Status of LIGO

Peter Shawhan
(LIGO Lab / Caltech)
For the LIGO Scientific Collaboration

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Thanks to Gabriela González, Michael Landry, Gary Sanders, and David Shoemaker

Highlights in 2002

Detector commissioning progress

All interferometers now operate in power-recycled configuration

Substantial improvements in sensitivity

First efforts to extract astrophysics from LIGO data

Performed by members of LSC “upper limit” working groups

Began with data from the E7 engineering run (Dec 2001 – Jan 2002)

First science run !

Almost 100 hours of simultaneous observation with all three detectors

New sensitivity record for binary inspirals

Data analysis is well underway

LSC "Upper Limit" Working Groups

Organized around types of gravitational-wave sources

Burst	(led by Sam Finn and Peter Saulson)
Inspiral	(led by Patrick Brady and Gabriela González)
Continuous-wave	(led by Maria Alessandra Papa and Michael Landry)
Stochastic	(led by Joe Romano and Peter Fritschel)

Each group has members from several LSC institutions

Groups encompass more than one search algorithm

Lots of telecons…

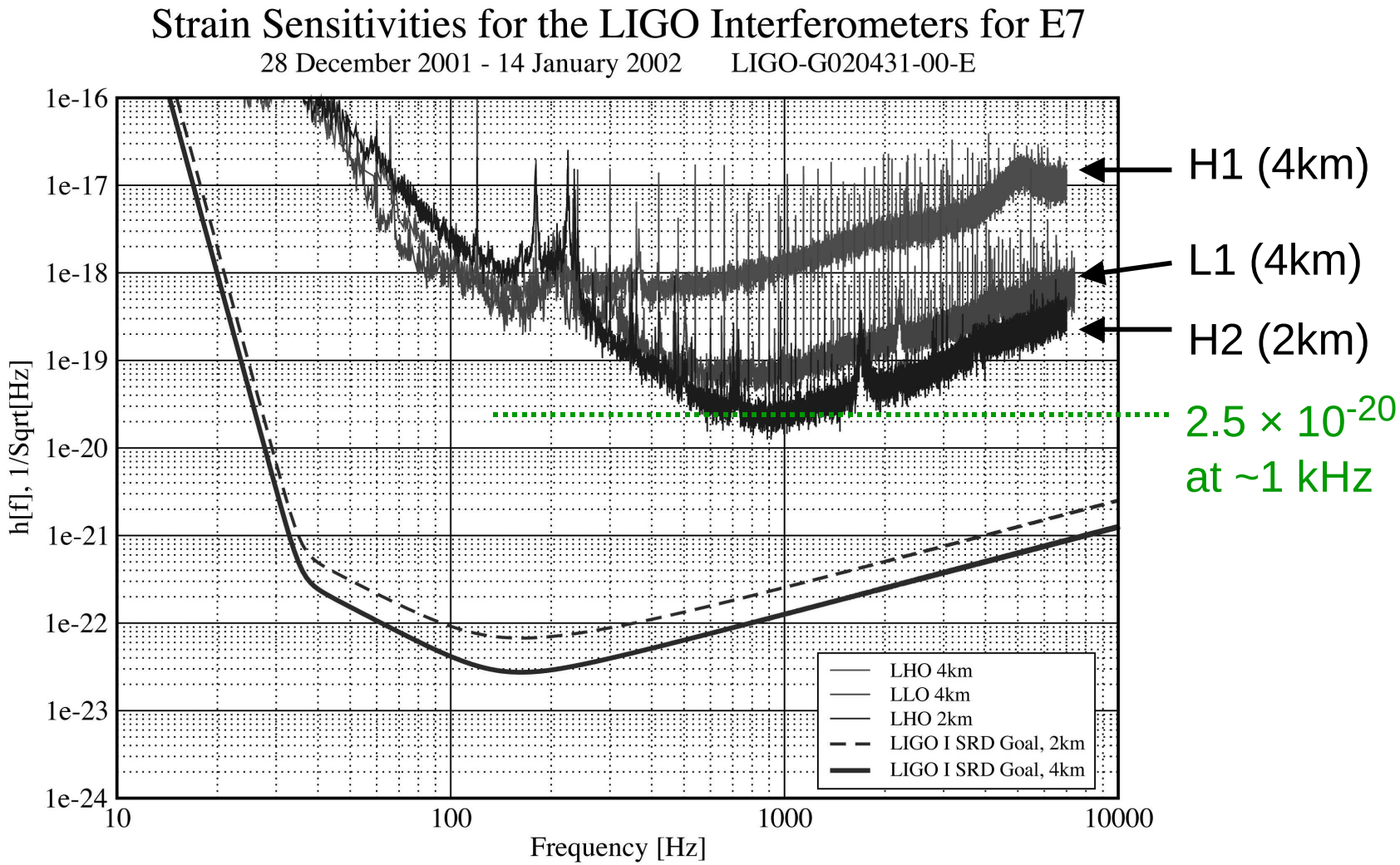
Have become the standard paradigm for LIGO data analysis

Seem to be more permanent than originally planned

It is OK to propose an analysis outside of these groups, but there are advantages to sharing ideas and working closely with others

The E7 Engineering Run

28 December 2001 – 14 January 2002



Data from the E7 Run

Observation time (clean locked data)

H2	162 hours (38%)	Lowest noise, but DAQ/control problems
L1	265 hours (61%)	
H1	267 hours (62%)	
All 3	93 hours (21%)	

GEO and ALLEGRO ran at same time

Some of the data was selected to make a “playground”

Used to tune up analysis procedures and cuts

Data analysis

Working groups made first attempt at a complete scientific analysis

Produced internal reports

A good warm-up for scientifically interesting data

The Summer Schedule Setback

The first science run was scheduled for 28 June – 15 July

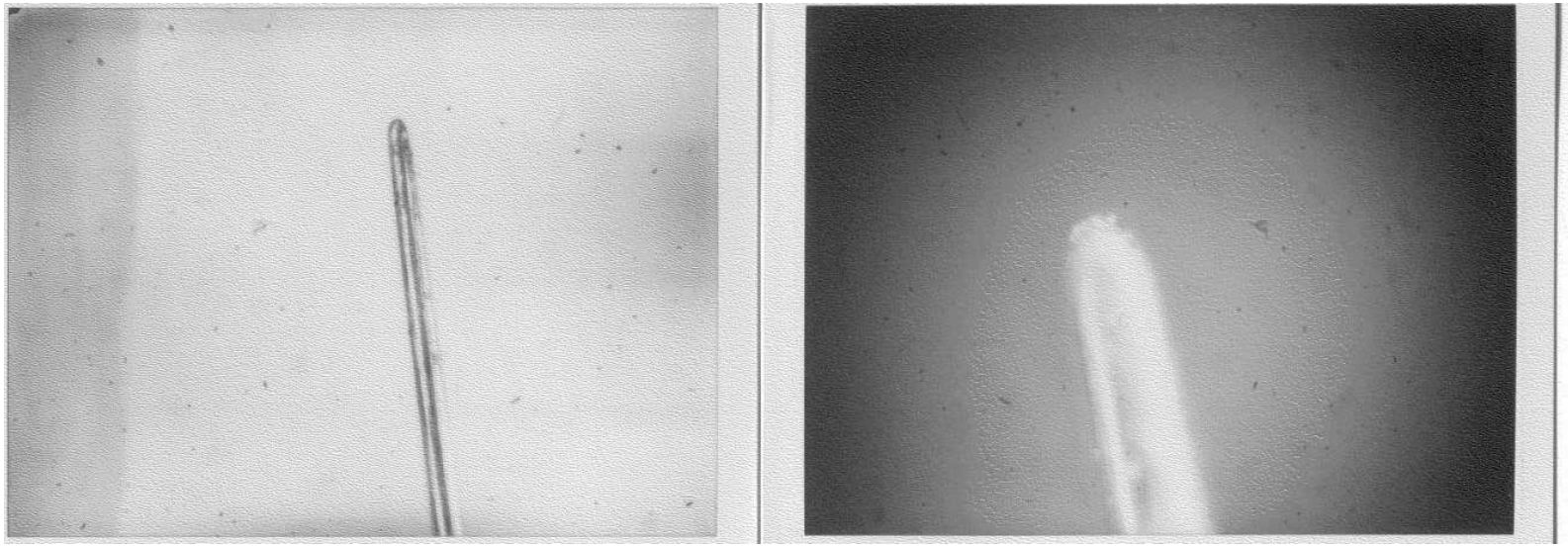
BUT: On 28 June, a magnitude 7.2 earthquake occurred in China

… which shook the mirrors at Hanford

… which caused one of the mirror position controllers to start oscillating

… which caused the H2 input laser beam to swing wildly

… which melted the wire suspending one of the other mirrors



The First Science Run ("S1")

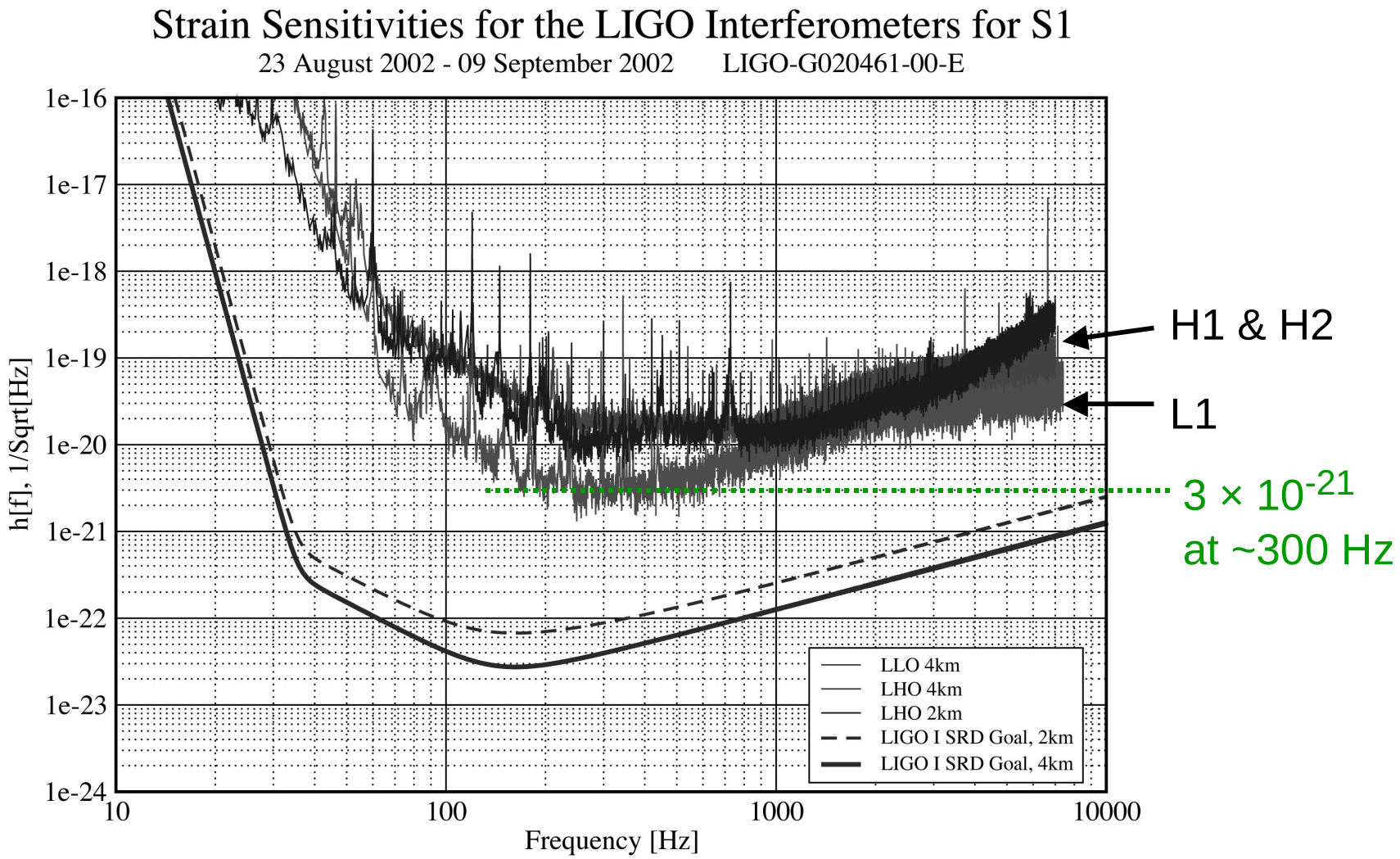
23 August – 9 September (17 days)

Improvements between E7 and S1

- Added power recycling in H1 and L1
- H2 laser increased to full power (others still at reduced power)
- Implemented "common-mode servo"
- Optical lever damping of test mass angular degrees of freedom
- Piezo-Electric Pre-Isolator (PEPI) installed at LLO to suppress seismic noise in 1-10 Hz range
- Operators now mark "science mode data" as it is collected
- etc.

GEO ran at same time (TAMA too, briefly)

Strain Sensitivities During S1



Data from the S1 Run

Observation time (science-mode data)

L1	170 hours	(42%)	Still limited by daytime seismic noise
H1	235 hours	(58%)	
H2	298 hours	(73%)	
All 3	96 hours	(23%)	

10% of triple-coincidence data was selected for playground

Has been used by burst and inspiral groups to develop analysis pipelines and to study vetoes

All S1 data is now on disk at Caltech, visible to LDAS and to a DMT (Data Monitoring Tool) machine

Status of S1 Data Analysis

Several search algorithms have been applied to the data

- Most run within LDAS
- In addition, DMT programs have been used to produce “veto triggers”

Internal reports have been written

- Have been made available to LIGO-1 LSC members
- Analyses have also been presented via telecon

What’s next:

- Refine the analyses
- Internal review committees
- Draft papers
- Circulate drafts within LSC during January
- Approve papers for publication at March LSC meeting

Commissioning Activities Between S1 and S2

New coil drivers and digital suspension controllers in L1, H2

To match H1

Better filtering in optical lever feedback

Acoustic isolation of PSL tables at LHO

Done

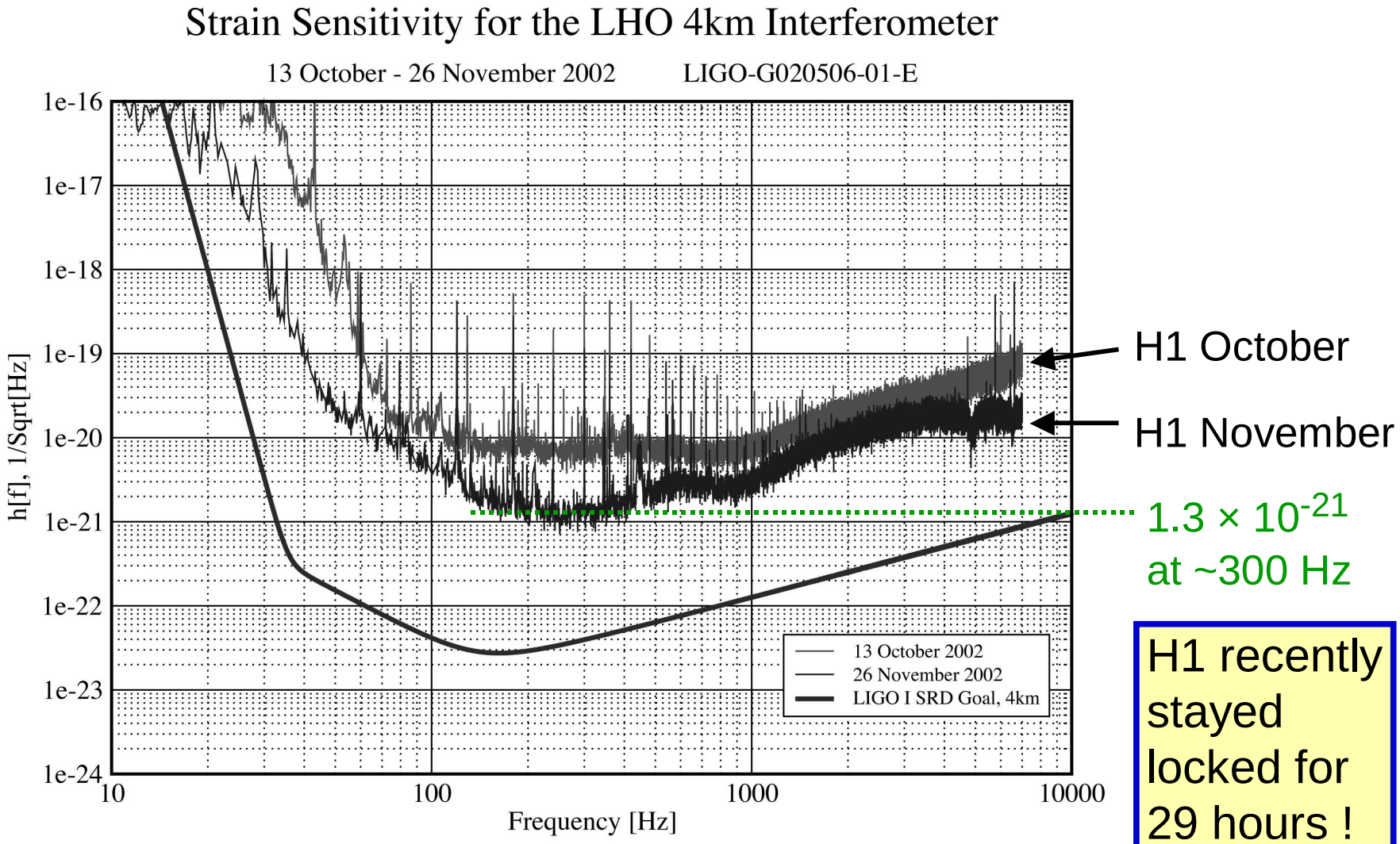
Microseismic feed-forward for H1, H2

Commission additional wavefront sensors (WFS) to stabilize the various alignment degrees of freedom

This is challenging

Various upgrades to control hardware, servos, and data acquisition

Sensitivity Improvements Continue



H1 recently stayed locked for 29 hours !

Preparations for the S2 Run

S2 run will be conducted from 14 February to 14 April

Taking steps to try to ensure smooth data collection and scientific value

- Make a coherent run plan
- “Freeze” hardware and software well before the run
- Have a better program of hardware signal injections
- Get “autocalibrator” running at both sites

Have conducted “mini-runs” at each observatory

- Focus on tuning DMT monitor programs

E9 Engineering run planned for 24-27 January

- Intended as a “dress rehearsal” for S2

Beyond the S2 Run

Commissioning Activities after S2

- Install seismic pre-isolation system at LLO
- Install PEPI at Hanford
- Further upgrades of servo electronics
- Reduce RF interference in electronics
- Actively stabilize beam pointing

The S3 run

- Long run (several months) beginning in Autumn 2003

Goal for the next ~4 years: at least one year (integrated) of simultaneous observing with highly sensitive detectors

Status of Advanced LIGO

Motivation for Advanced LIGO

- Take advantage of advances in detector technology and engineering
- Install completely new detectors at existing observatories
- Expect to reach at least 10 times as far as initial LIGO

Progress continues on detailed design and R&D

- Now prototyping seismic pre-isolation systems using hydraulic and electromagnetic actuators; chosen design to be installed at LLO after S2
- Selected "active" in-vacuum seismic isolation system
- Testing prototype of multiple-pendulum suspension based on GEO600
- Working on design of input beam optics
- Will select laser design in March 2003
- Will select between sapphire and silica in May 2003
- Technologies being evaluated at test facilities (LASTI, 40-m, Gingin, …)

Status of Advanced LIGO

Major technical issues

- Optical absorption and mechanical losses in test masses
- Compensation for thermal distortion of optical components
- Mechanical losses in optical coatings
- How to damp vibration modes in suspensions without introducing noise
- RF vs. DC readout

Schedule

- Submit proposal to NSF in early 2003
- Finalize design in 2005
- Begin installation in 2007
- Begin science observations in 2009

Summary

Great progress in 2002

- Collected scientifically interesting data
- Vigorous analysis effort is underway
- Commissioning team has continued to get closer to design sensitivity and has improved robustness

Great expectations for 2003

- Publication of results from S1
- S2 run
- Publication of results from S2
- Begin S3 run