



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

Component	Percentage
Dark Energy	68%
Dark Matter	26%
Ordinary Matter	5%



Science → Requirements

- **Diameter:** $\geq 42\text{m}$ (area $\geq 1200\text{ m}^2$)
 - 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)



E-ELT Programme

Where ?

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



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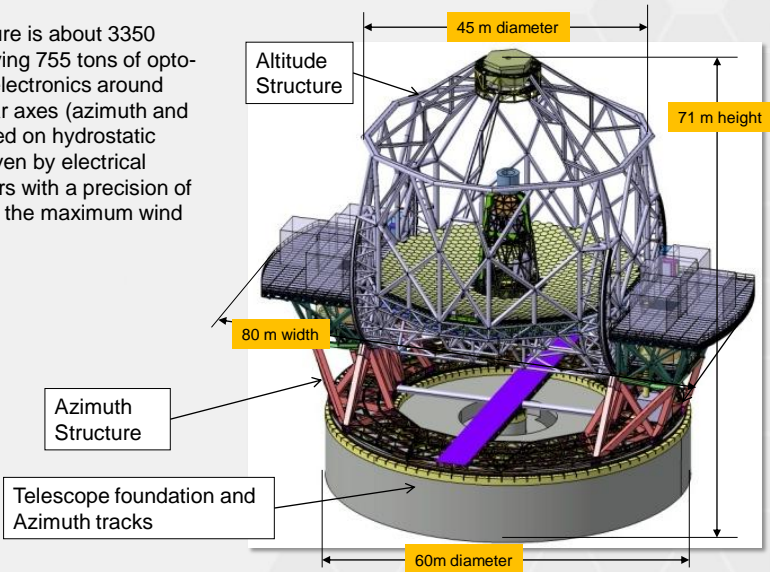


E-ELT Programme

Main Structure Design

General Overview

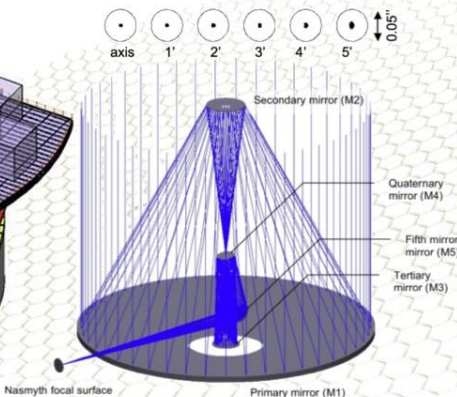
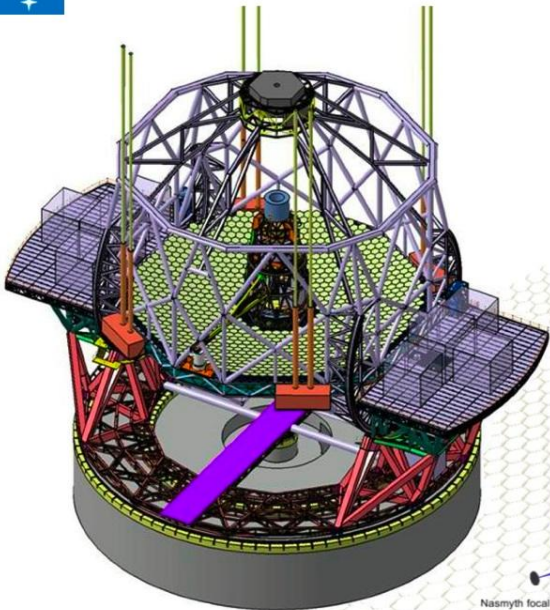
The Main Structure is about 3350 tons of steel moving 755 tons of opto-mechanics and electronics around two perpendicular axes (azimuth and altitude) supported on hydrostatic bearings and driven by electrical direct drive motors with a precision of 0.3 arcsec under the maximum wind disturbance.

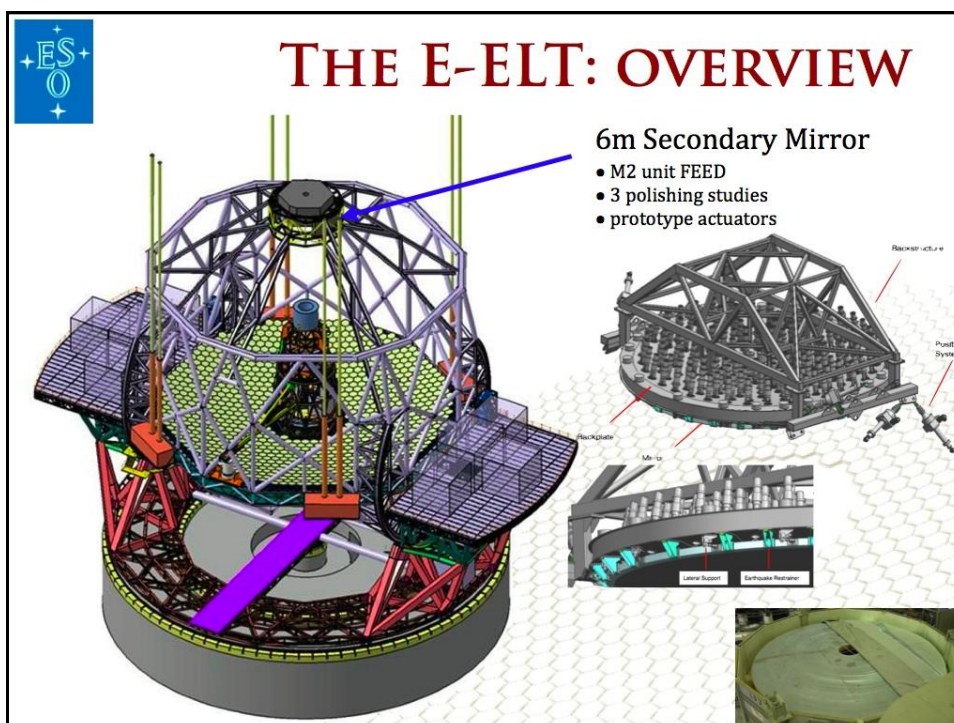
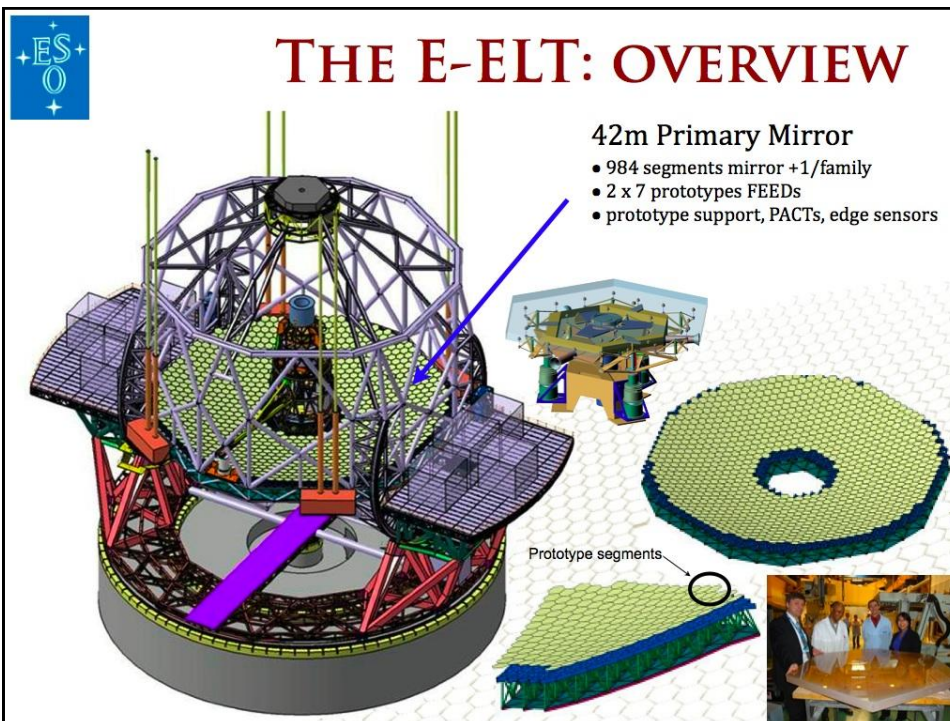


THE E-ELT: OVERVIEW

Optical design

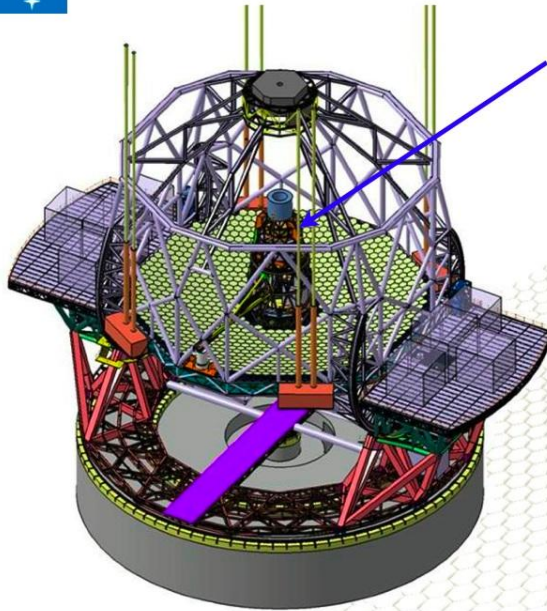
- 3-mirror anastigmat on axis + 2 flats
- diffraction limited over full 10' FoV
- Nasmyth, gravity invariant, coudé foci
- very low LGS wavefront aberrations





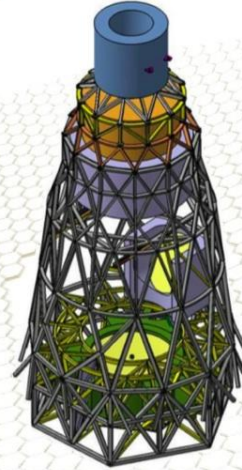


THE E-ELT: OVERVIEW

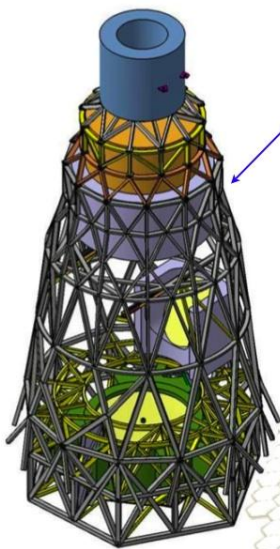


Central tower

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

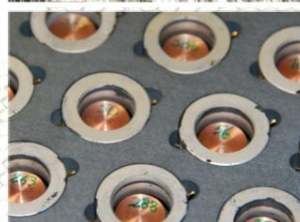
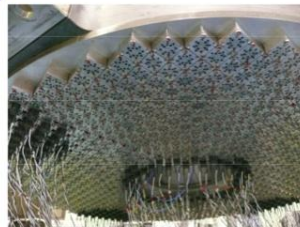
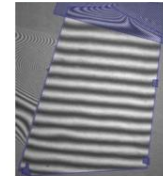


THE E-ELT: OVERVIEW



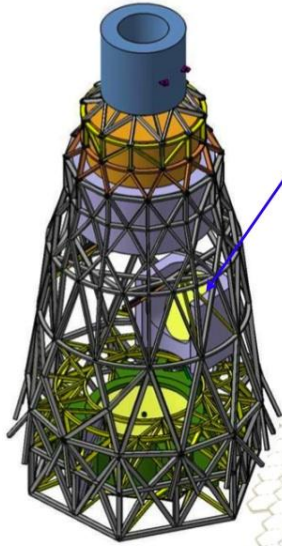
2.5m M4 unit

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





THE E-ELT: OVERVIEW

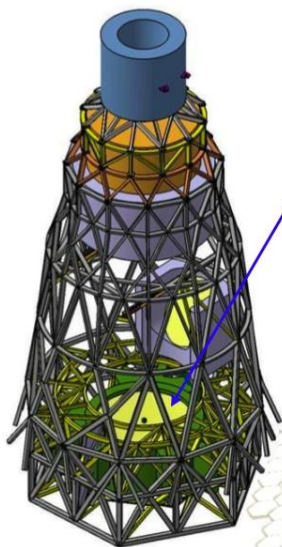


2.4m x 3m M5 unit

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

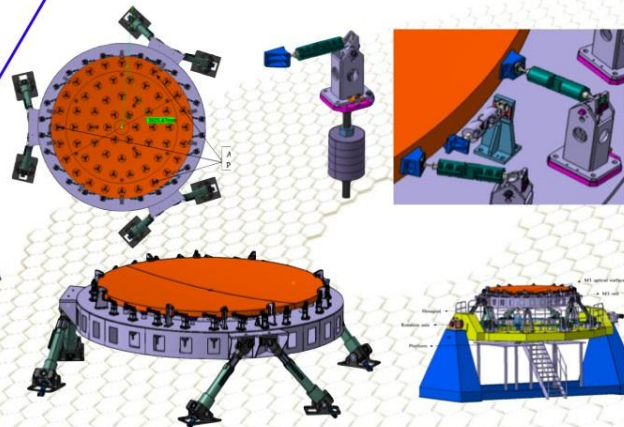


THE E-ELT: OVERVIEW



M3 unit

- Preliminary cell design concluded
- Prototype pneumatic actuators



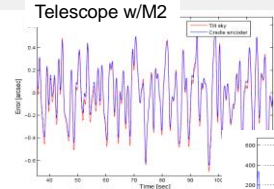


M5 Unit

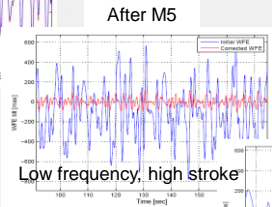
Tip/Tilt flat mirror 3.0 x 2.5 m

- 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

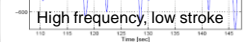
Telescope main axes control



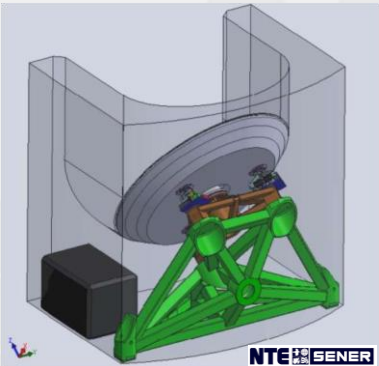
Remaining tip tilt < 1" rms



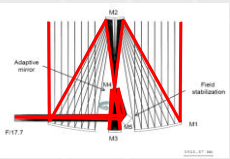
Low frequency, high stroke



High frequency, low stroke



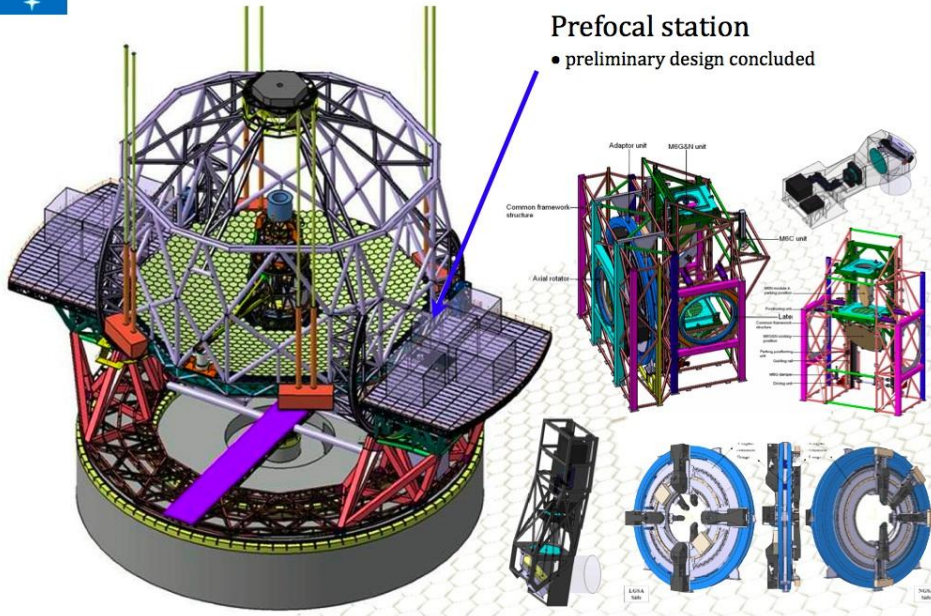
After M5+ M4

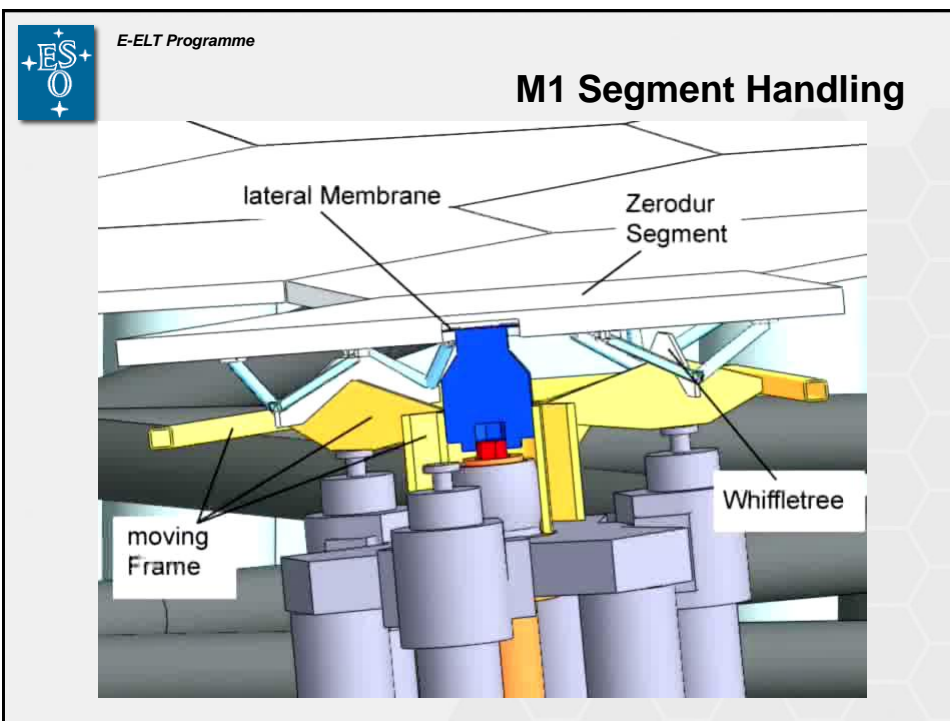
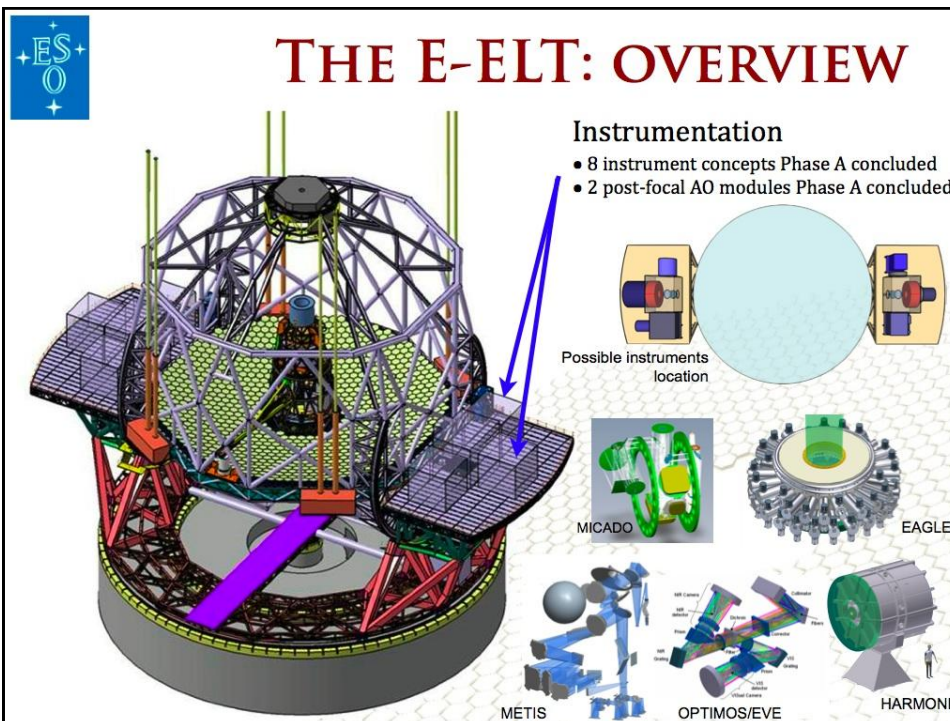


THE E-ELT: OVERVIEW

Prefocal station

- preliminary design concluded



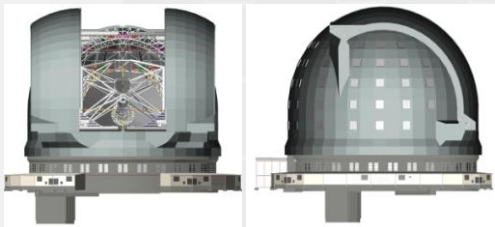




Scope

Dome contains:

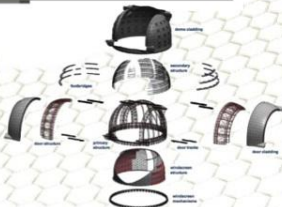
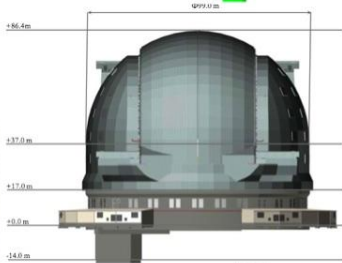
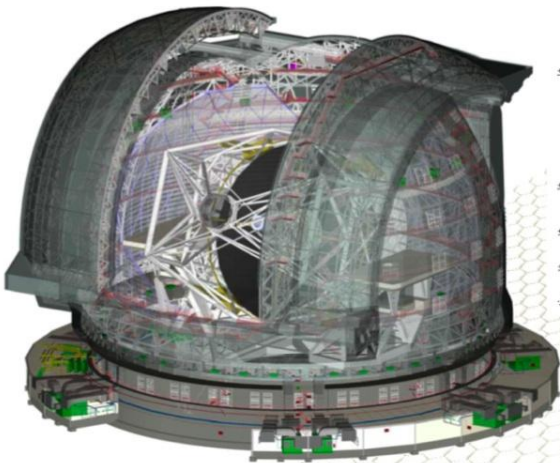
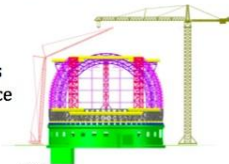
- the primary and secondary steel structures
- the concrete foundations for the dome and the main structure
- all mechanisms for the rotation and operation
- louvers, windscreen, ventilation and air-conditioning
- storage areas required within the dome and general access facilities such as staircases, 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.



THE E-ELT: OVERVIEW

Dome

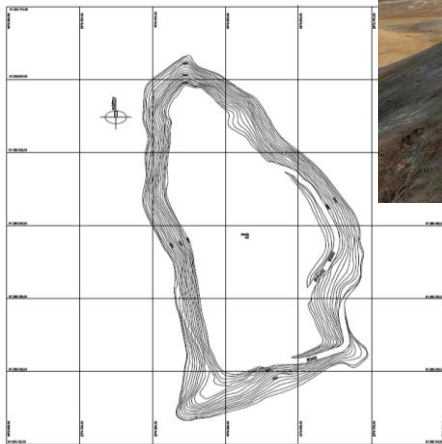
- 2 FEED contracts
- Erection sequence







E-ELT Programme



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E-ELT Programme

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

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Areas of Interest for Industry

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

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Up-coming Contracts

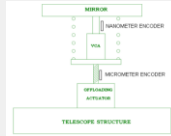
- Road Construction And Platform Preparation
- Final Design and Construction of Dome
- Final Design and Construction of Main Structure
- Procurement of 6000 Edge Sensors
- Procurement of 3000 Primary Mirror Segment Actuators

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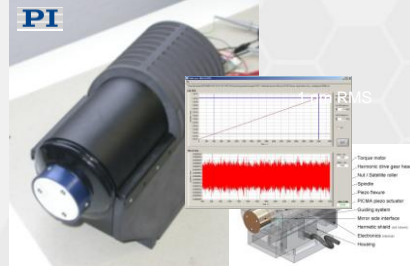


Position Actuators

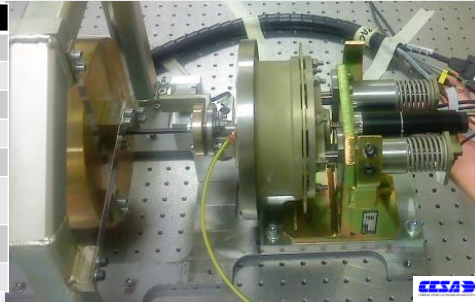
- Soft, 2 stage actuator
- Coarse Stage : brushless motor, gear box, lead screw
2 axial guides - Micron precision encoder – 15 mm stroke
- Fine Stage : voice coil actuator, two leaf springs
Nanometer precision encoder – +/- 5 micron stroke
typical



M1 Position actuators

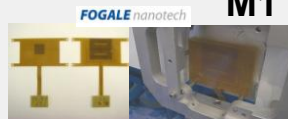


Requirement	Unit	Spec
Stroke	mm	15
Stiffness [in 0-4 Hz range]	N/micron	12
Positioning error, tracking	nm RMS	1.7
Tracking velocity	$\mu\text{m} / \text{s}$	+/- 10
Slewing velocity	$\mu\text{m} / \text{s}$	+/- 250
Power consumption, average Including electronics	W	< 2
Mass	kg	< 10
Bandwidth, update rate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

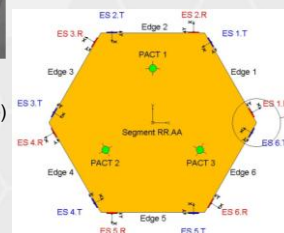


Edge Sensors

- 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



M1 Edge Sensors



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

