
# LIGO II

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Aspen Gravitational Wave Advanced Detector Workshop

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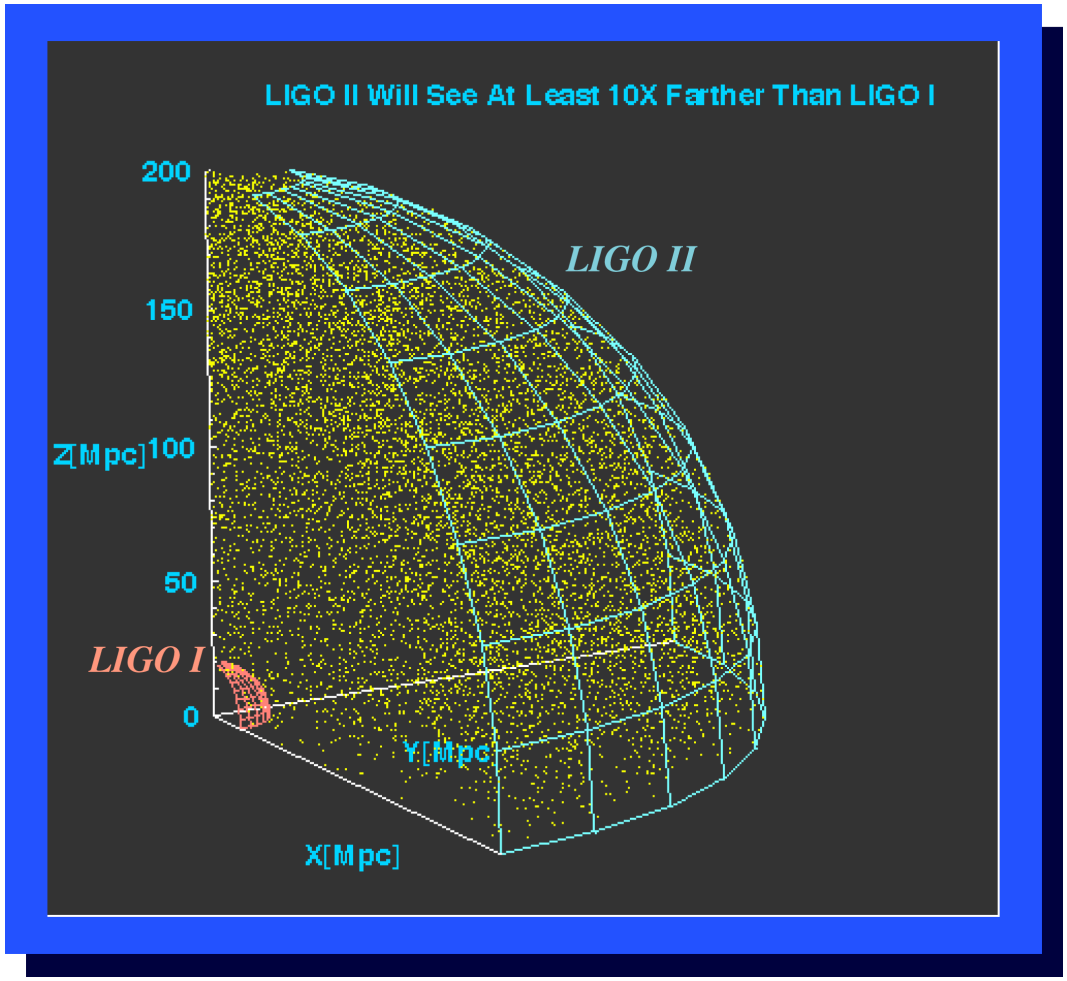
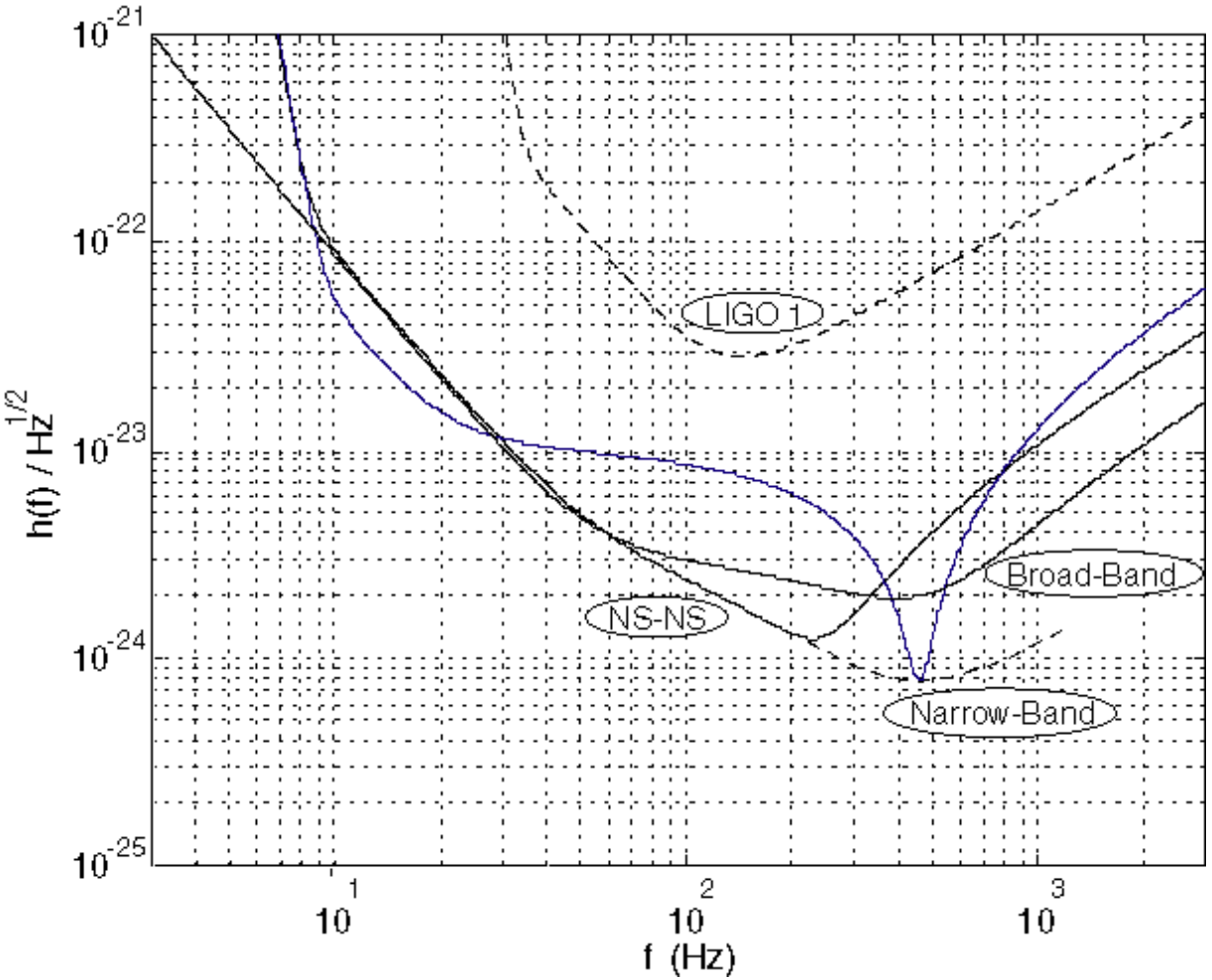
# LIGO II Reach



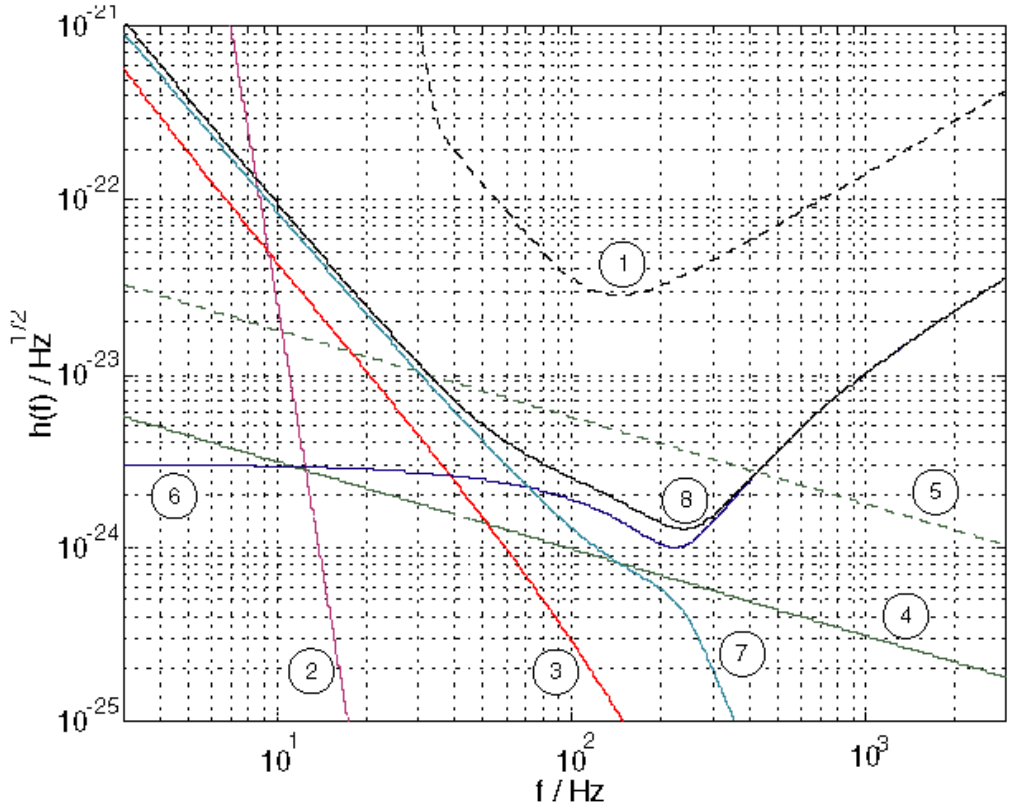

# LIGO II Reference Design Parameters / LIGO I Comparison

| Subsystem and Parameters | LIGO II Reference Design | LIGO I Implementation |
|---|---|---|
| *Comparison With LIGO I Top Level Parameters* | | |
| Strain Sensitivity [rms, 100 Hz band] | $2 \times 10^{-23}$ | *$10^{-21}$* |
| Displacement Sensitivity [rms, 100 Hz band] | $8 \times 10^{-20}$ m | *$4 \times 10^{-18}$ m* |
| Fabry-Perot Arm Length | 4000 m | *4000 m* |
| Vacuum Level in Beam Tube, (Vacuum Chambers) | $< 10^{-6}$ , ($< 10^{-7}$) torr | *$< 10^{-6}$ torr* |
| Laser Wavelength | 1064 nm | *1064 nm* |
| Optical Power at Laser Output | 180 W | *10 W* |
| Optical Power at Interferometer Input | 125 W | *5 W* |
| Power Recycling Factor | 80 x | *30 x* |
| Input Mirror Transmission | 3% | *3%* |
| End Mirror Transmission | 15 ppm | *15 ppm* |
| Arm Cavity Power Loss on Reflection | 1% | *3 %* |
| Light Storage Time in Arms | 0.84 ms | *0.84 ms* |
| Test Masses | Sapphire, 30 kg | *Fused Silica, 11 kg* |
| Mirror Diameter | 28 cm | *25 cm* |
| Test Mass Pendulum Period | 1 sec | *1 sec* |
| Seismic Isolation System | Active/Passive, 6 stage | *Passive, 4 stage* |
| Seismic Isolation System Horizontal Attenuation | $10^{-8}$ (10 Hz) | *$\geq 10^{-5}$ (100 Hz)* |
| Maximum Background Pulse Rate | 1 per 10 years, triple interferometer coincidence | *1 per 10 years, triple interferometer coincidence* |

# LIGO II and LIGO I Sensitivity



# Noise Anatomy of LIGO II




1 LIGO I total
2 Filtered seismic noise
3 Suspension thermal noise
4 Internal thermal noise - sapphire
5 Internal thermal noise - fused silica (fallback)
6 Shot noise
7 Radiation pressure noise
8 LIGO II total


# The Scenario

| YEAR | LIGO I | LIGO II |
|---|---|---|
| 2000 | Installation and commissioning | R&D |
| 2001 | Installation and commissioning | R&D |
| 2002 | Science run starts | MRE/R&D funds start, R&D, design, long lead items |
| 2003 | Science run | R&D, design, fabrication |
| 2004 | Science run | Fabrication, on-site assembly |
| 2005 | LIGO I interferometers removed | Fabrication, on-site assembly, installation into vacuum system |
| 2006 | | Installation and commissioning |


# Major Project Options

- How many interferometers to upgrade?
  - » Assume all 3 interferometers upgraded
- Convert the Hanford 2 kilometer to a 4 kilometer?
  - » Assume length is increased
- Upgrade done in one phase?
  - » Assume all 3 interferometers upgraded in one parallel installation
  - » Decision on this may interact with other gravitational wave detectors to insure that observational coverage is considered


# LIGO Laboratory and LSC Role

- LIGO Laboratory will organize and manage the LIGO II project
- LSC participation in the construction of LIGO II will be governed by Memoranda of Understanding (MOU) and specific, periodic Attachments describing tasks, funding, milestones and personnel, with subcontracts
  - » this model used successfully with Univ. of Florida during LIGO I
  - » this model used with LSC for R&D activities, without subcontracts

  LSC is driving the LIGO II scientific goal and concept
- GEO is proposing a collaborating role and a capital contribution role


# NSF Review

- LSC White Paper and Lab Project Book submitted
- Recommendations
  - » LIGO Lab should proceed with full construction proposal for LIGO II to be submitted late in 2000
  - » Proposal should identify Preconstruction R&D to begin in 2002
  - » LIGO Lab should submit an integrated R&D plan for Lab and LSC research in 2000 and 2001
  - » NSF should establish a framework for evaluating R&D proposals related to LIGO II in order to assure coordination and monitoring
  - » Meaningful LIGO I data analysis results should be in hand prior to turning LIGO I off


# LIGO Lab's Plan

- Integrated R&D Plan for 2000 and 2001 to be submitted in March
- Full LIGO II Proposal to be submitted near end of 2000, with LSC and GEO participating
- Request R&D $ increment for 2002
- Request construction $ for 2003
- Plan first installation in vacuum system in 2005


# Management of the R&D

- LIGO Lab is working with LSC Working Group Chairs to define R&D program
- Fully integrated schedule of Lab and LSC activities is in preparation
- MOU's/Attachments B,C, D updated to agree with this plan
- LSC will host monthly progress telecons with LIGO Lab participating to assess progress and to identify issues


# Since September, 1999 White Paper

- Braginsky et al and Thorne et al papers on thermoelastic damping change sapphire perspective
  - » goal is to work this result into R&D and into LIGO II design choices
  - » increased emphasis on measuring thermal noise limits with suspended sapphire optics
- Some R&D is being curtailed or accelerated to focus on the LIGO II goals
- R&D program is undergoing greater discussion and coordination