LBT-ADOPT
TECHNICAL REPORT

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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.

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B	10 Dec 2007	S. Esposito, A. Tozzi, A. Riccardi, D.Gallieni	all	Sections describing the LBT672 have been added. General revision of Wunit sections done.
C	06 May 2008	R. Biasi	Sec. 4.3	Electrical and electronic part expanded and detailed
D	28 Sep 2008	R. Biasi, A. Riccardi	Sec. 4.3, 4.4 and 4.5	Expanded and reorganized.
E	13 Mar 2009	A. Tozzi, A. Riccardi, R. Biasi, D. Gallieni	Sec 3 and 4	Expanded and reorganized. Document release presented as document FLAO_10 for the "LBT AO Review" held in Florence on 30-31 March 2008
F	30 Mar 2009	A. Riccardi	CAN number	CAN number changed to 485f005 to avoid conflict with another document (previously was 485f004). No other modification made with respect to issue E.
G	05 Oct 2009	A. Riccardi, M. Xompero	All sections	General update
H	18 Feb 2010	A. Riccardi	4.4.1	Trigger fiber added

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Abbreviations, acronyms and symbols

Symbol	Description
AGW	Acquisition, Guiding and Wavefront sensor unit
AO	Adaptive Optics
BGR	Bent Gregorian Rotator
CoG	Center of Gravity
FBGR	Front Bent Gregorian Rotator
LBT	Large Binocular Telescope
LBT672	672-actuator adaptive secondary mirror of LBT
NGS	Natural Guide Star
FLAO	First Light Adaptive Optics System
TCS	Telescope Control System
W unit	Wavefront sensor unit of the FLAO system

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1 Applicable documents

[1] 481f341, L. Fini, A. Puglisi and L. Busoni, “AOS, The complete guide”, Issue A, 16 Jul 2009
[2] 681a070, “AGW on-axis, General Assembly”, Issue A, 10 Jan 2008
[3] 681g860, “AO Basement”, Issue A, 10 Sep 2003
[4] 671s005, “XXX”, Issue G, XXX
[5] 561s003, “Electrical Power Supply Requirements”, Issue E, 08 May 2008
[6] 642a303, “Hydraulic system AO, General Assembly”, Issue B, 21 Feb 2008
[7] 610a045, “Test procedure and report for the LBT M2 Hexapod #1 and Hexapod #2”, Issue E, 21 Jan 2006
[8] 640f025, A. Riccardi, “Measurements of LBT672a mass”, Issue B, 23 Oct 2009
[9] E. Anaclerio, ADS Int., email on 25/03/2009 17.05
[10]XXX, “Spider-arm cabinet drawing”, Issue XXX, XXX
[11]643a001, “f/15 Adaptive Secondary, cooling system design report”, Issue A, 04 Apr 2008
[12]642a010, “Hub M2”, issue D, 31 Oct 2007
[13]642a115, “M2 Adaptive, Support Frame”, issue D, 18 Mar 2008
[14]641a186, “LBT Swing Arm Cabinet - 3ph Power Distribution”, Issue XXX, XXX
[15]641a185, “SWING ARM CABINET - MONOph Power Distribution”, Issue XXX, XXX
[16]641a132, “CAA049 - Cable LBT DigiPwr Rack 6U to Spider”, Issue 1.0, 08 Feb 2008
[17]641a181, “LBT Swing Arm Cabinet - Main Power Supply 1_2”, Issue 1.2, 18 Jan 2008
[18]641a131, “CAA048 - LBT DigiPwr Spider to M2 Cable”, Issue 1.0, 08 Feb 2008
[19]641a163, “CAF002 - LBT 14m FIBER ASSEMBLY TYPE CAB-07-002-18-14LC”, Issue XXX, 16 Apr 2007
[20]641a165, “CAF004 - LBT 1m FIBER ASSEMBLY TYPE CAB-07-002-18-1LC”, Issue XXX, 16 Apr 2007
[21]641a164, “CAF003 - LBT 1m MULTY FIBER EXTENSION CAB-07-002-18-1”, Issue XXX, 11 Jul 2007
[22]562s002, “Telescope cooling system installation”, Issue B, 26 Mar 2004
[23]XXX, “LBT672b acceptance test report”, in production by LBTO

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2 ICD document scope

Each side (left and right) of LBT is provided with one First Light Adaptive Optics System (FLAO). Each FLAO system joins the functionalities of two units to perform AO correction: the adaptive secondary mirror unit (hereafter referred as LBT672 unit) and the single-NGS pyramid wavefront sensor units (hereafter referred as W unit). INAF-Osservatorio Astrofisico di Arcetri provides the two W units to be installed at the rotator of the front bent Gregorian focal stations of LBT.

The Scope of this document is to describe the optical, mechanical, electrical and thermal interfaces of FLAO system to the LBT. From the software point of view, the FLAO system interfaces to the TCS through the AO-Arbitrator process (FLAO side) and the Adaptive Optics Subsystem (AOS, TCS side). The software interface between the AO-Arbitrator and the AOS is described in a separate document [1].

The two LBT672 units are labeled as LBT672a and LBT672b, the two W units are labeled as W#1 and W#2. All of them are interchangeable with respect the left and right sides of the telescope from the interfaces point of view, for this reason we will refer to a generic LBT672 and W unit for the purposes of this document.

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3 W unit and AGW frame

In this section we report the interfaces of the two W units (W#1 and W#2). The W units are located inside the corresponding two AGW units (see [2], 681a070) that are mounted to the left and right rotator gear of the Front Bent Gregorian Rotator (FBGR) (see Figure 1). We will refer to three interfaces:

- AGW Frame Interface (FIF): the interface between the AGW frame and the rotator gear
- W Interface (WIF): the interface between the W unit and the AGW frame or the electronic support rack (inside the frame)
- Instrument Interface (IIF): the interface between the AGW frame and the Instrument

The main components of a W unit are shown in Figure 2 and are:

- the WFS board;
- the XYZ stage assembly;
- the auxiliary unit bench;
- the three boxes containing the W unit control electronics.

The first three items are connected together on a common support structure (see Figure 3) called on-axis basement (see [3], 681g860), that is interfaced to the internal side of the AGW frame.

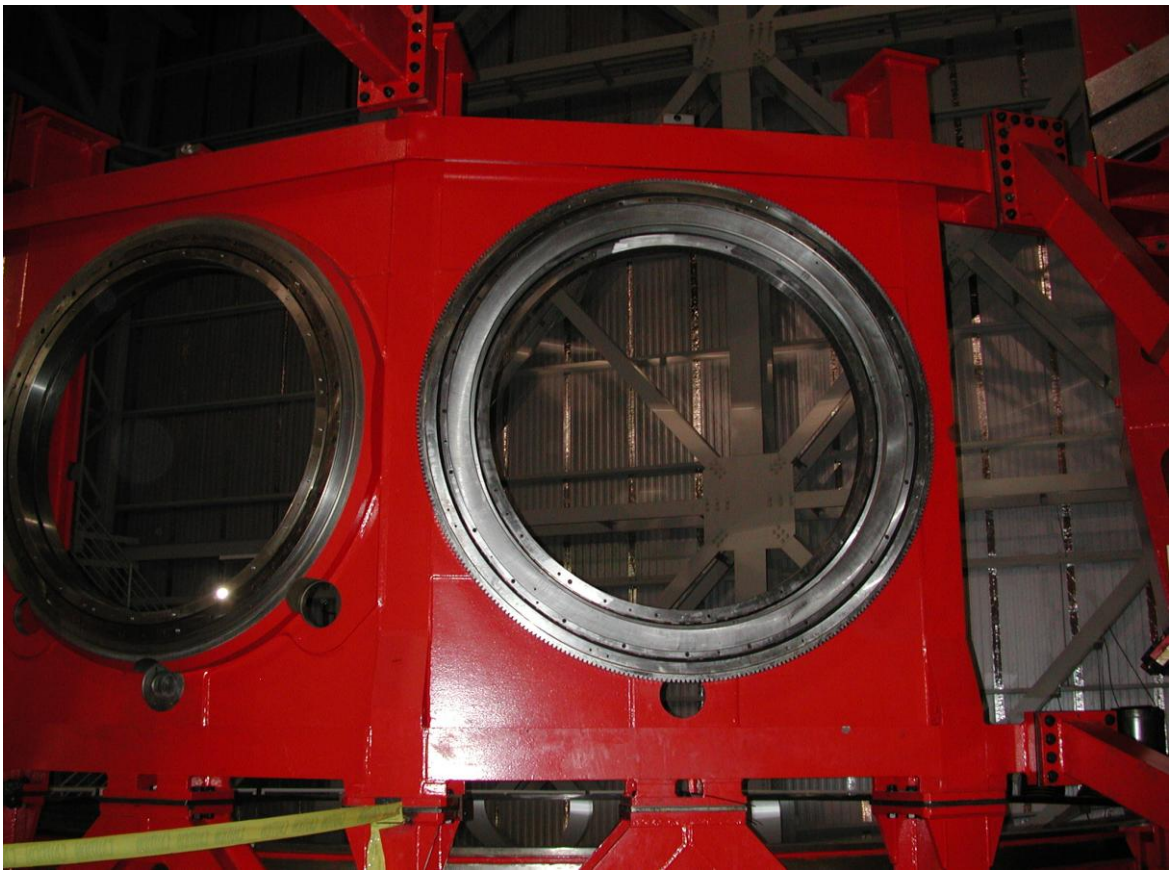

Figure 1. This view shows the left front Nasmyth rotator without the instrument rotator gear.

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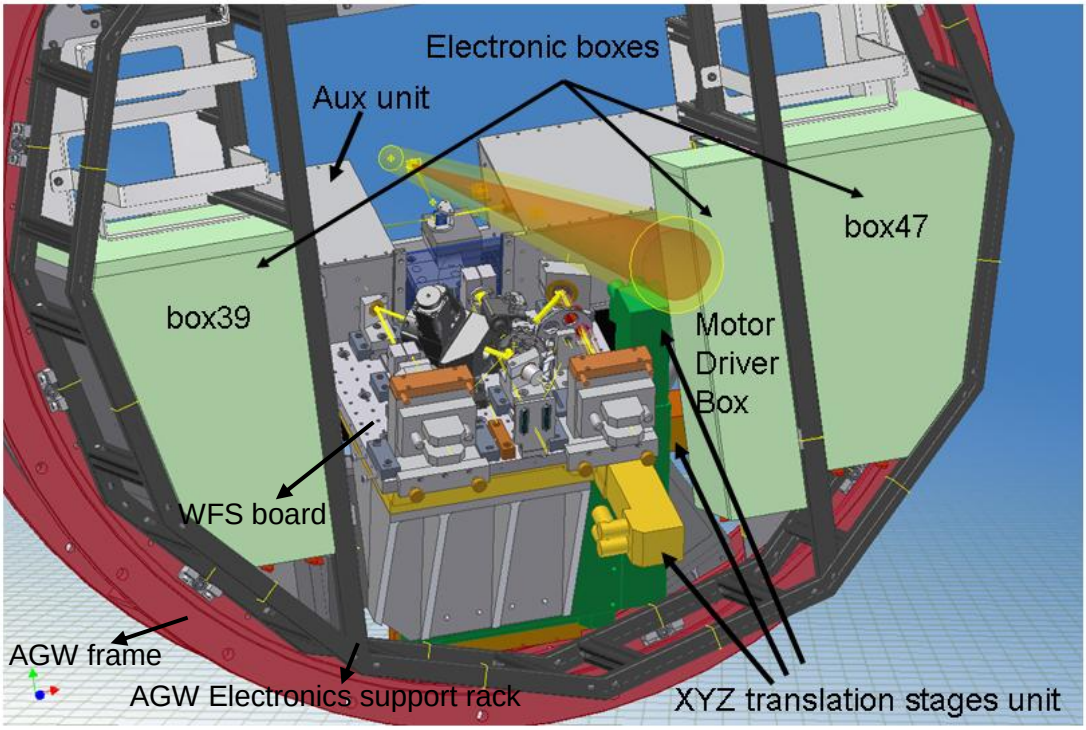

Figure 2 A 3D view of the W unit system and its main components (mirror side view)

3.1 Mechanical interfaces and relevant mass values

3.1.1 Mass values

The weight of the W#1 unit has been measured during the Acceptance Test in Potsdam and it is 264 kg.
The whole structure (W unit + off-axis unit + AGW structure + balancing masses) is 705 kg.
The used balancing masses (21 kg) place the CoG of the AGW on its mechanical axis.

3.1.2 AGW frame interface (FIF)

The AGW frame attaches to the BGR through a pilot diameter in the BGR gear and is secured with 24 M16x2 bolts on a 1480 mm diameter bolt circle. The AGW pilot diameter in the instrument rotator gear is specified to be between 1420.2 mm and 1420.4 mm (see [4], 671s005).

3.1.3 W interface (WIF)

The on-axis basement[3] supports the WFS board, the XYZ stage assembly and the auxiliary unit bench. The on-axis basement[3] is interfaced inside the AGW frame and bolted with 8 M8 and 4 M10 screws to the AGW frame as shown in Figure 3.

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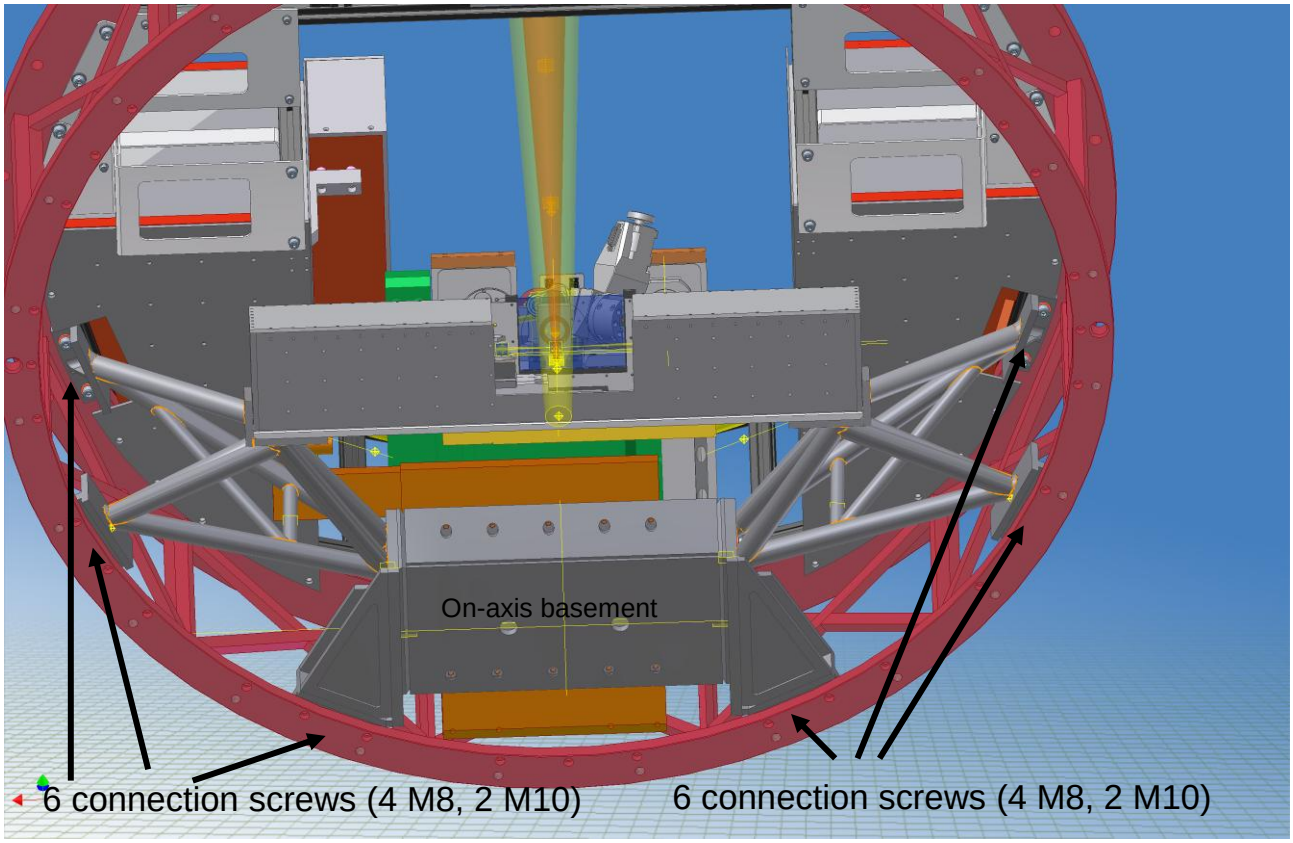

Figure 3 A 3D view of the W unit bolted to the AGW frame (red structure). The arrows show the connecting holes to bolt the on-axis basement of the W unit to the AGW frame (instrument side view).

The boxes containing the control electronics of the W unit have a different supporting structure. In particular the two boxes called *box39* and *box47* (see Figure 2) are supported through flat metal parts. Each box is bolted to the AGW frame structure with 6 M10 screws and with 2 additional M6 screws on the electronic support rack as showed in Figure 4 where the on-axis basement structure has been removed for clarity. The third electronic box containing the control electronic of the XYZ WFS board translation stages, called the *Motor Driver Box* (see Figure 2), is supported internally in the W unit structure on the electronic support rack on a side of the *box47*.

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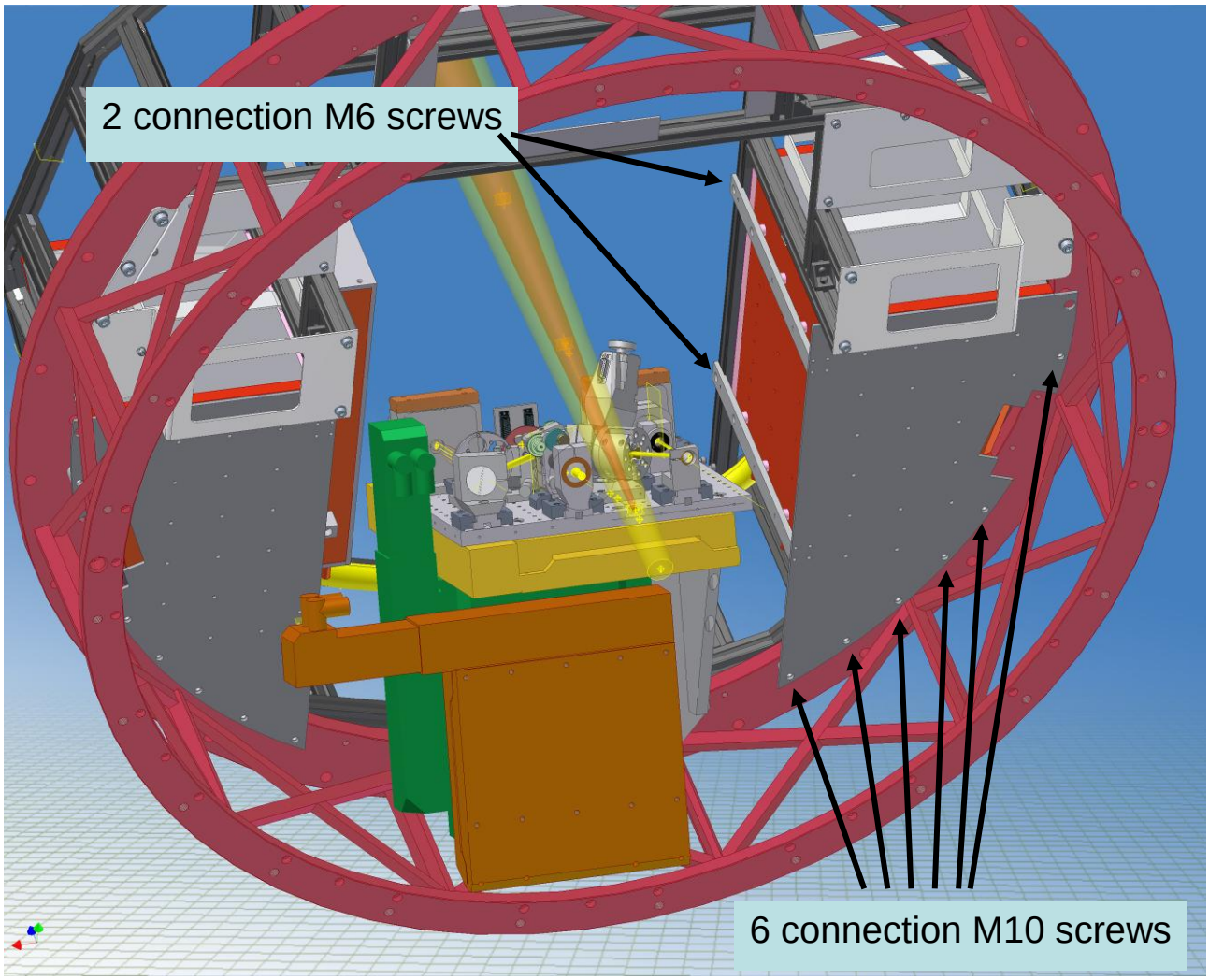

Figure 4 A 3D view of the flat metal parts supporting the two electronic boxes. Connection holes are showed by the arrows.

3.2 Optical Interfaces

The optical interface of the W unit with respect to the telescope is the LUCIFER 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 located in the Auxiliary unit: 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 5. The nominal distance between the window center and the vertex of lens L1 (first lens of the WFS board) is 289 mm.

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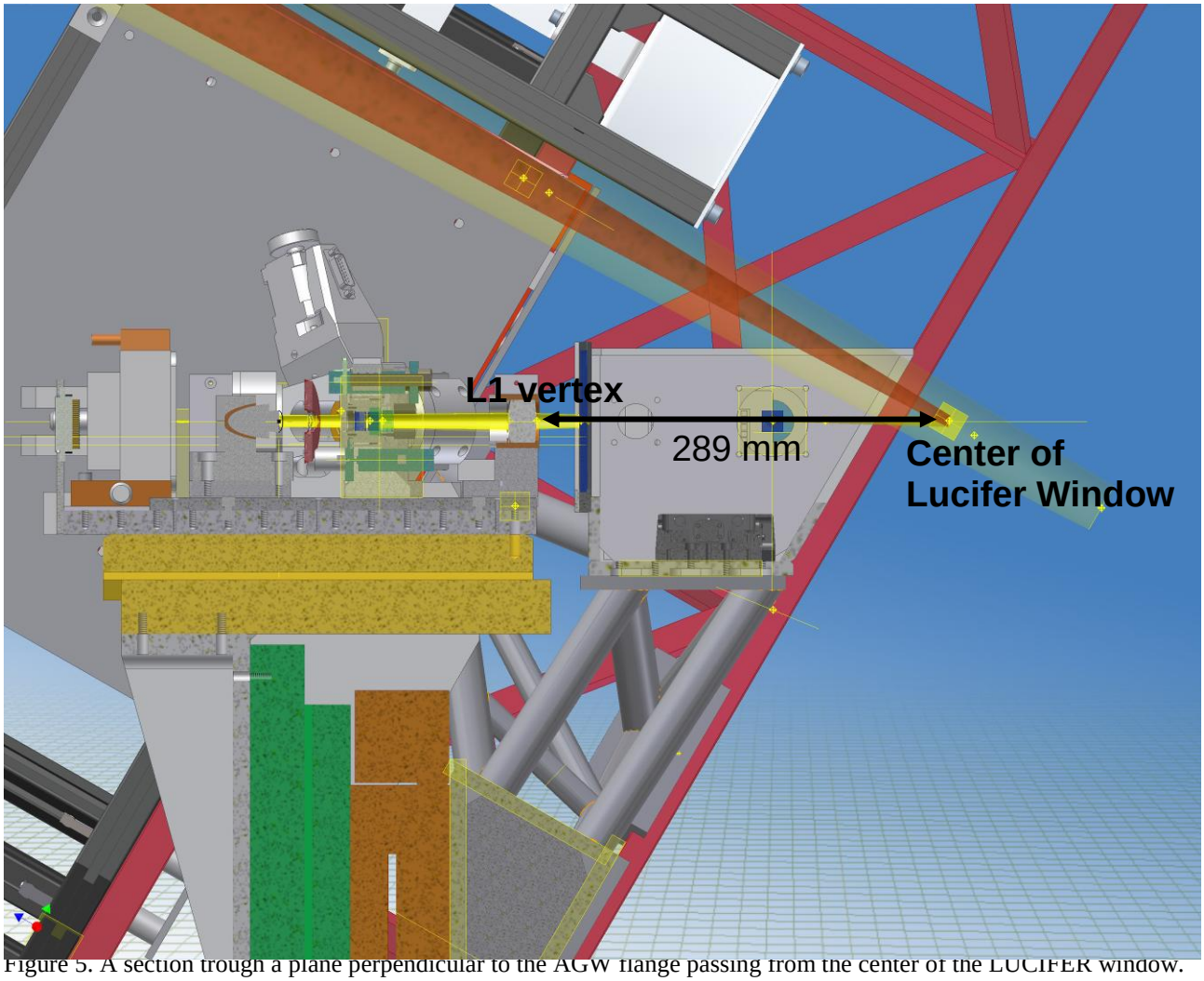

Figure 5. A section trough a plane perpendicular to the AGW flange passing from the center of the LUCIFER window.

3.3 Electrical Interfaces

3.3.1 AGW frame interface (FIF)

The electrical interface of W unit to the telescope is located on a panel of the external surface of the AGW frame (see Figure 6), as a single connector (HAN Q5/0 type, see box 4 in Figure 6) from telescope of 110V AC USP assisted (see [5], 561s003, Connection point CP3). The power lines from this connector are in common with the AG subsystem.

Actually the W unit 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, especially related at the RON of the CCDs, would be discovered at the telescope.

3.3.2 W interface (WIF)

Inside the AGW frame, in correspondence to the external AGW interface panel, the W unit interfaces to the DIN rail electrical connector as shown in **Figure 7**. The DIN rail is connected to the HAN Q5/0 type connector reported in Sec.3.3.1). 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.

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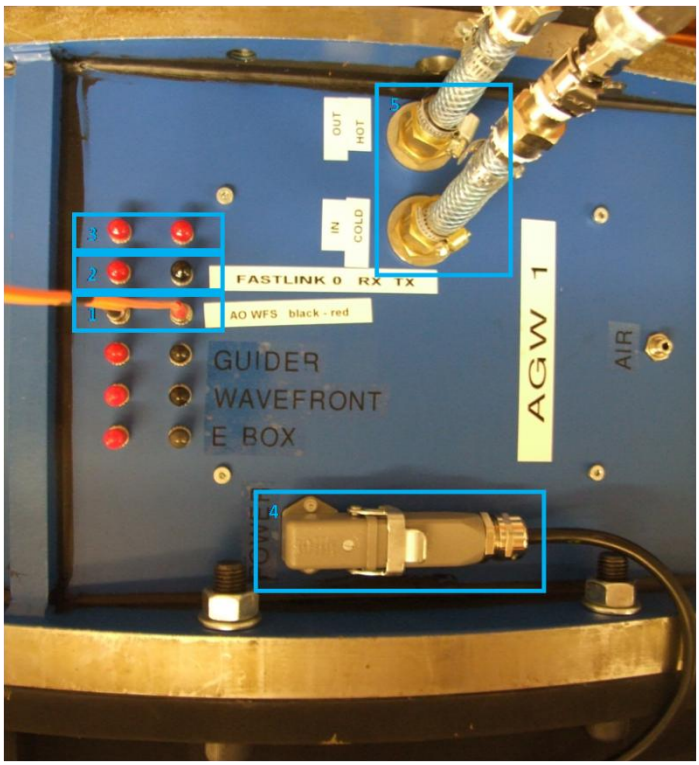

Figure 6. AGW external interface panel. 1: Ethernet fiber (1 pair); 2&3: FastLink fiber (2 pairs); 4: Power connector (in common with AG); 5: cooling lines (2 hoses, in common with AG)

3.4 Cooling Interfaces

3.4.1 AGW frame interface (FIF)

From the telescope cooling system one input and one output cooling lines connected to the external AGW panel to the brass fittings having 14mm external diameter (see box 5 in Figure 6). The cooling lines are in common with AG unit. The cooling fluid is a 50/50 ethylene glycol and water mixture. Input temperature XX°C below ambient.

3.4.2 W interface (WIF)

Inside the AGW frame, in correspondence to the external AGW interface panel, the cooling lines are split with T connectors between AG and W units as shown in **Figure 7**. The flux of cooling fluid required for the W unit is 3.5 l/min with a pressure drop of 0.4 bar at 20°C.

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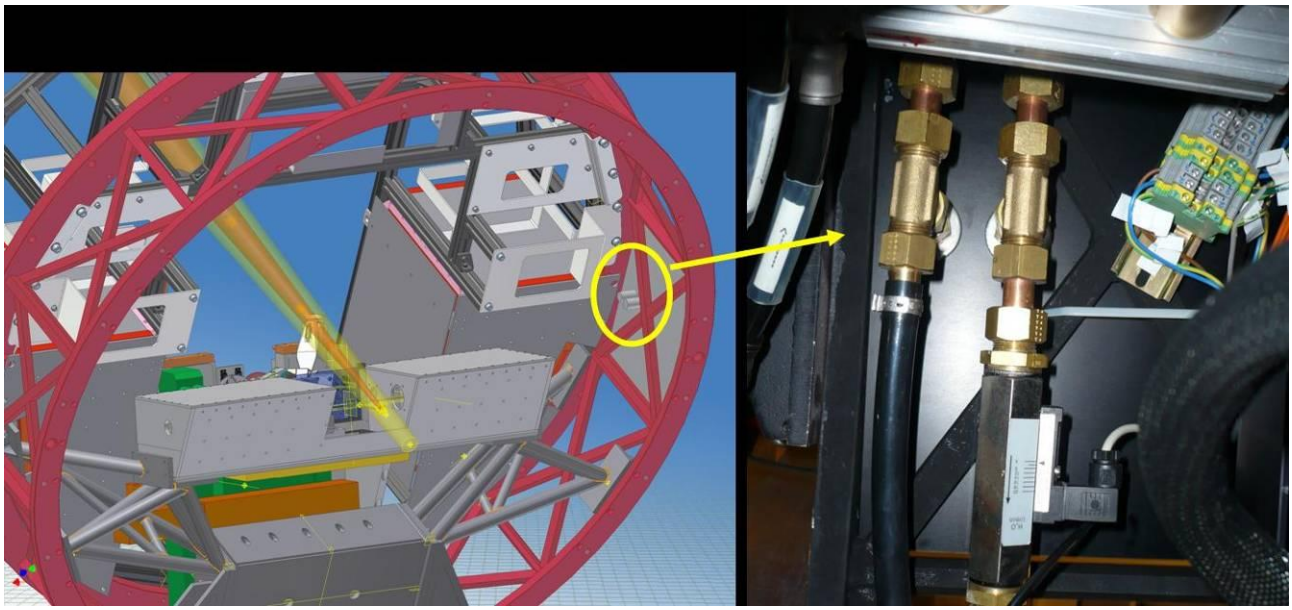

Figure 7 A 3D drawings showing the position of the input and output cooling lines for the W unit. The photo on the right side of the picture is showing the pipes as realized on the unit.

3.5 Network Interface

3.5.1 AGW frame interface (FIF)

From the Ethernet telescope network one fiber pair (multimode 62.5-125µm) with ST male connectors to be connected to the ST female connectors on the external AGW panel (connectors labeled as 1 in Figure 6).

3.5.2 W interface (WIF)

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 Mini MC is connected to the ST panel (female) connector located in the back side of the AGW interface panel using an SC-ST (male-male) optical fiber cable (like model Distrelec 68 60 42).

3.6 Real Time Data interface

3.6.1 AGW frame interface (FIF)

From the spider-arm cabinet of the LBT672 system two fiber pairs (multimode 62.5-125µm) with ST male connectors to be connected to the ST female connectors on the AGW panel (connectors labeled as 2 and 3 in Figure 6). the optical links are used to communicate WFS slopes from the W to the LBT672 unit. The second optical pair is initially used as spare and it will be used in future for upgrading.

3.6.2 W interface (WIF)

From the back side of the AGW interface panel to the BOX39 with a ST-ST (male-male) optical fiber cable (one pair multimode 62.5-125µm). An additional fiber pair is planned for future upgrade.

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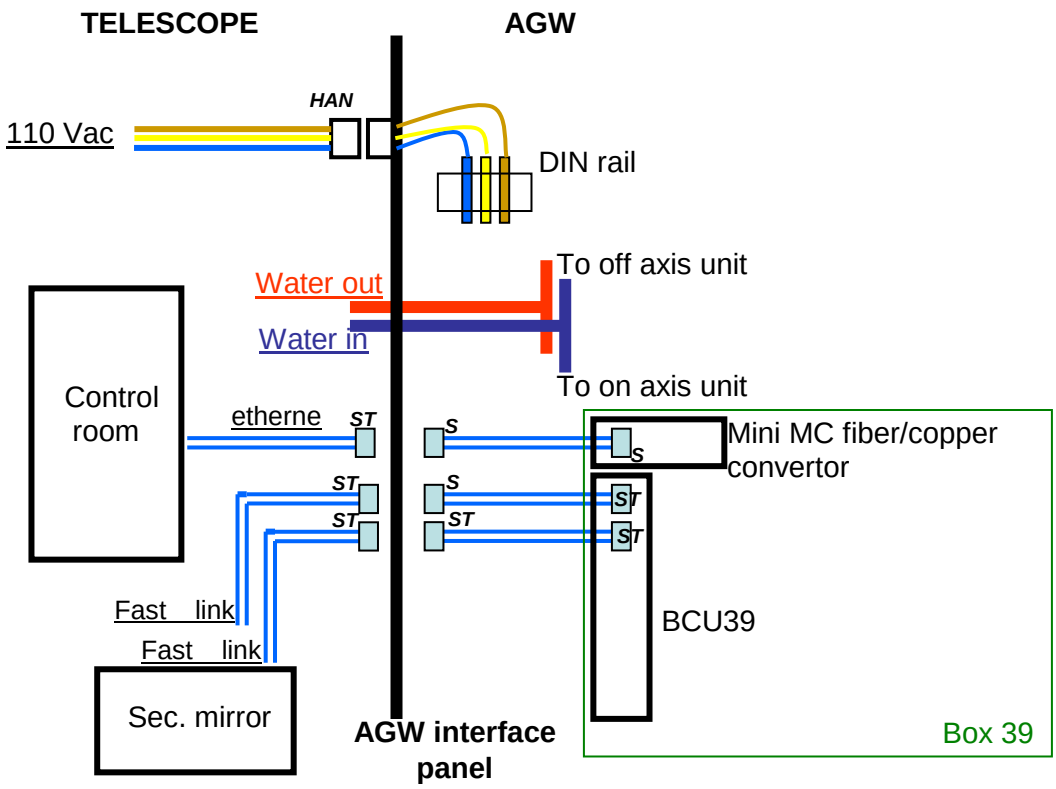

Figure 8 Schematic diagram of the electrical, cooling Real-Time and network communication interfaces

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4 LBT672 unit and Hexapod

The LBT672 unit is made of two parts: the Deformable Mirror (DM) Unit and the Spider-Arm Cabinet, as shown in Figure 9 (see [10], [11]). The DM Unit is located in the hub and is bolted on the mobile flange of the Hexapod. The fixed flange of the Hexapod is bolted to the top of the Hub. The hub is bolted to the swing arm. 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 four 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. Hub to Hexapod interface (hereafter Hexapod interface)

IF#5. Hexapod to the DM interface (hereafter DM interface)

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

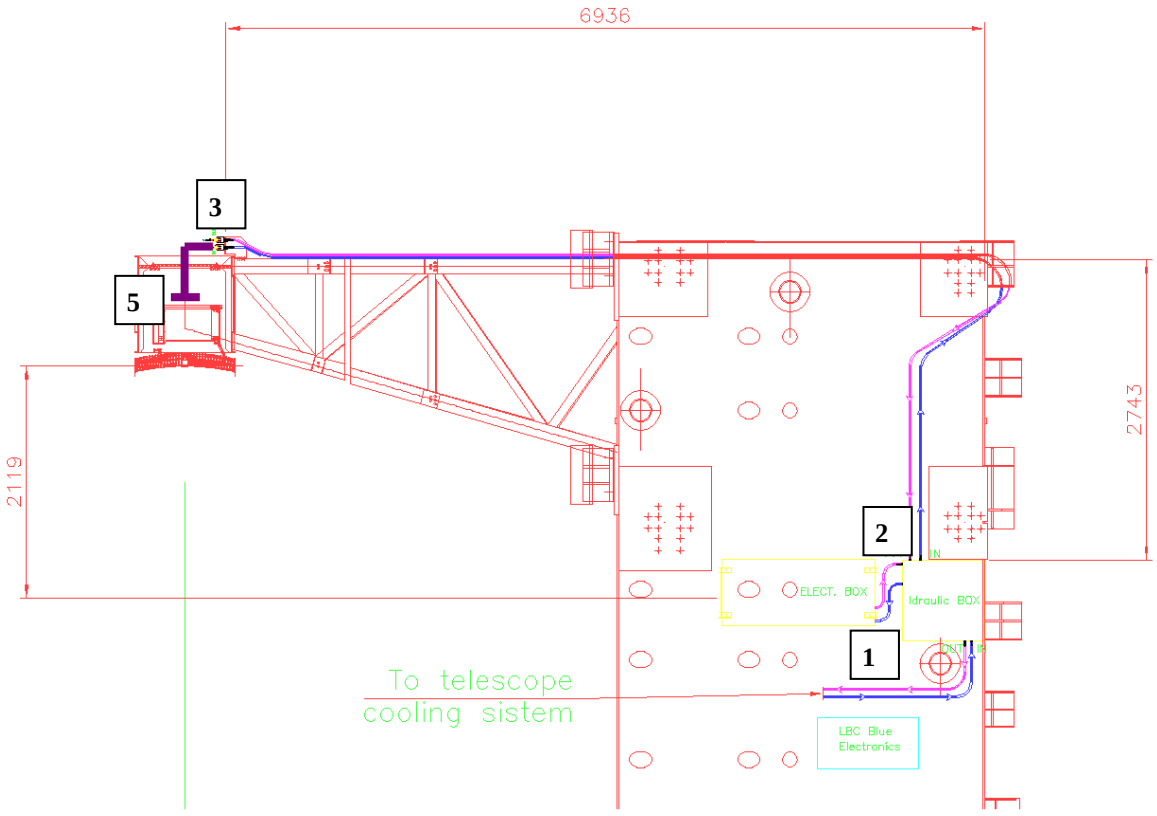

Figure 9. Interfaces schematics: Cabinet Interface is defined BEFORE the spider arm cabinet; Spider Interface is defined BETWEEN the spider and the hub, DM interface is put BETWEEN the DM and the hub. Location of the Spider Arm Cabinet (in yellow, labeled as “elect. box”). In and Out cooling lines are 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.

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4.1 Mechanical interface and relevant mass values

4.1.1 Mass values

Mass of sub-systems:

- Spider-arm cabinet: 154.8kg
- Cooling distribution box: to be measured after manufacturing
- Mirror unit cables (from cabinet to hub interface): to be measured
- Hexapod unit[7]: 115 kg
- hexapod cables (from cabinet to hub interface): to be measured
- Secondary mirror unit (without hexapod)[8]: 304.0kg ± 1.5kg.
- Secondary mirror hub (without hexapod and M2 mirror unit)[9]: 252 kg

Total mass of fully populated M2 Hub (Hub+hexapod+mirror unit, no laser mirror): 671 kg

Total mass of cables on swing arm (Hexapod+mirror unit): to be measured

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4.1.2 Cabinet interface (IF#1)

Mechanical interface of the electronic Cabinet to the telescope structure (spider arm) as shown in Figure 9 and Figure 10, (see [6] and [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

4.1.3 Hub interface (IF#3)

The hub is fixed on the swing arm interface by 16 M8 screws. See Figure 11 ([12], 642a010) for interface screw location. 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.

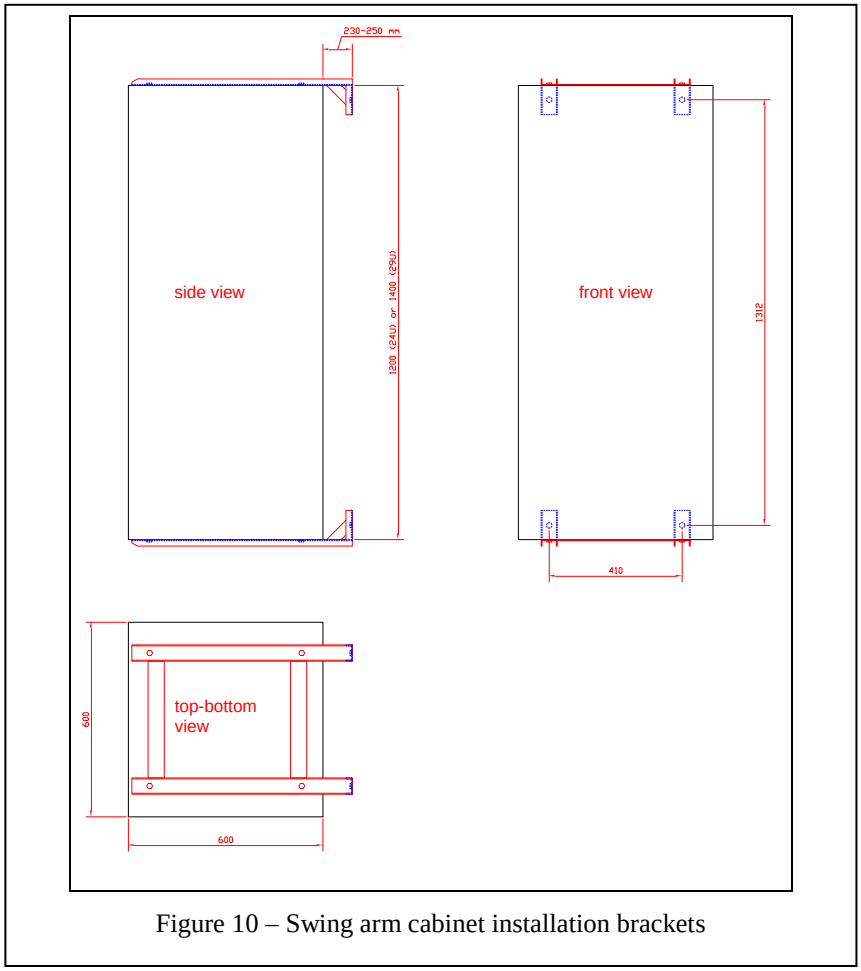

Figure 10 – Swing arm cabinet installation brackets

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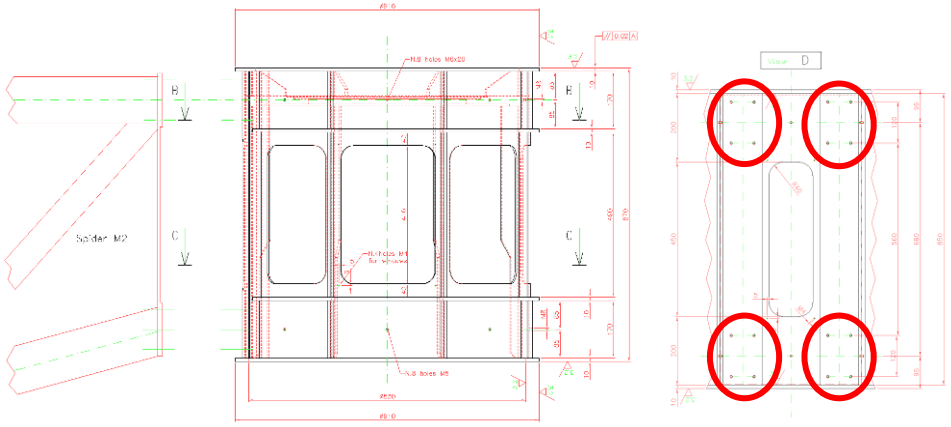

Figure 11. Mechanical interface between swing-arm and secondary mirror hub. Left: side view. Right: interface view on the hub side. The locations of the 16 M8 screws are highlighted with red circles.

4.1.4 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 (see [13] 642a115, 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.

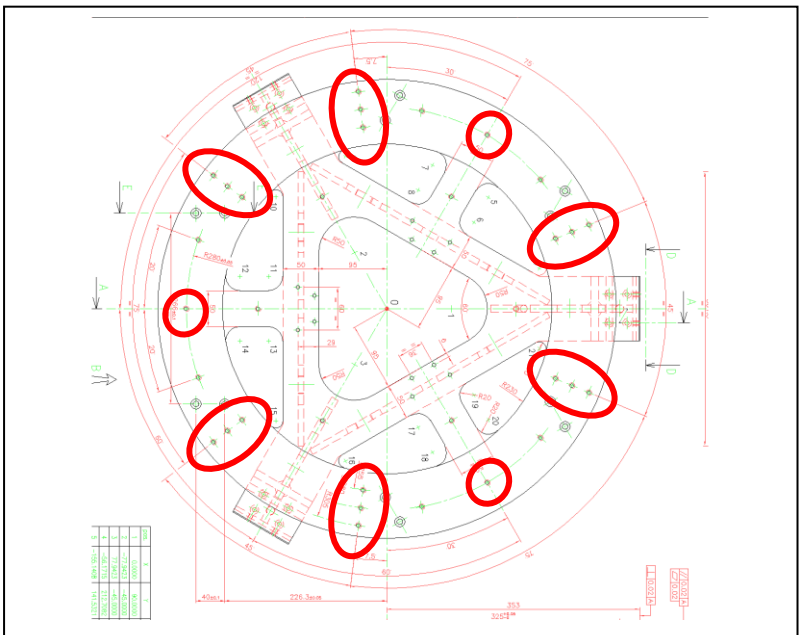

Figure 12. Top view of the mirror unit interface to the hexapod. The location of the connecting screws is highlighted with red circles.

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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 (see [5], 561s003, Connection point CP1) and the interfaces between spider arm cabinet and Adaptive Secondary unit.

4.3.1 Cabinet interface (IF#1)

Interface description	Voltage and power rating	Connectors	Cables
Main supply (from telescope)	3P 208 VAC, 4.5 kW max	Screw terminals inside the cabinet. Accepts up to AWG5.	See [14] *641a186 - SWING ARM CABINET - 3ph Power Distribution*
TSS supply (from telescope)	1P 120 VAC, 1.5kW max, UPS assisted	Screw terminals inside the cabinet. Accepts up to AWG5.	See [15] *641a185 - SWING ARM CABINET - MONOph Power Distribution*

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.

Interface description	Voltage and power rating	Connectors and length	Cables
Main supply, TSS supply and diagnostic signals	Main supply: 48V, 90A max, 42A typ. TSS supply: 48V, 60A max, 10A typ. Diagnostic lines: 48V, <100mA	Inside Spider Arm Cabinet – On Main supply unit: ITT CANNON CA3102E32-6S-B-A232, 23 ways, female, panel mount Lenghth: 14m (toward Hub interface), Bundle diameter: 26mm	see [16] *641a132 - CAA049 - Cable LBT DigiPwr Rack 6U to Spider* Cable pinout is reported in [17] *641a181 - SWING ARM CABINET - Main Power Supply 1_2*

4.3.3 Hub interface (IF#3)

Interface description	Voltage and power rating	Connectors	Cables
Main supply, TSS supply and diagnostic signals	Main supply: 48V, 90A max, 42A typ. TSS supply: 48V, 60A max, 10A typ. Diagnostic lines: 48V, <100mA	On Hub Interface flange: ITT CANNON CA3102E32-6P-B-A232, 23 ways, male, panel mount	see [16] *641a132 - CAA049 - Cable LBT DigiPwr Rack 6U to Spider* Cable pinout is reported in [17] *641a181 - SWING ARM CABINET - Main Power Supply 1_2* Cable length: 14m toward swing arm interface), Bundle diameter: 26mm

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4.3.4 DM interface (IF#2)

See Figure 13

Interface description	Voltage and power rating	Connectors	Cables
Main supply, TSS supply and diagnostic signals	Main supply: 48V, 90A max, 42A typ. TSS supply: 48V, 60A max, 10A typ. Diagnostic lines: 48V, <100mA	On DM Interface flange: ITT CANNON CA3102E32-6P-B-A232, 23 ways, male, panel mount	see [18] *641a131 - CAA048 - Cable LBT DigiPwr Spider to M2* Cable pinout is reported in [17] *641a121 - SWING ARM CABINET - Main Power Supply 1_2* Cable length 1m toward Hub interface), Bundle diameter: 26mm

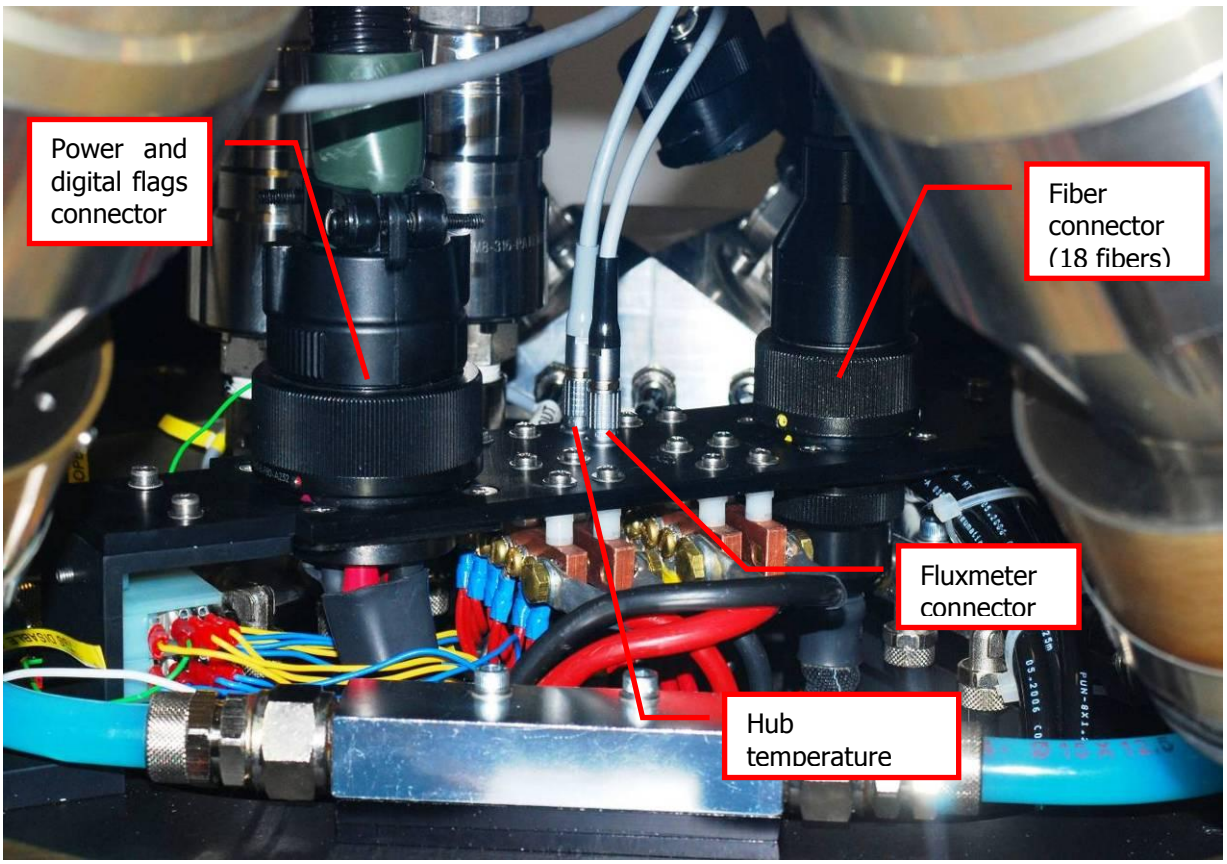

Figure 13 – Final cable connectors installed on the final DM interface flange on LBT672a.

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 14

Interface description	Type of interface	Connectors	Cables
Gigabit Ethernet communication (diagnostic, ADAM control, HP controller, from telescope)	Fiber optic link, 2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)	Optical ports of the Ethernet Switch inside the Cabinet Dual LC-type connectors	2 Fiber optic pair (provided by telescope, form Ethernet network) (1 pair initially used as spare, in future 2 pairs in truncking for bandwidth improvement)
Fast Communication Link (real time communication – connection between W-unit and Switch BCU installed in the Spider Arm Cabinet)	Fiber optic link, 2 multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)	Line-in optical port of Switch-BCU inside the Cabinet Dual LC-type connector	2 Fiber optic pair (provided by telescope, from W) (1 pair initially used as spare, in future 2 pairs for increasing bandwidth)
Trigger signal to 4D interferometer	Fiber optic link, 1 multimode fibers 62.5-125µm	Trigger port of Switch-BCU inside the Cabinet Single ST-type connector	1 single Fiber optic (provided by telescope, from transceiver box of 4D interferometer)

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.

Interface description	Type of interface	Connectors	Cables
Gigabit Ethernet communication (diagnostic)	Fiber optic link, 6x2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)	Inside Spider Arm Cabinet – on Ethernet Switch: Dual LC-type connector (optical ports of Ethernet switch)	Inside Spider Arm Cabinet: All the fibers are clustered as a single bundle in a 14m cable routed toward the Swing arm. Bundle diemeter: 21mm See [19] *641a163 - CAF002 - LBT 14m FIBER ASSEMBLY TYPE CAB-07-002-18-14LC*
Fast Communication Link (real time communication)	Fiber optic link, 2x2 multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)	Inside Spider Arm Cabinet – on Switch BCU: 2x Dual LC-type connector (on line-out optical port of Switch BCU)	

4.4.3 Hub interface (IF#3)

From-to the mirror unit

Interface description	Type of interface	Connectors	Cables
Gigabit Ethernet communication (diagnostic)	Fiber optic link, 6x2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)	On Hub Interface flange: Multifiber connector (18 fibers) type FRBOF3RT24-22PT39-	See [19] *641a163 - CAF002 - LBT 14m FIBER ASSEMBLY TYPE CAB-07-002-18-14LC*
Fast Communication Link	Fiber optic link, 2x2		

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(real time communication)	multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)	F125-1.6-G1-PG016	Cable length: 14m toward the swing arm interface. Bundle diemeter: 21mm

to-from the hexapod

Interface description	**Type of interface**	**Connectors**	**Cables**
Power and control lines for the hexapod legs. 4 cables per hexapod leg. 6 legs.	For each leg: • bipolar Fisher connectors for Motor • bipolar Fisher connectors for Brake • eight-poles Fisher connectors for ERO (rotary encoder) • six-poles Fisher connectors for Limit Switch	On Hub Interface flange: see 615a019b	14m length from spider arm cabinet (Hexapod control electronics) to Hub interface flange.

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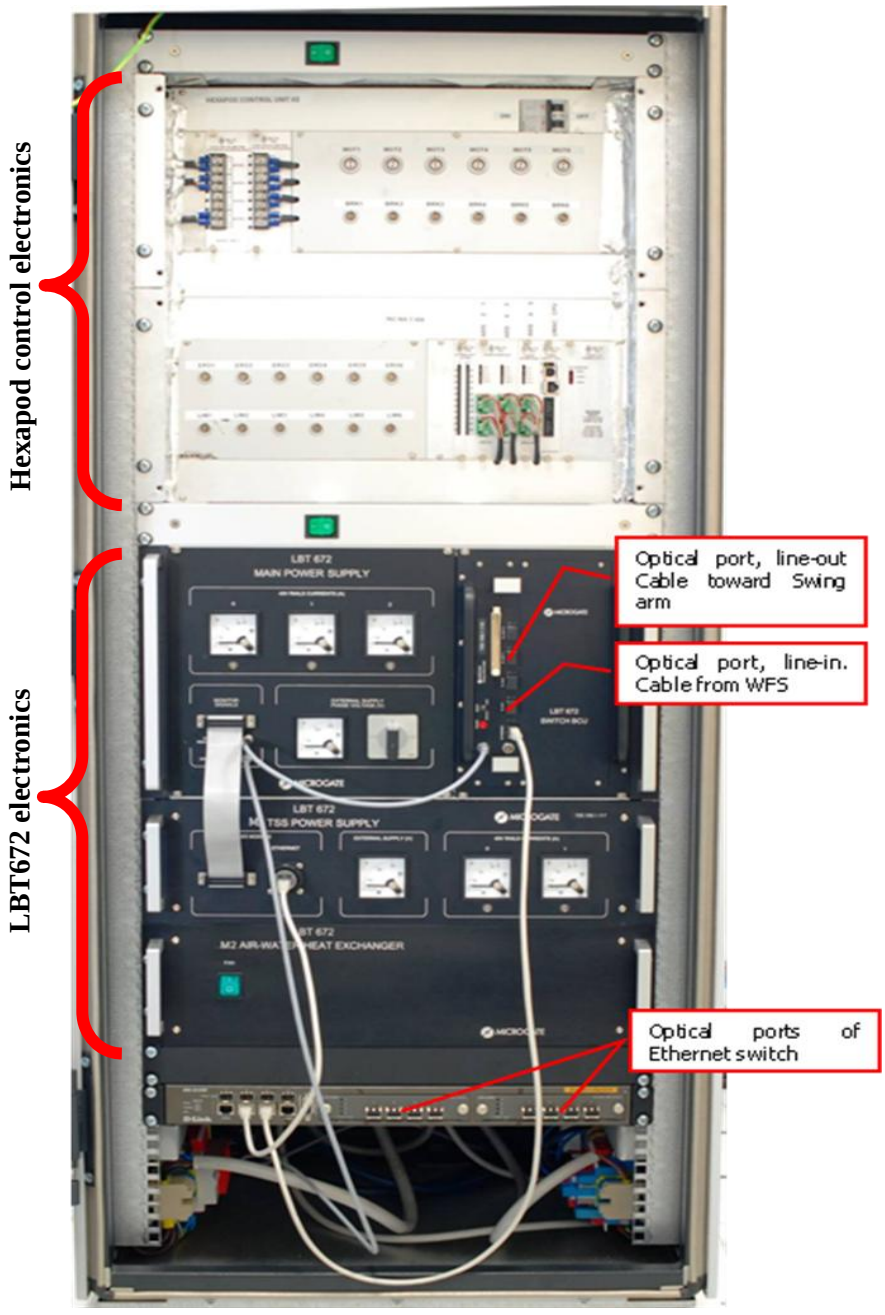

Figure 14 – Spider arm cabinet front panel showing interfaces to external communication lines

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4.4.4 DM interface (IF#2)

See Figure 12

Interface description	Type of interface	Connectors	Cables
Gigabit Ethernet communication (diagnostic)	Fiber optic link, 6x2 multimode fibers 62.5-125µm (1.25 Gbit/s TX/RX)	On DM Interface flange: Multifiber connector (18 fibers) type FRBOF3RT24-22PT39-F125-1.6-G1	See [20] *641a165 - CAF004 - LBT 1m FIBER ASSEMBLY TYPE CAB-07-002-18-1LC* For the interconnection cable between the two flanges, see [21].*641a164 - CAF003 - LBT 1m MULTY FIBER EXTENSION CAB-07-002-18-1*
Fast Communication Link (real time communication)	Fiber optic link, 2x2 multimode fibers 62.5-125µm (2x2.125 Gbit/s, TX/RX)		

4.5 Cooling interfaces

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

From the telescope cooling system[22] 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 14 lit/min with 2bar pressure drop at 20°C. Cooling fluid temperature 2°C below ambient. The above specification comes from the thermal tests during the LBT672b acceptance test[23]. 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 15). The lines shall be regulated to set a flux of 4 l/min to the spider-arm cabinet and 10 l/min to the adaptive secondary unit[23].

The cooling quick connectors on the Swing Arm Cabinet are ¼" diameter by Swagelock, 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 16.

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 16) and provided of stress-relief for safety.

Figure 15 Detail of the Swing Arm Cabinet rear wall with cooling quick connectors. Inlet: left; outlet: right

5 Laser mirror interface

The top of the hub has an interface for a 45deg mirror used for projecting the Laser Guide Star beam toward sky. Even if this mirror is not part of the FLAO system, its location gives constraints to the LBT672 cabling and mechanical interfaces. For this reason the mechanical interface between the hub and the mirror is reported in the present ICD.

The interface of the Laser Guide Mirror to the Hub is reported in Figure 17. The mirror attaches to the top of the Hub through 12 M6 bolts on a 580mm diameter bolt circle. The bolt locations are highlighted with blue circles in the cited figure.

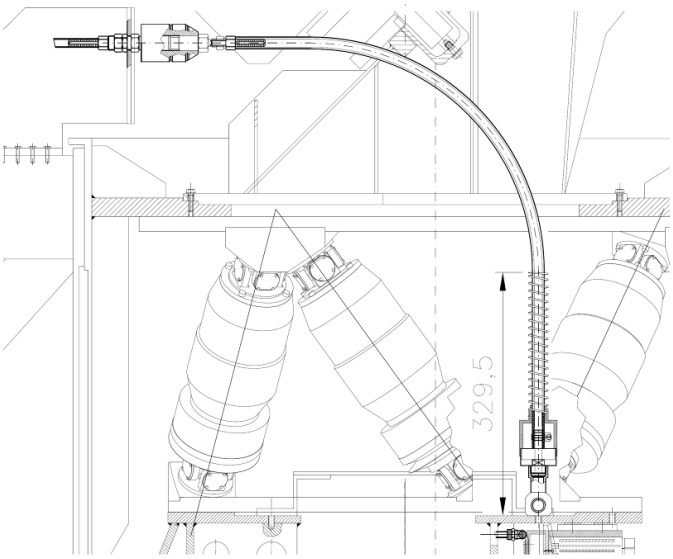

Figure 16 cooling line (just one of the two pipes is shown) from the secondary unit to the interface at the hub (top-left).

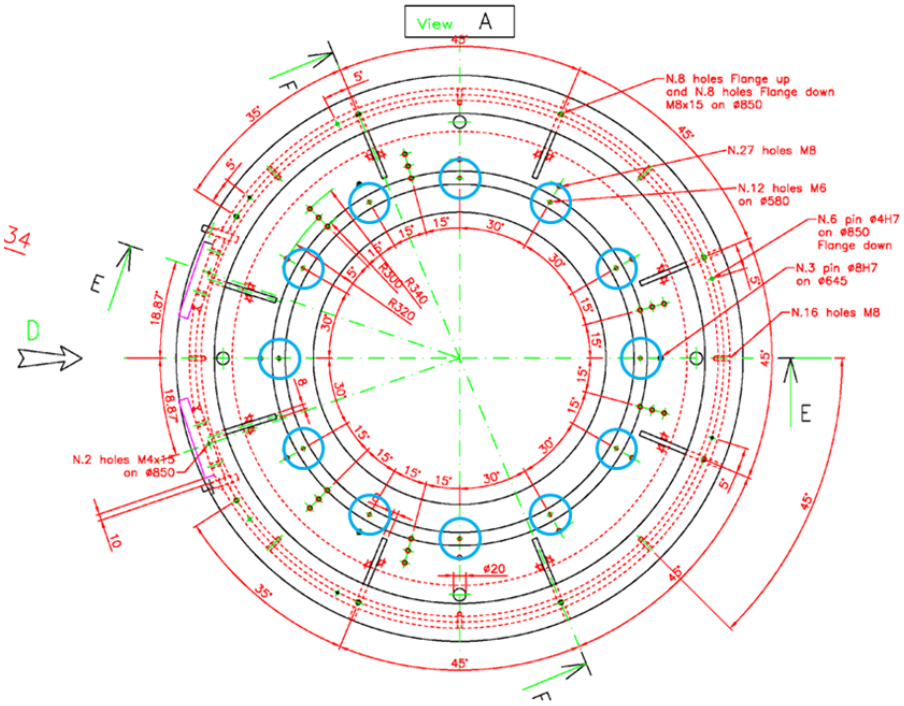

Figure 17. Mechanical interface of the Laser Mirror to the Hub (Hub view from the top)

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