



Operating the Observatories

Mark Coles



Goals of Presentation

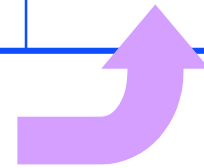
- Describe scope of work undertaken at sites
- Describe allocation of staff and budget needed to perform this work
- Describe changes as sites transition from installation and commissioning to scientific operation



FY2001 Site Operations 12 Month Budget ~ \$9M

	FY01	FY02
Site labor	50%	50%
Building and site maintenance, utilities	20%	18%
Vacuum system operation, liquid nitrogen	5%	4%
Computer and network operations, supplies, maintenance	4%	12%
Electronics, optics, administrative supplies, telephone	3%	3%
Other miscellaneous – travel by site staff, repairs, etc.	3%	4%
Outreach	0%	2%
Installation and commissioning related: supplies, fixturing, travel from campus, etc.	15%	6%

FY02 Budget ~ \$10.7M





Scope of site based responsibilities for maintenance:

Electrical power	Sewage treatment plant maintenance and inspection
Electrical maintenance	Water system maintenance and certification
Crane service	Sump cleanout
HVAC service, supplies, repairs	Road maintenance
Landscaping maintenance	Vehicle fuel and maintenance
Fence maintenance	Vehicle lease
Brush clearing	Property leases
Custodial service	Security patrol
Trash collection	Safety Equipment inspections
Pest control	Fire detection equipment service and inspection
	Telephone

FY01 annual cost of ~\$1.9 M



Site Staff Role 1996-2001

- Management and quality control during construction and installation of facilities
- Site maintenance
- Installation of interferometer, *in partnership with campus staff*
- Initial interferometer commissioning, *in partnership with campus and LSC staff*
- We have augmented regular staff with temporary contract labor as needed

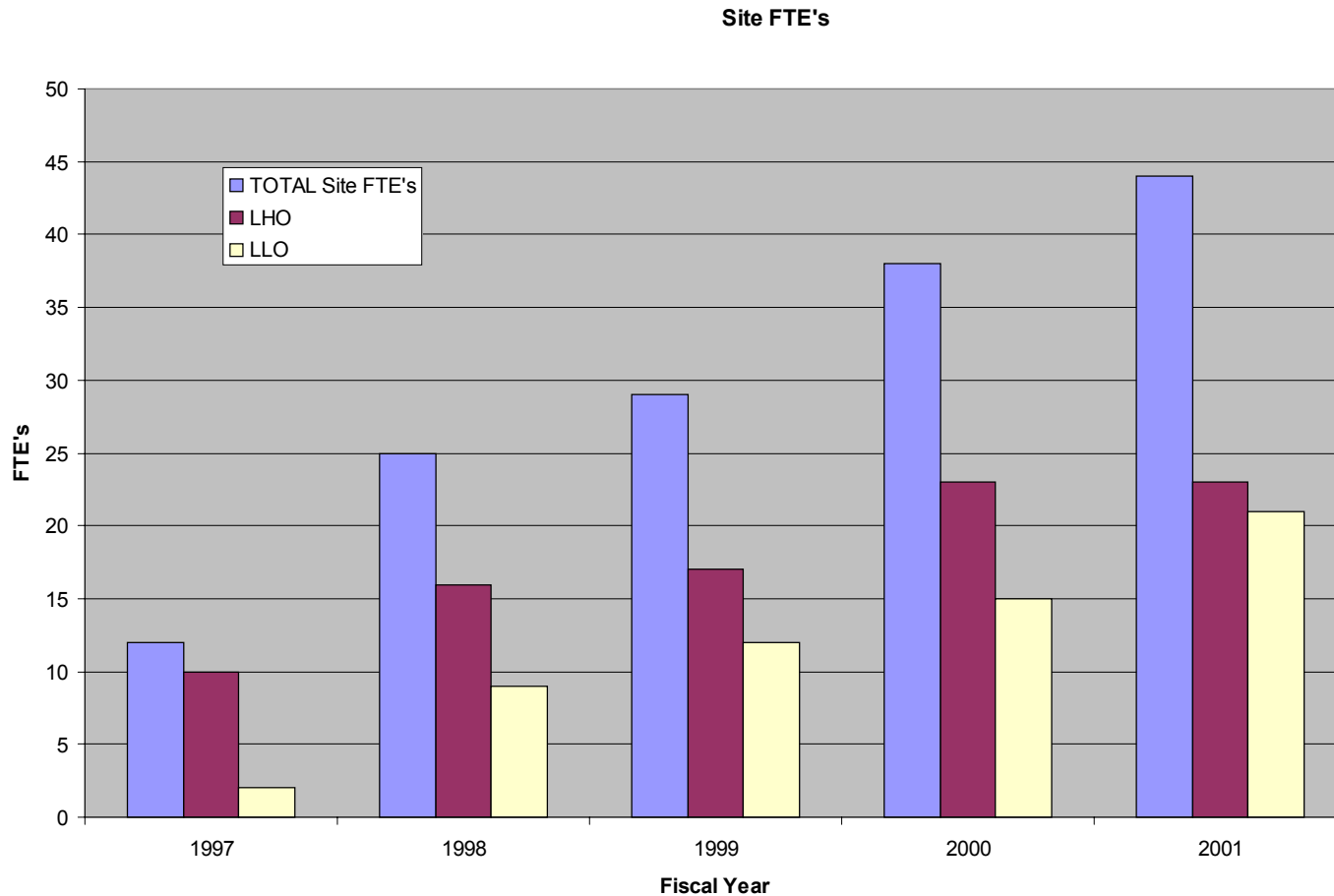


Composition of Present Staff at Each Site

- 7 Scientific staff positions available
- 7 Engineering and technical support staff
 - » Facilities maintenance, vacuum, electrical, control and data acquisition software, optics, network and computing
- 9 Operations specialists (mixture of technical skill backgrounds to support installation, maintenance, and control room operation)
- 1 site administrator
 - » Campus provides in-depth engineering and scientific support, administrative support for contracts, purchasing, travel
- Contract labor utilized to augment staff as required while maintaining flexibility



Site Staffing History



- Staff placed at both sites to participate in installation and commissioning of the interferometers, and to maintain the sites.

- Additional staffing will be required to support full operation and maintenance.



Staffing Responsibilities

Professional scientific and technical staff participate in LIGO Scientific Collaboration

- Scientific staff
 - » Participate in detailed studies of interferometer and subsystem performance
 - » Responsible for “quality control” of interferometer operation and data collection
 - » Operation of on-site Data Analysis System (LDAS)
- Engineering support staff
 - » Participate in installation and commissioning
 - » Maintain operation of installed systems
 - » Provide on-site technical support, in partnership with Caltech and MIT staff
- Operations Specialists
 - » Mix of junior engineering and scientific staff
 - » Support installation and commissioning activities
 - » Provide operations support during commissioning, control room operation



Scientific Staff Development

- Stagger 3 year term appointments for 3 staff members, replace one per year
- Look for opportunities to “leverage” scientific staff positions:
 - » Agreements on joint appointments between LLO and Southeastern Louisiana University – Hammond, LA
 - one half-time faculty position filled beginning January '01,
 - search in progress to fill second position in fall '01
 - » Agreement with U Florida to share cost of basing two UF staff at LLO
 - » Cost sharing to place U of Oregon and U of Michigan staff at LHO



Operations Staff Training

- We are broadly training staff in interferometer operation:
 - » Hands-on installation and commissioning activities
 - » Some formal lectures
 - » Evolving and expanding list of daily shift duties:
 - Monitoring DCU operations
 - Inspecting laser beam spots
 - PSL and mode cleaner locking
 - PEM data monitoring – do things look OK?
 - Checking configurations and values of servos
 - Vacuum system monitoring
 - » Trouble-shooting with expert staff when faults occur
- Control room staffing is presently Mon-Fri with day and evening shifts, plus additional shifts as necessary



Configuration Control

- Maintain tight configuration control so the sites do not diverge technically:
 - » Installation oversight led by Caltech/MIT campus staff
 - » Site staff technical liaisons assigned for each sub-system
 - » Joint commissioning meetings involving both sites and Caltech/MIT to insure common effort, equipment, and configurations
 - » Software and data acquisition and control electronics design files maintained on campus
 - » Site LDAS system activities directed from Caltech/MIT



Site Activities 2002-2006

- Interferometer operation and support
- Facility support and maintenance
- Related research and development activities based at sites
- Educational outreach



Interferometer Staffing During Operation

- 2 operations specialists per hour shift, plus scientific staff
 - » *at least one* scientist per shift for initial operation
 - » Role of scientist is to be “eyes and ears” of scientific community analyzing data – identify unique features of interferometer, environment, configuration, etc
- 24x7 operation requires ~ minimum 10 operations specialists vs 9 in current budget – assuming normal operation, no training courses, flu epidemics, etc
- Additional operating staff needed to make operation robust, ability to handle exceptional conditions, also maintenance and calibration, etc
- Accommodate staff turnover



Site Staffing Increases From 47 ➔ 60

FTE's

LDAS operation, maintenance, data management	2 scientists, 2 engineers
24x7 interferometer operation	4 engineers
LSC liaison with LSC	2 scientists
Computer and network systems administration	1 engineer
Educational outreach	1 technical, 1 admin/educator

Annual cost ~\$1,063K



Site Related Budget Augmentation FY2002-2006

- Annual equipment maintenance and replacement of LIGO Data Analysis and Computing hardware on 4 year cycle:
 - » ~\$1,380K annually
 - » *recognized by NSF review panel*
- Networked data distribution via OC3:
 - » ~\$540K annually
 - » *recognized by NSF review panel*

*These items can be discussed by Albert Lazzarini
in breakout session*



Site Related Budget Augmentation FY2002-2006

- Annual maintenance and replacement of control room data acquisition and control hardware, custom electronics, and embedded controllers
 - » ~\$514K annually
 - » Represents about 10% of total value of control room computers and 5% of total value of custom electronics and VME controllers



Long Term Major Repairs

- LIGO has not included a budget request for major facility and infrastructure repairs that will be needed as the sites age
- We do not expect to need funds for this during 2002-6
 - » The buildings and supporting infrastructure are new
- We want to raise the issue now, so that proper planning can be done in advance of future need

Discuss in breakout session



Intellectual Atmosphere at the Sites

- We are trying to create an intellectual center at each site, not an outpost
 - » Conduct LIGO related research on-site where feasible
 - » On-site Seminars
 - » Encourage participation and interaction with regional universities and with K-12 education – become valuable resource to regional education infrastructures
 - » Maintain strong connection to the campuses
 - ~10 visitors/day from LSC or Caltech/MIT
 - Weekly teleconferences with both sites and campuses
 - Site staff visit each other to share experiences, lessons learned, and to give “quick start” to new activities



On-site Research Activities During FY2002-6

- Characterization of seismic environment at LHO and LLO:
 - » “TriNet” real-time earthquake information system – Caltech, USGS, State of Calif
 - » Louisiana Tech Univ collaboration to operate seismometers, collect and analyze data
 - » Seismometers and data recorders loaned by: IRIS PASSCAL Instrument Center (NSF supported center) at New Mexico Tech U
- Advanced seismic isolation system development:
 - » reduce ground motion at 10 Hz by 3-4 orders of magnitude
 - » Develop two stage active seismic isolation platform on hydraulic actuators
 - » LLO provides lab and office space, project management, site infrastructure
- Operation of high power laser test facility at LLO:
 - » Anticipate upgrade in LIGO laser power to 100-200 W (from 6 watts)
 - » Measure thermal lensing, thermally induced bi-refringence, component selection, of core optics, modulators, isolators
 - » Facility jointly utilized by LLO, UF, Southern Univ., and SLU staff



Educational Outreach

- SST - Scientist, Student, Teacher program at LHO
 - » Collaboration with Pacific Northwest National Laboratory
 - » moves components of LIGO research to high school curricula through summer internships and academic-year research programs
- Classroom resource: "The Scientific Method at Work" video taped at LHO and distributed by The School Company as a classroom resource for Middle/High School science education



Educational Outreach

- Distance Learning: LHO developed interactive program for 8th grade science for broadcast over the the WA state K-20 teleconferencing network. Program involves discussion and experiments on the law of falling bodies to demonstrate the process of science
- LIGO Public Lecture: LHO sponsored a free lecture by Kip Thorne and John Archibald Wheeler, detailing Wheeler's contributions to local and global science - from the first production nuclear reactor at Hanford to LIGO
 - » Cooperative ventures during the Wheeler visit included B-Reactor Museum Society reunion and book signing at Columbia River Exhibition of History, Science and Technology



Educational Outreach

- Field trips by community and professional groups at both sites
- More than 3,000 visitors in last year at LLO (mostly school classes), 750 during public open house
- Teacher open houses in summer and winter, more than 100 middle and high school science teachers in Livingston Parish have toured LIGO as part of teacher in-service
- LLO hosted more than 100 African-American high school science students participating in Southern University's Timbuktu Academy
- Development of hands-on activities and educational resource materials at each site



Optical Telescope

- Funded through Prof. Greg Guzik at LSU via Louisiana Technical Innovation Fund and Louisiana Board of Higher Education (only state employees are eligible to apply)
- Endorsed by LIGO and to be located at LLO site
- \$98K in state funds for 16 inch robotic telescope, dome, controls
- Web accessible for remote use by classrooms
- LLO to provide:
 - » Site, internet connection, staffing
- Opportunities for outreach and possibly a modest science program in association with community organizations
 - » Monitoring variable stars, supernovae searches, etc
 - » Opportunity to attract staff with formal backgrounds in astronomy and interests in LIGO science



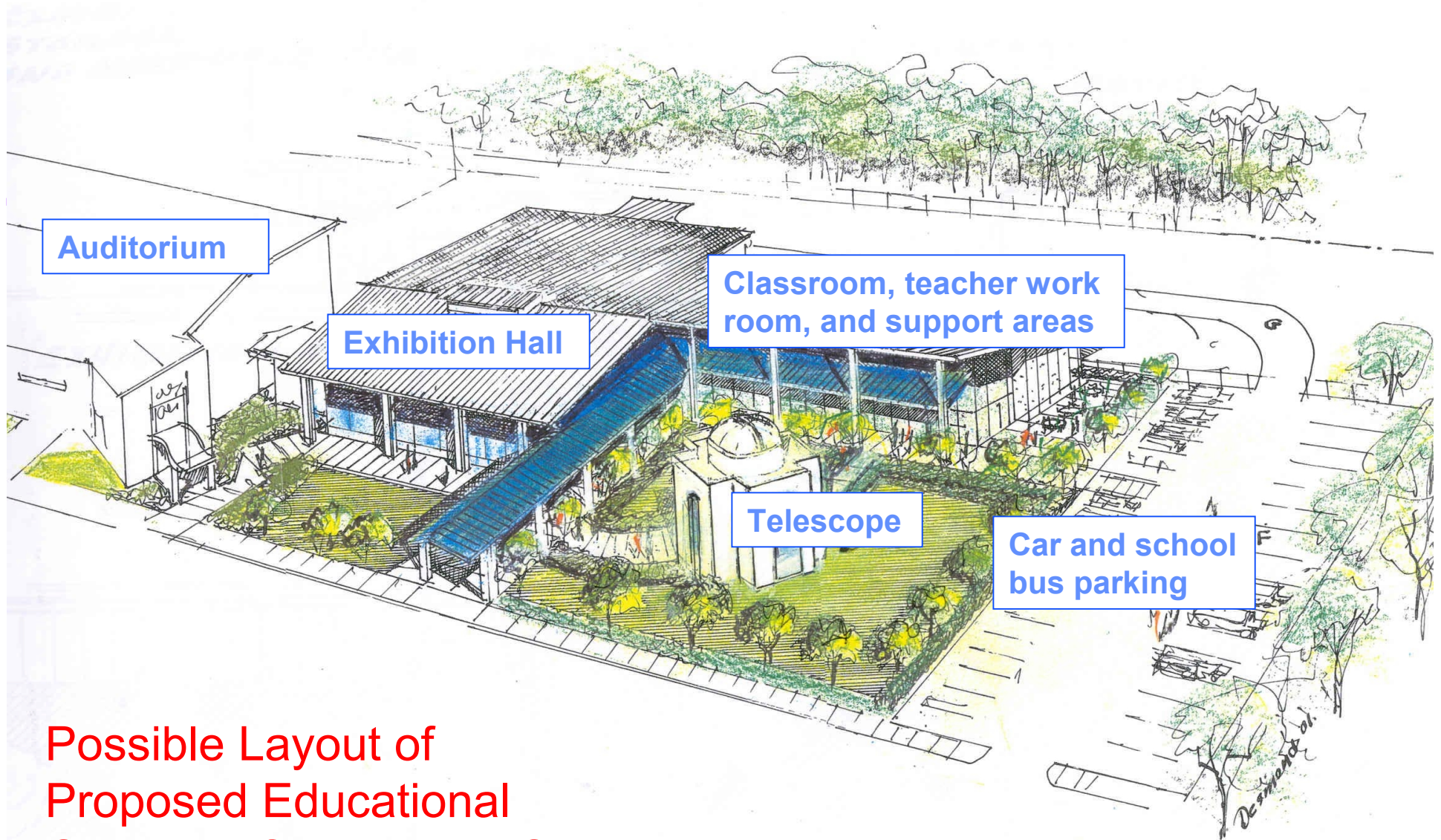
Educational Outreach

- Plan for formally budgeted outreach activities as part of future operations
- Possible extension of LIGO-SST (Scientist – Student – Teacher) program now underway at LHO to LLO
- Possible partnerships with professional K-12 educators
 - » Northwestern State University Space Science Education Program for middle school science enrichment
 - » Plan to submit NSF-IPSE program proposal to involve teachers in development of educational materials for schools
- Concentrate on sites-specific opportunities for outreach since needs and resources are different at each site



Educational Outreach Center

- Hope to establish Education Outreach Centers at both sites
 - » Host site visitors with hands-on exhibits and science classes (like NSF-funded Arecibo and Lowell Observatory centers)
 - » Teacher in-service training and support for classroom enrichment (also like Arecibo and Lowell Centers)
 - » Host a modest school-to-work program for vocational training
- In the past the NSF has financially supported the development of program content and start-up labor costs, but has not provided funds for infrastructure such as building, parking lots, etc
- Discuss plans for LLO and LHO in detail during breakout session



Possible Layout of Proposed Educational Outreach Center at LLO