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# Status of the ESO ELT

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**Abstract.** The 100 m OWL ESO Concept Study has undergone a full review early November 2005. The development of the concept, the conclusions of the review panel and the planned post-review actions for the European Extremely Large Telescope (ELT) to be built by ESO in the next 10 years are presented and discussed.

**Keywords.** telescopes

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## 1. Development of the OWL concept

Since almost 10 years, ESO has pursued the conceptual study for a giant optical-infrared telescope with a primary mirror diameter up to 100 meter, dubbed OWL for the eponymous bird's keen night vision. What started at first as a low-key evaluation of the main promises and challenges associated with such a daring endeavour picked up much momentum in the last few years. In December 2004, an ESO Council resolution mandated the organisation to "lead in the construction of an ELT on a competitive timescale," with the by then close to completion OWL concept study seen as the feasibility study for the next ESO-led large project beyond ALMA.

Design of the OWL facility has essentially been an ESO internal effort, with right from the start considerable feedback to and from industry but only a few ad-hoc contributions from within the ESO community. One important exception has been the building over the last 4 years of a thorough science case for a 50–100m ELT by a large segment of the European astrophysical community under the aegis of the OPTICON programme. This has been done in close connection with the OWL team. An executive summary of this science case can be downloaded from `http://www.astro-opticon.org/`. Moreover, preliminary definition and analysis of a potential OWL instrument suite that could cover the science case has been accomplished in the last 12 months through an ESO-coordinated intense community effort (see "OWL instrument concept studies," G. Monnet & S. D'Odorico, this workshop).

Construction of an ELT of any size – and even more if up to 100m – requires to first establish a significant number of new enabling technologies through an extensive R&D programme. Early collaboration with industry has led to substantial progress in a number of crucial telescope design areas such as serial production of (spherical) mirror segments either in glass or SiC, cheap yet high performance position actuators, large deformable mirrors, etc. The launch 4 years ago of $2^{nd}$ generation VLT instruments has led to the development of a number of OWL "pathfinders," in particular KMOS, Planet Finder, MUSE and the VLT Adaptive Optics Facility, largely by the ESO community (for more information, see `http://www.eso.org/instruments/` and `http://www.eso.org/projects/aot/`). In addition, a significant part of the R&D associated with this effort is being conducted through OPTICON.

These ELT-related R&D efforts are now accelerating, with a 5-year technological programme started by the European astronomical community and a number of European industry through the EC-sponsored FP6 ELT Design Study (see the ELT-DS paper by Ardeberg *et al.*, this workshop). With a consolidated 30.5M€ budget (including 8.4M€ from FP6), it is aimed at establishing generic technologies critically required for any ELT through the development of new concepts, advanced components, realistic simulations, breadboards and prototypes.

## 2. OWL conceptual study review

The OWL conceptual study was completed and its results collated early October 2005 in the so-called "Blue-Book" report. The files are accessible online at `http://www.eso.org/projects/owl/Phase_A_Review.html`.

A comprehensive review of the Blue Book report has been conducted by an international review panel on November 2-5, 2005. Its membership was: R. Davies, Oxford University (Chair); J.G. Cuby, LAM-Marseille; B. Ellerbroek, Thirty-Meter Telescope; D. Enard, formerly VIRGO; R. Genzel, MPE-Garching; J. Oschmann, Ball Aerospace; R. Ragazzoni, INAF-Arcetri; L. Ramsay, Hobby-Eberly Telescope; S. Shectman, Carnegie Observatories; L. Stepp, Thirty-Meter Telescope.

First objective of the review was to assess whether, or to what extent, the proposed technical feasibility solutions were reasonable, i.e. judge the OWL approach strengths and weaknesses, analyse feasibility issues, evaluate cost and schedule estimates, identify the main risks of the project and areas to be further explored. The second one was to recommend whether and how to proceed to a next phase of the project.

The review panel praised the OWL team for an extensive and largely successful feasibility study for a 100m ELT, having in particular succeeded in breaking the well-know – and potentially lethal – $D^{2.6}$ cost law. A much more shallow law of $\sim D^{1.3}$ has been established instead, notably owing to serial production of identical mirror segments, standardised mechanical parts and actuators. Another strong technical point stressed by the panel is the integrated approach chosen for the OWL active and adaptive optics system with in particular at least one large adaptive mirror as an integral part of the telescope design.

Substantial technical risks were however identified, associated with the OWL large segmented secondary mirror, the highly aspherical M4 mirror in the central corrector and the telescope sheer size, which makes it decidedly Laser Guide Star "unfriendly." In view of these technical risks, but also of a too high consolidated cost (∼1.2G€) compared to likely available resources in the 2008–2020 period, the review panel recommended that ESO proceed to a detailed design phase aiming for a smaller diameter, less complex and less risky ELT. The panel emphasised that most of the OWL design effort and virtually all technological developments started so far were directly useful for this new phase. In addition, it recommended to strongly involve the ESO community in all aspects of the project and to speed up the currently running ELT site selection programme, with additional attention given to start government level negotiations for site access as early as possible.

## 3. The European ELT: post-review actions

Following the review, and after ESO Council approval in December 2005, the planned two-year consolidation phase towards the project has started along the lines laid out by the review panel. As has been stressed by the panel, most of the building blocks developed for OWL remain valid for a smaller size telescope and we expect to reach a basic reference design for what is now the European ELT project by the end of 2006.

Our goal is to define the best "affordable" ELT, which could be built on a competitive time scale and with acceptable risks.

Strong involvement of the community in all phases of the project was already recognised as essential by ESO. Following the panel recommendation, five community-led working groups have been created. Their role is to help and advise the ESO ELT Team in the complex iteration loops ahead, hopefully weaving successfully science, adaptive optics, instruments, telescope design and site requirements to freeze the basic choices and produce a coherent and powerful project.

**Acknowledgements**

The OWL study has been the combined effort of many people, both inside and outside ESO. We would like to thank in particular the OWL team at ESO for an exciting time and especially an exhilarating half year during the preparation of the OWL Blue Book. We are also grateful to the review panel for their timely report and for their constructive criticism.

**Discussion**

ZINNECKER: It was once argued that the critical size for an OWL-like telescope is somewhere between 60 and 70m aperture, so that the mass production of the mirror segments pays off. Is that still a consideration in the OWL post-review ESO ELT concept?

MONNET: We'll certainly strive to keep the mass production concept as much as possible. Clearly with the rather drastic reduction in collecting area, this will be possible only to a limit, after all, while getting a mild $D^{1.3}$ cost scaling law is great to make even a 100m mirror plausible; it also means that by scaling down the diameter, the cost gain goes by the same factor!

COLLESS: What are the implications of de-scoping from a 100m ELT to a 40–60m ELT for the detection and study of exo-Earths?

MONNET: The impact is clearly large. There is a silver lining however: the gain in extraterrestrial planets detection scales essentially as $D^4$ and even a 'puny' (but already highly ambitious) 42m telescope would gain a factor 4 with respect to TMT. Earths around G2V stars are out, but super-Earths around cooler stars may well being reached — the Universe will be kind to us as always and provide the right objects.

DAVIDGE: I notice that the estimate costs are not greatly different from those estimated for the TMT and Gemini. How do you plan to keep the costs down?

MONNET: For diffraction-limited instruments it comes directly from their invariance with respect to telescopes diameter (with the caveat that it is only true if the field is also scaled down with $D^{-1}$) – same thing for partially corrected instruments.
For seeing-limited instruments (e.g. CODEX), cost is maintained by applying the same concept of serial production as for the telescope (if here on much smaller numbers): CODEX is made of 5 identical spectrometers, each optimized for minimal unit cost.