
LIGO



Plans Towards Early Operations

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March 31, 1998



NSF Review - March 31 - April 2, 1998

LIGO-G980000-00-M
G980152

LIGO Plans

schedule

- Main Activity

- | | | |
|------|-----------------------------|------------------------------------------|
| 1996 | Construction Underway | -mostly civil |
| 1997 | Facility Construction | -vacuum system |
| 1998 | Interferometer Construction | -complete facilities |
| 1999 | Construction Complete | -interferometers in vacuum |
| 2000 | Commission Detectors | -first light; testing |
| 2001 | Engineering Tests | -first coincidence ($h \sim 10^{-20}$) |
| 2002 | Initial LIGO Detector Run | -two year run ($h \sim 10^{-21}$) |



LIGO

schedule

- Commission (1999-2001)
 - » Implement Initial Detectors
 - $h \sim 10^{-20}$ - Coincidence (Hanford/Livingston)
 - Engineering run (end of 2000)
 - $h \sim 10^{-21}$ - Initial Design Sensitivity (end 2001)

- Operations (2002 + ...)
 - » Data Taking/Analysis
 - » Enhance Initial Detector
 - » Advanced Detectors



LIGO Operations

physics/enhancements

- First Physics Run (~2002-2004)
 - » LIGO I Development Group
 - » Initial LIGO design sensitivity $h \sim 10^{-21}$
 - » one year integrated data (~ 2 year run)
 - » data reserved for LIGO I group for two years from collection
- Enhancements/Data Taking (~2004- ?)
 - » Advanced R&D to reach $h \sim 10^{-22}$
 - » incremental improvements - LIGO II
 - » implemented from 2004, mixed with data taking
- Advanced Detector Configurations
 - » development work begins now
 - » implementation within 10 years (eg. 2008)?



LIGO Laboratory *formation*

- Mission and Responsibility
 - » operate Hanford and Livingston
 - » assure scientific vitality of these facilities
 - » provide for acquisition of data, and systems for modeling and data analysis
 - » operate research and test facilities at sites and at MIT and Caltech
 - » support engineering design and fabrication of detector upgrades of new detector systems
 - » carry out R&D toward future LIGO program
 - » support LSC in exploitation of scientific goals
 - » review and coordinate new LIGO research initiatives
- Laboratory Charter
 - » approved by Caltech/MIT; final wording being determined with NSF
 - » Directorate, plus functional operational units for Hanford and Livingston Sites; Detector support, Data Analysis and Computing; Advanced R&D; Research Facilities; Technical and Engineering Support and Administration



Technical Status

site operations

- Site operations provide resident infrastructure to support facilities operations and detector integration, commissioning and operations
- Hanford and Livingston are being staffed up
- Both sites are already operational
 - » operating conventional facilities
 - » supporting the bake
 - » supporting integration of detector
 - » hosted PAC fall 97 (~50 present) and LSC in Spring 98 (~90 present) at Hanford
 - » will host PAC and GWIC meetings in April 98 (~70 present)
 - » laboratories and technical infrastructure being developed
- **The action is now at the sites !!!**



Technical Status

data and computing

- Detector Diagnostics
 - » concepts and design
- Data Analysis System (DAS)
 - » data formats - frames (VIRGO)
 - » architecture and design
 - » 40 m data to test DAQ/DAS systems
- End to End Simulations
 - » development and 40 m validations

*These activities will interface with new
LSC development groups*



Technical Status

advanced r & d program

- Advanced R & D program initiated in FY97
 - » funding approved - \$0.8M and program is combined with the remaining construction R & D (eg. power recycling experiment on 40m)
 - » highly collaborative with other institutions
 - » topics include suspensions, thermal noise, sapphire test masses, new interferometer configurations, etc

- LIGO Lab proposed program on advanced R & D
 - » multiyear program proposed to enable early enhancements to LIGO initial detectors, and to work toward long term advanced configurations
 - » programs is keyed to uses of LIGO infrastructure and special expertise that exists within LIGO
 - » funding level proposed is \$2.7M in FY98 and out years. This represents about 40% of the LIGO related R&D supported by NSF



LIGO Laboratory

LIGO Science Collaboration

The Laboratory is the responsible institution for LIGO, operated through a cooperative agreement with the NSF, and through an approved structure to Caltech/MIT, including oversight .

The scientific collaboration is created by and will be responsible to the Laboratory

- LIGO Science Collaboration (LSC) carries out the LIGO science program .
- The LSC communicates with LIGO Laboratory, NSF and the community through the spokesman.
- LSC charter and publication policy under discussion.
 - » interface with Laboratory and Institutional programs must be determined



LIGO Laboratory

MOUs and Attachments

- LIGO Laboratory and each LSC Collaborating Group work defined through an MOU, plus attachments for each activity (updated every 6 months)
 - » the attachments describe the program of the group, the collaborating persons and FTE equivalents; and the requests and responsibilities of the laboratory
- Initial MOUs and Attachments are ALL ready to sign for each institution to be charter members of LSC
 - » 201 collaborators (159 FTEs,)
 - » 19 collaborating groups (including LIGO Labs)
 - » 41 members on collaboration council



LIGO

LSC membership

name	# members	#FTE	#council
ACIGA	4	1.9	1
CaRT	7	3.4	1
CEGG	2	1.6	1
Florida	12	10.15	3
Geo	26	13.45	3
JILA	7	4.05	1
LSU	5	2.35	1
Michigan	2	2	1
Moscow	10	9	2
Northwestern	4	4	1
Oregon	6	3.1	1
Penn State	1	1	1
Stanford	19	13.05	3
Syracuse	4	4	1
UW-Milwaukee	4	2.75	1
Caltech	56	52.85	11
MIT	19	17.75	4
Hanford	6	6	2
Livingston	7	7	2
TOTAL	201	159.4	41



LIGO Physics

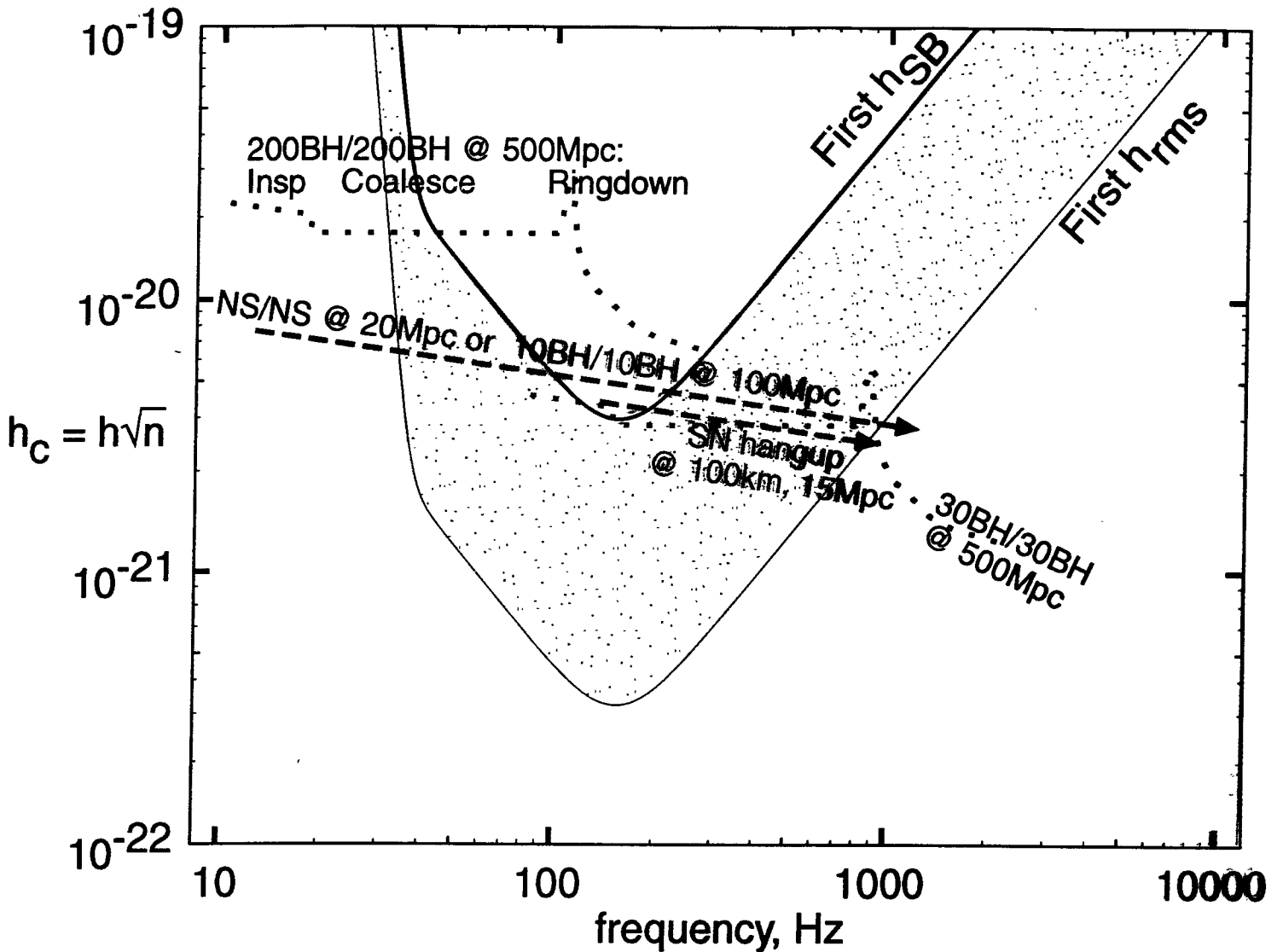
long range plan

- First Physics Run (~2002-2004)
 - » Initial LIGO design sensitivity $h \sim 10^{-21}$
 - » one year integrated data (~ 2 year run)
- Enhancements/Data (~2004-2007)
 - » incremental improvements to reach $h \sim 10^{-22}$
 - » typical costs are ~ \$5-10M/subsystem
 - » mixed with data taking
- Advanced Detectors (2007+)
 - » narrow band or broad band $h \sim 10^{-23}$
 - » new optical configs (eg. Sagnac, all reflective)
 - » implementation within 10 years ?
 - » typical costs ~\$50-75M



CAPABILITIES OF THE INITIAL LIGO INTERFEROMETERS

2002



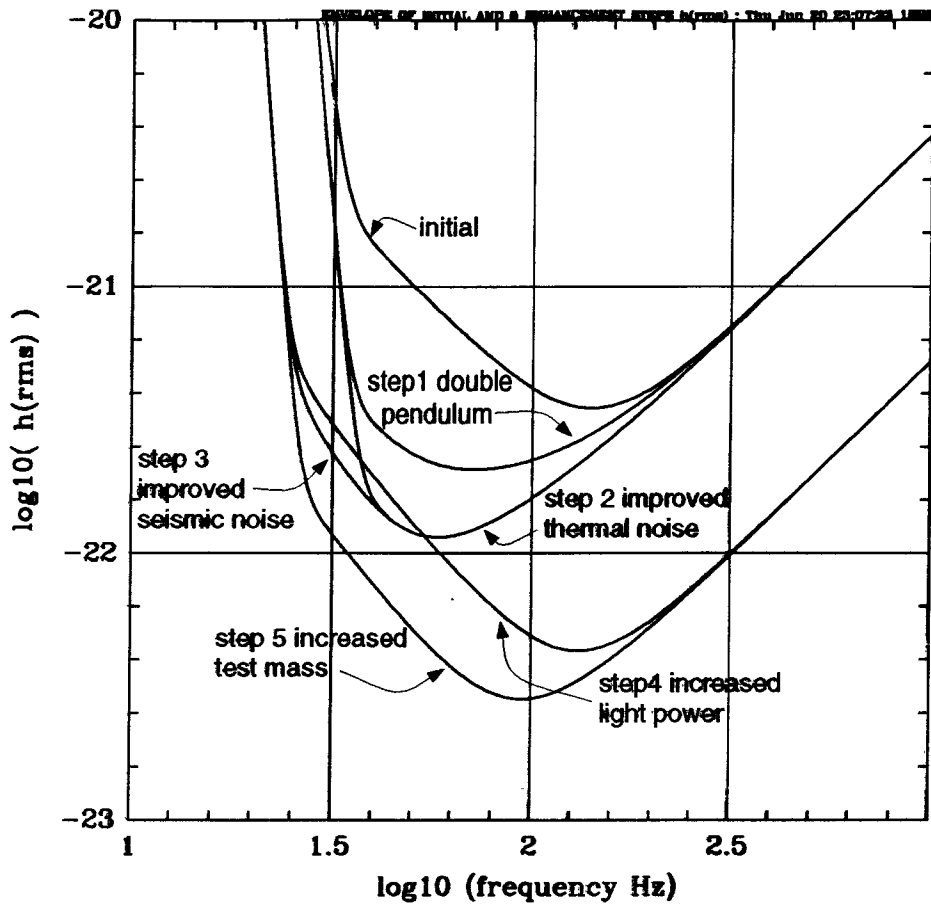
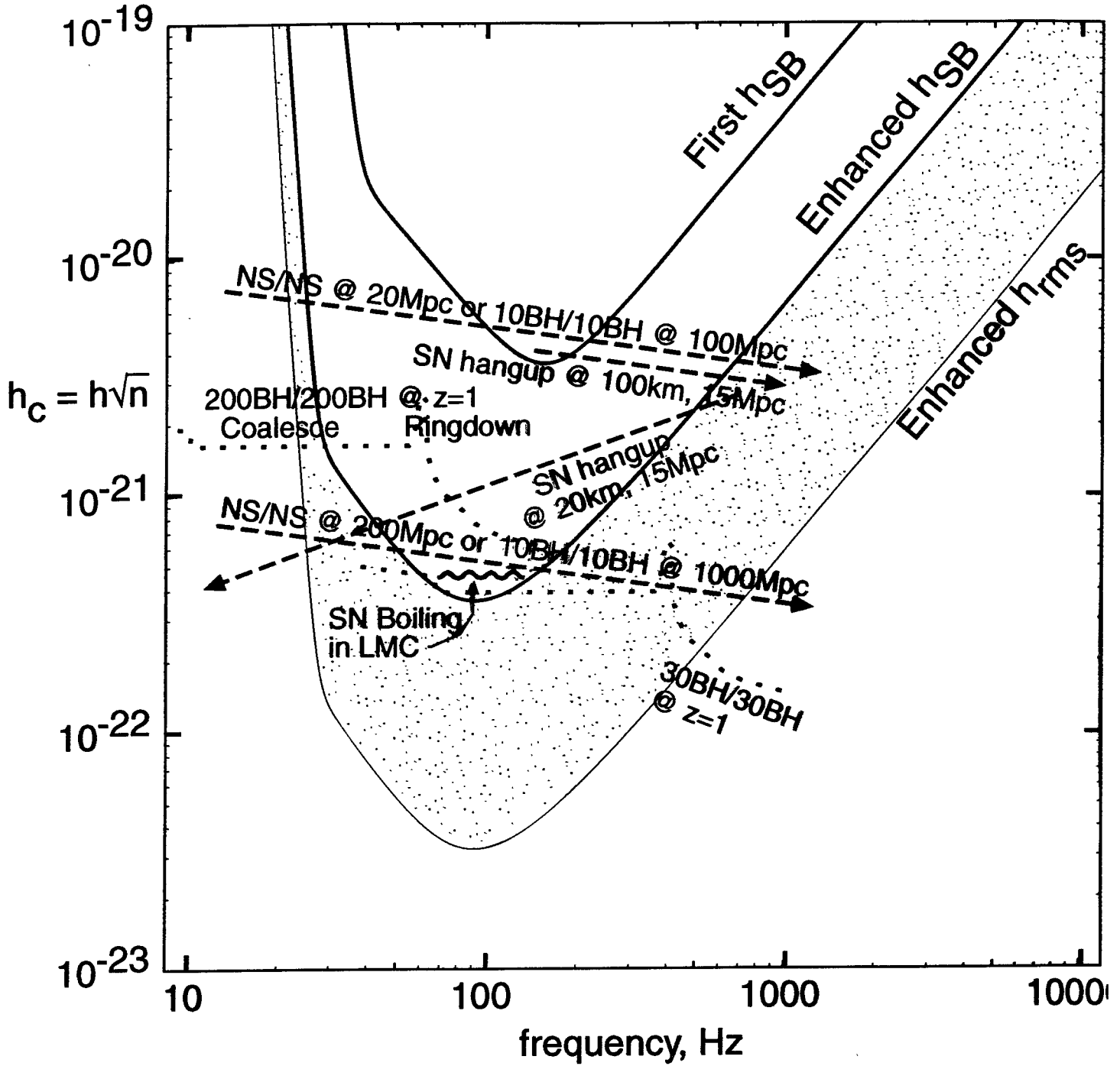


Figure 4:

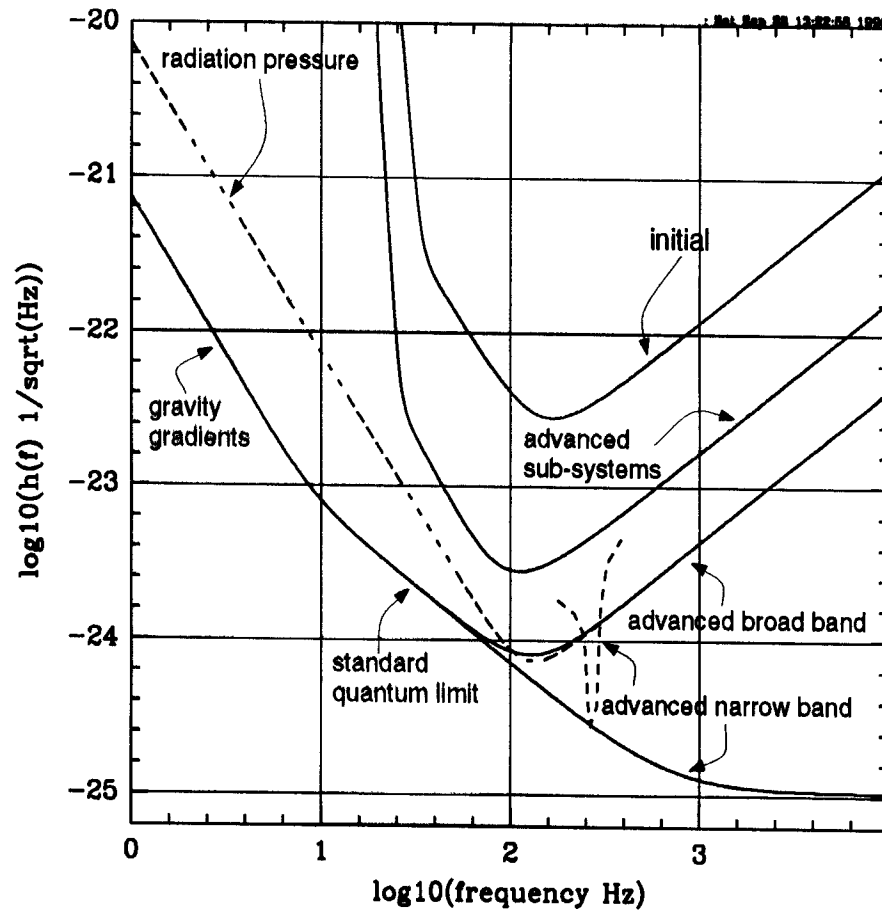
The improvements in h_{rms} associated with the steps outlined in the proposed program and resulting in the parameters given in Table 2. The logic of the steps is determined by the assumption that compact binary coalescences are the most likely source to be detected, hence the importance of improving the sensitivity near 100 Hz. The improvements associated with the do

CAPABILITIES OF ENHANCED LIGO INTERFEROMETERS

~2007



Amplitude Spectral Strain Noise Expressed as an Equivalent $h(f)$



Conclusions

- The LIGO Laboratory has been formed and is operating the sites, initiating an advanced R & D program, and coordinating laboratory efforts toward LIGO operations
- The LIGO Scientific Collaboration is formed and is beginning to participate in LIGO I, on LIGO data analysis, and on LIGO related advanced R & D
- The focus of all efforts is on early reliable detection of gravitational waves, including coincidence and combined analysis with other detectors

