EUROPEAN ORGANISATION FOR ASTRONOMICAL RESEARCH IN THE SOUTHERN HEMISPHERE

<table>
<thead>
<tr>
<th>Scientific Technical Committee</th>
<th>90th Meeting</th>
<th>24 and 25 October 2017</th>
<th>For Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance Committee</td>
<td>150th Meeting</td>
<td>6 and 7 November 2017</td>
<td>For Information</td>
</tr>
<tr>
<td>Council</td>
<td>145th Meeting</td>
<td>6 and 7 December 2017</td>
<td>For Information</td>
</tr>
</tbody>
</table>

ELT Project 6 Month Update

September 2017

This document is CONFIDENTIAL until Council review, afterwards it is for PUBLIC DISTRIBUTION

Distribution to Scientific Technical Committee, Finance Committee and Council members, their colleagues with a need-to-know, and their supervisors is authorised. This distribution also applies to AU Observers.

Scientific Technical Committee is invited to note this document.

Finance Committee is invited to note this document.

Council is invited to note this document.
# Change Record

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Paragraph</th>
<th>Changes made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cou-1738</td>
<td>10.10.2017</td>
<td>original document</td>
<td></td>
</tr>
<tr>
<td>Cou-1738 rev.</td>
<td>17.10.2017</td>
<td>whole document</td>
<td>removal of typos and format adjustments</td>
</tr>
</tbody>
</table>
Table of Contents

1. Executive Summary ................................................................. 3
2. ELT Programme Organisation ..................................................... 4
3. ELT Construction ...................................................................... 5
   3.1 Programme Office .................................................................. 5
   3.1.1 Programme Management .................................................. 5
   3.1.2 Systems Engineering ......................................................... 7
   3.1.3 Programme Science ......................................................... 8
   3.2 Dome and Main Structure ...................................................... 9
   3.3 Optomechanics .................................................................... 11
   3.3.1 Summary ........................................................................ 11
   3.3.2 M1 .............................................................................. 12
   3.3.3 M2 .............................................................................. 13
   3.3.4 M3 .............................................................................. 14
   3.3.5 M4 .............................................................................. 15
   3.3.6 M5 .............................................................................. 16
   3.3.7 Lasers Projection Subunit .................................................. 16
   3.4 Optical Control ..................................................................... 16
   3.4.1 Pre-focal Stations ............................................................. 17
   3.4.2 Metrology ....................................................................... 17
   3.4.3 Calibration Unit ............................................................... 17
   3.4.4 Telescope Test Unit ........................................................... 17
   3.5 Control System .................................................................... 18
   3.6 Civil Infrastructure ............................................................... 19
   3.7 Supporting Infrastructure ...................................................... 20
   3.7.1 Washing and Coating (mirror maintenance) ....................... 21
   3.7.2 Power conditioning and backup system ............................. 21
   3.7.3 Chilled Medium Plant, Compressor and Cryogenic Plant .... 21
   3.7.4 M4 Cooling Supply .......................................................... 21
   3.8 Instrumentation ................................................................... 22
4. Science Data Operations ............................................................ 23
1. Executive Summary

The main achievement over the last six months has been the timely implementation of the procurement and construction plan established back in December 2014 when ESO Council gave the green light for ELT Phase 1. More than 85% of the Phase 1 material budget is committed and ESO continues to work within the framework of the June 2016 Council resolution allowing the Programme to place all contracts in time for a first light target in late 2024.

ESO is now entering into a phase dominated by the follow-up of many large contracts.

At a strategic level, another important step towards an ELT that is capable of full science have been the initial discussions with the various committees on how to implement the postponed Phase 2 items. This led to a Council resolution in June authorising ESO to work on the assumption that all the M1 segments for the ELT (i.e. the inner five rings and seventh sector including the second M1 washing, stripping and coating unit) will be in place at first light. This paves the way to hopefully receive in due time, with respect to the options in the contracts placed, the authorisation to procure also the five inner rings and the seventh sector, including the 2nd washing, stripping and coating plant, after submission of an updated cash flow situation to the FC, for final spending approval by Council. Furthermore, it allows ESO to focus on one single scenario for the M1 configuration at first light and avoid team distraction.

In terms of public highlights, this quarter saw the formal “ELT First Stone” ceremony on 25 May that symbolically marked the start of the ELT construction on Armazones. The ceremony was attended by the President of Chile and many other VIPs. (See the release eso1716 for details.) Two more milestones were marked at that same occasion: i) the formal hand-over of the Armazones construction site to the Dome and Main Structure (DMS) contractor (ACe) for the duration of the DMS erection and testing and ii) the inauguration of the so-called Armazones substation as a step towards the connection of the Chilean national electrical grid to Cerro Paranal and Cerro Armazones sites. In July, another inauguration marked the formal connection of Paranal to the Chilean national electricity grid.

The significant achievements over the reporting period can be summarised as follows:

1) FC Approval in May to award the following new contracts:
   a) M1 Blank manufacturing with SCHOTT (DE);
   b) M1 Position Actuators (PACT) with Physik Instrumente GmbH & Co. KG (DE);
   c) Core Integration Infrastructure (CII) with Cosylab (SE).

2) Signature and/or kick-off for the following new contracts:
   a) M1 Blank manufacturing with SCHOTT (DE);
   b) M1 Segment polishing with SAFRAN REOSC (FR), the second largest ELT contract!
   c) M1 Position Actuators (PACT) with PI (DE);
   d) M3 Blank with SCHOTT (DE);
   e) Core Integration Infrastructure (CII) with Cosylab (SE).
3) Launch of the following Call for tenders:
   a) ELT Technical Facility at Paranal; issued on 2 May;
   b) M1 Segment Support issue on 31 May;
   c) Washing/Stripping/Coating issue on 27 June;
   d) Pre-Focal Station for Nasmyth A (PFS-A) on 26 July.
4) Progress in manufacturing and hardware delivery in running contracts:
   a) Casting of the M2 Blank by SCHOTT on 22 May (eso1715);
   b) First out of 6 (+ 6 spares) M4 Shell thinned to its final thickness (2mm) in June by REOSC;
   c) First 2 petals (out of 6) of the M4 Unit reference body in SiC by BOOSTEC;
   d) Delivery by ACe of the new M1 Test Bench;
   e) First M1 Segment Support Qualification Model (M1SS QM) delivered by VDL in July and installed in the M1 Test Bench in the ESO Technical Building.
5) Site hand-over to the DMS contractor (ACe).
6) ELT First Stone ceremony on 26 May at Paranal in presence of the President of Chile (eso1716).
7) Inauguration of the Armazones Power substation with SAESA on 26 May.
8) Inauguration of the connection of Paranal to the Chilean national electricity grid on 13 July.
9) Dome Preliminary Design Review (PDR) passed in June.
10) Technical and managerial evaluation of the responses to the Call for tenders for the ELT AIV and Ops Facilities at Paranal (ETF).
11) Second and final round of negotiation for the anticipated procurement of the ELT laser sources to profit from an option ESO placed in the contract for the laser sources of the VLT AOF project.
12) Progress in the planning and preparation of the System Verification Review (in 2018) to carry out an independent assessment on proper flow down of requirements from Top-Level Requirements (TLR) to subsystems, consistency of technical budgets and their allocation to subsystems as well as verification strategy also at system level.
13) Progress with the running industry contracts and instruments consortia agreements (see details below).

2. **ELT Programme Organisation**

On internal managerial matters, the semester saw the opening of a new position for an ELT Document Controller/Archivist to properly handle the large flow of internal and contractors’ documents, the selection of a new Administrative Assistant, the selection of the Dome and Main Structure on-site Manager and the re-introduction of the role of Telescope Scientist working under the Programme Engineer and focussing on the verification of the wavefront control strategy and the commissioning plan for the telescope.
The recurrent and critical under-allocation of resources to the Programme has been reviewed with the Directorate of Engineering and resulted in the identification of recruitment needs (engineers). Some of them have been opened and are currently under recruitment.

3. **ELT Construction**

3.1 **Programme Office**

3.1.1 **Programme Management**

During this reporting period (March 2017 – September 2017), the Programme Management office continued to give priority to the procurement activities to ensure timely signature of contracts. Following the latest FC approvals in May for the M1 Blank manufacturing (SCHOTT, DE), the M1 Position Actuators (PACT) (PI, Physik Instrumente GmbH & Co. KG, DE) and the Core Integration Infrastructure (CII) (Cosylab, SE), the following important contracts were signed and/or kicked off for the following new contracts:

a) M1 Blank manufacturing with SCHOTT (DE);

b) M1 Segment polishing with SAFRAN REOSC (FR), the second largest ELT contract!

c) M1 Position Actuators (PACT) with PI (DE);

d) M3 Blank with SCHOTT (DE);

e) Core Integration Infrastructure (CII) with Cosylab (SE).

Other achievements were the release of the following Calls for tenders:

a) ELT Technical Facility at Paranal - issued on 2 May;

b) M1 Segment Support issued on 31 May;

c) Washing/Stripping/Coating issued on 27 June;

d) Pre-Focal Station for Nasmyth A (PFS-A) on 26 July.

At a strategic level, another important step towards an ELT that is capable of full science have been the initial discussions with the various committees on which and how to implement the postponed Phase 2 items. This led to a Council resolution in June authorising ESO to work on the assumption that all the M1 segments for the ELT (i.e. the inner five rings and seventh sector including the second M1 washing, stripping and coating unit) will be in place at first light. Although its funding still needs to be worked out and specifically approved, it allows ESO to focus on one single scenario for the M1 configuration at first light and avoid team distraction.

This quarter saw a very important public event with the formal “ELT First Stone” ceremony on 25 May that symbolically marked the start of the ELT construction on Armazones. The ceremony was attended by the President of Chile and many other VIPs. (See the release eso1716 for details.) Three more site-related milestones were passed during the reporting period: i) the formal hand-over of the Armazones construction site to the Dome and Main Structure (DMS) contractor (ACe) for the duration of the DMS erection and testing, ii) the inauguration of the so-called Armazones substation as well as iii) the inauguration of the connection of Paranal to the Chilean national electricity grid.
It is worth noting that, due to the site hand over, only exceptional authorisations will be provided for site visits in order not to interfere with the contractor's activities.

Other activities included:

1) Support to the timely submission of administrative, legal and technical documentation required by the Chilean Authorities to place the electricity supply contract for Paranal and Armazones;

2) Support to the organisation of the public events mentioned above;

3) Support to the Project Managers in various tasks (chairing of specific reviews, participation to Dome PDR, definition of review plans, definition of procurement strategies, identification of resource shortage and recruitment needs, clarification of responsibilities and updating of the Work Breakdown Structure (WBS), promotion of exchange and collaboration with Paranal colleagues, contractual negotiation, e.g. laser sources, etc.);

4) Support to the Programme Engineer and the System Engineer to plan and perform some initial preparatory work needed for proper execution of the ELT System Verification Review planned for the first half of 2018;

5) Support at managerial level for assessing possible strategies for implementing critical Phase 2 items, in particular an LTAO capability at first light (post-PDR activities are currently part of Phase 2) as well as electrical power conditioning able to mitigate risks associated to grid power interruptions;

6) Preparation of an information package and review of policy terms together with ESO broker (MARSH, UK) to initiate a market survey for an ELT Construction All-Risk insurance (to be submitted to FC in February 2018);

7) Identification of additional recruitment needed to cover the currently unallocated Programme requests until 2024 and discussion with the DoE Director;

8) Participation to various recruitment activities (selection of an Optical Engineer, drafting of vacancy for an Opto-Mechanical Engineer, drafting of vacancy and selection of an ELT Document Controller/Archivist and for the replacement of an Administrative Assistant, etc.);

9) Clarification of the DMS Site Manager’s tasks and responsibilities and final recruitment;

10) Coordination with DoE for the deployment of the MELT (Minuscule ELT) optical test bench to validate the Wavefront Control Commissioning plan;

11) Introduction of the Telescope Scientist’s role in the ELT programme;

12) Oversight and decisions related to the Change Management process;

13) Regular coordination with ePOD to maintain the list of ELT milestones, until first light, eligible for an announcement or a press release and generation of a semi-regular ELT internal newsletter;

14) Organisation and participation in regular Programme meetings (bi-weekly oversight meeting with Directors, weekly Programme management-level meeting, Project Managers’ reporting meeting, overall Status Meeting with the whole team, etc.).
15) The standard set of documents (Fact Sheet, 6-month reports, contribution to Council document and to BFL) were prepared and the ELT status was presented and discussed at the full cycle of Governing Bodies: ESC (March), STC (April, in Chile), FC (May, with few but important requests for approval) and Council (June);

16) The ELT status was presented at three Industry Days: in France, in Finland and in Garching for the Polish industry;

17) Support was provided for an article for The Messenger about the First Stone event;

18) Initial preparation for the EMAC #4 meeting (end-November 2017).

3.1.2 Systems Engineering

SE participated in the final review of the document packages for the tendering of the ETF (ELT Technical Facilities in Paranal), the M1 Washing, Stripping and Coating Unit, the M1 Segment Support and Fixed Frames Manufacturing and the Pre-Focal Station. This focused on the technical specifications, Interface Control Documents (ICDs) and drawings, checking in particular consistency to higher level documents and technical budgets. In addition, the documentation packages were compiled and delivered to CP to launch the corresponding Call for tender processes.

SE also participated and provided oversight (from the system configuration and requirement management perspective) on the final update of the documentation packages for the contract signature for the procurement of the M1 Blanks, M1 Segment Assemblies Polishing, M1 Position Actuators and Core Integration Infrastructure.

Requirements linking has progressed accordingly to the plan. This is critical to perform a proper analysis of change impacts by looking at the chain of affected requirements. Also, as part of the requirement management activity, particular attention has been given to check the flow of the technical budgets down to the specification of the subsystems and to follow the actual implementation during the development of the subsystems.

As a standing activity, the interfaces diagram has been reviewed and updated to make sure that no interface is missing and that the ICDs are completed when needed for the related procurements. Given the criticality of the interfaces, SE devoted particular attention in following up the design of the subsystems to ensure compliance to the interfaces. A proper process and tool have been implemented in the last few months.

Substantial work has been carried out on the System Verification. The verification attributes of the Level 1 Requirements Specification are being defined. This refers to the verification methods, verification level (system or subsystem) and verification milestones. In addition, a draft of the System Verification Plan has been prepared.

As usual, SE has been supporting the several projects concerning discussions on requirements and on the analysis of potential impacts from changes (change requests and requests for waiver/deviation). The effort on the latter has again increased in the reporting period and is expected to still significantly increase in the coming months. SE has put in place
the means to face this situation (i.e. improving the tool to process the change requests, incorporating additional effort).

The work of the PAV (Performance Analysis and Verification) group has concentrated mainly on analysing the performance requirements for M5 unit and the Pre-Focal Station as well as on clarifying questions coming from the instrument consortia related to telescope performance and interfaces.

### 3.1.3 Programme Science

The ELT Programme Science is providing continuous and proactive scientific input across the various ELT work packages to facilitate the definition of the subsystem requirements and ensuring that the Observatory Top Level Requirements are met. The science operation requirement document for the ELT has been completed. It follows from a series of meetings with the Project Science Team (PST) and mini-workshops in Garching, Vitacura and Paranal. The document addresses specific ELT requirements in the broader context of the end-to-end data flow for VLT and ELT. The Operation Concept Document (OCD) for the ELT is in an advanced draft status and under internal review at ESO before being released to the instrument Consortia.

As part of the ELT Phased approach, substantial work, particularly with the help of the PST, has been carried out to analyse the scientific impact of potentially missing Phase 2 items (i.e. five inner rings and seventh sector, LTAO for HARMONI, atmospheric monitoring, etc.). The study involved simulations and analysis of the impact of the missing items on performance, sensitivity, Adaptive Optics, high-contrast, observations efficiency etc. As part of the mitigation strategies, the Programme also continued the study to evaluate the possibility and impact of using MAORY to provide AO performance and sky coverage to HARMONI, instead of a dedicated LTAO. The study carried out in collaboration with the Consortia and the PST, has focused on the performances, and in particular on the thermal background and Adaptive Optics. The study also looked at various technical aspects, risks and costs (the latter to be finalised at PDR by the end of the year).

The ELT Programme Science continues supporting the development of the first generation instruments (MICADO/MAORY, HARMONI and METIS) during their PDR phase and attended their science consortium meetings as well as reviews. The ELT Programme Science is also closely following the development of the Phase A study for MOS and HIRES. With the support of the PST, ESO has analysed the preliminary scientific trade-offs for MOS and HIRES with the aim of supporting the Consortia in defining the technical specification of the new instruments. The analysis is ongoing and will be finalised at the end of the Phase A studies (beginning 2018).

As part of the engagement with the public and the scientific community, the ELT Programme Science presented the status of the programme and its scientific goals to various conferences and workshops. In particular, the First Stone ceremony in May was an ideal stage to convey the status and science goals of the ELT to the general public, with several television and other media interviews.
The ELT special session at the EWASS meeting in Prague was very well received with significant attendance and interest. To enhance engagement with the scientific community, ESO continues with the monthly updates of the ELT Programme via the ESO Science Newsletter. Also organised and supported was a school on Cosmology and fundamental physics with current and future ESO facilities:
http://www.iastro.pt/research/conferences/azores17/.

The ELT Programme Science, in collaboration with the PST, proposed a symposium for the next IAU General Assembly. The proposal for the five-day symposium “Early Science with the ELTs” has been accepted and will take place in Vienna in August 2018. As part of the IAU event, ESO is also organising an International School for young scientists and a Teachers’ training workshop.

3.2 Dome and Main Structure

During this reporting period, various notable events of managerial and technical nature occurred related to the execution of the DMS Contract by the Astaldi - Cimolai Consortium (ACe) and their subcontractor EIE.

An important programmatic milestone for the DMS project was the timely completion of the Site Handover meeting in May, basically at the same time of the ELT First Stone ceremony. To achieve this milestone, ESO completed the remaining actions foreseen by the Statement of Work, including the installation of an earthquake monitoring station at the ATP. It is recalled that, in February 2017, ESO had already initiated this process and allowed ACe to access the site and in particular to start work on the preparation of the Armazones base camp, where the residential area, the offices and the technical facilities and the storage place will be located. This preliminary access was granted in order to give ACe sufficient time to prepare a fully operating camp in time for the start of the civil work activities in the first quarter of 2018.

With the completion of the Site Handover in May, ACe, and in particular Astaldi, as leader of the site activities within the Consortium, received full control of the site. The handover involved the checking and the technical acceptance of the overall site, including the platforms for the chillers and dry cooler installation, prepared ad hoc along the needs expressed by the bidders during the Call for tender and finally reviewed during the contract negotiations. In agreement with the DMS team at the Site Handover meeting, it was also decided by the ELT management to put back into operation the old construction road (“zig-zag road”) on site, in order to generate a secondary road to the ATP, to be available but to be used only in case of an emergency situation in case of obstructions to the normal road. Technically, this demands only minor earth works, which are being procured at the time of writing. In order to access the site, Astaldi has to comply with the overall safety policy of ESO, as detailed in the Contract. To this purpose, they have produced their internal safety documentation, which has been reviewed by ESO. The ESO safety organisation of Paranal has started to interact with the Astaldi safety organisation on site.

Another important milestone was achieved with the Preliminary Design Review of the Dome, which took place, as planned, at Astaldi headquarters in Rome at the end of June. As noted in the previous 6-month report, to achieve these results, ACe had to recover some of the initial
time invested in the trade-offs of the design during the whole of 2016. This was obtained by reallocating the scope of the design activities and shifting some of the detail design scope to specialised companies, while maintaining the system level design activities with the DMS architect and designer EIE. The PDR documentation package was delivered as planned and the review team, composed of personnel from various directorates and complemented by external consultants, provided written comments to ACe. The review board declared the PDR successful and identified a number of actions to be performed. The meeting had been scheduled over three days, so that a debriefing session could be scheduled with ACe at the conclusion of the meeting, prior to the redaction of the review board report. In parallel, the DMS project management has agreed with ACe on a plan for the closure of the open actions. The most urgent actions are closed at the time of writing, whereby a number of less critical actions have been deferred to the Main Structure PDR and are followed as part of the normal design process. The overall conclusions of the PDR review were that the ESO requirements had been translated in a sufficiently developed design baseline and that no indication could be found that the design baseline is not meeting the contractual specification.

In June, ESO inspected the M1 test stand at one of Cimolai’s steel factory in northern Italy. The test stand had been ordered in January for fast tracking the testing of the M1 Segment Supports inside ESO. The design of the M1 test stand incorporates many of the features of the final M1 Cell of the ELT, corresponding to the design available in spring 2017. In addition to the immediate M1 testing activities, the manufacturing of the stand, in advance of the MS PDR benefits also ACe in gaining manufacturing process experience and also the DMS team for checking and defining the access and the physical interfaces of the various equipment to be later mounted inside the M1 Cell itself. Currently, the M1 test stand is assembled in the ESO assembly room in Garching bei Muenchen and being used by the M1 system team.

In the second half of July, ESO received notice that the Project manager of ACe had resigned for private reasons and that Astaldi, as leader of the Consortium, was actively looking for a substitute Project Manager. At the beginning of August, a formal letter was received by ESO informing of the change of Contract representative and the appointment of a new PM, starting on 1 September. The new PM had spent a considerable part of his professional life in South and Central America and had previous involvement in the assembly of the VLT telescopes and enclosures in Paranal. The DMS team became acquainted with the new PM in the course of September at the occasion of regular technical and progress meetings. The departure of the previous PM has certainly caused some vacuum in the summer period, although the day-to-day direction of the design activities has been continued by the existing team. The DMS management team is of course doing its best to establish a positive relationship and communication with the new PM, wishes him success in his position, and tries to minimise any delays to the Project caused by this managerial change.

In terms of design, after the effort of the Dome PDR, ACe put strong emphasis on the progress of the Main Structure design. One of the key technical difficulties associated with the Main Structure is constituted by the vertical seismic isolation system, needed to prevent the hosted units exceeding their design acceleration during earthquakes. Here, considerable progress has been achieved and a number of promising solutions are being evaluated. The final solution will be prototyped and tested after the overall Main Structure design has formally undergone the Preliminary Design Review. ESO was recently presented the overall status of the design of the Main Structure in a dedicated technical meeting. ESO expects ACe to be able to perform
the MS PDR within December 2017. If this is confirmed, there is a six to eight weeks’ delay with regard to the original schedule for this activity. This is not expected at the present time to have an effect on the overall schedule, because the civil works on site is today driving the project critical path. This will be confirmed once the schedule is better refined. It is recalled here that changes are planned in the initial erection process, and that these changes have been verified for technical feasibility, but only schematically translated into a valid schedule for the site phases. Also, with the final choice of key components, some of which may have long lead procurement times, choice to be frozen at PDR, ACe will be in a better position to validate the schedule. It is worth noting that the successful performance of the Main Structure PDR as well as the planned Civil Works CDR has been put by ESO as a prerequisite condition to start the excavation on site, in advance of the DMS Final Design Review.

At the time of writing, Wind Tunnel tests are starting at the Politecnico di Milano to validate the design of the Dome and the Auxiliary Building on a 1/70 scale mock-up. The programme of testing will allow to validate the wind pressure presently applied in the design phase and estimated by Computational Fluid Dynamics, and to verify some key data of the windscreen of the dome. This qualification activity is one of the most urgent in view of validating the overall Dome design. The overall qualification plan of the DMS was provided at the Dome PDR, and will be later integrated and approved at the MS PDR. This will include the key mechanisms of the system.

On site, ACe has performed an independent geological survey of the ATP rock characteristics, finding some positive and some negative deviations from the geotechnical investigation contracted by ESO before cutting the mountain. ESO has asked to receive the new data and will verify their congruency. No detrimental effect on performance of the DMS is expected.

On site, the construction activities of the camp and the refurbishment of the existing facilities taken by Astaldi from Icafal are in progress. ESO agreed in due time to the camp design as proposed by ACe, and the readiness status of the facilities will be reviewed in October. At that time, ESO will also introduce the future DMS Site Manager, Mr. Pascal Lapeyre, who recently started at ESO in Garching and is becoming familiar with the project before his transfer to Chile planned in the first quarter of 2018, in time for the start of the civil works.

The DMS team is looking eagerly to the next period, which will be fundamental for the overall DMS project, in view of the Main Structure PDR and its conditional role, together with the CDR, in the start of the civil works. With these milestones, ESO expects to be able to review in more detail the integration activities in Chile, to have a better visibility on the overall schedule of the DMS project, and take any action if needed.

3.3 Optomechanics

3.3.1 Summary

The past period was a major achievement regarding the M1 Unit: Signature and contract kick-off for the production of the M1 Segment Blanks, the M1 Segment Assemblies manufacturing (M1 Polishing), and the Position Actuators. The contract for the construction design of the M1 Segment Support Mechanics has been nearly completed and ESO could release the Call for
tender for the mass production of the M1 Segment Support Mechanics in due time. The ‘M1 year’ is so far ongoing in accordance with the plans.

All the contracts for the manufacturing and design of the M2 and M3 Units are running: Blanks, Polishing and Cells. They are all progressing well and several important milestones have been successfully passed.

Regarding the M4 Unit development, several issues have been faced. The M4 Unit development is suffering some delays, although converging towards completion of the Final Design Review by the end of 2017. The production of the Silicon Carbide Reference Body has been delayed following a failure during the first petals manufacturing. There were incidents during the production of the first M4 Thin Shells. Those issues have not been considered critical yet, and the focus has been on finding corrective and preventive actions with the contractors.

The procurement of the M5 Unit has started. The M5 Mirror requirements consolidation has been nearly completed, the Request for Information for its design and manufacturing has been released. The M5 Cell will follow a few months later.

Regarding the Laser Guide Star Units, the procurement phase for the supply of the Laser Sources was completed, and its result was approved by FC in September.

3.3.2 M1

The M1 Polishing contractual package has been consolidated to match the content of the offer and the results of the technical, managerial, and contractual discussions. The contract was signed with SAFRAN REOSC in May. The contract was kicked off on 21 September. From contract signature to kick-off, REOSC have initiated several critical activities:

The SAFRAN REOSC project teams have been set up, most of the required positions have been allocated through internal movements or hiring.

The 4000 m² building into which the production equipment will be installed, in Poitiers – France, was emptied and prepared for fitting. Building fitting was tendered, the selection completed, and the contract was signed. Preliminary design was completed, final design phase is ongoing. Construction will start in December.

Most of the ‘pilot line’ production machines have been ordered or will be ordered before the end of 2017. The pilot line will be used to qualify the production plans in terms of performance and throughput. The remaining machines will be ordered after qualification.

The design of the Metrology Setup has started, and long lead item procurement is being launched (1.8-m Silica Test Plate, 2-m Calibration Sphere, ordered in October).

The design of the Segment interfaces has also been started. The plans for adhesive bonding development and qualification have been detailed.
The M1 Blank contract was signed with Schott in May, and was kicked off on 18 September. New machines and production equipment have been installed, both for ELT M1 and other production needs. The plans for qualifying the manufacturing process have been detailed, mostly regarding the machining parameters and the acid etching process. Qualification tests will start in October. The plans for logistics, packaging, transport, and blank delivery to REOSC have been detailed. The preliminary transport container design concepts have been presented and discussed.

The M1 Segment Support Mechanics design and qualification contract (with VDL, NL) has progressed well and is nearly complete (October). The qualification models were manufactured, assembled, and successfully tested. Design modifications were implemented where necessary, and included in the Segment Support Mechanics mass production Call for tender package.

The RFI and PI for the M1 Segment Support Mechanics production were completed, the Call for tender was released in May, with a closure date of 20 October. Offer evaluations, clarifications, and bidder selection will take place from November - January, for Finance Committee’s approval in February 2018.

The contract for the design, qualification, and manufacturing of the M1 Position Actuators was signed with Physik Instrumente (PI, Germany) in June and kicked off in July. The design activities have started. A design baseline review will be held in early October.

The development of the M1 Edge Sensors (Fames: Fogale & MicroEpsilon) continued. The interim design review was passed in June. There are no issues to report so far. Some changes are foreseen, consisting in attaching the Edge Sensor front-end electronics to the Segment Support Mechanics moving Frame.

3.3.3 M2

The design of the M2 Mirror interfaces is nearly complete (axial and lateral pads, tripods). The adhesive qualification testing is almost finished. All tests have been successful so far. A fatigue/aging test facility is being designed. These last tests will be launched on or before the end of 2017 and will last until mid-2018.

The PDR for the metrology means has been passed, detailed design is ongoing. The long lead item procurement was launched. The M2 Test Matrix Blank is being manufactured by Schott, it is nearly finished and will be delivered to REOSC in October. The Design of the M2 Mirror Auxiliary Equipment (Handling Tool, Support Stand, Transport Container, and Dummy Mirror) is almost complete. The Dummy Mirror parts (aluminium mirror halves) have been cast.

The facilitation, i.e. transformation of the REOSC VLT M1 building to fit the M2 and M3 Mirror production means, has been continued. The concrete work is complete. The very large 3D CMM has been installed. The turning table, robot, and CNC are planned to be installed during the last quarter of 2017.
The M2 Blank was cast in May, and then cooled down and annealed for three months. Inspection after annealing was performed in the second half of August/early September. Although the casted boule has some chipping on its outer edge (due to high stress during crystallisation), the inspection reports show that it will most probably be within specifications after final machining. The boule has been placed in an oven for ceramisation for another six months.

The M2 Blank Transport Container design is almost complete, it will be manufactured in early 2018.

The M2 Cell design is ongoing. The interim Preliminary Design Review was held in June. Most of the work has been focused on performance analysis and optimisation, on specification breakdown of the M2 Cell components. The CAD implementation is ongoing. The development of the positioning hexapod, which will be subcontracted to ADS – Italy, will be kicked off in autumn.

3.3.4 M3

The design of the M3 Mirror interfaces is nearly complete (axial and lateral pads, tripods). The adhesive qualification testing is almost finished. All tests have been successful so far. A fatigue/aging test facility is being designed. These last tests will be launched on or before the end of 2017 and will last until mid-2018.

The PDR for the metrology means was passed, detailed design is ongoing. The design of the M3 Mirror Auxiliary Equipment (Handling Tool, Support Stand, Transport Container, and Dummy Mirror) is almost complete.

The facilitation, i.e. transformation of the REOSC VLT M1 building to fit the M2 and M3 Mirror production means, has been continued. The concrete work is complete. The very large 3D CMM has been installed. The turning table, robot, and CNC are planned to be installed during the last quarter.

The M3 Blank was casted in August. It is currently in cooling/annealing until November. ESO must wait for the inspection after annealing in November before it can declare the casted boule is suitable for M3 Blank machining. If not, a new casting will be done in January 2018. Depending on the casting quality, ESO and Schott can decide in November to 'swap the boules', i.e. extract the M2 Blank from that last casting and the M3 Blank from the first one. This offers extra freedom to make sure both M2 and M3 Blanks well match the specifications, without affecting the production schedule of the M2 and M3 Mirrors at REOSC.

The M3 Cell design is ongoing. The interim Preliminary Design Review was held in June. Most of the work has been focused on performance analysis and optimisation, on specification breakdown of the M3 Cell components. The CAD implementation is ongoing. The development of the positioning hexapod, which will be subcontracted to ADS – Italy, will be kicked off in autumn.
3.3.5 M4

The M4 Unit final design (contract with AdOptica = ADS + Microgate, Italy) has been progressing, although this phase has now several months’ delay.

Separate design reviews are done at sub-assembly and sub-unit levels. Each of them is usually supported by validations on breadboards. The process is closed with the Final Design Review at which verification is done at Unit level, after all sub-level design reviews have been successfully completed.

The M4 Kinematic System design (the M4 Hexapod and Rotating Mechanism) could not be completed as expected. The hexapod leg breadboard manufacturing and testing has taken longer than expected. The associated design review is planned by mid-October.

The M4 Mirror Optomechanics (the Mirror Assembly) design is complete. However, adhesive bonding qualification has failed after aging tests. Bonding procedures have been improved; however, several issues are pending and additional qualifications are required. The Optomechanics design review is planned by the end of September.

On the side of electronics, control and software, the design is complete as well. Verification tests on breadboards also had delays. This part will be reviewed by mid-November.

The final design also became dependent on the results of the Silicon Carbide Reference Body manufacturing. As reported earlier, manufacturing of the reference body first petal failed: ribs of the lightweight structure have bent during sintering, and the overall part distortion was too large to achieve the required tolerances. A second attempt was made after the root causes were identified and remedies have been implemented. The distortion is now well mastered but some ribs still have bends. A recovery plan, which consists of repairing the bent areas, has been defined and is being tested. The plan is to have solved this issue before FDR, which is planned by mid-December.

All the 12 M4 shells are now in production (REOSC, France), queuing at various stages of the manufacturing process (a) optical surface polishing, b) thinning down to 2 mm and back surface polishing, c) cutting to final petal shape).

A first shell successfully passed readiness for final cutting recently (21 September). Cutting will start in early October.

Cracks were found on a second shell by the end of thinning (3.6 mm thick). They have been ‘stopped’ by drilling and local grinding/polishing. The cracks are outside the final shape so the shell could still be finished. However, investigation of the causes, plans to prevent further crack propagation and to avoid cracking on the other shells take time. Delivery of the two first shells is now planned with three to five months’ delay. The other shell deliveries are not critical and still have several months’/years’ contingency.
3.3.6 M5

The technical requirements of the M5 Mirror and M5 Cell have been consolidated. A Request for Information package for the M5 Mirror manufacturing (M5 Blank manufacturing, M5 Polishing) has been prepared and the RFI was released on 18 September. The plan is to iterate with industry on the managerial and technical requirements during the October/November period.

The Preliminary Inquiry is planned in November and release of the Call for tender in December with a closure date of early March 2018. If the Call for tender is successful, the M5 Mirror manufacturing will be presented to FC for approval in May 2018.

The M5 Cell will follow the same path, although shifted by a few months, aiming at FC’s approval in November 2018.

3.3.7 Lasers Projection Subunit

An RFQ for the procurement of the ELT Phase 1 Laser Sources was replied by Toptica (Germany) and further negotiated. This supply contract was submitted to FC in September and approved.

There is no specific work to report on the Laser Projection Subunit developments. Most of the work is performed as part of the VLT AOF development.

3.4 Optical Control

During this reporting period, there has been significant progress on the Pre-Focal Station (PFS) and the call for the PFS-A Main System was launched in July. Progress has been made within the Technology Development Programme on the definition and procurement of detectors for the PFS wavefront sensors and imaging cameras. The plans for the development and production of the complete camera systems (which house the detectors) are being elaborated, also within the Technology Development Programme.

The test bench activities on PEACE have been formalised into the MELT project under the responsibility of the Programme Engineer. Optical Control will support MELT in opto-mechanical areas where there is synergy with the Phasing and Diagnostic Station and Telescope Test Unit; the expected return from this support is a better definition and in some areas a breadboard validation of the requirements for these systems.

During the definition of the PFS-A Main System, provision has been made for a metrology station to be hosted in the PFS. This metrology station will support the telescope and instrument alignment and maintenance. A breadboard test of the metrology to check the validity of the current concept is planned for the next period.
3.4.1 Pre-Focal Stations

The Request for Information (RFI) and the Preliminary Inquiry (PI) for the Pre-Focal Station A Main System were successfully completed and the Call for tender for this system was launched in July. This work included the review and finalisation of detailed requirements and associated analysis for the PFS-A Main System and interfaces with its hosted units:

- PFS-A Main System
- Phasing and Diagnostic Station
- Imaging Camera
- Wavefront Sensing Camera
- Metrology

The development of the imaging and wavefront sensing is progressing within the Technology Development Programme. The development/procurement of the detectors is advancing; in the case of the wavefront sensor detector, this is a new development. The plans for the development of the complete camera systems are also being elaborated, and the current provisional schedule for delivery is quite critical for the overall PFS completion.

The definition of the phasing and diagnostic station and the telescope test unit requirements will be pursued, in the short term, in the frame of the MELT project.

3.4.2 Metrology

A breadboard test of the PFS hosted metrology is planned for the next period to check the validity of the current concept. Specifically, the purpose of the test is to check limitations on the accuracy with which the PFS optical axis can be measured and then transferred to the location of the instruments on the Nasmyth platform.

Requirements for other coarse metrology items are being developed within the Assembly, Integration and Verification team, for example in the telescope alignment plan.

3.4.3 Calibration Unit

The telescope alignment beacon (calibration unit) will be used in conjunction with the PFS optical sensing to characterise various aspects of the telescope, such as M4 response and phasing, M3 and M5 active control functions. These use cases have been captured in the PFS-A User Requirements. Consolidated user requirements for the calibration unit are pending.

3.4.4 Telescope Test Unit

The definition of the telescope test unit requirements will be pursued in the short term in the frame of the MELT project. The Optical Control project will provide support to the opto-mechanics work package of the MELT; the expected return from this support is a better definition and in some areas a breadboard validation of the requirements for the telescope
test unit and the phasing and diagnostic station. It is also planned, in some cases, to deploy the final hardware of the Telescope Test Unit (TTU) first on the MELT and then reuse it in the TTU. This early deployment is intended to validate the hardware and facilitate the timely development of the control system.

3.5 Control System

The Core Integration Infrastructure (CII) software contract was approved by FC in May 2017, and the contract is running on track. The selected contractor (CosyLab, Sweden) is currently focused on the high-risk technical aspects of the product involving design of abstracted interfaces to the various Ethernet based communication middleware standards used across the ELT Control System. CosyLab and Microgate (M4 supplier) are two initial external users of the ELT control system development environment (software tools and standards) and their feedback and experience is critical in improving the tool-chain to streamline the development process. ESO is being responsive to their needs in this respect.

The baseline Interlock and Safety System designed in 2010 remains valid. The Siemens safety equipment and tools on which it is based have evolved as expected, with improved tools and different hardware offerings, the baseline design remains valid. Procurement of updated technology is planned to repeat some reliability tests on the new products, and incorporate aspects of the preliminary safety system architecture presented at the ELT Dome Preliminary Design Review.

Networking Infrastructure RFI, issued to evaluate the market for alternate vendors meeting the ELT requirements, identified two potential suppliers (in addition to CISCO). However, their offers comprised a mix of smaller vendor equipment, and follow-up enquiries to test the equipment in-house failed (with the exception of CISCO). Testing of the new generation CISCO equipment is on-going, although no surprises are expected. The results of this RFI confirm that CISCO remains the only viable vendor for the ELT Networking Infrastructure. The Time Reference System project (“observatory clock”) commenced in Q2 this year, with an analysis of synchronisation requirements of the various control systems of the ELT telescope.

The M1 Local Control System (enabling deterministic control of the M1 segments, failure detection and isolation and power control and cooling of the M1 devices) is currently in Final Design Review. An RFI for the manufacture, assembly, integration and verification of the 140+ electronics cabinets of the ELT M1 was run in order to obtain a ROM cost estimate and compatibility of the procurement strategy with industry capabilities. There was a good response from the Member States identifying many vendors with the required resources at reasonable cost.

The preliminary design of the M1 segment deformation control (“warping harness controller”) has been built and tested on the M1 Segment Subunit models delivered by TNO. This development supports testing of engineering models of the Segment Subunits on the ESO M1 test stand in 2017 as well as acting as a path-finder for the final warping harness controller.

The Stereo-SCIDAR is fully operational, 44 nights were collected up to now (http://www.eso.org/astclim/paranal/asm/scidar/Stereo-SCIDAR/index.html). Spares have
been delivered to Paranal. A preliminary set of reference atmospheric profiles was provided to the ELT Instruments Consortia and an update is in preparation for SPIE Remote Sensing, September 2017.

<table>
<thead>
<tr>
<th>Year</th>
<th>#nights</th>
<th># profiles</th>
<th>Average R0(m)/seeing(“)</th>
<th>Average Theta0(“)</th>
<th>Average Tau0(ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>13 nights</td>
<td>2647</td>
<td>0.16/0.74</td>
<td>1.9</td>
<td>3.9</td>
</tr>
<tr>
<td>2017</td>
<td>31 nights</td>
<td>5008</td>
<td>0.16/0.72</td>
<td>1.8</td>
<td>3.8</td>
</tr>
<tr>
<td>2016-2017</td>
<td>44 nights</td>
<td>7655</td>
<td>0.16/0.72</td>
<td>1.8</td>
<td>3.9</td>
</tr>
</tbody>
</table>

*Stereo SCIDAR@Paranal Measurements Summary Table (dome subtracted)*

### 3.6 Civil Infrastructure

The ELT road, connecting the Armazones mountain with route B710 (public road), is finished and in use. During this period, the road has been opened for use by the electric line contractor (Saesa). Today, this company has finished its work and already left the site. A small punch list (regarding road issues) was created and passed to Saesa. Upon their departure, all items in the punch list were closed.

As of June 2017, the DMS contractor (ACe consortium) has been intensively using the approach road (first 19 km) to implement the facilities that are needed for its contract. The pavement has performed very well and the constant traffic of heavy trucks has been very beneficial for the asphalt coating. The same applies for the approach road, the so-called spiral road, has stayed in constant observation, but the traffic on this portion of the road has remained at a minimum. The whole road length is being maintained (swept) from time to time to keep it free from small amounts of debris that is freed from the rock cuts. During this winter, unusual weather with rain and snow fall has occurred, but the road has performed very well and stayed drivable all the time, except during a short period when there was ice on the surface of the spiral road from km 22,000 to the ATP.

The Armazones Top Platform (ATP), the Chillers, the Dry Coolers and the Storage platforms are all ready to receive the DMS initial works. During this period and from the infrastructure side, only small topographic works have been made over the ATP, all of them duly coordinated with ACe.

The global stability of the ATP dumps was revised and is found not to be of concern as the dumps are globally stable. The DMS contractor’s doubts about the stability of the dumps have ceased after the responses provided by the ESO Infrastructure Project Manager and the DMS Project Manager.

One of the recommendations resulting from the assessment of the global dumps stability was the installation of a dynamic mesh against rock fall (local instability). Such a dynamic barrier
was designed, supplied and installed between km 23,400 and km 23,700 of the spiral road. The work was completed in April 2017 and so far remains as a preventive safety measure, as no rock fall has happened since.

Regarding the Armazones infrastructure (rooms for coating equipment, instrument integration, small workshops and the like), its implementation is directly linked to the Dome and Auxiliary Building design, whose Preliminary Design Phase was completed at the Dome PDR last June 2017.

Some changes to the existing observatory infrastructure are also being planned at Paranal to accommodate the ELT needs.

Regarding new infrastructure at Paranal, the urbanisation of a piece of land located next to the fuel station and the Astrotaller building has been defined. It has an extension of around 6,500 m². In this area, new circulation roads, new fire and potable water grids, new sewerage grids and new power and data distribution grids need to be built in conjunction with the ELT Technical Facility (ETF). The ETF includes a roofed space to store the M1 segments and other delicate pieces as well as the M1 segments maintenance area and the 5-m mirror maintenance area.

After a successful RFI held between December 2016 and March 2017, a formal tender action was initiated in April 2017. As this was an engineering, procurement and construction contract, the typical SOW and technical specifications documents were created. In order to fully define the scope being contracted, a basic engineering design of the ETF facilities was developed in all disciplines, namely earth works, industrial architecture, sanitary, electricity and HVAC. The tendering process implied the answering of around 500 questions to fully clarify the scope to the bidders and nine offers were received on 18 August. So far, the technical evaluation is concluded, resulting in more than half of the offers being technically compliant. Based on the latter and with the commercial evaluation still under development, the steps forward to conclude the proposal of award of contract will be defined.

Finally, and with respect to the human resources needed in Chile to support the execution of the works described above, the process to fill the Bilingual Secretary position was successfully finished. Since mid of June 2017, Mrs. Ivanna Friedli started working for the ELT Project.

3.7 Supporting Infrastructure

Over the reporting period, the supporting infrastructure project mainly managed three topics:

- the CFT for the M1 Segment washing, stripping and coating plant;
- the electrical substations for Armazones;
- the M4 cooling infrastructure.

The supporting systems continued being involved in the definition of requirements for the ELT Technical Facilities (ETF) at Paranal and the review of layout and design to assure that all the installations related to mirror maintenance are properly considered.
### 3.7.1 Washing and Coating (mirror maintenance)

ESO launched a Preliminary Inquiry (PI) for the washing, stripping and coating of the M1 Segments in preparation for the CFT of this plant. Subsequently, the CFT was sent to qualified bidders, the result of this CFT will be known and presented in the next reporting period. ESO decided to have only one procurement process for the complete plant of coating removal, recoating and quality inspection, including the handling of the M1 Segments between the different sections of the plant. This makes the procurement process slightly more complex, but avoids additional external interfaces, which ESO would have to manage in case of splitting this plant into sections with individual procurements.

In addition, the previously started investigation for in situ cleaning process for the M1 resumed. The two potentially promising methods, gentle brush cleaning and laser cleaning, shall be further developed and detailed in independent feasibility studies. These studies shall prove the general feasibility of the method, applied to the large surface of the M1 and shall also help ESO in the decision, regarding if and which process shall be finally applied for the ELT.

### 3.7.2 Power conditioning and backup system

The electrical substations for Armazones and Paranal were installed. For Armazones, ESO had to place a contract for the civil works, which was successfully completed and on time. Currently, these substations are being electrically connected, allowing the use of Chilean grid power for the Armazones base camp in the near future. Two units were installed, one 23 kV switchgear, allowing the distribution of power to the telescope platform and the base camp. In the camp, the second substation contains a transformer to reduce the voltage from 23 kV to 400 V, as required for the camp operation. The completion of the commissioning is planned to take place during the month of October.

### 3.7.3 Chilled Medium Plant, Compressor and Cryogenic Plant

ESO is in contact with qualified companies which can deliver cryogenics infrastructure and cooling equipment for the ELT instruments. In the current phase, the supporting systems management is investigating which suppliers are interested in helping the project with the planning and preparation of the cryogenics infrastructure, most likely by performing a feasibility study for processes and hardware.

### 3.7.4 M4 Cooling Supply

The planning for the supply of the M4 Unit with the refrigerant gas cooling is ongoing. After the M4 Unit contractor had shown interest in supplying the gas cooling infrastructure, an RFI was prepared and will be launched in the next weeks to explore the most efficient option for the provision of this system. Technically, the best solution will be to add the cooling infrastructure to the M4 Unit contract, which will eliminate the ESO involvement with external interface, and will avoid any technical discussion in case of potential performance problems of the M4.
## 3.8 Instrumentation

Progress continues on the four instruments in construction and the two Phase A studies for ELT instrumentation. The instruments are:

- **HARMONI**, an AO-fed IFU spectrograph for the optical and near infrared;
- **MICADO**, an MCAO-fed near infrared imager with slit spectroscopy;
- **MAORY**, an MCAO module to feed MICADO and an auxiliary port;
- **METIS**, an AO-assisted imager/spectrometer for the thermal infrared;
- **MOSAIC**, an optical to NIR multi-object spectrograph (Phase A study); and
- **HIRES**, an optical to NIR high resolution spectrograph (Phase A study).

The first of the Preliminary Design Reviews of the ELT instrument programme will be held on 9 - 10 November and 7 - 8 December. This is the HARMONI PDR, split into two parts to cover the spectrograph and science case first and the adaptive optics systems (LTAO and SCAO) and managerial aspects of the project second. The split into two review meetings is needed to manage the substantial effort required for a thorough review of these complex systems. The Review Board will have members common to both reviews so that an overview of the complete HARMONI system is achieved. ELT INS will also adopt the current “best practice” from the LSP programme, holding parallel splinter sessions in the days before the formal review for well-focused, technical discussions among the relevant experts in the Consortium and from the Review Board on the most critical issues raised by the review.

The completion of the PDR for the HARMONI LTAO in December brings to a close the work on that project, the continuation of which is a Phase 2 item. Stopping this work at this stage presents risks to the ELT INS project, principally that the development of the instrument and its AO system will no longer proceed in parallel and that the consortium working on the LTAO system may disperse and not be available to continue the work at the uncertain future point when the funding is available. Mitigation of these risks is being discussed with the ELT Programme Management.

Furthermore, the risk to the Programme is that this functionality (laser guide star assisted adaptive optics) is required to deliver the complete HARMONI science case. To address the risk of late development of this item, ESO continued to study the option to provide this functionality by feeding HARMONI with an AO corrected beam from MAORY. This work has been carried out with the HARMONI and MAORY consortia. An opto-mechanical solution exists which has minimal impact on HARMONI and MAORY and none on MICADO (the only client instrument for MAORY in the current baseline). The adaptive optics performance and the scientific impact have been assessed. The principle scientific impact is a loss in sensitivity due to the increased thermal background from the additional warm mirrors in front of HARMONI. At the longest wavelengths at which HARMONI operates (the K band: 2.0-2.4um) either a loss of 0.25mag, or a factor of 1.6 in exposure time is required to observe a given object. A study of concepts for cooling MAORY will be procured from industry by ESO.

**MICADO** carried out their System Requirements Review in April 2017. This was an internal consortium activity that was supported by ESO in several ways. Members of the ESO follow-up team of engineers were invited to sit on the SRR Board (specifically, the specialists involved
in the data reduction pipeline, instrument control software and electronics). The ELT and ELT INS Systems Engineers also worked together with the MICADO System Engineer to answer the questions related to the ELT to instrument interface and requirements. Finally, the ESO MICADO project office attended the review as observers. MICADO is making good progress towards their Q4 2018 PDR.

MAORY are working towards their Preliminary Design Review which is planned for the first quarter of 2018. The consortium has initiated several key activities with industry to bring their design up to the required level. A market consultation on their “static” optics (i.e. not the deformable mirrors) was launched in July. This procurement activity has highlighted an issue with the feasibility of the large dichroic beam splitter and an extension of the deadline has been announced (now 26 September). A contract for the design of the large mechanical structure will also be placed, to bring the design to PDR level. INAF are carrying out an internal review of MAORY in October with an external panel of experts. Considering the additional time required for the procurement activities and to take into account the outcome of the internal review, MAORY have announced a delay to their PDR date of three months.

The METIS Internal System Requirements Review took place in June 2017 with the participation of the ESO follow-up team as observers. ESO also contributes to METIS (and the other instruments) by delivering scientific detector systems. The choice of detector for METIS is actively discussed. The current baseline is the Aquarius detector (as used in VISIR) which has some known performance limitations due to excess noise that correlates with the level of background radiation. While this detector will deliver good performance for the spectroscopic modes of METIS, it is expected to limit the broadband imaging performance. METIS are exploring trade-offs for improving the predicted performance including considering the possibility of an alternative detector.

In the past six months, ESO has initiated some key procurement activities related to ELT INS. Requests for Information have been released for the near-infrared scientific detectors that will be used by MICADO and HARMONI (0.8-2.5\(\mu\)m) and also those for the METIS short wavelength functions (3-5\(\mu\)m). The contract for development of the large format optical wavefront sensing detectors (LVSM) that are required by the laser guide star wavefront sensors was also signed. This contract is managed by the Enabling Technologies programme.

The Phase A studies of the ELT-MOS and ELT-HIRES instruments is coming to an end. The HIRES Phase A review will take place on 13 and 14 November. The MOSAIC review is planned for Q1 of 2018. ESO is currently discussing the options for the next steps after Phase A with the PIs.

4. **Science Data Operations**

The ELT science operations model assumes that ELT and VLT operations will be performed in an integrated environment. Therefore, the Data Flow System (DFS) will support both VLT and ELT operations. The integrated Data Flow System for the ELT and VLT seamlessly implements highly efficient science operations, meeting all high-level science policy requirements. The evolution of the VLT-DFS is already ongoing, carefully observing new or
additional requirements driven by the ELT infrastructure in general, and ELT instrumentation in particular.

The project management and development plan for the Science Data Operations Project has been released. It contains a roadmap for all development activities required to meet the Top-Level Observatory and Level 1 Requirement Specifications. The plan contains schedule, budget, resources, and milestones for the development of major subsystems, as well as global project risks. Developments in the area of Phase 1 (proposal preparation), Phase 2 (observation preparation) and archive services are ongoing according to plan.

The architecture and interface specifications between the DFS and the ELT control system are entering in their conceptual design phase.