HERSCHEL / PLANCK

Planck assembly sequence
HP-3-ASP-TN-0521

Product Code: 200000

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ENREGISTREMENT DES EVOLUTIONS / *CHANGE RECORDS*

ISSUE	DATE	§ : DESCRIPTION DES EVOLUTIONS *§ : CHANGE RECORD*	REDACTEUR *AUTHOR*
01	12/09/03	Creation of the document	P.SCHLOSSER
02	09/04/2004	Introduction of the acoustic model FPU integration on CQM Implementation of instruments More details introduced for CQM & FM mounting All pages modified	P.SCHLOSSER
03	23/07/2004	Taking into account new philosophy for FM SVM delivery : . two batches instead of three . PLM operations in ALENIA premises PPLM CDR Rids taken into account Miscellaneous improvements	P.SCHLOSSER

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TABLE OF FIGURES

1. SCOPE

This document intends to describe the mechanical integration of PLANCK FM satellite.

The specificity of the PLANCK Acoustic model integration is addressed in chapter 5.

Those regarding of the PLANCK CQM integration are addressed in chapter 6.

It is not a comprehensive description of all mechanical operation, it will be updated the further the design will advance and completed with the freeze of the configuration of each model.

Figure 1 - PLANCK satellite

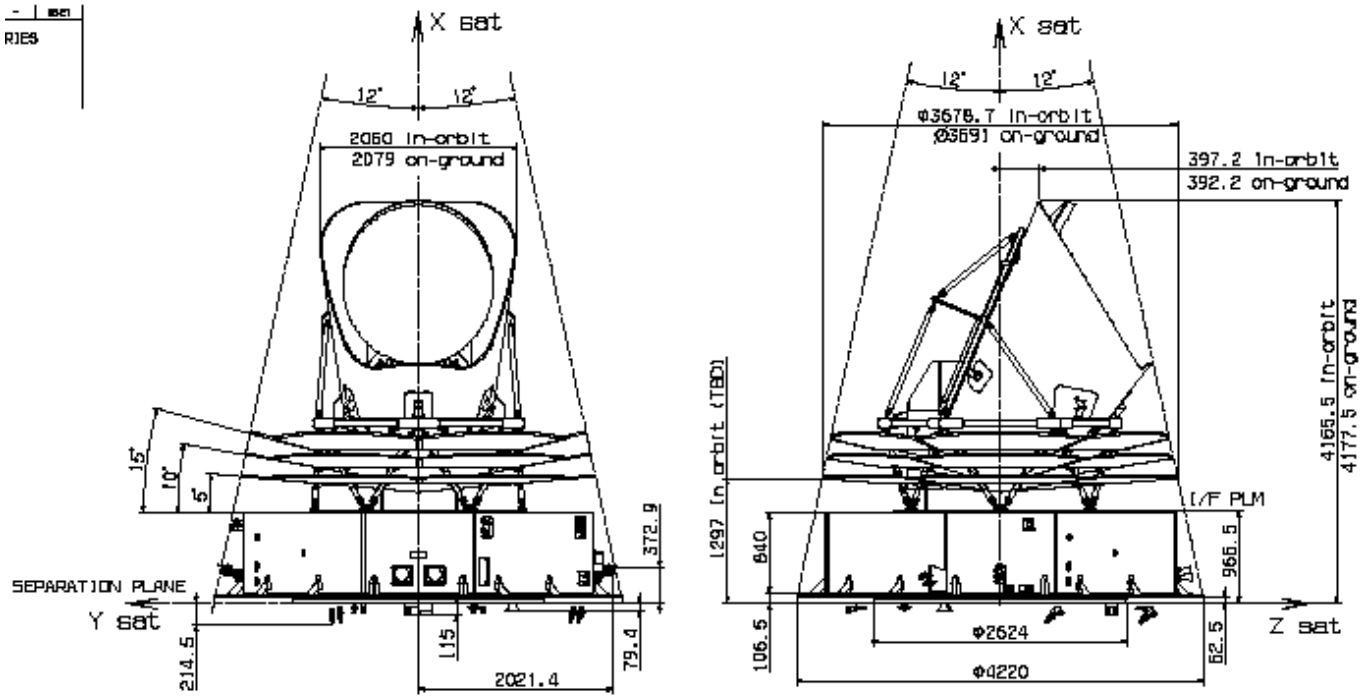


Figure 2 - PLANCK size

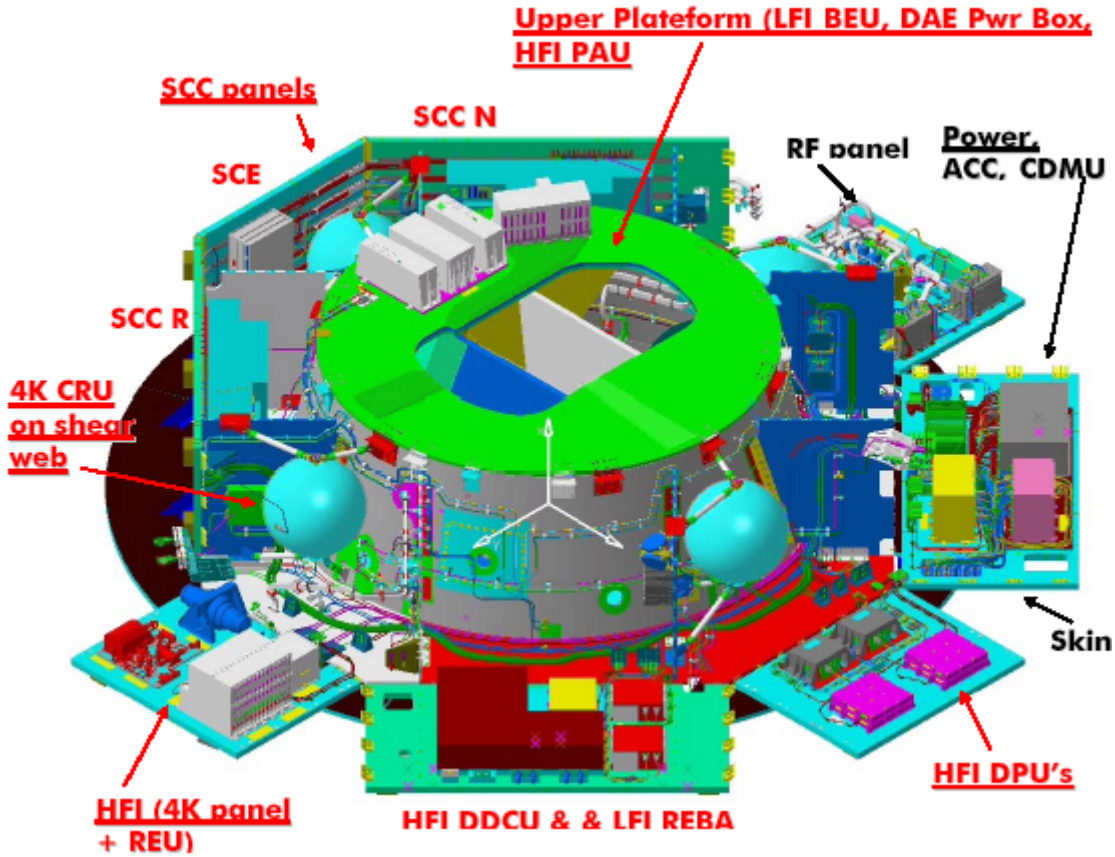


Figure 3 - SVM entirely integrated

2. DOCUMENTS AND ABBREVIATIONS

2.1 reference documents

Reference	Title
H-P-1-ASPI-LI-0119	MGSE deployment plan

2.2 applicable documents

Reference	Title
H-P-IC-AI-0001	Herschel / Planck SVM Mechanical Interface Control Document
H-P-3-ASP-IS-0492	PLANCK Ground Support Equipment Interface Control Document
H-P-3-ASP-TN-0442	PLANCK integration in clean rooms
H-P-3-ASPI-PL-0668	PLANCK PPL & S/C CQM AIT plan
H-P-3-ASPI-PL-0669	PLANCK RFQM AIT plan
H-P-3-ASPI-PL-0670	PLANCK STM AIT plan
H-P-3-ASPI-PL-0208	PLANCK PFM AIT plan

2.3 abbreviations

Acronyms	Keys
AIT	Assembly, Integration & Tests
CQM	Cryogenic Qualification Model
ESA	European Space Agency
FM	Flight Model
FPU	Focal Plane Unit
GSE	Ground Support Equipment
I/F(s)	Interface(s)
MGSE	Mechanical Ground Support Equipment
N/A	Not Applicable
NC	Not Communicated
PACE	Pipe Assembly and Cold End
PLM	Payload Module
PVHD	PLM Vertical Hoisting Device
RAA	Radiometry array Assembly
S/C	Spacecraft
SLD	SVM Lifting Device
SM	Structural Model
SVM	SerVice Module
TBC	To Be Confirmed
TBD	To Be Defined (by the Contractor)
TBS	To Be Specified (by the Prime Contractor)
THA	Transport and Handling Adapter

3. PLANCK MECHANICAL INTEGRATION PLAN

3.1 Integration sequence overview

The mainframe is the PFM assembly sequence.

Acoustic and CQM assembly sequence are derived from PFM, taking into account specificity like dummies

The overall PFM assembly sequence is (see following page):

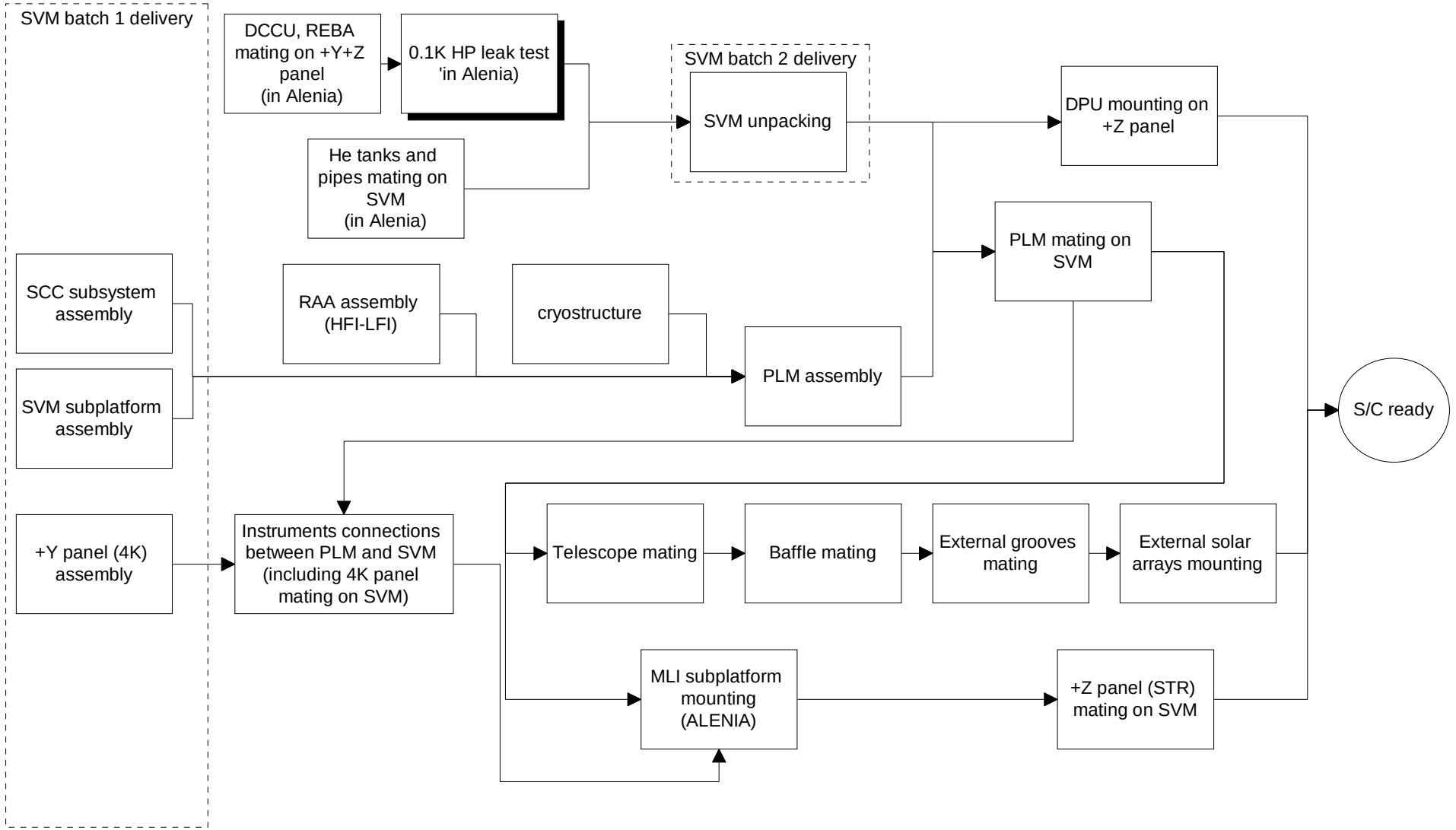


Figure 4 - Overall PFM integration PERT

4. PLANCK FM INTEGRATION SEQUENCE

The overall sequence of operations will be :

A. cryostructure integration
B. cryostructure mating on SVM
C. PLANCK integration and IST1
D. RF test in CATR (Cannes)
E. MCI characteristics in Cannes
F. Vibrations (Sinus/Acoustics) in Cannes
G. Fit-Check
H. Thermal test in CSL
I. IST2
J. Launch campaign in CSG

Obviously, only the main operations are described hereafter in the FM sequence. In order to have a clear understanding, operations like for instance MGSE preparations are not identified here.

The detailed mechanical integration sequence is the following:

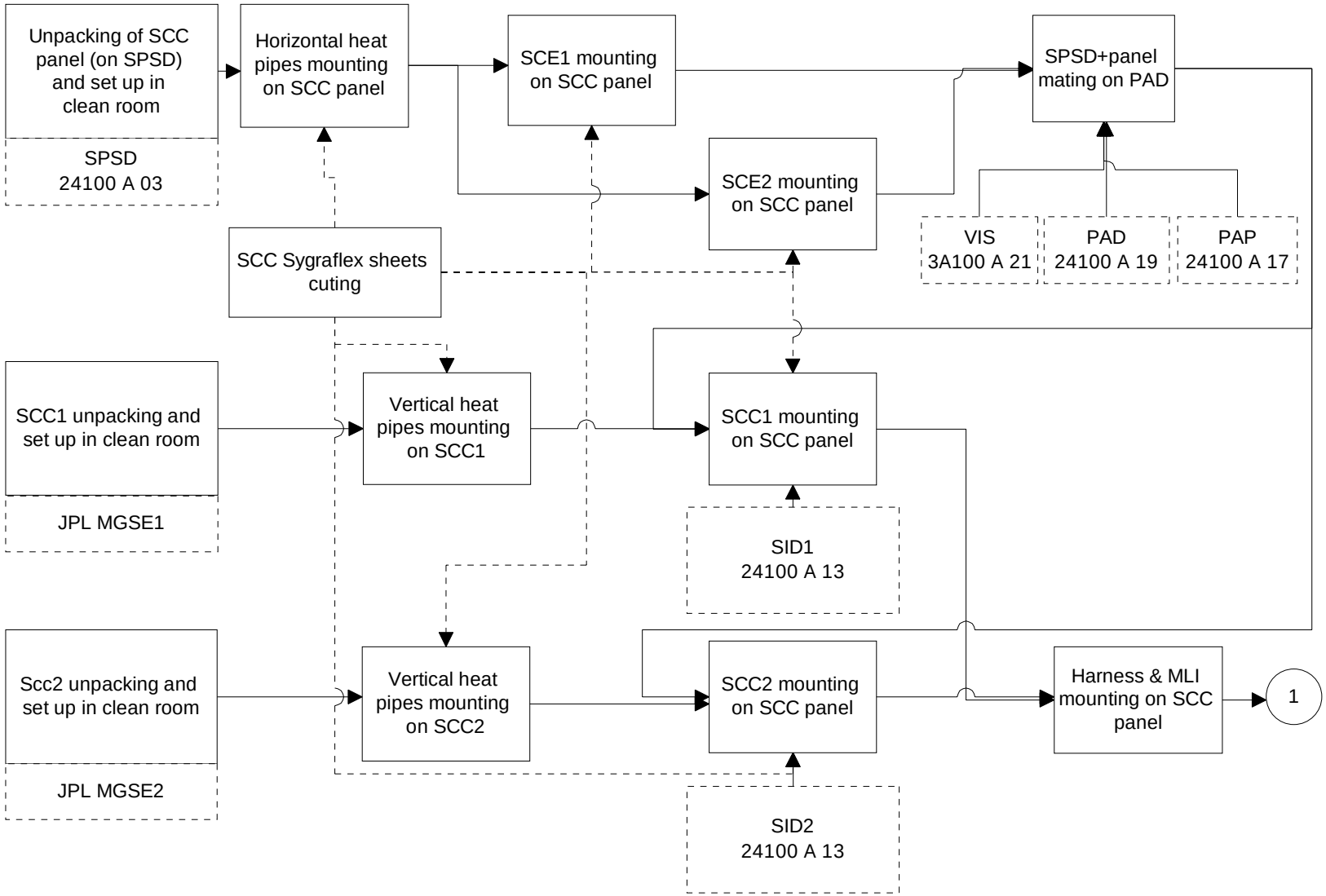


Figure 5 - PLANCK FM mechanical integration sequence

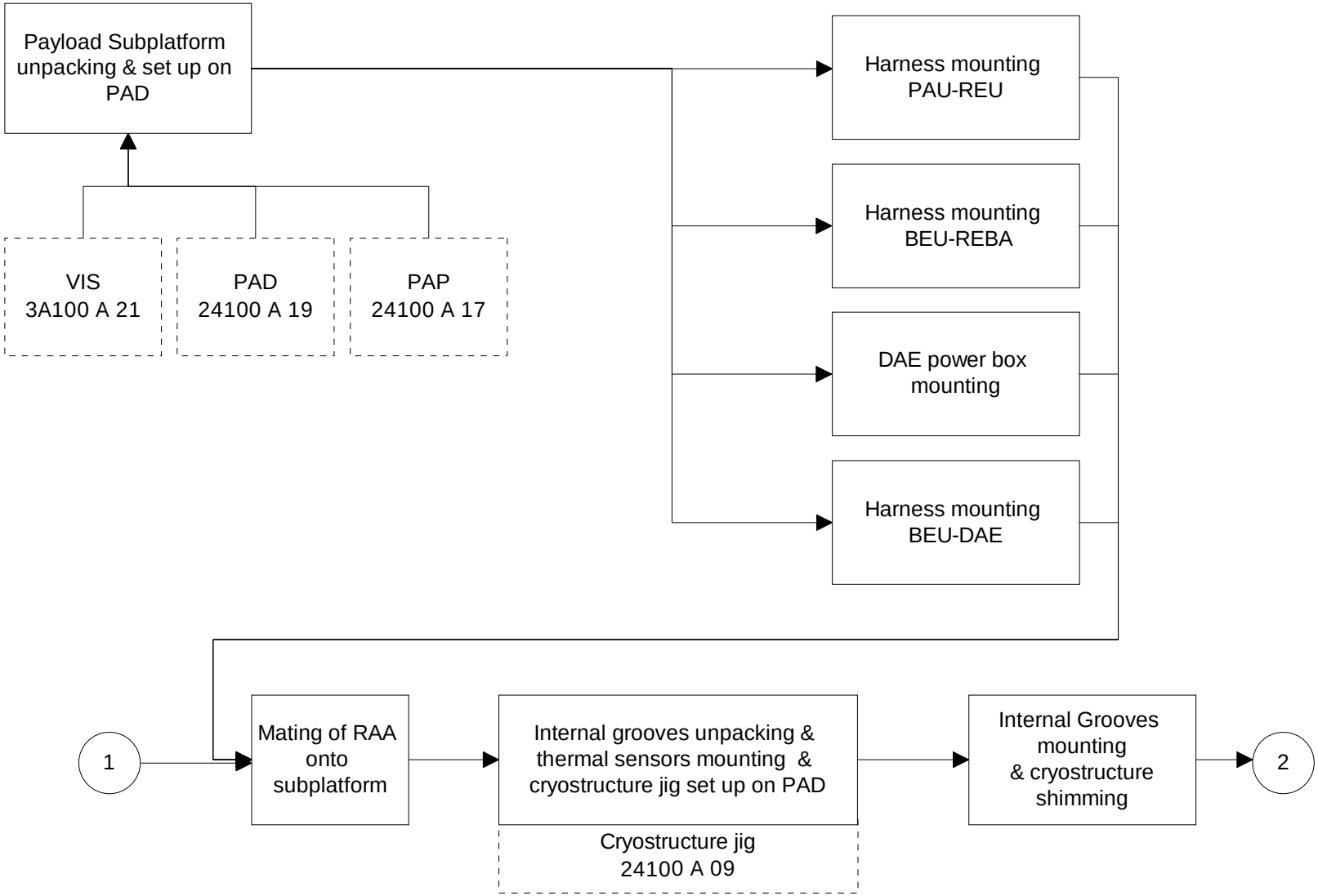


Figure 6 - PLANCK FM mechanical integration sequence (cont.)

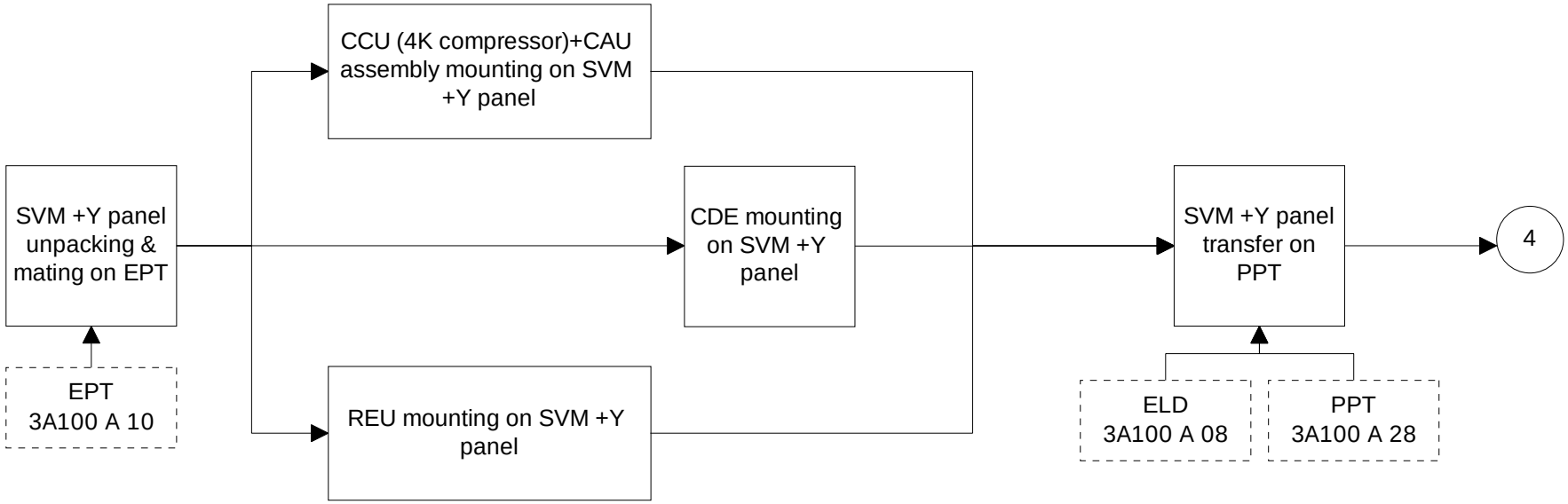


Figure 7 - PLANCK FM mechanical integration sequence (cont.)

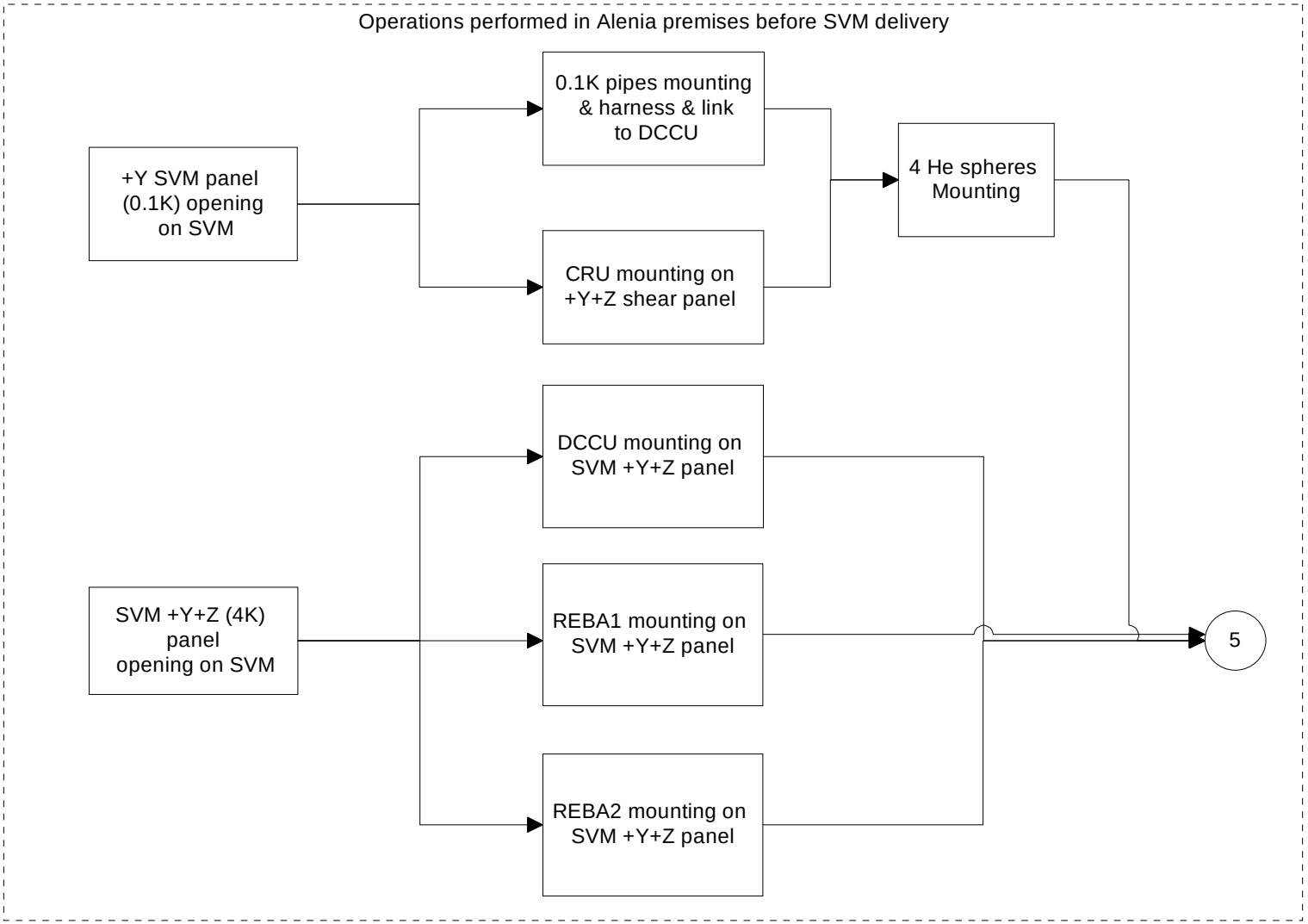


Figure 8 - PLANCK FM mechanical integration sequence (cont.)

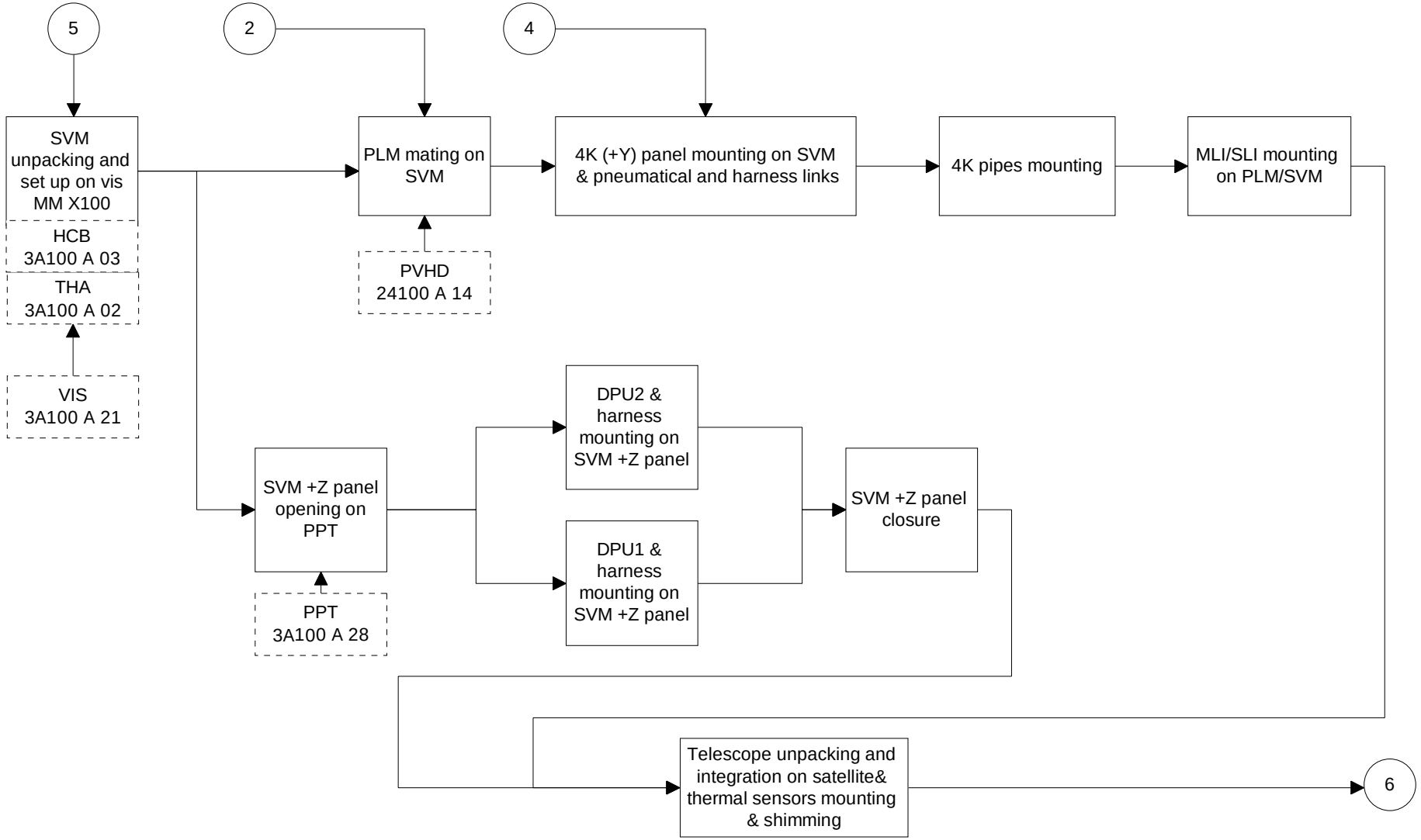


Figure 9 - PLANCK FM mechanical integration sequence (cont.)

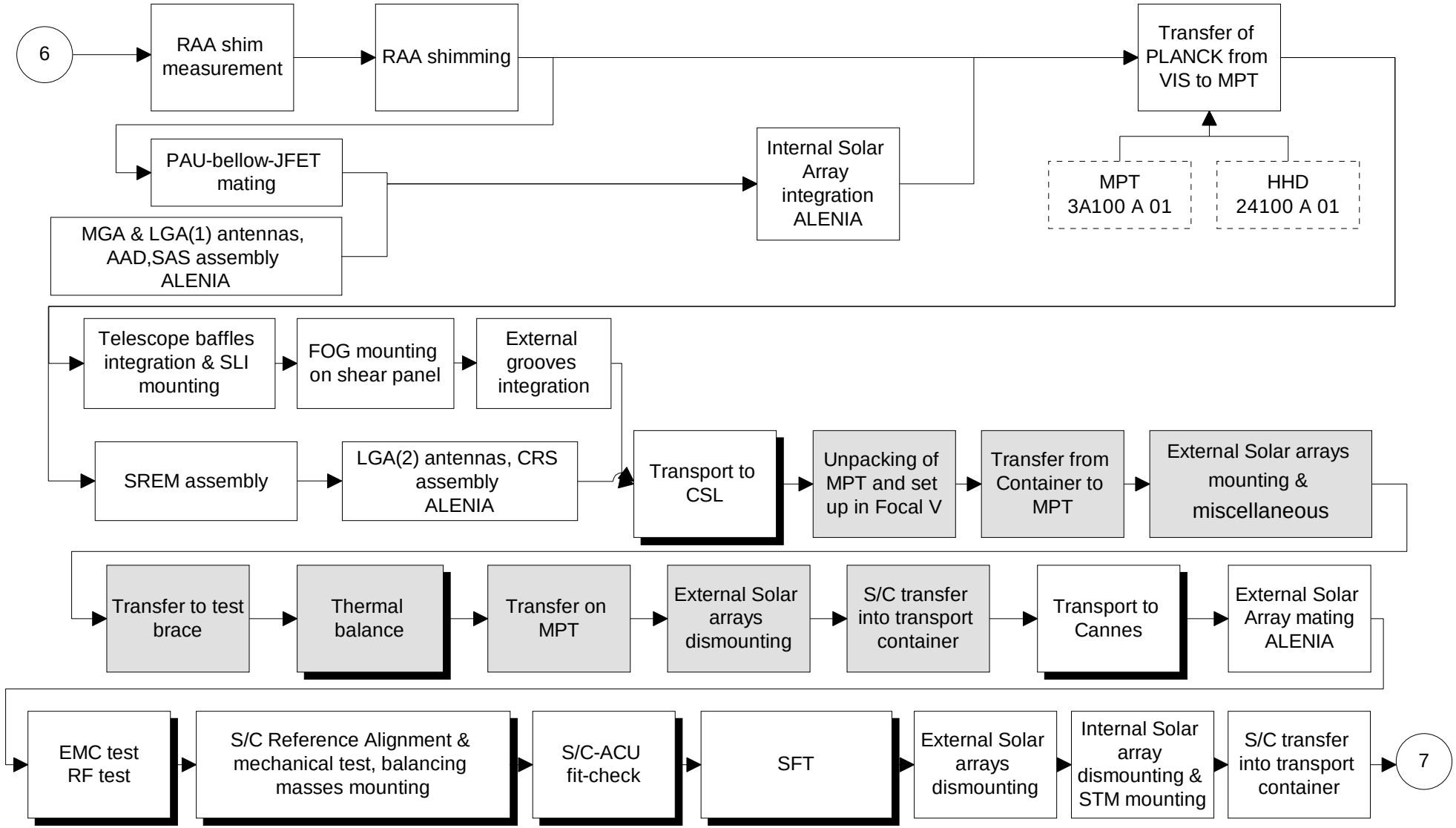


Figure 10 - PLANCK FM mechanical integration sequence (cont.)

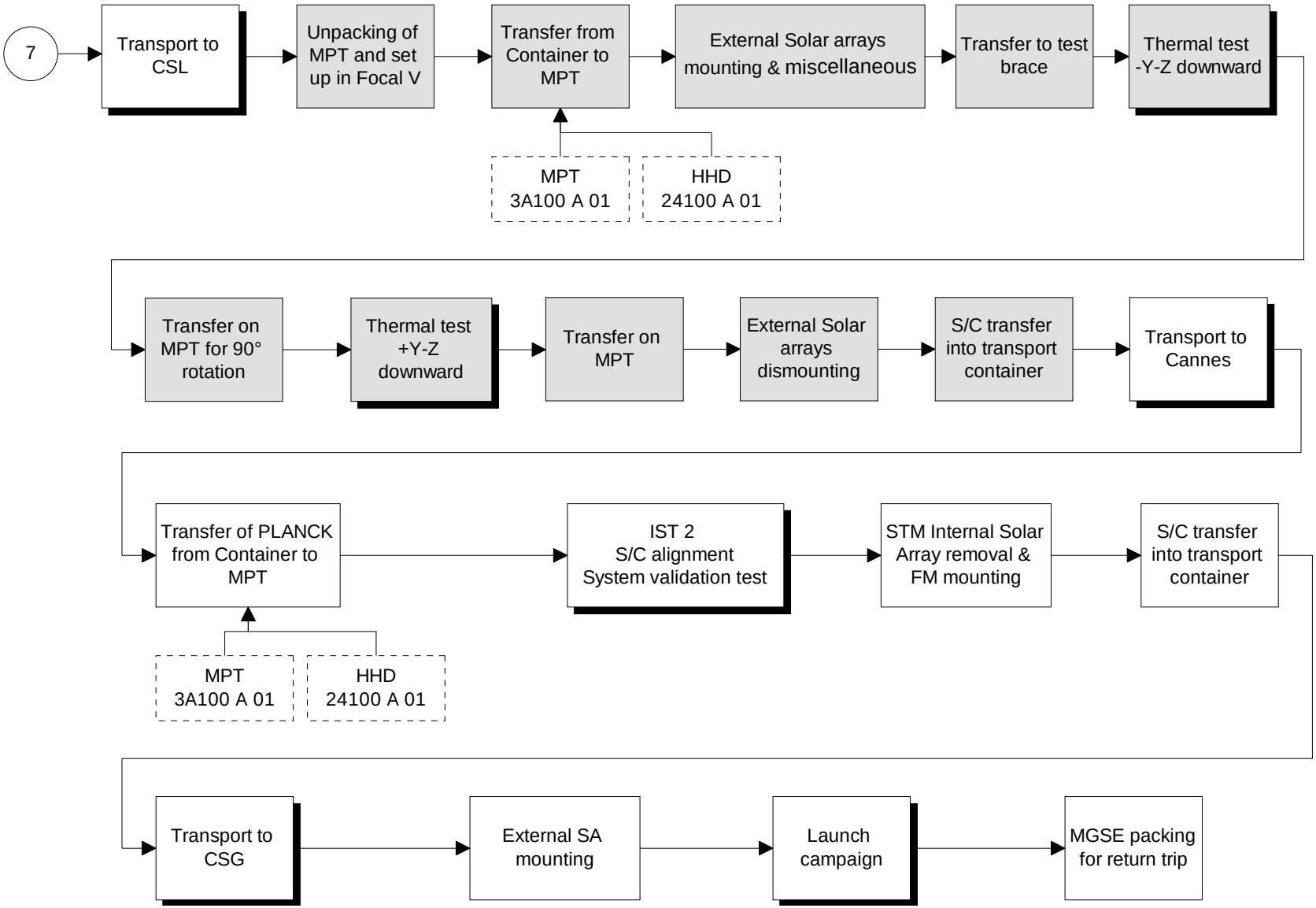


Figure 11 - PLANCK FM mechanical integration sequence (cont.)

4.1 SCC integration

MM001 : SCC panel unpacking

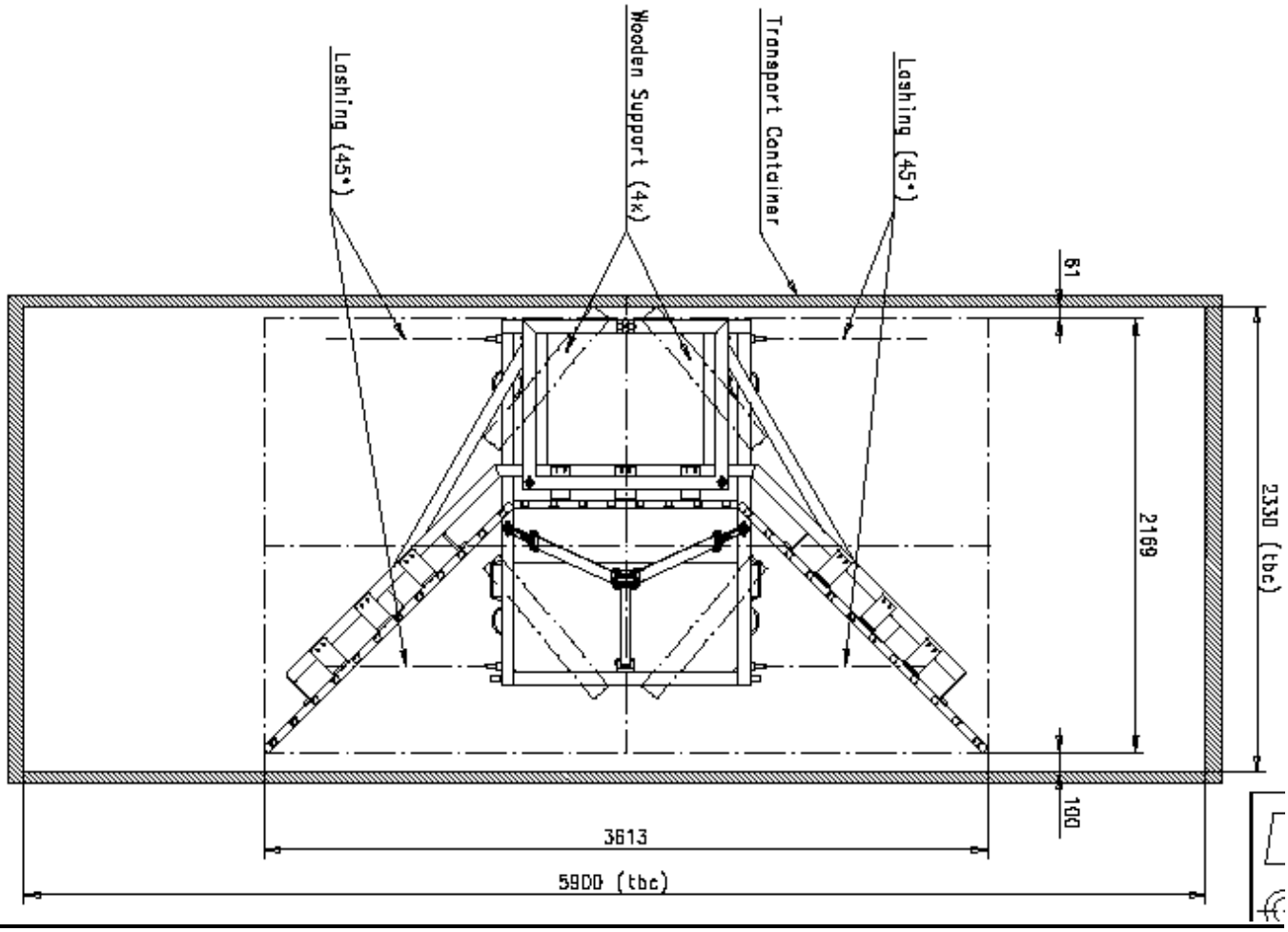


Figure 12 - SPSD + panel in transport box

SCC panel is delivered from ALENIA already mounted and fitted on the SPSD, MGSE used for transportation and SCC subsystem integration.

After opening of the container, the SPSD is configured for integration.
The upper part of SPSD is hoisted and turn by 180° around vertical axis.

Figure 13 - SCC Panel Stiffener Device (SPSD) on its trolley with hoisting device

MM002/MM003 : SCC unpacking

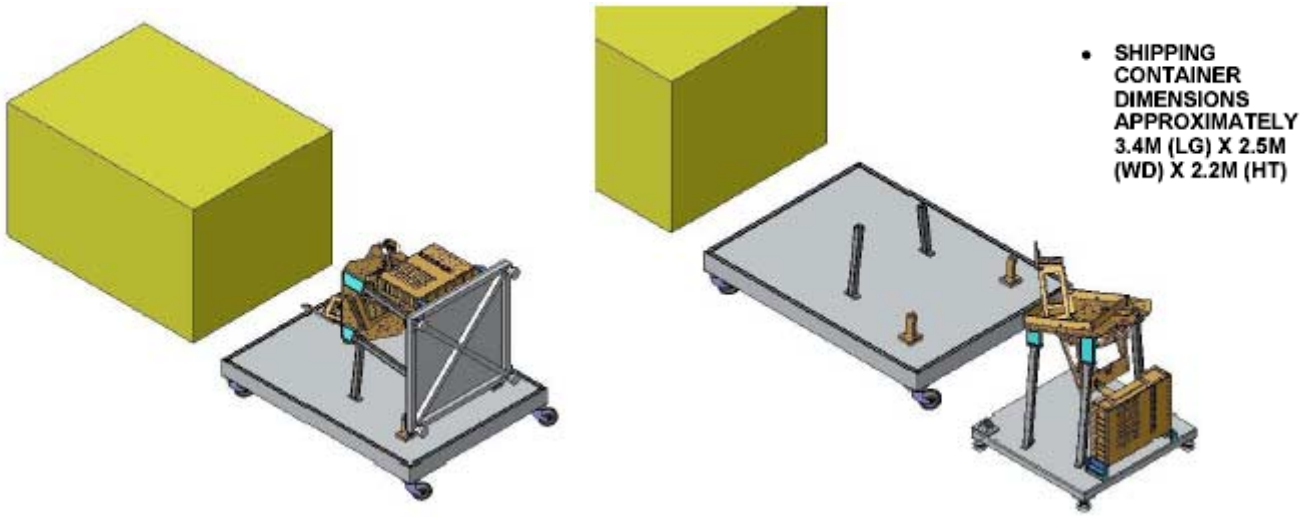


Figure 14 - SCC unpacking

MM005/MM006 : Vertical Heat Pipes mounting on SCC1/SCC2

SCC is set up on its transport MGSE for vertical heat pipes and spacers integration.

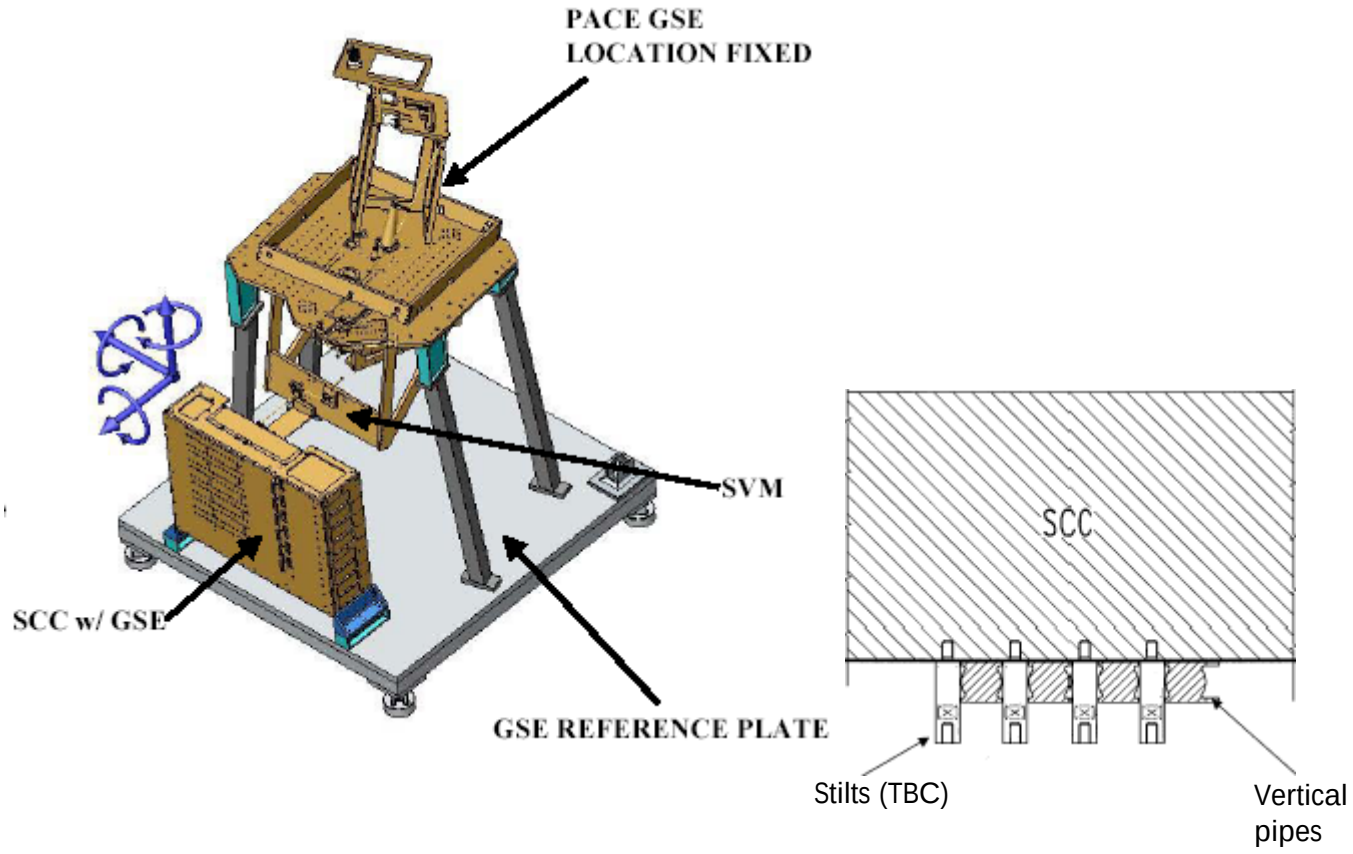


Figure 15 - Vertical HP integration

MM00? : SID set up

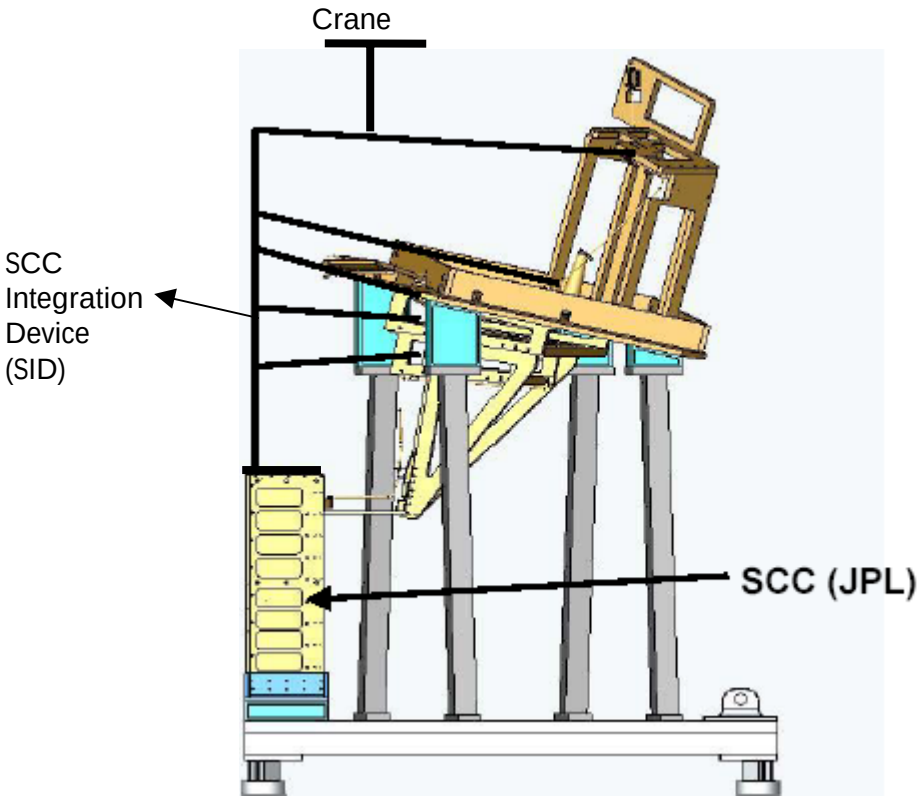


Figure 16 - SID installation on TMU, JPL MGSE still in place

one transfers the TMU to SID for spacecraft integration (JPL MGSE has not designed for integration with either the Planck payload or spacecraft).

JPL ships TMU attached to the flight side of PACE hardware, thus SID can be interfaced on the MGSE side of the precoolers for further grooves integration on PAD.

JPL PACE-MGSE is then removed sequentially.
JPL ships with flight side of the compressor exposed for attachment of heat pipes.

Subsequent removal of JPL MGSE is performed.

Nota : about SCC interface with SID, the top interface is preferred because of :

1. To avoid to stress a flight interface for handling during integration
2. The actual design of heat pipes not very convenient to define hoisting interface

MM004 : Horizontal Heat Pipes mounting on SCC panel

Horizontal heat pipes are mated on SCC panel (Sygraflex sheet between heat pipes and panel). The SCC panel is delivered mounted on the SPSD.

MM007/MM008 : SCE1/SCE2 mounting on SCC panel

The two SCE electronics are integrated on central panel on horizontal heat pipes with sygraflex sheet.

Mounting procedure TBD

MM009/MM010 SCC1/SCC2 : mounting on SCC panel

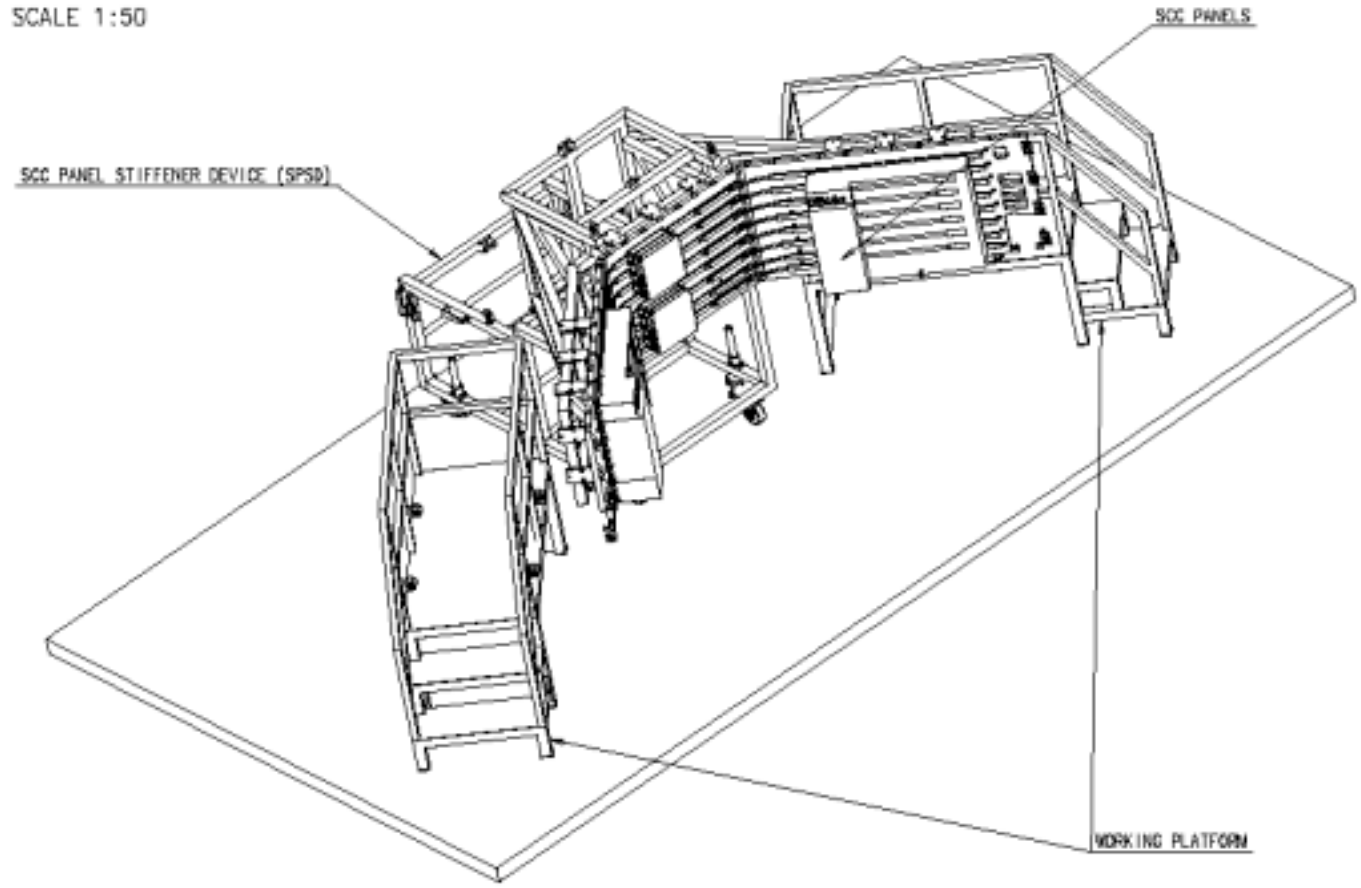
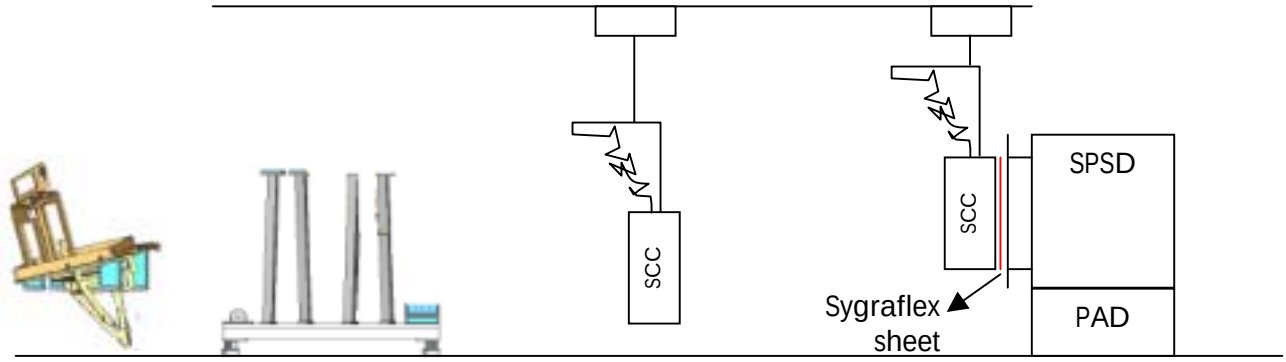


Figure 17 - SCC integration stand (SPSD is actually mated on PAD, not shown here)

Afterwards, the SCC is approached to the panel for mating.



Once the compressor is torqued on the panel, its handling fixture is removed.

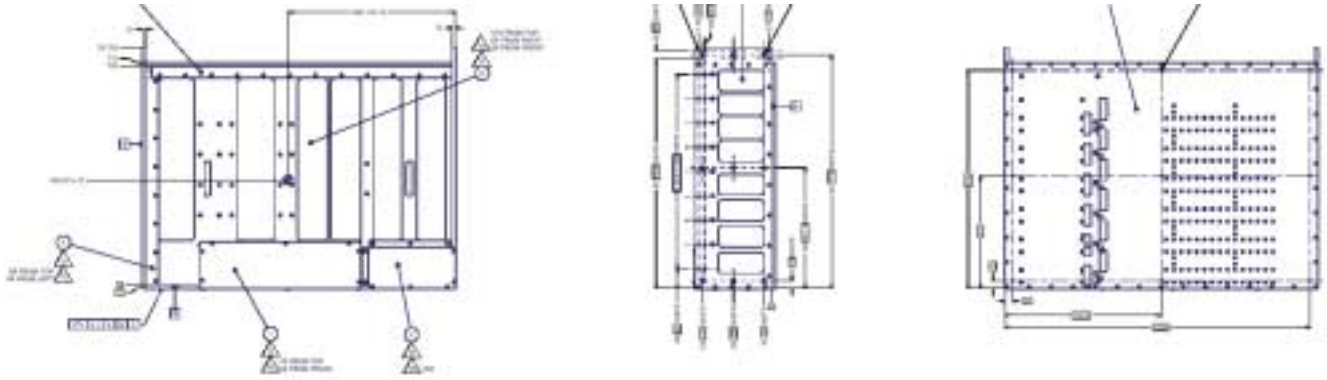


Figure 18 - SCC handling fixture (abstract of JPL 10203041X2N drawing)

Handling fixture internal brackets are then removed.

MM011 : Harness & MLI mounting on SCC panel

Electrical harness is mounted and electrical connections performed.
Mounting procedure TBD (waiting for definition)

MLI will be cut to fit in order to have access to SCC valves.

4.2 Cryostructure integration

4.2.1 Payload subplatform set up & DAE power box integration

MM020 : Payload subplatform unpacking & set up on PAD

The Payload Subplatform (35 kg TBC) will be set up on the integration stand (PAD) thanks to hoisting device delivered with it.

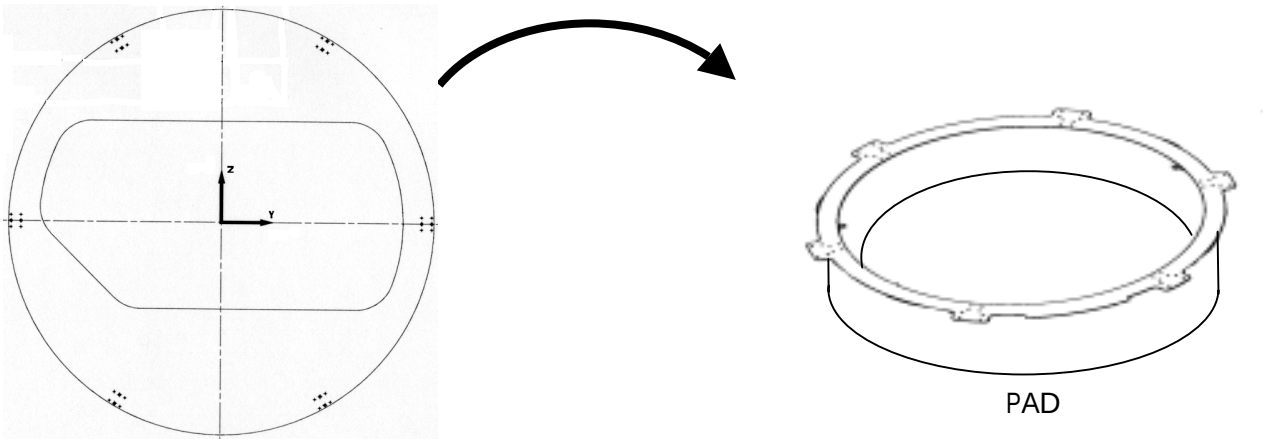


Figure 19 - Subplatform set up on PAD

MM023 : DAE power box mounting

The DAE Power Box is accommodated below the sub-platform on .+Z. side. The DAE Control Box is connected to the BEU which is located on top of the sub-platform + Z. side. For the mechanical fixation will follow the rules as for SVM units and no special thermal interface requirements are considered on the SVM platform.

The mass of DAE power box is ~7 kg).
The DAE power box will be mated by hand on the 'bottom' side of the platform.

Harness will be routed before mounting (as much as possible).

Figure 20 - DAE power box integration

MM025 : integration of SCC panel on PLM

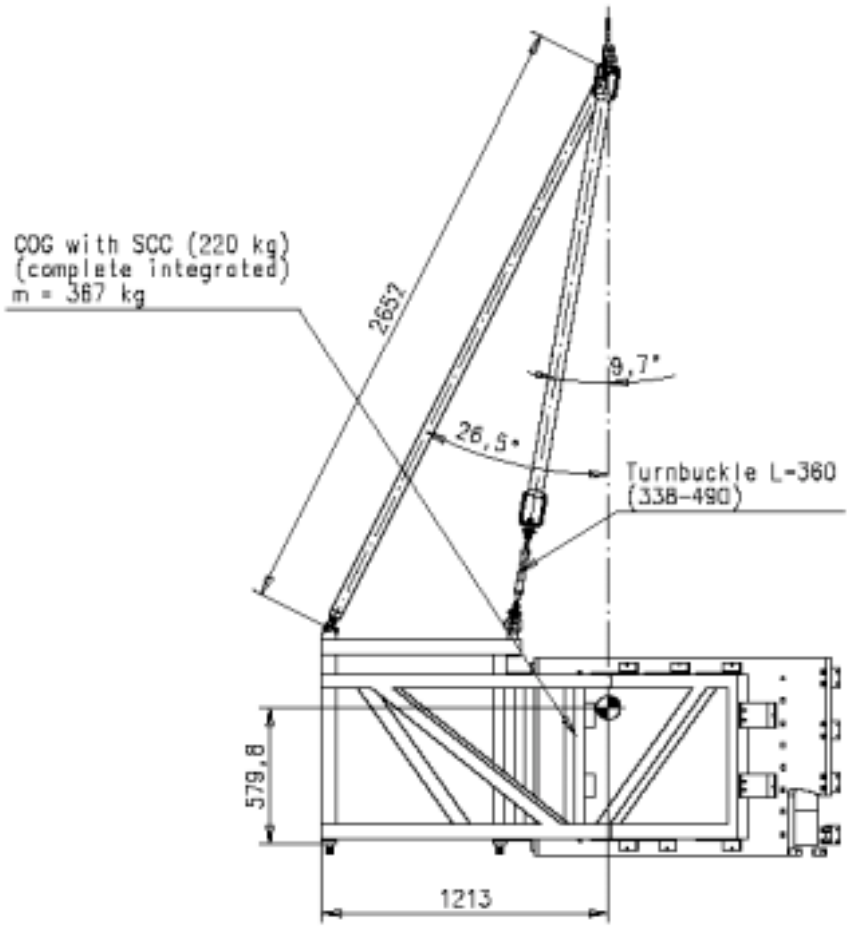


Figure 21 - SPSD sustaining SCC panel equipped ready for integration on Satellite

Once everything is assembled on panel, SPSD is hoisted by four slings attached to the crane to integrate the panel on the PAD by a top-down vertical approach as SCC envelop does not authorize horizontal approach because of interaction with SVM shear panel.

MM021 : PAU-REU harness mounting
MM022 : BEU-REBA harness mounting
MM024 : BEU-DAE harness mounting
Harness is routed onto and under subplatform.

TBD

Figure 22 - Harness routing on Subplatform (routing not contractual)

MM026 : RAA preliminary mating

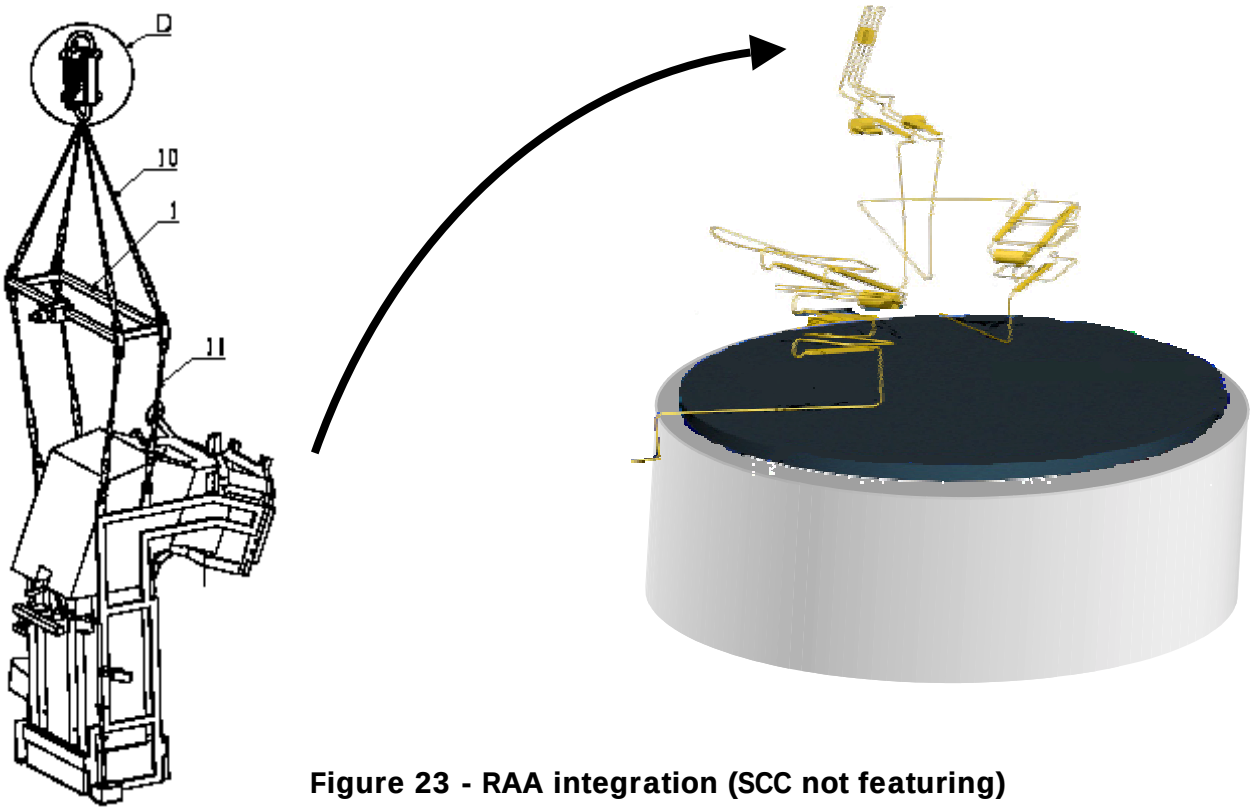
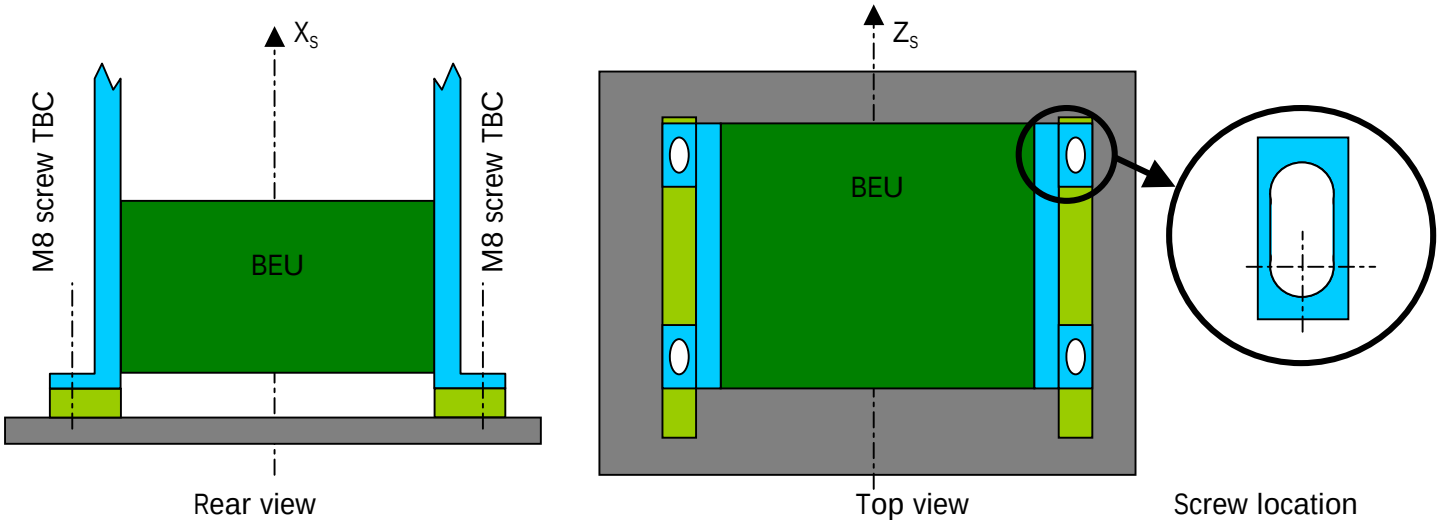


Figure 23 - RAA integration (SCC not featuring)

RAA is mated on the payload subplatform. A non-flight shim (thickness 10 mm) is installed between BEU (electronic box at the bottom of RAA) and the subplatform. As the flight shim is assessed between 2 and 9 mm, a 10 mm raising will create clearance between 0.1 K pipe & 4 K pipe regarding coming grooves.



The RAA is fixed on subplatform by four M8 (TBC) screws. The RAA MGSE will feature oblong holes in order to position along Z axis the RAA. The purpose is to get a maximum clearance between :

- 0.,1 K - 4 K thermal brackets and grooves
- FPU fixation struts and telescope primary panel.

4.2.2 Grooves integration

Grooves with struts will arrive completely assembled from sub contractor on an integration & transport MGSE.

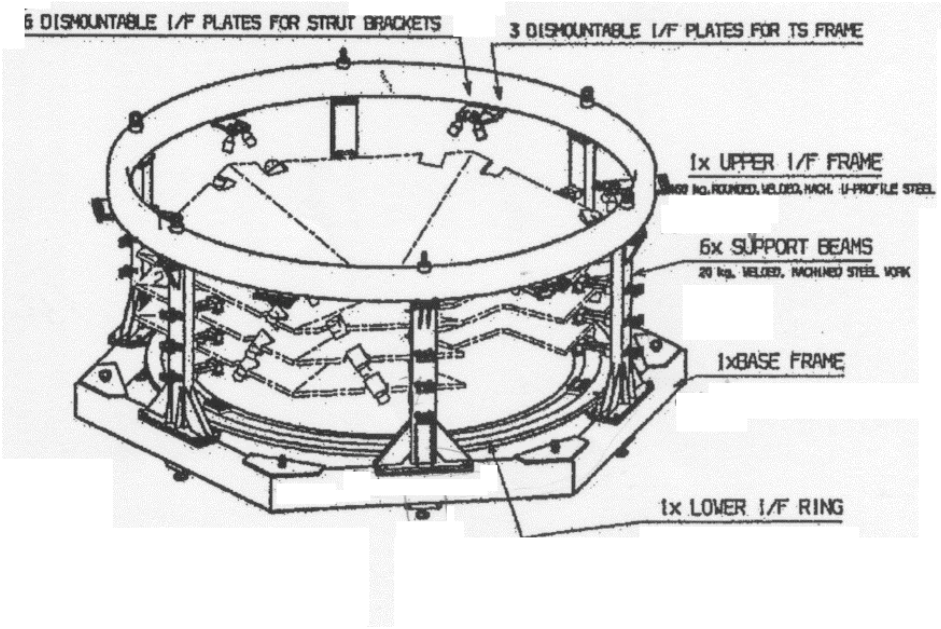


Figure 24 - Cryostructure integration tool

It is composed of a lower ring, six support beams and an upper frame. It is disassembled as it is used as integration tool. The three grooves will be put on floor (with protection) waiting integration.

Four support beams are mounted on the PAD. They are located thanks to the two pins featuring on the insert of the subplatform and two pins featuring on the support beam (location accuracy better than 0.1 mm)

To be introduced

Figure 25 - Support beam positioning regarding Subplatform

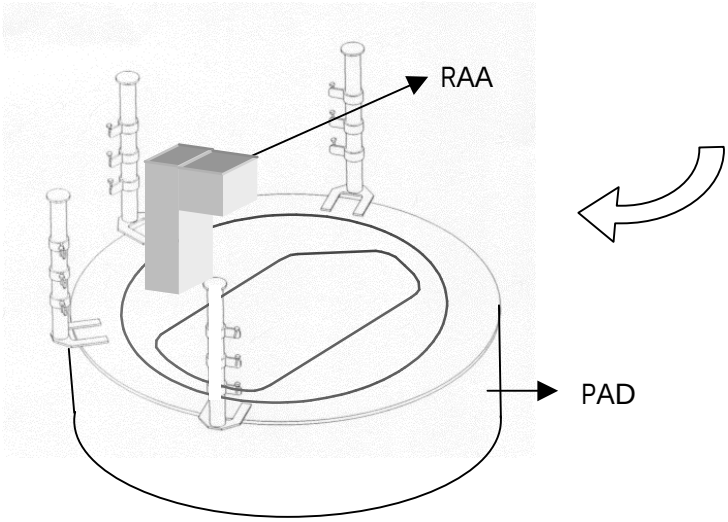


Figure 26 - Ready for groove 3 integration (PACE not featuring)

The bottom of the helix and pipe support above groove 3 have been removed. All grooves interfaces (PACE and 4K & 0.1K pipe) are protected thanks to PTFE sheets (to be prepared by AIT)

Groove 3 (upper one) is integrated first, followed by groove 2 and finally groove 1. Once one groove is set up, precoolers and brackets under it are fixed before mounting of the groove below.

The last two support beams are then mounted. Grooves lay down supports located on support beams. They center the grooves in order to repeat their position obtained on Contraves tool.

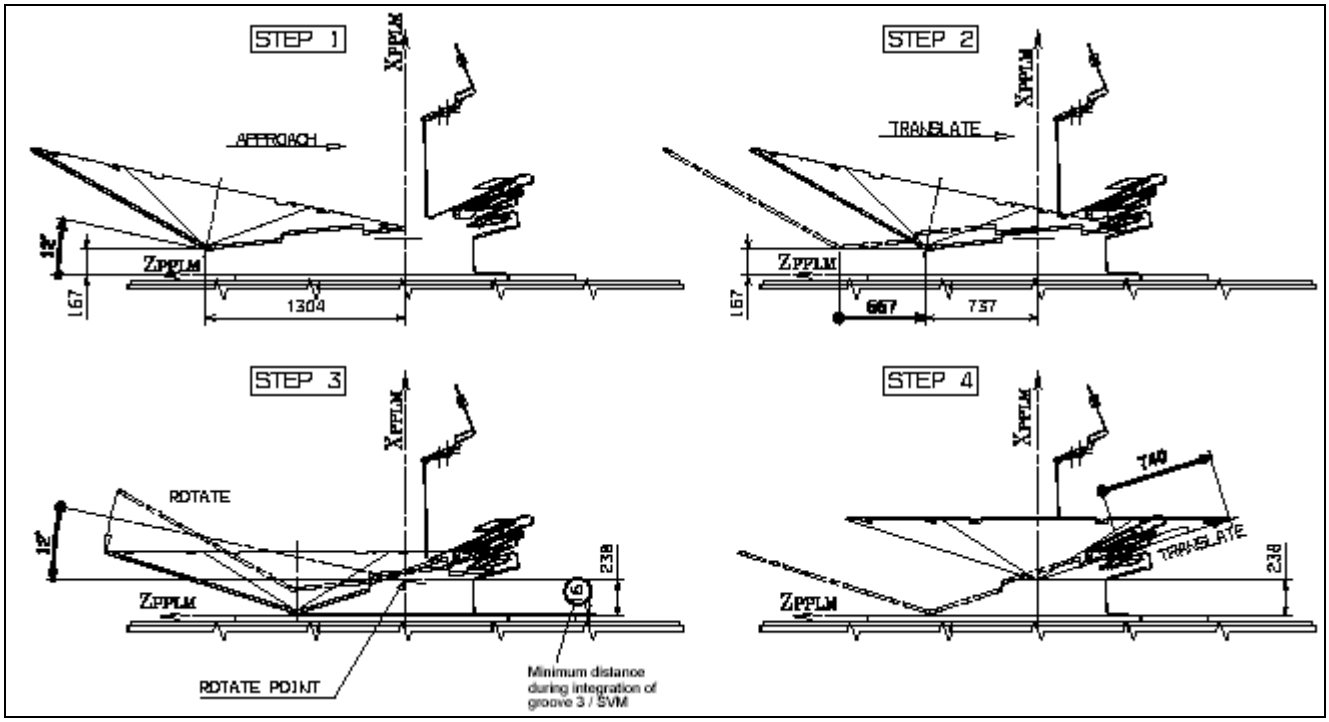


Figure 27 - Groove 3 integration kinematic

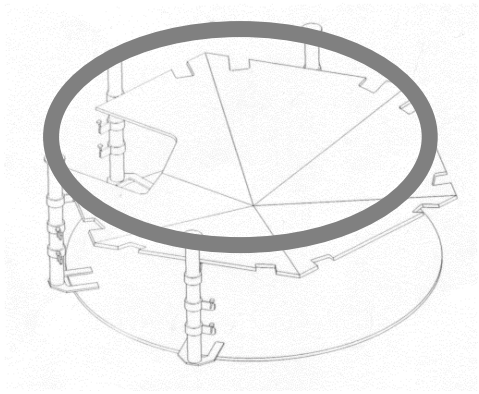


Figure 28 - Groove 3 mounting configuration

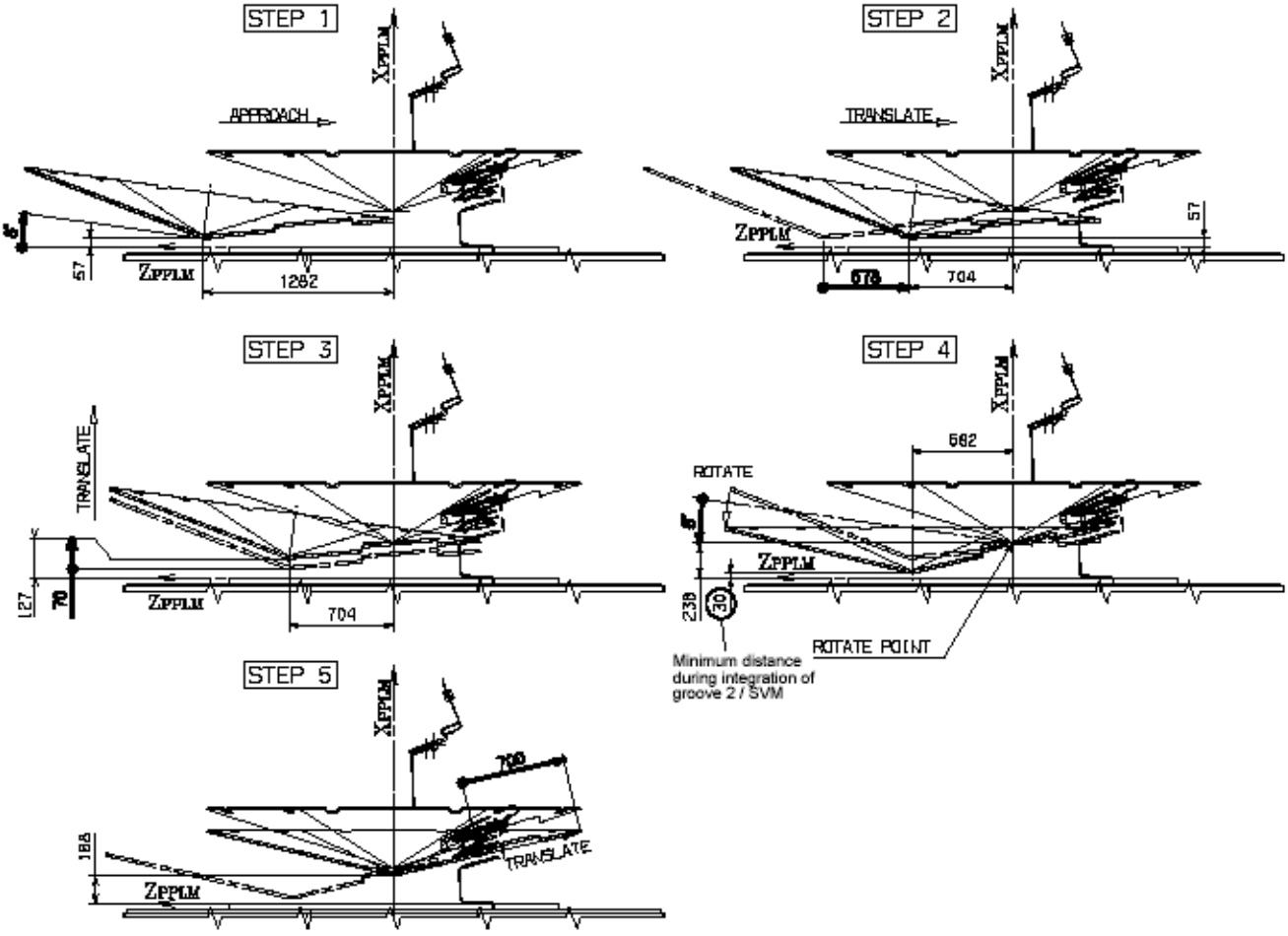


Figure 29 - Groove 2 integration kinematic

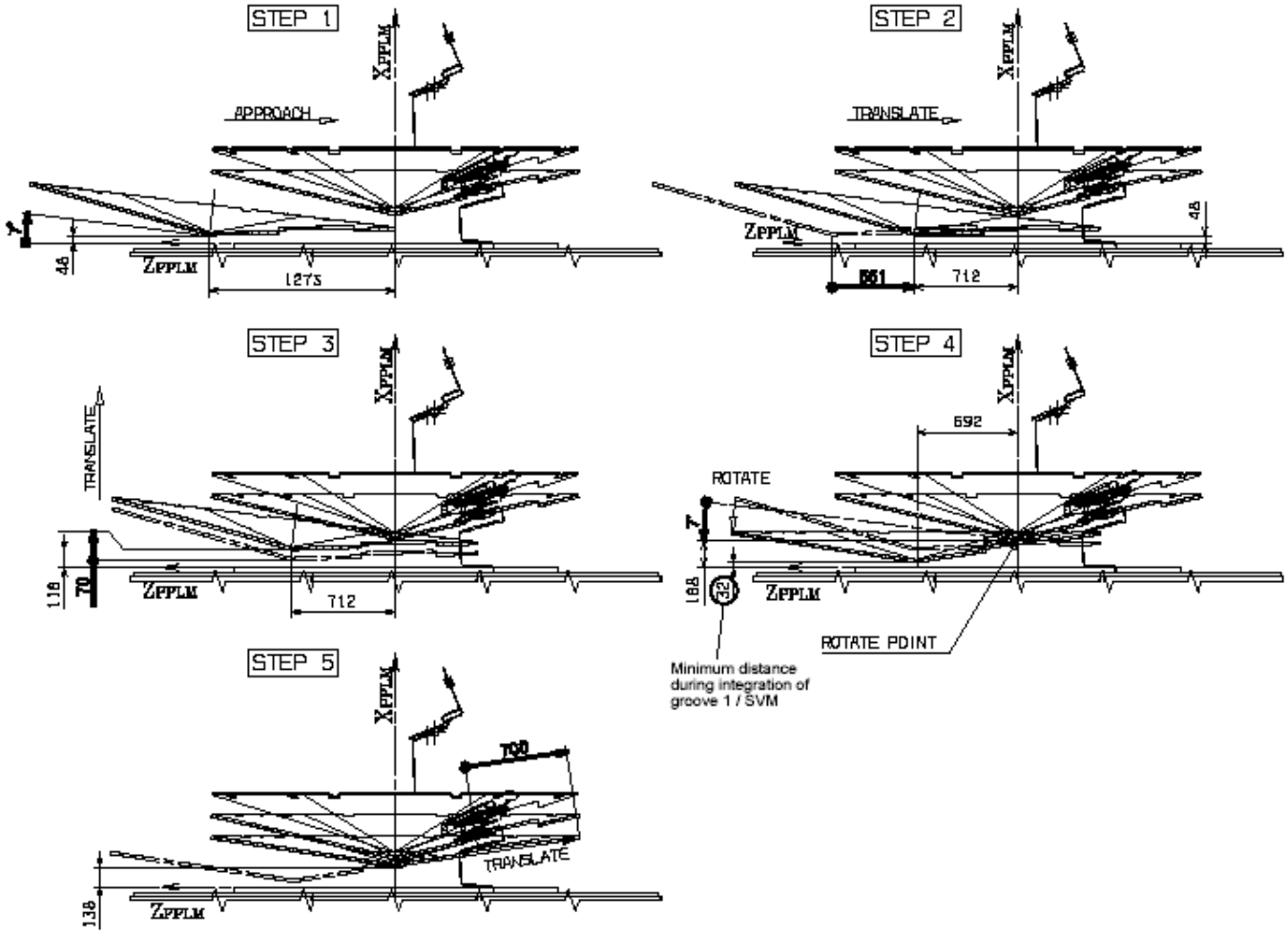
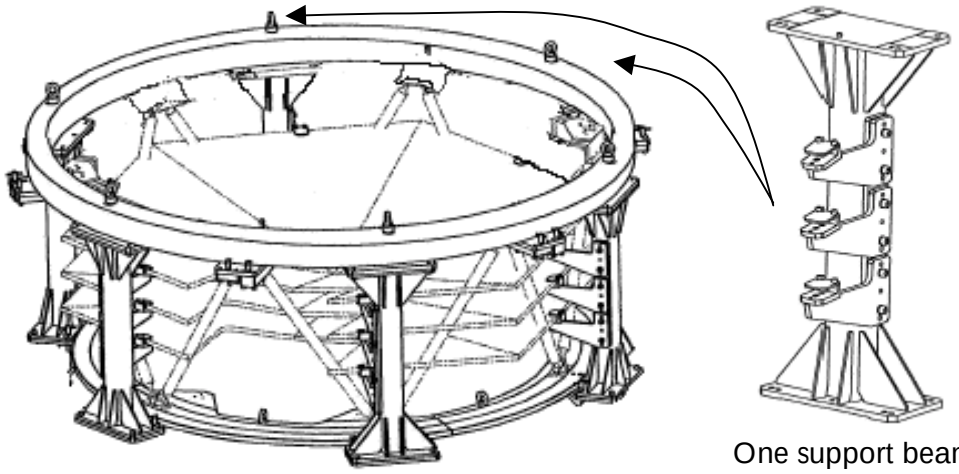


Figure 30 - Groove 1 integration kinematic



One support beam

The two remaining support beams are mounted between PAD and upper I/F frame of the cryostructure tool.

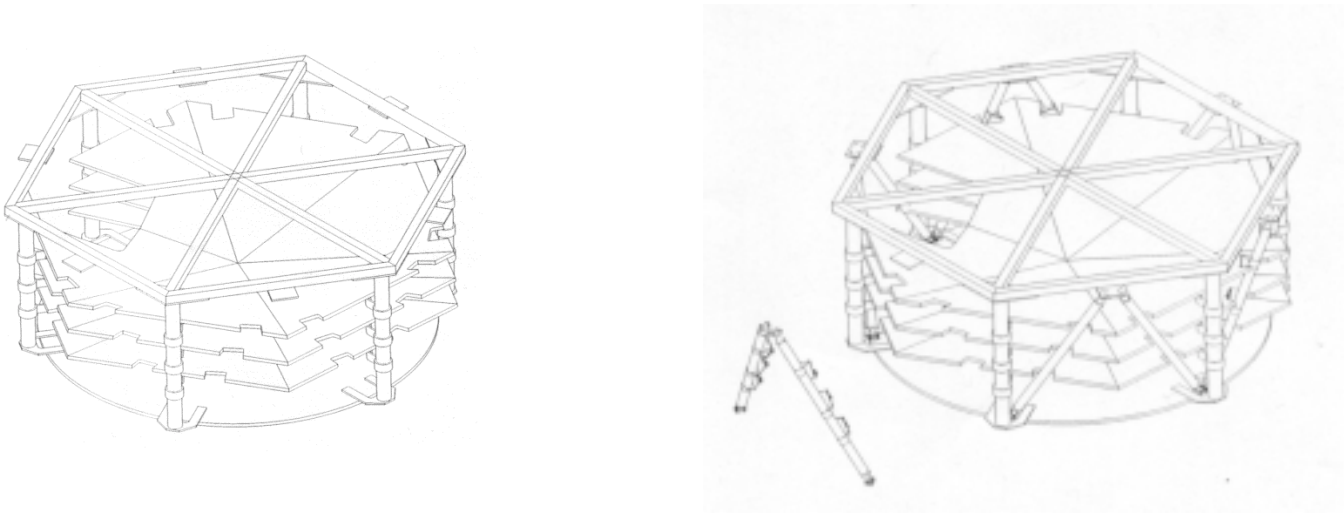
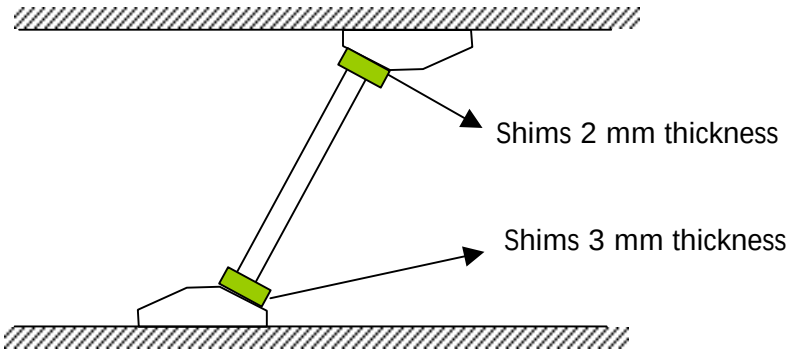


Figure 31 - cryostructure integration sequence

The 12 struts are mounted and attached on grooves.
Cryostructure struts are mounted on Contraves tool with shims (thickness 2 mm).



Upper shim is reused for satellite integration.
Lower shim will be replaced on Satellite by an adjusted shim to manufacture.
Once struts are mounted, cryostructure integration tool can be removed.

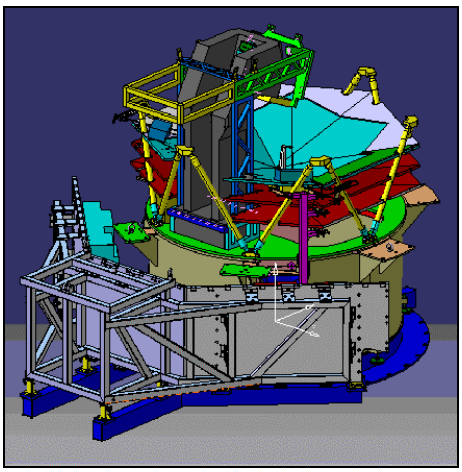
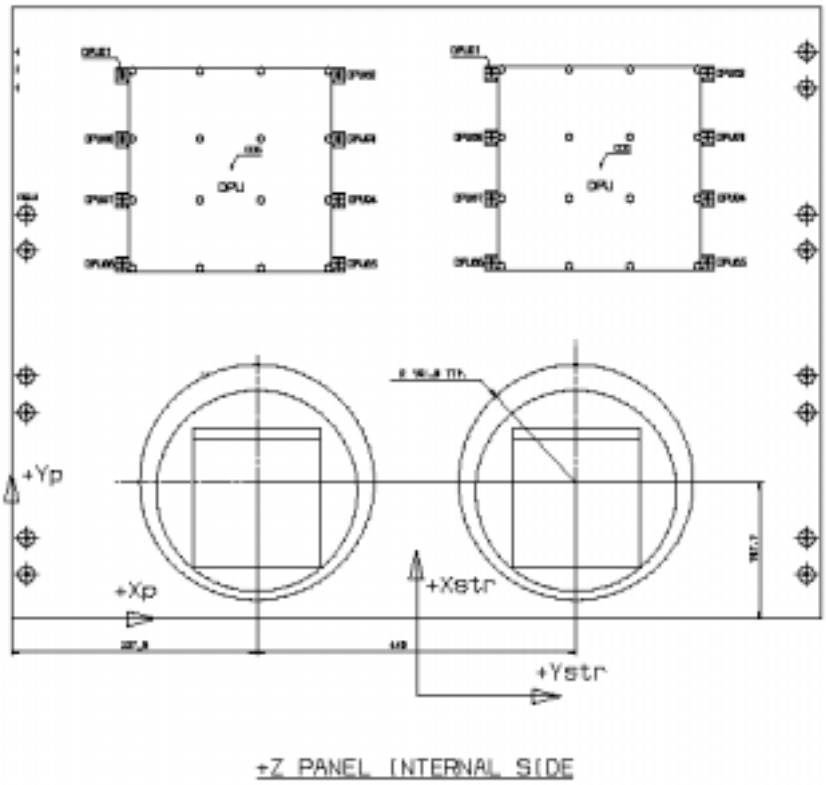


Figure 32 - PLM configuration after cryostructure tool removing

4.3 Lateral panel constitution



+Z PANEL INTERNAL SIDE

Figure 33 - +Z panel layout

+Y+Z INSTRUMENT PANEL ASSY (0.1 K)

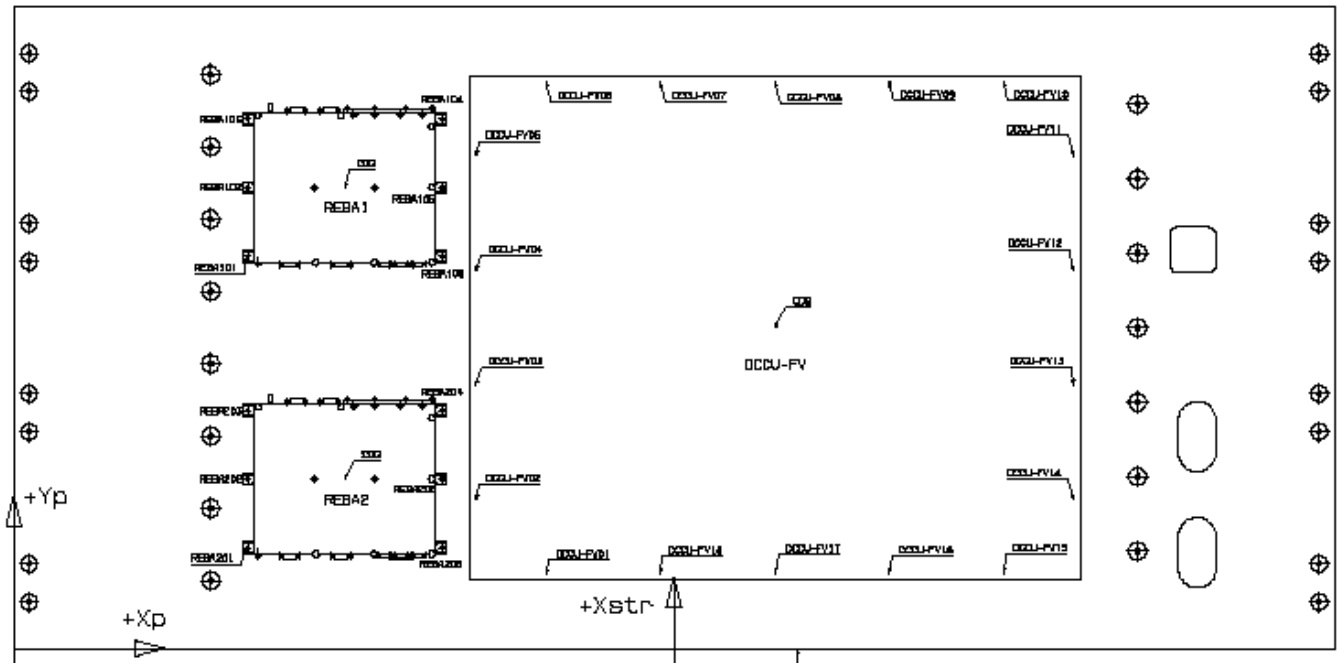
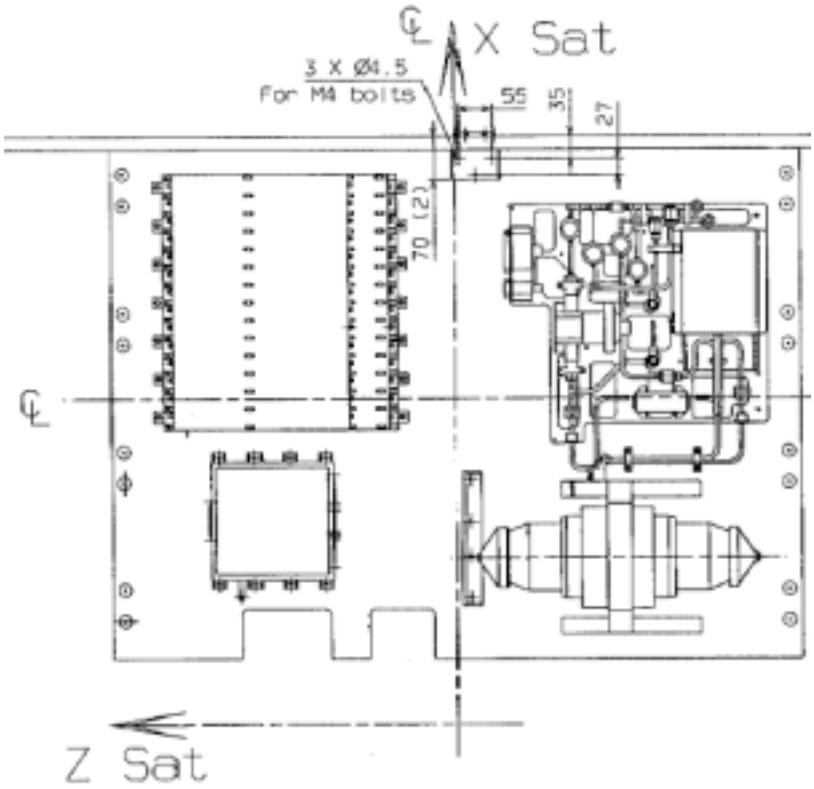


Figure 34 - +Y+Z panel layout



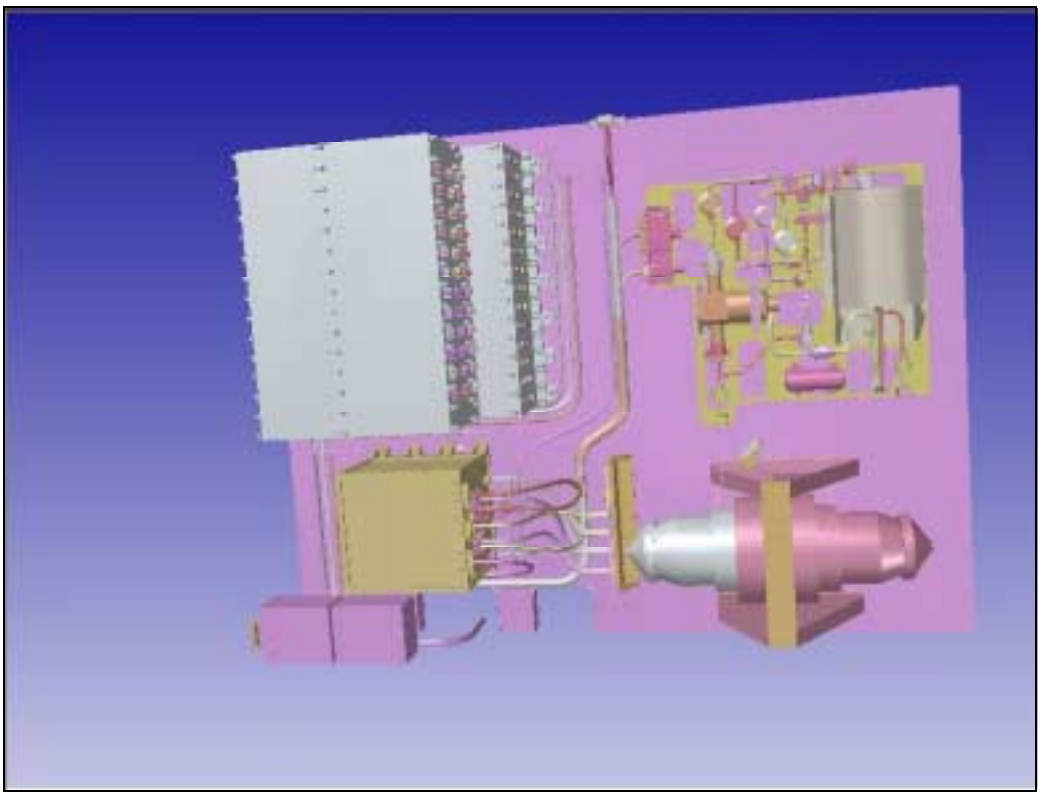


Figure 35 - +Y panel layout

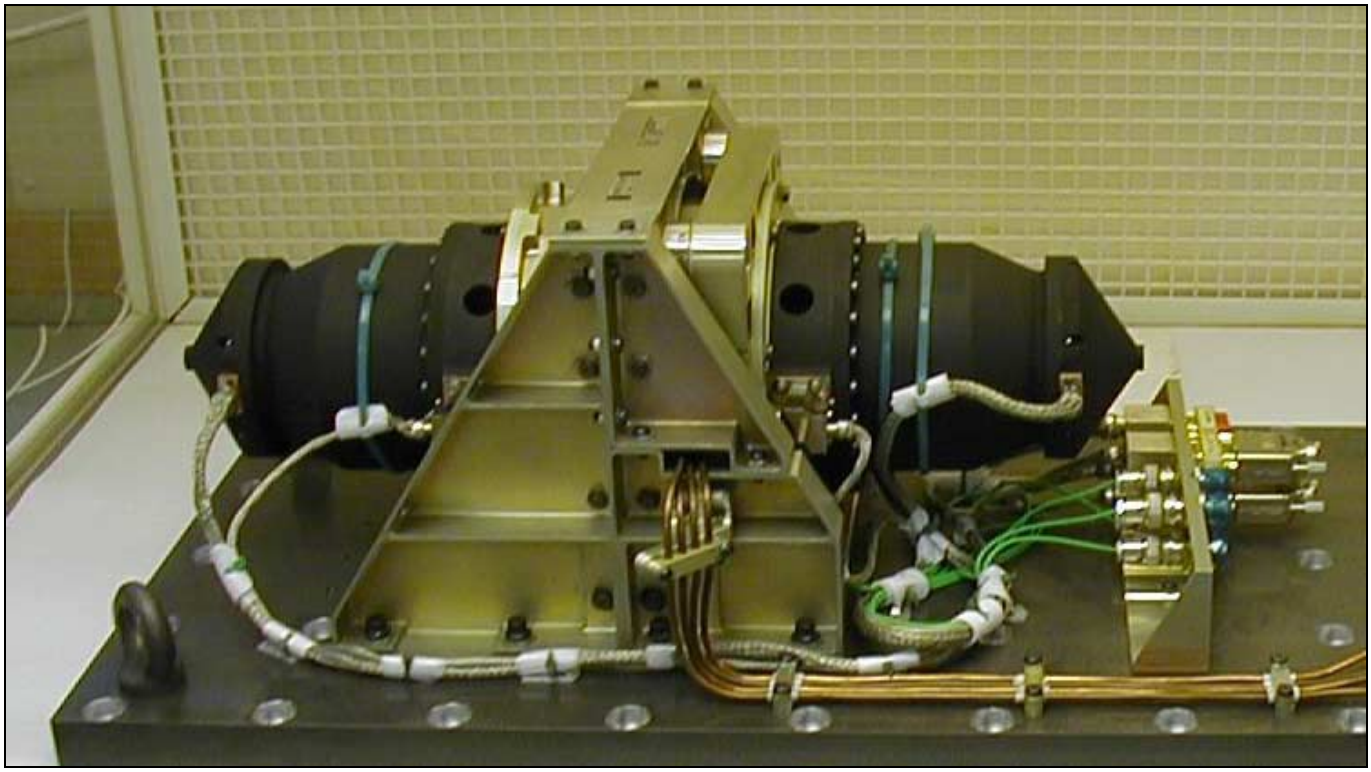


Figure 36 - 4K compressor to be integrated

4K compressor will be delivered connected to its ancillary panel (not shown on figure). Both items must be slid from delivery plate on SVM lateral panel by hand.

4.4 SVM preparation

MM100 : SVM unpacking and set up on VIS

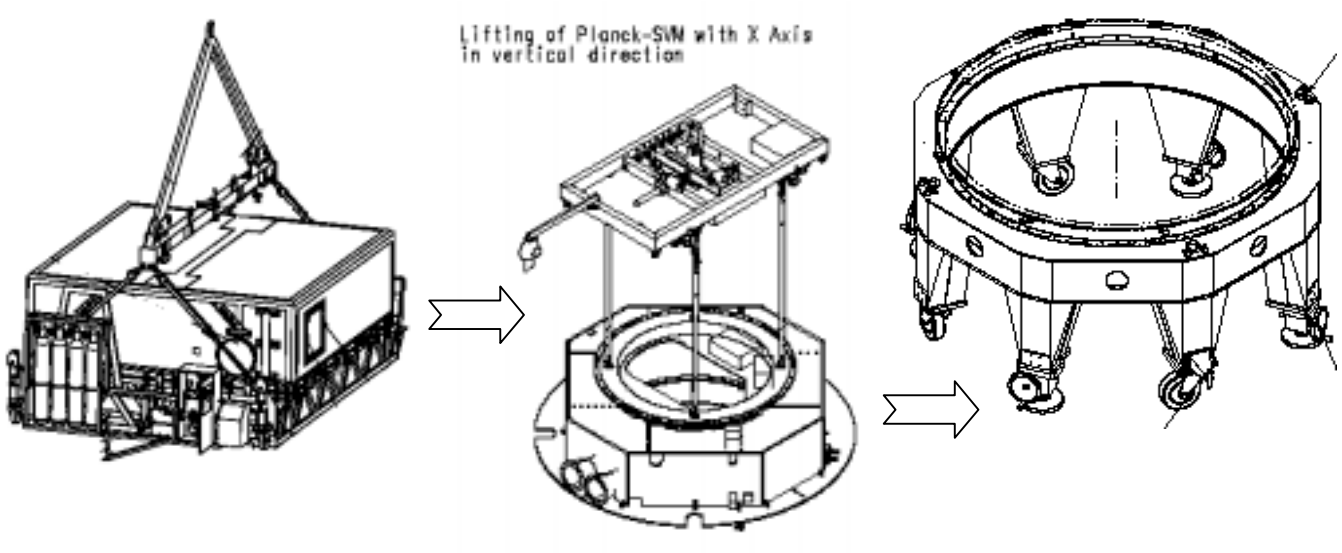


Figure 37 - SVM set up in clean room

SVM structure is received in its container (Lateral panels sustaining instruments and payload subplatform will be deliver in advance in order to start PLM integration).

SVM is fixed inside transport container thanks to the THA (Transport and Handling Adapter).

SVM + THA are hoisted by SLD (SVM Lifting Device) on the VIS(Vertical Integration Stand) in clean room

Two guide pins are set up on the VIS (see Figure 38 - SVM mating on VIS)

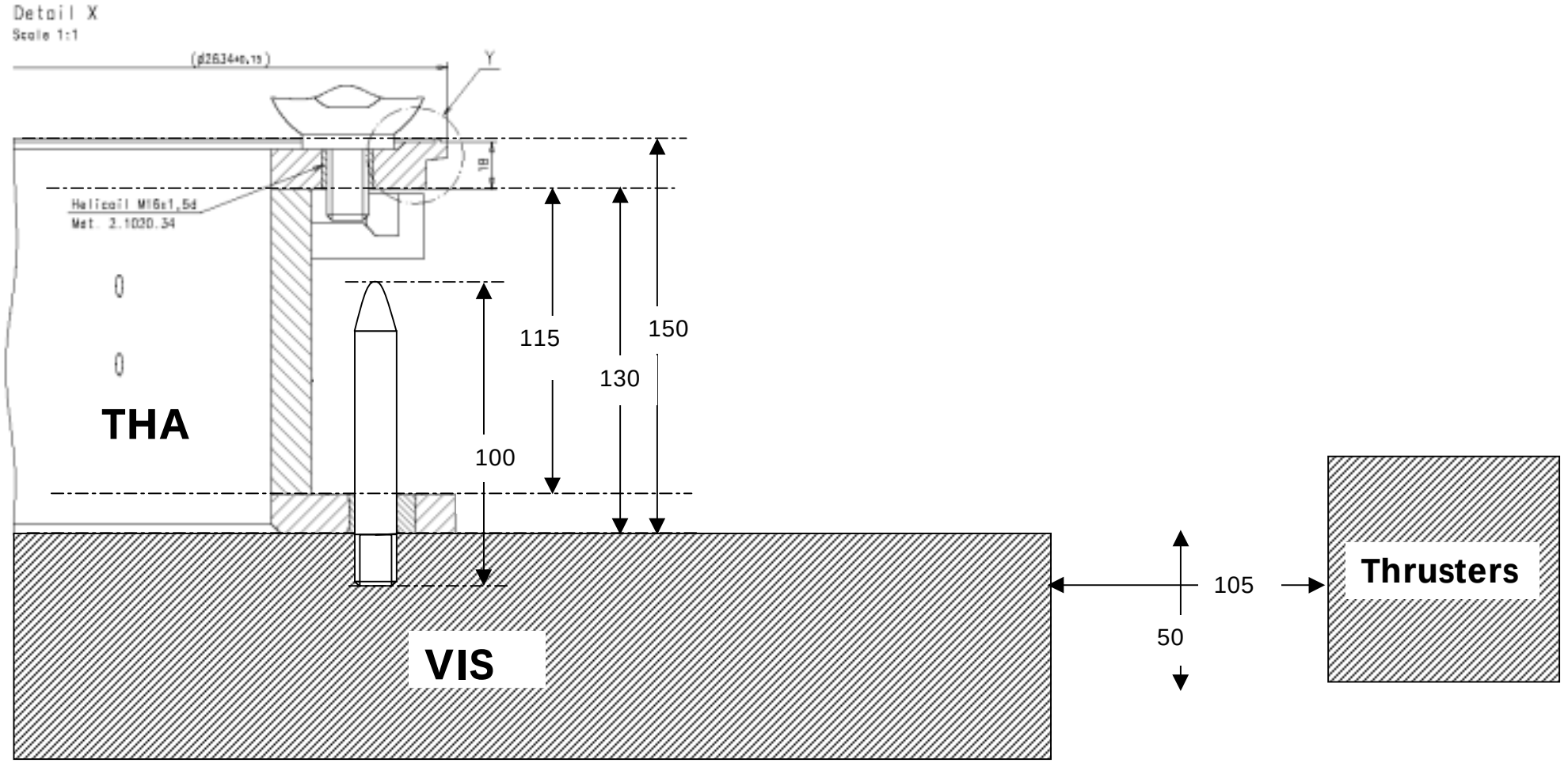


Figure 38 - SVM mating on VIS

MMXXX : CRU mounting on shear panel

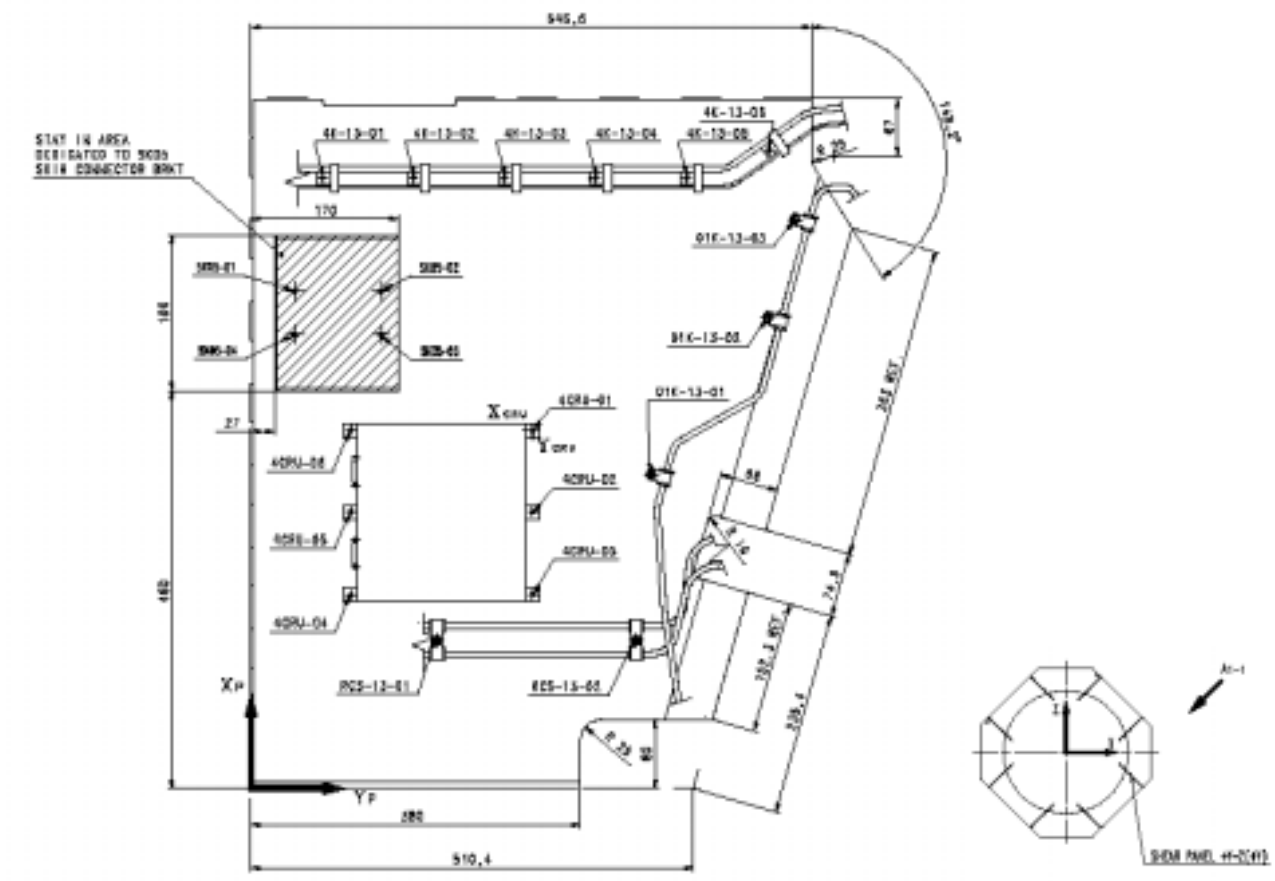


Figure 39 - CRU equipment on +Y-Z(+Y) shear panel

CRU must be mounted on SVM structure before +Y lateral panel for accessibility concern.
4K pipe will be mounted on shear panel and SVM cone.

MMXXX : 0.1K exhaust mounting

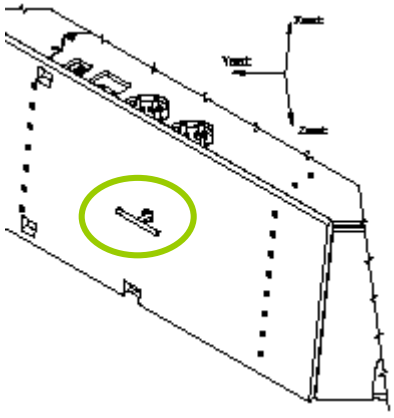


Figure 40 - 0.1 K exhaust

MMXXX : +Y+Z panel mating and REU electrical connection

+Y+Z panel mated on PTT is inclined to a TBD angle enough wide to allow access to the operator to REU electrical connectors to be compliant with harness length to connect it on REU.

Once all electrical connectors are connected, +Y+Z panel is closed and screwed on the SVM taking care of the routing of the harness.

Finally, harness is fixed with TBD (tyraps) to the SVM.

Harness bonding straps (located every 20 cms) are fixed by TBD (screws, rivets …)

…

MMXXX : ……..

To be completed with

Helium spheres integration
4K and 0.1 K pipes routing
MLI
…

4.5 Cryostructure integration on SVM

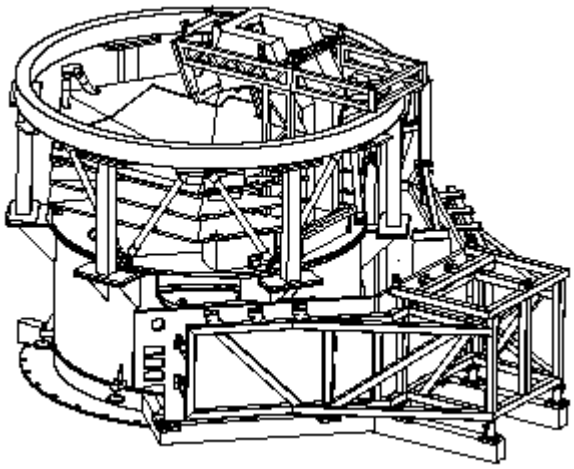
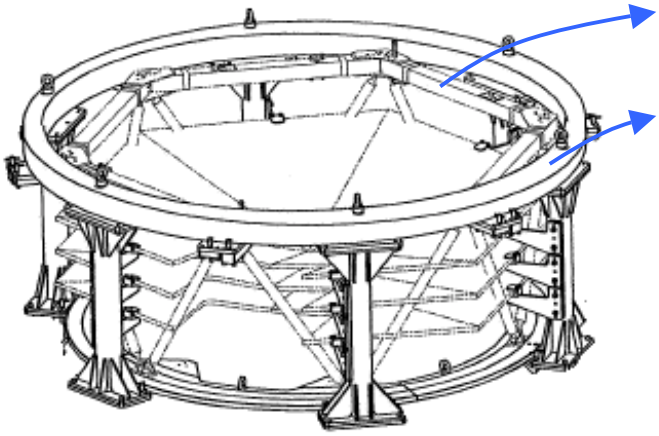


Figure 41 - PLM on its PAD ready for hoisting

PVHD (PLM Vertical Hoisting device) is compliant with two PLM configuration :

- FM PLM integration eg with SCC panel, which is the baseline for design.
- CQM and SM integration eg without SCC panel (no SCC on CQM, SCC already mounted on STM SVM on SM satellite)



First, the cryostructure ring, part of the PVHD, is mated on the cryostructure.

The upper I/F ring is then removed.

Six support beams are removed.

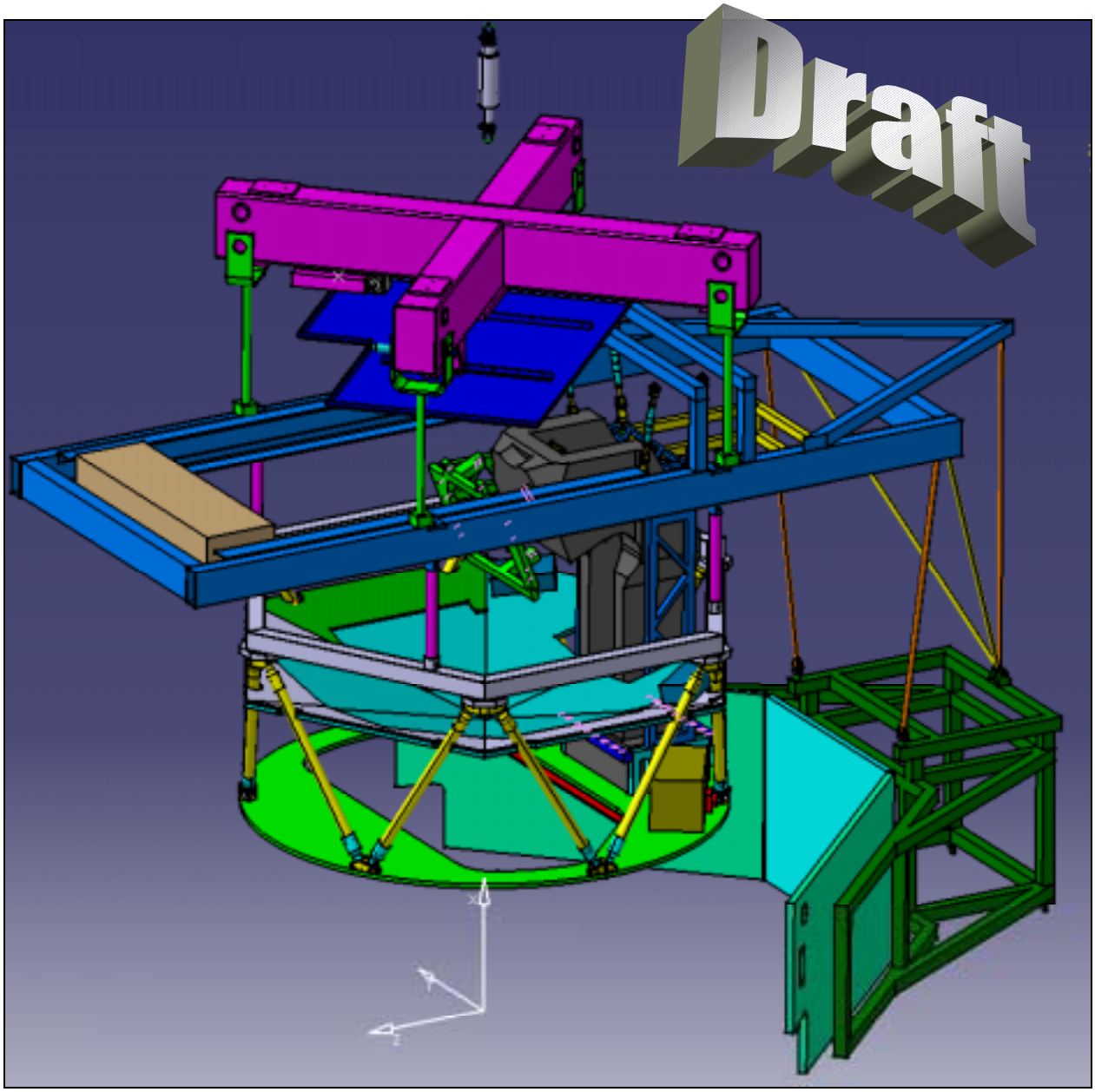


Figure 42 - Payload Vertical Integration Device (PVHD) (SCC and PACE non featuring on sketch)

PVHD is hoisted above PLM and fixed on cryostructure ring and SPSD.

Cryostructure is hoisted on the SVM (see Figure 42).

For approach purpose, SPSD/SCC location is adjustable

PVHD is dismounted.

4.6 Telescope integration

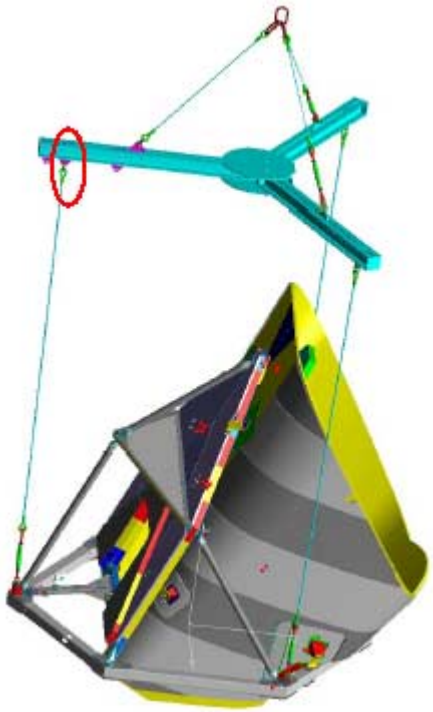


Figure 43 - Telescope hoisted

Telescope is hoisted off its stand to be mounted on the cryostructure with nominal shims of 2-mm thickness between the frame and the struts. Gaps are measured and shims are manufactured.

Telescope is then screwed on the cryostructure.

4.7 RAA final mating

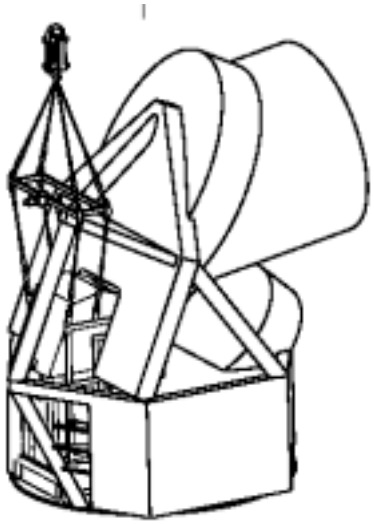


Figure 44 - RAA final mating configuration

RAA is hoisted under the telescope, hoisting device (RHD) geometry is compliant with telescope envelop. FPU is attached to the primary panel of the telescope (and remains hoisted by RHD) by using nominal shims FPU/telescope.

Distance between BEU and Payload subplatform is measured at the four corners of BEU.

An aluminum shim is manufactured (thickness foreseen between 2 and 9 mm, 1/10 mm accuracy for flatness). During manufacturing (1 to 3 days), RAA is put back on the subplatform on RAA MGSE shims.

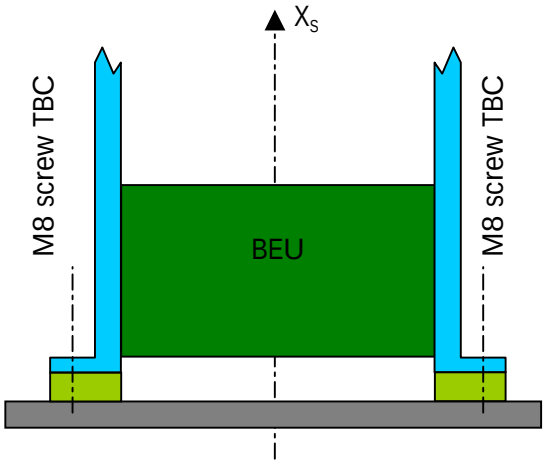


Figure 45 - RAA integration : initial state (front view)

A plastic sheet is installed under the BEU. The aluminum shim (between 2 and 9 kg depending of thickness)) is put on the plastic sheet. These two items are slide under BEU.

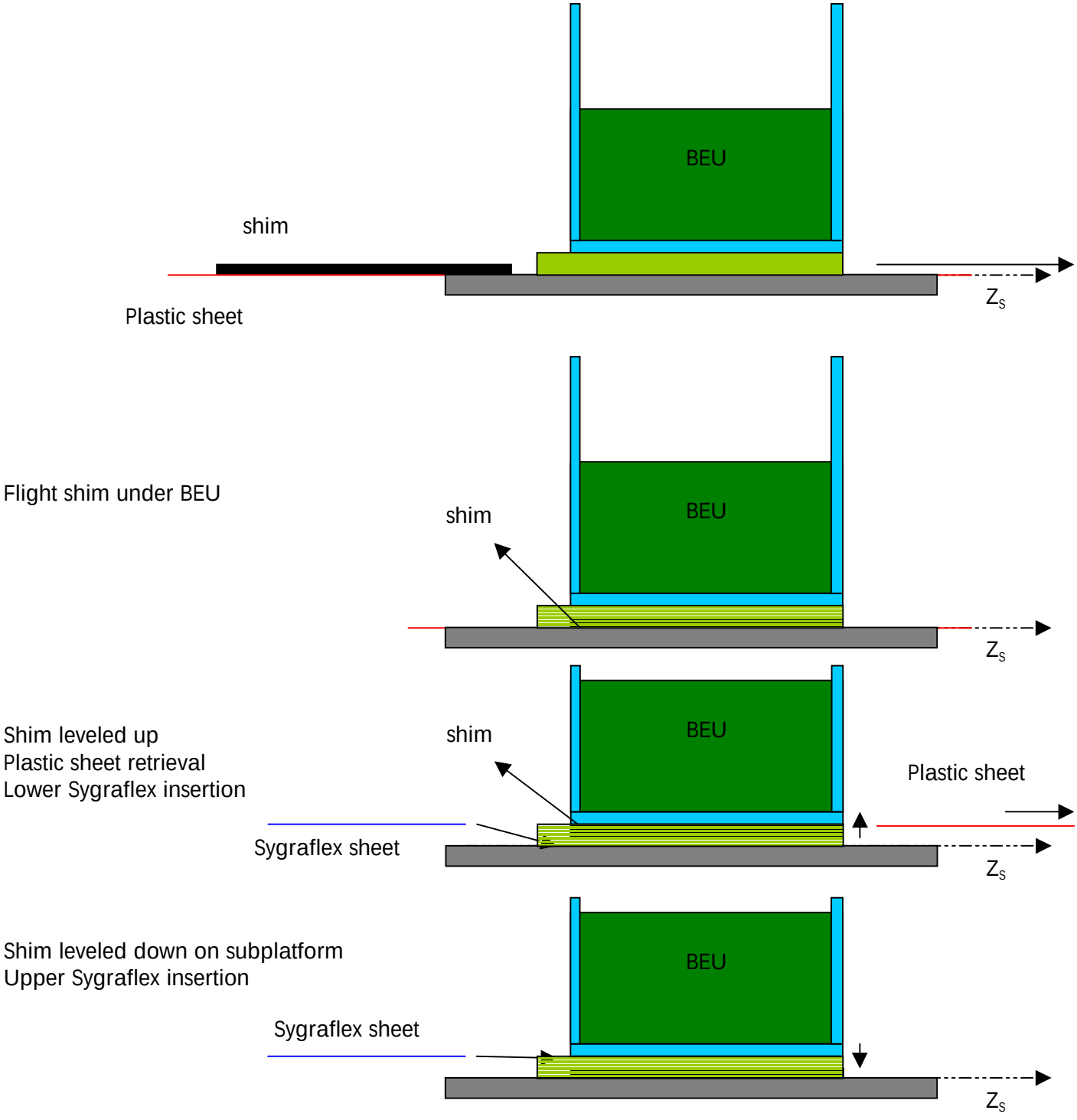


Figure 46 - Flight shim insertion sequence (lateral

RAA MGSE screws are untightened (but remains mounted to avoid RAA balancing regarding grooves and telescope)

RAA hoisted by RHD (RAA hoisting device) is translated along X axis to engage BEU-subplatform screws. MGSE RAA screws are removed, RAA MGSE shims are removed.

RAA is hoisted down on the flight shim. FPU-telescope screws are engaged. All screws are torked.

Internal access will be needed :

- to insert the shim
- to screw BEU on subplatform

Access configuration is described in § 4.11.

The two cold end are then screwed on the T-piece on FPU.

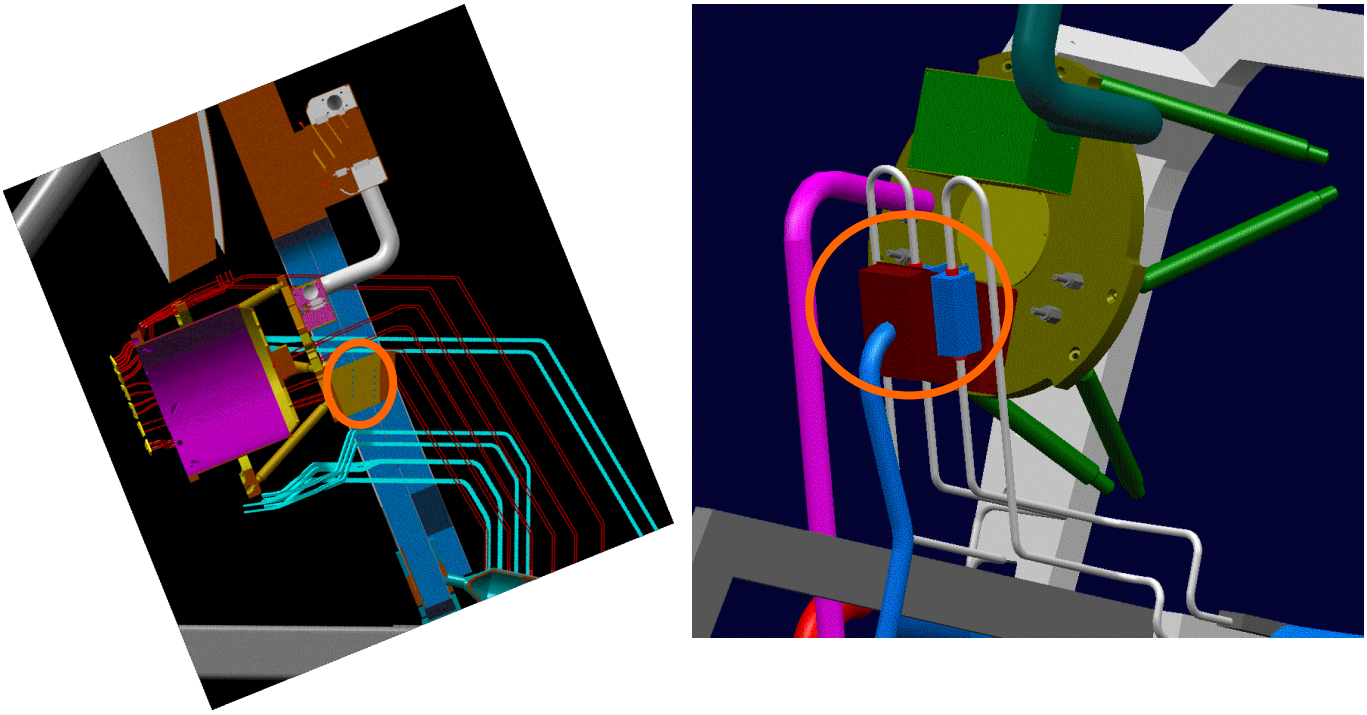


Figure 47 - Cold end interface on FPU T-piece

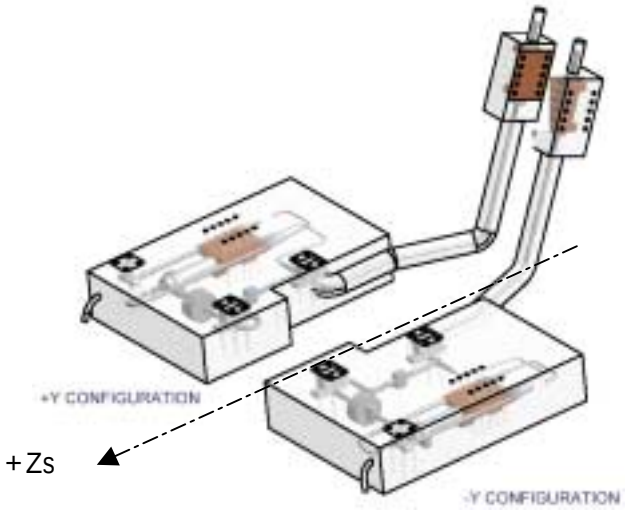
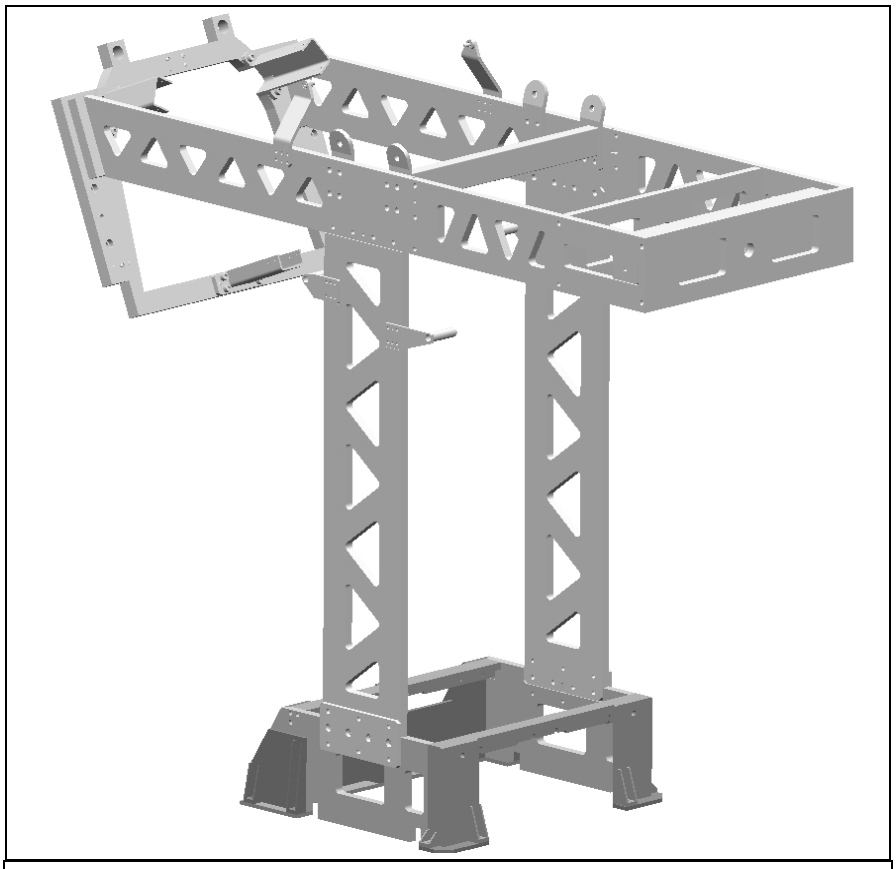
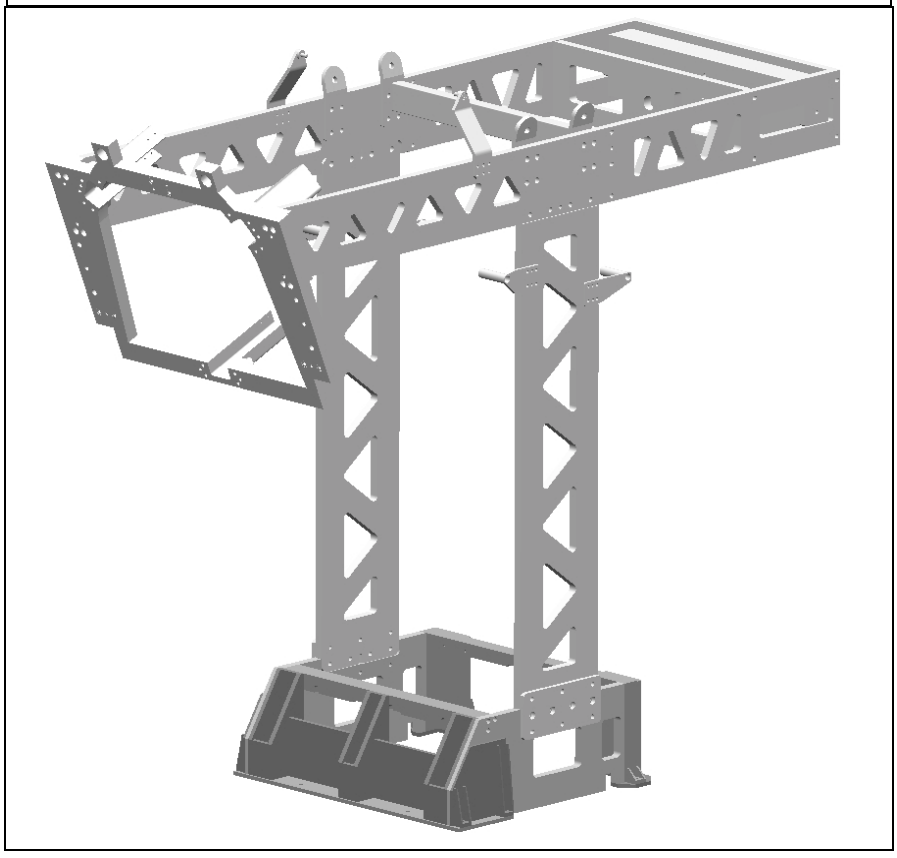
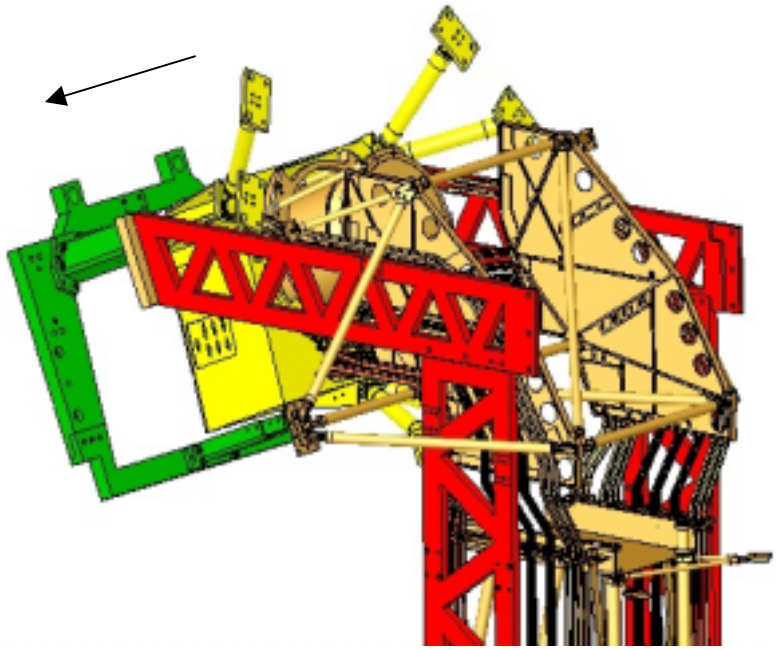


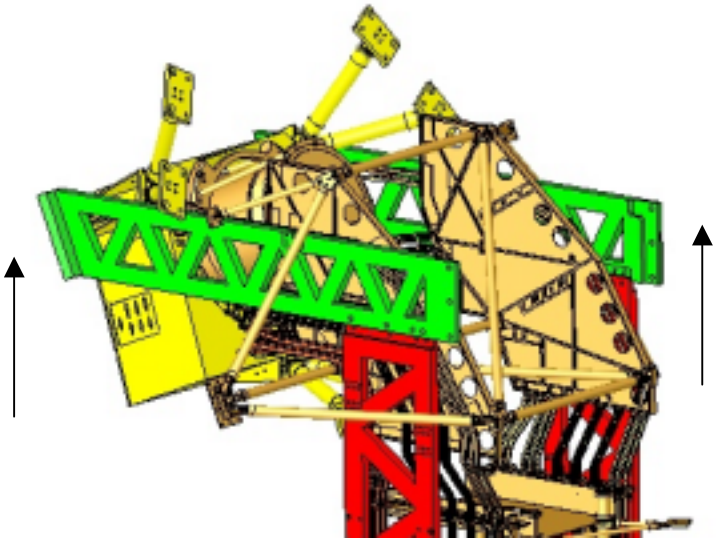
Figure 48 - Two Cold end lay out

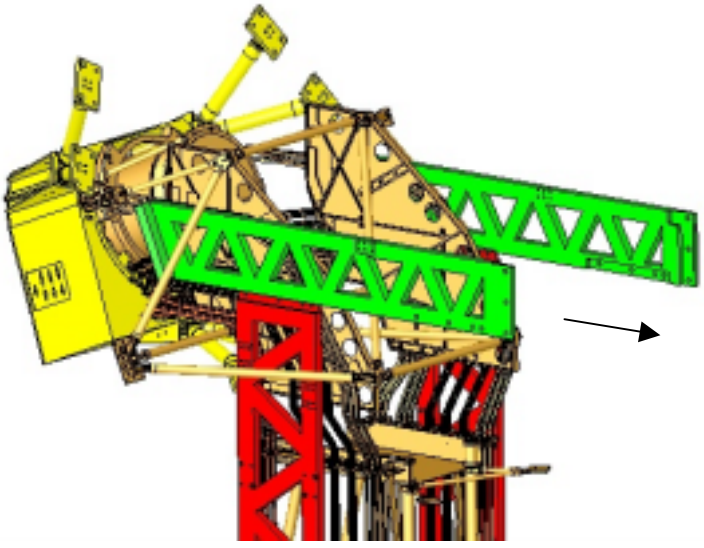
4.8 RAA MGSE dismounting

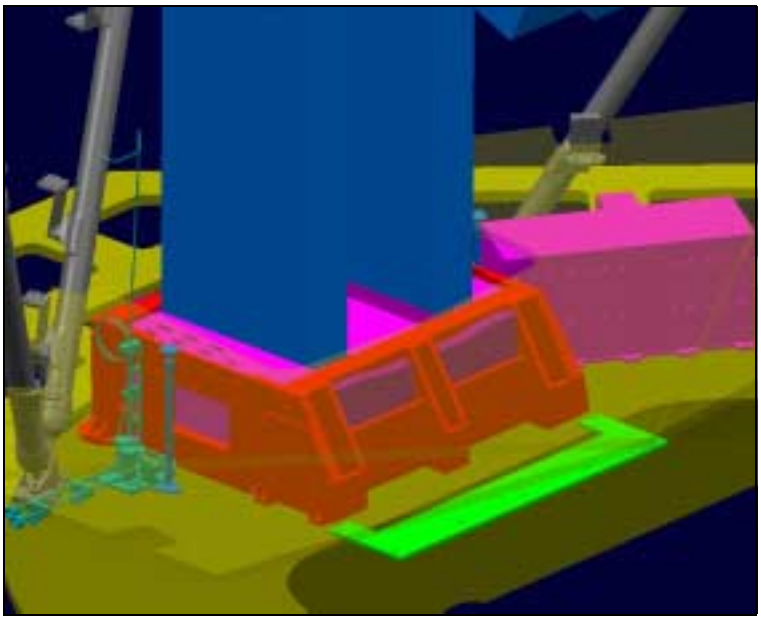


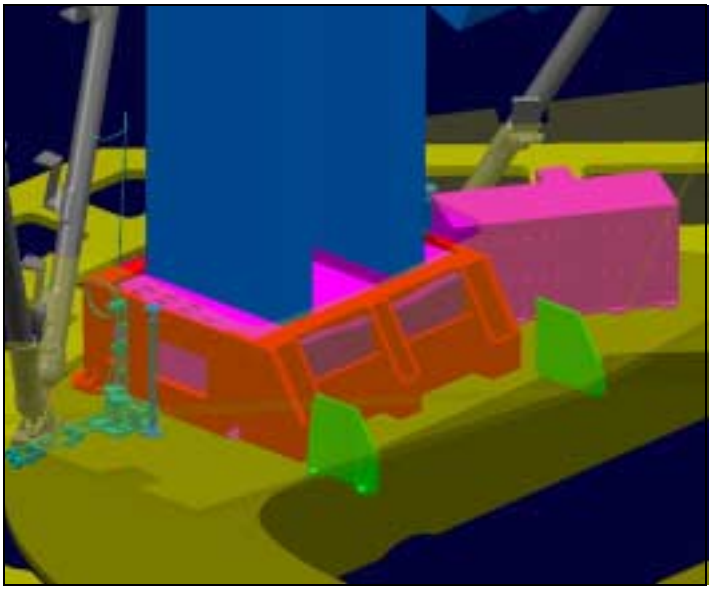


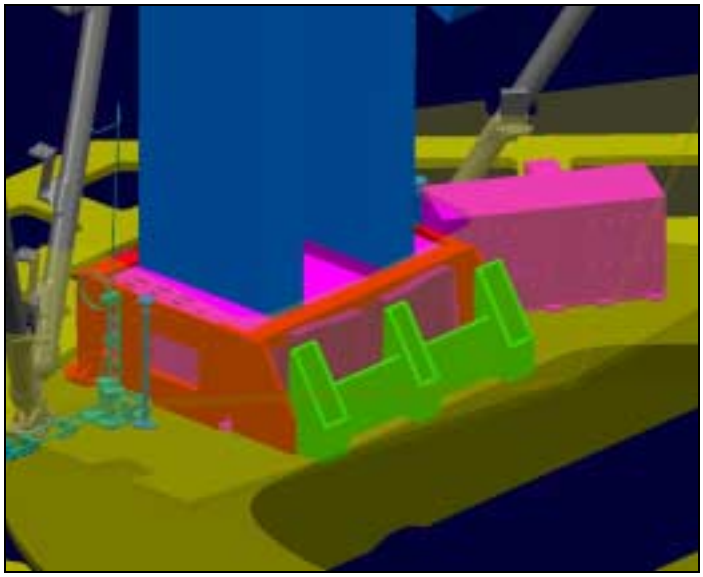


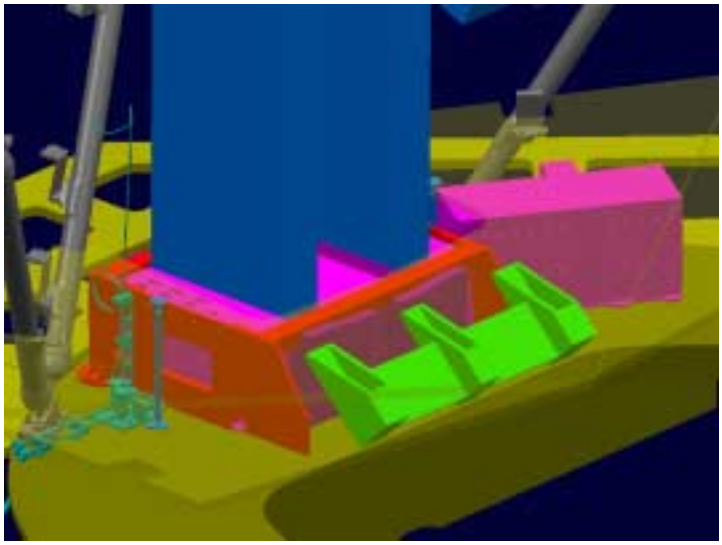


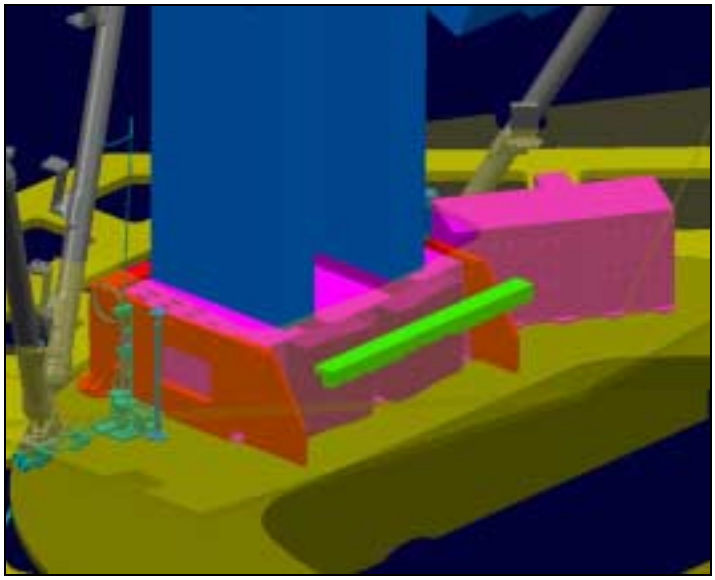


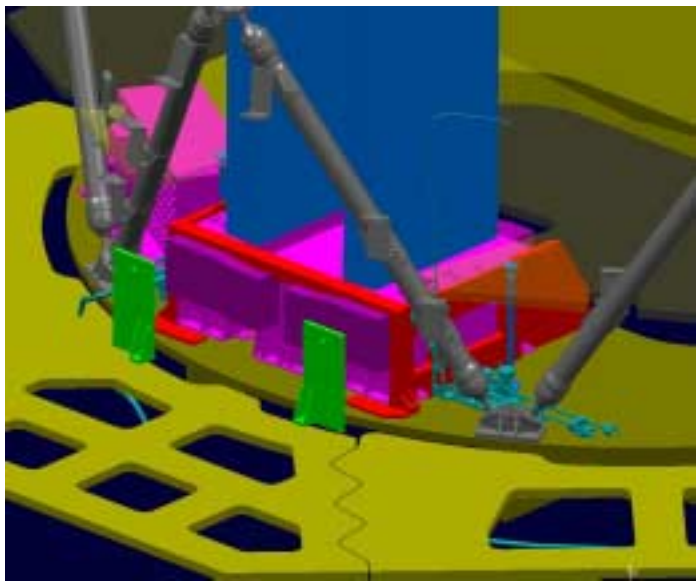


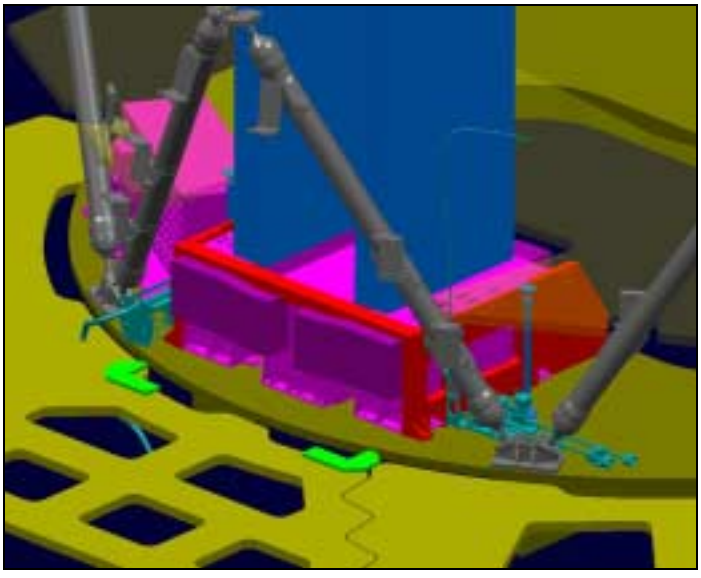


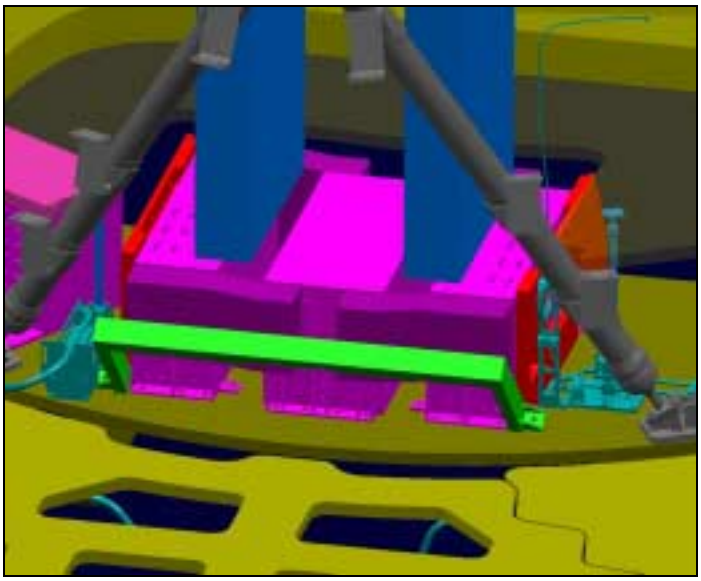


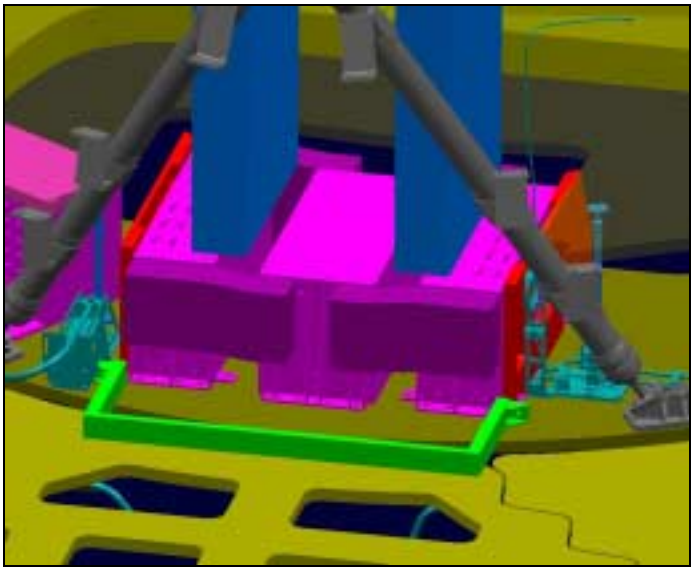


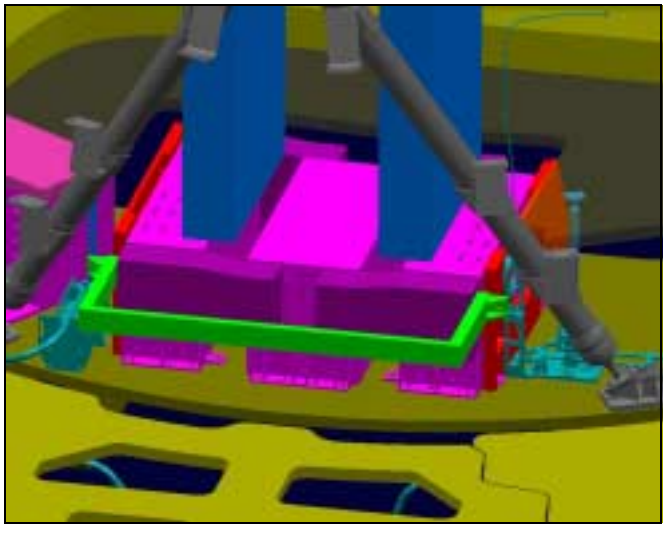


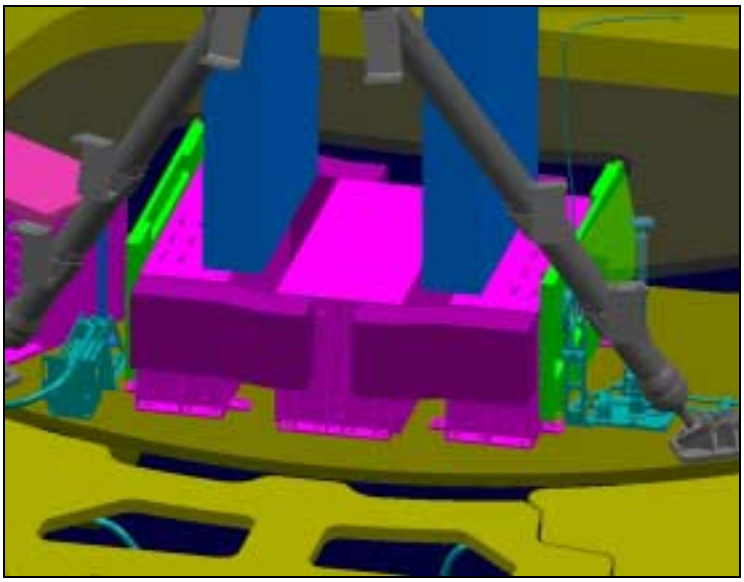


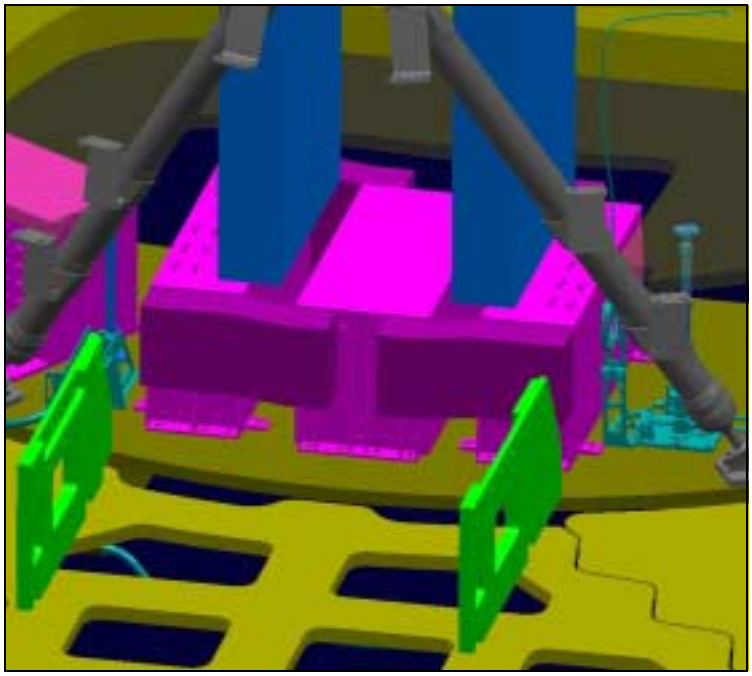












Upper structure is then mounted on the telescope.

4.9 4K pipe connection

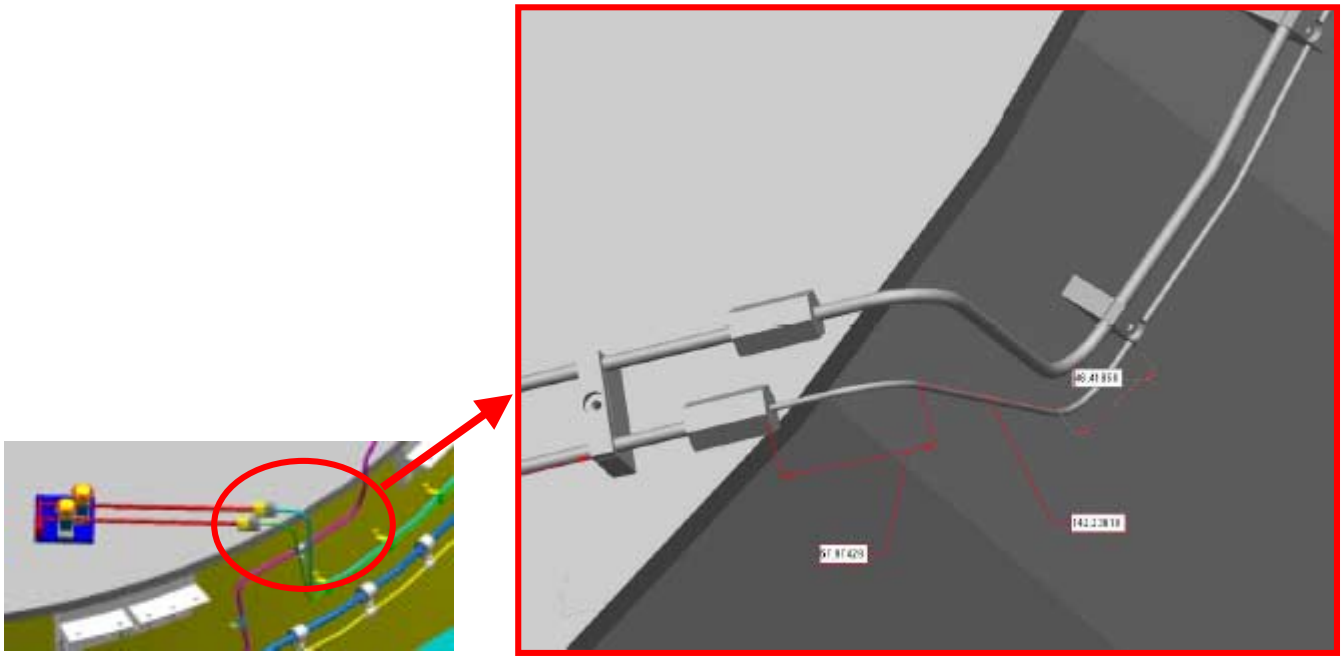


Figure 49 - 4K pipe connection

4.10 0.1K pipe connection

figure to introduce.

4.11 BEU electrical connection

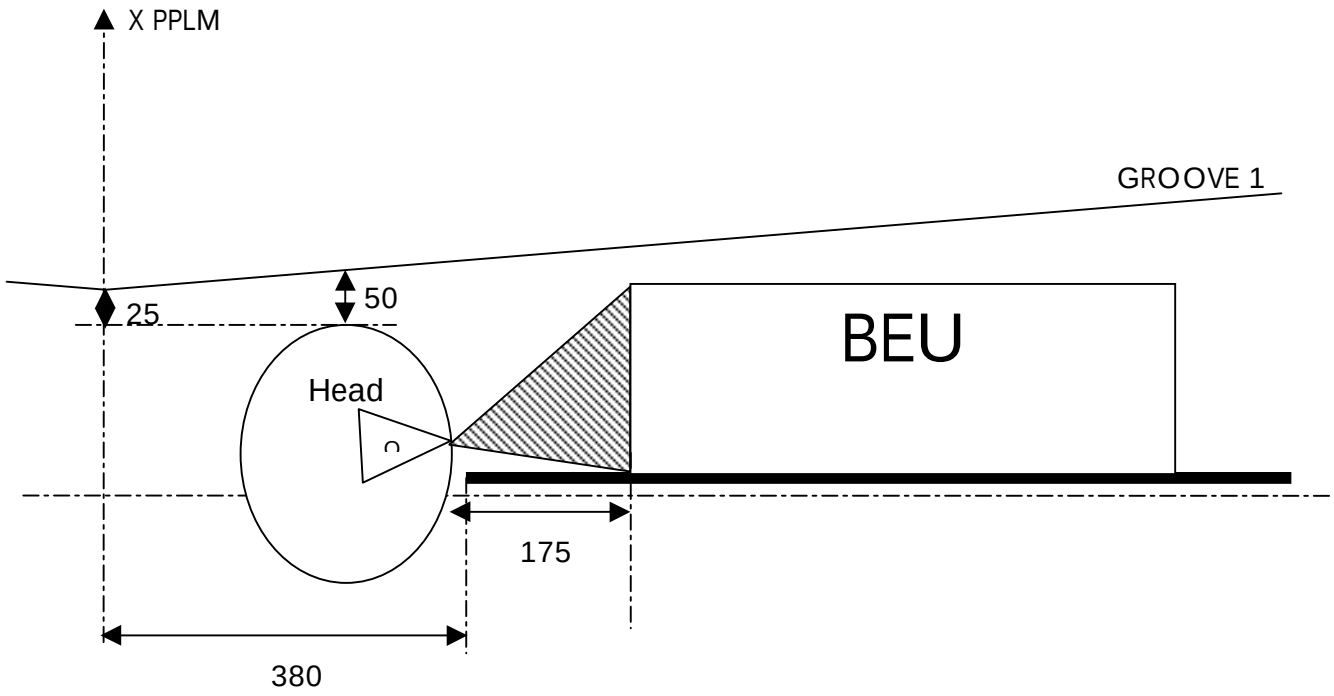


Figure 50 - Operator head position for BEU electrical connection

To be completed

4.12 JFET-PAU-bellow integration

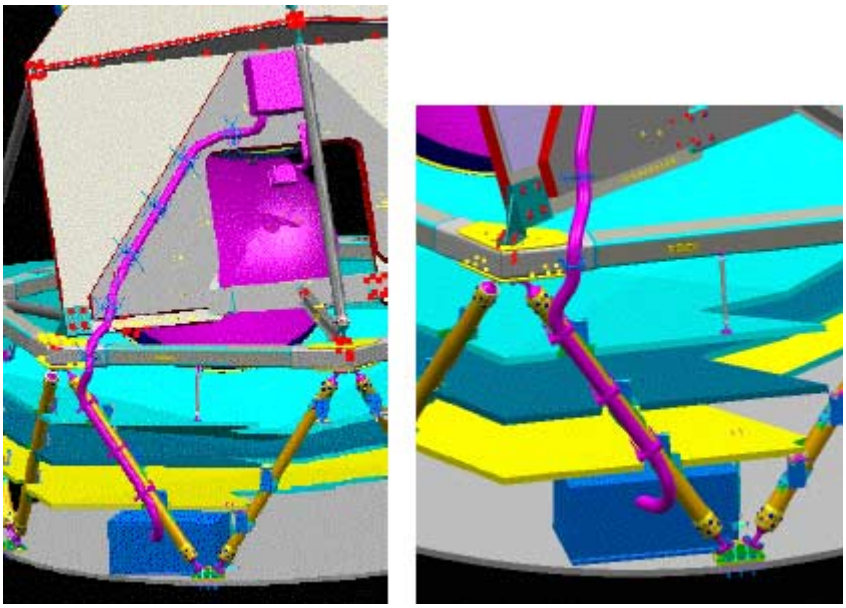


Figure 51 - routing of the HFI bellow

The baseline is to integrate the assembly PAU-bellow-JFET on satellite X axis vertical.

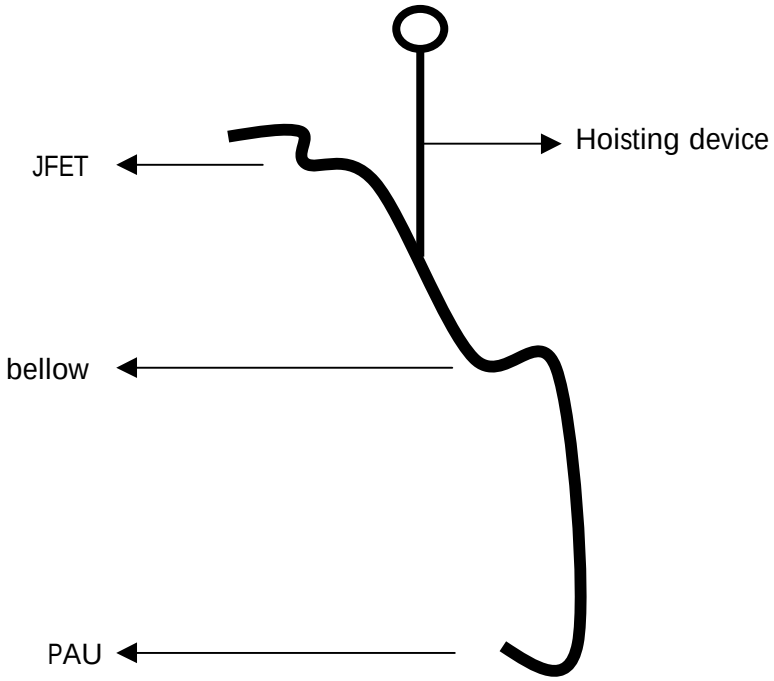


Figure 52 - PAU-bellow-JFET hosting

Sygraflex sheet and thermal radiator is put on SVM subplatform at the PAU footprint. Flight assembly is hoisted onto the satellite.

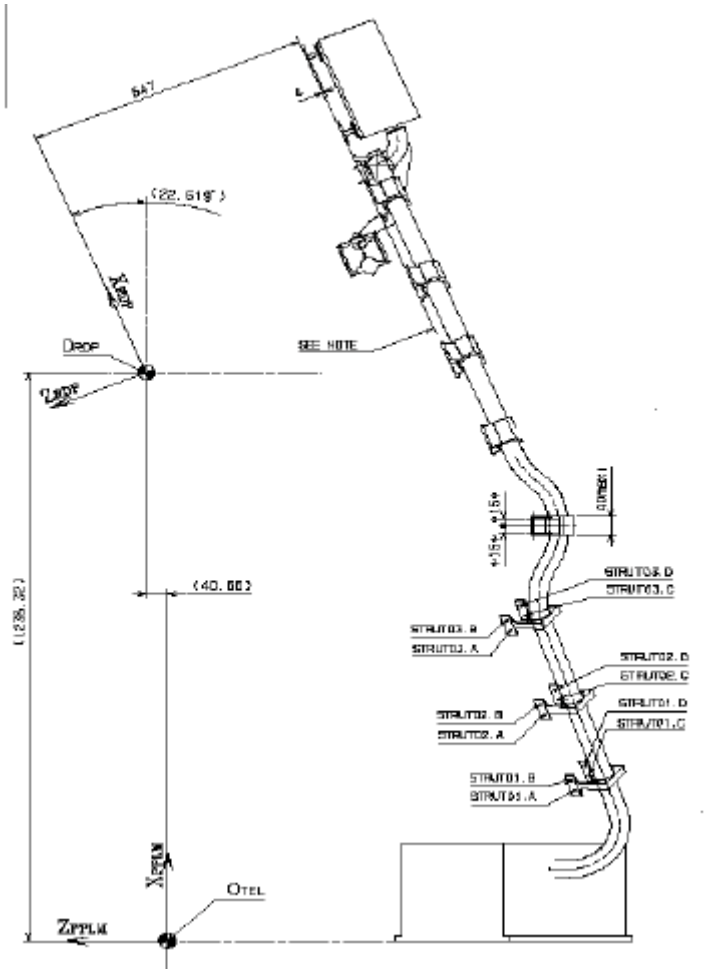


Figure 53 - PAU-bellow-JFET lay-out

To be completed as soon as HFI design will be received.

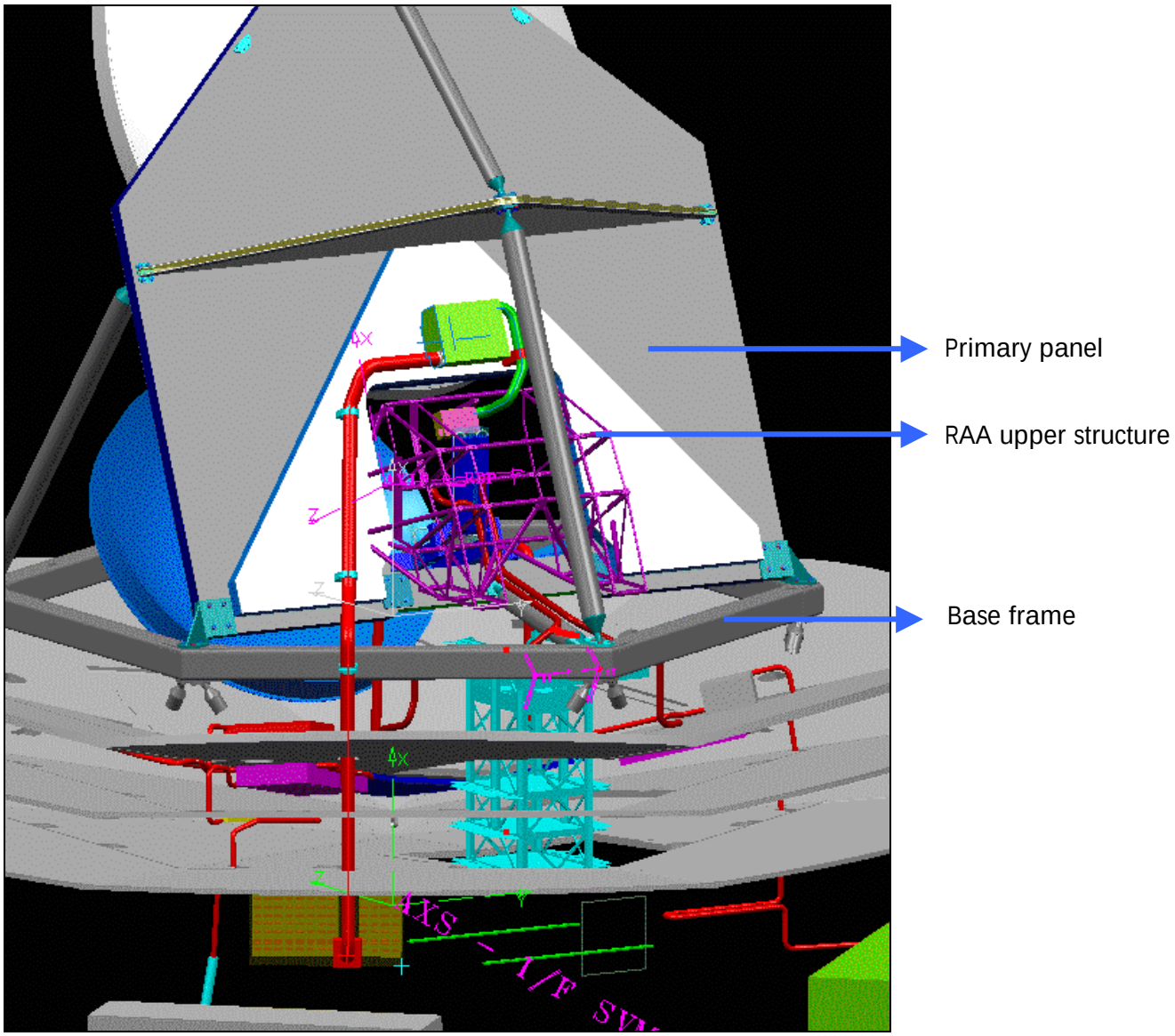
4.13 PAU electrical connection

Same configuration as for BEU electrical connection.

4.14 Heaters-sensors mounting

During satellite integration process, sensors will be mounted for qualification purpose.

4.15 RAA upper structure mounting



The RAA upper structure interfaces with telescope primary panel and telescope base frame.

4.16 Miscellaneous…

MLI set up
…

4.17 Baffles of telescope integration

To introduce

Figure 54 - Half baffle on integration jig

4.18 MM101 : FOG mounting on shear panel

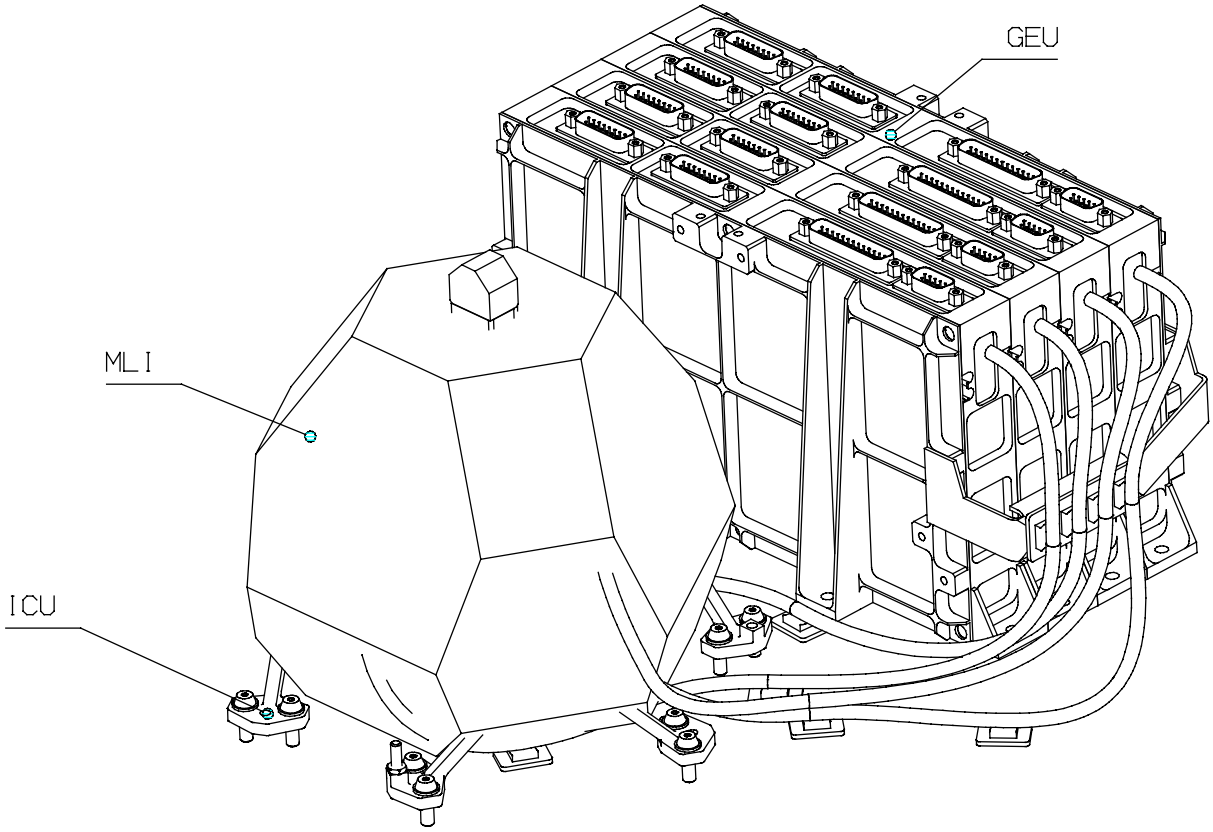


Figure 55 - FOG equipment

Fog must be mounted on SVM structure before Helium sphere located on +Z axis for accessibility concern.

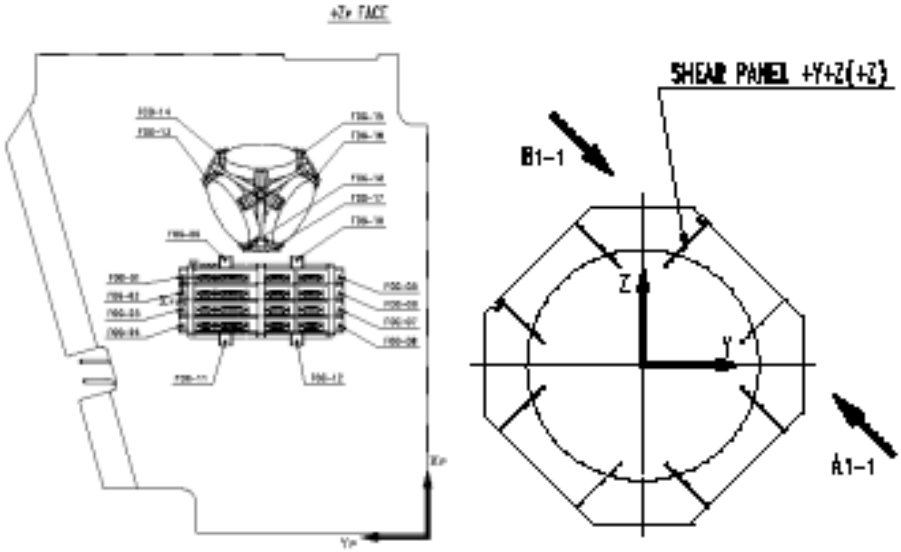


Figure 56 - FOG equipment on +Y+Z(+Z) shear panel

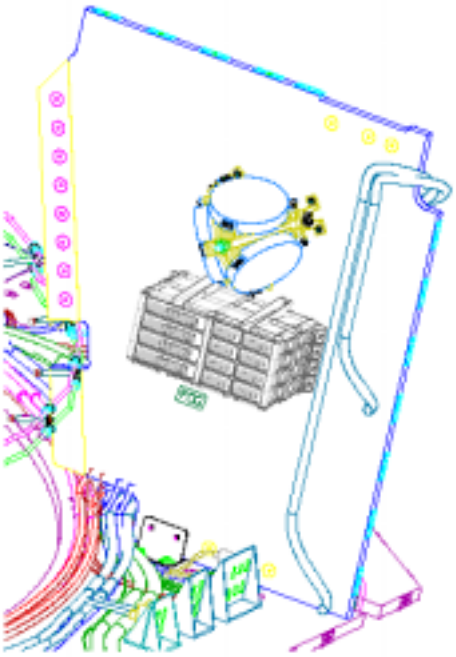


Figure 57 - FOG (head without cover) equipment on SVM, 0.1K panel not featuring

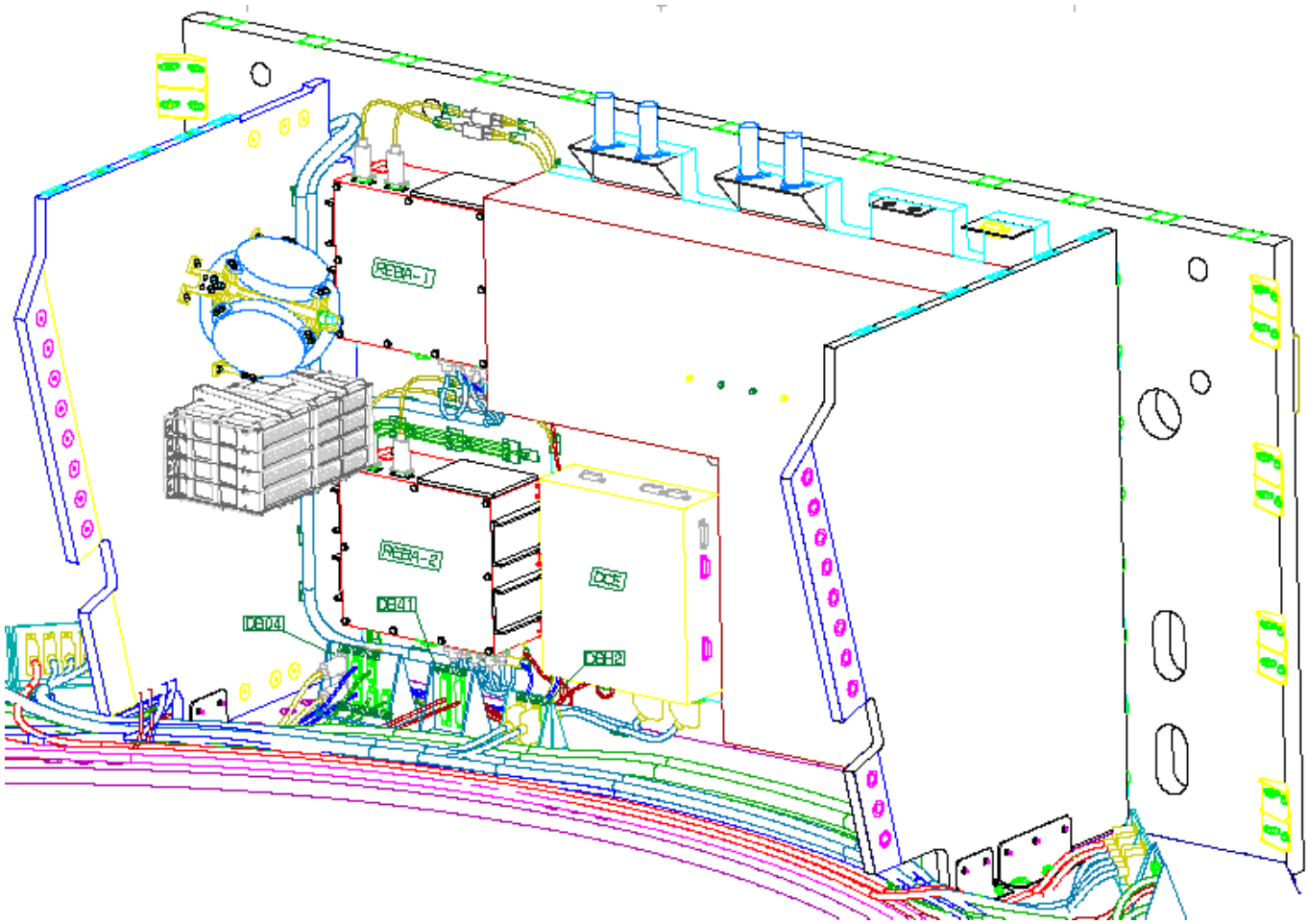


Figure 58 - SVM lay-out with FOG (head without cover)

FOG is supposed to be delivered at the same time with the batch 3 SVM delivery. Since it has to be mounted 0.1 K panel already in place, a dedicated tool is designed to link electronic box to the head during mounting.

4.19 External grooves integration

Done at the end of the satellite integration because of access concern.

4.20 Internal and external solar arrays integration

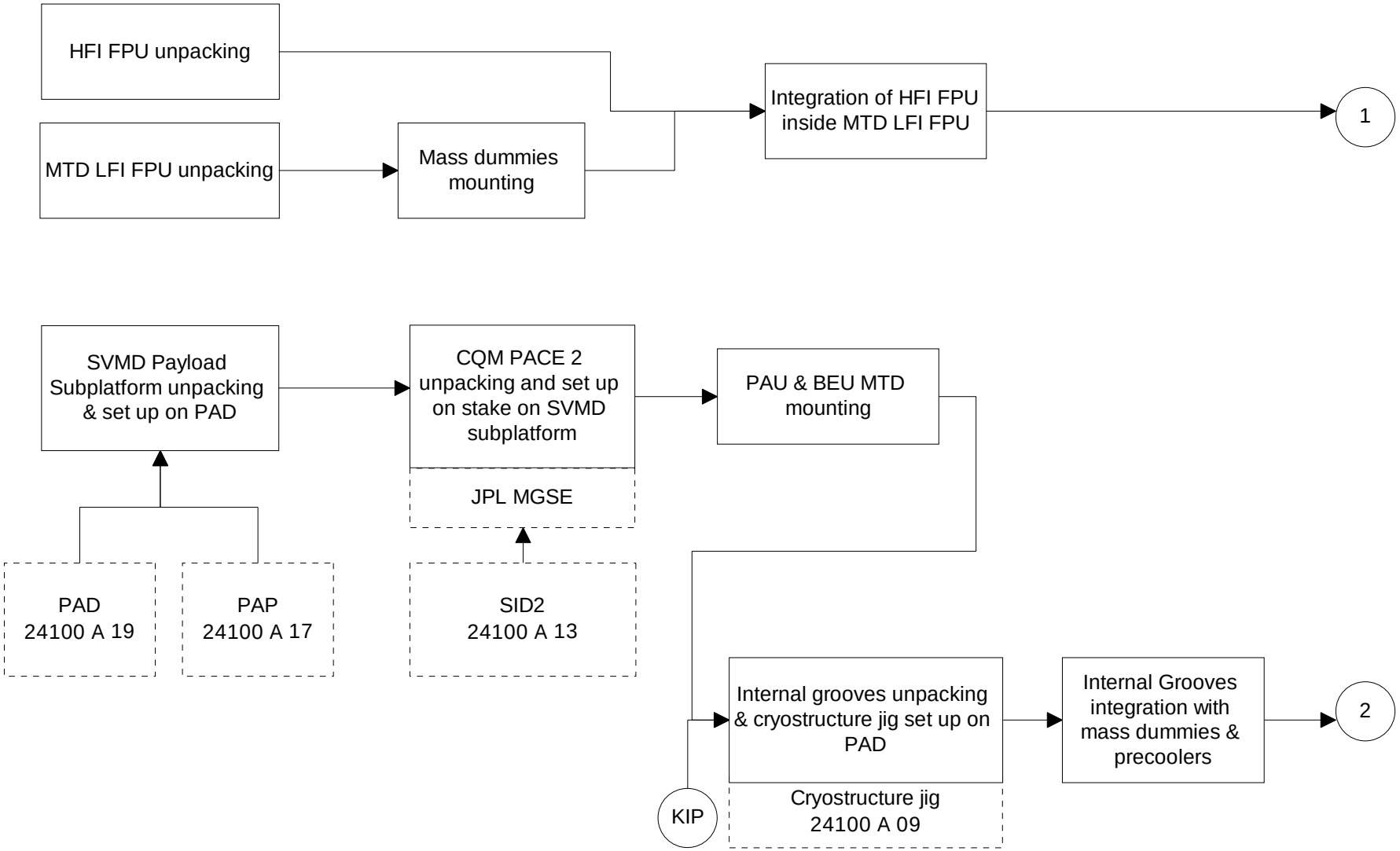
To be completed

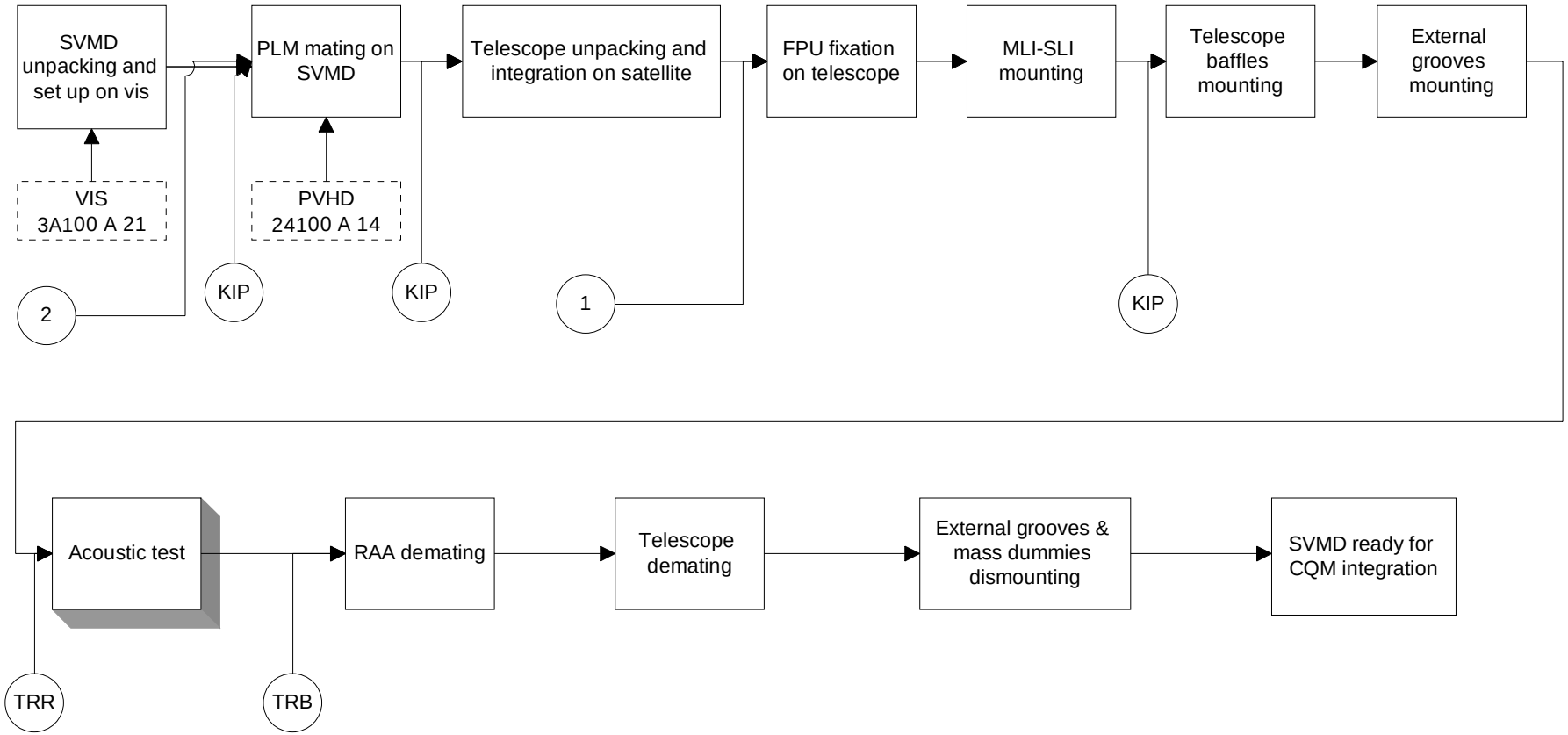
5. PLANCK ACOUSTIC MODEL INTEGRATION SEQUENCE DEVIATIONS

The overall sequence of operations will be :

A. PACE integration
B. Cryostructure integration
C. PLM mating on SVM dummy
D. Telescope mating
E. RAA constitution : HFI integration into MTD LFI FPU & FPUs mating on telescope
F. PLANCK Acoustic Model final integration
G. Acoustic test in Cannes
H. Dismounting

Mechanical operations are quite similar to those performed on CQM.





5.1 CQM PACE integration

Figure 59 - CQM PACE delivery lay out

The SID will be mounted on the PACE, the JPL MGSE then removed, and the SID will be hoisted to be fitted on the SVMD subplatform.

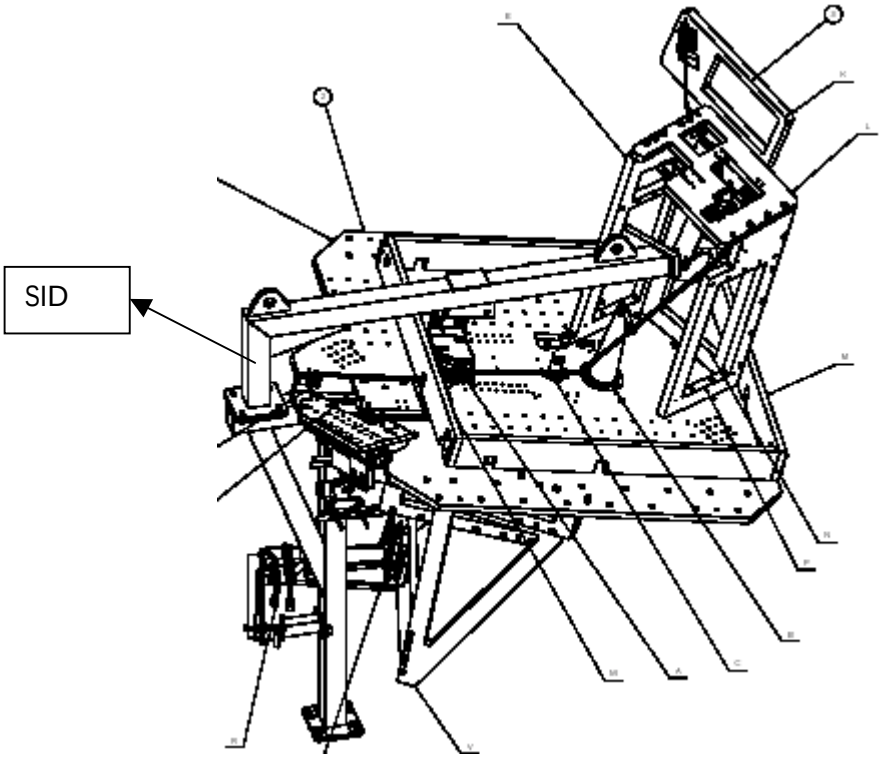


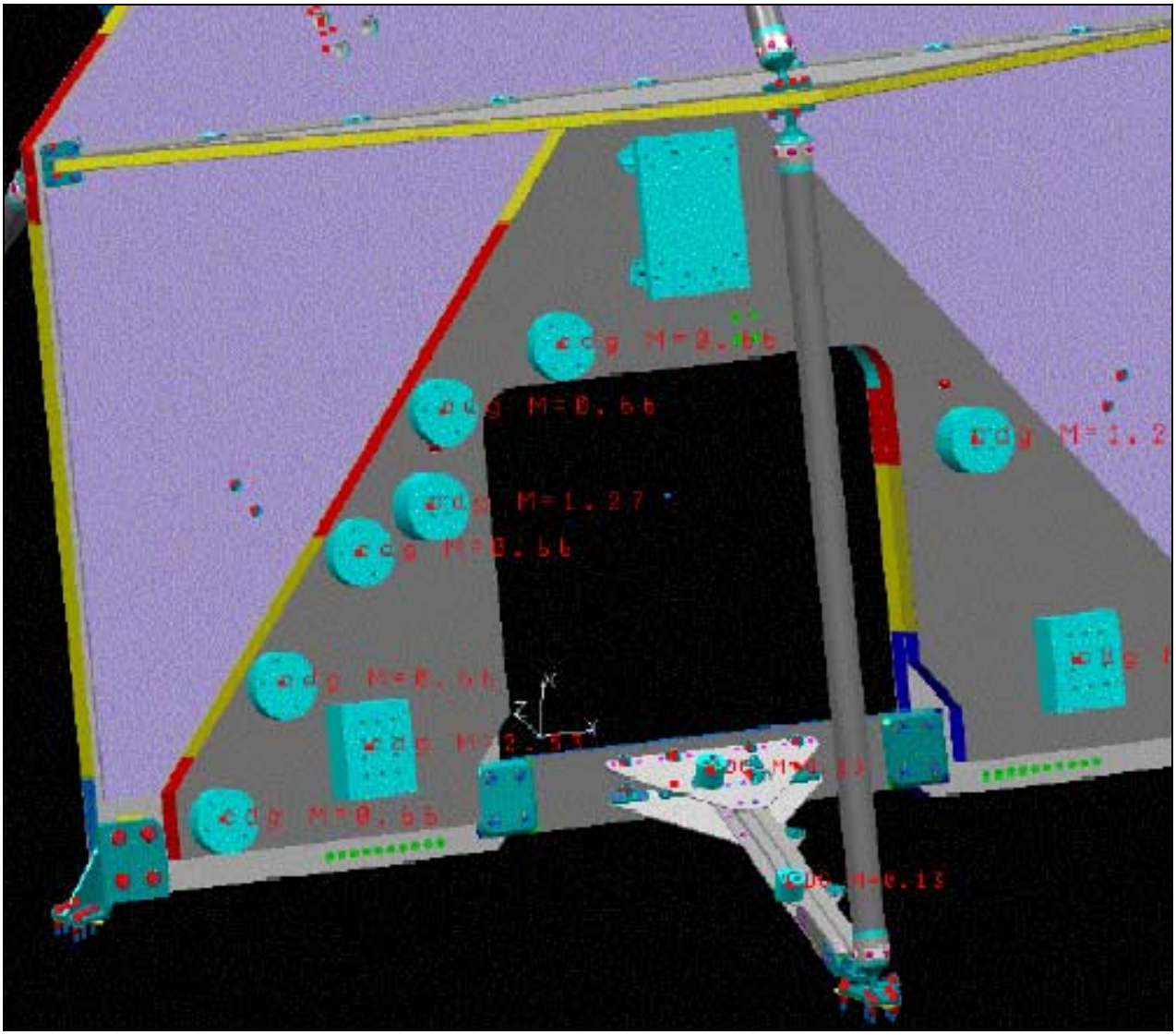
Figure 60 - PACE transfer between JPL MGSE and SID

The frame of this operation is quite the same as for FM, but SCC not featuring.

5.2 Cryostructure integration

The grooves integration is the **same as for FM**, but the **nominal PACE and RAA is not present**. For acoustic test, it will be replaced by mass dummies to be fixed on grooves.
Some of the mass dummies are on the telescope, they will be mounted prior telescope mating on cryostructure.

Mass dummies to be mounted :
(a) 10 mass dummies featuring pipes 0.1 K et 4K on grooves 1,2,3 et telescope beam for 0.1K
(b) 1 JFET + bellow on telescope
(c) bellow 50 K on PR panel
(d) Wave Guides braids on grooves 1,2,3
(e) 4 WG upper structure on PR panel telescope



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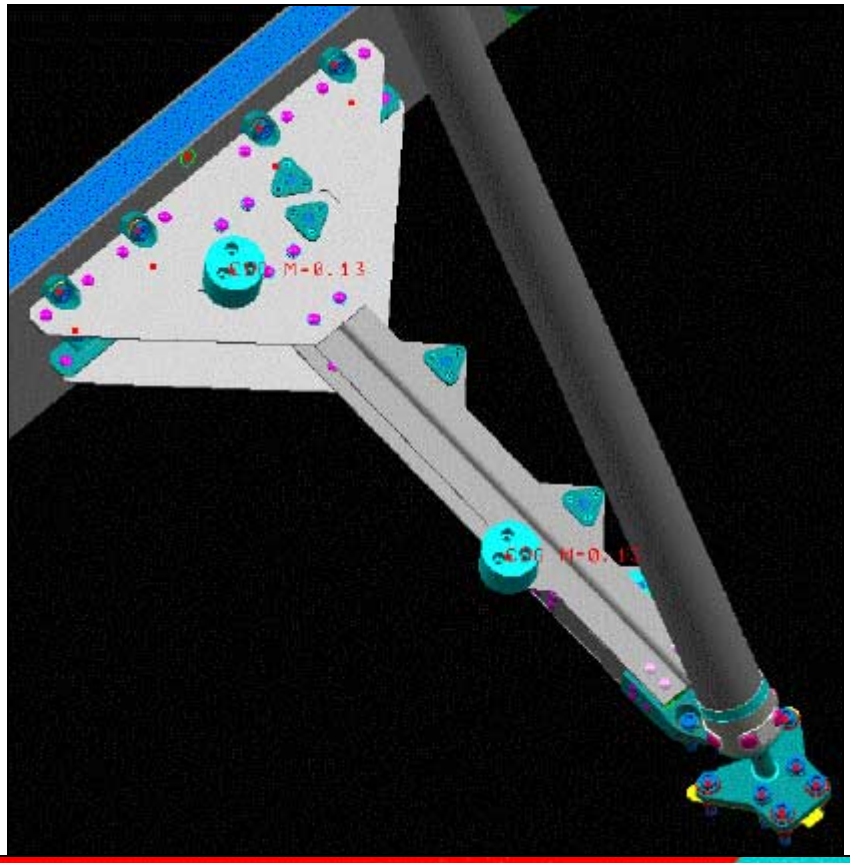
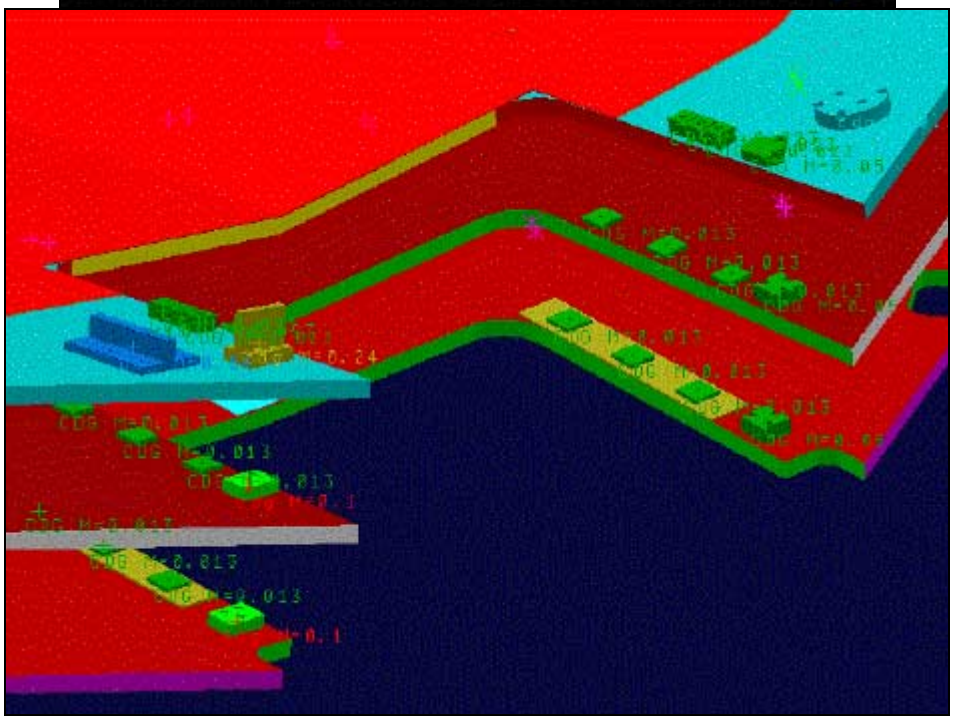




5.3 PLM mating on SVMD

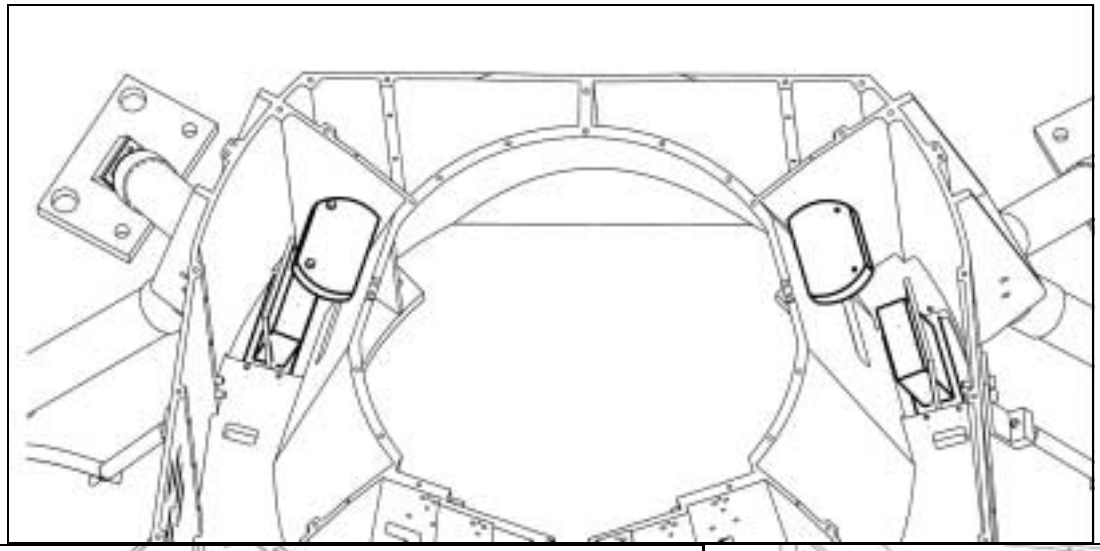
Same operation as for FM, but SCC is not featuring.

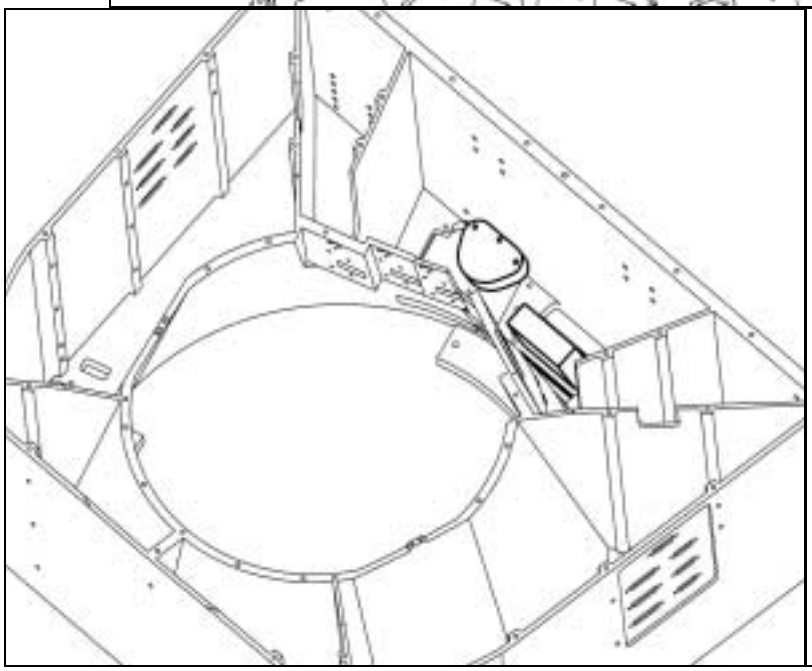
5.4 Telescope mating

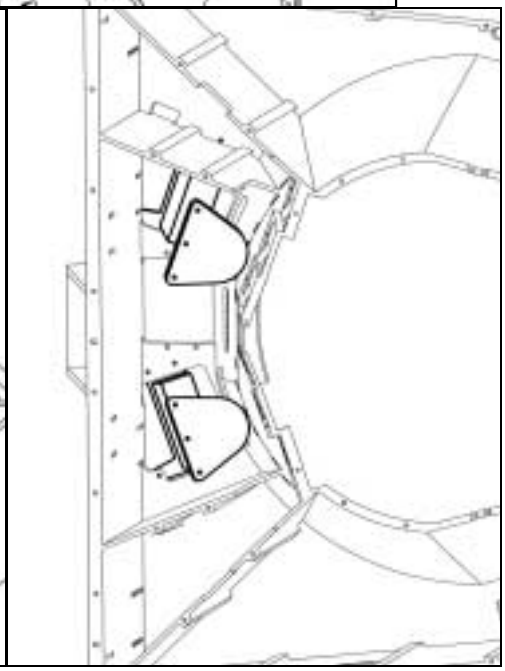
Same operation as for FM (§ C p 7).

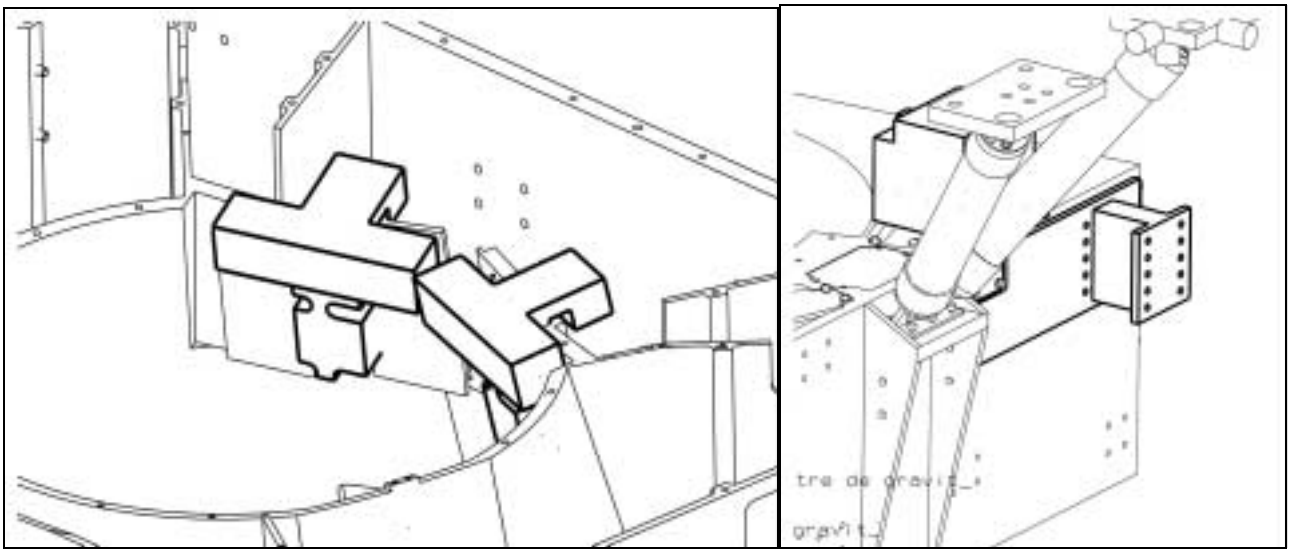
5.5 RAA constitution

Mass dummies have to be mounted in LFI mainframe prior HFI mating :









Mass dummies to be mounted :
(a) 1 SCCE N mass dummy
(b) 7 horn mass dummies : on mainframe (LFI FPU)
the two 70 GHz to be mounted before FPU HFI

HFI is then mated inside LFI mainframe.

Three bipod are delivered apart, to be mounted in clean room on mainframe.

FPUs, mounted on FHD, are then mated on the primary panel.

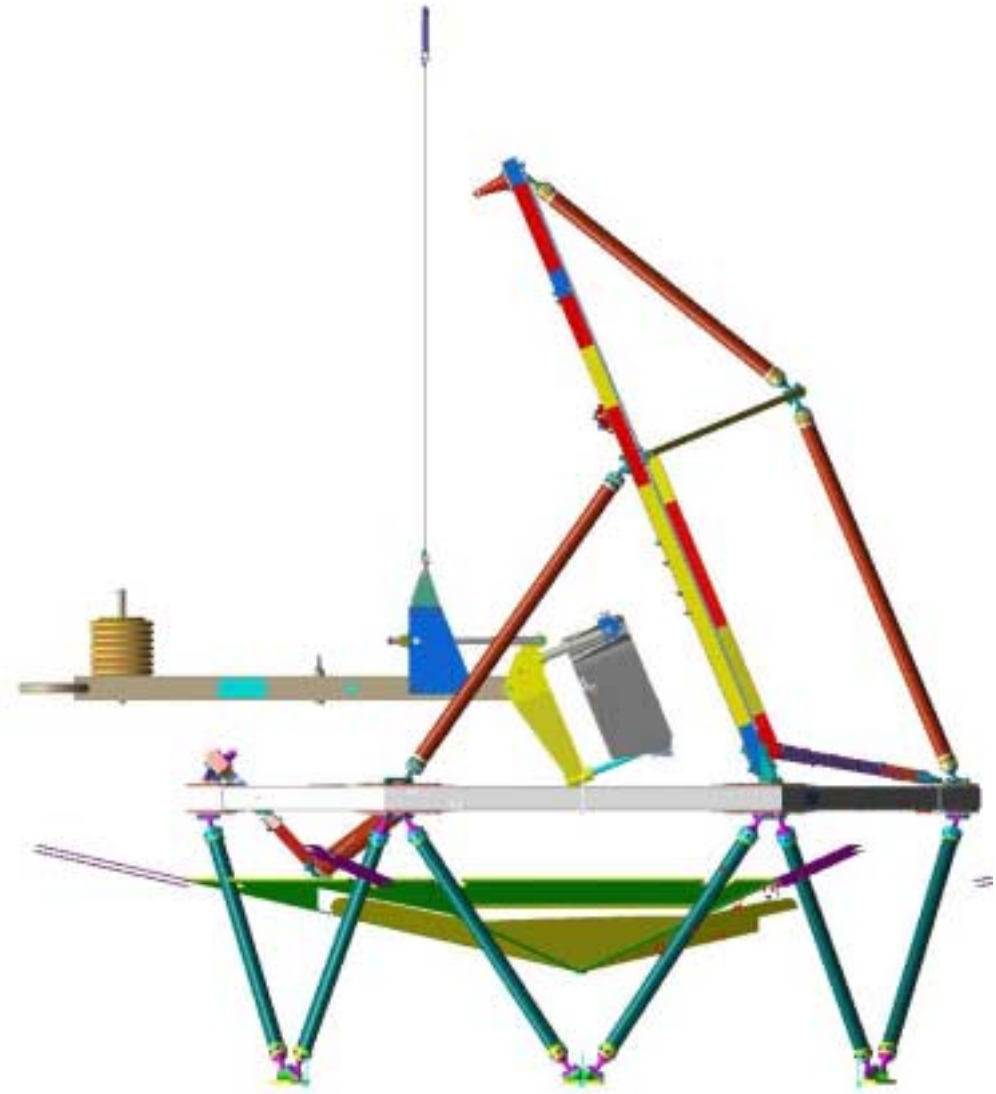


Figure 61 - FHD with FPU in telescope.

6. PLANCK CQM INTEGRATION SEQUENCE DEVIATIONS

The overall sequence of operations will be :

A. RAA constitution : HFI integration into MTD FPU
B. cryostructure integration with RAA dummy
C. cryostructure mating on SVM dummy Subplatform set up on PAD
D. PLM mating on SVM dummy
E. PLANCK CQM final integration
F. Thermal test in CSL
G. Dismounting

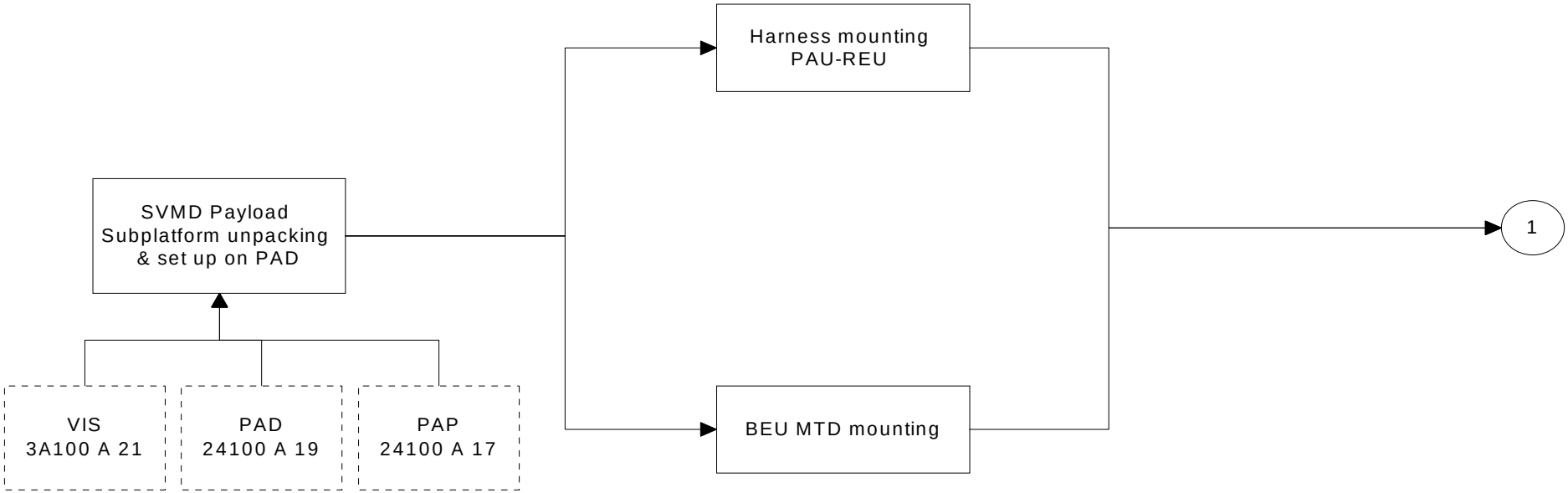


Figure 62 - Detailed CQM sequence.

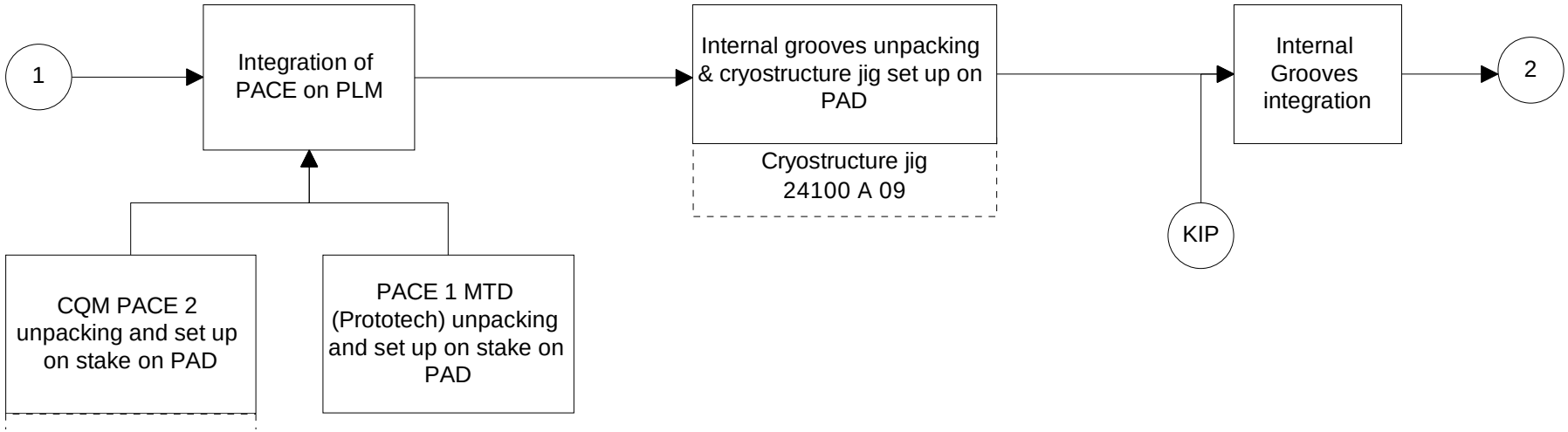


Figure 63 - Detailed CQM sequence (cont.).

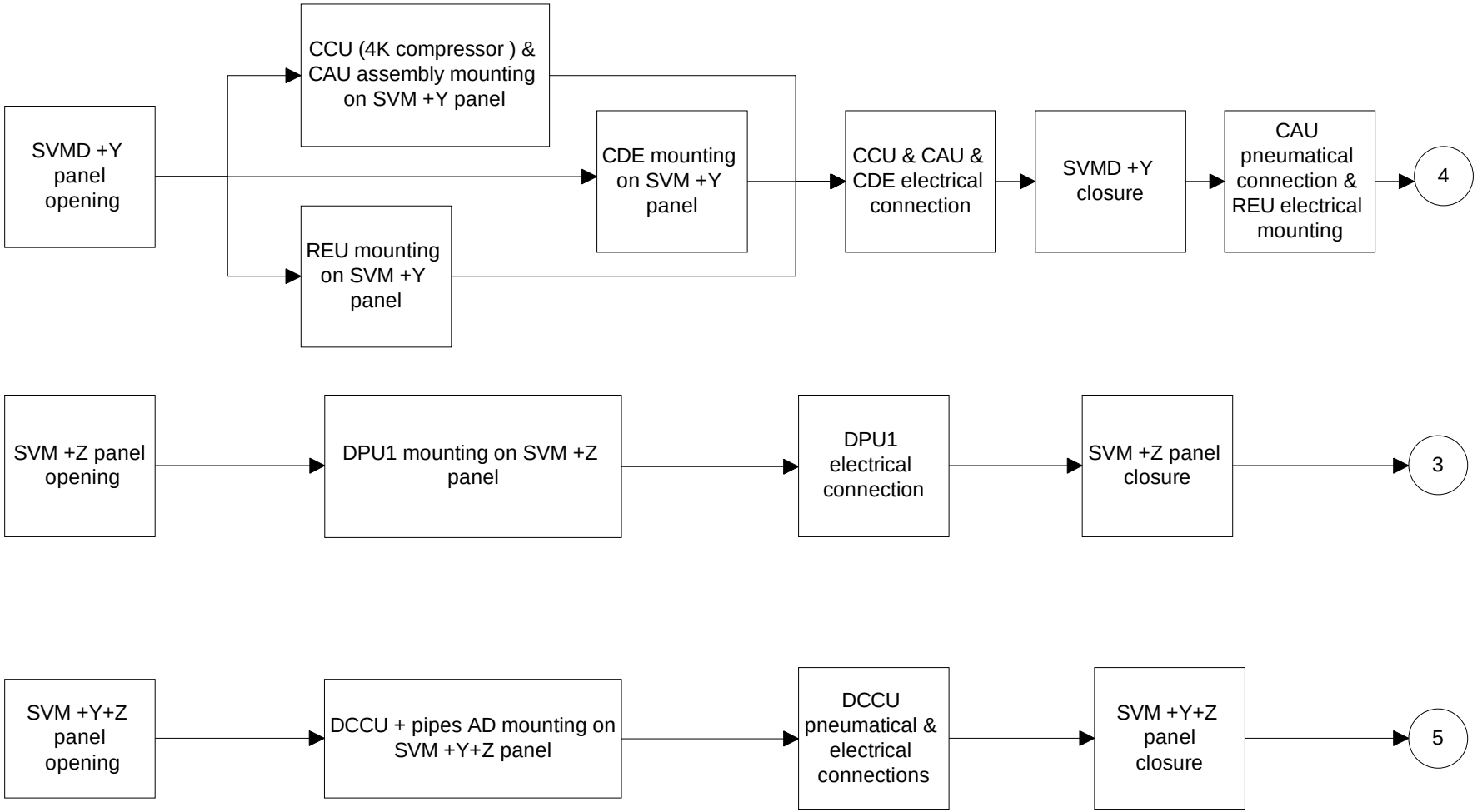


Figure 64 - Detailed CQM sequence (cont.).

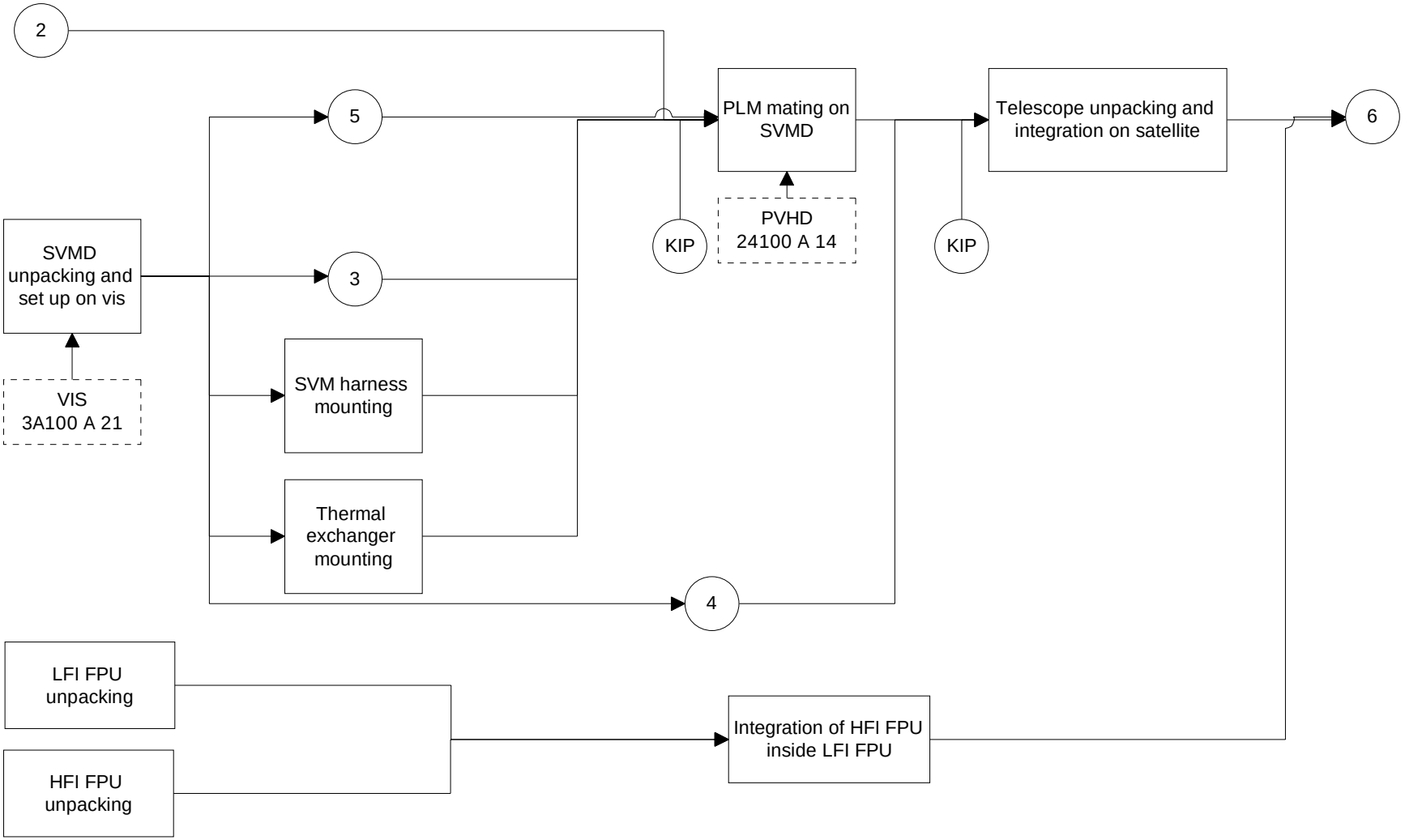


Figure 65 - Detailed CQM sequence (cont.).

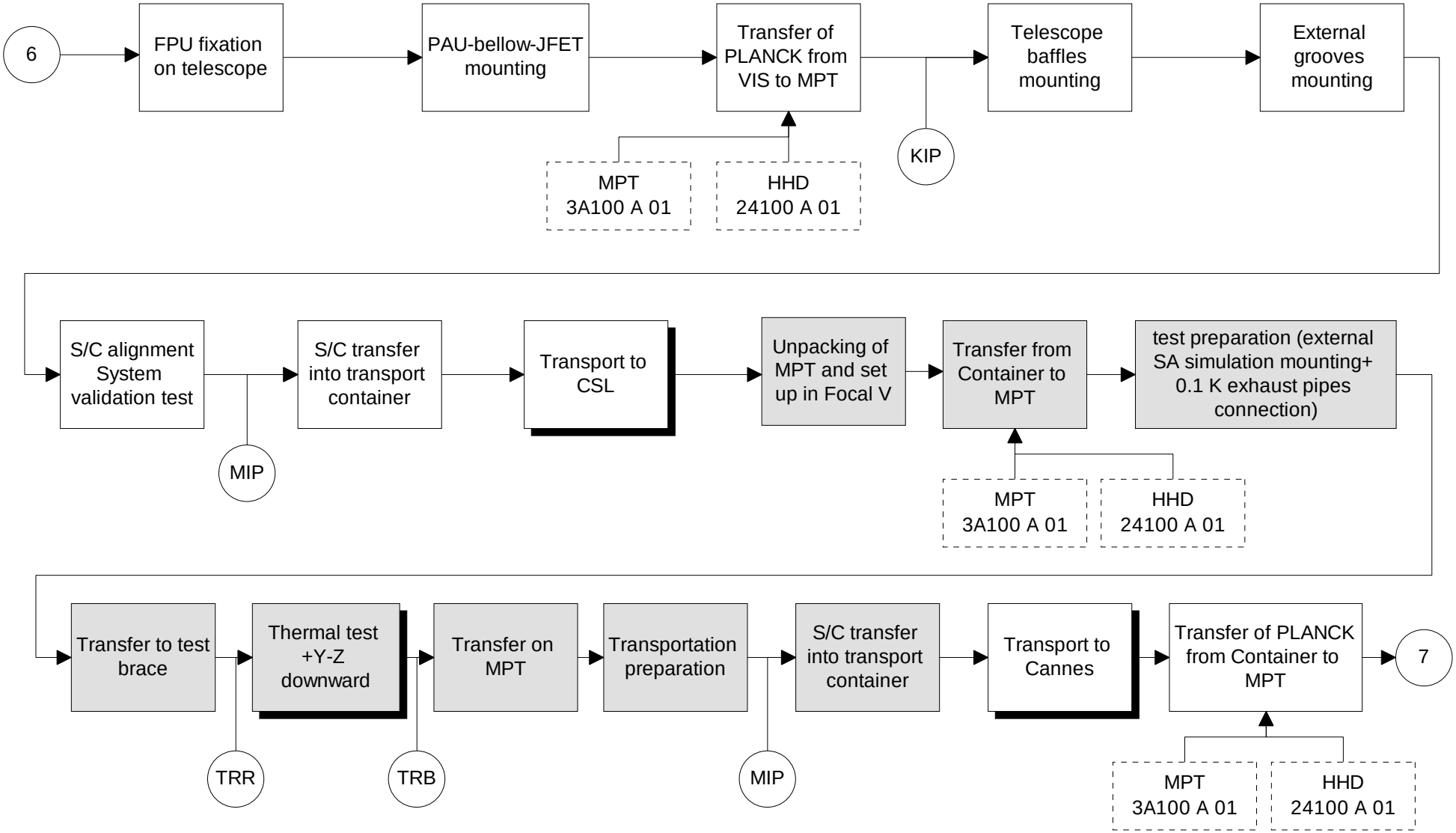


Figure 66 - Detailed CQM sequence (cont.).

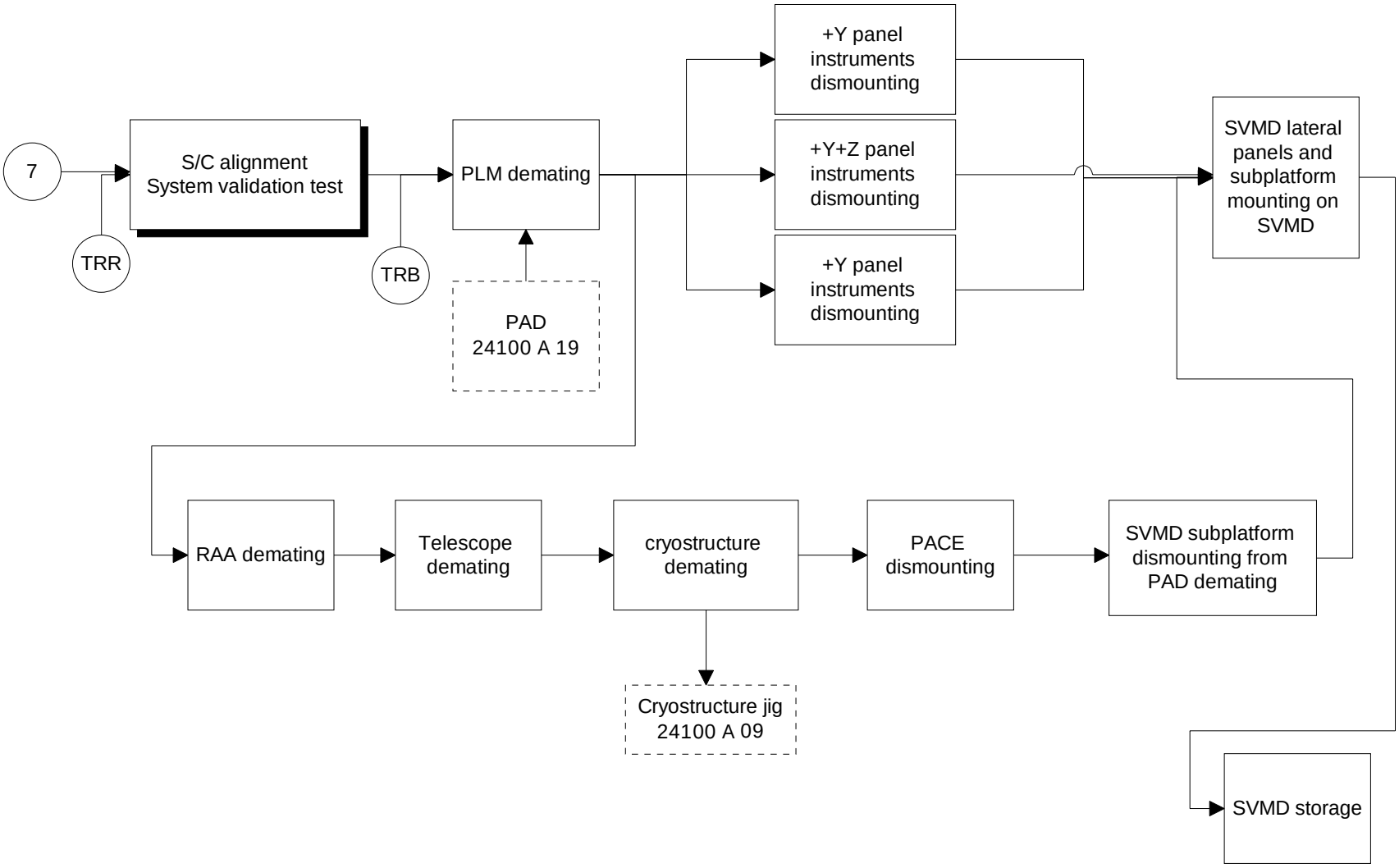


Figure 67 - Detailed CQM sequence (cont.).

The equipment to be mounted are shown on following sketch :

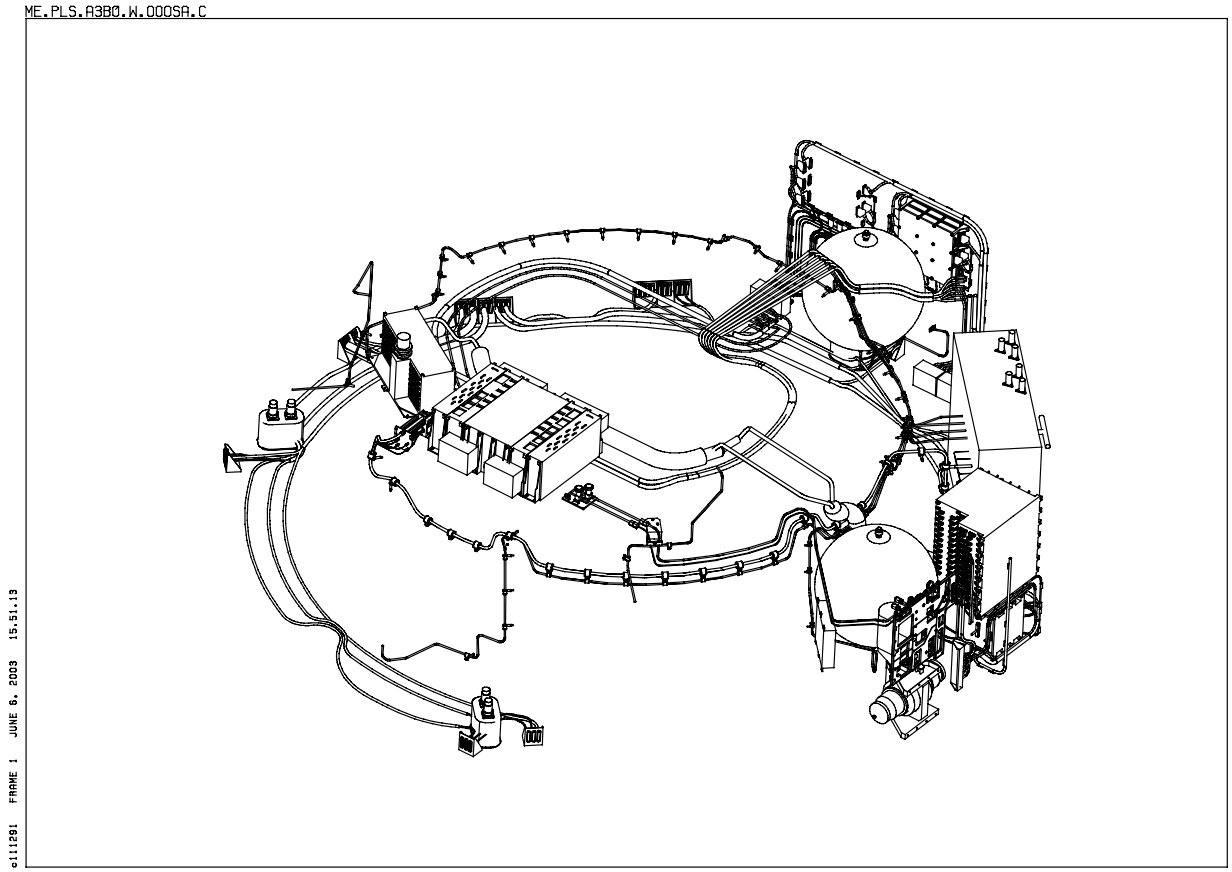


Figure 68 - SVMD equipment (spheres excepted, not mounted)

These flight equipment are mounted on a SVM Dummy (called hereafter SVMD) which is used for thermal test in CSL :

- 1 CQM DPU
- 1 CQM REU
- 1 CQM PAU-bellow-JFET
- 1 4K CQM set
- 1 CQM PACE without SCC on +Y side (redundant)
- 1 CQM DCCU
- 1 RAA dummy

RAA dummy is made up of :

- 1 CQM HFI FPU
- 1 LFI FPU dummy
- six FPU struts
- 1 BEU dummy

Integration of the RAA dummy is performed in Alcatel premises under HFI responsibility.

6.1 RAA integration

HFI CQM will be fixed into a MTD LFI FPU made by Alcatel. All items used on HFI side will be flight representative.

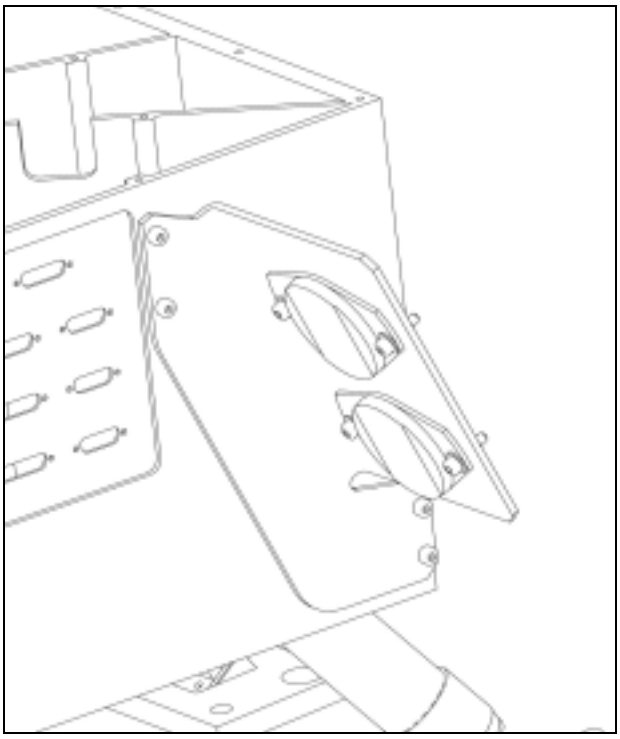


Figure 69 - FPU cleanliness witnesses

Optical cube will be mounted on FPU.

6.2 Thermal sensor/heater mounting

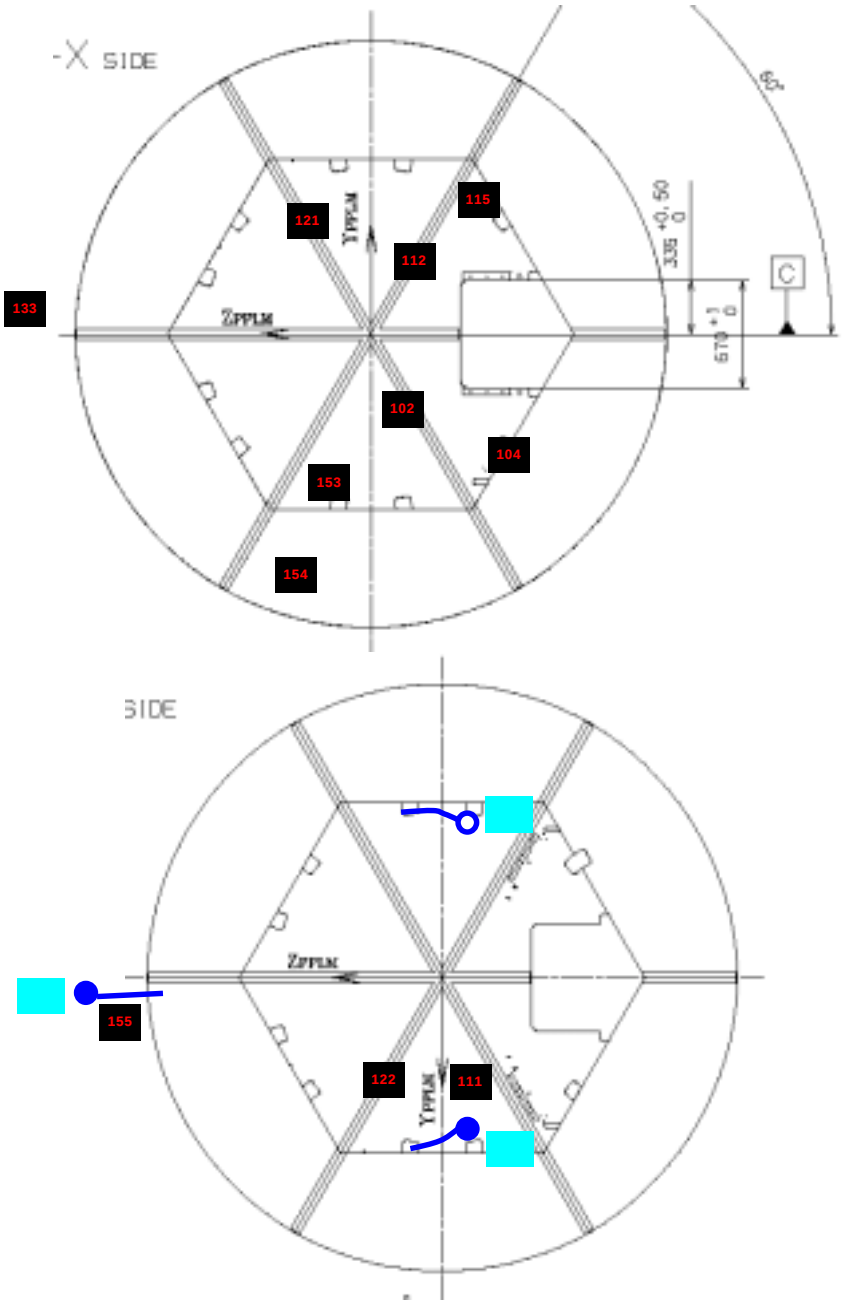


Figure 70 -Groove 1 Faces + et – X

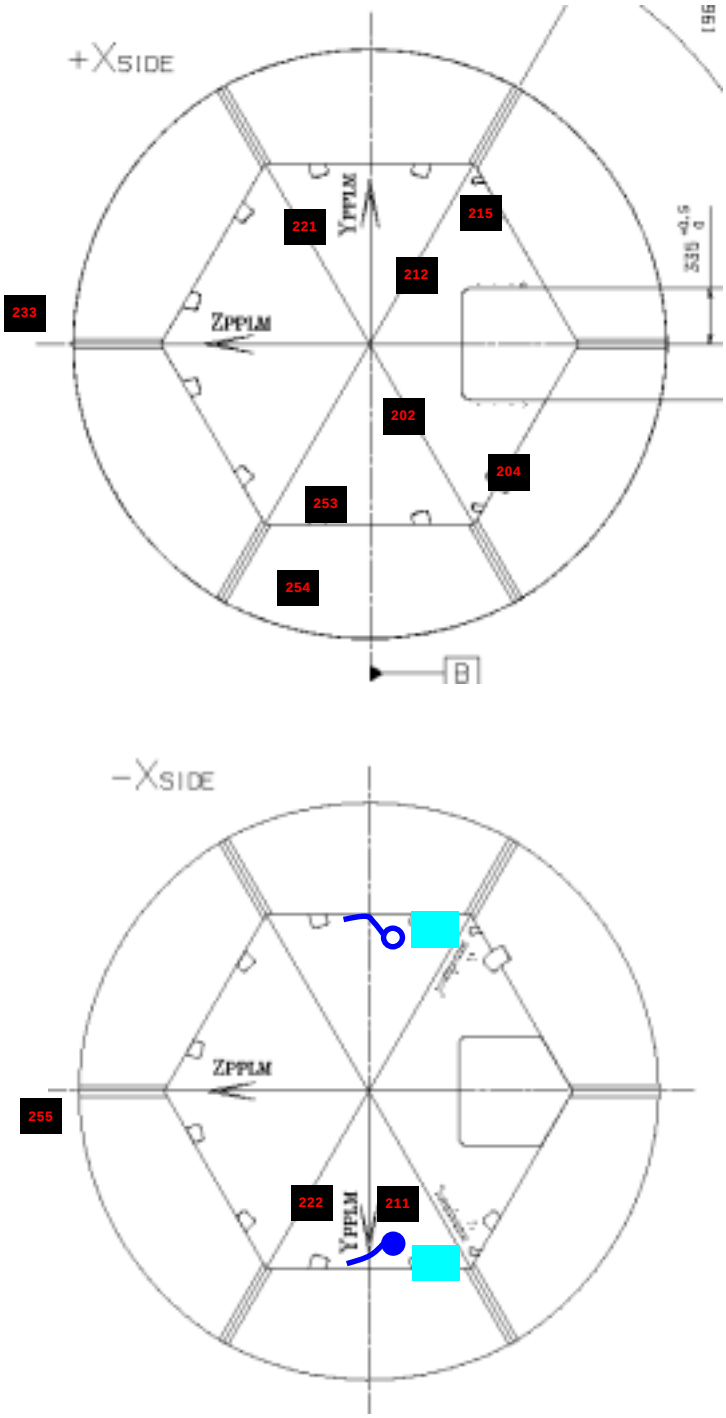


Figure 71 -Groove 2 Faces + et – X

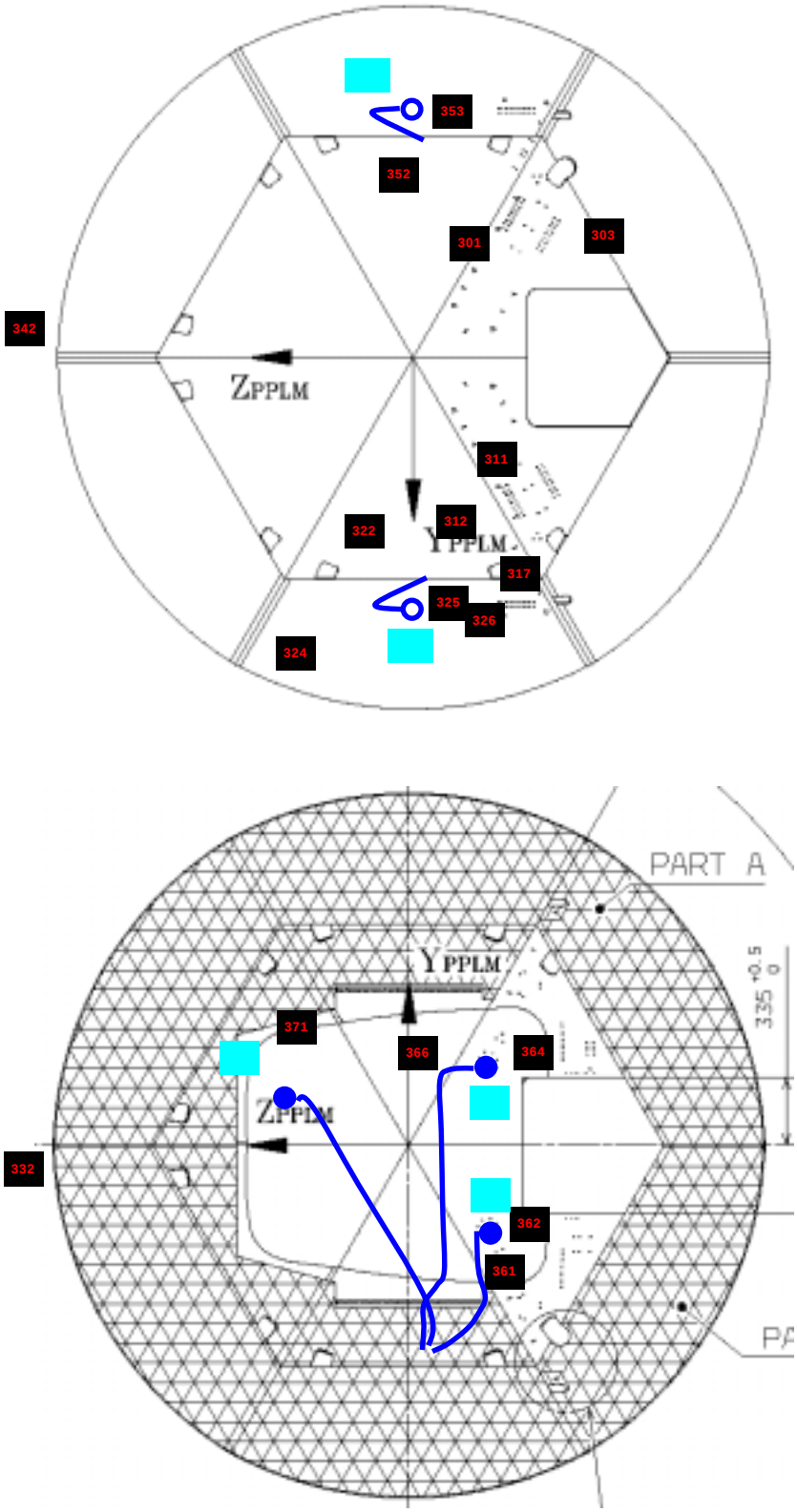


Figure 72 -Groove 3 Faces + et – X

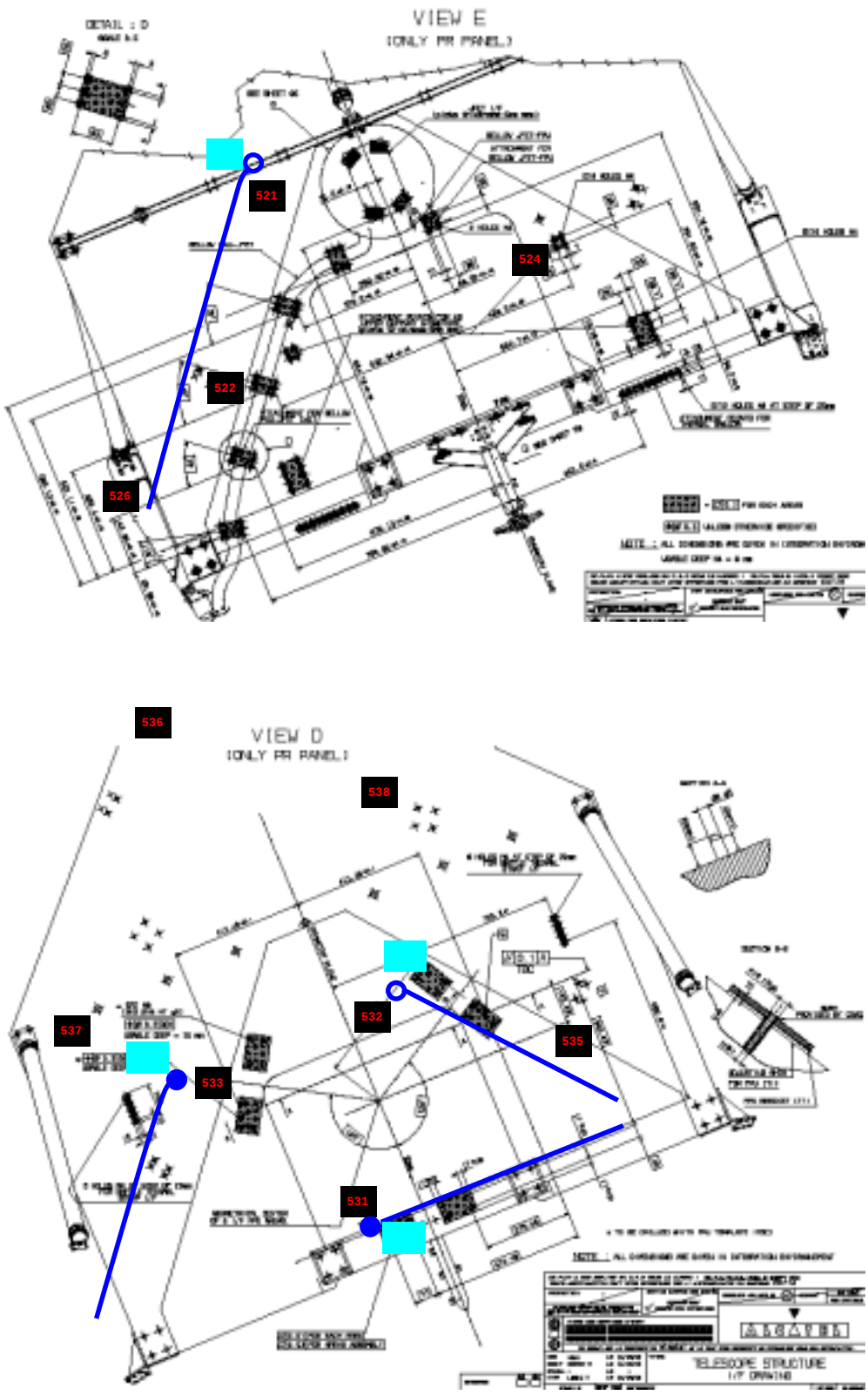


Figure 73 -PR Panel Faces +Z et – Z

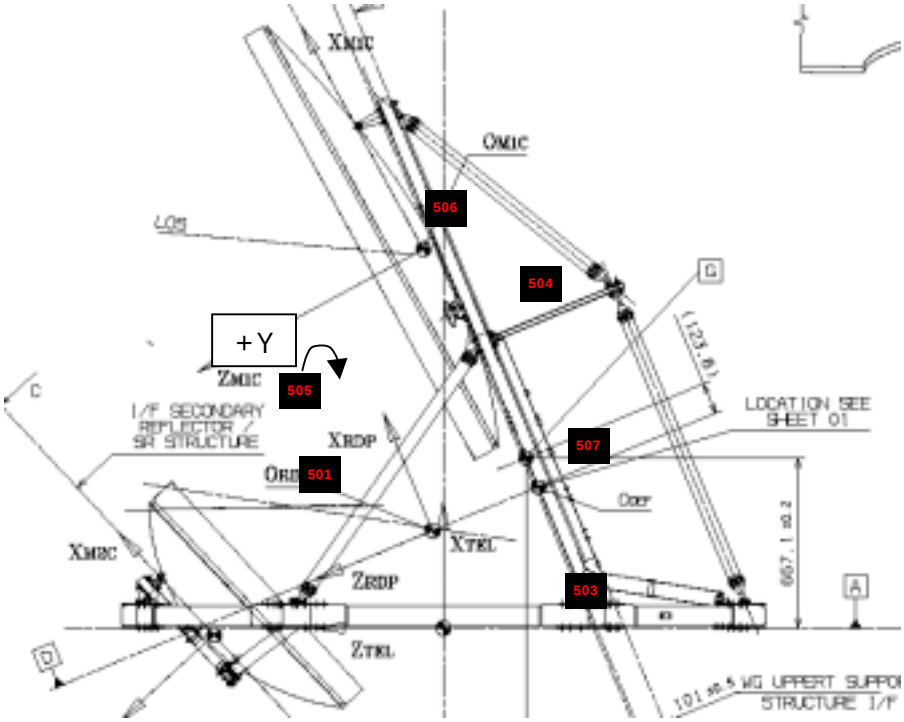


Figure 74 -Struts PR Panel

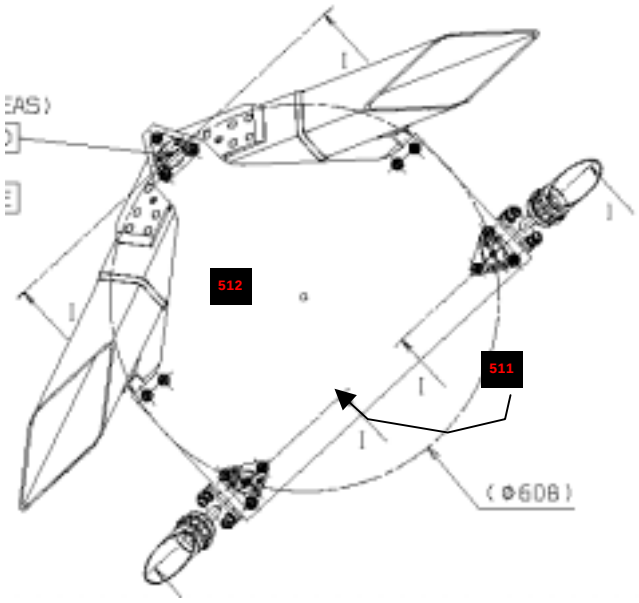


Figure 75 -SR Panel

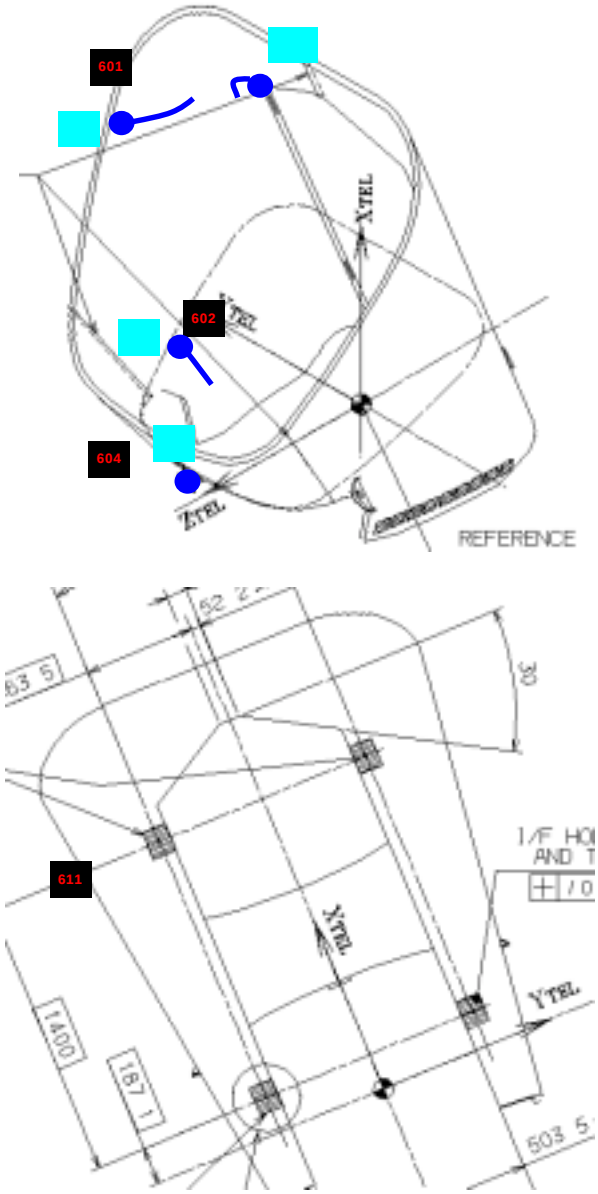


Figure 76 -Baffle (inner & outer faces)

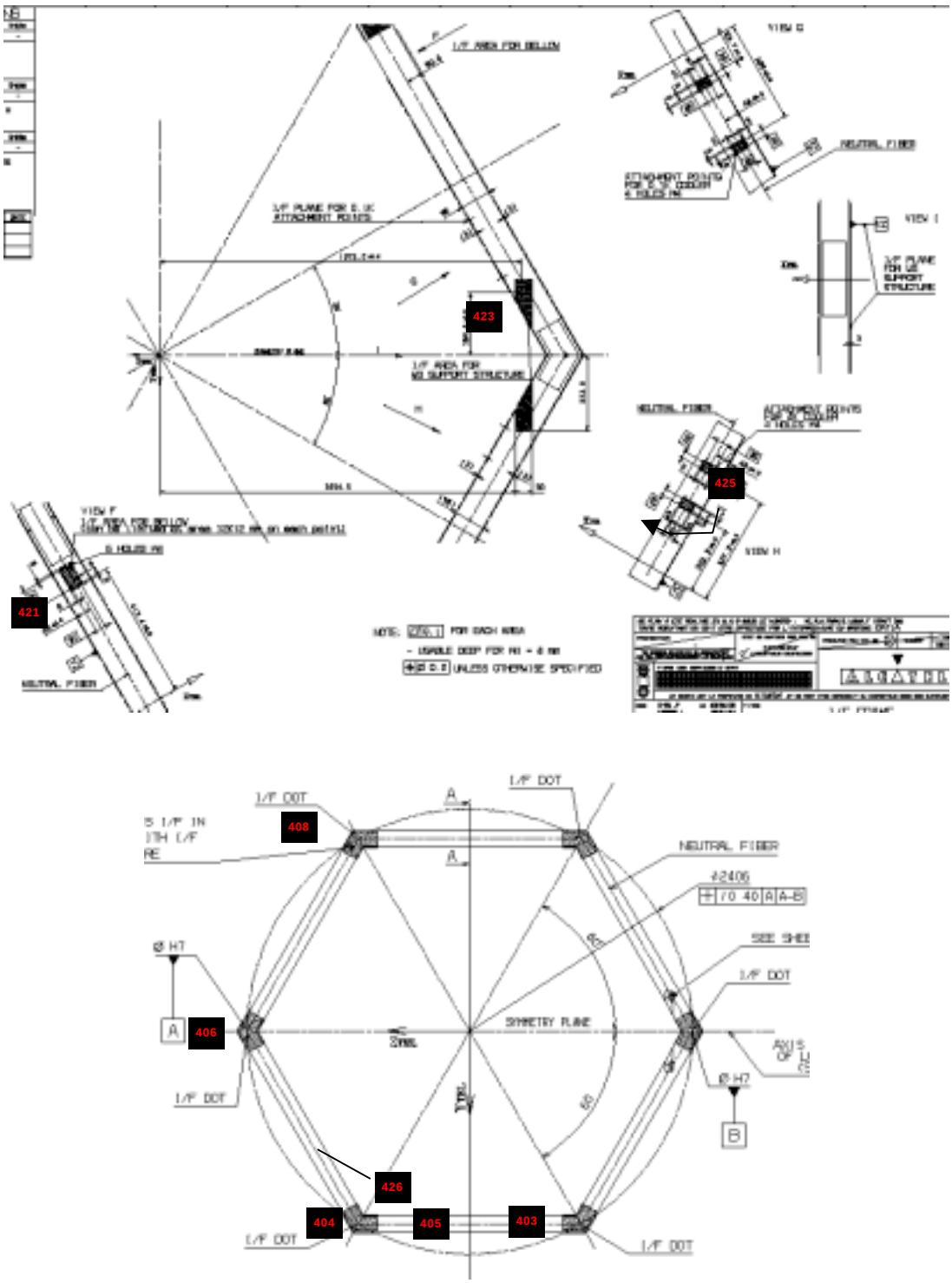


Figure 77 -Telescope Frame

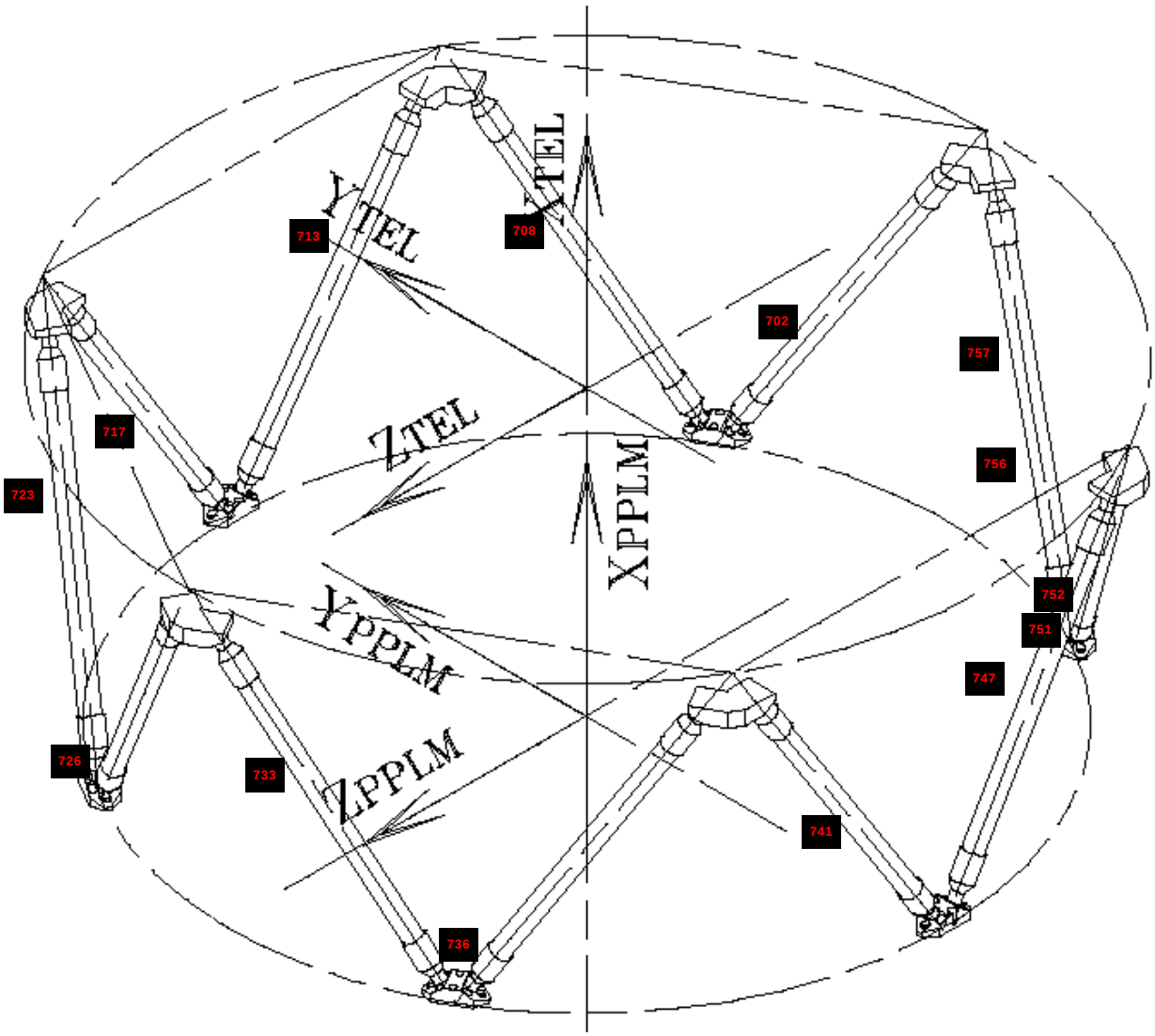


Figure 78 -Cryo-Struts assembly

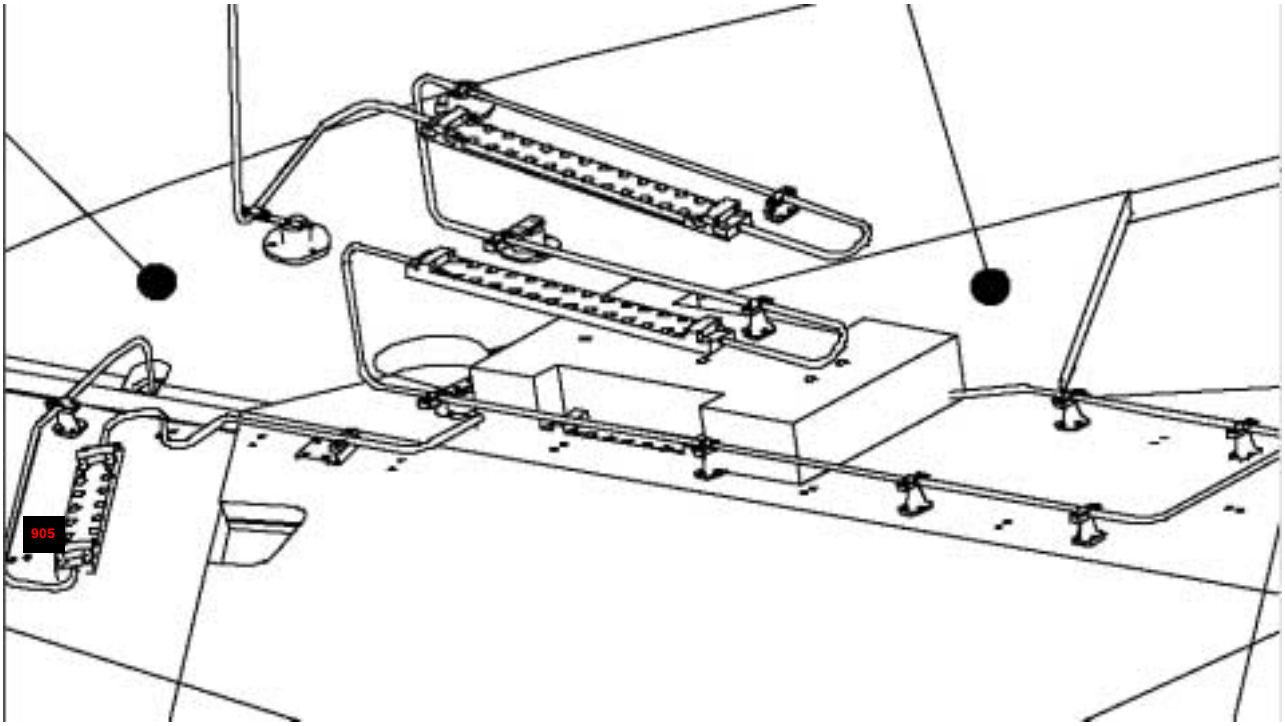
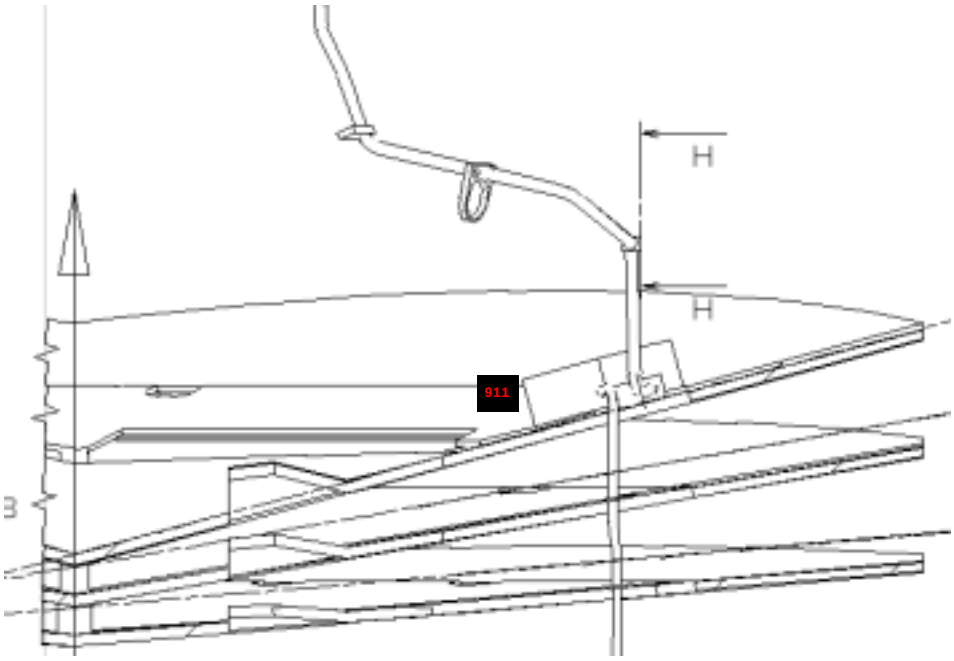


Figure 79 -20K JT VG Exchangers

Figure 80 -0.1K dil VG Exchangers



Test heaters (+details in flight T° sensors positions)

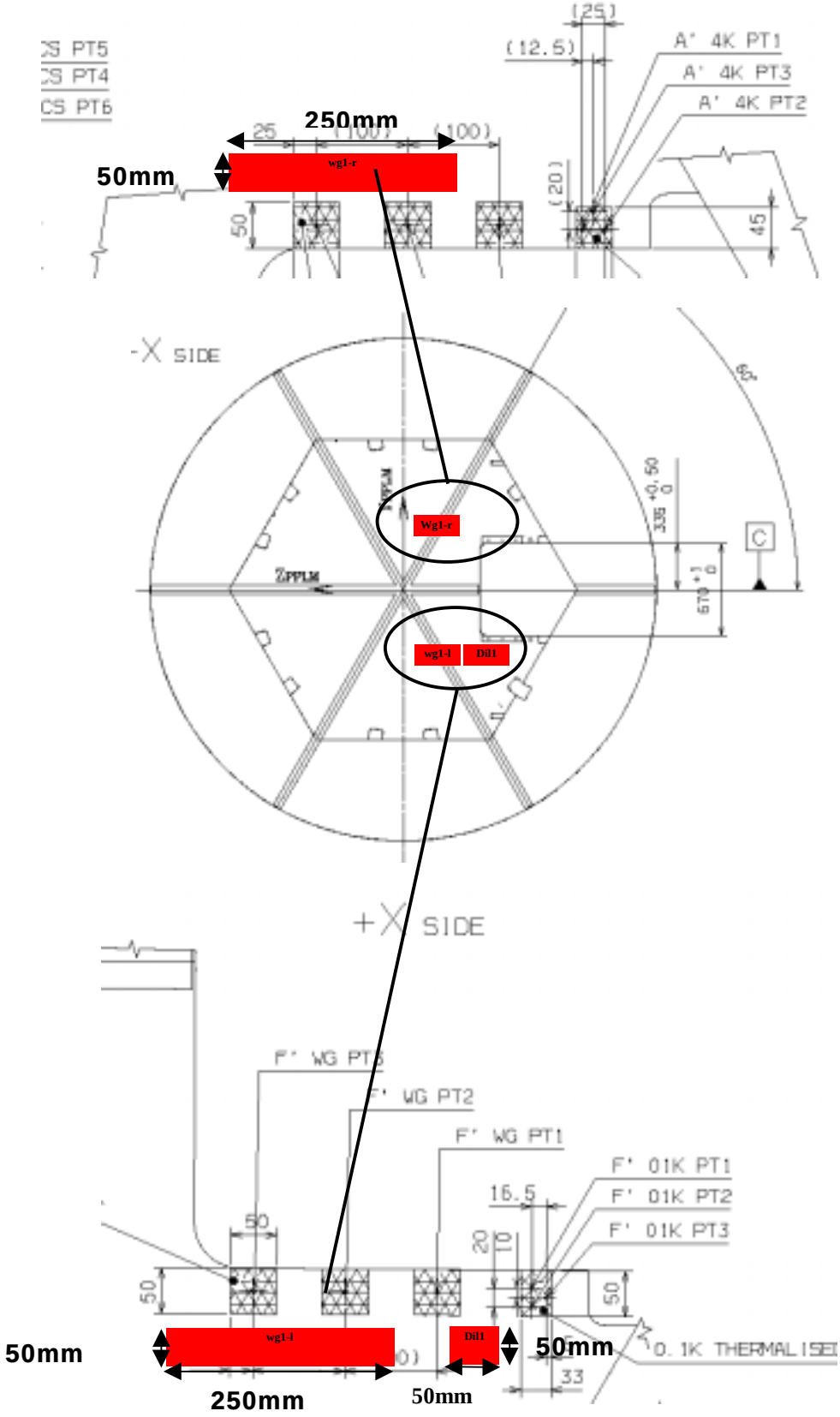


Figure 81 -Groove 1 Faces + et – X

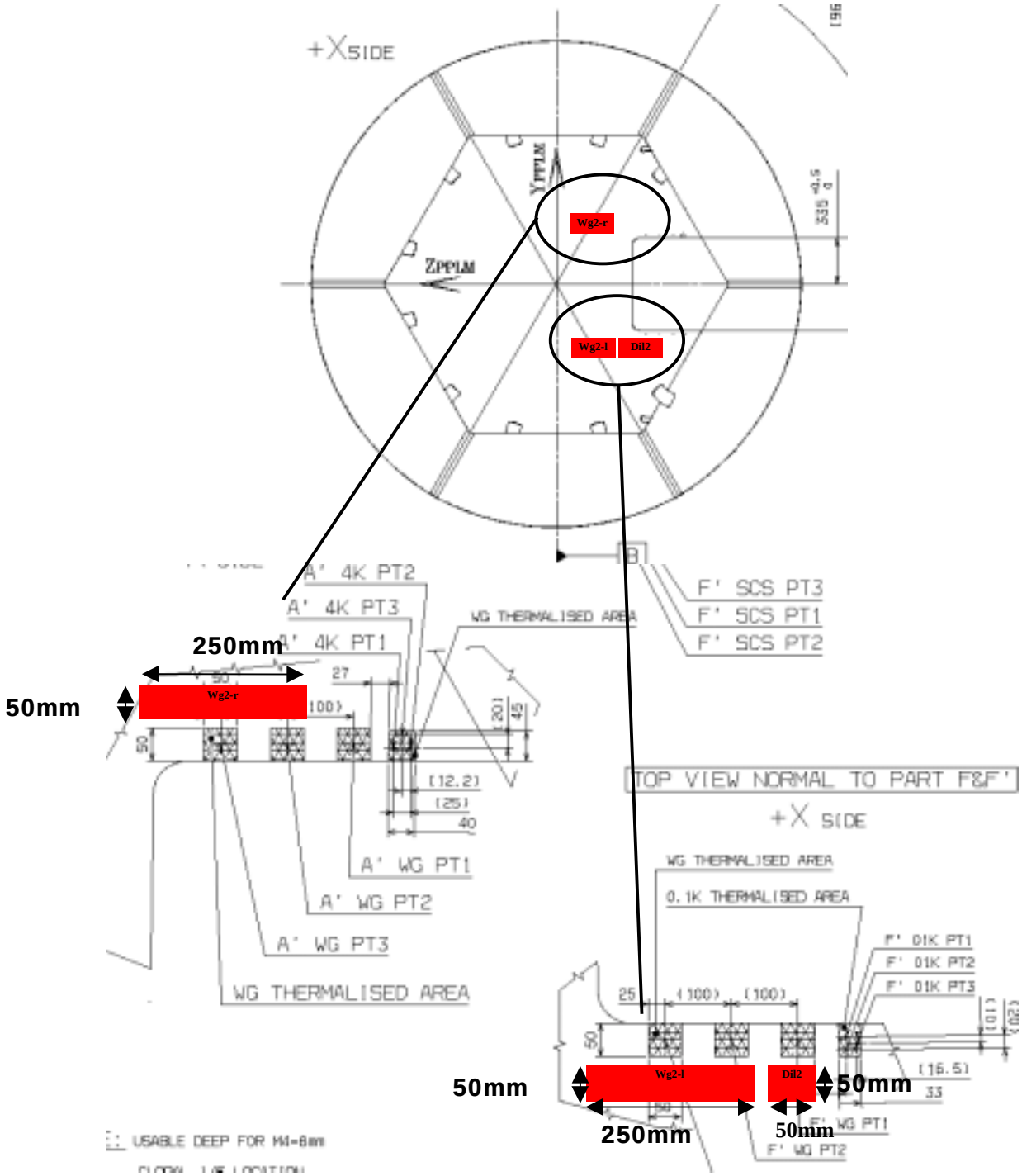


Figure 82 -Groove 2 Face +

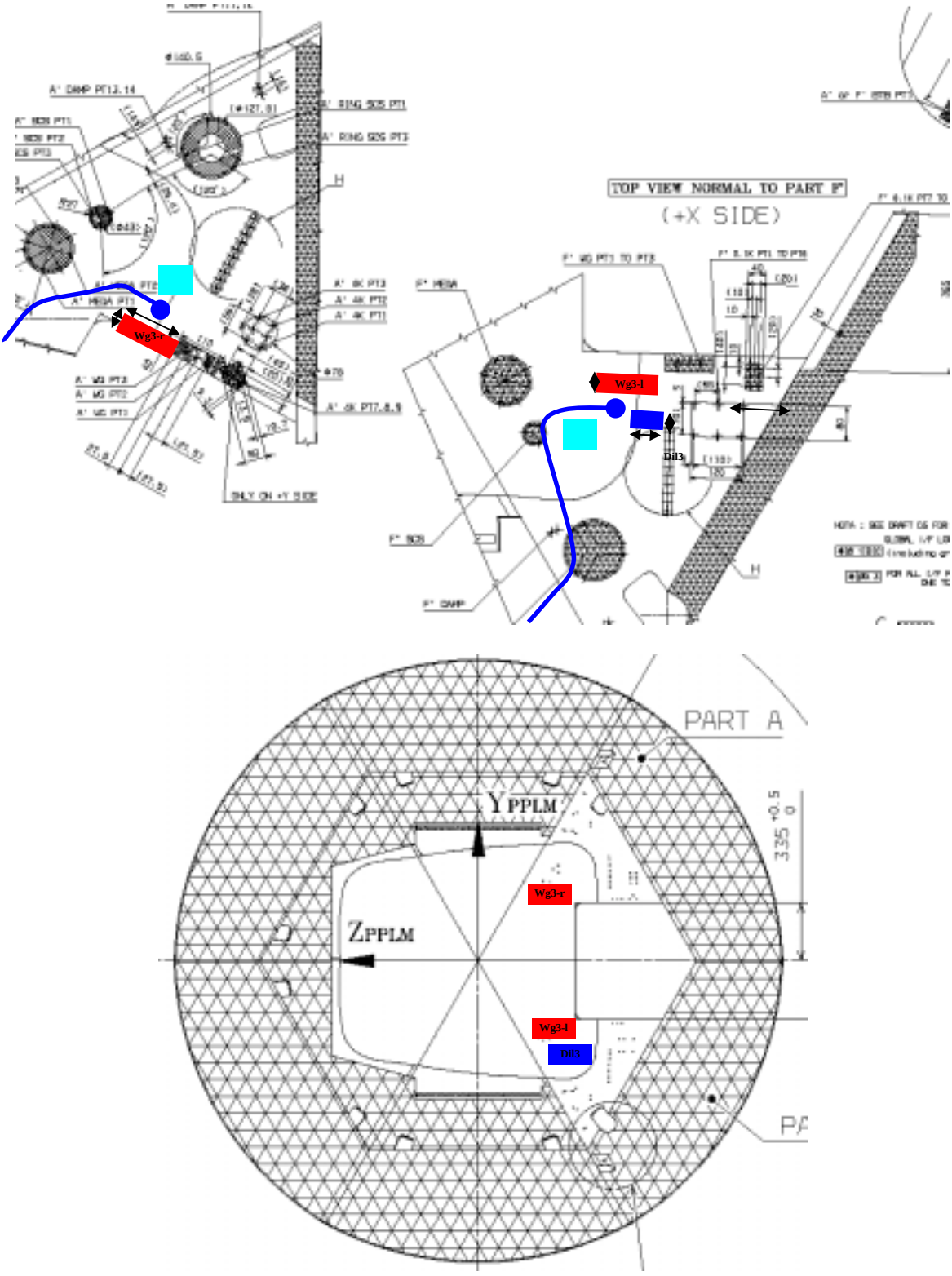
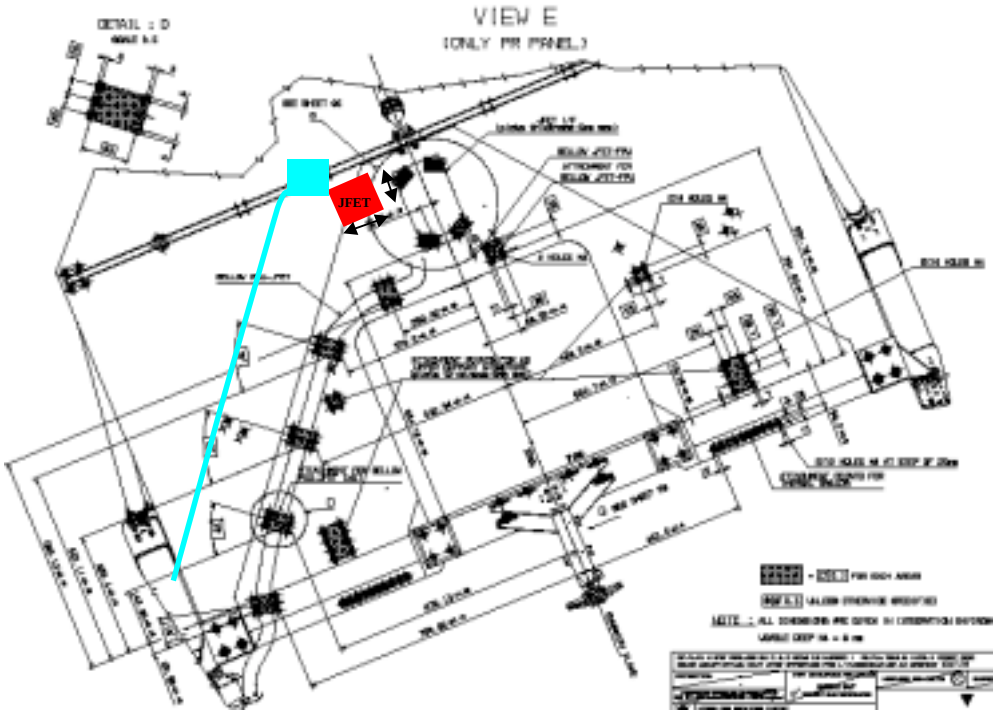


Figure 83 -Groove 3 Face +



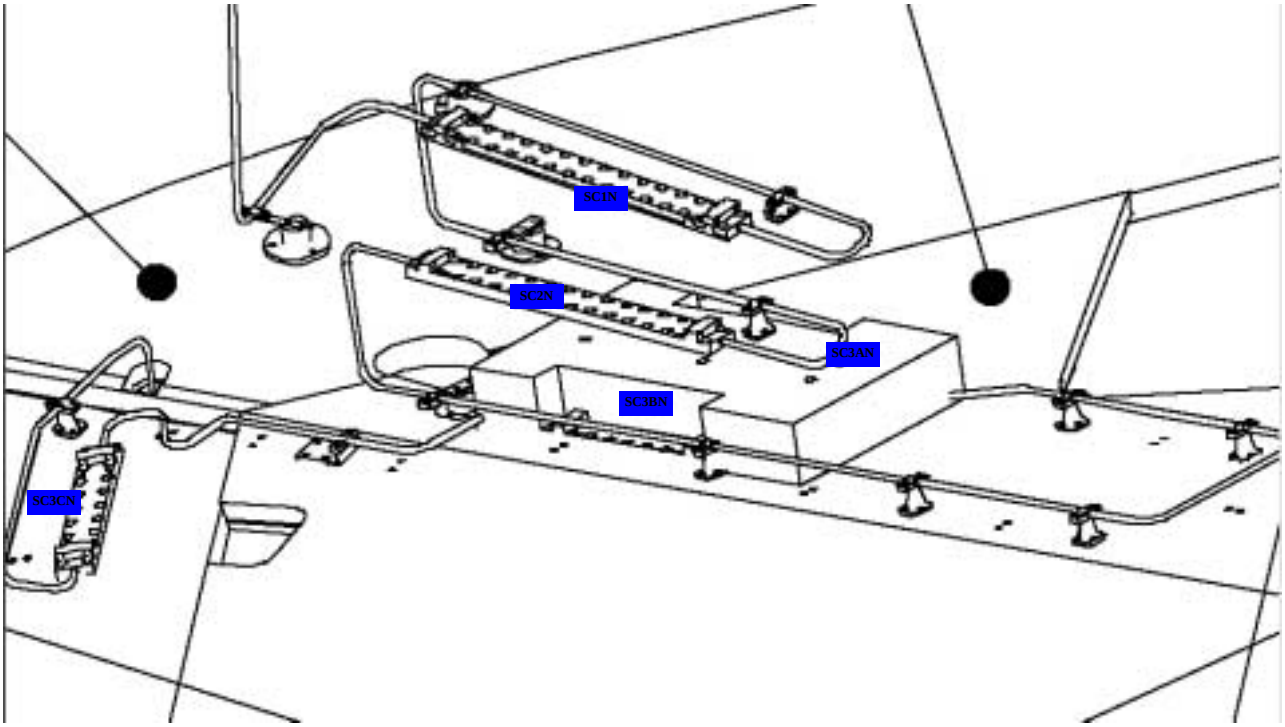


Figure 84 -20K JT VG Exchangers

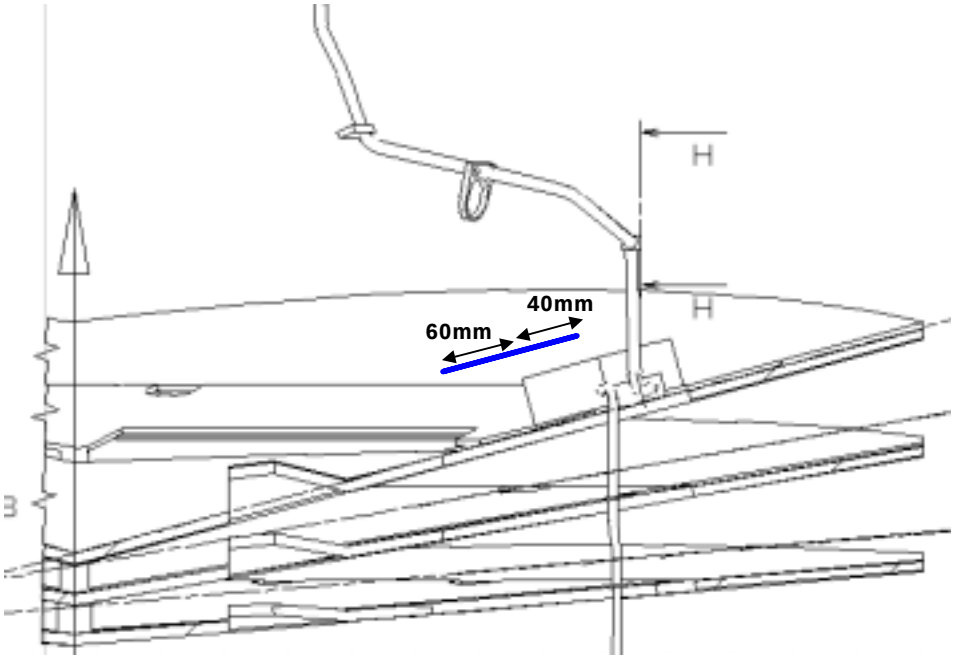


Figure 85 -4K JT VG Exchangers

6.3 Instruments integration on SVMD

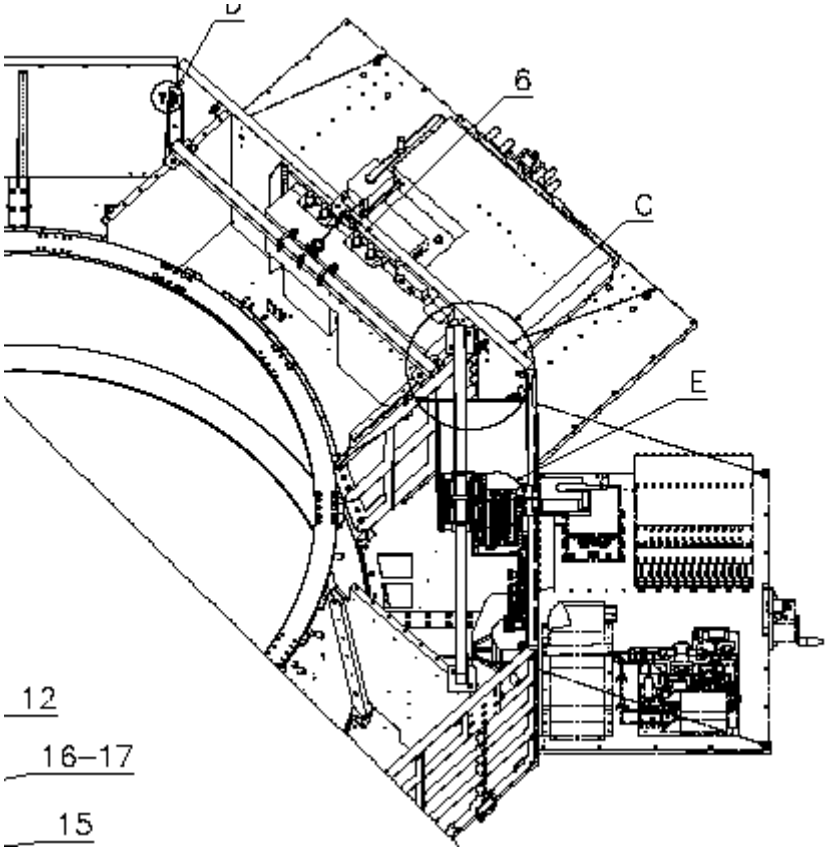


Figure 86 - 4K and 0.1 K panels opened

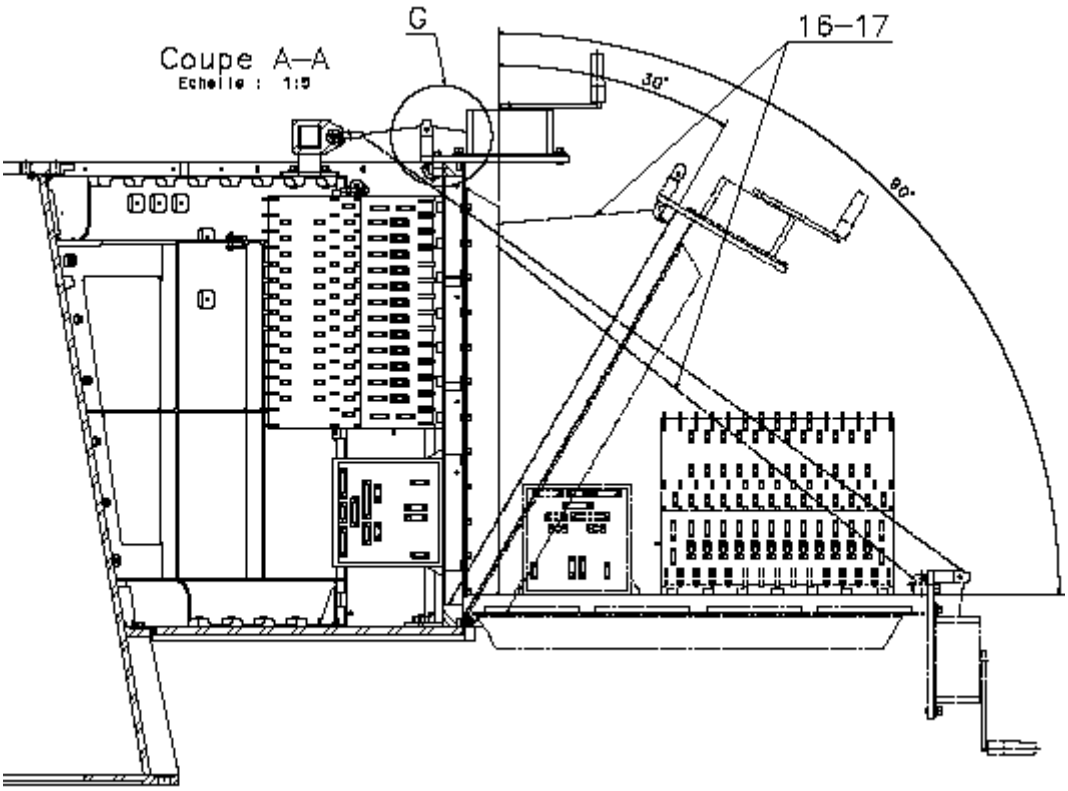


Figure 87 - Closure of the lateral panels

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