STAR workshop :Virgo news

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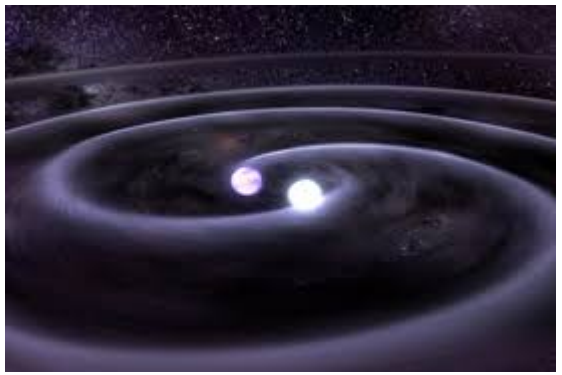
Gravitational waves

- Solution of the Einstein’s equations
- 2 polarisations “x” et “+”
- quadrupole

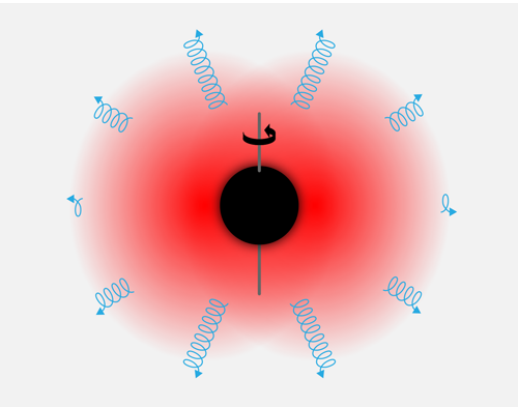
Sources

Coalescence of compact objects



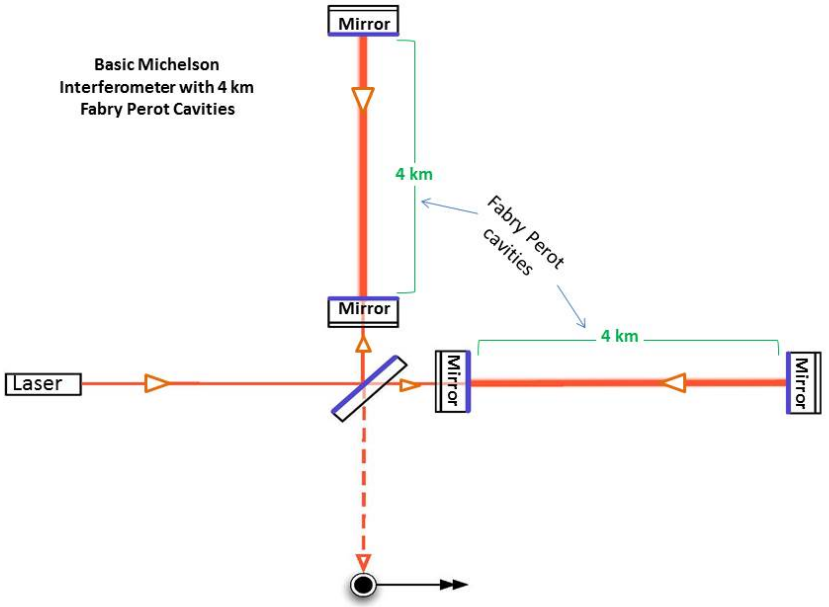
Pulsar

Superradiance of bosons



Detection

- LIGO-Virgo collaboration
- Use of Michelson interferometer
- 2 in USA, 1 in Italy

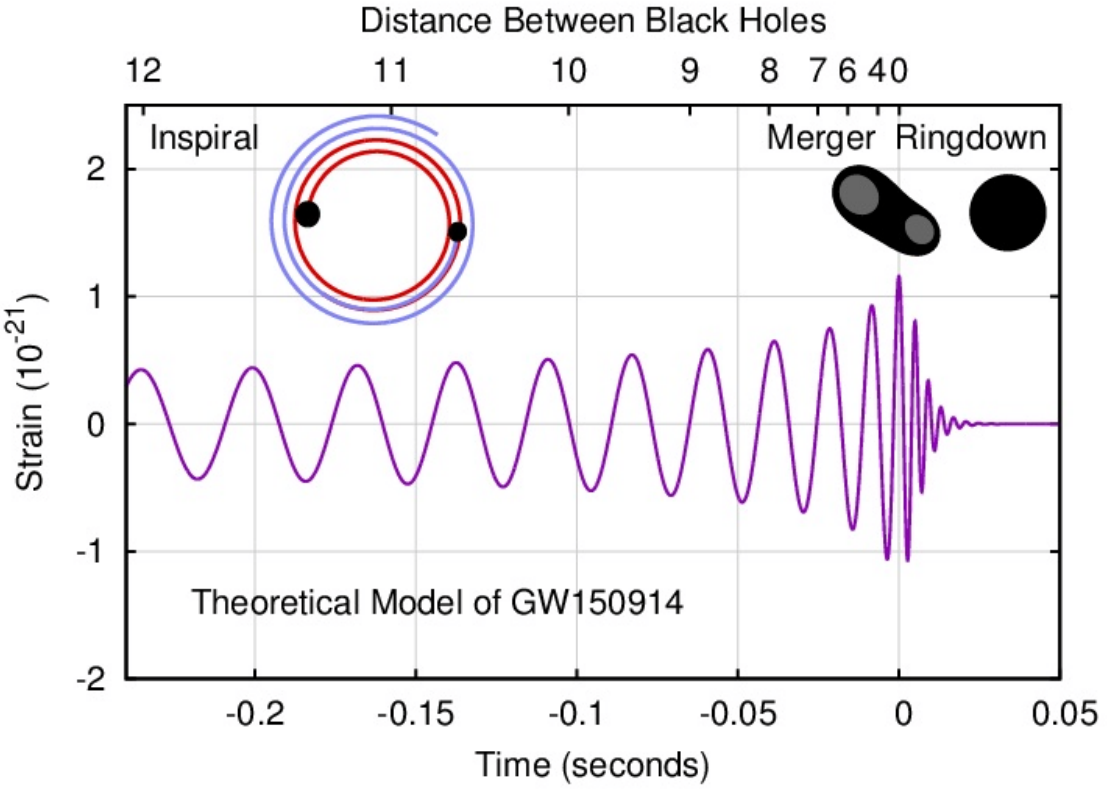


When a gravitational waves pass through the detector, one arm is contracted and the other one is dilated.

Length of the arm : 3km for Virgo

Precision of the interferometer : 10^{-18} m

Coalescence of compact objects

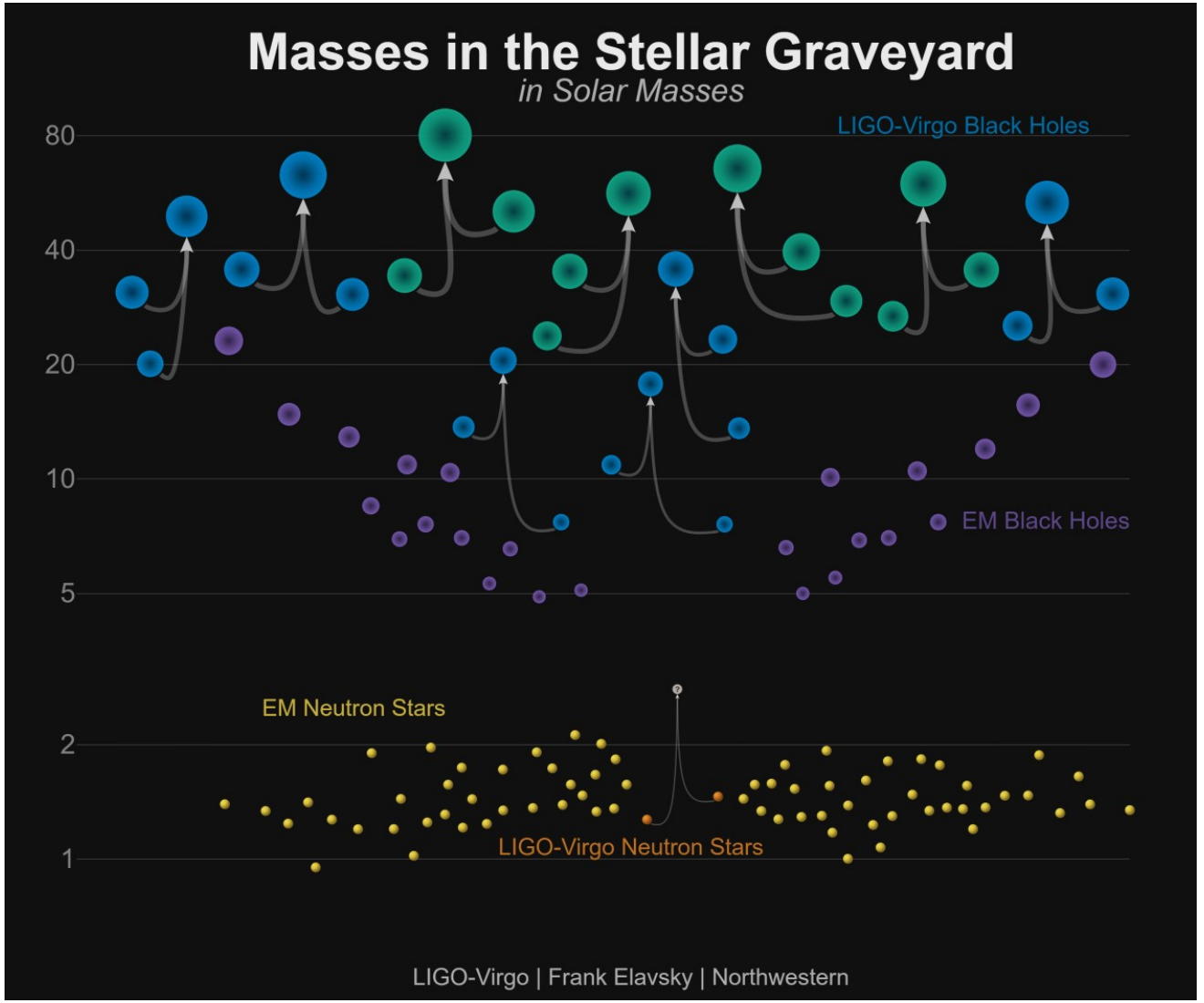


<u>3 phases for coalescence</u>

- Inspiral
- Merger
- Ringdown

Matched filter technique for detection of these gravitational waves

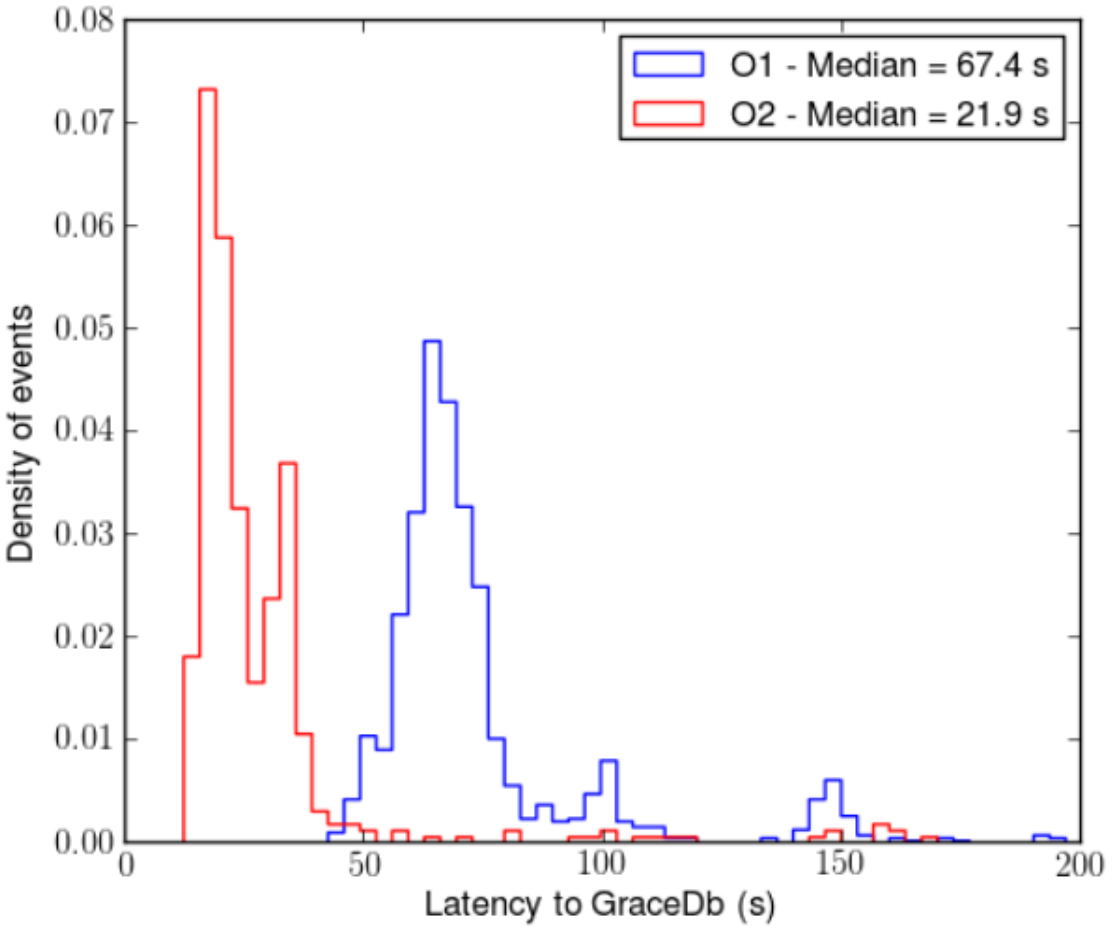
Actual detections



- 10 coalescences of black holes
- 1 coalescence of neutrons stars

4 of the 10 coalescences of black holes come from a second analyses of the first and second run of observation

The analyses upgrades : low latency



arXiv:1901.08580

- GW151226 detected with delay of 70 secondes
- Use a new filter => detectable in 20 secondes

Useful for **multi messenger astronomy**

The analyses upgrades : bank and likelihood

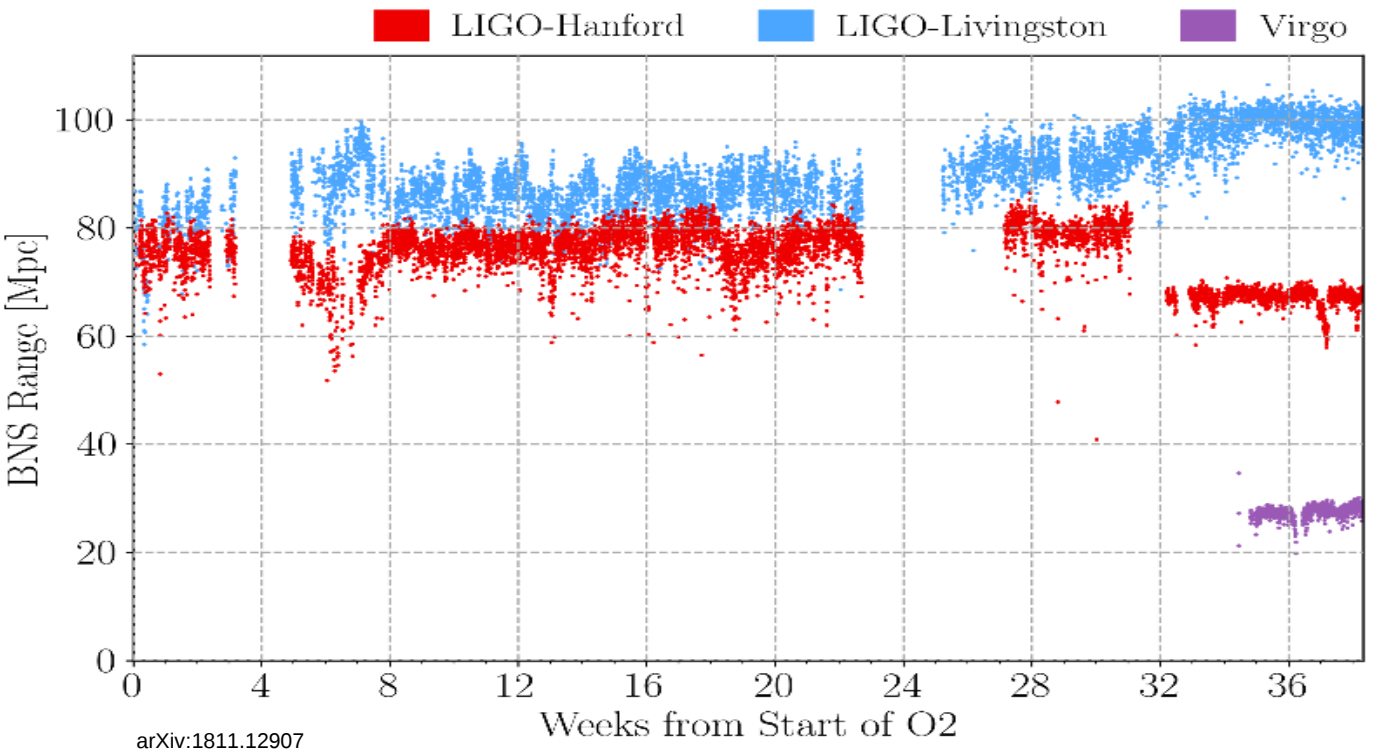
1) Template bank

- Old bank : 2 solar mass – 100 solar mass
- New bank : 2 solar mass – 400 solar mass

2) Likelihood

- Inclusion of phase and time delay into the likelihood

O2 : Virgo enters into the game



arXiv:1811.12907

- At the end of O2 Virgo was able to detect up to 30 Mpc
- GW170814 detected by the 3 interferometers

Recent upgrade : 50Mpc

Technical upgrades

- Laser upgrade :

At high frequency, the noise is dominated by the **shot noise** $s \sim \sqrt{I}$

Higher intensity of the laser = weaker shot noise

- Light squeezing :

At low frenquency, the noise is dominated by the **radiation pressure**

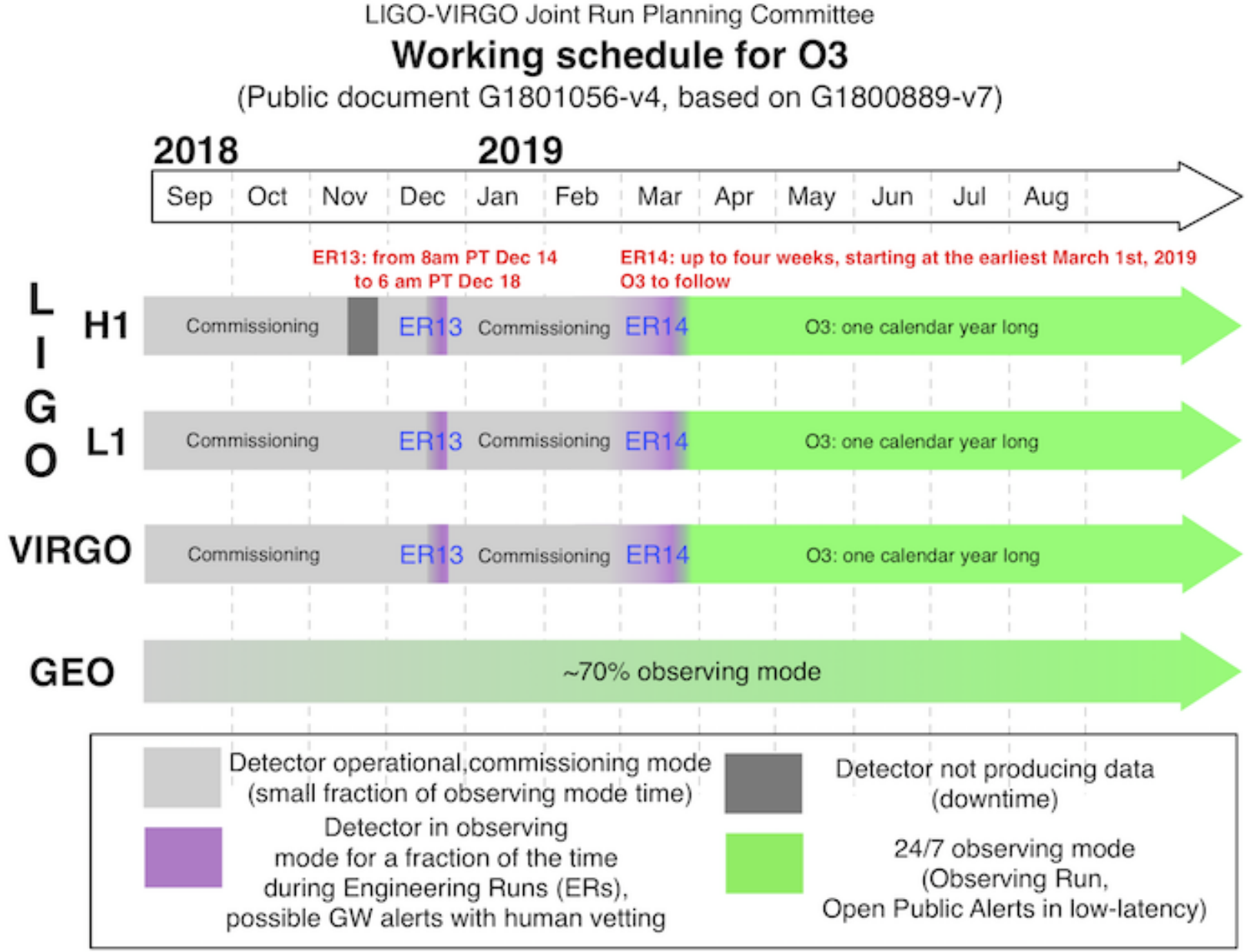
$$\Delta x \Delta p \geq \frac{\hbar}{2}$$

- Minimise the error on the phase
- Maximise the error on the amplitude

The objectives

- Number of events for O3 : **50 more**
- Distance for Virgo : 60Mpc for neutron star
- Triple detection and better localisation
- Multimessenger

The next months



Thank you for your attention