rebaselining Status & Options

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ALMA

- Successes
 - Technical
 - Funding
 - Collaboration
- Issues
 - Budget
 - Schedule
 - Scope
 - Collaboration
- Process: rebaselining
- ASAC: input from scientific viewpoint to guide decisions

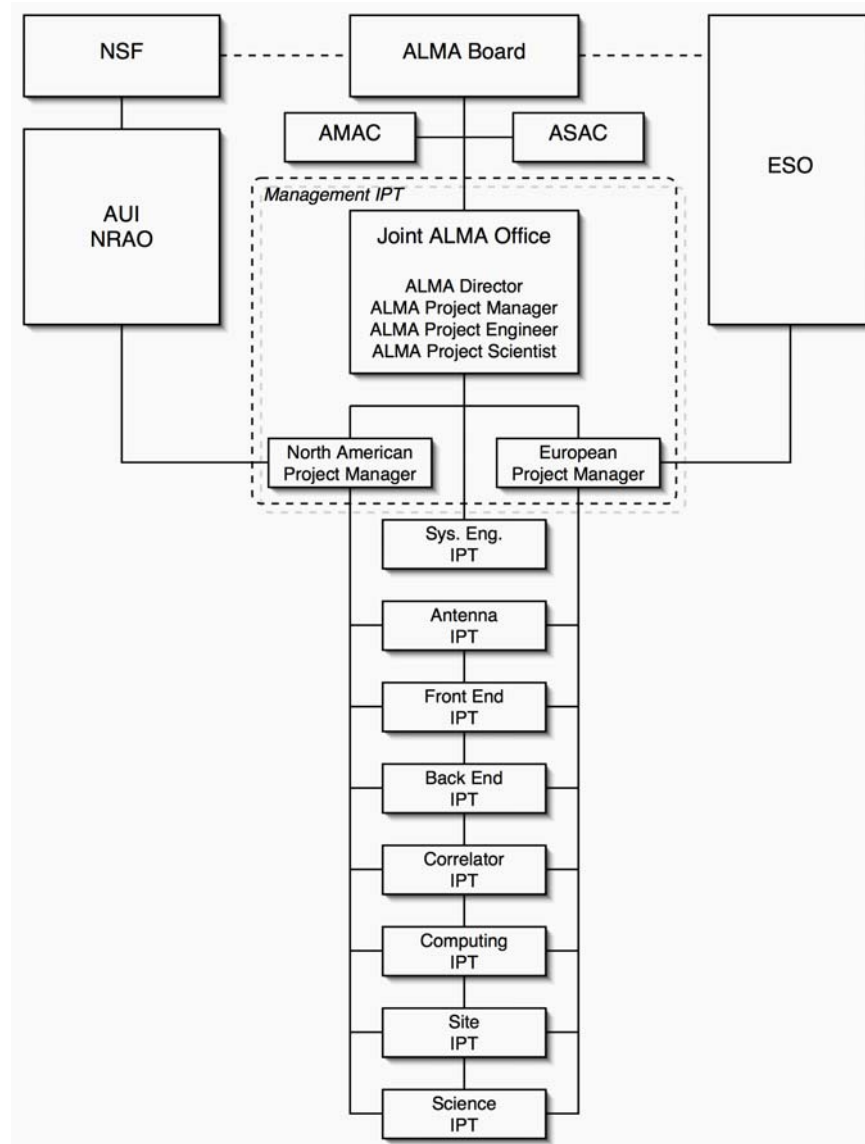


History

- ALMA scope/budget/schedule preliminary description – March 2002.
- October 2002 – substantial revision...
- Bilateral agreement (ESO/NSF) – Feb 2003
- Project management structure defined
- Ongoing informal modification of contingency to stay within \$\$ envelope
- Many rough estimates... new areas



ALMA Project Structure



Bilateral budget (March 2002)



Schedule of Values and Cost Summary for ALMA Phase 2 Construction (Y2000 K\$)

Level-1 WBS Task	Total Project			North American Tasks			European Tasks		
	Cost	Contingency	Value	Cost	Contingency	Value	Cost	Contingency	Value
1. Management/Administration	\$16,470	5.1%	\$17,313	\$8,440	5.0%	\$8,861	\$8,030	5.3%	\$8,452
2. Site Development	\$61,154	14.6%	\$70,049	\$23,418	14.4%	\$26,787	\$37,736	14.6%	\$43,262
3. Antenna Subsystem	\$198,022	15.0%	\$227,739	\$96,925	14.8%	\$111,299	\$101,097	15.2%	\$116,440
4. Front End Subsystem	\$90,800	20.0%	\$108,982	\$43,886	21.4%	\$53,291	\$46,914	18.7%	\$55,691
5. Back End Subsystem	\$40,777	22.0%	\$49,765	\$24,004	18.4%	\$28,416	\$16,773	27.3%	\$21,349
6. Correlator	\$13,204	12.5%	\$14,856	\$12,675	12.8%	\$14,294	\$529	6.2%	\$562
7. Computing Subsystem	\$29,843	15.5%	\$34,468	\$15,905	14.4%	\$18,199	\$13,938	16.7%	\$16,269
8. System Eng. & Integration	\$18,172	10.8%	\$20,125	\$9,358	10.4%	\$10,335	\$8,814	11.1%	\$9,790
9. Science	\$8,721	5.2%	\$9,173	\$4,527	5.0%	\$4,753	\$4,194	5.4%	\$4,420
Total	\$477,163	15.8%	\$552,470	\$239,138	15.5%	\$276,235	\$238,025	16.1%	\$276,235

Revised budget (October 2002)

	ALMA			North America			Europe		
	Task Subtotal Y2K \$k	Contingency %	Task Total Y2K \$k	Task Subtotal Y2K \$k	Contingency %	Task Total Y2K \$k	Task Subtotal Y2K \$k	Contingency %	Task Total Y2K \$k
Management	23,592	4.0%	24,536	11,796	4.0%	12,268	11,796	4.0%	12,268
Site	62,998	8.0%	68,056	22,873	5.5%	24,140	40,124	9.5%	43,916
Antenna	202,756	9.0%	221,095	98,095	6.8%	104,768	104,662	11.1%	116,327
Front End	100,416	12.2%	112,713	47,628	10.6%	52,669	52,788	13.7%	60,045
Backend	49,144	10.0%	54,061	33,052	8.4%	35,821	16,092	13.4%	18,240
Correlator	12,815	6.6%	13,655	12,148	6.7%	12,962	667	4.0%	694
Computing	31,789	9.9%	34,943	16,158	8.0%	17,445	15,631	11.9%	17,498
System Eng. & Integration	22,410	7.1%	23,993	10,839	5.7%	11,455	11,571	8.4%	12,538
Science	9,055	4.0%	9,417	4,527	4.0%	4,708	4,527	4.0%	4,708
	514,975	9.2%	562,470	257,110	7.4%	276,230	257,859	11.0%	286,230



2003-2004

- October 2002 – budget & scope changing..
- 2004 – Project Management Control System introduced (+)
- 2003-2004: information flow, fiscal control issues
- Deviation from baseline (schedule, level of contingency ↓)...
- 2004: rebaseline (Budget, Schedule, Scope)
- Here: Antenna: (risk, largest piece, longest span, industrial link) vs. rest of project (8 IPTs)
- Assumption: budget firewall between these areas





Rebaselining

■ Schedule

- Original level I milestones
- ⇒ Integrated Project schedule (underway) (diag)
- Best forecast to complete current scope...

■ Budget

- Decompose into Executive components
- Simplify tools for cost/contingency/risk estimation
- Regenerate bottoms-up estimates for identified baseline scope
- Give IPT ownership of budget/contingency

Integrated Project Schedule

WBS Level 1 and Level 2 Milestones Summary

WBS	Total Float	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.01 - Management	-599d	01Oct2001	[Redacted Bar]														04Jun2014		
	-599d															04Jun2014	★	Completion of ALM	
1.02 - Site	-556d	15Jan2002	[Redacted Bar]														03Oct2011		
	0			26Jul2003	★	Begin initial Phase of Civil Work in Chile													
	0					30Jun2005	★	Initial Phase of Civil Work in Chile Complete											
	1902d							17Nov2006	↑	Provisional Acceptance - AOS Hanger									
	1147d									03Apr2008	↑	PPS - Initial on-line - Provisional Acceptance							
1.03 - Antenna	-403d	02Jan2002	[Redacted Bar]														16Dec2011		
	-403d							18Apr2005	↑	Antenna Contract Implemented (Contract Award)									
	-235d									01Mar2007	★	First US Production Antenna available in Chile at OSF (Target)							
	-235d									01Mar2007	↑	First Transporter Accepted at OSF							
	-45d															11Nov2011	▲	Ready for Transporter to SI - Anter	
1.04 - Front End	-637d	Jan2001	[Redacted Bar]														10Aug2012		
	-198d									01Jun2006	↑	Solar Filter - Receive Design Specs from System Engr IPT (input from Science)							
	-257d									09Jun2006	↑	Freeze the Design of the FE Chassis							
	-108d									06Jun2006	★	Initial Front End Subsystem Available at OSF							
	-350d									18Oct2006	↑	FE Production authorization							
	-593d															04Feb2008	↑	Deliver WVR #8 to OSF	
1.05 - Back End	-554d	01Jan2003	[Redacted Bar]														02Apr2012		
	1387d									01Feb2005	★	Central Back End System Ready to Install at Array Site							
	-46d									26Jun2006	↑	Deliver BE antenna hardware for first two antennas							
	-46d									26Jun2006	↑	1st antenna racks (A & D) ready for shipment to OSF							
	1987d									20Jul2006	↑	All ALMA assembly, test and verification equipment in place in Chile							



- Scope
 - Multiple Statements of Work (SOWs) from IPTs – define deliverables, activities and interactions with the project
 - Missing scope (new)
 - Hidden scope (support visible scope)
 - Revise WBS (depth, detail - partial)
- Process
 - Prep Nov, begin Dec 2004
 - Lower project workload (?)
 - First deliverables – SOWs – Jan 15
 - Cost estimates – Feb 01 (last week...)
 - IPS – ongoing; critical path analyses underway



- Other deliverables
 - 10% descope options
 - Contingency estimate sheet (BOE)
 - Risk assessment (program risks)

- Preliminary results....



First look at rebaseline budget....



Changes

- MIPT: logistics costs; phase II SCO
- SIPT: \$13M AOS/OSF scope; infrastructure
- AIPT: -
- FE: integration; WVR; cryostat
- BE: -
- Corr: decrease from TFB
- Computing: requirements; reestimation
- SI: CSI (draft), SE activities
- Sci: -

All: return contingency to reasonable levels



Problems/assumptions at present

- Estimate for current baseline (64 antennas, 4 bands, Early science, all Software requirements, ...)
- Conservative; inclusive (needs filtering)
- Spares policies (-); equipment lists (+)
- Overlap between SI & Ops (infrastructure)

- Weak coupling of ALMA-J/Enhanced ALMA (major opportunities or problems); overhead not assessed



Descope options

- IPT request – identify items with 10% impacts - rough estimates for now...
- Not discussed or reviewed internally as yet; multiple issues...
- Here: changes that would impact science case at \geq \$1M level



1. Fewer antennas (\$0.5M BE, \$1M FE per, SI, pads, \$2M?)
 - Can production line be extended if \$\$\$?
 - Lower operations cost
 - Ant. cost servicing antenna contract...

2. AM LO scheme - \$1M? Higher phase noise?
 - May be required anyway...
 - ALMA-J – promising plan
 - Long baselines/High frequencies impacts



3. Remove 3 subarrays (laser synths) - \$1M
 - Decreased frequency coverage (cont+SL)
 - Can be added later...

4. BE: Remove 1 IF (pol or freq) from system - \$9M+ - goto 1 subarray (+ 2 ACA)
 - Decreased frequency coverage (cont+SL)
 - Can be added later...

5. FE: Simpler amplitude cal (ST vane) - \$1M
 - 3-5 % accuracy vs 1% (?)



6. FE cartridges – leave out 1 pol - \$1-1.5M per band
 - Decreased sensitivity/no polarization science
 - Derivative items (1/4 wave etc.)
 - Can be added later...

7. Defer long baselines (\$75k/pad; save 50? = \$3.75M)

8. Numerous sundry items \$N*100k...



Other

- Corr: nothing obvious unless Nant = 32
- Computing: substantially reduce requirements?
- Marching army costs: \$20M/year
- Operations items
 - Construction deliverables to Ops; Ops activities from different budgets; complex in US
 - Santiago building: \$3-5M
 - Dormitory at OSF: \$8M
 - PMCS
 - SE/I tasks - ?
 - Oxygenation at AOS
 - Ops software
- Problem: Would these be recovered later?



(Project – Antenna) summary

- 15% overrun on first pass (including return to full contingency) – acute problem.
- New funds required?
- Science feedback on options identified to date important; small number of high impact items
- Hard sell: restore confidence, ask for more money for smaller array...
- Impossible without strong science support

Antenna

- Core problem – assume \$2.9M per antenna (2002); bids are ~\$X-YM (US) across multiple vendors
 - Tough specs
 - Price of oil/steel
- Process: prototype phase to see if specs could be met, introduce vendors → Call for Tender/RFQ for production antennas; same SOW, TS but different evaluation, award procedures, organizational approaches...
- Currently: project has received multiple bids in both US and Europe, all directly based on, or derived from, the prototype designs





- Performance of prototypes relative to TS a key issue (partic. directly based designs)
- ALMA AEG – evaluate prototypes during 2002-2004. Problems:
 - Poor vendor delivery (all)
 - Little time for wide range of tests
 - VLA site not optimal (partic. Optical seeing)
- Technical review committee for bids (June 2004): issues with production designs based directly on prototypes
- Two subsequent committees (Sep/Nov 2004) concur; issues with AEG data sets and interpretations, complex vendor interactions



- Issues
 - Surface efficiency as function of elevation, long-term stability
 - Pointing performance (absolute, FS)
- Nov/Dec 2004 – procurement process stalled, missed Dec 15th signing opportunity
- Further testing: Joint Antenna Technical Group (JATG), ongoing Jan/Feb 2005
- Technical, contractual, procedural, political hurdles remain
- Negotiating area: 50 antennas
- Next opportunity to sign contract ~May 2005



- Delivery differences between vendors \Rightarrow interaction with schedule
- Good news: Met difficult science specs...
- Bad news: Expensive.
 - Tradeoffs not understood or in play.
 - ACA experience: ~20% saving
 - Relax specs – rebid (both?) – 1 yr
 - Delays: development & commissioning impacts – marching army costs...