
WBS 1.1.1 Pixel System

Cost and Schedule Summary

Overview

- Pre-Technical Baseline for Development approved October '98
 - Cost estimate through FY00
 - Baseline schedule through FY00(with some selected extension into FY01) - enclosed
- Estimate to Complete - two parts
 - Update of Pre-Technical Baseline costs
 - Very preliminary Production Cost Estimate
- Preliminary Production Cost Estimate
 - Based on well defined deliverables
 - Start on detailed estimate required for Production Baseline Review
 - Quality varies greatly now but obviously will improve over next 6 months or so.
 - Some items have extensive backup(eg. mechanics items for which prototypes have been built)
 - Some items are “physicist estimates”
 - Many in between
- Production Schedule
 - ATLAS schedule exists - see enclosed
 - US schedule doesn't yet exist
- Production/Cost Schedule ready for review in September

Pre-Technical Baseline ETC

- Baseline cost(base, not including contingency): \$2347K(FY00)
- Have costed \$1005 through September 1999.
- Significant funds prior to FY00 committed and “rolled over” into FY00.
- Have allocated \$699K additional in FY00.
- Current ETC exceeds baseline by 123K(AY\$). Increment not firm - needs review.
- Increase in mechanics and hybrids
 - **Mechanics**
 - Additional prototypes of sectors resulting from changing baseline design(cooling)
 - Services(cables) prototypes and mockup critical and added.
 - Incremental costs will be evaluated at dedicated review April 10 before Baseline Change Proposal made.
 - **Hybrids**
 - Hybrids now includes pigtailed, which also must be prototyped
 - Need to qualify multiple vendors
 - Again will review by May before BCP made.

Draft Total ETC

WBS Number	Description	Base Cost	Cont Cost (k\$)	Cont %	Total Cost	EDIA Labor	Mfg Labor	EDIA Matls	Mfg Matls	FTEs Project	FTEs Other
1.1.1	Pixels	8179	3689	45	11868	781	1584	248	5565	42.9	29.7
1.1.1.1	Mechanics and Final Assembly	2584	846	33	3431	518	653	228	1185	12.7	19.4
1.1.1.1.1	Design	743	211	28	954	516	0	228	0	5.3	11.4
1.1.1.1.2	Development and Prototypes	270	77	28	347	2	90	0	178	1.1	0.5
1.1.1.1.3	Production	1571	559	36	2129	0	563	0	1008	6.3	7.5
1.1.1.2	Sensors	675	149	22	824	49	33	0	593	2.4	0.5
1.1.1.2.1	Design/Engineering	49	5	10	54	49	0	0	0	0.6	0.0
1.1.1.2.2	Development and Prototypes	45	13	30	58	0	12	0	33	0.6	0.5
1.1.1.2.3	Production	581	131	22	712	0	21	0	560	1.1	0.0
1.1.1.3	Electronics	2680	1713	64	4393	119	73	0	2487	3.0	0.9
1.1.1.3.1	Design/Engineering	119	15	13	134	119	0	0	0	1.0	0.9
1.1.1.3.2	Development and Prototypes	436	110	25	546	0	0	0	436	0.0	0.0
1.1.1.3.3	Production	2125	1588	75	3712	0	73	0	2052	2.0	0.0
1.1.1.4	Hybrids, Cables and Optical	793	489	62	1283	39	180	20	554	9.4	3.3
1.1.1.4.1	Design/Engineering	59	8	13	67	39	0	20	0	1.2	3.2
1.1.1.4.2	Development and Prototypes	120	38	31	158	0	26	0	95	1.1	0.0
1.1.1.4.3	Production	614	444	72	1058	0	154	0	460	7.0	0.1
1.1.1.5	Module Assembly/Test	1333	455	34	1788	55	645	0	633	15.4	5.6
1.1.1.5.1	Design/Engineering	47	13	28	60	47	0	0	0	0.3	2.5
1.1.1.5.2	Development and Prototypes	223	82	37	305	8	66	0	149	1.1	1.6
1.1.1.5.3	Production	1063	359	34	1422	0	579	0	484	14.0	1.4
1.1.1.6	Pixel Misc Items	113	37	33	150	0	0	0	113	0.0	0.0
1.1.1.6.1	Test Support	63	21	33	83	0	0	0	63	0.0	0.0
1.1.1.6.2	Misc. Costs	50	17	33	67	0	0	0	50	0.0	0.0

Comments on Production ETC

- **Mechanics**
 - All preliminary costs will be reviewed in April at dedicated review. Costs for big ticket items will be based on prototype experience.
- **Sensors**
 - Call for Tender will go out shortly and will provide hard production quotes well in advance of Production Baseline Review.
- **Electronics**
 - Based on Temic(90%):Honeywell(10%) split - base cost. Temic numbers are firm quotes under Frame Contract. Honeywell numbers are preliminary quotes to CERN. Contingency covers doing all in Honeywell plus some yield uncertainties.
- **Hybrids**
 - Have preliminary production quotes from CERN and Compunetics. Need pigtail, assembly etc quotes and are working on this. Expect costs to be based on experience with prototypes.
- **Modules**
 - Have detailed yield model(enclosed) but not much actual experience.
 - Experience will be limited at time of Production Review
 - US role is carefully defined and very limited in area of bump bonding, that will have very large cost uncertainties.
- **Bottom line**
 - We can be ready with good estimates by September Production Baseline Review.
 - Major uncertainties, to be covered by contingency, will be electronics production costs(Temic or not and yield) and overall yield of module assembly process that affects multiple items.

Pre-Technical Baseline Schedule

- Primary issue for us is to move to Production status.
- Mechanics and sensors about on schedule
- Electronics on Development schedule but Production schedule remains to be defined and is critical path - see later.
- Hybrids and Modules behind expectations, in part from lack of electronics but also incomplete understanding in '98 of scope.

Milestone	Baseline	Current	
		Forecast	Comments
Production Baseline Review	5/29/00	9/10/00	
Mechanics			
Disk sector PRR	5/3/00	9/29/00	
Global support FDR	2/2/01	9/29/00	
Sensors			
Sensor FDR	1/20/00	12/3/99	
Begin preproduction fab	7/20/00	7/20/00	
IC Electronics			
Complete fab DMILL prototype	7/23/99	10/25/99	
Complete fab Honeywell prototype	8/25/99	12/15/00	Now only B-layer
IC vendor selection	2/29/00	DONE	Assuming DMILL has acceptable yield
Complete fab 2nd rad-hard prototype	11/29/00	7/1/00	
Hybrids			
Select production vendors	2/8/00	2/15/01	
Modules			
Select module production vendors(bump bonding)	4/3/00	1/10/01	But will be sole source orders

Front-End Electronics Milestones - Preliminary Plan

Task Name	2000				2001				2002				2003				2004				2005			
	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
Complete 1st DMILL prototype fabrication(FE-D1)	◆	10/27																						
Complete FE-D backup run fabrication(FE-D1b)		◆	3/15																					
Second DMILL prototype submitted(FE-D2)		◆	4/17																					
Complete FE-D2 fabrication			◆	7/3																				
Submit FE-H1			◆	7/3																				
Go/no go with Temic				◆	9/26																			
Final Design Review(DMILL - FE-D)				◆	11/15																			
Complete FE-H1 fabrication				◆	12/15																			
Start preproduction fabrication(DMILL)					◆	2/1																		
First preproduction fab(DMILL) complete						◆	7/2																	
Submit FE-H2						◆	7/16																	
Production Readiness Review(DMILL)							◆	11/15																
Complete FE-H2 fabrication							◆	12/20																
Release full production order(DMILL)								◆	1/7															
First production lot(s) fabricated(DMILL)									◆	4/8														
Final Design Review(Honeywell)									◆	5/15														
Production testing 10% complete(DMILL)									◆	6/3														
Production Readiness Review(Honeywell)									◆	8/1														
Production testing 25% complete(DMILL)									◆	9/2														
Start preproduction fabrication(Honeywell)									◆	9/16														
Production testing 50% complete(DMILL)									◆	11/8														
Complete preproduction fabrication(Honeywell)										◆	3/3													
Production testing complete(DMILL)										◆	4/8													
Release full production order(Honeywell)											◆	7/15												
First production lot(s) fabricated(Honeywell)												◆	12/15											
Production testing 10% complete(Honeywell)													◆	2/16										
Production testing 25% complete(Honeywell)														◆	4/15									
Production testing 50% complete(Honeywell)															◆	6/15								
Production testing complete(Honeywell)																◆	9/1							

Implications of FE-Electronics Preliminary Plan

- Devote all resources possible to ICs!
- Take risk of large preproduction order required to get module construction moving. This means similar orders for other module parts.
- Need to work with vendor(s) to minimize total fabrication time(have not done this yet) and have wafer screening very well planned.
- Develop different final assembly and installation plan
 - Install pixels after rest of barrel in solenoid? Gains 6 months for production but higher risk.
 - Current ATLAS planning does not have B-layer installed late(early 2005) as it could(should) be. Gains 16 months but we have already assumed this to happen.
- What ifs
 - Temic yield found to be unacceptable(decide 9/00) -> Honeywell. 6+ months delay and substantial cost increase possible.
 - Temic yield found to be unacceptable and start deep submicron. 12+ month delay.

Conclusions

- Cost
 - Pre-Technical Baseline - modest increases expected (well within contingency assigned in FY98) and will undergo in-depth review before fixing additional requests.
 - Have started production cost estimate and are confident can provide sound estimate by September but some items will have substantial contingencies to be credible.
- Schedule
 - Pre-Technical Baseline schedule
 - Mechanics, sensors on or close to baseline schedule
 - Electronics same but not well matched to ATLAS production/installation schedule.
 - Hybrids and modules, some aspects significantly delayed compared to baseline
 - Production schedule
 - Just starting to develop
 - IC electronics critical path and all else follows from this.
 - Need to develop work around plans, including taking risk of large preproduction orders and modifications to installation schedule.