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# HARPS

## ICD between Detector Unit and HARPS Spectrograph

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# Chapter 1: Introduction

## 1.1 Scope

The Detector Unit is in principle considered to be a subsystem of the HARPS instrument. The Detector Unit is fully developed by the Cryogenic Group and the Optical Detector Team at ESO Garching, which is in the realization of this important subsystem Partner of the HARPS Consortium. Although considerable adaptations specific to HARPS have been made, the Detector Unit will be delivered to the Consortium as an almost stand-alone subsystem using many standard VLT components. We have therefore decided to summarize and freeze within this document all interfaces between the Detector Unit on one hand and the HARPS Spectrograph and Vacuum Vessel on the other hand. Once released this document will be placed under configuration control.

## 1.2 Documents

### 1.2.1 Applicable Document

| | | | | |
|---|---|---|---|---|
| **AD-1** | Interface of the Continuous-Flow Cryostat | VLT-INS-98/0027 | 1 | 15/03/1998 |

### 1.2.2 Applicable Drawings

| | | | | |
|---|---|---|---|---|
| **AD-2** | Interface CCD Head for HARPS | HA-DU-A01-A | | 11/09/2000 |
| **AD-3** | Cryostat Interface for HARPS | HA-DU-A02-A | | 19/10/2000 |
| **AD-4** | HARPS Cryostat Overview | HA-DU-A03-A | | 18/10/2000 |

### 1.2.3 Reference Document

| | | | | |
|---|---|---|---|---|
| **RD-1** | Final System Design and Performance Report | 3M6-TRE-HAR-33100-0013 | 1.0 | 28/02/2001 |
| **RD-2** | Optics Final Design Report | 3M6-TRE-HAR-33103-0004 | 2.0 | 28/02/2001 |

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## 1.4 Acronyms

| | |
|---|---|
| AD | Applicable Document |
| CCD | Charge-Coupled Device |
| CFA | Cassegrain Fiber Adapter |
| CFC | Continuous-Flow Cryostat |
| ESO | European Southern Observatory |
| FDR | Final Design Review |
| FTS | Fourier Transform Spectrometer |
| HQ | Head Quarter |
| HW | Hardware |
| ICD | Interface Control Document |
| LCU | Local Control Unit |
| ODT | Optical Detector Team (ESO) |
| OG | Observatoire de Genève |
| OHP | Observatoire de Haute-Provence |
| PCB | Printed Circuit Board |
| RD | Reference Document |
| TBC | To Be Confirmed |
| TBD | To Be Defined |
| UVES | UV to Visible Echelle Spectrograph (VLT) |
| VLT | Very Large Telescope |

# Chapter 2: Interface Definition

## 2.1 Overview of the Instrument

The subsystem interfaces described in this document involve the Detector Unit on one hand, and the spectrograph and the Vacuum Vessel on the other. The spectrograph is mounted on the optical bench inside the vacuum enclosure. The Detector Unit is interfaced to the spectrograph via its Detector Head which is mounted on the optical bench. Three adjustable rods link the detector head to the Camera optics. The last lens of the camera optics, the field lens, is mounted on the top-cover plate of the Detector Head and acts as vacuum window as well. The present document defines precisely the optical interface between spectrograph and detector, i.e. the position and the spectral format of the spectra imaged on the CCDs.
The Detector Head itself is linked to the CFC through a flexible vacuum tube. The CFC is mounted on the outer side of the Vacuum Vessel containing the spectrograph in order to dissipate the cooling energy onto the Vacuum Vessel and not on the optical bench. In that configuration the Detector Head is rigidly linked to the spectrograph optics, while the CFC is mounted rigidly on the Vacuum Vessel. Through the flexible tube they share the same cryostat vacuum while being mechanically disconnected.
Apart from the flexible tube interfacing the Detector Head and the CFC the detector dewar is identical to the standard ESO dewar. The design of the different connectors on the Detector Head remains unchanged, but an additional vacuum feed-through to get the detector cables outside the Vacuum Vessel is foreseen. They will be identical to the connectors on the Detector Head. The pre-amplifier box of FIERA will be installed and fixed on the Vacuum Vessel as close as possible to the vacuum feed-through of the detector cables.
The general design which underlies this document is described in RD-1 and references therein. The next Chapter gives an overview of the interfaces defined by the present document.

## 2.2 Overview of the Interfaces

**Interfaces between Detector Head and Spectrograph**

- Optical Interface
- Mechanical Interface

**Interfaces between Detector Unit and Vacuum Vessel**

- Interface between CFC and Vacuum Vessel
- Interface between CFC and Pumping System

**Electrical Interfaces**

- Grounding
- Exposure Shutter and Pulpo
- Connectors and Cables

# Chapter 3: Interface between Detector Head and Spectrograph

## 3.1 Optical Layout and Interfaces

### 3.1.1 Coordinate Axis Convention

The coordinate system adopted is right handed. The optical axis is the z-axis with direction of propagation from the spectrograph to the detector. The x-axis is vertical and oriented towards the ground. The y-axis is horizontal and oriented towards the left when looking at the detector from the spectrograph.
(Note that this coordinate convention has been also adopted in the Optics Final Design Report (RD-2). However, in the ray tracing report realized with ZEMAX and presented in the appendix of RD-2 the orientation of the y and z-axis are inverted.)

### 3.1.2 Spectral Format

The spectral format is shown in Figure 1. Echelle orders 89 to 161 are represented covering the spectral range 3775 – 6905 Å. The horizontal y-axis represents the main dispersion direction with wavelengths decreasing in positive y-direction. The vertical x-axis represents the cross-dispersion direction with wavelengths decreasing and order number increasing in positive x-direction. The unit is mm for both axis. The dimension of the focal plane are limited to ± 31.4 mm along x-axis and ± 30.8 mm along y-axis which correspond approximately to the area covered by the CCDs. The highlighted zone corresponds to the free spectral range of the orders. Due to the dispersion characteristics of the grism the inter-order distance between the different echelle orders increases from the blue towards the red or decrease with x. The inclination and curvature of orders varies as a function of the order. Parameters of few orders located at the top, center and bottom of the focal plane are listed in Table 1. Inclination is measured as the slope between the two points located at the end of the order. Curvature is measured as the distance of the center of the order with respect to the straight line that connects the ends of the order. In reality each echelle order are double and contain the spectrum associated with the object fiber (Fiber A) and the spectrum associated with the calibration fiber (Fiber B, not represented here) which is shifted by about -250 microns along x-axis.

**Figure 1 : Spectral format in the focal plane of the spectrograph. The area is limited approximately to the size of the CCDs.**

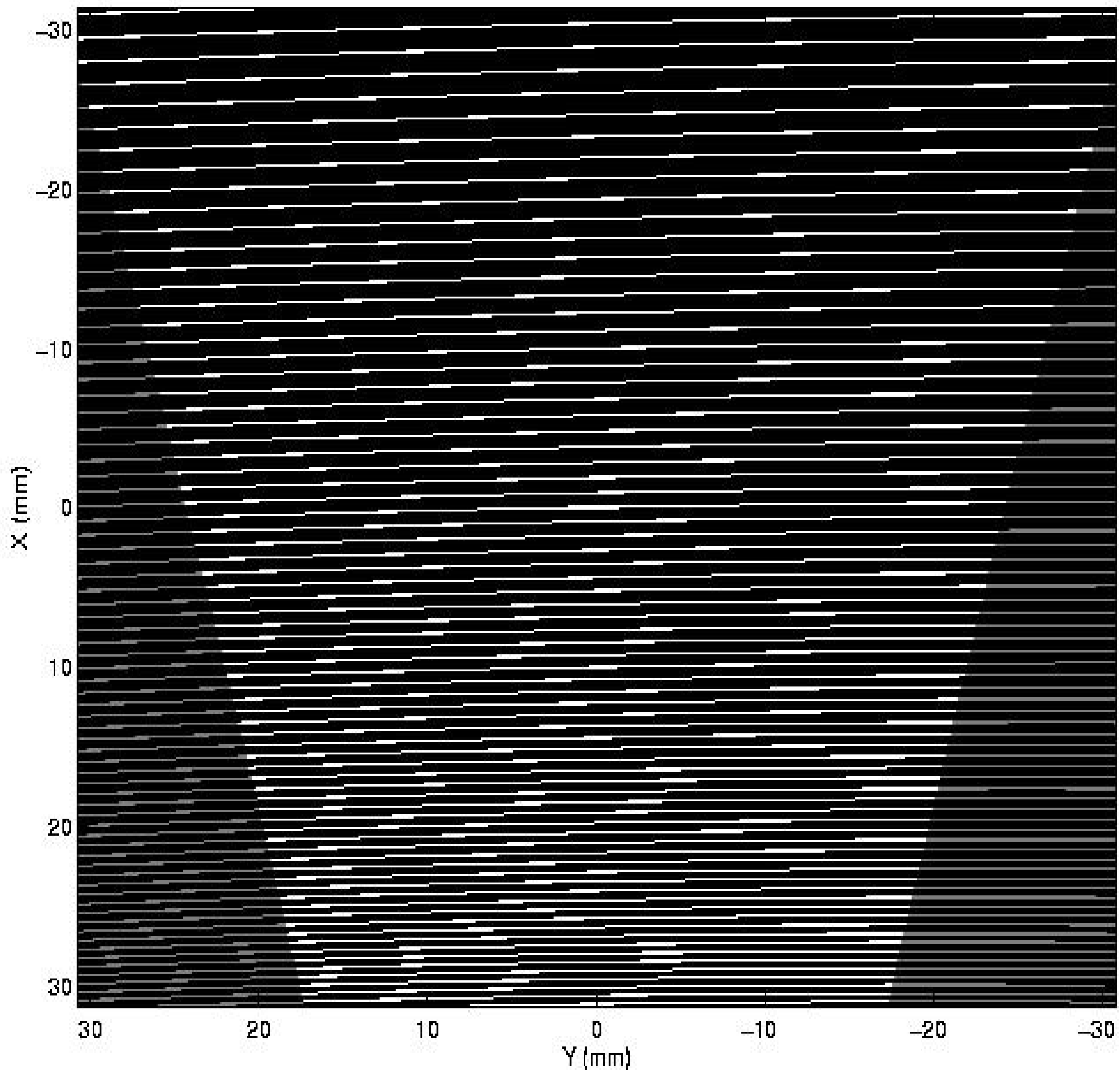


**Table 1: Characteristics of the echelle orders**

| Order N° | λcenter [(a)] (Å) | Δλ [(b)] (Å) | X (mm) | dX [(c)] (mm) | Slope (deg) | Curvature (mm) |
|---|---|---|---|---|---|---|
| 89 | 6868.5 | 78.8 | -30.371 | 1.510 | 1.424 | -0.192 |
| 90 | 6792.2 | 77.9 | -28.893 | 1.478 | 1.411 | -0.197 |
| | | | | | | |
| 114 | 5362.3 | 61.6 | -0.928 | 0.940 | 1.139 | -0.267 |
| 115 | 5315.6 | 61.0 | -0.003 | 0.925 | 1.130 | -0.269 |
| 116 | 5269.8 | 60.5 | 0.907 | 0.910 | 1.122 | -0.271 |
| | | | | | | |
| 159 | 3844.6 | 44.1 | 30.125 | 0.523 | 0.886 | -0.352 |
| 160 | 3820.6 | 43.8 | 30.643 | 0.518 | 0.881 | -0.353 |
| 161 | 3796.9 | 43.6 | 31.156 | 0.513 | 0.876 | -0.353 |

(a) wavelength at the center of the order
(b) spectral range covered by the order on the CCD
(c) inter-order distance

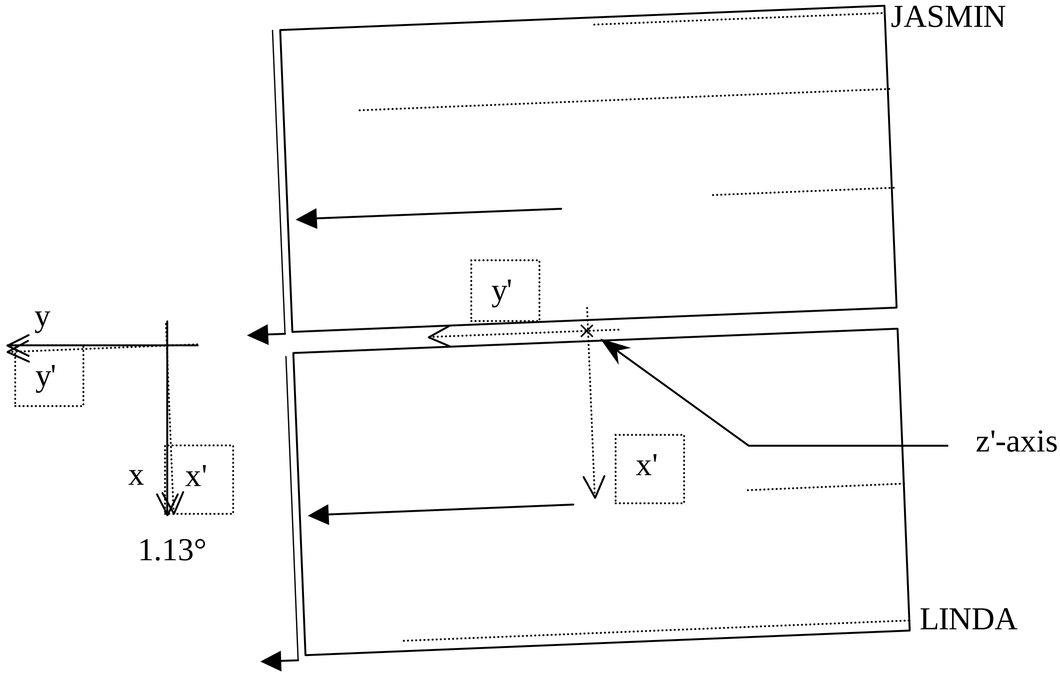
### 3.1.3 Opto-Mechanical References

The mechanical reference is given by the plane A shown in Figure 5 (or AD-2). The coordinate axis of this surface will be called x' and y'. They are parallel to the two "centering CCD axis" shown in the figure. x' corresponds to the centering CCD axis parallel to the CCD lines, while y' corresponds to that parallel to the CCD columns. The z' axis is perpendicular to the x'-y' plane and passes through the intersection of x' and y'. The orientation of these axis is identical to what defined in Section 3.1.1.

### 3.1.4 Position and Orientation of the CCDs

The CCD is a mosaic of two CCDs (called LINDA and JASMIN) with 2048 x 4102 pixels of 15 x 15 microns. The size of the photosensitive area is 30.72 x 61.53 mm. The CCDs must be positioned in the detector head at 6 mm from the vertex line of the cylindrical back face of the field lens (see Section 3.1.8). Considering that the quantum efficiency of LINDA is between 2 and 3 % better than JASMIN on the blue part of the spectral range, we have chosen to place JASMIN at the top of the focal plane (in the red part) and LINDA at the bottom (in the blue part). Considering the bad columns of the CCDs (represented by dashed lines), we have chosen to place the two serial registers at the left of the focal plane.
Position and orientation of these two CCDs are represented in Figure 2. The CCD sensitive surface is parallel to the plane A (x'-y' plane) and is placed at z' = -2.5 mm in front of it (towards outside, see Figure 5). CCDs columns are aligned parallel to the y'-axis and are mounted close together to fill the focal plane. The mosaic of CCDs is centered with respect to the z'-axis which will be made collinear to the optical axis of the camera. A small shift of the detector head along x-axis during fine alignment, however, will allow to optimize the position of the CCD gap with regard to the central echelle order 115.
During the alignment of the detector head with the spectrograph, a small rotation of the detector head around the z-axis of +1.13° (when looking towards the photosensitive surface) will allow to straighten the central order to the CCD gap. On account of this alignment the axis x' and y' of the detector head will be tilted counter-clockwise around z' by 1.13° with regard to x and y (see Figure 2).

**Figure 2: Position and Orientation of CCDs**




### 3.1.5 Optical and Mechanical Gap between CCDs

The gap between the CCDs must be as small as possible to lose the minimum of spectral information in the focal plane. The photosensitive area of a device is 500 microns from the edges and the mechanical gap cannot be reduced to less than 150 microns. The requirement is not to loose more than one object echelle order. However it is acceptable to loose one order plus one order of the adjacent reference fiber. This means a maximum optical gap of 1300 microns is allowed. Figure 3 represents the localization of the spectral orders on the CCDs with a gap of 1300 microns. For this simulation the order 115 has been placed on the gap (detector head shifted along x-axis by +0.100 mm) and straightens by a rotation of the detector head of 1.13° around the z-axis. Figure 4 presents a zoom of the top, center and bottom of the full image in order to see the localization of orders at the edges of the two CCDs. Order numbers are indicated on the right side. Continuous orders, associated with the object fiber (fiber A), are represented by a continuous line and the channeled orders, shifted of -250 microns from the others and associated with the calibration fiber (fiber B), are represented by a dashed line. Orders have been deliberately widened by 10 pixels to take account of the total extraction zone. Non photosensitive area and bad columns appear in black. This configuration allows collecting orders 89 to 114 (5329 – 6905 Å) on the JASMIN CCD and orders 116 to 161 (3773 – 5298 Å) on the LINDA CCD. This configuration allows us to eliminate the order 88 that contains very strong spectral lines of Argon coming from the ThAr calibration lamp.

### 3.1.6 Bad columns of the CCDs

Bad columns on CCD Jasmin are located on columns 661,662,1670,1671,2026,2027 and 2028. In the simulation shown in Figure 3 and Figure 4, none of these columns cuts a spectral order. Bad columns on CCD Linda are located on columns 57 and 930. Only column 57 cuts the spectral order 160 and makes it unusable.

**Figure 3: Spectral format covered by the two CCDs.**

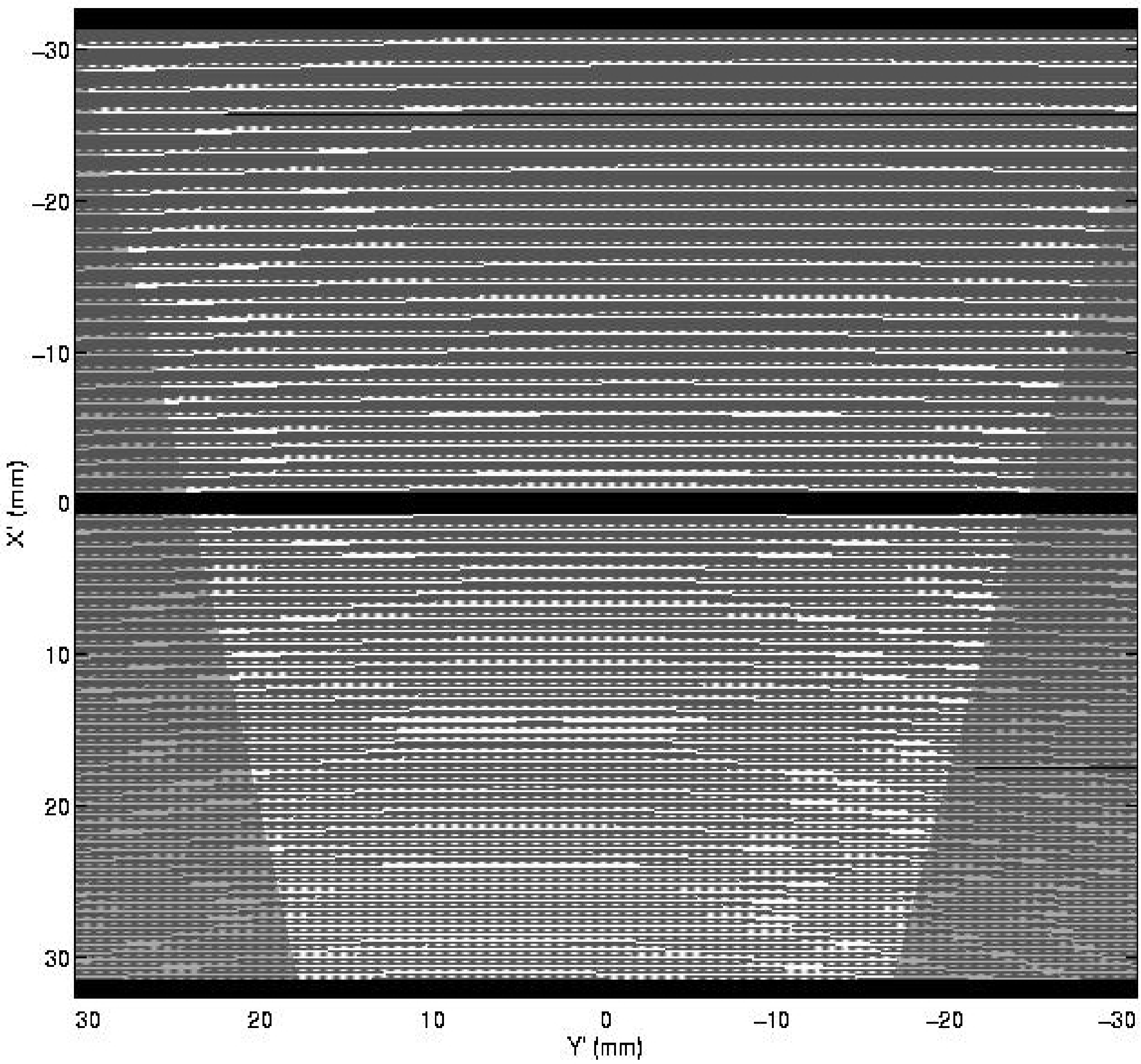
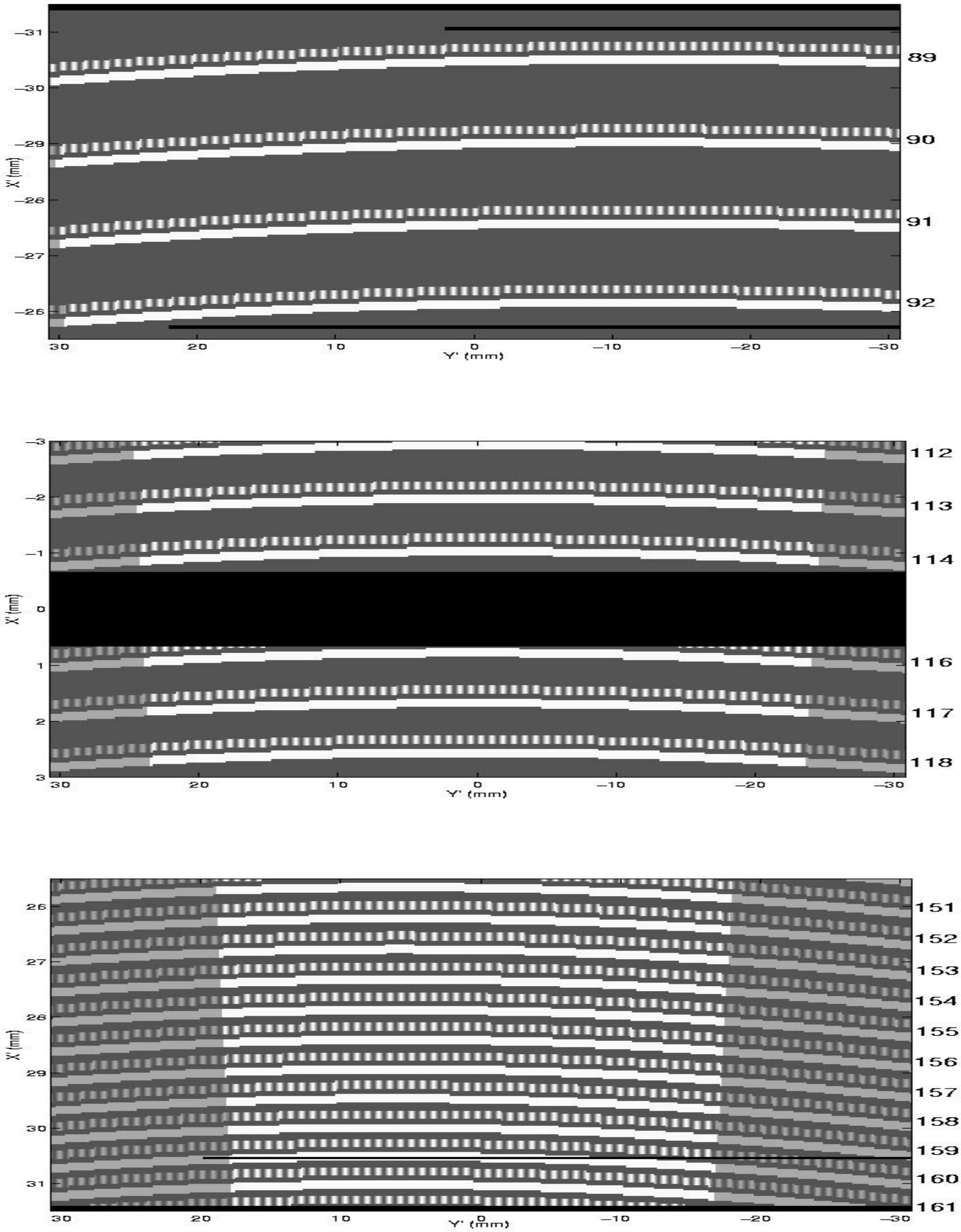


**Figure 4 : Spectral format at the edges of the two CCDs.**



### 3.1.7 Argon Mask in front of the CCD

The order 88 contains very strong spectral lines of Argon. These lines will give over-saturated bright spots, which risk contaminating the adjacent orders and make them unusable. Even if the order 88 is positioned outside the photosensitive area, light reflected by the non-photosensitive area could provoke parasitic light. A black-painted mask placed between the field lens and the CCD will cut these unwanted Argon lines. This mask has approximately the dimension of the photosensitive surface. The exact topology of the mask must be detailed during the laboratory tests of the spectrograph, however.

### 3.1.8 Position and Orientation of the Field Lens

The field lens is also used as vacuum window of the detector head. The front face of the field lens (looking to the camera) is spherical and the back face (looking to the CCDs) is cylindrical in the y-z plane and flat in x-direction.
The distance in z-direction between the CCD plane and the vertex line of the cylindrical back face must be 6 mm. Thus, the vertex line of the cylindrical back face is at -8.5 mm from the reference plane A of Figure 5. Considering the thickness of the field lens, the distance between CCDs and the vertex of the spherical front surface of the field lens is 21 mm.
The symmetry axis of the field lens is collinear to the mechanical symmetry axis z' of the detector head. The vertex line of the cylindrical face is parallel to the x-axis. *N.B.: The vertex line of the cylindrical surface is parallel to the x-axis! It is therefore tilted clockwise by 1.13° with regard to the x'-axis. This must be taken into account when the cylindrical lenses is mounted.*

### 3.1.9 Alignment of the Spectrograph and the Detector Head

The alignment of the detector head and the spectrograph has the following main objectives:

1. Focusing of the spectra on the CCD. Requires adjustment in z-direction.
2. Align the optical axis of the camera optics z with the detector axis z'. This guarantees the perpendicularity of the photosensitive area with regard to the optical axis z. Requires precise adjustment in x and y, as well as tilt of the detector head around x and y.
3. Fit the spectra onto the CCD as shown in Section 3.1.5 and 3.1.6. Requires precise adjustment of the detector head tilt angle around z.

### 3.1.10 Alignment Tolerances

#### 3.1.10.1 Alignment requirements for the detector head with the spectrograph

- The detector head can be oriented around z-axis with an angle of ±3°.
- The detector head can be shifted along x-axis by ± 1.5 mm. A displacement greater than 1.5 mm deteriorates the image quality (optical axis is not superposed with the axe of the field lens).
- The detector head can be shifted along z-axis by ± 10 mm to adjust focus.
- The detector head can be tilted around x- and y-axis with an angle of ± 1°.
- The axis of the front face of the cylindrical field lens can be tilted around z-axis in its holder in order to orient the vertex line of the cylindrical surface parallel to the x-axis.

#### 3.1.10.2 Alignment Tolerances on the detector head

- The optical gap between the two CCDs must be as small as possible but not larger than 1300 microns.
- The in-plane tilt between the two CCDs must be as small as possible but not larger than 5 arcmin.
- CCDs columns are positioned parallel to the y'-axis with a precision of ±1°.
- CCDs are positioned perpendicular to the z'-axis (or parallel with the reference surface) with a precision of ± 0.1°.
- The center of the mosaic must be superposed with the z'-axis (x' = y' = 0) with a precision of ± 0.3 mm.
- The vertex line of the cylindrical back surface of the field lens must be positioned at 6 mm of the photosensitive area with a precision of ± 0.1 mm.
- Parallelism of the field-lens axis with the z'-axis better than ±0.1°
- Orientation of the vertex line of the cylindrical surface of the field lens with regard to the CCD lines ±TBD°.

## 3.2 Mechanical Interface

### 3.2.1 Mechanical Interface Drawing

The mechanical interface between Detector Unit and Spectrograph is controlled by the Detector Head interface shown Figure 5 (AD-2). Fixations of the Detector Head on the optical bench and the camera optics support is designed with regard to this drawing.

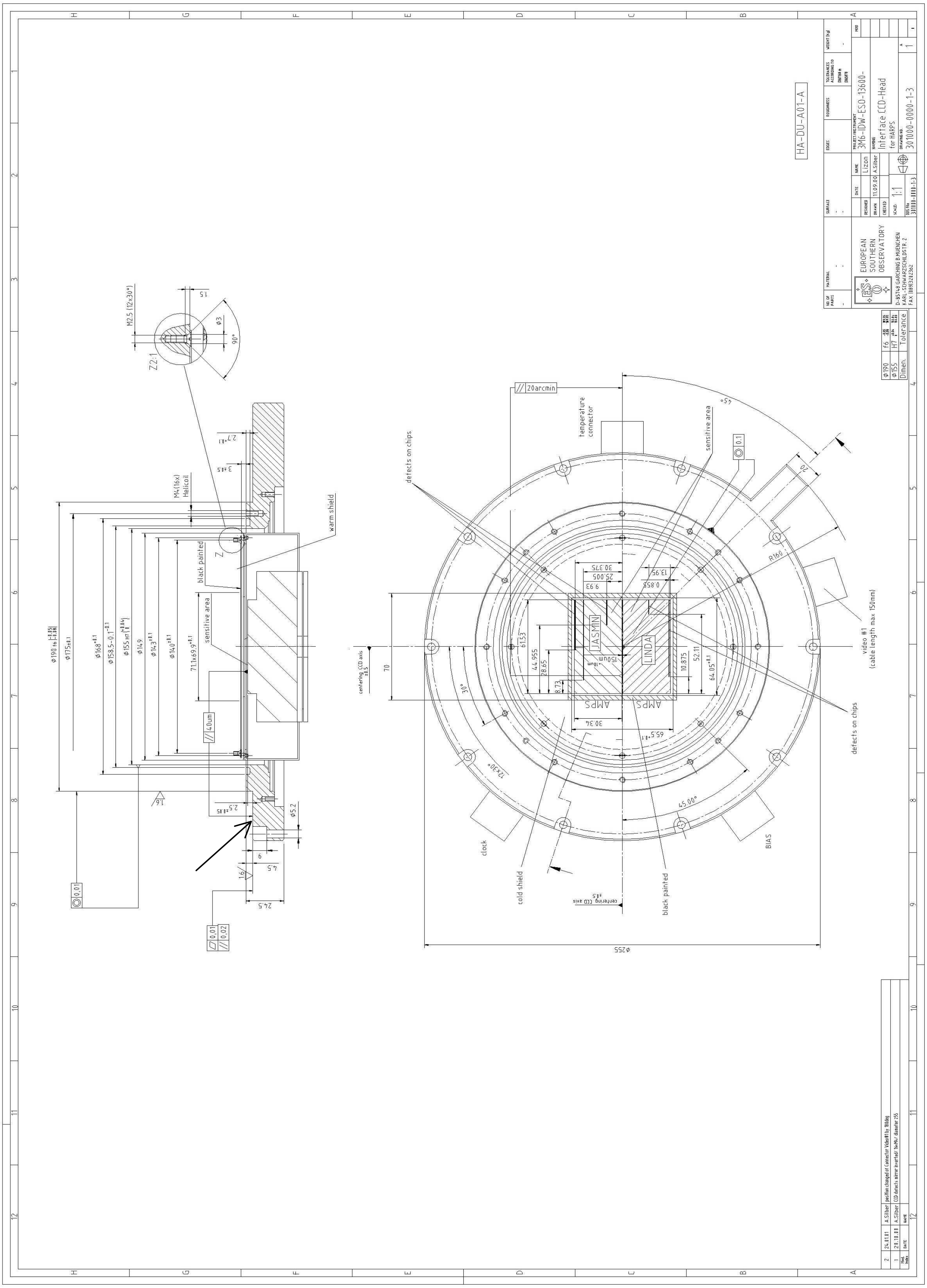
### 3.2.2 Heat Load on Optical Bench

The thermal heat load from the detector head onto the optical bench are mainly caused by the four following sources:

- The infrared radiation through the entrance window.
  This part is evaluated to -2.25 W for a chip operating at 150K. This is very constant in the time and well distributed around the window.
- The thermal leak through the four insulating supports of the cold bench.
  This part is evaluated to -1.3 W for a chip operating at 150K. This is also well distributed around the interface front flange.
- The radiation exchange between the radiation shield and the warm parts of the vacuum enclosure.
  For well polished aluminum surface this part can be estimated to -1.5W distributed over the complete vacuum envelope of the detector head.
- The conductance through the wiring.
  Large efforts are done in order to reduce this as far as possible without affecting the read-out performance. This part is estimated to be lower than 0.7 W including the four cables.

The global heat load on the optic bench is then: -5.75 W. Where probably only a part will contribute to lower slightly and locally the temperature of the optical bench. The complete vacuum envelope of the detector unit ( if connected to nothing else) would stabilize around 2.9 K below the temperature of the surrounding vessel.
What is more important is the fact that this heat load is very constant in the time. What is also very important is to have very low thermal coupling between the detector head and the vacuum vessel. This is guaranteed by the use of a very thin and long stainless steel bellows.

**Figure 5: Mechanical interface to the Detector Head**



# Chapter 4: Interface between Detector Unit and Vacuum System

## 4.1 Interface between CFC and Vacuum Vessel

### 4.1.1 Mechanical Drawing and Tolerances

The interface between the CFC and the vacuum vessel is defined in the ESO drawing AD-3. This drawing shows all components with information about the volume. The sealing is done at the level of the section AA with a Viton o'ring (160*4) as the vessel interface flange belongs to the cryostat. Elongate holes are foreseen for the fixation of the interface flange onto the vacuum vessel. This is in order to allow the orientation of the complete Detector Unit on the spectrograph.

### 4.1.2 Heat Load on Vacuum Vessel

The two main sources of heat load from the Continuous Flow Cryostat on the vacuum vessel are the following:

- The thermal conductance inside the Johnston fitting. This part is evaluated to -1.3 W.
- The thermal exchange by radiation between the vacuum envelope of the CFC and its radiation shield. This is evaluated to –0.8W.

## 4.2 Interface between CFC and Pumping System

The only interfaces between CFC and pumping system are the pumping port and the flange for mounting the vacuum gauge. They consist both of a standard KF DN-40 flange mounted on the CFC. Their position is shown in AD-2.

# Chapter 5: Installation and Alignment of the Detector Unit on the Spectrograph

The detector unit will be used on the spectrograph to carry out the first test outside the vacuum vessel. For this the detector unit will be operated in the configuration shown on the drawing VLT-DWG-ESO-13600-301000-0000-3-3. In that case the CFC unit is linked to the detector head via the intermediate spacer flange 15. Most of the adjustments (Focus, centering and orientation of the spectrum) will be done at this stage.
Before to install the spectrograph inside the vacuum vessel it is necessary to dismount the CFC from the Detector Unit. For this the following operations have to be done:

- Brake the vacuum (If possible with dry nitrogen)
- Unscrew (screws 203) the connection CFC/ Vessel interface flange(05)
- Slide the CFC 10mm away from the Detector Head
- Loosen the shield connection (screws 202)
- Slide the CFC 10mm more away from the Detector Head
- Loosen the two tube fittings
- Slide the CFC until it is in contact with the end stop
- Disconnect the PT100 connector (on part 03)
- Then remove the end stop (screw 209) and remove completely the CFC

After that it is still necessary to dismount the following parts:

- The back shield (11)
- The interface flange (05)
- The intermediate spacer (15)

Then the spectrograph can be installed inside the vacuum vessel. The end position of the spectrograph has to be defined and adjusted such that the intermediate flange (05) can be installed without stressing the Bellows. Then the rest of the equipment can be re-installed following the procedure in the reverse way.
It might be necessary to remove the front part of the vacuum vessel without dismounting detector unit. For this reason the front part of the vacuum vessel is mounted on accurate guides. These guides are adjusted such that the sliding of the vessel does not introduce any large motion of the spectrograph. A maximum motion ± 1.5 mm at the level of the interface flange (05) is allowed.

# Chapter 6: Electrical Interfaces

## 6.1 Grounding

The basic principle of grounding is the following: The CCD has a separate ground from the outer part of the head/cryostat. The cryostat/head will be tied to the same potential has the Harps vessel. Determining the best grounding scheme from the head the Fiera Boxes (Parts #3 and #4) is extremely difficult in advance and could have a big impact on noise performances. Empirical experiments will be done when the system will be installed to the vessel in order to determine the best grounding scheme.

## 6.2 Exposure Shutter and Pulpo

PULPO is able to drive many kinds of shutters. In that particular design, the SESO shutter controller is well fitted for PULPO (It has been used for VLT test camera 1, UVES, VLT test camera 2) . To connect PULPO to the shutter, it requires a simple custom-made cable (Schematics in annex). PULPO will take care of the following tasks :

- Sense the detector head vacuum
- Measure the temperature of the single PT100, for maintenance purposes
- Power up the two heaters, only for maintenance purposes, Lakeshore disconnected
- Receive the open shutter order form FIERA LCU (RS232)
- Measure the internal temperature of the FIERA boxes.

## 6.3 Cables and Connectors from the Detector Head to the FIERA System.

This section encompasses the cables from the detector head to the FIERA system

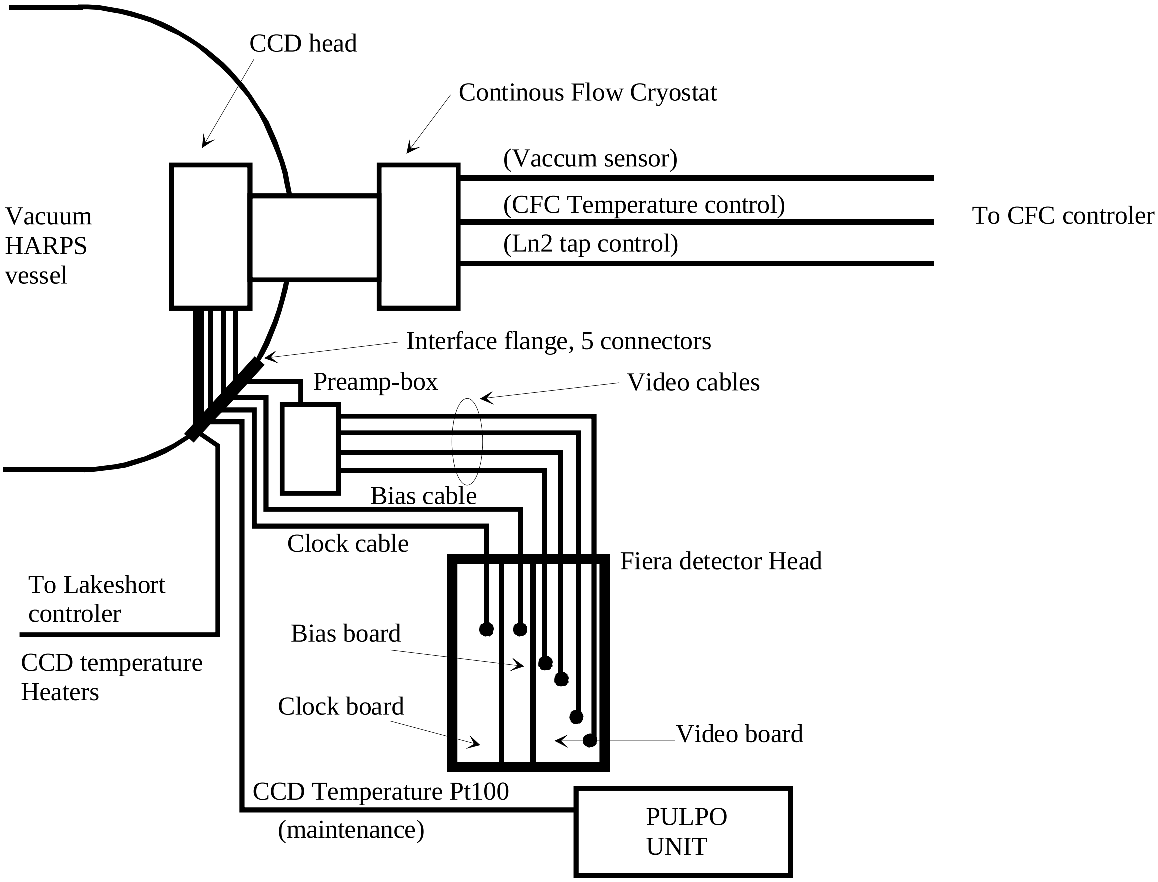
### 6.3.1 Overview

From the Harps vessel to the Fiera System, 5 kinds of cables have to been taken into account:

- The video cables, which brings the 4 video signals to the Fiera Detector head box.
- The clock cable, which clocks the CCD.
- The bias cable, which biases the CCD.
- The Pulpo cable, which provide temperature information through a pt100 for maintenance purposes.
- The Lakeshore cable which will regulate the CCD cold plate and measure accurately the CCD temperature.

An overview of the cables that must go through the vessel to FIERA is shown in Figure 6.

**Figure 6: Cables interface from the head/cryostat to the outside world**




## 6.3.2 Cables

### 6.3.2.1 The Video Cable

The video cable is made of 4 coax cables that go to the preamp box. They have to go through the interface flange. From the flange to the preamp box, all the cables are put together. At the exit of the preamp box to Fiera, they are all split to 4 single twisted pair shielded cables. This is the first time that ODT will deliver a system with so long video cables between the CCD and the preamp-box. **This could jeopardize noise performances** and could end up that noise performances do not meet specs. The Harps vessel flange has been positioned to get the shortest video cables. In that context, it has been decided to put the preamp box outside the tank, but a rescue solution, where the preamp box is inside, should be foreseen to overcome the cable length noise issue. We plan to make a test here at ESO, HQ in order to measure how noise performance degrades using a longer video cable.

### 6.3.2.2 The Bias Cable

The bias cable is made of 22 coax cables that provide the biases to the CCD. The cable will go through the vessel flange with a one to one wire scheme/connectors.

#### 6.3.2.3 The Clock Cable

The clock cable is made 26 coax cables that provide the clocks to the CCD. The cable will go through the vessel flange with a one to one wire scheme.

#### 6.3.2.4 The Pulpo and Lakeshore Cable

The Pulpo and the Lakeshore cable is a single cable merged from the head to the interface HARP vessel flange. At the flange level (from outside) the cable is split in two connectors which will allow two cables to be attached : one toward PULPO and another toward the Lakeshore controller. The later will drive the two heaters and read the two temperature diodes; in the meanwhile, PULPO will read detector head vacuum figure and a PT100 at the CCD table level. The use of the standard PULPO cable (Lakeshore controller disconnected) will permit PULPO for maintenance to read the PT100 and eventually control the heaters. It will be likely two heaters of 47 Ohm each, to accommodate the usable range of PULPO and Lakeshore. But in **any** cases both PULPO and Lakeshore controller will **not** drive the heaters at the same time: either PULPO or the Lakeshore.

### 6.3.3 Connectors on Detector Head

#### 6.3.3.1 Description of Function and Connector Layout

The head is fitted with Four connectors: The video, the bias, the clock and the temperature.
They are all of the type jam nut connector with the sealing surface inside the vacuum. Figure 7 shows the mechanical dimensions of the video connector. Figure 8 shows the mechanical dimensions of the three other connectors. These three connectors have the same mechanical interface but different pin distribution. A flat surface must be foreseen in order to prevent the connector to rotate while one tight it. This can be either on the largest square flange or on the threaded part (with a flat surface at xxmm from the axis for the video and xxmm for the other connectors). This connectors are foreseen to be mounted on a 4 mm thick wall.

**Figure 7: Clock connector on the detector head**

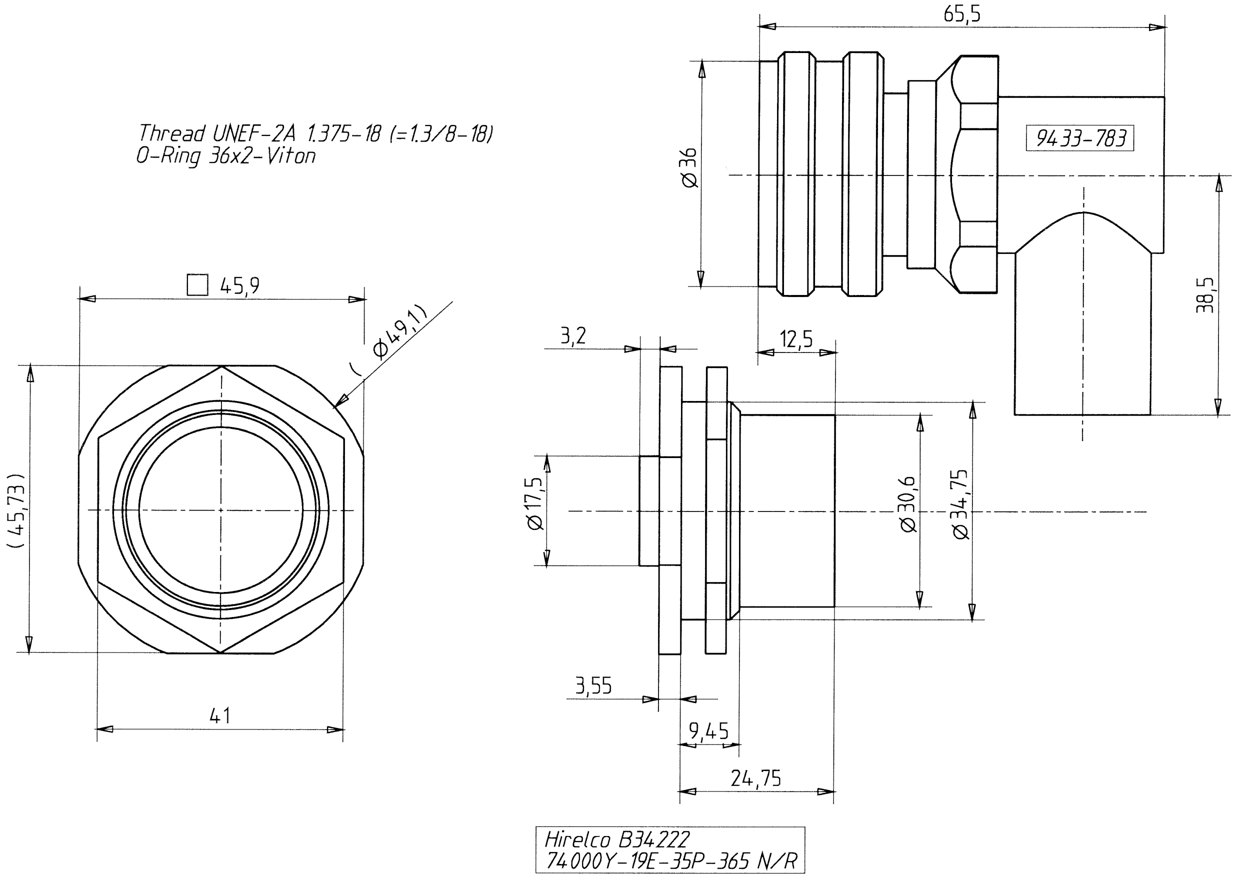
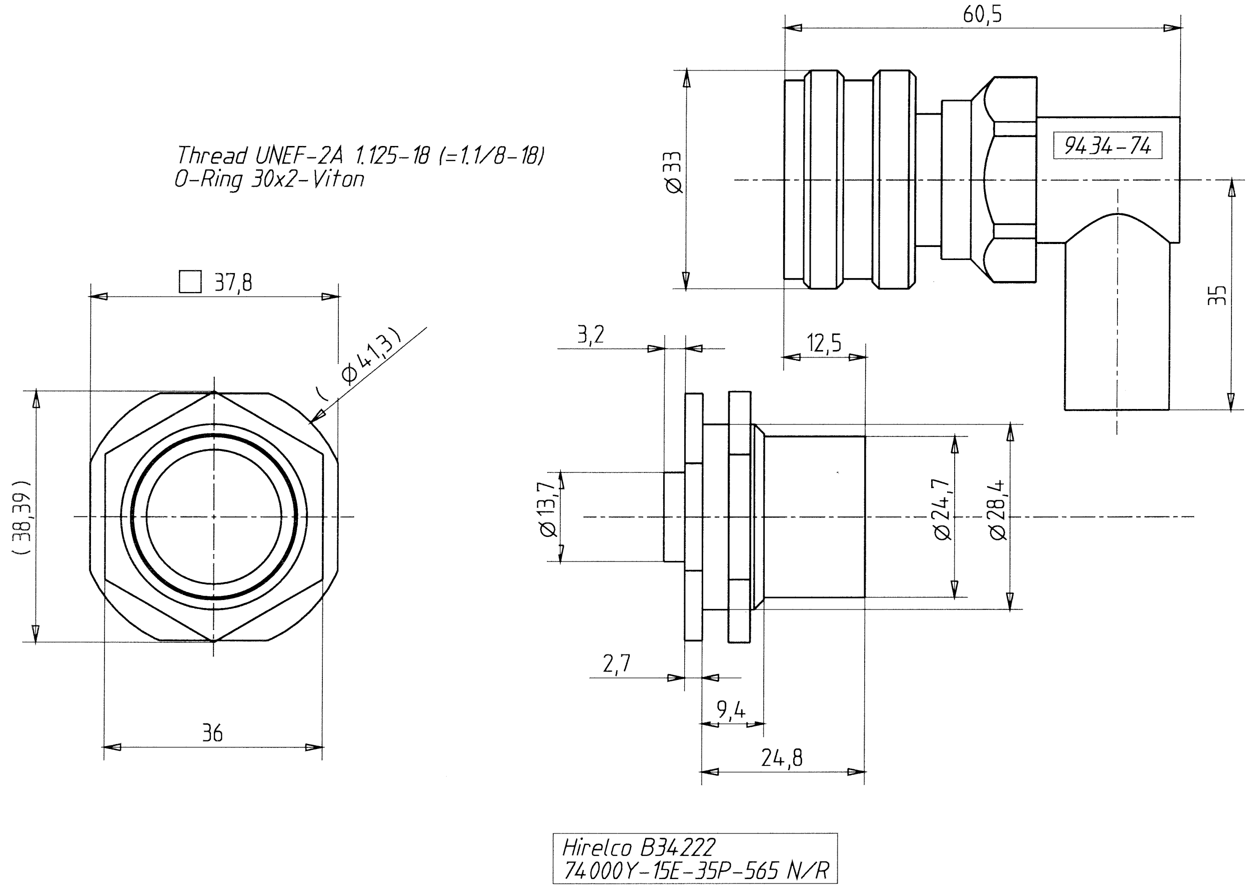


**Figure 8: Connectors of the detector head (video, PULPO, and temperature)**




### 6.3.3.2 Position of Connectors on the Detector Head

The position of the connectors is shown in drawing VLT-DWG-ESO-13600-301000-0000-1-3

## 6.3.4 Connectors on the Vacuum-Vessel Interface Flange

The four connectors present on the detector head have also to "duplicated" on the Vacuum Vessel. In addition to the drawing shown in Figure 7 and Figure 8 we can add the following recommendations concerning the implementation of these connectors: A flat surface must be foreseen in order to prevent the connector to rotate while one tight it. This can be either on the largest square flange or on the threaded part (with a flat surface at 15.7mm from the axis for the clock and 12.8mm for the other connectors). These connectors are foreseen to be mounted on a 4 mm thick wall. The pre-amplifier box is mounted outside the vacuum vessel and is fixed directly on the vacuum flange.

The main additional issues compared to a standard FIERA system are the following:

1. The detector head is located inside a large vacuum vessel leading to the fact that cables from the detector head have to go thru a vacuum tight interface flange.
2. The CCD temperature table is no longer driven by PULPO, but using a Lakeshore controller with temperature diodes.

The flange interface will be made of 5 vacuum connector of the same type that the one used at the detector head and shown in Figure 9. These connectors will be soldered into PCB in both side: 5 toward outside the vessel, 4 toward inside the Harps vessel (see Figure 10).

**Figure 9: Vacuum connectors that allows to be soldered to be PCB, Hirelco B34222 74000Y-15E-35P-565 N/R**

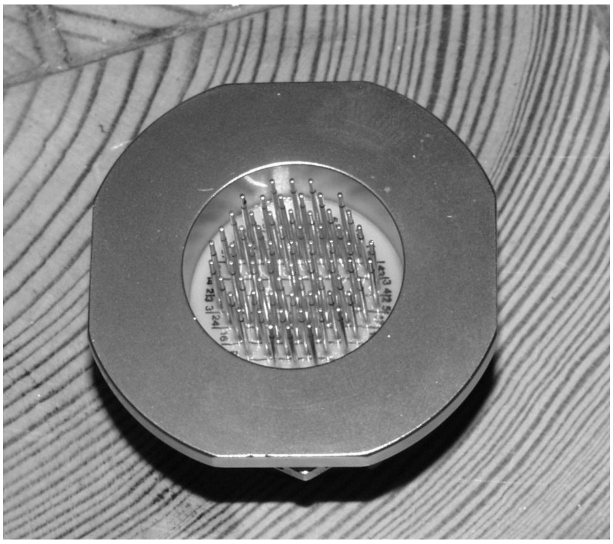
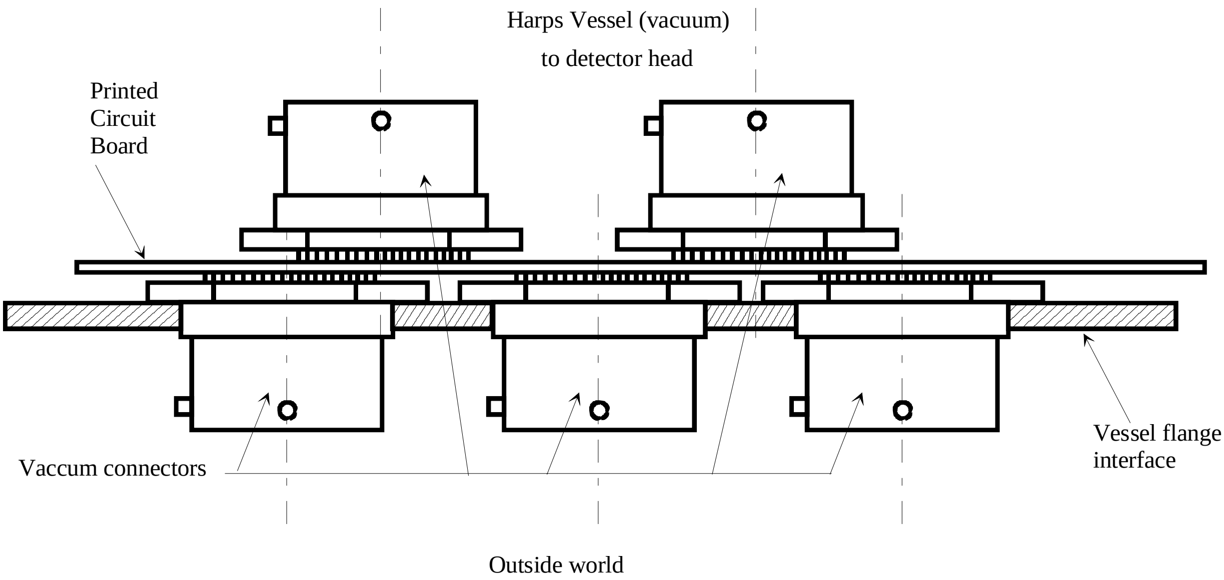


**Figure 10: Cross section of the PCB including connectors : 5 in the external side, 4 in the internal side**




The flange has to be large enough to accommodate 5 vacuum connectors on one side, and 4 on the other side. The largest vacuum connector is the one used for the clocks cable (46mm diameter), all the others are 38mm diameter. The cable housing must be straight, because usually, 90 degree cable housing are used at the detector head level. In that case those kind of cable housing could not fit in the tube holding the flange.

**Figure 11: 150 mm diameter PCB, external side 5 connectors**

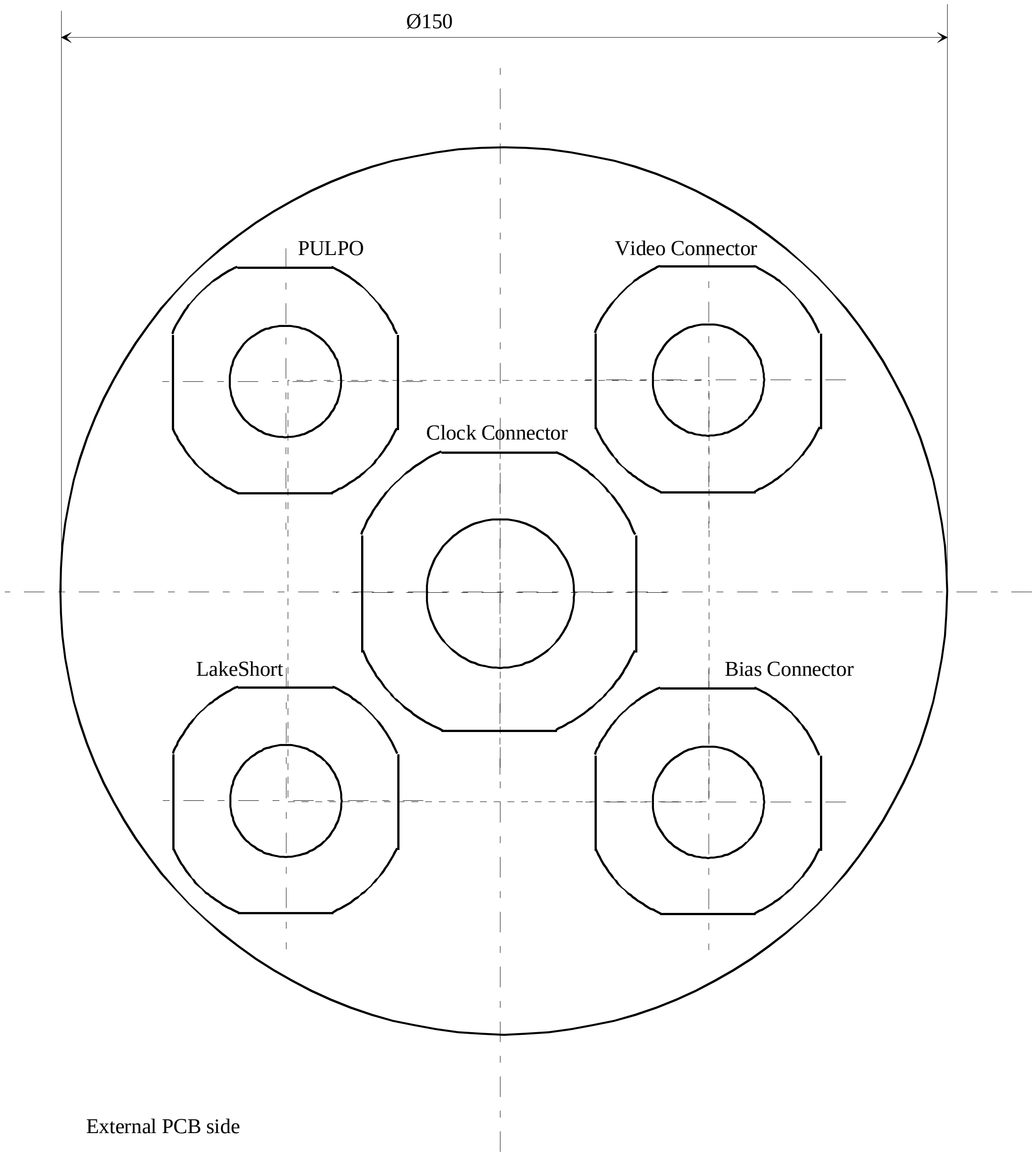
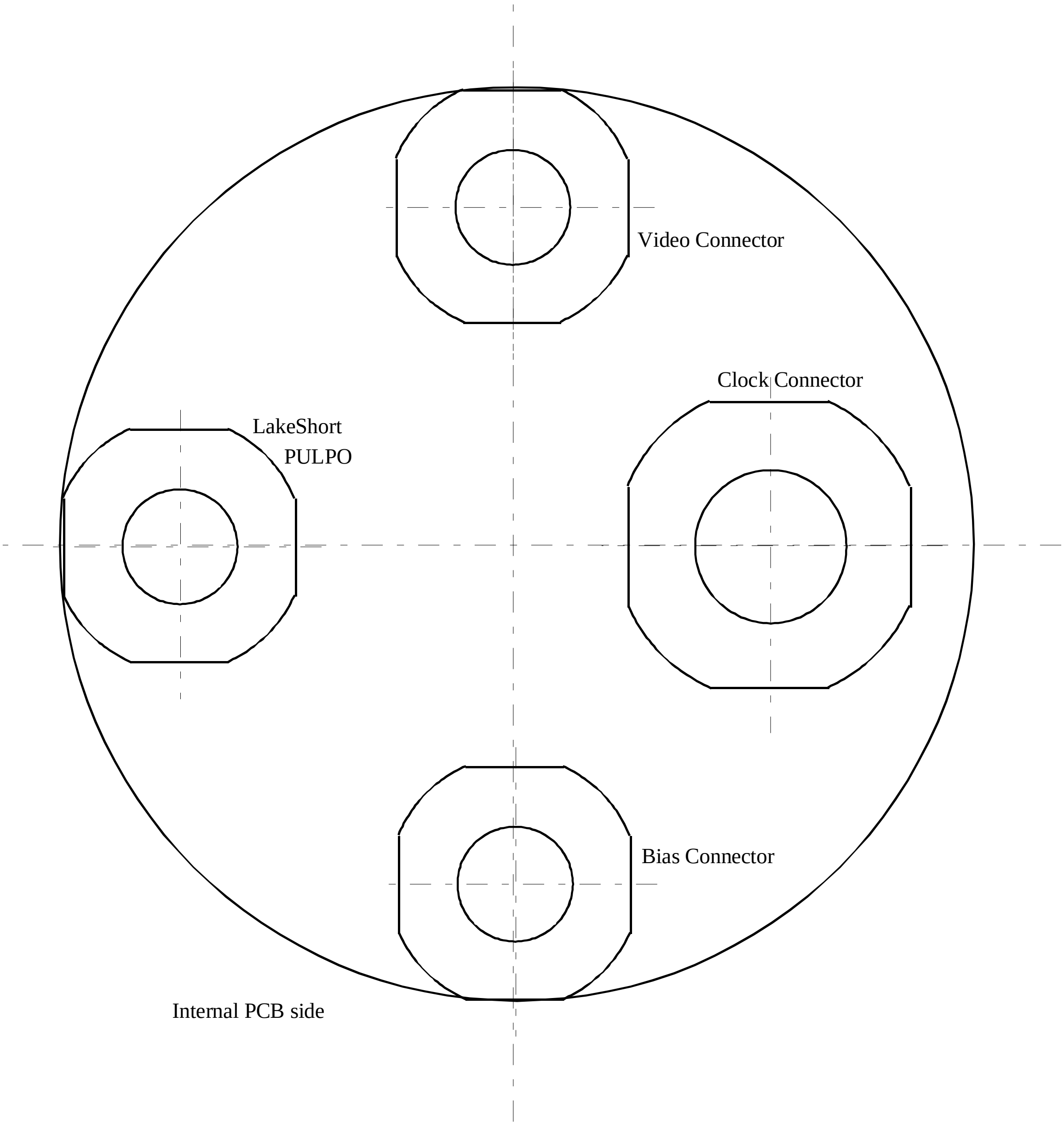
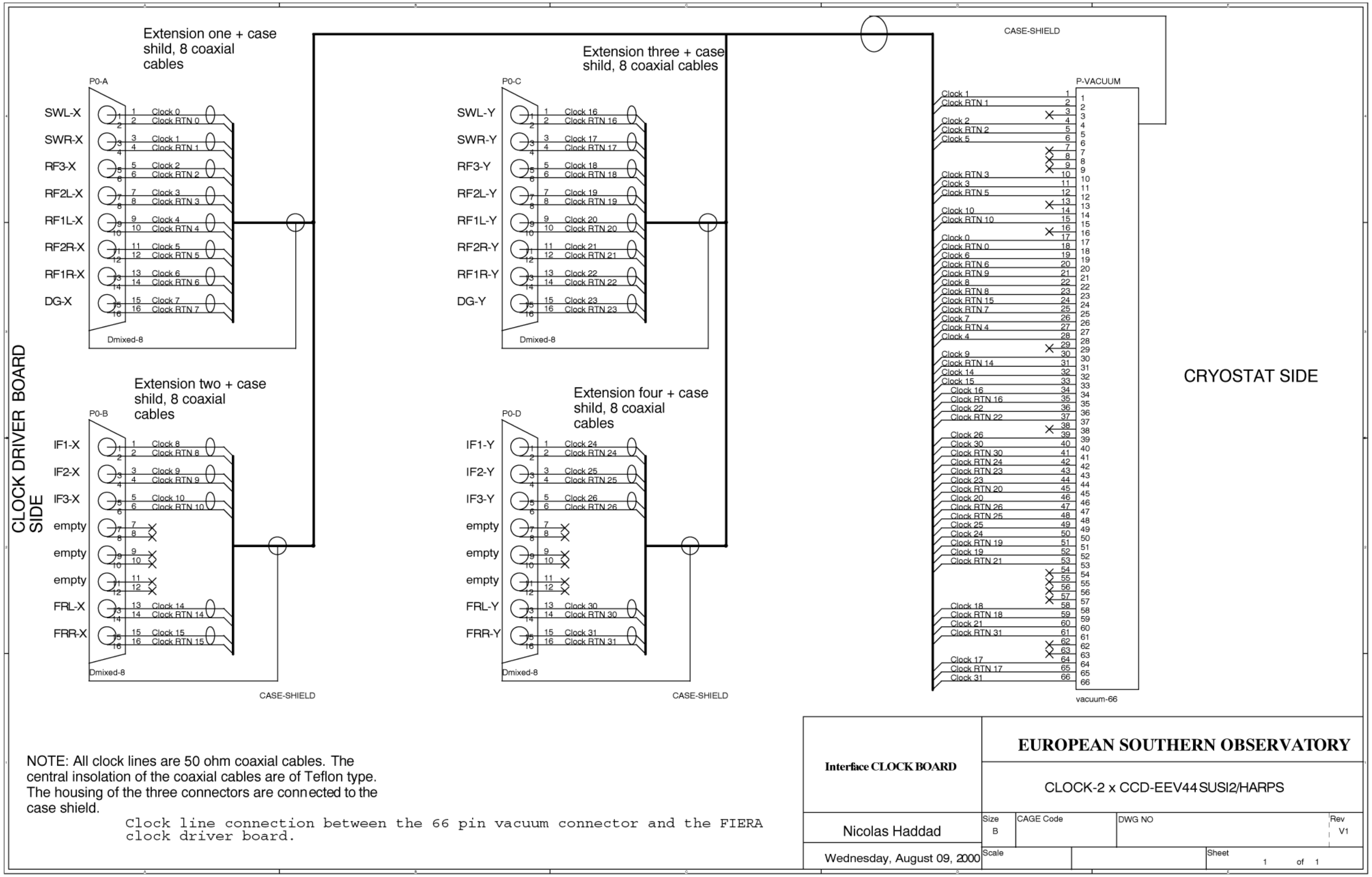


**Figure 12: 150 mm diameter PCB internal side 4 connectors**

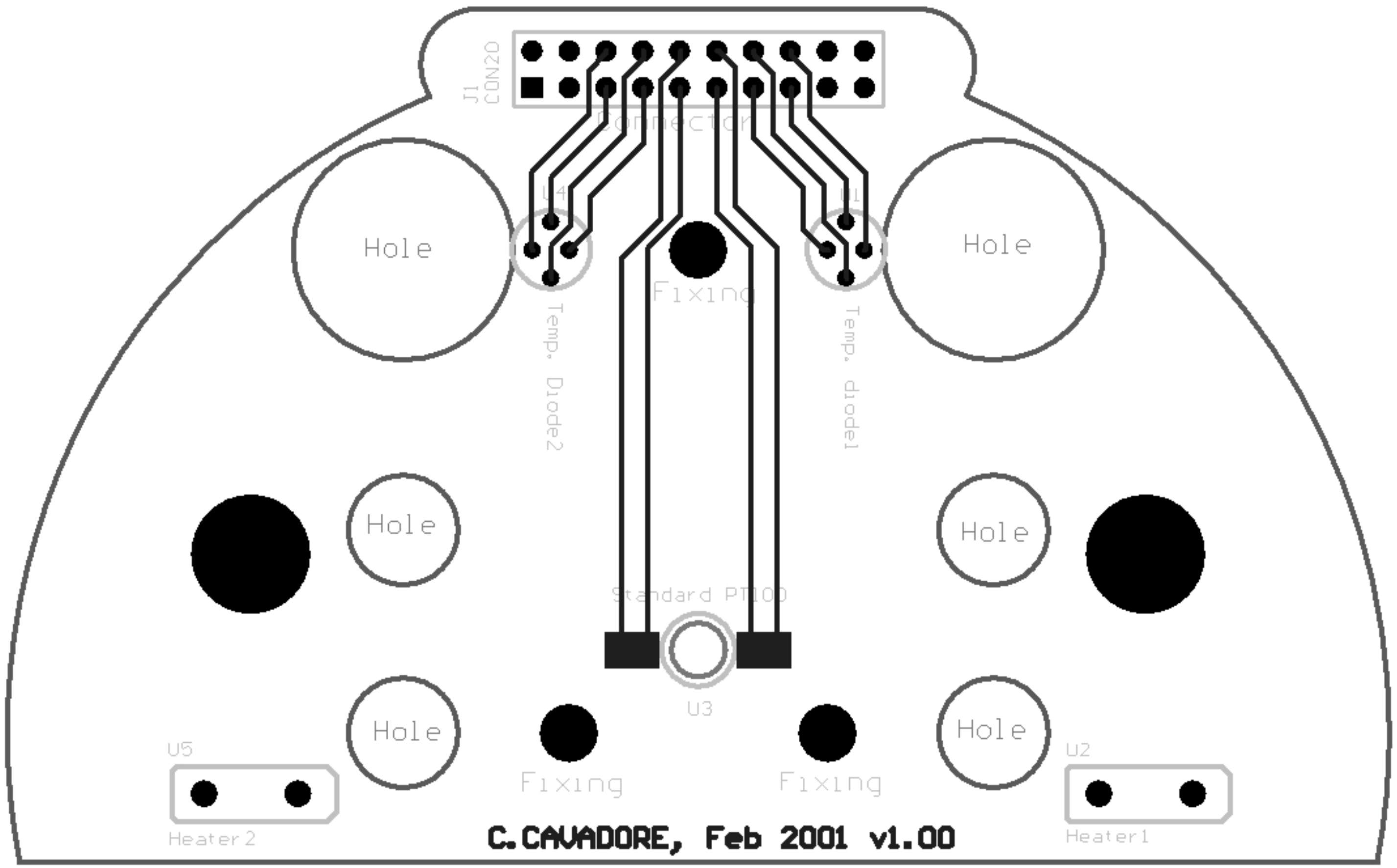


## 6.4 Annexes

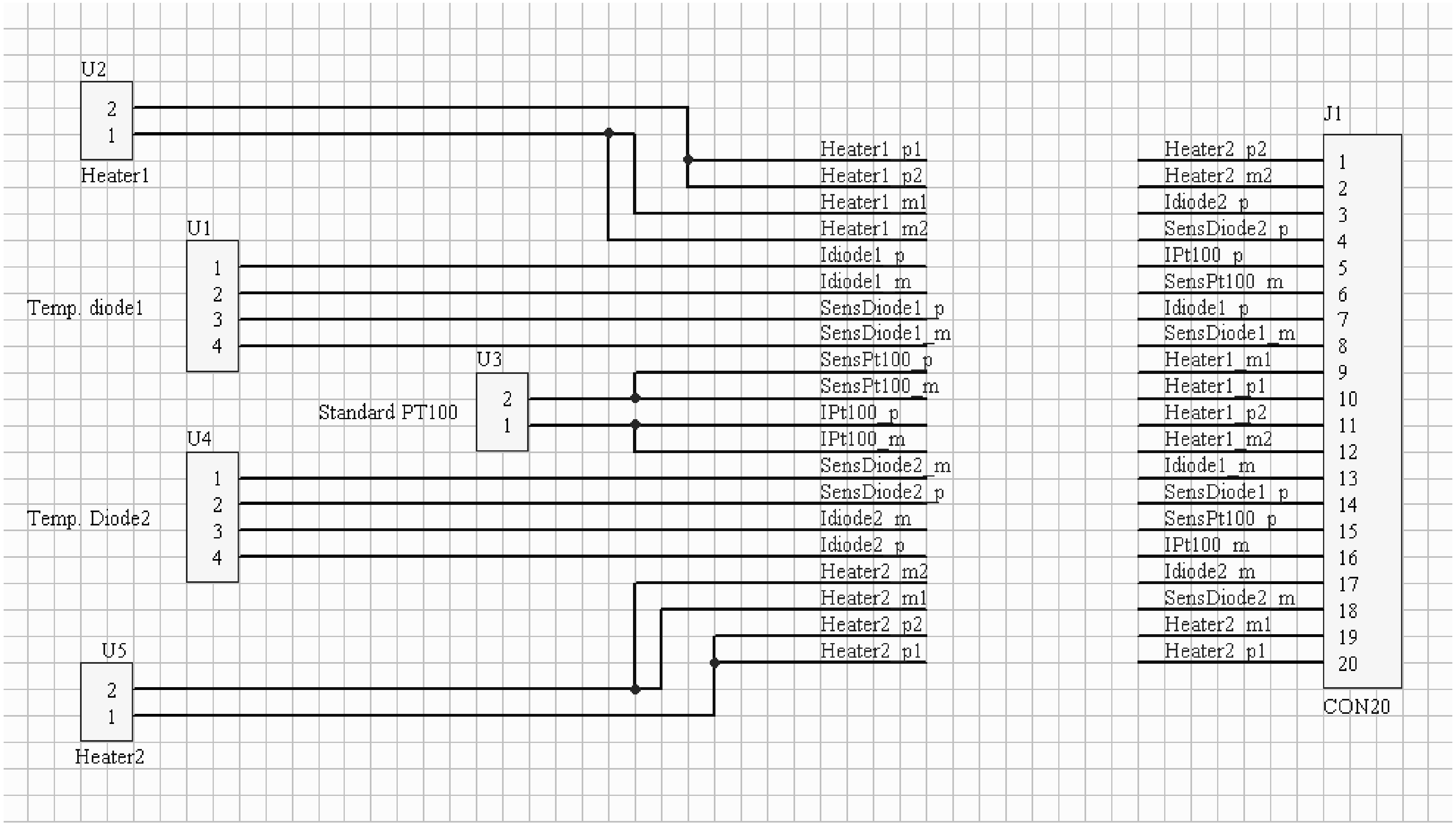
- *Clock cable schematics, from Vessel Flange to FIERA*
- *PCB underneath the CCD table, for two heaters, two temperature diodes and one PT100*
- *Schematics of the CCD table sensors to the 20 pins connector into the detector head*
- *Schematics of the flat-flex cable that goes from the CCD table to the 37 pins vacuum connector*
- *Pulpo to SESO shutter controller cable*
- *Bias cable, from vessel flange to FIERA.*
- *Video cable, from vessel flange to FIERA*
- *Schematics of the PCB at the flange level (Only Pulpo-Lakeshore)*



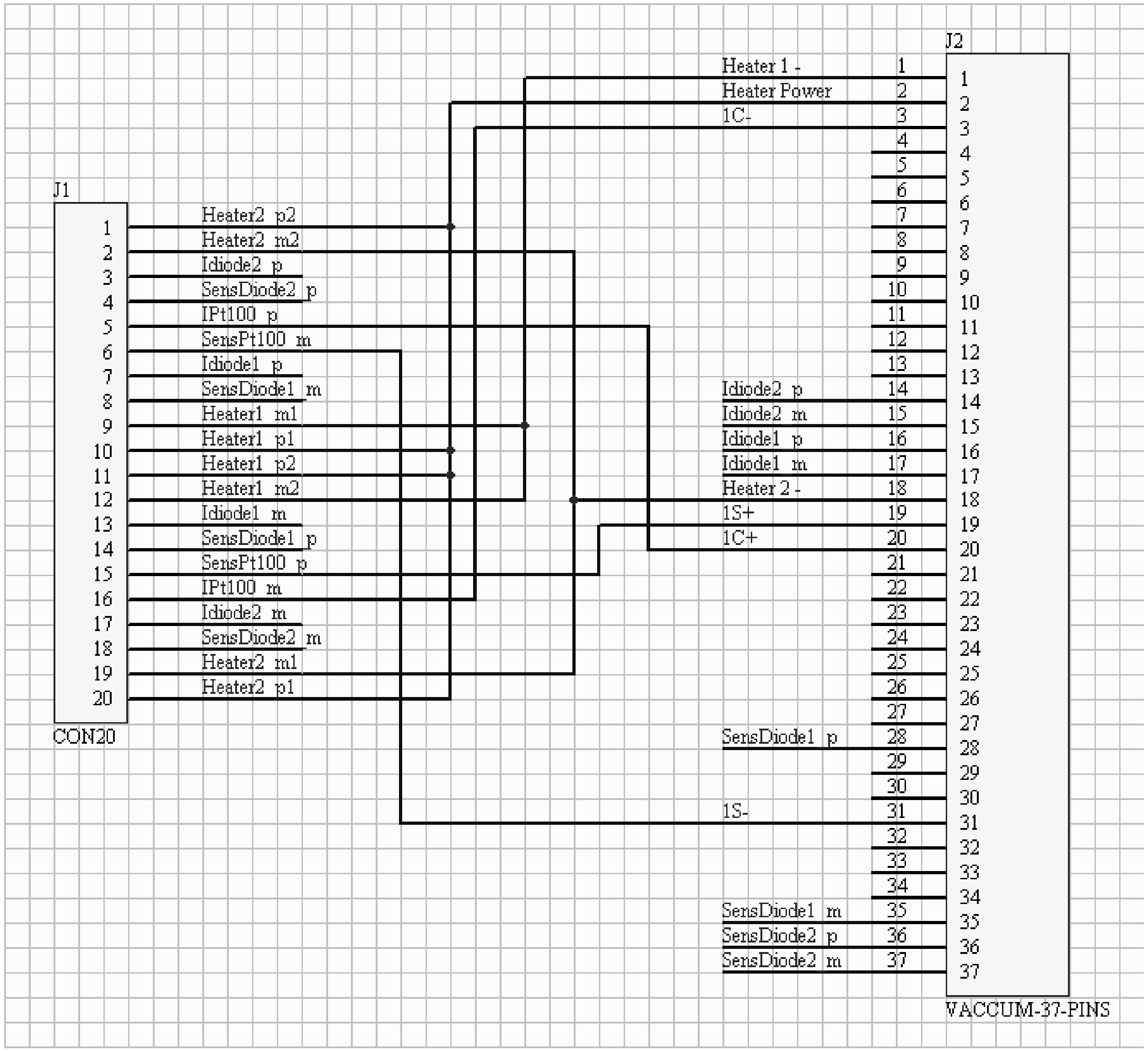

**Clock cable schematics, from Vessel Flange to FIERA**



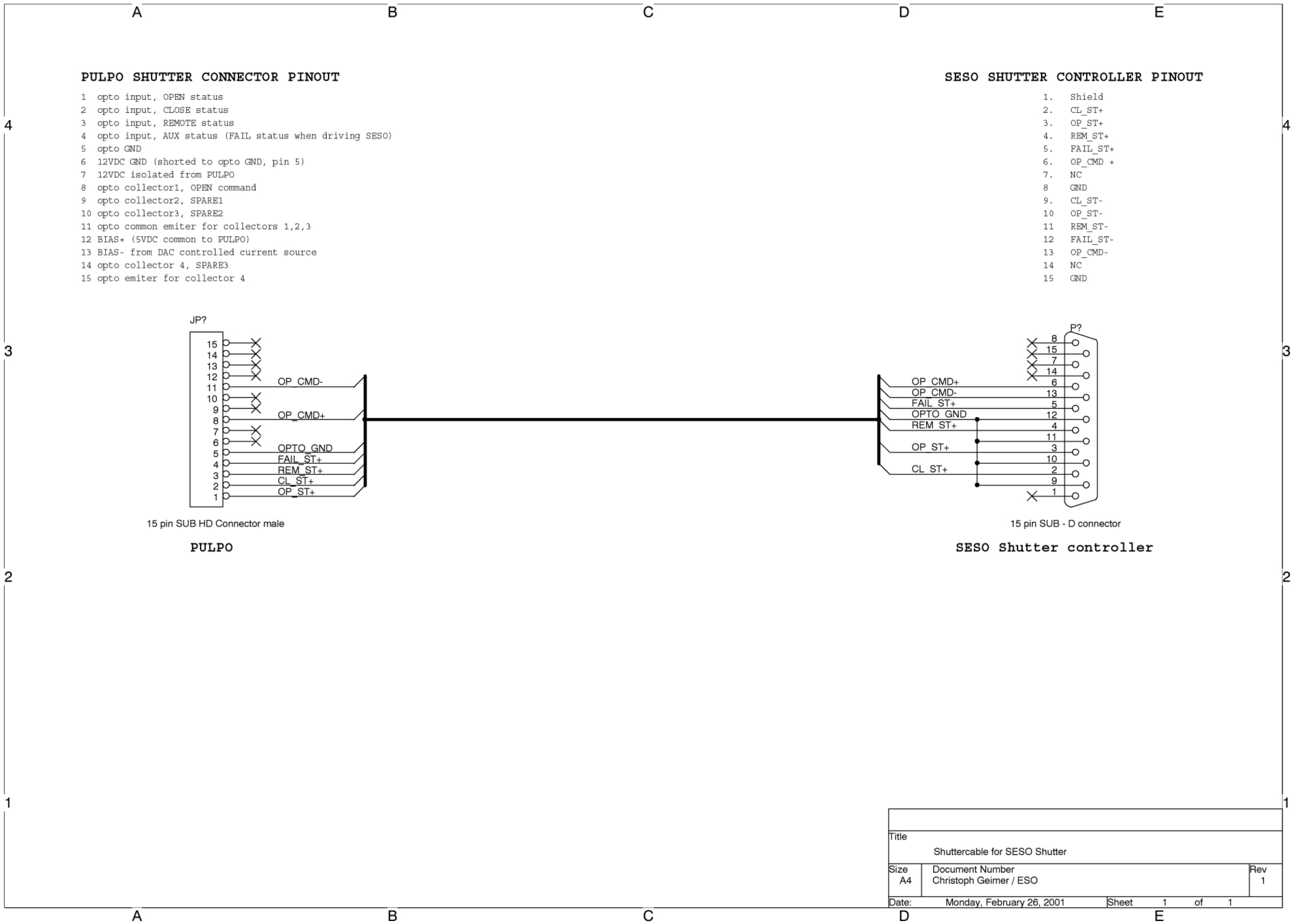

**PCB underneath the CCD table, for two heaters, two temperature diodes and one PT100**



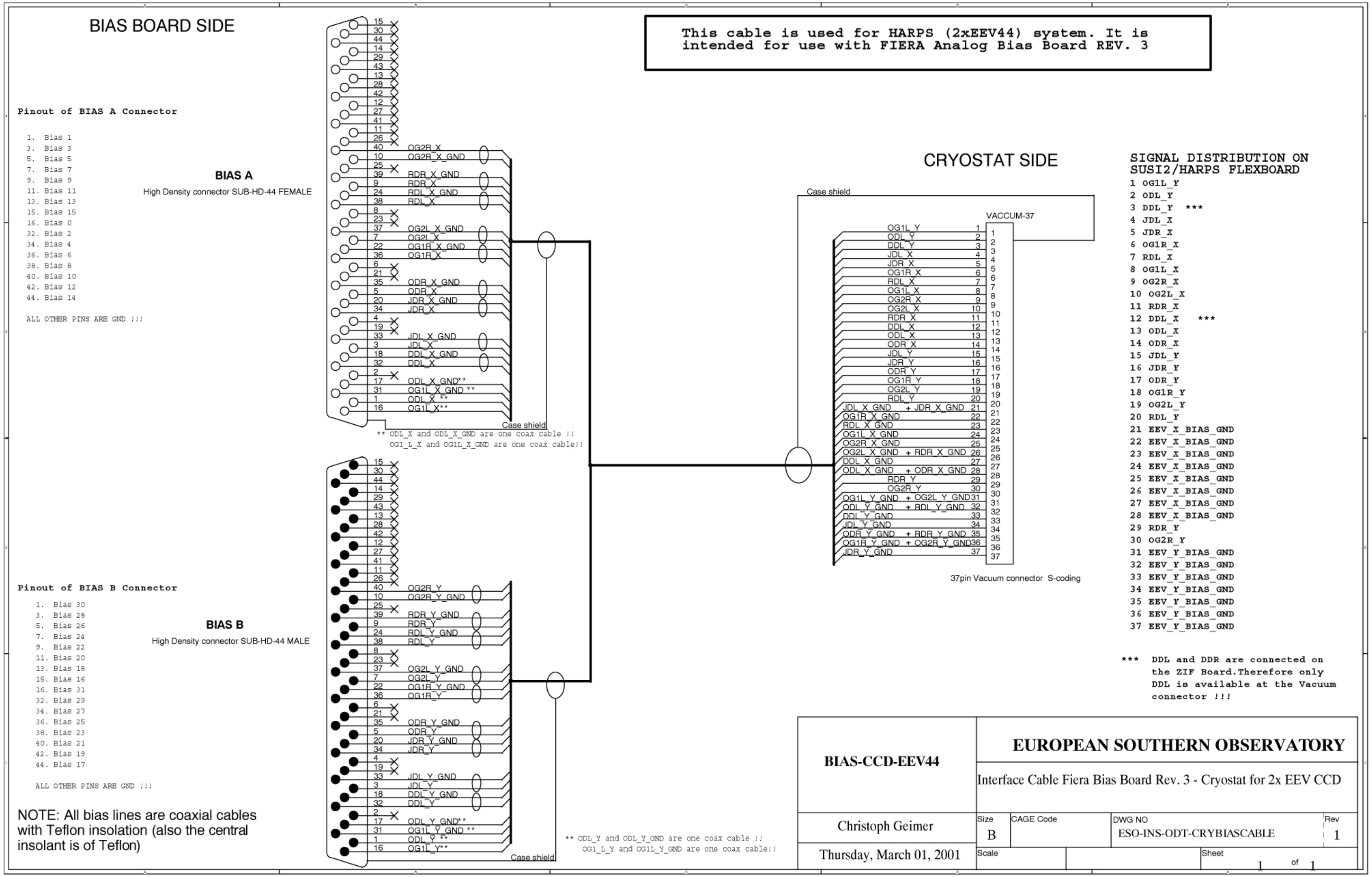

**Schematics of the CCD table sensors to the 20 pins connector into the detector head**



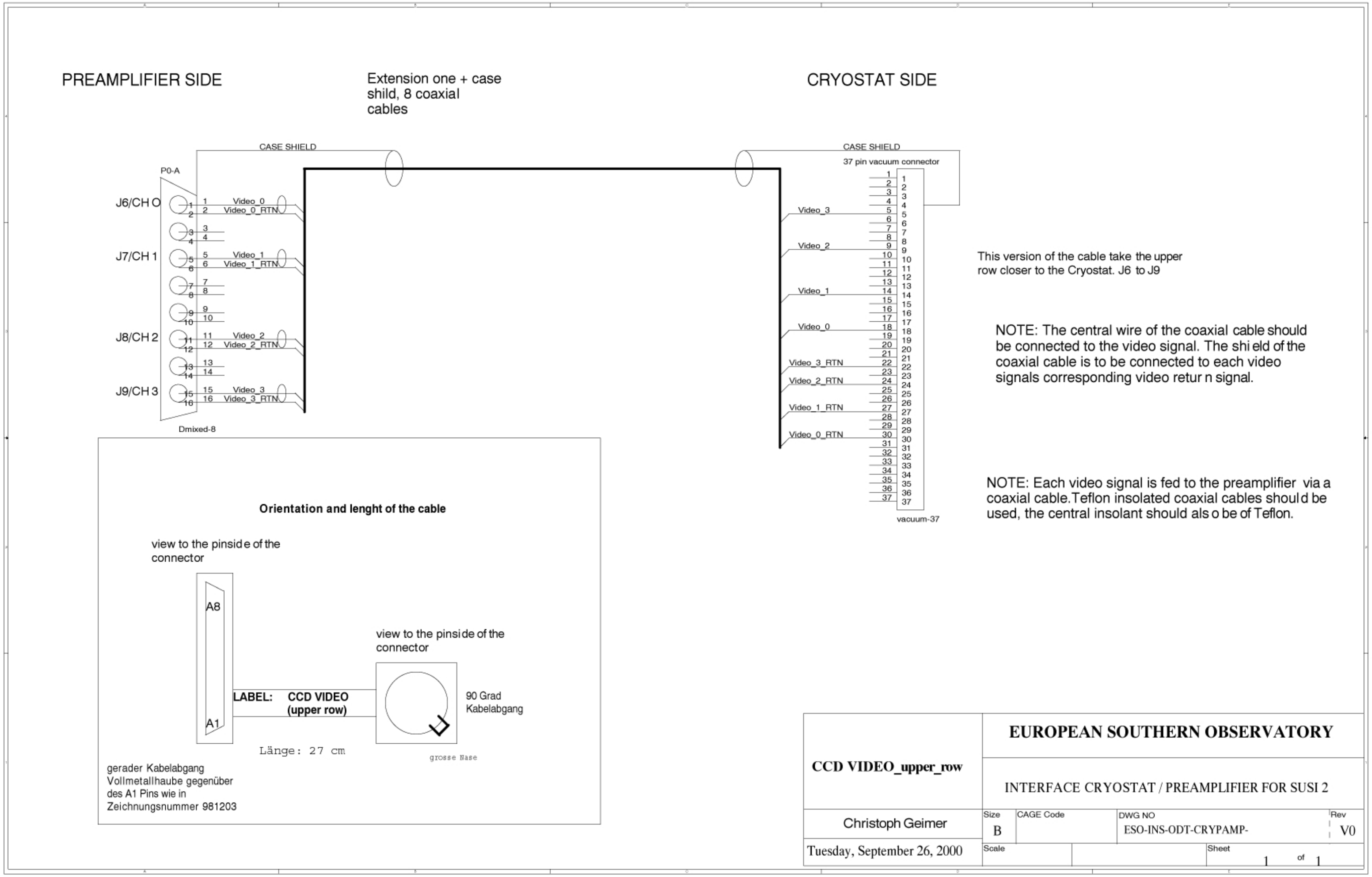

**Schematics of the flat-flex cable that goes from the CCD table to the 37 pins vacuum connector**



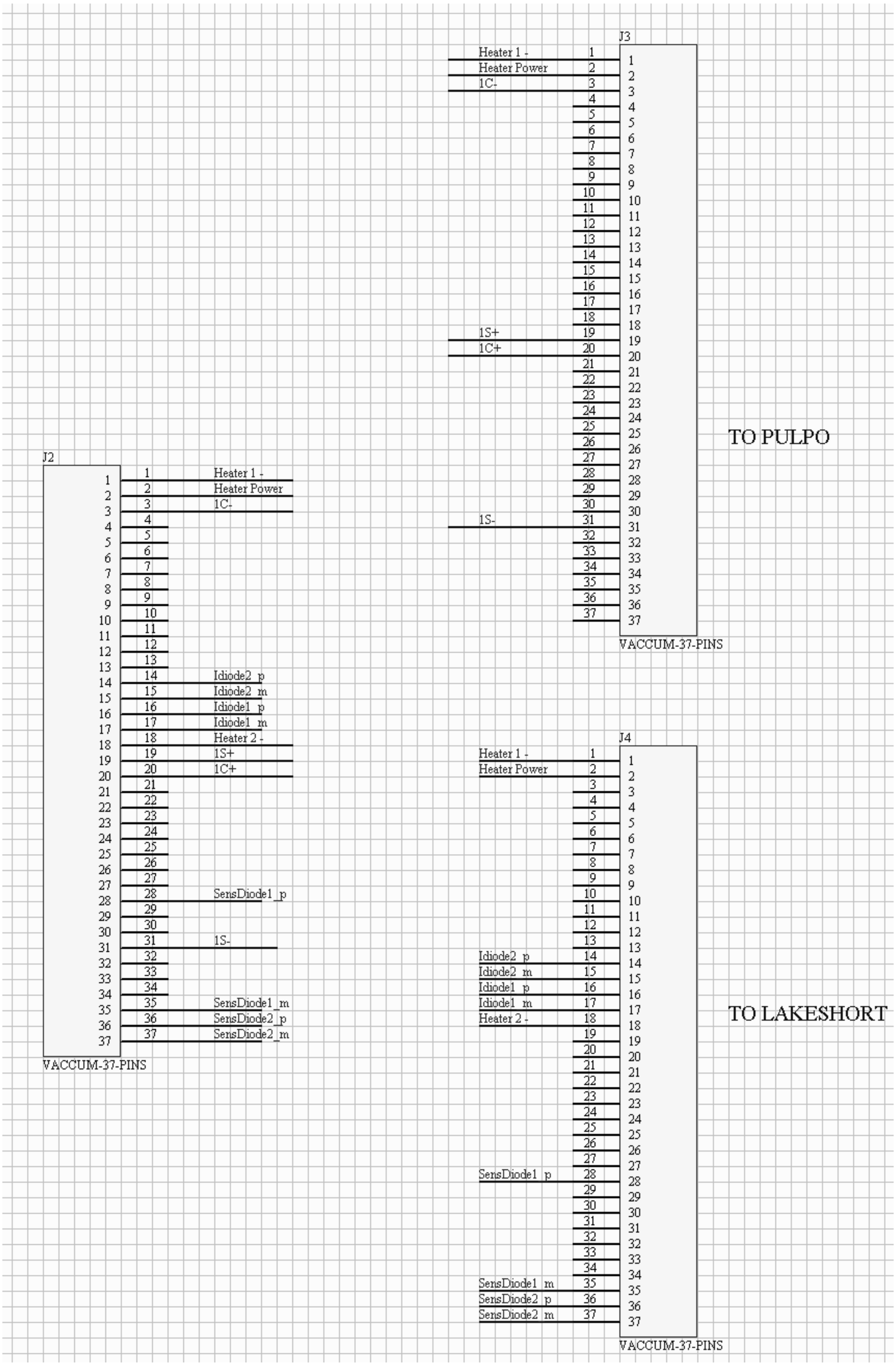

**Pulpo to SESO shutter controller cable**




**Bias cable, from vessel flange to FIERA**




**Video cable, from vessel flange to FIERA.**




**Schematics of the PCB at the flange level (Only Pulpo-Lakeshore)**