OWL CONCEPT OVERVIEW

Philippe Dierickx and Roberto Gilmozzi
European Southern Observatory

Abstract

As a series of 8- to 10-m class telescopes come into operation worldwide, the scientific challenges these instruments do already address, together with their space-based counterparts, imply that the increase in light-gathering power and resolution of the next generation of telescopes will have to exceed conventional scaling factors. Indeed, it seems unavoidable that the same progress in telescope diameter and resolution achieved throughout the century must now be realized within at most a couple of decades. The technologies required for such extrapolation appear realistically to be within reach. Large telescopes successfully commissioned within the last decade have demonstrated key technologies such as active optics and segmentation. Furthermore, current design methods and fabrication processes imply that the technological challenge of constructing telescopes up to the 100-m range could, in some critical areas, be simpler than those underlying, two decades ago, the design and construction of 8- to 10-m class telescopes. At system level, however, such giants are no size-extrapolated fusion of VLT and Keck, but fully integrated adaptive systems. We elaborate on the OWL concept of a 100-m telescope with integrated adaptive optics capability, identify major conceptual differences with classical, non-adaptive telescopes, and derive design drivers accordingly. We also discuss critical system and fabrication aspects, and the possible timeline for the concept to be realized.

1 Introduction

Over the past century, successive generations of ground-based telescopes have seen their aperture increase by about a factor two over each generation. For more than half a century, the Hooker 100-inches and the Hale 200-inches telescope roughly set the standard in telescope design, which virtually all large telescope copied, until the commissioning of the Russian 6-m in the 70's. The largest telescopes currently in operation or planned are completely different concepts, which bear little resemblance with their former counterparts. They may be a factor two larger in aperture size, but the comparison stops there. In many respects, the most recent large telescopes could be seen as precursors of the next generation rather than follow-ups of the previous one.

Substantial size extrapolation is made possible by a combination of three factors. First, it must allow fundamental science objectives that would otherwise not be attainable. Second, it must be feasible within reasonable technology and engineering constraints. The third and eventually most determinant factor is affordability, in a broad sense.

Science objectives are largely determined by accomplishments made with present and past telescopes. Planning ahead into the next decade, those will include NGST and interferometers such as VLTI, on top of HST and of a series of 8- to 10-m telescopes which will soon receive adaptive optics capability. Sub-millimetric astronomy, with the Atacama Large Millimetric Array (ALMA) will more than plausibly attack unprecedented challenges as well. Radio astronomy readily provides sub-milliarc second resolution. There is, indeed, unprecedented scientific motivation[1,2] for the next generation of optical ground-based telescopes to have extremely large apertures, much larger than twice those existing today, and to attain the theoretical resolution such aperture would permit after correction of atmospheric turbulence.

As of today, technology readily allows extrapolation well beyond the traditional factor two per generation. This factor was arguably the direct consequence of the tremendous difficulty of scaling up mirror substrates. Optical fabrication processes are inherently complex, and even a minor extrapolation may represent substantial risks and require heavy investments. All modern telescope projects gave top priority to developing mirror technologies overcoming this problem. All succeeded remarkably well:

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1. Active optics telescopes like NTT, VLT, Subaru and Gemini demonstrate the feasibility and virtue of active optics and automated control of optical quality;
2. The Keck telescope demonstrates the feasibility of segmented optics;
3. The Hobby-Eberly telescope demonstrates that large segmented mirrors can be made at very low cost.

By allowing increase of aperture size without corresponding extrapolation of mirror fabrication processes, optical segmentation potentially eliminates the limitation that traditionally sets the maximum aperture size to that allowed by optical fabrication and processes. Taking into account the mirror technologies demonstrated by the above-mentioned projects, the technological size limitation for the future telescope generation has to be found either in the control, mechanics, or adaptive optics.

Control complexity increases roughly like the aperture area, but related technologies progress very rapidly and there is no conceptual difficulty in transposing current solutions to dimensions far larger than currently available.

Mechanics is certainly more demanding. Assuming a site with low wind speed, use of advanced materials for critical structural parts, active optical components and moderately lightweight segments, the upper limit for a passive structure is according to our preliminary estimates of the order of 150-m height and/or width. Use of conventional, demonstrated technologies for the mirrors and the mechanical structure will probably lower the figure to about 120-m.

The limitations imposed by adaptive optics are still to be evaluated. There are, actually, physical reasons in favor of telescope aperture in the 80-m range and beyond[3]. Current developments in the area of adaptive mirrors, wavefront sensors and control strategies may allow the enormous potential of tomographic adaptive optics to be realized within the next decade. This area, however, should receive top priority within the next years.

The European Southern Observatory has initiated a phase A study for a concept of a 100-m class optical telescope, dubbed OWL for *OverWhelmingly Large*, with multi-conjugate adaptive optics capability. For the reasons outlined above, we consider a diameter of 100-m to be somewhat below the limit permitted by demonstrated technologies, adaptive optics set aside.

According to our estimates, the cost of OWL would be on the order of • 1 billion i.e., about three times that of the VLT program. Assuming that tomographic adaptive optics and associated technologies could be demonstrated within the next 3 to 4 years, the telescope could become fully operational within about 18 years, with an earlier start with limited (but already unequalled) capabilities within less than 16 years.

The conceptual design phase has started very recently and proposals made in this article should be considered as very preliminary. Effort initially concentrated on feasibility of the telescope optics, and has now shifted to mechanics. In both areas, results are more promising than anticipated.

2 Top level requirements

The science objectives of OWL are described elsewhere[2] but can be summarized in two main requirements. The first is angular resolution such as to allow resolving galaxies that look barely – and tantalizingly! – resolved in HST and future NGST images. This means resolutions comparable to what is already achieved/achievable with current or planned interferometric instruments (i.e. ≤ 0.001”).

The second requirement is extreme sensitivity to faint fluxes, ideally affording the detection of Cepheids out to redshifts $z \leq 1$, thereby measuring $H(t)$, and to detect *any* supernova since the beginning of star formation in the Universe (z possibly ≥ 10, i.e. $m - M \geq 50$), implying a limiting magnitude of ~ 38.

This translates directly into a telescope with diffraction limited performance corresponding to $D \geq 100$m, and to a collecting area $\geq 6000\text{m}^2$ with a goal of 7000 m^2 (i.e. again $D \geq 100$m).

The field of view requirement is set to 2 arc minutes with a goal of 3. This is considered a reasonable compromise between the astronomers’ wish of having it as large as possible (the “scientific efficiency” being proportional for most scientific goals, and especially in observational cosmology, to collecting area, contrast, and field of view) and obvious obstacles, both astronomical (e.g. dynamic range problems due to bright objects within the field) and technical (e.g. optical design complexity increasing very rapidly with the field of view).

The wavelength coverage should include the full ground window (optical and near infrared). Apart from the scientific arguments in favor of this requirement, a strong impulse is also given by the consideration that achieving milliarcsecond resolution imaging at these wavelengths from the ground would avoid the need for space telescopes working in this domain: if diffraction limited performance is achievable from the ground, an equivalent facility in space would have to have essentially the same dimensions, with costs orders of magnitude higher. It is clear that while many cosmological studies will have to be done in the infrared to compensate for redshift effects, many others, like primeval supernovae or the local Universe, would need access to much bluer wavelengths.

The wavelength range is set to 0.3 – 2.5 μm, where a ground based 100m telescope would be much superior to e.g. HST and NGST. The goal is to reach 12 μm, where such telescope would be competitive with respect to space in high resolution spectroscopy and in the spatial resolution of the images.

Sky coverage should be as large as possible, but in any case no less than 40% using tomographic adaptive optics.

The optical quality requirement is set to *Strehl Ratio > 20%* at λ=500 nm and above, over the entire science field of view and after adaptive correction of atmospheric turbulence with a seeing angle of 0.5 arc seconds or better. We tentatively split this requirement into telescope and atmospheric contributions:

- Loss of Strehl Ratio associated with all error sources except atmospheric turbulence ≤ 30% (goal ≤ 20%);
- Loss of Strehl Ratio associated with atmospheric turbulence ≤ 50% (goal ≤ 40%).

The optical quality requirement implies that part of the telescope errors have to be compensated by the adaptive system.

3 Engineering and design considerations

The objectives of the phase A are, first, to elaborate a technical concept of a reasonably feasible 100-m telescope fulfilling the requirements set forth in section 2 above and second, to identify risk areas, to prioritize and plan development and design activities.

We give very strong priority to demonstrated feasibility, in a broad sense. Proposed solutions must not only meet performance requirements; to the maximum possible extent they must also:

- be within the range of existing, demonstrated fabrication technologies;
- be affordable for the user community and *cost-attractive* to key suppliers;
- allow start of operation within a reasonably short schedule;
- allow reasonable transport, integration, maintenance and operation schemes.

Cost is evidently a major design driver. We tentatively limit capital investment to 1 billion •, including all necessary hardware, software and facilities required to make the telescope ready for operation in adaptive mode, with a palette of six instruments to be defined, and taking into account reasonable contingency.

Schedule constraints imply that development time be minimized wherever possible, which emphasizes reliance on proven technologies for long-lead items.

Taking these constraints into consideration, high cost, long-lead items such as the primary optics and telescope structure are best designed on the basis of a modular concept allowing economies of scale and reasonable integration and maintenance schemes. A modular design is also favorable with respect to fabrication, as it does not require dimensional scaling of fabrication and processes. Finally, in some critical areas it allows schedule optimization as module fabrication can, to a certain extent, start prior to completion of the overall system final design.

Once a concept is laid down, it is iterated with respect to individual module characteristics and complexity for optimal trade-off between cost, feasibility and overall system complexity. It should be noted that the conceptual design of OWL is still in progress i.e. module optimization has not yet started, and that full optimization is not part of the conceptual design phase.

As mentioned above, the first objective is to set up a baseline concept whose construction could readily be initiated. Advanced technologies are not ruled out but, at this stage, may only be incorporated into the design as alternative solutions. Depending on cost and performance merits of such alternatives, development and validation may evidently be considered in an ensuing preliminary design phase.

Design activities undertaken so far give confidence that a conservative concept can probably be consolidated in a fairly short time scale, exception being made for adaptive optics.

As ambitious as it may seem, the optical quality requirement generally translates, at subsystem level, into uncritical specifications. Taking into account active and adaptive correction capability, the allowable telescope wavefront error would be split into three components:

1. Low spatial and time frequency errors, to be covered by a suitable active optics budget, e.g. active forces applied to a suitable monolithic mirror (located in the corrector, see section 4 below).
2. Low spatial frequency errors with time frequencies outside the active optics range and mid-spatial frequency errors, to be compensated by the adaptive optics system.
3. High spatial frequency errors, uncorrected.

The first component may have fairly large excursion (up to ~100 waves of aberration for the lowest order terms). Contributions in this time and spatial frequency domain are expected to come essentially from misfigure of monolithic mirrors and misalignments.

The second component must have amplitude, time and spatial frequencies representing a minor fraction of the range permitted by adaptive correction (from a few waves to sub-micron aberrations, depending on spatial frequency). Contributions in this domain are expected to come essentially from segments misfigure (assuming segments larger than the sampling of the adaptive systems), local air conditions, and segments misalignments.

The third component must be well within the diffraction limit. Assuming adaptive systems tailored to an atmospheric coherence length of 200 mm in the visible, and a required Strehl Ratio of 70% with a goal of 80%, Fig. 1 shows the maximum allowable high spatial frequency wavefront residuals (uncorrectable terms) as a function of spatial frequency. The requirement illustrated in Fig. 1 does not appear constraining for optical fabrication. In this spatial frequency range, for example, the VLT primary mirrors are about an order of magnitude better than specified in Fig. 1. It is, however, constraining for allowable segmentation errors.

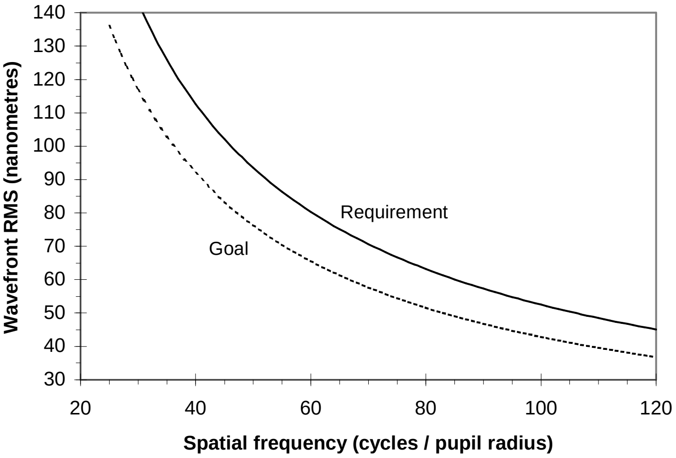

Figure 1. Allowable high spatial frequency wavefront errors (telescope only).

4 Telescope design

Optics

Top level requirements imply an entrance pupil diameter of 100-m with a focal ratio of f/60 for 15 µm pixel matching in the visible. At this stage, the design must accommodate for multi-conjugate adaptive optics with either laser or natural guide stars. The latter option evidently constrains the total field of view. According to current estimates[3,5], reasonable sky coverage in the visible would require 8 to 12 arc minutes field diameter with natural guide stars, and 5 to 6 arc minutes with laser guide stars. In the following, this field is called *technical field*.

Although OWL is designed as an adaptive telescope, it is convenient, at this point, to break the design down into telescope optics and adaptive modules. The design of the telescope optics is constrained as follows:

1. Segmented surfaces must be spherical.
2. Structure height must be minimized.
3. Monolithic mirrors must have diameters not exceeding 8.2-m.
4. The design must provide diffraction-limited optical quality within the science field of view.
5. The design must provide seeing-limited optical quality within the technical field of view.
6. Vignetting is allowed to the extent permitted by tomographic reconstruction of turbulent layers.

The first constraint results from cost considerations. Although aspheric segments could probably be made in a rather cost-effective manner (taking into account, in particular, the probable relaxation of specifications implied by adaptive correction capability), their fabrication inevitably implies additional cost items.

The first and second constraints imply a fast spherical primary mirror, which in turn implies a large, spherical and segmented secondary[6] and additional corrective optics for the compensation of spherical and field aberrations. The subsequent complexity and loss of throughput should be evaluated in relation to cost. The higher fabrication cost of an aspheric mirror would most likely imply, within a given budget, a reduction of telescope diameter, hence a loss of collecting power and, worse, of angular resolution.

The third constraint results from the engineering considerations mentioned in section 3 above (mirrors this size have already been made). There is reasonable confidence that monolithic mirrors with diameters of about 10 meters could be fabricated (most probably in Silica) and this constraint might be relaxed at a later stage. Design activities performed so far indicate that this will probably not be necessary.

The fourth constraint is meant to exclude the need for compensation of design aberrations between the telescope and the adaptive modules, thereby permitting off-axis design of adaptive modules. The fifth constraint is based on the assumption that active and possibly adaptive wavefront sensing will be performed at the non-adaptive technical focus, which implies moderate wavefront excursion for reasonable sensing accuracy and range.

The last constraint is evident but its implications rather complex. It is cautious to assume, at this point, that adaptive mirrors will be quite limited in size, in particular if they involve micro-actuation devices such as MEMS or MOEMS. It may therefore be impossible to transfer the entire technical field through the latter. However, non-relevant atmospheric turbulence data, which correspond to layers areas not affecting the science field, need to be neither corrected nor sensed. The corresponding light rays may therefore be vignetted and adaptive mirrors sized accordingly.

Several design solutions have been explored, and two pre-selected for further optimization. These are four- and six-mirror solutions, with spherical primary and secondary mirrors[6] (Fig. 2). Both include two large aspheric mirrors, the six-mirror design having an additional aspheric mirror and a 2-m class flat. The latter would be ideally suited for field stabilization. There is no difficulty to achieve diffraction-limited quality over the science field. The most constraining factors are the total field of view and, with the six-mirror design, the need for suppression of the stray light associated with the strong spherical aberration introduced by the primary mirror. Secondary mirror diameter is on the order of 34-m and structure height on the order of 120-m. The four-mirror solution has a monolithic mirror larger than 8-m but at the time of redaction of this article, further optimization was in progress, all monolithic mirrors had been made smaller than 8.2-m, and the two designs had been brought to primary-secondary mirror separations below 100-m.

The selection of segments dimension is the result of a rather complex trade-off. Material and optical fabrication costs, together with mass, passive support complexity, maintenance and handling considerations point towards smaller and thinner segments. Actuation costs, control complexity, reliability considerations as well as diffraction effects and emissivity point towards larger sizes. At this point, the most conservative approach is to assume large segments size, because of the major impact of the primary mirror mass on the mechanical design (smaller segments translating into lower mirror mass, hence better mechanical design). Further analysis and industrial studies will be required to complete the trade-off, at which point telescope design iteration may become necessary. On-site mirror production being ruled out for technical and cost reasons, the segment size considered so far is 2.3-m flat-to-flat, which is the maximum dimension for cost-effective transport in standard containers. Within this limit, secondary mirror segments may be cut to more complex shape, in order to reduce the effect of field-dependent mismatch with primary mirror segments. Under this scheme and with a segment size of 2.3-m, the primary mirror would be made of about 1,400 and the secondary mirror of about 200 segments, the latter shaped to the contour of groups of 7 hexagons.

In order to reduce the range of the high accuracy segments position actuators, segments would be grouped into modules (most probably of 7 individual segments, with their individual support systems and actuators), each module being positioned by large range, sub-mm accuracy actuators.

Assuming standard quality Zerodur or Silica, fabrication of segments blanks of up to 2.3-m is fully within the reach of current technologies and would require only modest investment in suitable production facilities. As for optical processing, the most effective solution seems to be optical figuring on planetary machines, followed by one or two runs of ion-beam finishing much in the same way the Hobby-Ebberly segments were produced[7]. Optical replication[8] may be an attractive alternative, but the durability of the masters and the predictability of surface stresses would be serious issues. Total production time would not exceed 10 years, and could plausibly be brought down to 6-8 years. The estimated cost is on the order of • 28,000 per square meter, ready for on-site integration.

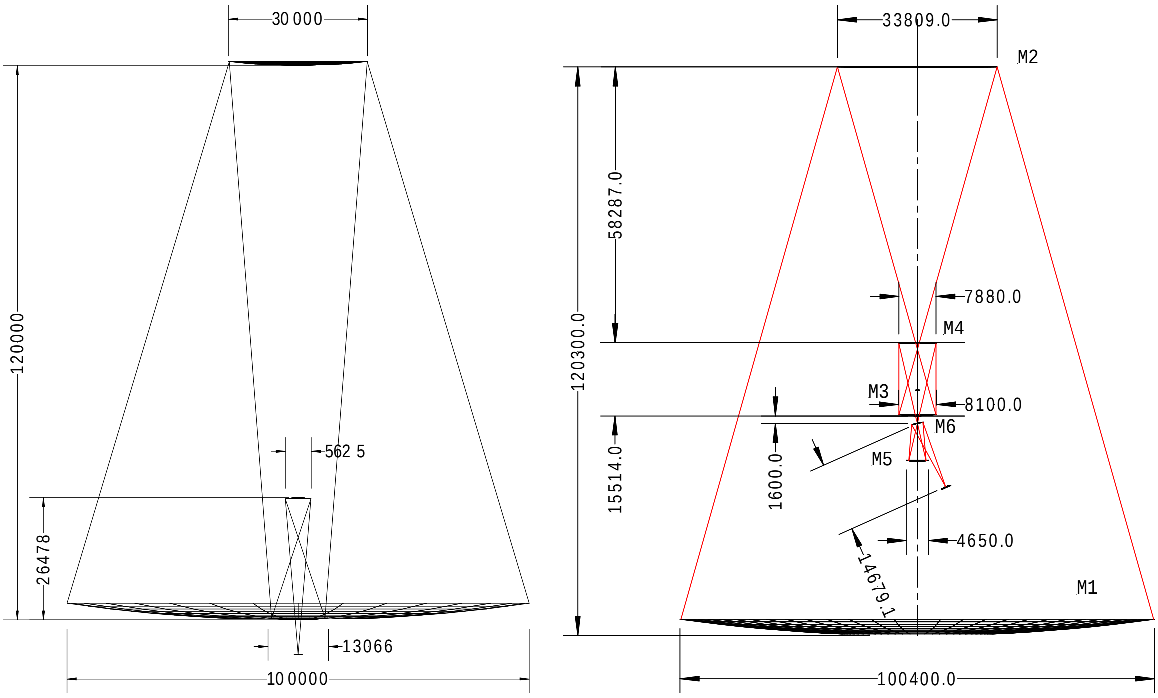

Figure 2. Optical layout. Left: two-mirror corrector; right: four-mirror corrector.

There are evident incentives to explore alternative materials providing low aerial density, in particular siliconized SiC. Suppliers feel confident that 2-m class SiC segments with aerial density on the order of 50 Kg/m^2 (to be compared with ~250 Kg/m^2 for glass-ceramics) could be supplied at the desired rate and with the same quality as with glass-ceramics. Although there are plausible reasons for such SiC blanks to be produced at competitive cost (e.g. relatively low material cost, fast process), the technology is not demonstrated and the authors feel that caution is mandatory when extrapolating optical fabrication processes. SiC is therefore not considered as a baseline, but its development for application to the OWL project should nevertheless receive high priority.

Adaptive optics set aside, the most challenging optical fabrication aspect of OWL is the highly aspheric surface required for the correction of spherical aberration. The progress of optical fabrication over the last two decades is such that generation of strongly aspheric surfaces to diffraction-limited quality is not any longer an issue per se. Virtually all technologies developed so far –be it stressed lap, small tool computer-controlled, membrane polishing or ion-beam finishing- have fulfilled their promises[11]. Any optical figuring technique, however, requires a suitable test method. The designs presented above have therefore been verified in this respect, and null-test set-ups identified for the most aspheric mirrors[6].

Adaptive optics is undoubtedly the most challenging aspect of OWL, and requires substantial extrapolation from existing technologies. An Adaptive Optics module for OWL would include 2 or 3 adaptive mirrors with 50,000 to 500,000 active elements each, for tomographic atmospheric compensation in the near-infrared and in the visible, respectively. The conjugation between adaptive mirrors and atmospheric layers appears to be uncritical and recent work indicates that the number of adaptive mirrors may be lower than the number of turbulent layers without substantial loss of performance.

Under fairly conservative assumptions, it can be shown[5] that a sky coverage on the order of 40% could be achieved with a Natural Guide Star (NGS) system, provided that the telescope provides a technical field of about 12 arc minutes diameter, the maximum allowed by our current designs. A Laser Guide Star (LGS) system would allow a reduction of the technical field of view to about 5-6 arc minutes and lead to substantial simplification of the telescope optics.

Mechanics

Two mechanical concepts[12] are being elaborated in parallel to the optical designs. Structural parts are standardized to the maximum possible extent, taking into account fabrication, transport, and integration constraints. As optical design is still progressing towards shorter structure height, virtually no design optimization has been done so far. Fig. 3 shows a preliminary concept of an all-steel structure for the 6-mirror solution. It is an alt-azimuthal design, where an azimuth ring embedded into the ground to minimize structure height above ground level replaces the conventional fork structure. The design incorporates primary mirror protection in the form of four independent covers (not shown in Fig. 3) sliding over the mirror when the telescope is pointing vertical. One of the covers would be equipped with mirror cleaning and handling tools. With this concept the telescope can point to horizon for maintenance and in stand-by mode. Total mass is about 20,000 tons. In proportion to size, the structure concept is about one order of magnitude lighter than existing 8-m class telescopes. The first eigenfrequency is a pure rotational mode about the optical axis at 1.1 Hz; the first significant global mode is above 2 Hz.

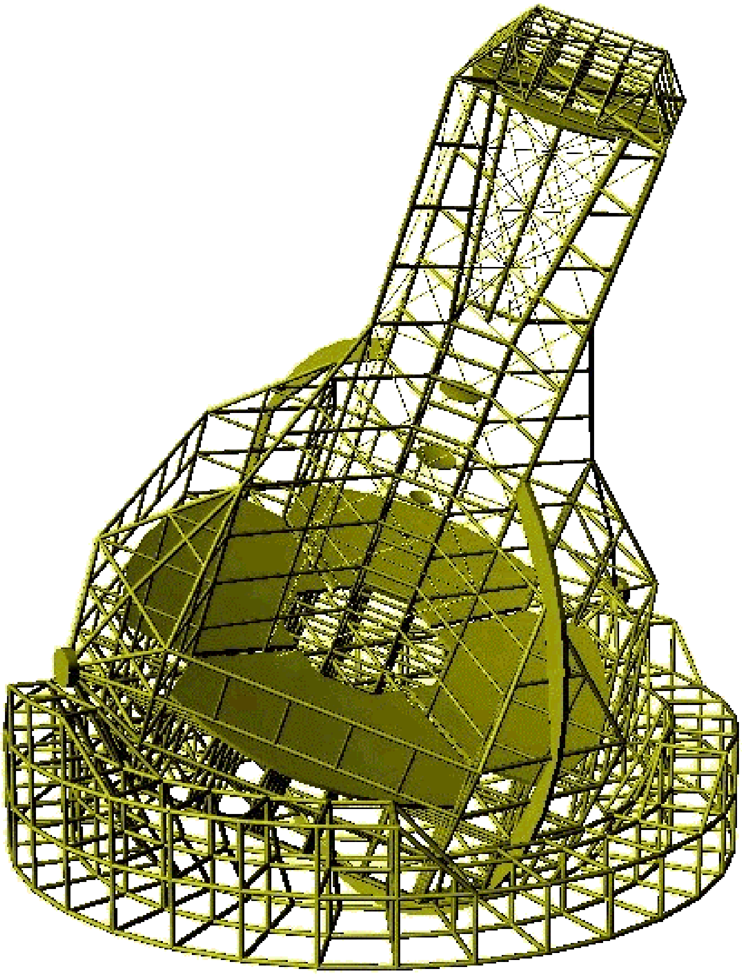

Figure 3 Telescope structure and azimuth tracks (6-mirror optical design)

Static primary-secondary mirrors decenters between 0 and 60º zenithal distance are on the order of 40 arc seconds tilt, 65 mm lateral and 10 mm axial. Preliminary analysis indicate these decenters need to be compensated within an accuracy of ~5%, residual effects being taken care of by active optics (decenters of suitably chosen elements of the corrector). The effect of static wind load is found to be negligible up to ~10 m/s; dynamic loads can however become an issue and may require vibration-damping mechanisms[12] to be incorporated into the design. These damping systems could also improve survival in case of earthquake.

Segmented drives comparable to those of the VLT elevation drives would achieve acceptable kinematics: 3 minutes for 90º elevation range, 12 minutes for 360º azimuth range, maximum centrifugal acceleration not exceeding 0.1 g at any location of the structure, and 1 degree zenithal blind angle. The number of motor segments would be on the order of 200 for elevation and 400 for azimuth.

The designs being in a very early phase, these numbers are only indicative and improvement is certainly possible. The designs must also be optimized with respect to criteria other than mass, inertia, and stiffness. Relevant constraints include cost, fabrication, transport, integration and maintenance (including handling and safety aspects), on top of optical obstruction, residual stresses, environmental loads, thermal inertia, and dust accumulation.

It is assumed that the telescope will operate in open air, a constraint that calls for a site with appropriate wind characteristics and relatively fast segments actuation. During daytime and under adverse meteorological conditions, the telescope would have to be protected by a movable enclosure. Assuming that the telescope can point to horizon (to minimize enclosure height) and is located in a seismically stable area, we do not expect the design and erection of such enclosure to be of critical concern. However, no design activity has been undertaken so far and potential costs have not been explored yet.

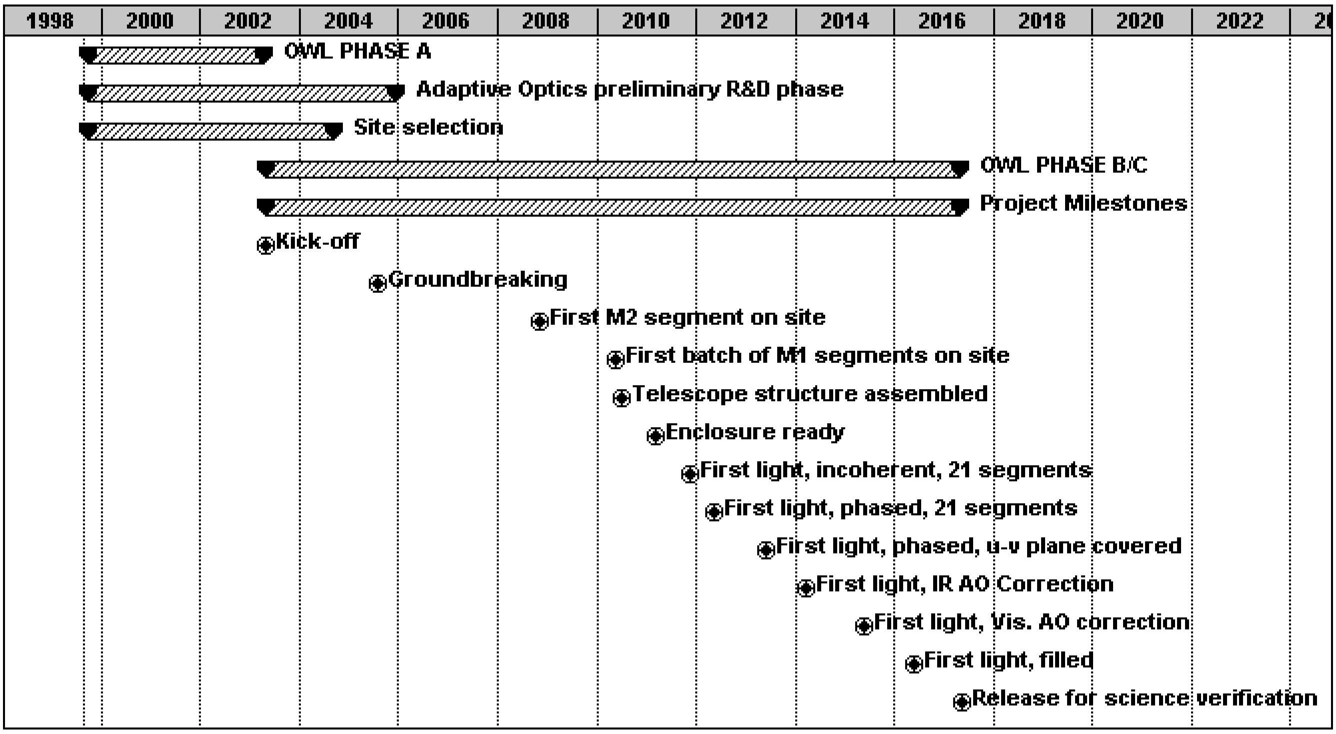

Figure 3 Major milestones

5 Schedule and cost estimates

Schedule and cost estimates have initially focused on the telescope optics, the production of the primary mirror segments being initially thought to be on the critical path. Discussions with potential suppliers showed that this assumption was pessimistic: continuous operation of the planetary polishers being desirable for machine stability, all segments could be delivered within 6 to 8 years production time. A first iteration places civil works, telescope mechanics and enclosure on or near the critical path for the technical first light (first light with ~21 segments, seeing-limited, incoherent). Subsequent events mostly depend on segments

1	OPTICS	378	
1.1	Primary mirror unit		295
1.2	Secondary mirror unit		34
1.3	M3 unit		14
1.3	M4 unit		21
1.3	M5 unit		5
1.3	M6 unit		8
2	ADAPTIVE OPTICS	50	
2.1	Prototype		5
2.2	Visible AO module		30
2.3	IR AO module		15
3	MECHANICS	244	
3.1	Nodes		31
3.2	Beams		35
3.3	Rocking chair & azimuth tracks		51
3.4	Cable wraps		5
3.5	Bearings		30
3.6	Drives		20
3.7	Mirror shields		15
3.8	Adapters		6
3.9	Erection		50
4	CONTROL SYSTEMS	17	
4.1	Telescope Control System		5
4.2	M1 Control System		8
4.3	M2 Control System		2
4.4	Active optics Control System		2
5	CIVIL WORKS	175	
5.1	Enclosure		60
5.2	Technical facilities		30
5.3	Site infrastructure		20
5.4	Concrete		65
5	INSTRUMENTATION	45	
TOTAL WITHOUT CONTINGENCY		908	
CONTINGENCY	10%	92	
TOTAL		1000	

Table 1 OWL Cost estimate

integration rate. According to this first iteration, segments could be delivered at least one year before they are needed on the site. On-site storage could be easily implemented at minor cost (about 200 segments i.e. ~15 standard containers) and therefore the segments integration rate, currently planned to correspond to about one module per week, could be adjusted after technical first light to allow earlier completion. For example, duplicating the on-site segment integration line would provide scheduling flexibility after structure integration. We feel, however, that further consolidation is necessary before considering a fast-track mirror integration approach.

The schedule is tentatively drawn on the assumption of a three-year phase A leading to a proposal approved by mid-2003. Figure 3 shows major project milestones, as derived from current estimates, and illustrates nothing more than what we currently believe to be possible from a pure technical point of view. Science operation could start, on a reduced basis, at a rather early stage. It could even be envisaged that a first generation of instruments be specifically built to this end, e.g. a high resolution spectrograph to be operated in non-adaptive mode as early as 2013 (with a telescope collecting power equivalent to a ~25-m aperture and increasing rapidly) and a high resolution near-IR imager to enter into operation by the end of 2014.

The schedule encompasses approximately 8 years of R&D for adaptive optics, including ~3 years during phase A.

The budget is tentatively fixed to 1 billion Euros, and the contingency adjusted according to total cost estimates (table 1). The figures given for the telescope optics and mechanics represent estimates; all other figures should be considered, at this stage, as allocations.

The spending profile would most likely ramp up after groundbreaking, and decrease progressively after technical first light.

6 Conclusions

ESO has started a Phase A study of OWL, a concept for a 100m filled aperture telescope. Preliminary designs and analyses of the most basic aspects of the project, in particular optics and mechanics, have shown that no obvious show stoppers can be identified even at a level substantially more advanced than our original study[11]. The current preliminary baseline design is considered “feasible” with today’s technology at “reasonable” cost (below one billion Euros) and schedule (less than 20 years).

Our plans include consolidation of the baseline design within the next year or so, including an optimization phase to begin studying in detail the major subsystems and the start of a vigorous program of R&D on multi conjugated adaptive optics. We will also begin in earnest to search for a possible site, as site characteristics are crucial in determining several key aspects of the optical and mechanical designs as well as in setting the requirements for the adaptive optics.

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