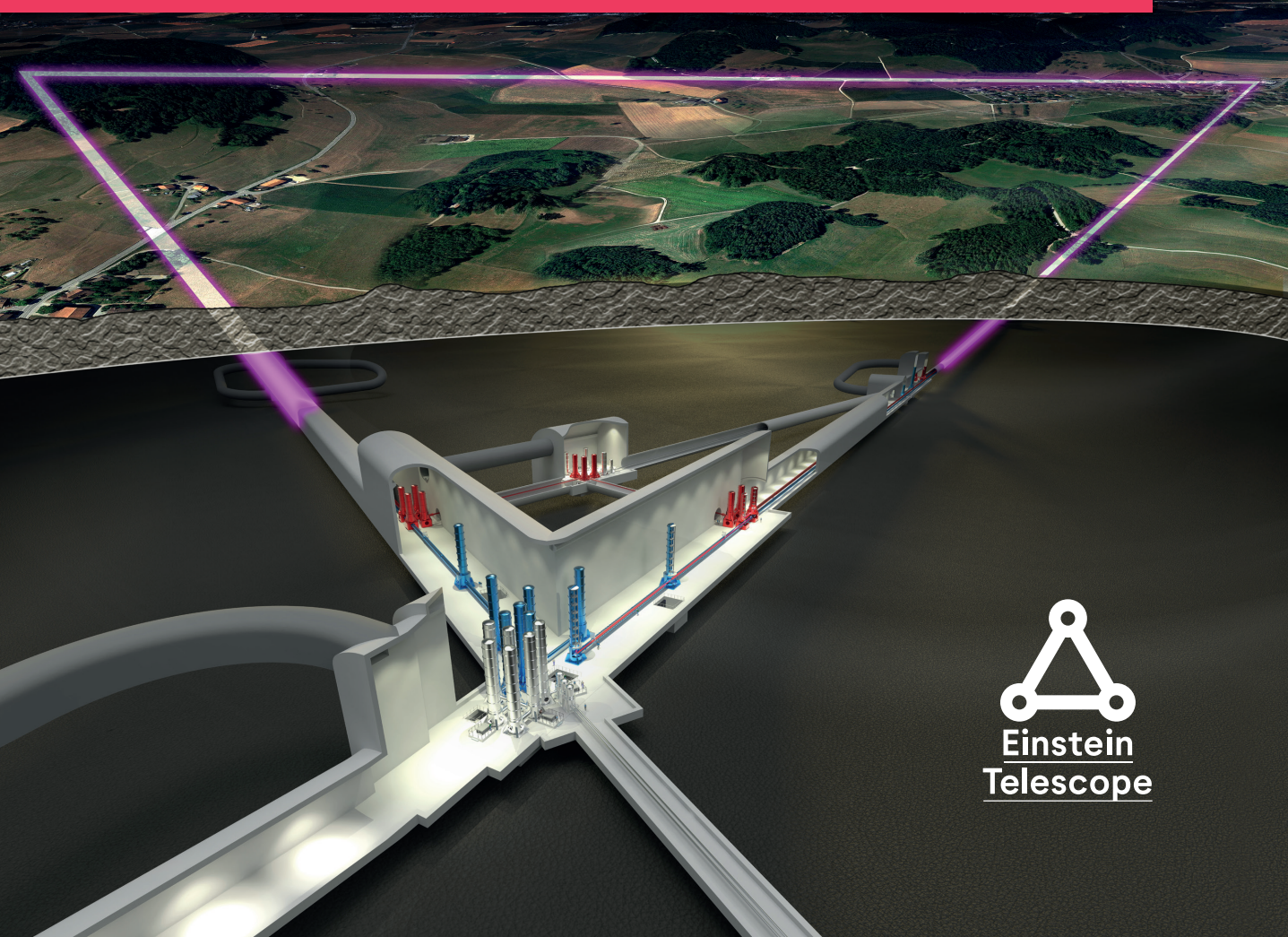


Einstein Telescope

Participate in the next generation underground observatory for gravitational waves

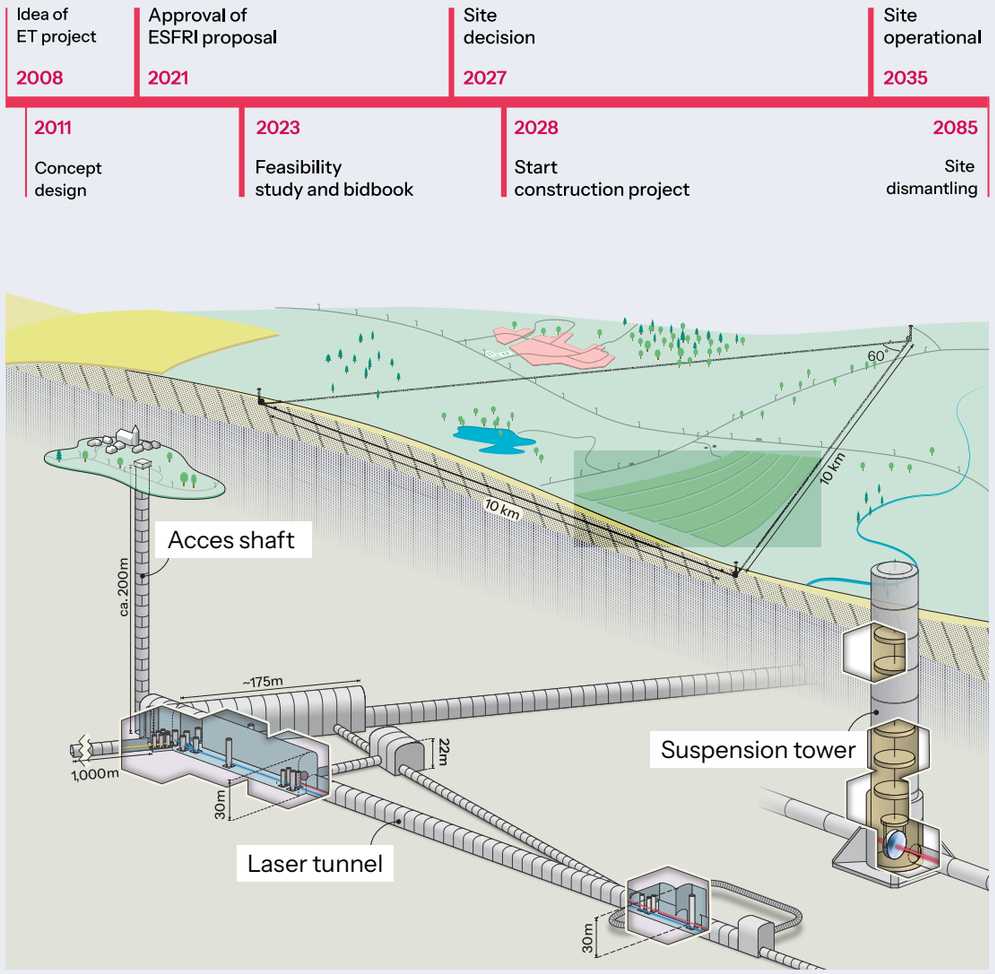


Einstein Telescope

Einstein Telescope, a new window on the Universe

Our universe vibrates when black holes or neutron stars collide. Albert Einstein predicted that distances stretch and contract almost immeasurably when gravitational waves pass by. The Einstein Telescope will measure gravitational waves by constantly monitoring the length of its three detector corridors with sensitive lasers and vibration-free suspended mirrors. By doing so it will detect a thousand times more gravity waves than its predecessors.

The construction costs for ET are estimated at more than 2.5 billion euro within a construction period of 10 years. As the installation is expected to be in use for a minimum of 50 years returning investments in supplies, maintenance and R&D for upgrades are expected.



Einstein Telescope: an underground detector for gravitational waves.

Join our Einstein Telescope ecosystem

Germany, Belgium and the Netherlands are jointly preparing to host Einstein Telescope in the Euregion Meuse-Rhine. The contribution of companies is essential to this project. We invite high-tech companies to participate in our ecosystem. Einstein Telescope is a great opportunity to boost employee satisfaction by working on the cutting edge of technology. The project serves as a world-class reference with impact on a global scale. Participating in Einstein Telescope drives advancements in your products and services. Technologies developed for Einstein Telescope can lead to opportunities in new markets such as life sciences, communications, quantum computing, aerospace, geophysics or semicon. There are a number of projects and programs set up for companies to encourage innovation and accelerate development of new technologies.

Einstein Telescope for business

The Einstein Telescope team can support your business by offering guidance to tenders and collaborative R&D projects, promoting projects and results, support technology exploitation in new markets and organizing networking and matchmaking events.

Does your company want to:

- Become part of the international ecosystem surrounding the Einstein Telescope?
- Be informed about new R&D funding and tenders?
- Participate in technology development at the cutting edge?

Visit www.einsteintelescope-emr.eu to enlist to our channels or to get in touch with our business representatives

20M€
funding

30M€
investment

27
R&D projects

80
R&D partners

400
companies

Business ecosystem development up to march 2025



The Einstein Telescope, a huge opportunity for Belgium, Germany and the Netherlands

Why the Einstein Telescope?

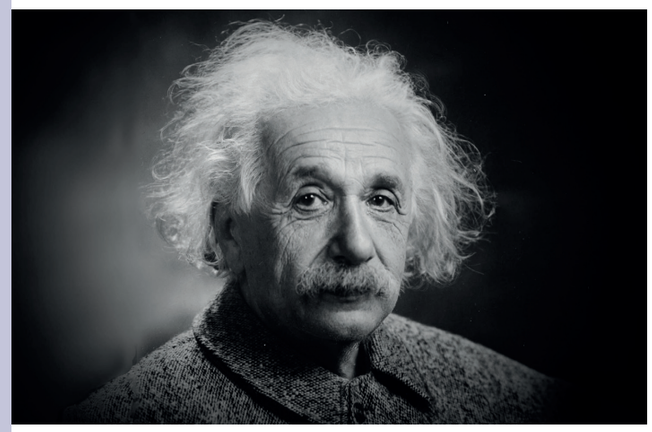
The Einstein Telescope will be Europe's most advanced observatory for gravitational waves, poised to revolutionize our comprehension of the universe and the fundamentals of gravity. Einstein Telescope aims to expand upon the success of first and second generation systems in Germany (GEO600), Italy (VIRGO), USA (LIGO) and Japan (KAGRA). Gravitational waves caused by colliding black holes and neutron stars far away in deep space were observed since 2015. Einstein Telescope will be many times more sensitive to realize precision gravitational wave astronomy and to test Einstein's theory of gravity in strong field conditions.

Impact

Besides serving the scientific needs, Einstein Telescope will push the boundaries of today's technologies into unexplored territory. It will promote innovations that benefit our society and economy in many ways. For example, the World Wide Web and touchscreens were invented in big science projects such as Einstein Telescope.

Location

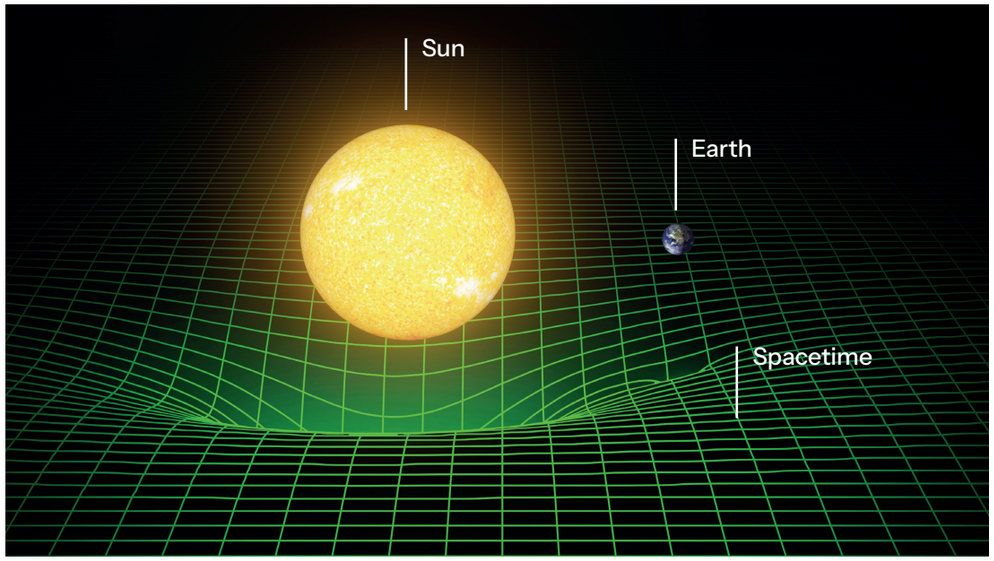
Extensive explorations are carried out in the border area of the Netherlands, Belgium and Germany (Euregio Meuse-Rhine) which shows that the surface area is suitable for the construction of the Einstein Telescope. Here, the area's soft topsoil blocks vibrations caused by human activity on the surface, allowing the underground observatory to take measurements undisturbed. In addition, the good connections and network of knowledge institutions and companies are important. In addition, Sardinia (Italy) and Saxony (Germany) are candidate sites. A location decision at European level is expected in 2027.



Credit: Orren Jack Turner

'The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.'

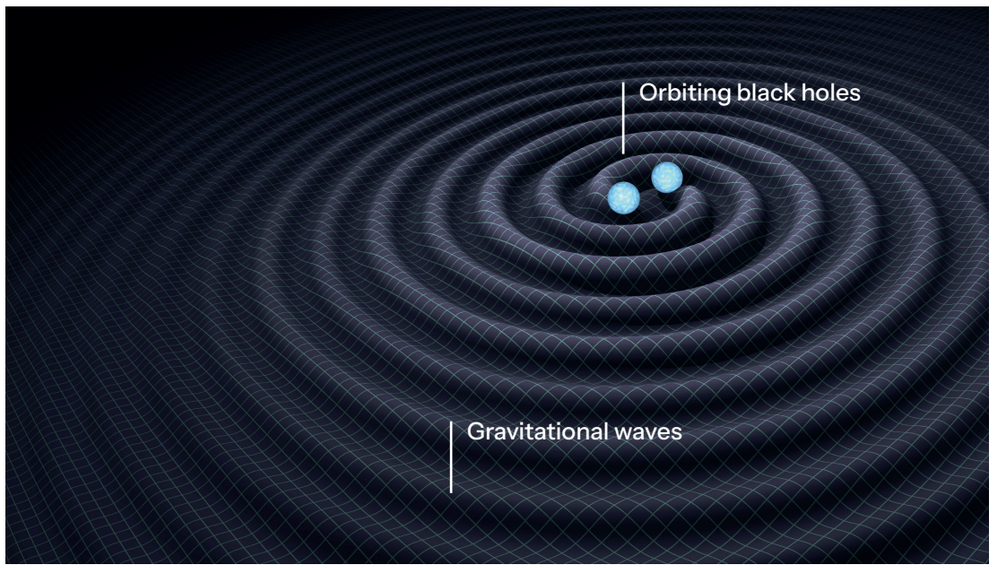
- Albert Einstein



Credit: Caltech/MIT/LIGO Lab/(T. Pyle)

Spacetime
How our sun and earth warp space and time, or spacetime, is represented here with a green grid. As Albert Einstein demonstrated in his theory of general relativity, the gravity of massive bodies warps the fabric of space and time—and those bodies move along paths determined by this geometry.

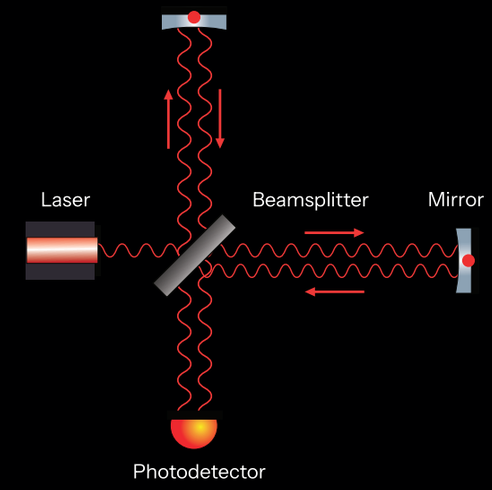
Gravitional waves
Einsteins' theory predicted the existence of gravitational waves, which are ripples in space and time. These waves, which move at the speed of light, are created when massive bodies accelerate through space and time. This illustration shows the merger of two black holes and the gravitational waves that ripple outward as the black holes spiral toward each other.



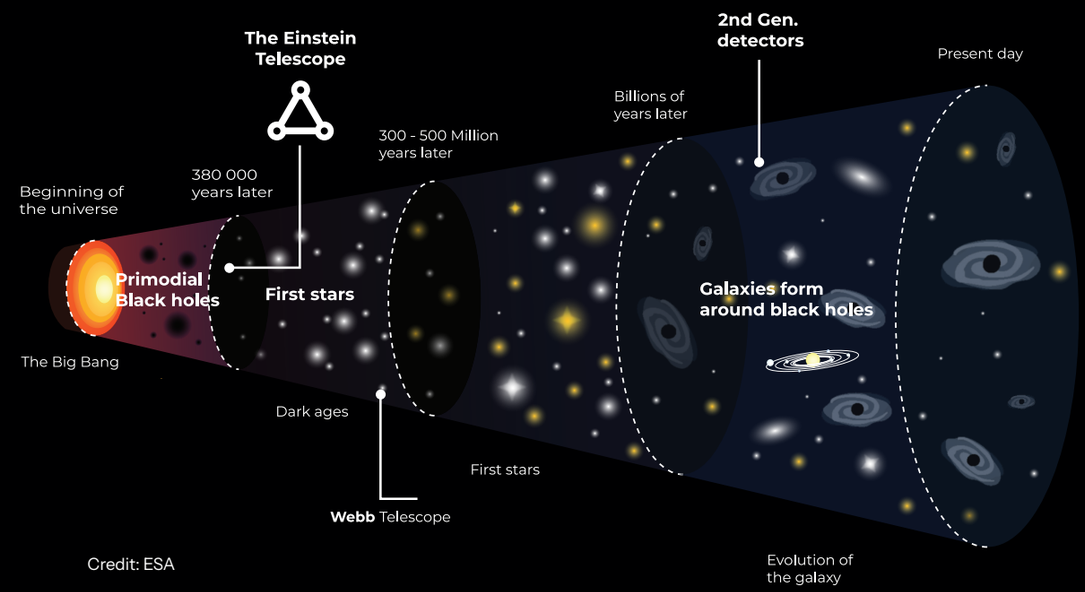
Credit: R. Hurt (Caltech-IPAC)

Gravitational wave detection, measuring ripples in the universe

Measurement principle
The operating principle of Einstein Telescope is based on interferometry. Laser beams travel through long vacuum tubes in different directions, running back and forth between mirrors until they recombine and generate an interference pattern on a photon detector. This method allows measurement of infinitesimal variations in the distance travelled by light inside the vacuum pipes as gravitational waves pass by. The distance variations are the size of an atom on the scale of the earth to the sun.



Listening to the origin of the universe
With Einstein Telescope, researchers will be able to detect events far beyond the horizon of today's telescopes. They can look at the birth process of black holes, the structure of neutron stars, and the nature of the universe immediately after the Big Bang. And they can test Einstein's theory of relativity as never before. This will give us new insights into our universe.



Credit: ESA



ETpathfinder; an R&D infrastructure in Maastricht, the Netherlands, for testing and prototyping new technologies for the Einstein Telescope

Credit: Ron Wiersma

Technology and innovation platform

A collaborative effort

The Einstein Telescope will promote cooperation between research and industry to a new level. The planned gravitational wave observatory is an innovative scientific instrument that expands the boundaries of current technologies. Developing these technologies requires not only Europe's leading minds from academia and institutes but also know-how, creativity and implementation experience from innovative companies.

Why do companies participate in the Einstein Telescope project?

Boost employee satisfaction and attract new talent

Spark engineers' enthusiasm and offer new talent the opportunity to work on unique challenges with world-class scientists.

Create competitive advantage

Place your company in pole position for calls in technology development and supplies, from hightech systems to everyday needs.

Operate at the forefront of new technologies

Engage in cutting-edge technology development, develop skills and capabilities.

Benefit from a world-class reference

Utilize the exposure of this unique and groundbreaking Big Science project, showcase your contribution and attract new business.

Collaborate in a global network

Join an international network of companies, universities and institutes to create new business opportunities.

Key technologies for Einstein Telescope

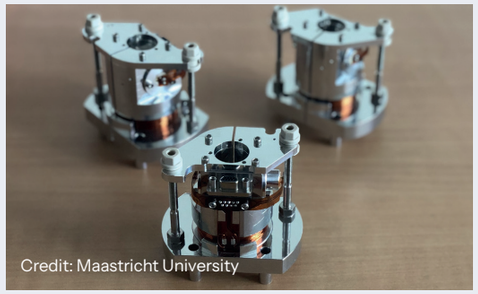
Optics and Optical metrology

At the end of the vacuum arm tubes ultra-stable laser beams are captured in super-polished and coated heavy mirrors, which form part of a complex optical system. The laser beams pass through highly precise photonic filters that stabilize the laser beams and filter out unwanted frequencies and noise. Additional optical systems serve to control and stabilize the instrument.


Credit: Cyril FRESILLON / Virgo / CNRS Images

Sensors and precision mechanics

The extremely high sensitivity of the Einstein Telescope can only be achieved if the mirrors and measuring systems remain free from vibrations. Vibration dampers must isolate the installation from all sources of disturbances, in particular from seismic movements. Horizontal, vertical and rotational vibrations must be reduced through active and passive control.


Credit: Maastricht University

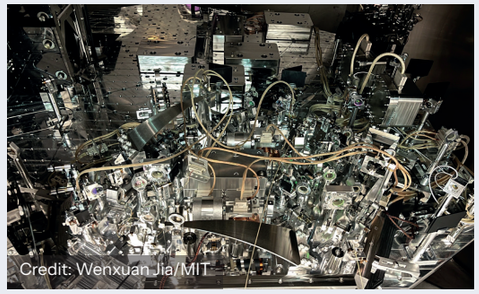
Vacuum technology

To let laser beams bounce undisturbed between the mirrors there is a need for 130 kilometers of ultra-high vacuum tubes (Ø 1 meter, operating pressure < 10^{-10} mbar). The mirrors are suspended in 10 - 20 meter high vacuum towers with a diameter of 3 to 5 meters. The vacuum system is estimated to be highly time and cost intensive, which requires innovations in design, manufacturing and installation.


Credit: Maastricht University

Lasers

The laser sources must have an extremely narrow line width and high stability at a high power output. Laser sources are already quite common for a wavelength of 1064 nm. For the ET, new lasers must be developed that operate at wavelengths of 1550 nm or 2090 nm. The implementation of novel quantum technologies such as squeezed light sources could be a further innovation domain.


Credit: Wenxuan Jia/MIT

Advanced control algorithms

Einstein Telescope requires advanced control systems to manage its thousands of signals and maintain the interferometers at optimal performance. Current interferometers are limited by control-generated noise at low frequencies. New algorithms including AI methods are crucial to overcoming this limitation.

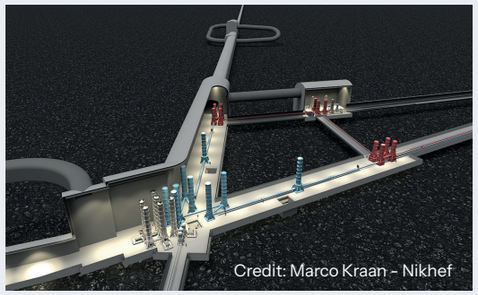

Credit: Maastricht University

Civil engineering, simulation and modelling

The underground facility requires advanced tunneling techniques and stable foundations to support the heavy and complex equipment with extreme precision. Technological advancements are for example augmented reality for visualization and computation of ground motions and Building Information Modelling (BIM) in civil engineering.

Vibration-free cooling technology

Einstein Telescope will feature core optics operating at a temperature of 10K / -263 °C. The 200kg mirrors are suspended by very thin wires. After the initial cooldown, the operating temperature of the mirrors must be maintained solely through radiation and conduction via low-stiffness thermal heat links to ensure that the system is not affected by vibrations from the cryogenic plant.


Credit: Marco Kraan - Nikhef

Data handling and processing

The vast amounts of data generated by Einstein Telescope require sophisticated data processing, visualization and storage solutions. The large amount of potentially overlapping gravitational wave detections from ET requires innovations in data analysis techniques. Collaboration with experts in big data, cloud computing and AI could lead to more efficient data management and analysis tools.


Credit: EGO/Virgo



Einstein Telescope

Join our ecosystem, **participate in Einstein Telescope**

Get in touch with our local business representatives and enlist to our channels.

March 2025

einsteintelescope-emr.eu

Credit cover: Marco Kraan – Nikhef