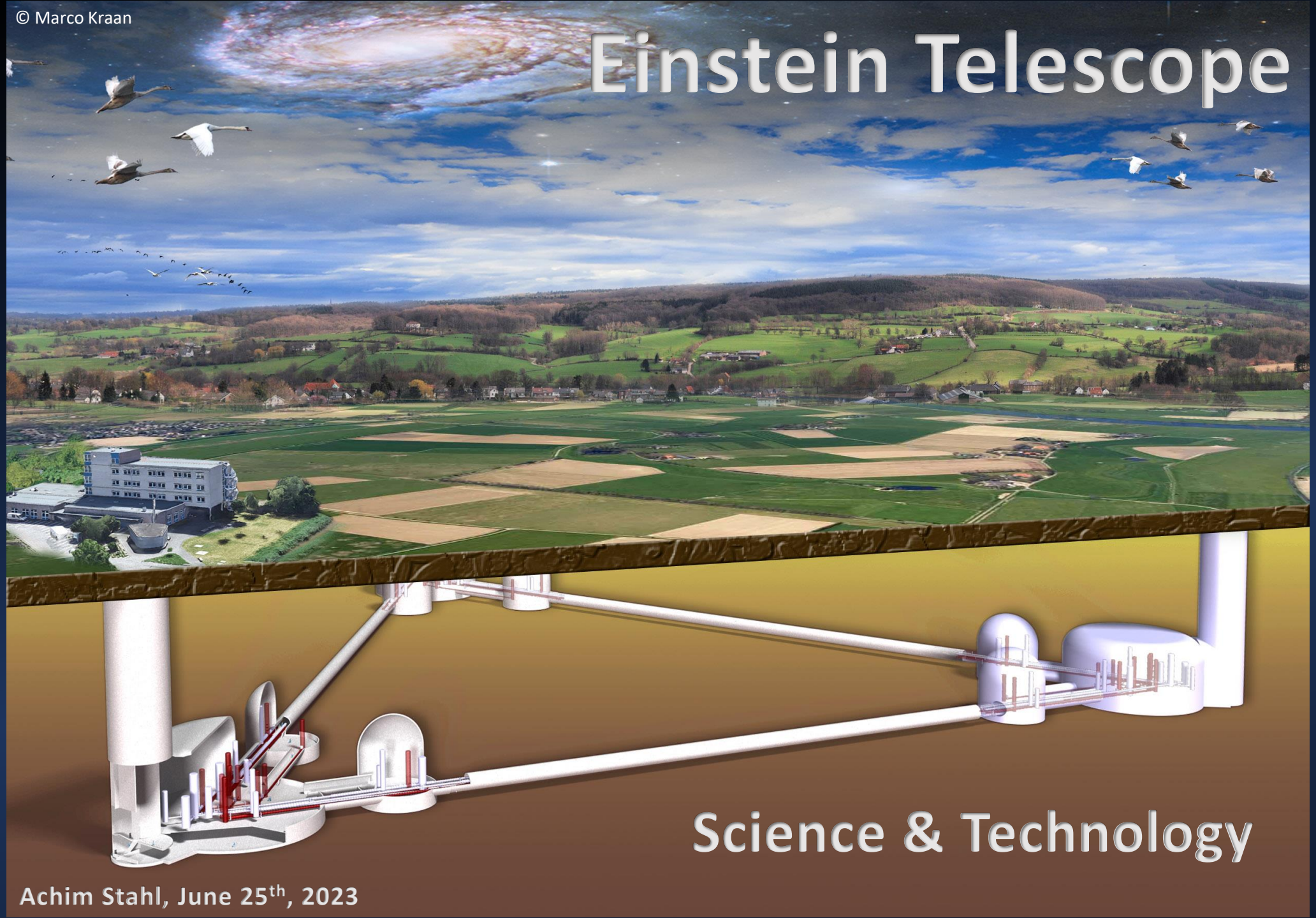
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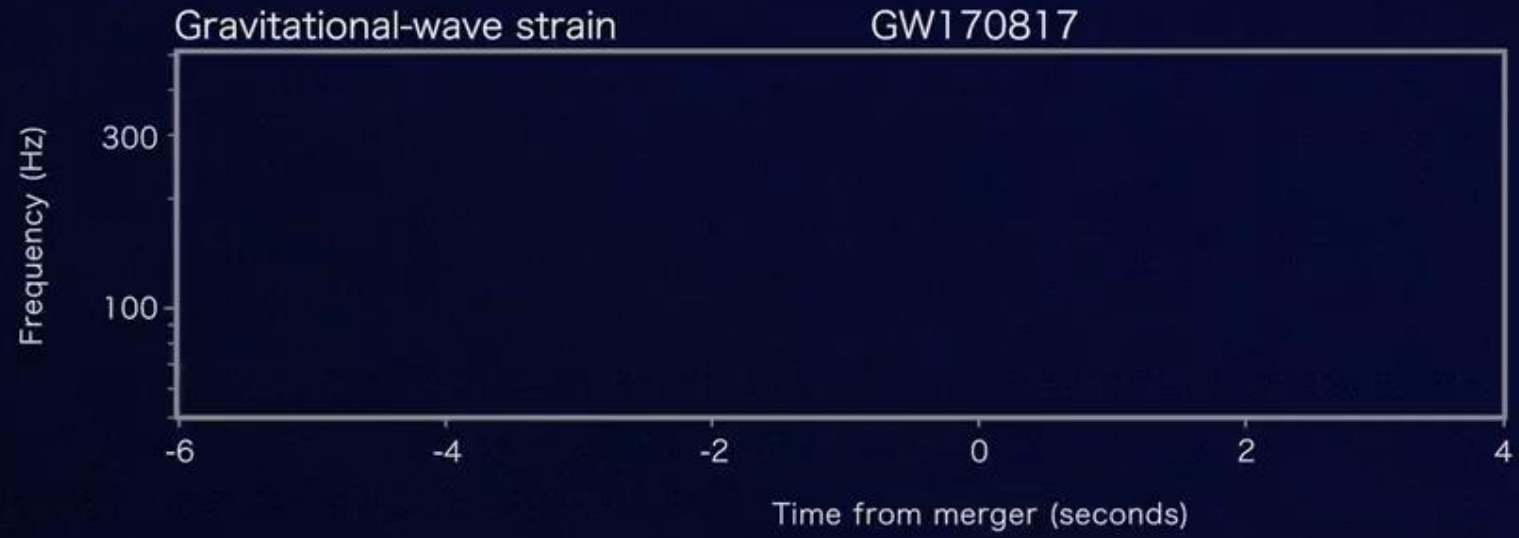
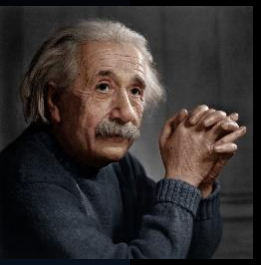
Einstein Telescope
Science & Technology
Achim Stahl, June 25th, 2023

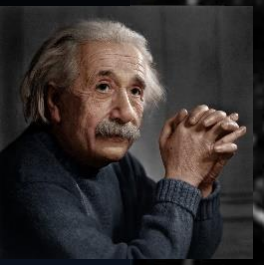
Fermi


Gamma rays, 50 to 300 keV
GRB 170817A
Counts per second
1,500
1,000
500

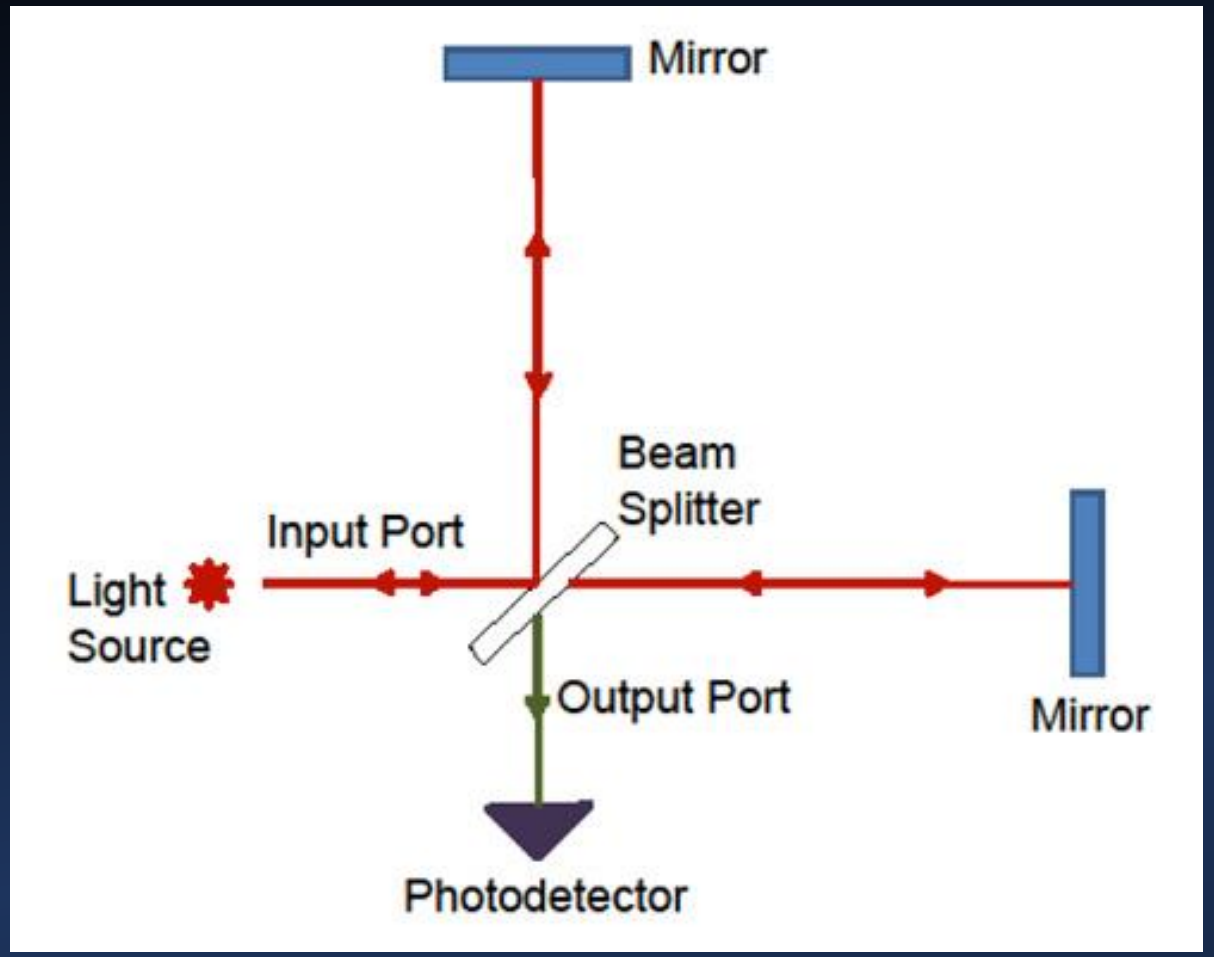
LIGO


Gravitational-wave strain
GW170817
Frequency (Hz)
300
100
-6
-4
-2
0
2
4
Time from merger (seconds)





Michelson-Interferometer



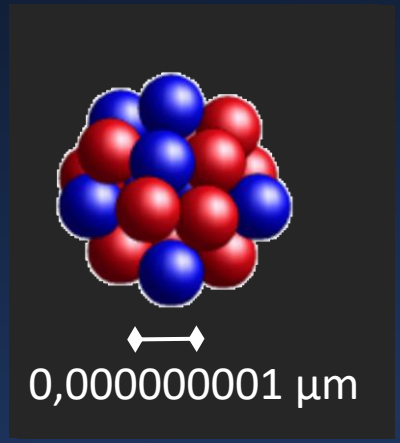
Sensitivity: 0,0000000000004 µm

Wave length: 1 µm

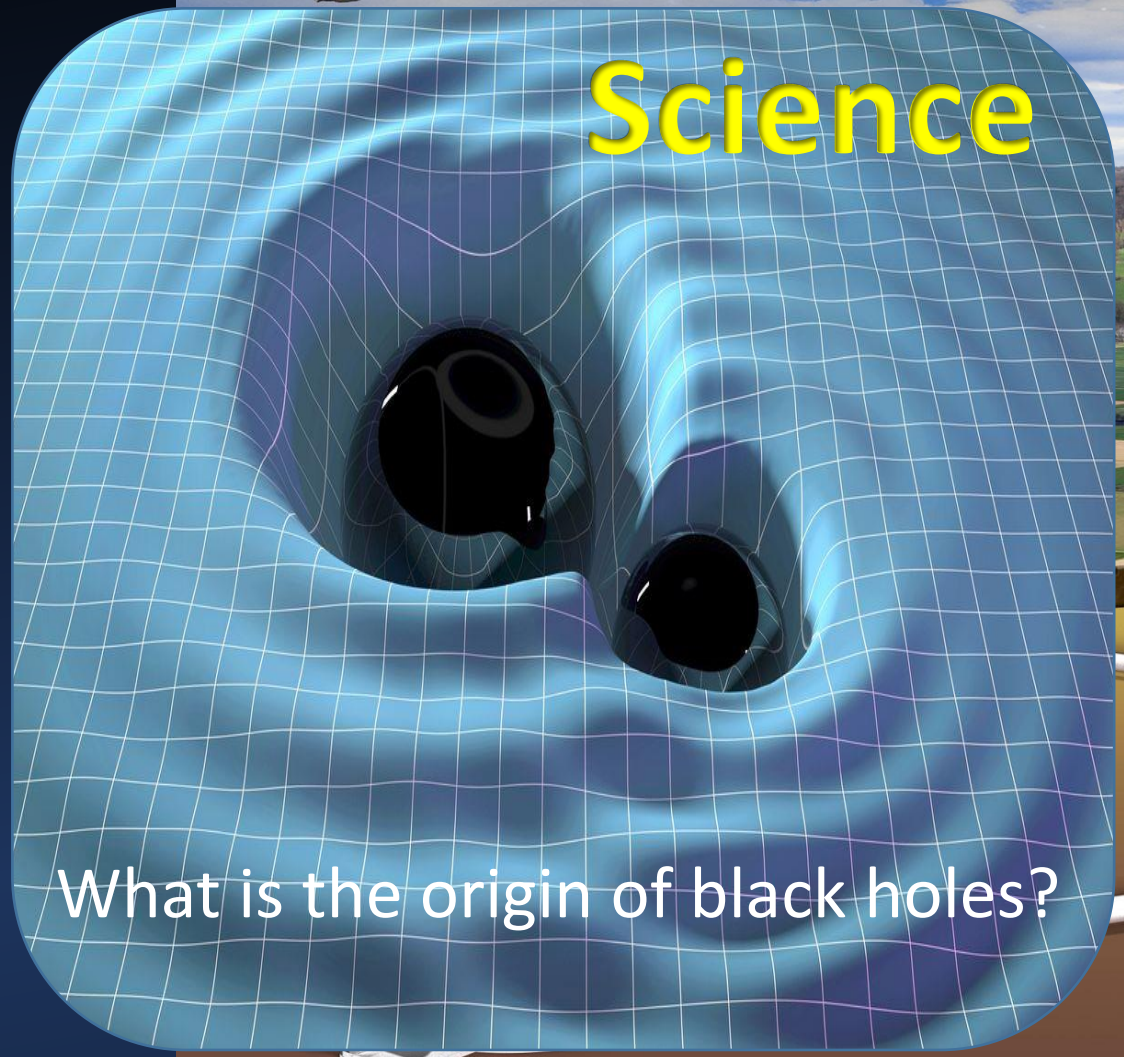
Atom: 0,0001 µm

Nucleus: 0,00000001 µm

Proton: 0,000000001 µm

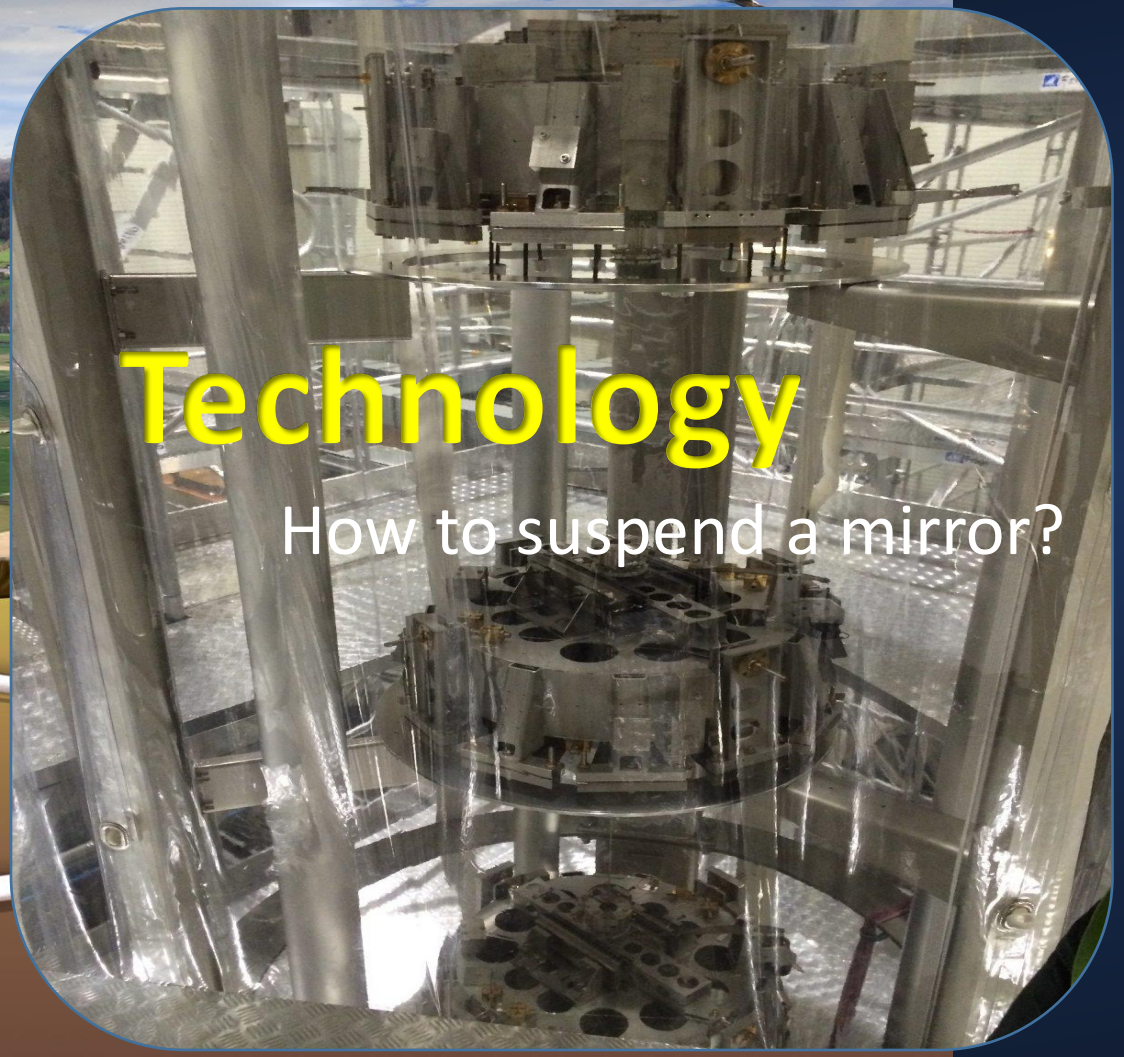


Einstein Telescope



Science

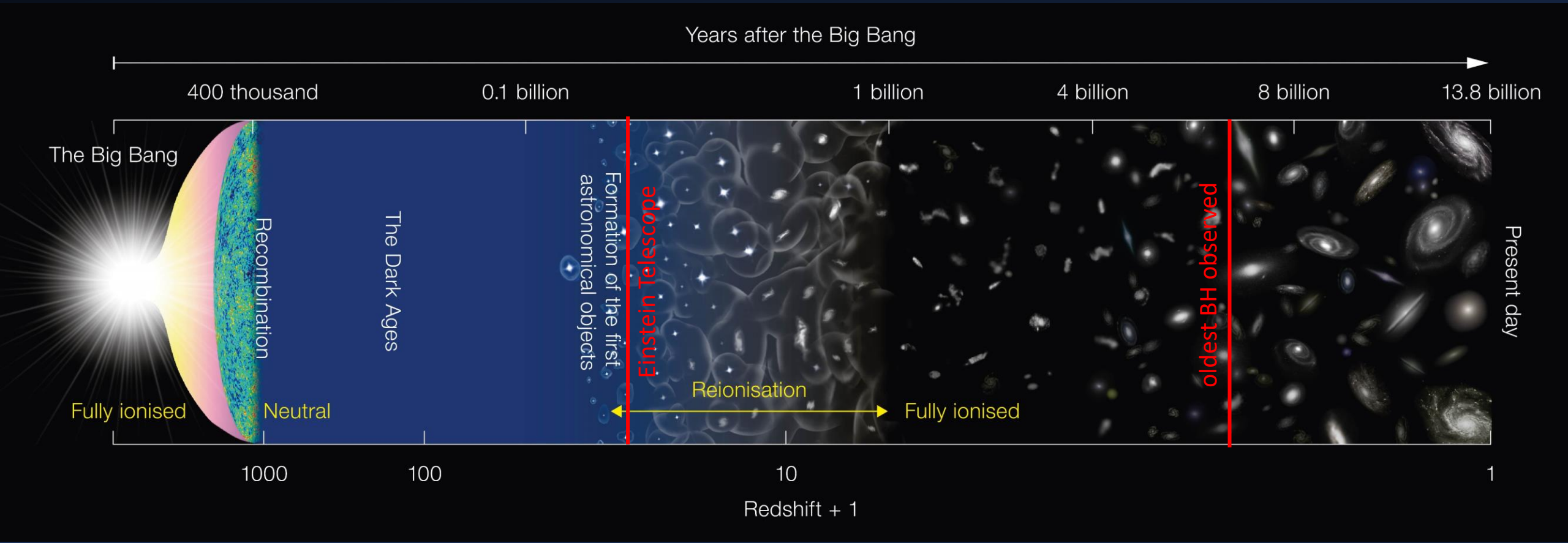
What is the origin of black holes?



Technology

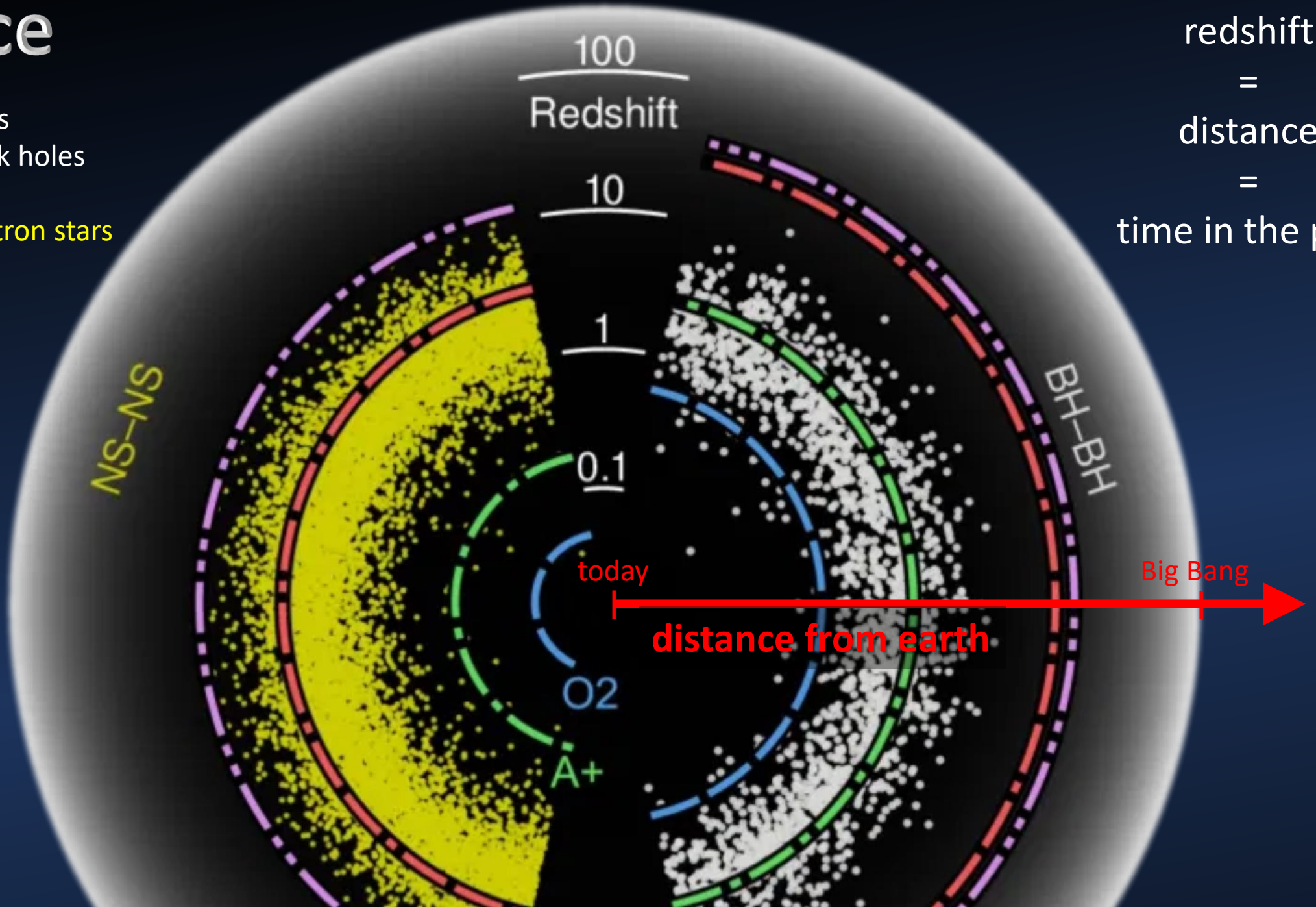
How to suspend a mirror?

Science


Years after the Big Bang
400 thousand
0.1 billion
1 billion
4 billion
8 billion
13.8 billion
The Big Bang
Recombination
The Dark Ages
Formation of the first astronomical objects
Einstein Telescope
oldest BH observed
Present day
Fully ionised
Neutral
Reionisation
Fully ionised
1000
100
10
1
Redshift + 1

Science

Binary mergers
- binary black holes
  BH - BH
- binary neutron stars
  NS - NS

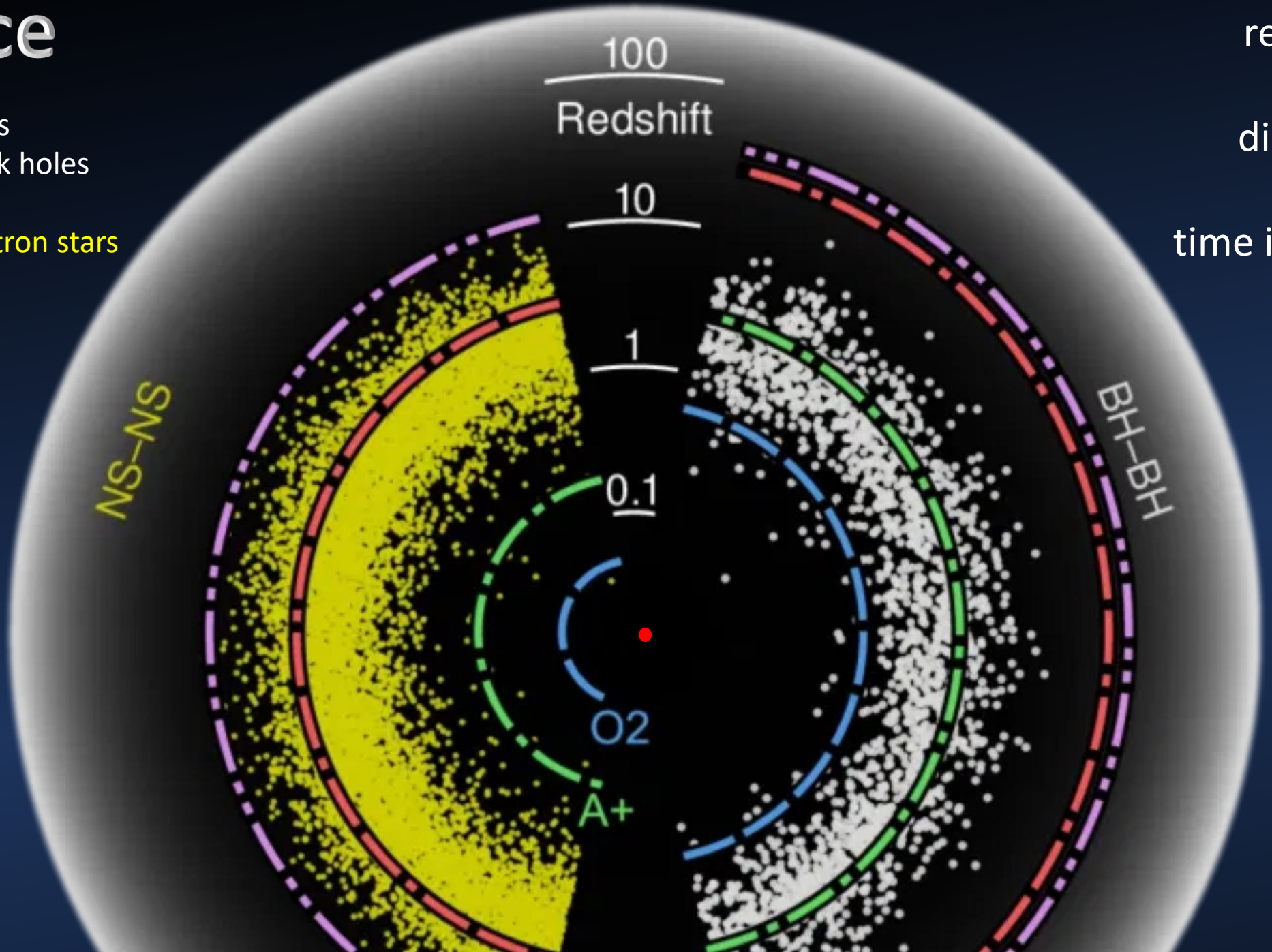


redshift
=
distance
=
time in the past

Science

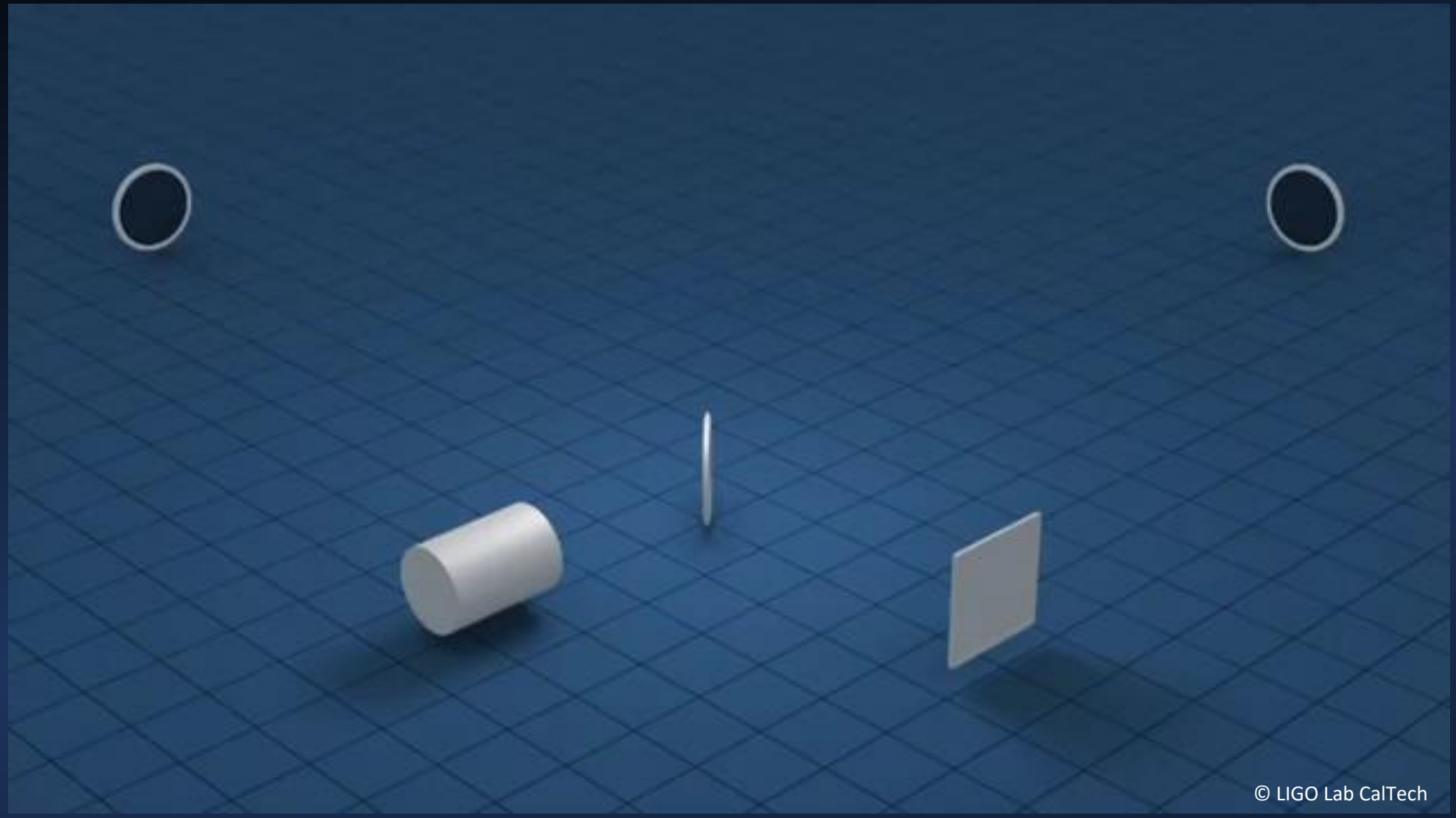
Binary mergers

- binary black holes
  BH - BH
- binary neutron stars
  NS - NS



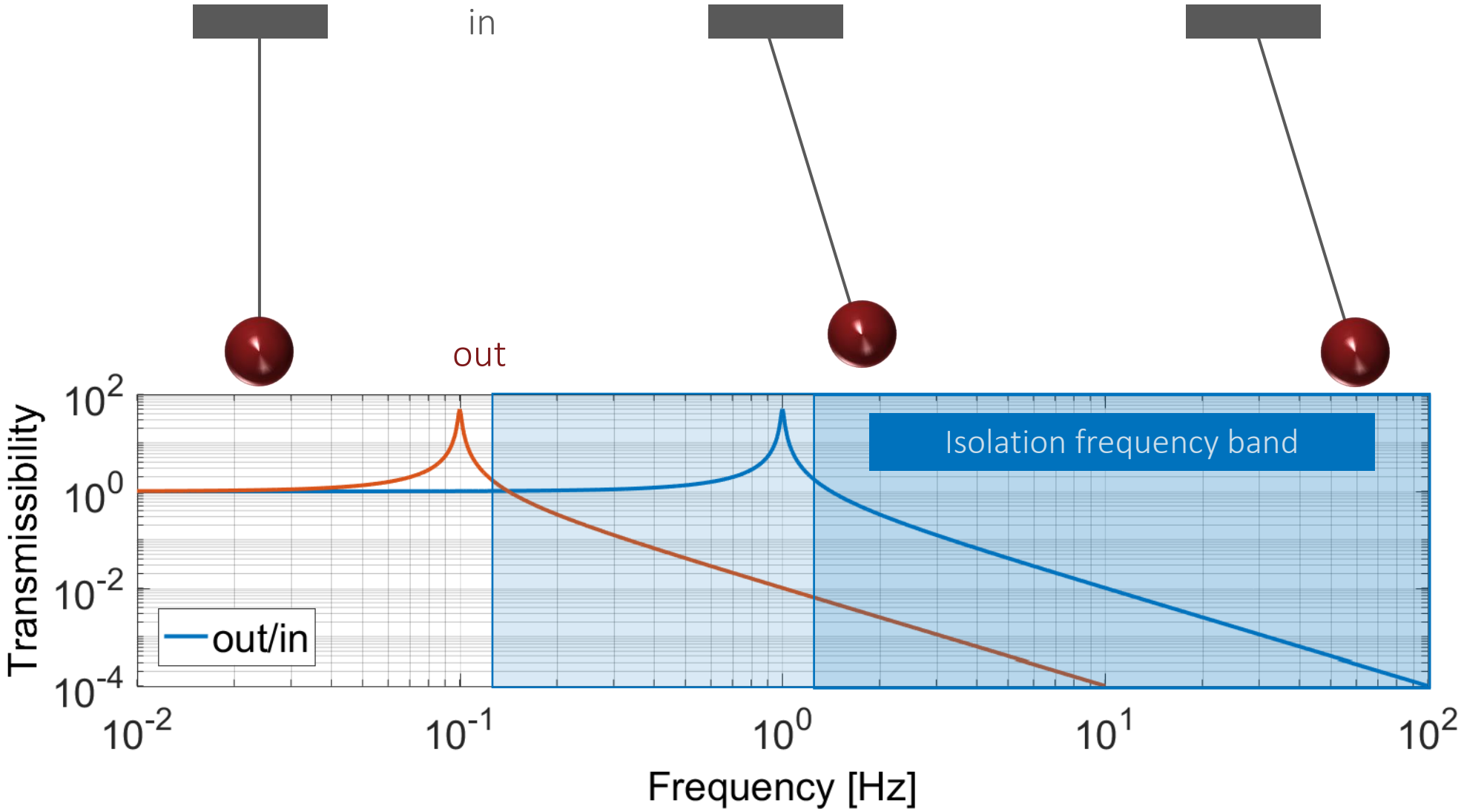
redshift
=
distance
=
time in the past

Michelson-Interferometer

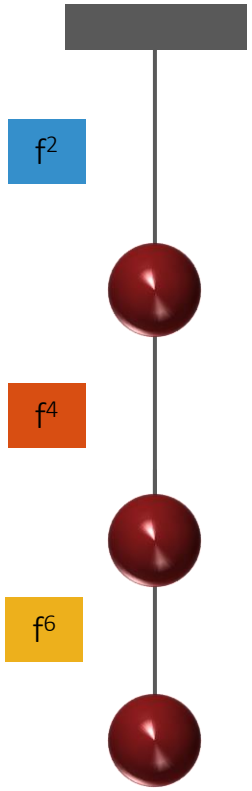


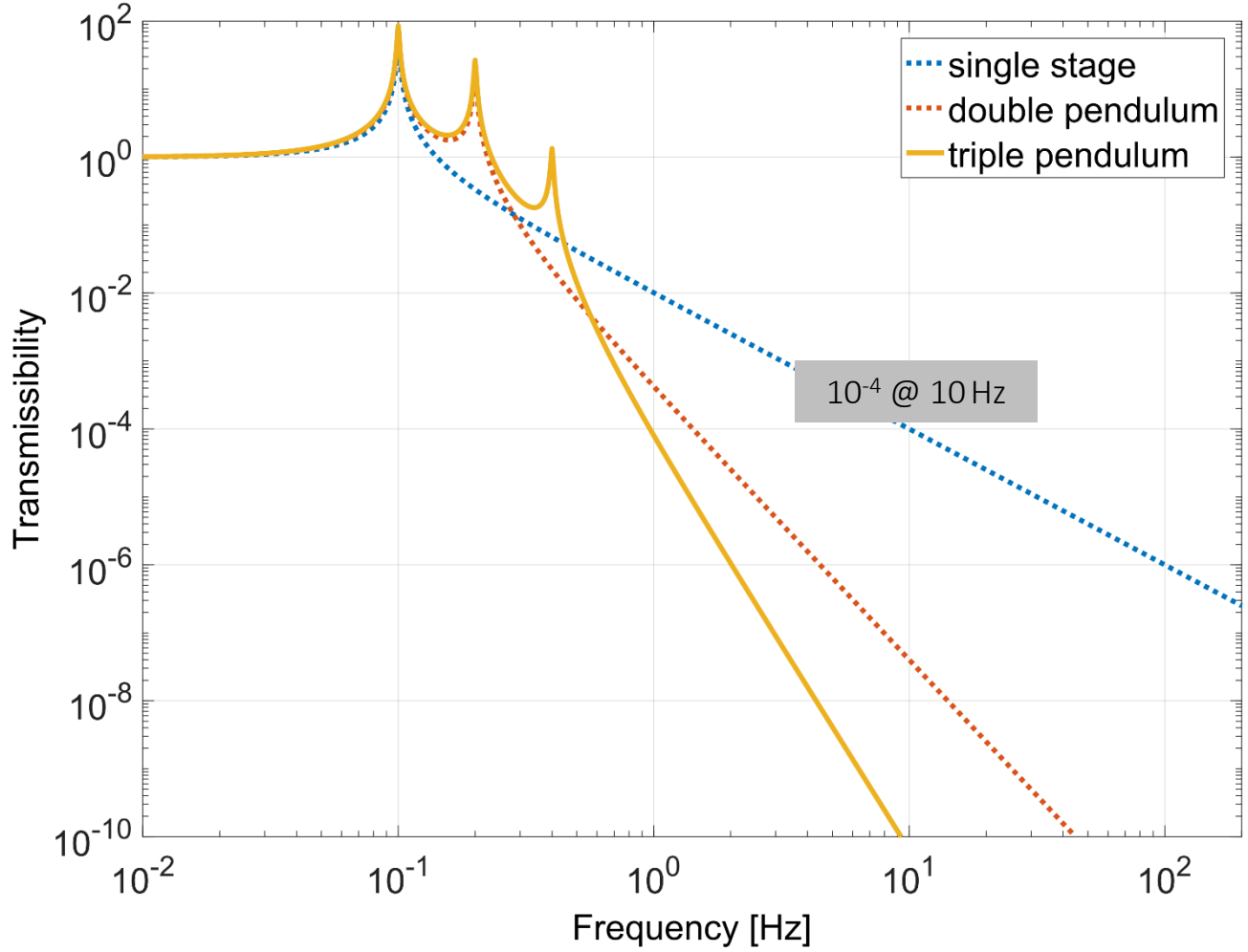
Seismic noise

Seismic Isolation

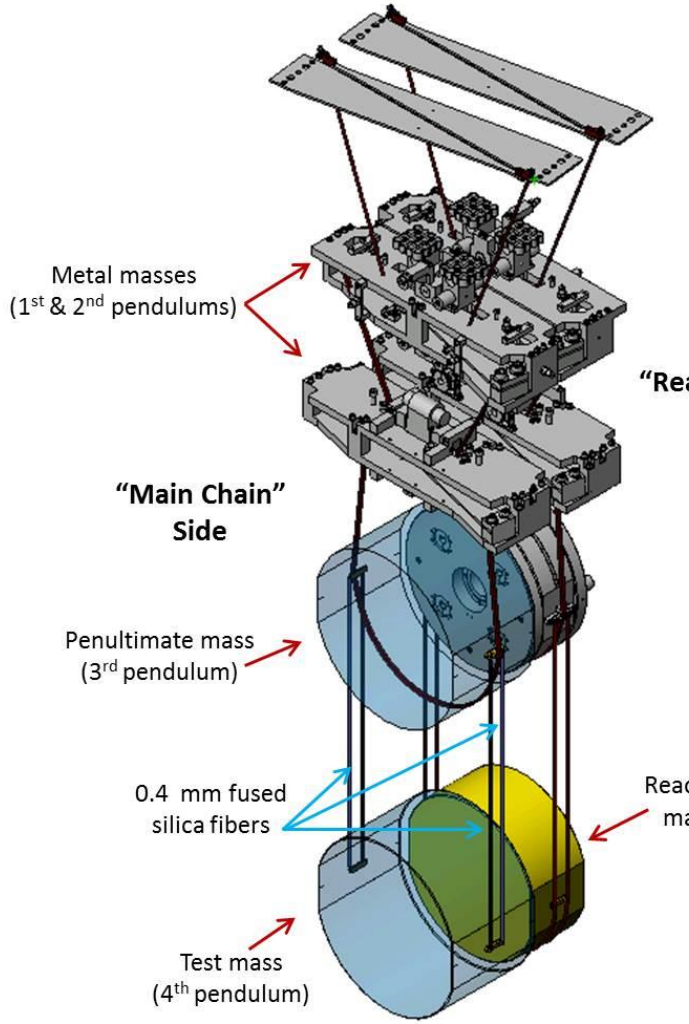


Seismic Isolation

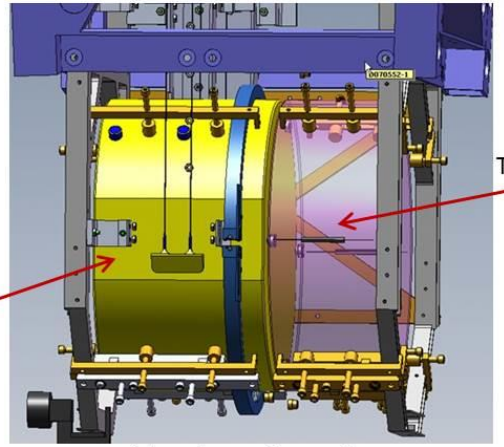




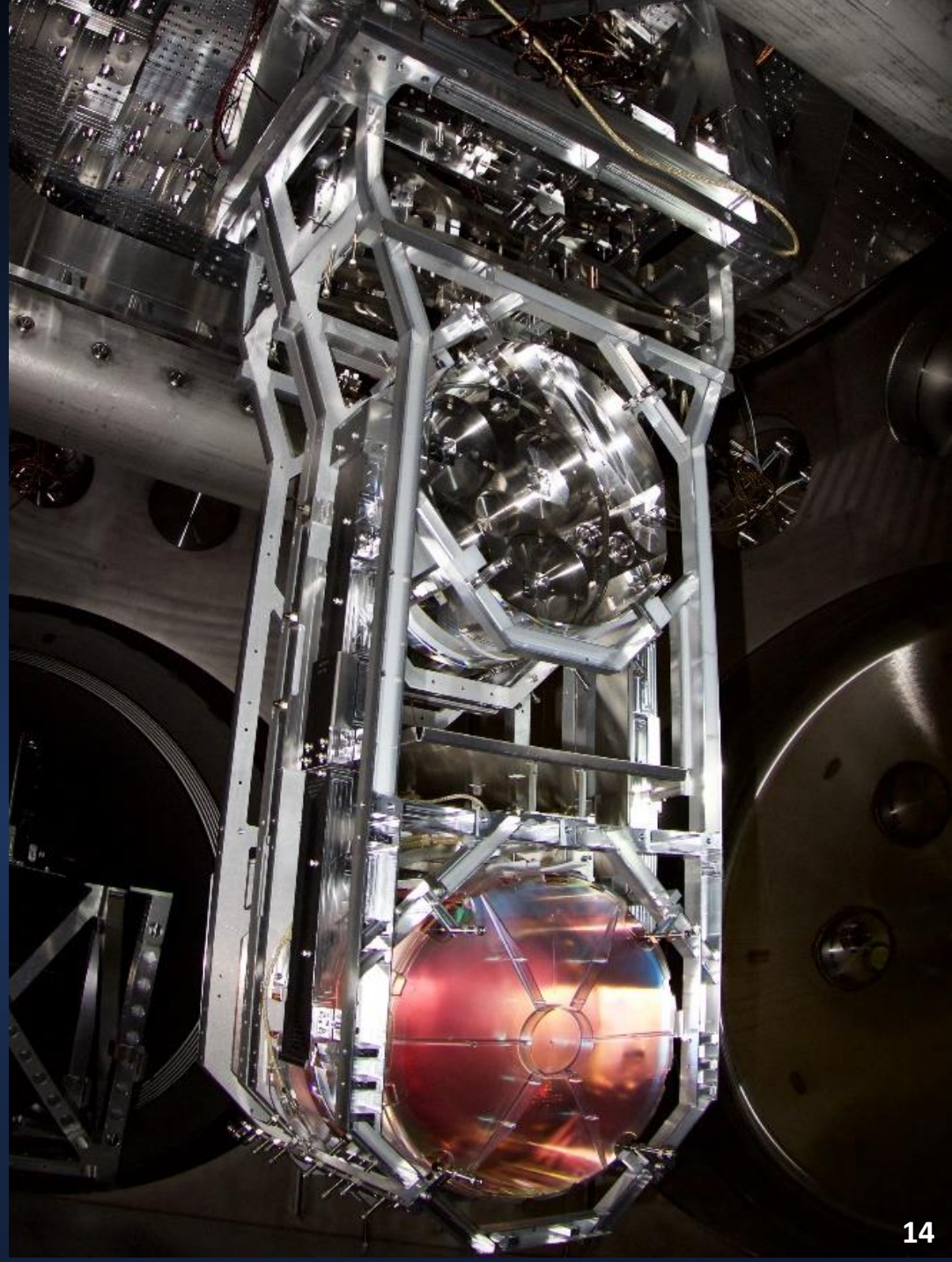
Seismic Isolation



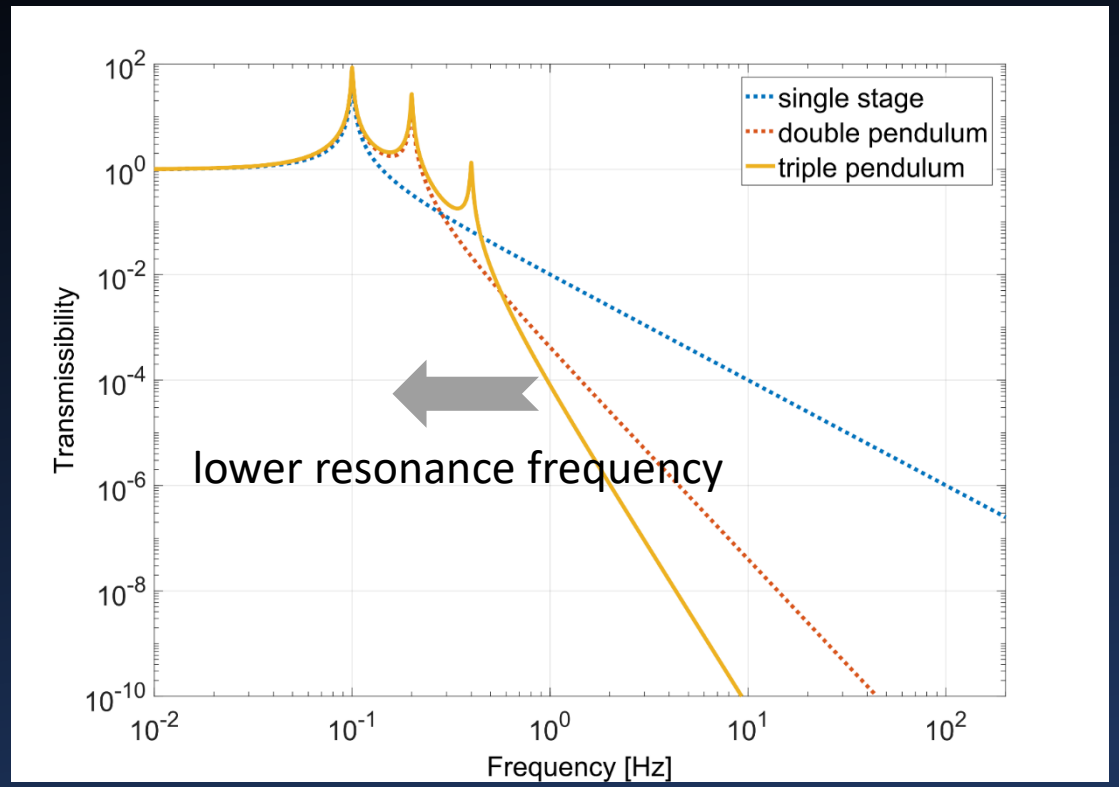
"Reaction Chain"
Side



Side-view of reaction and test masses



Seismic Isolation



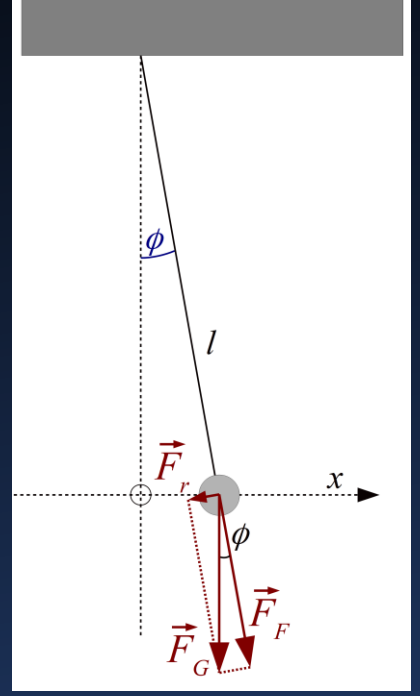
resonance frequency: $\omega_0 = \sqrt{g/l}$

mathematical pendulum

$$m\frac{d^2x(t)}{dt^2} = -k\,x(t)$$

$$\Rightarrow \omega_0 = \sqrt{k/m}$$

make k small! (here $k = mg/l$)



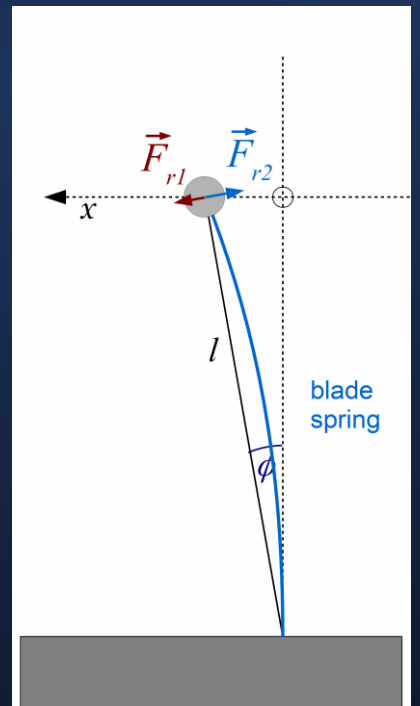
inverted pendulum

$$m\frac{d^2x(t)}{dt^2} = +k\,x(t)$$

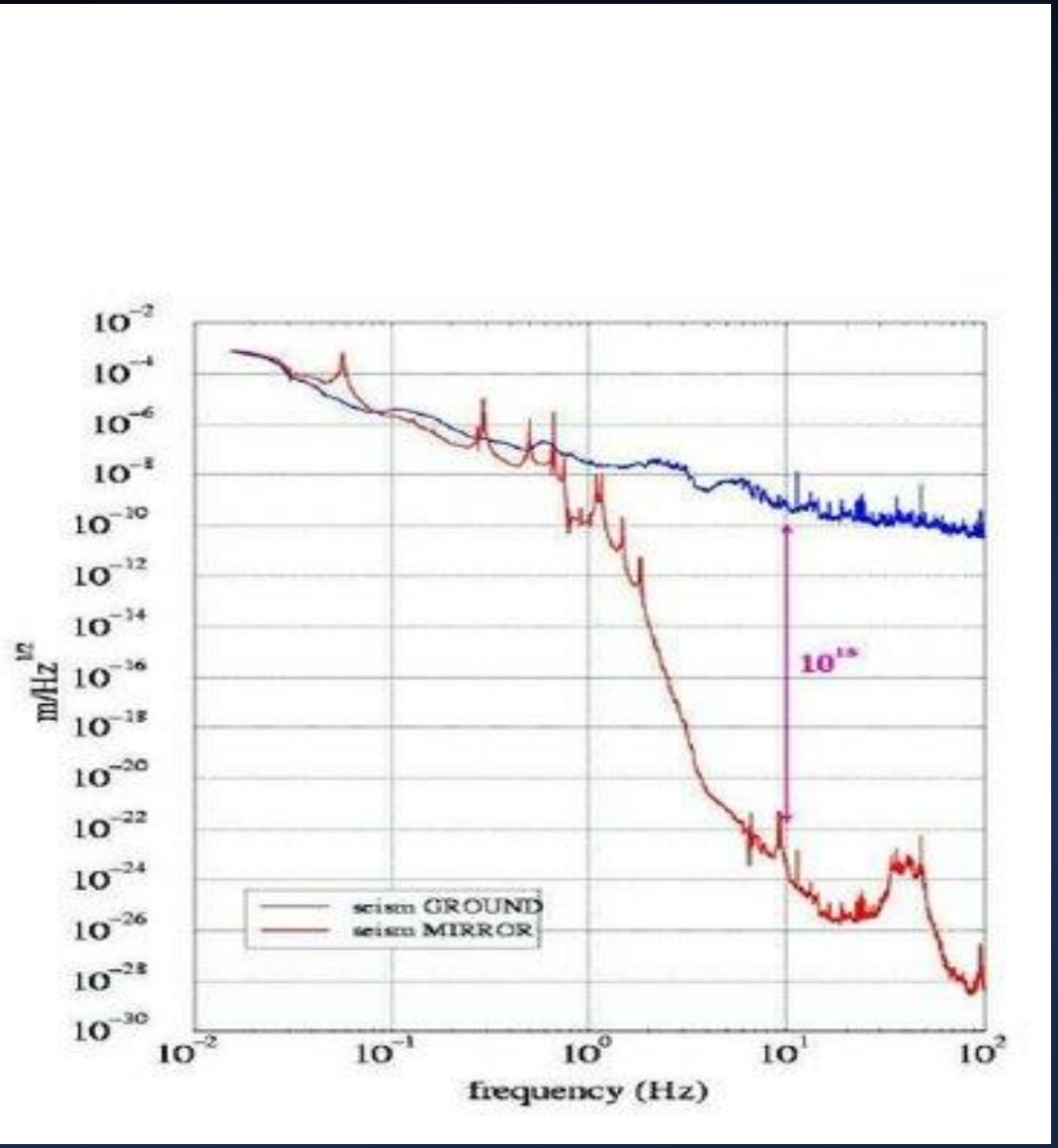
add a blade spring

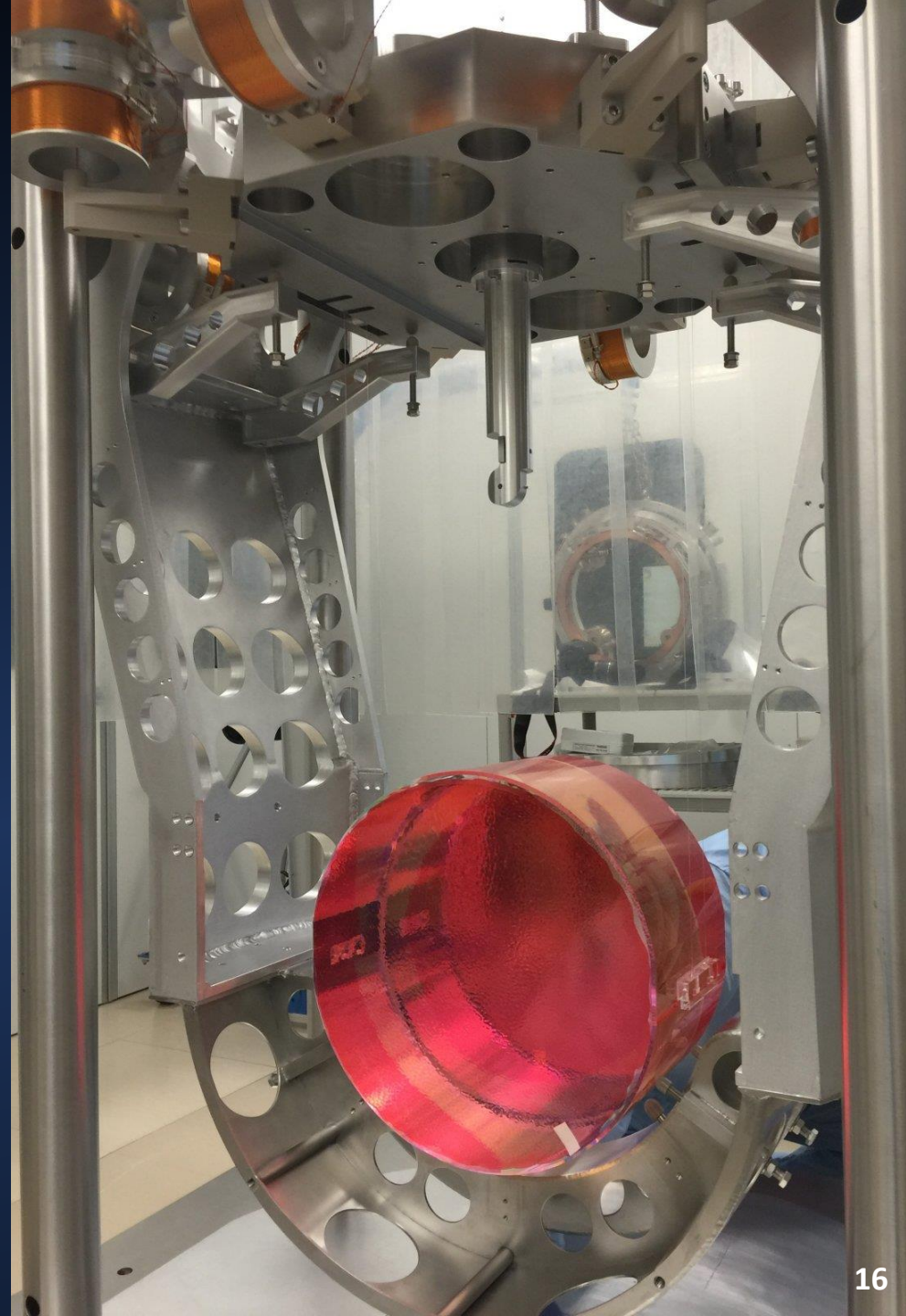
$$m\frac{d^2x(t)}{dt^2} = \underbrace{(k_1 - k_2)}\,x(t)$$

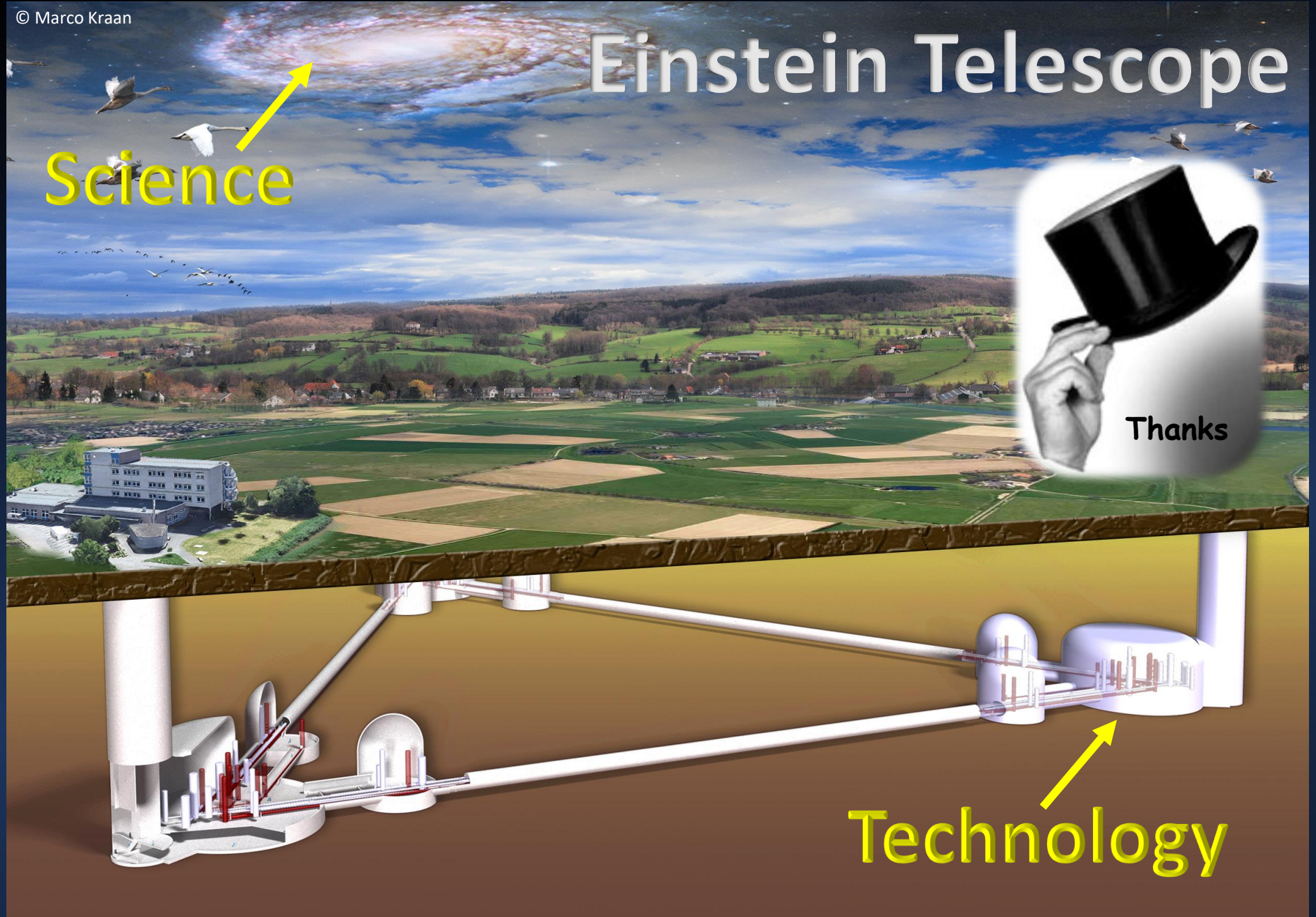
make small!



VIRGO Superattenuator



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Thanks
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