TITLE: # LSPE-StrIP: StrIP Integration procedure @ INAF-OAS

DOC. TYPE: Test procedure
PROJECT REF.: LSPE-STRIP-PR-004 **PAGE:** 1,
ISSUE/REV.: 4.1 **DATE:** 13 Jan 2020

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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
1.0	Jan 2019		First issue of the Report	
2.0	June 2019		Second issue: general updates	
3.0	October 2019		Some parts have been modified and other added (general revision)	
4.0	November 2019		Figure 4 updated Test integration flow changed (6.4) Test integration sections added: • 6.4.1 • 6.4.2 Appendix 7 integrated: • Test integration procedures added: 7.1 • Feedthrough descriptions: 7.3 • Harness description: 7.4 • Thermometers and heaters correspondence: 7.7 Integration sheets chapter added: 8 Minor general revision. Reference documents added.	

Sommario

1 REFERENCES

1.1 APPLICABLE DOCUMENTS

REF	DOC ID	TITLE	Release
AD-1.	LSPE-STRIP-PL-002	LSPE-StrIP: Integration and verification Plan	1.4
AD-2.	LSPE-STRIP-SCH-003	Instrument Level AIV Schedule	8.2
AD-3.	LSPE-STRIP-SP-004	LSPE/STRIP naming convention	0.1
AD-4.	LSPE-STRIP-SP-018	STRIP Configuration Item Data List (CIDL)	0.1
AD-5.	LSPE-STRIP-SP-011	LSPE-STRIP: Requirements for the STRIP- LSPE	1.0
AD-6.	LSPE-STRIP-SP-008	Scientific requirements for the W-band channel of the LSPE-STRIP instrument	1.0
AD-7.	LSPE-STRIP-SP-016	Disposition of LSPE-STRIP polarimeters in the focal plane	1.4
AD-8.	LSPE-STRIP-SP-024	LSPE-StrIP: FPU. As-built configuration.	1.0
AD-9.	LSPE-STRIP-SP-019	LSPE-STRIP harness specification	1.0
AD-10.	LSPE-STRIP-SP-020	LSPE-STRIP electronics (specification document)	0.1
AD-11.	LSPE-STRIP-SP-010	LSPE-STRIP Software Specification Document	0.1
AD-12.	LSPE-STRIP-MEM-005	TEMPORARY HK MONITORING SW	1.0
AD-13.	LSPE-STRIP-TN-026	LSPE-STRIP: Filters and cryostat window design	1.0
AD-14.	LSPE-STRIP-ID-001	STRIP W-band Interface Control Document	1.0
AD-15.	TBD	Draft Document from OAC	0.1

1.2 REFERENCE DOCUMENTS

REF	DOC ID	TITLE	Release
REF1.	LSPE-STRIP-RP-021	LSPE-StrIP: Focal Plane Unit Acceptance Test @ OAS-INAF	1.0
REF2.	LSPE-STRIP-RP-016	LSPE-STRIP cryogenic system acceptance tests	1.0
REF3.	LSPE-STRIP-RP-020	FPA Module Location Inspection Report	1.0
REF4.	LSPE-STRIP-TN-022	LSPE-STRIP scientific performance	1.0
REF5.	LSPE-STRIP-RP-017	LSPE-STRIP polarimeters warm acceptance tests	1.0
REF6.	LSPE-STRIP-RP-015	LSPE-STRIP electronics acceptance tests	1.0
REF7.		LSPE-STRIP FPU alignment procedure	0.1
REF8.	TBC	LSPE-STRIP: cryogenic harness design report	1.0
REF9.		Harness Conductivity test	
REF10.			
REF11.			
REF12.			
REF13.			
REF14.			
REF15.			
REF16.			

1.3 ACRONYMS

ACRONYM	
UniMiB	Università di Milano Bicocca
UNI-MI	Università Statale di Milano
OAS	Osservatorio di Astrofisica e Scienze dello Spazio di Bologna
OATs	Osservatorio Astronomico di Trieste
CNR-IEIIT	Istituto di Elettronica e di Ingegneria dell' Informazione e delle Telecomunicazioni - Torino
UdC	Università del Cile
FPU	Focal Plane Unit
ICD	Interface Control Document
ULT	Unit level Tests
GSE	Ground Support Equipment
EGSE	Electric ground support equipment
MGSE	Mechanical ground support equipment
SW	software
PH/SW	Phase switch

2 Scope

Scope of this document is to describe and report the procedure to be used to integrate the StrIP Focal Plane Unit and the cryogenic harness in the StrIP cryostat.

3 Relevant Hardware

3.1 LSPE-StrIP Focal Plane Unit

It includes:

- The StrIP Main frame, assembled with the Q and U polarimeter and with their cryogenic electronic boards.
- The copper thermal straps, providing the main frame and the polarimeters with the thermal links needed to efficiently cool them down to 20K.
- The thermometers and heaters eventually connected to the FPU.

The FPU is provided with a dedicated MGSE permitting to store, hold and rotate the FPU when placed on the integration table.
A special tool to be fixed to the FPU was also provided to attach and move the FPU by the crane bridge. This tool is not part of the FPU and will be used only to move and integrate the FPU.

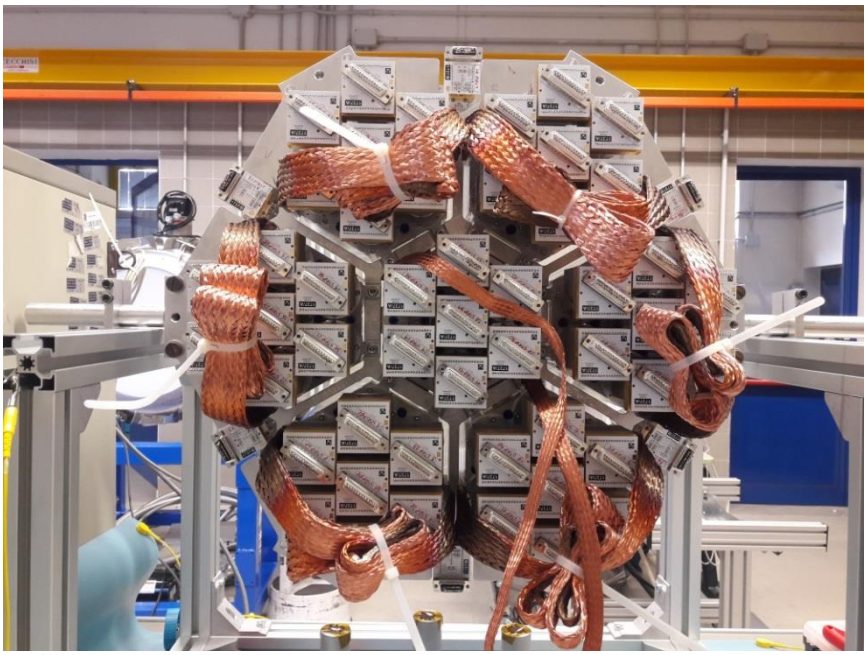


Figure 1 FPU view from the polarimeters: the Copper thermal harness is shown (straps are only temporary bended)

3.2 LSPE-StrIP cryogenic harness

The cryogenic harness is logically organized in two, depending on the function performed.

- Polarimeters harness
- Thermal HK harness

3.2.1 Polarimeters harness

It is aimed at:

- routing the scientific signals (voltage) from the polarimeters to the electronics for processing
- biasing the polarimeters
- readout the housekeeping from polarimeters.

It is was manufactured by "Allectra" [**Errore. L'origine riferimento non è stata trovata.**] and is composed by 3 families of cables, respectively routing signals as shown in the following table:

From	SUB-D	T (K)	To	SUB-D	T (K)
Polarimeters (CONN 1)	25	20	100K shield (CONN 2)	50	100
Shield (CONN 3)	50	100	Shield (CONN 4)	50	100
Shield (CONN 5)	50	100	Feedthrough (CONN 6)	50	300

Table 1 description of the harness routing polarimeters to electric feedthroughs.

3.2.1 Thermal harness

It is aimed at:

- Readout the thermometers placed on the FPU
- Readout the thermometers placed on the cryostat
- Control the heater(s) placed on the cryostat (interface between the cold finger and the thermal straps)

This harness was assembled @ INAF-OAS Bologna; it routes each sensor /heater independently to the feedthroughs. This harness is composed as it follows:

Sensor name	Position	T (K)
TSCX-1	R3-R4 FRONT	20
TSCX-2	V3-V4	20
TSCX-3	B1-B6	20
TSCX-4	G6-G5 SIDE	20
TSCX-5		
TSCX-6		
TSCX-7		
TSCX-8	MF Y6-Y5	20
TSCX-9	MF G4-G5	20
TSCX-10	MF V5-V4	20
TSCX-11	MF O5-I1-Y3	20
TSCX-12	W POL (O-Y)	20
TSCX-13	I5 OMT 28	20
TSCX-14	B2 STRIP-56 POL	20
TSCX-15	STRAP Y (EXT)	100
TSCX-16	Filter Holder (INT)	100
TSCX-17	Filter Holder (EXT)	
TSCX-18	STRAP Y (FPU)	20
TSDT-2	U-Cold head	20
TSDT-3	100K flange	100
TSDT-5	100K shield	100
TSDT-6	MF V1-V6-I3-I4	20

Table 2 Legend: MF= main frame; POL= polarimeter; OMT= OMT; STRAP:= thermal strap

3.3 Cryostat

The StrIP cryostat is fully described in **Errore. L'origine riferimento non è stata trovata.**. Only the interfaces relevant for the integration are summarized here below.

- Cryostat 300K Body
- Cryostat Top
  - Top base
  - Window
  - Top cover
- Cryostat BACK FLANGE
- Filter Holder
  - filter holder base
  - filter holder cover
  - filters
- 20K Ring (mechanical interface between the FPU main frame and the cryostat)
- 100 K shield
- 100K flange
- 20 K U-support
- 300K 140 mm flanges (including the electric feedthroughs)
- 300 K TBC mm flange (vacuum bench)

All the above interfaces and parts are indicated in the picture below.

Apart from the above items, to complete the integration the following items will be needed:

- Vacuum bench (Turbo + scroll pump)
- Thermal controller and monitor (lakeshore)
- Thermal control station
- Pressure control valve

3.4 Electronics

The electronic box, provided with the harness to connect it to the cryostat, is fully described in XXX and includes:

1 custom made RACK (19 inches wide) hosting:

- 7 DAQ + 7 DAC electronic boars
- 1 GPS/Sync board (it can be temporary replaced by an external SYNC unit)
- 1 GPS antenna

The harness cables, long approximately 4m each, are described in the table below:

NAME	NUMBER OF UNITS	FROM	TO
DB50DB25	22	CRYOSTAT	DAQ + ADC
DB50DB25W	6	CRYOSTAT	DAQ + ADC
Bank1-TH2	1	CRYOSTAT	Multiplexer
BanK2-TH1	1	CRYOSTAT	Multiplexer
LS331-TH3	1	CRYOSTAT	Thermal Controller

Table 3 Harness composition

The detailed scheme of the electric connectors is reported in APPENDIX 7.5.

1 temporary sync box:
it works as a backup of the SYNC/GPS board, providing a common time reference to the DAQ boards.

1 Thermal Monitor unit (Lakeshore 224).
It can manage 12 channels simultaneously.

1 Multiplexer unit (custom made).
It permits to switch between the first and the second set of 12 sensors.

1 thermal controller Lakeshore 331.
It permits to manage the PID control (2 sensors + 1 tape heater) and 1 tape heater placed on the 100K shield

1 Gigabit 24 channels switch connected to:

- The StrIP Workstation (1 Ethernet cable)
- The DAQ electronic boards (7 Ethernet cables)

The assembly scheme and procedure is reported in 8.5

3.5 Safety tools

Terminated connectors (electric shorts) are used to prevent polarimeters from damages due to EMC or electric discharges along the wires during the integration.
Before the integration with wires, the polarimeters are terminated by DB-25 terminations, one per polarimeter (49 for the Q- band polarimeters and 6 High density terminations DB-25 for the W-Band polarimeters).
To safely run the integration procedure, they are needed:

- 56 DB-25 FEMALE Terminations (to protect the CONN 0 on polarimeters)
- 28 DB-50 FEMALE Terminations (to protect the CONN 2)
- 28 DB-50 FEMALE Terminations (To protect the 300K feedthrough – external side)

Ground cables are used to prevent the polarimeters from risks of damages:

- **Long Ground cable**: it protects the polarimeters from possible electric discharges caused from the crane bridge during the integration or from handling.
- **Ground cable** it grounds the cryostat when it is still in its position.

The operators wear antistatic bracelets to handle the hardware during the integration phase.

3.6 Auxiliary tools

The following tools are needed for the integration:

- Crane bridge
- Belts to connect the crane bridge to the cryostat
- MGSE for the cryostat
- Trail to move the FPU form the integration table to a position below the crane bridge (for integration)
- Allen keys (full metric set)
- Screwdrivers
- Electric screwdriver
- Gloves
- Isopropyl alcohol
- Acetone (only for metals not treated)
- Antistatic towels
- Aluminium tape
- Kapton tape
- Labels for ID’s
- Thermal grease
- STYCAST or other Epoxy adhesive.

4 Logistics

The integration will be performed in Bologna, at the Cryowaves Laboratory of the Osservatorio di Astrofisica e Scienza dello Spazio, di Bologna (INAF-OAS). The Cryowaves Lab is provided with a crane bridge and with all the tools needed to perform the integration.
The Laboratory is actively conditioned: the temperature is kept around 22 °C and the relative average humidity is kept almost constant at 20%.
An integration table, provided with antistatic mat, is available to safely host and operate the FPU until its integration in the cryostat.
The laboratory host also other projects; the room is shared in a wise that the projects do not interfere each other.
The Cryostat is already mounted on its MGSE allowing to tilt it by 90 degrees and to keep it fixed in the two positions 0° (axis perpendicular to the floor) and 90° (axis parallel to the floor).

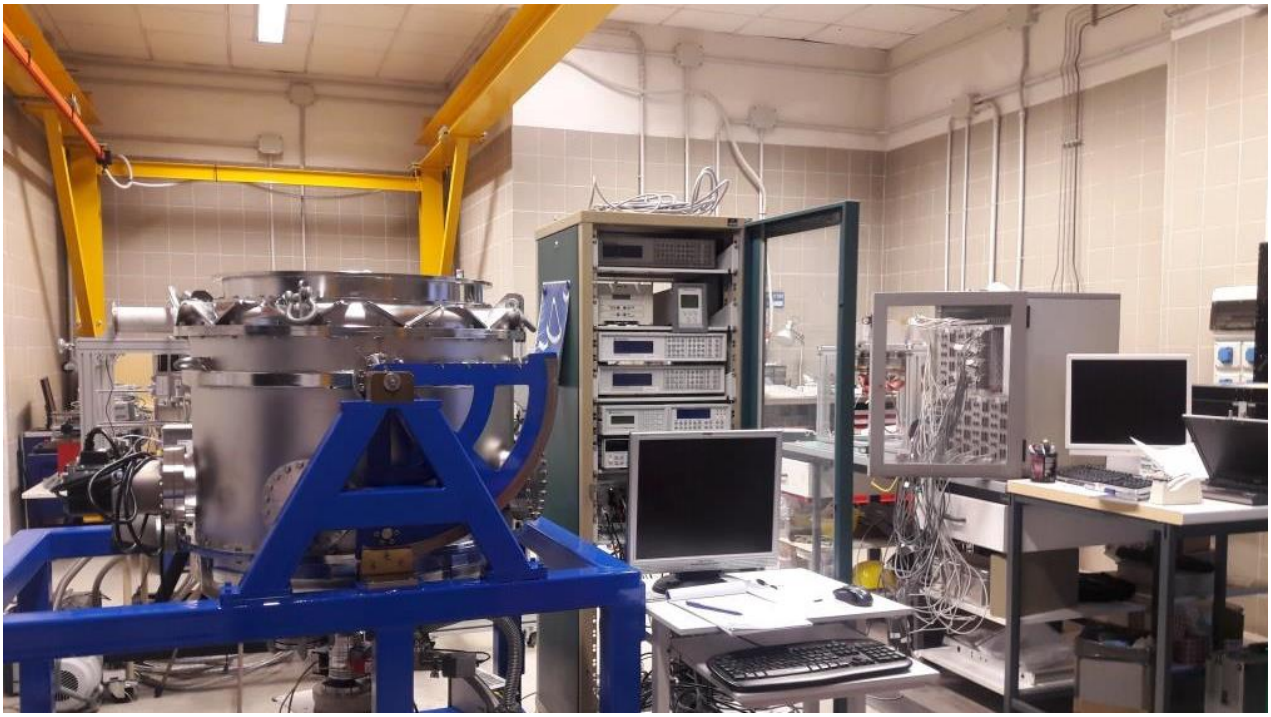


Figure 2 general view of the Cryowaves Lab. StrIP-LSPE cryostat in foreground. Top Left (yellow): the crane bridge, Center: the thermal control shelf; right: the integration and acceptance tests area (the Electronics is visible, grey open shelf) .

5 Responsibilities

5.1 Subsystems

The following table defines the persons responsible of each sub-unit to be integrated.

Subsystem	Responsibility (Node)	Responsibility (person)
FPU & MGSE	UniMi (TBC)	Franceschet
Cryostat & MGSE	INAF-OAS	Morgante
Cryogenic Harness	INAF-OAS	Terenzi
Electronics	UniMiB	Zannoni
Operational Software	OATs	Sartor
Thermometers & Heaters	INAF-OAS	Terenzi
Window & Filters dummy	INAF-OAS	Terenzi
Window & Filters nominal	INAF-OAS	Terenzi / Morgante
Vacuum bench	INAF-OAS	Terenzi / Morgante

Table 4 List of people responsible for subsystems

5.2 Integration phases

The integration will be performed under the AIV and the SE responsibility. In addition, other responsible are defined for specific phases of the integration:

Activity	Personnel
AIV Engineering	F. Cuttaia (OAS)
System Engineering	G. Morgante
Routing & wiring electric harness	L. Terenzi (OAS)
Routing & wiring thermal harness	L. Terenzi (OAS)
Harness integrity check by electronics	F. Cuttaia - L. Terenzi (OAS)
Harness TOP FLANGEacity measurement	S. Baù (UniMiB) - F. Cuttaia (OAS)
FPU alignment in the cryostat	F. Cuttaia (OAS) - F. Villa (OAS)

Table 5 Responsibilities during the integration.

6 Integration Procedure

6.1 Overview

Integration is run following a *Subset Integration* technique. Subsystems are pre-assembled and later integrated in parallel in their utilization order. Following this scheme:

- the FPU is assumed to be fully assembled and successfully verified before starting integration.
- The Cryostat is almost assembled in all its key components and its functionality fully verified before (dry run tests).
- The flex lines shall be routed to the proper compressor.
    - A dry run test can be run before starting the integration, if it fits the schedule.
- The Electric Harness is available and will be fully assembles only step by step during the overall integration.
- The Thermal sensors and heaters will come in part already integrated in the FPU, in part they will be integrated step by step during the overall integration.

6.2 Cleaning

All the subsystems and components to be integrated in the cryostat will be cleaned.
Paper towels are soaked in Isopropyl alcohol and used for cleaning.

They are the main parts to be cleaned:

- Cryostat internal 100K shield.
- 100K filter plate
- 100K cryostat flange
- Focal plane Unit:
  - Q tiles
  - W horns
- Main frame
- Vacuum window
- Filter disk (or filters tiles)
- O-rings
- Patch Heaters
- Thermal harness (evaluate the possibility to use an ultrasonic cleaning bath)
- Electric Cryo harness (TBC)
- Thermal straps

6.3 PARALLEL INTEGRATION

Four sub-systems will be assembled in parallel and then integrated later together.

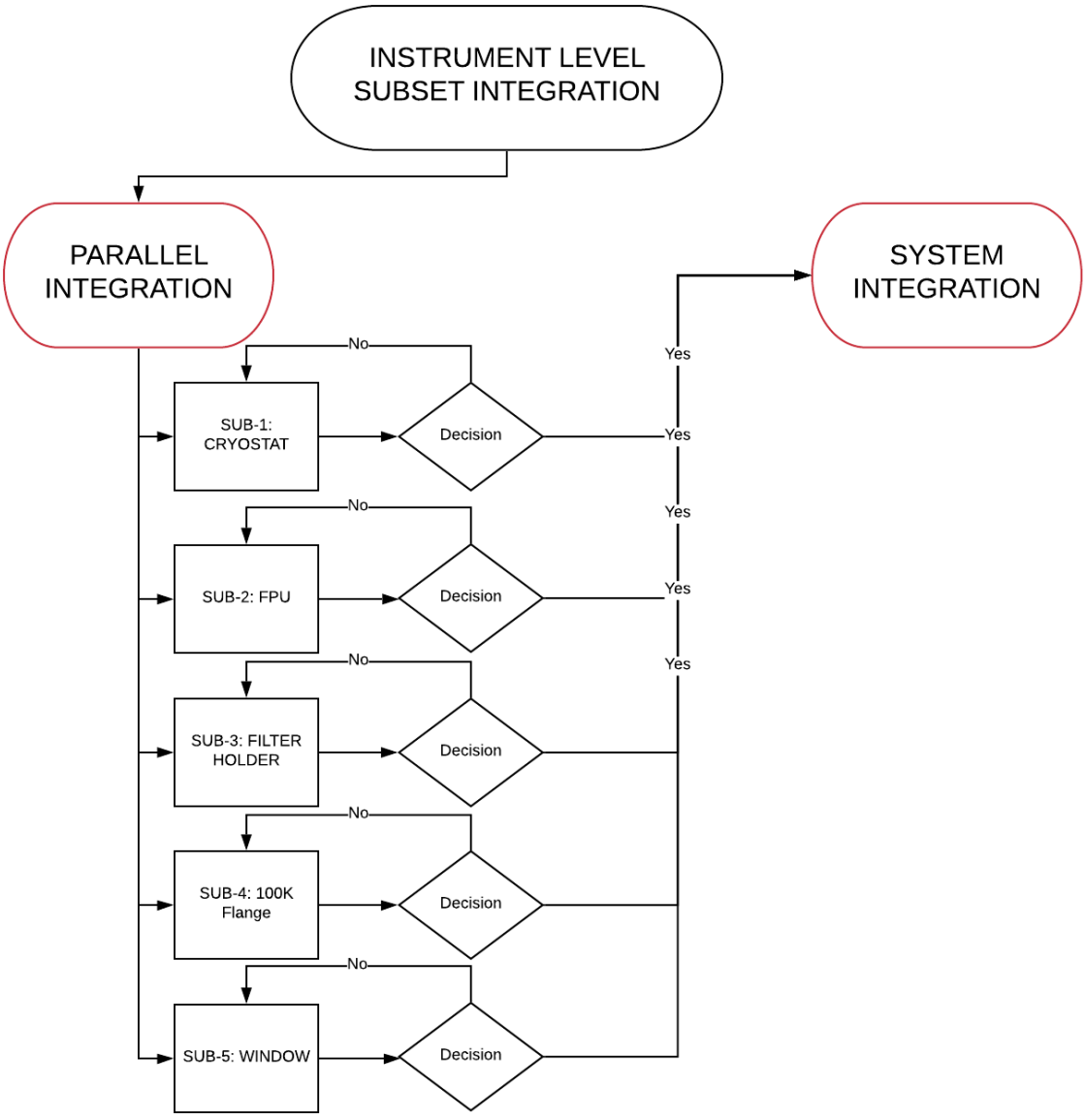


Figure 3 parallel integration flowchart

6.3.1 SUB-1: CRYOSTAT

1-	**Connect the Copper H-FRAME (it replaced the U-shaped Fork foreseen at the beginning) to the cold finger,** by the 8 X M-4 L=15mm screws. Eventually with flared head. **4 SS supports are used to hold the H-frame.**
2-	**Connect the 4SS supports by 1 M8 screw each (keeping the support tight to the ring) and 1 M5 screw (keeping the support tight to the H-frame)**
3-	Electrically test and then connect the heater (114 Ω, < 2A) by Al tape.
4-	Electrically test and then connect the sensor Ts-Cx-18 on the H-Frame at the interface between the Frame and the thermal strap. Use a 2.5 mm / 3mm screw.
5-	Electrically test and then connect the sensor ID (reported in the table) on the 100 K shield. Consider the possibility to glue the sensors
	a. Fix the sensor by aluminium tape. Route wires along the shield to thermalize them.
	b. Thermalize the wires by Al tape, leaving the electric pins free.
	c. Label the terminals of the wires
	d. Glue (TBC) the thermo-fit enclosures of the pins
6-	Dismount the 20K ring (interface between the main frame and the cryostat) 12 X M13 screws are provided to attach the two parts of the 20K ring to each other.
7-	Relax and tighten the 12 screws to center the ring: this operation is performed to get a pre-alignment of the ring w.r.t the 300K shield of the cryostat. The positions measured from the supports to the shield will be recorded.

6.3.2 SUB-2: FPU

8-	Connect the modified thermal straps to the MAIN FRAME. N°# M6 X 20 mm screws are needed (copper thickness=5mm; hole depth = 20mm) . Screws needed to connect straps to the 100K flange: 38 M4 L>10 mm (16 mm typical)
9-	Check the sensors MAP (Figure 4) and define the optimal sequence to connect the polarimeters.
10-	Fix one by one the 15 sensors by the M3 screws , by the Al tape, by STYCAST glue.
11-	Label one by one the 15 sensors.
12-	Connect the 20K harness to the polarimeters (DB 25 connectors) (MOVED FORWARD) (CHECK IF IT IS WORTH DOING THIS OPERATION AFTER THE FPU INSTALLATION)
	~~e. Terminate the 20K harness DB-50 (CONN 2) by the DB-50 terminal provided (28XMALE)~~
	~~f. Remove the DB25 terminal from the 1st polarimeter~~
	~~g. Connect the corresponding 20K harness (CONN 1-a)~~
	~~h. Leave the harness floating~~
	~~i. Remove the terminal from the 'paired' polarimeter~~
	~~j. Connect the paired DB 25 (CONN 1-b) of the 20K harness~~
	~~k. Reiterate the above operations for all the polarimeters following the provided MAP and SEQUENCE.~~
13-	Fix the two circular heaters to the main frame by Al tape.

6.3.3 SUB-3: Filter holder

1- Fix the TWO thermometer: a. CX 16 on the external side of the filter wheel b. CX 17 on the internal side of the filter wheel
2- Route the wire until the Al L-shaped supports on the 100K flange. Add the additional p2p wires extensions.

6.3.4 SUB-4: 100K FLANGE

1- Fix L-shaped Al supports on the 100K flange by screws 32 X M4 L=10 mm using 32 bell washers
2- Fix the connectors CONN X on the L-shaped supports. Dedicated screws are provided (from the connector case) . Tight the screws.
3- Remove the plastic covers
4- Map and label the connectors.
5- Thermalize the wires on the 100K flange by the copper plates; 32 X M4 L=15mm screws are needed.
6- Connect the 100-300K sections one by one:
a. Connect the 1st section to its corresponding connector.
b. Label the section
c. Perform a conductivity test by the electronics (REF9)
d. Measure TOP FLANGE capacity and resistance if possible **(**Superseded: DONE DURING THE HARNESS TESTS)
e. HARNESS is supposed already TESTED PIN TO PIN (REF8)
f. Disconnect the cable
g. Store the cable (identified the cable by its label)
h. Reiterate the process for all the cables

6.3.5 SUB-5: WINDOW

1- The “dummy” temporary window is supposed already mounted : A specific procedure shall be detailed to mount the nominal window

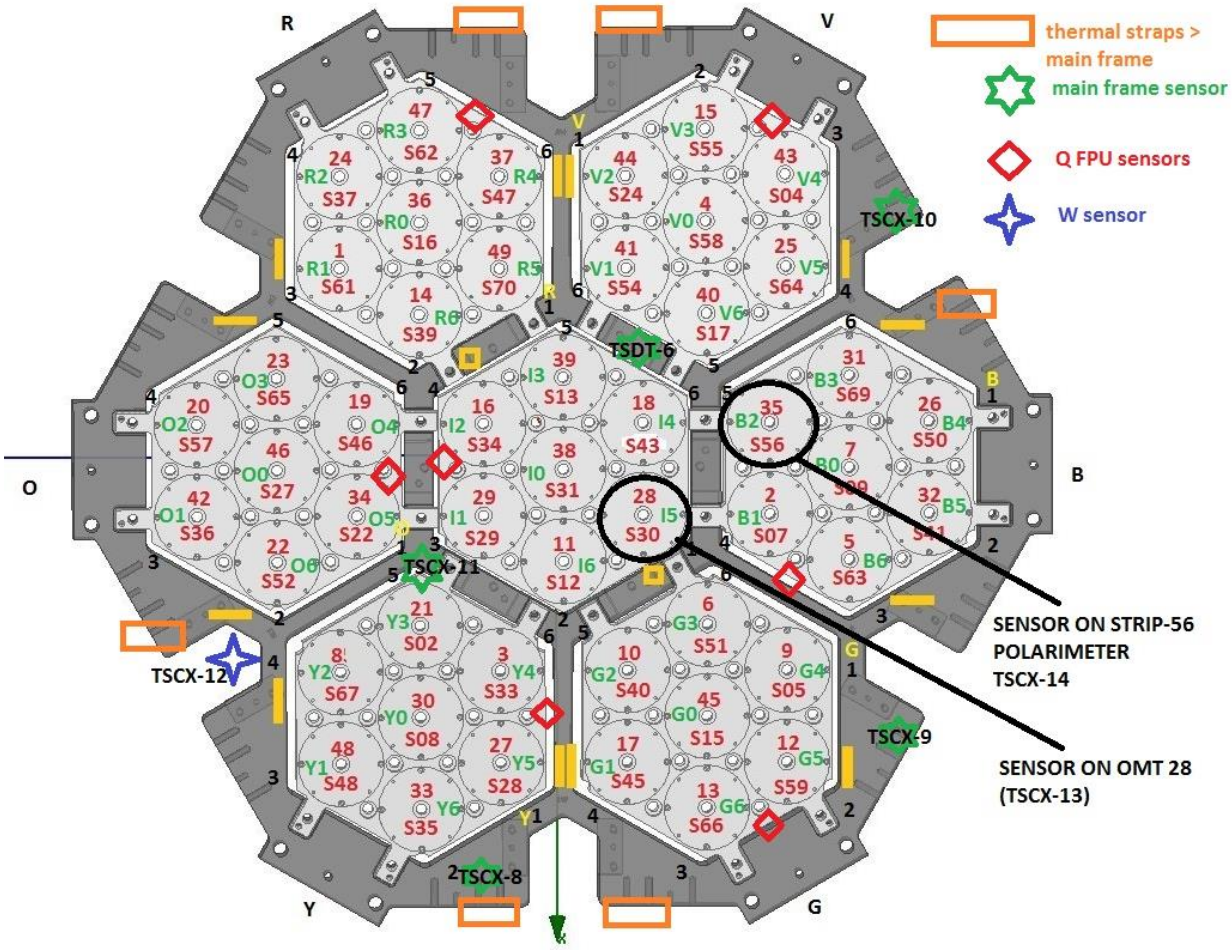


Figure 4 SENSORS AND THERMAL STRAPS MAP. In addition to the displayed sensor, they are present the following sensors:

1. **TSCX-15: on the thermal strap (100K side, in correspondence of TSCX-8)**
2. **TSCX-18: on the H FRAME (20K side, in correspondence of TSCX-8)**
3. **TSCX-16, TSCX-17: on the filters holder**
4. **DT2: on the cold head**
5. **DT3: on the 100K flange**
6. **DT5: on the 100K shield**

6.4 SYSTEM INTEGRATION

The parallel integration is assumed completed. The following steps will be performed in the same sequence as reported below.

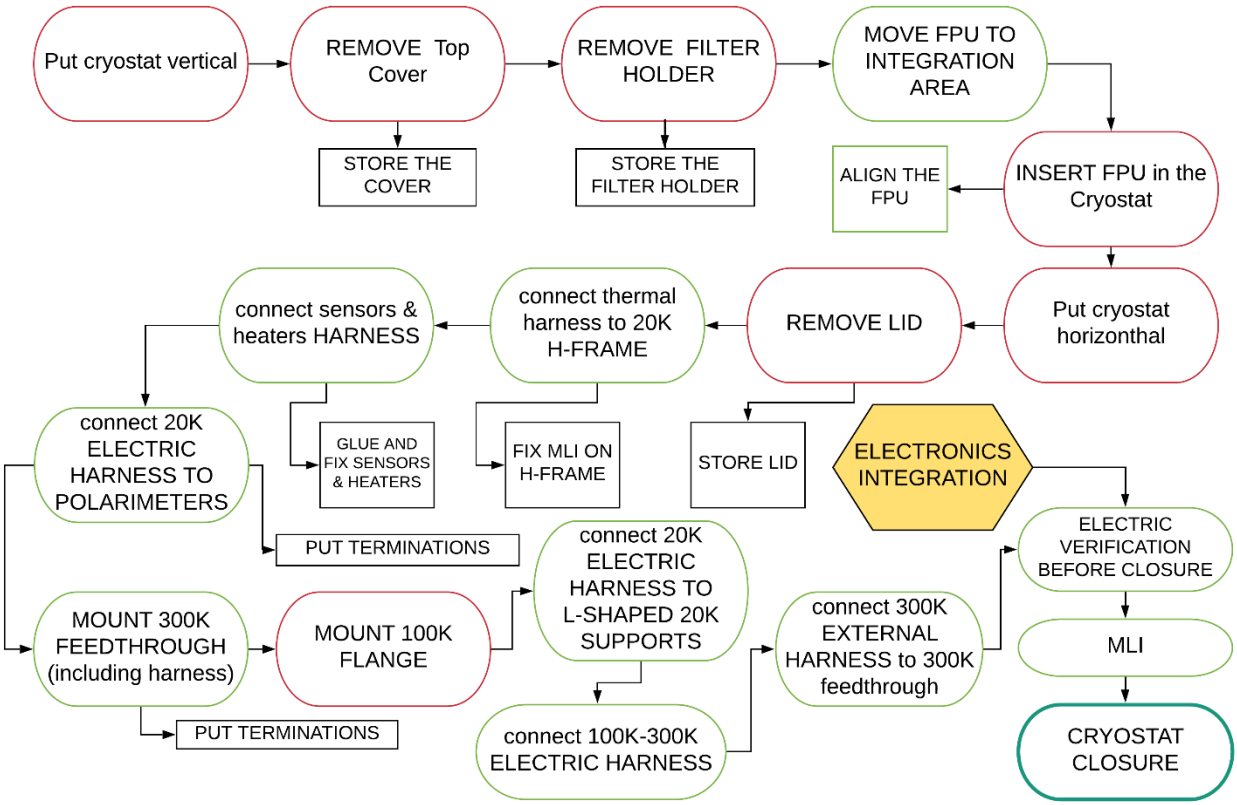


Figure 5 System integration activities: workflow (notes in the grey-blue inset)

6.4.1 FPU INTEGRATION

START	CRYOSTAT POSITION	TOP FLANGE	BACK FLANGE	100K FLANGE
	VERTICAL	YES	YES	NO

1- Starting form vertical position, remove the TOP FLANGE. To do this:	
a.	Use Crane Bridge (CB)
b.	Fix belts to the cover.
c.	Remove the cover and store it on a trailer having care of the window.
d.	Disconnect the belts and keep the CB back to the cryostat.

2- Starting form vertical position, remove the FILTER HOLDER. To do this:	
a.	Use Crane Bridge (CB)
b.	Fix belts to the HOLDER.
c.	Remove the holder and store it on a trailer: filters are not present at this stage.
d.	Disconnect the belts and keep the CB back to the cryostat.

3- FPU-RING PRE ALIGNEMENT	
a.	Perform a pre-alignment of the Stainless-Steel ring aimed at supporting the FPU by a Calliper (the procedure to be followed is described in APPENDIX 7.1

4- Move the FPU in the CB operational area. To do this:	
a.	Move the FPU wooden transport box close to the integration table
b.	Translate the FPU with its MGSE on the transport box (2 persons MIN are needed)
c.	Move the transport box in the crane bridge area
d.	Relax the FPU-MGSE brakes to rotate the FPU: put it horizontal (Feeds mouth up) and fix.
e.	Handle the thermal and electric harness carefully.

5- Lift the FPU by the CB. To do this:	
a.	Fix the FPU transport X-tool by its supports
b.	Connect the X-tool to the CB by the belts.
c.	Verify the mounting scheme of the FPU in the cryostat (RGB modules vs NORTH)
d.	Preload the CB and slightly lift the FPU up
e.	Disconnect the FPU from its MGSE

6- Insert the FPU in the cryostat by the CB. To do this:	
a.	Lift the FPU by the CB
b.	Keep it as high as to prevent collisions with the other objects in the laboratory.
c.	Use hands to help the FPU to get the vertical above the cryostat.
d.	Align the FPU correctly w.r.t the cryostat.
e.	Lower the FPU down into the cryostat driving the thermal and electric harness carefully into the cryostat until it touches the 20K Ring.
f.	Fix the FPU to the 20K Ring by its screws

7-	**Starting form vertical position, put the cryostat horizontal. To do this, follow the procedure described in** APPENDIX **Errore. L'origine riferimento non è stata trovata.** to move the cryostat when the TOP FLANGE (and eventually the BACK FLANGE) are dismounted**:**
a.	Use Crane Bridge (CB)
b.	Connect the belts to the BACK FLANGE and put the cryostat in tension along the vertical of the CB.
c.	Unfix the cryostat acting on the MGSE brake system.
d.	Rotate the cryostat to horizontal
e.	Fix the cryostat horizontal by the brake system
f.	Disconnect the CB.

8-	**Starting from the horizontal position, open the BACK FLANGE. To do this:**
a.	Use Crane Bridge (CB)
b.	Fix belts to the BACK FLANGE.
c.	Preload the CB and slightly lift the BACK FLANGE up
d.	Unscrew the BACK FLANGE, keeping at least 4 screws tighten.
e.	Relax the horizontal s
f.	Remove the BACK FLANGE and store it (verify that enough room is available)
g.	Disconnect the belts and keep the CB back to the cryostat.

9-	**FPU ALIGNEMENT / METROLOGICAL CHARACTERIZATION**
a.	Run the procedure described in APPENDIX 7.1.2

STOP	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	YES	YES	NO

6.4.2 THERMAL LINKS CONNECTION

START	CRYOSTAT POSITION	TOP FLANGE	BACK FLANGE	100K FLANGE
	HORIZONTHAL	**NO**	**NO**	NO

10- Starting from the horizontal position, connect one by one the thermal copper straps to the H-shaped copper frame. To do this:

a. Cut the copper thermal straps to get the exact length permitting to tighten the straps between the FPU and the copper frame. Before cutting a strap, enclose it in a plastic envelope to prevent the contamination of the cryostat from copper residues.
b. Fix the thermal straps to the U-20K rectangular H FRAME; 3 M4 screws and Bolts (7mm) shall be used to fix and secure the rectangular copper clamps provided; Three holes shall be used per clamp. The central screw shall pass through the copper strap.
Keep the electric thermal harness floating during this operation.
Repeat this procedure until all the straps will be connected.

11- Shield the copper straps by superinsulation.

a. Cut a piece of Single Layer Insulation (SLI) having about the same length of the copper strap to be shielded and approximately 10 cm wide.
b. Put at the extreme sides of the longest edge two pieces of Aluminium tape
c. Attach the tape to the copper strap
d. Wrap the SLI around the strap
e. Poorly tighten the SLI and fix it by 3 pieces of Kapton tape.

STOP	CRYOSTAT POSITION	TOP FLANGE	BACK FLANGE	100K FLANGE
	HORIZONTAL	NO	NO	NO

6.4.1 (ELECTRIC) THERMAL HARNESS ROUTING

START	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	NO

12- Route the electric thermal harness around the H copper frame, toward the NORTH side of the cryostat	
a.	Check the sensors distribution on the map
b.	Duplicate the flag reporting the name of each sensor and tape the second sign on the corresponding wires of the flat cable
c.	Unplug the 4 pins corresponding to the first sensor
d.	Route the 4 wires from the sensor to the north side of the cryostat, minimizing its interference with the polarimeters. Attach the wires in a few points on the H-frame by Kapton tape to avoid a direct contact between the wires and the H-frame
e.	Connect the unplugged 4 pins of the sensor to the corresponding pins of the flat cable (name and colour)
f.	Repeat this procedure for all the sensors
g.	**Group the wires per connector by plastic bands**

STOP	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	NO

6.4.2 ELECTRIC POLARIMETERS HARNESS CONNECTION TO THE FPU

START	CRYOSTAT POSITION	TOP FLANGE	BACK FLANGE	100K FLANGE
	HORIZONTAL	NO	NO	NO

13- Connect the 20K harness to the polarimeters (DB 25 connectors)	
a.	Terminate the 20K harness DB-50 (CONN 2) by the DB-50 terminal provided (28XMALE)
b.	Remove the DB25 terminal from the 1st polarimeter
c.	Connect the corresponding 20K harness (CONN 1-a)
d.	Leave the harness floating inside the H frame (for the south tiles) or suspended (attaching the short connectors by elastic binders) for the North tiles.
e.	Remove the terminal from the 'paired' polarimeter
f.	Connect the paired DB 25 (CONN 1-b) of the 20K harness: be careful of the P1 , P2 matching (follow the scheme reported in §7.3)
g.	Reiterate the above operations for all the polarimeters following the provided MAP and SEQUENCE (Table 6)
h.	**Group the wires per tiles by plastic bands**

STOP	CRYOSTAT POSITION	TOP FLANGE	BACK FLANGE	100K FLANGE
	HORIZONTAL	NO	NO	NO

ORDER	TILE
1	**O**
2	**Y**
3	**R**
4	**V**
5	**I**
6	**B**
7	**G**

Table 6 electric harness: filling order

6.4.1 ELECTRIC (POLARIMETERS & SENSORS) HARNESS CONNECTION TO THE 100K FLANGE (VACUUM SIDE)

START	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	NO

14- Mount the 100K flange containing the L-shaped supports including the SUB-D 50 connectors.	
a.	Keep the screws of the 100K flange close to the cryostat.
b.	two persons are needed.
c.	Put the 100K flange (with its trail) close to the working area of the CB
d.	Connect the belts to the lifting eyebolts and to the CB
e.	Put the 100K flange close to the cryostat
f.	Fix the screws, starting from top left, to make the flange turn around a point to align all the holes. The Flange must be pushed toward the cryostat to get a tight coupling; turn the screws (starting from the 4 placed at N, S, E, W).
g.	Turn the remaining screws: the torque to be applied is: < 2 Nm

15- Connect the 20-100 K Electric (polarimeters) harness. To do this:	
a.	Keep the 20-100K harness out of the 100K flange aperture. The harness is terminated by the DB50 protection terminals.
b.	Take the first DB-50 connector and check its position on the L-100K supports
c.	Remove the DB-50 terminal from the floating connector (CONN-2) at point b.
d.	Terminate the connector CONN-4 of the corresponding 100K harness.
e.	Connect CONN-2 to CONN-3
f.	Repeat the same operation from “b” to “e” for the remaining 3 connectors of the 1st module.
g.	Repeat the same operation for the 4 connectors of the remaining 6 modules.

16- Connect the Electric (Sensors) harness to the L-supports. To do this:	
a.	Check the sensors distribution on the map
b.	Connect the SUB-D connectors to the three (North) DB-50 on the L-supports
c.	**Optional** (in case it was needed for some sensors remained unplugged) : Connect the 4 pins from each sensor to the corresponding pins from each connector (name and colour)

STOP	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	**YES**

6.4.1 ELECTRIC HARNESS CONNECTION TO THE 100K FLANGE (AIR SIDE)

START	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	**YES**

17- Put the cryostat vertical	
a.	The procedure is described in APPENDIX 7.1.4

18- Connect the 100-300 K Electric harness. To do this:	
b.	Check the "connectors vs flange" MAP (APPENDIX 0)
c.	Find the position on the flange of the first wire/connector to be attached following the mounting sequence provided in APPENDIX 7.4.2.
d.	Dismount the 1st "300K 140mm" blind flange.
e.	Take the 1st 300K 140mm feedthrough flange
f.	LABEL the connectors basing on the connectors MAP
g.	PUT the gasket O-RING on the flange (> 4 ORINGS ARE NEEDED)
h.	Connect CONN-6 to the feedthrough FT-1
i.	Terminate the FT-2 by the DB-50 short
j.	Repeat the same operation for all the connectors of the same flange.
k.	Mount the flange in its position **POORLY FIXING THE SCREWS** (to prevent from damaging the GASKET ring). Two operators are needed to run this procedure: one holds the flange keeping it close to the corresponding feedthrough; the second operator facilitates the routing of the connectors and wires between the 300K external shield and the 100K internal shield. **Eventually,** the flanges can be all prepared before starting to assemble and screw them to the feedthrough, keeping them on a table. Assembly can be performed in a second step.
l.	FIX THE FLANGE BY ITS SCREWS (**VERY LOOSE**)
m.	Repeat the above procedure for the remaining 3 FLANGES

19- Terminate the external (air side) feedthrough connectors of the "300K 140mm" flanges before connecting the SUB-D to the connector on the 100K flange. To do this:	
n.	Take the XALE SUB-D 50 shorts.
o.	Remove the short from the SUBD-50 connector on the L-support (air side)
p.	Terminate the connector(s) on the external of the 300K flange
q.	Connect the 100K-300K harness connector to the SUBD-50 connector on the L-support (air side)
r.	Repeat it for all the connectors of the same flange
s.	Repeat the above steps from for the remaining 3 300K feedthrough flanges.

STOP	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	VERTICAL	NO	NO	YES

6.4.2 ELECTRIC VERIFICATION BEFORE CLOSURE

	CRYOSTAT POSITION	TOP FLANGE	BACK FLANGE	100K FLANGE
START	VERTICAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	YES (**LOOSE**)

20- Check the electric connections (polarimeters) using the temporary electric harness
a. Open the FT map (FT flanges vs Electronic board) APPENDIX 0
b. Connect the grey cables to the
c. Connect one by one the grey cables to the DB25 to DB50 adapters
d. Remove the short from the SUB-D 50 connector (on the feedthrough)
e. Connect one by one the grey cables to the SUB-D 50 connector (on the feedthrough)

21- Check the electric connections (thermometers)
f. By a multimeter: measure p2p the electric parameters accessing the pins on the corresponding FT flange
g. Compare to values measured before the integration

22- Check the electric connections (heaters)
h. By a multimeter: measure p2p the electric parameters accessing the pins on the corresponding FT flange
i. Compare to values measured before the integration

	CRYOSTAT POSITION	TOP FLANGE	BACK FLANGE	100K FLANGE
STOP	VERTICAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	YES (**LOOSE**)

6.4.3 TOP FLANGE (WITH WINDOW) INTEGRATION

START	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	VERTICAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	YES (LOOSE)

23- Put the cryostat horizontal
a. The procedure is described in APPENDIX 7.1.4

24- Integrate the window
b. The procedure is described in APPENDIX 0

STOP	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	YES (LOOSE)

6.4.4 CRYOSTAT CLOSURE

START	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	YES (LOOSE)

25- Integrate the BACK FLANGE
a. Keep the O-RING and spread some vacuum grease over.
b. Fit the O-RING
c. Integrate the Back-Flange: the integration procedure is described in APPENDIX 0

STOP	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	YES (LOOSE)

6.4.1 TIGHTEN THE VACUUM FEEDTHROUGH FLANGES

This procedure shall be run only when it will be clear that the instrument was properly integrated and the cryostat will not require any internal arrangement unless a failure occurs.

<u>BE CAREFUL</u>: Once the screws of the vacuum flanges have been tightened, the GASKET will be deformed and it will not be possible to reuse it.

START	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	YES (LOOSE)

26- Complete the integration of the FT vacuum flanges
d. Keep the SUB-D connectors shortened
e. Tight in turn the 20 opposite screws of one flange (a 13 mm socket wrench is needed). The torque to be applied is 18 Nm
f. Repeat the procedure for the remaining 3 flanges

STOP	**CRYOSTAT POSITION**	**TOP FLANGE**	**BACK FLANGE**	**100K FLANGE**
	HORIZONTAL	NO	NO	YES
	HARNESS 20-100	**HARNESS 100-100**	**HARNESS 100-300**	**FT FLANGES**
	YES	YES	YES	**YES (TIGHT)**

7 APPENDIX

7.1 PROCEDURES

7.1.1 pre-align the FPU and tighten the SS ring

A pre-alignment of the SS Ring supporting the FPU is performed before the integration of the FPU in the cryostat.
The procedure consists in measuring the distance of the ring from the 300K inner wall of the cryostat, by a calliper.
The distance shall be measured in correspondence of the SS supports holding and tensioning the FPU. Each support can be tensioned or relaxed by two hexagonal screws. The SS ring shall be centred acting simultaneously on diametral opposite supports: one shall be tensioned, the opposite shall be relaxed.
The aim is to centre the ring within 1 mm (maximum discrepancy between all the 6 points measured).
Two 10 mm wrenches are needed to operate the hexagonal supports (acting simultaneously on the hexagonal screw and on the bolt).

This procedure is run when the FPU is NOT integrated in the cryostat; The cryostat is VERTICAL.	
a.	Slightly tension the ring acting on the 6 supports
b.	Act simultaneously on two hexagonal screws of each support and on the two backing bolts.
c.	Measure the distance L by a calliper
d.	Act on the diametral opposite support to equalize the L distances
e.	Repeat steps form b to d in turn for the remaining diametral opposite supports.
f.	Try to simultaneously improve the equalization between all the supports.
g.	By two wrenches, act on the two bolts backing each hexagonal screw to improve the tightening. Be careful to not damage the plastic washers.

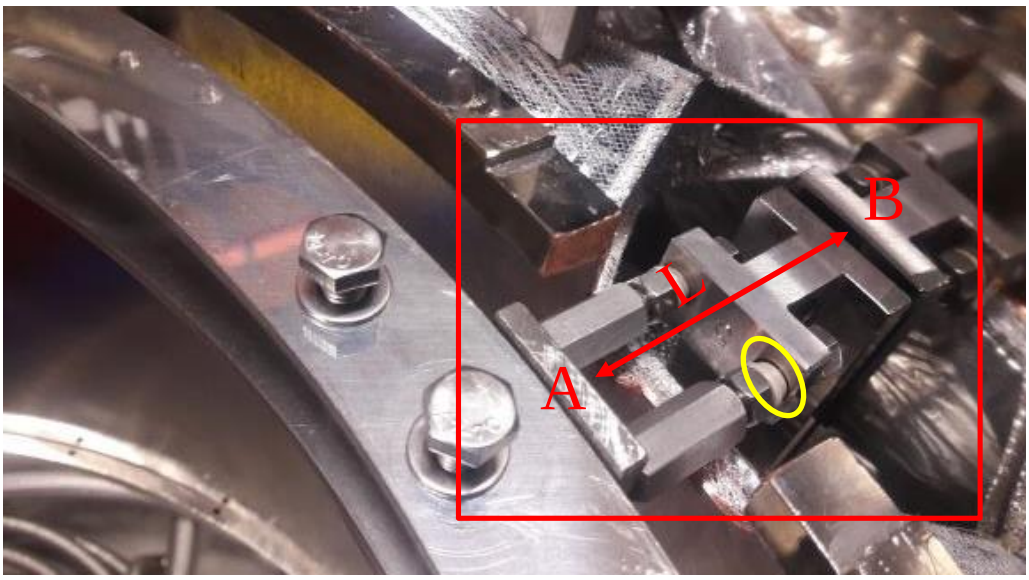


Figure 6 SS ring fixation system. The ring can be tensioned or relaxed acting on the two hexagonal screws on each out of the 6 supports. The pre alignment consists in measuring, for all the 6 supports, the distances L_i between the points A_i and B_i and to equalize it. Highlighted yellow: the plastic washer between the bolt and the H-support

7.1.2 metrological characterization/alignment of the FPU by a laser tracker.

The procedure consists in positioning several reference targets (spheres) on the FPU and on relevant parts of the cryostat to measure the relative displacement between each other by a laser tracker placed about 3 meters distant. In a first step, the positioning of the FPU relative to the cryostat front flange is measured, with the cryostat horizontal. The second step consists in rotating the cryostat by respectively 22.5° and 45° in elevation to measure eventual internal distortions due to the different positions, causing a relative offset between the FPU and reference on the cryostat.

The complete procedure is described in a separate document (REF7)

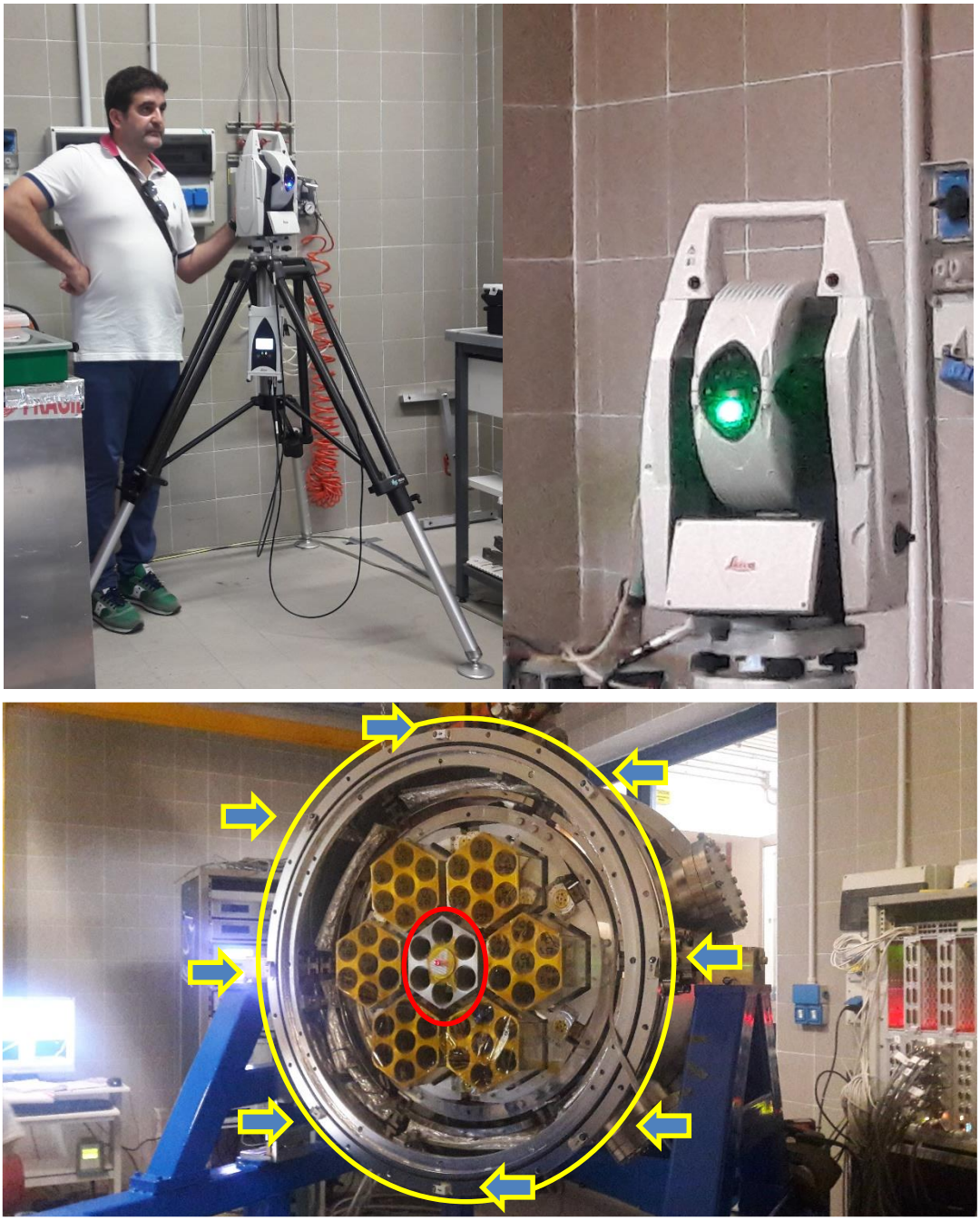


Figure 7 bottom: the central sphere is marked red; other spheres are positioned on the front flange ring (marked yellow);

7.1.3 rotate the cryostat when BACK FLANGE IS IN PLACE

This procedure applies the same to the following setup:

A- **SETUP 1**: BACK FLANGE and the TOP FLANGE are present

B- **SETUP 2**: The BACK FLANGE only is present

A. TO PUT THE CRYOSTAT VERTICAL	
Starting form horizontal position, put the cryostat vertical. To do this:	
h.	Use Crane Bridge (CB)
i.	Connect the belts (side A) to the two opposite eyelets present in the back flanges. Two eyebolts shall be connected to an eyelet each.
j.	Connect the belts (side B) to the CB hanger and put the cryostat in tension along the vertical of the CB (Figure 8)
k.	Unfix the cryostat acting on the MGSE brake system.
l.	gently lower the back of the cryostat by the CB to rotate the cryostat to vertical,
m.	Fix the cryostat vertical by the brake system (the central screw-pin must fit easy)
n.	Disconnect the CB.

B. TO PUT THE CRYOSTAT HORIZONTAL	
Starting form Vertical position, put the cryostat horizontal. To do this:	
a.	Use Crane Bridge (CB)
o.	Connect the belts (side A) to the two opposite eyelets present in the back flanges. Two eyebolts shall be connected to an eyelet each.
p.	Connect the belts (side B) to the CB hanger and put the cryostat in tension along the vertical of the CB (Figure 8)
b.	Unfix the cryostat acting on the MGSE brake system.
c.	gently lift the back of the cryostat by the CB to rotate the cryostat to horizontal,
d.	Fix the cryostat vertical by the brake system (the central screw-pin must fit easy)
e.	Disconnect the CB.

Figure 8 the four CB interfaces (eyelets) are shown. Only two of them shall be used

7.1.4 rotate the cryostat when the BACK FLANGE IS NOT IN PLACE

This procedure applies the same to the following setup:

A- **SETUP 1**: BACK FLANGE and the TOP FLANGE are NOT present
B- **SETUP 2**: The TOP FLANGE only is present

A. TO PUT THE CRYOSTAT VERTICAL
Starting form horizontal position, put the cryostat vertical. To do this:
q. Use Crane Bridge (CB)
Pass the belts around the two vacuum feedthrough flanges as shown in r. , right. Two eyebolts shall be used to keep the belts tight.
Connect the belts (side A and B of each) to the CB hanger and put the cryostat in tension along the vertical of the CB (Figure 9, left)
s. Unfix the cryostat acting on the MGSE brake system.
t. gently lower the back of the cryostat by the CB to rotate the cryostat to vertical,
u. Fix the cryostat vertical by the brake system (the central screw-pin must fit easy)
v. Disconnect the CB.

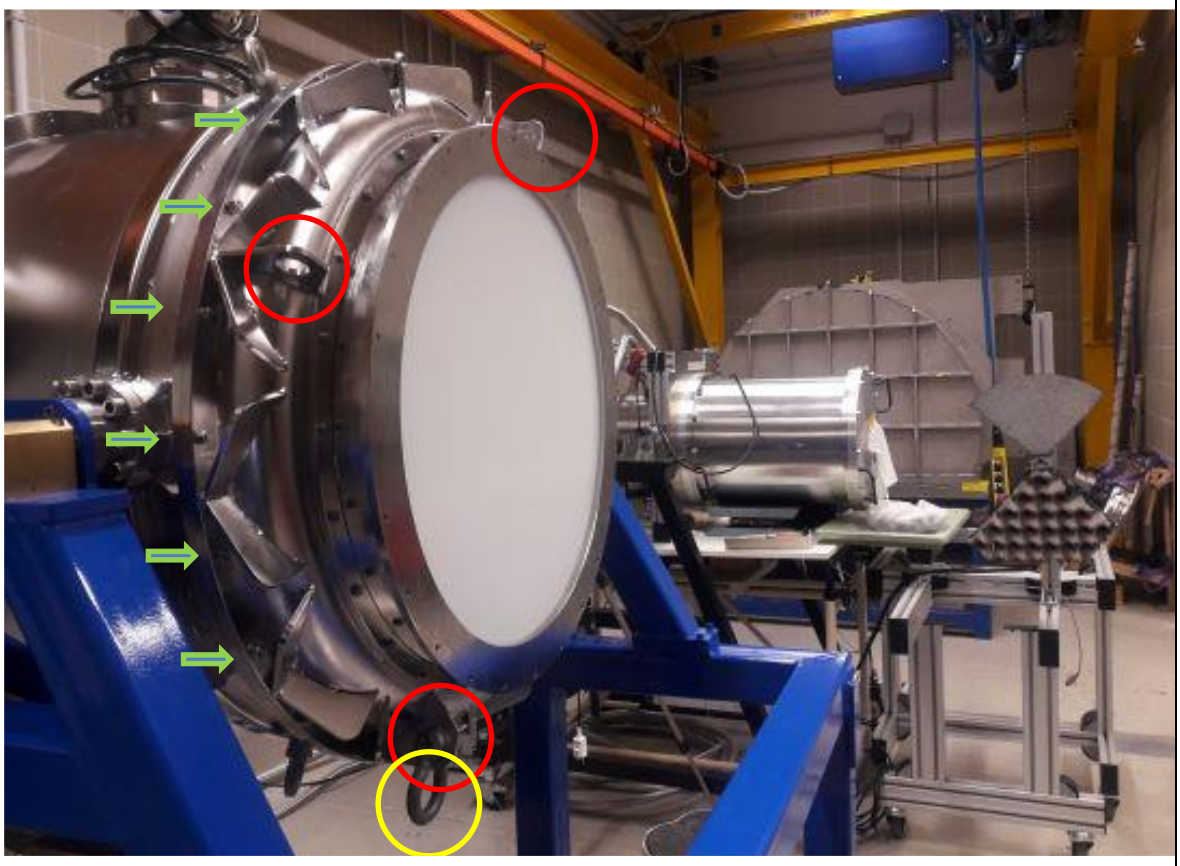
B. TO PUT THE CRYOSTAT HORIZONTAL
Starting form Vertical position, put the cryostat horizontal. To do this:
f. Use Crane Bridge (CB)
Pass the belts around the two vacuum feedthrough flanges as shown in g. , right. Two eyebolts shall be used to keep the belts tight.
h. Connect the belts (side A and B of each) to the CB hanger and put the cryostat in tension along the vertical of the CB (Figure 9, left)
i. Unfix the cryostat acting on the MGSE brake system.
j. gently lift the back of the cryostat by the CB to rotate the cryostat to horizontal,
k. Fix the cryostat vertical by the brake system (the central screw-pin must fit easy)
l. Disconnect the CB.

Figure 9 CB hanger (left) ; mounting scheme of the CB belts (right)

7.1.5 mount and dismount the full Top Flange (including the window)

Depending on the needs, this procedure can be run either when the cryostat **is vertical (preferred)** or when it is horizontal (it presents some criticalities due to the stress on the screws fixing the flange).

7.1.5.1 CASE 1: the cryostat is vertical

THE CRYOSTAT is VERTICAL	
a.	Check that the cryostat is fixed in the vertical position (the brake system is tightened)
b.	Prepare a trolley close to the cryostat, to put the Top Flange over (it shall be in the operative area of the CB).
c.	Unscrew the 24 screws + washer + bolts from the flange (they are screwed from bottom). 13 mm wrench + 13mm socket wrench are needed.
Connect the two belts passing through the 4 eyelets **in the top flange (**	
	
d.	Figure 10) using 4 eyebolts.
e.	Connect the sides A and B of each belt to the CB hanger: verify that the two belts are tighten the same (= have the same length) : the hanger must be well centered.
f.	**Gently lift the Top flange (few cm) by the CB to access the harness.**
g.	Lift the Top flange
h.	Put the top flange on the trolley.
i.	Store the trolley in a comfortable place
j.	Store the screws.

7.1.5.2 CASE 2: the cryostat is horizontal (UNFAVOURED).

THE CRYOSTAT is HORIZONTAL	
a.	Check that the cryostat is fixed in the horizontal position (the brake system is tightened)
b.	Prepare a trolley close to the cryostat, to put the Top Flange over (it shall be in the operative area of the CB).
c.	**Be prepared to unplug the thermometer**
d.	Connect the two belts passing through the **2 eyelets** in the top flange using 2 eyebolts)
e.	Connect the sides A and B of each belt to the CB hanger: verify that the two belts are tighten the same (= have the same length) : the hanger must be well centered.
f.	Put the belts in tension by the CB (UP)
g.	When the cryostat looks tensioned, unscrew 14 out of the 18 screws on the flange: 4 screws (N, S, E, O) shall remain.
h.	Relax in turn the opposite screws: be sure that the screws are working properly (they are not supporting the weight of the Top Flange)
i.	Finally unscrew and remove the 4 screws from the flange.
j.	**Gently lift the Top flange (few cm) by the CB, slightly taking the flange off to access the harness.**
k.	**Unplug the (2 TBC) thermometers**
l.	Lift the Top flange
m.	Put the top flange on the trolley.
n.	Store the trolley in a comfortable place
o.	Store the screws.

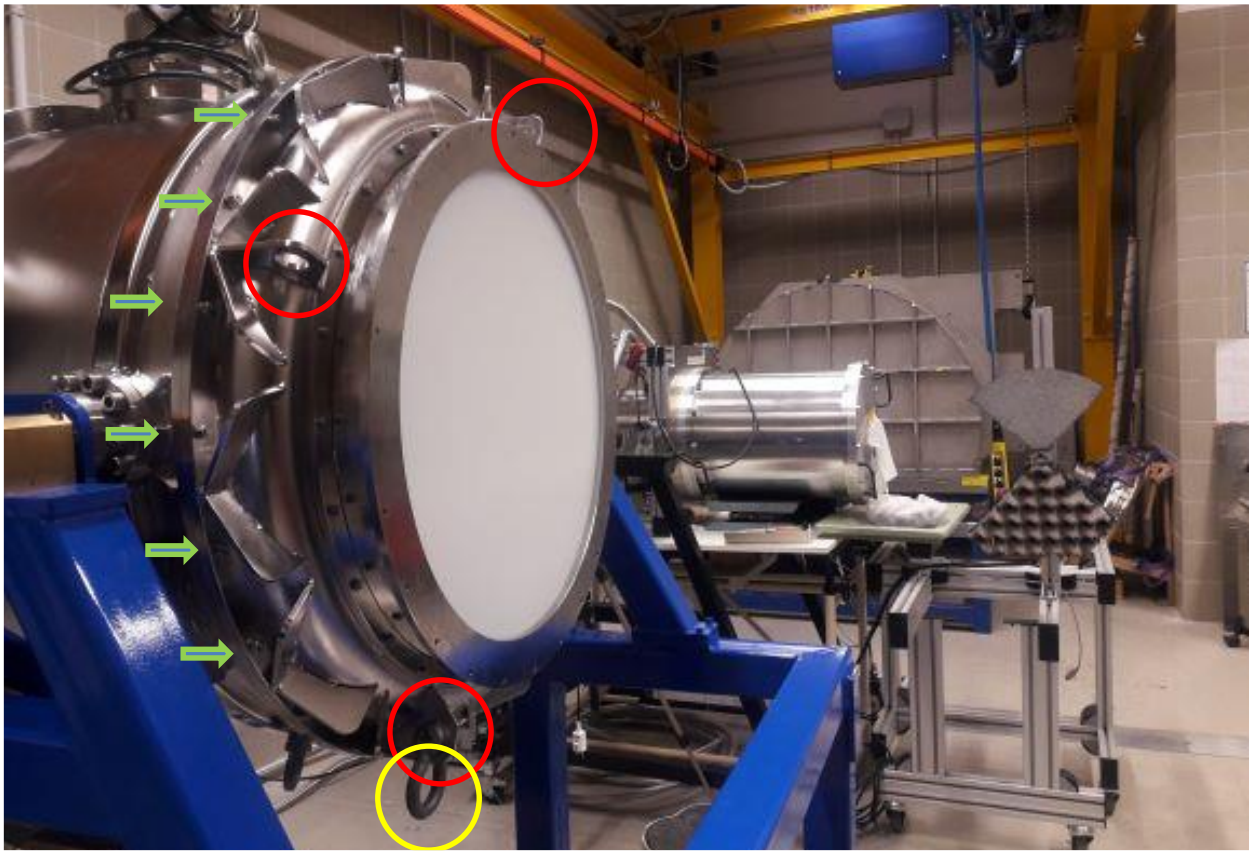


Figure 10 Top flange including the vacuum window, assembled in the cryostat. 3 out of the 4 eyelets are marked in red. A eyebolt is marked yellow; some of the perimetral screws fixing the flange are indicated by the green arrows.

Figure 11 Top flange detail: the vacuum window is dismounted. The two eyebolts to lift the flange are visible.

7.1.6 Mount and dismount the Back Flange

This procedure can be run only with the cryostat HORIZONTAL

7.1.6.1 CASE 1: the cryostat is vertical

THE CRYOSTAT is VERTICAL	
a.	**run before the procedure 7.1.3 to put the cryostat horizontal.**

7.1.6.2 CASE 2: the cryostat is horizontal.

THE CRYOSTAT is HORIZONTAL	
a.	Check that the cryostat is fixed in the horizontal position (the brake system is tightened)
a.	Prepare a trolley close to the cryostat, to put the Back Flange over (it shall be in the operative area of the CB).
b.	**WARNING: If the vacuum bench is already integrated, it shall be dismounted before going ahead, following the procedure described in0. Otherwise, go to the next point.**
b.	Connect the two belts passing through the **2 eyelets** in the top flange (Figure 8) using 2 eyebolts (TBC)
c.	Connect the sides A and B of each belt to the CB hanger: verify that the two belts are tighten the same (= have the same length) : the hanger must be well centered.
d.	Put the belts in tension by the CB (UP)
e.	When the cryostat looks tensioned, unscrew 14 out of the 18 screws on the flange: 4 screws (N, S, E, O) shall remain.
f.	Relax in turn the opposite screws: be sure that the screws are working properly (they are not supporting the weight of the Top Flange).
g.	Finally, in turn unscrew and remove the 4 screws from the flange. **The North screw will be the last to remove**
h.	**Gently lift the Back flange (few cm) by the CB, slightly taking the flange off to check that nothing remained trapped (harness, MLI, etc).**
~~**i.**~~	~~**Unplug the (2 TBC) thermometers**~~
j.	Lift the Back flange
k.	Put the back flange on the trolley (or carry the flange by the CB to its storing place)
l.	Store the trolley (or the Flange) in a comfortable place
m.	Store the screws in the dedicated box.

7.1.7 mount and dismount the vacuum window (on/from the window holder)

7.1.7.1 Flat window (temporary window)

7.1.7.2 A/R coating window (nominal window)

Figure 12

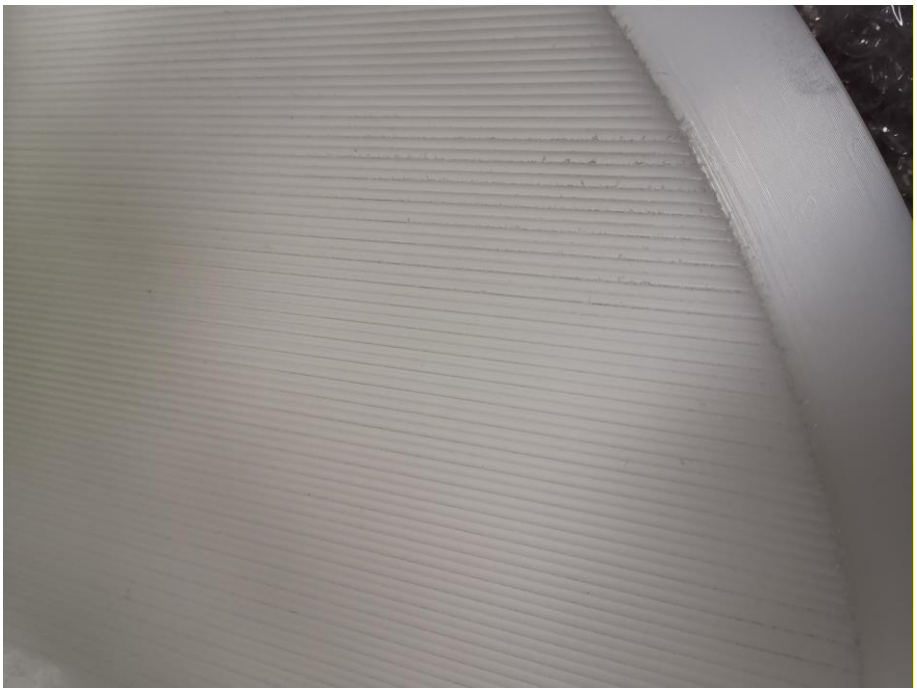


Figure 13

7.1.8 mount and dismount the IR filters holder

This procedure can be run either with the cryostat VERTICAL or HORIZONTHAL
HOWEVER: <u>It is recommended to run it with the cryostat VERTICAL</u> to prevent the bolts and washers from falling into the cryostat and the stress on the screws.

The filters holder can be unmounted either with the IR filters assembled or not.
HOWEVER: It is <u>preferred</u> to run this procedure when the IR filters are not assembled (to use the CB and for safety reasons).

7.1.8.1 CASE 1: the cryostat is vertical; IR filters are NOT mounted

THE CRYOSTAT is VERTICAL.	
a.	Unscrew **<u>NOT COMPLETELY</u>**, in turn the 2 screws and the 16 bolts. The 7mm socket wrench shall be used
b.	Finally unscrew the bolts using the dedicated tool (**pickup tool or the custom plastic tube**) to **prevent the bolts and washers from falling into the cryostat**.
c.	Store the screws in their dedicated box
d.	Pass the four belts through the large apertures in the filter holder,
e.	Place the CB hanger centred and lower it to easy fit side A and B of each belt.
f.	Place a dedicated trolley close to the cryostat, in the CB manoeuvring area.
g.	**UNPLUG THE two THERMOMETERS (4 plugin pins each); eventually remove the tape. (**Figure 15**)**
h.	Put the belts in tension by the CB and lift the filter holder.
i.	Place the holder on the trolley
j.	Cover the holder with a cloth or a cellophane to prevent it from damages or dust.
k.	Store the trolley

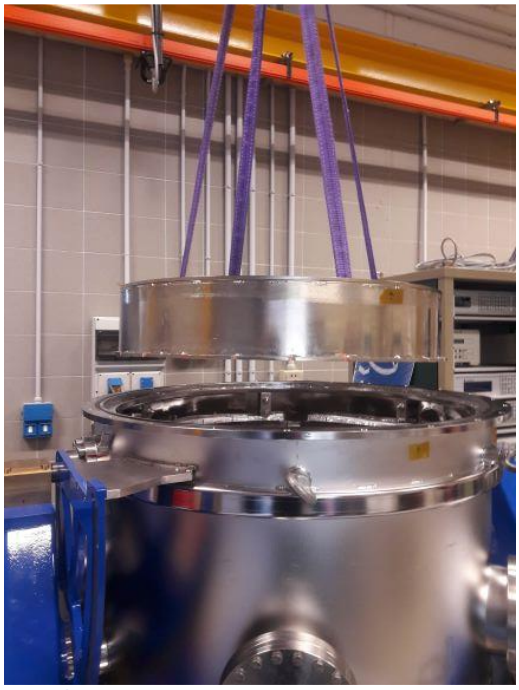


Figure 14 The IR filters holder hanging by the two belts on the CB hanger.

7.1.8.2 CASE 2: the cryostat is vertical, IR filters are MOUNTED

THE CRYOSTAT is VERTICAL	
l.	Unscrew **only partially**, in turn the 2 screws and the 14 bolts. The 7mm socket wrench shall be used
m.	Finally unscrew the bolts using the dedicated tool (forcipes or plastic tube) to **prevent the bolts and washers from falling into the cryostat**.
n.	Store the screws in their dedicated box
o.	Wear the gloves. **At least 2 operators are requested** to safely handle the holder.
p.	Place a dedicated trolley close to the cryostat.
q.	**UNPLUG THE two THERMOMETERS (4 plugin pins each); eventually remove the tape.**
r.	Lift by hands the filter holder having care to not damage the filters.
s.	Place the holder on the trolley
t.	Cover the holder with a cloth or a cellophane to prevent it from damages or dust.
u.	Store the trolley
v.	

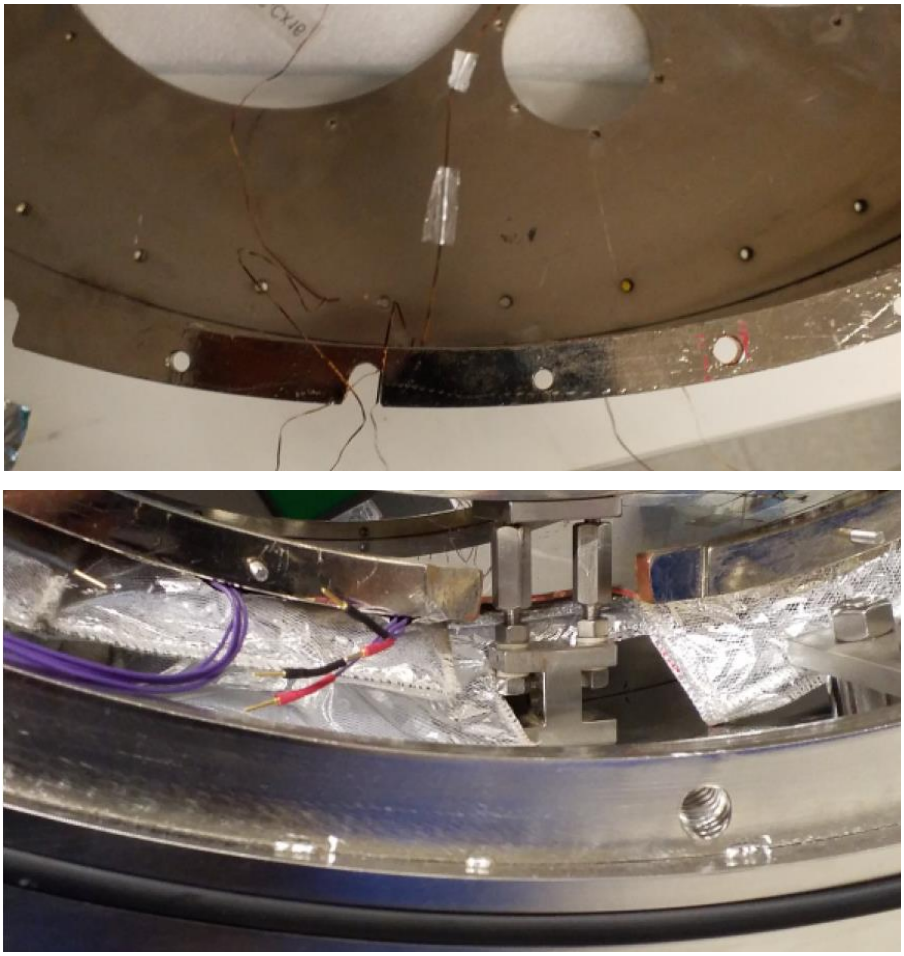


Figure 15 thermometers wires: 2 X4pin connectors are used to connect the manganine wires of the thermometers placed on the IR filter holder to the copper wires (violet, bottom picture) connected to the L-shaped connectors supports.

7.1.1 mount and dismount the IR filters (on/from the filter older)

7.1.1.1 nominal filters

7 Q band filters and 6 W band filters are present.

- Each Q band filter is provided with 6 M3 screws
- Each W band filter is provided with 6 M3 screws
- The filters shall be integrated on the filter holder, by the dedicated screws.

The filters shall be integrated on the filter holder with the cryostat vertical.

THE CRYOSTAT is VERTICAL
a. Unscrew the top shell of the filter holder (be careful to not damage the thermometers / wires)
b. Insert the Q and W filters in the dedicated apertures, using the screw holes to align their position keeping the grooves parallel to either the V or the H polarization plane
c. Integrate the top shell
d. Fix the screws
e. Fix the 4 terminals of the two thermometers

Table 7

7.1.1.2 backup filter

The backup filter consists in a single PTFE disk, provided with screws.

The backup filters shall be integrated on the filter holder with the cryostat vertical.

THE CRYOSTAT is VERTICAL
a. Unscrew the top shell of the filter holder (be careful to not damage the thermometers / wires)
b. Insert the PTFE filter without regard to its orientation w.r.t. the V, H planes.
c. Integrate the top shell
d. Fix the screws
e. Fix the 4 terminals of the two thermometers

Table 8

7.1.2 mount and connect the vacuum bench (from the back Flange)

The scheme of the vacuum bench connection is shown in the Figure 16

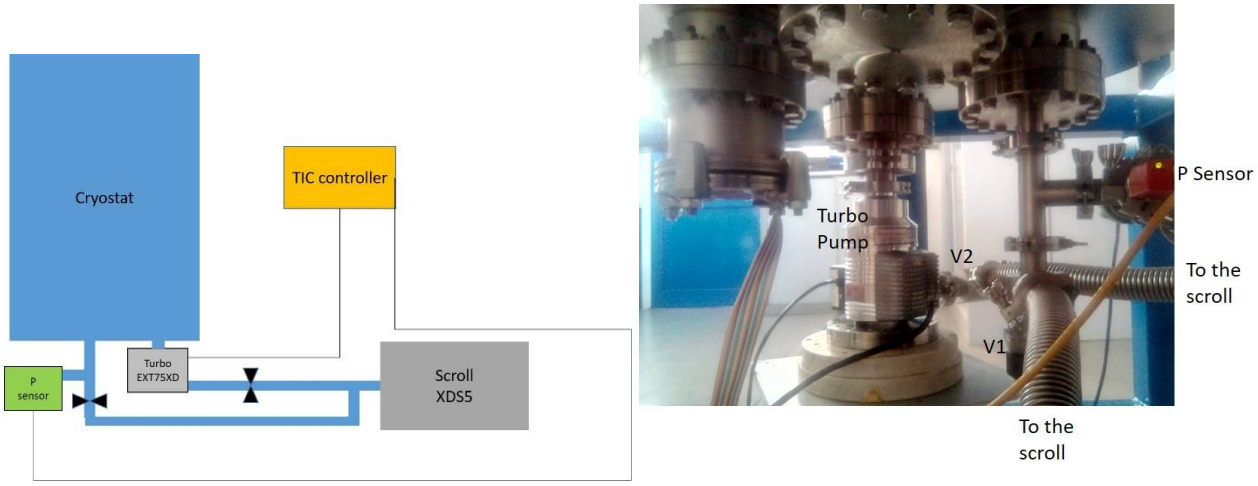


Figure 16 Left: the vacuum bench scheme. The scroll is connected through two valves directly to the cryostat and at the outlet of the turbo pump, depending on the phase of pumping sequence the valves are switched on or off. Right: a photo of the vacuum bench connections on the back flange of the cryostat: the turbo pump is connected directly to the DN40 flange of the cryostat, while on the other way a T-shaped passage has mounted the pressure monitoring devices on one side and the valve connecting the scroll on the other end.

Both the pressure sensors and the turbo pump are connected to a Turbo Instrument Controller, which also works as pressure data acquisition.

THE CRYOSTAT is VERTICAL. The turbo pump has the DN25 valve (V2) already installed at the outlet. The scroll pump is in position under the cryostat with a T-shaped passage installed at its inlet.	
a.	Connect through the dedicated o-ring and a DN40 collar the Turbo pump inlet
b.	Connect through a KF25 metal flexible hose the V2 end to one of the ends of the T-passage at the scroll inlet.
c.	Connect a T-shaped passage at the DN25 aperture flange of the cryostat.
d.	Connect the pressure monitoring device(s) to one end of the T-passage of step c. and the V1 valve to the other end.
e.	Connect through a KF25 metal flexible hose the V1 end to the open end of the T- passage at the scroll inlet.
f.	Connect the built-in cable of the turbo pumo to the deciated port of the TIC.
g.	Connect the pressure monitoring device(s) through a LAN cable to the corresponding TIC input

Table 9

7.1.3 mount/dismount and connect/disconnect the flex lines

7.1.3.1 mounting procedure:

The two flex lines terminals are flagged by coloured tapes: green and red

- The green flag indicates the XXX line
- The red flag indicates the XXX line.

The XXX flagged terminal is integrated first.

The dedicated XXX tool is used to screw/unscrew the bolts.

aggiungere immagine flexlines terminals

7.1.3.2 dismounting procedure:

The two flex lines terminals are flagged by coloured tapes: green and red

- The green flag indicates the XXX line
- The red flag indicates the XXX line.

The XXX flagged terminal is integrated first.

The dedicated XXX tool is used to screw/unscrew the bolts.

7.2 Connectors description

CONNECTOR #	TYPE	TEMP	ON
CONN1	DB25	20K	POLARIMETER
CONN2	DB50	100K	100K FLANGE (L1)
CONN3	DB50	100K	100K FLANGE (L1)
CONN4	DB50	100K	100K FLANGE (L2)
CONN5	DB50	100K	100K FLANGE (L2)
CONN6	DB50	300K	300K FEEDTHROUGH

Table 10

7.3 Feedthroughs descriptions

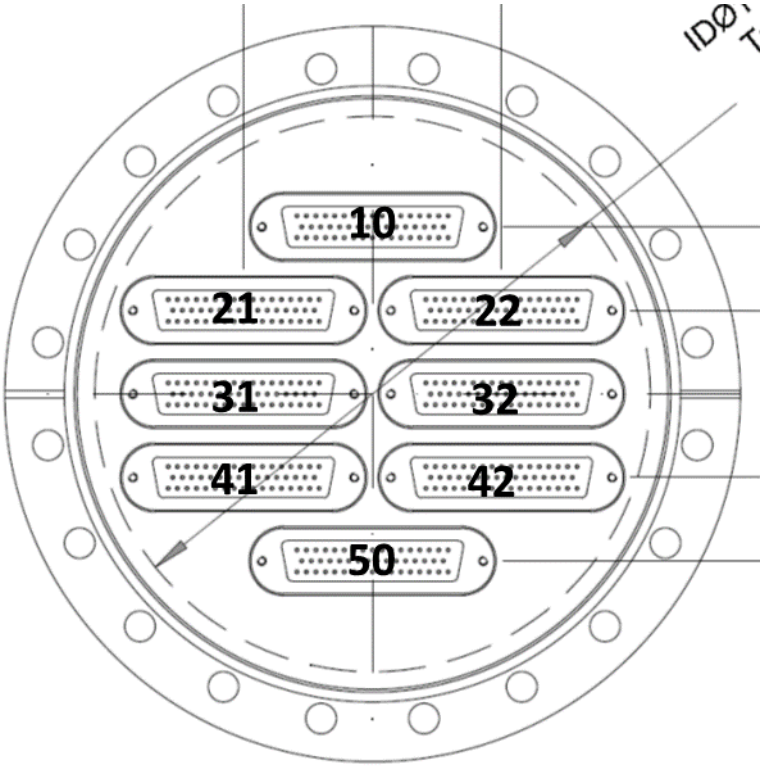


Figure 17 feedthrough flange sketch (View from INTERNAL the cryostat) : connectors are indicated by the two index i, j. I correspond to the row, J to the column, start from the left.

7.3.1 FLANGE NW

FLANGE (NAME, I, J)	COMPONENTS	300K CONNECTOR
NW-10	UNPLUGGED	//
NW-21	Conn_TH3	N-B2
NW-22	R4 + R5	O-A1
NW-31	Conn_TH2	N-B3
NW-32	R0 + R6	O-A2
NW-41	Conn_TH1	N-B4
NW-42	R2 + R3	O-A3
NW-50	R1 + W3	O-A4

Table 11

7.3.2 FLANGE NE

FLANGE (NAME, I, J)	COMPONENTS	300K CONNECTOR
NE-10	V2 + W4	E-B1
NE-21	V0 + V3	E-B2
NE-22	I5 (W CHANNEL IS MISSING)	N-A1
NE-31	V1 + V6	E-B3
NE-32	I1 + I6	N-A2
NE-41	V4 + V5	E-B4
NE-42	I0 + I4	N-A3
NE-50	I2 + I3	N-A4

Table 12

7.3.3 FLANGE SW

FLANGE (NAME, I, J)	COMPONENTS	300K CONNECTOR
SW-10	O4 + O5	O-B1
SW-21	O0 + O3	O-B2
SW-22	Y2 + Y3	S-A1
SW-31	O6 + W2	O-B3
SW-32	Y4 + Y5	S-A2
SW-41	O1 + O2	O-B4
SW-42	Y1 + Y0	S-A3
SW-50	Y6 + W1	S-A4

Table 13

7.3.4 FLANGE SE

FLANGE (NAME, I, J)	COMPONENTS	300K CONNECTOR
SE-10	G0 + G3	S-B1
SE-21	G4 + W6	S-B2
SE-22	B1 + B2	E-A1
SE-31	G1 + G2	S-B3
SE-32	B3 + W5	E-A2
SE-41	G5 + G6	S-B4
SE-42	B0 + B6	E-A3
SE-50	B4 + B5	E-A4

Table 14

POL ID	Connectors 100K	Connectors 300K
Y6 + W1	S-A4	SW-50
Y1 + Y0	S-A3	SW-42
Y4 + Y5	S-A2	SW-32
Y2 + Y3	S-A1	SW-22
G5 + G6	S-B4	SE-41
G1 + G2	S-B3	SE-31
G4 + W6	S-B2	SE-21
G0 + G3	S-B1	SE-10
O1 + O2	O-B4	SW-41
O6 + W2	O-B3	SW-31
O0 + O3	O-B2	SW-21
O4 + O5	O-B1	SW-10
R1 + W3	O-A4	NW-50
R2 + R3	O-A3	NW-42
R0 + R6	O-A2	NW-32
R4 + R5	O-A1	NW-22
B4 + B5	E-A4	SE-50
B0 + B6	E-A3	SE-42
B3 + W5	E-A2	SE-32
B1 + B2	E-A1	SE-22
V4 + V5	E-B4	NE-41
V1 + V6	E-B3	NE-31
V0 + V3	E-B2	NE-21
V2 + W4	E-B1	NE-10
I2 + I3	N-A4	NE-50
I0 + I4	N-A3	NE-42
I1 + I6	N-A2	NE-32
I5	N-A1	NE-22
Conn_TH1	N-B4	NW-41
Conn_TH2	N-B3	NW-31
Conn_TH3	N-B2	NW-21
		NW-10

Table 15 full correspondence between polarimeters)POL-ID) , 100K connector, 300K connector

7.4 CRYO Harness description

A complete description of the harness is given in REF8.

7.4.1 Sub-D 100-300K Connectors Versus Flanges: Map

Connectors 100K	Connectors 300K
S-A4	SW-50
S-A3	SW-42
S-A2	SW-32
S-A1	SW-22
S-B4	SE-41
S-B3	SE-31
S-B2	SE-21
S-B1	SE-10
O-B4	SW-41
O-B3	SW-31
O-B2	SW-21
O-B1	SW-10
O-A4	NW-50
O-A3	NW-42
O-A2	NW-32
O-A1	NW-22
E-A4	SE-50
E-A3	SE-42
E-A2	SE-32
E-A1	SE-22
E-B4	NE-41
E-B3	NE-31
E-B2	NE-21
E-B1	NE-10
N-A4	NE-50
N-A3	NE-42
N-A2	NE-32
N-A1	NE-22
N-B4	NW-41
N-B3	NW-31
N-B2	NW-21
	NW-10

Table 16

7.4.2 Sub-D 25 (26) - 100K SUB-D 50: Map

POL ID	Connectors 100K
Y6 + W1	S-A4
Y1 + Y0	S-A3
Y4 + Y5	S-A2
Y2 + Y3	S-A1
G5 + G6	S-B4
G1 + G2	S-B3
G4 + W6	S-B2
G0 + G3	S-B1
O1 + O2	O-B4
O6 + W2	O-B3
O0 + O3	O-B2
O4 + O5	O-B1
R1 + W3	O-A4
R2 + R3	O-A3
R0 + R6	O-A2
R4 + R5	O-A1
B4 + B5	E-A4
B0 + B6	E-A3
B3 + W5	E-A2
B1 + B2	E-A1
V4 + V5	E-B4
V1 + V6	E-B3
V0 + V3	E-B2
V2 + W4	E-B1
I2 + I3	N-A4
I0 + I4	N-A3
I1 + I6	N-A2
I5	N-A1
Conn_TH1	N-B4
Conn_TH2	N-B3
Conn_TH3	N-B2

Table 17

7.4.3 Thermometers and heaters correspondence

SENSOR ID	100 K FLANGE CONNECTOR	SENSOR ID	100 K FLANGE CONNECTOR
TS-CX1	N-B3	TS-CX12	N-B4
TS-CX2	N-B3	TS-CX13	N-B3
TS-CX3	N-B3	TS-CX14	N-B4
TS-CX4	N-B3	TS-CX15	N-B4
TS-CX5	N-B3	TS-CX16	N-B4
TS-CX6	N-B3	TS-CX17	N-B4
TS-CX7	N-B3	TS-CX18	N-B2
TS-CX8	N-B3	TS-DT2	N-B2
TS-CX9	N-B4	TS-DT3	N-B4
TS-CX10	N-B3	TS-DT5	N-B4
TS-CX11	N-B4	TS-DT6	N-B4

Table 18

7.4.4 100K flange: connectors MAP

The innermost L-shaped connectors holders are 4; they are named: North, South East, West.
They:

- connect the 20K harness from the polarimeters to the 100K flange
- connect the 100K harness to the outermost L-shaped connectors holders (NW, NE, SW, SE)

The outermost innermost L-shaped connectors holders are 4; they are named: North West, North Est, South West, South Est.
They:

- connect the 100K harness to the innermost L-shaped connectors holders (N, S, E, W)
- connect the 300K harness to the feedthrough flanges (NW, NE, SW, SE)

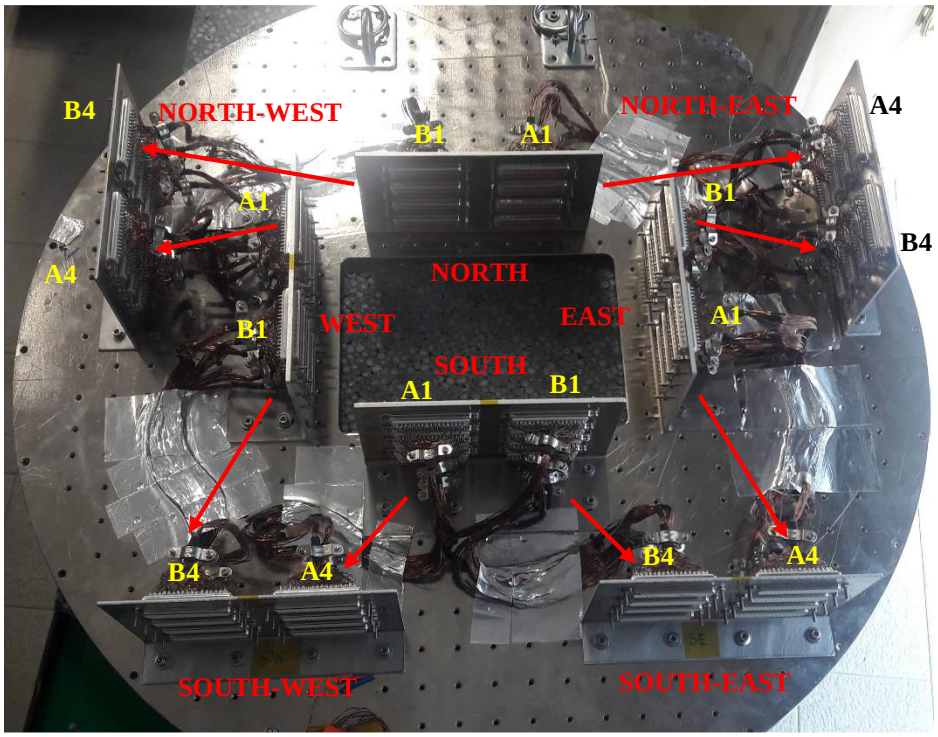


Figure 18 SUB-D connectors on the 100K flange: Map. The routing scheme is also indicated; letters A_i and B_i refer to the uppermost line of connectors (the closest to the observer).

7.4.5 Sub-D Connectors Versus Flanges: INTEGRATION SEQUENCE

The 300K to 100K harness is integrated following this sequence:

- Integrate the 300K copper wires and connectors on each of the 4 feedthrough flanges
- Terminate the outermost connectors on the flanges by SUB-D 50 short Female connectors (bridges)
- Dismount the 4 blind flanges on the cryostat
- Put a Gasket O-ring on each feedthrough
- Pass the wires and the connectors of each flange through the aperture on the cryostat and let them suspended between the 300K wall of the cryostat and the inner 100K shield.
- Poorly fix each feedthrough flange by the screws provided (13 mm Allan key is needed)
- Dismount the short connectors from the 100K SUB-D connectors on the L-shaped supports. Connect each 300K connector to the corresponding 100K SUB-D connector.
- Fix each connector by 2 bolts.
- Collect the wires and thermalize them by Aluminium tape
- Tight the screws on the feedthrough flanges.

7.4.6 Thermal Sensors: electric specs

Sensor Label	Position	Thermistor Type	ID Sensor	Reading_Check (Ohm)
TS-CX1	Module R	CX-1050-SD	X114560	63.1
TS-CX2	Module V	CX-1050-SD	X114624	62.6
TS-CX3	Module B	CX-1050-SD	X115716	85.8
TS-CX4	Module G	CX-1050-SD	X115715	83.7
TS-CX5	Module Y	CX-1050-AA	X33349	57.1
TS-CX6	Module O	CX-1050-AA	X34780	52
TS-CX7	Module I	DT670 SD	D42070	N/A (K)
TS-CX8	Frame_perimeter 0°	CX-1050-CU	X114489	82.1
TS-CX9	Frame_perimeter 60° - 90°	DT670 CU uncal	D49018	N/A (K)
TS-CX10	Frame_perimeter 120°-150°	CX-1050-CU	X34088	63
TS-CX11	Frame_Center_North	CX-1050-CU	X26468	60.6
TS-CX12	W-pol	DT670 SD	D48899	N/A (K)
TS-CX13	Q-pol x	CX-1050-AA	X113014	58
TS-CX14	Q-pol y	CX-1050-AA	X113924	53.8
TS-CX15	Frame interface 0°	Silicon Diodes DT-670B CU	D60196	N/A (K)
TS-CX16	Filter holder perimeter	DT670 CU uncal	D49530	N/A (K)
TS-CX17	Filter holder central	CX-1050-CU	X114311	63.5
TS-CX18	Strap Interface Cold Flange	CX-1050-CU	X114294	63.5
TS-DT2	Cold Head 20K	Silicon Diodes DT-670B CU	D50483	N/A (K)
TS-DT3	Bottom shield 100K	Silicon Diodes DT-670B CU	D60113	N/A (K)
TS-DT5	Side Shield 100K (flat I/F)	DT670 SD	D48809	N/A (K)
TS-DT6	Frame_Center_South	Silicon Diodes DT-670B CU	D6064985	N/A (K)

Table 19

7.5 WARM Harness description

7.5.1 DB50 to DB25

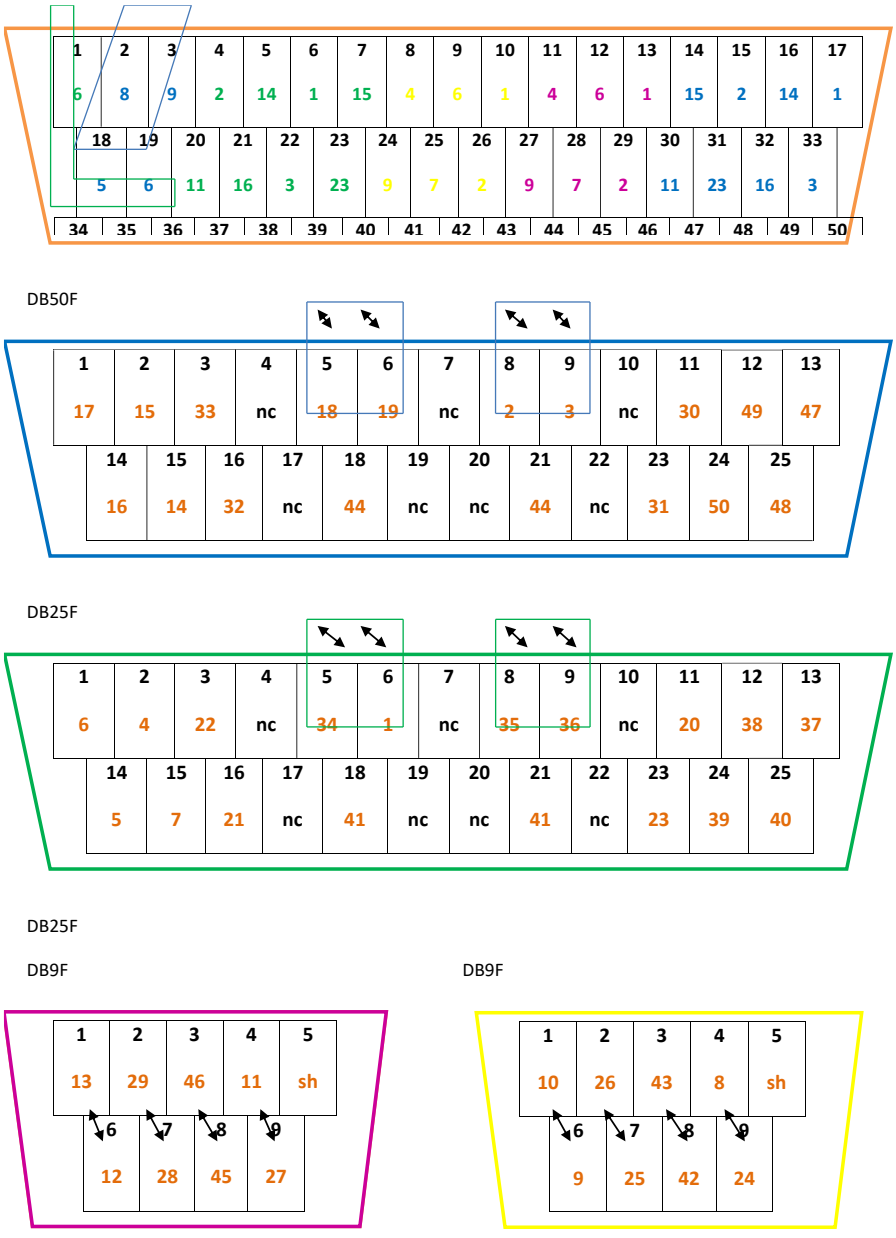


Figure 19

7.5.1 DB50 to DB25W

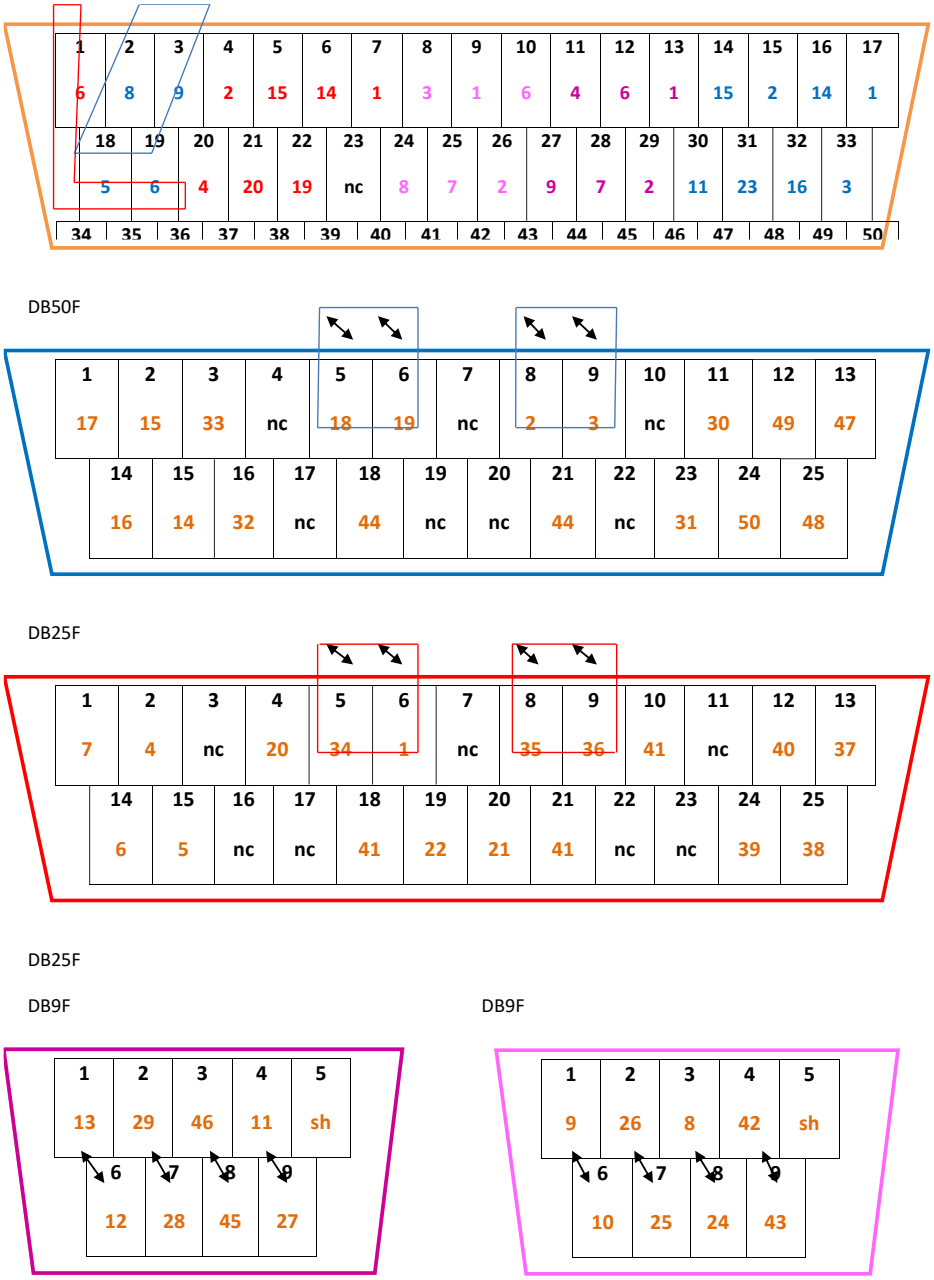


Figure 20

7.5.1 TH1

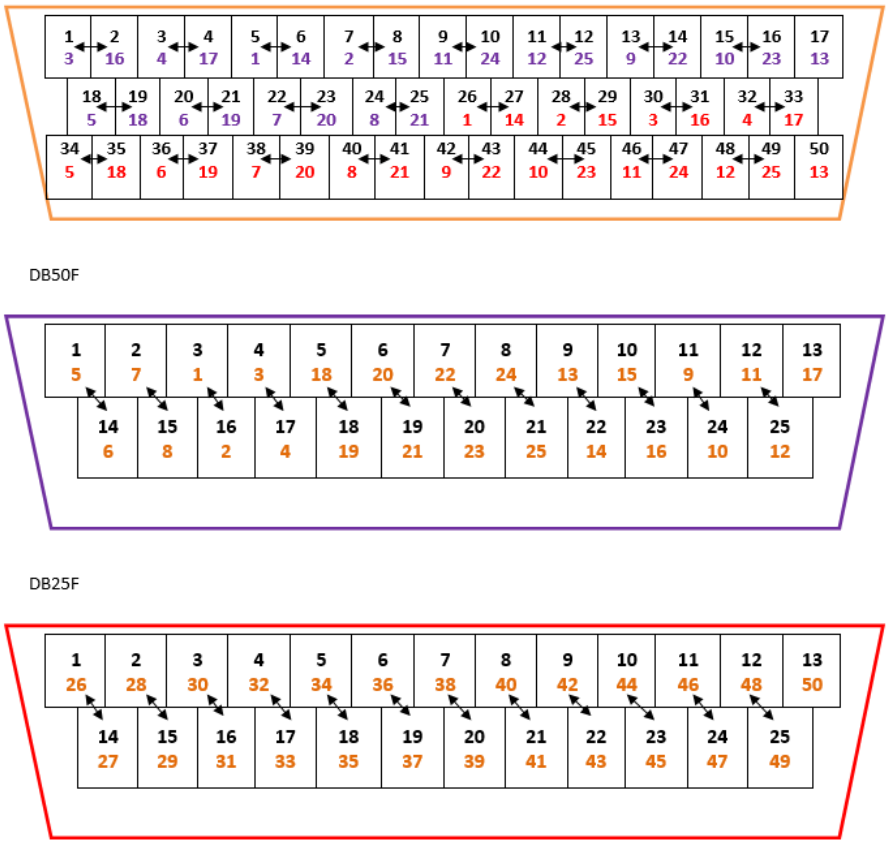
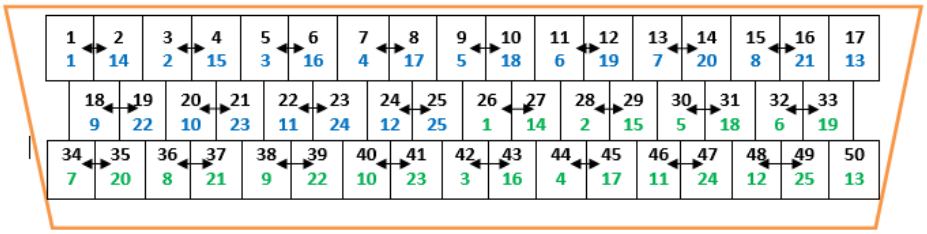
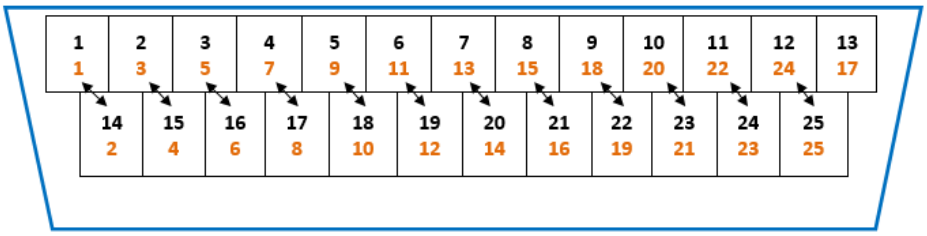


Figure 21 Connectors scheme

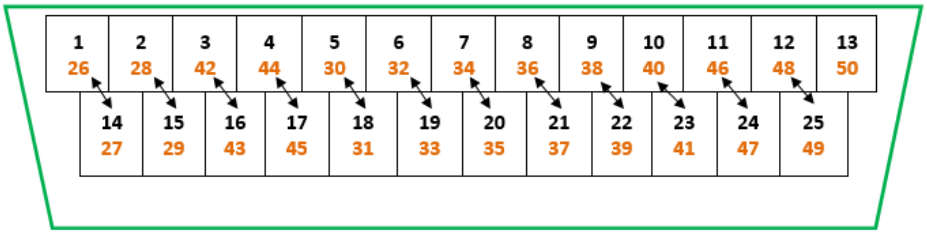
7.5.1 TH2



DB50F



DB25F



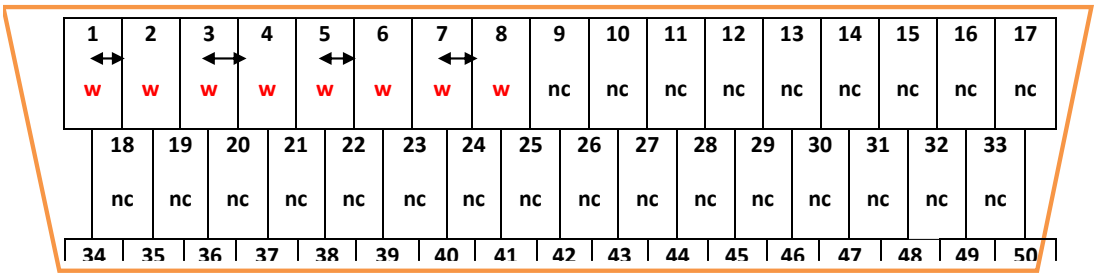
DB25F

Coppie identificate da frecce (nel caso di cavo a doppini) altrimenti connessione normale con cavo a 25 poli

In caso di doppini connettere i pin 13 dei DB25 ai pin 17,50 rispettivi del DB50 con cavo unipolare di sezione 0.5mm2

Figure 22

7.5.1 TH3



DB50F

W = wire

Pin da 1 a 8 a coppie con cavo schermati se disponibile (frecce) altrimenti cavo normale con terminazione a saldare

Pin da 41 a 44 e da 47 a 50 con cavo doppio per ogni pin usare due conduttori

CAVO A
1 Rosso
2 Blu
3 Marrone
4 Bianco
5 Verde
6 Giallo
7 Rosa
8 Grigio
CAVO B
41 Rosso/Blu
42 Marrone/Bianco
43 Verde/Giallo
44 Rosa/Grigio
CAVO C
47 Rosso/Blu
48 Marrone/Bianco
49 Verde/Giallo
50 Rosa/Grigio

Figure 23

7.6 Electronic Channels vs polarimeters correspondence.

TILE	CABLE	POLARIMETERS	Connectors 300K FLANGE	P1	SUB-D25 ELECT	P2	SUB-D25 ELECT	BOARD
O	O-B4	S36 – S57	SW-41	S36		S57		2
	O-B3	S52 – S73	SW-31	S52		S73		
	O-B2	S27 – S56	SW-21	S27		S56 S65		
	O-B1	S46 – S22	SW-10	S46		S22		
Y	S-A4	S35 – S82	SW-50	S35		S82		3
	S-A3	S48 – S08	SW-42	S48		S08		
	S-A2	S33 – S28	SW-32	S33		S28		
	S-A1	S67 – S02	SW-22	S67		S02		
R	O-A4	S61 – S81	NW-50	S61		S21 S81		1
	O-A3	S37 – S62	NW-42	S37		S62		
	O-A2	S19 – S39	NW-32	S19 S16		S39		
	O-A1	S47 – S70	NW-22	S47		S70		
\V	E-B4	S04 – S64	NE-41	S04		S64		6
	E-B3	S54 – S17	NE-31	S54		S17		
	E-B2	S58 – S55	NE-21	S58		S55		
	E-B1	S24 – S71	NE-10	S24		S71		
I	N-A4	S34 – S13	NE-50	S34		S13		7
	N-A3	S31 – S43	NE-42	S31		S43		
	N-A2	S29 – S12	NE-32	S29		S12		
	N-A1	S30	NE-22	S30				
B	E-A4	S50 - S41	SE-50	S50		S41		5
	E-A3	S09 - S63	SE-42	S09		S63		
	E-A2	S69 - S78	SE-32	S69		S78		
	E-A1	S07 - S56	SE-22	S07		S56		
G	S-B4	S59 - S66	SE-41	S59		S66		4
	S-B3	S45 - S40	SE-31	S45		S40		
	S-B2	S05 - S76	SE-21	S05		S76		
	S-B1	S15 - S51	SE-10	S15		S51		

Table 20 RED: wrong values reported in the LOG: checked on spec document (SP-024) THE CORRECT TABLE IS BELOW

TILE	CABLE	POLARIMETERS	Connectors 300K FLANGE	P1	DB9	SUB-D25 ELECT	P2	DB9	SUB-D25 ELECT	BOARD
O	O-B4	S36 – S57	SW-41	S36			S57			2
	O-B3	S52 – S73	SW-31	S52			S73			
	O-B2	S27 – S56	SW-21	S27			S65			
	O-B1	S46 – S22	SW-10	S46			S22			
Y	S-A4	S35 – S82	SW-50	S35			S82			3
	S-A3	S48 – S08	SW-42	S48			S08			
	S-A2	S33 – S28	SW-32	S33			S28			
	S-A1	S67 – S02	SW-22	S67			S02			
R	O-A4	S61 – S81	NW-50	S61			S81			1
	O-A3	S37 – S62	NW-42	S37			S62			
	O-A2	S19 – S39	NW-32	S16			S39			
	O-A1	S47 – S70	NW-22	S47			S70			
\V	E-B4	S04 – S64	NE-41	S04			S64			6
	E-B3	S54 – S17	NE-31	S54			S17			
	E-B2	S58 – S55	NE-21	S58			S55			
	E-B1	S24 – S71	NE-10	S24			S71			
I	N-A4	S34 – S13	NE-50	S34			S13			7
	N-A3	S31 – S43	NE-42	S31			S43			
	N-A2	S29 – S12	NE-32	S29			S12			
	N-A1	S30	NE-22	S30						
B	E-A4	S50 - S41	SE-50	S50			S41			5
	E-A3	S09 - S63	SE-42	S09			S63			
	E-A2	S69 - S78	SE-32	S69			S78			
	E-A1	S07 - S56	SE-22	S07			S56			
G	S-B4	S59 - S66	SE-41	S59			S66			4
	S-B3	S45 - S40	SE-31	S45			S40			
	S-B2	S05 - S76	SE-21	S05			S76			
	S-B1	S15 - S51	SE-10	S15			S51			

Table 21 TABLE CORRECTED: THE CONNECORS ARE MARKED IN THE COLOUR CORRESPONDING TO THOSE USED IN THE 300K HARNESS

7.7 Hex bolts recommended tightening torque (steinless steel)

STAINLESS HEX BOLTS - RECOMMENDED TIGHTENING TORQUE (Nm)

Nominal Size	Pitch (mm)	Stress Area (mm^2)	Class 50	Class 70	Class 80
M3	0.50	5.03	0.4	0.9	1.2
M4	0.70	8.78	1.0	2.1	2.7
M5	0.8	14.20	1.9	4.2	5.5
M6	1.00	20.10	3.3	7.1	9.4
M8	1.25	36.60	8.0	17.1	22.8
M10	1.50	58.00	15.8	33.9	45.2
M12	1.75	84.30	27.6	59.2	78.9
M14	2.00	115.00	44.0	94.2	125.6
M16	2.00	157.00	68.6	147.0	195.9
M18	2.50	192.00	94.3	202.2	269.6
M20	2.50	245.00	133.8	286.7	382.2
M22	2.50	303.00	182.0	390.0	519.9
M24	3.00	353.00	231.3	495.6	660.8
M27	3.00	459.00	338.3	725.0	966.7
M30	3.50	561.00	459.5	984.6	1312.7
M33	3.50	694.00	625.2	1339.8	1786.4
M36	4.00	817.00	802.9	1720.6	2294.1
M39	4.00	976.00	1039.1	2226.7	2969.0

k Factor = 0.2 The induced load is calculated at 65% yield stress

Note:

A k factor of 0.2 has been used which assumes threads are burr free and a good quality lubricant (molybdenum disulphate MoS_2) is used. Stainless fasteners that are not lubricated or coated often sieze and can exhibit k factors in excess of 0.35

Table 22

8 INTEGRATION SHEETS

8.1 Thermal Sensors: verification sheet

Sensor Label	ID Sensor	Reading_Check (Ohm)	Verification Post-integration (2019/11/06)	Verification LAKE 224 NOM (2019/11/21)	NOTES
TS-CX1	X114560	63.1	63,4	63.5	
TS-CX2	X114624	62.6	62,8	63	
TS-CX3	X115716	85.8	86	86.3	
TS-CX4	X115715	83.7	84	84.2	
TS-CX5	X33349	57.1	57,3	57.6	
TS-CX6	X34780	52	52,2	52.3	
TS-CX7	D42070	N/A (K)	OK	OK	
TS-CX8	X114489	82.1	82,2	82.4	
TS-CX9	D49018	N/A (K)	OK	OK	
TS-CX10	X34088	63	63	63	1st measure:73 due to a short circuit on the PCB (MPX-Relè): issue fixed
TS-CX11	X26468	60.6	60,5	60.6	
TS-CX12	D48899	N/A (K)	OK	OK	At the beginning the readout was 355K (contacts verified and improved)
TS-CX13	X113014	58	58,1	58.3	
TS-CX14	X113924	53.8	54.0	54.2	extension wires: changed
TS-CX15	D60196	N/A (K)	OK	OK	
TS-CX16	D49530	N/A (K)	OK	OK	
TS-CX17	X114311	63.5	64,3	64.4	
TS-CX18	X114294	63.5	63,8	N.A	
TS-DT2	D50483	N/A (K)	OK	N.A	It shows a -2K offset w.r.t other sensors
TS-DT3	D60113	N/A (K)	OK	N.A	
TS-DT5	D48809	N/A (K)	OK	N.A	
TS-DT6	D6064985	N/A (K)	OK	N.A	

Table 23

8.2 Cryo-harness integration

TILE	CABLE	POLARIMETERS	TEST (DATE)	INTEGRATION (DATE)	NOTES
O	O-B4	S36 – S57	2019/05/31	2019/11/07	
	O-B3	S52 – S73	2019/06/03	2019/11/07	
	O-B2	S27 – S56	2019/05/31	2019/11/07	
	O-B1	S46 – S22	2019/05/31	2019/11/07	
Y	S-A4	S35 – S82	2019/06/13	2019/11/08	
	S-A3	S48 – S08	2019/06/10	2019/11/08	2019/07/02-3 used for RF tests (crosstalk)
	S-A2	S33 – S28	2019/06/10	2019/11/08	2019/07/02-3 used for RF tests (crosstalk)
	S-A1	S67 – S02	2019/06/07	2019/11/08	2019/07/02-3-10 used for RF tests (crosstalk)
R	O-A4	S61 – S21	2019/06/04	2019/11/11	Moved heater to make the mounting easier
	O-A3	S37 – S62	2019/05/31	2019/11/11	
	O-A2	S19 – S39	2019/06/03	2019/11/11	
	O-A1	S47 – S70	2019/06/07	2019/11/11	
V	E-B4	S04 – S64	2019/06/07	2019/11/11	
	E-B3	S54 – S17	2019/06/07	2019/11/11	
	E-B2	S58 – S55	2019/06/04	2019/11/11	P1, P2 flags missing: correct attribution made by testing the pins (circuit board). P1 cable was flagged black on the DB25 connector
	E-B1	S24 – S71	2019/06/04	2019/11/11	
I	N-A4	S34 – S-13	2019/06/04	2019/11/15	
	N-A3	S31 – S43	2019/06/04	2019/11/15	
	N-A2	S29 – S12	2019/06/04	2019/11/15	
	N-A1	S30	2019/06/04	2019/11/18	DA AGGIUNGERE VITI
B	E-A4	S50 - S41	2019/06/07	2019/11/26	
	E-A3	S09 - S63	2019/06/07	2019/11/26	
	E-A2	S69 - S78	2019/06/07	2019/11/26	
	E-A1	S07 - S56	2019/06/07	2019/11/26	
G	S-B4	S59 - S66	2019/06/07	2019/11/25	
	S-B3	S45 - S40	2019/06/07	2019/11/25	
	S-B2	S05 - S76	2019/06/07	2019/11/25	
	S-B1	S15 - S51	2019/06/07	2019/11/25	

Table 24 cryo harness integration sheet.

8.3 Heaters integration

The heaters verification details are reported in table

Heater name	Heater position	Before integration 2019/07/11 (Ohm)	Integration Verification (2KOhm scale)
HRW1	WEST (shield)	72	76
HR-W2	Est (shield)	72	79
CTRL	H-Frame (top)	≈ 50	54

Table 25

8.4 100K - 300K internal harness integration

The vacuum feedthrough flanges have been labelled internally and externally.
The elastic binders were removed.
Each wires cable was labelled.
The plastic cases were removed.

The 100K-300K harness was integrated following the sequence reported in the table.

FLANGE NAME	INTEGRATION DATE	NOTES
NORTH WEST (NW)	2019/11/19	
NORTH EST (NE)	2019/11/18	
SOUTH WEST (SW)	2019/11/21	
SOUTH EST (SE)	2019/11/21	

Table 26

8.5 Electronics integration scheme

8.5.1 ELECTRONICS OVERVIEW

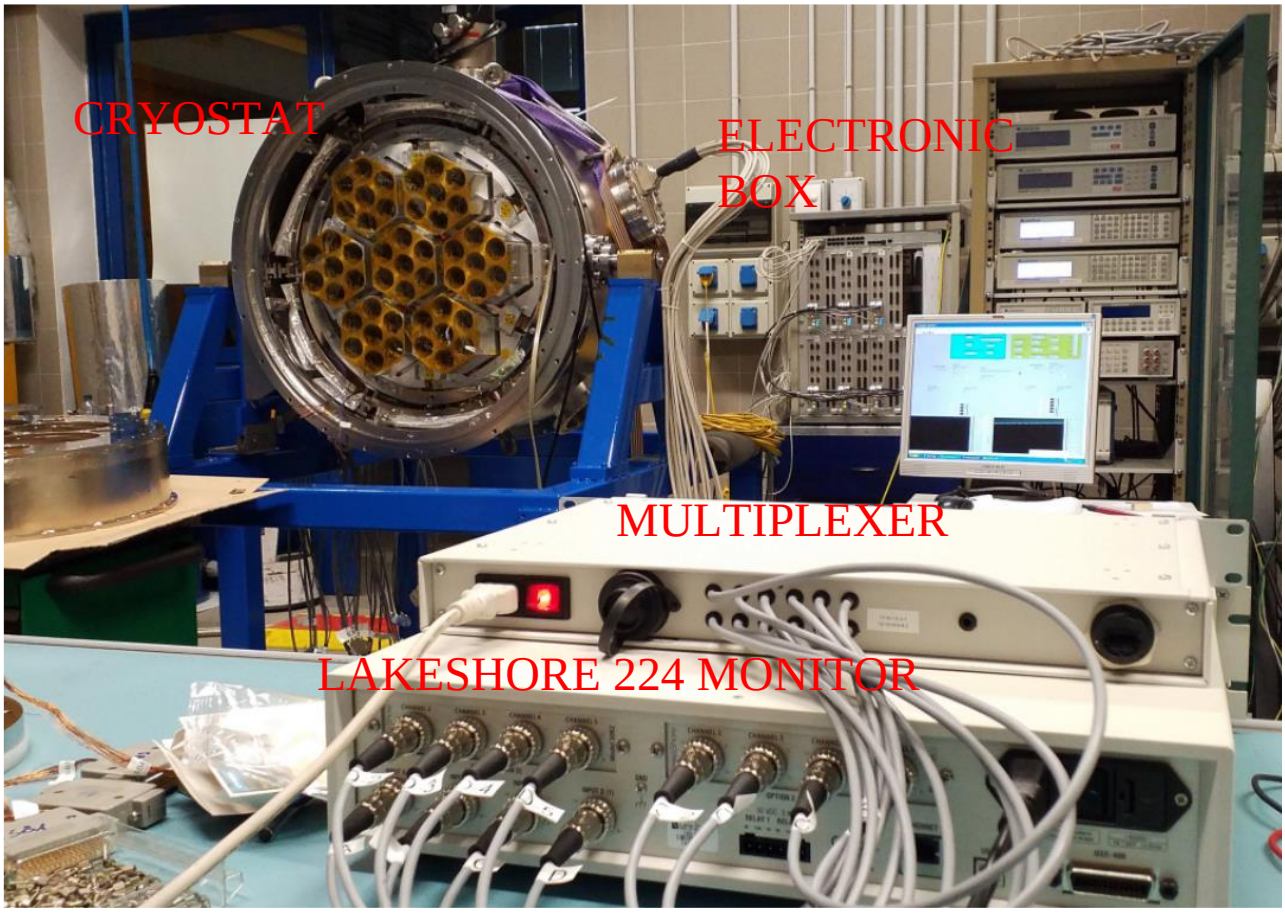


Figure 24

Figure 25 Harness from Multiplexer to Lakeshore. Labels are reported in §0

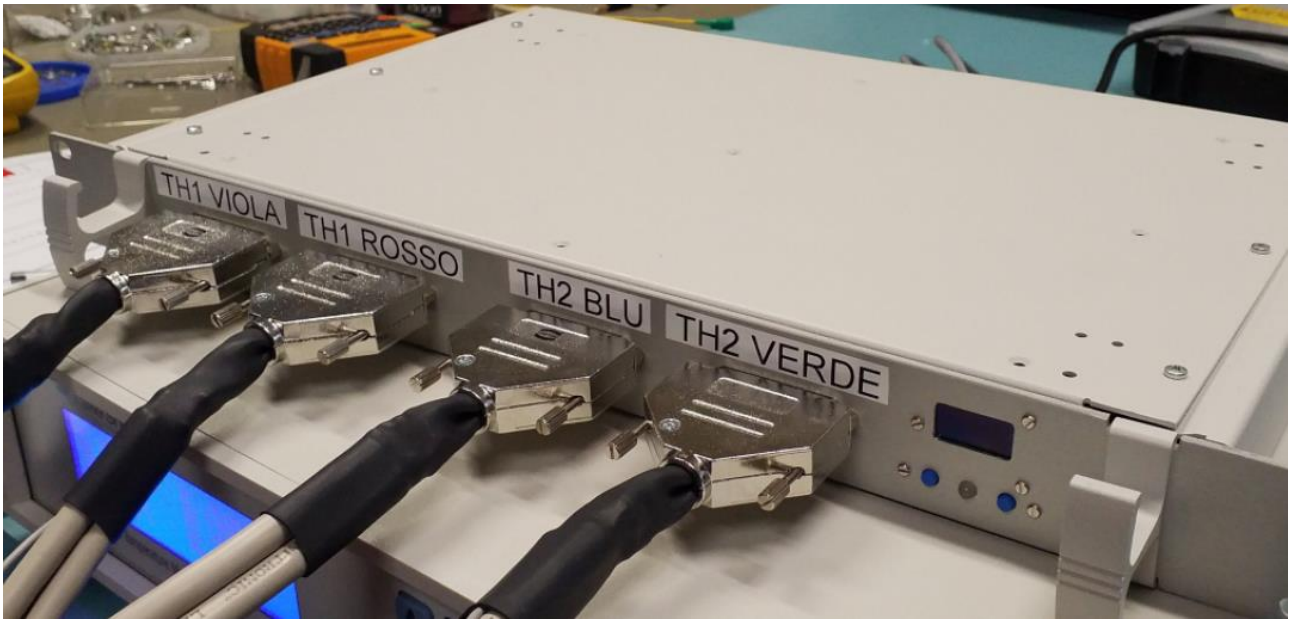


Figure 26 Multiplexer: cables labelling. Colours and names are the same reported in §0

Figure 27 External SYNC/CAN box (temporary backup for the CAN/SYNC board)

Figure 28 : CAN (black) / SYNC (grey) harness: connection scheme. All the board are connected in parallel to the SYNC/CAN external box.

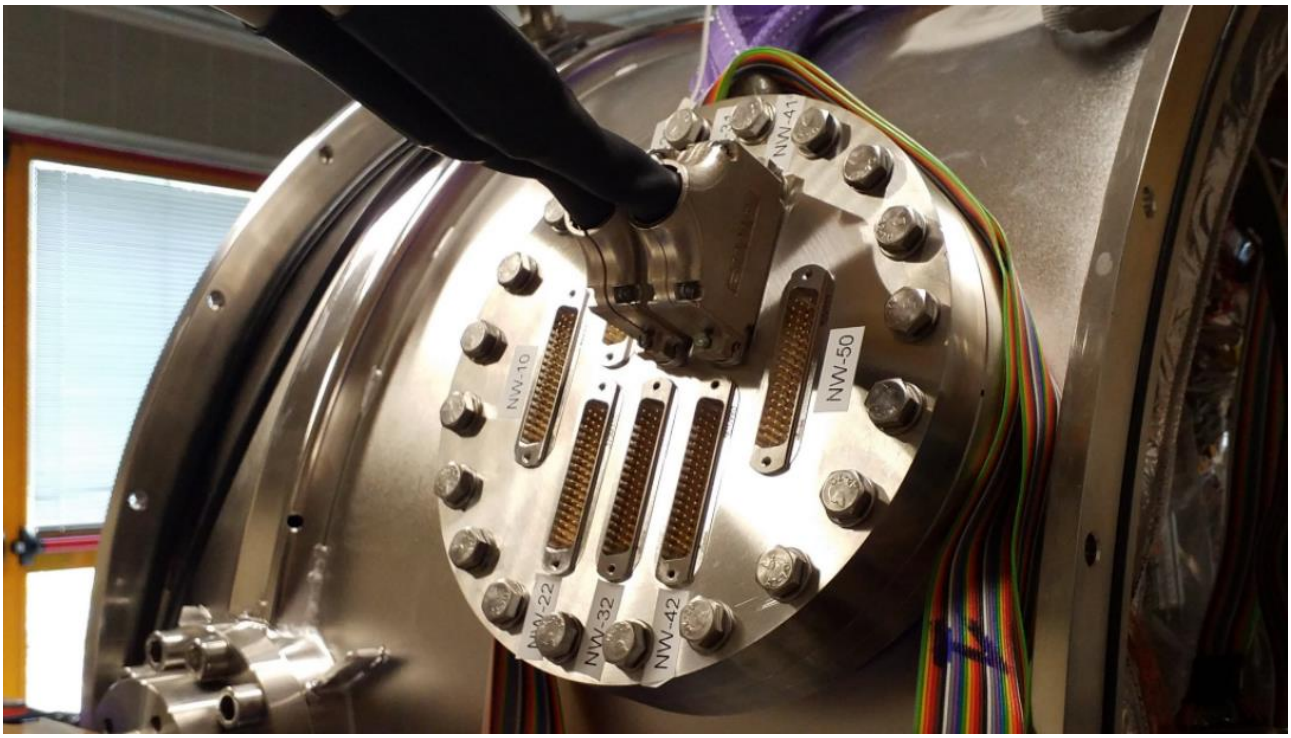


Figure 29 TH1 and TH2 harness connection to the NW flange (NW31 and NW41). Cable TH3. not shown in the picture, connects the cryostat to the Thermal Controller (Lakeshore 331)

8.5.2 Thermal Connectors – Multiplexer pairing

8.5.2.1 TH1– Multiplexer pairing

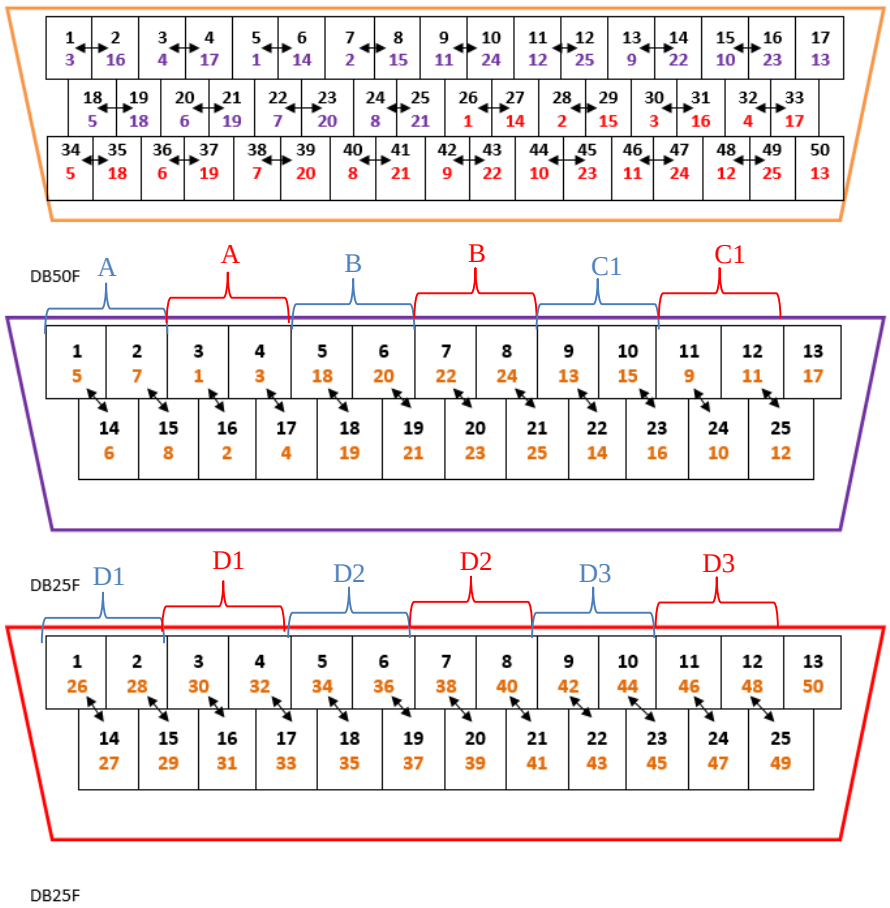


Figure 30 The letters (red and blue) indicate for each connector the channel of the multiplexer corresponding to the two switch states.

8.5.2.2 TH2– Multiplexer pairing

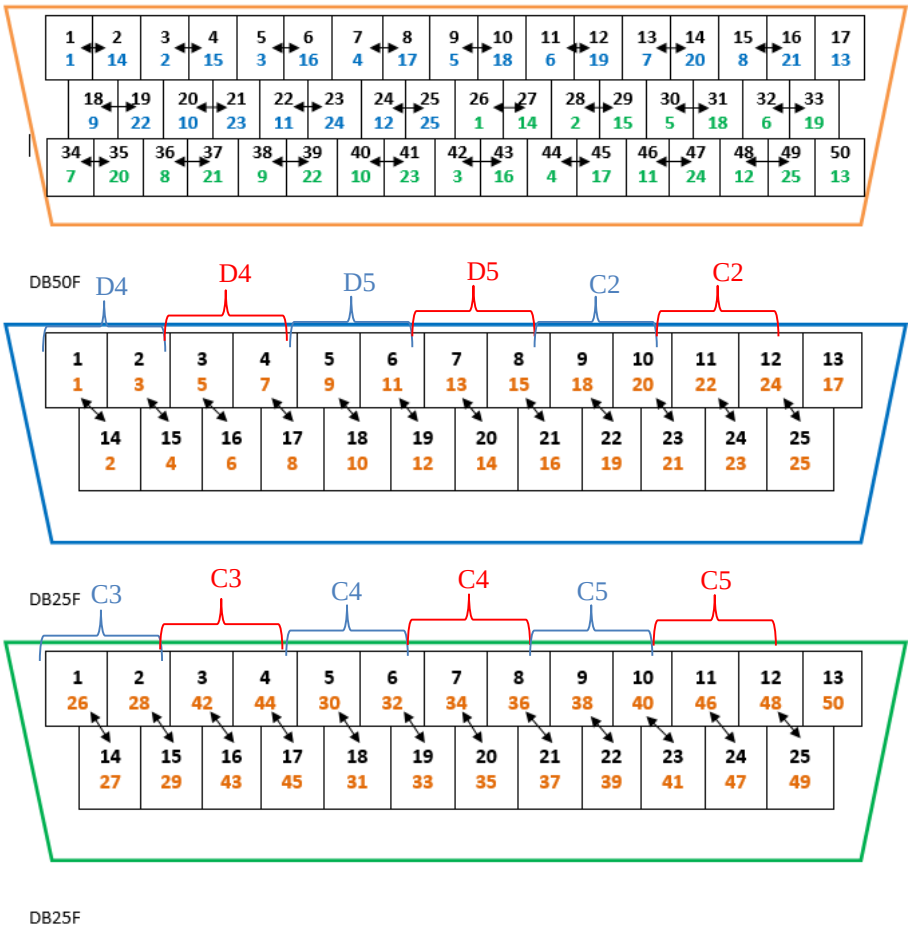


Figure 31 The letters (red and blue) indicate for each connector the channel of the multiplexer corresponding to the two switch states.