ESO update and Expanding Horizons: transformational science in the 2040s

Xavier Barcons

ESO science enabled

Scientific output

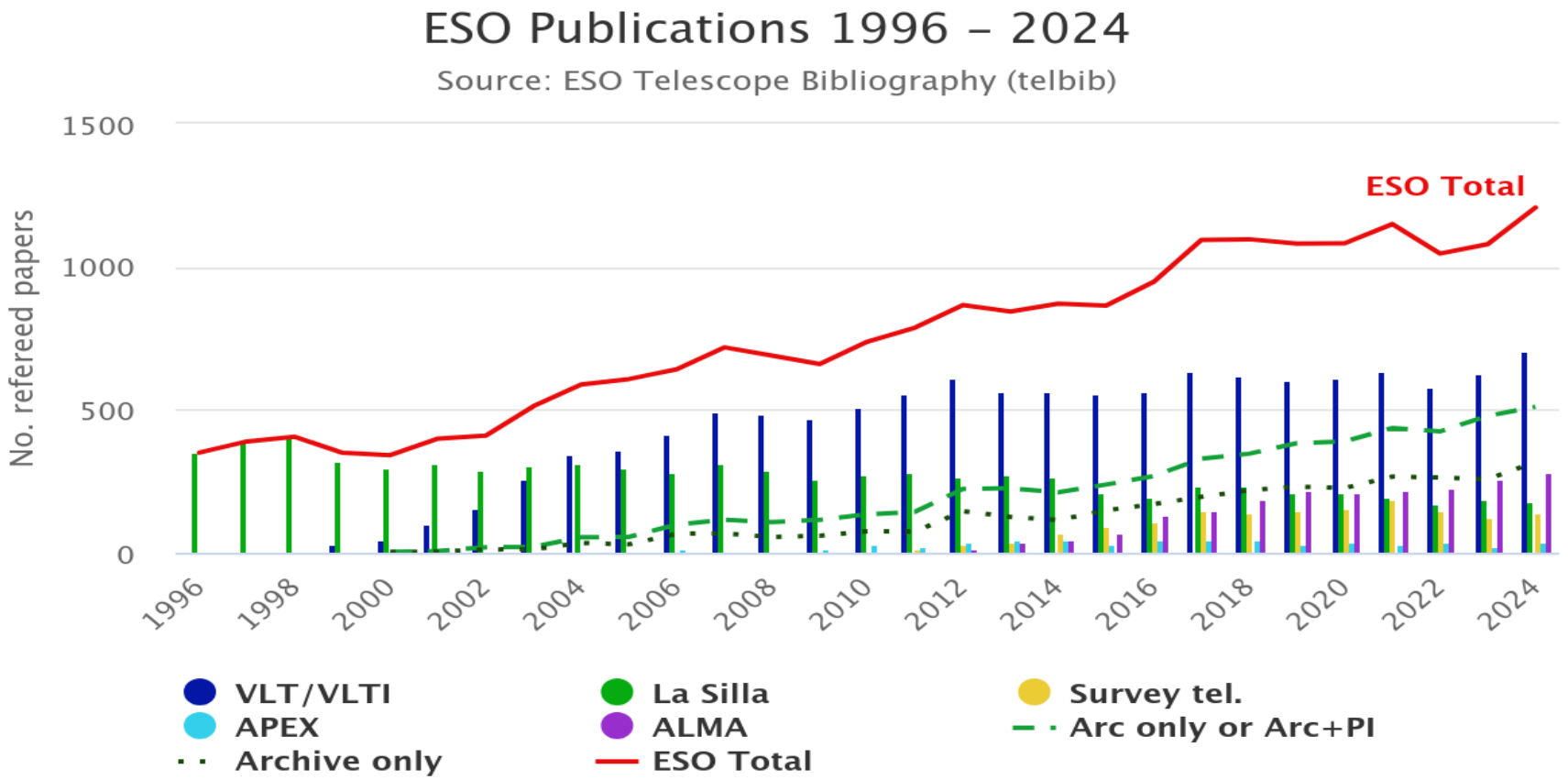


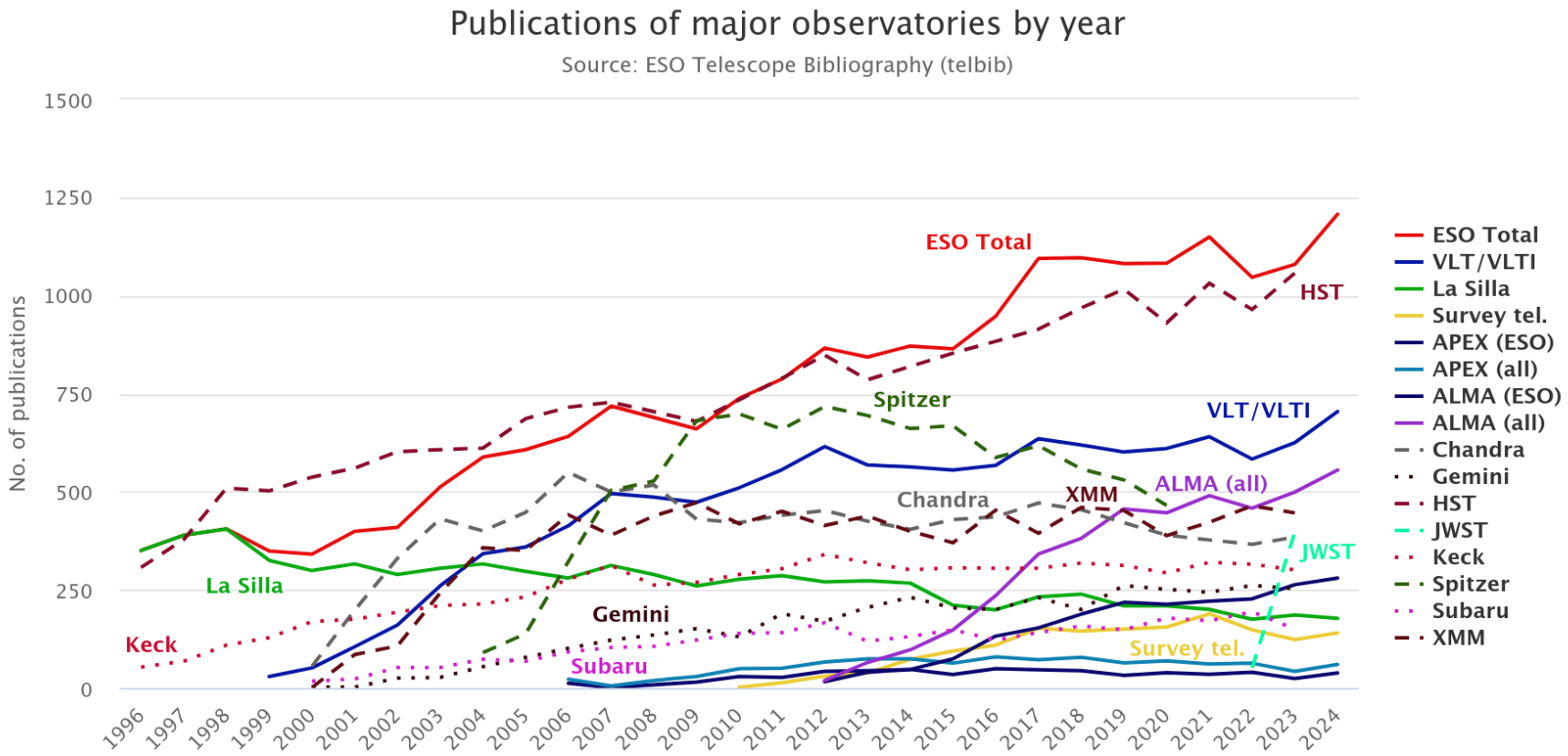
Fig. 1b: Refereed papers using ESO data

provided by the ESO Library & Information Centre, realized with Highcharts.com

Obs	Pub 2024
LPO	970
ALMA	280
Archive+PI	510
Archive only	310
Total	1207

ESO science enabled

Scientific output



Obs	Pub 2023
HST	1057
LPO	970
ALMA	555
Chandra	384
XMMNewton	446
Keck	301
Gemini	253
Subaru	150
JWST	397

Fig. 3: Refereed publications by ESO and other observatories. Statistics for a given year may remain incomplete throughout the following year.
***Solid lines:** ESO facilities. **Dotted lines:** other ground-based facilities. **Dashed lines:** space-based facilities.*
Please note that selection criteria for inclusion or exclusion of papers vary among observatories.

provided by the ESO Library & Information Centre, realized with Highcharts.com

LPO and VLT/I instrumentation

LPO operations nominal, major obsolescence projects coming up

All 4MOST elements shipped to Paranal. Installation on-going. First spectra of VISTA+4MOST expected 19-21.10.2025

GRAVITY+ lasers being installed, first light in Q4/2025 (8.11.2025 TBC)

MOONS shiping delayed to Nov 2025

CUBES FDR completed in Jul 2025

Progress towards TTR of FORSup (May 2026)

4MOST inside the VISTA dome

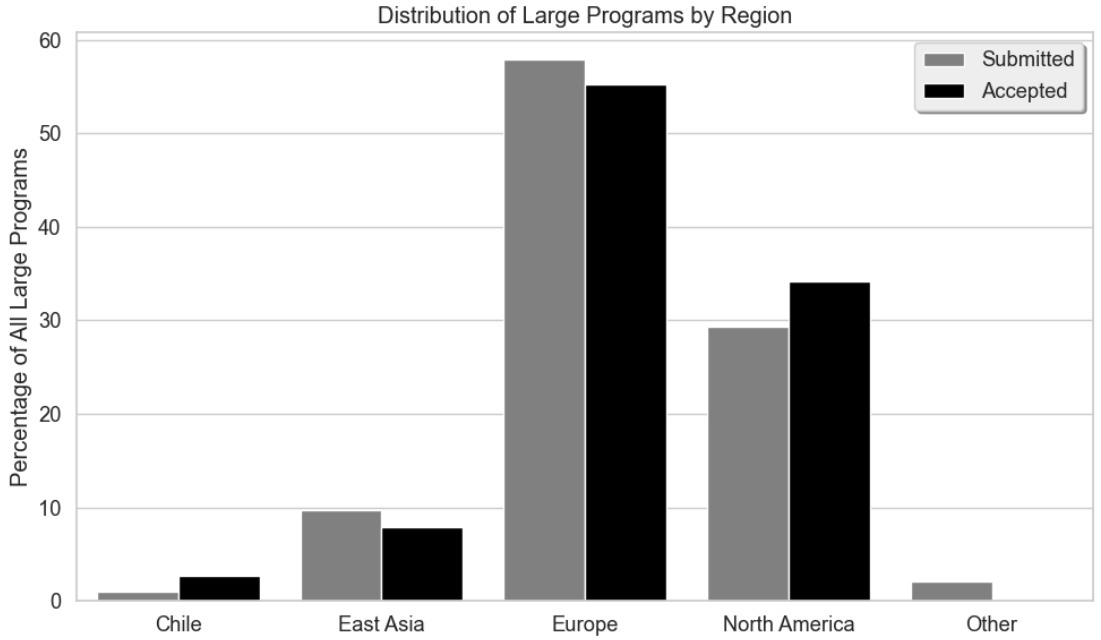
ALMA - operations

Cycle 11 high observing efficiency, but ALMA experienced serious bad weather episodes.

Good chance that total number of observing hours will still be around the nominal 4300 h

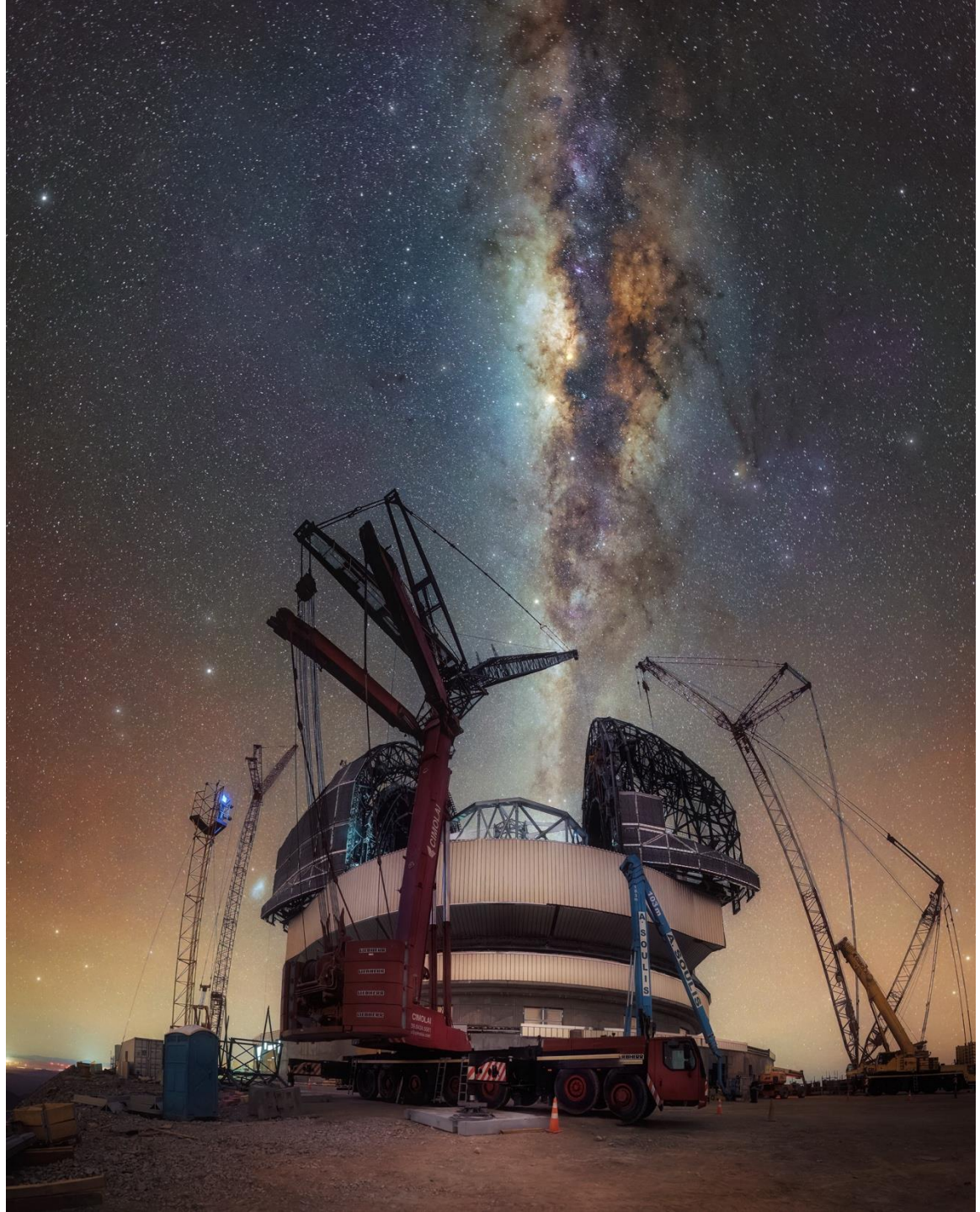
Cycle 12 proposal time allocation completed

ESO region astronomers very active/successful in submitting LPs



ALMA Wide-band Sensitivity Upgrade (WSU)

- Comprehensive development Programme of ALMA, focussing on the ALMA2030 scientific objectives: Origins of Galaxies, Origins of chemical complexity and Origins of Planets
- WSU focusses on extending the signal bandwidth of the existing array. Scope delivery
  - Implementation of signal chain: digitisers, transmission system, fiber link, new correlator data ingest 4x and correator 2x (expandible to 4x)
  - SW and computing infrastructure adequate for 4x chain
  - Commissioning modes with current receivers
  - New receiver bands: Band 2 (ongoing), Band 6, Band 7 and Band 8.
- Systems PDR passed with relevant actions. Preparations for a cost review.
- ALMA Board has established an WMAC to support programme oversight (Chair Colin Londsdale)
  - Potential approval by the ALMA Board in 2026



ELT - Extremely Large Telescope

Will be the largest optical/infrared telescope ever built or planned

Segmented primary mirror of 39.3 m diameter (798 tiles); adaptive optics

Construction 2015-2030

CtC: 1600 MEUR + Organisational support + in-kind contributions to the instrumentation (total ~ 2.3 Bn€)

First Telescope Light: Mar 2029

First Scientific Light: Dec 2030

Erected on Cerro Armazones. To be operated jointly with the VLT and VLTI in Paranal (24 km)

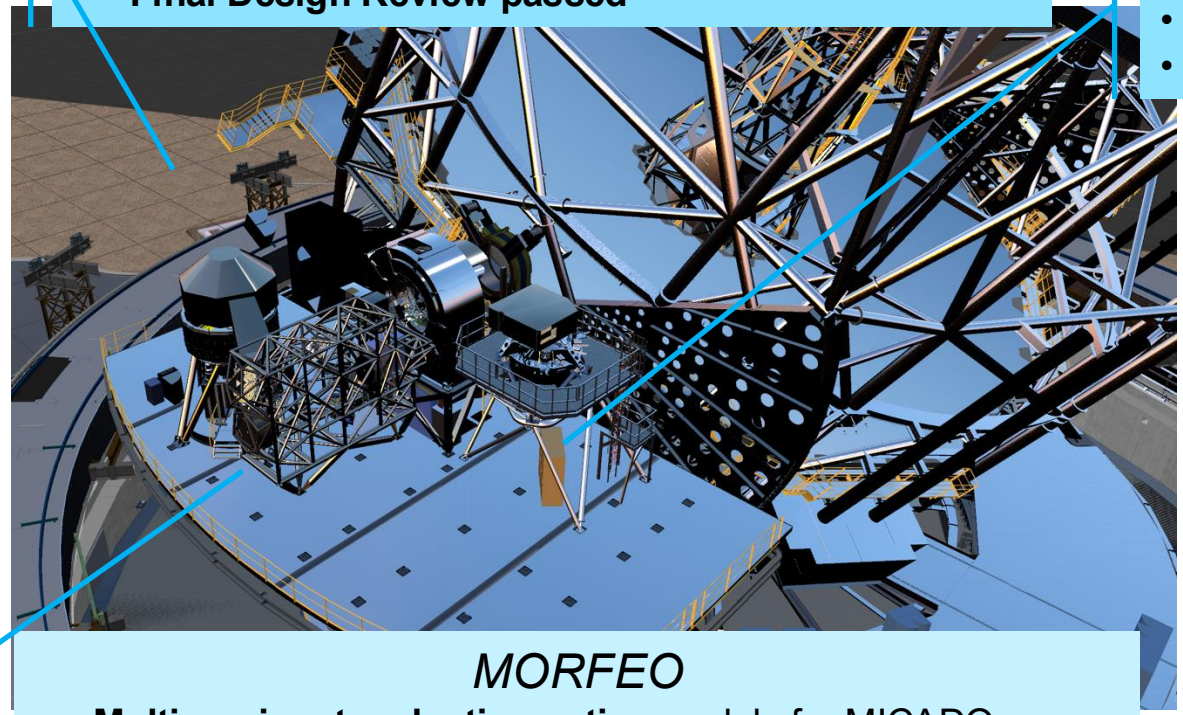
The ELT is the most powerful telescope of the new generation, the only one with secured funding and the one which is more advanced in its construction.

ELT at around 70% construction completion

ELT Instrumentation

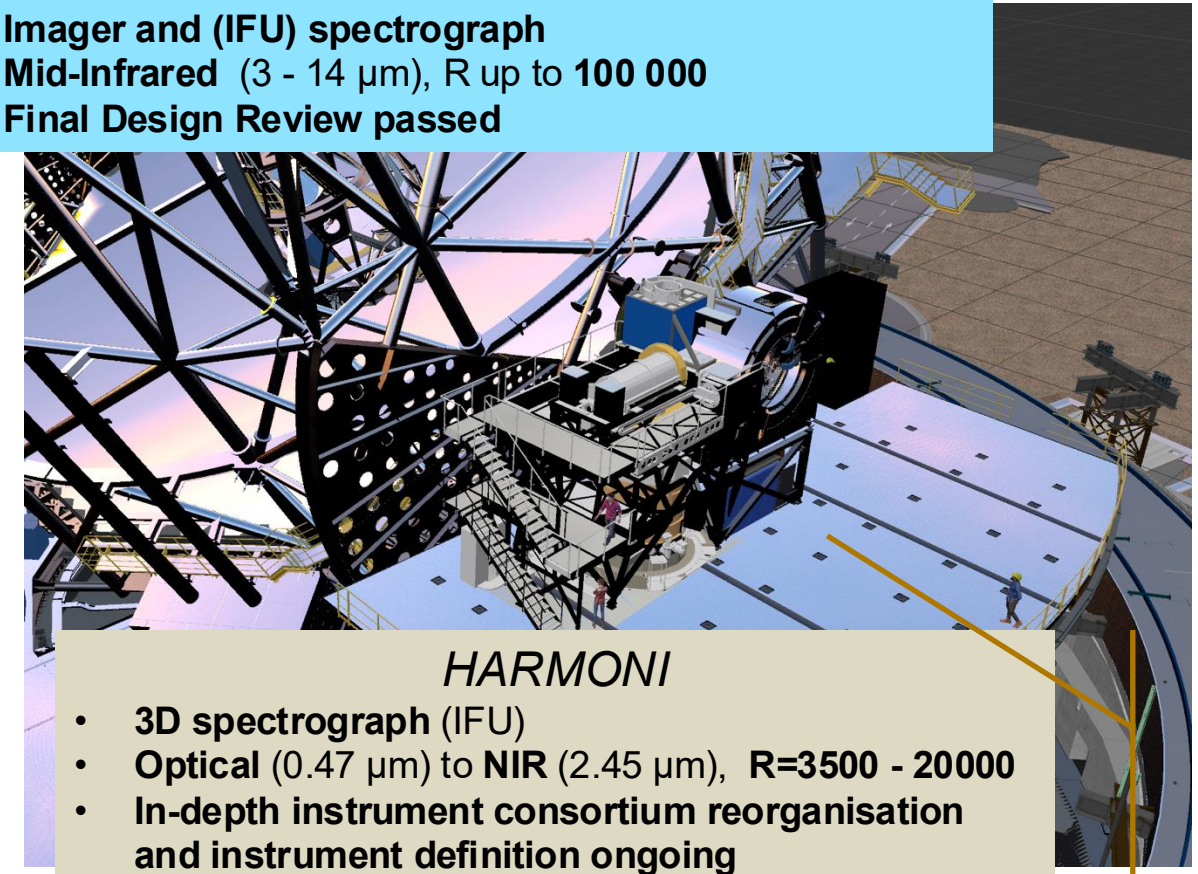
MICADO

- Diffraction limited **Imager and spectrograph**
- **Near-Infrared** (0.8 - 2.45 µm), **R~8000**
- **Final Design Review passed**



METIS

- **Imager and (IFU) spectrograph**
- **Mid-Infrared** (3 - 14 µm), R up to **100 000**
- **Final Design Review passed**



MORFEO

- **Multi-conjugate adaptive optics** module for MICADO
- 2 **deformable mirrors** inside instruments
- **FDR ongoing**

HARMONI

- **3D spectrograph** (IFU)
- **Optical** (0.47 µm) to **NIR** (2.45 µm), **R=3500 - 20000**
- **In-depth instrument consortium reorganisation and instrument definition ongoing**

Second generation instruments starting: ANDES heading towards PDR, MOSAIC to follow

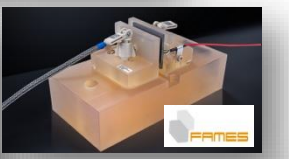
ELT Overall Status

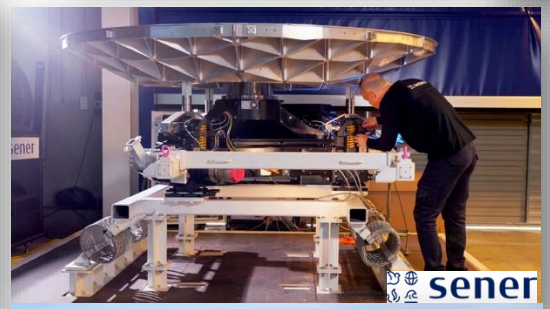
Overall ELT **construction progress beyond 70%**

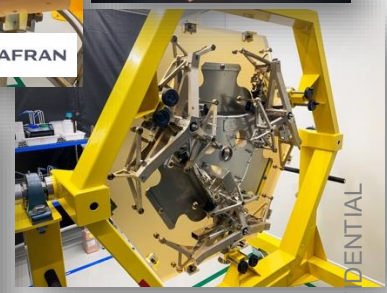
- Basic **Infrastructure** completed (Road & Platform, ETF, electricity supply, …)
- Dome and Main Structure **erection on site** progressing fast
- Several items already **accepted/delivered:**
  - First 234 M1 Segment Assemblies (polished segments)
  - All Blanks, Supports, Position Actuators, Edge Sensors
  - M5 Cell
  - M5 Commissioning blank

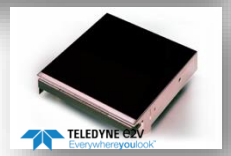
  Supporting Equipment:
  - M1 Coating Plants (2x)
  - Power Substation
  - Photovoltaic Plant

  Detectors, Laser Sources and Projectors, etc.









CTAO

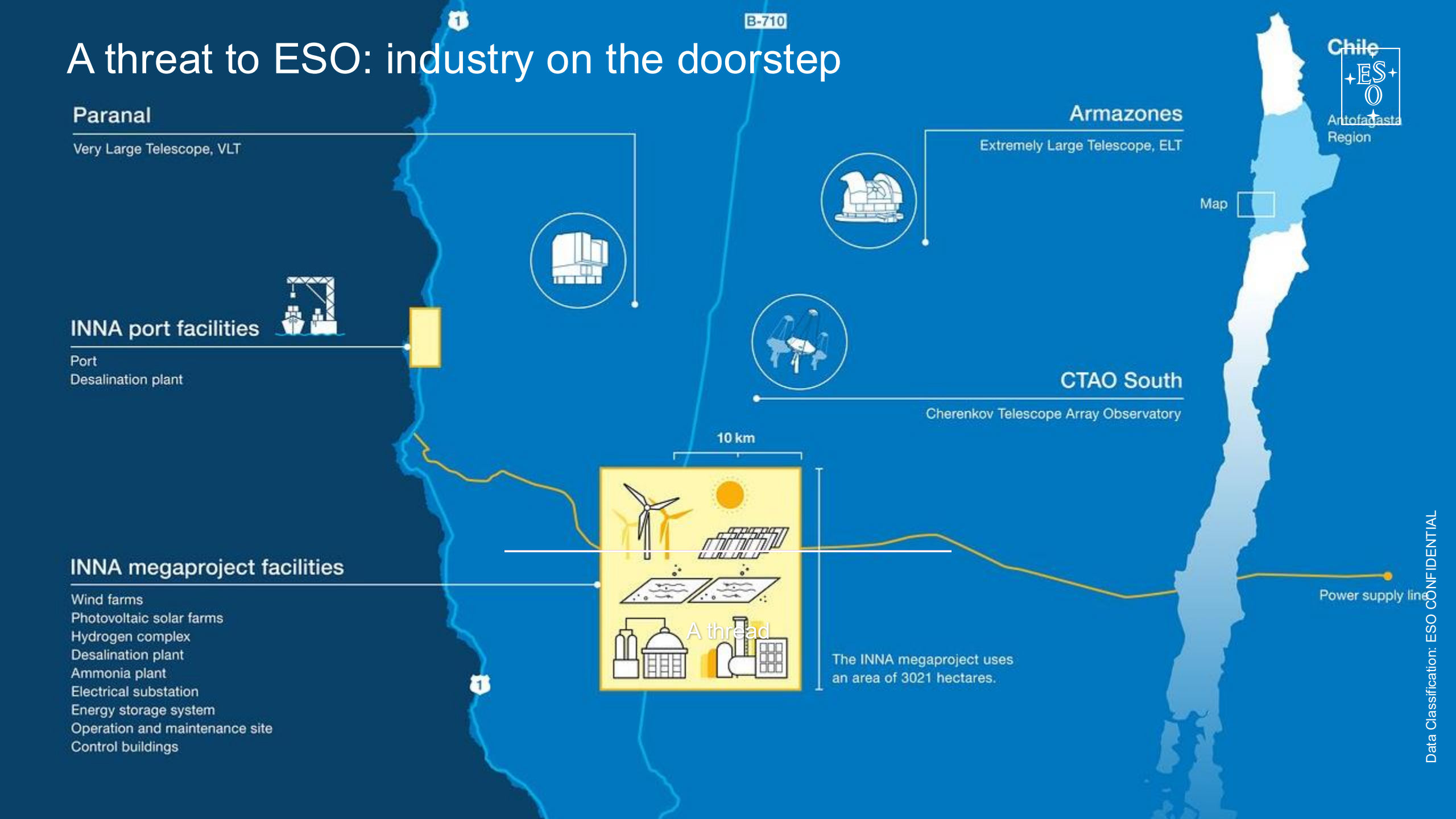
On 02.07.2025 ESO signed the contract for the construction of the roads and foundations for CTAO-South on behalf of CTAO ERIC

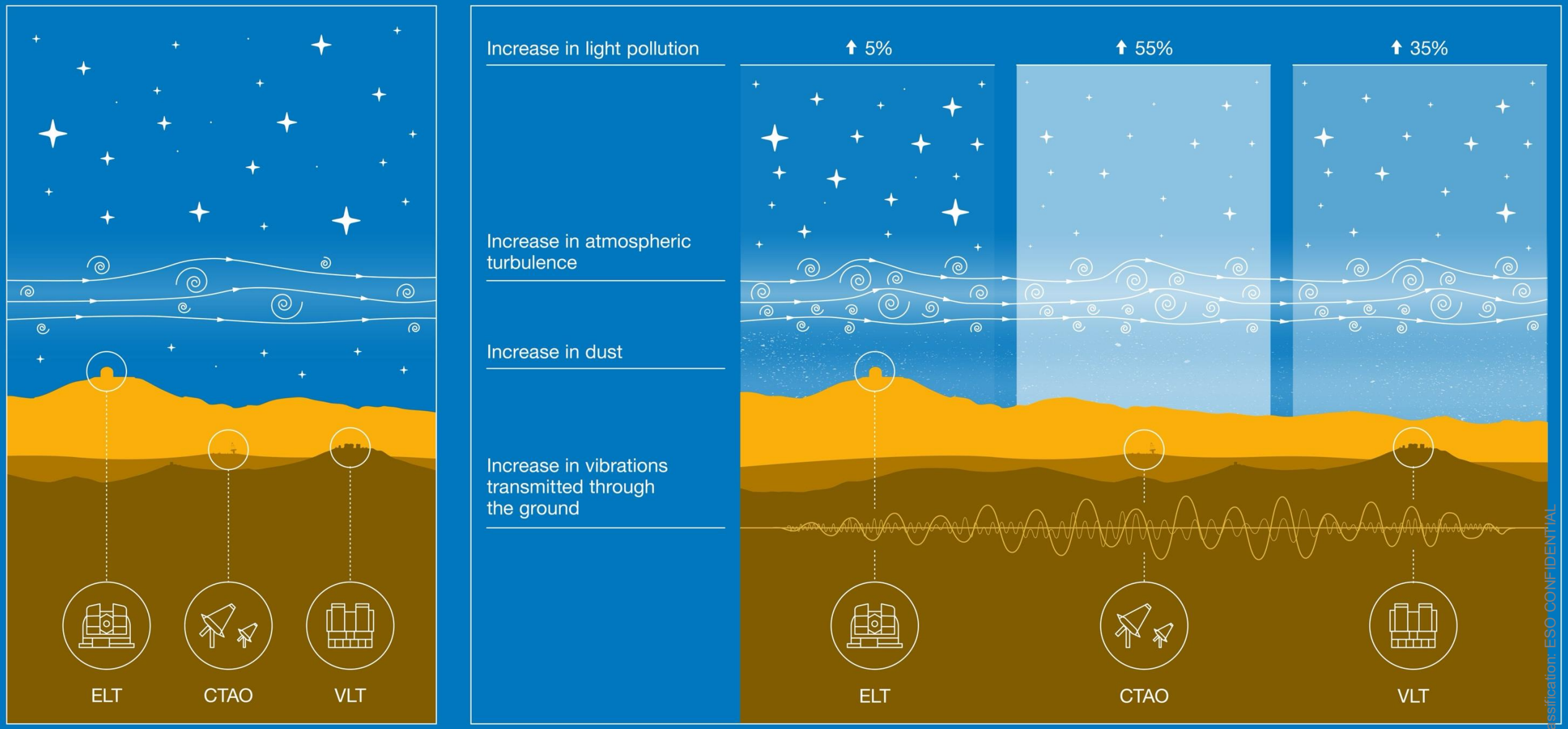
First CTAO-South telescopes may reach the site as soon as 2026

CTAO is becoming a reality, despite the many challenges it faces, including financial, organisational and community expectations.

Time for ESO to prepare for its hosting, operation and scientific exploitation

A threat to ESO: industry on the doorstep





Sketch of the various potential negative effects of INNA on Paranal sites

Visit of the Federal President of Germany Frank-Walter Steinmeier to ESO Paranal

05-06.03.2025

Visits to ESO HQ of the German Federal Minister of Research, Technology and Space Dorothee Bär

Visit to ESO HQ of German Federal Minister Dorothee Bär, and Bavarian State Minister Markus Blume and German Council delegates 23.06.2025

Encounter with ESA reserve astronauts **Amelie Schönnenwald** and **Nicola Winter**, and ESO engineer **Constanza Araujo**, and ESO scientist **Suzie Ramsay** 22.07.2025

Visit of the Federal President of Germany Frank-Walter Steinmeier to ESO HQ

02.09.2025

http://next.eso.org

What ESO's next programme could be

The next ESO Programme should be identified **in line with ESO's vision and strategy**. It should be a **transformational facility in the 2040s landscape** that enables scientific benefits in several areas and serves a **large part** of the scientific aspirations of the community. It could be:

- A new telescope facility at an existing or new observatory site;
- A significant upgrade of an existing facility that is (co-)owned by ESO;
- Other ideas or combinations,

Important: ESO does not operate as a funding agency. The new facility will be **led and owned** by ESO **alone** or in **partnership** with other organisations.

Note: the maturity of the proposal will not be a crucial point (as long as it can be assessed being doable)

Expanding Horizons timeline

July 2024–Q3 2026

- Present and explain the process to the community
- Trigger dialogue about astronomy challenges & disruptive technologies in 2040s

Jun-Nov 2025

- Launch of call: July 25
- White papers due: Nov 2026
- 3 pages max
- Science focus.

Q3 2026–Q2 2027

- Launch of call: Q3 2026
- Letters of Intent due 1 Dec 2026
- Proposals due: 1 Jun 2027

Q3 2027–Q3 2028

- Performed by SSC and ESO Executive
- Transparently share what ideas are being proposed at a dedicated community workshop

Q3–Q4 2028

- Presented at STC and Finance Committee
- Council decision
- Decision is **not** the start of the new Programme

The Senior Science Committee (SSC)

The SSC is a **diverse group** of experts in a broad variety of areas of astronomy and associated technologies. It provides independent and unconflicted advice on the **scientific drive** of the new programme.

Mandate of the SSC – Preparatory Phase

- Helping to identify scientific challenges in astronomy for the 2040 and support community engagement activities to discuss them;
- Provide guidance on which disruptive technologies may enable transformational science in 2040 or beyond.

Mandate of the SSC – Call for Ideas, Assessment and Decision Phase

- Provide independent scientific assessment of the proposals in response to the Call for Ideas

The SSC may also be tasked with other support activities related to the *Expanding Horizons* process, as requested by the ESO Director General or ESO Council.

Senior Science Committee (SSC)

- **Angela Adamo**, University of Stockholm (ESO STC, Galaxies)
- **Joss Bland-Hawthorn**, University of Sydney (Astrophotonics)
- **Marica Branchesi**, Gran Sasso Science Institute (Multi-messenger)
- **Paul Callanan**, University College Cork (ESO Council, Compact objects, chair)
- **Heather Cegla**, University of Warwick (Life & Habitability)
- **Stéphane Charlot**, Institute d'Astrophysique de Paris (Cosmology)
- **Vik Dhillon**, University of Sheffield (ESO Council, Transients & stars)
- **Norbert Hubin**, formerly ESO (Technology Development, starting 1 Nov 2025)
- **Marcella Marconi**, INAF- Osservatorio Astronomico di Capodimonte (ESO STC, Stellar populations)
- **Nanda Rea**, Institut de Ciències de l'Espai – CSIC (Transients & high-energy)
- **Hans-Walter Rix**, MPIA (Galaxies)
- **Karin Öberg**, Harvard (star/planet formation)

Science & technology in the 2040s

The main focus at the moment

What is/are the main science question(s) in astronomy that need to be answered in the 2040s?

Need to convince the member states to invest resources into the next major ESO facility. Science must be the driver. That science cannot be done with the facilities available in the 2030s.

White papers → workshops

The SSC decided to open a call for white papers focused purely on the science questions to focus on for the 2040s. This will then be a base to organise on-line workshop(s) where the scientific community should discuss which will be the scientific challenges of astronomy in the 2040s in different areas.

Disruptive Technologies Workshops

A place to discuss which potential disruptive technologies may become game changers for a transformational facility in the 2040s;

How ESO's next programme will be selected

A transparent selection process

Expanding Horizons is an **open and inclusive call** to ESO's community

- Call for ideas to **motivate convergence** among the community;
- Assessment of the proposals will be made based on **scientific drive** and **organisational ability**;
- Ample **preparation time and activities** foreseen to incentivise the community and **foster dialogue and debate.**

Selection criteria for ESO's next programme

Recommendation to Council will be prepared by ESO's Executive, including input by a Senior Science Committee (appointed by Council), based on:

- **Scientific drive:** Which fundamental problems in astronomy are expected to be addressed? How broad an impact will the new facility have? What synergies are there with other ESO facilities?
- **Organisational ability:** Are competencies and skillsets available to own the design and development of the new facility? Is the organisation able to fulfil its operational requirements?
- **Sustainability:** To what degree the new facility could be designed, built and operated in an environmentally, socially and financially sustainable manner?
- **Institutional model:** Should the new facility be developed in a partnership with another organisation?
- **Risks assessment:** Will the new programme compromise the successful operation and development of ESO's existing facilities?

Some FAQs

When:

Some time in the 2040s, timeline linked to ELT.

Where:

No preference.

Does ESO have a favourite?

No.

There are ESO scientists involved in most of the ideas under development – but they do this on their own science time and the projects they work on are not approved or favoured by ESO. They will not be involved in the evaluation of the proposals.

Expanding Horizons Summary – for now

- **Think about/discuss what science areas/questions you judge will be the highest priority in the 2040s**
- Submit a White Paper
- Determine what kind of facility will be able to address those scientific questions.
- Submit a Letter of Intent
- Work out the rough details of the facility needed.
- Submit a proposal.
- …

Thank you!

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