Detector Replan:
Transition to Science Run

Stan Whitcomb

NSF Review

May 9, 2000

Progress Against Schedule?

- Exciting technical progress on detector installation/commissioning
- However, a number of minor problems and delays:
  - » Start-up problems in seismic isolation production
  - » Adhesion problems for the magnet/standoff assembly to the optics
  - » Handling and fixture problems for completed suspension assemblies
  - » Loss of needed flourel components due to a tornado
  - » Re-baking of the seismic stack spring seats to mitigate water outgassing
  - » Number of secondary delays (not on critical path, but “just in time”)
- Work-arounds have minimized delays, but…
  - » Detector commissioning is about 7 months behind schedule

Original Installation and Commissioning Plan

- Original “plan” formulated in 1994
  - » Fab and install all three interferometers as rapidly as possible
  - » Commission them nearly simultaneously
  - » Single remaining milestone: Initiate coincidence testing – 12/00
- Suffers from two main weaknesses….
  - » By installing all three interferometers before beginning commissioning, any design deficiencies are replicated three times
    - – Example: Suspension controllers
  - » Sequential installation and commissioning episodes do not use the range of skills of the LIGO staff as effectively as possible
- …and one unnecessary constraint:
  - » To begin coincidence testing only after all three interferometers are operational, unduly drives the installation of the third interferometer

Reformulated Installation and Commissioning Plan

- Delay completion of the third interferometer (the Hanford 4km interferometer):
  - » Enable lessons learned from first two interferometers to be realized in redesign before installation (minimizes re-work/re-installation)
  - » Reduce simultaneous installation and commissioning workload on the LIGO lab staff
- Use the Hanford 2 km interferometer as a "pathfinder" to identify problems early
- Use the Livingston 4 km interferometer for problem resolution & detailed characterization
  - – Example: Modecleaner servo characterization

Reformulated Installation and Commissioning Plan (continued)

- Initiate coincidence testing when the first two interferometers are at a useful strain sensitivity
  - » Redefinition of “Initiate coincidence testing” milestone from three interferometers to two
- Define clear decision points in the schedule for the third interferometer installation elements
  - » Perform all in-vacuum work and infrastructure as early as possible
  - » Delay installation of the servo-control electronics until we’ve gained enough experience to incorporate anticipated re-design
- Smoothest path to successful Science Run

LIGO I Science Run

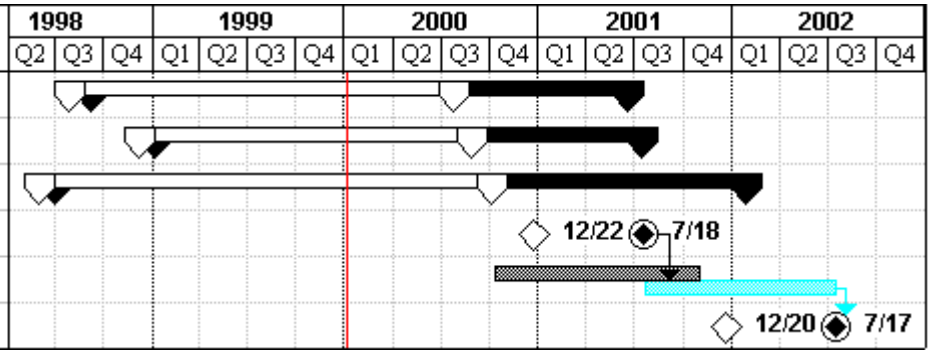
- Begins with reliable and calibrated coincidence data on three interferometers and stable configuration
  - » Not triggered by specific sensitivity number
  - » Early coincidence data for testing analysis techniques and software
  - » Involvement of LSC in detector characterization and data analysis
- Data runs to be alternated with improvements to reach design goals in sensitivity and reliability
- Commitment to acquire at least one year of integrated data at $h \sim 10^{-21}$ before initiating LIGO II

On-site Participation of LSC in LIGO I

- What marks transition from fabrication to research?
  - » Not clearly defined in Cooperative Agreement
- Enables non-LIGO Lab groups in LSC to participate in research in detector characterization
  - » Strengthen effort to achieve full sensitivity
  - » Provide training and “real-interferometer” experience for LSC
- Propose that individual detectors become available for LSC research (subject to LIGO Lab scheduling and configuration control) when:
  - » “Final” hardware configuration installed (no kludges)
  - » Gross electronic and mechanical deficiencies fixed (oscillations, line spikes, rubbing, …)
  - » Locks for long enough times to make meaningful measurements

Top Level Schedule

ID	Task Name
1	LHO 2km IFO
14	LLO 4km IFO
30	LHO 4km IFO
44	Coincidence Engineering Run starts
45	Observatory Operations & improvements
46	Science Run starts

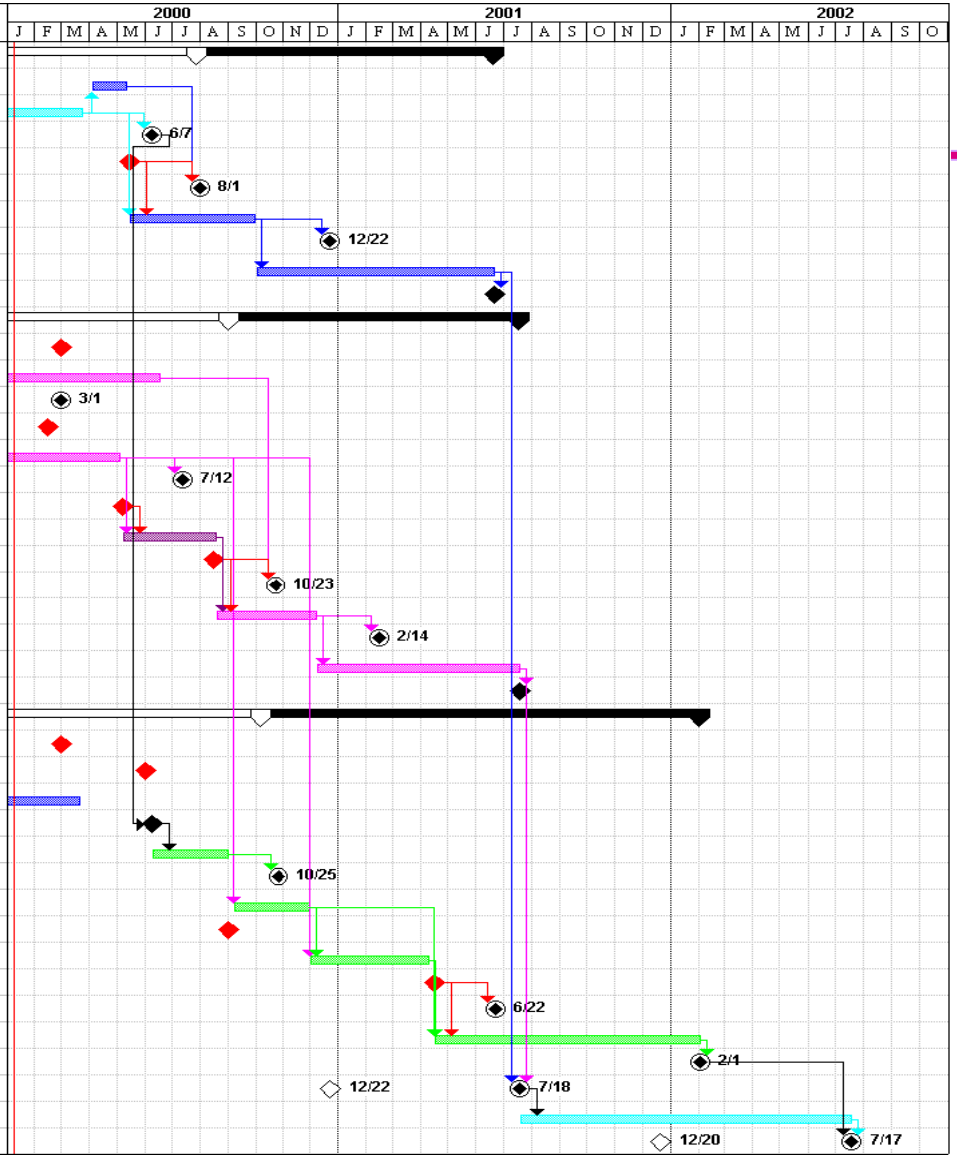


Projected Significant Events

Hanford 2km interferometer	Seismic isolation installed Input Optics completed Single arm test complete Interferometer installed Interferometer locked	done done done 8/00 12/00
Livingston 4km interferometer	Seismic isolation installed Input Optics completed Interferometer installed Interferometer locked	done 7/00 10/00 2/01
Coincidence Engineering Run (Hanford 2km & Livingston 4km)	Initiate Complete	7/01 7/02
Hanford 4km interferometer	Seismic isolation installed All in-vacuum components installed interferometer installed interferometer locked	done 10/00 6/01 8/01
LIGO I Science Run (3 interferometers)	Initiate Complete (obtain 1 yr @ h ~ 10^{-21})	7/02 1/05

Revised Schedule

ID	Task Name
1	**LHO 2km IFO**
2	Complete COS, ISC & CDS installation
3	long arm Fabry-Perot cavity test
4	single arm test complete
5	full LSC electronics/SW ready
6	interferometer installation complete
7	PR Near Michelson
8	locked interferometer
9	PR Michelson w/ FP Arms
10	LHO 2km IFO commissioned
11	**LLO 4km IFO**
12	complete LOS suspension electronics/SW
13	Install SEI, SUS, COS, ISC
14	seismic installation complete
15	IO electronics/SW ready
16	Input Optics
17	input optics complete
18	long arm cavity electronics/SW ready
19	long arm Fabry-Perot cavity test
20	full LSC electronics/SW ready
21	interferometer installation complete
22	PR Near Michelson
23	locked interferometer
24	PR Michelson w/ FP Arms
25	LLO 4km IFO commissioned
26	**LHO 4km IFO**
27	first LOS electronics/SW install
28	complete LOS electronics/SW install
29	SEI install
30	Decision: SUS sensor/act. head
31	Install SUS & COS
32	all in-vacuum installation completed
33	PSL
34	complete SOS electronics/SW install
35	Input Optics
36	full LSC electronics/SW ready
37	interferometer installation complete
38	Noise reduction
39	LHO 4km IFO commissioned
40	**Coincidence Engineering Run starts**
41	Observatory Operations & improvements
42	**Science Run starts**



Summary

- Installation & Commissioning successes!
  - » Two Mode Cleaners aligned and locked
  - » The 2km long arm cavity test completed last month (Lock durations up to 10 hours!)
  - » Have operated essentially all key pieces of full interferometer (separately)
- Delays have caused us to replan Installation & Commissioning
  - » 7 month delay due to installation problems on the critical path
  - » More effective plan for installation and commissioning
    - – Redefinition of “Initiate coincidence testing” milestone
- New plan ensures a smooth transition into Science Run