



E-ELT Overview



Roberto Tamai for Alistair McPherson PM E-ELT



Science drivers

• Planets in other stellar systems

- Imaging *and* spectroscopy
- *The quest for Earth-like exo-planets*

• Stellar populations

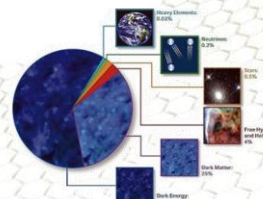
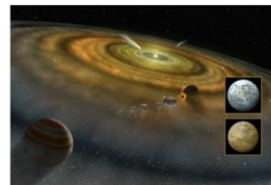
- In galaxies inaccessible today (e.g. ellipticals in Virgo cluster)
- Across the whole history (i.e. extent) of the Universe

• Cosmology

- The first stars/galaxies
- Direct measure of acceleration
- Evolution of cosmic parameters
- Dark matter, dark energy
- Tests of GR around black holes

• The unknown

- Open new parameter space





Science → Requirements

- **Diameter: $\geq 39\text{m}$ (area $\geq 1000\text{ m}^2$)**
 - Alt-Az, F/15 to F/18, fully steerable (0-360,0-90). Operational ZD: 0-70
- **Adaptive telescope**
 - GLAO correction ($\geq 5\text{ arcmin}$, 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 $>0.35\text{ }\mu\text{m}$, $>60\%$ at $>0.4\text{ }\mu\text{m}$, $>70\%$ at $0.7\text{ }\mu\text{m}$, $>80\%$ at $>1\text{ }\mu\text{m}$
- **Focal stations**
 - Two Nasmyth (multiple instruments, including gravity invariant option)
 - At least one Coudé
 - Fixed instrumentation (fast switching: $< 10\text{ min}$ same focus, < 20 otherwise)



Where ?

- Cerro Armazones, 2800 m, 25 km from Cerro Paranal [VLT]

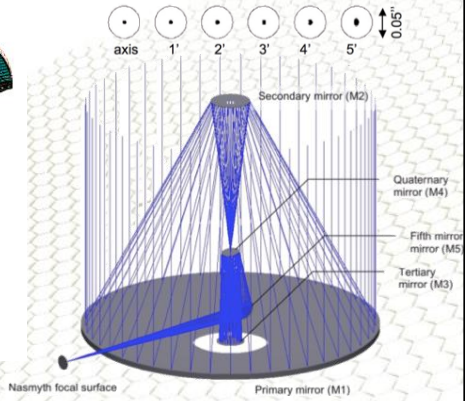
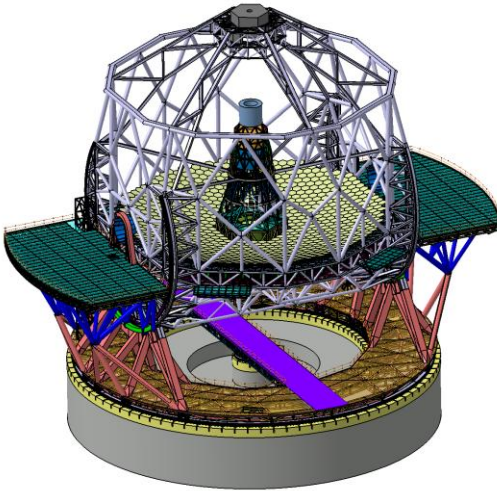




The E-ELT: overview

Optical design

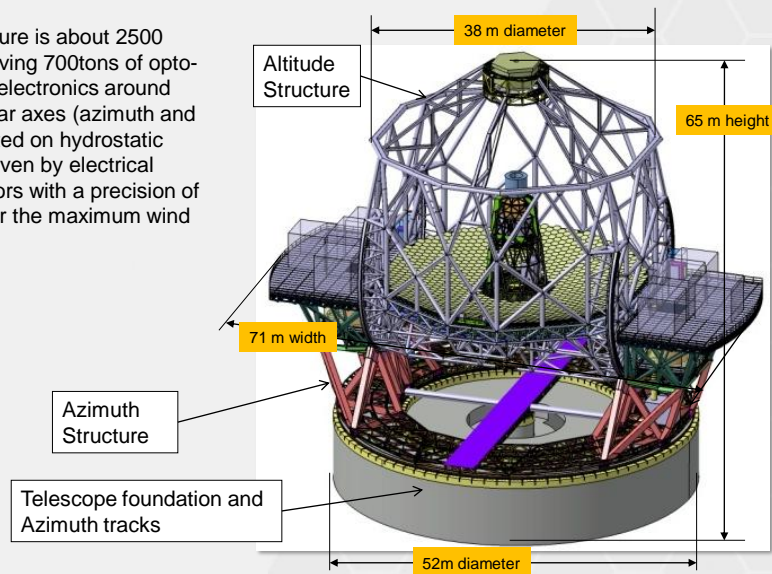
- 3-mirror anastigmat on axis + 2 flats
- diffraction limited over full 10' FoV
- Nasmyth, gravity invariant, coudé foci
- very low LGS wavefront aberrations



Main Structure Design

General Overview

The Main Structure is about 2500 tons of steel moving 700 tons of optomechanics 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.

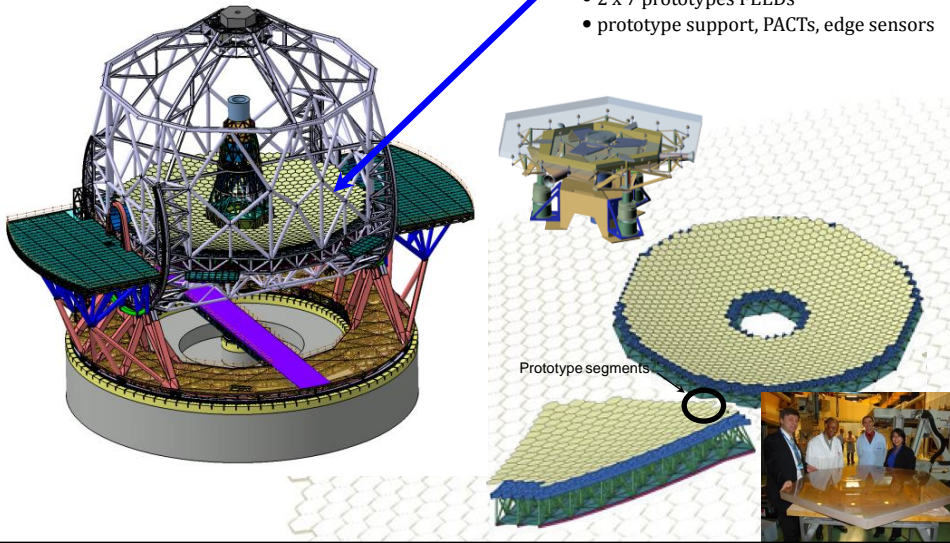




The E-ELT: overview

39m Primary Mirror

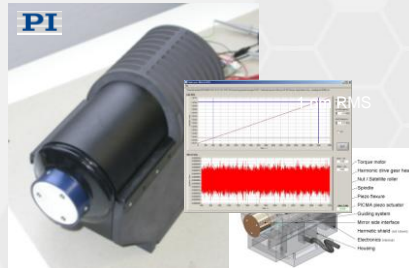
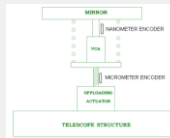
- 786 segments mirror +1/family
- 2 x 7 prototypes FEEDs
- prototype support, PACTs, edge sensors



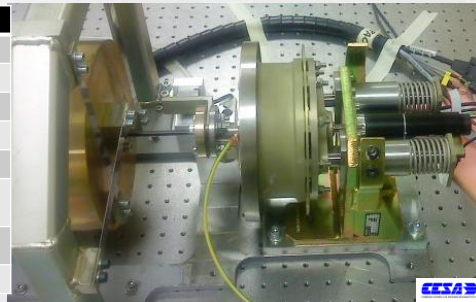
M1 Position actuators

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	$\mu\text{m} / \text{s}$	+/- 10
Slewing velocity	$\mu\text{m} / \text{s}$	+/- 250
Power consumption, average Including electronics	W	< 2
Mass	kg	< 10
Bandwidth, update rate	Hz	30, 1000



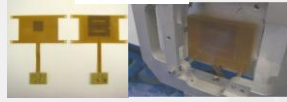


FOGALE nanotech

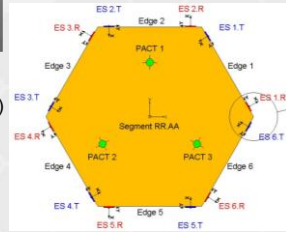
M1 Edge Sensors

Edge Sensors

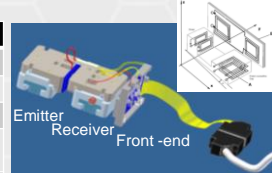
- 6 Emitters + 6 Receivers per Segment
- Inductive sensing technology :
Emitter & receiver Silver-palladium coils embedded in ceramic (Boron Nitride)
- Mechanics : casted low CTE Boron Nitride ceramic (metal free)
- Embedded low power (0.5W) front-end electronics for signal modulation, detection and digitization



Alternative : coils engraved in Zerodur



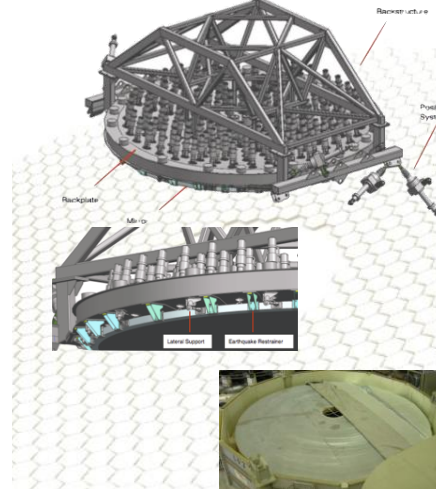
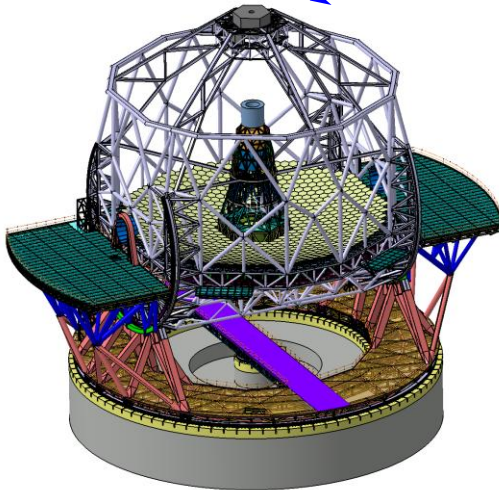
Requirement	Piston		Gap & Shear
	Catching range	Measuring range	Measuring range
Range	± 1 mm	± 200 μ m	± 1 mm
Linearity	1 ± 10 %	1 ± 1 % (over ≤ 100 nm)	1 ± 1 % (over ≤ 1 mm)
Noise	-	≤ 1 nm/ $\sqrt{\text{Hz}}$ [goal 0.2]	≤ 1 μ m/ $\sqrt{\text{Hz}}$
Drift	-	< 10 nm/week [goal 2 nm]	< 10 μ m/week [goal 2 μ m]
Temperature sensitivity	-	$\Delta P/\Delta T \leq 5$ nm/ $^{\circ}\text{C}$	$\Delta G(S)/\Delta T \leq 5$ μ m/ $^{\circ}\text{C}$
Humidity sensitivity	-	$\Delta P/\Delta RH \leq 10$ nm/50%	$\Delta G(S)/\Delta RH \leq 10$ μ m/50%
Power dissipation	0.5 W / sensor max		



The E-ELT: overview

4m Secondary Mirror

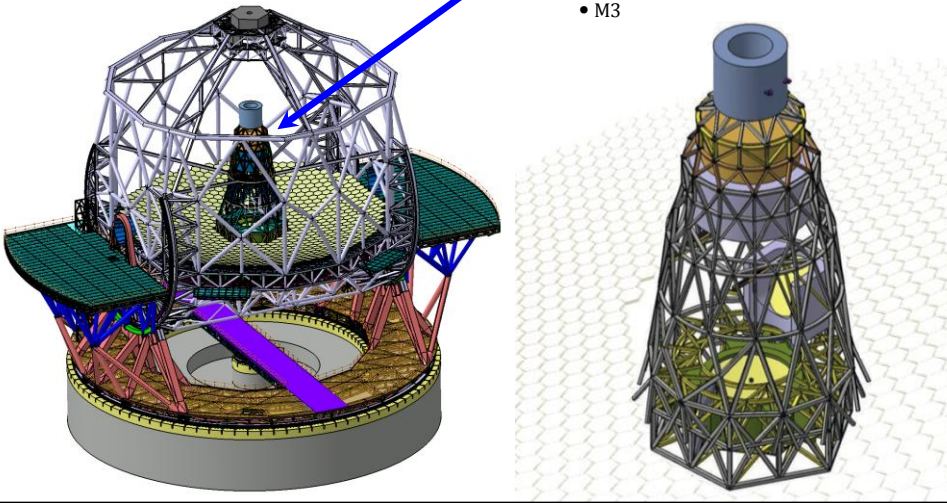
- M2 unit FEED
- 3 polishing studies
- prototype actuators



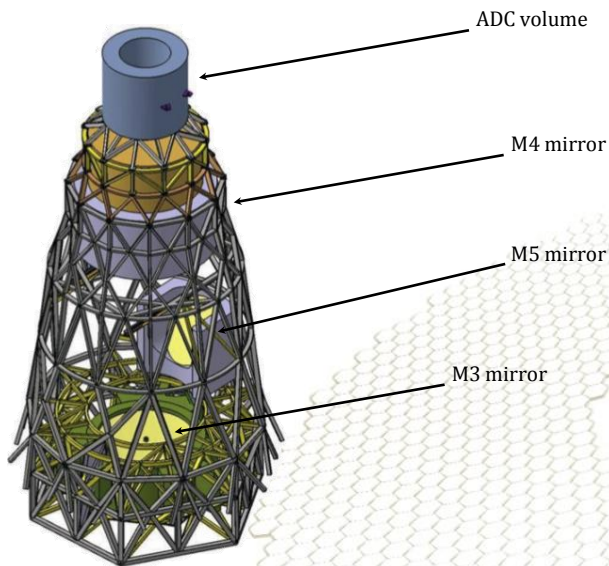


The E-ELT: overview

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

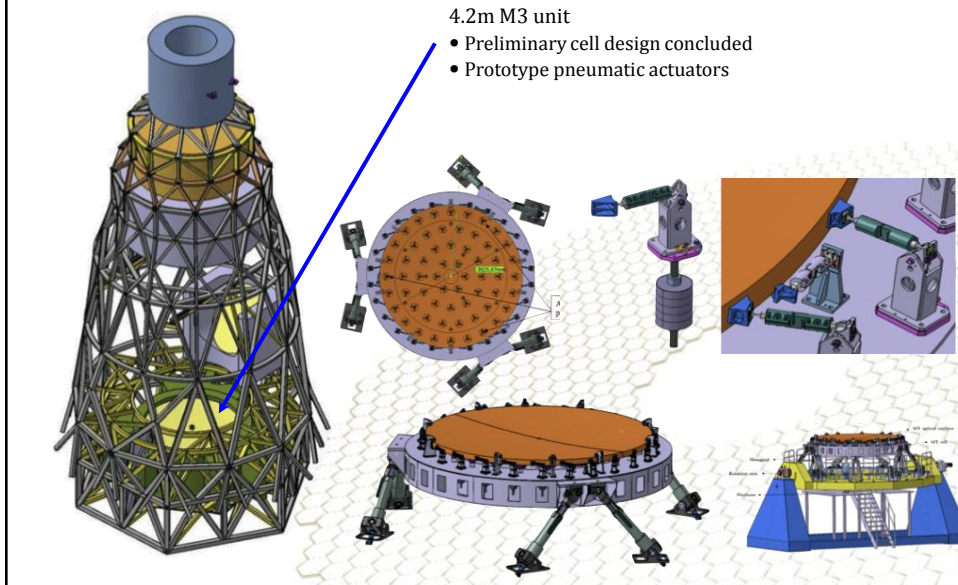


The E-ELT: overview

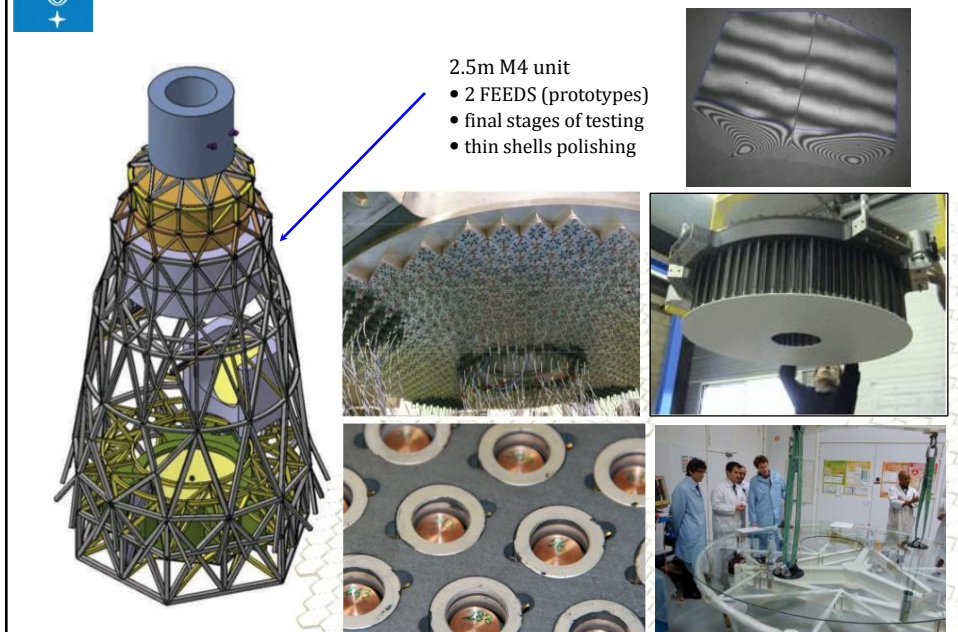




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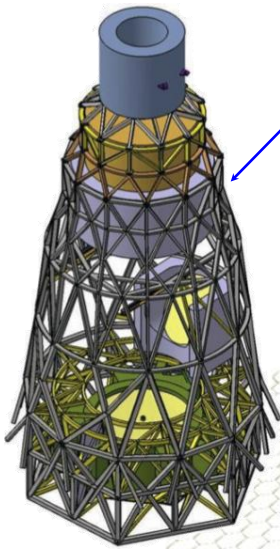


The E-ELT: overview





The E-ELT: overview



- 2.4m x 3m M5 unit
- scale-1 electromechanical prototype FEED
 - final stages of testing
 - 4 mirror polishing studies (including heavy option)



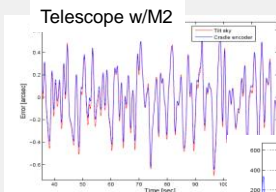
M5 Unit

Tip/Tilt flat mirror 3.0 x 2.5 m

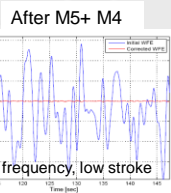
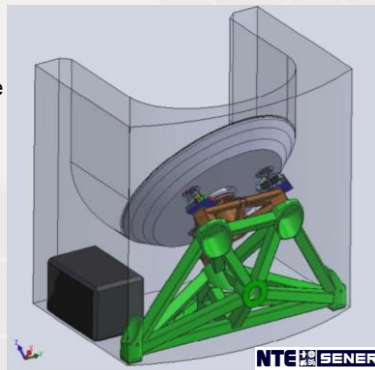
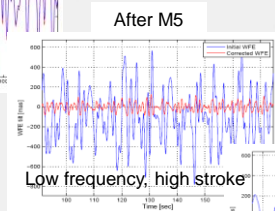
Incoming disturbance with 1" rms residual tip tilt

- 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

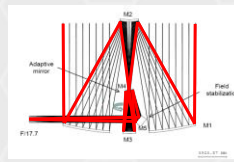


Remaining tip tilt < 1" rms



Low frequency, high stroke

High frequency, low stroke

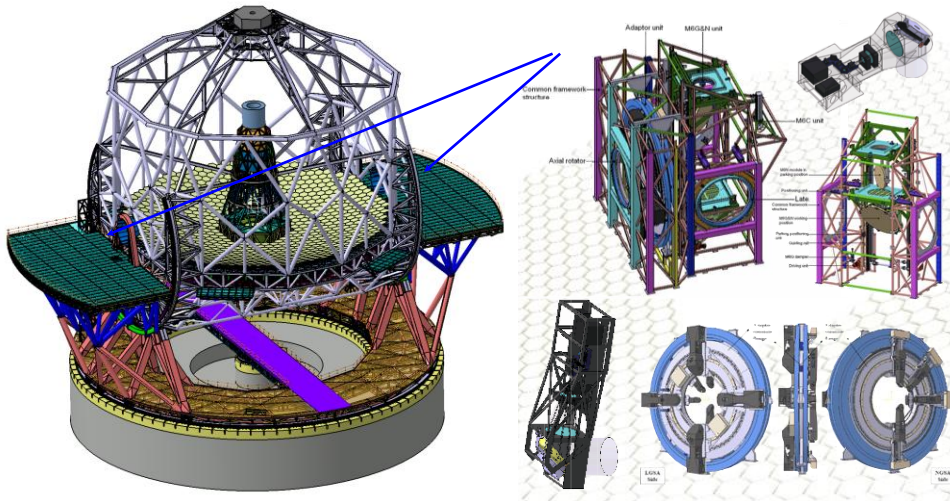




The E-ELT: overview

Prefocal station

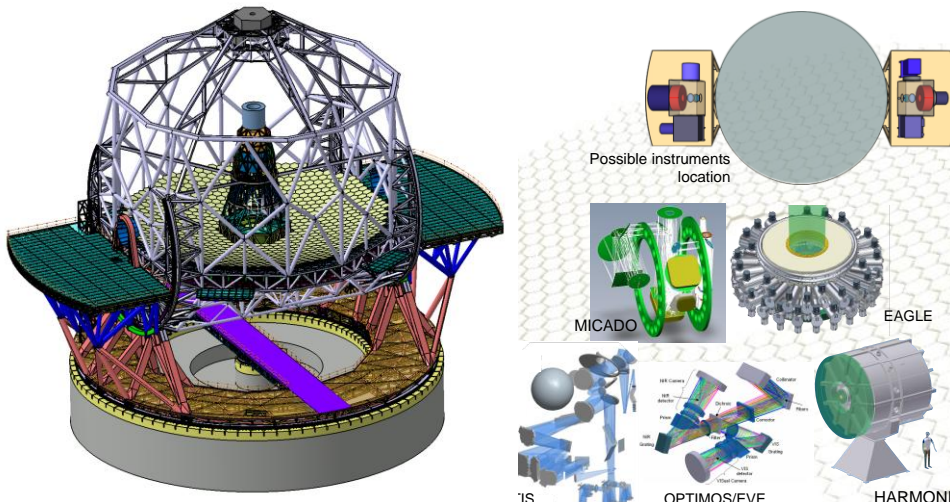
- preliminary design concluded



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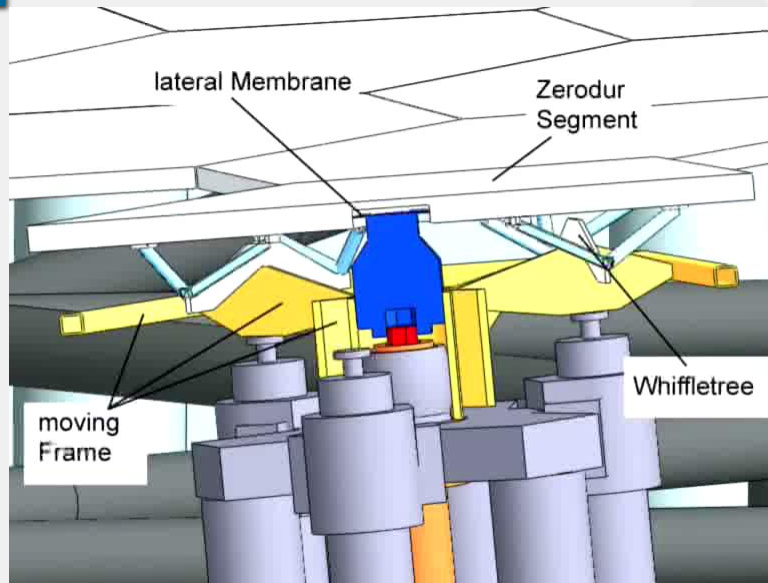
Instrumentation

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





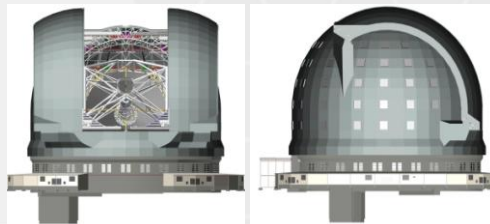
M1 Segment Handling



Dome Scope

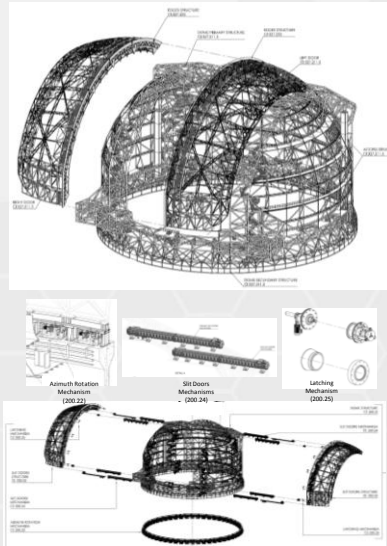
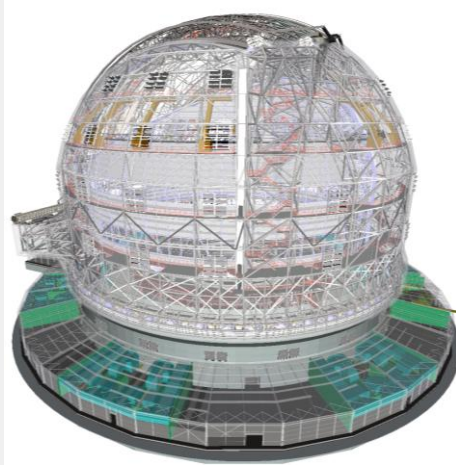
Dome contains:

- 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

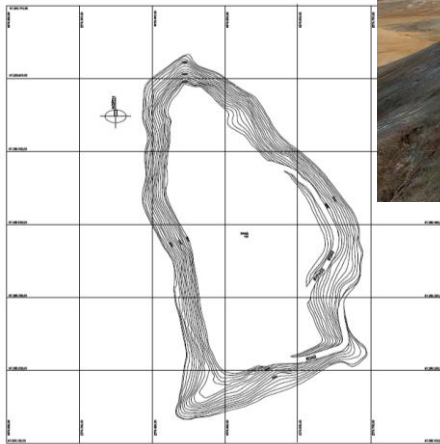
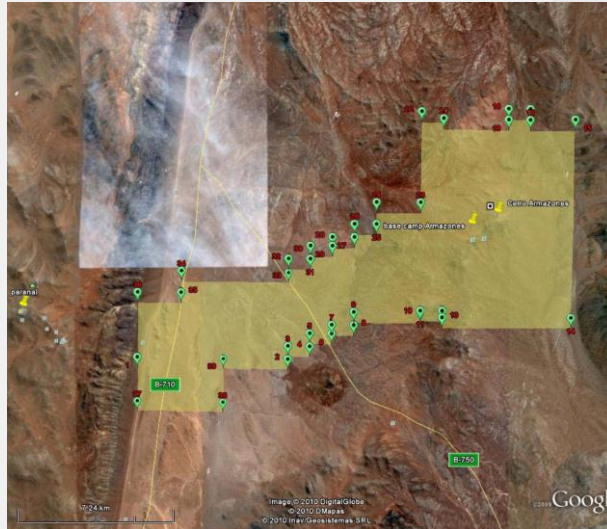


Areas of Interest for Industry

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



Route of 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



Areas of Interest for Industry

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



Up-coming Contracts

- Road Construction And Platform Preparation
- Final Design and Construction of Dome
- Final Design and Construction of Main Structure
- Procurement of 6000 Edge Sensors
- Procurement of 3000 Primary Mirror Segment Actuators
- Procurement of Power Supply



Questions

Roberto Tamai for Alistair McPherson PM E-ELT