Run IIB Silicon Upgrade: Cost and Schedule

Lehman Review

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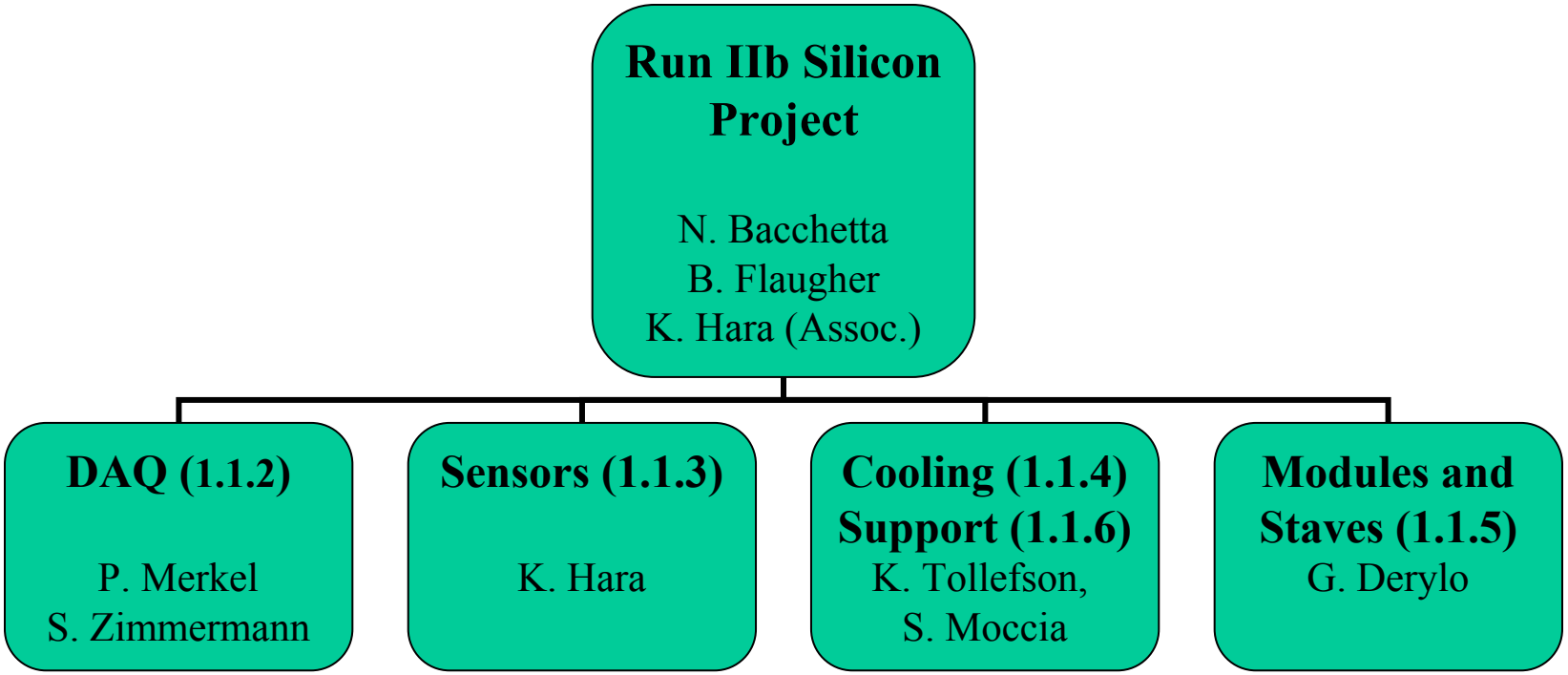
Fermilab

Outline

- Project Organization
- Cost
- Schedule
- Labor
- Equipment Resources
- Risk Analysis
- Conclusions

Silicon project organization

- Silicon project divides into 4 main Level 3 tasks
  - ⇨ Level 3 managers are in place
  - ⇨ Come from Universities and Fermilab
  - ⇨ Includes physicists and engineering leadership
  - ⇨ All have significant experience from Run IIa construction



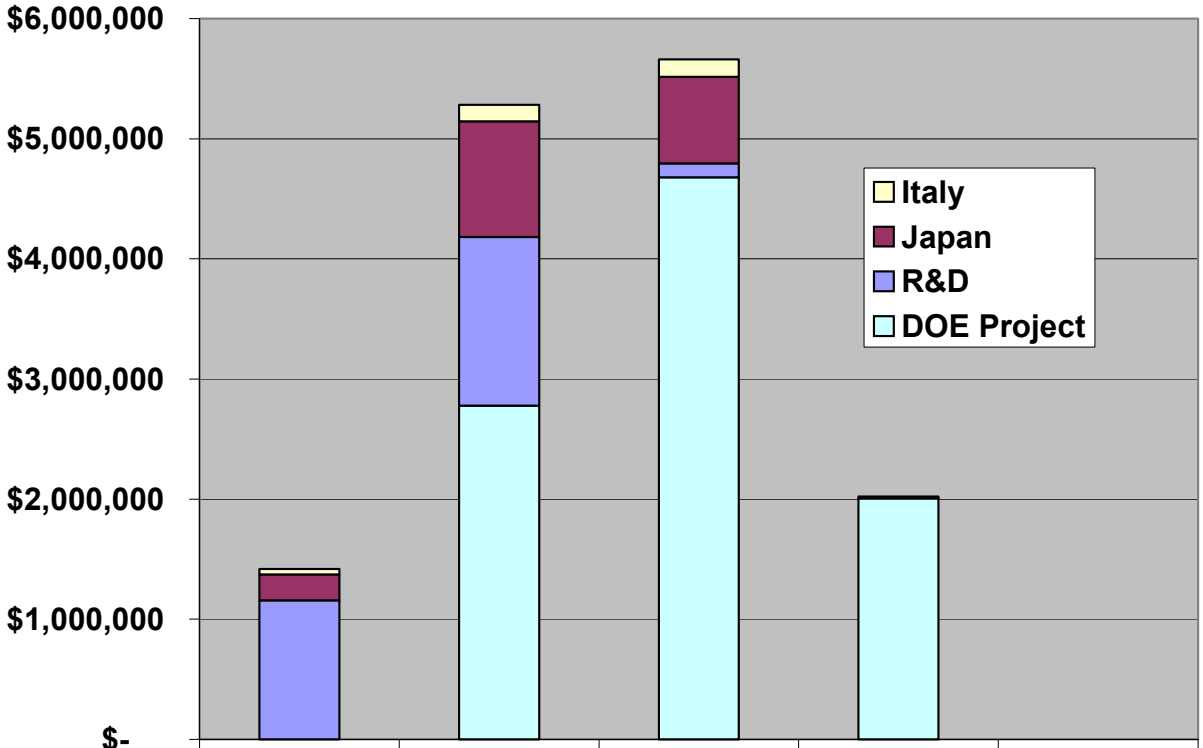
Cost Basis of Estimate

- Costs (M&S and Labor) were derived in consultation with Run IIa project mechanical and electrical engineers
- BOE notebooks contain: quotations and drawings which were used to estimate the costs.
- Contingency is assigned at the task level
  - ⇨ Most tasks assigned 50% on M&S and Labor
- Specific exceptions:
  - ⇨ Cost based on quotations: 30% contingency
    - sensors
    - power supplies
  - ⇨ A few high uncertainty items: 100% contingency
    - SVX4 chip layout cost estimates
    - L0 analogue cable production
- Contingency on Silicon Total Cost (M&S, Labor, G&A) is 50%
- Contingency money is treated as a global pool by Run IIb project manager and is not included in the plots in this talk.

Silicon Project Costs

Costs are in AY$ and include overhead.

Contingency is not shown



	2002	2003	2004	2005	$2,006
Italy	$45,000	$138,000	$144,000	$-	$-
Japan	$215,941	$961,354	$722,169	$-	$-
R&D	$1,156,803	$1,405,177	$115,198	$17,116	$-
DOE Project	$-	$2,777,937	$4,679,032	$2,005,654	$-

Grand Total

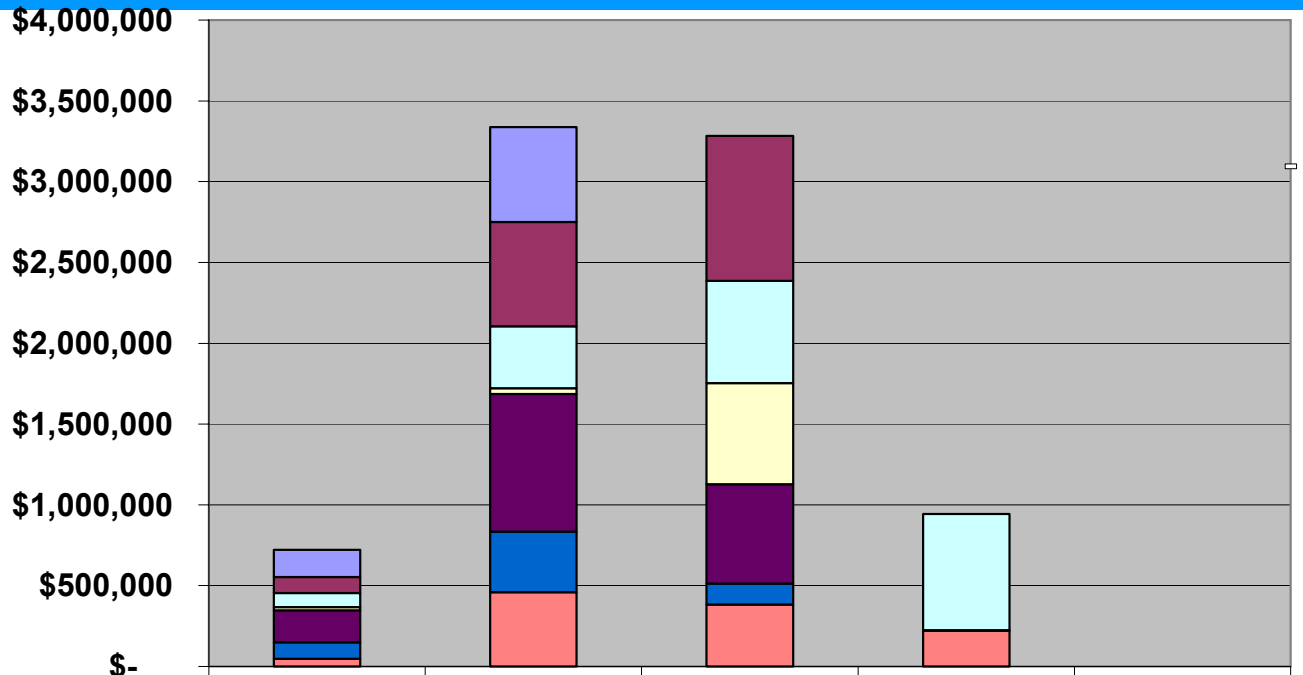
Total (M$)	1.42	5.28	5.66	2.02	0	14.38

Silicon M&S Cost breakdown

Costs are in AY$

Overhead not included.

Contingency not included



	2002	2003	2004	2005	$2,006
SVX4 & Trans. chips (1.1.2.1,2)	$168,863	$588,670	$-	$-	$-
Hybrids (1.1.2.3)	$98,559	$644,105	$897,669	$-	$-
Other DAQ (1.1.2.4-10)	$87,115	$384,105	$631,965	$718,916	$-
Power Supplies (1.1.2.11)	$20,000	$35,805	$626,155	$3,294	$-
Sensors (1.1.3)	$196,935	$850,578	$614,724	$-	$-
Mod. and Stave (1.1.5)	$103,100	$374,623	$129,817	$-	$-
Support/cooling (1.1.4,6)	$47,469	$460,079	$383,001	$221,220	$-
Total M&S (M$):	**0.72**	**3.34**	**3.28**	**0.94**	**0**

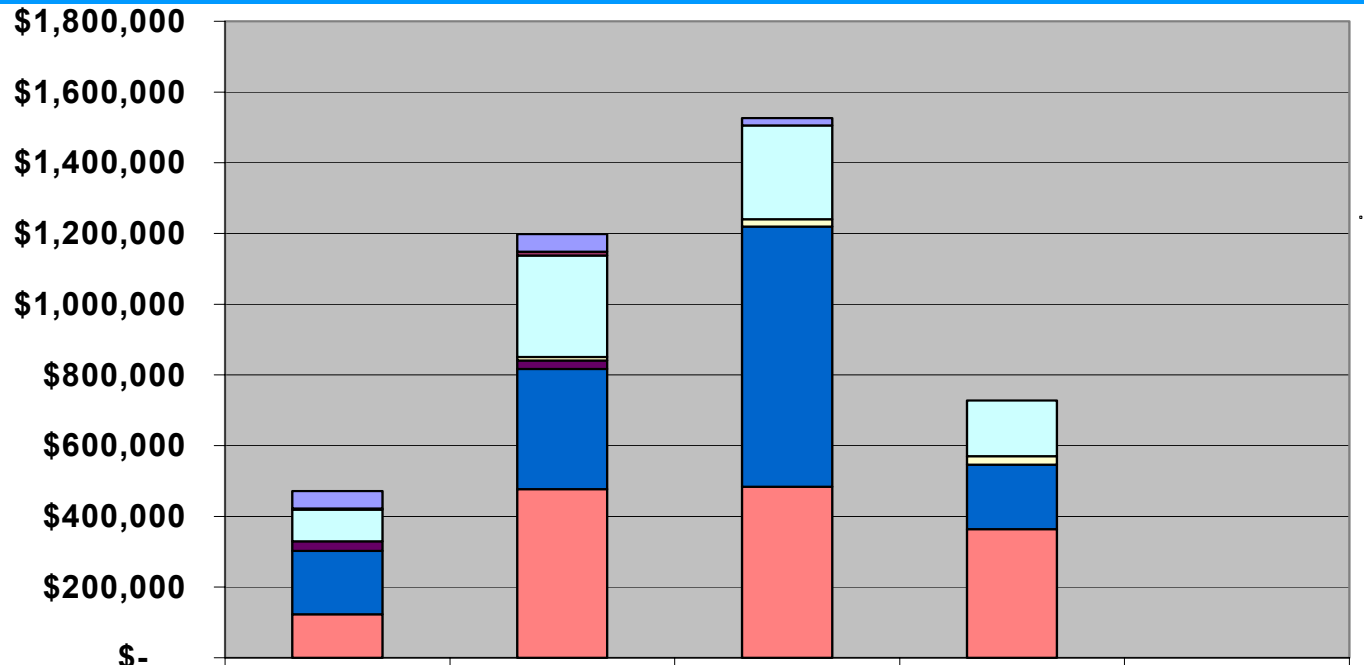
Total
8.29

Silicon Labor Cost Breakdown

Costs are in AY$

Overhead not included

Contingency not included



	2002	2003	2004	2005	$2,006	
SVX4 & Trans. chips (1.1.2.1,2)	$48,937	$50,050	$21,586	$-	$-	
Hybrids (1.1.2.3)	$3,432	$10,205	$-	$-	$-	
Other DAQ (1.1.2.4-10)	$89,505	$286,994	$264,422	$156,698	$-	
Power Supplies (1.1.2.11)	$-	$10,597	$20,970	$24,096	$-	
Sensors (1.1.3)	$27,038	$23,408	$-	$-	$-	
Mod. and Stave (1.1.5)	$179,278	$340,224	$735,664	$182,808	$-	
Support/cooling (1.1.4,6)	$123,136	$476,761	$484,053	$363,805	$-	Total
Total Labor (M$):	0.47	1.20	1.53	0.73	0	3.92

Schedule and Milestones

- The Base Schedule – No Contingency
  - ⇨ The schedule is constructed based on how long we think it will take to perform the tasks.
  - ⇨ has ~100 low level milestones scattered over the project
  - ⇨ End date is 5/20/05
  - ⇨ used to aggressively manage the project.
- Level 2 Milestones (includes 30 wks total contingency)
  - ⇨ Subset of low level milestones but dates include contingency
  - ⇨ 17 Level 2 milestones, ~1/quarter
  - ⇨ Reported to Directorate and DOE project manager
  - ⇨ End date with contingency is 12/23/05
  - ⇨ Use of the contingency will be managed within the project, Fermilab and DOE project manager via change orders (similar to money contingency)
- Level 1 Milestones (additional 47 weeks contingency)

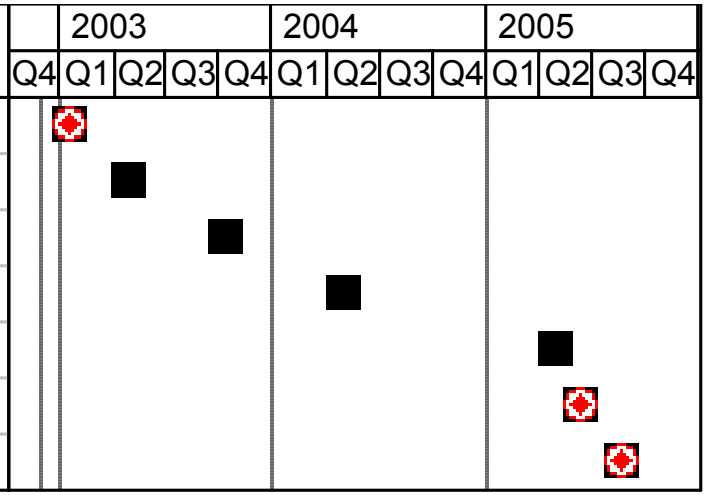
Contingency and Milestones

Reportable Level 2 Milestones	Cont.	Date
1st Chip ready for hybrids		7/15/02
Prototype Stave #1 available - Reporting	4 wks	11/12/02
Production Sensor submission (axials) - Reporting	4 wks	12/20/02
Testing of Prototype DAQ Chain Complete- go ahead for #2	8 wks	3/18/03
Production chip Submission - Reporting	8 wks	7/17/03
Tests of stave installation, screen mounting, complete	8 wks	8/22/03
Go ahead for DAQ Preproduction	8 wks	9/5/03
Bulkheads Complete	12 wks	3/24/04
Go ahead for DAQ Production	12 wks	4/21/04
L0 prototype modules complete	8 wks	6/2/04
Production Staves Available	20 wks	10/11/04
Stave installation begins	20 wks	11/15/04
L0 Supports Complete	16 wks	1/6/05
Stave installation complete	24 wks	7/19/05
Inner Detector Complete	24 wks	8/29/05
Outer Detector Complete	28 wks	9/28/05
SVX2b Ready for Installation into ISL	30 wks	12/23/05

Schedule: Critical Path

Critical Path Level 3 Milestones
(*Level 3 = Level 2 without the contingency)

Name	Start
Prototype Stave #1 available	Tue 10/15/02
Testing of Prototype DAQ Chain Complete- go ahead fo	Tue 1/21/03
Go ahead for Preproduction	Thu 7/10/03
DAQ Production Go-Ahead	Wed 1/28/04
Stave installation complete	Fri 1/28/05
Outer Detector Complete	Fri 3/11/05
SVX2b Ready for Installation into ISL	Fri 5/20/05

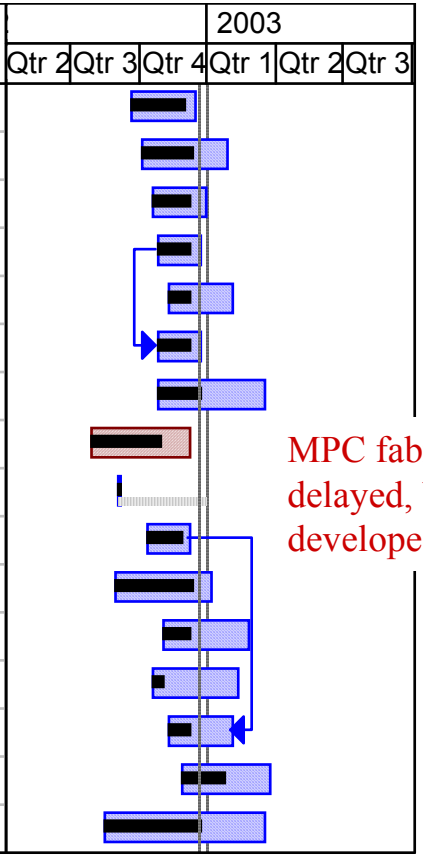


Schedule is driven by production and testing of outer layer stave components: Hybrids, Bus Cable, Mini-Portcard

Status of tasks in progress

- We have prototype parts and are just building and testing prototype modules - On track for 1st prototype stave milestone 10/15/02

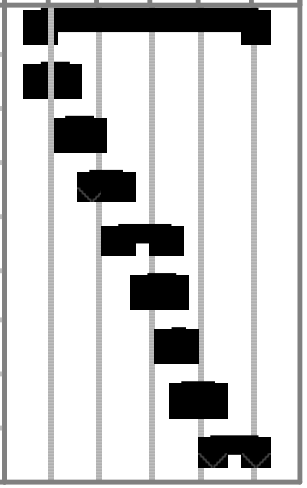
WBS	% Com	Name	Start
1.1.2.1.1.7	85%	1st Chip: engineering evaluation at LBL	Mon 6/17/02
1.1.2.1.1.8	60%	1st Chip: evaluation and radiation tests	Mon 7/1/02
1.1.2.2.1.5	70%	Transceiver: fabrication	Mon 7/15/02
1.1.2.3.1.1.5	80%	Hybrid #1 assembly and evaluation	Tue 7/23/02
1.1.2.3.1.1.7	35%	Hybrid #1: Evaluation at FNAL	Tue 8/6/02
1.1.2.3.2.1.1	75%	Prototype#1 L0 hybrid: Layout	Tue 7/23/02
1.1.2.4.2.1.2	40%	L0 prototype cable fabrication	Wed 7/24/02
1.1.2.6.1.3	70%	Prototype#1 MPC: manufacturing	Fri 4/26/02
1.1.2.11.1.2	80%	Procure sample supplies	Fri 5/31/02
1.1.3.1.1.2	80%	Dummy Sensors: manufacturing	Wed 7/10/02
1.1.3.1.1.5	80%	Prototype Sensor manufacturing (SAS)	Tue 5/28/02
1.1.3.1.1.8	30%	Prototype Sensor evaluation and Radiation tests	Wed 7/31/02
1.1.3.1.3.5	10%	Prototype Sensors tests	Wed 7/17/02
1.1.5.3.1.3	35%	Prototype Module: Assembling	Tue 8/6/02
1.1.5.4.1.7	50%	Prototype Stave: mechanical testing	Mon 8/26/02
.1.6.1.10.1.1	60%	CF Support Prototype: design	Mon 5/13/02



MPC fabrication is delayed, but we developed a workaround

Critical Path Summary Schedule

Task Name	Duration	Start	Finish
Silicon Project	**1092 days**	**Mon 7/15/02**	**Fri 11/24/06**
Stave Prototype Round 1	**126 days**	**Mon 7/15/02**	**Tue 1/21/03**
Stave Prototype Round 2	**120 days**	**Wed 1/22/03**	**Thu 7/10/03**
Stave Preproduction Round	**131 days**	**Fri 7/11/03**	**Wed 1/28/04**
Stave Production	**245 days**	**Thu 1/29/04**	**Fri 1/21/05**
Installation	**135 days**	**Mon 8/23/04**	**Fri 3/11/05**
Final Assembly	**50 days**	**Mon 3/14/05**	**Fri 5/20/05**
Level 2 Contingency	**150 days**	**Mon 5/23/05**	**Fri 12/23/05**
Level 1 Contingency	**235 days**	**Mon 1/2/06**	**Fri 11/24/06**



Each Round has all stave components: hybrids, bus cables, MPC

Before each Round is complete we will hold a workshop/signoff meeting to formally review all aspects of stave functionality.

Efficient procurement is essential – dedicated person for tracking procurement
Will run a report each month listing procurements in next 3 months
Get paperwork started through system early

Labor

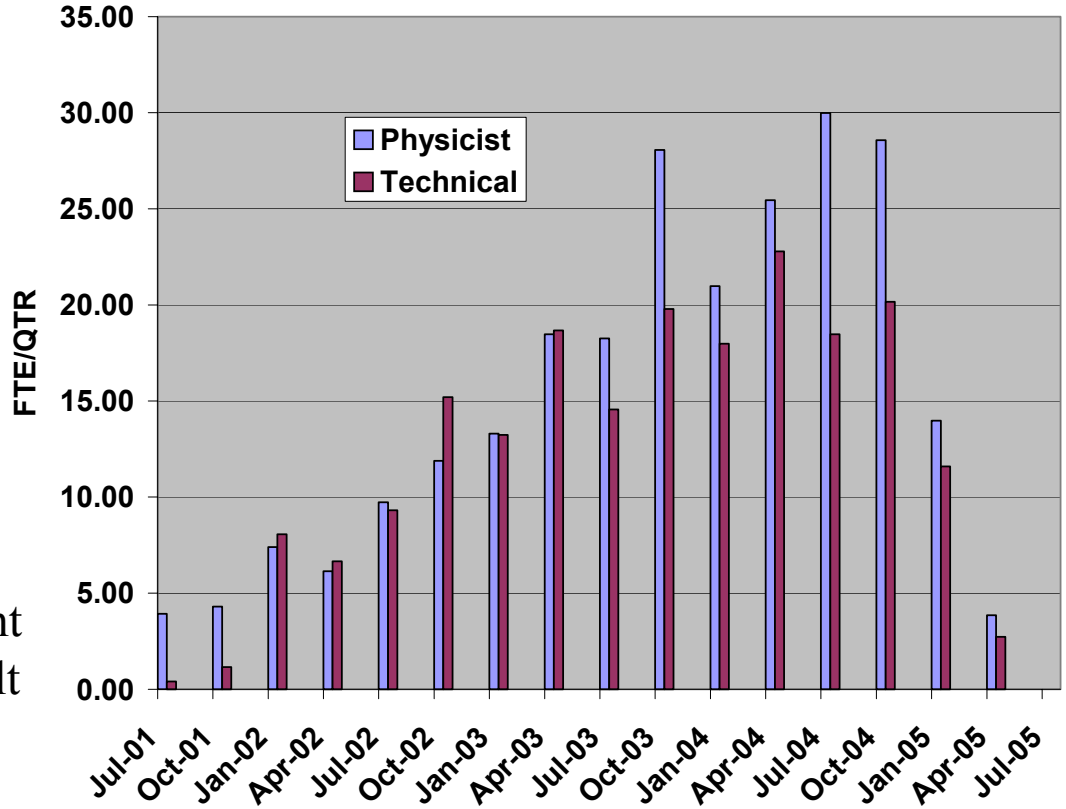
- Schedule based on what can be done in a realistic days work
- To convert to FTE we apply an efficiency factor of 0.85 (vac.,sick)
  - ⇨ 221 productive days work per person per year (442 hrs/qtr)

Run IIb Labor total: 197 K hours
Technical personnel: 89 K hours
Physicists: 108 K hours

Note contingency Labor is not inc.

Run IIa Techs (no eng.) used:
98 K hrs for L00, SVXII and ISL

Run IIb Tech. (no eng.)
63 Khrs for L00, SVXII replacement
Note ISL is not being rebuilt

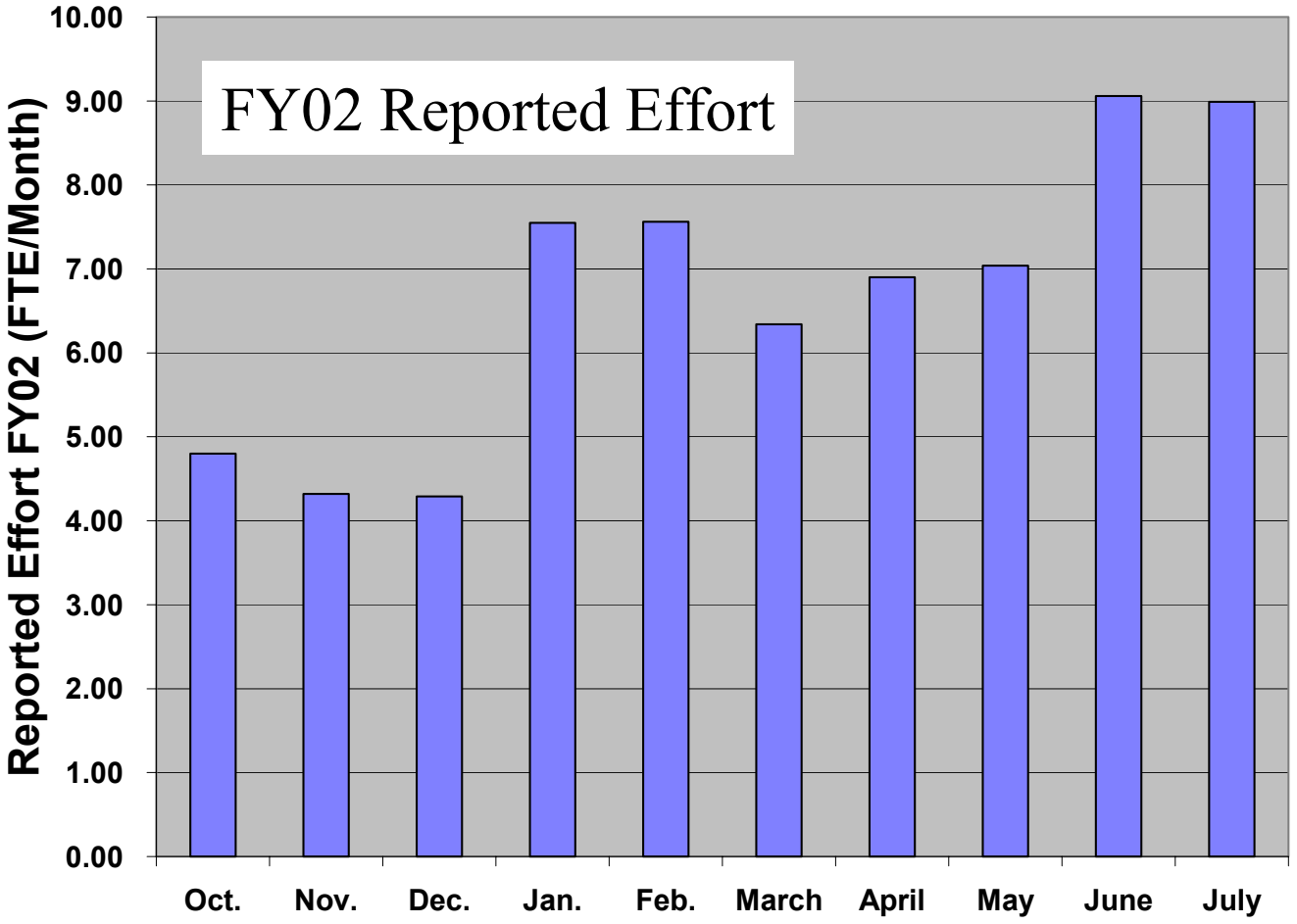


Reported Effort on CDF Run IIb Project

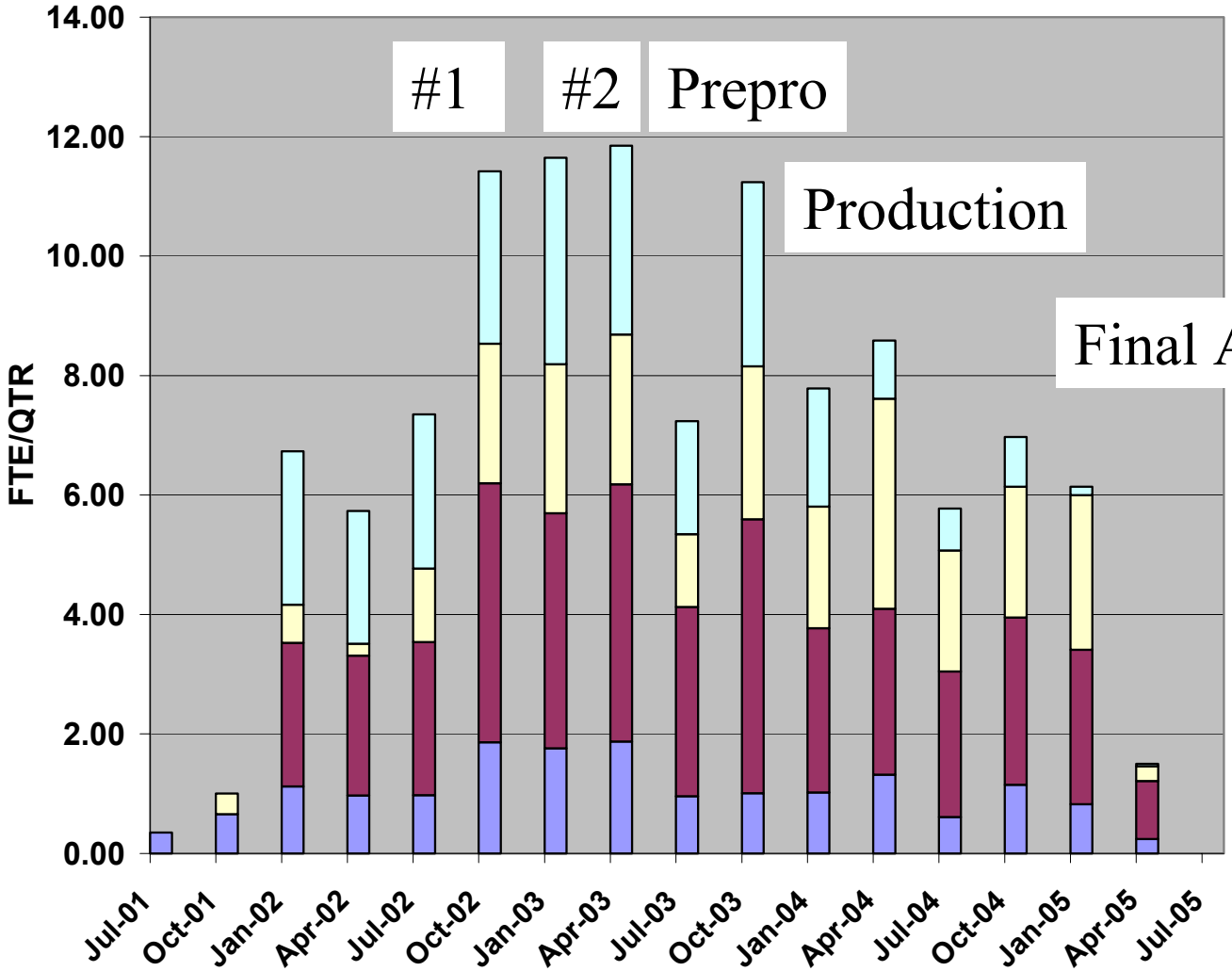
Cobra will be used to track effort on project in future.

Now it is tracked "by hand"

Reported Effort is growing as expected and is in good agreement with scheduled effort



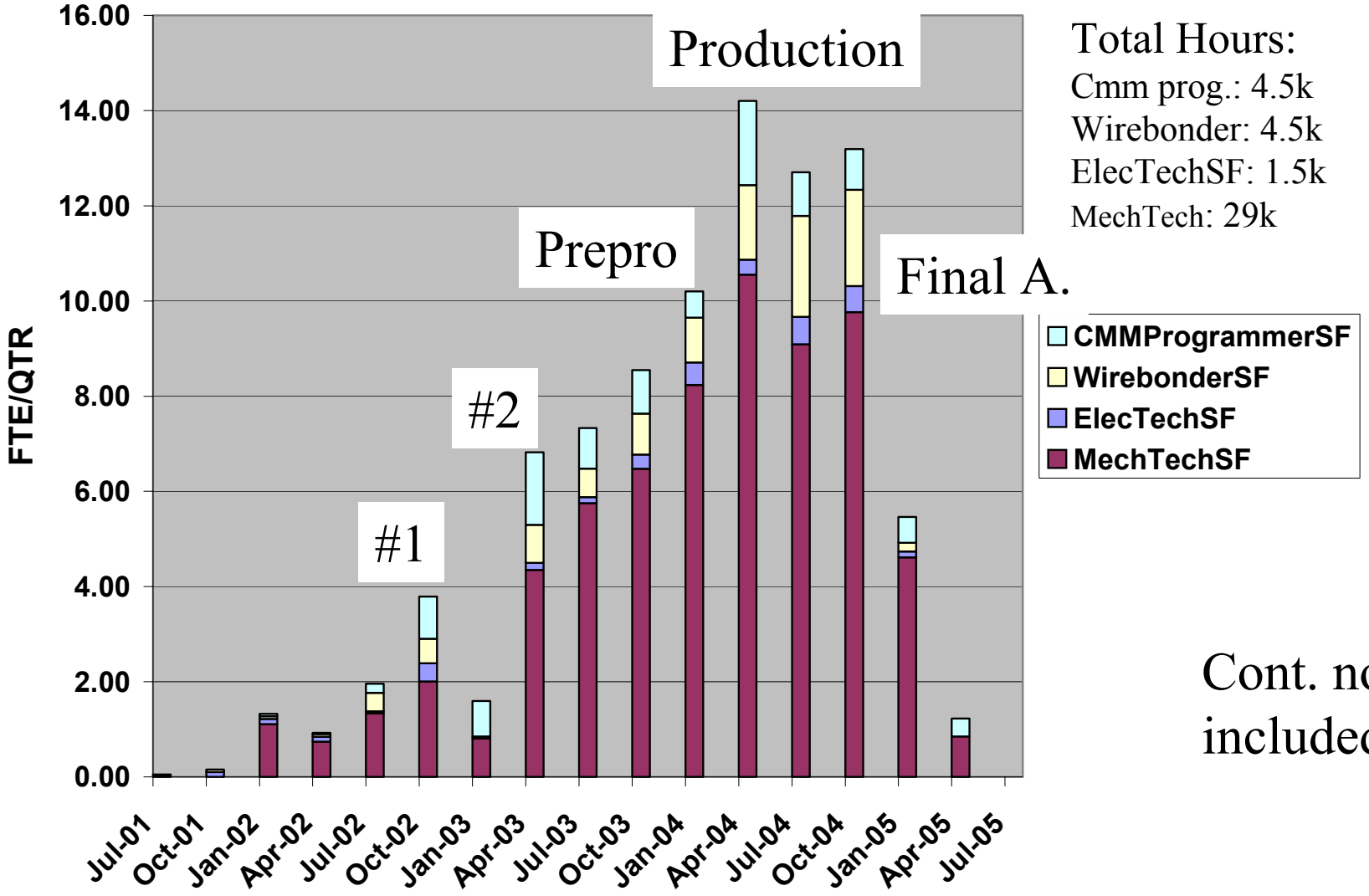
Engineering and associated support



Total hours:
ElecTech: 11.5k
ElecEng: 7.4k
Designer: 11.7k
MechEng: 18.5k

Labor Cont. not included

SiDet Technical Staff



Total Hours:
Cmm prog.: 4.5k
Wirebonder: 4.5k
ElecTechSF: 1.5k
MechTech: 29k

Cont. not included

Resources: Large Equipment

- Module Production – 8 modules/day
  - ⇨ 2 G&L CMMs (Lab D): 4 Modules/day/CMM
  - ⇨ Wirebonding – use 1.3 machines (have one 8090 and one 1478)
    - automatic 8090 bonder for data lines (Si-Si, Si-Pa, Pa-Hybrid) 100%
    - semiauto 1478 bonder for bonding hybrid to test card
- Stave Production – 1.3 staves/day
  - ⇨ 2 G&L CMMs (Lab D, Lab C): capacity for 2 staves/day
  - ⇨ Wirebonding – use 0.5 of the 1478
    - for hybrid-bus cable, MiniPC to bus cable
- Barrel Production
  - ⇨ 2 B&S 3m CMMs in Lab C
- Layer 0 – 1.5m B&S in Lab C

These CMMs and Wirebonders already exist at SiDet and are dedicated to CDF for Run IIb production

Risk Assessment

- Risk analysis performed by Project manager for CDF Run IIa Silicon project (Jeff Spalding)
  - ⇨ ~ independent review of cost and schedule risk
- Risk assessment document lists risks associated with Level 4 summary tasks, more detailed analysis for critical tasks
- Conclusion: Risk covered by Mitigation already in schedule
  - ⇨ Cost risk mitigated by attaching contingency to each task
    - Total cost contingency ~50% (M&S + Labor)
  - ⇨ Schedule risk mitigated by including contingency lag time on major milestones. This contingency time will be managed with change orders similar to cost contingency.
    - Total Schedule contingency = 30 weeks at Level 2
  - ⇨ Technical Risk mitigated by:
    - extensive testing time
    - 2 prototype rounds + preproduction before production of all stave components

Conclusions

- Run IIb silicon project is based on experience with Run IIa, Run Ia and Ib silicon detectors at CDF.
- Critical path is dominated by production and testing of outer layer staves

Costs are in AY$
Overhead is explicitly included
Contingency is not included.

Total Silicon Project Costs

	2002	2003	2004	2005	$ 2,006	Total
M&S	$ 722,040	$ 3,337,966	$ 3,283,332	$ 943,430	$ -	$ 8,286,768
Labor	$ 471,325	$ 1,198,239	$ 1,526,695	$ 727,407	$ -	$ 3,923,667
G&A	$ 224,379	$ 746,262	$ 850,372	$ 351,933	$ -	$ 2,172,946
Total	**$ 1,417,744**	**$ 5,282,468**	**$ 5,660,399**	**$ 2,022,770**	**$ -**	**$ 14,383,380**

Contingency = 7.2 M$

Grand Total = 21.6 M$

Risk Assessment analysis found the Silicon project risks are adequately mitigated by cost and schedule contingency (30 weeks at Level 2 + 47 weeks at Level 1).

Costs: AY$ and 2002 $

Total Project costs in 2002 $ without SWF escalation

	2002	2003	2004	2005	$ 2,006	Total
M&S	$ 722,040	$ 3,262,919	$ 3,121,038	$ 873,546	$ -	$ 7,979,543
Labor	$ 471,325	$ 1,126,249	$ 1,341,744	$ 598,761	$ -	$ 3,538,081
G&A	$ 224,379	$ 729,484	$ 808,339	$ 325,863	$ -	$ 2,088,065
Total	**$ 1,417,744**	**$ 5,118,653**	**$ 5,271,121**	**$ 1,798,171**	**$ -**	**$ 13,605,688**

Contingency = 6.6 M$

Grand Total = 20.2 M$

Total project costs in AY$ with SWF escalation

	2002	2003	2004	2005	$ 2,006	Total
M&S	$ 722,040	$ 3,337,966	$ 3,283,332	$ 943,430	$ -	$ 8,286,768
Labor	$ 471,325	$ 1,198,239	$ 1,526,695	$ 727,407	$ -	$ 3,923,667
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Contingency = 7.2 M$

Grand Total = 21.6 M$

Costs: AY$ and 2002 $

M&S costs in 2002 $

	2002	2003	2004	2005	$ 2,006	Total
SVX4 & Trans. chips (1.1.2.1,2)	$ 168,863	$ 575,435	$ -	$ -	$ -	$ 744,298
Hybrids (1.1.2.3)	$ 98,559	$ 629,624	$ 853,298	$ -	$ -	$ 1,581,481
Power Supplies (1.1.2.11)	$ 20,000	$ 35,000	$ 595,204	$ 3,050	$ -	$ 653,254
Other DAQ (1.1.2.4-10)	$ 87,115	$ 375,469	$ 600,728	$ 665,663	$ -	$ 1,728,975
Sensors (1.1.3)	$ 196,935	$ 831,455	$ 584,338	$ -	$ -	$ 1,612,728
Support/cooling (1.1.4,6)	$ 47,469	$ 449,735	$ 364,070	$ 204,833	$ -	$ 1,066,107
Mod. and Stave (1.1.5)	$ 103,100	$ 366,200	$ 123,400	$ -	$ -	$ 592,700
Total	**$ 722,040**	**$ 3,262,919**	**$ 3,121,038**	**$ 873,546**	**$ -**	**$ 7,979,543**

M&S costs in AY$

	2002	2003	2004	2005	$ 2,006	Total
SVX4 & Trans. chips (1.1.2.1,2)	$ 168,863	$ 588,670	$ -	$ -	$ -	$ 757,533
Hybrids (1.1.2.3)	$ 98,559	$ 644,105	$ 897,669	$ -	$ -	$ 1,640,334
Power Supplies (1.1.2.11)	$ 20,000	$ 35,805	$ 626,155	$ 3,294	$ -	$ 685,254
Other DAQ (1.1.2.4-10)	$ 87,115	$ 384,105	$ 631,965	$ 718,916	$ -	$ 1,822,102
Sensors (1.1.3)	$ 196,935	$ 850,578	$ 614,724	$ -	$ -	$ 1,662,237
Support/cooling (1.1.4,6)	$ 47,469	$ 460,079	$ 383,001	$ 221,220	$ -	$ 1,111,769
Mod. and Stave (1.1.5)	$ 103,100	$ 374,623	$ 129,817	$ -	$ -	$ 607,539
Total	**$ 722,040**	**$ 3,337,966**	**$ 3,283,332**	**$ 943,430**	**$ -**	**$ 8,286,768**

Costs: AY$ and 2002 $

Labor costs in 2002 $ without SWF escalation

	2002	2003	2004	2005	$ 2,006	Total
SVX4 & Trans. chips (1.1.2.1,2)	$ 48,937	$ 47,043	$ 18,971	$ -	$ -	$ 114,951
Hybrids (1.1.2.3)	$ 3,432	$ 9,592	$ -	$ -	$ -	$ 13,024
Power Supplies (1.1.2.11)	$ -	$ 9,960	$ 18,429	$ 19,835	$ -	$ 48,224
Other DAQ (1.1.2.4-10)	$ 89,505	$ 269,752	$ 232,389	$ 128,985	$ -	$ 720,630
Sensors (1.1.3)	$ 27,038	$ 22,002	$ -	$ -	$ -	$ 49,040
Support/cooling (1.1.4,6)	$ 123,136	$ 448,117	$ 425,413	$ 299,464	$ -	$ 1,296,130
Mod. and Stave (1.1.5)	$ 179,278	$ 319,784	$ 646,542	$ 150,477	$ -	$ 1,296,081
Total	**$ 471,325**	**$ 1,126,249**	**$ 1,341,744**	**$ 598,761**	**$ -**	**$ 3,538,081**

Labor costs in AY$ with SWF escalation

	2002	2003	2004	2005	$ 2,006	Total
SVX4 & Trans. chips (1.1.2.1,2)	$ 48,937	$ 50,050	$ 21,586	$ -	$ -	$ 120,573
Hybrids (1.1.2.3)	$ 3,432	$ 10,205	$ -	$ -	$ -	$ 13,637
Power Supplies (1.1.2.11)	$ -	$ 10,597	$ 20,970	$ 24,096	$ -	$ 55,663
Other DAQ (1.1.2.4-10)	$ 89,505	$ 286,994	$ 264,422	$ 156,698	$ -	$ 797,619
Sensors (1.1.3)	$ 27,038	$ 23,408	$ -	$ -	$ -	$ 50,446
Support/cooling (1.1.4,6)	$ 123,136	$ 476,761	$ 484,053	$ 363,805	$ -	$ 1,447,755
Mod. and Stave (1.1.5)	$ 179,278	$ 340,224	$ 735,664	$ 182,808	$ -	$ 1,437,973
Total	**$ 471,325**	**$ 1,198,239**	**$ 1,526,695**	**$ 727,407**	**$ -**	**$ 3,923,667**