Minutes from LBT672 progress meeting

Meeting: LBT672 monthly progress meeting
Date: Dec 4, 2008
Location: Telecon – LBTPo, Arcetri, Microgate, ADS

Participants: Brynnel, Green, Brusa, Demers, Miller, Riccardi, Salinari, Tozzi, Pieralli, Fini, Biasi, Gallieni

Agenda Item 1: Status of Action Items

#34: Guido to investigate alternatives for mouse-hole cover.
Update: No progress.

#64: Daniele to check status of ADS drawing tree.
Update: No progress.

#66: ADS, MG, OAA and PO will all review open AI’s and send updates to Guido.
Update: No progress. Still some open Action Items.

#73: Guido to start developing a plan for shipping TS3 back to US.
Update: No progress. Need new packing procedure. Richard said the PO is investigating new shipping procedures.

#79: Guido to obtain statistics on coil failures at the MMT.
Update: No progress.

#84: ADS/MG to propose strategy for solving coil insulation problem.
Update: See ADS report in [Appendix 3]. All defective coils are now at ADS.

#85: Daniele to propose collision avoidance system.
Update: Proposal from ADS (Fumi) based on ultrasonic sensors distributed, see [Appendix 2]. It was proposed to test sensor on unit #2. See also discussion in IssueTrak #1829. A decision of action required (how to stop motion) on sensor trigger is required. Doug pointed out that MMT used a stainless steel band as collision sensor.

Action Item: Doug to get information about MMT collision sensor implementation.

Armando suggested that the retro-reflector support be modified to avoid any collision risk for the telescope setup.
**Action Item:** Daniele to distribute plot of model showing the telescope retro-reflector setup.

**#86:** Armando to discuss new shroud design with ADS.

*Update:* Some discussions were held between Armando and Guido. No good solution identified yet.

**#89:** Daniele to propose design changes to the cooling system to avoid glycol contamination.

*Update:* No progress.

**#90:** Luca to respond to GUI review comments.

*Update:* Luca has sent email to reviewers. AI closed.

**Action Item:** Doug to poke GUI reviewers and seek further discussion.

**#91:** Doug and Guido to write GUI requirements document.

*Update:* No progress. Guido and Doug will discuss this next week.

**#92:** Daniele to provide missing information for ICD.

*Update:* Information provided, AI closed. See also [Appendix 3].

**#93:** Simone to distribute document list for LBTAO review.

*Update:* Information provided, AI closed. See also [Appendix 8].
Agenda Item 2: Official Schedule

Simone submitted an updated schedule V23, dated 28-Nov-08 [Appendix 1].

2.1 Line #19 “W unit #1 Action Items”

All Action Items closed except CCD39 RON. A consultant has been hired to help in solving this issue. New completion date 15 Dec 2008 (was 17 Nov). Work on CCD39 will be done on W#2, and no impact on the tower testing schedule is expected.

2.2 Line #24 “LBT672 optical test”

Nominal completion date was 5 Dec. After the hexapod collision on Nov 27, the revised completion date is now 22 Dec, please update.

2.3 Line #41 “Unit #2 integration ADS”

This activity is on track for completion on December 15 December. Schedule still shows completion date 28 Nov.

2.4 Line #44 “TS#4 Magnets gluing”

Activity complete.

2.5 Line #53-#54 “W#2 integration” and Line #55 “W#2 Acceptance test”

Acceptance test has been scheduled for 29-30 January.

2.6 Line #57 “TS#5 de-blocking”

Richard reported additional delay at SOML, new date for de-blocking 1 May 2009.
Agenda Item 3: Status update – progress since last meeting

Microgate

See separate progress report [Appendix 5].

ADS

See separate progress reports:

- ADS monthly report [Appendix 3]
- Proposal for collision detection system [Appendix 2]

Doug asked why one magnet detached from TS#5. Daniele responded that it is likely a clearance problem caused by dimensional tolerances. No problems with the gluing process was found.

Arcetri

See separate progress reports:

- W units activity report [Appendix 4]
- Software Progress Report November 2008 [Appendix 6]
- FLAO Commissioning plan, Draft 1.0 [Appendix 7]
- List of documentation for AO review [Appendix 8]

Doug brought up the reported issue with LBT TCS software installation in Arcetri. Luca replied that he has made some progress but the problem is not yet resolved.

Progress report from Armando pending.

Tucson

The PO has supported ADS with magnets gluing and shell handling. Guido reported about preparations at Sunnyside for TS#3 front side coating.

TS#5 has been inspected and all measurement results appear to be in specification. Further machining of TS#5 will start in January.

Doug said that while he is now able to collect anemometer data and other relevant TCS data, the LBT weather station compass is now broken and for this reason it is not possible to log wind direction.
**Agenda Item 4: Hot topics of the month**

**4.1 Glycol spillage accident report**

Armando said report will be finished Monday December 8. The review meeting is still planned for the week of December 15 (organized by Richard).

**4.2 Hexapod collision**

Armando stated that 2 distribution boards need to be replaced. All necessary spare parts are available in Arcetri.

Richard pointed out that we have experienced two accidents in the last quarter. What can be changed to reduce the risk of more accidents? Armando noted that we have had two hexapod related incidents: The hexapod connector failure leading to a hexapod runaway and the recent collision with the calibration hardware. Richard confirmed that we will need an accident report also for the collision accident.

Piero said that we have had three accidents, and he recommended that for future tower activities there should always be one responsible person for the secondary unit and one W sensor responsible person present. Joar asked how this can be accomplished in practice. Piero said he will need some time to think about this, and he will make a proposal.

*Action Item: Piero to suggest improved and safer procedures for testing in tower.*

Roberto recommended reducing the human factor as far as possible. He pointed out that while for the shell there are many layers of safety mechanisms, there is virtually nothing implemented for the hexapod motion.

Guido raised the question if we can continue testing without further action. Armando replied that a temporary collision control will be implemented before proceeding. Joar asked how this collision control can be validated. It was agreed that this will be done by review.

Rick added that it is important to review and discuss plans before doing tasks.

**4.3 Calibration Unit**

The Change Request from the ARGOS team to install a fiber through the AO unit was rejected. Guido is leading the discussion on technical and operational requirements for optical calibrations. This discussion includes key members of the LBTPO, LBT672 and the ARGOS teams. A meeting to discuss those topics will be scheduled during the week of December 8.
4.4 Mechanical clearance in hub

Daniele said no progress on this issue. This will be addressed after unit #2 has been delivered to MG.

4.5 Central hole cover

Roberto reported that the baseline cover has been designed, but not yet produced pending approval of the design.

Action Item: Guido to review baseline cover design.

4.6 Commissioning plan

A draft plan was distributed, see [Appendix 7].

4.7 Shell protective coating

Richard said that the Sunnyside facility responsible has not agreed to this process. The issue is still unresolved.

4.8 Next meeting

Due to next meeting date on January 1, the December progress meeting was re-scheduled for Thursday January 8.
**Agenda Item 5: Planned activities for the next month**

**Microgate:**
- Final modular testing for LBT672b
- Refurbishment of clean room air conditioning
- Final testing of external actuators

**ADS:**
- Finish integration of unit #2
- Deliver unit #2 to MG
- Support transport of TS#1 from Arcetri to MG

**Arcetri:**
- Glycol spillage accident review
- Temporary collision detection system
- CCD RON problem investigation
- Test reports for W sensor tip-tilt, ADC and de-rotator
- Preparation of W#2 for acceptance test

**Tucson:**
- Glycol spillage accident review
- Calibration unit discussion with ARGOS team
Action Item List

#34: Guido to investigate alternatives for mouse-hole cover.
#64: Daniele to check status of ADS drawing tree.
#66: ADS, MG, OAA and PO will all review open AI’s and send updates to Guido.
#73: Guido to start developing a plan for shipping TS3 back to US.
#79: Guido to obtain statistics on coil failures at the MMT
#84: ADS/MG to propose strategy for solving coil insulation problem.
#85: Daniele to propose collision avoidance system.
#86: Armando to discuss new shroud design with ADS.
#89: Daniele to propose design changes to the cooling system to avoid glycol contamination.
#91: Doug and Guido to write GUI requirements document
#94: Doug to get information about MMT collision sensor implementation.
#94: Daniele to distribute plot of model showing the telescope retro-reflector setup.
#95: Doug to poke GUI reviewers and seek further discussion.
#96: Guido to review baseline cover design.
#97: Piero to suggest improved and safer procedures for testing in tower.

Appendices

Appendix 1: Schedule V23, dated 28-Nov-08, S. Esposito
Appendix 2: Proposal for collision detection system, P. Fumi
Appendix 3: ADS monthly report 4-Dec-08, D. Gallieni
Appendix 4: W units activity report, A. Tozzi
Appendix 5: Microgate monthly report November 2008, R. Biasi
Appendix 7: FLAO Commissioning plan, Draft 1.0, S. Esposito
Appendix 8: List of documentation for AO review, S. Esposito
<table>
<thead>
<tr>
<th>Task</th>
<th>Start Date</th>
<th>End Date</th>
<th>Milestone</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO system #1</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #1 initiation</td>
</tr>
<tr>
<td>AO system #2</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #2 initiation</td>
</tr>
<tr>
<td>AO system #3</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #3 initiation</td>
</tr>
<tr>
<td>AO system #4</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #4 initiation</td>
</tr>
<tr>
<td>AO system #5</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #5 initiation</td>
</tr>
<tr>
<td>AO system #6</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #6 initiation</td>
</tr>
<tr>
<td>AO system #7</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #7 initiation</td>
</tr>
<tr>
<td>AO system #8</td>
<td>Week 1, 2009</td>
<td>Week 1, 2009</td>
<td></td>
<td>AO system #8 initiation</td>
</tr>
</tbody>
</table>

**Critical Tasks**

- AO system #1
- AO system #2
- AO system #3
- AO system #4
- AO system #5
- AO system #6
- AO system #7
- AO system #8

**Milestones**

- AO system #1 initiation
- AO system #2 initiation
- AO system #3 initiation
- AO system #4 initiation
- AO system #5 initiation
- AO system #6 initiation
- AO system #7 initiation
- AO system #8 initiation
1. ULTRASONIC SENSORS

The Ultrasonic Sensors (USS) are devices able to measure distance using ultrasonic waves. In the LBT case, the USS will be used to measure the distance between the M2 hub and the M2 Unit.

The signal coming from the USS will be used to stop the motion of the Hexapod in case the distance between the hub and the M2 unit will pass below a predetermined threshold.

The proposed USS are manufactured by Baumer Electric.

The following link:

is the webpage containing all the USS suitable for the LBT use.

The proper model will be selected once the location of the USS will be fixed, in order to choose the model with the proper measuring range. The resolution and the absolute accuracy of the USS are in the order of fraction of mm (usually 0.5 / 0.3 mm).

The following sections explain how the USS could be connected to the telescope system in terms of mechanical and electrical connection.


2. LOCATION

The location of the USS is not yet identified. The choice of the location must consider:

1. the maximum hexapod allowable attitude (X Y Z TIP TILT SPIN) at telescope
2. the distance between the M2 unit and the hub at the maximum hexapod attitude
3. the room needed for the installation of the USS

Points No. 1 and No. 2 lead to the conclusion that the best position is at the very bottom of the hub. However, in the middle height of the hub there are the 8 ribs that interfere with the AdOpt crates. A further investigation is needed to know if the flat cables connected to the crates are in the worst position in terms of interference.

Point No. 3 leads to the choice of the USS of the series UNDK 20 (see link above), because of its small size.

The USS could be connected:

1. to the M2 unit, looking at the hub
2. to the hub, looking at the M2 unit

At preliminary analysis, the installation on the M2 unit seems cumbersome, because of the few free space on the unit and the shroud that shall be completely closed.

The installation on the hub seems easier: the USS of the UNDK series could be easily installed on the internal side of the hub with two M3 screws, without through holes on the hub.

The USS to install on the system shall be at least 3, mounted 120deg apart.
3. FUNCTIONING

The USS can be used in 2 different modality:

1. **Software**: the measure of the USS is read by a controller that is connected to the TCS. The TCS software is in charge of stop the motion of the hexapod in case the reading of the USS goes below the threshold.

2. **Hardware**: the measure of the USS is read by a stand alone controller that, in case the reading of one of the USS goes below the threshold, cuts the power to the motor of the hexapod. The recovering will be able only by manually override the alarm of the USS.

3.1. **Option #1 – Software (VST style)**

The software option foresees 2 different implementations (see next section). The following list summarizes the general pros and cons of the Software option.

**Pros:**
- Continuous reading of the USS distance
- Immediate recovery of an alarm situation
- Possibility to change easily the threshold distances

**Cons:**
- Software fault/bug could lead to a not intervention of the safety strategies
- Update of the current TCS software

3.1.1 **Software option a:**

Install an expansion board on the Hexapod Control Unit (HCU), that is able to read the analog signal (0-10V or 4-20 mA) coming from the ultrasonic sensors.

**Pros:**
- Install a new board on a consolidated hardware
- The communication between TCS and the USS is performed over an already tested link (the same used to talk with the HCU)
- Minor software update on the HCU side

**Cons:**
- Mechanical working on the HCU (cut the front panel to accommodate the new board, re-cable the internal HCU)
- Add extra cable(s) to the cabinet (that is already filled with hexapod and AdOpt harness)

3.1.2 **Software option b:**

Install a new controller (PLC or similar) that is dedicated only to the reading of the USS measure.

**Pros:**
- A dedicated controller is more reliable in case of power failure on the HCU or AdOpt
- No intervention on the HCU and the Hexapod
- Installation of the hardware anywhere, it is not mandatory to install it inside the M2 cabinet

**Cons:**
- Add a link for the communication with this new controller
3.2. **Option #2 – Hardware**

The hardware solution foresees that a simple logic cut off the power of the hexapod motors in case the distance goes below the threshold. The cut off of the motors is performed by shutting down the 24V PSU that energize the power stage motors. The PSU that energize the motors is the same that energize the brakes, so at the same time the brakes are closed.

This power cut leads to an immediate stop of the motors that induces an immediate increasing of the Following Error of the actuators.

The recovery from this alarm is performed manually: the power to the 24V PSU is available only if a button is manually pushed (human intervention) and the hexapod is commanded to a safe attitude (without performing the homing procedure).

**Pros:**
- No software modification needed
- Immediate shut down of the system
- Fail safe design (no power on the USS → no possibility to use the hexapod)
- Hardware installable anywhere
- Few working on the HCU (installation of a relays near the 24V PSU)

**Cons:**
- No information is available about the USS distance
- The modification of the intervention threshold of the USS is performed in hardware (changing value of some resistors/trimmer)
- The following error alarm on the HCU side engaged only after a time depending on the speed of the actuator (the time is needed to gain enough following error to reach the “Fatal following error” threshold). However, even if the “fatal following error” is not risen, the actuators are halted because the brakes are engaged.
Status of Action Items (see below)

2. Schedule

- Unit #2 Integration @ ADS (41)

IT IS PROCEEDING AS PLANNED AND THE TRANSPORT TO MIC IS PLANNED FOR WEEK 51.

- TS#4 magnets integration (44)

TS4 ACTIVITY COMPLETED ON DEC.2

3. Status update - progress since last meeting

- ADS

WE HAVE COMPLETED THE TS4 MAGNETS GLUING ACTIVITY AND DOWNLOADED AND PACKED IT WITH GUIDO B. ASSISTANCE AS PLANNED (see picture next page).

WE HAVE FACED A PROBLEM DURING DOWNLOADING OF THE SHELL WHICH CAUSED ONE EXTERNAL MAGNET TO DETACH – WE HAVE PREPARED THE SHELL FOR THE RE-GLUING OF SUCH MAGNET – WE DECIDED TO POSTPONE THE RE-GLUING AFTER THE MEMBRANE WILL BE INSTALLED ON TS4 (@ ADS AFTER ACTIVITY IN MIC) TO MAKE SURE THE ALIGNMENT OF SUCH MAGNET WILL BE THE CORRECT ONE (2 DAYS ACTIVITY, NO IMPACT ON THE SCHEDULE, NO TECHNICAL RISK ASSOCIATED, NO DISMOUNT OF THE ELECTRONICS REQUIRED)
IN PARALLEL WE WERE ABLE TO PROCEED WITH SOME ACTIVITY ON THE 2\textsuperscript{ND} UNIT PREPARATION FOR THE TRANSFER TO MIC.

LBT672b mounted on its Integration and Test Stand (left) and Magellan ASM unit (right)

4. Hot topics of the month

- Status of Hub #1 clearance modification

\textbf{NOT YET ADDRESSED, AS SAID LAST TIME WE PLAN THIS TASK AFTER 2\textsuperscript{ND} UNIT IS MOVED TO MIC}

5. Planned activities for the next month

- ADS

\textbf{FINALIZE 2\textsuperscript{ND} UNIT PREPARATION FOR TRANSPORT TO MIC}

\textbf{TRANSPORT 2\textsuperscript{ND} UNIT TO MIC AND SUPPORT ITS INSTALLATION}

\textbf{SUPPORT THE ORGANIZATION OF TS1 TRANSPORT FROM ARCETRI TO MIC}
Open Action Items:

#64: Daniele to check status of ADS drawing tree.
   
   A: NOT YET DONE.

#84: ADS/MG to propose strategy for solving coil insulation problem.

WE HAVE RECEIVED FROM MIC THE COMPLETE SET OF DEFECTIVE COILS – ANALYSIS WILL BE CARRIED OUT BUT NOT IMMEDIATELY, AFTER THE CONCLUSION OF TS4 RELATED ACTIVITIES AND 2\textsuperscript{ND} UNIT PREPARATION FOR SHIPMENT TO MIC

#85: Daniele to propose collision avoidance system.

TECHNICAL NOTE SUMBITTED BY ADS TO LBTO. PENDING DECISION ON THE SOLUTION TO BE IMPLEMENTED WE WILL STUDY IT TO BE READY TO TEST IT AT ADS ON THE 2\textsuperscript{ND} UNIT

#89: Daniele to propose design changes to the cooling system to avoid glycol contamination.

DONE, CONTRIBUTED TO THE REPORT PRESENTED BY ARMANDO

#92: Daniele to provide missing information for ICD.

DONE AND REPORTED ON 13Nov TO MIC+ARMANDO FOR SOME MISSING INFO ON THEIR SIDE.
W#1 activity
-------------
W1 installed in the tower optical bench on November 26th. All HW was working.
W1 uninstalled after hexapod problem on December 1st.
W1 ready for AO system test

Resolution of W#1 action items
---------------------------------
W1 all AOINT action items has been closed, except CCD39 RON.

W#2 activity
-------------
WFS board
----------
1) Pupil rotator aligned on the WFS board and the optical alignment of the WFS board has been completed.
2) Optical Performances of the ADC has been measured (see CAN archive #687f003a document).
3) Preliminary Acceptance Test has been done. All the tests done for the W#1 acceptance have been replicated on the W#2 (see CAN archive #687f003a document).
4) The Lab Preliminary Acceptance Test Report for W#2 has been generated and uploaded into the LBT CAN archive with number 687f003a.
5) The firmware of the custom electronic board (the "Power Board") that controls the power on/off of the devices has been upgraded to resolve the AI2 ("over temperature protection doesn't work"). The reprogrammed Power Electronic Board will be swapped with the actually one that has been used on the W#2 during Preliminary Acceptance Test.
6) AI1 ("RON ccd39 is not in spec for each pixel rate"): we have contacted Dr. Carbone by SkyTech (La Spezia - Italy) in order to find a solution to this problem. Carbone has already worked with Ragazzoni at the engineering of LBC CCD controller. He will be in Arcetri within the 20th December.

Activity for the next month
-------------------------------
1) CCD RON problem investigation (AI1)
2) Writing the Reference Documents cited in the 687f003a document:
   [RD3] Tip-Tilt mirror test report
   [RD4] ADC Test Report
   [RD5] Optical de-rotator test report
3) Working on the Action Item W#2
LBT PROJECT

LBT672 ADAPTIVE SECONDARIES

Microgate monthly report

November 2008

Date : 03.12.2008
TABLE OF CONTENTS

1 Status report .................................................................................................................................................. 3
2 Other activities .............................................................................................................................................. 4
3 Program for December activity ..................................................................................................................... 5
1 Status report

During the past month we have completed the full test, calibration and integration of distribution boards, power backplanes and backplanes. The activity has been performed also on all spares and on the Magellan units. In fact, upon the shift in the delivery of the LBT672b electromechanical subsystem to Microgate, currently planned for Dec. 22nd, we decided to complete testing all available units, including the Magellan ones.

We are now proceeding with the test of the DSP boards. Depending on the test results and speed, we will decide on the fly whether to complete only the LBT672b units + spare or to test the MAG585 DSP boards as well. The priority is clearly in being 100% ready to start the final integration activity as soon as the system arrives to Microgate.
2 Other activities

We have planned for the next two weeks a minor refurbishment of the clean room, in particular to enhance the performance of the air conditioning. This is not affecting the unit cooling, that is connected to a dedicated chiller, so the activity has substantially no risk for the performance of the testing environment.
3 Program for December activity

We will be focused on the final modular testing before starting the integration on LBT672b.

The refurbishment of the clean room air conditioning will be certainly completed before the LBT672b unit comes in.

As already remarked, the final testing and calibration of the external actuators is still pending. This has been done to find on the final unit the optimal adjustment of the flexible contacts. Considering the limited number of actuators and the fact that the boards and the coils have been already pre-tested, we consider this activity to be very low risk.
Here follows my short report.

AdOpt Software

* The deadlock problem in the Message Daemon has been solved. As a side effect of the debugging process many enhancements to improve reliability of the program have been added.
* A problem related with signals has been discovered and solved in the IDL wrapper.
* We have learned some lessons related to Operating System configuration and maintenance in order to increase system availability. Proper procedures will be added to the software configuration of the AdOpt Workstation at the telescope.
  * The diagnostic GUI of the adaptive secondary has been enhanced.
  * More work on the installation procedures.

AOS

* The list of interchange variables has been increased and the TCS has been upgraded to the last "trunk" version.

--

Luca Fini
INAF - Oss. Astrofisico di Arcetri
L.go E.Fermi, 5. 50125 Firenze
mailto:lfini@arcetri.inaf.it http://www.arcetri.inaf.it/~lfini
First Light Adaptive Optics System telescope commissioning plan.
Draft version #1.0, date 26 / 11 / 2008

1 Scope of the document
The document describes the various activities to be done in order to complete the First Light AO system telescope commissioning.

2 Applicable documents
AD1 FLAO system WFS opto-mechanical acceptance test
AD2 FLAO system acceptance test in the solar tower

3 Telescope requirement for FLAO commissioning
The telescope bent Gregorian focal station should be aligned before starting the AO system commissioning. The following specifications should be followed in order to have a correct operation of the FLAO system:

1) Telescope optical axis has to be aligned with the derotator axis with the following tolerance in position and angle: TBD
2) Optical axis wobble for a full rotation of the derotator not larger then TBD
3) Focal plane center displacement for a full rotation of the derotator not larger then TBD
4) Input F/ of the bent Gregorian optical train telescope has to be 15 +/- 0.3
5) Telescope vibrations should have an rms less then TBD and a maximum frequency of TBD

4.1 Phase 1: system unpacking, re-integration and functional check (12DD)

4.1.1 Shipping, unpacking and re-integration (10DD)
Shipping, unpacking and re-integration of the two main subsystems: the adaptive secondary mirror or LBT672a and the AO system wavefront sensor or W unit will be done in parallel. The tasks to be done for these two units are reported below:

4.1.1.1 LBT672 shipping notes unpacking and re-integration (10DD)
To be completed

4.1.1.2 W unit shipping notes
The shipment of AGW unit will be done in the following way: the WFS board will be shipped in a small separate box. The box will have internal insulation against shocks. The WFS optics will be kept in place except for the (1) the glass pyramid 2) the tip tilt fast steering unit including piezo-electric stage and mirror (3) the camera lens positioner including camera lens and piezo-electric
stage (4) the beam splitter cube located in the auxiliary unit bench. These four parts will be shipped separately due to their sensitivity to shocks. Separate shipping of the pupil rerotator is now being considered because of the strict requirements on the alignments of the mirrors combination installed in the rotator unit. The problem in removing this unit is the sensitivity of the WFS alignment to the pupil rotator axis position. Electronics: the two CCD heads will be shipped separately because of their extreme sensitivity to shocks. In particular boxes with foam insulation should be used to ship the two CCD heads. The electronic boxes will be shipped attached to the AGW frame as they will be during telescope operation. The cabling of the unit will be shipped together with the AGW unit as it will be during telescope operations. All the spare parts should be shipped in a separate box.

4.1.1.2 W unit re-integration (10DD)
The W unit re-integration should take place in an optical lab. An optical bench should be provided. Dimension of the optical bench can be 1.5x1.5m. The WFS board components shipped separately will be re-installed on the WFs board. An internal optical alignment of the board will be done using an external fiber provided by the Arcetri group. After re-alignment of the WFs board the unit will be installed in the AGW structure. The WFS board alignment with the center of the mechanical structure will be checked. The alignment of the WFS reference source to this axis will be checked and readjusted if needed. After completion of the WFS re-alignment and installation in the AGW unit the W unit is ready for the functional test. A functional test of the unit will be done accordingly to the procedure already used during the W unit acceptance test in Arcetri.

4.1.2 Functional checks of the FLAO system (2DD)
A functional check of the full AO system will be performed before installing it at the telescope. To do this test a fiber connection between the adaptive secondary and the AGW unit should be provided. Then the system will be connected with the AO supervisor computer in order to test the system functionalities. A compliance matrix should be compiled to have a report of the available functionalities of the system. A test of the SW interaction with the TC would be performed at this early stage of the commissioning activity to start as soon as possible any needed action of SW additional coding or adaptation. This last phase is not included in the two days period dedicated to functional checks and could be done in parallel with the other operations.

5 Telescope installation of subsystems (9DD)

5.1 Adaptive secondary installation and functionalities (3DD)
To be completed

5.2 AGW installation and functionalities (3DD)
The procedure to install the AGW unit on the derotator of the bent Gregorian focal station should be very similar to the procedure already followed by the LBTO team and AIP team to install the AGw unit. To be completed

5.3 Infrared test camera installation and functionalities (2DD)
To be completed

The infrared test camera will be installed on the FLAO system AGW unit. The installation procedure should be the same used by LBTO team to install the IRTC for the alignment campaign of the bent Gregorian focal station. The IRTC functionalities will be tested with particular attention to interaction with the AO supervisor and with the main control SW.
5.4 Retro-reflecting optics installation (1DD)
To be completed

5.5 Alignment of AGW unit with retro-reflecting optics using the secondary hexapod (3DD)
The alignment of the FLAO system should be done in two parts: in the first part the LBT bent Gregorian focal station should be aligned to have the telescope optical axis coincident with the derotator axis. This part of the work will be executed by the LBTO team. After this alignment has been done the W unit will be aligned to have the W unit optical axis coincident to the derotator optical axis. When the alignment condition is reached the system is ready for calibration checks.

6 System initial calibration and first light on sky (10DD, 4NN)
The AO system will arrive to the mountain with a set of look-up tables and data sufficient to provide initial on-sky operations. The most important calibration elements are the system interaction matrices (IM) and reconstructors and the WFS slope null vector (both elements are measured during the solar tower test and depends on tilt modulation and WFS CCD binning).

6.1 Pupil geometry registration (2DD)
Before that the IM and slope null vectors acquired in during the solar tower test can be used at the telescope the WFS pupil geometry has to be properly registered. The pupil geometry is registered when pupil diameters, centers and WFS focus are placed accordingly to the WFS requirements (AD1). A correct pupil registration is clearly needed before to start any new measurements of IM at the telescope.

6.2 Infrared test camera PSF optimization (3DD)
After achieving the nominal registration parameters the closed loop test can be done by using the IRTC. In order to achieve the best AO system performance non common path aberration between the WFS and the IRC has to be corrected. The main non common path aberrations are low order aberrations. The secondary shape will be changed to optimize the SR on the IRTC. Then a corresponding set of slope null will be measured at the WFS. This slope null set is the one that will be used during on sky observations. In this procedure differential tilt and focus will be adjusted by using the WFS main stages.

6.3 Initial day-time closed loop test and system interaction matrices measurements (5DD)
After WFS is registered in the same configuration used in the solar tower initial closed loop test will be done. The system calibration needed to operate the system will be taken initially from the set of data measured in the solar tower test. The aim of this test is to measure the system performance as a function of photon flux (or CCD counts) and seeing conditions (r0,t0). To simulate different seeing conditions some pre-computed disturbances will be injected in the secondary actuators positions. The system performance will be measured in terms of PSF SR and FWHM (AD1). System performance achieved will be compared with the performance achieved at the solar tower in Arcetri. Some measurements of the interaction matrices will be done again at the telescope to check that the calibration achieved in the solar tower still provides optimal performance. The number of required measurements to provide the proper set of calibration data will be decided on site after analysis of the achieved closed loop performance. After acquisition of the needed interaction matrices closed loop test with solar tower and LBT measured calibration data will be done and performance compared. Once that the better set of calibration data is identified the system will be ready for on sky operations.
6.4 AO system control SW test including TCS interactions (2DD)
The full AO control SW to be used during observations when the IRTC is operated will be tested in
day time. A test of the SW interaction with the TCS will be done. In particular a test of the mode
offloading procedure should be done in order to have the AO system able to work safely during
telescope operations.

6.5 First light of AO system on sky in engineering mode (4NN)
The first on sky test of the system will start by a test of the star acquisition procedure. A check of
the WFS registration will be done after a successful star acquisition. Because the system pupil is
the secondary mirror we do not expect to have large pupil displacements when passing from the
calibration optics (using secondary and tertiary) to the complete optical train of the telescope.
Moreover using the camera lens translation stage a displacement of about +/- 5% of the pupil can
be corrected. Then the next step is measuring/checking the WFS counts for a given star
magnitude. Then a set of closed loop test, using the engineering interface, will be done by
measuring the closed loop system performance (SR and FWHM on the IRTC) as a function of the
WFS counts or reference star magnitude. Initially bright reference star will be used and then
moving to faint reference star. In this phase the AO system configuration will be done interactively
using the engineering interface and the look up tables built during the solar tower test. An estimate
of the seeing conditions will be very important in this phase to compare the achieved results with
numerical simulation estimate. We expect to use the two first nights for the star acquisition, pupil
registration check, alignment refinement, measurement of WFS CCD counts versus star
magnitudes, and the two last nights for the closed loop test.

7 AO system observing modes and on sky test (8DD & 5NN)

7.1 Day time test (8DD)

7.1.1 Closed loop test (2DD)
After data reduction of the closed loop data of the first night time observations a new set of
interaction matrices will be measured if needed. Some daytime test mostly devoted to faint
reference star magnitude will be done.

7.1.2 Observing modes test (6DD)
During daytime the observing modes of the AO system will be tested as much as possible using
the IRTC and the full AO system SW. The test have the aim of showing that the AO system SW is
able to perform the AO system configuration properly once that it receives the correct input
parameters. The system observing modes are listed here:

1) Seeing limited Mode (SLM, 1DD)
In this mode the system is idle and the adaptive secondary is maintaining affixed shape during
observations. Different mirror shape could be loaded depending on the instrument that is used to
observe.

2) Field Stabilization Mode (using standard PI and Kalmann filtering)(FSM, 2DD)
In this mode the secondary is correcting tip and tilt. This mode is available to LUCIFER in both seeing limited and diffraction limited configuration. This observing mode could be extended to other instruments having their own tip tilt sensor.

3) AO modes ACE & ICE (AOM, 3DD)

These are the two AO observing modes. The first one (ACE) provides an automatic configuration of the AO system while the second one (ICE) provides an interactive way of changing a few parameters of the AO system configuration. This last observing mode SW allows the system to optimize the configurations achieved by using the lookup table doing an on sky data acquisition to optimize a few AO system parameters.

7.2 Night time test (5NN)

After day time test completion a new set of observing nights is planned. Closed loop test in engineering mode will be done in particular with faint reference stars (2NN). Then on sky test of the AO system observing modes will be done requiring a total of three nights. As listed below

1) SLM 0.5 night
2) FSM 0.5 night
3) AOM 2 night

8 Final commissioning test of the AO system (10NN)

A period of data reduction should be done prior this final phase. This is done to assess the AO system performance on sky in order to identify possible issues to be solved before the final measurements. For this reason this final phase should be separated by at least one week from the previous one.

8.1 System performance in engineering mode (4NN)

The observing period will start by doing observations with the AO system in engineering mode to measure the closed loop performance. This final task should provide the best AO system performance (SR & FWHM with IRTC) as a function of the reference star magnitude. The achieved performance will be compared with the numerical simulations done with the seeing values experienced in the observing nights. The data reduction should demonstrate that the system can achieve the baseline performance stated in AD2. After this performance test the observing modes of the system will be tested in terms of system performance.

8.2 Observing modes SLM and FSM (2NN)

Night observation in SLM and FSM will be done and the achieved results will be compared with the simulated result at the seeing value experienced during observations. The achieved data should demonstrate that the system is reaching the baseline performance reported in AD2.

8.3 Observing modes AOM (4NN)

Night observation in the two observing modes (ACE, ICE) will be done and the achieved results will be compared with the simulated result at the seeing value experienced during observations. The achieved data should demonstrate that the system is reaching the baseline performance reported in AD2. The achieved performance will be compared with the performance measured when the system was operated in engineering mode.
9 Telescope time required for system commissioning

The total time required for system commissioning is of 39 days and 19 nights. This commissioning period is divided into five blocks as described above. The total period of time to have 39 working days and 19 nights considering having five working days per week is found to be of 81 days. In this computation an observing night has been compute as a full day. In other words no daytime and night time activity has been accounted in the same day. In this way the full commissioning period is of 2.7 months.

10 Telescope commissioning schedule

A schedule of the task described above is provided below. The tasks names are taken from the sections of the document.
Documentation set for the First Light AO (FLAO) system review II

1) AO system baseline and goal performance (L. Busoni, F. Quiros)
2) LBT672 opto-mechanical acceptance test specifications (A. Riccardi)
3) LBT672 opto-mechanical acceptance test report
4) W unit opto-mechanical acceptance test specifications (S. Esposito, A. Tozzi, E. Pinna)
5) W unit opto-mechanical acceptance test report (J. Brynnel)
6) AO system control SW and telescope SW interfacing (L. Fini, A. Puglisi)
7) AO system test plan in solar tower (S. Esposito, A. Riccardi)
8) Acceptance of AO system after solar tower test (S. Esposito, A. Riccardi)
9) AO system commissioning plan (S. Esposito, A. Riccardi, G. Brusa)
10) AO system shipping plan (A. Riccardi, E. Pinna, G. Brusa)
11) AO system telescope alignment procedure (S. Esposito, A. Riccardi, G. Brusa)

Schedules (S. Esposito)

1) General schedule for AO systems (#1&2)
2) Schedule for AO test plan in solar tower
3) Schedule for the AO system commissioning at the telescope