

## Advanced technology used in LIGO

LIGO (Laser Interferometer for Gravitational-Wave Observatory) is one of the technological marvel involving world's advanced technology. It has overcome many difficulties to achieve one of the finest scientific measurements ever taken precisely. Its extreme engineering can be divided into different domains including mechanical structures, optics, civil engineering, physics, geology, electronics, high performance computation, analysis, testing, etc. Some of the following are the advances in LIGO experiment:

**Vacuum tubes:** The vacuum tubes are world's third largest vacuum tubes having one trillionth of pressure as that of the atmospheric pressure carried by very thin walls for 20 years now. Its a blind L shaped 4 km long tubes and it took 40 days to achieve this vacuum. Also it is second in the world for having Ultra-High vacuum in the tubes.

**Sensitivity:** It is able to measure motion 10000 times smaller than the atomic nucleus. It has some of the best seismic isolation and dampening systems e.g. HAM AUX. Its accuracy of measuring the distance of the nearest star (4.2 light years) is smaller than the human hair.

**Civil Construction:** The length of the tubes is 4 Km long. While construction care had to be taken to overcome the Earth's curvature of about one meter by pouring concrete. Also CFD models were taken into account while constructing the structure to cancel the wind load effect on the tubes giving rise to vibrations.

**Optics:** LIGO's main mirror absorb only one photon out of 3.3 million photons. The test masses each weigh 40 Kg giving acting as large inertial masses to resist vibrations upto certain level. The test masses are coated with many optical coatings and polished to a nanometer smoothness. There are 280 reflections before reaching the photo detector.

**Laser:** It uses electricity to generate 4 watt near-IR laser. It is 800 times more powerful than off-the-shelf laser pointers. The control and use of this laser is a very complex game of optics and electronics.

These are very few engineering marvels involved. It has many important and complex electronics and computers involved in its complete operation which can be studied and discussed in detail.