FLAO Interface Control Document

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ABSTRACT

The document is reporting the interfaces of the First Light Adaptive Optics System for LBT called FLAO. The two main parts of the AO system are the W unit and the adaptive secondary. The interfaces of the two units are described separately in two different sections of the document. The interfaces have been divided in: mechanical, optical, electrical, thermal, network, and real time data.
## Modification Record

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<tr>
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<tr>
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### Abbreviations, acronyms and symbols

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<th>Description</th>
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<tbody>
<tr>
<td>LBT</td>
<td>Large Binocular Telescope</td>
</tr>
<tr>
<td>FLAO</td>
<td>First Light Adaptive Optics System</td>
</tr>
<tr>
<td>W unit</td>
<td>Wavefront sensor of the FLAO system</td>
</tr>
<tr>
<td>LBT672</td>
<td>Adaptive secondary mirror of LBT</td>
</tr>
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1 ICD document scope

The Arcetri Observatory is providing two units of First Light Adaptive Optics System (FLAO) to be integrated at the LBT telescope. The AO system will be installed at the front bent Gregorian focal stations (671s005f).

The Scope of this document is to describe the requirements and to establish the specifications for the optical, mechanical, electrical and thermal interfaces of FLAO with the LBT telescope. The software interfaces are described in the “FLAO system control SW and telescope SW interfacing” (486f009).
2 ICD summary

The document report the FLAO system interfaces. The main parts of the system are the adaptive secondary mirror called LBT672 and the pyramid wavefront sensor called W unit. The document will describe the interfaces of these two article in two separate sections.

3 W unit

In this chapter we report the interfaces with the other parts of LBT telescope for the W unit. The unit main components are: the WFS board, the XYZ stages assembly, the auxiliary unit bench, and the three boxes containing the W unit control electronics.

![Figure 1 A 3D view of the W unit system](image)

An interface panel between the W unit and the AGW is not contemplated, this because:

1) The electrical interface that will be used is the DIN rail electrical connections visible in Figure 7 and 8, the same of the off-axis unit (see par 3.3). The DIN rail connectors are cabled to the HAN Q5 type 110 Vac connector present on the AGW interface panel.

2) The optical fiber connections (Ethernet, FastLink 0 and FastLink 1) are located in the AGW interface panel as the off-axis unit. Six ST optical fiber connectors are present on this panel. (see par 3.5).

3) The cooling line interface panel is the AGW one, the same used by off-axis unit (see par 3.4)

The weight of the W unit has been measured during the Acceptance Test in Potsdam and it is 264 Kg. The whole structure (on-axis unit + off-axis unit + AGW structure) is 684 Kg.

The maximal rotational imbalance of the AGW will be measured
3.1 Mechanical interfaces

The mechanical interfaces of the W unit are positioned on the AGW structure (681g301). The AGW structure is connected to the Front bent Gregorian rotator gear (671s005f). The WFS hardware is bolted to the supporting structure of the AGW frame with 12 screws. The AGW frame is colored red in the picture. The positions of the 12 screws is reported in Figure 2.

![A 3D view of the W unit bolted to the AGW structure (red structure). The arrows show the connecting holes to bolt the W unit to the mentioned structure.](Image)

Figure 2 A 3D view of the W unit bolted to the AGW structure (red structure). The arrows show the connecting holes to bolt the W unit to the mentioned structure.

The boxes containing the control electronics of the W unit have some other supporting structure. In particular the two boxes (called box39 and box47) are supported through flat metal parts. Each one of these components is bolted to the beams structure of the AGW unit with 6 M10 screws and to the AGW structure with 2 M6 screws as showed in Figure 3 where the supporting structure has been removed for clarity.
Figure 3 A 3D view of the flat metal parts supporting the two electronic boxes. Connection holes are showed by the arrows.

. The third electronic box containing the control electronic of the XYZ WFS board translation stages, called the XYZbox, is supported internally in the W unit structure.

3.2 Optical Interfaces

The optical interface of the W unit with the LBT telescope is the LUCIFER dummy window that reflects the incoming light from the tertiary mirror to the WFS unit. The LUCIFER window is also the optical interface for the WFS internal reference source. This means that the reference source uses the reflection on the LUCIFER window to be propagated up to the secondary mirror when AO system calibration is required. The position of LUCIFER window with respect to the W unit is showed in Figure 4.
Figure 4. A section through a plane perpendicular to the AGW flange passing from the center of the LUCIFER window. The nominal distance between the window center and the vertex of lens L1 is 289m.

### 3.3 Electrical Interfaces

The electrical interface of W unit to the LBT telescope (561s003) is a single connection to the telescope of 110V AC. The total power used by the unit has been measured during the acceptance test to be 385W. This value is under review at the moment.

We assume that the power is supplied by UPS, but the system has been designed not to be damaged in case of power cut: various tests have been executed and nothing dangerous was observed.

Actually the FLAO is using as ground connection the main connection that is present at the 110 Vac AGW power supply input connector located on the AGW Interface Panel.

The presence of electrical bonding straps between the AGW and the telescope would be necessary in case of ground electrical problems discovered in a future, especially related at the RON of the CCDs.
3.4 Cooling Interfaces

The connection of the cooling circuits of the W units to the cooling of the LBT telescope (562x002) is done using two connections (input and output of the cooling line) supported by the AGW structure. Pipes used are produced by Legris and pipes type is (TBC). A photo of the cooling lines in and out on the AGW structure below.

![Cooling Lines](image)

**Figure 5** A 3D drawings showing the position of the input and output coolin lines for the W unit. The photo on the right side of the picture is showing the pipes as realized on the unit.

The flux of cooling fluid required is 3.5 L/s. Input and output pressures measured during acceptance test were 1.4 and 1.0 Bars respectively.

We expect the cooling fluid to be a mixture of ethanol glycol and water at 50% having a temperature working range of -20°C to +25°C.

3.5 Network Interface

The W unit network interface is a standard Ethernet fiber with SC type connectors located into the BOX39 (MINI MC fiber/copper Ethernet convertor). The W unit in principle allows to have a copper Ethernet interface. This connection is not used at present.

Using an SC-ST optical fiber cable (like model Distrelec 68 60 42) we connect the Mini MC to the ST panel connector located in the back side of the AGW interface panel.

3.6 Real Time Data interface

The W unit has a real time data interface to communicate WFS slopes to the secondary mirror. This connection uses one fiber pair with ST-ST type connectors located on the BCU39 Slope Computer in one side and on the back of the AGW interface panel on the other side. An additional fiber pair is planned for future upgrade. In **Figure 6** we report all the interfaces of the W unit already addressed in sections 3.3,3.4,3.5,3.6.
**Figure 6** Schematics of the interfaces described in sections 3.3, 3.4, 3.5, 3.6.

**Figure 7** Schematic diagram of the electrical, cooling and network interfaces.
4 LBT672 unit

The LBT672 unit is made of two parts: the Deformable Mirror (DM) Unit and the Spider-Arm Cabinet, as shown in Figure 9. The DM Unit is located in the hub and is bolted on the mobile flange of the Hexapod. The Spider-Arm Cabinet is located on the spider-arm. The electrical, communication and cooling connections between the two parts are sectioned at the level of the interface between the Swing Arm and the Hub. In general we identify three levels of interfaces, namely:

IF#1. Telescope to Spider-arm electronics cabinet interface (hereafter Cabinet Interface)
IF#2. Spider-arm electronics cabinet to Swing arm interface (hereafter Swing arm Interface)
IF#3. Swing arm to hub interface (hereafter Hub Interface)
IF#4. Hexapod to the DM interface (hereafter DM interface)

The harness between Telescope Interface and Hub Interface is meant to be permanently installed.

Figure 8. Interfaces schematics: Cabinet Interface is defined BEFORE the spider arm cabinet; Spider Interface is defined BETWEEN the spider and the hub, DM interface is put BETWEEN the DM and the hub. Location of the Spider Arm Cabinet (in yellow, labeled as “elect. box”). In and Out cooling lines are shown (pink and blue lines). The cooling distribution box (in yellow labeled as “Idraulic box”) splits and regulates the cooling from the telescope to the Spider-Arm Cabinet and secondary mirror unit.
4.1 Mechanical interface and relevant mass values

Mass of sub-systems
- Spider-arm cabinet: to be measured
- Hexapod unit: 149 kg
- Secondary mirror unit (without hexapod): 300 kg
- Secondary mirror hub (without hexapod and M2 mirror unit): to be measured

4.1.1 Cabinet interface (IF#1)

Mechanical interface of the electronic Cabinet to the telescope structure (spider arm) as shown in 642a303 issue B (see also Figure 9 and Figure 10). The cabinet is fixed to the telescope structure by means of 4 bolts (410mm horizontal distance and 1312mm vertical distance). The holes diameter on the brackets is 10mm, so we recommend the use of 8mm bolts for the installation.
4.1.2 Hub interface (IF#3)
The hub is fixed on the swing arm interface by 16 M8 screws. See drawing 642a010 issue D for interface screw location (see also Figure 11). Tightening torque is 18 Nm.

NOTE: the clearance between the spider interfaces and the hub leave the Z position undetermined: pins must be drilled on site at the first installation and alignment to be able to reproduce its position.

4.1.3 DM interface (IF#4)
The interface is made of 21 M8 screws with pass through holes into the hexapod aluminum flange and threaded ones in the adaptive secondary flange (drawing 642a115 issue D, see also Figure 12). These screws are mounted and tightened from the hexapod side with 6 Nm max nominal tightening torque. Alignment pins are provided between these two plates.

4.2 Optical interfaces
The optical interface of the DM unit with respect to the telescope can be represented by the coupling in the Gregorian configuration of primary and secondary. The nominal optical coupling is achieved positioning the secondary mirror so that the primary focus is placed 1063.7mm from the secondary vertex.
4.3 Electrical and Diagnostic Signal Interfaces

This chapter describes the external electrical and diagnostic signal line interfaces. The external interfaces comprehend the interfaces between Spider Arm cabinet and Telescope Control and Supply Systems (561s003) and the interfaces between spider arm cabinet and Adaptive Secondary unit.

4.3.1 Cabinet interface (IF#1)

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Voltage and power rating</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main supply (from telescope)</td>
<td>3P 208 VAC, 4.5 kW max</td>
<td>Screw terminals inside the cabinet. Accepts up to AWG5.</td>
<td>See 641a121 - SWING ARM CABINET - 3ph Power Distribution</td>
</tr>
<tr>
<td>TSS supply (from telescope)</td>
<td>1P 120 VAC, 1.5kW max</td>
<td>Screw terminals inside the cabinet. Accepts up to AWG5.</td>
<td>See 641a121 - SWING ARM CABINET - MONOph Power Distribution</td>
</tr>
</tbody>
</table>

4.3.2 Swing arm interface (IF#2)

The electrical connection of lines from the Spider Arm Cabinet toward the Swing arm are located inside the cabinet itself.

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Voltage and power rating</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main supply, TSS supply and diagnostic signals</td>
<td>Main supply: 48V, 90A max, 42A typ. TSS supply: 48V, 60A max, 10A typ. Diagnostic lines: 48V, &lt;100mA</td>
<td>Inside Spider Arm Cabinet – On Main supply unit: ITT CANNON CA3102E32-6S-B-A232, 23 ways, female, panel mount</td>
<td>see 641a132 - CAA049 - Cable LBT DigiPwr Rack 6U to Spider Cable pinout is reported in 641a121 - SWING ARM CABINET - Main Power Supply 1_2</td>
</tr>
</tbody>
</table>

4.3.3 Hub interface (IF#3)

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Voltage and power rating</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main supply, TSS supply and diagnostic signals</td>
<td>Main supply: 48V, 90A max, 42A typ. TSS supply: 48V, 60A max, 10A typ. Diagnostic lines: 48V, &lt;100mA</td>
<td>On Hub Interface flange: ITT CANNON CA3102E32-6P-B-A232, 23 ways, male, panel mount</td>
<td>see 641a132 - CAA049 - Cable LBT DigiPwr Rack 6U to Spider Cable pinout is reported in 641a121 - SWING ARM CABINET - Main Power Supply 1_2</td>
</tr>
</tbody>
</table>
4.3.4 DM interface (IF#2)

See Figure 12

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Voltage and power rating</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main supply, TSS supply and diagnostic signals</td>
<td>Main supply: 48V, 90A max, 42A typ.</td>
<td>On DM Interface flange: ITT CANNON CA3102E32-6P-B-A232, 23 ways, male, panel mount</td>
<td>see 641a131 - CAA048 - Cable LBT DigiPwr Spider to M2</td>
</tr>
<tr>
<td></td>
<td>TSS supply: 48V, 60A max, 10A typ.</td>
<td></td>
<td>Cable pinout is reported in 641a121 - SWING ARM CABINET - Main Power Supply 1_2</td>
</tr>
<tr>
<td></td>
<td>Diagnostic lines: 48V, &lt;100mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 12 – Final cable connectors installed on the final DM interface flange on LBT672a.
4.4 Communication Interfaces

This chapter describes the external electrical and diagnostic signal line interfaces. The external interfaces comprehend the interfaces between Spider Arm cabinet and Telescope Control and Supply Systems and the interfaces between spider arm cabinet and Adaptive Secondary unit.

4.4.1 Cabinet interface (IF#1)

See Figure 13

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Type of interface</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit Ethernet communication (diagnostic, ADAM control, HP controller, from telescope)</td>
<td>Fiber optic link, 2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)</td>
<td>Optical ports of the Ethernet Switch inside the Cabinet</td>
<td>1 Fiber optic pair</td>
</tr>
<tr>
<td>Fast Communication Link (real time communication – connection between W-unit and Switch BCU installed in the Spider Arm Cabinet)</td>
<td>Fiber optic link, 2 multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)</td>
<td>Line-in optical port of Switch-BCU inside the Cabinet</td>
<td>1 Fiber optic pair</td>
</tr>
</tbody>
</table>

4.4.2 Swing arm interface (IF#2)

The communication connection of lines from the Spider Arm Cabinet toward the Swing arm are located inside the cabinet itself.

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Type of interface</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit Ethernet communication (diagnostic)</td>
<td>Fiber optic link, 6x2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)</td>
<td>Inside Spider Arm Cabinet – on Ethernet Switch: Dual LC-type connector (optical ports of Ethernet switch)</td>
<td>Inside Spider Arm Cabinet: All the fibers are clustered as a single bundle in a cable routed toward the Swing arm. See 641a163 - CAF002 - LBT 14m FIBER ASSEMBLY TYPE CAB-07-002-18-14LC</td>
</tr>
<tr>
<td>Fast Communication Link (real time communication)</td>
<td>Fiber optic link, 2x2 multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)</td>
<td>Inside Spider Arm Cabinet – on Switch BCU: 2x Dual LC-type connector (on line-out optical port of Switch BCU)</td>
<td>See 641a163 - CAF002 - LBT 14m FIBER ASSEMBLY TYPE CAB-07-002-18-14LC</td>
</tr>
</tbody>
</table>

4.4.3 Hub interface (IF#3)

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Type of interface</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit Ethernet communication (diagnostic)</td>
<td>Fiber optic link, 6x2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)</td>
<td>On Hub Interface flange: Multifiber connector (18 fibers type)</td>
<td>See 641a163 - CAF002 - LBT 14m FIBER ASSEMBLY TYPE CAB-07-002-18-14LC</td>
</tr>
<tr>
<td>Fast Communication Link (real time communication)</td>
<td>Fiber optic link, 2x2 multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)</td>
<td>FRBOF3RT24-22PT39-F125-1.6-G1-PG016</td>
<td>See 641a163 - CAF002 - LBT 14m FIBER ASSEMBLY TYPE CAB-07-002-18-14LC</td>
</tr>
</tbody>
</table>

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Figure 13 – Spider arm cabinet front panel showing interfaces to external communication lines
4.4.4 DM interface (IF#2)

See Figure 12

<table>
<thead>
<tr>
<th>Interface description</th>
<th>Type of interface</th>
<th>Connectors</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit Ethernet communication (diagnostic)</td>
<td>Fiber optic link, 6x2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)</td>
<td>On DM Interface flange: Multifiber connector (18 fibers) type</td>
<td>See 641a165 - CAF004 - LBT 1m FIBER ASSEMBLY TYPE CAB-07-002-18-1LC</td>
</tr>
<tr>
<td>Fast Communication Link (real time communication)</td>
<td>Fiber optic link, 2x2 multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)</td>
<td></td>
<td>For the interconnection cable between the two flanges, see 641a164 - CAF003 - LBT 1m MULTY FIBER EXTENSION CAB-07-002-18-1</td>
</tr>
</tbody>
</table>

4.5 Cooling interfaces

4.5.1 Cabinet and Swing arm Interfaces (IF#1/2)

From the telescope cooling system (562s002) there is an ½ inch pipe cooling lines (inlet+outlet) at Cabinet level. The cooling fluid is a 50/50 ethylene glycol and water mixture, flow rate is 11 lit/min with 2bar pressure drop at 20°C. Cooling fluid temperature 3°C below ambient (TBC by Brusa/Biasi from EM acceptance thermal tests and Cabinet final test). Two lines are driven, through the cooling distribution box (see Figure 9), in parallel from the telescope cooling line: 1 line (inlet+outlet) for the Cabinet, 1 line (inlet+outlet) toward the Hub interface. The line toward the cabinet (inlet+outlet) has Swagelok male Quick Connectors. Cabinet has female Swagelok Quick Connectors located on the back panel of the Cabinet (see Figure 16). The lines shall be regulated to set a flux of 2.5l/min to the spider-arm cabinet and 8.5l/min to the adaptive secondary unit.

The cooling quick connectors on the Swing Arm Cabinet are ¼” diameter, type SS-QTM2A-B1-400 on the rear cabinet wall, mating to type SS-QTM2-D-4FS on the tubing.

4.5.2 Hub interface (IF#3)

Two ½ inch pipes for cooling line (inlet+outlet) with Swagelok male Quick Connectors (1/2” 8-HC type). Two panel Swagelok female Quick Connectors on Hub Interface panel (1/2” QTM8 type). See Figure 17.

4.5.3 DM interface (IF#4)

Two ½ inch pipes for cooling line (inlet+outlet) directly interfaced (no plugs) to the DM Interface panel (see Figure 17) and provided of stress-relief for safety.
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