The VLT – Genesis of a Project

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Maybe it is not reasonable to write the history of a project before it even gets started. On the other hand, it is the common lot of the definition and pre-definition phases of projects to be rapidly forgotten. First of all, this is unfair to the people who have played a decisive role for the project to exist at all. Secondly, the choices made during this "pre-history" tend to survive the reasons which justified them at a certain moment. Tracing back the origin of the main trade-offs can later on prove to be quite useful. This is why a project such as the VLT should be well documented. It is the reason for this paper to be written now, before this part of the VLT history is completely forgotten.

Looking back to the genesis of any large project, one is amazed by the incredible long time ideas need to mature before they materialize into realistic proposals. This maturation time is usually comparable to, if not longer than the project duration. Telescopes and their instruments are no exception. Nor is the VLT: the very first discussions on an ESO 16-m VLT started more than 10 years ago!

The idea that giant telescopes would be needed did not originate only at ESO. Several astronomical organizations, after drawing the lessons from the 4-m class telescopes of the "Palomar generation" built in the 60's and 70's, saw clearly the need for a new generation of larger and more powerful telescopes. A first conference was held at ESO in 1977 (Optical Telescopes of the Future). At that time the ESO 3.6-m telescope was completed, the MMT was well on its way and J. Nelson presented the first description of the 10-m University of California telescope (now the Keck telescope). Interestingly enough, J. Nelson's paper was classified in the proceedings in the "conventional large telescopes" section! This gives an idea about the enthusiastic and somewhat surrealistic atmosphere of the time.

As a result of this conference, a study group chaired by Wolfgang Richter was created at ESO and a very preliminary analysis of three fundamental solutions carried out in 1978/79, a single 16-m telescope, four 8-m telescopes and sixteen 4-m telescopes. Though no real agreement as to which solution was preferable could be reached, at the end of this study some persons preferred a 16-m segmented telescope, but no real solution was proposed for manufacturing and controlling the segments. The main reason advanced for this preference was the expected lower cost of a single telescope compared to an array.

At the same epoch, an extensive study of all possible concepts applicable to a 25-m telescope was being conducted at Kitt Peak, and Soviet astronomers had also some plans for a monster 25-m telescope.

At the beginning of 1980, just at the time when concrete work could have started, ESO was shaken by its removal from Geneva to Garching. During this year ESO lost most of its technical staff and it became necessary to concentrate the efforts on current projects: essentially the CAT/CES, the CASPEC, the 3.6-m prime focus camera, I.R. photometer, etc. . . . New staff members were being hired, and the technical division was being reorganized at the very moment when 2 new projects were softly landing in. The 2.2-m telescope, which was offered in loan to ESO by the Max-Planck Society, but which nevertheless needed a building as well as an upgrading of its electronics, and a 3.5-m telescope which became necessary after Italy and Switzerland decided to join the organization. The ESO scientific community was becoming larger, and new observing facilities were necessary. Funds were available from the entrance fees of those 2 countries. Only the staff was missing.

The project started off effectively in 1981 under the leadership of Ray Wilson (and of Massimo Tarenghi from 1984). It took the name of New Technology Telescope (NTT).

The NTT concept laid down by Ray Wilson included two major new ideas: a thin metallic mirror substrate and an active support, which would correct for the thermal and gravity deformations as well as for some manufacturing errors. Because of scheduling problems, the metal option was abandoned but the active correction of a thin meniscus remains the fascinating part of this project.

A new VLT study group was set up in January 1981. It was chaired by R. Wilson and after April 1981 by Jean-Pierre Swings. The Cargèse workshop in May 1983 marked the end of this 2nd study phase.

This group consisted of a dozen of persons mainly from ESO. The fundamental question was again: which concept to select? To the 3 basic concepts investigated earlier in Geneva, the MMT was added as a potential candidate. The discussions concentrated on the relative scientific performance of the concepts. Because of lack of manpower there was little engineering input.

Though one can imagine a discussion on basic telescope concepts becoming rapidly emotional and inconclusive, J.-P. Swings managed to get the group to agree to a preferred solution: a limited array of four 8-m telescopes. This conclusion was reached already mid-1982. This was indeed the concept that L. Woltjer and R. Wilson had in mind when it was decided to conceive the NTT as a prototype for the active optics technology to be used later in the VLT.

From mid-1982 till May 1983, the study group concentrated its efforts on the scientific advantages one could draw from the limited array concept and particularly on interferometry. P. Léna, F. Roddier and O. Citterio advised the group on this matter.

At the end of 1983 there were mixed feelings. In the visible the prospects for interferometry appeared poor whereas in the I.R. the situation looked definitely more favourable. Everything was hanging on the possibility or not of correcting the atmospheric turbulence with adaptive optics which, at that time, did not appear as promising as it does now. Interferometry was therefore not considered as a driver, but as a potential advantage of the limited array concept. The hope that interferometry could be a definitive concept discriminator seemed to have vanished. It was then clear that the discussion could not be carried on further without some extensive engineering analysis which indeed required a financial commitment and an official decision. The first step was to take the community pulse. It was therefore decided to organize a workshop at Cargèse in May 1983.

Nearly 50 European scientists gathered together in this lovely Corsican village to discuss the opportunity for the European community to build a very large telescope.

As Prof. Woltjer pointed out in his concluding remarks:

"It was not the function of the Cargèse workshop to come to definitive conclusions about the VLT, rather it was a meeting where a number of scientists from the ESO countries could review the present situation and see what needed to be done next. The workshop showed full unanimity about the need for a VLT for the dual purpose of collecting more light and of providing better angular resolution, at least in the I.R. and in speckle modes."

The direct outcome of the workshop was twofold:

(a) There was a clear trend that some form of limited array was the right direction for the VLT.

(b) The Scientific and Technical Committee which met after the workshop recommended that a dedicated project group be set up.

At its meeting of June 1983 the ESO Council endorsed this recommendation and mandated the Director General to set up such a group. Soon after Prof. Woltjer asked the author of this account to lead this VLT project group.

Thus, at the end of 1983 a project group existed, though it barely consisted of even one single person for some time. The NTT and instrumentation projects were by no means overstaffed and it was not possible to divert any manpower from within ESO. In fact, a few new positions had been made available, but it was not before the summer of 1984 that the first engineers did effectively arrive.

It was also necessary to ensure that the community be able to express its wishes and that scientific advice be provided to the project group. An advisory structure was set up, consisting of an advisory committee and of specialized working groups (imaging and low resolution spectroscopy, high resolution spectroscopy, I.R., interferometry and site selection). The findings of the W.G. were to be automatically relayed to the VLT advisory committee, composed of the W.G. chairmen and of a few scientists from ESO. The advisory committee was chaired by J.-P. Swings. This structure in which participated more than 40 scientists from the ESO community functioned efficiently till the Venice workshop and should probably continue to play an important role during the execution of the project.

In October 1983 the main question was: "what to begin with"! It could have seemed logical to study in detail a number of concepts in parallel and then establish some trade-offs and ask the community to select the preferred solution. This would have taken many years, would have dispersed the efforts, led to endless and inconclusive discussions and split the community into self-destructive lobbies. Time was pressing and for Europe to have a chance to get a VLT before the end of the century, a great deal of pragmatism was necessary. The VLT concept had to be definitely selected in the months to come for the engineering studies to be fully effective.

After the Cargèse workshop, there were indeed feelings that a limited array would be the best solution. However, to the extent that no engineering studies had been made, it was necessary first to be fully convinced that this solution would be competitive with other alternatives.

An array of small telescopes would not fulfill the I.R. requirements and, used as independent telescopes, would not provide any gain over existing telescopes. This solution, which was also clearly not optimal from the cost point of view, could therefore be safely eliminated.

The segmented mirror approach had considerable attraction. Neither ESO nor European industry had done any work on this technology. Conversely, ESO had a substantial lead in the active correction of monolithic mirrors. Since the segmented mirror appeared somewhat risky, it was decided out of pragmatism to consider exclusively a solution based on large monolithic mirrors. There were two possibilities: the MMT and the limited array.

To discriminate between an MMT and an array was not easy. Both solutions are very similar to the extent that an MMT can be viewed as an array of telescopes on a common mount. The decisive argument was the versatility of the array which was seen as an advantage not only from the scientific point of view, but also for the practical realization of the project: adapting the project to the available flow of resources and offering the community the possibility to use a part of the collecting area at an early stage.

Indeed, the array concept presented a number of problems which had to be matched by adequate solutions. There were three of them: the feasibility of the primary mirror, an efficient way to recombine the beams and a building concept combining a low cost, a minimal degradation of seeing, the best use of the sites topography, and an optimal arrangement for interferometry. A few months of reflexion and discussions with optical firms were sufficient to realize that solutions would be found and also that a mirror diameter of 8 metres was a good compromise between the scientific requirements, especially for the I.R., and the risks during manufacture and handling of the primary mirrors.

A preliminary concept, called the linear array, was presented to the Advisory Committee. After a few meetings it was decided to adopt it as the ESO base line concept. The first public presentation was on the occasion of the IAU Colloquium on large telescopes in April 1984 (No. 79).

By mid-1984, the project group had 4 people, the scientific working groups were operational and the real work began.

Quite a number of contracts mainly on feasibility studies were given to industry and institutes. A number of studies were also conducted by ESO directly. To the maximum extent possible, competitive studies were done in parallel. The result was an incredible amount of information, and a substantial number of new ideas. Parallel studies were found to be highly productive and very helpful to reliably assess the validity and costs of various solutions. The elements of the puzzle were then critically analysed and a coherent and detailed proposal could be presented in October 1986 at the

The Pre-VLT Milestones

1976	Completion of the ESO 3.6-m telescope.
December 1977	ESO Conference on the large telescopes of the future.
1978/1979	First ESO study group on a 16-m telescope (Geneva).
1981/1982	Second ESO study group on a 16-m telescope (Garching).
April 1983	Cargèse workshop.
June 1983	Decision to create a project group.
September 1983	Permanently manned station set up at Paranal.
October 1983	ESO workshop on site testing for future large telescopes.
April 1984	IAU Colloquium No. 79. First presentation of the linear array concept.
1984	Setting-up of the project group and advisory structure.
October 1986	Venice conference.
March 1987	Proposal for the construction of the 16-m ESO Very Large Telescope.
December 1987	Decision to fund the project.

Venice workshop on the ESO Very Large Telescope.

During this conference, the technical and scientific aspects of the project were discussed. Nothing can better summarize the conference than Prof. Woltjer's conclusion:

". . . I am particularly struck by the large consensus that has been achieved. Of course, there are aspects where different scientists have somewhat different perceptions. But much more important is the strong support which the concept of the array of four 8-m telescopes has found. . . . Now is the time to realize the project."

The official ESO proposal, which also included plans for the financing and organization of the project, was finalized at the beginning of 1987 and distributed to the ESO governing bodies in March for a final decision to be taken in December.

Site testing activities had begun as early as 1983. Arne Ardeberg had explored a number of places in northern Chile and found that several of them would combine an outstanding percentage of clear nights with very low atmospheric water vapour content. One of them looked particularly attractive, because it offered, in addition, an easy access. This was Cerro Paranal. A workshop on site testing took place at La Silla in October 1983. Before that, a permanently manned station had been set up at Paranal, sophisticated equipment acquired and progressively installed. A large quantity of data has been processed since. This effort is still expanding.

A lot more events than reported here took place during the project genesis. Also, many more people than could be quoted in this paper have made major contributions. The purpose of this article was not to give a detailed account of those last 10 years which preceded the decision to build the VLT, but rather to indicate the major milestones which led to it. What is important is that a decisive page of ESO history is about to be turned, and that this fascinating project is to become a reality.

Pre-Assembly of an Inflatable Dome Prototype for the VLT

Those who are familiar with the present technical proposal for the VLT, or have just seen pictures of the model published in the press, will have remarked the peculiar inflatable domes proposed. They can be opened entirely, leaving the telescopes in the open air during favourable weather conditions.

While the idea and the basic technology for such domes have been derived from existing inflated radomes for antennas found all over the world, a quite innovative design concept was demanded by the particular requirements of an astronomical observatory. In order to prove the validity of this design and to acquire the know-how necessary for a successful realization of all details, ESO has built with French and Dutch contractors a prototype with a diameter of 15 metres, about half the size required to house the unit telescopes of the VLT.

Figure 1: *The 15-m dome almost open.*

The dome consists of a double-wall fabric hemisphere, supported by rigid hoops that open and close in two symmetrical parts. Each side of the double-wall cover is made of seven lenticular ribs which are inflated once the dome is closed, thereby providing a rather stiff surface. Also the interior is pressurized, with an overpressure that will be increased by an automatic system in case of strong winds. The dome has been pre-assembled in the Netherlands and found satisfactory. It will be installed on a specially made base at La Silla, starting in February 1988. After being thoroughly tested, it will be used to house experimental set-ups in connection with the development of VLT optical systems.

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Figure 2: *The closed and inflated dome.*