to check the performance of the telescope under realistic observing conditions. The telescope routinely matches the outside. The active optics is run in continuous closed loop.

FORS, the first instrument to go on to the telescope in September, is already being re-integrated on the mountain, and ISAAC, which goes onto the telescope in November, is already integrated in the Control building.

A first commissioning/installation of the data-flow software was undertaken by Peter Quinn, Michèle Péron and Miguel Albrecht in June. All data from UT1 are now being archived immediately after they are taken. This includes the extensive operations logs that record all actions of the system. For example, all aberrations calculated in every active optics calculation are logged. All temperatures of the telescope, and there are many, are also logged. Every preset, offset, change in guide star and many other actions are logged. All telescope errors or unforeseen events are also logged. We use this information to better understand the telescope and how it can be optimised.

A lot of work remains to be done. The tertiary mirror will go into the telescope in August and the Nasmyth foci can then see light for the first time. The Linear Atmospheric Dispersion Compensator for the Cassegrain focus also goes into the telescope in August. Commissioning of the Nasmyth foci will take place between instrument installations. A better understanding of the dome louvers and how they affect the telescope performance is high on our priority list.

Science verification of the telescope is scheduled for the dark run in August, and we fully expect some beautiful data to result from these two weeks.

The cast of people working towards a successful VLT is too great to mention explicitly in such an article. The administrative support both in Garching, Santiago and Paranal that somehow managed to get all the pieces onto the mountain in time are thanked. Isabel Osorio was ever present and helping with pretty much everything. We also thank La Silla for providing us with coating facilities. Special thanks are due to Armin Silber, Enzo Brunetto, Mario Kiekebusch, Olaf Iwert and Claudio Cumani who all worked to get the test camera going; Marco Quattri who spent most of the northern winter on the mountain monitoring the erection of the telescope; Mathias Hess who worked tirelessly on the M1 cell and the transport of the mirror and then missed first light by a few weeks; Jean-Michel Moresmau who managed to fit the Cassegrain adapter into the cell and hook up all those little cables and wires; Manfred Ziebell who never stopped worrying about everything and anything and Michel Duchateau who worried about all the little details like emergency stop buttons; Jörg Eschwey and the facilities department on Paranal who built most of the things around us and who also switched all the lights off in the base camp; Canio Dichirico who made sure we had power when we needed it; Bruno Gilli, Gianni Raffi, Giorgio Filippi and others in the software group who kept us on the true path. Of course, we thank the entire VLT division in Garching for designing and building such an excellent telescope; our system and network administrators on the mountain, Chris Morrison, Nick Lock, Marcelo Carrasco, Sebastian Lillo, Graeme Ross, Mark Tadross and the ever present Harry Reay who made sure all systems were ready. We apologise to all that we have missed in our thanks.

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# The Cost of the VLT

*Text of a Report of the ESO Director General to Council at its (extraordinary) meeting of September 15, 1998*

The purpose of this document is to provide an overview of the VLT cost evolution since 1987, and an estimate as of to-date of the total cost of this project at ESO until the completion of the VLT/VLTI in 2003. The total cost we quote includes the external contractual costs, the internal labour and other costs directly VLT-related, the development of the Paranal Observatory and its operations until 2003. This is the date that will see the completion of all 8-metre telescopes, the auxiliary telescopes and all approved instrumentation. It does not include the manpower costs at member state institutes contributing to the instrumentation programme.

The information compiled here is extracted from documents already submitted to Council. However it appears useful after the successful completion of first light, which removes any major technical uncertainties, to present a summary giving Council a global perspective on the project.

## 1. The VLT Contractual Cost

The VLT Programme was approved in 1987 on the basis of a proposal known as the “Blue Book”, which gave a cost estimate of 524 MDM (1998 prices) for the external contracts, including 34.8 MDM (1998 prices) for VLTI.

Since then the scope of the VLT Programme has evolved considerably to include some major new features and more complex solutions. These include the introduction of a Cassegrain focus and adapters with their subsequent impact on the M1 Cell and Main Structure, sophisticated test cameras, a time reference system, astronomical site monitors, etc.

In 1993 a complete Cost to Completion analysis was performed (Cou-483 and Add.) and subject to an external audit in 1994. Council subsequently approved a VLT Programme for 592 MDM (1998 prices) in which the Interferometry part had been postponed and its funding reduced to 7 MDM (Cou-516 conf.).

ESO worked out a recovery plan for the VLTI, which was presented to Council in 1996. The cost of this new plan (32 MDM in 1998 prices) was financed by reprogramming within the VLT and Instrumentation programme, by an additional contribution of 10 MDM by MPI and CNRS and through release of contingency funds.

Thus in the period 1994 to 1998 we have not changed the VLT programme cost to member states while fully restoring the VLTI programme.

The current VLT cost ceiling of 602 MDM for external contracts appears quite firm since we are at a point in the programme where we have committed 87% of the contractual cost. The increase of 15% with respect to the Blue Book Value of 1987 is fully justified by the substantial changes in scope of the project mentioned above.

## 2. Total Cost of the VLT Programme

The Blue Book did not provide an estimate of the total cost (including ESO staff and other internal costs). An evaluation of the VLT-related internal costs, i.e. engineering costs in Garching and site costs at Paranal, was performed in 1993 and also subject to the 1994 external audit.

In 1996 ESO submitted to Council a long-range plan to bring the Organisation to the steady state of operations of the full VLT/VLTI (1996–2003) while implementing strict cost containment measures to meet a reduction in the projected mem-

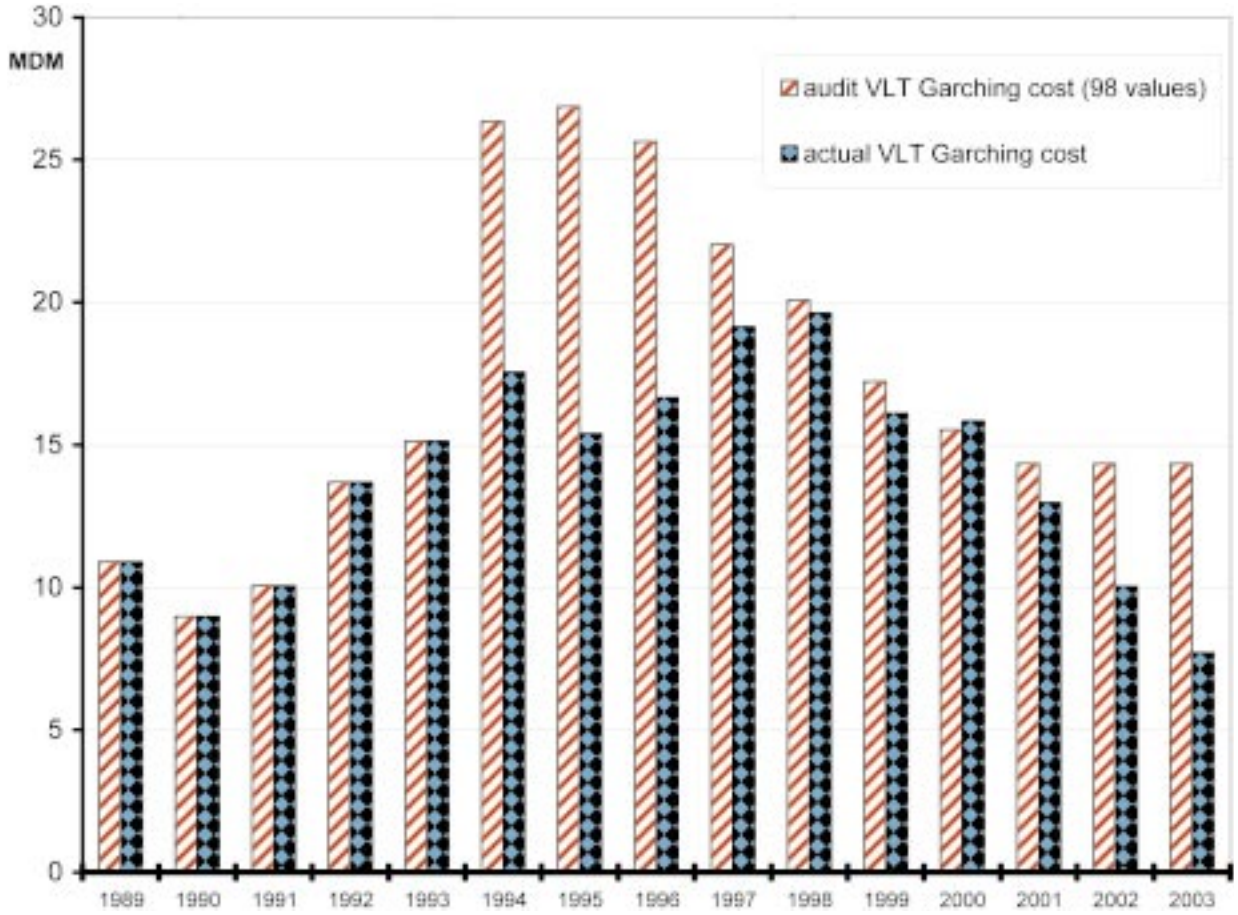


*Figure 1: VLT Garching cost (yearly) (ESO internal staff, operations and investments).*

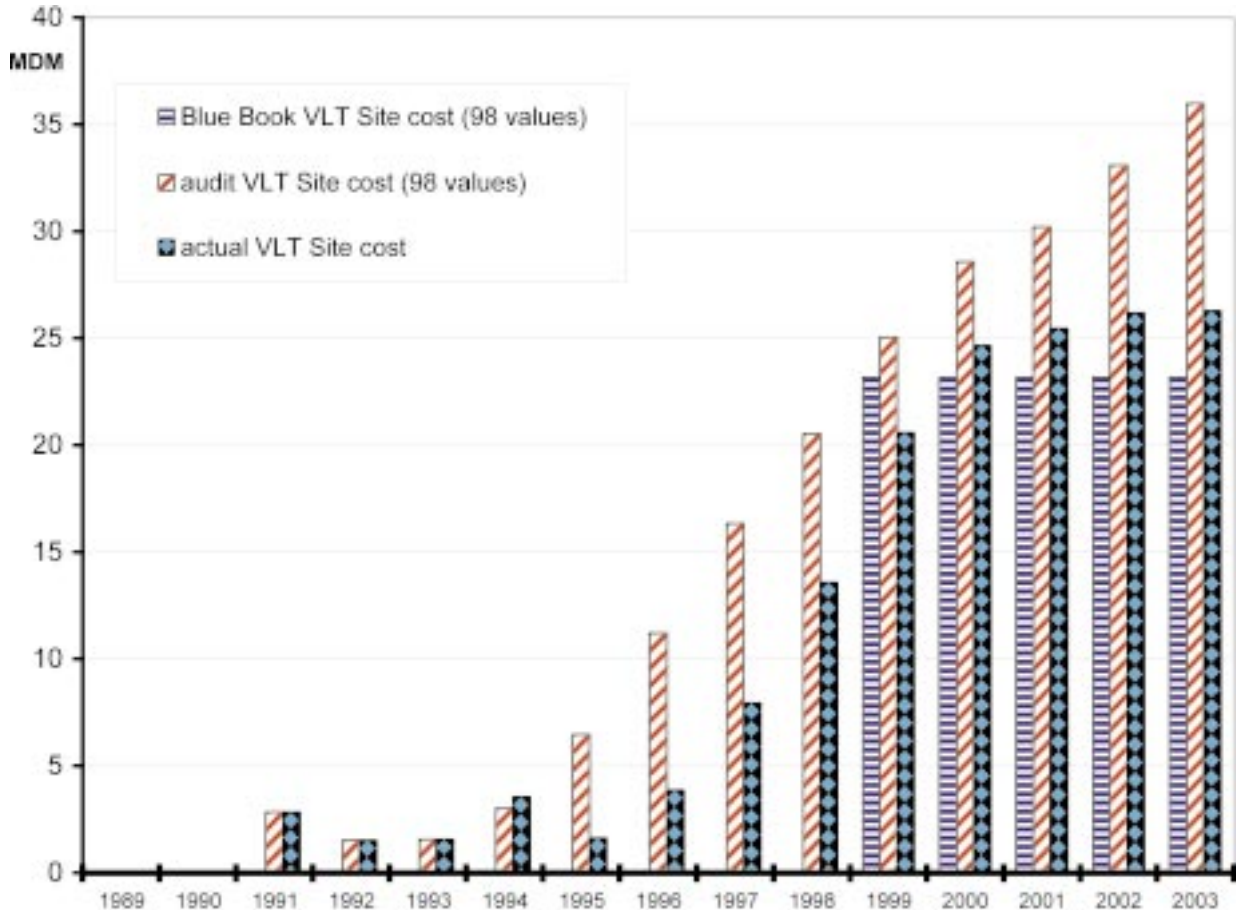


*Figure 2: VLT site cost (yearly) (ESO internal staff, operations and investments).*

| **1988** Organisation International Staff | 1988 staffing | share of total staff |
|---|---|---|
| Office of the Director General & Science | 24 | 16.4% |
| Administration (HQ & Chile) | 26 | 17.8% |
| Technical Support Division 40<br>VLT 14 | | |
| total Technical + Projects | 54 | 37.0% |
| Image Processing | 8 | 5.5% |
| La Silla Observatory | 32 | 21.9% |
| Space Telescope - ECF | 2 | 1.4% |
| Grand total International Staff | 146 | 100.0% |
| Local Staff in Chile | 126 | |
| Fellows/ Paid Associates | 27 | |
| Visiting Astronomers | 310 | |

| **1998** Organisation International Staff | 1998 staffing | 1998/1988 increase | share of total staff |
|---|---|---|---|
| Office of the Director General & Science | 25 | 4.2% | 10.5% |
| Administration (HQ & Chile) | 38 | 46.2% | 15.9% |
| VLT 60<br>Instrumentation 50 | | | |
| total Technical + Projects | 110 | 103.7% | 46.0% |
| Data management & Operations | 25 | 212.5% | 10.5% |
| La Silla Observatory | 20 | -37.5% | 8.4% |
| Paranal Observatory | 15 | - | 6.3% |
| Space Telescope - ECF | 6 | - | 2.5% |
| Grand total International Staff | 239 | 63.7% | 100.0% |
| Local Staff in Chile | 151 | 19.8% | |
| Fellows/ Paid Associates | 34.5 | 27.8% | |
| Visiting Astronomers | 370 | 19.4% | |

*Figure 3: Evolution of ESO staffing between 1988 and 1998.*

ber states contributions and still restore the VLTI programme. Reductions in cost and delays in spending were also necessary to reduce the anticipated negative cash flow projections.

As a result, the actual internal cost of the VLT engineering in Garching between 1993 and 1998, and the projected estimates up to 2003 are in fact substantially lower than the 1993 estimate (Fig. 1).

The evolution of the Paranal site cost also shows a decrease (Fig. 2). Preliminary VLT operation cost after 1999 was indicated in the Blue Book. This is also given in Figure 2 for comparison.

The VLT total cumulative cost to completion (including the initial operations of the Paranal Observatory) is estimated to reach 990 MDM (1998 prices) in 2003. Thus while the contract costs increased from 592 MDM to 602 MDM (due to the additional contributions of 10 MDM for VLTI), the total VLT/VLTI costs at completion decreased from the 1994 estimate of 1060 MDM to 990 MDM (1998 values).[1]

## 3. ESO Overheads

The ESO organisation has substantially grown and evolved since 1988 to cope with a programme whose value in external contracts is 8 fold its 1987 annual budget (total cost 13 times the 1987 budget) (Fig. 3).

In 1988, the ESO staff complement was composed of 146 International Staff positions (ISM), 126 Local Staff in Chile (LSM), 27 Fellows and Paid associates (Fel/PA). In 1998 the staff complement includes 239 ISM (+64%), 151 LSM (+20%) and 34.5 Fel/Pa (+28%).

In 1988, 50 ISM (34% of the total ISM) worked for the Office of the Director General, Science Office and Administration. There are 63 ISM (26% of the total ISM) working in these areas in 1998. In these 10 years we have therefore decreased the fraction of the staff not directly engaged in programmatic activities.

The rest of the staff works directly for the core activities of ESO: VLT, Instrumentation, Paranal Observatory, Data Management and Operations, La Silla Observatory, and ST-ECF (Fig. 3). During the same period and even prior to the initiation of the VLT programme the number of astronomers using the ESO facilities (visiting astronomers) has increased by 20%. We expect this number to more than double when the VLT initiates science operations (April 1, 1999).

The comparatively low increase of the management and administrative resources is a very clear indication that the overhead cost of ESO in general has decreased compared to the era before VLT. (More detailed comparisons are difficult due to the accounting tools available in 1988).

## 4. Conclusion

In conclusion, the VLT contract cost ceiling has increased 15% in comparison to the Blue Book (1987), an increase which is fully justified by the technical evolution of the Programme scope. The cost which now includes a fully restored VLTI Programme has remained unchanged compared to the approved Cost to Completion of 1994. A comparison of the cumulative VLT total cost (including VLT contract cost, personnel cost, operations, site development and investments) at the time in 2003 when VLT will be in full operational phase shows a decrease from 1060 MDM to 990 MDM with respect to the estimates audited in 1994.

These results were obtained in spite of the contractual and overall cost increases due to the delays experienced in Chile as a result of the Paranal ownership issues.

At the same time, the Organisation has improved its efficiency by containing the growth of the administrative staff and reducing its proportion of the total.

Cost and technical performance at the level achieved on the VLT programme is rare among major scientific/technical enterprises and could not have been achieved without the professionalism, competence and dedication of the ESO staff.

1 Please note that all figures have been entirely updated to 1998 prices to provide for a coherent comparison, including the expenditure actually occurred in the past years, which accounting value would normally not be updated. The current "mixed" value of the VLT contracts is 574 MDM while the current "mixed" value of the VLT total cost estimate is 944 MDM.