

LIGO Overview and Status



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Caltech



Overview

- Overview of LIGO
 - » The promises of the 1989 Proposal
- Charge
 - » Completion of commissioning and beginning of Science Run
 - » Advanced LIGO progress
 - » Two year extension and supplement
 - » Recompetition?
Caltech and MIT commitment to LIGO



What is LIGO?

The 1989 Proposal

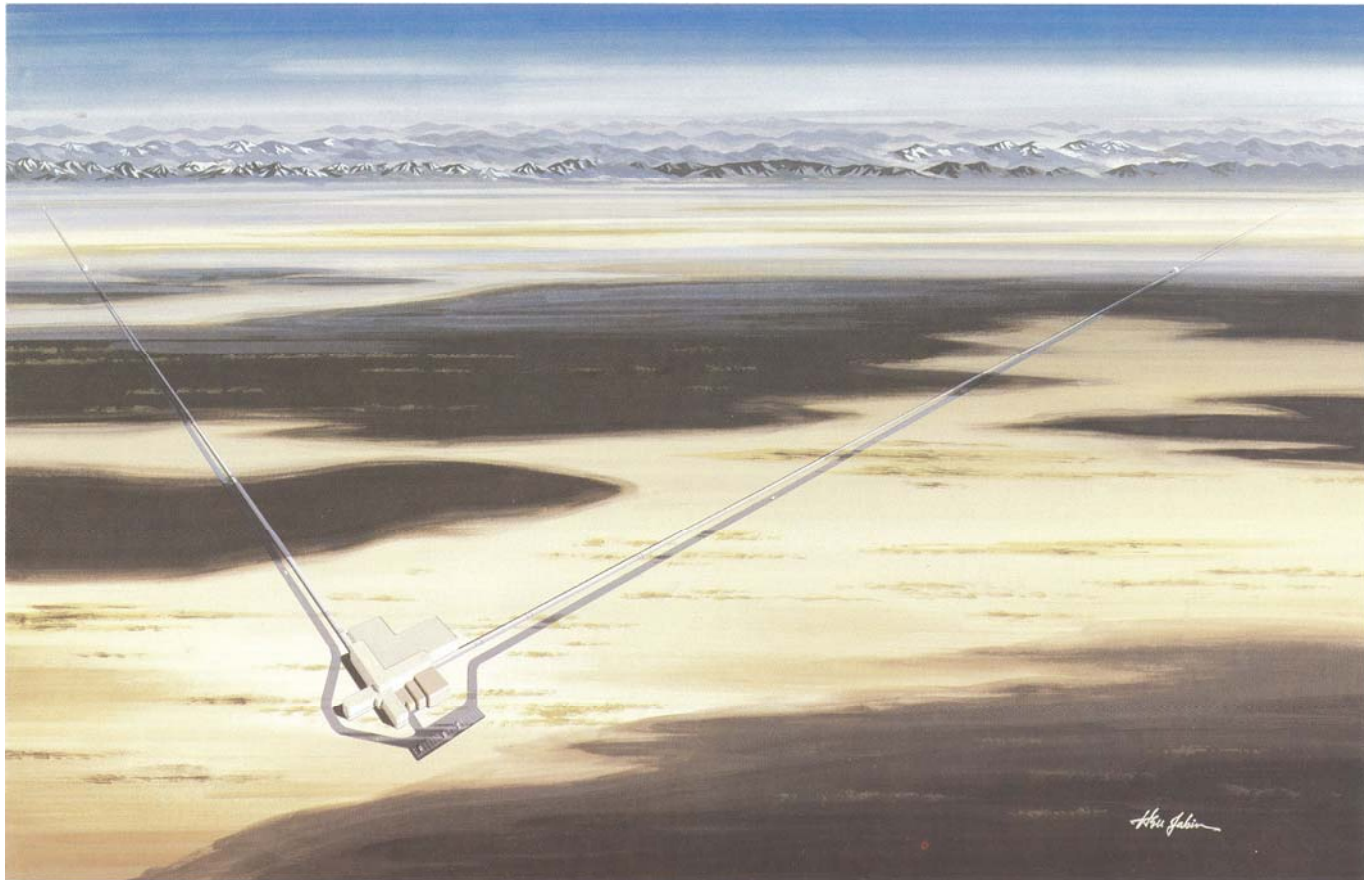
PREFACE

This proposal requests support for the design and construction of a novel scientific facility—a gravitational-wave observatory—that will open a new observational window on the universe.

The scale of this endeavor is indicated by the frontispiece illustration, which shows a perspective of one of the two proposed detector installations. Each installation includes two arms, and each arm is 4 km in length.



What is LIGO? The 1989 Proposal





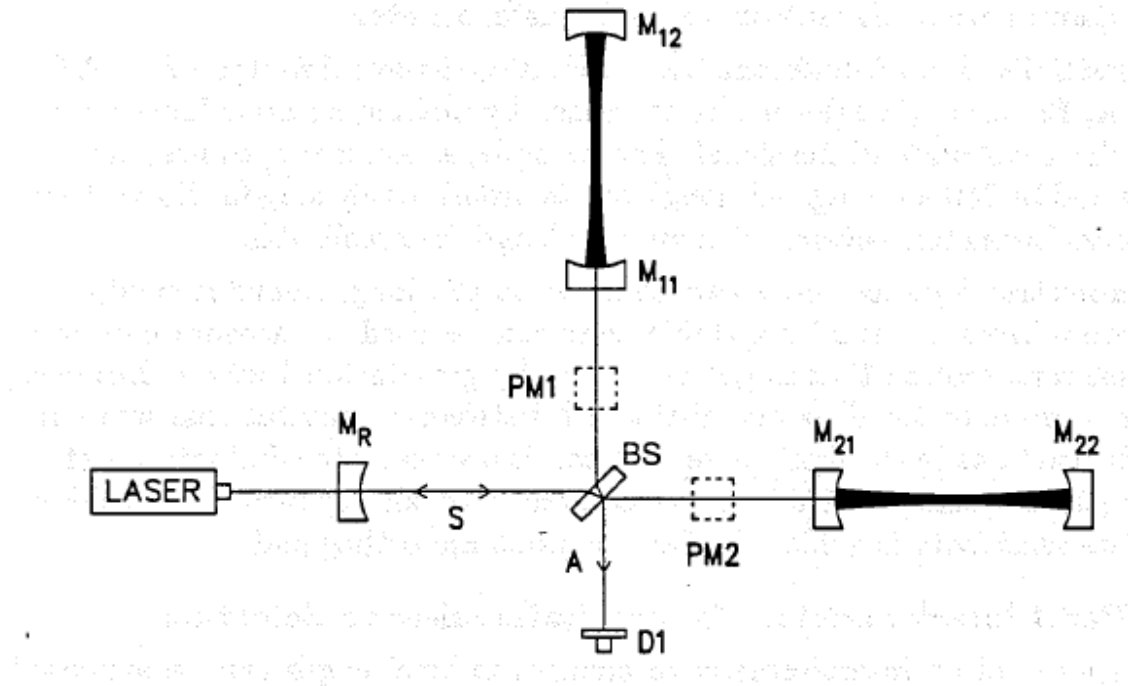
What is LIGO? Today



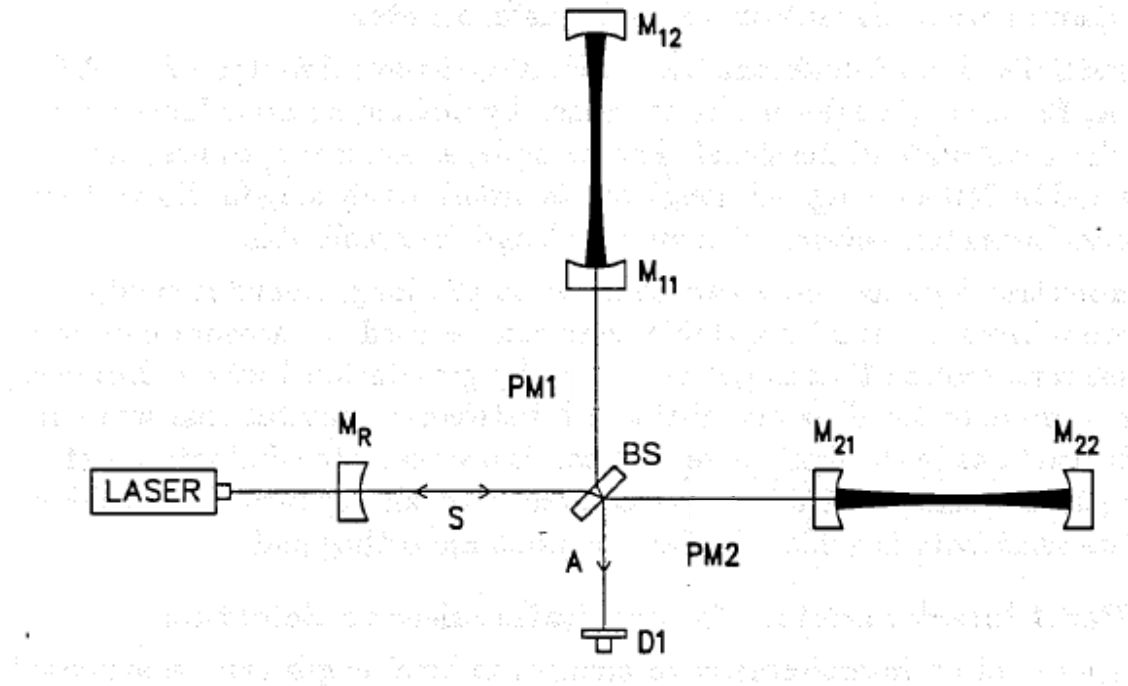


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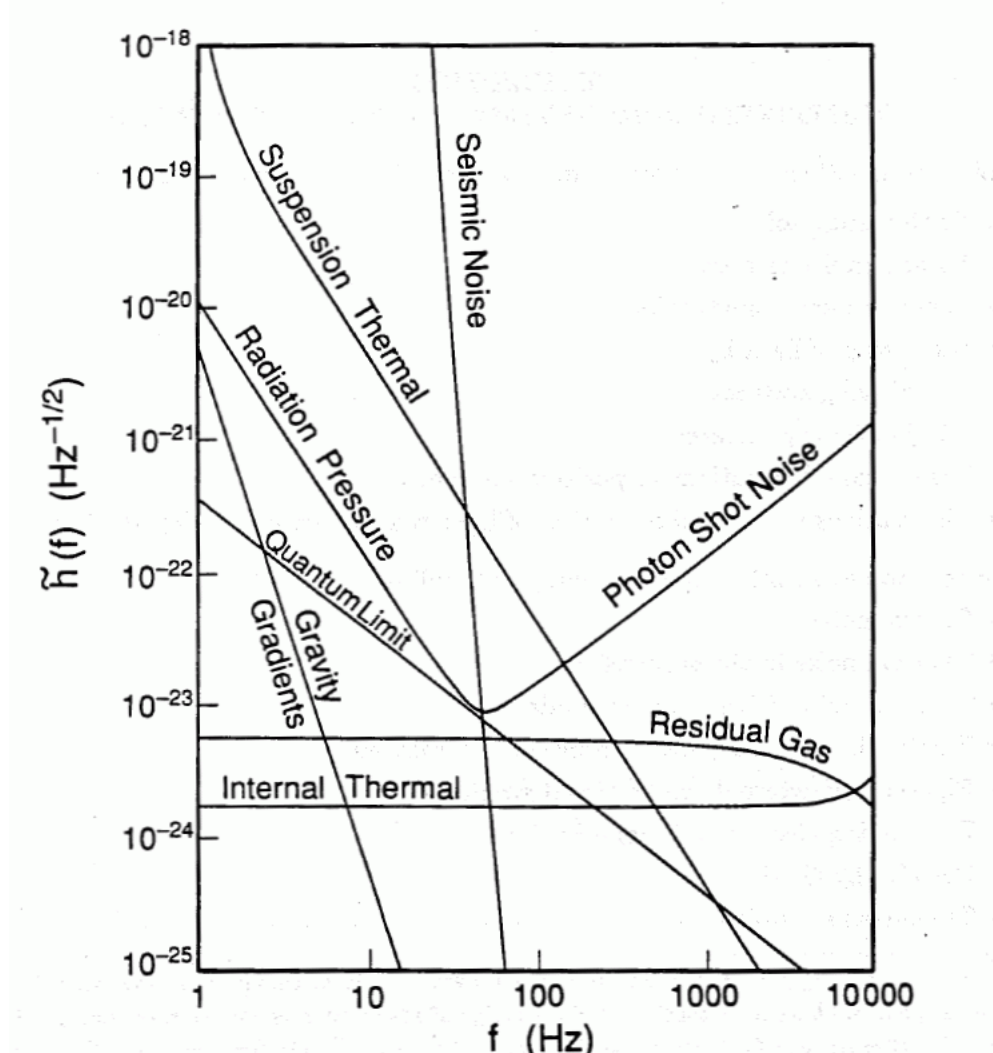


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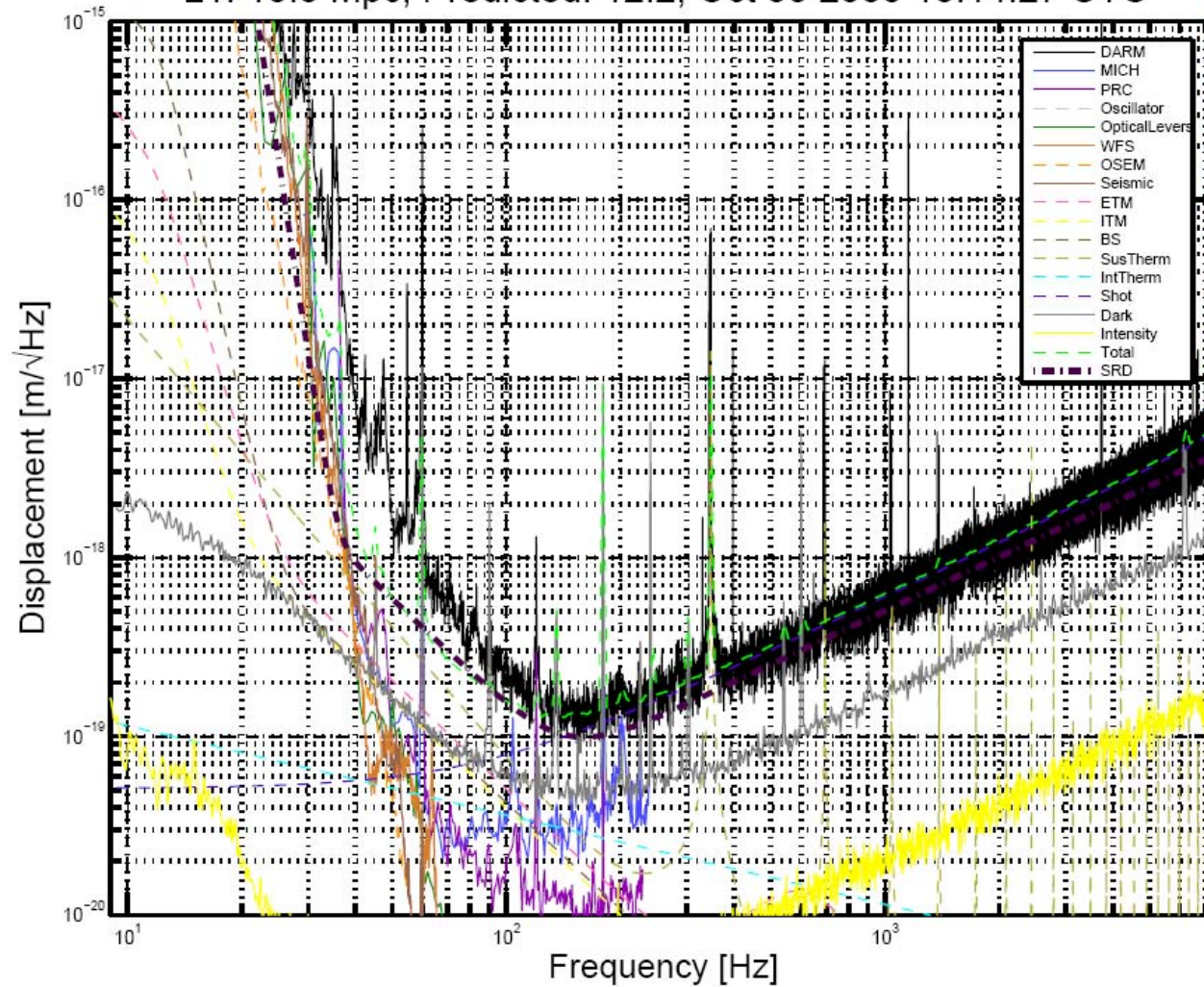
What is LIGO? The 1989 Proposal





What is LIGO? Today

L1: 10.5 Mpc, Predicted: 12.2, Oct 30 2005 10:14:27 UTC





What is LIGO?

The 1989 Proposal

B. Evolution of LIGO Interferometers

To detect gravitational waves, the use of high performance detectors in extended observational runs is necessary. Development of better detectors that enhance our ability to make new discoveries is also vital. A continuing detector development program is planned to improve LIGO capabilities. The design of the first LIGO interferometer emphasizes simplicity, so that we may place a detector in service as rapidly as possible; succeeding generations of interferometers will more fully exploit the unique capabilities of the LIGO.

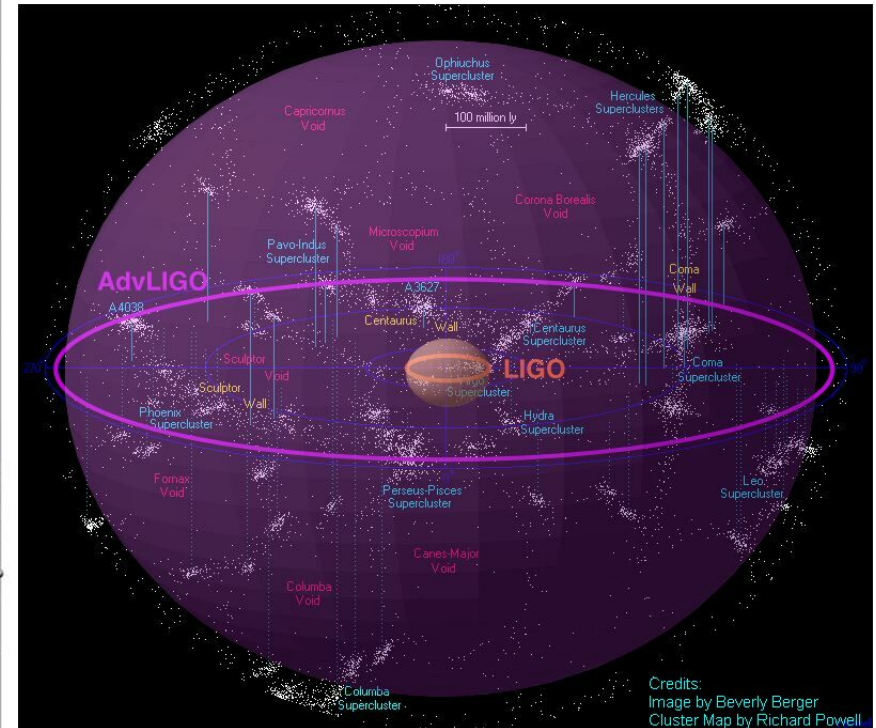
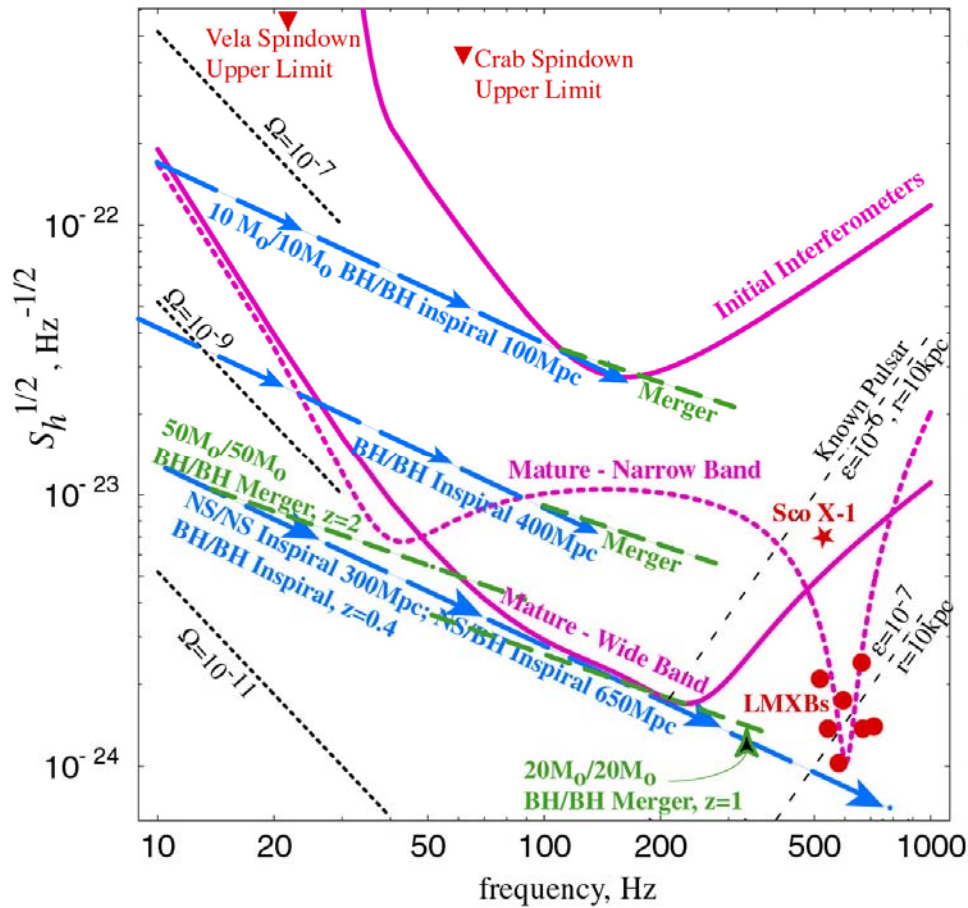
2. Development of the second-generation LIGO detector

While the Mark I detector is going into operation, campus development of the second-generation LIGO detector, Mark II, will be proceeding. The Mark II design will include options not incorporated in Mark I and improvements based on the experience gained from operating Mark I. The advantages of new technology, made available after the Mark I design freeze, will be evaluated.



What is LIGO? Today

- Advanced LIGO approved for FY2008 start





What is LIGO?

The 1989 Proposal

B. National Context

We envision the LIGO as an initial quasi-experimental project, focused upon the invention, development, verification, and first use of technologies for laser interferometer gravitational-wave astronomy, with a gradual transition to a mature facility. The early stages of evolution will be conducted primarily by the Caltech/MIT LIGO team, followed by a gradual transition to broader-based national and international participation.

Caltech and MIT, with the principal support of the National Science Foundation (NSF), have invested close to two decades of effort in developing a laser interferometer for gravitational-wave astronomy. The two institutions are committed to continuing a vigorous program leading to the establishment of the LIGO and gravitational-wave astronomy, and subsequently developing, operating, and maintaining LIGO under NSF sponsorship in the interest of the scientific community.

Completion of the LIGO, bringing it to operational readiness in the course of the early search for gravitational waves and, ultimately, conversion to a broadly accessible facility, will require the full commitment and expertise of the Caltech/MIT team. It is expected that once a firm NSF commitment towards construction and operation of the LIGO exists, a broader-based national scientific community will be interested in participation.



What is LIGO? Today





What is LIGO?

The Final Promise

PREFACE

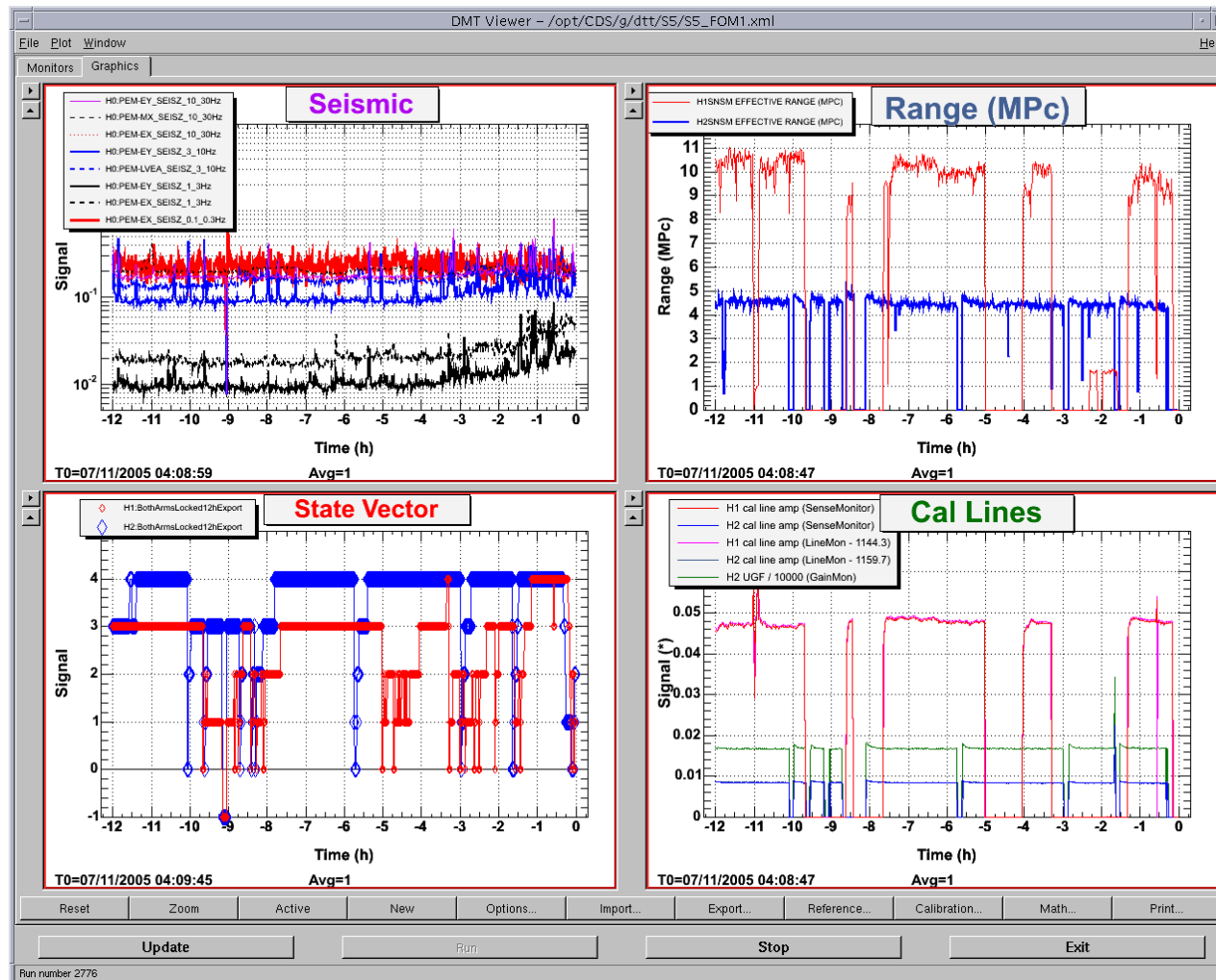
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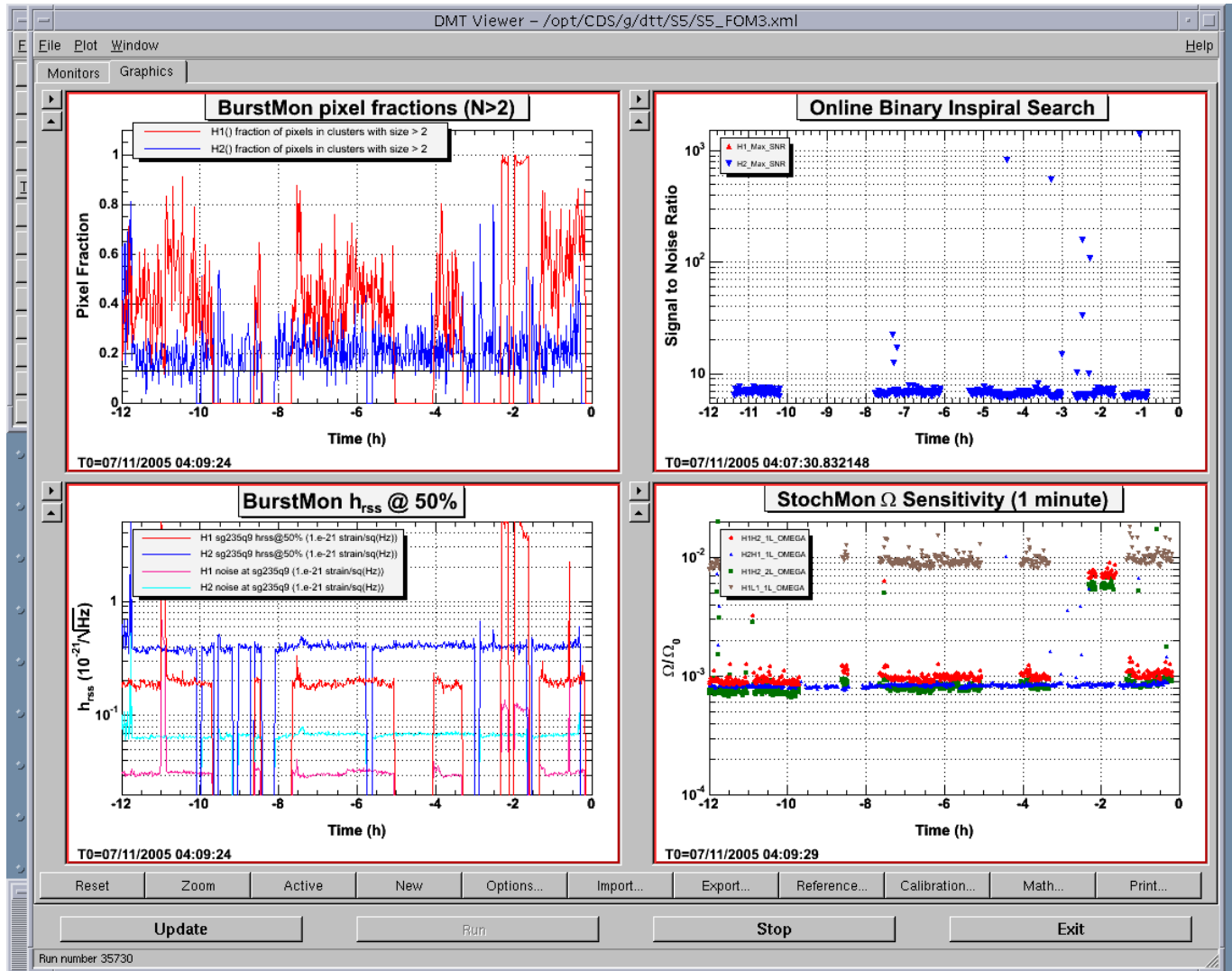
What is LIGO?

The Final Promise Today





What is LIGO? The Final Promise Today





Two Year Extension and Supplement

- Current Cooperative Agreement for operation of LIGO expires in September 2006
 - » Approximately mid-way through S5
- Requested extension for two years (FY2007-08) to:
 - » Operate the LIGO Lab and complete S5 science run
 - » Management, archiving and distribution of LIGO data
 - » Development and application of data analysis tools
 - » R&D for Advanced LIGO
 - » Evolution and enhancements to initial LIGO
 - » Education and outreach
 - » Next generation R&D
- Delays start of new Cooperative Agreement until start date for Advanced LIGO is known
 - » Allows better coordination between Ops and AdvLIGO labor



Annual Budget for FY2007-8

- Budget for FY2003-4 \$33M per year
- Budget for FY2005-6 \$32M per year
- Requested budget for FY2007-08: \$33M each year
 - » Operations activities extrapolation of current level
 - » AdvLIGO R&D activities based on AdvLIGO plan

Operate the LIGO Lab/Site Operations	\$8.6M/\$11.5M
Data management and analysis	\$5.3M
R&D for Advanced LIGO	\$5.5M
Enhancements for initial LIGO	\$1.0M (availability?)
Education and Outreach	\$0.6M
Next Generation R&D	\$0.5M



Recompetition?

Support for LIGO at MIT and Caltech

- Oversight and management assistance
 - » LIGO Oversight Committee
 - » Ready access to management at both institutions

- Administrative and business support
 - » Dedicated personnel for key business activities
 - Property Management, Purchasing, Accounts Payable
 - » Observatory visits from HR, Safety, training staff
 - » Support from Caltech Outreach Coordinator

- Special considerations for off-campus operation
 - » Employee benefit packages tied to location
 - » Offer of special assistance for Katrina-affected staff



Facilities for LIGO at MIT and Caltech

- **Space at Caltech**
 - » 40 m interferometer lab
 - » High bay space in synchrotron building
 - » Beowulf cluster facility (currently being expanded)
 - » Over 30,000 sq ft labs and offices
- **Space at MIT**
 - » \$2M renovation in 1999
 - » Office space 5200 sq ft
 - » High bay lab space (LASTI) 4000 sq ft
 - » Other lab space (laser, electronics, vacuum prep, etc.) 8000 sq ft
- **Biggest space issue is dispersion of LIGO staff**
 - » **Commitment to co-location from both MIT and Caltech**



Intellectual Involvement in LIGO at MIT and Caltech

- Faculty working directly on LIGO
 - » Five current faculty at Caltech (two emeritus)
 - Barish, Thorne, Weinstein, Drever, Libbrecht
 - » Three current faculty at MIT (one emeritus)
 - Weiss, Katsavounidis, Mavalvala
- Related interests
 - » Broad astrophysics programs at both Caltech and MIT
 - » MIT Kavli Institute, drawing together cosmology with relativity and astrophysics
 - » HETE (Gamma Ray Bursts) at MIT
 - » Numerical relativity at Caltech –major new initiative
 - » LISA (Caltech, JPL and MIT)
 - » Quantum optics—Kimble and Mabuchi groups



Search for LIGO Director

- LSC Search Committee
 - » Prof. Jim Hough (Glasgow) chair
 - » Broad LSC representation, with significant outside participation
- LIGO Oversight Committee as Selection Committee
 - » Including representatives from major LSC stakeholder institutions
 - » Validate both the process and the recommendation
- Final appointment to be made by Caltech President in consultation with MIT President
 - » Current status can be discussed later with Emlyn Hughes, Oversight Committee chair



Students in LIGO

- Graduate students on LIGO
 - » Caltech—8 Ph.D students in LIGO Lab
 - Includes 1 from University of Pisa, and 1 from University of Bologna
 - » MIT—10 Ph.D students in LIGO Lab
 - Includes 1 from Institut National des Sciences Appliqu'ees (INSA) Lyon
 - » Typically host 3-6 students from other LSC groups doing Ph.D research at Observatories
 - » Caltech—10 Ph.D students in theory group
- Undergraduate students
 - » LIGO REU program integrated with Caltech SURF program
 - Typically 30-35 undergraduates per summer split among Caltech, LIGO Hanford, LIGO Livingston
 - 10 week research program with individual mentoring
 - Past summer: 38 students, 26 universities, 8 countries
 - » MIT UROP program—typically 10 students per year with 2-3 senior theses

- Building a Science Education facility at Livingston Observatory
 - » 8000 sq ft facility stocked with ~50 exhibits from the Exploratorium tied to LIGO science themes
 - » School visits
 - » In-service and Pre-service teacher professional development
- Hanford Observatory
 - » More oriented to family activities as opposed to school activities
 - » Monthly tours and evening activities
 - » Joint activities with WSU-Tri-cities, Columbia Basin College, Tri-cities Astronomy Club





Response to Recommendations from Last Year

- “The LIGO Laboratory should finalize its Computer Security Policy and develop computer security plans based upon it .”
 - » The plan was approved and is being implemented
- “The draft computer security policy should include an explicit program of periodic self-assessment and peer review .”
 - » Included as recommended
- “LIGO should develop a patch management program for all the major operating systems deployed at the LIGO sites.”
 - » This is in place. Progress was reviewed in March 2005 in a meeting at LHO
- “LIGO should form a working group to develop a plan for selecting and deploying a common authentication infrastructure.”
 - » The collaboration has focused on this issue for grid computing and is about to set up its own Virtual Organization (VO) to issue and manage LIGO-specific certificates.



Summary

- LIGO is on the verge of fulfilling the final promise from the 1989 proposal
- Supplement/extension for FY2007-08
 - » Provides for completion of S5 Science Run
 - » Supports the needed R&D leading into AdvLIGO
- Recompetition vs. continued CIT/MIT management
 - » Strong Caltech/MIT institutional support
 - » Office space and unique labs--commitment to future co-location
 - » Strong and effective management
 - » Vibrant intellectual home for LIGO Science