

Detector Cost/Schedule Status

NSF Presentation
April 13, 1997

Richard L. Fischer



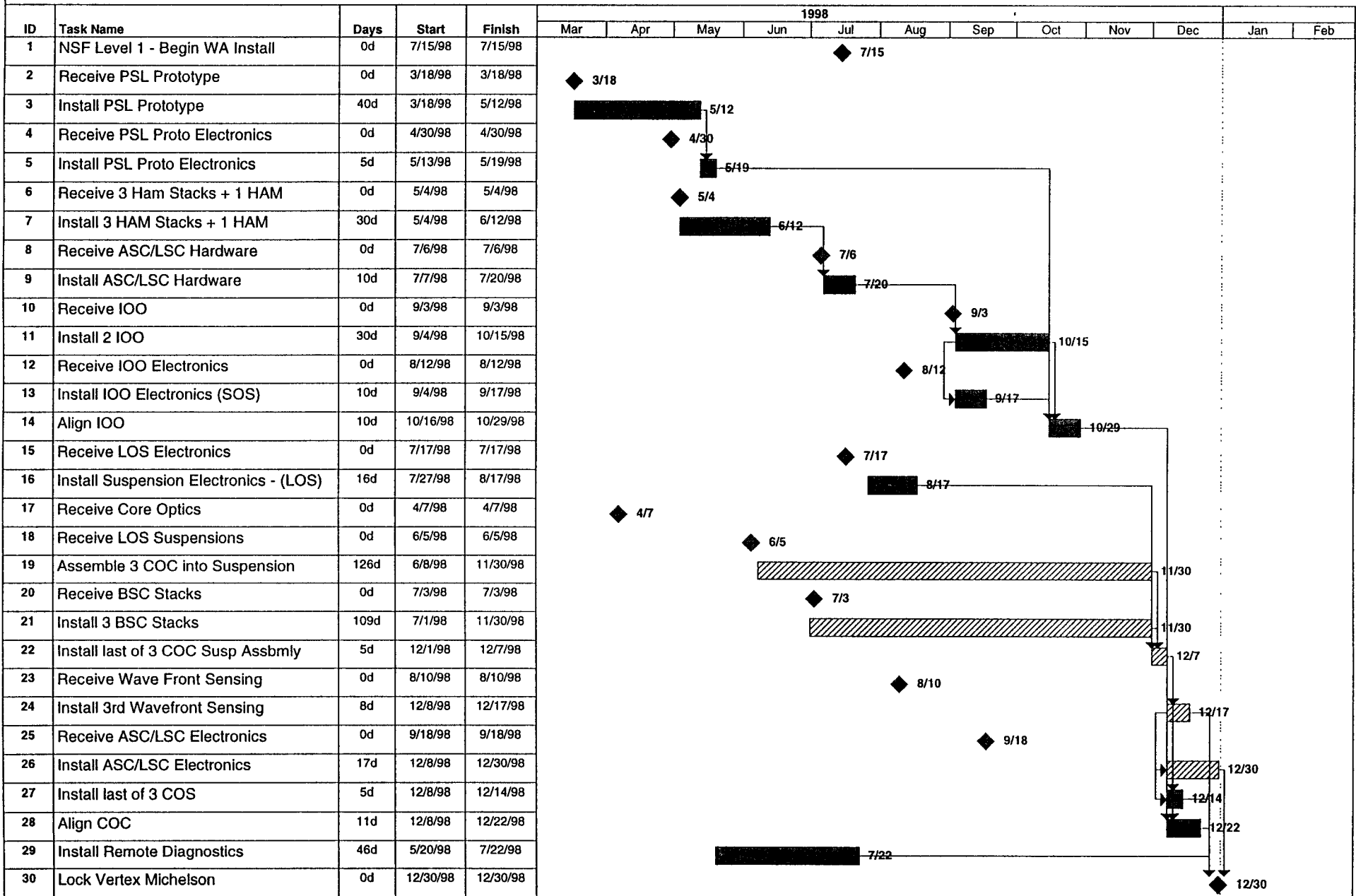
Detector Cost/Schedule Status Outline

- I. Current Detector Organization
- II. Current Cost/Schedule Status & Accomplishments
 - Detector Cost/Schedule Status
 - Schedule Milestones
 - Task Group Accomplishments
- III. Replanned Detector Schedule
 - Beginning Detector Installation Schedule
 - Detector Critical Path(s)
 - Key Milestone Comparisons
- IV. Anticipated Detector Budget
 - Anticipated Budget Changes
- V. Conclusions

Conclusions

1. The Detector Subsystems are Completing Preliminary Design or are in Final Design.
2. Over the Last 12 Months the Detector has Accomplished most of its Milestones.
3. The Detector is Roughly Two Months Behind Schedule and is \$1M Under Budget.
4. The Detector is Staffing up - 8 new people in the last 3 months and 13 new people within the last 6 months.
5. The Seismic Stacks and Core Optics Continue to Pace Interferometer Installation as the Critical Path Items.

Begin WA 4K Installation



LIGO Detector Organization



DETECTOR GROUP

Leader: *S. Whitcomb* Deputy: *D. Shoemaker*

Lead Engineer: *D. Coyne* Programmatics: *R. Fischer*

Implementation / Ops / 40m
F. Raab / M. Coles / R. Spero

- *Denise Durance*
- *Stephen Vass*
- *Karthik Naidu **

Lasers and Optics
 Task Leader:
J. Camp

Suspension and Isolation
 Task Leader:
*M. Fine **

IFO Sensing & Control
 Task Leader:
M. Zucker

Control & Data Systems
 Task Leader:
R. Bork

- COC
- *Gari Billingsley*
- *Bill Kells*
- *Doug Jungwirth*
- *Steve Elieson*
- *William Lee **
- *Alex Golovister*
- PSL
- *Rick Savage*
- *Stefan Seel **
- *Lee Cardenas **
- *Peter King **
- COS
- *Mike Smith **
- *Dennis Rose **
- *Paul Kabot **
- IOO
- *Florida (4 FTEs)**

- SUSPENSION
- *Janeen Hazel*
- *Seiji Kawamura*
- *Mark Barton **
- SEISMIC
- *HYTEC (6 FTEs)*

- LSC
- *Lisa Sievers*
- *Nergis Mavalvala*
- *Alex Marin **
- *Peter Csatorday (Grad)*
- ASC
- *Peter Fritschel*
- *Daniel Sigg*
- *Ken Mason **
- R&D
- *Jennifer Logan (40m)*
- *Brent Ware (40m)*
- *Gabriela Gonzales (PNI)*
- *Haisheng Rong (PNI)*
- *Brian Lantz (Grad)*
- *Ralph Burgess (PNI)*
- *Edward Kruzel (PNI)*

- SOFTWARE
- *David Barker*
- *Christine Patton **
- *Tryon Mitchel **
- ELECTRONICS
- *Rich Abbott*
- *Jay Heefner*
- *Sander Liu*
- *Oliver McCullough*
- *Paul Russell*
- *Tony Terranova*
- *Dale Ouimette*

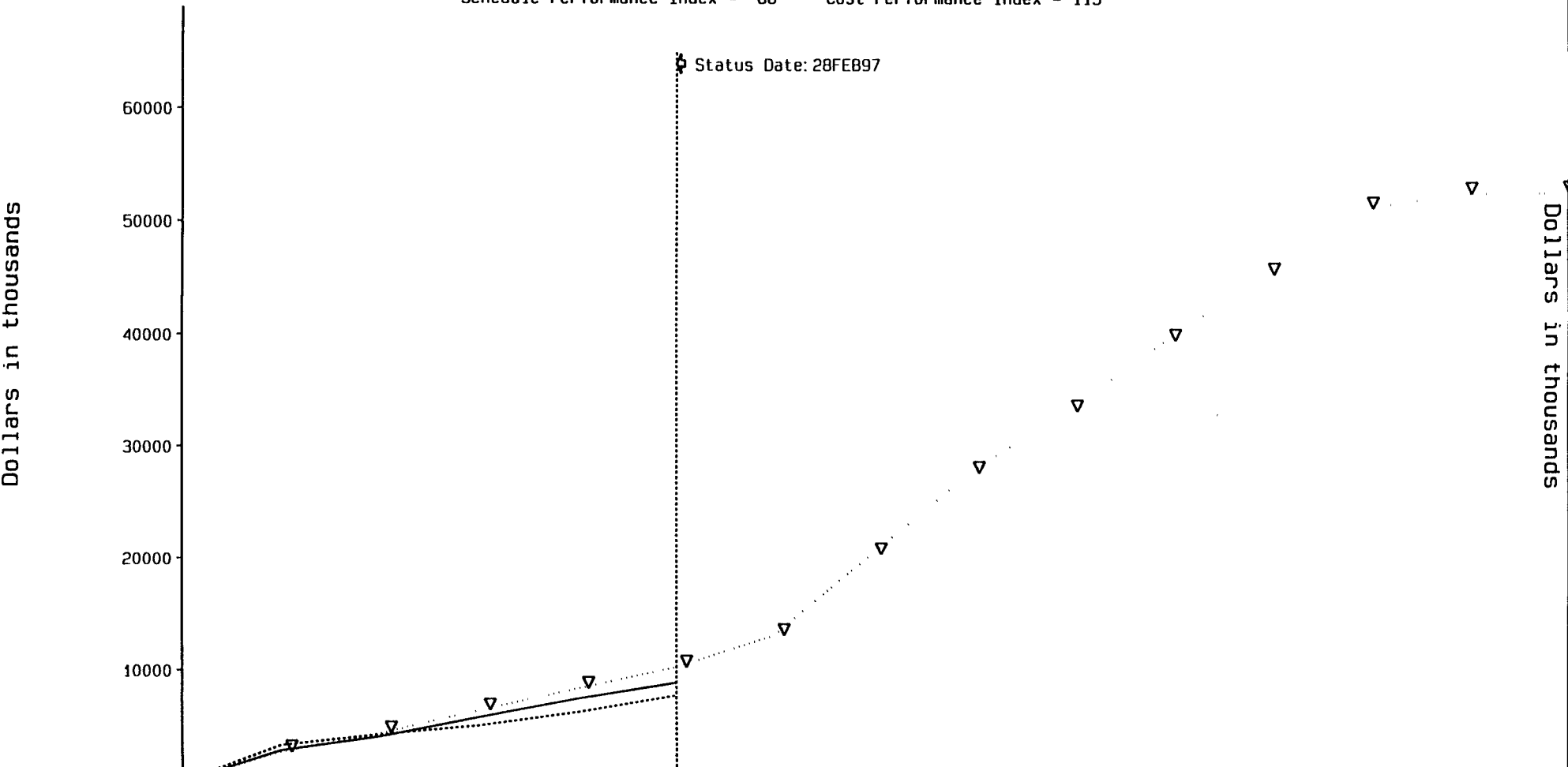
* = New Staff since October 1996

LIGO PROJECT 1.2 Detector

Date: 11APR97
 Program: LIGOPMB2
 Report: LIGOSPA
 COBRA (R)

LEGEND
 Bud ▽ ▽ ▽
 Per ▽ ▽ ▽
 Act ▽ ▽ ▽

Budget vs Performance vs Actual
 Schedule Performance Index = 86 Cost Performance Index = 115



	FEB96	MAY96	AUG96	NOV96	FEB97	MAY97	AUG97	NOV97	FEB98	MAY98	AUG98	NOV98	FEB99	MAY99
Planned Budget	2,610	4,314	6,421	8,396	10,327	13,178	20,410	27,690	33,257	39,561	45,377	51,165	52,459	52,559
Performance	2,759	4,013	5,780	7,486	8,928									
Actuals	3,218	4,199	5,011	6,231	7,752									
Schedule Variance	149	-301	-641	-910	-1,399									
Cost Variance	-459	-186	769	1,255	1,176									

Schedule Variance = Perf-Budg Cost Variance = Perf-Actual Schedule Performance Index = Perf/Budg Cost Performance Index = Perf/Actual

Key Near Term Detector Activities-----Month End February 1997

4/11/97

Activity Identification	Milestone Description	Plan Dates	Current Month End Status FEB-1997	Schedule Change (DAYS)
12009100	Award Contract for Nd:YAG Laser Development	Jun-96	May-96	Complete
12045020	PDR for Optics Suspension System	Jun-96	Jun-96	Complete
12033425	DRR II Alignment Sensing Control	Jun-96	Aug-96	Complete
12003020	Test of new Suspension Design on 40m	Jul-96	Aug-96	Complete
12039058	Award Contract for Core Optics Polishing	Dec-96	Oct-96	Complete
12085065	PDR for Global CDS	Jul-96	Sep-96	Complete
12039122	Demonstration of Coating Uniformity	Dec-96	Dec-96	Complete
13220442	Completion of PNI recycling experiments (with AR Laser)	Aug-96	Dec-96	Complete
12009020	Completion of Nd: YAG Master Oscillator Stabilization	Aug-96	Jan-97	Complete
12057020	PDR for Seismic Isolation Stacks	Jan-97	Feb-97	Complete
12033445	PDR for Alignment Sensing Control	Oct-96	Feb-97	Complete
12024075	PDR for Length Sensing Control	Oct-96	May-97	-153
13221935	First Operation of 40m with Recycling Mirror	Apr-97	May-97	-20
12012120	Nd:YAG LASER PDR	Apr-97	Apr-97	0
12062035	PDR for Data Acquisition System	Mar-97	May-97	-45

Level 1 DETECTOR Milestone's - FEB 1997

4/11/97

Milestone Description	Project Mgmt Plan Dates	Current Month End Status Feb-1997	PMP vs Current Month End (Days)
Pre-Stabilized Laser FDR	8/30/98	7/30/98	22
Input/Output Optics FDR	4/30/98	5/19/98	-15
Length Sensing Control FDR	5/30/98	12/15/97	110
Wavefront FDR	4/30/98	2/13/98	56
Core Optics Components FDR	7/30/97	10/27/97	-66
Core Optics Support FDR	4/30/97	12/9/97	-181
BSC Stack Final Design Review	7/30/97	8/21/97	-16
HAM Stack Final Design Review	7/30/97	8/21/97	-16
Control Data System DAQ FDR	4/30/98	5/28/98	-22
Physics Environ Monitoring FDR	6/30/98	8/6/97	-22
WA Cntl Area/Net Sys Ready To Install	9/30/97	9/29/97	0
Detector System Prelim Design Review	12/30/97	4/3/98	-88
Begin WA IFO Installation	7/30/98	7/30/98	0
Begin LA IFO Installation	1/30/99	1/30/99	0
Begin COINCIDENCE TEST	12/31/00	12/31/00	0

Laser/Optics

Schedule Accomplishment

A. Core Optics Accomplishments

1. Awarded Glass Contracts with Heraeus and Corning - Oct '96
 - Corning - expect 17 of 21 pieces delivered by 1 May '97
 - Heraeus - expect first deliveries in June '97
2. Awarded Polishing Contracts with CSIRO, G.O. - Dec '96
 - CSIRO, 4 of 4 FMs in polishing; 2 of 4 ETMs in Figuring
 - G.O. , 4 of 8 ETMs in final polishing
3. Achieved Coating Uniformity Consistent with LIGO Reqs.- Dec '96
4. Added new optical engineer, William Lee

B. Input Optics (IOO) Accomplishments

1. Awarded University of Florida contact - Summer '96
2. Held Input Optics Requirement Review - Oct '96
3. Input Optics Preliminary Design Review scheduled for June '97

Laser/Optics

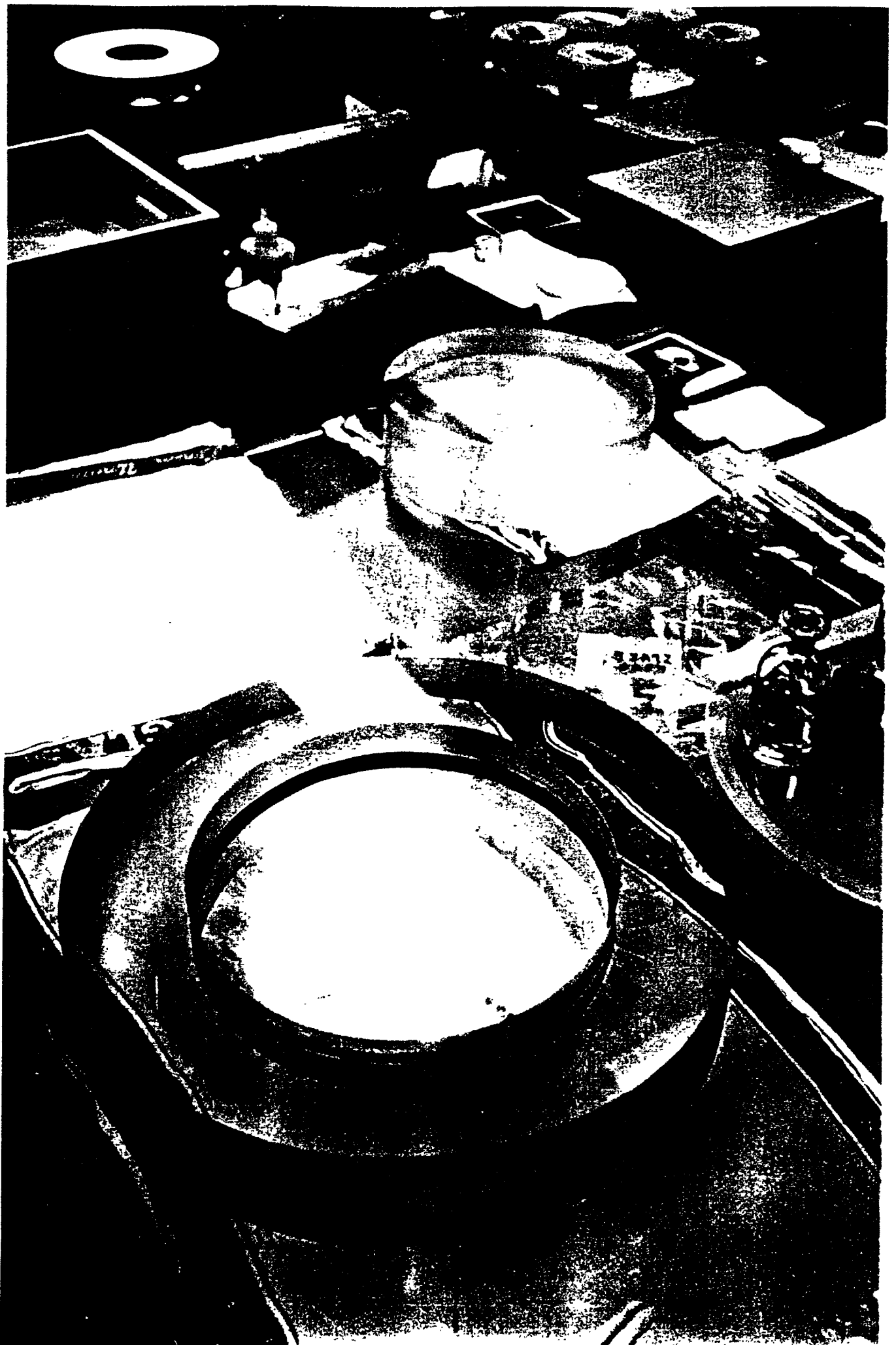
Schedule Accomplishment - continued

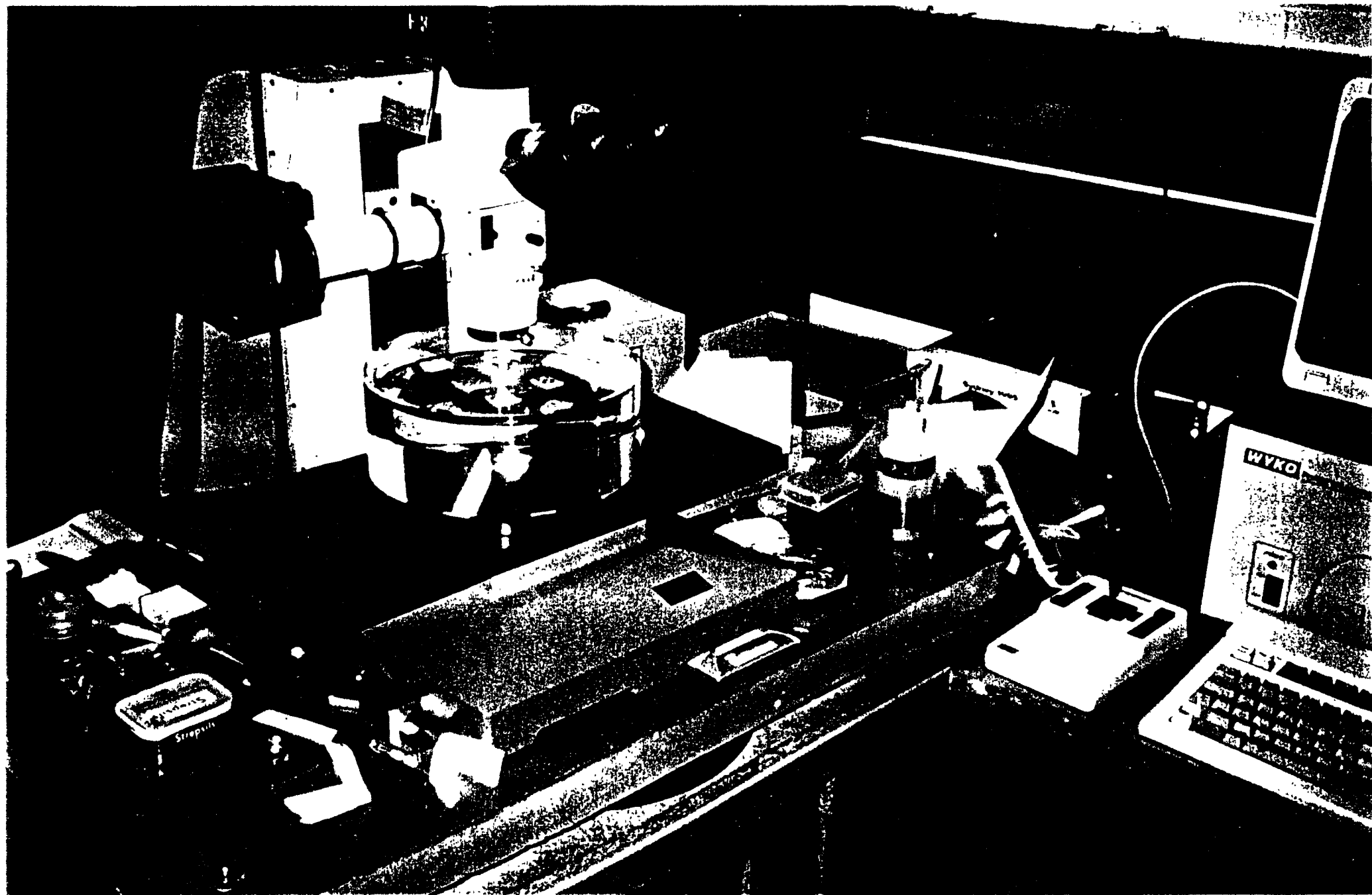
C. Pre-Stabilized Laser

1. Awarded Lightwave contract - Jun '96
2. Held YAG Laser Conceptual Design Review - Dec '96
3. Hired two laser scientist and a junior engineer - King, Seel, Cardinas - Mar '97
4. Laser Preliminary Design Review scheduled for the April 25th (>10w)
5. PSL Requirements Review is scheduled for May '97

D. Core Optics Support

1. Hired New Physicist, Mike Smith, - Nov '96
2. Held COS Requirements Review - April '97
3. Hired Optical Designer, Dennis Rose - Apr '97
4. Started Preliminary Design and mock-up
5. Preliminary Design Review Scheduled for July '97







CSIRO



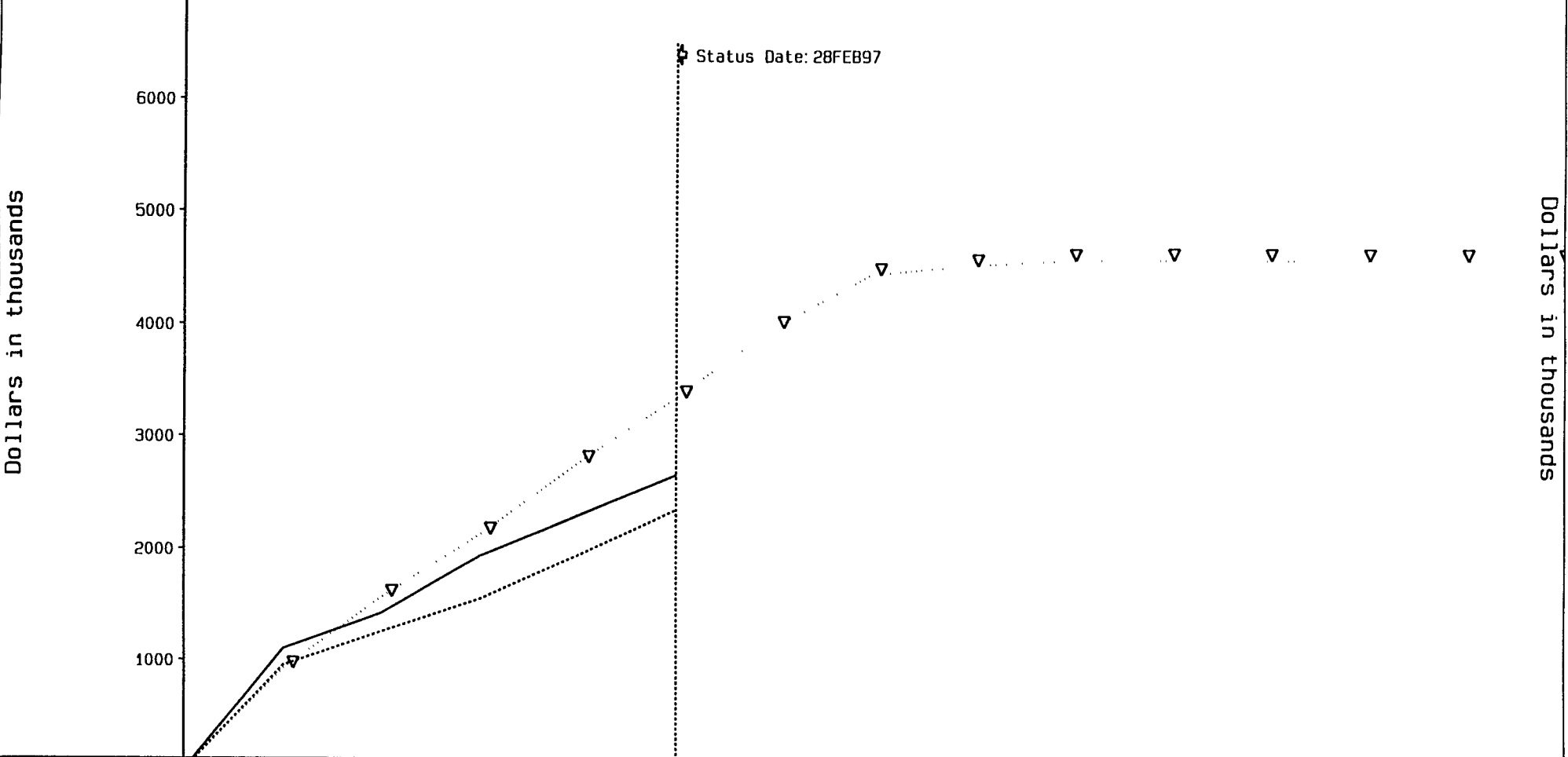
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LIGO PROJECT

LASER / OPTICS (5E512, 5E513, 5E514, 5E515)

Date: 11APR97
 Program: LIGOPMB2
 Report: LIGOSPA
 COBRA (R)

Budget vs Performance vs Actual
 Schedule Performance Index = 80 Cost Performance Index = 113



	FEB96	MAY96	AUG96	NOV96	FEB97	MAY97	AUG97	NOV97	FEB98	MAY98	AUG98	NOV98	FEB99	MAY99
Planned Budget	921	1,565	2,134	2,768	3,348	3,974	4,445	4,529	4,580	4,586	4,586	4,586	4,586	4,586
Performance	1,103	1,421	1,940	2,305	2,663									
Actuals	953	1,257	1,552	1,949	2,354									
Schedule Variance	182	- 144	- 194	- 463	- 685									
Cost Variance	150	164	388	356	309									
Schedule Variance = Perf-Budg Cost Variance = Perf-Actual Schedule Performance Index = Perf/Budg Cost Performance Index = Perf/Actual														

Seismic/Suspension Schedule Accomplishments

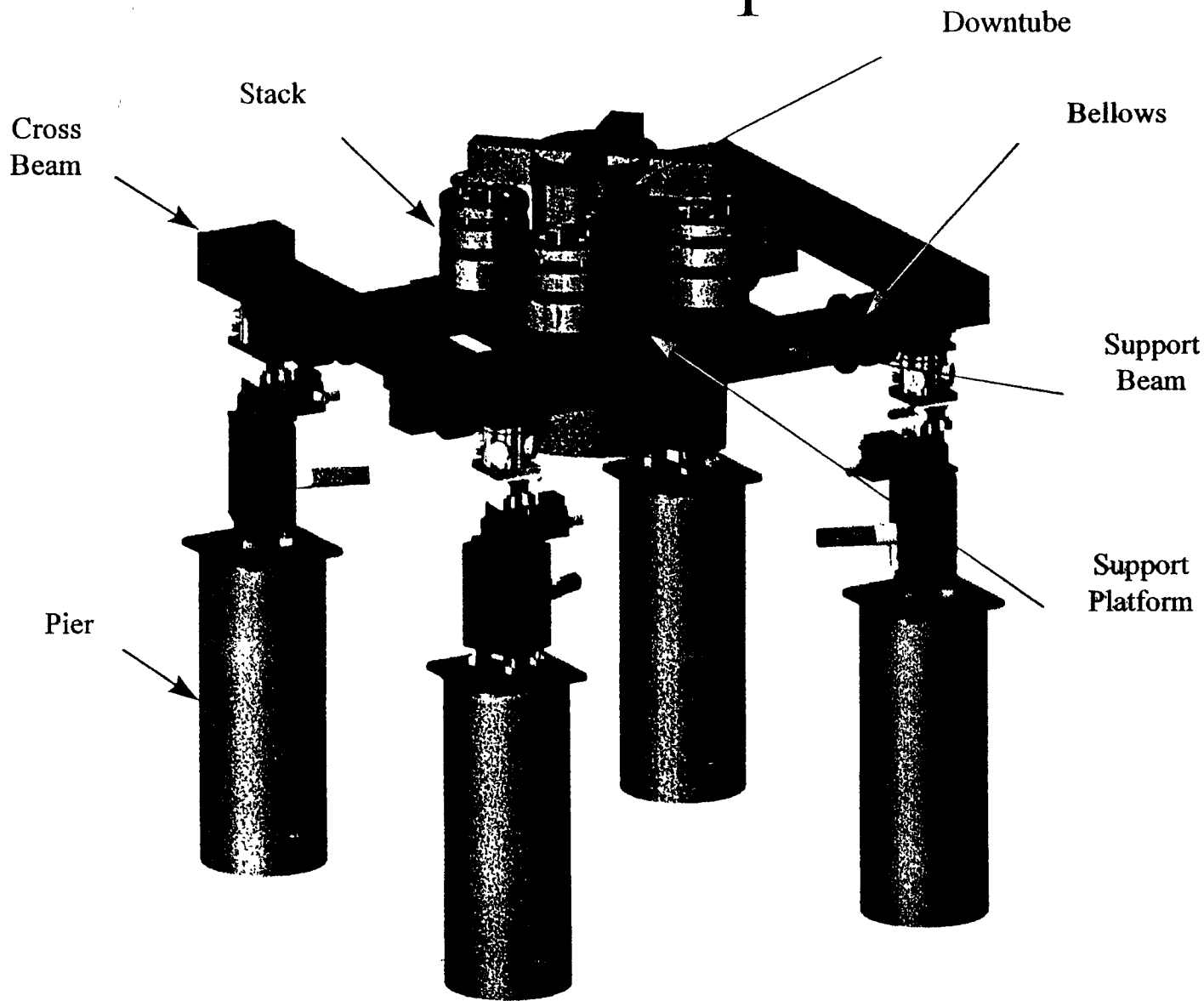
A. Seismic Isolation System

1. Hired New Task Leader, Mike Fine, - Oct '96
2. Held BSC/HAM Stack Preliminary Design Review with HYTEC - Mar '97
3. Developed two spring designs for prototype testing, Decision June '97
4. Completed Replan to allow for 1st Article testing before production
5. 1st Article Readiness Review June '97
6. Place 1st Article Hardware contracts June '97

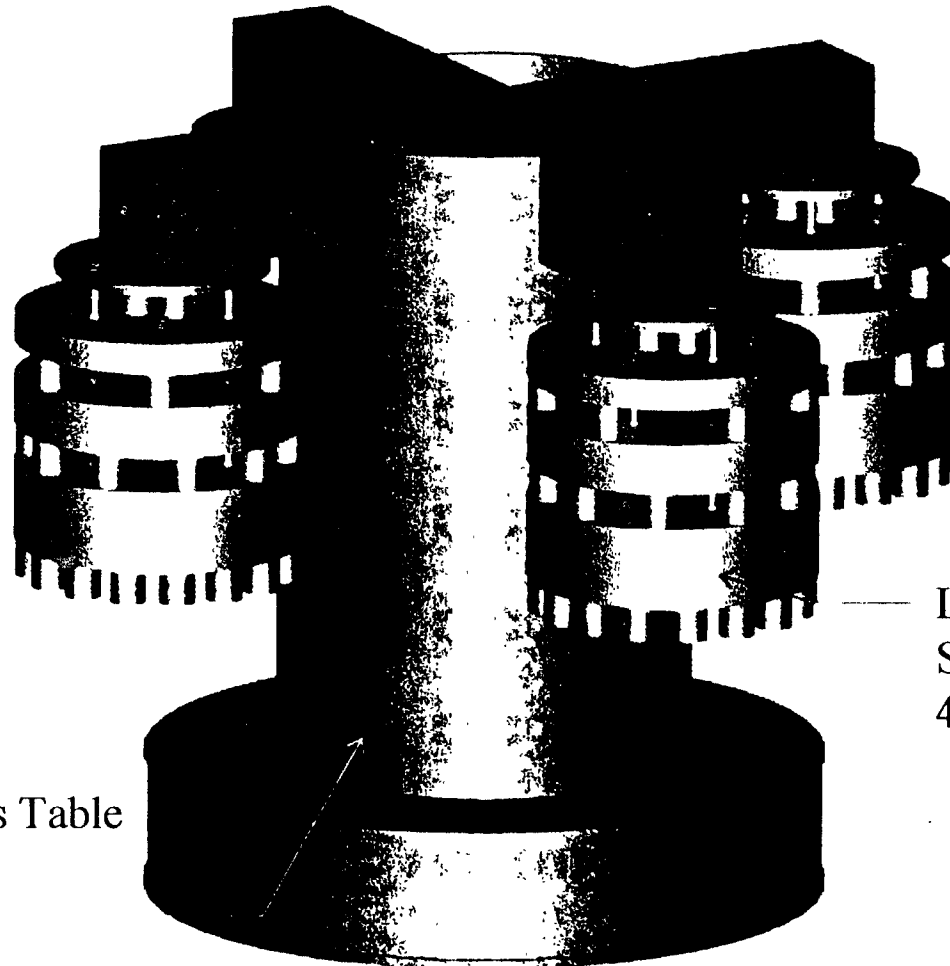
B. Suspension Systems

1. Held Suspension Prelim Design Review June '96
2. Have Built a Large Optic and a Small Optic Suspension prototype
3. Suspension Final Design Review is scheduled for June '97
4. New suspension scientist, Mark Barton, to start July '97

BSC SEI Components



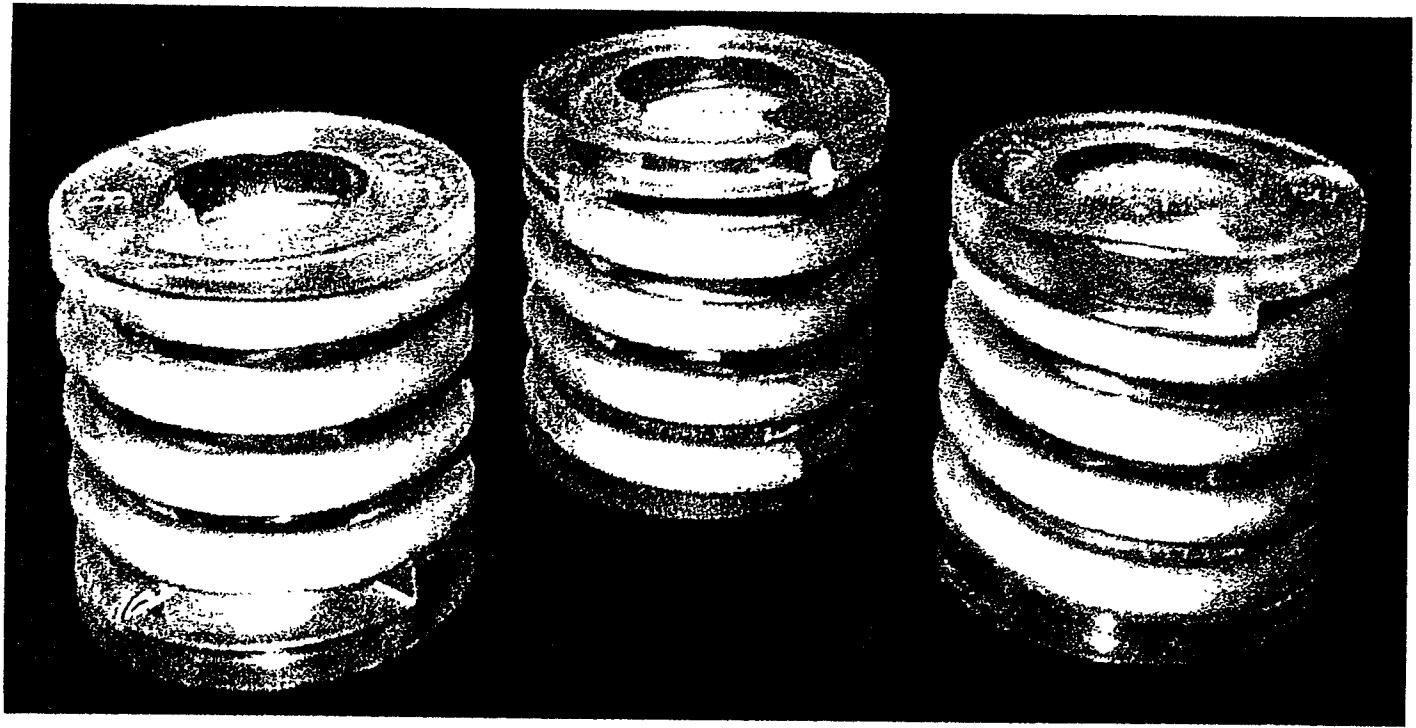
Isolation Stack Assembly



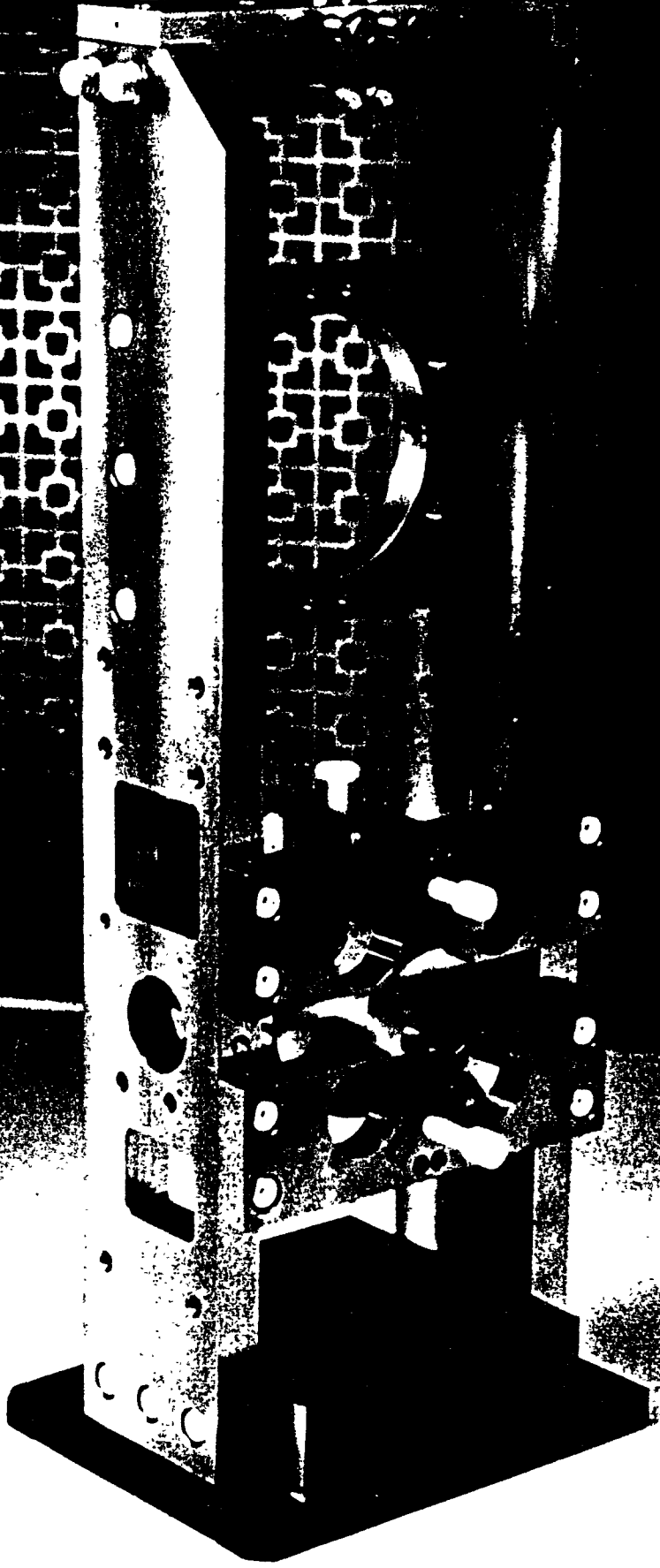
Downtube/Optics Table
Aluminum
424 kg (935 lb)

Legs: 4x 3 elements
Stainless Steel
4 x 578 kg (1272 lb)

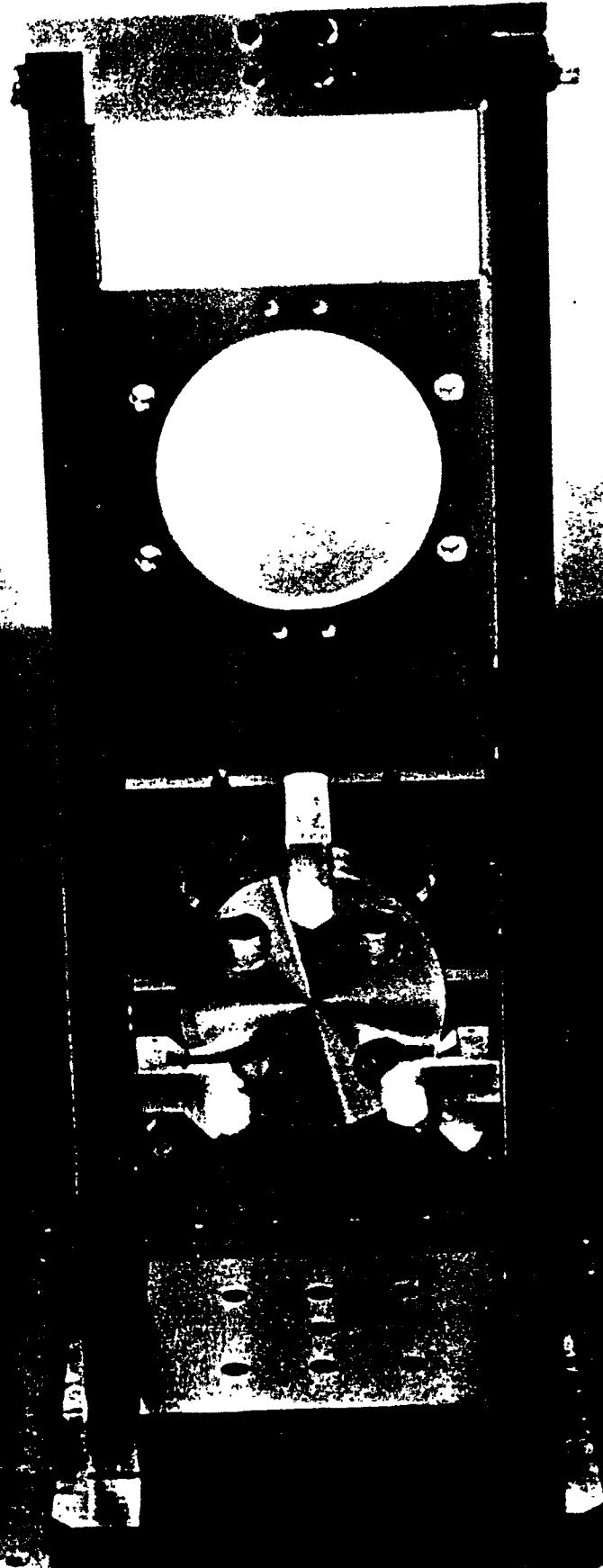
Total Weight = 2733 (6025 lb)



L14C-G970069-06-DPV



1.100 - 6570065 - 07 - DPA



LIGO PROJECT

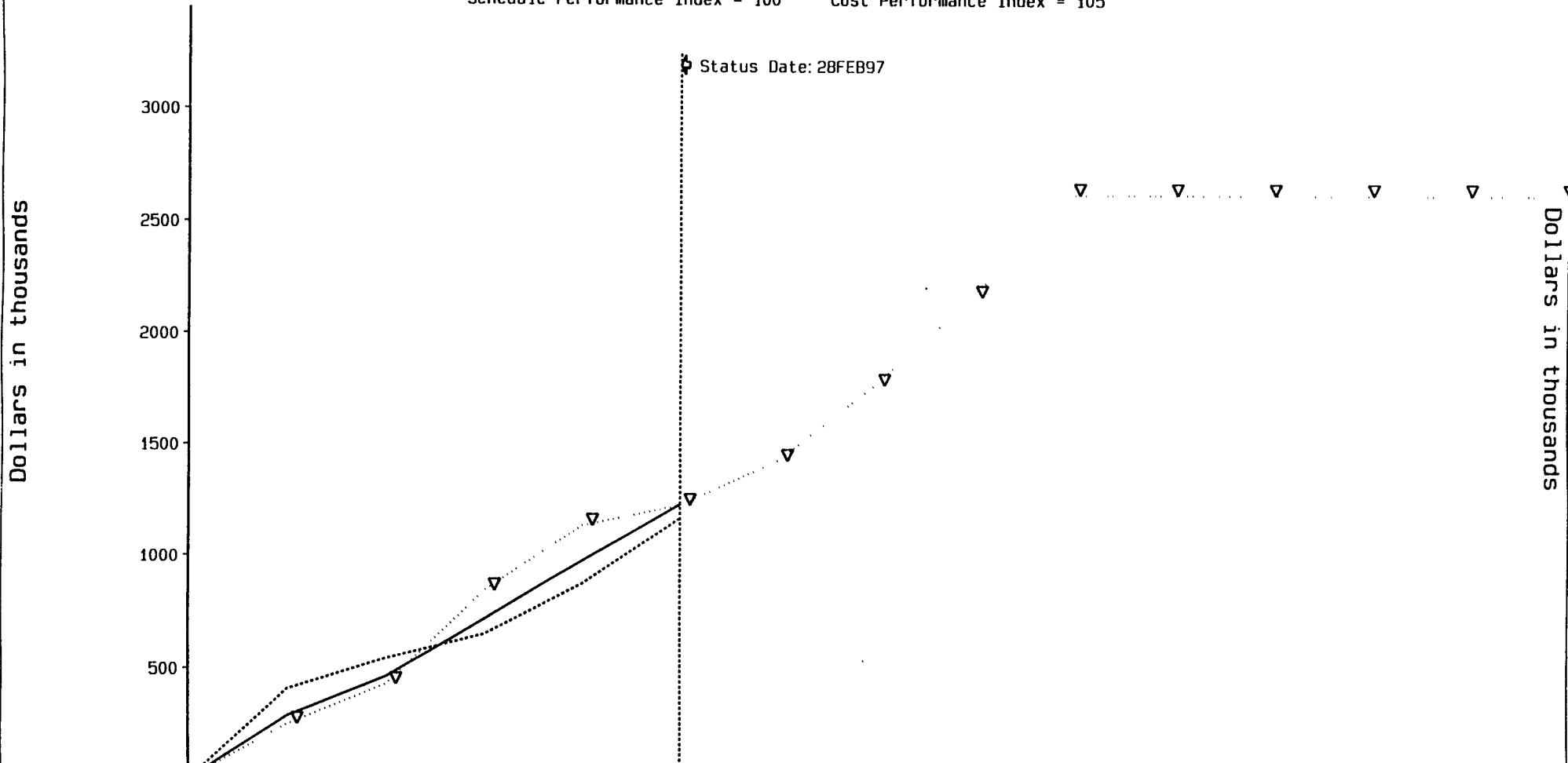
VIBRATION ISOLATION (5E511, 5E518)

Date: 11APR97
 Program: LIGOPMB2
 Report: LIGOSPA
 COBRA (R)

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Budget vs Performance vs Actual
 Schedule Performance Index = 100 Cost Performance Index = 105

Status Date: 28FEB97



	FEB96	MAY96	AUG96	NOV96	FEB97	MAY97	AUG97	NOV97	FEB98	MAY98	AUG98	NOV98	FEB99	MAY99
Planned Budget	253	433	849	1,145	1,237	1,434	1,773	2,171	2,623	2,623	2,623	2,623	2,623	2,623
Performance	290	467	725	984	1,241									
Actuals	409	548	658	880	1,178									
Schedule Variance	37	34	- 124	- 161	4									
Cost Variance	- 119	-81	67	104	63									

Schedule Variance = Perf-Budg Cost Variance = Perf-Actual Schedule Performance Index = Perf/Budg Cost Performance Index = Perf/Actual

Interferometer Sensing and Control (ISC) Schedule Accomplishments

A. Alignment Sensing and Control (ASC)

1. Completed simulation software for Interferometer Lock Acquisition - Sept '96
2. Completed FMI experiment validating Modal Alignment Model - Nov '96
3. Successfully tested the Wavefront Sensing Alignment Control concept - Nov '96
4. Held ASC Requirements Review - Aug '96
5. Held ASC Preliminary Design Review - Feb '97

B. Length Sensing and Control

1. Hired New Engineer, Ken Mason, for ASC/LSC design and fab - Jan '97
2. Held LSC Requirements Review - April '96
3. LSC Preliminary Design Review is scheduled for May '97

LIGO PROJECT

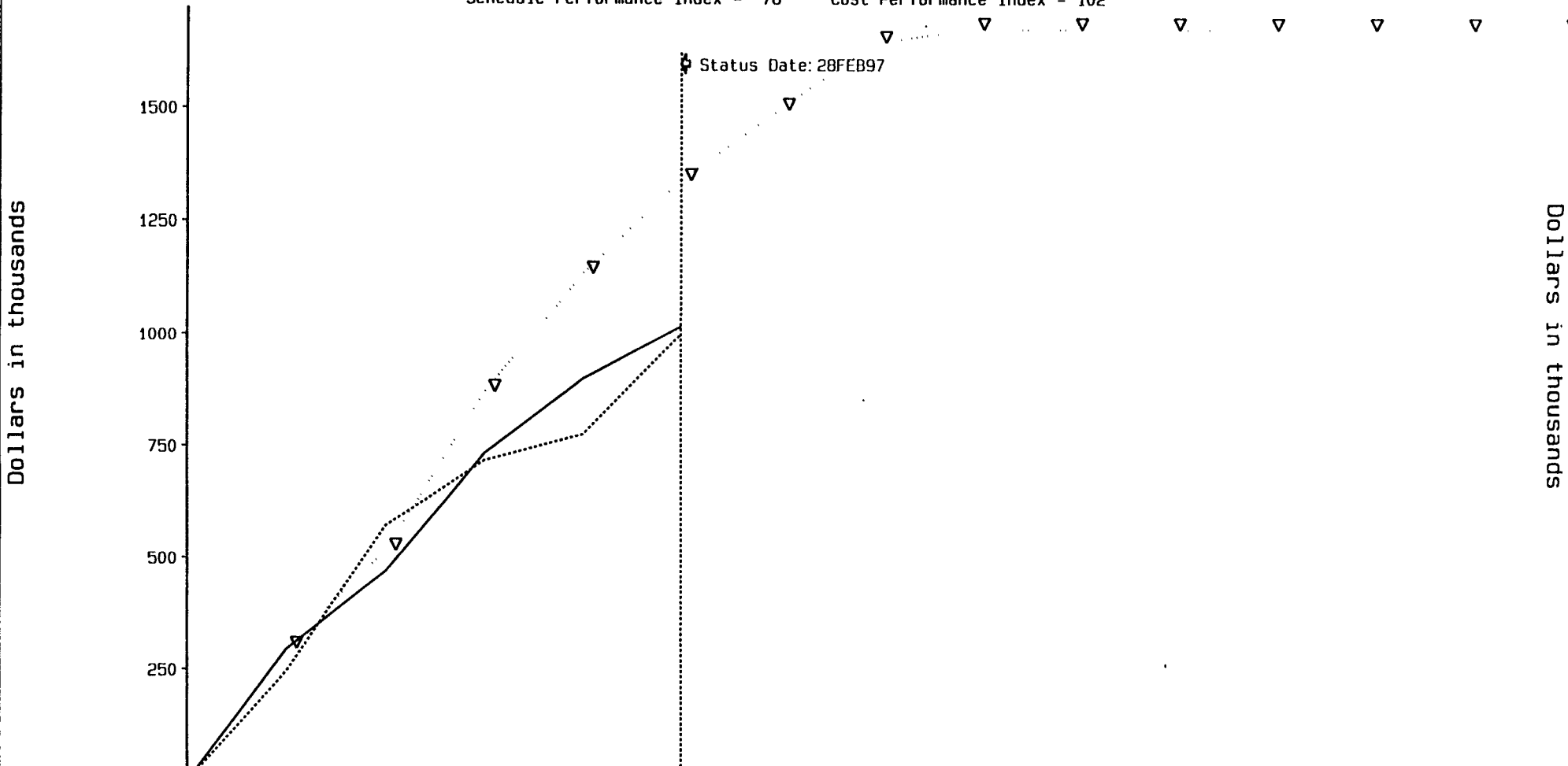
INTERFEROMETER SENSING CONTROL (5E516, 5E517)

Date: 11APR97
 Program: LIGOPMB2
 Report: LIGOSPA
 COBRA (R)

Budget vs Performance vs Actual

Schedule Performance Index = 76 Cost Performance Index = 102

Status Date: 28FEB97



	FEB96	MAY96	AUG96	NOV96	FEB97	MAY97	AUG97	NOV97	FEB98	MAY98	AUG98	NOV98	FEB99	MAY99
Planned Budget	296	517	871	1,135	1,339	1,496	1,648	1,678	1,678	1,678	1,678	1,678	1,678	1,678
Performance	295	470	735	900	1,018									
Actuals	245	573	719	776	999									
Schedule Variance	-1	-47	-136	-235	-321									
Cost Variance	50	-103	16	124	19									

Schedule Variance = Perf-Budg Cost Variance = Perf-Actual Schedule Performance Index = Perf/Budg Cost Performance Index = Perf/Actual

Control and Data Systems (CDS) Schedule Accomplishments

A. General CDS

1. Established CDS at Hanford with 3 software engineers including two new staff hires - Mar '97
2. Procured first 20 Racks and VME Crates to Hanford

B. Vacuum Controls

1. Completed Vac Controls Prelim and Final Design Reviews
2. Vac Control System and Software in fabrication
3. First Vac Control Hardware Ready on Schedule - Aug '97

C. ASC - CDS

1. Completed conceptual design and held Requirements Review
2. Prototype hardware is on order

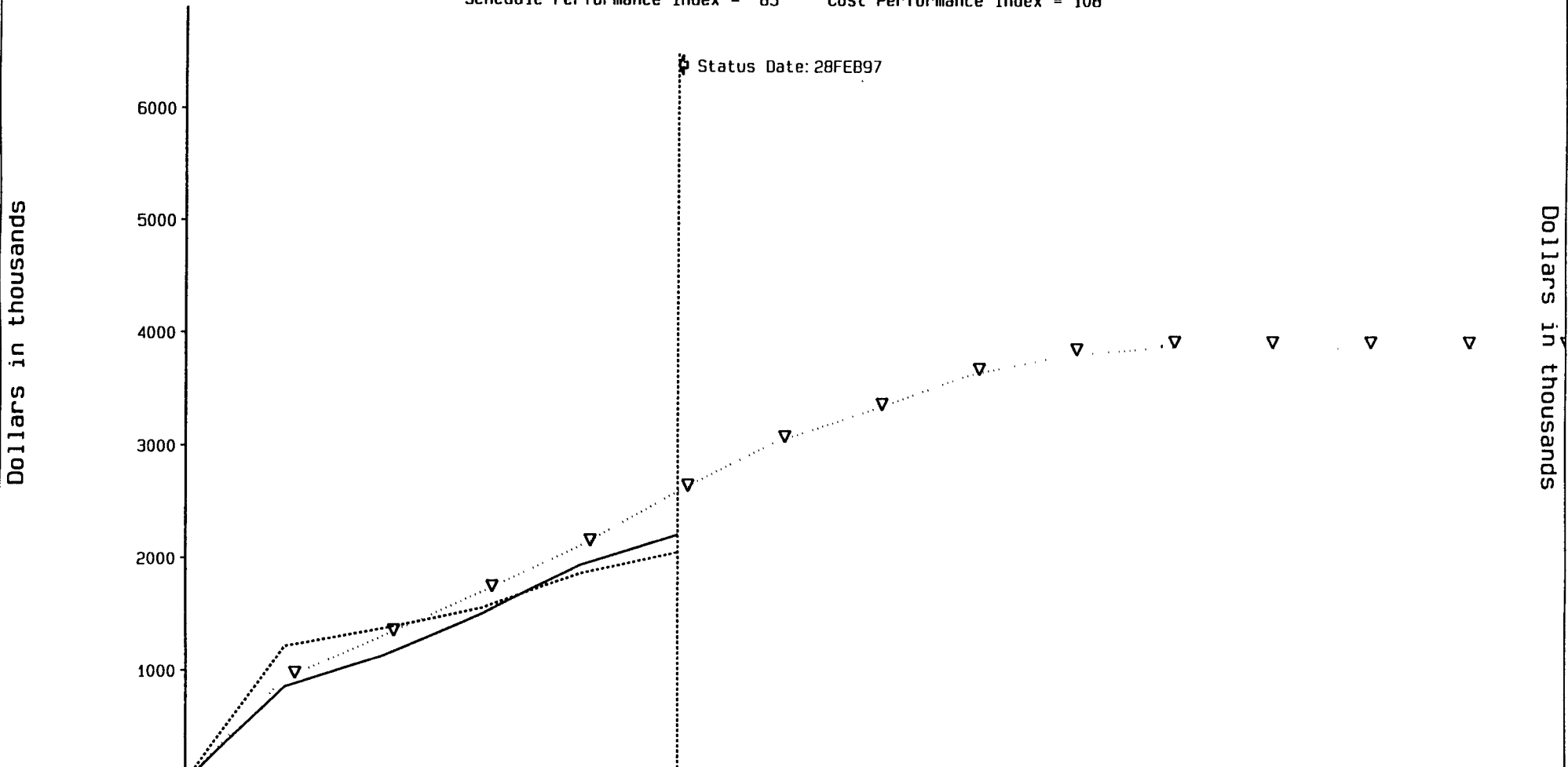
D. NPRO PSL Controls

1. Designed, fabricated, tested and shipped one NPRO Laser Controls System to MIT for use in the PNI

LIGO PROJECT CDS DESIGN

Date: 11APR97
 Program: LIGOPMB2
 Report: LIGOSPA
 COBRA (R)

Budget vs Performance vs Actual
 Schedule Performance Index = 85 Cost Performance Index = 108



	FEB96	MAY96	AUG96	NOV96	FEB97	MAY97	AUG97	NOV97	FEB98	MAY98	AUG98	NOV98	FEB99	MAY99
Planned Budget	932	1,317	1,706	2,124	2,608	3,047	3,332	3,641	3,821	3,892	3,892	3,892	3,892	3,892
Performance	856	1,143	1,516	1,952	2,226									
Actuals	1,221	1,383	1,566	1,875	2,068									
Schedule Variance	-76	-174	-190	-172	-382									
Cost Variance	-365	-240	-50	77	158									
Schedule Variance = Perf-Budg Cost Variance = Perf-Actual Schedule Performance Index = Perf/Budg Cost Performance Index = Perf/Actual														

R & D

Schedule Accomplishments

A. 40 Meter

1. Completed vacuum envelope reconfiguration For Recycling
2. Installed New Beam Splitter with Small Optics Suspension Prototype
3. Locked Recombined Interferometer with High Transmission Test Masses

B. PNI

1. Started Reconfigure of the PNI with YAG laser
2. Completed PNI measurements Argon Laser, achieving the highest recorded phase sensitivity

C. FMI

1. Confirmed Validity of Model for Wavefront Sensing
2. Demonstrated Closed Loop Operation of Recycled Interferometer Using Wavefront Sensing

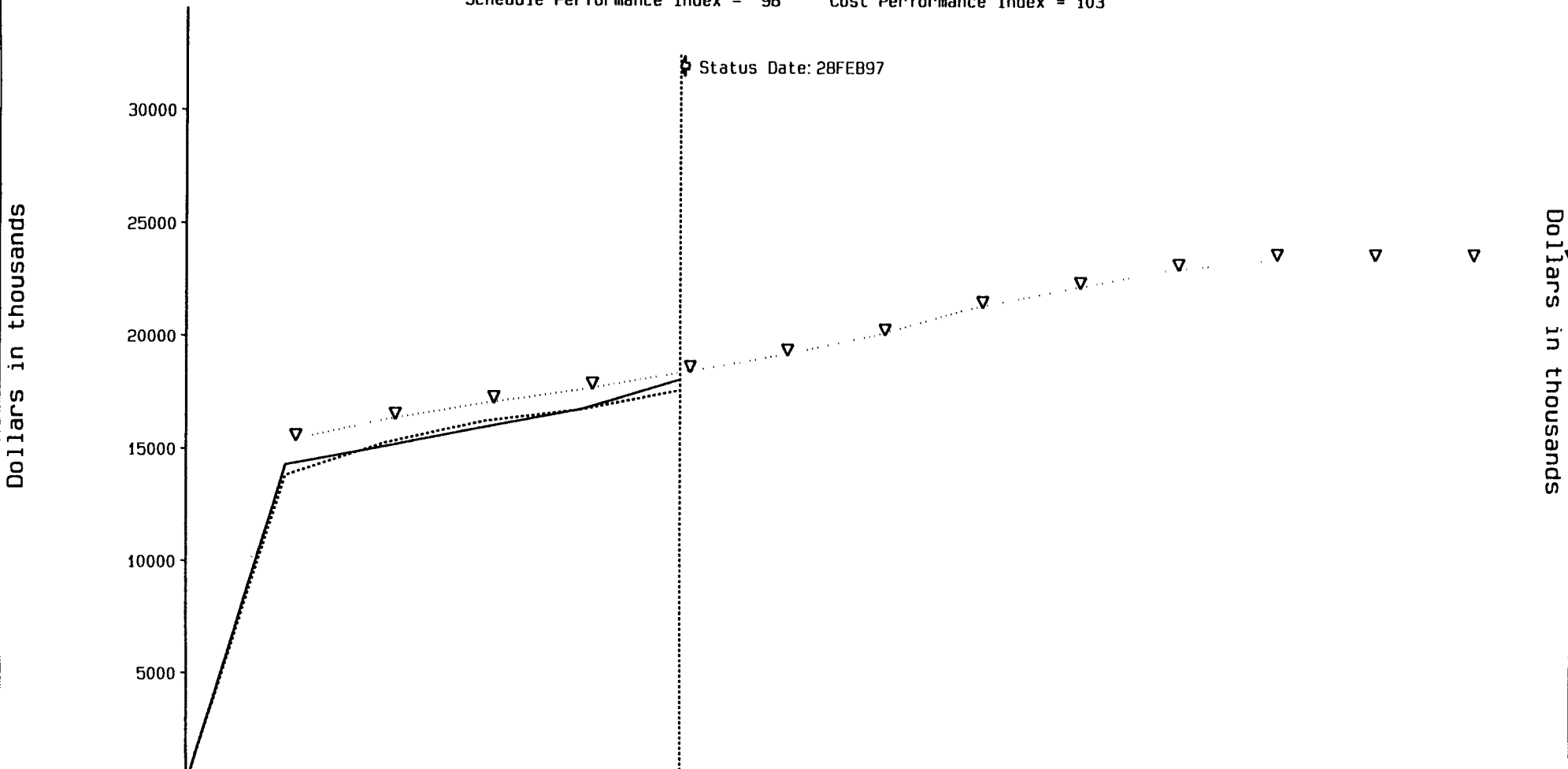
LIGO PROJECT

1.3 Research & Development

Date: 11APR97
 Program: LIGOPMB3
 Report: LIGOSPA
 COBRA (R)

Budget vs Performance vs Actual
 Schedule Performance Index = 98 Cost Performance Index = 103

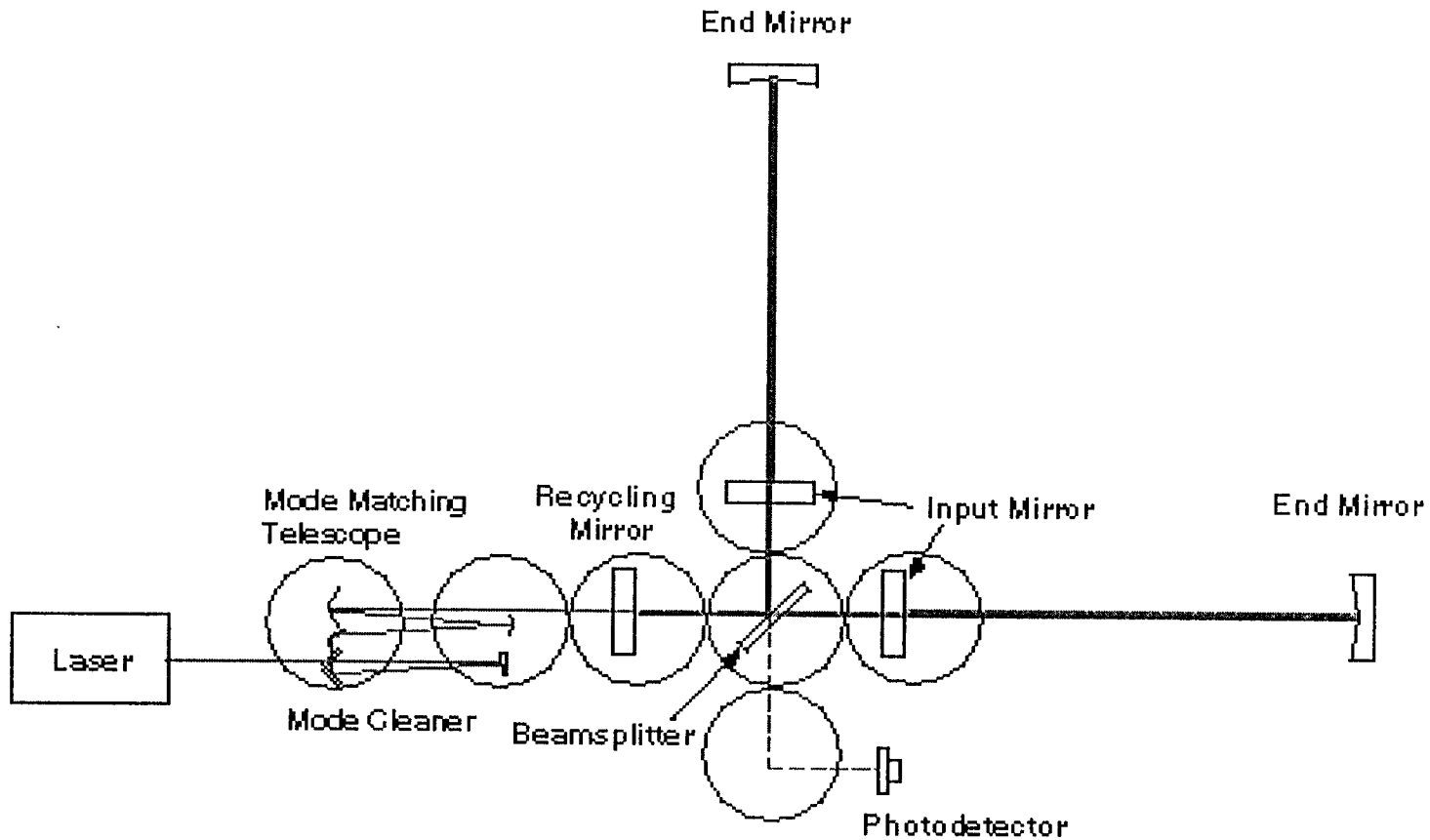
Status Date: 28FEB97



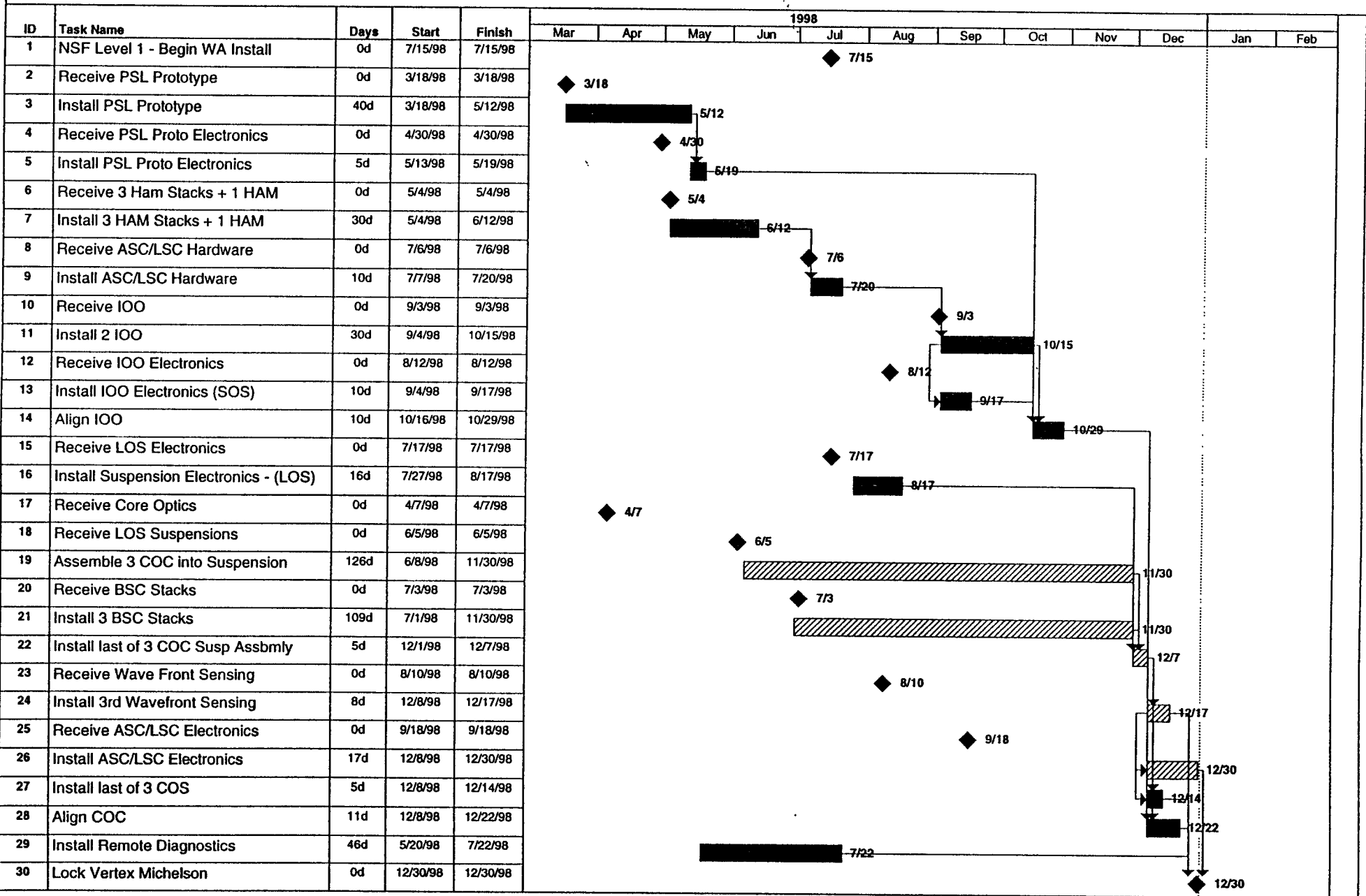
	FEB96	MAY96	AUG96	NOV96	FEB97	MAY97	AUG97	NOV97	FEB98	MAY98	AUG98	NOV98	FEB99	MAY99
Planned Budget	15,346	16,334	17,069	17,680	18,429	19,182	20,110	21,356	22,211	23,030	23,490	23,490	23,490	23,490
Performance	14,298	15,135	16,011	16,840	18,121									
Actuals	13,839	15,294	16,284	16,815	17,661									
Schedule Variance	-1,048	-1,199	-1,058	-840	-308									
Cost Variance	459	-159	-273	25	460									

Schedule Variance = Perf-Budg Cost Variance = Perf-Actual Schedule Performance Index = Perf/Budg Cost Performance Index = Perf/Actual

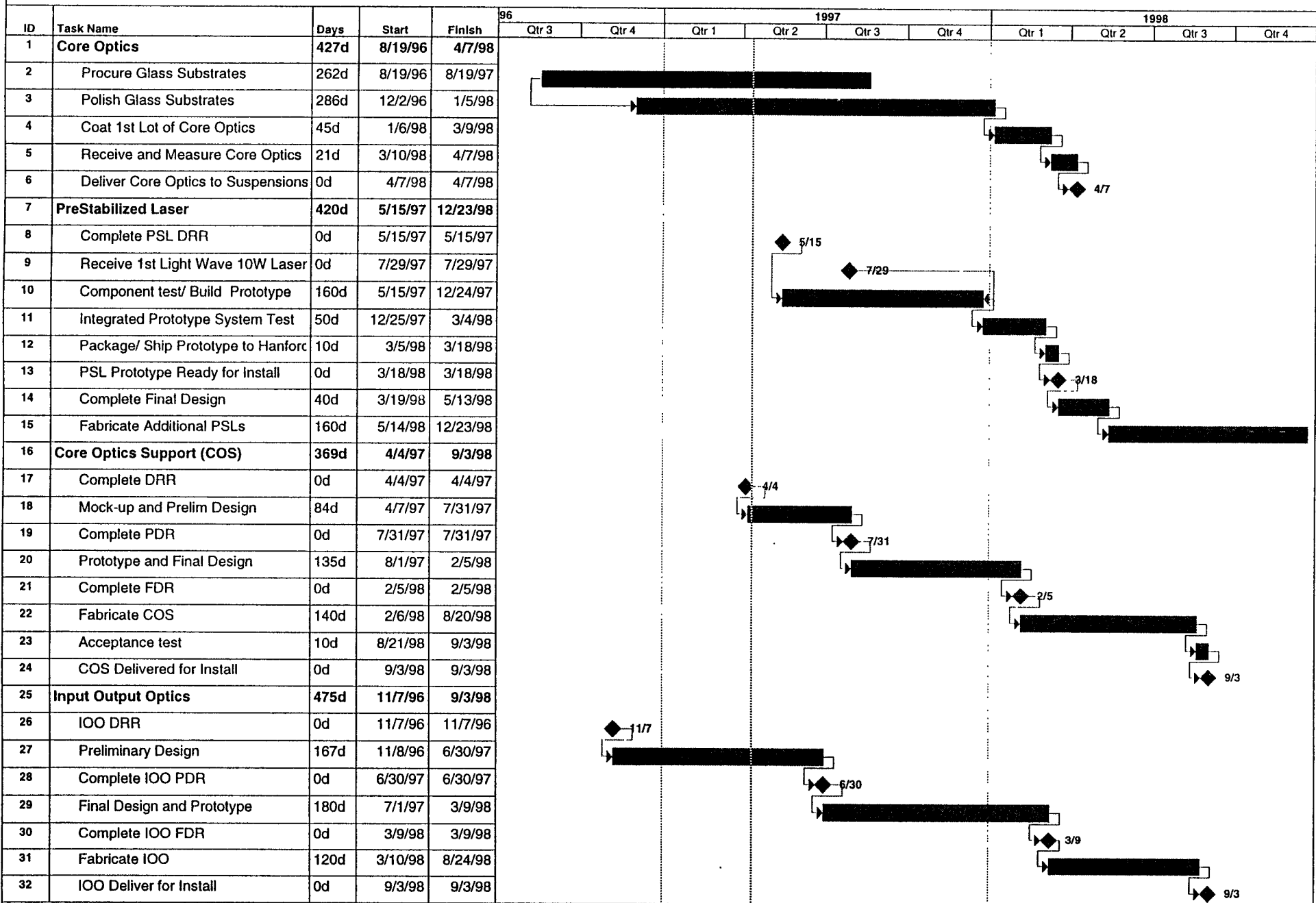
WA 4K Vertex Michelson



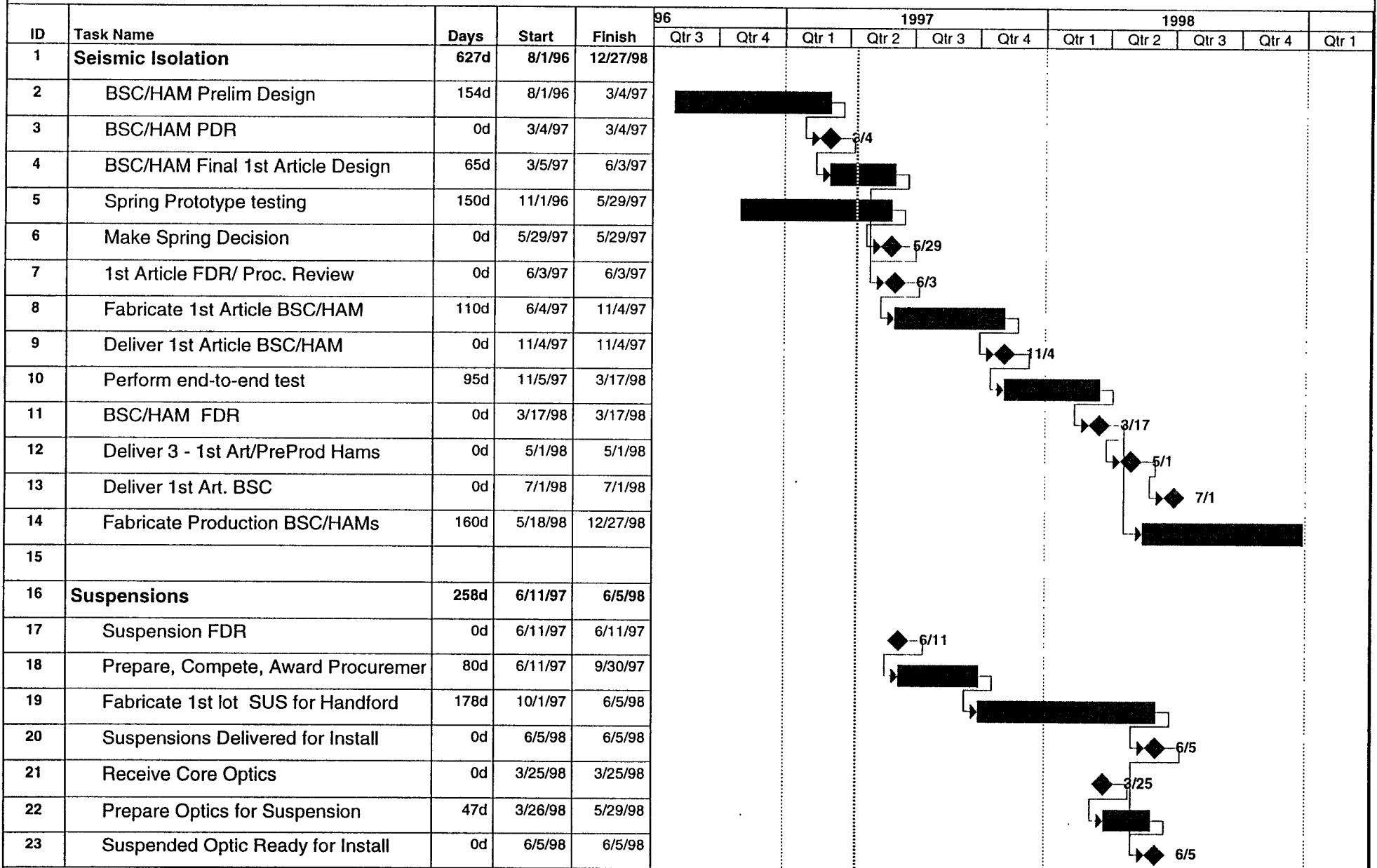
Begin WA 4K Installation



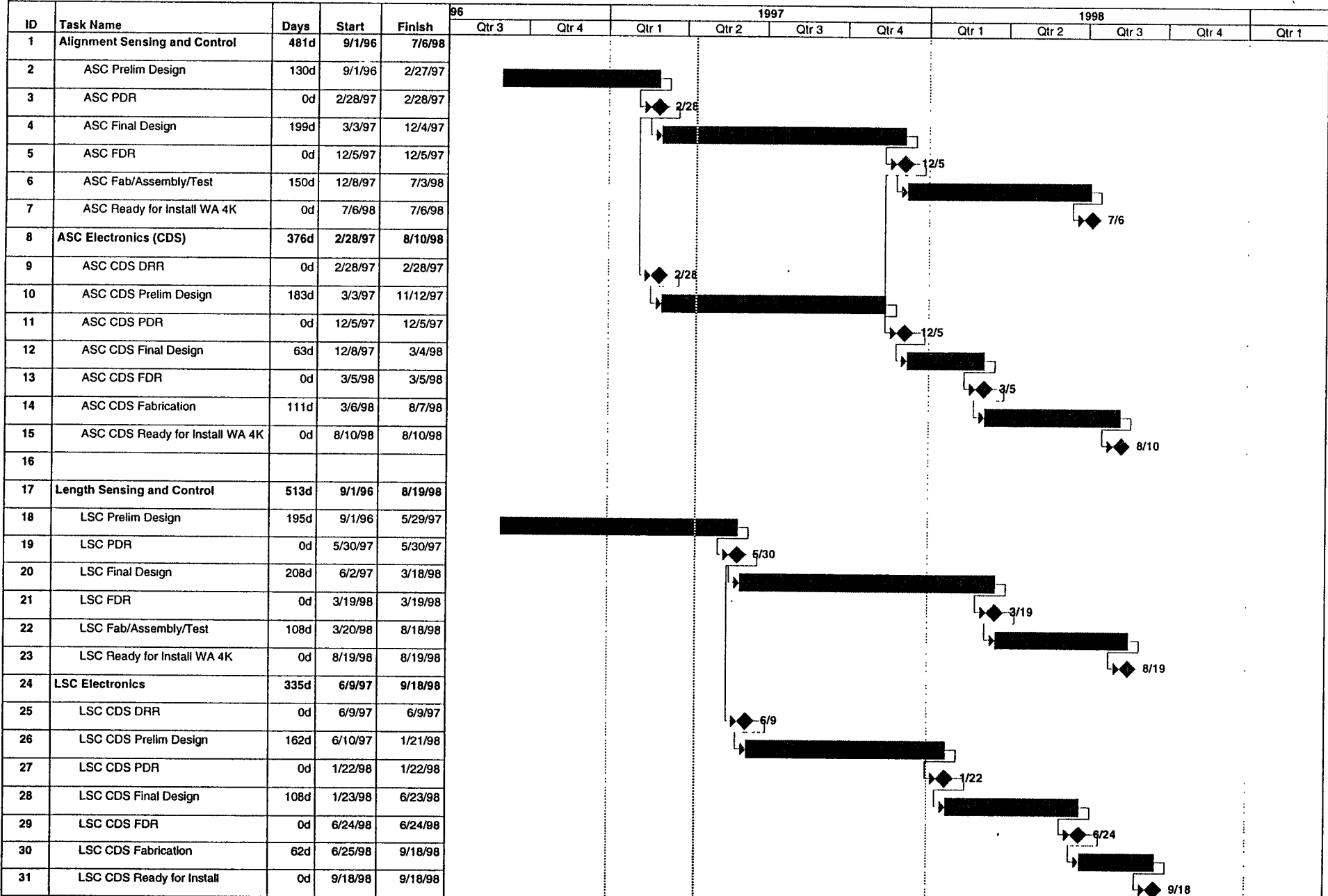
LASER/OPTICS SCHEDULE



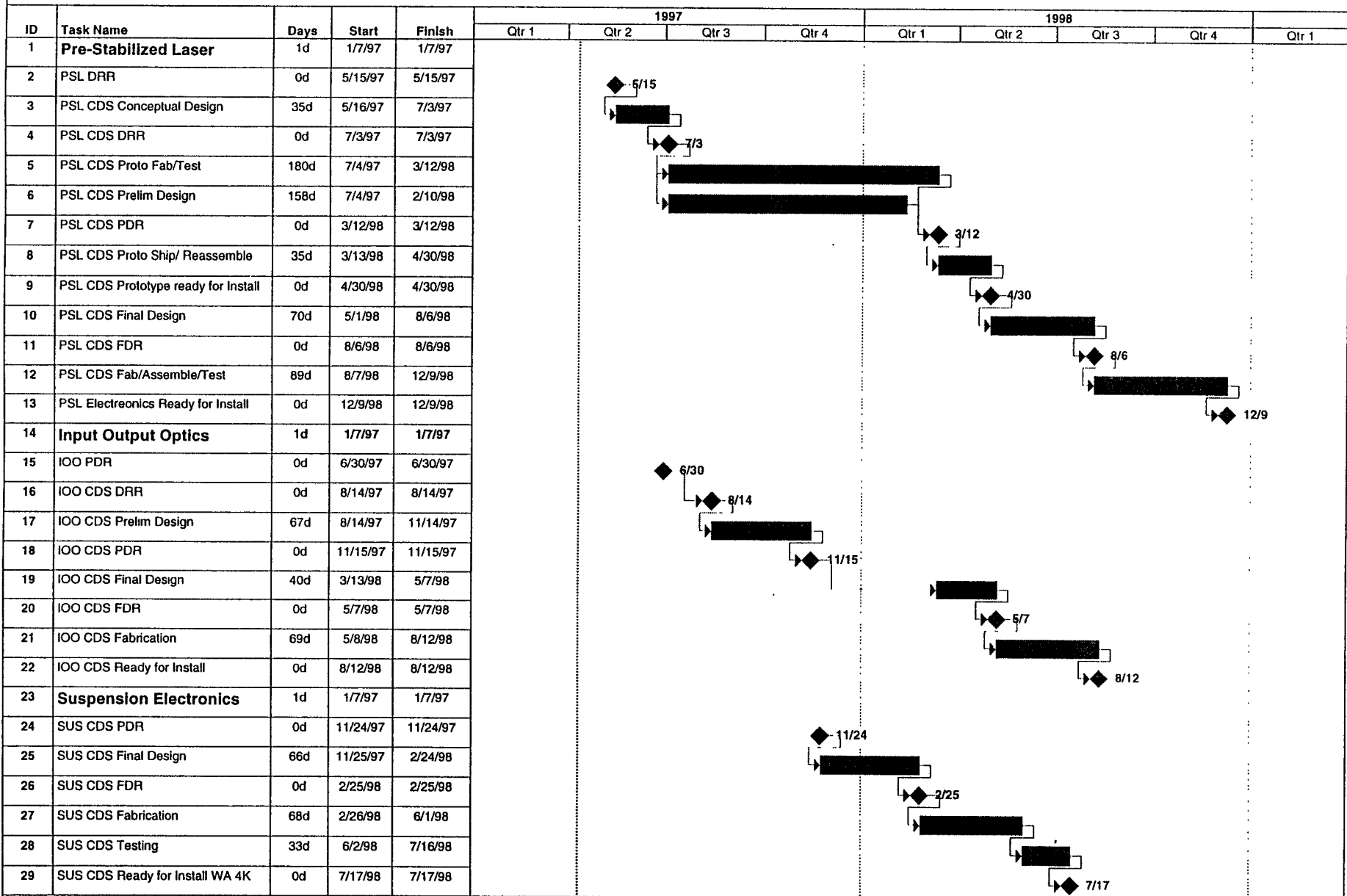
SEISMIC/SUSPENSION SCHEDULE



Interferometer Sensing and Control



CDS Schedule



Project:
 Date: 4/11/97

Task	■	Milestone	◆	Rolled Up Task	■	Rolled Up Progress	■
Progress	■	Summary	■	Rolled Up Milestone	◇		

Level 1 DETECTOR Milestone's - FEB 1997

4/11/97

Milestone Description	Current Month End Status Feb-1997	Project Mgmt Plan Dates	REPLAN Feb-1997	PMP vs REPLAN (Days)
Pre-Stabilized Laser FDR	7/30/98	8/30/98	4/28/98	88
Input/Output Optics FDR	5/19/98	4/30/98	12/31/97	88
Length Sensing Control FDR	12/15/97	5/30/98	3/19/98	32
Wavefront FDR	2/13/98	4/30/98	12/5/97	97
Core Optics Components FDR	10/27/97	7/30/97	12/19/97	-103
Core Optics Support FDR	12/9/97	4/30/97	2/20/98	-242
BSC Stack Final Design Review	8/21/97	7/30/97	4/6/98	-182
HAM Stack Final Design Review	8/21/97	7/30/97	4/6/98	-182
Control Data System DAQ FDR	5/28/98	4/30/98	5/28/98	-22
Physics Environ Monitoring FDR	8/6/97	6/30/98	8/6/97	286
WA Cntl Area/Net Sys Ready To Install	9/29/97	9/30/97	11/3/97	-27
Detector System Prelim Design Review	4/3/98	12/30/97	12/31/97	0
Begin WA IFO Installation	7/30/98	7/30/98	7/30/98	0
Begin LA IFO Installation	1/30/99	1/30/99	1/30/99	0
Begin COINCIDENCE TEST	12/31/00	12/31/00	12/31/00	0

Anticipated Detector Replan Budget

Detector Baseline Budget (as of last October '96 Review)	\$52,567,000
Cost Reductions:	
1. CR-970009 COC <u>Savings</u>	- 881,636
2. CR-970010 Output Mode Cleaner <u>Savings</u>	- 471,000
Anticipated Cost Reduction:	
1. PEM Descope <u>Savings</u>	- 650,000
Anticipated Cost Increases:	
1. Seismic Stack 1st Article Scope	+ 1,500,000
2. Increase Staffing Requirements	+ <u>2,200,000</u>
Anticipated Detector Replan Budget	\$54,264,364
Delta Increase of 3.2%	\$ 1,697,364

- Original Detector Budget w/YAG Laser Requirements \$51,728,000.



Conclusions

1. The Detector Subsystems are Completing Preliminary Design or are in Final Design.
2. Over the Last 12 Months the Detector has Accomplished most of its Milestones.
3. The Detector is Roughly Two Months Behind Schedule and is \$1M Under Budget.
4. The Detector is Staffing up - 8 new people in the last 3 months and 13 new people within the last 6 months.
5. The Seismic Stacks and Core Optics Continue to Pace Interferometer Installation as the Critical Path Items.