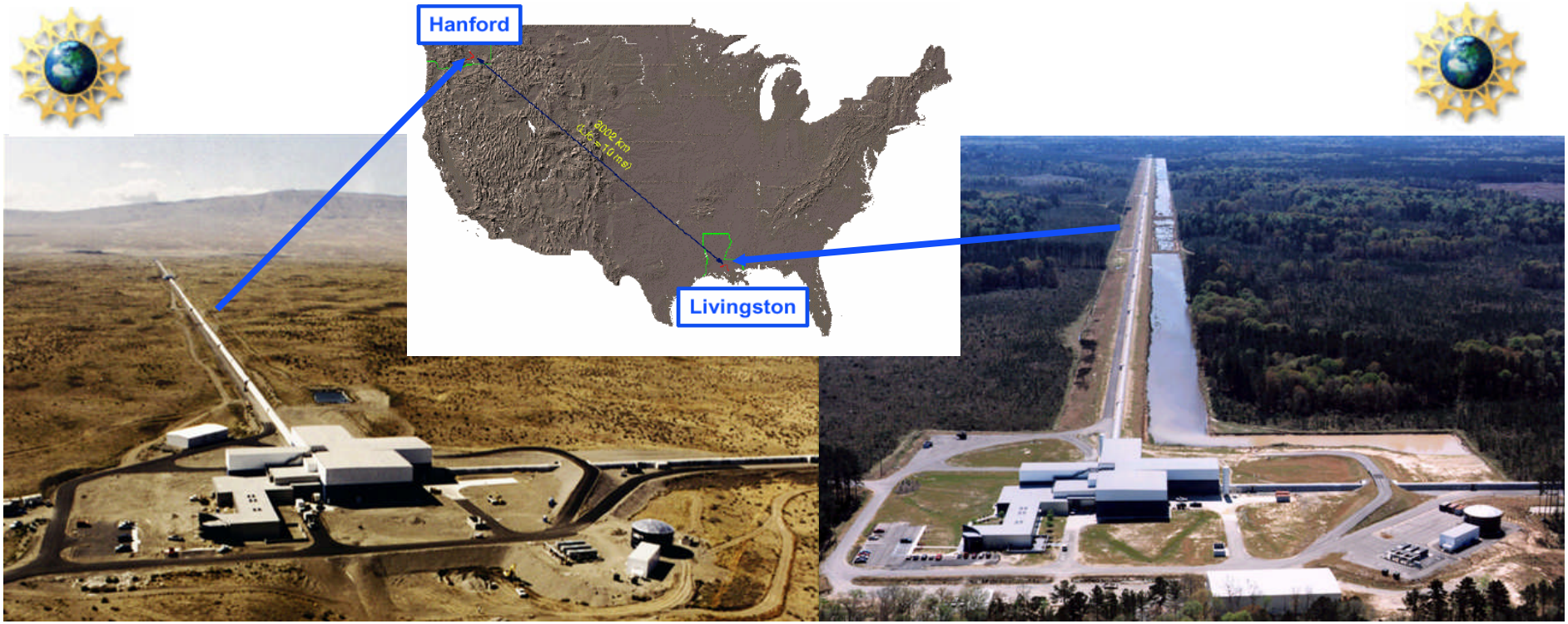
# The Laser Interferometer Gravitational Wave Observatory

G070301-00-Z

- The LIGO gravitational wave detector consists of two observatories
  - » LIGO Hanford Observatory – 2 interferometers (4 km long arms and 2 km long arms)
  - » LIGO Livingston Observatory – 1 interferometers (4 km long)
- Funded by the National Science Foundation
- Operated by the California Institute of Technology and Massachusetts Institute of Technology
- Funded in 1992, began construction in 1997, began operation in 2001



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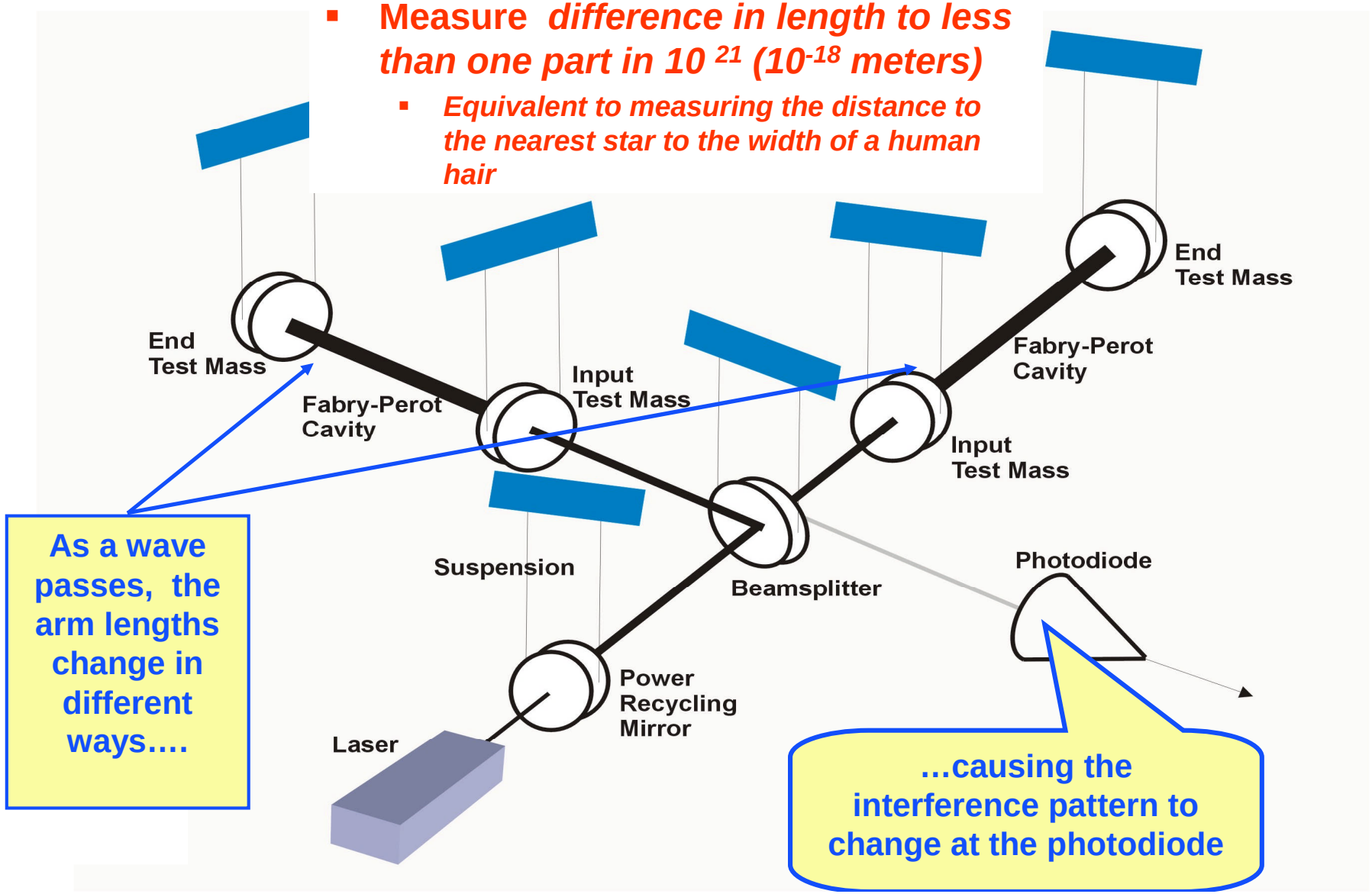
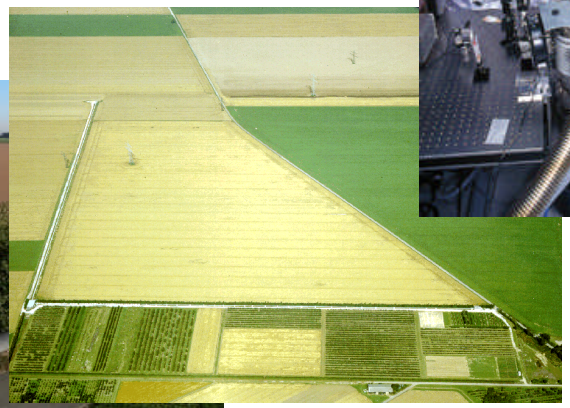
- **Measure *difference in length to less than one part in $10^{21}$ ($10^{-18}$ meters)***
  - ***Equivalent to measuring the distance to the nearest star to the width of a human hair***



# GEO600

G070301-00-Z

- LIGO runs in collaboration with the GEO600, the German-British interferometer in Hannover Germany
  - » Operated as one of the four LSC detectors and has been taking data since 2002.
  - » Also a think-tank and test-bed for the technical improvements for future gravitational wave detectors.



MAX-PLANCK-GESELLSCHAFT

Science & Technology Facilities Council

Leibniz Universität Hannover

UNIVERSITY of GLASGOW

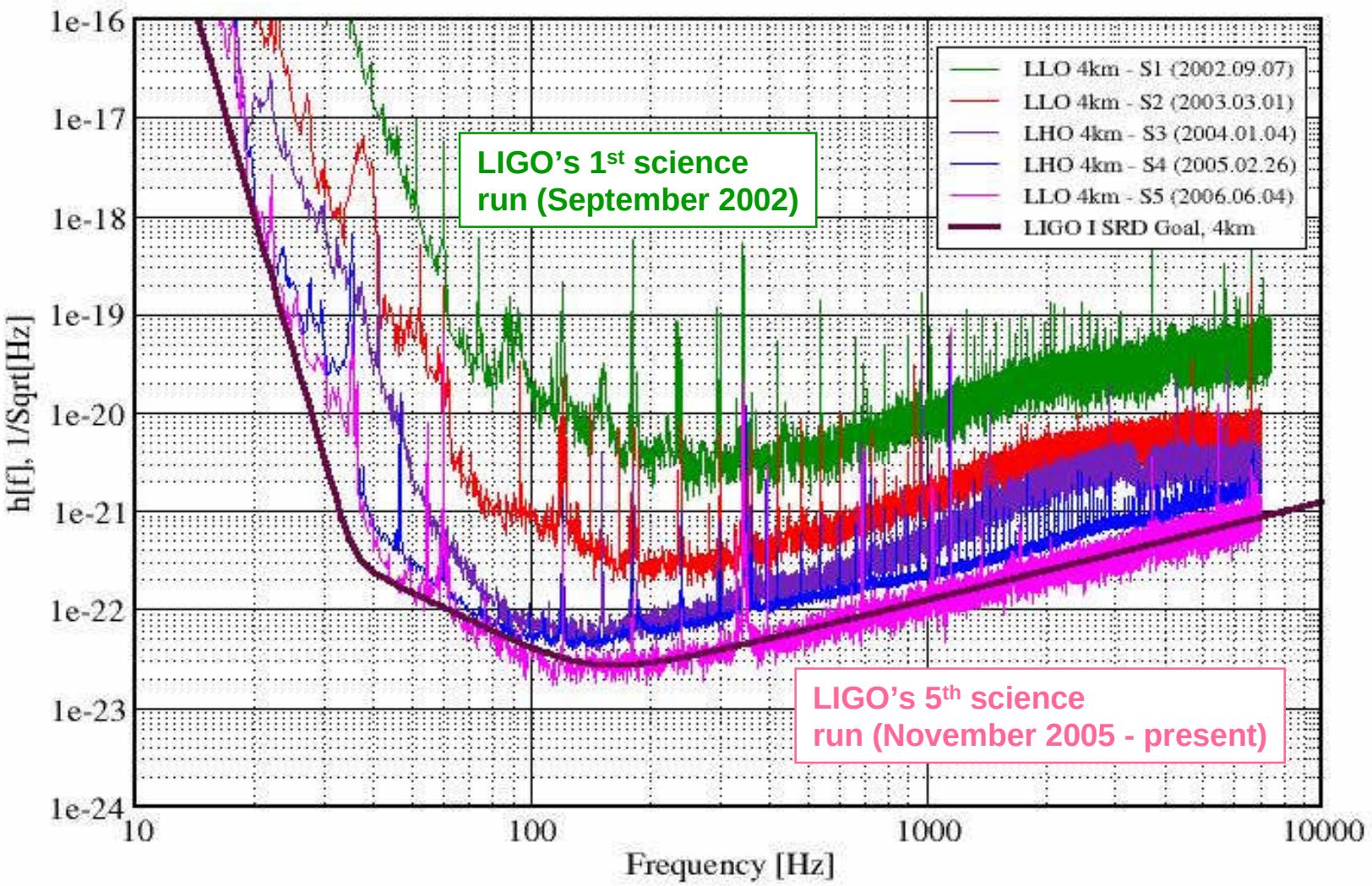
# The LIGO Scientific Collaboration




The LSC has members from **11** countries:

- USA, Australia, Germany, India, Italy, Japan, Hungary, Poland, Spain, Russia, United Kingdom

# A History of LIGO in Sensitivity



# Highlights of LSC Science

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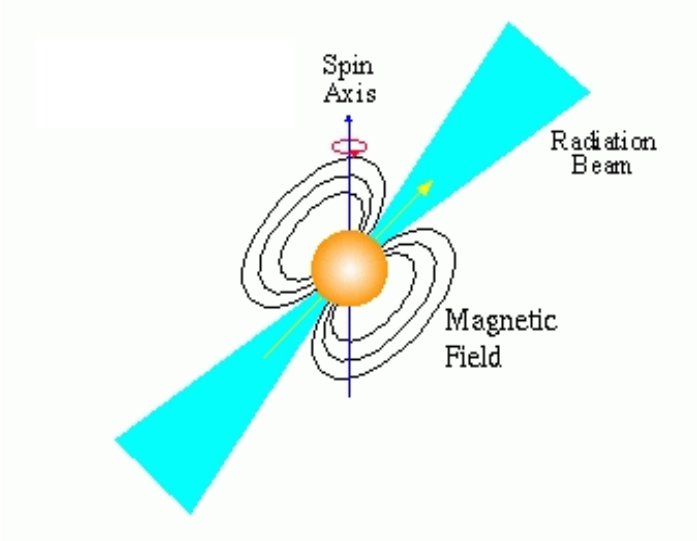
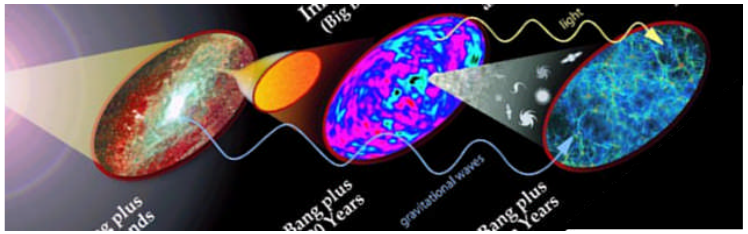
- *Pulsars*
  - » Search for signals from 100 known pulsars in the galaxy
  - » Best upper limits on pulsar ellipticity (PSR J2124-3358) of 1 part in 10 million
    - – ~ 1 mm deviation from sphere for 10 km
  - » Upper limit for GW emission from the Crab pulsar is less than twice the spin-down limit
    - – Less than 10% of the energy is radiated by GWs




- *Primordial stochastic Gravitational wave background*
  - » Constrain fraction of closure density of the universe in GWs
    - – in our frequency band, less than 65 parts per million of the energy density is made up of gravitational waves



# The Global Network Will Give Us:

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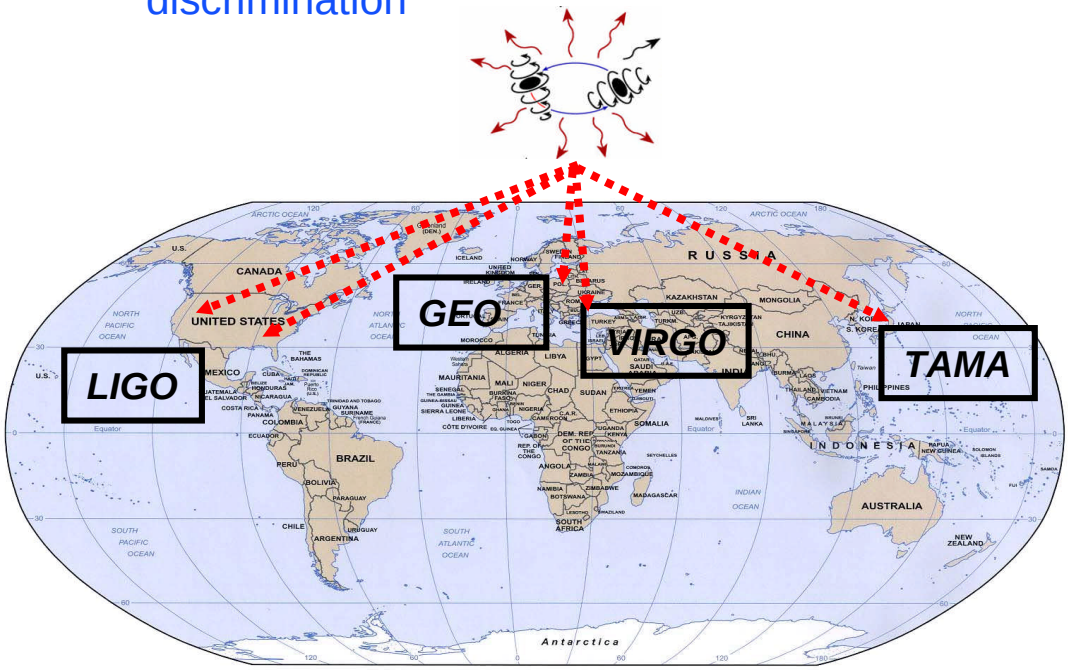
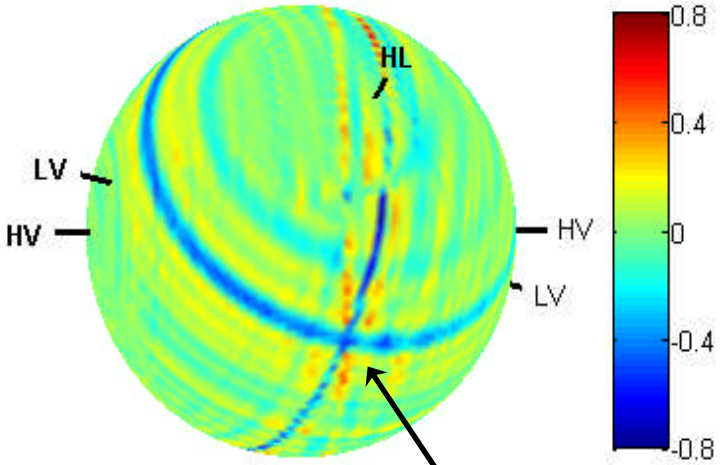
- *Better detections*: Coincidence through redundancy
- *Coverage*: Ability to be 'on the air' with one or more detectors
- *Source location*: Ability to triangulate and more accurately pinpoint source locations in the sky
- *Polarization*: array of oriented detectors is sensitive to two polarizations
- *Coherent analysis*: optimal waveform and coordinate reconstruction, better discrimination



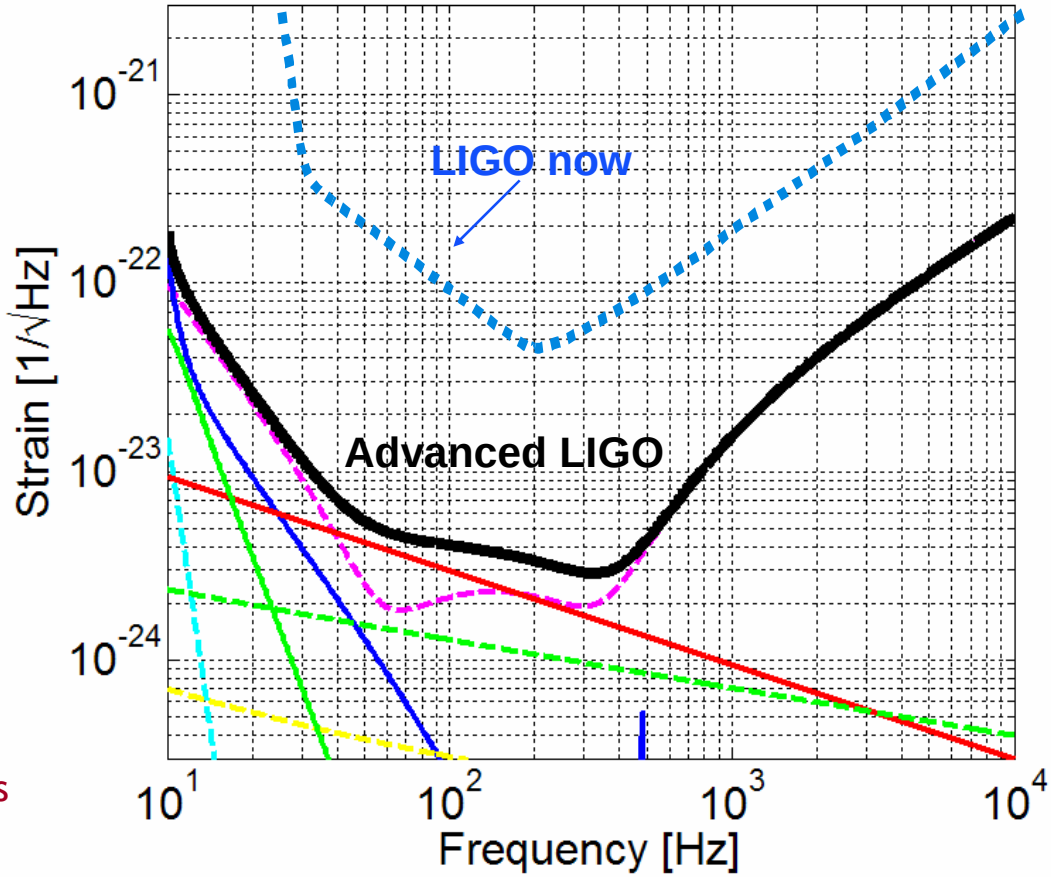




source location

# Advanced LIGO

G070301-00-Z

- LIGO is currently detection rate-limited at 0.01 events per year for NS/NS inspirals
- Advanced LIGO will increase sensitivity (hence rate) over initial LIGO
  - » range $r \sim h$
  - » Event rate $\sim r^3$
- Most probable NS/NS event rate in Advanced LIGO is 40/yr
- Anticipate funding to start in October 2007, construction to begin in 2011; operation in 2014
  - » GEO600 contributes suspensions (UK Science & Technology Facilities Research Council) and lasers (MPG)



# The Gravitational Wave Universe