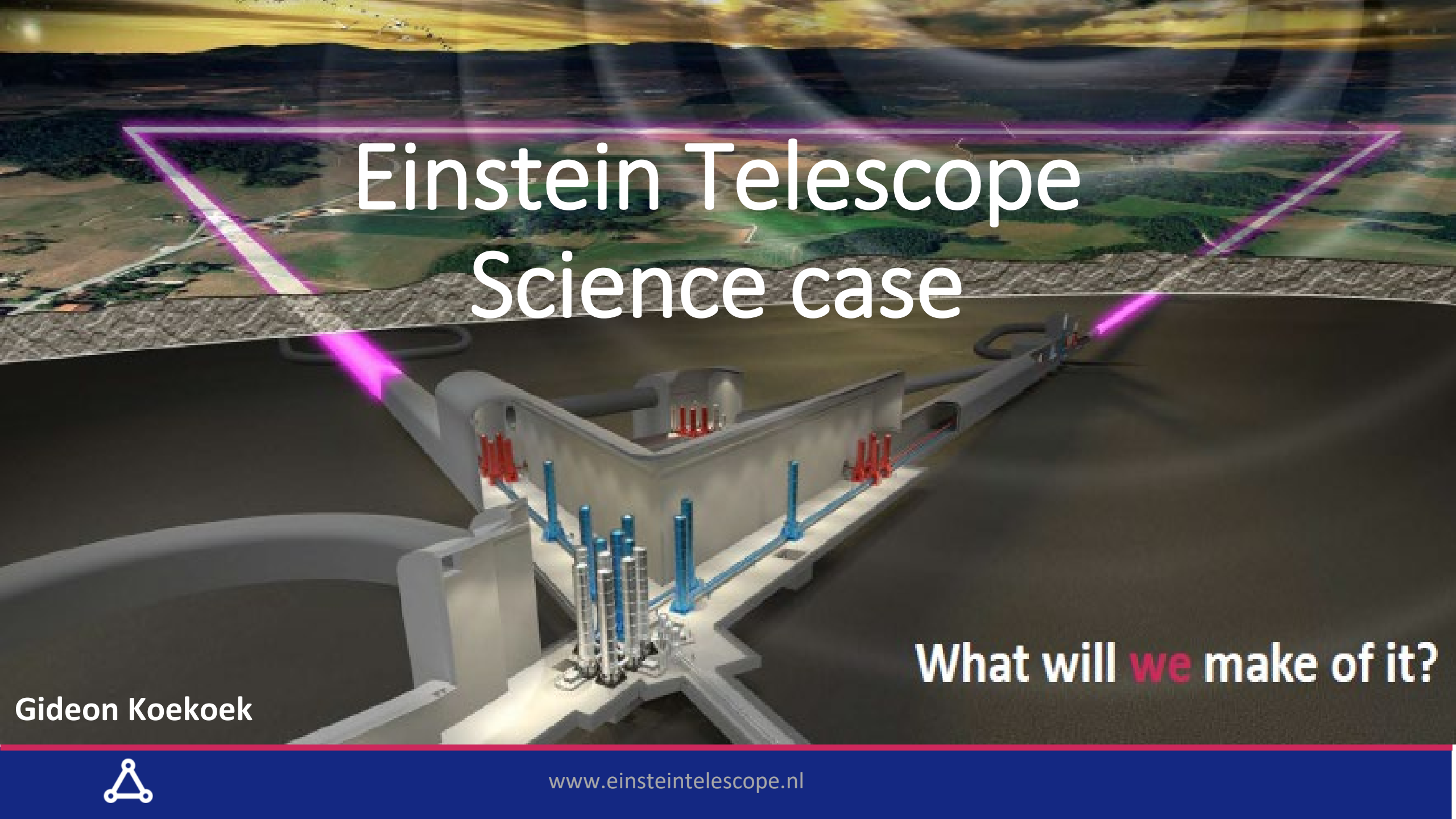




Einstein Telescope Science case

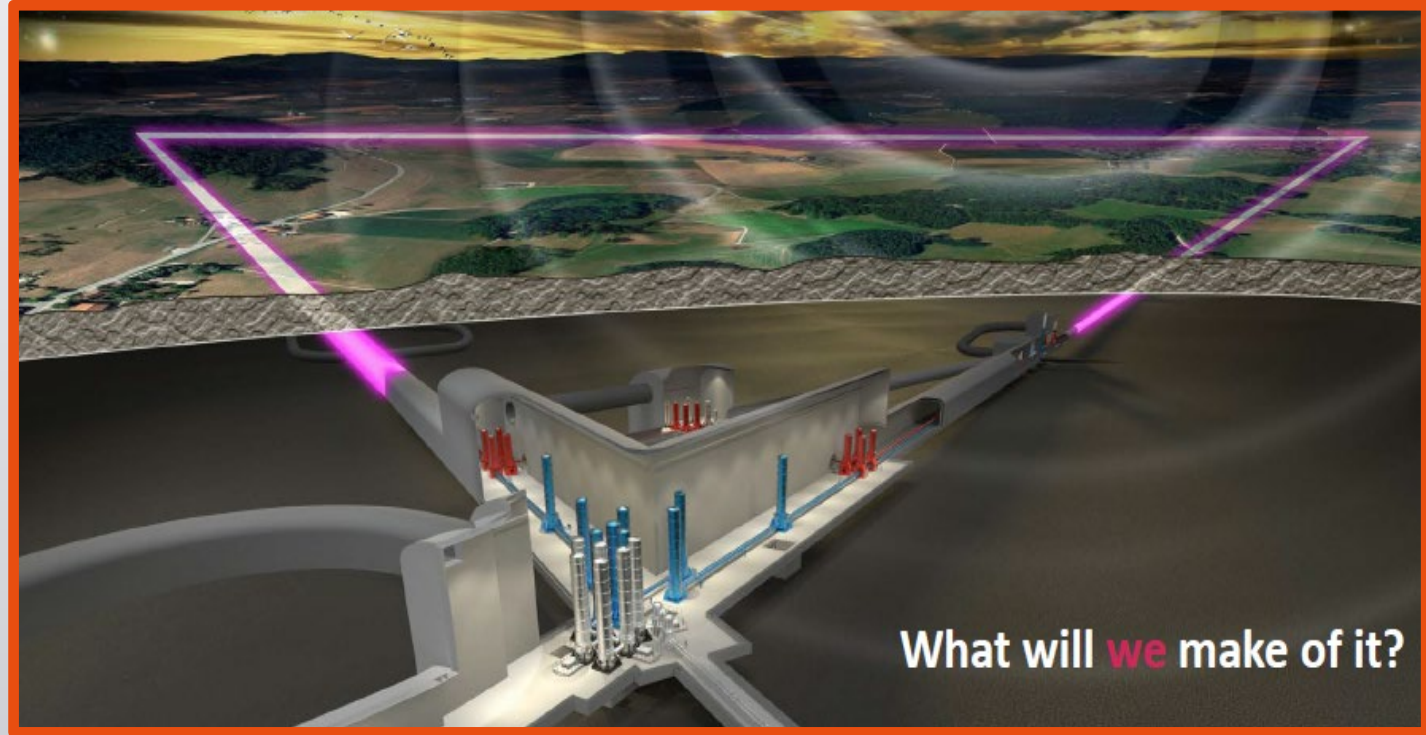
What will **we** make of it?

Gideon Koekoek



www.einsteintelelescope.nl

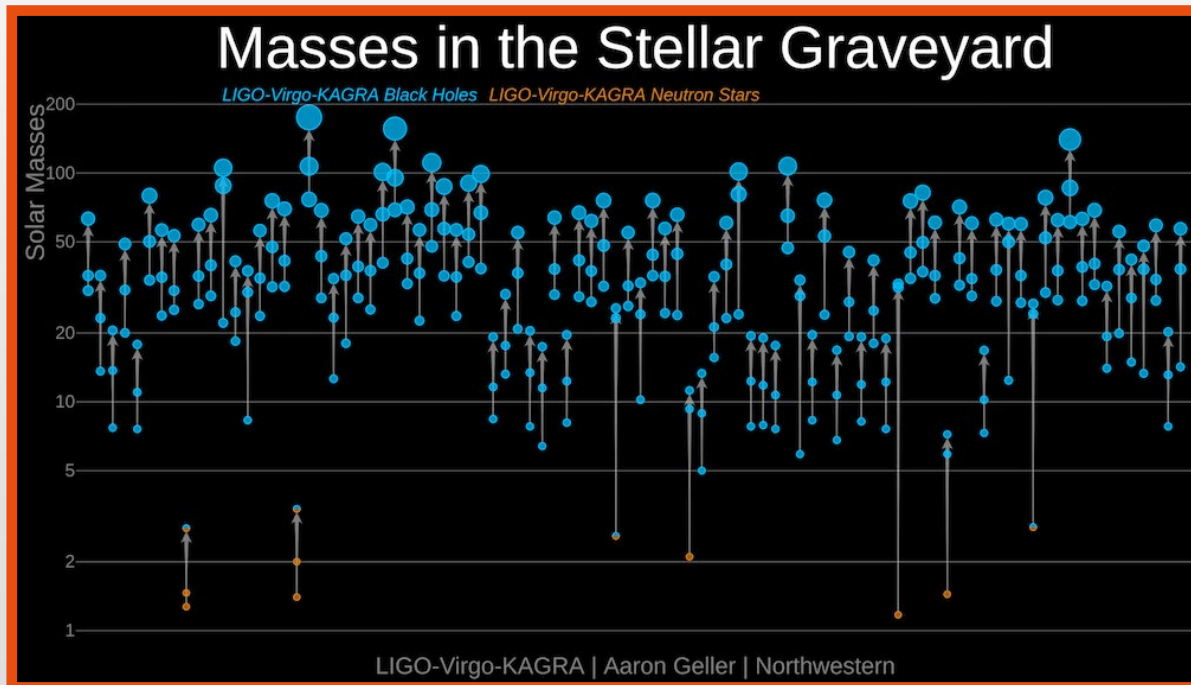
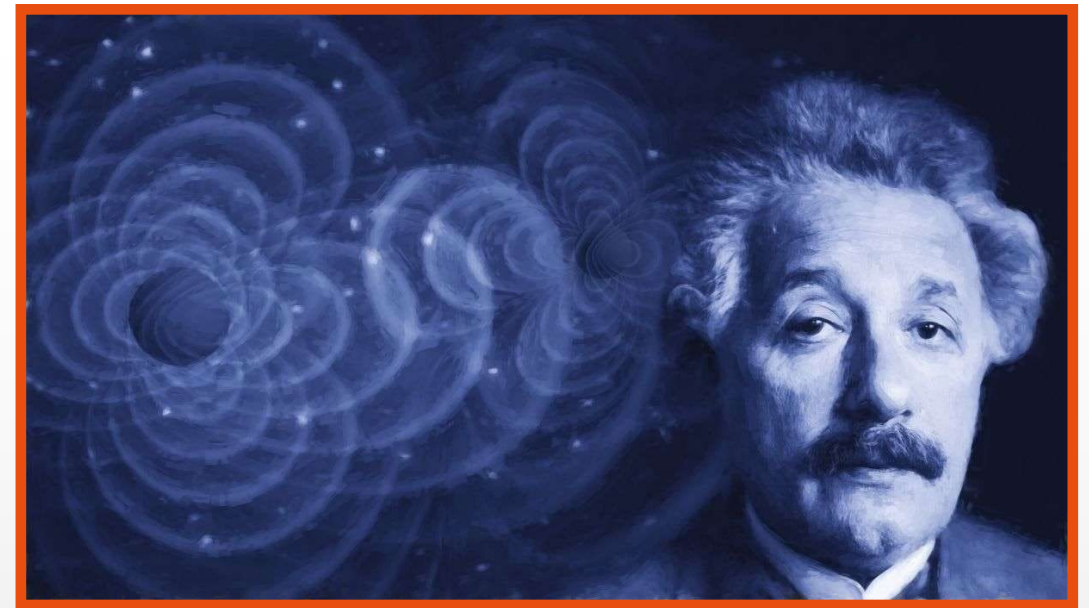
- Underground laboratory
- Three arms, each 10 km long,
- low temperature, in vacuum
- Clean measurements
- European collaboration
- filled to the brim with new technologies



Current detectors measure ~ 1 gravitational wave per week(!).

Total catalogue to this point: 100+

LIGO-Virgo Collaboration:
catalog.cardiffgravity.org/

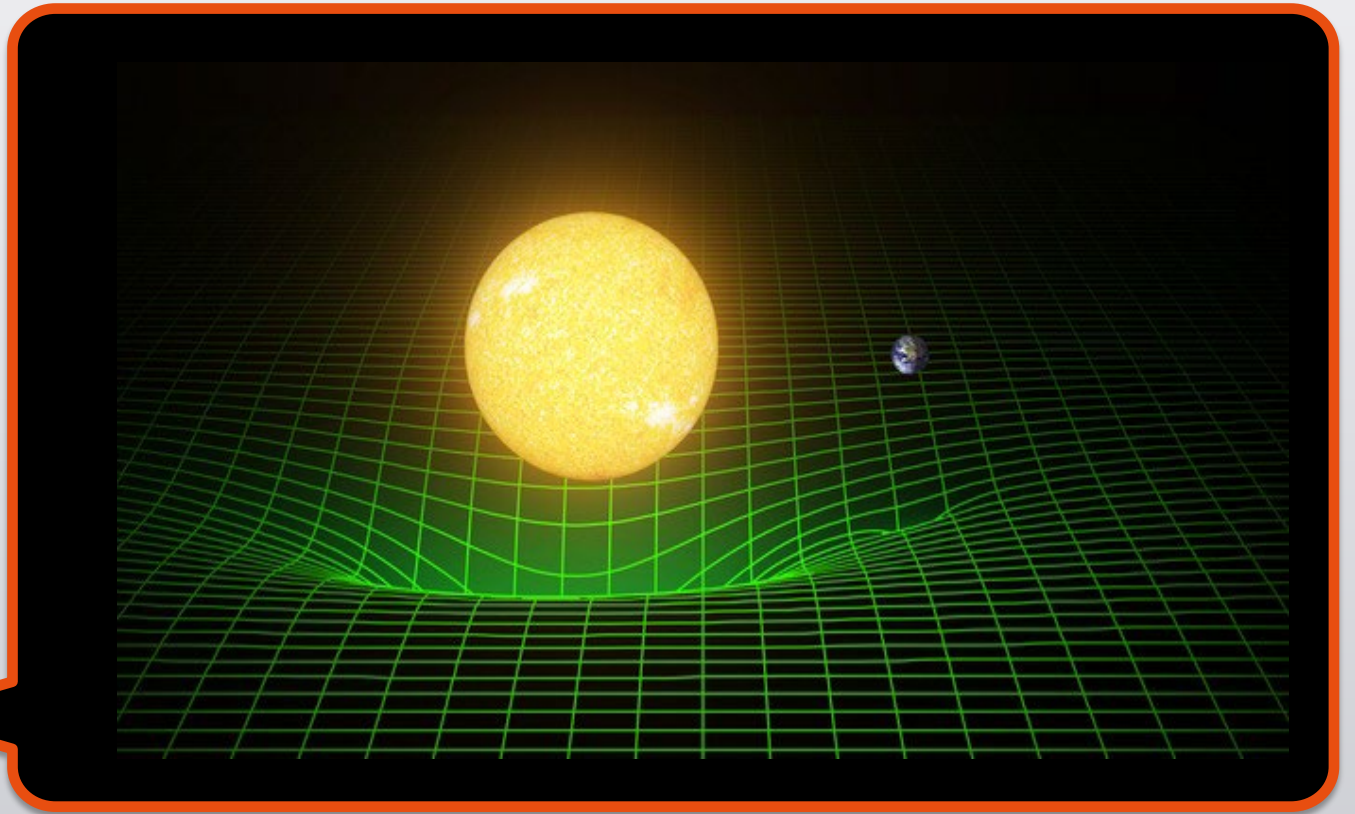


What are gravitational waves?



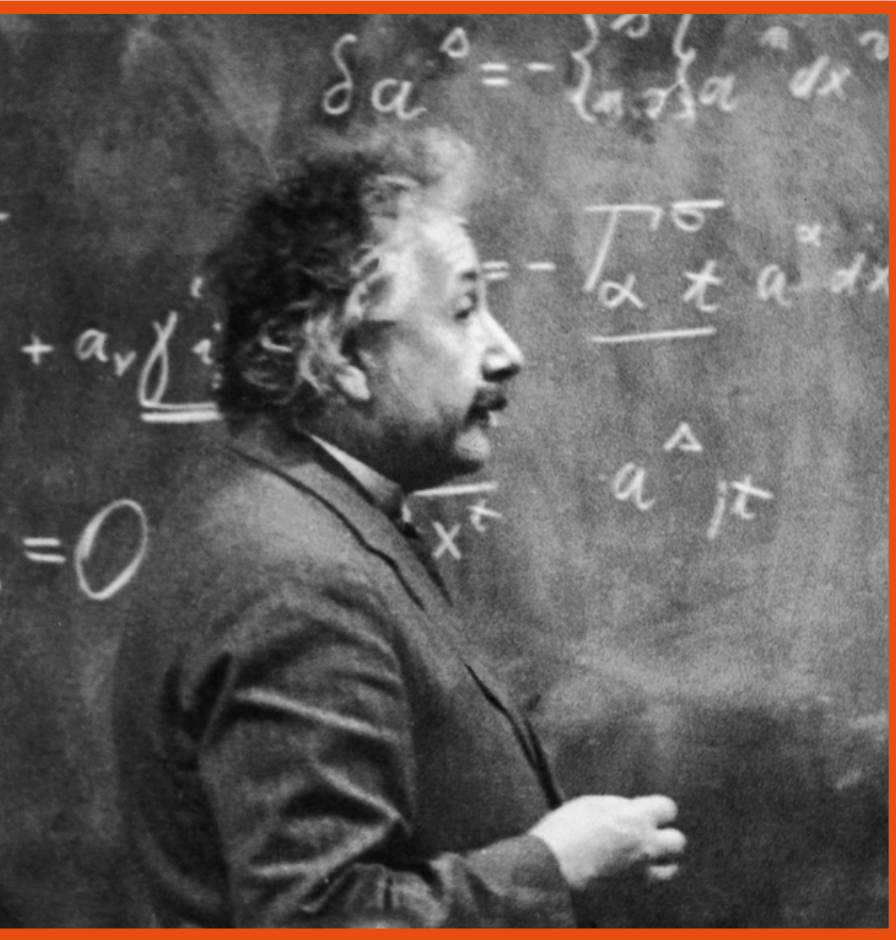
Einstein's General Relativity:

Gravity = elastic
spacetime



$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = - \frac{8\pi G}{c^4} T_{\mu\nu}$$

Einstein Field Equations



$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -\frac{8\pi G}{c^4} T_{\mu\nu}$$

These equations are so complicated, that no one will ever find the exact solutions.

(A. Einstein, 1916)

Einstein Field Equations

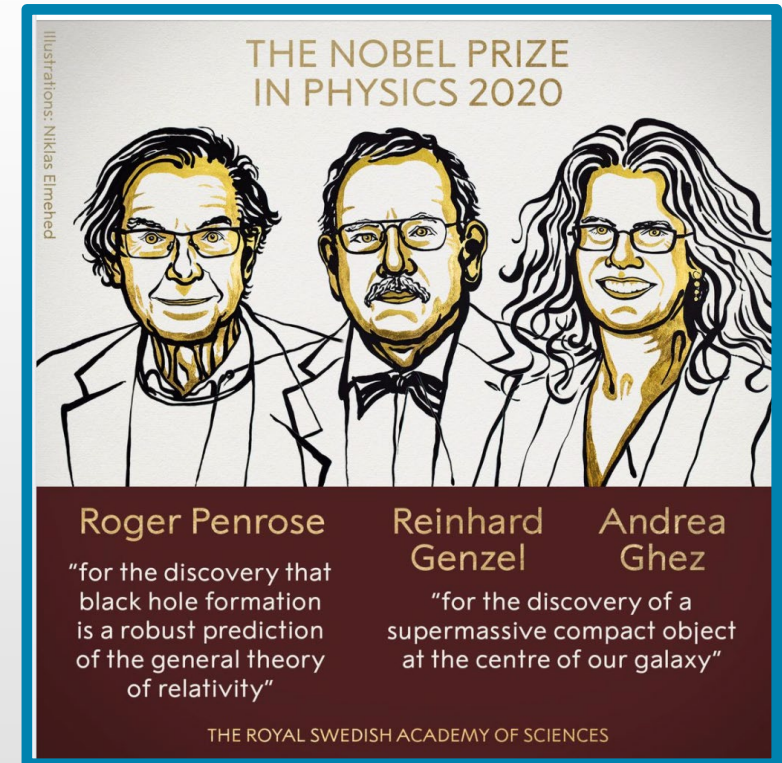
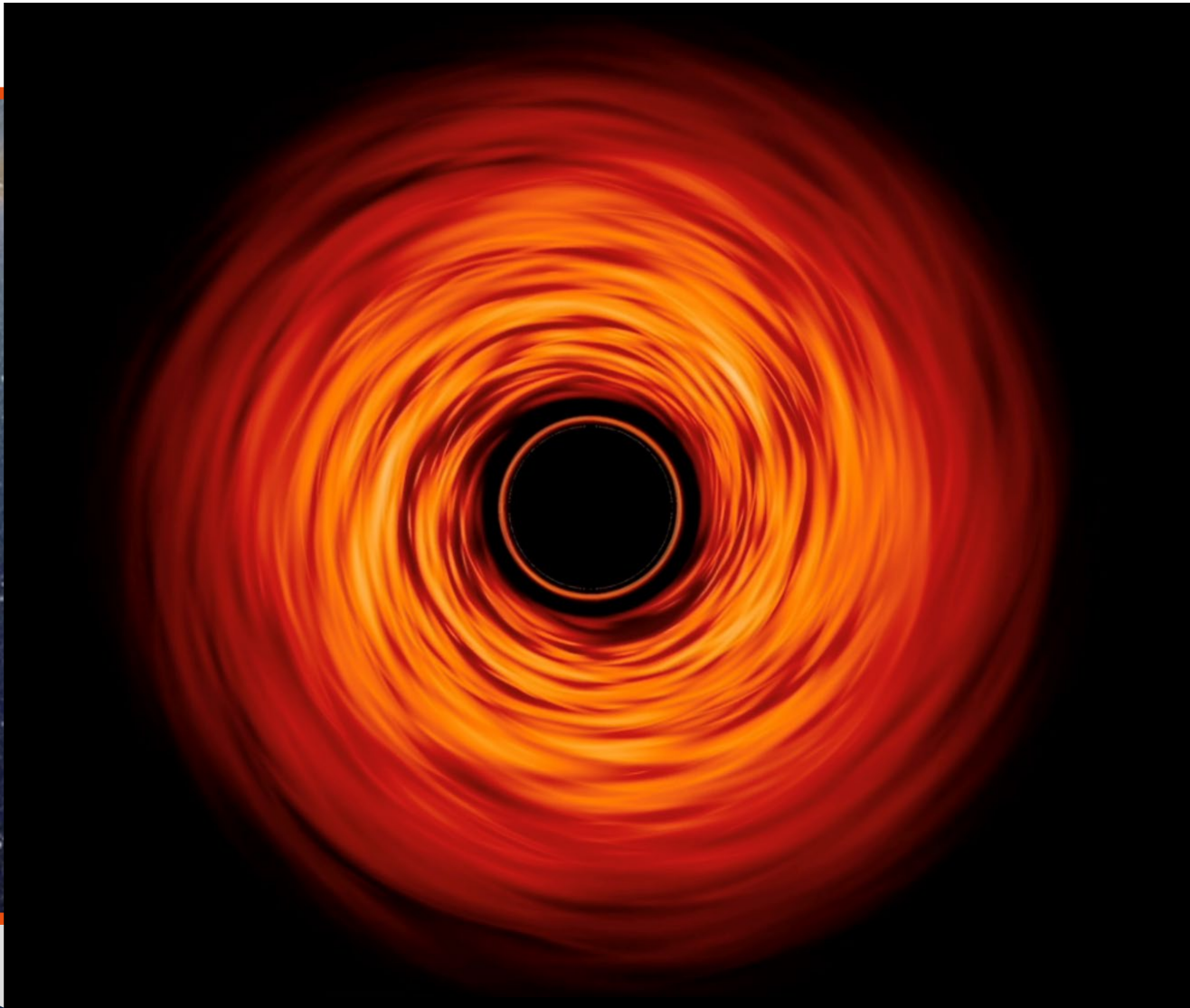


$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -\frac{8\pi G}{c^4} T_{\mu\nu}$$

I found an exact
solution!

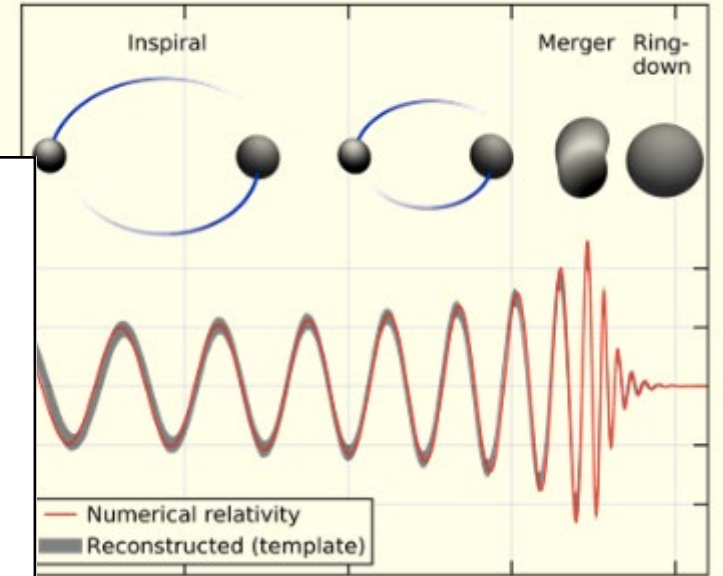
(K. Schwarzschild, three months later)

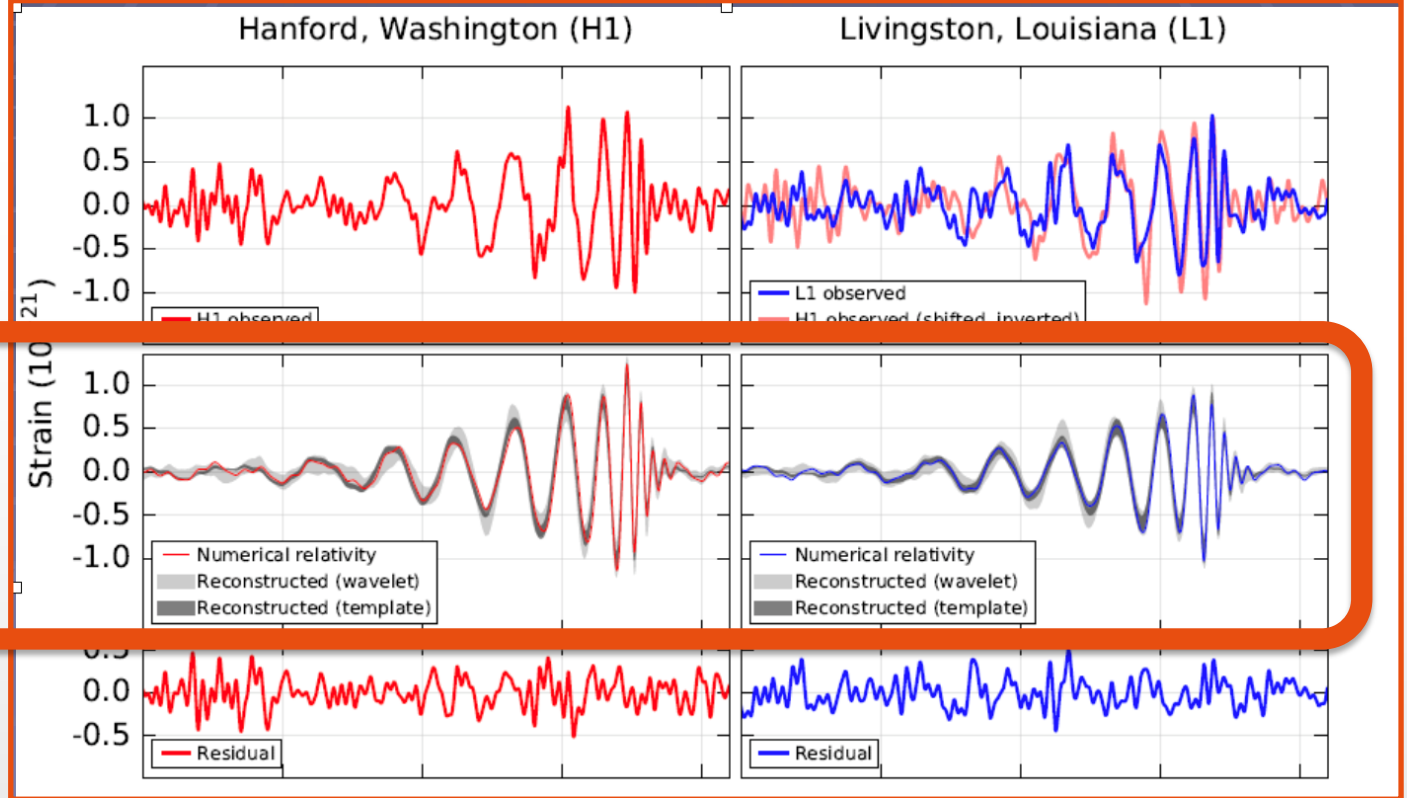
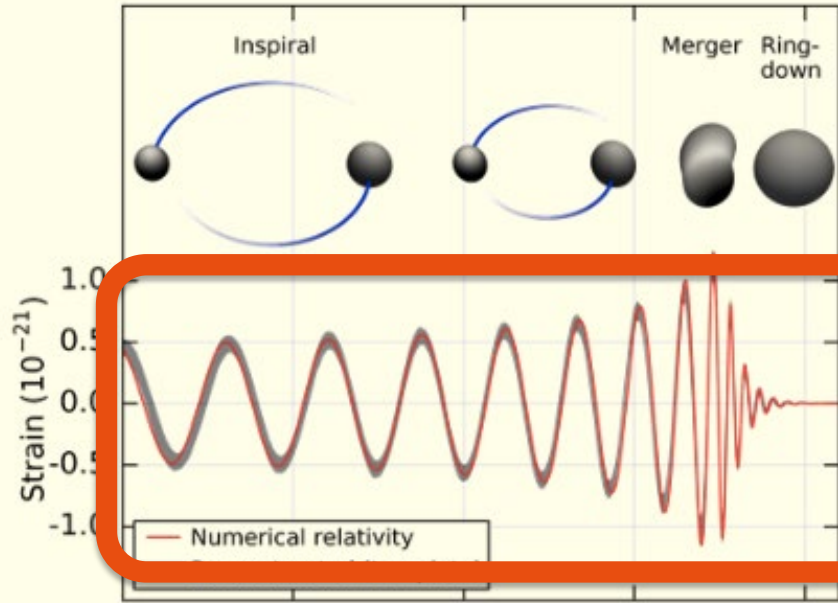
Black holes!



Nobel Prize 2020

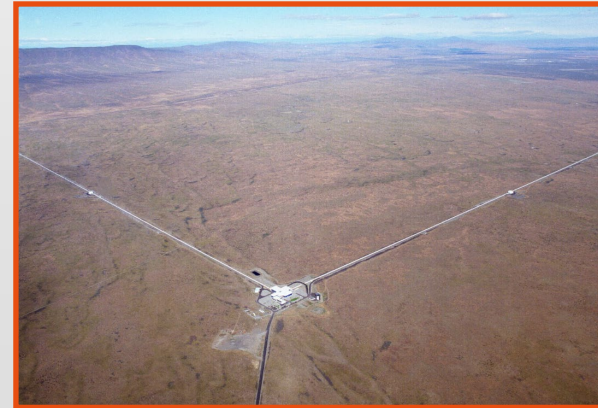
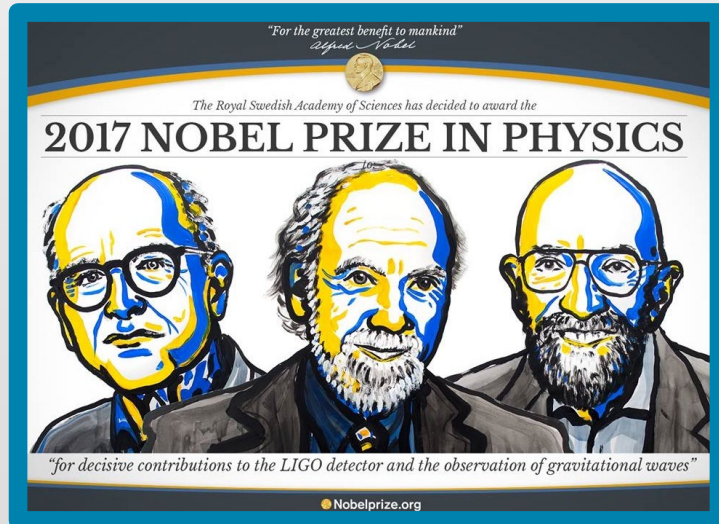
Colliding black holes!



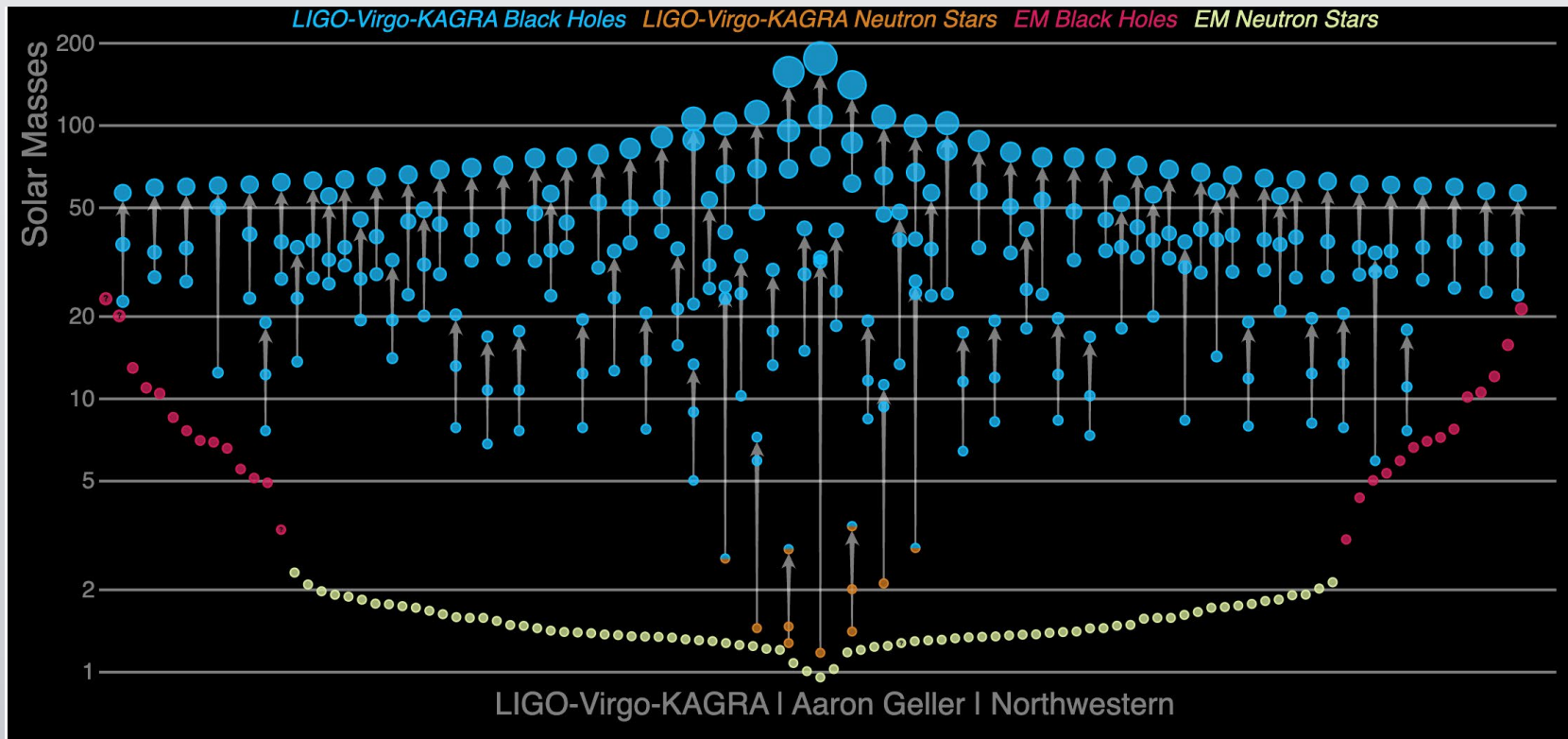


Theory

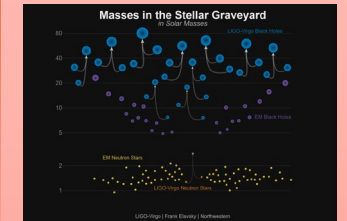
Measurements



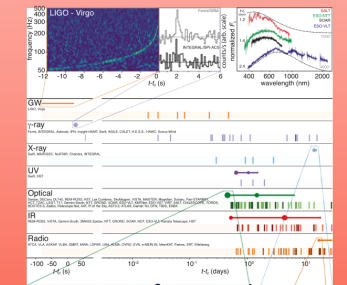
Current* catalogue (*Summer 2023)



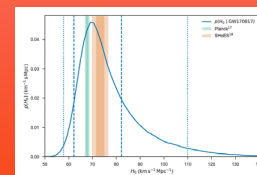
media.ligo.northwestern.edu/gallery/mass-plot



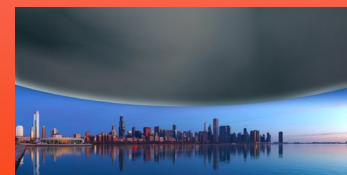
Found new class of heavy stellar mass BBH



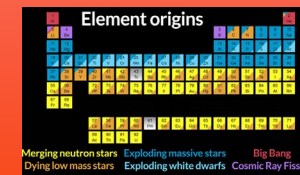
Start of GW multi-messenger astronomy



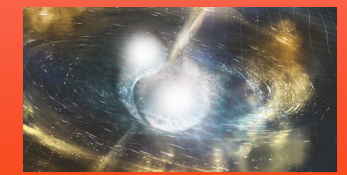
Cosmology independent of distance ladder



Ruled out some proposed EOS of neutron stars



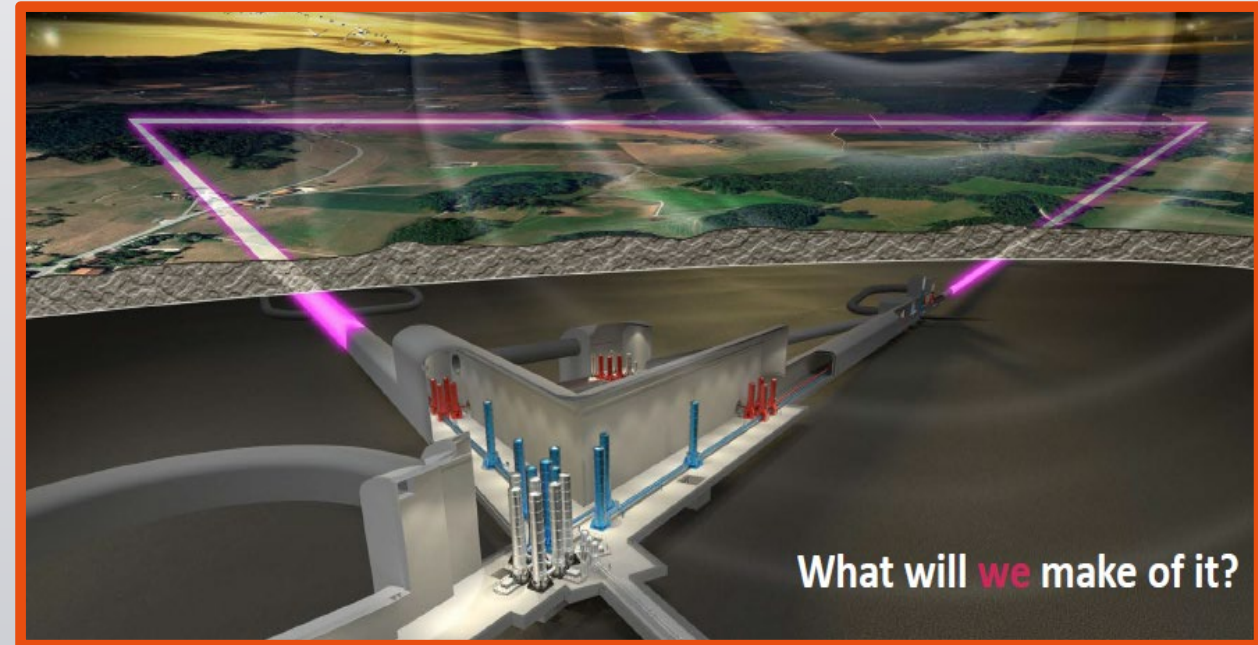
Confirmed Kilonova and R-process



Confirmed BNS as origin for some GRBs

Gravitational waves offer us..

- .. a new window on the universe,
- .. opportunity to measure the very big and the very small
- .. measurements of the past and the future,
- .. a photo of the origin of the universe.
-



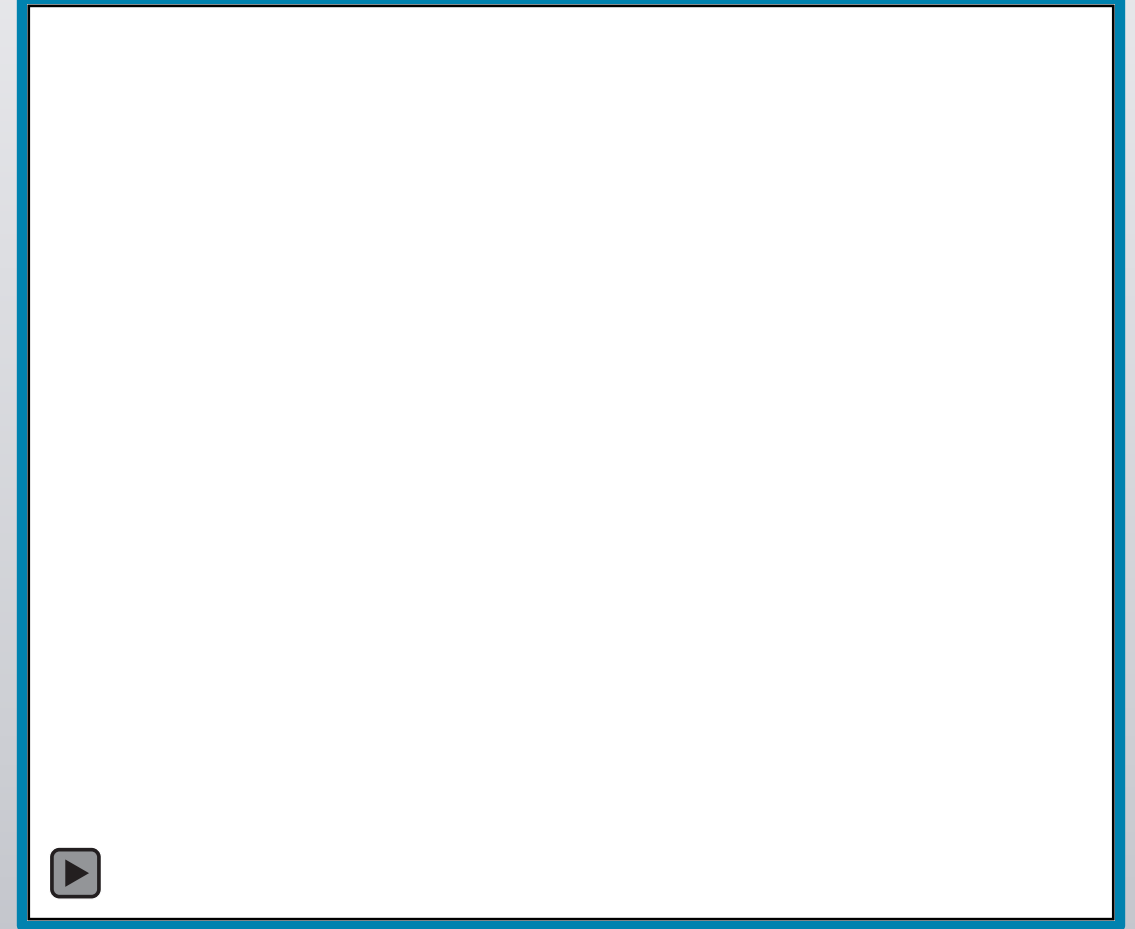
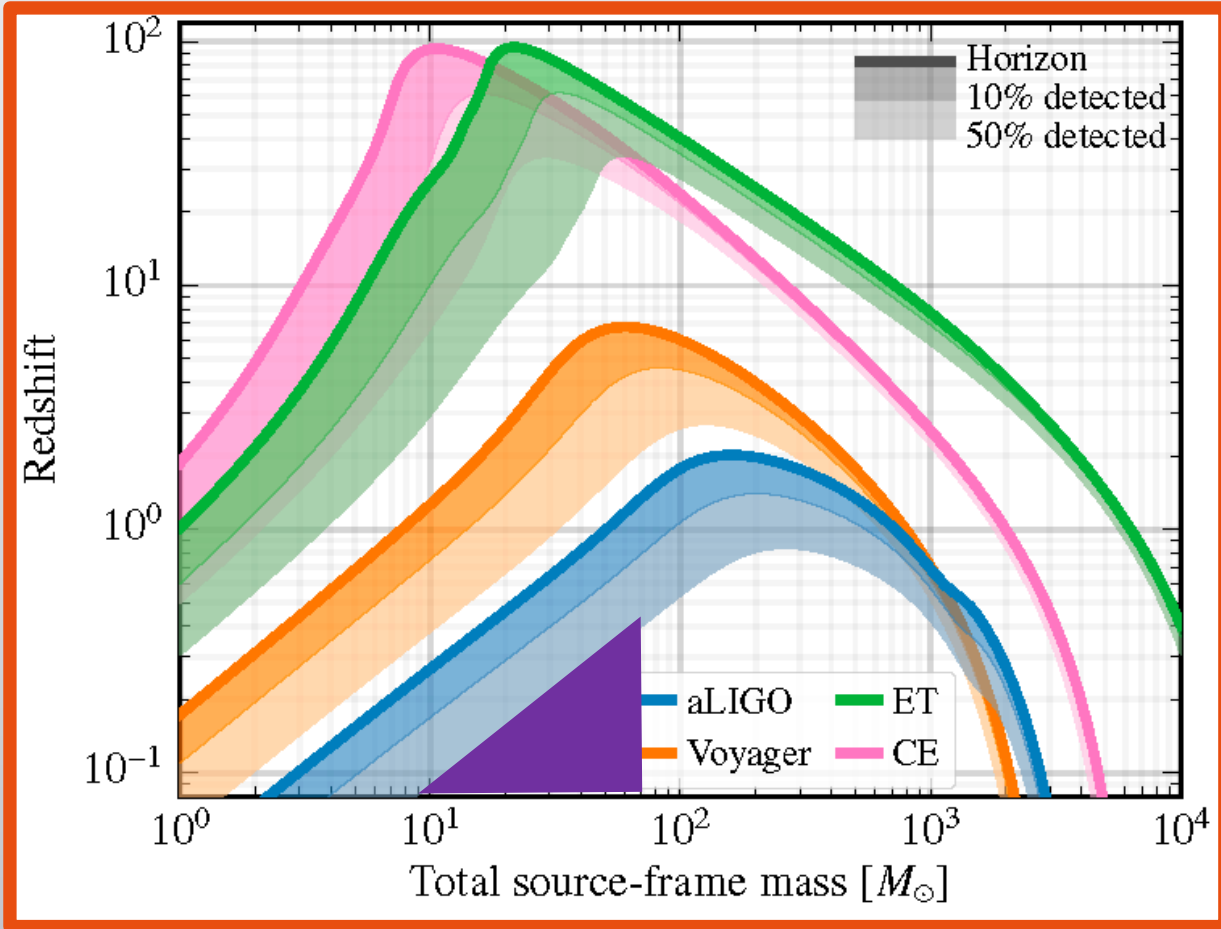
▪ Connection

Science

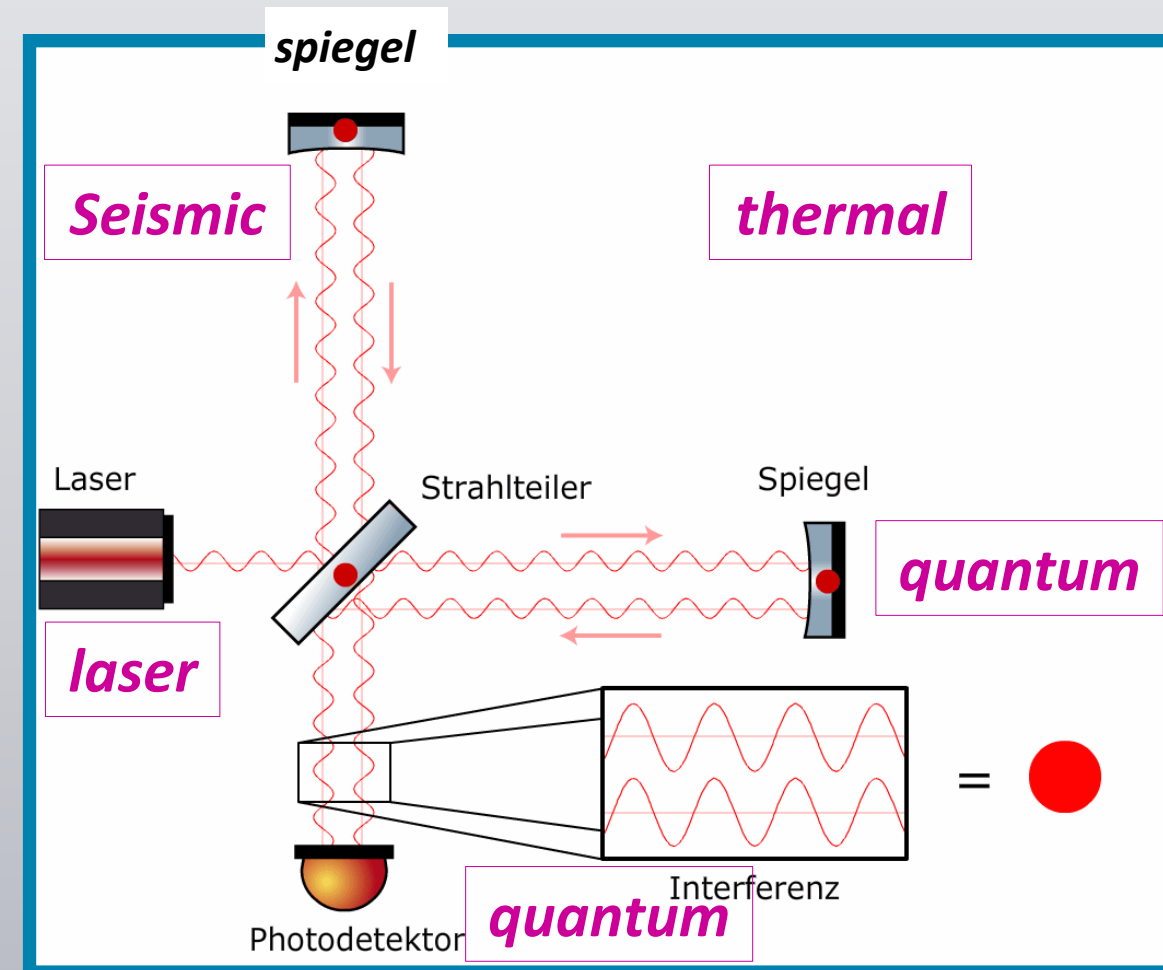
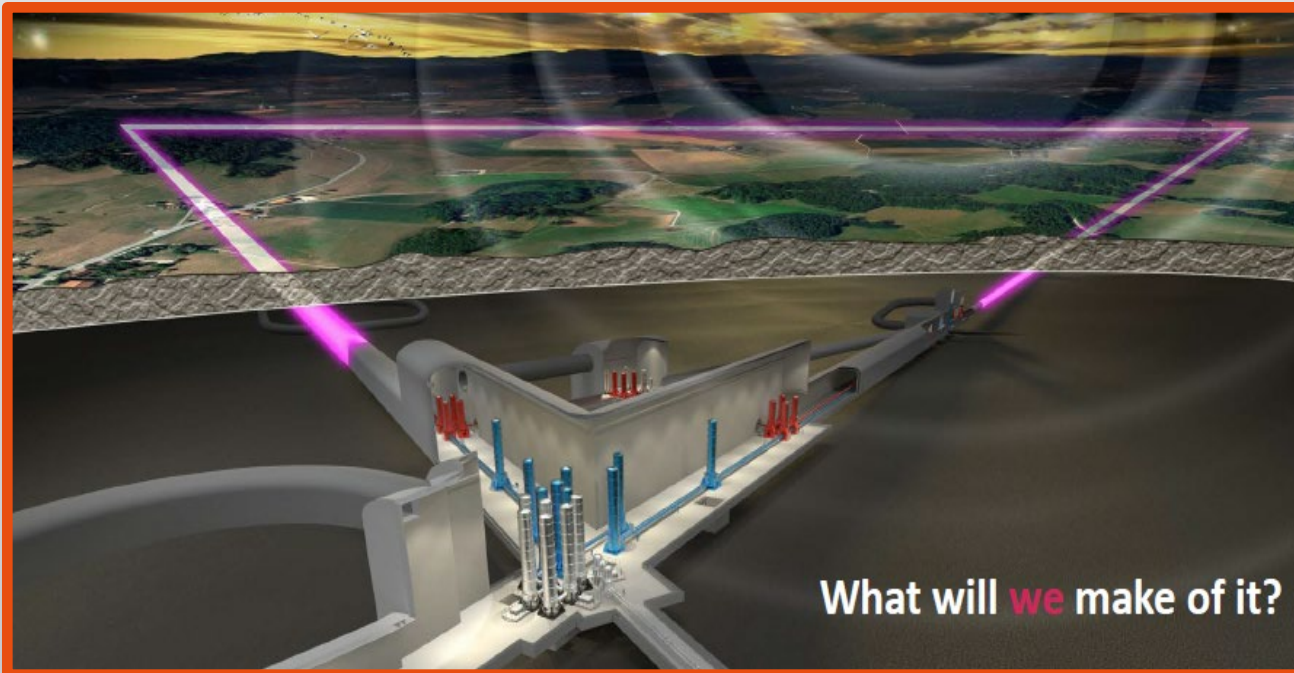
Technology & industry

Society

Einstein Telescope will measure the entire visible universe



Measuring gravitational waves

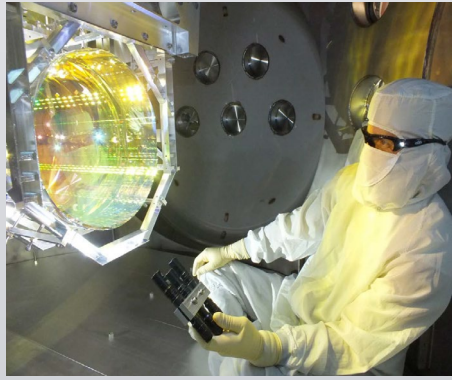


New technologies include..

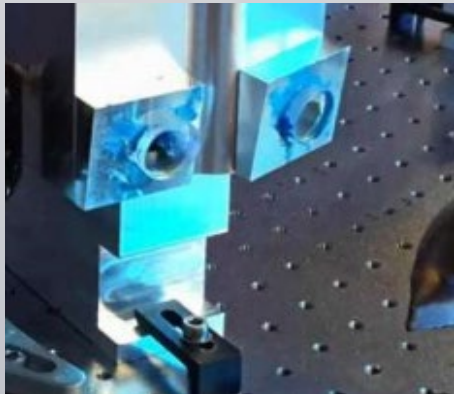
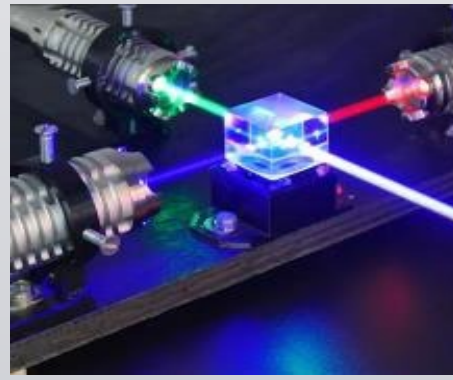
controls



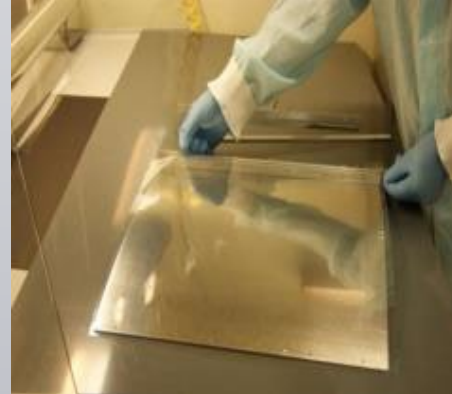
(quantum) optics



lasers



sensors



materials

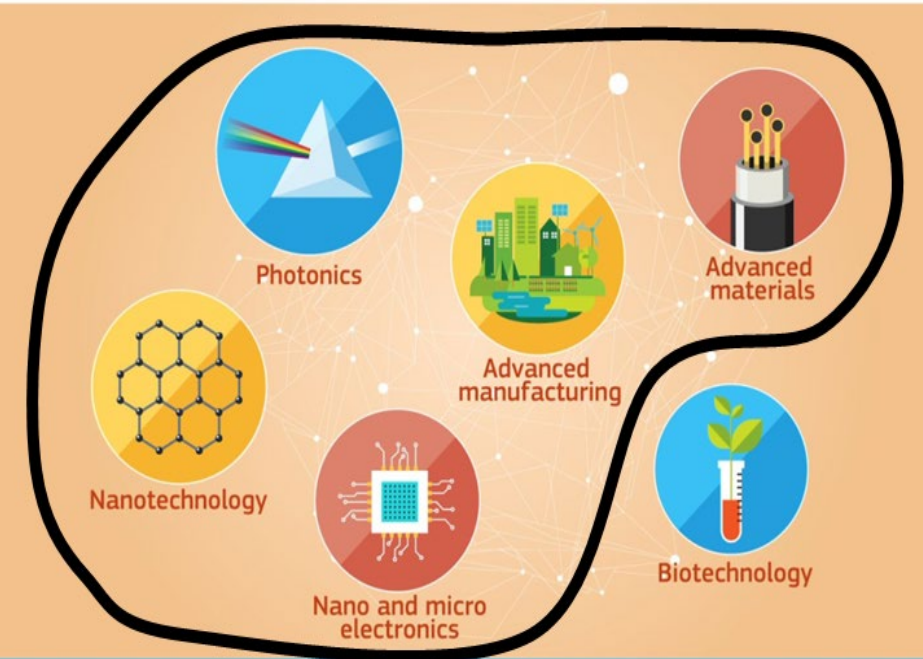


algorithms



Key Enabling Technologies in the EU

Key Enabling Technologies (KETs) are driving innovation and underpinning the shift towards a smart and clean economy



KETs are a priority of EU industrial policy as they can fuel economic growth and job creation. They enable a wide range of advanced products, processes and services including:

ETpathfinder:

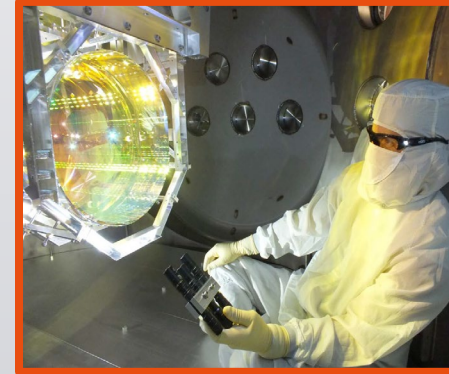
Development of new technologies



Maastricht

ETpathfinder:

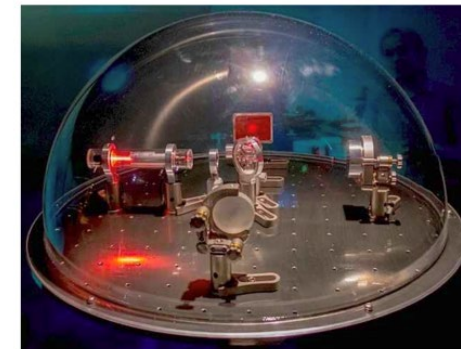
Small version of the Einstein Telescope, meant to research and develop new measuring techniques.



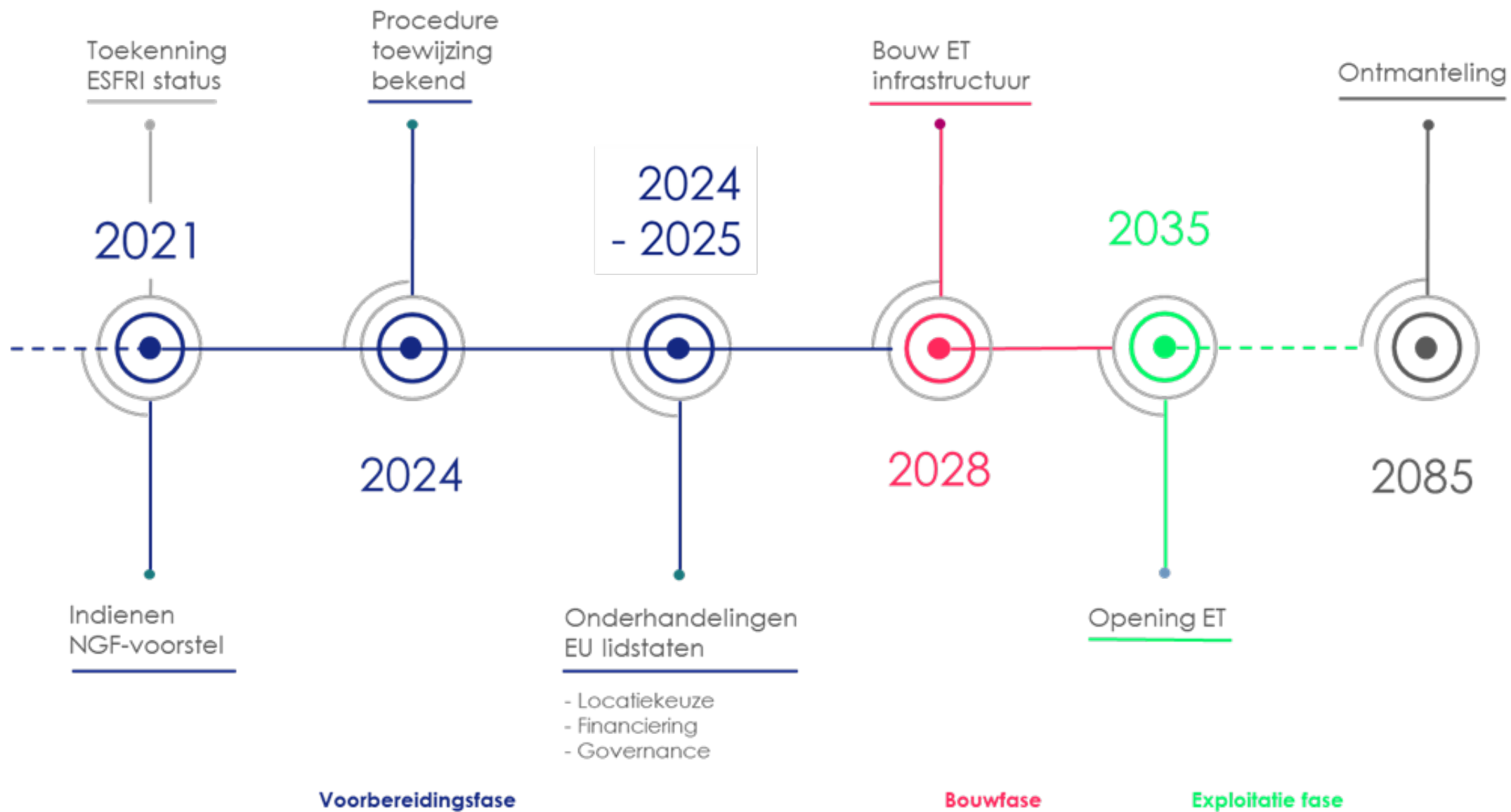
Einstein Telescope Education Centre

EINSTEIN TELESCOPE
EDUCATION CENTRE

DISCOVERY MUSEUM



www.maastrichtuniversity.nl/nl/nieuws/onderwijscentrum-over-einstein-telescope-krijgt-plek-bij-discovery-museum-kerkrade?fbclid=IwAR1d0MOMxCUs8y9cH7KHu9-QJjoJigao_6NfJw0mjPCOXsWOM37Ro6nlpvg



Thank you!

For questions or follow-up:

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<https://www.maastrichtuniversity.nl/gideon.koekoek>