Introduction to ESO and its projects

Technology Development in Chile in the ELT era

Itziar de Gregorio-Monsalvo — ESO Chile Representative

ESO: Mission

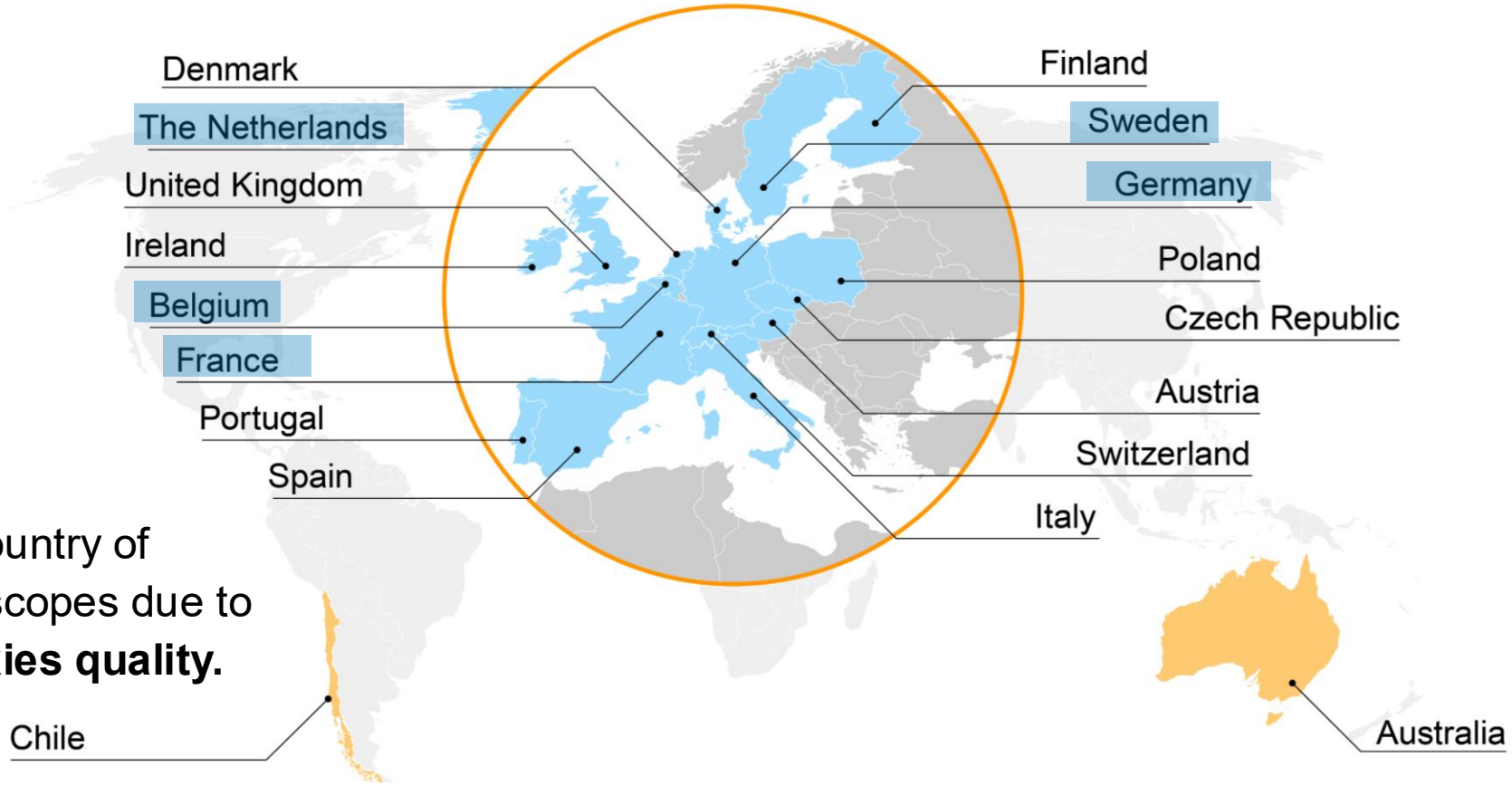
The most productive and more advanced ground-based optical and infrared telescopes on Earth

Design, build and operate advanced ground-based astronomical telescopes

Fostering international collaboration for astronomy

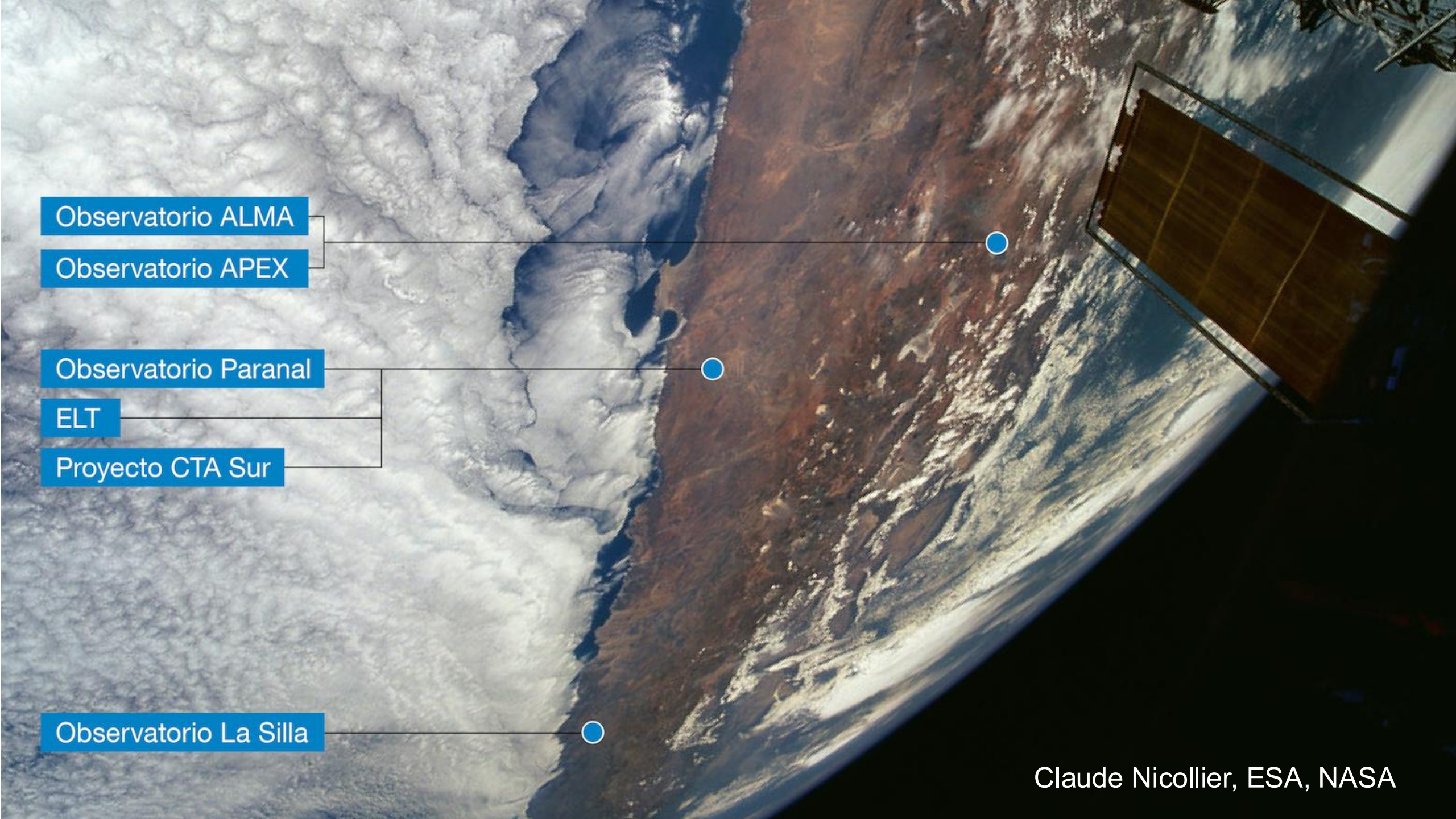
Member States and partners

Founded in 1962 by 5 states. Today it consists of **16 member states**

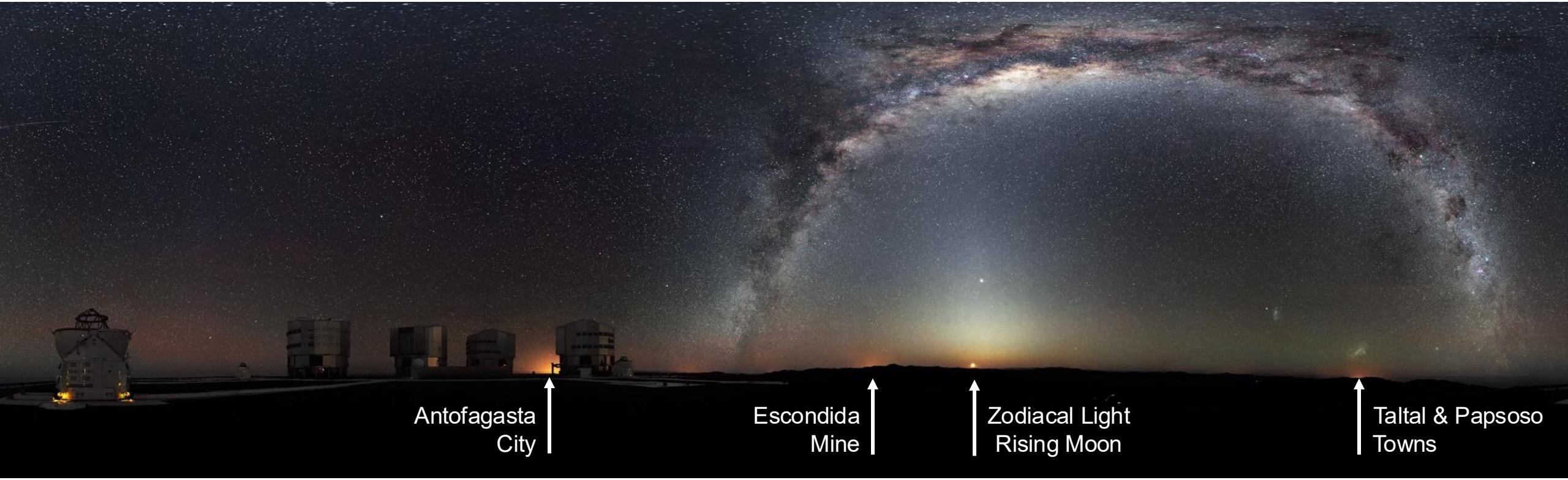


Chile is the host country of ESO's current telescopes due to the **exceptional skies quality.**

Australia is a strategic partner


Observatorio ALMA
Observatorio APEX
Observatorio Paranal
ELT
Proyecto CTA Sur
Observatorio La Silla
Claude Nicollier, ESA, NASA

(Almost) Pristine Sky above Paranal



270° W | 0° N | 90° E | 180° S

La Silla (1969+)– ESO's first observatory

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

Telescopes currently operated by ESO at La Silla

Telescopes hosted at La Silla by ESO

Credit ENEL

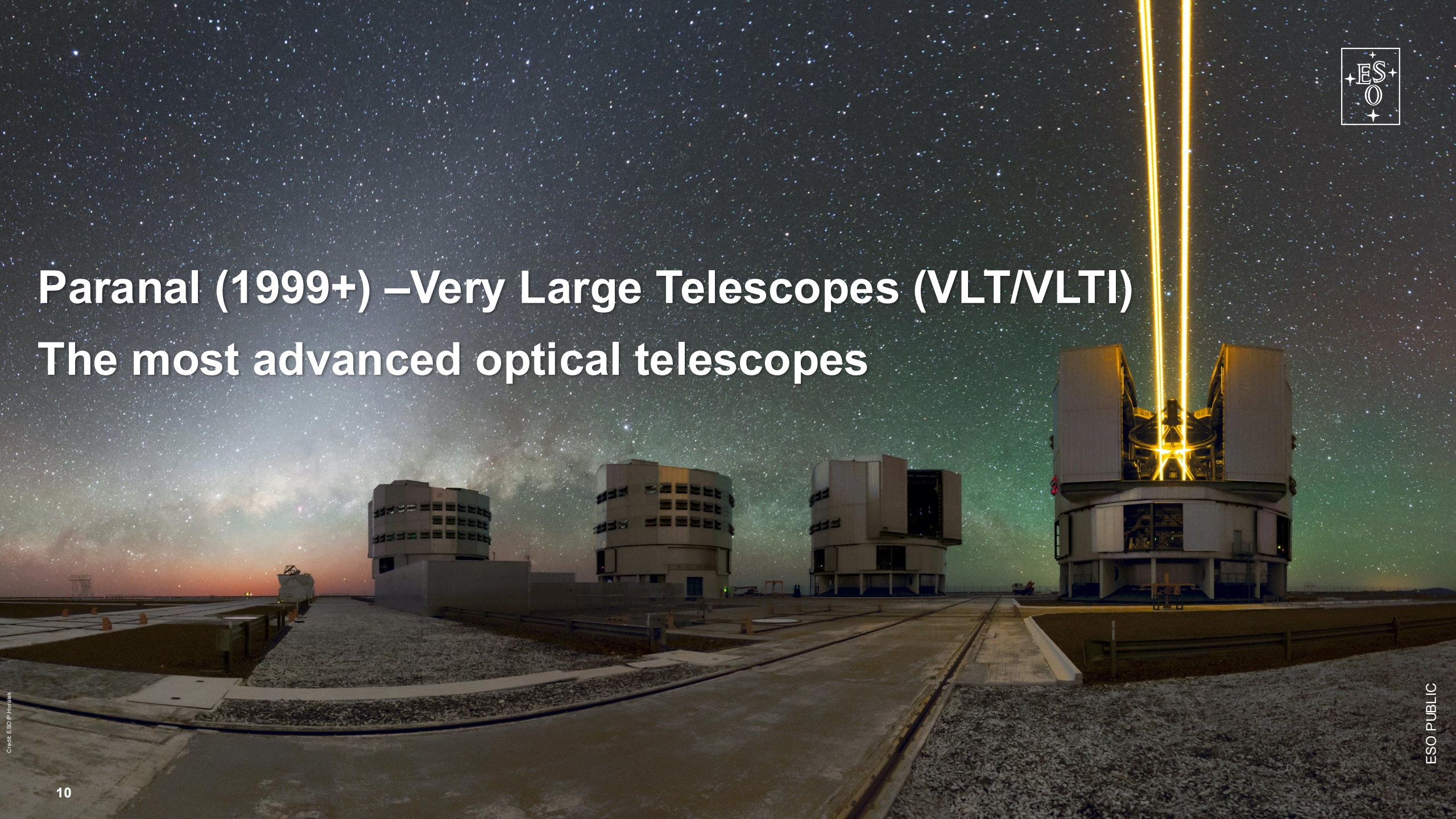
Active optics

An invention that changed everything

In the 1980s, ESO engineer Ray Wilson invented a revolutionary technology for the NTT: it corrects the deformation of the main mirror caused by gravity and wind

Today all telescopes in the world use **Active Optics**.

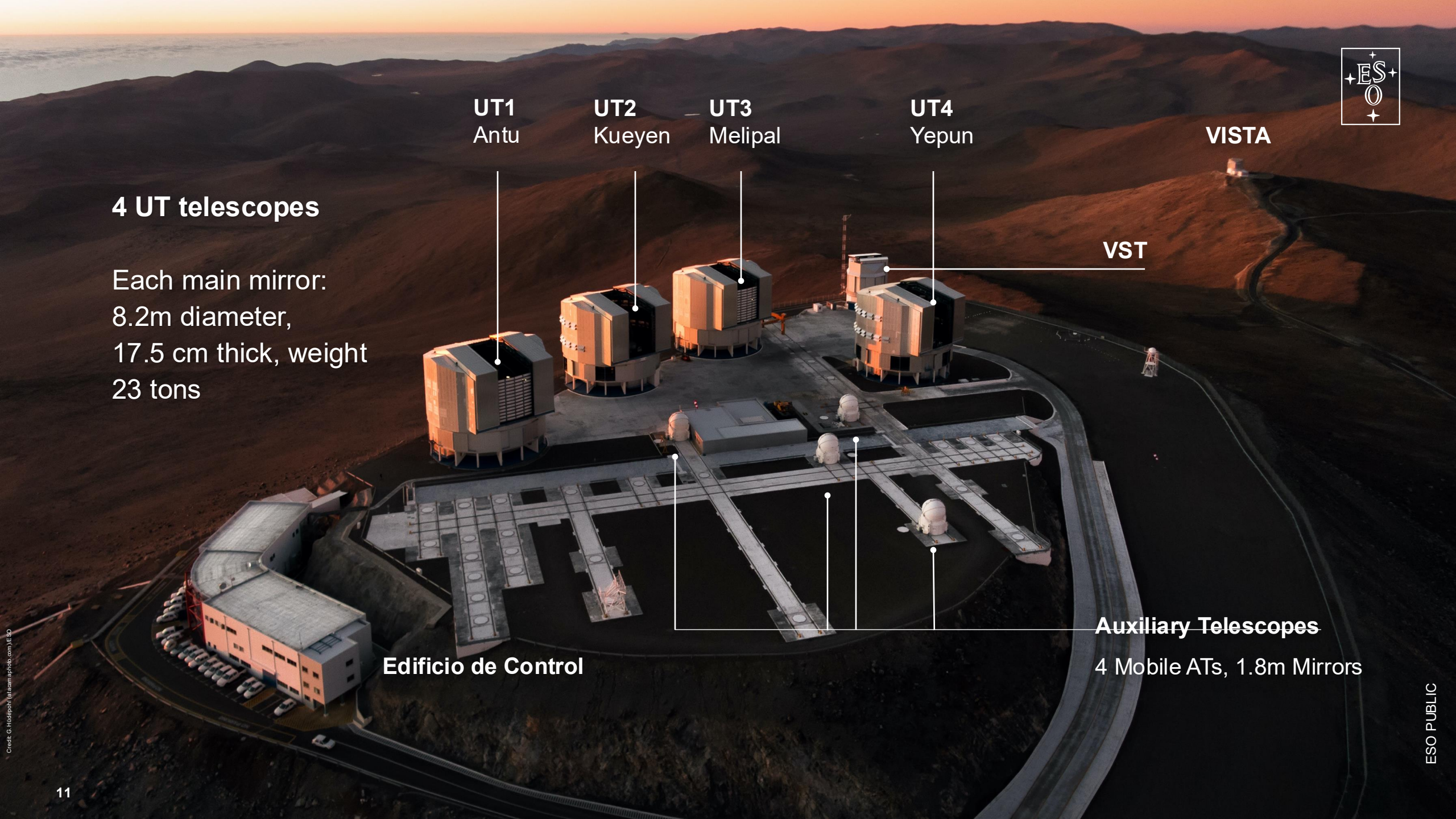
Active Optics Actuators on the Reverse of the NTT Primary Mirror(3,5 m)



Paranal (1999+) –Very Large Telescopes (VLT/VLTI)

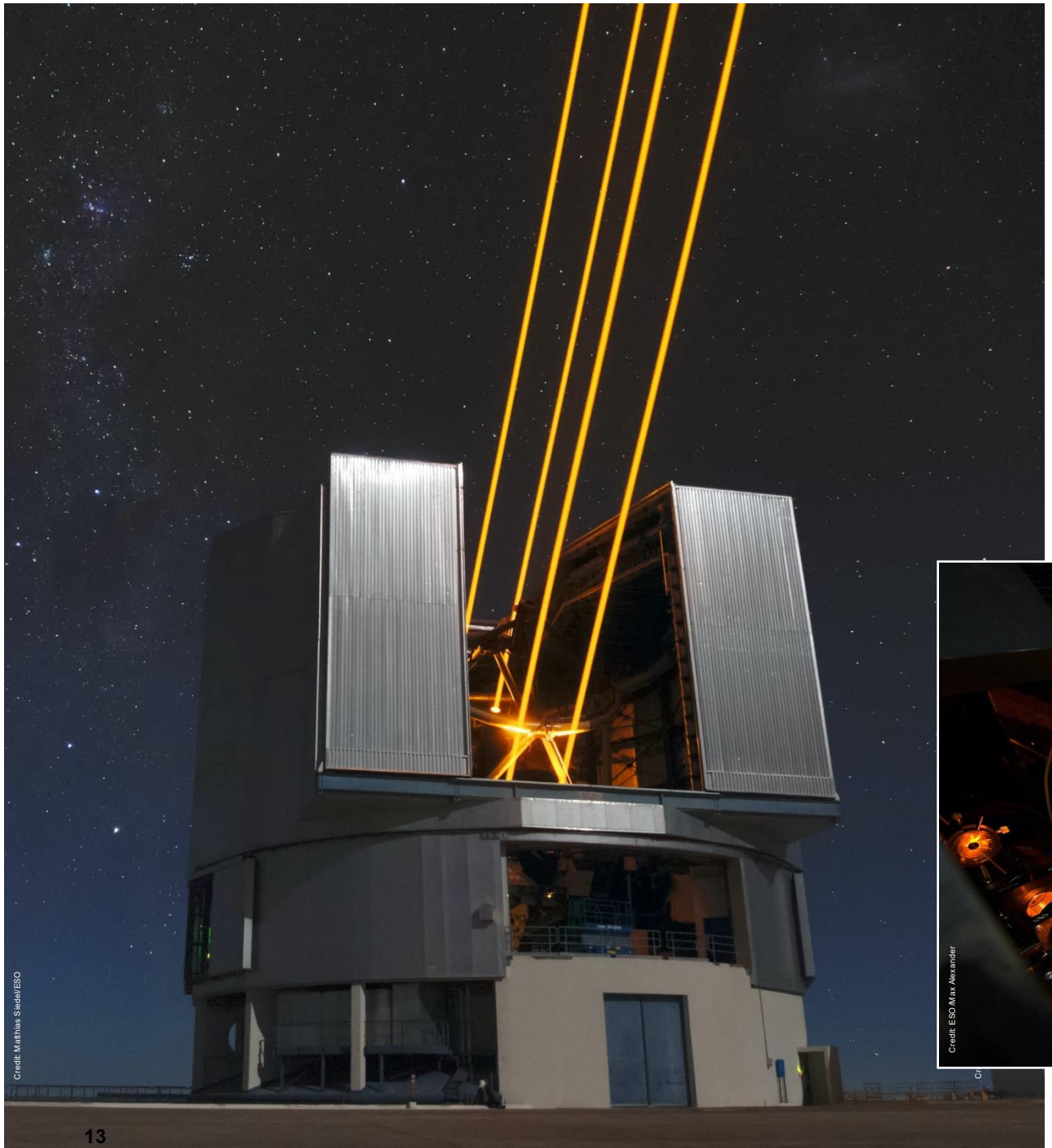
The most advanced optical telescopes

Credit: ESO/P.Horálek



4 UT telescopes

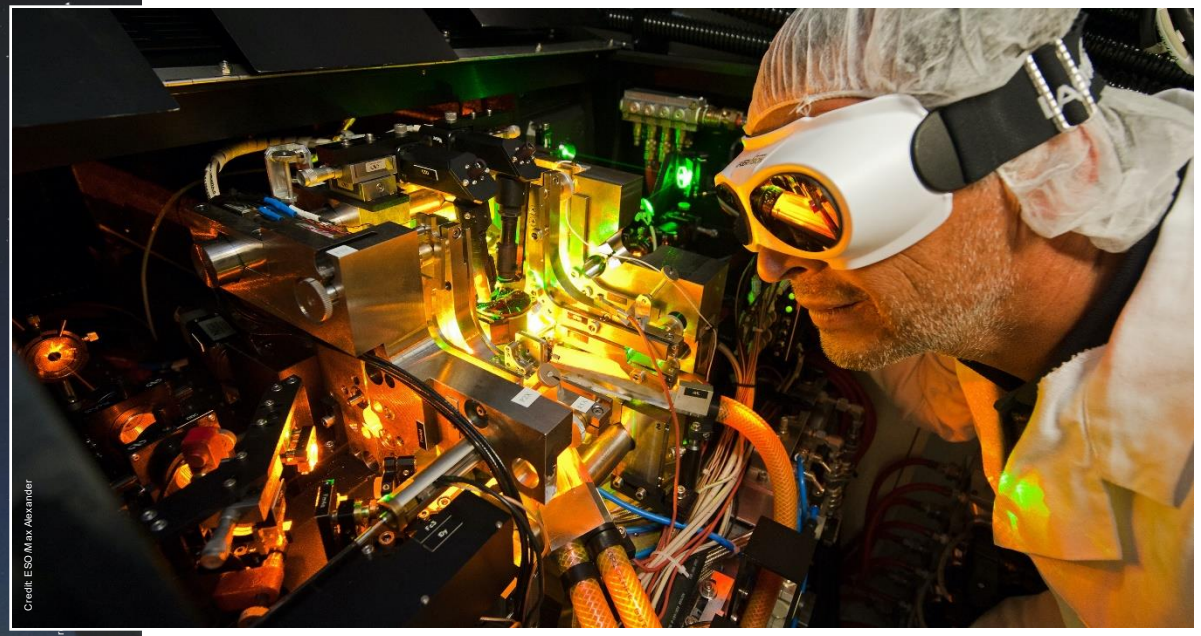
Each main mirror:
8.2m diameter,
17.5 cm thick, weight
23 tons



Adaptive optics

Corrects light distortions introduced by turbulence in the Earth's atmosphere

Based on a sophisticated system of lasers and actuators on the secondary mirror.




VLTI Interferometer


VLT with artificial stars

2020

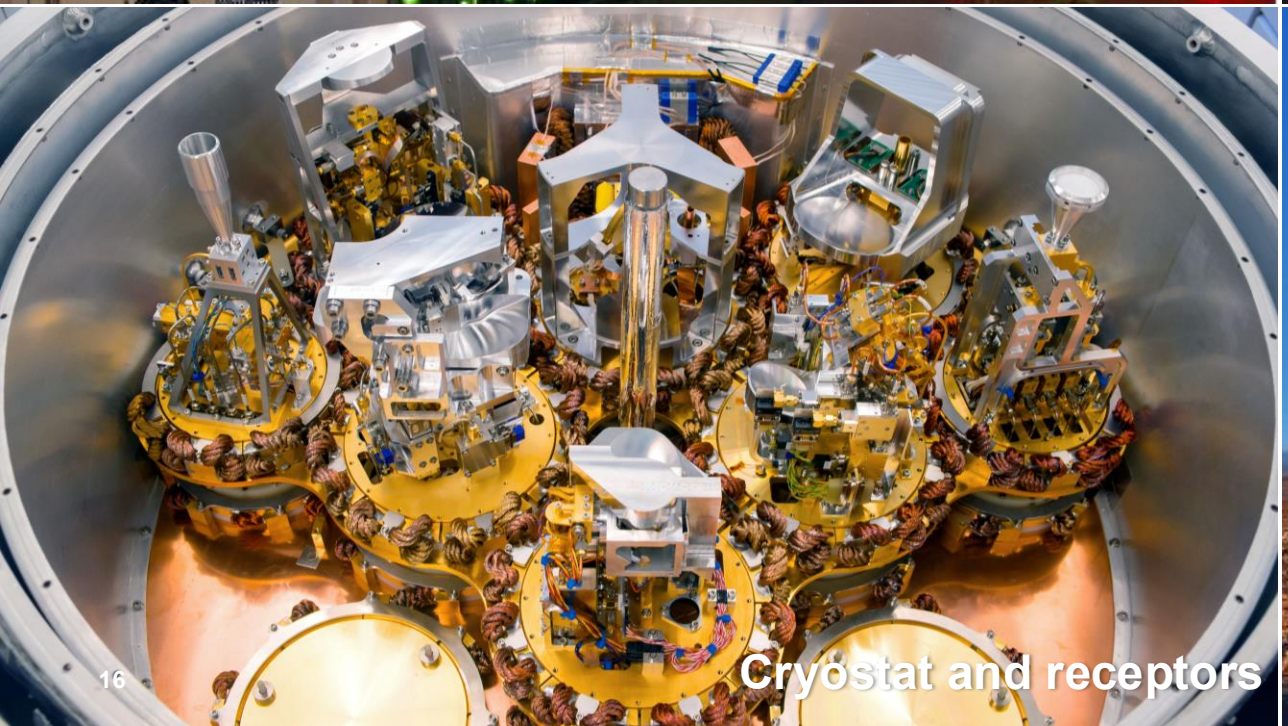
GRAVITY, VLTI instrument


MUSE, VLT instrument

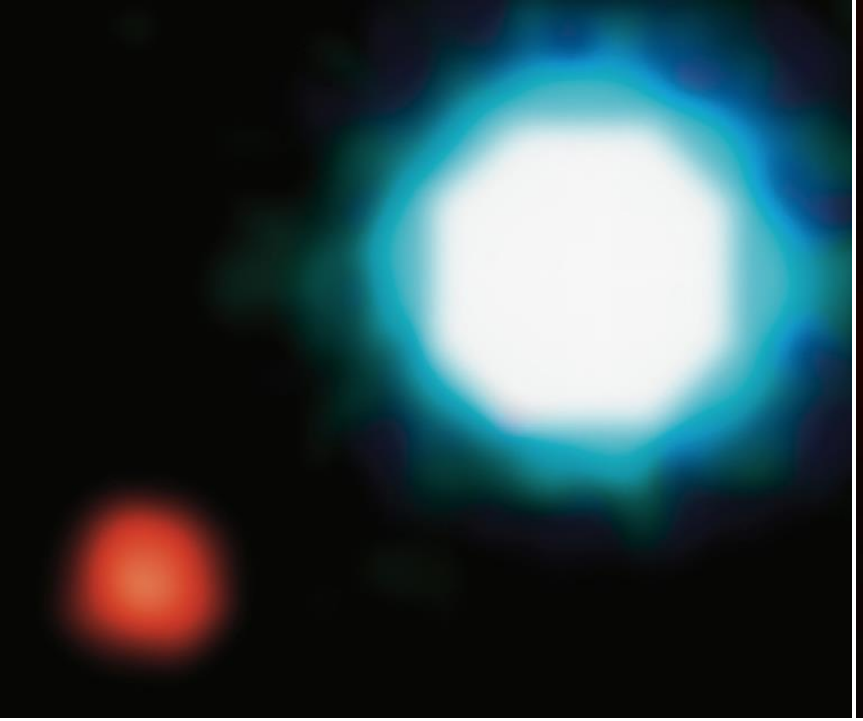
ALMA (2013+) — Atacama Large Millimeter/submillimeter Array

Global Partnership between ESO, NSF, NINS, in cooperation with Chile

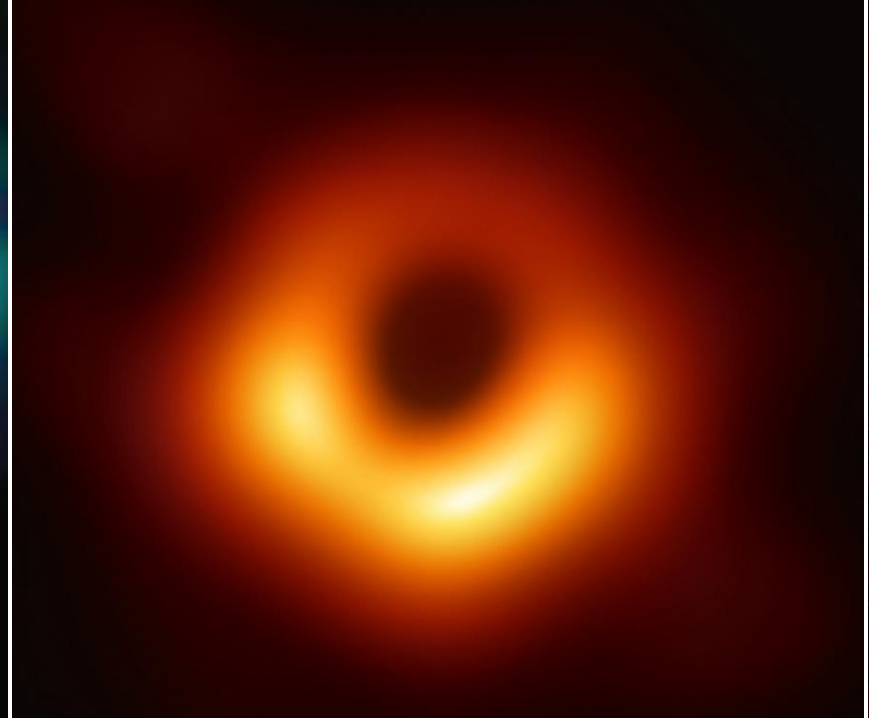

Correlator


Cryostat and receptors

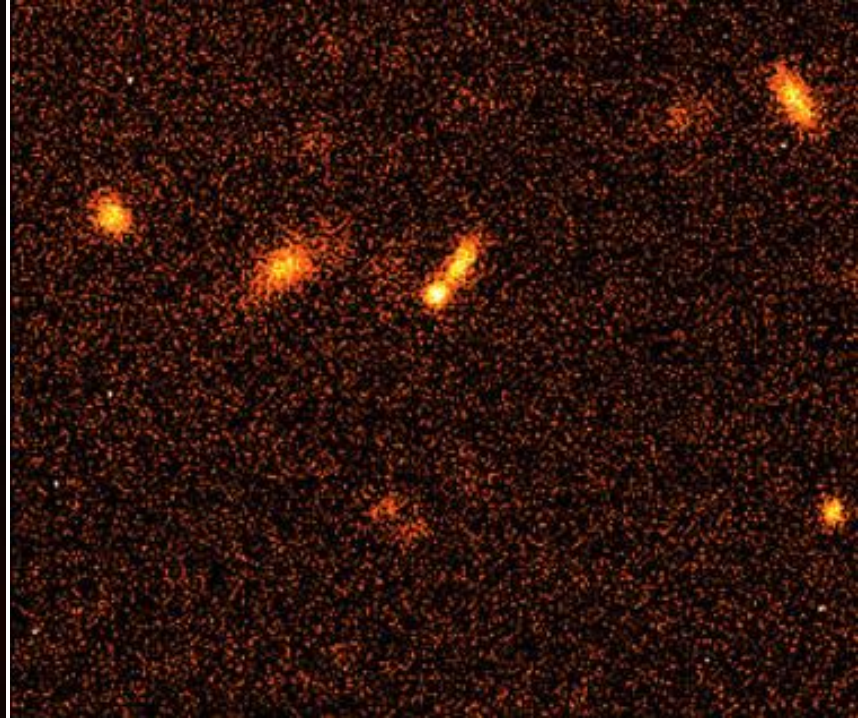

Transporter



First image of an exoplantet



First image of a black hole



Accelerated expansion of the Universe

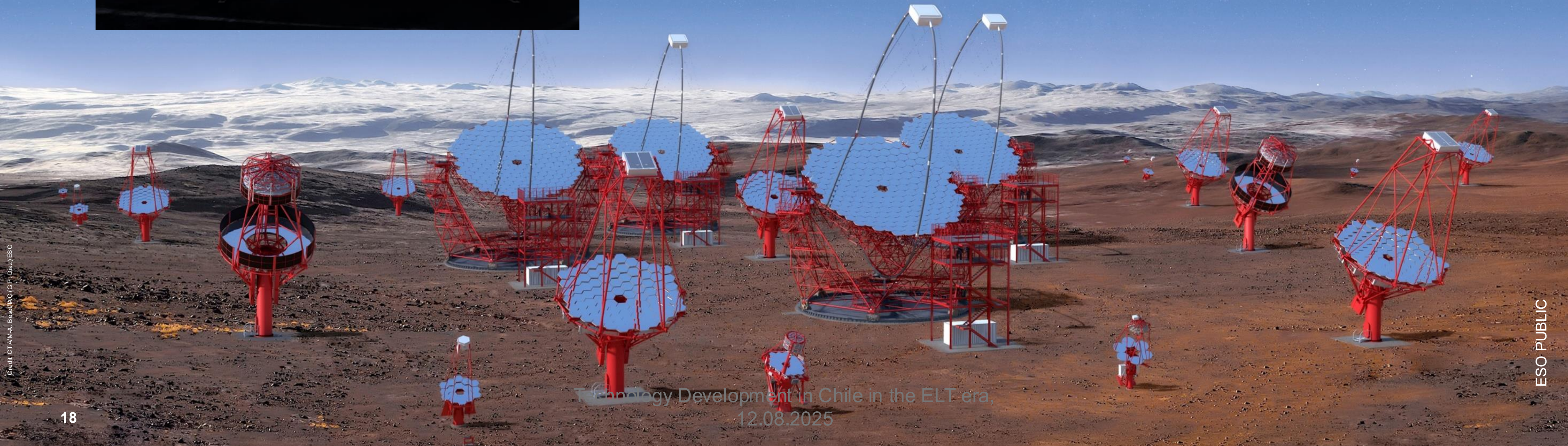
Pushing the limits of technology enables transformational Science that changes scientific paradigms

3 Nobel Prizes

Cherenkov Telescope Array – South (CTAO-S)

CTAO will be the first ultra-energetic gamma-ray observatory, with one part (CTAO-N) in La Palma and another (CTAO-S) in Paranal-Armazones.

The construction phase of CTAO will start this year.



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

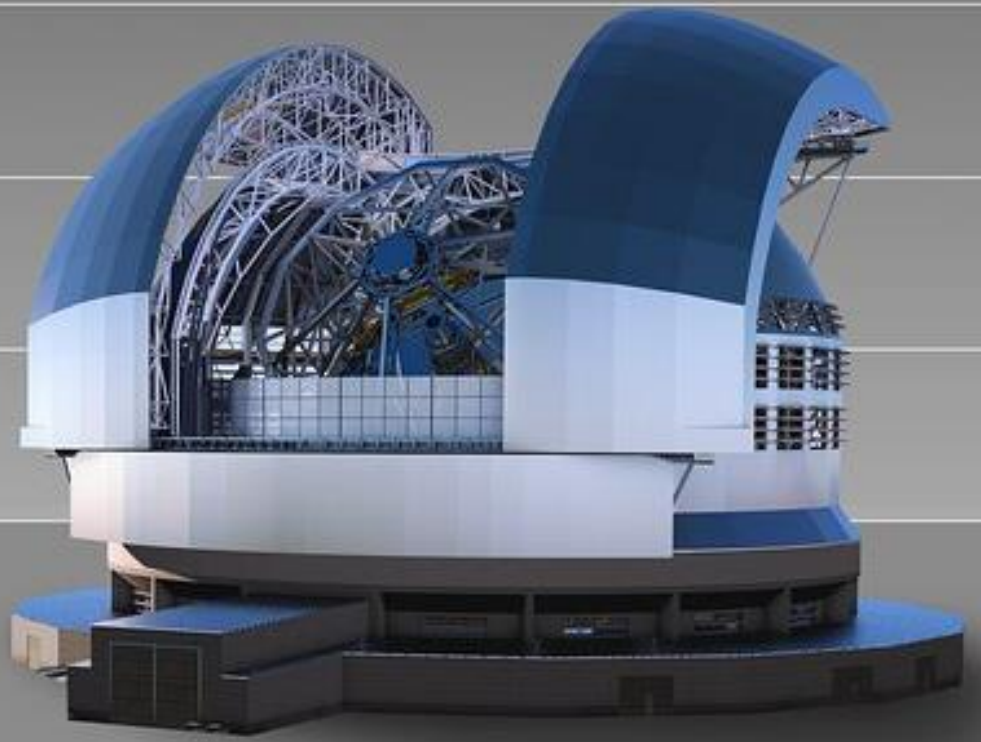
ESO PUBLIC

ESO’s Extremely Large Telescope (ELT), a complex and challenging machine

Extremely Large Telescope (ELT)

- It will be the largest optical-infrared telescope in the world.
- 39.3 m diameter
- Construction 2015-2029 (~1500 MEUR) + Organisational support + in-kind contributions to the instrumentation (~2500 MEUR)
- It is the most powerful telescope of the new generation, the only one that has secured its financing and the most advanced in its construction
- Goal: detect life in other planets surrounding other stars

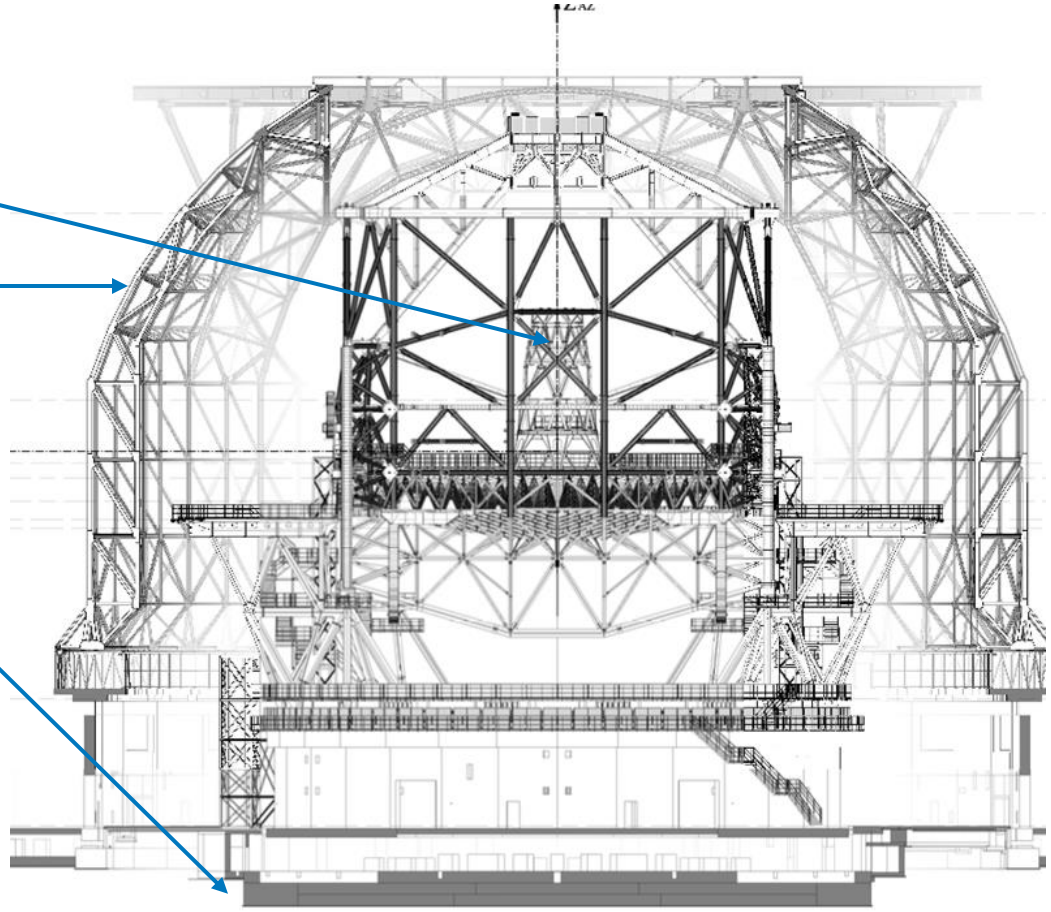
La Portada
Chile



ELT

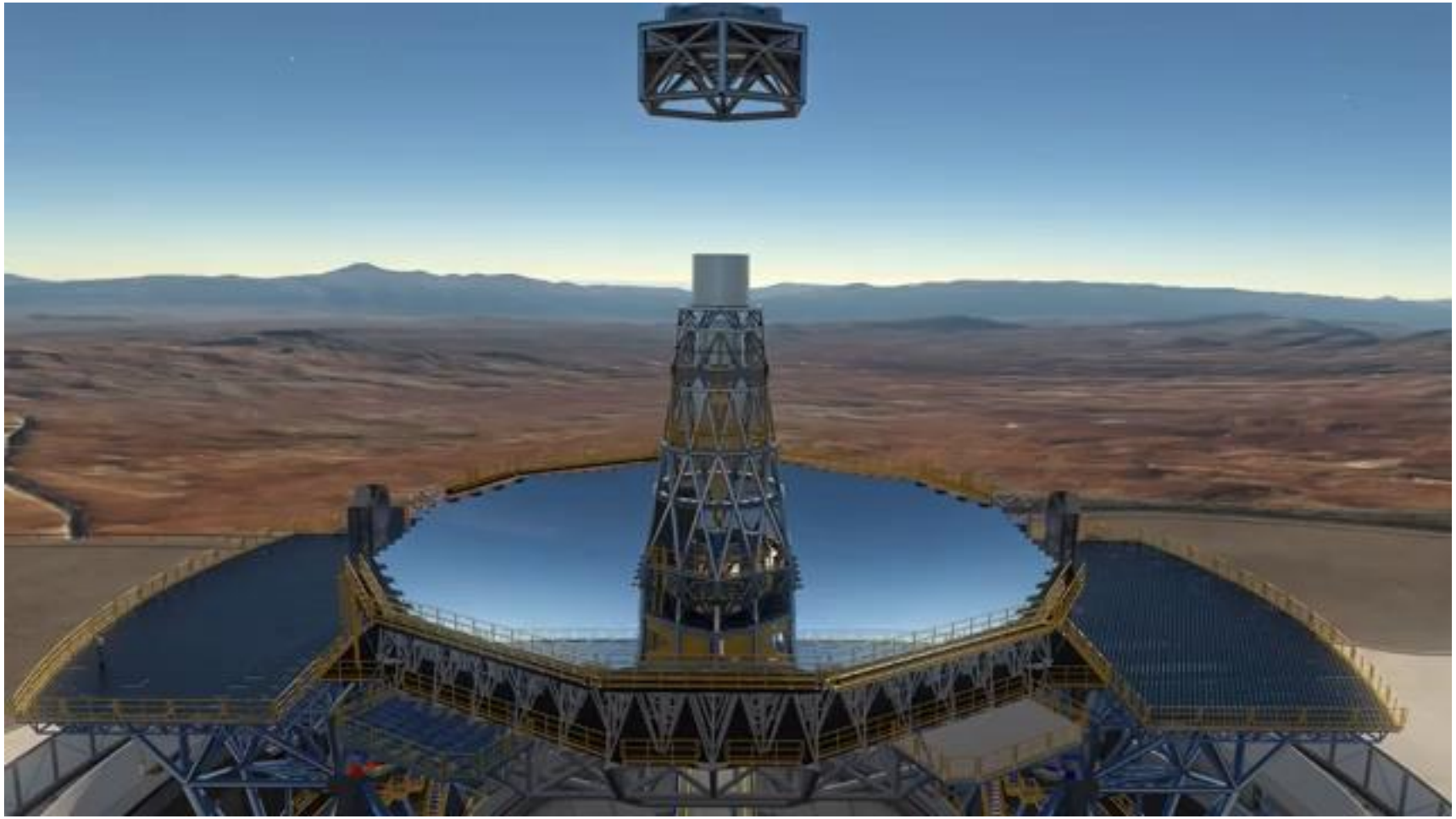
Dome and Main Structure

- Main structure 4600 tons. High precisión movemente 2 deg/s
- Dome: 80 m height, 6100 tons.
- Main Structure Fundation: 60 m diámeter, 9000 m^3 concrete.
- Last Generation anti-seismic system.

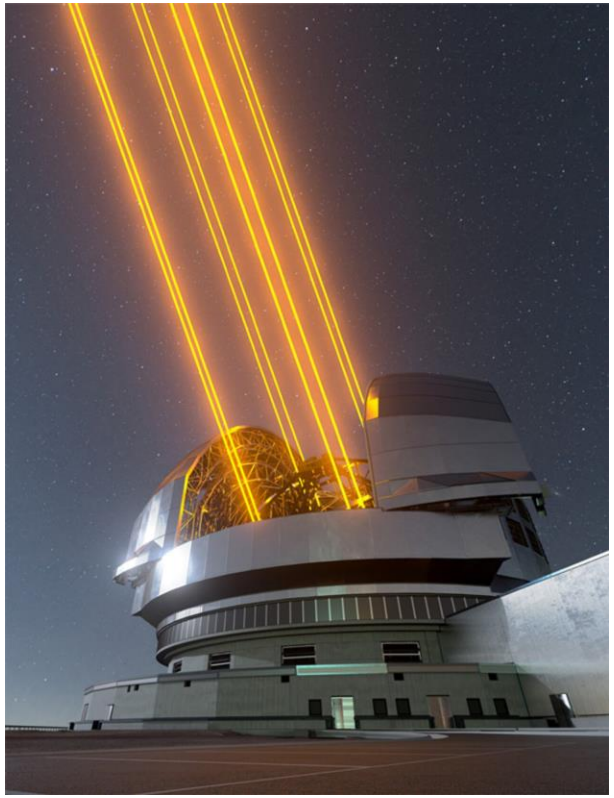


ELT Dome and Main Structure

ELT Optics System



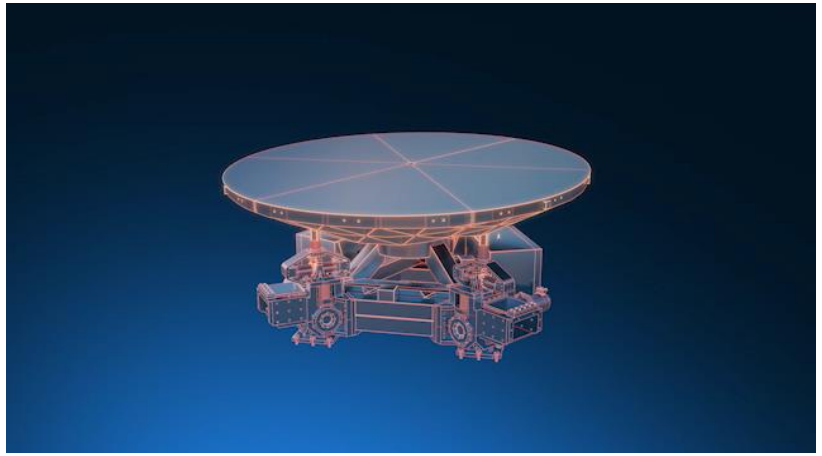
Adaptative Optics:



8 laser guides

M4: Deformable mirror

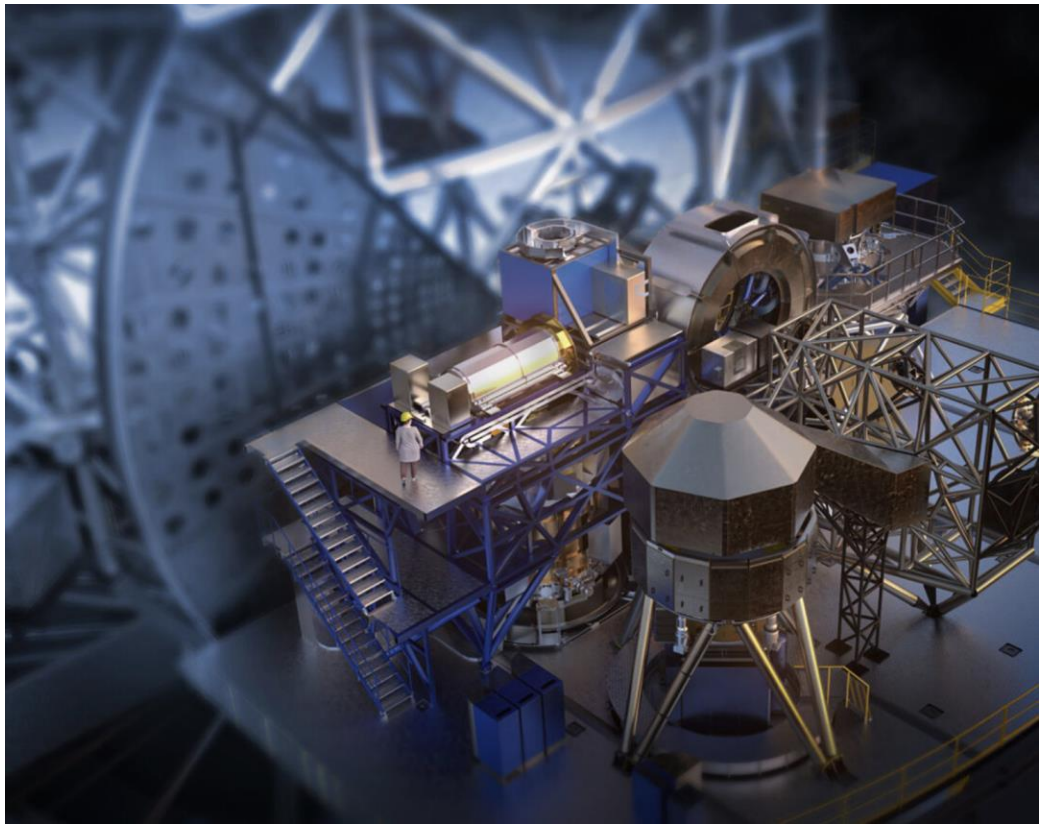
- 2 mm thicknes
- 5000 actuators changing form 1000 times/s
- Magnetic levitation



M5: Image stabilizer

- Ajusts its position 10 times/s

Scientific Instruments



- High precision and sensitive instruments.

- First generation:
- HARMONI, MICADO, METIS, MORFEO

- Second generation:
- ANDES, MOSAIC

Integrated Operations Programme (IOP)

The Future of Paranal observatory

- Paranal will operate in the future a set of world-leading telescopes: the Very Large Telescope, the Extremely Large Telescope, and possibly the CTAO-South.

- The Operations model (logistics, science operations, commuting, technical maintenance,…) is not scalable to the ELT
- A new operational concept needed, based on digitisation and making use of Industry 4.0 tools.

The Integrated Operations Programme (IOP)

Digital Transformation of all relevant processes in Operations.

- ESO-wide programme led by the Paranal Observatory aiming at a sustainable operations paradigm.
- Sustainable → financially, environmentally and socially

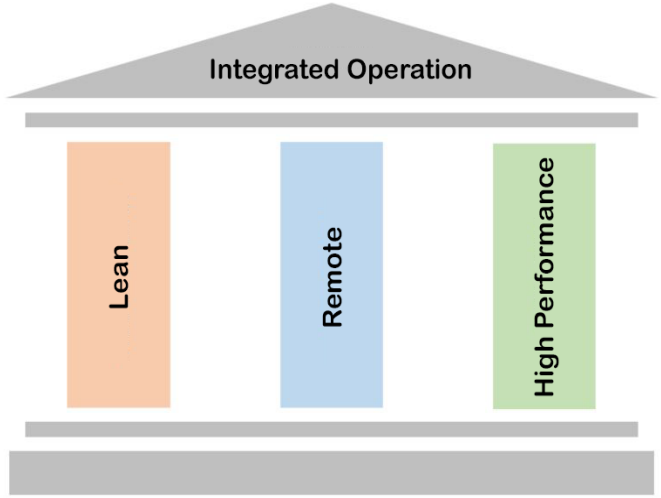
Programme Objective

- Integrated science and technical operations of the ELT (on Cerro Armazones) and the VLT (on Cerro Paranal), maintaining the VLT at the forefront of ground-based astronomy
- Deliver high-performance science data through sustainable operational processes

The Integrated Operations Programme (IOP)

Programme Pillars: Lean, Remote, and High-Performance Operations

- **Lean Principles** - use available resources efficiently
  - Optimize and automate processes (operations, maintenance, logistics)
  - Provide infrastructure for efficient multi-site operations
- **Remote Operations** - control/monitor systems from remote locations
  - Minimize on-site activities (inspections, corrective maintenance)
  - Predictive maintenance and remote control assets
- **High Performance** - enhance/maintain performance & availability
  - Strengthen data & system analysis
  - Maximize the scientific output



The Integrated Operations Programme (IOP)

- Top Level Requirements released in 2021
- Phase A (feasibility) review done in 2023
- Phase B (consolidation) review scheduled for 2026

Milestones

- Readiness to start executing the technical maintenance of the ELT mid-2027
- Readiness for the ELT early operations in 2030
- Full integration with ‘’modernized” VLT operations around 2032

Many thanks!

Twitter: @eso_Chile
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Youtube: European Southern Observatory

Credit: ESO/L. Calçada