EUROPEAN EXTREMELY LARGE TELESCOPE


BUDGET: 8 MIA DKK

ASTRONOMY

"The study of everything beyond the Earth"

Objects are far away, hence appear small and faint:

- Need for large telescopes: resolution and sensitivity

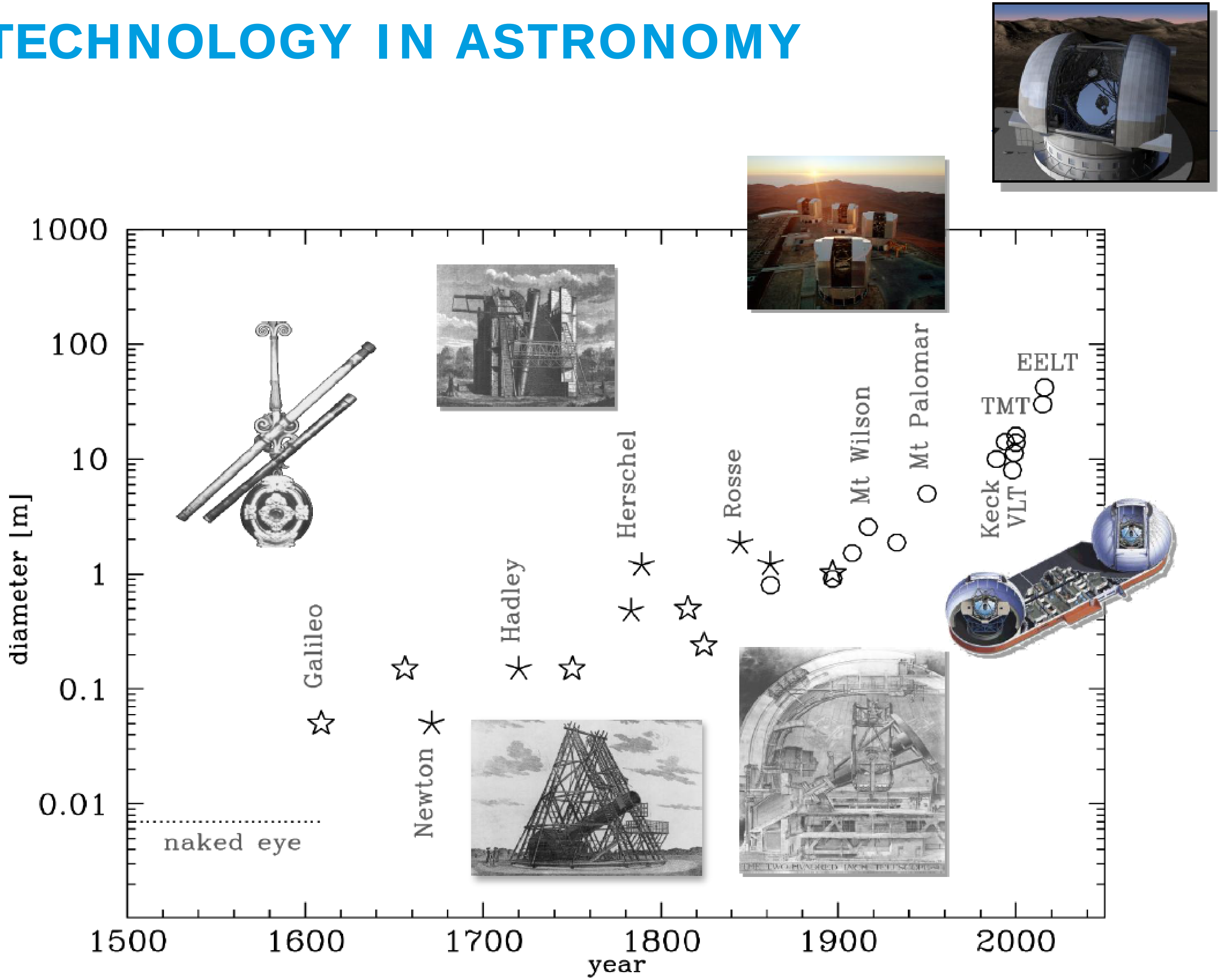
Observationally-driven science:

- Visual light and radio signals can be detected with telescopes on the ground

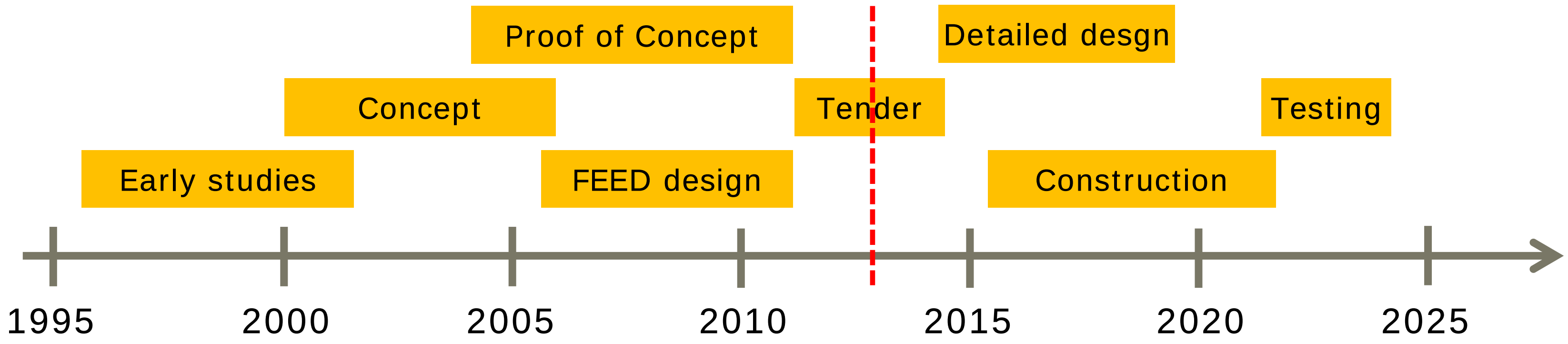
Technology now available to:

- Study objects over 95% of the age of the Universe
- Detect and study planets around other stars

TECHNOLOGY IN ASTRONOMY



THE HISTORY OF ELT



- Scientist from all over Europe collaborate
- The ELT project has already been going on for 15 years
- In the beginning nobody knew what was possible
- Ramboll helped design the OWL* already in year 2000

** Overwhelmingly Large Telescope*

SHARPER PICTURES = SEE MORE

HST = Hubble Space Telescope
VLT = Very Large Telescope
ELT = Extremely Large Telescope
AO = Active Optics

ELT COMPARED TO HST

ESO – EUROPEAN SOUTHERN OBSERVATORY

1962

- ESO created by five Member States with the goal to build a large telescope in the southern hemisphere
- This became the 3.6m telescope on La Silla (1976)
- Denmark joined in 1967

2013

- 14+1 Member States (~30% of the world's astronomers)
- Paranal is the world-leading ground-based observatory
- ALMA (in partnership) on Chajnantor completed in 2013
- Construction of 39m E-ELT on Armazones to start soon

ESO LOCATIONS

La Silla

•First site, 3.6 m telescope

Chajnantor

•5100 m altitude, radio waves

Paranal

•3000 m altitude, VLT

Armazones

•3000 m altitude, ELT

RAMBØLL

EUROPEAN VERY LARGE TELESCOPE ON PARANAL

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ALMA & APEX
ON CHAJNANTOR

Purpose to detect submillimeter radio waves from the Universe

Requires minimal water vapour: 5100m altitude

APEX:

- 12m antenna in partnership with Sweden and Germany

ALMA

- 66 antennas: tremendous resolution and sensitivity
- Global partnership with North America and East Asia

EUROPEAN EXTREMELY LARGE TELESCOPE ON AMAZONES

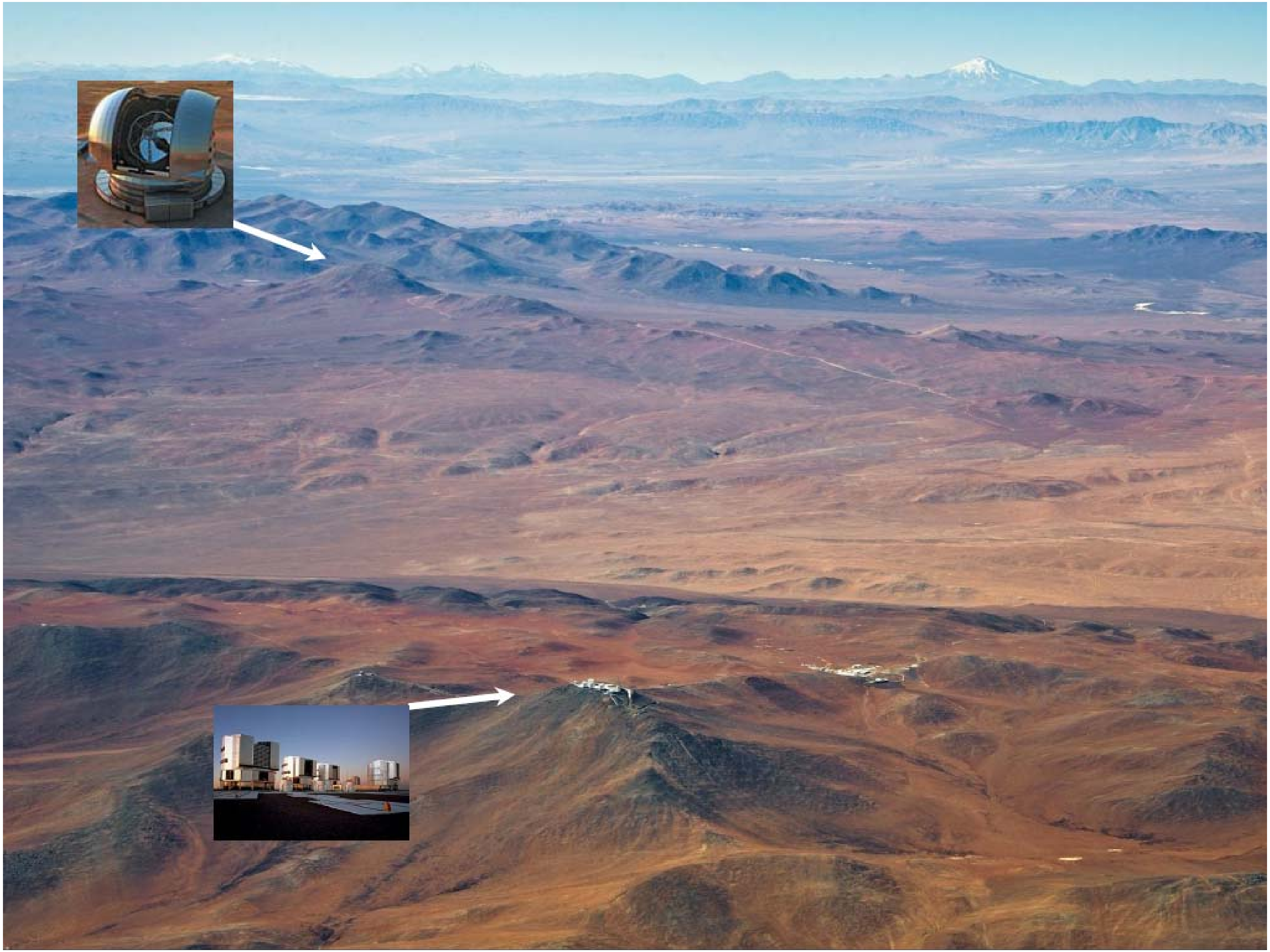
Largest optical/infrared telescope in the world

- 39m segmented primary mirror: transformational step
- Front end design complete, incl. instrumentation roadmap

Project

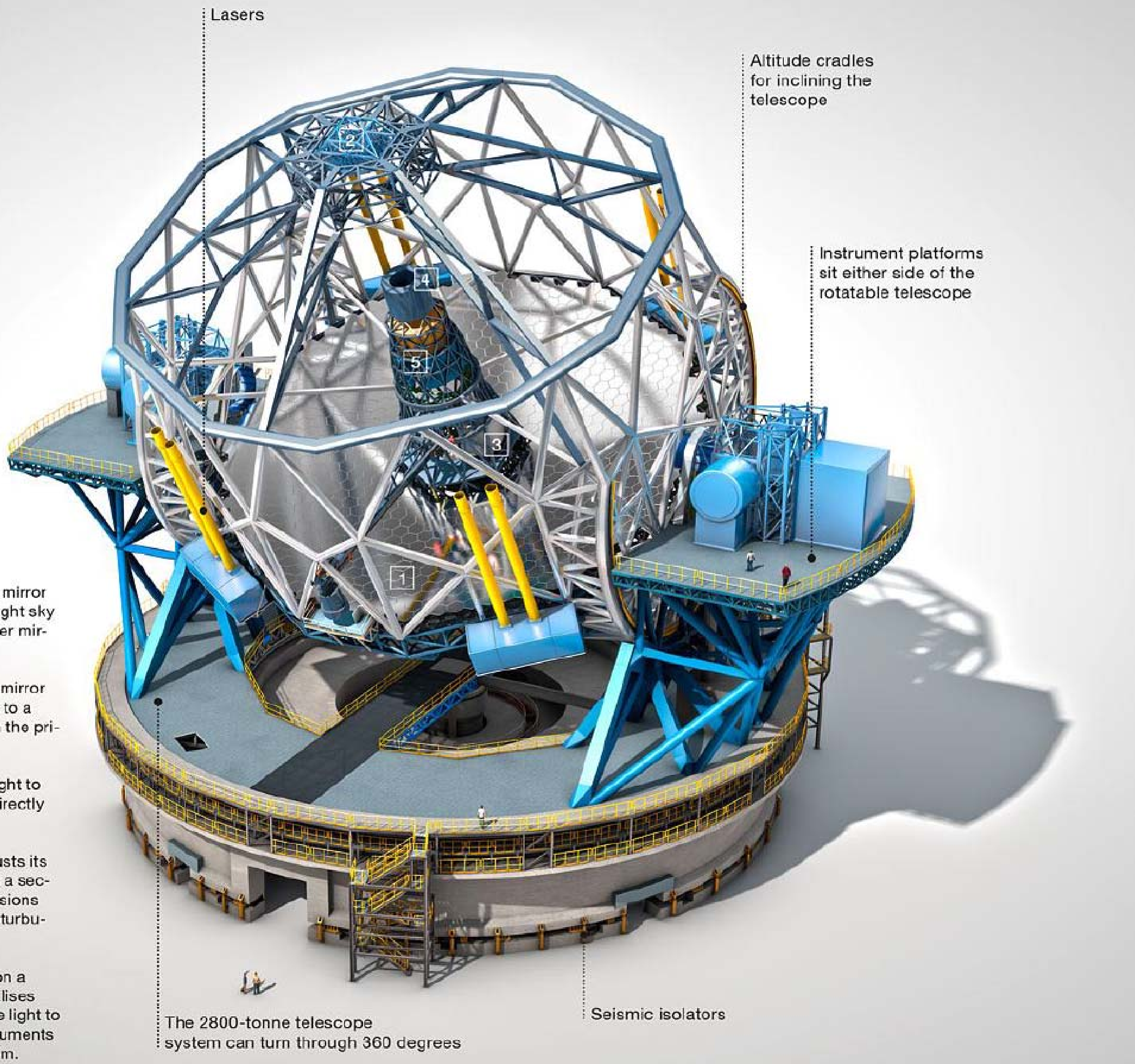
- Construction 2013-2024, on Cerro Armazones
- As integral part of the Paranal Observatory
- ESO cost: ~1100 MEUR incl. instruments and contingency

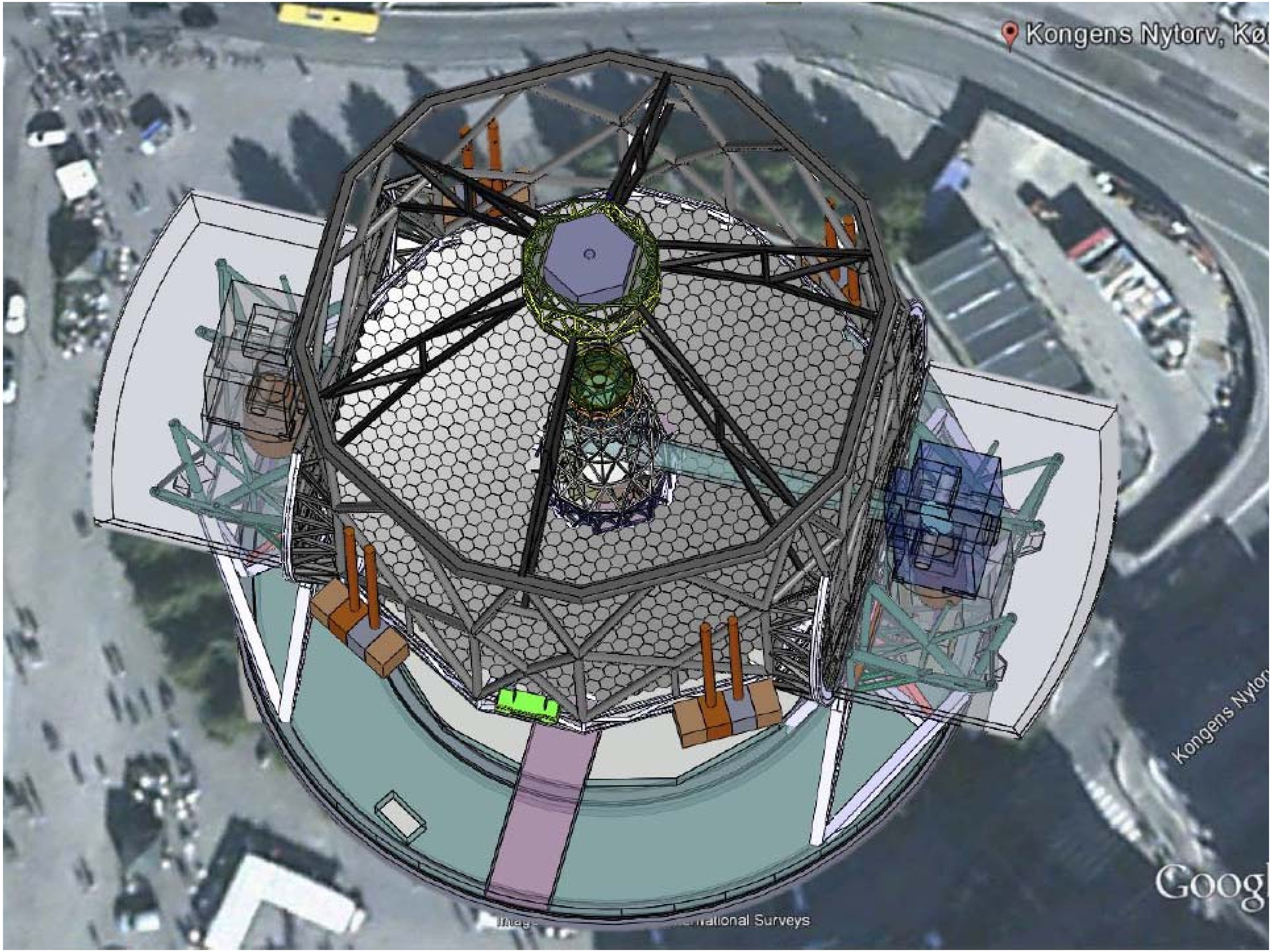
EUROPEAN EXTREMELY LARGE TELESCOPE ON AMAZONES



Five-mirror design

1. The 39.3-metre primary mirror collects light from the night sky and reflects it to a smaller mirror located above it.
2. The 4-metre secondary mirror reflects light back down to a smaller mirror nestled in the primary mirror.
3. The third mirror relays light to an adaptive flat mirror directly above.
4. The adaptive mirror adjusts its shape a thousand times a second to correct for distorsions caused by atmospheric turbulence.
5. A fifth mirror, mounted on a fast-moving stage, stabilises the image and sends the light to cameras and other instruments on the stationary platform.

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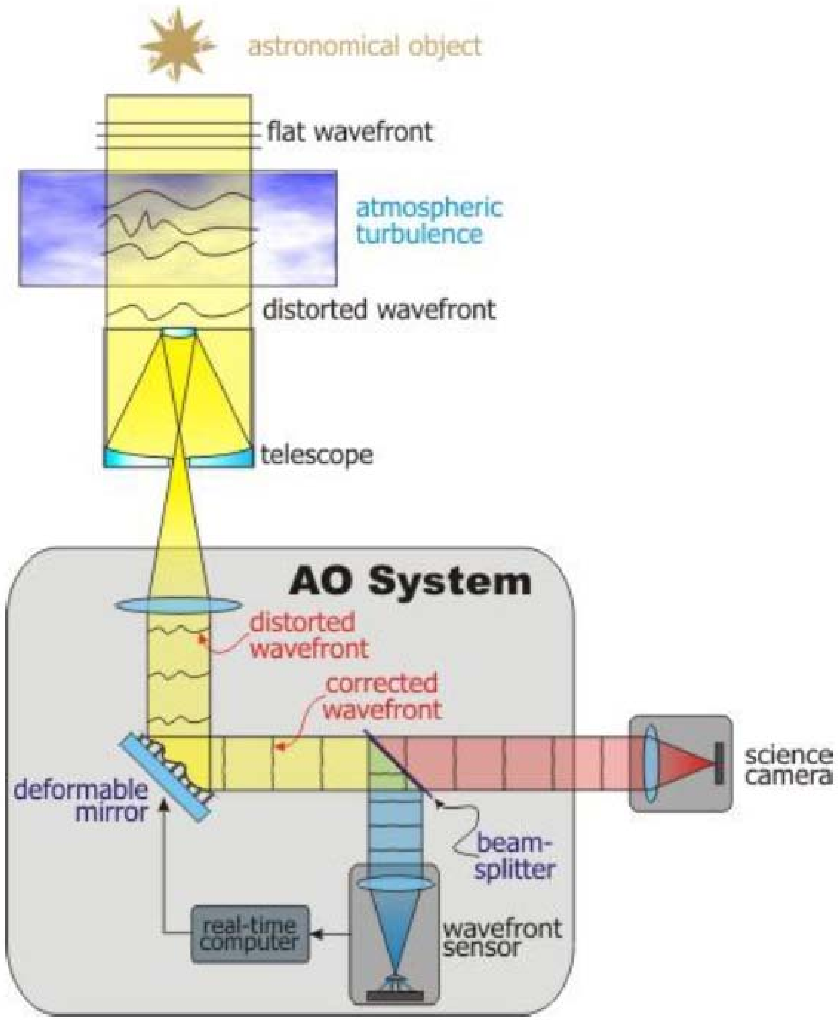
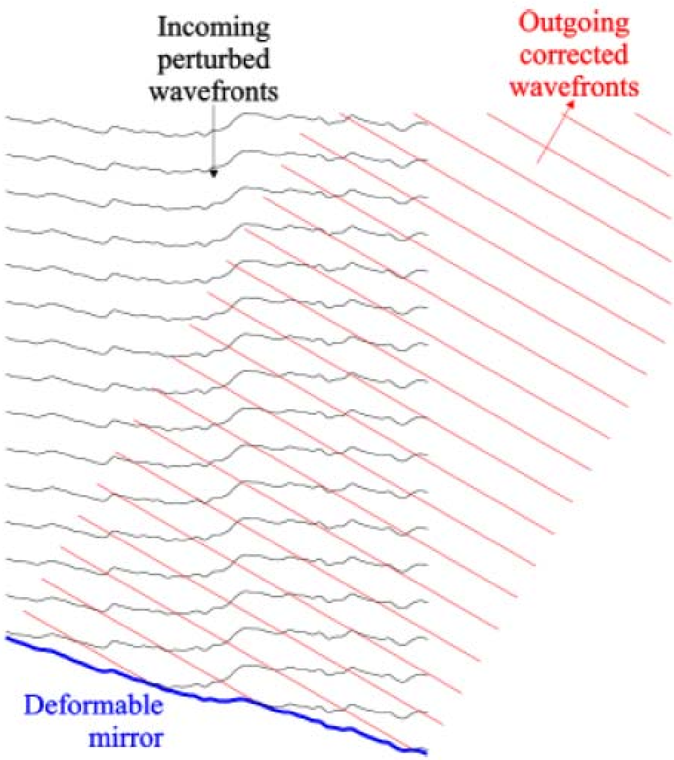
NEW TECHNOLOGIES DEVELOPED BY ESO

- ACTIVE OPTICS, now in use in most modern medium and large telescopes. It preserves optimal image quality by pairing a “flexible” mirror with actuators that actively adjust the mirror's shape during observations.
- ADAPTIVE OPTICS, the bigger a mirror, the greater its theoretical resolution, but even at the best sites for astronomy, large, ground-based telescopes observing at visible wavelengths cannot achieve an image sharpness better than telescopes with a 20- to 40-cm diameter, due to distortions introduced by atmospheric turbulence. One of the principal reasons for launching the Hubble Space Telescope was to avoid this image smearing.

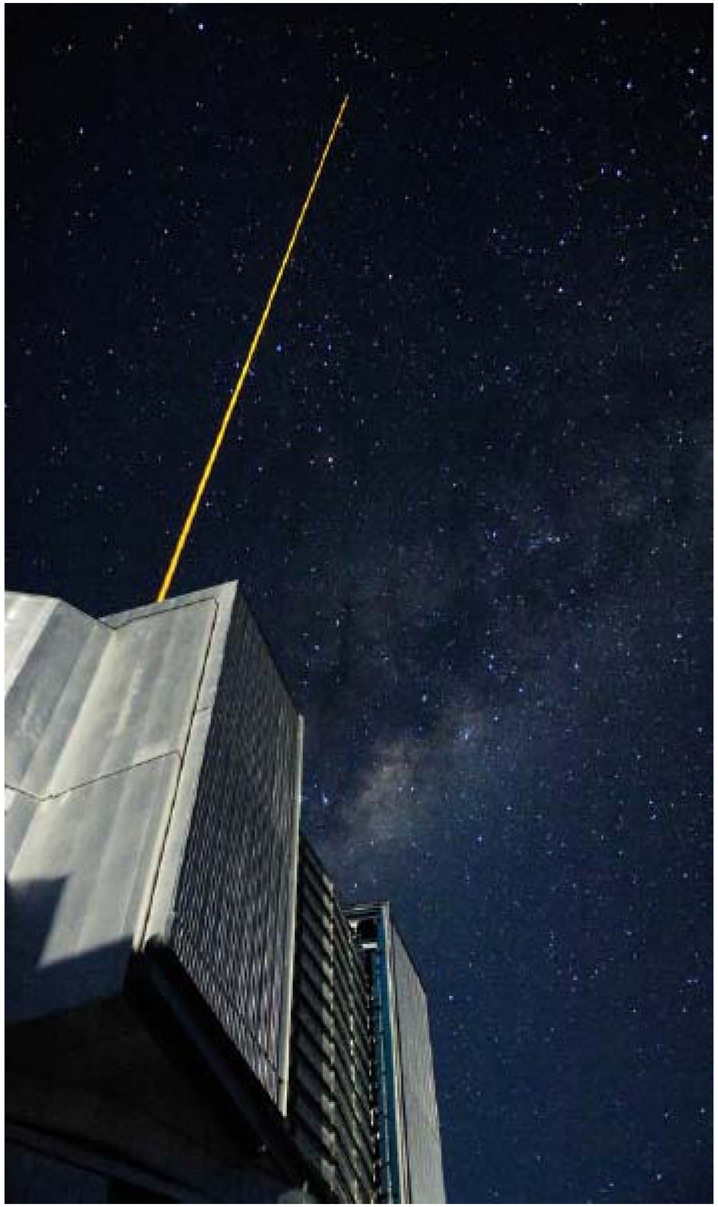
ADAPTIVE MIRROR TECHNOLOGY



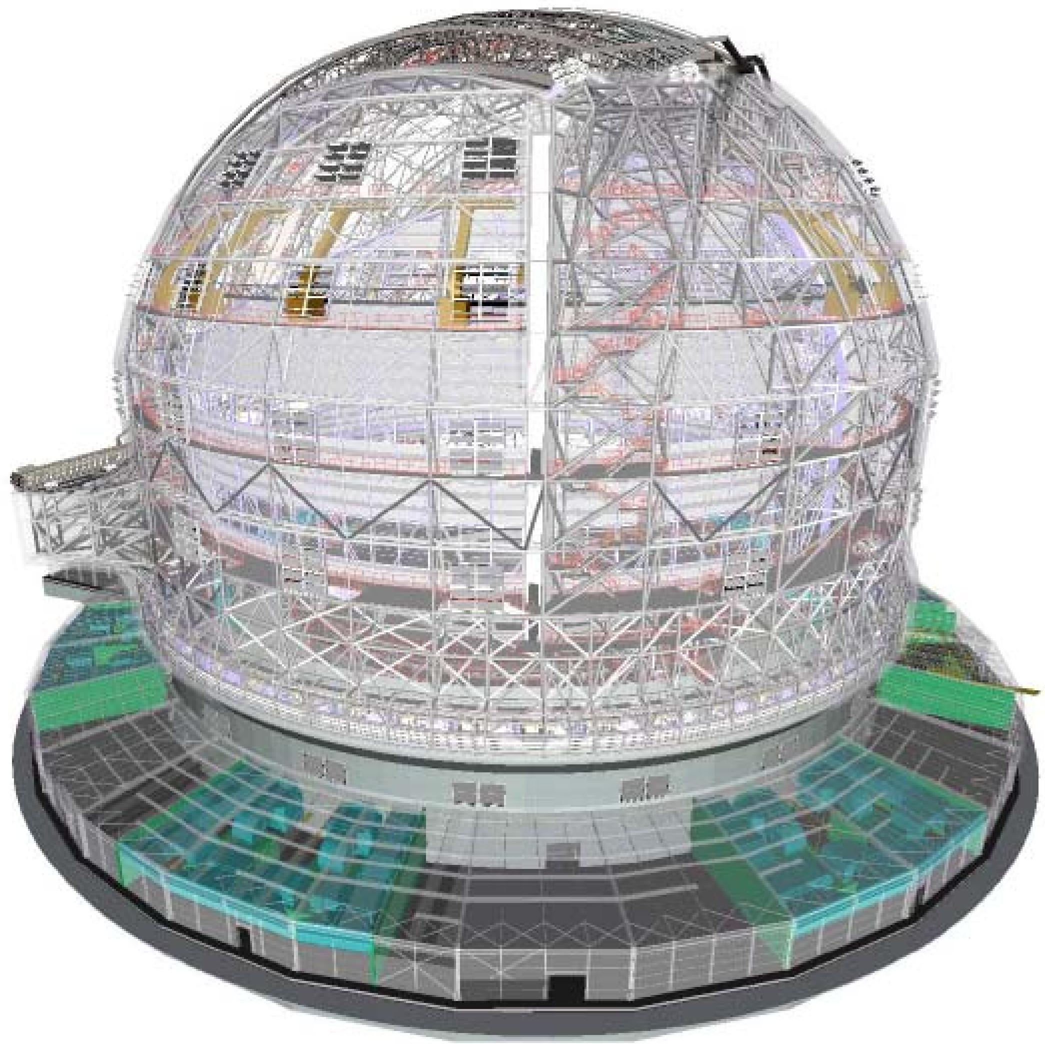


LASER GUIDE STARS

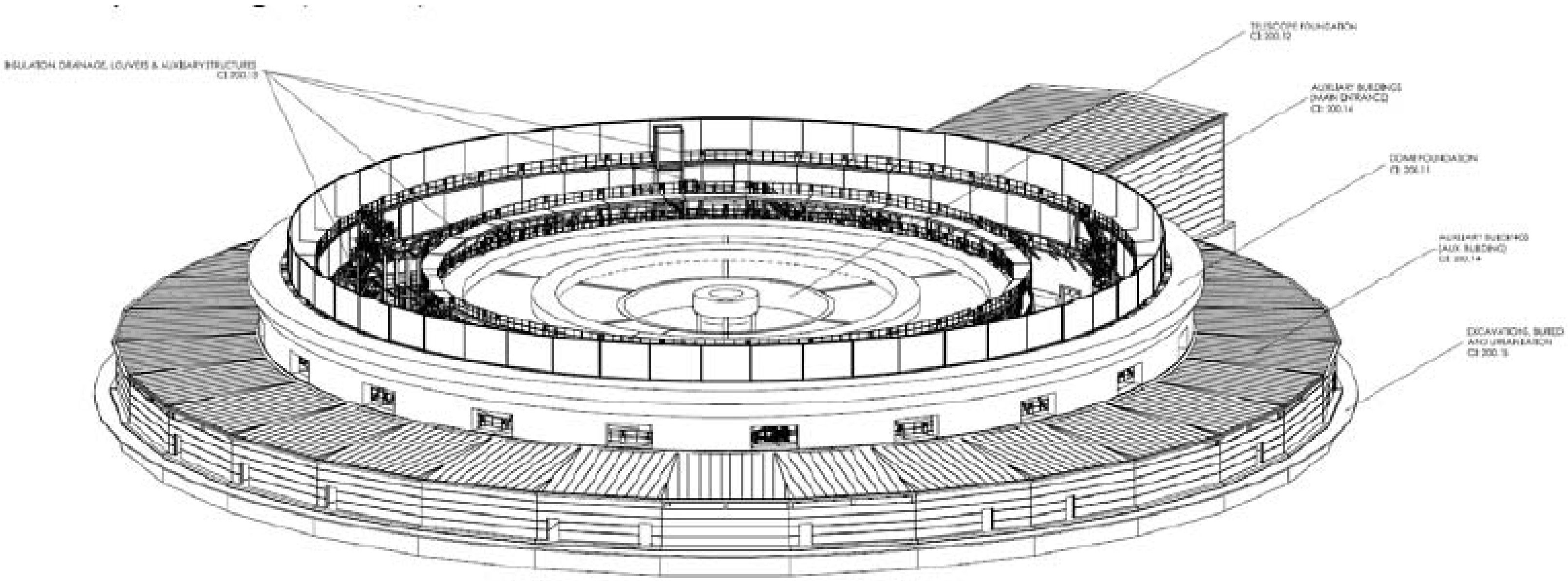
- Laser guide stars are artificial stars generated by exciting atomic sodium in the mesosphere at a height of 90km
- This requires a powerful laser beam launched from the telescope
- The yellow wavelength (589nm) is the colour of a sodium street lamp



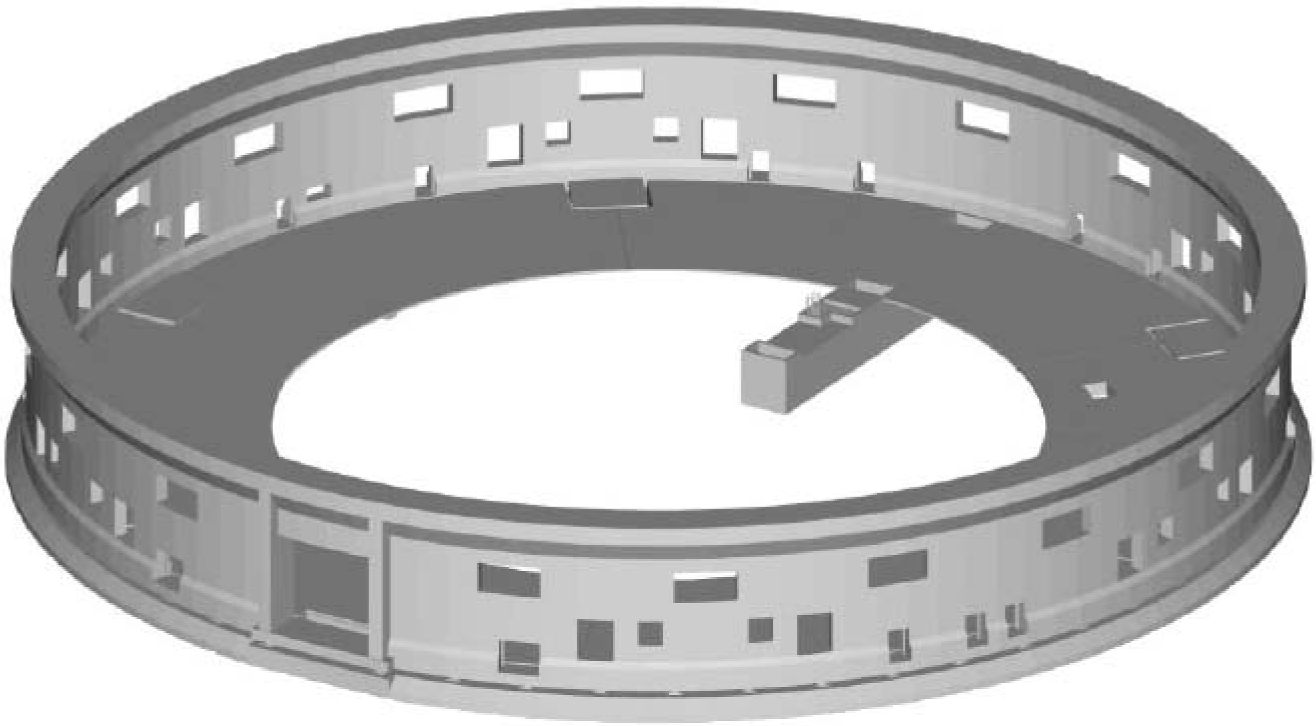
STRUCTURES



SUB-STRCUTURE



DOME FOUNDATION



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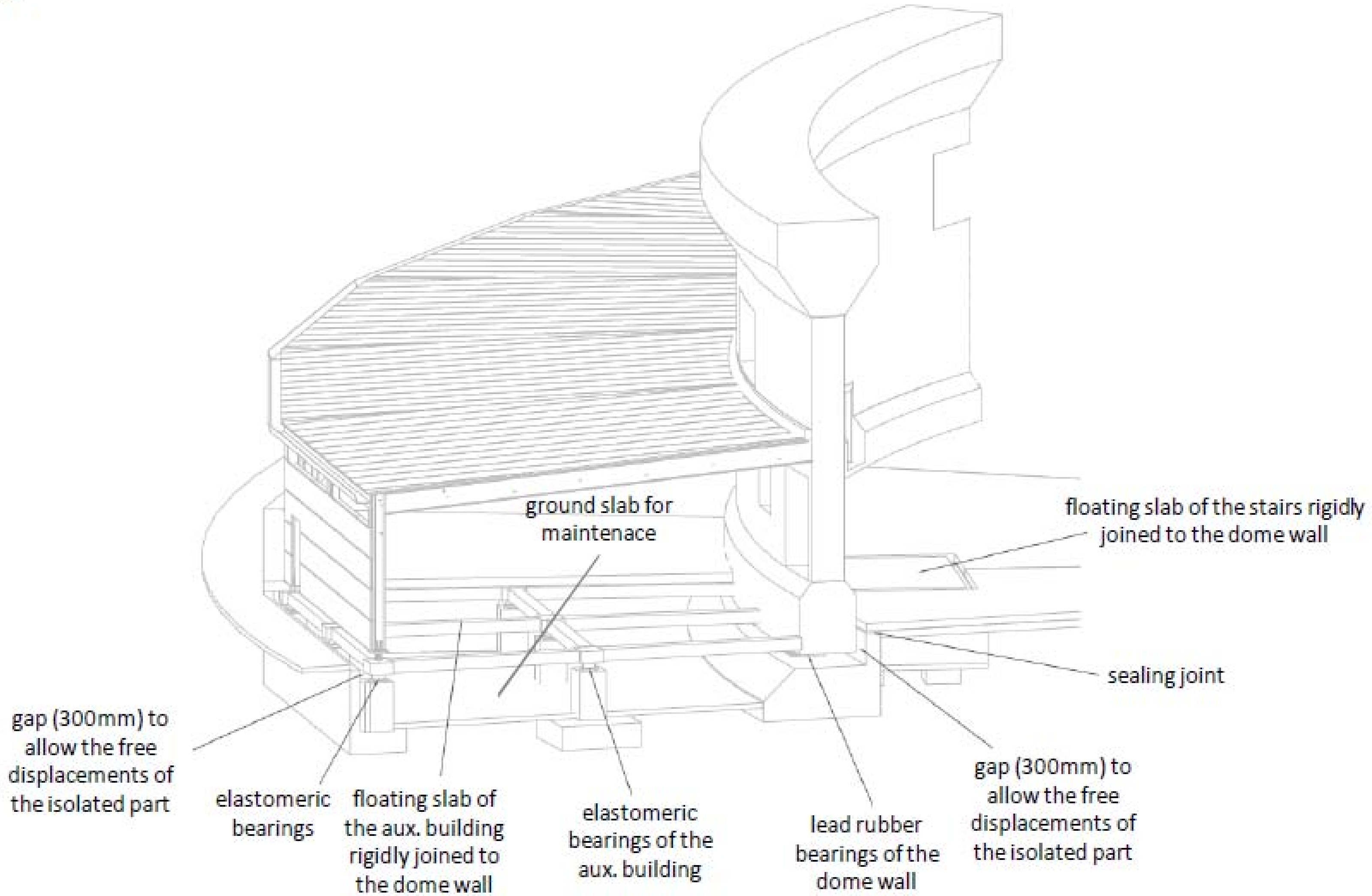
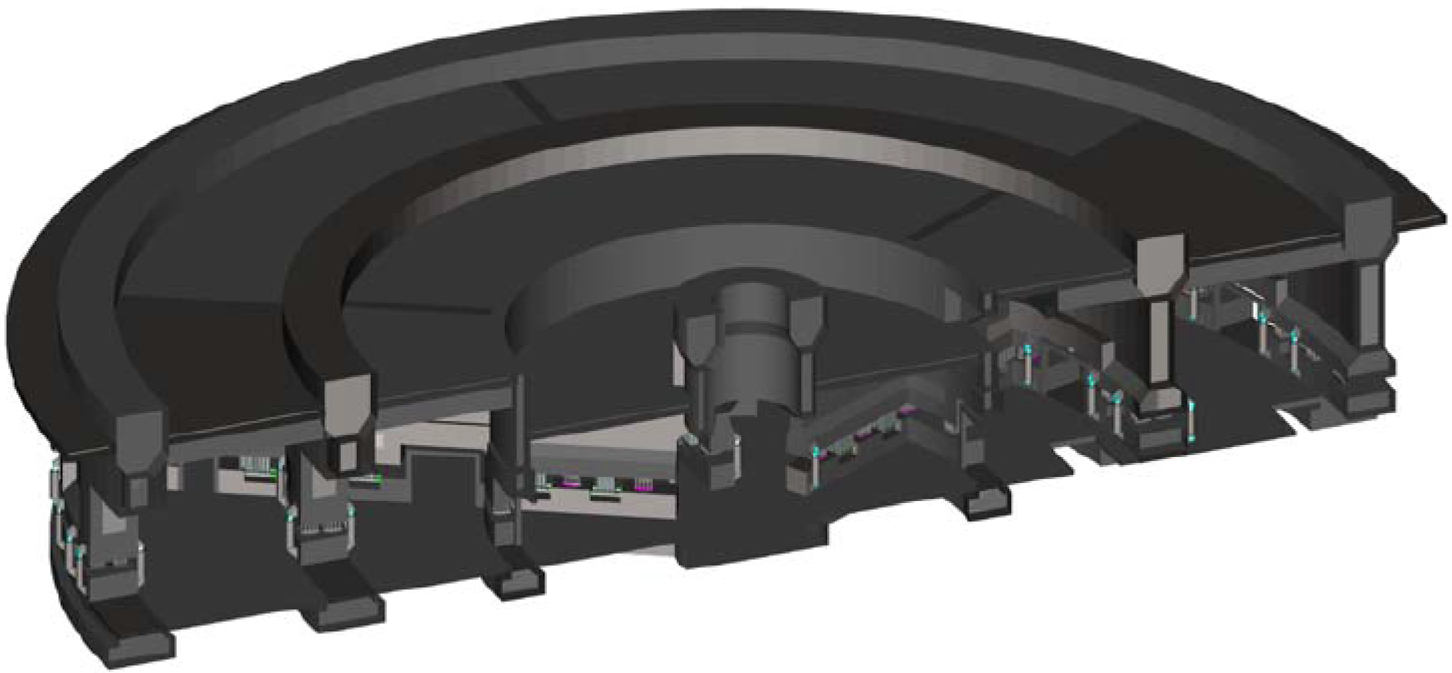
E-ELT
2013-11-14

CROSS SECTION



TELESCOPE FOUNDATION



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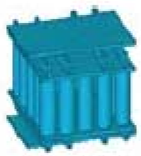
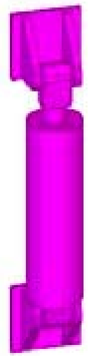
SEISMIC ISOLATION SYSTEM

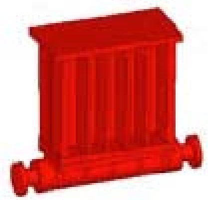
Common springs combined with dashpots



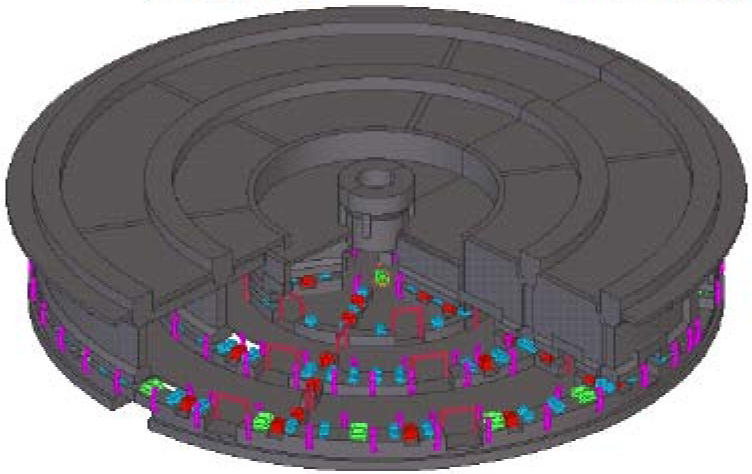
Common springs

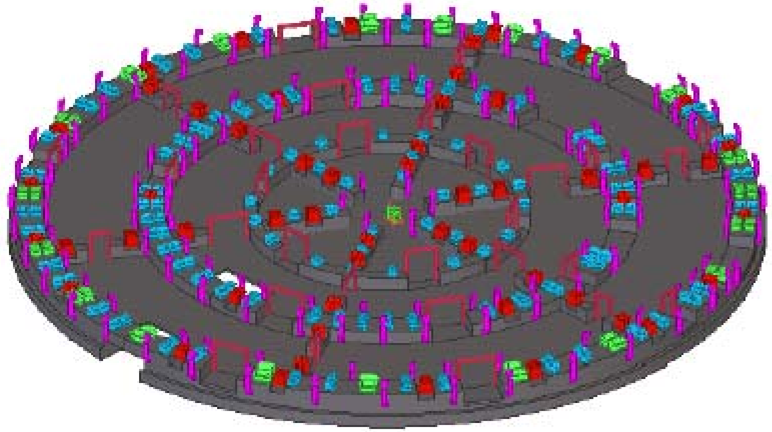


Vertical preloaded units

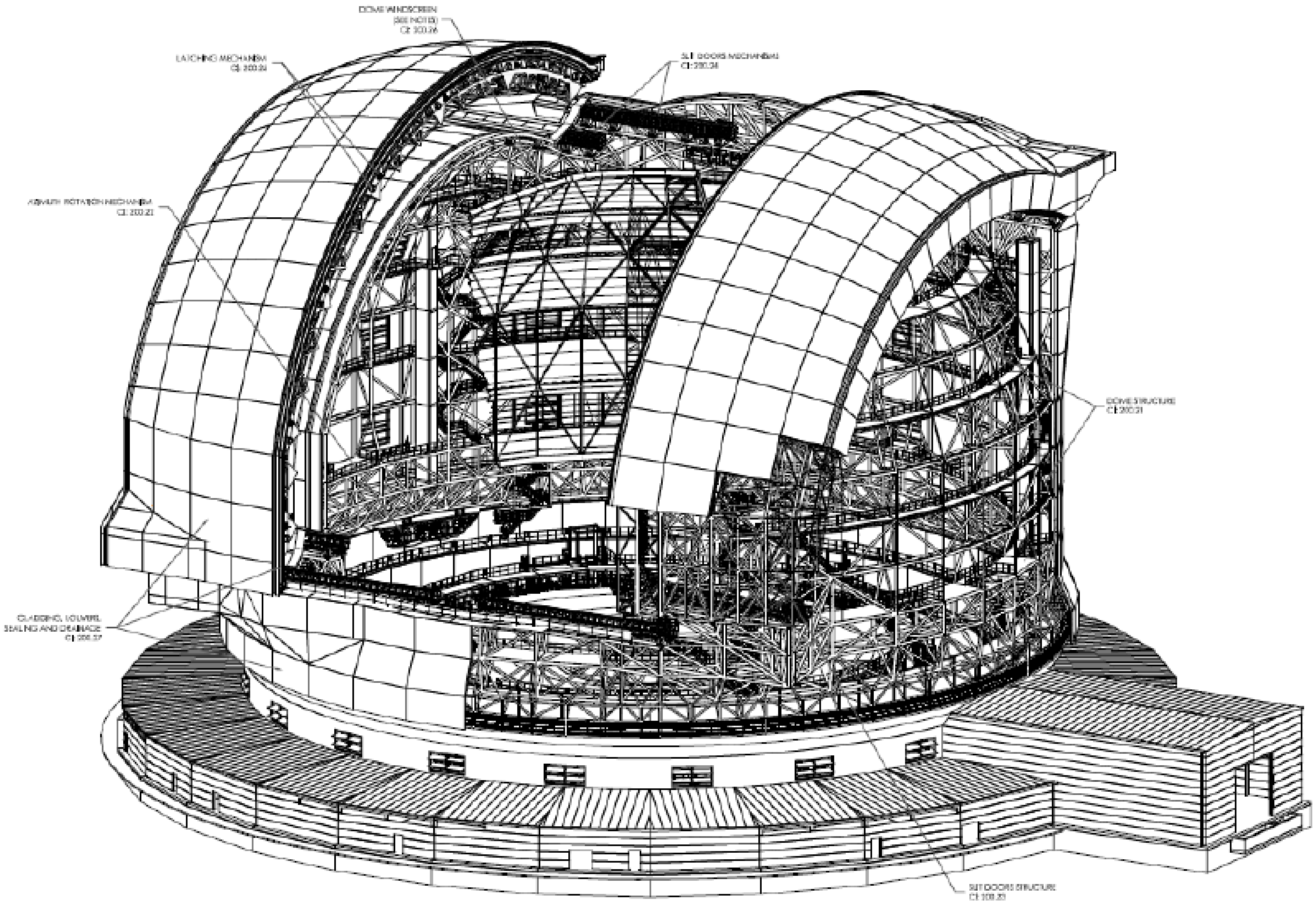


Horizontal preloaded units

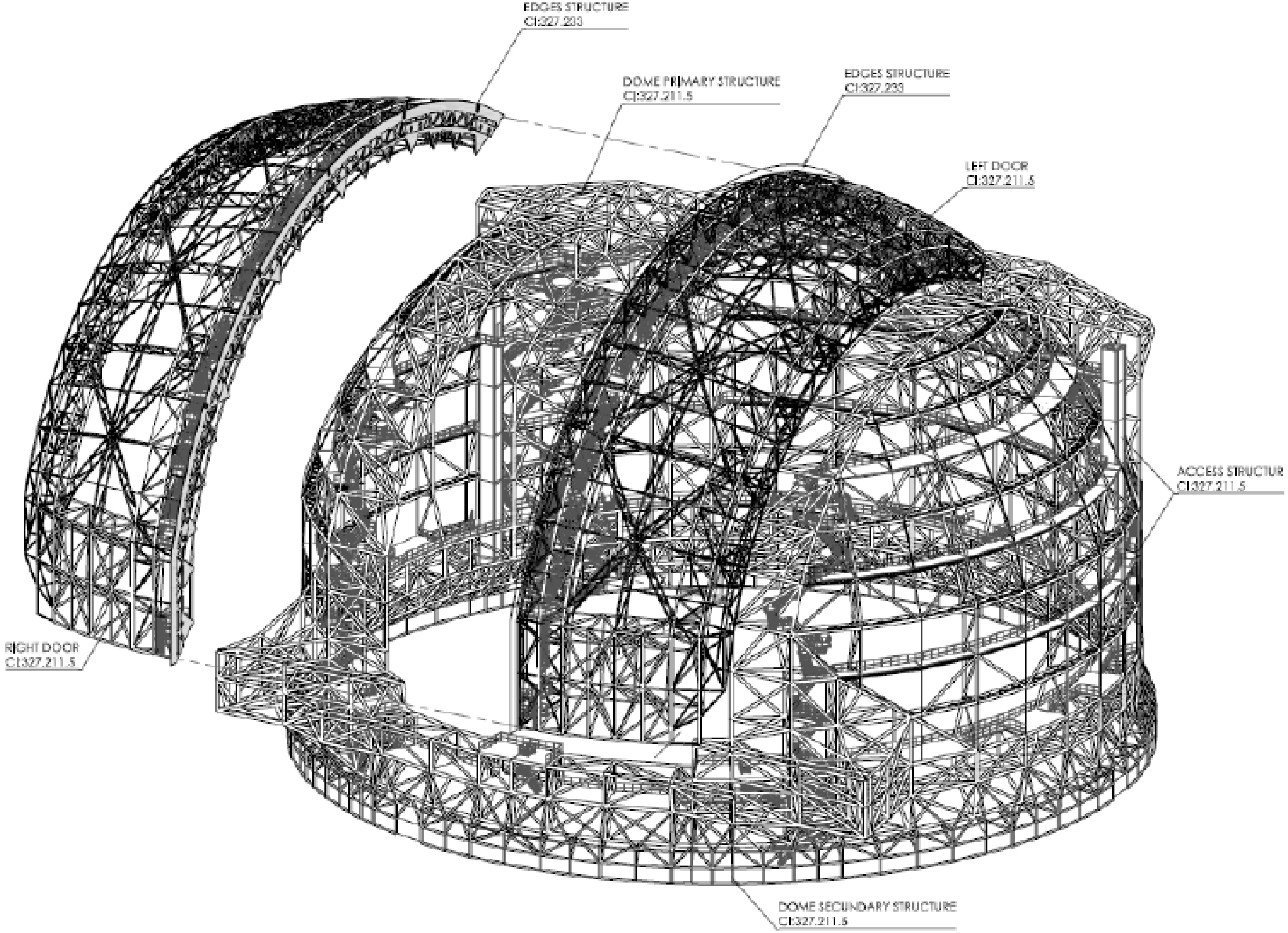




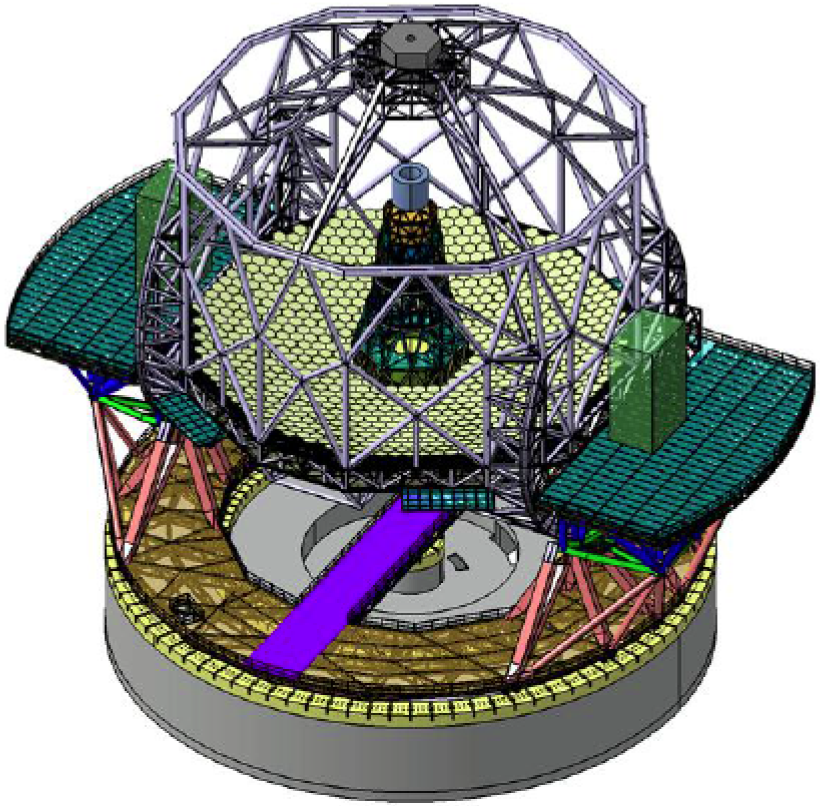
DOME STRUCTURE (WITHOUT TELESCOPE)



DOME STRUCTURE



MAIN TELESCOPE STRUCTURE



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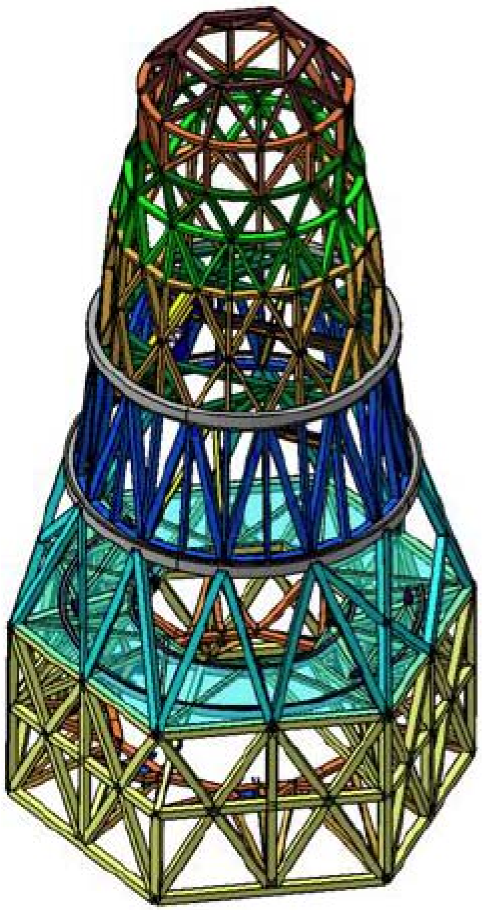
TELESCOPE STRUCTURE
ADAPTIVE RELAY TOWER



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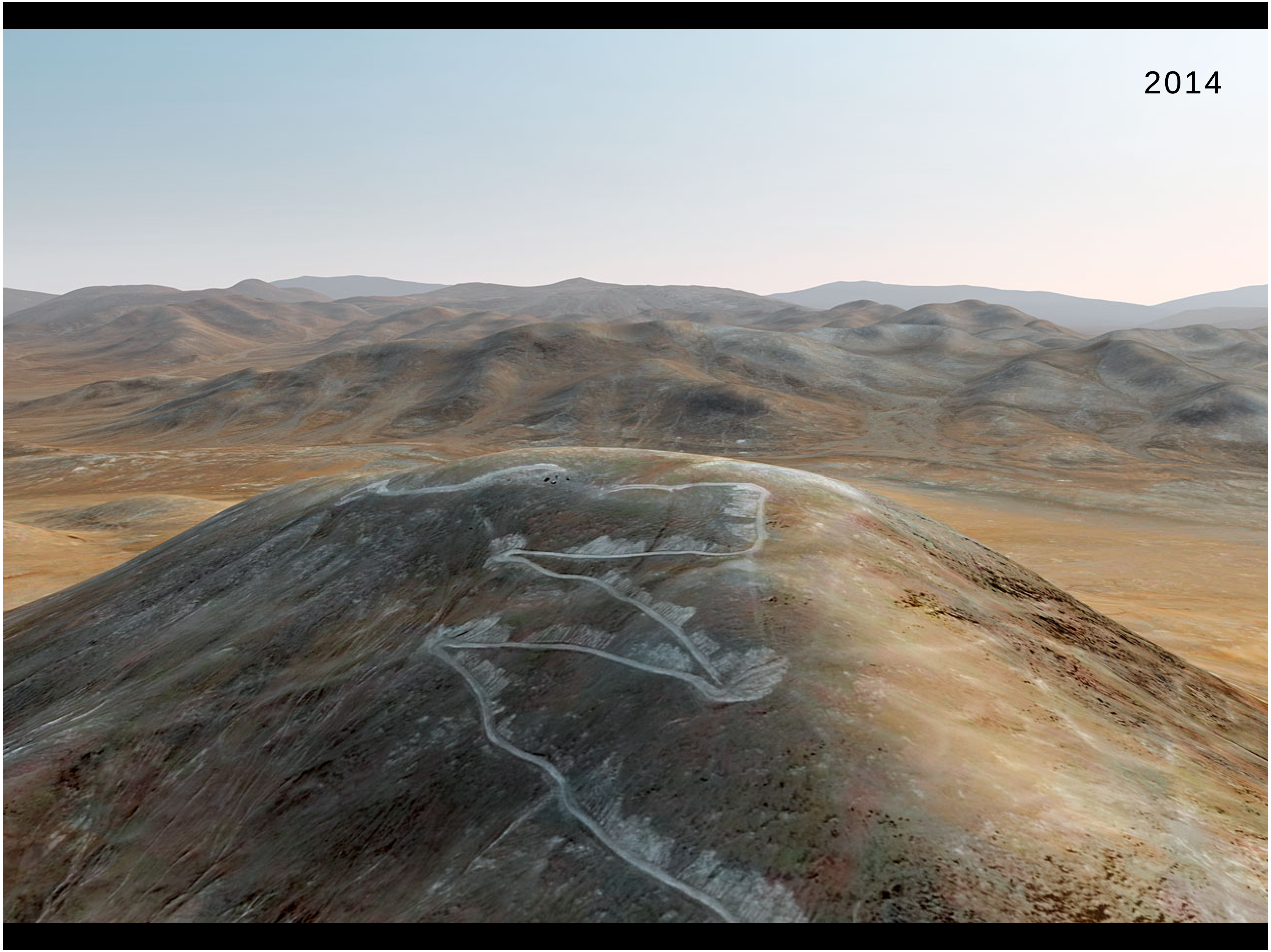
E-ELT
2013-11-14

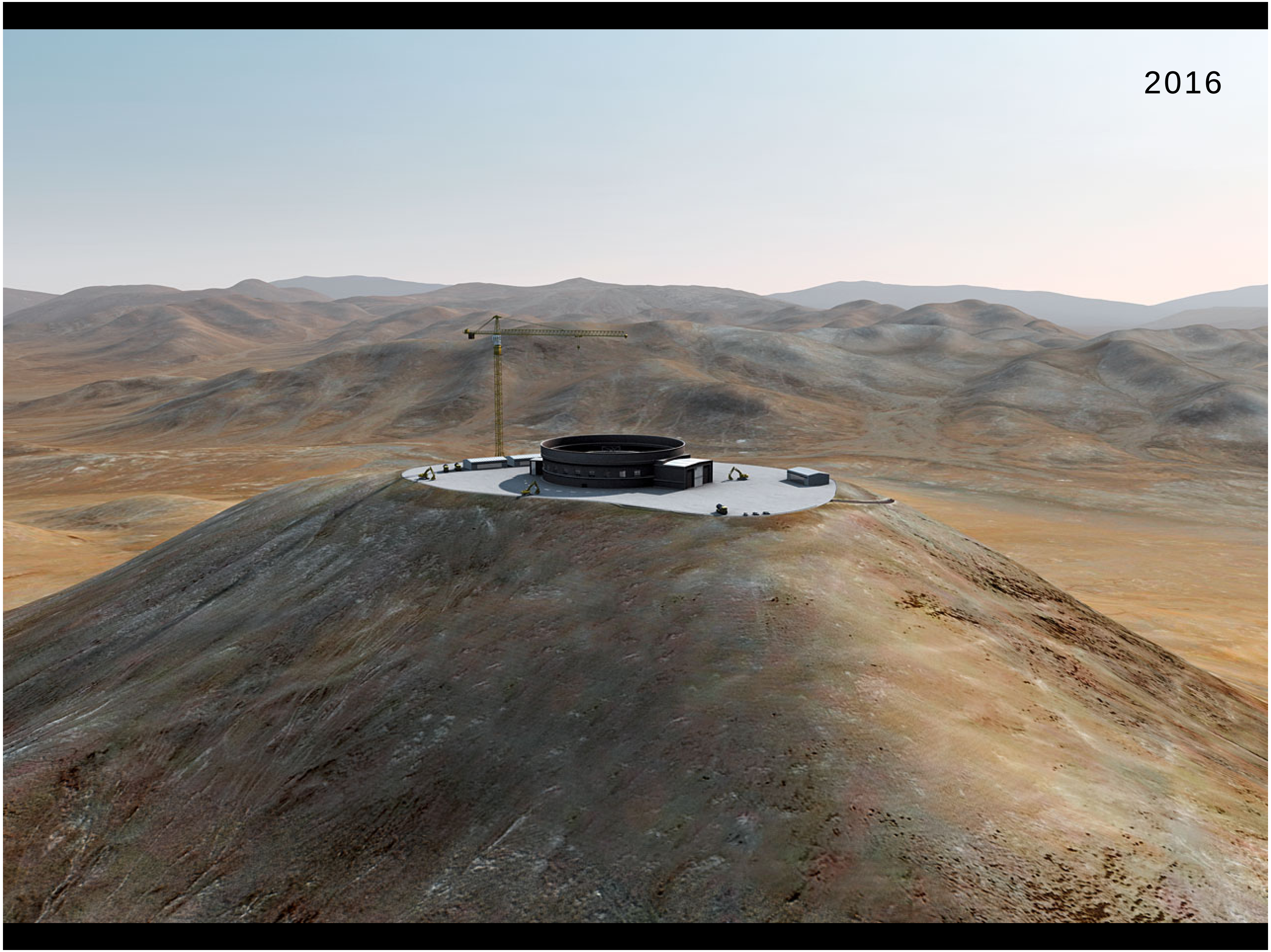
RAMBOLL'S ROLE

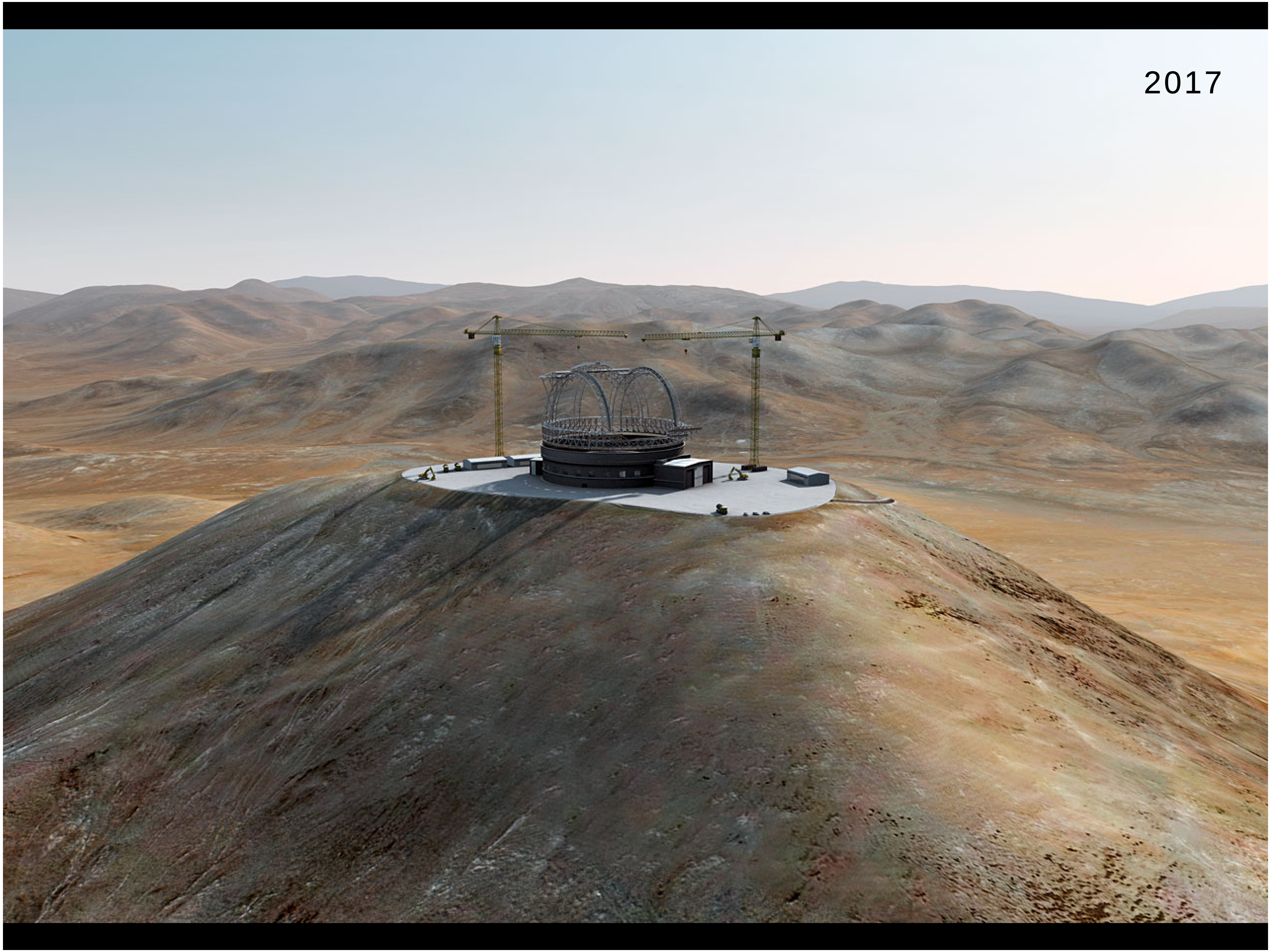
Client Consultant / Client's Engineer

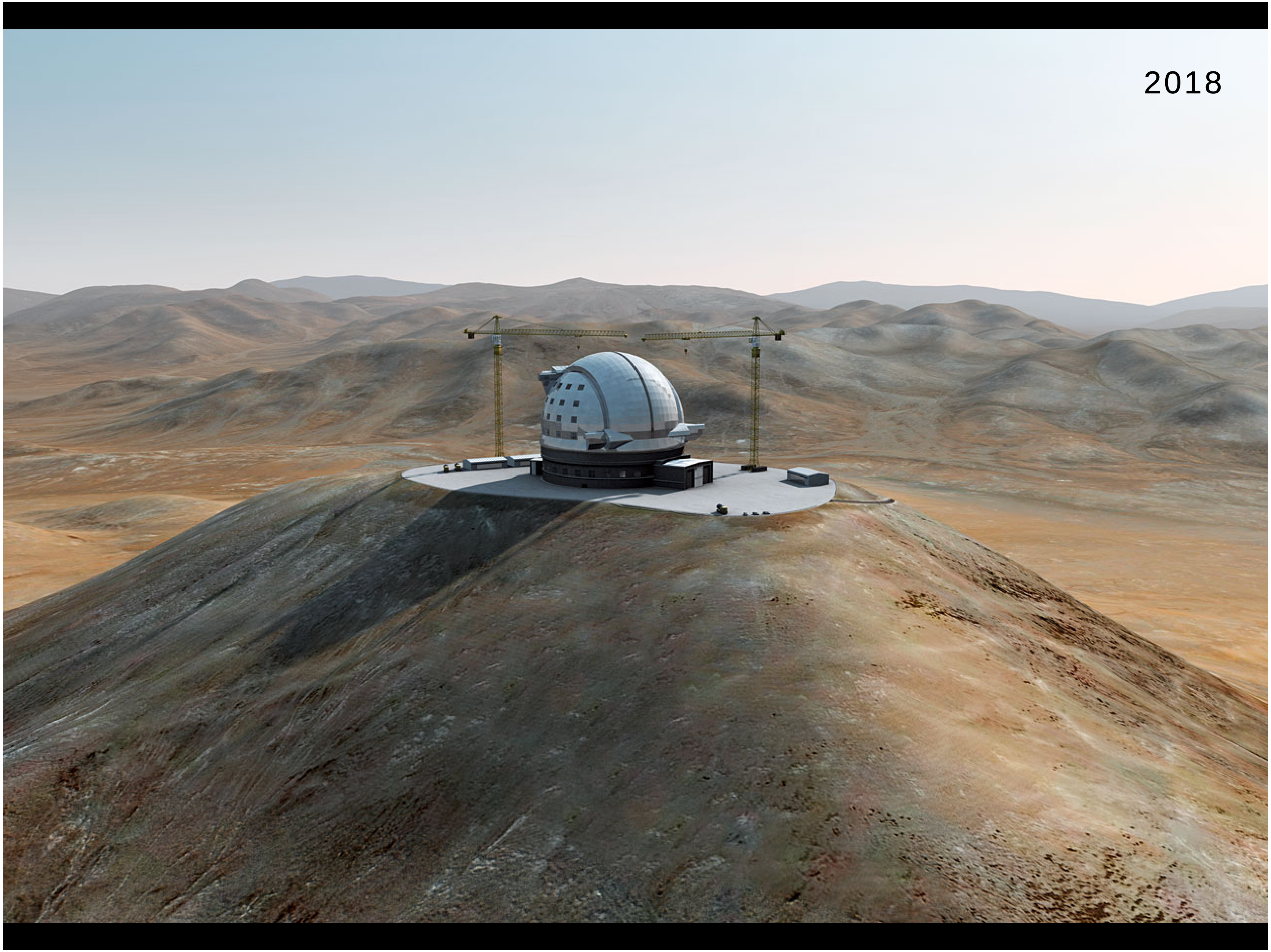
- ESO has never built a telescope like this before
- ESO's in-house skills are mainly within technology
- There are a lot uncertainties
- Getting the right experience involved is crucial
- An independent consultant was needed
- Ramboll will be involved in the next 10 years

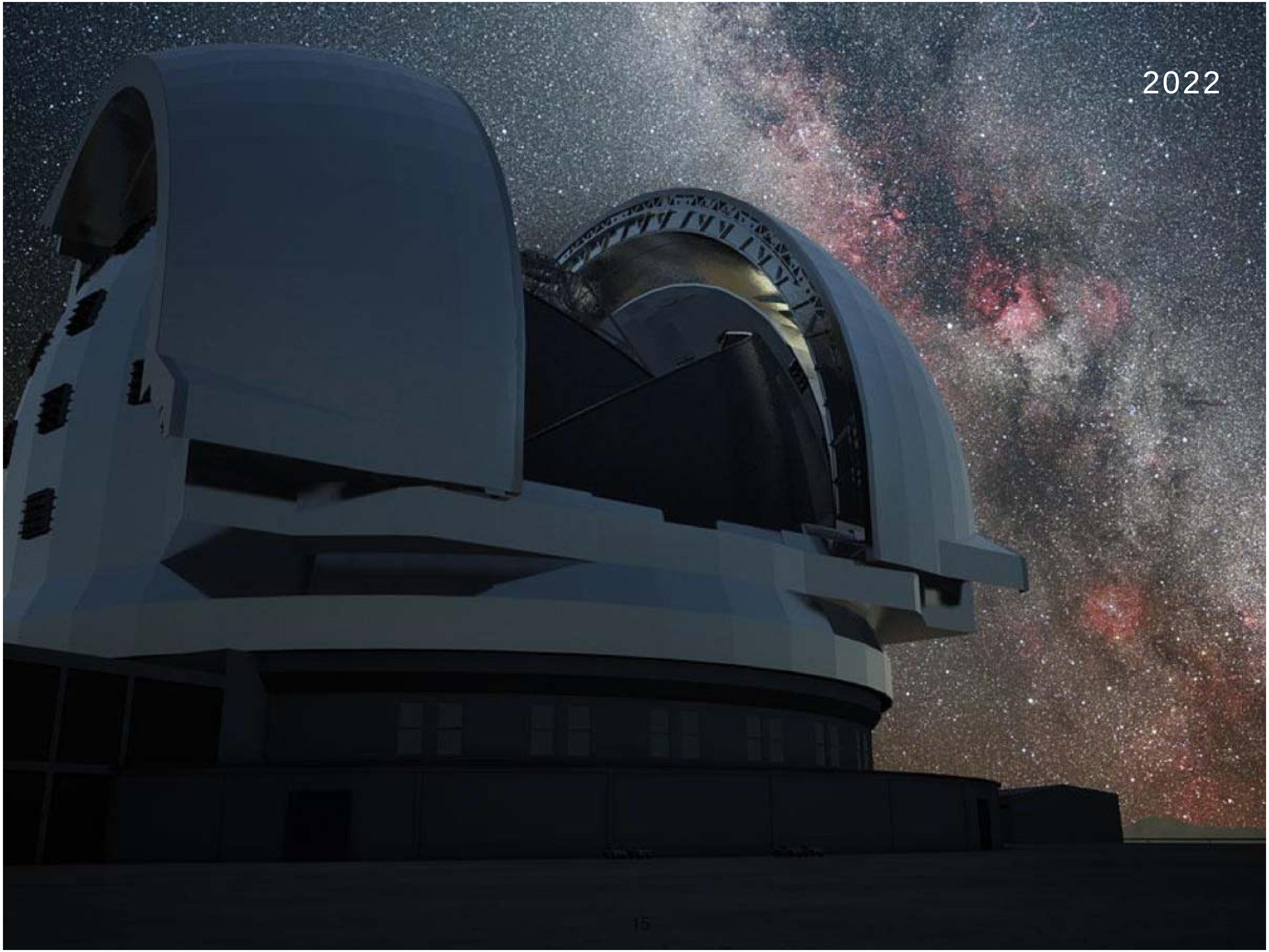

2014


2015


2016


2017


2018


2022

THE END (OF THE UNIVERSE)