
NSF Review - Detector Status

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Outline

- **Overview**
- **Lasers and Optics**
 - ›› Technical accomplishments
 - ›› Basis for ETC
 - ›› Schedule status and issues
- **Suspensions and Isolation**
- **Interferometer Sensing/Control**
- **Control and Data System**
- **Physics Environment Monitoring**
- **Summary**

Cost Graph

Detector Milestones

<i>Milestone</i>	<i>PMP Date</i>	<i>Projected</i>
<i>BSC Seismic Isolation FDR</i>	<i>4/98</i>	<i>6/98</i>
<i>HAM Seismic Isolation FDR</i>	<i>4/98</i>	<i>6/98</i>
Core Optics Support FDR	2/98	8/98
Suspension FDR	--	9/97 (Act.)
Core Optics Components FDR	12/97	4/98
Input Optic FDR	4/98	3/98 (Act.)
Prestabilized Laser FDR	8/98	10/98
Alignment S&C FDR	4/98	7/98
Initial Alignment System FDR	-	4/98
<i>Length S&C FDR</i>	<i>5/98</i>	<i>7/98</i>
Detector System PDR	12/97	7/98
CDS Network Installation	4/98	3/98 (Act.)
Data Acquisition System FDR	4/98	4/98
Physics Environ. Mon. FDR	6/98	10/97 (Act.)
Initiate Interferometer Installation	7/98 (WA) 1/99 (LA)	7/98 (WA) 1/99 (LA)
Begin Coincidence Tests	12/00	12/00

LASERS AND OPTICS

Technical Accomplishments

- **Prestabilized laser**

- ›› First 10 W diode-pumped Nd:YAG laser delivered to LIGO; second unit due by mid-April
- ›› Acceptance testing at Lightwave at or near all output specifications, including demanding limits on intensity noise at 60 Hz harmonics
- ›› Prestabilized laser prototype, including VME electronics, under test
- ›› Optical tables delivered to Hanford this month; table enclosure delivery scheduled in April

- **Input Optics**

- ›› Final Design Review held last week
- ›› Mode cleaner and mode matching optics being polished
- ›› Fabrication of 2 km Small Optics Suspensions completed

Technical Accomplishments, cont

- **Core optics**

- ›› All fused silica blanks delivered
- ›› Over half of polished substrates received
- ›› Full-sized Pathfinder optics coated at REO and tested at NIST show uniformity meets LIGO req'ts
- ›› First 1064 nm coatings planned for early May

- **Core Optic Support**

- ›› Preliminary Design Review held early March
- ›› Detailed design underway

LASERS AND OPTICS EAC

<i>Subsystem</i>	<i>Budget</i>	<i>Cost + Commitment</i>	<i>EAC</i>
Prestabilized Laser	2,908 k	1,766 k	2,915 k
Input Optics	1,840 k	935 k	1,840 k
Core Optics	7,556 k	6,316 k	7,883 k
Core Optics Support	1,918 k	488 k	1,918 k

- **Variance: + 337 k (2%)**

LASERS AND OPTICS

Basis of ETC

- **Prestabilized Laser**

- ›› Fabricated and purchased parts based on prototype costs
- ›› Includes labor through 1998

- **Input Optics**

- ›› Component and fabricated parts based on detailed FDR list
- ›› Includes labor through mid 1999

- **Core Optics**

- ›› Fixed price subcontracts for ~80% of fabrication effort already in place
- ›› Includes labor through 1998

- **Core Optic Support**

- ›› Mixture of vendor quotes and engineering estimates for fabricated parts
- ›› Includes labor through mid-1999

LASERS AND OPTICS Schedule

- **Prestabilized laser and input optics will be ready for installation at Hanford by summer**
- **First core optics coating runs planned for May**
 - ››Critical schedule issue is IR interferometer for certifying core optics
- **Lasers and optics for subsequent interferometers should be available as needed**

SUSPENSIONS AND ISOLATION

Technical Accomplishments

- **Large Optics Suspension**

- ›› Fabrication of most suspension mechanical components underway
- ›› Installation tooling in final design phase
- ›› First Article controller currently under test

- **Seismic Isolation System**

- ›› Piers, cross-beams, bellows deliveries starting!
- ›› First run of constrained-layer-damped metal springs (450) starting to be delivered and tested
- ›› First Article assembly just beginning for HAM test at Hanford
 - Critical path is assembly fixtures and tooling
 - Expect to authorize production of nonvacuum hardware by May

SUSPENSIONS AND ISOLATION EAC

<i>Subsystem</i>	<i>Budget</i>	<i>Cost + Commitment*</i>	<i>EAC</i>
Seismic Isolation	11,609 k	8,480 k	13,270 k
Suspensions	3,266 k	751 k	1,512 k

* “Commitments” include priced options signed but not executed

- **Variance: - 94 k (0.7%)**

SUSPENSIONS AND ISOLATION

Basis of ETC

- **Large Optics Suspensions**

- ›› Suspension parts mostly under contract (~70%), but installation fixtures (\$100 k est) still in design
- ›› Includes labor through 1998

- **Seismic Isolation Systems**

- ›› Fixed price subcontracts (with priced options) on ~75% of fabricated parts
- ›› Includes labor through 1998

SUSPENSIONS AND ISOLATION Schedule

- **Large optics suspensions deliveries to start in April**
- **Vacuum preparation of suspensions a potential bottleneck for full installation**
 - ››Oven for prebaking on order
- **Seismic isolation fabrication is tight, dependent on success in first article assembly and test**
 - ››Highest priority on HAM test to enable input optics installation

INTERFEROMETER SENSING AND CONTROL

Technical Accomplishments

- **Input Optics Controls**

- ›› Frequency and mode cleaner length and alignment control designs completed

- **Alignment Sensing and Control**

- ›› Alignment prototype fabrication and testing underway (essentially equivalent to input optics alignment system)

- ›› Core optic installation alignment procedures finalized

- ›› Initial alignment system (tooling for initial installation, optical levers, viewports) ready for final review

- ›› Long-lead items for 2 km installation on order

- **Length Sensing and Control**

- ›› Continued development of preliminary design

- ›› Detection-mode differential control design finalized

- ›› DSP closed-loop prototype test underway on PNI

- ›› ADC selected & tested to meet required signal to noise ratio

- ›› CPU selected & tested to meet DSP timing requirements

INTERFEROMETER SENSING AND CONTROL EAC

<i>Subsystem</i>	<i>Budget</i>	<i>Cost + Commitment</i>	<i>EAC</i>
Alignment Sensing and Control	4,805 k	1,388 k	4,112 k
Length Sensing and Control	1,682 k	714 k	1,748 k

- **Variance: - 629 k (-10%)**

INTERFEROMETER SENSING AND CONTROL

Basis of ETC

- **Alignment Sensing and Control**

- ›› Mostly vendor quotes (with a few engineering estimates) for parts and materials
- ›› Includes labor through early 1999

- **Length Sensing and Control**

- ›› Minimal fabricated parts
- ›› Includes labor through early 1999

INTERFEROMETER SENSING AND CONTROL Schedule

- **Staffing shortages have delayed ISC and ISC/CDS design work**

- ›› Have concentrated effort on two schedule-critical areas

- Initial alignment system (viewports, optical levers, alignment tooling,...)
- Input optics length and alignment control

- ›› Delays will permit completion of prototype tests before FDR, reducing technical risk

- **Expect input optics control to meet input optics installation requirement**

- **Interferometer controls show just in time delivery**

- ›› Among the last subsystems to be integrated

- ›› Ok if no problems encountered

CONTROL AND DATA SYSTEM

Technical Accomplishments

- **Interferometer Controls and Diagnostics**

- ›› Large optic suspension controller first article being tested
- ›› Prestabilized laser prototype being tested
- ›› Prototype control system for input optics being built
- ›› ADC's tested and proven for the LSC and ASC servos
- ›› In vacuum cabling and feedthroughs for 2 km HAM chambers on order

- **Data Acquisition**

- ›› Prototype data acquisition system installed and tested on the 40 m interferometer
- ›› Final design review scheduled for April

- **Global CDS and Infrastructure**

- ›› CDS network installation started in Hanford, scheduled to start in April in Livingston
- ›› Vacuum controls integration underway in Hanford, fabrication for Livingston underway

CONTROL AND DATA SYSTEM EAC

<i>Subsystem</i>	<i>Budget</i>	<i>Cost + Commitment</i>	<i>EAC</i>
Interferometer Controls and Diagnostics	6,300 k	2,203 k	6,471 k
Data Acquisition	3,175 k	982 k	2,915 k
Global CDS and Infrastructure	3,256 k	2,401 k	3,294 k

- **Variance: - 50 k (- 0.4%)**

CONTROL AND DATA SYSTEM

Basis of ETC

- **Interferometer Controls and Diagnostics**

- ›› Mixture of vendor quotes and engineering estimates for fabricated parts
- ›› Includes labor through 1998

- **Data Acquisition**

- ›› Mostly catalog items for parts and materials
- ›› Includes labor through 1998

- **Global CDS and Infrastructure**

- ›› Mostly catalog items for parts and materials
- ›› Includes labor through 1998

CONTROL AND DATA SYSTEM Schedule

- **Infrastructure and vacuum controls will be ready on schedule**
- **Prestabilized laser and input optics controls should be delivered as needed**
- **Data acquisition system ready for Physics Environment Monitoring by fall**
- **Critical item will be length control servo electronics**
- **Main cost risks are delays in design and fabrication and potential redesign/rework during integration**

PHYSICS ENVIRONMENT MONITORING SYSTEM

Technical Accomplishments

- **Final Design Review held October 1997**
- **First items of PEM equipment delivered**
 - ››Orders placed on ~15% of PEM hardware
- **Schedule**
 - ››Some installation to begin this spring
 - ››Most installation paced by detector installation
 - ››Correlations studies of PEM data between sites planned at earliest possible time

PHYSICS ENVIRONMENT MONITORING SYSTEM

Basis of ETC

<i>Subsystem</i>	<i>Budget</i>	<i>Cost + Commitment</i>	<i>EAC</i>
Physics Environment Monitoring System	2196 k	327 k	2,152 k

- **Bottoms-up re-estimate based on final design completed in January**
 - ››80% of components are commercial
 - ››Includes labor through mid-1999
- **CCB action to reduce costs by ~\$760k to match re-estimate**

Summary

- **Detector well underway to make the transition from design into full fabrication**
 - ›› First detector hardware deliveries to Hanford beginning
 - ›› On-track to begin installation as soon as PSI finishes with vacuum diagonal section
- **Up-dated ETC shows detector costs still under control**
 - ›› Parts and materials more certain than labor
 - ›› Some subsystems up, some down, but net change is less than few%
 - ›› Potential contingency need identified for staffing costs due to delays (up to 6 months)
 - Some fraction already incurred, between 1/3 and 1/2
 - Still expect completion within available contingency
- **Still expect to reach 10^{-21} operation by end of 2001**