Atacama
Large
Millimeter
Array

ALMA ACA 12 m Mitsubishi Production Antenna Receiver Cabin Layout

ALMA-80.00.01.00-001-A-REP

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Change Record

Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A	2006-08-19	All	Draft A	First release

Table of Contents

1 Scope

This report corresponds to the previously issued ALMA Vertex and AEC receiver cabin layout study.

The goals of this document are

- To verify that no mechanical interference exists
- No functional and operational obstruction between single units exists
- Comparison between the allocated volume of equipment and its given space in the receiver cabin
- To verify that the final design of subsystems does not exceed the allocated design volumes
- To assure that all units are accessible by opening cabinet doors and drawers far enough to remove parts and LRUs
- To verify that all functional groups which will need access for maintenance or repair are easily achievable and no interference occurs between the BE racks, FEND units and the A/C ducts
- To show that the handling for mounting and removal of subsystems is possible in the given configuration

2 Introduction

Based on the design of the **12m Mitsubishi production** antenna, a 3D CAD model of its receiver cabin was created using the CAD program Inventor, which contains the future installations of the ALMA subsystems. This report should illustrate where installation conflicts exist and modifications of the current layout are recommended/necessary.

Change requests were issued before this document was written and are currently in the process of approval (see documents of chapter 3.1). These changes are implemented as a proposal, which is not binding.

The Front End model is the same as for the Vertex and AEC receiver cabin. This model was integrated into the cabin together with the Front End Support Structure.

The Back End racks were modeled based on the drawings of the candidate of the new rack which has a height of 1565 mm (RD18).

The reference documents to build the 3D model of the production receiver cabin are listed in 4.1.1.

The 3D Inventor files for the receiver were originally delivered by the FE IPT. For this document the FE model was integrated into the antenna model using the FESS as the interface.

Further details are missing such as cable trays and hose/cable routing inside the cabin.

3 RELATED DOCUMENTS AND DRAWINGS

3.1 Applicable Change Requests

No	Document Title	Reference
AD01	Add Detail to Antenna to Backend Interfaces and Fiber Optics Wrap	ALMA-57.02.00.00-003-B-CRE
AD02	Comments and additions to Antenna/BE ICD for fiber optics issues	ALMA-57.02.00.00-015-A-CRE
AD03	On-Axis Fiber Wrap Interface	ANTD-34.00.00.00-004-B-DWG
AD04	Change Request to the Antenna to Front End ICD and applicable documents	ALMA-40.00.00.00-068-A-CRE
AD05	Front End Design Space and Handling Interface	FEND-40.00.00.00-026-C-DWG

3.2 Reference Documents

No	Document Title	Reference
RD01	Front End Design Space and Handling interface	FEND-40.00.00.00-026-B-DWG
RD02	Interface Control Document between Antenna and Front End	ALMA-34.00.00.00-40.00.00.00-B-ICD
RD03	Front End Mass Budget	ALMA-40.00.00.00-043-A-GEN
RD04	Interface Control Document between Antenna Subsystem and Back End Subsystems	ALMA-34.00.00.00-50.00.00.00-B-ICD
RD05	Band 3 OPTIC Ensemble dated 10/04	60-10-00/1
RD06	ALMA Cryostat Window and Filter Interface (draft)	FEND-40.00.00.00-016-B-DWG
RD07	Front End Interface flange	ALMA-34.00.00.00-016-A-DWG
RD08	Vacuum Vessel Assembly, ALMA Cryostat	KG0772-050
RD09	ALMA Production Cryocooler Interface details	KG0772-401
RD10	SHI cryocooler specification	SRDK-3ST-R1-A61D-B (Sumitomo Number)
RD11	On-Axis Fiber wrap Interface	ANTD-34.00.00.00-004-B-DWG
RD12	Draft model for calibration device	

RD13	ALMA Coordinate Systems Specification	ALMA-80.05-00.00-009-B-SPE
RD14	Technical Specification for the Design, Manufacturing, Transport and Integration on Site of the 64 ALMA antennas	ALMA-34.00.00.00-006-A-SPE
RD15	ALMA Vertex Receiver cabin layout study	ALMA-80.00.00.00-007-A-REP
RD16	ALMA AEC Prototype Antenna Receiver Cabin Layout Study	ALMA-80.00.00.00-007-A-REP
RD17	ALMA Back End Shielded Racks	BEND-57.02.00.00-017-A-DWG
RD18	RFI CABINET ASSEMBLY	990-4585-0900 from BE
RD19	Cryostat Design Report	FEND-40.03.00.00-007-A-REP

3.3 ABBREVIATIONS AND ACRONYMS

ACA	Atacama Compact Array
AEC	Alcatel EIE Consortium
ALMA	Atacama Large Millimeter/submillimeter Array
ALMA-B	ALMA Bilateral
ALMA-J	ALMA Japan
A/C	Air Conditioning
ATF	Antenna Test Facility
BE	Back-End
FE	Front-End
FESS	Front End Support Structure
He	Helium
HVAC	Heating Ventilation and Air Conditioning
ICD	Interface Control Document
IPT	Integrated Product Team
LO	Local Oscillator
LPR	Local Photonic Receiver
LRU	Line Replaceable Unit
NAOJ	National Astronomical Observatory of Japan
NRAO	National Radio Astronomy Observatory
M2-Rack	Subreflector (Mirror 2) control Rack
OSF	Operations Support Facility
PCD	Point Cycle Diameter
PDB	Power Distribution Board
TP	Total Power
TPA	TP Array
WVR	Water Vapor Radiometer

4 Model description

The complete model consists of:

- The 3D model of the receiver cabin of the 12 m Mitsubishi production antenna with its equipment
- Front End
  - Cryostat and FE chassis model
  - WVR design space
  - Cryogenic equipment (He line, buffer tank)
  - Calibration device conceptual design
- Candidate of new BE racks and cable tray
- The requested volume for the on axis fiber wrap according to AD03 with splice box

Components available only as an allocated volume, not as a detailed design, are shown in blue.

4.1 RECEIVER CABIN MODEL

4.1.1 Model references

The receiver cabin model is built based on a combination of design drawings provided from Mitsubishi:

ACA-M-06-0031, Study for On Axis Fiber Wrap arrangement 18/04/06

ACA-M-06-0034, Shape of platform and arrangement of cabin equipment, 26/04/06

ACA-M-06-0037, Cabin I/F flange and dimension of 2F veranda, 19/05/06

ACA-M-06-0044, drawing of RCV-SUPPORT, 30/05/06

These drawings are not electrical formats, thus the dimensions that are not described in the drawings was estimated by scaling and have errors.

4.1.2 Receiver cabin inner layout

The 12m Mitsubishi receiver cabin is shown in Figure 1. The receiver cabin consists of three connecting compartments: A, B and C. The compartment A is a square room with inner dimensions of 3000 x 3000 mm (x-direction x y-direction) according the coordinate defined in RD14. This dimension fulfills the specification and no problem must be expected. The 4 access ports are prepared for the adjustment of the counter weights as shown in the Figure 1 (black color in the floor, 100 x 80 mm). The proof stress of the floor surface including this access ports is 1000 kg-weight/m^2 (980 Pa). The major antenna equipment in the compartment A includes the Power Distribution Board (PDB, 600 x 400 mm) and the subreflector control rack (M2-Rack, 500 x 400 mm). Each height is 1600 and 1000 mm. The PDB will supply the power for the digital rack, analog rack, and FE electric chassis. The PDB and the M2-Rack are settled in a corner of the cabin. The space occupied by the antenna equipment (except HVAC ducts, TBD) is 0.44 m^2, and less than the maximum requirement of 0.75 m^2 according to RD14. The height of the compartment A is about 1900 mm.

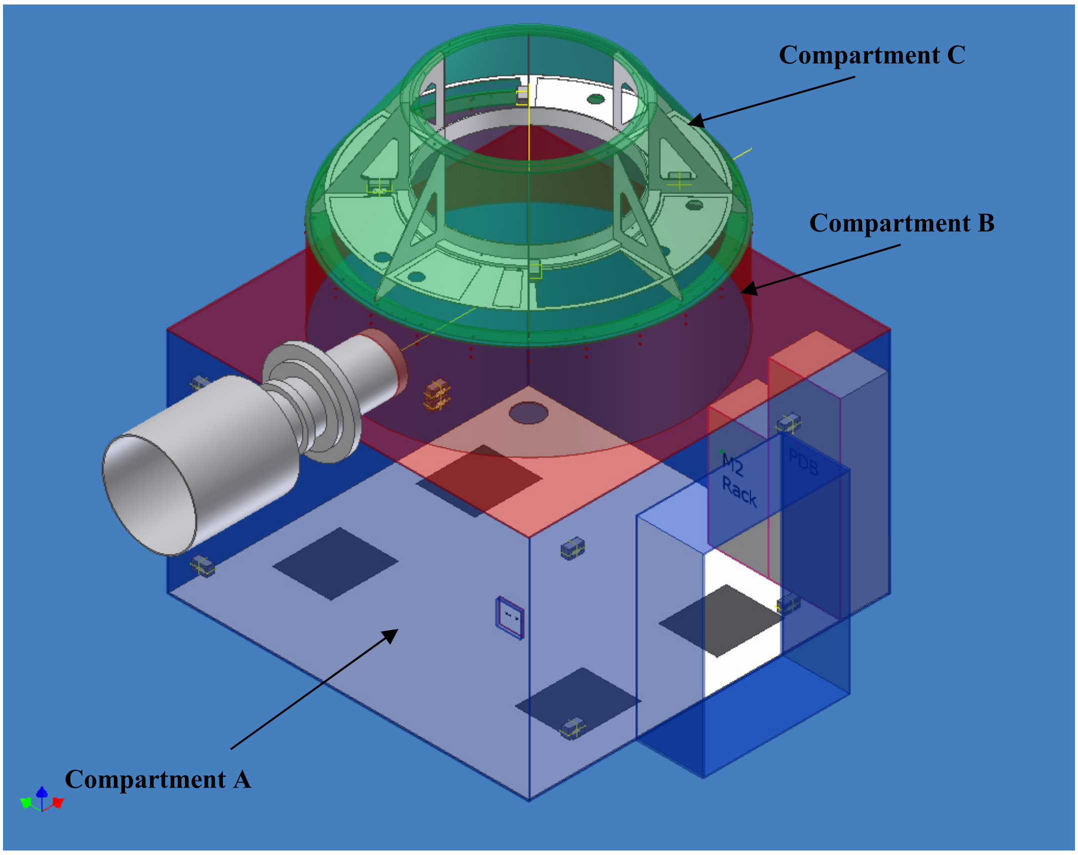


Figure 1: The receiver cabin of the ALMA ACA 12 m Mitsubishi antenna. The cabin consists of three compartments, i.e. the compartment A (blue clear), the compartment B (red clear), and compartment C (green clear). Note: The 3D model describes the inner walls in the receiver cabin, thus it differs from external view.

The compartment B is a cylindrical volume which measures ~2500 mm in diameter and ~800 mm in height. This compartment is structurally connected to the EL axis. The compartment C is placed above the antenna/FE interface flange, where the Cassegrian focus is located. The total height of the compartment B is about 800 mm. The compartment C will be used for the calibration device. This space for the calibration device is separated from the compartment A and B, by the FE interface flange and EMC shielding covers. The covers have fans for circulating air between compartment B and C. The three of those covers are removable for accessing to the calibration device (see section 6). The air-sealing membrane and the mechanical shutter for reducing the Cloudsat radar power will be placed on the top of the compartment C.

The height of the antenna flange interfacing with the FESS is 2933 mm from the floor. The distance from the antenna flange to the elevation axis is nominally 633 mm. The Figure 2 shows a half sectional view of the receiver cabin along the x-axis with most of FE and BE equipment such as receiver, aux electronics chassis, BE racks, WVR, on axis fiber warp, splice boxes, and calibration device.

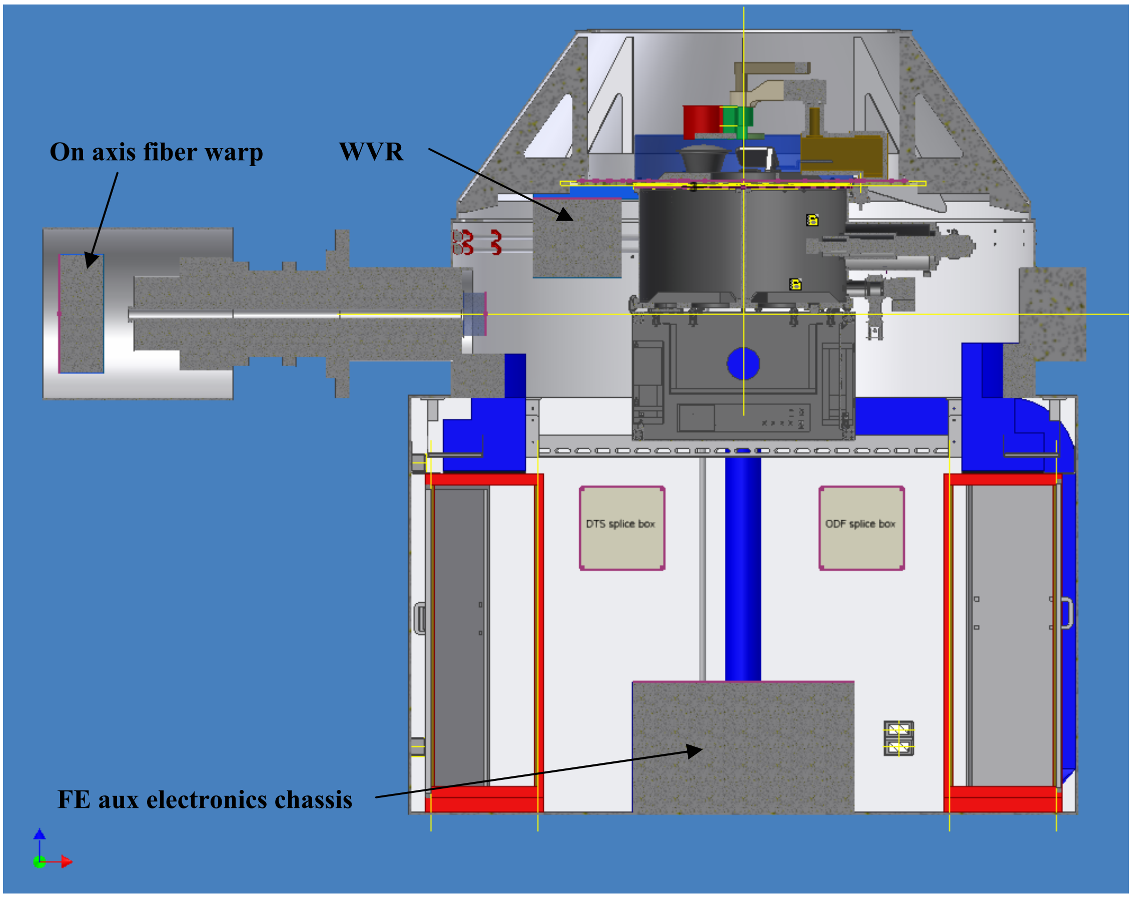


Figure 2: Half sectional view (x-axis) of receiver cabin with most of FE and BE equipment.

In the section of Figure 3 along the y-axis other installations, such as HVAC duct (TBD) to the BE rack, vertical cable tray and Feed-through plates, tray with OPT power supply (TBD).

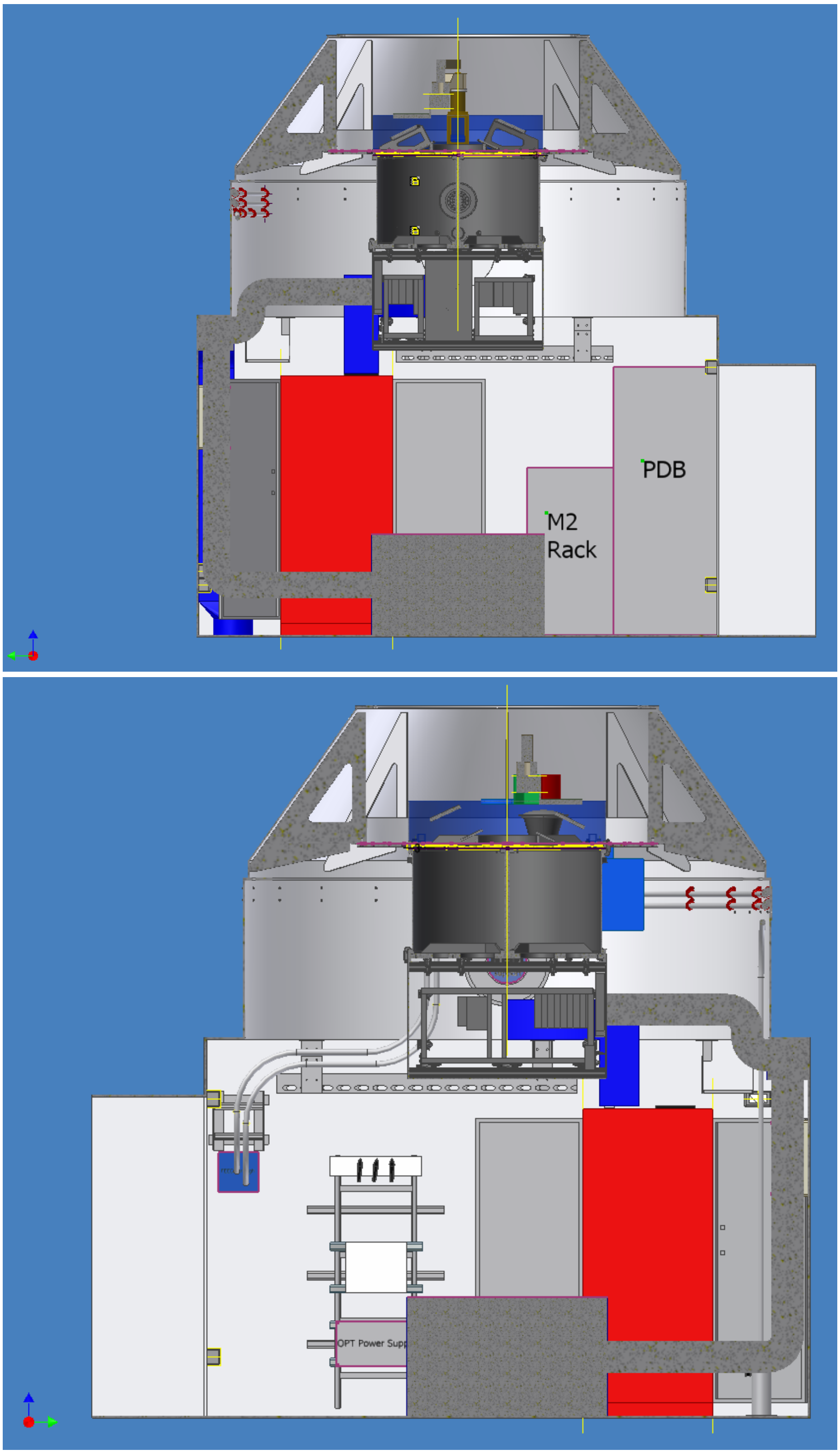


Figure 3: Half sectional view (y-axis) of receiver cabin with equipment.

4.2 Equipment list

The following table lists the equipment to be installed by ALMA As these are ALMA deliverables, the list is the same as for the Vertex antenna and the AEM antenna, but their each location inside the antenna can be different.

IPT	Equipment	Mass (kg)	Dimensions (HxWxD or ϕ) (mm)
FEND	Auxiliary electronics chassis	Max. 200	600 x 1000 x 1000
FEND	FESS	130	ϕ 1500
FEND	FE assembly	Max. 750	
FEND	Water Vapour Radiometer	Max. 100	360 x 400 x 1000
FEND	He buffer tank	5 (input from SHI)	ϕ 101.6 (Max. 150)x 270
FEND	Amplitude calibration device	Max. 60	
BEND	Digital rack	350 +- 25	1565 x 533.4 x 698.5
BEND	Analog rack	375 +- 25	1565 x 533.4 x 698.5
BEND	Fiber optic splice box	5 +- 1	406 x 356 x 178
BEND	On-axis cable wrap	8.5 +- 1	ϕ 550 x 200
BEND	Fiber splice box for on axis cable wrap		381 x 381 x 178
COMP	Antenna Bus Master		In digital rack
COMP	Power strip with Ethernet interface		In digital rack
COMP	Ethernet switch		In digital rack
COMP	VoIP telephone		
ANT	Optical pointing telescope	TBD	TBD (deliverable from NAOJ)
ANT	Optical pointing telescope power supply	TBD	TBD (deliverable from NAOJ)

Where the mass is missing in the list, it is either not relevant or not available. The dimensions of the fiber optics splice box are subject of a pending CRE and the numbers in the table show the requested values, which will become valid after the approval.

The optical pointing telescope will be installed permanently and will not be removed even after initial pointing tests.

4.3 Front End

For the FE system, six subsystems (see table above) need to be installed inside the receiver cabin as shown in the previous table. The FE auxiliary electronics chassis is still under discussion and it is, for access and handling reasons, recommended to find a different solution than the large squared box below the receiver assembly. RD01 define the volume to be 1 m x 1m x 600 mm. The details of mechanical and HVAC duct interfaces should be defined as soon as possible.

The connector panel in the FE chassis is placed on the side of +Y (it is located on the other side of the cabin entrance). The details of the layout of the panel are needed for the routing of cable, especially for the fiber cable from the ODF (The special cable tray might be needed for this cable because of stabilizing this cable).

4.3.1 Front End versus manufacturing drawing

The comparison between the receiver 3D model and the RAL manufacturing drawings (RD08) as well as the dimensional verification were done in the Vertex receiver cabin document, and the deviations between model and drawings were clarified and corrected where needed. The results can be found in RD15.

The two issues are pending for clarification:

The band 3/4 warm optics assembly

The connectors of the cold head are incomplete and not correct

The warm optics assembly is important as the height of the setup affects the clearance in the door frame; therefore the final design is very useful to check the cabin door clearance and to see if the allocated volume was fully used. So far RD05 served as reference.

The second point is no major issue for the space allocation and handling check. The correct cold head connectors are shown on the cold head drawing, being a part of RD10. To correct the FE 3D model the RAL drawing KG 0772-401 must be updated.

For the following units and subassemblies no released and final drawings are available as references for verification:

- Electronics chassis, design is in preparation and no drawing is available yet
- FESS, which is in its final design process
- Interface between Cryostat and FESS is not released yet
- WVR design is not completed
- Auxiliary Electronics chassis, not developed yet

4.3.2 Front End model versus design and handling space allocation

The FE design space is according to RD01, and changed from the Vertex document as this allocation was part of the CRE (AD05).

After the update of RD01, which still in the DAR, the allocated volume for the ALMA receiver was modified to accommodate the cryogenics equipment. With this update only some details of the receiver are not yet covered by this specified volume.

The FE equipment which will be installed into the Mitsubishi 12 m antenna is exactly identical as that of Vertex and AEM. Thus the detail differences between the receiver 3D model and RD01 are skipped in this document. An important point which should be confirmed in this document, is the door clearance against the FE assembly. This will be discussed in the Section 5.

4.4 Back End racks

Two BE racks will be installed inside the receiver cabin. The digital rack is located on the left side (looking from the door into the receiver cabin) and the analog rack on the right side.

In this documents the new BE racks were modeled from drawings in RD18. The mechanical interface between the BE racks and antenna should be confirmed in terms of mounting.

4.5 Local Oscillator fiber/On-axis cable wrap with splice boxes

The reference fiber for the first LO is very sensitive to bending and twist. Therefore a special on-axis fiber wrap will be installed each for the azimuth and elevation rotation mechanisms. This device was designed by the BE IPT. In RD11 a cylindrical volume of 550 mm diameter and 200 mm length was specified for this unit. The diameter of the unit itself is 350 mm plus additional 200 mm for the access and fiber routing. As specified this unit can either be installed inside the receiver cabin or inside the yoke arm. As shown in Figure 4, the wrap can be installed in the yoke arm (negative X-axis side). The radial distance from the cabin center to the warp is about 2900 mm according to ACA-M-06-0031. The straight path of ϕ 40 mm along the EL axis will be prepared for the on-axis fiber. The volume for the torque tube support, a cylindrical volume of 200 mm diameter and 100 mm length, was allocated in this model.

The dimensions to allocate the volume of the wrap were taken from a not-yet-approved CRE (AD01) as RD11 is part of the BEND CRE and this still in the DAR.

One additional splice box (ODF) inside the cabin will be necessary and the size is 381x381x178 mm. The requirement for the installation is to be as close as possible to the analog rack and the LPR in the FE subsystem. In this model the box is located at the rear cabin wall close to the analog rack. The optical fiber from the ODF to the LPR input-port on the FE chassis has to be supported by a special cable tray in order to avoid vibrations. If we use the special cable tray, the accurate position of the LPR input-port should be described by the FE IPT.

Attention needs to be paid to the routing of the reference fiber, as minimum bend radii are defined and it has to run in a thermally insulated protection tube. Also vibration isolation must be considered. When more details are available a draft routing will be foreseen in an update of this document. This could mean special routing with possible implications for the mounting and handling of other equipment, in particular the receiver.

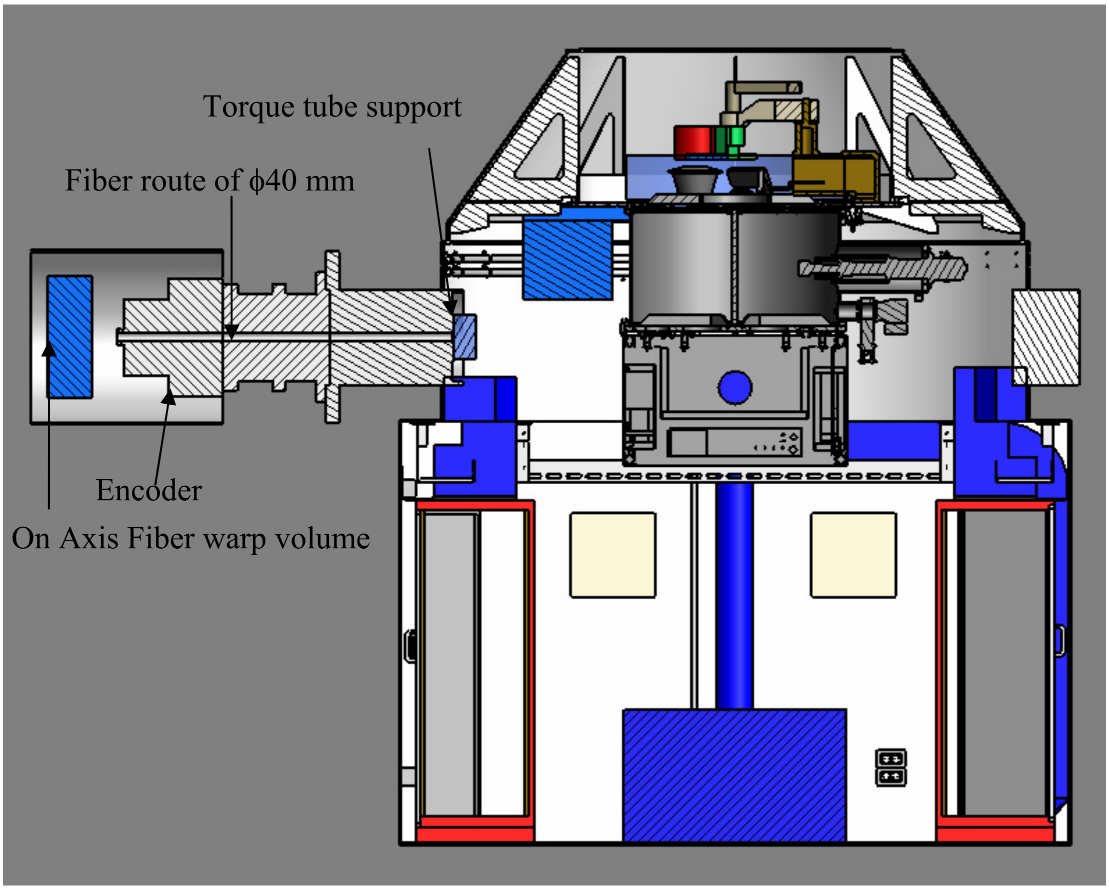


Figure 4: Half sectional view (x-axis) of receiver cabin with the EL axis support.

4.6 Calibration device

The installation of the conceptual model of the calibration device in the Vertex prototype receiver cabin was described in RD15. The mechanical layout of the robot has not evolved since then. The electronic control however does not seem to be housed inside the unit and probably another electronic box needs to be installed inside the cabin. This can only be done in the model when more detailed information is available about size and location requirements.

The calibration device installation is similar to that in the Vertex antenna above the receiver mounted on the FESS. All information about the installation and handling is still valid from the previous document and can be obtained from RD15.

For the Mitsubishi antenna the given volume for this unit is called as the compartment C in this document. As can be seen on Figure 5, the allocated space is sufficient for the hardware.

During this status of the robot development no further checks need to be done. When the hardware is fully designed with movement limitations and all volumes available one should check that the unit still fits in its given volume according to RD01 and that no operational risk exists due to movements, which are not restricted inside the allocated volume.

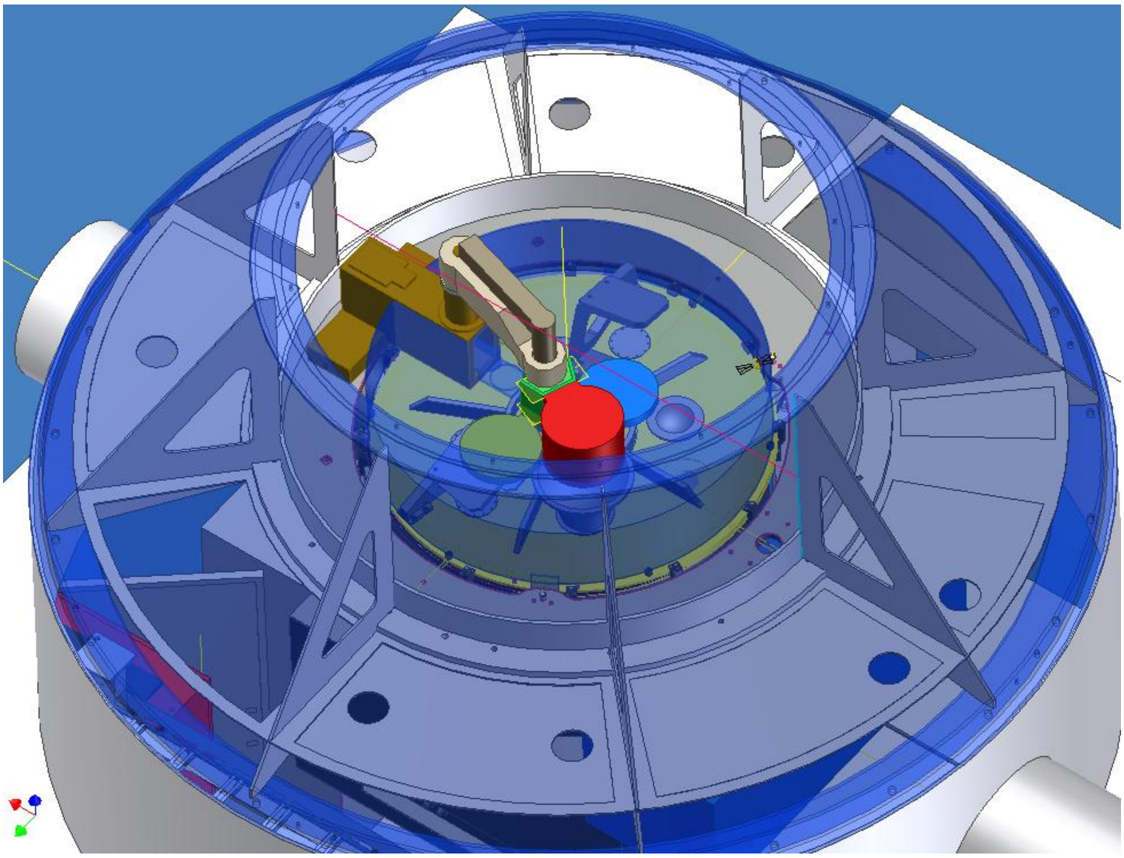


Figure 5: Calibration device installed in the compartment C. The clearance is a cylindrical volume of 1410 mm diameter and about 620 mm height.

4.7 Water Vapor Radiometer

For the WVR no new design information was published since the issuing of RD15. Therefore the only reliable information is the position and design volume of AD05.

There is no volume conflict, however the clearance around the FE interface flange is tight. The positions where the clearance is tight are shown as Figures 6-10. The compartment C structure will have eight ribs around the FE interface flange. Two ribs near the WVR are defined as Rib-A and Rib-B in this document as described in Figure 6. The Rib-A, which parallel with X axis, has a height of 55 mm from the FE interface flange. On the other hand, the top surface of the allocated volume for the WVR is 80 mm (thickness of the FESS+ thickness of arm of the WVR=18+62) below from the interface flange according to the RD01. Thus the clearance is 25 (80-55) mm as shown in Figure 7. The corner of the Rib-B is ~42 mm away from the WVR. Another tight clearance occurs around the corner of the WVR as shown in Figures 9 and 10. The distance between the corner of the WVR and the compartment C seems to be larger than 6.7 mm.

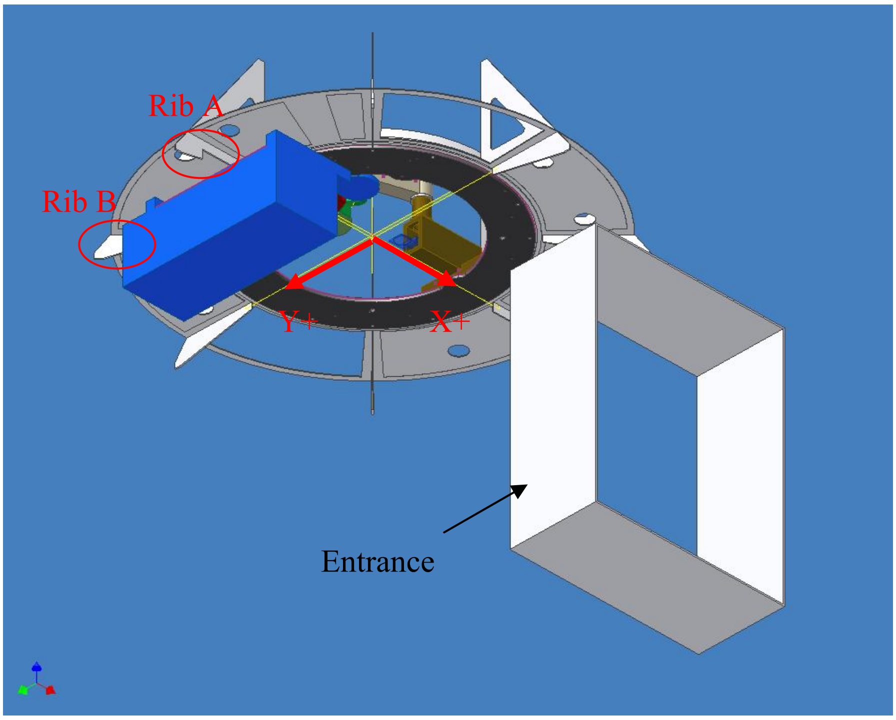


Figure 6: Ribs definition and the antenna coordinate.

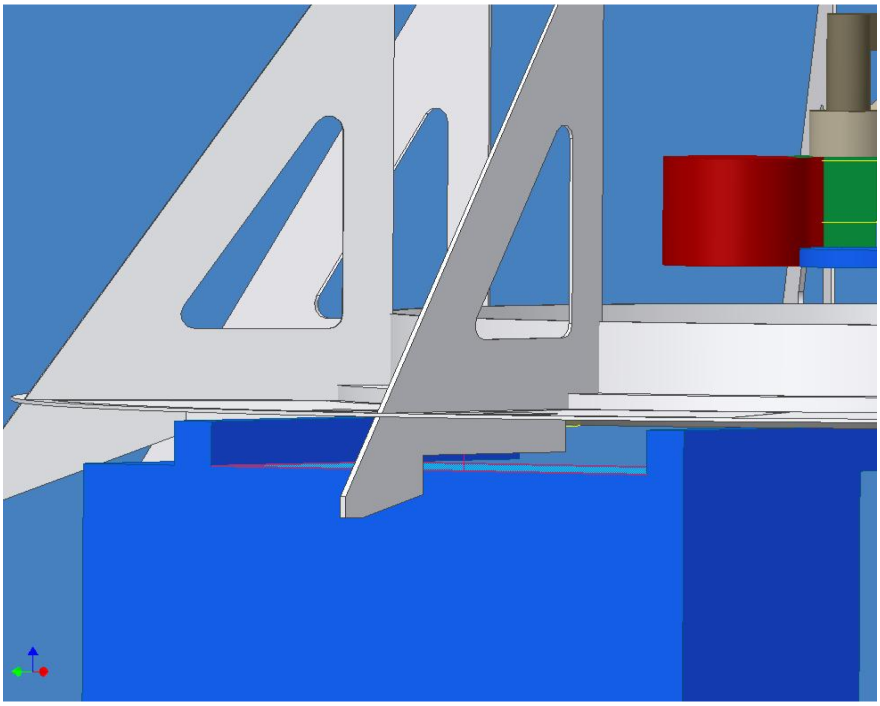


Figure 7: The clearance between the Rib-A and the WVR. The distance is 25 mm (red line).

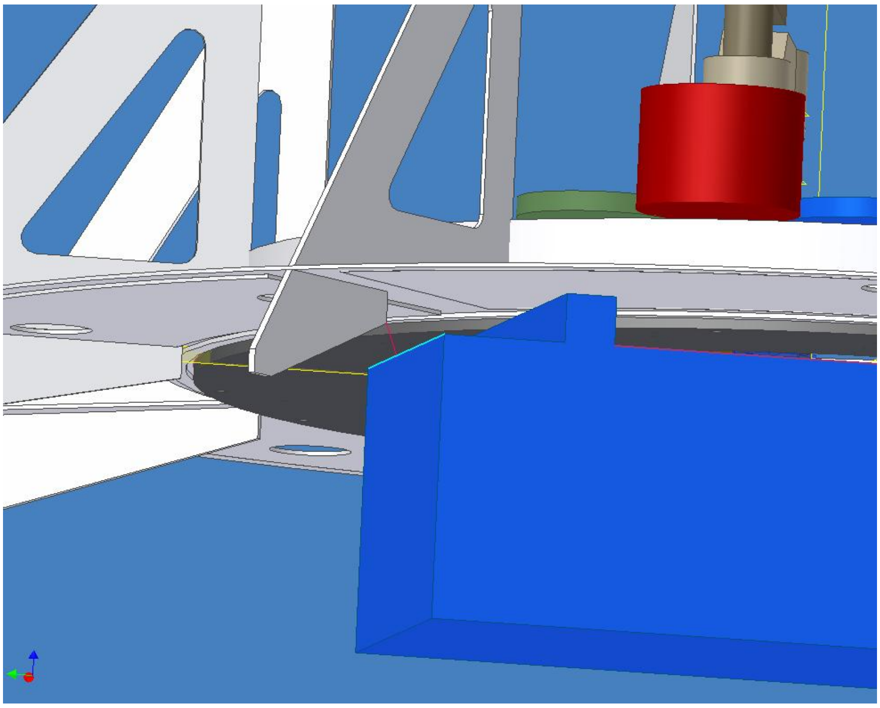


Figure 8: The clearance between the Rib-B and the WVR. The distance is about 42mm (red line).

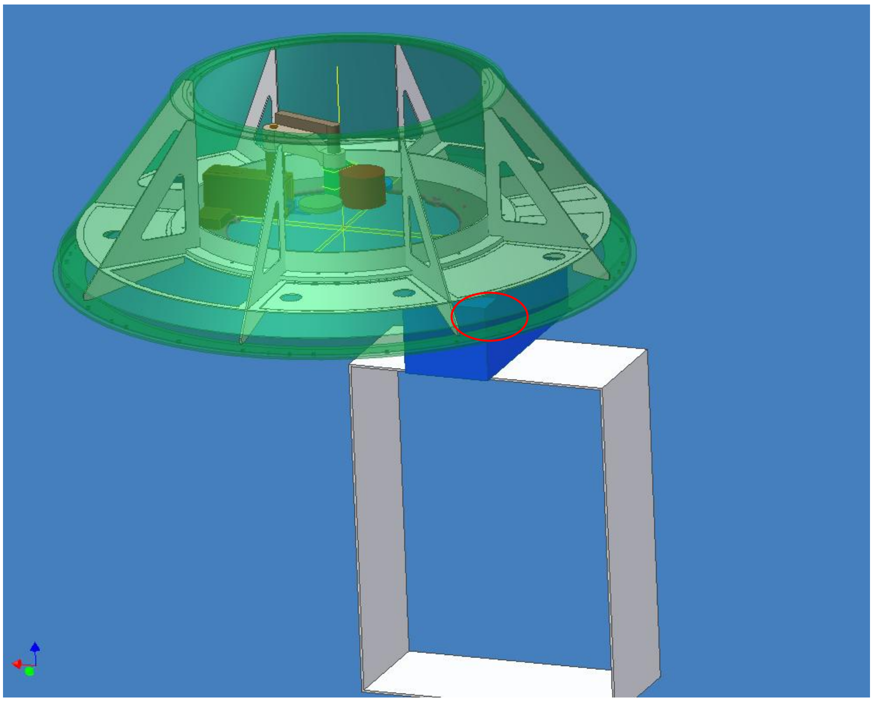


Figure 9: Position of the tight clearance between the WVR and the wall of the compartment C.

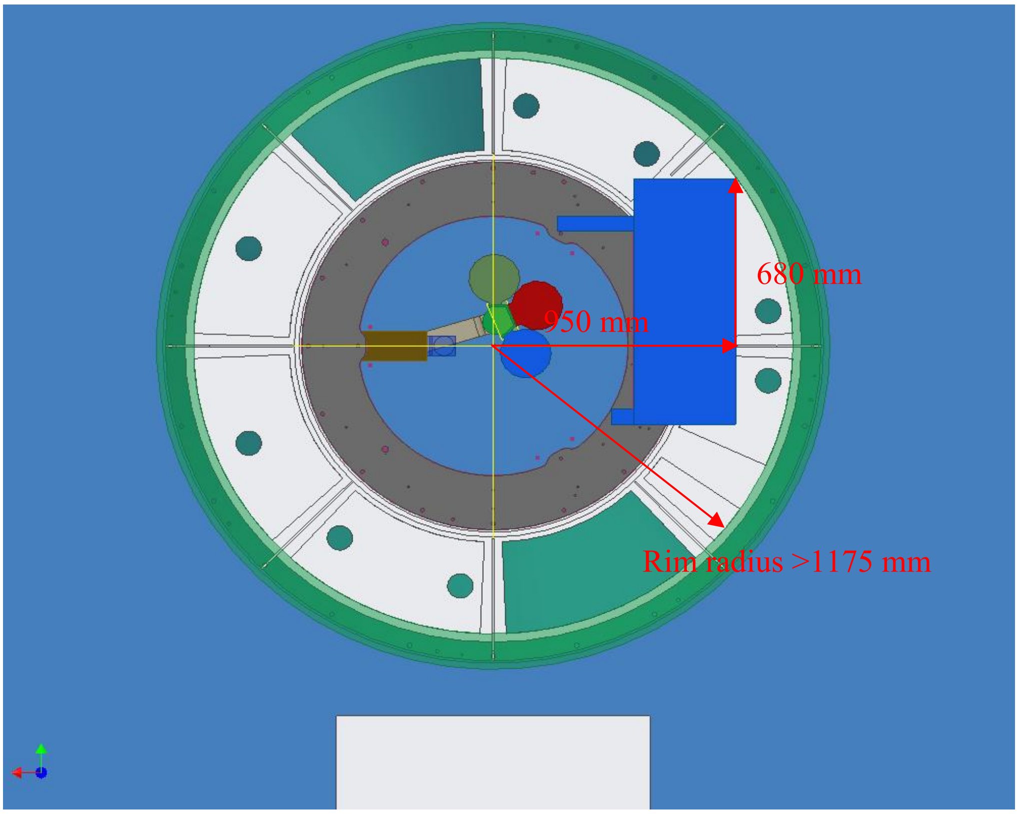


Figure 10: The clearance between the corner of the WVR and the wall of the compartment C. The distance from the Z axis to the corner of the WVR is 1168.289 mm. The minimum clearance is >6.7 mm (1175-1168.289).

4.8 Cryogenic equipment for the cold head Helium supply

The cold head of the receiver is supplied with Helium gas from a compressor, which is located on the Azimuth platform outside the receiver cabin. Two hoses, one for supply and the other for return, have to be routed through the elevation cable wrap and connected to the cold head in the receiver cabin.

Additionally one Helium buffer tank will be installed inside the cabin according to AD04. The size and the shape are according RD10.

The AEM prototype antenna had shut off valves to isolate the compressor from the cold head, as shown in RD16. It is not clear whether such valves are necessary in the receiver cabin, thus this model does not include such valves.

A proposal to use rigid pipes instead of flexible hoses was suggested by the RD15 and RD16 for the Vertex and AEM antennas. However this document proposes to use the flexible hoses for the Mitsubishi production antenna. The flexible hoses do not increase necessary space so much in the case of Mitsubishi receiver cabin, and that solution has an advantage that the number of joint couplings, which are an item of potential gas leakage, is minimized.The route is shown in Figures 11 and 12. Cable clamps (e.g., Nylon clamps as shown in Figure 13) can clamp and release Helium lines easily. Thus this plan has flexibility that enough work space can be supplied when the equipment will be installed or uninstalled.

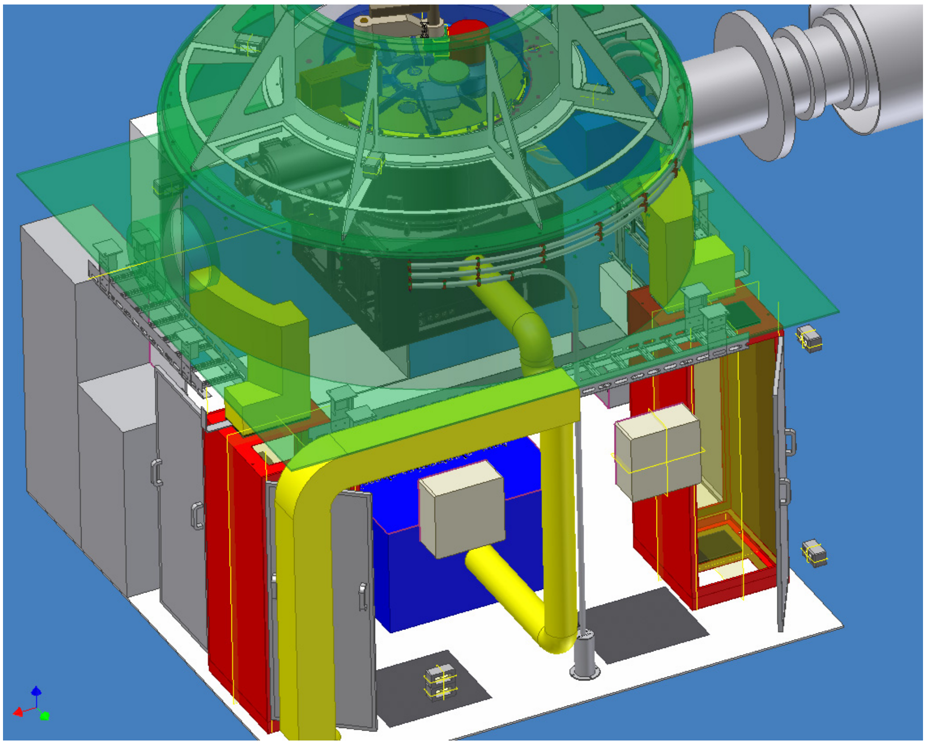


Figure 11: Route of Helium line.

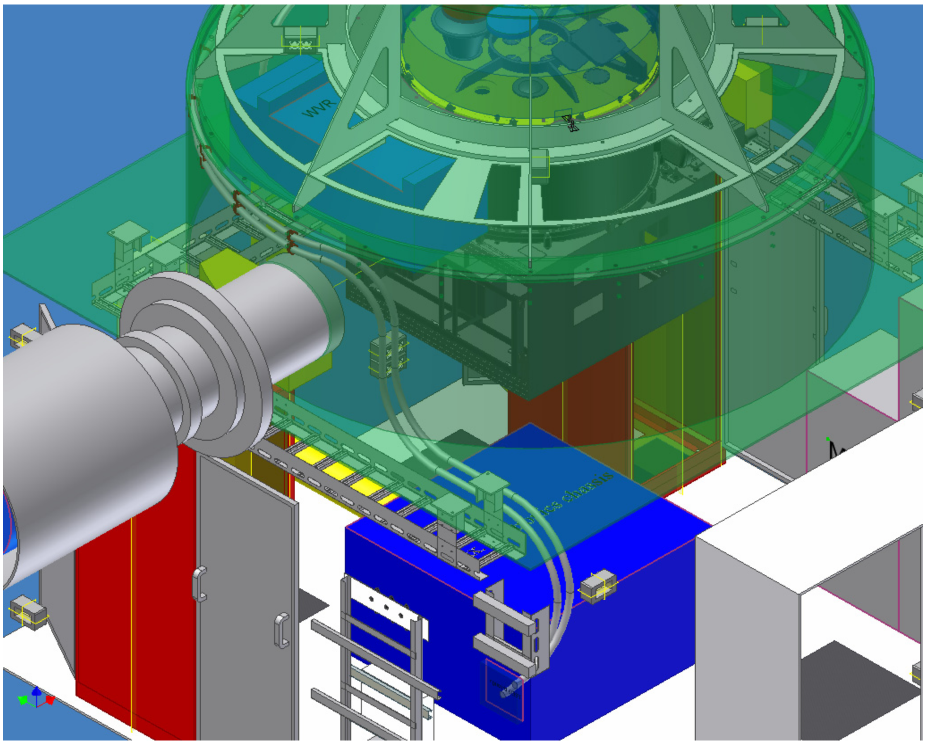


Figure 12: Helium lines from the Feed-through.

Figure 13: Example of cable clamps for Helium lines (http://www.shinagawashoko.co.jp)

4.9 Helium buffer tank

The cyocooler needs the maintenance of 1 year cycle. In the case of the cryocooler maintenance, two FE subsystems will be exchanged on the site. We have to keep these FEs cooled during the exchanging, due to minimize the downtime of the antenna (cooled swap case). This process means that the FE subsystem, carried by the FE service vehicle and cooled by the compressor and the buffer tank on the vehicle, should be reconnected to the compressor and the buffer tank on the antenna. However the process of removing the helium lines from the *cooled* cryocooler, is beyond the scope in terms of the usual operation of the cryocooler.

When the helium lines and the buffer tank disconnect from the cooled cryocooler, inner gas pressure of the cryocooler and of the helium-pot rapidly increases as temperature increases. If the inner pressure attains to leak pressure of the relief valves (320 psig=2.2Mpa), the helium gas will be leaked from this valves. We can roughly estimate the start time of leak for the helium-pot line. If we assume that the gas in the helium-pot is cooled to be 4 K and the gas in the its supply line is negligible, the relation between the inner pressure of the helium-pot line, P, and the temperature, T, can express as

P=T/T0 x P0,

where T0 and P0 are the operated temperature and pressure. This equation is simply based on the ideal gas law. The real helium in the helium-pot might almost liquefy, thus, we have to note that the leak start time that is led in this document might be optimistic. If we assume T0=4 K and P0=1.7 MPa, the temperature in the case of the pressure inside the helium-pot of 2.3 Mpa is 5.4 K. After turning off the cryocooler, the temperature after 30 minutes is about 11 K as described in RD19. Thus the leak from the relief valve of the helium-pot might start before 30 minutes. If we have to avoid the leakage, the exchange of the FE subsystem should be finished earlier than 30 minutes. Though it is likely to be thought about some strategies to avoid this issue, one of simple solutions is to attach the buffer tank on the FE subsystem as shown in Figure 14. This solution includes an advantage that the swap of the FE subsystems can be performed without disconnection of the helium line of the buffer tank. It is necessary to discuss the leak issue also for the two lines between the cryocooler and the compressor (the start time of leakage might be longer as compared with that of the helium-pot because the average temperature of each temperature stage should be higher).

We need more discussions about this issue in terms of operation/maintenance and safety.

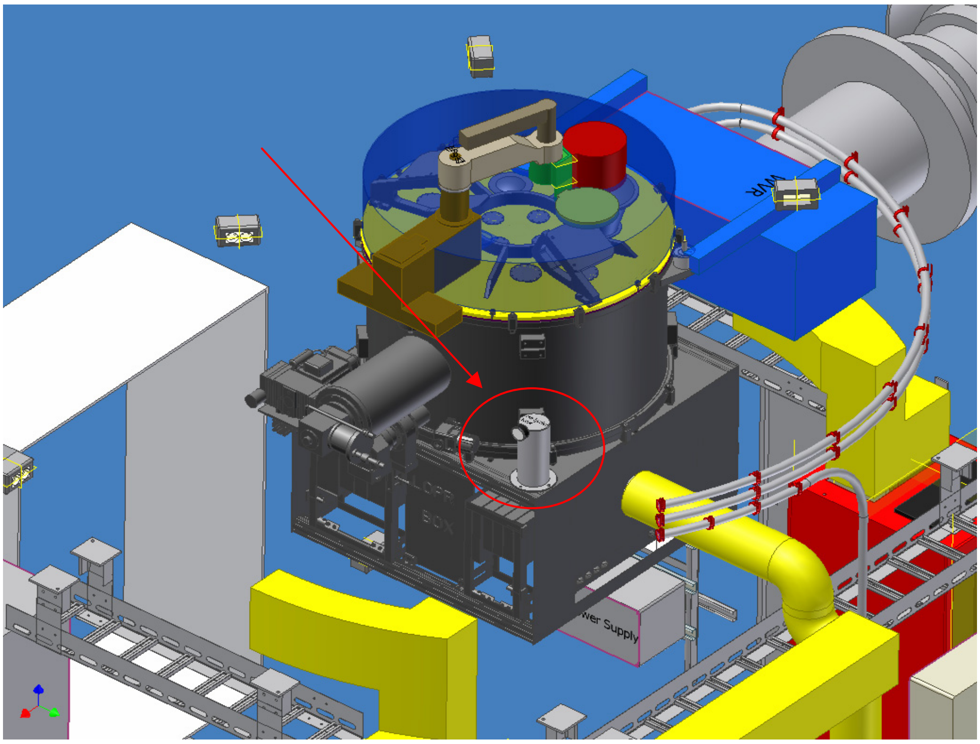


Figure 14: One solution for the gas leak issue in the cooled swap process of the FE subsystems - buffer tank attachment.

4.10 Cable trays and electrical installations

The minimum width of the cable tray is specified to be 200 mm in RD04. The CAD model of the cable tray in RD15 (width 250 mm) was used also for modeling the Mitsubishi cabin. The length of tray was modified to fit the cabin (2300 mm) as shown in Figure 17.

This CAD model has the other two trays along the Y axis. One tray is mounted on the ceiling of the receiver cabin (compartment A) from the Feed-through to the digital rack, as shown in Figure 16. The other is mounted from the PDB to the analog rack, as shown in Figure 17.

In addition to the above trays, the following trays will be needed,

- Special cable trays for the On-axis fiber (torque tube support to ODF, ODF to analog rack and to FE assembly).
- A special cable tray for FE cable (cable tray to FE assembly).
- A special cable tray for FE cable (FE chassis to FE electronics chassis).

These cable trays have to designed not to conflict with the space requirements for the FEND installation.

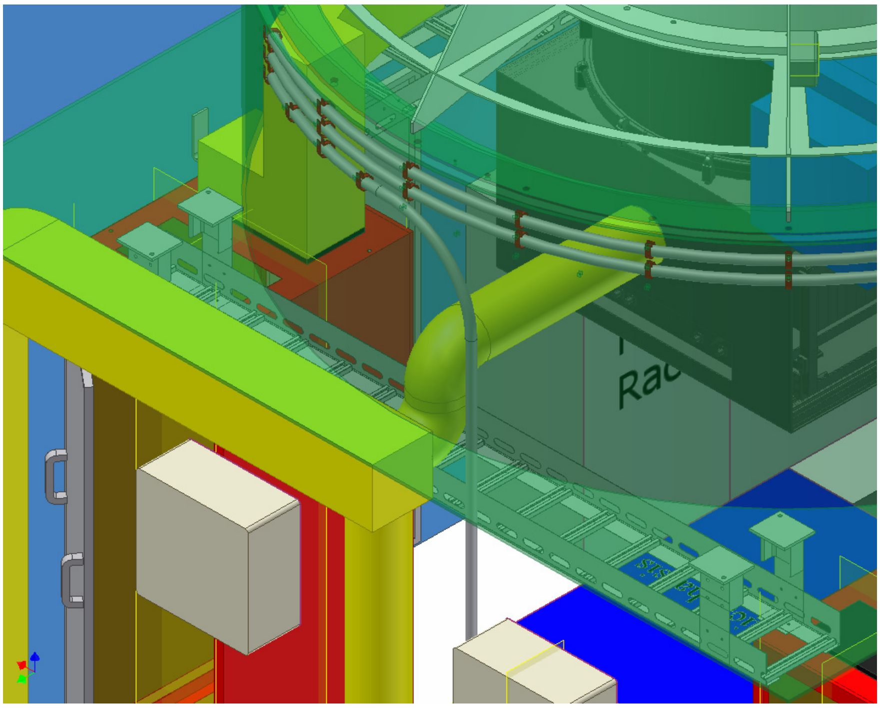


Figure 15: Cable tray between the digital rack and the analog rack. The size of the tray is assumed to be 2300 mm in length and 250 mm in width.

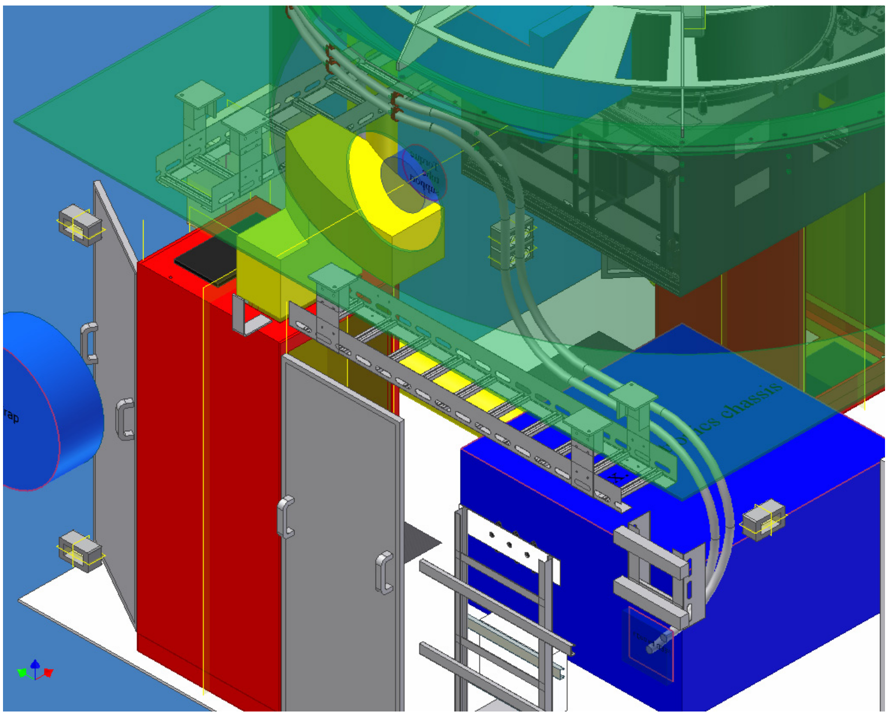


Figure 16: Cable tray between the Feed-through and the digital rack. The size of the tray is assumed to be 1500 mm in length.

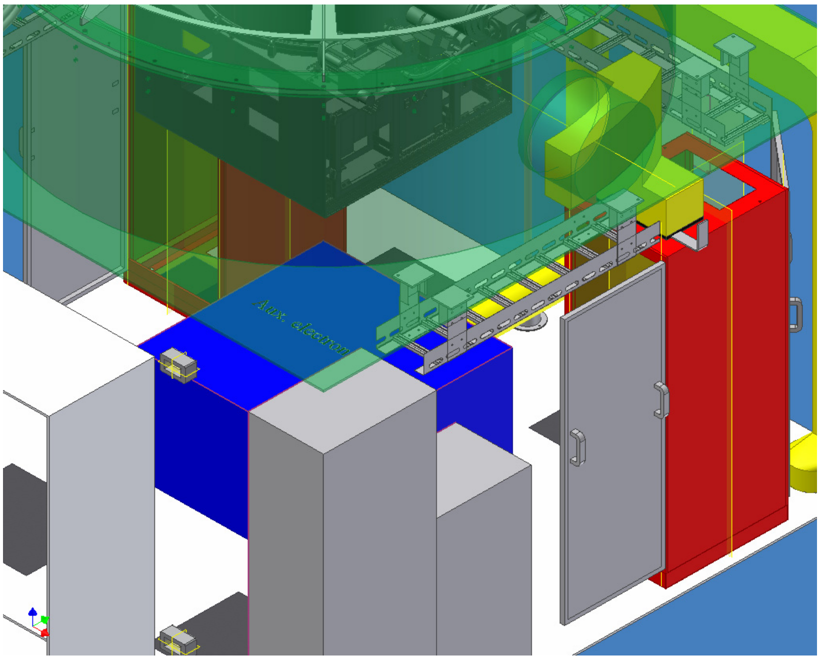


Figure 17: Cable tray between the PDB and the analog rack. The size of the tray is assumed to be 1250 mm in length.

4.11 Feed-through plate

All ALMA cables pass though the Feed-through on the left side wall of the receiver cabin. The position of the Feed-through plate for ALMA cables is defined as shown in Figure 18.

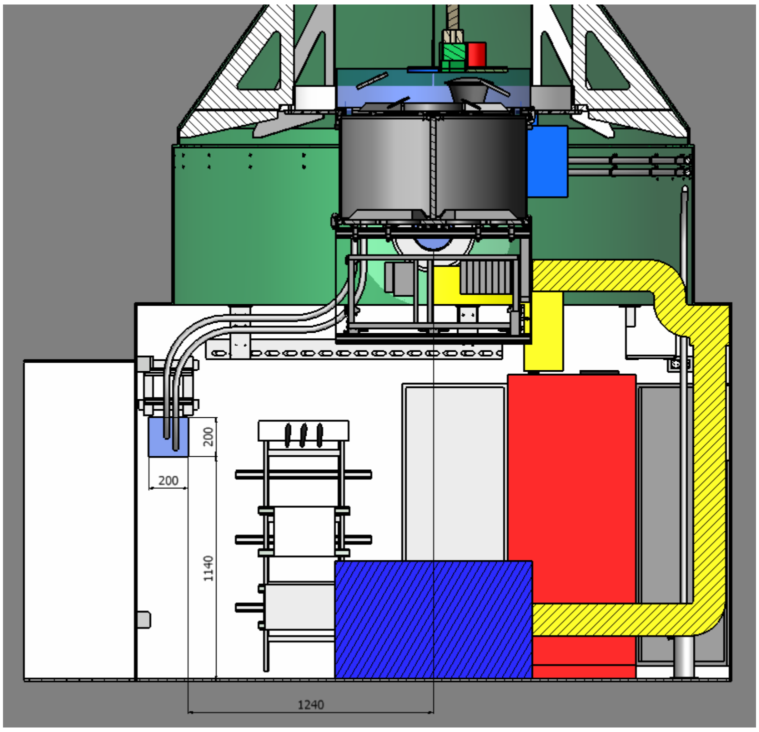


Figure 18: Feed-through position.

4.12 BEND rack connector panel and HVAC duct

Another check is advised for a possible interference of the production BEND rack connector panel with the HVAC duct. Access to the panel needs to be assured as well as the required minimum bend radius of 100 mm for cables from the cable tray to the rack connector panel. To assess this, the final position of the rack and its connection panel, the final size and position of the cable tray and the final shape and position of the HVAC duct must be known.

As most of these are not finally defined yet, it is not possible to determine if problems will arise.

5 Front End installation and handling

Although the detail procedure of the receiver installation is not defined yet, the volume clearance when the receiver is installed into the receiver cabin is checked in this document.

The door clearance is 1210 x 1610 mm. This is almost the minimum of 1100 x 1600 mm as specified in RD14. The remaining space between the receiver and the entrance is ~90 mm on each side at minimum. Below Figure 19 a gap of 200 mm to the floor is visible. This should be the requirement for a moving and lifting device.

To avoid damage of the delicate warm optics the top should be protected by a cover during transport. The design of this protection should be part of the handling equipment development. No space should be wasted under this cover, still assuring a safe handling and assembly of the cover. In case the design volume for the warm optics will not be fully used by the mirror system the height of the cover should be adopted to gain this space for the handling equipment.

The Figure 20 illustrates that the receiver can be moved into the cabin below the FESS. The receiver has to be rotated by 90 degree before the attachment to the FESS as shown in Figures 21 and 22.

Handling simulation with a receiver dummy: RD16 proposed to exercise handling of the production FE with a mockup. This should give valuable information which kind of equipment will be suitable for this activity.

Solutions for the handling equipment are recently under development and do not need to be discussed in this document any more.

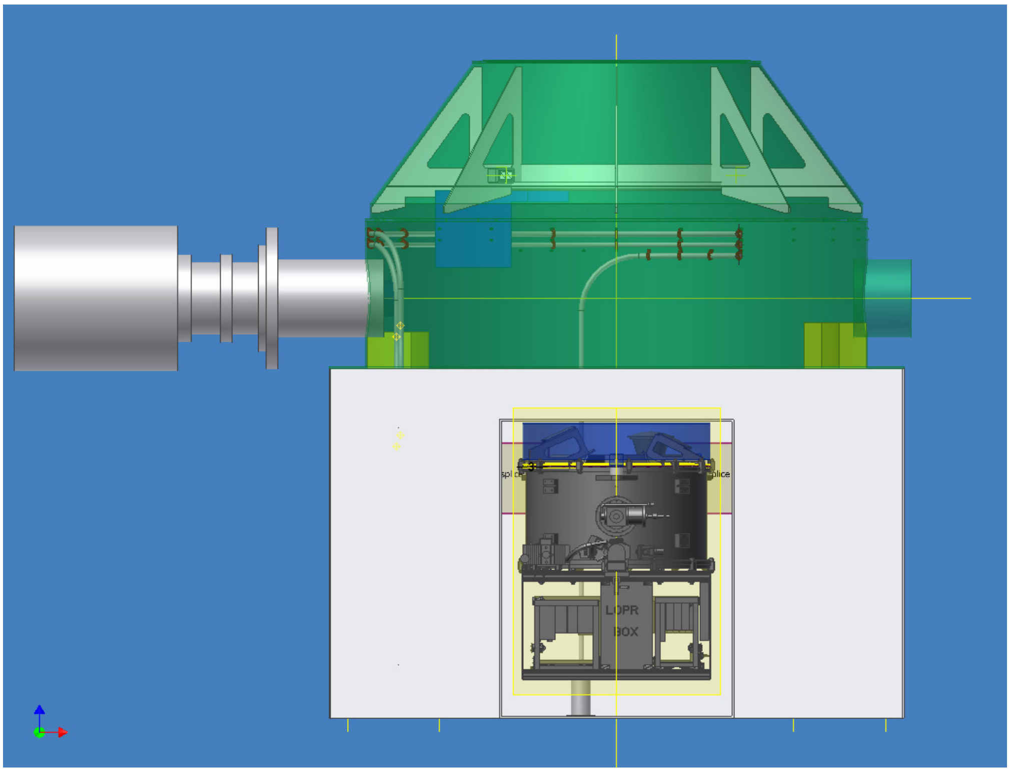


Figure 19: Receiver in the cabin door frame

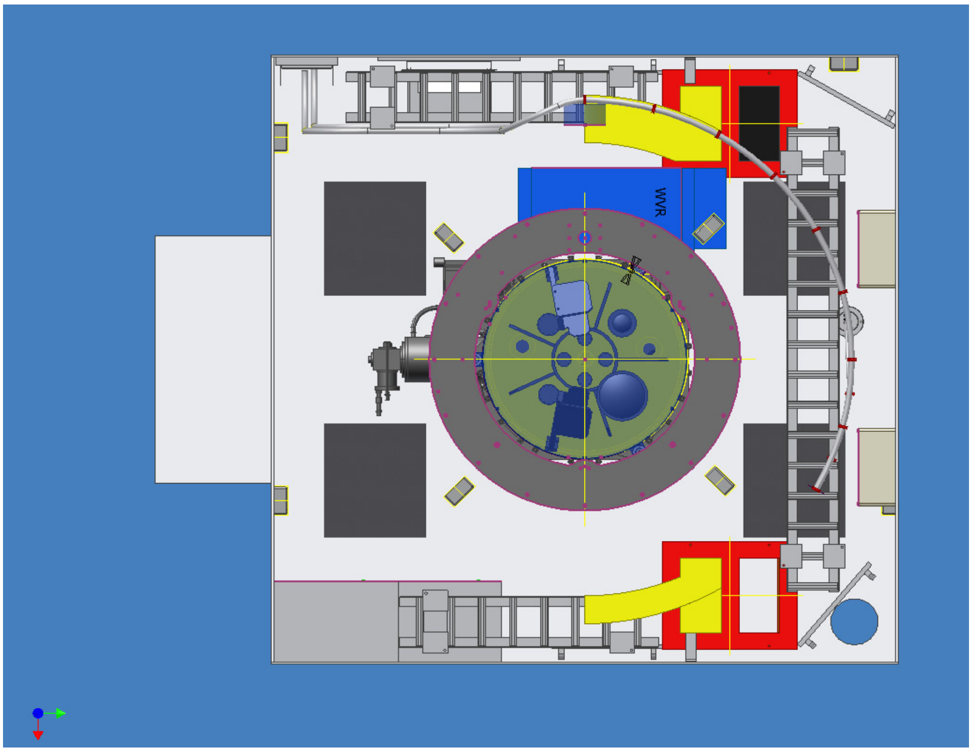


Figure 20: Receiver inside the cabin top view.

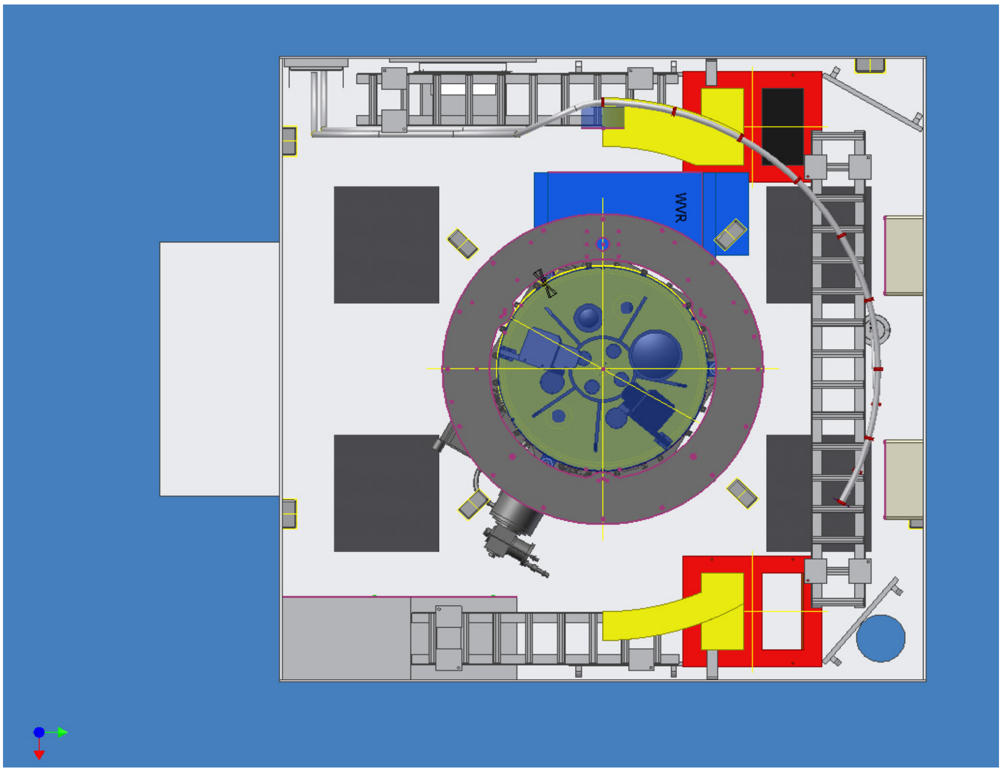


Figure 21: Receiver rotated by 60 deg

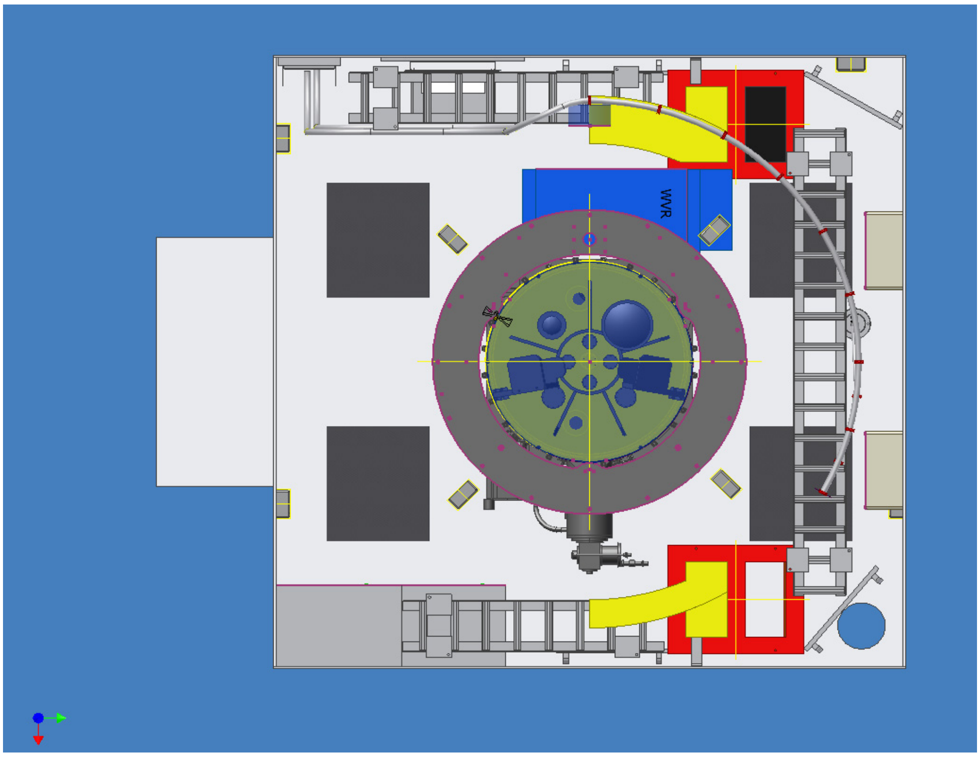


Figure 22: Receiver rotated by 90 deg

6 Access to subsystems

For various activities sufficient clearance between units is required, either to have access to perform repair and maintenance or for the movement of equipment and the handling of other items. In some cases also a safety concern exists, e.g. a risk of banging one’s head or applicable safety standards. A detailed hazard analysis, defining and considering these standards should be carried out by safety engineering of ALMA.

The distance floor-ceiling is larger in the Mitsubishi model, which makes the access to some unit difficult. From the floor to the lower end of the receiver chassis the distance is about 1700 mm. Thus a ladder is needed when the access to the electronics drawers is required. The height of the lower edge of the gate valve is about 2160 mm from the floor as shown in Figure 23. This is not critical for head injuries as compared as RD16, however a protection for this edge should be considered.

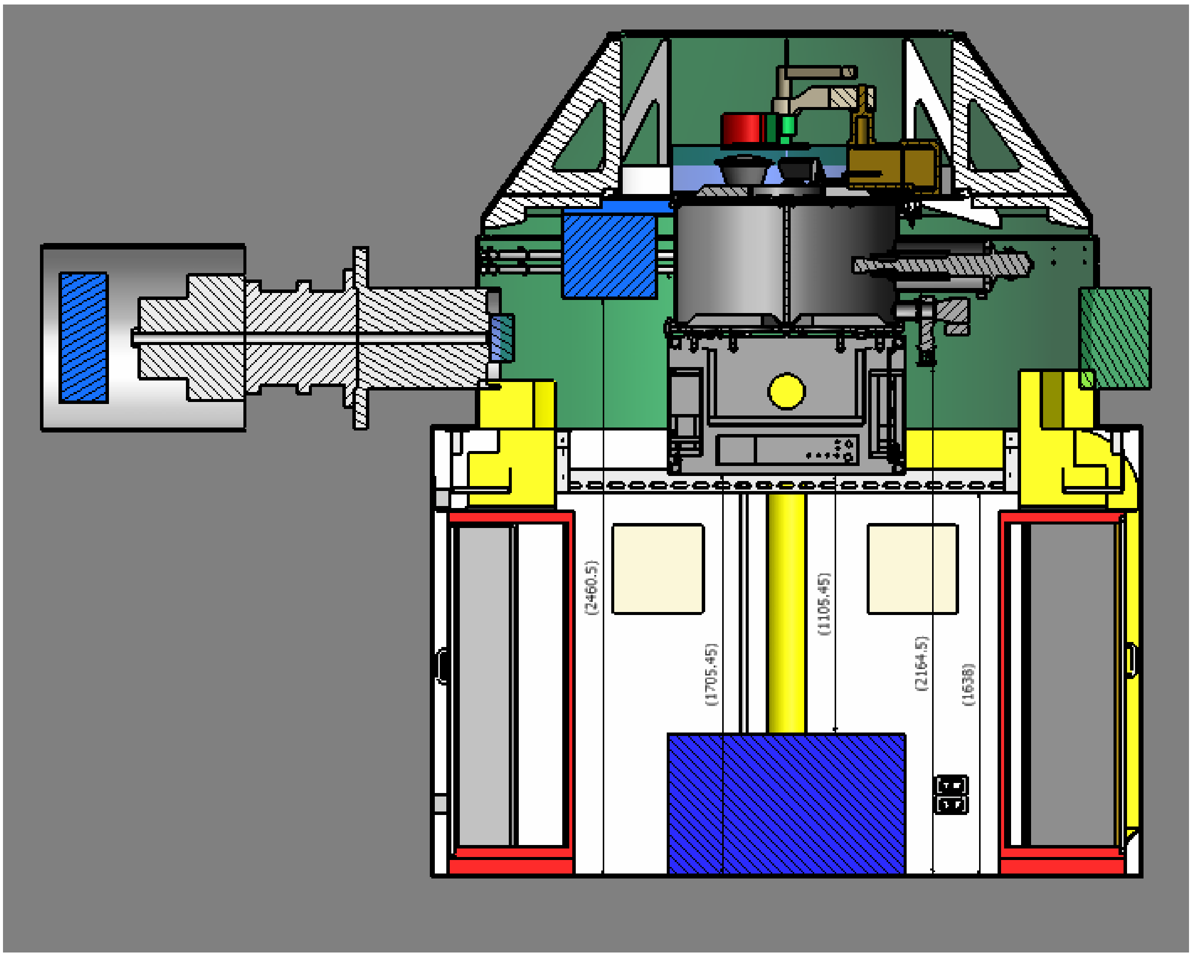


Figure 23: Critical clearances entrance view

The Figures 24, 25 and 26 describe the scenes of the access to the electronics drawers of the Front End. These figures model humans who are 1700 mm tall with 500 mm ladders. In addition to the suggestion by RD16, protection for the torque tube support should be considered in terms of safety.

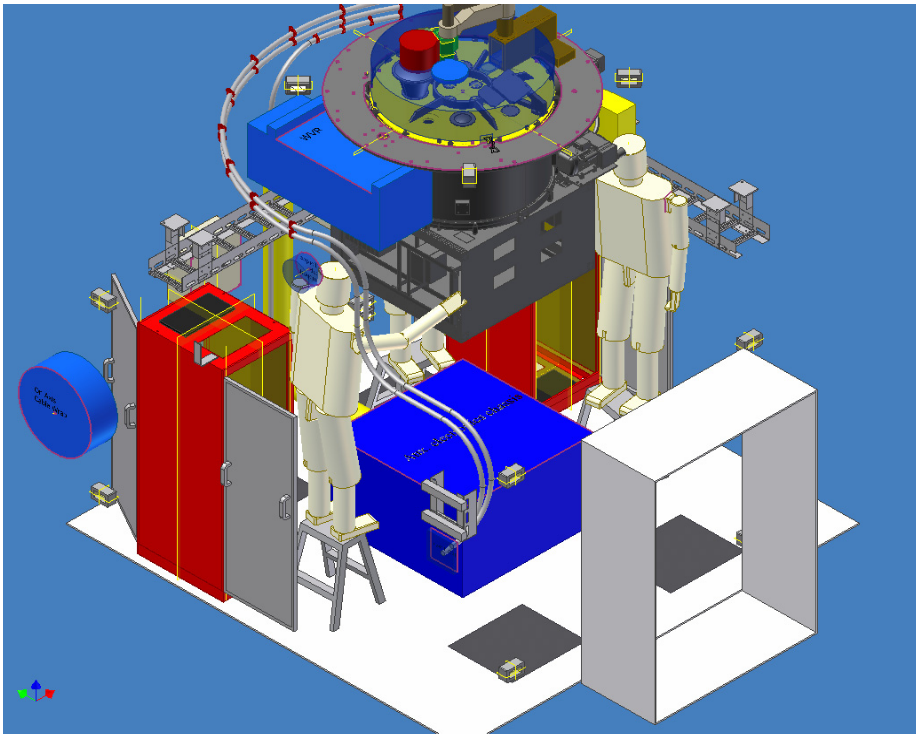


Figure 24: Access to the electronics drawers of Front End (left side).

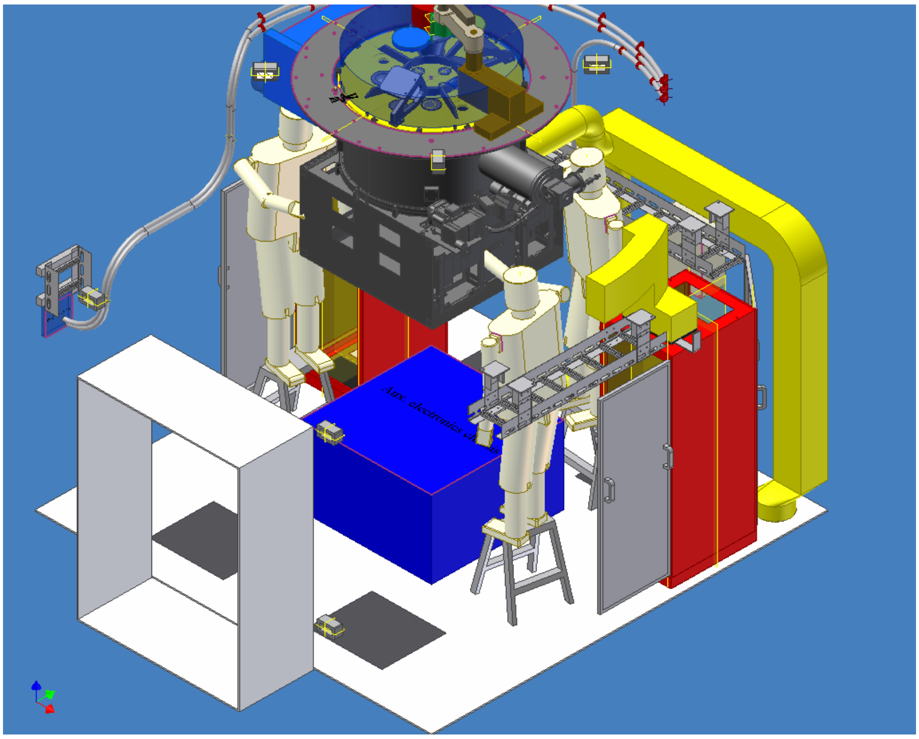


Figure 25: Access to the electronics drawers of Front End (right side).

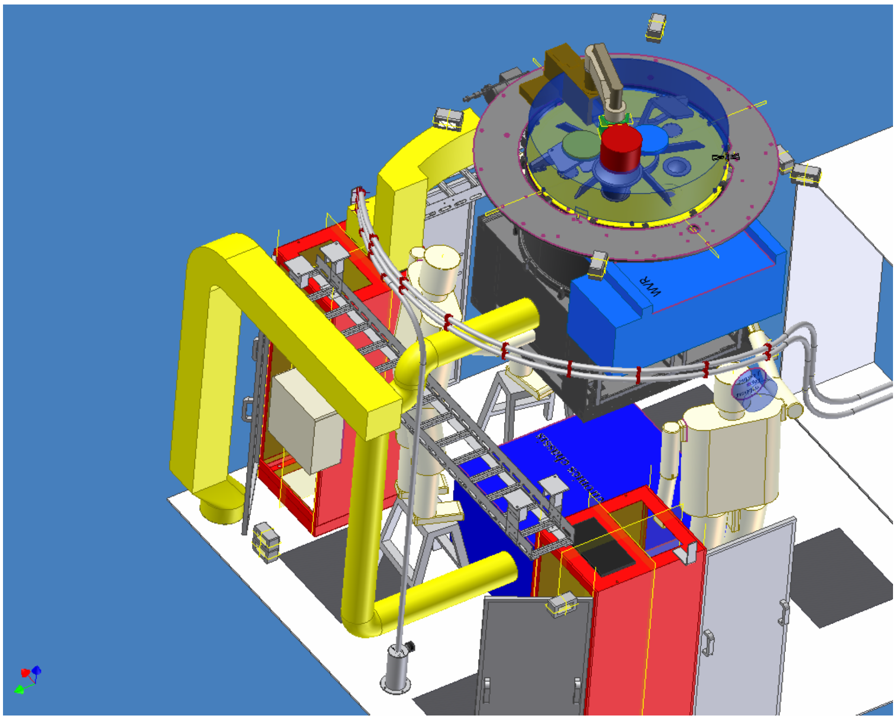


Figure 26: Access to the electronics drawers of Front End (right side).

Mitsubishi receiver cabin has access ports to the compartment C, which includes the warm optics mirrors and the calibration device volumes. It is unknown what maintenances are planned without uninstalling of the FE subsystem, thus we concentrate only accessibility to this volume. Three ports are prepared for accessing to the compartment C from the compartment A and B. The size of each port is 375 mm in width and ~558 mm in length as shown in Figure 27 (the radius of the inner rim is 800 mm and the opening angle is 40 deg). The positions of access ports are shown in Figure 28. Only inspection or easy work can be done from these access ports because of few work spaces as shown in Figures 29 and 30. The discussion should be needed from the viewpoint of safety because of work at height (ladders of 1700 mm height were used in the CAD model).

RD18 requests the minimum opening angles of the BE rack doors of 40 degree. The Mitsubishi cabin can comply with this requirement, however the conflict with duct can not allow more angle in terms of the back-side door of the analog rack. Figure 31 describes the access to the back-side of the analog rack. In addition to limited opening angle, the cable tray forces tight posture to worker.

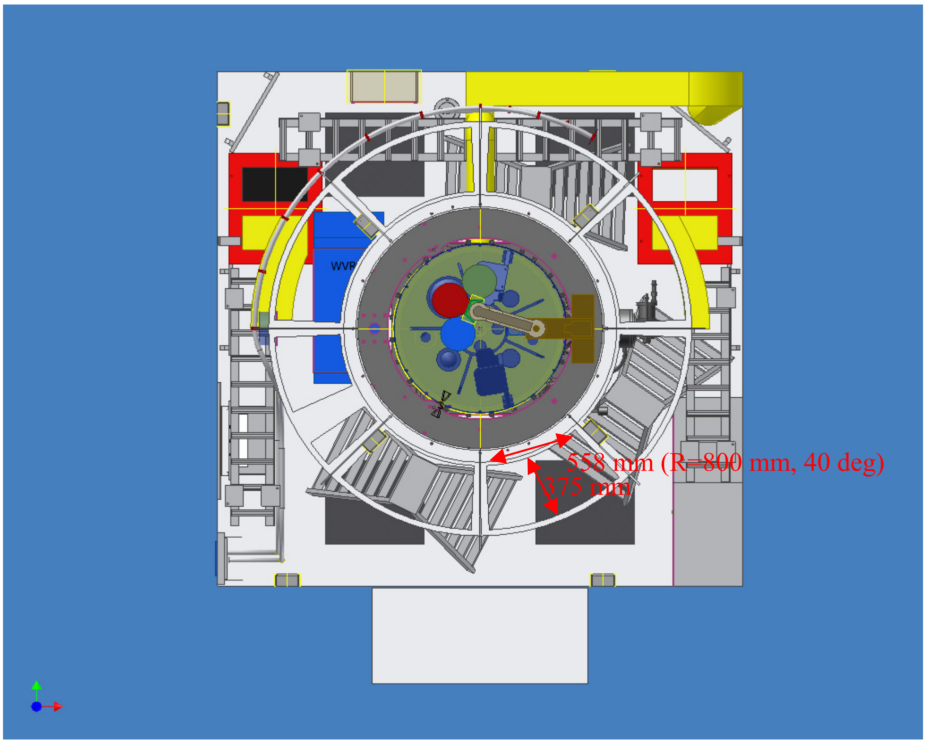


Figure 27: Ladders for access to the compartment C (without panels).

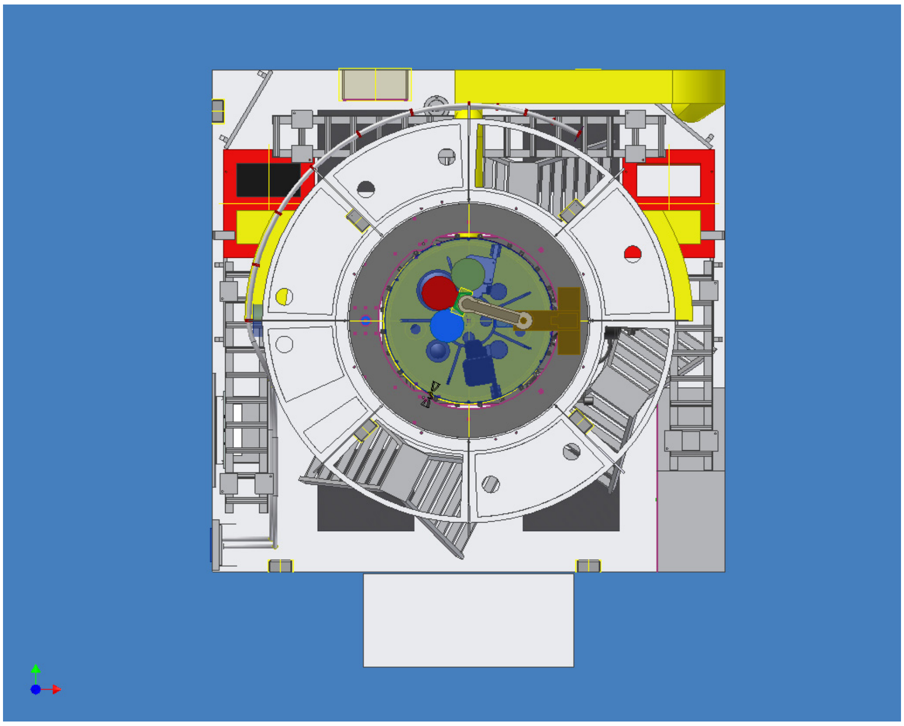


Figure 28: Ladders for access to the compartment C (with panels).

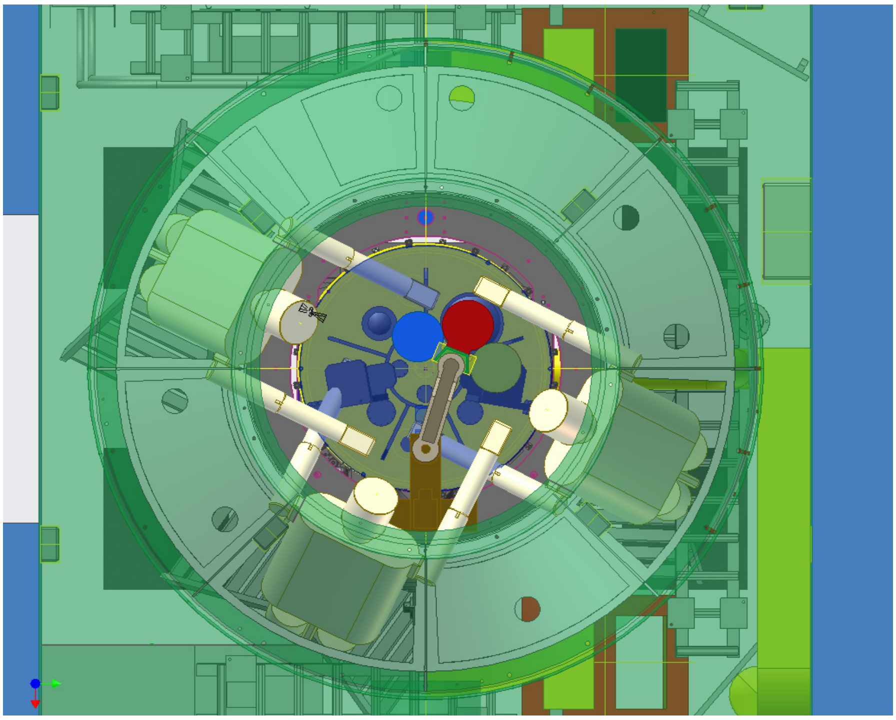


Figure 29: Top view of the access to the compartment C.

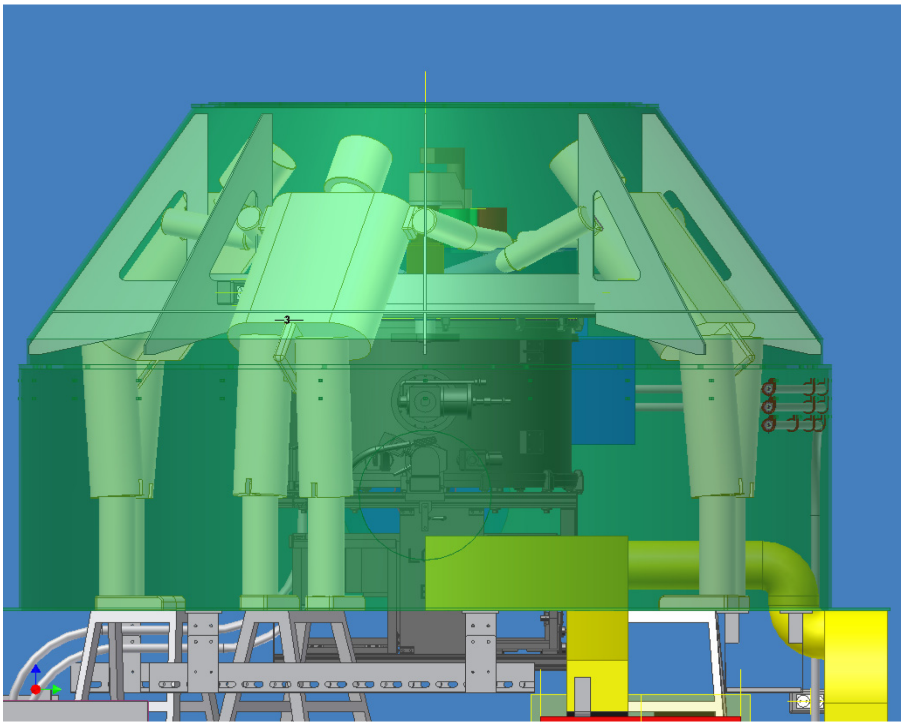


Figure 30: Side view of the access to the compartment C.

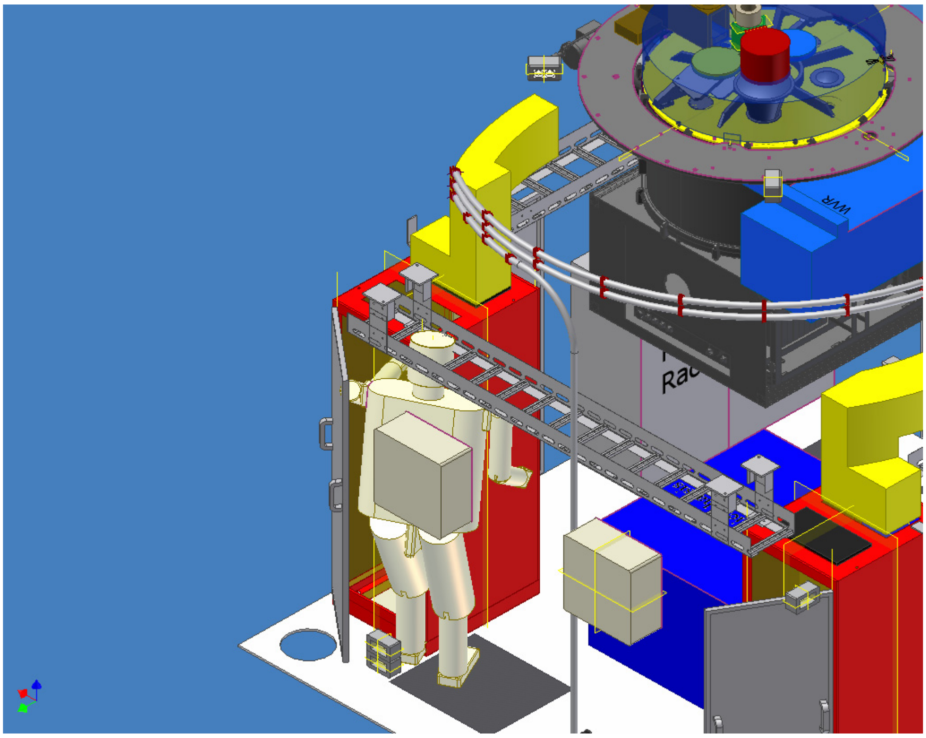


Figure 31: Access to the analog rack.

6.1 Other equipment possibilities - Holography Mini-Rack and NAOJ Rack

The Holography Mini-Rack are planned to be temporarily installed in the receiver cabin when holography measurements are performed. A permanent location might be needed for this rack because later holography tests will be carried out with the digital and analog rack already installed inside the antenna.

Installation of a permanent rack to the ACA Mitsubishi cabin is in discussion. We call this rack as NAOJ rack in this document. This rack might include the power supply of the optical telescope and can provide attachment places for temporary measurement equipment, e.g. spectrum analyzer, synthesizer etc.

The installation possibility of the above two racks was checked in terms of volume as shown in Figures 32 and 33. The size of the Holography Mini-Rack was assumed to be 553 mm in width, 600 mm in depth and 604 mm in height. The size of NAOJ rack was assumed to be 570W x 650D x 1000H mm. As reference, the size of NAOJ rack is based on the drawing of the rack provided from Settsu Metal Industrial Co., Ltd (http://www.settsu.co.jp, model: FDC-1001-650/W). Careful consideration, e.g. EMC, is necessary for selecting NAOJ rack.

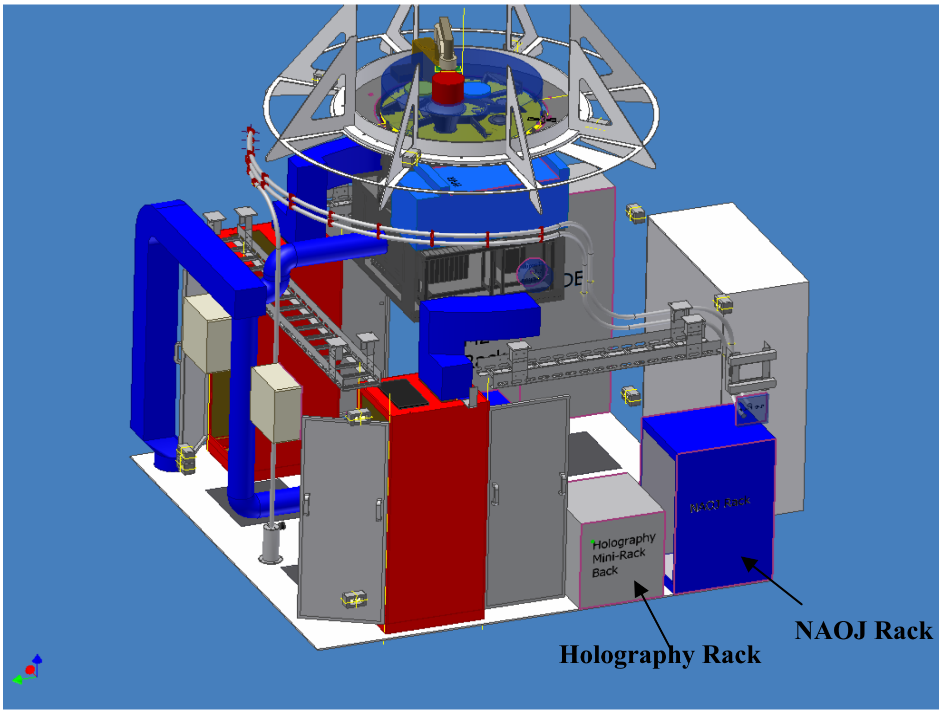


Figure 32: Candidate place for the Holography Mini-Rack and the NAOJ Rack

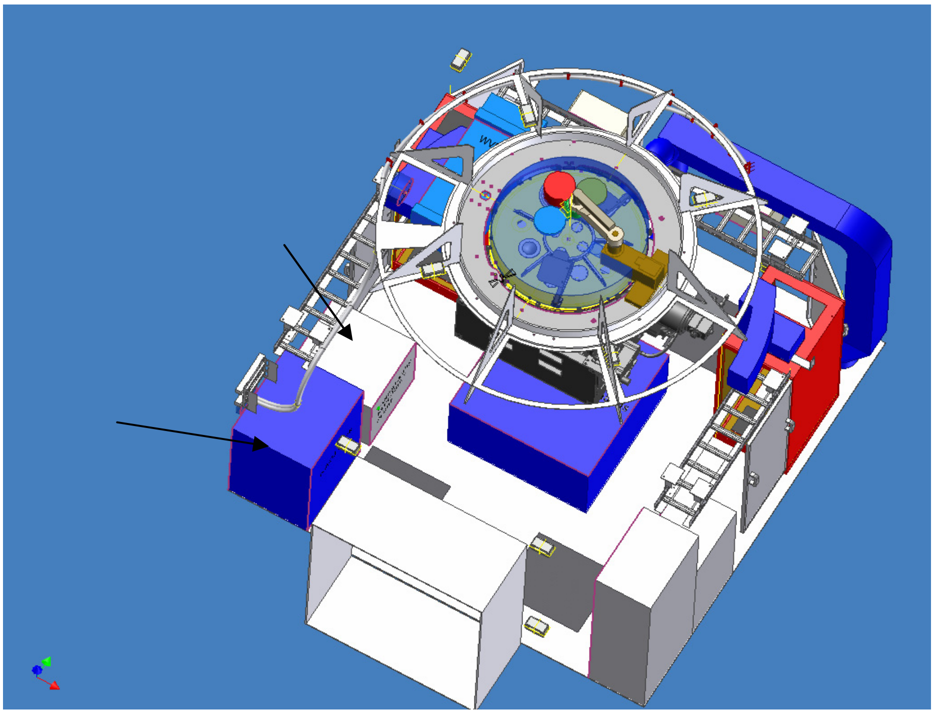


Figure 33: Candidate place for the Holography Mini-Rack and the NAOJ Rack

7 Open points

1 FE

1.1 Implementation of the real mechanical and HVAC interface between the FE aux. electronics chassis and antenna

1.2 Implementation of the real HVAC interface between the FE assembly and antenna in the 3D model

1.3 Cable tray between the FE assembly and FE aux. electronics chassis?

1.4 Implementation of the real WVR in the 3D model

1.5 Replace the FESS against final design

2 BE

2.1 Confirmation of the mechanical interface between the racks and antenna in terms of mounting.

2.2 Implementation of the HVAC interface of the racks in the 3D model

2.3 Clarify if any special protection of the photonic reference fiber routing is necessary

2.4 Detail design of cabinet restraining angle between the racks and the cabin walls if necessary.

3 ANT

3.1 Implementation of the real design of the Feed-through in 3D model

3.2 Implementation of the real design of the torque tube support in 3D model

3.3 Design of the optical pointing telescope and power supply and their interface to antenna

3.4 Routing of the HVAC ducts

4 Others

4.1 Added chapter hazard analysis for layout and safety requirements for handling and mounting in consultation with ALMA safety

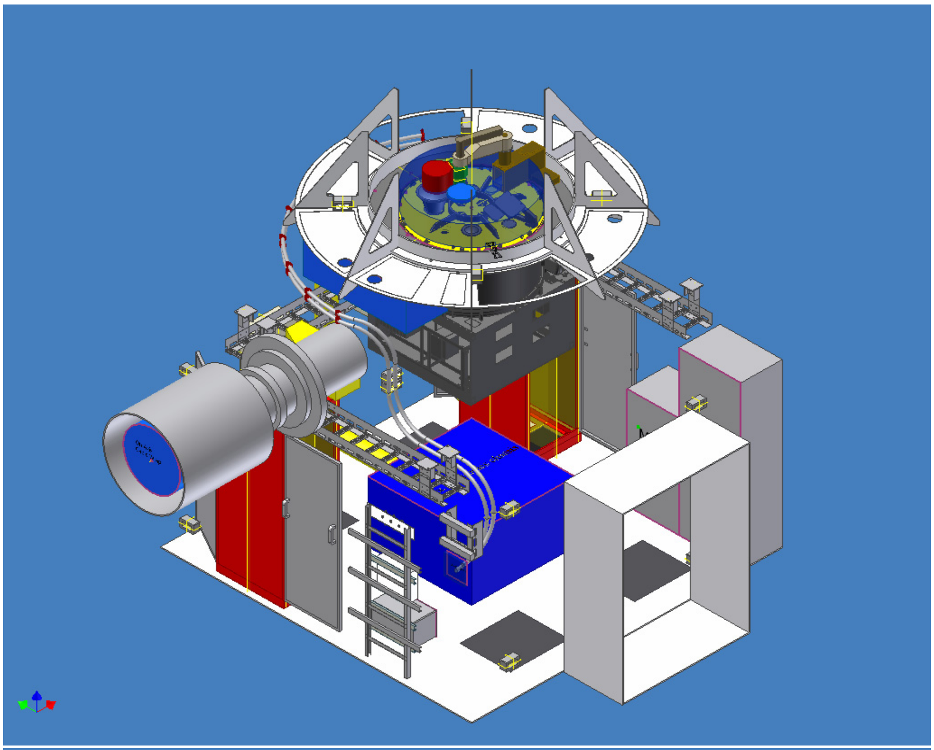
4.2 Interface of Holography mini-rack

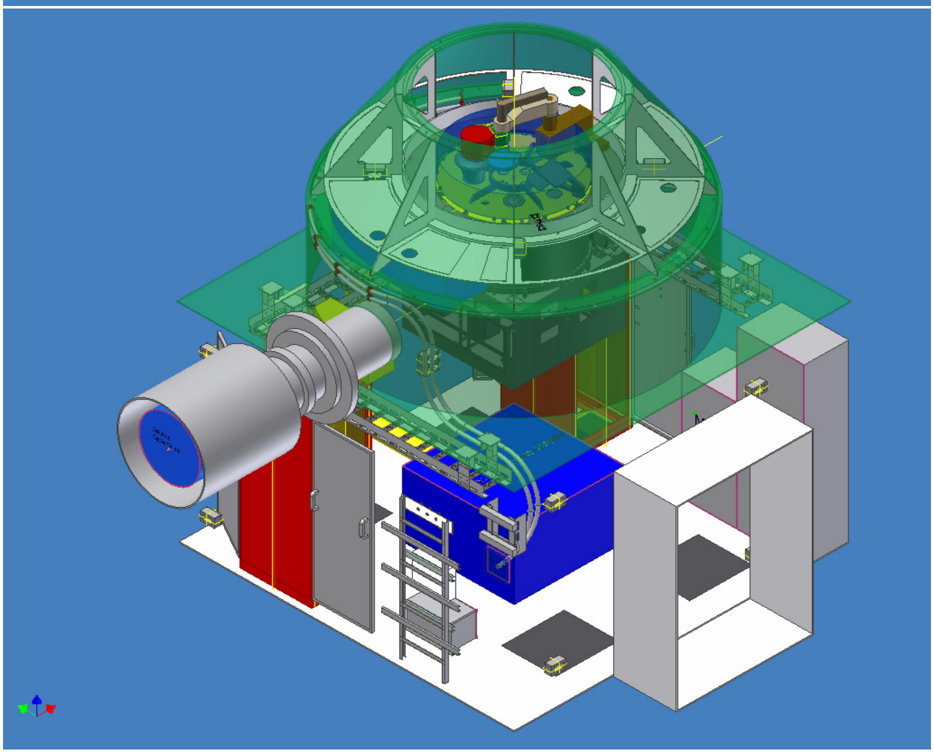
4.3 Design of NAOJ Rack and its interface

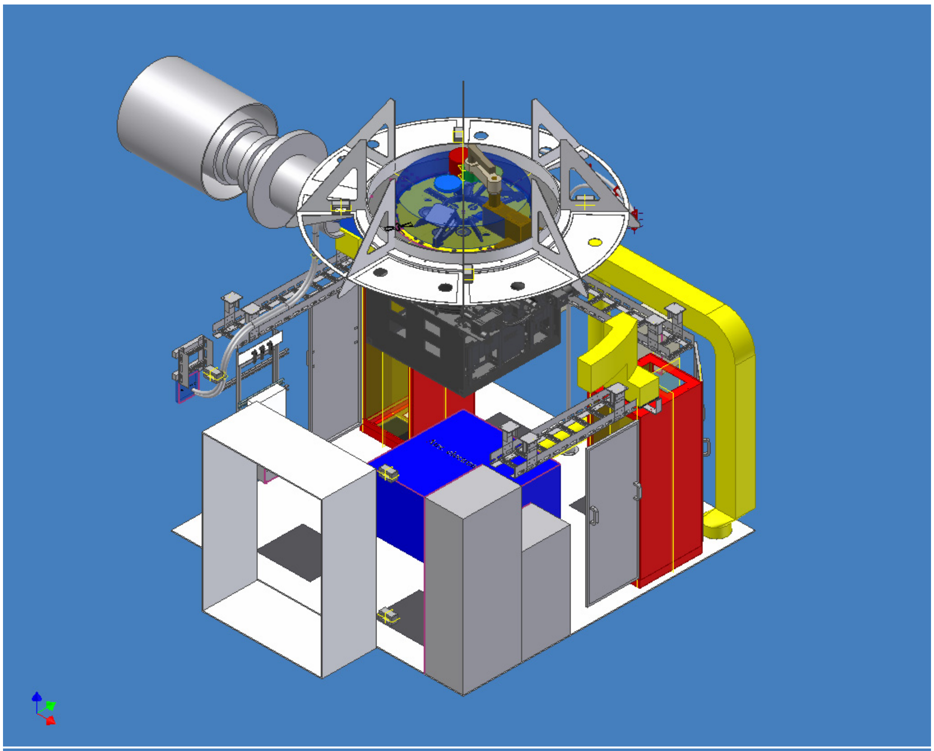
4.4 VoIP phone interface to antenna

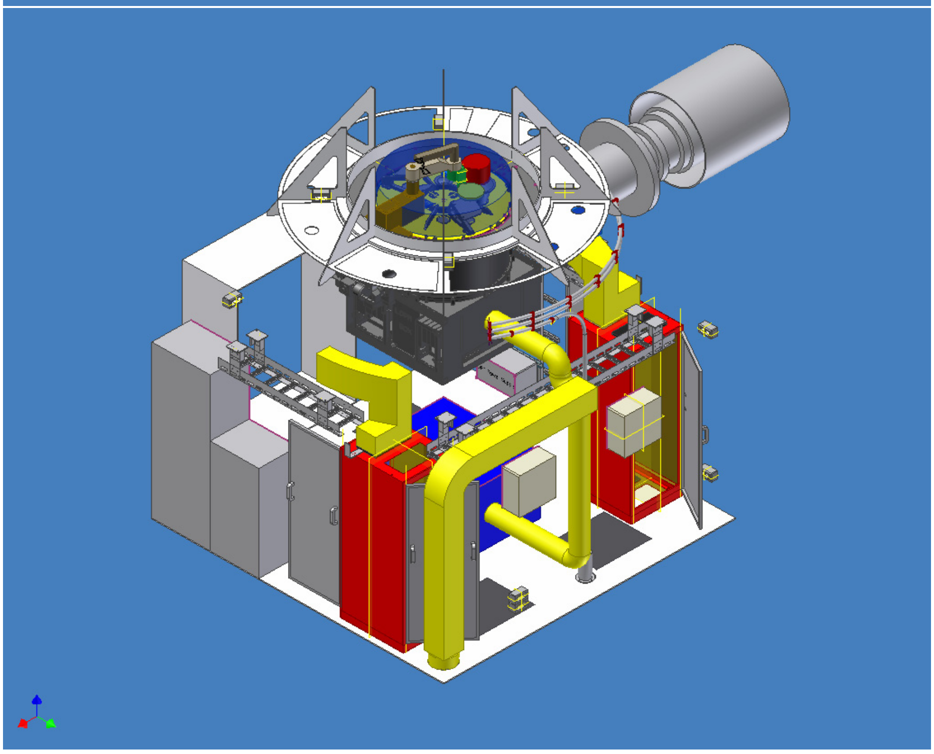
4.5 Version up of the cable tray based on the Mitsubishi proposal

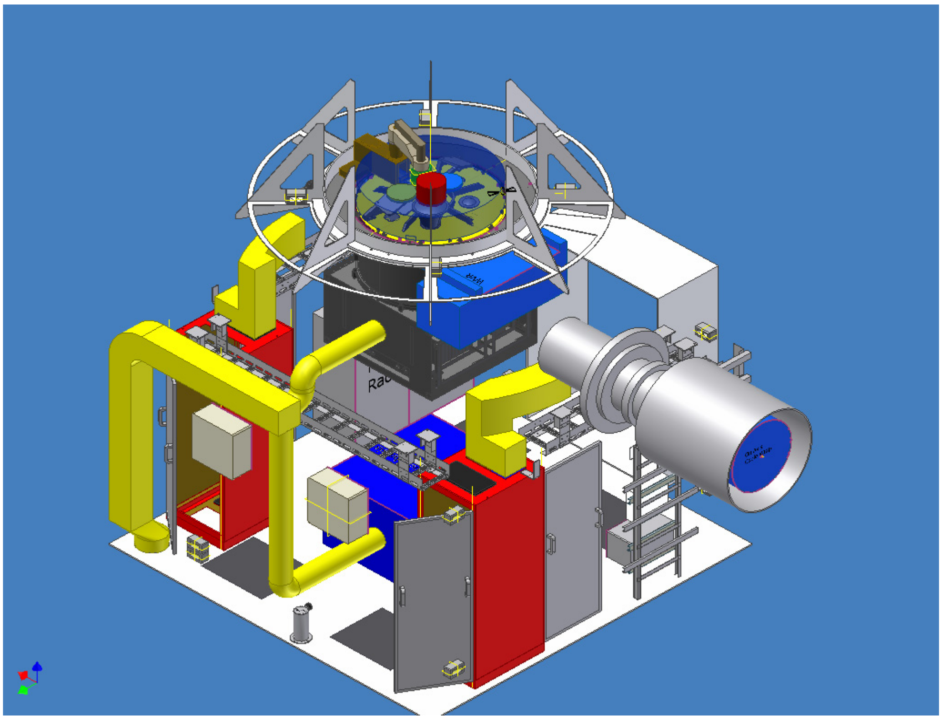
8 Appendix – 3D figures with all equipment

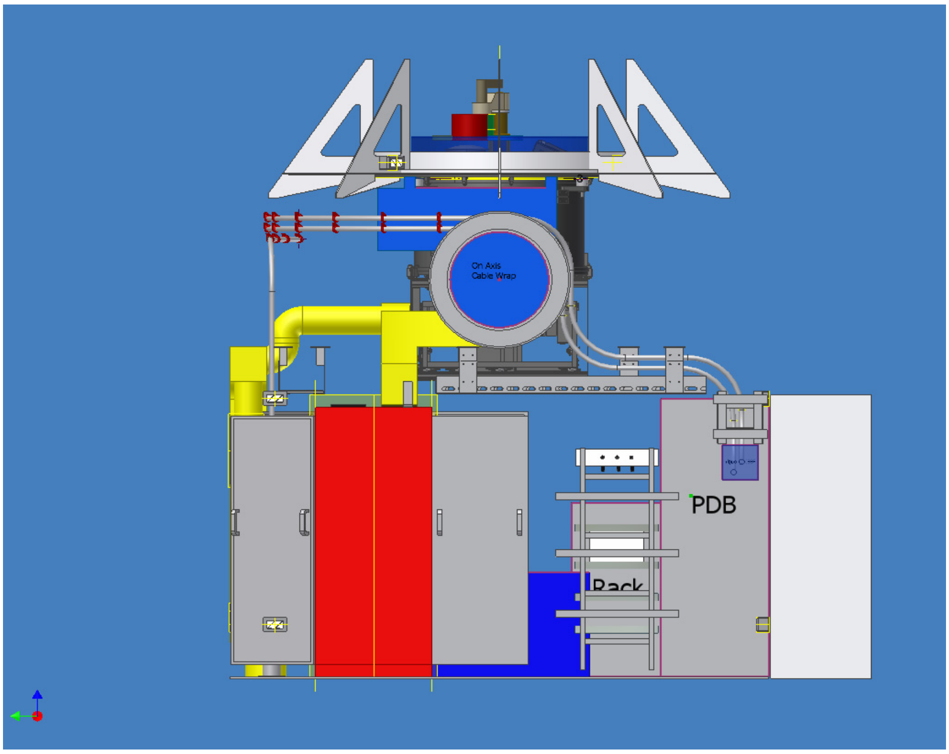


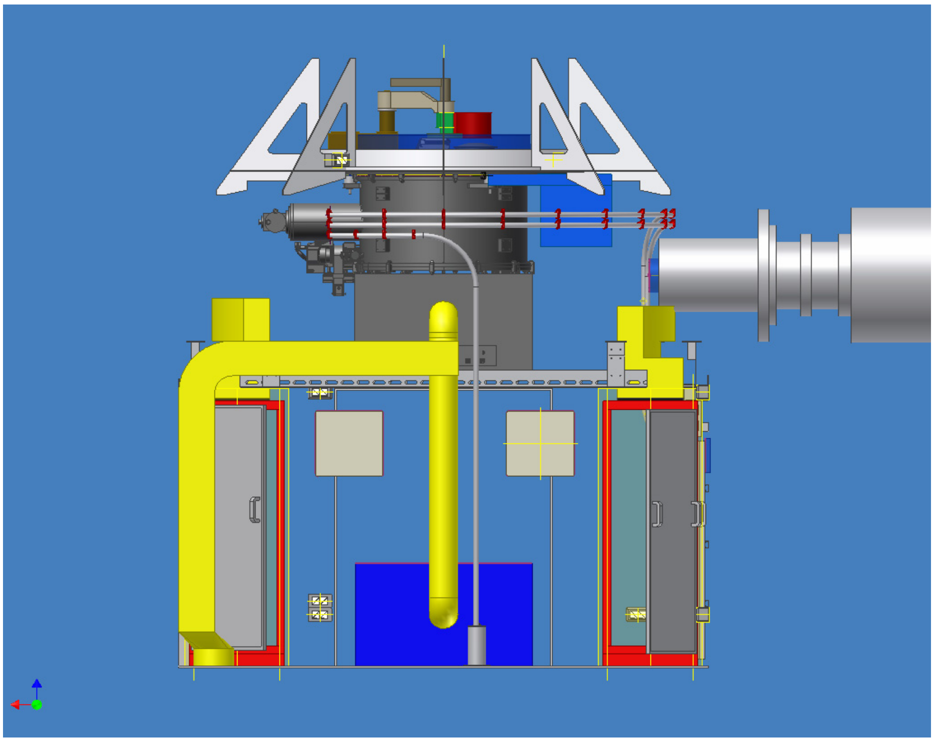


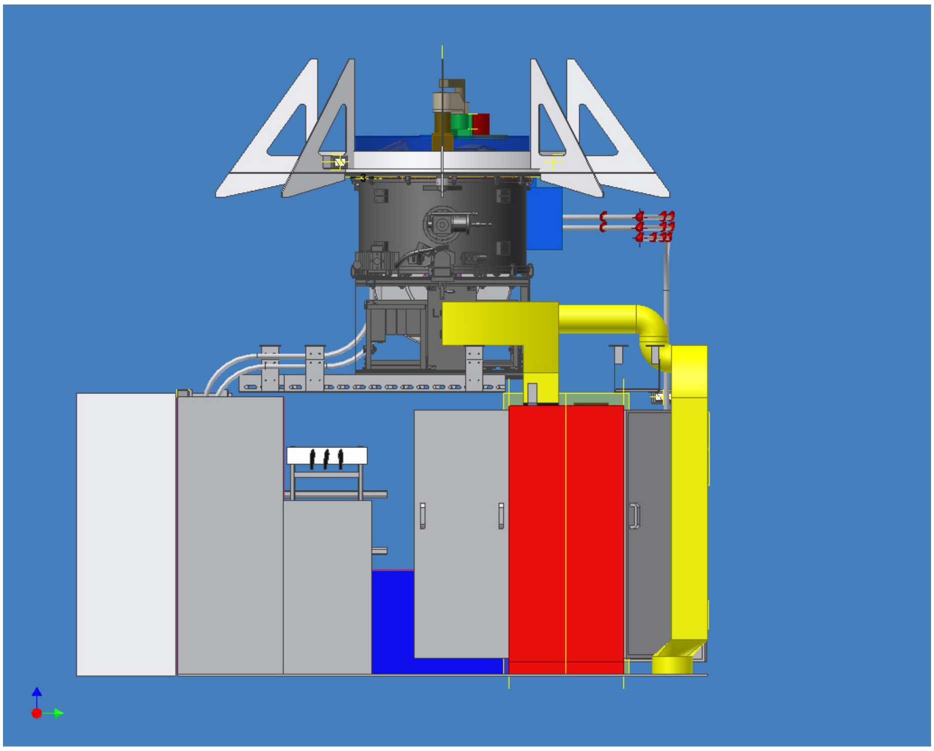


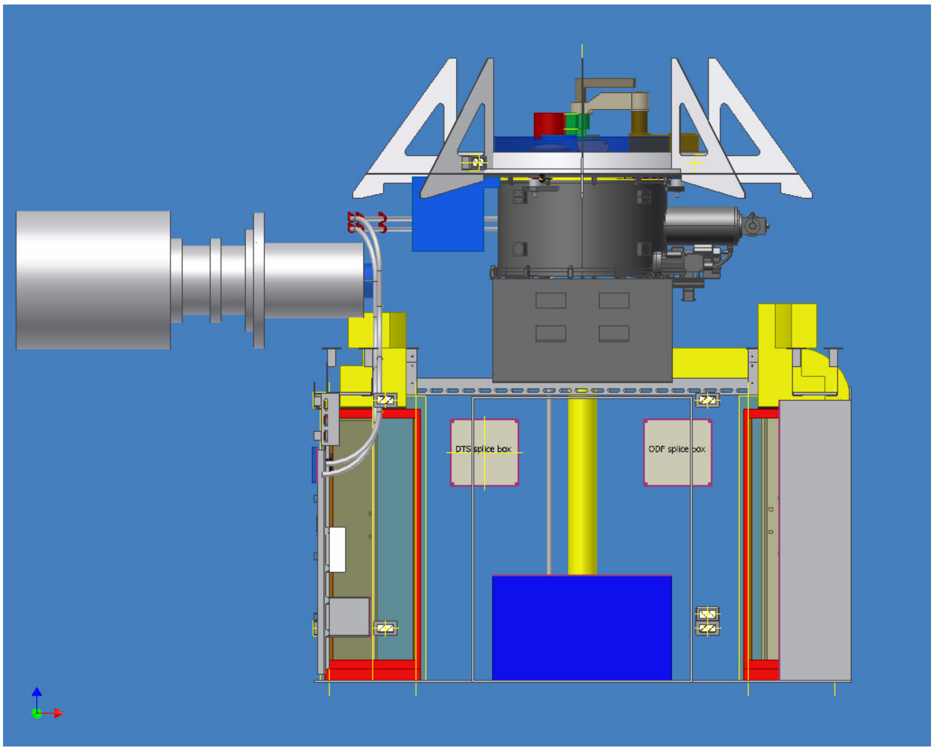


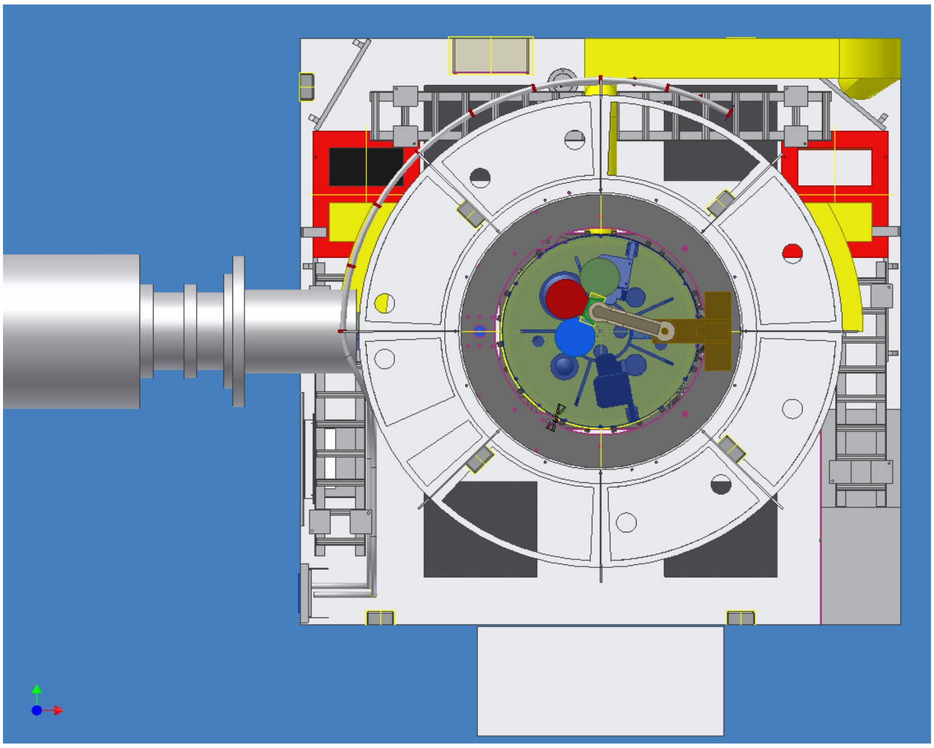


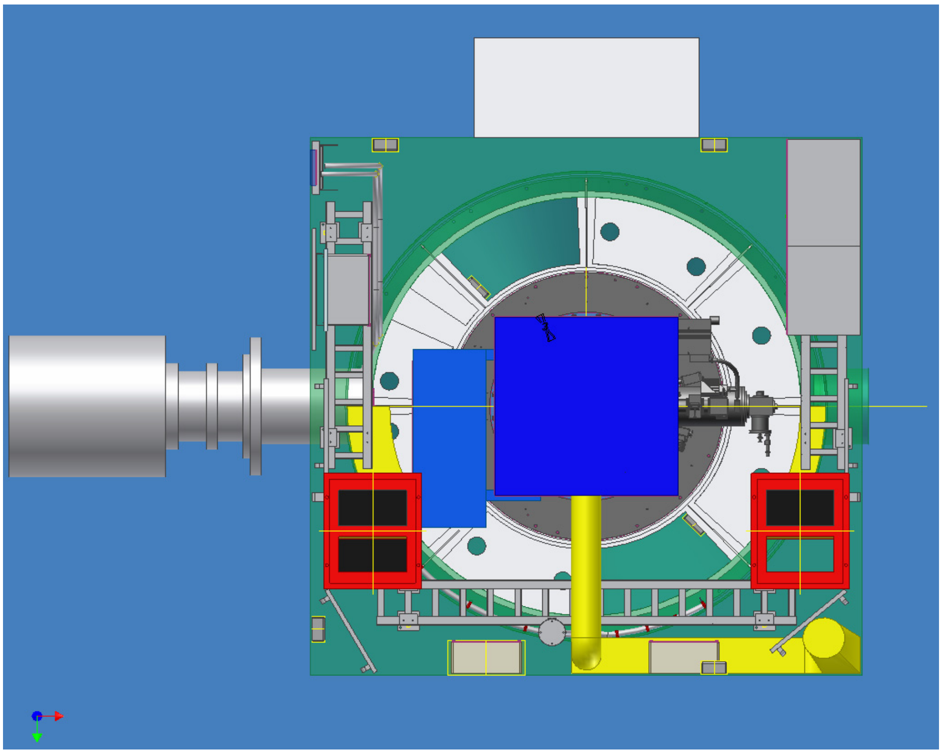

On Axis
Cable Wrap
PDB
Rack






DTS splice box
ODF splice box





9 Appendix - Receiver cabin entrance area and platform layout (TBD)