LIGO-G980143-00-M

Table 1: Current members of the LIGO Scientific Collaboration

University of Adelaide ACIGA	Max Planck (Garching) GEO
Australian National University ACIGA	Max Planck (Potsdam) GEO
Caltech LIGO	MIT LIGO
Caltech Experimental Gravitation CEGG	University of Michigan UM
Caltech Theory CART	Moscow State University MSU
University of Cardiff GEO	University of Oregon UO
University of Florida (Gainesville) UF	Pennsylvania State University Exp PSUE
Glasgow University GEO	Pennsylvania State University Theory PSUT
University of Hannover GEO	(Russian) Institute of Applied Physics IAP
Joint Institute of Laboratory Astrophysics JILA	Stanford University ST
LIGO Livingston Louisiana Site LIGOLA	Syracuse University SU
LIGO Hanford Washington Site LIGOWA.	University of Western Australia ACIGA
Louisiana State University LSU	University of Wisconsin (Milwaukee) UWM
Louisiana Tech University LTU	

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LIGO SCIENTIFIC COLLABORATION

- Research and Development Groups
  - ›› Stochastic Forces - Isolation systems and suspensions
    - — David Shoemaker
  - ›› Sensing Noise - lasers and optics
    - — Eric Gustafson
  - ›› Interferometer Configurations
    - — Ken Strain
- Data Analysis Groups
  - ››Astrophysical Source Identification and Signatures
    - — Bruce Allen/Tom Prince
  - ››Detector Characterization
    - — William Hamilton/Daniel Sigg
  - ›› Detection Confidence and Statistical Analysis
    - — Sam Finn/Albert Lazzarini

Data Analysis Groups

Astrophysical source identification and signatures

techniques to search for posited sources - templates, filter and algorithm for:
- compact binary inspiral
- impulsive sources
- black hole formation
- periodic sources
- stochastic background

search for unknown sources
source statistics - logs/logN estimation
on-line and off-line functions

B. Allen, T Prince

Detector Characterization

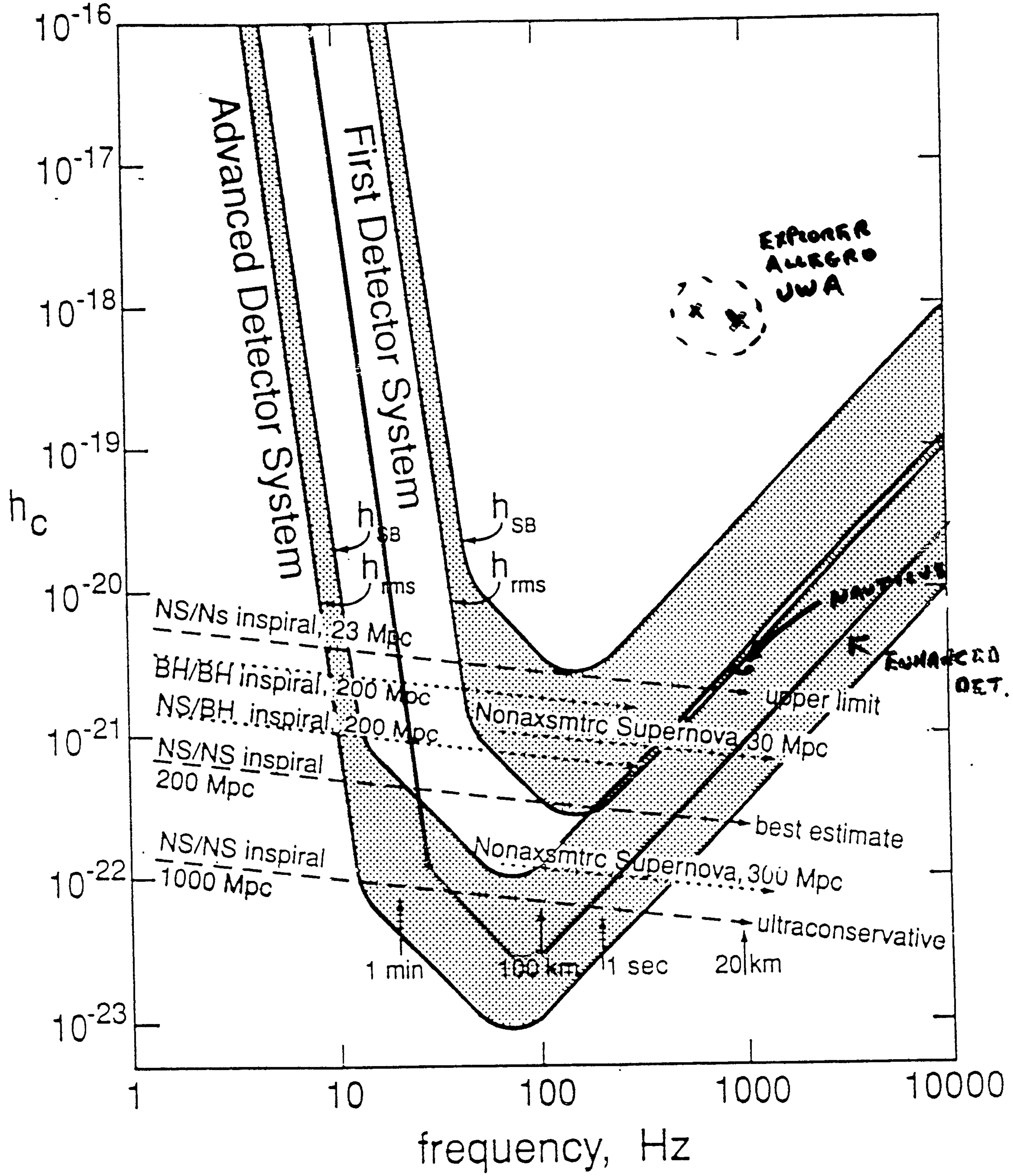
development of statistical descriptions in time and frequency domains
design of event catalogs
correlation with environmental measurements
correlation with internal detector parameters
variance and covariance analysis
correlation of noise between interferometers
correlation of noise between sites
on-line and off-line functions
end to end models of the detector

W. Hamilton, D. Sigg

Detection Confidence and Statistical Analysis

assess detection confidence and uncertainties in astrophysical parameters
Monte- Carlo models, Bayesian analysis ....
multi-interferometer analysis
correlation with other gravitational wave and particle detectors
development of overall analysis system tests
simulated time series
software tests
determination of on-line and off-line functions

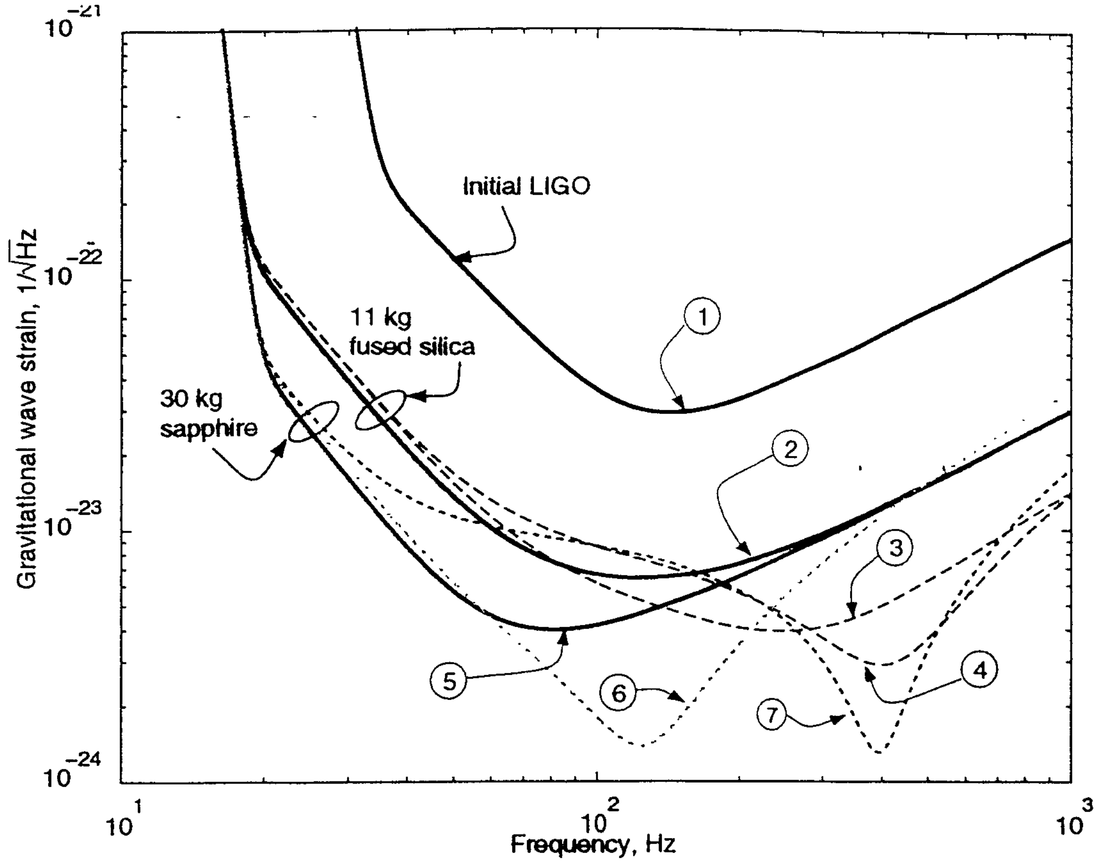
S. Finn, A.Lazzarini



Advanced Detector System
First Detector System
EXPLORER
ALLEGRO
UWA
NAUTILUS
ENHANCED DET.
upper limit
best estimate
ultraconservative
NS/Ns inspiral, 23 Mpc
BH/BH inspiral, 200 Mpc
NS/BH inspiral, 200 Mpc
NS/NS inspiral 200 Mpc
NS/NS inspiral 1000 Mpc
Nonaxsmtrc Supernova, 30 Mpc
Nonaxsmtrc Supernova, 300 Mpc
1 min
100 km
1 sec
20 km
frequency, Hz

LSC Whitepaper on Research and Development

- Recommended Program
  - ›› A baseline plan for the first LIGO upgrades
    - — Near term LIGO II --- small extrapolation from current practice
    - — Medium term LIGO II --- significant extrapolation
  - ›› A research plan for the advanced detectors - LIGO III
    - — Basic research program
    - — Approach facility and fundamental limits to the sensitivity
- Next steps
  - ›› Report on progress yearly to LIGO PAC
  - ›› Iteration of program as guided by research results
  - ›› Schedule and costs for baseline developed by LIGO laboratory in coordination with LSC



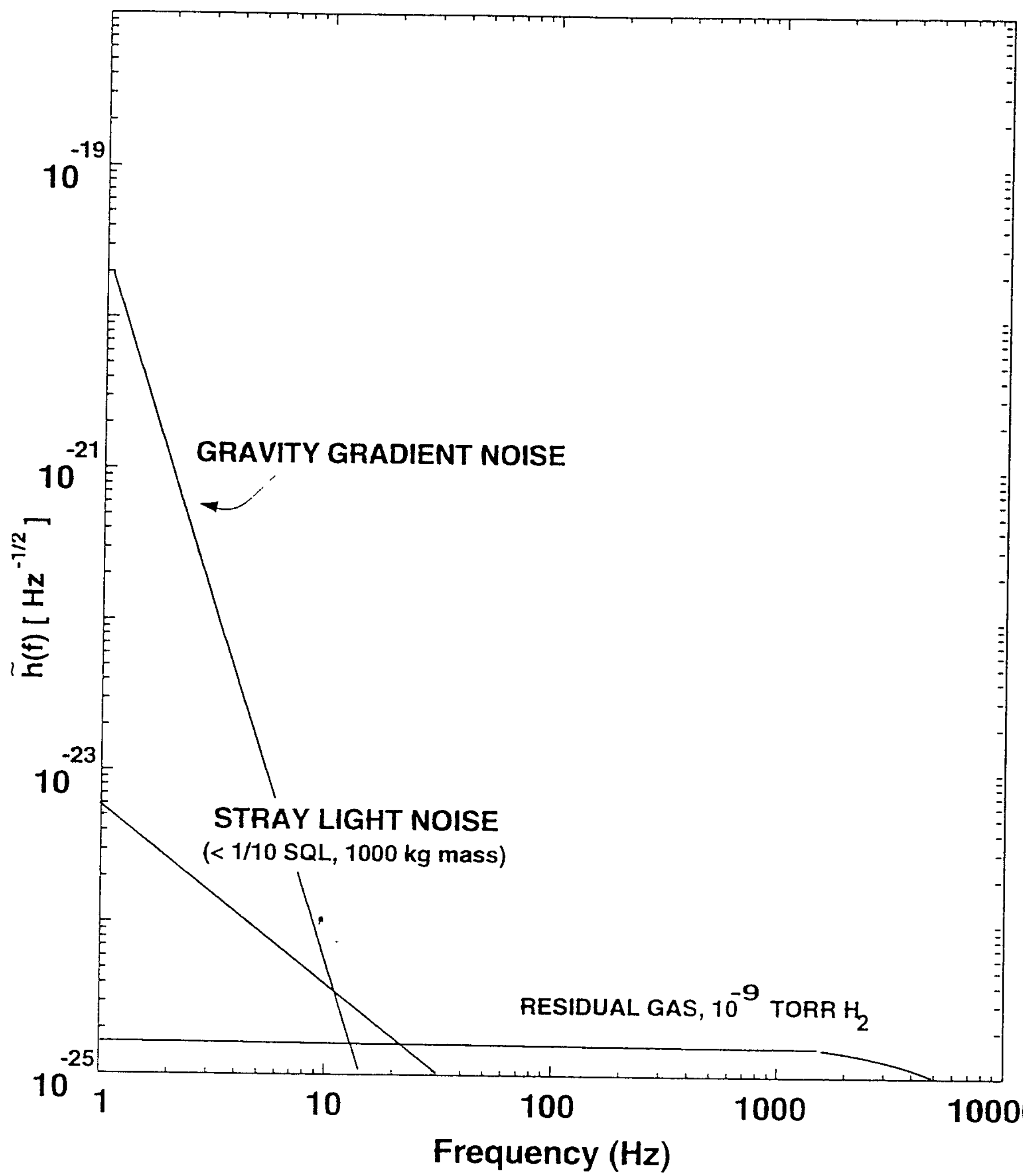
Parameter	Curve 1	Curve 2	Curve 3, 4	Curve 5, 6, 7
Parameter	Initial LIGO I value	Double suspension, 100 W laser, thermal de-lensing	Signal tuned configuration	Alternative test mass material
Input power to recycling mirror	6w	62w	140w	
Mirror loss (transmission+scatter)	50 ppm	20 ppm		
Effective power recycling	30	93		
Substrate absorption	5ppm/cm	0.4 ppm/cm		17 ppm/ cm
Thermal lensing correction	(none)	factor 10		
Suspension fiber	steel wire, $Q = 1.6\times10^5$	fused silica $Q = 3 \times 10^7$		
Test mass	fused silica, 10.8 kg, $Q = 1\times10^6$	fused silica, 10.8 kg, $Q = 3\times10^7$		sapphire, 30 kg, $Q = 2\times10^8$
Signal recycling mirror transmission	(none)		T=0.6 (curve 3) T=0.15 (curve 4)	Curve 5: none T=0.3 (curve 6) T=0.09 (curve 7)
Tuning phase			0.7 rad (curve 3) 0.45 rad (curve 4)	1.3 rad (curve 6) 0.45 rad (curve 7)

Figure and Table 1 : Performance and parameters of interferometers described in program.

	Top-level Goal	Key technologies
LIGO-II **near-term** research results	• factor 6 increase in distance of detectable NS binaries • SQL 11 kg test mass	• 100 W laser source to reduce shot noise and ancillary optics • correction of thermal lensing to permit higher powers • use of low-absorption optical substrates and coatings to permit higher powers • Double pendulum test mass suspension with silica substrate and lower loss pendulum fiber to reduce thermal noise • elimination of all actuation on the test mass to reduce thermal and excess noise • Active low-frequency isolator to reduce RMS motion
LIGO-II **medium-term** research results	• additional 3x increase in NS binary seeing • SQL 30 kg test mass	• incremental increases in laser power • signal-tuned interferometer configuration to reshape the shot-noise limited sensitivity • lowered coating absorption • larger test mass (~30 kg) to reduce radiation pressure noise; alternative crystalline test mass material such as sapphire to lower thermal noise • improved seismic isolation via active and/or passive systems to realize benefit of lower thermal noise
LIGO-III research targets	• further 5x increase in NS binary seeing • Performance limited by facilities down to 15 Hz • SQL 300 kg test mass • Performance exceeding naive facility and quantum limits	• megawatts of circulating power to reduce shot noise • alternative test mass materials for optical, thermal, and mechanical properties • Cryogenic test mass and suspension *and/or* sensing/feedback to significantly reduce thermal noise • larger test mass to reduce radiation pressure noise • additional active or passive lower-frequency isolation, probably requiring additional auxiliary sensor/actuator layers to realize benefit of lower thermal noise • extra low-frequency isolation for detection down to gravity gradient noise, perhaps below. • alternative optical configurations • QND readout scheme with low circulating power

Table 2: **Research and Development Program for LIGO-II and LIGO-III systems**

Limits due to facilities



	Double pendulum suspension	100 W Laser and ancillary optics	Signal-tuned Configuration
Top-level Requirements review	4th qtr '98	1st qtr '99	2nd qtr '99
Conceptual design; **Design summit**	1st qtr '99	3rd qtr '99	1st qtr '00
Internal requirements, component research, configuration trades; **Preliminary Design Review**	2nd qtr '99	1st qtr '00	3rd qtr '00
Component Prototypes; **Test Review**	3rd qtr '00	1st qtr '01	4th qtr '02
Fabrication of Engineering Prototypes	1st qtr '01	1st qtr '02	4th qtr '04
System tests; **Final Design Review**	3rd qtr '02	1st qtr '03	1st qtr '05
Fabrication complete	4th qtr '03	4th qtr '03	3rd qtr '05
Installation complete	2rd qtr '04	2nd qtr '04	1st qtr '06
Shakedown; **Commissioning**	4th qtr '04	4th qtr '04	3rd qtr '06

Table 3: Schedule for LIGO II improvements (end dates)

Interferometer Configurations

Table 1: Tasks, Coordinators, Active Groups

Selection/Optimization (Fritschel)	LIGO/MIT, LIGO/Caltech, UF, GEO
Dual Recycling/Resonant Sideband Extraction (Strain)	ACIGA/ANU, GEO, LIGO/Caltech, UF
Sagnac Interferometers (Fejer)	Stanford
Squeezing (McClelland)	ACIGA/ANU
QND (Braginsky)	MSU, CaRT

Stochastic Forces - Isolation and suspensions

Table 2: Tasks, Coordinators, Active Groups

Internal Requirements (Gonzalez)	PSU, LIGO/MIT, Stanford
Configuration (Hough)	Joint activity, Design Summit
Controls (How)	Stanford, GEO, LIGO/MIT, PSU, JILA, CEGG
Passive Isolation (Giaime)	LIGO/Caltech, LIGO/MIT, PSU, JILA, GEO
Thermal/Excess Noise (Saulson)	Syracuse, LIGO/Caltech, Stanford, MSU, GEO, CEGG
Systems (Shoemaker)	LIGO/Caltech, LIGO/MIT, Stanford, PSU, LTU

Sensing Noise - Lasers and Optics.

Table 3: Tasks, Active Groups

Core Optics (Whitcomb)	LIGO/Caltech, Stanford, Syracuse, GEO, IAP
Contamination (Camp)	LIGO/Caltech, Stanford, IAP
Active compensation (Zucker)	LIGO/MIT, Stanford
Diffractive Optics (Munch)	CEGG, Stanford, ACIGA/Adelaide
Ancillary Optics (Reitze)	UFlorida, Stanford, LIGO/MIT, IAP
100 W Laser (Byer)	Stanford, LIGO/Caltech, ACIGA/Adelaide, GEO