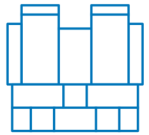
ESO’s scientific facilities

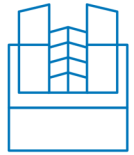
ESO telescopes

Paranal



VLT

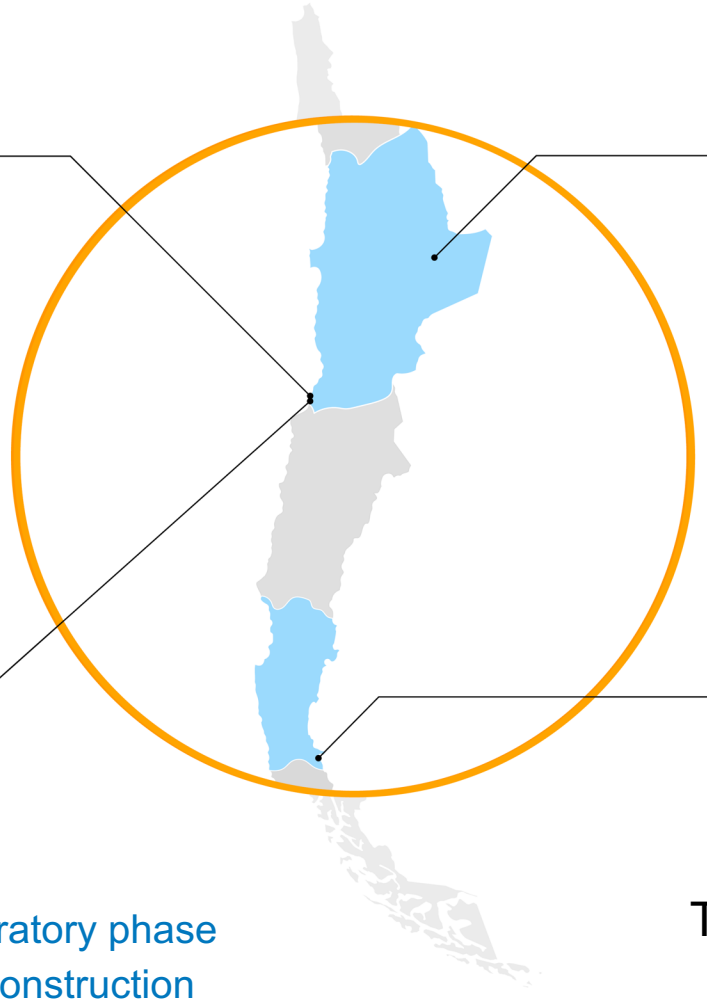
VLTI



VISTA

CTA

South*



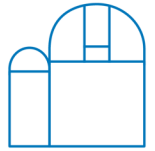
Chajnantor

ALMA

Armazones

ELT**

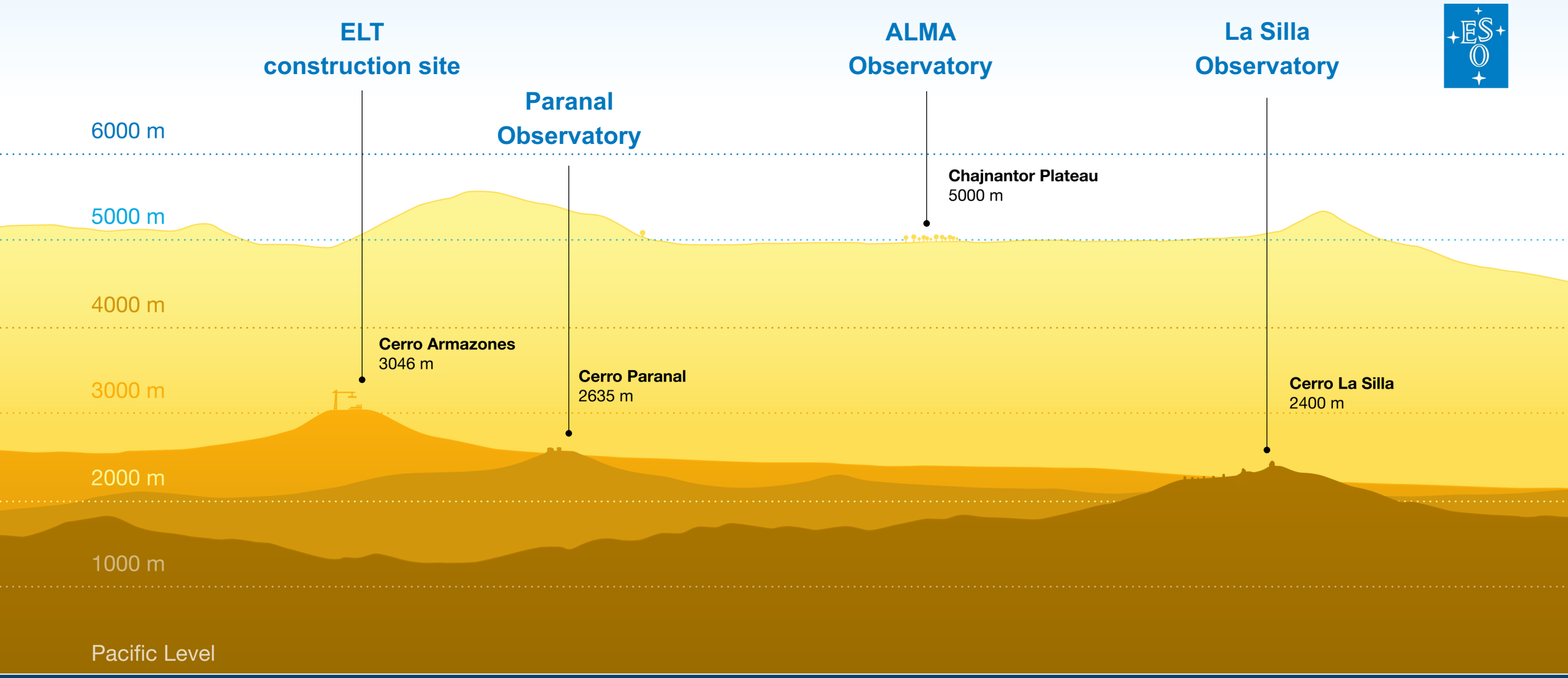
La Silla



Telescopes at La Silla

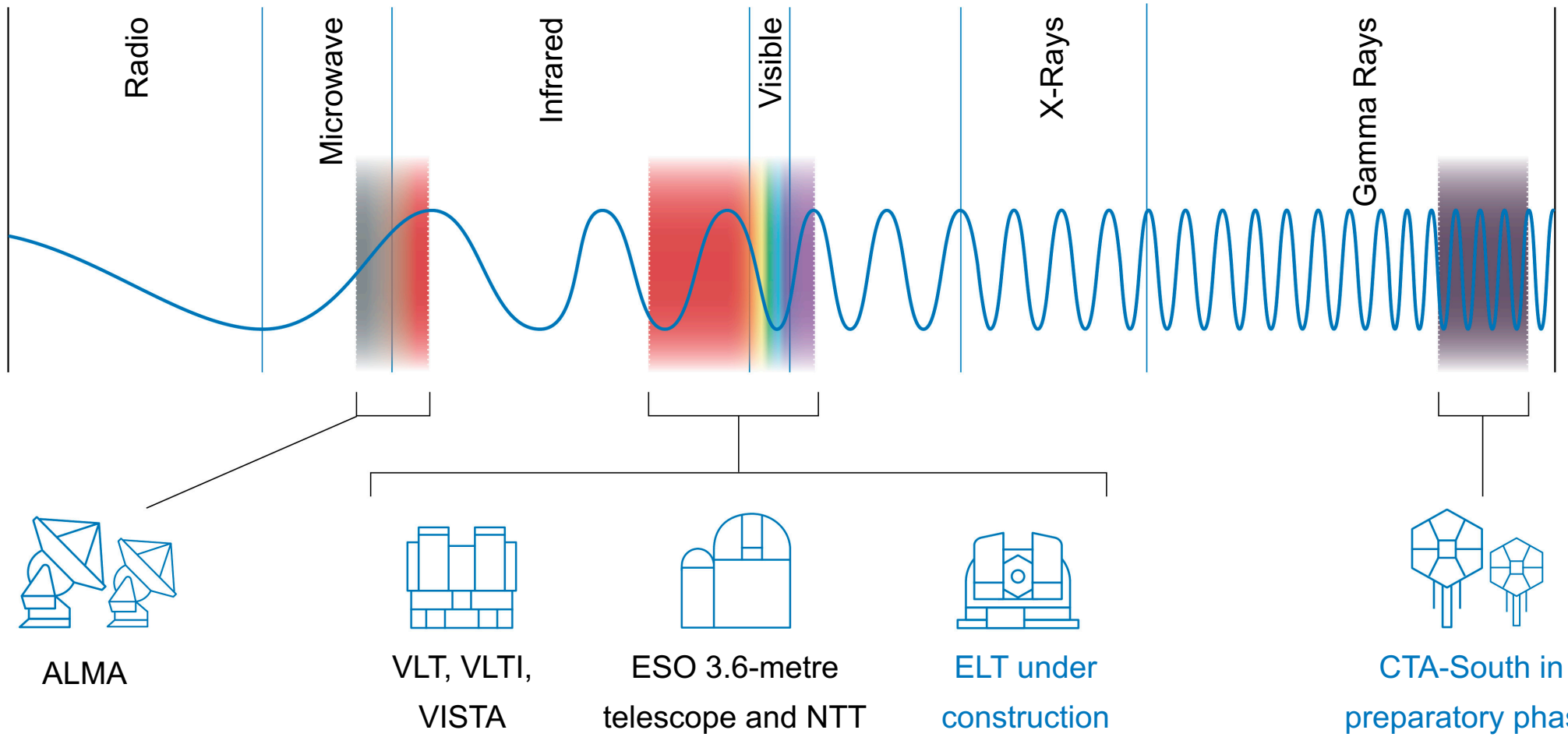
* in preparatory phase

** under construction



ESO site elevations

Wavelengths of ESO telescopes



La Silla – ESO’s first observatory

Credit: ESO/B. Tafreshi (twanight.org)

Telescopes currently operated by ESO

Credit: Y. Beletsky (LCO)/ESO

Hosted telescopes

Credit: ENEL

Science highlights of La Silla Observatory

Accelerating Universe

Based on **observations of exploding stars**,
two independent research teams showed that
the **expansion** of the Universe **is accelerating**

The 2011 Nobel Prize in Physics was awarded for this result

Planet found in the **habitable zone**
around Proxima Centauri, the nearest star to Earth

Credit: ESO/M. Kornmesser

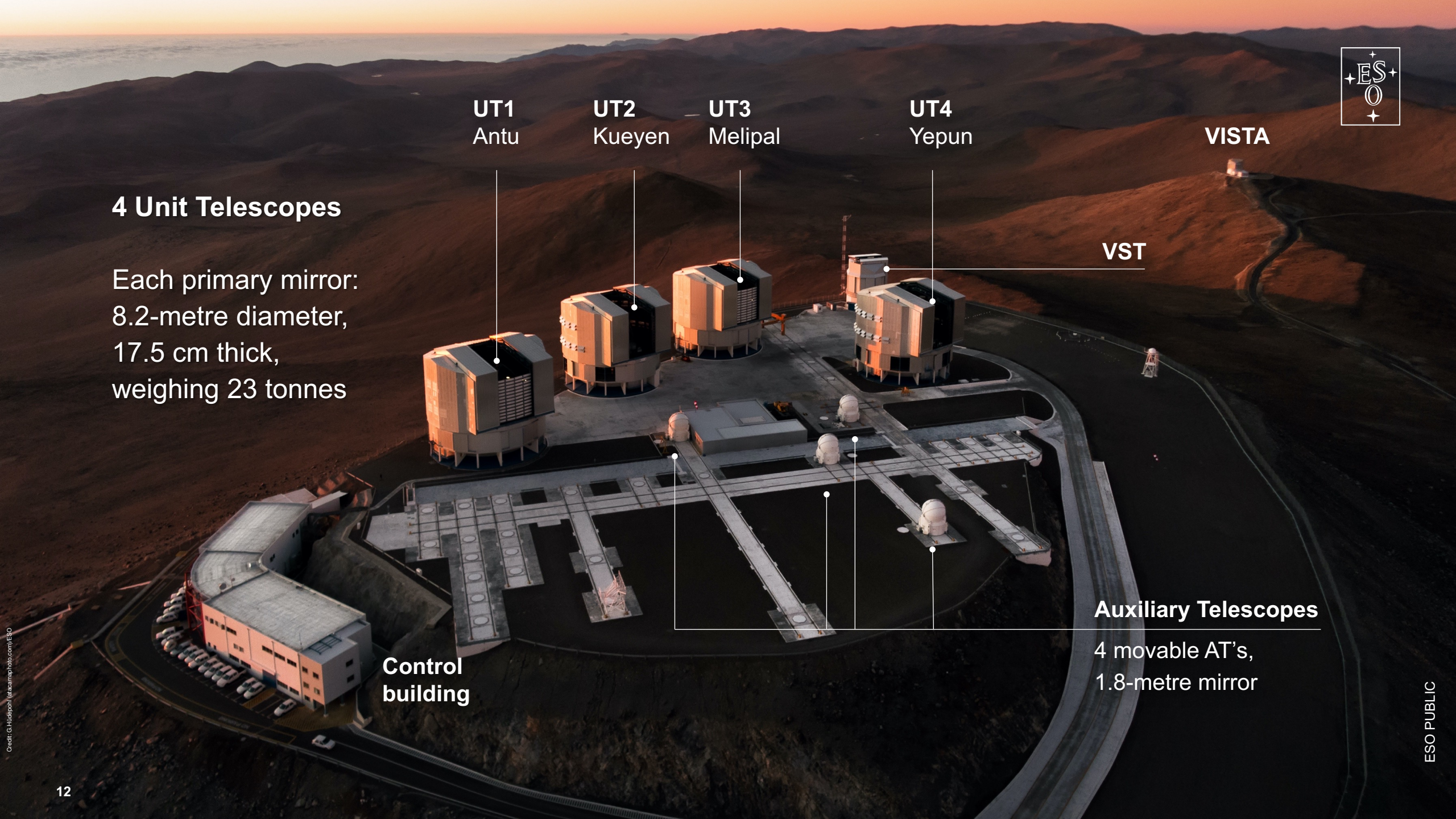
Credit: JAXA

The anatomy of an asteroid

ESO’s New Technology Telescope (NTT) provided the first evidence that asteroids can have a highly varied internal structure

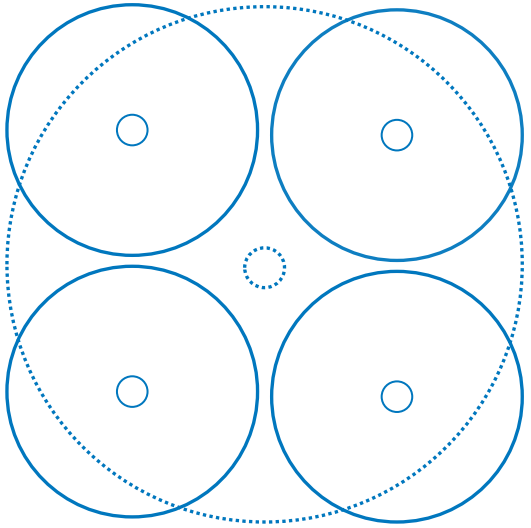
Paranal – home of the Very Large Telescope

Credit: ESO/P.Horálek

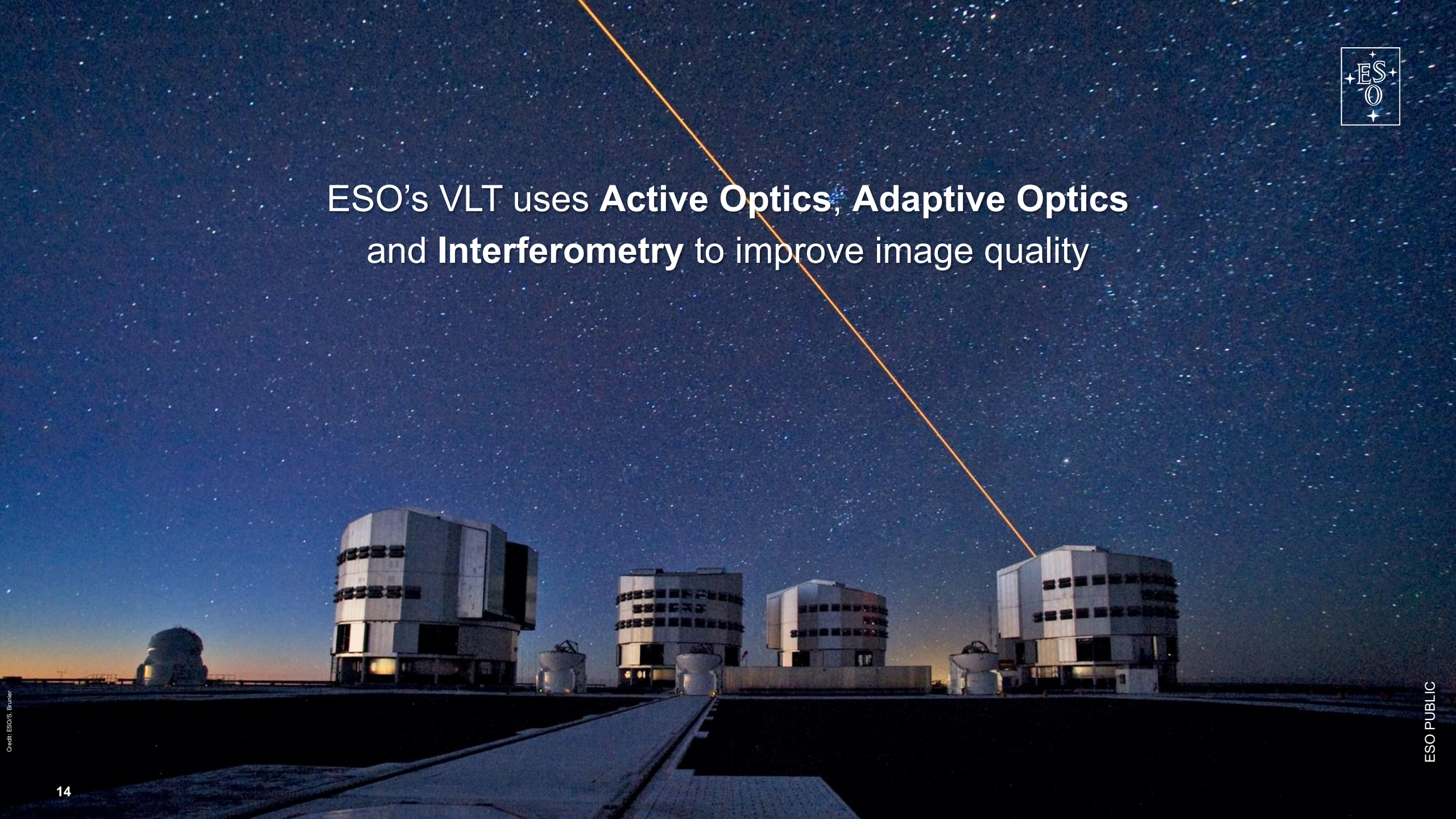


4 Unit Telescopes

Each primary mirror:
8.2-metre diameter,
17.5 cm thick,
weighing 23 tonnes



The VLT's **combined mirror area** is equivalent to that of a **16-metre telescope**, which effectively makes it the **largest optical telescope in the world**.



ESO's VLT uses **Active Optics**, **Adaptive Optics** and **Interferometry** to improve image quality

Credit: ESO/S. Brunier

Active optics
Inventing a game changer

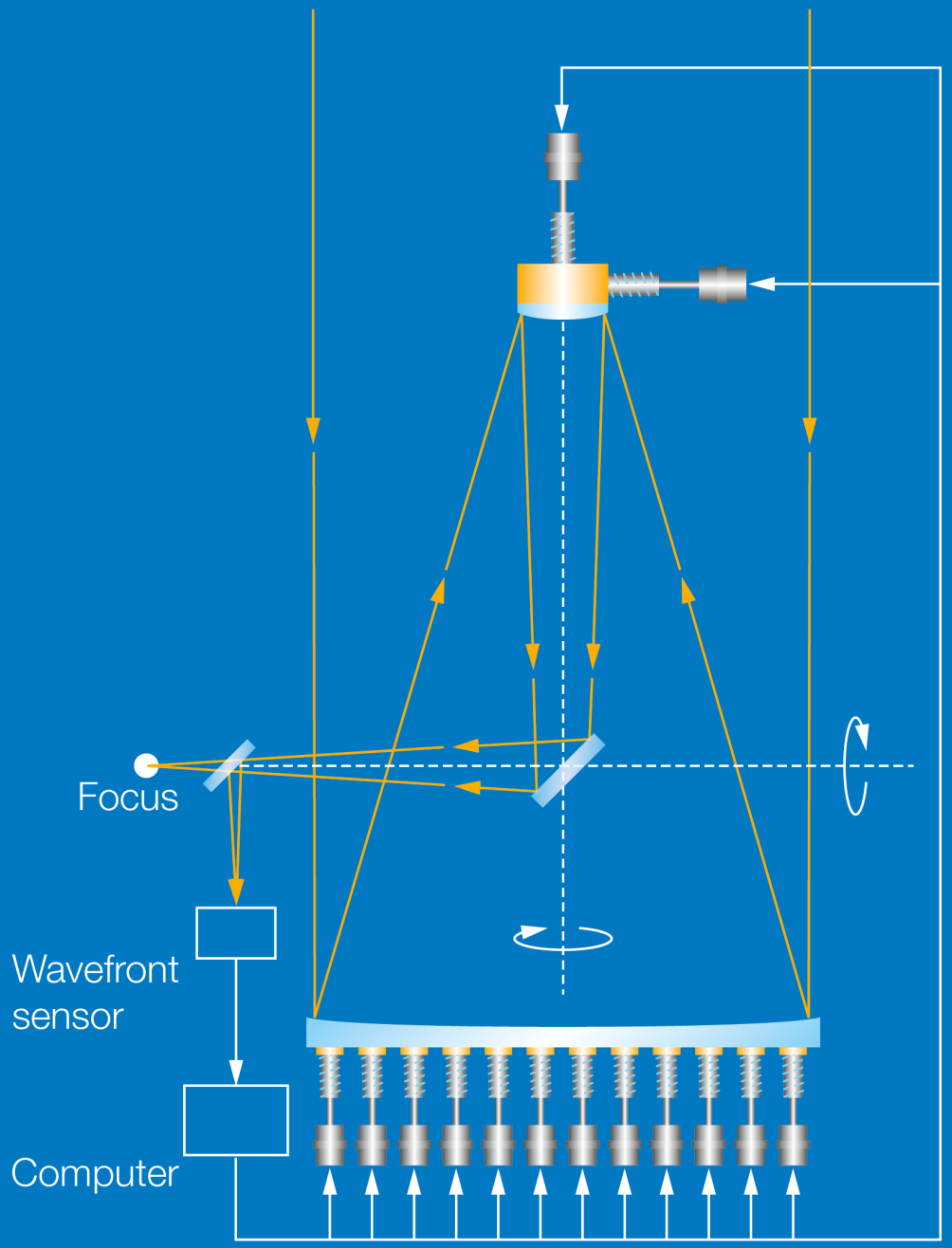
In the late 1980s ESO engineer **Raymond Wilson** invented a **revolutionary technology** and pioneered it at ESO's NTT.

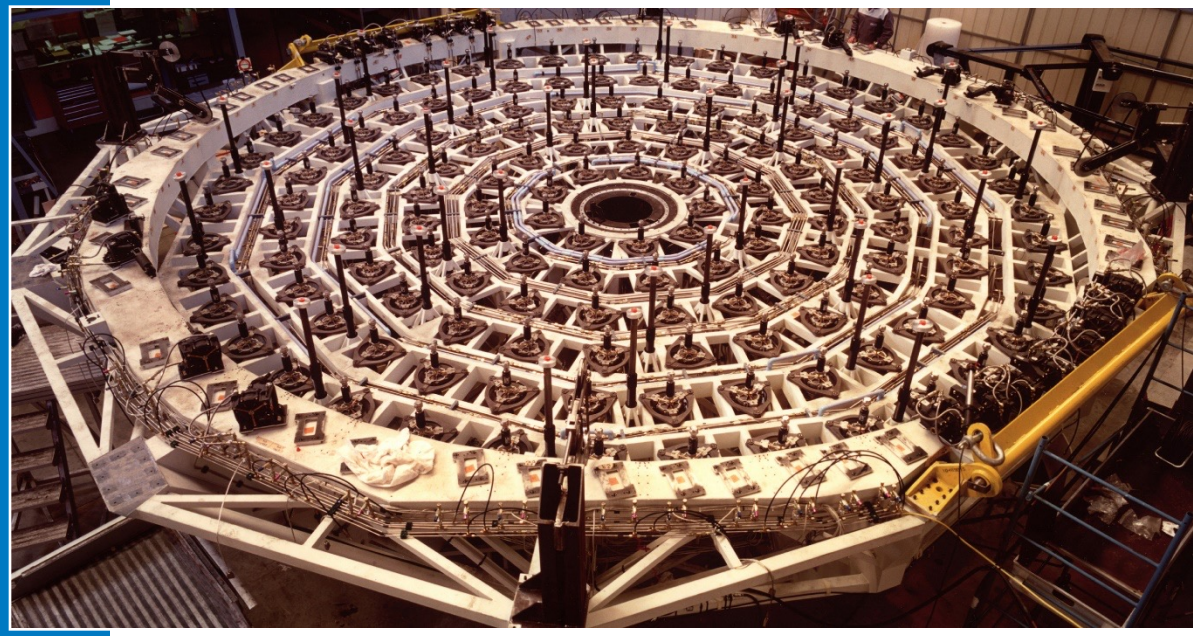
Today, **Active optics** is widely used in large telescopes all over the world.

Active optics actuators for the NTT's primary mirror

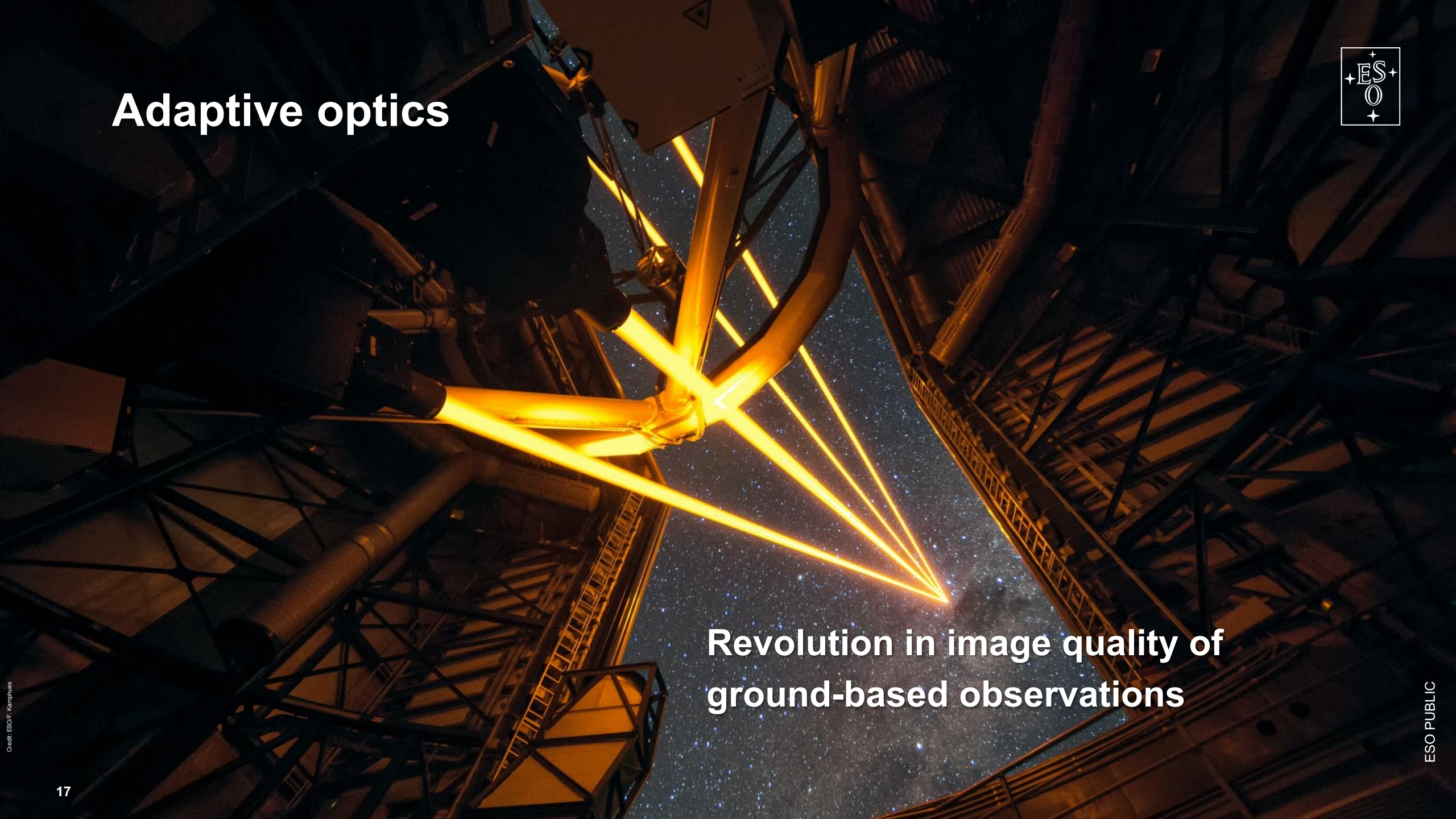
Active optics

Actuators move very accurately to **correct the mirror's shape**, **compensating** for the distortion produced by **gravity**





Adaptive optics



Revolution in image quality of ground-based observations

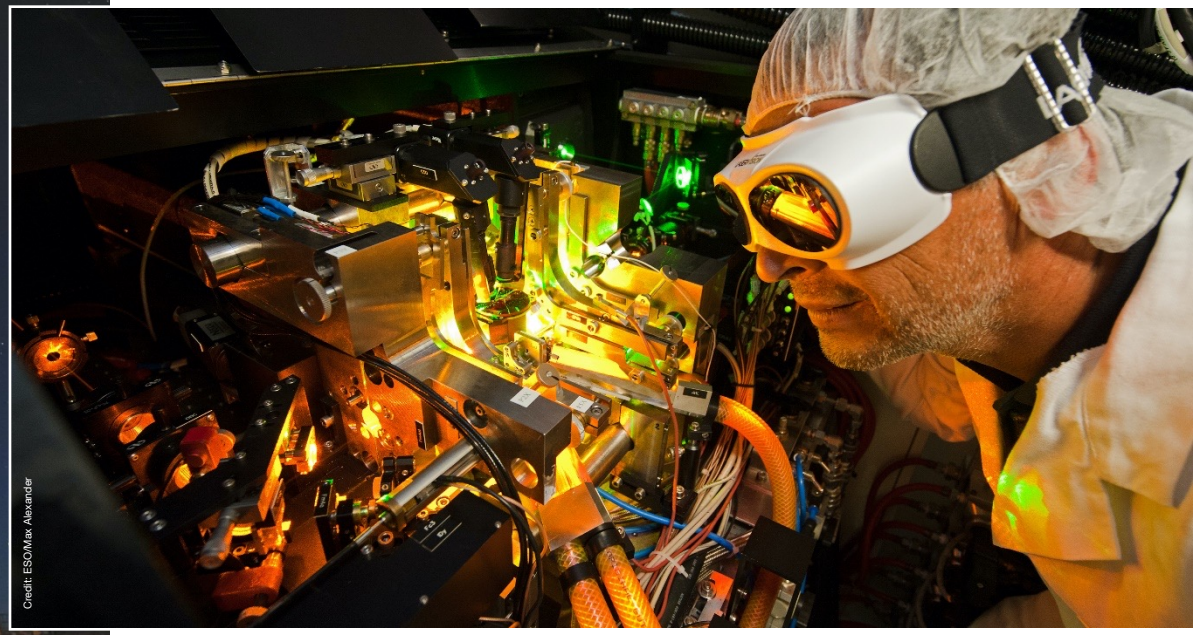
Credit: ESO/F. Kamphues

Adaptive optics

Corrects the distortions of light introduced by Earth's atmosphere.

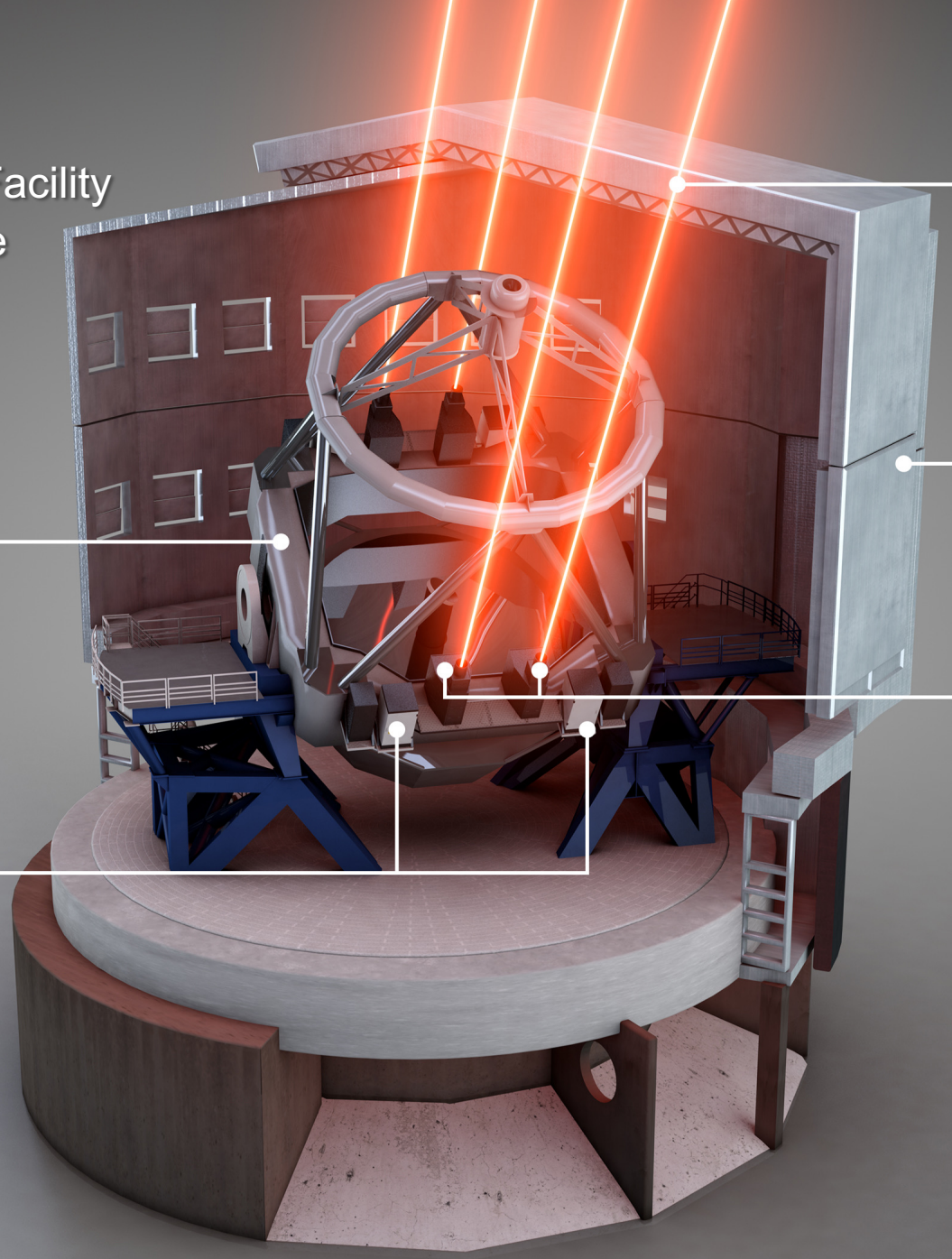
Relies on a sophisticated system of powerful lasers and deformable mirrors.

Credit: Matthias Siebel/ESO



Credit: ESO/Max Alexander

The VLT Laser Guide Star Facility was the first of its kind in the southern hemisphere.



30-cm diameter laser beams (wavelength 589 nm)

Telescope enclosure (mostly cut-away)

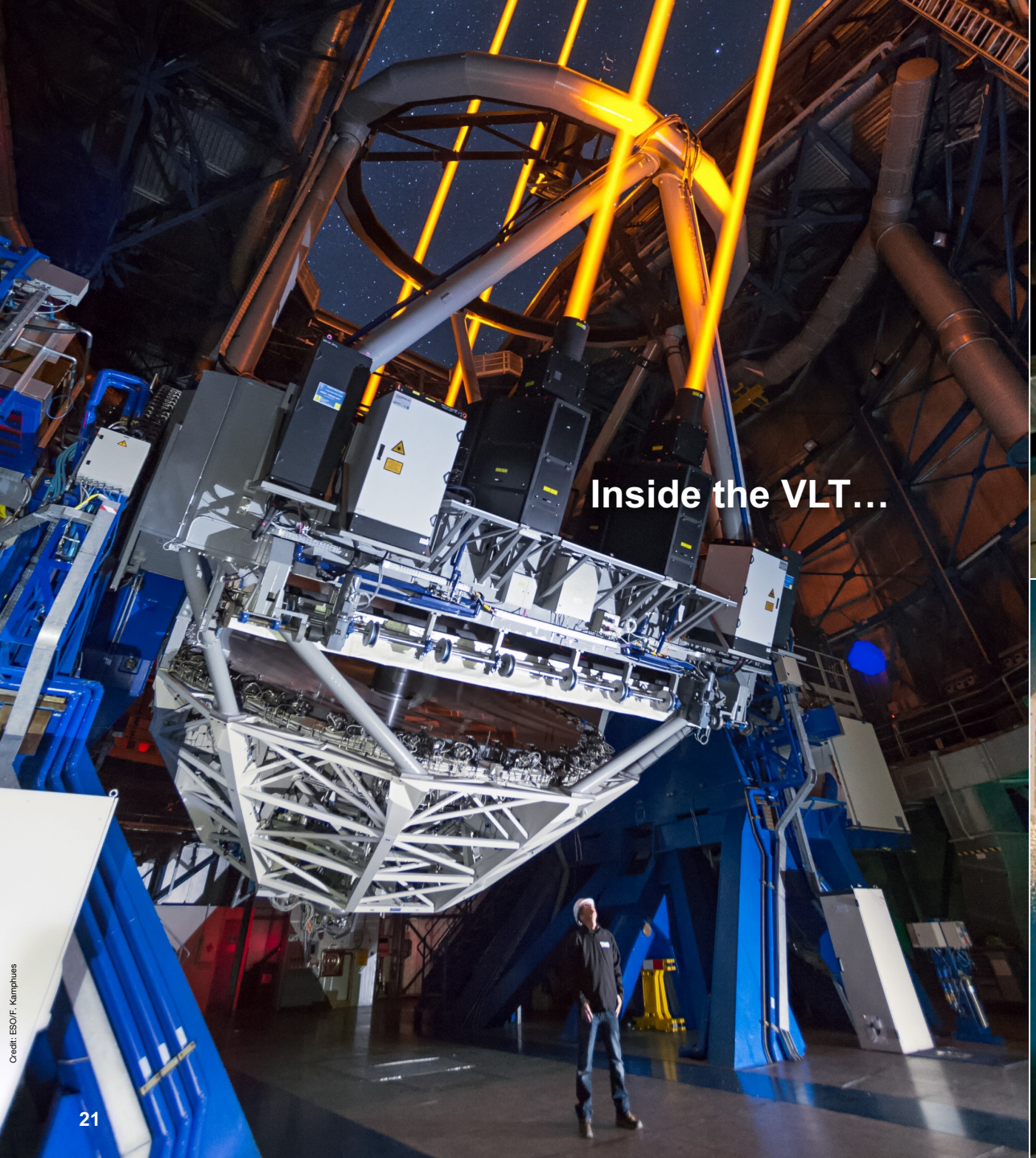
VLT Unit Telescope 4

Laser-launch telescopes
Beam control and frequency doubler

Raman laser cabinets
Reference laser
and pump laser
(wavelength 1178 nm, infrared)

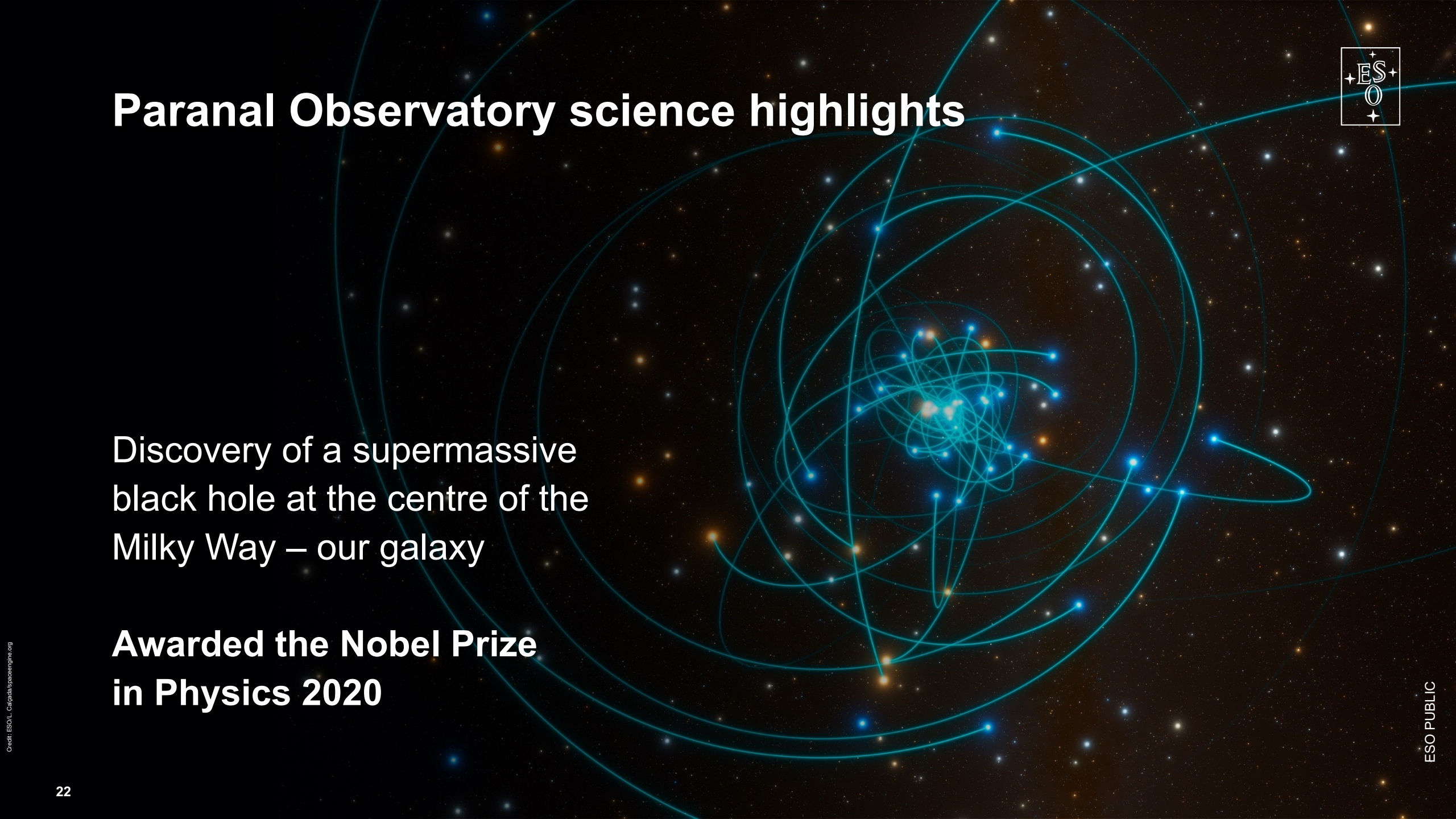
Credit: ESO/L. Calçada


VLT Interferometer (VLTI)
acts like a virtual 130-metre telescope



Credit: ESO/F. Kamphues

Paranal Observatory science highlights



Discovery of a supermassive black hole at the centre of the Milky Way – our galaxy

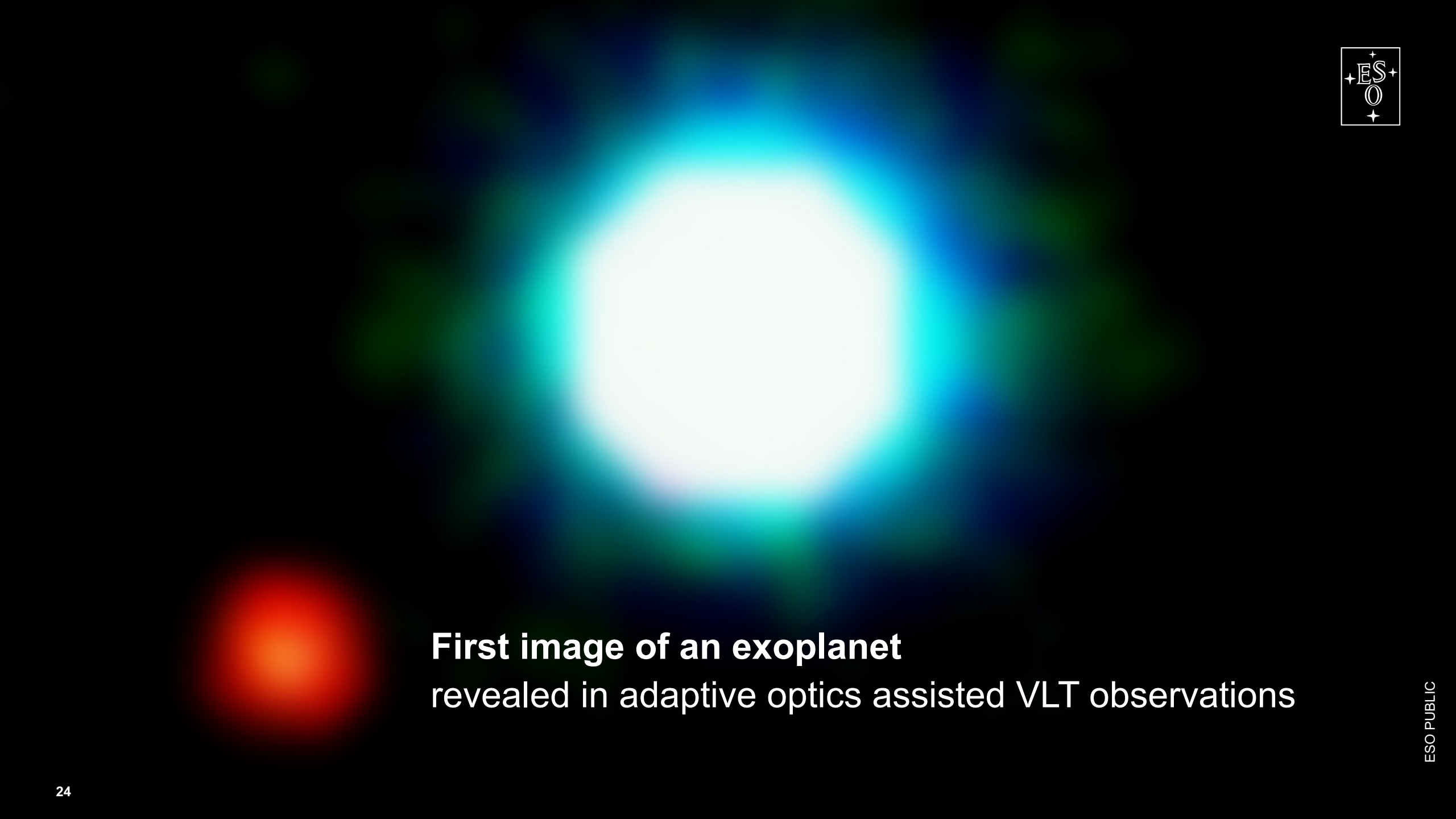
Awarded the Nobel Prize in Physics 2020

Credit: ESO/L. Calçada/spaceengine.org

First light from a gravitational wave event

ESO’s fleet of telescopes characterised the first visible counterpart of a gravitational wave source. These **historic observations** helped reveal that this unique object is the result of the **merger of two neutron stars**

Credit: ESO/A.J. Levan, N.R. Tanvir



First image of an exoplanet
revealed in adaptive optics assisted VLT observations

ALMA — the Atacama Large Millimeter/submillimeter Array

Credit: Clem & Axel Ballot/Monmer (wingsforscience.com)/ESO

The **ALMA telescope** is a **global partnership** between the scientific communities of **East Asia**, **ESO** and **North America** together with **Chile**

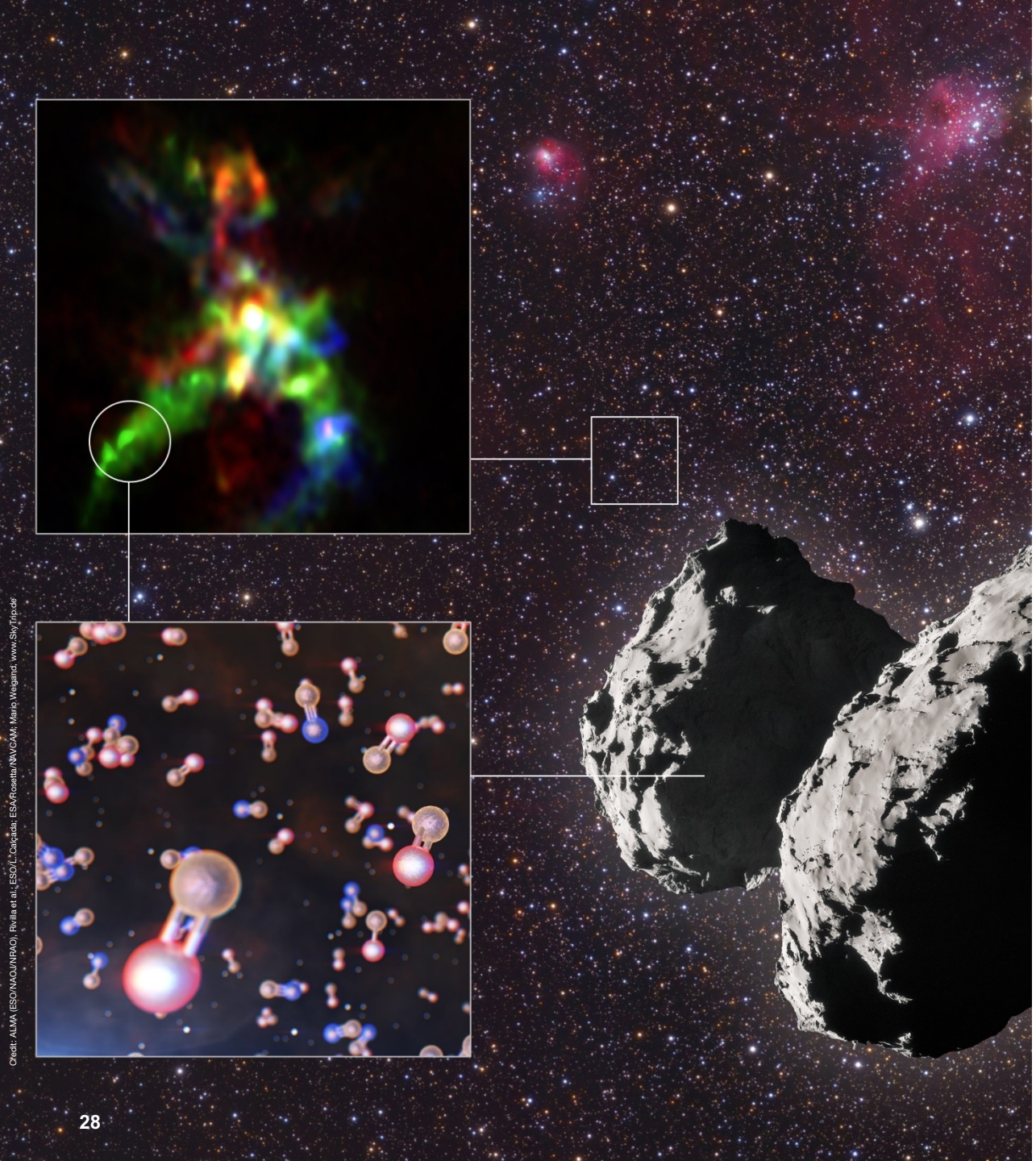
Credit: ESO/S. Guisard (www.eso.org/~sguisard)

ALMA

is the most powerful telescope for observing the cool Universe — molecular gas and dust — as well as the distant Universe.

Credit: ESO/José Francisco Salgado (josefrancisco.org)

Credit: ESO/H. Drass/ALMA (ESO/NAOJ/NRAO)/A. Hacar



Credit: ALMA (ESO/NAOJ/NRAO), Rivilla et al., ESO/L. Calçada, ESA/Rosetta/NAVCAM, Mario Weigand, www.SkyTrip.de

ALMA

is studying the building blocks of stars, planetary systems, galaxies and life itself.

Thanks to ALMA, astronomers could pinpoint where phosphorus-bearing molecules form in a star-forming region and comet 67P.

Array Operations Site in Chajnantor (5050 m):
66 movable antennas, over a 16-km plateau,
receivers, back-end and correlator

Credit: ESO/S. Otarola

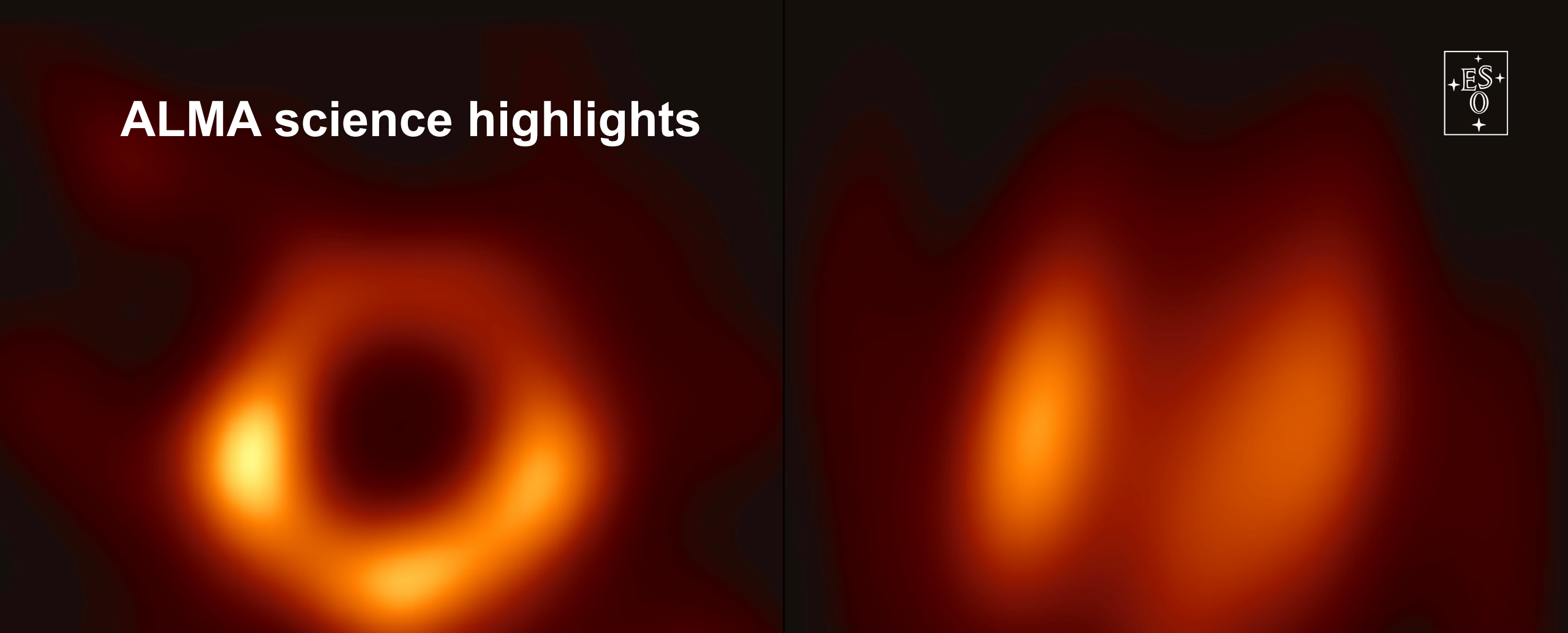
Operations:

Support Facility at 3000 m, near San Pedro de Atacama

Regional Support Centres in Europe, North America and East Asia

Credit: ESO/A. Siber

ALMA science highlights

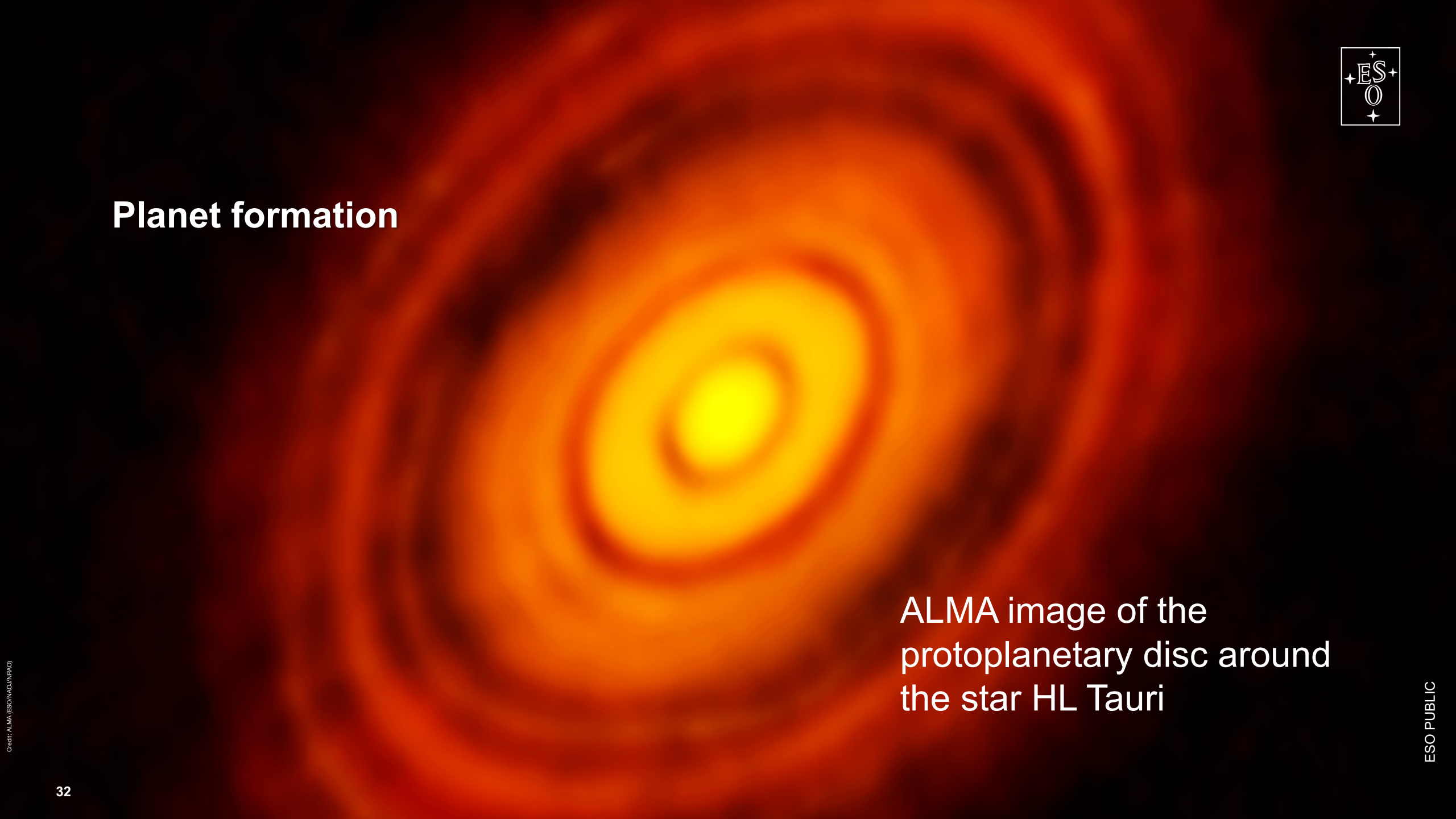


The first image of the shadow of the M87 black hole

ALMA's & APEX's crucial contribution to the Event Horizon Telescope (EHT):
Full EHT (left) and without ALMA and APEX (right)

Credit: EHT Collaboration

Planet formation



ALMA image of the protoplanetary disc around the star HL Tauri

Credit: ALMA (ESO/NAOJ/NRAO)

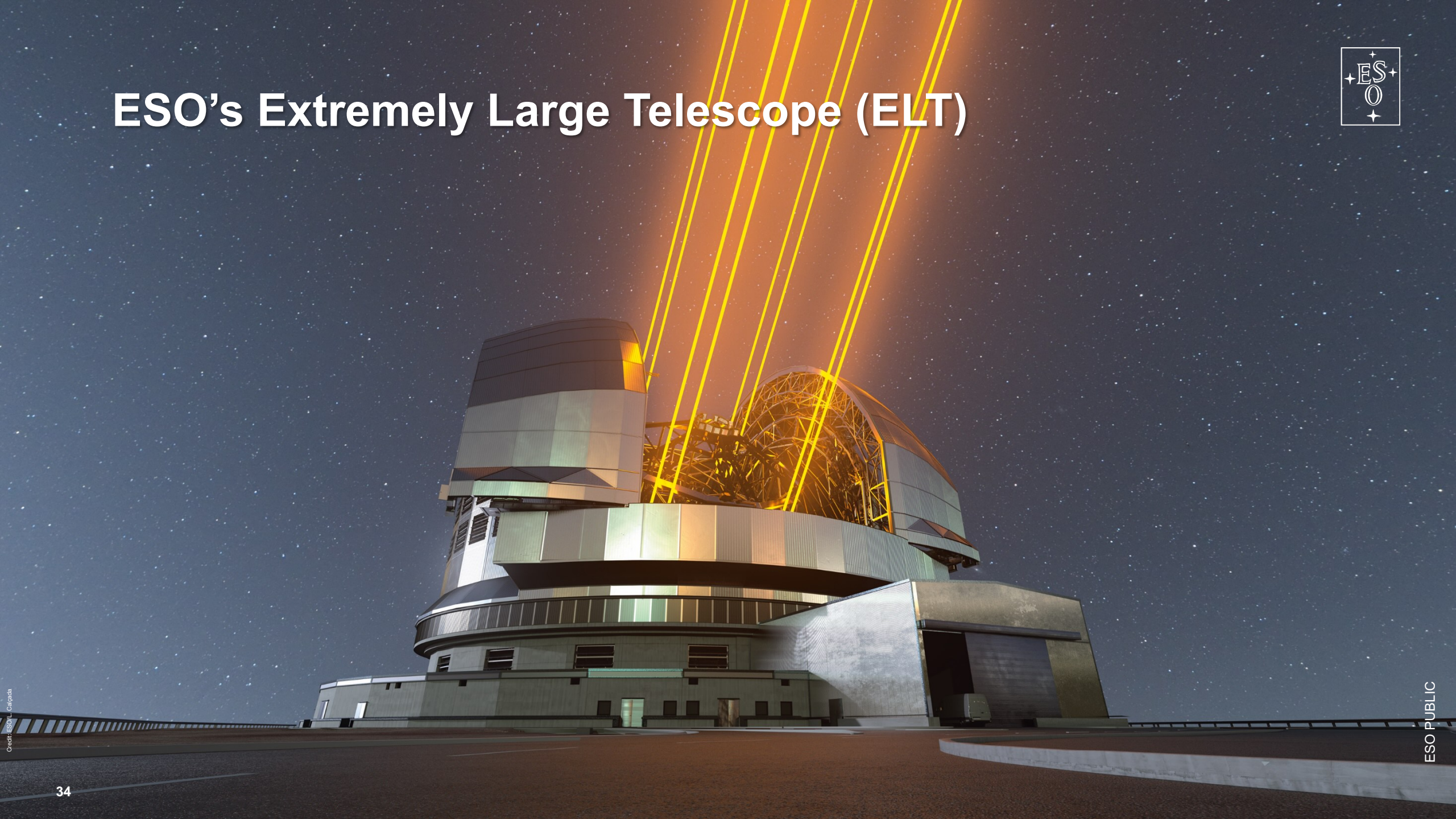
ESO PUBLIC

Chemical building blocks of life – prebiotic molecules in space

ALMA detects methyl isocyanate around young Sun-like stars

Credit: ESO/Digitized Sky Survey 2/L. Calçada

ESO’s Extremely Large Telescope (ELT)



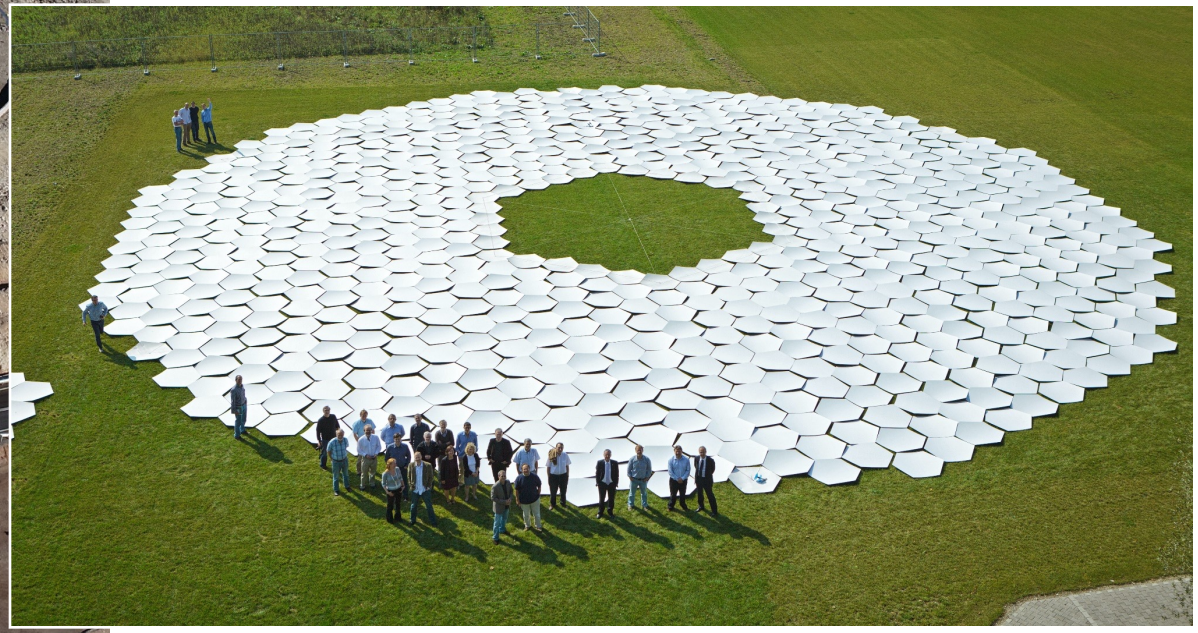
Credit: ESO/L. Calçada

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

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

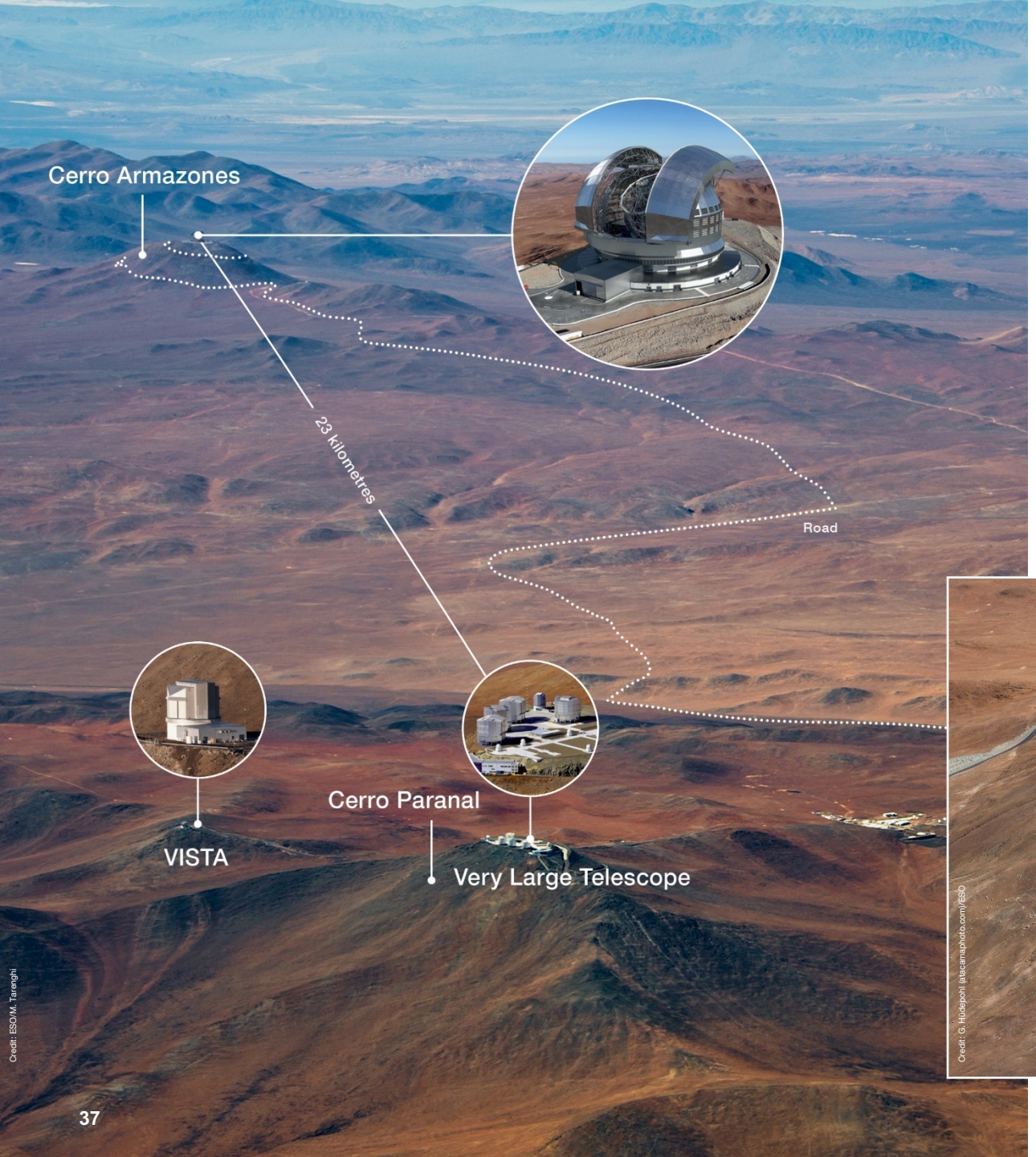
The ELT

will be the **largest optical/infrared telescope** in the world



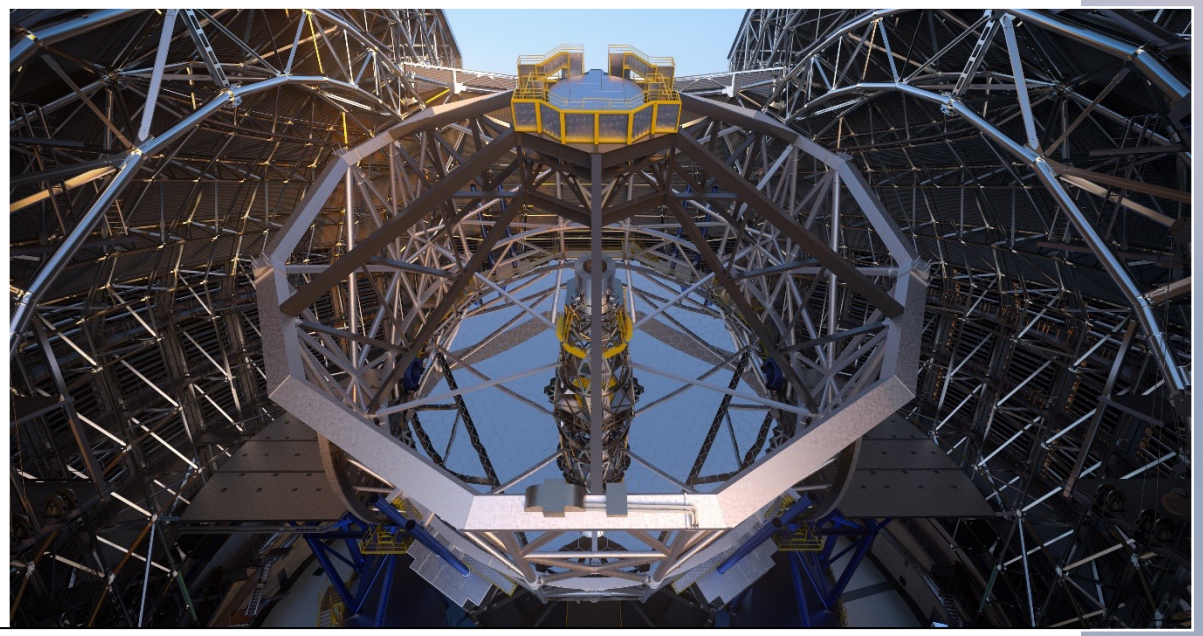
The ELT

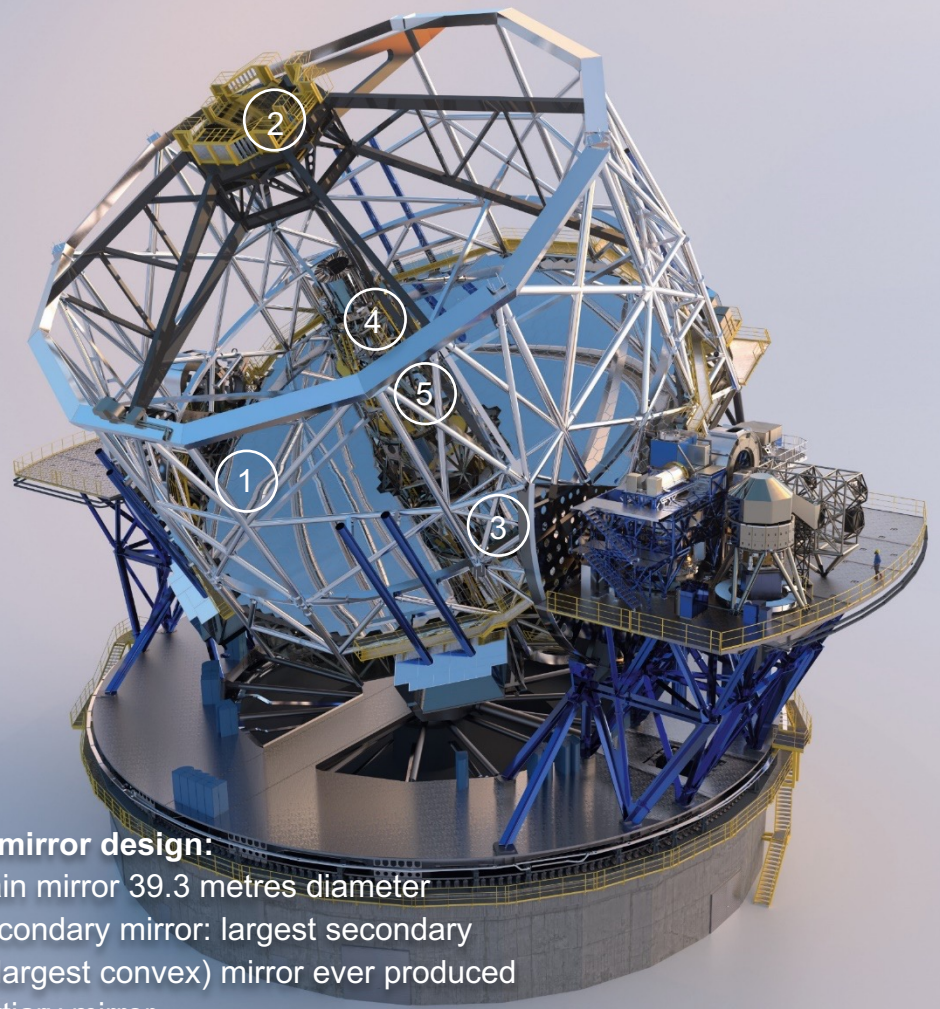
is being built on Cerro Armazones in the Chilean Atacama Desert, at 3046 metres altitude and just 23 kilometres from the site of ESO's Very Large Telescope (VLT) at Paranal.



The ELT

it will have a 39.3-metre segmented primary mirror with adaptive optics.





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

How extremely large is the ELT?

120 m

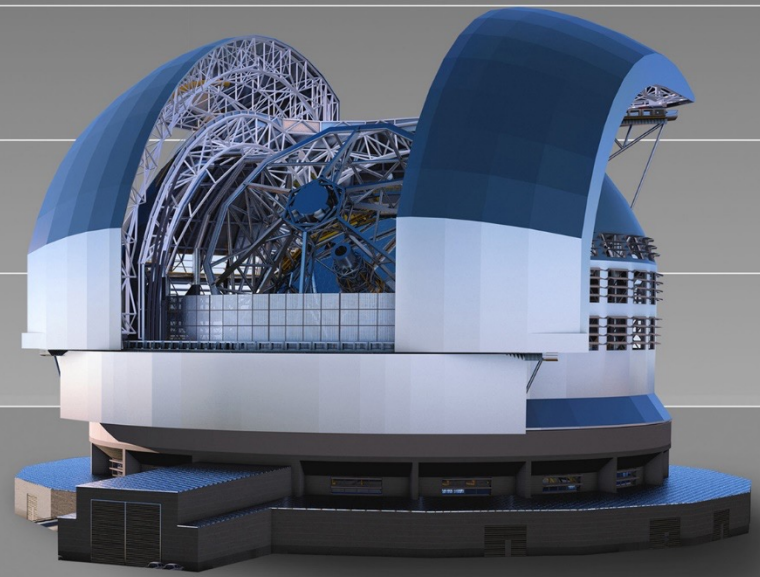
100 m

80 m

60 m

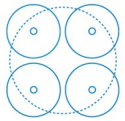
40 m

20 m



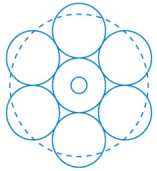
Credit: ESO/L. Calçada

How extremely large is the ELT?



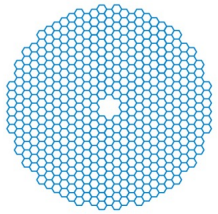
4 x 8.2 metres

ESO's Very Large Telescope
Cerro Paranal, Chile



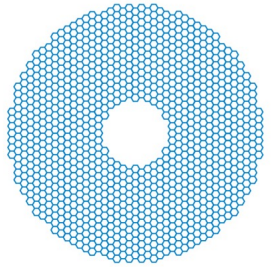
24.5 metres

Giant Magellan Telescope
Las Campanas Observatory, Chile
(Under construction)



30 metres

Thirty Meter Telescope
Mauna Kea, Hawaii
(Planned)

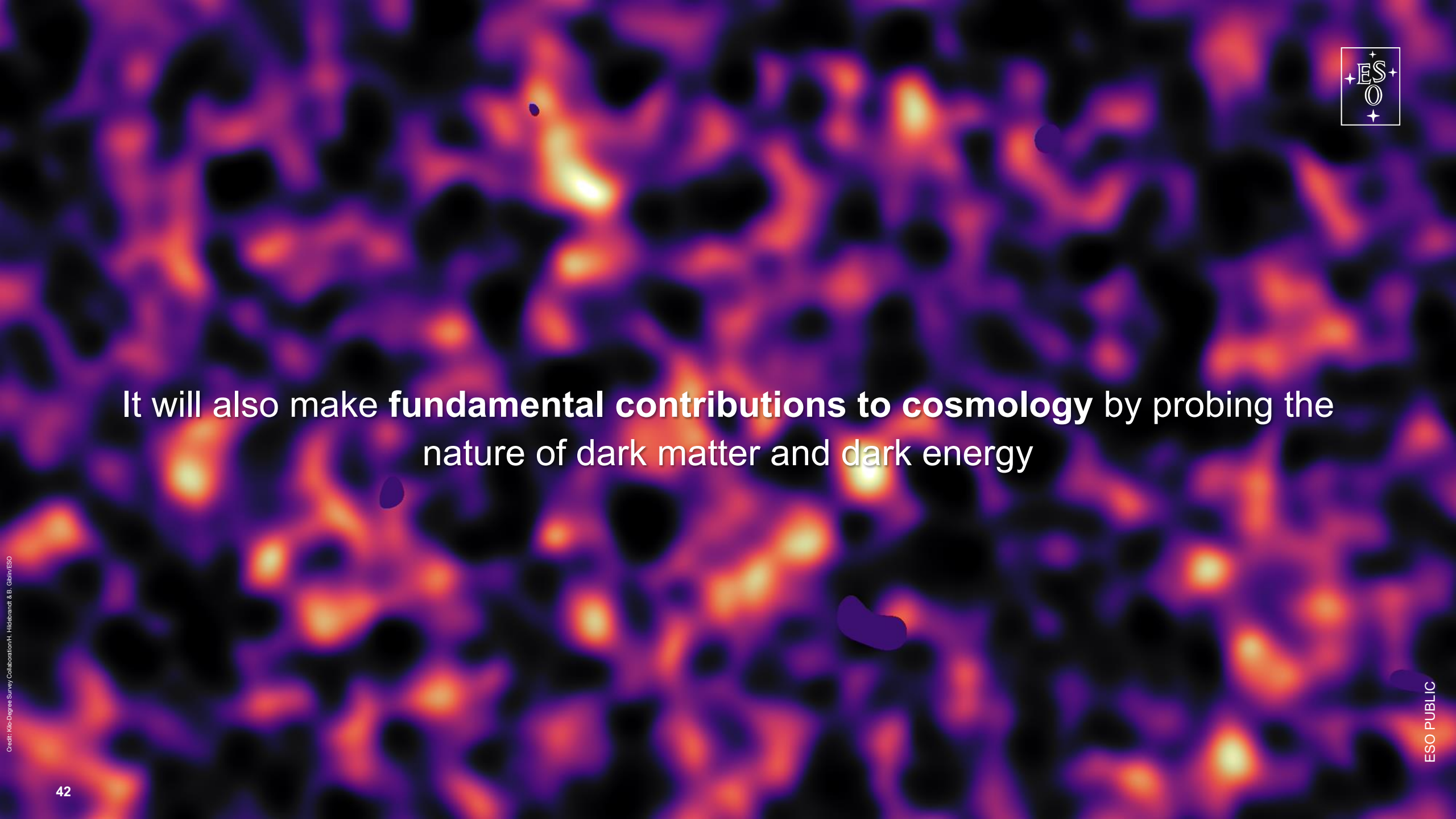


39.3 metres

Extremely Large Telescope
Cerro Armazones, Chile
(Under construction)

Science with the ELT

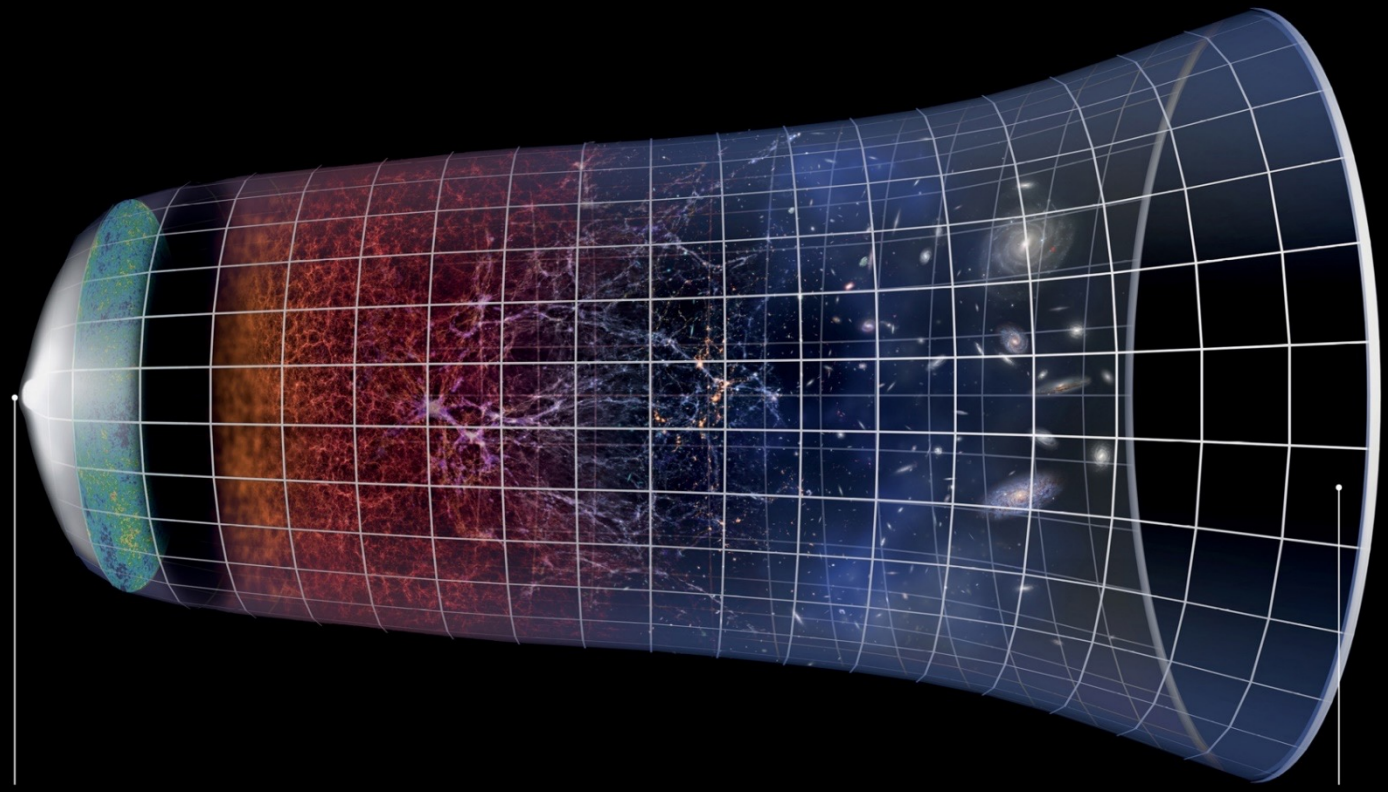
The ELT will tackle the **biggest scientific challenges of our time**, and will aim for a number of notable firsts, including **tracking down Earth-like** planets around other stars in the habitable zones where life could exist.



It will also make **fundamental contributions to cosmology** by probing the nature of dark matter and dark energy

Credit: Kilo-Degree Survey Collaboration/H. Hildebrandt & B. Giblin/ESO

Other key science areas include the **study of stars** in our galaxy and beyond, **black holes**, **the evolution of distant galaxies**, up to the very first galaxies in the earliest epoch of the Universe



Big Bang

Present Day

Credit: ESO/M. Kornmesser

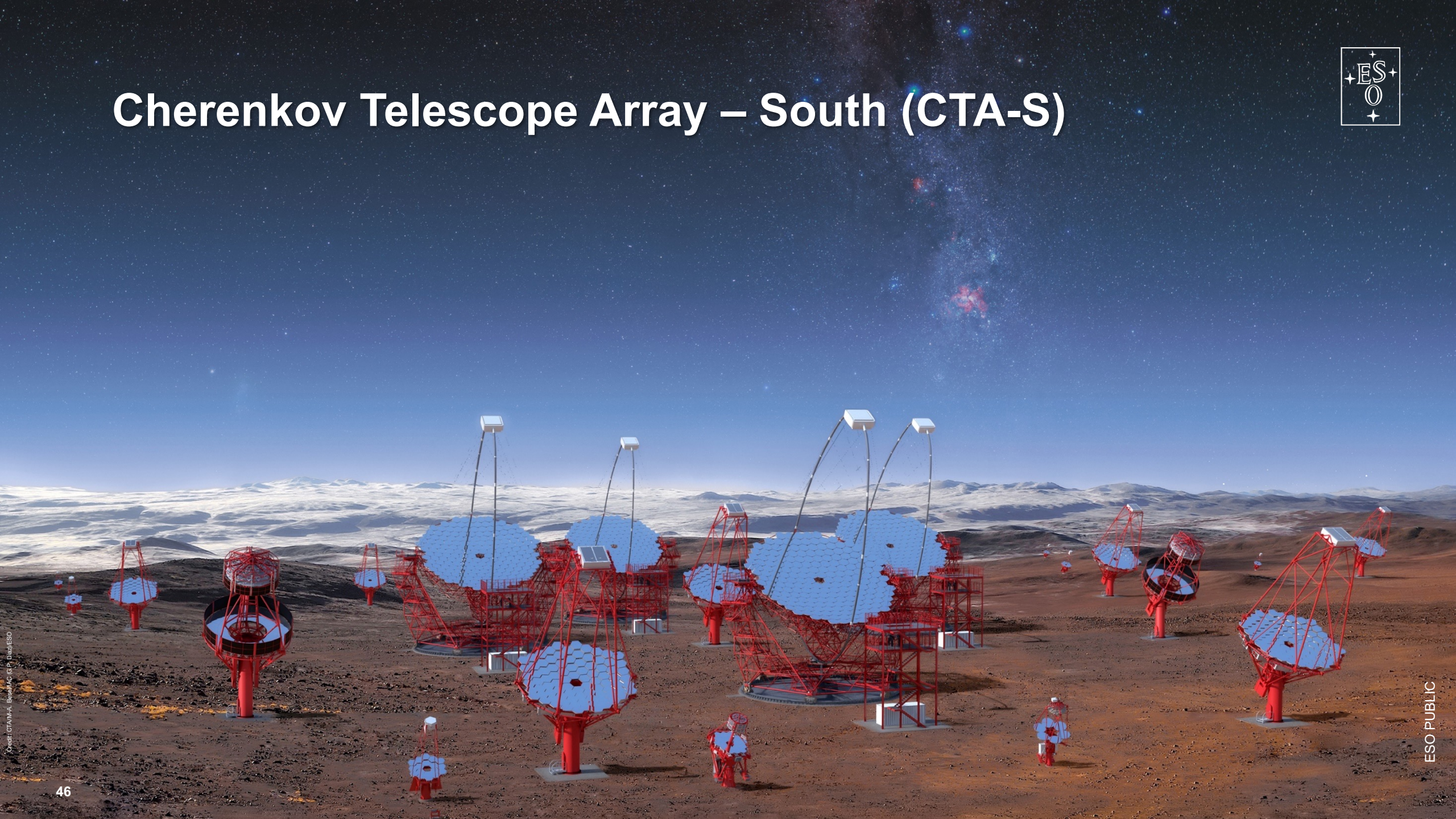
And discoveries that **nobody** has ever even thought about

Credit: ESO/M. Kornmesser

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

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

Cherenkov Telescope Array – South (CTA-S)



Credit: CTA/M-A. Besel/IAC (G.P. Diaz)/ESO

The CTA is a **Cherenkov-light telescope** that will enable us to observe the most energetic phenomena in the Universe

Credit: ESO/NASA, ESA and the Hubble Heritage Team (STScI/AURA)/F. Vogt et al.; Acknowledgments: Mahdi Zamani

It will detect gamma rays that reach the earth’s atmosphere and interact with it

Credit: CTAO

CTA will comprise about **70 telescopes** spread between two sites in the northern and southern hemispheres

Credit: CTAO

The Southern site, CTA-S,
will be located in the vicinity of
ESO's Paranal Observatory

It will be hosted and operated by ESO,
an 8 % partner in the CTA Observatory.

This partnership will generate important
operational and scientific synergies.

Credit: ESO/P. Horálek

ESO Science Archive Facility – open data for open science

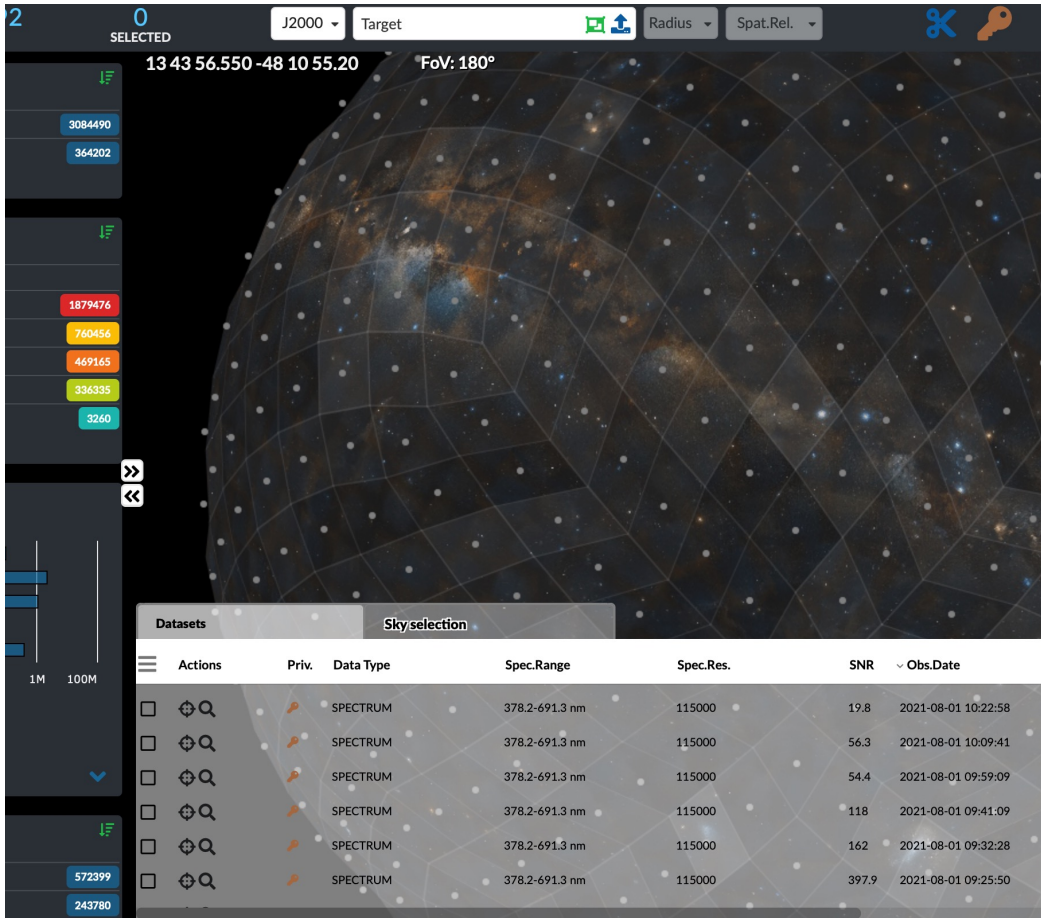
Credit: ESO/H.H.Heyer

ESO Science Archive Facility

Astronomy is an example of open/shared data.

- Open data from all ESO telescopes
- The SAF contains raw, processed, and advanced data products for scientists worldwide to use
- More than 3.5 million processed data sets

archive.eso.org



ESO telescopes help uncover the largest group of rogue planets yet

Credit: ESO/M. Kornmesser/S. Guisard (www.eso.org/~sguisard)

ESO premises

ESO Headquarters in Germany

ESO's science, administration and technology centre is located in Garching, near Munich, where

450 people work on site

ESO Headquarters in Germany

Home of ESO's Integration Hall, the Science Archive Facility, and ESO Supernova Visitor Centre & Planetarium

Credit: E. Grat/ESO

ESO’s integration hall

The main laboratory where many instruments are built and prepared before being installed on ESO's telescopes in Chile

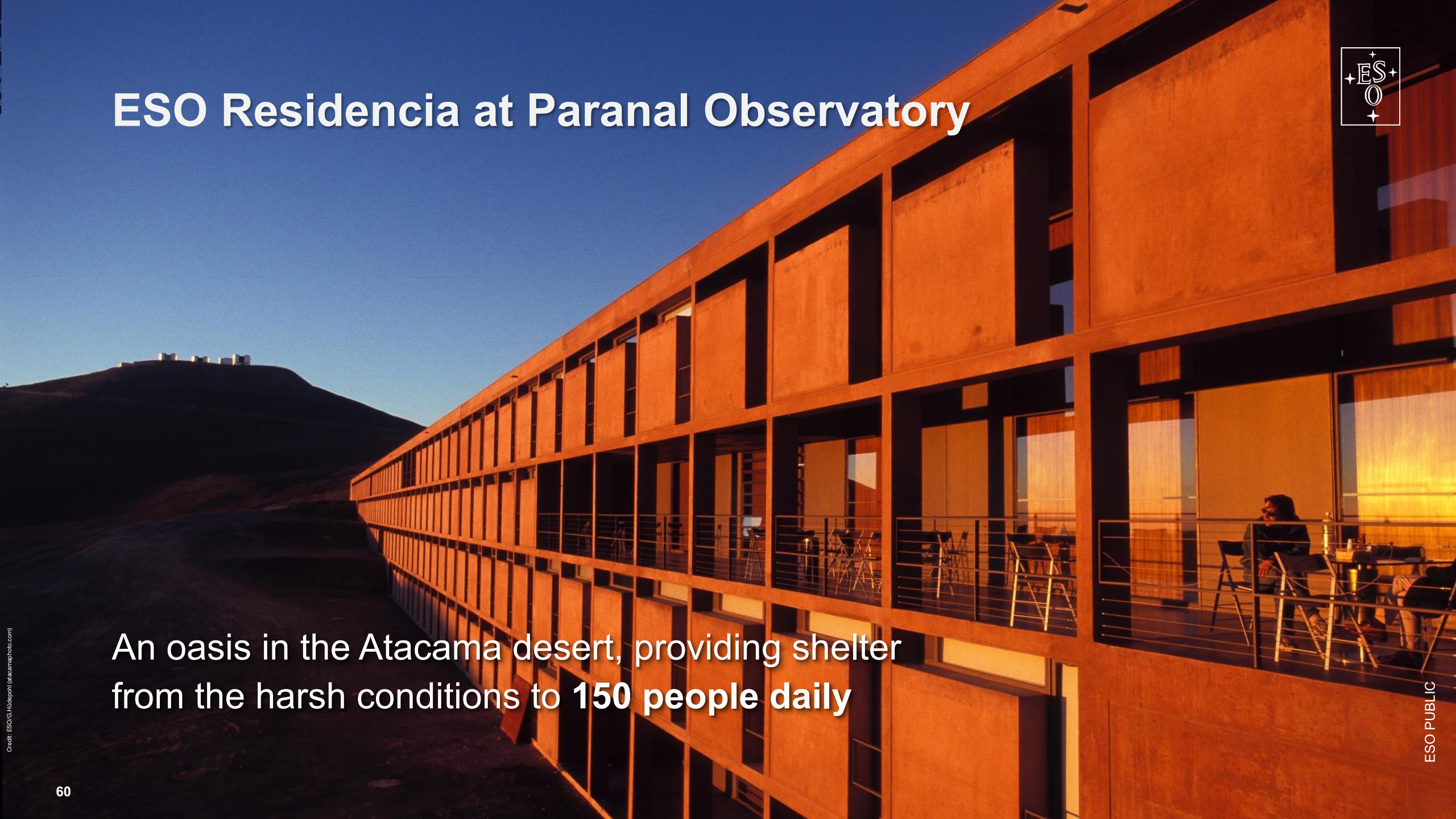
Credit: Aldo Amoretti | San Pietro

ESO office in Vitacura, Santiago, Chile

ESO's hub for science and technology in Chile

Credit: ESO & ALMA (ESO/NAOJ/NRAO)

ESO Residencia at Paranal Observatory



An oasis in the Atacama desert, providing shelter from the harsh conditions to **150 people daily**

Credit: ESO/G.Hüdepohl (atacamaphoto.com)

The Residencia houses a 1000-m^2 indoor garden and 35-m-wide dome for natural daylight

Credit: ESO/José Francisco Salgado (josefrancisco.org)