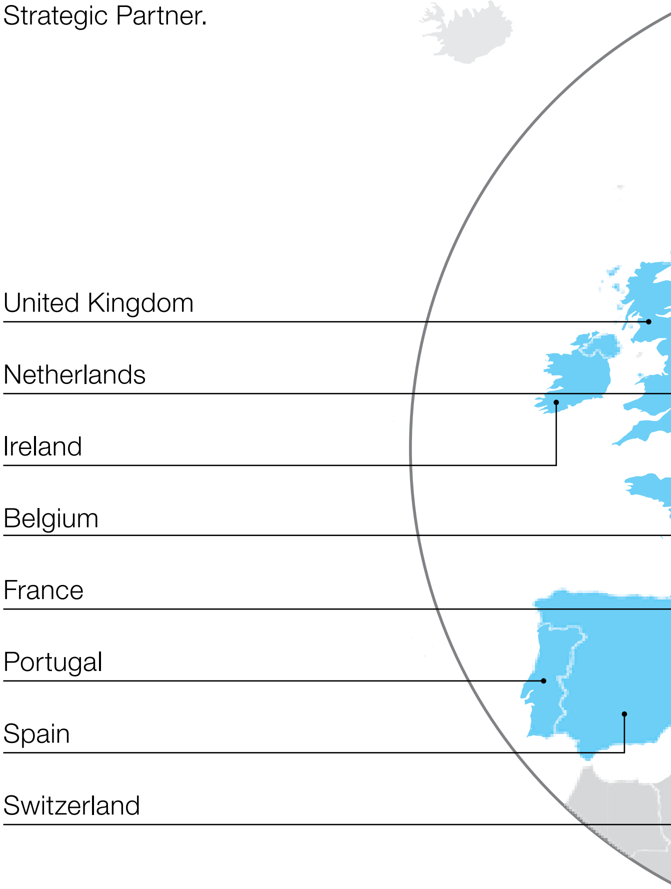
ESO

European Organisation
for Astronomical
Research in the
Southern Hemisphere

Annual Report 2025

What is ESO?

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 for astronomy. Established as an intergovernmental organisation in 1962, today ESO is supported by 16 Member States (Austria, Belgium, Czechia, Denmark, France, Finland, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Spain, Sweden, Switzerland and the United Kingdom), along with Chile as the Host State of our observatories and Australia as a Strategic Partner.

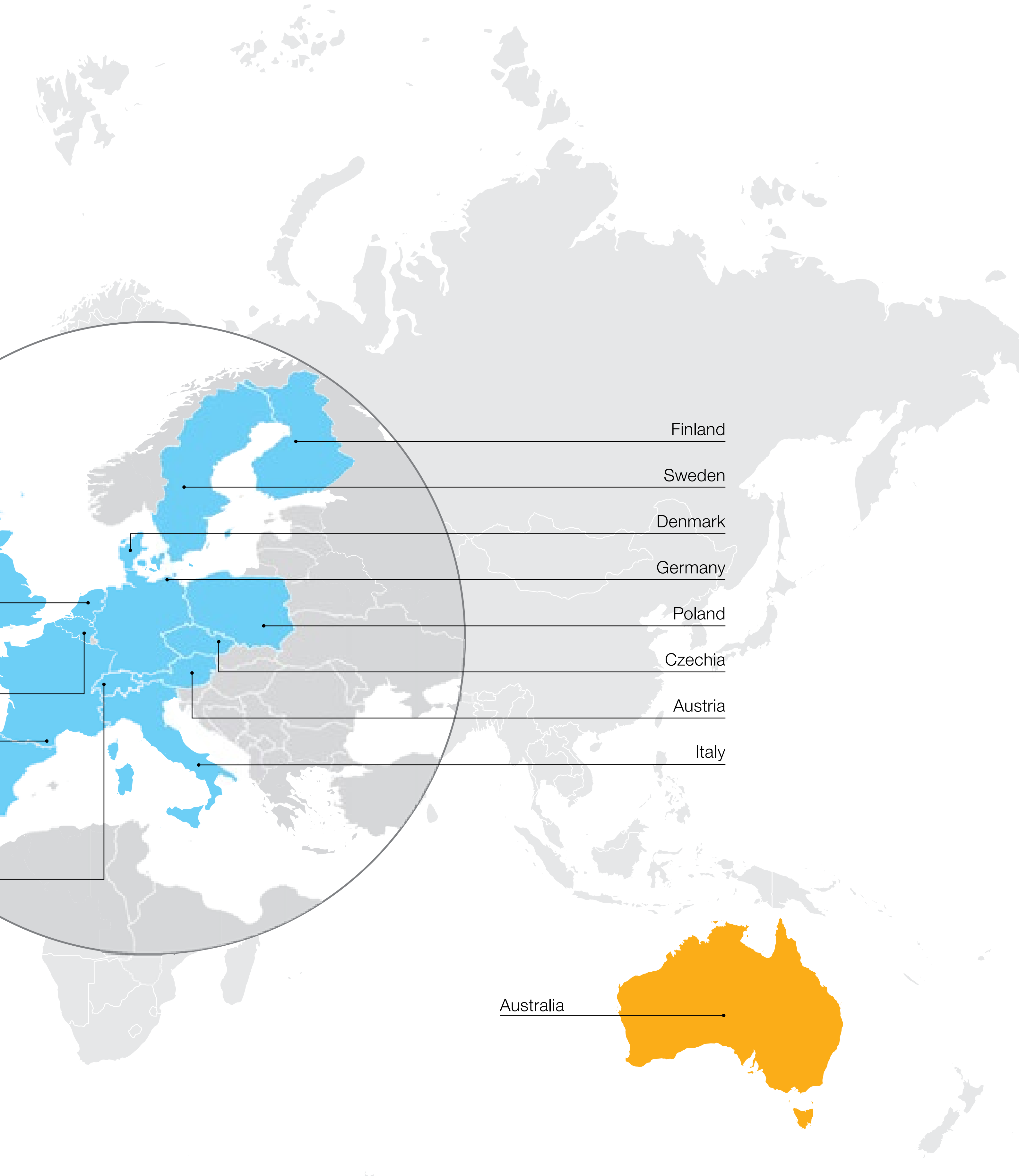


ESO's Organisational Locations

Garching near Munich, Germany — is where ESO has its Headquarters, where most telescope design and development takes place, and the ESO Supernova. From here, ESO staff also manage data from ESO's observatories, including archiving and user support.

Vitacura, Santiago, Chile — the site of ESO's organisational hub in the Host State of our observatories.

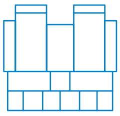
Image credits from top to bottom: ESO/A.Tsaousis; ESO/N. Schafer


Finland
Sweden
Denmark
Germany
Poland
Czechia
Austria
Italy
Australia

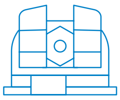
Our Telescopes in Chile

All our current observatories are in Chile's Atacama Desert, a special place with unique conditions to observe the sky. Our most advanced telescope yet is under construction: ESO's Extremely Large Telescope (ELT) will dramatically change what we know about our Universe and make us rethink our place in the cosmos.

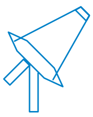
Paranal



VLT/VLTI — the Very Large Telescope is the world's most advanced optical and near-infrared observatory. Its telescopes work individually or together to form the Very Large Telescope Interferometer, which can pick up much finer details of the cosmos. The nearby Visible and Infrared Survey Telescope for Astronomy (VISTA) complements the VLT/VLTI by surveying the night sky.

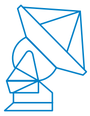


ELT (under construction) — the Extremely Large Telescope is a revolutionary 39-metre optical and near-infrared telescope that will explore the Universe in unprecedented depth and detail.



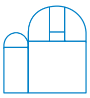
CTAO-South (under construction) — the future Cherenkov Telescope Array Observatory will explore the Universe at the highest energies. ESO is a fully participating member of the CTAO organisation and will host and operate the southern array.

Chajnantor

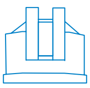


ALMA — together with international partners, ESO operates the Atacama Large Millimeter/submillimeter Array, the most powerful telescope for observing the cold Universe.

La Silla



ESO 3.6-metre telescope



NTT

Telescopes at La Silla — ESO's first observatory hosts pioneering telescopes, such as the ESO 3.6-metre Telescope and the New Technology Telescope, along with various hosted telescope projects.

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Background map "World – Pacific Rim"
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ESO’s Mission

is to design, build and operate advanced ground-based observatories, and to foster international collaboration for astronomy.

ESO’s Vision

is to advance humanity’s understanding of the Universe by working with and for the astronomy community, providing it with world-leading facilities.

ESO’s Organisational Values

ESO strives for **excellence**. It achieves this through **innovation.** ESO provides outstanding **services to its communities.** ESO fosters **diversity & inclusion.** ESO believes in the key role of **sustainability** for its future. These values of the organisation are realised and maintained by the people working at ESO.

ESO’s Personal Values

Our efforts to achieve ESO’s values are only possible on the basis of personal values and attitudes: **respect, integrity, accountability, commitment, collaboration, clear and open communication.**

Foreword

Throughout the year ESO has continued to make great advances towards its goals and to deliver world-class science, as shown by the highlights presented in this report from the Extremely Large Telescope, the La Silla Paranal Observatory, ALMA, and more.

The international search for ESO's next Director General concluded with the selection by ESO Council of Andreas Kaufer. I am delighted with the outcome, and confident that the organisation will remain in excellent hands for the future. I also thank Xavier Barcons for his tireless leadership as Director General since 2017, delivering enormous progress on all of ESO's programme.

Throughout 2025 the threat posed to the unique observing conditions at Paranal from a proposed industrial megaproject near the site was a major concern for Council and the astronomical community. I would therefore like to thank ESO's leadership and staff for their determined efforts to protect the dark skies at Paranal and elsewhere, as well as congratulating them for the great progress across the whole of ESO's programme during 2025.

Tom Ray, ESO Council President

Introduction

It was another year of impressive progress at ESO. The Extremely Large Telescope had its topping-out ceremony in April and construction passed 70% completion by the end of the year. The project is preparing for its assembly, integration and verification phase, and is on track for telescope first light in 2029. At Paranal, all four VLT Unit Telescopes now have laser guide star units, bringing the power of adaptive optics to the VLT Interferometer, and construction began on the CTAO-South gamma-ray observatory, marked by its groundbreaking ceremony. ALMA delivered a record-breaking almost 4500 hours of successful observations in cycle 11, and preparatory work on its Wideband Sensitivity Upgrade continues.

Some of the darkest skies on Earth were under threat this year from a proposed industrial megaproject near Paranal. Extensive efforts were made to protect the unique conditions at Paranal by ESO, its Member States and the astronomy community and the public in Chile and around the world, and we are deeply grateful for this wide-ranging and strong support. While this specific risk disappeared, the need to protect dark and quiet skies for astronomy remains, and ESO is developing long-term strategies to protect this unique natural heritage.

This is my last full year as Director General. I'm immensely grateful and proud of having accompanied ESO throughout nine years of challenges and successes, and I will be very happy to pass the responsibility to my colleague Andreas Kaufer in September 2026.

Xavier Barcons, ESO Director General

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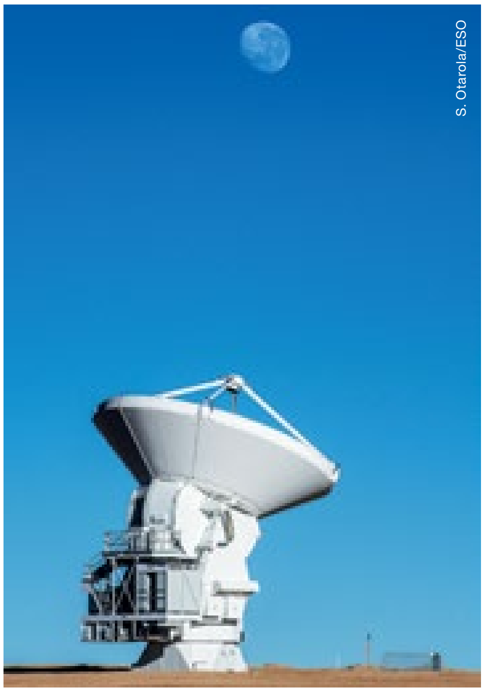

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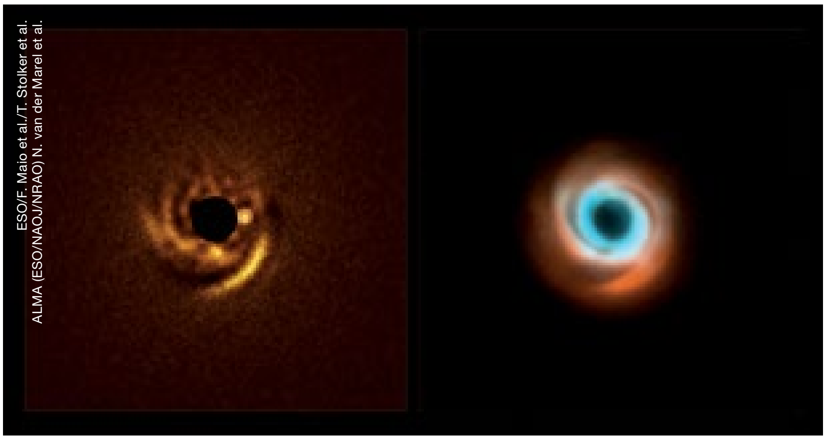

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ESO's year in numbers

Over
1100
papers published using data from ESO facilities[1]

Almost
23 000
total papers published since 1996

Over
2700
observing proposals submitted[2]

[1] See publication digest on page 120 for more details.

[2] La Silla Paranal Observatory (includes Period 117, the first yearly cycle) plus ESO's share of the ALMA partnership. See page 52 for more details.

[3] La Silla Paranal Observatory plus ESO's share of the ALMA partnership.

Over

33 000

mentions of ESO in online media

Approximately

19 000

hours of scientific observations[3]

About

800

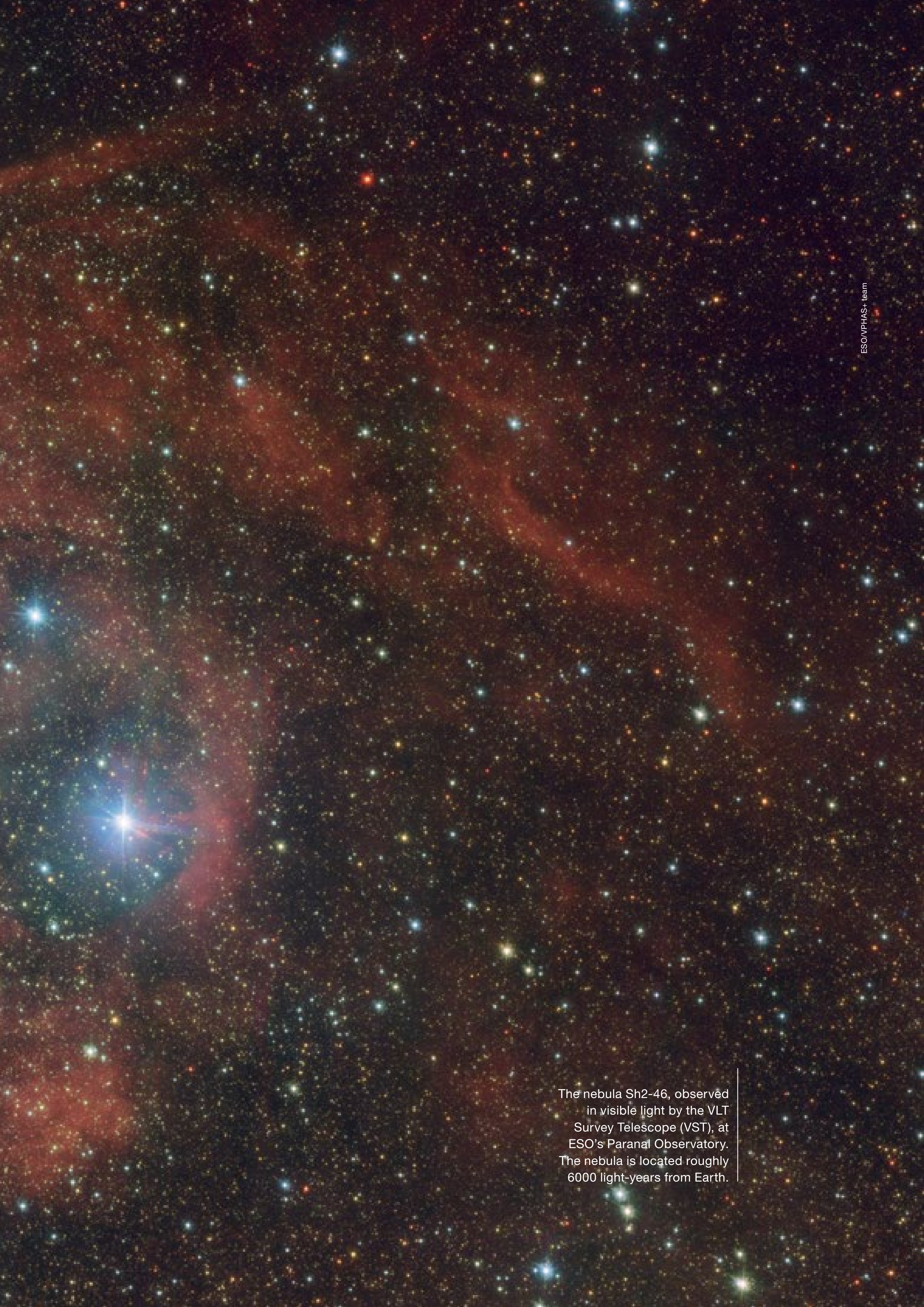
staff drawn from approximately **50 different nationalities**

€255 million

financial contributions from ESO Member States

Science highlights

The flow of high-impact scientific publications using observations from ESO facilities is testimony to the talent of a world-leading community of astronomers, the productivity and quality of ESO's observatories, and the remarkable data obtained there. The highlights presented here are just a small sample of the many fascinating results that emerged during 2025.

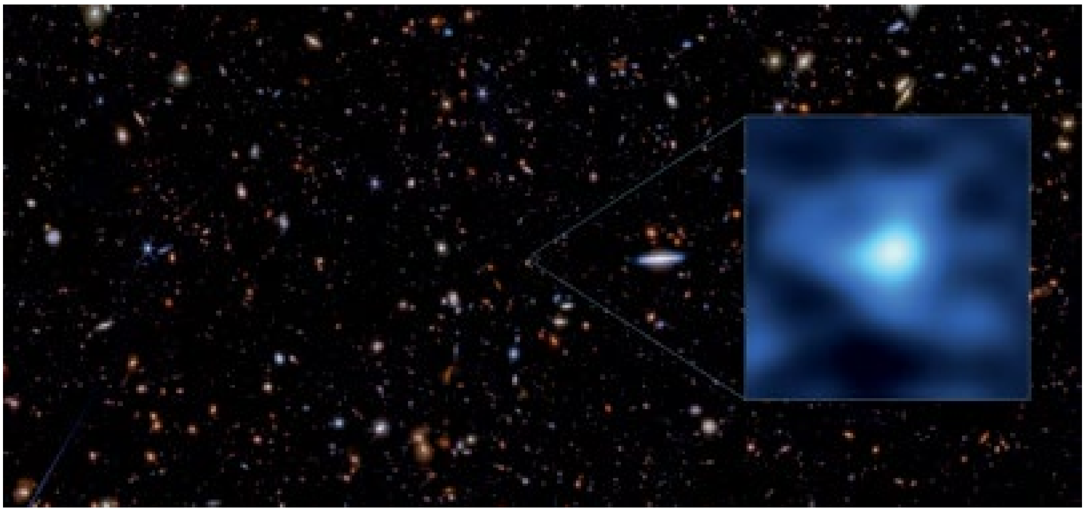


ESO/VPHAS+ team

The nebula Sh2-46, observed in visible light by the VLT Survey Telescope (VST), at ESO's Paranal Observatory. The nebula is located roughly 6000 light-years from Earth.

Oxygen discovered in most distant galaxy known

The inset image shows a close-up of the very distant primordial galaxy JADES-GS-z14-0 as seen with ALMA. It is overlaid on an image taken with the James Webb Space Telescope, showing the precise position of the galaxy in the constellation Fornax.



Two different teams of astronomers detected oxygen in what was at the time the most distant galaxy known, thanks to ALMA. This record-breaking detection is making astronomers rethink how quickly galaxies formed in the early Universe.

The galaxy, JADES-GS-z14-0, is so far away its light took 13.4 billion years to reach us, meaning we see it as it was when the Universe was less than 300 million years old, about 2% of its present age. The new detections of oxygen suggest the galaxy is much more chemically mature than expected.

Galaxies usually start their lives full of young stars, which are made mostly of light elements such as hydrogen and helium. As stars evolve, they create heavier elements, including oxygen, which get dispersed through their host galaxy after they die. Researchers had thought that, at 300 million years old, the Universe was still too young to have galaxies ripe with heavy elements. However, the two ALMA studies indicate JADES-GS-z14-0 has about 10 times more heavy elements than expected.

One of the two studies was led by Sander Schouws (Leiden Observatory, the Netherlands) and the other by Stefano Carniani (Scuola Normale Superiore of Pisa, Italy).

The unexpected results lead to a new view of the first phases of galaxy evolution and add to a growing body of evidence that the formation of galaxies happened much faster than was expected.

Carniani, S. et al., *The eventful life of a luminous galaxy at z = 14: metal enrichment, feedback, and low gas fraction?*, Astronomy & Astrophysics 696, A87 (2025), https://doi.org/10.1051/0004-6361/202452451
Schouws, S. et al., *Detection of* $[O\,III]_{88\,\mu m}$ *in JADES-GS-z14-0 at z = 14.1793*, Astrophysical Journal 988, 19 (2025), https://doi.org/10.3847/1538-4357/adbf1b

ALMA sheds light on the nature of Little Red Dots

Since the James Webb Space Telescope (JWST) started operating in late 2022, it has discovered hundreds of astronomical objects named Little Red Dots (LRDs). They are point-like and red-tinted in appearance and appear to exist within the first billion years or so after the Big Bang. While more than 300 of these objects have been identified, their nature remains a mystery. Three recent papers have used ALMA to shed light on LRDs.

Initially astronomers believed the dots were mature galaxies, red because of an aged population of stars. But they were too compact to be evolved galaxies, with evidence suggesting that they were illuminated by something at their centre instead, such as a supermassive black hole feasting on matter around it or intense star formation obscured by cosmic dust. None of the scenarios explains all the peculiarities of these strange objects, though: for example, while standard active galaxies powered by supermassive black holes at their centre emit heavily in X-rays, LRDs have limited X-ray emission.

Three different studies, led by Caitlin Casey (University of California, Santa Barbara, USA and Cosmic Dawn Center, Denmark), Ivo Labbe (Swinburne University of Technology, Australia) and Ivan Delvecchio (INAF – OAS Bologna, Italy) report on observations of dozens of LRDs with ALMA and other telescopes, specifically investigating their dust content.

They found a remarkable lack of dust in the objects, which favours a scenario in which LRDs are 'reddened' luminous active galactic nuclei, where hot material obscures the central black holes and limits emission in certain wavelengths of light. Casey et al. point out that their results are consistent with LRDs having black holes either surrounded by compact but modest dust reservoirs or enshrouded in dense gas. Overall, the studies suggest that LRDs may represent a brief yet intense phase of black hole growth before typical active galaxies arise. However, more observations such as those possible with ALMA will be needed to confirm these theories.

Casey, C. et al., *An Upper Limit of 10^6 $M_\odot$ in Dust from ALMA Observations in 60 Little Red Dots*, Astrophysical Journal Letters 990, L61 (2025), https://doi.org/10.3847/2041-8213/adfa91

Labbe, I. et al., *UNCOVER: Candidate Red Active Galactic Nuclei at $3 < z < 7$ with JWST and ALMA*, Astrophysical Journal 978, 92 (2025), https://doi.org/10.3847/1538-4357/ad3551

Delvecchio, I. et al., *Active galactic nuclei-heated dust revealed in "little red dots"*, Astronomy & Astrophysics 704, A313 (2025), https://doi.org/10.1051/0004-6361/202557164

ALMA antennas on the Chajnantor plateau in the Chilean Atacama Desert.

Mass of very distant black hole measured with GRAVITY+

When the Universe was between about 1 and 3 billion years old, galaxies and their central black holes were both growing rapidly. This period, which shaped the cosmos into what it is today, is now more accessible to study thanks to the GRAVITY+ upgrade to the VLTI.

For nearby black holes, the movement of the surrounding gas and stars can be directly tracked, so their masses can be inferred. However, resolving these motions becomes increasingly challenging with distance. Now, GRAVITY+ has opened the door to observations of supermassive black holes at much greater distances than was possible before, enabling us to understand how galaxies and their central engines grow over cosmic time.

The GRAVITY+ Collaboration used the instrument to observe gas around a black hole, designated J0529, in a galaxy so distant that its light has travelled for almost 12 billion years to reach us, meaning that we see it as it was when the Universe was just 1.6 billion years old.

The observations, coupled with additional observations conducted with the VLT instrument ERIS, were used to measure the mass of the black hole, making it the most distant black hole whose mass has been determined directly.

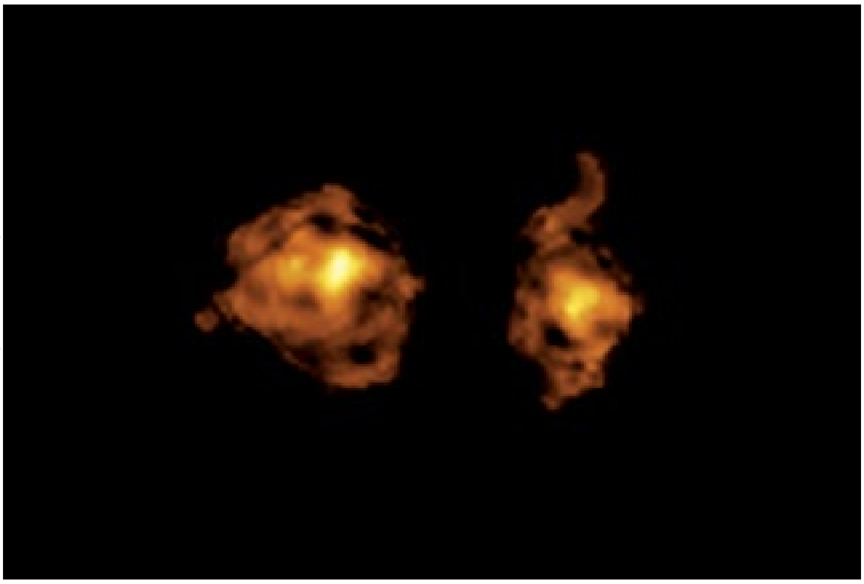
This mass, 800 million times that of the Sun, is an order of magnitude lower than estimated by indirect methods. The astronomers suggest that the indirect methods, which use the luminosity of the galaxy, are biased by emission from outflowing material.

GRAVITY+ Collaboration, *Spatially resolved broad line region in a quasar at z = 4: Dynamical black hole mass and prominent outflow*, Astronomy & Astrophysics (accepted), https://doi.org/10.48550/arXiv.2509.13911

This artist's impression — not to scale — imagines the swirling material around a distant black hole above ESO's Very Large Telescope Interferometer (VLTI) at Paranal in Chile.

ESO/M. Kornmesser, Y. Beletsky

Astronomers observe pair of galaxies in deep-space 'cosmic joust'



ALMA (ESO/NAOJ/NRAO)/S. Balashev and P. Noterdaeme et al.

ALMA observations showing the molecular gas content of two galaxies involved in a cosmic collision. The one on the right hosts a quasar — a supermassive black hole that is accreting material from its surroundings and releasing intense radiation directly into the other galaxy.

Astronomers have witnessed for the first time a violent cosmic battle in which one galaxy pierces another with intense radiation. Over and over, the pair of galaxies charge towards each other at speeds of 500 km s^{-1} on a collision course, only to land a glancing blow before retreating and winding up for another round, in a 'cosmic joust'. But these galactic knights aren't exactly chivalrous, and one has a very unfair advantage: its bright core is a quasar, powered by a supermassive black hole, which releases a spear of radiation that pierces its opponent. The battle was captured by a team led by Sergei Balashev (Ioffe Institute, Russia) and Pasquier Noterdaeme (Institut d'Astrophysique de Paris, France, and French-Chilean Laboratory for Astronomy, Chile), using observations with the VLT's X-shooter instrument and ALMA.

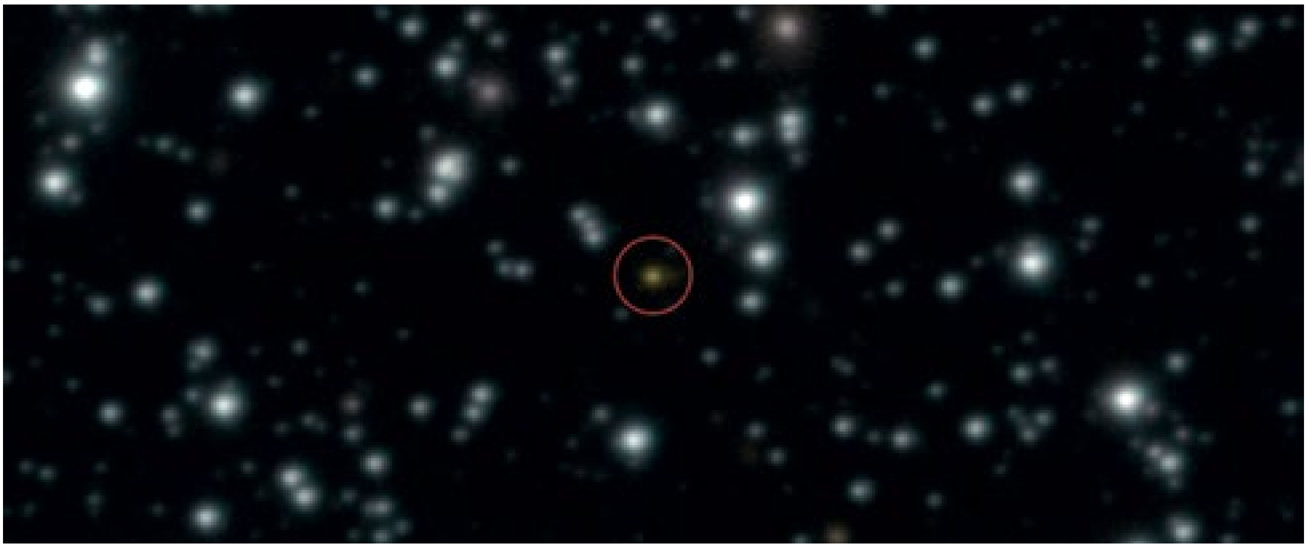
The light from the distant galaxies has taken over 11 billion years to reach us, so we see the events as they were when the Universe was only 18% of its current age.

The observations show for the first time how the quasar's radiation disrupts the clouds of gas and dust in the other, regular galaxy, leaving only the smallest, densest regions behind. These regions are likely too small to be capable of forming stars, damping the wounded galaxy's ability to form new stars.

But this galactic victim isn't all that is being transformed. As the galaxies dance around each other new reserves of fuel are brought within reach of the black hole powering the quasar. As the black hole feeds, the quasar can continue its damaging attack.

Balashev, S., *Quasar radiation transforms the gas in a merging companion galaxy*, Nature 641, 1137–1141 (2025), https://doi.org/10.1038/s41586-025-08966-4

A mysterious gamma-ray explosion, unlike any detected before



ESO/A. Levan, A. Martin-Carrillo et al.

Image taken with the VLT's HAWK-I camera, pinpointing the location of the unusual gamma-ray burst GRB 250702B, seen here as the orange dot in the centre. Its location is highlighted by a red circle.

Astronomers have detected an explosion of gamma rays unlike anything ever witnessed before. Gamma-ray bursts (GRBs) are the most powerful explosions in the Universe, normally caused by, among other things, the catastrophic destruction of stars dying in powerful blasts or being ripped apart by black holes.

GRBs usually last milliseconds to minutes, but this one — known as GRB 250702B — repeated several times over the course of a day. Not only is this 100–1000 times longer than most, but gamma-ray bursts are not expected to repeat, since the event that is thought to produce them is catastrophic. No known scenario can completely explain this new GRB, which was unlike any other seen in 50 years of observations.

Initial detections by the Fermi Gamma-ray Space Telescope and the Einstein Probe X-ray space telescope only provided an approximate location for the GRB, towards the plane of our galaxy, a region crowded with stars. It was therefore assumed that the GRB originated within our own galaxy, but this assumption was fundamentally upended when a team led by Andrew Levan (Radboud University, the Netherlands) and Antonio Martin-Carrillo (University College Dublin, Ireland) used the VLT's HAWK-I camera to pinpoint the actual source. They found evidence that the GRB may actually reside in another galaxy, which was later confirmed by the Hubble Space Telescope.

Excitingly, the fact that the GRB is extragalactic means that it is considerably more powerful given its observed brightness. What caused this GRB is still unknown, but finding that this explosion took place in another galaxy will be key to deciphering it. To learn more, the team has been monitoring the aftermath of the explosion with different telescopes and instruments, including the VLT's X-shooter spectrograph and the James Webb Space Telescope.

Levan, A. J. et al., *The Day-long, Repeating GRB 250702B: A Unique Extragalactic Transient*, Astrophysical Journal Letters 990, L28 (2025), https://doi.org/10.3847/2041-8213/adf8e1

For the first time, astronomers witness the dawn of a new solar system

Researchers have, for the first time, pinpointed the moment when planets began to form around a star beyond the Sun. Using ALMA and the James Webb Space Telescope (JWST), they observed the creation of the first specks of planet-forming material — hot minerals just beginning to solidify. This is the first time a planetary system has been identified at such an early stage and opens a window onto the past of our own Solar System.

The team, led by Melissa McClure (Leiden University, the Netherlands), observed the newborn planetary system emerging around HOPS-315, a protostar or 'baby star' some 1300 light-years away from us.

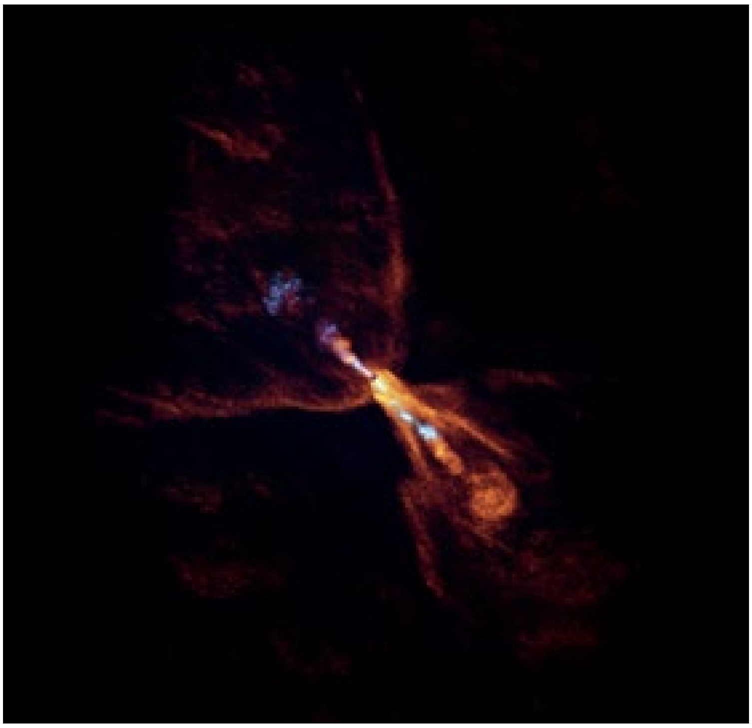
Around such protostars, astronomers often see discs of gas and dust known as 'protoplanetary discs', the birthplaces of new planets. While astronomers have previously seen young discs that already contain newborn, massive, Jupiter-like planets, the very first solid parts of planets, or 'planetesimals', must form when the discs are even younger.

A key ingredient is crystalline minerals, including silicon monoxide (SiO), which can condense at the extremely high temperatures present in young planetary discs, binding together and sowing the seeds of planet formation. With their new discovery, astronomers have found evidence of these hot minerals beginning to condense around HOPS-315. The SiO is present around the protostar in its gaseous state, as well as within these crystalline minerals, suggesting it is only just beginning to solidify.

The minerals were first identified using the JWST, but it was only by combining these observations with sharper images from ALMA that astronomers could pinpoint them to a small region of the disc around the star, equivalent to the orbit of the asteroid belt around the Sun in our Solar System. Because of this, HOPS-315 provides a wonderful analogue for studying our own Solar System's history. The result also highlights the combined strength of the JWST and ALMA for exploring protoplanetary discs.

McClure, M. K., et al., *Refractory solid condensation detected in an embedded protoplanetary disk*, Nature 643, 649–653 (2025), https://doi.org/10.1038/s41586-025-09163-z

ALMA image of the protostar HOPS-315. The orange colour shows the distribution of carbon monoxide, blowing away from the star in a butterfly-shaped wind. In blue is a narrow jet of silicon monoxide, also beaming away from the star.



ALMA (ESO/NAOJ/NRAO)/M. McClure et al.

Astronomers witness newborn planet sculpting the dust around it

Astronomers may have caught a still-forming planet in action, carving out an intricate pattern in the gas and dust that surrounds its young host star. Using the VLT, they observed a planetary disc with prominent spiral arms, finding clear signs of a planet nestled in its inner regions.

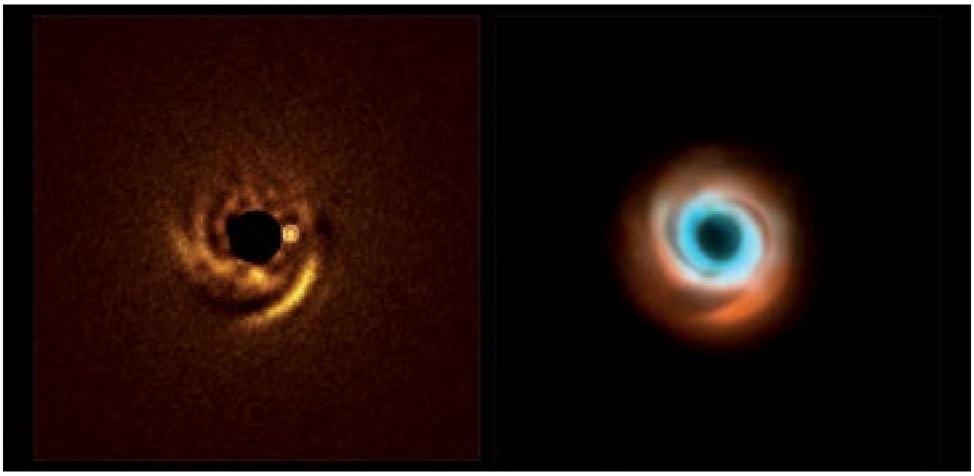
The potential planet-in-the-making was detected around the star HD 135344B, within a disc of gas and dust around it called a protoplanetary disc. The budding planet is estimated to be twice the size of Jupiter and as far from its host star as Neptune is from the Sun. It has been observed shaping its surroundings within the protoplanetary disc as it grows into a fully formed planet.

Protoplanetary discs have been observed around other young stars, often displaying intricate patterns, such as rings, gaps or spirals. Astronomers have long predicted that these structures are caused by baby planets, which sweep up material as they orbit their star. But until now they had not caught one of these planetary sculptors in the act.

In the case of HD 135344B's disc, swirling spiral arms had previously been detected by another team using the SPHERE instrument on the VLT. However, none of the previous observations of this system found proof of a planet forming within the disc.

Now, with new observations from the ERIS instrument on the VLT, researchers led by Francesco Maio (INAF Osservatorio Astrofisico di Arcetri, Italy) may have found their prime suspect. They spotted the planet candidate right at the base of one of the disc's spiral arms, exactly where theory had predicted they might find the planet responsible for carving such a pattern. This is the first time astronomers have detected a planet candidate embedded inside a disc spiral.

Maio, F. et al., *Unveiling a protoplanet candidate embedded in the HD 135344B disk with VLT/ERIS*, Astronomy & Astrophysics 699, L10 (2025), https://doi.org/10.1051/0004-6361/202554472



Left: Image captured with the VLT instrument ERIS showing a possible planet being born around the young star HD 135344B. The central black circle corresponds to a coronagraph a device that blocks the light of the star to reveal faint details around it. The white circle indicates the location of the planet. Right: Combination of previous observations with the VLT instrument SPHERE (in red) and ALMA (in orange and blue), which did not find signatures of a planet.

ESO/F. Maio et al./T. Stolker et al. ALMA (ESO/NAOJ/NRAO)/ N. van der Marel et al.

Space mission's target asteroid is tinier and spinning faster than thought

Astronomers have used observatories around the world, including the VLT, to study the asteroid 1998 KY_{26}, revealing it to be almost three times smaller and spinning much faster than previously thought. The new observations offer key information for the extended mission of Japan's Hayabusa2 spacecraft, which will encounter the asteroid in 2031.

Toni Santana-Ros (University of Alicante, Spain) led a study to observe 1998 KY_{26} from the ground to support the preparation of the mission. Because the asteroid is very small, and hence very faint, studying it required waiting for a close encounter with Earth and using large telescopes such as the VLT.

The new observations, combined with previous radar data, have revealed that the asteroid is just 11 metres wide, meaning it could easily fit inside the dome of the VLT Unit Telescope used to observe it. It is also spinning about twice as fast as previously thought, completing a rotation every five minutes.

1998 KY_{26} is set to be the final target asteroid for Hayabusa2. In its original mission, Hayabusa2 explored the 900-metre-diameter asteroid 162173 Ryugu in 2018, returning asteroid samples to Earth in 2020. With fuel remaining, the spacecraft was sent on an extended mission until 2031, when it's set to encounter 1998 KY_{26}, aiming to learn more about the smallest asteroids. This will be the first time a space mission encounters a tiny asteroid — all previous missions visited asteroids with diameters in the hundreds or even thousands of metres.

An artist's impression of Japan's Hayabusa2 space mission touching down on the surface of the asteroid 1998 KY_{26}, showing the updated size comparison, after VLT observations revealed that the asteroid is just 11 metres wide, almost three times smaller than previously thought.

The smaller size and faster rotation will make Hayabusa2's visit even more interesting, but also even more challenging. This is because a touchdown manoeuvre, where the spacecraft 'kisses' the asteroid, will be more difficult to perform than originally thought.

Santana-Ros, T., et al., *Hayabusa2 extended mission target asteroid 1998 KY_{26} is smaller and rotating faster than previously known*, Nature Communications 16, 8275 (2025), https://doi.org/10.1038/s41467-025-63697-4

ESO in society and our communities

Providing outstanding services to our communities is one of ESO’s Values as an organisation. Our passion for research, innovation, and collaboration leads to far-reaching and invaluable impacts in our Member States, Chile as the Host State of our observatories, our Strategic Partner Australia, and beyond. The benefits are seen not only in science and engineering, but in talent development, education and outreach, the economy and innovation, and international collaboration and policy.

In this section, we share some highlights from the year of how ESO has contributed to and engaged with our many communities and society as a whole.

Early-years educators from the Munich area visit the ESO Supernova Planetarium & Visitor Centre, at an event organised by ESO and Forscherstation Heidelberg.

ESO's mission to protect dark and quiet skies

Astronomy is humanity's oldest science and for thousands of years humans have looked up at the stars, used them as our guides and time keepers, and been inspired by the cosmos. Over the past few decades, however, the quality of the night sky around the world has been diminished as a result of human activity.

ESO has been actively involved in the campaign for the preservation of dark and quiet skies for many years, and participates in many projects supporting the reduction of pollution resulting from artificial light at night, satellite constellations and other sources.

Safeguarding the world's darkest and clearest skies over Paranal

In January 2025 ESO publicly raised the alarm about the threat posed to the world's darkest and clearest skies, those of ESO's Paranal Observatory, from the industrial megaproject INNA. The proposed project — by AES Andes, a subsidiary of the US power company AES Corporation — included multiple energy and processing facilities for green hydrogen and ammonia, spread over an area of more than 3000 hectares, the size of a small city.

ESO and its Member States are fully supportive of energy decarbonisation and initiatives that ensure a more prosperous and sustainable future. Green-energy projects — and other industrial projects that drive national and regional development — are fully compatible with astronomical observatories, if the different facilities are located at sufficient distances from one another. However, the planned location of the INNA megaproject was just a few kilometres from the Paranal telescopes. It would also likely have encouraged the further development of an industrial hub in the area, which would lead to even greater impacts.

Responding to the planned megaproject became a major area of activity for ESO during the year, with intense work across the organisation, including expert technical, legal and political analyses, media relations, and campaigns to raise awareness in Chile and internationally (see the next pages for more details).

Following these activities throughout 2025, AES Andes cancelled the INNA project in the first weeks of 2026, formally withdrawing it from evaluation by Chile's Environmental Assessment Service on 6 February 2026.

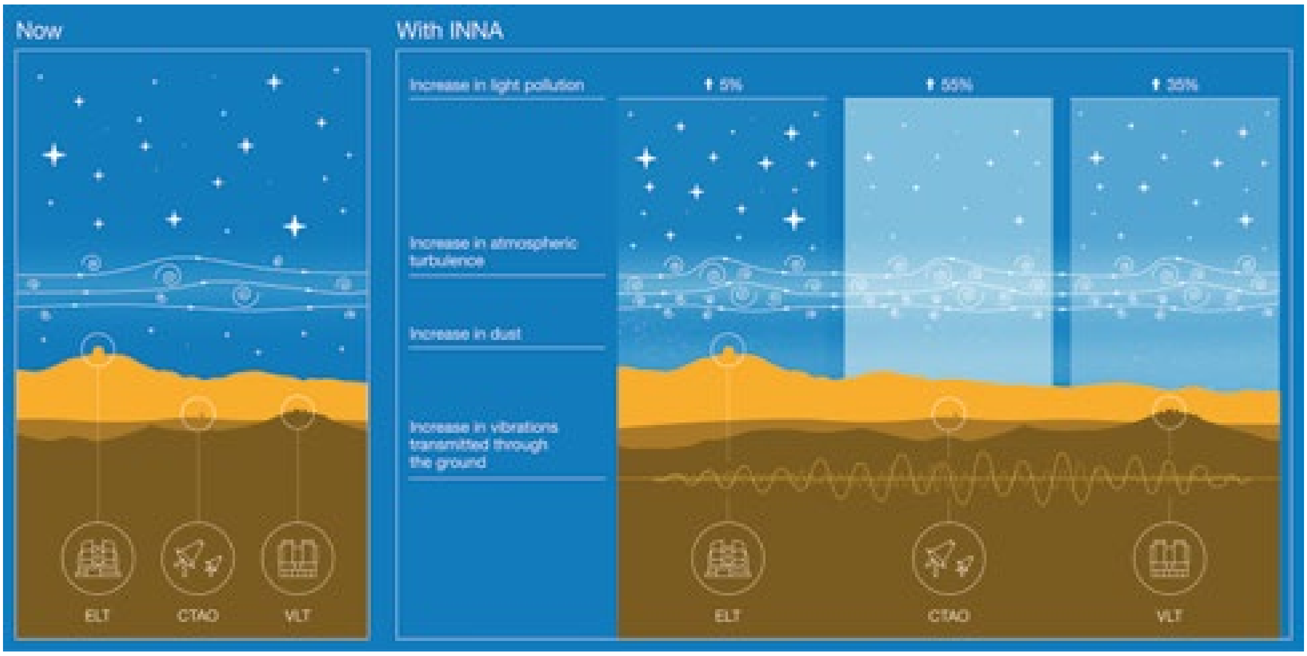
While this specific project has now been withdrawn, ESO continues its wider work to safeguard and emphasise the importance of dark and quiet skies, in collaboration with partners in Chile and elsewhere.

Devastating and irreversible impacts of proposed project

An in-depth technical analysis by ESO revealed that the impact of the proposed INNA megaproject on the facilities at Paranal would be devastating and irreversible. The alarming results showed that INNA would increase light pollution above the Very Large Telescope (VLT) by at least 35% and by more than 50% above the south site of the Cherenkov Telescope Array Observatory (CTAO-South). INNA would also increase air turbulence in the area, further degrading conditions for astronomical observations, while micro-seismic vibrations from the project could seriously impair the functioning of facilities such as the VLT Interferometer (VLTI) at Paranal and the Extremely Large Telescope (ELT) on the nearby Cerro Armazones. Furthermore, dust stirred up during the INNA construction would also affect the observatories, as it settles on and contaminates the delicate telescope mirrors.

The study was carried out by a team of experts including ESO staff, who joined forces with Martin Aubé, a world-leading expert on sky brightness at astronomical sites, to run simulations using the most advanced light-pollution models. As input, the simulations used publicly available information provided by AES Andes when submitting the project for environmental assessment.

The full technical report was made public and submitted to the Chilean authorities in early April 2025, as part of the citizen participation process (*participación ciudadana*, PAC) of the environmental impact assessment for the INNA proposal.



Infographic summarising the main results of a detailed technical analysis of the impact of the proposed INNA megaproject on the facilities at the Paranal Observatory.

Raising awareness of the threat to the darkest and clearest skies on Earth

Throughout the year people and organisations in Chile and around the world spoke up for the protection of dark and quiet skies in the context of the INNA proposal. ESO is deeply and sincerely grateful for this engagement and solidarity from members of the astronomy community in Chile, in ESO's Member States and beyond, political leaders and authorities at international, national, regional and local level, and countless members of the public, who all made their voices heard in support of the protection of dark and quiet skies in Chile and elsewhere — for astronomy research and as a unique heritage for all of humankind.

The wide-ranging engagement included statements during visits by high-level Member State representatives, including heads of state (for more about some of these visits see page 28).

There was tremendous support from the Chilean and international scientific community. This included public statements from the Chilean Society of Astronomy (*Sociedad Chilena de Astronomia*, SOCHIAS), the Chilean Academy of Sciences and the Institute of Chile (*Instituto de Chile*), as well as open letters by prominent astronomers and other scientists. Among them was a letter to the Chilean Government, signed by nearly 40 winners of the National Prize of Chile, as well as a letter led by Nobel Prize winner Reinhard Genzel and signed by nearly 30 distinguished astronomers from Chile and around the world.

The Skies of Chile Foundation (*Fundación Cielos de Chile*) took an active role in communication and outreach efforts, supporting informed and effective engagement by the Chilean public in the citizen participation (*participación ciudadana*, PAC) process of the environmental impact assessment for the INNA proposal. The PAC process received more than 700 comments, one of the largest responses in the history of Chile's environmental assessment system, highlighting widespread concern for the protection of dark skies.

Intense interest from Chilean and international media led to a large number of enquiries, interview requests, and visits to Paranal and the nearby ELT construction site on Cerro Armazones. The media interest throughout the year culminated in a question on the topic being raised directly by a journalist during the final televised debate of the Chilean presidential election in December.

A. Ghizzi Panizza/ESO

The Milky Way, visible in the dark skies over Cerro Paranal and the VLT.

Ministry of Science expert advisory commission visits Paranal

Members of the expert advisory commission, with representatives from ESO and the Chilean Ministry of Science, Technology, Knowledge, and Innovation, at the ELT construction site on Cerro Armazones.

In June 2025 members of an expert advisory commission formed by the Chilean Ministry of Science, Technology, Knowledge, and Innovation visited Paranal. The commission was tasked with providing input for updating the ministry's Supreme Decree No. 2/2023, a regulation which designates areas of scientific value for astronomical research and observation. The original regulation established protection zones to preserve the unique qualities of the skies over these areas, but the expansion of urban areas and industrial projects have put this protection at risk. The commission was asked to review the regulation and recommend updates, in light of the March 2025 recommendations on the protection of astronomical sites made by the International Astronomical Union (IAU), which follow studies by two UN/IAU-sponsored working groups.

The delegation's visit gave them the opportunity to experience with their own eyes the quality of the dark skies at Paranal, and to see the ELT construction site on the summit of Cerro Armazones.

In December the commission submitted its final report to the ministry, containing recommendations which include proposals for core protection zones of 50 km radius around areas of scientific value for astronomy. Implementing the recommendations would ensure long-term, effective protection of Chile's dark skies, which are an invaluable asset for scientific research and economic activities such as astro-tourism, and would consolidate Chile's position as a global leader in its commitment to preserving these exceptional conditions for observing the Universe.

International astronomical observatories join forces to protect Chile's skies

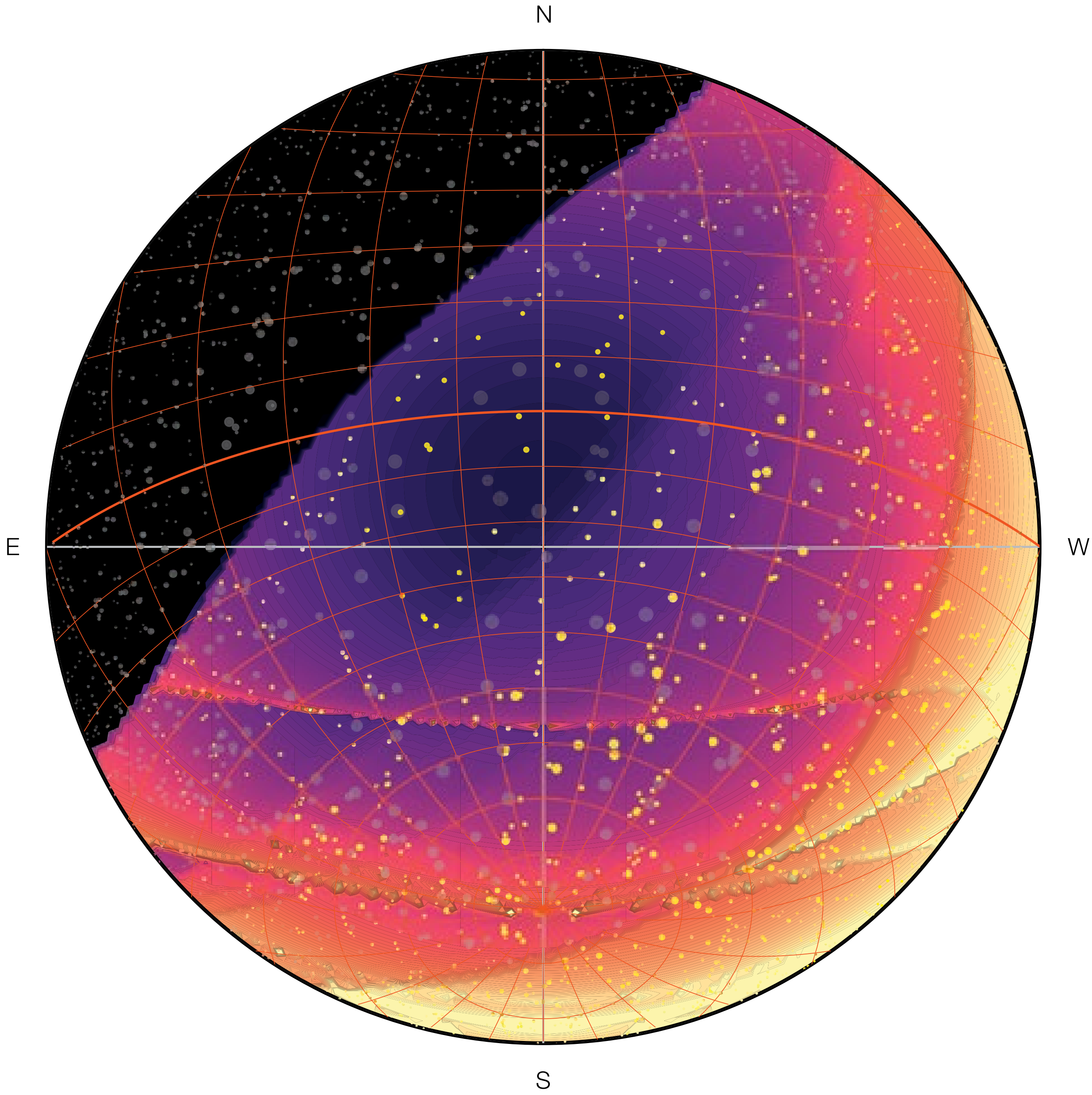
In June 2025 the main international observatories with a presence in Chile formed a joint organisation, the Dark Skies Council, dedicated to protecting the dark skies of the northern part of the country. The council will act through Fundación Cielos de Chile and the Office for the Protection of the Quality of the Northern Chilean Sky (OPCC), to coordinate strategies and actions in the face of advancing light pollution. ESO joined with the Association of Universities for Research in Astronomy (AURA), the Giant Magellan Telescope (GMT), and the Las Campanas Observatory of the Carnegie Institution for Science in signing the agreement to create the Dark Skies Council. Through this alliance, the institutions committed to work in a coordinated manner to protect Chile's privileged skies.

ESO becomes a partner in the IAU Centre for the Protection of the Dark and Quiet Sky

On 9 December 2025 ESO signed an agreement with the International Astronomical Union (IAU)'s Centre for the Protection of the Dark and Quiet Sky (CPS) to become a contributing partner. The CPS brings together astronomers, satellite operators, policy makers and other stakeholders to coordinate efforts and unify voices across the global astronomical community with regard to the protection of the dark and quiet skies from satellite constellation interference. ESO joins the centre's two founding partners, the US NSF NOIRLab and the SKA Observatory, as a formal partner, dedicating personnel and resources to the centre and having an active role in its decision-making process. The agreement was signed by Xavier Barcons, ESO Director General and Piero Benvenuti, IAU CPS Director during a high-level event on the protection of astronomical sites held in Vienna.

A. Daniels (SKAO)

Signature of the agreement for ESO to become a contributing partner of the IAU Centre for the Protection of the Dark and Quiet Sky, by Xavier Barcons (left) and Piero Benvenuti (right).



This simulation illustrates the impact of increasing light pollution from satellite constellations on the VLT at Paranal. It includes constellations from four major operators, a total of 64500 satellites. This is six times more than were in orbit in 2025, but significantly below the number in published plans for 2030. It shows the whole sky above Paranal, two hours after sunset, well into the night of observations. The edge of the circle is the horizon (compass directions are marked). The dots are an illustrative snapshot of the positions of individual satellites. The satellites are in constant motion, and observations have an extended exposure time, so the colour scale shows the expected number of satellite trails that will pollute an observation. Brighter colours indicate areas of the sky that are more affected. The dark area in the top-left, where all satellites are completely in Earth's shadow, is the only area free from this light pollution.

Leading the field in international collaboration

As an intergovernmental organisation, ESO brings countries together to create a scientific and political capacity for development that is beyond the reach of its individual Member States. ESO therefore stands out as a role model, offering a platform for international research and development, collaboration and science diplomacy that actively encourages political and cultural understanding between nations.

ESO is a founding member of EIROforum, the partnership of European research infrastructures, and also maintains formal cooperation agreements with the European Space Agency, CERN and the SKA Observatory. ESO is an observer on the United Nations Committee on the Peaceful Uses of Outer Space and is a member of the UN-mandated International Asteroid Warning Network, which monitors the skies for potentially threatening asteroids. ESO also actively participates in other bodies such as ASTRONET, a planning and advisory network for European astronomy; RadioNet, the European Radio Astronomy Consortium; and the Committee on Radio Astronomy Frequencies of the European Science Foundation (ESF-CRAF).

High-level visits to ESO sites

During the year ESO was honoured to host several high-level visits to our sites. ESO always welcomes opportunities to share the latest developments and news from our programme with stakeholders from our Member States, Chile as the Host State of our observatories, our Strategic Partner Australia, or elsewhere.

“If this research is to be maintained at this level then this location must also be permanently protected from light emissions from other sources.”

Frank-Walter Steinmeier
President of the Federal Republic of Germany

In March the Federal President of Germany, Frank-Walter Steinmeier, visited Paranal and the ELT construction site at Armazones with a high-level delegation. Germany is a founding Member State and the Host State of ESO’s Headquarters, and has had a major role in many of ESO’s technological and scientific achievements. President Steinmeier highlighted the country’s ongoing commitment to ESO, the value of international collaboration, and the critical role that Chile and its clear skies play in furthering our view of the Universe.

In September President Steinmeier made a follow-up visit to the ESO Headquarters, along with a delegation including the Bavarian State Minister for European and International Affairs, Eric Beißwenger, touring engineering and outreach facilities at ESO's Garching site.

This followed a visit to the headquarters in June by Dorothee Bär, the German Federal Minister of Research, Technology and Space, together with the Bavarian State Minister for Science and the Arts, Markus Blume. These visits provided excellent opportunities for our guests to learn more about ESO's contributions to technology and research, and to strengthen the links between ESO and Germany.

ESO/CHEPOX

The President of Germany, Frank-Walter Steinmeier, at ESO's Paranal Observatory.

The President of Germany, Frank-Walter Steinmeier, and the ESO Director General, Xavier Barcons, at the ESO Headquarters in Garching.

In June King Philippe and Queen Mathilde of the Belgians visited Paranal and Armazones, touring the ELT construction site and visiting SPECULOOS (Search for Planets EClipsing ULtra-cOOl Stars), a Belgium-led facility sited at Paranal, as well as seeing the VLT and VLTI. Belgium is one of the five founding members of ESO, contributing greatly to the achievements of the organisation.

King Philippe and Queen Mathilde of the Belgians (foreground, centre and left) at the ELT.

ESO’s EIROforum presidency

ESO held the presidency of EIROforum from 1 July 2024 to 30 June 2025, a position which rotates annually among the partnership’s members. In this role, ESO helped coordinate EIROforum’s activities, fostering international collaboration in science, establishing and exchanging best practices among Europe’s leading research organisations, and ensuring that basic science and research infrastructures have a strong voice in European policymaking.

At the EIROforum Directors-General Assemblies, held in January and May, informal discussion topics included open science, research security policies and AI. Exchanges with other European bodies included meetings with the Chairs of the European Research Infrastructure (ERIC) Forum and the European Strategy Forum on Research Infrastructures (ESFRI), an expert from the cabinet of the European Commissioner for Startups, Research and Innovation, and staff from the EC Directorate-General for Research and Innovation.

EIROforum workshop on cryogenics

The 2025 EIROforum Topical Workshop on Cryogenics, organised by EIROforum’s Instrumentation Working Group, was hosted by ESO in Garching in October. With keynote presentations, interactive sessions, a lab tour of the ESO facilities, and networking opportunities, it was an opportunity for collaboration and knowledge exchange between more than 20 participants from EIROforum organisations. The workshop focused on the latest developments in and applications of cryogenics and vacuum technology, including the design of systems, achieving and maintaining ultra-high vacuum environments, safety and control software design, and operation and maintenance.

Participants in the 2025 EIROforum Topical Workshop on Cryogenics, at the ESO Headquarters in Garching.

ESO/A. Tsaousis

ESO and EIROforum at the EU Contest for Young Scientists

The 36th EU Contest for Young Scientists (EUCYS) took place in Riga, Latvia, from 15 to 20 September. Every year, EUCYS celebrates the scientific achievements of students aged 14 to 20 from Europe and associated countries, who have won first prize in their national science competitions.

The 2025 event brought together about 150 young scientists, from nearly 40 countries, to present their innovative research projects across various scientific disciplines. EUCYS serves as a platform for fostering collaboration and cultural exchange among young researchers, offering them the opportunity to showcase their work to an international jury and the public, and supporting their path towards scientific careers.

In addition to the contest's core prizes awarded by the European Commission, EUCYS features special donated prizes. Among them are prizes sponsored by each of the EIROforum organisations, including ESO, tailored to support young scientists in continuing their scientific journeys. The prize from ESO was awarded to Mariia Yatsiuk, from Ukraine, for her project "Detection of transit signals of exoplanets in sector 85 of the telescope TESS". Mariia will have the opportunity to spend a week at the ESO Headquarters, visiting the facilities and seeing research conducted first-hand.

Kaspars Teilāns

Above: Winners of the EIROforum special donated prizes at the 2025 EU Contest for Young Scientists.

Kaspars Teilāns

Mariia Yatsiuk, winner of the ESO prize, talks about her project with other participants.

The EIROforum member organisations are: CERN, the European Organisation for Nuclear Research; EMBL, the European Molecular Biology Laboratory; ESA, the European Space Agency; ESO, the European Southern Observatory; ESRF, the European Synchrotron Radiation Facility; EUROfusion, the European Consortium for the Development of Fusion Energy; the European XFEL (X-ray Free-Electron Laser); and ILL, the Institut Laue-Langevin.

Serving scientists and engineers in Member States, Chile, and worldwide

It is no surprise that ESO's most significant benefits to society are in the areas of science and engineering — many of which are showcased throughout the rest of this report.

We serve a growing user community of astronomers in our Member States, Chile, our Strategic Partner Australia, and around the world, who make use of the telescopes and data archives of the La Silla Paranal Observatory and of the ALMA partnership.

In addition to designing, building, and operating advanced ground-based observatories, ESO fosters international collaboration by promoting and contributing to the development — by consortia of universities and research institutes — of state-of-the-art astronomical instruments and technologies. Over 50 institutes from more than 20 countries are involved in instrument development for the ELT, Paranal, and La Silla. This investment has a direct economic impact, as well as developing technology expertise and industrial collaborations.

Expanding Horizons: crowdsourcing to shape the next ESO programme

With the ELT just a few years away from completion, ESO is already looking to the future. In 2024 ESO launched Expanding Horizons, the process to identify ESO's next transformational ground-based facility. It will address scientific challenges that cannot be tackled with ESO's facilities, both the current telescopes and those under construction or planned, and — in line with ESO's Vision — advance humanity's understanding of the Universe whilst fostering international collaboration.

ESO is reaching out to the entire astronomical community to collect a broad range of original ideas. With an open and inclusive process, and transparent and fair assessment of all proposals, ESO is anchoring its mission of serving the community even deeper into its way of working.

In 2025 ESO organised a dedicated session at the European Astronomical Society Annual Meeting in Cork, Ireland to describe the Expanding Horizons process, as well as attending and giving presentations at 11 events organised by the astronomical communities in various Member States.

Expanding Horizons is overseen by a specially appointed Senior Science Committee (SSC) of internationally recognised experts. To encourage broad discussion, and to help the SSC identify the key scientific questions and challenges of interest to ESO's astronomical community in the 2040s and beyond, the SSC and ESO issued a call for science White Papers, open to researchers at all career levels. The call ran from June 2025, with a deadline of 15 December 2025. A total of 208 White Papers were sub-

July 2024–July 2026
Preparatory phase
Workshops for astronomical community to encourage dialogue and debate

Q3 2026–June 2027
Call for ideas
Letters of Intent before 1 December 2026, call open until 1 June 2027

June 2027–September 2028
Assessment phase
Assessment by ESO Executive and Senior Science Committee

October–December 2028
Final decision
by the ESO Council

mitted, demonstrating the keen interest in the process from the community.

This input will be used to define the key scientific themes for an Expanding Horizons workshop, planned for mid-2026. The workshop will investigate synergies between the themes, the facilities that would be needed, and the key enabling technologies that would be required.

Proposals for the new facility will then be invited in a call for ideas, to run from the third quarter of 2026 to 1 June 2027. ESO's Executive and the SSC will assess the proposals, and ESO will host dedicated community workshops to transparently share the most promising ideas. The final selection of the concept for the new programme will be made by the ESO Council, with a decision expected at the end of 2028.

Find out more about Expanding Horizons at https://next.eso.org/

Training and inspiring the next generation of scientists and engineers

ESO develops unique expertise which we spread back into our communities to educate the next generation of scientists and engineers, and to trigger the next generation of instruments and telescopes.

Students and postdoctoral researchers at ESO

Having active staff who also conduct front-line research in science and engineering is critical to enabling us to achieve our mission by keeping on top of the latest developments and pushing ideas and facilities to their limits. The scientific and engineering community at ESO in Garching and Chile is enriched by postdoctoral researchers, as well as postgraduate students who spend part or all of their project work at ESO.

At any one time we have at ESO about 45 PhD students, who spend between six months and four years with us, depending on the studentship. We additionally have about 45 ESO Fellows and other postdoctoral researchers, who spend three to four years with us.

The students and postdoctoral researchers at ESO are hosted through various schemes, including ESO Studentships and Fellowships and other ESO funding, the International Max Planck Research Schools, the Irish Research Council–ESO Studentship Programme, the ESO–Czechia training programme, European Research Council grants held by staff at ESO, and other grants from national funding organisations.

Participants in the 2025 ESO–Gruber Summer School: From nearby worlds to distant galaxies, at the ESO Headquarters.

On-the-job training at ESO for recently graduated engineers

In December the ESO Council approved a new National Engineering Graduate Trainee Scheme, based on the positive experience of the existing ESO–Czechia training programme, and expanding the concept to all Member States. The scheme is for talented early-career engineers, who are looking for their first 'on the job' training experience but not for a PhD. Trainees may become interested in applying for positions at ESO after the scheme, thus creating an important and reliable talent pipeline for engineering at ESO, or may return to roles in Member States after ESO, enriching the national systems with trained talent while building connections for future collaboration between ESO and national institutions. Successful candidates will work hands-on on exciting projects, designing and building next-generation research facilities, and developing cutting-edge technologies for ground-based astronomy that enable transformational science.

From nearby worlds to distant galaxies: ESO–Gruber Summer School offers students hands-on experience

The ESO–Gruber Summer School, held at the Garching headquarters from 2 to 6 June 2025, was a unique opportunity for master's and first-year PhD students from around the world to learn about a broad range of topics in astronomy, as well as how to use ground- and space-based telescope data. The twenty participants were selected from 80 applicants, based on their academic potential and likelihood to benefit significantly from the experience.

Ten invited lecturers presented topics that included exoplanets, star and planet formation, galactic astronomy, transients, active galactic nuclei, gravitational waves, galaxy evolution, and the high-redshift Universe. Participants also worked throughout the week on a research project and got hands-on experience with archival data from ALMA, VLT, VLTI, and JWST.

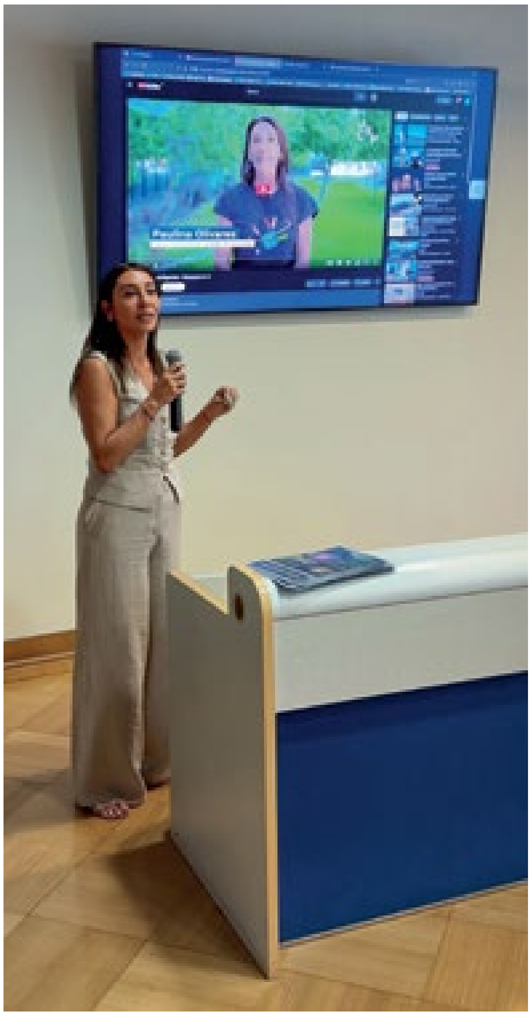
The organisation of the summer school was led by Pooneh Nazari, an ESO Fellow who was awarded an IAU–Gruber Foundation Fellowship in 2023. These fellowships, funded by the Gruber Foundation in conjunction with the International Astronomical Union, are awarded to extremely promising early-career researchers in astrophysics. Pooneh decided to use the 25 000 US dollars (approximately 22 000 euros) funding associated with her fellowship not only to organise this summer school, but also to offer summer research opportunities in 2024 and 2025 aimed at university students not yet enrolled in a PhD programme who were interested in gaining experience in astrophysical research.

Astronomy for all: supporting diversity, equity and inclusion in the astronomical community in Chile

Strengthening and supporting diversity, equity and inclusion (DEI) is not only a matter of broader social justice but also an essential aspect of delivering high-quality science. Fostering an inclusive astronomical community, with the diverse perspectives that this brings, helps ensure that the field can reach its full potential, driving both innovation and excellence.

In January 2025 a two-day workshop was held at the ESO premises in Vitacura and online, aimed at promoting DEI within the astronomical community based in Chile. It was organised by ESO in collaboration with other observatories based in Chile, and the Chilean astronomy community, including SOCHIAS. Its primary focus was on: raising awareness and assessing the current status of DEI within the community; sharing and evaluating existing initiatives and encouraging collective learning; discussing future directions and long-term strategies for DEI efforts with sustainable progress and measurable outcomes.

The Astronomy for All workshop, held at the ESO premises in Vitacura.



The Carina Nebula, a massive star-forming region in our galaxy, is seen here as the pink spot in the Milky Way just above one of the VLT's Auxiliary Telescopes on Paranal.

J. Looten/ESO

Fostering public interest in astronomy, science and engineering

Astronomy has a strong popular appeal, and its discoveries generate excitement and interest. ESO harnesses the public excitement for astronomy to increase society's understanding of and engagement with science and technology, and to inspire more children and young people to pursue science, technology, engineering and mathematics (STEM) fields.

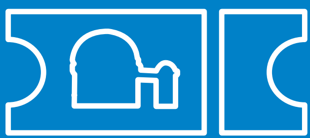
We share ESO's achievements and challenges in research, technology development and engineering with the world, highlighting also the people behind them. We tell our stories through many channels, including traditional and social media, public visit programmes at our observatory sites, conferences and outreach events and the ESO Supernova Planetarium & Visitor Centre, situated at the Garching Headquarters.

A particular focus of ESO's public outreach efforts in 2025 was in Chile, with emphasis on the importance of dark and quiet skies. For more about our outreach activities in Chile, see the ESO in Chile section, starting on page 43.

During 2025

Mentions of ESO in online media: over

33 000

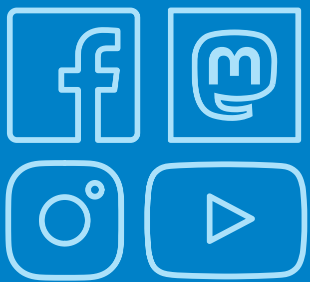


Members of the public, school students and teachers visiting our observatory sites: about

7000

Visitors to the ESO Supernova Planetarium & Visitor Centre: more than

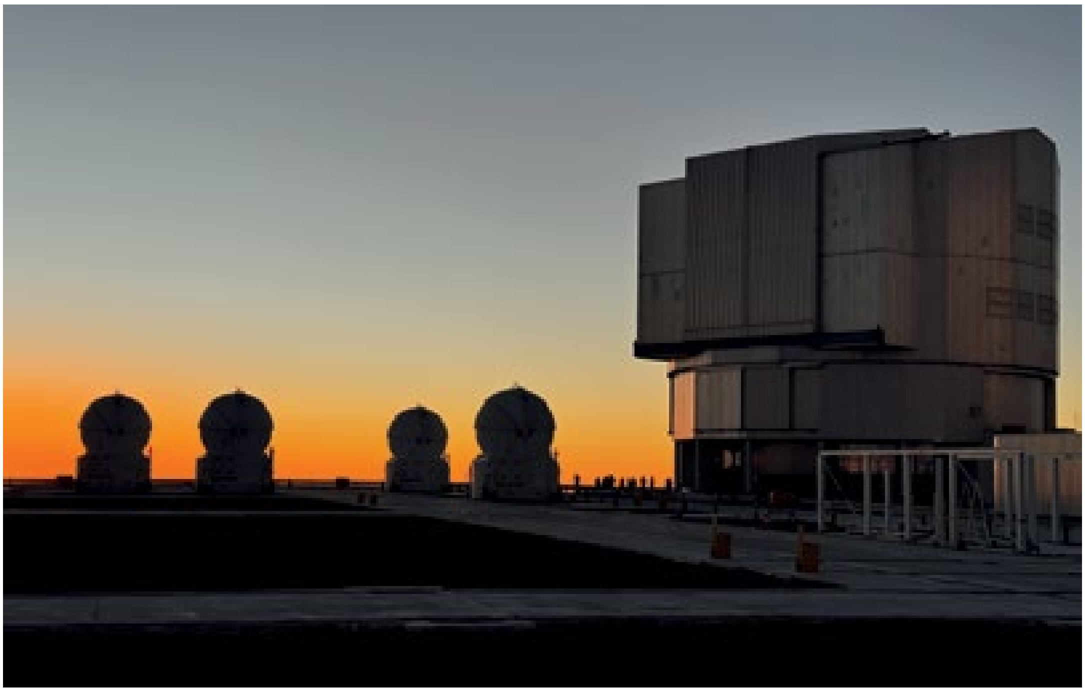
61 000



Followers of ESO social media channels: over

900 000

Keen media interest in the ELT and other activities in Chile



Journalists silhouetted against the sunset on the VLT observing platform at Paranal, on a group media visit to Paranal and Armazones in November 2025.

The strong interest from media around the world in the ELT, as well as ESO's other activities, continued in 2025, especially in the context of the threat posed by the proposed INNA project (see page 22 for more on this).

Throughout 2025 ESO hosted about 20 individual and group media visits to Paranal and the ELT site on Armazones. The visitors, who came from Chile, ESO Member States and elsewhere, included journalists, broadcasters, filmmakers, book authors and museum professionals, and they produced a wide range of material about ESO that has either been published already in the media or is part of ongoing projects that are in production.

One of the largest events was a group media visit in November, when ESO hosted 11 journalists from Belgium, Canada, Finland, Germany, Ireland, Italy, Poland and the United Kingdom at Paranal and Armazones. This visit alone led to extensive coverage across multiple media, including television, online video, radio and long-form articles, highlighting the progress of the ELT and the threat of light pollution.

Showcasing the ELT at the Open House Day of the German Federal Ministry of Research, Technology and Space

BMFTR/Hans-Joachim Rickel

Showcasing the ELT at the Open House Day of the German Federal Ministry of Research, Technology and Space in Berlin in August 2025.

The Open House Day of the German Federal Ministry of Research, Technology and Space took place in August 2025, at the ministry in Berlin. At the two-day public event, which was attended by over 8800 visitors, the ELT was showcased by ESO in collaboration with German representatives from the ESO Science Outreach Network (ESON) and partner institutes working on instrumentation for the ELT. ESON is a network of science communicators in ESO Member States and other countries, who act locally as ESO's media and outreach representatives. Thanks to this support from our partners, we were able to showcase the ELT with an exhibition stand, scale models of the ELT and instrumentation, video material and handouts, and the ELT Explorer — an immersive 3D experience that allows visitors to experience the observatory as though they are on Cerro Armazones themselves.

ESO Supernova helps reveal the impact of out-of-school learning

The ESO Supernova Planetarium & Visitor Centre participated in a research project, coordinated by the Technical University of Munich (TUM), which investigated the effect of ‘out-of-school learning’ field trips on the learning and motivation of high school students aged 10–16.

The TUMjunior project connected schools in the Munich area with out-of-school learning facilities, including the ESO Supernova, for STEM subjects. As part of the project, during 2024 and 2025 a total of 810 students from 31 school classes, aged around 13–14, came to the ESO Supernova.

Under the themes “Light, Shadows and Colours in the Universe” and “Lenses, Mirrors, Telescopes” the visiting students took part in an inquiry-based workshop on near-infrared wavelengths of light and on optics respectively, watched a specially created live planetarium show and made a tour of the exhibition. The visit to the ESO Supernova was complemented by pre- and post-visit lessons at school, designed in collaboration with teachers.

The students’ experiences were evaluated through questionnaires, which revealed that they found the visit and associated lessons interesting and wanted to learn more, that during the experience they felt they could solve even difficult questions and take actions autonomously, and that they could collaborate well with classmates.

The project demonstrated that such field trips, which are related to the curriculum and complemented by in-school activities, can have a positive effect on students’ motivation, social integration and academic self-efficacy.

Workshop experiment on near-infrared light: A bottle of cola drink, a houseplant, and a poster panel of the VLT are seen in visible light (left) and near-infrared light (right). In near-infrared light the cola is transparent, revealing the plant through it, and the print on the panel cannot be seen.

Cosmic Cinema and celebrating 100 years of the planetarium

2025 was the first full year of the Cosmic Cinema (*Kosmisches Kino*) events held in the ESO Supernova's planetarium, organised by ESO in collaboration with the Excellence Cluster ORIGINS. These are talks for non-experts, supplemented by breathtaking fulldome planetarium material, given by speakers from ESO and other institutes in the Garching and Munich area. The talks address exciting questions currently being explored by researchers: Is there a common thread linking the Big Bang to the origin of life? How do we measure radiation from space and its effects on humans? Where and how do planets and stars form? What is dark matter? What are the building blocks of life on Earth, and do they exist elsewhere in the Universe? During the year we hosted a total of ten such events, alternating between English and German, for over 1000 visitors.

2025 was also the 100th anniversary of the first planetarium opening to the public. As part of this worldwide celebration, the work of planetariums was recognised by the German UNESCO Commission as intangible cultural heritage. At the ESO Supernova we marked this centennial milestone with a dedicated "100 days of planetarium" campaign, with late-night openings and specially selected planetarium shows.

Cosmic Cinema (*Kosmisches Kino*) event at the ESO Supernova Planetarium & Visitor Centre.

ESO in Chile

P. Romaniuk/ESO

ESO's Extremely Large Telescope (ELT), under construction on Cerro Armazones, seen against a beautifully dark starry sky with the Milky Way.

In 1963 ESO and Chile signed a visionary agreement which paved the way for the construction of the La Silla Observatory, ESO's first observatory site. The ongoing spirit of trust and cooperation stemming from this agreement, and the successes that began with La Silla, have led ESO to build and operate some of the most powerful observatories on the planet in Chile, building a unique and deeply valued relationship with the country.

In addition to delivering scientific discoveries about the Universe, ESO's observatories stimulate local development, generate business opportunities, and play a role in training new generations of scientists and engineers. ESO has had a direct and tangible impact on the development of astronomy in Chile, which has grown in scale and prestige. The country has become a world-class option for studying and working in fields directly or indirectly related to astronomy and ESO is proud to have contributed to this development.

ESO is glad to contribute to Chile through outreach and education initiatives, including visits to the observatories, offering opportunities to regional and local communities to engage with the unique natural heritage of the dark skies in the country, and the world-leading science that this makes possible. We are especially glad to collaborate with local partners in the Antofagasta and Coquimbo regions, where ESO's observatories are sited, and the Metropolitan region, home to our premises in Vitacura, Santiago. We actively engage with local and national media to share the latest news and results from the telescopes and the excitement of scientific discovery.

A major focus during 2025 was on efforts to protect the uniquely dark and quiet skies that have made Chile a centre for world-class astronomy. For more information about ESO's mission to protect dark and quiet skies see page 22, including the campaign to safeguard the skies over Paranal from the proposed INNA industrial megaproject. Throughout the year, we raised public awareness of this important topic as part of our ongoing public outreach activities.

Celebrating the Day of Astronomy in Chile

ESO celebrated the Day of Astronomy in Chile by organising and participating in events on and around the official date of 21 March. On the Day of Astronomy itself ESO and ALMA, together with their international partners, held an Open House Day on the premises in Vitacura to welcome people of all ages and share astronomical activities. The morning was dedicated to school visitors and the afternoon to the general public.

Additional events in March included the Astro Concert at the Huechuraba Planetarium in Santiago, which was so successful that two sessions were held on the same day, an ELT exhibition and talk at the Antofagasta Library, participation in the Astro Day in Coquimbo, and special tours of Paranal, with buses bringing visitors directly from Antofagasta and Taltal.

Fundación Cielos de Chile

Fundación Cielos de Chile

Activities at the ESO–ALMA Open House Day in Vitacura on 21 March 2025.

Outreach and regional relations in the Antofagasta Region

ESO continued to engage with the public and other stakeholders in the Antofagasta Region, where Paranal and ALMA are located. In addition to the Day of Astronomy activities described opposite, and the regional Joint Committee initiatives described on page 49, we present here a selection of other highlights from the region.

Puerto de Ideas Science Festival

In April ESO once again took part in the Puerto de Ideas Antofagasta Science Festival, one of the country's most significant science events. The 2025 festival featured more than 100 activities in astronomy and other fields, including engineering, robotics, mathematics, biodiversity, oceanography, volcanology, artificial intelligence and art.

ESO's contribution included talks on the construction of the ELT and the dark, pristine skies where it is located, as well as — for the first time during the festival — a guided tour to experience the sunset and the opening of the telescopes at the Paranal Observatory.

ESO activities at the 2025 Puerto de Ideas Antofagasta Science Festival.

Night tour to Paranal for Chilean Heritage Day

On 24 May 2025 ESO organised a special night tour to Paranal for people from the community of Taltal to celebrate Chilean Heritage Day. This was an opportunity for us to offer people in the local community near Paranal a first-hand way to experience the uniquely dark night skies over Paranal, the science it enables and the importance of protecting it. The visitors left extremely impressed, and local media covered the activity in almost 20 press articles. In an interview before the celebrations, the Under-secretary for Cultural Heritage of Chile, Carolina Perez Dattari, highlighted the tour as her top pick among 3500 nationwide activities.

University of Antofagasta Day 2025 at ESO

Participants in the 2025 University of Antofagasta Day at the ESO premises in Vitacura.

The 2025 "University of Antofagasta Day", organised by ESO and the university, took place at the ESO premises in Vitacura in November. The event, part of an ongoing partnership agreement between the university and ESO, brought together students and researchers from the university's Center for Research, Technology, Education and Astronomical Outreach (CITEVA) with teams from ESO to foster collaboration and strengthen the development of astronomy and related sciences in the Antofagasta Region.

Collaboration agreement between ESO and the Regional Government of Antofagasta

Another highlight was the signature in March at Paranal of a memorandum of understanding between the Regional Government of Antofagasta and ESO for the joint promotion of regional astronomical initiatives. The agreement supports collaboration in fostering the scientific and astronomical development of the Region through research, advisory, training, education and outreach.

Astrophotography workshop for the anniversary of Taltal

On 23 July 2025, as part of a visit to Paranal and Armazones, world-renowned astrophotographer Cari Letelier organised an astrophotography workshop at Paranal for people from Taltal, on the occasion of the anniversary of the municipality. The workshop demonstrated techniques and tips for taking nighttime photography, in the context of raising awareness of the need to protect the night skies. During her time at Paranal and Armazones, Cari also captured dramatic images of the VLT and ELT against the night sky.

C. Letelier/ESO

The ELT against a dramatic night sky and the band of the Milky Way, captured by astrophotographer Cari Letelier.

Technology Development in Chile in the ELT Era

ESO and Chile's National Research and Development Agency (*Agencia National de Investigación y Desarrollo*, ANID) held a workshop at the ESO premises in Vitacura in August to exchange ideas for future development of Chilean astronomical engineering projects related to the Extremely Large Telescope. The event brought together stakeholders from universities, research institutes and industry.

It was held as part of the 2021 scientific and technological cooperation agreement between ESO and the Government of Chile, through ANID, for the construction and operation of the ELT. This agreement supports the development in Chile of highly specialised scientific and technical expertise in instrumentation and technologies related to astronomy. Under the agreement, ESO and ANID jointly fund projects for the development of ELT-related technologies, as part of ANID's IDeA funding scheme for applied R&D projects. ESO provides the funds each year for up to two 2-year positions for scientific, technical or engineering personnel working at Paranal or at institutions selected by ANID. The event also served as a kick-off for the 2026 IDeA call for proposals.

At the workshop, two projects from the 2024 round of the IDeA scheme were presented. One was to develop predictive maintenance solutions for the rotation transmission mechanism that drives the movement of the ELT dome, and the other was to develop upgrades to the motor control systems of the SPHERE instrument on the VLT.

Working on upgrades to the motor control systems of the VLT instrument SPHERE, a project funded by the IDeA scheme, at the Universidad de La Frontera in Temuco, Chile.

Joint Committee projects funded in 2025

The Joint Committee of ESO and the Government of Chile provides funds to promote cooperation with Chile, the Host State of our observatories, in areas related to astronomy, technology and scientific culture in the country. Every year delegates from ESO together with Chilean authorities jointly evaluate and select a number of eligible programmes to be supported by this fund.

In 2025 the Joint Committee funded 16 projects in the national call, out of a total of 98 eligible proposals received, distributing more than 600 million Chilean pesos (approximately 600 000 euros) to a wide range of initiatives across the country. Among the funded projects were seven in astronomy education and dissemination and six supporting astronomical postdoctoral programmes and technology development projects in Chilean institutions.

In addition to the national call, a regional funding call took place for the fifth time, organised jointly with support from ESO, the national Chilean Government and the regional governments of Antofagasta and Coquimbo. In 2025 308 million pesos (approximately 300 000 euros) were distributed among 14 winning projects, benefiting communities in both regions. In the Antofagasta region, several initiatives were funded which benefit the Taltal community. One project, led by a group from the Juan Cortés-Monroy Cortés school in Taltal, involves secondary students recording the brightness of the night sky in their local area using sensors to measure sky quality, giving them a practical introduction to scientific work and the protection of their environment. Through this fieldwork and sharing their findings at community events, the students will not only enhance their education but also help raise local awareness of the importance of using artificial lighting responsibly and protecting the dark skies of northern Chile.

In the Coquimbo region, one of the projects supports ten local astro-tourism businesses through training sessions and educational materials for their visitors, strengthening their role as ambassadors for the area's dark skies. This will help them convey the importance of caring for the night sky and promoting responsible tourism, and will reinforce the cultural, natural and scientific value of this unique heritage for the local community and the country.

The Joint Committee is composed of representatives from ESO, the Chilean Ministry of Foreign Affairs and the Chilean Ministry of Science, Technology, Knowledge, and Innovation, plus (for the national call) the Chilean Astronomical Society and (for the regional call) the regional governments of Coquimbo and Antofagasta.

Allocation of telescope time

Observing time is among ESO's most precious resources, and access to ESO's telescopes is highly sought after by a world-leading community of astronomers. Researchers submit proposals for observing projects to address specific scientific objectives, and each year many times more observing time is requested than is available. Projects are therefore selected through a competitive process in which the proposals are peer-reviewed by experts from the community.

ESO/E. Congiu et al.

The Sculptor Galaxy, captured with the MUSE instrument on ESO's Very Large Telescope (VLT). The pinkish areas spread throughout the galaxy indicate light from ionised hydrogen in star-forming regions.

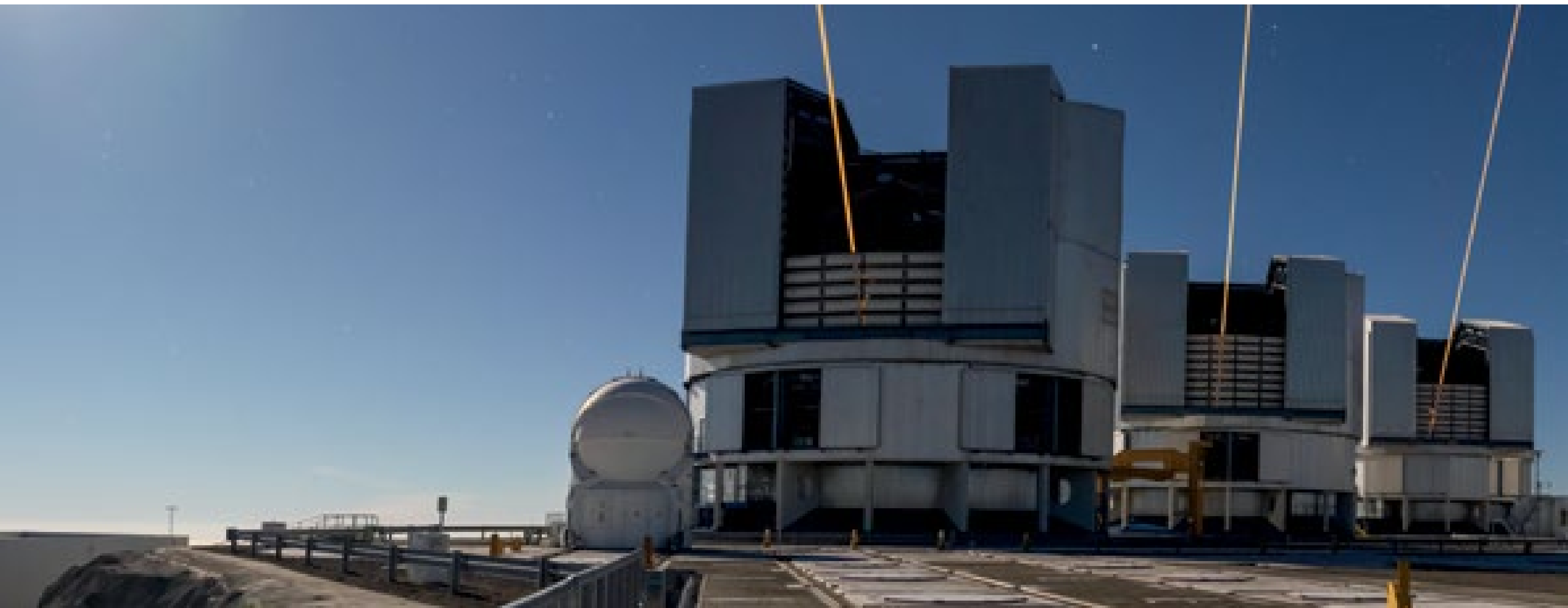
La Silla Paranal Observatory

The numbers of proposals submitted to ESO in 2025 for observations to be executed at the La Silla Paranal Observatory in Periods 116 (1 October 2025 to 30 April 2026) and 117 (1 May 2026 to 30 April 2027; the first yearly cycle) were 913 and 1285, respectively. Large Programmes (LPs) were offered only in Period 117.

Period 117 marks the change from the traditional six-monthly calls for proposals to yearly calls. The change follows the recommendations of ESO's Time Allocation Working Group. It reduces the total number of proposals that need to be reviewed per year, by removing the need for two identical proposals to be submitted and reviewed to cover a full annual cycle. The time requested for the year-long Period 117 was approximately double that in a six-month period, as expected, and the pressure on the telescopes remained roughly constant, while the number of proposals increased by only about 40% compared to a traditional six-month period. The use of yearly calls also follows that of other larger astronomical facilities, including ALMA.

The table on the right shows the requested and scheduled observing time (in units of hours) in the two observing periods combined. Ongoing LPs and Monitoring Programmes approved in previous periods, Director's Discretionary Time, Guaranteed Time Observations Programmes and Public Surveys are not included. The pressure is computed as the ratio of the requested and the scheduled time. The last two columns show the total telescope time allocations (this time including the ongoing LPs approved in previous periods and other categories listed above) and the fractions per instrument. Some columns may not sum exactly to the total shown, owing to rounding effects. The Incoherent Combined Coudé Focus (ICCF) is listed separately and presents the statistics for ESPRESSO in the 1-Unit-Telescope (UT) and 4-UT modes. In the requested time, the ESPRESSO-1UT time does not formally correspond to any specific UT and is all counted under ICCF-1UT. The allocated time reflects the final schedule, which is constructed considering the loads on the different UTs.

Four lasers at Paranal, one launched from each of the four VLT Unit Telescopes. Having laser guide star units on all four Unit Telescopes is a major milestone for the GRAVITY+ project and the VLT Interferometer (VLTI).



Allocation of telescope time for the La Silla Paranal Observatory

Telescope	Instrument	Requested time (hours)	%	Scheduled time (hours)	%	Pressure	Total allocation (hours)	%
UT1	FORS2	6002	76.6%	1084	80.5%	5.54	1231	47.9%
	KMOS	1832	23.4%	112	8.3%	16.38	1188	46.2%
	ESPRESSO1			151	11.2%		151	5.9%
Total		**7834**	**100.0%**	**1347**	**100.0%**	**5.82**	**2570**	**100.0%**
UT2	FLAMES	2440	30.4%	478	19.0%	5.11	478	17.5%
	UVES	5430	67.6%	949	37.7%	5.72	1036	38.0%
	VISIR	158	2.0%	48	1.9%	3.32	48	1.7%
	ESPRESSO2			1042	41.4%		1164	42.7%
Total		**8027**	**100.0%**	**2516**	**100.0%**	**3.19**	**2725**	**100.0%**
UT3	CRIRES	2524	22.1%	303	11.9%	8.34	303	11.2%
	SPHERE	1590	13.9%	325	12.8%	4.89	325	12.0%
	X-SHOOTER	7307	64.0%	1606	63.2%	4.55	1769	65.4%
	ESPRESSO3			308	12.1%		308	11.4%
Total		**11420**	**100.0%**	**2541**	**100.0%**	**4.49**	**2704**	**100.0%**
UT4	ERIS	2755	22.8%	246	16.0%	11.22	801	34.8%
	HAWK-I	779	6.4%	139	9.0%	5.62	171	7.4%
	MUSE	8553	70.8%	1151	75.0%	7.43	1328	57.7%
	ESPRESSO4			0	0.0%		0	0.0%
Total		**12087**	**100.0%**	**1535**	**100.0%**	**7.87**	**2300**	**100.0%**
ICCF	ESPRESSO-1UT	8386		1501			1622	
	ESPRESSO-4UT	55		0			0	
VLTI	GRAVITY	3496	74.9%	1170	70.7%	2.99	1460	71.4%
	MATISSE	809	17.3%	352	21.2%	2.30	452	22.1%
	PIONIER	362	7.8%	133	8.0%	2.73	133	6.5%
Total		**4667**	**100.0%**	**1654**	**100.0%**	**2.82**	**2045**	**100.0%**
3.6-metre	HARPS	4599	72.1%	1693	68.7%	2.72	1833	40.5%
	NIRPS	1784	27.9%	772	31.3%	2.31	2698	59.5%
Total		**6383**	**100.0%**	**2465**	**100.0%**	**2.59**	**4530**	**100.0%**
NTT	EFOSC2	1667	55.3%	1578	59.7%	1.06	1578	52.6%
	ULTRACAM	1347	44.7%	1067	40.3%	1.26	1421	47.4%
Total		**3014**	**100.0%**	**2645**	**100.0%**	**1.14**	**3000**	**100.0%**


A. Berdeu/ESO

ALMA

The ALMA Cycle 12 Call for Proposals (covering the period from October 2025 to September 2026) resulted in 1640 proposals, including 43 LPs, worldwide. Of the 1597 non-LP proposals, 570 had Principal Investigators (PIs) from an ESO Member State. Of the 43 LPs, 39 had a PI or co-PI from an ESO Member State. The proposal review process used Distributed Peer Review for all proposals except LPs. Dual-anonymous reviewing was employed, independent of proposal type.

The table below shows the total number of proposals submitted and the total requested time per array type (12-metre, 7-metre and Total Power). For the 12-metre Array, the requested and scheduled (priority A and B) time is also shown per ALMA frequency band, and separately for the community in the ESO Member States and the rest of the world. The statistics for the number of proposals per band are not given since one proposal may request more than one band. The pressure is defined as the number of hours requested divided by the number of hours scheduled in priority A and B. Some columns may not sum exactly to the total shown, owing to rounding effects.

Allocation of telescope time for ALMA

	Number of proposals	Requested time (hours)			Band	Requested 12-metre time (hours)		Scheduled 12-metre time (hours)		Pressure	
		12-m	7-m	Total power		All	ESO	All	ESO	All	ESO
ALMA	1640	30109	16560	11271	1	1706.0	593.5	274.2	63.3	6.2	9.4
					3	4775.5	2051.6	523.2	169.1	9.1	12.1
					4	1767.4	756.5	185.4	58.2	9.5	13.0
					5	1287.6	361.6	58.1	4.3	22.2	84.1
					6	9330.3	3070.1	1609.3	491.0	5.8	6.3
					7	8718.5	3544.2	1217.4	515.2	7.2	6.9
					8	1577.2	572.3	137.7	58.4	11.5	9.8
					9	614.9	250.8	84.7	14.9	7.3	16.8
					10	331.9	74.0	92.8	11.4	3.6	6.5
Total						**30109.1**	**11274.6**	**4182.7**	**1385.8**	**7.2**	**8.1**

ALMA antennas on the Chajnantor plateau, 5000 metres above sea level.

Y. Villalon/ESO

The Extremely Large Telescope

ESO's Extremely Large Telescope, or ELT for short, is a revolutionary ground-based telescope that will be the largest visible- and infrared-light telescope in the world. The ELT is situated on Cerro Armazones, at an altitude of 3046 metres in Chile's Atacama Desert. It is currently under construction and will become operational later this decade.

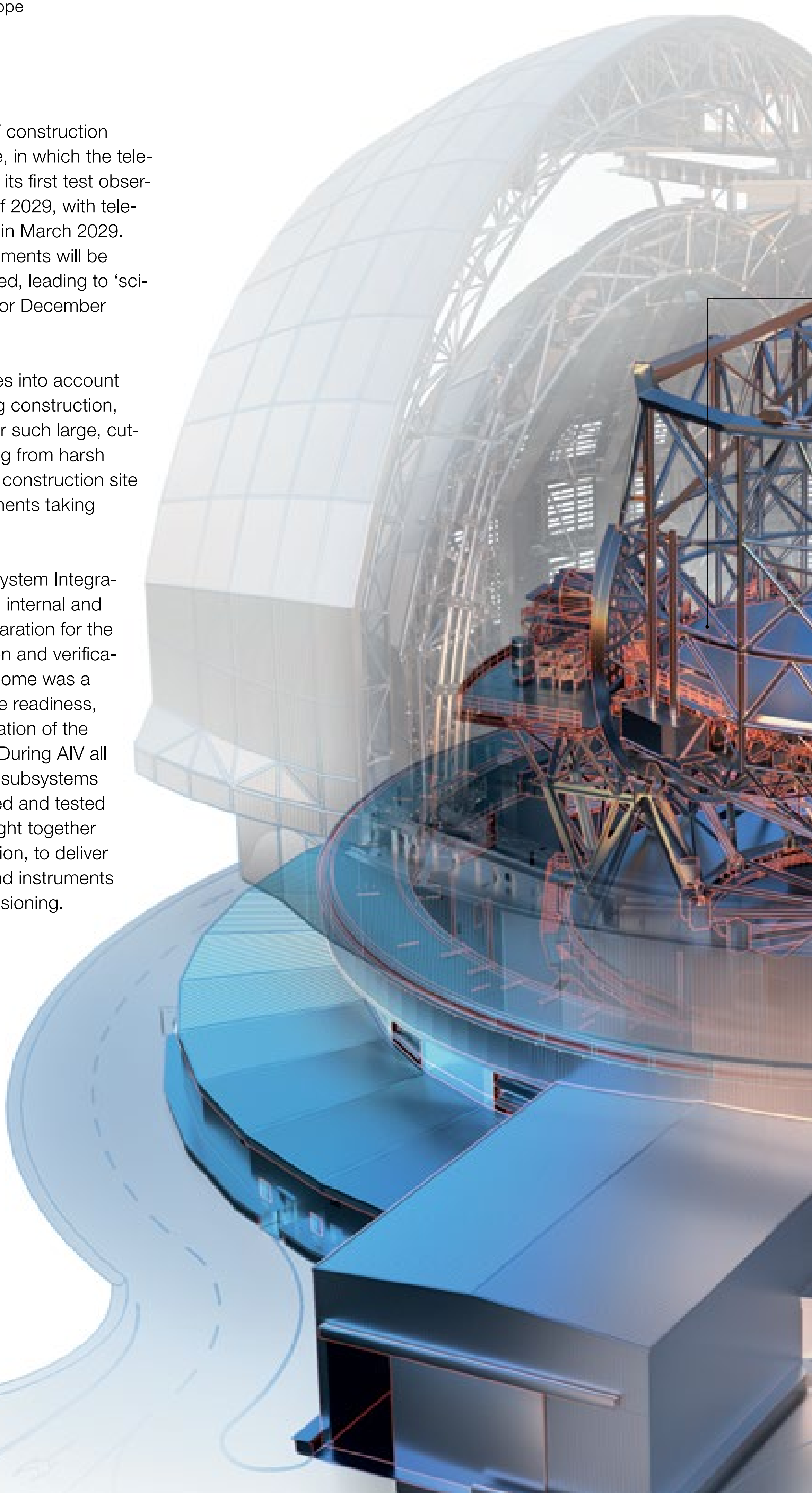
A full Moon rises behind the ELT on Cerro Armazones on 13 March 2025.

J. Beltrán/ESO

In March, an updated ELT construction schedule was put in place, in which the telescope is now set to make its first test observations at the beginning of 2029, with telescope first light expected in March 2029. Afterwards, the first instruments will be installed and commissioned, leading to ‘scientific first light’ planned for December 2030.

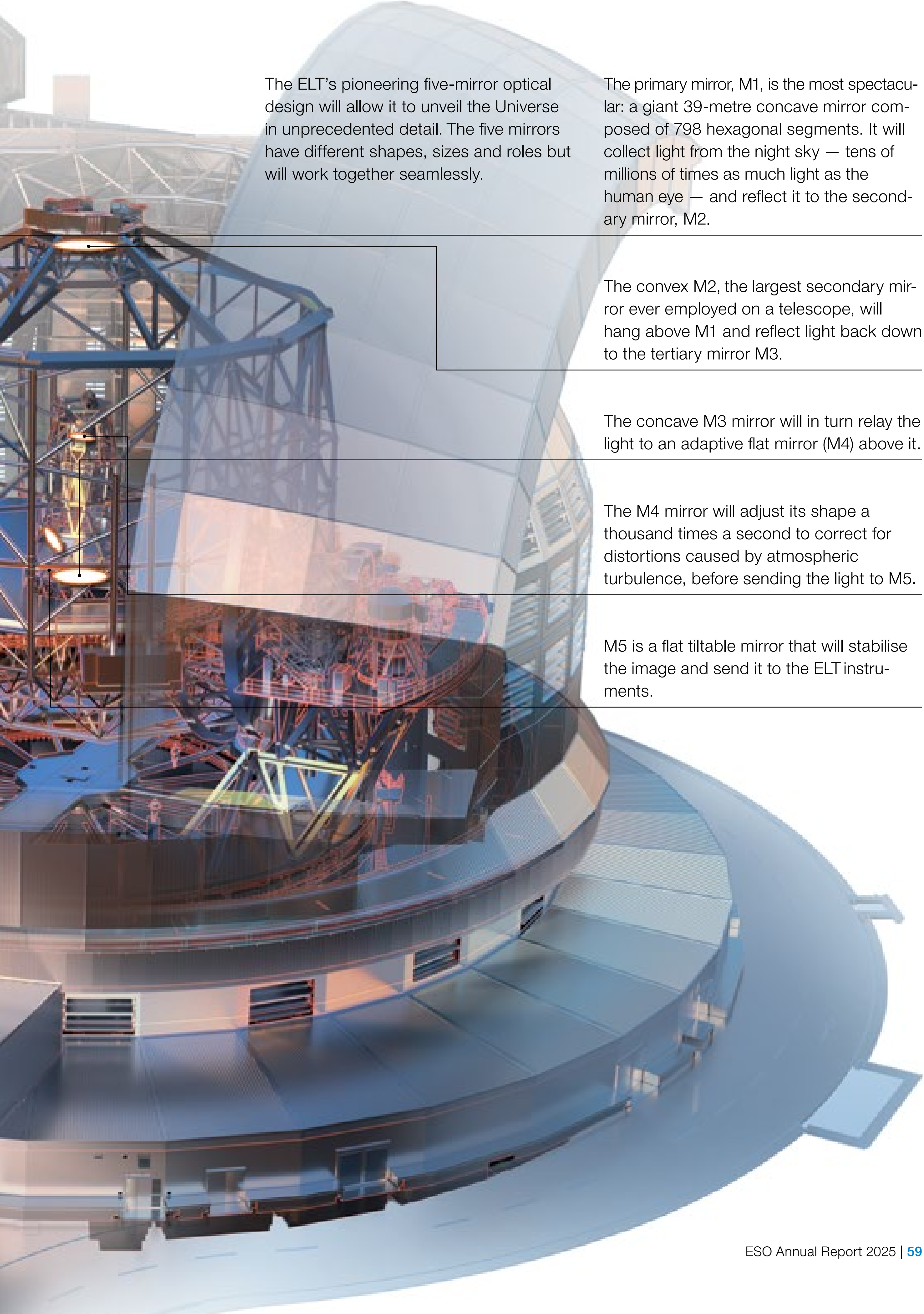
The revised schedule takes into account delays experienced during construction, which are not untypical for such large, cutting-edge projects, ranging from harsh weather conditions at the construction site to technological developments taking longer than expected.

At the end of October a System Integration Review was held with internal and external reviewers in preparation for the ELT’s assembly, integration and verification (AIV) phase. The outcome was a positive assessment of the readiness, robustness and risk-mitigation of the plans for this vital phase. During AIV all the ELT components and subsystems will be assembled, installed and tested on-site by ESO staff brought together from across the organisation, to deliver a completed telescope and instruments ready for science commissioning.



A list of industrial and institutional partners working on ELT construction can be found at https://elt.eso.org/about/industrial/

The ELT’s pioneering five-mirror optical design will allow it to unveil the Universe in unprecedented detail. The five mirrors have different shapes, sizes and roles but will work together seamlessly.



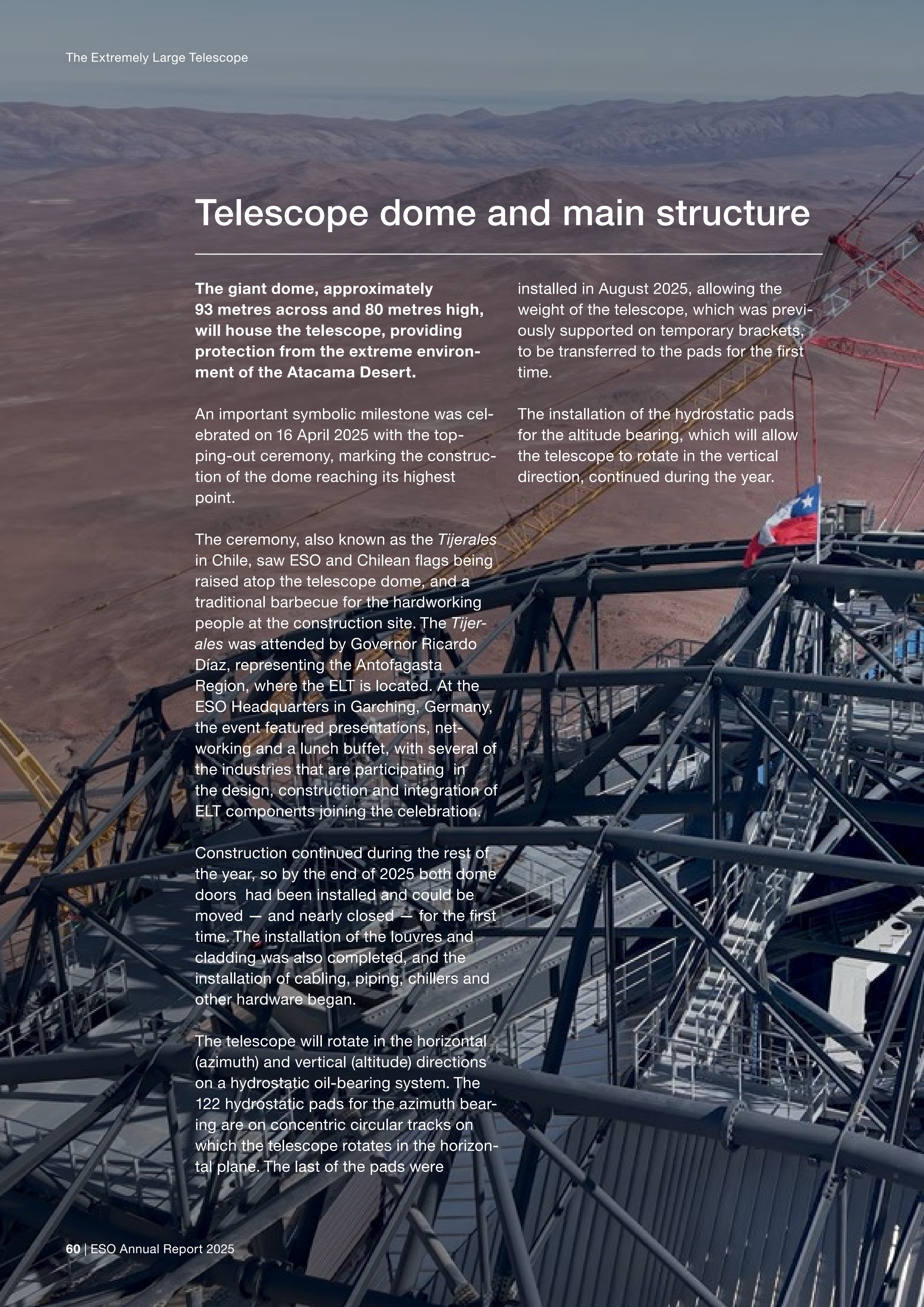
The primary mirror, M1, is the most spectacular: a giant 39-metre concave mirror composed of 798 hexagonal segments. It will collect light from the night sky — tens of millions of times as much light as the human eye — and reflect it to the secondary mirror, M2.

The convex M2, the largest secondary mirror ever employed on a telescope, will hang above M1 and reflect light back down to the tertiary mirror M3.

The concave M3 mirror will in turn relay the light to an adaptive flat mirror (M4) above it.

The M4 mirror will adjust its shape a thousand times a second to correct for distortions caused by atmospheric turbulence, before sending the light to M5.

M5 is a flat tiltable mirror that will stabilise the image and send it to the ELT instruments.



Telescope dome and main structure

The giant dome, approximately 93 metres across and 80 metres high, will house the telescope, providing protection from the extreme environment of the Atacama Desert.

An important symbolic milestone was celebrated on 16 April 2025 with the topping-out ceremony, marking the construction of the dome reaching its highest point.

The ceremony, also known as the *Tijerales* in Chile, saw ESO and Chilean flags being raised atop the telescope dome, and a traditional barbecue for the hardworking people at the construction site. The *Tijerales* was attended by Governor Ricardo Díaz, representing the Antofagasta Region, where the ELT is located. At the ESO Headquarters in Garching, Germany, the event featured presentations, networking and a lunch buffet, with several of the industries that are participating in the design, construction and integration of ELT components joining the celebration.

Construction continued during the rest of the year, so by the end of 2025 both dome doors had been installed and could be moved — and nearly closed — for the first time. The installation of the louvres and cladding was also completed, and the installation of cabling, piping, chillers and other hardware began.

The telescope will rotate in the horizontal (azimuth) and vertical (altitude) directions on a hydrostatic oil-bearing system. The 122 hydrostatic pads for the azimuth bearing are on concentric circular tracks on which the telescope rotates in the horizontal plane. The last of the pads were installed in August 2025, allowing the weight of the telescope, which was previously supported on temporary brackets, to be transferred to the pads for the first time.

The installation of the hydrostatic pads for the altitude bearing, which will allow the telescope to rotate in the vertical direction, continued during the year.

The ESO and Chilean flags fly atop the ELT's dome, as part of the topping out ceremony (known as *Tijerales* in Chile) on 16 April 2025.

ESO/CHEPOX

M1 primary mirror

The ELT's primary mirror has a diameter of 39 metres. Too large to be made from a single piece of glass, it is composed of 798 hexagonal segments, each 1.45 metres across and 5 centimetres thick. Each segment assembly, including support structure, weighs 250 kg.

To achieve the required scientific performance, the mirror needs to be held 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, despite the effects of wind, gravity and changing temperature.

The polishing of the mirror segment blanks and their integration with the supports to make the M1 segment assemblies is ongoing, at a rate of about five segments per week.

By the end of the year a total of 342 of the completed segment assemblies had made the 10 000-kilometre journey from Europe to Chile, where they are given their reflective coating before being stored at the ELT Technical Facility at Paranal.

Mirror washing and coating

Of the 342 M1 mirror segment assemblies delivered to the site, 298 had received their reflective coating by the end of 2025. The coating is done at the ELT Technical Facility (ETF) at Paranal using a pair of coating plants designed for the M1 segments.

The segments will also need to be washed and have their coatings stripped before recoating, as part of regular maintenance when the ELT is in operation. The M1 Washing and Stripping Plant passed its factory acceptance tests in February and was shipped to Chile, where it was successfully commissioned and tested on-site at the ETF.

Meanwhile, the Large Coating Plant, which will be used to coat the larger M2, M3, M4 and M5 mirrors, passed its factory acceptance tests in March and was also shipped to the ETF, where it was installed and commissioned in August.

Inspecting mirror samples on the dummy M5 mirror during commissioning of the ELT's Large Coating Plant.

Phasing and diagnostic station

Once they are installed, all 798 segments will be positioned in the ideal shape to act as one single mirror — a process called phasing — by a phasing and diagnostic station (PDS) that will test the telescope before and during operation. The PDS was designed and is being manufactured internally at ESO.

By the end of 2025 almost all of the PDS optics had been delivered and all the mechanical subsystems had been assembled. Integration of the elements of the PDS started in the Large Integration Hall at the ESO HQ.

The mechanical structure of the ELT Phasing and Diagnostic Station is lowered into position in the Large Integration Hall at ESO Headquarters.

ESO/G. Vecchia

M2 mirror and M3 mirror

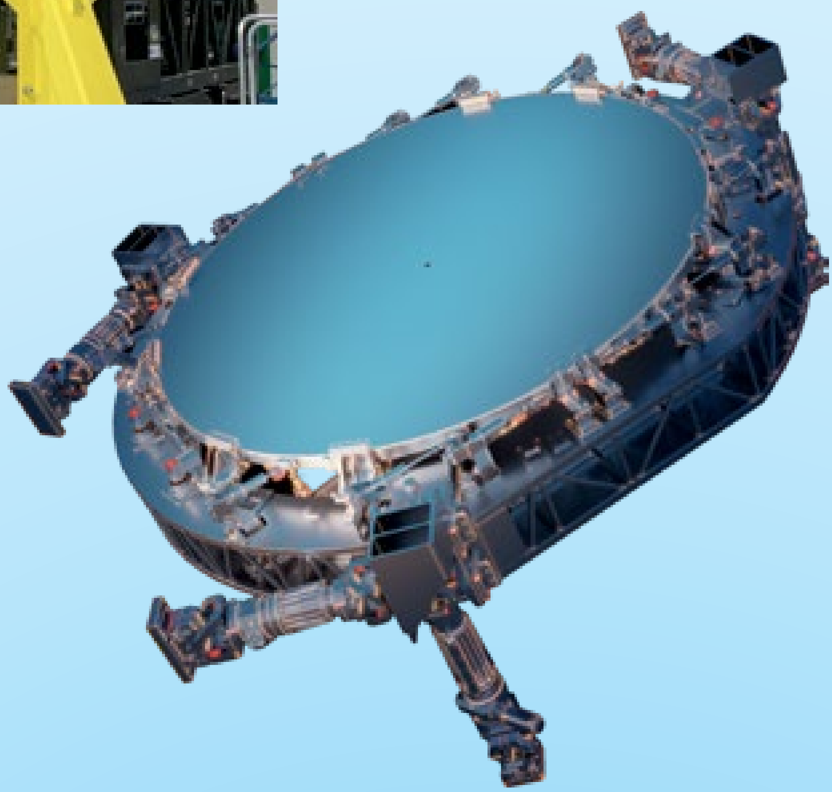
The ELT's 4.25-metre-diameter secondary mirror is the largest convex mirror ever produced. It will reflect light collected by M1 to the tertiary mirror M3, a 4-metre-diameter concave mirror. The three curved mirrors will allow the ELT to deliver a better image quality over a larger field of view than would be possible otherwise.


SAFRAN

Removal of the M2 mirror from its cell at Safran Reosc.

The M2 mirror reached some key milestones in 2025. In January the polished mirror passed its technical tests. The mirror was integrated with its support cell in April for system tests, in which the optical performance of the mirror in its cell was tested. These tests were successfully completed in September. After this, the mirror was removed from the support cell, cleaned, inspected, and packed in its container in November. It is now ready for shipment to Chile. Meanwhile, separate assembly, integration and testing of the support cell resumed.

The grinding of the M3 mirror was completed in May and the polishing of the mirror began, already achieving a high initial quality of the mirror shape.



Artist's impression of the ELT's M3 mirror and cell.

M4 mirror

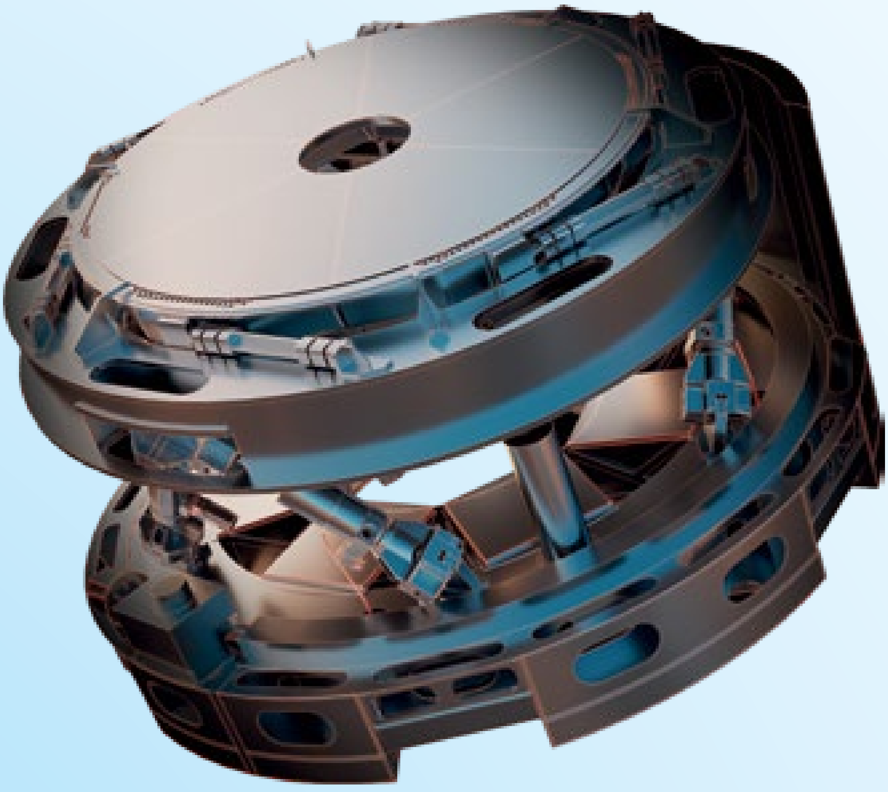
The M4 mirror's surface can be distorted and adapted to correct for atmospheric turbulence and the residual vibration of the telescope itself, allowing for the delivery of the sharp images needed for science. With a diameter of 2.4 metres, it is the largest deformable mirror ever made.

Adoptica-Microgate

M4 Unit, equipped with an 'engineering shell'.

The mirror is an assembly of six thin shells, each forming a sector of the circular mirror. The shells are only 1.95 mm thick, allowing about 5000 voice-coil actuators to push and pull the entire mirror like the surface of a loudspeaker, adjusting its shape up to 1000 times per second.

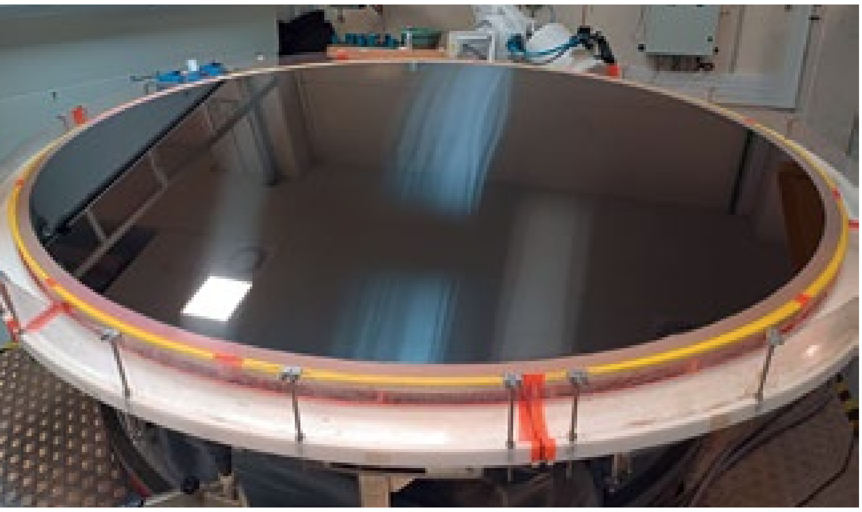
The M4 unit is in the assembly, integration and testing phase. During 2025 a dummy shell — referred to as an 'engineering shell' — was installed on each of the six shell positions in the M4 unit, testing the integration procedure that will be used for the final shells.



Artist's impression of the ELT's M4 mirror and cell.

M5 mirror

Together with M4, M5 is a crucial component of the ELT's adaptive optics system. Its precise tip and tilt movements will ensure images are stabilised before they reach the ELT instruments. The mirror therefore must be very light and very rigid, and will be made of silicon carbide, a material with exceptional mechanical and thermal stability. M5 will be a flat, elliptical mirror measuring 2.7 by 2.2 metres, constructed from six lightweight 'petal' segments brazed together. It will be the biggest tip-tilt mirror ever employed in a telescope.



SAFRAN

The M5 mirror assembly on its polishing stand.

The initial grinding of the M5 mirror blank — the shaped piece of material that is polished to become the mirror — took place in the first half of 2025 and the first polishing and lapping runs took place in August and September, followed by optical interferometric measurements to check the mirror's surface shape. The polishing was ongoing at the end of 2025. Once the polishing is complete, the surface of the mirror will be accurate to less than a hundredth of the width of a human hair.

Such a large silicon-carbide mirror, with such strict polishing requirements, has never been produced before and several risks remain during the process.

As part of the mitigation for these risks, a spare silicon-carbide M5 blank is being produced. The six petals for this spare have already been manufactured. During 2025 a new recipe was tested for the thin layer of amorphous silicon carbide that forms the polishable optical surface on the petals, which is applied using chemical vapour deposition. The tests showed a significant reduction in internal mechanical stress and so the six spare petals were coated with this improved recipe. First tests were also performed on a new material for brazing the spare petals together, with initial results demonstrating a significantly increased brazing joint strength and reduced internal stress.

A further risk mitigation is the production of a smaller, glass-ceramic backup mirror, which would be used to start commissioning the telescope if the silicon carbide M5 was not yet ready. The blank for this ‘M5 commissioning mirror’ is currently in storage, ready to be sent for polishing.

The M5 mirror support cell successfully passed its control system tests at ESO Garching, with a dummy mirror, and is now ready for packing and shipment to Chile.

The M5 mirror support cell operating in the Large Integration Hall at ESO Headquarters.

Artist’s impression of the ELT’s M5 mirror.

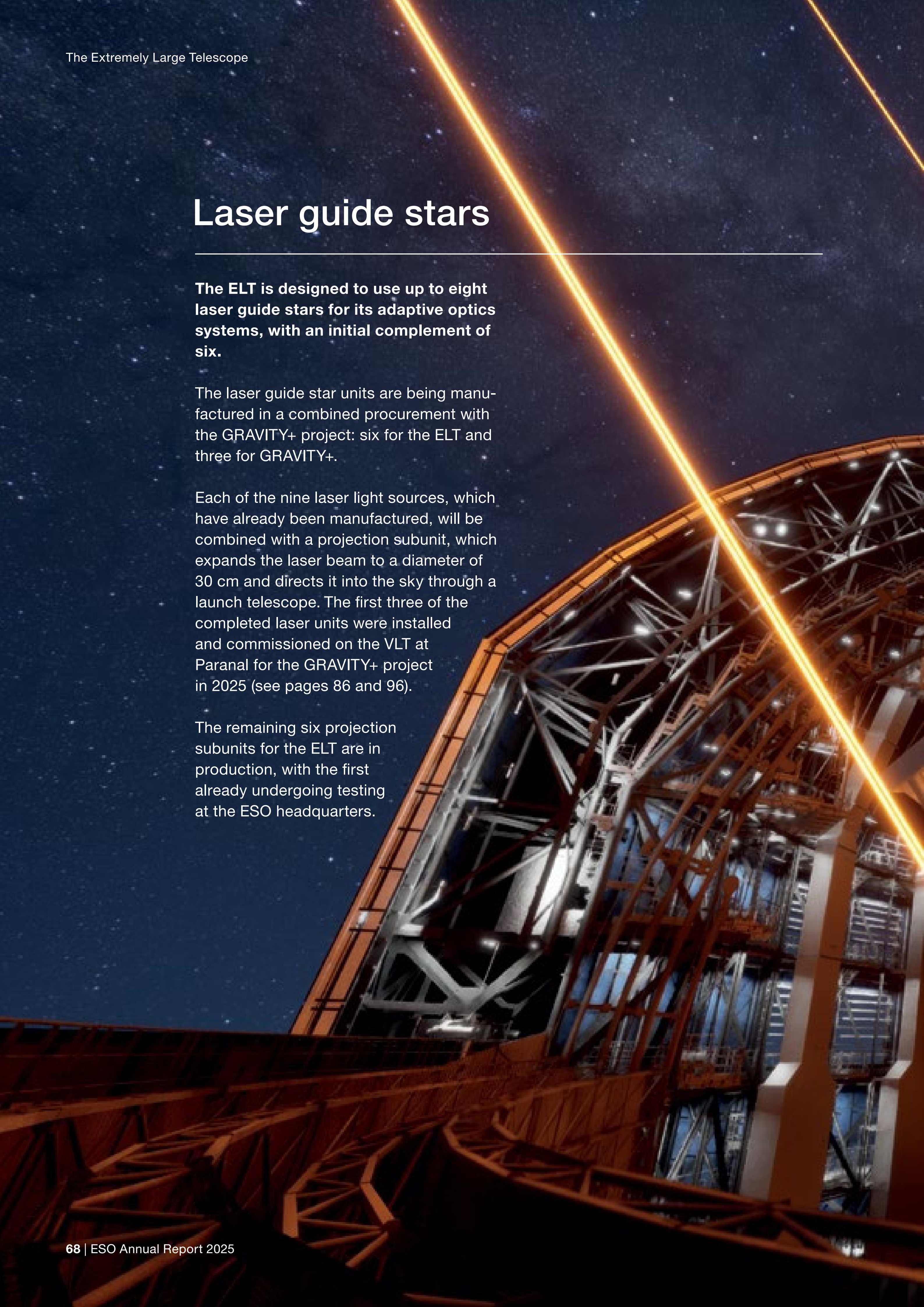
Laser guide stars

The ELT is designed to use up to eight laser guide stars for its adaptive optics systems, with an initial complement of six.

The laser guide star units are being manufactured in a combined procurement with the GRAVITY+ project: six for the ELT and three for GRAVITY+.

Each of the nine laser light sources, which have already been manufactured, will be combined with a projection subunit, which expands the laser beam to a diameter of 30 cm and directs it into the sky through a launch telescope. The first three of the completed laser units were installed and commissioned on the VLT at Paranal for the GRAVITY+ project in 2025 (see pages 86 and 96).

The remaining six projection subunits for the ELT are in production, with the first already undergoing testing at the ESO headquarters.

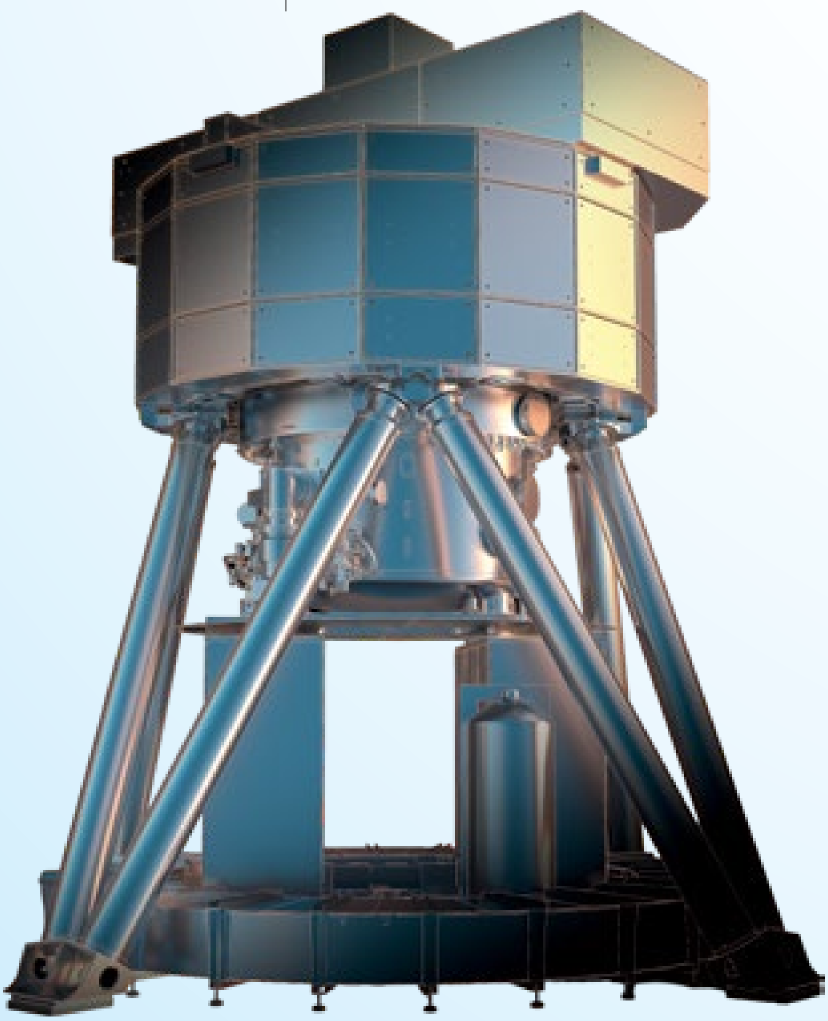


Instruments for the ELT

MICADO

MICADO, the Multi-AO Imaging Camera for Deep Observations, is a near-infrared camera that will take high-resolution images of the Universe, making it ideal for identifying exoplanets, and also for resolving individual stars in other galaxies and investigating the centre of the Milky Way.

Artist's impression of the ELT instrument MICADO.



The instrument is currently in its manufacturing and assembly phase. Much work was done during the year on hardware manufacturing, testing and software development for the instrument. MICADO's cryostat, in which the instrument's optics and detectors will be cooled with liquid nitrogen to a temperature of –190 °C so they can work effectively at infrared wavelengths, was successfully tested and accepted. Good progress was also made on the mechanics and optics.

M. Harlander/ESO

The MICADO cryostat is carefully lowered by crane into the integration hall at the Max Planck Institute for Extraterrestrial Physics.

Read more about MICADO, including consortium members, at https://elt.eso.org/instrument/MICADO/

METIS

METIS — the Mid-infrared ELT Imager and Spectrograph — combines a powerful spectrograph and a high-contrast imager, both operating in the infrared. This two-in-one instrument will allow astronomers to study a wide range of science topics, from objects in our Solar System to distant active galaxies.

METIS is currently in its manufacturing and assembly phase. Many hardware components, for subsystems including the imagers, the adaptive optics, the spectrograph, and the calibration unit, are undergoing testing at consortium institutes around Europe. The instrument's cryostat has been delivered and is being integrated in a newly constructed dedicated facility. The first cooldown of the cryostat at the integration facility was performed and testing is ongoing.

Another key part of METIS is its field de-rotator, which will keep the image of the sky aligned on the instrument's detector as Earth rotates during observations, by rotating a set of mirrors with very high precision. This mechanism will be inside the cryostat and so must work at a temperature of −200 °C. The de-rotator was tested at ESO Headquarters by cooling it in a cryostat and performing almost 200 000 cycles — more than twice the number expected during METIS's lifetime. Not only was no degradation identified, but a visual inspection revealed no wear on the bearing, so it was decided to use the same tried-and-trusted bearing for METIS's operation.

Integration of the METIS field de-rotator actuator for cold testing at ESO.

Read more about METIS, including consortium members, at https://elt.eso.org/instrument/METIS/

Artist's impression of the ELT instrument METIS.

MORFEO

MORFEO, the Multiconjugate adaptive Optics Relay For ELT Observations, is a unique instrument that will not make observations itself. Instead, it is an adaptive optics module which, by further correcting for the blurring effect of Earth's atmosphere, will enable the MICADO and HARMONI instruments to take exceptional images and spectra.

MORFEO is currently in its final design phase, but critical long-lead items are being procured before the full Final Design Review of the entire instrument. Among these are some of MORFEO's optics, for which contracts were placed during the year.

Already in their manufacturing phase are two large deformable mirrors, each almost a metre in size, which provide additional adaptive-optics correction on top of that from the ELT's own 2.4-metre deformable M4 mirror. These mirrors formally passed their final design review in mid 2025, following an earlier review meeting.

The second of these two mirrors was originally outside the baseline design of the instrument, but is now included. This will improve MORFEO's scientific performance and sky coverage and enhance its system robustness and resilience. During the year the instrument's technical specifications were revised, not only to account for these changes, but also to take the opportunity for general updates and clarification, with the introduction of stronger verification tests and new, science-driven technical requirements reflecting the major performance gains. The revised specifications were agreed in December, as a result of close collaboration and joint effort by the MORFEO instrument consortium and ESO.

Read more about MORFEO, including consortium members, at https://elt.eso.org/instrument/MORFEO/

HARMONI

HARMONI, the High Angular Resolution Monolithic Optical and Near-infrared Integral field spectrograph, is a work-horse 3D-spectrograph that will disperse the visible and near-infrared light from astronomical objects into its component wavelengths, allowing astronomers to study many different astronomical targets, from the far-off — distant galaxies, energetic quasars, and gamma-ray bursts — to individual stars in nearby galaxies and exoplanets in the Milky Way.

Following 2024's restructuring of the HARMONI project, the consortium and ESO worked closely together to develop a revised concept for the instrument and a viable way forward for its construction that reduces risk, construction time and cost while still achieving the required performance and retaining the key scientific goals.

The revised concept significantly simplifies HARMONI's design, with the removal of some less critical observation modes, and will make use of the MORFEO adaptive optics module instead of requiring HARMONI to have its own adaptive optics systems. It will deliver an extremely powerful and robust integral field spectrograph, which not only meets the original specifications but in some cases exceeds them.

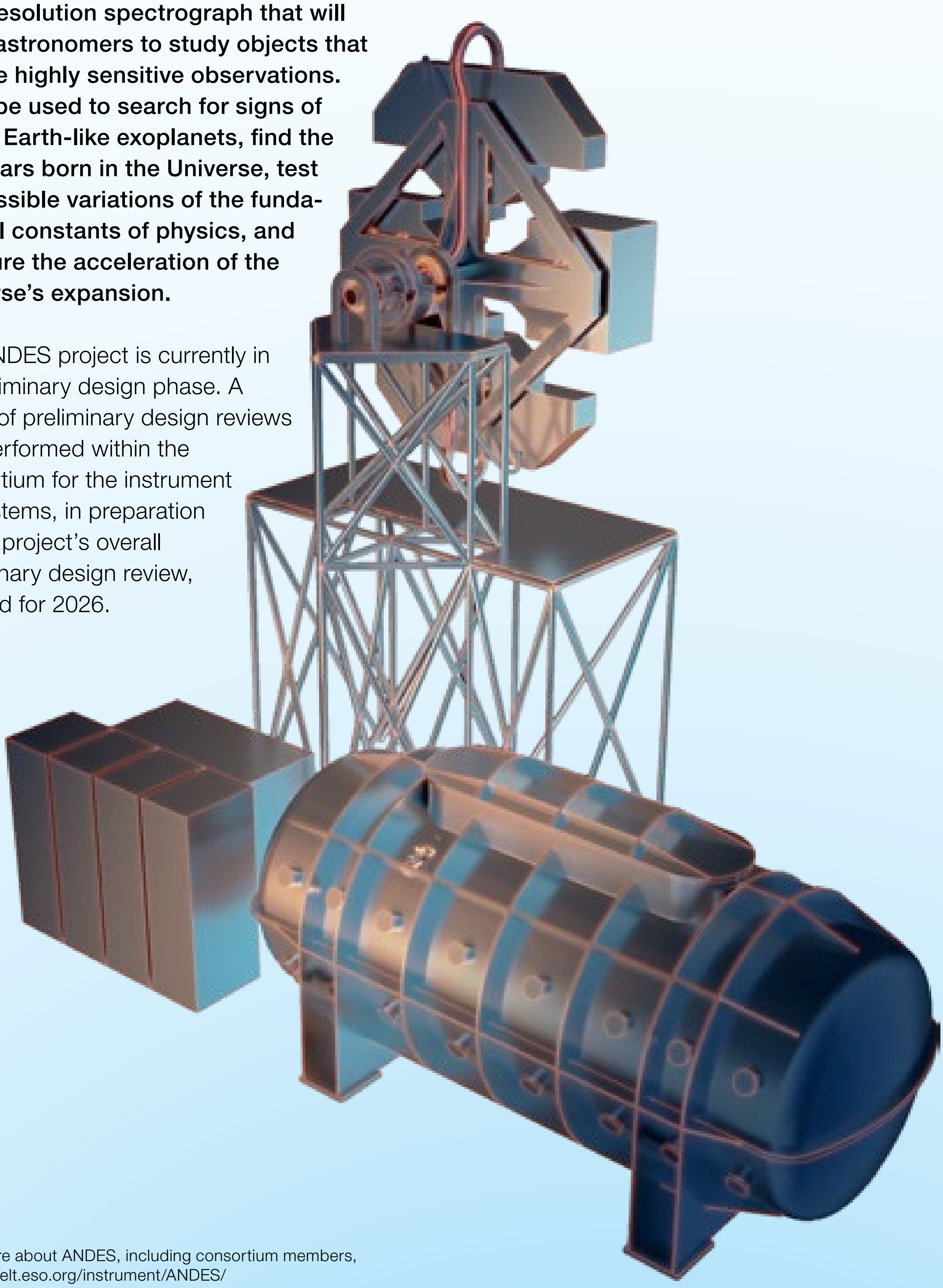
The new concept will be presented for approval to ESO's Scientific Technical Committee in April 2026.

Read more about HARMONI, including consortium members, at https://elt.eso.org/instrument/HARMONI/

ANDES

ANDES — the ArmazoNes high Dispersion Echelle Spectrograph — is a high-resolution spectrograph that will allow astronomers to study objects that require highly sensitive observations. It will be used to search for signs of life on Earth-like exoplanets, find the first stars born in the Universe, test for possible variations of the fundamental constants of physics, and measure the acceleration of the Universe's expansion.

The ANDES project is currently in its preliminary design phase. A series of preliminary design reviews was performed within the consortium for the instrument subsystems, in preparation for the project's overall preliminary design review, planned for 2026.



Artist's impression of the ELT instrument ANDES.

Read more about ANDES, including consortium members, at https://elt.eso.org/instrument/ANDES/

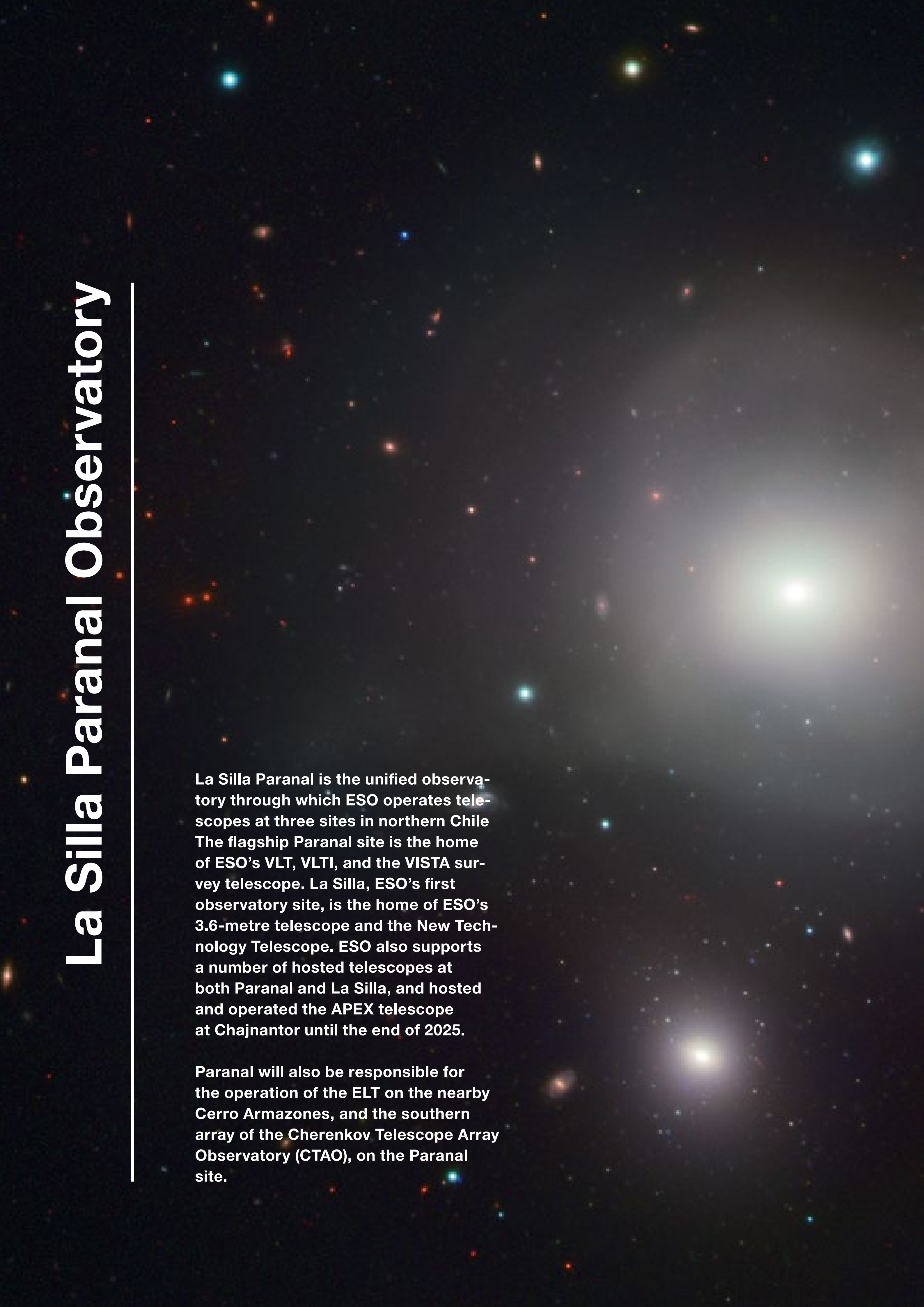
MOSAIC

MOSAIC is a multi-object spectrograph, operating at visible and infrared wavelengths, that will allow astronomers to observe more than one hundred targets simultaneously. By studying the light of objects from stars at the heart of the Milky Way to the most distant galaxies at the very edge of the observable Universe, MOSAIC will enable astronomers to trace the growth of galaxies and the distribution of matter from the Big Bang to the present day.

MOSAIC passed its System Architecture Review in mid-2025 and on 1 December ESO signed an agreement with the instrument consortium for the design and construction of the instrument, marking the beginning of MOSAIC's design and construction phase.

Read more about MOSAIC, including consortium members, at https://elt.eso.org/instrument/MOSAIC/

Artist's impression of the ELT instrument MOSAIC.



La Silla Paranal Observatory

La Silla Paranal is the unified observatory through which ESO operates telescopes at three sites in northern Chile The flagship Paranal site is the home of ESO’s VLT, VLTI, and the VISTA survey telescope. La Silla, ESO’s first observatory site, is the home of ESO’s 3.6-metre telescope and the New Technology Telescope. ESO also supports a number of hosted telescopes at both Paranal and La Silla, and hosted and operated the APEX telescope at Chajnantor until the end of 2025.

Paranal will also be responsible for the operation of the ELT on the nearby Cerro Armazones, and the southern array of the Cherenkov Telescope Array Observatory (CTAO), on the Paranal site.

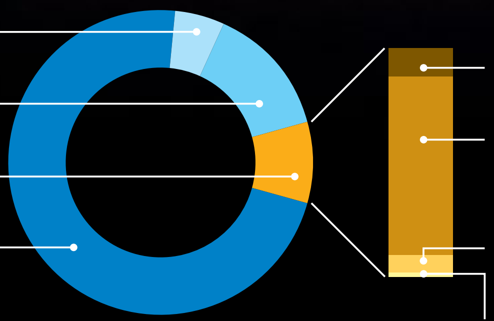
ESO/INAF/M. Mirabile et al./R. Ragusa et al.

NGC 3640, an elliptical galaxy 88 million light-years away, imaged with the VLT Survey Telescope, hosted at Paranal.

Operational statistics

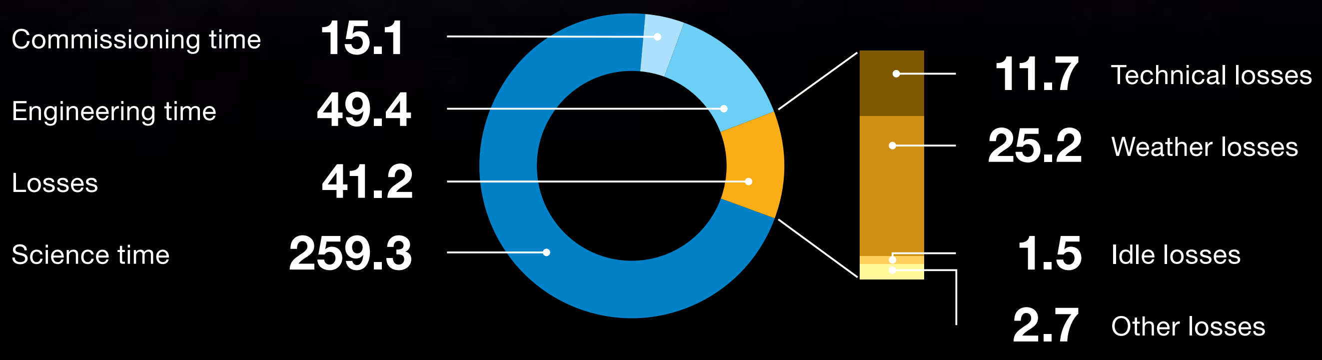
Telescope time usage and losses in nights – Paranal

UT1

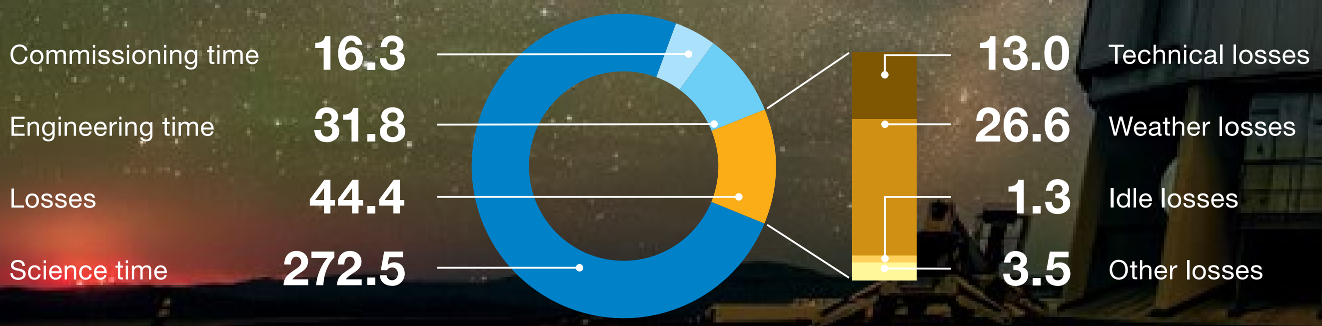


J. Looten/ESO

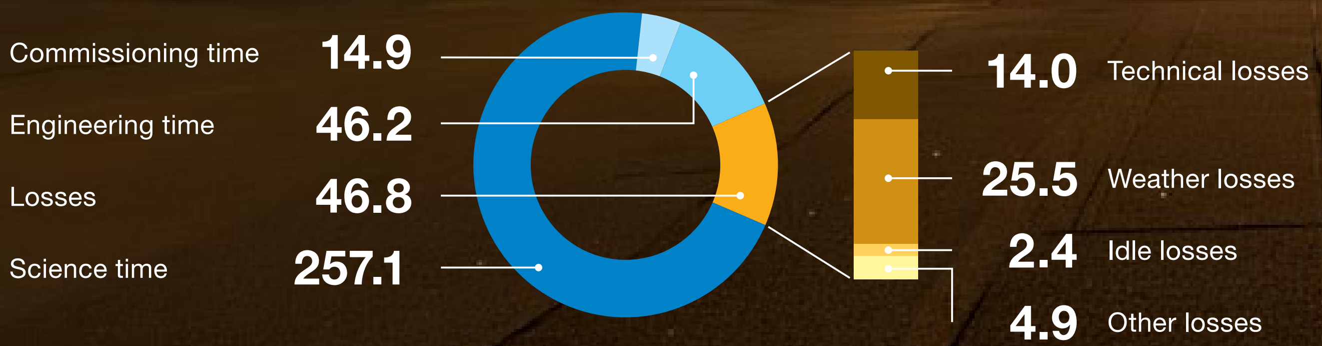
UT2



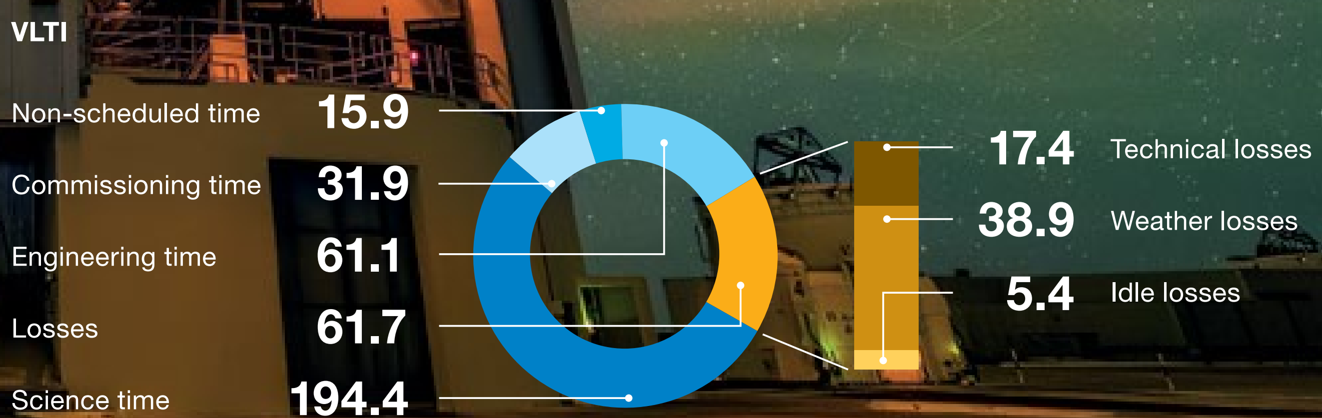
UT3

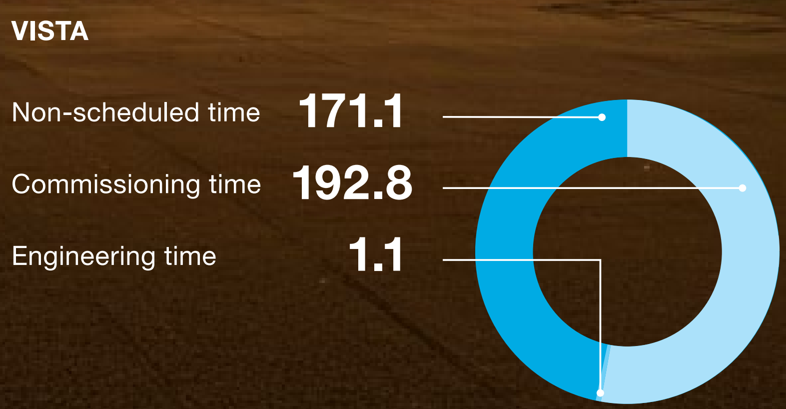

Commissioning time 16.3
Engineering time 31.8
Losses 44.4
Science time 272.5
13.0 Technical losses
26.6 Weather losses
1.3 Idle losses
3.5 Other losses

UT4


Commissioning time 14.9
Engineering time 46.2
Losses 46.8
Science time 257.1
14.0 Technical losses
25.5 Weather losses
2.4 Idle losses
4.9 Other losses

ESO/A. de Burgos Sierra

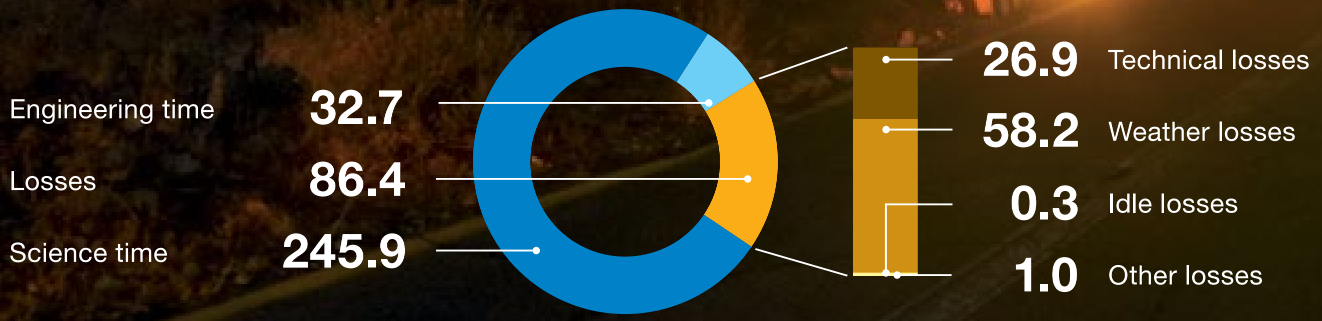




During 2025 VISTA was recommissioned after its upgrades and reconfiguration for 4MOST, and the 4MOST instrument was installed and commissioned.

Telescope time usage and losses in nights – La Silla

3.6-metre telescope



ESO/P. Horálek

NTT

Commissioning time	82.5
Engineering time	52.3
Losses	47.9
Science time	182.3

6.4	Technical losses
41.0	Weather losses
0.2	Idle losses
0.2	Other losses

Paranal

At 2600 metres above sea level in Chile's Atacama Desert, ESO's Paranal Observatory is one of the very best astronomical observing sites in the world. It is home to several world-class telescopes: ESO's VLT, VLTI, and VISTA survey telescope, as well as several telescopes hosted by ESO. There are also observatory support facilities, including the Paranal Residencia.

ESO's ELT will be operated from Paranal, and the ELT Technical Facility is located here. The southern array of the Cherenkov Telescope Array Observatory (CTAO) will also be located on ESO's Paranal site and operated by ESO.

About VLT and VLTI

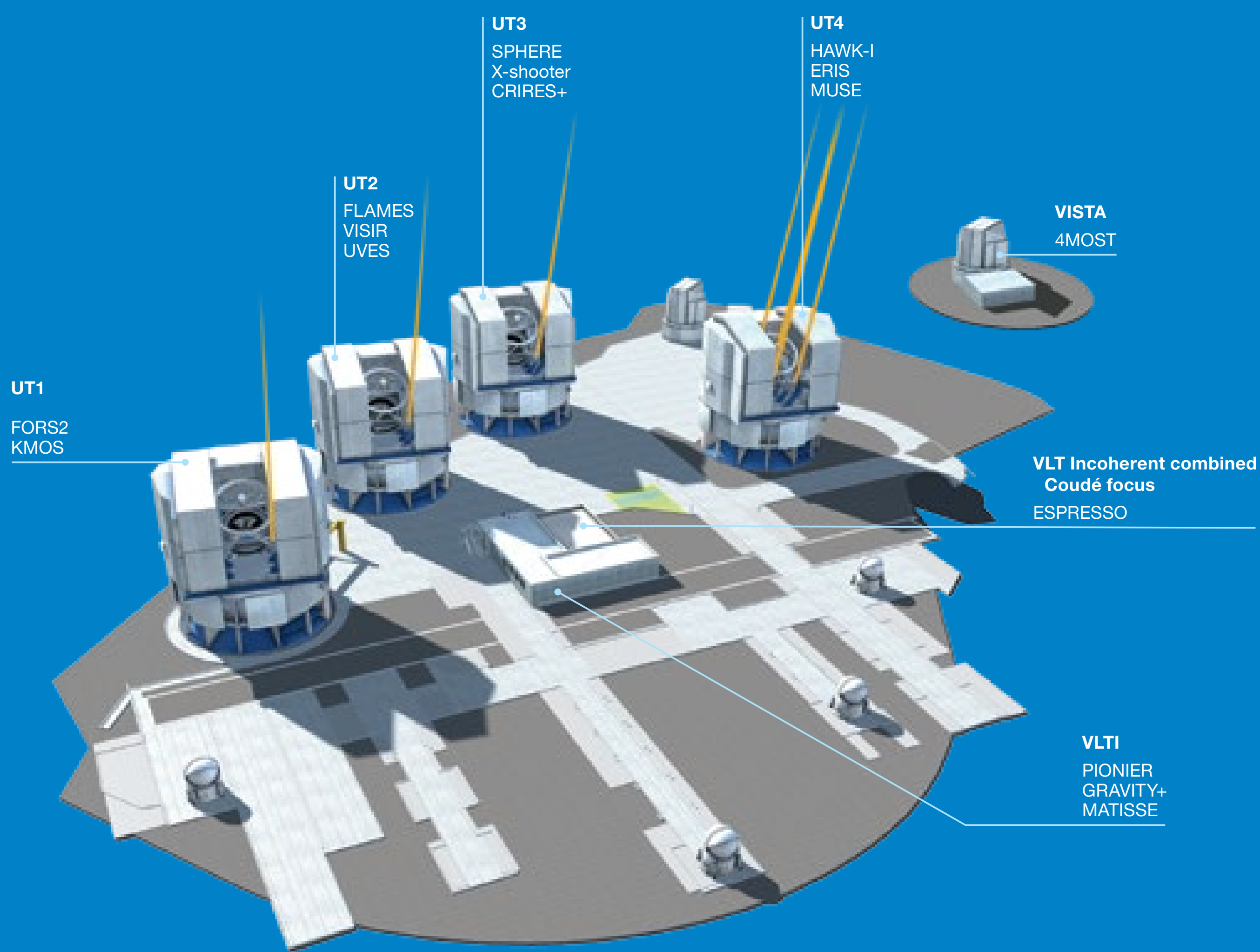
ESO's Very Large Telescope (VLT) consists of four Unit Telescopes (UTs) with main mirrors of 8.2 metres diameter and four movable 1.8-metre-diameter Auxiliary Telescopes (ATs). The Unit Telescopes can observe individually, with a suite of advanced instruments capable of a wide range of scientific applications at visible and infrared wavelengths.

UT4 is an adaptive optics telescope, with four laser guide stars and a deformable secondary mirror, allowing it to correct for the distortions caused by Earth's atmosphere.

The VLTI (VLT Interferometer) combines the light from either the four UTs or the four ATs using a technique called interferometry, allowing the combined telescopes to act like a single telescope as large as the distance between them. This lets astronomers make observations, using dedicated interferometric instruments, with much finer resolution than would be possible with a single UT.

About VISTA

The Visible and Infrared Survey Telescope for Astronomy (VISTA) is a survey telescope, whose 4.1-metre-diameter mirror and wide field of view allow it to map wide areas of the sky quickly, creating atlases and catalogues of objects that can be further studied with telescopes such as the VLT and VLTI.



Instruments on the VLT, VLTI, and VISTA, as of the end of 2025. 4MOST and the lasers on UT1, UT2 and UT3 were in commissioning.

ESO/N. Schafer

Operations, infrastructure, upgrades

Three new lasers for GRAVITY+

Laser guide star units were installed on the VLT’s UT1 and UT2 in August, and on UT3 in October, as part of the GRAVITY+ project to upgrade the GRAVITY instrument and the VLTI infrastructure. The lasers were tested and verified on the sky in October, allowing the first interferometric observations with four UTs and laser guide stars to be made in November. For more information about these results, see page 96.

A. Berdeu/ESO

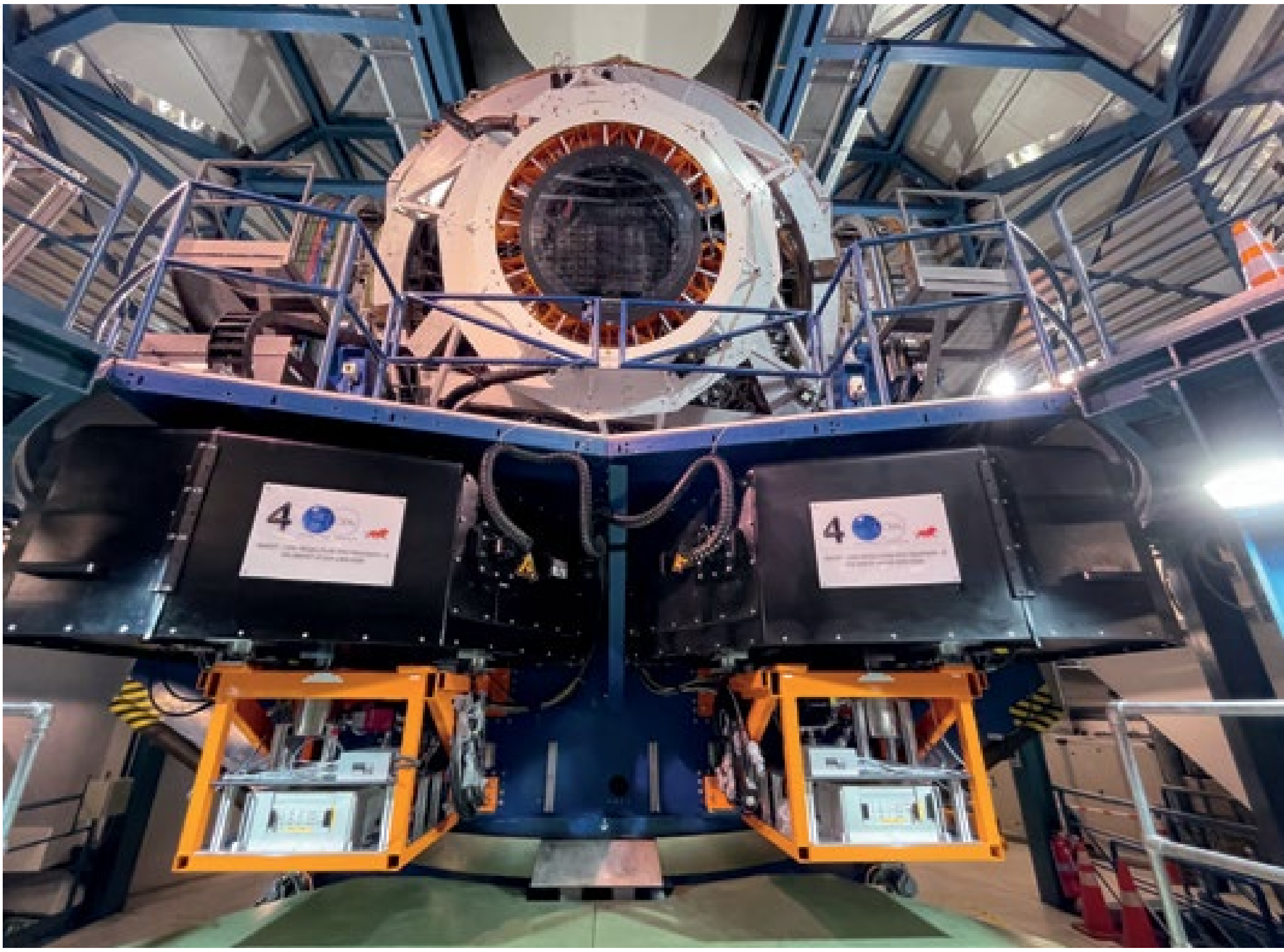
S. Menéndez Mendoza/ESO

Testing the new laser guide star units for GRAVITY+, with the telescope domes closed, on UT1 (left) and UT2 (right).

VISTA recommissioned and ready for 4MOST

The recommissioning of the VISTA telescope, after the upgrades and reconfiguration needed for 4MOST, was successfully completed in June 2025. This made the telescope ready for the arrival and installation of the instrument. For more information about 4MOST, see page 97.

Allar Saviauk (AIP)



View of the 4MOST Low Resolution Spectrographs integrated at the VISTA telescope.

News from the Integrated Operations Programme

The Integrated Operations (IOP) Programme aims to make Paranal Observatory fit for the future joint operations of the VLT and the ELT. Its goal is to deliver an operations model that is lean, efficient and sustainable in the 2030s and beyond. The programme is gaining momentum, with several projects moving closer to implementation.

Maintenance of the ELT Dome and Main Structure

One ongoing project will develop maintenance processes for the ELT Dome and Main Structure (DMS) and ELT Technical Facility (ETF). This includes not only maintenance during the assembly, integration and verification phase of ELT construction, but also enhanced maintenance processes for integrated operations of the ELT and the VLT.

A Phase A review of this project was held in February 2025, providing recommendations for the next stages of this important project.

ESO/G. Vecchia

Aerial view of the ELT dome and main structure taken in November 2025.

A more flexible future with the Smart Operations Platform

The Smart Operations Platform is a project to update the hardware, software and procedures used for operations at Paranal, delivering modern operator interfaces for existing and future hardware, with a strong focus on usability. The changes may be centred on the control room at Paranal, but will spread far beyond, enabling remote operation of the telescopes by distributed teams. The project will make operations, troubleshooting and commissioning activities significantly more flexible.

One of the first uses for the platform will be an application for Integrated Telescope Operations, which will streamline the operation of the VLT UTs. This will support the long-term goal of operating the VLT and the ELT in an efficient and sustainable way, as well as potentially additional telescopes.

The Smart Operations Platform successfully passed its Phase A review in November 2025 and the team is now working on the detailed design for the platform and its first application.

Managing obsolescence for the VLT's next 25 years

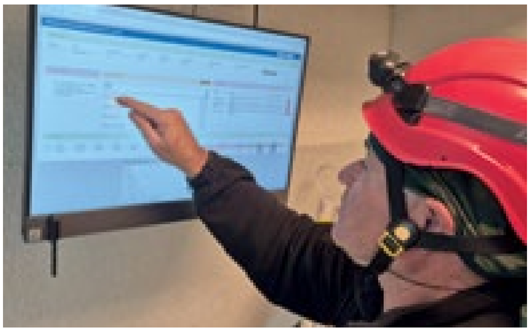
The VLT saw first light at Paranal in 1998 and, with an original design lifetime of about 25 years, we are increasingly dealing with maintenance, repair or upgrade tasks for parts of the VLT. Managing obsolescence — which occurs when components are no longer supported or sold by manufacturers — is vital to keeping the systems operating for another 25 years. The obsolescence programme at Paranal includes a wide range of running projects. One is to replace the telescope chillers, used for cooling electronics cabinets, air conditioning and other systems. Another is to replace the five-tonne capacity cranes used to move heavy and bulky telescope components and instruments into, out of and around the UT enclosures. Cranes for three of the four UTs were replaced in 2025. During the year funding was approved for additional projects until 2030 and a 10-year plan roadmap was drafted to mitigate the risk of a wave of obsolescence in the coming decade.

A. Doberti/ESO

New five-tonne capacity crane installed at the VLT.

Daytime coordination with the new telescope access tool

During the daytime it is sometimes necessary for people to enter the telescope enclosures or take remote control of the telescopes, for example to carry out maintenance. Previously, the designated Telescope Coordinators would manage these activities by receiving telephone and radio requests from colleagues and tracking who was doing what and where manually, and often on paper. This information is vital for checking for clashes and safety issues and knowing who is working in a telescope in case of emergencies.



Using the new web-based telescope access tool at Paranal.

A new web-based tool was introduced in 2025 to help manage this access. Users can register their plans themselves, checking ongoing activities and safety constraints. The plans are visible to everyone at the observatory, and are also shared at the daily morning meetings, improving coordination.

The tool has reduced the number of calls and interruptions for the Telescope Coordinators during the day by a factor of three, as they now only need to handle special cases that have to be escalated to them. The improved data also allow tracking the ‘wrench time’, that is the time spent actually doing hands-on maintenance work at the telescopes, which is one of the metrics we aim to improve. The system is also a testbed for ways to coordinate activities for future integrated operations at Paranal, including the ELT.

Coolant leak incident on Unit Telescope 3

On 23 October 2025 a glycol leak occurred in one of the cooling distribution lines of the VLT’s UT3. Glycol is a liquid coolant used to extract heat from many telescope and instrument subsystems.

The leak led to a full shutdown of UT3 and its instruments. Following careful cleaning, checking, and recovery of all the affected telescope and instrument components, the telescope resumed science operations on the night of 2–3 November with the SPHERE instrument. The commissioning of the GRAVITY+ laser guide star unit, which had also been interrupted, resumed on 4 November. CRIRES+ returned to regular science operations in mid-November. X-shooter, which was transported to the Paranal base camp for disassembly, cleaning, reassembly and realignment, was successfully recommissioned in mid-December.

ESO has started an investigation, ongoing at the end of the year, to learn as much as possible from the incident in order to prevent similar incidents in the future.

Forthcoming instruments

The ESO community, in close collaboration with teams of engineers, scientists and other staff at ESO, is deeply involved in ESO's Instrumentation Programme, which is responsible for the development and delivery of all the new optical and infrared instruments for Paranal and La Silla and for the ELT. Most projects are delivered by collaborations between research institutes in the Member States and ESO in return for Guaranteed Time Observations.

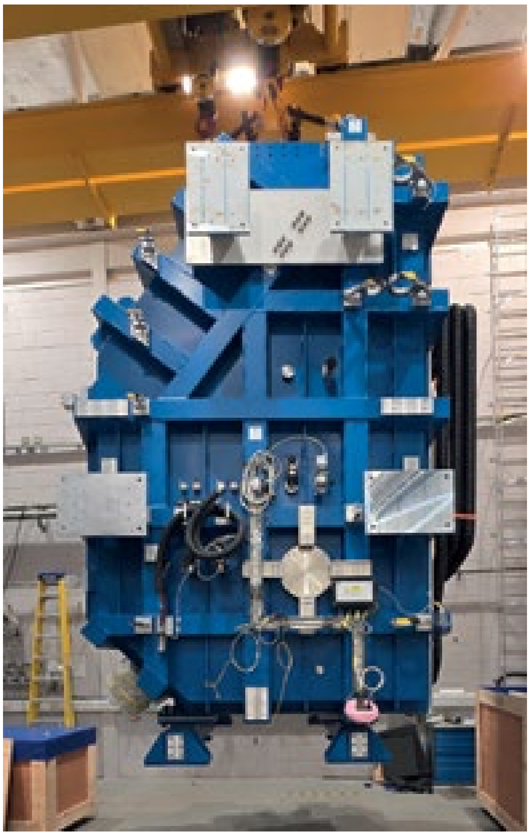
B. Häußler/ESO

An all-sky image at Paranal, taken in early February 2025, captures the Moon, the Milky Way, the comet C/2024 G3, and the planets Saturn, Venus, Jupiter and Mars.

MOONS

MOONS (Multi Object Optical and Near-infrared Spectrograph) is a 0.8–1.8-µm multi-object spectrometer designed to work at the Nasmyth focus of the VLT's UT1. It will have 1000 optical fibres patrolling a field the size of the full Moon. MOONS can be used with a spectroscopic resolving power *R* ~ 4000 spanning the full near-infrared wavelength range, or with *R* ~ 9000 in the *I* band and *R* ~ 20 000 in the *H* band.

MOONS has two main sub-components, the rotating front end (which is at the focal plane and houses the fibre positioners, the acquisition system and the metrology system for the fibres) and the cryogenic spectrographs, which will be on the telescope's Nasmyth platform.



The completed MOONS cryostat, with a mass of 9.5 tonnes, is lifted in December 2025 in preparation for its transport to Chile.

Following the successful Preliminary Acceptance Europe meeting held in December 2024, the mechanism that switches between the high- and low-resolution modes of the MOONS spectrographs was modified to address the longevity of the motor system, which must operate at cryogenic temperatures of –130 °C. Unfortunately, the new mechanism failed during the instrument's cool-down in January 2025. During the year a solution to the problem was identified. New components were produced, tested at cryogenic temperatures and installed, after which the cryostat was successfully cooled down.

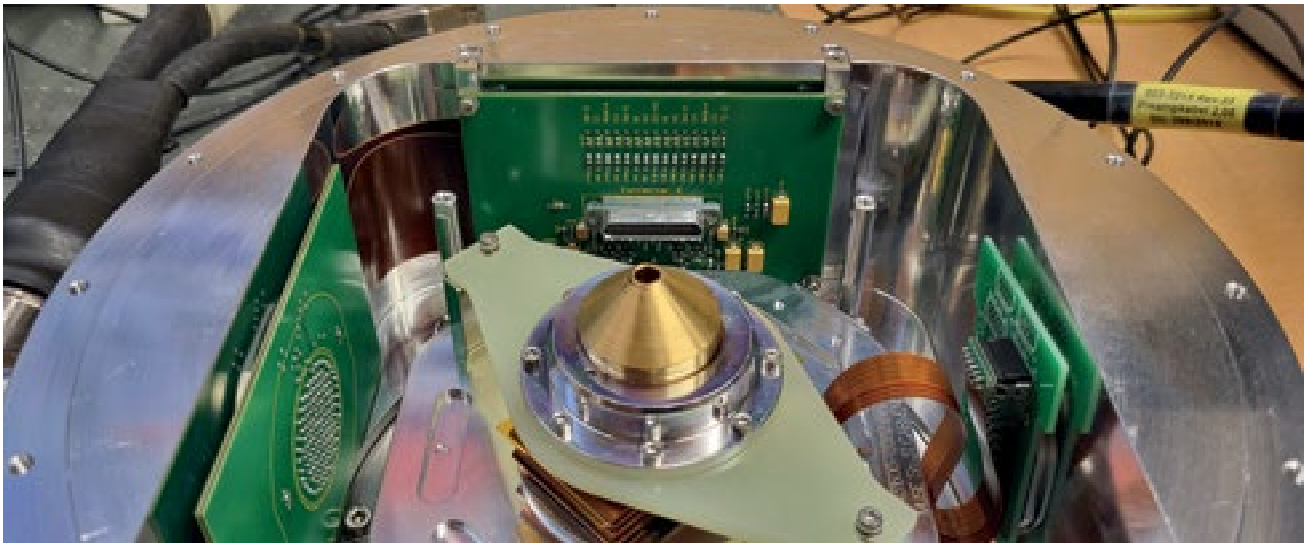
MOONS was then dismantled and packed and left Europe in December 2025 en route to Chile, where the instrument will be reintegrated at the telescope.

Science with MOONS is expected to include:

Probing the structure of the Milky Way; studying galaxy formation and evolution over most of the history of the Universe; spectroscopic follow-up for ground- and space-based optical and near-infrared surveys, as well as for facilities operating at other wavelengths.

Read more about MOONS, including consortium members, at https://www.eso.org/public/teles-instr/paranal-observatory/vlt/vlt-instr/moons/

FORS upgrade project



J. Reyes/ESO

Electronics inside the cryostat of the FORS1 instrument, during testing with the NGCII detector controller, as part of the FORS upgrade project.

FORS (Focal Reducer and low-dispersion Spectrograph) can not only take images of astronomical targets but also capture spectra from multiple objects, and even measure the polarisation of light, making it an extremely versatile tool. Twin instruments were made: FORS1, decommissioned in 2009, and FORS2, currently operating on UT1. However, FORS needs an update to make it ready for the next decade of operations. The project will refurbish FORS with a new detector, calibration unit, and filters and grisms, plus new software, making it a testbench for the ELT standard technologies that will come to all instruments at the VLT and ELT. To minimise downtime, the upgrade is being performed on the previously decommissioned FORS1 while FORS2 remains in operation.

The FORS upgrade project is currently in its manufacturing, assembly, integration and testing phase, with the integration of the instrument's subsystems continuing during the year. The implementation of electronics and control software following the new ELT standard is progressing well, as is the rest of the instrument's hardware.

Science with the upgraded FORS is expected to include:

A very wide range of astronomical investigations, from studying very distant galaxies and galaxy clusters, to individual and binary stars, and from the explosions of supernovae and the atmospheres of exoplanets, to asteroids and other objects within our Solar System.

Read more about the FORS upgrade project, including consortium members, at https://www.eso.org/public/teles-instr/paranal-observatory/vlt/vlt-instr/fors-up/

MAVIS

MAVIS (MCAO-Assisted Visible Imager and Spectrograph) will be an imager and an integral-field-unit spectrograph operating at visible wavelengths on the VLT, using adaptive optics to compensate for the blurring effects of atmospheric turbulence. MAVIS will take advantage of UT4's powerful laser guide stars and deformable secondary mirror, and will extend its capabilities with a technique called multi-conjugate adaptive optics (MCAO). This will deliver diffraction-limited science observations at visible wavelengths — offering comparable spatial resolution to near-infrared observations with the ELT — with an unprecedentedly wide 30-arcsecond field of view.

To do this MAVIS will add two additional deformable mirrors to correct for turbulence at different heights in the atmosphere, and will split each of the four UT4 lasers into two beams, producing eight laser guide stars, in addition to which it will also use three natural guide stars.

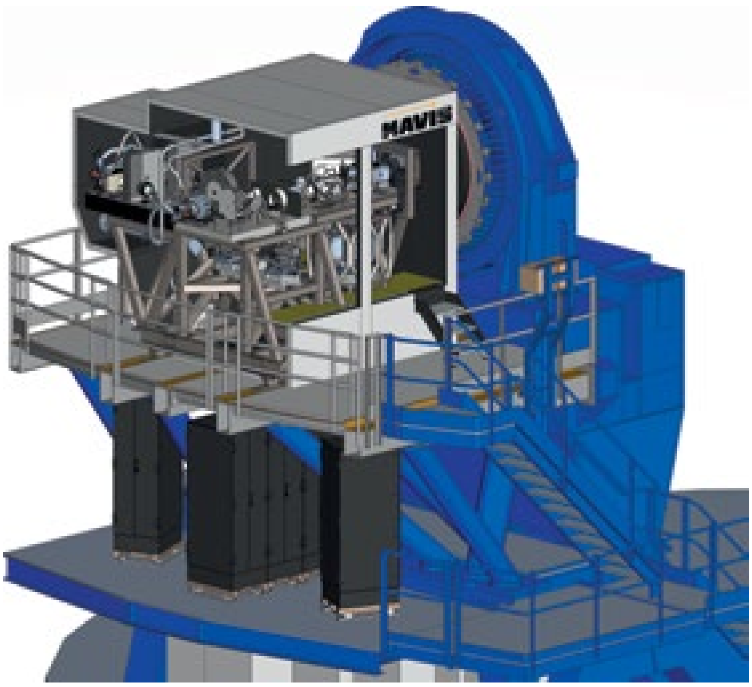
The first of these two mirrors, with over 3000 electromagnetic actuators that rapidly adjust its shape, was produced as part of an ESO technology development project. Following tests that started in September 2024, the mirror was officially accepted by ESO and was delivered to the ESO headquarters in June 2025. The second mirror is being assembled by the manufacturer and tests were ongoing at the end of the year.

A Final Design Review meeting for the entire MAVIS instrument took place in October 2025. The remaining actions which need to be closed before the design review is formally granted were identified and these will be worked on during 2026.

Science with MAVIS is expected to include:

A wide variety of research questions, ranging from how the first stars formed 13 billion years ago to how weather changes on the planets and moons of the Solar System.

Read more about MAVIS, including consortium members, at https://www.eso.org/public/teles-instr/paranal-observatory/vlt/vlt-instr/mavis/



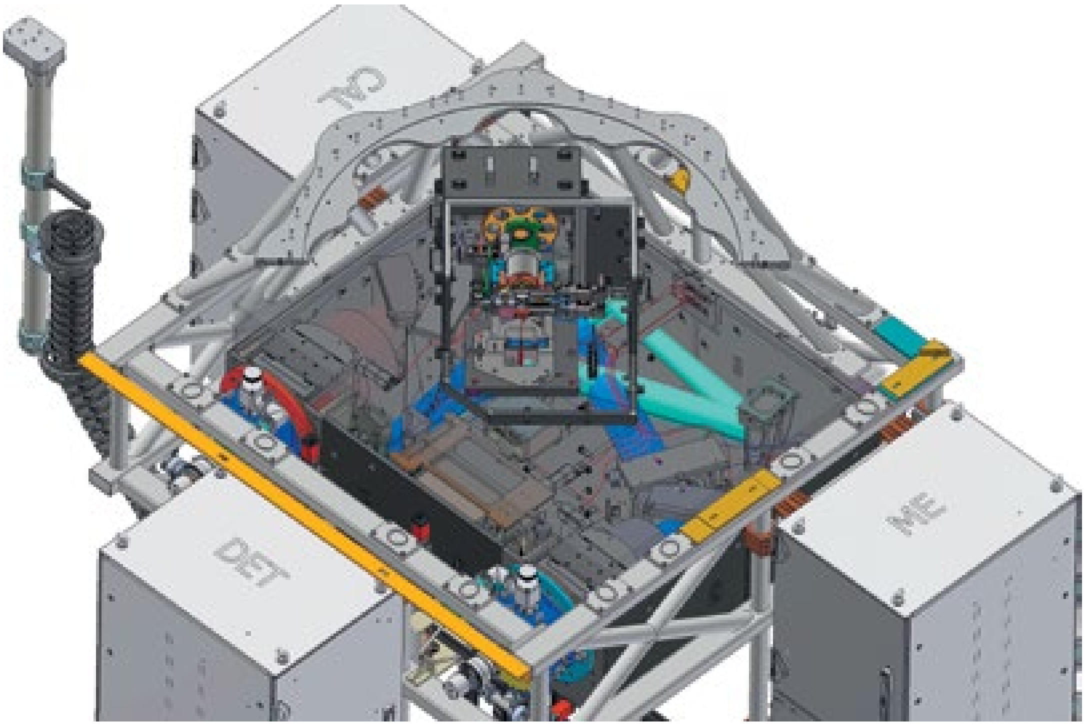
Gaston Gausachs, Astralis-AITC

Computer rendering of the MAVIS instrument on the Nasmyth platform of the VLT's UT4.

CUBES

CUBES (Cassegrain U-Band Efficient Spectrograph) will bring a unique capability to the VLT: a high-efficiency ultraviolet spectrograph in the wavelength range 300–405 nm with two spectral resolution modes of 20 000 and 7000.

Following the Final Design Review meeting of October 2024, the few remaining actions were successfully closed and the Final Design Review was granted in July 2025. The project is now in the manufacturing and assembly phase, with procurement of the components for the instrument ongoing.



CUBES Consortium

Computer rendering of part of the CUBES instrument.

Science with CUBES is expected to include:

New windows on distant galaxies and the gas in and around them, elements and molecules in the spectra of stars, and targets in our Solar System including comets and the surfaces of icy moons.

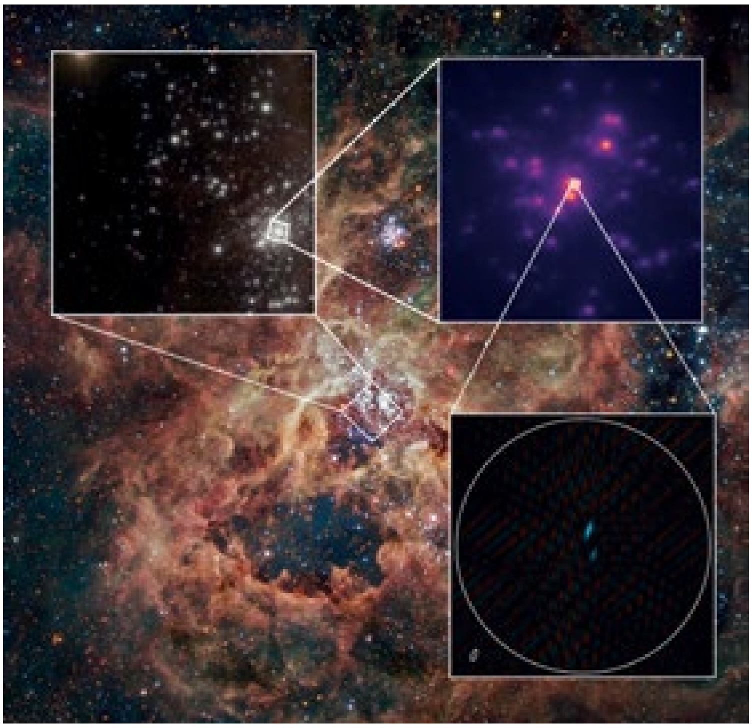
Read more about CUBES, including consortium members, at https://www.eso.org/public/teles-instr/paranal-observatory/vlt/vlt-instr/cubes/

GRAVITY+

GRAVITY+ is a very demanding project to upgrade the GRAVITY instrument and the VLTI infrastructure, enabling the imaging of fainter and more distant astronomical objects than previously possible, while also improving the high contrast precision on bright objects.

GRAVITY+ equips each of UTs 1, 2 and 3 with a laser guide star unit, and makes use of one of the lasers already installed on UT4. The project will also upgrade the VLTI's fringe-tracking capabilities, allowing for further correction of atmospheric turbulence, to image targets in unprecedented detail. The new features will benefit all present and future VLTI instruments.

ESO/GRAVITY+ Collaboration. Background images: ESO/IDA/Danish 1.5 m/R. Gendler, C. C. Thöne, C. Féron, and J.-E. Ovaldsen/P. Crowther/C. J. Evans



Bottom right: One of the first images obtained with VLTI/GRAVITY+ working with four lasers shows a binary star in the central region of the Tarantula Nebula. A zoom is shown with images from the Danish 1.54-metre telescope at La Silla (background), the VLT (top left), and the GRAVITY+ acquisition camera (top right).

The new laser guide star units were installed on UTs 1, 2 and 3 during 2025. The lasers create bright artificial stars 90 km above Earth's surface, enabling the correction of atmospheric blur using adaptive optics. With lasers now on all the UTs, the VLTI's observing power is dramatically enhanced over the whole southern sky.

The GRAVITY+ and ESO teams at Paranal performed successful test observations using the lasers in November 2025. Their target was a cluster of massive stars at the centre of the Tarantula Nebula, a star-forming region in our neighbouring galaxy the Large Magellanic Cloud. These observations revealed that a bright object in the nebula, thought to be an extremely massive single star, is actually a binary of two stars close together, and showcased the stunning sharpness of vision and scientific potential of the upgraded VLTI. Following this successful 'first light', commissioning of the GRAVITY+ laser guide star mode began at the end of 2025.

Science with GRAVITY+ is expected to include:

The discovery and characterisation of exoplanets, the imaging of young stars and their protoplanetary discs, the study of active galactic nuclei, and the search for intermediate-mass black holes. It will also take us deeper and closer to Sagittarius A*, the black hole at the centre of the Milky Way, providing us with a better understanding of the heart of our galaxy.

Read more about GRAVITY+, including consortium members, at https://www.eso.org/public/teles-instr/paranal-observatory/vlt/vlt-instr/gravity+/

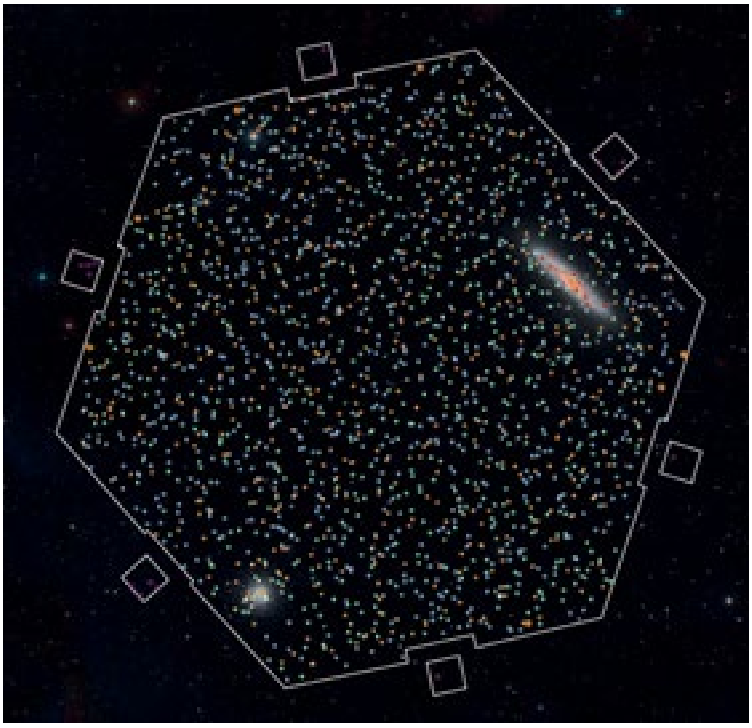
4MOST

The 4MOST (4-metre Multi-Object Spectrograph Telescope) facility will give VISTA the ability to perform large visible-light spectroscopic surveys, capturing the spectra of 2400 objects simultaneously by feeding their light through independently positionable optical fibres, over an area on the sky equivalent to 20 full Moons. Its unique capabilities result from the combination of a large field of view, very high multiplex, and simultaneous observations at medium and high spectral resolution for both Galactic and extragalactic astrophysics. 2436 fibres are available simultaneously — 1624 dedicated to low-resolution and 812 to high-resolution spectroscopy.

The 4MOST instrument completed its Preliminary Acceptance Europe in June, and was shipped to Paranal for installation on VISTA, which was completed in September.

4MOST successfully made its 'first light' test observations in October, with the instrument performing as expected. Within a single wide field of view, 4MOST collected spectra of multiple targets in the Sculptor Galaxy and the NGC288 star cluster, as well as about one thousand stars in our Milky Way and more than a thousand galaxies near and far, demonstrating its impressive capabilities.

Commissioning of the instrument was completed at the end of December, paving the way for the final test and verification activities that are needed before the start of science operations, which is planned for 2026.



AIP/Background: Harshwardhan Pathak/Telescope Live

The hexagonal 4MOST field-of-view and the many objects (marked with coloured dots) for each of which it captured a spectrum in its 'first light' test observations. The Sculptor galaxy is visible in the upper right and the globular cluster NGC288 in the lower left.

Science with 4MOST is expected to include:

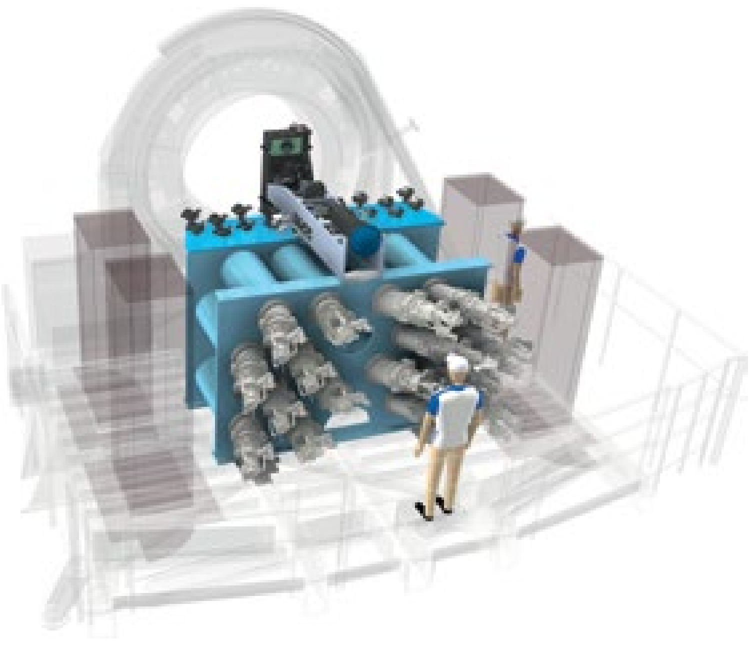
Studying the dynamics and chemical evolution of the Milky Way, analysing large numbers of active galaxies and galaxy clusters, and helping to constrain models of the accelerating Universe. It will also complement space-based and ground-based all-sky survey projects.

Read more about 4MOST, including consortium members, at https://www.eso.org/public/teles-instr/paranal-observatory/surveytelescopes/vista/4most/

Phase A studies

Future instrumentation projects for ESO telescopes are identified and selected in a careful process, undertaken in collaboration with ESO's community of astronomers and instrument builders and ESO's governing bodies. The earliest major project stage is a 'Phase A study', a conceptual design phase which defines the project, consolidates science cases, and develops top-level requirements. Depending on the outcome, the Phase A study may lead to an agreement between ESO and a consortium to develop the project.

BlueMUSE



BlueMUSE Consortium

Computer rendering of the BlueMUSE instrument.

BlueMUSE is a proposed integral-field spectrograph with a wide field of view, to be installed at the VLT, which is an evolution of the technology used on the VLT's MUSE instrument. It has a similar architecture, but is optimised for blue and near-ultraviolet light, covering shorter wavelengths than MUSE.

BlueMUSE would offer new and unique science opportunities in many fields of astrophysics. These are expected to include surveying large samples of massive stars in our galaxy and the Local Group, studying ionised nebulae, starburst and low-surface-brightness galaxies. At high redshift, BlueMUSE would allow astronomers to detect unambiguously for the first time the intergalactic medium in emission, as well as to study the evolution of the properties of the circumgalactic medium near the peak of the cosmic star formation history.

BlueMUSE successfully passed its Phase A review in February 2025 and was approved by the ESO Finance Committee and Council in November and December 2025 respectively. The agreement between ESO and the instrument consortium for the instrument's design and construction is expected to be signed in 2026.

A second-generation deformable secondary mirror for the VLT

The Adaptive Optics Facility (AOF) on the VLT's UT4, including the deformable secondary mirror and 4-Laser Guide Star Facility, has significantly enhanced the observational capabilities of UT4. As a result, UT4 is significantly oversubscribed compared to the other UTs, with even extremely good scientific observing proposals being rejected because there is insufficient time.

Relocating any of the UT4 instruments to another UT is currently not possible, as none of the telescopes has a deformable secondary mirror for adaptive optics. However, installing a new deformable secondary mirror on one of the other UTs, and taking advantage of the new single laser guide star unit installed on that UT as part of the GRAVITY+ project (see pages 86 and 96), would enable a more balanced distribution of instruments, improving the scientific performance of the VLT overall.

The Phase A study to investigate the possibility of installing such a second-generation deformable secondary mirror on UT1, UT2 or UT3 was successfully completed in early 2025 and the project was approved by the ESO Finance Committee in November. As this is an ESO internal project, no Guaranteed Time Observations are involved, so further approval from the ESO Council was not required. The contract is intended to be signed in 2026.

The second-generation deformable secondary mirror would be installed on one of UT1, UT2, or UT3, seen in the centre of this image, to take advantage of its new laser guide star unit.

A. Trigo/ESO

La Silla

La Silla was ESO's first observatory site, at an altitude of 2400 metres on the outskirts of the Chilean Atacama Desert. Here, ESO's 3.6-metre telescope and NTT (New Technology Telescope) are in operation. The La Silla site further supports several hosted telescope projects, among them the Max-Planck-Gesellschaft/ESO 2.2-metre telescope, the Swiss 1.2-metre Leonhard Euler Telescope, and the Danish 1.54-metre telescope.

J. Pérez/ESO

This fisheye view of La Silla shows the ESO 3.6-metre telescope under the Milky Way. The green light is faint 'airglow' from Earth's atmosphere, natural emission only visible to sensitive cameras in locations with little light pollution.

Operations, infrastructure, upgrades

A next-generation cryogenic system for the Wide Field Imager

Integrating the new Stirling cryocooler on the WFI detector head at the MPG/ESO 2.2-metre telescope at La Silla.

In March 2025 the Wide Field Imager (WFI) instrument on the Max-Planck-Gesellschaft/ESO 2.2-metre telescope, hosted by ESO at La Silla, was upgraded with a new cryogenic system. The existing liquid-nitrogen bath cryostat was decommissioned after more than 25 years of flawless operation and successfully replaced by a Stirling cryocooler. This next-generation cooling concept removes the need for liquid nitrogen, increasing safety and bringing the reliability and availability benefits of compact commercial off-the-shelf coolers.

It is the second such system to enter operation at La Silla, following the installation of a Stirling cooler on the Rapid Eye Mount telescope in 2024, and it is ESO's first such system in the Cassegrain position on a telescope, serving as a proof of concept for similar applications. These include planned use for the FORS upgrade project on the VLT, for which tests were performed at Paranal in November 2025.

The deployment of Stirling cryocoolers is part of the effort to reduce or remove La Silla's reliance on purchasing and handling liquid nitrogen. The system has a mean-time-to-failure of over 20 years, and by installing it on WFI, La Silla will be able to make significant savings of about 0.5 FTE (full-time equivalent) in service effort and more than 6000 litres of liquid nitrogen per year. The next planned installation of a Stirling cryocooler is for HARPS on the ESO 3.6-metre telescope in 2026.

Forthcoming instruments

An earlier call for proposals for new instruments led to the selection of two instruments at La Silla for development — originally within the framework of the Paranal Instrumentation Programme and now the newly combined Instrumentation Programme — by consortia in close collaboration with ESO, in exchange for Guaranteed Time Observations. The first of these instruments, NIRPS (Near Infra Red Planet Searcher) on the ESO 3.6-metre telescope, entered operations and was offered to the community in 2023.

SOXS

SOXS (Son Of X-Shooter) is a new instrument for the NTT. This instrument, inspired by X-shooter on the VLT, will be a unique spectroscopic facility for following-up transient and variable astronomical events identified in imaging surveys. It has two spectrographs, optimised for the visible and near-infrared wavelength ranges, respectively.

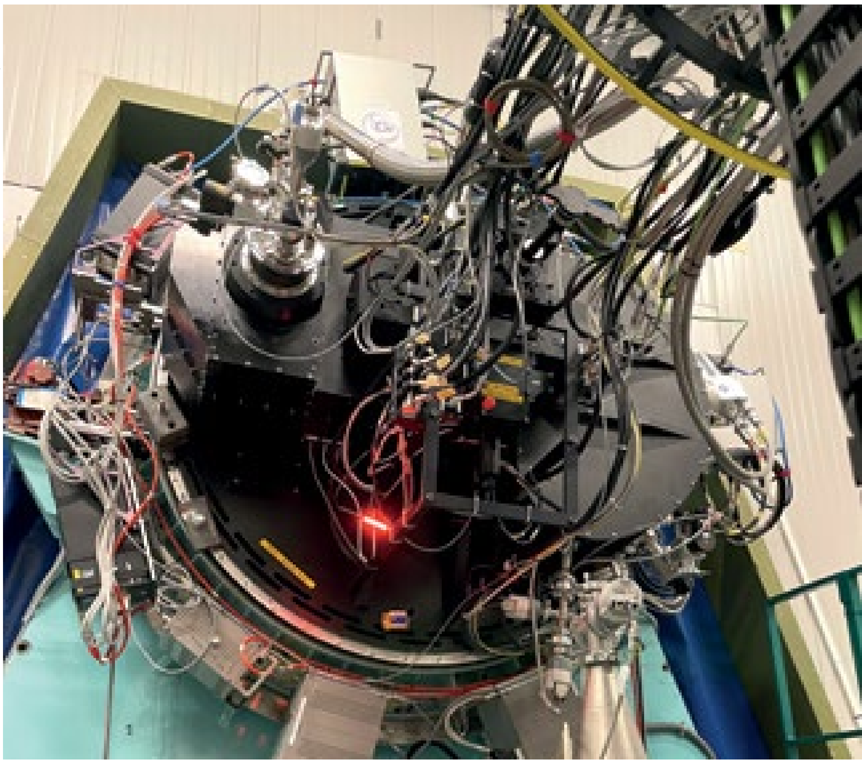
SOXS arrived at La Silla from Europe in February 2025, and its assembly, integration and verification process on the NTT began at the end of that month. Among the issues addressed during this period were problems with the cooling system for the near-infrared part of the instrument, for which the cooling system was replaced in September. SOXS made its 'first light' observations in December, and commissioning was ongoing at the end of the year..

Science with SOXS is expected to include:

Following up transient events encompassing all distance scales and branches of astronomy, including fast alerts such as gamma-ray bursts and gravitational waves, mid-term alerts such as supernovae and X-ray transients, and fixed-time events such as the close passage of a minor planet or asteroid. It will also observe exoplanet transits, active galactic nuclei and blazars, tidal disruption events, fast radio bursts, and more.

Read more about SOXS, including consortium members, at https://www.eso.org/public/teles-instr/lasilla/ntt/soxs/

Close-up of the SOXS instrument installed on the NTT.



S. Campana/INAF

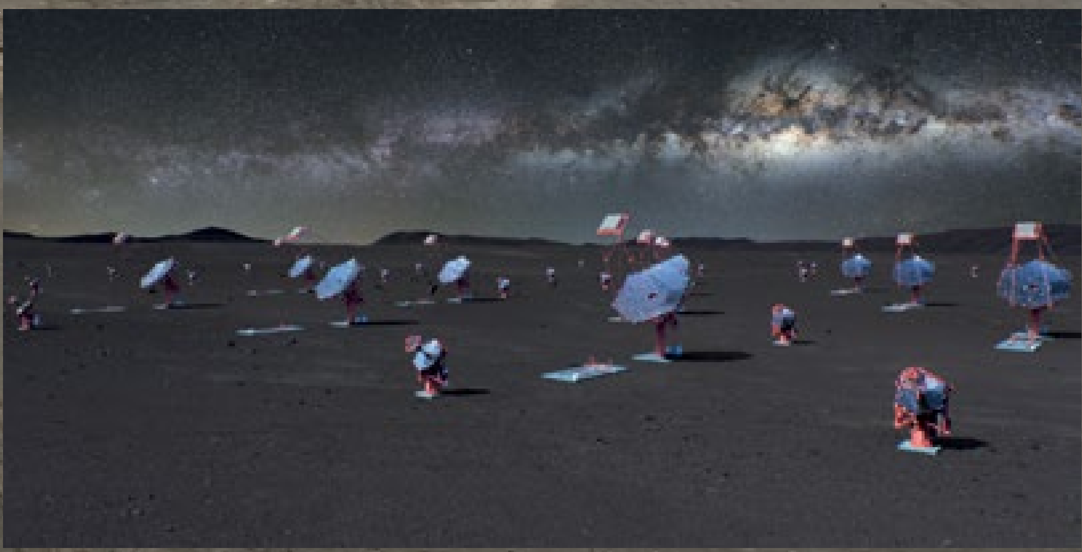
CTAO

The Cherenkov Telescope Array Observatory (CTAO) will be the world's most powerful ground-based gamma-ray observatory. It will consist of two arrays of telescopes: CTAO-North in La Palma, Spain, and CTAO-South at ESO's Paranal site in Chile. In addition to hosting CTAO-South, ESO is a fully participating member of the CTAO organisation.

In its planned configuration, the CTAO will comprise 64 telescopes of different sizes, 13 in the northern site and 51 in the southern one. They will detect the faint and ephemeral radiation produced when gamma rays from deep space hit our atmosphere, thus probing the most powerful and extreme objects in the Universe, such as supermassive black holes and supernovae, with unprecedented sensitivity. CTAO's high-energy capabilities constitute a perfect match to ESO's current roster of telescopes, which observe all the way from visible/infrared light to submillimetre wavelengths, a synergy that will allow astronomers to study the Universe in brand new ways.

Aerial view of the work on the foundations on the CTAO-South site, near ESO's Paranal Observatory.

Constructora Icafal/Flesan



Artist's impression of the CTAO-South telescopes.

Signature of contract between ESO, on behalf of the CTAO, and a consortium of Chilean companies for the construction of telescope foundations for the ‘alpha configuration’ of CTAO-South.

On 7 January 2025 the European Commission formally established the CTAO as a European Research Infrastructure Consortium (ERIC), under European law, with ESO as a founding member of the ERIC. The creation of the CTAO ERIC will enable the observatory’s construction to advance rapidly and provide a framework for distributing its data worldwide, significantly accelerating its progress toward scientific discovery. The change from the previous legal entity — the gGmbH, a non-profit, limited-liability entity under German law — to the CTAO ERIC was completed by the end of September.

In July a major contract, worth several million euros, was signed between ESO on behalf of the CTAO, and a consortium of Chilean companies for the construction of telescope foundations for the ‘alpha configuration’ of the CTAO’s southern hemisphere array (CTAO-South) at ESO’s Paranal Observatory. The contract includes more than 50 foundations for CTAO-South telescopes, as well as approximately 17 km of roads connecting these foundations to the support facilities. The construction of this important civil infrastructure paves the way for the first telescopes to be erected on site.

By the end of 2025 25% of the concrete for the foundations of the alpha configuration had been poured.

On 17 December 2025 the groundbreaking ceremony for CTAO-South took place on

Construction of one of the telescope foundations for the ‘alpha configuration’ of CTAO-South.

ESO's Paranal site, attended by representatives of the CTAO, ESO, the Chilean government and local authorities. Following a welcome and speeches, a time capsule was buried and a commemorative plaque was set upon nearby stones, marking the capsule's location close by the future telescope array. It contains items from Chile and CTAO partners around the world, symbolising how the work undertaken in Chile will contribute to scientific progress on a global scale, and representing the ultimate goal of the telescopes now under construction: to advance our understanding of the Universe and expand human knowledge.

ESO/CHEPOX

ESO/CHEPOX

Top: Representatives of ESO, CTAO, the Chilean government and local authorities at the groundbreaking ceremony for CTAO-South.

Above: Close-up of the plaque marking the time capsule's location at the CTAO-South site.

ESO/CHEPOX

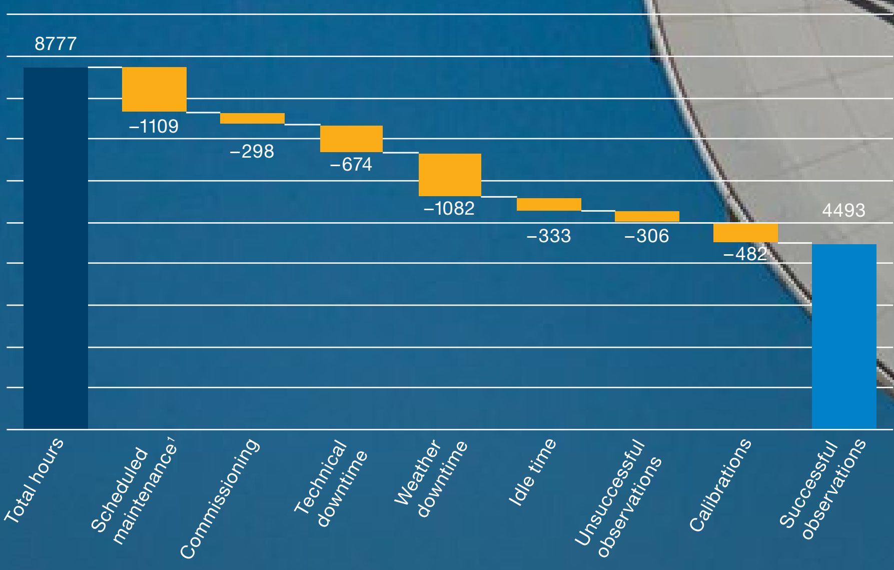
Burying the time capsule at the CTAO-South site.

ALMA

ALMA is a large interferometer operating at millimetre and submillimetre wavelengths, operated jointly through an international collaboration involving Europe, North America and East Asia in cooperation with the Republic of Chile. The ALMA observatory comprises 66 high-precision antennas with state-of-the-art receivers located on the Chajnantor Plateau at 5000 metres above sea level in the district of San Pedro de Atacama in the Chilean Andes. The antennas, which have diameters of 12 metres and 7 metres, can be placed in various configurations, with separations ranging from 15 metres to 16 kilometres. They are moved between foundation pads using two custom-built transporter vehicles, named Otto and Lore.

Operational statistics

ALMA observing cycle 11 (October 2024–September 2025)



[1] During the ‘Altiplanic winter’ period of January–March, seasonal atmospheric conditions can limit observations at submillimetre wavelengths. Scheduled maintenance therefore also includes the month of February, routinely used as an extended maintenance and upgrade period, during which no science observations are planned.

An ALMA (Atacama Large Millimeter/submillimeter Array) antenna with the Moon in the background.

Y. Villalon/ESO

Operations and infrastructure

Another record number of successful observation hours in Cycle 11

ALMA's observing cycle 11, from October 2024 to September 2025, produced another record of 4493 hours of successful observations. This not only far exceeded the goal of 4300 hours, which is used when planning the observing queue, but was also just a few hours short of the observatory's stretch goal of 4500 hours.

What makes this impressive result especially encouraging is that it was achieved despite several challenges: the winter was the worst in the last decade in terms of precipitation; various power issues affected operations; and ALMA's array of antennas was in a widely dispersed, 'long-baseline' configuration during the year, which produces sharper observations but is less efficient in terms of observing hours.

Preparing the European ARC Network for the WSU era

The annual European ALMA Regional Centre (ARC) All Hands meeting took place in October 2025, in Lancaster, UK, bringing together all ALMA staff from ESO and the European ARC network nodes. Among the discussion topics was the European ARC network's strategic plan for the 2026–2032 period, including supporting the community with the transition to the ALMA Wideband Sensitivity Upgrade (WSU).

Participants in the 2025 European ARC All Hands meeting.

S. Otarola/ESO

Close-up view of an ALMA antenna. The secondary reflector is in the foreground and the primary dish is in the background. Circular windows to the receivers are visible through the circular hole in the centre of the dish.

ALMA Wideband Sensitivity Upgrade

The Wideband Sensitivity Upgrade (WSU) is the most ambitious upgrade to ALMA since its conception. As the top priority of the ALMA 2030 roadmap, the WSU will deliver what is in effect a 'brand new ALMA' with dramatically increased speed and sensitivity. This will be done by increasing ALMA's bandwidth by up to a factor of four, while also upgrading the entire signal chain, starting with the receivers and digitisers, and including a second-generation correlator — the specialised supercomputer that combines the signals from the antennas to transform them into a single vast telescope.

The WSU passed its System Preliminary Design Review, a major milestone, in July 2025. The review concluded that the project is well structured, with early milestones on track, and provided guidance for the next stages of the project.

Science verification with ALMA Band 2 receivers

ALMA Band 2, the flagship ALMA upgrade project being led by ESO, is the first set of receivers designed for the new, wider bandwidth of the WSU. The receivers allow ALMA to observe within the final wavelength range — between 2.6 and 4.5 millimetres (67–116 GHz) — for which it was designed. This so-called Band 2 opens a new window onto our cosmic origins, allowing observations of redshifted carbon monoxide in distant galaxies, as well as dense gas in a period of cosmic history when star formation was declining rapidly. In addition, Band 2 enables observations of deuterated molecules — those containing deuterium instead of hydrogen — which probe the coldest, densest regions of molecular gas in a range of environments.

The series production of the Band 2 receivers, which started in 2024, is progressing well and according to schedule. By the end of 2025, 54 of the planned 67 receivers had been produced, and 28 of these had been integrated into ALMA antennas at Chajnantor. Tests showed that the receivers have very good performance levels in all key areas. As the first wide-band receivers on ALMA, they are ready for wide-band operation once the WSU project upgrades the rest of the signal chain.

Band 2 Science Verification observations were made in November and December 2025. Science Verification is the process whereby selected astronomical targets are observed to demonstrate that the data produced are of the quality required for scientific research. The targets were: the high-mass star-forming region G31.41+0.31, which contains numerous complex organic molecules; the nearby ultraluminous infrared galaxy Arp 220, formed by two galaxies which collided and are now merging; the distant and dusty star-forming galaxy SPT 0027-50; and the main-sequence star

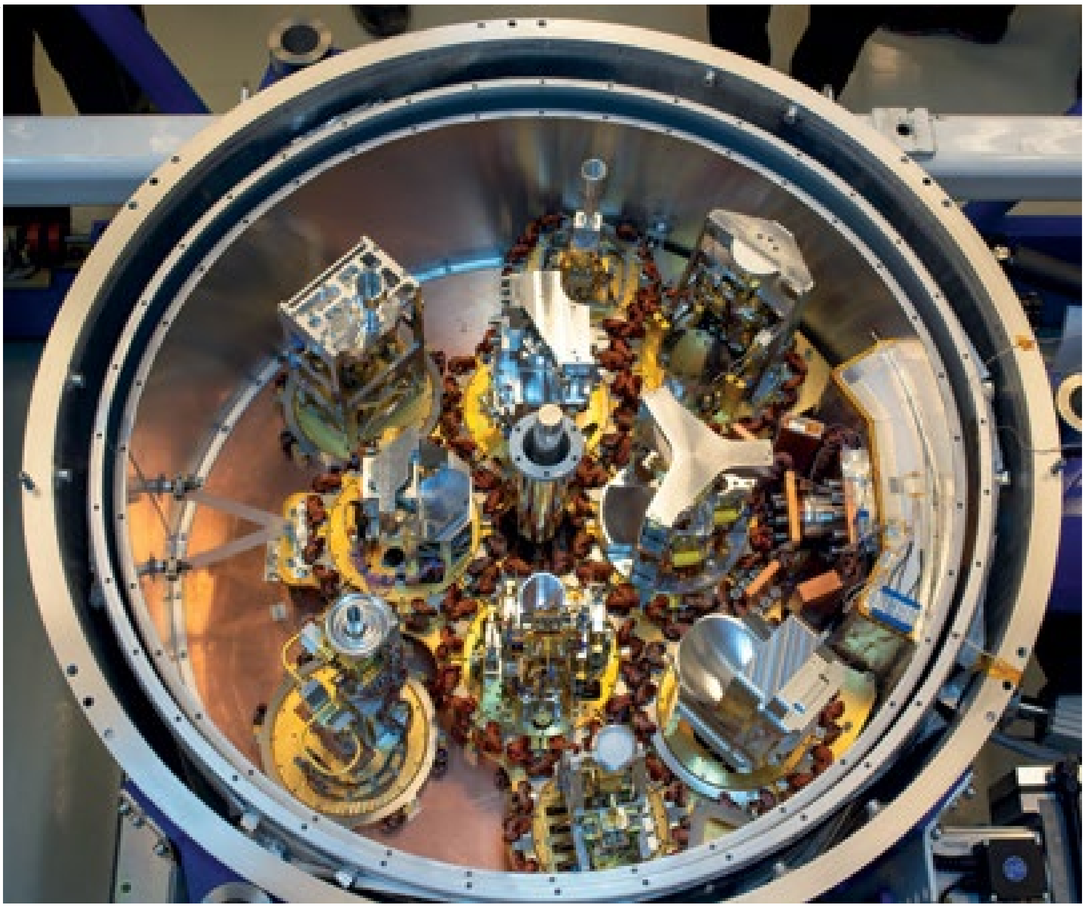
HR 5907, which has a strong magnetic field and spins very rapidly, completing a rotation every 12 hours.

The European ALMA Regional Centre (ARC) network — a coordinated network of scientific support nodes distributed across Europe — was deeply involved in this process. Participants from the ARC network met with ESO colleagues to analyse the Science Verification data during a ‘busy week’ held at the ESO headquarters in Garching in December.

The data, which are of excellent quality, will be released to the community in early 2026. It is planned to offer general Band 2 observing to the ALMA community from Cycle 13, which begins in October 2026.

Read more about ESO contributions to the WSU, including projects, partners and consortium members, at https://www.eso.org/sci/facilities/alma/wsu.html

S. Otarola, ALMA(ESO/NAOJ/NRAO)



The cryostat of an Atacama Large Millimeter/submillimeter Array (ALMA) antenna populated with 10 receivers.

Data flow and science archives

Observations with ESO's telescopes are made as an integral part of an end-to-end 'data-flow system', from the initial submission and selection of proposals for observing time, through the scheduling and execution of the observations themselves, including quality control and processing, to delivery of the final data products. The researchers who proposed the observations typically have exclusive access for the first year, after which the data are made publicly accessible worldwide.

All science data collected at La Silla and Paranal, as well as data collected at APEX until mid-2023, are made available online through the ESO Science Archive, physically located at the ESO Headquarters in Garching. ALMA data products are also directly accessible from the ESO archive and can be queried together with data from other ESO observatories. ESO also hosts and operates the European instance of the dedicated ALMA Science Archive.

Fostering open access to data and ensuring they are findable, accessible, interoperable and reusable (the FAIR principles) lets the wider community do even more science with the same observations. The number of papers that use partly or exclusively archival data has increased steadily during recent years, demonstrating the important legacy value of the archives.

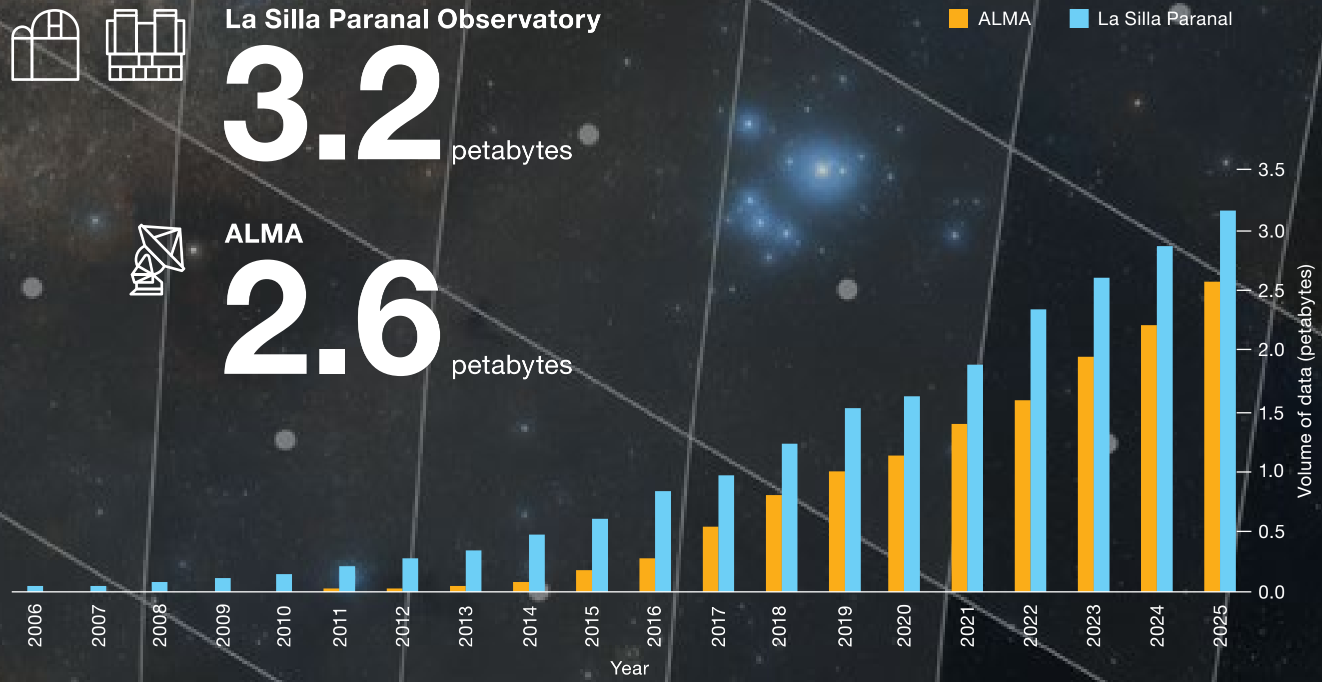
Total volume of data stored in the ESO archives

La Silla Paranal Observatory

3.2 petabytes

ALMA

2.6 petabytes

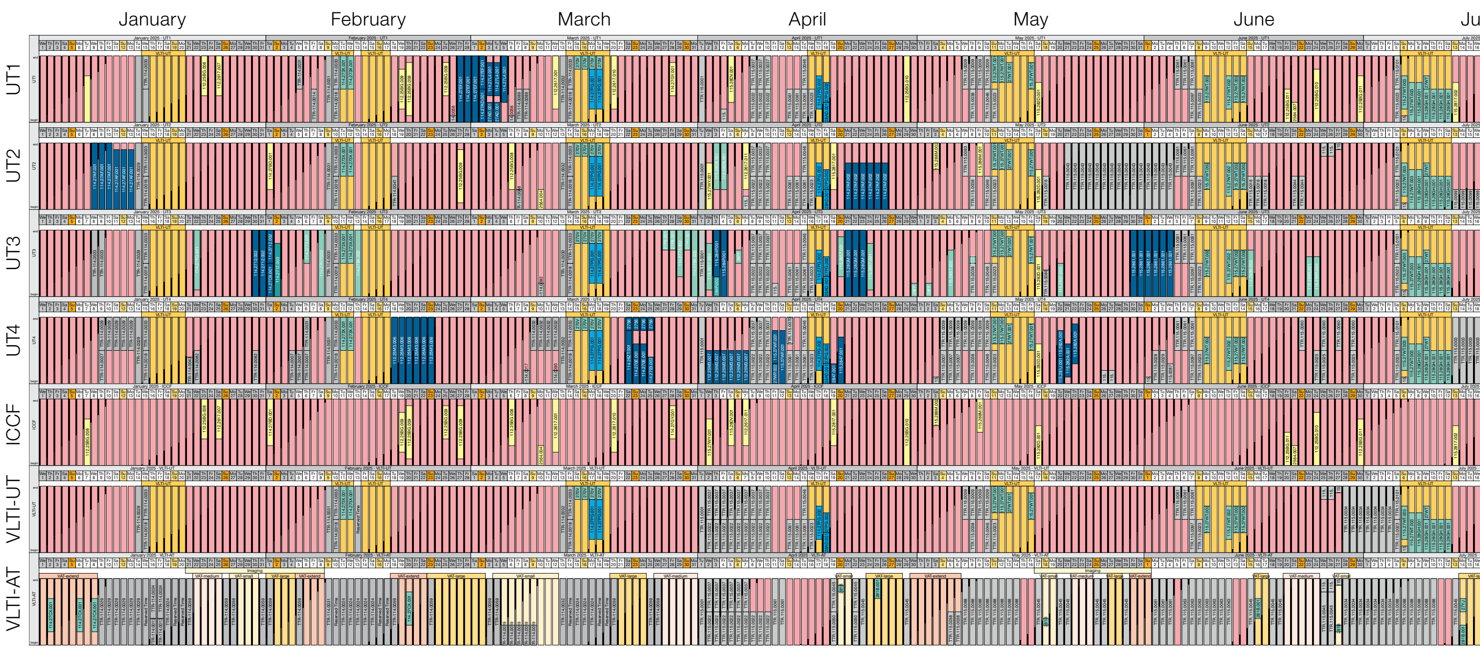


Dynamic scheduling at La Silla Paranal: fast, flexible and more efficient

The new scheduling tool for the La Silla Paranal telescopes, which was first used in 2023, replacing a system that was about twenty years old, has undergone further rapid development since then.

Among the new features that have been recently implemented are upgrades to enable dynamic re-scheduling of the telescopes. This is required for the change from six-monthly to yearly observing periods, which starts from Period 117 (1 May 2026 to 30 April 2027, see page 53 for more information). As regular calls for proposals will now only happen once a year, ESO is also introducing a Fast Track Channel, with deadlines every few months, for emerging scientific opportunities that require a response on a faster timescale. These Fast Track Channel observations must be fitted into the schedule of an already running 12-month observing period. This change requires substantial updates to ESO's time allocation and scheduling processes, as well as to the underlying software tools.

The old process for generating telescope schedules required cumbersome manual handling of many constraints, such as time-critical observations and visitor-mode observing runs. Schedules created using the old tool were furthermore effectively frozen once released, with modifications requiring inconvenient manual edits in the operational database. The new scheduling tool can instead process a wider range of more detailed input data, handling complex constraints with less manual intervention. It can also include new requested runs, while preserving ongoing commitments. The more reproducible process with the new tool means that the schedule can be easily modified and republished whenever changes are needed. This increased flexibility is a prerequisite for dynamically accommodating Fast Track Channel observations throughout the year.

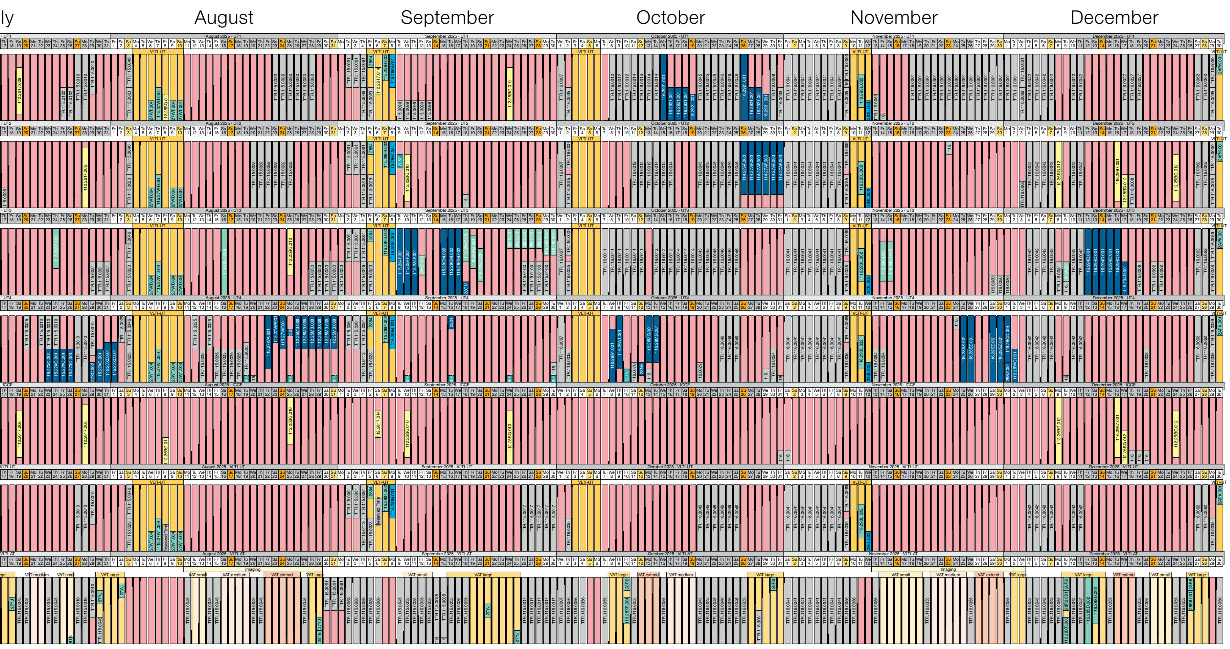


Other improvements deployed in 2025 include the joint scheduling of technical activities — such as the commissioning of new instruments, or engineering and maintenance work — and science observations, on a common priority scale. This means that technical activities, which were formerly fixed in the schedule, can be moved around more flexibly, ensuring that the final schedule maximises the inclusion of high-priority scientific observations and the necessary technical activities.

In 2025 ESO also deployed a new, more sophisticated scheduler algorithm for the VLT Interferometer (VLTI). It not only accounts for scientific requirements, but now also technical activities. For example, mirror coating on a VLT Unit Telescope is automatically reflected in the algorithm, preventing the scheduling of observations that would require that Unit Telescopes, while still allowing VLTI operations with the Auxiliary Telescopes. The algorithm also optimises the VLTI baseline configurations by considering the time needed to reconfigure the array, including Auxiliary Telescope relocations. Together, these improvements have significantly streamlined the VLTI scheduling process.

The wide-ranging upgrades to the scheduling tool not only make the switch to yearly observing periods and the Fast Track Channel possible, but — as programmes are now scheduled in a much more flexible way according to their constraints — also offer enhanced efficiency and effectiveness at the observation level, to make the most of the precious time available on the telescopes.

Looking further ahead, the new scheduling tool is also ready to schedule observations with the ELT, once ESO's next telescope enters operations.



Example telescope schedule generated by the new La Silla Paranal scheduling tool. Each row represents the detailed schedule for an individual telescope, with the different colour blocks showing time allocated to astronomical observations and technical activities. For clarity, the rows for the La Silla telescopes and VISTA have been omitted here, but they are part of the full schedule.

Towards better ALMA data through faster feedback on observations

ALMA observations go through a rigorous quality assurance (QA) process to ensure that the final data products meet the parameters required for the given science goals. The first basic checks, known as QA0, are performed shortly after each of the individual Execution Blocks (EBs) — the smallest schedulable ALMA observations — is executed. The observatory also monitors array and antenna performance parameters to ensure high data quality, in a process known as QA1. Observations that pass QA0 are then calibrated and imaged, either using the ALMA pipeline or, in some cases, manually, and are subjected to a final assessment known as QA2.

However, the QA2 processing does not take place until a sufficient number of Execution Blocks have been accumulated. For extended observations, weeks can elapse between the first Execution Block and the final QA2 assessment. If a problem is identified in the QA2 phase, for example if some data need to be excluded from further processing, the desired sensitivity level may not be reached for the observations. At this point it may be too late to repeat the observations, for example if the ALMA antennas have been reconfigured in the meantime.

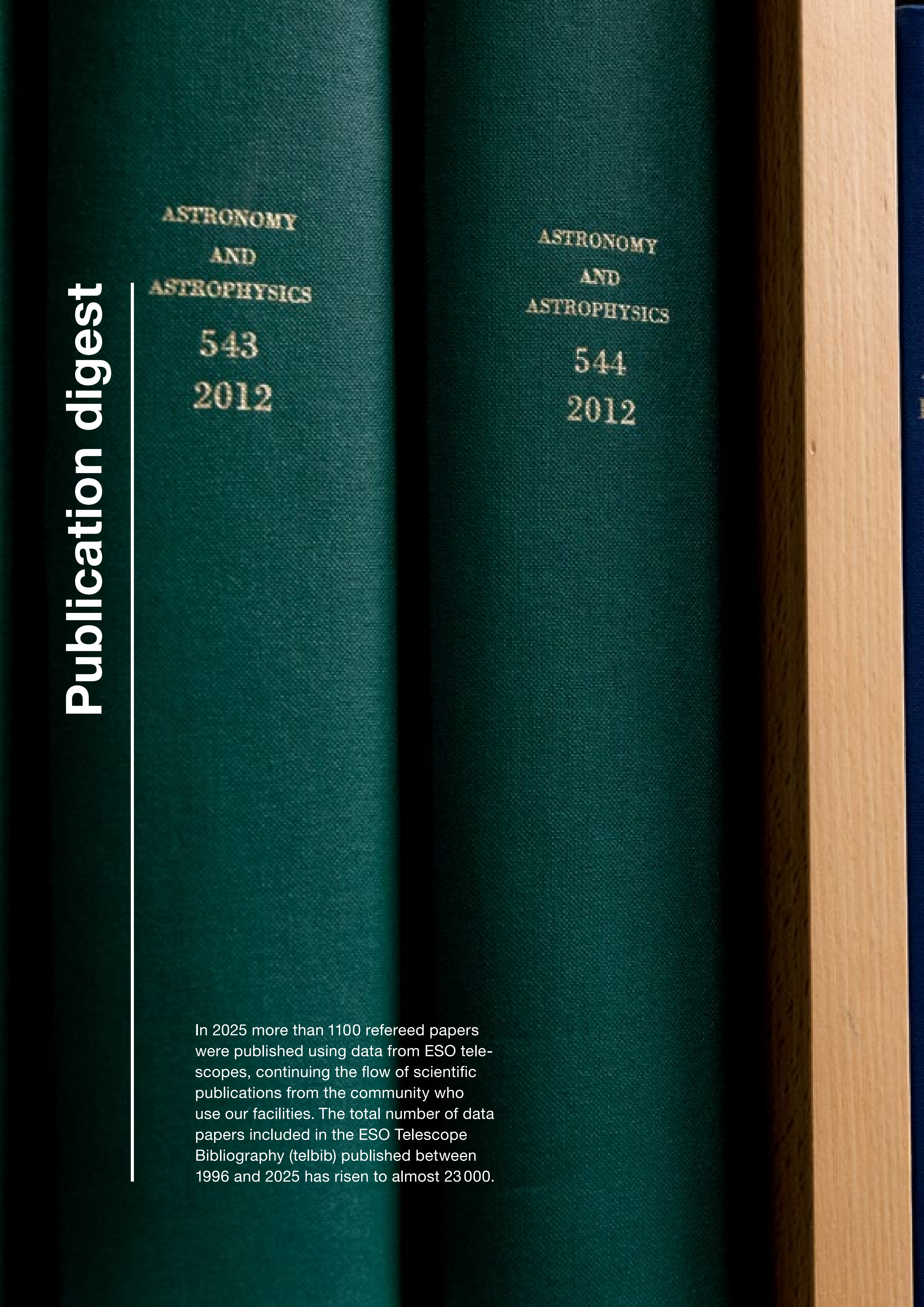
The ALMA Fast Feedback Project is developing ways to identify potential issues with observations faster. It involves major changes in the data processing software and workflow, by splitting the calibration and image processing parts of QA2, to perform the calibrations immediately after each Execution Block is run, rather than waiting for the rest of the QA2 process. This delivers valuable feedback on a timescale of hours, letting the observatory know the amount of good data obtained. If there is a problem, this can be discovered in time to schedule new observations within the next days.

The project began in 2025, and initial tests in October 2025 provided valuable feedback. Further development was ongoing at the end of the year, with the goal of testing in restricted operations in early 2026. The Fast Feedback approach offers the possibility of making more effective use of ALMA observing time, with data more reliably passing the QA2 checks, and providing better science data products for researchers.

Six of ALMA's sixty-six antennas on the Chajnantor plateau. The antennas are pointed towards the Sun to help thaw snow that accumulated on them after a snowfall.

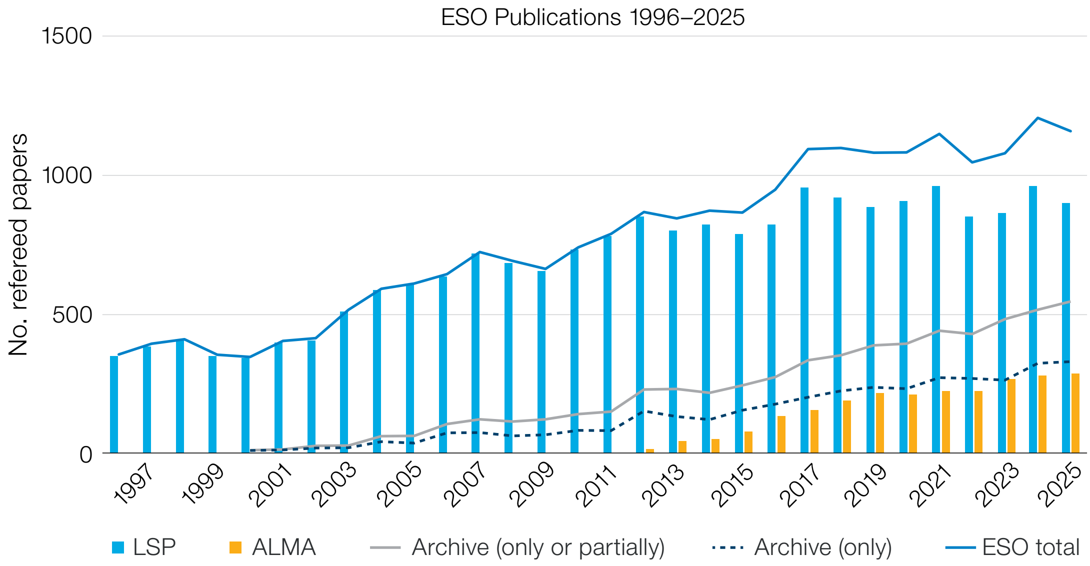
S. Otarola/ESO

Publication digest



In 2025 more than 1100 refereed papers were published using data from ESO telescopes, continuing the flow of scientific publications from the community who use our facilities. The total number of data papers included in the ESO Telescope Bibliography (telbib) published between 1996 and 2025 has risen to almost 23 000.

V. Gonzalez/ESO



The chart gives an overview of refereed papers using ESO data, by year of publication. Only data taken in ESO observing time are counted, that is, time recommended by the ESO Observing Programmes Committee (OPC), or ESO's share of observing time for ALMA.

La Silla Paranal: papers that use data taken in ESO observing time at the La Silla Paranal Observatory, including the VLT and VLTI, the La Silla facilities, the VISTA and VST survey telescopes, and APEX. Papers are shown by publication year, so may appear after the end of ESO observations on telescopes which have since become hosted facilities, such as VST and APEX.

ALMA: papers that use data taken in ESO observing time at ALMA.

ESO total: these are all papers that use data taken in ESO observing time at La Silla Paranal or ALMA. Papers may use data from both facilities, so this total cannot be calculated by adding the separate La Silla Paranal and ALMA statistics.

J. Looten/ESO

Archival papers

An archival paper uses ESO data (from La Silla Paranal or ALMA) but none of the original observers are among the authors of the paper. These data are accessed via the ESO Science Archive. The number of such papers has increased steadily in recent years, demonstrating the important legacy value of the archive.

Archive (only) means that the paper uses ESO archival data but no ESO data obtained directly by the authors as original observers.

Archive (only or partially) means that the paper uses ESO archival data and may also make use of ESO data obtained by the authors as original observers.

About these statistics

These statistics are derived from telbib, a database curated and developed by ESO to link publications with data in the ESO Science Archive and help evaluate ESO's productivity and impact. Whilst text-mining scripts are applied to screen the literature for papers using ESO data, papers are carefully examined by human curators to ensure that telbib only includes papers that are refereed, which make direct use of data (as opposed to in review articles or in citations), and that these data were obtained in ESO observing time.

The telbib website, at telbib.eso.org, offers visualisations of search results including on-the-fly graphs and predefined charts, as well as details of the methodology used to screen and classify papers.

Records of all 2025 data papers written by the ESO user community can be accessed at https://telbib.eso.org/ESODataPapers2025.php

ESO's Paranal Observatory at sunset. The pinkish band in the sky is the Belt of Venus, an atmospheric phenomenon caused by the scattering of sunlight at sunrise or sunset.

Technology development and R&D

A closeup of the CaNaPy laser guide star adaptive optics bench. The scene is illuminated by scattered laser light. In the foreground, the laser beam is wide and therefore harder to see. In the background, it is focused and more easily visible.

Technology development and R&D are activities at ESO that are vital to making our vision and mission possible. We aim to develop and secure key technologies which will keep our facilities at the forefront of astronomy, by taking technologies that are at low levels of technological readiness and developing them to a level sufficient to be incorporated in new projects.

Keeping ESO facilities at the forefront of astronomy

Technology development projects are funded by ESO through its Technology Development Programme and its ALMA Development Programme. In the case of ALMA, the North American and East Asian ALMA partners also run similar programmes.

A full list of ESO's currently running technology development projects can be seen in the tables below, and selected highlights from the year are presented.

In addition to the ongoing technology development projects, our engineers are engaged in a wide range of further research and development activities, which come from across the engineering disciplines at ESO, using our laboratory infrastructure and funding from the Directorate of Engineering.

ESO's Technology Development projects running during 2025

Project	Description
Astrocomb design study	Development of a next-generation laser frequency comb calibration system for ESO's high resolution spectrographs
ATTRACT Phase 2 & 1B	ESO's activity as a consortium partner in ATTRACT, a Horizon 2020 research and innovation project funded by the European Union
Curved CCD Project	Investigating potential curved CCD detectors for future astronomical instruments
Curved CMOS design study and prototyping	Investigating potential curved CMOS detectors for future astronomical instruments
Deformable Mirror Development	Development of deformable mirrors for adaptive optics instruments for both the VLT and the ELT
Laser Guide Star Systems R&D	Development of the CaNaPy laser guide star adaptive optics facility and the Wendelstein Laser Guide Star System
New General Controller II	Development of NGCII, a customisable controller platform for all infrared and optical detectors for all VLT and ELT instruments in construction
PCS Technology Development (Phase 2)	Technology development for the Planetary Camera and Spectrograph, a future planet-finding instrument for ELT
PLANETES	Developing technologies for PLANETES, a system for high-contrast planet detection with the VLTI. Part of a European Research Council funded project.
SAXO+ demonstrator on SPHERE	Developing a second-stage adaptive optics system for high-contrast imaging, which will be a technology demonstrator for the ELT's Planetary Camera and Spectrograph
GPU Technology for Correlators	Investigating potential use of Graphics Processing Units for radio and (sub)millimetre interferometry correlators
Cryogenic Amplifiers for advanced ALMA Receivers	Developing prototype cryogenic low-noise broadband IF and RF amplifiers for ALMA receivers

A list of partner institutes for ESO's Technology Development projects can be found at https://www.eso.org/sci/future/techdev.html

ESO's ALMA Development studies running during 2025

Study	Description
Development of InP MMIC based Wideband Low-Noise Amplifiers for the Next Generation ALMA Receivers	Developing cryogenic low-noise broadband IF amplifiers based on monolithic microwave integrated circuits (MMICs) for ALMA receivers
TASER: Towards ALMA System on Chip European Receivers	Extending MMIC technology to further integrate higher-frequency RF amplifiers and other ALMA receiver components
Towards a Producible ALMA2030-Ready Band 9 CCA	Producing a refurbished ALMA Band 9 cold cartridge receiver compatible with the Wideband Sensitivity Upgrade requirements
Streaming visibility processing for ALMA	Investigating a streaming approach to the initial processing of raw ALMA data from the correlator
Advanced waveguide component technologies	Developing a new low-loss microfabrication technique for waveguide components to improve the sensitivity of ALMA receivers
ALMA Band 6 and 7 Cold Cartridge Demonstrator	Investigating the additional upgrade requirements, on all the ALMA Band 6 and 7 receiver components, of a significant increase in IF bandwidth
Towards High-resolution Solar ALMA Images Overcoming current ObsMode limitations	Verifying if ALMA observations of the Sun can be made in more extended antenna configurations, increasing both spatial resolution and available observing time
Scientific opportunities and technical considerations for the development of ALMA focal plane arrays	Defining transformative yet technically attainable science cases for potential focal-plane arrays for ALMA.
Prototype for ALMA Spectral Line Advanced Data Product Pipeline	Optimising an automated spectral line detection method on ALMA data cubes and developing an imaging pipeline to derive scientifically relevant information from them

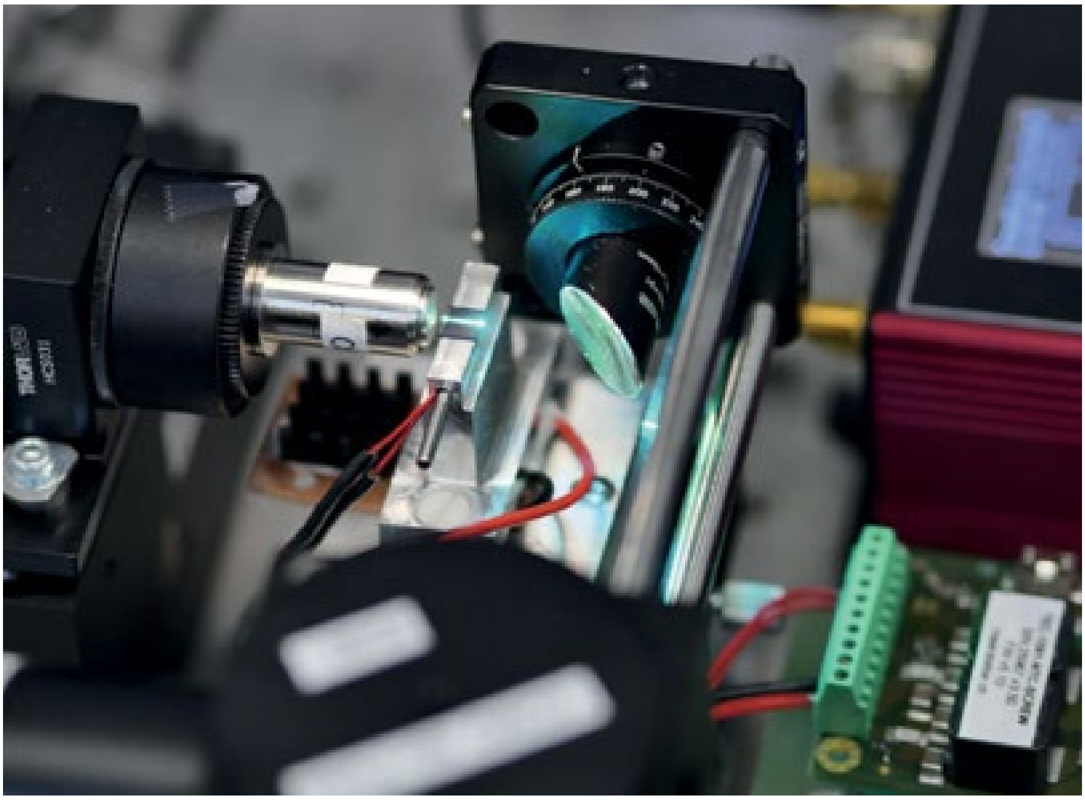
A list of partner institutes for ESO's ALMA Development studies can be found at https://www.eso.org/sci/facilities/alma/development-studies.html

Prototyping new technologies for astrocombs

Laser frequency combs (LFCs) are optical devices that produce a series of spectral lines that are equally spaced in frequency. They can therefore serve as very precise and stable 'rulers' for measuring the frequencies of light in astronomical spectral observations.

The first 'astrocomb' — an LFC tailored for astronomical purposes — was developed by ESO, partner institutes and industry, and was installed on the HARPS planet-finder instrument on the ESO 3.6-metre telescope in 2015. Subsequently, astrocombs have also been installed on the NIRPS instrument, which works with HARPS, and on the ESPRESSO instrument on the VLT.

Now, an ESO Technology Development project, as well as another collaboration between research institutes, industry and ESO, have studied technologies and developed hardware prototypes for next-generation astrocombs.



CSEM/Ewelina Obrzud

Testing a prototype photonic chip for an astrocomb on an optical bench. The chip is the small square in the centre of the image with the line of light passing through it. The light of the seed comb enters the chip from the left, and the broadened comb exits on the right, where it is reflected off a mirror.

EPFL/CSEM and the BLUVES project

Close-up of a prototype photonic chip for an astrocomb. The waveguides are visible as horizontal lines. The chip is about 5 mm on each side.

The starting point for an astrocomb is a ‘seed’ frequency comb created with a rapid series of very short laser pulses. The first prototype developed by this project is a seed comb using electro-optic components, which change their optical properties in response to an applied voltage. This is a newer technology than that used for the earliest astrocombs, such as the one on HARPS, which use fibre optics to create the seed comb. The more recent system in operation on NIRPS is also electro-optic, but the new prototype offers two important advantages. It has a higher repetition rate of the laser pulses, which produces a wider separation between the lines in the comb, and which in turn makes it easier for an astronomical instrument to distinguish them. It is also built using commercial off-the-shelf components, developed for fibre-optic communication in the telecommunications industry, which offers the possibility of easier manufacture without the need for custom components.

The second area of hardware development concerns the next step, taking the seed comb and broadening it with more lines to produce a ‘ruler’ long enough to be used as the astrocomb.

ESO, partner institutes and industry have collaborated on prototypes to perform this step with photonic devices, which manipulate light in monolithic chips, similar to microchips for electronics. Not only are photonic chips very compact (just centimetres in size) and stable, but they are relatively cheap and easy to reproduce.

The light of the seed comb is injected into a waveguide — a channel just a few micrometres across that guides light — created on a photonic chip. Nonlinear optical effects in the chip broaden the spectrum, producing the additional lines desired.

One of the advantages of using a photonic chip is that it can be manufactured with many slightly different waveguides on it and tested to determine which is the best. The next chip can then be made with waveguides using only the best parameters. Only one waveguide is needed to create the astrocomb, but the additional ones can act as spares.

These prototype electro-optic seed combs and photonic chips demonstrate a potential way forward for improved astrocombs, and therefore for future astronomical instruments.

Exploring novel technologies for laser guide star adaptive optics

CaNaPy is a laser guide star adaptive optics demonstrator being developed by ESO, institutional partners and industry, which was installed in 2023 on the ESA Optical Ground Station 1-metre telescope at the Observatorio del Teide, Tenerife.

CaNaPy is being used to explore novel technologies for laser guide star adaptive optics. One of these is the use of a deformable mirror not only to correct incoming signals for the turbulence in Earth's atmosphere, but also to adjust a laser guide star beam at launch, 'pre-compensating' for the atmosphere, and resulting in a smaller laser guide star spot. Another goal is to use a pyramid wavefront sensor — a different technology from the Shack-Hartmann wavefront sensors usually used, and one which can take advantage of a smaller laser spot size to enable better correction of atmospheric turbulence.

A limitation of existing laser guide star systems is that they still need at least one natural guide star to correct for the lowest-order 'tip-tilt' distortion of light by the atmosphere, which causes apparent wandering' of the image. CaNaPy's third major goal is to demonstrate the possibility of measuring the tip-tilt distortion using only a laser guide star, thus removing this final reliance on natural guide stars for adaptive optics.

In 2025 CaNaPy demonstrated an important step towards these goals. Using a sodium laser launched from a separate telescope — what's known as a bistatic configuration — the team successfully detected the laser guide star spot using the pyramid wavefront sensor, allowing them to measure the atmospheric turbulence and close the feedback loop to drive the deformable mirror. This is the first time that this has been achieved with a pyramid wavefront sensor and a sodium laser guide star.

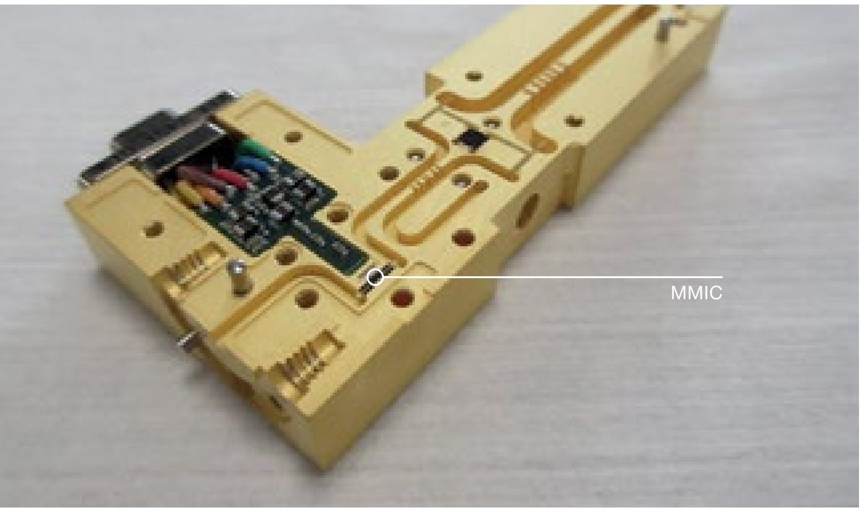
This was achieved not only at night but also during the day, which requires both a laser guide star with increased power and also a wavefront sensor with a very narrow-band magneto-optical filter, so it can observe the guide star without being blinded by sunlight.

Among the next steps for 2026 are to launch the laser from the same telescope that is used to observe the guide star, without the need for a separate launch telescope. This 'monostatic' configuration will make it possible to use the deformable mirror to pre-compensate the laser and produce a smaller laser guide star spot.

The techniques being explored with CaNaPy are not only relevant for astronomical observations. With the ability to operate during the day as well as the night, the technology could be used to improve communication with satellites, by pre-compensating communication lasers going from a ground-station to a satellite in Earth orbit.

The CaNaPy laser propagating from the ESA OGS telescope dome during the daytime.

TASER: Towards ALMA System-on-chip European Receivers



Hui Wang (RAL)

TASER Band 2 integrated low-noise amplifier and mixer. The monolithic microwave integrated circuit (MMIC) is labelled.

To deliver the necessary sensitivity and bandwidth for a telescope like ALMA, which operates at millimetre and submillimetre wavelengths, we need cryogenically-cooled receivers with low-noise amplifiers which amplify the faint signals to a level that can be processed by the rest of the system. They must operate either at the original very high radio frequency (RF) of the astronomical signal, or at a lower intermediate frequency (IF), to which the astronomical RF signal is downconverted.

The ESO ALMA development study TASER (Towards ALMA System-on-chip European Receivers), which was completed in 2025, has advanced the development of key technologies for producing compact ALMA receivers that integrate low-noise amplifiers with the mixers needed for the RF to IF frequency downconversion.

The benefits of receiver integration and miniaturisation include lower operational costs, more streamlined production, testing and setup, and the potential for constructing high-density arrays of receivers.

Among the technologies used in the study are monolithic microwave integrated circuits (MMIC), where most of the circuitry is integrated on a single chip, offering benefits over designs using discrete components, such as the possibility of series production of the receivers.

TASER produced hardware prototypes in two areas.

The first was a proof-of-concept that uses MMIC technology to integrate a low-noise amplifier and a mixer, covering the frequency range of ALMA Band 2 (67–116 GHz). Testing of the prototypes confirmed that integration of the amplifier and mixer did not degrade the performance compared with separate components.

The second prototype was a mixer unit, built with discrete components rather than an MMIC but still compact in design, covering the higher frequency ALMA Bands 4 and 5 (125–211 GHz). Tests of the prototype demonstrated robust performance at room temperature, suggesting that the technology would perform competitively at cryogenic temperatures, and the components' compact design and other characteristics make this concept highly suitable for future ALMA upgrades.

A further feasibility study looked ahead and investigated the practicability of an integrated design combining both a mixer and an amplifier in one MMIC, again for ALMA Band 4 and 5. The study explored integration strategies and technologies, examined trade-offs between size, performance and manufacturability, and promising routes for further miniaturisation and improved performance.

Streaming visibility processing for ALMA

ALMA uses a very powerful specialised supercomputer — known as the correlator — to combine the flood of signals coming from its many antennas. The raw data from the correlator are known as the 'visibilities'. The data rate is already very high and the forthcoming Wideband Sensitivity Upgrade (see page 112) will increase this even more, by more than an order of magnitude, to as high as several tens of gigabytes per second. At these rates, it becomes increasingly difficult to store the raw visibility data for a full observation before starting the further data processing needed to produce science-ready data.

A new development study has therefore investigated the possibility of doing the initial processing of the visibility data in a streaming process. The goal is to perform the initial processing in real time, up to a point where the raw data are reduced to more tractable rates for subsequent processing. The study successfully demonstrated compression of real ALMA visibility data by up to a factor of four before writing the data to storage, without any significant loss in the quality of the scientific end products.

This study builds on synergies with the LOFAR and SKA telescopes, which are also interferometric telescopes with correlators, as it uses the Default PreProcessing Pipeline (DP3), a modular software framework for LOFAR and SKAO that this study demonstrated can also be adapted to be used on ALMA data.

Another potential use for streaming visibility processing is to generate low-latency images from the ALMA data in close to real time. In normal operations, it can take from minutes to hours to generate an initial 'quick-look' image from observations. With streaming visibility processing, not only could a quick-look image be generated within seconds, but additional calibrations can be applied while doing so, thus giving ALMA astronomers on duty higher-quality and more useful feedback almost immediately, allowing them to make near real-time decisions about ongoing observations.

A final review meeting for this development study was held in December 2025, demonstrating the successful results and leaving only a handful of close-out items to be completed in early 2026. The streaming visibility processing concept has been shown to offer many potential benefits, especially as ALMA prepares for the higher data rates of the WSU era.

The streaming visibility processing study has investigated processing the flood of raw data from ALMA's correlator, seen here, in real-time to reduce it a more tractable rate before storage.

ALMA (ESO/NAOJ/NRAO), S. Argandoña

Organisational matters

Delivering ESO's wide-ranging and ambitious programme is only possible thanks to the work of all areas of the organisation, from our engineers and scientists, to our administrators and support staff.

Running an international organisation with sites in two Host States, Germany and Chile, and multiple collaborations with partners around the world, requires complex administration, in areas including human resources, contracts and procurement, facilities management, and logistics and transport activities, including shipments of hardware between Europe and Chile, and domestic and international travel for staff and visitors.

ESO was established as an intergovernmental organisation by its Member States in order to ensure that it could function independently and effectively. Accordingly, some aspects of how ESO operates reflect this intergovernmental status, such as the implementation of internal rules and regulations that take into account international recommendations, standards and best practices.

Whether our work is directly visible to our communities in our facilities, activities and publications, or is in the equally essential internal tasks that allow the organisation to operate, all parts of ESO act together to ensure that we can fulfil our mission, successfully, efficiently, and safely, throughout the year.

Progress on ESO's Sustainability Strategy

Following the approval of ESO's Sustainability Strategy in 2024, 2025 saw important work on its implementation, starting with the development of policies, guidelines and Local Action Plans (LAPs). The LAPs will translate global sustainability targets into concrete, site-specific initiatives. They combine top-down projects — defined by ESO's management and addressing strategic and operational needs — and bottom-up contributions from staff, fostering engagement across ESO. Staff contributed dozens of ideas for the LAPs, in areas including energy efficiency, greenhouse gas emissions reduction, sustainable mobility, resource circularity, water conservation, well-being, and improved communication on sustainability initiatives. Selected initiatives were incorporated into the draft LAPs, which were being finalised at the end of the year in preparation for submission to the Directors Team for approval.

In mid-2025 preparation of ESO's first Sustainability Report began. The report is intended to increase transparency, demonstrate accountability and track progress. The report will be based on the GRI (Global Reporting Initiative) Standards and mapped to the UN Sustainable Development Goals.

An external consultancy began working closely with ESO teams in Garching and Vitacura and at the observatory sites to define the report structure and list of 'disclosures' — the specific data or information to be reported according to our sustainability priorities and the GRI standards. The external consultants are also reviewing current practices and ongoing initiatives, and setting up the data collection processes needed for this report and for transparent and consistent future tracking of ESO's sustainability progress.

ESO's Sustainability Strategy sets ten organisational targets, grouped into three pillars.

Improving accessibility for wheelchair users at ESO in Vitacura

A ‘Wheelchair Day’ was held at the ESO premises in Vitacura in May, to share first-hand insight into the experiences of wheelchair users, reflect on the accessibility of the site, and collaborate on making ESO more inclusive for everyone.

After an introductory talk and discussion about the general challenges encountered by wheelchair users in their day-to-day activities, a number of attendees — who did not usually use wheelchairs — tried navigating the ESO Vitacura site in wheelchairs and engaging in everyday tasks. Participants discussed the difficulties they encountered and suggested ways to mitigate them. The suggestions are being used to inform potential improvements to the site in the short, medium and long term

At ‘Wheelchair Day’ attendees who do not usually use wheelchairs tried navigating the ESO Vitacura site.

ESO launches e-Connect project to implement new ERP system

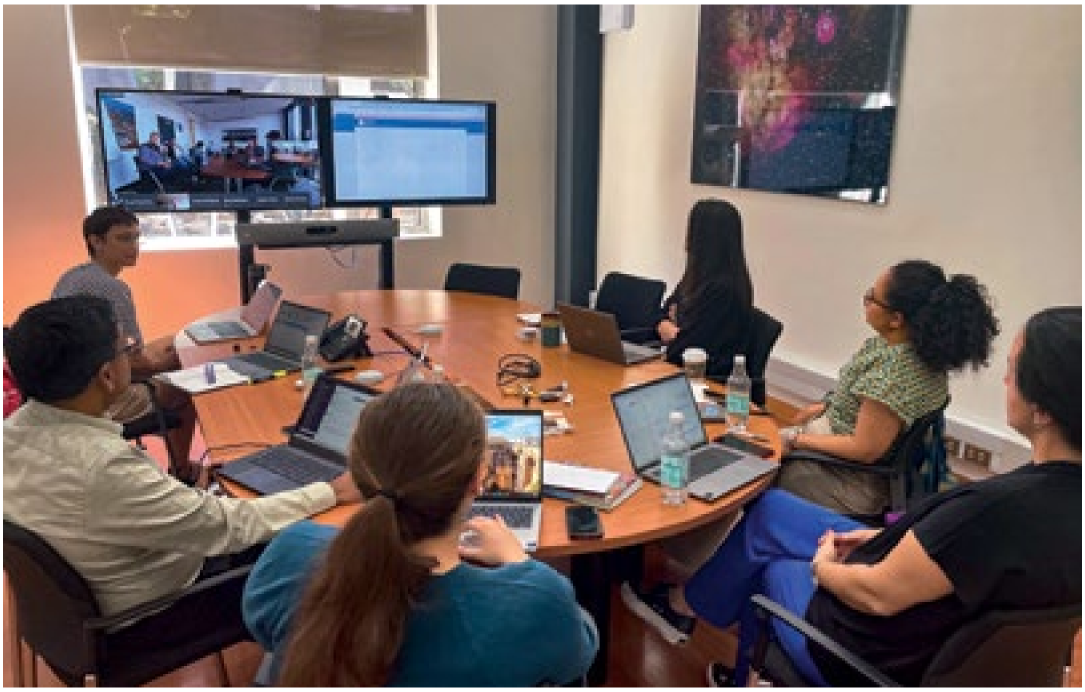
In February 2025 ESO launched the e-Connect project, to replace ESO's existing Enterprise Resource Planning (ERP) system with a modern solution aimed at improving efficiency, data management and business processes. The project launch followed a preparation phase starting in 2022 that included in-depth analysis and comprehensive evaluation of providers, and an extensive procurement process.

An intense design phase ran from mid-June to early August, during which over 50 ESO staff from Garching and Chile met in person at the Garching headquarters in daily workshops with consultants from the new ERP provider. They designed over 250 business processes, discussing the best possible solutions to meet ESO's requirements.

The implementation of the new system is taking place in four 'waves' covering different areas: human resources; finance, procurement and logistics; payroll, time and labour; and project management tools.

In the fourth quarter, the first 'playback sessions' took place, for the human resources and the finance, procurement and logistics waves. These sessions saw the first tests of the ESO business processes on the new platform, using relevant use cases and real ESO data. This allowed the team to validate decisions, identify necessary refinements and capture early training and communication needs.

Further playback sessions, including those for the other two project waves, are scheduled for 2026. The first end-user training is planned for mid-2026 and phased deployment of the live system, starting with the human resources wave, is planned to begin in the second half of the year.



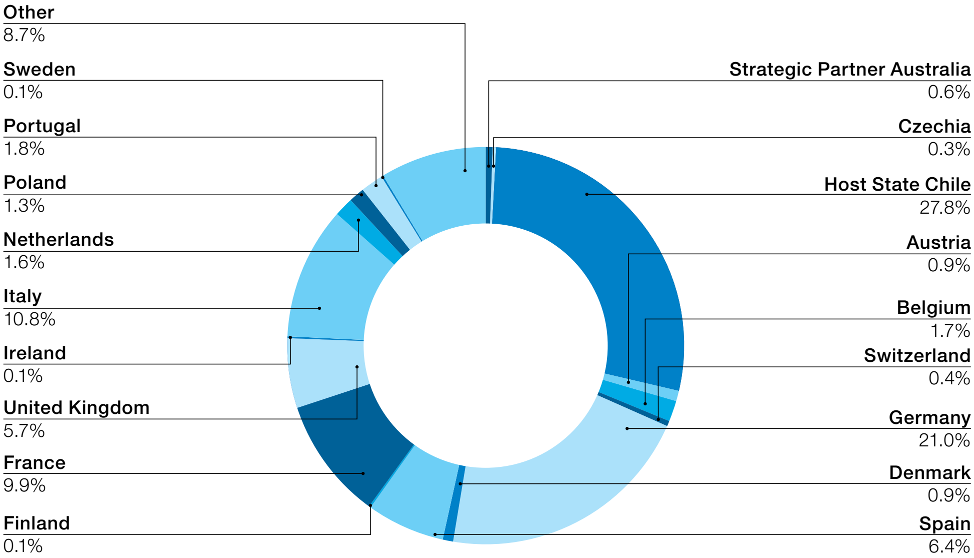
Teams in Vitacura and Garching take part in a joint 'playback session' for the e-Connect project.

People at ESO

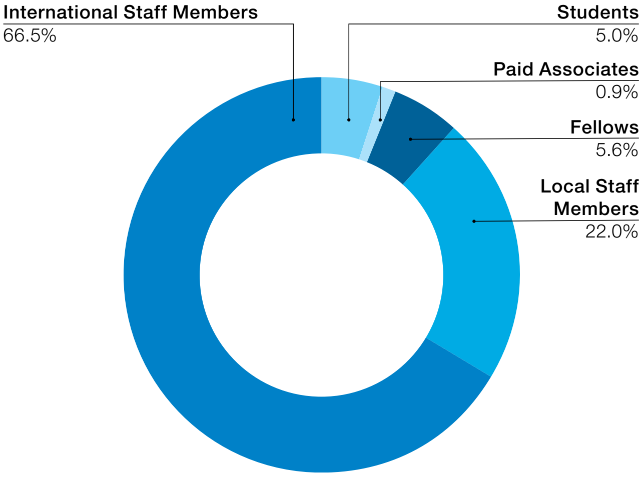
An essential ingredient of ESO's continued success is our highly talented, committed and hard-working staff.

We employ around 800 people, drawn from about 50 different nationalities.

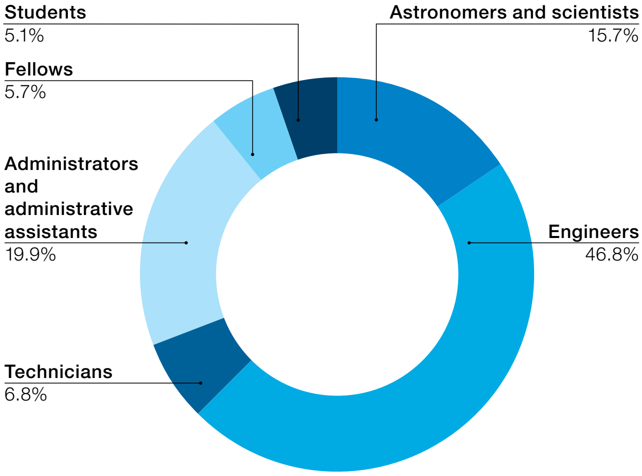
Distribution of International Staff Members and Local Staff Members by nationality (December 2025)



Distribution of ESO personnel by staff category (December 2025)



Distribution of ESO personnel by job category (December 2025)



Launch of ESO's People Strategy

In mid-2025 ESO launched its People Strategy to strengthen how the organisation manages, develops and supports people at ESO — the organisation's key resource — over the coming decade. The transformation initiative aims to ensure that ESO attracts and retains the people we need and equips them with the necessary skills to fulfil our mission to design, build and operate world-class observatories, and to foster cooperation for astronomy in an increasingly complex environment.

A consultation conducted in collaboration with an external partner took place between June and October, comprising a survey, 35 individual interviews and 25 focus groups and involving a total of around 200 staff across all ESO sites, in Garching and Chile. The conversations covered fundamental topics such as how we collaborate, lead and support staff members, grow and develop them, and how we could strengthen our workplace culture. The candid feedback shared during this phase was invaluable and will directly inform the following stages of this project.

The strategy development stage followed the consultation and ran until the end of the year. The project team synthesised insights from the consultation to identify and define shared priorities, and create a roadmap for implementation of the strategy, to begin in September 2026.

Results from a gender pay audit at ESO

As part of our commitment to diversity, equity and inclusion, and following the results of the organisation's first, internal, gender pay audit in 2023, ESO engaged an external consultancy company to conduct a more detailed assessment in 2025. The analysis covered all employees with a fixed and long-term contract (International Staff Members and Local Staff Members), who were actively employed in December 2024.

A key objective is that of "equal pay for equal work": men and women who perform the same work should not receive different pay because of their gender alone. The study analysed the pay of men and women under the same job conditions, that is taking into account factors such as job classification (career path and job family), and time in position. The analysis showed a pay gap among International Staff Members of 3.1% in favour of men, and among Local Staff Members of 4.6% in favour of women.

The next steps for ESO include the definition of realistic and achievable targets and indicators for the gender pay gaps, as well as actions, monitoring tools, and training to address these gaps and ensure our practices continue to evolve in line with the organisation's commitment to fairness.

Introducing Sara Krauss as Director of Engineering

ESO's new Director of Engineering, Sara Krauss, took office on 1 January 2025. Sara is a British-German national, who has a bachelor's degree in aeronautical engineering and a research master's degree in mechanical engineering from the City University, London, a PhD in engineering (propulsion systems) from the University of Cambridge, and an executive master's degree in major programme management from the University of Oxford.

During her extensive career in aerospace spanning over 20 years, she has worked in leading organisations in both industry and the public sector, including Rolls Royce Plc, Airbus Defence & Space, the DLR Space Applications Institute, and the EU Agency for Space Programme (EUSPA), where she held the role of Head of Engineering immediately prior to joining ESO.

Driven by a deep passion for space, in her roles starting as an engineer and progressing to executive management she has led large multi-disciplinary teams, working in complex multi-billion-euro international programmes. Her strong motivation to push technology and knowledge frontiers further, delivering infrastructure and services to stakeholders, is what attracted her to join ESO and to contribute to the ELT and our other programmes.

Introducing Jarle Brinchmann as Director for Science

ESO's new Director for Science, Jarle Brinchmann, took office on 1 April 2025. A Norwegian national, Jarle has bachelor's and master's degrees from the University of Oslo, and a PhD from the University of Cambridge. He has held positions at the University of Oxford, the Max Planck Institute for Astrophysics, and the University of Leiden. Jarle's most recent roles before coming to ESO were as coordinator of the Institute for Astrophysics and Space Sciences in Portugal, and as assistant professor and Director of the Centre for Astrophysics at the University of Porto.

Jarle has extensive expertise in galaxy evolution, stellar populations and dark matter in galaxies, the inference of physical parameters of galaxies from spectroscopy and photometry, and machine learning and statistical methods in astronomy, and has been heavily involved in the Euclid space mission.

Jarle already had long-standing connections with ESO, ranging from membership of the working group that provided the first look at the instrumentation for the ELT to membership of the MUSE Guaranteed Time Observations team and being a frequent member of the Observing Programmes Committee and other ad-hoc committees. He was also, until 31 December 2024, a member of the Scientific Technical Committee and chaired its ELT Subcommittee.

G. Doyen/ESO

Guide-star lasers from the VLT's Unit Telescope 4 at Paranal. The bluish band in the sky is zodiacal light — sunlight scattered by interplanetary dust in our Solar System — visible clearly only in places with very dark skies such as Paranal.

Finance and budget

The External Auditors, from the Spanish Court of Audit, have expressed their opinion that the financial statements for 2025 give a true and fair view of the affairs of the Organisation.

The accounting statements for 2025 show a positive result of 47.1 million euros. The operating income increased by 9.2 million euros, mainly due to the in-kind income following the release of liability for Guaranteed Time for Observation (GTO) to Consortia members participating in the Organisation's Instrumentation programme.

The surplus from operating activities amounted to 43.8 million euros. Financial activities generated a net surplus of 3.2 million euros, mainly as a result of increased investment activity, which resulted in considerable interest income from deposits. There was also a surplus of 0.1 million euros from non-periodic and extraordinary revenues and expenditures. This revenue was primarily generated by the outcome of the Supreme Court of Chile's decision regarding a tax reimbursement case ongoing since 2012. The release of accruals and income related to grant agreements from previous years further contributed to the positive result.

The net assets of the organisation have increased by 272.1 million euros, mainly thanks to actuarial gains for both the Pension Fund and the Health Fund, the valuation of the Non-Deliverable Forward (NDF) agreement concluded for the period 2026–2030, and the current year's gain.

Total cash flow in 2025 was positive by 106.8 million euros, as the organisation received long-term loans.

Operational cash flow amounted to 135.4 million euros. The closing cash position at 31 December 2025 stood at 256.6 million euros.

ESO Council approved the budget for 2026 in December 2025. The approved 2026 expenditure budget amounts to 394.1 million euros, remaining considerably high, with a large fraction dedicated to the ELT programme.

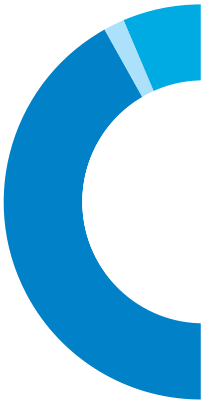
The 2026 approved income budget amounts to 284.8 million euros. It comprises the regular contributions from the ESO Member States including their additional contributions for the ELT, income from third parties and partners, and other income.

Financial Statements 2025

Accounting Statements 2025
(in €1000)

Statement of Financial Position	31.12.2025	31.12.2024
Assets		
Cash and cash equivalents	256 568	149 724
Inventories, receivables, advances and other current assets	69 417	99 502
Non-current assets	1 678 345	1 525 013
Total Assets	**2 004 330**	**1 774 239**
Liabilities		
Payables, advances received and other current liabilities	68 144	64 427
Non-current liabilities	1 005 171	1 050 886
Total Liabilities	**1 073 315**	**1 115 313**
Accumulated surpluses/deficits	658 926	760 403
Other changes in net assets	224 955	– 150 246
Net surplus/deficit for the year	47 134	48 769
Total Net Assets	**931 015**	**658 926**
Total Liabilities and Net Assets	**2 004 330**	**1 774 239**

Assets 2025



Cash and cash equivalents
Inventories, receivables, advances and other current assets
Non-current assets

Liabilities 2025

Payables, advances received and other current liabilities
Non-current liabilities
Accumulated surpluses/deficits incl. other net changes
Net surplus/deficit for the year

Cash Flow Statement	2025	2024
Cash Flow		
Net surplus for the year	47 134	48 769
Non cash relevant transactions	83 792	90 775
Changes in current assets and liabilities	4 460	– 10 715
Net Cash Flow from Operating Activities	**135 386**	**128 829**
Net Cash Flow from Investment Activities	**–145 767**	**–162 573**
Net Cash Flow from Financing Activities	**117 225**	**3 469**
Net Cash Flow = Net Increase/Decrease in Cash and Cash Equivalents	**106 844**	**–30 275**

External auditors, Spanish Court of Audit

Enriqueta Chicano Jávega (External Auditor, President of the Spanish Court of Audit)
Santiago Martinez Arguelles (Director General)
Guadalupe Fernández Espinosa (Director International Relations and Coordinator)
Beatriz Sanchez Almendros (Audit Manager)
Alberto Sánchez Chaves (Senior Auditor)
Javier Regueiro Lopez (Senior Auditor)
Aranzazu Piñeiro Hernaiz (Contracts and Procurement Senior Auditor)
Paloma Pardo Oláguez (Contracts and Procurement Auditor)
Jaime Ramos Fuentes (In-house IT Support)

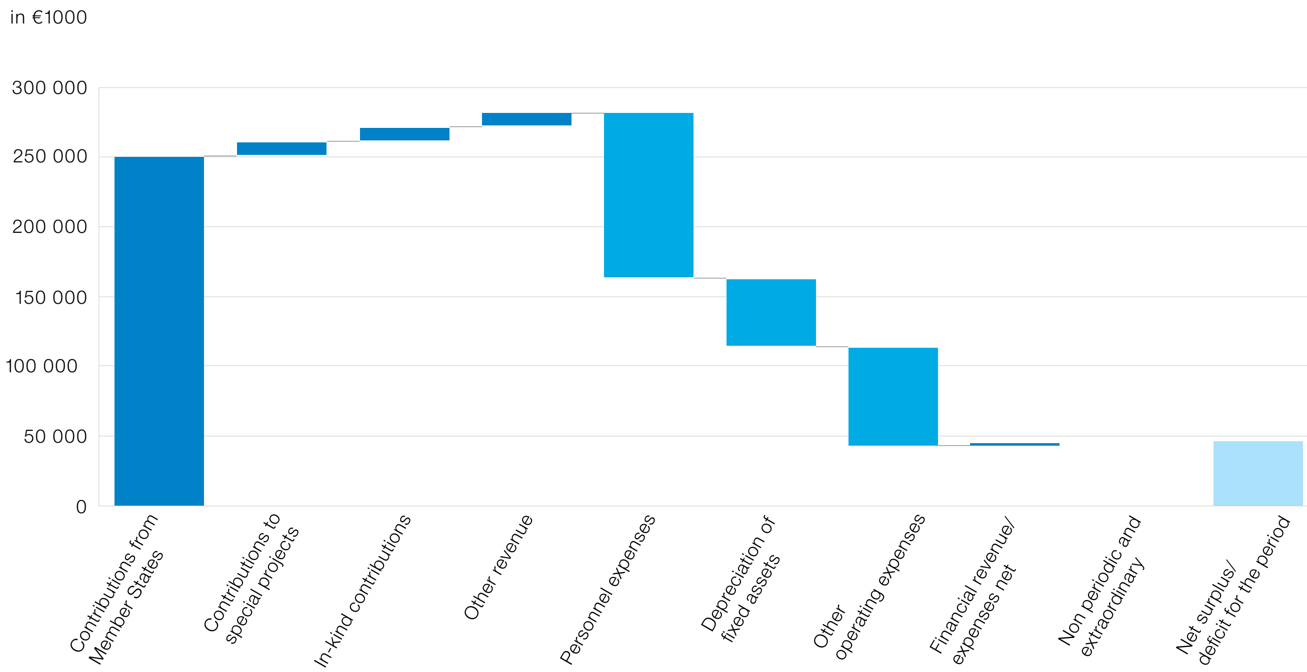
Statement of Financial Performance	2025	2024
Operating Revenue		
Contributions from Member States	250 322	250 512
Contributions to special projects	11 159	10 880
In-kind contributions	10 805	3 826
Other revenue	10 807	8 692
Total Operating Revenue	**283 093**	**273 910**
Operating Expenses		
Personnel expenses	118 779	105 950
Depreciation of fixed assets	49 262	59 462
Other operating expenses	71 259	71 670
Total Operating Expenses	**239 300**	**237 082**
Net Surplus/Deficit from Operating Activities	**43 793**	**36 828**
Net Surplus/Deficit from Financial Activities	**3 230**	**6 373**
Net Surplus/Deficit from Non-periodic and Extraordinary Activities	**111**	**5 568**
Net Surplus/Deficit for the Period	**47 134**	**48 769**

Budgetary Reports 2025
(in €1000)

Income Budget	Actual	Budget
Contributions from Member States	255 313	235 134
Income from partnerships	12 044	22 055
Income from third parties	4 552	3 467
Other income	4 746	3 865
Consolidated entities	4 766	3 441
Total Income Budget	**281 422**	**267 962**

Expenditure Budget	Actual	Budget
Programmes	151 733	198 625
Technical infrastructure and production	8 502	10 709
Operations	89 581	118 005
Science support	8 974	11 561
Other expenses	4 800	4 378
General activities	39 907	46 550
Total Expenditure Budget	**303 497**	**389 828**

Statement of Financial Performance 2025



Budget for 2026
(in €1000)

Income Budget	2026 (Approved)
Contributions from Member States	236 256
Income from partnerships	37 465
Income from third parties	1 440
Other income	5 426
Consolidated entities	4 242
Total Income Budget	**284 829**

Expenditure Budget	2026 (Approved)
Programmes	192 425
Technical infrastructure and production	10 663
Operations	126 404
Science support	11 468
General activities	45 783
Other expenses incl. consolidated entities	7 403
Total Expenditure Budget	**394 146**

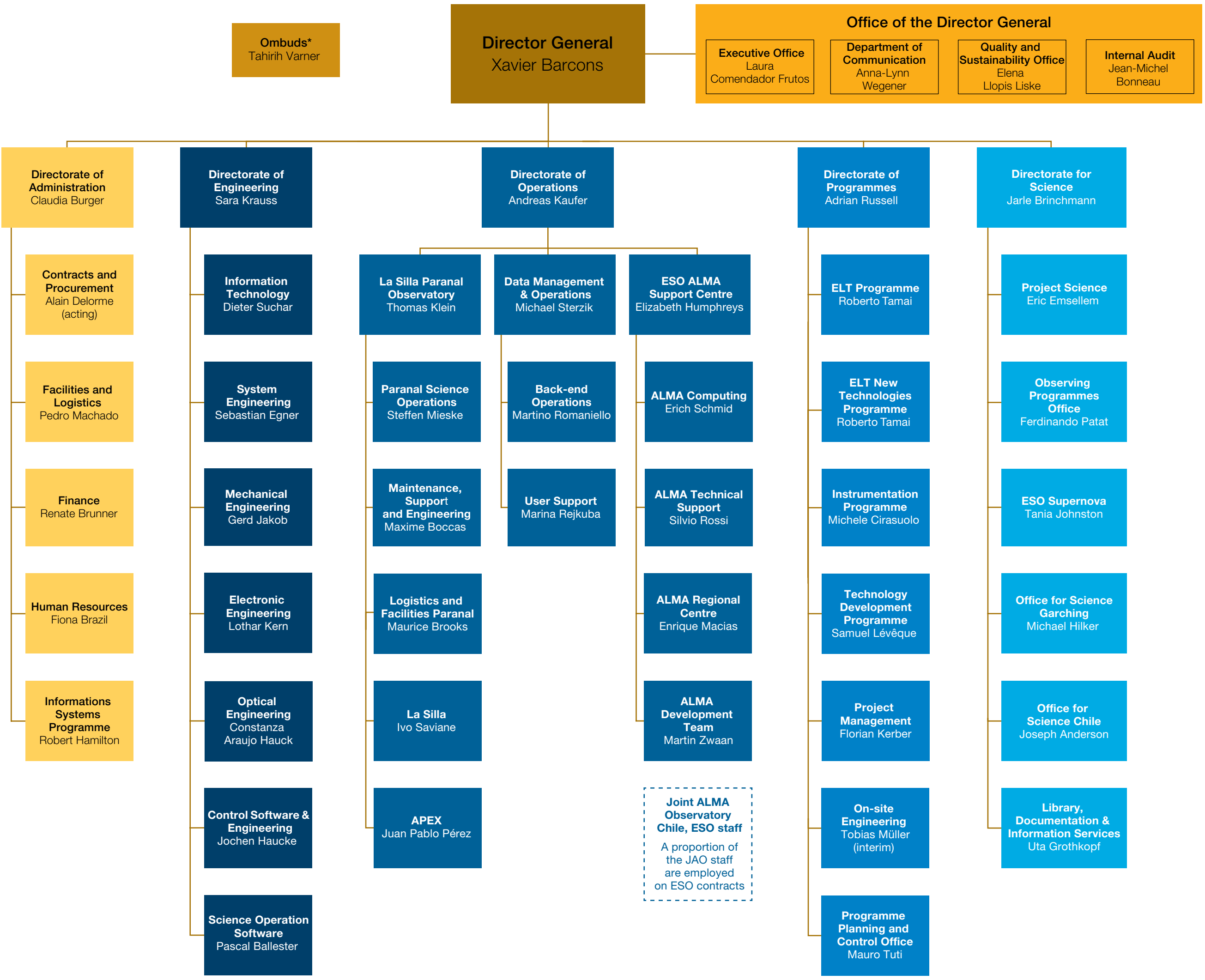
Income Budget for 2026
(in €1000)

Contributions from Member States
236 256
Income from partnerships
37 465
Other income
5 426
Consolidated entities
4 242
Income from third parties
1 440

Expenditure Budget for 2026
(in €1000)

Programmes
192 425
Operations
126 404
General activities
45 783
Science support
11 468
Technical infrastructure and production
10 663
Other expenses incl. consolidated entities
7 403

Organisational structure



*Independent as per Terms of Reference

Directorate of Administration

The Directorate of Administration comprises ESO's administration in Garching and in Chile, in charge of all administrative matters across the organisation. It also hosts the ESO-wide Quality and Information Systems (QIS) Programme. The Director of Administration is responsible for site safety in Garching, Vitacura and the Santiago Guesthouse.

Contracts and Procurement Department
is responsible for performing the procurements and sales needed by ESO, in compliance with the organisation's policies and procedures. The department also contributes to the administration of contracts after their award and provides commercial and contractual advice wherever requested internally.

Facilities and Logistics Department
plans, constructs, operates, and maintains ESO facilities, grounds, and infrastructure on the Garching and Vitacura campus, focusing on safety, as well as social, environmental, and economic sustainability. The department manages logistics operations, namely reception, imports/exports of goods into/from Germany and Chile, inland transports in Chile and Europe, shipments for the ESO web shop, and removals for staff in Europe and in Chile.

Finance Department
ensures that the financial resources entrusted to ESO are used according to the applicable rules and regulations, and in line with the directions defined by ESO's governing bodies. The department's activities cover four main areas: budgeting & controlling, accounting, invoice control and treasury. Finance also plays a key role in the long-term financial planning related to ESO's activities and strategic initiatives.

Human Resources Department
manages all services connected with employment at ESO, in Garching and Chile, including hiring, pay, benefits, training and development, travel, health, social security and wellbeing.

Information Systems Programme
leads and governs strategic planning and implementation of ESO's information, documentation, and configuration systems, aligning them with organisational needs, managing major projects and resources, and driving modernisation, data governance, and continuous improvement across the organisation.

Directorate of Engineering

The Directorate of Engineering provides Information Technology services and solutions across ESO, and engineering expertise to construction programmes by developing pioneering technologies and designing telescopes, instruments and technical infrastructure. The directorate supports observatory operations with science operation software and with equipment and control software upgrade projects, is responsible for engineering standards, and leads R&D projects to keep ESO facilities at the forefront of astronomy.

Information Technology Department
delivers IT services and solutions to all of ESO, enabling users and science operations to fulfil the ESO mission, whilst ensuring user satisfaction, operational stability, cybersecurity and continuous service improvement, in alignment with ESO's long-term organisational goals.

Systems Engineering Department
acts as Technical Authority within projects, coordinating the design and development of systems and subsystems throughout the development lifecycle. Work ranges from translating science goals into system technical requirements, to initiating technology developments, controlling technical baselines, managing configuration and interfaces, system modelling and analysis, managing the technical budgets, and providing Assembly, Integration, Verification and Commissioning support. In short they act as glue between science goals, engineering disciplines, operations and project management.

Mechanical Engineering Department
provides mechanical engineering expertise to all ESO programmes including design, analysis, manufacturing and assembly, integration and verification of mechanical, opto-mechanical, cryogenics, instrumentation, telescope and infrastructure systems.

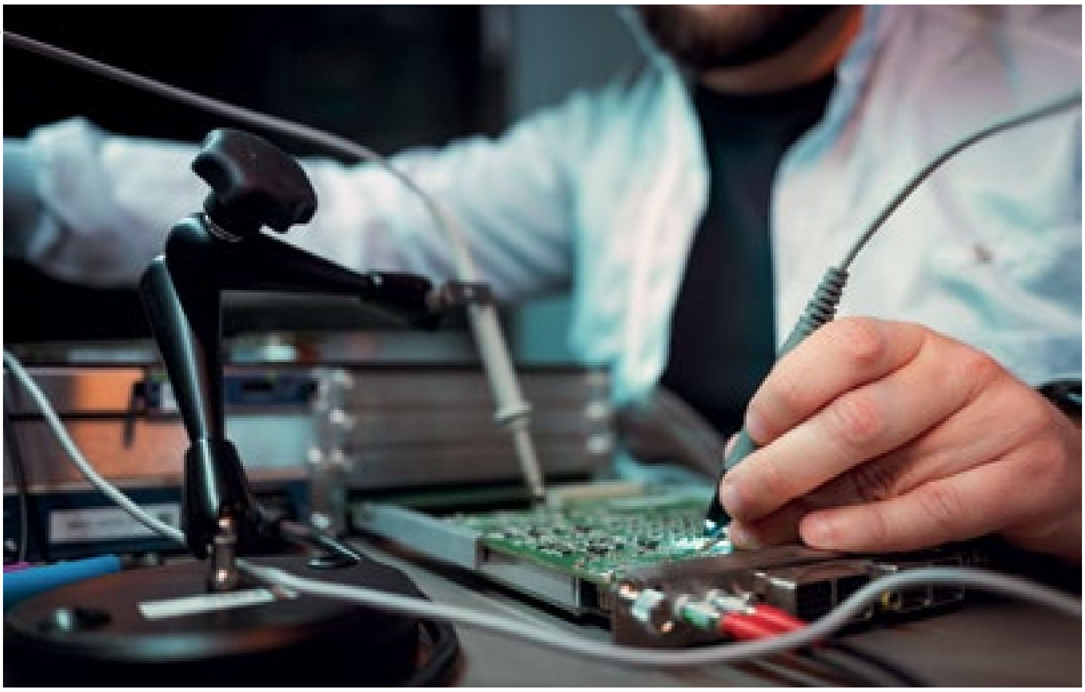
Electronic Engineering Department
is responsible for the definition, design and manufacturing of control electronic and detector systems and subsystems for telescopes and instruments, as well electrical compliance verification for all ESO projects. The department's expertise ranges from instrument and telescope control electronics and automation to detector system design, production, qualification and testing.

Optical Engineering Department
provides engineering expertise to the whole suite of ESO projects, in the areas of optical design and analysis, active optics, phasing, metrology for telescope alignment, laser guide stars, photonics technology and assembly, integration and testing of optical systems and instruments.

Control Software and Engineering Department
is responsible for the design, implementation, verification and commissioning of control systems, and for the development of control software for telescopes, astronomical instruments, and infrastructure projects over the full software lifecycle. This includes the development and maintenance of software frameworks.

Science Operation Software Department
is responsible for all science operation software for end-to-end operations of ESO observatories. This includes all components required for proposal submission, observation preparation, scheduling, execution, archiving, data processing, and quality control of observations. This software is used within the organisation as well as by the user community.

ESO/L. Calçada



Testing a hardware module for the NGC II detector controller.

Directorate of Operations

The Directorate of Operations is responsible for all science operations activities, encompassing preparation and execution of observing programmes, operation of the La Silla Paranal Observatory, and delivery of raw and calibrated data, including user support, data flow management, and science archive facilities. It also includes ESO's contribution to ALMA operations and development, and the construction support and future operation of the southern Cherenkov Telescope Array (CTAO-South).

La Silla Paranal Observatory

provides and operates telescopes and other facilities at the La Silla, Paranal, and APEX sites, including the VLT and VLTI, VISTA, ESO 3.6-metre telescope, and NTT, as well as several hosted telescopes including APEX. Paranal will also be responsible for operation of the ELT on Cerro Armazones, and CTAO-South.

Paranal Science Operations Department
is responsible for executing all scheduled observations and producing astronomical data of the highest quality. The department also maintains and improves the scientific and operational performance of the Paranal telescopes and instruments, and its instrument scientists lead the Instrument Operations Teams of all VLT and VLTI instruments.

Maintenance, Support and Engineering Department
is responsible for keeping the Paranal Observatory telescopes, instruments and key technical infrastructure operational, and at the expected technical performance, for use by Paranal Science Operations every day and every night of the year. To maximise the availability of our systems, we run an ongoing programme of maintenance and improvement.

Paranal Logistics and Facilities Department
ensures the delivery of consistent, budget-focused logistics and facilities services for the entire Paranal community, while maintaining the effective running of civil infrastructure on the site.

La Silla Department
is in charge of operating the NTT and 3.6-m telescopes, and supporting hosted projects on the La Silla site.

APEX Department
supports the operation by ESO of the APEX (Atacama Pathfinder Experiment) telescope, including the telescope site at 5100 metres altitude on Chajnantor, the base station at Sequitor near San Pedro de Atacama, and related logistics activities, as a hosted project on behalf of the Max Planck Institute for Radioastronomy.

Data Management and Operations Division

is responsible for off-site operations and user support of the La Silla Paranal Observatory in the framework of an end-to-end data flow system, maintaining the archive facility and its data holdings as a powerful scientific and operational resource. It owns and executes a development programme for integrated scientific operations of the VLT, VLTI and ELT.

User Support Department
ensures optimal preparation and efficient execution of Service Mode observations for the La Silla Paranal Observatory (LPO) and related reporting; implements and operates the support helpdesk; prepares and maintains LPO telescope schedules; organises Visiting Astronomer travel; and is responsible for user requirements and scientific oversight of operations support tools.

Back-end Operations Department
is responsible for the management of the science data stream from the La Silla Paranal Observatory. This includes the development and operations of the ESO Science Archive Facility, and the scientific oversight of the data processing tools, and encompasses the generation of science data products and the handling of those provided by the community.

L. Sbordone/ESO

A cutout in the concrete structural supports of a VLT Unit Telescope provides a distinctive framing for this unusual monochrome view of Paranal.

ESO ALMA Support Centre

carries out all ALMA operations-related activities within ESO and with the ALMA partners and Joint ALMA Observatory, including operation of the European ALMA Regional Centre (ARC), offsite engineering maintenance support to JAO, software development, and delivery of the studies and projects of the European ALMA development programme.

ALMA Computing Team
develops and maintains ALMA software supporting the full observing lifecycle, including archive services, observing preparation, project tracking and reporting, quality control, telescope calibration and automation & testing. It contributes to data processing software and ALMA development projects and is part of the global ALMA Integrated Computing Team.

ALMA Technical Team
supports the global ALMA Integrated Engineering Team as the ESO component of the team. It supports the JAO Department of Engineering, coordinates and performs maintenance activities, especially tier-3 corrective maintenance of ESO deliverables, identifies opportunities for improvement, especially for ESO deliverables, and develops projects.

ALMA Regional Centre Department
supports ALMA global science operations in policy, data flow, and execution of science programmes. It develops enhanced observing and data processing techniques and coordinates delivery of subsystem software. It also delivers quality-assured, high-quality data products, and facilitates science through coordination of user support.

ALMA Development Team
is responsible for delivering the Wideband Sensitivity Upgrade (WSU) as well as longer-term European ALMA development. It oversees and financially manages development projects and studies, strategically plans the European ALMA development priorities, and liaises with ALMA partners, industry, and institutes in Europe.

Directorate of Programmes

The Directorate of Programmes is responsible for the management and delivery of ESO's construction programmes and projects within ESO's matrix organisation. The overall work is broken down into the programmes for ELT Construction and ELT New Technologies, Armazones Instrumentation, Paranal Instrumentation, and Technology Development. Each programme encompasses many projects.

ELT Construction Programme
is responsible for the delivery of a fully functional and complete ELT, including the telescope with all the optics and optomechanics, the dome, and infrastructure, as well as the verification of the telescope with the first scientific instrument.

ELT New Technologies Programme
comprises all technology development activities directly needed to fulfil the objectives of the ELT Construction Programme. The programme is managed by the ELT Construction Programme Manager.

Instrumentation Programme
is the framework within which ESO develops, delivers, and upgrades optical and infrared instruments for the ELT and ESO facilities at Paranal and La Silla.

Technology Development Programme
develops and secures key technologies which will maintain ESO's facilities at the cutting edge of astronomy, contributing to achieving ESO's mission, and supports technology development for new ESO standards.

Project Management Department
provides leadership and management to the full range of ESO's projects — telescopes, instruments, and organisational — from inception to delivery using the triple constraints of scope, cost and schedule. The department owns ESO's project management framework and processes, and develops them in order to meet the evolving needs of the organisation.

On-Site Engineering Department
is a matrixed department primarily hosting engineers and technicians needed on-site for ELT assembly, integration and verification (AIV), as well as staff for dome and main structure, and ELT Supporting Systems, activities on site. Once full AIV activities on Armazones begin, the department will move to the Directorate of Engineering.

Programme Planning and Control Office
provides support to projects and programmes within the Directorate of Programmes with respect to all financial and programmatic aspects. This includes material and level-of-effort budgeting, financial planning, schedule and cost control, reporting, estimating, risk management and performance measurement.

Directorate for Science

The Directorate for Science provides guidance to all science-related projects at ESO, supports community science with ESO facilities, provides the scientific environment for the astronomers at ESO, and runs the ESO student and fellowship programmes.

Project Science Department
hosts and supports ESO Project Scientists, providing scientific leadership, guidance and monitoring for the design, development and implementation of ESO observing facilities and systems. Project Scientists are responsible for developing and maintaining the end-to-end science requirements, ensuring compliance with the scientific goals of the respective programmes and with operation standards while maximising scientific exploitation.

Observing Programmes Office
manages the entire process for telescope time proposals at ESO, from issuing Calls for Proposals to providing statistics on time allocations to both internal and external stakeholders.

ESO Supernova Department
operates the visitor centre and planetarium at the ESO Garching Headquarters, bringing the fascinating world of astronomy closer to the general public. This includes planning, promoting and implementing a varied programme of activities for the general public and schools and coordinating the technical maintenance of the facility.

Offices for Science in Garching and in Chile
run the Science Programmes at ESO, fostering a stimulating scientific environment that allows the students, Fellows, and staff astronomers at ESO to develop and conduct cutting-edge science and to disseminate ESO expertise into the scientific community.

Library, Documentation, & Information Services Department
manages and supports the central organisation of ESO institutional, project and product documentation; provides access to scientific and technical publications; develops tools that help assess ESO's scientific impact including the ESO Telescope Bibliography (telbib); and shares developments in publishing and research communication.

Office of the Director General

The Office of the Director General deals with activities that are under the direct authority of the Director General, including corporate and organisation-wide horizontal activities that are not delegated to the directorates.

Executive Office
supports the Director General's internal and external duties, including the ESO Representation in Chile, and legal and institutional affairs. The office also supports Council with the development and implementation of ESO's strategy, and provides executive and secretarial support to Council, the Directors Team, and other auxiliary bodies.

Department of Communication
is responsible for internal and external communication for ESO in areas including media relations, content production, public and local outreach, digital communication and internal communication, engaging with audiences from scientists, decision-makers and industry partners to journalists and the public.

Quality and Sustainability Office
provides corporate services and support across ESO in matters related to quality management, corporate risk management, and sustainability and diversity.

Internal Audit
carries out independent, objective assurance and consulting activities to add value and improve ESO's operations, assisting all levels in the organisation. Internal Audit liaises and cooperates with ESO's external auditors. The Internal Auditor reports organisationally to the Director General, and has direct and independent access to the ESO Council President.

Ombuds

is a designated neutral person providing independent, impartial and confidential assistance to people working at ESO and the Joint ALMA Observatory for informal resolution of work-related disputes, in accordance with the Standards of Practice and Code of Ethics of the International Ombudsman Association. The Ombuds works independently, with unrestricted access to the ESO Council President.

ESO's Governing Bodies

ESO's ruling body is its Council, which delegates day-to-day responsibility to the Executive under ESO's Director General. Other governing bodies of ESO are: the Finance Committee, the Scientific Technical Committee, the Observing Programmes Committee and the Users Committee.

Council

The ESO Council decides the organisation's policies regarding scientific, technical, and administrative matters, and is the main governing body of ESO.

Council and Committee of Council 2025	
President	Tom Ray
Austria	Daniel Weselka João Alves
Belgium	Sophie Pireaux Emmanuël Jehin
Czechia	Jan Buriánek Soňa Ehlerová
Denmark	René Michelsen Lise Christensen
Finland	Oskari Miettinen Seppo Mattila
France	Guy Perrin Karine Perraut
Germany	Sabine Carl Matthias Steinmetz
Ireland	Peter Healy Paul Callanan
Italy	Piergiorgio Alotto Roberto Ragazzoni
Netherlands	Mirjam Lieshout-Vijverberg Paul Groot
Poland	Dariusz Drewniak Marek Sarna
Portugal	Ricardo Conde Marta Gonçalves (alternate for Ricardo Conde) Paulo Garcia
Spain	Inmaculada Figueroa Rafael Bachiller (until 5 March 2025) David Barrado (as of 6 March 2025)
Sweden	Camilla Jakobsson Sofia Feltzing
Switzerland	Kevin Reymond Francesco Pepe
United Kingdom	Jenny Hiscock Vikram Dhillon
Observers	
Australia	Natalie Weddell (until 6 November 2025) Jo Fielding (as of 7 November 2025) Sarah Brough

Finance Committee

The ESO Finance Committee (FC) advises the ESO Council on all dealings related to administrative and financial management.

Finance Committee 2025	
Chair	Harald Haakh
Austria	Susanne Sulzbacher
Belgium	Alain Heynen
Czechia	Pavel Křeček
Denmark	René Michelsen
Finland	Marjut Kaukolehto
France	Carine Bernard
Germany	Sarah Kudling
Ireland	Lola Hourihane
Italy	Salvatore Vizzini
Netherlands	N.N.
Poland	Dariusz Drewniak
Portugal	Filipa Batista Coelho
Spain	Ana Aricha
Sweden	Sofie Björling
Switzerland	Patrice Soom
United Kingdom	Chris Woolford
Observers	
Australia	Bridgette Hargreave

Scientific Technical Committee

The Scientific Technical Committee (STC) determines ESO's scientific and technical priorities, and advises the ESO Council and Director General on relevant decisions for ESO's projects and programmes.

Scientific Technical Committee 2025	
Chair	Serena Viti
Austria	Stefan Kimeswenger
Belgium	Olivier Absil
Chile	Laura M. Pérez
Czechia	Martina Boháčová
Denmark	Marianne Vestergaard
Finland	Talvikki Hovatta
France	Audrey Delsanti
Germany	Natascha Foerster Schreiber
Ireland	Rebeca Garcia Lopez
Italy	Marcella Marconi
Netherlands	Ignas Snellen
Poland	Tomasz Kamiński
Portugal	Sonia Anton
Spain	Ignacio Negueruela
Sweden	Angela Adamo
Switzerland	Miroslava Dessauges
United Kingdom	Nial Tanvir
Observers	
Australia	Michael Murphy
Members at Large	
Australia	Claudia Lagos

Observing Programmes Committee

The Observing Programmes Committee (OPC) receives and evaluates proposals submitted to ESO for observations.

The Observing Programmes Committee 2025	
Konrad Kuijken	(Chair)
Paola Pinilla	(Vice Chair)
Simon Albrecht	(P116)
Thomas Bensby	
Andrea Chiavassa	(P116)
Timea Csengeri	(P117)
Valentina D'Orazi	(P117)
Luca Fossati	(P116)
Caroline Foster	(P117)
Karl Glazebrook	(P116)
Jacqueline Hodge	(P116)
James S. Jenkins	
Kirsten Kraiberg Knudsen	(P117)
Heidi Korhonen	
Georgios Magdis	(P117)
Francine Marleau	
Isabel Marquez	(P117)
Sarah Martell	(P117)
David Martinez Delgado	(P116)
Mikako Matsuura	(P116)
Joseph Mohr	(P116)
Sandra Savaglio	
Sergio Sousa	(P117)
Susanna Vergani	
Norbert Werner	

Users Committee

The Users Committee (UC) advises the Director General on matters related to La Silla Paranal Observatory and ALMA, providing feedback and recommendations on operations.

Users Committee 2025	
Austria	Miguel A. Urbaneja Perez
Belgium	Denis Defrère
Czechia	Daniela Korčáková
Denmark	Thomas Rodriguez Greve
Finland	Hanindyo Kuncarayakti
France	Philippe Salomé
Germany	Peter Schilke
Ireland	Emma Whelan
Italy	Enrichetta Iodice (Chair)
Netherlands	Søren Schack Larsen
Poland	Agnieszka Maria Pollo
Portugal	Ana Paulino-Afonso (co-Chair)
Spain	Alba Vidal
Sweden	Ragnhild Lunnan
Switzerland	Xavier Dumusque
United Kingdom	Timothy Davis
Chile	Timo Anguita
Australia	Sarah Sweet

ESO/VVVX survey

The star cluster RCW 38, located 5500 light-years away in the constellation Vela, imaged with ESO's Visible and Infrared Survey Telescope for Astronomy (VISTA) at Paranal.

Cover: Four guide-star lasers at Paranal, each one launched from one of ESO's VLT Unit Telescopes. The launch of these lasers is a major milestone for the VLT Interferometer and the GRAVITY+ project, unlocking the whole southern sky to the VLTI and enhancing its observing power dramatically.

Credit: J. Beltrán/ESO

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ESO is a partner in the international ALMA project

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ALMA Array Operations Site
II Región
Chile

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