ELT DESIGN STUDY

A European(...) R&D effort towards ELT enabling technologies
European-wide preparatory work 2004-2007

⇒ enable design & construction of a 50-100-m optical/IR telescope in the 2015 horizon.

- Foster academic & industrial readiness
- Focus on enabling technologies
- Clear path for crucial decisions (e.g. site)
- Cost-consciousness and schedule as high priorities

13 countries, 39 participants, ESO as lead.

42 M€ total, 22 M€ requested to EC
Shares, in % of total estimated budget

- International: 38%
- Institute / university: 40%
- Industry: 22%

Country Shares:
- Australia: 3.8%
- France: 16.4%
- Germany: 2.2%
- International: 38.0%
- Ireland: 0.5%
- Israel: 0.2%
- Italy: 10.4%
- NL: 1.3%
- Spain: 10.6%
- Sweden: 4.8%
- UK: 5.9%
- Belgium: 4.5%
- CH: 1.4%
- Greece: 0.5%
- Portugal: 1.2%
- Spain: 10.6%
- Sweden: 4.8%
Project organisation

Participants (39)

WP/Task (50) A   B   C   ...   Z

1  2  3  4  5 ... 49  50

Part. budget  Part. budget  Part. budget

WP budget  WP budget  WP budget

WP consol. tool

Budget prep. tool

Added complexity: sensitive information
⇒ cross-participants confidentiality!
# ELT Design Study: highlights

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<td>Infrastructure</td>
<td>Enclosure concepts</td>
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Total cost per WP, k€

- Adaptive optics, 11513
- Wavefront Control, 8652
- Optical Fabrication, 4590
- Mechanics, 2918
- Control, 2138
- Enclosure & infrastructure, 2717
- System layout, analysis & integrated modelling, 2160
- Project coordination, 1299
- Science requirements, 227
- Observatory & science operations, 498
- Instrumentation, 2455
- Site Characterization, 2521
- Opticon, Gent, April 2004
STUDIES, PROTOTYPES AND BREADBOARDS.

WP 4100: Description and classification of wavefront errors
WP 4200: Metrology
WP 4300: Position Actuators
WP 4400: Characterization of image properties
WP 4500: Coronography
WP 4600: Active Phasing Experiment (APE)
WP 4800: Wind Evaluation Breadboards (WEB)

WP Manager: L. Noethe (ESO)
WP Deputy: N. Devaney (GRANTECAN)
Wavefront control

Metrology

- Internal alignment system (FOGALE)
- Capacitive or inductance-based position sensors (FOGALE)
- Piston-sensitive wavefront sensing
  - Mach-Zehnder (FOGALE, LAM, ESO)
  - Curvature (IAC)
  - Pyramid (INAF)

All to be tested on-sky (APE)
Position actuators

- Position actuators for WEB (subcontract)
- Alternative design / prototyping (Dutch Space)
APE (DeLuxe)

GOALS

✓ Compare the performance of 3 types of wavefront sensors:
  - Curvature
  - Mach-Zehnder
  - Pyramid

✓ Test the control of combined active optics & segmentation

✓ Design & test control software

For control systems, an alternative to an “intermediate step”
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

Probably installed on La Palma

Major "credibility step"
OB j e c t i v e s ( T A S K S  0 5 1 0 0  T O  0 5 4 0 0 )

✓ Development & verification of potentially cost- and performance-effective materials and processes (e.g. SiC)
✓ Optical finishing and edge control
✓ Verification of CTE homogeneity of large Aluminum mirrors
✓ High performance reflective coatings

WP Manager: P. Dierickx (ESO)
WP Deputy: D. Walker (UCL)
Optical Fabrication

✓ Substrates:
  – Silicon Carbide for segments
    • Lighter, stiffer, cheaper?
    • 4 blanks already produced (ESO contract)
    • 4 additional by ECM
    • Technology still uncertain for segmented apertures (bimetallic effects?)
  – Aluminium for large mirrors
    • 1.8-m mirrors produced under ESO contract in 1992
    • Verify their ageing

✓ Polishing & testing
  – SiC segments + edges (SESO, REOSC)
  – Edge control (UCL)

✓ Coatings (study + samples)
STUDIES, PROTOTYPES AND BREADBOARDS.

WP 6100: Structural ropes application for ELT.
WP 6200: Composite structural element for the ELT.
WP 6300: Magnetically levitated systems & linear drives.
WP 6400: Characterization of the friction drive & bearing.

WP Manager: Enzo Brunetto (ESO)
WP Deputy: N. N.
WP 6200 - Composite structural elements

WHY ?

✓ All ELT concepts benefit from the reduction of mass of structural elements on critical areas.

SCOPE OF THE STUDY.

✓ Define alternative material to steel cylindrical pipes.
✓ Define fittings and mechanical interfaces.
✓ Define manufacturing and installation methods.
✓ Define maintenance criticality and concept.
✓ Define suppliers and costs.
✓ Friction drives

(AMOS, ESO)
AO-WP Management

- 100m-Layer WFS experiment
- 1st generation AO & MCAO design for ELTs
- Large format, high Density DMs R&D

- Novel AO concepts
- AO & MCAO simulations
- Algorithms for reconstruction & control

Adaptive optics
## Schedule-deliverables WP 9200

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**Configuration**

- **Input Meeting**
- **Des. Phase**
- **CDR**
- **Meeting**
- **Videoconf.**

*Opticon, Gott, April 2004*
The current generation of 8-m class facilities explores new operations paradigms from those of classical observatories.

Upcoming large, unique facilities (ALMA) will already enforce further evolution of such paradigms.

Technical and scientific operations of an ELT are expected to involve further significant differences.

An integrated approach to problems is proposed to ensure that operations exploit the full capabilities of telescope and instrumentation at the highest efficiency.

The goal is to generate level one requirements for the telescope based on the astronomical goals and the needs of the auxiliary instrumentation.
3 POINT DESIGN STUDIES (PDSs: €433k)

- WFSPEC – Wide Field (5 – 10 arcmin) seeing-limited (or boundary-layer corrected) SPECtrometer (Lyon)
- MOMSI – Optical /NIR Multi-Object & Multi-field Spectrometer & Imager (1-2 arcmin MCAO-corrected FOV) (UK ATC + Durham)
- MIDIR – MID-IR diffraction-limited high-resolution spectrometer/imager (1-2 arcmin MCAO-corrected FOV) (Leiden + MPIA)

and....
...and 6 Small Studies (SSs: €82k)

- Planet Finder – High dynamic-range (coronagraphic) imager/spectrometer (UKATC + Durham, ANU: higher level)
- HISPEC – O/NIR high spectral resolution instrument (AAO + ANU higher level?)
- HiTRI – High Time Resolution Instrument (UIG)
- GRB-Catcher – Fast-response broad-band imaging spectrometer for transients (AAO)
- SCUBA-3 (alias SCOWL) – Submm imager (UKATC)
- ADC: Atmospheric Dispersion Correction – Basic Study of “AO” aspects of ADC (UK ATC + Durham + AO WP Gp)
- Innovative instrument designs search (Durham + Oxford)
  * ALSO: Meudon group seeks to study “Falcon” AO button WF facility
And more …

- Top level ELT requirements (Salinari, Hook)
- Enclosure & infrastructure concepts (Pescador, Quattri)
- Standardized site testing equipment & measurements, environmental impact study (Vernin, Munoz, Sarazin)
- System modeling, development of software tools (andersen, Koch)
Getting ready
...we’ll know more in June / July