LIGO Discussion With NSF DGA

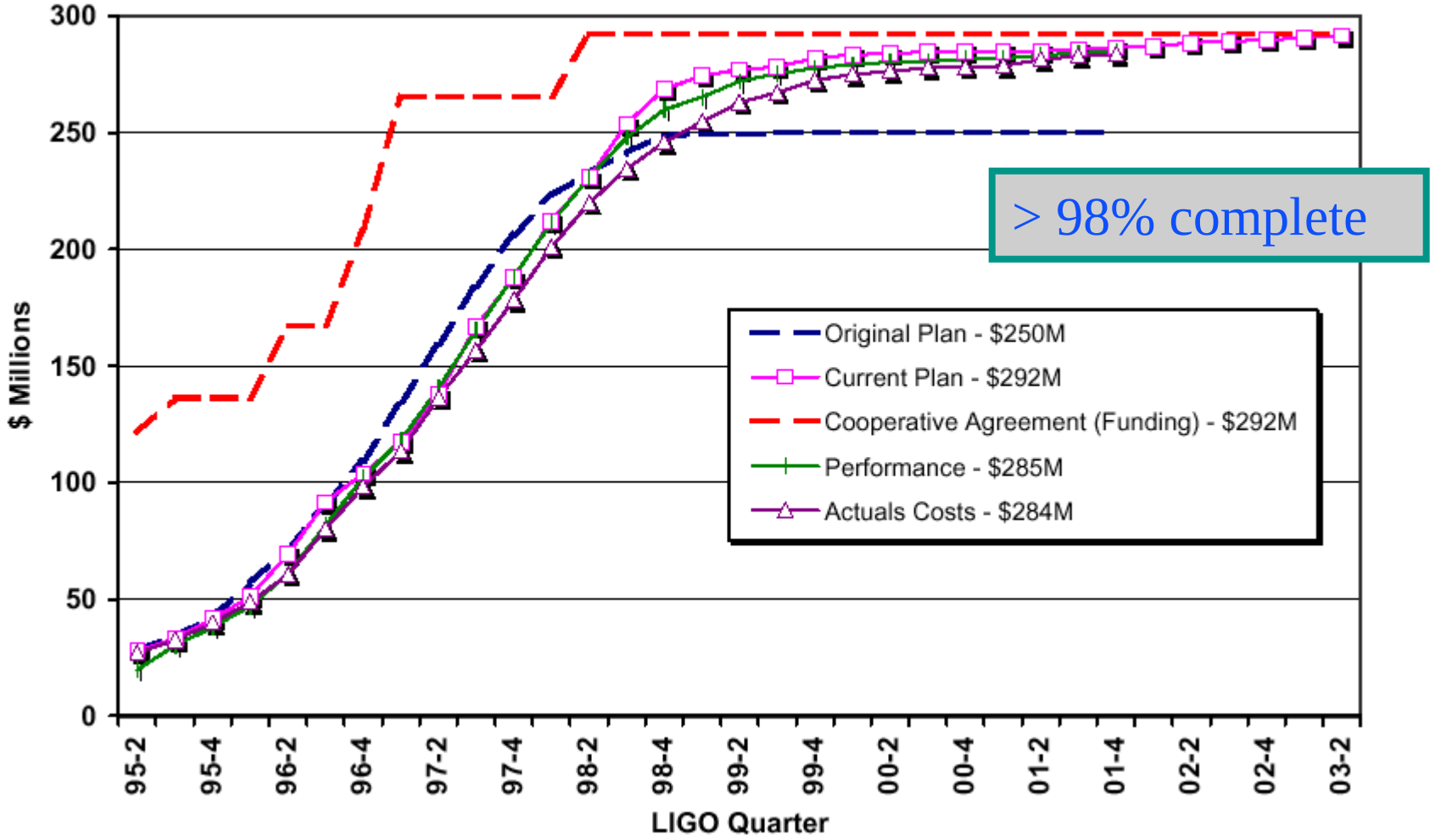
Gary Sanders

Caltech/LIGO

April 3, 2002

Construction Cost/Schedule Performance

Support buildings and LDAS remain



> 98% complete

LIGO Plans

schedule

1996	Construction Underway (mostly civil)
1997	Facility Construction (vacuum system)
1998	Interferometer Construction (complete facilities)
1999	Construction Complete (interferometers in vacuum)
2000	Detector Installation (commissioning subsystems)
2001	Commission Interferometers (first coincidences)
2002	Sensitivity studies (initiate LIGO I Science Run)
2003+	LIGO I data run (one year integrated data at $h \sim 10^{-21}$)
2006+	Begin 'advanced' LIGO installation
2007	

“State of LIGO” Summary

- January E7 run accomplished a great deal
  - » 15 days running both sites and 3 interferometers
- GEO and Allegro coincidence running also a global landmark
- LIGO Scientific Collaboration analyzing E7 data
- On to science runs (S1, S2 and S3) with interleaved analysis, detector development and engineering runs
- LIGO Data Analysis System and simulations software advancing
- Advanced R&D program making significant progress
- Advanced LIGO proposal planned late this year


Task Name
2002
2003
2004
Q1
Q2
Q3
Q4
Q1
Q2
Q3
Q4
Q1
Interferometer Runs
E8
configuration freeze before S1
S1
configuration freeze before S2
S2
configuration freeze before S3
S3
LHO 2k Interferometer
Pre S1 Commissioning
Pre S2 Commissioning
Pre S3 Commissioning
LHO 4k Interferometer
Pre S1 Commissioning
Pre S2 Commissioning
Pre S3 Commissioning
LLO 4km Interferometer
Pre S1 Commissioning
Pre S2 Commissioning
Pre S3 Commissioning
LDAS - External Software
LDAS Software Releases
LDAS 0.2
LDAS 0.3
LDAS 0.4
LDAS 0.5
LDAS 1.0.0
LAL Software Releases
LAL 2 Release
LAL 3 Release
LAL 4 Release
LDAS Hardware
LDAS Commercial hardware
LDAS at CIT
LDAS at LHO
LDAS at LLO
LDAS at MIT
seismic upgrade

LIGO Scientific Collaboration

- 35 institutions in 6 countries
- More than 350 scientists including 25% from LIGO Laboratory
- Led by a Spokesman, Executive Committee and technical Working Group chairs
- Leads the advocacy of the science
- To deliver the promise of NSF's 1996 Panel on the Long Range Uses of LIGO

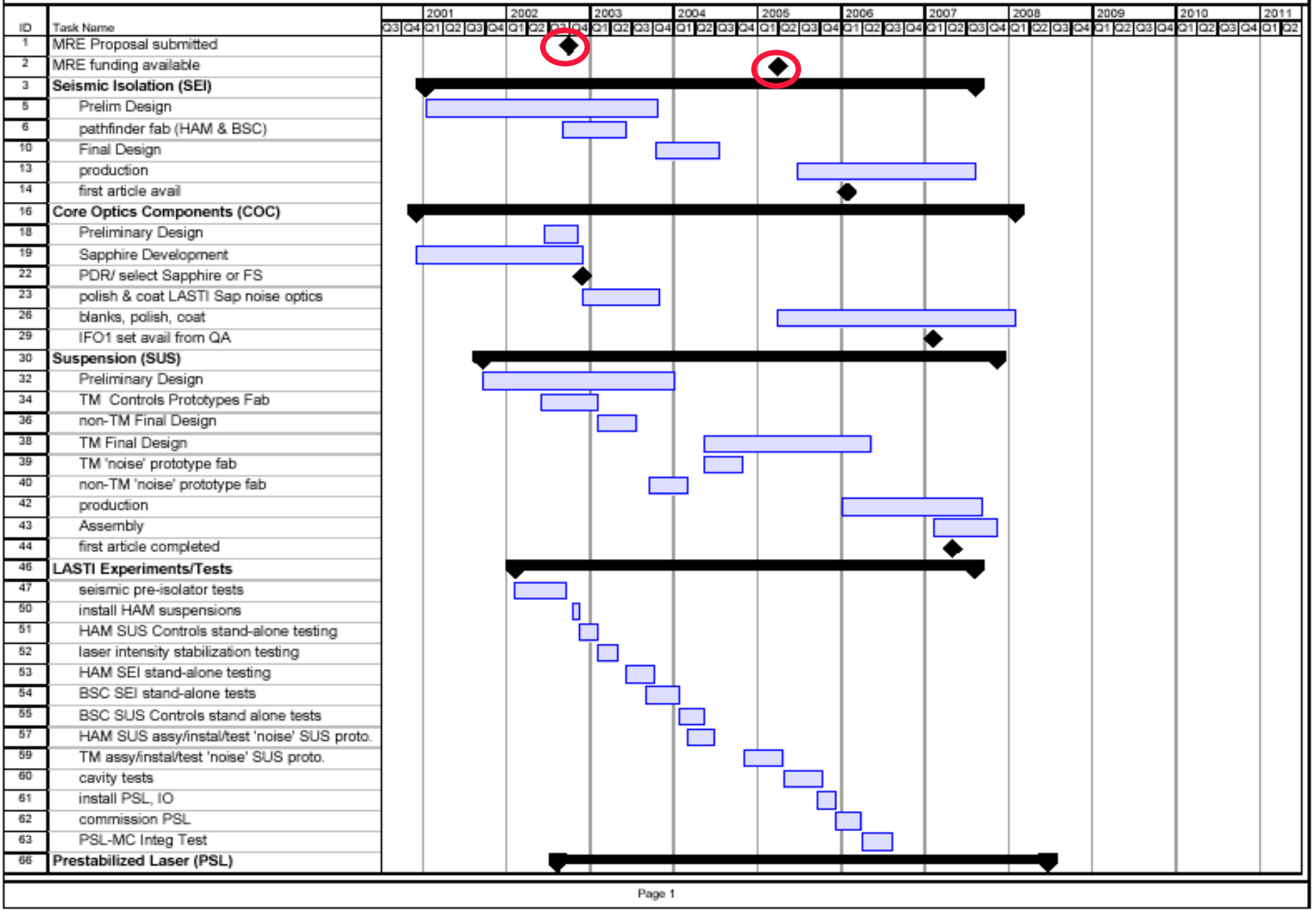
Advanced LIGO

- The Advanced LIGO interferometer systems will deliver one year of initial LIGO sensitivity in 2.5 hours
- Detection of gravitational waves moves from “plausible” to “likely”
- Reviewed by NSF in January 2000
- Planning, design, R&D included in new Cooperative Agreement
- Decision has been made by LIGO Directors to submit proposal for FY2005 MREFC funds for construction by end of 2002

ADVANCED LIGO SUMMARY SCHEDULE

3/18/2002

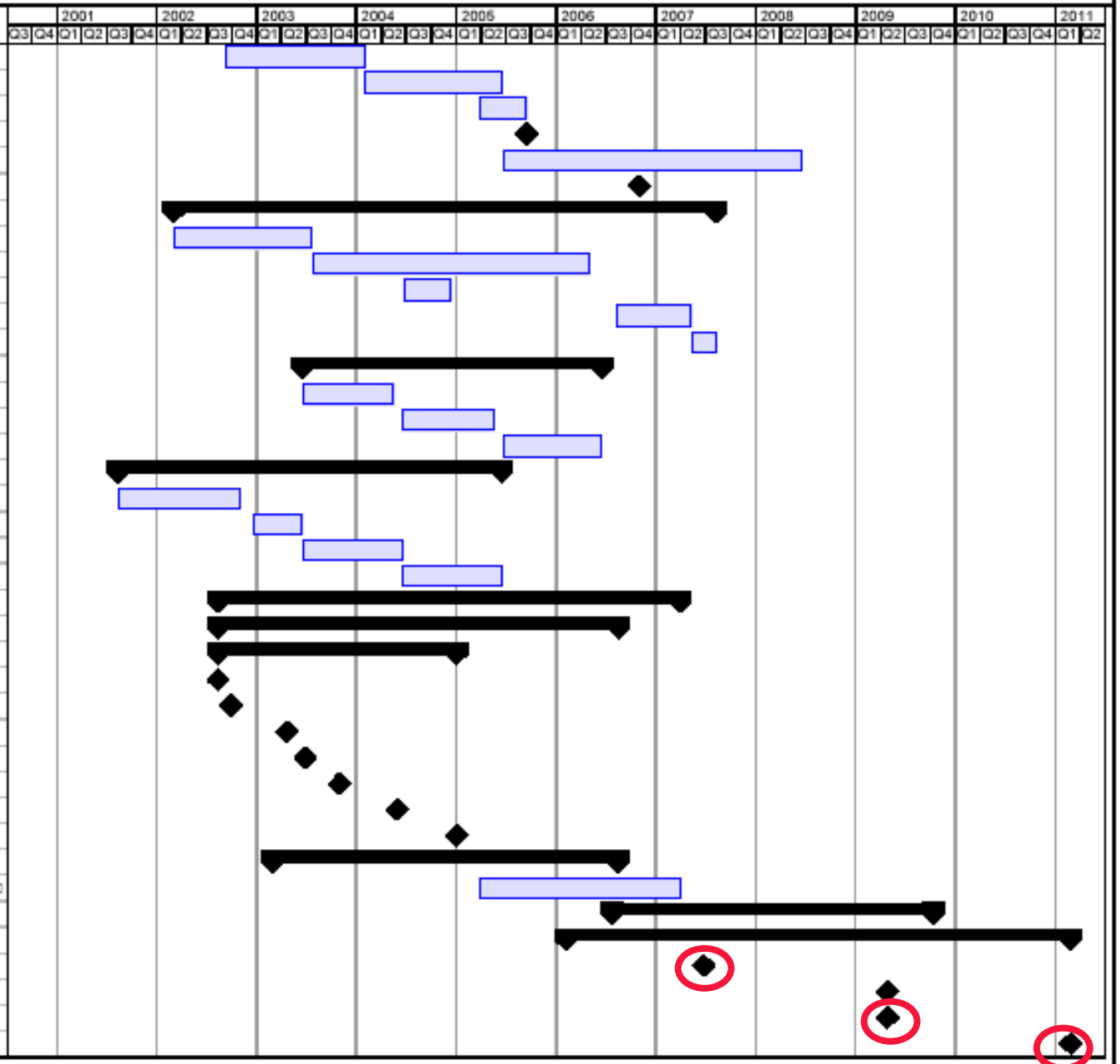
[derived from LIGO-M020121-A]



ADVANCED LIGO SUMMARY SCHEDULE

3/18/2002

[derived from LIGO-M020121-A]



ID	Task Name
69	preliminary design
71	final design
73	pathfinder
74	pathfinder ship to LASTI
75	production
76	Ship PSL to LLO
77	**Input Optics (IO)**
79	prelininary design
82	final design
84	mod/isolator prototype fabrication
87	fabrication
88	assembly
89	**Interferometer Sensing and Control (ISC)**
91	prelininary dsign
93	final design
95	fabrication
96	**40m**
98	preliminary experiments/shakedown
100	ISC controls fab
102	experiment phase 1
103	experiment phase 2
104	**Auxiliary Optics (AOS)**
106	**active optics compensation**
118	**Gingin High Power Experiment**
119	LIGO delivers ring heater parameters
120	LIGO delivers sapphire test masses (2)
121	LIGO delivers prototype AOC system
122	Gingin delivers 1st exper. Results
123	UFla delivers modulators/isolators
124	Gingin delivers results on mod/isol
125	Gingin delivers final results to LIGO
126	**photon drive**
136	Data Acquisition, Networking & Supervisory Cont
138	**Facility Modifications (FAC)**
143	**Installation (INS)**
145	start LLO install
148	start LHO install
152	LLO operational
153	LHO operational

Schedule Options for Earlier Advanced LIGO Science

	Options	proposal submission	MRE $ available	start install	1st Obs on-line	2nd Obs on-line
-1	Aug/2001 LSC	4Q2001	4Q2003	Jan-06	Dec-08	Dec-08 (Jun-10)
0	Mar/2002 LSC	4Q2002	1Q2005	Jun-07	Apr-09	Feb-11
1	both observatories in parallel			Jun-07	Apr-09	Apr-09
2	+ purchase core optics early			Mar-07	Jan-09	Jan-09
3	+ parallel (or no) first article test at LASTI			Nov-06	Sep-08	Sep-08
4	+ production SEI < (MRE, LASTI cavity test)			Dec-05	Nov-07	Nov-07

International Participation in Advanced LIGO - GEO

- GEO Project is commissioning a 600 meter interferometer in Hannover, Germany
- GEO consists of UK and German groups
  - » Support from PPARC (UK) and Max Planck Society (Germany)
- GEO has joined LIGO in LSC
  - » We run interferometers together and publish together
- GEO has announced they intend to partner in construction of Advanced LIGO
- German group providing high power laser R&D and planning to provide constructed lasers for Advanced LIGO
  - » Using existing funding and planning to request supplemental funds
- UK groups currently funded for joint R&D and proposal for project support is under review by PPARC now
  - » PPARC “roadmap” includes Advanced LIGO
  - » PPARC decision will be related to US decision on Advanced LIGO

International Participation in Advanced LIGO – Virgo/EGO

- Virgo is a 3 km Italian/French interferometer near Pisa
- Currently undergoing commissioning
  - » 1 – 2 years behind LIGO
- Now managed through the EGO consortium
- Negotiating joint data runs and joint publishing
- Discussing participation in Advanced LIGO project
- Current joint R&D on optical coatings 75% complete
  - » Co-funding by LIGO approved in amendment to PHY-9801158
- May Elba meeting to discuss joining in Advanced LIGO

Interface with NSF DGA and NSF Program Manager

- Much corporate memory has departed NSF on program and DGA side of LIGO oversight
- Communications defined in **Cooperative** Agreement and Lab Charter
- Procedures for communications to DGA or LIGO Program Manager
  - » Responses by LIGO to NSF-initiated requests will be transmitted by LIGO to requestor
    - – DGA or Program
  - » LIGO initiated communications will be transmitted according to our reading of Cooperative Agreement
  - » We will not copy the other party
    - – This avoids DGA review of transmittals to Program when such review is not required
    - – Copies to other party should be made internally within NSF

LIGO Annual Review and Reporting to NSF

- Annual Reports transmitted formally through Caltech Office of Sponsored Research to DGA
- Same path used for Annual Work Plan
- We will combine them
- Annual Review
  - » Last conducted in April 2001
  - » Followed January and February 2001 reviews of renewal proposal
- Suggest that 2002 annual review be held in Fall 2002
  - » Results from first science run available
    - – Major deliverable for 2002
- GPRA milestones for 2002 not defined

Cash Flow at End of FY 2002

- Prior Cooperative Agreement provided funds through September 2001
- New Cooperative Agreement awarded in March 2002
- LIGO operated on FY2001 carryover and Caltech advance
  - » $3.1 million in carryover expended during October 1 to December 31, 2001
  - » Several million expended at Caltech's risk between December 2001 and March 2002
- Carryover not likely at end of FY 2002
- Caltech will not advance funds of this magnitude
- Timely funding essential for FY 2003
- Anticipated FY 2003 funding is $33 million
  - » LIGO is making commitments to purchases and staffing in anticipation of this funding level
- Progress of LIGO towards design sensitivity and scientific reach depends directly on this level
  - » Outreach and support of external scientific community also a variable

Caltech Interface

- LIGO governed through a Cooperative Agreement
- Formal NSF interface is through Caltech Office of Sponsored Research
- Caltech cost structure and procurement system approved through Office of Naval Research
- All audit relations through Caltech Controller
  - » Audit contacts not to be made directly to LIGO program
- NSF IG audits subcontracted through DCAA
- DCAA does not have much experience with ONR role, Caltech Controller role, or difference between a Cooperative Agreement and a DOD/NASA contract

NSF IG Preaward Audits

- Preaward audit of original budget
  - » It is LIGO's view that every finding in the draft DCAA report was incorrect or represented a misunderstanding of the flowdown to LIGO
  - » DCAA cut many procedural corners and did not complete the audit QA process
- Preaward audit of revised budget
  - » DCAA continues to assert findings that are not correct in terms of government flowdown to LIGO
  - » Procedural corners cut and QA minimized
- A major opportunity for LIGO and NSF to learn how to improve process and to assure smooth sailing ahead has been lost

NSF IG Incurred Costs Audit

- Caltech and LIGO have established a more structured process for audit relations involving Controller, Office of Sponsored Research, Federal Accounting staff and LIGO
- DCAA has assigned a much more experienced auditor
  - » His experience with NSF programs is minimal
- Focus of audit is on total cost, schedule, program completion and segregation of preconstruction R&D R&RA $, MRE $ and early operations R&RA $

LIGO Coordinating Committee

- LIGO Project Advisory Team (PAT) = LIGO Coordinating Committee
  - » Oversight tool now included in NSF Facility Management Plan was first used in LIGO oversight
- Please use it
- LIGO Program Manager has acted as chairperson
- LIGO will travel to participate in meetings or use telephone conference as needed
  - » Good communication essential

Subawards

- During next 12 months, LIGO expects a small number of new subawards in excess of $100K or international MOU's/subawards
  - » Seismic Isolation system upgrades for LIGO interferometer at Livingston
  - » Low Noise Digital to Analog Converter
  - » Advanced R&D Seismic Isolation System prototypes for the HAM and BSC (LASTI)
    - competed RFP for design & prototype fabrication
  - » Advanced R&D EGO (SMA/Lyon) optical coatings

“Maiden Wind Farm” Project at Hanford

- LIGO LHO currently experiencing influence of vitrification plant construction
- Gravel mine planned with permit provisional on compatibility with LIGO
- Bonneville Power Administration (BPA) proposing 200 – 600 windmills on nearby mountain at cost of $200M - $600M
- Low frequency vibration of ground may impact LIGO operations
- Benton County has rejected BPA EIS partly on grounds of impacts on LIGO
- BPA wrestling with LIGO insistence that BPA measure impacts convincingly to determine effects are tolerable, or can be mitigated, or cannot be tolerated
  - » 9 months have elapsed while BPA takes no action
  - » BPA active in advocating project recently
  - » Benton County supports LIGO concerns
- LIGO acting as NSF’s agent in this matter

Scientific American Article

- April 2002, page 62
- Described LIGO test run as “noise won”
- Decribed LIGO as “controversial”
- Revived 1991 claims by critics at time of NSB and Congressional approval
  - » Interviews with the same critics
- Claimed LIGO not cost effective in comparison to other gravitational wave interferometer projects
  - » Cost comparisons not accurate
  - » Sensitivity comparisons not accurate
  - » Scope comparisons not accurate

LIGO Comments on Scientific American Comparison

SCIAM info

my info

Project	Sponsor	Arm Length (meters)	# of IFOs	# Sites	Sensitivity (/√Hz)	SCIAM Cost	Sensitivity Comment	Project Cost to Ops	Uncounted Labor FTE	Labor Cost	Construction Cost
LIGO	US	4000	3	2	~3×10^{-23} (180 Hz)	$530M thru 2007	Broadband (30 x more volume searched than GEO) (multi-site confidence)	$365M			$365M for 3 IFO, 2 sites and platform for future
TAMA	Japan	300	1	1	~5×10^{-21} (700-1kHz)	$10M	Broadband				
GEO	UK, Germany	600	1	1	~8×10^{-23} (600 Hz)	$10M	Used narrow band sensitivity	$10M	300 FTE	$30M to $60M	$55M for 1 IFO and no platform for future*
Virgo	France, Italy	3000	1	1	~1×10^{-22} (500 Hz)	$66M	Ignored low freq advantage of Virgo	$66M	1000 FTE	$100M to $200M	$216M for 1 IFO and no platform for future*

* Site infrastructure tailored to current IFO

Media Treatment of LIGO

- LIGO has been very open
- Free access to individuals
- Reporters select the sensational part of comments
- Reporters aware of decade old critics and controversy
- Progress toward design sensitivity will be watched carefully and reported critically
- Lack of detections will be watched carefully and reported critically
- LIGO upgrade plans will be criticized
- LIGO will be managing media contacts more carefully

International REU Proposal

- Ken Libbrecht PI at Caltech
- Must be in contact to submit supplementary request
- Nature of Italian support not defined

ITR 2003

- IT technology has grown scope of LIGO effort
- Original vision for LIGO planned small centralized data archive and analysis at Caltech and MIT
- LSC growth drove collaborative analysis demand
- Internet has supported this
- Grid computing now driving virtual laboratory approach
- ITR funding goes mainly to CS research
- Small amounts to LIGO community support early enry to grid capabilities and distributed processing
- Strong need for professional support staff for these Tier 2 and 3 centers
- Drivers proposals to ITR 2003 program
- This may not match ITR program goals