Gravitational Wave Astronomy Module

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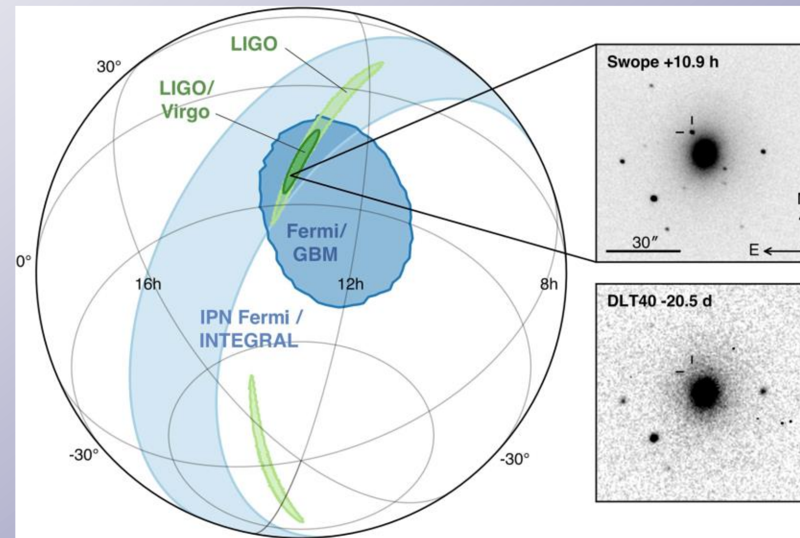
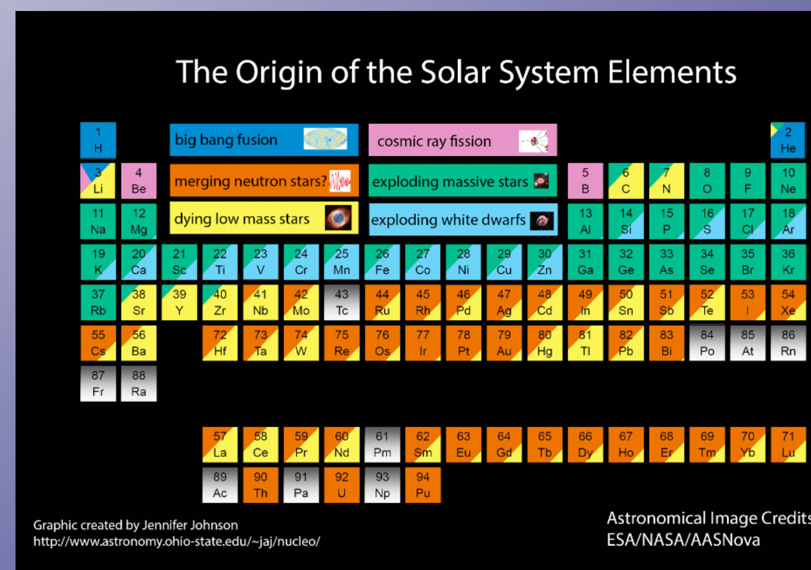
GW Astronomy





Virgo and LIGO sensitivity

Imagine to drop a glass of wine (or water) in the ocean…….

Ocean Surface (S):
70% x 4π x R_terra^2 =
0.7 x 4 x 3.14 x (6.37e6 m)^2
~ 3.6e14 m^2

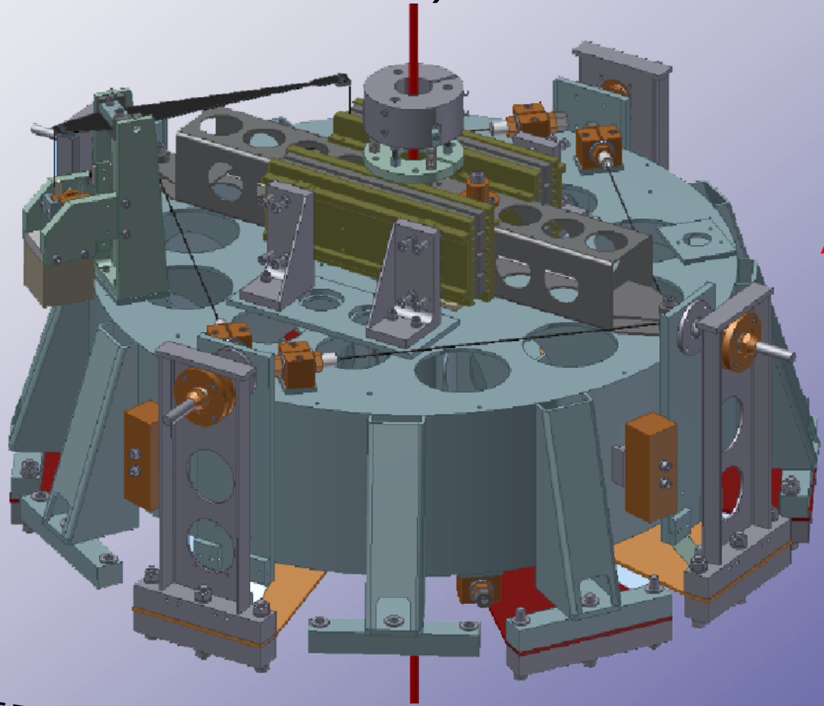
Volume of the glass (V):
~ 0.25e-3 m^3

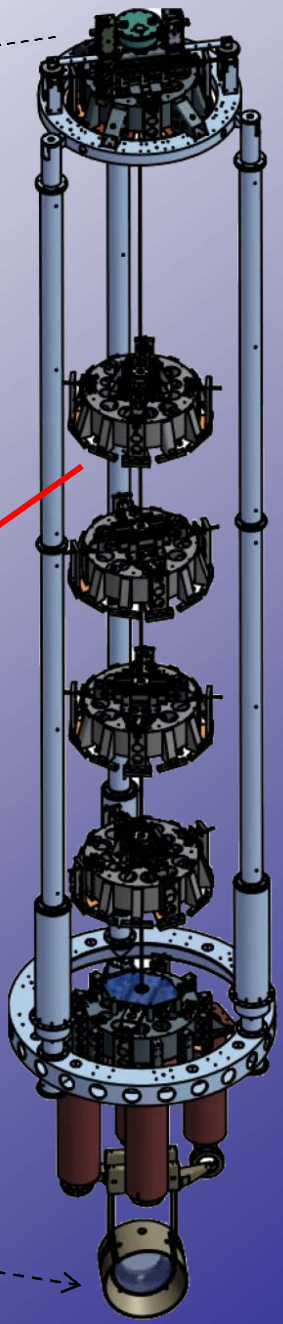
Increase of the global sea level:
h ~ V / S ~ 1e-18 m

This is the level of sensitivity we need to reach with GW detectors !!

VIRGO superattenuator

It's able to attenuate the seismic motion of the mirrors by more than a factor 10^{12} (a million of a million times)





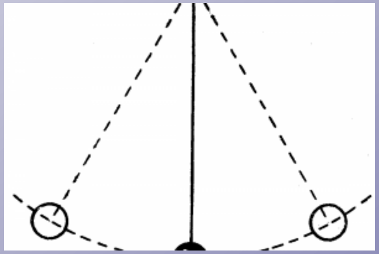
Standard filter

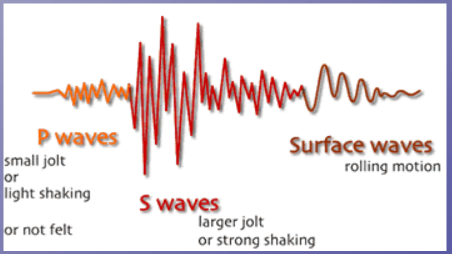
Suspended mirror

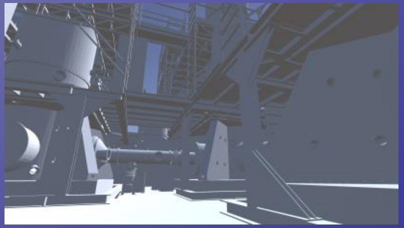
GW Module
The demonstrators

- ***Discovering and building a Michelson interferometer***
- ***The pendulum***
- ***Earthquake Interferometer***
- ***Finding Black Holes in a Chirp***
- **Gravitational Wave Noise Hunting**
- Control (Class)room
- VIRGO Virtual Visits

http://www.frontiers-project.eu/gravitational-wave-astronomy/

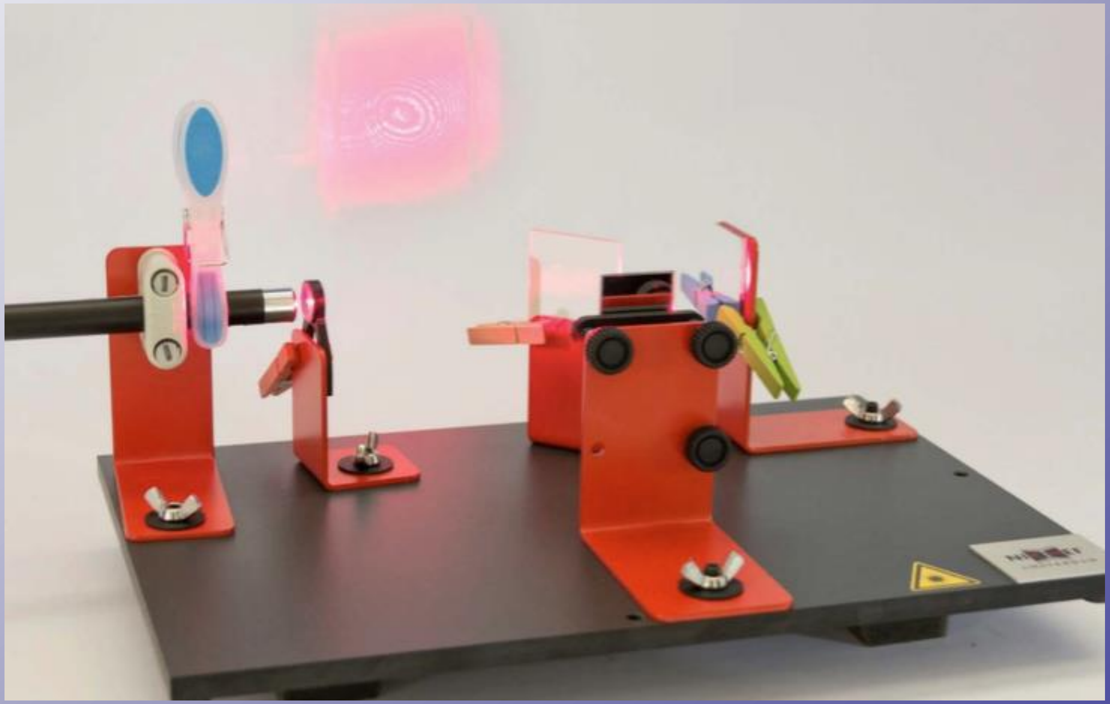






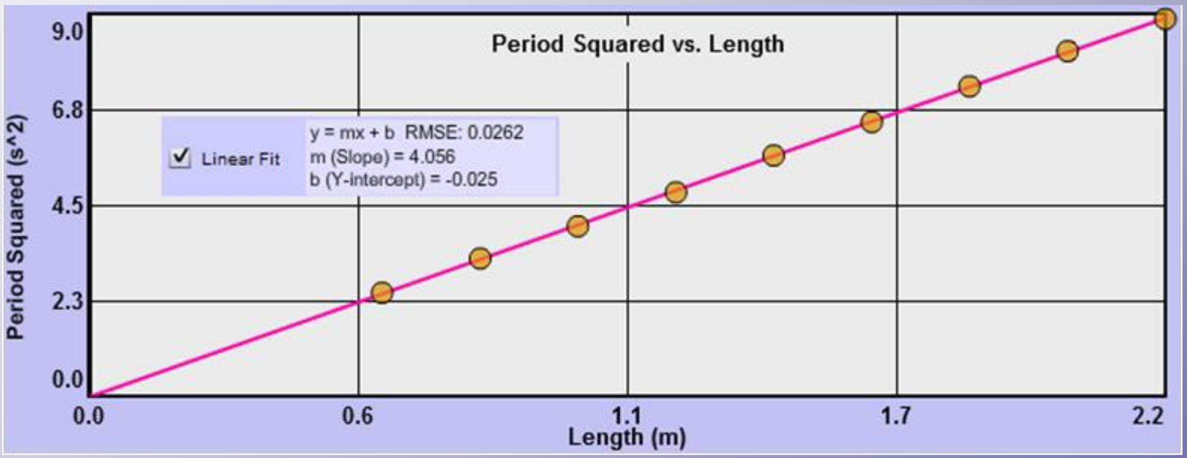
GW Demonstrators
Build an interferometer in your class!

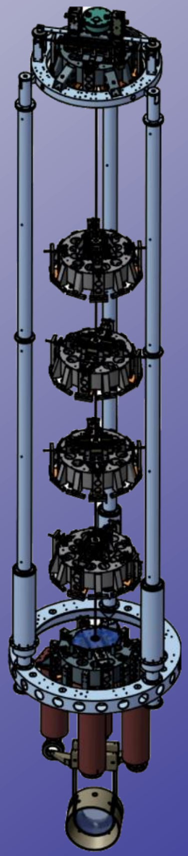
- We will assemble a Michelson interferometer using a small construction kit developed by NIKHEF, the Dutch National Institute for Subatomic Physics, a high energy and astroparticle physics laboratory in Amsterdam, Netherlands, which participates to the Virgo experiment.
- The NIKHEF interferometer costs around € 70 + VAT. The same interferometer can also be built with simple optical components.



GW Demonstrators
The pendulum

- In this lesson we will explore the pendulum, a very simple mechanical system but at the same time an extremely powerful tool for exploring physical phenomena such as oscillations, gravity, the transmission of vibrations and also the concepts of speed, acceleration, energy and resonance.



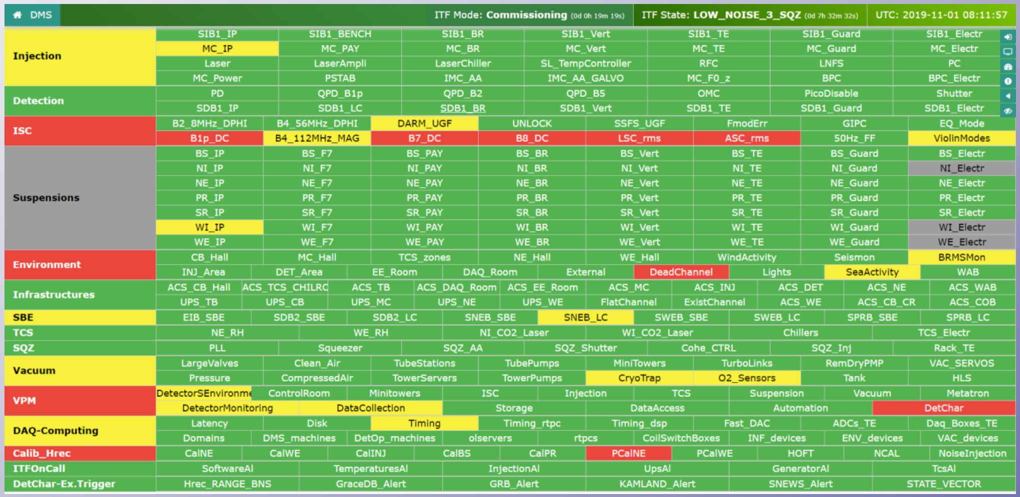


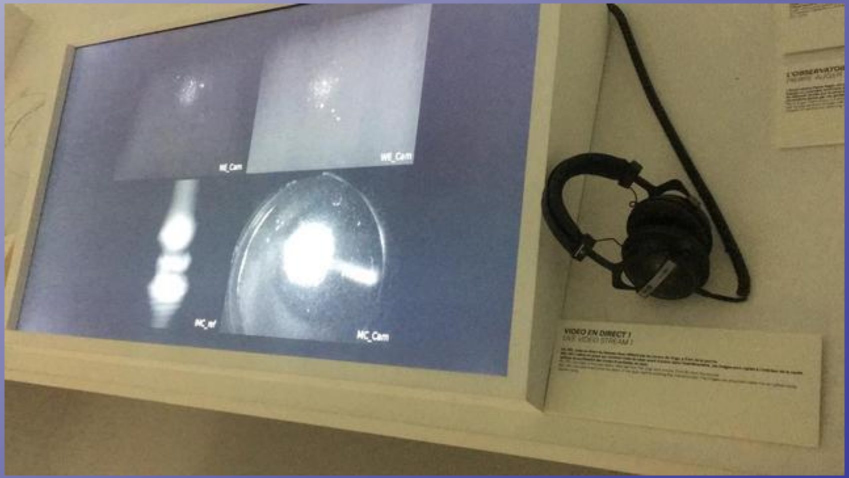
GW Demonstrators
Control (class)room

Whether you are detecting gravitational waves or measuring colliding particles, the control room is where all the magic happens !!

GW Demonstrators
Control (class)room

Using simply a set of PCs or Raspberry PIs you can have all the data shown in the control room in your class !!

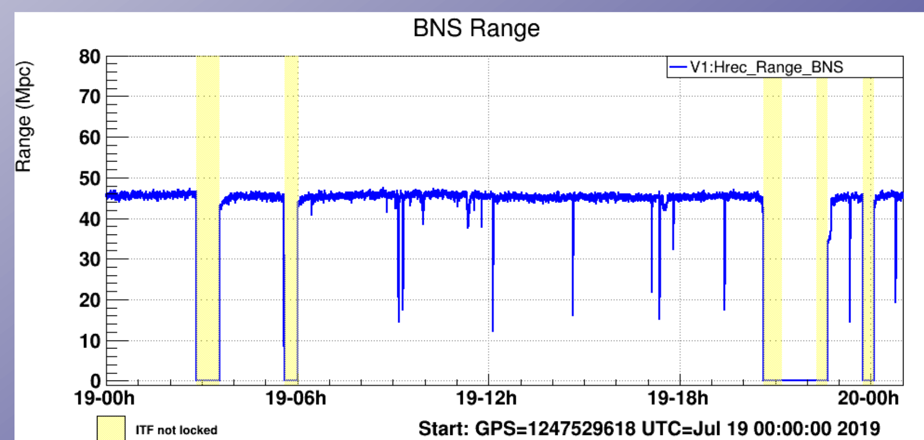




GW Demonstrators
Earthquake interferometer

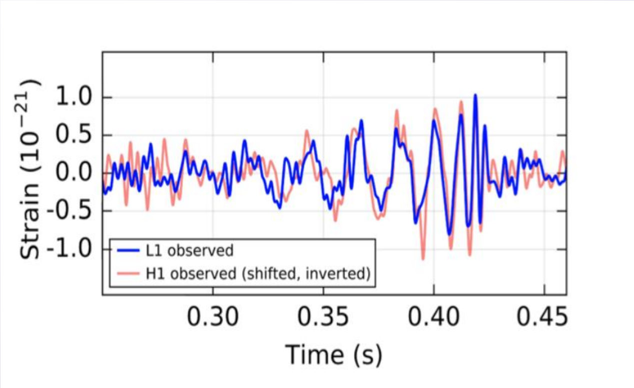
How can you use Virgo data ? Control room data constitute a powerful tool to understand how the environment interact with the detector

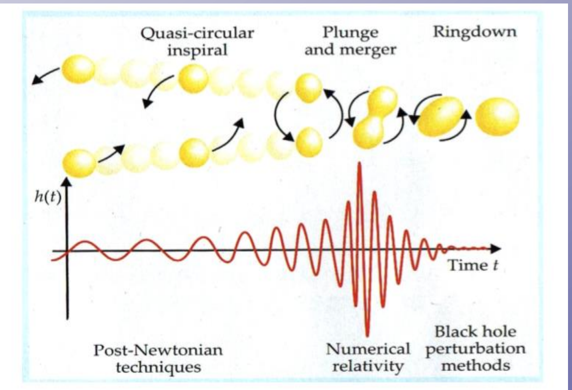
- What is the effect of the wind on Virgo ?
- What is the effect of the sea waves ?
- What happen when an earthquake reach the Virgo site ?

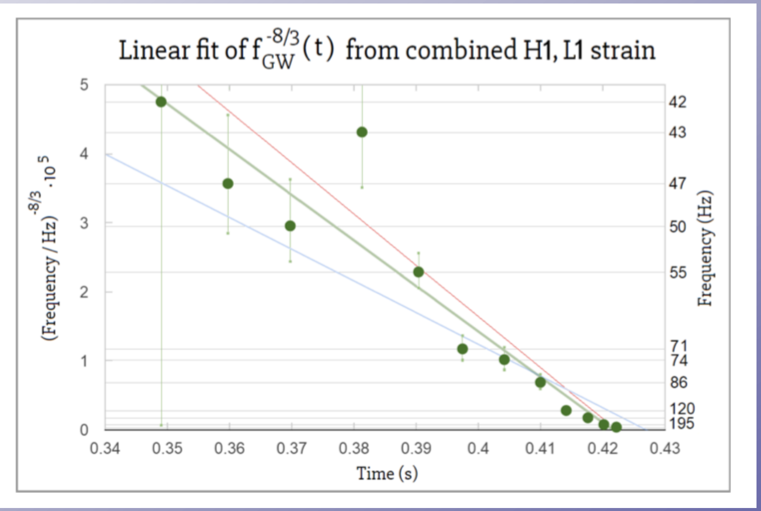


GW Demonstrators
Finding black holes in a chirp

Using LIGO/Virgo data, students will learn how to determine the masses and the radius of a binary system, to identify the two objects as black holes, and what are the fundamental properties and parameters of a black hole.







$$\mathcal{M} = \left[\frac{5K}{(8\pi)^{8/3}}\right]^{3/5} \frac{c^3}{G}$$