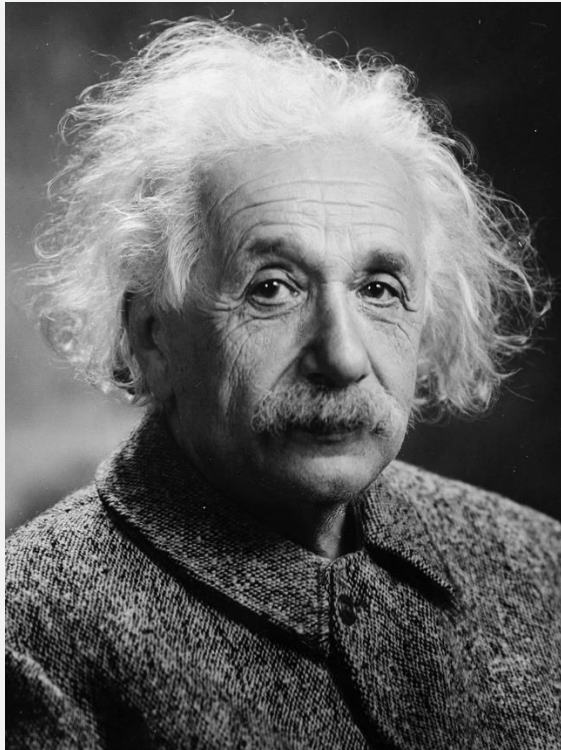
The background of the slide features a visualization of gravitational waves, showing concentric, wavy lines in shades of blue and white against a dark blue background. In the top-left corner, there are several colored circles: a large pink one, a medium brown one, and a small blue one. In the bottom-left corner, there are a large pink circle, a medium blue circle, and a small yellow circle.

# Gravitational waves data analysis

**An introduction**

Melissa Lopez  
12th February 2025

# Brief history of gravitational waves (GW)



Albert Einstein

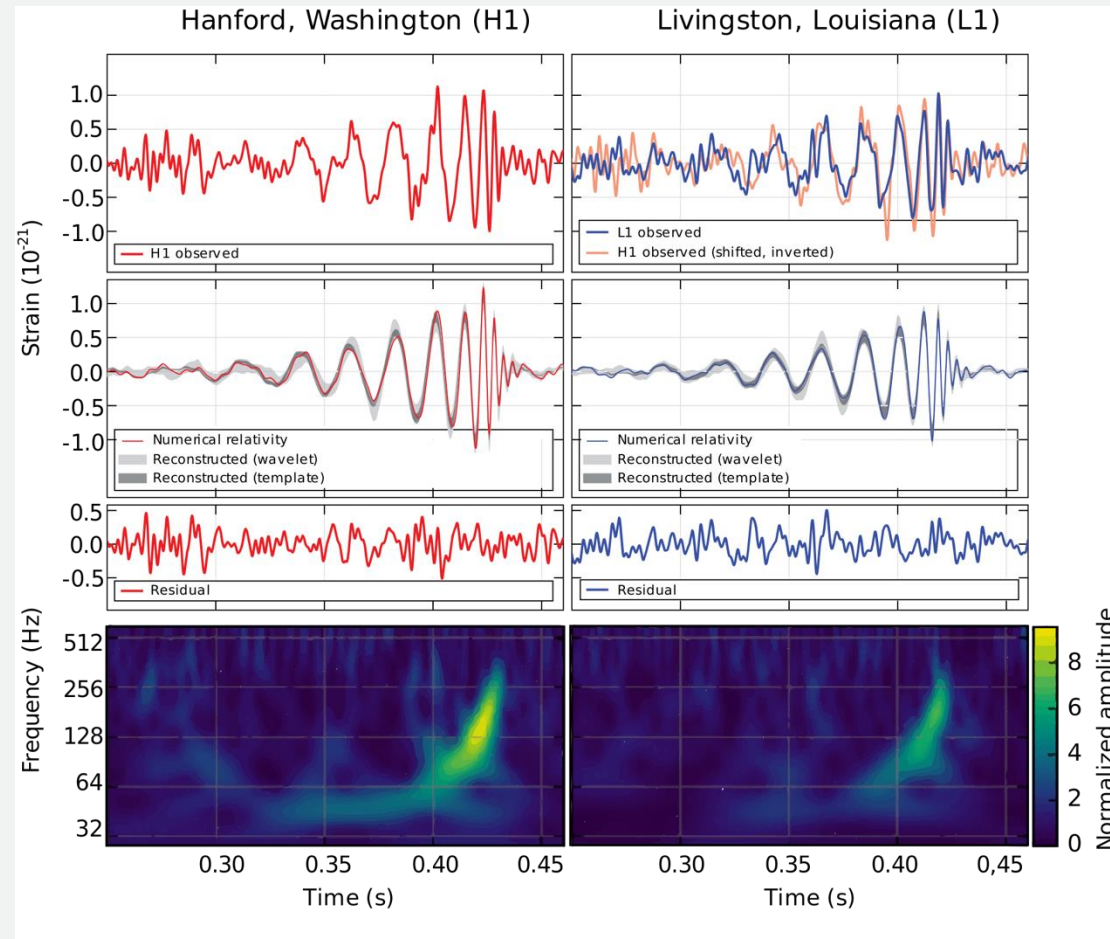
Einstein (1916)  
"GW are ripples in  
space-time"

Nobel prize (2017)

LIGO/Virgo (2015)  
1st GW detection

# What are gravitational waves (GW)?

Einstein (1916): “GW are ripples in space-time”

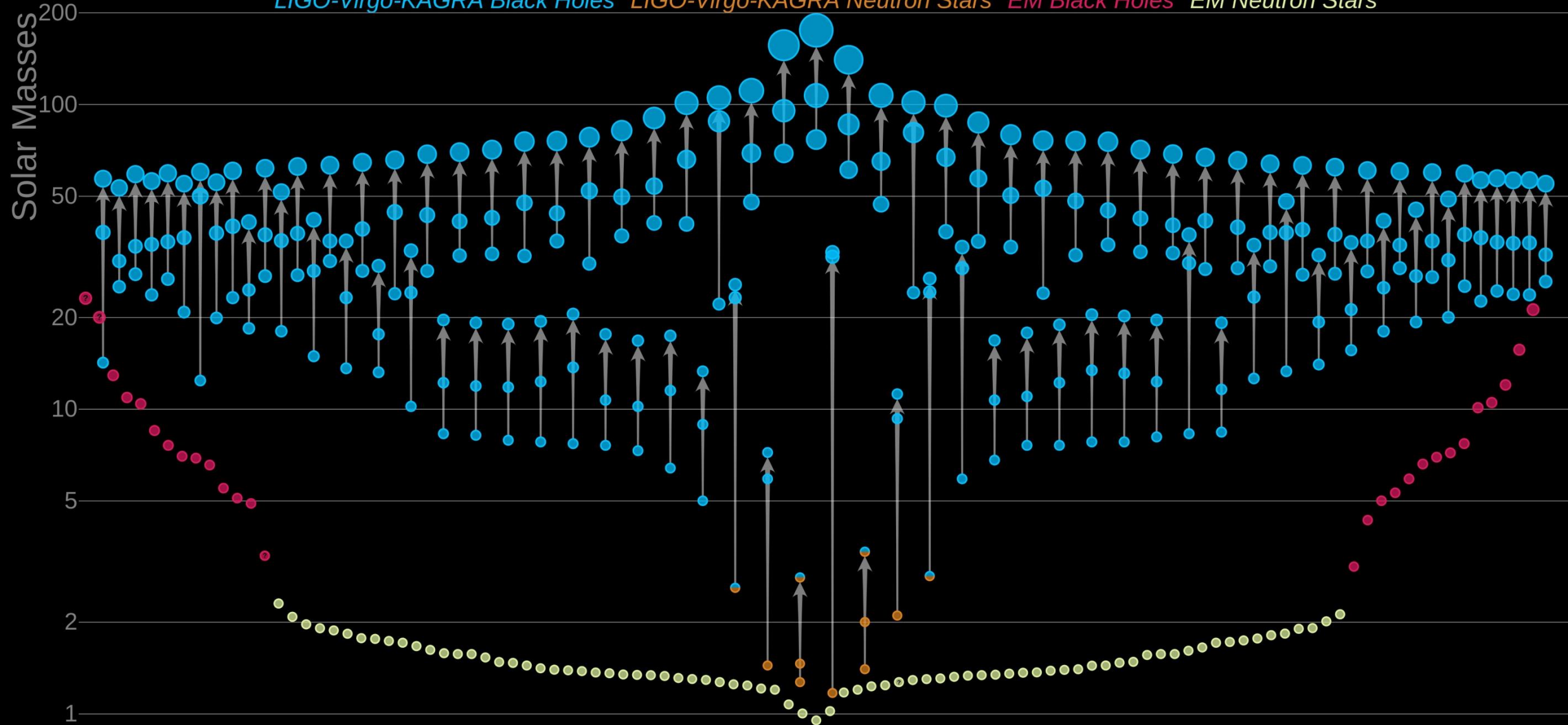


Credits: Shanika Galaudage



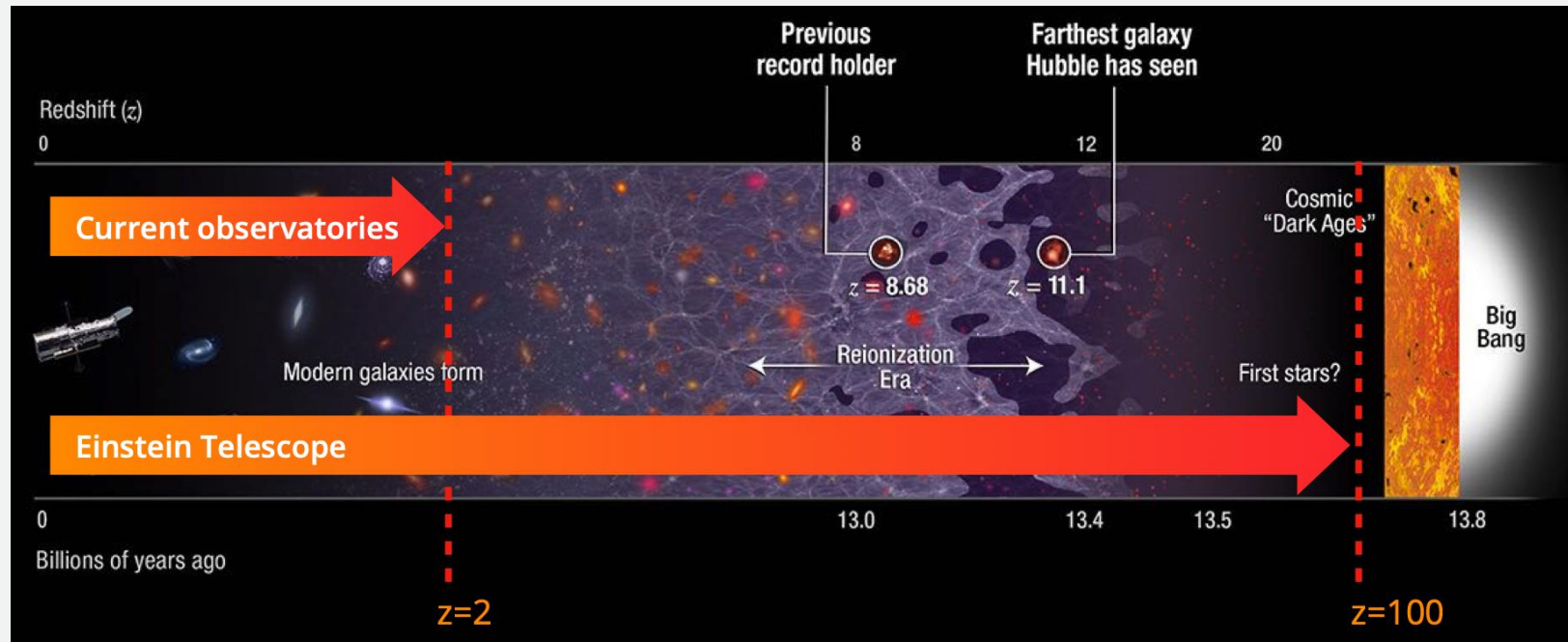
# Masses in the Stellar Graveyard

*LIGO-Virgo-KAGRA Black Holes* *LIGO-Virgo-KAGRA Neutron Stars* *EM Black Holes* *EM Neutron Stars*



# Listening to the symphony of the Universe with Einstein Telescope

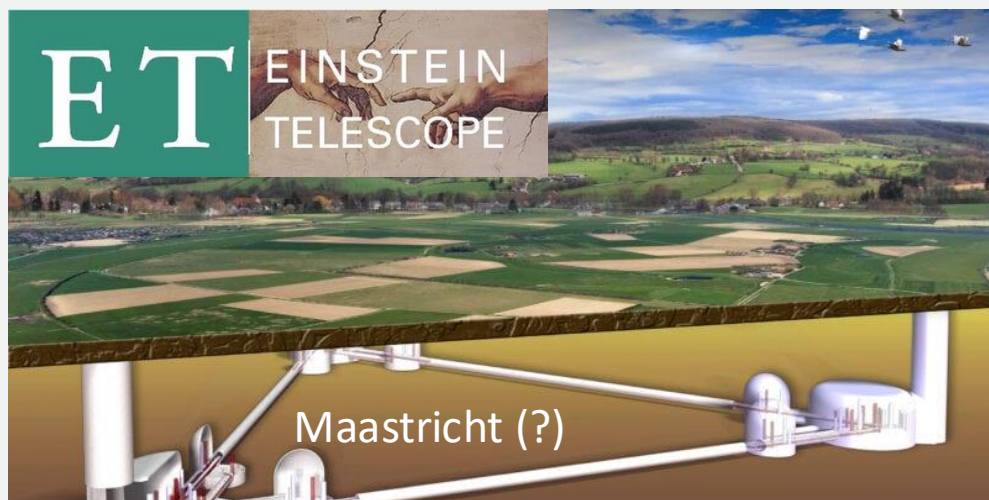
Credits: Andreas Freise



We will see *more* signals for *longer times*

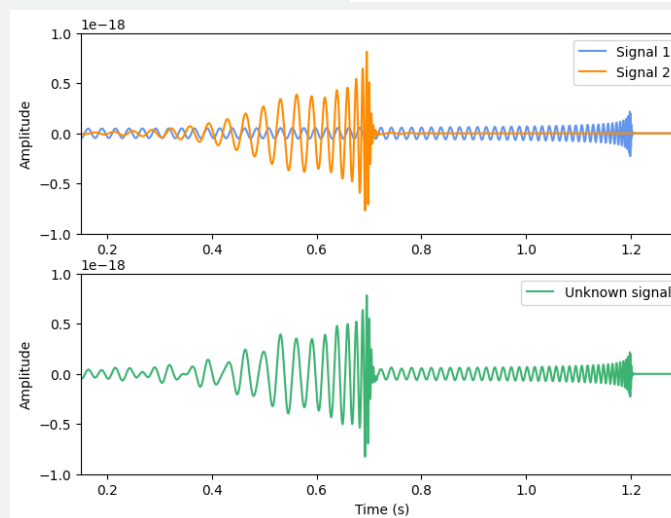
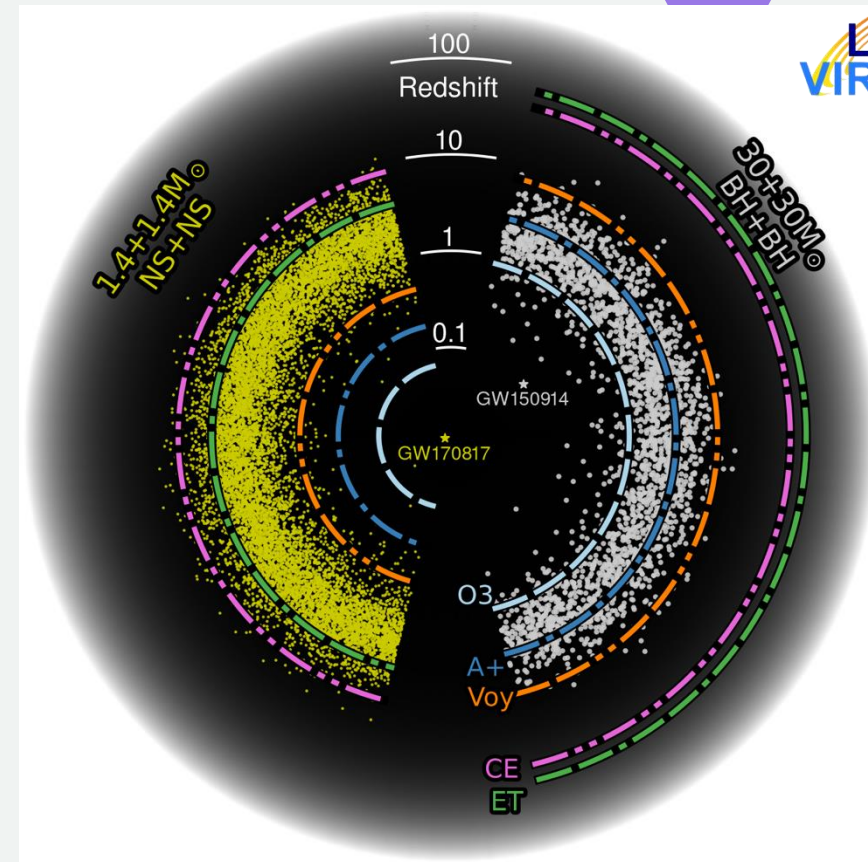
# The future

First detection in 2015 and now we have 100 GW detections so far....



Site will be decided in 2026

... and the future looks bright!



We will see more signals for longer times...

... but not only GW will overlap!

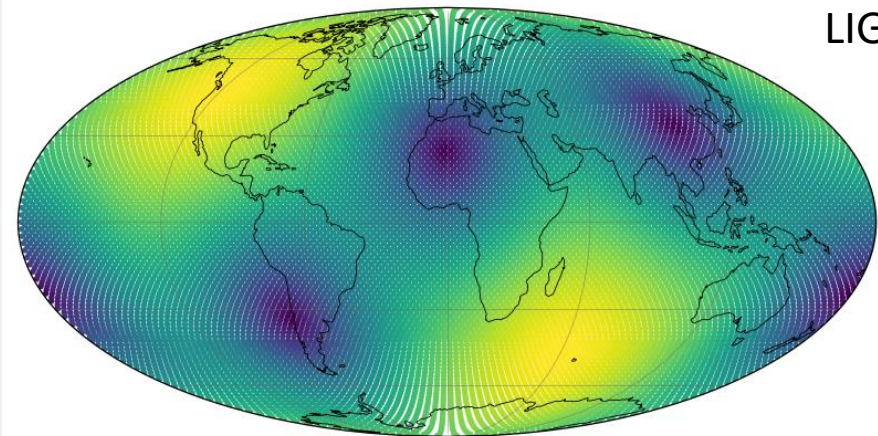
# Today: a peak at GW data analysis

- **GW tutorial 1:** in this tutorial we talk about the antenna pattern of ground-based detectors.
- **GW tutorial 2:** we introduce the basics on how to read, pre-process and represent real detector data. It includes PSD computation.
- **GW tutorial 3:** some times it is useful to generate your own simulations. We also introduce matched filtering.
- **GW tutorial bonus track:** ET configuration - redshift as a function of the total mass.



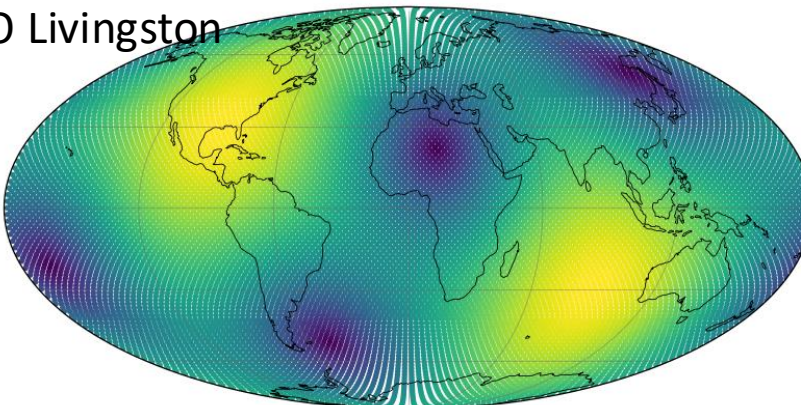


# GW tutorial 1: Antenna Pattern

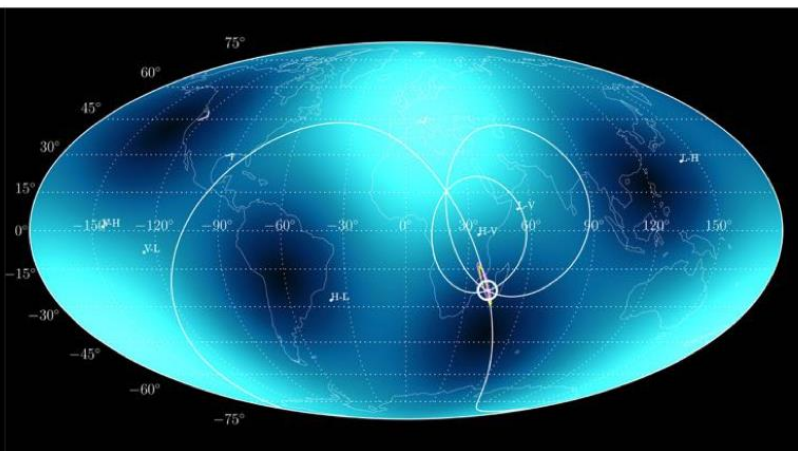
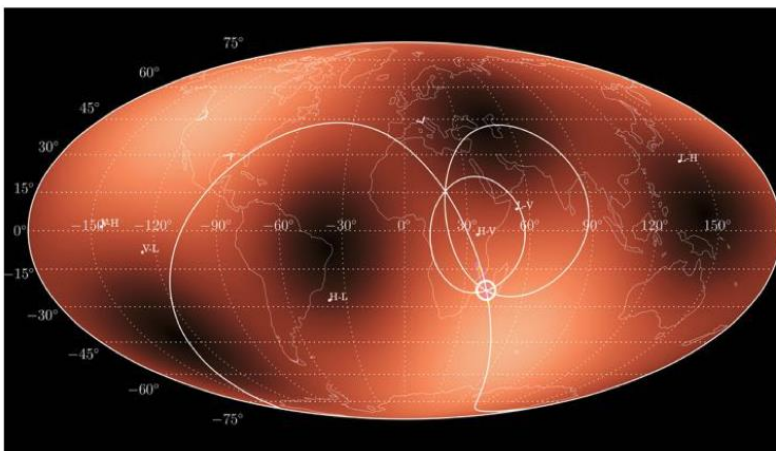
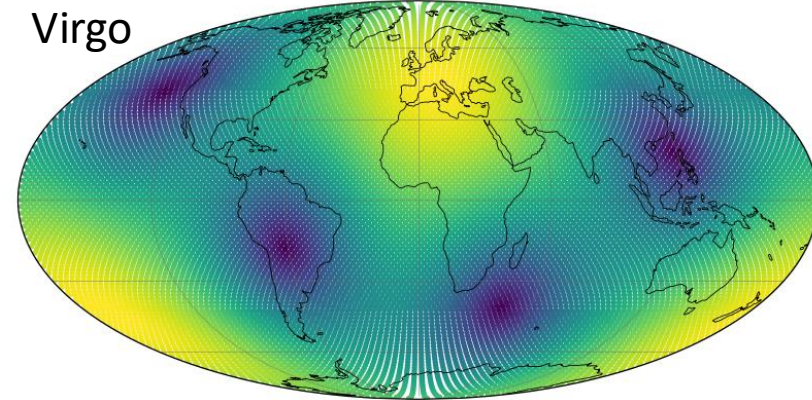


LIGO Hanford

LIGO Livingston



Virgo

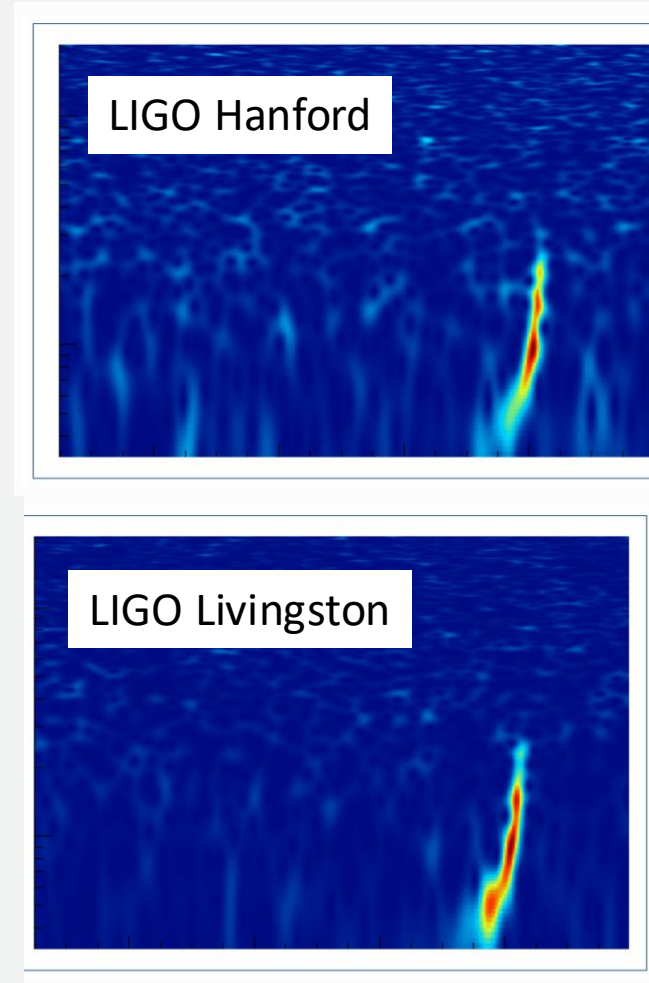
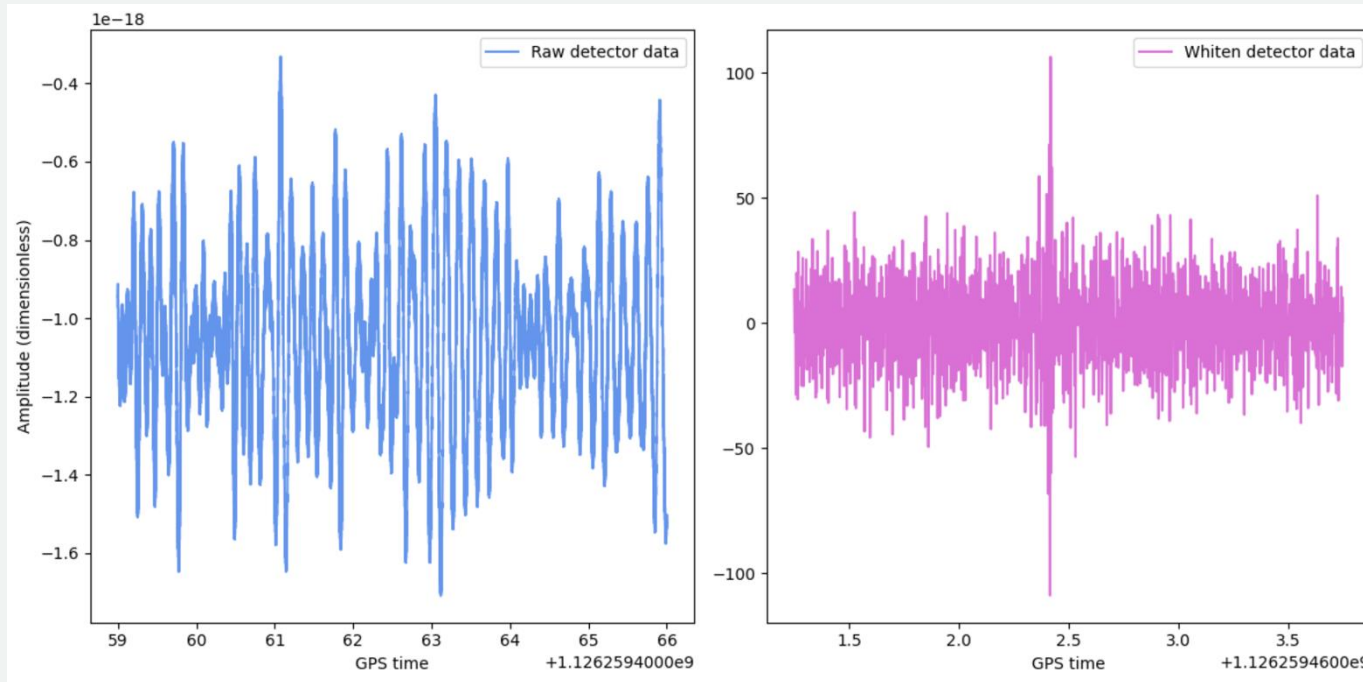


GW170817



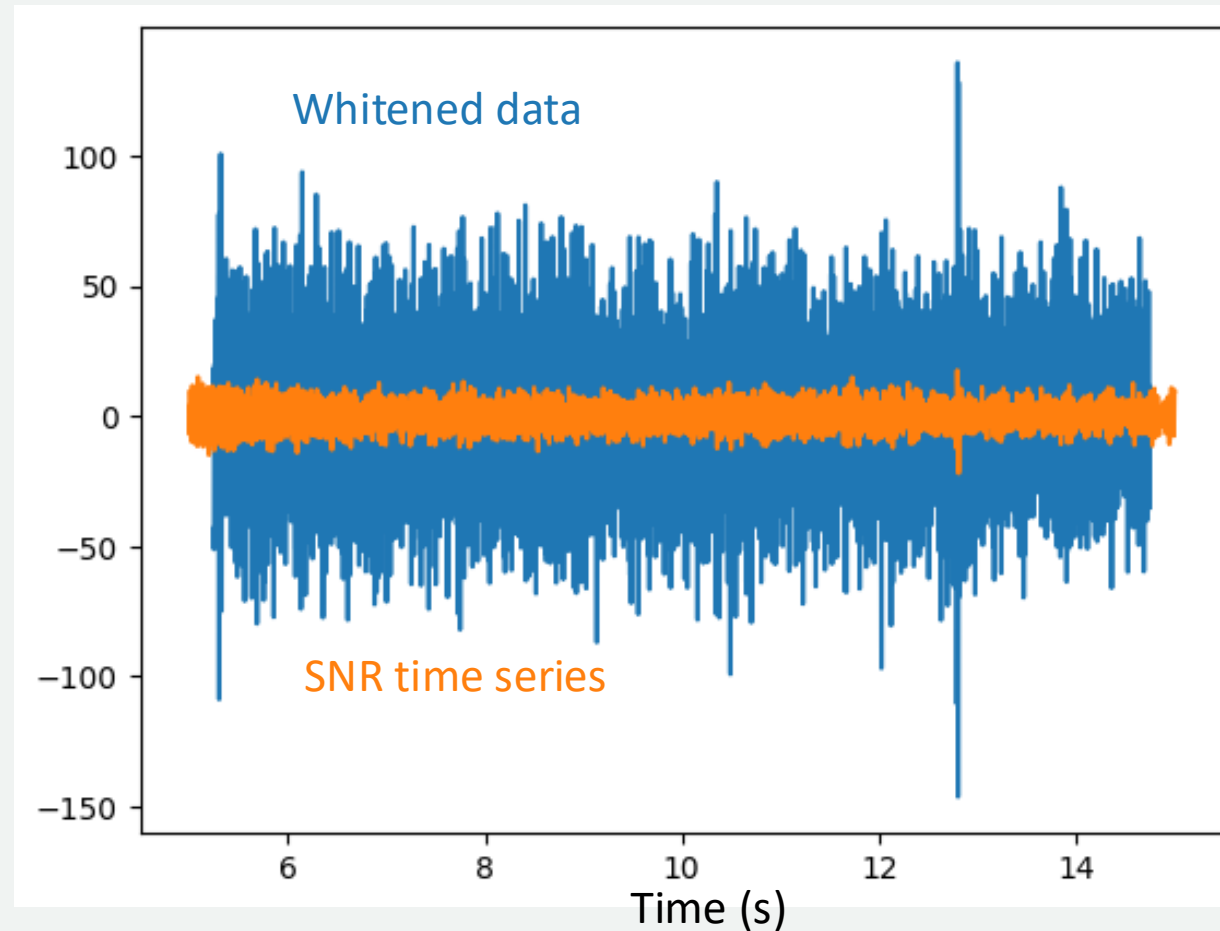
# GW tutorial 2: Detector noise

THE first detection: GW150914



First “picture” of a GW signal from a BBH

# GW tutorial 3: Matched filtering



# GW tutorial bonus track

