
LIGO Organization & Management

Barry C. Barish
NSF Review
May 22, 1995

LIGO

Project Management

B. Barish

- Organization and Management
 - » Fall '94 Review → LIGO Responses
 - » Organization/Staffing Status
 - » Project Management Control System (PMCS)
 - » Commissioning/Operations Proposal

G. Sanders

- Overview of the Project
 - » Six Month Review of Accomplishments
 - » Plans for the Future

LIGO Management Approach

Project Management Plan

- Submitted to NSF - December 1994
 - » Incorporated Comments-NSF Review(Sept '94); LIGO Oversight Committee; and from the NSF
- NSF Response - (pending)
- Project Proceeding as in the PMP

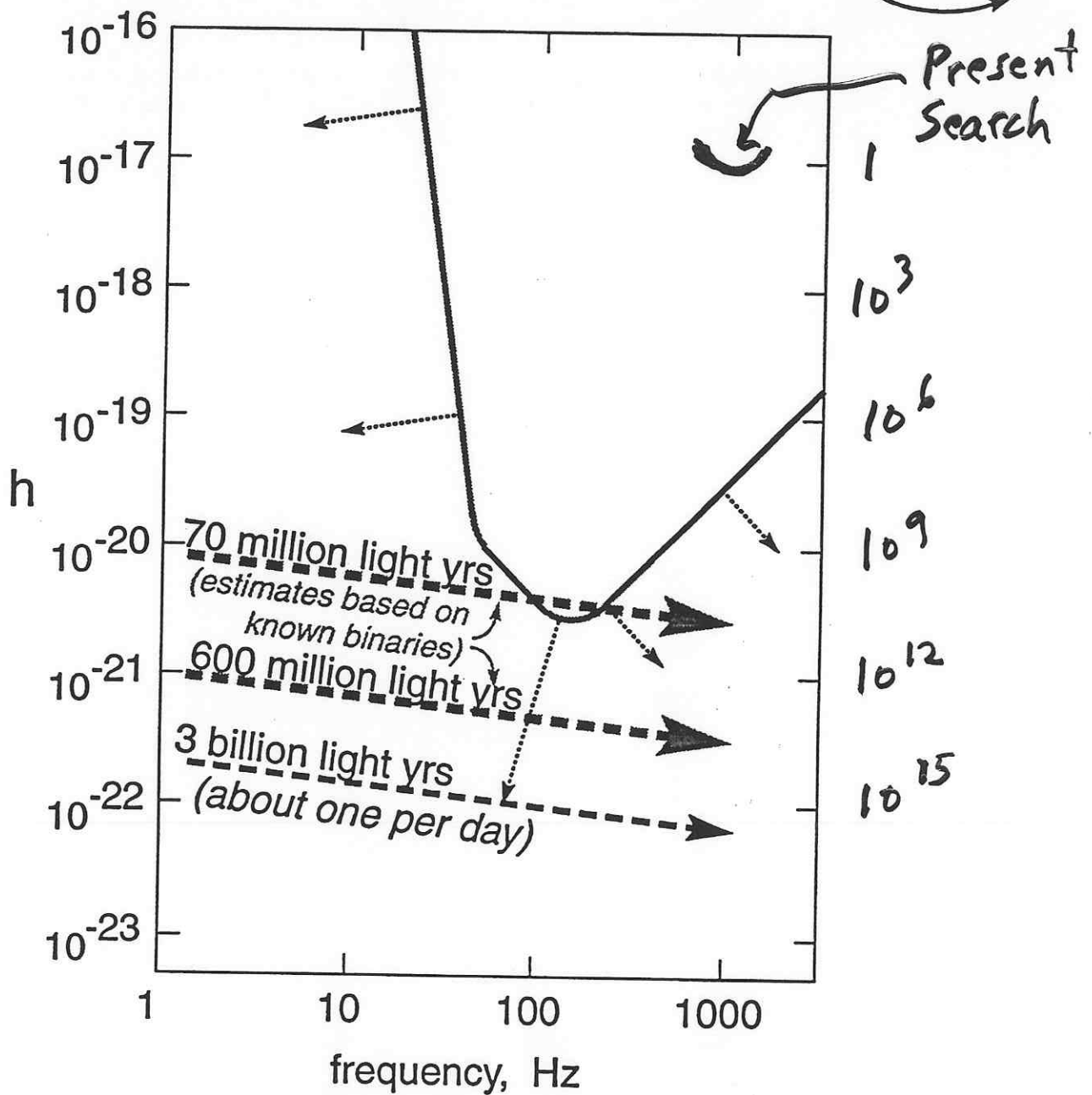
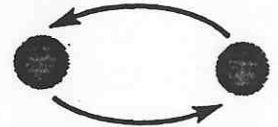
NSB Revalidation & Budget Approval

- Construction + R&D Budget - \$292.1M
 - » Construction Completed in 1999
- Commissioning/Operations - \$68.7M
 - » Commissioning Commences in 1997
 - » 3-fold Sensitivity 10^{-20} by July 2000
 - » First Search for Gravitational Waves
 - » Sensitivity 10^{-21} by end of 2001
- Established as our Working Baselines



NEUTRON STAR BINARIES

[“Guaranteed” source]



■ 15 minutes & 10,000 orbits in LIGO band

■ Rich information in waveforms:
 masses, spins, distance, direction,
 nuclear equation of state

LIGO

Funding Plan

Fiscal Year	Construction	R&D	Operations	Total
1992	\$15.9M	\$3.2M		\$19.1M
1993	\$20.0M	\$4.0M		\$24.0M
1994	0	\$4.0M		\$4.0M
1995	\$85.0M	\$4.0M		\$89.0M
1996	\$55.0M	\$4.0M		\$59.0M
1997	\$55.0M	\$0.8M	\$0.3M	\$56.1M
1998	\$41.2M		\$7.3M	\$48.5M
1999			\$20.9M	\$20.9M
2000			\$21.1M	\$21.1M
2001			\$19.1M	\$19.1M
Total	\$272.1M	\$20.0M	\$68.7M	\$360.8M

Reviews, Reports, Committees

- **NSF Reviews**
 - » Twice/Year (alternate management and technical)
 - » Special Review of MIT (June '95)
- **NSF Reports**
 - » Monthly, Quarterly, Annual
- **Internal Progress (Weekly)**
 - » Weekly Report from Groups
 - » Project Control Meeting Minutes
 - » Weekly Progress Report (WWW - soon)
- **PPAC (Preliminary)**
 - » Temporary PAC, EPAC
 - » P. Saulson (chair), S. Finn, A. Giazotto, J. Hall, W. Hamilton, C. Prescott, A. Ruediger,
- **Oversight Committee(MIT/Caltech)**
 - » L. Allen(chair), C. Canizares, G. Gibberson, E. Moniz, T. Phillips, T. Tombrello

After examining the LIGO Cost Estimate and Draft Management Plan, as well as various supporting documents, and after participating in presentations and in-depth interviews of LIGO staff by the Committee members, the following conclusions were formulated by the Committee as a whole and adopted unanimously by them:

1. LIGO can be constructed for the proposed cost, including contingency, of \$276 million (FY94\$). This requires continuation of a shared vision of LIGO by the entire staff .
2. The Committee identified areas where the contingency is too small. The Committee also identified areas where the base cost could be reduced. The conceptual design should be engineered and refined further to lower the base cost and generate greater contingency. The cost risk could thereby be reduced to a comfortable level while maintaining the total cost estimate (base cost plus contingency) at the proposed \$276 million.
3. Strong management, project control, cost estimate/tracking tools, and personnel are mostly in place to manage the project . The present LIGO team, augmented by a few seasoned engineers (already planned for), will provide for a successful completion of LIGO construction.
4. Demonstrated results from a strong, long-term R&D program provide a firm foundation on which to construct the LIGO interferometers. It is this foundation that gives the committee confidence that the scientific goals can be achieved.
5. A mature technical design exists for the vacuum system; a prototype beam tube will be tested by January 1995. The remaining vacuum system elements, while at the conceptual design stage, are of low technical and cost risk; opportunities exist in this area for significant cost savings.
6. Conventional facilities designs are at the conceptual design stage; these must be developed rapidly into final designs for the construction. The LIGO plan to hire the Architect/Engineer firm which will accomplish this critical step is on track and will meet LIGO needs. Proposals from the appropriate Architect/Engineer firms are due September 23, 1994. Opportunities also exist in this area for significant cost savings to offset the need for increased contingency at the conceptual stage.
7. Further work needs to be done on the estimates for the commissioning/startup and operations.
8. The recently implemented user program for LIGO will facilitate future scientific developments with a growing community of users. We encourage project management to implement their plans to extend the educational outreach program to the general public.
9. We commend management for its plan to accomplish large parts of this project using extensive commercial involvement. This will provide significant technology transfer to industry and is likely to provide significant cost savings over the lifetime of the facility.
10. The Committee considered candidate scope reductions submitted by the LIGO management and believes that the savings that might be realized are not commensurate with the risk that will be added to the scientific mission.

FALL
1994
NSF
REVIEW

Response to Fall '94 NSF Review

1 “..shared vision.. to construct on cost”

2 “..identify areas where base cost can be reduced..”

» *Our Approach:*

- *Trade Studies (e.g. beam enclosure) , Value Engineering*
- *Cost Containment Options under review now.*
- *Management Tools (PMCS)*

3 “..augment with a few seasoned ‘engineers’..”

» *Added strong, experienced senior technical managers (M. Coles, D. Coyne, R. Fischer, E. Jasnow, O. Matherny, S. Meshkov, A. Sibley)*

4 - “Demonstrated Results from R &D provide firm foundation scientific goals can be achieved”

» **WE AGREE !!!!**

Response to Fall NSF Review

- 5 “A mature technical design exists for the vacuum system opportunities exist for cost savings..”
 - » *Identifying cost saving items*
 - » *Two competitive design contracts*
- 6 Hire and A & E.. “opportunities exist for cost savings ..”
 - » *H. M. Parsons -- Design & Construction Mgt*
 - » *Conceptual design -- June 30*
 - » *Extensive interaction and Trade Studies !!*
- 7 “..further work needs to be done on commissioning/startup and operations..”
 - » *Proposal submitted -- grounds up costing, from time phased, resource loaded tasks*

Response to Fall NSF Review

- 8 User program and public outreach
 - » *Aspen Meeting in Jan '95 for LIGO Users + ...*
 - » *Whitepaper on Educational Outreach ..*
- 9 ... Tech transfer..”
 - » *White paper (implementation in future)*
- 10 “..scope reductions... not commensurate with the risks”
 - » ***Maintaining scope !!***
 - » *Project is grappling with questions like how much future expansion to build in or where to just provide flexibility ?*

Staffing and Organization

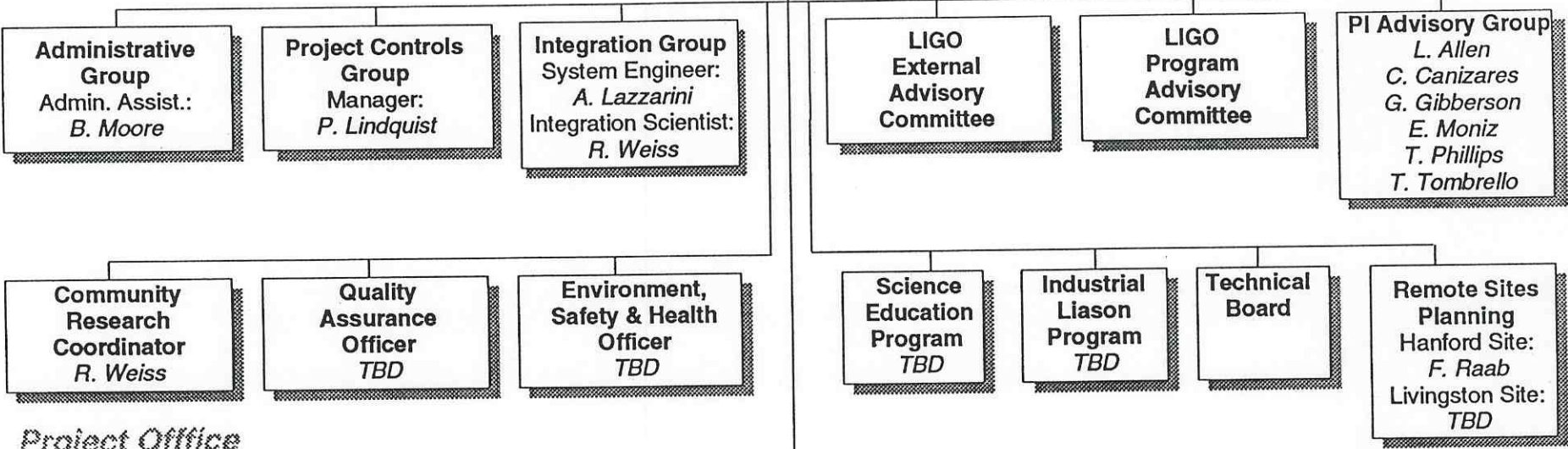
- **Staffing**
 - » Total Hiring on Schedule
 - » Total Staff Doubled in Past Year
 - » Key Positions are Staffed

- **New Organizational Structure in Place**
 - » Product Oriented
 - » Parallels the WBS
 - » Tasks, Resources and Schedules as in Baseline

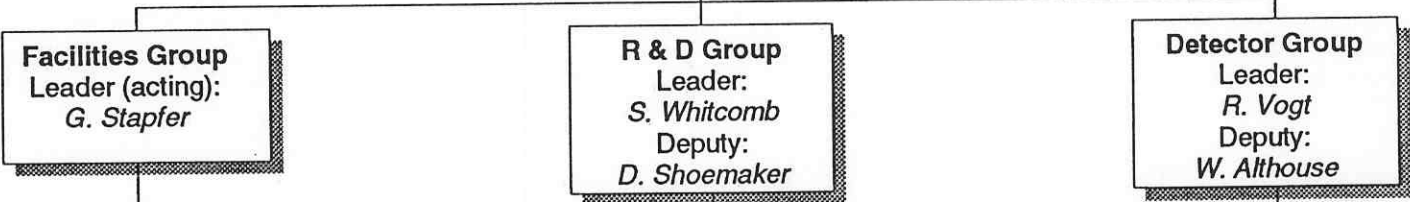
- **Transition to Operating Phase**
 - » Plan for Organization and Staffing
 - » Long Range Needs for Commissioning and Operations Consideration in Staffing



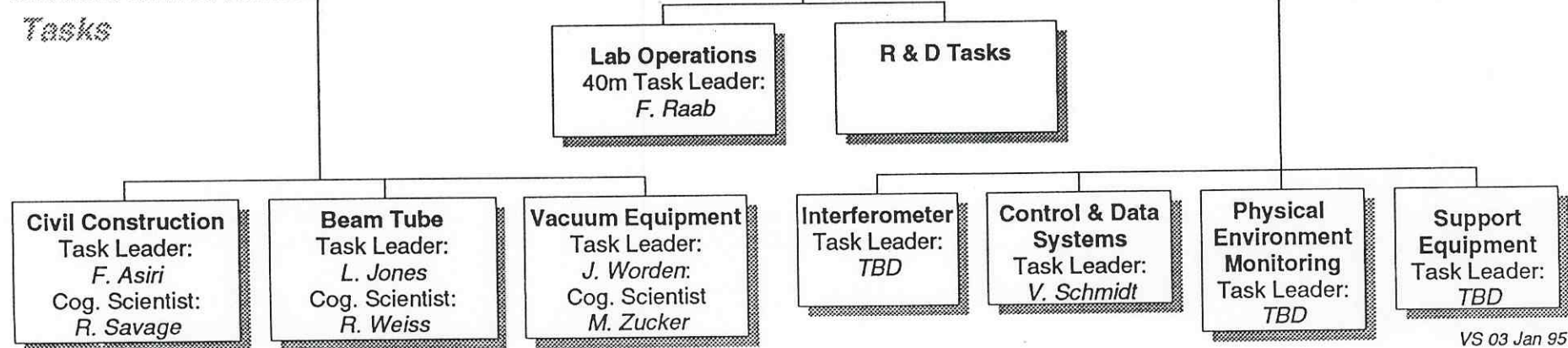
Project Management
 Principal Investigator:
B. Barish
 Project Manager:
G. Sanders



Groups



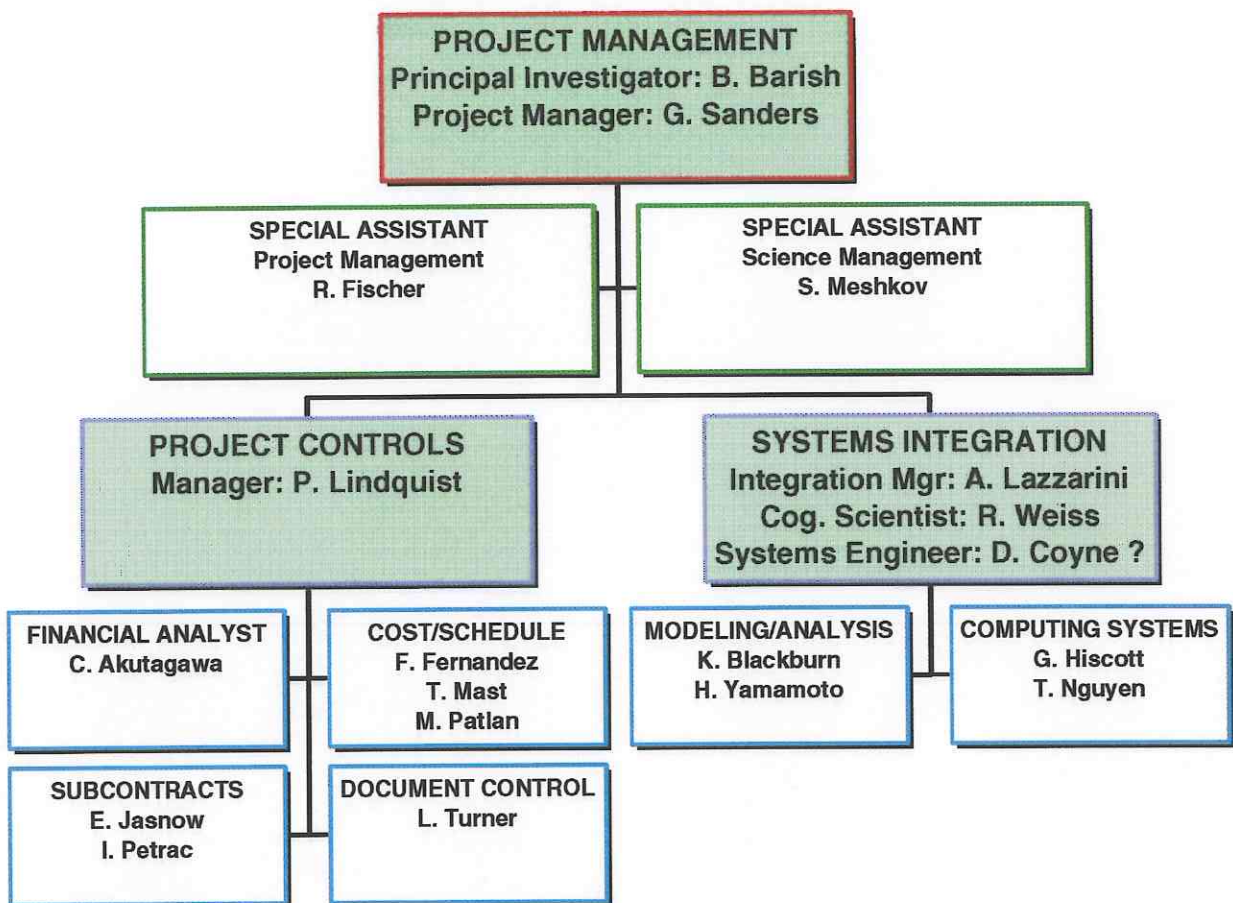
Tasks



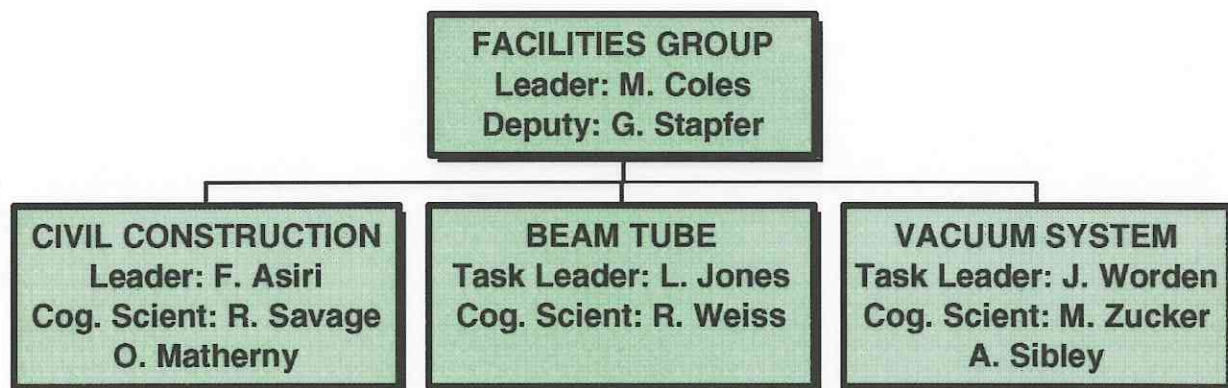
LIGO Staffing (Head)

Task	Caltech	MIT	Total
Proj Mgt	4	0	4
Admin	6	2	8
P Control	8	0	8
Syst Int	6	1	7
Facilities	7	0	7
Detector	17	2	19
R&D	10	7	17
Grad Stud	4	5	9
TOTAL	62	17	79

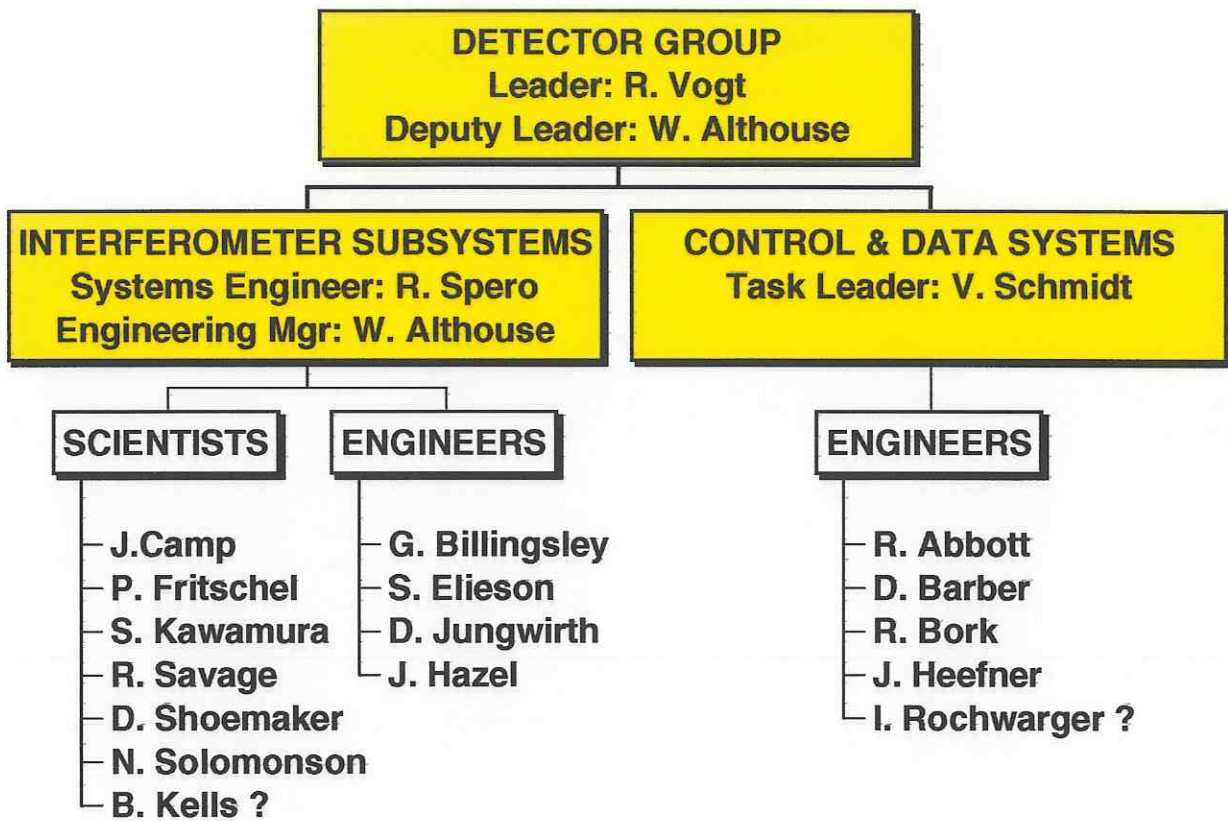
Project Office



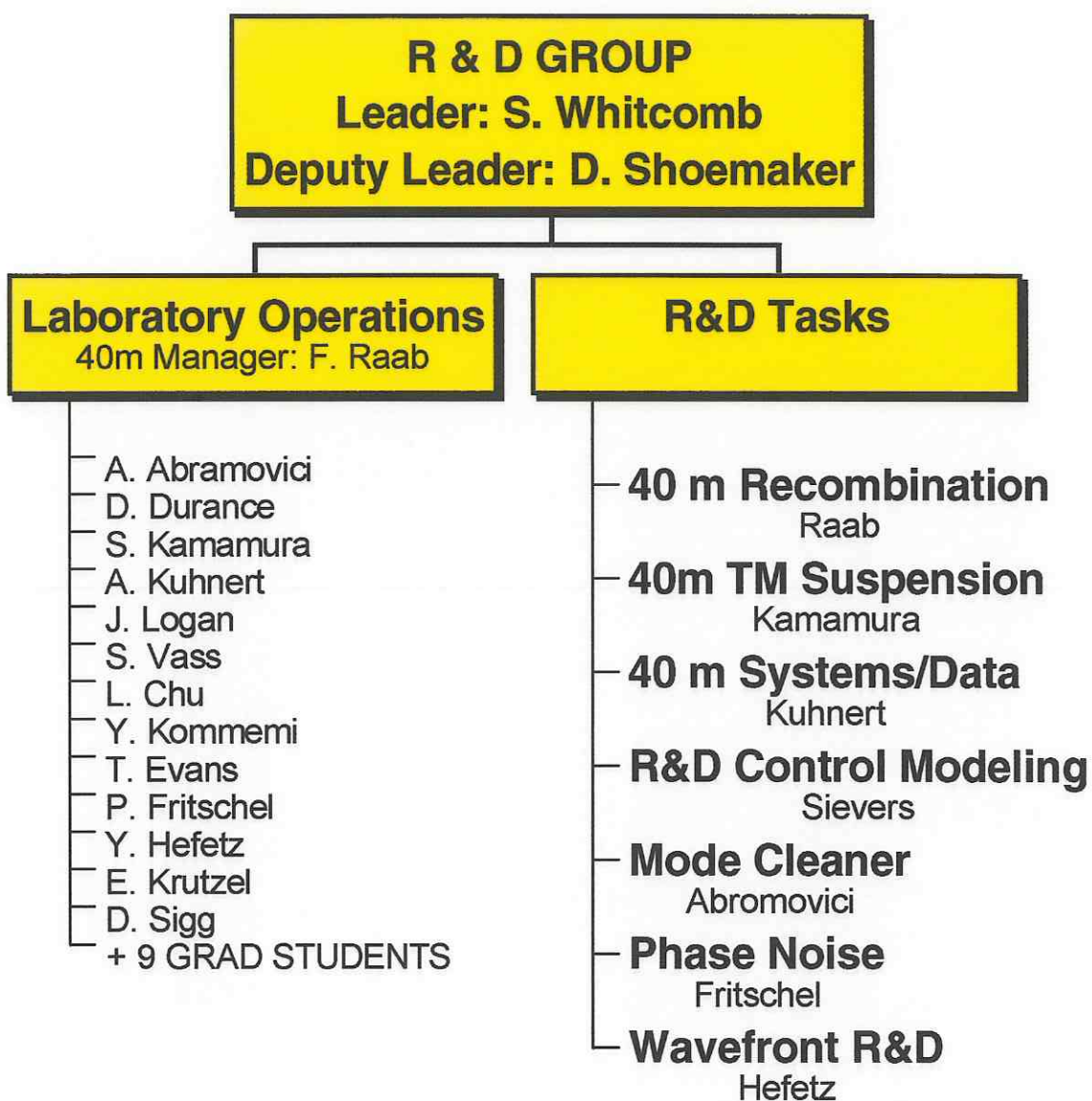
Facilities and Vacuum Systems



Detector Group



R & D Group



Management of LIGO Project

Regular Project Meetings

- Group Meetings - Weekly (Detectors, R&D, etc.)
- Management -Weekly (Project Control)
- Science and Integration - Quarterly

On-Demand Meetings

- “All Hands” - Informational for Staff
- Technical and other Reviews
- Planning (eg. procurement strategy)
- Change Control Board

Management of LIGO Project

Technical Design and Management

Project Controls

- Project Management Control System (PMCS)
 - » measure performance, report, and manage
- Configuration Management
 - » changes in technical, cost and schedule baseline
 - » manage contingency
- Document Control
 - » official 'paper trail' for contracting, etc..
 - » technical reports, publications, etc..

LIGO PMCS System

- What was Promised?
 - » June 94 NSF Review -
 - » Sept 94 NSF Review -
 - » Project Management Plan -

- PMCS
 - » Cost Book is the Basis of Baseline
 - » Software (Cobra & Open Plan)
 - » Integrated Cost-Schedule Baseline
 - » Reports of Performance Compared to Established Baseline and Actual Costs
 - » **Milestone of April 28 !!**

- Next Goal: Establish PMCS as an Effective Management Tool in LIGO

NSF Review - Sept 94 (G. Sanders)

Baseline Implementation

- Proposed in June NSF review to be completed by April, 1995
- Deliverables:
 - » LIGO Science Requirements (12/15)
 - » Level 1, 2, 3 Specifications including Availability (Level 1, 2; 2/1) (Level 3; 4/1)
 - » Detector Implementation Plan (12/1) (1/1)
 - » R&D Plan (FY95; 10/10) (to completion; 12/1)
 - » Document/Drawing Control Plan (1/15)
 - » Configuration Management Plan and Procedures (12/15)
 - » Interface Control Plan and Procedures (1/15)
 - » WBS Dictionary to Level 4 (Level 1,2; 12/1) (Level 3; 2/1) (Level 4; 3/1)
 - » Configuration Identified/Controlled to Level 3 (envelopes, parameters, interfaces) (Level 1,2; 2/15) (Level 3; 4/1)
 - » Responsibility Matrix (1/15)
 - » Baseline Cost Estimate (review revisions incorporated by 10/15)
 - » Integrated Project Schedule 1/20
 - » Performance Measurement Baseline (4/1)
 - » Financial Status including Earned Value and Estimate to Complete (3/1)
 - » PreOps/Operations Commissioning Plan (Acceptance and Test) (4/1)

Activity Description	Early Finish	Resp. Party	1994												1995			
			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
LIGO PMCS Implementation Schedule																		
Restructure LIGO WBS	09JUN94	B. Barish/S. Whitcom																
Develop Re-Cost Estimating Methodology	09JUN94	U.S. Cost Inc.																
Write New WBS Dictionary	11JUL94	LIGO Engrs w/US Cost																
Re-Estimate LIGO Project Costs	23SEP94	U.S. Cost w/Engrs																
Define NSF Requirements for a PMCS System	23SEP94	Proj Mgr/Bus. Mgr																
NSF Cost Estimate Review	23SEP94	NSF Review Committee																
Evaluate and Purchase PMCS Software	21NOV94	Bus Mgr/Eval Board																
Develop LIGO Scheduling Methodology	30SEP94	Bus Mgr/Staff																
Develop Detailed System Schedules against WBS	30DEC94	PMCS Staff w/Engrs																
Integrate System schedules into IPS	20JAN95	PMCS Staff w/Engrs																
Reconcile Top Down/Bottoms up schedules	10FEB95	Meet w/Mgmt & Engrs																
Resource Load Schedules from WBS Cost Estimate	15MAR95	PMCS Staff w/US Cost																
Develop Cost Accounts and Work Packages	03APR95	PMCS Staff																
Prepare PMCS Documentation and CAM Training	03APR95	David Pells																
Internal LIGO Review	14APR95	Mgmt & Engrs																
Mock CAM Interviews	21APR95	Mgmt & CAMS																
NSF Review of Project Management Control System	28APR95	Mgmt & CAMS																

Project Start	03MAY94		Early Bar
Project Finish	28APR95		Progress Bar
Data Date	31MAY94		Critical Activity
Plot Date	03JUN94		

LIGO PMCS Implementation Schedule

Organization

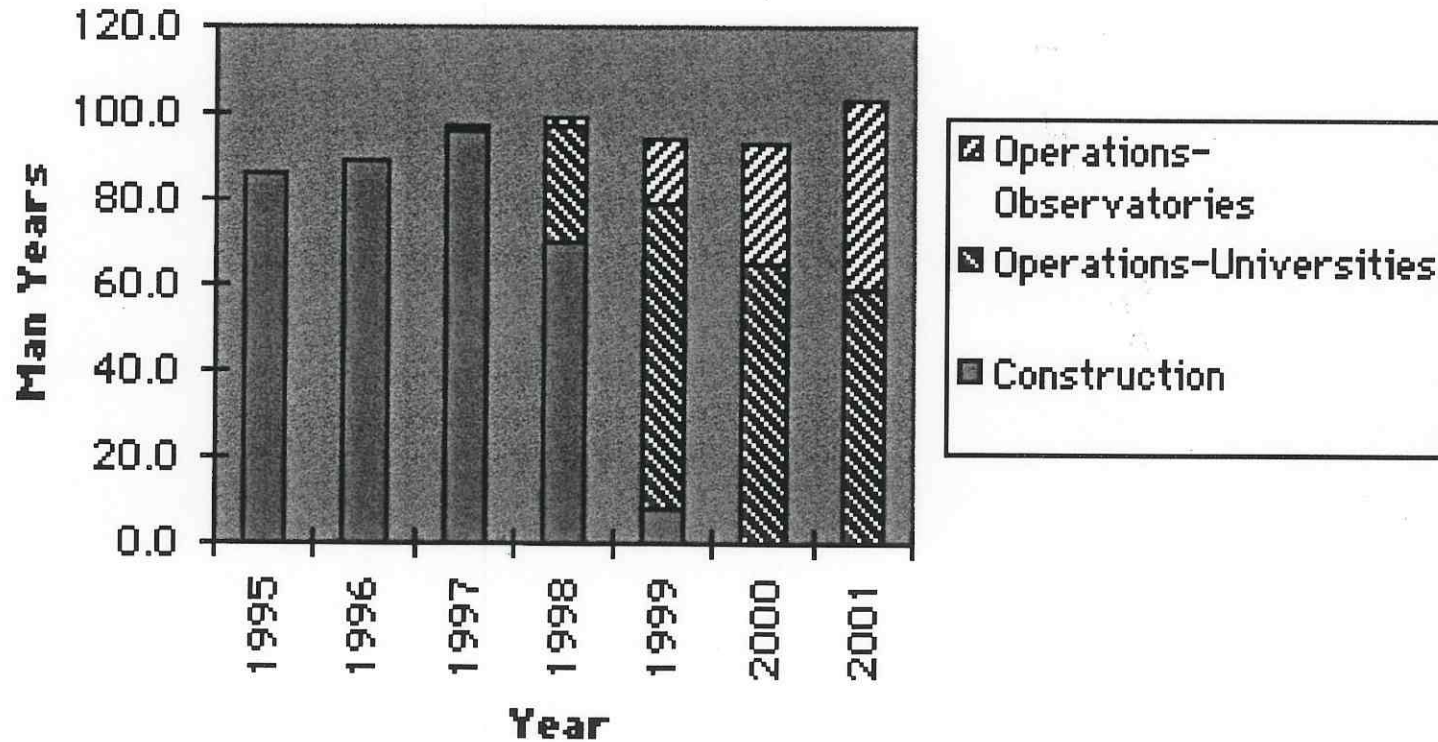
LIGO Project Responsibility Assignment Matrix

<i>WBS</i>	<i>Account Code</i>	<i>Description</i>	<i>Account Manager</i>	<i>Baseline (K\$)</i>
1.1		Facilities	Cole/Stapfer	156,658
1.1.1	5A5	Vacuum Equipment	J. Worden	45,061
1.1.2	5B5	Beam Tubes	L. Jones	43,785
1.1.3	5C5	Beam Tube Enclosures	F. Asiri	18,062
1.1.4	5D5	Facility Design and Construction	F. Asiri	49,750
1.2		Detector Systems	R. Vogt	48,331
1.2.1	5E5	Interferometer Design/Fabrication	R. Vogt	31,088
1.2.2	5J5	CDS	V. Schmidt	12,292
1.2.3	5K5	Physics Monitoring	TBD	3,387
1.2.4	5L5	Support Equipment	TBD	1,564
1.3	5M5	Research and Development	S. Whitcomb	23,400
1.3.1		Lab Operations	S. Whitcomb	6,790
1.3.2		R & D Tasks	S. Whitcomb	16,610
1.4	5N5	Project Office	G. Sanders	21,472
1.4.1		Project Management	G. Sanders	11,142
1.4.2		Support Services	G. Sanders	848
1.4.3		System Integration	A. Lazzarini	4,613
1.4.4		Administration	B. Moore	4,869

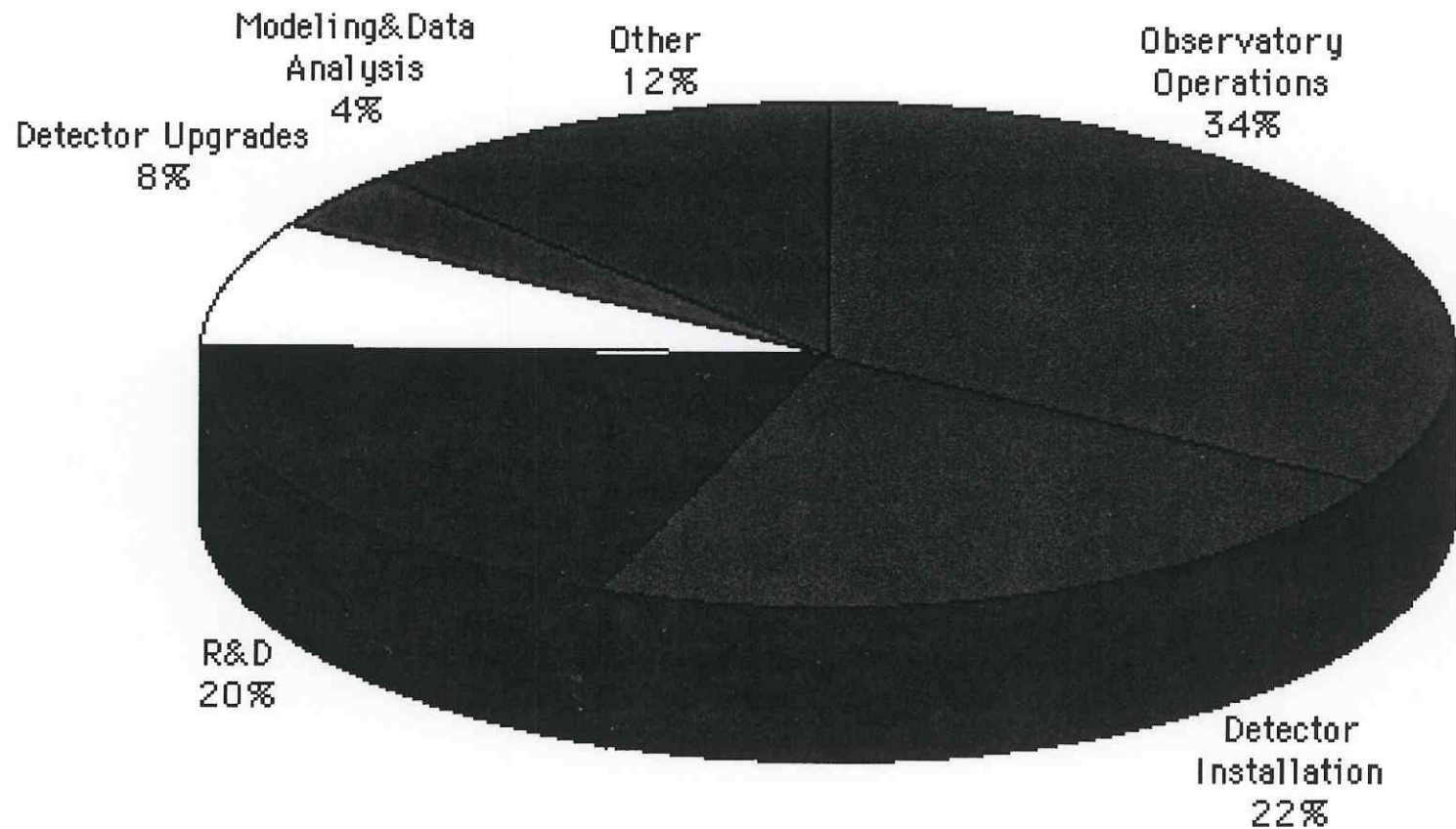
Commissioning/Operations

- **Proposal Submitted to NSF**
 - » Yearly Funding same as Presented to NSB
- **Commissioning Plan**
 - » Time Phased Manpower/Resources
- **Management for Hanford:**
 - » F. Raab (Head)
 - » O. Matherny (Facilities Manager)
 - » J. Worden (Vacuum Engineer)
- **Management for Livingston**
 - » M. Coles (Head)
 - » G. Stapfer (Facilities Manager)
 - » A. Sibley (Vacuum Engineer)
- **Caltech/MIT**
 - » Support operations, data analysis, detector development
 - » Staffing reduced to accommodate staffing sites

LIGO Manpower Profile 1995-2001



Integrated Expenditures By Activity For LIGO Operations



The LIGO Community

- **LIGO Users**

- » Aspen Workshop (Jan 95)
- » Formed charter, organization
- » Joint with VIRGO?

- **Collaborations**

- » VIRGO : Visit in March (Barish, Sanders)
 - cooperate on technology, data analysis;
MOU in process
- » GEO 600: Planning meeting in April (Kuhnert)
- » New MOUs in Progress:
 - K. Thorne (Caltech), Bender (JILA), Cutler (Penn State), Australian groups, etc

- **LIGO Visitor Program**

- » MIT: K. Sliwa (Tufts) on sabbatical next year
- » Caltech: P. Saulson (July), B. Allen (Winter 96)

- **General**

- » WWW, published papers, technical documents
- » educational, technology transfer white papers