E-ELT Overview

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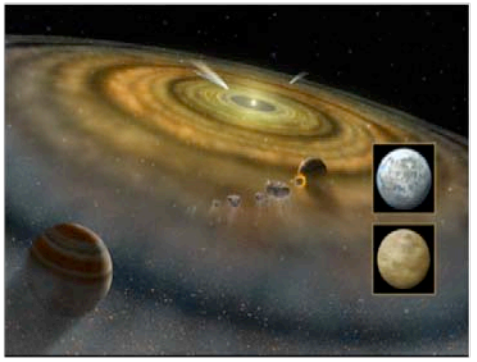
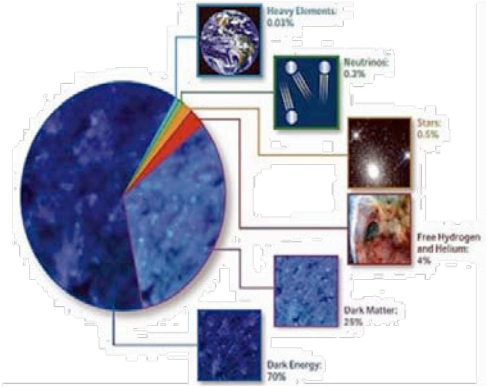
Programme Manager

Science drivers

- Planets in other stellar systems
  - Imaging *and* spectroscopy
  - *The quest for Earth-like exo-planets*
- Stellar populations
  - In galaxies inaccessible today (e.g. ellipticals in Virgo cluster)
  - Across the whole history (i.e. extent) of the Universe
- Cosmology
  - The first stars/galaxies
  - Direct measure of deceleration
  - Evolution of cosmic parameters
  - Dark matter, dark energy
  - Tests of GR around black holes
- The unknown
  - Open new parameter space



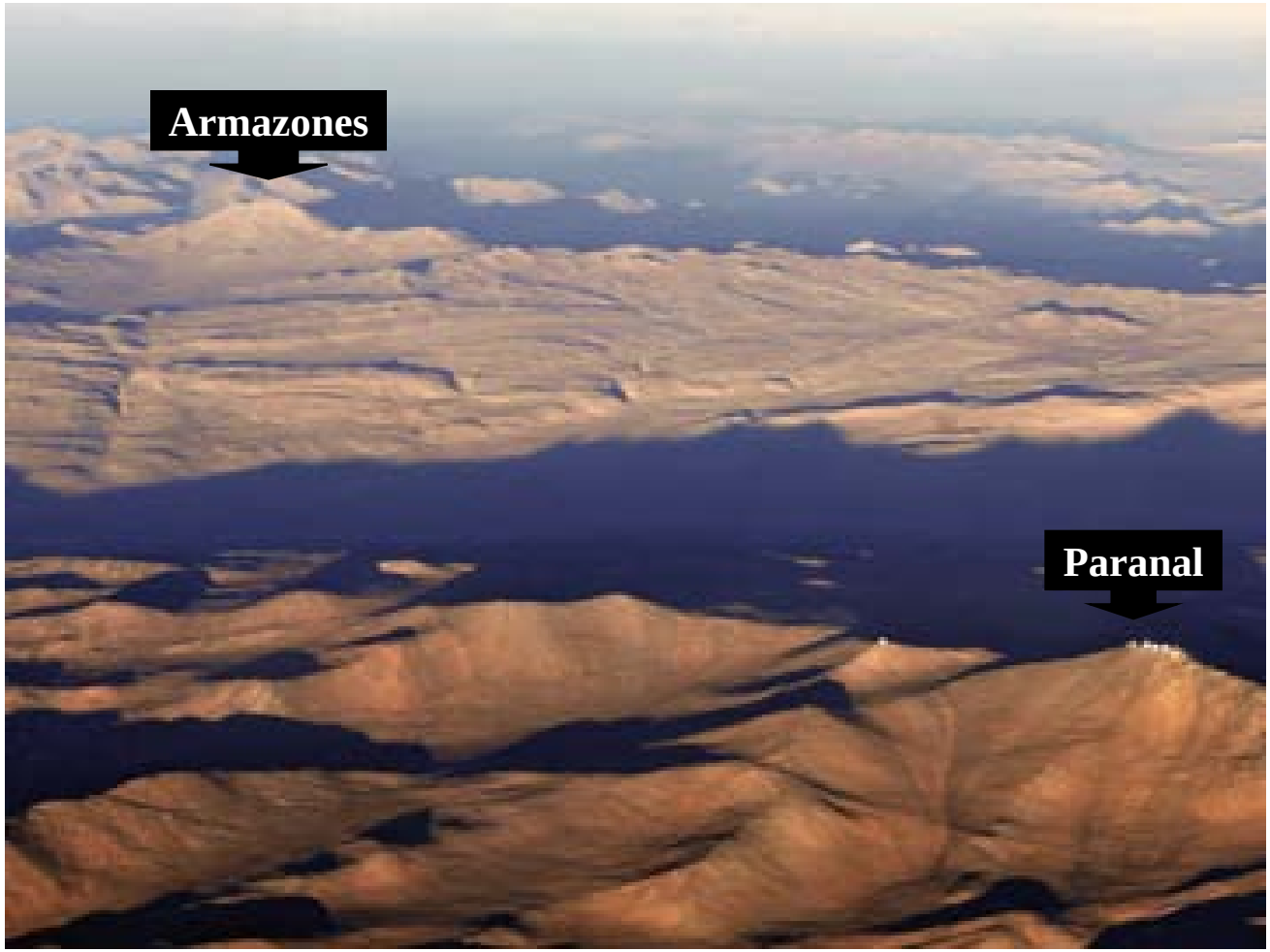


Science → Requirements

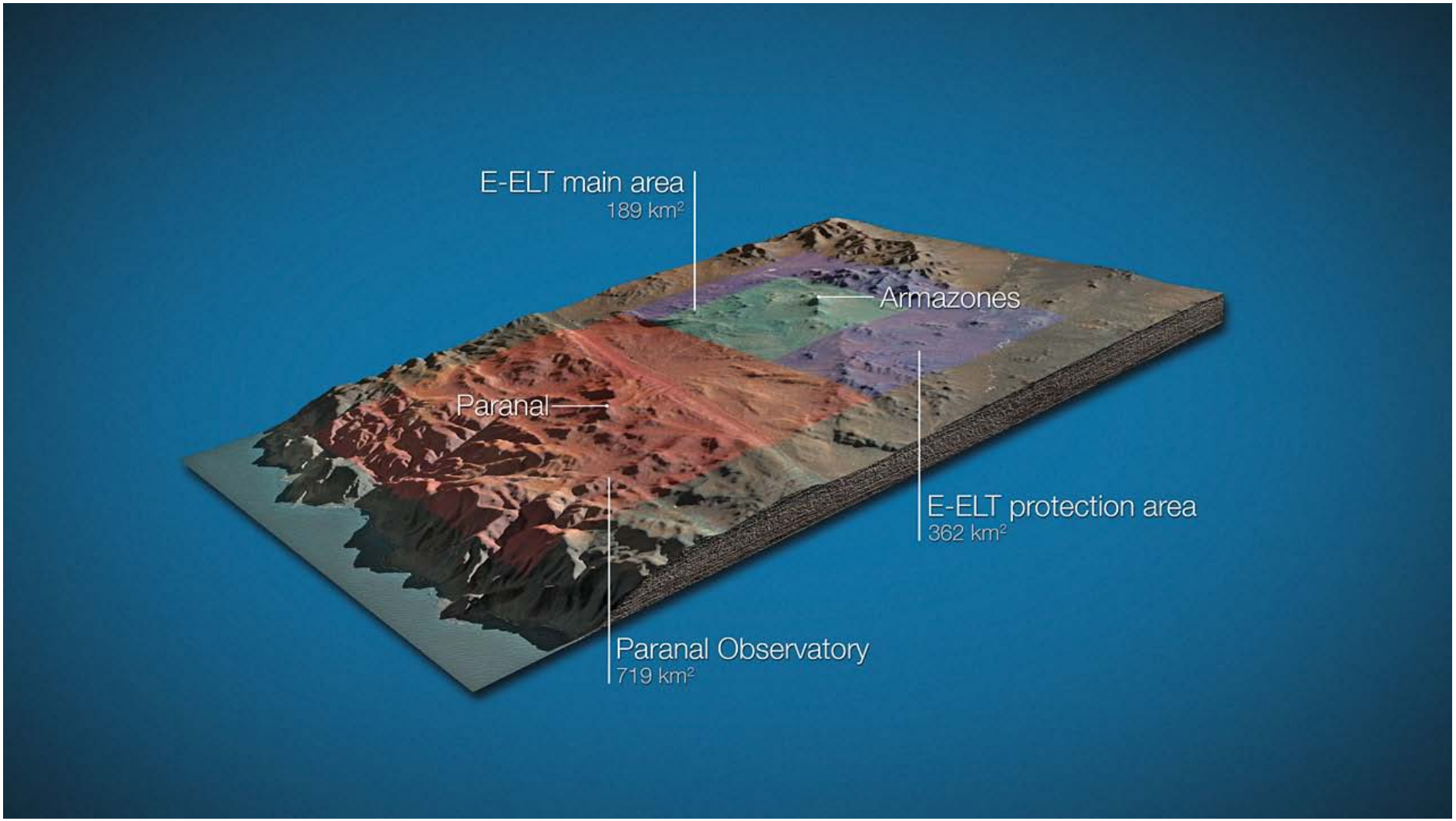
- Diameter: ≥39m (area ≥ 1000 m2)
  - Alt-Az, F/15 to F/18, fully steerable (0-360,0-90). Operational ZD: 0-70
- Adaptive telescope
  - GLAO correction (≥ 5 arcmin, 90% sky, 80% time)
    - better than 2x FWHM improvement for median seeing conditions
  - Post-focal: SCAO, MCAO, LTAO, ExAO, MOAO, ...
- Science field of view:
  - 10 arcmin unvignetted. Diffraction limited by design
  - 5 arcmin unobscured by guide probes
- Wavelength range: 0.3 – 24 μm
- Transmission @Nasmyth:
  - >50% at >0.35 μm, >60 % at >0.4 μm, >70% at 0.7 μm, >80% at > 1 μm
- Focal stations
  - Two Nasmyth (multiple instruments, including gravity invariant option)
  - At least one Coudé
  - Fixed instrumentation (fast switching: < 10 min same focus, < 20 otherwise)

Where ?

- Cerro Armazones, 2800 m, 25 km from Cerro



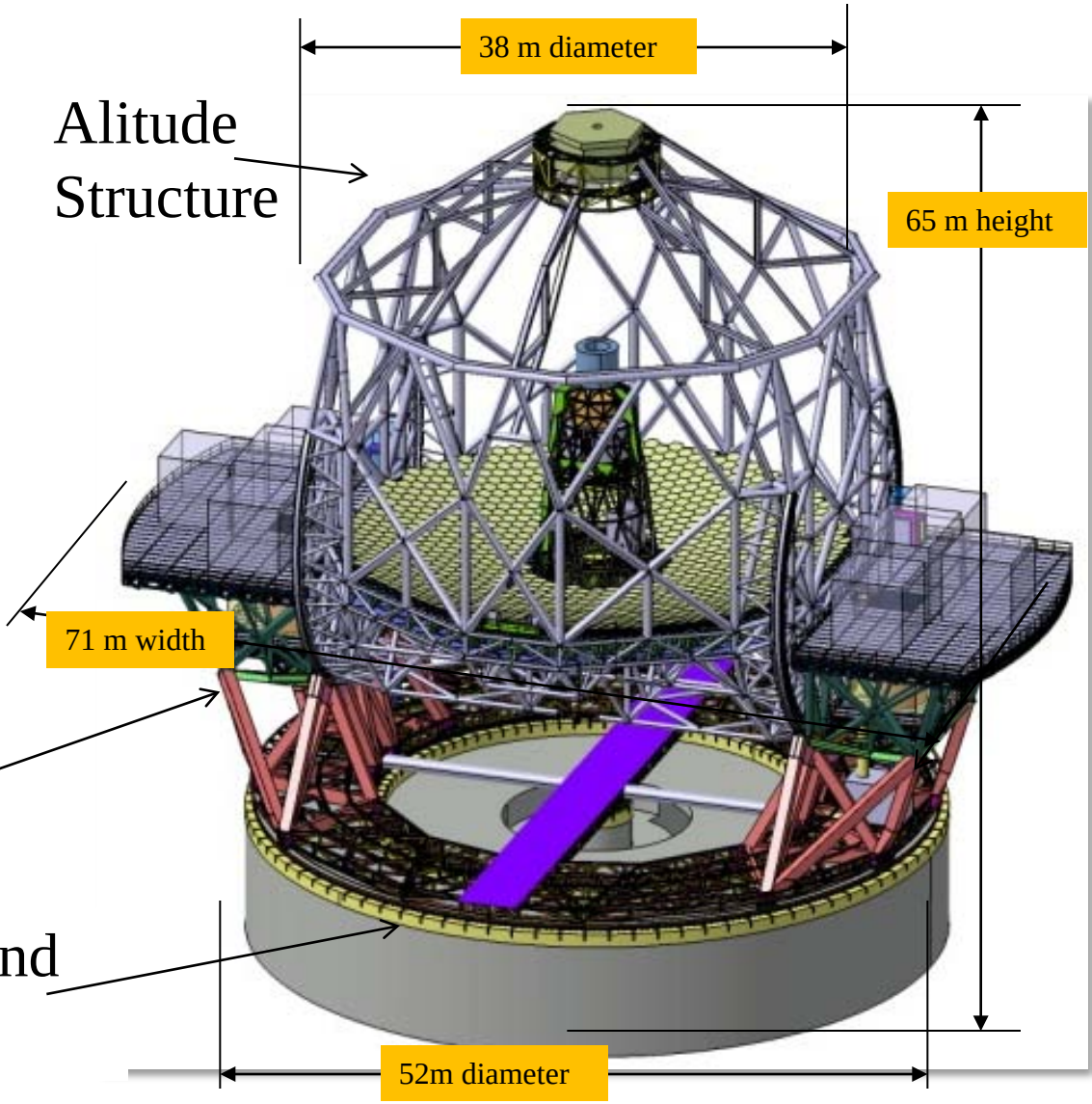
Location


E-ELT main area
189 km²
Armazones
Paranal
E-ELT protection area
362 km²
Paranal Observatory
719 km²

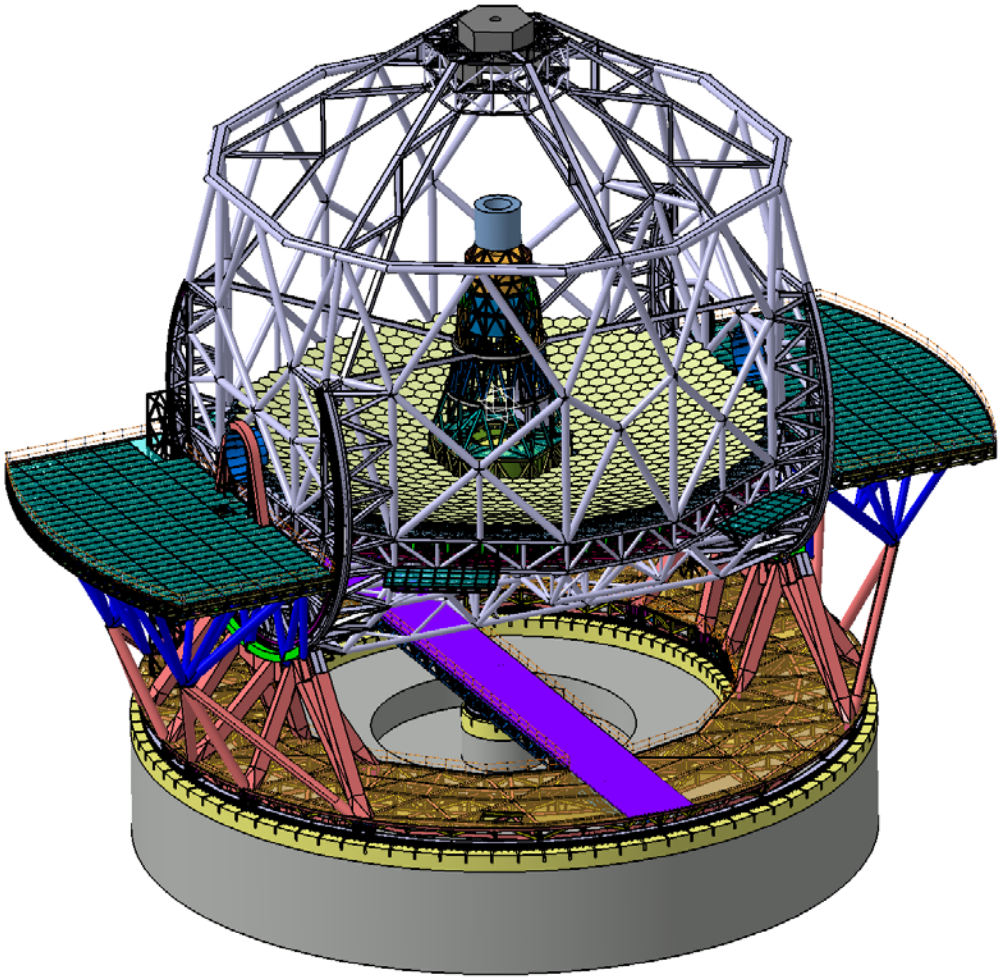
Main Structure Design

General Overview

The Main Structure is about 2500 tons of steel moving 700tons of opto-mechanics and electronics around two perpendicular axes (azimuth and altitude) supported on hydrostatic bearings and driven by electrical direct drive motors with a precision of 0.3 arcsec under the maximum wind disturbance.



The E-ELT: overview

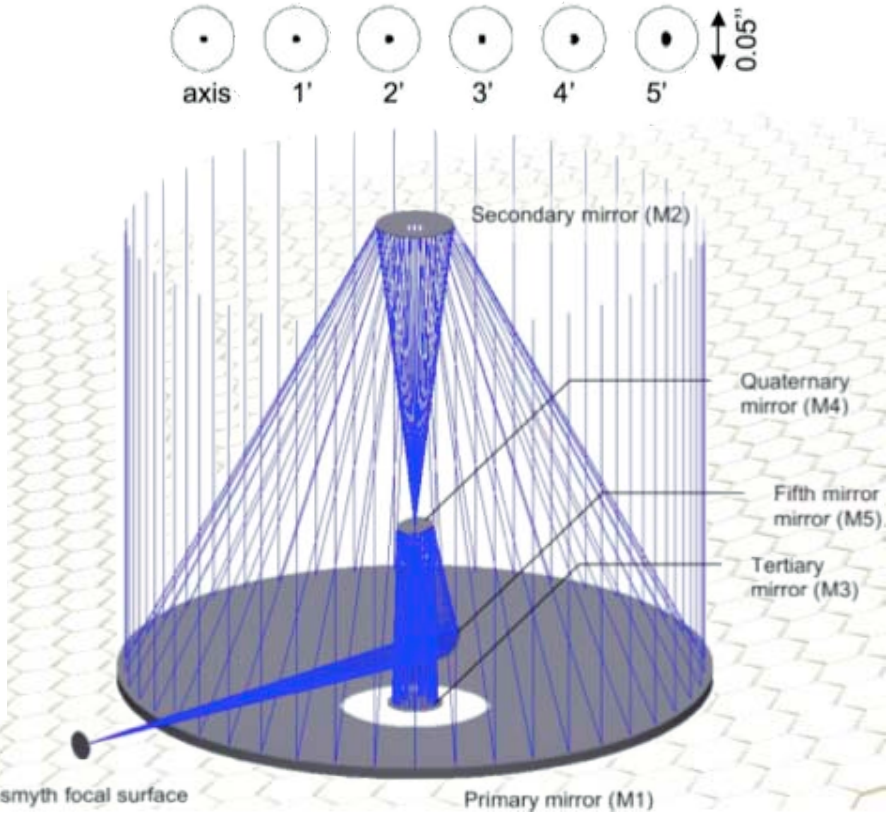


Optical design

- 3-mirror anastigmat on axis + 2 flats
- diffraction limited over full 10′ FoV

Nasmyth, gravity invariant, coudé foci

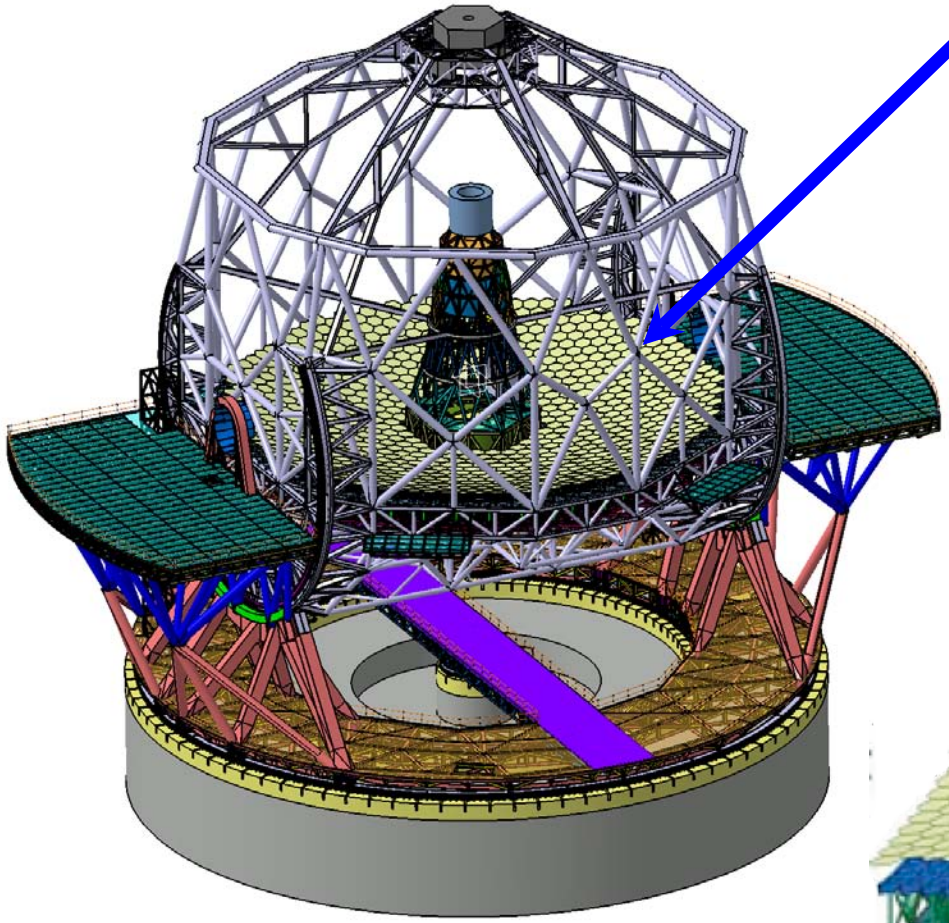
- very low LGS wavefront aberrations

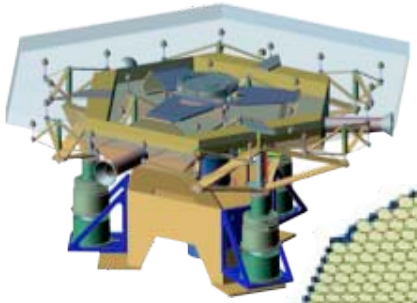


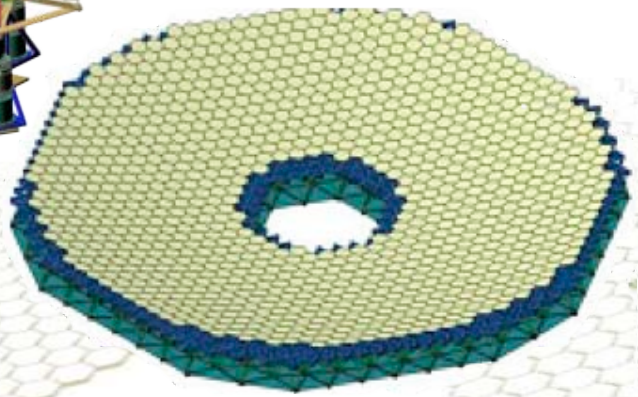
The E-ELT: M1

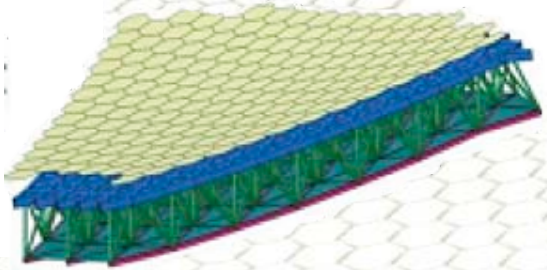
39m Primary Mirror

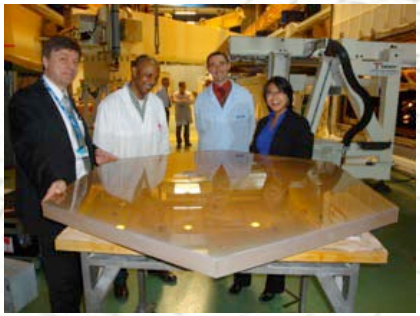
- 798 segments mirror +1/family
- 2 x 7 prototypes FEEDs
- prototype support, PACTs, edge sensors



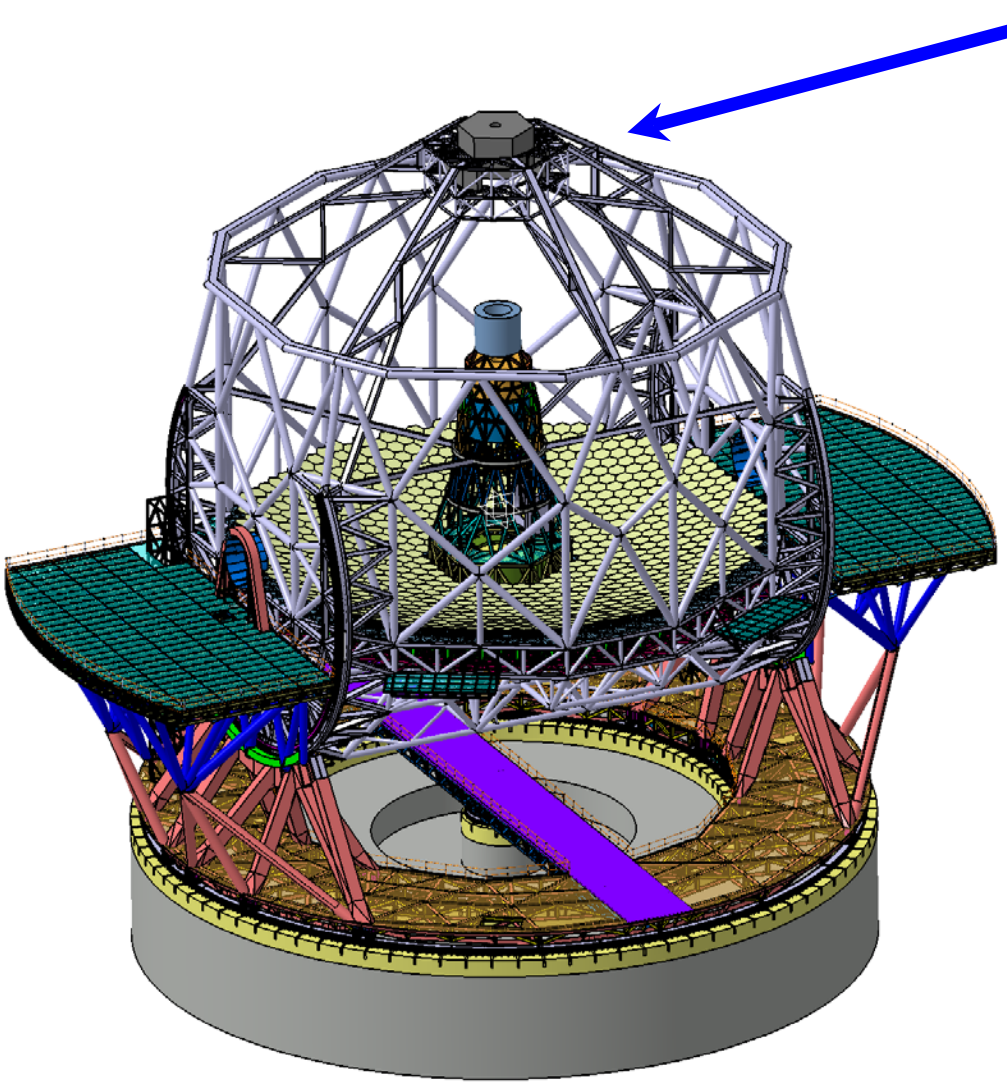






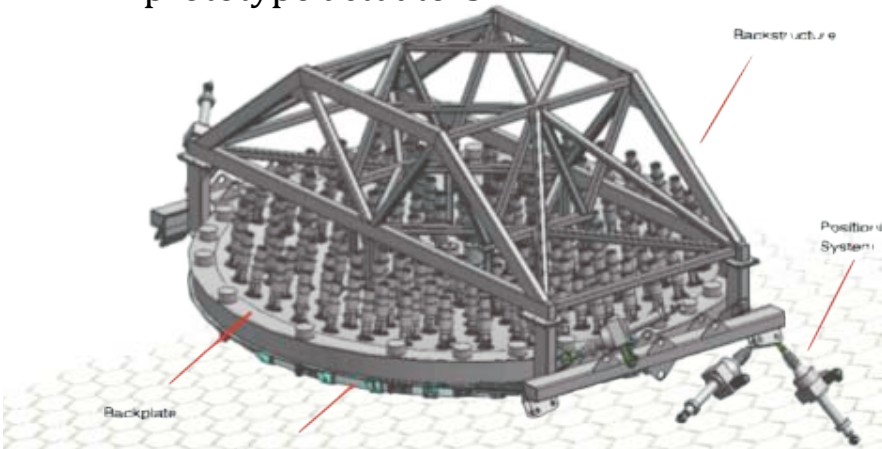


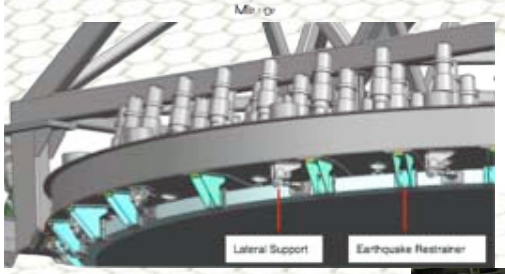
The E-ELT: M2



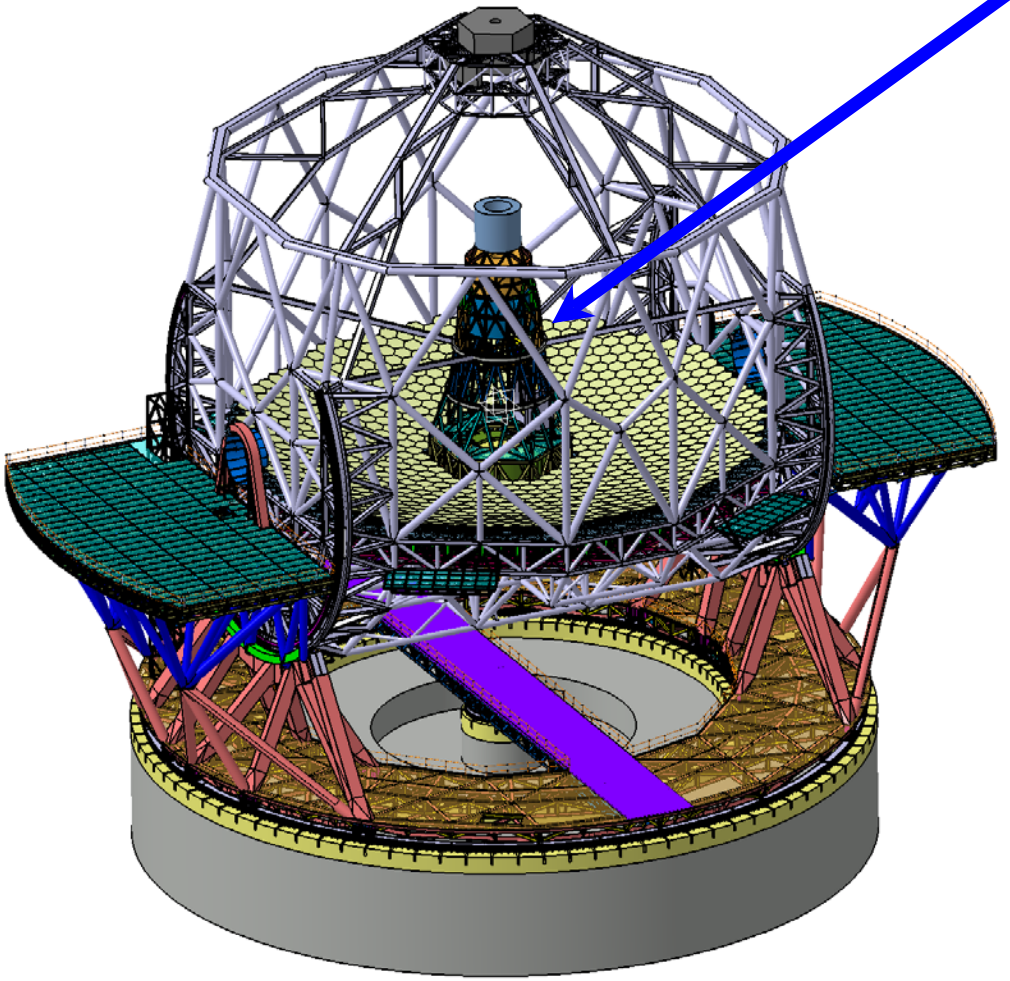
4m Secondary Mirror

- M2 unit FEED
- 3 polishing studies
- prototype actuators



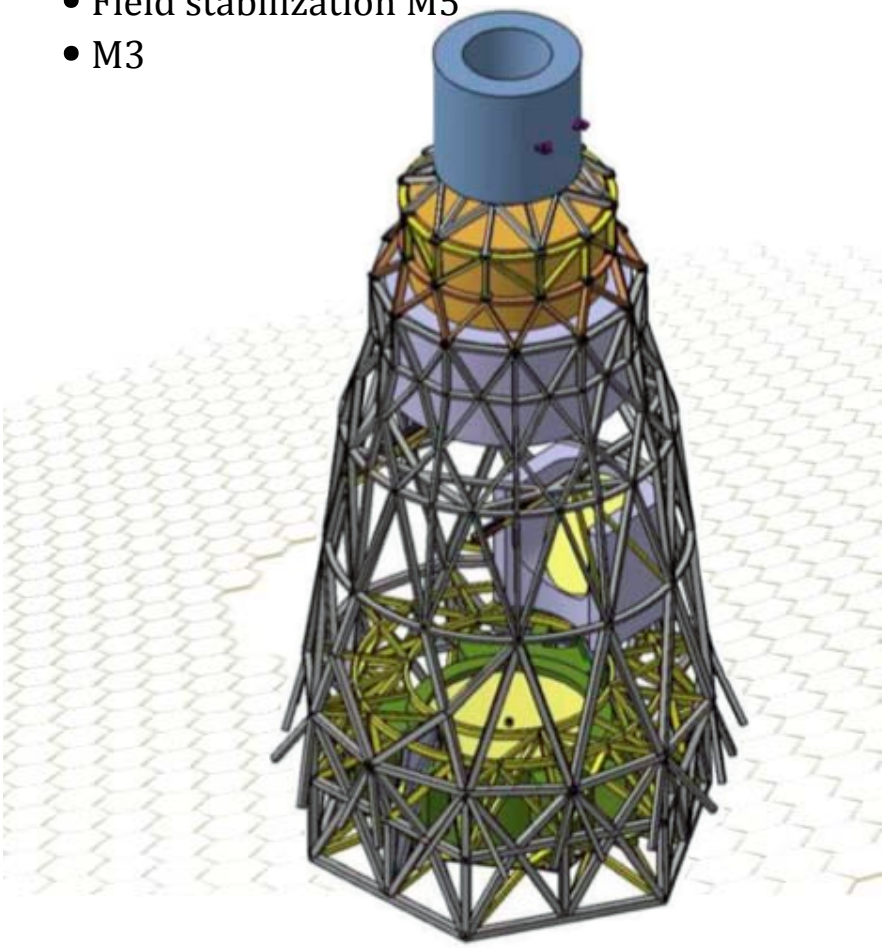


The E-ELT: ARU Tower



Central tower

- ADC volume
- Adaptive M4
- Field stabilization M5
- M3



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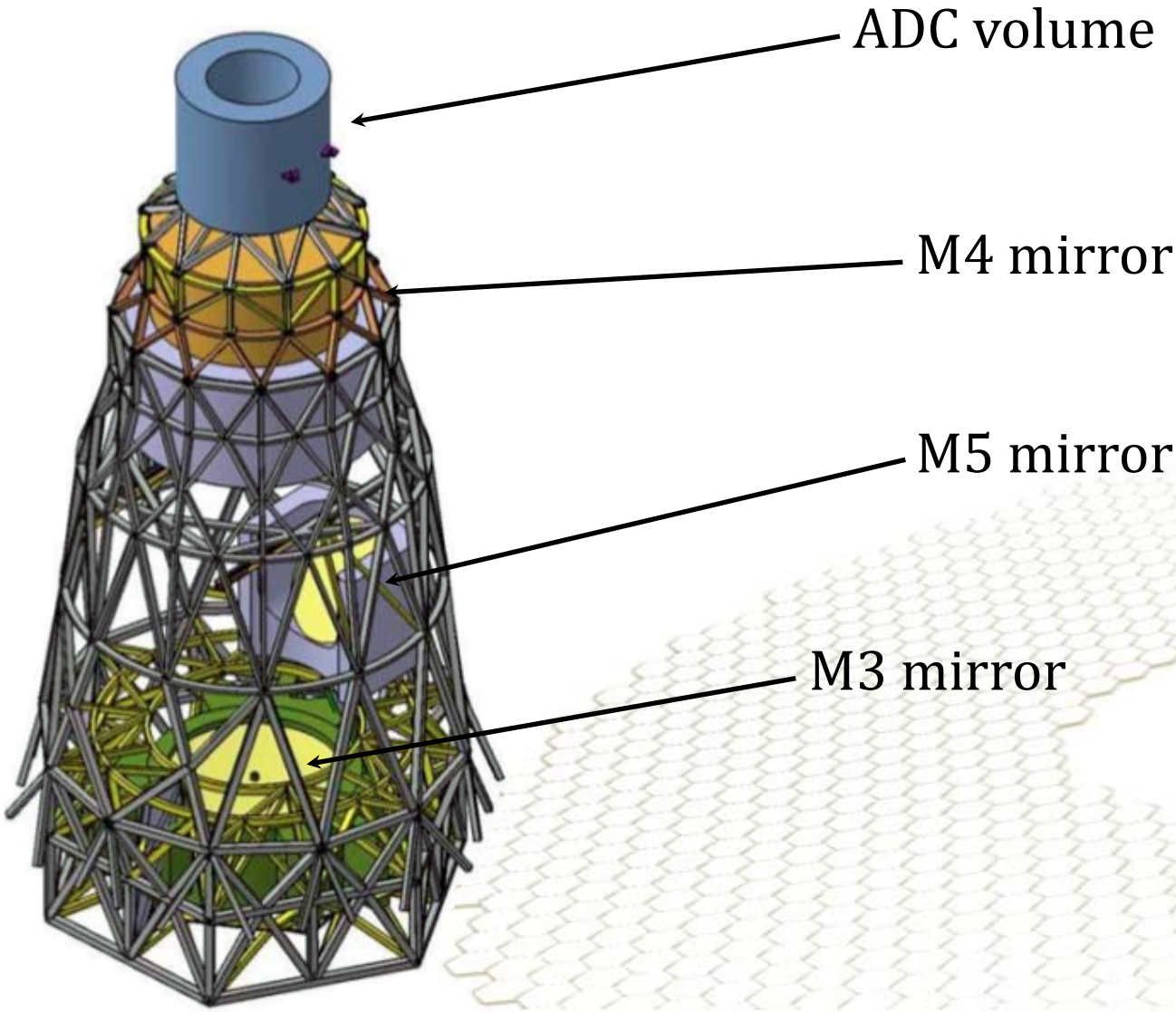
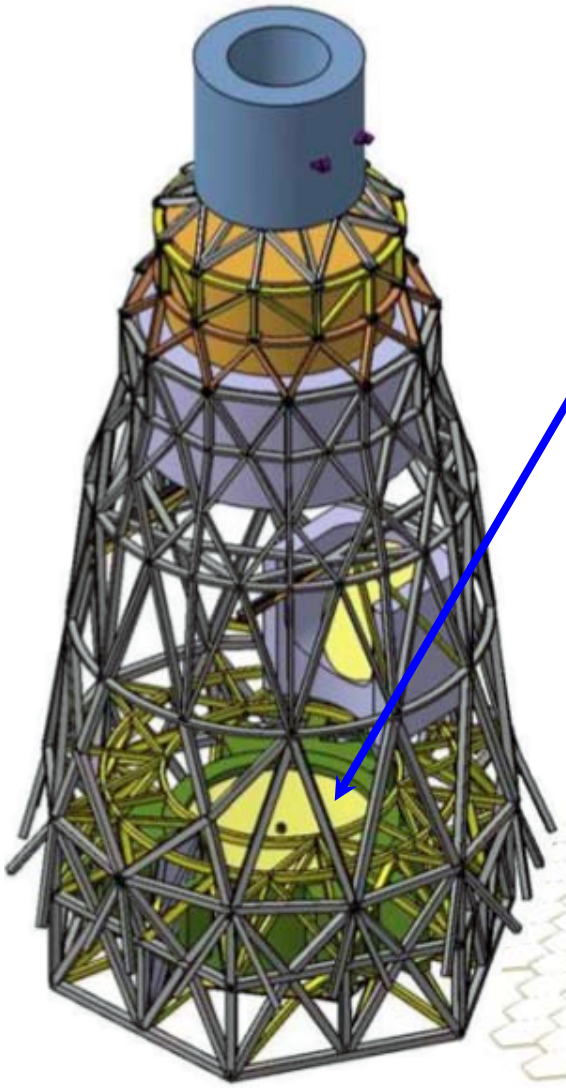
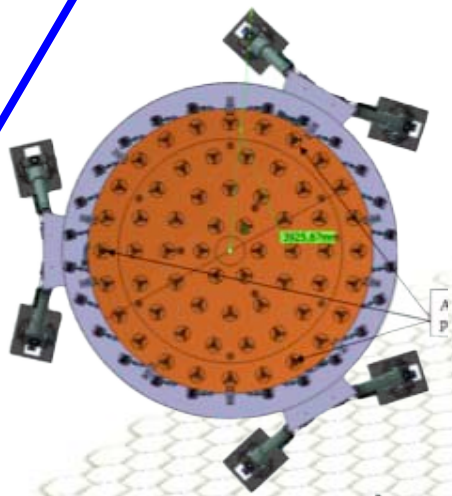


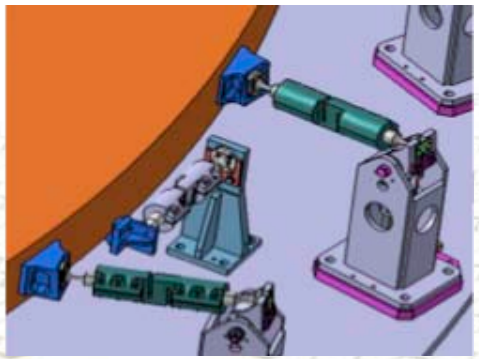
The E-ELT: M3

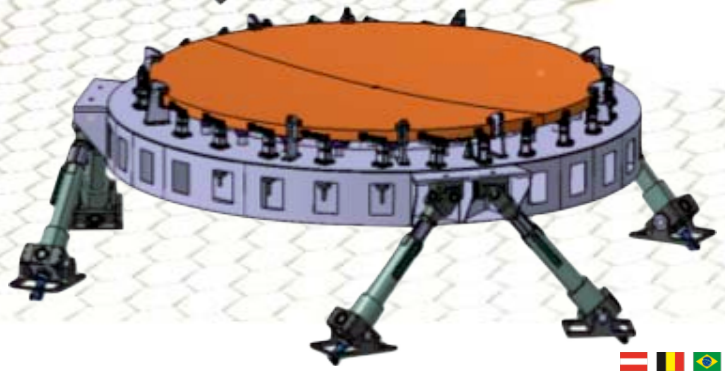
4.2m M3 unit

- Preliminary cell design concluded
- Prototype pneumatic actuators

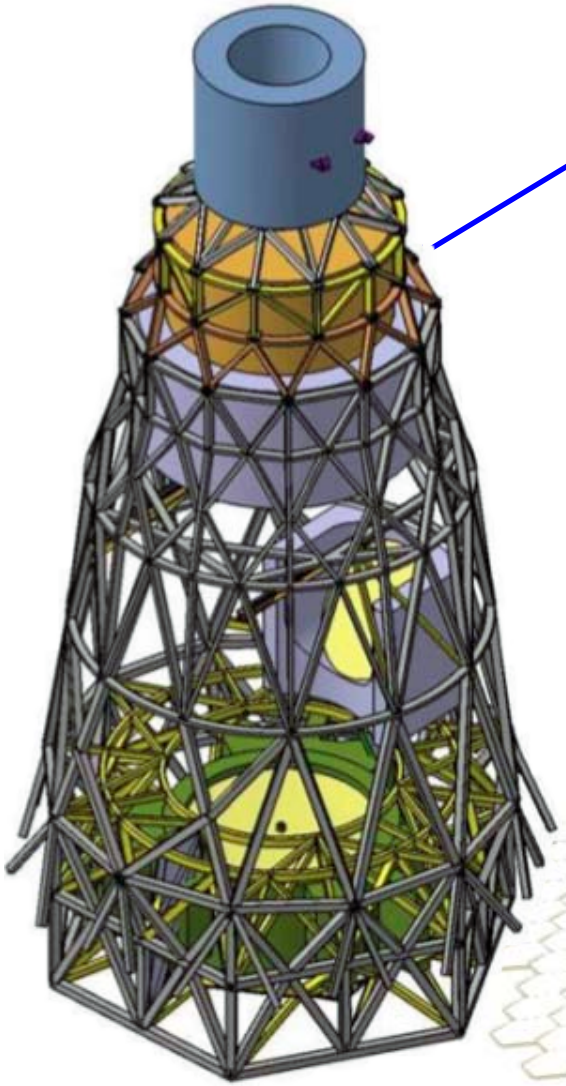






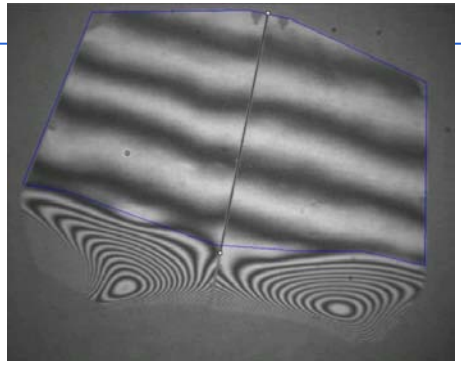


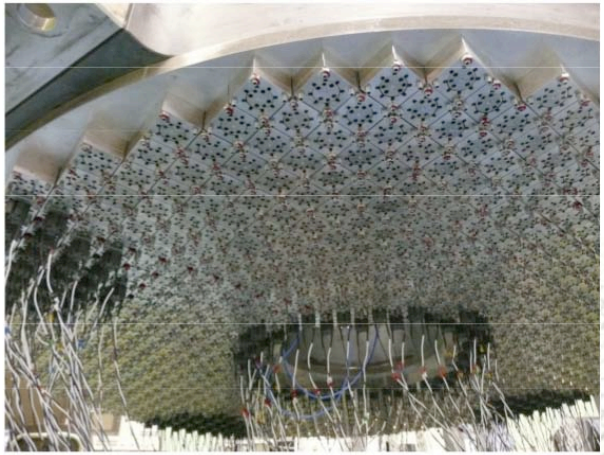
The E-ELT: M4

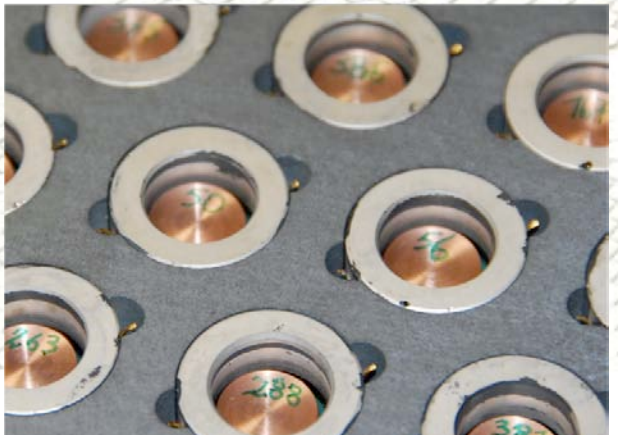


2.5m M4 unit

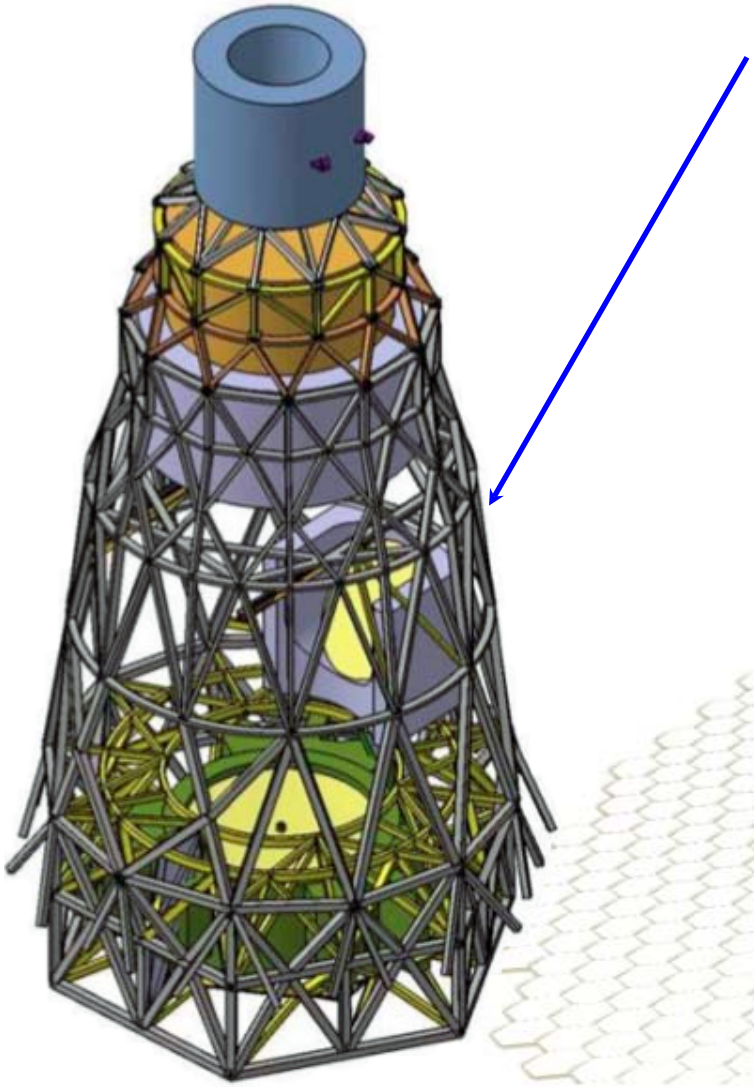
- 2 FEEDS (prototypes)
- final stages of testing
- thin shells polishing





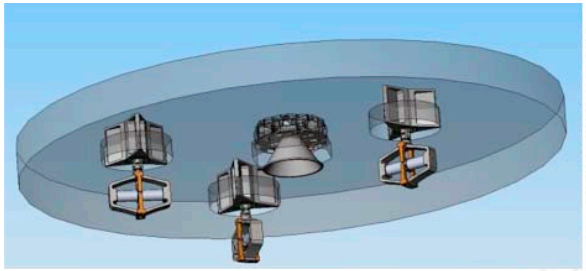


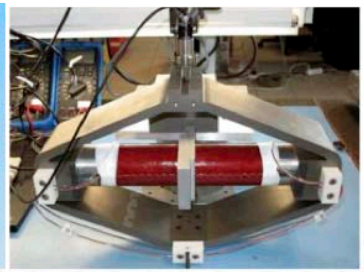
The E-ELT: M5



2.4m x 3m M5 unit

- scale-1 electromechanical prototype FEED
- final stages of testing
- 4 mirror polishing studies (including heavy option)





M5 Unit

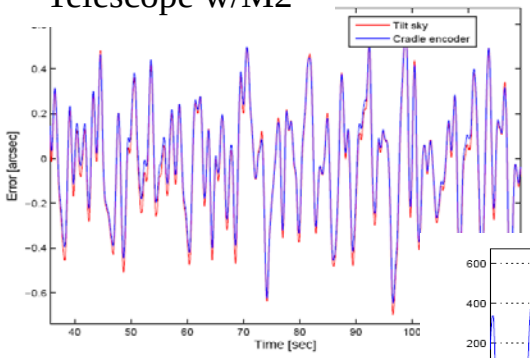
Tip/Tilt flat mirror 3.0 x 2.5 m

Incoming disturbance with 1” rms residual tip tilt

- Residual after M5 stabilisation, on sky tip-tilt:
  - < 0.07” rms (goal 0.06”) over entire frequency range
  - < 0.004” rms for [9Hz to ∞] all peaks < 2σ

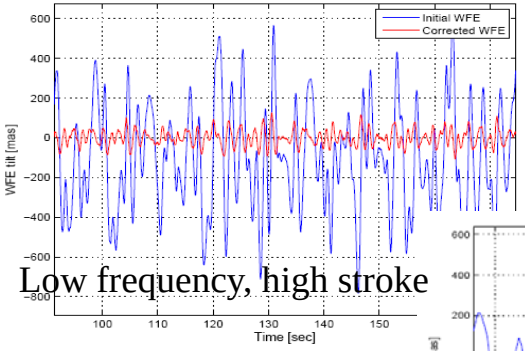
Telescope main axes control

Telescope w/M2



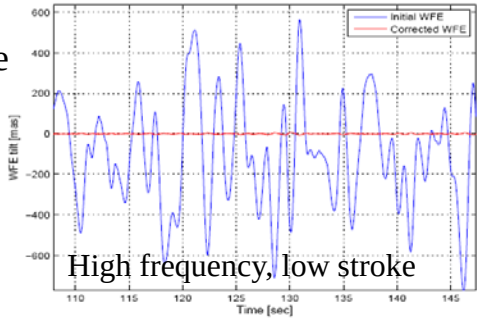
Remaining tip tilt < 1” rms

After M5

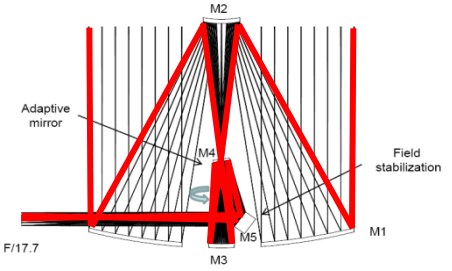


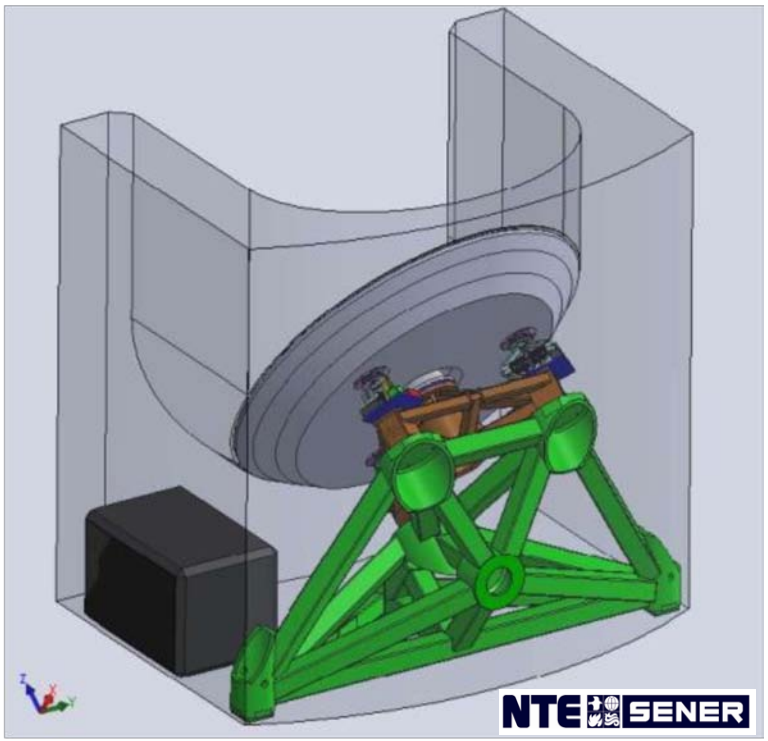
Low frequency, high stroke

After M5+ M4

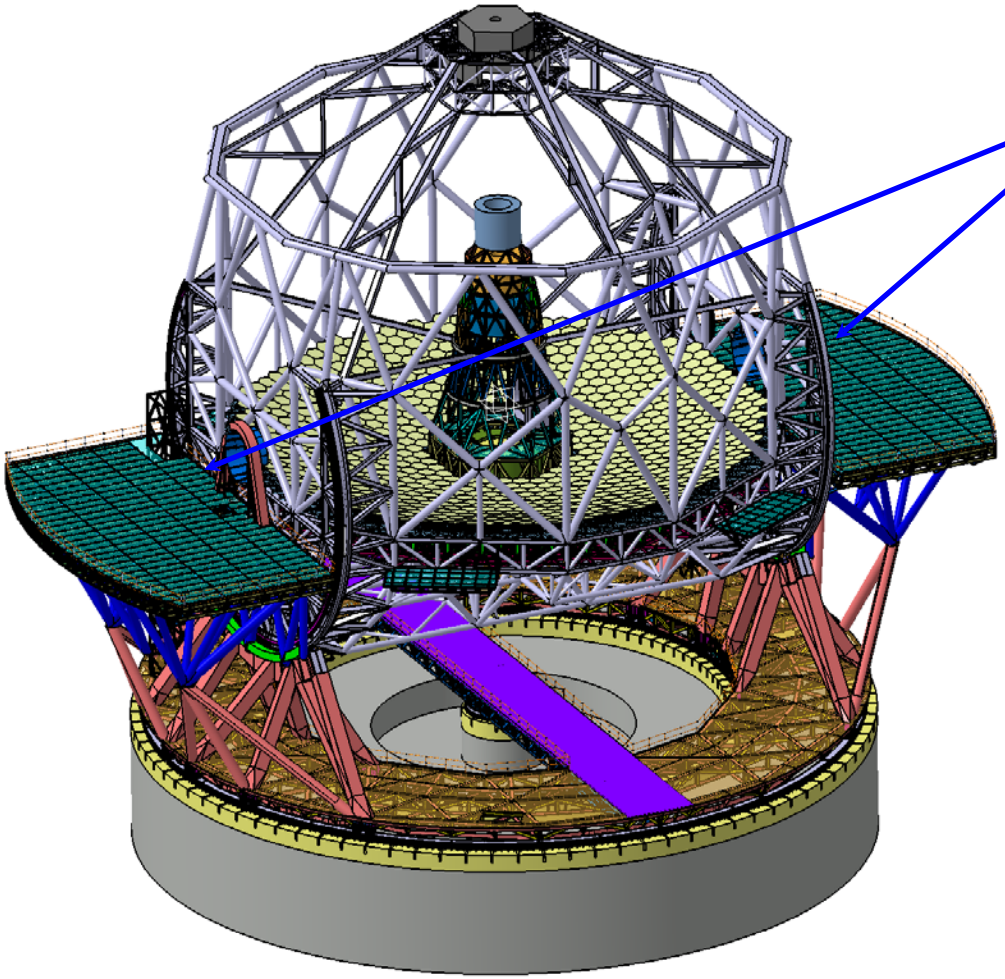


High frequency, low stroke



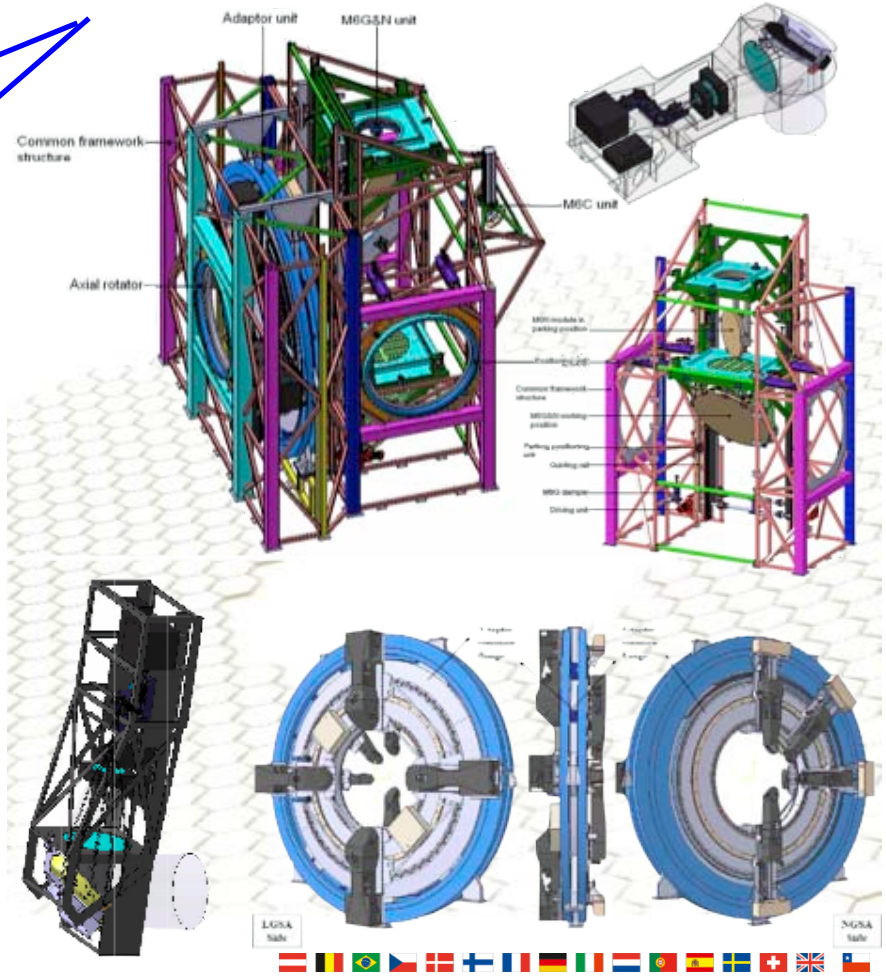


Pre-Focal Station

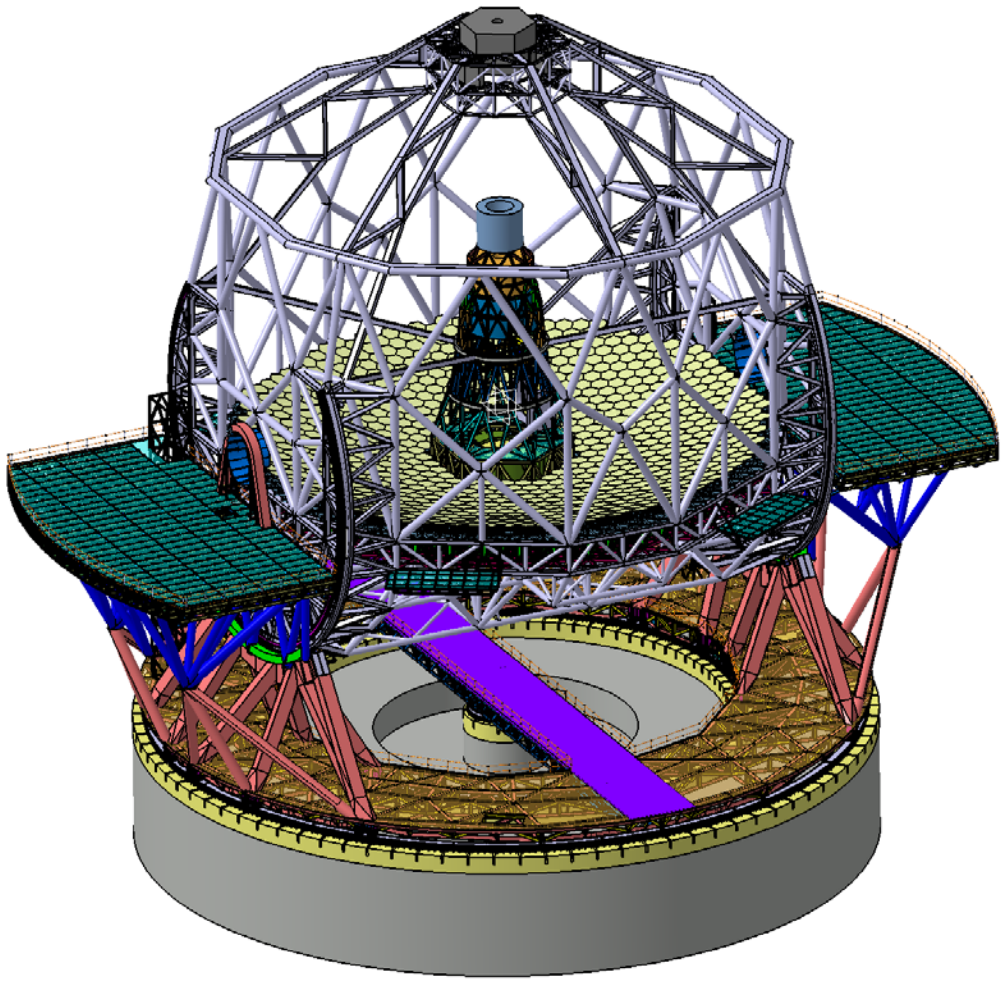


Prefocal station

- preliminary design concluded



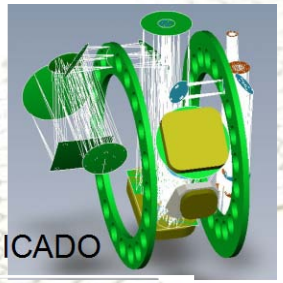
Instrumentation



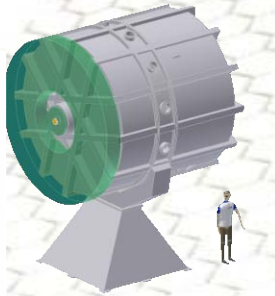
Instrumentation

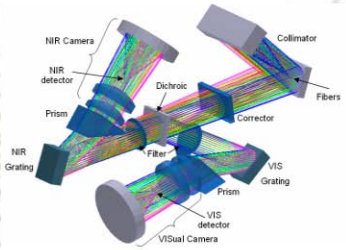
- 8 instrument concepts Phase A concluded
- 2 post-focal AO modules Phase A concluded

Possible instruments location



EAGLE



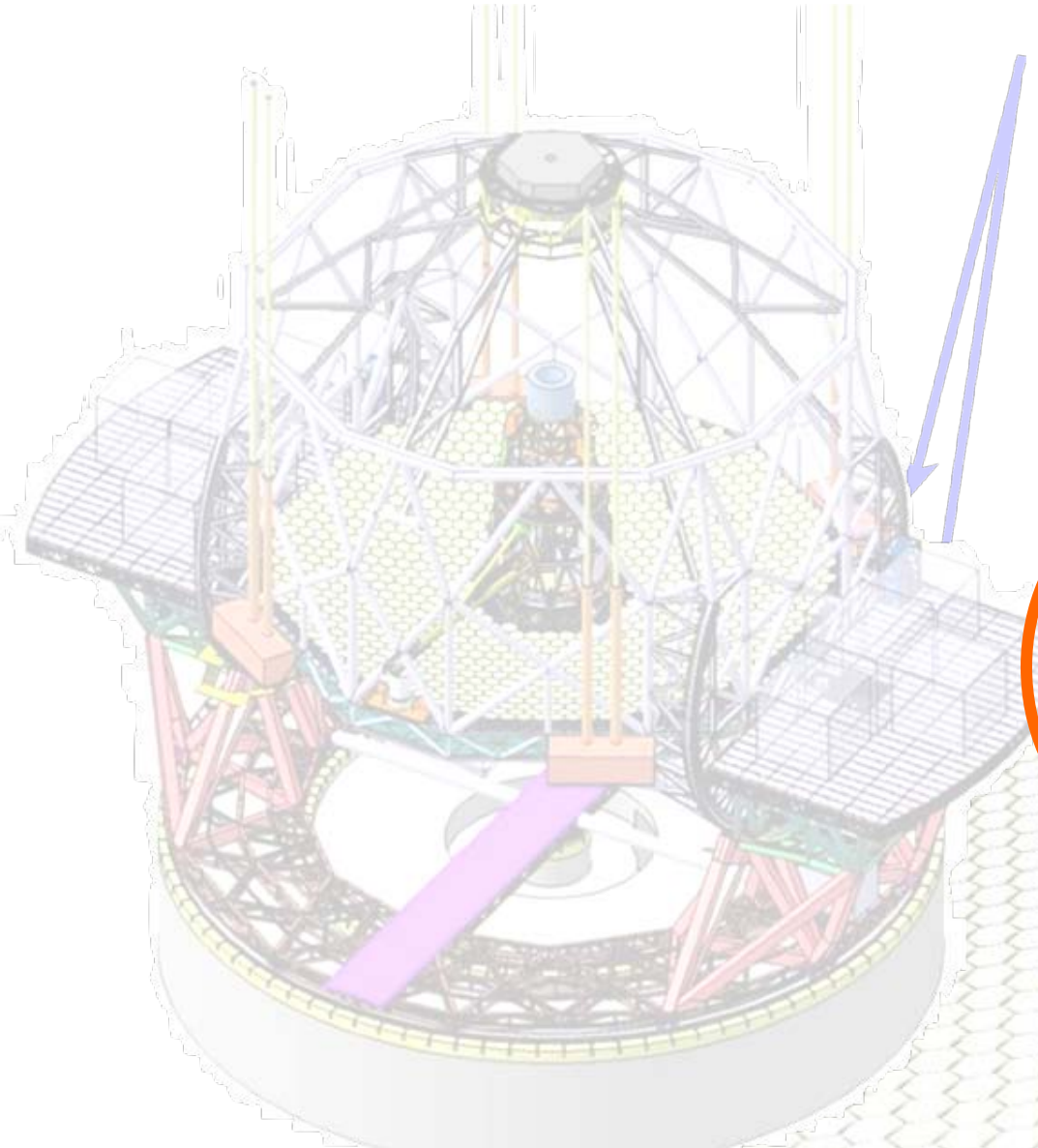


METIS

OPTIMOS/EVE

HARMONI

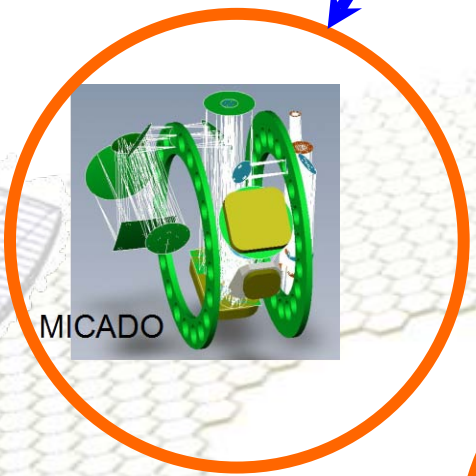
E-ELT First Light Instruments



Instrumentation

- 8 instrument concepts Phase A concluded
- 2 post-focal AO modules Phase A concluded

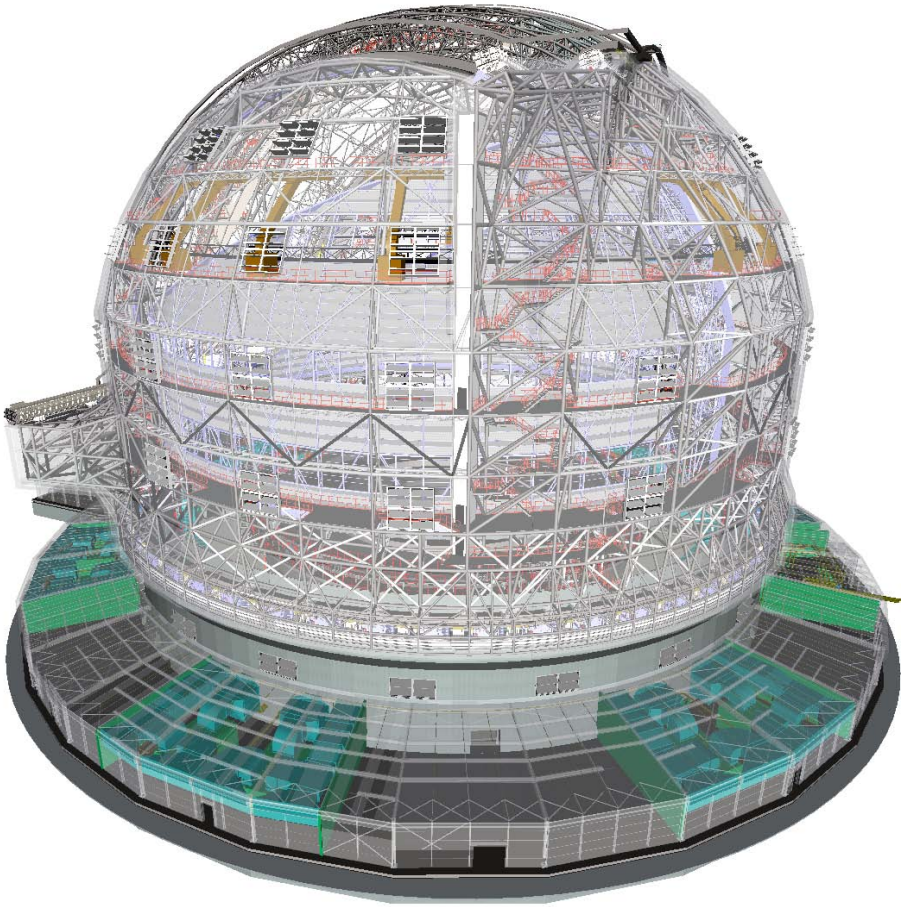
First Light Instruments

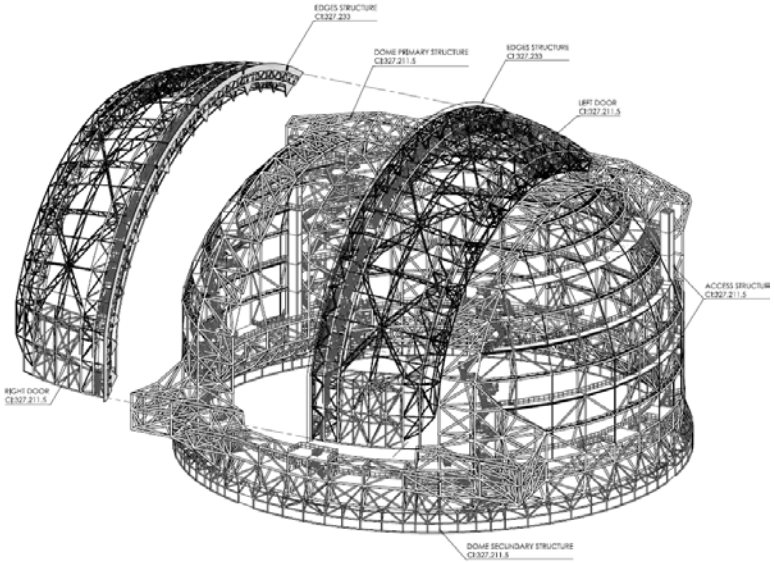


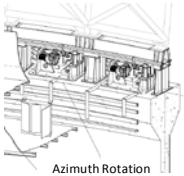
Dome

- Dome contains:
  - the primary and secondary steel structures
  - the concrete foundations for the dome and the main structure
  - all mechanisms for the rotation and operation
  - louvers, windscreen, ventilation and air-conditioning
  - storage areas required within the dome and general access facilities such as staircases, platforms, elevators, cranes etc.
  - all auxiliary installation like electrical equipment, thermal control equipment, lighting facilities etc.
  - the hardware and software for the local control of the dome functions.

Dome

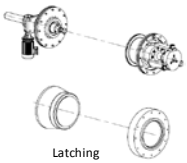




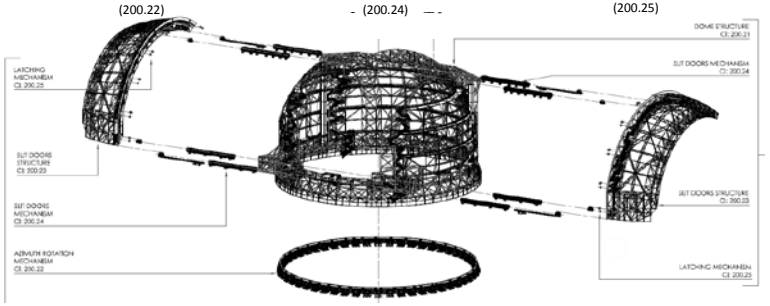


Azimuth Rotation Mechanism (200.22)

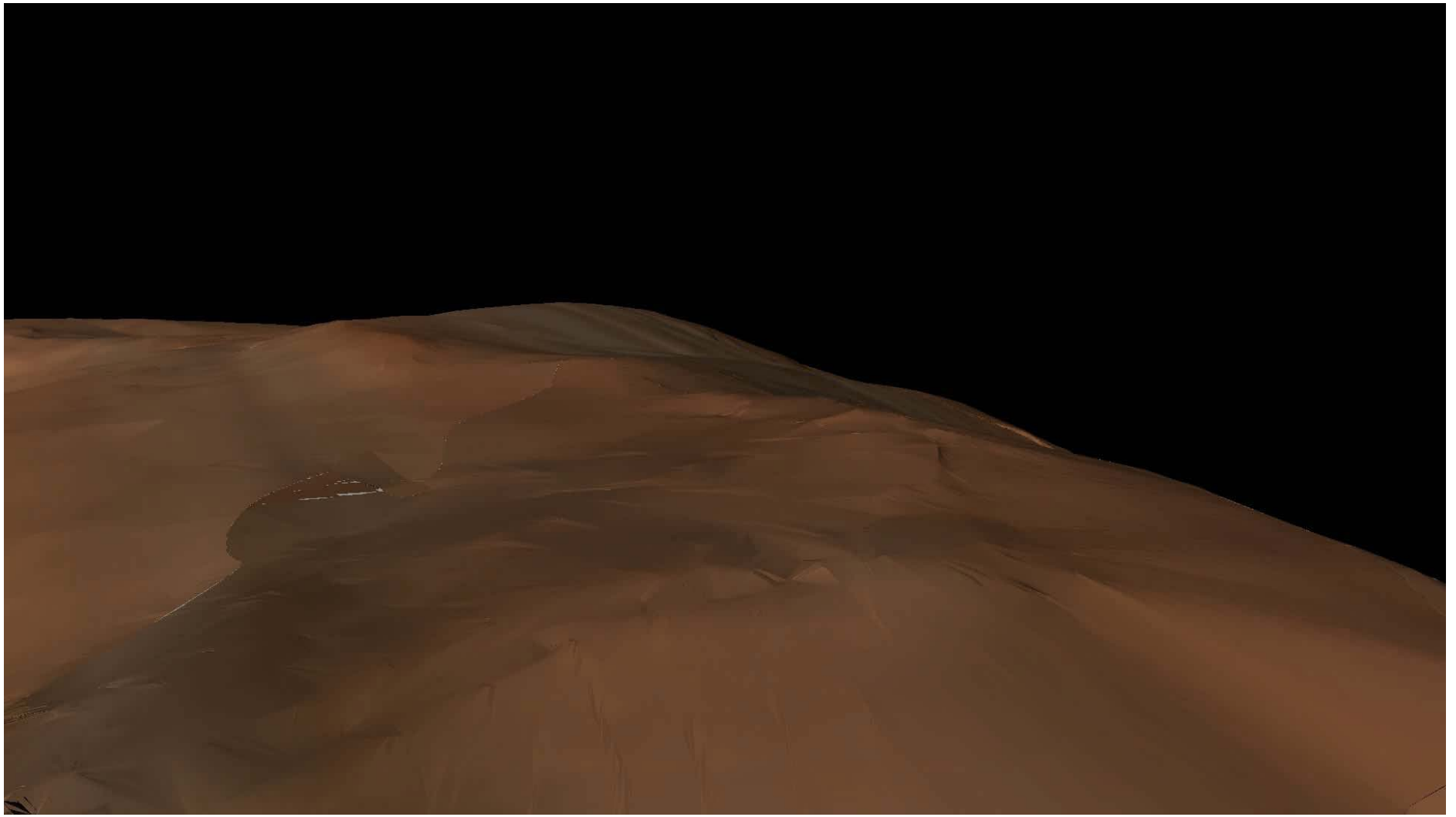
Slit Doors Mechanisms - (200.24)



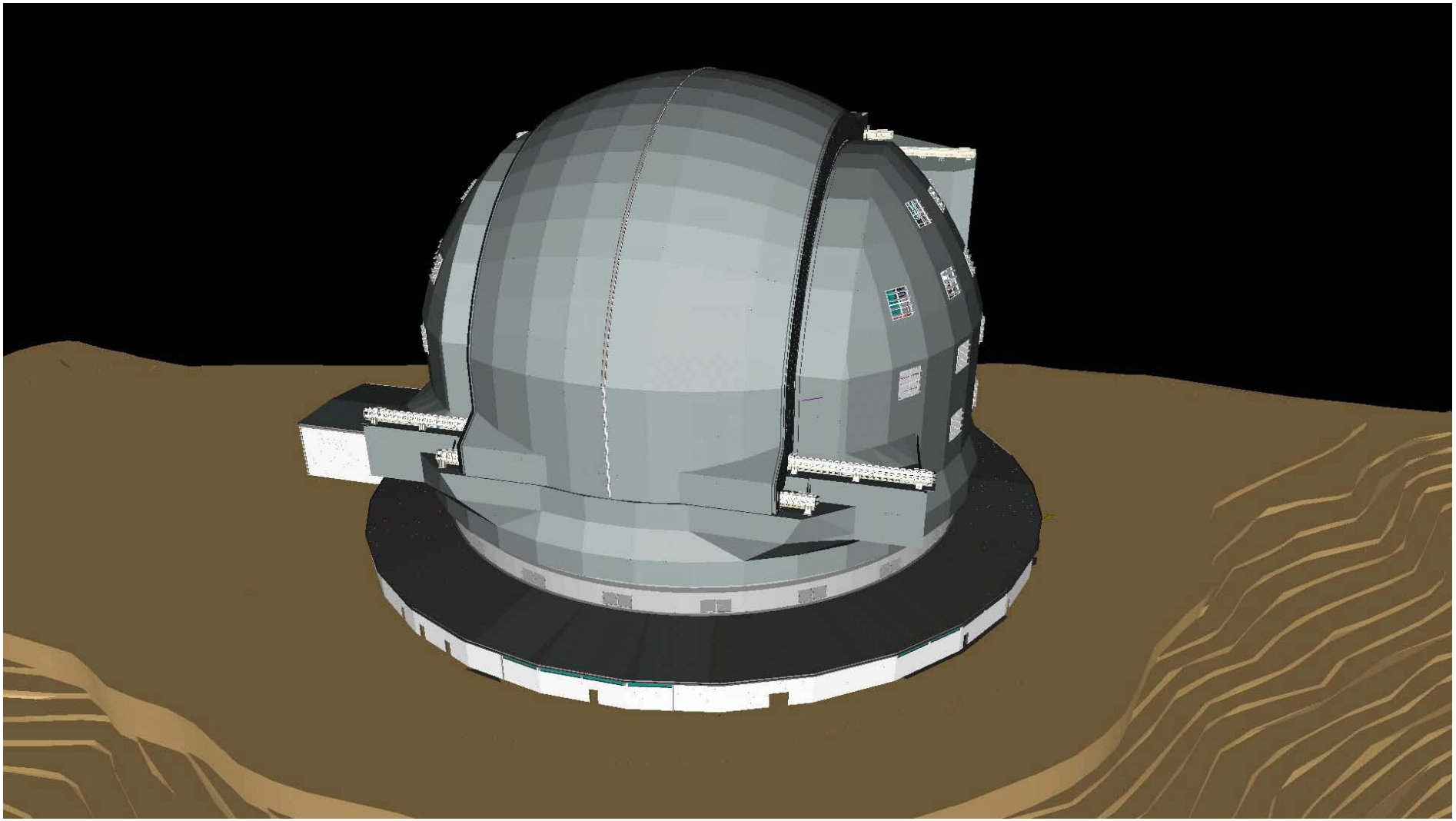
Latching Mechanism (200.25)



Dome Construction



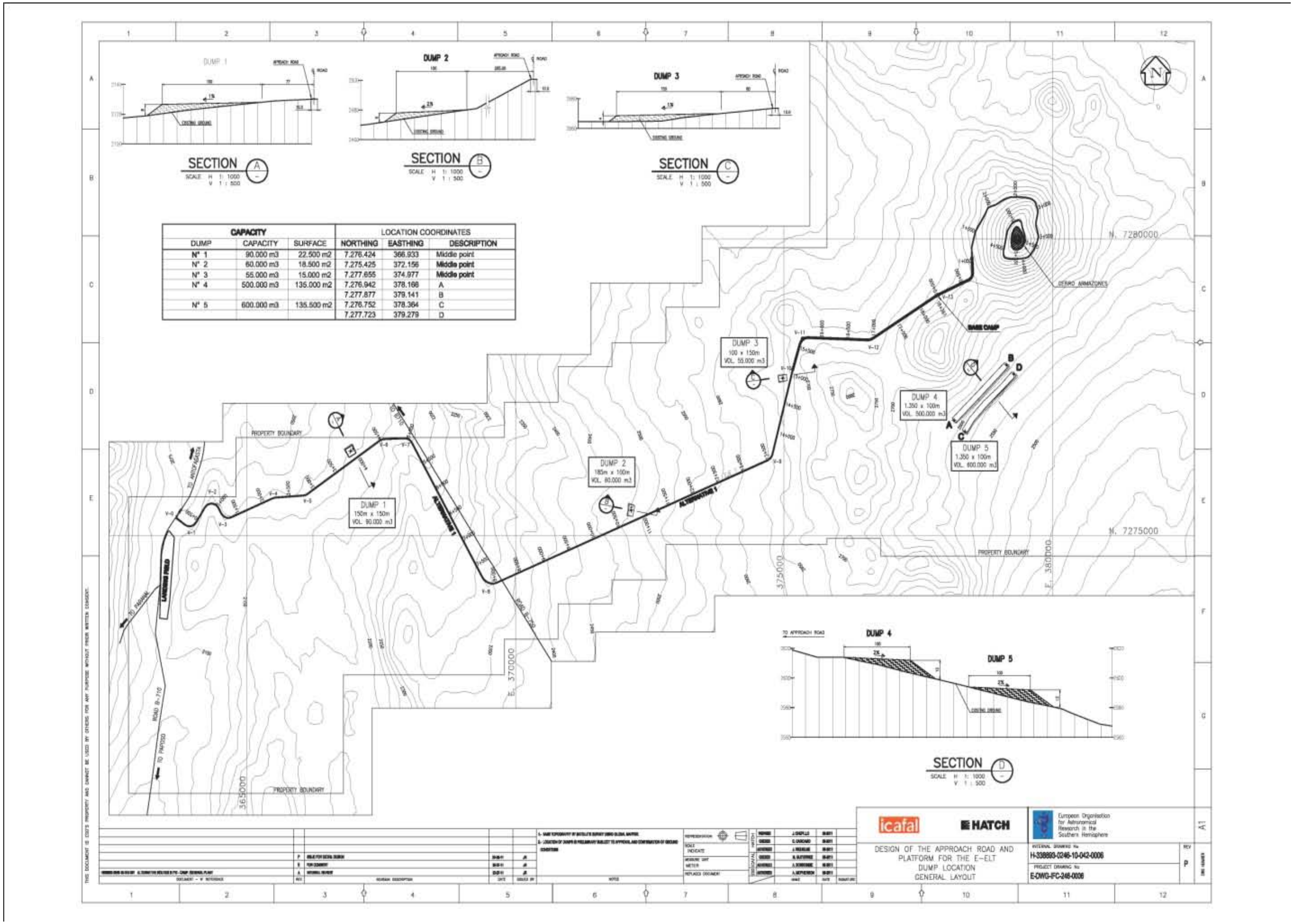
Dome – Fly Through

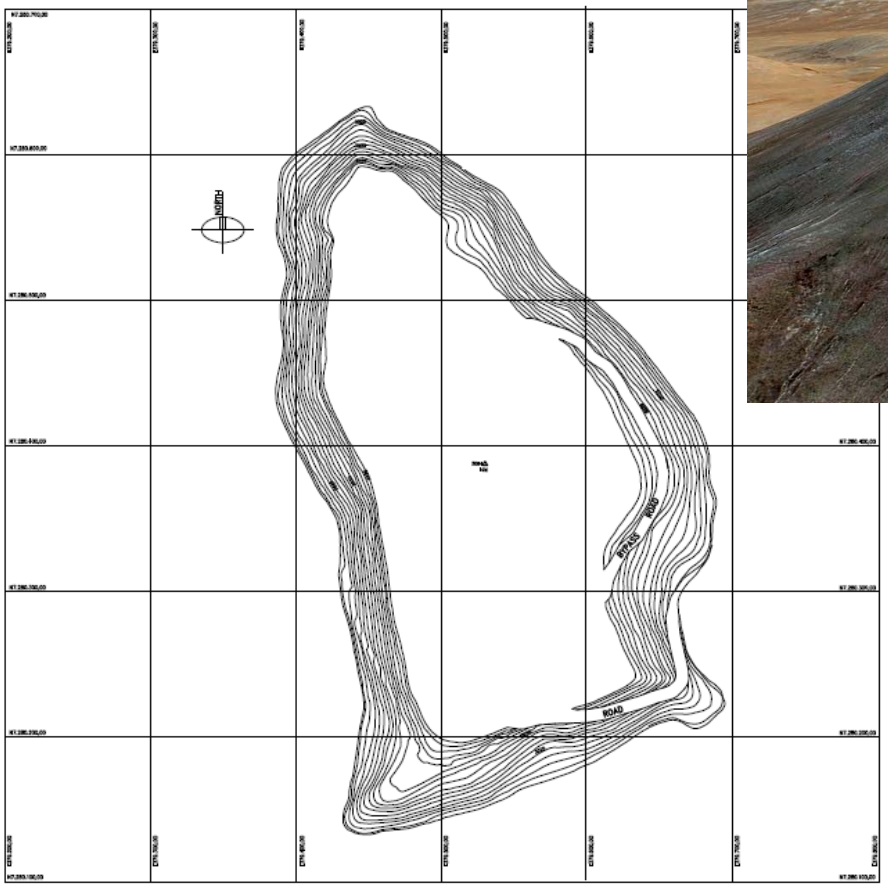


Areas of Interest for Industry

- Electronics and IT
  - Detectors
  - Control Electronics
  - Safety & Interlocks
  - Software
  - IT Hardware
- Infrastructure
  - Stand-by Power Generation
  - Coating Plant for 1.4m segments
  - Coating facility for large mirrors (4m diameter)
  - Handling equipment

Road


DUMP 1
DUMP 2
DUMP 3
SECTION A
SCALE H 1: 1000 V 1 : 500
SECTION B
SCALE H 1: 1000 V 1 : 500
SECTION C
SCALE H 1: 1000 V 1 : 500
CAPACITY
LOCATION COORDINATES
DUMP CAPACITY SURFACE NORTHING EASTHING DESCRIPTION
N° 1 90.000 m3 22.500 m2 7.276.424 366.933 Middle point
N° 2 60.000 m3 18.500 m2 7.275.425 372.156 Middle point
N° 3 55.000 m3 15.000 m2 7.277.655 374.977 Middle point
N° 4 500.000 m3 135.000 m2 7.276.942 378.166 A
7.277.877 379.141 B
N° 5 600.000 m3 135.500 m2 7.276.752 378.364 C
7.277.723 379.279 D
N. 7280000
N. 7275000
CERRO ARMAZONES
BASE CAMP
DUMP 3 100 x 150m VOL. 55.000 m3
DUMP 4 1.350 x 100m VOL. 500.000 m3
DUMP 5 1.350 x 100m VOL. 600.000 m3
DUMP 2 185m x 100m VOL. 60.000 m3
DUMP 1 150m x 150m VOL. 90.000 m3
PROPERTY BOUNDARY
LANDING FIELD
ROAD B-710
TO PAPOSO
TO ANTOFAGASTA
365000
370000
375000
E. 380000
DUMP 4
DUMP 5
SECTION D
SCALE H 1: 1000 V 1 : 500
icafal
HATCH
European Organisation for Astronomical Research in the Southern Hemisphere
DESIGN OF THE APPROACH ROAD AND PLATFORM FOR THE E-ELT
DUMP LOCATION
GENERAL LAYOUT
E-DWG-IFC-246-0006


NORTH
ROAD
ROAD

Areas of Interest for Industry

- Mechanical Engineering
  - Steel Structures
  - Actuation & Metrology
- Civil Engineering
  - Dome civil construction
  - Civil Works
  - Roads & Infrastructure
  - Consultancy
- Optics
  - Small Optics
  - Large Optics
  - Coatings

E-ELT Primary Mirror Segment Support

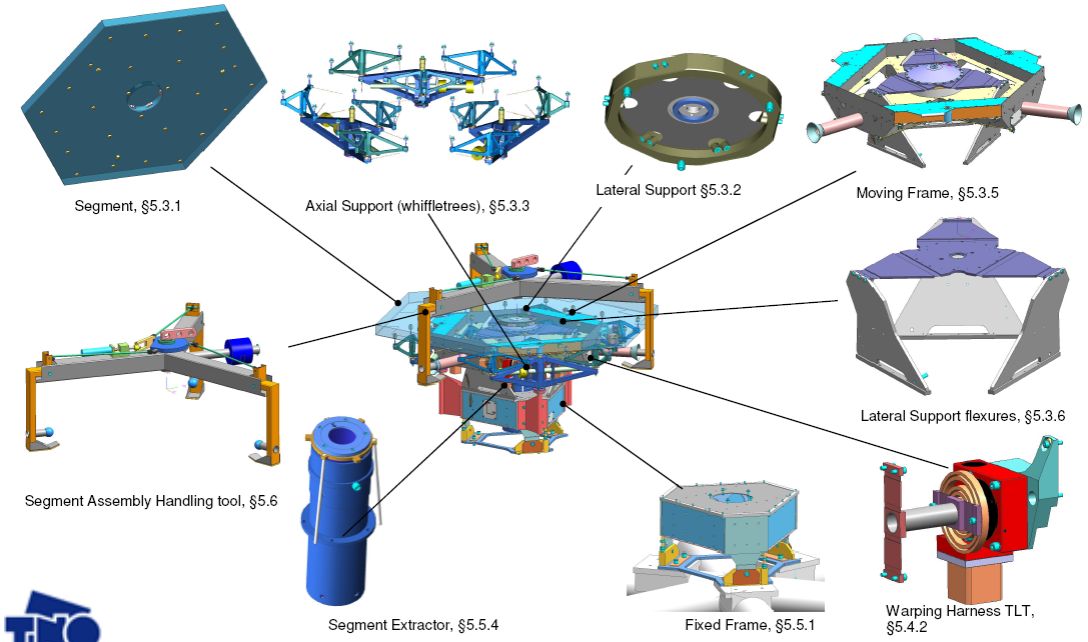
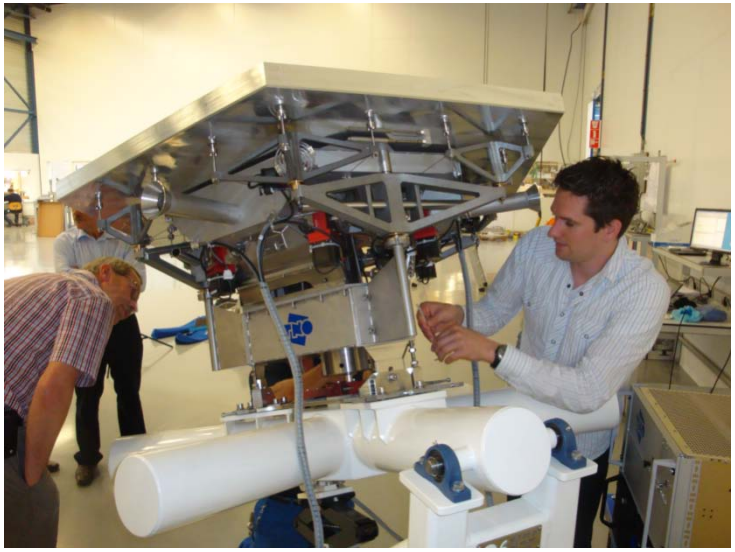
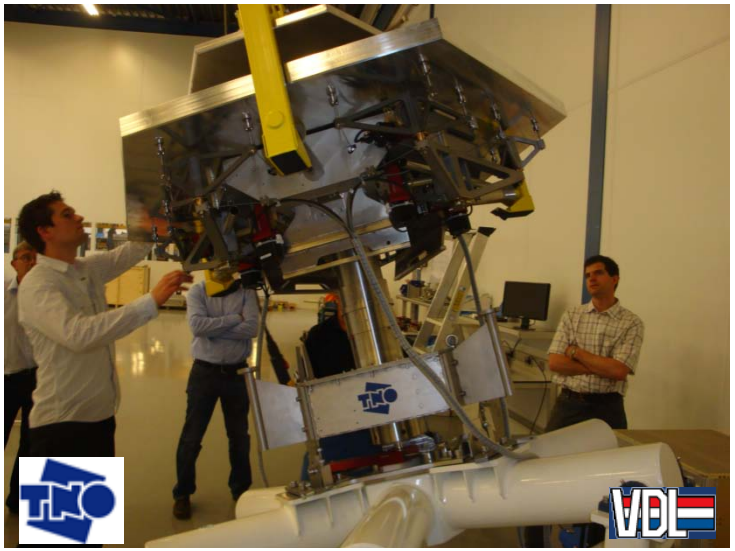


figure 3: Overview of main subassemblies

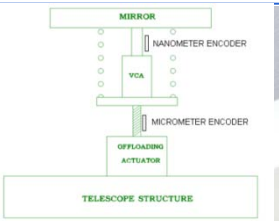


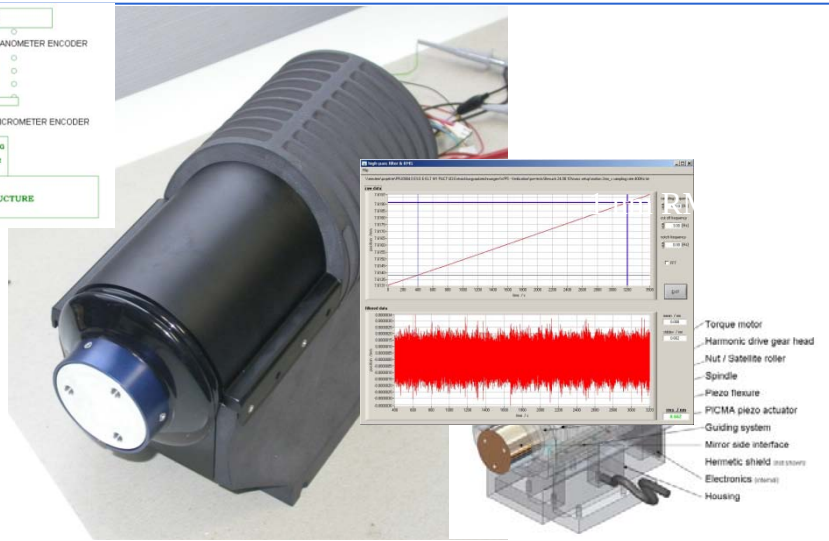


M1 Position actuators

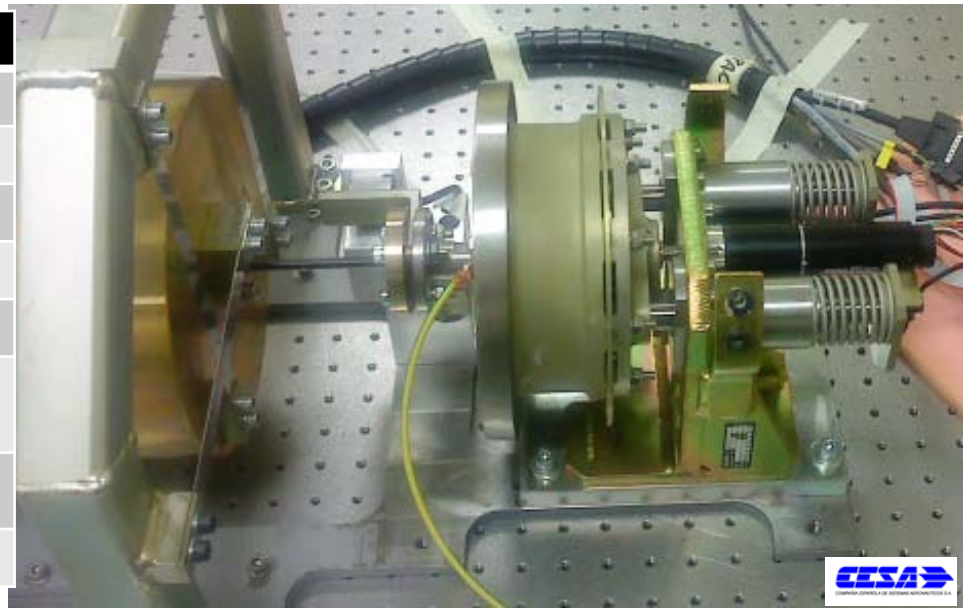
Position Actuators

- Soft, 2 stage actuator
- Coarse Stage : brushless motor, gear box, lead screw
  2 axial guides - Micron precision encoder – 15 mm stroke
- Fine Stage : voice coil actuator, two leaf springs
  Nanometer precision encoder – +/- 5 micron stroke
  typical





Requirement	Unit	Spec
Stroke	mm	15
Stiffness [in 0-4 Hz range]	N/micron	12
Positioning error, tracking	nm RMS	1.7
Tracking velocity	µm / s	+/- 10
Slewing velocity	µm / s	+/- 250
Power consumption, average Including electronics	W	< 2
Mass	kg	< 10
Bandwidth, update rate	Hz	30, 1000



M1 Edge Sensors

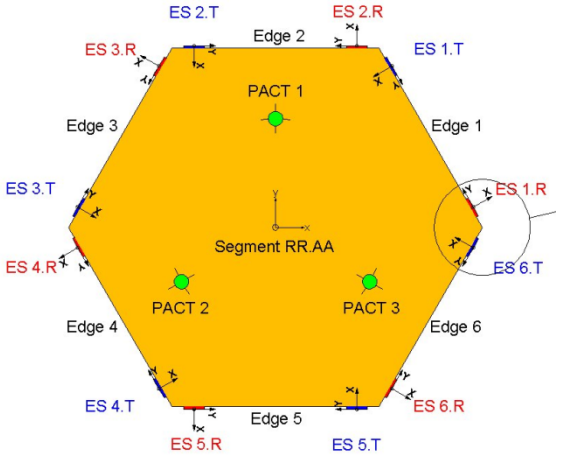
FOGALE nanotech

Edge Sensors

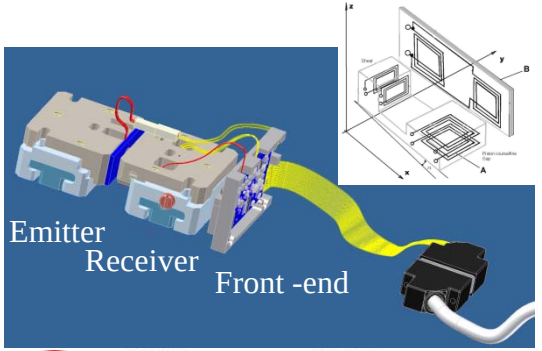
- 6 Emitters + 6 Receivers per Segment
- Inductive sensing technology :

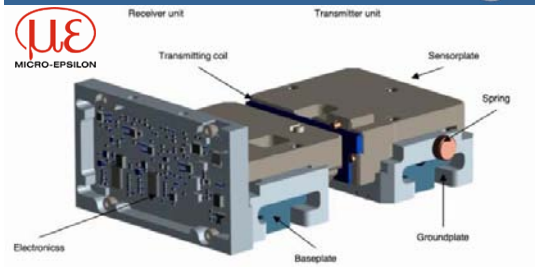
Emitter & receiver Silver-palladium coils embedded in ceramic (Boron Nitride)

- Mechanics : casted low CTE Boron Nitride ceramic (metal free)
- Embedded low power (0.5W) front-end electronics for signal modulation, detection and digitization



Requirement	Piston		Gap & Shear
	Catching range	Measuring range	Measuring range
Range	± 1 mm	± 200 µm	± 1 mm
Linearity	1 ±10 %	1 ±1 % (over ≤100 nm)	1 ±1 % (over ≤1 mm)
Noise	-	**≤ 1 nm/√(Hz) [goal 0.2]**	≤ 1 µm/√(Hz)
Drift	-	< 10 nm/week [goal 2 nm]	< 10 µm/week [goal 2 µm]
Temperature sensitivity	-	ΔP/ΔT ≤ 5 nm/°C	ΔG(S)/ΔT ≤ 5 µm/°C
Humidity sensitivity	-	ΔP/ΔRH ≤ 10 nm/50%	ΔG(S)/ΔRH ≤ 10 µm/50%
Power dissipation	0.5 W / sensor max		

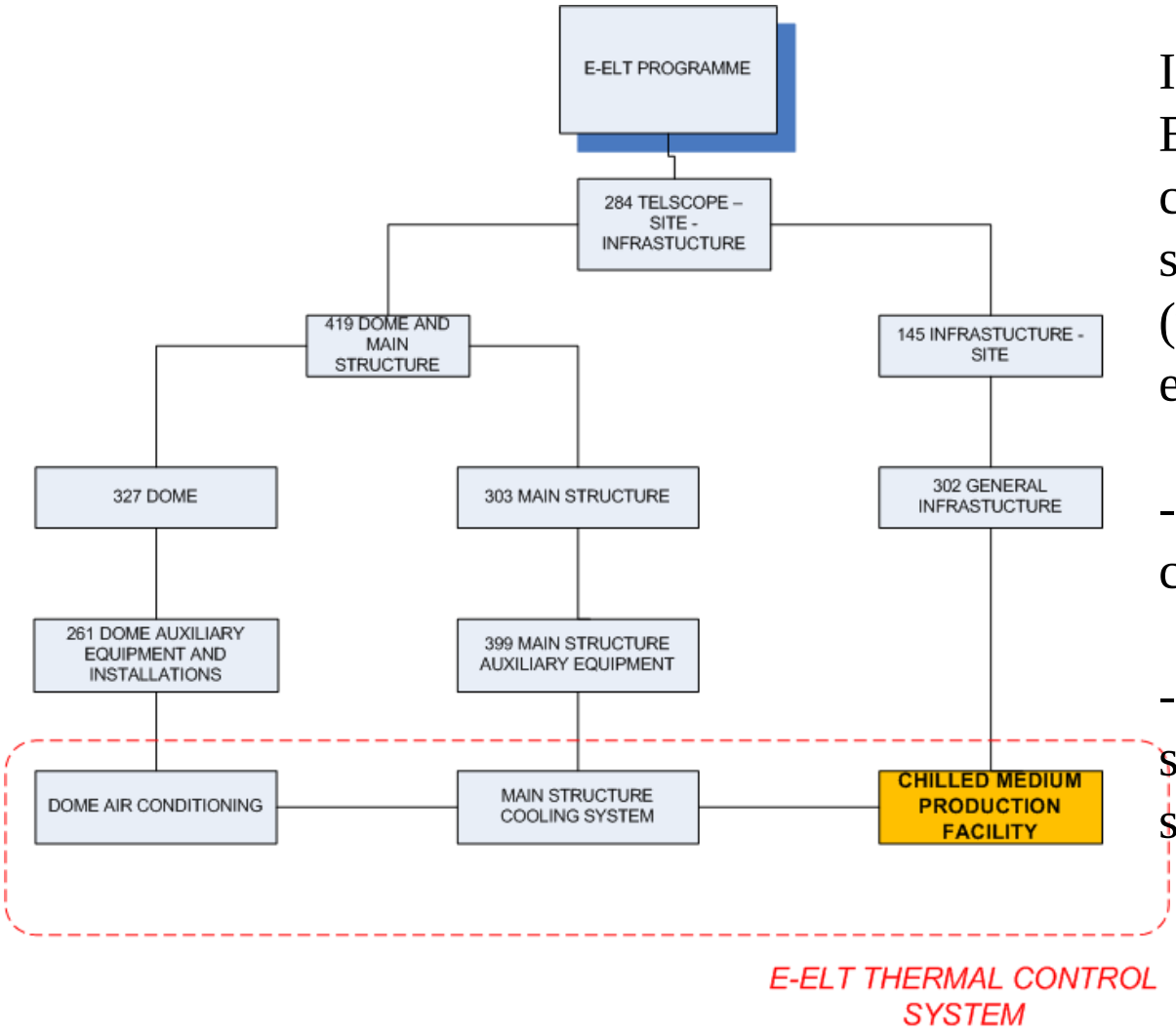




Areas of Interest for Industry

- Cryogenics & HVAC
  - Cryogenic storage and handling
  - Compressors & Cooling Engines
  - Vacuum Equipment

CHILLED MEDIUM PRODUCTION FACILITY



It forms part of the E-ELT thermal control system by supplying cold fluid (water + ethylenglycol) to:

-Dome air conditioning system

- Telescope Main structure cooling system

E-ELT CHILLED FLUID DEMAND

Dome maximum demand	2700 kw
Dome normal demand during day	900 kw
Dome normal demand during observation	400 kw
Telescope normal demand during day	710 kw
Telescope normal demand during observation	1175 kw
Normal demand during day for dome and telescope	1610 kw
Normal demand during observation for dome and telescope	1575 kw
Maximum demand for dome and telescope (maximum capacity of the chiller plant)	3410 kw (650 m3/h fluid)

Up-coming Contracts

- Final Design and Construction of Dome & Main Structure
- Procurement of 6000 Edge Sensors
- Procurement of 900 Segment Support Structures
- Procurement of Control DDS Middleware
- Procurement of Verification and Validation Services
- Procurement of QA Services
- Procurement of temporary generators
- Procurement of Chillers


Questions