



ESO's Extremely Large Telescope (ELT)

The world's **biggest eye** on the sky

“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



How the ELT will look atop
Cerro Armazones, Chile.

Credit: ESO/L. Calçada

A revolutionary telescope

The past decade has brought astronomical revelations that have excited people from all walks of life, from finding planets around Proxima Centauri, the nearest star to the Sun, to the first image of a black hole. On a mountain in the Atacama Desert in Chile, ESO, the European Southern Observatory, is building a telescope that will revolutionise astronomy for decades to come. ESO's Extremely Large Telescope (ELT) will dramatically change what we know about our Universe and make us rethink our place in the cosmos.

The Orion Nebula as seen by ESO's Very Large Telescope. The ELT will allow us to capture images of cosmic objects like this with a resolution five times greater.

Credit: ESO/H. Drass et al.



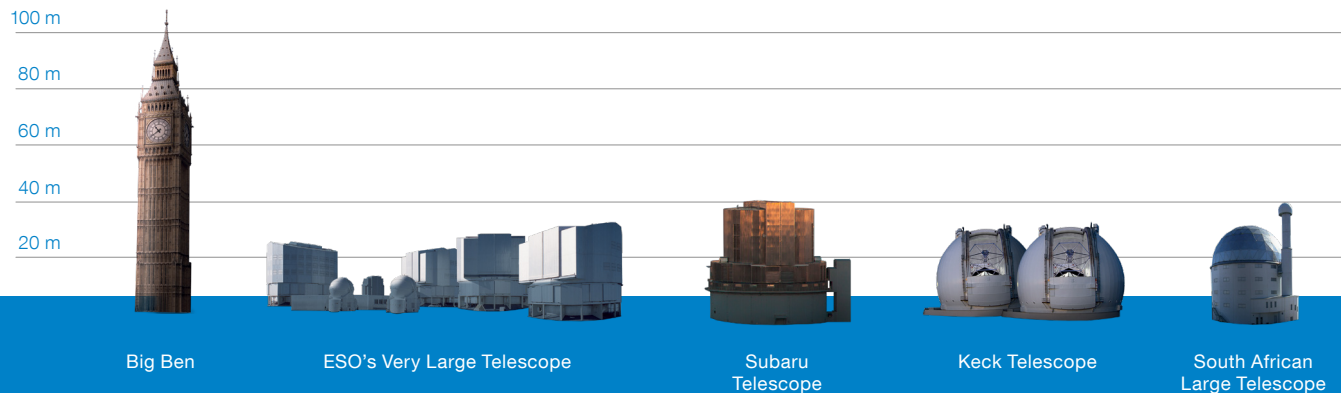
When it starts operating later this decade, the ELT will track down Earth-like planets around other stars, and could become the first telescope to find evidence of life outside of our Solar System. It will also probe the furthest reaches of the cosmos, revealing the properties of ancient galaxies and the nature of the dark Universe. On top of this, astronomers are hoping for the unexpected with the ELT — yet unimaginable discoveries that will push the boundaries of our knowledge of the cosmos.

Building a giant

Pushing the boundaries of science requires thinking big. The ELT will be the largest optical/infrared telescope in the world.

The telescope will have a main mirror nearly 40 metres in diameter, too large to be made from a single piece of glass. The mirror will consist of nearly 800 hexagonal segments that, working together, will gather more light than all the existing large research telescopes on the planet combined, and 100 million times more light than the human eye. Thanks to this giant mirror, and other sophisticated systems, ESO's ELT will provide images 15 times sharper than those from the NASA/ESA Hubble Space Telescope.

The telescope will be housed in a huge dome that will shelter it from the extreme environment of Chile's Atacama Desert. With a diameter of 88 metres, the dome will have a footprint roughly equivalent to that of a football (soccer) pitch. It will be 80 metres high, about the height of Big Ben without the spire. The dome consists of an enclosure that opens and closes to allow observations of the night sky, as well as a pier that rotates with high accuracy to track celestial objects.

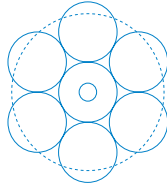




8.4 metres

NSF Rubin Observatory

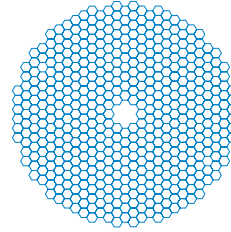
El Peñón, Chile
(planned 2022–2023)



24.5 metres

Giant Magellan Telescope

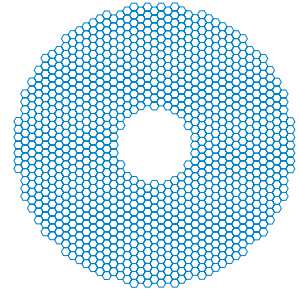
Las Campanas Observatory,
Chile (planned 2029)



30 metres

Thirty Meter Telescope

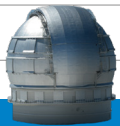
Mauna Kea, Hawaii
(planned 2027)



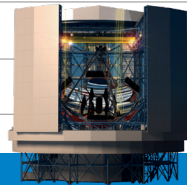
39.3 metres

Extremely Large Telescope

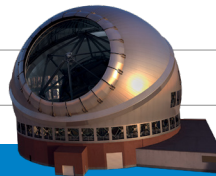
Cerro Armazones, Chile
(planned 2027)



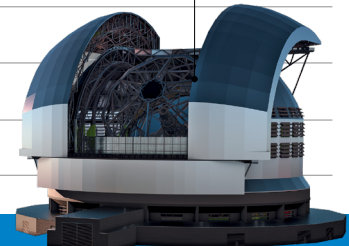
Gran Telescopio
Canarias



Giant Magellan
Telescope



Thirty Meter
Telescope



ESO's Extremely
Large Telescope

ELT facts

Name Extremely Large Telescope (ELT)

Site Cerro Armazones, Atacama Desert, Chile

Altitude 3046 metres

Main mirror diameter 39 metres

Light collecting area 978 square metres

Number of main mirror segments 798

Main mirror segments alignment precision Tens of nanometres (1/10 000 the thickness of a human hair) across its entire 39-metre diameter

Type Optical/near-infrared extremely large telescope

Optical design Five-mirror design

Telescope field of view 10 arcminutes

Enclosure Hemispherical dome

Weight of the main structure 3700 tonnes

Number of bolts used in the dome ~30 million

First light date 2027

Cerro Armazones



23 kilometres

Road



VISTA

Cerro Paranal



Very Large Telescope

The Extremely Large Telescope is being built on Cerro Armazones in the Chilean Atacama Desert, at 3046 metres altitude and just 23 kilometres from the site of ESO's Very Large Telescope (VLT) at Paranal.

Credit: ESO/M. Tarenghi

Pushing the boundaries of technology

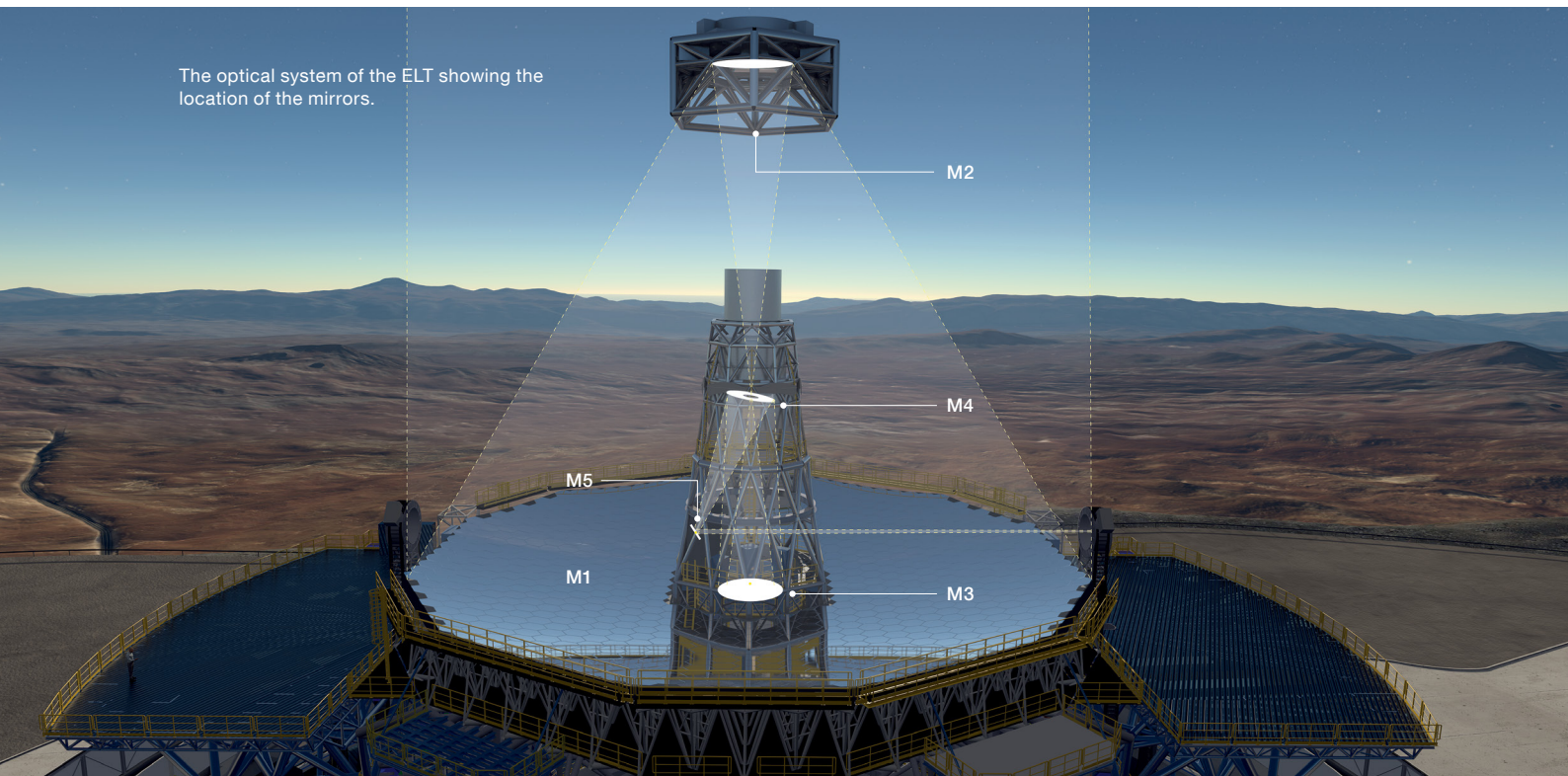
ESO's ELT has an unusual optical design based on a novel five-mirror scheme that will yield exceptional image quality coupled with a wide field of view (one third of the width of the full Moon).

Adaptive mirrors, as components of both the telescope and its instruments, will compensate for the fuzziness in images introduced by atmospheric turbulence. One of these, the telescope's fourth mirror, or M4, will be very thin and supported by more than 5000 actuators that adjust its shape up to a thousand times a second.

The telescope will be equipped with giant instruments to analyse the light that it captures. They are currently under development at institutes around Europe and will be mounted on a platform so big it could support one of the Unit Telescopes of ESO's Very Large Telescope.

The contract for the ELT telescope main structure and dome is the largest ever placed for a ground-based telescope.

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



Up to 8 lasers to create artificial stars for adaptive optics

Altitude cradles for inclining the telescope

Instrument platforms sit either side of the rotatable telescope

Five-mirror design:

1. Main mirror 39.3 metres diameter
2. Secondary mirror. Largest secondary (and largest convex) mirror ever produced
3. Tertiary mirror
4. Adaptive fourth mirror
5. Rapid tip-tilt fifth mirror

First-generation instruments:

HARMONI, a 3D spectrograph used to explore galaxies in the early Universe, study the constituents of the local Universe and characterise exoplanets in great detail.

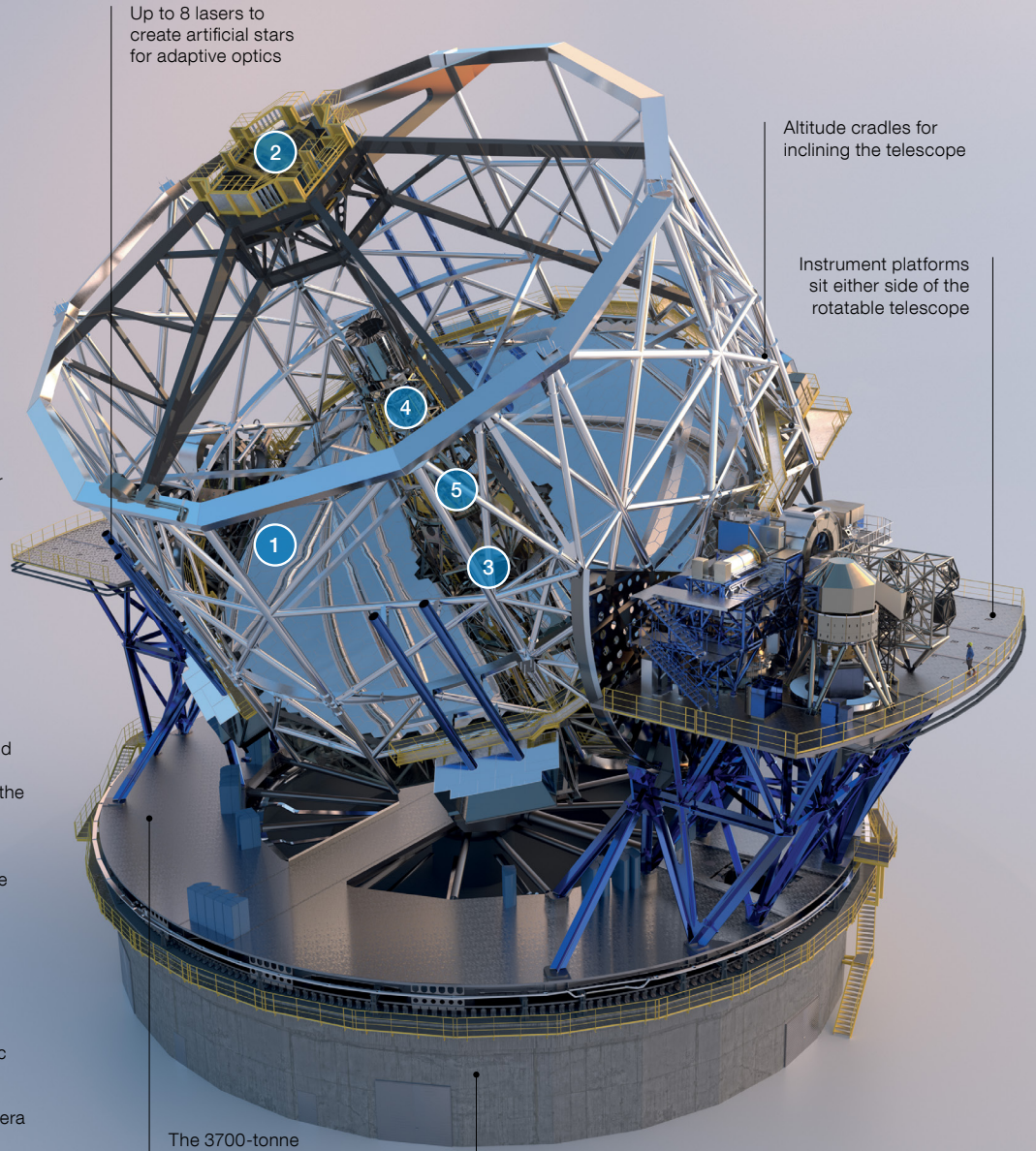
MAORY, an adaptive-optics module designed to help compensate for distortions caused by turbulence in the Earth's atmosphere.

METIS, a mid-infrared imager and spectrograph, will focus on exoplanets, protoplanetary discs, Solar System bodies, active galactic nuclei, and high-redshift galaxies.

MICADO, a dedicated imaging camera for the ELT, will have a sensitivity comparable to that of the James Webb Space Telescope and a resolution six times greater.

The 3700-tonne telescope system can turn through 360 degrees

Seismic isolators



Preparing for a revolution



October 2011

Agreement with Chilean Government on land for the ELT

June 2014

Ground-breaking ceremony

May 2017

First-stone ceremony on Cerro Armazones

June 2012

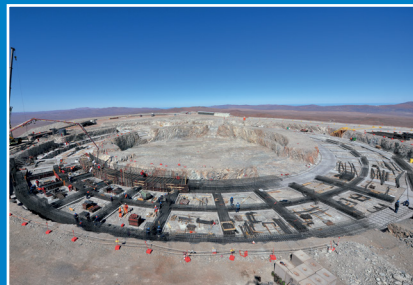
ELT Programme approved by ESO Council

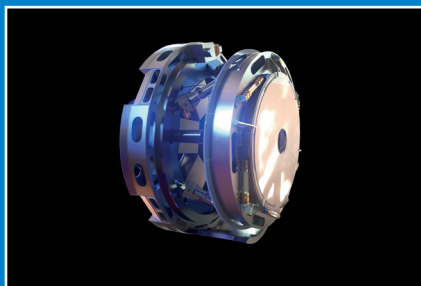
September 2015

Agreements for first-generation instruments

September 2019

Construction of the ELT dome foundations begins





2022

First main mirror segment completed

2025

M4 adaptive unit completed

2026

Main mirror segments installed

2023

Secondary mirror completed

2025

Dome and telescope structure completed

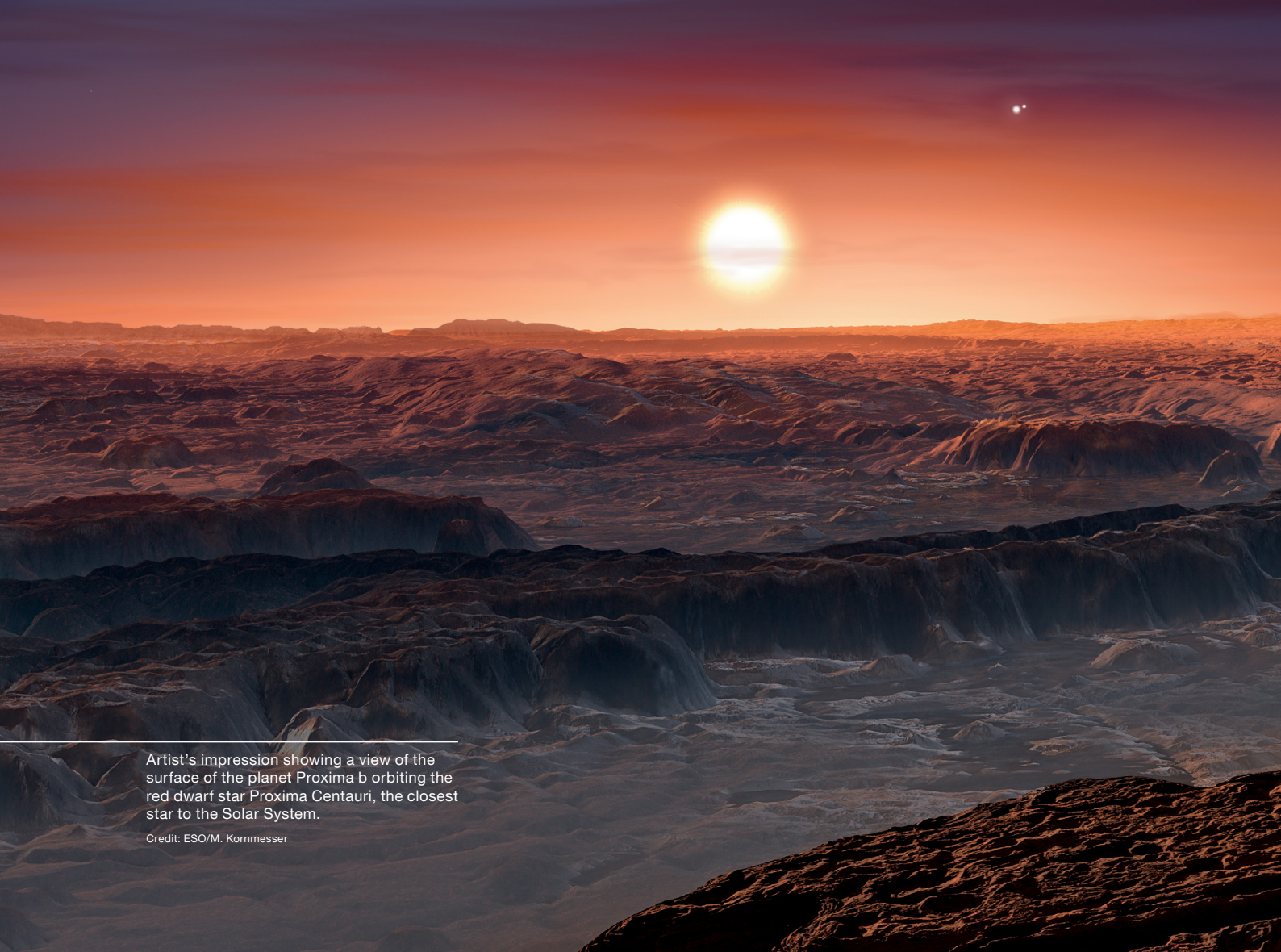
Late 2027

Start of scientific operations




Tackling the **biggest cosmic challenges**

With the start of scientific operations targeted for late 2027, ESO's Extremely Large Telescope will address many of the most pressing unsolved questions in astronomy. Thanks to its size and suite of front-line instruments, it may eventually revolutionise our perception of the Universe, much as Galileo's telescope did 400 years ago.



Artist's impression showing a view of the surface of the planet Proxima b orbiting the red dwarf star Proxima Centauri, the closest star to the Solar System.

Credit: ESO/M. Kornmesser



ESO's ELT may be the first telescope to enable us to identify life beyond the Solar System, at long last answering one of humanity's most fundamental questions.

The ELT will discover and study planets with masses as low as the Earth's in the habitable zone, by making precise measurements of the wobbling motion of stars perturbed by the planets in orbit around them. The ELT will also be able to obtain direct images of larger planets and via high-resolution spectroscopy characterise the atmospheres of transiting planets — and possibly find the telltale biomarkers indicating that there may be life present on those planets. ELT's suite of instruments will allow astronomers to probe the earliest stages in the formation of planetary systems and to study protoplanetary discs around stars in the making.

Exploring the history of the Universe

By probing the most distant objects, ESO's ELT will provide vital clues to help us understand the formation of the first objects in the Universe — primordial stars, primordial galaxies and black holes — and learn how they are related.

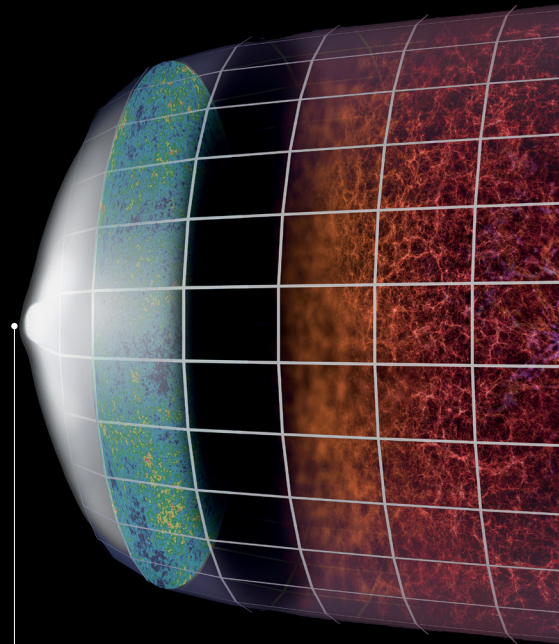
Studies of extreme objects like black holes will benefit from the power of the ELT to provide greater insight into time-dependent phenomena.

The ELT is designed to carry out detailed studies of the first galaxies and to follow their evolution through cosmic time.

ESO's ELT will be a unique tool for making an inventory of the changing abundances of the elements in the Universe with time, and for understanding the history of star formation in galaxies.

The ELT has the potential to make a direct measurement of the acceleration of the Universe's expansion, a measurement that would have a major impact on our understanding of the Universe.

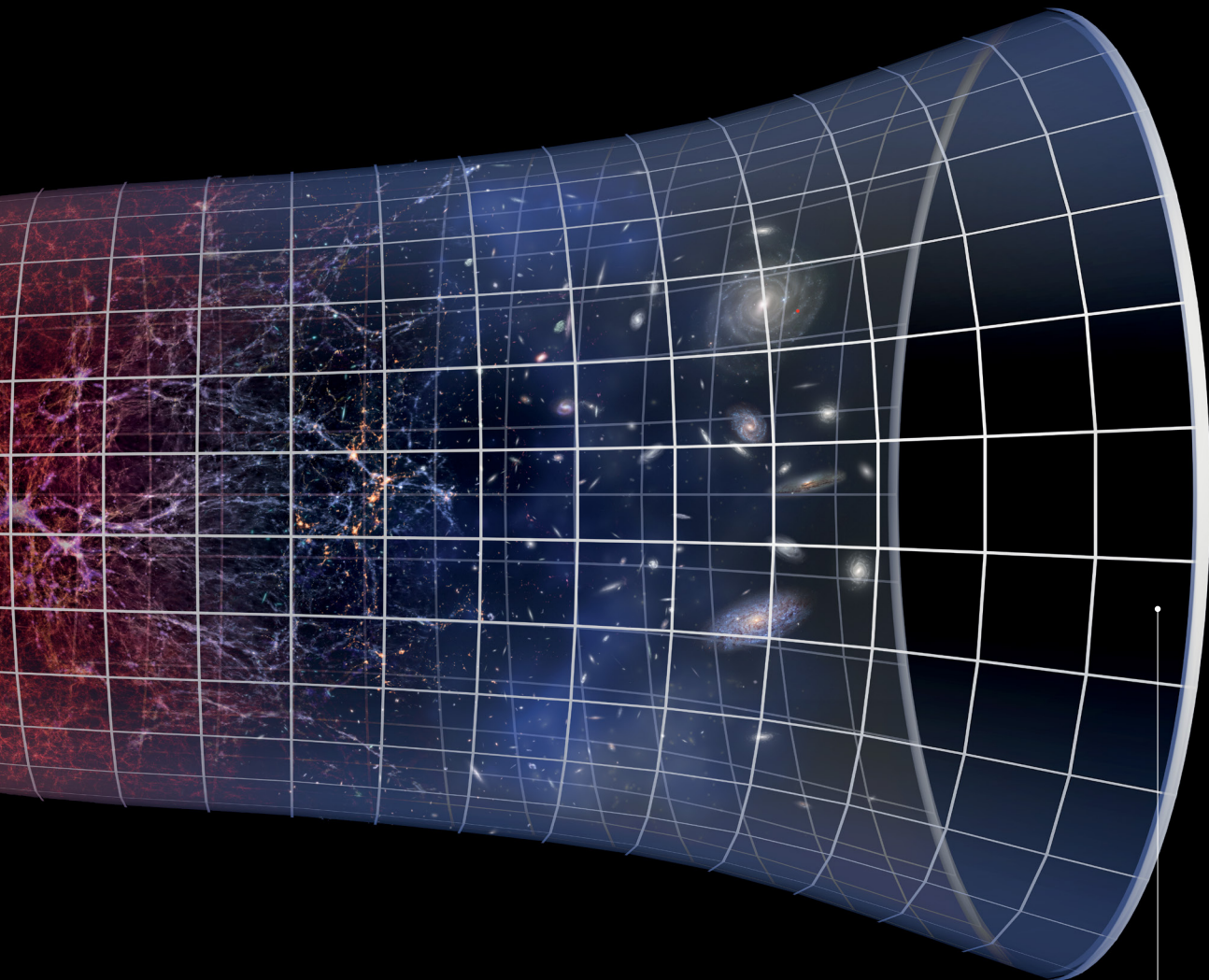
ESO's ELT will also search for possible variations with time of the fundamental physical constants. An unambiguous detection of such variations would have far-reaching consequences for the basic laws of physics.



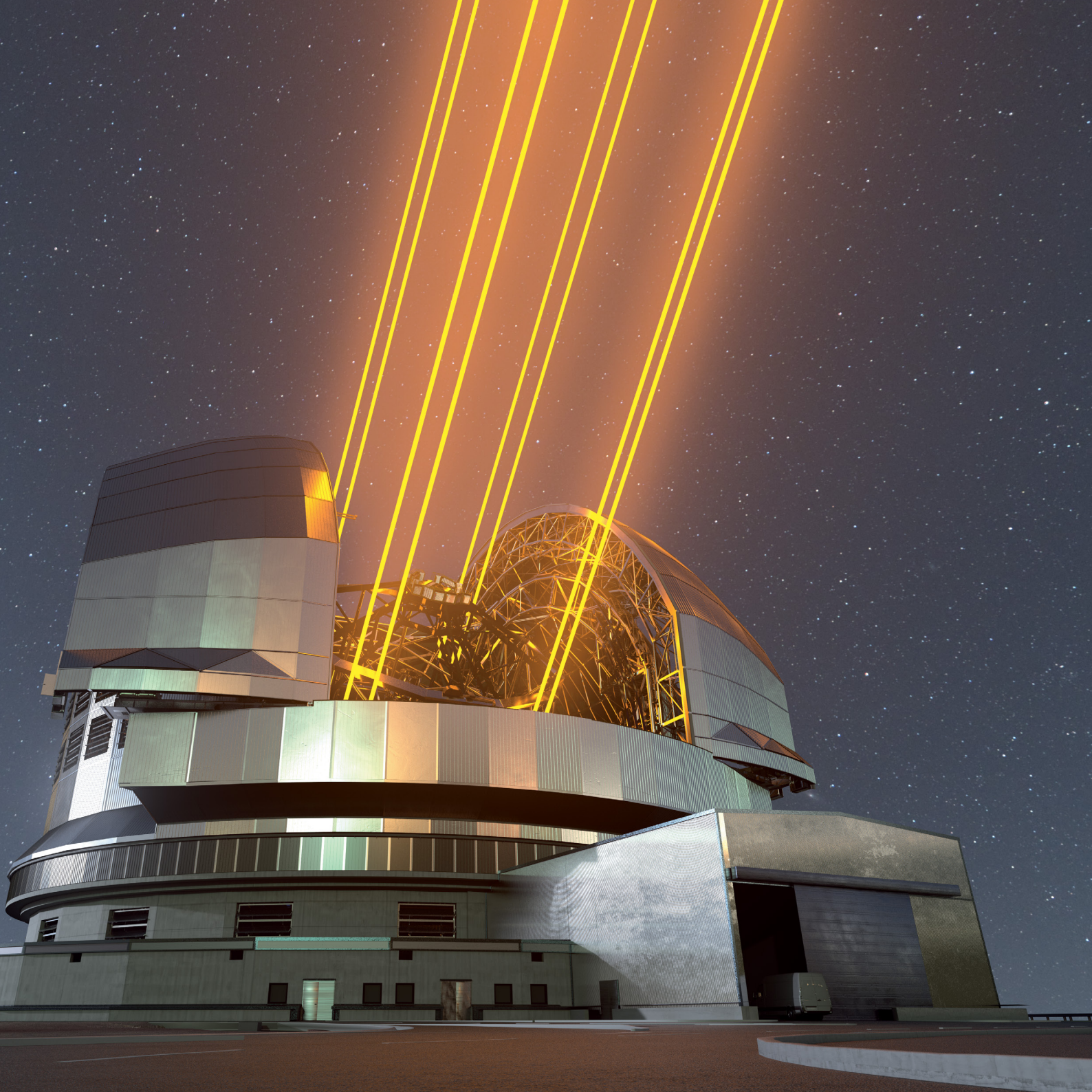
Big Bang

Graphical representation of the Universe's evolution and expansion, from the Big Bang to the present day, spanning nearly 14 billion years.

Credit: ESO/M. Kornmesser



Present day



“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



European
Southern
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.

European Southern Observatory

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