



*The Extremely Large Telescope
Design Study in the
Framework Programme 6*

April 2003



ELT Design Study

European-wide preparatory work over 2004-2007 - enable design & construction of a 50-100-m optical/IR telescope in the 2015 horizon.

*We do not want to show it is possible,
we want to be ready to do it.*

⇒ Focus on *enabling technologies*:

- Technical preparatory work, development & testing of critical components, subsystems, etc.
- Explore fundamental techniques underpinning the ELT concept (adaptive optics, phasing, wavefront control);
- Develop design & analysis tools;

⇒ Clear path for crucial decisions (e.g. site);

⇒ Cost-consciousness and schedule as high priorities

Keep options open: mostly design-independent activities, designs available for reference.

Participation of Institutes, SMEs, major suppliers

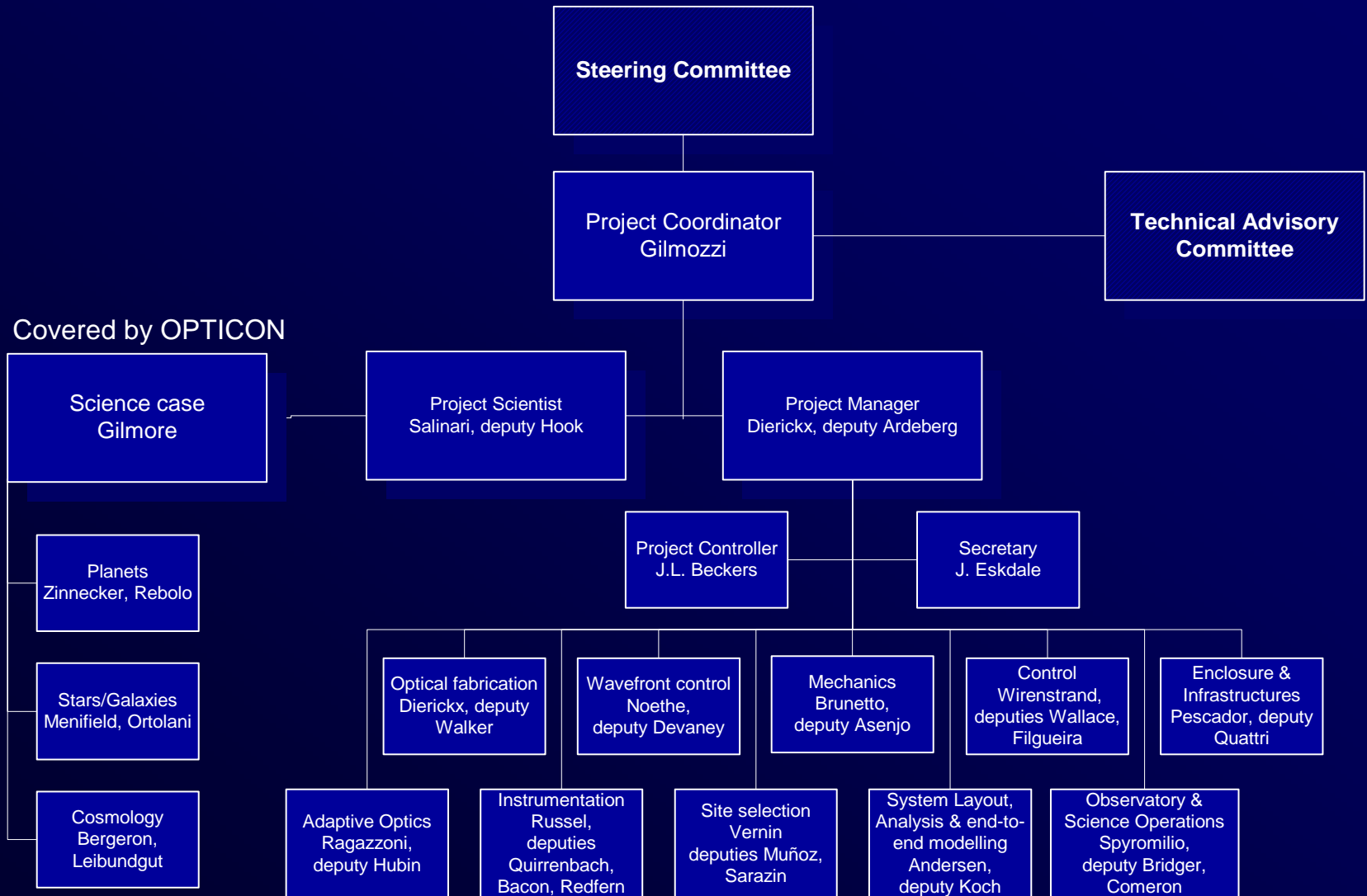


HIGHLIGHTS

- Wavefront control
 - Ability to combine active optics, segmentation, etc.
 - Phasing techniques
 - Ability to cope with wind
- Optical fabrication: segment substrates (major cost position)
- Adaptive optics (technology development)
- Site characterization, atmosphere beyond L_0
- Integrated modeling tools
- Use of composite structural elements
- Instruments “point designs”



Project Organization





Participants

Institutes & European Infrastructures

- ESO
- GRANTECAN
- INAM
- Instituto de Astrofísica de Canarias
- Leiden Observatory
- Lund University
- Marseille Observatory
- National Physics Laboratory (?)
- Observatoire de Lyon
- UKATC
- University College London

Industry (TBC)

- BOOSTEC Mirror substrates
- ECM ? Mirror substrates
- FOGALE Metrology, AO ?
- Microgate ? AO
- SAGEM Optical fab, AO, coatings ?
- SESO Optical fab, AO

... list still growing ...



Work plan 2003 (tentative)





Work Breakdown Structure (in progress)

00000 Proposal Preparation

01000 Project coordination

02000 Science requirements

03000 Project Management

04000 Wavefront control

04100 Description & classification of wavefront errors

04200 Wavefront error estimates

04300 Metrology

04310 Internal Alignment Systems

04320 Wavefront sensing for fine centering

04330 Wavefront sensing for multi-conjugate Active Optics

04340 Phasing - Position sensors

04350 Phasing - Calibration techniques

04400 Wavefront correction

04410 Position actuators

04420 Force actuators

04430 Active mirrors characteristics

04440 Correction of residual errors by Adaptive Optics

04500 APE

04600 MAD APE

04700 WEB

05000 Optical fabrication

05100 Silicon Carbide prototypes

05400 Optical testing of 1.8-m Aluminium mirrors

05500 Aspheric segment

05600 SELT

05700 Coating

06000 Mechanics

06100 Structural ropes

06200 Composite structural elements

06300 Magnetic levitation

07000 Control

08000 Enclosure & infrastructure

08100 Enclosure concepts

08200 Wind studies

08300 Maintenance infrastructures

09000 Adaptive Optics

10000 Data Flow

11000 Instrumentation

12000 Site characterization

13000 System layout, analysis & Integrated Modelin

14000 Operations



Deliverable hardware

Deliverable items – hardware (proposal)

No	Item	Qty	M€	FTEs	In-kind (M€)
1	Internal Metrology System	1	0.375	1.65	
2	APE bench & camera	1			
3	Piston-sensitive wavefront sensors for APE	2	1.26	42.2	
4	SELT segment breadboard	1	3.37	13.5	
5	WEB segment breadboard (wind control)		1.24	9.25	
6	1-m SiC Boostec segments coated & polished	4	0.25	0.75	0.25
7	1-m SiC ECM segments coated & polished	2-3	0.15	0.50	
8	Adaptive mirror prototype + thin shells	1-3?	TBD	TBD	
9	1000 elements MEM prototypes	3	TBD	TBD	
10	10,000 elements MEM prototypes	2	TBD	TBD	
11	TBD (site measuring equipment)	TBD	TBD	TBD	
12	<i>Aspherical segment (Zerodur or Astro-Sitall, 1.6-m)</i>	1	<i>TBD</i>	<i>TBD</i>	
TOTAL			6.645	67.85	



Deliverable hardware

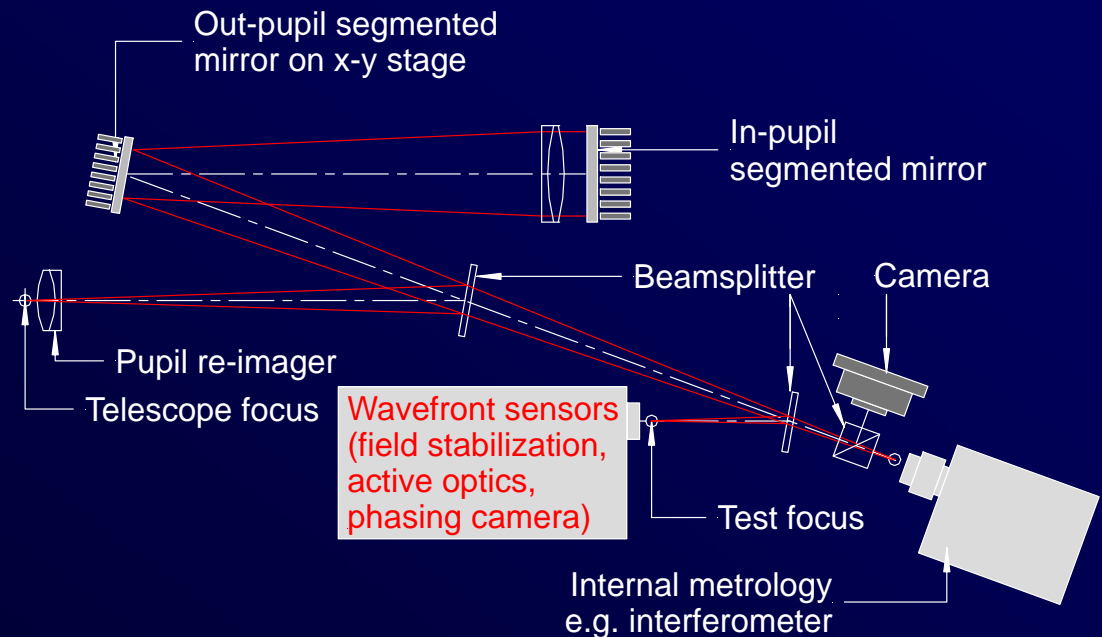
✓ APE:

- Integrate non-adaptive wavefront control functions in a working system (add segmentation to VLT)
- Evaluate on-sky phasing (calibration) techniques
- EGOT control strategy & software
- Possible upgrade:
MAD APE

ROM estimates

~3 years, 1.2 M€,

42 FTEs





Wind Evaluation Breadboard (WEB)

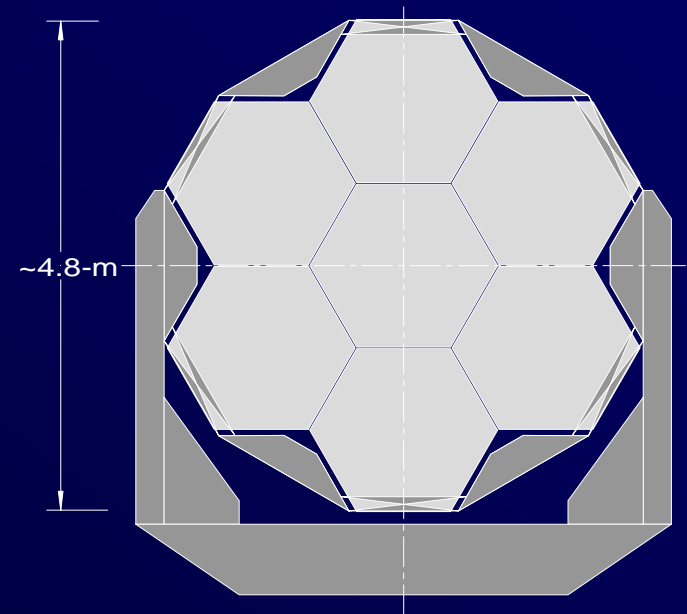
7 Aluminium panels on a (manually) steerable mount

- ✓ 3 lightweight + 4 solid panels, mass & dimensions representative of SiC and Glass-Ceramic segments
- ✓ Position sensors & actuators
- ✓ Metrology (e.g. laser interferometer)
- ✓ Open air, control of wind buffeting

Major "credibility step"

ROM estimates

~3 years, 1.2 M€, 10 FTEs



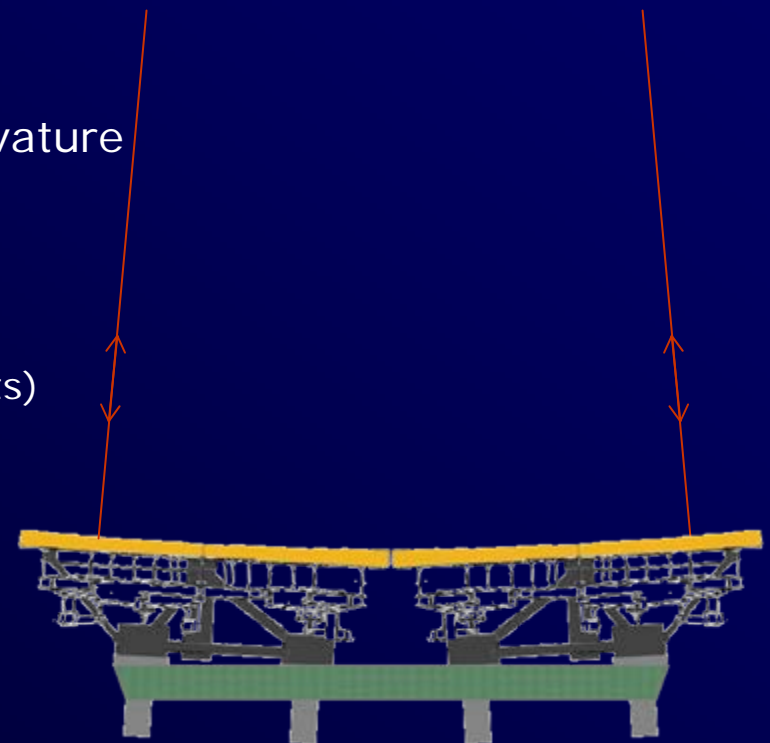


Segments Evaluation at Low Temperatures (SELT)

- Cell holding 3 spherical segments
 - ✓ One reference, 2 segments under test
 - ✓ 2 x 2 SiC, 2 Astro-Sitall, 1 Zerodur
 - ✓ Segments "final" design
- Interferometric test at center of curvature
 - ✓ Sensors & actuators accuracy
 - ✓ Supports performance, vertical & horizontal tests
 - ✓ Thermal effects (substrates, supports)

ROM estimates

~3.5 years, 3.4 M€, 14 FTEs





Integrated modelling

- ✓ Development of Tools
 - Integrated Model Architecture and Block Library
 - CFD
 - In collaboration with other groups behind other WP's
 - AO, Wavefront control, optics, etc.

- ✓ Non-linear Simulation Tools
 - Saturation and non-linearities
 - Non-linear noise effects
 - Fresnel propagation and Fourier optics
 - Servo bootstrapping issues

- ✓ Linear Simulation Tools
 - Faster simulations
 - Control loop design
 - Analytical calculation of noise propagation
 - Frequency responses and spectral analysis



00000	Proposal Preparation	not started
01000	Project coordination	draft definition
02000	Science requirements	draft definition
03000	Project Management	draft definition
04000	Wavefront control	technical content under consolidation, industrial partners
05000	Optical fabrication	technical content under consolidation, industrial partners
06000	Mechanics	technical content completed, contracts (studies) only
07000	Control	support WP, still TBD
08000	Enclosure & infrastructure	technical content to be reviewed
09000	Adaptive Optics	input missing
10000	Science & observatory ops	not started
11000	Instrumentation	technical content under consolidation
12000	Site characterization	preliminary input only
13000	System layout, analysis & Integrated Modeling	technical content under consolidation



The good and the bad gnus



BAD GNUS

- ✓ Distribution of matching funds
 - 50% rule applies to individual participants
 - A serious drawback for industrial partners
- ✓ Slow input
 - Site characterization WP
 - Adaptive optics WP
- ✓ Observatory & science WP not started
- ✓ Availability of GTC people
- ✓ Possible shortage of FTEs

GOOD GNUS

(the OWL effect ...)

- ✓ Industrial interest in AO
 - Thin membranes technologies (SESO, SAGEM)
 - AO mirror technologies, incl. support (SAGEM)
- ✓ Industrial interest in Wavefront Control
 - Fogale
 - Building on SALT experience
- ✓ Industrial interest in SiC development
 - Boostec producing OWL 1-m SiC prototypes
 - Polishing: SESO and SAGEM