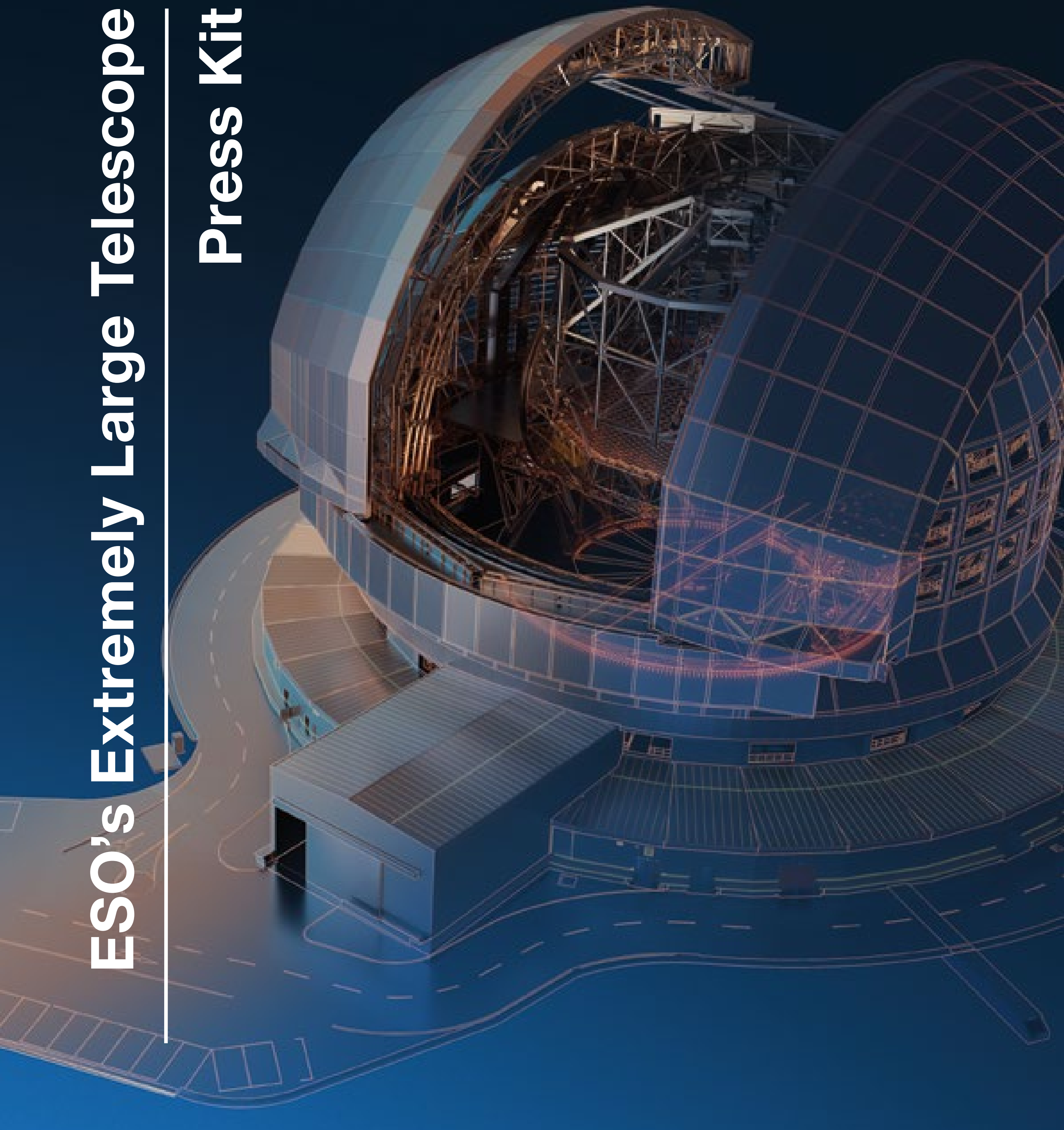
ELT

ESO's Extremely Large Telescope

Press Kit



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ESO/T. Preibisch

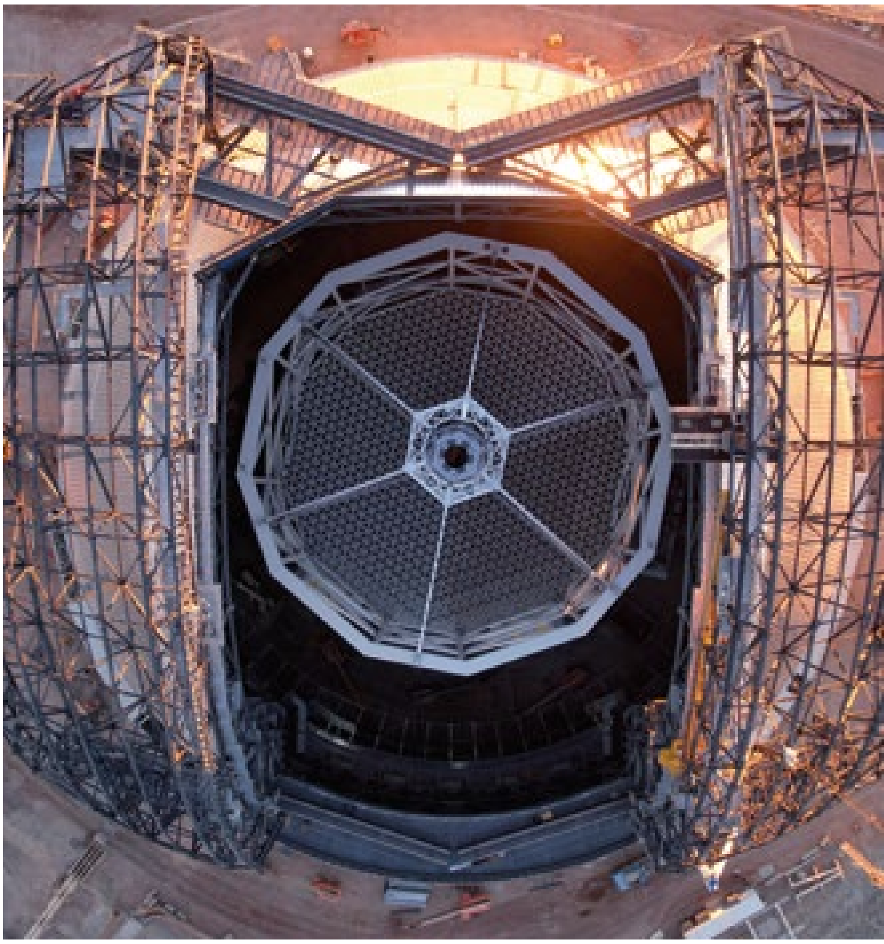
The ELT in a nutshell

The European Southern Observatory's Extremely Large Telescope (ESO's ELT) is a groundbreaking astronomy project that will help us explore the Universe in unprecedented depth and detail. It will be the largest optical and near-infrared telescope in the world.

When it starts operating on Cerro Armazones in Chile's Atacama Desert, ESO's ELT will take advantage of some of the clearest and darkest night skies in the world and enable unique and exciting new discoveries, dramatically changing what we know about our Universe. It will probe remote and ancient galaxies, help unravel mysteries such as the nature of black holes and dark matter, and search for possible variations in the fundamental constants of physics. The ELT could also become the first telescope to find signs of life on planets orbiting stars other than the Sun, making us rethink our place in the cosmos.

With its pioneering five-mirror design, including a revolutionary main mirror 39 metres in diameter, ESO's ELT will be a wonder of modern engineering, whose construction is driving technology beyond what was previously possible. Around 80% of its 1.5 billion euro budget is spent on industry contracts and over 50 institutes contribute to the development of the ELT instruments, opening new business markets and stimulating high-tech economies.

This truly international endeavour builds on ESO's 60-year success story of global collaboration in astronomy, sharing resources and expertise. The ELT will engage citizens in ESO's Member States in Europe, Chile and across the world with astronomy and inspire generations to come.



ESO/G. Vecchia

View of the ELT from above, taken in May 2025 while the telescope was under construction.

The ELT in numbers

39 m diameter

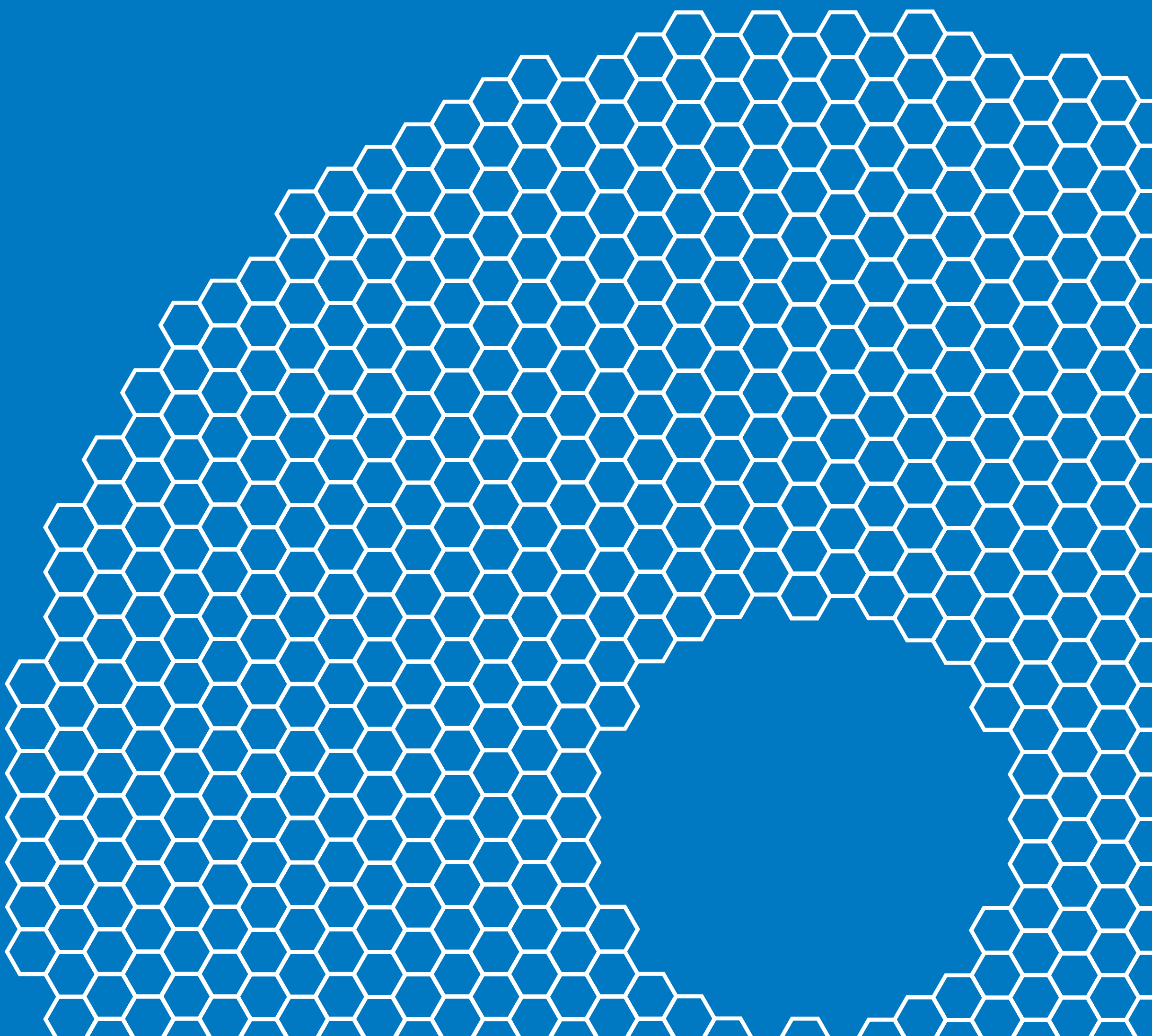
of the ELT's main mirror, which is almost one and a half times the height of the **Brandenburg Gate** in Berlin or the height of Chile's La Portada de Antofagasta.

798

Number of **hexagonal segments** making up the main mirror.

0.0000001 m

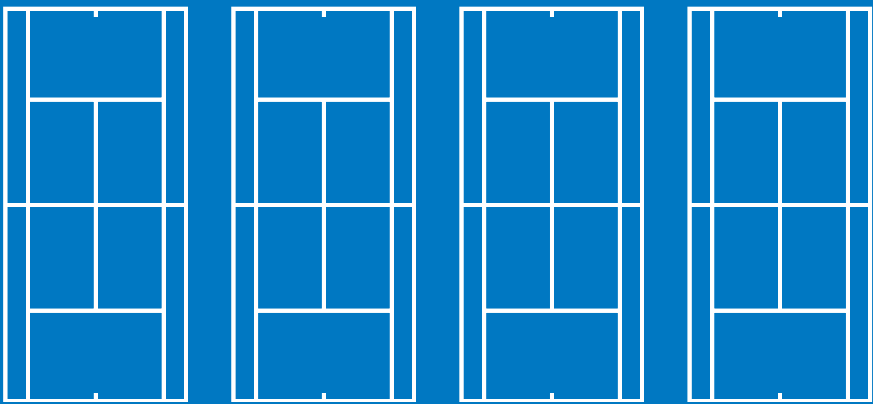
Precision level at which the segments will be aligned across the entire 39 m diameter. This is 10 000 times thinner than a human hair.



978 m^2

light-collecting area

of the telescope, which is comparable to the area of four **tennis courts**.



This means ESO's ELT can collect:

20 times more light

than each of the four unit telescopes
making up ESO's Very Large Telescope (VLT).

8 million times more light

than Galileo's telescope.

100 million times more light

than the human eye.

500 km

Total length of the cables used on the ELT, which is approximately the length of the **island of Ireland**.

1500 km

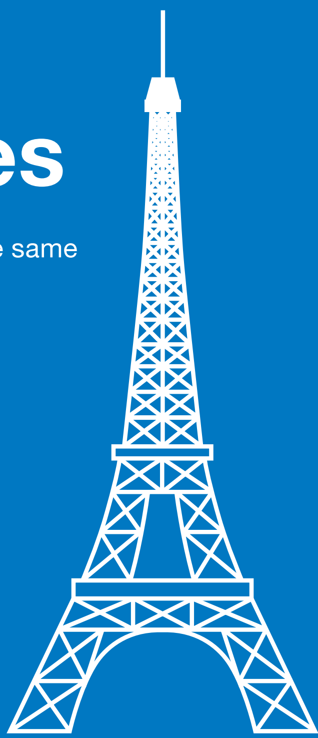
Total length of the optical fibres used on the ELT, roughly the distance between Rome and Copenhagen, or the distance between Santiago de Chile and Buenos Aires.

3700 tonnes

Weight of the ELT main structure, the same as nine International Space Stations.

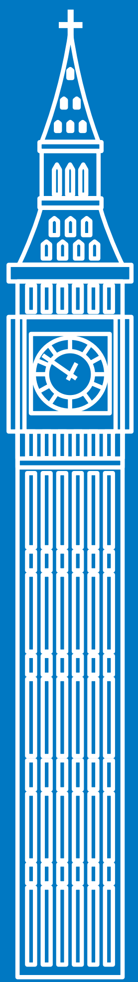
30 million

bolts in the ELT dome, **12 times** more than the number of rivets used in the **Eiffel Tower** in Paris.



150 × 300 m

Size of the ELT platform on Cerro Armazones, which is comparable to eight times the floor area of the **Sagrada Família** in Barcelona.



3046 m

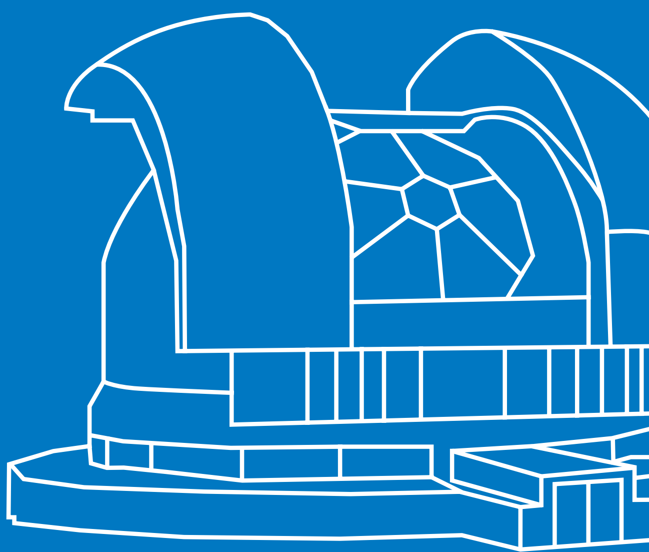
Height above sea level of the ELT platform on Cerro Armazones.

220 000 m^3

Amount of rock removed to flatten the top of Cerro Armazones and host the ELT site, approximately sixteen times the volume of the **Big Ben clock tower** in London.

2030

Planned year of scientific first light, when the telescope will begin its first science observations.



30+ years

The **ELT**’s estimated lifespan.

Science with the ELT

The science cases of ESO's ELT range from unravelling age-old mysteries in our own Solar System to glimpsing the oldest and most distant galaxies in the Universe.

Exploring the Solar System

Though our Solar System is the corner of the Universe we know the best, there remains a lot to be discovered. The ELT will be able to provide new and more detailed views of familiar objects, offering a fresh perspective on our place in space. For example, it will help astronomers to:

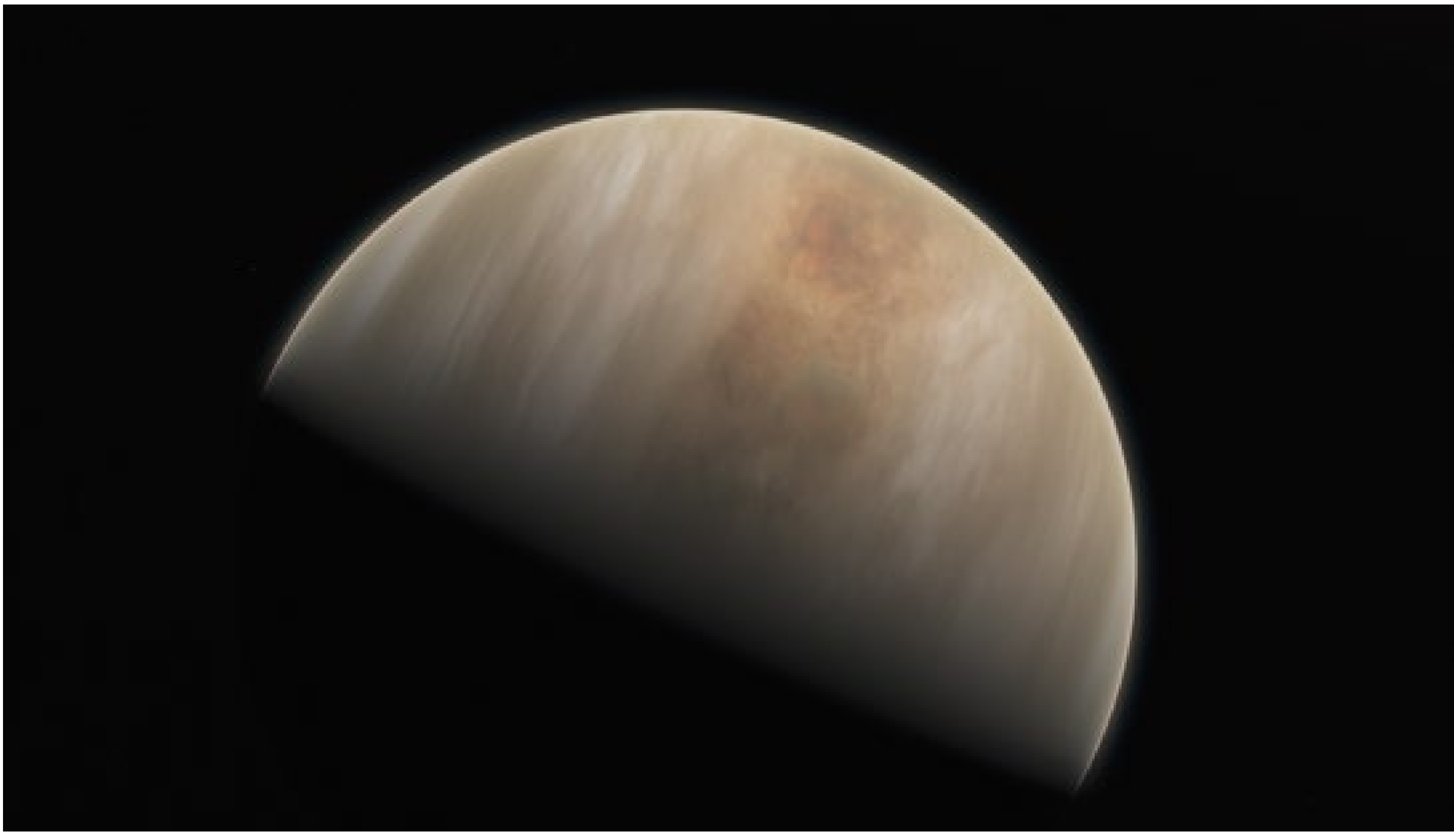
– find clues about the origin of the Solar System through observations of the asteroid and Kuiper belts. These are home to some of the oldest objects in the Solar System and are remnants of the disc of gas and dust from which the planets formed.

– study the faintest objects in the Solar System. For the first time, planets like Uranus and Neptune, which today can only be investigated in detail using space probes, will be viewed in high-resolution from Earth. The ELT will also help discover primitive bodies far away from the Sun, such as comets previously too small to observe, and determine their origins.

– probe the atmospheres and weather systems of our planetary neighbours, Venus and Mars, in unprecedented detail, augmenting the views delivered by space missions. In addition to this, the ELT will provide new insights into the evolving atmospheres and surfaces of the moons of Saturn and Jupiter, potential hotspots for extraterrestrial life within the Solar System.

This artistic impression depicts our Solar System neighbour Venus.

ESO/M. Kornmesser & NASA/JPL/Caltech



Searching for new worlds

A few thousand planets have already been discovered outside the Solar System, a number which is set to increase dramatically. Thanks to its high precision and resolution, the ELT will have unparalleled capabilities to find new rocky planets in the habitable zone of their stars. These planets could have liquid water on their surfaces and could host life.

Currently, exoplanets are discovered using a variety of techniques. One example is the radial velocity method, where the presence of a planet is inferred from its tiny gravitational tug on its parent star. ESO's ELT will be able to use this technique with a much higher accuracy than currently possible, allowing it to discover new, Earth-sized rocky worlds.

ESO's ELT will also be able to image already known exoplanets directly. Further, astronomers will be able to search for biomarkers in exoplanetary atmospheres that could hint at extraterrestrial life, meaning the ELT could become the first telescope to find evidence of life outside our Solar System.

ESO/L. Calçada

This artist's impression shows a sunset seen from the super-Earth Gliese 667 Cc. The brightest star in the sky is the red dwarf Gliese 667 C, which is part of a triple star system. The other two more distant stars, Gliese 667 A and B also appear in the sky to the right. Astronomers have estimated that there are tens of billions of such rocky worlds orbiting faint red dwarf stars in the Milky Way alone.

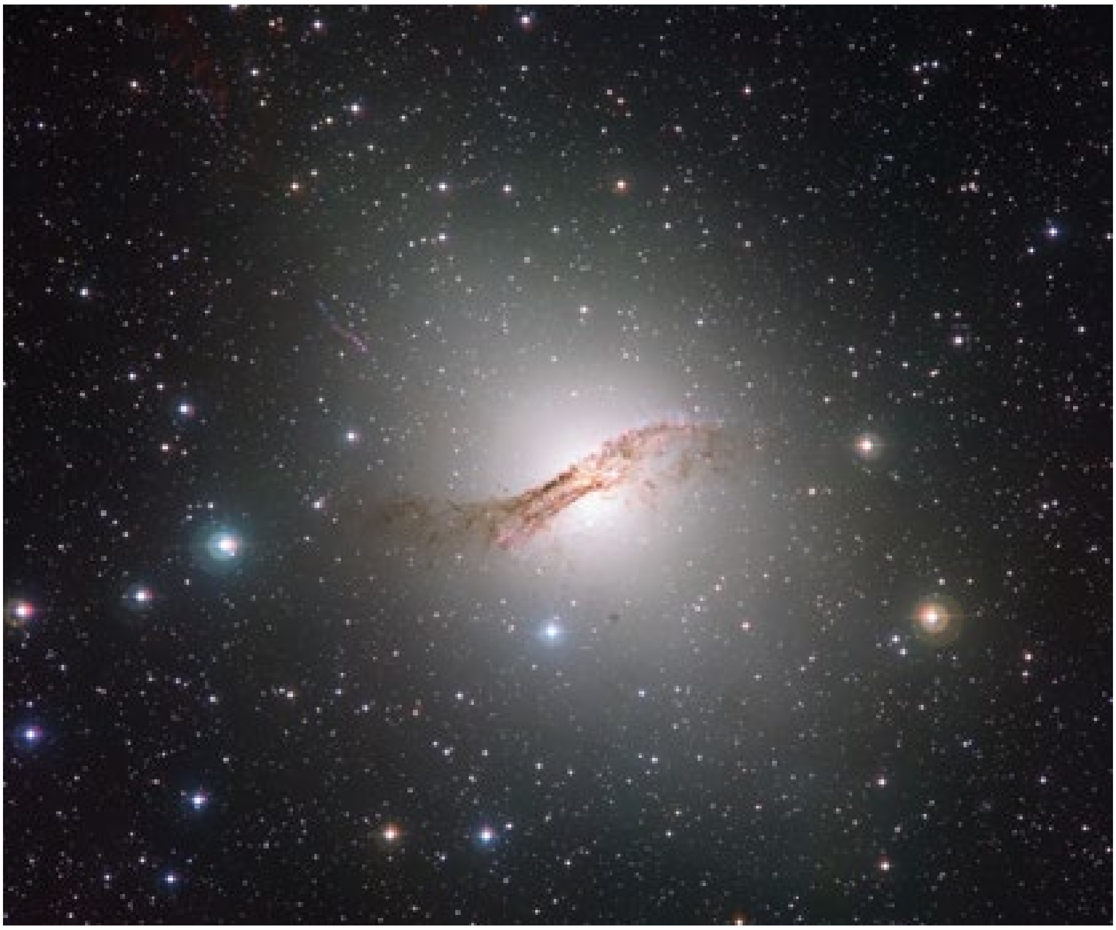
Studying stars and uncovering the history of galaxies

ESO's ELT will look to solve some of the biggest unanswered questions in cosmology. For example, it will help astronomers to:

– study distant galaxies much further away than current telescope capabilities allow. The further away an object, the further back in time we are viewing it, so astronomers will be looking at some of the first galaxies to form after the Dark Ages period, just a few hundred million years after the Big Bang.

– resolve individual stars in distant galaxies and look for the oldest stars in the Universe. By studying stars in galaxies near and far, the ELT will allow astronomers to understand where and when most stars were born. By studying old stars in galaxies, which act as a fossil record of the formation of cosmic structures, astronomers will also be able to shed light on how galaxies formed and evolved.

– further our understanding of the intergalactic medium, the hot gas in the space between galaxies. The intergalactic medium makes up most of the visible matter in the Universe, and studying it will provide astronomers with new insights into the galactic life-cycle.



The galaxy Centaurus A (NGC 5128).

Shedding light on dark matter and dark energy

Two cosmological enigmas that continue to puzzle astronomers are dark matter and dark energy.

– It is estimated that visible matter only makes up 5% of the Universe, with the other 95% consisting of dark energy and invisible dark matter which holds galaxies together. As the first telescope able to tell apart the distributions of visible and dark matter, ESO's ELT will allow astronomers to probe the haloes of dark matter surrounding galaxies, a major step towards addressing the question of its nature.

– Dark energy is the mysterious force believed to cause the accelerating expansion of the Universe. With ESO's ELT, cosmologists will be able to measure this acceleration using a unique technique called redshift drift, a key advance in our quest to uncover the secrets of dark energy.

A multitude of faint galaxies, small luminous dots scattered over the dark sky, was captured by the Wide Field Imager on the MPG/ESO 2.2-metre telescope at La Silla Observatory in Chile. Images such as this one are powerful tools that help us to understand how dark matter is distributed in galaxies.

Building on our knowledge of black holes

ESO/M. Kornmesser

This illustration depicts a star (in the foreground) experiencing spaghettification as it's sucked in by a supermassive black hole (in the background) during a 'tidal disruption event'.

Following on from the Nobel Prize winning work done using ESO's Very Large Telescope (VLT) that found evidence for the supermassive black hole at the centre of the Milky Way, the ELT will be uniquely suited to probing this and other supermassive black holes lurking at the heart of galaxies. The telescope will excel at tracking the movement of stars around these invisible goliaths with unprecedented precision, from which astronomers can infer key information on the structure of the black holes themselves.

In addition, astronomers hope to find out more about intermediate-sized black holes hidden among the stars. Using ESO's ELT, they will bridge the gap in our knowledge and find the missing link between the smaller black holes that emerge from the death of the biggest stars in the Universe, and the supermassive black holes in galactic centres.

Making unexpected discoveries and rewriting the laws of nature

There are many discoveries that astronomers can anticipate making with the ELT, but the observations made with this telescope will also raise — and hopefully answer — entirely new questions that we cannot conceive of today. The unexpected discoveries enabled by the ELT will trigger theorists to find new explanations and models of how nature works.

The ELT could make discoveries that will radically change our views of the Universe. For example, it will be used to explore the spectra of bright and distant quasars — remote celestial objects that emit extremely large amounts of energy. Using these spectra, cosmologists will be able to probe whether the fundamental constants of physics, which regulate the strength of all physical processes happening in nature, have remained fixed or have changed throughout the history of the Universe.

NASA, ESA, R. Ellis (Caltech), and the HUDF 2012 Team

The Hubble Space Telescope is perhaps most famous for its spectacular observations of 'deep fields' of galaxies, such as the Hubble Deep Field. Observing a small patch of the sky was, however, not one of the initial aims of the project. The discoveries these deep-field observations allowed were, therefore, unexpected.

“With the ELT we’re going to see things that were impossible to see before. We’re going to see things and we’re going to be surprised!”

Didier Queloz, Nobel Prize Laureate,
Professor at the Universities of Cambridge, UK,
and Geneva, Switzerland

ESO/M. Kornmesser

How the ELT works

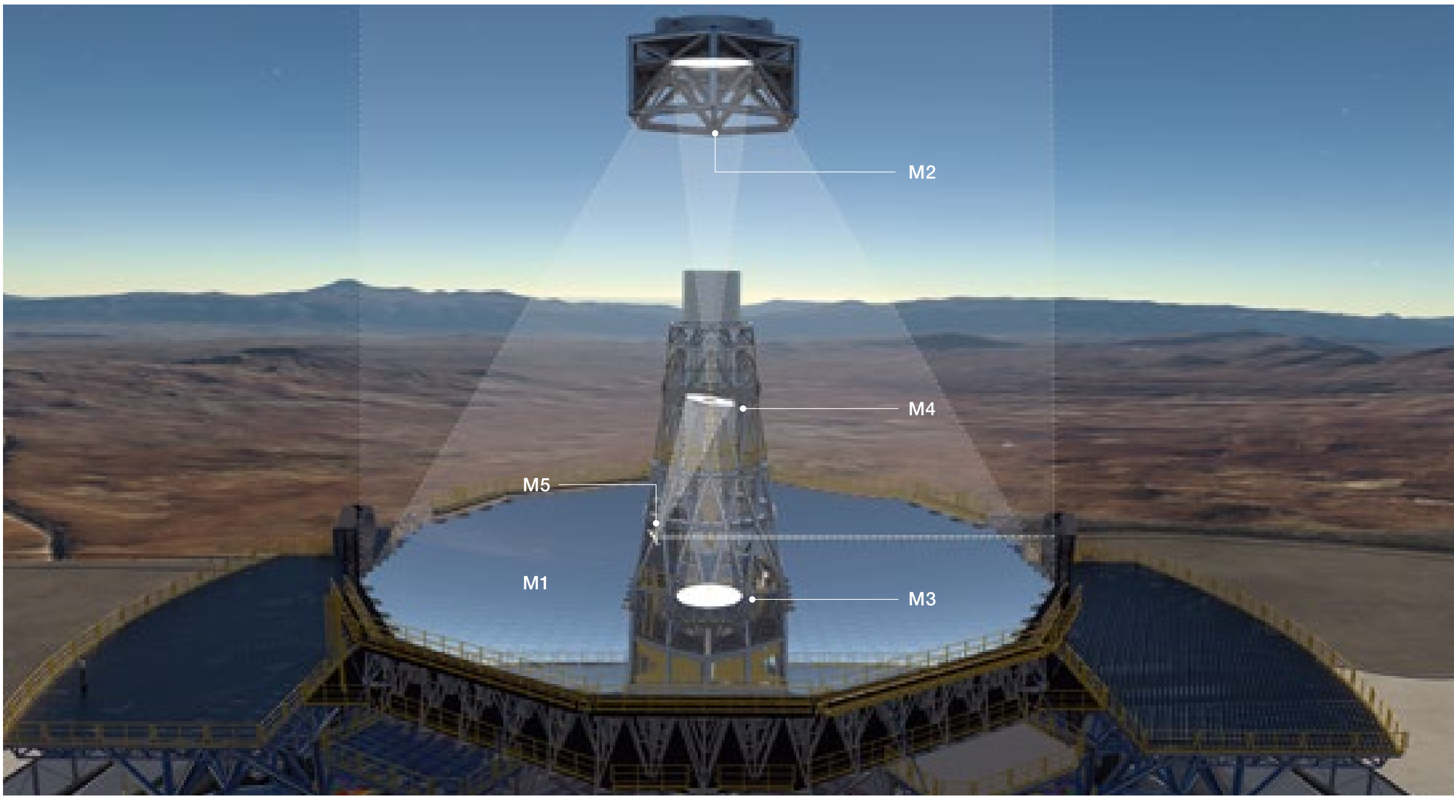
Designing the world's largest optical and infrared telescope was no small feat. From the construction of the impressive telescope dome structure to the casting of each of the five mirrors, the work on this wonder of modern engineering has been made possible thanks to a spirit of innovation and collaboration. ESO has worked alongside a worldwide community of astronomers, as well as dozens of Europe's and Chile's most cutting-edge companies, to bring the ELT to scientific first light.

The ELT, which will be operated from ESO's Paranal Observatory in Chile's Atacama Desert, will have a pioneering five-mirror optical design and a suite of powerful instruments that will allow it to explore the Universe in unprecedented detail. It will employ sophisticated 'adaptive optics' technologies to compensate for the turbulence of Earth's atmosphere and to ensure its images are sharper than those of any other telescope. A giant dome will house the telescope and its components, providing protection from the extreme desert environment.

Mirrors

The five mirrors (M) of ESO's ELT have different shapes, sizes and roles but will work together seamlessly to pass light to its instruments. The primary, M1, is the most spectacular: a giant 39-metre concave mirror that will collect light from the night sky and reflect it to the secondary mirror, M2. The convex M2, the largest secondary mirror ever employed on a telescope, will hang above M1 and will reflect light back down to M3, which in turn will relay it to an adaptive flat mirror (M4) above it. This fourth mirror will adjust its shape a thousand times a second to correct for distortions caused by atmospheric turbulence, before sending the light to M5, a flat tiltable mirror that will stabilise the image and send it to the ELT instruments.

The optical system of the ELT showing the location of the mirrors.



M1 — The giant primary mirror

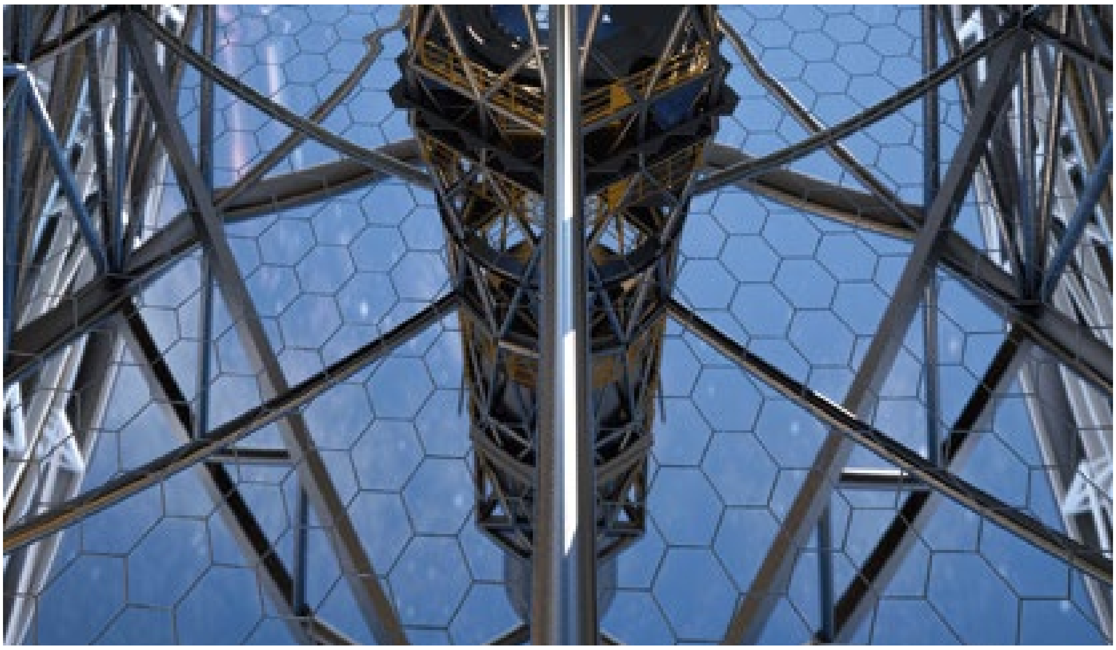
The purpose of the M1 primary mirror is to collect as much light as possible. As the largest optical telescope mirror in the world, M1 will be able to collect 20 times more light than each of the 8.2-metre unit telescopes that make up ESO's VLT, allowing astronomers to see fainter and more distant objects than ever before.

M1 is, without a doubt, one of the most impressive and challenging aspects of the entire ELT project. Too large to be made from a single piece of glass, the 39-metre-diameter concave mirror will consist of 798 segments, each about 5 centimetres thick, measuring close to 1.5 metres across and weighing 250 kilograms, including its support.

Since the segments have to work together as a single mirror, they require specific infrastructure and control schemes. This is extremely challenging, as the entire structure will be moving constantly during an observation and will be affected by wind and temperature changes. To achieve the required scientific performance, the mirror needs to be maintained in position and in shape to an accuracy of tens of nanometres — 10 000 times thinner than a human hair — across its entire 39-metre diameter.

M1 and the ELT's other mirrors are manufactured from Zerodur©, a glass-ceramic material that is highly resistant to changing shape with variations in temperature. The mirror blanks were made by SCHOTT in Germany, who begin by casting and machining them to their approximate shape. After this, they are delivered to Safran Reosc in France, who are responsible for shaping the segments and mounting them on their support systems, as well as for polishing and testing. VDL ETG Projects B.V. in the Netherlands are responsible for the production and testing of the segment supports, which act as the backbone of the mirror.

This artist's rendering shows some of the hexagonal segments of the ELT primary mirror.



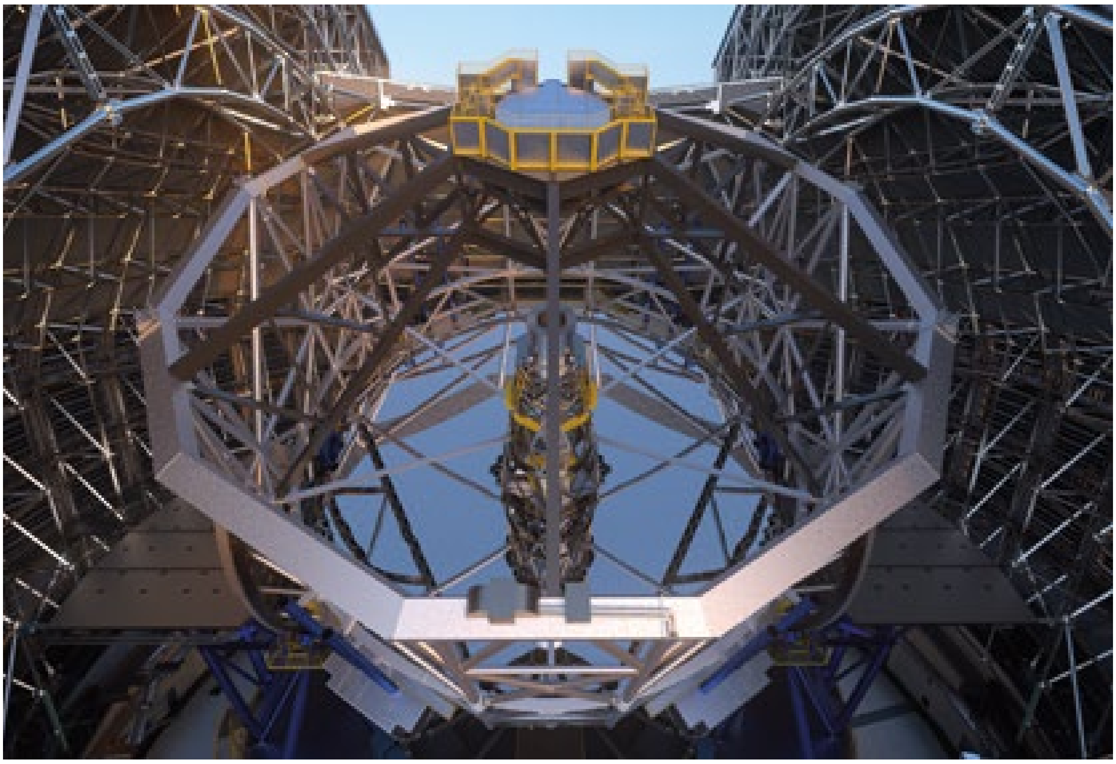
ESO/L. Calçada

M2 and M3 — Perfecting image quality

Unlike most other large telescopes, which use only two curved mirrors, the ELT will use three. The convex M2 will hang above M1 and will reflect light back down to M3. These three mirrors work in tandem to allow ESO's ELT to deliver a better image quality over a larger field of view than would otherwise be possible.

With its 4.25-metre diameter, the ELT's M2 mirror will set another record in the astronomical landscape. M2 will be the largest optical secondary mirror ever used on a telescope — as big as the primary mirrors of many of today's world-class telescopes. There is also the added challenge that M2 will hang upside down over the ELT's main mirror, about 60 metres above the ground, held in mid-air by its support structure and anchored to the telescope main structure. The M3 mirror is similarly large and complex, with a 4-metre diameter. The mirrors alone weigh more than 3 tonnes each; with the cell and structure included, the overall weight of each assembly is about 12 tonnes.

M2 and M3 are manufactured by SCHOTT and Safran Reosc, and the cells to hold the mirrors are made by the Spanish company SENER.



This artist's rendering shows some of the mirrors of the ELT, with the M2 mirror visible at the top centre of the frame. M3 is located below it, within the structure at the centre of the large main mirror.

M4 — The largest adaptive mirror ever built

A true technological wonder, the ELT's fourth mirror is the largest deformable mirror ever made.

M4 is the main adaptive mirror of the ELT. The term 'adaptive mirror' means that its surface can be deformed in real time to correct for atmospheric turbulence, as well as for the effects of the wind and the vibration of the telescope structure induced by its motion. In the case of M4, more than 5000 actuators are used to change the shape of the mirror up to 1000 times per second. In combination with the ELT's fifth mirror, M4 is vital to delivering the sharp images needed for science.

Measuring 2.4 metres in diameter, it will be made up of six petal-shaped thin segment mirrors, each only 1.95 millimetres thick.

The six petals that make up the M4 mirror were produced by SCHOTT and Safran Reosc. The reference body that holds the mirror petals was made by French company Mersen Boostec and polished by Belgian company AMOS. The AdOptica consortium in Italy produced the segment assemblies and the entire support unit.

Rendering of M4, the main adaptive mirror of the ELT.

ELT adaptive optics

Our planet's atmosphere causes the stars as seen from Earth to 'twinkle', which blurs the finest details of the cosmos. To correct for these distortions, as well as for disturbances from the telescope itself, the ELT will use advanced adaptive optics technology, some of which is especially developed for the ELT. This includes very fast and accurate sensing cameras, able to measure atmospheric distortions, and powerful lasers that create artificial stars close to the objects of interest to help with the measurements. These measurements are then passed to extremely fast real-time computers that are able to calculate the necessary corrections to be applied to M4, the adaptive optics mirror of the ELT.

These beams of light shooting towards the sky show the laser guide stars of the future ELT. These lasers (six at first light, but up to eight may be installed) are vital to the operation of the ELT, helping it adapt to the ever-changing atmospheric conditions above the telescope. This information is sent to the ELT's M4 mirror which will adjust its shape to compensate for the distortion caused by atmospheric turbulence, allowing astronomers to observe finer details of much fainter astronomical objects than would otherwise be possible from the ground.

M5 — The largest tip-tilt mirror in the world

M5 is the final mirror in the path of the light collected by the ELT. Although it is the smallest mirror on ESO's ELT, it is the biggest tip-tilt mirror ever employed on a telescope and its precise tip and tilt movements will ensure images are stabilised before they reach the scientific instruments.

Along with M4 it forms part of the adaptive optics system of the telescope, allowing the ELT to take extremely high-quality, sharp images.

The M5 is a flat mirror measuring 2.7 × 2.2 metres, and is constructed from six lightweight silicon-carbide segments fused together. Safran Reosc will supply the M5 mirror along with the auxiliary equipment required for its handling, transport, operation and maintenance. Mersen Boostec has supplied the mirror's lightweight base surface, and will also be responsible for the supply of the M5 replacement blanks if necessary. The Spanish company SENER has carried out the design, construction and verification of the cell for the M5 mirror, as well as its control system and auxiliary equipment.

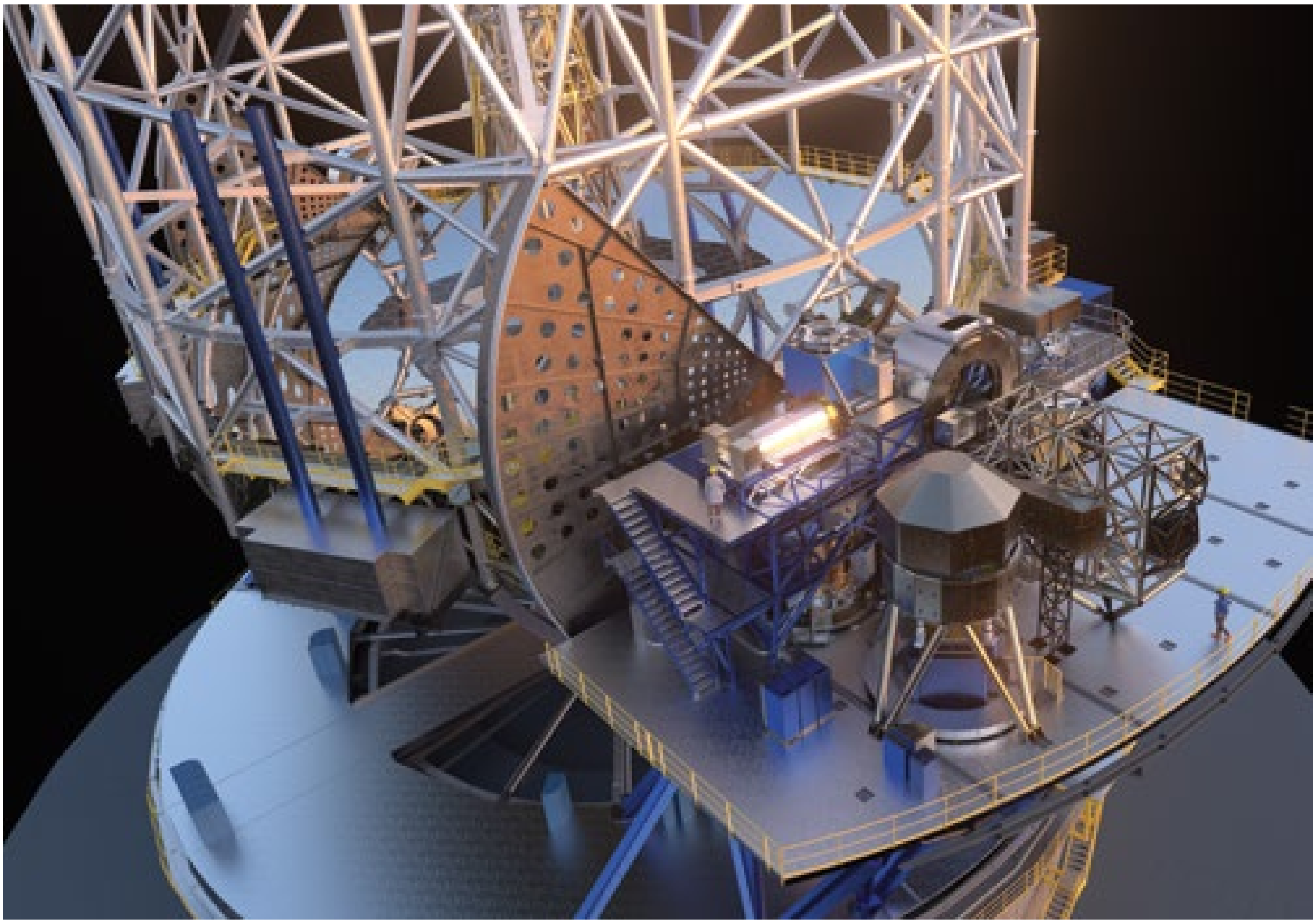
This rendering shows the ELT's fifth mirror — M5. M5 will be the world's largest tip-tilt mirror, playing a crucial role in the ELT's adaptive optics system.

Instruments

After the light from astronomical objects has arrived at the ELT's spectacular mirrors and has been collected and corrected, it is sent to the instruments. The suite of instruments planned for the ELT includes a variety of different tools, from cameras to spectrographs, which will allow astronomers to observe and study the cosmos in multiple ways.

The four first-generation ELT instruments (HARMONI, MICADO, MORFEO and METIS) will start operating in the years soon after telescope first light. An additional two instruments (ANDES and MOSAIC) will begin their operations at a later stage. Throughout the telescope's lifetime, these instruments will be updated and others will be installed to study the Universe in ever more detail.

ESO/L. Calçada

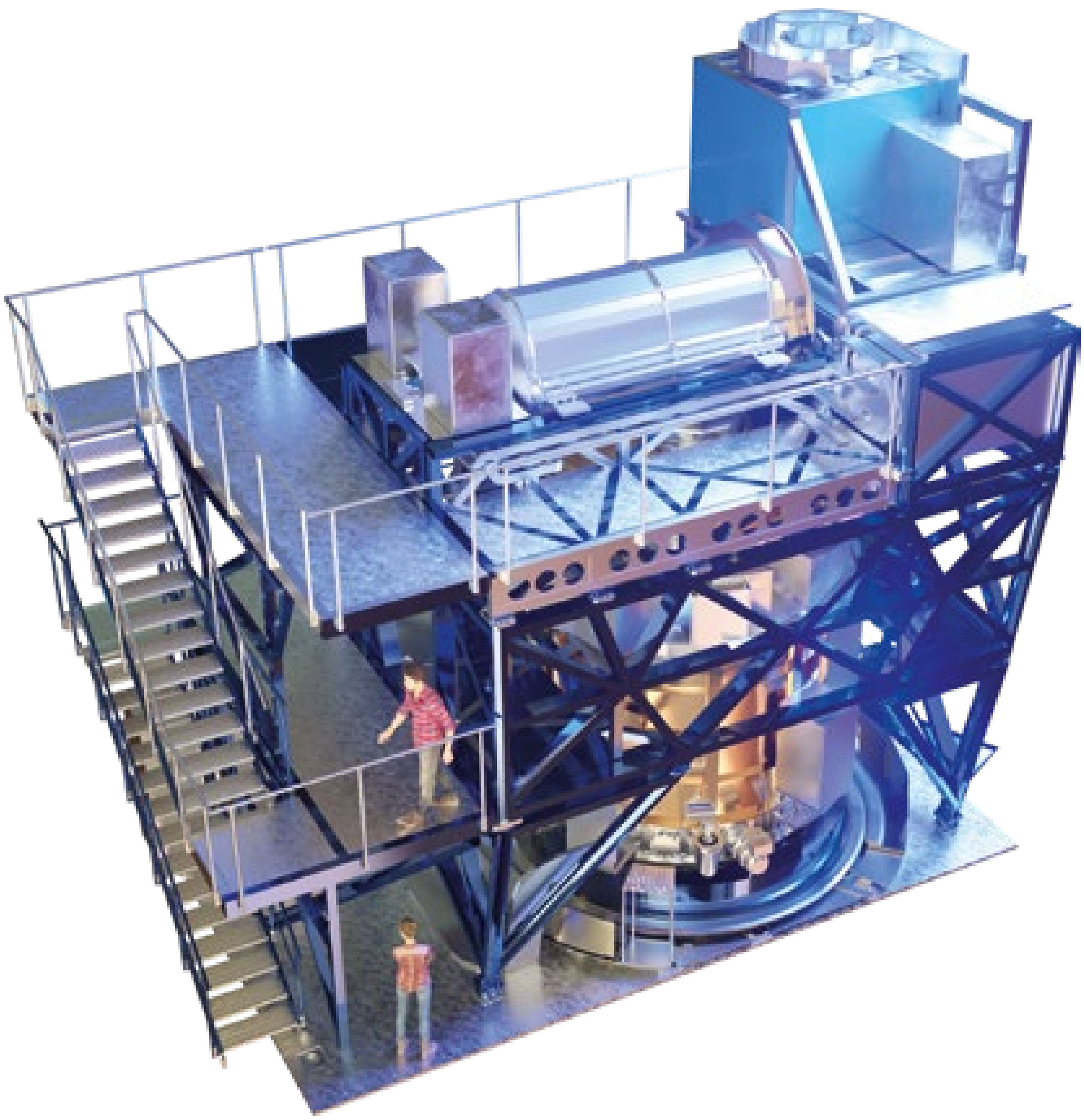


This rendering shows how part of ESO's ELT will look. It showcases the telescope structure and one of its side plaftorms (called Nasmyth platforms) where the science instruments will be located.

HARMONI

Powerful and versatile, the High Angular Resolution Monolithic Optical and Near-infrared Integral spectrograph (HARMONI) will enable astronomers to study many different astronomical targets, from distant galaxies, energetic quasars, and gamma-ray bursts, to individual stars in nearby galaxies and exoplanets in the Milky Way.

This workhorse instrument, a 3D spectrograph, will disperse the light from astronomical objects into its component wavelengths, allowing scientists to study them in fine detail and go beyond what we can achieve with current spectrographs.



Computer rendering of HARMONI.

MICADO

Astronomers will use the Multi-AO Imaging Camera for Deep Observations (MICADO) to image the detailed structure of distant galaxies, study individual stars in nearby galaxies, and — using a coronagraph to block starlight — discover and characterise exoplanets. MICADO will also be a unique, powerful tool for exploring environments where gravitational forces are extremely strong, such as close to the supermassive black hole at the centre of our galaxy.

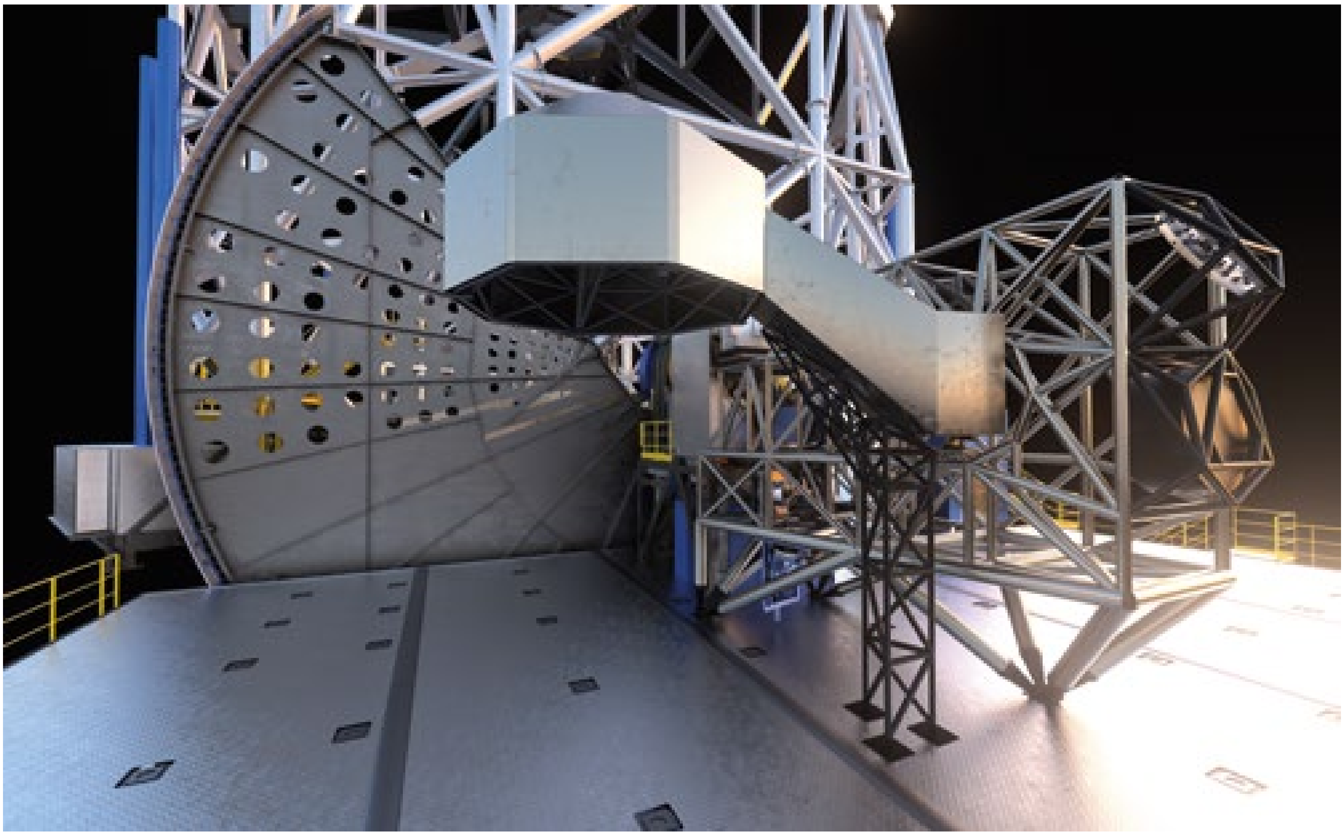
MICADO will work with the ELT's adaptive optics module, MORFEO, to reach its scientific goals.

MICADO, seen modelled here, will specialise in the in-depth imaging of our Universe.

MORFEO

The Multiconjugate adaptive Optics Relay For ELT Observations (MORFEO) will not make observations itself. Rather, it will enable other instruments to take exceptional images by compensating in real time for the distortion of light caused by turbulence in Earth's atmosphere, which makes astronomical images blurry.

MORFEO will use deformable mirrors and other state-of-the-art systems to correct for different layers of turbulence high above the ELT. In particular, it will rely on six artificial reference stars (known as laser guide stars), projected from around the circumference of the ELT's primary mirror and arranged in a circle on the sky. These artificial stars provide a reference to measure the distortion caused by Earth's atmosphere. This process enables MORFEO to obtain a 3D map of atmospheric turbulence.



This artist's rendering shows MORFEO. The instrument will help compensate for the distortion of light caused by turbulence in Earth's atmosphere.

METIS

The Mid-infrared ELT Imager and Spectrograph (METIS) is expected to make large contributions to one of the most dynamic and exciting fields of astronomy for both scientists and the public — exoplanets. It will allow astronomers to investigate the basic physical and chemical properties of these distant worlds, such as their orbital parameters, temperature, luminosity, and the composition and dynamics of their atmospheres.

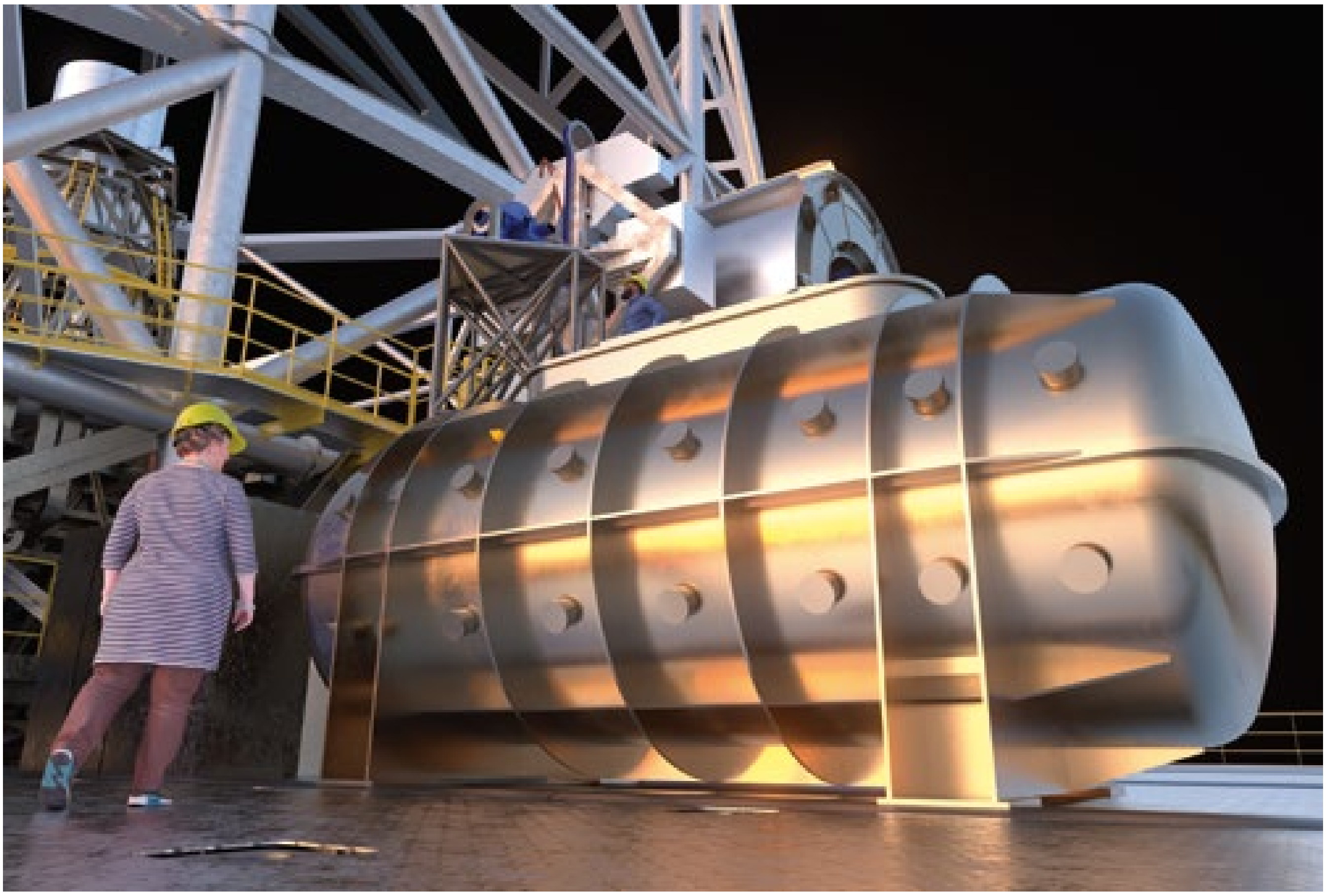
In addition, METIS will contribute to numerous other areas of astrophysics, including the study of Solar System objects, star-forming regions, the centre of the Milky Way, and bright distant galaxies.

Artist depiction of the METIS instrument. METIS will make full use of the giant main mirror of the telescope to study a wide range of science topics, from objects in our Solar System to distant active galaxies.

ANDES

The ArmazoNes high Dispersion Echelle Spectrograph (ANDES), will observe the Universe at visible and near-infrared wavelengths by collecting data with exquisite detail and sensitivity.

The instrument will enable astronomers to research an unprecedented range of topics spanning most areas of astrophysics, such as measuring the accelerated expansion of the Universe, searching for life on exoplanets and studying the oldest stars in the Universe.



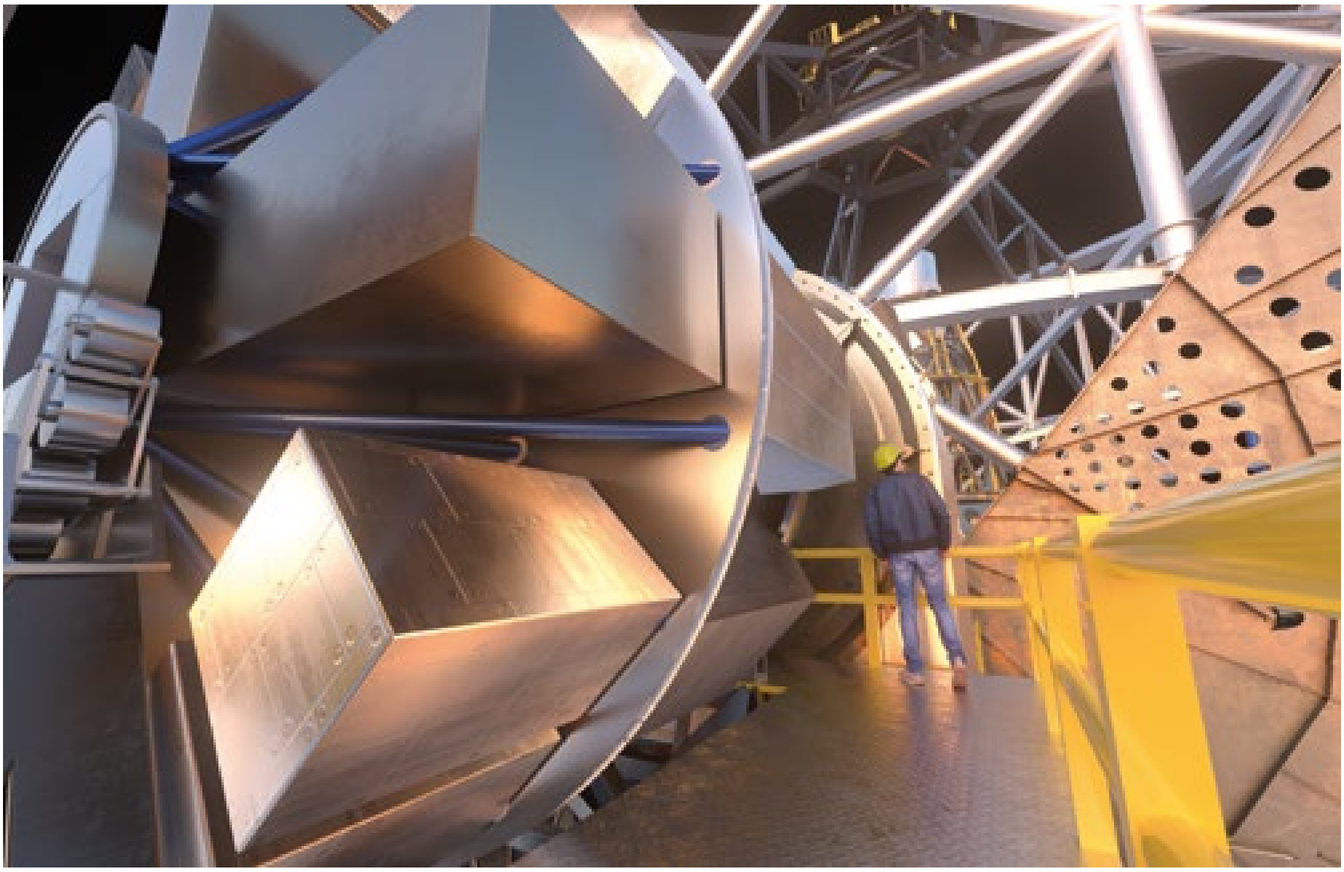
The high-resolution ELT instrument ANDES is depicted in this artist's rendering.

MOSAIC

The Multi-Object Spectrograph (MOSAIC) will address one of the major challenges faced by astronomers observing the vastness of the Universe — how to study many objects in detail at once.

Making use of the widest possible field of view provided by ESO's ELT, MOSAIC will operate at the visible and infrared wavelengths to observe more than a hundred sources simultaneously – from stars at the heart of the Milky Way to the most distant galaxies at the very edge of the observable Universe.

It will conduct the first exhaustive inventory of matter in the early Universe, lifting the veil on how matter is distributed in and between galaxies, and resulting in a tremendous leap forward in our understanding of how present-day galaxies formed and evolved.



MOSAIC will be a versatile multi-object spectrograph on the ELT. It will have three operating modes that cover observations in visible and infrared light for more than a hundred sources simultaneously.

Main structure

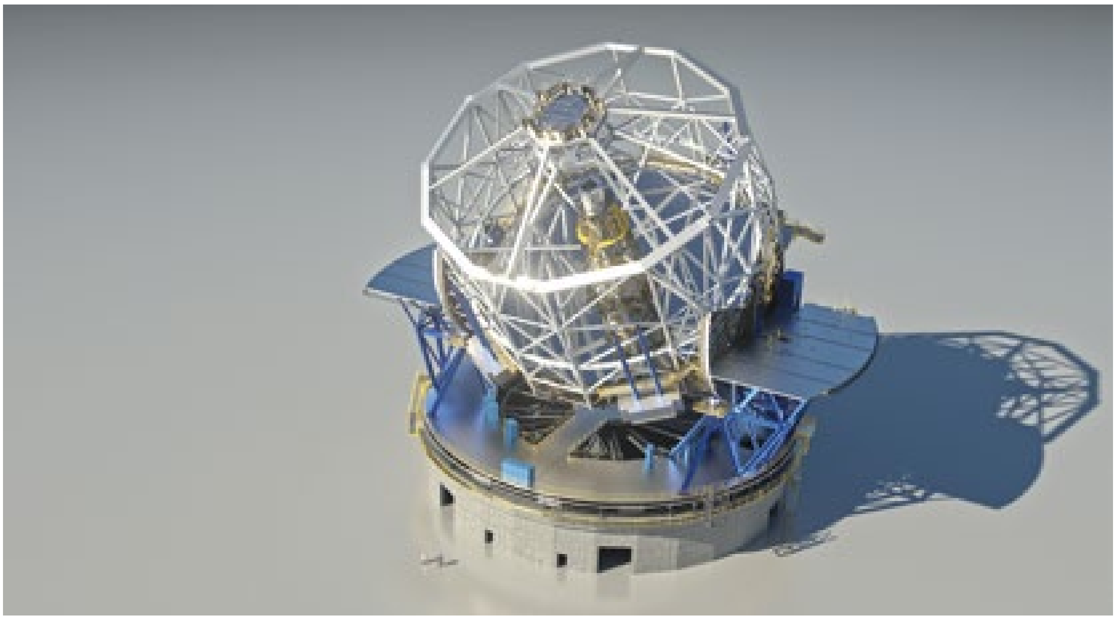
The purpose of the main structure of the ELT is to hold the five mirrors and optics, including the enormous 39-metre primary mirror. Producing a structure large enough to hold these mirrors is a feat of engineering that must satisfy two conflicting demands: ensuring the structure is stiff enough to keep its components stable and precisely aligned, whilst keeping it light enough to prevent the ELT from buckling under its own weight. Overall, when fully equipped with optics and scien-tific instruments, the main structure of ESO's ELT will weigh around 3700 tonnes.

There are three elements making up the main structure of the ELT:

– The horizontal part, or azimuth structure, supports the telescope tube and has two large platforms hosting all the ELT's scientific instruments. These platforms would be large enough to contain the entirety of one of the 8.2-metre unit telescopes of ESO's Very Large Telescope.

– The vertical part, or altitude structure, contains the ELT's five mirrors and is 50 metres tall. The impressive 39-metre primary mirror is supported at the bottom of this structure and the secondary mirror, which is about 4 metres in diameter, hangs high above it at the top of the telescope tube.

– The 10-metre central tower sits at the centre of the primary mirror support structure and holds the M3, M4 and M5 mirrors.



Once built, this gigantic structure will hold the world's largest optical telescope. The combined weight of the ELT's 5 mirrors, multiple scientific instruments and base structure will reach around 3700 tons.

Dome

The main structure of the ELT, the telescope and its instruments are all housed inside a giant dome, providing protection from the extreme environment of Chile's Atacama Desert. The dome will be about 80 metres high and have a diameter of about 93 metres, giving it a footprint roughly equivalent to that of a football pitch. It will weigh around 6100 tonnes and consist of a fixed lower portion, a rotating upper section and an enclosure.

The dome enclosure has a thermally insulated cladding made of aluminium, which allows thermal conditioning of the telescope chamber during the day and limits cooling during the night. In addition, a powerful air conditioning system minimises the amount of heat transmitted inside the enclosure, preventing thermal deformation of the telescope structure and potential blurring of the images. Engineers have carefully modelled the airflow in and around the ELT dome to test these systems.

An earthquake protection system is located below the telescope structure. The dome pier is mounted on foundations that are structurally separated to avoid possible propagations of vibrations which would affect image quality, and both the pier and the auxiliary building rest on shock absorbers mounted on top of the foundations to dampen earthquake vibrations.

The upper part of the dome will rotate to allow the telescope to point in any direction through its large observing slit. Its outer diameter is able to move at approximately 5 kilometres an hour in order to quickly track celestial objects whilst minimising vibrations.

Since the ELT dome has a large opening, it requires a windscreen to protect the telescope's primary and secondary mirrors from direct wind exposure, which could negatively affect the pointing performance of the telescope. The windscreen reduces the overall wind speed and avoids degrading seeing effects.

Both the ELT dome and the telescope structure are being designed and built by the Italian consortium ACe (Cimolai, Astaldi).

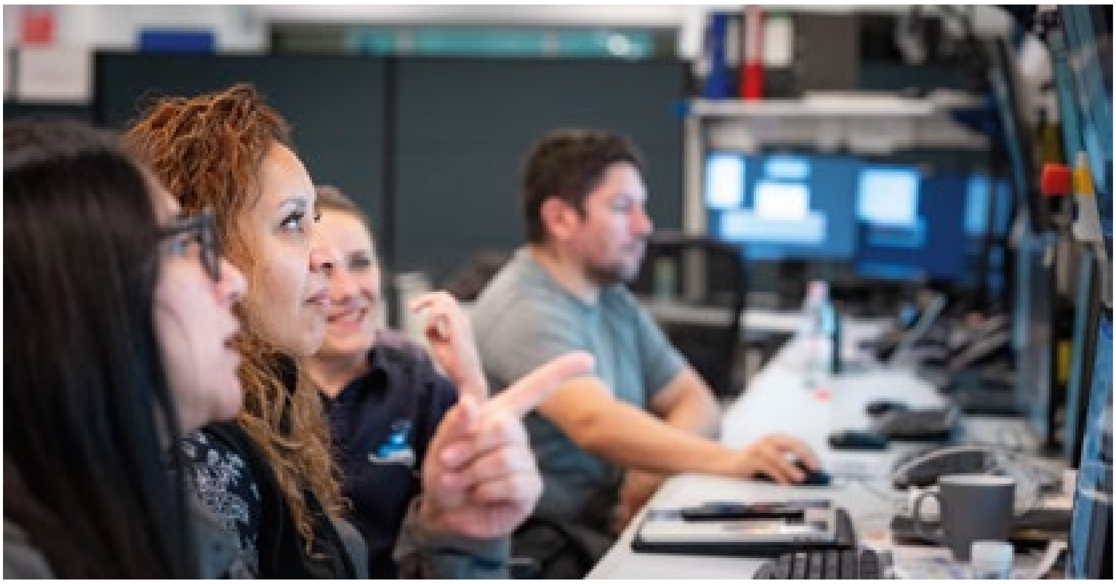
A huge structure is required to protect ESO's ELT from the elements. The telescope's structure and optical elements, including its giant 39-metre main mirror, will be housed in the largest telescope dome in the world, which is shown in this 3D rendering, along with the auxiliary building. The ELT's dome will open its large sliding doors during the nightly telescope observations, while the rest of the structure shelters the telescope from the wind. The entire upper enclosure will rotate to allow the telescope to observe almost the entire visible night sky.

Operations

The ELT will be part of ESO's Paranal Observatory and will be operated from the same control room as other ESO telescopes such the Very Large Telescope, 23 km away from the ELT itself.

Once the enormous telescope and instruments of ESO's ELT are up and running, scientific observations of the night sky can commence. A challenge for the observatory is to efficiently schedule a huge number of planned (and sometimes unplanned) observations of different phenomena across the night sky, and across a range of different science areas, whilst ensuring the highest possible quality of the resulting scientific data. This process has already been fine-tuned by ESO for the VLT, and will be advanced for the ELT.

The control room will be a hub of activity. From there, observing teams will control the ELT and its instruments, alongside observing teams for the VLT telescopes. The work will include continuous monitoring and optimisation of the telescope and instruments, pointing of the telescope to lock on to celestial objects, and subsequent evaluation of the scientific data (e.g., images and spectra). The control room is underpinned by a gigantic array of computers, and powered mostly through renewable energy from the Paranal Observatory's 9 MW solar plant. Essential support will also be provided by ESO engineers, who perform regular maintenance of the telescopes.



View into part of the control room at ESO's Paranal Observatory.

ESO/L. Calçada

“I’m hoping that with the ELT we will be able to understand what our place in the Universe is in concrete terms – maybe finding the answer to whether we’re alone in the Universe.”

Amina Helmi, ESO Council Member,
Full Professor at Kapteyn Astronomical Institute, the Netherlands

The road to the ELT

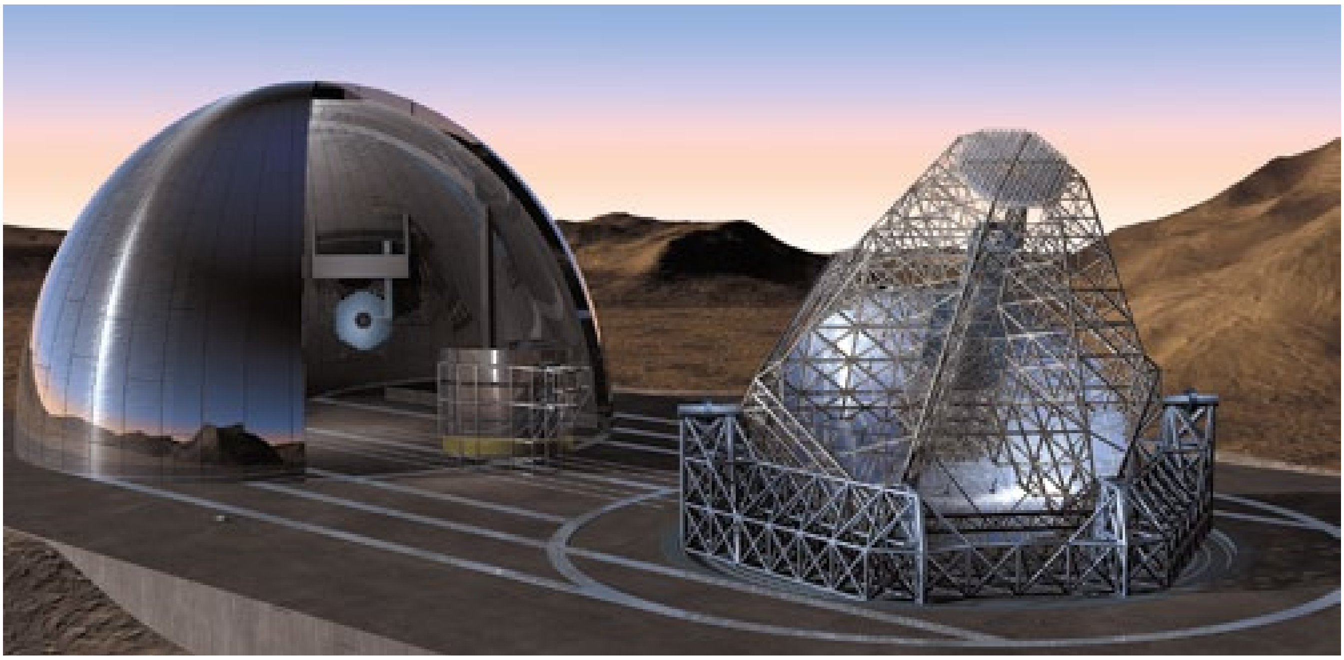
ESO/G. Hüdepohl

In the beginning there was the OWL...

In 1998 ESO began pursuing a conceptual study for a giant optical-infrared telescope with a primary mirror 100 metres in diameter. This was called the OverWhelmingly Large telescope or OWL, in reference to the keen night vision of the bird of the same name. The study was concluded by the end of 2005, when a review by an international panel recommended considering a smaller diameter, less complex and less risky telescope – an Extremely Large Telescope or ELT – given the substantial technical risks identified.

Following on from the work done for the OWL project, ESO conducted a new study in 2006, with the help of more than 100 astronomers, to carefully evaluate the performance, cost, schedule and risk of the ELT. The results were subject to detailed discussions by over 250 European astronomers, and their enthusiastic welcome paved the way for the ESO Council's decision to move to the crucial next phase: detailed design of the full facility.

At the end of 2006 the European Strategy Forum on Research Infrastructures, which supports policy-making on research infrastructures in Europe, chose the ELT as one of the large-scale projects to be conducted in astronomy and the only one in optical astronomy. By 2010 the final decision on a 39-metre design concept had been made and Cerro Armazones had been selected as the ELT site. Since then, ESO has been working in earnest on the challenging construction of this telescope.



Conceptual study for a giant optical-infrared telescope with a primary mirror 100 metres in diameter: the Over Whelmingly Large telescope or OWL.

Construction highlights

June 2014

Part of the 3000-metre peak of Cerro Armazones was blasted away during a ground-breaking ceremony, the first step towards levelling the summit in preparation for construction.

December 2014

ESO Council gives the green light for the ELT construction.

July 2015

ESO Council authorises the ESO Director General to sign the contracts for the first set of instruments for the ELT.

January 2018

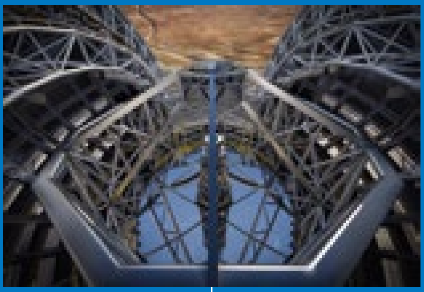
The first hexagonal segments for the ELT's 39-metre main mirror are successfully cast by the German company SCHOTT.

May 2018

Foundation work begins atop Cerro Armazones, paving the way for construction of the dome and telescope structure.

August 2019

The first 18 ELT primary mirror blanks are delivered to the French company Safran Reosc for polishing before they are cut into hexagons and receive a final precise polishing.



2023

First mirror segments polished.

2028 (planned)

Mirrors installed.

2030 (planned)

Scientific first light.

July 2022

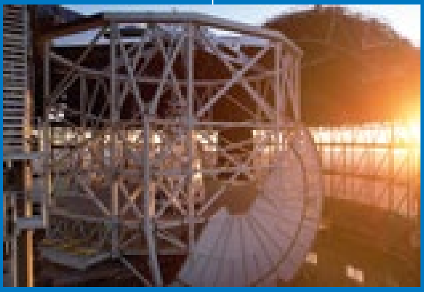
Inauguration of the Paranal–Armazones solar power plant, which will supply renewable energy to the ELT.

2026 (planned)

Telescope structure completed.

2029 (planned)

Telescope first light.



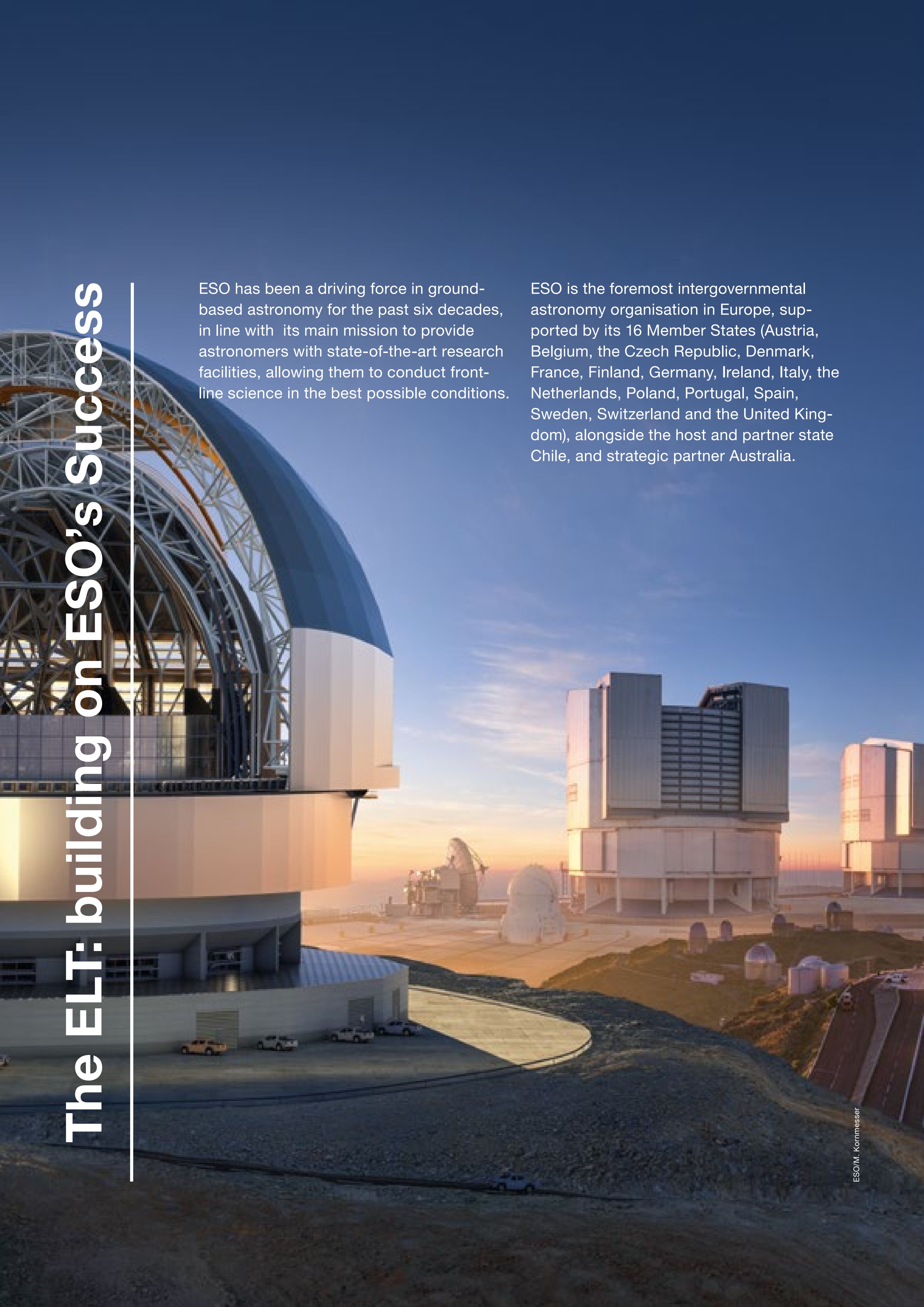
2025

Secondary mirror completed.

The ELT: building on ESO's Success

ESO has been a driving force in ground-based astronomy for the past six decades, in line with its main mission to provide astronomers with state-of-the-art research facilities, allowing them to conduct front-line science in the best possible conditions.

ESO is the foremost intergovernmental astronomy organisation in Europe, supported by its 16 Member States (Austria, Belgium, the Czech Republic, Denmark, France, Finland, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Spain, Sweden, Switzerland and the United Kingdom), alongside the host and partner state Chile, and strategic partner Australia.



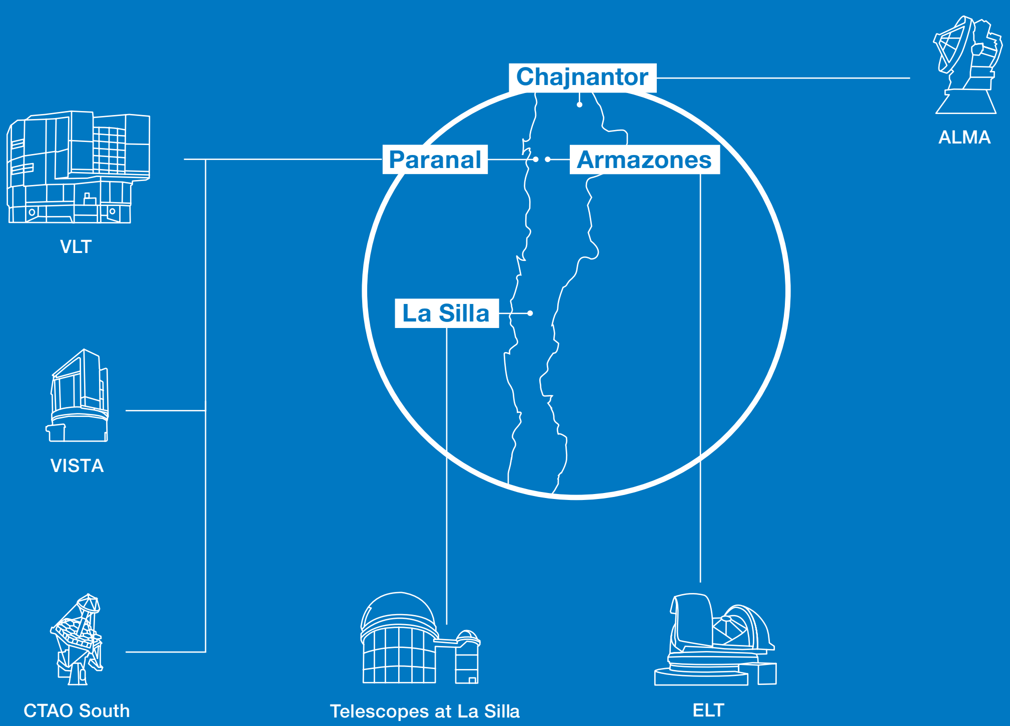
ESO/M. Kornmesser

The ESO Headquarters (comprising the scientific, technical and administrative centre of the organisation), as well as the ESO Supernova Planetarium & Visitor Centre, are located in Garching near Munich, Germany. In Chile, ESO operates the Vitacura centre in Santiago as well as three unique observing sites: Paranal, La Silla and Chajnantor.

Over decades of designing, building, and operating state-of-the-art telescopes and instruments, ESO has developed an immense scientific and engineering heritage. This invaluable legacy will nurture and inspire ESO's ambitious future endeavours, including the ELT. For example, technologies such as active optics, invented at ESO, have been further improved upon, scaled up and integrated into the ELT design, and the ELT will be operated from the same control room as other telescopes at the Paranal Observatory, 23 km away from the ELT's location (Armazones).

The ELT will be the youngest sibling in the family of ESO's telescopes, a family whose members do not work as isolated projects, but join forces to deepen our understanding of the immense and fascinating cosmos. The ELT will add new breakthroughs to the long list of ESO's stunning scientific results.

ESO telescopes



In addition to the ELT, the telescopes operating at ESO sites include ESO's Very Large Telescope (VLT) and ESO's Visible and Infrared Survey Telescope for Astronomy (VISTA), as well as the southern array of the Cherenkov Telescope Array Observatory (CTAO South) and the Atacama Large Millimeter/submillimeter Array (ALMA), in which ESO is a partner.

Major breakthroughs in astronomy

Over the past decades, observations made with ESO telescopes have resulted in countless scientific discoveries, including major breakthroughs in astronomy, such as:

- the most detailed view of the surroundings of Sagittarius A*, the supermassive black hole at the centre of the Milky Way. This was achieved by carefully tracking the orbits of the stars transiting close to Sagittarius A* in a 30-year-long study, which was awarded part of the 2020 Nobel Prize in Physics. From these results, astronomers could infer many of the properties of the black hole and its gravitational field.

- the discovery of the nearest planet outside the Solar System which could host life. The planet, named Proxima b, is a rocky world little more massive than Earth. It orbits Proxima Centauri — the star closest to the Sun, located approximately four light-years away — at the right distance from the star for liquid water to possibly exist on the planet's surface.

- capturing the optical counterpart of the first observation of both light and gravitational waves from the same cosmic event. The ability to conduct such joint observations marks a new era for astronomy, as they provide complementary information. By combining them, astronomers can achieve a much deeper understanding of the observed objects and phenomena. The event in question was the collision of two neutron stars which, as ESO's contribution confirmed, is how heavy elements such as gold and silver are forged in the Universe.

- proof that the expansion of the Universe is accelerating. The result, awarded the 2011 Nobel Prize in Physics, was based on the observation of exploding stars known as Type Ia supernovae, and has dramatically changed our understanding of the cosmos and its fate, with models now predicting an indefinite expansion of the Universe.

ESO/L. Calçada/M. Kornmesser

This artist's impression shows two tiny but very dense neutron stars at the point at which they merge and explode as a kilonova.

Societal benefits

ESO/P. Horálek

Visitors to the ESO Supernova Planetarium & Visitor Centre are seen here enjoying a tour through the exhibition.

The growing knowledge of the cosmos enabled through its groundbreaking scientific discoveries, although invaluable, is not ESO's only contribution to humanity. From inspiring young generations to innovating in engineering, the impact of ESO on our society is tangible in many different fields:

- **Education:** ESO's achievements and outreach activities spur great interest among the general public, bringing the scientific community and society closer to one another. By stimulating the curiosity of young people about the wonders of the Universe, ESO encourages them to undertake careers in fields such as science, mathematics and engineering.

- **Engineering and innovation:** ESO's mission to look deeper into the cosmos poses immense technological challenges. These are embraced by industries and manufacturers, leading to the development of new know-how and state-of-the-art technologies. For example, ESO worked with industry to develop powerful lasers to correct for the blur of Earth's atmosphere in VLT images and, in the future, ELT observations. This was the first transfer of patented technology from ESO to industry. This and other developments are also finding applications in fields beyond astronomy; for example, techniques used to study galaxies with the MUSE instrument on ESO's VLT are being transferred for application to cancer treatment.

- **Economy:** the investments in engineering and research and development made by ESO to unravel the secrets of the Universe continuously enable the creation of new jobs, industrial collaborations, spin-offs and market opportunities.

- **International collaboration:** science is a truly international endeavour and ESO, as an intergovernmental organisation, acts as a platform where member and partner states meet, work together and join forces to conceive and implement some of the most stunning sci-tech projects ever undertaken by humanity.

Information for the media

Press releases, images and videos

To receive news updates about the ELT, please sign up to ESO's media newsletter using the form at the end of our online Press Room at https://www.eso.org/public/outreach/pressmedia/.

If you'd like to use images or videos about the ELT in your reporting, you can find high-quality visuals in our image (https://elt.eso.org/public/images/archive/category/elt/) and video (https://elt.eso.org/public/videos/archive/category/elt/) archives. Since all ESO visuals are licensed under a Creative Commons Attribution licence, ESO images and motion pictures may be reproduced on a non-exclusive basis without fee so long as ESO is clearly credited as the source of the video material. Please consult our copyright notice at https://www.eso.org/public/outreach/copyright/ for full terms of use.

Information about media visits

ESO welcomes journalists, science writers and producers who are interested in visiting the sites in Chile as part of the production process for news stories, documentaries, photo books and other projects. As these visits represent a significant investment of resources on the part of ESO, the ESO Department of Communication reserves the right to choose projects that have the largest return on investment (for instance, in terms of the media exposure of ESO and astronomy in general).

The ELT will be part of ESO's Paranal Observatory, located 120 km south of the city of Antofagasta and 110 km north of the town of Taltal, in the Atacama Desert, Chile.

There are two ways to visit the ELT as a media representative: individual media visits and ESON group media visits.

If you are interested in an individual media visit, please get in touch with ESO's Department of Communication in Chile (contacto@eso.org) as far in advance as possible (preferably two to three months). ESO usually grants two days/one night for media visits at Paranal. If necessary, extended periods can be arranged.

ESO also organises ESON group media visits through its Department of Communication and its Science Outreach Network (ESON). ESON visits are an exclusive service offered to a limited number of media representatives annually, and ESO covers all expenses to and from Santiago airport. These visits are planned 6–18 months ahead, and therefore long advance notice from interested journalists is needed.

For both types of visits, lodging at Paranal Residence is sponsored by ESO for accredited media representatives. For further questions, don't hesitate to get in touch with ESO's Department of Communication (contacto@eso.org).

Map showing the location of ESO's Paranal Observatory.

The European Southern Observatory (ESO) enables scientists worldwide to discover the secrets of the Universe for the benefit of all. We design, build and operate world-class observatories on the ground — which astronomers use to tackle exciting questions and spread the fascination of astronomy — and promote international collaboration in astronomy. An intergovernmental organisation supported by 16 Member States and two partner countries, ESO has headquarters in Germany and operates three observing sites in Chile.

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