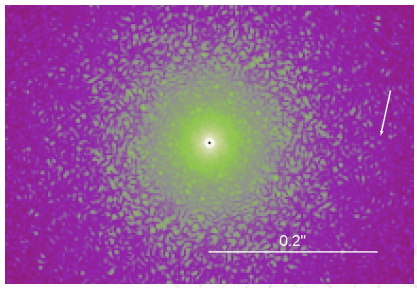
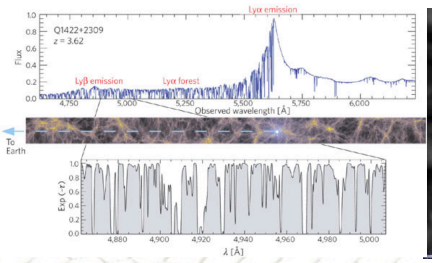
The European ELT

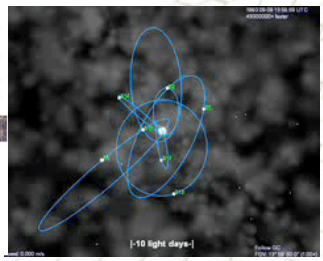
- A 40m class adaptive telescope with segmented primary based on a 5-mirror design
- Completed Phase B (detailed design): 2007-2010
  - Construction Review (Sep 2010, passed)
- Currently in Δ Phase B
  - Goal: optimize solutions, reduce cost (1.25 B€) and risks
  - Cost Review (Sep 2011)
- Schedule:
  - Start of construction: 2012
  - First light: 2021
- Cost
  - Telescope + 1st gen instruments: ~ 1050 million Euros
  - Operations (incl new instruments, overheads): ~ 50 M€/year
- Resources
  - Phase B: 2007-2009: 57.2 M€ (including 110 FTEs)
  - ΔφB: 7 M€ + 27 FTEs
  - Supporting activities from FP6 (28.8 M€) & FP7 (6.1 M€)

The driver

- **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
  - Tests of GR around black holes
- **The unknown**
  - Open new parameter space

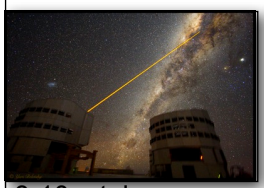


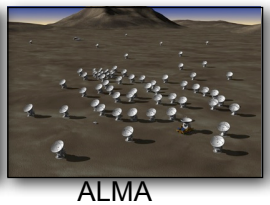




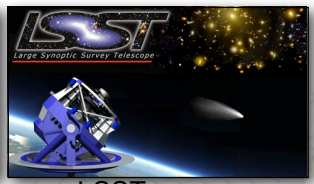
The Science Case: three pillars

- **Contemporary science:** *Today's clever ideas* ➠ *the DRM*
- **Synergy with other facilities:**

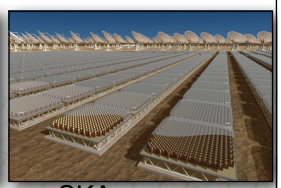

8-10m telescopes


ALMA

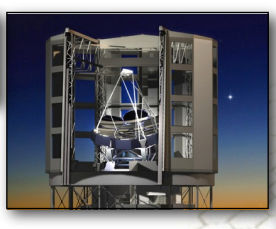

JWST

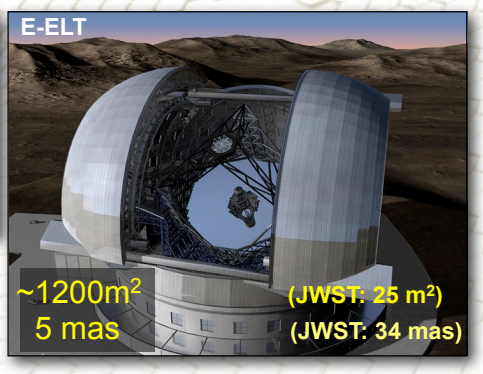


LSST


SKA

- **Discoveries:** *Opening parameter space* (*photon sensitivity, spatial resolution*)





	VLT	GMT	TMT
	~50 m²	~400 m²	~600 m²
1μm:	25 mas	9 mas	7 mas

STATUS OF PROGRAMME:
PHASE B CONCLUDED, Δ IN PROGRESS

- Site selected: Armazones (20 km from Paranal)
  - *VLT and E-ELT as a single observatory*
- Proposal for Construction passed construction review
- Major contracts (FEEDs) concluded
  - *Prototypes and breadboards produced and tested*
  - *Industrial reviews contracted*
- Excellent field results at GTC and VLT (control system)
- Instrumentation Phase A studies concluded
  - *First light instruments selected*
- Science
  - *Design Reference Mission, Design Reference Science Plan*
- Observatory operations plan established
  - *Daily activities (maint, calib etc) → FTEs → costs*
  - *Observing modes developed (based on VLT paradigm)*

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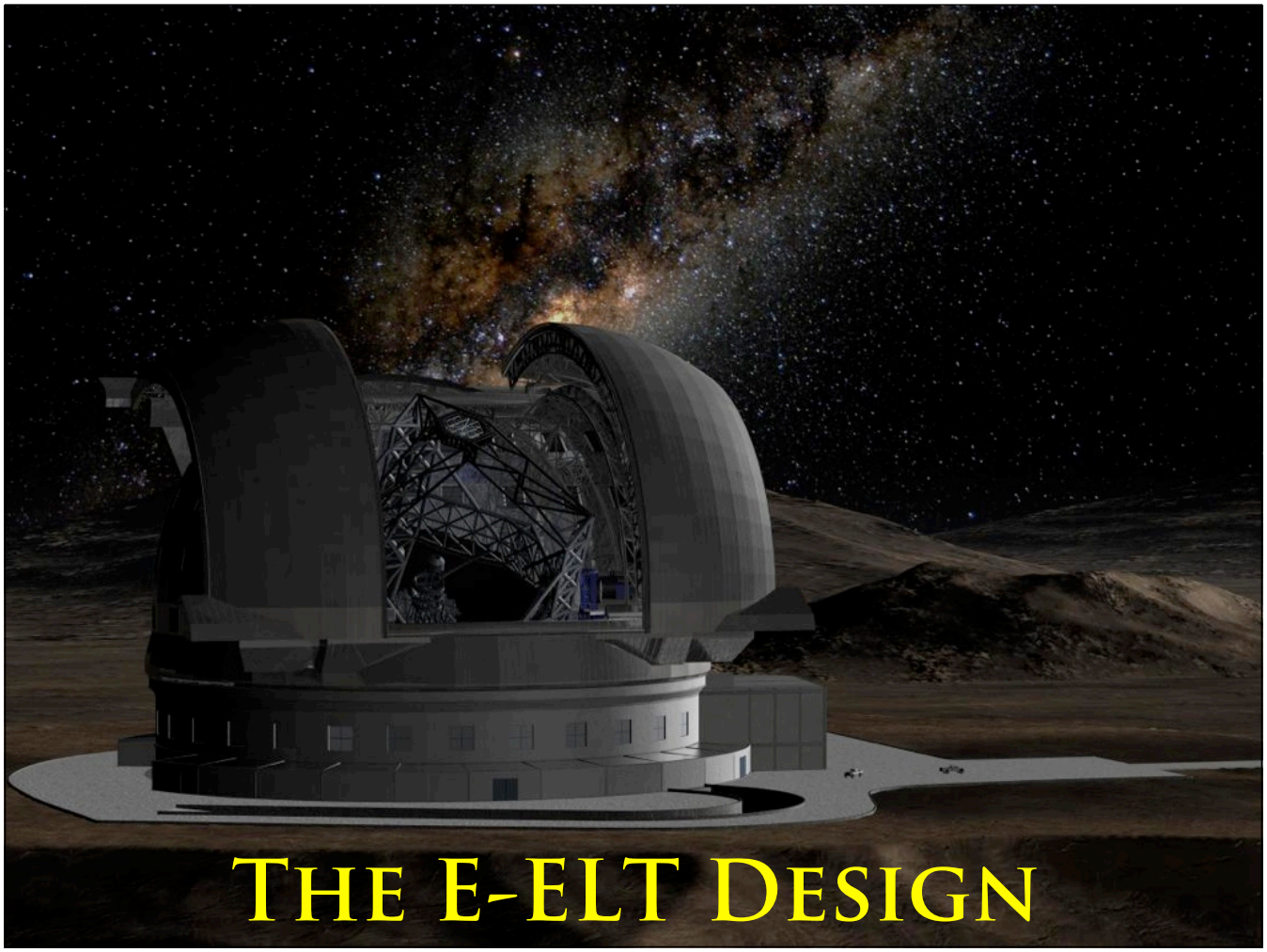


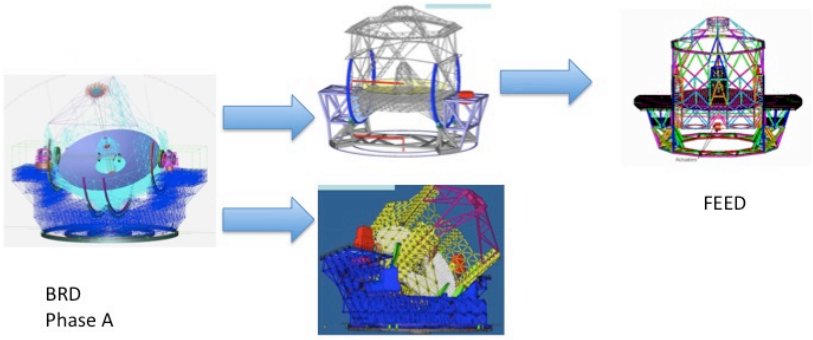
E-ELT TLRs

- **Diameter: ≥~~42~~39m**
  - **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)**

Design goals

- Establish technical & managerial feasibility
  - Based on technologically demonstrated industrial input.
    - Three phases of design of subsystems (competitive tendering, typically more than one supplier)
      - conceptual (BRD)
      - preliminary (BRDv2)
      - detailed (FEED)
- Develop instrumentation plan
  - Engaging the ESO astronomical community for the development of an instrumentation package that matches the telescope and delivers on the science drivers for the project.

Design strategy



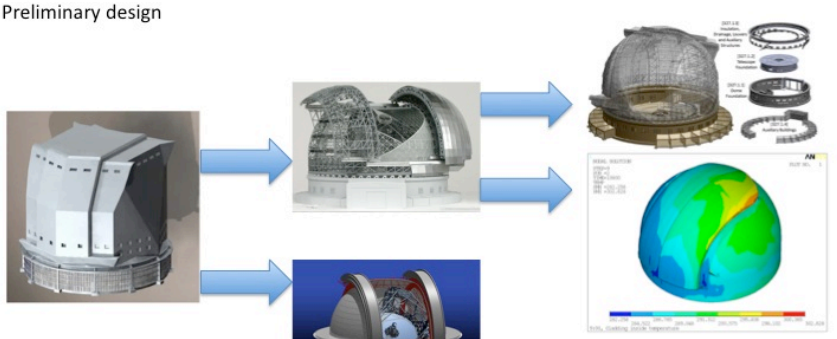
BRD
Phase A

BRDv2
Preliminary design

FEED

Front End Engineering Designs

- Detailed Design
- CfT documentation
- Prototyping
- Cost & Schedule backed by firm fixed price offer to build

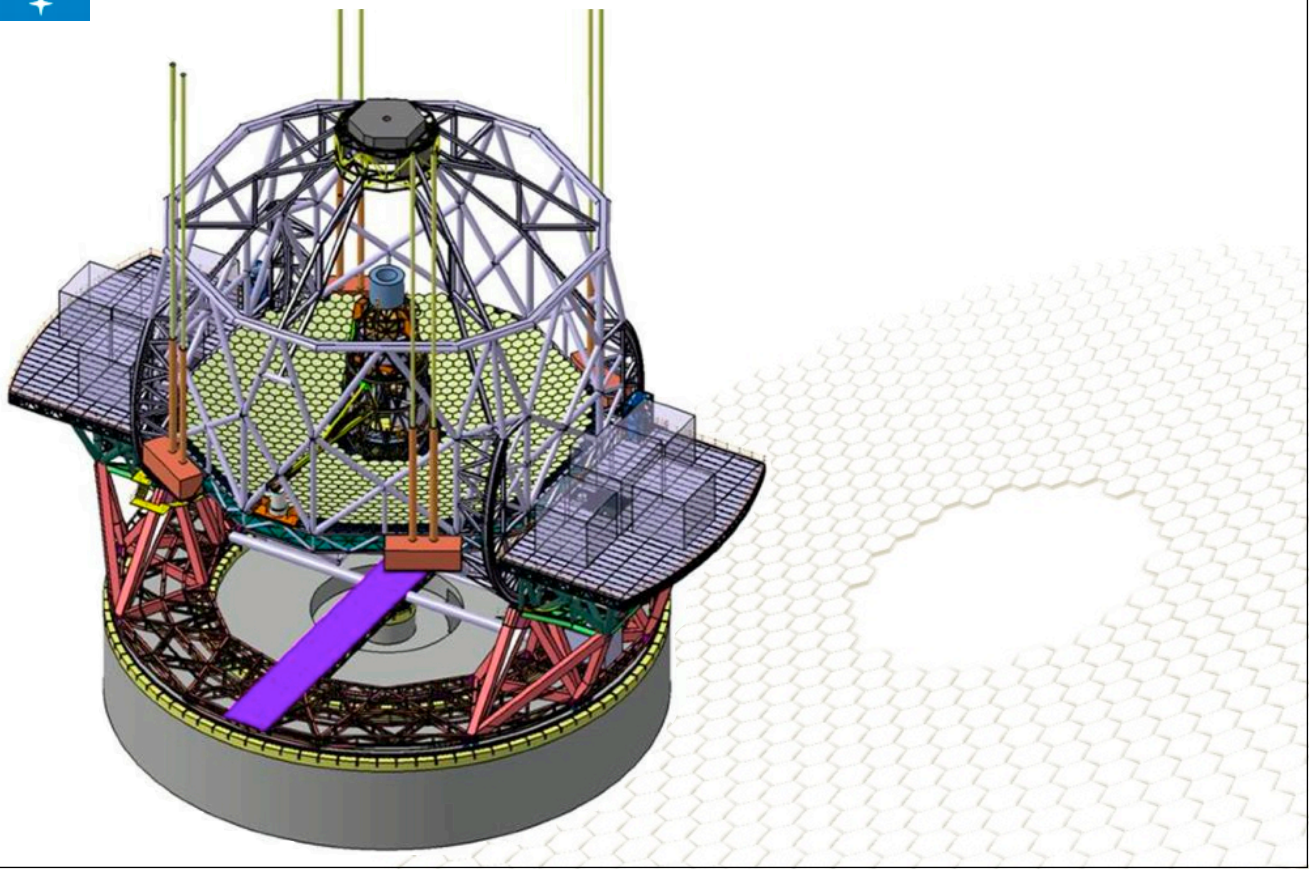


BRD
Phase A

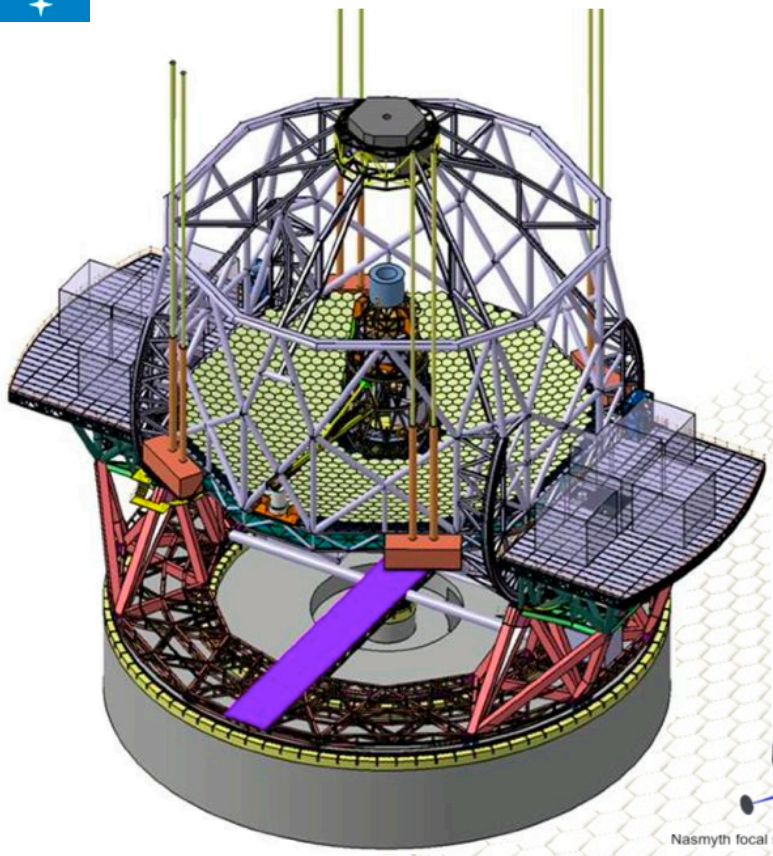
BRDv2
Preliminary design

FEED

The E-ELT: overview

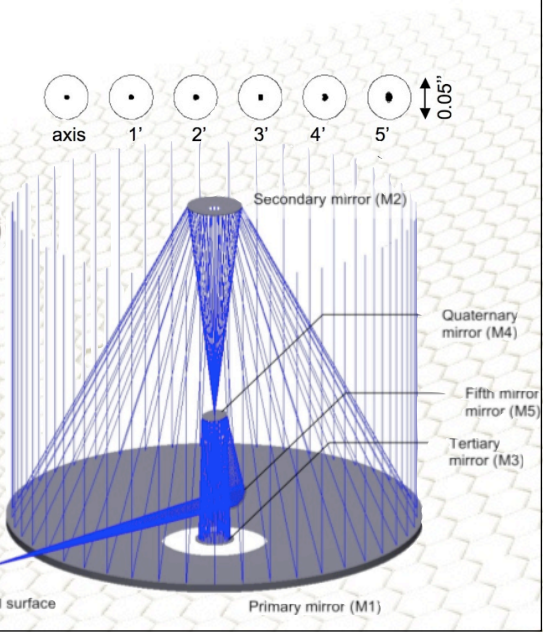


The E-ELT: overview



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



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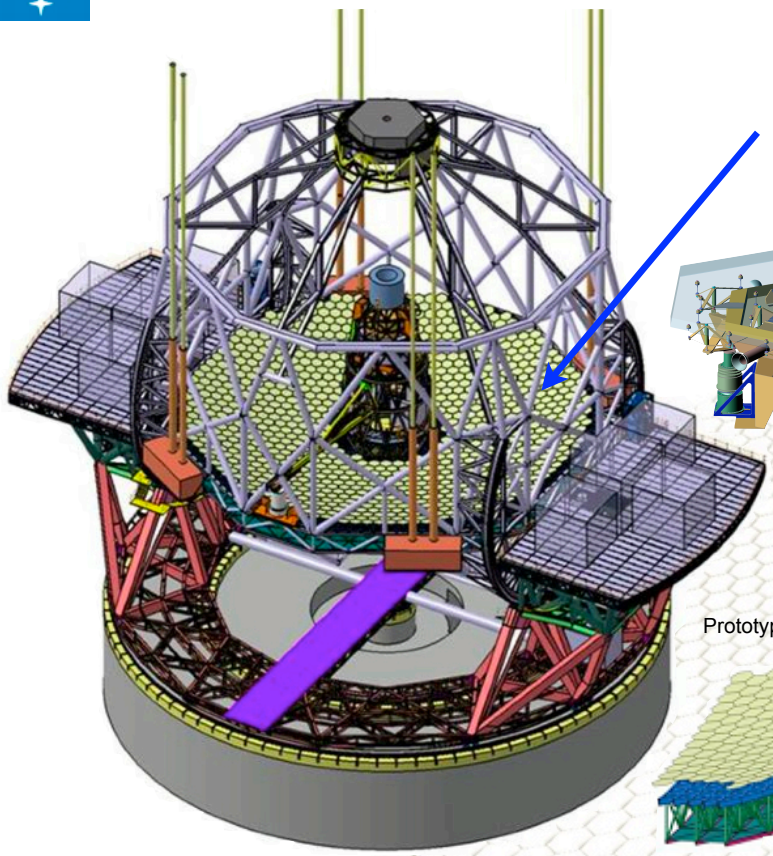
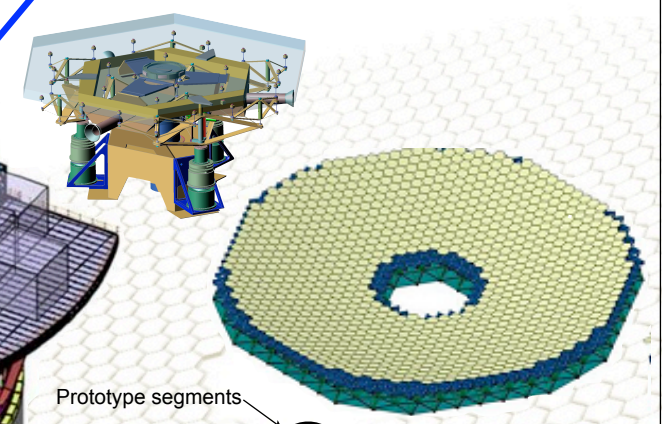
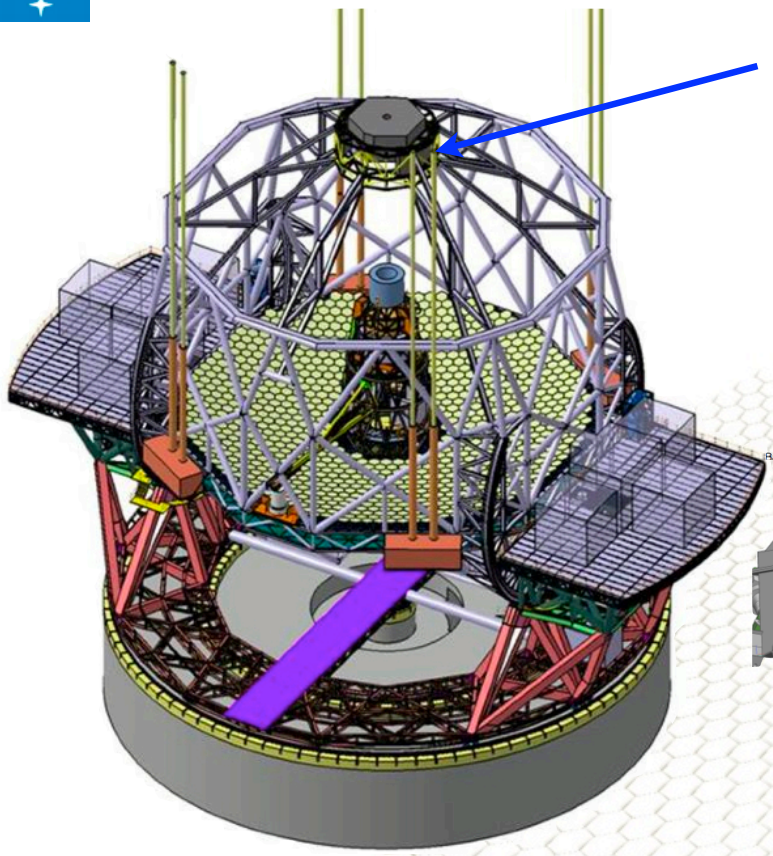


42m Primary Mirror

- 984 segments mirror +1/family (→ 794)
- 2 x 7 prototypes FEEDs
- prototype support, PACTs, edge sensors

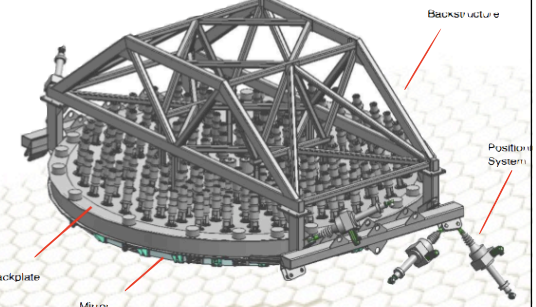


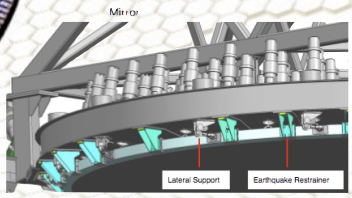
THE E-ELT: OVERVIEW

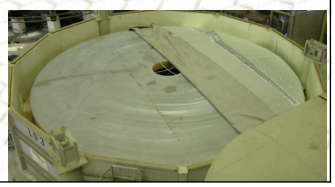


6m Secondary Mirror (→ 4.1)

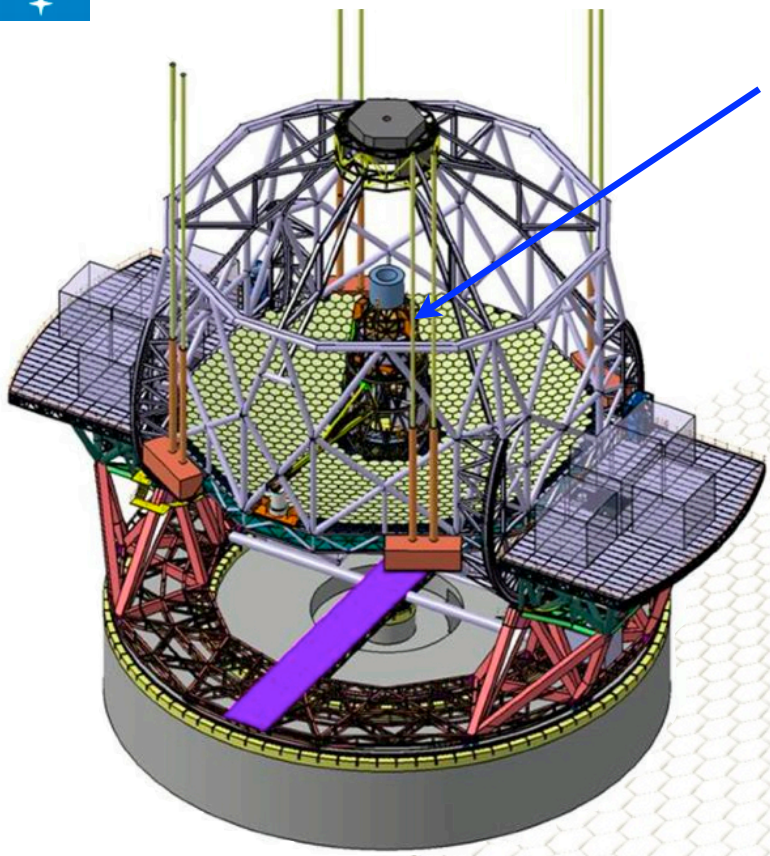
- M2 unit FEED
- 3 polishing studies
- prototype actuators





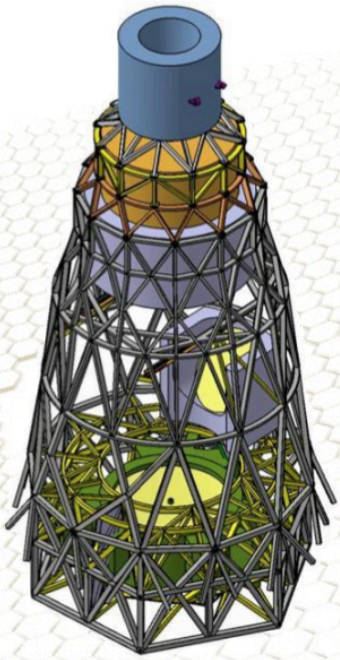


THE E-ELT: OVERVIEW



Central tower

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



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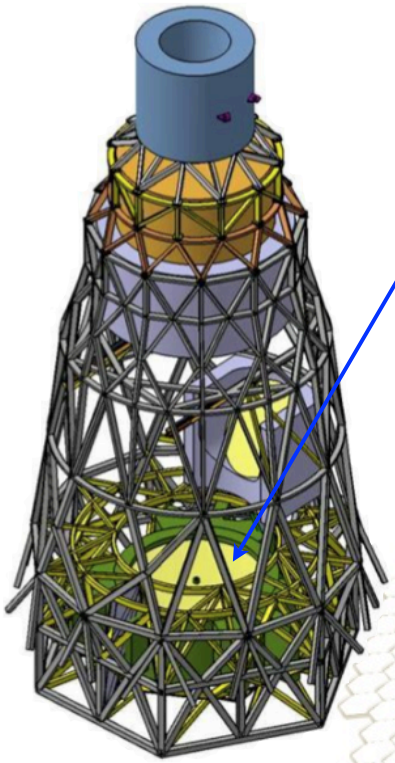
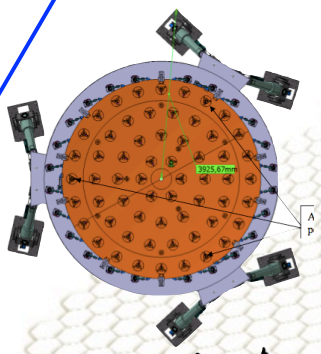
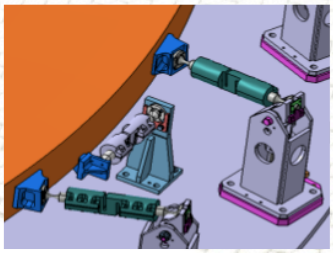
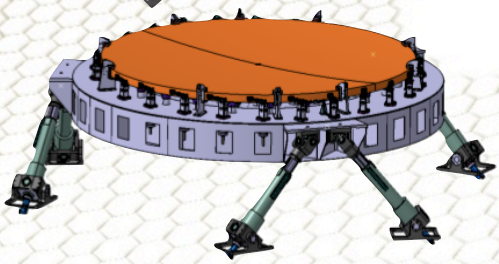


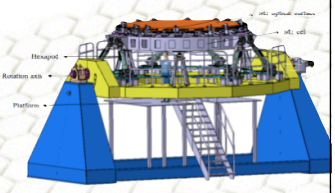
4.2m M3 unit

- Preliminary cell design concluded
- Prototype pneumatic actuators

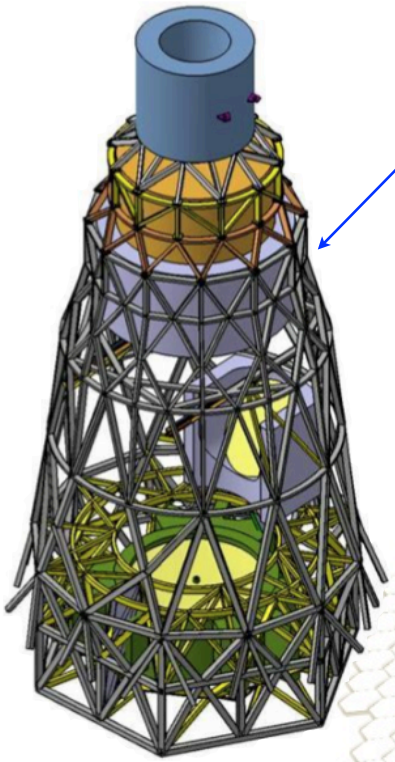






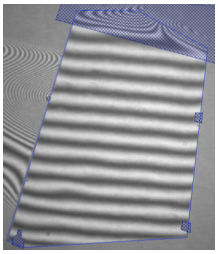


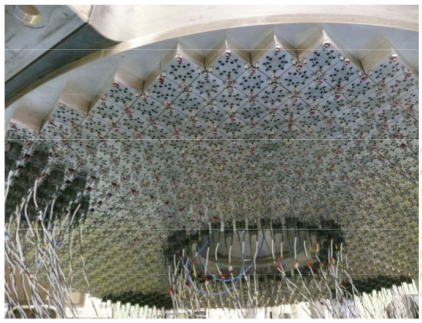
THE E-ELT: OVERVIEW

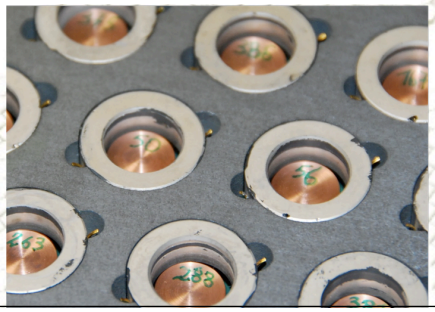


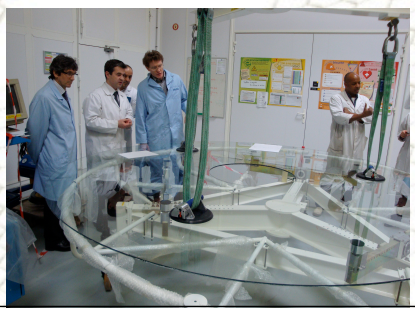
2.5m M4 unit

- 2 FEEDS (prototypes)
- final stages of testing
- thin shells polishing
- ~ 8000 actuators

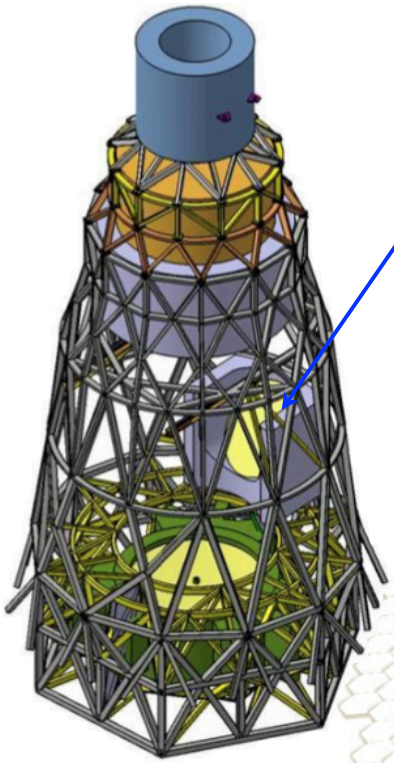






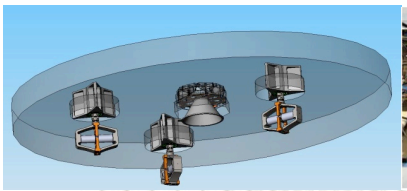


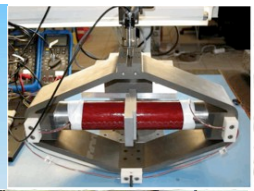
THE E-ELT: OVERVIEW



2.4m x 3m M5 unit

- scale-1 electromechanical prototype FEED
- in depth testing
- 4 mirror polishing studies (including heavy option)





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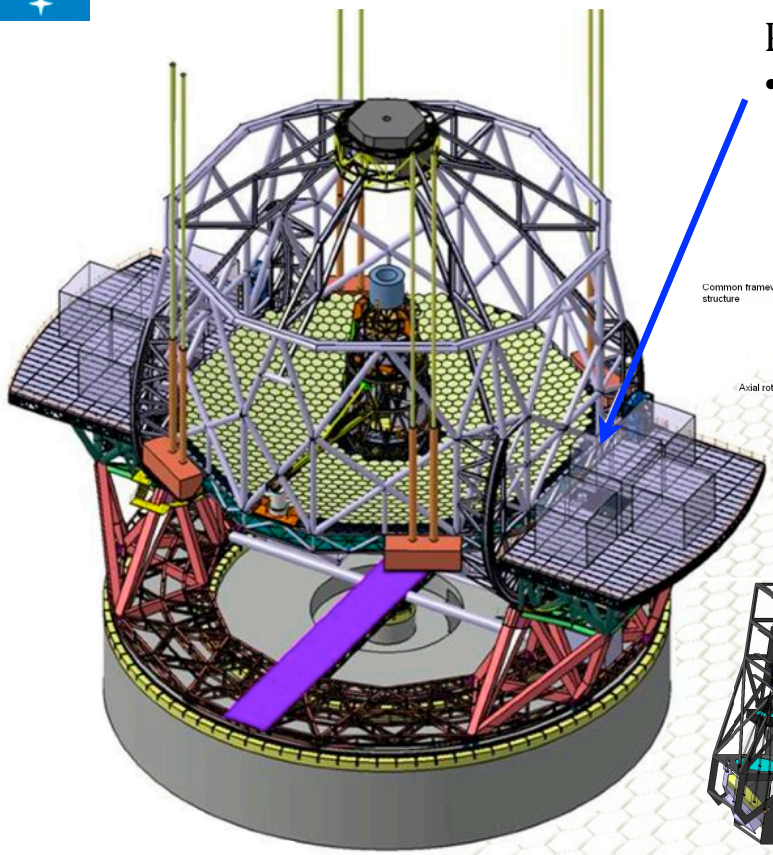
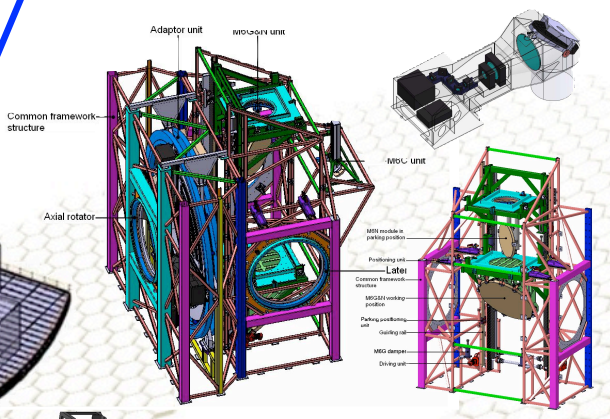
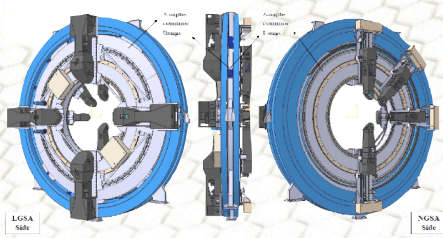


Prefocal station

- preliminary design concluded





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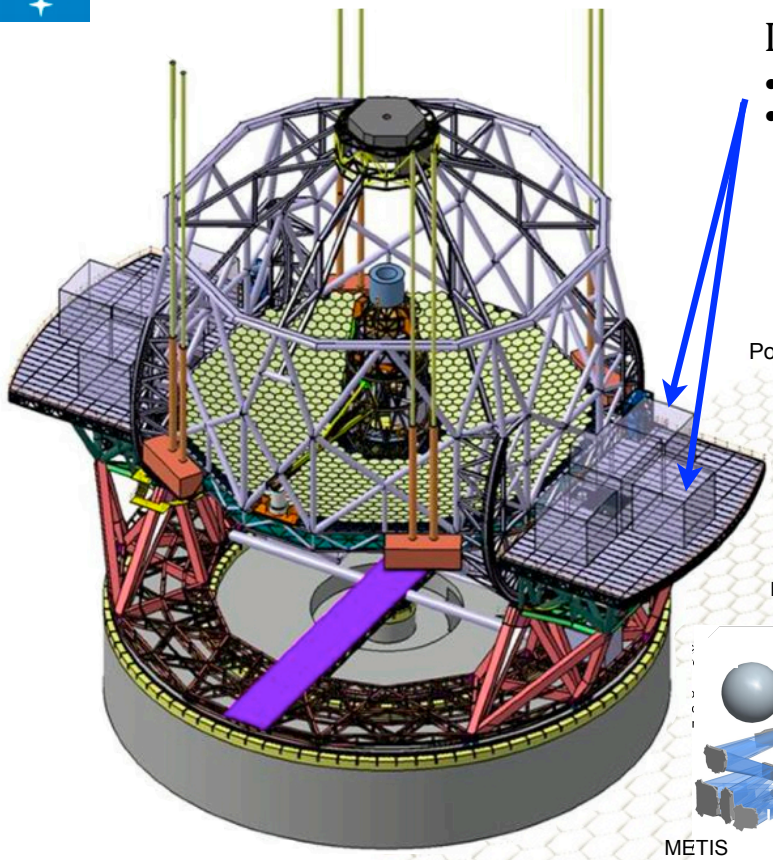
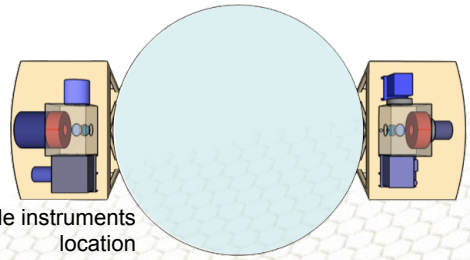


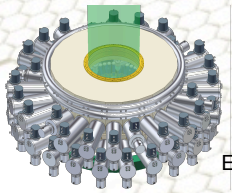
Instrumentation

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

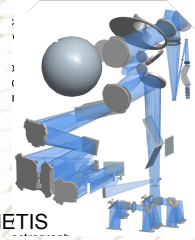


Possible instruments location

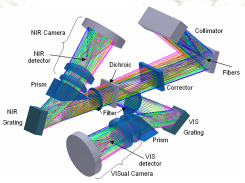
MICADO



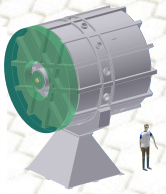
EAGLE



METIS

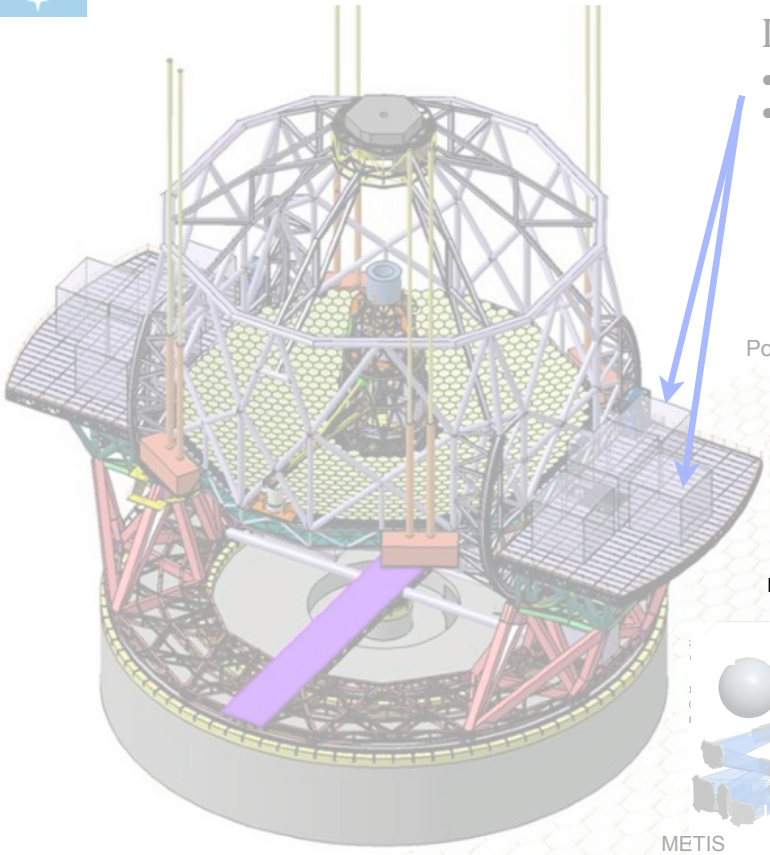


OPTIMOS/EVE



HARMONI

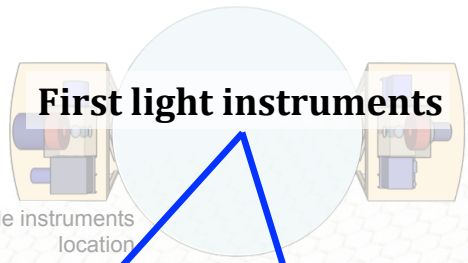
THE E-ELT: OVERVIEW



Instrumentation

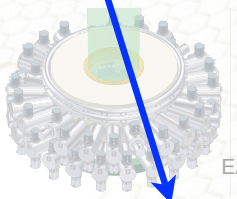
- 8 instrument concepts Phase A concluded
- 2 post-focal AO modules Phase A concluded

First light instruments



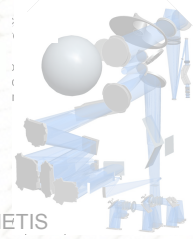
Possible instruments location

MICADO

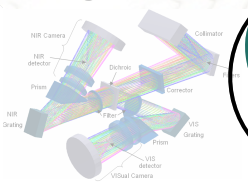


EAGLE

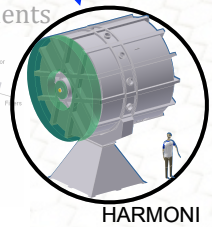
First light instruments



METIS



OPTIMOS/EVE

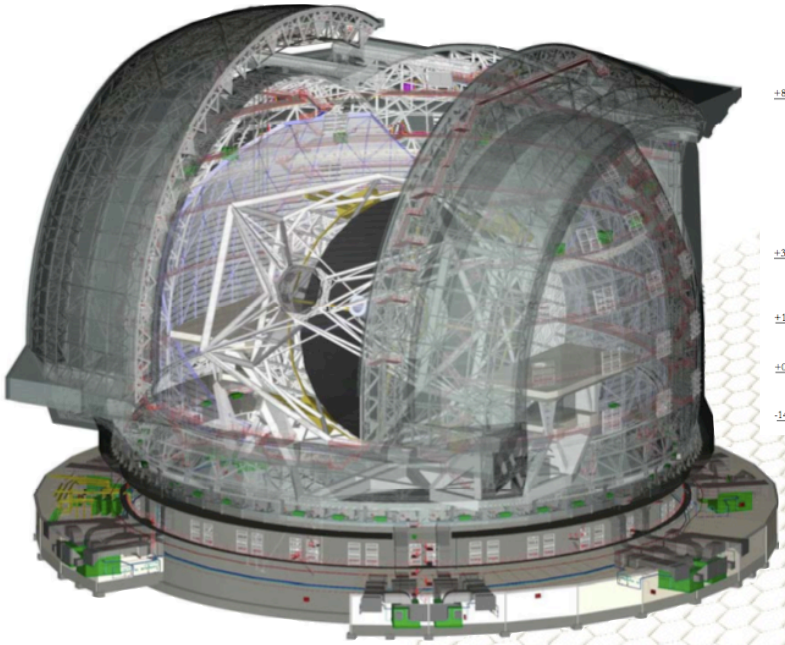


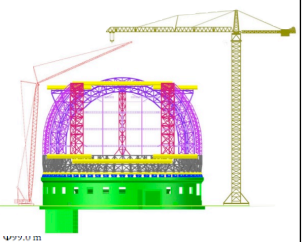
HARMONI

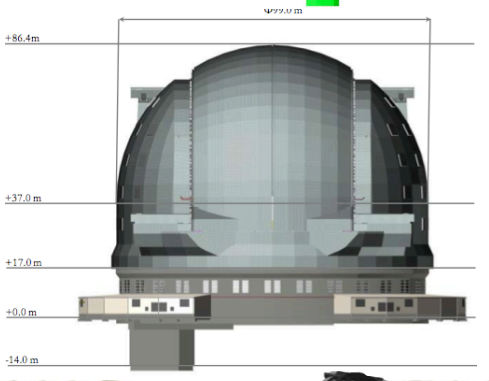
The E-ELT: overview

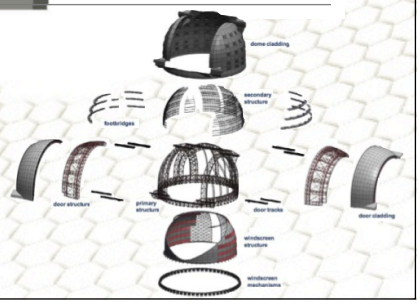
Dome

- 2 FEED contracts
- Erection sequence









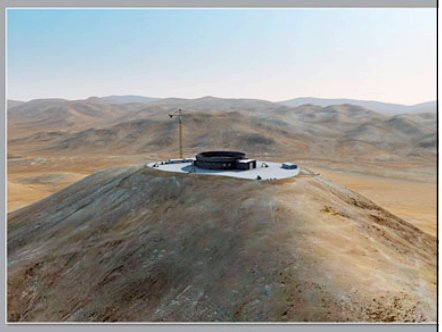
Delta Phase B

- Explore cost/risk reductions
  - Most challenging areas:
    - Timely completion of M1; manufacturing M2 unit; wind
  - Savings on the 42m baseline design
    - Smaller instrument platforms (→ smaller dome)
    - Removal of gravity invariant focus (→ simpler structure)
  - Savings if outer two segment rings removed from M1
    - Only option to reduce total cost substantially
    - Smaller M1 (39.3m)
    - Smaller/shorter dome, main structure
    - Smaller Armazones platform
    - Faster M1:
      - M2 < 4.2m: more suppliers, simpler polishing (1 matrix)
      - further reduction of telescope length and width
        - ➡ reduce dome volume, exposure to wind
        - ➡ easier to achieve safety under earthquake loading

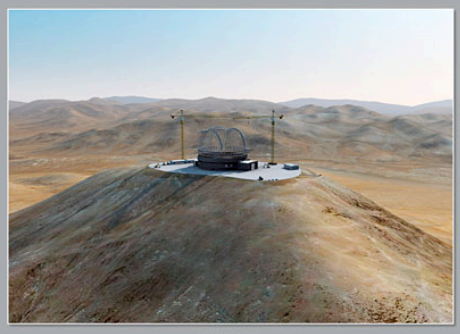
Conclusions:
First light possible in 2021

2010

2011



2012



2013

2014

(Dome erection sequence at Armazones, Phase B)