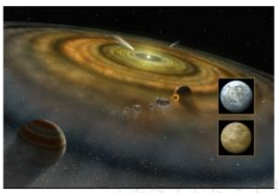
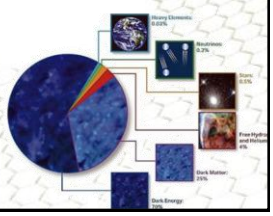
Science drivers

- **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



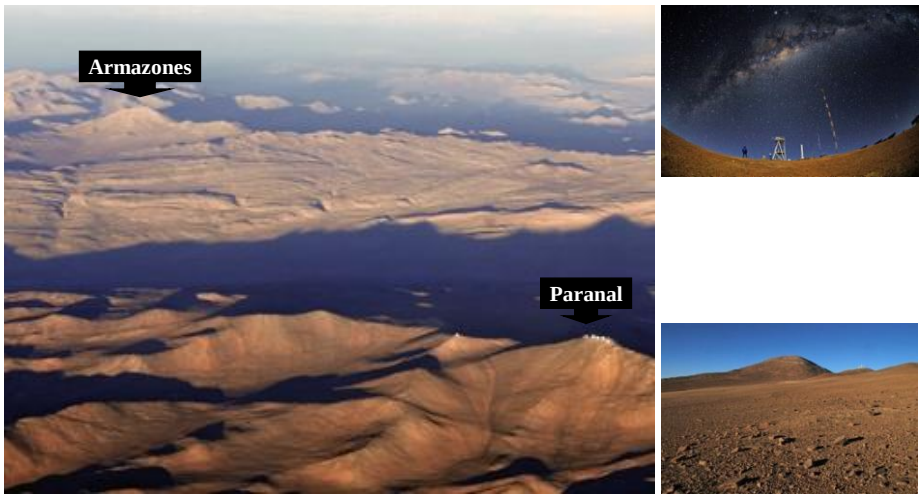



Science → Requirements

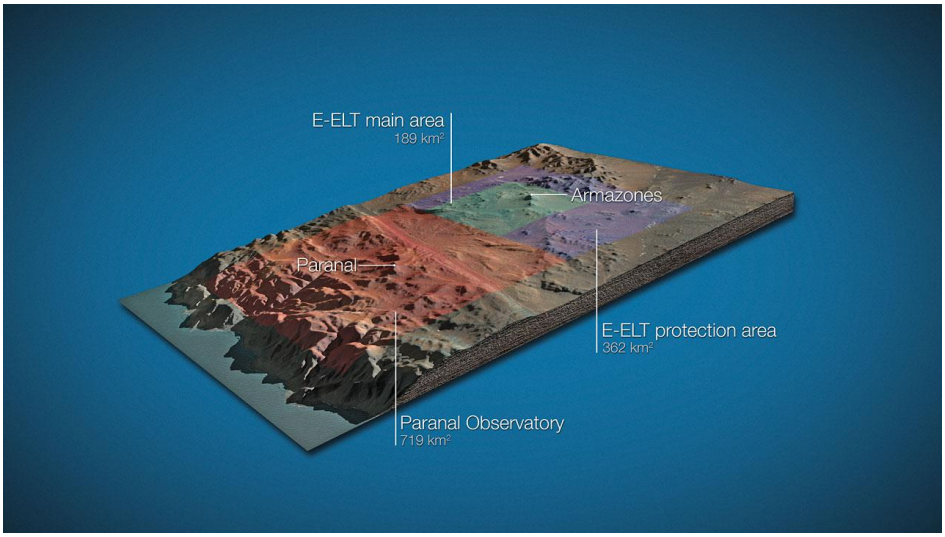
- **Diameter: ≥39m (area ≥ 1000 m^2)**
  - **Alt-Az, F/15 to F/18, fully steerable (0-360,0-90). Operational ZD: 0-70**
- **Adaptive telescope**
  - **GLAO correction (≥ 5 arcmin, 90% sky, 80% time)**
    - **better than 2x FWHM improvement for median seeing conditions**
  - **Post-focal: SCAO, MCAO, 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



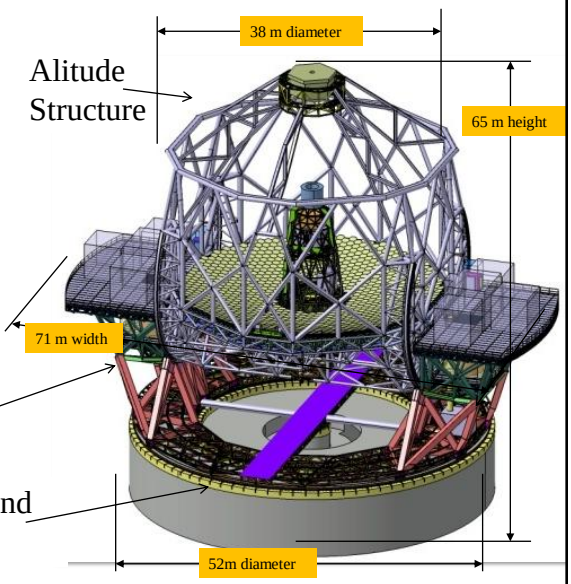
Location



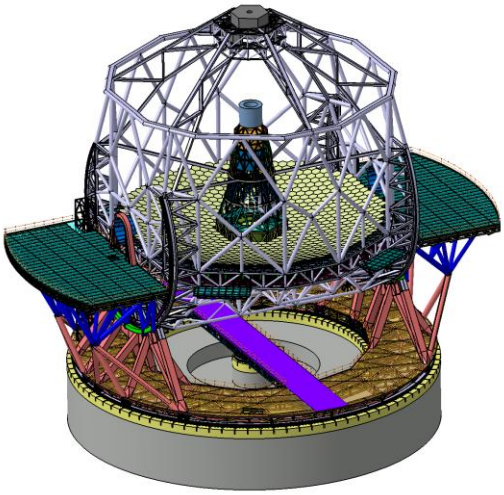
Main Structure Design

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

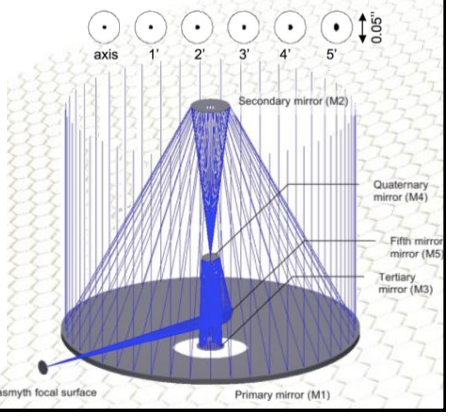


Optical design

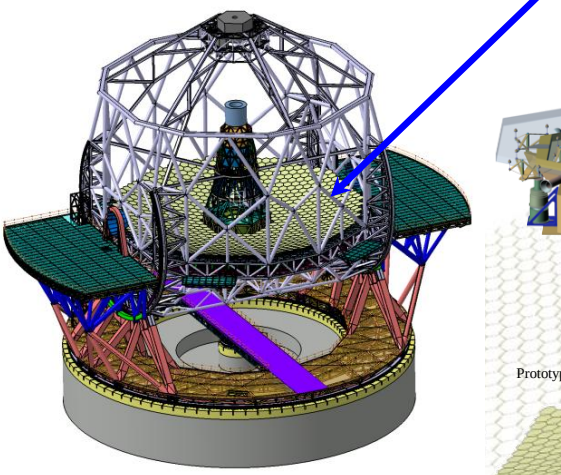
- 3-mirror anastigmat on axis + 2 flats
- diffraction limited over full 10′ FoV

Nasmyth, gravity invariant, coudé foci

- very low LGS wavefront aberrations

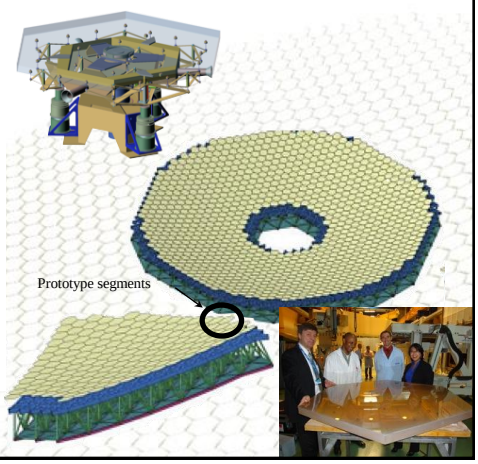


The E-ELT: overview



39m Primary Mirror

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



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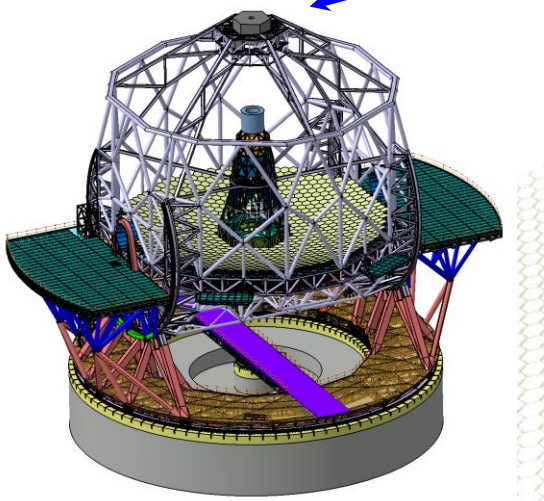
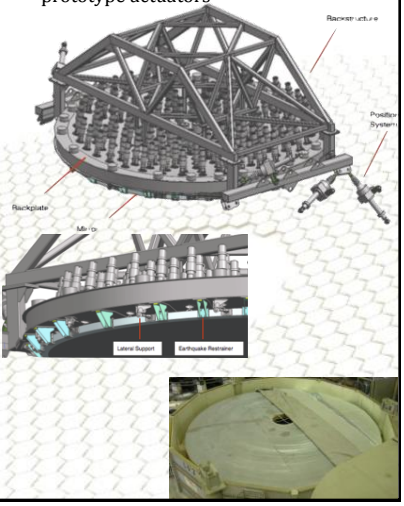
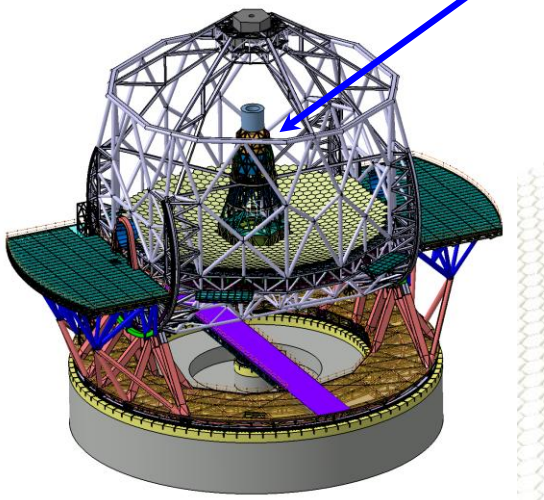


4m Secondary Mirror

- M2 unit FEED
- 3 polishing studies
- prototype actuators

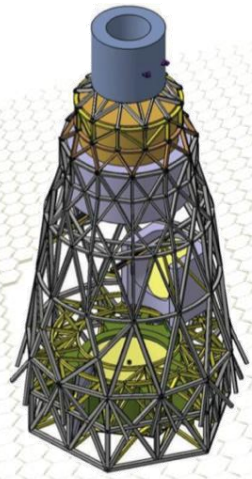


The E-ELT: overview

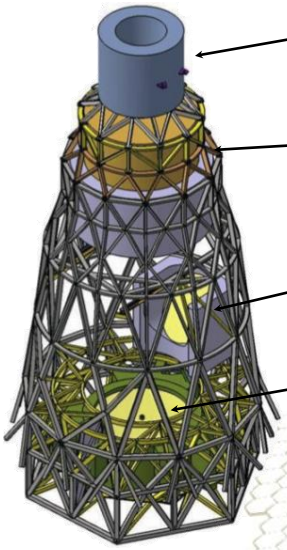


Central tower

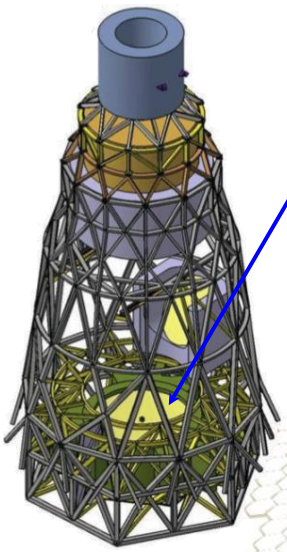
- ADC volume
- Adaptive M4
- Field stabilization M5
- M3



The E-ELT: overview

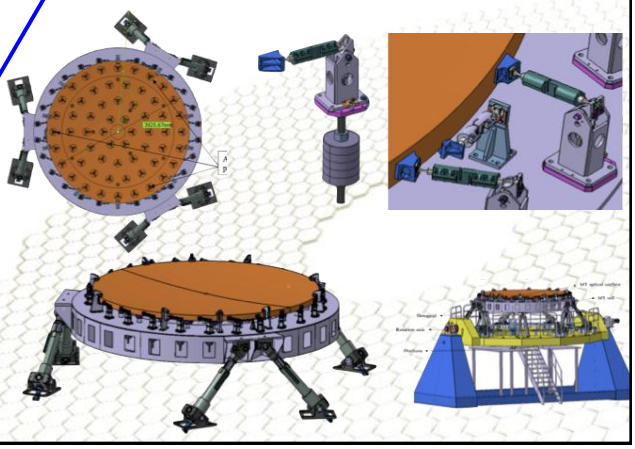


The E-ELT: overview



4.2m M3 unit

- Preliminary cell design concluded
- Prototype pneumatic actuators



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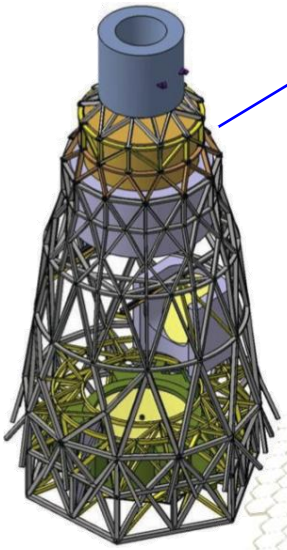
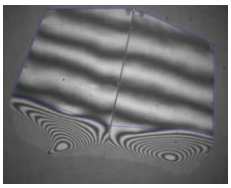
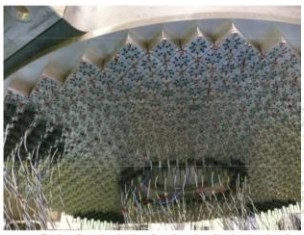
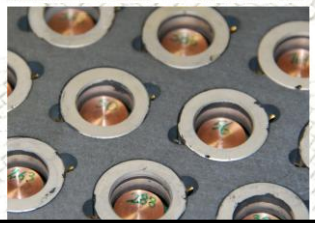


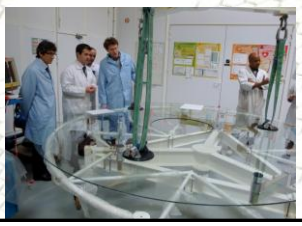
2.5m M4 unit

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

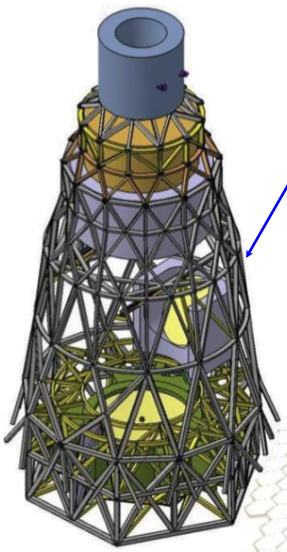






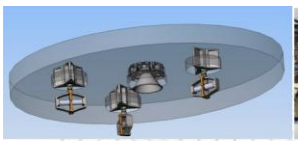


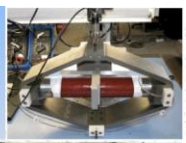
The E-ELT: overview



2.4m x 3m M5 unit

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





M5 Unit

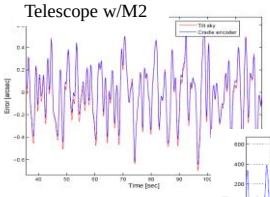
Tip/Tilt flat mirror 3.0 x 2.5 m

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

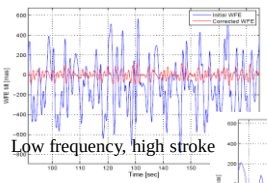
Telescope main axes control

Telescope w/M2



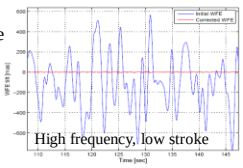
Remaining tip tilt < 1" rms

After M5

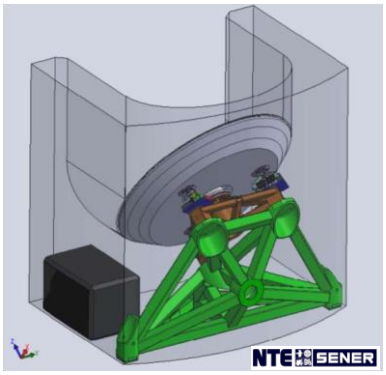


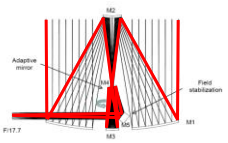
Low frequency, high stroke

After M5+ M4



High frequency, low stroke

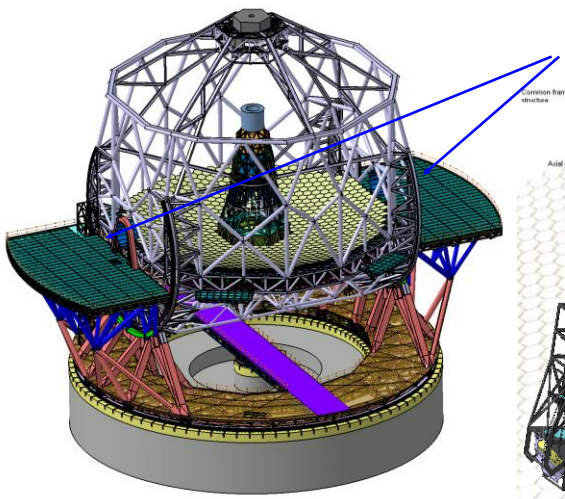


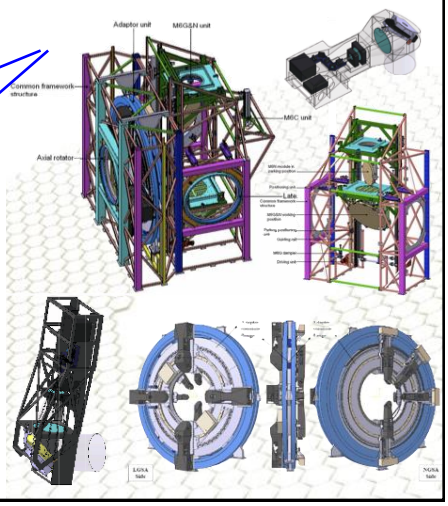


The E-ELT: overview

Prefocal station

- preliminary design concluded

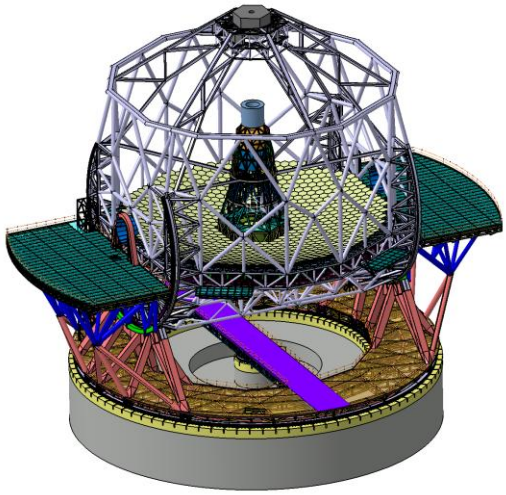


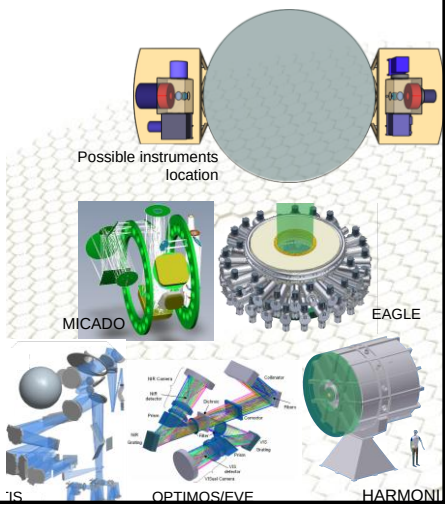


The E-ELT: overview

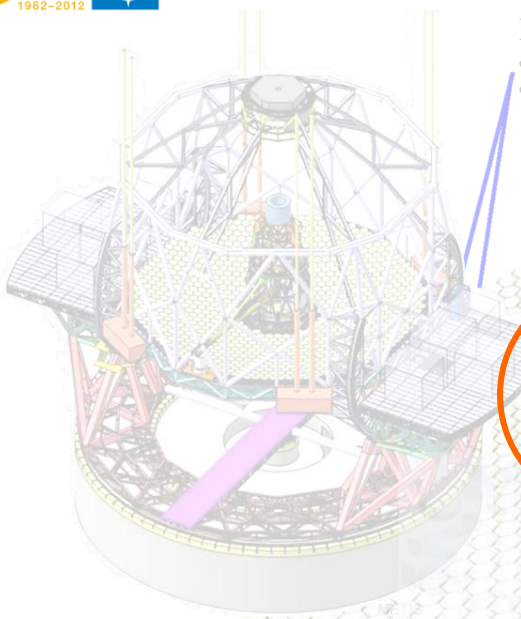
Instrumentation

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





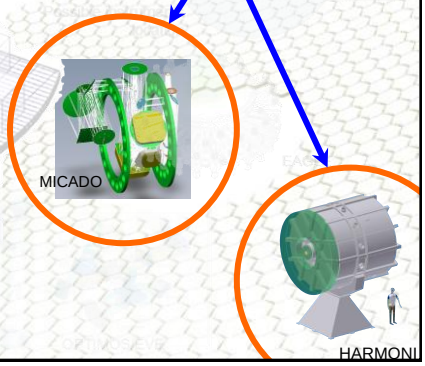
The E-ELT: overview



Instrumentation

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

First Light Instruments

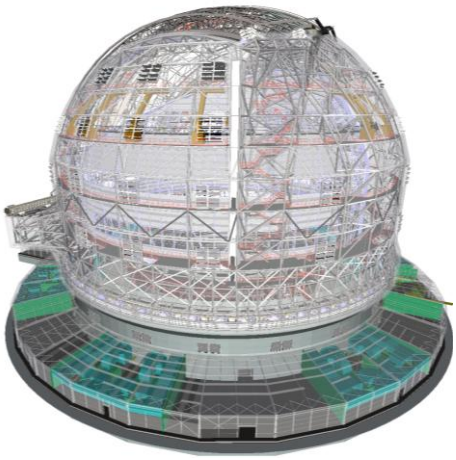


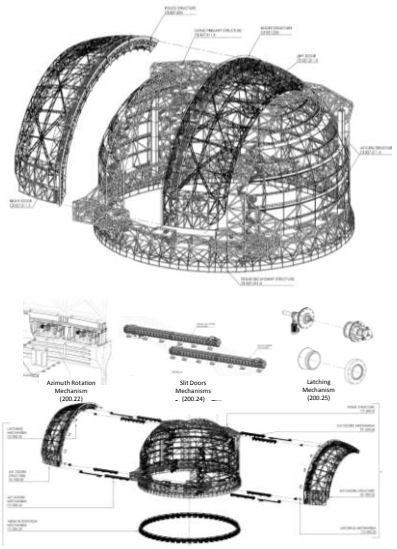
Dome

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.

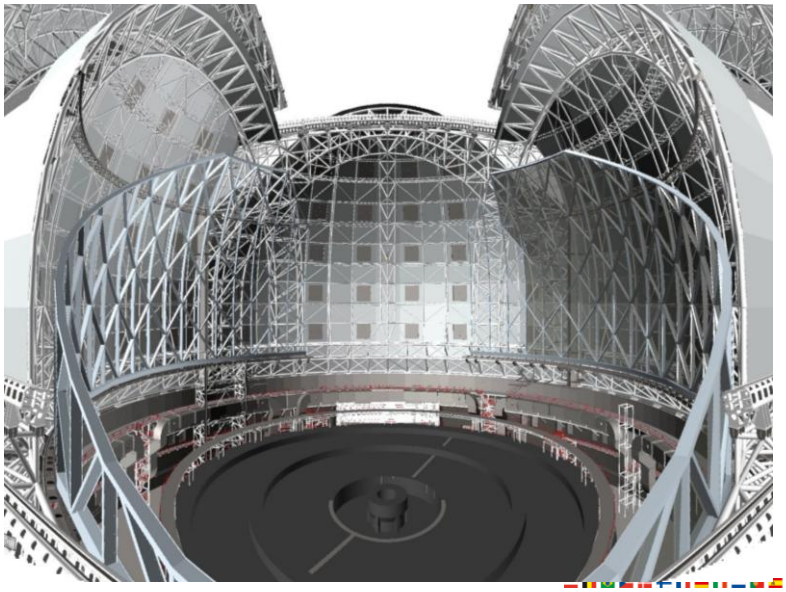
Dome





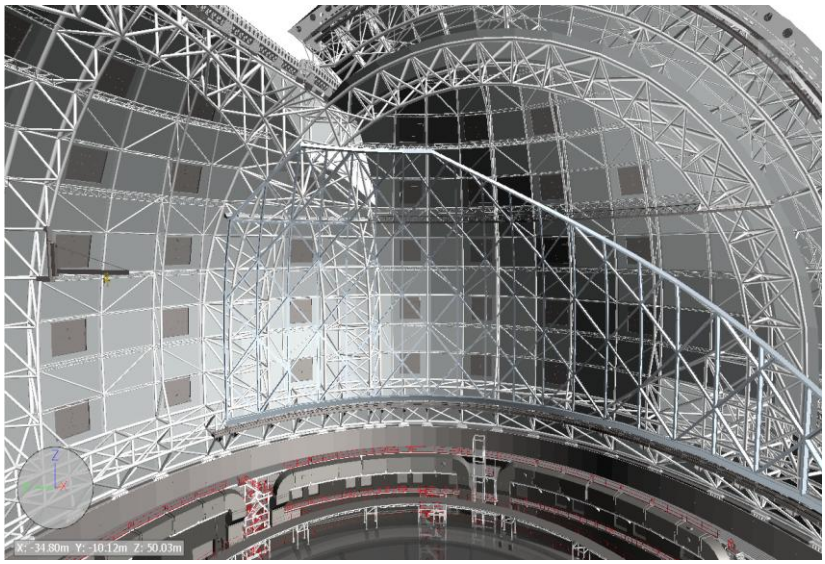
Dome Design Integrated Model

Overall internal view



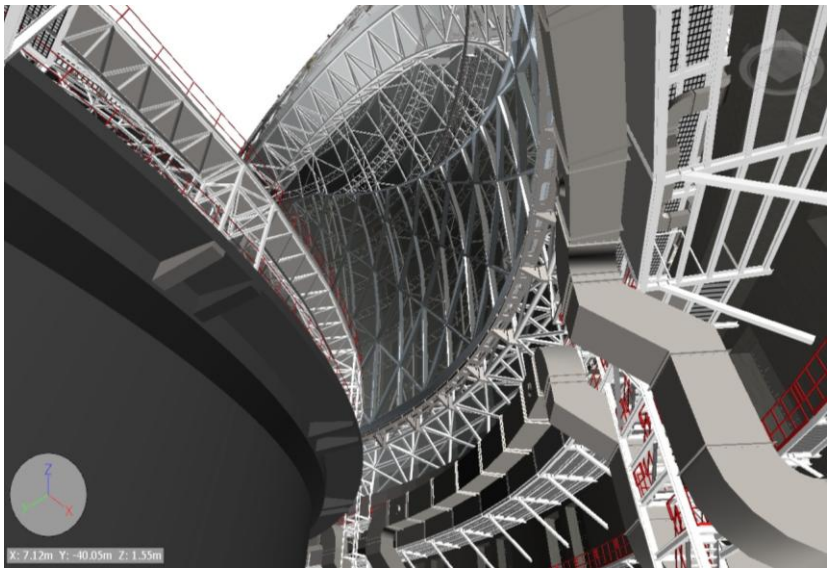
Dome Design Integrated Model

Lateral internal view



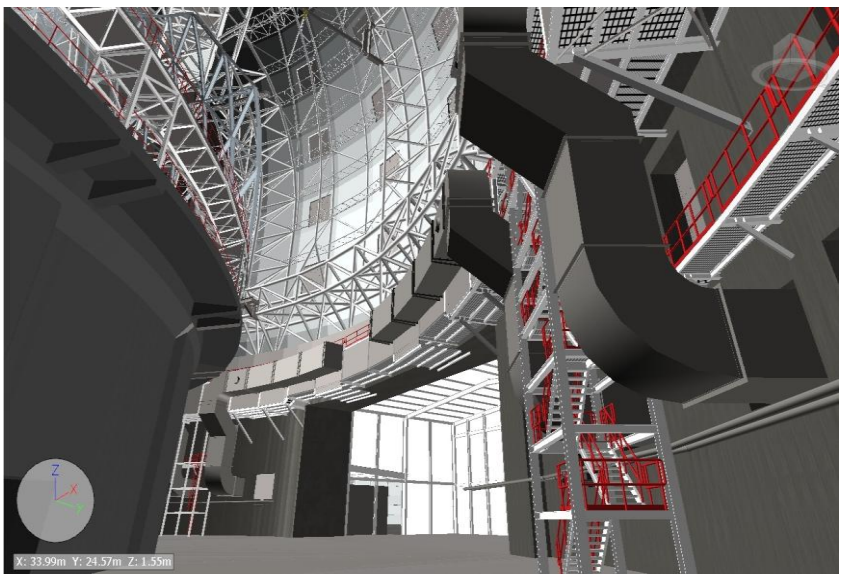
Dome Design Integrated Model

Internal view from the ground slab I



Dome Design Integrated Model

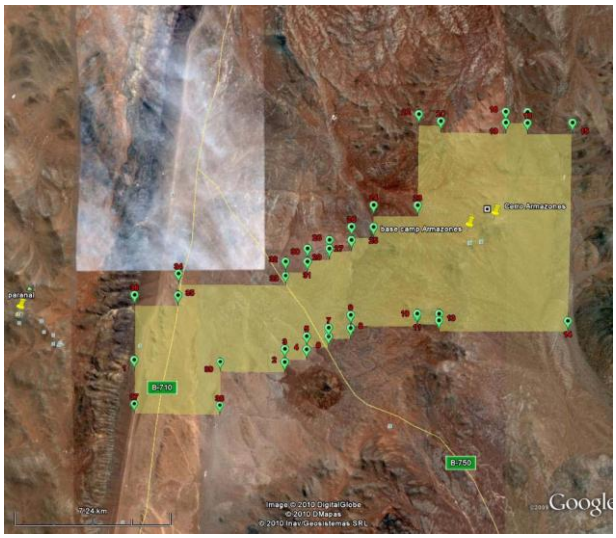
Internal view from the ground slab II



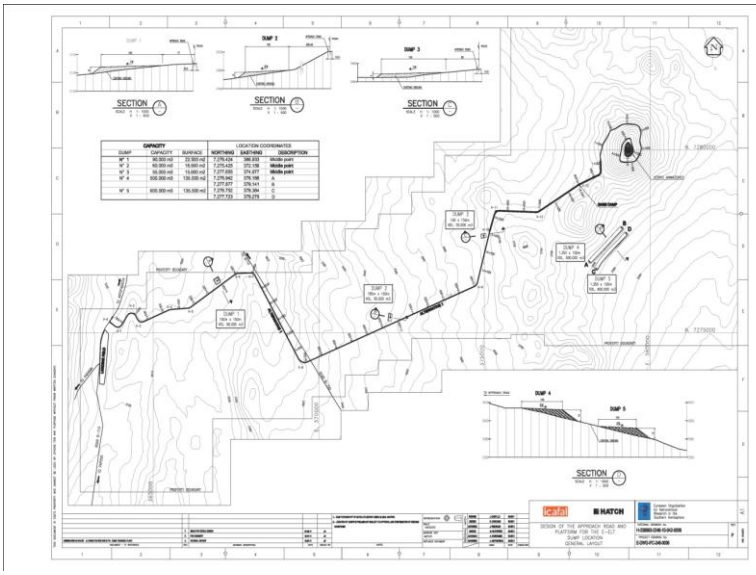
Areas of Interest for Industry

- 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

Route of Road



Road


SECTION
SECTION
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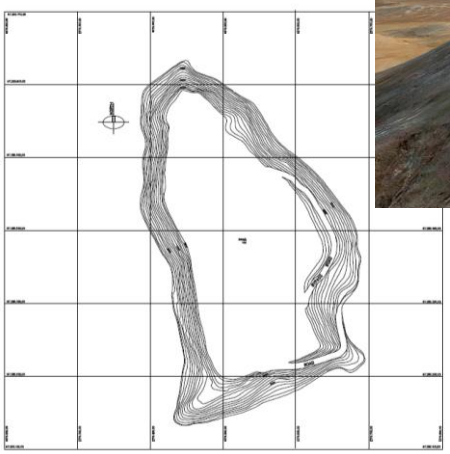
SECTION
DUMP 1
DUMP 2
DUMP 3
DUMP 4
DUMP 5
HATCH



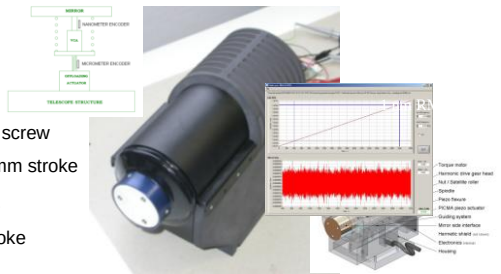
Areas of Interest for Industry

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

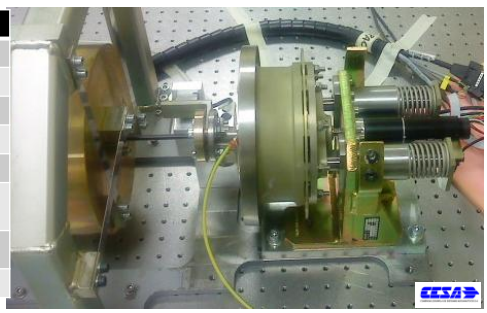
M1 Position actuators

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

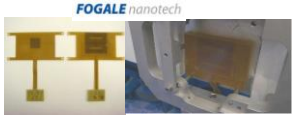


Requirement	Unit	Spec
Stroke	mm	15
Stiffness [in 0-4 Hz range]	N/micron	12
Positioning error, tracking	nm RMS	1.7
Tracking velocity	µm / s	+/- 10
Slewing velocity	µm / s	+/- 250
Power consumption, average Including electronics	W	< 2
Mass	kg	< 10
Bandwidth, update rate	Hz	30, 1000



M1 Edge Sensors

FOGALE nanotech

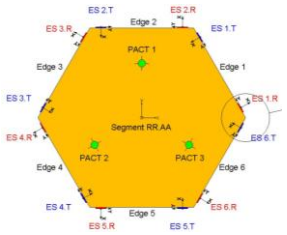


Edge Sensors

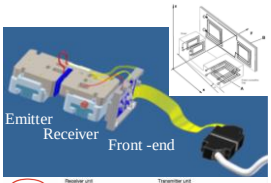
- 6 Emitters + 6 Receivers per Segment
- Inductive sensing technology :

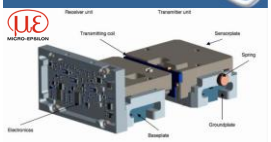
Emitter & receiver Silver-palladium coils embedded in ceramic (Boron Nitride)

- 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

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 900 Segment Support Structures