



## **ALMA Project**

**Cost Estimate Evolution – 2002 - 2005**

Author: Beasley  
Date: 2005-09-26  
Status: Unapproved

# **Cost Estimate Evolution – 2002-2005**

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The ALMA Cost Estimate presented to the Board on September 8<sup>th</sup> 2005 was the result of approx. nine months of work exploring and re-estimating the project scope, budget and schedule. During the course of this work we significantly restructured certain elements of the budget to improve clarity and accountability. These changes included activities such as:

- relocating items from one account to another;
- restoring a small number of critical items deleted in 2002 budget revisions (e.g. the permanent power supply, spares);
- identification and (in some cases) implementation of descope options;
- creation of new accounts or Work Breakdown Structure (WBS) numbers.

In addition to these changes, there were two external influences on the budget whose visibility was complex – (1) the production antenna costs, and (2) the contributions to the Site infrastructure agreed to by ALMA-J (and implemented in, e.g., the AOS Technical Building and OSF designs). In all cases budget estimates were fluctuating in response to increasingly detailed analysis of requirements and push-back from management (questioning the validity of the estimates, assumptions made, identifying soft items in the budget, etc.).

During the course of 2005 numerous requests were made to the JAO for budget updates – from the ALMA Board, the ASAC & ESAC, and the Executives. These summaries were (of course) produced; however the IPT totals and bottom-line costs presented were naturally influenced by the maturity of the re-estimation process at different stages, the ongoing internal structural changes mentioned above, the availability of information from the Executives, the external influences mentioned above, and other factors. Comparison of numbers presented in November 2004 or April 2005 with the final Cost Estimate numbers is therefore difficult.

The goal of this document is to summarize the evolution of the Cost Estimate at several key points. Only major changes and budget components are described, however detailed records of all changes since November 2004 are available upon request. All amounts shown are Year 2000 US dollars. Throughout this document I will refer to the total cost of the project ignoring the cost of the production antenna contracts as (*project minus antennas*).



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## 1. Bilateral Agreement Budget

Table 1 shows the project budget used as part of the definition of the ALMA Bilateral Agreement. The total is Y2K\$552,470. This budget was used to define Value (effectively, the fraction of ALMA observing time awarded to the partners). This estimate predated the next budget (March 2002), even though it was actually signed into effect later (February 2003, Bilateral Agreement signing).

NOTE: This budget is for the baseline 64-antenna ALMA.

NOTE: Contingency is 15.8%.

**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
<b>Total</b>	<b>\$477,163</b>	<b>15.8%</b>	<b>\$552,470</b>	<b>\$239,138</b>	<b>15.5%</b>	<b>\$276,235</b>	<b>\$238,025</b>	<b>16.1%</b>	<b>\$276,235</b>

**Table 1**



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## 2. March 2002 budget

Table 2 shows the project budget in March 2002. The increase from a total of \$552M to \$562M occurred as \$10M of Design & Development (Phase I) money in Europe was included in this budget by agreement of the Board and the Executives; this correction resulted from the later start of European funding. The revised \$562M total was considered the total project envelope throughout 2002-2005.

NOTE: this \$10M change was eventually REMOVED from the Cost Estimate (in May 2005) for purposes of clarity (and all items associated with this work were removed from the project actuals from Europe). The variance section in Table 1 of the September Cost Estimate documentation references back to the \$552M budget).

NOTE: No ALMA-J interaction is present at this point, in either design or budget.

NOTE: Contingency is 15.5%

NOTE: The production antenna contract funding available in this budget (ignoring contingency) was  $63 * \$2.9M = \$182.7M$ . Antenna 64 was considered to be one of the prototype antennas, shipped to Chile (with \$0.5M allocated for that) – total **\$183.2M**.

NOTE: The budget estimate for (*project minus antennas*) is  $(\$562.470 - 183.2M) = \mathbf{\$379.3M}$ .

NOTE: This budget is for the baseline 64-antenna ALMA.

2002Mar12	Subtotal	Contingency		Total
WBS Task De	Y2000 \$	Y2000 \$	Percent	Actuals
				Y2000 \$
1 Management	16,880	844	5.00%	17,724
2 Site Develop	62,040	8,894	14.30%	70,933
3 Antenna Su	200,539	29,728	14.80%	230,267
4 Front End S	93,492	18,176	19.40%	111,668
5 Backend Su	41,512	8,985	21.60%	50,496
6 Correlator	13,343	1,652	12.40%	14,994
7 Computing	31,586	4,625	14.60%	36,211
8 System Eng	18,716	1,953	10.40%	20,669
9 Science	9,055	453	5.00%	9,507
<b>Total Year 200</b>	<b>487,162</b>	<b>75,308</b>	<b>15.50%</b>	<b>562,470</b>
<b>Minus Japan</b>	<b>0</b>			<b>562,470</b>

Table 2



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### 3. October 2002 budget

Table 3 shows the project budget in October 2002. During mid 2002 significant exploration and revision of the project scope and budget occurred; items were shifted from one Executive to another, new items inserted, others deleted. All changes were documented, but labeling them as simple scope or cost changes is difficult. At this point management saw that the project cost was beginning to climb, and the only compensating mechanism was to lower the project-wide contingency, as the total project envelope was fixed (and, in fact, the Bilateral Agreement was still 4-5 months away). The management increase seen included the insertion of overhead requirements for the Executives.

NOTE: Contingency declined ~\$28M, from 15.5 to 9.2% during this period to fund the changes being implemented.

NOTE: No ALMA-J interactions are present at this time in design or budget.

NOTE: Most IPTs increased as requirements were slowly exposed....

NOTE: The production antenna amounts available in this budget remained at 63\*\$2.9M, however \$1M was now allocated to relocating the prototype – total **\$183.7M**.

NOTE: The budget estimate for (*project minus antennas*) is (\$562.470-183.7M) = **\$378.8M**.

NOTE: This budget is for the baseline 64-antenna ALMA.

2002oct16 WBS Task De	Subtotal		Contingency		Total
	Y2000 \$	Y2000 \$	Percent		Y2000 \$
1 Management	23,592	944	4.00%		24,536
2 Site Develop	62,998	5,059	8.00%		68,056
3 Antenna Su	202,756	18,339	9.00%		221,095
4 Front End S	100,416	12,298	12.20%		112,713
5 Backend Su	49,144	4,916	10.00%		54,061
6 Correlator	12,815	840	6.60%		13,655
7 Computing	31,789	3,154	9.90%		34,943
8 System Eng	22,410	1,583	7.10%		23,993
9 Science	9,055	362	4.00%		9,417
<b>Total Year 200</b>	<b>514,975</b>	<b>47,495</b>	<b>9.20%</b>		<b>562,470</b>
<b>Minus Japan</b>	<b>0</b>				<b>562,470</b>

**Table 3**



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#### 4. November 2004 budget

Table 4 shows the project budget in November 2004. During 2002-2004 the ALMA budget was under the control of the ALMA Board, the JAO and the Executives. Project development proceeded in all IPTs. A small number of Budget Change Requests (BCRs) were approved by the Board for the items such as the JAO & PMCS (BCR 003, \$13M) and the ALMA & Contractor's Camps (BCR 17 & 18, \$2M).; these were funded out of contingency.

NOTE: at this point, incremental costs associated with ALMA-J are still not included in the budget, however their technical requirements were already inserted into the design of the AOS and OSF facilities; at a meeting in Heathrow in June 2004, contributions from ALMA-J to cover these infrastructure costs (\$16M) and a major contribution towards the restored Permanent Power Supply (\$15M BAC, estimated at Y2K\$11.2M with the provided funding profile), were agreed to. It is difficult to assess how formal these agreements were.

2004nov09 WBS Task De	Subtotal	Contingency		Total
	Y2000 \$	Y2000 \$	Percent	Y2000 \$
1 Management	36,627	773	2.11%	37,401
2 Site Develop	64,893	3,680	5.67%	68,574
3 Antenna Su	202,724	13,519	6.67%	216,243
4 Front End S	99,805	9,356	9.37%	109,161
5 Backend Su	49,142	3,773	7.68%	52,915
6 Correlator	10,520	605	5.75%	11,124
7 Computing	31,913	2,338	7.33%	34,251
8 System Eng	22,410	1,145	5.11%	23,555
9 Science	9,055	191	2.11%	9,246
<b>Total Year 200</b>	<b>527,089</b>	<b>35,381</b>	<b>6.71%</b>	<b>562,470</b>
<b>Minus Japan</b>	<b>0</b>			<b>562,470</b>

**Table 4**

NOTE: Project contingency was \$35.8M at this point (6.7%); during 2002-2004 all budget additions were implemented by lowering contingency project-wide.

NOTE: The production antenna amounts available in this budget remained at 63\*\$2.9M plus \$1M to relocate a prototype – total \$183.7M.



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At this point, we can begin to assess the evolution of the Cost Estimate due to rebaselining. The production antenna contracts were still under evaluation at this point and could not be sensibly re-estimated, so separating out those costs, the starting number for (*project minus antennas*) was  $$(562.470 - 183.7) = \mathbf{\$378.8M}$  (unchanged since Oct 2002, two years earlier).

During this period the management of the project was centralized via the creation of the JAO as it currently exists.

NOTE: This is the budget estimate for the baseline 64-antenna ALMA.



## 5. April 2005 budget

Table 5 shows the first rebaselining budget estimate, produced by the JAO in April 2005 for the April Board meeting. This information represented the initial attempt by the IPTs to re-estimate the cost of their programs using the methodology provided to them. Again, please note that no attempt was made to estimate the impacts of the production antenna contracts – at the time this estimate was produced the Executives were still negotiating with the vendors.

2005apr03 WBS Task De	Subtotal		Contingency		Total
	Y2000 \$	Y2000 \$	Percent		Y2000 \$
1 Management	38,983	773	1.98%		39,756
2 Site Develop	70,475	16,969	24.08%		87,444
3 Antenna Su	202,724	13,519	6.67%		216,243
4 Front End S	124,481	18,334	14.73%		142,815
5 Backend Su	51,349	3,496	6.81%		54,845
6 Correlator	10,516	574	5.46%		11,090
7 Computing	36,913	2,338	6.33%		39,251
8 System Eng	40,933	3,746	9.15%		44,679
9 Science	8,895	881	9.90%		9,776
<b>Total Year 200</b>	<b>585,269</b>	<b>60,630</b>	<b>10.36%</b>		<b>645,899</b>
<b>Minus Japan</b>	<b>0</b>				<b>645,899</b>

**Table 5**

This first attempt to revise the project budget included the following changes from the November 2004 estimates:

- A \$25M increase in contingency based on the DOE formalism analysis;
- A \$25M increase in FE as the scope of work and risks were analyzed;
- A \$19M increase in SEI as the scope of work and risks were analyzed; SE&I was clearly underestimated in the original budget;
- Increases in most IPTs reflecting improving understanding of scope, coping with inflating contracting and construction costs being incurred through the delays to the project;
- The permanent power supply was added to the budget; although the return of the PPS to the construction project has been discussed throughout 2003-2004 (and in fact, negotiations with ALMA-J had already occurred in June 2004), the item had not actually been added to the budget sheets until this time. Note the ALMA-J contribution to PPS covers ~2/3rds of the cost for this subsystem.





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- Spares restored to the construction budget based on a spares policy defined by the JAO: *IPTs supply two years of equipment spares, beginning with their deliverables to AIV, thereafter Operations pays for spares.* Some IPTs (e.g. FE) developed different spares policies more appropriate for their deliverables (e.g. three spare Front Ends).

NOTE: No ALMA-J design and costs were included in the project definition at this point, however all the additions to the Site (AOS Technical Building, OSF technical facilities, contribution to the Permanent Power Supply, pads, other infrastructure) have been removed from the above figures (assuming a 20% contribution, as agreed in Heathrow June 2004).

NOTE: This is the budget for the baseline 64-antenna ALMA.

NOTE: The production antenna amounts available in this budget remained at 63\*\$2.9M plus \$1M to relocate a prototype – total **\$183.7M**.

NOTE: The cost of (*project minus antennas*) implied was  $(\$645.889 - \$183.7) = \mathbf{\$462.1M}$ . The difference between this estimate for the budget increase required (assuming ~identical scope and ignoring antenna costs) and the pre-rebaselining November 2004 budget was **\$83.4M**. This number was seen at the ASAC meeting in February 2005 and at the Board meeting in April 2005, and despite all warnings about work-in-progress, in development etc., was widely distributed. As we will see later, this was about half of the eventual final budget increase required.

What was apparent to JAO management upon a detailed review of these first rebaselining estimates was that the IPTs had not fully considered their scope/deliverables/responsibilities to the project, and that incomplete integrated planning of the project was limiting their ability to identify the many boring and necessary items that had been missed. The Executives were also encountering problems clearly accounting for the actuals spent on ALMA up to the end of 2004. Furthermore, during this period the production antenna delivery schedule was unknown and clearly slipping, and the growing impacts of the associated delays made planning difficult.

We began another round of IPT Cost Estimate analysis in early April 2005, and continued to turn up areas of missing scope, calculating or typo errors, misunderstandings and duplications. This intensive second round of review took approximately 6-8 weeks, and ended with a budget freeze on May 27<sup>th</sup> 2005 (Version 3). With hindsight this first weak result might have been predicted – although we provided tools and guidance, numerous areas of project planning were still fluctuating (in particular, those related to site development and to the production antenna delivery schedule), and (more importantly) the IPT mindset and understanding was only beginning to move beyond that used for a number of years in budget estimation. Several IPTs were still not adequately assessing the risks to their programs and providing contingency consistent to cover the risks.



## 6. May 27th 2005 budget

Table 6 shows the May 27<sup>th</sup> budget estimate (Version 3.1). IPTs were warned a week earlier that all analysis had to be completed by May 27<sup>th</sup>.

2005may27 WBS Task De	Subtotal	Contingency	Actual Costs (if not inc		IPT Total
1 Management	49,101	2,507	5.11%	0	51,608
2 Site Develop	123,136	21,633	17.57%	6448	151,217
3 Antenna Su	207,155	13,739	6.63%	0	220,894
4 Front End S	124,863	19,567	15.67%	0	144,430
5 Backend Su	58,041	10,026	17.27%		68,068
6 Correlator	10,516	574	5.45%		11,090
7 Computing	36,298	5,871	16.17%		42,169
8 System Eng	43,143	4,444	10.30%	4274	51,861
9 Science	11,373	732	6.43%		12,105
<b>Total Year 200</b>	<b>663,627</b>	<b>79,092</b>	<b>11.18%</b>	<b>10722</b>	<b>753,441</b>
<b>Minus Japan</b>	<b>33,958</b>				<b>719,483</b>

**Table 6**

NOTE: This is the budget for the baseline 64-antenna ALMA.

NOTE: ALMA-J site costs are now included and visible in the Site IPT, and explicitly removed in the last line of the sheet (\$33.9M); this figure assumes their stated PPS contribution and a 20% contribution towards site infrastructure.

NOTE: Pressure on the IPTs to comprehensively assess their risks via the DOE formalism resulted in an additional \$19M in contingency assessed, including \$5M in Site, \$6.5M in Back End and \$4M in Computing (missed due to an accounting error in April budget).

NOTE: The production antenna amounts budgeted was  $64 * \$2.9M = \$185.6M$ . Each Executive was pursuing 32-antenna contracts at this point; evaluation of relocating prototypes to save money will occur after the signing of the final contracts.

Other increases:

- *Management* – the cost increase of ~\$10M includes budgeting of all Chilean IT support activities (previously juggled between Computing and the JAO)(\$3.8M), a conservative estimate



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(\$3M) to cover all-risk insurance for the construction project (based on Paranal numbers), and revised contingency estimate (\$2M).

- *Site* – removing the ALMA-J \$33.9 to provide a basis for comparison with the previous figures gives a revised Site total estimate of \$117.3M, an increase of ~\$30M from April 2005. Approximately \$5M of this is additional contingency; Site also incorrectly overestimated the ALMA-J contributions by ~\$5M (an error in the inflation calculation). The remaining ~\$20M increase includes \$2.5M resulting from revised bids assessing to-build prices for the antenna pads at the high site, \$5.7M from revised estimates for utility installations (fiber optics, power) at the high site, \$2.8M in descopes which Site assumed in their April estimate for the OSF but were replaced into the May estimate (these reappear as BCP items later); and \$3.7M descopes assumed in the April budget for the AOS TB which were replaced (also now BCP items). In summary, the Site increases are related to (1) accounting changes to clearly separate cost estimates and descopes (BCPs), (2) accounting corrections, and (3) re-estimation of significant activities to account for the rapidly increasing cost of construction in Chile.

- *Backend* – ongoing cleanup of budget (\$7M); Back End's first (April) estimate contained some omissions, and a revised examination of their risks led to an increased contingency (going from 6.8 to 17.3%).

- *Science* – accounting corrections (failure to incorporate actuals to date in April budget) (\$2.5M).

The estimate of (*project minus antennas*) here is  $(\$719.483 - 185.6) = \mathbf{\$533.8M}$ , an increase of ~\$72M over the April estimate (dominated by those components listed above: \$19M contingency + \$10M Management + \$30M Site + \$7M BE + \$2.5M Science).

The required budget increase relative to the baseline project can be compared to an estimate provided by T. Beasley to ESO in May 2005 at their request (email to Executives V2 05/20/05). In that email the ALMA budget increase required (excluding antennas) was estimated at \$145M (with error: -0.5M,+20M). The May 27<sup>th</sup> estimate above for the same quantity (the growth in (*project minus antennas*) between November 2004 and May 2005) is  $(\$533.8 - 378.8M) = \mathbf{\$155M}$ .

Other items in that email (estimates of recovery costs and BCPs) have not changed dramatically; the large change was the estimate of the budget increase required for the production antenna contracts – at the time, an assumption of a 25+25 production antenna run (and associated costs) was made, with a projected production antenna required budget increase of \$57.5M. As we have seen from Table 2 in the September Cost Estimate documentation, the true budget increase required is likely to be \$30-40M higher.



## 7. September 8<sup>th</sup> Cost Estimate.

Table 7 shows the presented September Cost Estimate, with one CRITICAL DIFFERENCE – the value of the European Production Antenna Contract which was deleted at ESO’s request from the September Cost Estimate documentation is inserted here assuming an equivalent cost to the signed NA contract (line 5 & 6 in the table below). This is done to more accurately reflect the expected program costs. The green shaded lines in Table 7 are not seen in other tables in this document.

2005sep08 Task Name	50 Antenna ALMA			Total
	Subtotal	Contingency	Cont. %	
Management / Adm	44,480	2,420	5.44%	46,900
Overhead / Other D	33,122	2,548	7.69%	35,670
Site Development	98,057	19,625	20.01%	156,482
Antenna IPT	17,240	1,336	7.75%	18,576
NA Antenna Contra	143,519	7,176	5.00%	150,695
EU Antenna (copy)	143,519	7,176	5.00%	150,695
Front End Subsystem	102,697	13,987	13.62%	116,684
Back End Subsystem	49,000	6,886	14.05%	55,886
Correlator	10,069	219	2.18%	10,288
Computing Subsystem	32,513	4,991	15.35%	37,504
System Engineering	40,035	3,881	9.69%	43,916
Science	9,325	460	4.94%	9,785
<b>Total Year 2000 kilo</b>	<b>723,575</b>	<b>70,706</b>	<b>9.77%</b>	<b>833,082</b>
<b>Minus Japan</b>	<b>0</b>	<b>38,800</b>		<b>794,282</b>

**Table 7**

NOTE: this budget is for the **new baseline 50-antenna ALMA**. Certain IPTs here (FE, BE, SEI, Computing) have reduced budgets shown here due to the removal of recovery costs (the approximately \$30M recovered from lowering the number of unit deliverables from 64 to 50).

NOTE: The ALMA-J contribution (20% of the total Site infrastructure costs) is seen in the Site IPT, then subtracted on the last line, i.e. the \$38.8M. This figure has been discussed with ALMA-J but not agreed to formally.



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NOTE: Please remember: in this Table the European production antenna contract has been assumed to have the same value as the NA one (a conservative assumption?).

NOTE: In this Table, ALL IPT budgets have had the Executive overhead charges (27% on direct labor) removed and collected together into the second line item. The Management IPT therefore appears to have inflated dramatically; this is artificial.

During June/July 2005 an IPT-by-IPT, line-by-line review of all May 27<sup>th</sup> V3 Cost Estimate sheets was undertaken by the Management IPT (scrubbing). This resulted in numerous clarifications and scope reductions.

The changes between the May 27<sup>th</sup> budget and the final September Cost Estimate (\$794.2-719.4M) = **\$74.8M** include the following:

- The increases due to the estimate for the budget increase required to service the production antenna contracts (\$93M, Table 2 in the September Cost Estimate documents).
- A ~\$10M increase in NA Executive overhead request based on revised estimate of NA Project costs. This information was first requested in November 2004, and delivered in the last week of August 2005.
- A \$10M increase in the Site to cope with bids recently received for the OSF and road culvert bids (replanning is underway).
- A \$10M decrease in contingency from reanalysis of the risk associated with FE and BE development; recent progress by System Engineering has lowered uncertainties for some of the technical IPTs.
- The budget decrease across numerous IPTs from the removal of the recovery costs (~\$30M).
- Budget decreases due to additional estimate cleanup by the JAO, and savings from replanning areas of project development.

(check:  $74.8 \approx 93 + 10 + 10 - 10 - 30$ ).

The September 2005 estimate for (*project – antennas*) is  $(\$794.282 - 301.390) = \mathbf{\$492.9M}$ . This initially appears lower than the May 27<sup>th</sup> estimate (\$533M). For purposes of comparison: in this period the expected change to (*project minus antennas*) is +\$10M NA overhead +\$10M OSF/culverts -\$10M contingency – \$30M recovery, i.e. net -\$20M. An increased contribution from ALMA-J and additional budget scrubbing and replanning led to further decreases. The final budget increase required for (*project minus antennas*) relative to the March 2002 budget is \$151M, as seen in Table 1 of the September Cost Estimate documentation.



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### 8. Summary

Some remarks:

- It is unfortunate that the first estimate of the budget increase required for (*project minus antennas*) (April 2005) was basically half the final number. In fact, the budget increase required continued to climb right up to the end of rebaselining, creating multiple rounds of “sticker shock” and a bad impression. See Figure 1.
- The budget increase required in (*project minus antennas*) as compared to the March 2002 (bilateral agreement era) budget is  $\$151.4\text{M}/379.3\text{M} = 39\%$ .
- The budget increased required in the production antenna contracts (assuming a EU contract similar to that of the NA one) is  $\$93\text{M}/183.2\text{M} = 51\%$ .
- There are a few remaining items of concern to the budget (see the September Cost Estimate documentation), with recovery plans under analysis.
- The scientific and operational scope of the instrument budgeted in the September 2005 Cost Estimate documentation is the same as the one originally estimated in early 2002 EXCEPT the array now is defined with 50 antennas. No new receivers, no larger bandwidth, no new software, etc. are included.
- The technical achievements of the project team have been remarkable. Significant technical and organizational challenges have been overcome; the level of significant technical risk in the project is low, with contingency allocated (now) to cope with the risks remaining. The costs of integration (and collaboration), previously significantly underestimated, are now revised.
- The ALMA-J impact seen in these estimates is well-defined; it should be noted however that their assumed contribution has risen from ~\$27M as defined at Heathrow in June 2004 (\$11.2M for the PPS according to the profile they proposed, and \$16M [20% of Site costs at that time]) to the current \$38.8M (basically, Site costs have increased \$50M since June of last year, and they are up for 20% of that. The \$50M increases are detailed on page 5 of the “IPT by IPT Changes” doc in the September Cost Estimate documentation).
- Fundamental point – The September Cost Estimate is in most ways the first bottoms-up detailed analysis of the cost of ALMA. At no time previously in the project was the scope of the program defined in sufficient detail to enable this level of analysis. During the past nine months there has been a strong focus on examining every aspect of the project technically and managerially, and to include reasonable estimates of the cost to complete.



### ALMA Budget Component Increases

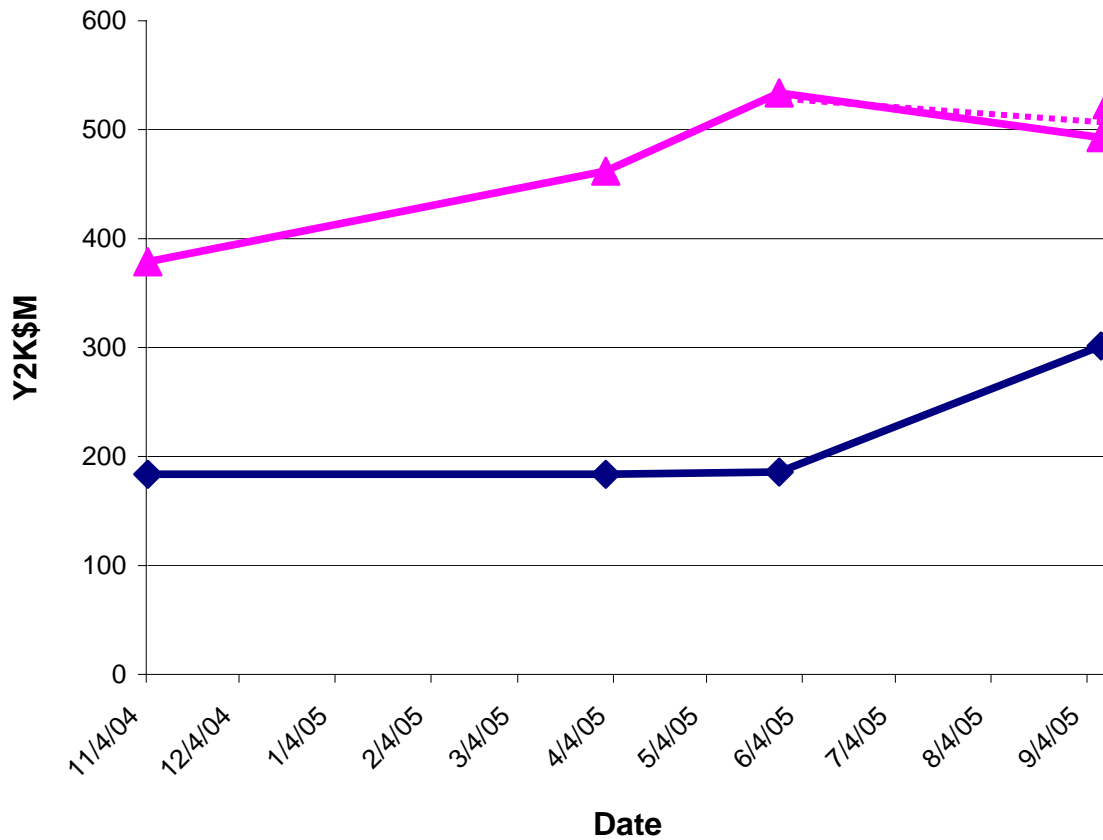


Figure 1 : Cost Increases – March 2002 and October 2002 data similar to first point on left hand side (November 2004) as no revision to the components had occurred up to that time. The blue line shows the estimated value of the production antenna contracts (assuming an equivalent cost contract for Europe in the final point). The pink line shows the change in (*project minus antennas*), including the growth in contingency. The final point (September 2005) shows two points; the lower one is the calculated value of (*project minus antennas*), the upper point is the same data with the recovery costs (~\$30M) replaced – this is a better comparison to May 27<sup>th</sup>.