In the course of the last year, these studies have been carried out and the first results obtained were presented at the ESO UC/STC in April 1996.

Some of the early reports have been reported in *The Messenger* (Gilliotte, 1996; Guisard, 1996; No. 83). The document presented at the UC/STC is available in the 3.6-m+CAT www page.

The 3.6-m Upgrade, in addition to the refurbishment of the telescope, also foresees an upgrade of the present instrumentation and instrument control, according to a plan which follows the suggestions of the 'La Silla 2000 Committee' (Andersen, 1996). The instrumentation plan is given in Table 1.

At first, the status of the Upgrade Project shall be briefly illustrated and thereafter detailed information will be given on the two important issues of the main mirror aluminisation and image quality analysis.

2. The Status of the Upgrade Project

The Upgrade Project has been divided in smaller sub-projects, called work components (WC). An overview is given in Table 2. Activity has been already started in 15 WC's, most of the requirement specifications have passed review by this time and are ready for the conceptual design.

The definition of the TCS GUI (graphical user interface) (WC1) is one of the major tasks. The aim is to develop one single standard user interface that shall be available for all telescopes at La Silla in the future. There is a lot of experience accumulated at La Silla for building the human-machine interface, and an attempt is made to receive from the review as much input as possible. The TCS software (WC2) will be VLT compatible to the largest extent possible, the difference is found at the level of the servos and the interface to existing subsystems which are not subject to upgrade.

The conceptual design for the modification of the Cassegrain adapter and the calibration unit (WC6) is already well advanced. Most of the opto-mechanical functions will be refurbished, but without building a new adapter. Great care shall be taken in order to limit heat dissipation in the adapter. The guide-probe field will be ~ 36′ and the unvignetted field for EFOSC2 6′ × 6′. The new calibration unit will be housed in tow intermediate flanges which are required because of (i) the different front focal distance of EFOSC2 and (ii) the new position of the focal plan. The unit consists of an integrating sphere in the upper flange with fiber-fed calibration sources located outside the adapter, both for space reasons and also to prevent heat dissipation. The same calibration unit will also be available for the CES fiber link (WC 45). A VLT-standard technical CCD is employed for the guide-probe and centre field and it shall have a position accuracy of < 1″. A second CCD will be used for image analysing and for the slit view option. First it was planned to use the same CCD, but optical and mechanical constraints oblige us to choose an approach with two CCDs.

The auxiliary functions (WC 5) are already well advanced and due for review, further work has to be closely co-ordinated with the Cassegrain adapter and the calibration unit, as these functions are controlled from the same subsystem.

The upgrade of EFOSC2 includes WC 11 for the GUI, WC 15 for the instrument modification like new grisms, polarimetry mode, Lyot stop, MOS wheel and the mechanical interface to the telescope, and WC 17 for the MOS star plates punching machine. EFOSC2 shall be controlled by modern instrument control SW (ICS), similar to EMMI at the NTT.

The same applies for CASPEC (WC 12), but there is no instrument modification foreseen here. CASPEC will be later in the pipeline, as priority has been given to EFOSC2.

The Cassegrain/CES fiber link (WC 45) and the Image Slicer/Focal Enlarger (WC 53) are in the preliminary design phase. For the very high-resolution option it is foreseen to seek the collaboration with an interested institute. Two minor work components are: (i) the modification of the F/35 infrared top end, to increase the adjustment range for the coma correction. This implementation will take place already in October, and: (ii) the installation of pneumatic sensors on the lateral support pads of the main mirror for diagnostic purposes.

For TIMMI 2, an external institute (University Observatory Jena) made an interesting proposal to ESO and they could provide this instrument by the 1st Quarter of 1999. TIMMI 2 shall fulfil the important role to serve as a test bench for the VLT–VISIR instrumentation. A memorandum of understanding is presently being prepared.

Table 1: Base Line Instrumentation

Instrument	In Operation	Decommissioned
EFOSC 1	Now	June 1997
EFOSC 2	October 1997	July 1999
CASPEC	Now	January 2000
ADONIS	Now	January 2001
TIMMI 2	January 1999	January 2003
CES Very High Res.	January 1998	January 2003

Table 2: Work Components for the 3.6-m Upgrade Project

WC	Description	Status
1, 2	TCS: Graphical User Interface and Control SW	Requ. Specs.
4	Autoguider with technical CCD	Requ. Specs.
5	Auxiliary Systems Functions	Prelim. Design
6	Modification of F/8 Cassegrain Adapter and new Calibration	Unit Design Review
11, 15	EFOSC 2: Instrument Control Software and Instrument Modification	Requ. Specs.
17	MOS Starplate Punching Machine	Requ. Specs.
12	CASPEC: Instrument Control Software	Requ. Specs.
19	F/35: Top End Modification	Prelim. Design
31, 32	Image Quality & Seeing and Structural Analysis of Telescope	Study
35	Hydraulic and Pneumatic Sensors for Pressure Monitoring	Study
45, 53	CES: Fiber Adapter and Image Slicer	Prelim. Design
–	TIMMI 2 (external provider)	Negotiations
–	CES: Very Long Camera (external provider)	Negotiations

3. Report on the Technical Time in June 1996

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Although a lot of the work is still in the requirement specification phase (see Table 2), a few urgent interventions were needed, and the study of some of the relevant telescope aspects had to be completed.

In the two last weeks of June the main mirror aluminisation was performed (somewhat in advance to the normal schedule), and the opportunity was taken to perform some of the work, in particular in the area of thermal and mechanical control of the telescope and of the image quality problem. This report summarises these actions:

3.1 Installation of Water Cooled Electronic Racks in the Cassegrain Cage

The heat produced by the racks inside the Cassegrain cage can be as high as 1KW and is dissipated below the primary mirror cell, resulting in an increase of the mirror temperature always above ambient temperature. Getting rid of this major heat source was essential to improve both, dome and mirror seeing. Water cooled racks have now been installed which house the electronics for the control of the adapter functions and auxiliary systems. All the cabling had to be refurbished and the control electronics re-assembled in the new racks. Obsolete items have been removed to obtain space and gain simplicity. Extensive testing was required thereafter and servicing of a couple of functions was necessary too. Additional refrigerated racks can be installed in the cage to accommodate the instrument control electronics.

3.2 Re-Arrangement of the Mirror Cover

This was probably one of the most impressive changes made at the 3.6-m. To reduce mirror seeing, it is essential that the mirror temperature matches the air temperature. This usually involves cooling during the day and, in some cases, ventilation when the outside temperature increases during the night. With the old configuration (the primary mirror was completely enclosed inside the centre piece) it would have never been possible to build an efficient cooling and ventilation system. For this reason, the mirror cover has been moved from its old position (a few centimetres above the mirror) to the top of the centre piece some 2 metres above the mirror. This change has several advantages:

- the space, where the cover was located, provides now for full access to the mirror surface (about 30 cm space), and could be used for forced mirror ventilation.
- there is now a direct access between the mirror and the declination axis hole, located in the centre piece. This 90-cm hole was part of the Coudé train of the telescope. It could now be used as an air duct to cool the mirror with air coming from the telescope base.

This operation required a lot of time due to the heavy work involved (grinding off welded parts, etc.) and cleaning of the complete telescope and its environment was necessary thereafter. Most of the hardware, like motor units, drive shafts, etc. have been “recycled” and are again in use.

3.3 Elimination of M3

This point is not directly related to the improvement of the image quality but it was necessary for the relocation of the mirror cover above the centre piece. However, the 2500 kg of metal and glass that have been removed can only help to reduce telescope flexure and will improve the dynamical behaviour of the telescope. Although some difficulties were expected for the balancing of the telescope after dismounting M3, the range of the polar counterweight could be extended by taking off the heavy cable cover (500 kg) on the delta twist of the other (West) side.

3.4 Installation of New Sensors for M1 and Mirror Cell

A study on the thermal behaviour of the dome is currently being developed by Philippe Sacre (ESO Garching) with the intention to build a simple thermal model that gives a prediction of the temperatures in the dome and on M1 as a function of external parameters. New temperature sensors have been installed on M1 and on the mirror cell together with the corresponding cabling. Displacement sensors have also been installed to measure possible movements of M1 inside the cell.

4. M1 Aluminisation and Status

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4.1 Aluminisation

The last aluminisation was performed in October 1994. After coating, a reflectivity of 89.5% and a micro-roughness of 60 Å was measured. These parameters were re-evaluated before the 1996 aluminisation, giving a reflectivity of 84.6% and a micro-roughness of 86 Å. These values are very good, when considering the 19 months of time between aluminisations, and these achievements have been obtained thanks to the CO_2 cleaning performed regularly during this period.

After mirror washing, the measurements were repeated, by using an Atomic Force Microscope. The reflectivity increased to 89% and the micro-roughness decreased to 65 Å. Then the standard procedure was applied: aluminium layer removal, alcohol cleaning and removal of dust particles. The coating plant was modified and improved last year; now a better vacuum pressure can be achieved than in the past, and the coating process runs in automatic mode. The aluminisation was very successful, resulting in a reflectivity of 90.5% and 59.5 Å micro-roughness.

One interesting conclusion from this set of measurements is the fact that the 3.6-m mirror coating interval may be more than 2 years, provided these figures can be confirmed in the future. This result is in agreement with the good photometric stability of EFOSC (Benetti, 1996, *The Messenger* No. 83). Also, they show the importance of a regular CO_2 mirror cleaning.

4.2 M1 Status

Although a more detailed report will be given elsewhere (Gilliotte, in preparation), some of the results can be anticipated:

1. The analysis of the mirror surface showed that no new “frosted zones” developed, when comparing the 1996 and the 1994 mirror defect maps.
2. The analysis of the mirror surface showed that the degradation of the mirror is produced by an increase of the micro-hole (digs) density. In these areas the glass looks to be more fragile and sensitive to scratches. The reflectivity in these zones is only 85% and the roughness increases to 120 Å.
3. For the first time it was possible to measure and compare the reflectivity with and without the specular reflection, with two different techniques.

The results show that: at 670 nm, the reflectivity of the “good” and “affected” regions is of 90% and 86%, the diffusion 1.1% and 8.1% respectively. At 400 nm, the diffusion increases to 1.6% in the good zones and to 17% in the frosted zones.

A roughness of 59 Å produces a diffusion within a 2π solid angle of 1.1% whereas a value of 120 Å produces 8.1% at 670 nm. The results on the frosted zones at 400 nm indicate that reflectivity measurements in the B-UV will be needed in the future.

The previous analysis (Gilliotte, 1995, *The Messenger* No. 82) can be confirmed at the moment: frosted zones still are limited to only 2% of the mirror surface, and their contribution to the diffusion is very limited, comparable to the effects due to dust.