

# **LIGO PROJECT**

## **COST AND SCHEDULE SUMMARY BOOK**



**SEPTEMBER 1994**

**Prepared For:**  
**NATIONAL SCIENCE FOUNDATION**

**Prepared By:**  
**U.S. COST, INCORPORATED &**  
**LIGO Project Staff**

*LIGO-G940007-00-P*

# **LIGO PROJECT TOP LEVEL SUMMARY**

LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION		TOTAL COST
								%	(\$K)	
1	1	-LIGO	5,755	56,254	37,723	141,753	235,729	17.18%	40,488	276,216
2	1.1	-Facilities and Vacuum Systems	497	7,118	0	140,859	147,977	15.29%	22,620	170,597
2	1.2	-Detector	1,463	15,146	29,054	894	45,094	28.20%	12,718	57,812
2	1.3	-Research and Development	2,274	15,445	7,243	0	22,688	18.12%	4,110	26,798
2	1.4	-Project Office	1,521	18,545	1,425	0	19,970	5.20%	1,039	21,009

LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION		TOTAL COST
								%	(\$K)	
1	1	-LIGO	5,755	56,254	37,723	141,753	235,729	17.18%	40,488	276,216
2	1.1	-Facilities and Vacuum Systems	497	7,118	0	140,859	147,977	15.29%	22,620	170,597
3	1.1.1	-Vacuum Equipment	150	1,934	0	41,151	43,084	17.01%	7,328	50,412
4	1.1.1.1	-Vacuum Equipment Design	75	1,009	0	5,806	6,815	29.82%	2,032	8,847
4	1.1.1.2	+Vacuum Equipment Construction - Washington	36	447	0	22,472	22,918	15.38%	3,525	26,443
4	1.1.1.3	-Vacuum Equipment Construction - Louisiana	39	478	0	12,872	13,351	13.26%	1,771	15,121
3	1.1.2	-Beam Tubes	146	2,032	0	38,748	40,780	13.60%	5,547	46,327
4	1.1.2.1	-Beam Tube Design	76	1,036	0	1,852	2,888	6.65%	192	3,080
4	1.1.2.2	-Washington Beam Tube Construction	38	543	0	21,110	21,653	13.96%	3,023	24,676
4	1.1.2.3	-Louisiana Beam Tube Construction	32	452	0	15,786	16,239	14.36%	2,332	18,571
3	1.1.3	-Beam Tube Enclosures (BTE)	3	111	0	17,010	17,121	17.49%	2,994	20,115
4	1.1.3.1	-BTE Design	3	111	0	470	581	18.00%	104	685
4	1.1.3.2	-WA BTE Construction	0	0	0	8,370	8,370	15.00%	1,255	9,625
4	1.1.3.3	-LA BTE Construction	0	0	0	8,171	8,171	20.00%	1,634	9,805
3	1.1.4	-Facility Design and Construction	198	3,043	0	43,950	46,992	14.37%	6,751	53,743
4	1.1.4.1	-Facility Design	66	1,081	0	3,524	4,605	13.94%	642	5,247
4	1.1.4.2	-WA Construction Contract	72	1,065	0	22,350	23,415	13.37%	3,131	26,545
4	1.1.4.3	-LA Construction Contract	60	897	0	18,076	18,973	15.70%	2,978	21,951
2	1.2	-Detector	1,463	15,146	29,054	894	45,094	28.20%	12,718	57,812
3	1.2.1	-Interferometer Design/Fabrication	990	10,133	18,071	894	29,098	33.37%	9,710	38,808
4	1.2.1.1	-Interferometers Design/Non-recurring Items/Syst	521	5,847	705	894	7,446	34.33%	2,556	10,002



LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
4	1.2.1.2	-Interferometer Fabrication-WA Site	317	2,898	11,809	0	14,706	32.98%	4,851	19,557
4	1.2.1.3	-Interferometer Fabrication -LA Site	153	1,389	5,557	0	6,946	33.15%	2,303	9,249
3	1.2.2	-Control and Data System	422	4,492	6,965	0	11,456	24.28%	2,782	14,238
4	1.2.2.1	-CDS Design and Systems Engineering	332	3,472	672	0	4,144	23.26%	964	5,107
4	1.2.2.2	-CDS Procurement/Fabrication - WA Site	56	620	3,908	0	4,528	25.30%	1,145	5,674
4	1.2.2.3	-CDS Procurement/Fabrication - LA Site	34	400	2,384	0	2,784	24.16%	673	3,457
3	1.2.3	-Physics Monitoring	39	383	2,710	0	3,093	5.00%	155	3,248
4	1.2.3.1	Physics Monitor Design	27	274	64	0	338	5.00%	17	355
4	1.2.3.2	WA Physics Monitors Fabrication	6	55	1,587	0	1,642	5.00%	82	1,724
4	1.2.3.3	LA Physics Monitors Fabrication	6	55	1,059	0	1,114	5.00%	56	1,169
3	1.2.4	-Support Equipment	13	138	1,308	0	1,446	5.00%	72	1,518
4	1.2.4.1	Design/Fabrication Support Equipment	1	3	20	0	23	5.00%	1	25
4	1.2.4.2	WA Site Support Equipment	6	67	697	0	764	5.00%	38	802
4	1.2.4.3	LA Site Support Equipment	6	67	591	0	659	5.00%	33	692
2	1.3	-Research and Development	2,274	15,445	7,243	0	22,688	18.12%	4,110	26,798
3	1.3.1	-Lab Operations	240	2,085	3,655	0	5,741	11.76%	675	6,416
4	1.3.1.1	Lab Operations (Actuals)	60	505	733	0	1,239	0.00%	0	1,239
4	1.3.1.2	Lab Operations (To-do)	180	1,580	2,922	0	4,502	15.00%	675	5,177
3	1.3.2	-R & D Tasks	2,034	13,359	3,588	0	16,947	20.27%	3,435	20,383
4	1.3.2.1	R & D Tasks (Actuals)	594	4,239	1,258	0	5,497	0.00%	0	5,497
4	1.3.2.2	R & D Tasks (To-do)	1,440	9,121	2,330	0	11,451	30.00%	3,435	14,886

## LIGO PROJECT

**ESTIMATE WBS SUMMARY**

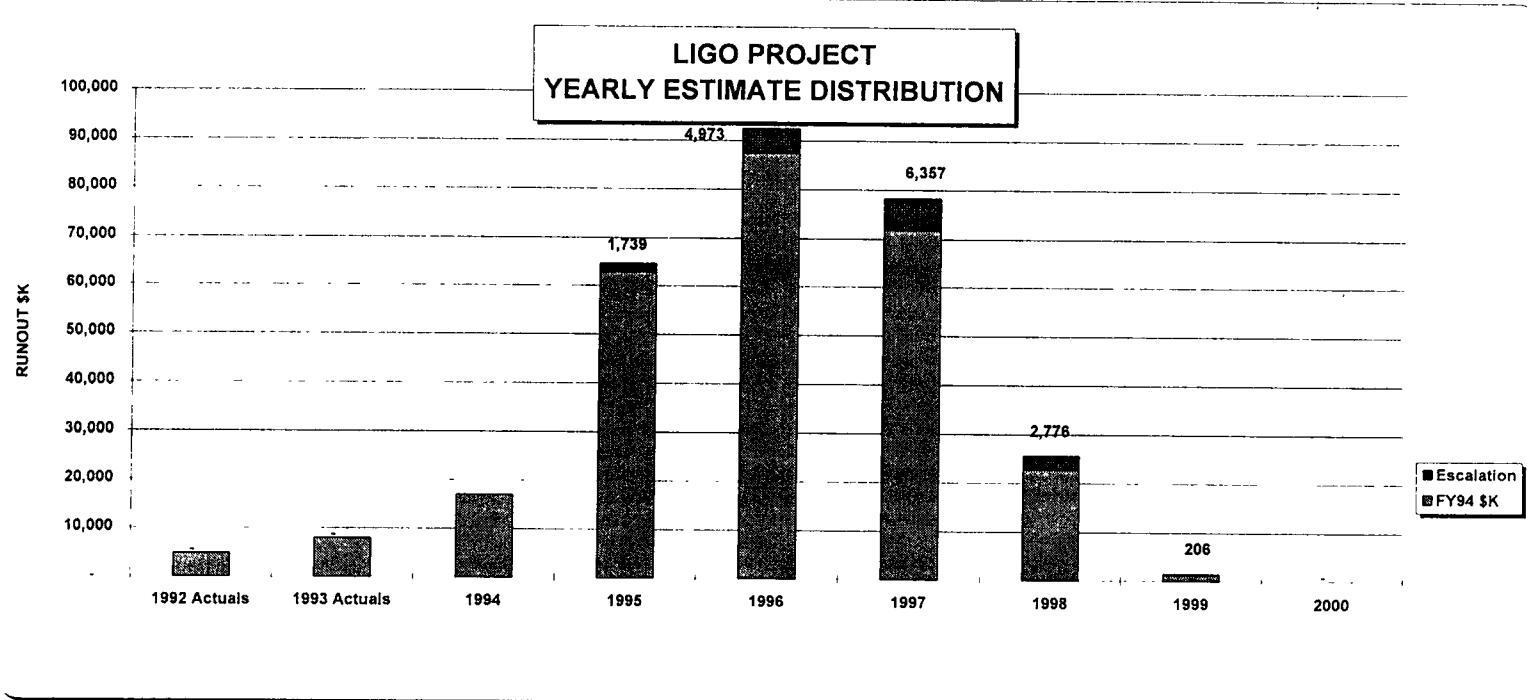
(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	CONTINGENCY (\$K)	TOTAL COST
2	1.4	-Project Office	1,521	18,545	1,425	0	19,970	5.20%	1,039	21,009
3	1.4.1	-Project Management	723	10,473	0	0	10,473	5.05%	529	11,001
4	1.4.1.1	-Management	414	7,349	0	0	7,349	4.91%	361	7,710
4	1.4.1.2	-Project Control	309	3,124	0	0	3,124	5.38%	168	3,292
3	1.4.2	-Support Services	60	808	0	0	808	4.95%	40	848
4	1.4.2.1	-QA Services	30	353	0	0	353	5.00%	18	371
4	1.4.2.2	-ES&H Services	30	353	0	0	353	5.00%	18	371
4	1.4.2.3	-Consultants	0	102	0	0	102	4.62%	5	107
3	1.4.3	-System Engineering	378	4,462	105	0	4,567	5.82%	266	4,833
4	1.4.3.1	-System Integration	234	2,883	0	0	2,883	5.74%	165	3,049
4	1.4.3.2	-Documentation	0	0	105	0	105	5.43%	6	111
4	1.4.3.3	System Modeling	144	1,579	0	0	1,579	6.00%	95	1,673
3	1.4.4	-Office Operations	360	2,802	1,320	0	4,122	4.96%	204	4,326
4	1.4.4.1	-Administration	312	2,237	605	0	2,842	4.82%	137	2,979
4	1.4.4.2	-General Computing	48	565	715	0	1,280	5.27%	68	1,348

# LIGO PROJECT RUNOUT COST SUMMARY

SEPTEMBER 1994

	1992 Actuals	1993 Actuals	1994	1995	1996	1997	1998	1999	2000	TOTAL
FY94 \$K	4860	8014	16,987	62,913	87,444	71,855	22,818	1,326	-	276,217
NSF Inflation			1.000	1.028	1.057	1.088	1.122	1.156	1.180	
Then Year \$K	4,860	8,014	16,987	64,652	92,417	78,212	25,594	1,532	-	292,268



# LIGO PROJECT COST ESTIMATE SUMMARY

12-Sep-94

CURRENT YEAR COST (In millions of FY94 dollars)

Manpower/Expenses	41	
Materials	30	
Contracts	142	
Subtotal Direct Costs	<u>213</u>	
Contingency	40	(19%)
Subtotal	<u>254</u>	
R&D	23	(11%)*
<b>TOTAL LIGO PROJECT FY94 \$M</b>	<u><b>276</b></u>	

\*% of Subtotal Direct Costs

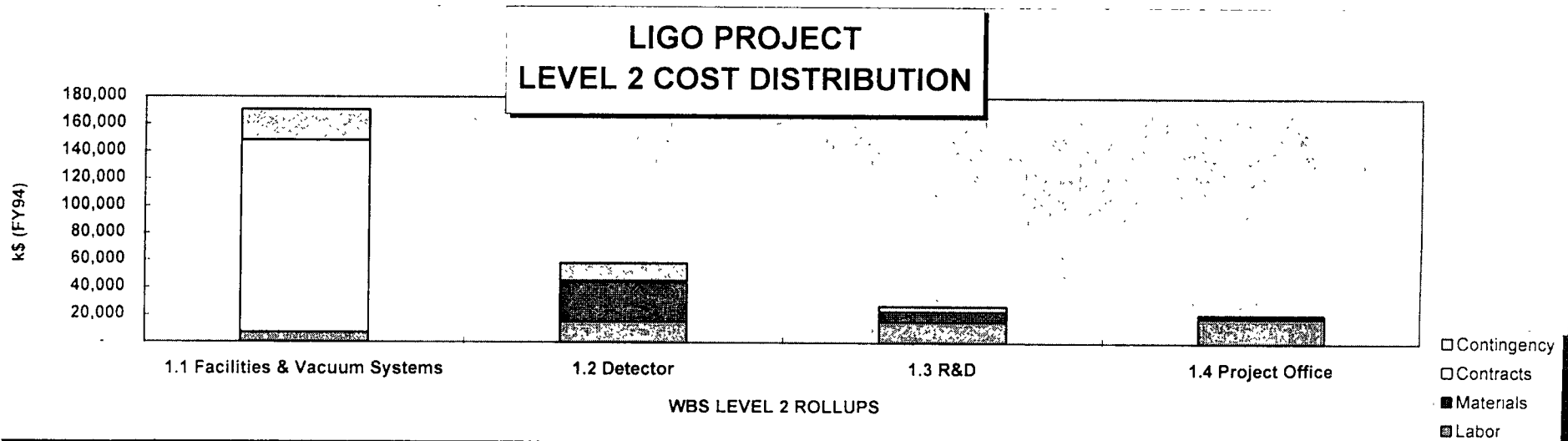


# LIGO PROJECT

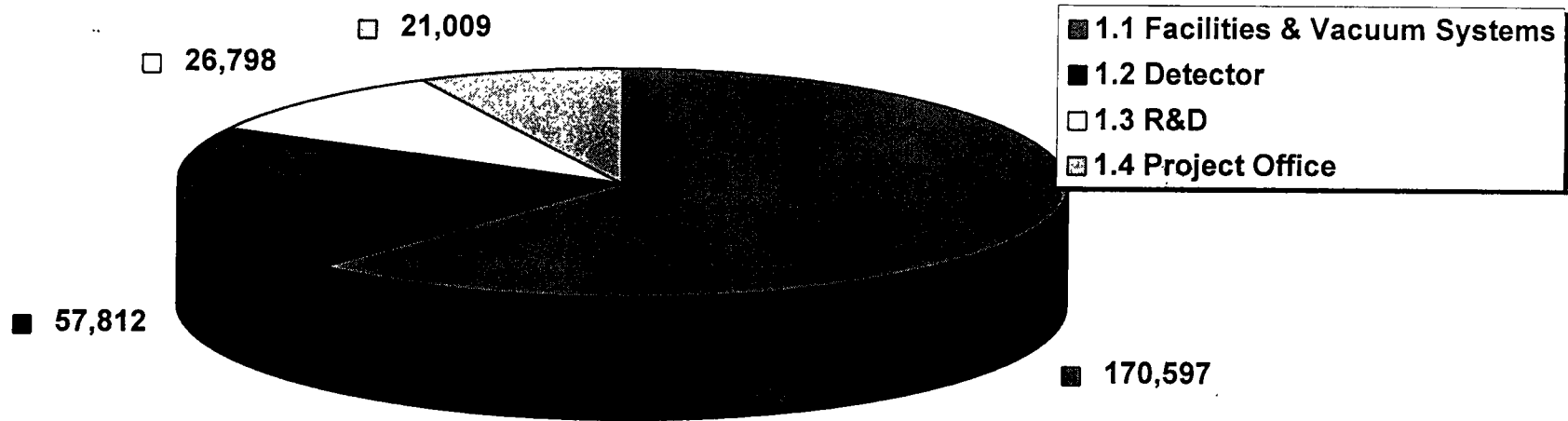
## LEVEL 2 COST DISTRIBUTION (FY94 \$K)

SEPTEMBER 1994

	1.1 Facilities & Vacuum Systems	1.2 Detector	1.3 R&D	1.4 Project Office	1. TOTAL LIGO
Labor	7,118	15,146	15,445	18,545	56,254
Materials	-	29,054	7,243	1,425	37,722
Contracts	140,859	894	-	-	141,753
Contingency	22,620	12,718	4,110	1,039	40,487
<b>Total</b>	<b>170,597</b>	<b>57,812</b>	<b>26,798</b>	<b>21,009</b>	<b>276,216</b>



**LIGO PROJECT**  
**LEVEL 2 COST DISTRIBUTION**  
**FY94 \$K**



# LIGO PROJECT FTE LABOR RATES

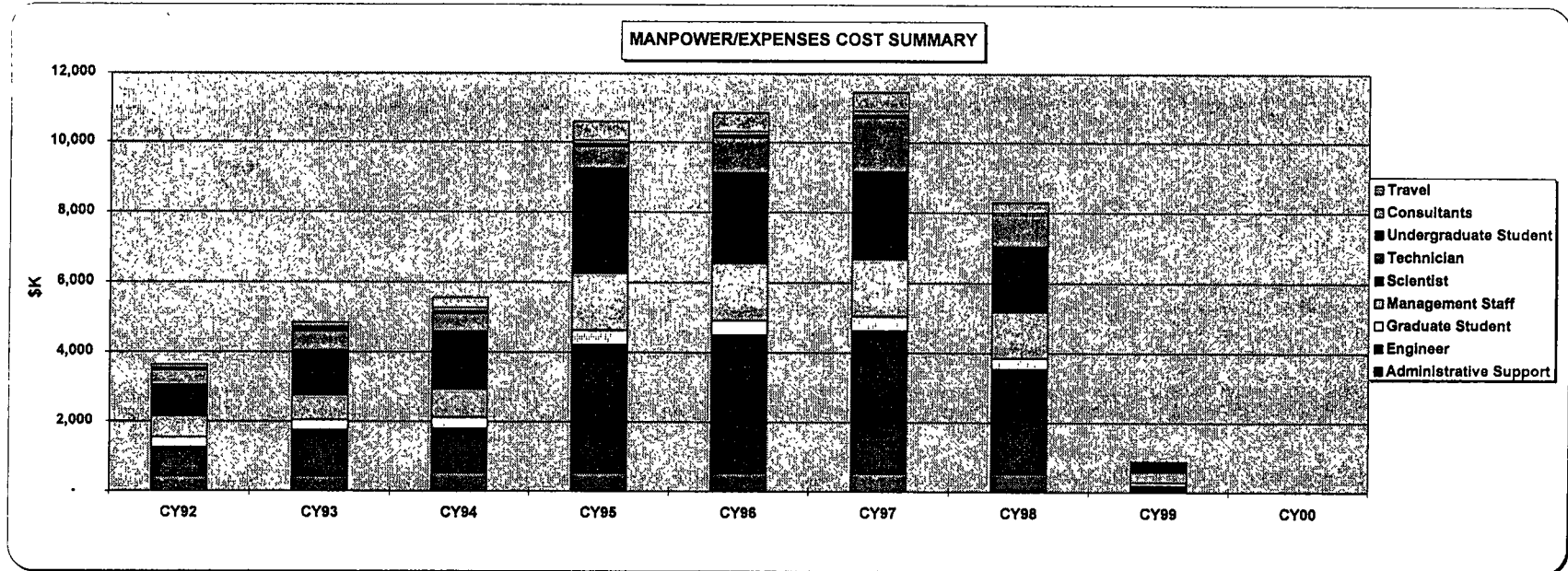
SEPTEMBER 1994

<i>In-house Labor Crafts</i>	<i>\$K/FTE-Manmonth</i>
Administrative Support	7.170
Engineer	11.770
Graduate Student	2.910
Management Staff	16.890
Scientist	10.560
Technician	6.860
Undergraduate Student	2.910

# LIGO PROJECT

## MANPOWER/EXPENSES SUMMARY (\$K & MANMONTHS) SEPTEMBER 1994

Labor Craft	\$K	MM	\$K	MM	\$K	MM	\$K	MM	\$K	MM	\$K	MM	\$K	MM	\$K	MM	\$K	MM	\$K	MM
	CY92	CY92	CY93	CY93	CY94	CY94	CY95	CY95	CY96	CY96	CY97	CY97	CY98	CY98	CY99	CY99	CY00	CY00	TOTAL	TOTAL
Administrative Support	409	57	430	60	516	72	516	72	516	72	516	72	516	72	-	-	-	-	3,420	477
Engineer	847	72	1,318	112	1,271	108	3,693	314	3,979	338	4,106	349	3,019	257	194	17	-	-	18,428	1,566
Graduate Student	279	96	297	102	332	114	419	144	419	144	419	144	314	108	93	32	-	-	2,572	884
Management Staff	608	36	709	42	811	48	1,622	96	1,622	96	1,622	96	1,318	78	304	18	-	-	8,614	510
Scientist	908	86	1,299	123	1,669	158	3,003	284	2,596	246	2,514	238	1,869	177	201	19	-	-	14,059	1,331
Technician	412	60	535	78	494	72	613	89	985	144	1,533	224	897	131	48	7	-	-	5,517	804
Undergraduate Student	67	23	64	22	79	27	79	27	79	27	79	27	-	-	-	-	-	-	445	153
Consultants	8		63		95		94		113		124		70		-	-	-	-	566	-
Travel	97		131		300		547		544		543		293		53		-	-	2,508	-
<b>TOTALS</b>	<b>3,836</b>	<b>430</b>	<b>4,846</b>	<b>539</b>	<b>5,565</b>	<b>599</b>	<b>10,587</b>	<b>1,027</b>	<b>10,852</b>	<b>1,067</b>	<b>11,455</b>	<b>1,150</b>	<b>8,297</b>	<b>822</b>	<b>893</b>	<b>93</b>	<b>-</b>	<b>-</b>	<b>56,130</b>	<b>5,726</b>

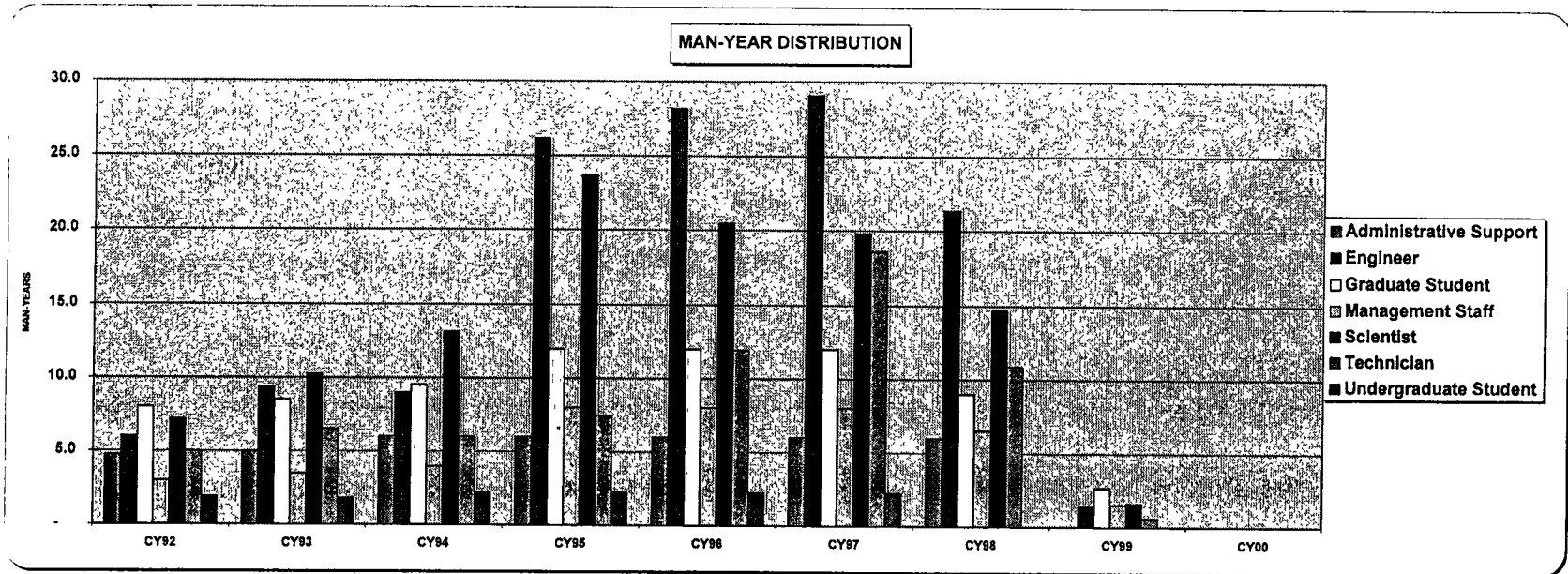


# LIGO PROJECT

## MANPOWER/EXPENSES SUMMARY (\$K & MANYEARS)

SEPTEMBER 1994

Labor Craft	\$K	MY	\$K	MY	\$K	MY	\$K	MY	\$K	MY	\$K	MY	\$K	MY	\$K	MY	\$K	MY	\$K	MY	TOTAL	TOTAL
	CY92	CY92	CY93	CY93	CY94	CY94	CY95	CY95	CY96	CY96	CY97	CY97	CY98	CY98	CY99	CY99	CY00	CY00	CY00	CY00		
Administrative Support	409	4.8	430	5.0	516	6.0	516	6.0	516	6.0	516	6.0	516	6.0	-	-	-	-	-	-	285	40
Engineer	847	6.0	1,318	9.3	1,271	9.0	3,693	26.2	3,979	28.2	4,106	29.1	3,019	21.4	194	1.4	-	-	-	-	1,536	130
Graduate Student	279	8.0	297	8.5	332	9.5	419	12.0	419	12.0	419	12.0	314	9.0	93	2.7	-	-	-	-	214	74
Management Staff	608	3.0	709	3.5	811	4.0	1,622	8.0	1,622	8.0	1,622	8.0	1,318	6.5	304	1.5	-	-	-	-	718	43
Scientist	908	7.2	1,299	10.3	1,669	13.2	3,003	23.7	2,596	20.5	2,514	19.8	1,869	14.8	201	1.6	-	-	-	-	1,172	111
Technician	412	5.0	535	6.5	494	6.0	613	7.5	985	12.0	1,533	18.6	897	10.9	48	0.6	-	-	-	-	460	67
Undergraduate Student	67	1.9	64	1.8	79	2.3	79	2.3	79	2.3	79	2.3	-	-	-	-	-	-	-	-	37	13
Consultants	8	-	63	-	95	-	94	-	113	-	124	-	70	-	-	-	-	-	-	-	47	-
Travel	97	-	131	-	300	-	547	-	544	-	543	-	293	-	53	-	-	-	-	-	209	-
<b>TOTALS</b>	<b>3,636</b>	<b>36</b>	<b>4,846</b>	<b>45</b>	<b>5,565</b>	<b>50</b>	<b>10,587</b>	<b>86</b>	<b>10,852</b>	<b>89</b>	<b>11,455</b>	<b>96</b>	<b>8,297</b>	<b>69</b>	<b>893</b>	<b>8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>56,130</b>	<b>477</b>

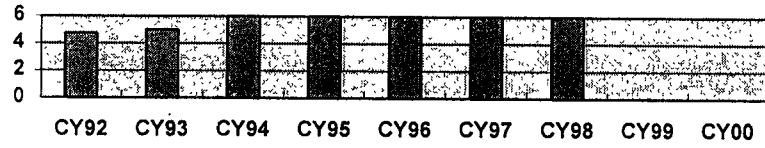


# LIGO PROJECT

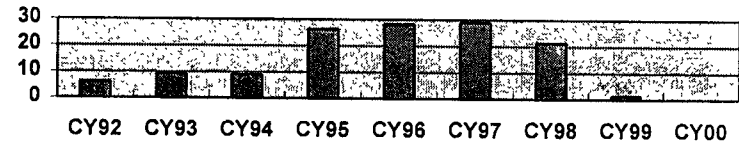
SEPTEMBER 1994

## IN-HOUSE STAFFING YEARLY DISTRIBUTION

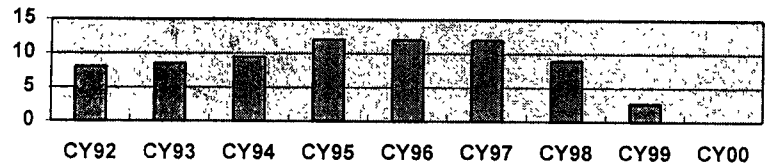
**Administrative Support**



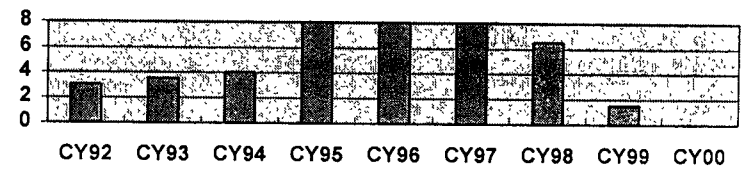
**Engineer**



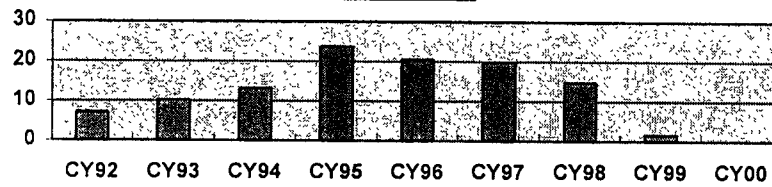
**Graduate Student**



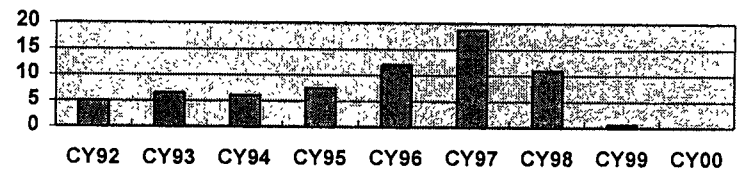
**Management Staff**



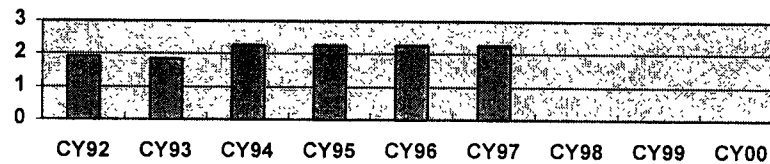
**Scientist**



**Technician**



**Undergraduate Student**



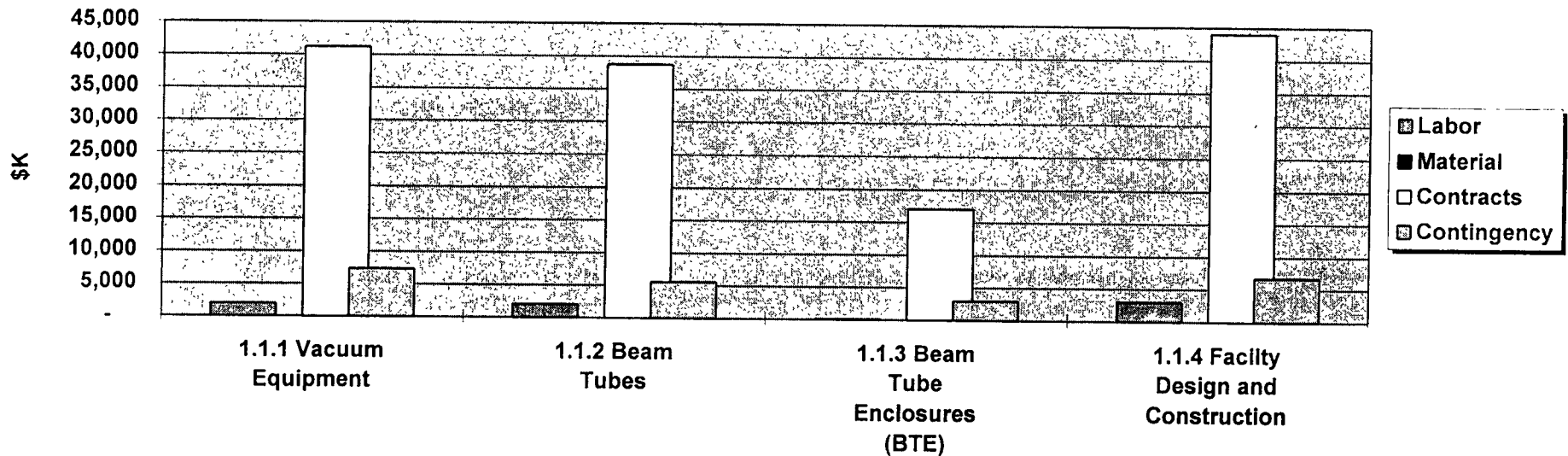
# **FACILITIES AND VACUUM EQUIPMENT**

# LIGO PROJECT

SEPTEMBER 1994

1.1 Facilities and Vacuum Systems		<--\$K-->			
Subsystem	Labor	Material	Contracts	Contingency	TOTAL
1.1.1 Vacuum Equipment	1,934	-	41,151	7,328	50,412
1.1.2 Beam Tubes	2,032	-	38,748	5,547	46,327
1.1.3 Beam Tube Enclosures (BTE)	111	-	17,010	2,994	20,115
1.1.4 Facility Design and Construction	3,043	-	43,950	6,751	53,743
<b>TOTAL</b>	<b>7,118</b>	<b>-</b>	<b>140,859</b>	<b>22,620</b>	<b>170,597</b>

1.1 FACILITIES AND VACUUM SYSTEMS



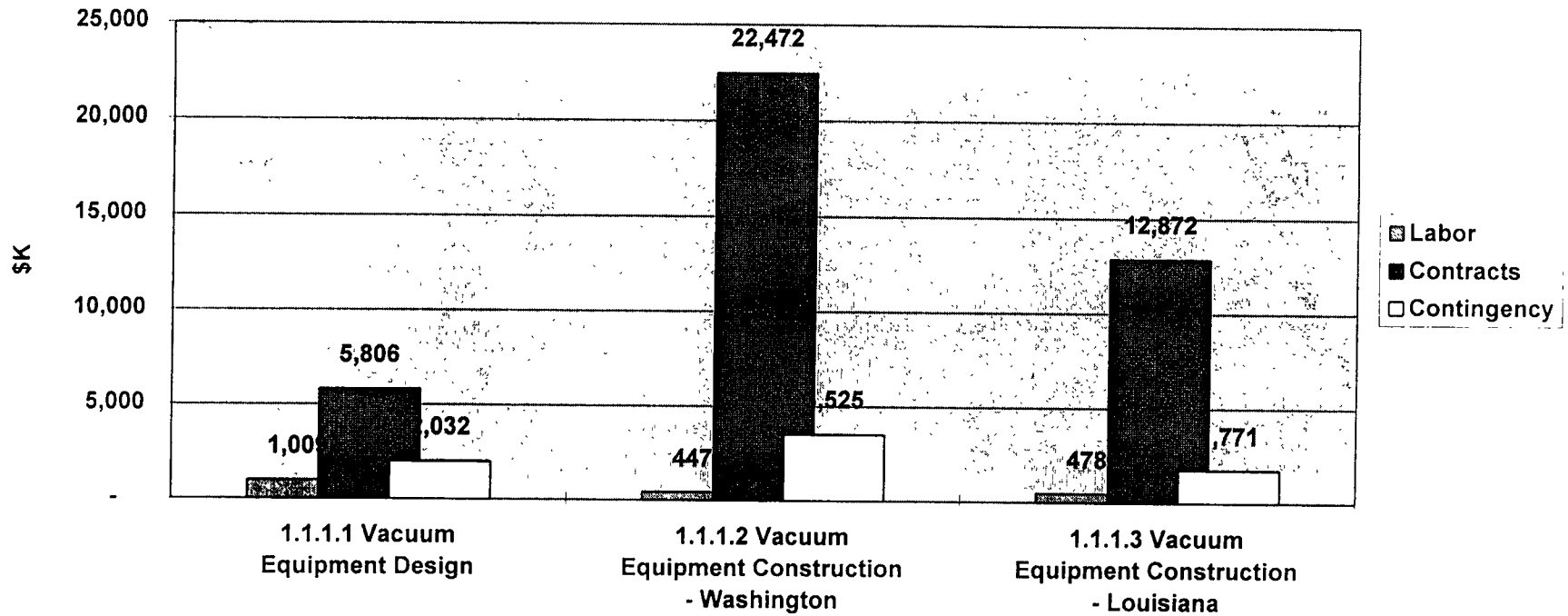


# LIGO PROJECT

SEPTEMBER 1994

1.1.1 Vacuum Equipment		<--\$K-->		
Subsystem	Labor	Contracts	Contingency	TOTAL
1.1.1.1 Vacuum Equipment Design	1,009	5,806	2,032	8,847
1.1.1.2 Vacuum Equipment Construction - Washington	447	22,472	3,525	26,443
1.1.1.3 Vacuum Equipment Construction - Louisiana	478	12,872	1,771	15,121
<b>TOTAL</b>	<b>1,934</b>	<b>41,151</b>	<b>7,328</b>	<b>50,412</b>

## 1.1.1 VACUUM EQUIPMENT

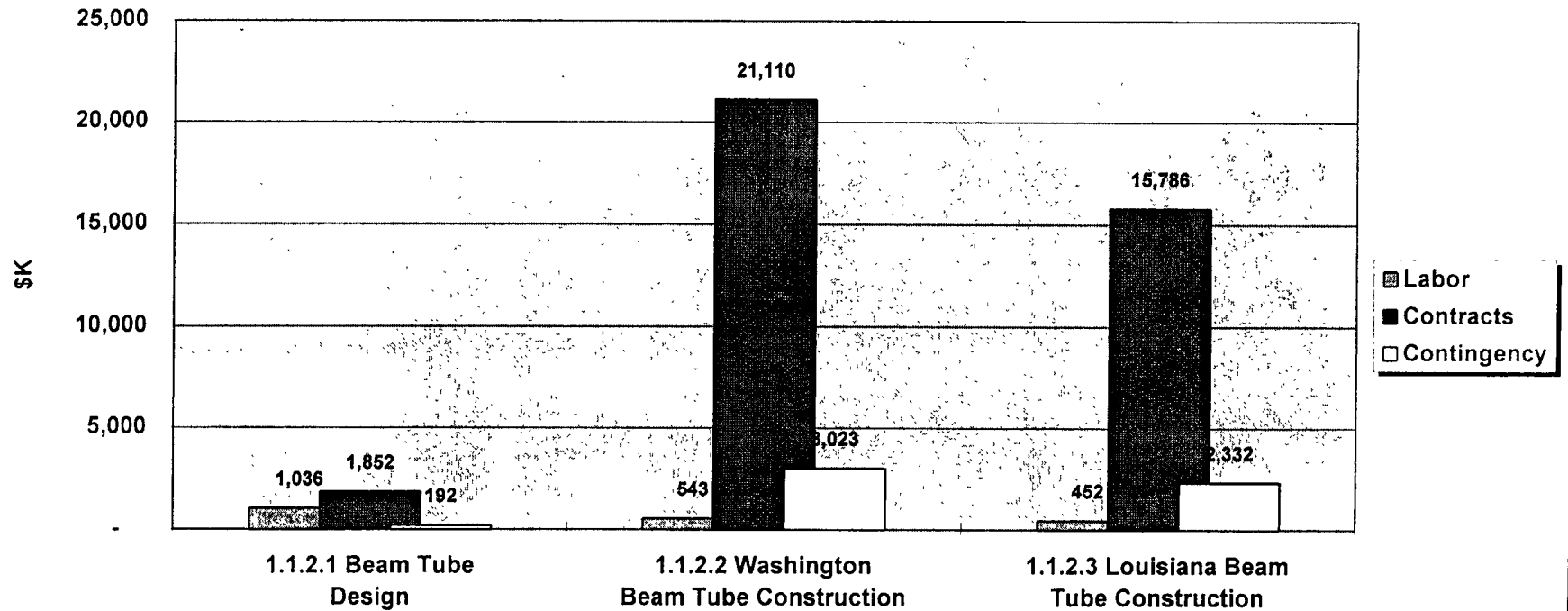


# LIGO PROJECT

SEPTEMBER 1994

1.1.2 Beam Tubes		<--\$K-->		
Subsystem	Labor	Contracts	Contingency	TOTAL
1.1.2.1 Beam Tube Design	1,036	1,852	192	3,080
1.1.2.2 Washington Beam Tube Construction	543	21,110	3,023	24,676
1.1.2.3 Louisiana Beam Tube Construction	452	15,786	2,332	18,571
<b>TOTAL</b>	<b>2,032</b>	<b>38,748</b>	<b>5,547</b>	<b>46,327</b>

## 1.1.2 BEAM TUBES



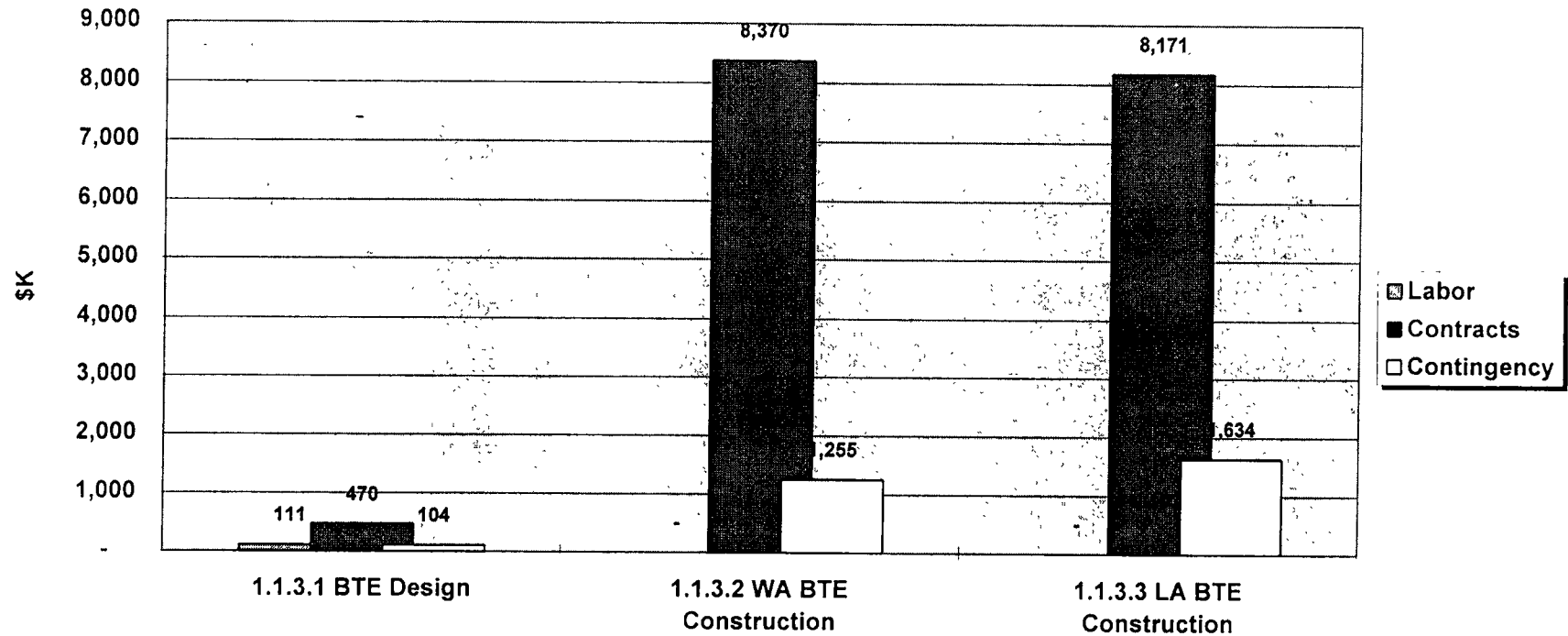
# LIGO PROJECT

SEPTEMBER 1994

## 1.1.3 Beam Tube Enclosures (BTE)

Subsystem	<--\$K-->			TOTAL
	Labor	Contracts	Contingency	
1.1.3.1 BTE Design	111	470	104	685
1.1.3.2 WA BTE Construction	-	8,370	1,255	9,625
1.1.3.3 LA BTE Construction	-	8,171	1,634	9,805
<b>TOTAL</b>	<b>111</b>	<b>17,010</b>	<b>2,994</b>	<b>20,115</b>

### 1.1.3 BEAM TUBE ENCLOSURES

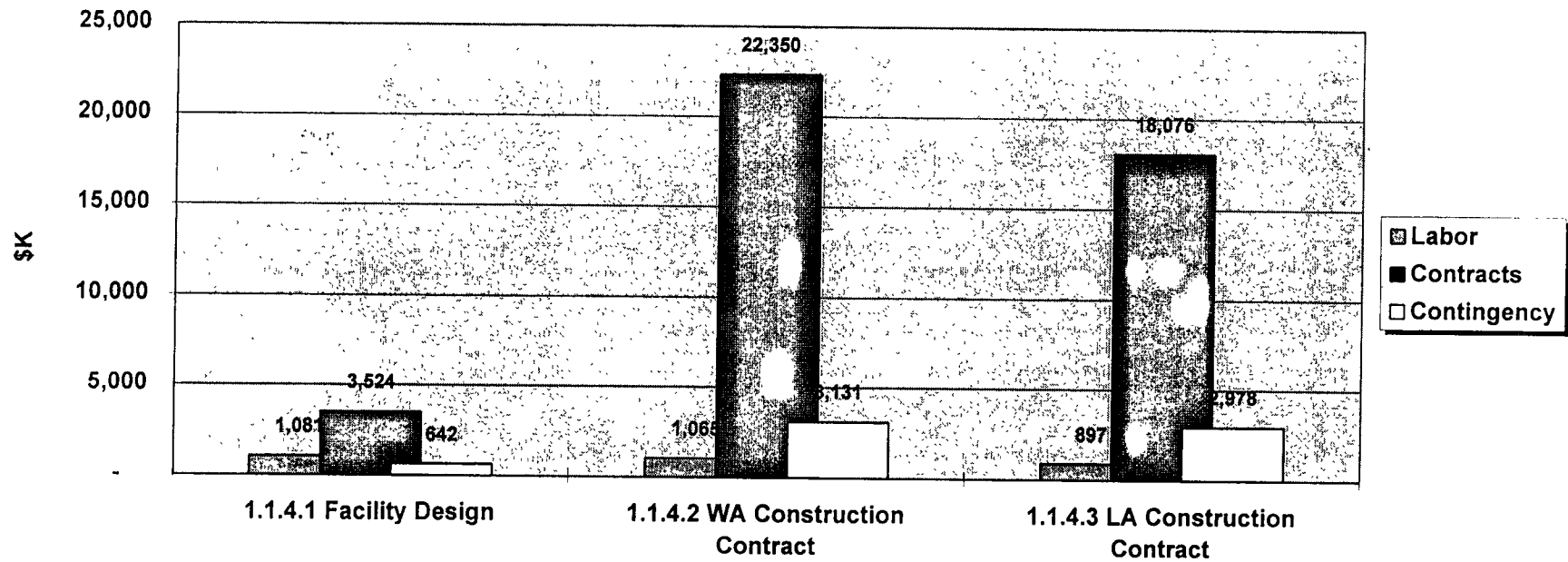


# LIGO PROJECT

SEPTEMBER 1994

1.1.4 Facility Design and Construction		<--\$K-->		
Subsystem	Labor	Contracts	Contingency	TOTAL
1.1.4.1 Facility Design	1,081	3,524	642	5,247
1.1.4.2 WA Construction Contract	1,065	22,350	3,131	26,545
1.1.4.3 LA Construction Contract	897	18,076	2,978	21,951
<b>TOTAL</b>	<b>3,043</b>	<b>43,950</b>	<b>6,751</b>	<b>53,743</b>

1.1.4 FACILITY DESIGN & CONSTRUCTION



**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY		TOTAL COST
								ALLOCATION %	(\$K)	
2	1.1	-Facilities and Vacuum Systems	497	7,118	0	140,859	147,977	15.29%	22,620	170,597
3	1.1.1	-Vacuum Equipment	150	1,934	0	41,151	43,084	17.01%	7,328	50,412
3	1.1.2	-Beam Tubes	146	2,032	0	38,748	40,780	13.60%	5,547	46,327
3	1.1.3	-Beam Tube Enclosures (BTE)	3	111	0	17,010	17,121	17.49%	2,994	20,115
3	1.1.4	-Facility Design and Construction	198	3,043	0	43,950	46,992	14.37%	6,751	53,743

LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION		TOTAL COST
								%	(\$K)	
2	1.1	-Facilities and Vacuum Systems	497	7,118	0	140,859	147,977	15.29%	22,620	170,597
3	1.1.1	-Vacuum Equipment	150	1,934	0	41,151	43,084	17.01%	7,328	50,412
4	1.1.1.1	-Vacuum Equipment Design	75	1,009	0	5,806	6,815	29.82%	2,032	8,847
5	1.1.1.1.1	In House Design	75	1,009	0	0	1,009	0.00%	0	1,009
5	1.1.1.1.2	Contracted Design	0	0	0	5,806	5,806	35.00%	2,032	7,839
4	1.1.1.2	-Vacuum Equipment Construction - Washington	36	447	0	22,472	22,918	15.38%	3,525	26,443
5	1.1.1.2.1	-WA Contract Management	36	447	0	1,614	2,061	27.42%	565	2,625
6	1.1.1.2.1.1	WA Vacuum Engineering and Contract Monit	36	447	0	0	447	0.00%	0	447
6	1.1.1.2.1.2	WA Contractor Management and QA	0	0	0	1,614	1,614	35.00%	565	2,179
5	1.1.1.2.2	-WA Chambers	0	0	0	6,424	6,424	20.00%	1,285	7,708
6	1.1.1.2.2.1	WA BSC Chambers	0	0	0	1,618	1,618	20.00%	324	1,942
6	1.1.1.2.2.2	WA HAM Chambers	0	0	0	2,142	2,142	20.00%	428	2,570
6	1.1.1.2.2.3	WA TMC Chambers	0	0	0	2,664	2,664	20.00%	533	3,196
5	1.1.1.2.3	-WA Tubes, Bellows, Adapters, Caps, Supports	0	0	0	3,635	3,635	12.00%	436	4,071
6	1.1.1.2.3.1	WA Tubes	0	0	0	1,538	1,538	12.00%	185	1,722
6	1.1.1.2.3.2	WA Bellows	0	0	0	1,043	1,043	12.00%	125	1,168
6	1.1.1.2.3.3	WA Adapters and Caps	0	0	0	863	863	12.00%	104	967
6	1.1.1.2.3.4	WA Supports	0	0	0	191	191	12.00%	23	214
5	1.1.1.2.4	-WA Pumps and Leak Detectors	0	0	0	5,562	5,562	12.84%	714	6,276
6	1.1.1.2.4.1	WA Roots System	0	0	0	524	524	4.00%	21	545
6	1.1.1.2.4.2	WA Turbo System	0	0	0	291	291	4.00%	12	302



LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	CONTINGENCY (\$K)	TOTAL COST
6	1.1.1.2.4.3	-WA LN2 Pump System	0	0	0	2,436	2,436	24.00%	585	3,021
7	1.1.1.2.4.3.1	WA Long LN2 Pump	0	0	0	854	854	24.00%	205	1,059
7	1.1.1.2.4.3.2	WA Short LN2 Pump	0	0	0	1,582	1,582	24.00%	380	1,962
6	1.1.1.2.4.4	WA Main Ion and Getter Pumps	0	0	0	1,770	1,770	4.00%	71	1,840
6	1.1.1.2.4.5	WA Annulus pumping system	0	0	0	393	393	4.00%	16	408
6	1.1.1.2.4.6	WA Helium Leak Detectors	0	0	0	99	99	7.00%	7	106
6	1.1.1.2.4.7	WA Laboratory Pumps	0	0	0	50	50	7.01%	3	53
5	1.1.1.2.5	-WA Main Valves	0	0	0	2,890	2,890	7.64%	221	3,111
6	1.1.1.2.5.1	WA 48 Inch Valves	0	0	0	2,631	2,631	8.00%	210	2,842
6	1.1.1.2.5.2	WA 10 Inch Roughing Valves	0	0	0	259	259	4.00%	10	269
5	1.1.1.2.6	-WA Instrumentation	0	0	0	311	311	7.00%	22	333
6	1.1.1.2.6.1	WA Main Gages	0	0	0	88	88	7.00%	6	95
6	1.1.1.2.6.2	WA Differential Pressure Switches	0	0	0	33	33	7.01%	2	35
6	1.1.1.2.6.3	WA RGA Ports and Valves	0	0	0	190	190	7.00%	13	203
5	1.1.1.2.7	-WA Purge and Vent System	0	0	0	1,020	1,020	18.00%	184	1,204
6	1.1.1.2.7.1	WA Portable Clean Rooms	0	0	0	286	286	18.00%	52	338
6	1.1.1.2.7.2	WA Purge Air Supply	0	0	0	734	734	18.00%	132	866
5	1.1.1.2.8	-WA Bakeout Equipment	0	0	0	315	315	18.00%	57	371
6	1.1.1.2.8.1	WA Insulation and Heaters	0	0	0	245	245	18.00%	44	289
6	1.1.1.2.8.2	WA Controllers and Cabling	0	0	0	70	70	18.00%	13	83
5	1.1.1.2.9	-WA Misc. Support	0	0	0	702	702	6.02%	42	744



## LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
6	1.1.1.2.9.1	WA Gage Calibration System	0	0	0	158	158	7.00%	11	170
6	1.1.1.2.9.2	WA Diagnostic Cart	0	0	0	198	198	7.00%	14	212
6	1.1.1.2.9.3	WA Spares	0	0	0	345	345	5.00%	17	363
4	1.1.1.3	-Vacuum Equipment Construction - Louisiana	39	478	0	12,872	13,351	13.26%	1,771	15,121
5	1.1.1.3.1	-LA Contract Management	39	478	0	832	1,310	24.84%	325	1,636
6	1.1.1.3.1.1	LA Vacuum Engineering and Contract Monit	39	478	0	0	478	35.00%	167	645
6	1.1.1.3.1.2	LA Contractor Management and QA	0	0	0	832	832	19.00%	158	990
5	1.1.1.3.2	-LA Chambers	0	0	0	2,288	2,288	16.00%	366	2,654
6	1.1.1.3.2.1	LA BSC Chambers	0	0	0	1,327	1,327	16.00%	212	1,539
6	1.1.1.3.2.2	LA HAM Chambers	0	0	0	961	961	16.00%	154	1,114
5	1.1.1.3.3	-LA Tubes, Bellows, Adapters, Caps, Supports	0	0	0	2,410	2,410	12.00%	289	2,699
6	1.1.1.3.3.1	LA Tubes	0	0	0	1,045	1,045	12.00%	125	1,171
6	1.1.1.3.3.2	LA Bellows	0	0	0	738	738	12.00%	89	827
6	1.1.1.3.3.3	LA Adapters and Caps	0	0	0	519	519	12.00%	62	582
6	1.1.1.3.3.4	LA Supports	0	0	0	107	107	12.00%	13	120
5	1.1.1.3.4	-LA Pumps and Leak Detectors	0	0	0	3,771	3,771	11.42%	431	4,202
6	1.1.1.3.4.1	LA Roots Systems	0	0	0	420	420	4.00%	17	436
6	1.1.1.3.4.2	LA Turbo Systems	0	0	0	291	291	4.00%	12	302
6	1.1.1.3.4.3	-LA LN2 Pump System	0	0	0	1,381	1,381	24.00%	331	1,713
7	1.1.1.3.4.3.1	LA Long LN2 Pump	0	0	0	854	854	24.00%	205	1,059
7	1.1.1.3.4.3.2	LA Short LN2 Pump	0	0	0	527	527	24.00%	127	654



**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	ALLOCATION (\$K)	TOTAL COST
6	1.1.1.3.4.4	LA Main Ion and Getter Pumps	0	0	0	1,322	1,322	4.00%	53	1,375
6	1.1.1.3.4.5	LA Annulus pumping system	0	0	0	233	233	4.00%	9	243
6	1.1.1.3.4.6	LA Helium Leak Detectors	0	0	0	74	74	7.00%	5	79
6	1.1.1.3.4.7	LA Laboratory Pumps	0	0	0	50	50	7.01%	3	53
5	1.1.1.3.5	-LA Main Valves	0	0	0	1,734	1,734	7.64%	133	1,867
6	1.1.1.3.5.1	LA 48 Inch Valves	0	0	0	1,579	1,579	8.00%	126	1,705
6	1.1.1.3.5.2	LA 10 Inch Roughing Valves	0	0	0	155	155	4.00%	6	162
5	1.1.1.3.6	-LA Instrumentation	0	0	0	182	182	7.00%	13	195
6	1.1.1.3.6.1	LA Main Gages	0	0	0	55	55	7.00%	4	58
6	1.1.1.3.6.2	LA Differential Pressure Switches	0	0	0	16	16	6.98%	1	17
6	1.1.1.3.6.3	LA RGA Ports and Valves	0	0	0	111	111	7.00%	8	119
5	1.1.1.3.7	-LA Purge and Vent System	0	0	0	639	639	18.00%	115	754
6	1.1.1.3.7.1	LA Portable Clean Rooms	0	0	0	179	179	18.00%	32	211
6	1.1.1.3.7.2	LA Purge Air Supply	0	0	0	460	460	18.00%	83	543
5	1.1.1.3.8	-LA Bakeout Equipment	0	0	0	315	315	18.00%	57	371
6	1.1.1.3.8.1	LA Insulation and Heaters	0	0	0	245	245	18.00%	44	289
6	1.1.1.3.8.2	LA Controllers and Cabling	0	0	0	70	70	18.00%	13	83
5	1.1.1.3.9	-LA Misc. Support	0	0	0	702	702	6.02%	42	744
6	1.1.1.3.9.1	LA Gage Calibration System	0	0	0	158	158	7.00%	11	170
6	1.1.1.3.9.2	LA Diagnostic Cart	0	0	0	198	198	7.00%	14	212
6	1.1.1.3.9.3	LA Spares	0	0	0	345	345	5.00%	17	363

## LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	CONTINGENCY (\$K)	TOTAL COST
3	1.1.2	-Beam Tubes	146	2,032	0	38,748	40,780	13.60%	5,547	46,327
4	1.1.2.1	-Beam Tube Design	76	1,036	0	1,852	2,888	6.65%	192	3,080
5	1.1.2.1.1	Beam Tube Design Contract Management	76	1,036	0	0	1,036	0.00%	0	1,036
5	1.1.2.1.2	-Beam Tube Design Contract	0	0	0	1,852	1,852	10.37%	192	2,044
6	1.1.2.1.2.1	Beam Tube Design Contract (1993)	0	0	0	1,287	1,287	0.00%	0	1,287
6	1.1.2.1.2.2	Beam Tube Design Contract (1994)	0	0	0	565	565	34.00%	192	757
4	1.1.2.2	-Washington Beam Tube Construction	38	543	0	21,110	21,653	13.96%	3,023	24,676
5	1.1.2.2.1	WA Beam Tube Contract Management	38	543	0	0	543	6.00%	33	576
5	1.1.2.2.2	WA Beam Tube Factory Fab	0	0	0	14,069	14,069	11.00%	1,548	15,617
5	1.1.2.2.3	WA Beam Tube Field Installation	0	0	0	5,004	5,004	19.00%	951	5,954
5	1.1.2.2.4	WA Beam Tube Insulate & Bake	0	0	0	1,736	1,736	11.00%	191	1,927
5	1.1.2.2.5	WA Beam Tube Acceptance Test	0	0	0	301	301	100.00%	301	602
4	1.1.2.3	-Louisiana Beam Tube Construction	32	452	0	15,786	16,239	14.36%	2,332	18,571
5	1.1.2.3.1	LA Beam Tube Contract Management	32	452	0	0	452	6.00%	27	480
5	1.1.2.3.2	LA Beam Tube Factory Fab	0	0	0	10,011	10,011	11.00%	1,101	11,112
5	1.1.2.3.3	LA Beam Tube Field Installation	0	0	0	4,004	4,004	19.00%	761	4,765
5	1.1.2.3.4	LA Beam Tube Insulate & Bake	0	0	0	1,493	1,493	11.00%	164	1,657
5	1.1.2.3.5	LA Beam Tube Acceptance Test	0	0	0	279	279	100.00%	279	557
3	1.1.3	-Beam Tube Enclosures (BTE)	3	111	0	17,010	17,121	17.49%	2,994	20,115
4	1.1.3.1	-BTE Design	3	111	0	470	581	18.00%	104	685
5	1.1.3.1.1	BTE Contract Management	3	111	0	0	111	18.00%	20	130

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**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION		TOTAL COST
								%	(\$K)	
5	1.1.3.1.2	BTE Design Contract	0	0	0	470	470	18.00%	85	555
4	1.1.3.2	-WA BTE Construction	0	0	0	8,370	8,370	15.00%	1,255	9,625
5	1.1.3.2.1	WA BTE Construction Mgmt. & QA Contract	0	0	0	370	370	15.00%	55	425
5	1.1.3.2.2	WA BTE Construction Contract	0	0	0	8,000	8,000	15.00%	1,200	9,200
4	1.1.3.3	-LA BTE Construction	0	0	0	8,171	8,171	20.00%	1,634	9,805
5	1.1.3.3.1	LA BTE Construction Mgmt. & QA Contract	0	0	0	361	361	20.00%	72	433
5	1.1.3.3.2	LA BTE Construction Contract	0	0	0	7,810	7,810	20.00%	1,562	9,372
3	1.1.4	-Facility Design and Construction	198	3,043	0	43,950	46,992	14.37%	6,751	53,743
4	1.1.4.1	-Facility Design	66	1,081	0	3,524	4,605	13.94%	642	5,247
5	1.1.4.1.1	-Design Engineering	66	1,081	0	0	1,081	12.57%	136	1,216
6	1.1.4.1.1.1	Design Engineering (Actuals)	26	401	0	0	401	0.00%	0	401
6	1.1.4.1.1.2	Design Engineering (To-do)	40	679	0	0	679	20.00%	136	815
5	1.1.4.1.2	-Design Contract	0	0	0	2,542	2,542	19.90%	506	3,048
6	1.1.4.1.2.1	Design Contract (Actuals)	0	0	0	13	13	0.00%	0	13
6	1.1.4.1.2.2	Design Contract (To-do)	0	0	0	2,530	2,530	20.00%	506	3,036
5	1.1.4.1.3	-Site Investigation	0	0	0	982	982	0.00%	0	982
6	1.1.4.1.3.1	WA Site Investigation	0	0	0	362	362	0.00%	0	362
6	1.1.4.1.3.2	LA Site Investigation	0	0	0	620	620	0.00%	0	620
4	1.1.4.2	-WA Construction Contract	72	1,065	0	22,350	23,415	13.37%	3,131	26,545
5	1.1.4.2.1	WA Contract Management	72	1,065	0	184	1,249	15.00%	187	1,437
5	1.1.4.2.2	-WA Construction	0	0	0	22,166	22,166	13.28%	2,943	25,109



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**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
6	1.1.4.2.2.1	-WA CM & QA	0	0	0	1,290	1,290	8.00%	103	1,393
7	1.1.4.2.2.1.1	WA CM & QA - Site Development	0	0	0	389	389	8.00%	31	420
7	1.1.4.2.2.1.2	WA CM & QA - Buildings	0	0	0	901	901	8.00%	72	974
6	1.1.4.2.2.2	-WA Site Development	0	0	0	6,452	6,452	10.00%	645	7,098
7	1.1.4.2.2.2.1	Earthwork	0	0	0	2,906	2,906	10.00%	291	3,196
7	1.1.4.2.2.2.2	Access Roads & Parking	0	0	0	1,259	1,259	10.00%	126	1,385
7	1.1.4.2.2.2.3	Drainage & Erosion Control	0	0	0	197	197	10.00%	20	217
7	1.1.4.2.2.2.4	Electrical Power	0	0	0	1,300	1,300	10.00%	130	1,430
7	1.1.4.2.2.2.5	Domestic Water & Sewer	0	0	0	412	412	10.00%	41	454
7	1.1.4.2.2.2.6	Fire Protection	0	0	0	283	283	10.00%	28	311
7	1.1.4.2.2.2.7	Miscellaneous Site Improvements	0	0	0	95	95	10.00%	10	105
6	1.1.4.2.2.3	-WA Corner Station	0	0	0	9,734	9,734	15.00%	1,460	11,194
7	1.1.4.2.2.3.1	Vacuum Chamber	0	0	0	7,858	7,858	15.00%	1,179	9,036
7	1.1.4.2.2.3.2	Utility Room	0	0	0	176	176	15.00%	26	203
7	1.1.4.2.2.3.3	Office/Shop/Service Area	0	0	0	1,341	1,341	15.00%	201	1,542
7	1.1.4.2.2.3.4	Chiller Plant	0	0	0	360	360	15.00%	54	414
6	1.1.4.2.2.4	-WA Left Arm End Station	0	0	0	1,015	1,015	15.00%	152	1,167
7	1.1.4.2.2.4.1	Vacuum Chamber	0	0	0	692	692	15.00%	104	796
7	1.1.4.2.2.4.2	Utility Room	0	0	0	18	18	15.00%	3	20
7	1.1.4.2.2.4.3	Shop/Service Area	0	0	0	266	266	15.00%	40	306
7	1.1.4.2.2.4.4	Chiller Plant	0	0	0	39	39	14.99%	6	45



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(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	CONTINGENCY (\$K)	TOTAL COST
6	1.1.4.2.2.5	-WA Left Arm Mid Station	0	0	0	1,015	1,015	15.00%	152	1,167
7	1.1.4.2.2.5.1	Vacuum Chamber	0	0	0	692	692	15.00%	104	796
7	1.1.4.2.2.5.2	Utility Room	0	0	0	18	18	15.00%	3	20
7	1.1.4.2.2.5.3	Shop/Service Area	0	0	0	266	266	15.00%	40	306
7	1.1.4.2.2.5.4	Chiller Plant	0	0	0	39	39	14.99%	6	45
6	1.1.4.2.2.6	-WA Right Arm End Station	0	0	0	1,015	1,015	15.00%	152	1,167
7	1.1.4.2.2.6.1	Vacuum Chamber	0	0	0	692	692	15.00%	104	796
7	1.1.4.2.2.6.2	Utility Room	0	0	0	18	18	15.00%	3	20
7	1.1.4.2.2.6.3	Shop/Service Area	0	0	0	266	266	15.00%	40	306
7	1.1.4.2.2.6.4	Chiller Plant	0	0	0	39	39	14.99%	6	45
6	1.1.4.2.2.7	-WA Right Arm Mid Station	0	0	0	1,015	1,015	15.00%	152	1,167
7	1.1.4.2.2.7.1	Vacuum Chamber	0	0	0	692	692	15.00%	104	796
7	1.1.4.2.2.7.2	Utility Room	0	0	0	18	18	15.00%	3	20
7	1.1.4.2.2.7.3	Shop/Service Area	0	0	0	266	266	15.00%	40	306
7	1.1.4.2.2.7.4	Chiller Plant	0	0	0	39	39	14.99%	6	45
6	1.1.4.2.2.8	WA Building Furnishings	0	0	0	629	629	20.00%	126	755
4	1.1.4.3	-LA Construction Contract	60	897	0	18,076	18,973	15.70%	2,978	21,951
5	1.1.4.3.1	LA Contract Management	60	897	0	200	1,097	15.00%	165	1,261
5	1.1.4.3.2	-LA Construction	0	0	0	17,876	17,876	15.74%	2,814	20,690
6	1.1.4.3.2.1	-LA CM & QA	0	0	0	1,300	1,300	8.00%	104	1,404
7	1.1.4.3.2.1.1	WA CM & QA - Site Development	0	0	0	368	368	8.00%	29	398

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**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
7	1.1.4.3.2.1.2	WA CM & QA - Buildings	0	0	0	931	931	8.00%	75	1,006
6	1.1.4.3.2.2	-LA Site Development	0	0	0	6,491	6,491	18.00%	1,168	7,659
7	1.1.4.3.2.2.1	Earthwork	0	0	0	3,110	3,110	18.00%	560	3,670
7	1.1.4.3.2.2.2	Access Roads & Parking	0	0	0	1,097	1,097	18.00%	198	1,295
7	1.1.4.3.2.2.3	Drainage & Erosion Control	0	0	0	807	807	18.00%	145	953
7	1.1.4.3.2.2.4	Electrical Power	0	0	0	1,032	1,032	18.00%	186	1,218
7	1.1.4.3.2.2.5	Domestic Water & Sewer	0	0	0	138	138	18.00%	25	163
7	1.1.4.3.2.2.6	Fire Protection	0	0	0	213	213	18.00%	38	251
7	1.1.4.3.2.2.7	Miscellaneous Site Improvements	0	0	0	93	93	18.00%	17	110
6	1.1.4.3.2.3	-LA Corner Station	0	0	0	7,494	7,494	15.00%	1,124	8,618
7	1.1.4.3.2.3.1	Vacuum Chamber	0	0	0	5,701	5,701	15.00%	855	6,556
7	1.1.4.3.2.3.2	Utility Room	0	0	0	172	172	15.00%	26	198
7	1.1.4.3.2.3.3	Office/Shop/Service Area	0	0	0	1,309	1,309	15.00%	196	1,505
7	1.1.4.3.2.3.4	Chiller Plant	0	0	0	312	312	15.00%	47	359
6	1.1.4.3.2.4	-LA Left Arm End Station	0	0	0	991	991	15.00%	149	1,139
7	1.1.4.3.2.4.1	Vacuum Chamber	0	0	0	675	675	15.00%	101	777
7	1.1.4.3.2.4.2	Utility Room	0	0	0	17	17	15.01%	3	20
7	1.1.4.3.2.4.3	Shop/Service Area	0	0	0	260	260	15.00%	39	299
7	1.1.4.3.2.4.4	Chiller Plant	0	0	0	39	39	14.99%	6	44
6	1.1.4.3.2.5	-LA Left Arm Mid Station	0	0	0	16	16	15.03%	2	19
7	1.1.4.3.2.5.1	Pump Room	0	0	0	16	16	15.03%	2	19



LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	CONTINGENCY (\$K)	TOTAL COST
6	1.1.4.3.2.6	-LA Right Arm End Station	0	0	0	991	991	15.00%	149	1,139
7	1.1.4.3.2.6.1	Vacuum Chamber	0	0	0	675	675	15.00%	101	777
7	1.1.4.3.2.6.2	Utility Room	0	0	0	17	17	15.01%	3	20
7	1.1.4.3.2.6.3	Shop/Service Area	0	0	0	260	260	15.00%	39	299
7	1.1.4.3.2.6.4	Chiller Plant	0	0	0	39	39	14.99%	6	44
6	1.1.4.3.2.7	-LA Right Arm Mid Station	0	0	0	17	17	14.98%	3	20
7	1.1.4.3.2.7.1	Pump Room	0	0	0	17	17	14.98%	3	20
6	1.1.4.3.2.8	LA Building Furnishings	0	0	0	577	577	20.00%	115	692

**DETECTOR**

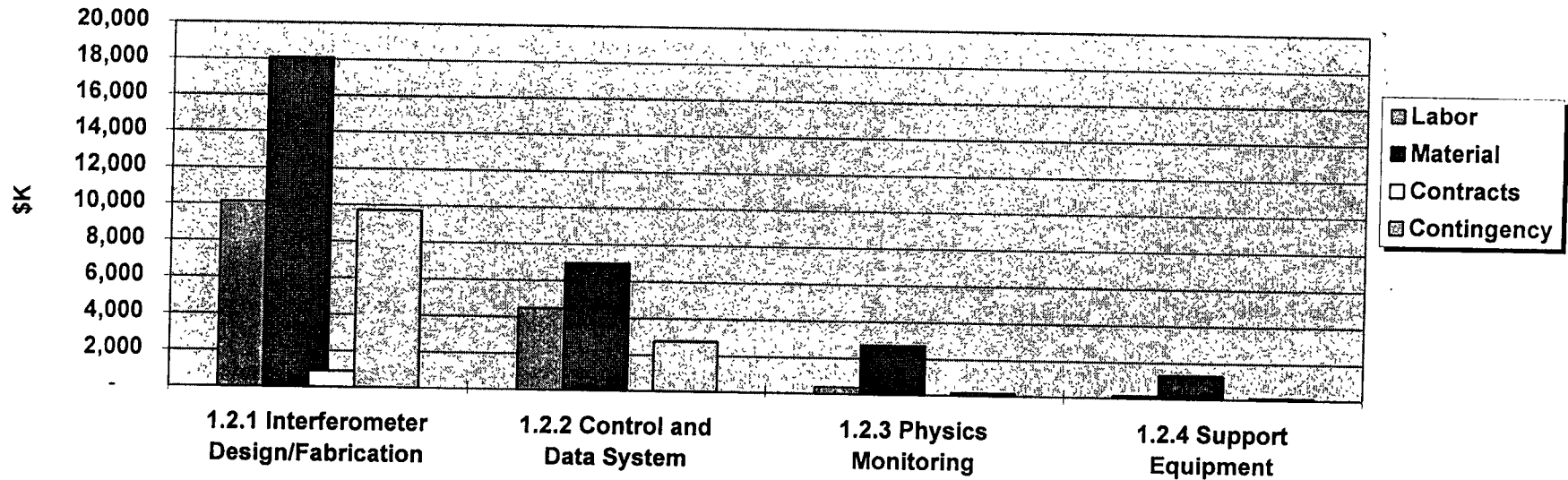


# LIGO PROJECT

SEPTEMBER 1994

1.2 Detector		<--\$K-->			
Subsystem	Labor	Material	Contracts	Contingency	TOTAL
1.2.1 Interferometer Design/Fabrication	10,133	18,071	894	9,710	38,808
1.2.2 Control and Data System	4,492	6,965	-	2,782	14,238
1.2.3 Physics Monitoring	383	2,710	-	155	3,248
1.2.4 Support Equipment	138	1,308	-	72	1,518
<b>TOTAL</b>	<b>15,146</b>	<b>29,054</b>	<b>894</b>	<b>12,718</b>	<b>57,812</b>

1.2 DETECTOR

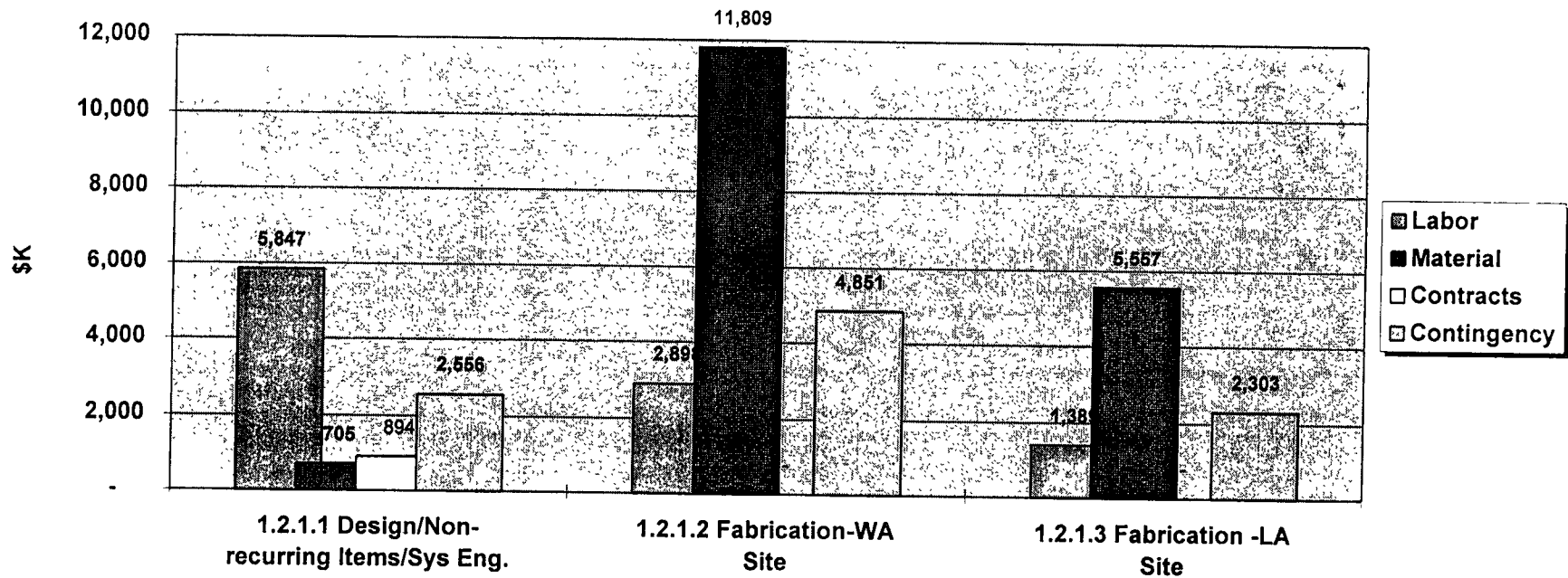


# LIGO PROJECT

SEPTEMBER 1994

1.2.1 Interferometer Design/Fabrication					
Subsystem	←-\$K→				
	Labor	Material	Contracts	Contingency	TOTAL
1.2.1.1 Design/Non-recurring Items/Sys Eng.	5,847	705	894	2,556	10,002
1.2.1.2 Fabrication-WA Site	2,898	11,809	-	4,851	19,557
1.2.1.3 Fabrication -LA Site	1,389	5,557	-	2,303	9,249
<b>TOTAL</b>	<b>10,133</b>	<b>18,071</b>	<b>894</b>	<b>9,710</b>	<b>38,808</b>

1.2.1 INTERFEROMETER DESIGN/FABRICATION

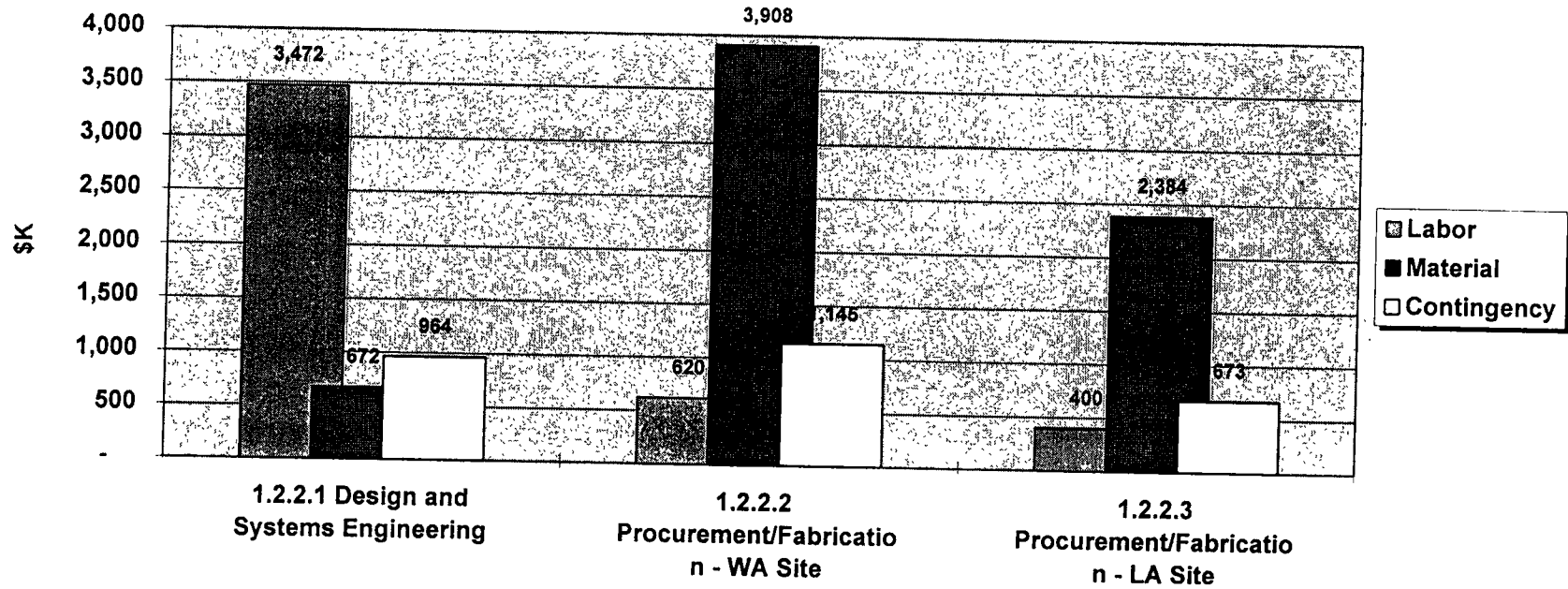


# LIGO PROJECT

SEPTEMBER 1994

1.2.2 Control and Data System		<--\$K-->		
Subsystem	Labor	Material	Contingency	TOTAL
1.2.2.1 Design and Systems Engineering	3,472	672	964	5,107
1.2.2.2 Procurement/Fabrication - WA Site	620	3,908	1,145	5,674
1.2.2.3 Procurement/Fabrication - LA Site	400	2,384	673	3,457
<b>TOTAL</b>	<b>4,492</b>	<b>6,965</b>	<b>2,782</b>	<b>14,238</b>

1.2.2 CONTROL AND DATA SYSTEM

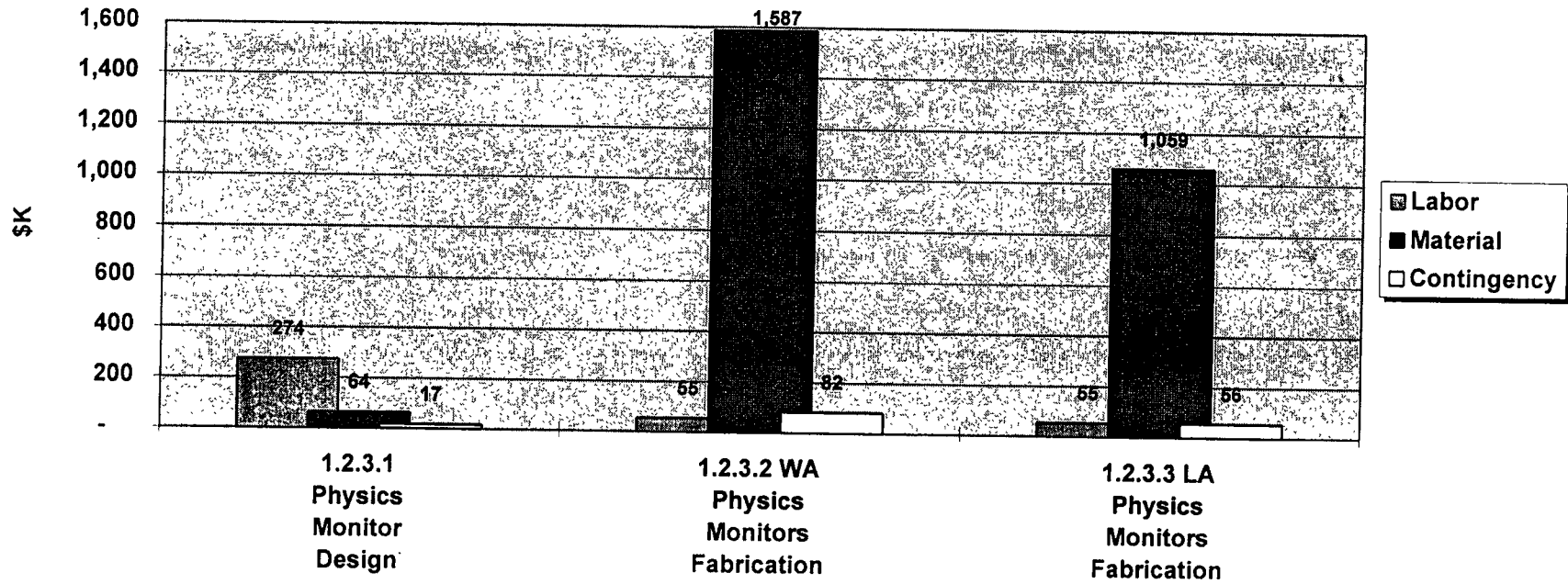


# LIGO PROJECT

SEPTEMBER 1994

1.2.3 Physics Monitoring		<--\$K-->		
Subsystem	Labor	Material	Contingency	TOTAL
1.2.3.1 Physics Monitor Design	274	64	17	355
1.2.3.2 WA Physics Monitors Fabrication	55	1,587	82	1,724
1.2.3.3 LA Physics Monitors Fabrication	55	1,059	56	1,169
<b>TOTAL</b>	<b>383</b>	<b>2,710</b>	<b>155</b>	<b>3,248</b>

1.2.3 PHYSICS MONITORING

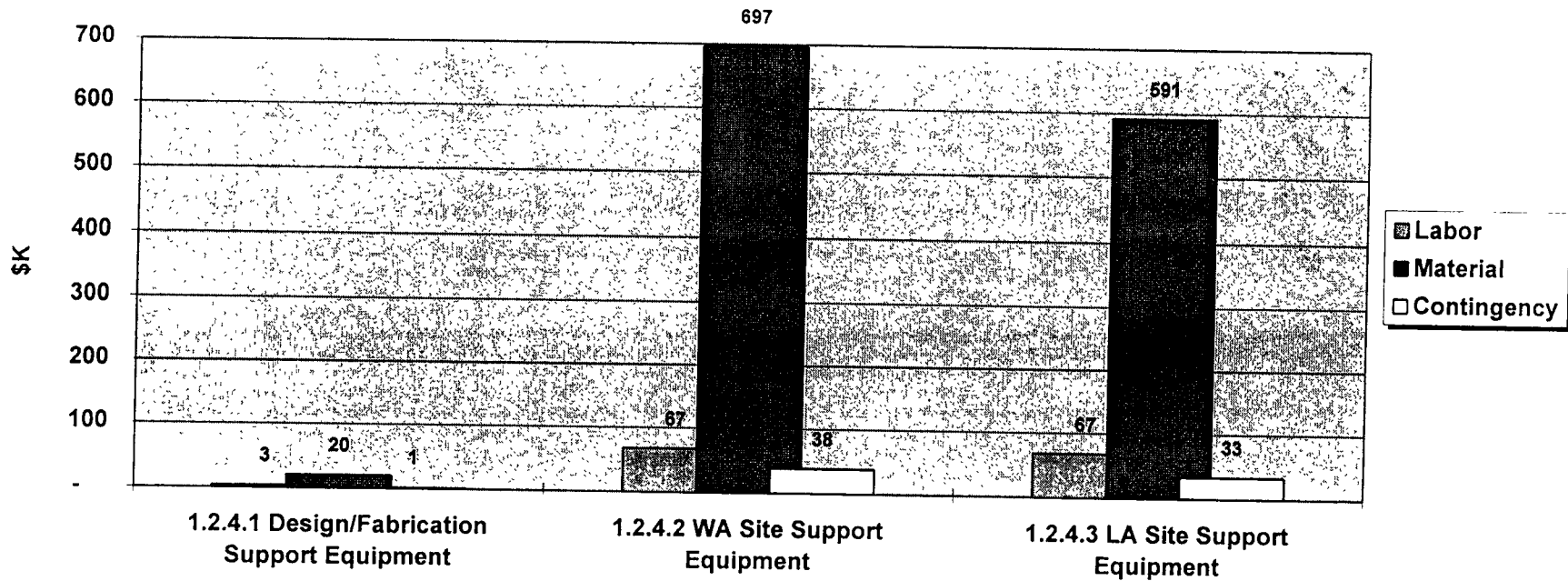


# LIGO PROJECT

SEPTEMBER 1994

1.2.4 Support Equipment		<--\$K-->		
Subsystem	Labor	Material	Contingency	TOTAL
1.2.4.1 Design/Fabrication Support Equipment	3	20	1	25
1.2.4.2 WA Site Support Equipment	67	697	38	802
1.2.4.3 LA Site Support Equipment	67	591	33	692
<b>TOTAL</b>	<b>138</b>	<b>1,308</b>	<b>72</b>	<b>1,518</b>

1.2.4 CDS SUPPORT EQUIPMENT



LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	CONTINGENCY (\$K)	TOTAL COST
2	1.2	-Detector	1,463	15,146	29,054	894	45,094	28.20%	12,718	57,812
3	1.2.1	-Interferometer Design/Fabrication	990	10,133	18,071	894	29,098	33.37%	9,710	38,808
3	1.2.2	-Control and Data System	422	4,492	6,965	0	11,456	24.28%	2,782	14,238
3	1.2.3	-Physics Monitoring	39	383	2,710	0	3,093	5.00%	155	3,248
3	1.2.4	-Support Equipment	13	138	1,308	0	1,446	5.00%	72	1,518

LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION		TOTAL COST
								%	(\$K)	
2	1.2	-Detector	1,463	15,146	29,054	894	45,094	28.20%	12,718	57,812
3	1.2.1	-Interferometer Design/Fabrication	990	10,133	18,071	894	29,098	33.37%	9,710	38,808
4	1.2.1.1	-Interferometers Design/Non-recurring Items/Syst	521	5,847	705	894	7,446	34.33%	2,556	10,002
5	1.2.1.1.1	-Seismic Isolation	50	540	376	0	916	29.36%	269	1,185
6	1.2.1.1.1.1	HAM Seismic Isolation Design	15	164	87	0	251	25.00%	63	313
6	1.2.1.1.1.2	BSC/TMC Seismic Isolation	35	376	289	0	665	31.00%	206	871
5	1.2.1.1.2	Prestabilized Laser Design	20	206	6	0	212	25.00%	53	265
5	1.2.1.1.3	Input/Output Optics	39	407	22	0	429	31.00%	133	561
5	1.2.1.1.4	Design/NR Costs/SE Core Optics Components	87	1,019	123	614	1,756	43.00%	755	2,510
5	1.2.1.1.5	Design Core Optics Support	18	186	29	0	215	39.01%	84	298
5	1.2.1.1.6	Alignment Sensing/Control	105	1,136	41	0	1,177	35.00%	412	1,589
5	1.2.1.1.7	Length Sensing/Control	21	228	0	30	258	39.00%	101	358
5	1.2.1.1.8	Suspension Design	38	394	109	0	503	31.00%	156	659
5	1.2.1.1.9	Interferometer Systems and Integration Engin	144	1,732	0	250	1,982	30.00%	594	2,576
4	1.2.1.2	-Interferometer Fabrication-WA Site	317	2,898	11,809	0	14,706	32.98%	4,851	19,557
5	1.2.1.2.1	-WA 4km Interferometer Fabrication	153	1,389	5,635	0	7,023	31.95%	2,244	9,267
6	1.2.1.2.1.1	-Seismic Isolation	21	163	2,327	0	2,490	20.29%	505	2,995
7	1.2.1.2.1.1.1	WA 4km HAM Seismic Isolation	13	102	607	0	709	16.00%	113	822
7	1.2.1.2.1.1.2	WA 4km BSC Seismic Fabrication	8	61	1,720	0	1,781	22.00%	392	2,173
6	1.2.1.2.1.2	Prestabilized Laser Fabrication	11	106	186	0	292	16.00%	47	338
6	1.2.1.2.1.3	Input/Output Optics Fabrication	39	345	943	0	1,288	34.00%	438	1,726



LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	CONTINGENCY (\$K)	TOTAL COST
6	1.2.1.2.1.4	WA 4km Core Optics Components	22	250	935	0	1,184	50.00%	592	1,776
6	1.2.1.2.1.5	WA 4km Core Optics Support	26	229	385	0	614	50.00%	307	922
6	1.2.1.2.1.6	WA 4km Alignment Sensing/Control Fabrica	27	222	802	0	1,024	28.00%	287	1,311
6	1.2.1.2.1.7	WA 4km Length Sensing/Control Fabricatio	8	74	58	0	131	51.99%	68	199
5	1.2.1.2.2	-WA 2km Interferometer Fabrication	164	1,509	6,174	0	7,683	33.93%	2,607	10,290
6	1.2.1.2.2.1	-Seismic Isolation	21	165	2,458	0	2,623	23.06%	605	3,228
7	1.2.1.2.2.1.1	WA 2km HAM Seismic Isolation Fabrica	13	102	530	0	632	16.00%	101	733
7	1.2.1.2.2.1.2	BSC Seismic Isolation Fabrication	2	12	338	0	351	22.00%	77	428
7	1.2.1.2.2.1.3	TMC Seismic Isolation Fabrication	7	51	1,590	0	1,641	26.00%	427	2,067
6	1.2.1.2.2.2	WA 2km Prestabilized Laser Fabrication	11	106	186	0	292	16.00%	47	338
6	1.2.1.2.2.3	WA 2km Input/Output Laser Fabrication	39	345	943	0	1,288	34.00%	438	1,726
6	1.2.1.2.2.4	WA 2km Core Optics Components	29	333	1,259	0	1,593	50.00%	796	2,389
6	1.2.1.2.2.5	WA 2km Core Optics Support	30	264	468	0	732	50.00%	366	1,098
6	1.2.1.2.2.6	WA 2km Alignment Sensing/Control Fabrica	27	222	802	0	1,024	28.00%	287	1,311
6	1.2.1.2.2.7	WA 2km Length Sensing/Control Fabricatio	8	74	58	0	131	51.99%	68	199
4	1.2.1.3	-Interferometer Fabrication -LA Site	153	1,389	5,557	0	6,946	33.15%	2,303	9,249
5	1.2.1.3.1	-LA 4km Interferometer Fabrication	153	1,389	5,557	0	6,946	33.15%	2,303	9,249
6	1.2.1.3.1.1	-Seismic Isolation	21	163	2,249	0	2,413	20.43%	493	2,905
7	1.2.1.3.1.1.1	LA 4km HAM Seismic Isolation Fabrica	13	102	530	0	632	16.00%	101	733
7	1.2.1.3.1.1.2	LA 4km BSC Seismic Isolation Fabrica	8	61	1,720	0	1,781	22.00%	392	2,172
6	1.2.1.3.1.2	LA 4km Prestabilized Laser Fabrication	11	106	186	0	292	16.00%	47	338





LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
6	1.2.1.3.1.3	LA 4km Input/Output Optics Fabrication	39	345	943	0	1,288	34.00%	438	1,726
6	1.2.1.3.1.4	LA 4km Core Optics Components	22	250	935	0	1,184	56.00%	663	1,847
6	1.2.1.3.1.5	LA 4km Core Optics Support	26	229	385	0	614	50.00%	307	922
6	1.2.1.3.1.6	LA 4km Alignment Sensing/Control Fabrica	27	222	802	0	1,024	28.00%	287	1,311
6	1.2.1.3.1.7	LA 4km Length Sensing/Control Fabricatio	8	74	58	0	131	51.99%	68	199
3	1.2.2	-Control and Data System	422	4,492	6,965	0	11,456	24.28%	2,782	14,238
4	1.2.2.1	-CDS Design and Systems Engineering	332	3,472	672	0	4,144	23.26%	964	5,107
5	1.2.2.1.01	-Interferometer Controls Design	183	1,872	211	0	2,083	28.00%	583	2,666
6	1.2.2.1.01.01	Seismic Isolation Controls Design	10	107	9	0	115	27.99%	32	148
6	1.2.2.1.01.02	Prestabilized Laser Controls Design	38	386	41	0	427	28.00%	120	547
6	1.2.2.1.01.03	Input/Output Optics Controls Design	18	181	15	0	197	28.00%	55	252
6	1.2.2.1.01.04	Core Optics Components	0	0	0	0	0	0.00%	0	
6	1.2.2.1.01.05	Core Optics Support Controls Design	13	130	3	0	133	28.00%	37	170
6	1.2.2.1.01.06	Alignment Systems Controls Design	52	538	91	0	630	28.00%	176	806
6	1.2.2.1.01.07	Length Sensing Systems Controls Design	23	230	36	0	266	27.99%	75	341
6	1.2.2.1.01.08	Suspensions Controls Design	10	105	6	0	111	28.01%	31	142
6	1.2.2.1.01.09	Interferometer CDS Integraton	10	103	0	0	103	27.99%	29	132
6	1.2.2.1.01.10	Vacuum Feedthru and Cabling Design	9	91	10	0	101	28.01%	28	129
5	1.2.2.1.02	40M Prototype	0	0	0	0	0	0.00%	0	
5	1.2.2.1.03	Interferometer Data Acquisition Design	38	403	286	0	689	18.00%	124	813
5	1.2.2.1.04	Physics Monitoring Data Acquisition Design	14	135	20	0	156	12.00%	19	174



LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	ALLOCATION (\$K)	TOTAL COST
5	1.2.2.1.05	Vacuum System Controls Design	18	184	22	0	206	16.00%	33	239
5	1.2.2.1.06	Control Area and Networking Systems Design	24	224	0	0	224	16.00%	36	259
5	1.2.2.1.07	Timing System Design	11	117	12	0	129	14.00%	18	147
5	1.2.2.1.08	Remote Diagnostics Design	10	92	21	0	113	18.00%	20	133
5	1.2.2.1.09	Global CDS Design	35	445	100	0	545	24.00%	131	675
4	1.2.2.2	-CDS Procurement/Fabrication - WA Site	56	620	3,908	0	4,528	25.30%	1,145	5,674
5	1.2.2.2.1	-WA 4K Interferometer Controls Procurement/F	20	235	859	0	1,095	34.00%	372	1,467
6	1.2.2.2.1.1	WA 4K Seismic Isolation Control Equipmen	0	0	64	0	64	34.00%	22	86
6	1.2.2.2.1.2	WA 4K Prestabilized Laser Control Equipm	0	0	37	0	37	34.00%	12	49
6	1.2.2.2.1.3	WA 4K Input/Output Optics Control Equipm	0	0	98	0	98	34.00%	33	131
6	1.2.2.2.1.4	WA 4K Core Optics Components Control Equ	0	0	0	0	0	0.00%	0	
6	1.2.2.2.1.5	WA 4K Core Optics Support Control Equipm	0	0	114	0	114	34.00%	39	153
6	1.2.2.2.1.6	WA 4K Alignment Systems Control Equipmen	0	0	508	0	508	34.00%	173	681
6	1.2.2.2.1.7	WA 4K Length Sensing Systems Control Equ	0	0	38	0	38	33.99%	13	51
6	1.2.2.2.1.8	WA 4K Interferometer Controls Software	20	235	0	0	235	34.00%	80	315
5	1.2.2.2.2	-WA 2K Interferometer Controls Procurement/F	6	71	890	0	961	34.00%	327	1,287
6	1.2.2.2.2.1	WA 2K Seismic Isolation Control Equipmen	0	0	64	0	64	34.00%	22	86
6	1.2.2.2.2.2	WA 2K Prestabilized Laser Control Equipm	0	0	37	0	37	34.00%	12	49
6	1.2.2.2.2.3	WA 2K Input/Output Optics Control Equipm	0	0	98	0	98	34.00%	33	131
6	1.2.2.2.2.4	WA 2K Core Optics Components Control Equ	0	0	0	0	0	0.00%	0	
6	1.2.2.2.2.5	WA 2K Core Optics Support Control Equipm	0	0	145	0	145	34.00%	49	194



**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	ALLOCATION (\$K)	TOTAL COST
6	1.2.2.2.2.6	WA 2K Alignment Systems Control Equipmen	0	0	508	0	508	34.00%	173	681
6	1.2.2.2.2.7	WA 2K Length Sensing Systems Control Equ	0	0	38	0	38	33.99%	13	51
6	1.2.2.2.2.8	WA 2K Interferometer Control Software	6	71	0	0	71	34.01%	24	95
5	1.2.2.2.3	WA Interferometer Data Acquisition	8	84	835	0	920	20.00%	184	1,104
5	1.2.2.2.4	WA Physics Monitoring Data Acquisition	3	35	290	0	325	14.00%	46	371
5	1.2.2.2.5	WA Vacuum Systems Controls	12	112	100	0	211	20.00%	42	254
5	1.2.2.2.6	WA Control Area and Networking Systems	4	47	746	0	793	18.00%	143	936
5	1.2.2.2.7	WA Timing System	1	12	72	0	84	15.00%	13	97
5	1.2.2.2.8	WA Remote Diagnostics	2	24	116	0	139	14.01%	19	158
4	1.2.2.3	-CDS Procurement/Fabrication - LA Site	34	400	2,384	0	2,784	24.16%	673	3,457
5	1.2.2.3.1	-LA 4K Interferometer Controls Procurement/F	18	212	890	0	1,102	34.00%	375	1,477
6	1.2.2.3.1.1	LA 4K Seismic Isolation Control Equipmen	0	0	64	0	64	34.00%	22	86
6	1.2.2.3.1.2	LA 4K Prestablized Laser Control Equipm	0	0	37	0	37	34.00%	12	49
6	1.2.2.3.1.3	LA 4K Input/Output Optics Control Equipm	0	0	98	0	98	34.00%	33	131
6	1.2.2.3.1.4	LA Core Optics Components Control Equipm	0	0	0	0	0	0.00%	0	
6	1.2.2.3.1.5	LA 4K Core Optics Support Control Equipm	0	0	145	0	145	34.00%	49	194
6	1.2.2.3.1.6	LA 4K Alignment Systems Control Equipmen	0	0	508	0	508	34.00%	173	681
6	1.2.2.3.1.7	LA 4K Length Sensing Systems Control Equ	0	0	38	0	38	33.99%	13	51
6	1.2.2.3.1.8	LA 4K Interferometer Controls Software	18	212	0	0	212	33.99%	72	284
5	1.2.2.3.2	Reserved	0	0	0	0	0	0.00%	0	
5	1.2.2.3.3	LA Interferometer Data Acquisition	6	71	418	0	488	20.00%	98	586

LIGO PROJECT

**ESTIMATE WBS SUMMARY**

(1994 \$K)

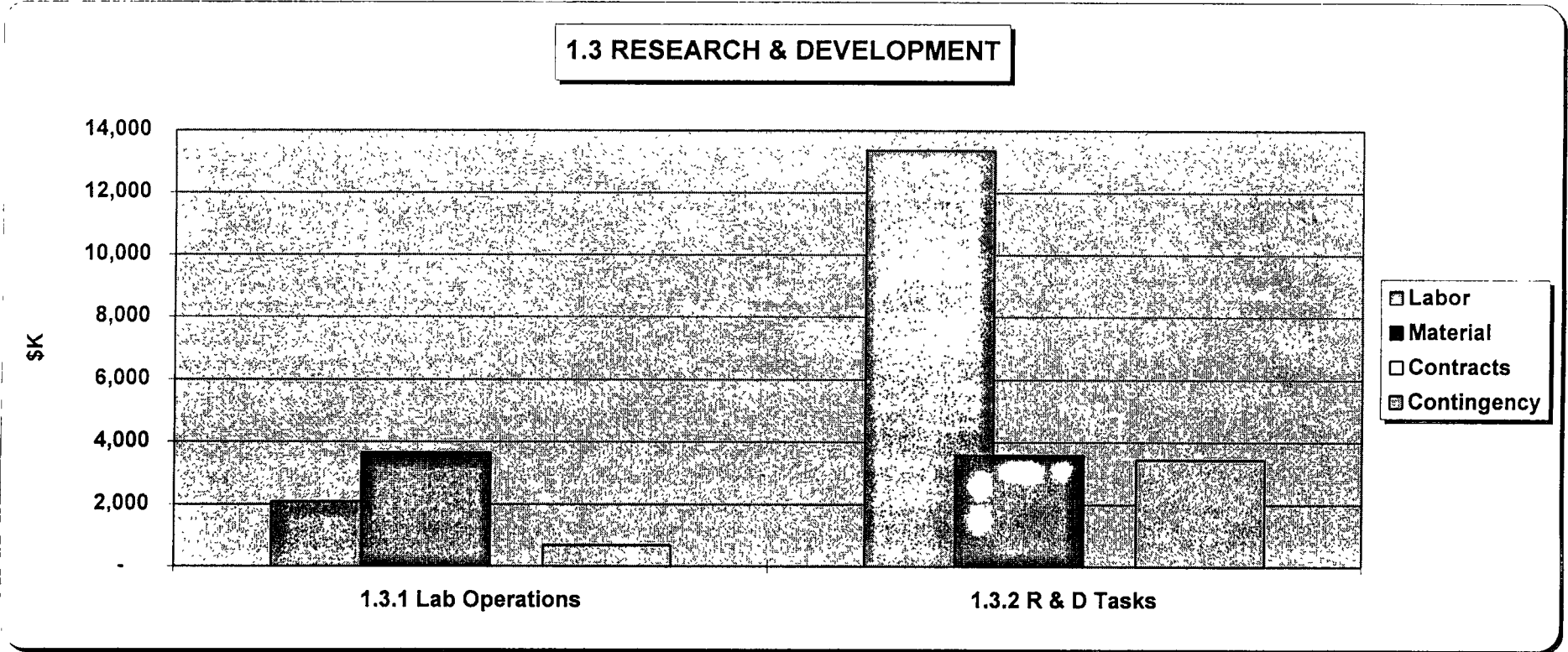
LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
5	1.2.2.3.4	LA Physics Monitoring Data Acquisition Contr	2	24	306	0	330	14.00%	46	376
5	1.2.2.3.5	LA Vacuum Systems Controls	4	47	97	0	144	20.00%	29	173
5	1.2.2.3.6	LA Control Area and Networking Systems	2	24	577	0	600	18.00%	108	708
5	1.2.2.3.7	LA Timing System	1	12	39	0	51	15.00%	8	58
5	1.2.2.3.8	LA Remote Diagnostics	1	12	58	0	70	14.00%	10	79
3	1.2.3	-Physics Monitoring	39	383	2,710	0	3,093	5.00%	155	3,248
4	1.2.3.1	Physics Monitor Design	27	274	64	0	338	5.00%	17	355
4	1.2.3.2	WA Physics Monitors Fabrication	6	55	1,587	0	1,642	5.00%	82	1,724
4	1.2.3.3	LA Physics Monitors Fabrication	6	55	1,059	0	1,114	5.00%	56	1,169
3	1.2.4	-Support Equipment	13	138	1,308	0	1,446	5.00%	72	1,518
4	1.2.4.1	Design/Fabrication Support Equipment	1	3	20	0	23	5.00%	1	25
4	1.2.4.2	WA Site Support Equipment	6	67	697	0	764	5.00%	38	802
4	1.2.4.3	LA Site Support Equipment	6	67	591	0	659	5.00%	33	692

# **RESEARCH AND DEVELOPMENT**

# LIGO PROJECT

SEPTEMBER 1994

1.3 Research & Development		<--\$K-->			
Subsystem	Labor	Material	Contracts	Contingency	TOTAL
1.3.1 Lab Operations	2,085	3,655	-	675	6,416
1.3.2 R & D Tasks	13,359	3,588	-	3,435	20,383
<b>TOTAL</b>	<b>15,445</b>	<b>7,243</b>	<b>-</b>	<b>4,110</b>	<b>26,798</b>



**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION		TOTAL COST
								%	(\$K)	
2	1.3	-Research and Development	2,274	15,445	7,243	0	22,688	18.12%	4,110	26,798
3	1.3.1	-Lab Operations	240	2,085	3,655	0	5,741	11.76%	675	6,416
4	1.3.1.1	Lab Operations (Actuals)	60	505	733	0	1,239	0.00%	0	1,239
4	1.3.1.2	Lab Operations (To-do)	180	1,580	2,922	0	4,502	15.00%	675	5,177
3	1.3.2	-R & D Tasks	2,034	13,359	3,588	0	16,947	20.27%	3,435	20,383
4	1.3.2.1	R & D Tasks (Actuals)	594	4,239	1,258	0	5,497	0.00%	0	5,497
4	1.3.2.2	R & D Tasks (To-do)	1,440	9,121	2,330	0	11,451	30.00%	3,435	14,886

# **PROJECT OFFICE**

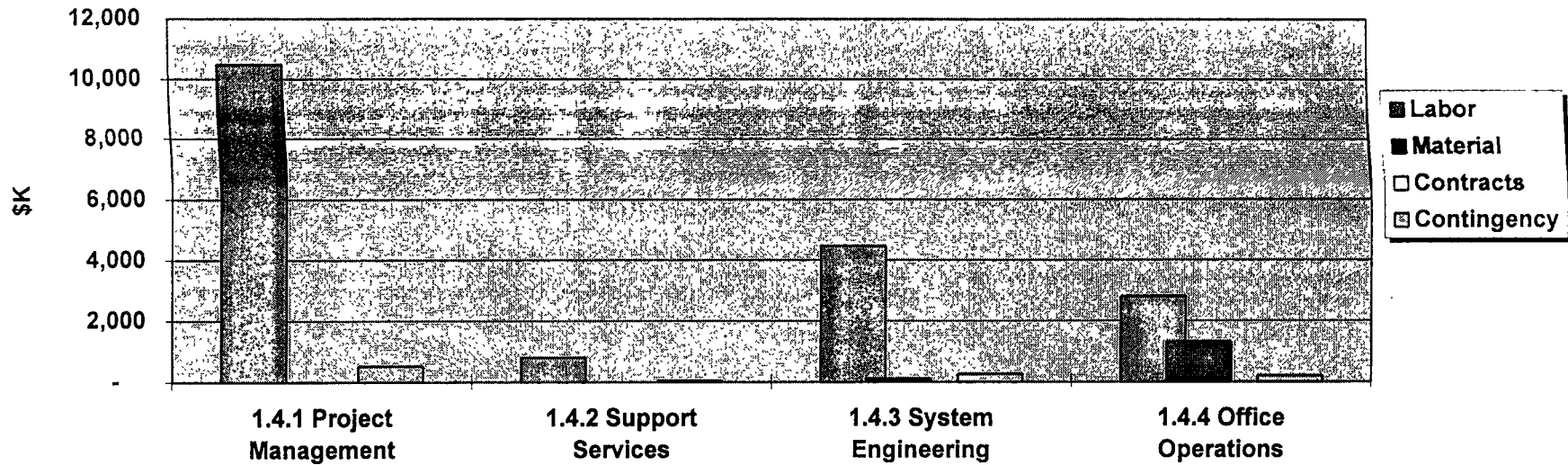


# LIGO PROJECT

SEPTEMBER 1994

1.4 Project Office		←-\$K→			
Subsystem	Labor	Material	Contracts	Contingency	TOTAL
1.4.1 Project Management	10,473	-	-	529	11,001
1.4.2 Support Services	808	-	-	40	848
1.4.3 System Engineering	4,462	105	-	266	4,833
1.4.4 Office Operations	2,802	1,320	-	204	4,326
<b>TOTAL</b>	<b>18,545</b>	<b>1,425</b>	<b>-</b>	<b>1,039</b>	<b>21,009</b>

1.4 PROJECT OFFICE



**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
2	1.4	-Project Office	1,521	18,545	1,425	0	19,970	5.20%	1,039	21,009
3	1.4.1	-Project Management	723	10,473	0	0	10,473	5.05%	529	11,001
3	1.4.2	-Support Services	60	808	0	0	808	4.95%	40	848
3	1.4.3	-System Engineering	378	4,462	105	0	4,567	5.82%	266	4,833
3	1.4.4	-Office Operations	360	2,802	1,320	0	4,122	4.96%	204	4,326

**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
2	1.4	-Project Office	1,521	18,545	1,425	0	19,970	5.20%	1,039	21,009
3	1.4.1	-Project Management	723	10,473	0	0	10,473	5.05%	529	11,001
4	1.4.1.1	-Management	414	7,349	0	0	7,349	4.91%	361	7,710
5	1.4.1.1.1	Management (Actuals)	78	1,338	0	0	1,338	0.00%	0	1,338
5	1.4.1.1.2	Management (To-do)	336	6,011	0	0	6,011	6.00%	361	6,372
4	1.4.1.2	-Project Control	309	3,124	0	0	3,124	5.38%	168	3,292
5	1.4.1.2.1	Project Control (Actuals)	45	323	0	0	323	0.00%	0	323
5	1.4.1.2.2	Project Control (To-do)	264	2,801	0	0	2,801	6.00%	168	2,969
3	1.4.2	-Support Services	60	808	0	0	808	4.95%	40	848
4	1.4.2.1	-QA Services	30	353	0	0	353	5.00%	18	371
5	1.4.2.1.1	QA Services (Actuals)	5	59	0	0	59	0.00%	0	59
5	1.4.2.1.2	QA Services (To-do)	25	294	0	0	294	6.00%	18	312
4	1.4.2.2	-ES&H Services	30	353	0	0	353	5.00%	18	371
5	1.4.2.2.1	ES&H Services (Actuals)	5	59	0	0	59	0.00%	0	59
5	1.4.2.2.2	ES&H Services (To-do)	25	294	0	0	294	6.00%	18	312
4	1.4.2.3	-Consultants	0	102	0	0	102	4.62%	5	107
5	1.4.2.3.1	Consultants (Actuals)	0	24	0	0	24	0.00%	0	24
5	1.4.2.3.2	Consultants (To-do)	0	79	0	0	79	6.00%	5	83
3	1.4.3	-System Engineering	378	4,462	105	0	4,567	5.82%	266	4,833
4	1.4.3.1	-System Integration	234	2,883	0	0	2,883	5.74%	165	3,049
5	1.4.3.1.1	System Integration (Actuals)	12	127	0	0	127	0.00%	0	127



**ESTIMATE WBS SUMMARY**

(1994 \$K)

LEVEL	WBS No.	WBS TITLE	Manmonths	Labor	Material	Contracts	SUBTOTAL ESTIMATE	CONTINGENCY ALLOCATION %	(\$K)	TOTAL COST
5	1.4.3.1.2	System Integration (To-do)	222	2,757	0	0	2,757	6.00%	165	2,922
4	1.4.3.2	-Documentation	0	0	105	0	105	5.43%	6	111
5	1.4.3.2.1	Documentation (Actuals)	0	0	10	0	10	0.00%	0	10
5	1.4.3.2.2	Documentation (To-do)	0	0	95	0	95	6.00%	6	101
4	1.4.3.3	System Modeling	144	1,579	0	0	1,579	6.00%	95	1,673
3	1.4.4	-Office Operations	360	2,802	1,320	0	4,122	4.96%	204	4,326
4	1.4.4.1	-Administration	312	2,237	605	0	2,842	4.82%	137	2,979
5	1.4.4.1.1	Administration (Actuals)	72	516	44	0	560	0.00%	0	560
5	1.4.4.1.2	Administration (To-do)	240	1,721	561	0	2,282	6.00%	137	2,419
4	1.4.4.2	-General Computing	48	565	715	0	1,280	5.27%	68	1,348
5	1.4.4.2.1	General Computing (Actuals)	0	0	155	0	155	0.00%	0	155
5	1.4.4.2.2	General Computing (To-do)	48	565	560	0	1,125	6.00%	68	1,193