

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY  
- LIGO -  
CALIFORNIA INSTITUTE OF TECHNOLOGY  
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**Development of Laser Interferometers for  
Gravitational Wave Detection:  
Abstract and Summary**

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Development of Laser Interferometers for Gravitational Wave Detection

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Abstract

The Laser Interferometer Gravitational-wave Observatory Project is developing facilities aimed at detecting gravitational waves. The detectors will use two remote 4 km-long Fabry-Perot Michelson interferometers with an unprecedentedly high sensitivity.

## Development of Laser Interferometers for Gravitational Wave Detection

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### Summary

The Laser Interferometer Gravitational-wave Observatory (LIGO) project [1] by California Institute of Technology and Massachusetts Institute of Technology aims to detect and study gravitational waves from astrophysical sources (See Figure 1). The LIGO detectors will use highly sensitive laser interferometry between suspended test masses over two 4 km-long arms perpendicular to each other; gravitational waves are expected to produce differential arm length changes on the order of  $10^{-18}$  m several times per year. Attaining a sensitivity good enough to detect such a small motion places extreme demands on the performance of the optical systems as well as mechanical systems of the detectors.

LIGO relies on high-power high-quality laser beams, high-quality mirrors, and a sophisticated interferometer configuration to improve sensitivity [2]. LIGO will use a 10 W Nd:YAG laser, which is being developed by Lightwave Electronics Corp. The laser will be stabilized in intensity and frequency to an extremely high level with TEM<sub>00</sub> mode. Mirrors for LIGO, which are 25 cm

in diameter, require state-of-the-art low loss performance. A program is underway with industry to develop and test the technology for appropriate polishing and coating. An optical configuration adopted for LIGO is a recycled Fabry-Perot Michelson interferometer as shown in Figure 2. The use of the “recycling” mirror is equivalent to increasing the laser power.

A 40 m-long prototype [3] in California Institute of Technology is one of the principal research tools in this effort for testing many of the features of the planned 4 km-long detectors. The sensitivity attained on the 40 m prototype (Figure 3) is close to the expected limits, which gives us confidence that the sensitivity will scale up with size when LIGO detectors become operational.

Civil construction of two facilities (in Washington and Louisiana) is under way and is expected to be completed by 1998. The detectors, which are under development are scheduled to become operable in the year 2000 with the expectation of detecting gravitational waves shortly thereafter.

#### References

- [1] A. Abramovici, W. Althouse, R. Drever, Y. Gursel, S. Kawamura, F. Raab, D. Shoemaker, L. Sievers, R. Spero, K. Thorne, R. Vogt, R. Weiss, S. Whitcomb, and M. Zucker, “LIGO: The Laser Interferometer Gravitational-Wave Observatory”, *Science* **256** (1992) p.325
- [2] R. E. Spero and S. E. Whitcomb, “The Laser Interferometer Gravitational-wave Observatory (LIGO)”, *Optics & Photonics News*, v.6, no.7 (1995), p.35
- [3] A. Abramovici, W. Althouse, J. Camp, D. Durance, J. Giaime, S. Kawamura, A. Kuhnert, T. Lyons, F. Raab, R. Savage, D. Shoemaker, L. Sievers, R. Spero, R. Vogt, R. Weiss, S. Whitcomb, and M. Zucker, “Improved Sensitivity in a Gravitational Wave Interferometer and Implications for LIGO”, *Phys. Lett.* **A218** (1996) p.157

## Figure Captions

Figure 1: Conceptual sketch of the LIGO facility.

Figure 2: Schematic view of the LIGO interferometer.

Figure 3: Sensitivity of the 40m prototype.

**See the picture attached!**

Figure 1

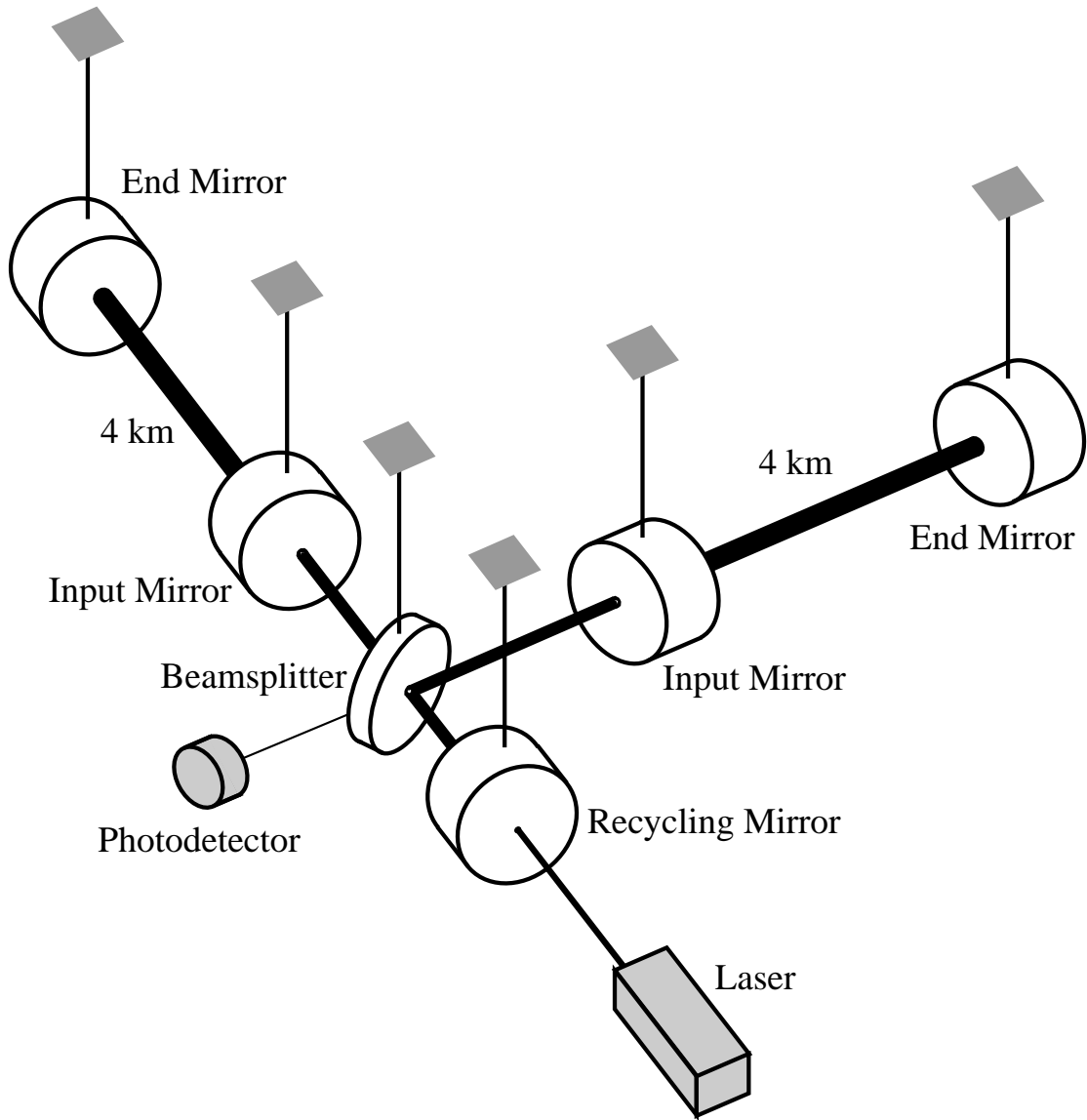


Figure 2

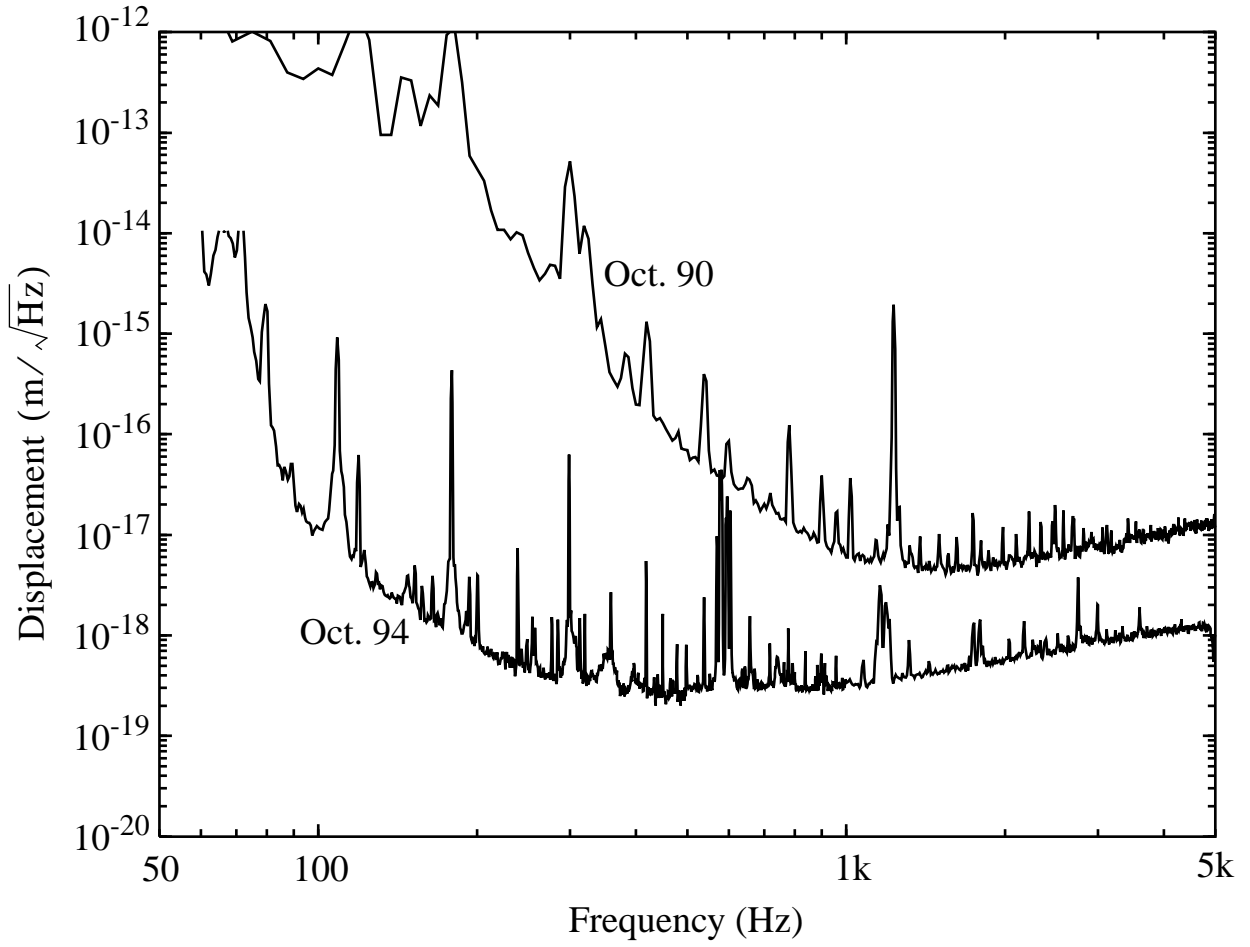


Figure 3